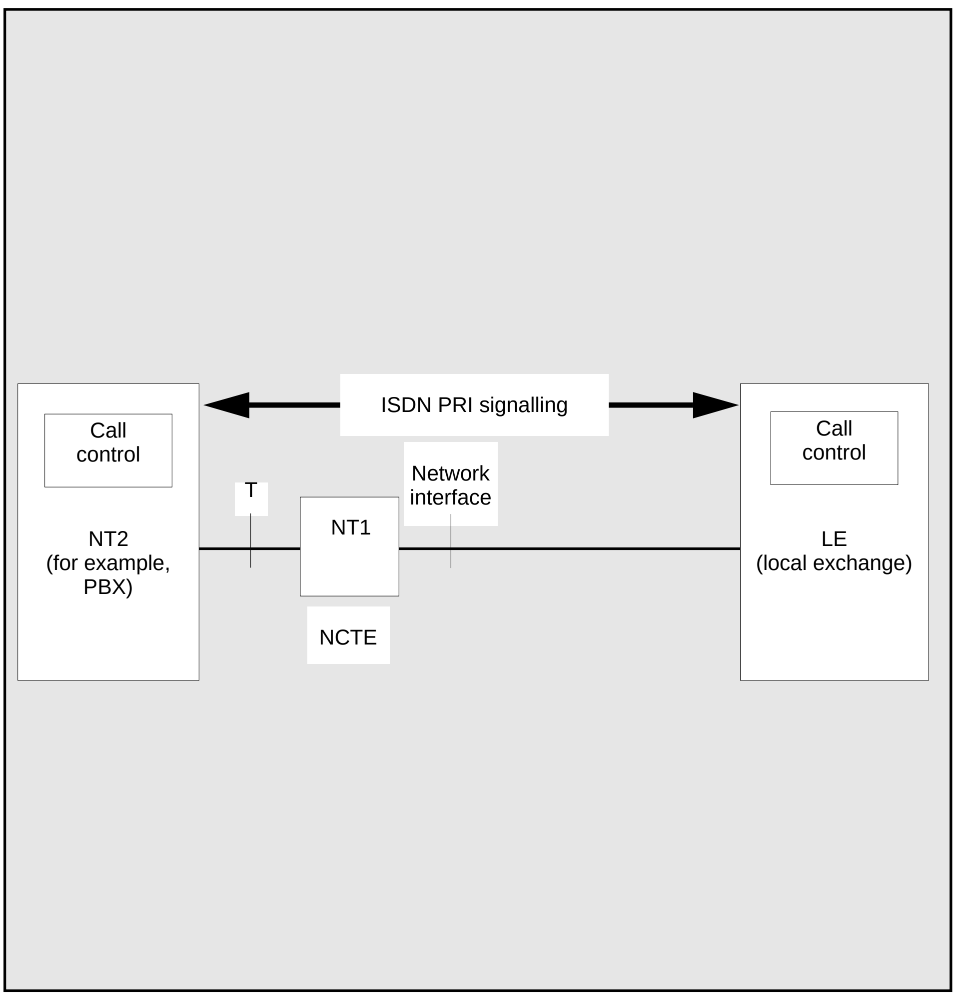
NIS A220-1

Digital Switching Systems

INS Net 1500

Primary Rate Interface Specification

BCS36 and up Standard 05.02 April 95



northern telecom

Digital Switching Systems

INS Net 1500

Primary Rate Interface Specification

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Notice

Revision history

This new standardized version of the DMS-100 INS Net 1500 primary rate interface specification will be used to track all subsequent development of this protocol. This document supersedes a series of documents issued to Northern Telecom's customers. This section is used to track the major factual changes made to this specification.

March, 1995 Version 05.02, BCS36

Chapter 1-1, Overview of PRI, was replaced with the correct information for DMS-100 INS Net 1500 primary rate interface.

Tables 6-49 and 6-50 were modified.

The footers were changed throughout to reflect version 05.02. The date of this reissue was changed to March 1995.

Change bars for version 05.02 have been added to those which were left in for version (Release) 05.01.

October, 1994 Release 05.01, BCS36

The following changes, identified by change bars, have been made:

- **Cause screening**

  A screening facility has been added to map locally significant causes received by the terminating interface to more generalized ones.

- **Inband treatment subscription**

  A capability has been added to provide inband treatment for calls originating on a PRI interface.

- Minor editorial changes.

  Note:

Change bars have been manufactured for figures, and must be deleted separately when required.

January 1994 Version 04.01, BCS35 standard (3rd issue)

All references to direct inward dialing were changed to direct dialing inward. All references to DID were changed to DDI.

Added a row at the bottom of Table 4-5 to discuss the *Progress indicator* information element.

Changed the second paragraph after Figure 4-3 to say that the *Call reference* information element is two octets long instead of one or two octets long.

Added mention of reserved bit in last sentence of first paragraph on page 4-37.

Added reference to Note 1 beside octet 6 and 7 in Figure 4-10.

Added a third note on page 4-51. The note is about digits in the CGN IE that are considered invalid.

Changed Ext. 1 to Ext. 0/1 on octet 3 in Figure 4-16.

Removed mention of bit 0 from D-channel indicator, and bits 0 and 1 from Information channel selection in Figure 4-17.

Added a note on page 4-68. The note gives the maximum number of digits that may be included in the *Keypad facility* information element.

Added a note on page 4-72. The note says that the network will reject any received *Progress indicator* value other than “#2 Destination address in non-ISDN.”

Clarified Note 2 in Figure 4-24.

Removed the paragraph below the first Note 3 in Figure 6-6.

Corrected cause values in Table 6-50.

August 1992 Release 3, BCS 34 standard version (2nd issue)

Change 2nd sublist item in Section 2, Layer 1, Chapter 2-4, Para 4.4, pg 2-15. Polynomial coefficients reported in wrong order.

Added cross reference to Table 3-4 in first paragraph of Section 3, Layer 2, Chapter 3-6, Para 6.1, pg 3-57.

Corrected introductory text to *Notify* and *Progress* messages in Section 4, Layer 3, Chapter 4-3, Para 3.1.6 and 3.1.7, pgs 4-18 and 4-19. *Notify* is sent only by user, *Progress* is only sent by network.

Corrected error in Note 1 of paragraph 4.5.12 in Section 4, Layer 3, Chapter 4-4. (Internal should be Interface)

Corrected error in slot map table in Section 4, Layer 3, Chapter 4-4, Para 4.5.12 on pg 4-63. (1554 bits should read 1544 bits).

Added statement that Progress indicator information element #2 could be returned, in addition to #1, when call leaves ISDN environment. See para 5.1.5 in Section 4, Layer 3, Chapter 4-5 on pg 4-78.

Added statement that Progress indicator information element #3 could be returned, in addition to #1, when call enters non-ISDN environment . See para 5.2.5 in Section 4, Layer 3, Chapter 4-5 on pg 4-84.

Rearranged notes in Figure 4-24 in Section 4, Layer 3, Chapter 4-5, Para 5.6.3 on pg 4-96.

Corrected headings for timer values in Table 4-22 in Section 4, Layer 3, Chapter 4-6, Para 6.1 on pg 4-107. Changed timer T309, T310, T316, and T317 defaults from 30, 10, 30, and 20 sec to 90, 180, 120, and 100 seconds, respectively..

Corrected SDL drawing. Section 4, Layer 3, Chapter 4-7, Figure 4-38 on pg 4-125. Also removed annotation “zz” on other SDLs in this Chapter.

Corrected figure cross reference in Section 5, Supplementary services, Chapter 5-2, para 2.1 on pg 5-5.

Changed wording in 3rd para of Para 2.5.1 in Section 5, Supplementary services, Chapter 5-2 on pg 5-12. (“noting” to “referencing”)

June 1992 Release 2, BCS 34 Standard version (Issue 1)

Issue 2-Standard-Corrections made to Sections 1 through 4 of the specification. In addition, Section 5, “Supplementary services” and Section 6, “Interworking specification” added to the document

March 1992 Release 1, BCS 34 Draft version

Issue 1-Draft-Supersedes document NIS A211-1, version 3 for Layers 1 and 2, and AG2505.AA08 for Layer 3.

Layer 1

Isolated pulse template (Figure 2-3 "Isolated pulse template") updated to reflect the changes in the CCITT Q.920 and Q.921 Recommendations.

Layer 2

Paragraph 3.6.3. A data link layer entity confirms acceptance of a SABME command by transmitting a UA response at the first opportunity. In the previous version, a DM response could also be transmitted. This has been deleted to conform to the CCITT recommendations.

In Table 3-1 "Primitives associated with the data link layer",the primitives *MDL-Assign -Indication* and *MDL-Error-Response* have been added to conform to the CCITT recommendations.The text associated with this table has also been updated to correspond with these additions.

Figure 3-15 "SDL states 1" has been modified to indicate the actions resulting from changes in state as follows:

- Change between state 5 to state 7: LAP established
- Change between state 7 to state 6: Release requested
- Change between state 6 to state 4: LAP release completed.

Layer 3

Paragraph 4.5.9 "Calling party number" has been updated to include information with respect to the numbers of digits (12) that the DMS-100 is able to accept and send in this information element. This is the same number that were previously noted in the Called party number information element.

Paragraph 4.5.12 "Channel identification". The slot map octet numbering scheme has been modified so that it corresponds to the scheme in the CCITT Recommendations.

In paragraph 5.8.6, sub-paragraph "Mandatory information element content error", it has been noted that information elements received with a length in excess of their maximum will be treated as an information element with content error, and a *Status* message with Cause #43 (User information discarded) will be returned.

In paragraph 5.8.7, sub-paragraph "Unrecognized information elements", it has been noted that if more than one unrecognized information element is received, the diagnostic field only includes the identifier of the first such element.

In the next sub-paragraph "Non-mandatory information element content error" it has been noted that information elements received with a length in excess of their maximum will be treated as an information element with content error, and a *Status* message with Cause #43 (User information discarded) will be returned.

In paragraph 5.8.8 "Data link reset", the action in the event of a call being in an active phase has been added.

The procedures in paragraph 5.8.9 "Data link failure" have been updated to include calls that are in an active state.

The procedures in paragraph 5.8.10 "Status enquiry procedure" have been further clarified to match the implementation on the DMS-100.

Timer 317 has been added to the Layer 3 user side list of system parameters in Table 4-24.

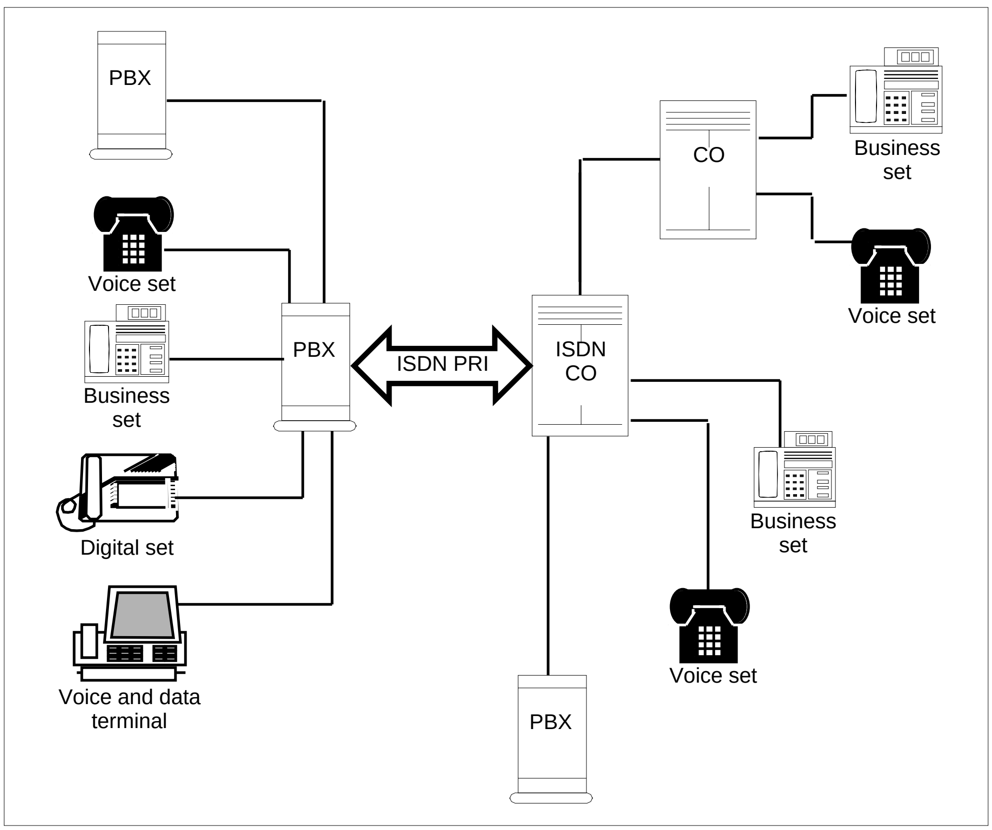
General corrections applied to the Layer 3 SDL diagrams, specifically, Figure 4-62 "Detailed protocol control: Network side (5 of 18)".

Annex E and its information has been moved into the Interworking section.

About this specification

This document specifies the Integrated Services Digital Network (ISDN) Primary Rate Interface (PRI) user-network interface between the Northern Telecom integrated services digital network (ISDN) DMS-100 switch and user equipment.

Figure 1
ISDN PRI service



Scope

This specification describes the distribution of services across a network, highlighting the connectivity between a central office (CO) and a private branch exchange (PBX). This provides the basis for the definition of ISDN call-control for PBX to CO applications and, hence, the signaling protocol requirements for PRI.

In the definition of PRI services, full consideration has been given to the requirements to provide end-to-end service for all users (for example, the need to connect a station user on a PBX to another station user on a CO or Centrex switch).

Structure of document

This specification contains six sections:

- Section 1: Introduction
- Section 2: Physical Layer Specification
- Section 3: Data-Link Layer Specification
- Section 4: Call-Control Signaling Specification
- Section 5: Supplementary Services Specification
- Section 6: Interworking Specification

Service compatibility

The intent of the PRI service definition is to develop the ISDN primary rate signaling protocol so that it conforms, as closely as possible, to the current directions being taken in national and international standards bodies (for instance, TTC and CCITT).

Standards

This specification is a subset of the *NTT INS Net 1500 service interface specification, volumes 1 through 3, dated June 16, 1989*. The standards and specifications with which the various sections of this specification comply are listed below.

- Layer 1 specification
  - NTT INS NET 1500 Service Interface V olume 2, part 2 *Primary rate user-network interface Layer 1 specification (Rev 1 1989)*
  - ANS T1.408, *ISDN primary rate-customer installation metallic interfaces Layer 1 specification (T1E1/89-46R6)*
  - ANS T1.403, *Carrier to customer installation -DS-1 metallic interface specification, 1989*
  - CCITT Recommendation I.431, *Primary rate user-network interface-Layer 1 specification*

- Layer 2 specification
  - NTT INS NET 1500 Service Interface V olume 2, part 3 *Primary rate user-network interface Layer 2 specification (Rev 1 1989)*
  - CCITT Recommendation Q.920(I.440), *ISDN user-network interface data link layer-general aspects*
  - CCITT Recommendation Q.921(I.441), *ISDN user-network interface data link layer specification*
  - ANS T1.602, *ISDN signaling specification for application at the user-network interface- Layer 2 specification*
  - CCITT Recommendation X.25, *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*
- Layer 3 specification
  - NTT INS NET 1500 Service Interface V olume 3 *Primary rate user-network interface Layer 3 specification (Rev 1 1989)*
  - CCITT Recommendation Q.930(I.450), *ISDN user-network interface layer 3-general aspects*
  - CCITT Recommendation Q.931(I.451), *ISDN user-network interface Layer 3-specification*
  - ANS T1.607, *Layer 3 signalling specification for circuit switched bearer service*
- Supplementary services specification
  - NTT INS NET 1500 Service Interface V olume 3 *Primary rate user-network interface Layer 3 specification (Rev 1 1989)*

Contents

Section 1: Introduction

Chapter 1-1: Overview of PRI services

This chapter provides an overview of the primary rate interface (PRI) in the telecommunications network, and describes how PRI interworks with other network facilities.

1.1 PRI structure

The basic PRI structure consists of 23 B-channels and a D-channel. Each 64 kbit/s B-channel carries user information such as voice calls or circuit switched data. The D-channel is a 64 kbit/s channel that is used to carry the control or signaling information.

The transmission rate of a 23B+D PRI is 1544 kbit/s which is equivalent to a DS-1. A D-channel may also support the signaling requirements of B-channels on other DS-1s in addition to the B-channels located on the same DS-1 as the D-channel. This configuration is called non-facility associated signaling. DMS-100 supports a maximum PRI structure that consists of 479 B-channels plus one D-channel. The one D-channel provides the signaling for all the B-channels.

1.2 Network configurations

PRI plays two roles in a private branch exchange (PBX) to central office (CO) connection:

- PRI provides access services in a switched telephone network.

  This definition of a switched telephone network is very broad. It may consist of private and public networks that may be owned by more than one utility.
- PRI distributes services in a logical private network between PBXs with optional networking with central exchange (Centrex) users. From this perspective, the PBX is thought of as a network node like a CO.

  Services are distributed over PRI the same way that they are distributed within the public network, for instance, between COs over CCS7.

For a summary of these functions, see Figure 1-1 and Figure 1-2.

Figure 1-1
PRI provides access to the switched telephone network

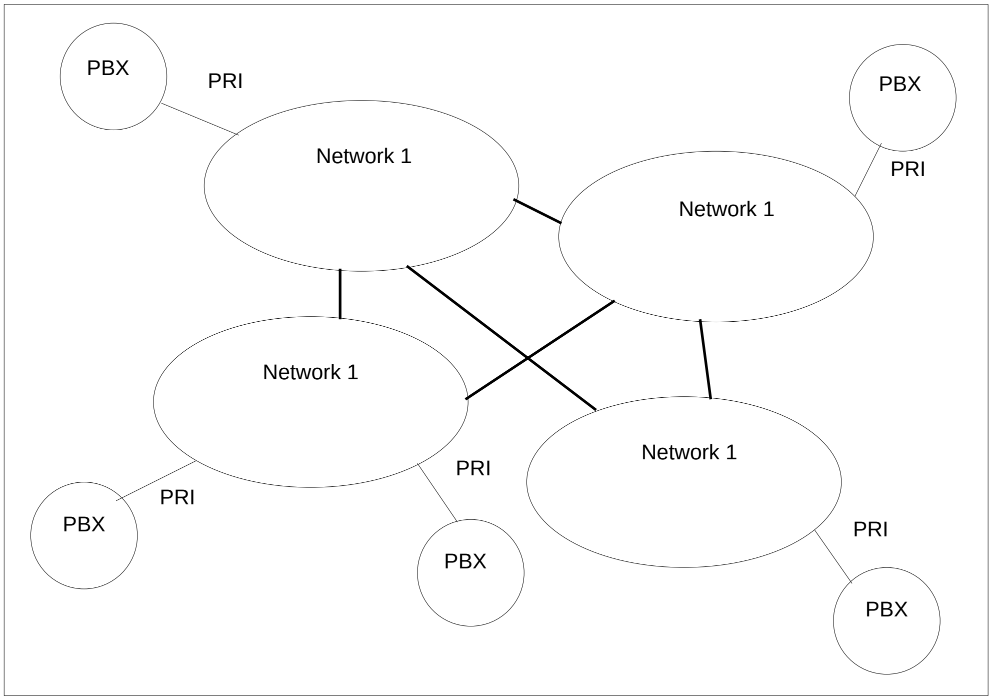
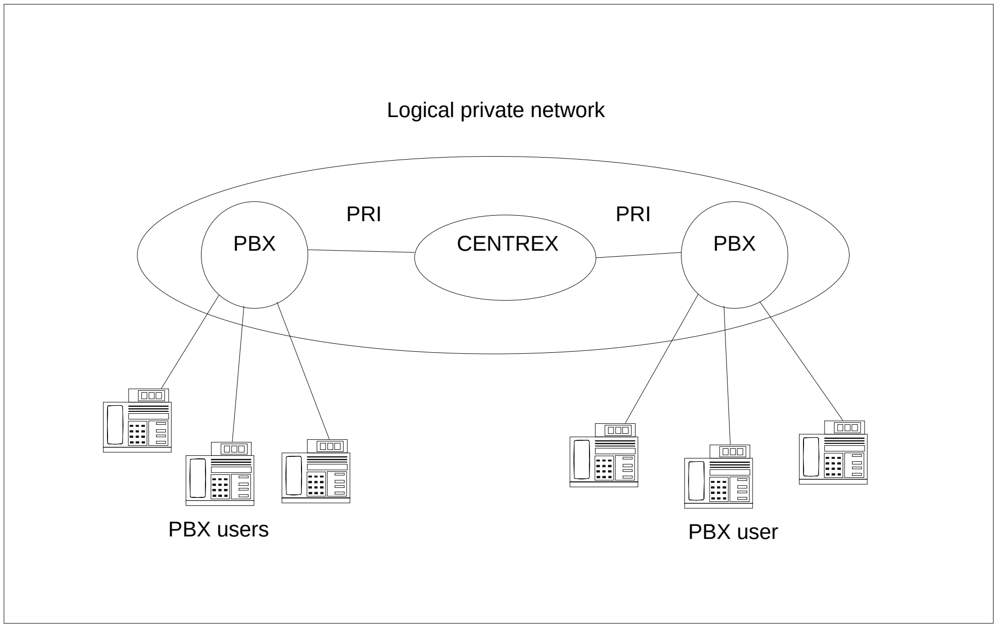


Figure 1-2
PRI distributes services in a private network



1.3 Description of basic connection service

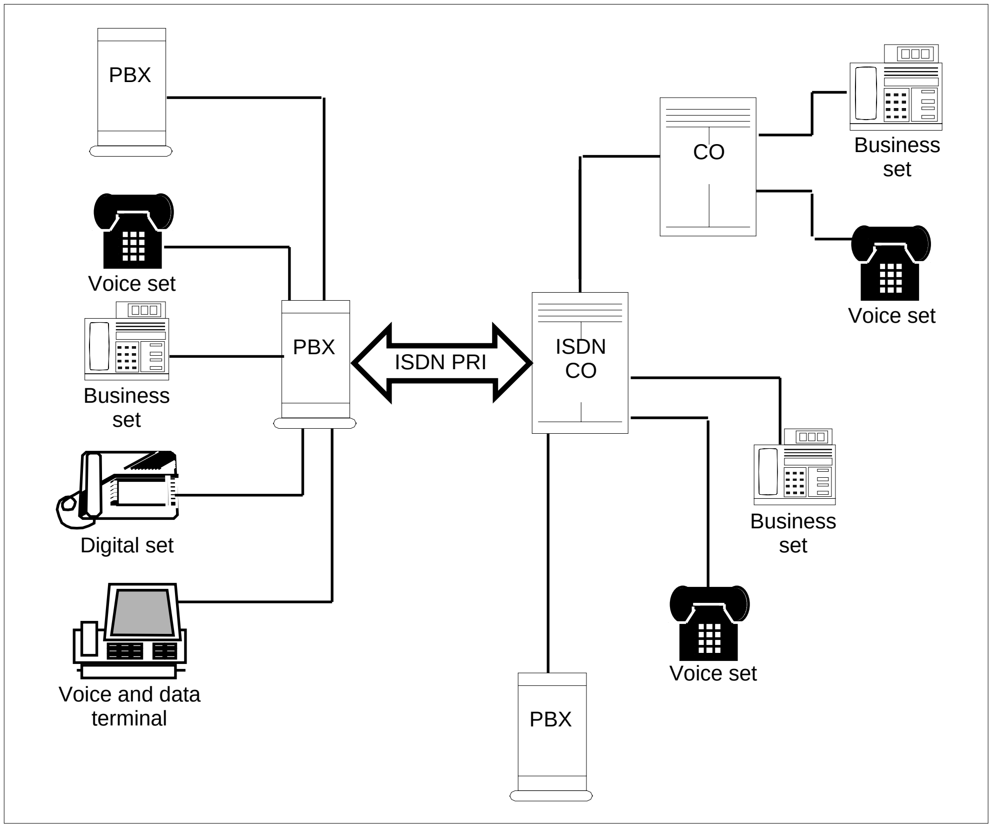
The objective of the basic connection service is to connect voice or data terminals similar to current networks. This requires interworking between

- T1 analog and digital trunks with conventional A/B signaling
- CCS7 trunks
- ISDN PRI trunks

1.3.1 Voice terminal connectivity

Figure 1-3 shows the end-to-end connection of voice terminals in a typical ISDN network.

Figure 1-3
Basic connection service: voice terminal connectivity



In an ISDN network, end-to-end voice communication circuits need to have a specific bearer service.The default bearer service that is used for interworking with a switched telephone network is the speech bearer service. A 3.1 kHz audio bearer service may also be used.

The speech bearer service has the following characteristics:

- information transfer rate of 64 kbit/s
- information transfer capability of speech
- user information Layer 1 protocol of μ-law speech

The 3.1 kHz audio bearer service has the following characteristics:

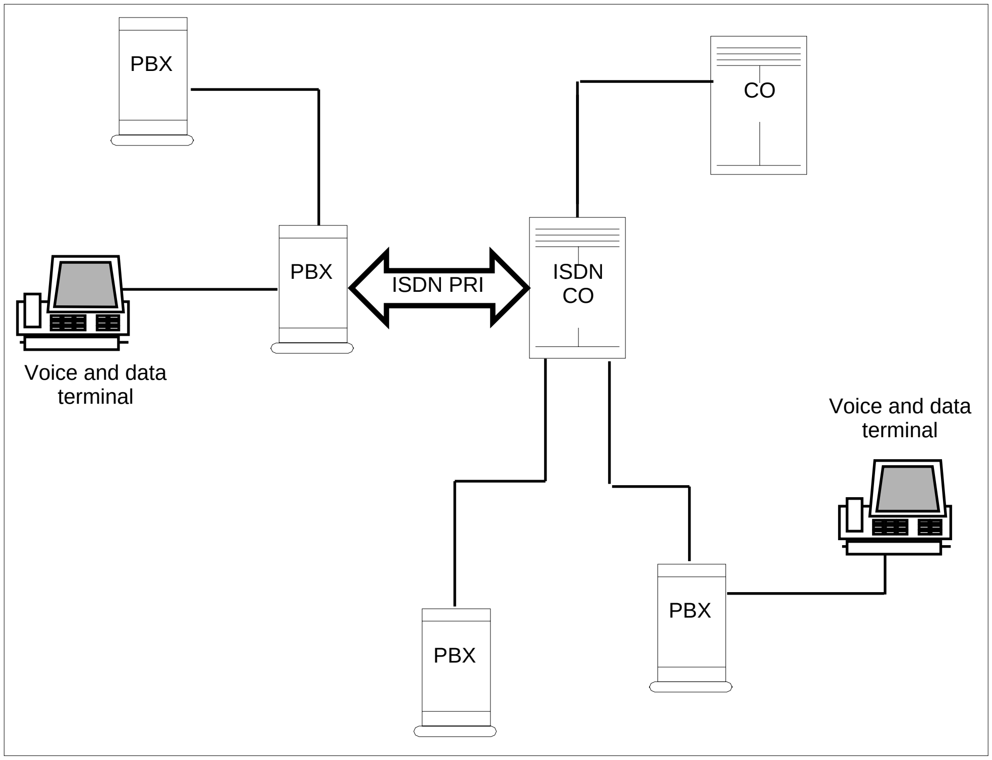
- information transfer rate of 64 kbit/s
  This is the transfer rate of raw information.
- information transfer capability of 3.1 kHz audio
- user information layer 1 protocol of μ-law speech
  This specifies that the voice encoding is in accordance with the CCITT recommendation G.711 for μ-law speech.

The 3.1 kHz audio bearer service can also be used to support voice band (analog) data.

1.3.2 Digital data terminal connectivity

Figure 1-4 shows the end-to-end connection of digital data terminals in a typical ISDN network.

Figure 1-4
Basic connection service: data terminal connectivity



In an ISDN network, end-to-end digital data terminal circuits need to have a specific bearer service.The ISDN bearer service has the following characteristics:

- information transfer rate of 64 kbit/s
- information transfer capability (unrestricted digital information)
  This allows the digital data to be routed over facilities that support the B8ZS transmission scheme. This transmission scheme does not require zero code suppression and it allows 64 kbit/s clear data to be transmitted.

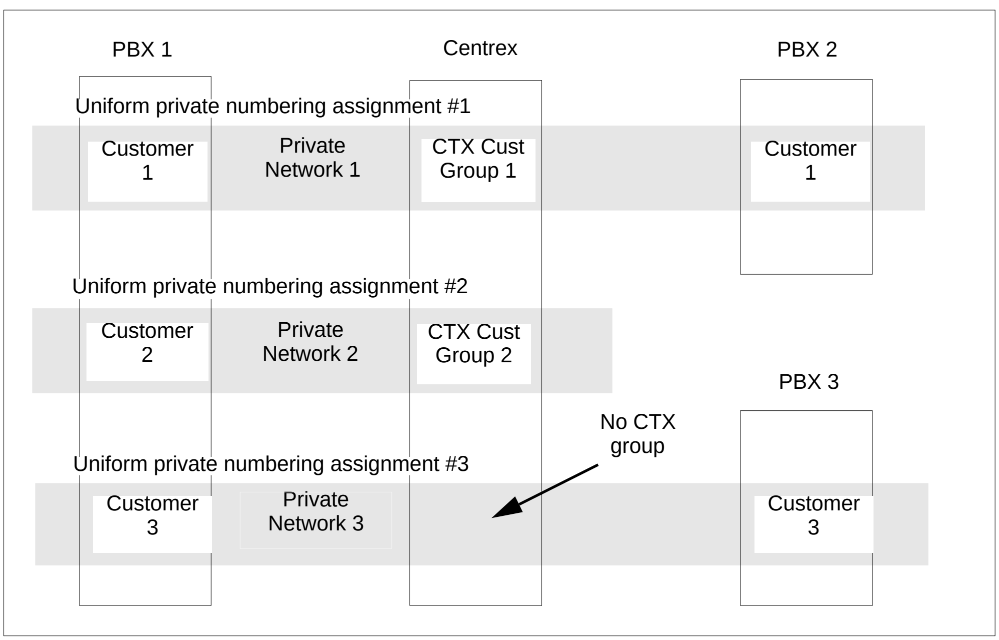
  When “unrestricted digital information” is entered in the information transfer capability field, the user information layer 1 protocol and user rate may be omitted.
- user information layer 1 protocol of CCITT rate adaption
  This parameter specifies that the 56 kbit/s data rate adaption scheme used is a CCITT standard (CCITT recommendations I.463) which sets every 8th bit to “1”.

  The advantage of setting the 8th bit to “1” is that it meets the current ZCS “1”s density requirements, and allows transmission of the user’s data over trunks still using in-band A/B bit signaling (which robs bit 8).

1.3.3 Numbering plans

PBX users are allocated numbers conforming to a private numbering plan. Any PBX may support multiple customers and multiple private networks, as shown by the example in Figure 1-5.

Figure 1-5
Multiple private networks on a PBX and Centrex



Note: Until standards have been agreed, all customers sharing a PBX must have their own PRIs. In the future, ISDN PRI will require a customer to indicate the customers unique private network number assignment set. This would allow two customers to have the same number assignments without causing a conflict. In the future, sharing of the PRI may be done through Business Group service, which is currently being defined in standards bodies.

1.3.4 Comparison between dialing plan and numbering plan

There is a clear distinction between dialing plans and numbering plans. The following definitions will be used throughout this specification:

Dialing plan

A dialing plan defines the digits that a terminal user should dial or press to establish a connection or to access a service on a line interface. Dialing plans may include prefix digits and special numbers. Private dialing plans, which may be used by PBX and Centrex users, are not subject to standardization.

Numbering plan

A numbering plan defines the network address of a user and is used for routing within the network. Numbering plans are internationally standardized (for instance, CCITT Recommendation E.164).

Figure 1-6
Comparison of dialing plan and numbering plan

On a typical terminal connected to a PBX, the user dials the digits,
55095.

The PBX recognizes the customer as a member of Group 1. The Group 1 translation table indicates that the initial 5 in the number should be replaced with the following digits:
613-763

Thus the complete dialing number that is used to route the call is:
613-763-5095

In ISDN, dialing plan digits are carried within information elements. These digits request the functions implied by the digits dialed which are not part of the numbering plan. In most cases, users will access the basic connection service by using a dialing plan which contains additional information or special numbers that are not part of the numbering plan.

1.3.5 Connection types

The basic connection service provides two types of connections:

Permanent connections

Permanent connections are nailed-up or provisioned connections between a B-channel on a PRI and a trunk or a line interface (including a B-channel on a PRI). The capability of the permanent connection to carry the different bearer services is dependent on the information transfer capability of the connections.

In essence, a permanent B-channel may be described by the same characteristics as a switched B-channel, except they are provisioned by service order.

To establish a permanent connection, the address associated with the connection may not uniquely identify the endpoints of the connection and further qualification is needed (for example, local switch loop numbers and B-channel number in ISDN PRI). No ISDN D-channel signaling is required to set up these circuits as they are provisioned by the service order process.

The addresses associated with permanent connections should have a single appearance.

Switched connections

Switched connections are set up under control of the user. The user provides the appropriate call establishment information in a connection request (that is, the user specifies a destination address, the bearer service, and the B-channel for each call).

1.3.6 Progress reporting and cut-through

The user interface to terminals is placed as close as possible to the user. For example, ISDN terminals receive out-of-band signals and generate the appropriate displays, audible tones, and announcements.

For other terminals, the user interface is generated from the local switch. This allows the local user interfaces to be consistent. For example, since the local switch creates the custom user interface, if a call is made to a foreign country, the local switch would receive the out-of-band messages and translate them to locally generated tones. For example, Japanese announcements and Japanese displays would be generated for the called user in Japan, no matter where the call originated.

Some exceptions to the rule above have been made to permit interworking with non-ISDN network trunks and to overcome engineering problems. These special cases are:

- When a call is set up between an ISDN network and a non-ISDN network, call-progress signaling reverts to “far-end” in-band signaling (for example, busy tone, audible ringing, and announcements). A progress report is always sent back to the originating party indicating that interworking with non-ISDN facilities has occurred.
- In order to provide consistent operation to non-ISDN terminals, the local switch translates ISDN messages and progress reports to the appropriate protocol on the terminal access interface. For example, it will translate an ISDN *Disconnect* message to a busy tone. The general rule in an ISDN network is that, as a call progresses through the ISDN, the circuit is cut through in both directions at the originating and intermediate switches. Cut-through at the terminating switch to the terminating access interface occurs when the called terminal indicates it is connected to (accepts) the call. This introduces a short clipping delay as there is a race condition between the connected indication arriving and being acted upon in the D-channel and the user talking on the B-channel.

  However, a major clipping problem is introduced if near-end audible “ringback” is generated on receipt of the D-channel *Alerting* message. The circuit cannot be cut-through to the far-end if the near-end supplies a ringback generator. The *Connect* message has to be forwarded across the ISDN network, to switch out the ringback generator, before cut-through is achieved. For this reason, audible ringback, when needed, will always be generated in-band from the far end.

To allow the generation of tones and announcements from the terminating switch, the intermediate switches cut through the B-channel on successful B-channel selection.

1.3.7 Conversion of a dialing plan into a network numbering plan

PBX users, and Centrex or CO users that have simple terminals supply routing and destination information to the basic connection service by supplying digit strings in conformance to the network dialing plan. The dialed digits must be converted into information elements in a *Setup* message for routing and conveyance through the ISDN network. This conversion is done by the originating switch (PBX or CO) supporting the non-ISDN user access interface.

The following fields are data filled in the PBX to allow the user to define how the dialing plan is converted into ISDN information:

- Number, address, directory number: a string of digits conforming to a standardized numbering plan or a private numbering plan. In this release, only private numbering plan digits are acceptable.

- Numbering plan identification: determines whether the numbering plan used is a private or a standardized numbering plan. In this release, only a private numbering plan is acceptable.
- Type of number: determines whether the number is the subscriber number, a number represented in a standard numbering plan, or an unknown number. In this release, only unknown numbers are acceptable.

The following rules are used by the network for calls received from PRI users to determine numbering plan and routing information. The PRI user should encode the *Setup* message for outgoing calls according to these requirements for desired services. Customer-specific dialing plans to access private facilities must be arranged with the network by subscription.

Digit strings are encoded in the number digits field of the *Called party number* information element. Details of the encoding of the referenced information elements can be found in the Call Control Signaling section of this specification.

1.3.8 Channel allocation

Where there is a choice of channels to be allocated, the equipment routing the call (for example, the terminal or switch) allocates the outgoing channel. That is, the PBX usually allocates channels on calls from the PBX to the CO, and the CO allocates channels on calls from the CO to the PBX. The DMS-100 supports channel negotiation and, hence, the outgoing channel selected by the DMS-100 CO may be changed by the PBX. If this channel is unacceptable to the DMS-100-due, for instance, to the channel being busy-the call is dropped.

In the event of “glare” (that is, channel contention) one end of the channel or trunk must be preconfigured as the “master”. The master is set to win all contentions.

To minimize the possibility of glare, the “master” should allocate channels in ascending order and the “slave” in descending order. In this specification, the CO is always the “master”.

1.3.9 Basic connection service scenarios

Figure 1-7 through Figure 1-14 show how the basic connection service and progress reporting works. Scenarios include PRI connections with both ISDN and non-ISDN line interfaces.

Figure 1-7
INS-1500 to ANSI7+ ISUP interworking

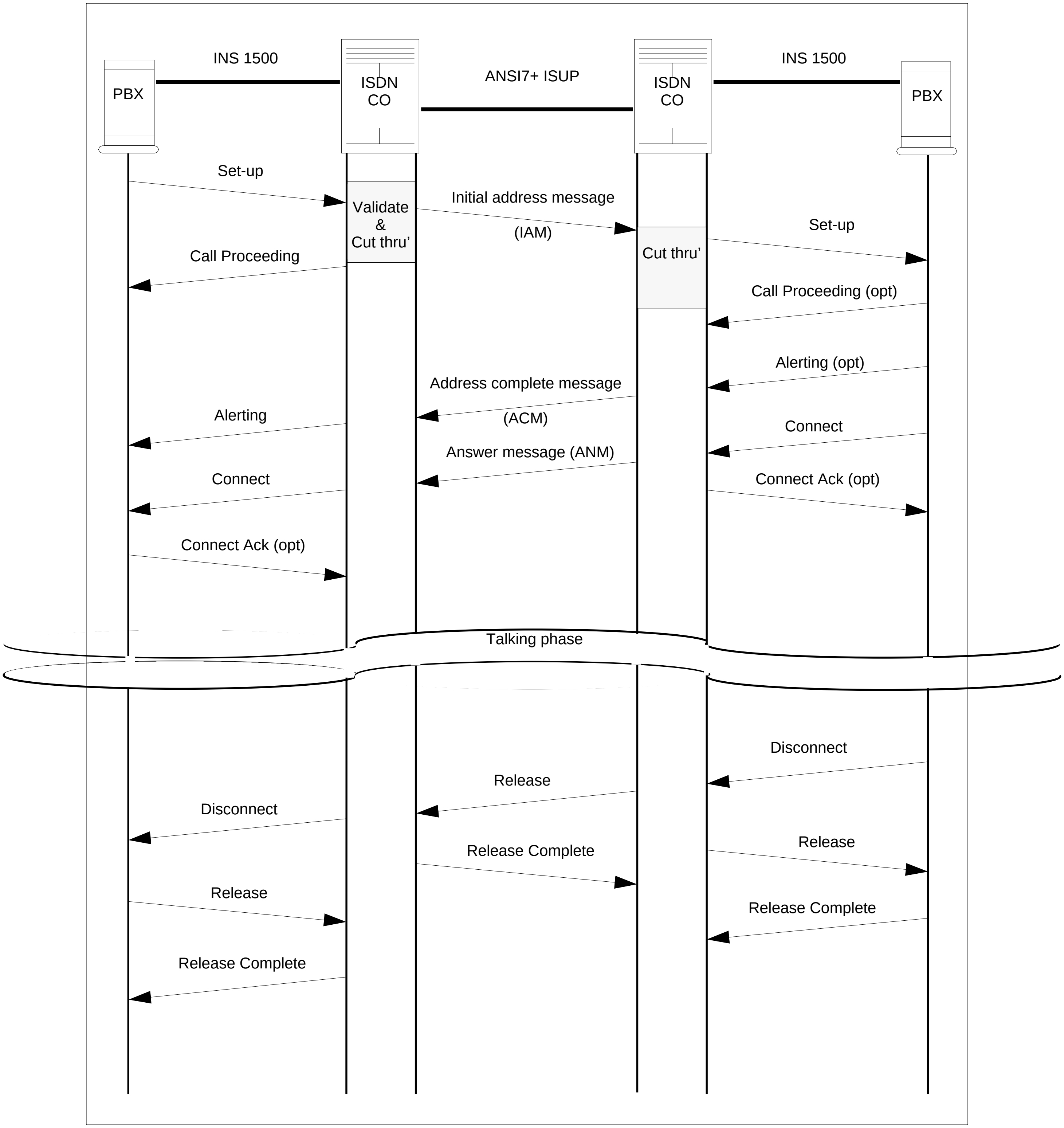


Figure 1-8
INS-1500 to ANSI7+ ISUP to PTS interworking

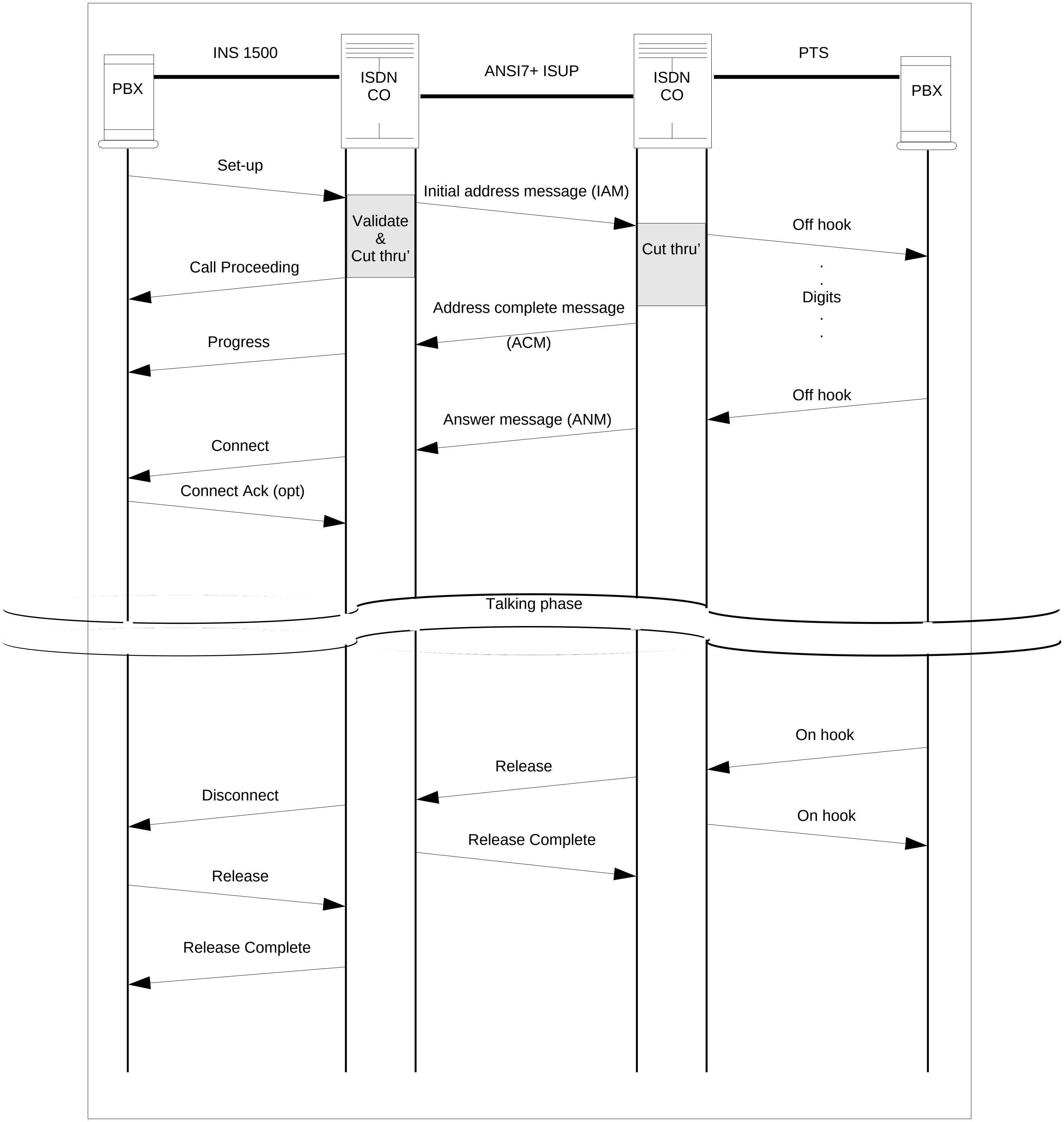


Figure 1-9
PTS to ANSI7+ ISUP to INS-1500 interworking

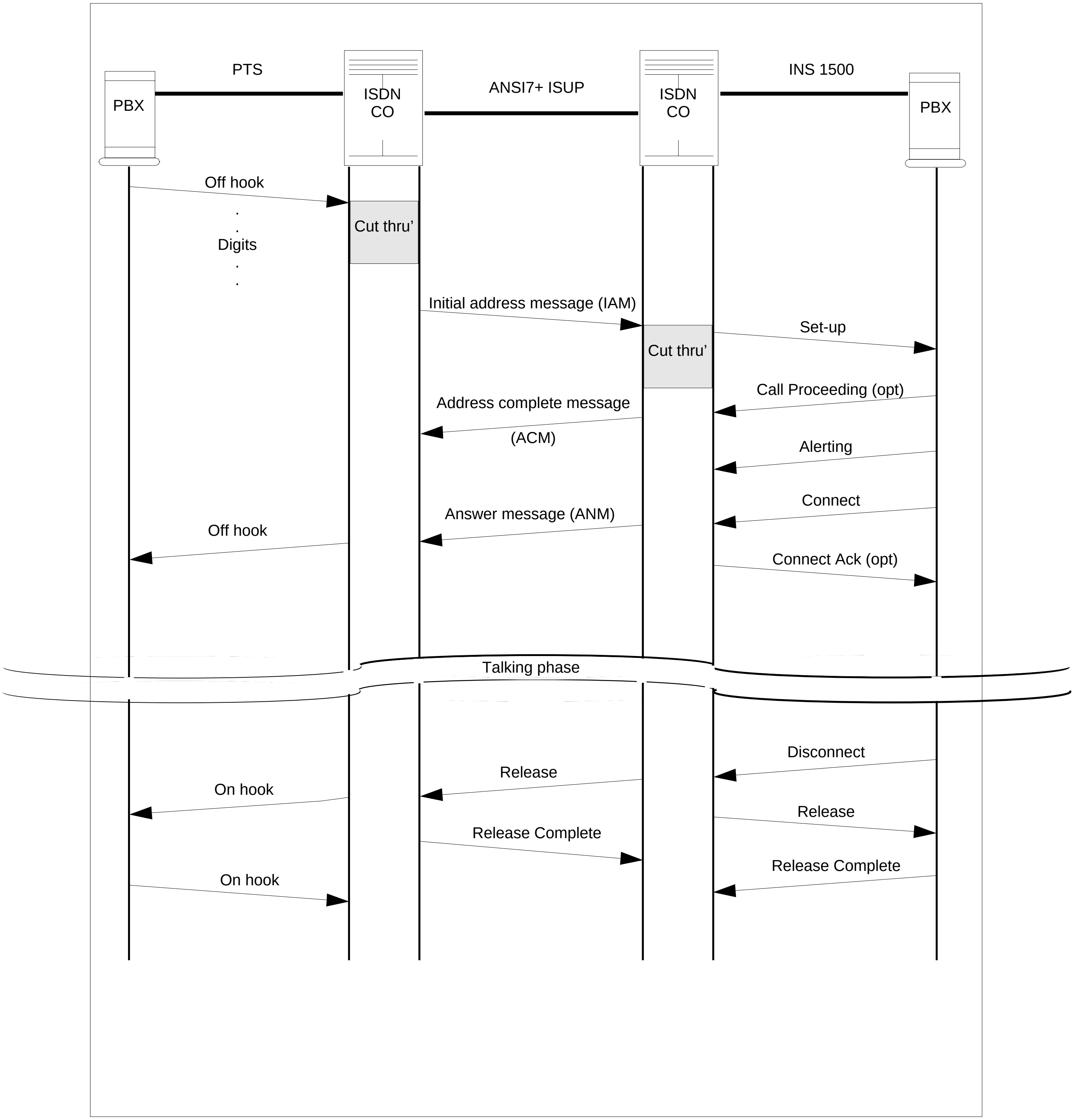


Figure 1-10
INS-1500 to PTS interworking

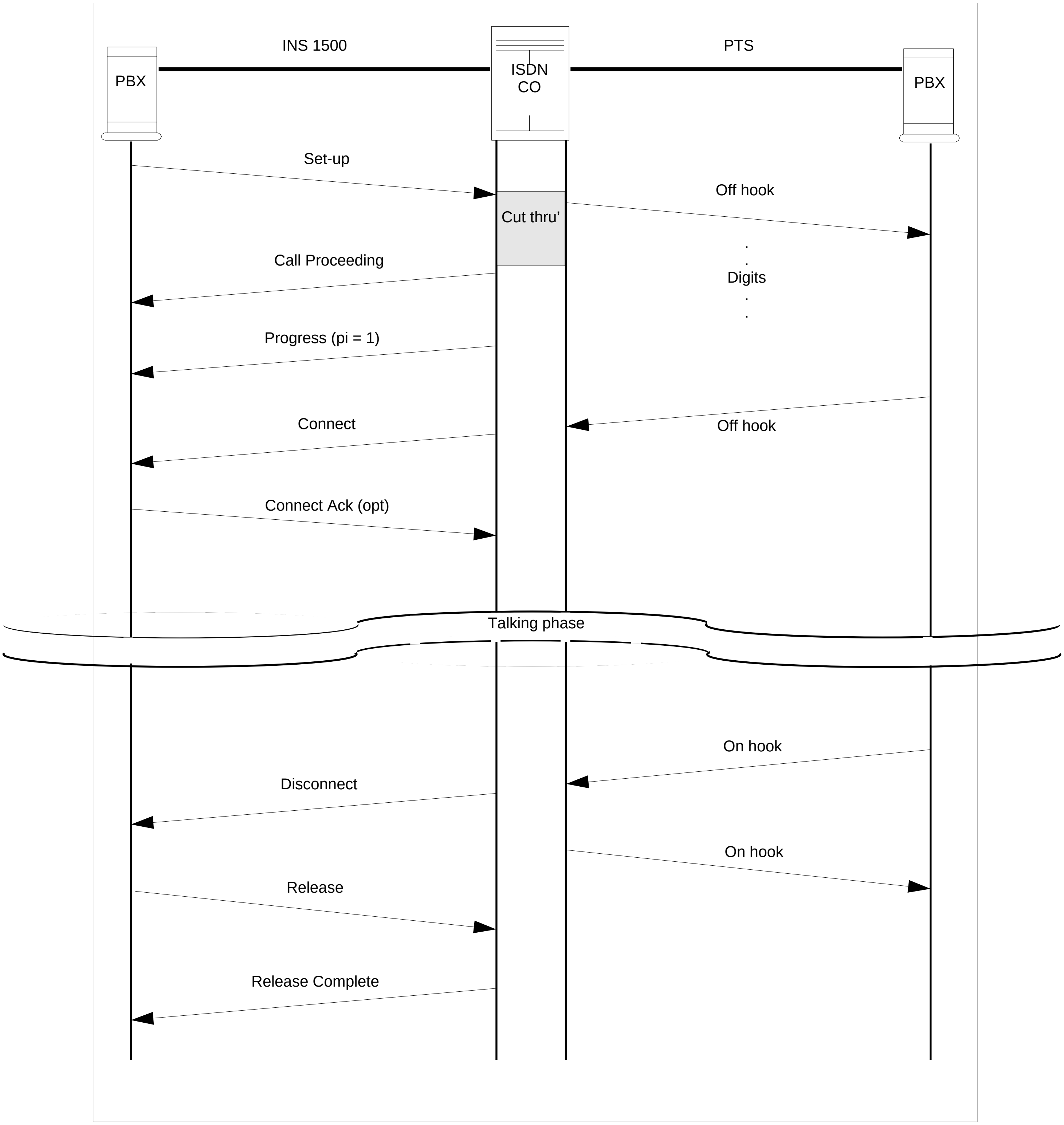


Figure 1-11
PTS to INS-1500 interworking

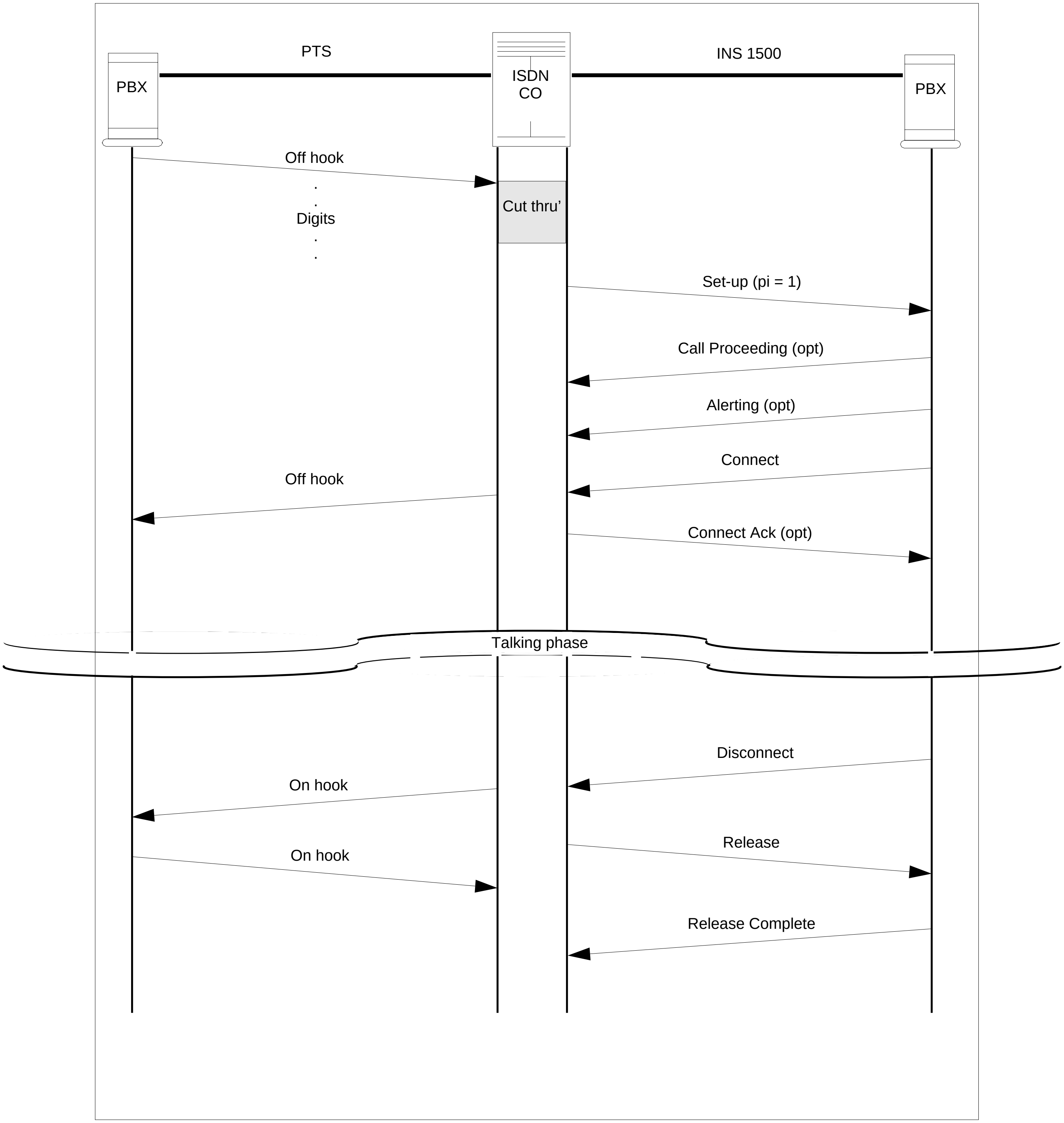


Figure 1-12
INS-1500 to INS-1500 interworking

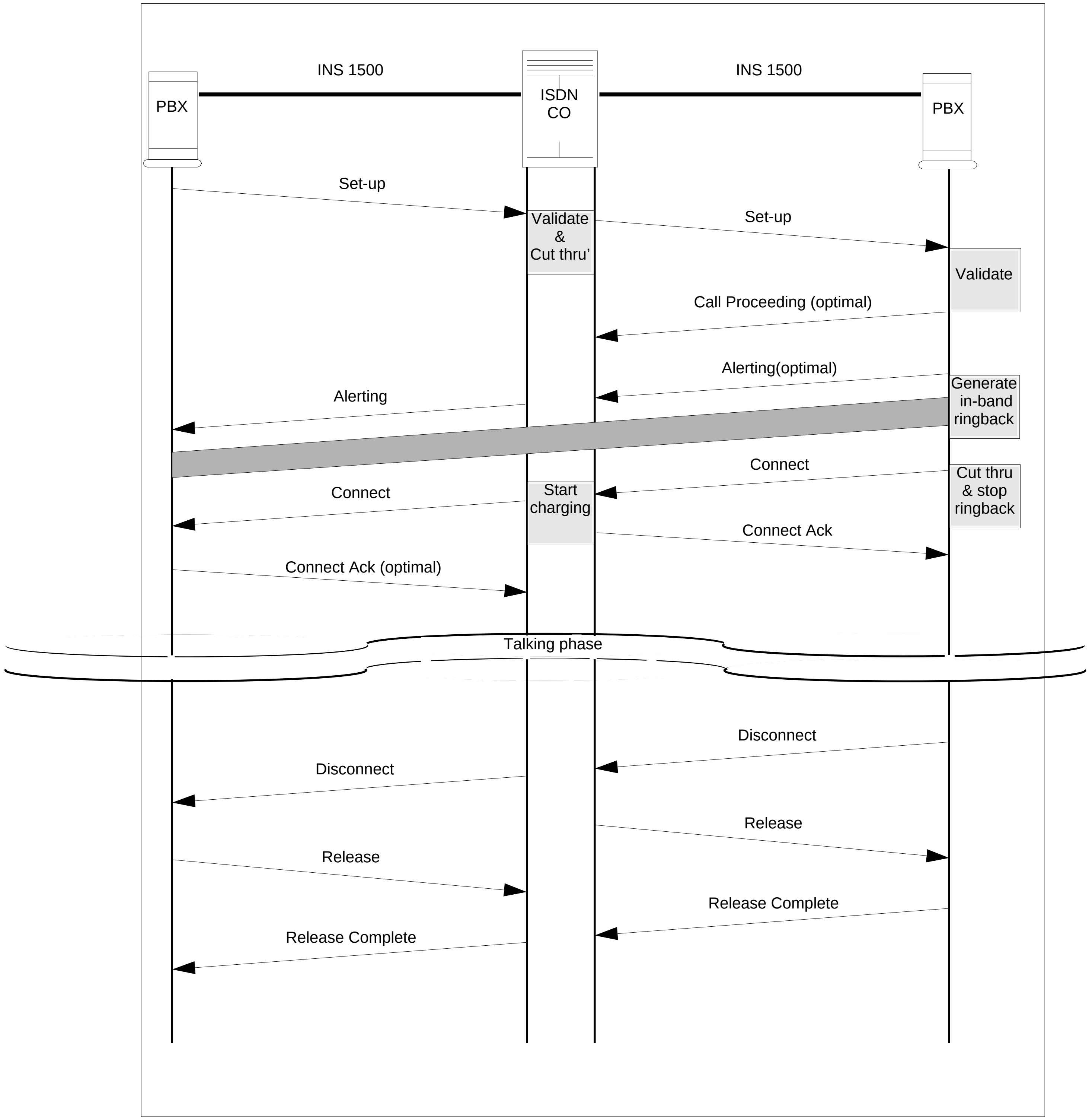


Figure 1-13
INS-1500 to NT PRI interworking

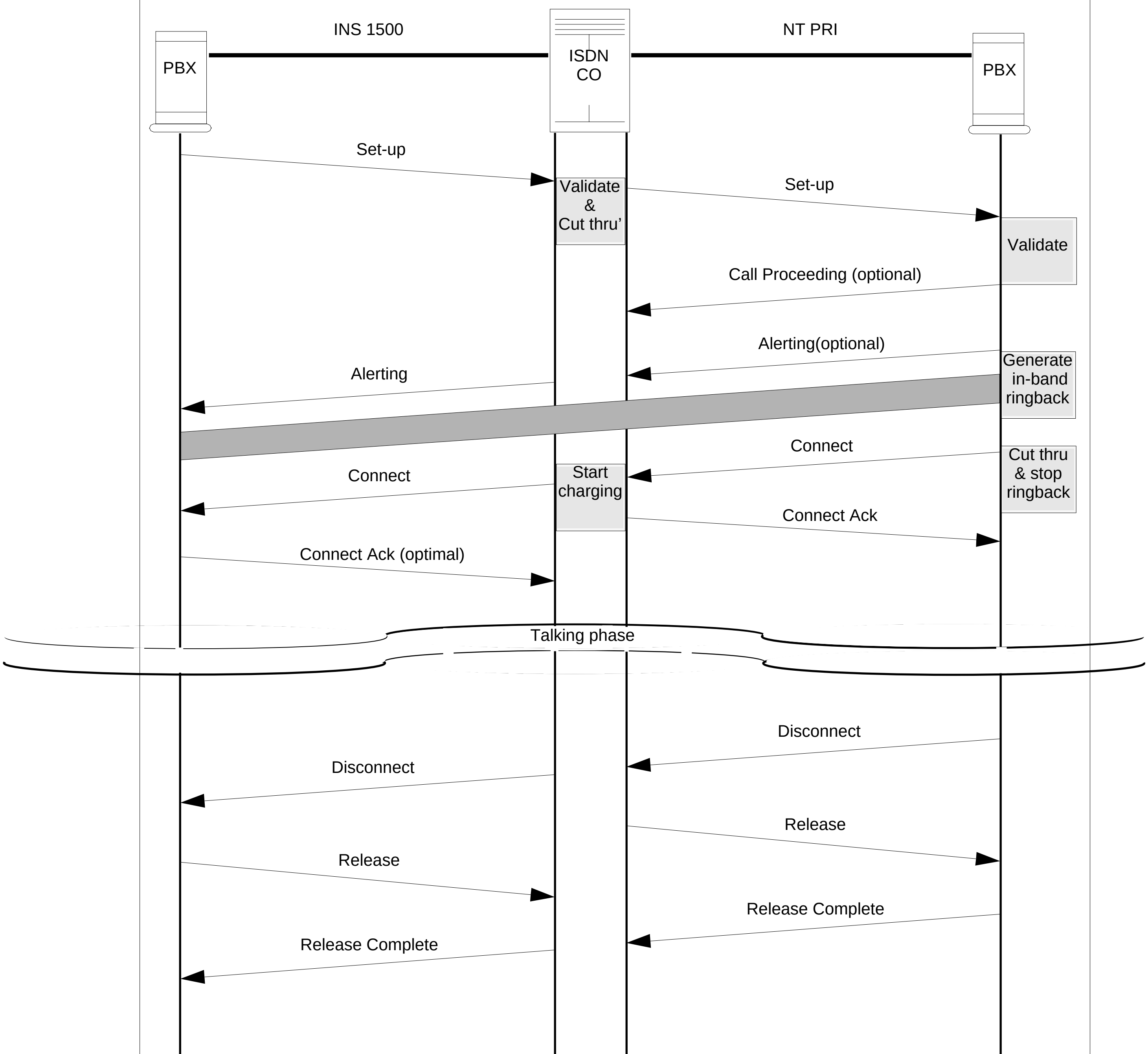
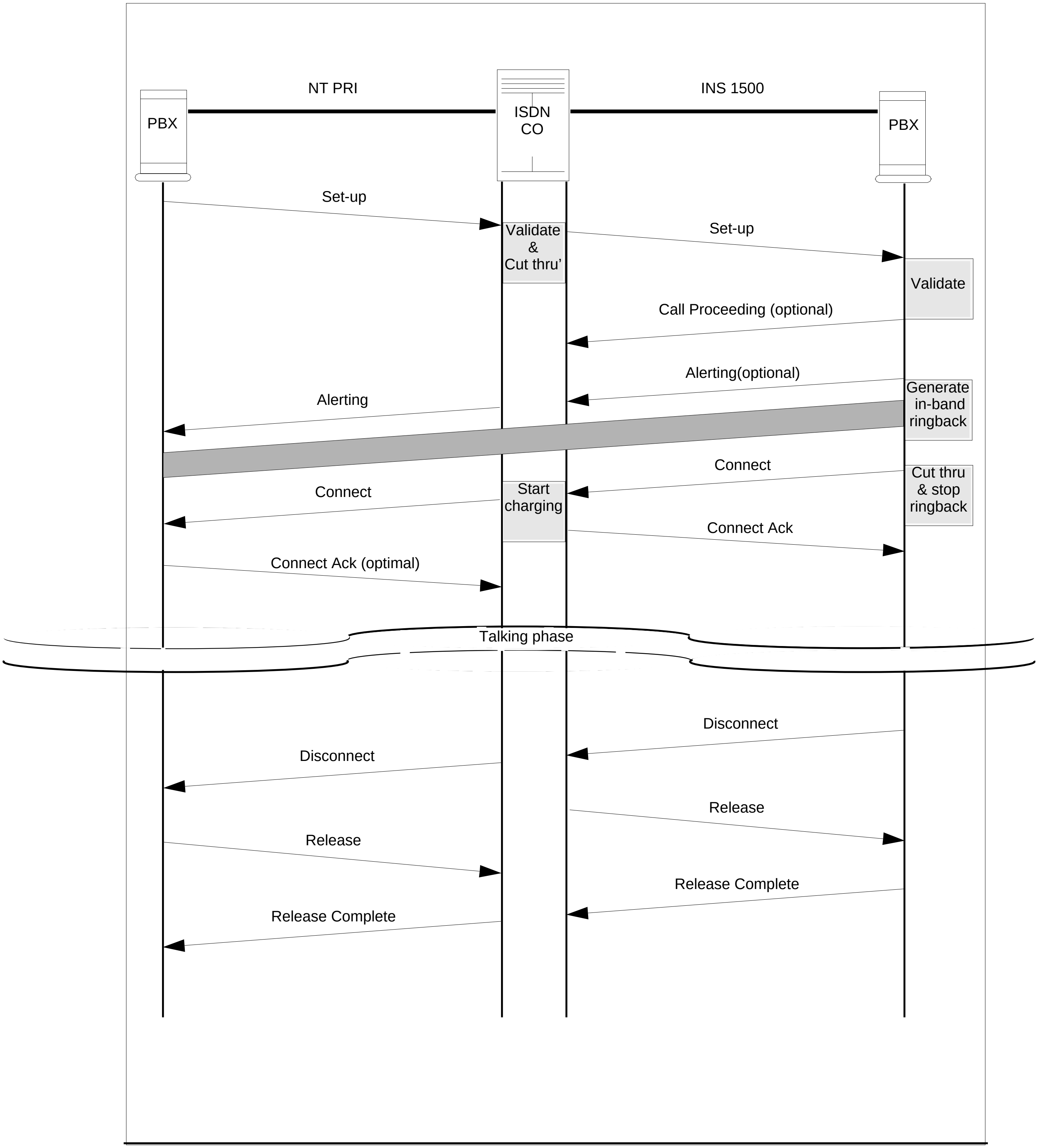


Figure 1-14
NT PRI to INS-1500 interworking



Section 2:
Layer 1 specification for primary rate interfaces

Chapter 2-1:
Layer 1 introduction

This section defines the physical layer of the ISDN primary rate interface (PRI) between a central office (CO) and a private branch exchange (PBX). The physical layer consists primarily of a standard DS-1 interface. There are a number of DS-1 options which have to be specified for this application. Various annotations and additions are included which reflect Northern Telecom's interpretation of the applicable standards (See paragraph 1.2 on page 2-4).

This section includes:

- a general description of the interface and configuration
- an electrical definition including formats for the data link (DL)
- a physical definition of connectors

1.1 Technical conformance

All products which fully conform to this specification implement DS-1 with the following schemes:

- bipolar coding with 8-zero suppression (B8ZS)
- current zero code suppression (ZCS) (with bit insertion)

  Note: Although the ISDN PRI standard requires the support of 64 kbit/s unrestricted/clear information transfer for a DS-0 channel (which requires B8ZS), the current ZCS scheme must also be supported as the existing DS-1 transmission facilities may not yet support B8ZS. Provision of ZCS avoids the need for the telephone company to have to replace the ZCS equipment. It also avoids restricting PRI to a clear channel service.

Bit-robbed signaling (for example, A/B bits) are supported on a per DS-0-channel basis, allowing ISDN PRI DS-0 channels (that is, B- and D-channels) to be intermixed on the same DS-1 facility as conventional trunks.

Additionally, a DS-0 nominated as the ISDN PRI D-channel must be able to transmit data at 56 kbit/s (by setting bit 8 to "1") or at 64 kbit/s clear.

Note: A D-channel with a transmission rate of 56 kbit/s (by setting bit 8 to "1") is needed for ISDN PRI configurations where the deployed transmission facilities require the use of the existing ZCS scheme.

1.2 Standards compatibility

The network interface is based on:

- *ANS T1.403, Carrier to customer installation -DS-1 metallic interface specification, 1989*
- *ANS T1.408, ISDN primary rate-customer installation metallic interfaces Layer 1 specification (T1E1/89-46R6)*
- *NTT INS NET 1500 Service Interface Volume 2, part 2 Primary rate user-network interface Layer 1 specification (Rev 1 1989)*
- *CCITT Recommendation I.431, Primary rate user-network interface-Layer 1 specification*

The interface does not support the following features: (for further discussion, see later in this specification).

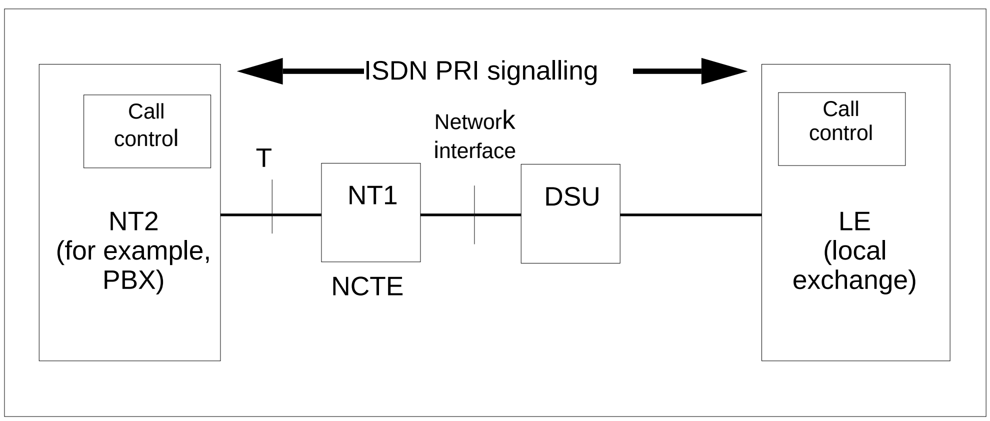
- extended super frame data link message-oriented code words
- extended super frame data link bit-oriented code words other than remote alarm indication (RAI)
- line and payload loopbacks.

Chapter 2-2: Layer 1 general information

2.1 Architecture

This specification defines the physical DS-1 interface including the DS-0 pipes used by the ISDN B-channels, D-channel, and conventional bit-robbing trunks to transmit information. Figure 2-1 shows the ISDN PRI functional architecture.

Figure 2-1
ISDN PRI architecture



2.2 Services offered by the physical layer

The physical layer DS-1 facility provides the following services to the higher layers. These services are dependent on the DS-1 facility options being used.

- DS-1 with B8ZS and extended superframe (ESF)

  This DS-1 option set conforms to the ISDN PRI standard as defined in *ANS T1.408, ISDN primary rate-customer installation metallic interfaces Layer 1 specification (T1E1/89-46R6)*. The DS-0 channels may be used for ISDN PRI (B-channels or D-channels) or for conventional bit robbing signaling trunks with A/B/C/D bit signaling or A/B signaling. The DS-0 channels used for ISDN PRI have the capability to support an information transfer rate of 64 kbit/s unrestricted. An end-to-end 64 kbit/s connection requires the access and network connections to support the 64 kbit/s capability.

Note: The use of the ESF format also provides a special data link which may be used for link management (for example, alarm indication, loopback set up, performance reporting).

- DS-1 with current ZCS and standard framing (SF)

  This DS-1 option set permits DS-0 channels to be used for ISDN PRI (D channels or B channels) with an information transfer rate of up to 56 kbit/s (by setting bit 8 of each byte to “1”), and for conventional trunking with A/B bit signaling.

2.3 Layer 1 signaling

This section of the specification establishes the requirements at the network interface necessary for compatible operation between the carrier and the customer installation.

The signals at the network interface, described in the following chapters, are of two types:

- normal operating signals
- maintenance signals

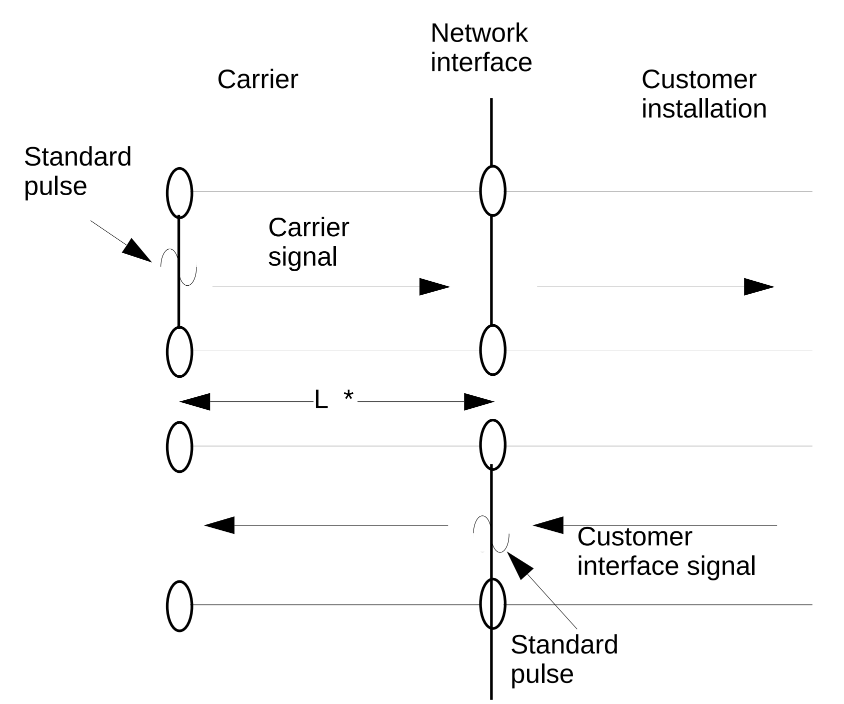
Signals that appear as a result of the environment (for example, voltages and currents induced by lightning hits) are not covered.

Chapter 2-3: Layer 1 electrical specification

3.1 Introduction

The Layer 1 electrical specification describes the DS-1 signals delivered to the carrier and to the customer installation (CI) at the network interface (NI). The NI is shown in Figure 2-2. The signal delivered to the NI by the carrier is identified as the carrier signal, and the signal delivered to the NI by the CI is identified as the CI signal. The NI, as defined in this document, is not symmetrical. That is, at the NI, some of the electrical requirements of the carrier signal differ from those of the CI signal.

Figure 2-2
Network interface



* L is the loss, at 772 kHz, of the indicated cable section.
0.0 ≤ L ≤ 16.5 dB

3.2 Impedance matching

Exchange cables generally used by the carriers in the loop plant are non-loaded, staggered-twist paired cables. The characteristic impedance of these cable pairs and the impedance of their associated terminations, at 772 kHz, is nominally 100 ohms[1].

3.3 Signal specifications

The following signal specifications describe characteristics for all signals at the NI. Differences between the carrier and the CI signals are identified in paragraph 3.4 on page 2-10 and paragraph 3.5 on page 2-11.

3.3.1 Transmission rate

The transmission rate of the DS-1 signal is 1.544 Mbit/s ± 50 bit/s. Older equipment has rate variations of ±200 bit/s.

3.3.2 Line codes

The line code for the DS-1 signal is bipolar, except where intentional bipolar violations are introduced by B8ZS.

3.3.3 Test load

A termination of 100 ohms ± 5% resistive is used at the network interface for the evaluation of signal characteristics.

3.3.4 Standard pulse characteristics

Pulse shape

An isolated pulse, both positive and inverted negative, has an amplitude between 2.4 V and 3.6 V and fits the normalized template shown in Figure 2-3 when scaled by a constant factor. Table 1 defines the corner points of the pulse template.

Power levels

For an all “1”s transmitted pattern, the power in the 3 kHz band centered at 772 kHz is in the range of 12.0 to 19.0 dBm and the power in the 3 kHz band centered around 1544 kHz is at least 25 dB less.

Pulse imbalance

In any window of 17 consecutive bits, the maximum variation in pulse amplitudes is less than 200 mV, and the maximum variation in pulse width (half amplitude) is less than 20 nsec.

[1]There may be a small number of low capacitance-type cables in the carrier’s plant. The characteristic impedance of these cables ranges from 120 to 145 ohms at 772 kHz. These cables are non-standard for this interface and, if used, must be tested on an individual basis, to ensure that impedance discontinuities do not result in interface reflection losses great enough to affect the stated performance objectives.

Figure 2-3
Isolated pulse template

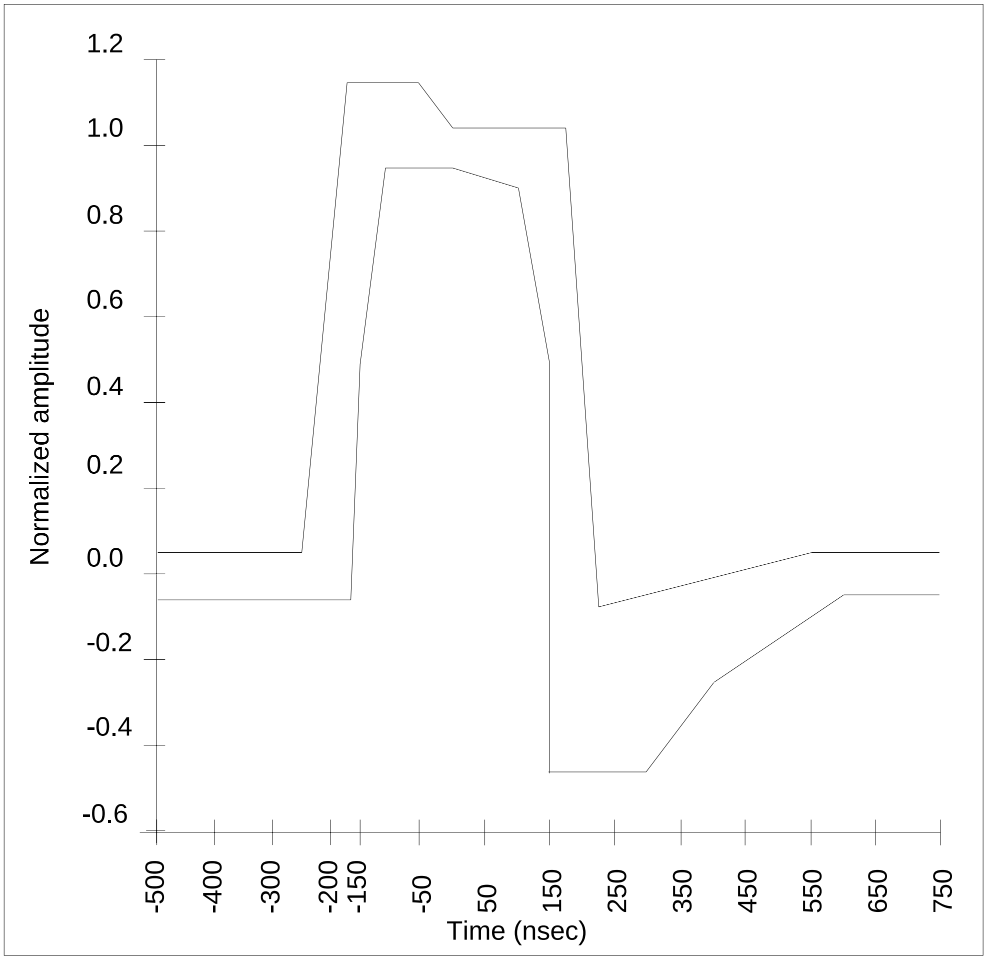


Table 2-1
Pulse template corner points: maximum curve

Time	**nanoseconds**	-500	-250	-175	-175	-75	0	175	228	500	750
	time slots	-0.77	-0.39	-0.27	-0.27	-0.12	0	0.27	0.35	0.77	1.16
Normalized amplitude		.05	.05	.80	1.15	1.15	1.05	1.05	-0.07	0.05	0.05

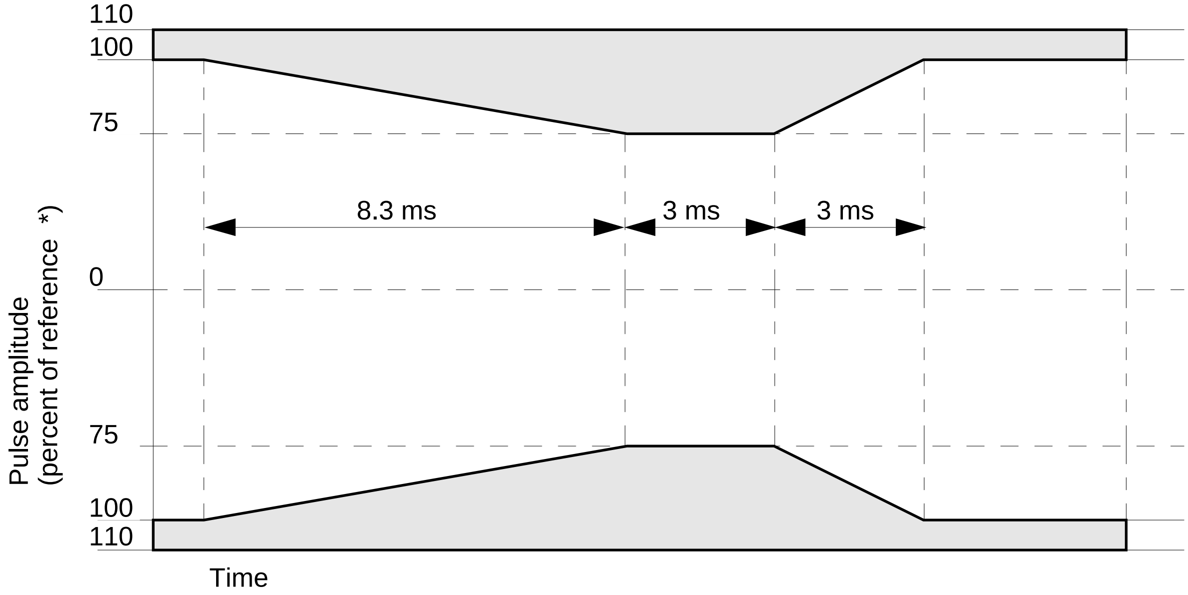
Table 2-2
Pulse template corner points: minimum curve

Time	**nanoseconds**	-500	-150	-100	0	100	150	300	390	600
	time slots	-0.77	-0.23	-0.15	0	0.15	0.23	0.46	0.66	0.93
Normalized amplitude		-0.05	0.50	0.95	0.95	0.90	0.50	-0.45	-0.26	-0.05
			-0.05				-0.45			

3.3.5 60 Hz variations in pulse amplitude

Pulse amplitude may vary at a 60 Hz rate as a result of the presence of 60 Hz longitudinal currents in the powering loops of T1 repeaters. In such cases, the envelope of pulse amplitudes is limited as shown in Figure 2-4. Any pulse amplitude in the range of 2.4 V to 3.45 V may be used as the 100 per cent point in the figure.

Figure 2-4
Pulse amplitude envelope



Envelope of pulse amplitudes lies within the shaded areas
* Reference (100 percent) point may be in the range 2.4 V ≤ Ref ≤3.45 V

3.4 Signal from the carrier (carrier signal)

The carrier signal at the network interface meets the signal specifications identified in paragraph 3.3 on page 2-8, except that:

- the pulse characteristics are those of a standard pulse (see paragraph 3.3.4 on page 2-8) transmitted through a cable pair with a loss in the range of 0.0 to 16.5 dB at 772 kHz between 100 ohm terminations
- the lower limit on the standard pulse amplitude is 2.25 V rather than 2.4 V

The variable length and characteristics of installed cable pairs make it impractical to define a pulse template for the carrier signal at the NI. However, the standard pulse template may be used with the appropriate mathematical procedures to construct representative hypothetical signals (seeFigure 2-3). These signal constructions should be based on the approximate electrical characteristics of 100 ohm cables as shown in Appendix A of T1.403 “Carrier to Customer Installation-DS-1 Metallic Interface Specification”, 1989.

3.5 Signal from the customer installation (CI signal)

The CI should not apply voltages to the NI other than those described in this specification.

The CI signal at the NI should meet all the specifications defined in paragraph 3.3 on page 2-8.

3.6 Pulse density

The CI signal at the NI must contain at least one pulse in each eight-bit time slot.

3.7 Jitter and wander

The following specification provides a quantitative measurement for jitter and wander.

Jitter is defined as the short-term variations of the significant instants of a DS-1 signal from their ideal positions in time. Wander is the long-term variation of the same instants. The boundary between long-term and short-term is a frequency of 10 Hz. The magnitudes of jitter and wander are specified in terms of unit intervals (UIs). One UI is equal to 648 ns (one pulse period).

3.7.1 Jitter

Timing jitter is specified in two frequency bands: Band 1 and Band 2. The characteristics of the weighting functions which define these bands are provided in Figure 2-5.

Carrier signal

At the NI, the jitter of the carrier signal does not exceed the following limits:

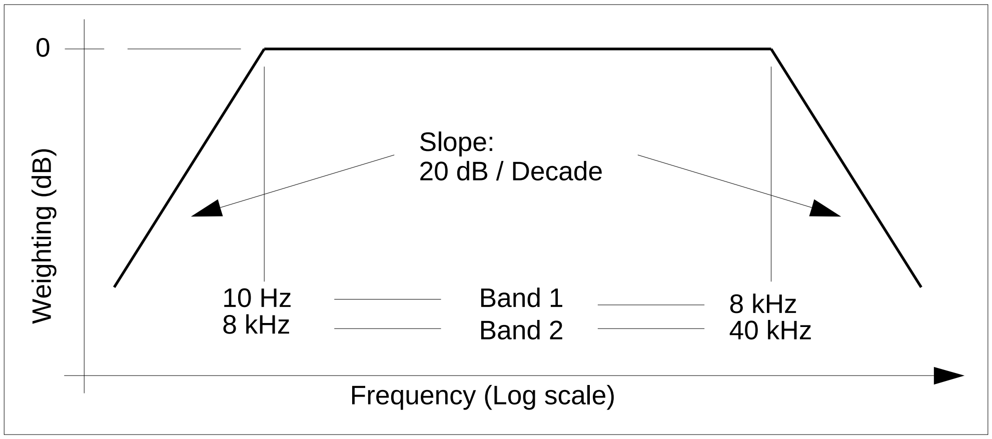
- Band 1: 5.0 UI, peak-to-peak
- Band 2: 0.1 UI, peak-to-peak

CI signal

At the NI, the jitter of the CI signal must not exceed the following limits:

- Band 1: 0.5 UI, peak-to-peak
- Band 2: 0.05 UI, peak-to-peak

Figure 2-5
Frequency weighting function for jitter



3.7.2 Wander

Wander is specified in frequency band 3. The characteristics of the weighting function which define this band are shown in Figure 2-6.

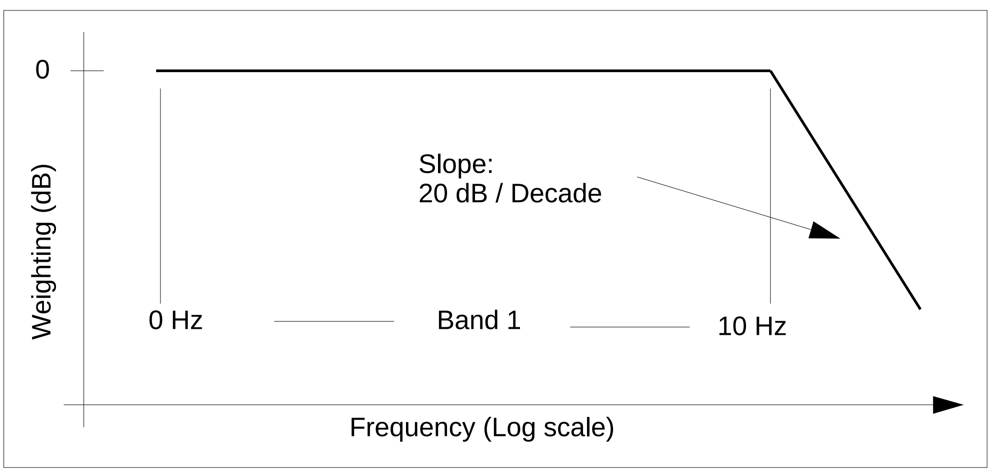
Carrier signal

At the NI, the wander of the carrier signal does not exceed 28 UI, peak-to-peak.

CI Signal

At the NI, the wander of the CI signal also must not exceed 28 UI, peak-to-peak.

Figure 2-6
Frequency weighting function for wander



3.8 Powering arrangements

Direct-current power is not delivered to the NI.

Chapter 2-4:
Layer 1 frame formats

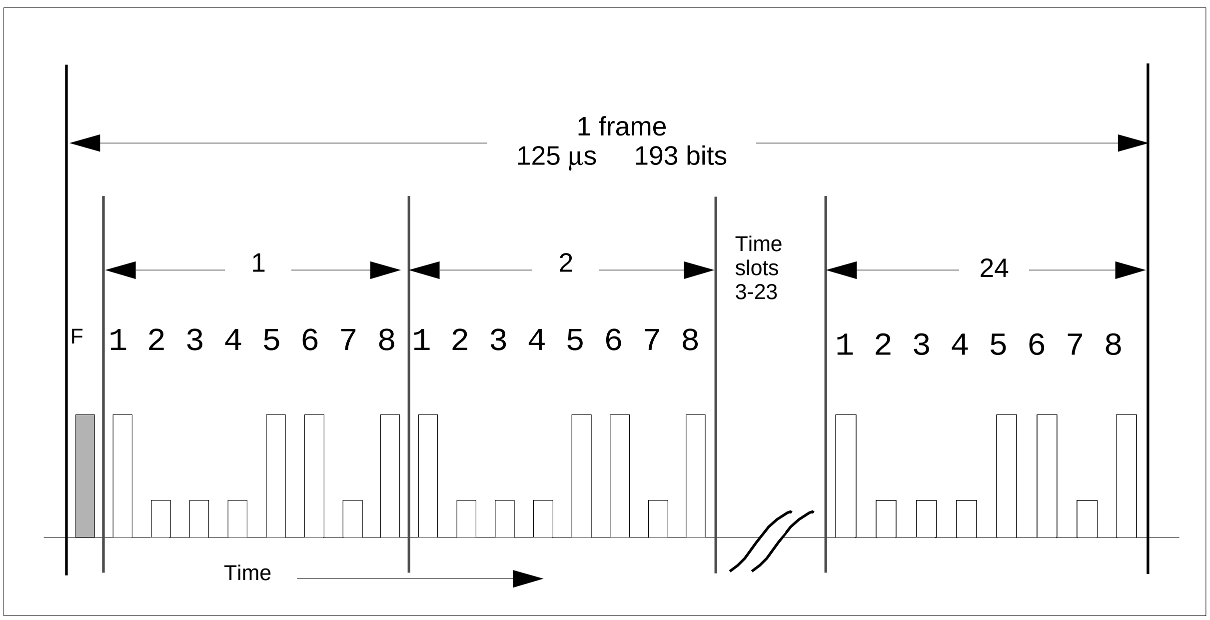
4.1 Introduction

The carrier and the CI signals at the NI are in either the superframe (SF) or the extended superframe (ESF) format. The same framing format is used in both directions of transmission.

4.2 Frame format definition

A frame is a set of 192 information digit time slots preceded by a one-digit time slot containing a framing bit (F bit), for a total of 193 digit time slots. The 192 information digit time slots may be partitioned into 24 eight-bit time slots, as shown in Figure 2-7.

Figure 2-7
DS-1 frame bit assignment



4.3 Superframe format definition

A superframe consists of twelve consecutive frames as shown in Table 2-3. The superframe format is a structure in which the F bits are used for framing only. In the superframe format, the F bits are divided into two groups:

- terminal framing (Ft) bits, used to identify frame boundaries
- signaling framing (Fs) bits, used to identify superframe boundaries. (When the 192 digit time slots are channelized, the Fs bits are used to identify the robbed-bit signaling frames and associated signaling channels A and B.)

The F-bit position, with respect to every group of 192 information bits is always maintained from NI to NI or from NI to central office (CO).

Table 2-3
Superframe format

Frame no.	F bits			Bit use in each time slot		Signaling bit use options	
	Bit no.	Terminal framing bit (Ft)	Signaling framing bit (Fs)	Traffic	Signaling	T	Signaling channel
1	0	1	-	1-8	-		
2	193	-	0	1-8	-		
3	386	0	-	1-8	-		
4	579	-	0	1-8	-		
5	772	1	-	1-8	-		
6	965	-	1	1-7	8	-	A
7	1158	0	-	1-8	-		
8	1351	-	1	1-8	-		
9	1544	1	-	1-8	-		
10	1737	-	1	1-8	-		
11	1930	0	-	1-8	-		
12	2123	-	0	1-7	8	-	B

Note 1: Frame 1 is transmitted first.

Note 2: Frames 6 and 12 are called signaling frames.

Note 3: Option T - traffic (bit 8 is not used for signaling).

4.4 Extended superframe format

An extended superframe (ESF) consists of twenty-four consecutive frames. The ESF is a structure in which the F bits are used as shown in Table 2-4 and the following list:

- A 2 kbit/s framing pattern sequence (FPS) channel is used to identify the frame and the extended superframe boundaries. (When the 192 information digit time slots are channelized, the FPS bits are used to identify the robbed-bit signaling frames and the associated signaling channels, A, B, C, and D.)
- A 4 kbit/s data link (DL) channel. When idle, the DL channel contains continuous repetitions of the data link idle code-0111 1110.
- A 2 kbit/s cyclic redundancy check (CRC) channel which carries the CRC-6 code. The CRC-6 bits from ESF frame N that are transmitted in ESF frame (N+1) are determined as follows:
  - For the purpose of CRC-6 calculation only, every F bit is set to “1” in ESF(N), that is, the ESF just preceding ESF(N+1). ESF(N) is altered in no other way.
  - The resulting 4632 bits of ESF(N) are used, in order of occurrence, to construct a polynomial in x such that bit 4631 of ESF(N) is the coefficient of the term x^0 and bit 0 of ESF(N) is the coefficient of the term x^{4631}.
  - The polynomial is multiplied by the factor x^6, and the result is divided, modulo 2, by the generator polynomial x^6+x+1. The coefficients of the remainder polynomial are used, in order of occurrence, as the ordered set of check bits, C1 through C6, for ESF(N+1). The ordering is such that the coefficient of the term x^5 in the remainder polynomial is check bit C1 and the coefficient of the term x^0 in the remainder polynomial is check bit C6.
  - The check bits C1 through C6 contained in any ESF frame are always those associated with the content of the ESF frame immediately preceding the one in which the check bits occur. When there is no immediately preceding ESF frame, the check bits may be assigned any value.

Table 2-4
Extended superframe format

Frame no.	F bits				Bit use in each time slot		Signaling bit use options	
	Bit no.	FPS	DL	CRC	Traffic	Signaling	T	Signaling channel
1	0	-	m	-	1-8	-		
2	193	-	-	C1	1-8	-		
3	386	-	m	-	1-8	-		
4	579	0	-	-	1-8	-		
5	772	-	m	-	1-8	-		
6	965	-	-	C2	1-7	8	-	A
7	1158	-	m	-	1-8	-		
8	1351	0	-	-	1-8	-		
9	1544	-	m	-	1-8	-		
10	1737	-	-	C3	1-8	-		
11	1930	-	m	-	1-8	-		
12	2123	1	-	-	1-7	8	-	B
13	2316	-	m	-	1-8	-		
14	2509	-	-	C4	1-8	-		
15	2702	-	m	-	1-8	-		
16	2895	0	-	-	1-8	-		
17	3088	-	m	-	1-8	-		
18	3281	-	-	C5	1-7	8	-	A
19	3474	-	m	-	1-8	-		
20	3667	1	-	-	1-8	-		
21	3860	-	m	-	1-8	-		
22	4053	-	-	C6	1-8	-		
23	4246	-	m	-	1-8	-		
24	4439	1	-	-	1-7	8	-	B

Note 1: Frame 1 is transmitted first.

Note 2: Frames 6, 12, 18, and 24 are denoted signaling frames.

Note 3: FPS is the Framing Pattern Sequence (...001011...).

Note 4: DL is the 4 kbit/s Data Link (m bits).

Note 5: CRC is the CRC-6 Cyclic Redundancy Check (bits C1 - C6).

Note 6: Option T is traffic (bit 8 is not used for signaling).

4.5 Idle codes

4.5.1 Codes for idle channels and idle slots

A keep-alive signal is applied to idle channels to ensure that no more than 80 consecutive “0”s are transmitted. The keep alive signal is removed when the pulse density returns to the requirements detailed in paragraph 3.6 on page 2-11.

The keep alive signal is an unframed, continuous repetition of the channel idle code-0111 1111.

4.5.2 Interframe (layer 2) timefill

Contiguous HDLC flags are transmitted on the D-channel when its layer 2 has no frames to send.

Chapter 2-5: Layer 1 clear channel capability

5.1 Clear channel capability

To provide DS-1 clear channel capability (CCC), a DS-1 signal with unconstrained information bits is altered by some method to meet the pulse density requirements specified in paragraph 3.6 on page 2-11. The method used to provide DS-1 CCC is the same in both directions of transmission. The long-term method of providing DS-1 CCC will be B8ZS. DS-1 CCC is a necessary, but not a sufficient condition for providing clear channel capabilities end-to-end for customers.

Chapter 2-6: Layer 1 maintenance

Maintenance messages and signals are transmitted in-band in the superframe format and in the data link layer in the extended superframe (ESF) format.

6.1 Remote alarm indication

The remote alarm indication (RAI) signal-also called the Yellow Alarm-is transmitted in the outgoing direction when a DS-1 terminal determines that it has lost the incoming signal. The RAI signal is transmitted to the interface as follows:

- In the superframe format, the RAI signal is transmitted for the duration of the alarm condition or for at least one second, whichever is greater. For the duration of the alarm, bit 2 in every eight-bit time slot is a “0”.
- In the extended superframe format, the RAI signal is transmitted for the duration of the alarm condition or for at least one second, whichever is greater. For the duration of the alarm, a repeating 16-bit pattern consisting of eight “1”s followed by eight “0”s (1111 1111 0000 0000) is transmitted continuously on the ESF data link.
- For either framing format, the minimum time between the end of one transmission and the beginning of another transmission is one second. Certain services provided by the network may require longer time intervals than these minimum values, and may require unequal “on” and “off” intervals, or both.

6.2 Alarm indication signal (AIS)

The alarm indication signal (AIS) is not supported in INS 1500.

6.3 Loopback

The line and payload loopbacks that are described in *ANS T1.408, ISDN primary rate-customer installation metallic interfaces Layer 1 specification (T1E1/89-46R6)* are not supported by the network in INS1500.

6.4 ESF maintenance

6.4.1 Introduction

The extended superframe format incorporates a block error detection code (CRC-6) and a data link (DL) channel that allow carrier maintenance of DS-1 transmission facilities. The following paragraphs specify the functions that are necessary in the CI to support monitoring of digital circuits.

Errors in the transmission received by the CI may be detected by:

- detecting CRC violations by comparing a locally calculated CRC with the CRC encoded in the received signal
- detecting errors in the framing bit pattern, or detecting the loss of a frame
- detecting line code violations (non-B8ZS bi-polar violations)
- detecting controlled slips (for CIs that are components of a synchronized network)

The presence of all or some of these errors can indicate the location of a problem. The CI monitors the incoming signal for these conditions.

Once each second, the CI reports the parameters over the DL channel as specified in the following paragraphs. These reports ensure that the quality of transmission, as received at the CI, is reported. The reports are sent over the DL channel using bit-oriented signals.

6.4.2 Transmission measurement parameters

During periods of ideal transmission, no error events occur. If the CI detects any error, it sends an RAI-a yellow alarm.

The one-second timing intervals may be derived from the DS-1 signal, or from a separate, equally accurate (± 32 ppm) source. The phase of the one-second periods with respect to the occurrence of error events is arbitrary. That is, the one-second timing does not depend on the time of occurrence of any error event.

The events that are detected and reported are:

- no event
- CRC error
- severely-errored frames

The events that may be detected and reported are:

- frame-synchronization-bit error
- line-code violation
- controlled slip

These are defined as follows:

CRC error event
A CRC error event is reported if the received CRC code for a particular frame is not identical to the corresponding locally calculated code.

Severely errored framing event
A severely errored framing event is reported if two or more framing-bit-pattern errors occur within a 3 ms period. Contiguous 3 ms intervals are examined. The 3 ms period may coincide with the extended superframe period.

Frame-synchronization-bit error event
A frame-synchronization-bit error event is the occurrence of a received framing-bit-pattern error.

Line code violation event
A line code violation event occurs when a bipolar violation is received for an AMI-coded signal. For a B8ZS-coded signal, a line code violation event occurs when a bipolar violation is received and this violation is not part of an associated zero-substitution code.

Controlled slip event
A controlled slip occurs when there is a difference between the timing of a synchronous receiving terminal and that of the received signal of such a magnitude as to exhaust the buffer capability of the synchronous terminal.

6.4.3 ESF data link
There are two categories of bit-oriented messages-priority messages, and command and response messages. Only priority messages are currently supported.

Message-oriented codewords are used to carry performance monitoring information (see *ANS T1.408, ISDN primary rate-customer installation metallic interfaces Layer 1 specification (T1E1/89-46R6)*). Message-oriented codewords based on LAPD protocol are not supported by the network.

Priority messages
Priority messages indicate a service-affecting condition. The only priority message generated by the network is an RAI-a yellow alarm. It is transmitted continuously until the cause no longer exists or for at least 1 second as in paragraph 6.1 on page 2-21.

Command and response messages
Command and response messages are not currently supported by the network, although it is recommended that user equipment support these for future compatibility.

Table 2-5 lists all the messages, and their associated code words, that have been defined.

Table 2-5
Bit-oriented data-link messages

Priority Messages	Code word
RAI (Yellow alarm)	000 0000 0111 11111

Note 1: Only RAI is supported by the current network. All other values are reserved.

Chapter 2-7: Layer 1 connector arrangements

7.1 Connector arrangements

All connections at the network interface use one of three Universal Service Ordering Code (USOC) connectors (RJ48C, RJ48X, or RJ48M) (FCC Rules and Regulations, Sub-part F of Part 68, supplemented by Public Notice 2526, February 10, 1986). The physical arrangement of these connectors is shown in Figure 2-8,Figure 2-9, and Figure 2-10.

Figure 2-8
Connector pin assignment (RJ48C)

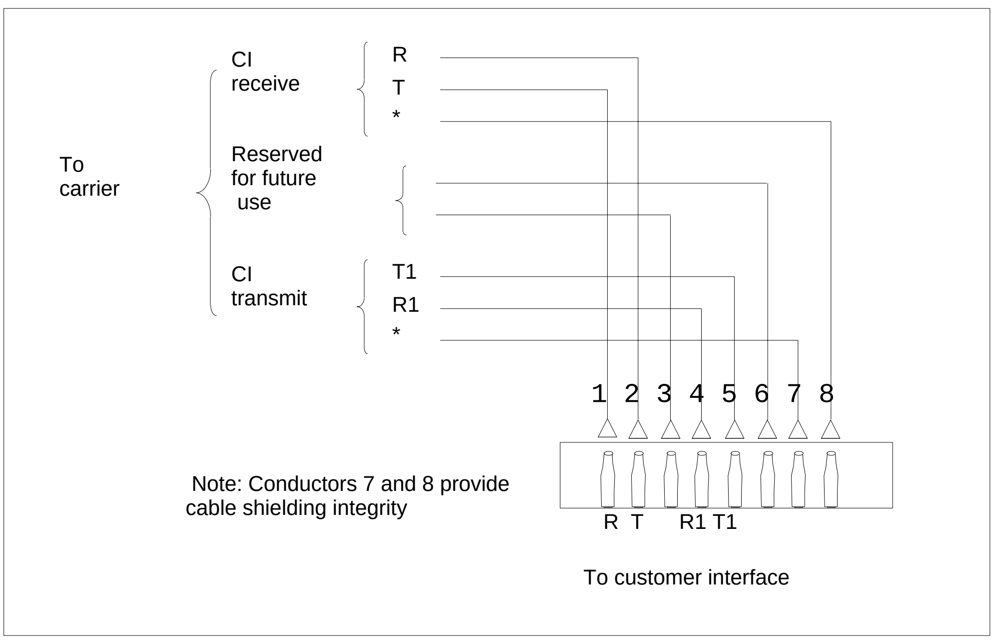


Figure 2-9
Connector pin assignment (RJ48X)

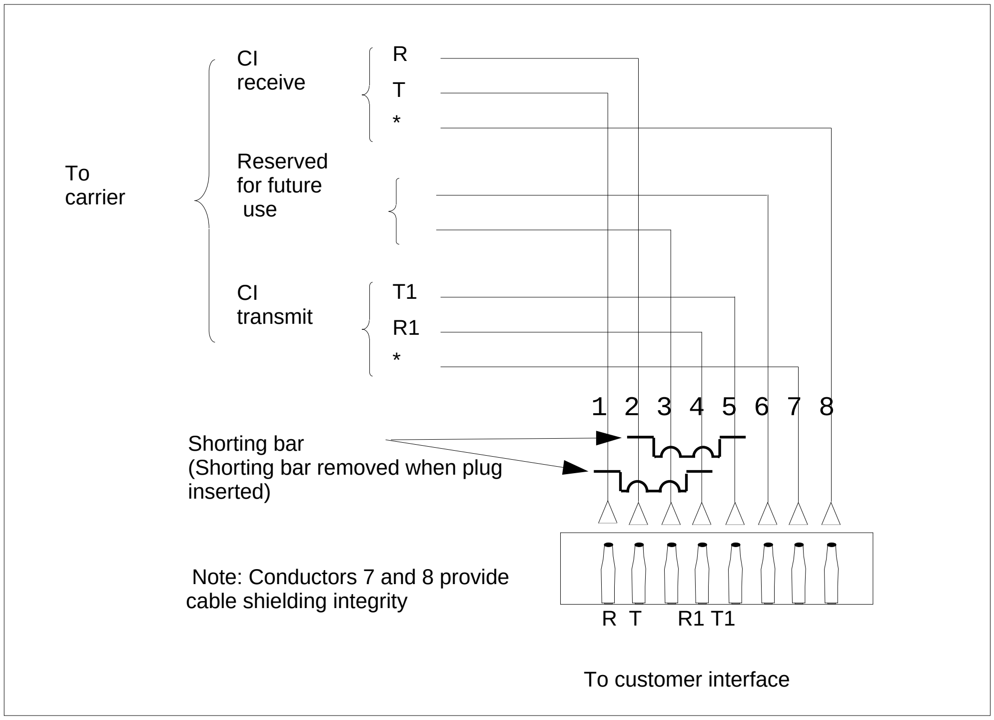
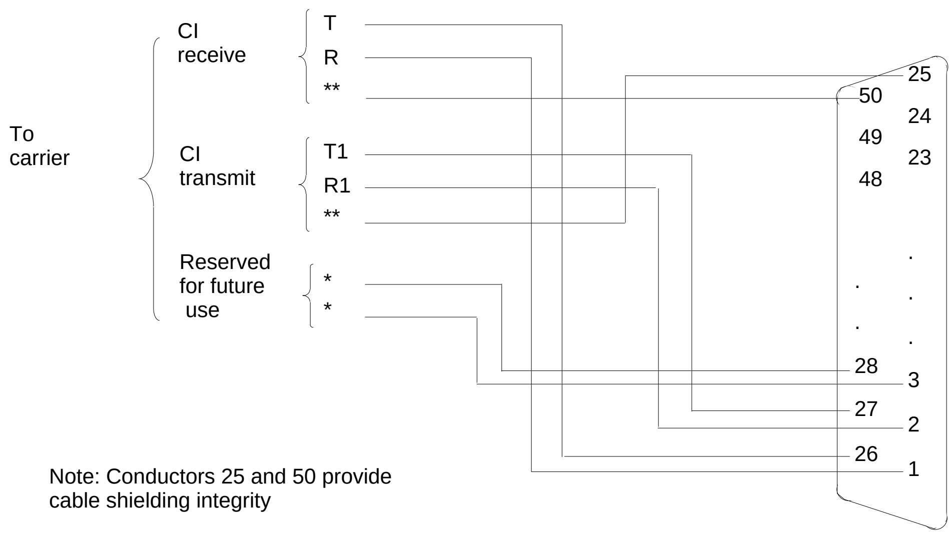


Figure 2-10
Connector pin assignment (RJ48M)



Connector pin number						
Line	**T**	**R**	**T1**	**R1**	*****	*****
1	26	1	27	2	28	3
2	29	4	30	5	31	6
3	32	7	33	8	34	9
4	35	10	36	11	37	12
5	38	13	39	14	40	15
6	41	16	42	17	43	18
7	44	19	45	20	46	21
8	47	22	48	23	49	24
* Conductors reserved for future use						

Section 3:
Layer 2 specification for primary interfaces

Chapter 3-1: Introduction to Layer 2

1.1 Scope

This section defines the link access protocol for the D-channel (LAPD) of the ISDN primary rate interface (PRI). It specifies the frame structure, elements of procedure, format of fields, and procedures for the proper operation of the Link Access Procedure (LAP) on the D-channel.

In particular, it specifies:

- the peer-to-peer protocol for the transfer of information and control between any pair of service access points on the data link layer
- the interactions between the data link layer[1] and Layer 3, and between the data link layer and the physical layer (Layer 1).

LAPD, in the Open Systems Interconnection (OSI) reference model, is the Layer 2 protocol for the interface. It is independent of transmission rate, and requires a duplex, bit-transparent D-channel. The purpose of LAPD is to convey information between Layer 3 entities across the ISDN primary rate interface using the D-channel. The protocol defines the procedures required to establish, maintain, and disconnect the link.

The LAPD procedures in this section are suitable for all applications of the ISDN primary rate interface (for example, private branch exchange (PBX) to central office (CO)).

1.2 Feature summary

The LAPD features that are supported are:

- point-to-point, acknowledged, multiple frame information transfer

[1]The term “data link layer” is used in the main text of this specification. However, the terms “Layer 2”and “L2”are used as abbreviations. Similarly, in accordance with Recommendations Q.930 (I.450) and Q.931 (I.451), the term “layer 3”is used to indicate the layer above the data link layer.

All references to ‘layer management entity’ or ‘connection management entity’ refer to those entities at the data link layer.

- Service access point identifier (SAPI) = 0, and terminal endpoint identifier (TEI) = 0 (fixed TEI)
- TEI administration procedures limited to those interactions that do not involve peer entities. For example, assignment of a TEI value by the user-side management entity to the user-side data link layer entity do not involve interactions with the network side.
- Default parameter values used.

The features that are not supported are as follows:

- Unnumbered information (UI) commands, and the *DL-Unit Data* primitive
- Broadcast procedures (that is, TEI 127 is not supported)
- Management information transfer (that is SAPI 63, Identity Remove message, and *MDL-Unit Data* primitive)
- TEI removal procedure (the network or user cannot request that the other end remove its TEI)
- Exchange identification (XID) procedures
- MPH primitives (used for communication between the management entity and Layer 1)
- Deactivation procedures

1.3 Standards compatibility

This data link layer specification is based on the *ANS T1.602, ISDN signaling specification for application at the user-network interface- Layer 2 specification*, and is a subset of the *CCITT Recommendation Q.920(I.440), ISDN user-network interface data link layer-general aspects*, and the *CCITT Recommendation Q.921(I.441), ISDN user-network interface data link layer specification*.

1.4 Overview description of LAPD functions and procedures

The purpose of LAPD is to convey information between Layer 3 entities across the ISDN PRI using the D-channel.

All data link layer messages are transmitted in frames which are delimited by flags. A flag is a unique bit pattern.

LAPD includes functions for

- provisioning of one or more data link connections on a D-channel. Discrimination between the data link connections is by means of a data link connection identifier (DLCI) contained in each frame.
- frame delimiting, alignment, and transparency, that allows a sequence of bits transmitted over a D-channel to be recognized as a frame

- sequence controlling, to maintain the sequential order of frames across a data link connection
- detection of transmission, format, and operational errors on a data link connection
- recovery from detected transmission, format, and operational errors
- notification to the management entity of unrecoverable errors
- flow controlling

Data-link-layer functions provide the means for information transfer between multiple combinations of data link connection endpoints. In the case of PRI, the information is transferred through point-to-point data link connections in which each frame is directed to a single endpoint.

1.5 Protocol service definition

The data link layer provides services to Layer 3 and the management of the data link layer (Layer 2). It uses the services provided by the physical layer (Layer 1) and by layer management.

1.5.1 Services provided to Layer 3

The specification of the interactions with Layer 3 (primitives) provides a description of the services that the data link layer, plus the physical layer offer to Layer 3, as viewed from Layer 3.

The information transfer service is based on acknowledged information transfer at the data link layer.

The characteristics of the service are as follows:

- provision of a data link connection between Layer 3 entities for acknowledged information transfer of Layer 3 message units
- identification of data link connection endpoints
- sequence integrity of data link layer message units in the absence of malfunctions
- notification to the peer entity in the case of errors; for example, loss of sequence
- notification to the management entity of unrecoverable errors detected by the data link layer
- flow control

The primitives associated with the acknowledged information transfer services are:

- *DL-Data-Request* and *-Indication*-for transferring data

- DL-*Establish-Request* and *-Indication*-for establishing multiple-frame operation
- DL-*Release-Request, -Indication,* and *-Confirm*-for terminating multiple-frame operation

1.5.2 Administrative services

The administrative services functions are:

- assignment and removal of TEI values
- notification of errors

These services are considered to be provided conceptually by layer management either on the user side or on the network side. The primitives associated with these services are:

- *MDL-Assign-Request* and *-Indication*-for assigning TEI value

  These primitives are used to send a TEI value obtained from the layer manager. The layer manager passes the TEI value to the data link layer in order that the user data-link-layer entities can begin to communicate with the network data-link-layer entities.
- *MDL-Remove-Request*-for removing TEI value

  This primitive is used to send a layer manager request for removal of a TEI value that has previously been assigned using the *MDL-Assign* primitives.
- *MDL-Error-Indication* and *-Response*-used for error notification.

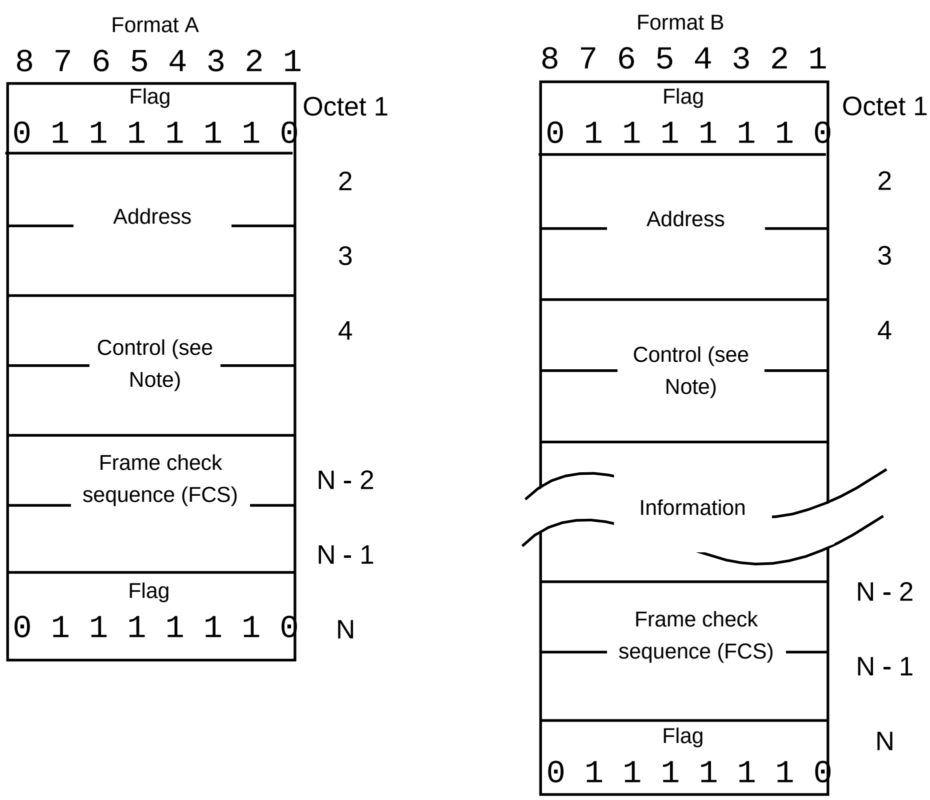
  These primitives are used to report errors between the layer manager and the data-link-layer entities.

Chapter 3-2: Layer 2 frame structure

2.1 Introduction

All peer-to-peer exchanges at the data link layer conform to one of the formats shown in Figure 3-1. Format A is used for frames that do not have an information field. Format B is used for frames that do contain an information field.

Figure 3-1
Frame formats



Note:

Acknowledged operation (modulo 128) -2 octets for frames with sequence numbers

-1 octet for frames without sequence numbers

2.2 Flag sequence

All frames start and end with a flag sequence that consists of one “0” bit followed by six contiguous “1” bits and one “0” bit (`0111 1110`). The flag preceding the address field is called the opening flag. The flag following the Frame Check Sequence (FCS) field is called as the closing flag. The closing flag may also serve as the opening flag of the next frame in some applications.

When the layer 2 entity has no frames to transmit, it sends contiguous HDLC flag sequences (`0111 1110`). The receiving equipment should also be capable of receiving an interframe abort. This consists of one “0” bit followed by seven contiguous “1” bits (`0111 1111`).

2.3 Address field

The address field consists of 2 octets as shown in Figure 3-1. The address field identifies the intended receiver of a command frame and the transmitter of a response frame. The format of the address field is defined in paragraph 3.2 on page 3-15.

2.4 Control field

Depending on the type of operation, the control field consists of 1 or 2 octets as shown in Figure 3-1. This field is used to identify the type of command and response. The format of the control field is defined in paragraph 3.4 on page 3-17.

2.5 Information field

The information field of a frame, when present, follows the control field and precedes the frame check sequence as shown in Figure 3-1. The contents of the information field consist of an integral number of octets which hold a message from layer 3.

The maximum number of octets in the information field is a system parameter, refer to paragraph 5.9.3 on page 3-54

2.6 Transparency

A transmitting data-link-layer entity examines the frame content between the opening and closing flag sequences, (address, control, information and FCS fields). It inserts a “0” bit after all sequences of five contiguous “1” bits (including the last five bits of the FCS) to ensure that a flag or an abort sequence is not simulated within the frame.

At the receiving end, a similar data-link-layer entity examines the frame contents between the opening and closing flag sequences and discards any “0” bit which directly follows five contiguous “1” bits.

2.7 Frame checking sequence (FCS) field

The FCS field is a 16-bit sequence. It is the “1”s complement of the sum (modulo 2) of the following formulas:

- the remainder of $(x^k)(x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^9 + x^8 + x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + x + 1)$ divided modulo 2 by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where “k” is the number of bits in the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency
- the remainder of the division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, of the product of x^{16} by the content of the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency

As a typical implementation at the transmitter, the initial content of the register of the device computing the remainder of the division is preset to all “1”s. This is modified by division by the generator polynomial (as described above) of the address, control and information fields; the “1”s complement of the resulting remainder is transmitted as the16-bit FCS.

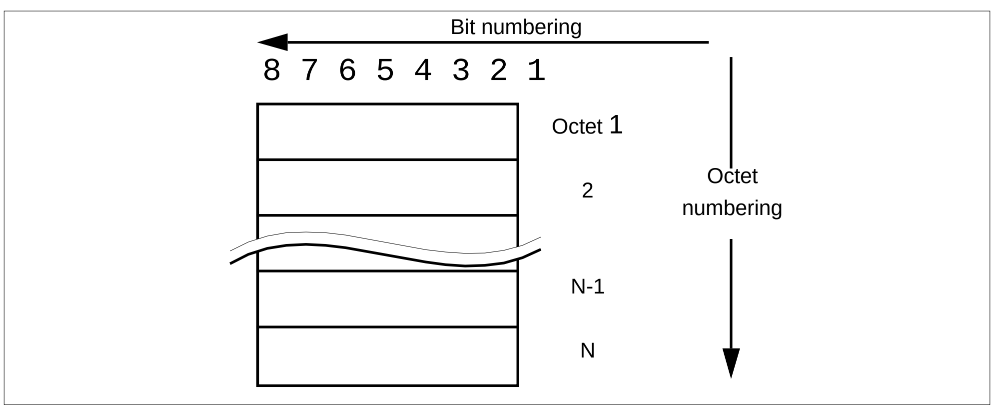
As a typical implementation at the receiver, the initial content of the register of the device computing the remainder is preset to all “1”s. The final remainder, after multiplication by x and division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ of the serial incoming protected bits and the FCS, is ‘0001 1101 0000 1111’(x^{15} through x^o, respectively) in the absence of transmission errors.

2.8 Format convention

2.8.1 Numbering convention

The basic frame numbering convention used is shown in Figure 3-2. The bits are grouped into octets.

Figure 3-2
Format convention



2.8.2 Order of bit transmission

The octets are transmitted in ascending numerical order; inside an octet, bit 1 is the first bit to be transmitted.

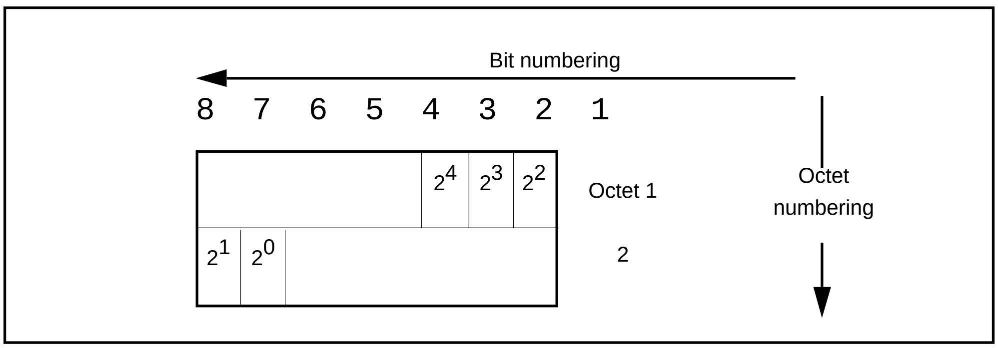
2.8.3 Field mapping convention

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

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

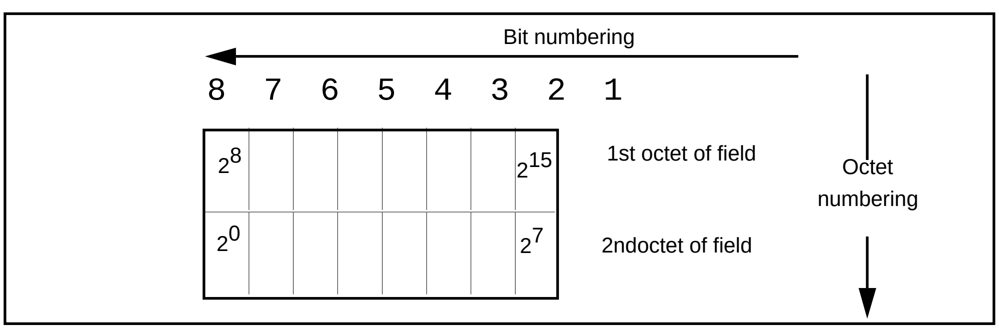
For example, a bit number can be identified as a couple (o, b) where o is the octet number and b is the relative bit number within the octet. Figure 3-2 shows a field that spans from bit (1, 3) to bit (2, 7). The high order bit of the field is mapped on bit (1, 3) and the low order bit is mapped on bit (2, 7).

Figure 3-3
Format mapping convention



An exception to the preceding field mapping convention is the data-link-layer frame check sequence (FCS) field, which spans two octets. In this case, bit 1 of the first octet is the high order bit and bit 8 of the second octet is the low order bit (Figure 3-4).

Figure 3-4
Format mapping convention



2.9 Invalid frames

An invalid frame is a frame which has one or more of the following properties:

- it is not properly bounded by two flags
- it has fewer than 6 octets between flags of frames that contain sequence numbers and fewer than 5 octets between flags of frames that do not contain sequence numbers
- it does not consist of an integral number of octets prior to zero bit insertion or following zero bit extractions
- it contains a frame-check sequence error
- it contains a single octet address field
- it contains a service access point identifier (SAPI) which is not supported by the receiver

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

2.10 Frame abort

Receipt of seven or more continuous “1”bits is interpreted as an abort message and the data-link-layer entity ignores the frame currently being received.

Chapter 3-3: Layer 2 elements of procedures

3.1 Introduction

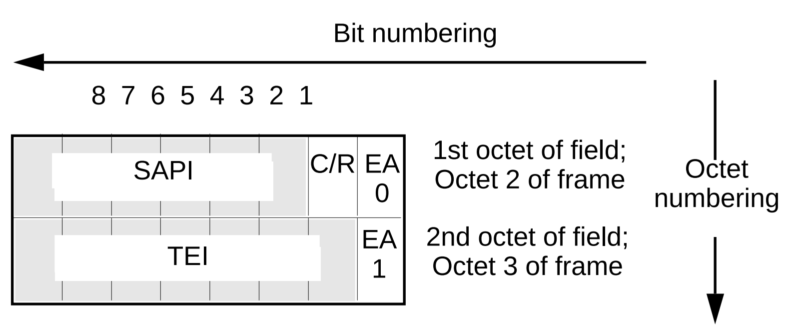
This chapter defines the commands and responses that are used on the data link connections carried on the D-channel.

Procedures are derived from these elements and are described in Chapter 3-5: "Definition of peer-to-peer procedures for Layer 2".

3.2 Address field format

The address field format shown in Figure 3-5 contains the address field extension bits, a command and response indication bit (C/R), a data-link-layer Service Access Point Identifier (SAPI) subfield, and a Terminal Endpoint Identifier (TEI) subfield.

Figure 3-5
Format mapping convention



EA = Address field extension bit
C/R = Command and response indication bit
SAPI = Service access point identifier
TEI = Terminal endpoint identifier

3.3 Address field variables

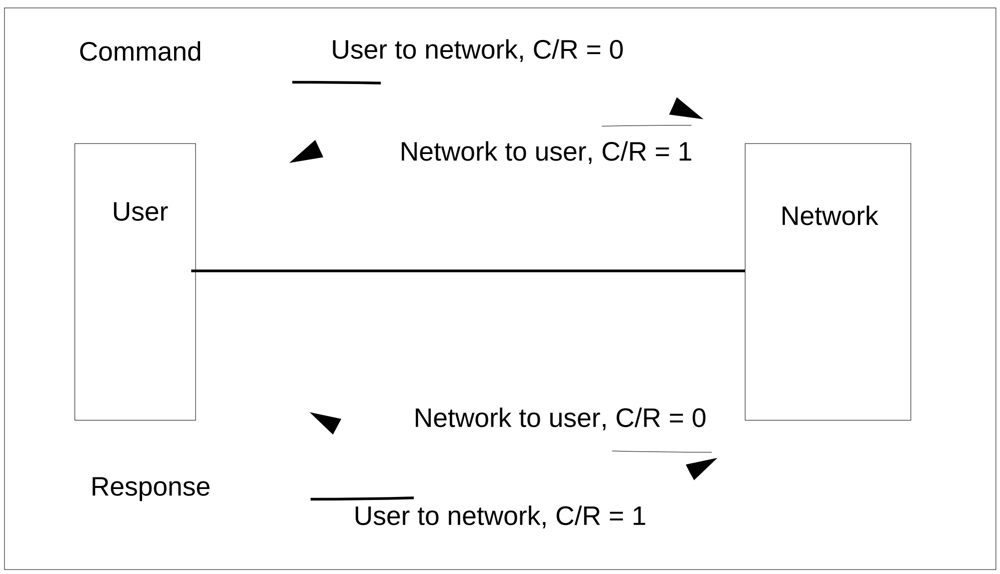
3.3.1 Address field extension bit (EA)

The address field range is extended by reserving the first transmitted bit of the address field octets to indicate the final octet of the address field. The presence of a “1”in the first bit of an address-field octet signals that it is the final octet of the address field. The double-octet address field for LAPD operation has bit 1 of the first octet set to a “0”and bit 1 of the second address octet set to “1”.

3.3.2 Command response field bit (C/R)

The C/R bit identifies a frame as either a command or a response. The user side sends commands with the C/R bit set to “0”, and responses with the C/R bit set to “1”. The network side does the opposite; that is commands are sent with C/R set to “1”, and responses are sent with C/R set to “0”. The combinations for the network side and user side are shown in Figure 3-6.

Figure 3-6
C/R field bit usage



3.3.3 Service access point identifier (SAPI)

The SAPI identifies an endpoint at which data-link-layer services are provided by a data-link-layer entity to a Layer 3 or management entity. Consequently, the SAPI specifies a data-link-layer entity that should process a data-link-layer frame and also a Layer 3 or management entity which is to receive information carried by the data-link-layer frame.

The SAPI allows 64 (2^5) service access points to be specified. In the address field octet containing the SAPI, bit 3 is the least significant binary digit and bit 8 is the most significant. The SAPI values are allocated as shown in Figure 3-7

Figure 3-7
Allocation of SAPI values

SAPI value	Related Layer 3 or management entity
0	Call control procedures
All others	Reserved for future standardization

3.3.4 Terminal end-point identifier (TEI)

The TEI for a point-to-point data link connection may be associated with a single item of terminal equipment (TE). A TE contains one TEI for point-to-point data transfer. The TEI subfield allows 128 (2^6)values to be specified. where bit 2 of the address field octet containing the TEI is the least significant binary digit and bit 8 is the most significant binary digit.

The TEI values from 0 to 126 are used for the point-to-point data link connections associated with the addressed SAP. The TEI subfield bit pattern `111 1111` (=127) is reserved for assignment to the broadcast data link connection. This value is not supported.

The user side is assigned one TEI value, that is, the value of 0. The TEI is assigned at the time of subscription (and consequently described also as fixed or non-automatic TEI equipment), and may be entered into TE, for example, by the user or manufacturer.

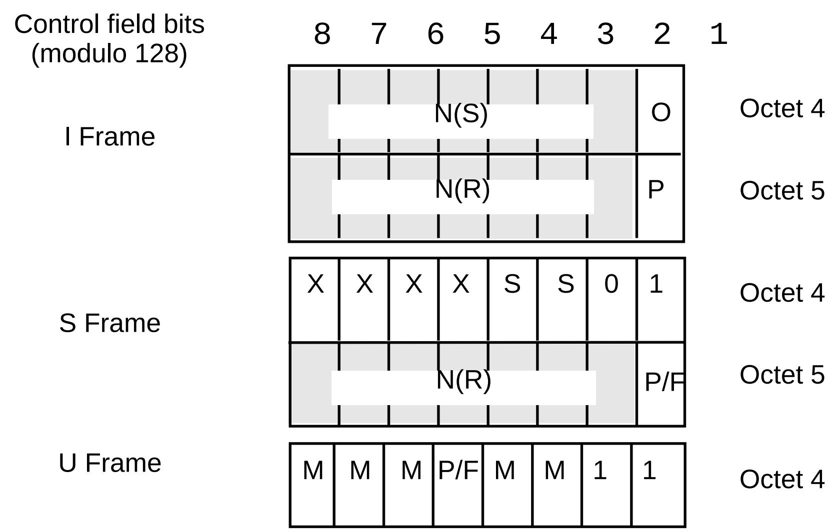
3.4 Control field formats

The control field identifies the type of frame. It can be either a command or a response frame. The control field contains sequence numbers where applicable. Three types of control field formats are specified:

- numbered information transfer (I format)
- supervisory function (S format)
- unnumbered information transfers and control functions (U format).

The control field formats are shown in Figure 3-8.

Figure 3-8
Control field formats



N(S)	Transmitter send sequence number	M	Modifier function bit
N(R)	Transmitter receive sequence number	P/F	Poll bit when issued as a command, final bit when issued as a response
S	Supervisory function bit	X	Reserved and set to “0”

3.4.1 Information transfer format-I frame

The I format is used for frames that transfer information between Layer 3 entities. The functions of N(S), N(R) and P (defined in paragraph 3.5 on page 3-19) are independent. Each I frame has an N(S) sequence number and an N(R) sequence number which may or may not acknowledge additional I frames received by the data-link-layer entity. The P bit that may be set to “0” or “1”.

The use of N(S), N(R), and P bits are defined in Chapter 3-5: "Definition of peer-to-peer procedures for Layer 2".

3.4.2 Supervisory format-S frame

The S format is used for frames that perform data link supervisory control functions such as

- acknowledging I frames
- requesting retransmission of I frames
- requesting a temporary suspension of transmission of I frames

The functions of N(R) and P/F are independent. Each supervisory frame has an N(R) sequence number which may or may not acknowledge additional

I frames received by the data-link-layer entity. The P/F bit that may be set to “0” or “1”.

The use of N(S), N(R) and P bits are defined in Chapter 3-5: "Definition of peer-to-peer procedures for Layer 2".

3.4.3 Unnumbered format-U frame

The U format is used for frames that provide additional data link control functions. This format does not contain any sequence numbers. It does include a P/F bit that may be set to “0” or “1”. Unnumbered frames have a one-octet-sized control field.

The use of the P bit is defined in Chapter 3-5: "Definition of peer-to-peer procedures for Layer 2".

3.5 Control field parameters and associated state variables

The various parameters associated with the control field formats are described in this paragraph.

The coding of the bits within these parameters is such that the lowest numbered bit within the parameter field is the least significant bit.

3.5.1 Poll/final (P/F) bit

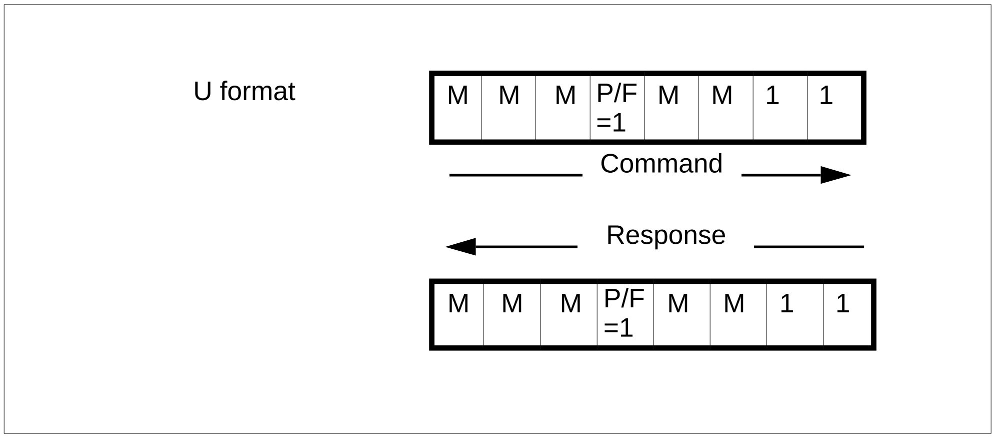
All frames contain a poll/final (P/F) bit. The P/F bit is used in both command and response frames. In command frames, the P/F bit is called the P bit. In response frames it is called the F bit.

When the P bit set to “1”, this indicates that the data-link-layer entity is requesting a response frame (polling) from the data-link-layer entity to which the frame is addressed.

When the F bit set to “1”, this indicates that the frame is a response from a data-link-layer entity sent as a result of a soliciting (poll) command.

The use of the P/F bit is fully described in Chapter 3-5: "Definition of peer-to-peer procedures for Layer 2".

Figure 3-9
Example of P/F bit for U-format frames



3.5.2 Multiple frame operation-variables and sequence numbers

This paragraph describes all the variables and sequence numbers that are used when frames are transmitted. Figure 3-10 shows how these numbers progress as different frames are sent.

Modulus

Each I frame is sequentially numbered. The modulus is 128, and the sequence numbers cycle through the entire range, 0 through 127.

Send state variable, V(S)

When using I-frame commands, each point-to-point data link connection endpoint has an associated send state variable [V(S)]. The send state variable denotes the sequence number of the next in-sequence I frame that the end point transmits.

The send state variable has a value in the range 0 through 127. The value of the send state variable is incremented by 1 with each successive I-frame transmission. It cannot exceed V(A) by more than the maximum number of outstanding I frames, “k”. The value of “k” ranges from 1 through 127.

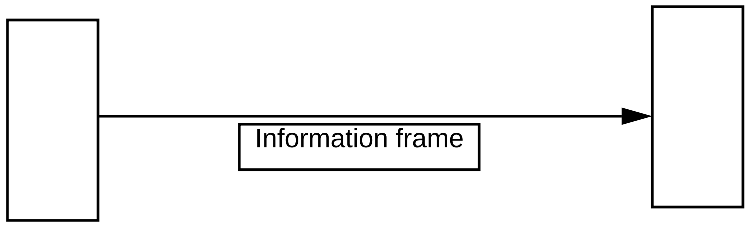
Acknowledge state variable, V(A)

When using I-frame commands and Supervisory frame commands and responses, each point-to-point data link connection endpoint has an associated acknowledge state variable [V(A)]. The acknowledge state variable identifies the last frame that has been acknowledged by its peer.

N(S) of last acknowledged I frame = V(A) - 1

The acknowledge state variable has a value in the range 0 through 127. The value of the acknowledge state variable is updated whenever a frame with a valid receive sequence number [N(R)] is received from its peer. A valid N(R) has a value in the range V(A) ≤ N(R) ≤ V(S).

Figure 3-10
Variable and sequence number progression



First frame sent

V(S) = 1	In frame 1	Assume k = 2 in this example
V(A) = 1	N(S) = 1	
V(R) = 1	N(R) = 1	

Second frame sent

V(S) = 2	In frame 2
V(A) = 1	N(S) = 2
V(R) = 1	N(R) = 1

Third frame to be sent

V(S) = 3	In frame 3	
V(A) = 1	N(S) = 3	Frame cannot be sent until
V(R) = 1	N(R) = 1	an acknowledge is returned

because
V(S) [=3] - V(A) [=1] ≥ k [=2]

When 1st acknowledge frame returned:
V(S) = 2
V(A) = 2
V(R) = 1

When 2nd acknowledge frame returned for both frames sent:
V(S) = 2
V(A) = 3
V(R) = 1

Send sequence number, N(S)

Only I frames contain send sequence numbers [N(S)].When an in-sequence I frame is transmitted, the value of the send sequence number [N(S)] in the frame is set equal to the value of the send state variable [V(S)].

Receive state variable, V(R)

When using I frame commands and supervisory frame commands and responses, each point-to-point data link connection endpoint has an associated receive state variable [V(R)].

The receive state variable [V(R)] denotes the sequence number of the next in-sequence I frame expected to be received. The receive state variable has a value in the range 0 through 127. The value of the receive state variable is incremented by one when each error free, in-sequence I frame is received provided its N(S) value equals the receive state variable [V(R)].

Figure 3-11
Layer 2 commands and responses

Format	Commands	Responses	Encoding 8 7 6 5 4 3 2 1	Octet No.
Information transfer	I (Information)		N(S) | 0	4
			N(R) | P	5
Supervisory	RR (Receive ready)	RR	0 0 0 0 0 0 0 1	4
			N(R) | P/F	5
	RNR (Receive not ready)	RNR	0 0 0 0 0 0 0 1	4
			N(R) | P/F	5
	REJ (Reject)	REJ	0 0 0 0 1 0 0 1	4
			N(R) | P/F	5
Unnumbered	SABME*		0 1 1 P 1 1 1 1	4
		DM (Disconnect mode)	0 0 0 F 1 1 1 1	4
	DISC (Disconnect)		0 1 0 P 0 0 1 1	4
		UA (Unnumbered acknowledge)	0 1 1 F 0 0 1 1	4
		FRMR (Frame reject)	1 0 0 F 0 1 1 1	4

*Set asynchronous balance mode extended

Receive sequence number, N(R)

All I frames and supervisory frames contain N(R), the expected send sequence number of the next received I frame. When any I or S frame is transmitted, the value N(R) in that frame is set equal to the current value of the receive state variable [V(R)]. N(R) indicates that the data-link-layer entity transmitting the

N(R) has correctly received all I frames numbered up to and including N(R) - 1.

3.6 Frame types

3.6.1 Commands and responses

This paragraph describes the commands and responses that are used by either the user or the network data-link-layer entities. Each data link connection supports all the commands and responses identified below.

Only point-to-point, acknowledged, multiple frame information transfer is supported. Frame types associated with other information transfer modes are discarded. No other action is taken.

All commands and responses that are transmitted in a Supervisory frame-with its supervisory function bits set to “11”-are ignored. Similarly those commands and responses sent in an unnumbered frame that has its modifier bits set to any other value than those identified in Figure 3-11 are also ignored.

3.6.2 Information (I) command

The information (I) command is used to transfer, across a data link connection, sequentially numbered frames containing information fields provided by layer 3. This command is used in the multiple frame operation on point-to-point data link connections.

3.6.3 Set asynchronous balanced mode extended (SABME) command

The SABME command is used to place the addressed user side or network side into a multiple-frame, acknowledged, information transfer operating mode with modulo 128 sequence numbering. The SABME frame is not numbered.

No information field can be present in the SABME command frame. A data-link-layer entity confirms acceptance of a SABME command by transmitting a UA response at the first opportunity.

When the UA is received, the sending side data-link-layer entity’s variables are reset as follows. The send state variable V(S), acknowledge state variable V(A), and receive state variable V(R) are set to zero. The transmission of an SABME command indicates that all exception conditions have been cleared.

Previously transmitted I frames that are unacknowledged when this command is processed remain unacknowledged and are discarded. It is the responsibility of a higher level (for example, Layer 3) or the management entity to recover any such loss of information.

3.6.4 Disconnect (DISC) command

The DISC unnumbered command is transmitted to terminate multiple frame operation.

No information field can be present in the DISC command frame. The data-link-layer entity receiving the DISC command confirms the acceptance of a DISC command by transmitting a UA response. The data-link-layer entity sending the DISC command terminates the multiple frame operation when it receives an acknowledging UA response.

Previously transmitted I frames that are unacknowledged when this command is processed remain unacknowledged and are discarded. It is the responsibility of a higher level (for example, Layer 3) or the management entity to recover any such loss of information.

3.6.5 Receive ready (RR) command and response

The RR supervisory frame is used by a data-link-layer entity to

- indicate it is ready to receive an I frame
- acknowledge previously received I frames numbered up to and including N(R) - 1
- clear a busy condition that was indicated by the earlier transmission of an RNR frame by that same data-link-layer entity

In addition to indicating the status of a data-link-layer entity, the RR command (with the P bit set to “1”) is used by the data-link-layer entity to ask for the status of its peer data-link-layer entity.

3.6.6 Receive not ready (RNR) command and response

The RNR supervisory frame is used by a data-link-layer entity to indicate to the other end of the link that it is in a busy condition. That is, for a short time, it cannot accept additional incoming I frames. The value of N(R) in the RNR frame acknowledges I frames numbered up to and including N(R) - 1 have been received.

In addition to indicating the status of a data-link-layer entity, the RNR command (with the P bit set to “1”) may be used by the data-link-layer entity to ask for the status of its peer data-link-layer entity.

3.6.7 Reject (REJ) command and response

The REJ supervisory frame is used by a data-link-layer entity to request retransmission of I frames starting with the frame numbered N(R). The value of N(R) in the REJ frame acknowledges that I frames numbered up to and including {N(R) - 1} have been received. New I frames pending initial transmission are transmitted following the retransmitted I frame(s).

Only one REJ exception condition for a given direction of information transfer is established at a time. The REJ exception condition is reset when an I frame with an N(S) equal to the N(R) of the REJ frame is received.

The transmission of a REJ frame also indicates that the busy condition has cleared on a sending data-link-layer entity. The busy state would normally have been signalled by the transmission of an RNR frame by that same data-link-layer entity.

In addition to indicating the status of a data-link-layer entity, the REJ command (with the P bit set to “1”) is used by the data-link-layer entity to ask for the status of its peer data-link-layer entity.

3.6.8 Receive not ready (RNR) command and response

The RNR supervisory frame is used by a data-link-layer entity to indicate a busy condition. That is, a temporary inability to accept additional incoming I frames. The value of the receive sequence number [N(R)] in the RNR frame acknowledges I frames numbered up to and including [N(R) - 1].

In addition to indicating the status of a data-link-layer entity, the RNR command-with the P bit set to 1-may be used by the data-link-layer entity to enquire about the status of its peer data-link-layer entity.

3.6.9 Unnumbered acknowledgment (UA) response

The UA response is used by a data-link-layer entity to acknowledge the receipt and acceptance of the mode-setting commands (SABME or DISC). Received mode-setting commands are not processed until the UA response is transmitted. The UA response frame does not contain an information field.

The transmission of the UA response is also used to indicate the clearance of any busy condition that was reported by the earlier transmission of an RNR frame by that same data-link-layer entity.

3.6.10 Disconnected mode (DM) response

The DM response is used by a data-link-layer entity to report to its peer that the data link layer is in a state such that multiple frame operation cannot be performed. This frame is not numbered. The DM response frame does not contain an information field.

3.6.11 Frame reject (FRMR) response

The FRMR unnumbered response may be received by a data link layer entity as a report of an error condition not recoverable by retransmission of the identical frame; that is, at least one of the following error conditions, resulting from the receipt of a valid frame:

- a frame containing a command or response control field that is not defined or is not implemented. An undefined or unimplemented control or response field is any control field code not identified in Figure 3-11.

- A supervisory or unnumbered frame of incorrect length. A frame containing an information field that is not permitted, with exception to the following message types; SABME, DISC, UA, RR, RNR, and REJ. For these messages, the frame is simply ignored.
- A frame received with an invalid receive sequence number [N(R)]. A valid N(R) value is one that is in the range V(A) ≤ N(R) ≤ V(S).

If such an error occurs, an information field immediately following the control field is returned It consists of five octets with this response and provides the reason for the FRMR response. This information field format is shown in Figure 3-12.

Figure 3-12
FRMR information field format for extended (modulo 128) operation)

8	7	6	5	4	3	2	1	
Rejected frame control field								Octet 5
								Octet 6
V(S)							0	Octet 7
V(R)							C/R	Octet 8
0	0	0	0	Z	Y	X	W	Octet 9

Notes:
The rejected frame control field is the control field of the received frame which causes rejection. When the rejected frame is not numbered, the control field of the rejected frame is positioned in octet 5, with octet 6 set to “`0000 0000`”.

V(S) is the value of the current send state variable (on the user side or network side) that is reporting the rejection condition.

If C/R set to “1”, it indicates that the rejected frame was a response. If C/R is set to “0”, it indicates that the rejected frame was a command.

V(R) is the value of the current receive state variable (on the user side or network side) that is reporting the rejection condition.

W set to “1” indicates that the control field received and returned in octets 5 and 6 was undefined or not implemented.

X set to “1” indicates that the control field received and returned in octets 5 and 6 was considered invalid because the frame contained an information field which is not permitted with this frame, or the frame is a supervisory or unnumbered frame of incorrect length. Bit W must be set to “1” in conjunction with this bit.

Y set to “1” indicates that the information field received exceeded the maximum established information field length (N201) of the user side or network side reporting the rejection condition.

Z is set to “1” indicates that the control field received and returned in octets 5 and 6 contained an invalid N(R).

Octet 7, bit 1 and octet 9, bits 5 through 8, are always set to “0” as indicated.

> ***Note:*** DMS implementation does not generate FRMR frame under any conditions. However, it responds to a received FRMR frame as specified in this document.

Chapter 3-4: Layer 2 elements for layer-to-layer communication

4.1 Introduction

Communication between layers and between the data link layer and the management entity is accomplished by means of primitives.

Primitives represent, in an abstract way, the logical exchange of information and control between the data link layer and adjacent layers. They do not specify or constrain implementations.

Primitives consist of commands and their respective responses associated with the services requested of a lower layer. The general syntax of a primitive is:

Interface- Generic name - Type: Parameters

4.2 Interface

The interface part of the primitive determines the interface across which the primitive flows. For ISDN PRI, the following primitives have been defined:

- DL defines communication between Layer 3 and the data link layer
- PH defines communication between the data link layer and the physical layer
- MDL defines communication between the layer management and the data link layer

4.3 Generic names

The generic name specifies the activity that should be performed by the primitive. Table 3-1 illustrates the primitives defined in this chapter. (Note that some of the primitives do not have associated parameters.) A list of all the primitives and their uses follows Table 3-1.

Table 3-1
Primitives associated with the data link layer

Generic name	Type				Parameters		Message unit contents
	Request	Indi-cation	Res-ponse	Confirm	Priority indicator	Message unit	
Layer 3-to-Layer 2 boundary							
DL-Establish	X	X	-	X	-	-	
DL-Release	X	X	-	X	-	-	
DL-DM-Release	X	-	-	-	-	-	
DL-Data	X	X	-	-	-	X	Layer 3 peer-to-peer message
Management entity-to-Layer 2 boundary							
MDL-Assign	X	X	-	-	-	X	TEI value-CES
MDL-Remove	X	-	-	-	-	X	TEI value-CES
MDL-Error	-	X	X	-	-	X	Reason for error
Later 2-to-Layer 1 boundary							
PH-Data	X	X	-	-	X	X	Layer 2 peer-to-peer message

4.3.1 DL-Establish

The *DL-Establish* primitives are used to request, indicate, and confirm the outcome of the procedures used to establish multiple-frame operation.

4.3.2 DL-Release

The *DL-Release* primitives are used to request, indicate, and confirm the outcome of the procedures for terminating a previously established multiple-frame operation. These primitives are also used to report unsuccessful attempts to establish multiple-frame operation.

4.3.3 DL-DM-Release

The *DL-DM-Release* primitives are equivalent to a *DL-Release* request. These primitives cause the Layer-2 entity to respond to a SABME command with a DM response. This primitive is used in the D-channel backup procedures (see Chapter 3-5: "Definition of peer-to-peer procedures for Layer 2").

4.3.4 DL-Data

The *DL-Data* primitives are used to request and indicate layer-3 messages which are to be transmitted, or have been received by the data link layer. These primitives are only used if the Layer-3 messages are transmitted using the acknowledged information transfer service.

4.3.5 MDL-Assign

The *MDL-Assign* primitives are used by the layer management entity to request that the data link layer associate the TEI value contained within the message portion of the primitive with the specified connection endpoint suffix (CES), across all SAPIs.

In addition, an *MDL-Assign* primitive is used by the data link layer to indicate to a layer management entity that a TEI value needs to be associated with the CES specified in the primitive message unit.

4.3.6 MDL-Remove

The *MDL-Remove* primitives are used by the layer management entity to request that the data link layer remove the association of the specified TEI value with the specified CES, across all SAPIs. The TEI and CES are specified in the *MDL-Remove* primitive message unit.

4.3.7 MDL-Error

The *MDL-Error* primitives are used to indicate to the connection management entity that one of the following has been detected:

- an error associated with a previous management function request
- an error in a communication with the data link layer peer entity, which cannot be corrected by the data link layer

The management entity may respond with an *MDL-Error* primitive if the management entity cannot obtain a TEI value

4.3.8 PH-Data

The *PH-Data* primitives are used to request and indicate message units containing frames used for data link layer peer-to-peer communications passed to and from the physical layer.

4.4 Primitive types

The primitive types defined in this specification are defined in the following paragraphs.

4.4.1 Request

The *Request* primitive type is used when a higher layer or a management entity is requesting a service from the next lower layer.

4.4.2 Indication

The *Indication* primitive type is used by a layer providing a service to inform the next higher layer or layer management.

4.4.3 Response

The *Response* primitive type is used by layer management as a consequence of the *Indication* primitive type.

4.4.4 Confirm

The *Confirm* primitive type is used by the layer providing the requested service to confirm that the activity has been completed.

4.5 Parameter definition

4.5.1 Priority indicator

Since several service access points (SAPs) may exist on the network side or on the user side, protocol message units sent by one SAP may contend with those of other SAPs for the physical resources available for message transfer.

The priority indicator is used to determine which message unit has greater priority when contention exists. The priority indicator is only needed on the user side. It is used to distinguish message units sent by the SAP (with a SAPI value of "0") from all other message units.

4.5.2 Message unit

The message unit contains additional layer-to-layer information concerning actions and results associated with requests. For *Data* primitives, the message unit contains the requesting layer peer-to-peer messages. For example, the *DL-Data* message unit contains Layer 3 information. The *PH-Data* message unit contains the data link frame.

> ***Note:*** The operations across the Layer 2-to-Layer 3 boundary are such that the layer sending the *DL-Data* primitive assumes a temporal order of the bits within the message unit. It is also assumed that the layer receiving the primitive can reconstruct the message with its assumed temporal order.

4.6 Primitive procedures

Primitive procedures specify the interactions used (between adjacent layers of the protocol) to invoke and provide a service. The service primitives represent the elements of the procedures.

In this section, the interactions between Layer 3 and the data link layer are specified.

The states of a data link connection endpoint may be derived from the internal states of the data link layer entity supporting this type of a data link connection.

The data link connection endpoint states for point-to-point data link connection endpoints are as follows:

- link connection released

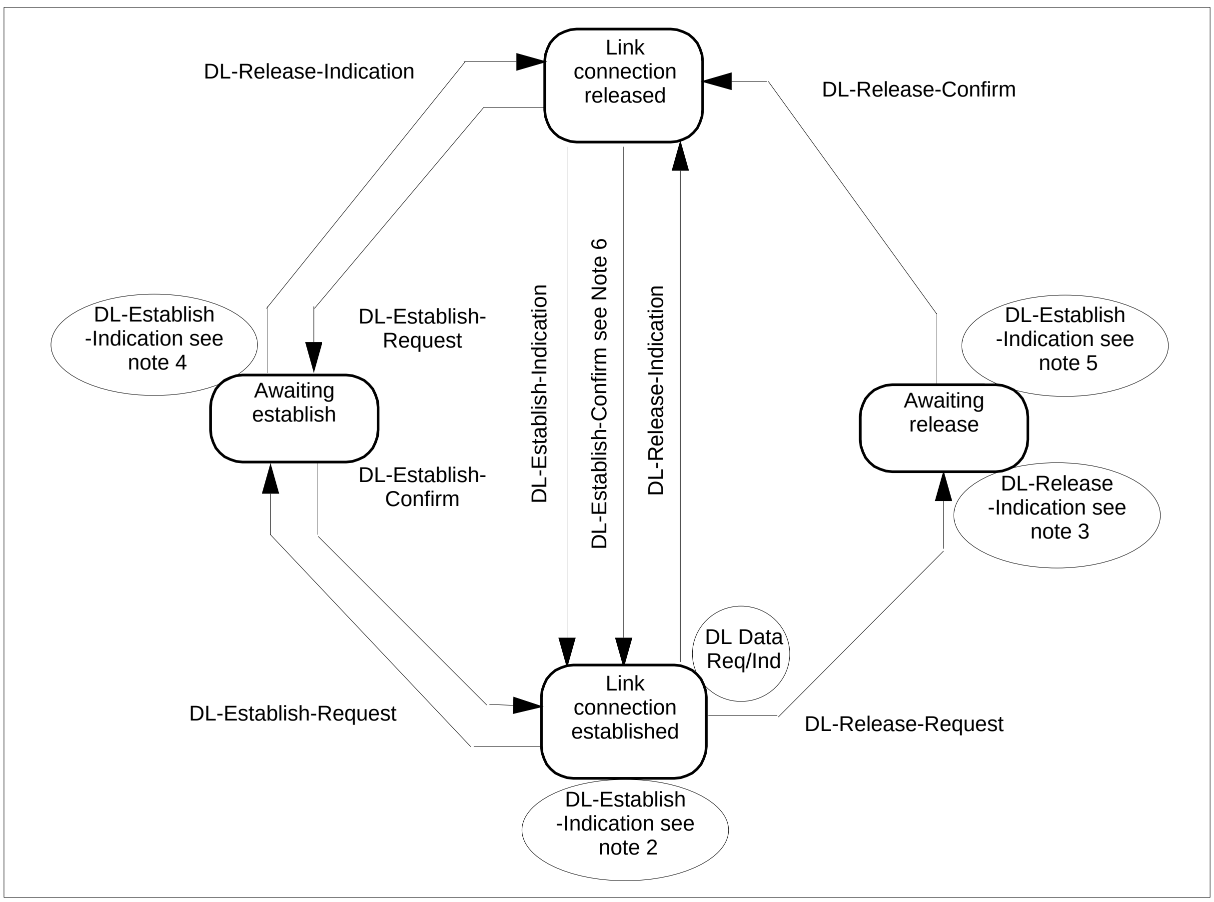
- awaiting establish
- awaiting release
- link connection established

The primitives provide the procedures to specify, conceptually, how a data link service user can invoke a service.

The possible overall sequences of primitives at a point-to-point data link connection endpoint are shown in the state transition diagram (Figure 3-13) The sequences are related to the states at one point-to-point data link connection endpoint.

The *Link connection released* and *Link connection established* states are stable states while the *Awaiting establish* and *Awaiting release* states are transition states.

Figure 3-13
State transition diagram for sequences of primitives at a point-to-point data link connection endpoint as seen by Layer 3.



Note 1: If the data link layer entity issues a *DL-Establish-Indication* primitive, (for instance, if the data link layer is initiated or the peer system initiated re-establishment), a *DL-Release-Confirm* primitive, or a *DL-Release-Indication* primitive, all the data link service data units representing *DL-Data-Request*s are discarded.

Note 2: This primitive notifies Layer 3 that the link is re-established.

Note 3: This primitive is generated if a *DL-Release-Request* collides with a *DL-Release-Indication*.

Note 4: This primitive is generated if a *DL-Establish-Request* collides with a *DL-Establish-Indication*.

Note 5: This primitive is generated if a *DL-Release-Request* collides with a *DL-Establish-Indication*.

Note 6: This primitive is generated if a *DL-Establish-Request* (generated if Layer 3 attempts to re-establish the call) collides with a *DL-Release-Indication*. Since this *DL-Release-Indication* is not related to the *DL-Establish-Request*, the data link layer establishes the link and issue a *DL-Establish-Confirm*.

Chapter 3-5: Definition of peer-to-peer procedures for Layer 2

This chapter specifies the procedures used by the data-link-layer entities.

The elements of procedure (frame types) which apply to point-to-point, acknowledged, and multiple-frame information transfer are:

- Set asynchronous balanced mode extended (SABME) command
- Unnumbered acknowledgment (UA) response
- Disconnected mode (DM) response
- Disconnect (DISC) command
- Receive ready (RR) command and response
- Receive not ready (RNR) command and response
- Reject (REJ) command and response
- Information (I) command
- Frame reject (FRMR) response

5.1 Procedure for use of the P/F bit

5.1.1 Unacknowledged information transfer

Unacknowledged information transfer is not supported for PRI.

5.1.2 Acknowledged multiple-frame information transfer

A data-link-layer entity receiving an SABME, DISC, RR, RNR, REJ, or I-frame with the P bit set to “1”, sets the F bit to “1” in the next response frame it transmits as shown in Table 3-2.

Table 3-2
Immediate response operation of P/F bit

Command received with P bit = 1	**Response transmitted with F bit = 1**
SABME, DISC	UA, DM
I, RR, RNR, REJ	RR, RNR, REJ, FRMR, DM

5.2 Procedures for unacknowledged information transfer

Unacknowledged information transfer is not supported for PRI.

5.3 Terminal endpoint identifier (TEI) management procedures

User equipment in the TEI-unassigned state enters the TEI-assigned state when layer management assigns a TEI value of 0 to that equipment. The state change is carried out when layer management issues an *MDL-Assign-Request* primitive.

User equipment in the TEI-assigned state enters the TEI-unassigned state when layer management removes the TEI from that equipment. The TEI is removed when layer management issues an *MDL-Remove-Request* primitive.

5.4 Automatic negotiation of data-link-layer parameters

Automatic negotiation of data-link-layer parameters is not supported in this specification.

5.5 Procedures for establishment and release of multiple frame operation

5.5.1 Establishment of multiple frame operation

Only the extended multiple-frame operation (modulo 128 sequencing) is supported for PRI.

The following procedures are used to establish multiple-frame operation between the network and a designated user entity.

Layer 3 requests establishment of multiple frame operation by the using the *DL-Establish-Request* primitive. Re-establishment may be initiated by the data-link-layer procedures defined in paragraph 5.7 on page 3-49. All frames (other than unnumbered frames) received during the establishment procedures are ignored.

Establishment procedures

A data-link-layer entity initiates a request for multiple frame operation by transmitting the *Set asynchronous balanced mode extended* (SABME) command. The SABME command:

- clears all existing exception conditions
- Resets the retransmission counter to zero
- Starts timer T200. (Timer T200 is defined in paragraph 5.9.1 on page 3-53.) All mode setting commands are transmitted with the P bit set to “1”.

Establishment procedures initiated by Layer 3 imply that all outstanding *DL-Data-Requests* and all I-frames in queues are discarded.

Having received a SABME command, and provided it can enter the multiple frame established state, the data-link-layer entity

- responds with an unnumbered acknowledgment (UA) response. The F bit is set to the same binary value (“0” or “1”) as the P bit in the received SABME command.
- sets the send state variable V(S), the receive state variable V(R), and the acknowledge state variable V(A) to “0”
- enters the multiple-frame established state and inform Layer 3 using the *DL-Establish-Indication* primitive
- clears all existing exception conditions
- clears any existing peer receiver busy condition
- starts timer T203. (Timer T203 is defined in paragraph 5.9.8 on page 3-54.)

If the data-link-layer entity cannot enter the multiple-frame established state, it responds to the SABME command with a Disconnected mode (DM) response. The F bit is set to the same binary value (“0” or “1”) as the P bit in the received SABME command.

If a UA response is received-by the originator of the SABME command-with the F bit set to “1”, the originator:

- resets timer T200
- starts timer T203
- sets the send state variable V(S), the receive state variable V(R), and the acknowledge state variable V(A) to “0”
- enters the multiple-frame established state and informs Layer 3 using the *DL-Establish-Confirm* primitive

If a DM response is received (by the originator of the SABME command) with the F bit set to “1”, the originator of the SABME command:

- informs Layer 3 that it has received this command using the *DL-Release-Indication* primitive
- resets timer T200
- enters the TEI-assigned state

If a DM response is received (by the originator of the SABME command) with the F bit set to ‘”0”, the originator of the SABME command ignores the response.

If a *DL-Release-Request* primitive is received during re-establishment by the data link layer, it is serviced on completion of the establishment mode-setting operation.

Procedure on expiry of timer T200

If timer T200 expires before the UA or DM response (with the F bit set to “1”) is received, the data-link-layer entity

- retransmits the SABME command
- restarts timer T200
- increments the retransmission counter
- (after retransmission of the SABME command N) indicates this to Layer 3 and the connection management entity by using the *DL-Release Indication* and *MDL-Error-Indication* primitives, respectively. After discarding all outstanding *DL-Data-Request* primitives and all I-frames in the queue, the data-link-layer entity enters the TEI-assigned state.

The value of N is set using the retransmission counter, N200. This counter is defined in paragraph 5.9.2 on page 3-54.

5.5.2 Information transfer

I-frames and supervisory frames are transmitted and received (according to the procedures described in paragraph 5.6 on page 3-41) if:

- UA is transmitted in response to a received SABME command.
- UA response is received in response to a transmitted SABME command.

If an SABME command is received while in the multiple-frame established state, the data-link-layer entity goes through the re-establishment procedures described in paragraph 5.7 on page 3-49.

5.5.3 Termination of multiple frame operation

The following procedures are used to terminate the multiple-frame operation between the network and a designated user entity.

A Layer-3 entity can request termination of the multiple frame operation by using the *DL-Release-Request* primitive.

All frames, other than the unnumbered frames received during the release procedures, are ignored. All outstanding *DL-Data-Request* primitives, and all I-frames in queue, are discarded.

If there is a persistent Layer 1 failure, the data-link-layer entity

- discards all I queues
- AND, delivers a *DL-Release-Confirm* primitive to Layer 3, if a *DL-Release-Request* primitive is outstanding.
- OR delivers a *DL-Release-Indication* primitive to Layer 3.

Release procedure

A data-link-layer entity can initiate a request for release of the multiple-frame operation by transmitting the Disconnect (DISC) command with the P bit set to “1”. Timer T200 is started and the retransmission counter, N200 is reset to zero.

If a data-link-layer entity receives a DISC command while in the multiple-frame established state, or the timer recovery state, it transmits a UA response with the F bit set to the same binary value (“0” or “1”) as the P bit in the received DISC command. A *DL-Release-Indication* primitive is passed to Layer 3 and the entity enters the TEI-assigned state.

If the originator of the DISC command receives one of the following, it enters the TEI-assigned state and timer T200 is reset:

- a UA response with the F bit set to “1”
- a DM response with the F bit set to “1” (indicating that the peer data-link-layer entity is already in the TEI-assigned state)

The data-link-layer entity which issued the DISC command notifies Layer 3 using the *DL-Release-Confirm* primitive. The conditions relating to the TEI-assigned state are defined in paragraph 5.5.4 on page 3-40.

Procedure on expiry of timer T200

If timer T200 expires before a UA or DM response with the F bit set to “1” is received, the originator of the DISC command

- retransmits the DISC command as defined above
- restarts the retransmission timer (T200)
- increments the retransmission counter, N200 by one

This is procedure is repeated N times. The value of N is set using the retransmission counter, N200. This counter is defined in paragraph 5.9.2 on page 3-54.

If the data-link-layer entity does not receive the correct response after N attempts to recover, the data-link-layer entity indicates this to the management entity using the *MDL-Error-Indication* primitive. The data-link-layer entity enters the TEI-assigned state, and notifies Layer 3 using the *DL-Release-Confirm* primitive.

5.5.4 TEI-assigned state

While in the TEI-assigned state, the data link layer responds to the various commands, as follows:

- DISC command received: A disconnected mode (DM) response is transmitted with the F bit set to the binary value (“0” or “1”) of the received P bit.
- SABME command received: The entity tries to enter the multiple-frame operation state as described in paragraph 5.5.1 on page 3-36.
- Unsolicited DM response (with the F bit set to “0”) received: The entity tries to enter the multiple-frame operation state as described in paragraph 5.5.1 on page 3-36, or, if it cannot, it ignores the DM response.
- Unsolicited UA response received: The entity issues an *MDL-Error-Indication* primitive.

All other frame types are ignored by the entity and are discarded.

5.5.5 Collision of unnumbered commands and responses

Identical transmitted and received commands

If the transmitted and received unnumbered commands (SABME or DISC) are the same, the data-link-layer entities send the UA response at the earliest possible opportunity.

The entity receiving the UA response enters the indicated state. The data-link-layer entities each notify their respective Layer 3 entity using the appropriate *-Confirm* primitive.

Different transmitted and received commands

If the transmitted and received unnumbered commands (SABME or DISC) are different, the data-link-layer entities issue a DM response at the earliest possible opportunity.

The entity receiving a DM response (with the F bit set to “1”) enters the TEI-assigned state and notifies its Layer 3 using the appropriate primitive.

The entity receiving the DISC command issues a *DL-Release-Indication* primitive while the other entity issues a *DL-Release-Confirm* primitive.

5.5.6 Unsolicited DM response and SABME or DISC command

When a DM response (with the F bit set to “0”) is received by a data-link-layer entity, a collision between a transmitted SABME or DISC command and the unsolicited DM response may have occurred. This is caused (typically) when the user equipment applies a protocol procedure according to X.25 LAPB to ask for a mode-setting command. See the reference *CCITT Recommendation X.25, 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*.

In order to avoid misinterpretation of the DM response received, a data-link-layer entity always sends a SABME or DISC command with the P bit set to “1”.

If a DM response (with the F bit set to “0”) collides with an SABME or DISC command, the DM response is ignored.

5.6 Procedures for information transfer in multiple frame operation

The procedures for transmitting I-frames are defined in the following paragraphs. The term “transmission of an I-frame” and its equivalents, refers to the delivery of an I frame by the data link layer to the physical layer.

5.6.1 Transmitting I-frames

Information is received by the data-link-layer entity from Layer 3 using the *DL-Data-Request* primitive. This information is transmitted between peer entities in an I-frame. The control field parameters, N(S) and N(R), in the I-frame are assigned the values of the send and receive state variables V(S) and V(R), respectively. The value of the send state variable V(S) is incremented by one at the end of the transmission of the I-frame.

If the retransmission timer, T200 is not running at the time of transmission of an I-frame, it is started. If the timer T200 expires before an acknowledgment is received by the sending entity, the procedures defined in paragraph 5.6.7 on page 3-48 are carried out.

If:
Send state variable V(S) = Acknowledge state variable V(A)
+ k (where k is the maximum number of
outstanding I-frames),
the data-link-layer entity does not transmit any new I-frames. It may retransmit an I-frame as a result of the error recovery procedures described in paragraph 5.6.4 on page 3-44 and paragraph 5.6.7 on page 3-48.

When the network side or user side is in the own-receiver busy[1] condition, it may still transmit I-frames, provided that a peer-receiver busy condition does not exist.

> ***Note:*** Any *DL-Data-Request* primitives received while in the timer recovery condition are queued.

5.6.2 Receiving I-frames

Independent of a timer recovery condition, when a data-link-layer entity is not in an own-receiver busy condition, and receives a valid I-frame, whose send sequence number N(S) is equal to the current receive state variable V(R), the data-link-layer entity

- passes the information field of this frame to Layer 3 using the *DL-Data-Indication* primitive.
- increments its receive state variable V(R) by one.

The following actions are done depending on the state of the P bit.

P bit set to "1"

If the P bit of the received I-frame is set to "1", the data-link-layer entity responds to its peer in one of the following ways:

- If the data-link-layer entity receiving the I-frame is still not in an own receiver busy condition, it sends an RR response (with the F bit set to "1").
- If the data-link-layer entity receiving the I-frame enters an own receiver busy condition upon receipt of the I-frame, it sends an RNR response (with the F bit set to "1").

P bit set to "0"

If the P bit of the received I-frame is set to "0" and:

- If the data-link-layer entity is still not in an own-receiver busy condition:
  - If no I-frame is available for transmission, or if an I-frame is available for transmission but a peer receiver busy condition exists, the data-link-layer entity transmits an RR response (with the F bit set to "0").
  - If an I-frame is available for transmission and no peer receiver busy condition exists, the data-link-layer entity transmits the I-frame with the value of N(R) set to the current value of V(R).
  - If, on receipt of this I-frame, the data-link-layer entity is now in an own-receiver busy condition, it transmits an RNR response (with the F bit set to "0").

---

[1]The term own- or peer-receiver busy refers to the peer-to-peer flow control state in the data-link-layer entities

When the data-link-layer entity is in an own receiver busy condition, it processes any received I-frame according to the procedures defined in paragraph 5.6.6 on page 3-47.

5.6.3 Sending and receiving acknowledgments

Sending acknowledgments

Whenever a data-link-layer entity transmits an I-frame or a supervisory frame, the value of N(R) is set equal to the value of V(R).

Receiving acknowledgment

On receipt of a valid I-frame or supervisory frame (RR, RNR, or REJ)-even in an own receiver busy or timer (T200) recovery condition-the data-link-layer entity treats the receive sequence number [N(R)] contained in this frame as an acknowledgment for all the I-frames it has transmitted with a send sequence number [N(S)] up to and including the received [N(R)-1].

The value of the acknowledge state variable V(A) is set to the value of N(R).

The data-link-layer entity resets the acknowledgment timer, T200 on receipt of one of the following:

- a valid I-frame.
- a supervisory frame with the receive sequence number [N(R)] higher than V(A) (actually acknowledging some I-frames).
- a REJ frame with an N(R) equal to V(A).

  Note 1: If a supervisory frame with the P bit set to “1” has been transmitted and not acknowledged, acknowledgment timer, T200 is not reset.

  Note 2: Upon receipt of a valid I-frame, acknowledgment timer, T200 is not reset if the data-link-layer entity is in the peer receiver busy condition.

If the acknowledgment timer, T200 has been reset by the receipt of an I, RR, or RNR frame, and if there are outstanding I-frames still unacknowledged, the data-link-layer entity restarts acknowledgment timer, T200. If the timer then expires, the data-link-layer entity attempts to recover as defined in paragraph 5.6.7 on page 3-48.

If the acknowledgment timer, T200 has been reset by the receipt of a REJ frame, the data-link-layer entity retransmit any outstanding frames as described in paragraph 5.6.4 on page 3-44.

5.6.4 Receiving REJ frames

On receipt of a valid REJ frame, the data-link-layer entity carries out the following

- if the data-link-layer entity is *not* in the timer recovery condition, the data-link-layer entity:
  - clears any existing peer receiver busy condition.
  - sets its send state variable V(S) and its acknowledge state variable V(A) to the value of the N(R) contained in the REJ frame control field.
  - stops the acknowledgment timer, T200.
  - starts the timer recovery timer, T203.
  - if it was a REJ command frame with the P-bit set to “1”, it transmits an appropriate supervisory response frame[1] with the F-bit set to “1”.
  - transmits the corresponding I-frame as soon as possible, as defined in paragraph 5.6.1 on page 3-41 taking into account the conditions 1 through 3 below.
  - notifies the management entity that a protocol violation has occurred. Use the *MDL-Error-Indication* primitive, if it was a REJ response frame with the F bit set to “1”.
- If the data-link-layer entity is in the timer recovery condition and it was a REJ response frame with the F bit set to “1”, the data-link-layer entity
  - clears any existing peer receiver busy condition.
  - sets its send state variable V(S) and its acknowledge state variable V(A) to the value of N(R) contained in the REJ frame control field.
  - stops the acknowledgment timer, T200.
  - starts timer recovery timer (T203).
  - enters the multiple-frame-established state.

---

[1]If the data-link-layer entity is not in an own receiver busy condition and is in a Reject exception condition (that is, an N(S) sequence error has been received, and a REJ frame has been transmitted, but the requested I-frame has not been received), the appropriate supervisory frame is the RR frame.

If the data-link-layer entity is not in an own receiver busy condition, but is in an N(S) sequence error exception condition, (that is, an N(S) sequence error has been received but a REJ frame has not been transmitted), the appropriate supervisory frame is the REJ frame.

If the data-link-layer entity is in its own receiver busy condition, the appropriate supervisory frame is the RNR frame.

Otherwise, the appropriate supervisory frame is the RR frame.

- transmits the corresponding I-frame as soon as possible, as defined in paragraph 5.6.1 on page 3-41 taking into account the conditions 1 through 3 below.

- If the data-link-layer entity is in the timer recovery condition and it was a REJ frame-other than a REJ response frame with the F bit set to “1”, the data-link-layer entity
  - clears any existing peer receiver busy condition
  - sets its acknowledge state variable V(A) to the value of the N(R) contained in the REJ frame control field
  - if it was a REJ command frame with the P bit set to “1”, it transmits an appropriate supervisory response frame with the F bit set to “1”. See footnote 1 on page 44 for a definition of the appropriate supervisory frame.

When I-frames are transmitted the following conditions are taken into account:

1. If the data-link-layer entity is transmitting a supervisory frame when it receives the REJ frame, it completes that transmission before commencing transmission of the requested I-frame.
2. If the data-link-layer entity is transmitting an SABME command, a DISC command, a UA response, or a DM response when it receives the REJ frame, it ignores the request for retransmission.
3. If the data-link-layer is not transmitting a frame when the REJ frame is received, it immediately commences transmission of the requested I frame.

All outstanding unacknowledged I-frames, commencing with the I-frame identified in the received REJ frame are transmitted. Other I-frames not yet transmitted may be transmitted following the retransmitted I-frames.

5.6.5 Receiving RNR

If the data-link-layer entity is not engaged in a mode setting operation, after receiving a valid RNR command or response, it sets a peer receiver busy condition and then

- if it was an RNR command (with the P bit set to “1”) and the data-link-layer entity is *not* in an own receiver busy condition, it responds with an RR response (with the F bit set to “1”)
- if it was an RNR command (with the P bit set to “1”) and the data-link-layer entity *is* in an own receiver busy condition, it responds with an RNR response (with the F bit set to “1”)
- If it was an RNR response (with the F bit set to “1”) any existing timer recovery condition is cleared and the receive sequence number [N(R)] contained in the RNR response is used to update the send state variable [V(S)]

The data-link-layer entity takes note of the peer receiver busy condition and does not transmit any I-frames to the peer which has indicated the busy condition.

> ***Note:*** The receive sequence number [N(R)] in any RR or RNR command frame-irrespective of the setting of the P bit-is *not* used to update the send state variable [V(S)].

The data-link-layer entity then

- treats the receive sequence number [N(R)] contained in the received RNR frame as an acknowledgment for all the I-frames that have been (re)transmitted with an N(S) up to and including [N(R) - 1]. It sets its acknowledge state variable [V(A)] to the value of the N(R) contained in the RNR frame.
- restarts the acknowledgment timer, T200 unless a supervisory response frame (with the F bit set to “1”) is still expected

If timer T200 expires, the data-link-layer entity

- if it is not yet in a timer recovery condition, enters the timer recovery condition, and resets the retransmission counter, N200
- OR, if it is already in a timer recovery condition, adds one to its retransmission counter, N200

The data-link-layer entity then

- if the value of the retransmission counter, N200 is less than its trip value:
  - transmits an appropriate supervisory command (with a P bit set to “1”). See footnote 1 on page 44 for a definition of the appropriate supervisory frame.
  - restarts the acknowledgment timer, T200
- If the value of the retransmission counter, N200 is equal to its trip value, the data-link-layer entity
  - initiates a re-establishment procedure as described in paragraph 5.7 on page 3-49.
  - indicates re-establishment is occurring by sending the *MDL-Error-Indication* primitive to the management entity.

The data-link-layer entity receiving the supervisory frame (with the P bit set to “1”) responds, at the earliest opportunity, with an appropriate supervisory response frame (with the F bit set to “1”), to indicate whether or not its own receiver busy condition still exists. See footnote 1 on page 44 for a definition of the appropriate supervisory frame.

When the supervisory response frame (with the F bit set to “1”) is received, the data-link-layer entity resets the acknowledgment timer, T200, and

- if the response is an RR or REJ response, the peer receiver busy condition is cleared and the data link entity may transmit new I-frames or retransmit I-frames.
- if the response is an RNR response, the data-link-layer entity receiving the response proceeds as indicated in the first paragraph of this description.

If a supervisory command (RR, RNR, or REJ) (with the P bit set to “0”or “1”) or a supervisory response frame (RR, RNR, or REJ) (with the F bit set to “0”) is received during the enquiry process, the data-link-layer entity carries out one of the following:

- If the supervisory frame is an RR or REJ command frame or an RR or REJ response frame (with the F bit set to “0”) the data-link-layer entity clears the peer receiver busy condition. I-frames are not (re)transmitted until the appropriate supervisory response frame (with the F bit set to “1”) is received, or the acknowledgment timer, T200 expires.
- If the supervisory frame is an RR or REJ command frame (with the P bit set to “1”) the data-link-layer entity transmits the appropriate supervisory response frame (with the F bit set to “1”). See footnote 1 on page 44 for a definition of the appropriate supervisory frame. I-frames are not (re)transmitted until the appropriate supervisory response frame (with the F bit set to “1”) is received, or the acknowledgment timer, T200 expires.
- If the supervisory frame is an RNR command frame or an RNR response frame (with the F bit set to “0”) the data-link-layer entity retains the peer receiver busy condition.
- If the supervisory frame received is an RNR command (with the P bit set to “1”) the data-link-layer entity transmits the appropriate supervisory response frame-with the F bit set to “1”.See footnote 1 on page 44 for a definition of the appropriate supervisory frame.

When an SABME command is received, the data-link-layer entity clears the peer receiver busy condition.

5.6.6 Data link layer own receiver busy condition

When the data-link-layer entity enters an own receiver busy condition, it transmits a receiver not ready (RNR) frame at the earliest opportunity.

The RNR frame may be one of the following:

- an RNR response-with the F bit set to “0”
- an RNR response (with the F bit set to “1”) if the busy condition occurs when a command frame (with the P bit set to “1”) is received

- an RNR command (with the P bit set to “1”) if the busy condition occurs when the acknowledgment timer, T200 expires

All I-frames (with the P bit set to “0”) that are received, are discarded, after the acknowledge state variable V(A) is updated.

All supervisory frames (with the P/F bit set to “0”) that are received are processed, including updating the acknowledge state variable, V(A).

All I-frames (with the P bit set to “1”) that are received are discarded, after the acknowledge state variable V(A) is updated. An RNR response frame (with the F bit set to “1”) is transmitted.

All supervisory frames (with the P bit set to “1”) that are received are processed including updating the acknowledge state variable V(A). An RNR response (with the F bit set to “1”) is transmitted.

To indicate to the peer data-link-layer entity that the own receiver busy condition has been cleared, the data-link-layer entity transmits one of the following:

- an RR frame
- if a previously detected N(S) sequence error has not been reported, an REJ frame with the N(R) set to the current value of the receive state variable V(R)

The transmission of an SABME command or a UA response (in reply to an SABME command) also indicates to the peer data-link-layer entity that the own receiver busy condition.has been cleared.

5.6.7 Waiting acknowledgment

The data-link-layer entity maintains an internal retransmission count variable.

If the acknowledgment timer, T200 expires, the data-link-layer entity

- if it is *not* in the timer recovery condition, enters the timer recovery condition and resets the retransmission counter, N200
- if it *is* in the timer recovery condition, adds one to its retransmission counter, N200

The data-link-layer entity then

- if the value of the retransmission counter, N200 is less than its trip value:
  - restarts timer T200, and, either
    - transmits an appropriate supervisory command (with the P bit set to “1”) (see footnote 1 on page 44 for a definition of the appropriate supervisory frame), or

- retransmits the last transmitted I-frame (V(S)-1) (with the P bit set to “1”)

- if the value of the retransmission counter, N200 is equal to its trip value
  - initiates a re-establishment procedure as defined in paragraph 5.7 on page 3-49.
  - indicates this to the management entity by issuing the *MDL-Error-Indication* primitive.

The timer recovery condition is cleared when the data-link-layer entity receives a valid supervisory frame response, with the F bit set to 1.

If the receive sequence number [N(R)] of the received supervisory frame is within the range from its current acknowledge state variable [V(A)] to its current send state variable [V(S)] inclusive, it sets its send state variable [V(S)] to the value of the received N(R).

The acknowledgment timer, T200 is reset if the received supervisory frame response is an RR or REJ response. After the timer is reset, the data-link-layer entity resumes I-frame (re)transmission, as appropriate.

The acknowledgment timer, T200 is reset and restarted if the received supervisory response is an RNR response. This allows the enquiry process-described in paragraph 5.6.5 on page 3-45-to proceed.

5.7 Re-establishment of multiple frame operation

5.7.1 Criteria for re-establishment

To re-establish the multiple-frame mode of operation, one or more of the following conditions must be satisfied:

- while in the multiple-frame mode of operation, an SABME command is received
- a *DL-Establish-Request* primitive is received from Layer 3
- while in the multiple-frame mode of operation, the retransmission counter, N200 must have reached its limit and the acknowledgment timer, T200 must have timed out
- while in the multiple-frame mode of operation, an FRMR response frame is received
- while in the multiple-frame mode of operation, an unsolicited DM response (with the F bit set to “0”) (with the F bit set to “0”) is received
- while in a timer recovery condition, a DM response (with the F bit set to “1”) is received

5.7.2 Procedures

In all re-establishment situations, the data-link-layer entity follows the procedures defined in paragraph 5.5.1 on page 3-36. Any locally generated condition that causes re-establishment procedures to be started, starts the re-establishment procedure by transmitting a SABME command.

For data-link-layer- and peer-initiated re-establishment, the data-link-layer entity also

- issues an *MDL-Error-Indication* primitive to the management entity
- if the send state variable [V(S)] > acknowledge state variable [V(A)], issue a *DL-Establish-Indication* primitive to Layer 3, and discard all I queues prior to re-establishing the call

For Layer 3-initiated re-establishment, or if a *DL-Establish-Request* primitive occurs before re-establishment, the *DL-Establish-Confirm* primitive is used.

5.8 Exception condition reporting and recovery

Exception conditions may occur as the result of physical layer errors or data-link-layer procedural errors.

The error recovery procedures which are available to effect recovery following the detection of an exception condition at the data link layer are defined in the following paragraphs.

5.8.1 Send sequence number [N(S)] sequence error

A send sequence number [N(S)] sequence error exception condition occurs in the receiver when a valid I-frame is received in which:

Send sequence number N(S) value ≠ Receive state variable V(R) at the receiver.

All information fields of all I-frames whose N(S) does not equal V(R) are discarded.

The receiver does not acknowledge the I-frame causing the sequence error or increment its V(R). It does not acknowledge any I-frames which may follow. Recovery from this condition is indicated when an I-frame with the correct send sequence number [N(S)] is received.

A data-link-layer entity which receives one or more I-frames having sequence errors which are otherwise error free, or subsequent supervisory frames (RR, RNR, and REJ), uses the control field information contained in the N(R) field and the P or F bit to perform data link control functions.

For example, it receives acknowledgment of previously transmitted I frames and causes the data-link-layer entity to respond if the P bit is set to “1”.

Therefore, the retransmitted I-frame may contain an N(R) field value and P bit that are updated from (and different from) those contained in the originally transmitted I-frame.

The REJ frame is used by a receiving data-link-layer entity to initiate an exception condition recovery (retransmission) following the detection of an N(S) sequence error. Only one REJ exception condition for a given direction of information transfer can be established at any one time.

When a data-link-layer entity receives a REJ command or response it initiates sequential transmission (retransmission) of all I-frames starting with the I frame indicated by the N(R) contained in the REJ frame.

A REJ exception condition is cleared when the requested I-frame is received or when an SABME or DISC command is received.

5.8.2 Receive sequence number [N(R)] sequence error

A receive sequence number [N(R)] sequence error exception condition occurs in the transmitter when a valid supervisory frame or I-frame is received which contains an invalid receive sequence number [N(R)] value.

A valid N(R) is one that is in the range:

$$V(A) \leq N(R) \leq V(S)$$

That is, Acknowledge state variable ≤ Receive sequence number ≤ Send state variable

The information field contained in an I-frame that is in sequence and is error-free may be delivered to Layer 3 using the *DL-Data-Indication* primitive.

The data-link-layer entity informs the management entity of this exception condition using the MDL-*Error-Indication* primitive, and initiates re-establishment according to the procedures defined in paragraph 5.7 on page 3-49.

5.8.3 Acknowledgment timer, T200 recovery condition

If a data-link-layer entity, due to a transmission error, does not receive a single I-frame or the last I-frame(s) in a sequence of I-frames, it cannot detect an out-of-sequence exception condition and therefore, does not transmit a REJ frame.

The data-link-layer entity which transmitted the unacknowledged I-frame(s), on the expiry of the acknowledgment timer, T200, takes the recovery action defined in paragraph 5.6.7 on page 3-48 to determine which I-frame(s) must be re-transmitted.

5.8.4 Invalid frame condition

Any frame received which is invalid is discarded. No other action is taken as a result of that frame being received. Invalid frames are defined in Chapter 3-2: paragraph 2.9 on page 3-13 and Chapter 3-3: paragraph 3.6 on page 3-23).

5.8.5 Frame rejection condition

A frame rejection condition occurs when undefined commands or response frames are received. See paragraph 3.6.11 on page 3-25 for a listing of such commands and responses

When a frame rejection condition occurs, while in multiple-frame mode of operation, the data-link-layer entity

- issues an *MDL-Error-Indication* primitive
- initiates re-establishment as described in paragraph 5.7 on page 3-49

5.8.6 Receipt of an FRMR response frame

When an FRMR response frame is received, while in the multiple-frame mode of operation, the data-link-layer entity

- issues an *MDL-Error-Indication* primitive.
- initiates re-establishment as described in paragraph 5.7 on page 3-49.

5.8.7 Unsolicited response frames

The action taken on the receipt of an unsolicited response frame is defined in Table 3-3.

5.8.8 Multiple assignment of a TEI value

Not supported in this release.

5.9 List of system parameters

The system parameters listed below are associated with each individual service access point.

The parameter values are assigned when the data link is configured. Only default values of the parameters are supported by the network.

Table 3-3
Action on receipt of an unsolicited response frame

Unsolicited response frame	TEI assigned	Awaiting estab-lishment	Awaiting release	Multiple frames of operation	
				Established mode	Timer recovery condition
UA response- F = 1	Issue MEI	Solicited	Solicited	Issue MEI	Issue MEI
UA response- F = 0	Issue MEI	Issue MEI	Issue MEI	Issue MEI	Issue MEI
DM response- F = 1	Ignore	Solicited	Solicited	Issue MEI	Re-establish Issue MEI
DM response- F = 0	Establish	Ignore	Ignore	Re-establish Issue MEI	Re-establish Issue MEI
Supervisory response- F = 1	Ignore	Ignore	Ignore	Issue MEI	Solicited
Supervisory response- F = 0	Ignore	Ignore	Ignore	Solicited	Solicited

Key
Issue MEI = Issue *MDL-Error-Indication* primitive to Layer 3
Ignore= Ignore response
Establish= Establish multiple-frame mode of operation
Re-establish= Re-establish multiple-frame mode of operation

5.9.1 Acknowledgment timer, T200

The acknowledgment timer, T200 is used to verify that an acknowledgment for any frame is received within a set time. If the acknowledgment is not received before the timer times out, the frame is resent. This is repeated until the retransmission counter, N200 indicates that the frame is not being received.

This timer has a default value of 1 second. This assumes that there is no satellite link in the transmission path.

> ***Note:*** The proper operation of the procedure requires that the time-out for the acknowledgment timer be set greater than the maximum time between transmission of command frames and the reception of their corresponding response or acknowledgment frames.

5.9.2 Retransmission counter, N200

The maximum number of retransmissions of a frame is a system parameter. It is set using the retransmission counter, N200. The default trip value of N200 is 3.

5.9.3 Maximum number of octets in an information field, (N201)

The maximum number of octets that can be inserted into a frame is set using the system parameter N201.

The default value of N201 is 260 octets.

5.9.4 Maximum number of transmissions of an identity request message, (N202)

Not supported for PRI.

5.9.5 Maximum number of outstanding I-frames, k

The maximum number (k) of sequentially numbered I-frames that may be outstanding (that is, unacknowledged) at any given time is a system parameter that is in the range 1 through 127.

The default value is 7.

5.9.6 TEI identity check timer, T201

Not supported for PRI.

5.9.7 Timer, T202

Not supported for PRI.

5.9.8 Data link verification timer, T203

The data link verification timer, T203 is used to set the maximum period that the data link is allowed to remain up without frames being exchanged. The default value of timer T203 is 10 seconds.

5.10 Data-link-layer monitor function

5.10.1 General

The procedural elements defined in this chapter allow for the supervision of the data-link-layer resource. This section describes procedures which may be used to provide this supervision function.

5.10.2 Data link layer supervision in the multiple-frame-established state

The following procedures propose a solution which is already identified in the HDLC classes of procedures. Connection verification is a service provided by the data link layer to Layer 3. This implies that Layer 3 is informed in case of a failure only. Furthermore, the procedure may be incorporated in the “normal” exchange of information and may become more efficient than a procedure based on the involvement of Layer 3.

The procedure is based on supervisory command frames (RR command, RNR command) and the data link verification timer (T203). It operates in the multiple-frame-established state as follows.

If there are no frames being exchanged on the data link connection (neither new or outstanding I-frames, or supervisory frames-with a P bit set to “1”) there is no means to detect a faulty data link connection condition, or to detect if the user equipment has been unplugged. The data link verification timer (T203) represents the maximum time allowed without frames being exchanged.

If timer T203 expires, a supervisory command (with a P bit set to “1”) is transmitted.

Such a procedure is protected against transmission errors by making use of the procedures associated with the retransmission timer,T200 and the retransmission counter, N200.

5.10.3 Connection verification procedures

Start of data link verification timer, T203

The data link verification timer, T203 is started

- when the multiple-frame-established state is entered
- AND, whenever the acknowledgment timer, T200 is stopped (while in the multiple-frame established state). That is, T200 and T203 are never running concurrently.

When an I or supervisory frame is received, timer T203 is restarted if timer T200 is not to be started.

Stop of data link verification timer, T203

The data link verification timer, T203 is stopped

- when in the multiple-frame established state, timer T200 is started (see note), *and*
- when leaving the multiple-frame established state.

  Note: These two conditions mean that timer T203 is only started whenever T200 is stopped and not restarted.

Expiry of timer T203

If timer T203 expired-and timer T200 is neither running or expired-the data-link-layer entity

- sets the retransmission counter, N200 to zero
- enters the timer recovery state
- transmits a supervisory-type command (with the P bit set to “1”) as follows:
  - if there is *not* a receiver busy condition (own receiver not busy), it transmits an RR command
  - if there is a receiver busy condition (own receiver busy), it transmits an RNR command
- starts timer T200
- sends an *MDL-Error-Indication* primitive to layer management after N200 retransmissions

Chapter 3-6: Occurrence of *MDL-Error-Indication*

6.1 Introduction

The *MDL-Error-Indication* primitive is used to notify the management entity of the data link layer of almost any error situation. The error situations for which this primitive is generated are shown in Table 3-4.

The associated error parameter contains the error code that describes the unique error conditions. The table also identifies the associated management actions that are taken from the network and the user side, for the various types of error reported.

The following paragraphs provide a key to the information contained in the table.

Error code

The *Error code* column gives the identification value for each error situation that is included as a parameter with the *MDL-Error-Indication* primitive.

Error condition and affected states

The *Error condition* column together with the *Affected states* column describes the unique protocol error events and the state of the data link layer entity at the time that the *MDL-Error-Indication* primitive is generated.

Network management action

For each error condition, the *Network management action* column describes the preferred action taken by the network management entity.

User management action

This column describes the preferred action taken by the user side management entity on a given error condition.

6.2 Preferred management actions

The preferred management actions on an error situation is to issue an error log. This suggests that the network side management entity has the preferred action of logging the event into an error counter. The length and the operation of the counter mechanisms for the error situations are implementation dependent.

In all error situations, the action to be taken by the user side is implementation dependent.This means that it is optional whether the user side has incorporated any form of error counter to log or store the reported event.

If action is taken, the layer management has to take into account that the data link layer has initiated a recovery procedure.

Table 3-4
Management entity actions for *MDL-Error- Indication*s

Error code	Error condition	Affected states *	Network management action	User management action
Receipt of unsolicited response (error codes A through E)				
A	Supervisory frame-F = 1	7	Error log	Implementation dependent
B	DM frame-F = 1	7, 8	Error log	Implementation dependent
C	UA frame-F = 1	4, 7, 8	Error log	Implementation dependent
D	UA frame-F = 0	4, 5, 6, 7, 8	Error log	Implementation dependent
E	Receipt of DM response-F =0	7, 8	Error log	Implementation dependent
Peer initiated re-establishment (error code F)				
F	SABME frame	7, 8	Error log	Implementation dependent
Unsuccessful transmission (after N200 tries) (error codes G through I)				
G	SABME frame	5	Error log	Implementation dependent
H	DISC frame	6	Error log	Implementation dependent
I	Status enquiry	8	Error log	Implementation dependent
Other errors (error codes J through O)				
J	N(R) error	7, 8	Error log	Implementation dependent
K	Receipt of FRMR response	7,8	Error log	Implementation dependent

Table 3-4
Management entity actions for *MDL-Error- Indication*s (Continued)

Error code	**Error condition**	**Affected states ***	**Network management action**	**User management action**
L	Receipt of non-implemented frame	4, 5, 6, 7, 8	Error log	Implementation dependent
M	Receipt of I field not permitted	4, 5, 6, 7, 8	Error log	Implementation dependent
N	Receipt of frame with wrong size	4, 5, 6, 7, 8	Error log	Implementation dependent
O	N201 error	4, 5, 6, 7, 8	Error log	Implementation dependent

Chapter 3-7: Layer 2 SDL diagrams

To assist in the understanding of the data link layer, this chapter provides an example of a detailed SDL (Specification and description language) diagram of the point-to-point procedures.

This representation does not describe all of the possible actions of the data-link-layer entity. A non-partitioned representation is used to minimize complexity. This representation does not show all possible interactions and shows just one of many sequences of events.

The representation is a peer-to-peer model of the point-to-point procedures of the data-link layer and is applicable to the data-link-layer entities at both the user and network sides for all ranges of TEI values.

7.1 Use of queues

To enable a satisfactory representation of the data-link-layer entity, conceptual queues for the I-frame transmission has been explicitly brought out. These conceptual queues are finite but unbounded and should in no way restrict the implementation of the point-to-point procedures. An additional signal has been provided to initiate the servicing of these queues.

Figure 3-14 shows the symbols and abbreviations used in the SDL representations. Full descriptions of their meanings and application can be found in the CCITT Z series of recommendations.

Figure 3-14
SDL symbol key

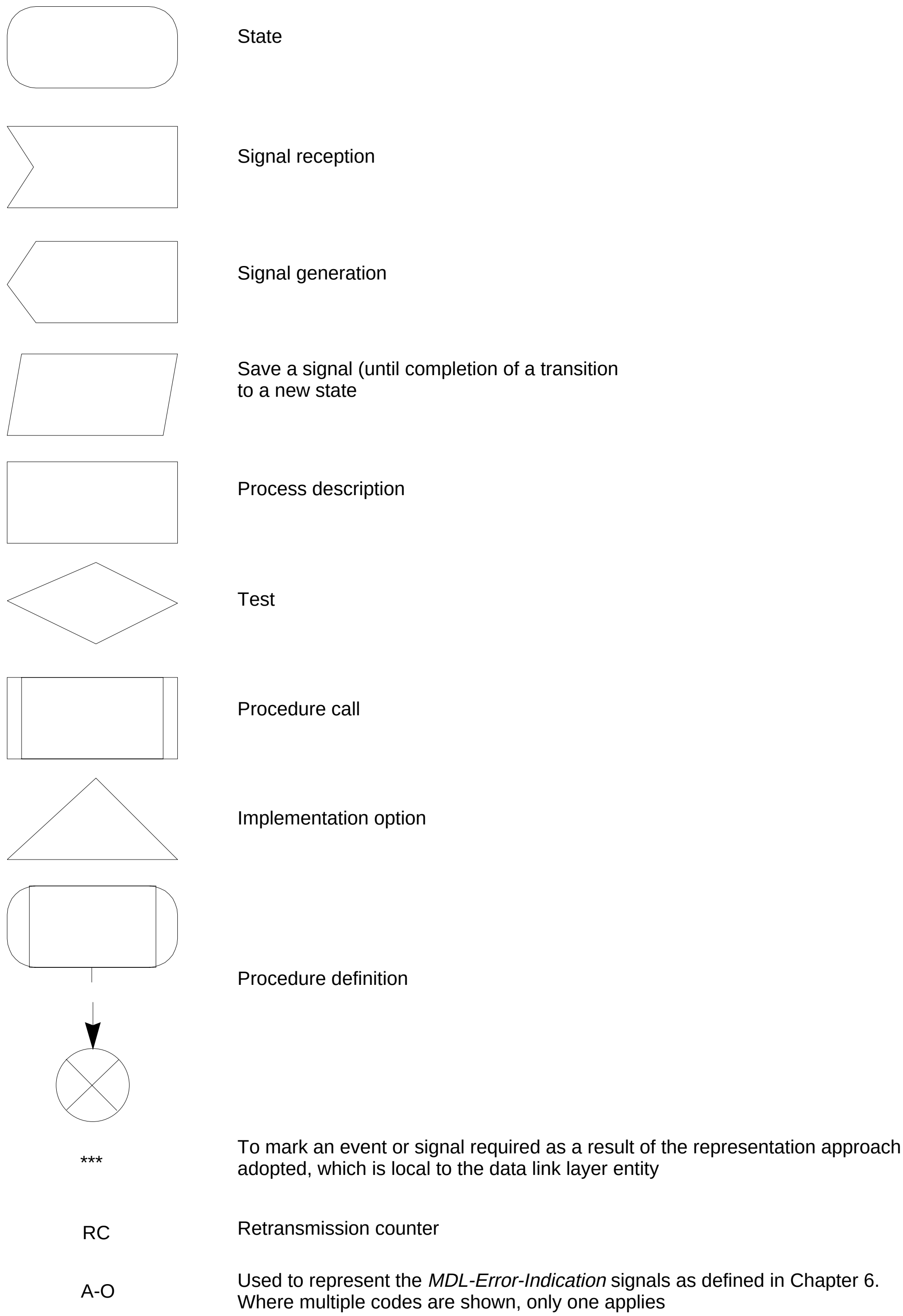


Figure 3-15
SDL states 1

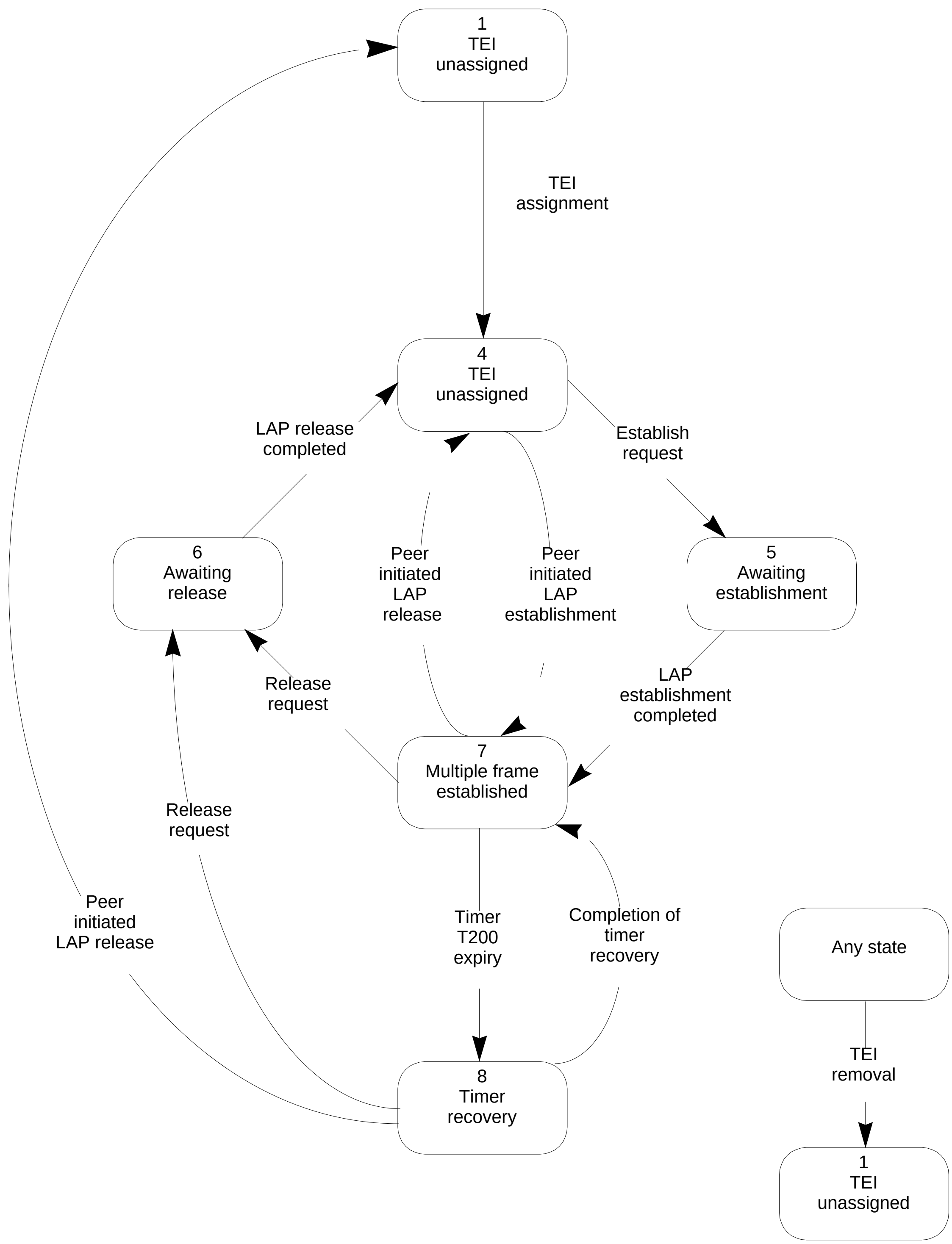


Figure 3-16
SDL states II

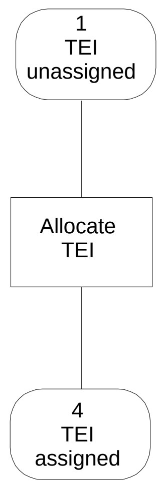


Figure 3-17
SDL states III

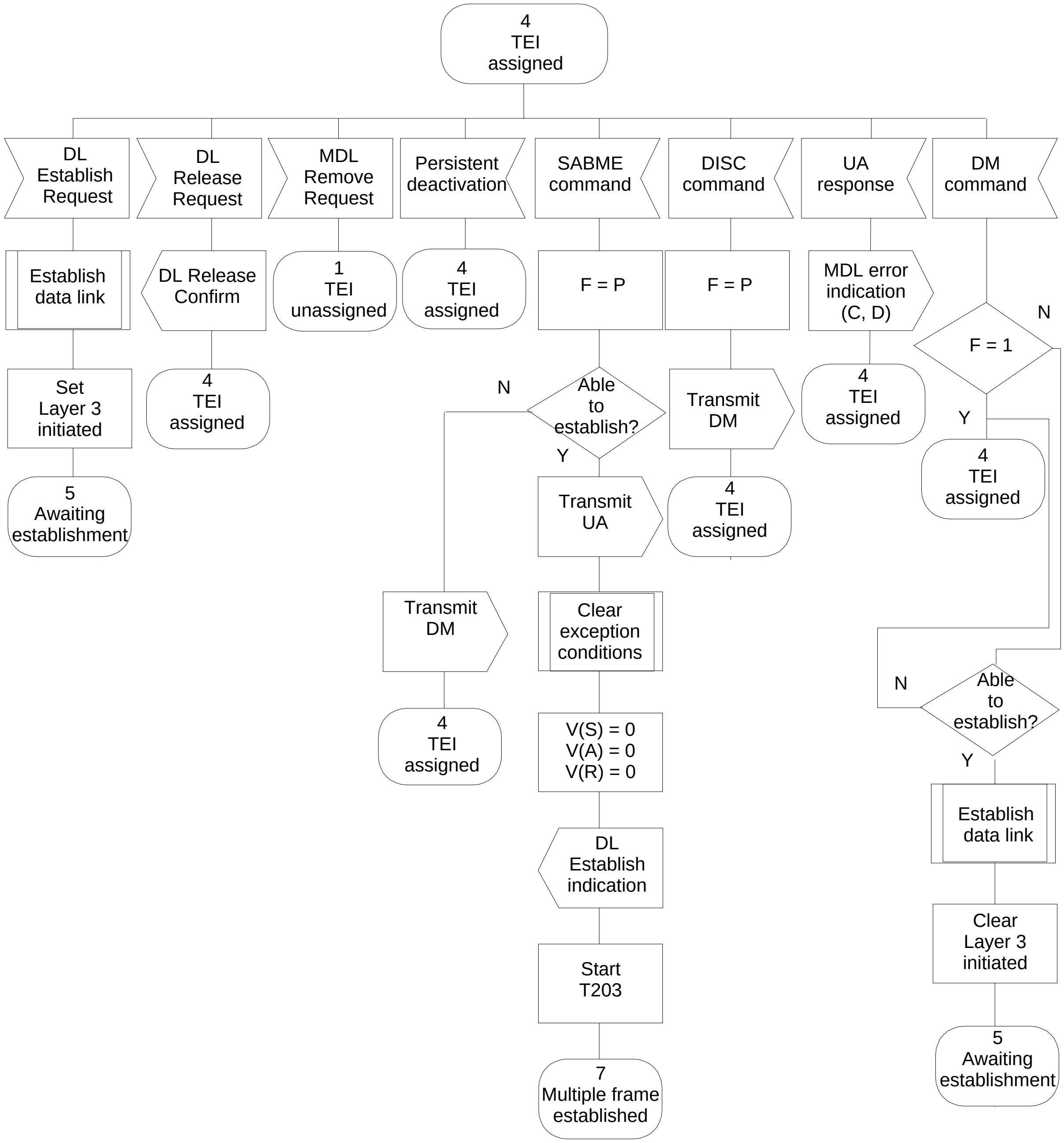
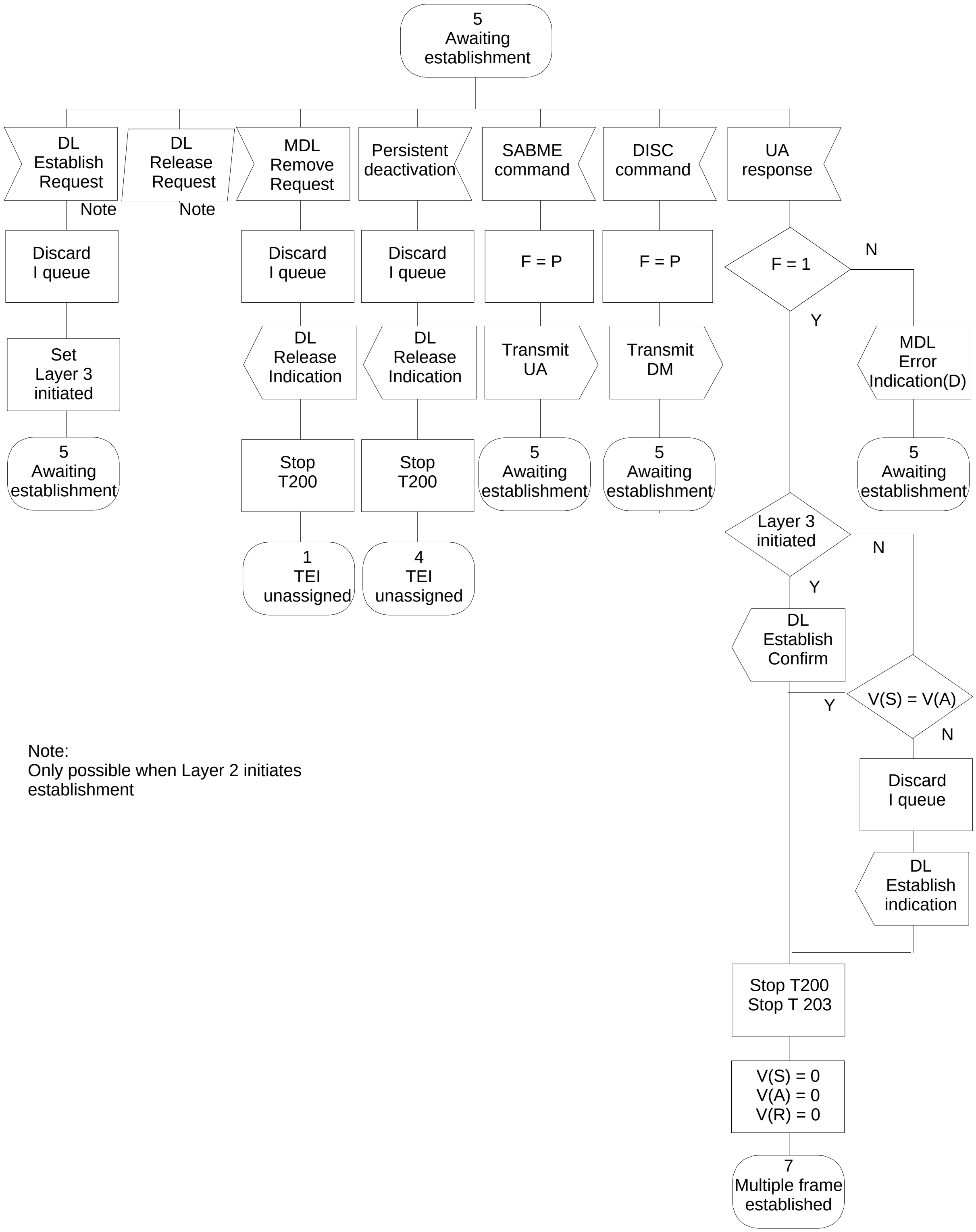


Figure 3-18
SDL states IV



Note:
Only possible when Layer 2 initiates establishment

Figure 3-19
SDL states V

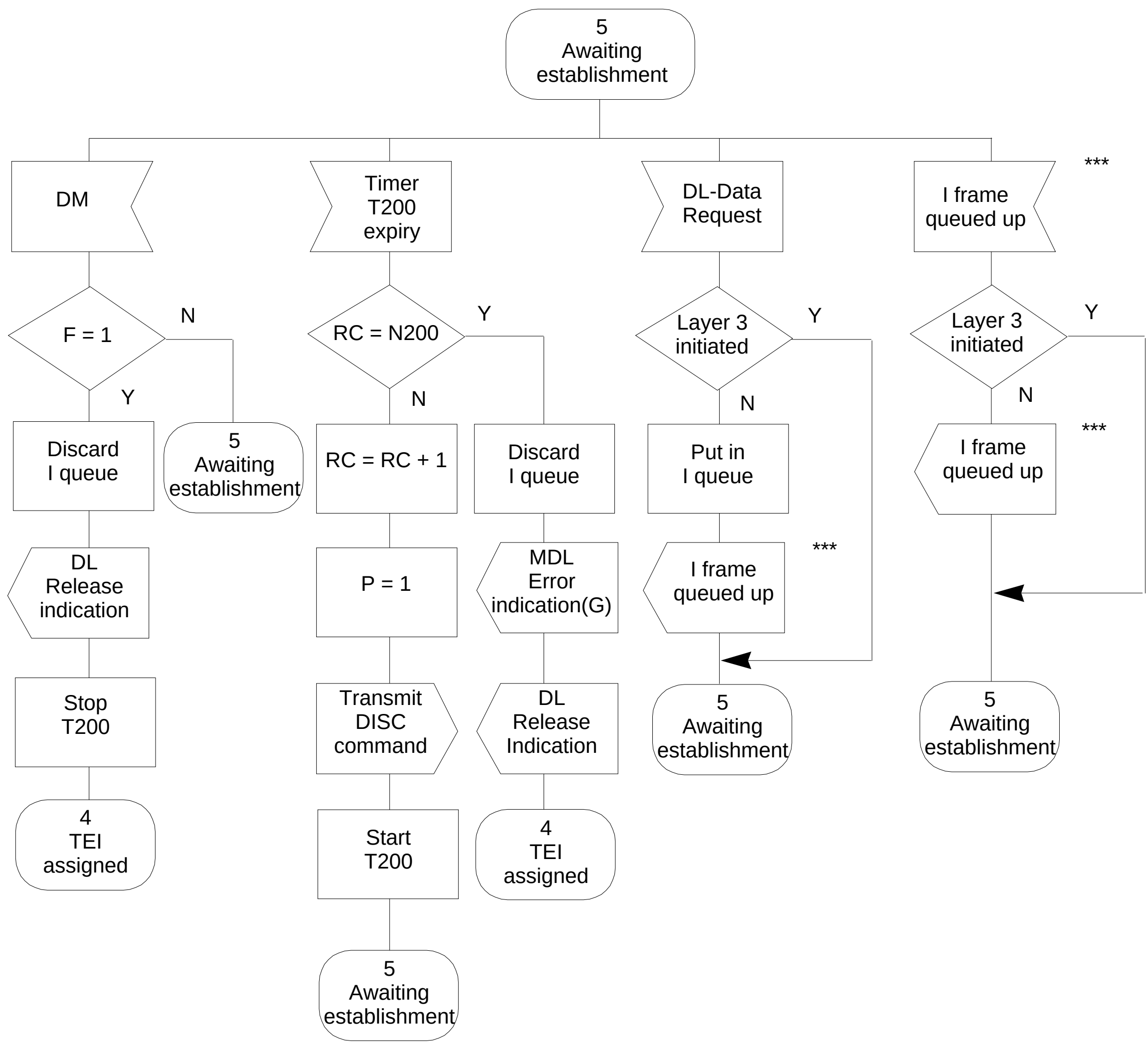


Figure 3-20
SDL states VI

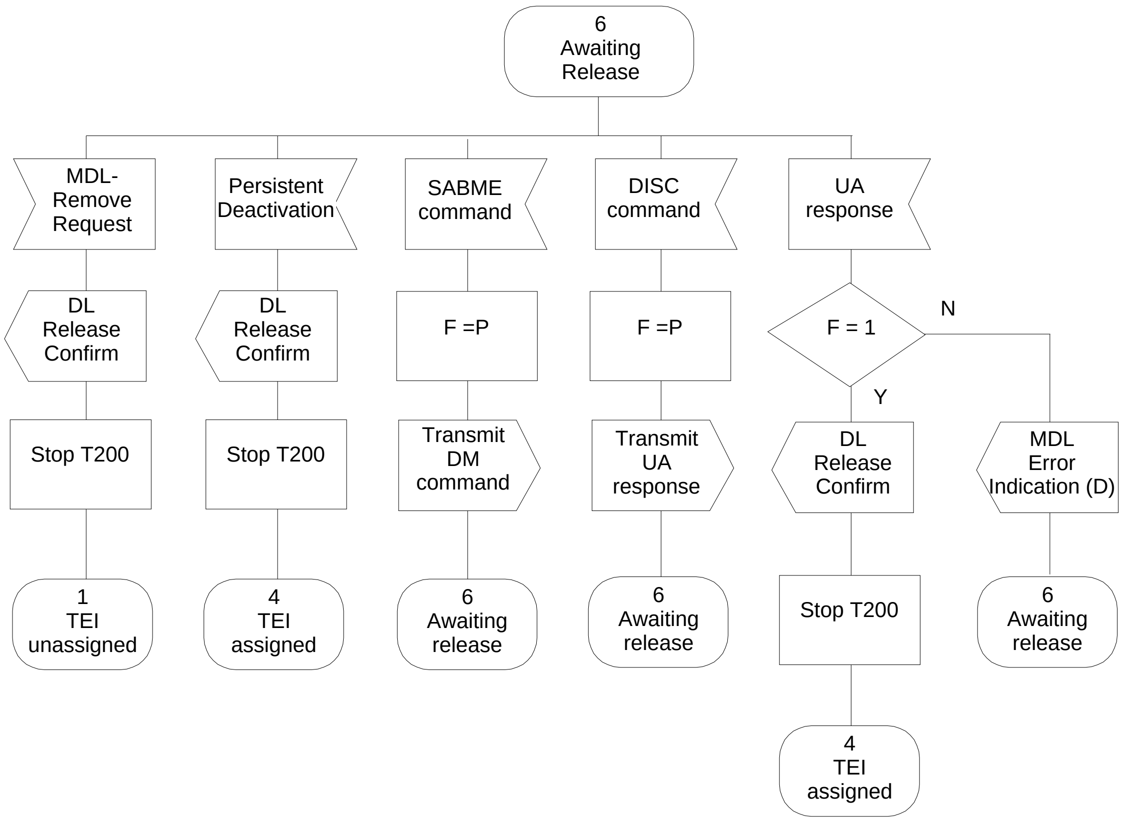


Figure 3-21
SDL states VII

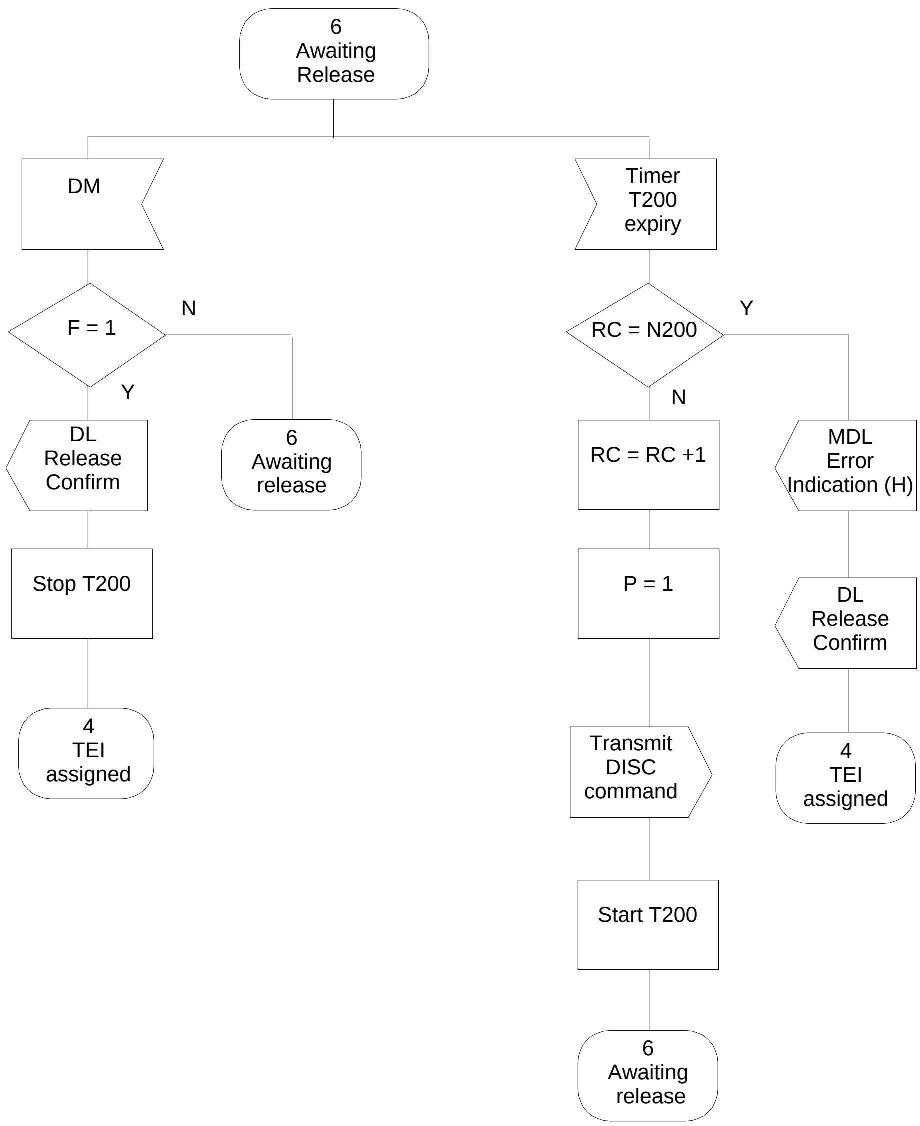
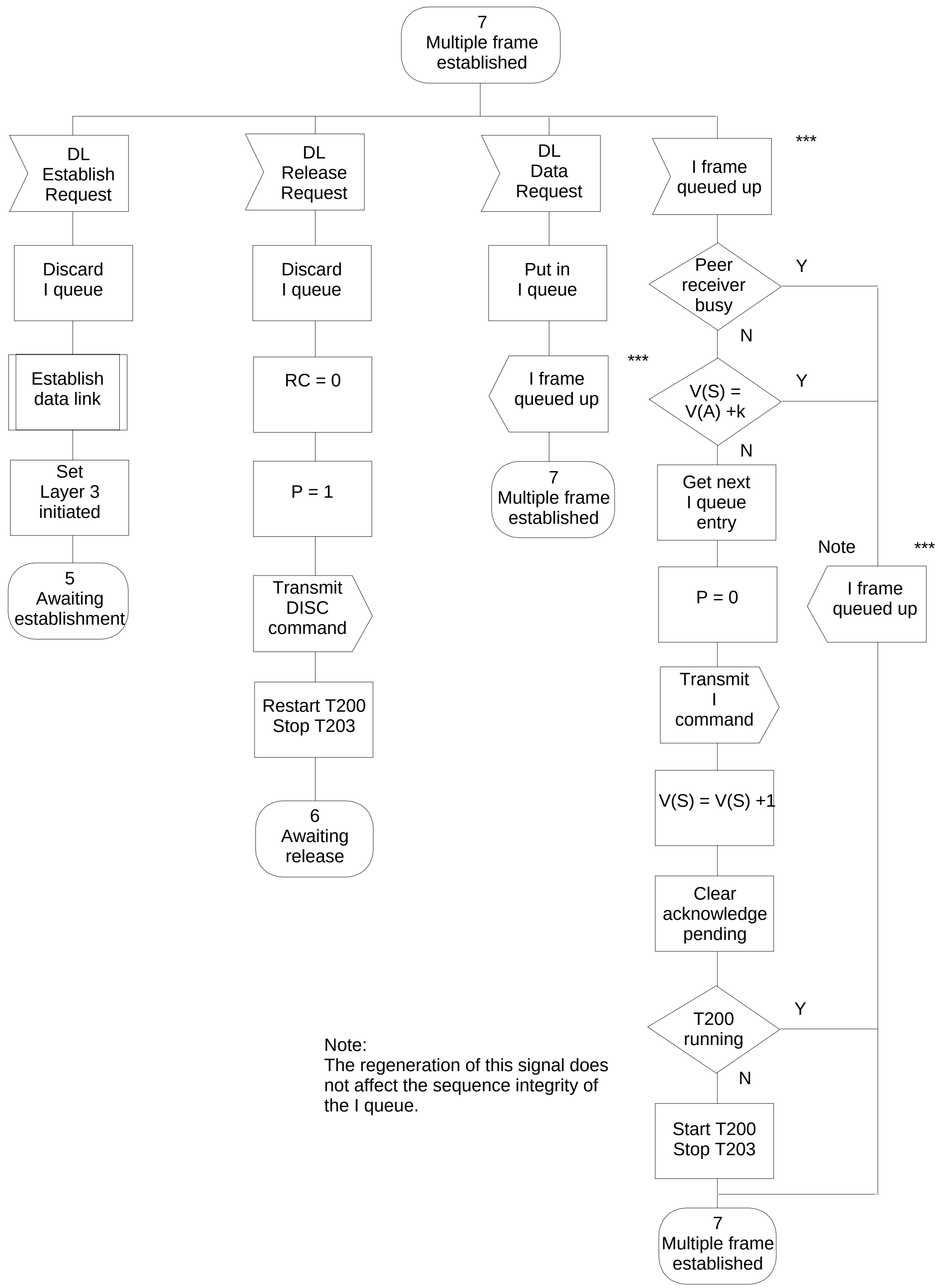


Figure 3-22
SDL states VIII



Note:
The regeneration of this signal does not affect the sequence integrity of the I queue.

Figure 3-23
SDL state IX

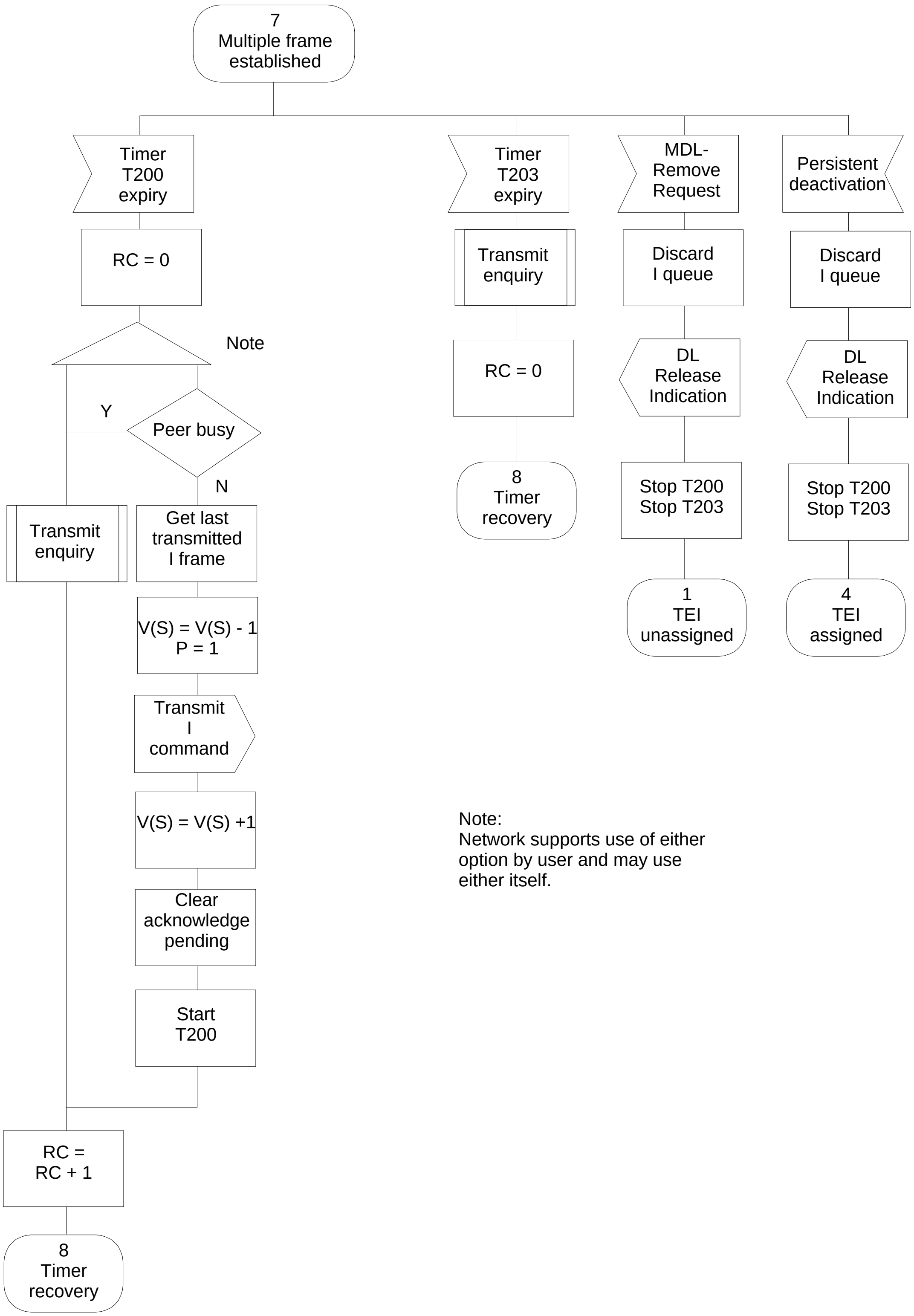
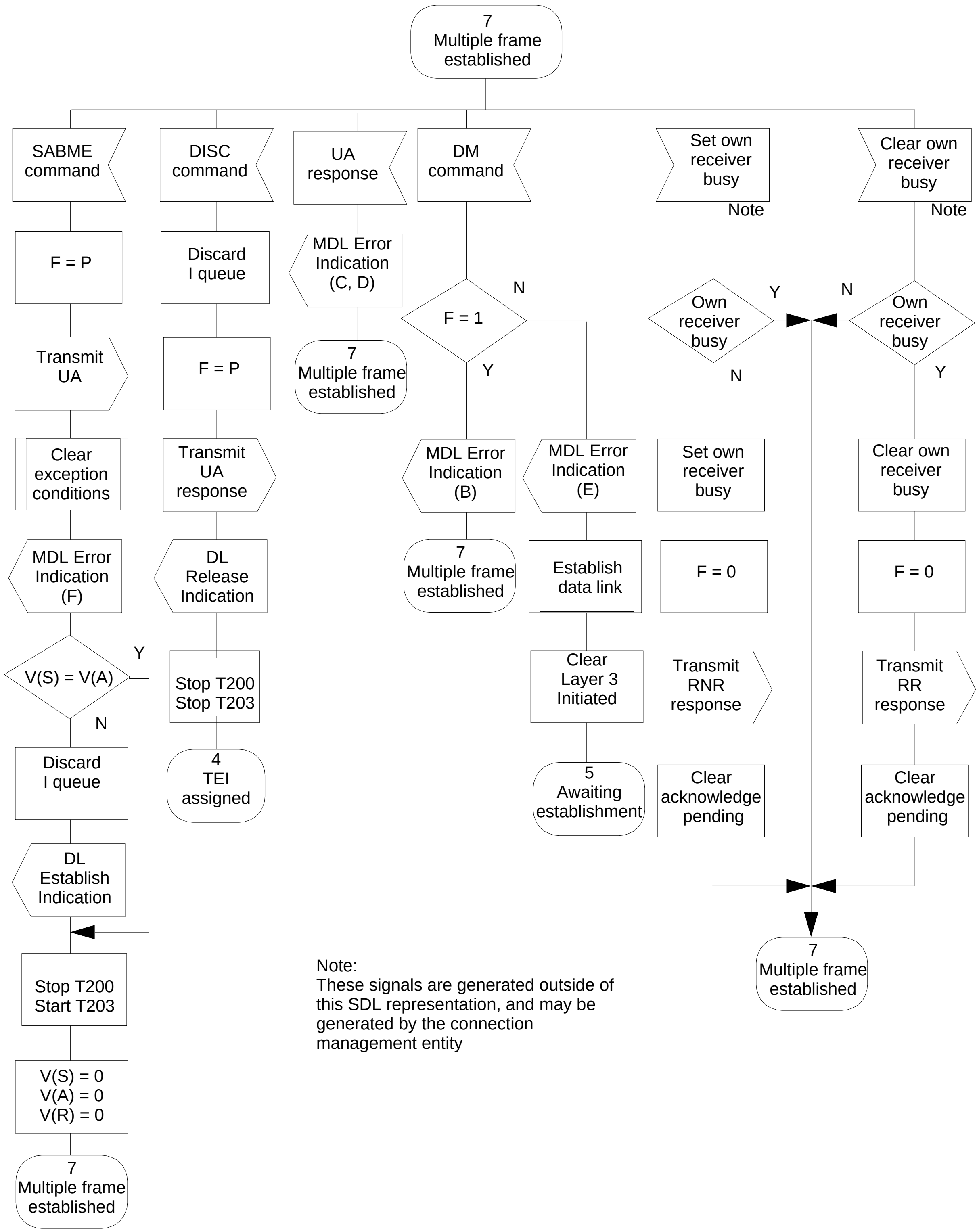


Figure 3-24
SDL state X



Note:
These signals are generated outside of this SDL representation, and may be generated by the connection management entity

Figure 3-25
SDL state XI

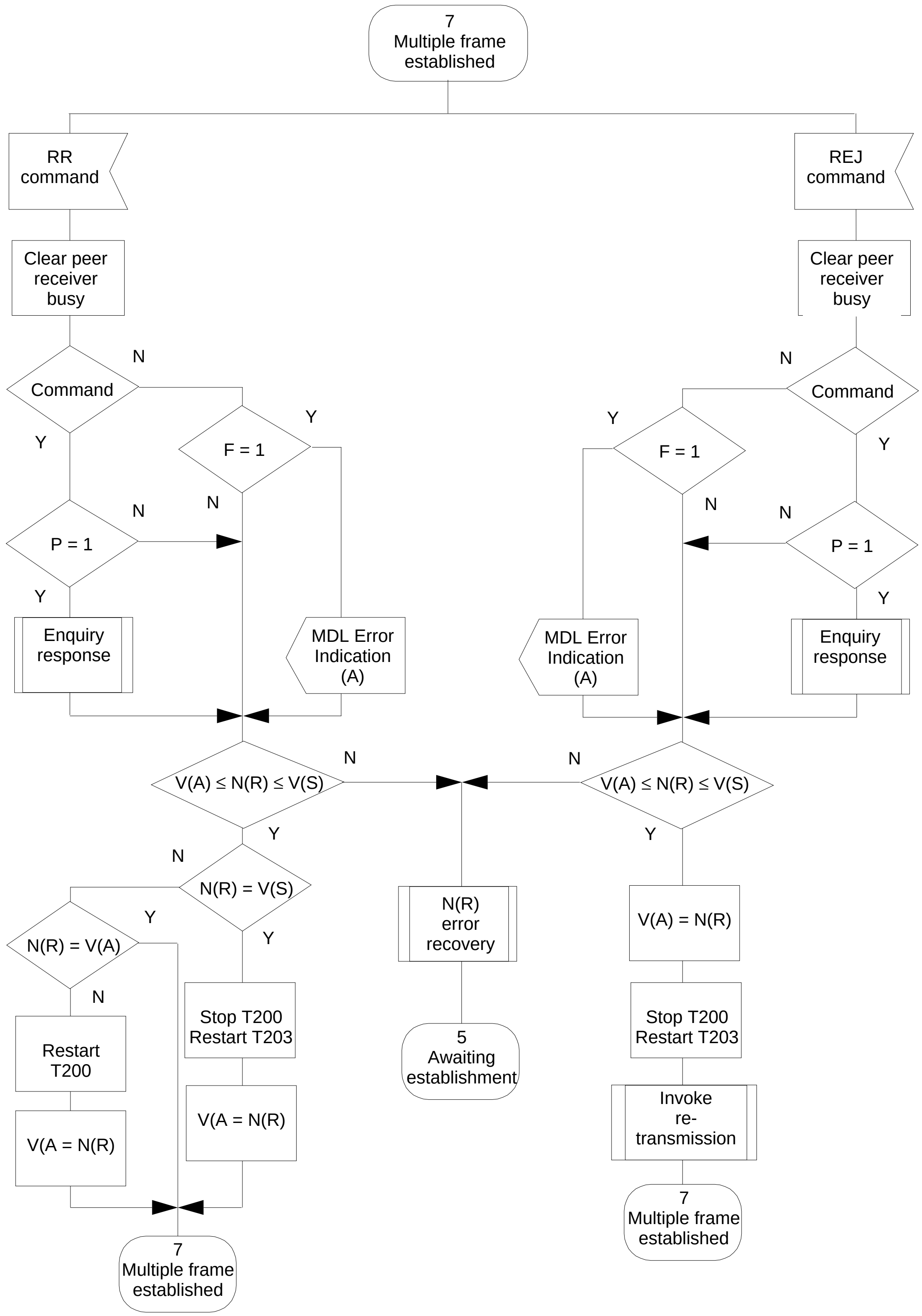


Figure 3-26
SDL state XII

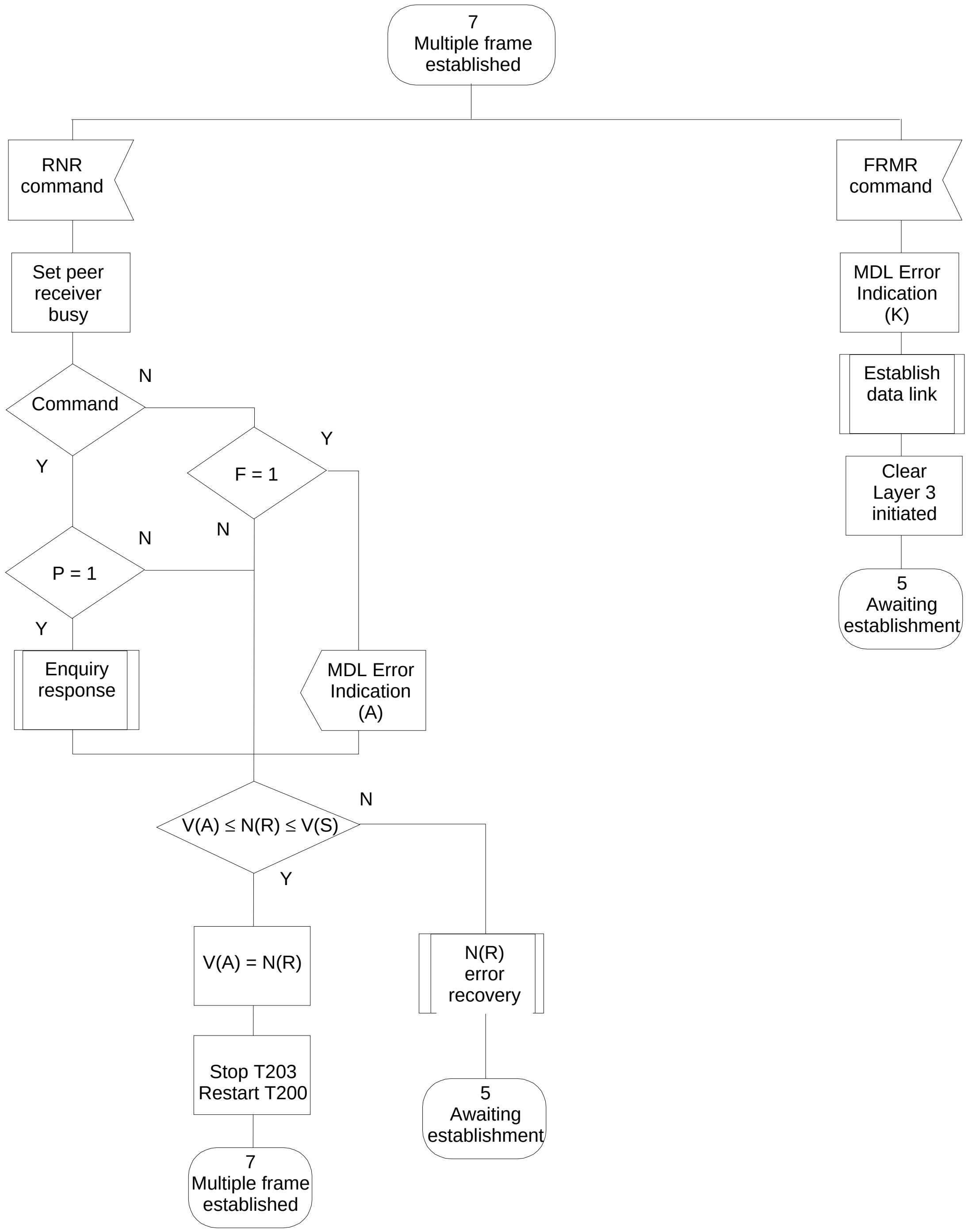


Figure 3-27
SDL state XIII

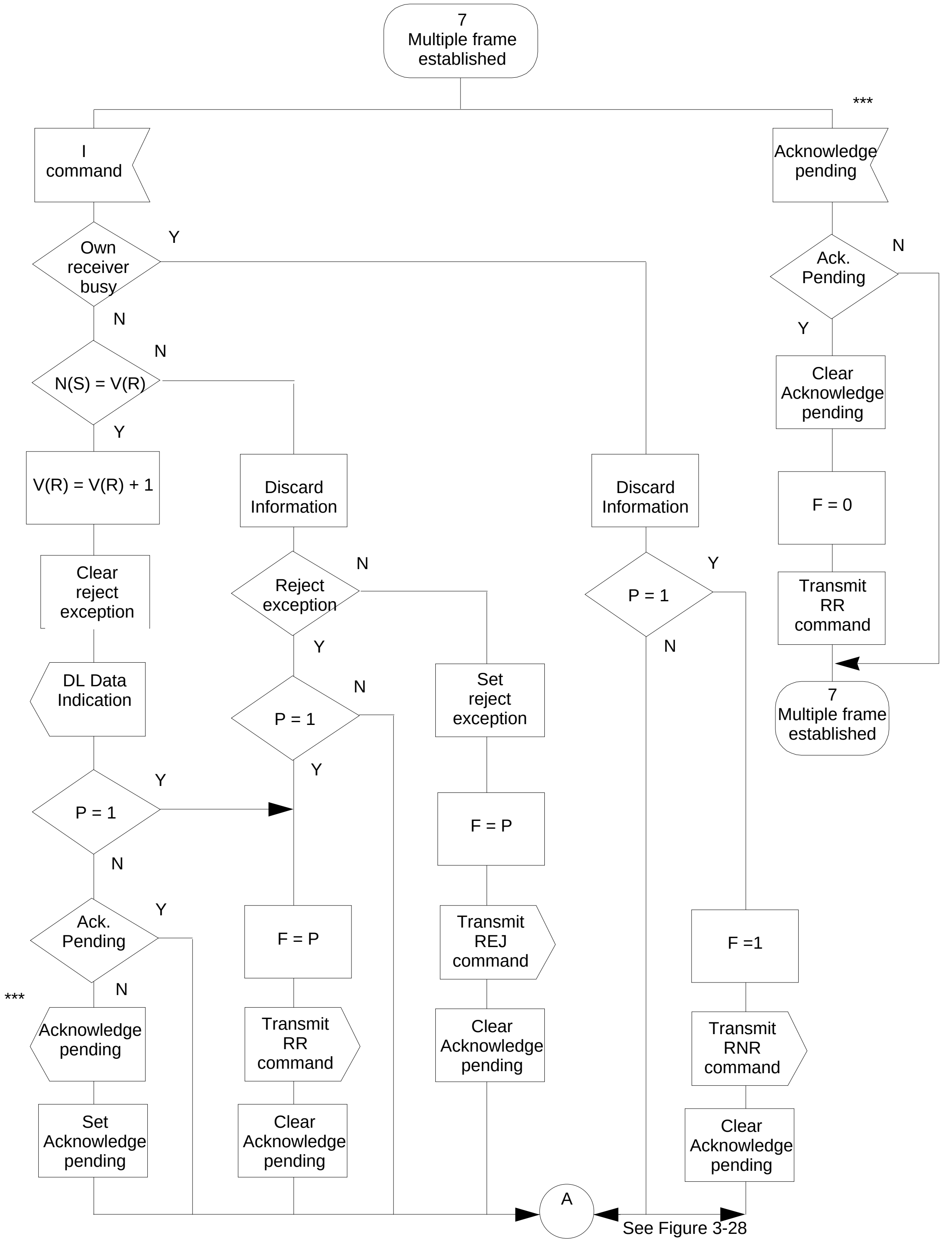


Figure 3-28
SDL state XIV

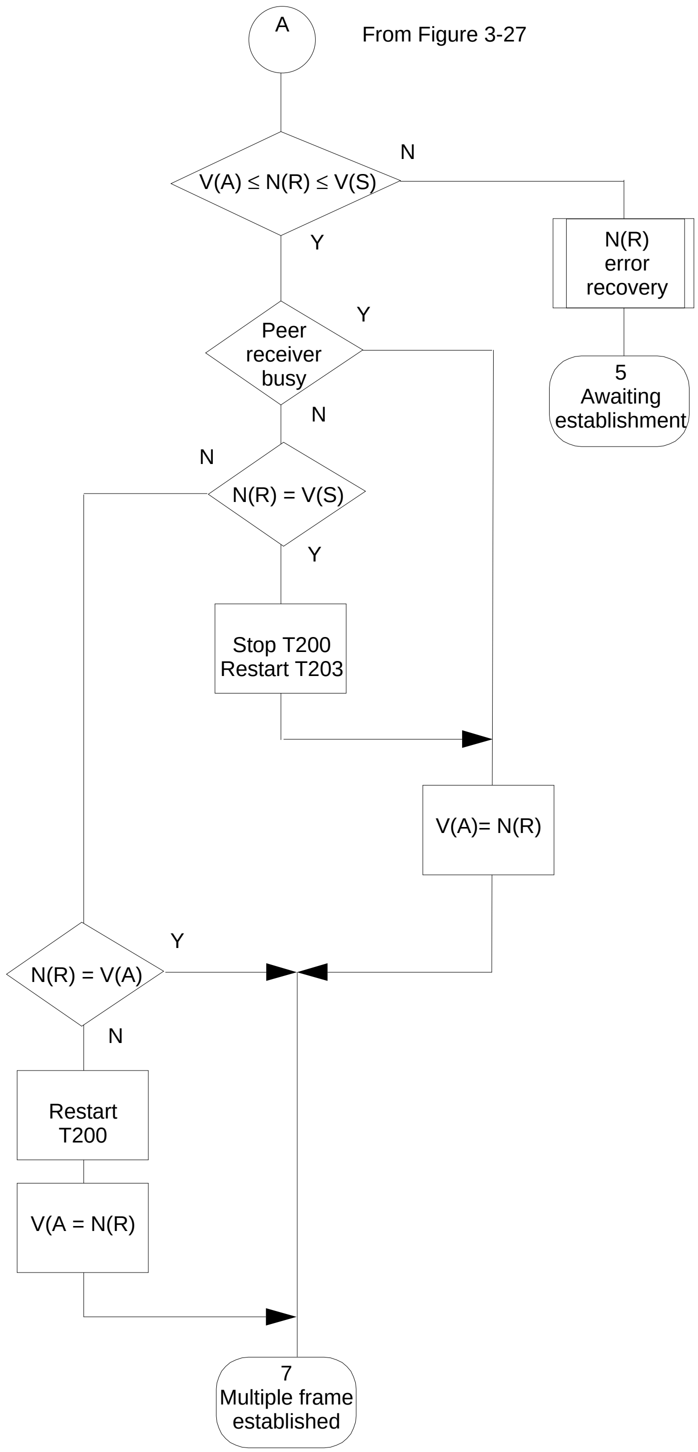


Figure 3-29
SDL state XV

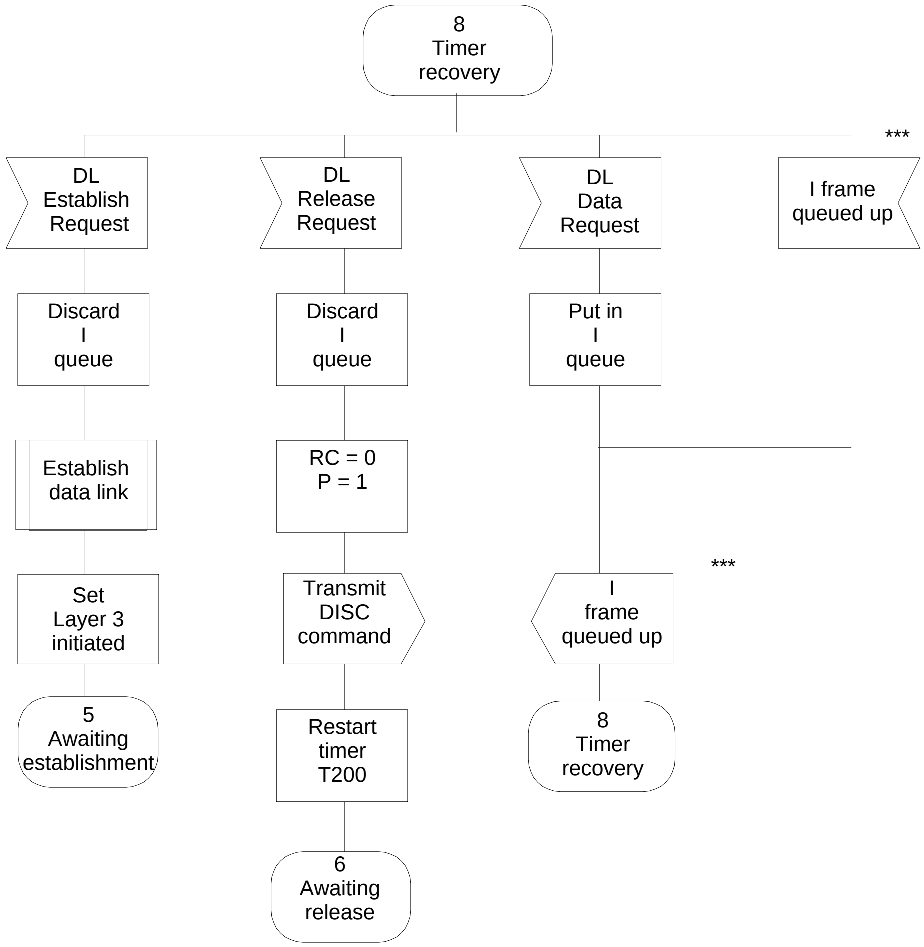
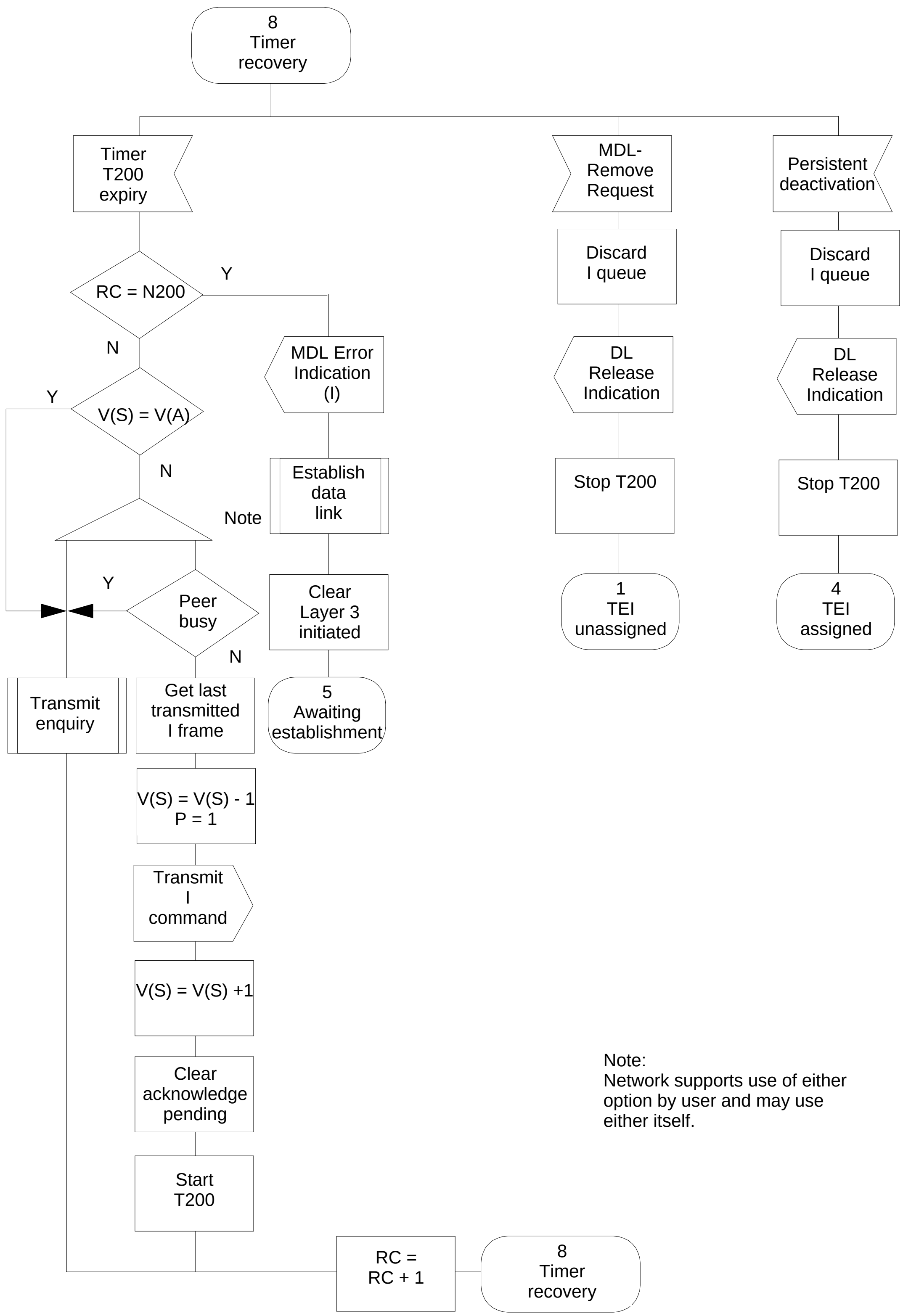


Figure 3-30
SDL state XVI



Note:
Network supports use of either option by user and may use either itself.

Figure 3-31
SDL state XVII

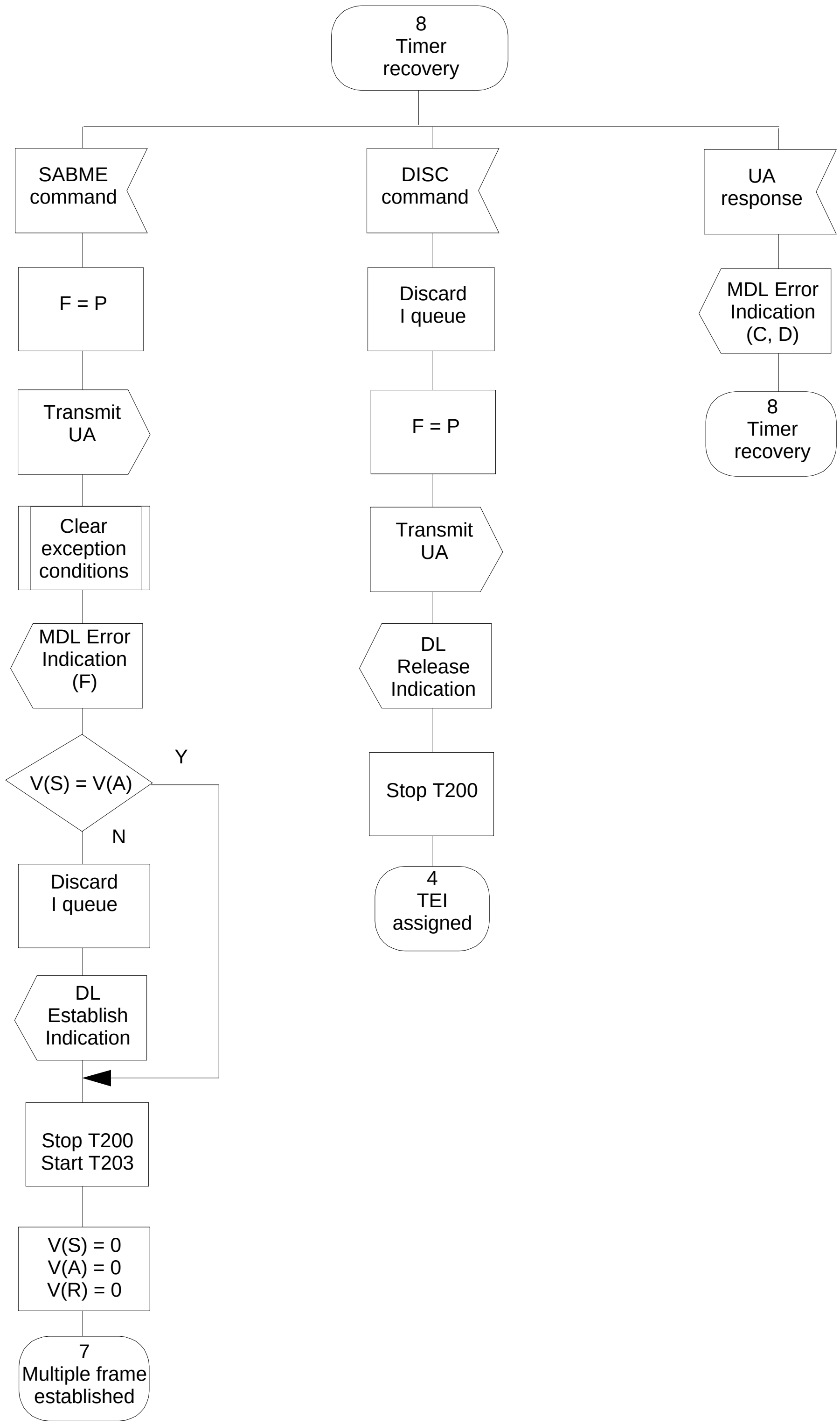
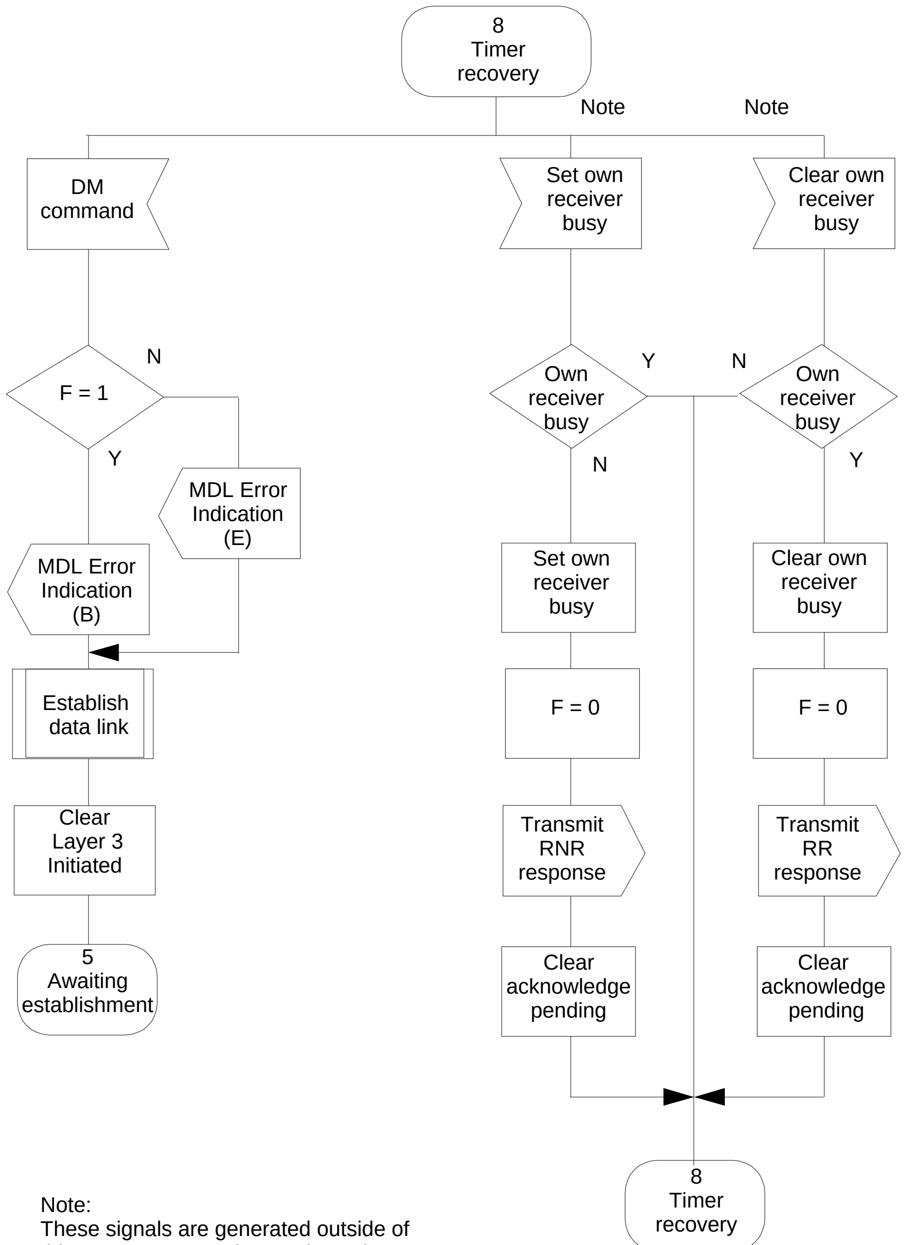


Figure 3-32
SDL state XVIII



Note:
These signals are generated outside of this SDL representation, and may be generated by the connection management entity.

Figure 3-33
SDL state XIX

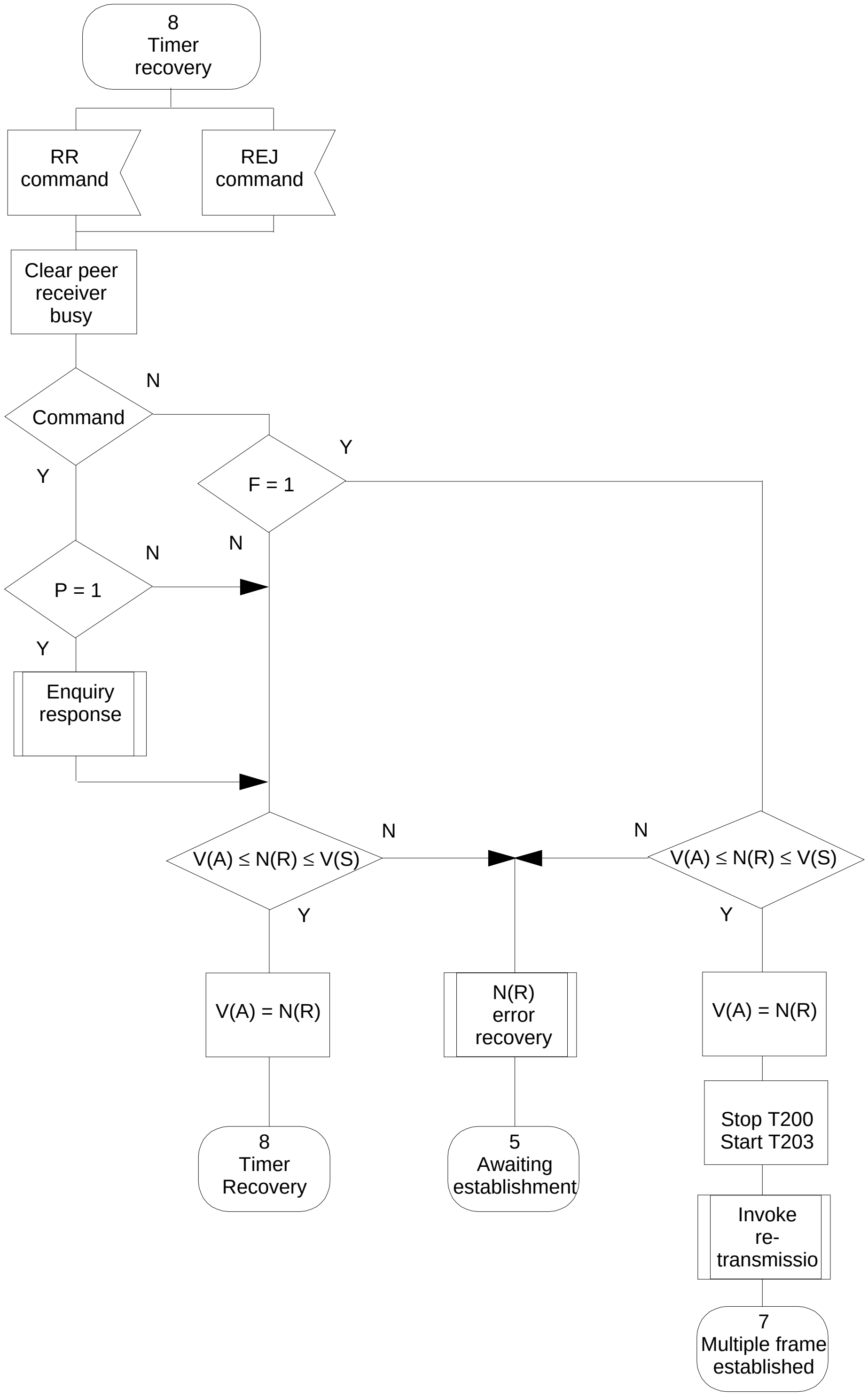


Figure 3-34
SDL state XX

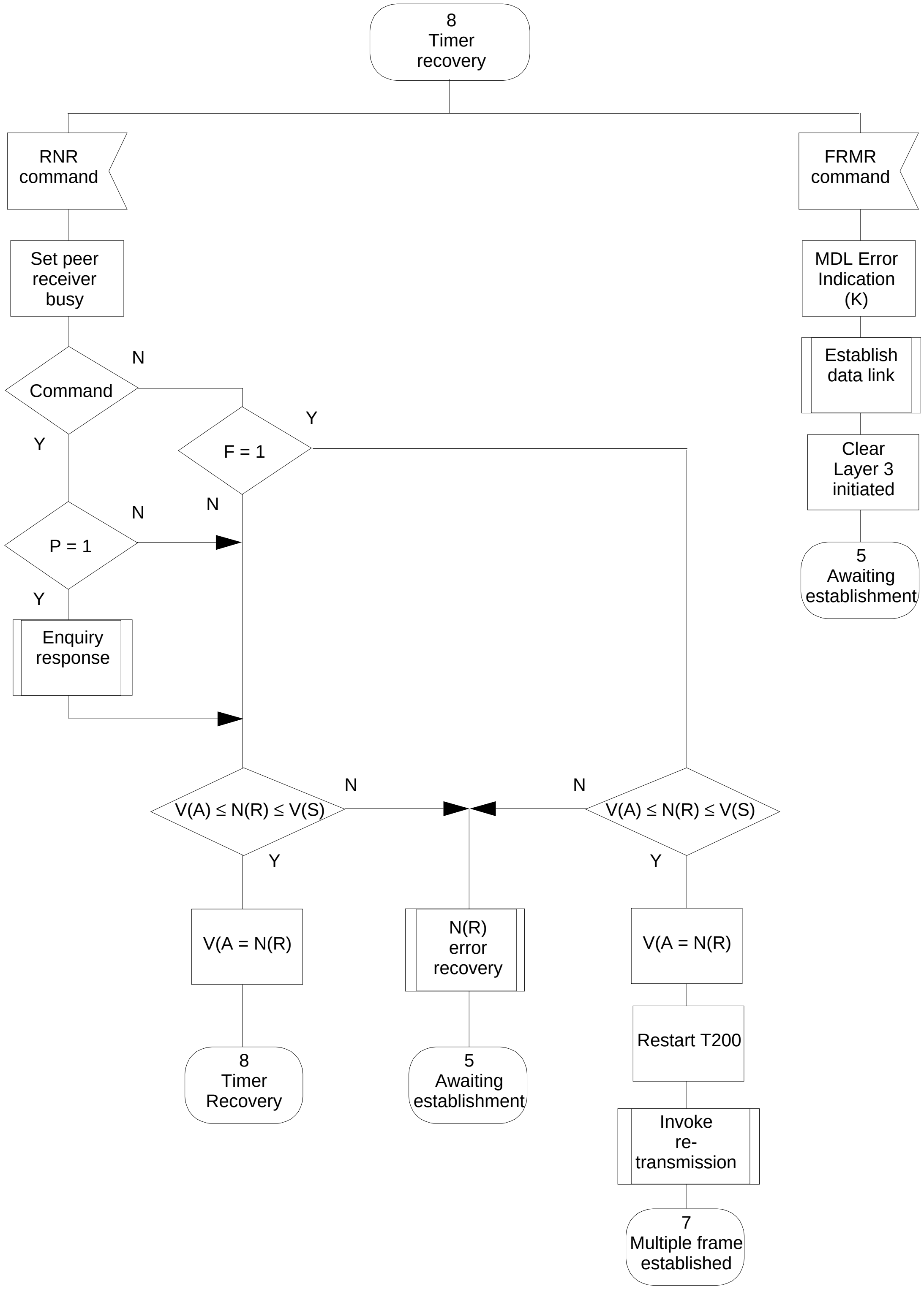


Figure 3-35
SDL state XXI

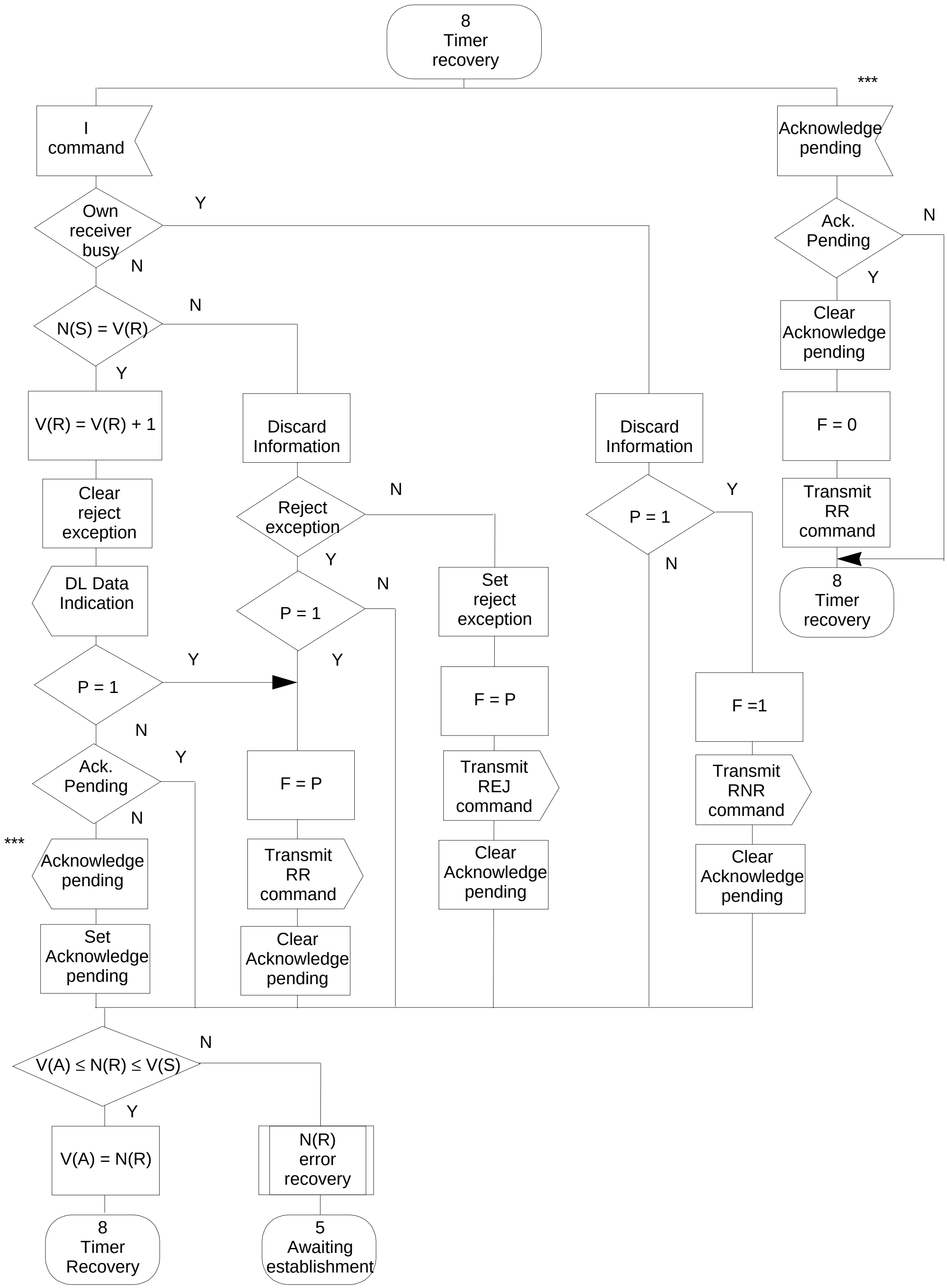
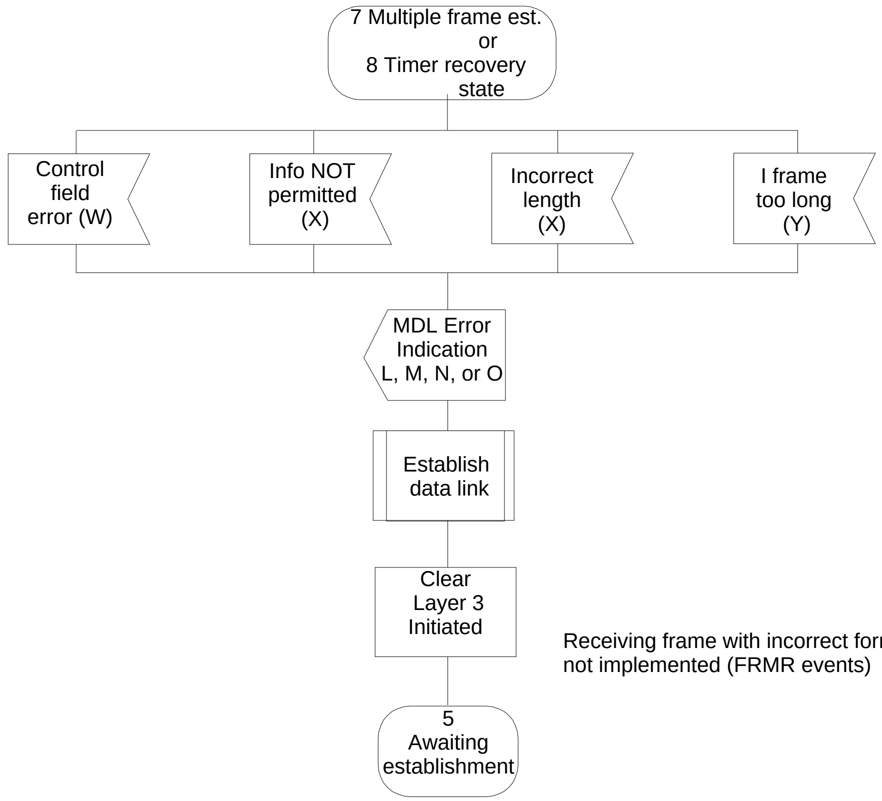
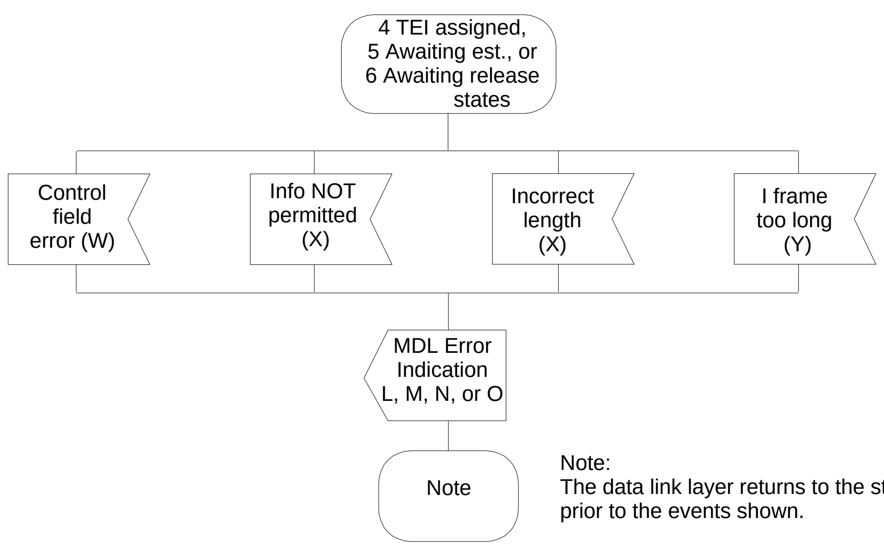


Figure 3-36
SDL state XXII

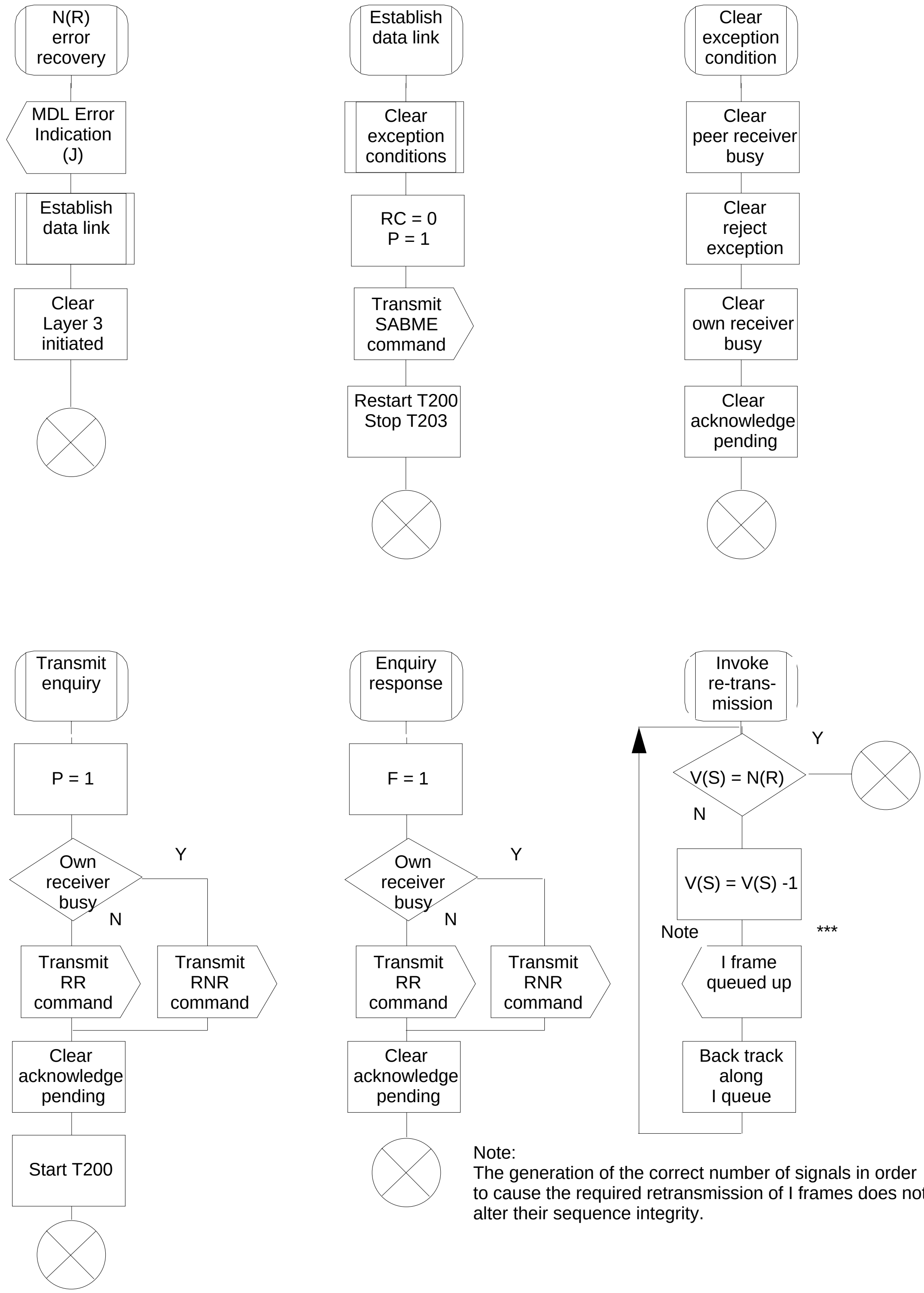


Receiving frame with incorrect format or frame not implemented (FRMR events)



Note:
The data link layer returns to the state it was in prior to the events shown.

Figure 3-37
SDL state XXIII



Note:
The generation of the correct number of signals in order to cause the required retransmission of I frames does not alter their sequence integrity.

Section 4: Layer 3 call control signaling

Chapter 4-1: Introduction to Layer 3

1.1 Scope

This section defines the call signaling protocol for DMS-100-to-PBX applications using an Integrated Services Digital Network (ISDN) Primary Rate Interface (PRI).

The format of this section is similar to the standards to enable comparison between the standard and the implementation of this interface. Additional messages, procedures, and parameter encodings have been provided in order to satisfy the signaling requirements of the interface.

This section specifies the procedures for establishing, maintaining, and clearing network connections at the ISDN user-network interface for support of circuit-switched calls. These procedures are defined in terms of messages exchanged over the D-channel of a PRI. This section also describes the protocol structure on which supplementary services are based. Procedures for the operation of supplementary services are defined in Section 5.

References in the text to “network side” equipment are to be understood as relating to a DMS-100 Central Office (CO). Similarly, the terms “incoming” and “outgoing” are used to describe the call as viewed by the user side of the interface.

1.2 Conformance

Products conforming to this specification support all mandatory procedures and information elements outlined in Chapters 2 through 7 inclusive of this section of the specification.

It is intended that the call signaling protocol be fully symmetric to enable direct user-to-user communication.

1.3 Standards compatibility

This call control signaling specification is based on the general format and procedures found in the *CCITT Recommendation Q.931(I.451), ISDN user-*

network interface Layer 3-specification and *ANS T1.607, Layer 3 signalling specification for circuit switched bearer service* recommendations.

Chapter 4-2: Layer 3 overview of call control

In this chapter, call states are defined for circuit switched calls in paragraph 2.1 on page 4-7 and for the interface in paragraph 2.2 on page 4-10.

Paragraph 2.1 defines the basic 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 signaling on the D-channel. Because several 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.

Detailed descriptions of the procedures for call control are given in Chapter 4-5: "Layer 3 call control procedures" in terms of:

- The messages (defined in Chapter 4-3: "Layer 3 message function definitions") which are transferred across the user-network interface.
- The information processing and actions that take place at the user side and the network side.

Overview and detailed specification and description language (SDL) diagrams for call control of circuit-switched calls are contained in Chapter 4-7: "Layer 3 SDL diagrams".

2.1 Circuit switched calls

This section defines the basic call control states for circuit switched calls. These states are also applicable for circuit switched data on a B-channel.

2.1.1 Call states on the network or user side of the interface

The states which may exist on the user side or on the network side of the user-network interface are defined in Table 4-1.

Table 4-1
Call states

State no.	State name	User side	Network side	Definition
0	Null	X	X	No call exists.
1	Call initiated	X	X	This state exists for an outgoing call, when the user requests call establishment from the network, but the network has not responded. On the network side, this state exists when the network has received a call establishment request, but has not yet responded.
2				Not used.
3	Outgoing call proceeding	X	X	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. On the network side, this state exists when the network has sent acknowledgement that it has received all call information necessary to effect call establishment.
4	Call delivered	X	X	This state exists for an outgoing call when the calling user has received an indication that the remote user has been alerted. On the network side, this state exists for an outgoing call when the network has indicated that the remote user has been alerted.
5				Not used.
6	Call present	X	X	This state exists for an incoming call when the user has received a call establishment request but has not yet responded. On the network side, this state exists when the network has sent a call establishment request, but has not received a satisfactory response.
7	Call received	X	X	This state exists for an incoming call when the user has initiated alerting but has not yet answered. On the network side, this state is entered when the network receives an indication that the user has initiated alerting, but has not yet answered.
8	Connect request	X	X	This state exists for an incoming call when the user has answered the call and is waiting to be awarded the call. On the network side, this state exists when the network has received an answer but the network has not awarded the call.

Table 4-1
Call states (Continued)

State no.	State name	User side	Network side	Definition
9	Incoming call proceeding	X	X	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. On the network side, this state exists when the network has received acknowledgement that the user has received all call information necessary to effect call establishment.
10	Active	X	X	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. That is, the call is in an end-to-end communication mode.
11	Disconnect request	X	X	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. This state exists on the network from the time that the network has received the call clearing request from the user.
12	Disconnect indication	X	X	This state exists when the user has received an invitation to disconnect because the network has disconnected the end-to-end connection (if any). On the network side, this state is entered when the network has disconnected the call, and sent an invitation to disconnect to the user-network connection.
13				Not used
14				Not used
15				Not used
16				Not used
17				Not used
18				Not used
19	Release request	X	X	This state exists when the user has requested the network to release the call and is waiting for a response. On the network side, this state exists when the network has requested the user to release and is waiting for a response

2.2 States associated with the global call reference

This paragraph defines the states that the protocol may adopt using the global call reference. The procedures for use of the global call reference for restart procedures are contained in Chapter 4-5: "Layer 3 call control procedures".

There is only one global call reference per interface.

The states which may exist on the user side and the network side of the user-network interface are defined in Table 4-2.

Table 4-2
Call states associated with global call reference

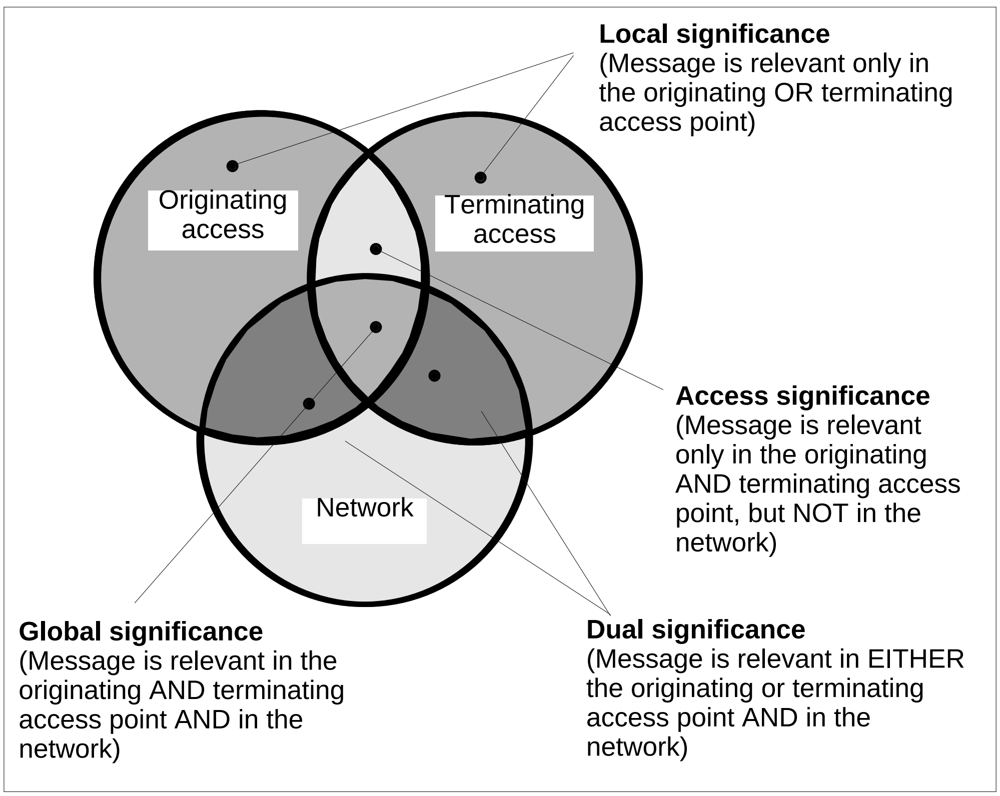
State no.	State name	User side	Network side	Definition
0	Null	X	X	No transaction exists.
1	Restart request	X	X	This state exists for a restart transaction when the user has sent a restart request but has not yet received an acknowledgement response from the network. On the network side this state exists when the network has sent a restart request, but has not received an acknowledgement response from the user.
2	Restart	X	X	This state exists when a request for a restart has been received from the network and responses have not yet been received from all locally active call references. Similarly, on the network side, this state exists when a request for a restart has been received from the user, but a response has not been received from all locally active call references.

Chapter 4-3: Layer 3 message function definitions

This chapter provides an overview of the message structure, providing the function definition and information content (that is, the semantics) of each message. Each definition includes:

- a brief description of the message direction and use, including the significance of the message with respect to the originating access point, the terminating access point, and the network as shown in Figure 4-1

Figure 4-1
Message significance within the network



- a table listing the information elements in the order of their appearance in the message. The relative order of information elements is the same for all message types). For each information element the table indicates:
  - the direction in which the message information element may be sent, that is, user to network (‘u-n’), network to user (‘n-u’), or ‘Both’ directions.
  - whether inclusion is mandatory (‘M’) or optional (‘O’), with a reference to notes explaining the circumstances under which the information element is included
  - the length of the information element (or permissible range of lengths), in octets. Note that the *Channel identification* information element may contain a repeated field and its length is therefore marked as “*”(unknown).
- Further explanatory notes, as necessary

3.1 Messages for circuit mode connection control

Table 4-3 summarizes the messages for circuit-mode connection control.

Table 4-3
Messages for circuit-mode connection control

Call establishment messages	**Reference**
Alerting	Table 4-4
Call proceeding	Table 4-4
Connect	Table 4-6
Connect acknowledge	Table 4-7
Progress	Table 4-10
Setup	Table 4-13
Call clearing messages	
Disconnect	Table 4-8
Release	Table 4-11
Release complete	Table 4-12
Miscellaneous messages	
Notify	Table 4-9
Status	Table 4-14
Status enquiry	Table 4-15

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.

Table 4-4
Alerting message content

Message type: Alerting

Significance: Global

Direction: Both

Information element	Reference	Direction	Type	Length
Protocol discriminator	See 4.2 on page 4-32.	Both	M	1
Call reference	See 4.3 on page 4-32.	Both	M	2 - 3
Message type	See 4.4 on page 4-35.	Both	M	1
Channel identification	See 4.5.12 on page 4-61.	Both (see Note 1)	M/O (see Note 2)	2 - *
Progress indicator	See 4.5.17 on page 4-71.	Both	O (see Note 3)	2 - 4

Note 1: Included in the network-to-user direction for support of symmetric call control procedures.

Note 2: Mandatory in the network-to-user direction if this message is the first message in response to *Setup* message. Mandatory in the user-to-network direction if this message is the first message in response to *Setup* message, unless the user accepts the B-channel indicated in the *Setup* message.

Note 3: Included for interworking. Included in the network-to-user direction in connection with the provision of in-band information and patterns

3.1.2 Call proceeding

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

Table 4-5
Call proceeding message content

Message type: Call Proceeding **Significance:** Local **Direction:** Both				
Information element	**Reference**	**Direction**	**Type**	**Length**
Protocol discriminator	See 4.2 on page 4-32.	Both	M	1
Call reference	See 4.3 on page 4-32.	Both	M	2 - 3
Message type	See 4.4 on page 4-35.	Both	M	1
Channel identification	See 4.5.12 on page 4-61.	Both	M/O (see Note)	2 - *
Progress indicator	See 4.5.17 on page 4-71.	Both	O	2 - 4

Note: Mandatory in the network-to-user direction if this message is the first message in response to *Setup* message. Mandatory in the user-to-network direction if this message is the first message in response to *Setup* message, unless the user accepts the B-channel indicated in the *Setup* message.

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.

Table 4-6
Connect message content

Message type: Connect **Significance:**Global **Direction:** Both				
Information element	**Reference**	**Direction**	**Type**	**Length**
Protocol discriminator	See 4.2 on page 4-32.	Both	M	1
Call reference	See 4.3 on page 4-32.	Both	M	2 - 3
Message type	See 4.4 on page 4-35.	Both	M	1
Channel identification	See 4.5.12 on page 4-61.	Both (see Note 1)	M/O (see Note 2)	2 - *
Progress indicator	See 4.5.17 on page 4-71.	Both	O	2 - 4
Low layer compatibility	See 4.5.15 on page 4-69.	Both	O	2 - 16

Note 1: Included in the network-to-user direction for support of symmetric call procedures.

Note 2: Mandatory in the network-to-user direction if this message is the first message in response to *Setup* message. Mandatory in the user-to-network direction if this message is the first message in response to *Setup* message, unless the user accepts the B-channel indicated in the *Setup* message.

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.

Table 4-7
Connect acknowledge message content

Message type: Connect Acknowledge

Significance: Local

Direction: Both

Information element	Reference	Direction	Type	Length
Protocol discriminator	See 4.2 on page 4-32.	Both	M	1
Call reference	See 4.3 on page 4-32.	Both	M	2 - 3
Message type	See 4.4 on page 4-35.	Both	M	1

3.1.5 Disconnect

This message is sent by the user to request the network to clear an end-to-end connection or is sent by the network to indicate that the end-to-end connection is cleared.

Table 4-8
Disconnect message content

Message type: Disconnect

Significance: Global

Direction: Both

Information element	Reference	Direction	Type	Length
Protocol discriminator	See 4.2 on page 4-32.	Both	M	1
Call reference	See 4.3 on page 4-32.	Both	M	2 - 3
Message type	See 4.4 on page 4-35.	Both	M	1
Cause	See 4.5.11 on page 4-53.	Both	M	2 - 32

3.1.6 Notify

This message is sent by the user to indicate information pertaining to a call. The DMS 100 may receive this message but ignores it if the call state is NOT N10 (active state).

Table 4-9
Notify message content

Message type: Notify

Significance: Access

Direction: User- to-network

Information element	Reference	Direction	Type	Length
Protocol discriminator	See 4.2 on page 4-32.	u - n	M	1
Call reference	See 4.3 on page 4-32.	u - n	M	2 - 3
Message type	See 4.4 on page 4-35.	u - n	M	1
Notification indicator	See 4.5.16 on page 4-70.	u -n	M	3

3.1.7 Progress

This message is sent by the network to indicate the progress of a call in the event of interworking or in relation with the provision of in-band information and patterns.

Table 4-10
Progress message content

Message type: Progress

Significance: Global

Direction: Network-to-user

Information element	Reference	Direction	Type	Length
Protocol discriminator	See 4.2 on page 4-32.	n - u	M	1
Call reference	See 4.3 on page 4-32.	n - u	M	2 - 3
Message type	See 4.4 on page 4-35.	n - u	M	1
Progress indicator	See 4.5.17 on page 4-71.	n - u	M	2 - 4

3.1.8 Release

This message is sent by the user or the network to indicate that the equipment sending the message has disconnected the channel (if any) and intends to release the channel and the call reference, and that the receiving equipment should release the channel and prepare to release the call reference after sending *Release complete* message.

Table 4-11
Release message content

Message type: Release **Significance:** Local (see Note 1) **Direction:** Both				
Information element	**Reference**	**Direction**	**Type**	**Length**
Protocol discriminator	See 4.2 on page 4-32.	Both	M	1
Call reference	See 4.3 on page 4-32.	Both	M	2 - 3
Message type	See 4.4 on page 4-35.	Both	M	1
Cause	See 4.5.11 on page 4-53.	Both	O (see Note 2)	2 - 32

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

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

3.1.9 Release complete

This message is sent by the user or the network to indicate that the equipment sending the message has released the channel (if any) and call reference. The channel is available for reuse, and the receiving equipment releases the call reference.

Table 4-12
Release complete message contents

Message type: Release Complete

Significance: Local (see Note 1)

Direction: Both

Information element	Reference	Direction	Type	Length
Protocol discriminator	See 4.2 on page 4-32.	Both	M	1
Call reference	See 4.3 on page 4-32.	Both	M	2 - 3
Message type	See 4.4 on page 4-35.	Both	M	1
Cause	See 4.5.11 on page 4-53.	Both	O (see Note 2)	2 - 32

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

Note 2: Mandatory in the first call clearing message, including when the *Release complete* message is sent as a result of an error handling condition.

3.1.10 Setup

This message is sent by the calling user to the network and by the network to the called user to initiate call establishment.

Table 4-13
Setup message content

Message type: Setup

Significance: Global

Direction: Both

Information element	Reference	Direction	Type	Length
Protocol discriminator	See 4.2 on page 4-32.	Both	M	1
Call reference	See 4.3 on page 4-32.	Both	M	2 - 3
Message type	See 4.4 on page 4-35.	Both	M	1
Bearer capability	See 4.5.5 on page 4-41.	Both	M	4 - 10
Channel identification	See 4.5.12 on page 4-61.	Both	M/O (see Note 1)	2 - *
Progress indicator	See 4.5.17 on page 4-71.	Both	O (see Note 2)	2 - 4
Keypad facility	See 4.5.14 on page 4-68.	u - n	O (see Note 4)	2 - 34
Calling party number	See 4.5.9 on page 4-50.	Both	O (see Note 3)	2 - 36
Calling party subaddress	See 4.5.10 on page 4-52.	Both	O (see Note 5)	2 - 23
Called party number	See 4.5.7 on page 4-47.	Both	O (see Note 4)	2 - 35
Called party subaddress	See 4.5.8 on page 4-49.	Both	O (see Note 5)	2 - 23
Low layer compatibility	See 4.5.15 on page 4-69.	Both	O (see Note 5)	2 - 16
High layer compatibility	See 4.5.13 on page 4-64.	Both	O (see Note 5)	2 - 4

Note 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, any channel is considered acceptable. If multiple channels are indicated, the first is used.

Note 2: Included in the event of interworking or in connection with the provision of in-band information and patterns. Only one *Progress indicator* information element is allowed with this message. All further *Progress indicator* information elements are ignored

Note 3: May be included by the calling user or the network to identify the calling user.

Note 4: One or both of the *Keypad facility* or the *Called party number* information elements must be included in the *Setup* message in the user-to-network direction. If both are included, the *Called party number* information element takes precedence and the *Keypad facility* is ignored. If only the *Keypad facility* information element is present, the *Type of Number* and *Numbering Plan Indicator* are assumed to be *Unknown*. If neither information element is included, the DMS-100 treats this case as a mandatory information element missing. In the network-to-user direction, the *Called party number* information elements are optional.

Note 5: The *Called party subaddress, Calling party subaddress, Low layer compatibility,* and *High layer compatibility* information elements are transparently transported across the network.

3.1.11 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 error conditions as described in Chapter 5 in paragraph 5.8 on page 4-99.

Table 4-14
Status message content

Message type: Status

Significance: Local

Direction: Both

Information element	Reference	Direction	Type	Length
Protocol discriminator	See 4.2 on page 4-32.	Both	M	1
Call reference	See 4.3 on page 4-32.	Both	M	2 - 3
Message type	See 4.4 on page 4-35.	Both	M	1
Cause	See 4.5.11 on page 4-53.	Both	M	2 - 32
Call state	See 4.5.6 on page 4-45.	Both	M	3

3.1.12 Status enquiry

This message is sent by the user or the network at any time during a call to solicit a *Status* message from the peer layer 3 entity. Sending a *Status* message in response to a *Status enquiry* message is mandatory.

Table 4-15
Status enquiry message content

Message type: Status enquiry

Significance: Local

Direction: Both

Information element	Reference	Direction	Type	Length
Protocol discriminator	See 4.2 on page 4-32.	Both	M	1
Call reference	See 4.3 on page 4-32.	Both	M	2 - 3
Message type	See 4.4 on page 4-35.	Both	M	1

3.2 Messages used with the global call reference

Table 4-16 summarizes the messages which may use the global call reference as defined in paragraph 4.3 on page 4-32 in Chapter 4-4:

Table 4-16
Messages using the global call reference

Messages:	**Reference**
Restart	Table 4-17
Restart acknowledge	Table 4-18
Status	Table 4-19

3.2.1 Restart

This message is sent by the user or the network to request the recipient to restart (that is, return to an idle condition) the indicated channel(s) or interface.

Table 4-17
Restart message content

Message type: Restart **Significance:** Local **Direction:** Both				
Information element	**Reference**	**Direction**	**Type**	**Length**
Protocol discriminator	See 4.2 on page 4-32.	Both	M	1
Call reference	See 4.3 on page 4-32.	Both	M (see Note 1)	2 - 3
Message type	See 4.4 on page 4-35.	Both	M	1
Channel identification	See 4.5.12 on page 4-61.	Both	O (see Note 2)	2 - *
Restart indicator	See 4.5.18 on page 4-73.	Both	M	3

Note 1: This message is sent with the global call reference as defined in paragraph 4.3 on page 4-32.

Note 2: Included when necessary to indicate the particular channel(s) which are to be restarted.

3.2.2 Restart acknowledge

This message is sent to acknowledge the receipt of the *Restart* message and to indicate that the requested restart is complete.

Table 4-18
Restart acknowledge message content

Message type: Restart acknowledge **Significance:** Local **Direction:** Both				
Information element	**Reference**	**Direction**	**Type**	**Length**
Protocol discriminator	See 4.2 on page 4-32.	Both	M	1
Call reference	See 4.3 on page 4-32.	Both	M (see Note 1)	2 - 3
Message type	See 4.4 on page 4-35.	Both	M	1
Channel identification	See 4.5.12 on page 4-61.	Both	O (see Note 2)	2 - *
Restart indicator	See 4.5.18 on page 4-73.	Both	M	3

Note 1: This message is sent with the global call reference as defined in paragraph 4.3 on page 4-32.

Note 2: Included when necessary to indicate the particular channel(s) which have been restarted.

3.2.3 Status

This message may be sent from either the user or the network at any time when an unexpected message with a global call reference is received, or when it is required to report other conditions of the call.

Table 4-19
Status message content

Message type: Status **Significance:** Local **Direction:** Both				
Information element	**Reference**	**Direction**	**Type**	**Length**
Protocol discriminator	See 4.2 on page 4-32.	Both	M	1
Call reference	See 4.3 on page 4-32.	Both	M (see Note 1)	2 - 3
Message type	See 4.4 on page 4-35.	Both	M	1
Cause	See 4.5.11 on page 4-53.	Both	M	2 -32
Call state	See 4.5.6 on page 4-45.	Both	M	3

Note 1: This message is sent with the global call reference as defined in paragraph 4.3 on page 4-32.

Chapter 4-4: Layer 3 message formats

4.1 Overview

Within this protocol, every message consists of the following elements:

- protocol discriminator
- call reference
- message type
- other information elements, as required

The first three information elements are common to all messages and are always present, while the last information element is specific to each message type. This organization is illustrated in Figure 4-2.

Figure 4-2
General message organization

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
Protocol discriminator								1
0	0	0	0	Length of call reference value				2
Call reference value								3
0	Message type							…
Other information elements as required								n

A particular message may contain more information than particular (user or network) equipment needs or can understand. All equipment should be able to ignore any extra information present in a message which is not required for the proper operation of that equipment. For example, a user may ignore the calling party number if that number is of no interest to the user when a *Setup* message is received.

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

The term “default” implies that the value defined should be used in the absence of any assignment, or the negotiation of alternative values.

The messages are sent as an ordered set of octets. In the following figures, the message contents are shown with a consistent bit and octet numbering pattern.Within each octet, bit “1” is transmitted first, followed by bits “2” through “8”. Similarly, the octet shown at the top of each figure is sent first.

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

4.2 Protocol discriminator

The *Protocol discriminator* information element is used to distinguish the user-to-network call control messages from other messages. In this specification, only two values are allowed; one for maintenance messages and one for call control messages as shown in Table 4-20.

The *Protocol discriminator* information element is the first part of every message and is one complete octet.

Table 4-20
Q.931 protocol discriminator coding

8 7 6 5	4 3 2 1	
0 0 0 0	1 0 0 0	Q.931 (I.451) user-to-network call control message
0 0 0 0	0 0 1 1	Maintenance message

All other values are reserved.

4.3 Call reference

The *Call reference* information element is used to identify the call request at the local user-network interface to which the particular message applies. The *Call reference* information element does not have end-to-end significance across ISDN networks.

The *Call reference* information element is the second part of every message. The length of the *Call reference* information element is indicated in octet 1, bits 1 through 4. The default maximum length of the *Call reference* information element value field is three octets. See Figure 4-3. The *Call reference* information element includes the length of the call reference value, the call reference value and the call reference flag.

Figure 4-3
Call reference information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
0	0	0	0	Length of call reference value				1
Flag	Call reference value							2
								3

The actions taken by the receiver are based on the numerical value of the *Call reference* information element and are independent of the length of the *Call reference* information element.

The *Call reference* information element value is two octets long for primary rate interface. The INS 1500 network always uses two octets for the *Call reference* information element.

Call reference values are assigned by the originating side of the interface for a call. These values are unique to the originating side only within a particular D-channel Layer 2 logical link connection. The call reference value is assigned at the beginning of a call and remains fixed for the duration of the call.

When a call ends, the associated call reference value may be reassigned to a later call. Two identical call reference values on the same D-channel Layer 2 logical link connection may be used when each value is associated with a call originated at the opposite end of the link.

The call reference flag is used to identify which end of the Layer 2 logical link originated a call reference.The call reference flag (Bit 8, Octet 2) can be set to one of the following:

- “0”, indicating that the message is sent from the side that originates the call reference.
- “1”, indicating that the message is sent to the side that originates the call reference.

The call reference flag is used to resolve simultaneous attempts to allocate the same call reference value. The call reference flag also applies to functions which use the global call reference (for example, *Restart* procedures).

A *Call reference* information element containing a dummy (null) call reference is one octet long and is coded “0000 0000”, see Figure 4-4.

Figure 4-4
Dummy (null) call reference

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
				Length of call reference value				
0	0	0	0	0	0	0	0	1

The numerical value of the global call reference is zero, see Figure 4-5. The equipment receiving a message containing the global call reference should interpret the message as pertaining to all call references associated with the appropriate data link connection identifier. The messages which can use the global call reference value are defined in Chapter 4-3: "Layer 3 message function definitions"in paragraph 3.2 on page 4-26.

Figure 4-5
Examples of the encoding for the global call reference

Global call reference (1 octet value)

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
				Length of call reference value				
0	0	0	0	0	0	0	0	1
Flag (0/1)	0	0	0	0	0	0	0	2

Global call reference (2 octet value)

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
				Length of call reference value				
0	0	0	0	0	0	0	0	1
Flag (0/1)	0	0	0	0	0	0	0	2
0	0	0	0	0	0	0	0	3

4.4 Message type

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

The message type is the third part of every message. The message type is coded as shown in Figure 4-6.

Figure 4-6
Message type information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
0	Message type							1

8 7 6 5	4 3 2 1	
0 0 0 -	- - - -	**Call establishment messages**
0	0 0 0 1	Alerting
0	0 0 1 0	Call Proceeding
0	0 1 1 1	Connect
0	1 1 1 1	Connect Acknowledge
0	0 0 1 1	Progress
0	0 1 0 1	Setup
0 1 0 -	- - - -	**Call clearing messages**
0	0 1 0 1	Disconnect
0	1 1 0 1	Release
1	1 0 1 0	Release Complete
0	0 1 1 0	Restart
0	1 1 1 0	Restart Acknowledge
0 1 1 -	- - - -	**Miscellaneous messages**
0	1 1 1 0	Notify
1	1 1 0 1	Status
1	0 1 0 1	Status Enquiry

4.5 Other information elements

4.5.1 Coding rules

The coding of other information elements follows the coding rules described below. These rules are formulated to allow each piece of equipment which processes a message to find information elements important to it, and to ignore information elements not important to that equipment.

Two categories of information elements are defined (see Figure 4-7):

- single octet information elements
- variable length information elements

The descriptions of the following information elements are organized in alphabetical order. However, there is a particular order of appearance for each information element in a message within each code set (see paragraph 4.5.2 on page 4-38).

Figure 4-7
Information element formats

Single octet information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
1	Information element identifier			Contents of information element				**1**

Variable length information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
0	Information element identifier							1
Length of contents of information element, octets 3 through n								2
Contents of information element								3... n

The code values of the information element identifier for the variable length formats are assigned in ascending numerical order, according to the actual order of appearance of each information element in a message. This allows the receiving equipment to detect the presence or absence of a particular information element without scanning through an entire message. Single octet information elements may appear at any point in the message.

Where the description of information elements in this specification contains spare bits, these bits are indicated as being set to "0". In order to allow compatibility with future implementations, messages are not rejected because spare and reserved bits are set to "1".

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

A variable length information element may be present, but empty. For example, a *Setup* message may contain a *Called party number* information element, which has a content of zero length. This should be interpreted by the receiver as equivalent to that information element being absent. Similarly, an absent information element should be interpreted by the receiver as equivalent to that information element being empty.

The following rules apply for the coding of variable length information elements from octet 3 and above.

- The first digit in the octet number identifies one octet or a group of octets.
- Each octet group is a self-contained entity. The internal structure of an octet group may be defined in alternative ways.
- An octet group is formed by using an extension mechanism. The preferred extension mechanism is to extend an octet (N) through the next octet(s) (Na, Nb, ...) by using bit 8 in each octet as an extension bit. The bit value "0" indicates that the octet group continues through the next octet. The bit value "1" indicates that this octet is the last octet. If an octet (Nb) is present, then the preceding octets (N and Na) must be present.

  In the format descriptions (appearing in the later paragraphs in this chapter), bit 8 is marked "0/1 Ext" if another octet may follow. Bit 8 is marked "1 Ext" if this is the last octet in the extension domain.

  Additional octets may be defined in future implementations (that is, "1 Ext" may be changed to "0/1 Ext"). All equipment should be prepared to receive these additional octets although it need not interpret or act upon the contents of these octets.
- In addition to the extension mechanism defined above, an octet (N) may be extended through the next octet(s) (N.1, N.2 ...) by indications in bits 7 through 1 (of octet N).
- The two extension mechanisms described above may be combined.

Figure 4-8
Code set 0 information element identifier encoding

Information element identifier 8 7 6 5	4 3 2 1	
1 : :	: : : :	**Single octet information element**
0 0 1	0 - - -	Locking shift
0 0 1	1 - - -	Non-locking shift (see Note 1)
0 : : :	: : : :	**Variable length information element**
0 0 0	0 1 0 0	Bearer capability
0 0 0	1 0 0 0	Cause
0 0 1	0 1 0 0	Call state
0 0 1	1 0 0 0	Channel identification
0 0 1	1 1 1 0	Progress indicator
0 1 0	0 1 1 1	Notification indicator
0 1 0	1 1 0 0	Keypad facility
1 1 0	1 1 0 0	Calling party number
1 1 0	1 1 0 1	Calling party sub-address
1 1 1	0 0 0 0	Called party number
1 1 1	0 0 0 1	Called party sub-address
1 1 1	1 0 0 1	Restart indicator
1 1 1	1 1 0 0	Low layer compatibility
1 1 1	1 1 0 1	High layer compatibility

Note 1: Not supported by DMS-100 in BCS 34

4.5.2 Extension of code sets

In BCS 34, DMS-100 does not support code sets other than code set 0. In the future, the DMS-100 will support extensions of the code set, and this section is included to indicate the possible implementations of these extensions.

There are a number of possible information element identifier values using the formatting rules described in the previous paragraph. There are a possible 128 values for the variable length information element format and at least 8 values for the single octet information element format.

It is possible to expand this structure to eight code sets with at least 133 information element identifier values each. One common value in the single octet format is employed in each code set to allow shifting from one code set to another. The content of this *Shift* information element identifies the code set to be used for the next information element or elements. The code set in use at any given time is referred to as the “active code set”. By convention, code set 0 is the initially active code set.

The coding rules specified in paragraph 4.5.1 on page 4-36 apply to information elements belonging to any active code set.

Transitions from one active code set to another-by means of the locking shift procedure-may only be made to a code set with a higher numerical value than the original.

User or network equipment should have the capability to recognize a *Shift* information element and can determine the length of the following information element. The equipment need not be able to interpret and act upon the contents of the information element. This enables the equipment to determine the start of a subsequent information element.

Code set 6 is reserved for information elements specific to the local network (either public or private). These elements do not have significance across the boundaries between local networks, or across a national or international boundary. Therefore, code set 6 information elements are treated as if they were unrecognized information elements beyond the local network boundary. (See the procedures in paragraph 5.8.7 on page 4-104 in Chapter 4-5:)

4.5.3 Locking shift procedure

In BCS 34, DMS-100 does not support the locking shift procedure. In the future, the DMS-100 will support extensions of the code set, and this section is included to indicate the possible implementations of these extensions.

The locking shift procedure employs a *Locking shift* information element to indicate the new active code set. The specified code set remains active until another *Locking shift* information element is encountered which specifies the use of another code set.

For example, code set 0 is active at the start of message content analysis. If a *Locking shift* information element to code set 6 is encountered, the next information elements are interpreted according to the information element identifiers assigned in code set 6. Code set 6 remains active until another *Locking shift* information element is encountered.

The locking shift is valid only within the message which contains the *Locking shift* information element.The *Locking shift* information element uses the single octet information element format as shown in Figure 4-9.

Figure 4-9
Locking shift

8 7 6 5	4 3 2 1	
1 0 0 1	0 1 1 0	Code set 6

4.5.4 Non-locking shift procedure

The non-locking shift procedure is not supported in the 1989 version of the INS-1500 specification. If the DMS-100 receives a *Non-locking shift* information element, the *Non-locking shift* information element and the information element immediately following it are treated as not-implemented information elements.

4.5.5 Bearer capability

The *Bearer capability* information element is used to indicate that the network is to provision one of the bearer capabilities as defined in CCITT Recommendation I.211. No default bearer capability is assumed by the absence of this information element.

Figure 4-10
Bearer capability information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
0	Bearer capability information element identifier 0	0	0	0	1	0	0	1
Length of information element								2
1	Coding standard		Information transfer capability					3
1	Transfer mode		Information transfer rate					4
Ext. 0/1	Layer 1 identifier 0	1	Layer 1 protocol identification					5 (see Note 1)
1	Spare 0	0	Data access rate					5a (see Note 2)
Ext. 1	Layer 2 identifier 0	1	Layer 2 protocol identification					6 (see Note 1)
Ext. 1	Layer 3 identifier 1	1	Layer 3 protocol identification					7 (see Note 1)

Note 1: This octet may be omitted

Note 2: This octet is present if octet 5 is set to 0010 0001, indicating rate adaption.

Coding standard (octet 3)

7 6	
0 0	CCITT/TTC standardized coding

All other values are reserved.

Information transfer capability (octet 3)

5 4 3 2 1	
0 0 0 0 0	Speech
0 1 0 0 0	Unrestricted digital information
0 1 0 0 1	Reserved
1 0 0 0 0	3.1 kHz audio (modem) [a]

a. 3.1 kHz audio receives identical treatment to speech

Transfer mode (octet 4)

7 6	
0 0	Circuit mode

Information transfer rate (octet 4)

5 4 3 2 1	
1 0 0 0 0	64 kbit/s

Layer and protocol identification (Octet 5, 5a)

This field identifies the protocols and data rate adaption used for the user information on the access channel at the user-to-network interface

7 6	
0 1	Layer 1

5 4 3 2 1	
0 0 0 0 1	Rate adaption based on CCITT I, X, and V series. To indicate the data rate, octet 5 bit 8 is set to “0” and the following octet indicates the user information data rate. See encoding of octet 5a
0 0 0 1 0	Recommendation G.711 μ -law speech

Access data rate (octet 5a)

8	
1	Last octet of this octet group

7 6	
0 0	Spare

5 4 3 2 1	**Synchronous rate**
0 1 1 1 1	56 kbit/s

User information Layer 2 protocol (Octet 6)

5 4 3 2 1	
0 0 0 1 0	Recommendation Q.921 (I.441)

User information Layer 3 protocol (Octet 7)

5 4 3 2 1	
0 1 1 1 0	Recommendation Q.931 (I.451)

Examples of bearer capability codes

The codes used in this information element for the bearer services supported by DMS-100, are:

Attribute	Encoding	Octet
(1) Speech		
Transfer capability = speech	1000 0000	3
Transfer mode and rate = circuit-mode, 64 kbit/s	1001 0000	4
Layer 1 protocol identifier = μ- law	1010 0010	5
Octet 5a not present		
(2) 64 kbit/s unrestricted digital, rate adapted to 56 kbit/s		
Transfer capability = unrestricted digital	1000 1000	3
Transfer mode and rate = circuit-mode, 64 kbit/s	1001 0000	4
Layer 1 protocol ID = Rate adaption	0010 0001	5
Data rate = 56 kbit/s	1000 1111	5a
(3) 64 kbit/s clear, unrestricted digital, circuit-mode		
Transfer capability = unrestricted digital	1000 1000	3
Transfer mode and rate = circuit-mode, 64 kbit/s	1001 0000	4
Octets 5 and 5a are not present		
(4) 3.1 kHz audio		
Transfer capability = 3.1 kHz audio	1001 0000	3
Transfer mode and rate = circuit-mode, 64 kbit/s	1001 0000	4
Layer 1 protocol ID = μ- law	1010 0010	5
Octet 5a not present		

4.5.6 Call state

The purpose of the *Call state* information element is to describe the current status of a call.

Figure 4-11
Call state information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
	Call state information element identifier							1
0	0	0	1	0	1	0	0	
Length of information element								2
0	0	0	0	0	0	0	1	
Coding standard		Call state or global call state value						3

Coding standard (octet 3)

8 7	
0 0	CCITT/TTC standardized coding

Call state value (octet 3)

6 5	4 3 2 1	State no.	User state	Network state
0 0	0 0 0 0	0	Null	Null
0 0	0 0 0 1	1	Call initiated	Call initiated
0 0	0 0 1 1	3	Outgoing call proceeding	Outgoing call proceeding
0 0	0 1 0 0	4	Call delivered	Call delivered
0 0	0 1 1 0	6	Call present	Call present
0 0	0 1 1 1	7	Call received	Call received
0 0	1 0 0 0	8	Connect request	Connect request
0 0	1 0 0 1	9	Incoming call proceeding	Incoming call proceeding
0 0	1 0 1 0	10	Active	Active
0 0	1 0 1 1	11	Disconnect request	Disconnect request
0 0	1 1 0 0	12	Disconnect indication	Disconnect indication
0 1	0 0 1 1	19	Release request	Release request

All other values are reserved. States are defined in Chapter 4-2: "Layer 3 overview of call control"

Global interface state value (octet 3)

6 5	4 3 2 1	State no.	User state
0 0	0 0 0 0	0	REST 0 - Null
1 1	1 1 0 1	1	REST 1 - Restart request
1 1	1 1 1 0	2	REST 2 - Restart

All other values are reserved.

4.5.7 Called party number

The purpose of the *Called party number* information element is to identify the called party of a call.

Figure 4-12
Called party number information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
0	Called party number information element identifier							1
	1	1	1	0	0	0	0	
Length of information element								2
1 Ext.	Type of number			Numbering plan identification				3
0 Spare	Number digits (IA5 characters, see Note 1)							4 ...n

Note 1: The address (number) digit in octet 4 precedes the digit in octet 5. Similarly, for the digit in octet (n) and octet (n+1). Therefore the digit that is “dialled” first is the one located in octet 4

Type of number (octet 3)

7 6 5	
0 0 1	Unknown

All other values are reserved

Numbering plan identification (octet 3)

4 3 2 1	
0 0 0 0	Unknown

All other values are reserved

Number digit coding (octet 4 ...n)

7 6 5	4 3 2 1	Address digit value
0 1 1	0 0 0 0	0
0 1 1	0 0 0 1	1
0 1 1	0 0 1 0	2
0 1 1	0 0 1 1	3
0 1 1	0 1 0 0	4
0 1 1	0 1 0 1	5
0 1 1	0 1 1 0	6
0 1 1	0 1 1 1	7
0 1 1	1 0 0 0	8
0 1 1	1 0 0 1	9

Note: The maximum number of digits that may be included in the *Called party number* information element is 32. However, the DMS-100 ignores any digits after the 24th. Similarly the DMS-100 does not send more than 24 digits in a *Called party number* information element.

4.5.8 Called party sub-address

The purpose of the *Called party sub-address* information element is to identify the sub-address of the called party of a call.

Figure 4-13
Called party sub-address information element

<table>
<tr><th>Bit 8</th><th>Bit 7</th><th>Bit 6</th><th>Bit 5</th><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Bit 1</th><th>Octet</th></tr>
<tr><td rowspan="2">0</td><td colspan="7">Called party sub-address information element identifier</td><td rowspan="2">1</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td colspan="8">Length of information element</td><td>2</td></tr>
<tr><td>Ext.
1</td><td colspan="3">Type of sub-address</td><td>Odd/
even
indicator</td><td colspan="3">Spare
0 0 0</td><td>3</td></tr>
<tr><td colspan="8">Sub-address information</td><td>4 ...n</td></tr>
</table>

Type of sub-address (octet 3)

7 6 5	
0 0 0	NSAP (X.213, ISO 8348 AD2)
0 1 0	User specified sub-address

All other values are reserved

Odd/even indicator (octet 3)

4	
0	Even number of address signals
1	Odd number of address signals

Note: The *Odd/even indicator* information element is used when the type of sub-address is “User specified” and the coding is binary coded decimal.

Sub-address information (octet 4 ...n)

The information in this field is passed with the message by the DMS-100, but is not validated by the DMS-100. The maximum length of this field is 20 octets.

4.5.9 Calling party number

The purpose of the *Calling party number* information element is to identify the origin of a call.

Figure 4-14
Calling party number information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
	Calling party number information element identifier							1
0	1	1	0	1	1	0	0	
Length of information element								2
Ext. 0/1	Type of number			Numbering plan identification				3
Ext. 1	Present indicator		Spare 0	Reserved 0	0	Screening indicator		3a (see Note 1)
Spare 0	Number digits (IA5 characters)							4 … n

Note 1: This octet may be omitted

Note 2: The contents of this information element, other than octet 3a, are coded as shown for the *Called party number* information element.

Presentation indicator (octet 3a)

7 6	
0 0	Presentation allowed
0 1	Presentation restricted
1 0	Number not available due to interworking
1 1	Reserved

Note: If octet 3a is omitted then:

- “Presentation allowed” is the default in the network->user direction.
- Subscription default is assumed in the user->network direction.

Screening indicator (octet 3a)

2 1	
0 0	Reserved
0 1	User provided, verified, and passed
1 0	Reserved
1 1	Network provided

Note 1: If octet 3a is omitted “Network provided” is assumed to be default.

Note 2: The maximum number of digits that may be included in the *Calling party number* information element is 32. However, the DMS-100 ignores any digits after the 12th. Similarly the DMS-100 does not send more than 12 digits in a *Calling party number* information element.

Note 3: Non-numeric digits in the CGN IE are considered invalid and are therefore ignored. Numeric digits that follow invalid digits are accepted as valid.

4.5.10 Calling party sub-address

The purpose of the *Calling party sub-address* information element is to identify the sub-address of the calling party of a call.

Figure 4-15
Calling party sub-address information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
	Called party sub-address information element identifier							1
0	1	1	1	0	0	0	1	
Length of information element								2
Ext. 1	Type of sub-address			Odd/ even indicator	Spare 0	0	0	3
Sub-address information								4...n

Type of sub-address (octet 3)

7 6 5	
0 0 0	NSAP (X.213, ISO 8348 AD2)
0 1 0	User specified sub-address

All other values are reserved

Odd/even indicator (octet 3)

4	
0	Even number of address signals
1	Odd number of address signals

Note: The *Odd/even indicator* information element is used when the type of sub-address is “User specified” and the coding is binary coded decimal.

Sub-address information (octet 4 ...n)

The information in this field is passed with the message by the DMS-100, but is not validated by the DMS-100. The maximum length of this field is 20 octets.

4.5.11 Cause

The purpose of the *Cause* information element is to describe the reason for generating certain messages, to provide diagnostic information in the event of procedural errors and to indicate the location of the cause originator.

The *Cause* information element is coded as shown in Figure 4-16. Diagnostic information is not available on the DMS-100 for every cause.

Figure 4-16
Cause information element

<table>
<tr><th>Bit 8</th><th>Bit 7</th><th>Bit 6</th><th>Bit 5</th><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Bit 1</th><th>Octet</th></tr>
<tr><td rowspan="2">0</td><td colspan="7">Cause information element identifier</td><td rowspan="2">1</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="8">Length of information element</td><td>2</td></tr>
<tr><td>Ext.
0/1</td><td colspan="2">Coding standard</td><td>Spare
0</td><td colspan="4">General location</td><td>3</td></tr>
<tr><td>Ext.
1</td><td colspan="7">Recommendation</td><td>3a (see Note 1)</td></tr>
<tr><td rowspan="2">Ext.
1</td><td colspan="7">Cause value</td><td rowspan="2">4</td></tr>
<tr><td colspan="3">Class</td><td colspan="4">Value</td></tr>
<tr><td colspan="8">Diagnostics (if any)</td><td>5 … n (see Note 1).</td></tr>
</table>

Note 1: These octets may be omitted

Coding standard (octet 3)

7 6	
0 0	CCITT/TTC standardized coding
0 1	Reserved
1 0	Reserved
1 1	Standard specific to the identified location which is indicated by the *General location* field in octet 3. This coding standard should only be used when the desired cause cannot be represented with the CCITT/TTC standardized coding. The DMS-100 treats receipt of this coding standard as an information element content error.

General location (octet 3)

4 3 2 1	
0 0 0 0	User
0 0 0 1	Private network serving the local user
0 0 1 0	Public network serving the local user
0 0 1 1	Transit network
0 1 0 0	Public network serving the remote user
0 1 0 1	Private network serving the remote user
0 1 1 1	International network
1 0 1 0	Network beyond interworking point

All other values are reserved.

Recommendation (octet 3a)

7 6 5	4 3 2 1	
0 0 0	0 0 0 0	TTC standard JT -Q931

Note 1: If octet 3a is omitted from the *Cause* information element, it is assumed that the TTC standard JT-Q931 is to be used

Cause value (octet 4)

The cause value is divided into two fields, a class (bits 5 through 7) and a value within the class (bits 1through 4). The class indicates the general nature of the event.

Class (000)	Normal class
Class (001)	Normal class
Class (010)	Network congestion class
Class (011)	Service or option not available class
Class (100)	Service or option not implemented class
Class (001)	Invalid message (for example, parameter out of range) class
Class (110)	Protocol error (for example, unknown message) class
Class (111)	Interworking class

Diagnostics (octet 5)

Diagnostic information is not available for every cause value (see Table 4-21 following). The inclusion of diagnostics is optional. When available, the coding of the diagnostic(s) is the same as for the corresponding information element or message type.

Table 4-21
Cause value definitions

Cause value Class 7 6 5	Cause value Value 4 3 2 1	Cause no.	Cause (and definition)	Diagnostics
		Normal class		
0 0 0	0 0 0 1	1	"Unassigned number" Indicates that the destination requested by the calling user cannot be reached because, although the number is in a valid format, it is not currently assigned	
0 0 0	0 0 1 0	2	"No route to specified transit network" Indicates that the equipment sending this cause has received a request to route the call through a particular transit network which it does not recognize. The equipment sending this cause does not recognize the transit network either because the transit network does not exist or because that particular transit network, while it does exist, does not serve the equipment which is sending this cause	
0 0 0	0 0 1 1	3	"No route to destination" Indicates that the called user cannot be reached because the network through which the call has been routed does not serve the destination desired.	
0 0 0	0 1 1 0	6	"Channel unacceptable" Indicates the channel most recently identified is not acceptable to the sending entity for use in this call.	Zero in diagnostic field
0 0 0	0 1 1 1	7	"Call awarded and being delivered to an established channel" Indicates the user has been awarded the incoming call, and that the call is being connected to a channel already established to that user for similar calls.	
		Normal class		
0 0 1	0 0 0 0	16	"Normal call clearing" Indicates that the call is being cleared because one of the users involved in the call has requested that the call be cleared.	Zero in diagnostic field
0 0 1	0 0 0 1	17	"User busy" Indicates that the called user is unable to accept another call because another call(s) is occupying the resources required to handle the new call.	

Table 4-21
Cause value definitions (Continued)

Cause value Class 7 6 5	Value 4 3 2 1	Cause no.	Cause (and definition)	Diagnostics
0 0 1	0 0 1 0	18	"No user responding" Indicates a user is not responding to a call establishment message with either an alerting or connect indication within the prescribed period of time allocated.	Zero in diagnostic field
0 0 1	0 0 1 1	19	"No answer from user (user alerted)" Indicates a user has provided an alerting indication but has not provided a connect indication within a prescribed period of time.	Zero in diagnostic field
0 0 1	0 1 0 1	21	"Call rejected" Indicates the equipment sending this cause does not wish to accept this call, although it could have accepted the call because the equipment sending this cause is neither busy or incompatible.	Zero in diagnostic field
0 0 1	0 1 1 0	22	"Number changed address" Indicates the called number, indicated by the calling party number is no longer assigned. This cause is returned to calling user.	
0 0 1	1 0 1 0	26	"Non-selected user clearing the call" Indicates that the user has not been awarded the incoming call.	
0 0 1	1 0 1 1	27	"Destination out of order" Indicates that the destination indicated by the user cannot be reached because the interface to the destination is not functioning correctly. "Not functioning correctly" indicates that a signaling message was unable to be delivered to the remote user; for example, a physical layer or data link layer failure at the remote user, or user equipment off-line	Zero in diagnostic field
0 0 1	1 1 0 0	28	"Incomplete *Number* information element" Indicates that the destination indicated by the calling user cannot be reached because the number is not in a valid format or is not complete.	
0 0 1	1 1 0 1	29	"Facility rejected" Indicates that a facility requested by the user cannot be provided by the network.	
0 0 1	1 1 1 0	30	"Response to *Status enquiry*" This cause is included in the STATUS message when the reason for generating the STATUS message was the prior receipt of a STATUS ENQUIRY message.	

Table 4-21
Cause value definitions (Continued)

Cause value Class 7 6 5	Value 4 3 2 1	Cause no.	Cause (and definition)	Diagnostics
0 0 1	1 1 1 1	31	“Normal unspecified” Indicates that a normal event has occurred, but no other cause in the normal class applies.	Zero in diagnostic field
			Network congestion class	
0 1 0	0 0 1 0	34	“No circuit/channel available” Indicates that there is no appropriate circuit or channel, presently available, to handle the call.	Zero in diagnostic field
0 1 0	0 1 1 0	38	“Network out of order” Indicates that the network is not functioning correctly and that the condition is likely to last a relatively long period of time. That is, re-attempting the call is not likely to be successful	
0 1 0	1 0 0 1	41	“Temporary failure” Indicates that the network is not functioning correctly but that the condition is *not* likely to last a long period of time. That is, the user may wish to try another call attempt almost immediately.	Zero in diagnostic field
0 1 0	1 0 1 0	42	“Switch equipment congestion” Indicates that the switching equipment generating this cause is experiencing a period of high traffic.	Zero in diagnostic field
0 1 0	1 0 1 1	43	“User information discarded” Indicates that the network could not deliver access information to the remote user as requested.	Information element identifier
0 1 0	1 1 0 0	44	“Requested circuit or channel not available” Indicates that the channel requested by the user during local channel negotiation is not currently available. (For example, the channel is in use, or out of service for maintenance).	Zero in diagnostic field
0 1 0	1 1 1 1	47	“Resources unavailable” Indicates that the user has requested a resource that is not available, and no other cause in the resource unavailable class applies.	Zero in diagnostic field
			Service or option not available class	
0 1 1	0 0 1 0	50	“Requested facility not subscribed” Indicates that the user has not subscribed to this facility and therefore cannot access the facility at this time.	
0 1 1	1 0 0 1	57	“Bearer capability not authorized” Indicates that the user has requested a bearer capability which is implemented by the equipment which generated this cause but which the user is not authorized to use.	Zero in diagnostic field

Table 4-21
Cause value definitions (Continued)

Cause value Class 7 6 5	Cause value Value 4 3 2 1	Cause no.	Cause (and definition)	Diagnostics
0 1 1	1 0 1 0	58	"Bearer capability not presently available" Indicates that the user has requested a bearer capability which is implemented by the equipment which generated this cause but which is not available at this time.	
0 1 1	1 1 1 1	63	"Service or option not available, unspecified" This cause is used to report a service or option not available event only when no other cause in the service or option not available class applies.	
			Service or option not implemented class	
1 0 0	0 0 0 1	65	"Bearer capability not implemented" Indicates that the equipment sending this cause does not support the bearer capability requested	Information element identifier
1 0 0	0 0 1 0	66	"Channel type not implemented" Indicates that the equipment sending this cause does not support the channel type requested.	
1 0 0	0 1 0 1	69	"Requested facility not implemented" This cause indicates that the equipment sending this cause does not support the requested supplementary service.	
1 0 0	0 1 1 0	70	"Only restricted digital information bearer capability is available" Indicates that the user has requested an unrestricted bearer service but that the equipment sending this cause only supports the restricted version of the requested bearer capability.	
1 0 0	1 1 1 1	79	"Unspecified service or option not implemented" This cause is used to report a service or option not implemented event only when no other cause in the service or option not implemented class applies.	
			Invalid message (for example, parameter out of range) class	
1 0 1	0 0 0 1	81	"Invalid call reference value" Indicates that the equipment sending this cause has received a message with a call reference which is not currently in use on the user-network interface.	Message type

Table 4-21
Cause value definitions (Continued)

Cause value Class 7 6 5	Value 4 3 2 1	Cause no.	Cause (and definition)	Diagnostics
1 0 1	0 0 1 0	82	"Identified channel does not exist" Indicates that the equipment sending this cause has received a request to use a channel not activated on the interface for a call. For example, if a user has subscribed to channels 1 through 12 on a primary rate interface, and the user equipment or the network attempts to use channels 13 through 23, this cause is generated.	Zero in diagnostic field
1 0 1	1 0 0 0	88	"Incompatible destination" Indicates that the equipment sending this cause has received a request to establish a call to a destination in which the required attributes cannot be accommodated (for example, data rate).	Zero in diagnostic field
1 0 1	1 0 1 1	91	"Invalid transit network selection" This cause indicates that a transit network identification was received which is of an incorrect format.	
1 0 1	1 1 1 1	95	"Invalid message, unspecified" This cause is used to report an invalid message event only when no other cause in the invalid message class applies.	
			Protocol error (for example, unknown message) class	
1 1 0	0 0 0 0	96	"Mandatory information element is missing" Indicates that the equipment sending this cause has received a message which is missing an information element which must be present in the message before that message can be processed.	Information element identifier
1 1 0	0 0 0 1	97	"Message type non-existent or not implemented" Indicates that the equipment sending this cause has received a message with a message type it does not recognize either because this is a message not defined or, it is defined but not implemented by the equipment sending this cause.	Message type
1 1 0	0 0 1 0	98	"Message not compatible with call state, or message type non-existent, or not implemented" This cause is a combination of causes 97 and 101 where the sender cannot distinquish between an unexpected and an unrecognized message.	

Table 4-21
Cause value definitions (Continued)

Cause value Class 7 6 5	Value 4 3 2 1	Cause no.	Cause (and definition)	Diagnostics
1 1 0	0 0 1 1	99	"Information element non-existent or not implemented" Indicates that the equipment sending this cause has received a message which includes the information elements not recognized because the information element identifier is not defined or it is defined but not implemented by the equipment sending the cause. However, the information element is not required to be present in the message in order for the equipment sending the cause to process the message.	Information element identifier
1 1 0	0 1 0 0	100	"Invalid information element contents" Indicates that the equipment sending this cause has received an information element which it has implemented; however, one or more of the fields in the information element are coded in a way which has not been implemented by the equipment sending this cause.	Information element identifier
1 1 0	0 1 0 1	101	"Message not compatible with call state" Indicates that the equipment sending this cause has received a message such that the procedures do not indicate that this is a permissible message to receive while in the call state, or a *Status* message was received indicating an incompatible call state.	Message type
1 1 0	0 1 1 0	102	"Recovery on timer expiry" Indicates that a procedure has been initiated by the expiry of a timer in association with error handling procedures.	Zero in diagnostic field
1 1 0	1 1 1 1	111	"Protocol error, unspecified" This cause is used to report a protocol error event only when no other cause in the protocol error class applies.	Zero in diagnostic field
			Interworking class	
1 1 1	1 1 1 1	127	"Interworking, unspecified" Indicates that there has been interworking with a network which does not provide causes for actions it takes; thus, the precise cause for a message which is being sent cannot be ascertained.	

All other values are reserved.

4.5.12 Channel identification

The purpose of the *Channel identification* information element is to identify a channel within the interface controlled by these signaling procedures (see Figure 4-17).

Figure 4-17
Channel identification information element

<table>
<tr><th>Bit 8</th><th>Bit 7</th><th>Bit 6</th><th>Bit 5</th><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Bit 1</th><th>Octet</th></tr>
<tr><td rowspan="2">0</td><td colspan="7">Channel identification information element identifier</td><td rowspan="2">1</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="8">Length of information element</td><td>2</td></tr>
<tr><td>Ext.
1</td><td>Interface identifier present</td><td>Interface type
1</td><td>Spare
0</td><td>Pref/Excl</td><td>D-channel indicator</td><td colspan="2">Information channel selection</td><td>3</td></tr>
<tr><td>Ext.
1</td><td colspan="7">Interface identifier</td><td>3.1 (see Note 1)</td></tr>
<tr><td rowspan="2">Ext.
1</td><td colspan="2">Coding Standard</td><td rowspan="2">Number or map</td><td colspan="4" rowspan="2">Channel or map element type</td><td rowspan="2">3.2</td></tr>
<tr><td>0</td><td>0</td></tr>
<tr><td>Ext.
0/1</td><td colspan="7">Channel number or slot map</td><td>3.3</td></tr>
</table>

Note 1: This octet is only present if the *Interface identifier present* field, (octet 3, bit 7) is set to 1.

Interface identifier present (octet 3, bit 7)

7	
0	Interface implicitly identified
1	Interface explicitly identified in octet 3.1 (Interface identifier).

Interface type (octet 3, bit 6)

6	
0	Reserved
1	Primary rate interface

Preferred/exclusive (octet 3, bit 4)

4	
0	Indicated channel is preferred
1	Exclusive; only the indicated channel is acceptable

D-channel indicator (octet 3, bit 3)

3	
0	Channel identified is not the D-channel
1	Channel identified is the D-channel

Information channel selection (octet 3, bits 1 and 2)

2 1	**Primary interface**
0 0	Reserved
0 1	As indicated in following octets
1 0	Reserved
1 1	Any channel. Note that this value is *not* sent by the DMS-100

Interface identifier (octet 3.1)

The value of the *Interface identifier* information element is in the range 0 to 31(binary coded). The length of the *Interface identifier* information element is always 1 octet. It is assigned to the interface at subscription time.

Coding standard (octet 3.2)

7 6	
0 0	CCITT/TTC Standardized coding

All other values are reserved.

Number or map (octet 3.2)

5	
0	Channel indicated by number in the following octet
1	Channel indicated by slot map in the following octets

Channel or map element type (octet 3.2)

4 3 2 1	
0 0 1 1	B- channel units

All other values are reserved

Channel number or slot map (octet 3.3)

Channel number The binary number that is assigned to the channel. The channel number equals the time slot number.

Slot map The bit position in the slot map that corresponds to the time slot used by the channel is set to 1. The following table shows the mapping between the channel number and the time slot assigned to that channel.

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
24	23	22	21	20	19	18	17	3.3.1
16	15	14	13	12	11	10	9	3.3.2
8	7	6	5	4	3	2	1	3.3.3

1544 kbit/s

Note 1: In a *Setup* message, multiple *Channel numbers* or multiple time slots in a slot map are not accepted. The first channel encountered is used and the remainder are ignored.

Note 2: For call set up, the slot map is used.

Note 3: During call set up, the choice of channel number or slot map coding in the network-to-calling-user direction is the same as that received from the calling user.

Note 4: In *Restart* and *Restart acknowledge* messages, multiple time slots are accepted.

Note 5: In a *Restart* message, in the network-to-user direction, slot map coding is used.

Note 6: In a *Restart acknowledge m*essage, in the network-to-user direction, the choice of channel number or slot map is the same as that received from the user in the *Restart* message.

4.5.13 High-layer compatibility

The *High layer compatibility* information element, along with the bearer capability information element, provides a way for the remote user to check compatibility.

Figure 4-18
High-layer compatibility information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
0	High-layer compatibility information element identifier 1	1	1	1	1	0	1	1
Length of information element								2
Ext. 1	Coding standard		Interpretation			Presentation meth. of protocol profile		3
Ext. 0/1	High-layer characteristics identification							4
Ext. 1	Extended high-layer characteristics identification							4a (see Note 1)

Note 1: This octet is only present if octet 4 indicates maintenance or management.

Coding standard (octet 3)

7 6	
0 0	CCITT/TTC coding, as described following
0 1	Reserved for other international standards (see Note 1)
1 0	National standard (see Note 1)
1 1	Standard defined for the network (Public or private) present at the network side of the interface (see Note 1).

Note 1: These other coding standards should only be used when the desired high layer compatibility cannot be represented with the CCITT/TTC standardized coding.

Interpretation (octet 3)

5	4	3	
1	0	0	First (primary or only) high layer characteristics identification (in Octet 4) to be used in the call.

All other values are reserved

Note 1: *Interpretation* indicates how the *High layer characteristics identification* (in Octet 4) should be interpreted.

Note 2: Currently, *Interpretation* has only a single value. However, *Interpretation,* when enhanced, will indicate how the *High layer characteristics identification* in the same information element is interpreted when multiple *High layer characteristics identifications* are used and the exact relationship between them needs to be identified (for example, sequential usage, alternative list, simultaneous usage).

Presentation method of protocol profile (octet 3)

2	1	
0	1	High -layer protocol profile (without specification of attributes)

All other values are reserved

Note 1: Currently, *Presentation method of protocol profile* has only a single value. That is, a "profile value" is used to indicate that a service, supported by high layer protocols, is required. The necessity of other presentation methods-for example, service indications in the form of layer-by-layer indication of protocols to be used in high layers-may be introduced later.

High layer characteristics identification (Octet 4)

7 6 5	4 3 2 1	
0 0 0	0 0 0 1	Telephony
0 0 0	0 1 0 0	Facsimile group 2/3
0 1 0	0 0 0 1	Facsimile group 4 document application profile
0 1 0	0 1 0 0	Document application profile for formatted mixed-mode
0 1 0	1 0 0 0	Document application profile for processable-form
0 1 1	0 0 0 1	Teletext
0 1 1	0 0 1 0	Document application profile for videotex interworking between gateways
0 1 1	0 1 0 1	Telex
0 1 1	1 0 0 0	Message handling systems
1 0 0	0 0 0 1	OSI application (see Note 1)
1 0 1	1 1 1 0	Reserved for maintenance (see Note 2)
1 0 1	1 1 1 1	Reserved for management (see Note 2)
1 1 1	1 1 1 1	Reserved

All other values are reserved

The coding above applies where:

- *Coding standard* = CCITT standard
- *Presentation method of protocol profile* = High layer protocol profile

Code points are added only to those services for which CCITT recommendations are available

Note 1: Further compatibility checking is executed by the OSI high layer protocol

Note 2: When this coding is included, octet 4 may be followed by octet 4a

Extended high layer characteristics identification (Octet 4a)

7 6 5	4 3 2 1	
0 0 0	0 0 0 1	Telephony
0 0 0	0 1 0 0	Facsimile group 2/3
0 1 0	0 0 0 1	Facsimile group 4 document application profile
0 1 0	0 1 0 0	Document application profile for formatted mixed-mode
0 1 0	1 0 0 0	Document application profile for processable-form
0 1 1	0 0 0 1	Teletext
0 1 1	0 0 1 0	Document application profile for videotex interworking between gateways
0 1 1	0 1 0 1	Telex
0 1 1	1 0 0 0	Message handling systems
1 0 0	0 0 0 1	OSI application
1 0 1	1 1 1 0	Not available for assignment
1 0 1	1 1 1 1	Not available for assignment
1 1 1	1 1 1 1	Reserved

All other values are reserved

4.5.14 Keypad facility

The *Keypad facility* information element is used to convey IA5 characters that are entered by terminal keypad, for example.(See Figure 4-19.)

Figure 4-19
Keypad facility information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
	Keypad facility information element identifier							1
0	0	1	0	1	1	0	0	
Length of information element								2
Spare	Number digits (IA5 characters)							3 ...n
0								

Number digits (octet 3)

The number digits are coded as shown for the *Called party number* information element in paragraph 4.5.9 on page 4-50.

> ***Note:*** The maximum number of digits that may be included in the *Keypad facility* information element is 32. However, the DMS-100 ignores any digits after the 24th.

4.5.15 Low-layer compatibility

The *Low-layer compatibility* information element, in conjunction with the bearer capability information element, provides a way for the remote user to check compatibility. This information element is not interpreted by the DMS-100 but is passed to the terminating user. The maximum length of the *Compatibility information* field is 14 octets (see Figure 4-20).

Figure 4-20
Low-layer compatibility information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
0	Low-layer compatibility information element identifier 1	1	1	1	1	0	0	1
Length of information element								2
Compatibility information								3...n

4.5.16 Notification indicator

The *Notification indicator* information element is used to indicate information associated with a call.The information element is coded as shown in Figure 4-21.

Figure 4-21
Notification indicator information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
0	Notification indicator information element identifier 0	1	0	0	1	1	1	1
Length of information element								2
Ext. 1	Notification description							3

Notification description (octet 3)

7 6 5	4 3 2 1	
0 0 0	0 0 0 0	User suspended
0 0 0	0 0 0 1	User resumed

All other values are reserved.

Note: If an invalid code point is received in the call active state (State N10) a *Status message* is returned.

4.5.17 Progress indicator

The *Progress indicator* information element is used to describe an event which has occurred during the life of a call.

Figure 4-22
Progress information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
0	Progress indicator information element identifier 0	0	1	1	1	1	0	1
Length of information element								2
Ext. 1	Coding standard		Spare 0	General location				3
Ext. 1	Progress description							4

Coding standard (octet 3)

7 6	
0 0	CCITT/TTC standardized coding

All other values are reserved.

General location (octet 3)

4 3 2 1	
0 0 0 0	User
0 0 0 1	Private network serving a local user
0 0 1 0	Public network serving a local user
0 1 0 0	Public network serving a remote user
0 1 0 1	Private network serving a remote user
1 0 1 0	Network beyond interworking point

All other values are reserved.

Progress description (octet 4)

7 6 5	4 3 2 1	Desc no.	
0 0 0	0 0 0 1	1	Call is not end-to-end ISDN (interworking trunk facilities); further call progress information may be available in-band
0 0 0	0 0 1 0	2	Destination address is non-ISDN
0 0 0	0 0 1 1	3	Origination address is non-ISDN
0 0 0	0 1 0 0	4	Call has returned to the ISDN network
0 0 0	1 0 0 0	8	In-band information or pattern is now available

All other values are reserved.

The situations in which each of the *Progress descriptions* are supported depends on message type, call direction, and interworking conditions.

Note: The network will reject any received *Progress indicator* value other than “#2 Destination address in non-ISDN.”

4.5.18 Restart indicator

The purpose of the *Restart indicator* information element is to identify the class of the facility (that is, channel or all interfaces) to be restarted.

Figure 4-23
Restart indicator information element

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Octet
	Restart indicator information element identifier							
0	1	1	1	1	0	0	1	1
Length of information element								2
Ext.	Spare				Class			
1	0	0	0	0				3

Class (octet 3)

3 2 1	
0 0 0	Indicated channel (see Note1)
1 1 0	Single interface (DMS-100 does not initiate restart with this code)
1 1 1	All channels associated with the D-channel

All other values are reserved.

Note 1: If the *Class* = 0 0 0 (octet 3, bits 1 through 3), the *Channel identification* information element must be included. This information element indicates which channel is to be restarted. If the *Channel identification* information element is not present, the interface-including the D-channel- is restarted, (that is, the class is assumed to be 1 1 0).

Chapter 4-5:
Layer 3 call control procedures

This chapter describes the procedures that define the flow of messages across a primary rate interface between an ISDN user and the network. The call states referred to in this chapter refer to:

- states seen by the network
- states seen by the user
- states which are common to both user and network

Unless noted, all states described in the following text should be understood as common. (See "Call states on the network or user side of the interface" on page 4-8 in Chapter 4-2: for user and network call states.)

Detailed Specification and Description Language (SDL) diagrams for the procedures specified in this section are contained in Chapter 4-7: "Layer 3 SDL diagrams". If there is an ambiguity in the narrative text, the SDL diagrams should be used to resolve the conflict. If the text and SDL are in disagreement, the text should be considered correct.

> ***Note:*** This chapter describes the sequence of messages associated with the control of circuit-switched connections.

5.1 Call establishment at the originating interface

Before these procedures are invoked, a reliable data link connection must be established between the user and the network. All Layer 3 messages are sent to the data link layer using a *DL-Data-Request* primitive. The data link services described in the Layer 2 procedures (Section 3 of this specification) are assumed.

5.1.1 Call request procedure

A user initiates call establishment by transferring a *Setup* message across the user-network interface.

Following the transmission of the *Setup* message, the call is considered by the user to be in the *Call initiated* state. The message always contains a *Call* *reference* information element, selected according to the procedures given in "Call reference" on page 4-32. The *Bearer capability, Channel identification* and *Called party number* information elements are mandatory in the *Setup* message.

If the user knows all appropriate channels controlled by the D-channel are in use, it does not send a *Setup* message across the user-network interface. If the user does not monitor the status of the channels in use, it may send a *Setup* message when all channels are busy.

The *Setup* message contains all of the call information necessary for call establishment.

5.1.2 B-channel selection-originating

In the *Setup* message, the user indicates one of the following using the *Channel identification* information element

- channel is indicated, no acceptable alternative
- channel is indicated, any alternative is acceptable
- any channel is acceptable

If no *Channel identification* information element is included, the last option is assumed to be requested. If an acceptable channel is available, the network selects that channel for the call. If the network cannot grant the preferred channel, it selects any other available B-channel associated with that D-channel.

The selected B-channel is indicated in the first message returned by the network in response to the *Setup* message (that is, a *Setup acknowledge* or a *Call proceeding* message). After transmitting this message, the network activates the selected B-channel connection.

The user need not attach until it receives a *Call proceeding*, *Progress*, or *Alerting* message with a *Progress indicator* information element with one of the following *Progress description* values:

- #8 “Inband information or appropriate pattern is now available”
- #1 “Call is not end-to-end ISDN; further call progress information may be available in-band”

Prior to this time, the network cannot assume that the user has attached to the B-channel. After this time, the user is connected to the B-channel, provided the equipment does not generate local tone. Upon receipt of the *Connect* message, the user attaches to the B-channel (if it has not already done so).

If the specified B-channel is not available and no acceptable alternative is specified, a *Release complete* message with *Cause* value #44 “Requested circuit/channel not available” is sent by the network as described in "Call clearing" on page 4-85.

If no channel is available, a *Release complete* message with a *Cause* value #34 “No circuit/channel available” is sent by the network as described in "Call clearing" on page 4-85.

Unsuccessful termination of the B-channel selection procedure by the side offering the call is accomplished by sending a *Release* message as described in "Exception conditions" on page 4-86. The *Release* message has *Cause* value #6 “Channel unacceptable”.

5.1.3 Invalid call information

If, following the receipt of the *Setup* message, the network determines that the call information received from the user is invalid (for example, an invalid number is sent), the network initiates call clearing in accordance with "Call clearing" on page 4-85. The *Cause* value returned is one of the following:

- #1 “Unassigned number”
- #3 “No route to destination”
- #22 “Number changed address”
- #28 “Incomplete number information element”

5.1.4 Call proceeding

If the network determines that the *Setup* message contains all the information required from the user to establish the call and that access to the requested service is authorized and available, the network:

- sends a *Call proceeding* message to the user to acknowledge the *Setup* message and to indicate that the call is being processed
- enters the *Outgoing call proceeding* state

When the user receives the *Call proceeding* message, the user also enters the *Outgoing Call proceeding* state.

If the network determines that a requested service is not authorized or is not available, the network initiates call clearing in accordance with "Call clearing" on page 4-85. The network returns one of the following *Cause* values:

- #57 “Bearer capability not authorized”
- #58 “Bearer capability not presently available”
- #63 “Service or option not available, unspecified”
- #65 “Bearer capability not implemented”

5.1.5 Notification of interworking at the originating interface

During call establishment, the call may leave the ISDN environment (for example, because of interworking with non-ISDN facilities). When this situation occurs, a *Progress indicator* information element is returned to the calling user in one of the following messages:

- in an appropriate call control message when a state change is required, (for example, *Alerting*)
- in the *Progress* message when no state change is appropriate

The *Progress indicator* information element in the message sent to the user has *Progress description* value #1 “Call is not end-to-end ISDN (interworking trunk facilities); further call progress information may be available in-band”. *Progress description* value #2 “Destination address is non-ISDN” can also be returned.

If the *Progress indicator* information element is included in a call control message, the procedures described in the following apply. If the *Progress indication* information element is included in the *Progress* message, no state change occurs, but any supervisory timers are stopped. In both cases, if indicated by the *Progress indicator* information element, the user connects to-if not already connected-and monitors the B-channel for further in-band information.

If the interface at which the *Progress indicator* originates is where the call enters the ISDN environment from a non-ISDN environment, any *Setup* message sent to the network should include a *Progress indicator* information element with one of the following *Progress description* values:

- #1 “Call is not end-to-end ISDN (interworking trunk facilities); further call progress information may be available in-band”
- #3”Origination address is non-ISDN”

5.1.6 Call confirmation indication

Upon receiving an indication that user alerting has been initiated at the called address, the network

- sends an *Alerting* message across the user-network interface of the calling address
- enters the *Call delivered* state

When the user receives the *Alerting* message, the user may begin an internally-generated alerting indication and enters the *Call delivered* state.

5.1.7 Call connected

Upon receiving an indication that the call has been accepted, the network

- sends a *Connect* message across the user-network interface to the calling user
- enters the *Active* state

The *Connect* message indicates to the calling user that a connection has been established through the network. This stops a possible local indication of alerting.

On receipt of the *Connect* message, the calling user

- stops any user-generated alerting indications
- (optionally) sends a *Connect acknowledge* message
- enters the *Active* state

The network takes no action on receipt of a *Connect acknowledge* message if it sees the call is in the *Active* state.

5.1.8 Call rejection

Upon receiving an indication that the network or the called user is unable to accept the call, the network initiates clearing at the originating user-network interface as described in "Call clearing" on page 4-85. It uses the *Cause* provided by the terminating network or the called user.

5.2 Call establishment at the destination interface

This procedure assumes that a data link connection providing services described in the Layer 2 procedures-as outlined in Section 3 of this specification-exists before the first Layer 3 message (that is a *Setup* message) is transferred across the interface.

All Layer 3 messages are sent to the data link layer using a *DL-Data-Request* primitive.

The *Call reference* information element contained in all messages exchanged across the user-network interface contains the call reference value specified in the *Setup* message delivered by the network.

5.2.1 Incoming call

The network indicates the arrival of a call at the user-network interface by transferring a *Setup* message across the interface. This message is sent if the network can select an idle B-channel.

In addition to the mandatory information elements, the *Setup* message may include any of the optional information elements described in "Setup" on page 4-22.

After sending the *Setup* message, the network

- starts timer T303
- enters the *Call present* state

The *Setup* message contains all the information required by the called user to process the call. Upon receipt of a *Setup* message, the user enters the *Call present* state.

If no response to the *Setup* message is received by the network before the first expiry of timer T303, the *Setup* message is retransmitted and timer T303 is restarted.

5.2.2 Compatibility checking

A user receiving a *Setup* message performs compatibility checking before responding to the *Setup* message. Any reference to “user” in this chapter implicitly refers to compatible user equipment.

Calling side compatibility checking

At the calling side, the network checks that the bearer service requested by the calling user in the *Bearer capability* information element matches the bearer services provided to that user by the network. If a mismatch is detected, the network rejects the call using one of the causes listed in "Call proceeding" on page 4-77

Called side compatibility checking

When the network is providing a bearer service at the called side, the user checks that the bearer service offered by the network in the *Bearer capability* information element matches the bearer services that the user can support. If a mismatch is detected, the user either ignores or rejects the offered call using *Cause* value #88 “Incompatible destination”.

Action in the event of a mismatch

An incompatible user responds to the *Setup* message with

- a *Release complete* message with *Cause* value #88 “Incompatible destination”
- enters the *Null* state

The network processes the *Release complete* message as described in the paragraph entitled "Called user clearing during incoming call establishment" on page 4-83.

5.2.3 B-channel selection-destination

When the *Setup* message is delivered by a point-to-point data link, negotiation for the selection of a B-channel is permitted between the network and the user. Only B-channels controlled by the same D-channel can be the subject of the selection procedure.

The selection procedure is as follows:

- In the *Setup* message, the network indicates one of the following:
  - case 1: channel is indicated, no acceptable alternative
  - case 2: channel is indicated, any alternative is acceptable
  - case 3: any channel is acceptable. The DMS-100 does not support this option o outgoing calls. A channel is always selected for the outgoing call prior to sending the *Setup* message.
- The response to these procedures is as follows:
  - for case 1 and 2, if the indicated channel is acceptable and available, the user selects it for the call.
  - for case 2, if the user cannot grant the indicated channel, it selects any other available B-channel associated with the D-channel, and identifies that channel in the first message sent in response to the *Setup* message.
  - for case 1, if the B-channel indicated in the first response message is not the channel offered by the network, or in case 2, the B-channel indicated in the first response message is unacceptable to the network, it clears the call by sending a *Release message* with *Cause* value #6 “Channel unacceptable”.
- If no *Channel identification* information element is present in the first response message, the B-channel indicated in the *Setup* message is assumed.
- When a B-channel has been selected by the user, the user may connect to that channel.
- In case 1, if the indicated B-channel is not available, or in cases 2 and 3, if no B-channel is available, the user returns a *Release complete* message with *Cause* value
  - #44 “Requested circuit or channel not available”
  - OR, #34 “No circuit/channel available”
- The user returns to the *Null* state

5.2.4 Call confirmation

Response to *Setup*

When the user determines that sufficient call setup information has been received and compatibility requirements (see "Compatibility checking" on page 4-80) have been satisfied, the user responds with a *Call proceeding*, an *Alerting*, or a *Connect* message. It enters the *Incoming call proceeding, Call received*, or *Connect request* state, respectively.

> ***Note 1:*** A *Progress indicator* information element may be included an *Alerting* message
>
> ***Note 2:*** The *Call proceeding* message may be sent by a user that cannot respond to a *Setup* message with an *Alerting*, *Connect*, or *Release complete* message before expiration of timer T303.

An incompatible user responds by

- sending a *Release complete* message with *Cause* value #88 “Incompatible destination”
- entering the *Null* state

The network processes this *Release complete* message in accordance with the procedures described in "Called user clearing during incoming call establishment"on page 4-83.

A busy user that satisfies the compatibility requirements indicated in the *Setup* message normally responds with a *Release complete* message with *Cause* value #17 “User busy”.

The network processes this *Release complete* message in accordance with the procedures described in "Called user clearing during incoming call establishment" on page 4-83.

If the user wishes to refuse the call

- a *Release complete* message is sent with the *Cause* value #21 “Call rejected”
- user returns to the *Null* state

The network processes this *Release complete* message in accordance with the procedures described in "Called user clearing during incoming call establishment"on page 4-83.

Receipt of *Call proceeding* and *Alerting*

Upon receipt of the *Call proceeding* message from a user, the network

- stops timer T303

- starts timer T310
- enters the *Incoming call proceeding* state.

The *Call proceeding* message contains a *Channel identification* information element.

Upon receipt of the *Alerting* message from a user, the network

- stop timers T303 or T310 (if running)
- starts timer T301
- enters the *Call received* state
- sends a corresponding *Alerting* message to the calling user

If the received *Alerting* message is the first response to the *Setup* message it contains the *Channel identification* information element.

Called user clearing during incoming call establishment

If a *Release complete* or *Disconnect* message is received before a *Connect* message, the network

- stops timer T303 or T310 (if running)
- continues to clear the user as described in "Clearing initiated by the user" on page 4-86
- clears the call to the calling user with the *Cause* value received in the *Release complete* or *Disconnect* message

Call failure

If the network does not receive any response to the retransmitted *Setup* message prior to the expiration of timer T303, the network

- initiates clearing procedures towards the calling user with *Cause* value #18 “No user responding”
- initiates clearing procedures towards the called user. The called user is cleared in accordance with the procedures defined in "Clearing initiated by the network" on page 4-89 using *Cause* value #102 “Recovery on timer expiry”.

If the network has received a *Call proceeding* message, but does not receive an *Alerting, Connect,* or *Disconnect* message prior to the expiration of timer T310, the network

- initiates clearing procedures toward the calling user with *Cause* value #18 “No user responding”

- initiates clearing procedures towards the called user. The called user is cleared in accordance with the procedures defined in "Clearing initiated by the network" on page 4-89 using *Cause* value #102 “Recovery on timer expiry”

If the network receives an *Alerting* message, but does not receive a *Connect* or *Disconnect* message prior to the expiration of timer T301 the network

- initiates clearing procedures toward the calling user with *Cause* value #19 “No answer from user (user alerted)”
- initiates clearing procedures towards the called user. The called user is cleared in accordance with the procedures defined in "Clearing initiated by the network" on page 4-89 using *Cause* value #102 “Recovery on timer expiry”

5.2.5 Notification of interworking at the terminating interface

During call establishment, a call may enter a non-ISDN environment because, for example

- the ISDN network is interworking with another network
- the call may be from or to a non-ISDN user,
- the call may be to or from non-ISDN equipment

When this occurs, the point at which the call enters the non-ISDN environment causes a *Progress indicator* information element to be included in the *Setup* message that is sent to the called user. The information element has *Progress description* value #1 “Call is not end-to-end ISDN (interworking trunk facilities); further call progress information may be available inband”. *Progress description* value #3 “Origination address is non-ISDN” can also be returned.

On receipt of *Progress indicator* information element with *Progress description* value #1, the called user connects to the B-channel in accordance with the procedures defined in "Active indication" on page 4-85

In addition, the called user notifies the calling party of the following:

- whether the call has left the ISDN environment within the called user’s premises
- possible availability of in-band information or patterns.

When such situations occur, a *Progress indicator* information element is sent by the user to the network in an appropriate call control message when a state change is required (*Alerting* or *Connect,* for example). The *Progress indicator* information element has the following *Progress description* value:

- #2 “Destination address is non-ISDN”

5.2.6 Call accept

A user indicates acceptance of an incoming call by sending a *Connect* message to the network. When the *Connect* message is sent, the user starts timer T313 (the value of timer T313 is specified in Chapter 4-6: "Layer 3 list of system parameters"). If an *Alerting* message has previously been sent to the network, the *Connect* message may contain only the *Call reference* information element.

If a call can be accepted using the B-channel indicated in the *Setup* message, and no user alerting is required, a *Connect* message may be sent without a previous *Alerting* message. If the *Connect* message is the first response to the *Setup* message, it contains the *Channel identification* information element.

5.2.7 Active indication

On receipt of the first *Connect* message, the network

- stops timers T301, T303 and T310 (if running)
- completes the circuit-switched path to the selected B-channel
- sends a *Connect acknowledge* message to the user which first accepted the call
- initiates procedures to send a *Connect* message towards the calling user
- enters the *Active* state

The *Connect acknowledge* message indicates completion of the circuit-switched connection. There is no guarantee of an end-to-end connection until a *Connect* message is received at the calling user.

Upon receipt of the *Connect acknowledge* message, the called user:

- stops timer T313
- enters the *Active* state

If timer T313 expires prior to receipt of a *Connect acknowledge* message, the called user initiates clearing in accordance with the procedures defined in "Clearing initiated by the user" on page 4-86

A user that has received the *Setup* message may connect to the B-channel as soon as channel selection has been completed.

5.3 Call clearing

5.3.1 Terminology

The following terms are used in the description of the clearing procedures:

- A channel is *connected* when the channel is part of a circuit-switched ISDN connection established according to this specification.

- A channel is *disconnected* when the channel is no longer part of a circuit-switched ISDN connection, but is not yet available for use in a new connection.
- A channel is *released* when the channel is not part of a circuit-switched ISDN connection and is available for use in a new connection. Similarly, a call reference that is *released* is available for reuse.

5.3.2 Exception conditions

Under normal conditions, call clearing is usually initiated when the user or the network sends a *Disconnect* message and follows the procedures defined in "Clearing initiated by the user" on page 4-86 or "Clearing initiated by the network" on page 4-89, respectively. The only exceptions to this rule are as follows:

- In response to a *Setup* message, the user or network can reject a call (for example, because of the unavailability of a suitable B-channel) by
  - responding with a *Release complete* message provided no other response has previously been sent
  - releasing the call reference and entering the *Null* state.
- Unsuccessful termination of the B-channel selection procedure (see "B-channel selection-destination" on page 4-81 and "B-channel selection-originating" on page 4-76) by the side offering the call. The call is terminated by sending a *Release* message as described in "Clearing initiated by the user" on page 4-86 and "Clearing initiated by the network" on page 4-89. The *Release* message has *Cause* value #6 “Channel unacceptable”.

5.3.3 Clearing initiated by the user

Apart from the exception conditions identified in "Exception conditions" on page 4-86 and "Handling of error conditions" on page 4-99, the user initiates clearing by

- sending a *Disconnect* message
- starting timer T305 (the value of timer T305 is specified in Chapter 4-6: "Layer 3 list of system parameters")
- disconnecting the B-channel
- entering the *Disconnect request* state

Note: When a user initiates call clearing by sending a *Release* message, the procedures described in "Clearing initiated by the network" on page 4-89 are followed.

The network enters the *Disconnect request* state upon receipt of a *Disconnect* message. This message causes the network to disconnect the B-channel and to initiate procedures for clearing the network connection to the remote user. When the B-channel used for the call has been disconnected, the network

- sends a *Release* message to the user
- starts timer T308 (the value of timer T308 is specified in Chapter 4-6: "Layer 3 list of system parameters")
- enters the *Release request* state.

> ***Note:*** The *Release* message has only local significance and does not imply an acknowledgement of clearing from the remote user.

On receipt of the *Release* message, the user

- cancels timer T305
- releases the B-channel
- sends a *Release complete* message
- releases the call reference
- returns to the *Null* state

Following the receipt of a *Release complete* message from the user, the network

- stops timer T308
- releases both the B-channel and the call reference
- returns to the *Null* state.

If a *Release complete* message is not received by the network before the first expiry of timer T308, the *Release* message is retransmitted and timer T308 is restarted. If no *Release complete* message is received from the user before T308 expires a second time, the network

- places the B-channel in a maintenance state
- releases the call reference
- returns to the *Null* state

If timer T305 expires, the user

- sends a *Release* message to the network with the cause number originally contained in the *Disconnect* message
- starts timer T308
- enters the *Release request* state. In addition, the user may indicate a second *Cause* information element with value #102 “Recovery on timer expiry”.

If user timer T308 expires for the first time, the user

- retransmits the *Release* message
- restarts timer T308

In addition, the user may indicate a second *Cause* information element with a value #102 “Recovery on timer expiry”.

If no *Release complete* message is received from the network before timer T308 expires a second time, the user

- may place the B-channel in a maintenance state
- releases the call reference
- returns to the *Null* state

> ***Note:*** The restart procedures contained in "Call collisions" on page 4-99 may be used on B-channels in the maintenance state.

5.3.3.1 Cause Screening

When an initial call clearing message is received by the terminating interface with a cause other than the ones which result in a reroute attempt or inband treatment, the originating interface normally sends a clearing message to the originating interface with the cause received from the terminating interface. However cause values that only have significance locally are mapped to a more generalized one for the DMS-100 platform. Table 4-22 on page 4-89 shows the causes that are affected. When one of these causes is received at the terminating interface, cause #41, “temporary failure”, is substituted.

Table 4-22 Cause screening table

Received cause
6. Channel unacceptable
30. Response to status enquiry
81. Invalid call reference value
82. Identified channel does not exist[a]
95. Invalid message unspecified
96. Mandatory information element is missing
97. Message type nonexistent or not implemented
98. Message not compatible with state, or message type nonexistent or not implemented
99. Information element nonexistent or not implemented
100. Invalid information element contents
101. Message not compatible with state
102. Recovery on timer expiry
111. Protocol error, unspecified

a. screening is done ONLY if the remote interface (remote interface refers to the PRI trunk connected to the other end of the terminating interface) is NOT controlled by an MSL-1 PBX.

5.3.4 Clearing initiated by the network

Apart from the exceptions identified in "Exception conditions" on page 4-86 and "Handling of error conditions" on page 4-99, the network initiates clearing by

- sending a *Disconnect* message
- entering the *Disconnect indication* state

  Note: When the network initiates clearing by sending a *Release* message, the procedures in "Clearing initiated by the user" on page 4-86 are followed.

Clearing when tones or announcements provided

When tones or announcements are provided in conjunction with call clearing, the network sends a *Progress* message (see "In-band tones and announcements" on page 4-93).

If a call originating on a PRI trunk cannot be completed, a clearing message, containing an appropriate cause, is generally sent back to the calling interface. In some cases, however, an inband treatment (a tone or an announcement) may be preferable, instead of immediately clearing the call.

Inband treatment procedures apply only for originating PRI calls with a bearer capability (BC) of speech or 3.1-kHz audio. Inband treatment is available when normally, a DISCONNECT or RELEASE COMPLETE message containing either cause #1, “unallocated (unassigned) number”,or cause #27, “destination out of order”, would be sent to the calling interface. Inband treatment can also be applied if the terminating interface receives a call clearing message containing cause #1, “unallocated (unassigned) number”.

Subscribing to this option enables inband treatment procedures for originating PRI calls with a bearer capability (BC) of speech or 3.1-kHz audio for the following scenarios:

- The call attempt results in a DMS treatment of VACT (vacant code), UNDN (unassigned number), or BLDN (blank directory number). (Normally, a DISCONNECT or RELEASE COMPLETE message containing cause #1, “unallocated (unassigned) number”, would be sent to the calling interface.)
- The terminating interface receives a call clearing message containing cause #1, “unallocated (unassigned) number”.
- The call attempt results in a DMS treatment of TRBL (trouble intercept). (Normally, a DISCONNECT or RELEASE COMPLETE message containing cause #27, “destination out of order”, would be sent to the calling interface.)

For these cases, when inband treatment is subscribed to, the originating interface will send the calling interface a PROGRESS message containing progress indicator #8, and either cause #1 or cause #27 (as appropriate), and a tone or an announcement will be supplied over the allocated b-channel.

Clearing when tones or announcements not provided

When tones or announcements are *not* provided, clearing is initiated by the network, when the network

- sends a *Disconnect* message
- starts timer T305
- disconnects the B-channel
- enters the *Disconnect indication* state

On receipt of the *Disconnect* message the user

- disconnects the B-channel
- sends a *Release* message
- starts timer T308
- enters the *Release request* state

On receipt of the *Release* message, the network

- stops timer T305
- releases the B-channel
- sends a *Release complete* message
- releases the call reference
- returns to the *Null* state

If timer T305 expires, the network

- sends a *Release* message to the user with the *Cause* value originally contained in the *Disconnect* message
- starts timer T308
- enters the *Release request* state

In addition to the original clearing cause, the *Release* message may contain a second *Cause* information element with a value #102 “Recovery on timer expiry”.

Completion of clearing

Following the receipt of a *Release complete* message from the user, the network

- stops timer T308
- releases both the B-channel and the call reference
- returns to the *Null* state

If a *Release complete* message is *not* received by the network before the first expiry of timer T308

- the *Release* message is retransmitted
- timer T308 is restarted

If no *Release complete* message is received from the user before timer T308 expires a second time, the network

- places the B-channel in a maintenance state

- releases the call reference
- returns to the *Null* state

If a *Release complete* message is not received by the user before the first expiry of timer T308

- the *Release* message is retransmitted
- timer T308 is restarted

In addition to the original clearing cause, the *Release* message may contain a second *Cause* information element with a value #102 “Recovery on timer expiry”.

If no *Release complete* message is received from the network before T308 expires a second time, the user

- may place the B-channel in a maintenance state
- releases the call reference
- returns to the *Null* state

  Note: The restart procedures contained in "Call collisions" on page 4-99 may be used on B channels in the maintenance state.

5.3.5 Clear collision

Clear collision occurs when both the user and the network simultaneously transfer *Disconnect* messages specifying the same call reference value. When the network receives a *Disconnect* message while in the *Disconnect indication* state, the network

- stops timer T305
- sends a *Release* message
- starts timer T308
- enters the *Release request* state.

Similarly, when the user receives a *Disconnect* message while in the *Disconnect request* state, the user

- stops timer T305
- disconnects the B-channel (if not disconnected)
- sends a *Release* message
- starts timer T308
- enters the *Release request* state

Clear collision can also occur when both sides simultaneously transfer *Release* messages related to the same call reference value. The entity receiving such a *Release* message while within the *Release request* state

- stops timer T308
- releases the call reference and B-channel, if appropriate
- enters the *Null* state (without sending or receiving a *Release complete* message)

5.4 In-band tones and announcements

Inband treatment procedures apply only for PRI calls with a bearer capability (BC) of speech or 3.1 kHz audio. When inband tones or announcements not associated with a call state change are to be provided before reaching the *Active* state a *Progress message* is returned with the application of the in-band tone or announcement. The *Progress* message contains the *Progress indicator* information element with *Progress description* value #8 “In-band information or appropriate pattern now available”.

When tones or announcements have to be provided together with a call state change, the appropriate message (for example, *Alerting)* with *a Progress indicator* information element with *Progress description* value #8 “In-band information or appropriate pattern now available” is sent simultaneously with the application of the in-band tone or announcement.

> ***Note 1:*** When the *Progress* message is used, the user may initiate call clearing as a result of the applied in-band tone or announcement, according to procedures specified in "Clearing initiated by the user" on page 4-86.
>
> ***Note 2:*** The protocol currently described in this specification applies at the calling user-to-network interface. The *Progress* message is not sent in the user-to-network direction.

5.5 Interworking with existing networks

Although the method of functional out-of-band signaling is unique to ISDN facilities, it is essential to preserve the same human interface for calls that are routed over these facilities, and to allow for interworking with non-ISDN interfaces. Methods for providing audible ringback, user busy tones, and announcements are essential to preserving the traditional human interface for telephony calls.

These procedures identify the agent responsible for generating in-band busy and audible ringback tones. The agent generates the tones for calls that are within an ISDN network(s) as well as calls between ISDN and non-ISDN networks.

Three call scenarios are considered:

- the call has been delivered successfully to the terminating user, who is being alerted
- the call is unsuccessful because the terminating user is busy
- the call requires that network-provided announcements be sent to the calling user

In addition, three call types need to be considered:

- type 1, within ISDN,
- type 2, from non-ISDN to ISDN
- type 3, from ISDN to non-ISDN.

For these procedures, the non-ISDN network provides tones and announcements as currently implemented regardless of the network connection and call scenario. An ISDN exchange acts independently of the three network connections, that is, it is independent of the possible existence and character of interworking.

The terms *originating exchange* and *terminating exchange* are used in the following description to refer to equipment such as private branch exchanges (PBXs) or central offices(COs) that are closest to the respective end users. An intermediate exchange is a PBX or CO situated between the originating and terminating exchanges.

5.5.1 Generation of audible ringback tones

The terminating exchange (either ISDN or non-ISDN) is responsible for the generation of audible ringback tones for all three types of calls.

Calls terminating on ISDN facilities

This section describes procedures for calls involving network connections that remain in the ISDN network(s) (Type 1 calls) or are from non-ISDN networks but terminate on an ISDN network (Type 2 calls).

In order to remain consistent with the pre-ISDN implementation, audible ringback tone is provided by the terminating exchange.

For Type 1 calls, audible ringback is generated by the terminating exchange. The network assumes that the user provides other tones and announcements and therefore clears the call back to the originating user in the event of call failure.

For Type 2 calls, the following procedure is performed:

- the terminating exchange determines it is a type 2 call by the presence of the *Progress indicator* information element in the *Setup* message, having *Progress description* value #1 “Call is not end-to-end ISDN (interworking trunk facilities); further call progress information may be available in-band”.
- if the call proceeds through the network and successfully reaches the terminating exchange, the terminating exchange
    - determines if the endpoint terminal is available
    - if so, alerts the end-user terminal, propagates the alerting indicator back to the originating exchange and provides in-band audible ringback tone
    - when the terminal at the terminating exchange answers the call by sending a *Connect* message (or equivalent “off-hook” indication) audible ringback is removed, and the *Connect* message is propagated back towards the originating exchange

ISDN to non-ISDN calls

For this call type-call type 3- interworking occurs at the interworking exchange. When the interworking condition is detected, it is the responsibility of the interworking exchange to send a *Progress* message towards the originating side of the interface. The *Progress* message contains the *Progress indicator* information element having *Progress description* value #1 “Call is not end-to-end ISDN (interworking trunk facilities); further call progress information may be available in-band”.

This is an indication that the call has left the ISDN network and that audible ringback is provided in-band from the terminating exchange. The *Progress* message, in conjunction with interexchange signalling, causes cut through from the ISDN originating exchange to the interworking exchange. Further, the interworking exchange monitors the outgoing non-ISDN trunking facilities for answer and disconnect supervision. These conditions, upon detection, are translated into *Connect* or *Disconnect* messages, respectively, for the ISDN side of the call.

5.5.2 Generation of busy tones

In-band busy tones are generated as close as possible to the calling user, allowing network resources used to reach the terminating exchange to be released. The user can subscribe to have the network provide busy tone as a subscription option.

ISDN to ISDN (call type 1)

Upon notification that the called user is busy, the terminating exchange generates a *Disconnect* message with *Cause* value #17 “User busy” towards the originating side. In response to this message, the originating exchange disconnects the B-channel and generates the in-band busy tone locally.

Non-ISDN to ISDN (call type 2)

Upon notification that the called user is busy, the terminating exchange generates an appropriate clearing message towards the originating side. In response to this message from the ISDN network, the interworking exchange generates the busy tone towards the originating user.

ISDN to non-ISDN (call type 3)

In this call type, the busy tone is generated by the terminating exchange. In this call type, a *Progress* message with *Progress indicator* information element with *Progress description* value #1 is sent towards the originating user by the interworking exchange indicating that the call is not end-to-end ISDN and that call progress information is only available in-band. The *Progress* message causes cut through from the originating exchange to the interworking exchange.

5.5.3 Announcements

Calls within an ISDN network may still have treatment applied, involving in-band information, for example, tones or voice announcements.

The cut-through procedures ensure that in-band tones may be provided. Therefore, the network or user may insert in-band tones or announcements after returning or receiving the initial response to the *Setup* message.

5.6 Restart procedure

The restart procedure is used to return channels and interfaces to an idle condition. The procedure is invoked

- after a data link reset following a data link failure (that is, after expiry of timer T309)
- following expiry of timer T308 for a second time. This is due to the absence of a response to the *Release* message (to restart that specific channel).
- when adding or returning B channels to service from a Maintenance or Out of Service State
- (optionally) on data link establishment at time of system initialization

5.6.1 Sending Restart

A *Restart* message is sent by the network or user to return channels or interfaces to the *Null* state. The *Channel identification* information element must be present in the *Restart* message when a specified channel, or interface other than the one containing the D-channel, is returned to the idle condition. If the *Channel identification* information element is absent, this indicates that the interface containing the D-channel requires restarting.

In the event of a global restart, the *Restart* message is sent without any channel identification information.

After transmitting the *Restart* message, the sender

- enters the *Restart request* state
- starts timer T316
- waits for a *Restart acknowledge* message

No further *Restart* message is sent until a *Restart acknowledge* message is received, or timer T316 expires.

When the *Restart acknowledge* message is received

- timer T316 is stopped. This frees the channels and call reference values for reuse. (Note that in the DMS-100, the call is cleared prior to sending a *Restart* message and therefore call reference values are ready for reuse prior to sending that message.)
- sender enters the *Null* state

If a *Restart acknowledge* message is not received prior to the expiry of timer T316, one or more *Restart* messages are sent until a *Restart acknowledge* message is returned. Meanwhile, no calls can be placed or accepted over the channel or interface by the originator of the *Restart* message.

The network restricts the number of consecutive unsuccessful restart attempts to a default limit of two. When this limit is reached, the network makes no further restart attempts. An indication of failure is provided to an appropriate maintenance entity. The channel or interface is considered to be in an out-of-service condition until maintenance action has been taken.

In the event of a global *Restart*, there is no restriction on the number of restart attempts. The message will continue to be resent until it is successful.

The *Restart* and *Restart acknowledge* messages contain the global call reference value (all zeroes) with which the *Restart request* state is associated. These messages are transferred using the appropriate point-to-point data link in the multiple frame mode using the *DL-Data-Request* primitive.

5.6.2 Receipt of Restart

After receiving a *Restart* message, the recipient

- enters the *Restart* state associated with the global call reference
- starts timer T317
- initiates the appropriate internal actions to return the specified channels to the idle condition and call references to the *Null* state

- after completion of internal clearing, a *Restart acknowledge* message is transmitted to the originator
- enters the *Null* state.

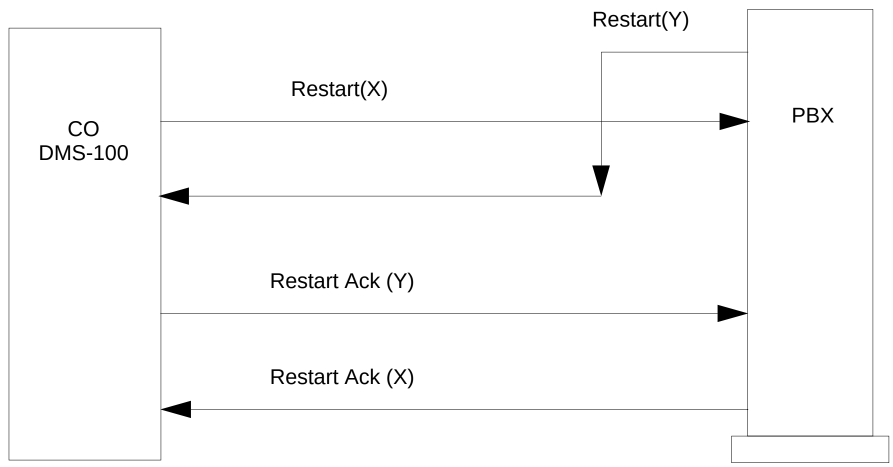
If timer T317 expires prior to completion of internal clearing, a primitive should be transmitted to the system management entity. No *Restart acknowledge* is sent in this instance.

> ***Note:*** Even if all call references are in the *Null* state, and all channels are in the idle condition, the receiving entity transmits a *Restart acknowledge* message to the originator after receiving a *Restart* message.

5.6.3 Restart collisions

A Restart collision occurs when a *Restart* has been sent and a *Restart* message is received before a *Restart acknowledge* message is received. If both sides of the interface have initiated simultaneous restart requests, each request is managed independently. If the same channels or interface are specified, these are not considered free until the restart procedures are completed (see Figure 4-24).

Figure 4-24
Restart collision



Note 1: X and Y can be a single channel, multiple channels, or an interface.
Note 2: If X = Y, the channels or interface are not available for call processing until both sides have reponded to the Restart request

5.7 Call collisions

Call collisions cannot occur in the network. Any simultaneous incoming or outgoing calls are managed separately and are assigned different call references.

Channel selection conflicts may occur if an incoming call and outgoing call select the same channel. This is resolved by the network through the channel selection mechanisms described in "B-channel selection-originating" on page 4-76 and "B-channel selection-destination" on page 4-81.

In such conflicts, the network gives priority to the incoming call over the call request received from the user. It clears the outgoing call if the B-channel cannot be

- allocated by the network
- accepted by the user originating the call

5.8 Handling of error conditions

All procedures transferring signaling information by using the protocol discriminator of “Q.931 user-network call control messages” are applicable only to those messages which pass the checks described in "Protocol discrimination error" on page 4-100 through "Non-mandatory information element errors" on page 4-104.

The following paragraphs detail the procedures for the treatment of error conditions.

The network may establish a threshold for the number of messages or information elements received that are either incorrect or are not understood. The network does not release calls if the threshold is exceeded.

The "Protocol discrimination error" on page 4-100 through "Non-mandatory information element errors" on page 4-104 are listed in order of precedence.

5.8.1 Protocol discrimination error

When a message is received with a protocol discriminator coded other than “Q.931 user-network call control message” or “maintenance messages”, that message is ignored. That is, the network continues to operate as if the message had not been received. (See "Protocol discriminator" on page 4-32 for further details).

5.8.2 Message too short error

When a message is received that is too short to contain a complete *Message type* information element, that message is ignored. For a single octet reference value, the message must be at least 4 octets in length; for a two-octet reference value the message must be at least 5 octets in length.

5.8.3 Call reference error

Invalid call reference format

In the *Call reference* information element, if octet 1, bits 5 through 8 are not set to 0 0 0 0, the message is ignored.

In the *Call reference* information element, if octet 1, bits 1 through 4 indicate a length greater than the maximum length supported by the receiving equipment, the message is ignored. (See "Call reference" on page 4-32 for further details.)

When a message is received specifying the “dummy” call reference, this message is ignored.

Call reference procedural errors

- Whenever any message-except *Setup*, *Release*, *Release complete*, *Status*, or *Status enquiry*-is received specifying a call reference which is not recognized as relating to an active call or to a call in progress, the receiver initiates clearing. Clearing is initiated by sending a *Release complete* message with *Cause* value #81 “Invalid call reference value”. This message specifies the call reference value of the received message. The receiver remains in the *Null* state.
- When a *Release* message is received that specifies a call reference value which is not recognized as relating to an active call or to a call in progress, a *Release complete* message with *Cause* value #81 “Invalid call reference value” is returned. This message specifies the call reference value of the received message.
- When a *Release complete* message is received specifying a call reference value which is not recognized as relating to an active call or to call in progress, no action is taken.
- When a *Setup* message is received specifying a call reference value which is not recognized as relating to an active call or to a call in progress, and with a call reference flag incorrectly set to “1”, the message is ignored.
- When a *Setup* message is received specifying a call reference value which is recognized as relating to an active call or to a call in progress, this message is ignored.
- When any message except *Restart*, *Restart acknowledge* or *Status* is received using the global call reference, no action is taken. A *Status* message using the global call reference with a call state indicating the current state associated with the global call reference and a *Cause* value #81 “Invalid call reference value” is returned.
- When a *Status* message is received specifying a call reference value which is not recognized as relating to an active call or to a call in progress, the procedures of "Receiving a Status message" on page 4-108 are followed.
- When a *Status enquiry* message is received specifying a call reference value which is not recognized as relating to an active call or to a call in progress, a *Status* message is returned indicating the *Null* call state with *Cause* value #30 “Response to Status enquiry”.

5.8.4 Message type or message sequence errors

Whenever an unexpected message-except *Release* or *Release complete*-or an unrecognized message is received in any state other than the *Null* state, a *Status* message is returned with one of the following *Cause* values

- #97 “Message type non-existent or not implemented”
- #101 “Message not compatible with call state”

However, two exceptions to this procedure exist:

- When the network or the user receives an unexpected *Release* message (for example, if the *Disconnect* message is corrupted by undetected transmission errors). In this case, no *Status* message is sent.
  - When the network receives an unexpected *Release* message, the network
    - disconnects and releases the B-channel
    - clears the network connection and the call to the remote user with the cause in the *Release* message sent by the user or, if not included, *Cause* value #31 “Normal, unspecified”
    - returns a *Release complete* message to the user
    - releases the call reference
    - stops all timers
    - enters the *Null* state
- When the network or the user receives an unexpected *Release complete* message
  - When the network receives an unexpected *Release complete* message, the network
    - disconnects and releases the B-channel
    - clears the network connection and the call to the remote user with *Cause* value #16 “Normal call clearing”
    - releases the call reference
    - stops all timers
    - enters the *Null* state.
  - Whenever the user receives an unexpected *Release complete* message, the user
    - disconnects and releases the B-channel
    - releases the call reference
    - stops all timers
    - enters the *Null* state

5.8.5 General information element errors

The general information element error procedures may also apply to information elements in code sets other than 0. The diagnostics in the *Cause* information element may indicate information elements other than those in code set 0 by applying the locking shift procedures as described in "Other information elements" on page 4-36.

Information element out-of-sequence error

A variable length information element which has a code value lower than the code value of the variable length information element preceding it is considered as an out-of-sequence information element.

If the network or user receives a message containing an out-of-sequence information element, it may ignore this information element and continue to process the message.

If this information element is mandatory, and the network or user chooses to ignore this out-of-sequence information element, the error handling procedure for missing mandatory information elements as described in "Mandatory information element content error" on page 4-104 are followed.

If the ignored information element is not mandatory, the receiver continues to process the message.

Duplicated information elements error

If an information element is repeated in a message in which repetition of the information element is not permitted, only the contents of the information element appearing first are handled. All subsequent repetitions of the information element are ignored.

When repetition of information elements is permitted, only the contents of permitted information elements are handled. If the limit on repetition of information elements is exceeded, the contents of information elements appearing first up to the limit of repetitions are handled. All subsequent repetitions of the information element are ignored.

5.8.6 Mandatory information element errors

Mandatory information element missing

When a message-other than *Setup, Disconnect, Release,* or *Release complete*- is received that has one or more mandatory information elements missing, no action is taken. No state change occurs. A *Status* message is returned with *Cause* value #96 “Mandatory information element is missing”.

When a *Setup* or *Release* message is received that has one or more mandatory information elements missing, a *Release complete* message with *Cause* value #96 “Mandatory information element is missing” is returned.

When a *Disconnect* message is received with the *Cause* information element missing, the actions taken are same as if a *Disconnect* message with *Cause* value #31 “Normal, unspecified” was received (see "Call clearing" on page 4-85).The exception is that the *Release* message sent to the user has *Cause* value #96 “Mandatory information element is missing”.

When a *Release complete* message is received with a *Cause* information element missing, it is assumed that a *Release complete* message has been received with *Cause* value #31 “Normal, unspecified”.

Mandatory information element content error

When a message other than *Setup*, *Disconnect*, *Release*, or *Release complete* is received that has one or more mandatory information elements with invalid content, no action is taken. No state change occurs. A *Status* message is returned with *Cause* value #100 “Invalid information element contents”.

When a *Setup* or *Release* message is received which has one or more mandatory information elements with invalid content, a *Release complete* message is returned with *Cause* value #100 “Invalid information element contents”.

When a *Disconnect* message is received with invalid content of the *Cause* information element, the action taken is the same as if a *Disconnect* message with *Cause* value #31 “Normal, unspecified” was received (see "Call clearing" on page 4-85). The exception is that the *Release* message sent on the local interface has *Cause* value #100 “Invalid information element contents”.

When a *Release complete* message is received with invalid content of the *Cause* information element, it is assumed that a *Release complete* message was received with *Cause* value #31 “Normal, unspecified”.

Information elements with a length exceeding the maximum length are treated as information elements with content error. A *Status* message is returned with *Cause* value #100, “Invalid information element contents”.

5.8.7 Non-mandatory information element errors

The following paragraphs identify actions on information elements not recognized as mandatory.

Unrecognized information elements

Unrecognized information elements are non-mandatory information elements whose information element identifiers are not implemented by the receiver of the information element.

When a message is received which has one or more unrecognized information elements, the receiving entity checks whether any are encoded to indicate “comprehension required”. If any unrecognized information element is encoded to indicate “comprehension required”, the procedures in "Mandatory information element errors" on page 4-103 are followed. That is, as if a missing mandatory information element error condition had occurred.

If all unrecognized information elements are not encoded to indicate “comprehension required”, the receiving entity proceeds as follows:

- Action is taken on the message and those information elements which are recognized and have valid content.
- When the received message is other than *Disconnect*, *Release*, or *Release complete*, a *Status* message may be returned. It has one *Cause* information element. The *Status* message indicates the call state in which the receiver detected the error. The *Cause* information element has *Cause* value #99 “Information element non-existent or not implemented”, and the diagnostic field contains the information element identifier of the unrecognized information element. If multiple unrecognized information elements occurred in the message, the diagnostic field only contains the identifier of the first.
- Subsequent actions are determined by the sender of the unrecognized information elements. If a clearing message contains more than one unrecognized information element, the error is reported to the local user as follows:
  - When a *Disconnect* message is received that has more than one unrecognized information element, a *Release* message is returned with *Cause* value #99 “Information element non-existent or not implemented”. The *Cause* information element diagnostic field contains the first information element identifier that is unrecognized.
  - When a *Release* message is received that has more than one unrecognized information element, a *Release complete* message is returned with *Cause* value #99 “Information element non-existent or not implemented”. The *Cause* information element diagnostic field contains the first information element identifier that is unrecognized.
  - When a *Release complete* message is received that has more than one unrecognized information element, no action is taken on the unrecognized information.

  Note: Inclusion of the diagnostics is optional. The diagnostic field of *Cause* value #99 helps the network decide which recovery procedure to use when a *Status* message is received. Therefore, it is recommended that the user provide *Cause* value#99 with a diagnostic field.

Non-mandatory information element content error

When a message is received which has one or more non-mandatory information elements with invalid content, action is taken on the message and those information elements that are recognized and have valid content.

A *Status* message may be returned containing one *Cause* information element. If the message containing one or more non-mandatory information elements with invalid content is a *Release complete* message, no *Status* message is returned.

The *Status* message indicates the call state in which the receiver detected the error. The *Cause* information element has *Cause* value#100 “Invalid information element contents”. The diagnostic field, if present, contains the information element identifier of the element that has invalid contents.

Information elements with a length exceeding the maximum length (given in Section 3 of this specification) are treated as an information element with content error. A *Status* message is returned with *Cause* value #100, “Invalid information element contents”. However, access information elements- *Called party subaddress, Lower layer compatibility*, for example- a *Status* message is returned with *Cause* value #43, “User information discarded”

5.8.8 Data link reset

Whenever a Q.931 entity is informed of a spontaneous data link layer reset by means of the *DL-Establish-Indication* primitive, the following procedures are carried out:

- For calls in the dis-establishment phase (states N11, N12, N19, U11, U12, and U19), no action is taken
- Calls in the establishment phase (states N1, N3, N4, N6, N7, N8, N9, U1, U3, U4, U6, U7, U8 and U9) are cleared according to the procedures defined in "Call clearing" on page 4-85
- For calls in the active state (state N10), a *Status enquiry* is sent from the network to the user. For calls in the active state (state U10), a *Status enquiry* may be sent from the user to the network (see "Status enquiry procedure" on page 4-107 and "Receiving a Status message" on page 4-108).

5.8.9 Data link failure

Whenever a Q.931 entity is notified by its data link entity by means of the *DL-Release-Indication* primitive that there is a data link layer malfunction, the following procedures are carried out:

- Any calls not in an active state are cleared internally
- For any call in the active state, without a timer running, timer T309 is started (if timer T309 is implemented)

  Note: If timer T309 is already running, it is not restarted.

- The Q.931 entity requests a Layer 2 re-establishment by sending a *DL-Establish-Request* primitive
- When informed of Layer 2 re-establishment by means of the *DL-Establish-Confirm* primitive, the Q.931 entity carries out the following procedures:

- Stops timer T309, and
  - either sends out a *Status* message with *Cause* value #31 “Normal unspecified” to report the current state to the peer entity
  - OR, sends out a *Status enquiry* message to verify the call state of the peer entity (see "Status enquiry procedure" on page 4-107)
- If timer T309 expires prior to data link re-establishment, the network
  - clears the network connection
  - clears the call to the remote user with *Cause* value #27 “Destination out of order”
  - disconnects and releases the B-channel
  - releases the call reference
  - enters the *Null* state
- The implementation of timer T309 on the user side is optional, but is mandatory on the network side. If timer T309 expires prior to data link establishment, the user:
  - clears the attached connection (if any) with *Cause* #27 “Destination out of order”
  - disconnects and releases the B-channel
  - releases the call reference
  - enters the *Null* state

5.8.10 *Status enquiry* procedure

Whenever an entity wishes to check the call state at a peer entity, a *Status enquiry* message is sent requesting the call state. This may, in particular, apply to procedural error conditions described in "Data link reset" on page 4-106 and "Data link failure" on page 4-106.

After sending the *Status enquiry* message, timer T322 is started in anticipation of receiving a *Status* message. While timer T322 is running only one outstanding request for call state information can exist. Therefore, if timer T322 is already running, it is not restarted. If a clearing message is received before timer T322 expires, timer T322 is stopped, and call clearing continues.

When a *Status enquiry* message is received, the receiver responds with a *Status* message, reporting the current call state and *Cause* value #30 “Response to status enquiry”. Receipt of the *Status enquiry* message does not result in a state change.

The sending or receipt of the *Status* message does not directly affect the call state of either the sender or receiver. The side that receives the *Status* message inspects the *Cause* information element. If the *Status* message has *Cause* value

#97 “Message type non-existent or not implemented”, timer T322 continues to run-waiting for an explicit response to the *Status enquiry* message.

If a *Status* message is received that has *Cause* value #30 “Response to status enquiry” the following events occur:

- timer T322 is stopped
- call is cleared if the status of the network side is not compatible with that on the user side

If timer T322 expires, and a *Status* message is received with *Cause* value #97 “Message type non-existent or not implemented”, the call is cleared if the status of the network side is not compatible with that on the user side.

If timer T322 expires before a *Status* message is received, the call is cleared to both the calling and called parties with *Cause* value #41 “Temporary failure”.

5.8.11 Receiving a *Status* message

When a *Status* message reporting an incompatible state is received, if the receiving entity determines that the state mismatch is a valid error condition (see Note) it carries out one of the following procedures:

- clears the call by sending the appropriate clearing message with *Cause* value #101 “Message not compatible with call state”
- takes other actions that attempt to recover from the mismatch. These actions are implementation options. If a DMS-100 is acting as the network a *Status enquiry* is sent out when the received state is incompatible and the procedures in "Status enquiry procedure" on page 4-107 are followed.

  Note: The sending and receiving state machines are dynamic, and valid state mismatches can occur due to message flow during the status enquiry and response stage. Further, one or both entities may not implement all call states.

The determination of which states are incompatible is left as an implementation option decision.

The network considers the following states to be incompatible:

- If a *Status* message indicating any call state except the *Null* state is received in the *Null* state, the receiving entity sends a *Release complete* message with a *Cause* value #101 “Message not compatible with call state”. The receiving entity remains in the *Null* state.
- If a *Status* message indicating any call state except the *Null* state is received in the *Release request* state, no action is taken.

- If a *Status* message, indicating the *Null* state, is received in any state except the *Null* state, the receiver releases all resources and changes to the *Null* state. When in the *Null* state, the receiver of a *Status* message that indicates the *Null* state takes no action other than to discard the message.
- If a *Status* message, indicating any call state except the *Active* state, is received in the *Active* state, a *Status enquiry* message is sent.

A *Status* message may be received indicating a compatible call state but which has one of the following *Cause* values:

- #96 “Mandatory information element is missing”
- #97 “Message type non-existent or not implemented”
- #99 “Information element non-existent or not implemented”
- #100 “Invalid information element contents”.

The actions taken are an implementation option. If other procedures are not defined, the receiver clears the call with the appropriate procedure defined in "Call clearing" on page 4-85. It uses the *Cause* specified in the received *Status* message. If a DMS-100 is acting as the network, it clears the call only when receiving a *Cause* value #96 “Mandatory information element is missing”.

On receipt of a *Status* message specifying a global call reference and reporting an incompatible state in the *Restart request* or *Restart* state, the receiving Q.931 entity informs layer management and takes no further action on this message.

When in the *Null* state, if a *Status* message is received with the global call reference, no action is taken.

> ***Note:*** Further action as a result of a higher layer activity (for example, system or layer management) is implementation dependent (including the retransmission of the *Restart* message).

Except for the above case, the error handling procedures-when receiving a *Status* message that specifies the global call reference-are implementation options.

Chapter 4-6:
Layer 3 list of system parameters

6.1 Introduction

This chapter lists all the timers associated with the Layer 3 primary rate interface. The description of timers in the following tables should be considered a brief summary. The precise details are found in Chapter 4-5: "Layer 3 call control procedures" which should be considered the definitive description.The time-out values shown in these tables are recommended. They are modifiable by the telephone operating company.

This chapter is divided into two tables; Table 4-23 describes the timers on the network side of the interface and Table 4-24 describes the tables on the user side of the same interface. Northern Telecom does not support the user side of the interface at this time. The user side table is included for reference and guidance only.

Table 4-23
Timers on the network side of the interface

Timer number	Time-out value (secs)			State	When started	When stopped (normally)	Action taken on expiry
	Def	Min	Max				
T301	180	1	1023	N7	On receiving *Alerting* message	On receiving *Connect* message	Clear call
First start of T303	4	1	30	N6	On sending *Setup* message	On receiving *Call proceeding, Alert, Connect,* or *Release complete* message	Resend *Setup* message. Restart T303 If *Release complete* message is received, clear the call
Second start of T303	4	1	30	N6	On re-sending *Setup* message	On receiving *Call proceeding, Alert, Connect, Release complete* message	Clear network connection. Send *Release complete* message to called user Enter *Null* state

Table 4-23
Timers on the network side of the interface (Continued)

Timer number	Time-out value (secs)			State	When started	When stopped (normally)	Action taken on expiry
	Def	Min	Max				
T305	30	1	80	N12	On sending *Disconnect* message	On receiving *Release* or *Disconnect* message	Send *Release* message. Start T308
T306	30	1	180	N12	On sending *Disconnect* message with Pro-gress indicator #8	On receiving *Release* message	Stop tone or announcement Send *Release* message. Start T308
First start of T308	4	1	10	N19	On sending *Release* message	On receiving *Release* or *Release complete* message	Resend *Release* message. Restart T308
Second start of T308	4	1	10	N19	On re-sending *Release* message	On receiving *Release* or *Release complete* message	Invoke *Restart* procedures for the B-channel. Enter state N0
T309	90	1	120	Any stable state	On receiving *DL-Disconnect* Calls in stable state not lost	On receiving *DL-Reconnect*	Clear network connection
T310	180	1	200	N9	On receiving *Call proceeding* message	On receiving *Alerting, Connect,* or *Disconnect* message	Clear call in accordance with "Called user clearing during incoming call establishment" on page 4-83
First start of T316	120	1	200	REST 1	On sending *Restart* message	On receiving *Restart acknowledge* message	Resend *Restart* message. Restart T316
Second start of T316	120	1	200	REST 1	On re-sending *Restart* message	On receiving *Restart acknowledge* message	Notify maintenance (system initialization)

Table 4-23
Timers on the network side of the interface (Continued)

Timer number	Time-out value (secs)			State	When started	When stopped (normally)	Action taken on expiry
	Def	Min	Max				
T317	100	1	180	REST 0	On receiving *Restart* message	When call references cleared internally	Notify internal maintenance entity. Cleared channels placed in *Null* state. Place uncleared channels in an unavailable state
T322	4	1	30	Any, but not N0, N11, N12, N19	On sending *Status enquiry* message	Receipt of *Status, Disconnect, Release,* or *Release complete* message	Initiate call clearing

Table 4-24
Timers on the user side of the interface[1]

Timer number	Typical value (sec)	State	When started	When stopped (normally)	Action taken on expiry
First start of T303 (option al)	4	U1	On sending *Setup* message	On receiving *Call proceeding, Alert, Connect,* or *Release complete* message	Resend *Setup* message. Restart T303
Second start of T303 (option al)	4	U1	On re-sending *Setup* message	On receiving *Call proceeding, Alert, Connect, Release complete* message	Send *Release complete* message Enter *Null* state
T305	30	U11	On sending *Disconnect* message	On receiving *Release* or *Disconnect* message	Send *Release* message. Start T308
First start of T308	4	U19	On sending *Release* message	On receiving *Release* or *Release complete* message	Resend *Release* message. Restart T308

Table 4-24
Timers on the user side of the interface[1] (Continued)

Timer number	Typical value (sec)	State	When started	When stopped (normally)	Action taken on expiry
Second start of T308	4	U19	On re-sending *Release* message	On receiving *Release* or *Release complete* message	Invoke *Restart* procedures for the B-channel Enter state N0
T309	90	Any stable state	On receiving DL-disconnect Calls in stable state not lost	On receiving *DL-Reconnect*	Release network connection
T310 (option al)	10	U3	On receiving *Call proceeding*	On receiving *Alerting, Connect, Progress,* or *Disconnect* message	Send *Disconnect* message
T313	4	U8	On sending *Connect* message	On receiving *Connect acknowledge* message	Send *Disconnect* message
First start of T316	120	REST 1	On sending *Restart* message	On receiving *Restart acknowledge* message	Resend *Restart* message. Restart T316
Second start of T316	120	REST 1	On re-sending *Restart* message	On receiving *Restart acknowledge* message	Notify maintenance (system initialization)
T317	< T316	REST 0	On receiving *Restart* message	When call references cleared internally	Notify internal maintenance entity.
T322	4	Any, but not U0, U11, U12, U19	On sending *Status enquiry* message	Receipt of *Status, Disconnect, Release,* or *Release complete* message	Initiate call clearing

1. Northern Telecom does not support the user side of the interface at this time. This table is for reference only.

Chapter 4-7: Layer 3 SDL diagrams

7.1 Introduction

This chapter includes overview and detailed SDL diagrams which show Q.931 protocol control for circuit-switched basic calls. In the event of conflict between these diagrams and the text in the previous chapters of this section, the text should be the prime source. Similarly, in the event of conflict between overview SDL and detailed SDL diagrams, the detailed SDL diagrams should be the prime source.

Northern Telecom does not support the user side of the interface at this time. The SDLs that are shown in the following figures for the user side are for reference only.

Figure 4-25 and Figure 4-26 show a key to the Q.931 protocol control SDL diagrams for network side and user side respectively.

Figure 4-27 through Figure 4-31 show overview control SDL diagrams for the user side (for reference only).

Figure 4-32 through Figure 4-47 show detailed control SDL diagrams for the user side (for reference only).

Figure 4-48 through Figure 4-51 show detailed SDL diagrams for the global call reference to be applied to the network side.

Figure 4-52 through Figure 4-57 show overview control SDL diagrams for the network side.

Figure 4-58 through Figure 4-74 show detailed control SDL diagrams for the network side.

Figure 4-25 Key to Q.931 protocol control SDL diagrams Network side

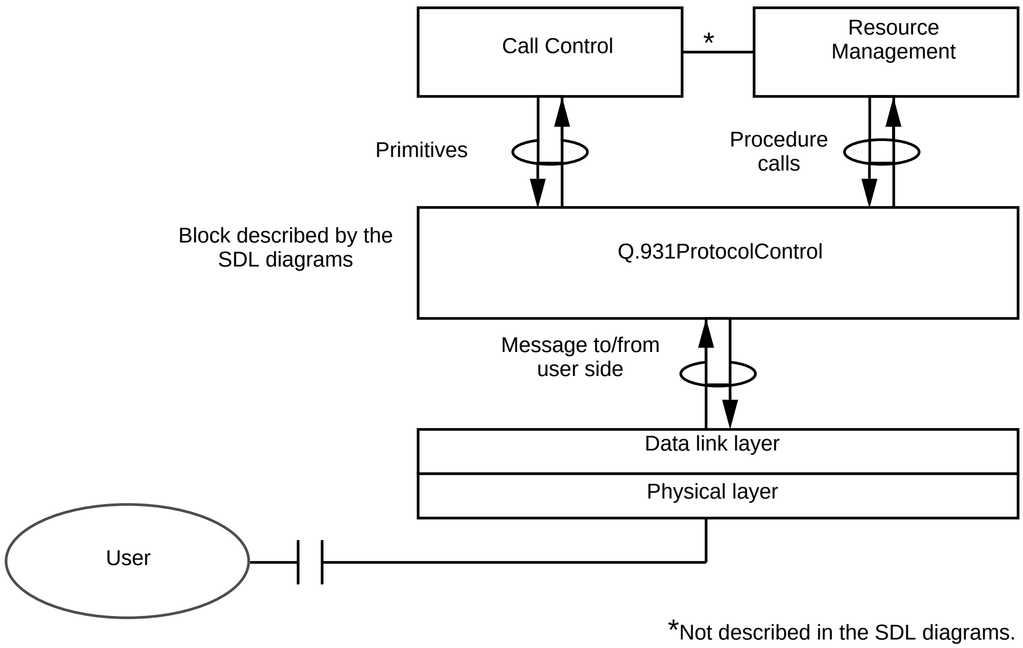
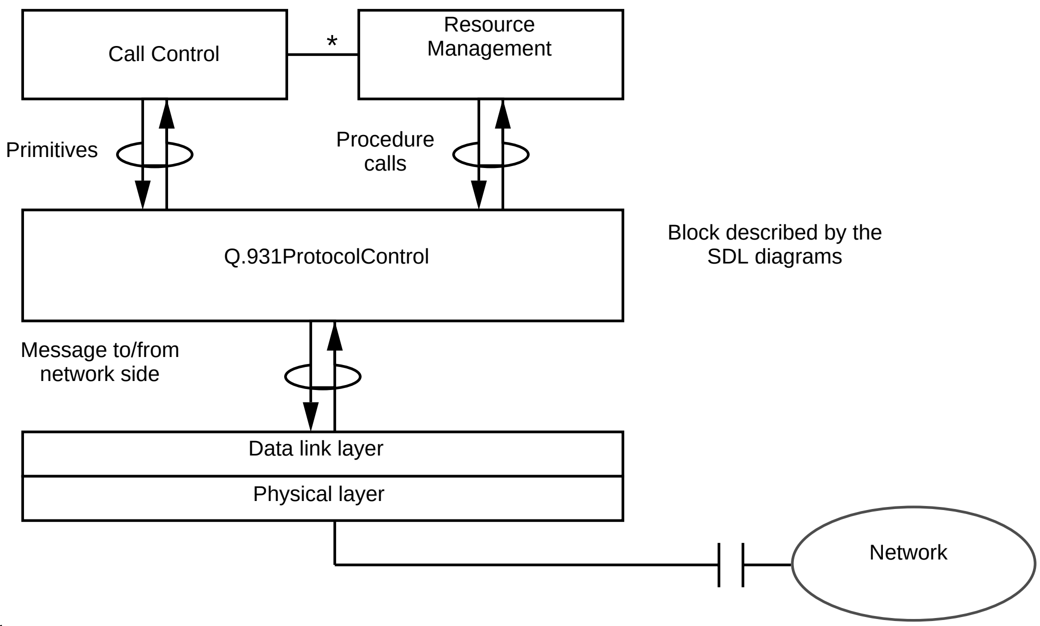
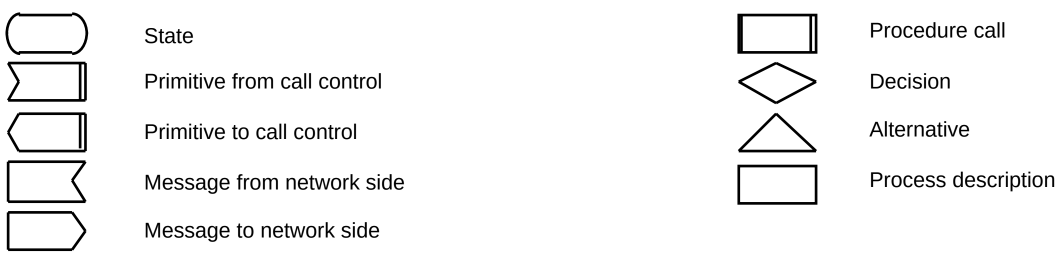


Figure 4-26 Key to Q.931 protocol control SDL diagrams
User side[1]

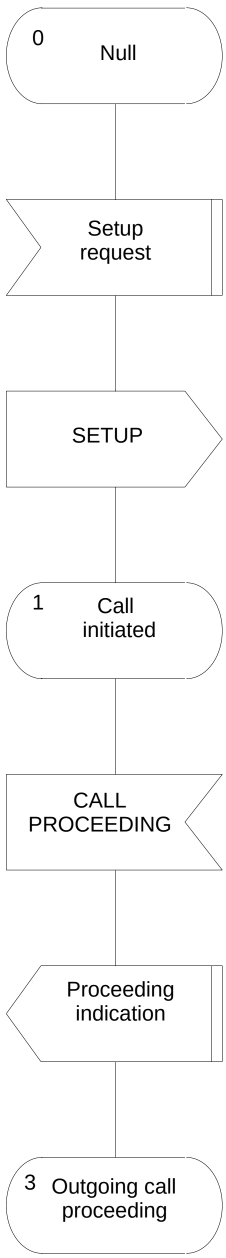


*Not described in the SDL diagrams.



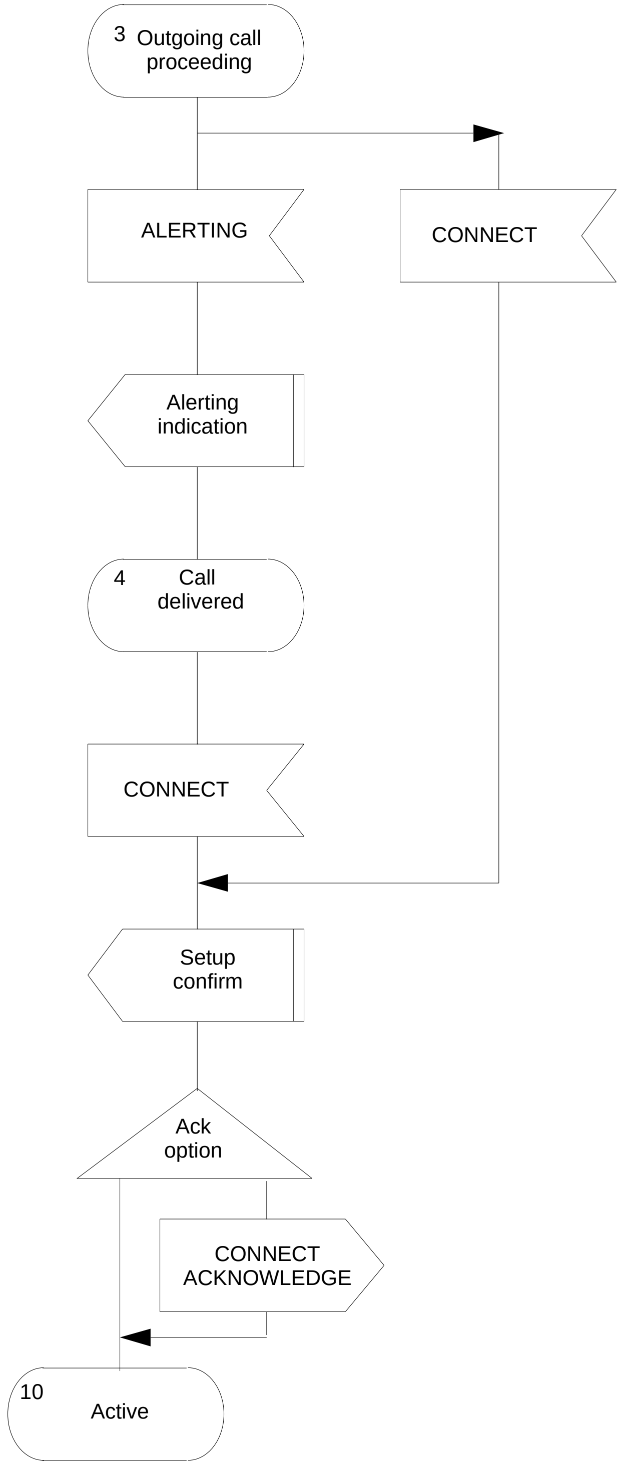
[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-27Overview protocol control: user side (1 of 5)
Outgoing set up procedure [1](1 of 2)



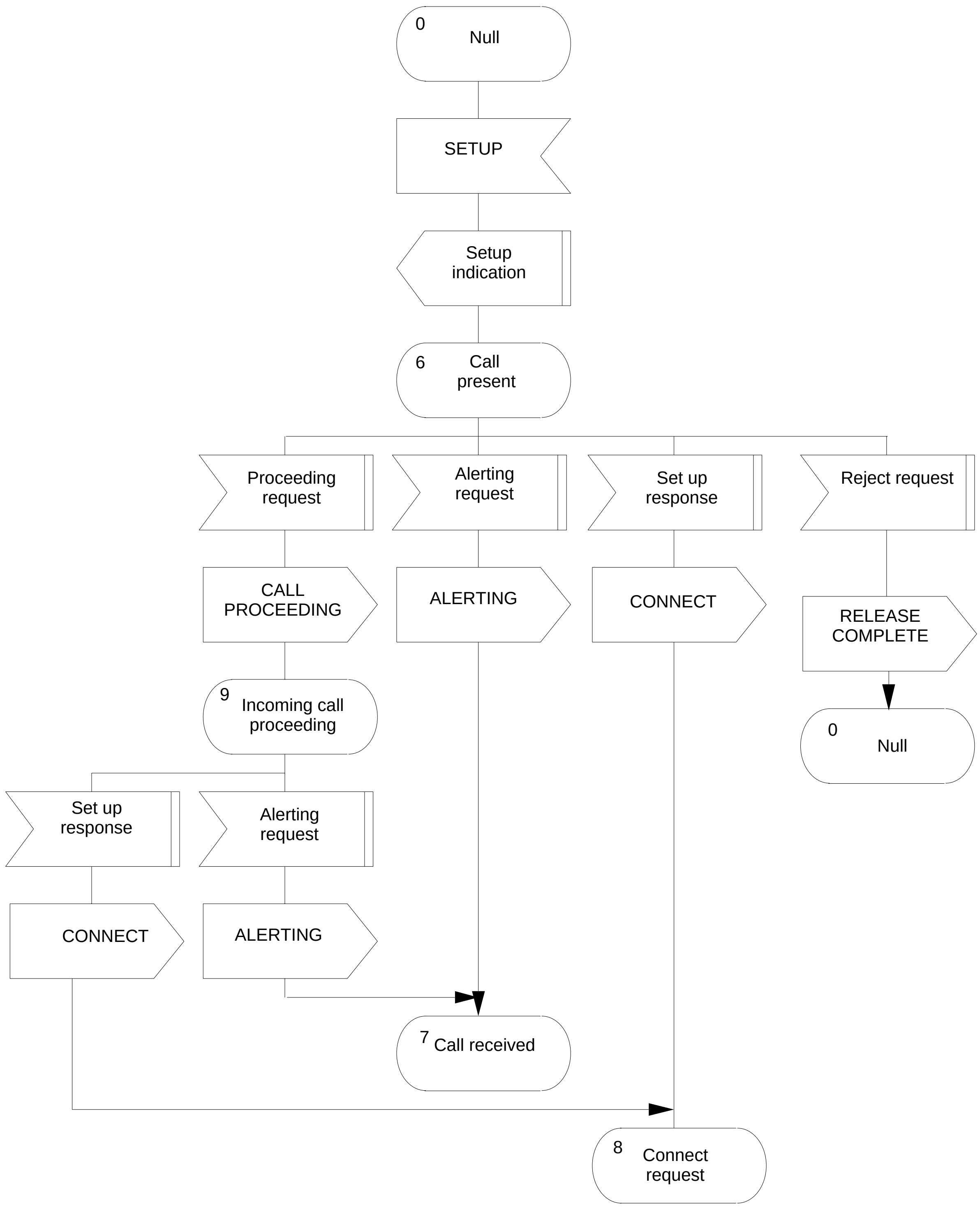
[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-28Overview protocol control: user side (2 of 5)
Outgoing set up procedure [1](2 of 2)



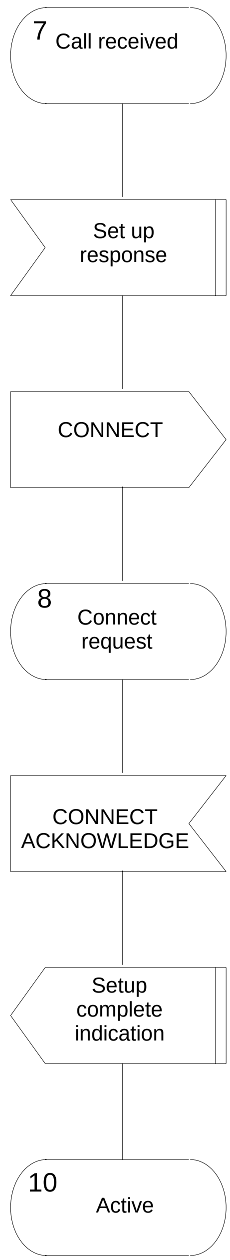
[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-29Overview protocol control: user side (3 of 5)
Incoming setup procedure [1](1 of 2)



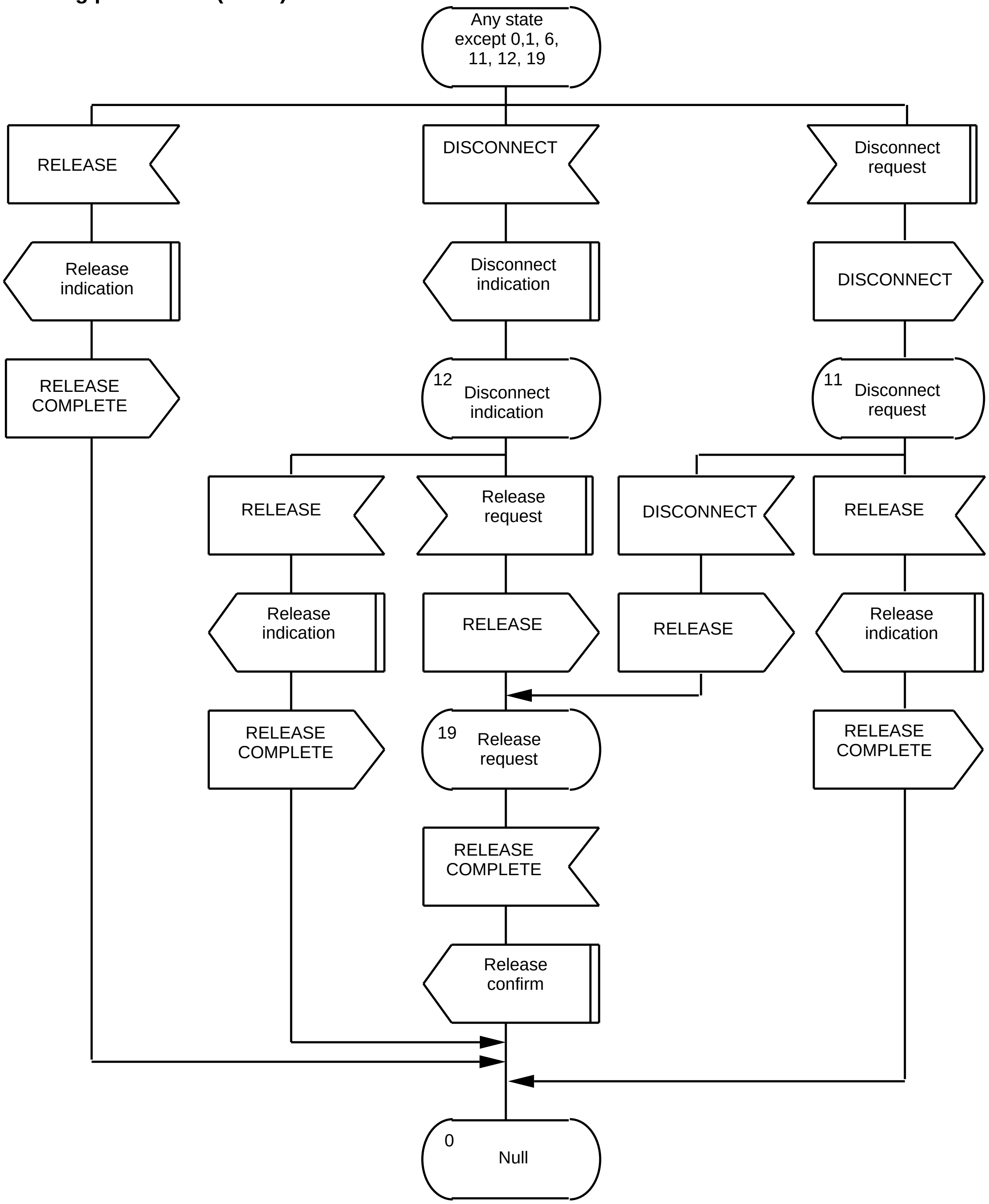
[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-30 Overview protocol control: user side (4 of 5)
Incoming set up procedure [1](2 of 2)



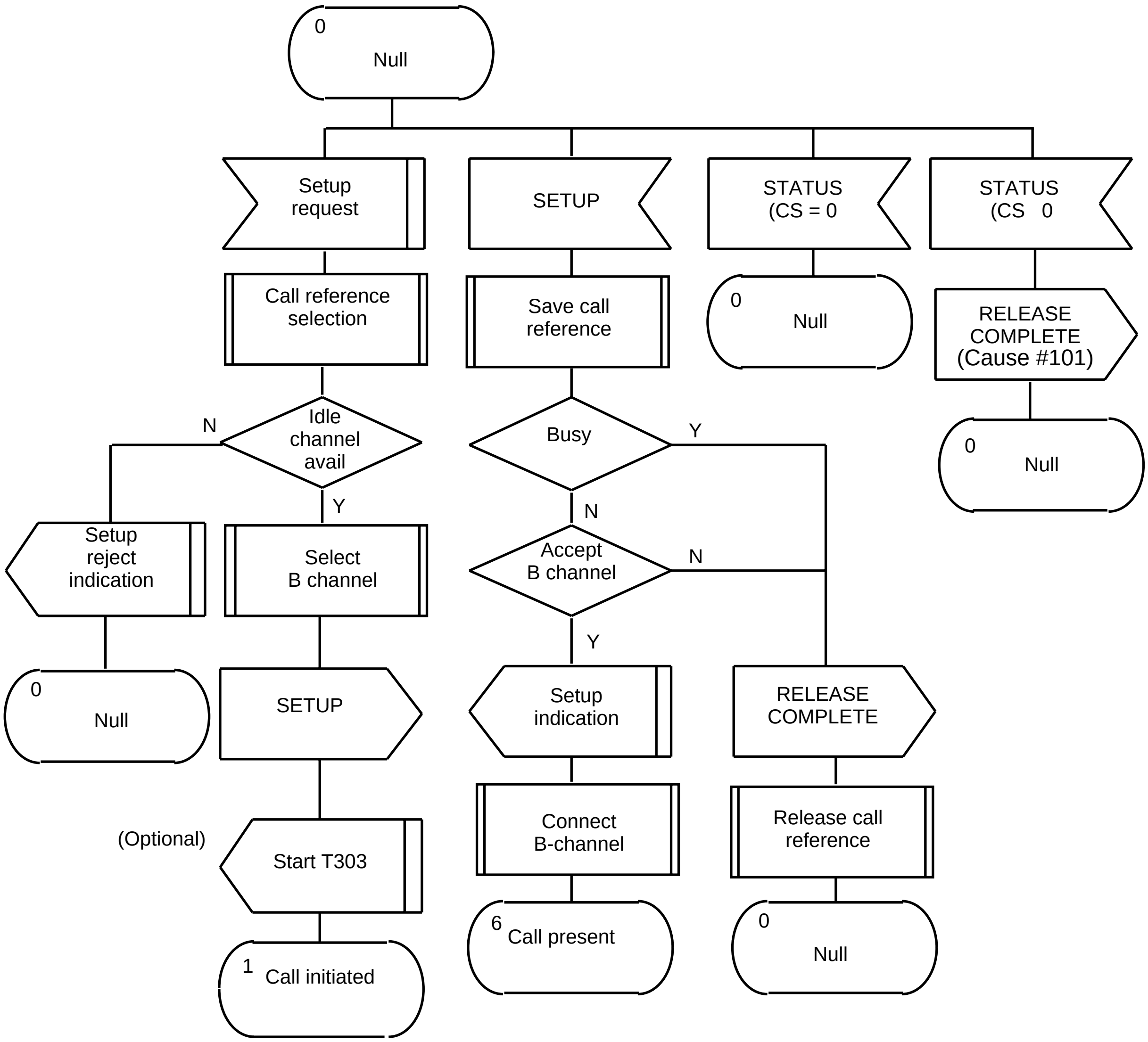
[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-31 Overview protocol control: user side (5 of 5)
Clearing procedure[1] (1 of 1)



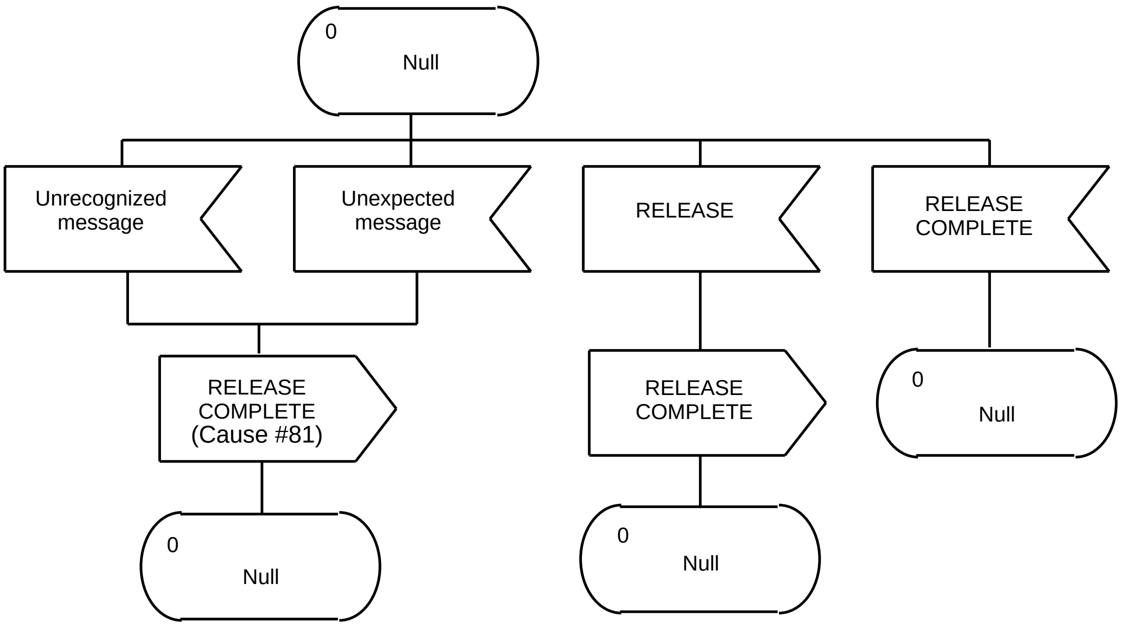
[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-32
Detailed protocol control: User side [1](1 of 16)



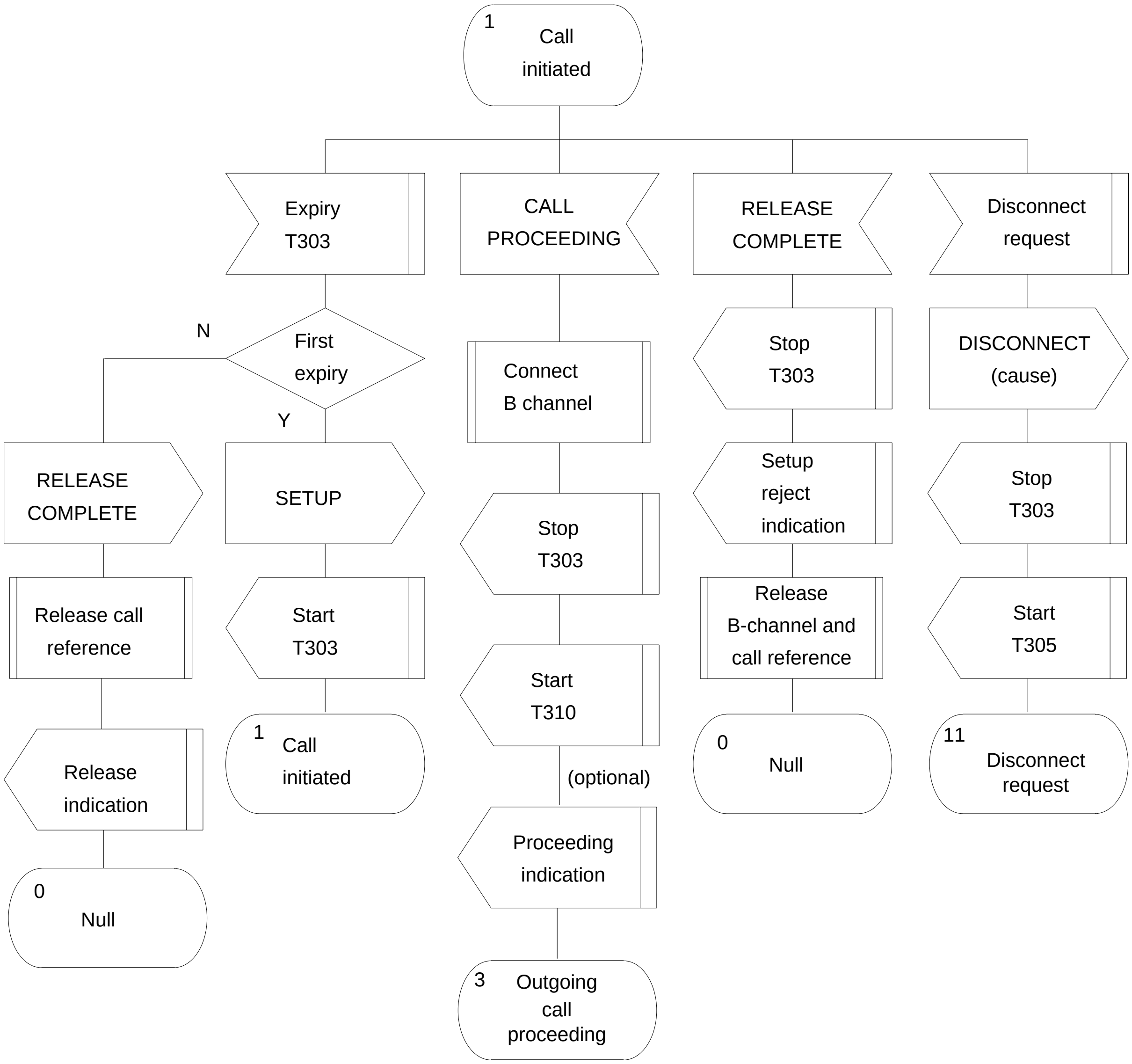
[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-33
Detailed protocol control: User side [1](2 of 16)



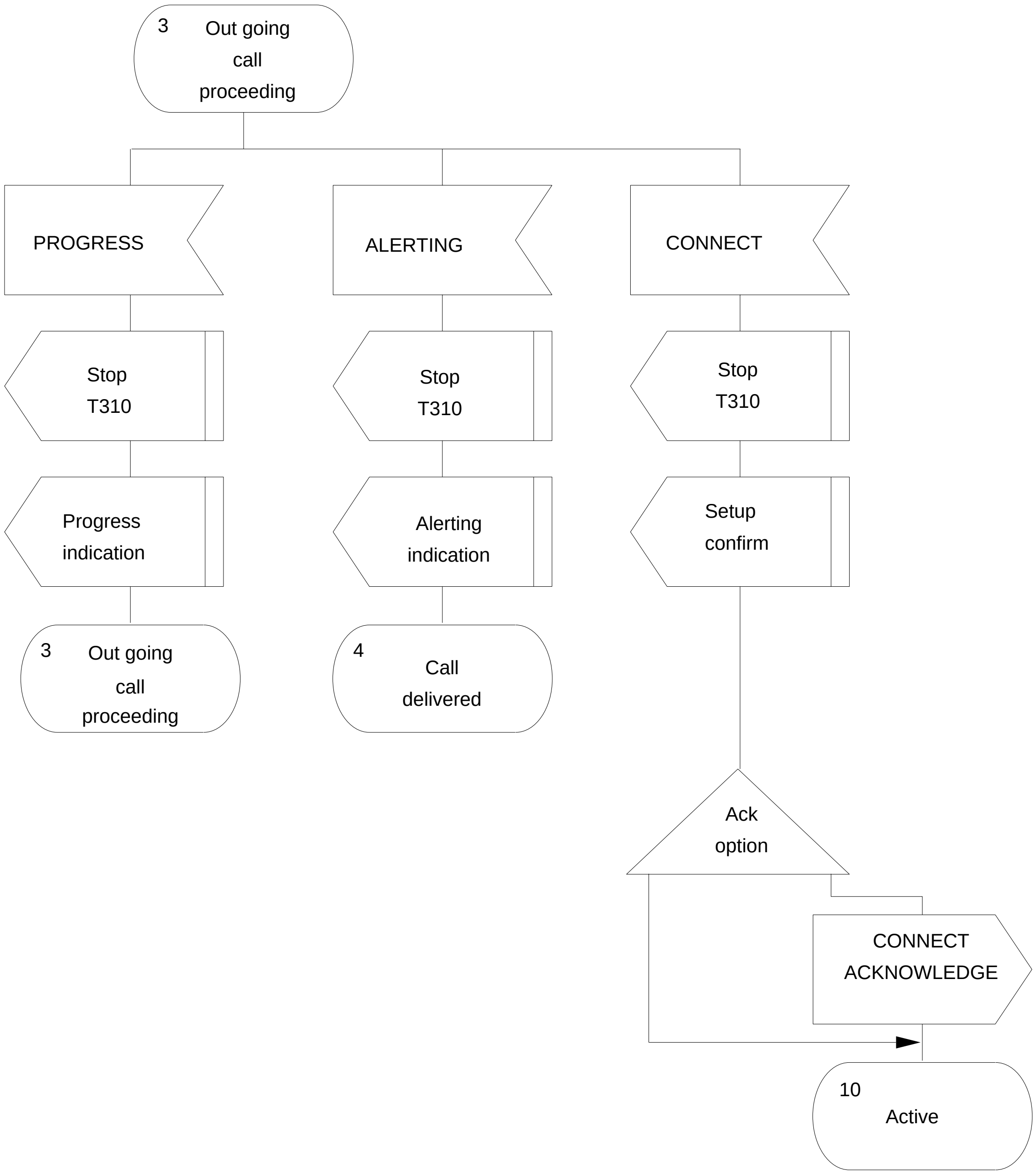
[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-34
Detailed protocol control: User side [1] (3 of 16)



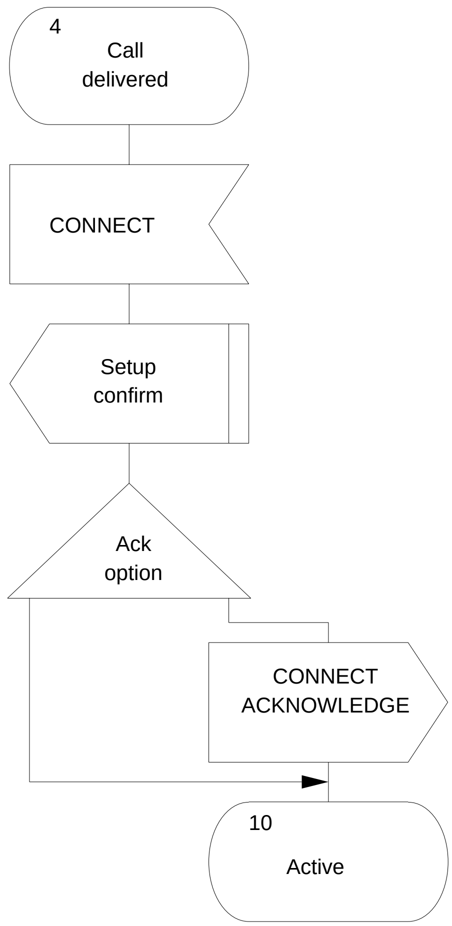
[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-35
Detailed protocol control: User side [1]
(4 of 16)



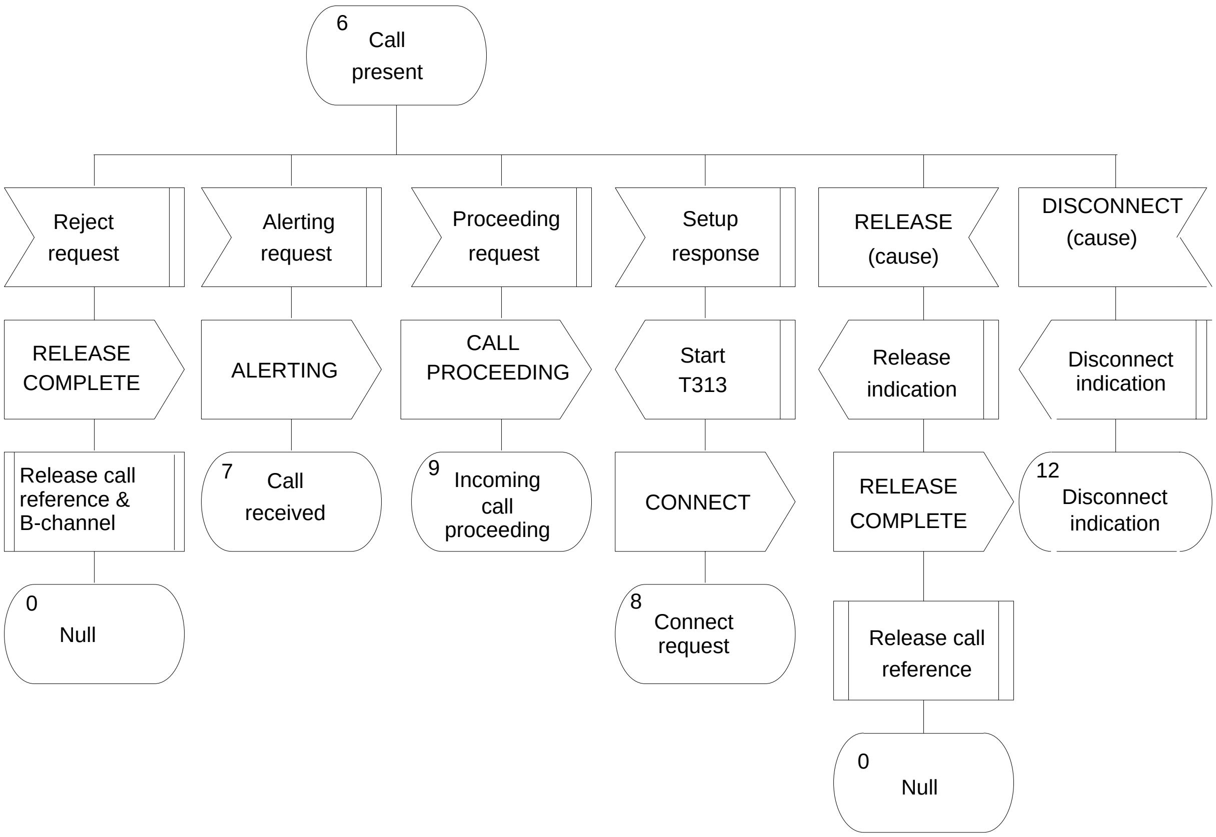
[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-36
Detailed protocol control: User side [1](5 of 16)



[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-37
Detailed protocol control: User side[1] (6 of 16)

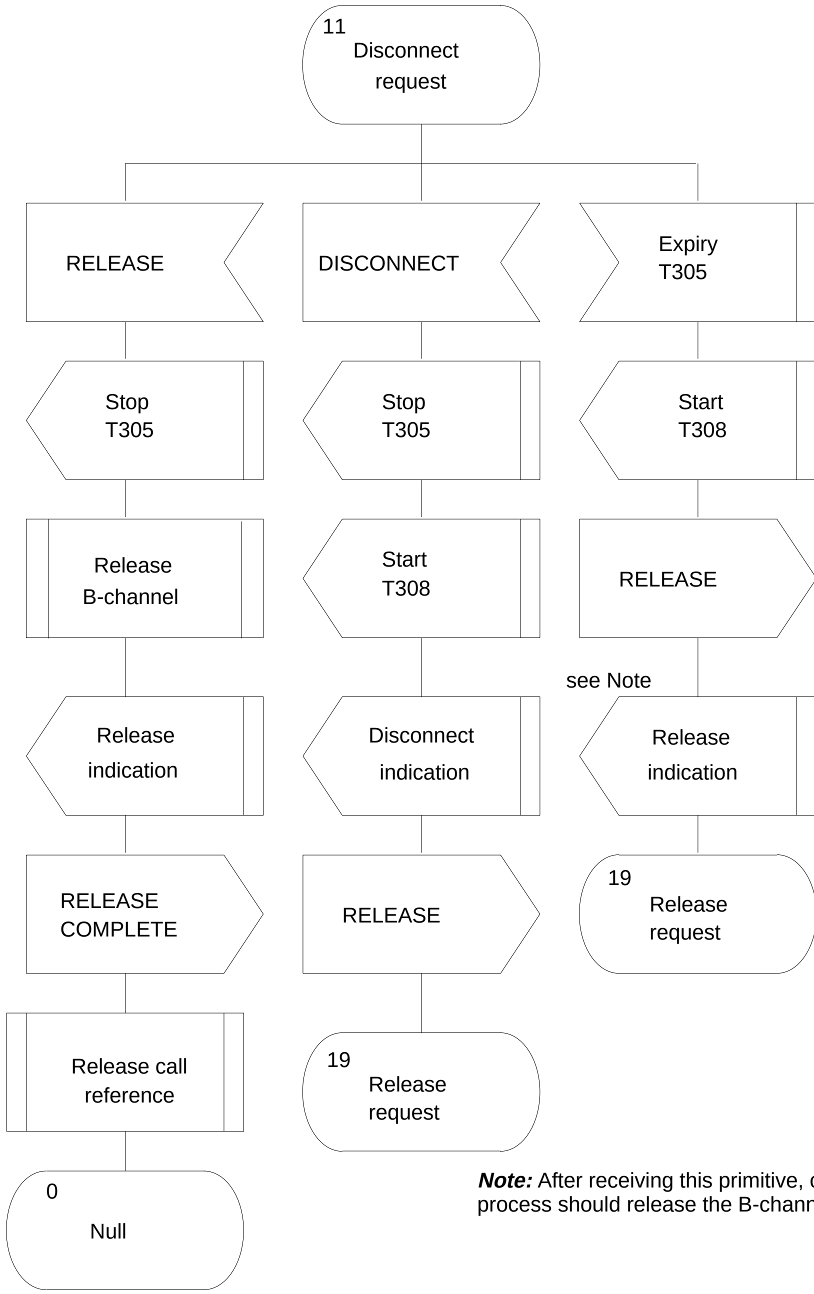


[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-38
Detailed protocol control: User side[1] (7 of 16)160

[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

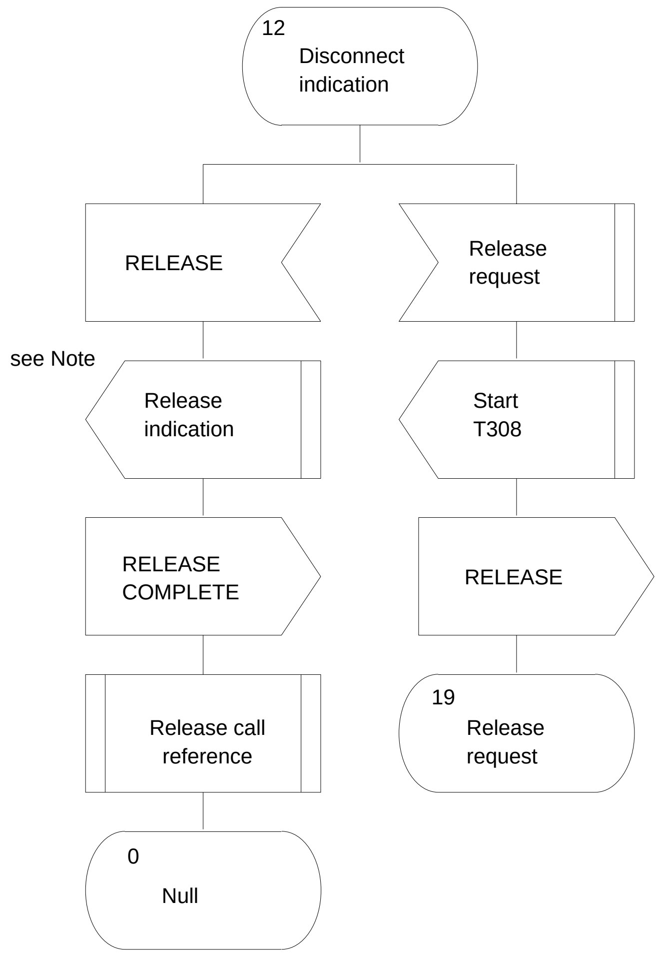
Figure 4-39
Detailed protocol control: User side[1] (8 of 16)



Note: After receiving this primitive, call control process should release the B-channel

[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

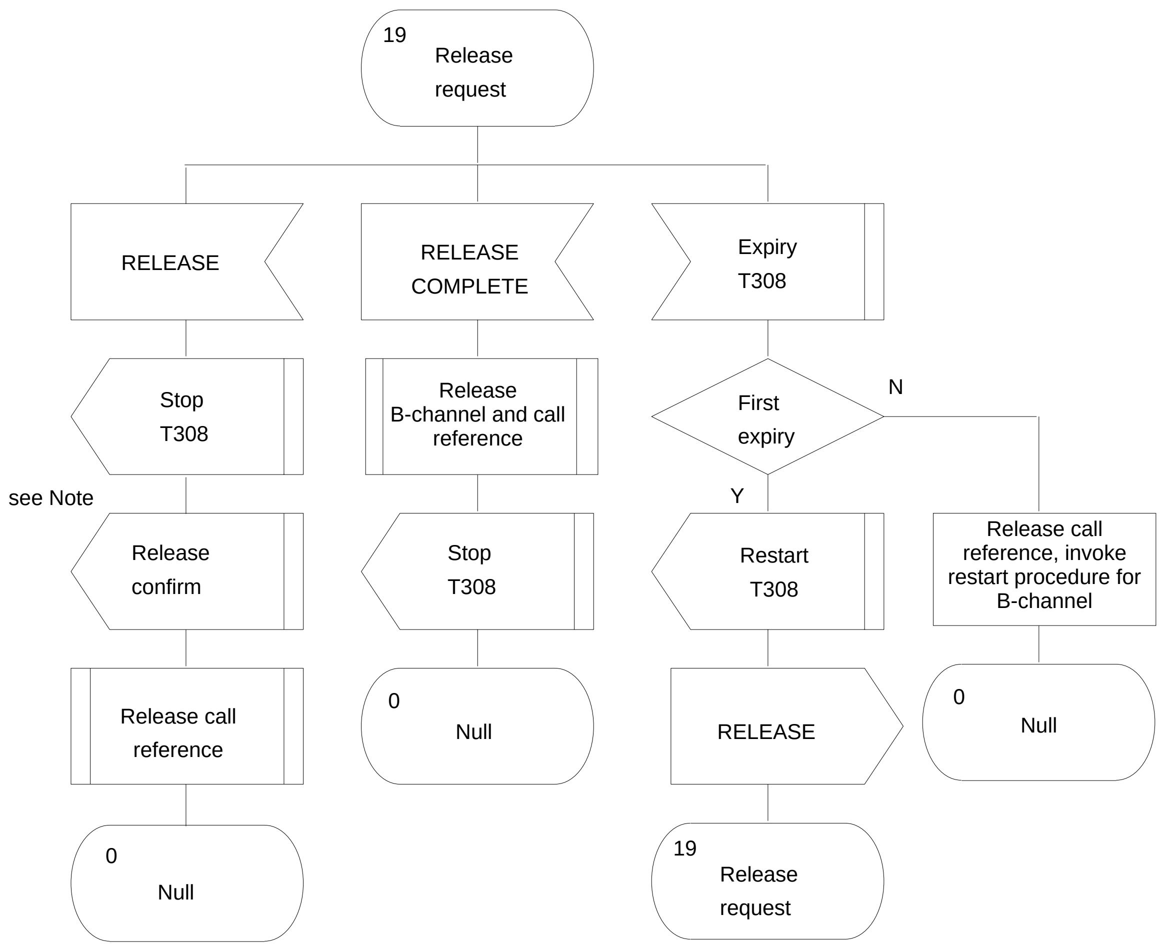
Figure 4-40
Detailed protocol control: User side[1] (9 of 16)



Note: After receiving this primitive, call control process should release the B-channel

[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

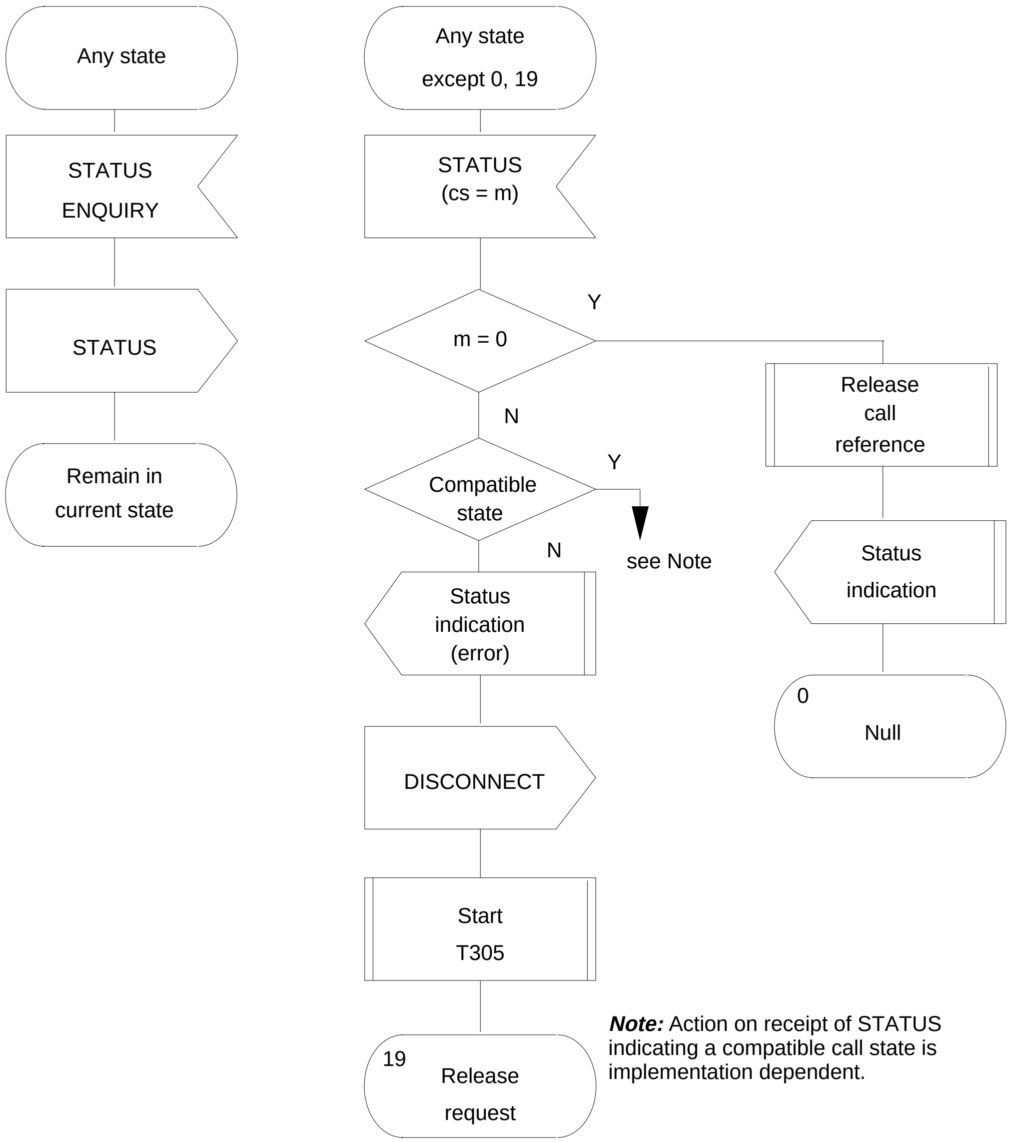
Figure 4-41
Detailed protocol control: User side[1] (10 of 16)



Note: After receiving this primitive, call control process should release the B-channel

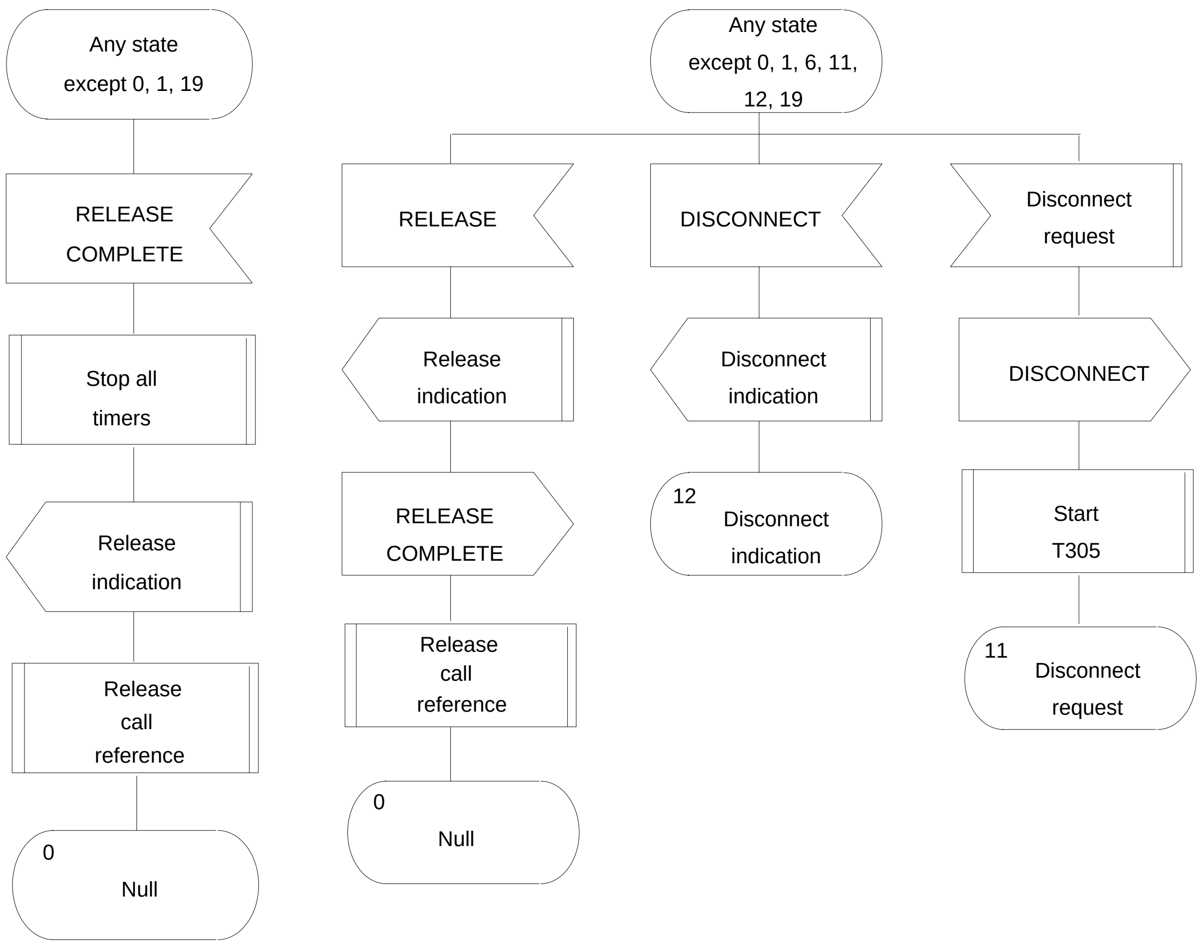
[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-42
Detailed protocol control: User side[1] (11 of 16)



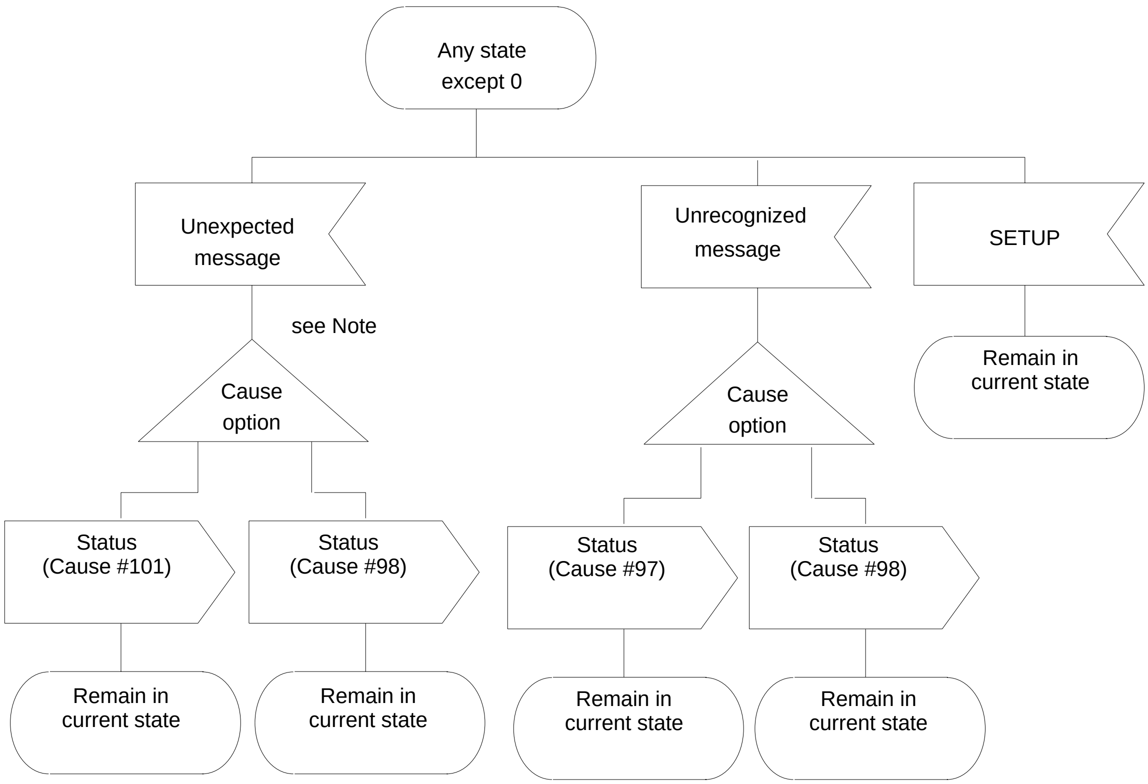
[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-43
Detailed protocol control: User side[1] (12 of 16)



[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

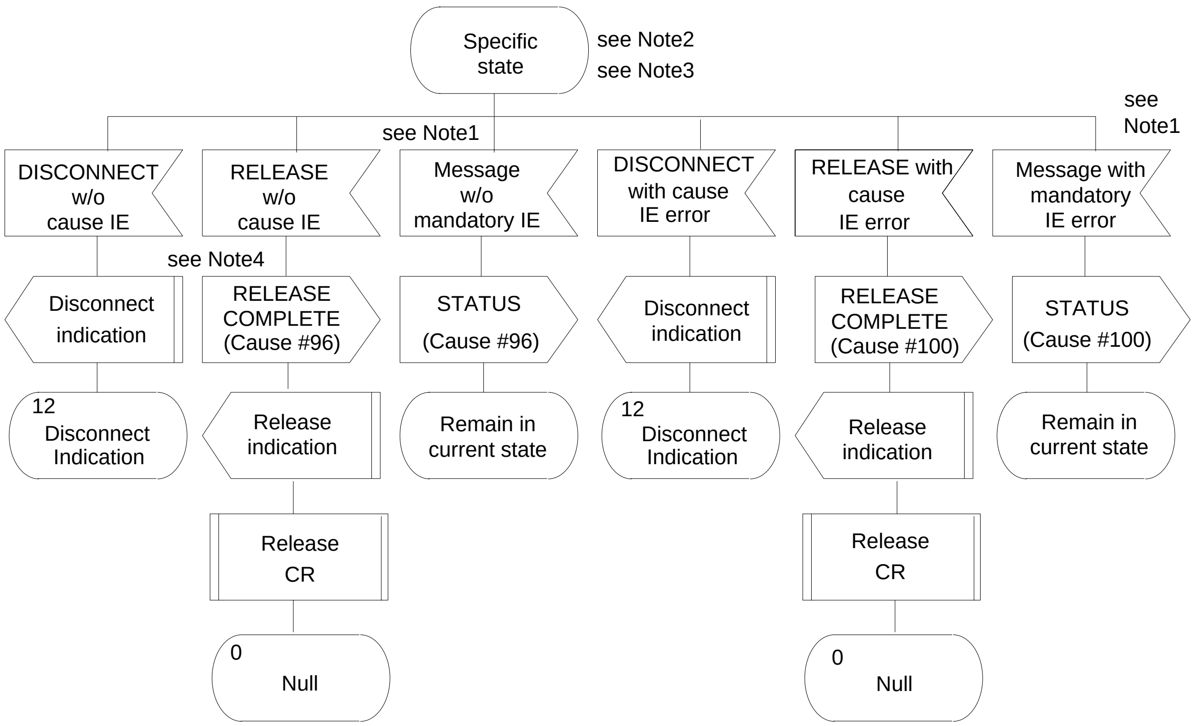
Figure 4-44
Detailed protocol control: User side[1] (13 of 16)

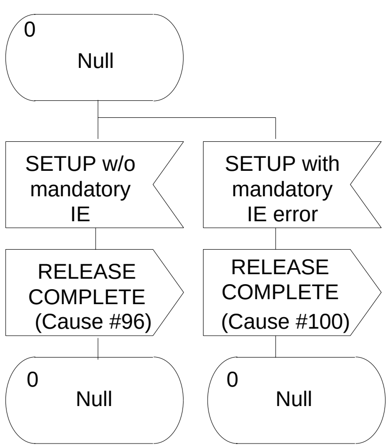


Note: Except RELEASE or RELEASE COMPLETE

[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-45
Detailed protocol control: User side[1] (14 of 16)





Note 1: Except SETUP, RELEASE COMPLETE, and DISCONNECT.

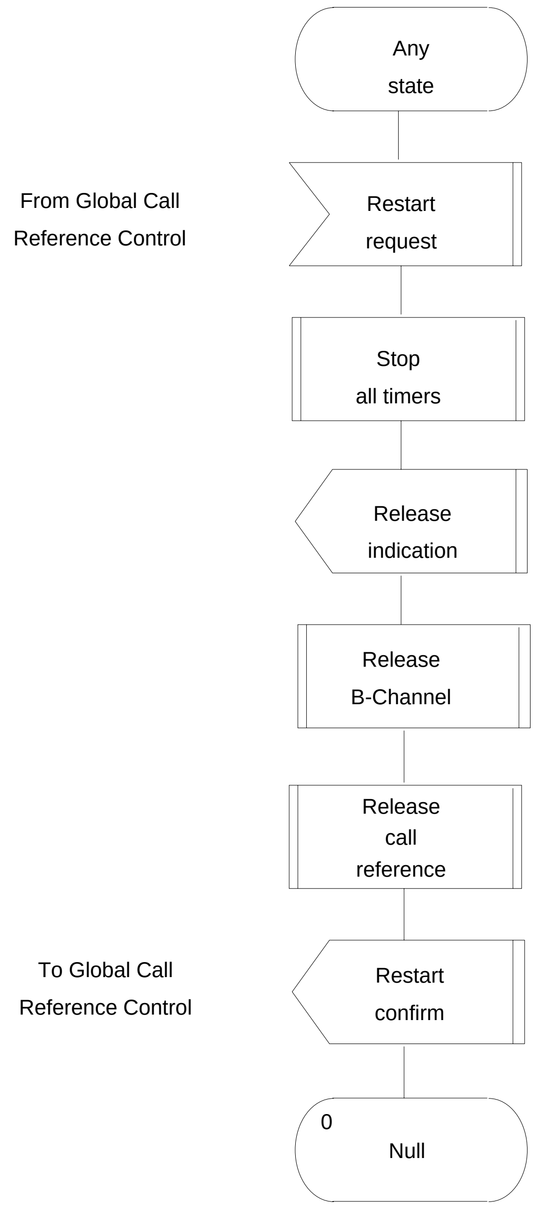
Note 2: These messages are recognized by the user and expected messages in the state.

Note 3: See procedures for specific states

Note 4: Release the B channel

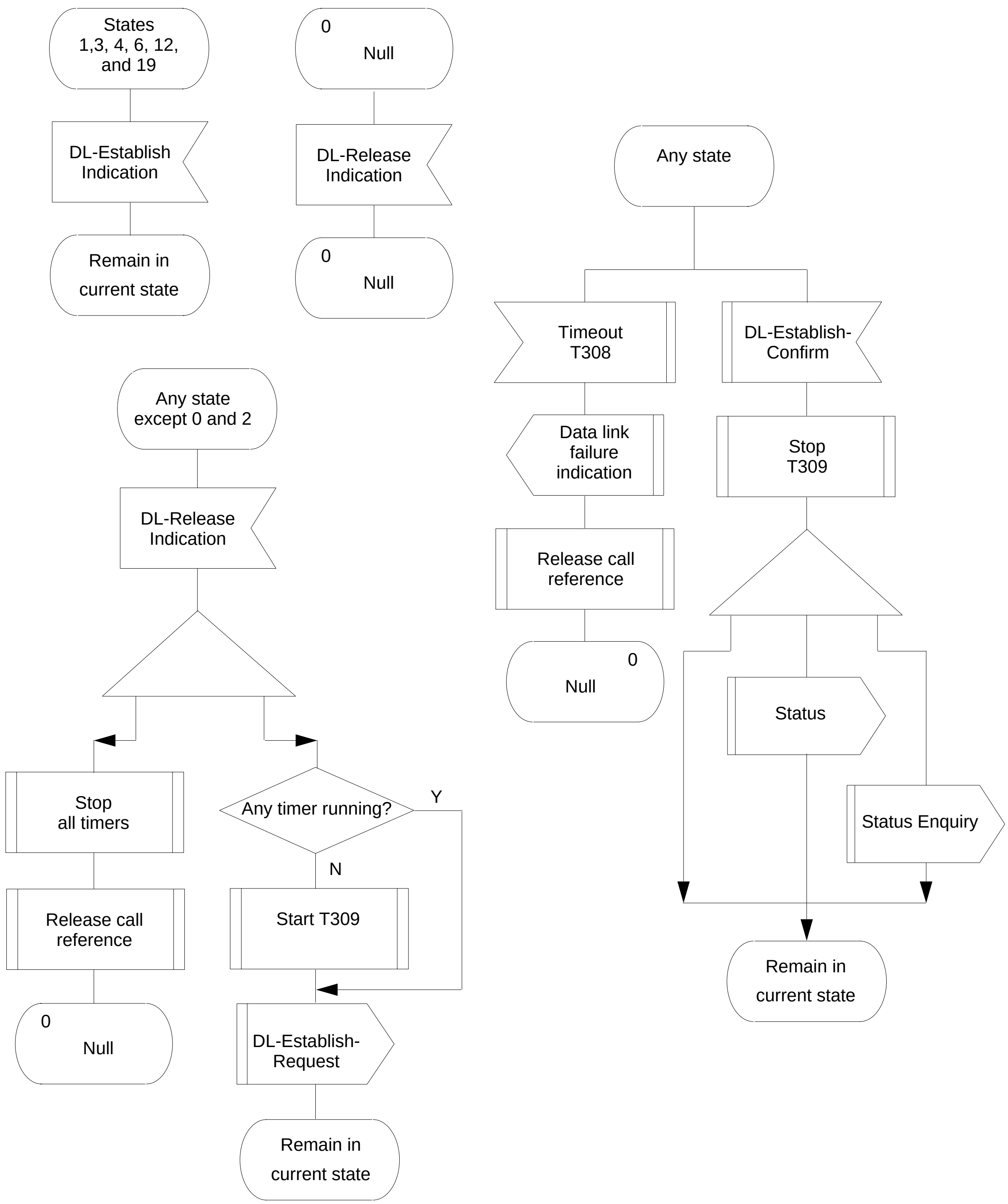
[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-46
Detailed protocol control: User side[1] (15 of 16)



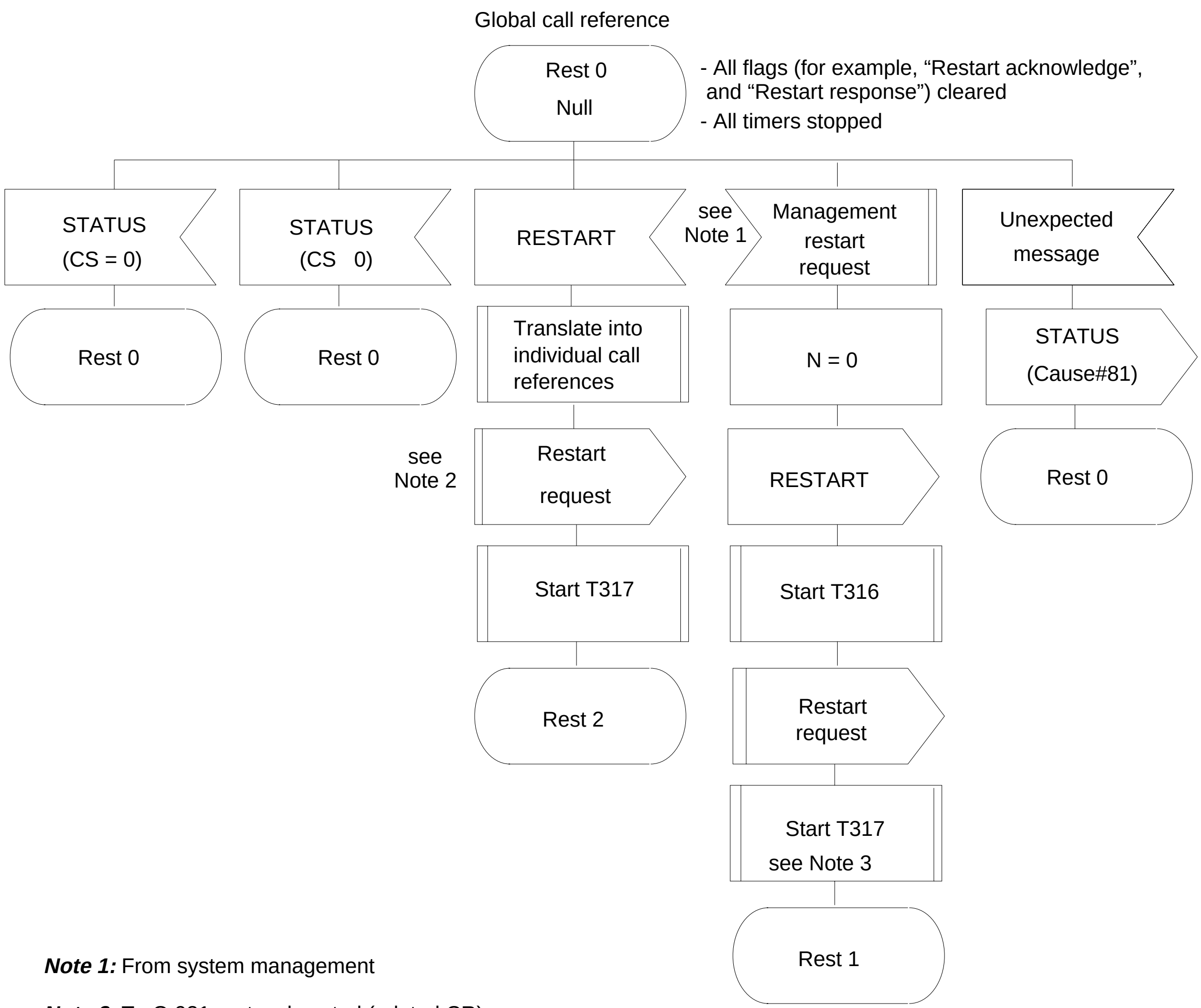
[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-47
Detailed protocol control: User side[1] (16 of 16)



[1]Northern Telecom does not support the user side of the interface at this time. The figure is for reference only.

Figure 4-48
Detailed protocol control for the global call reference (1 of 4)



Note 1: From system management

Note 2: To Q.931 protocol control (related CR)

Note 3: The value of T317 is implementation dependent.

Figure 4-49
Detailed protocol control for the global call reference (2 of 4)

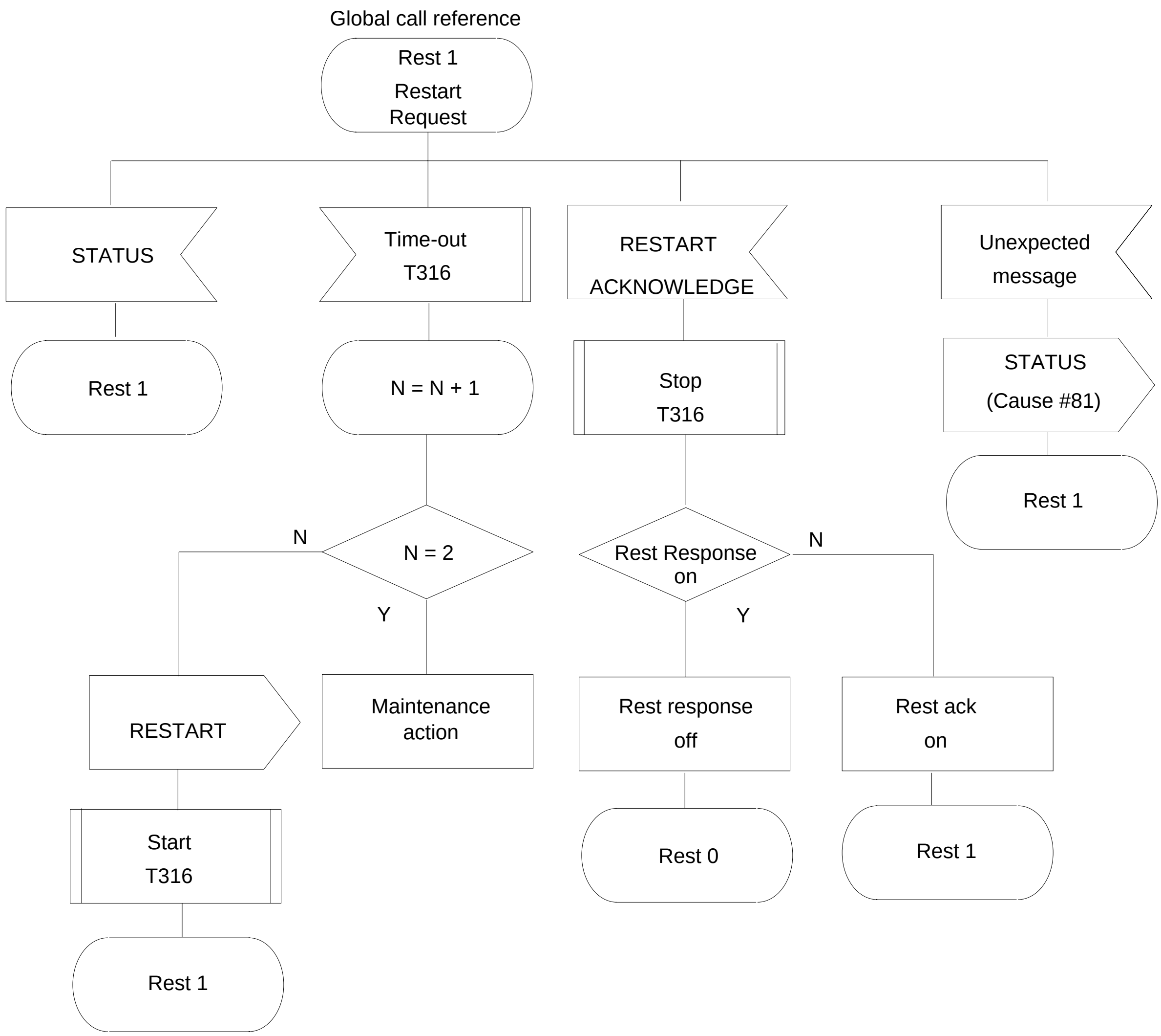


Figure 4-50
Detailed protocol control for the global call reference (3 of 4)

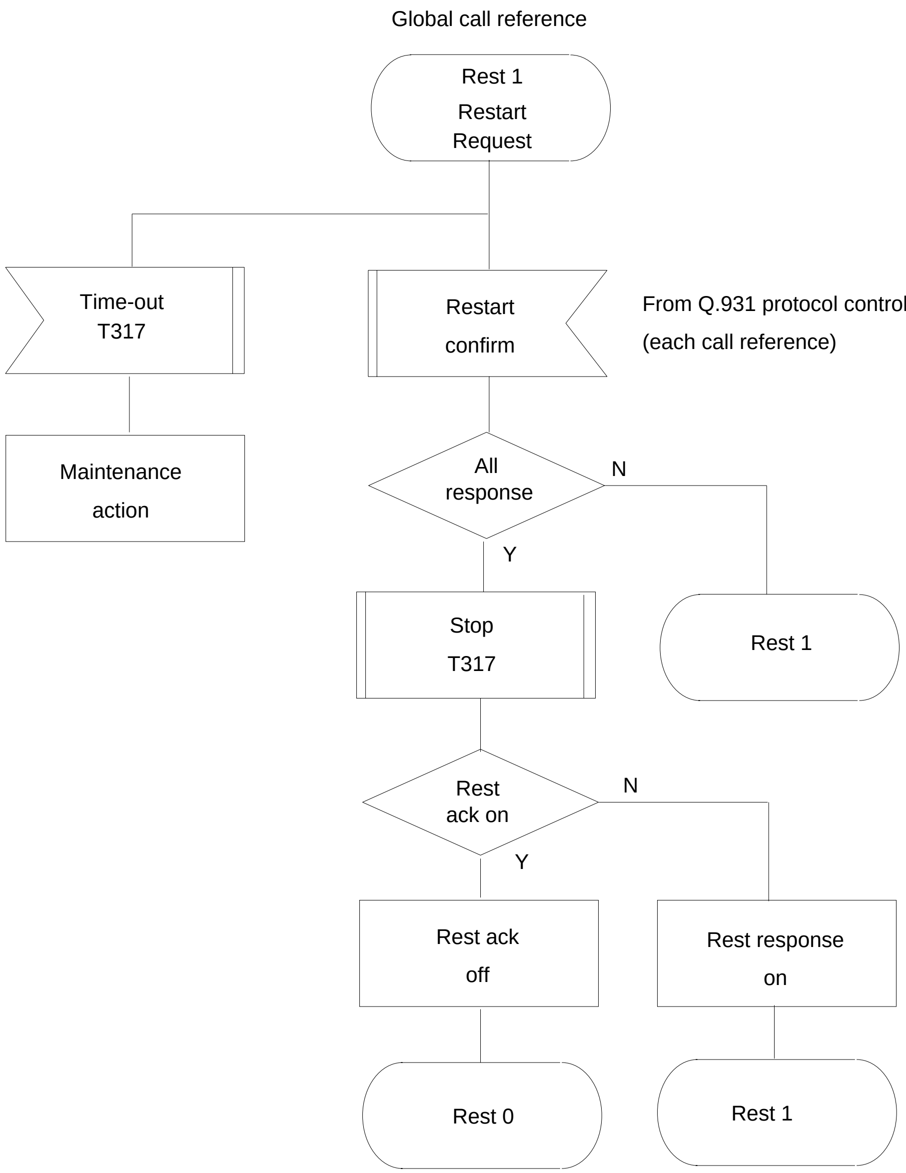


Figure 4-51
Detailed protocol control for the global call reference (4 of 4)

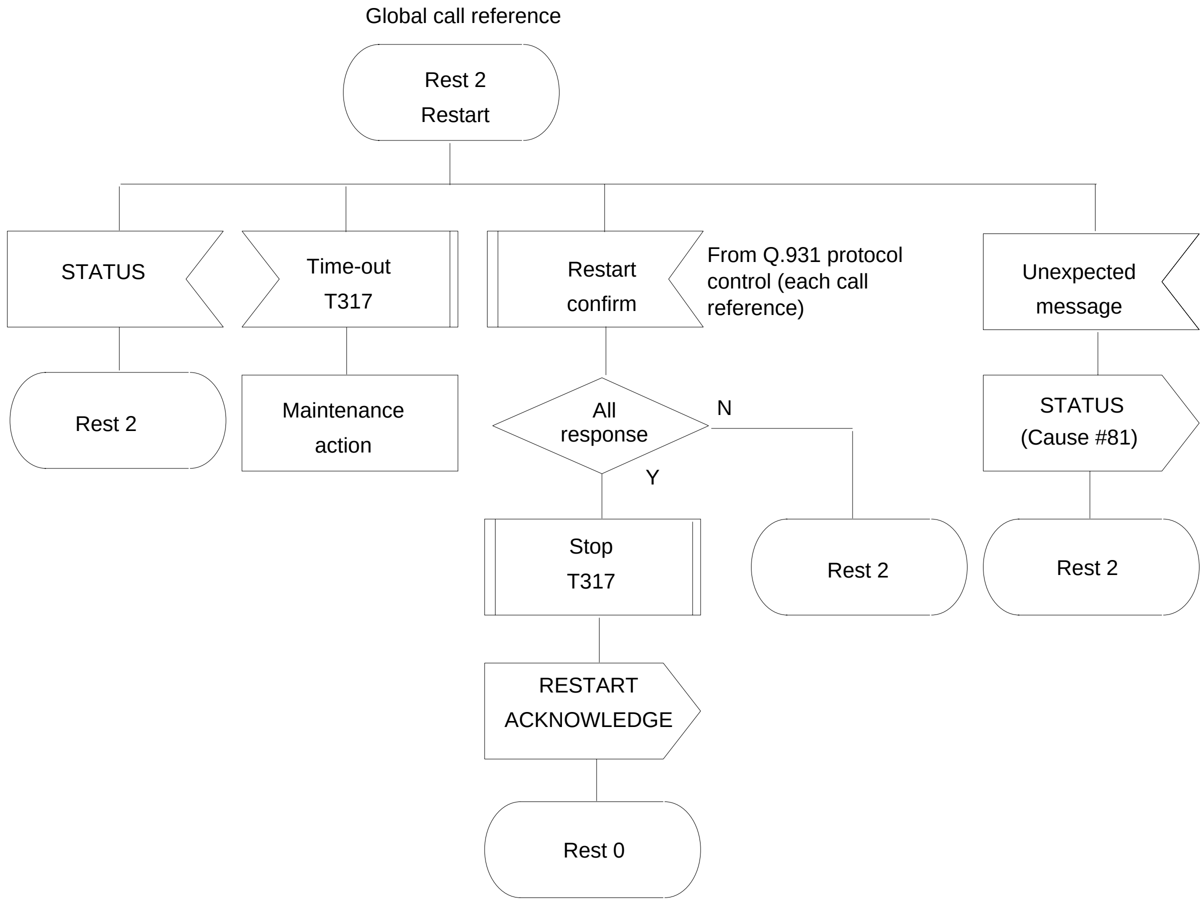


Figure 4-52 Overview protocol control: Network side (1 of 6)
Outgoing set up procedure (1 of 2)

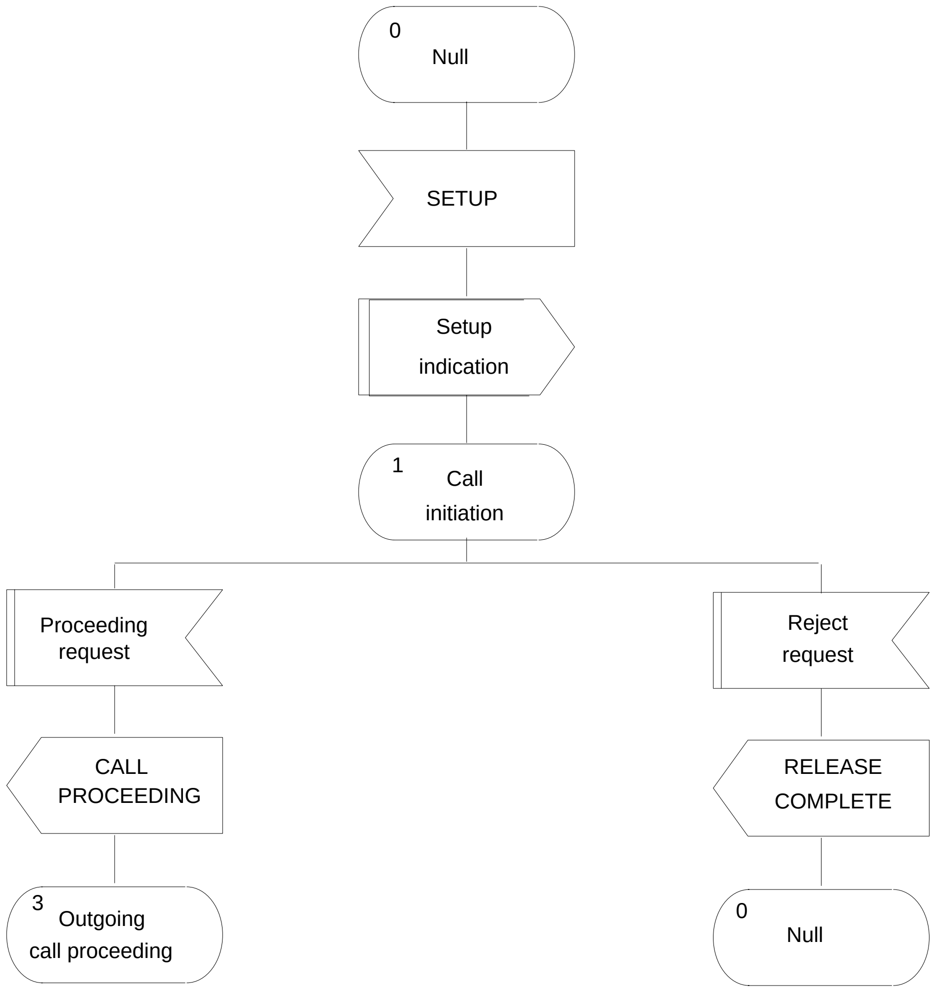


Figure 4-53 Overview protocol control: Network side (2 of 6)
Outgoing set up procedure (2 of 2)

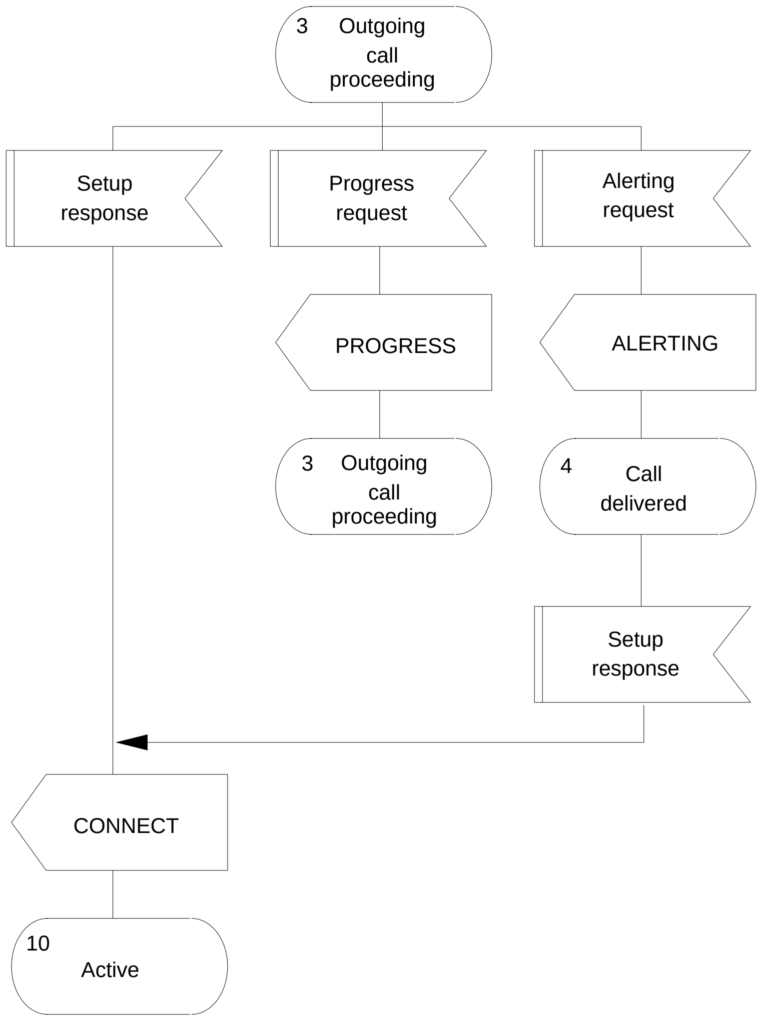


Figure 4-54 Overview protocol control: Network side (3 of 6)
Incoming set up procedure (1 of 2)

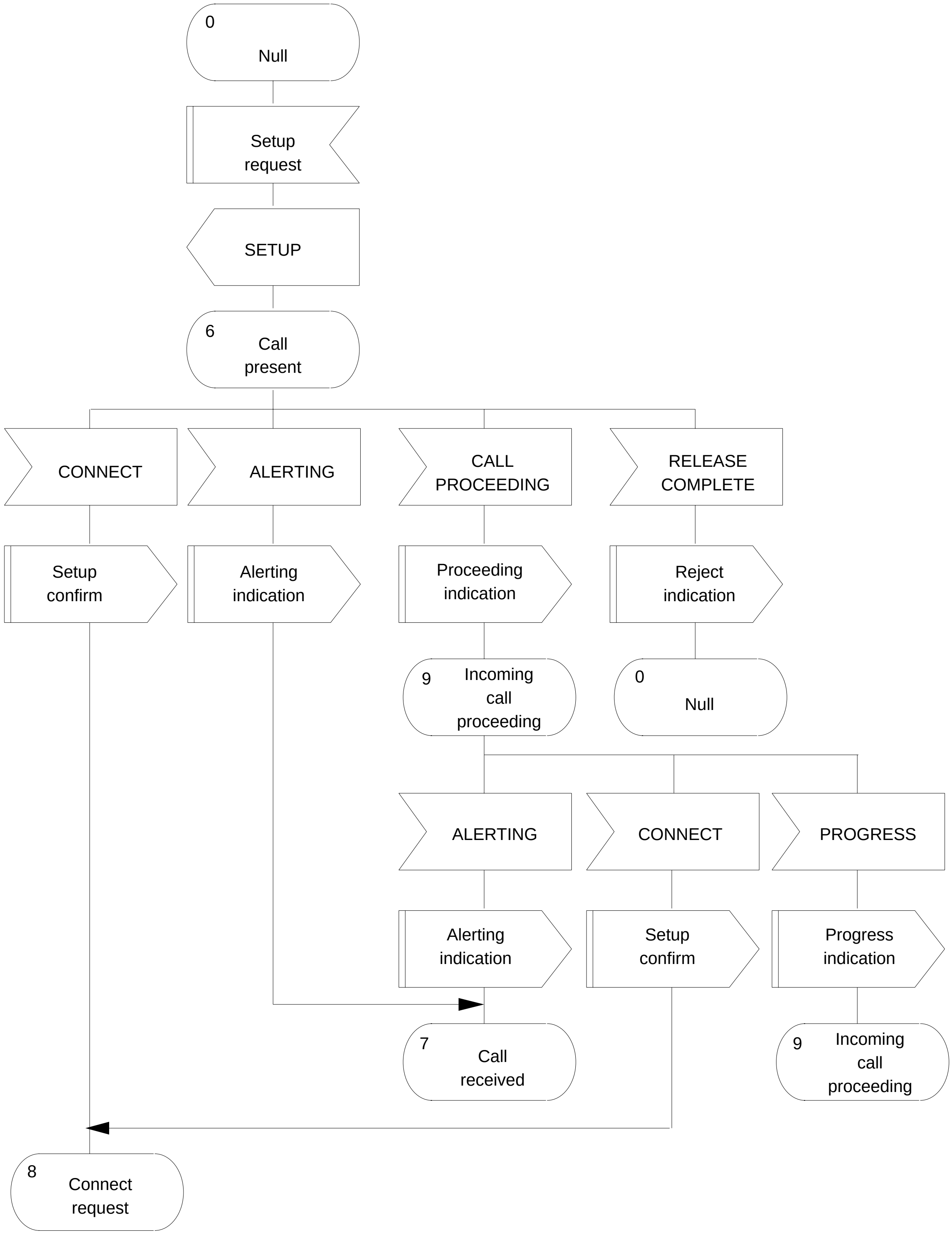


Figure 4-55 Overview protocol control: Network side (4 of 6)
Incoming set up procedure (2 of 2)

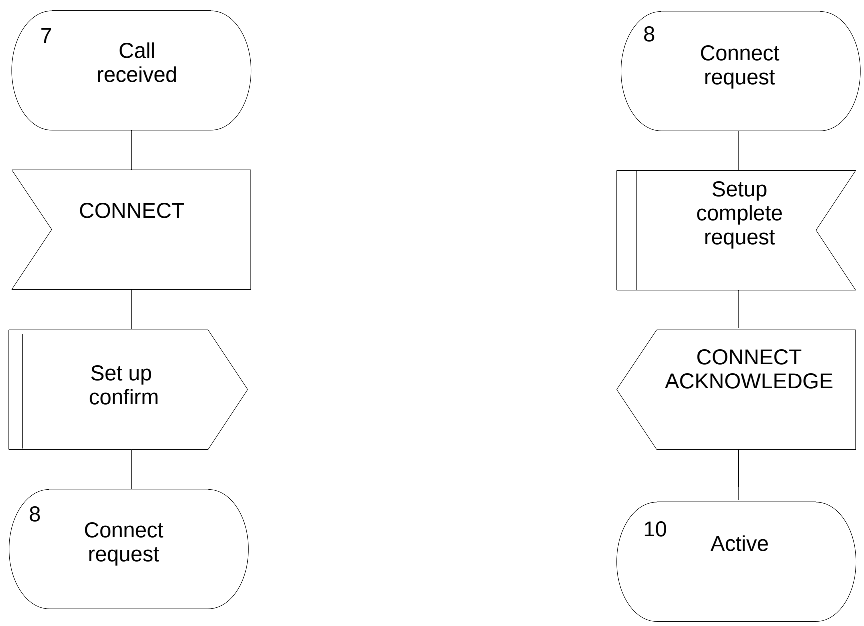


**Figure 4-56 Overview protocol control: Network side (5 of 6)
Clearing procedure (1 of 2)**

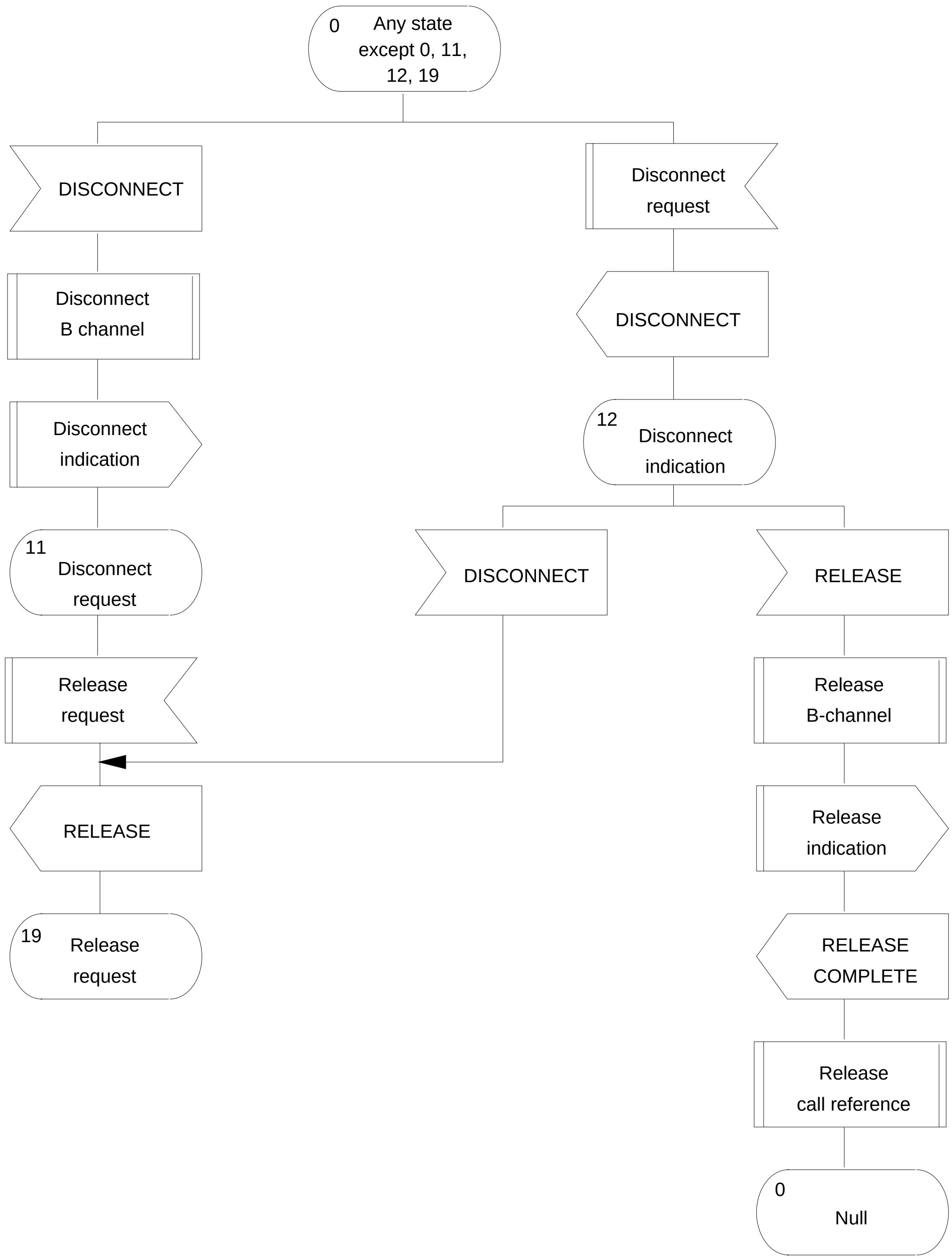


Figure 4-57 Overview protocol control: Network side (6 of 6)
Clearing procedure (2 of 2)

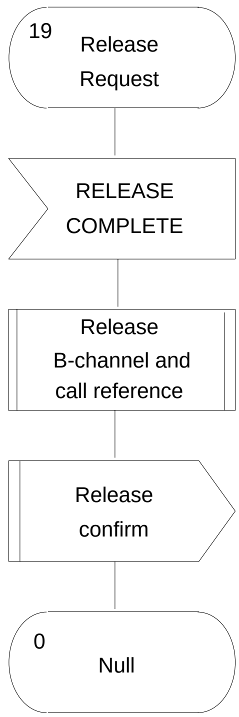


Figure 4-58
Detailed protocol control: Network side (1 of 18)

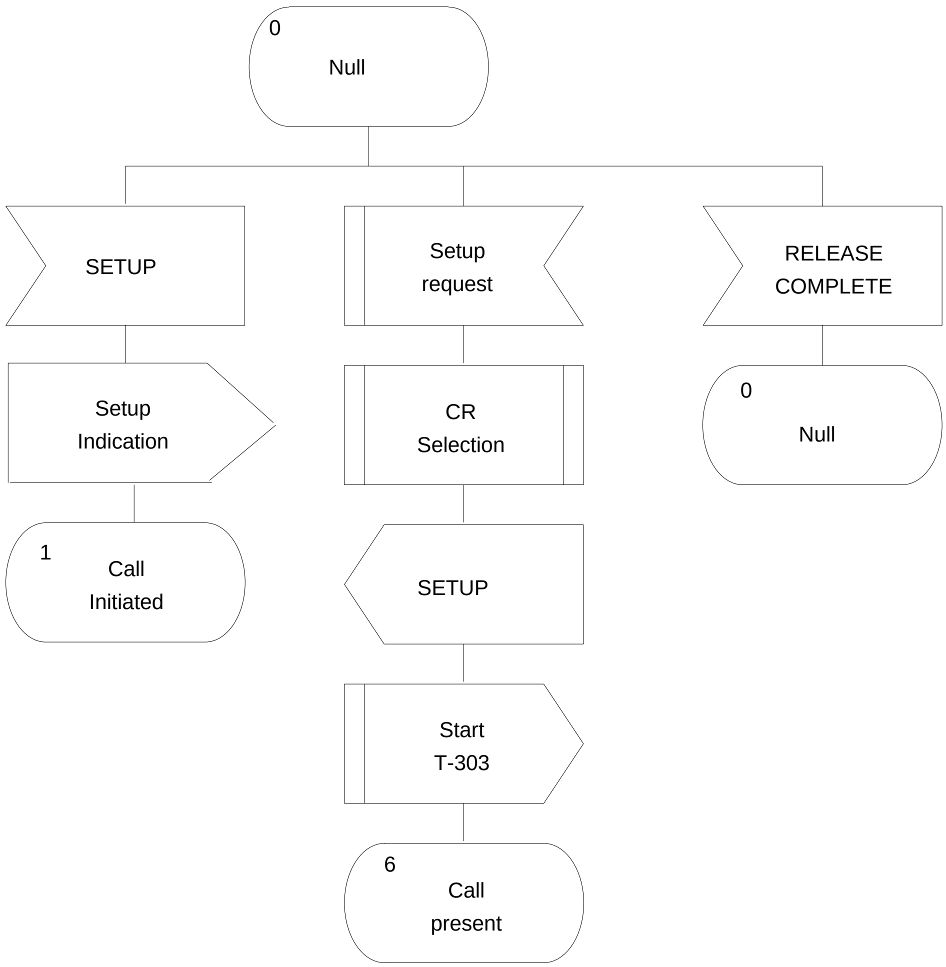


Figure 4-59
Detailed protocol control: Network side (2 of 18)

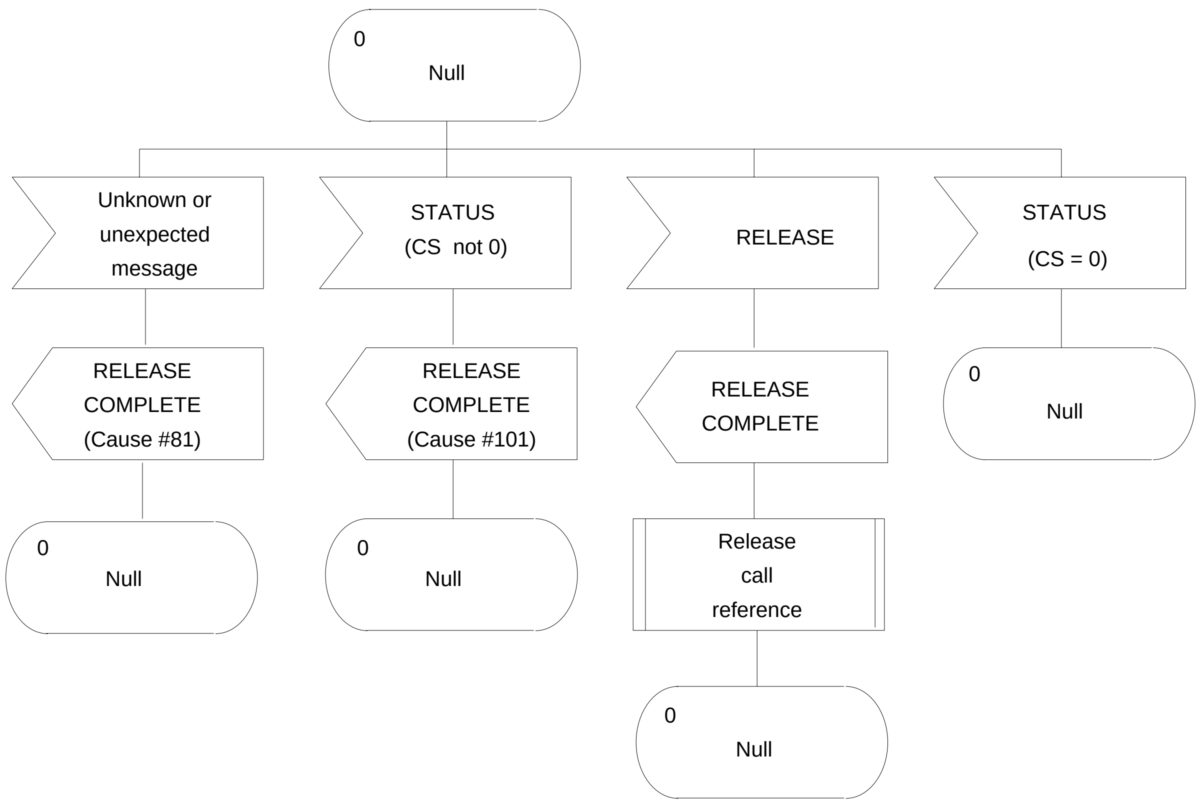


Figure 4-60
Detailed protocol control: Network side (3 of 18)

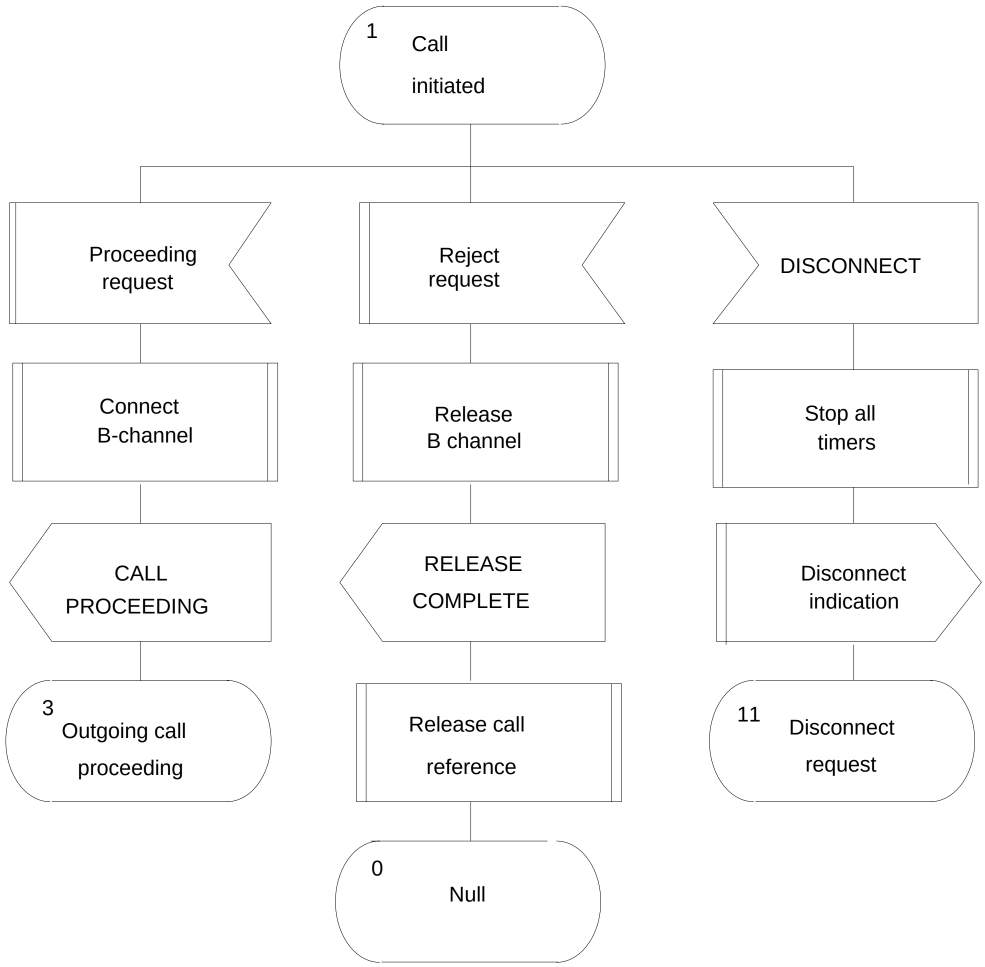


Figure 4-61
Detailed protocol control: Network side (4 of 18)

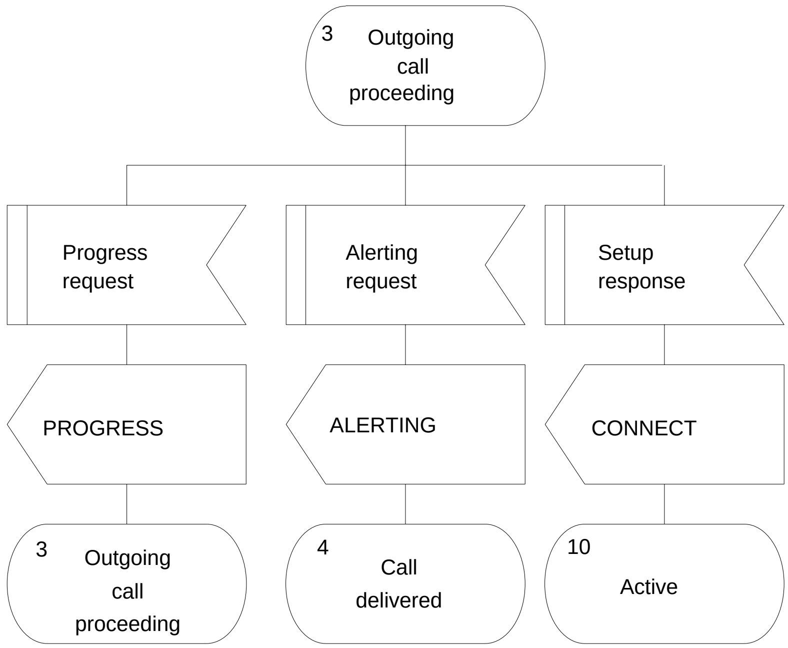


Figure 4-62
Detailed protocol control: Network side (5 of 18)

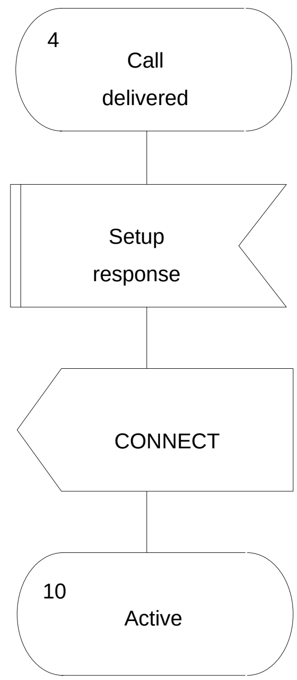


Figure 4-63
Detailed protocol control: Network side (6 of 18)

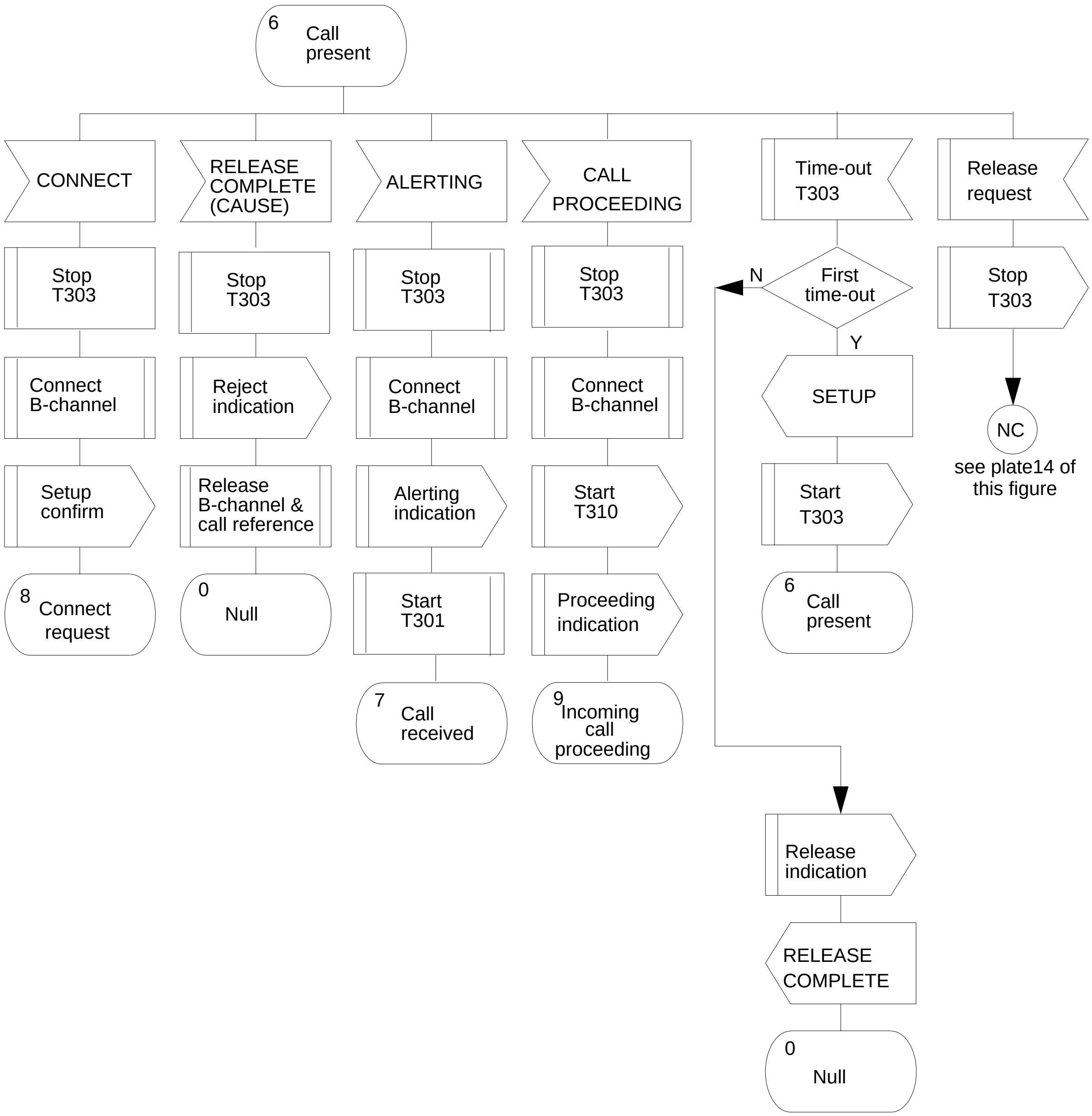


Figure 4-64
Detailed protocol control: Network side (7 of 18)

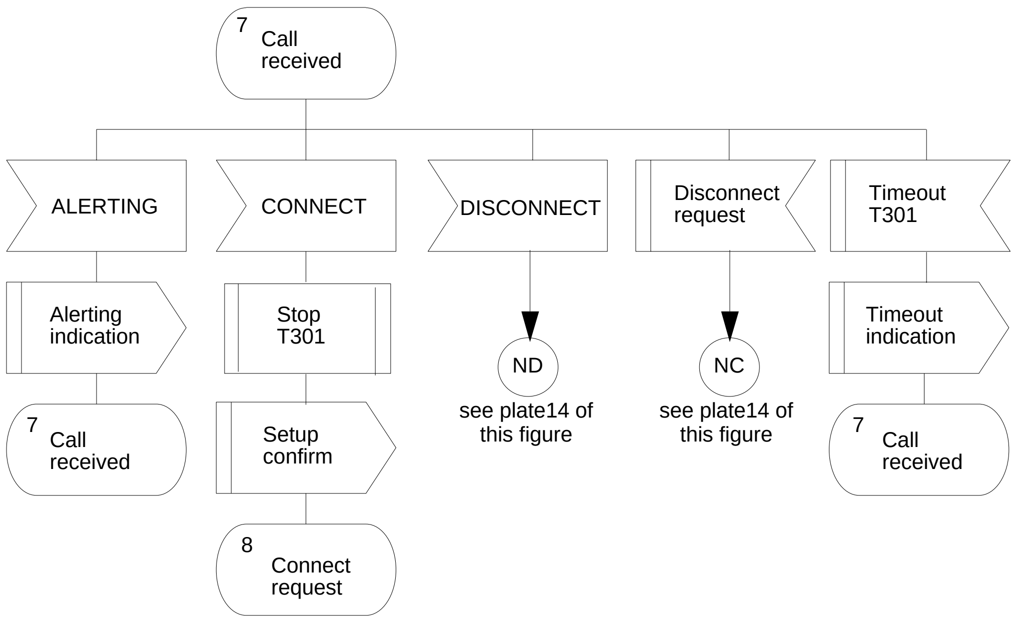


Figure 4-65
Detailed protocol control: Network side (8 of 18)

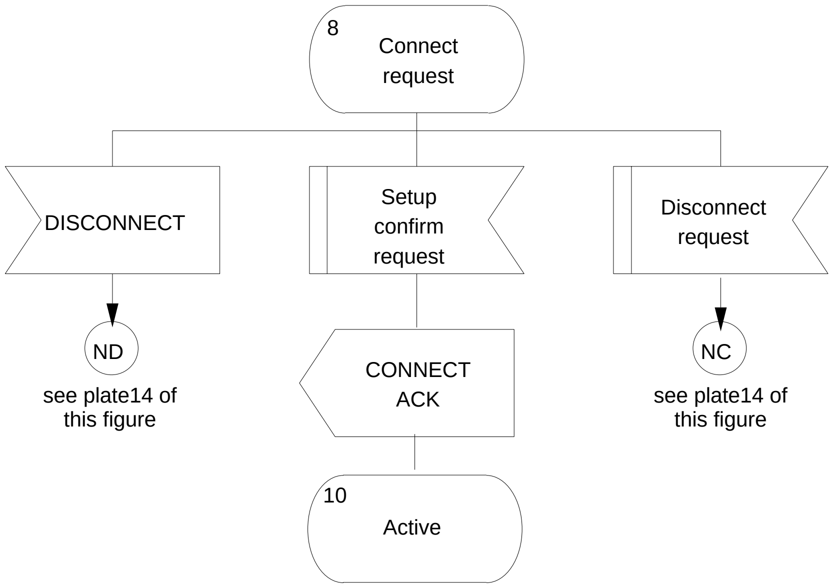


Figure 4-66
Detailed protocol control: Network side (9 of 18)

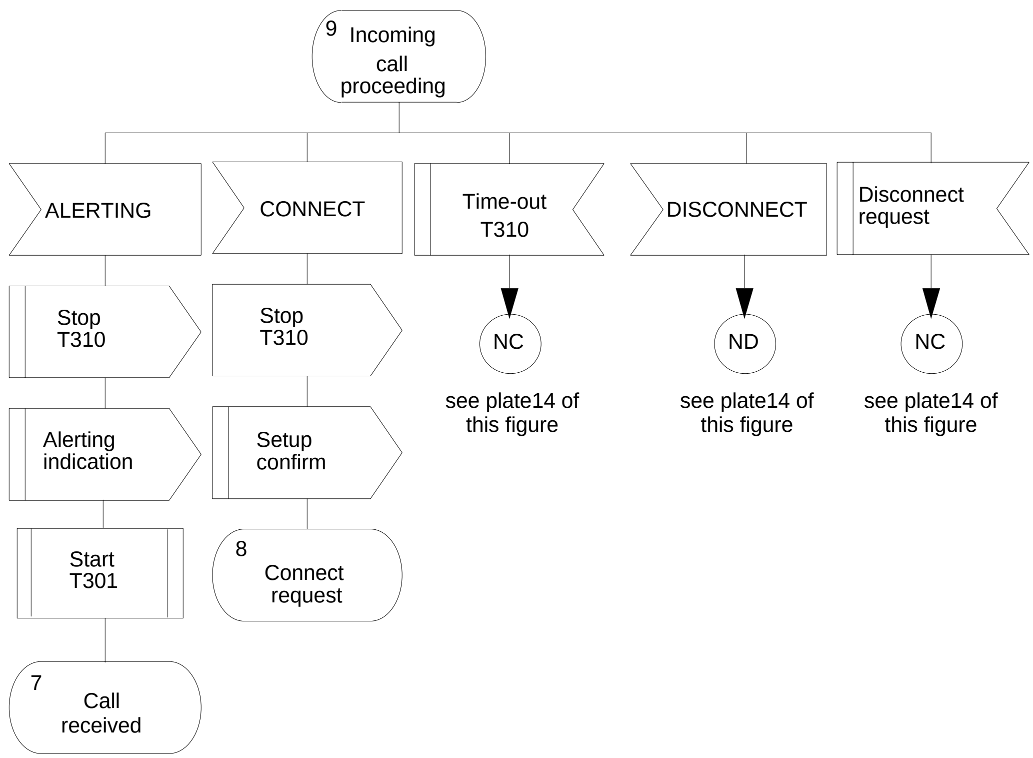


Figure 4-67
Detailed protocol control: Network side (10 of 18)

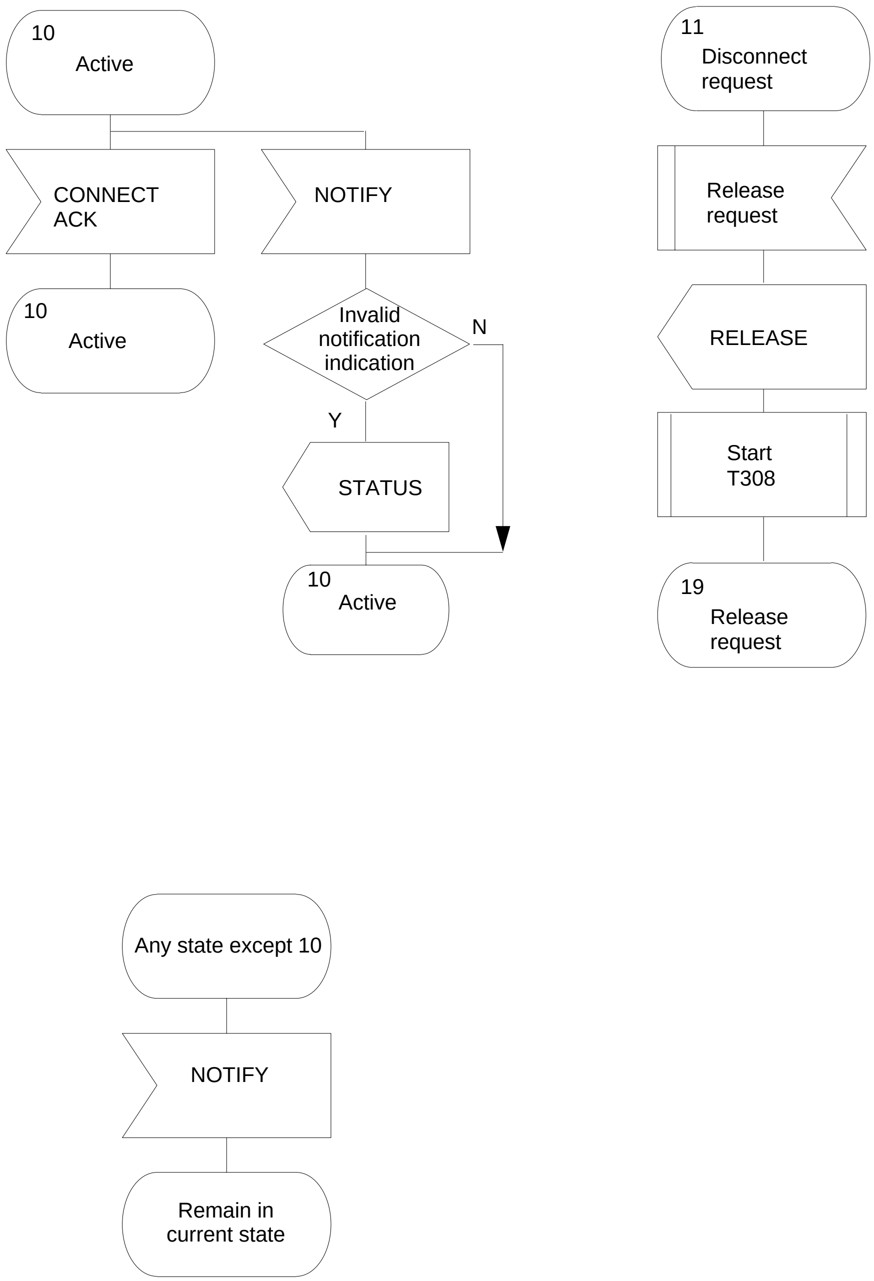


Figure 4-68
Detailed protocol control: Network side (11 of 18)

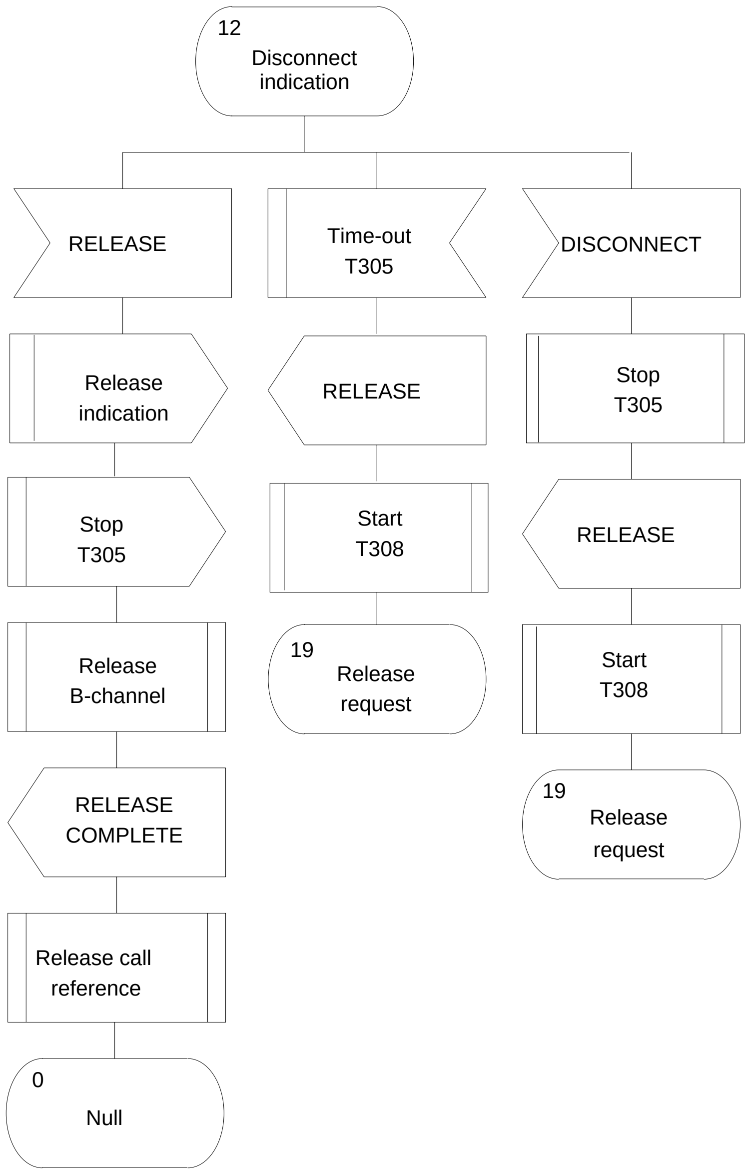


Figure 4-69
Detailed protocol control: Network side (12 of 18)

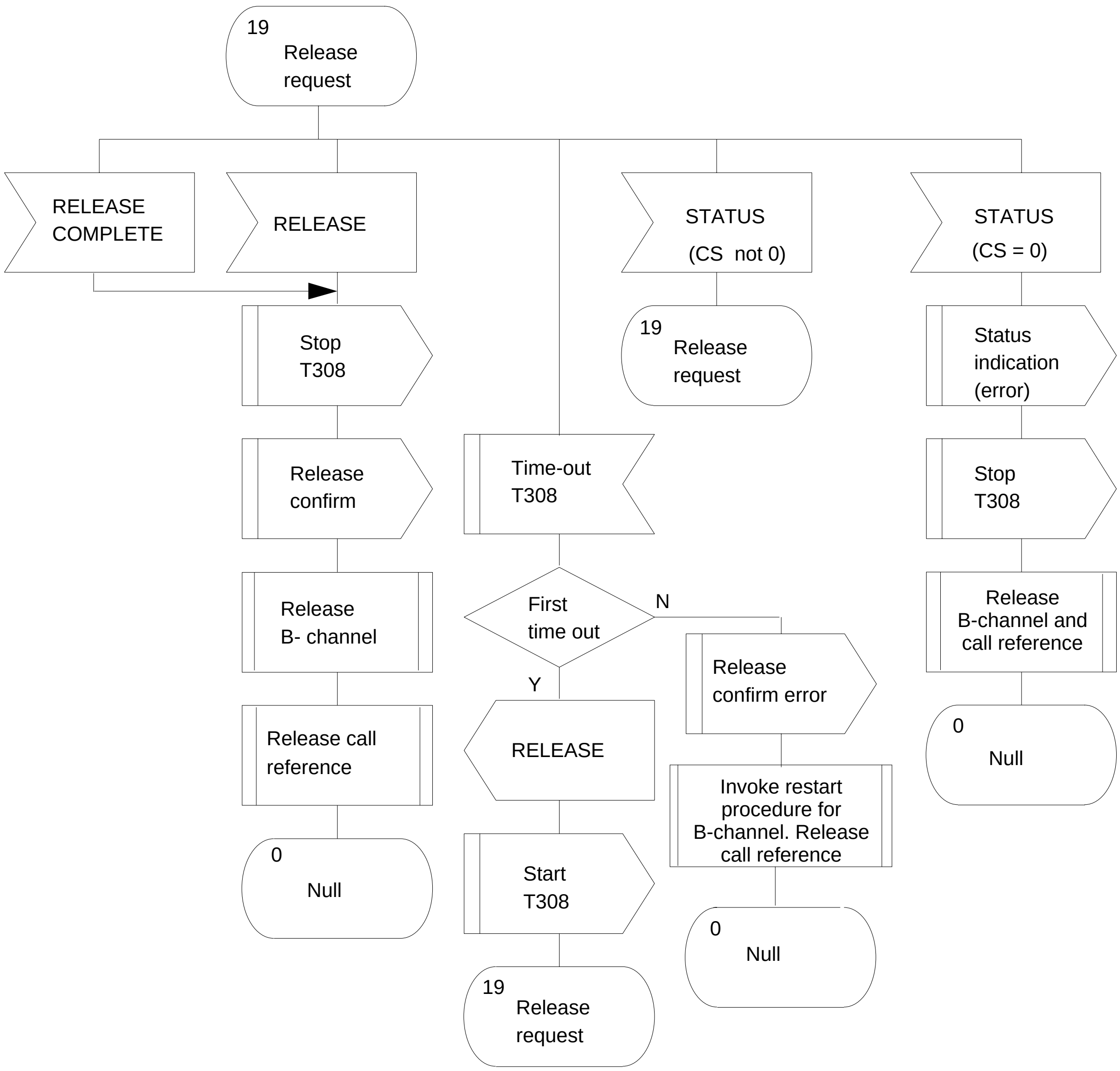


Figure 4-70
Detailed protocol control: Network side (13 of 18)

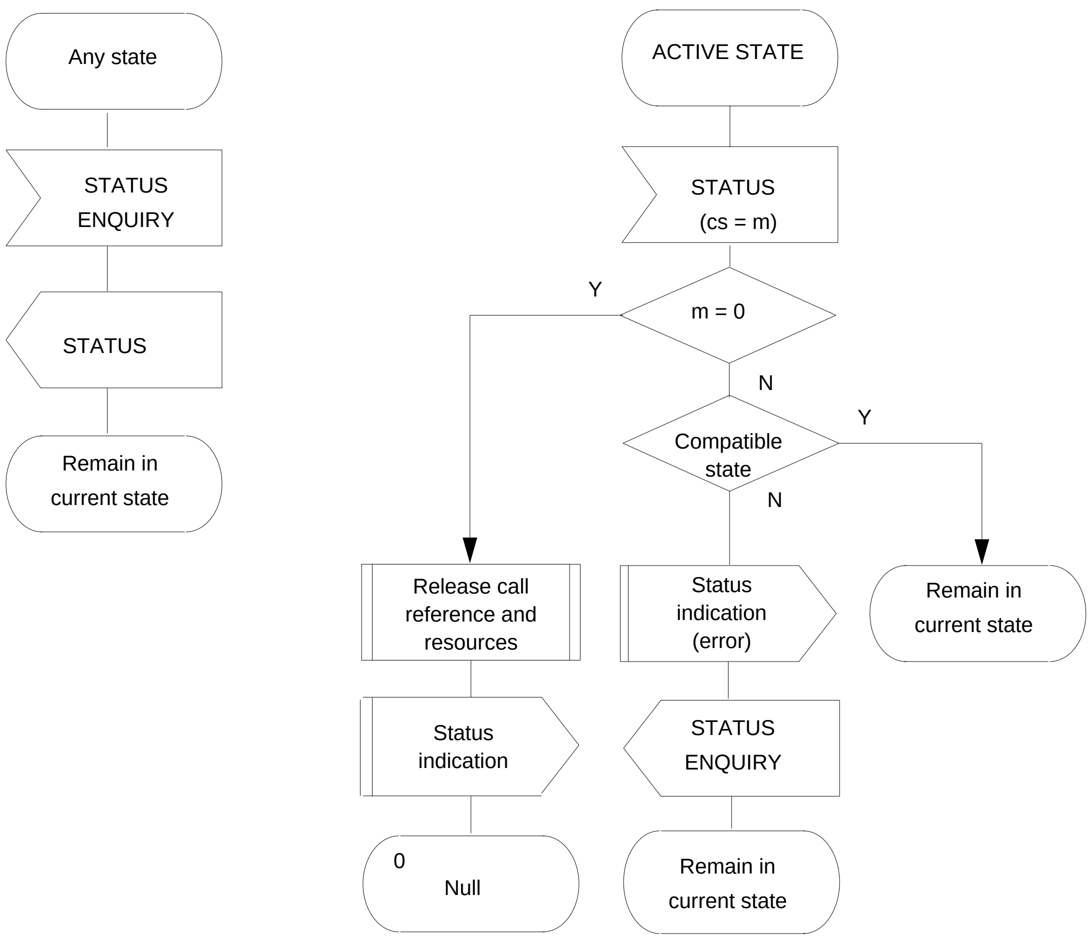


Figure 4-71
Detailed protocol control: Network side (14 of 18)

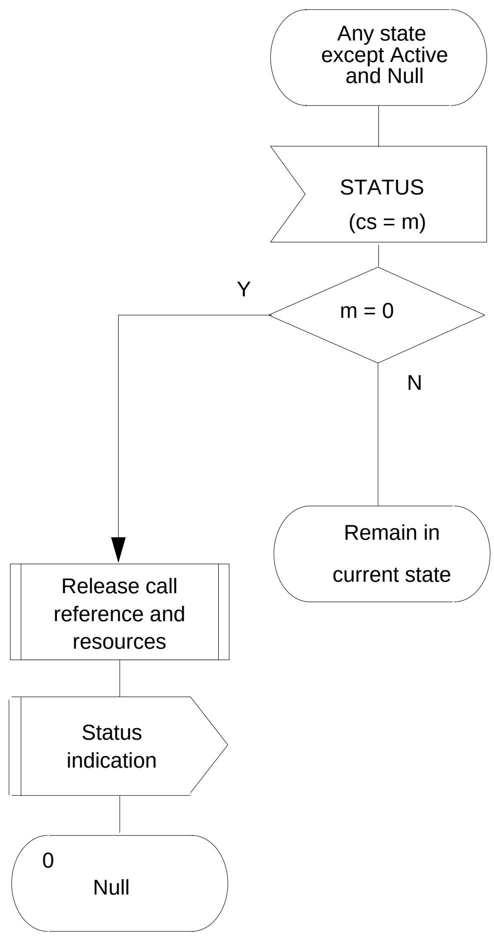


Figure 4-72
Detailed protocol control: Network side (15 of 18)

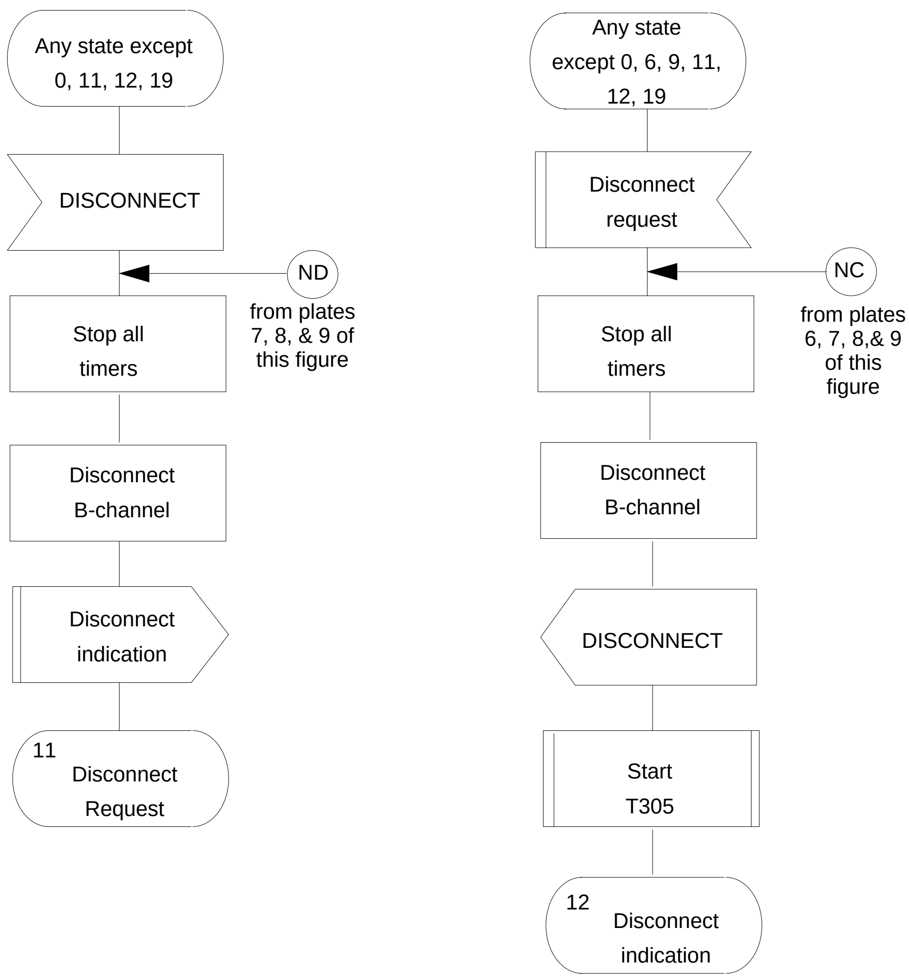
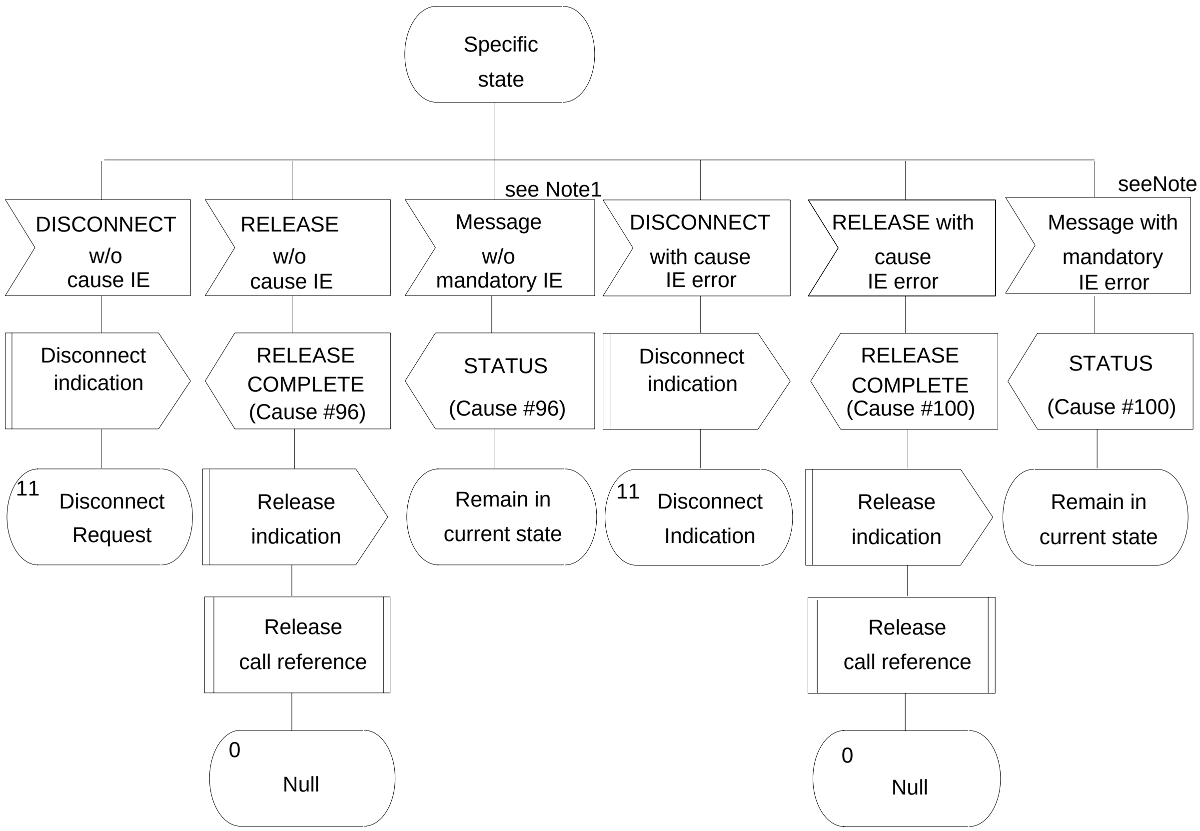
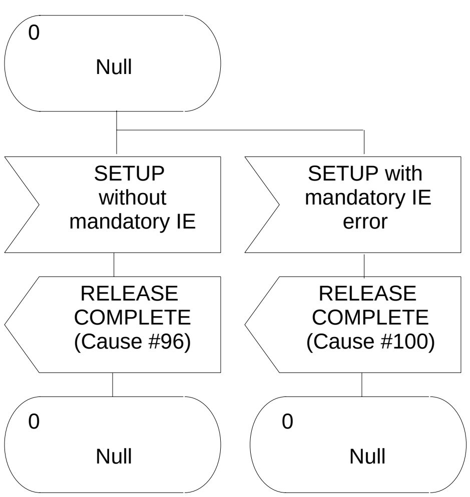


Figure 4-73
Detailed protocol control: Network side (16 of 18)

Note: Except RELEASE or RELEASE COMPLETE

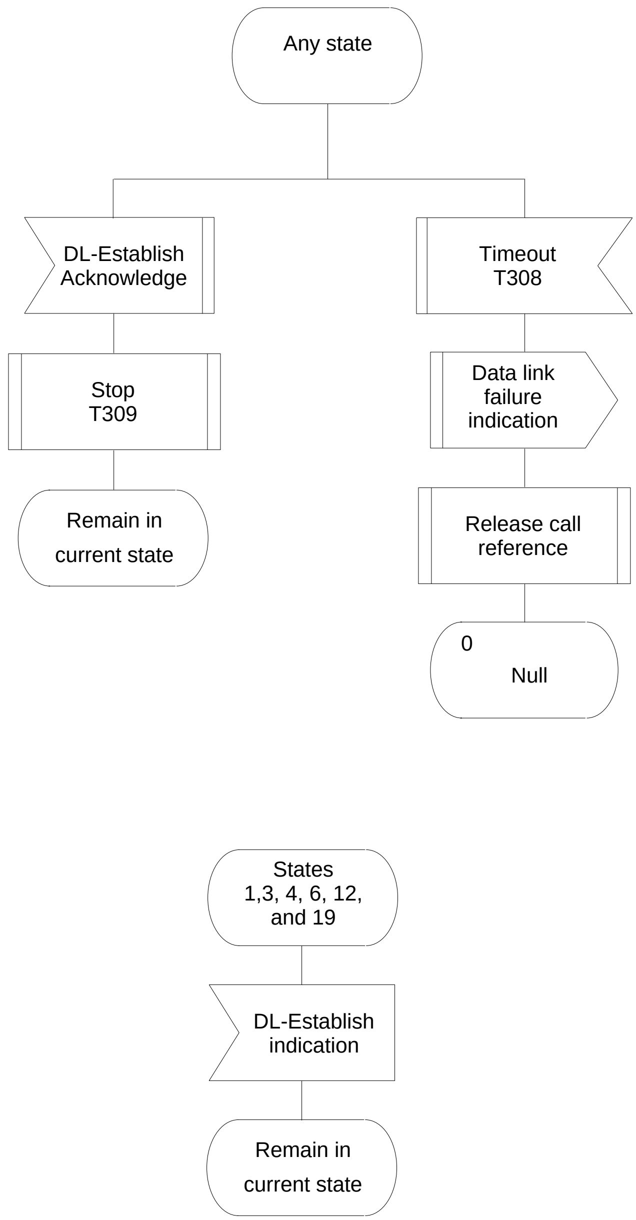
Figure 4-74
Detailed protocol control: Network side (17 of 18)





Note: Except SETUP, RELEASE, RELEASE COMPLETE, and DISCONNECT

Figure 4-75
Detailed protocol control: Network side (18 of 18)



Section 5: Supplementary services

Chapter 5-1: Introduction

1.1 Introduction

The ISDN primary rate interface (PRI) supplementary services described in this section are those offered by a DMS-100 switch (the network) to a PRI user such as a private branch exchange (PBX).

The supplementary services offered with this specification are as follows:

- Calling line identification presentation/restriction (including calling line subaddress)
- Called party subaddress transmission
- Low and high layer compatibility
- Direct dial inward
- Hunt group
- Multiple interface per D-channel

The services offered are in accordance with *NTT INS NET 1500 Service Interface Volume 3 Primary rate user-network interface Layer 3 specification (Rev 1 1989)*

The call contol messages and associated information elements necessary to support the supplementary services are described in Section 4 of this specification.The message formats must be supported by the protocol in order that the service can be defined.

In the following chapters in this section, the service implementation is defined; there are a number of references to the messages and information elements in Section 4 should the reader require more information on the call control procedures.

Chapter 5-2: Supplementary services

2.1 Calling line identification presentation/restriction

The calling line identification presentation/restriction (CLIP/CLIR) supplementary service transmits the calling party number from the network to the terminating user. Calling line identification uses the *Calling party number* information element in the *Setup* message to transfer information from the calling terminal to the called terminal. The content of the *Calling party number* information element is subject to mandatory and subscription option controls.

In addition to the calling party number, the calling party subaddress is also transmitted to the called user if the *Calling party subaddress* information element is presented in the *Setup* message. The delivery of the subaddress information is not subject to the controls placed on the delivery of the calling party number. Note also that delivery of the subaddress is only available if the service provider has configured the network to permit the transmission of subaddress information.

The calling user may restrict presentation of their number on a per-call basis or for all calls.

The detailed SDL diagrams in Figure 5-1 and Figure 5-1 show the controls for the calling line identification presentation supplementary service. The *Calling party number* information element is described in Chapter 4-4: "Layer 3 message formats" of this specification.

2.1.1 Mandatory controls at the originating interface

If the calling party number is not included in an incoming *Setup* message:

- the network provides the default calling party number from subscription data
- the screening indicator in the *Calling party number* information element is set to “Network provided”.

If the calling party number is included in the incoming *Setup* message the network performs screening to determine whether a network-provided or user-provided calling party number is used to identify the calling user.

Figure 5-1
SDL diagram for calling line identification presentation/restriction at originating exchange

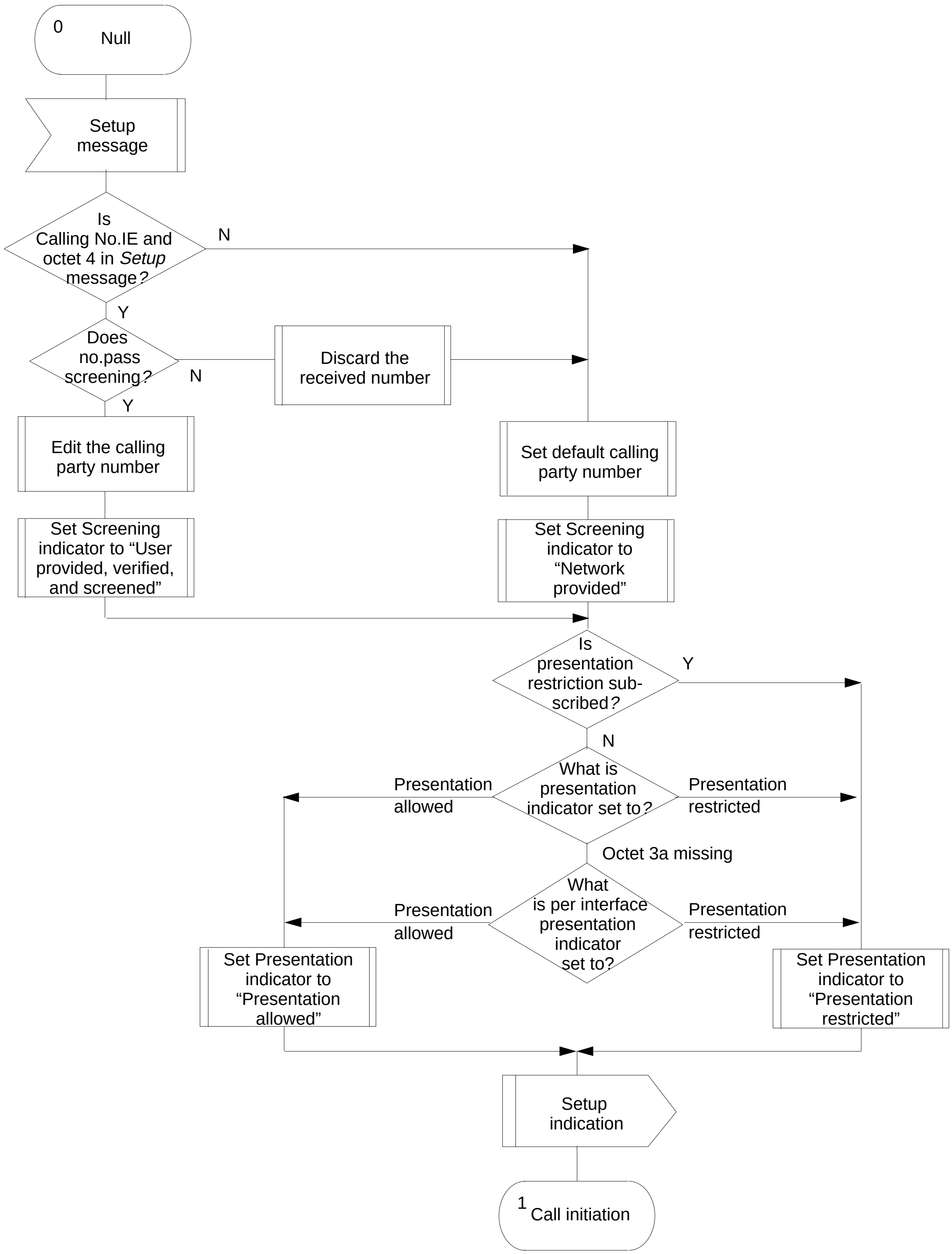
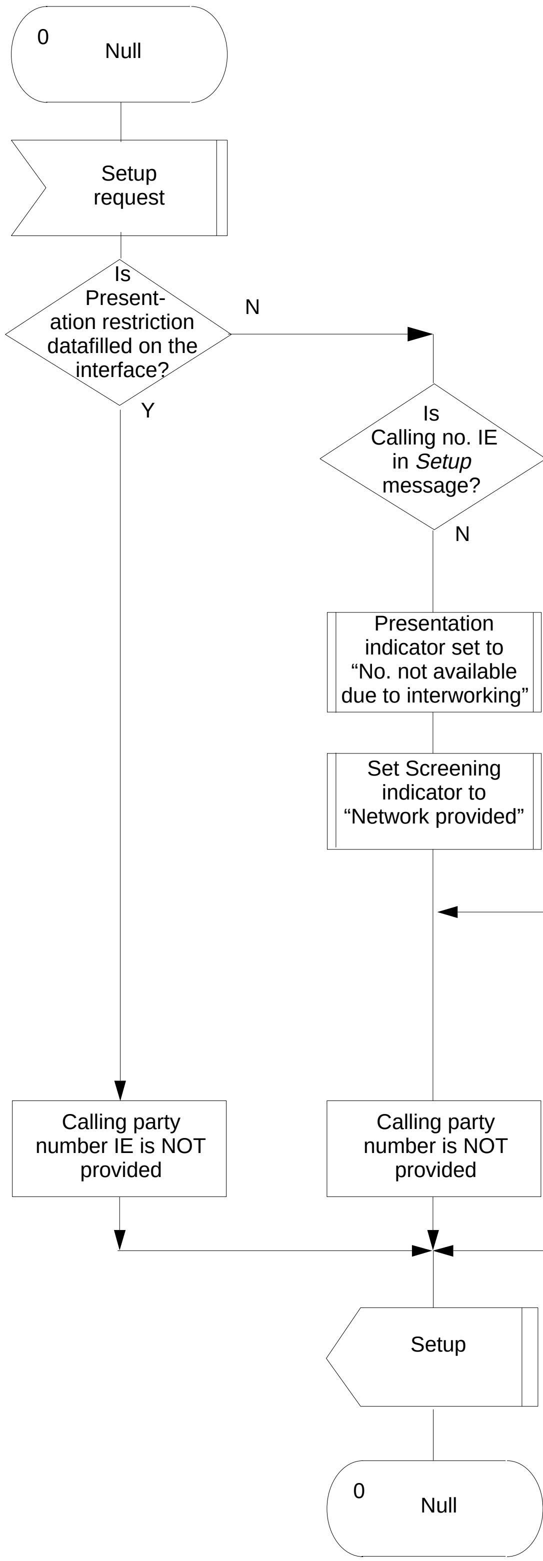


Figure 5-2
SDL diagram for calling line identification presentation/restriction at terminating exchange



If the calling party number fails screening

- the network provides the default calling party number from subscription data
- the screening indicator in the *Calling party number* information element is set to “Network provided”

If the screening passes, the network sets the screening indicator to “User provided, verified and passed” and performs editing on the calling party number.

Editing is performed to convert a partial number delivered to the network interface at the calling end into a complete address that can be transmitted through the network to the called user. That is, if the number delivered by the calling party is of the form (*local office code + subscriber number*), it can be modified to a network number of the form (*0 + area code + local office code + subscriber number)* before transmission to the called party.

2.1.2 Optional controls at the originating interface

The user may select, as a subscription option, to have all calling party numbers marked as “Presentation restricted” by the *Calling party number* information element-in field *Presentation indicator*. Alternatively, the presentation indicator can be taken from the calling party number information provided by the user on a per call basis.

If the presentation indicator is not included in an incoming *Setup* message, the network provides the default calling party number presentation indicator value from subscription data.

2.1.3 Controls at the terminating interface

The following paragraphs describe the controls for the delivery of the calling party number to the terminating user.

Interworking

If the *Calling party number* information element is not present, the presentation indicator is set to “Number not available due to interworking” and the screening indicator is set to “Network provided”. No calling party number is passed to the terminating user.

Normal termination

If the presentation indicator is set to “Presentation allowed” the terminating exchange receives the calling party number.

If the presentation indicator is set to “Presentation restricted”, no calling party number is sent to the terminating user, unless that user has subscribed to override the restriction.

2.1.4 Exception conditions

The service provider must configure the mandatory and optional controls, especially the default calling party number, to ensure that correct information is transmitted across the network.

If the network is unable to transmit the *Calling party subaddress* information element, a *Status* message containing *Cause* value #43 “Access information discarded” is returned to the user that sent the initial information element.

2.2 Called party subaddress transmission

The called party subaddress transmission supplementary service allows the transparent transport of called user subaddress information from the originating interface to the destination interface.

This service may be used to extend the addressing capacity beyond that supported by the network. For example, a PBX may only subscribe to one public ISDN number, but may allocate a unique subaddress (independent of the public ISDN numbering plan) to each of its terminals. This allows calls to be terminated on individual terminals in the PBX if the calling party specifies the private subaddress in addition to the public ISDN number of the PBX. Since the subaddress is tariffed as part of the basic call, this feature provides for an alternative tariff in comparison to the Direct dial inward service described in paragraph 2.4 of this chapter.

2.2.1 Description

A called party subaddress, if presented by a calling user, is delivered unchanged by the network to the called user. The called party subaddress may be used by the called user for terminal identification or for compatibility checking. The called user specifies the use of the subaddress.

This supplementary service does not include the transfer and delivery of the calling party subaddress information.

2.2.2 Operational requirements

The called party subaddress transmission supplementary service uses the incoming call and call offering procedures defined in Chapter 4-4: "Layer 3 message formats".

If the calling user wants to transfer called party subaddress information to the called user, the calling user inserts the called party subaddress information in the *Called party subaddress* information element that is carried in the *Setup* message.

Similarly, at the destination interface, called party subaddress information is offered to the called user in the *Setup* message.

The called party subaddress transmission supplementary service is available to all users without prior arrangement or subscription between the user and the service provider.

2.2.3 Exception condition

If the *Called party subaddress* information element exceeds the maximum length (20 octets), it is truncated to that length.

The service is only available if the service provider has configured the network to permit transmission of the called party subaddress information.

If the network is unable to transmit the *Called party subaddress* information element, a *Status* message containing *Cause* value #43 “Access information discarded” is returned to the user that sent the original information element.

2.3 Lower and higher layer compatibility

This service allows the transparent transport of low layer compatibility (LLC) and high layer compatibility (HLC) information from the originating interface to the destination interface.

It may be used by the calling and called user for user-to-user compatibility checking and terminal identification. It allows calls to be terminated on a terminal that has the LLC and HLC compatibilities specified by the caller.

For example, a call offered on the destination interface with HLC encoded to *Group 4 Facsimile* is accepted only by a Group 4 facsimile terminal. In these situations, the destination interface can have one common ISDN address shared by voice, X.25, and facsimile terminals.

2.3.1 Description

This service allows the calling user to specify, and the called user to verify, the compatibility of their lower layer and higher layer protocols for communication on the bearer channel. The lower layer and higher layer compatibility information is not examined by the network; it is transferred unchanged through the network.

Lower layer compatibility is used to specify or check the compatibility at the lower protocol layers. That is, layers 1 through 3 in the NTT PRI. The higher layer compatibility is used to specify or check the higher protocol layers; typically layers 4 through 7 in the OSI model.

2.3.2 Operational requirements

The lower and higher layer compatibility services use the incoming call and call offering procedures defined in Chapter 4-4: "Layer 3 message formats". The lower layer compatibility information is encoded in the *Lower layer compatibility* information element that is carried in the *Setup* and *Connect* messages. The higher layer compatibility information is encoded in the *Higher layer compatibility* information element that is carried in the *Setup* message only.

The calling user may transfer either the lower or the higher layer compatibility information (or both) to the called user by inserting the relevant information elements in the *Setup* message as part of the basic call procedures. For lower layer compatibility, the *Connect* message may be used also.

Similarly, at the destination interface, the lower or higher layer (or both) compatibility information is offered to the called user in the *Setup* message. For lower layer compatibility, the *Connect* message may be used also.

The HLC and LLC feature is available to all users without prior arrangement or subscription between the user and the service provider.

2.3.3 Lower layer compatibility negotiation

The lower layer compatibility negotiation service allows the network to the *Lower layer compatibility* information element transparently in the *Connect* message. This allows the called and calling users to negotiate, out of band, one or more of the lower layer level attributes prior to call set up.

2.3.4 Exception conditions

The Lower and higher layer compatibility service is only available if the service provider has configured the network to permit transmission of these two information elements.

If the network is unable to transmit the *Lower level compatibility* or *Higher layer compatibility* information elements, a *Status* message containing *Cause* value #43 “Access information discarded” is returned to the user that sent the original information element.

2.4 Direct dial inward

The Direct dial inward supplementary service allows the called party number to be delivered to the called user interface. That is, on a PBX, this service allows the call to be set up directly to the terminal of the called user without intervention by an attendant.

2.4.1 Description

When the Direct dial inward supplementary service is provided, the destination local exchange delivers called party number information to the called user as part of the call set up procedures.

This service does not include the subaddress supplementary feature, though this may be combined with this service.

The number of digits delivered, the types of number, and the numbering plans that are supported are detailed in Chapter 4-4: "Layer 3 message formats".

2.4.2 Operational requirements

The Direct dial inward supplementary service uses the incoming call and call offering procedures defined in Chapter 4-4: "Layer 3 message formats". The called party number is encoded in the *Called party number* information element that is carried in the *Setup* message.

The Direct dial inward supplementary service requires prior arrangement or a subscription arrangement between the user and the service provider.

2.5 Hunt group

The hunting supplementary service is provided in the DMS-100 PRI trunk group selection mechanism.

2.5.1 Description

The hunting supplementary service allows the user to select the order that the B-channels are selected on the PRI interface.Six channel selection algorithms are available:

- Ascending sequential (ASEQ)
- Descending sequential (DSEQ)
- Clockwise circular trunk hunt (CWCTH)
- Counter clockwise circular trunk hunt (CCWCTH)
- Most idle (MIDL)
- Least idle (LIDL)

In the *ascending and descending search* sequence, the selection order and the selection starting point are fixed. In general, the administrator should set the beginning of the list on the network side as the end of the list on the user side, and to select one side to use the ascending search and the other to use the descending search.

An example of a typical setup is shown in .

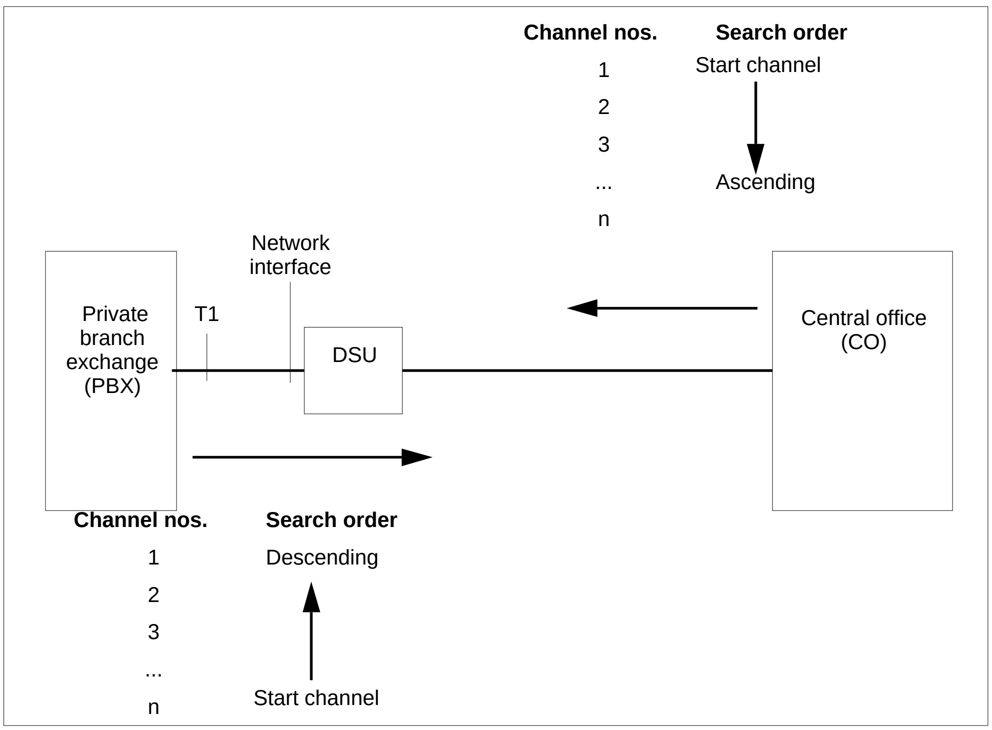
If a *circular search* sequence is selected, the B-channel is selected by referencing the previous channel that was used and then picking the next free channel that is available-either clockwise or counter-clockwise (see Figure 5-4).

Note that the trunk should be set up so that the user and network side use different direction searches so that the incidence of glare is reduced.

If a *most idle and least idle channe search* sequence is selected, the channels are selected depending on the length of time that they have been idle.. One switching group selects a channel that has been idle for the longest period of time. The opposite end selects a channel that has been idle for the shortest possible time. This ensures that the selection order of trunks is never fixed or predictable

In all cases, the search is carried out on all B-channels associated with a trunk group. Therefore, as indicated in the introduction to the specification, a total of 479 B-channels may be associated with a single D-channel. All channels associated with that D-channel form the trunk group.

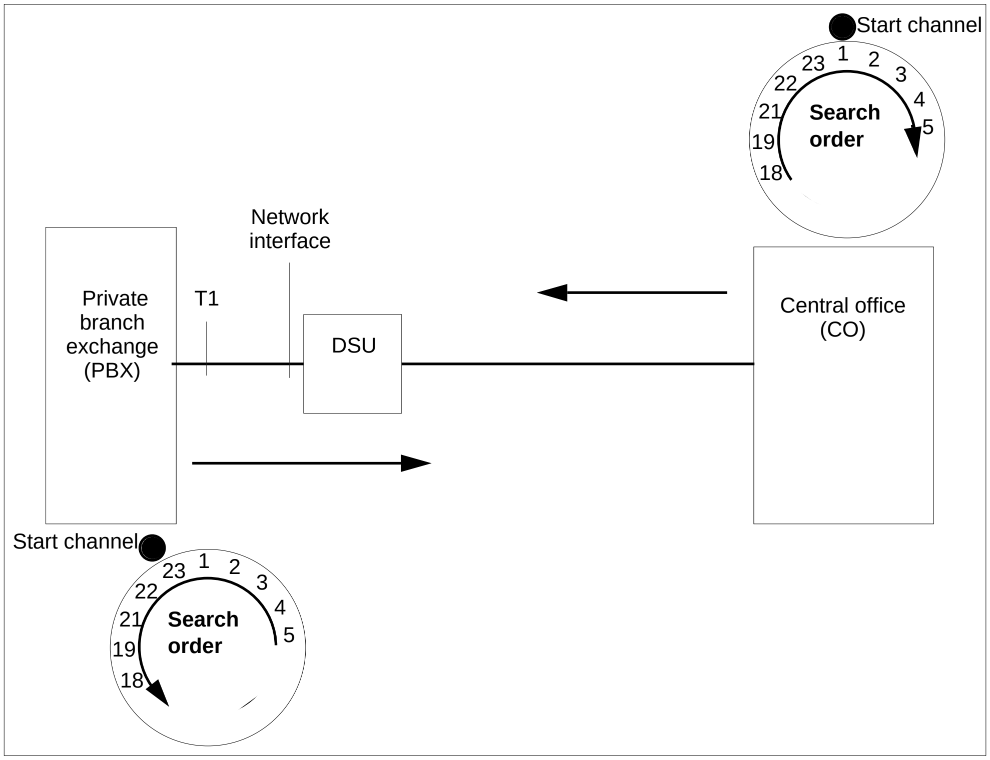
Figure 5-3
Ascending and descending hunting search



2.5.2 Operational requirements

For this supplementary service to operate efficiently, both sides of the network interface must have an agreement on the search method and the direction of search that each uses.

Figure 5-4
Circular hunting search



2.6 Multiple interface per D-channel

The multiple interface per D-channel (or non-associated signalling, as it is sometimes called) supplementary service enables a D-channel signal entity to assign calls on more than one interface (including the one containing the D-channel).

2.6.1 Description

The multiple interface per D-channel supplementary service provides support for nB + D channels on a single interface, where n is greater than 23. The number n is limited by the number of available interfaces on the DTCI. This is 20 on the DMS-100.Therefore, the maximum number of B-channels that can be supported by a single D-channel on a DMS-100 is 479. This number may be reduced in normal operation depending on the D-channel traffic capacity.

2.6.2 Operational requirements

This supplementary service requires explicit identifiers in the *Channel identification* information element as defined in Chapter 4-4: "Layer 3 message formats".

Whenever the *Channel identification* information element is used in the call procedures, an interface identifier must be included in the information element if the channel is on an interface other than the one containing the D-channel. identifier (octet 3.1).

The value of the *Interface identifier* information element is in the range 0 to 31(binary coded). The length of the *Interface identifier* information element is always 1 octet. It is assigned to the interface at subscription time. Note that although the value is in the range 0 to 31, the maximum number allowable is 20.

Section 6: INS-1500 interworking specification

Chapter 5-1: Introduction

1.1 Introduction

The ISDN primary rate interface (PRI) supplementary services described in this section are those offered by a DMS-100 switch (the network) to a PRI user such as a private branch exchange (PBX).

The supplementary services offered with this specification are as follows:

- Calling line identification presentation/restriction (including calling line subaddress)
- Called party subaddress transmission
- Low and high layer compatibility
- Direct dial inward
- Hunt group
- Multiple interface per D-channel

The services offered are in accordance with *NTT INS NET 1500 Service Interface Volume 3 Primary rate user-network interface Layer 3 specification (Rev 1 1989)*

The call contol messages and associated information elements necessary to support the supplementary services are described in Section 4 of this specification.The message formats must be supported by the protocol in order that the service can be defined.

In the following chapters in this section, the service implementation is defined; there are a number of references to the messages and information elements in Section 4 should the reader require more information on the call control procedures.

Chapter 6-2: INS 1500-to-NT PRI interworking

2.1 Interworking message flow diagrams

2.1.1 Successful call set up procedures

During call set up procedures, the following INS 1500 and NT PRI messages may be sent or received:

- *Setup*
- *Call proceeding*
- *Alerting*
- *Connect*
- *Connect acknowledge*
- *Progress*

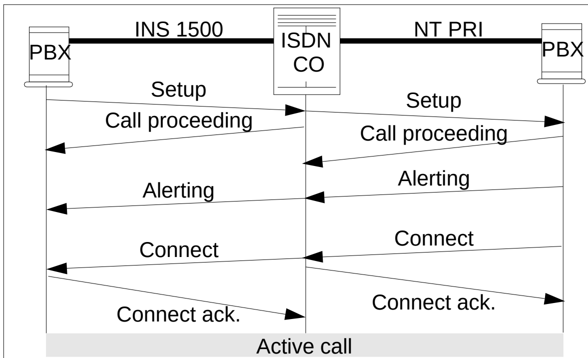
The *Call proceeding* and *Connect acknowledge* messages have local significance only. They do no impact interworking. The INS 1500 and NT PRI protocols support only enbloc sending and receiving. They do not support overlap sending and receiving. These capabilities are taken into account in the interworking between the two protocols. Figure 6-2 shows the different message flows that can occur for typical successful call setups.

Progress description numbers are included in the following diagrams. These refer to the message codes found in octet 3 of the *Progress indicator* information element (see Chapter 4-4: "Layer 3 message formats"). The coding is reproduced here for convenience.

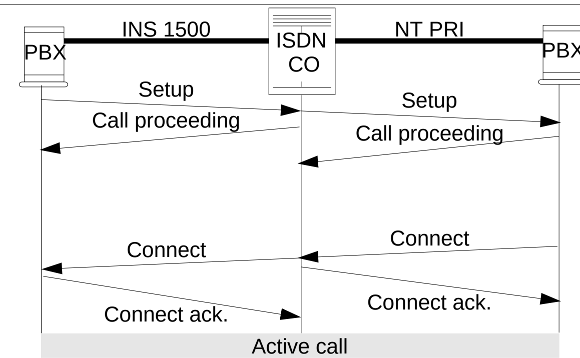
Table 6-2

7 6 5	4 3 2 1	Desc. no.	
0 0 0	0 0 0 1	1	Call is not end-to-end ISDN
0 0 0	0 0 1 0	2	Destination address is non-ISDN
0 0 0	0 0 1 1	3	Origination address is non-ISDN
0 0 0	0 1 0 0	4	Call has returned to the ISDN network
0 0 0	1 0 0 0	8	In-band information or pattern is now available

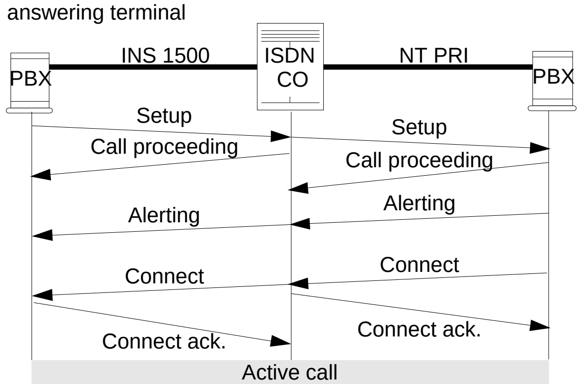
Figure 6-2
Message flow sequence diagram: Successful call setup procedures



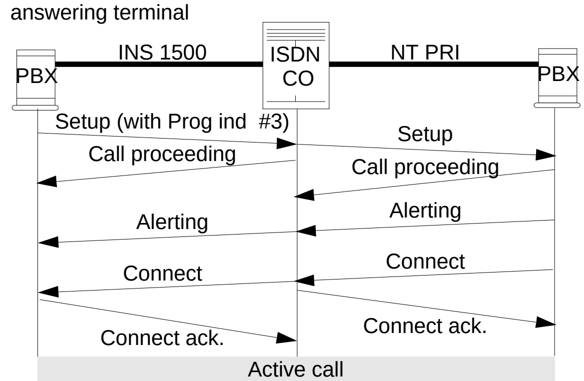
En bloc addressing signal, called party is NOT an automatic answering terminal



En bloc addressing signal, called party IS an automatic answering terminal

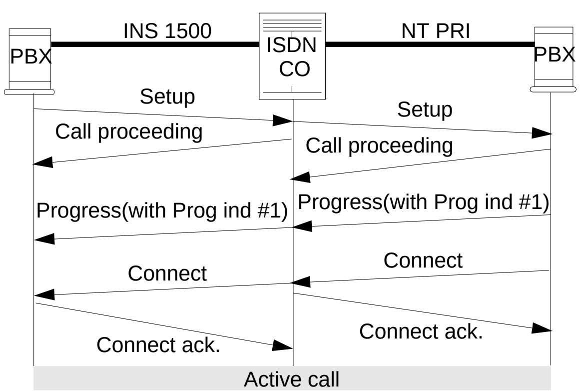


ISDN to analogue subscriber:
Non-ISDN subscriber is beyond the terminating PBX.
NT PRI does not support Progress description #2. Therefore it is not expected to be received or tandemmed from the NT PRI. When call is from NT PRI to INS 1500, *Alerting* with Progress description #2 is mapped to Progress description #8.For the INS 1500, if an *Alerting* message is received in the backwards call direction, with Progress description #2, and bearer capability indicates audio capabilities, a *Progress* message also may be sent in the backwards call direction with progress description #8.

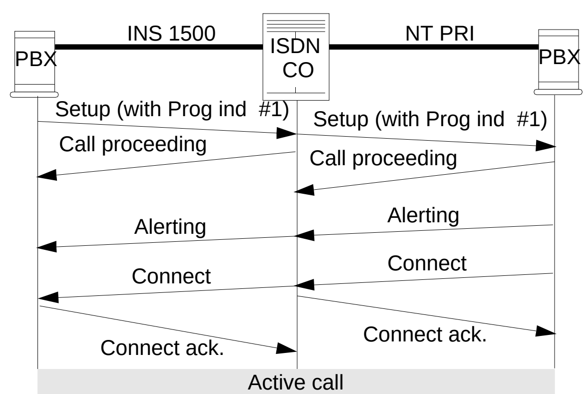


Analogue subscriber to ISDN
Non-ISDN subscriber is beyond the originating PBX.

NT PRI does not support Progress indicator #3 “Originating address is non-ISDN” in the *Setup* message.



ISDN-PSTN interworking
Non-ISDN equipment is beyond the terminating PBX.
INS 1500 does not support Progress message in the user to network direction. If call direction is NT PRI to INS 1500, no Progress message is sent in the backwards call direction.



PSTN-ISDN interworking
Non-ISDN equipment is beyond the originating PBX.
The Progress indicator is optional in the Setup message.
It may be present if interworking occurred within the PSTN.

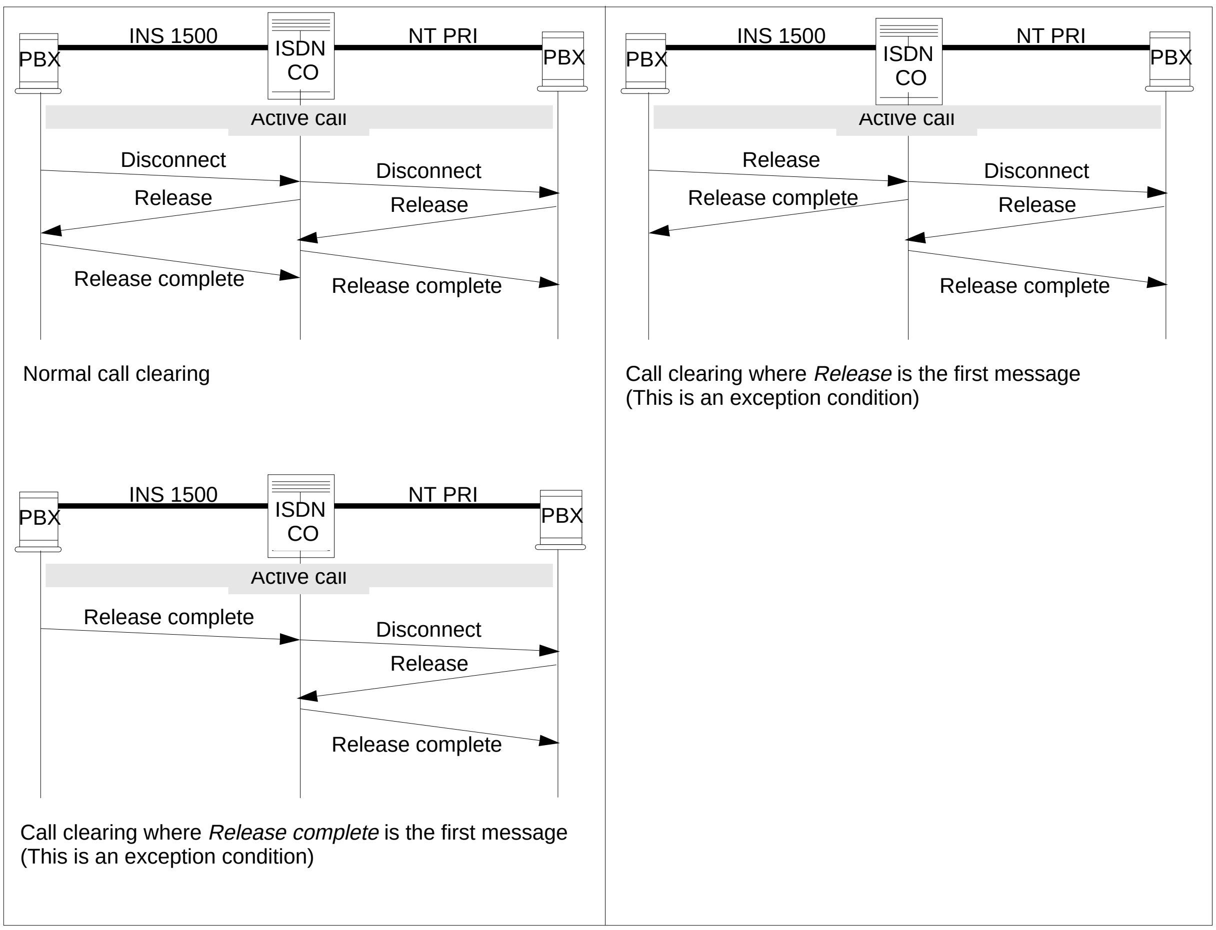
2.1.2 Call clearing procedures

During call clearing procedures, the following INS 1500 and NT PRI messages may be sent or received:

- Disconnect
- Release
- Release complete

Figure 6-3 shows the different message flows that can occur for typical call clearing procedures.

Figure 6-3
Message flow sequence diagram: Call clearing procedures



2.1.3 Unsuccessful call setup procedures

During unsuccessful call set ups, the following INS 1500 and NT PRI messages may be sent or received:

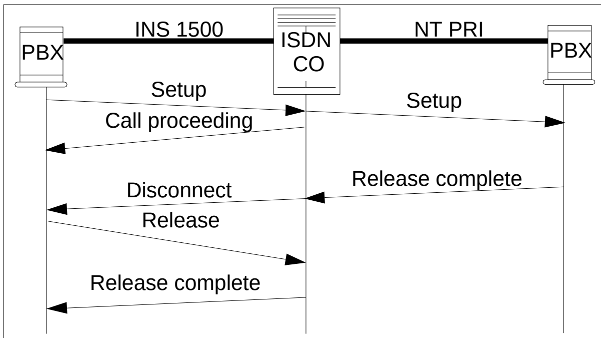
- Setup
- Call proceeding
- Alerting
- Progress
- Release
- Release complete
- Disconnect

The message *Call proceeding* has local significance only. It does not impact interworking. Figure 6-4 shows the different message flows that can occur for typical unsuccessful call set ups.Logs are generated for unsuccessful call setups only if the call is routed to treatment locally.

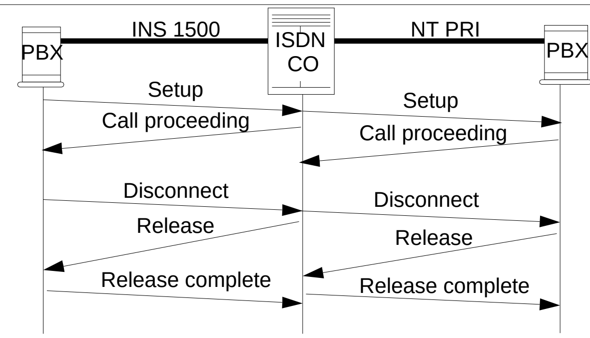
2.1.4 Active call procedures

No messages that require interworking are supported by INS 1500 or NT PRI in the active call state.

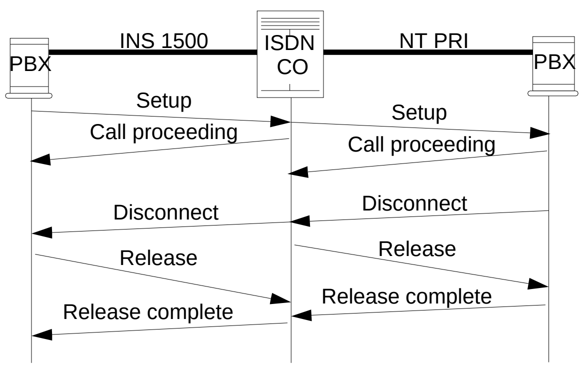
Figure 6-4
Message flow sequence diagram: Unsuccessful call setup procedures



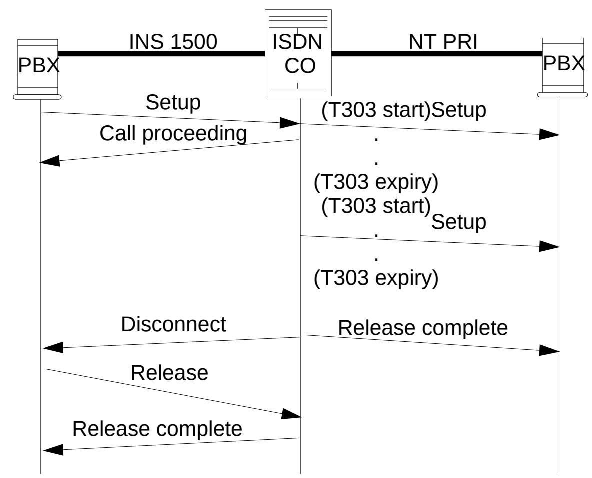
Unsuccessful call setup: NO in-band tones or announcements provided
OR
In-band tones or announcements ARE provided
OR
In-band tones or announcements time out (Originating PBX must ensure that the call is cleared when the in-band tones or annmouncements time out).



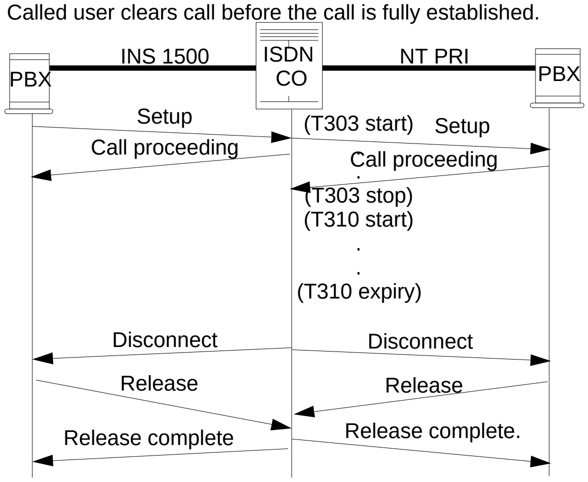
Unsuccessful call setup: Premature release
Disconnect message is received at the originating exchange before the called user responds to the call *Setup* message.



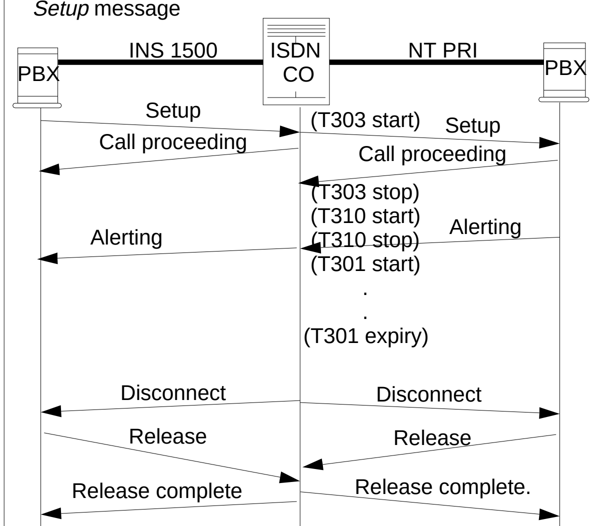
Unsuccessful call setup: Called user clears
Called user clears call before the call is fully established.



Unsuccessful call setup: Called user does not respond to *Setup* message



Unsuccessful call setup: Called user: no answer after *Call proceeding*
This shows the sequence of events where no response is received after called user sends a *Call proceeding* message.



Unsuccessful call setup: Called user alerting: no answer
This shows the sequence of events after the called user is sent an alerting message but does not respond.

2.2 Mapping at the message level

Some messages have interworking requirements when calls are being set up between networks that support INS 1500 and another network that supports NT PRI. The figures and tables in this paragraph detail the message mappings for those messages that are required to interwork between the different protocols.

The following information elements are common to both INS 1500 and NT PRI, and hence are not shown in the following mappings:

- Protocol discriminator
- Call reference
- Message type

Only the contents of the messages are shown.

2.2.1 Alerting

Table 6-3
Alerting mapping: (INS 1500 →NT PRI)

INS 1500	NT PRI	Reference
Channel identification	This information element is not processed by the interworking function. It is processed by the local exchange	
Progress indicator	Progress indicator	See 2.3.5 on page 6-30.

Table 6-4
Alerting mapping: (NT PRI →INS 1500)

NT PRI	INS 1500	Reference
Channel identification	This information element is not processed by the interworking function. It is processed by the local exchange	
Facility	This information element (IE) is not supported in the *Alerting* message for INS 1500. It is not processed by the interworking function,and is not mapped or tandemed. If received,therefore, appropiate IE exception handling is invoked. This IE is not sent by the DMS-100.	
Progress indicator	This information element (IE) is not supported in the *Alerting* message in the NT PRI implementation, or is not supported in the specified call direction in NT PRI. It is not processed by the interworking function, and is not mapped or tandemed.	

2.2.2 Connect

Table 6-5
Connect mapping: (INS 1500 →NT PRI)

INS 1500	NT PRI	Reference
Channel identification	This information element is not processed by the interworking function. It is processed by the local exchange	
Progress indicator	This information element (IE) is not supported in the *Connect* message in the NT PRI implementation, or is not supported in the specified call direction in NT PRI. It is not processed by the interworking function, and is not mapped or tandemed.	
Lower layer compatibility	This information element (IE) is not supported in the *Connect* message in the NT PRI implementation, or is not supported in the specified call direction in NT PRI. It is not processed by the interworking function, and is not mapped or tandemed.	

Table 6-6
Connect mapping: (NT PRI →INS 1500)

NT PRI	INS 1500	Reference
Channel identification	This information element is not processed by the interworking function. It is processed by the local exchange	

2.2.3 Disconnect

Table 6-7
Disconnect mapping: (INS 1500 →NT PRI)

INS 1500	NT PRI	Reference
Cause	Cause	See 2.3.4 on page 6-27.
Progress indicator	This information element (IE) is not supported in the *Disconnect* message in the NT PRI implementation, or is not supported in the specified call direction in NT PRI. It is not processed by the interworking function, and is not mapped or tandemed.	

Table 6-8
Disconnect mapping: (NT PRI →INS 1500)

NT PRI	INS 1500	Reference
Cause	Cause	See 2.3.4 on page 6-27.

2.2.4 Progress

Note: INS 1500 does not support *Progress* messages in the user-to-network direction. The table is included for completeness

Table 6-9
Progress mapping: (INS 1500 →NT PRI)

INS 1500	NT PRI	Reference
Cause	Cause	See 2.3.4 on page 6-27.
Progress indicator	Progress indicator	See 2.3.5 on page 6-30.

Table 6-10
Progress mapping: (NT PRI →INS 1500)

NT PRI	INS 1500	Reference
Cause	Cause	See 2.3.4 on page 6-27.
Progress indicator	Progress indicator	See 2.3.5 on page 6-30.

2.2.5 Release to Disconnect

Table 6-11
Release to Disconnect mapping: (INS 1500 →NT PRI)

INS 1500	NT PRI	Reference
Cause	Cause	See 2.3.4 on page 6-27.

Table 6-12
Release to Disconnect mapping: (NT PRI →INS 1500)

NT PRI	INS 1500	Reference
Cause	Cause	See 2.3.4 on page 6-27.

2.2.6 Release complete to Disconnect

Table 6-13
Release Complete to Disconnect mapping: (INS 1500 →NT PRI)

INS 1500	NT PRI	Reference
Cause	Cause	See 2.3.4 on page 6-27.

Table 6-14
Release Complete to Disconnect mapping: (NT PRI →INS 1500)

NT PRI	INS 1500	Reference
Cause	Cause	See 2.3.4 on page 6-27.

2.2.7 Setup

Table 6-15
Setup mapping: (INS 1500 →NT PRI)

INS 1500	NT PRI	Reference
Bearer capability	Bearer capability	See 2.3.1 on page 6-21.
Channel identification	This information element is not processed by the interworking function. It is processed by the local exchange	
Progress indicator	Progress indicator	See 2.3.5 on page 6-30.
Keypad facility	Called party number	See 2.3.2 on page 6-23.
Calling party number	Calling party number	See 2.3.3 on page 6-25.
Calling party subaddress	This information element (IE) is not supported in the *Setup* message in the NT PRI implementation, or is not supported in the specified call direction in NT PRI. It is not processed by the interworking function, and is not mapped or tandemed.	
Called party number	Called party number	See 2.3.2 on page 6-23.
Called party subaddress	This information element (IE) is not supported in the *Setup* message in the NT PRI implementation, or is not supported in the specified call direction in NT PRI. It is not processed by the interworking function, and is not mapped or tandemed.	
Lower layer compatibility	This information element (IE) is not supported in the *Setup*message in the NT PRI implementation, or is not supported in the specified call direction in NT PRI. It is not processed by the interworking function, and is not mapped or tandemed.	
Higher layer compatibility	This information element (IE) is not supported in the *Setup* message in the NT PRI implementation, or is not supported in the specified call direction in NT PRI. It is not processed by the interworking function, and is not mapped or tandemed.	

Table 6-16
Setup mapping: (NT PRI →INS 1500)

NT PRI	INS 1500	Reference
Bearer capability	Bearer capability	See 2.3.1 on page 6-21.
Channel identification	This information element is not processed by the interworking function. It is processed by the local exchange	
Facility	This information element (IE) is not supported in the *Setup* message for INS 1500. It is not processed by the interworking function,and is not mapped or tandemed. If received,therefore, appropiate IE exception handling is invoked. This IE is not sent by the DMS-100.	
Progress indicator	Progress indicator	See 2.3.5 on page 6-30.
Network specific facilities	This information element (IE) is not supported in the *Setup* message for INS 1500. It is not processed by the interworking function,and is not mapped or tandemed. If received,therefore, appropiate IE exception handling is invoked. This IE is not sent by the DMS-100.	
Calling party number	Calling party number	See 2.3.3 on page 6-25.
Called party number	Called party number	See 2.3.2 on page 6-23.
Original called number	This information element (IE) is not supported in the *Setup* message for INS 1500. It is not processed by the interworking function,and is not mapped or tandemed. If received,therefore, appropiate IE exception handling is invoked. This IE is not sent by the DMS-100.	
Transit network selection	This information element (IE) is not supported in the *Setup* message for INS 1500. It is not processed by the interworking function,and is not mapped or tandemed. If received,therefore, appropiate IE exception handling is invoked. This IE is not sent by the DMS-100.	

2.3 Mapping at the parameter and bit level

The following tables detail the mapping between the INS 1500 and NT PRI protocols at the bit level within the messages.

2.3.1 Bearer capability

Table 6-17
Bearer capability mapping: (INS 1500 →NT PRI)

INS 1500	**NT PRI**
Coding standard, octet 3 `00` CCITT standard	Coding standard, octet 3 `00` CCITT standard
Information transfer capability, octet 3 `00000` speech `01000` unrestricted digital information `10000` 3.1 kHz audio	Information transfer capability, octet 3 `00000` speech `01000` unrestricted digital information `10000` 3.1 kHz audio
Transfer mode, octet 4 `00` circuit mode	Transfer mode, octet 4 `00` circuit mode
Information transfer rate, octet 4 `10000` 64 kbit/s	Information transfer rate, octet 4 `10000` 64 kbit/s
Layer 1 identification, octet 5 `01` Layer 1 identifier	Layer 1 identification, octet 5 `01` Layer 1 identifier
Layer 1 protocol , octet 5 `00001` Rate adaption `00010` Recommendation G.711µ law	Layer 1 protocol , octet 5 `00001` Rate adaption `00010` Recommendation G.711µ law
Access data rate , octet 5a `01111` 56 kbit/s	Access data rate , octet 5a `01111` 56 kbit/s
Octets 6, 7 are not mapped	

Table 6-18
Bearer capability mapping: (NT PRI →INS 1500)

NT PRI	**INS 1500**
Coding standard, octet 3 00 CCITT standard	Coding standard, octet 3 00 CCITT standard
Information transfer capability, octet 3 00000 speech 01000 unrestricted digital information 01001 restricted digital information 10000 3.1 kHz audio	Information transfer capability, octet 3 00000 speech 01000 unrestricted digital information Call is cleared 10000 3.1 kHz audio
Transfer mode, octet 4 00 circuit mode	Transfer mode, octet 4 00 circuit mode
Information transfer rate, octet 4 10000 64 kbit/s	Information transfer rate, octet 4 10000 64 kbit/s
Octets 4a and 4b are not mapped.	
Layer 1 identification, octet 5 01 Layer 1 identifier	Layer 1 identification, octet 5 01 Layer 1 identifier
Layer 1 protocol , octet 5 00001 Rate adaption 00010 Recommendation G.711µ law	Layer 1 protocol , octet 5 00001 Rate adaption 00010 Recommendation G.711µ law
Access data rate , octet 5a 01111 56 kbit/s	Access data rate , octet 5a 01111 56 kbit/s

2.3.2 Called party number

Table 6-19
Called party number mapping: (INS 1500 →NT PRI)

INS 1500	NT PRI
Type of number, octet 3 000 unknown	Type of number, octet 3 This value is generated by the translation operation
Numbering plan identification, octet 3 0000 unknown	Numbering plan identification, octet 3 This value is generated by the translation operation
Number digit coding, octet 4 ... n 011 0000 digit 0 011 0001 digit 1 011 0010 digit 2 011 0011 digit 3 011 0100 digit 4 011 0101 digit 5 011 0110 digit 6 011 0111 digit 7 011 1000 digit 8 011 1001 digit 9	Number digit coding, octet 4 ... n 011 0000 digit 0 011 0001 digit 1 011 0010 digit 2 011 0011 digit 3 011 0100 digit 4 011 0101 digit 5 011 0110 digit 6 011 0111 digit 7 011 1000 digit 8 011 1001 digit 9
Note: The number digits presented may be changed as a result of translations in the network.	

Table 6-20
Called party number mapping: (NT PRI →INS 1500)

NT PRI	INS 1500
Type of number, octet 3 000 unknown 001 international number 010 national number 100 subscriber number	Type of number, octet 3 000 unknown 000 unknown 000 unknown 000 unknown
Numbering plan identification, octet 3 0001 E.164/E.163 1001 Private numbering plan	Numbering plan identification, octet 3 0000 unknown 0000 unknown
Number digit coding, octet 4 ... n 011 0000 digit 0 011 0001 digit 1 011 0010 digit 2 011 0011 digit 3 011 0100 digit 4 011 0101 digit 5 011 0110 digit 6 011 0111 digit 7 011 1000 digit 8 011 1001 digit 9	Number digit coding, octet 4 ... n 011 0000 digit 0 011 0001 digit 1 011 0010 digit 2 011 0011 digit 3 011 0100 digit 4 011 0101 digit 5 011 0110 digit 6 011 0111 digit 7 011 1000 digit 8 011 1001 digit 9
Note: The number digits presented may be changed as a result of translations in the network.	

2.3.3 Calling party number

Table 6-21
Calling party number mapping: (INS 1500 →NT PRI)

INS 1500	**NT PRI**
Type of number, octet 3 000 unknown	Type of number, octet 3 This value is generated by the translation operation
Numbering plan identification, octet 3 0000 unknown	Numbering plan identification, octet 3 0000 unknown
Presentation indicator, octet 3a 00 presentation allowed 01 presentaion restricted 10 number not available	Presentation indicator, octet 3a Code point selected depends on subscription parameters
Screening indicator, octet 3a 01 user provided, verified and passed 11 network provided	Screening indicator, octet 3a Code point selected depends on subscription parameters
Number digit coding, octet 4 ... n 011 0000 digit 0 011 0001 digit 1 011 0010 digit 2 011 0011 digit 3 011 0100 digit 4 011 0101 digit 5 011 0110 digit 6 011 0111 digit 7 011 1000 digit 8 011 1001 digit 9	Number digit coding, octet 4 ... n 011 0000 digit 0 011 0001 digit 1 011 0010 digit 2 011 0011 digit 3 011 0100 digit 4 011 0101 digit 5 011 0110 digit 6 011 0111 digit 7 011 1000 digit 8 011 1001 digit 9
Note: The number digits presented may be changed as a result of translations in the network.	

Table 6-22
Calling party number mapping: (NT PRI →INS 1500)

NT PRI	INS 1500
Type of number, octet 3 000 unknown 001 international number 010 national number 100 subscriber number	Type of number, octet 3 000 unknown 000 unknown 000 unknown 000 unknown
Numbering plan identification, octet 3 0001 E.164/E.163 1001 Private numbering plan	Numbering plan identification, octet 3 0000 unknown 0000 unknown
Presentation indicator, octet 3a 00 presentation allowed 01 presentaion restricted 10 number not available	Presentation indicator, octet 3a Code point selected depends on the *Calling line presentation service,* refer to Chapter 5-2: "Supplementary services"
Screening indicator, octet 3a 00 user provided, not screened 01 user provided, verified and passed 10 user provided, verified and failed 11 network provided	Screening indicator, octet 3a Code point selected depends on the *Calling line presentation service,* refer to Chapter 5-2: "Supplementary services"
Number digit coding, octet 4 ... n 011 0000 digit 0 011 0001 digit 1 011 0010 digit 2 011 0011 digit 3 011 0100 digit 4 011 0101 digit 5 011 0110 digit 6 011 0111 digit 7 011 1000 digit 8 011 1001 digit 9	Number digit coding, octet 4 ... n 011 0000 digit 0 011 0001 digit 1 011 0010 digit 2 011 0011 digit 3 011 0100 digit 4 011 0101 digit 5 011 0110 digit 6 011 0111 digit 7 011 1000 digit 8 011 1001 digit 9
Note: The number digits presented may be changed as a result of translations in the network.	

2.3.4 Cause

The *Cause* values do not all map directly. The *Cause* value generated is dependent on the specific call clearing scenario.

Table 6-23
Cause mapping: (INS 1500 →NT PRI)

INS 1500	NT PRI
Coding standard, octet 3 00 CCITT standard	Type of number, octet 3 This value is generated by the translation operation
Location, octet 3 0000 user 0001 private network serving local user 0010 public network serving local user 0011 transit network 0100 public network serving remote user 0101 private network serving remote user 0111 international network 1010 network beyond interworking point	Location, octet 3 0000 user 0001 private network serving local user 0010 public network serving local user 0011 transit network 0100 public network serving remote user 0101 private network serving remote user 0111 international network 0011 transit network
Recommendation, octet 3a is not mapped	
Cause value, octet 4 Class Number Value 000 0001 1 000 0010 2 000 0011 3 000 0110 6 000 0111 7 001 0000 16 001 0001 17 001 0010 18 001 0011 19 001 0101 21 001 0110 22 001 1010 26 001 1011 27 001 1100 28 001 1101 29 001 1110 30 001 1111 31 010 0010 34 010 0110 38 010 1001 41 010 1010 42 010 1011 43 010 1100 44 010 1111 47	Cause value, octet 4 Class Number Value 000 0001 1 000 0010 2 000 0011 3 010 1001 41 Unsupported: INS 1500 is point-to-point only 001 0000 16 001 0001 17 001 0010 18 001 0011 19 001 0101 21 001 0110 22 Unsupported: INS 1500 is point-to-point only 001 1011 27 001 1100 28 Unsupported: INS 1500 does not support Facility Local significance only, Cause IE not tandemed 001 1111 31 010 0010 34 010 0110 38 010 1001 41 010 1010 42 010 1011 43 010 1100 44 010 1111 47

Table 6-23
Cause mapping: (INS 1500 →NT PRI) (Continued)

INS 1500	NT PRI
Cause value, octet 4 Class Number Value 011 0010 50 011 1001 57 011 1010 58 011 1111 63 100 0001 65 100 0010 66 100 0110 70 100 1111 79 101 0001 81 101 0010 82 101 1000 88 101 1011 91 101 1111 95 110 0000 96 110 0001 97 110 0010 98 110 0011 99 110 0100 100 110 0101 101 110 0110 102 110 1111 111 111 1111 127	Cause value, octet 4 Class Number Value Unsupported: INS 1500 does not support Facility 011 1001 57 011 1010 58 011 1111 63 100 0001 65 100 0010 66 100 0110 70 100 1111 79 Local significance only, Cause IE not tandemed Local significance only, Cause IE not tandemed 101 1000 88 Unsupported: INS 1500 does not support TNS Local significance only, Cause IE not tandemed Local significance only, Cause IE not tandemed Local significance only, Cause IE not tandemed Local significance only, Cause IE not tandemed Local significance only, Cause IE not tandemed Local significance only, Cause IE not tandemed Local significance only, Cause IE not tandemed Local significance only, Cause IE not tandemed Local significance only, Cause IE not tandemed 111 1111 127

Table 6-24
Cause mapping: (NT PRI →INS 1500)

NT PRI	INS 1500
Coding standard, octet 3 00 CCITT standard	Type of number, octet 3 00 CCITT standard
Location, octet 3 0000 user 0001 private network serving local user 0010 public network serving local user 0011 transit network 0100 public network serving remote user 0101 private network serving remote user 0111 international network	Location, octet 3 0000 user 0001 private network serving local user 0010 public network serving local user 0011 transit network 0100 public network serving remote user 0101 private network serving remote user 0111 international network
Recommendation, octet 3a is not mapped	

Table 6-24
Cause mapping: (NT PRI →INS 1500) (Continued)

NT PRI	INS 1500
Cause value, octet 4 Class Number Value 000 0001 1 000 0010 2	Cause value, octet 4 Class Number Value 000 0001 1 000 0010 2
Cause value, octet 4 Class Number Value	Cause value, octet 4 Class Number Value
000 0011 3	000 0011 3
000 0110 6	010 1001 6
001 0000 16	001 0000 16
001 0001 17	001 0001 17
001 0010 18	001 0010 18
001 0011 19	001 0011 19
001 0101 21	001 0101 21
001 0110 22	001 0110 22
001 1011 27	001 1011 27
001 1100 28	001 1100 28
001 1101 29	Unsupported: INS 1500 does not support Facility
001 1110 30	Local significance only, Cause IE not tandemed
001 1111 31	001 1111 31
010 0010 34	010 0010 34
010 1001 41	010 1001 41
010 1010 42	010 1010 42
010 1011 43	010 1011 43
010 1100 44	010 1100 44
010 1111 47	010 1111 47
011 0010 50	Unsupported: INS 1500 does not support Facility
011 1001 57	011 1001 57
011 1010 58	011 1010 58
011 1111 63	011 1111 63
100 0001 65	100 0001 65
100 0010 66	100 0010 66
100 0110 70	100 0110 70
100 1111 79	100 1111 79
101 0001 81	Local significance only, Cause IE not tandemed
101 0010 82	Local significance only, Cause IE not tandemed
101 1000 88	101 1000 88
101 1111 95	Local significance only, Cause IE not tandemed
110 0000 96	Local significance only, Cause IE not tandemed
110 0001 97	Local significance only, Cause IE not tandemed
110 0010 98	Local significance only, Cause IE not tandemed
110 0011 99	Local significance only, Cause IE not tandemed
110 0100 100	Local significance only, Cause IE not tandemed
110 0101 101	Local significance only, Cause IE not tandemed
110 0110 102	Local significance only, Cause IE not tandemed
110 1111 111	Local significance only, Cause IE not tandemed
111 1111 127	111 1111 127

2.3.5 Progress indicator

Table 6-25
Progress indicator mapping: (INS 1500 →NT PRI)

INS 1500	NT PRI
Coding standard, octet 3 00 CCITT standard	Type of number, octet 3 00 CCITT standard
Location, octet 3 0000 user 0001 private network serving local user 0010 public network serving local user 0100 public network serving remote user 0101 private network serving remote user 1010 network beyond interworking point	Location, octet 3 0000 user 0001 private network serving local user 0010 public network serving local user 0100 public network serving remote user 0101 private network serving remote user 0011 transit network
Progress descriptor, octet 4 000 0001 Call is not end-to-end ISDN	Progress descriptor, octet 4 000 1000 In-band info or pattern is now available
000 0010 Destination address is non-ISDN	Progress ind IE is not tandemed. NT PRI does not support corresponding code points.
000 0011 Origination address is non-ISDN	Progress ind IE is not tandemed. NT PRI does not support corresponding code points.
000 0100 Call has returned to ISDN network	INS 1500 does not support Progress message in user-to-network direction. This code point exists in Progress indicator IE within Progress message.
000 1000 In-band info or pattern is now available	INS 1500 does not support Progress message in user-to-network direction. This code point exists in Progress indicator IE within Progress message.

Table 6-26
Progress indicator mapping: (NT PRI →INS 1500)

NT PRI	INS 1500
Coding standard, octet 3 00 CCITT standard	Type of number, octet 3 00 CCITT standard
Location, octet 3 0000 user 0001 private network serving local user 0010 public network serving local user 0011 transit network 0100 public network serving remote user 0101 private network serving remote user	Location, octet 3 0000 user 0001 private network serving local user 0010 public network serving local user 1010 network beyond interworking point 0100 public network serving remote user 0101 private network serving remote user

Table 6-26
Progress indicator mapping: (NT PRI →INS 1500) (Continued)

Progress descriptor, octet 4 `000 0001` Call is not end-to-end ISDN `000 1000` In-band info or pattern is now available	Progress descriptor, octet 4 `000 0001` Call is not end-to-end ISDN `000 1000` In-band info or pattern is now available

Chapter 6-3:
INS 1500-to-ANSI7+ ISUP interworking

ANSI7+ ISUP is a standardized protocol within the general CCS7-type protocols. ANSI7+ ISUP is a subset of the CCS7 protocol. Other forms of these protocols may be supported in the future.

3.1 Interworking message flow diagrams

3.1.1 Successful call set up procedures

During call set up procedures, the following INS 1500 messages may be sent or received:

- *Setup*
- *Call proceeding*
- *Alerting*
- *Connect*
- *Connect acknowledge*
- *Progress*

At the same time the following ANSI-ISUP messages may be sent or received:

- *Initial address message (IAM)*
- *Address complete message (ACM)*
- *Call progress message (CPG)*
- *Answer message (ANM)*

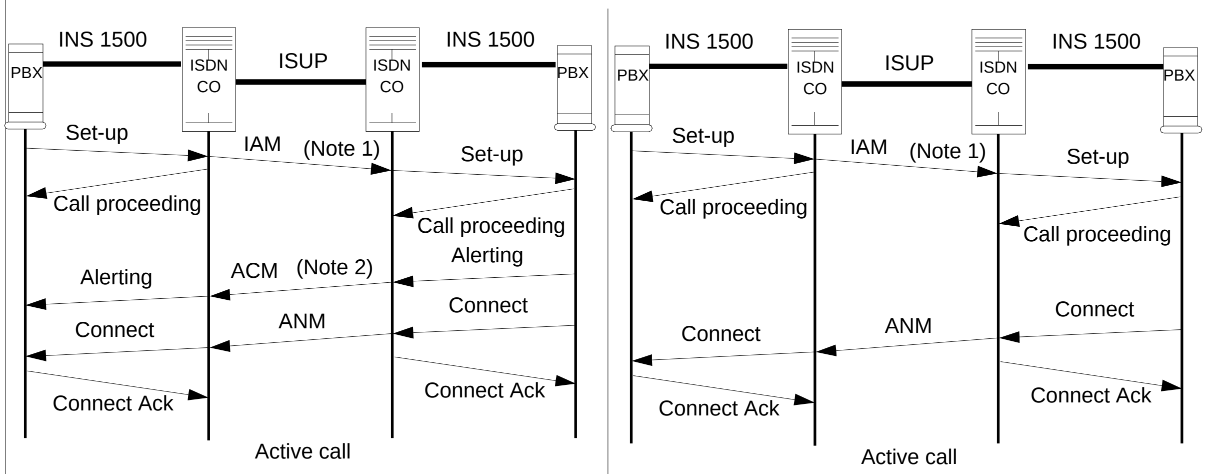
The INS 1500 messages *Call proceeding* and *Connect acknowledge* have local significance only. They do no impact interworking. The INS 1500 protocol supports only enbloc sending and receiving of called party digits. It does not support overlap sending or receiving. For enbloc sending, all digit infiormation needed to route a call to its destination is contained in one messsage.

Figure 6-7 and Figure 6-7 show the different message flows that can occur for typical successful call set ups.

Progress description numbers are included in the following diagrams. These refer to the message codes found in octet 3 of the *Progress indicator* information element (see Chapter 4-4: "Layer 3 message formats"). The coding is reproduced here for convenience.

7 6 5	4 3 2 1	Desc. no.	
0 0 0	0 0 0 1	1	Call is not end-to-end ISDN
0 0 0	0 0 1 0	2	Destination address is non-ISDN
0 0 0	0 0 1 1	3	Origination address is non-ISDN
0 0 0	0 1 0 0	4	Call has returned to the ISDN network
0 0 0	1 0 0 0	8	In-band information or pattern is now available

Figure 6-5
Message flow sequence diagram: Successful call setup procedures



En bloc addressing signal, called party is NOT an automatic answering terminal

Note 1: Forward call indicators:
Bit D = 0, no interworking encountered
Bit F = 1, ISUP used all the way
Bit I = 1, originating access is ISDN

Note 2: Backward call indicators:
Bit I = 0, no interworking encountered
Bit K = 1**,** ISUP used all the way
Bit M = 1, terminating access is ISDN

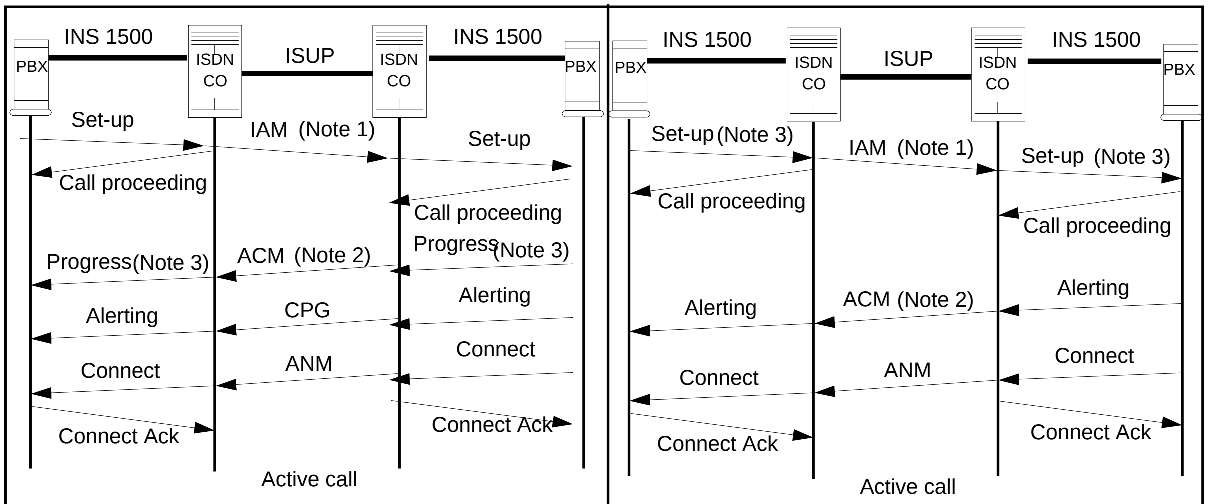
En bloc addressing signal, called party IS an automatic answering terminal

Note 1: Forward call indicators:
Bit D = 0, no interworking encountered
Bit F = 1, ISUP used all the way
Bit I = 1, originating access is ISDN

Note 2: Backward call indicators:
Bit I = 0, no interworking encountered
Bit K = 1, ISUP used all the way
Bit M = 1, terminating access is ISDN
Bit BA = 10, charge
Bit DC = 01, subscriber free
Bit FE = 01, ordinary subscriber

In this case,the *Address complete* and *Connect indication* are combined in the *Answer* message in the networ**k.**

Figure 6-6
Message flow sequence diagram: Successful call setup procedure (continued)



ISDN-PSTN interworking
Interworking has occurred within the PSTN. Call originates in the ISDN. The non-ISDN equipment is beyond the terminating PBX. INS 1500 does not support *Progress* message in the user-to-network direction. Hence in the backwards call direction, there will be no *Progress* message.

Note 1: Forward call indicators:
Bit D = 0, no interworking encountered
Bit F = 1, ISUP used all the way
Bit I = 1, originating access is ISDN

Note 2: Backward call indicators:
Bit I = 1, interworking encountered
Bit K = 1, ISUP used all the way
Bit M = 1, terminating access is ISDN

Note 3: *Progress* indicator, progress description = 1, “Call is not end-to-end ISDN.

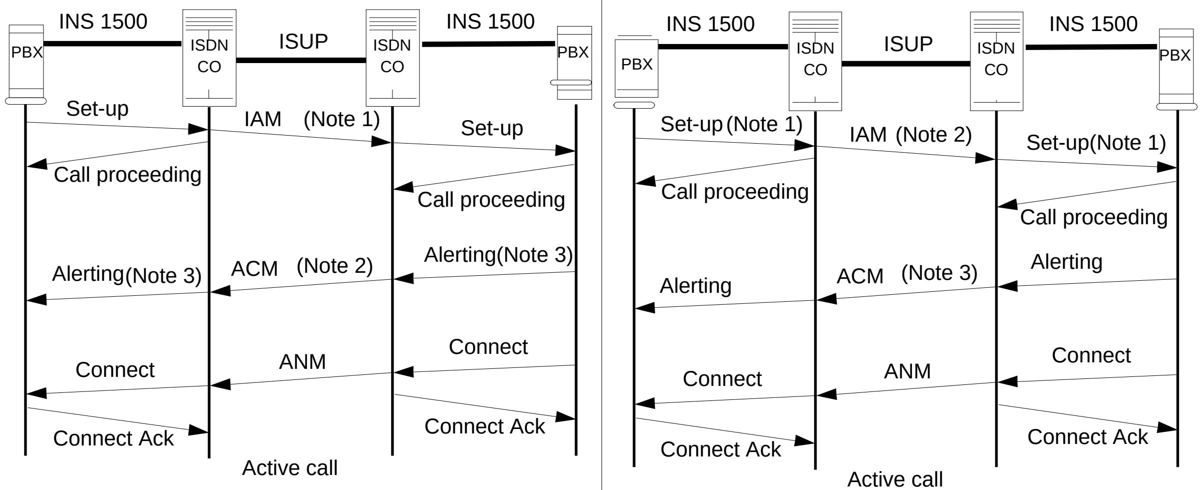
PSTN-ISDN interworking
Call originates in the PSTN. The non-ISDN equipment is beyond the originating PBX. The *Progress indicator* information element is optional in the *Setup* message. It may be present if interworking occurred within the PSTN.

Note 1: Forward call indicators:
Bit D = 1, interworking encountered
Bit F = 1, ISUP used all the way
Bit I = 1, originating access is ISDN

Note 2: Backward call indicators:
Bit I = 0, no interworking encountered
Bit K = 1, ISUP used all the way
Bit M = 1, terminating access is ISDN

Note 3: *Progress* indicator, progress description = 1, “Call is not end-to-end ISDN.

Figure 6-7
Message flow sequence diagram: Successful call setup procedures (end)



ISDN to analogue subscriber:
Call is from an ISDN subscriber to an analogue subscriber; both subscribers are beyond the PBX shown in the diagram.

Note 1: Forward call indicators:
Bit D = 0, no interworking encountered
Bit F = 1, ISUP used all the way
Bit I = 1, originating access is ISDN

Note 2: Backward call indicators:
Bit I = 0, no interworking encountered
Bit K = 1**,** ISUP used all the way
Bit M = 0, terminating access is non-ISDN

Note 3: Progress indicator, progress description 2, “Destination address is non-ISDN”

Analogue subscriber to ISDN:
Call is from an analogue subscriber to an ISDN subscriber; both subscribers are beyond the PBX shown in the diagram.

Note 1: Progress indicator, progress description 3, “Originating address is non-ISDN”

Note 2: Forward call indicators:
Bit D = 0, no interworking encountered
Bit F = 1, ISUP used all the way
Bit I = 0, originating access is non-ISDN

Note 3: Backward call indicators:
Bit I = 0, no interworking encountered
Bit K = 1**,** ISUP used all the way
Bit M = 1, terminating access is ISDN

Note 4: Progress indicator, progress description 2, “Destination address is non-ISDN”

3.1.2 Call clearing procedures

During call clearing procedures, the following messages may be sent or received:

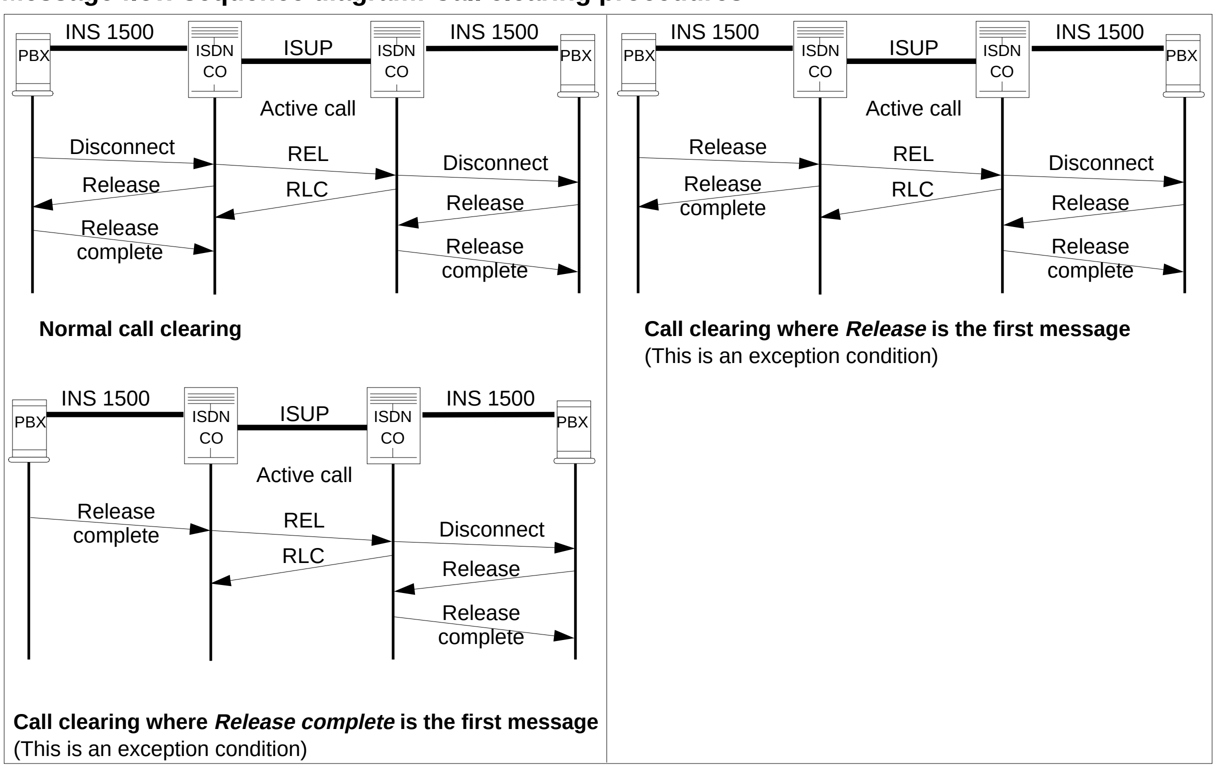
- INS 1500
  - *Disconnect*
  - *Release*
  - *Release complete*
- ANSI7+ ISUP
  - *Release (REL)*
  - *Release complete (RLC)*

The ANSI7+ ISUP *Release complete (RLC)* message has local significance only. No interworking is required for this message.

For all call clearing procedures, the first INS 1500 call clearing message is mapped to an ANSI7+ ISUP *Release* message

Figure 6-8 shows the different message flows that can occur for typical call clearing procedures.

Figure 6-8
Message flow sequence diagram: Call clearing procedures



3.1.3 Unsuccessful call setup procedures

During unsuccessful call set ups, the following messages may be sent or received:

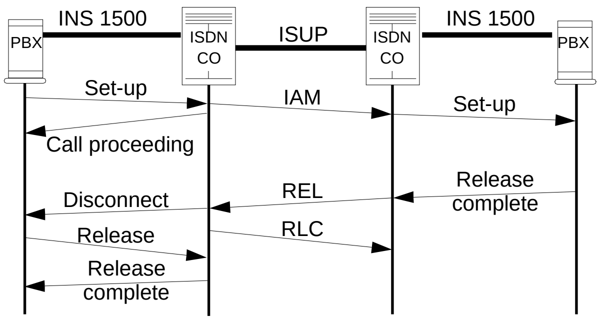
- INS 1500
  - *Setup*
  - *Call proceeding*
  - *Alerting*
  - *Progress*
  - *Disconect*
  - *Release*
  - *Release complete*
- ANSI7+ ISUP
  - *Initial address (IAM)*
  - *Address complete (ACM)*
  - *Release (REL)*
  - *Release complete (RLC)*
  - *Call progress (CPG)*

The messages *Call proceeding* and *Connect acknowledgement* have local significance only. They do not impact interworking. Figure 6-9 and Figure 6-10 show the different message flows that can occur for typical unsuccessful call set ups. Logs are generated for unsuccessful call setups only if the call is routed to treatment locally.

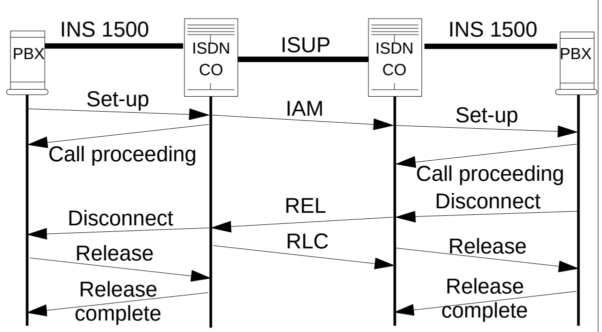
3.1.4 Active call procedures

No messages that require interworking are supported by INS 1500 or ANSI7+ ISUP in the active call state.

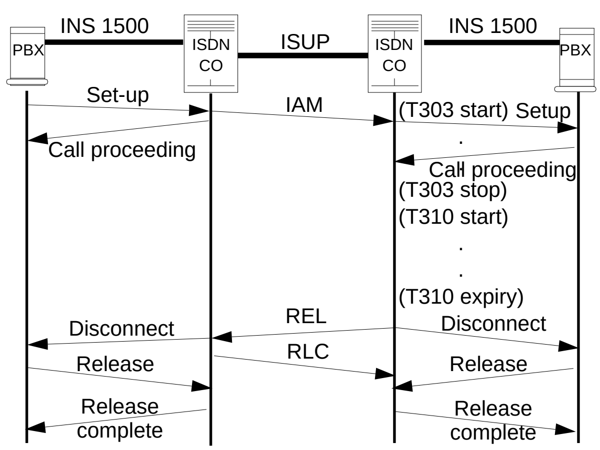
Figure 6-9
Message flow sequence -diagram: Unsuccessful call setup procedures



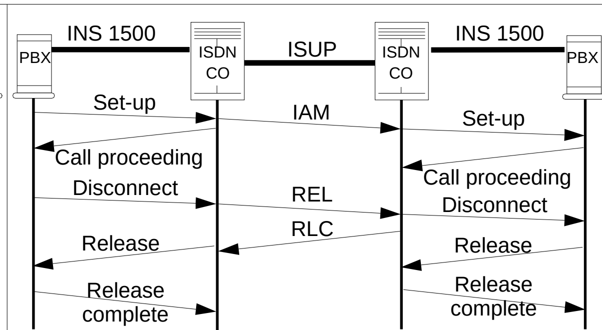
Unsuccessful call setup: NO in-band tones or announcements provided
OR
In-band tones or announcements ARE provided
OR
In-band tones or announcements time out (Originating PBX must ensure that the call is cleared when the in-band tones or announcements time out)**.**



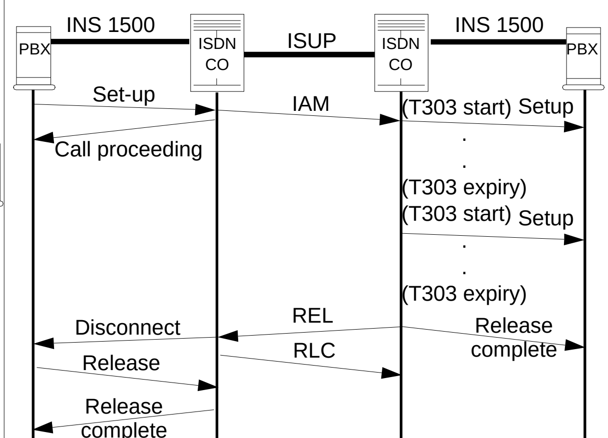
Unsuccessful call setup: Called user clears
Called user clears call before the call is fully established.



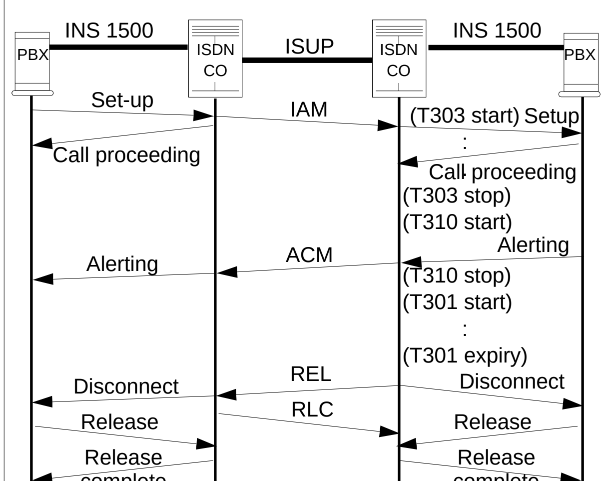
Unsuccessful call setup: Called user: no answer after *Call proceeding*
This shows the sequence of events where no response is received after called user sends a *Call proceeding* message.



Unsuccessful call setup: Premature release
Disconnect message is received at the originating exchange before the called user responds to the call *Setup* message.

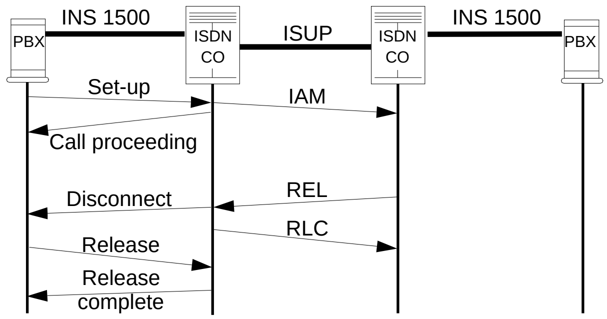


Unsuccessful call setup: Called user does not respond to a retransmitted *Setup* message



Unsuccessful call setup: Called user: no answer after *Alerting.*
This shows the sequence of events where no response is received after called user sends an*Alerting* message.

Figure 6-10
Message flow sequence diagram: Unsuccessful call setup procedures-continued



Unsuccessful call setup: Terminating exchange cannot continue call due to congestion

3.2 Mapping at the message level

Some messages have interworking requirements when calls are being set up between networks that support INS 1500 and another network that supports ANSI7+ ISUP. The tables in this paragraph detail the message mappings for those messages that are required to interwork between the different protocols.

The INS 1500 *Protocol discriminator* and *Call reference* information elements do not map to ANSI7+ ISUP fields and are not shown. Only the mappings of the contents of the messages are shown.

3.2.1 Alerting and Address complete message (ACM)

Table 6-27
Alerting to ACM mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP	Reference
Channel identification	This information element is not processed by the interworking function.	
Progress indicator	Backwards call indicator	See 3.3.6 on page 6-63.

Table 6-28
ACM to Alerting mapping: (ANSI7+ ISUP →INS 1500)

ANSI7+ ISUP	INS 1500	Reference
Backwards call indicator	Progress indicator	See 3.3.6 on page 6-63.
Access transport	This *Access transport* parameter (ATP) is ignored.	
Cause indicator	No mapping	
Connection request	No mapping	
Optional backwards call indicator	No mapping	

3.2.2 Alerting and Call progress message (CPG)

Table 6-29
Alerting to ACM mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP	Reference
Channel identification	This information element is not processed by the interworking function.	
Progress indicator	Backwards call indicator	See 3.3.6 on page 6-63.
Progress indicator	Event information	See 3.3.7 on page 6-64.

Table 6-30
ACM to Alerting mapping: (ANSI7+ ISUP →INS 1500)

ANSI7+ ISUP	INS 1500	Reference
Access transport	This *Access transport* parameter (ATP) is ignored.	
Backwards call indicator	Progress indicator	See 3.3.6 on page 6-63.
Cause indicator	No mapping	
Event information	Progress indicator	See 3.3.7 on page 6-64.
Optional backwards call indicator	No mapping	
Redirection number	No mapping	

3.2.3 Connect and Answer message (ANM)

Table 6-31
Connect to ANM mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP	Reference
Channel identification	This information element is not processed by the interworking function.	
Progress indicator	Access transport	
Lower layer compatibility	Access transport	

Table 6-32
Connect mapping: (ANSI7+ ISUP →INS 1500)

ANSI7+ ISUP	INS 1500	Reference
Backward call indicator	No mapping	
Access transport	Access transport parameter (ATP) may contain the *Lower layer compatibility* and the *Progress indicator* information. This is inserted in the *Setup* message in accordance with the INS 1500 encoding rules.	
Connected number	No mapping	
Connection request	No mapping	

3.2.4 Disconnect and Release message (REL)

Table 6-33
Disconnect to REL mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP	Reference
Cause	Cause indicators	See 3.3.4 on page 6-56.
Progress indicator	This information element (IE) is not supported in the user-to-network call direction. It is not tandemed.	

Table 6-34
REL to Disconnect mapping: (ANSI7+ ISUP →INS 1500)

ANSI7+ ISUP	INS 1500	Reference
Cause indicator	Cause	See 3.3.4 on page 6-56.
Access transport	The Access transport parameter (ATP) is ignored.	
Closed user group	No mapping	

3.2.5 Progress and Call progress message (CPG)

Note: INS 1500 does not support *Progress* messages in the user-to-network direction. The table is included for completeness

Table 6-35
Progress to CPG mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP	Reference
Cause	No mapping	
Progress indicator	Backward call indicator	See 3.3.6 on page 6-63.
Progress indicator	Event information	See 3.3.7 on page 6-64.

Table 6-36
CPG to Progress mapping: (ANSI7+ ISUP →INS 1500)

ANSI7+ ISUP	INS 1500	Reference
Event information	Progress indicator	See 3.3.7 on page 6-64.
Access transport	The Access transport parameter (ATP) is ignored.	
Backward call indicator	Progress indicator	See 3.3.6 on page 6-63.
Cause indicator	No mapping	
Optional backward call indicator	No mapping	
Redirection number	No mapping	

3.2.6 Progress and Address complete message (ACM)

Note: INS 1500 does not support *Progress* messages in the user-to-network direction. The table is included for completeness

Table 6-37
Progress to ACM mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP	Reference
Cause	No mapping	
Progress indicator	Backward call indicator	See 3.3.6 on page 6-63.

Table 6-38
ACM to Progress mapping: (ANSI7+ ISUP →INS 1500)

ANSI7+ ISUP	INS 1500	Reference
Access transport	The Access transport parameter (ATP) is ignored.	
Backward call indicator	Progress indicator	See 3.3.6 on page 6-63.
Cause indicator	No mapping	
Connection request	No mapping	
Optional backward call indicator	No mapping	

3.2.7 Release and Release message (REL)

Table 6-39
Release to REL mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP	Reference
Cause	Cause indicators	See 3.3.4 on page 6-56.

3.2.8 Release complete and Release message (REL)

Table 6-40
Release Complete to REL mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP	Reference
Cause	Cause indicators	See 3.3.4 on page 6-56.

3.2.9 Setup and Initial address message (IAM)

Table 6-41
Setup to IAM mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP	Reference
Bearer capability	User service information	See 3.3.1 on page 6-51.
Channel identification	Not applicable	
Progress indicator	Forward call indicators	See 3.3.5 on page 6-62.
Calling party number	Calling party number	See 3.3.3 on page 6-54.
Calling party subaddress	Access transport parameter. The IAM message will contain a maximum of 1 Access transport parameter. This contains all the INS 1500 information elements required.	
Called party number	Called party number	See 3.3.2 on page 6-53.
Called party subaddress	Access transport, see Calling party subaddress	
Lower layer compatibility	Access transport, see Calling party subaddress	
Higher layer compatibility	Access transport, see Calling party subaddress	

Table 6-42
IAM to Setup mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP	Reference
Nature of connection	No mapping	
Forward call indicator	Progress indicator	See 3.3.5 on page 6-62.
Calling party category	No mapping	
User service information	Bearer capability	See 3.3.1 on page 6-51.
Access transport	Access transport parameter contains one or more of: *Higher level compatibility, Lower layer compatibility, Calling party subaddress,* and *Called party subaddress*. This is inserted in the *Setup* message in accordance with the INS 1500 encoding rules.	
Called party number	Called party number	See 3.3.2 on page 6-53.
Calling party number	Calling party number	See 3.3.3 on page 6-54.
Carrier selection information	No mapping	
Charge number	No mapping	
Closed user group	No mapping	
Connect request	No mapping	
Optional forward call indicator	No mapping	
Original called number	No mapping	
Origination line information	No mapping	
Party information	No mapping	
Redirection number	No mapping	
Redirection indicators	No mapping	

3.3 Mapping at the parameter and bit level

The following tables detail the mapping between the INS 1500 and ANSI7+ ISUP protocols at the bit level within the messages.

3.3.1 Bearer capability and User service information

Table 6-43
Bearer capability to User service information mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP
Coding standard, octet 3 00 CCITT standard	Coding standard, octet 1 00 CCITT standard
Information transfer capability, octet 3 00000 speech 01000 unrestricted digital information 10000 3.1 kHz audio	Information transfer capability, octet 1 00000 speech 01000 unrestricted digital information 10000 3.1 kHz audio
Transfer mode, octet 4 00 circuit mode	Transfer mode, octet 2 00 circuit mode
Information transfer rate, octet 4 10000 64 kbit/s	Information transfer rate, octet 2 10000 64 kbit/s
Layer 1 identification, octet 5 01 Layer 1 identifier	Layer 1 identification, octet 3 01 Layer 1 identifier
Layer 1 protocol , octet 5 00001 Rate adaption 00010 Recommendation G.711 µ law	Layer 1 protocol , octet 3 00001 Rate adaption 00011 Recommendation G.711 µ law
Access data rate , octet 5a 01111 56 kbit/s	Access data rate , octet 3a 01111 56 kbit/s
Octets 6, 7 are not mapped	

Table 6-44
User service information to Bearer capability mapping: (ANSI7+ ISUP →INS 1500)

ANSI7+ ISUP	INS 1500
Coding standard, octet 1 00 CCITT standard	Coding standard, octet 3 00 CCITT standard
Information transfer capability, octet 1 00000 speech 01000 unrestricted digital information 01001 restricted digital information 10000 3.1 kHz audio	Information transfer capability, octet 3 00000 speech 01000 unrestricted digital information Mapped to unrestricted digital information, 64 kb/s, rate adapted from 56 kb/s 10000 3.1 kHz audio
Transfer mode, octet 2 00 circuit mode	Transfer mode, octet 4 00 circuit mode
Information transfer rate, octet 2 10000 64 kbit/s	Information transfer rate, octet 4 10000 64 kbit/s
Octets 2a and 2b are not mapped	
Layer 1 identification, octet 3 01 Layer 1 identifier	Layer 1 identification, octet 5 01 Layer 1 identifier
Layer 1 protocol , octet 3 00001 Rate adaption 00011 Recommendation G.711 μ law	Layer 1 protocol , octet 5 00001 Rate adaption 00010 Recommendation G.711 μ law
Access data rate , octet 3a 01111 56 kbit/s	Access data rate , octet 5a 01111 56 kbit/s

3.3.2 Called party number

Table 6-45
Called party number mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP
Type of number, octet 3 000 unknown	Nature of address indicator, octet 1 This value is generated by the translation operation
Numbering plan identification, octet 3 0000 unknown	Numbering plan identification, octet 2 001 E.164
Number digit coding, octet 4 ... n 011 0000 digit 0 011 0001 digit 1 011 0010 digit 2 011 0011 digit 3 011 0100 digit 4 011 0101 digit 5 011 0110 digit 6 011 0111 digit 7 011 1000 digit 8 011 1001 digit 9	Number digit coding, octet 3 ... n 0000 digit 0 0001 digit 1 0010 digit 2 0011 digit 3 0100 digit 4 0101 digit 5 0110 digit 6 0111 digit 7 1000 digit 8 1001 digit 9
Note: The number digits presented may be changed as a result of translations in the network.	

Table 6-46
Called party number mapping: (ANSI7+ ISUP →INS 1500)

ANSI7+ ISUP	INS 1500
Nature of address, octet 1 000 0001 subscriber number 000 0011 national number 000 0100 international number	Type of number, octet 3 000 unknown 000 unknown 000 unknown
Numbering plan identification, octet 3 001 E.164	Numbering plan identification, octet 3 0000 unknown
Number digit coding, octet 3 ... n 0000 digit 0 0001 digit 1 0010 digit 2 0011 digit 3 0100 digit 4 0101 digit 5 0110 digit 6 0111 digit 7 1000 digit 8 1001 digit 9	Number digit coding, octet 4 ... n 011 0000 digit 0 011 0001 digit 1 011 0010 digit 2 011 0011 digit 3 011 0100 digit 4 011 0101 digit 5 011 0110 digit 6 011 0111 digit 7 011 1000 digit 8 011 1001 digit 9
Note: The number digits presented may be changed as a result of translations in the network.	

3.3.3 Calling party number

Table 6-47
Calling party number mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP
Type of number, octet 3 000 unknown	Nature of address, octet 1 This value is generated by the translation operation
Numbering plan identification, octet 3 0000 unknown	Numbering plan identification, octet 2 001 E.164
Presentation indicator, octet 3a 00 presentation allowed 01 presentation restricted 10 number not available	Address presentation restricted indicator, octet 2 Code point selected depends on the *Calling line identification presentation service,* refer to Chapter 5-2: "Supplementary services".
Screening indicator, octet 3a 01 user provided, verified and passed 11 network provided	Screening indicator, octet 2 Code point selected depends on the *Calling line identification presentation service,* refer to Chapter 5-2: "Supplementary services".
Number digit coding, octet 4 ... n 011 0000 digit 0 011 0001 digit 1 011 0010 digit 2 011 0011 digit 3 011 0100 digit 4 011 0101 digit 5 011 0110 digit 6 011 0111 digit 7 011 1000 digit 8 011 1001 digit 9	Address signal, octet 3 ... n 0000 digit 0 0001 digit 1 0010 digit 2 0011 digit 3 0100 digit 4 0101 digit 5 0110 digit 6 0111 digit 7 1000 digit 8 1001 digit 9
Note: The number digits presented may be changed as a result of translations in the network.	

Table 6-48
Calling party number mapping: (ANSI7+ ISUP →INS 1500)

ANSI7+ ISUP	INS 1500
Nature of address, octet 1 000 0001 subscriber number 000 0011 national number 000 0100 international number	Type of number, octet 3 000 unknown 000 unknown 000 unknown
Numbering plan identification, octet 2 001 E.164	Numbering plan identification, octet 3 0000 unknown
Address presentation restricted indicator, octet 2 00 presentation allowed 01 presentaion restricted 10 address not available, calling party number not present in IAM	Presentation indicator, octet 3a Code point selected depends on the *Calling line presentation service,* refer to Chapter 5-2: "Supplementary services".
Screening indicator, octet 3a 00 user provided, not verified 01 user provided, verified and passed 10 user provided, verified and failed 11 network provided	Screening indicator, octet 3a Code point selected depends on the *Calling line presentation service,* refer to Chapter 5-2: "Supplementary services".
Address signal, octet 3 ... n 0000 digit 0 0001 digit 1 0010 digit 2 0011 digit 3 0100 digit 4 0101 digit 5 0110 digit 6 0111 digit 7 1000 digit 8 1001 digit 9	Number digit coding, octet 4 ... n 011 0000 digit 0 011 0001 digit 1 011 0010 digit 2 011 0011 digit 3 011 0100 digit 4 011 0101 digit 5 011 0110 digit 6 011 0111 digit 7 011 1000 digit 8 011 1001 digit 9
Note: The number digits presented may be changed as a result of translations in the network.	

3.3.4 Cause

The *Cause* values do not all map directly. The *Cause* value generated is dependent on the specific call clearing scenario.

The following terms are used to describe the cause mapping:

Undefined cause value: Cause value which is not defined in INS1500 protocol or ANSI7+ ISUP protocol.

Unsupported cause value: Cause value which is defined in INS1500 protocol or ANSI7+ ISUP protocol but is not implemented in DMS100.

Table 6-49
Cause mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP
Coding standard, octet 3 00 CCITT standard	Coding standard, octet 1 00 CCITT standard
Location, octet 3 (Note 1) 0000 user 0001 private network serving local user 0010 public network serving local user 0011 transit network 0100 public network serving remote user 0101 private network serving remote user 0111 international network 1010 network beyond interworking point	Location, octet 1 0000 user 0001 private network serving local user 0010 public network serving local user 0011 transit network 0100 public network serving remote user 0101 private network serving remote user 0111 international network 0011 transit network
Note 1: Location mapping is transparent above except for special cases described below. (Notes)	
Recommendation, octet 3a is not mapped	
Cause value, octet 4 (Note 6) Class Number Value 000 0001 1 000 0010 2 000 0011 3 (Note 7) 000 0110 6 (Local significance only) 000 0111 7 (Unsupported cause: Note 2) 001 0000 16 (Note 5) 001 0001 17 001 0010 18 001 0011 19 001 0101 21 001 0110 22 001 1010 26 (Unsupported cause: Note 2) 001 1011 27 001 1100 28 001 1100 29 (Unsupported cause: Note 3)	Cause value, octet 2 Class Number Value 000 0001 1 000 0010 2 000 0000 0 010 1001 41 001 0000 31 001 0000 16 001 0001 17 001 0010 18 001 0011 19 001 0101 21 001 0110 22 001 0000 31 001 1011 27 001 1100 28 001 1111 31 **(Continued)**

Table 6-49
Cause mapping: (INS 1500 →ANSI7+ ISUP) (Continued)

INS 1500				ANSI7+ ISUP		
Cause value, octet 4				Cause value, octet 2		
Class	Number	Value		Class	Number	Value
001	1110	30	(Local significance only)	010	1001	41
001	1111	31		001	1111	31
010	0010	34		010	0010	34
010	0110	38		010	0110	38
010	1001	41		010	1001	41
010	1010	42		010	1010	42
010	1011	43		010	1011	43
010	1100	44		010	1100	44
010	1111	47		010	1111	47
011	0010	50	(Unsupported cause: Note 3)	010	1111	47
011	1001	57		011	1001	57
011	1010	58	(Note 7)	000	0000	00
011	1111	63		011	1111	63
100	0001	65		100	0001	65
100	0010	66		100	0010	66
100	1001	69	(Notes 3 & 7)	000	0000	00
100	0110	70		100	0110	70
100	1111	79		100	1111	79
101	0001	81	(Local significance only)	010	1001	41
101	0010	82	(Local significance only)	010	1001	41
101	1000	88		101	1000	88
101	1011	91	(Unsupported cause: Note4)	001	1111	31
101	1111	95	(Local significance only)	010	1001	41
110	0000	96	(Local significance only)	010	1001	41
110	0001	97	(Local significance only)	010	1001	41
110	0010	98	(Local significance only)	010	1001	41
110	0011	99	(Local significance only)	010	1001	41
110	0100	100	(Local significance only)	010	1001	41
110	0101	101	(Local significance only)	010	1001	41
110	0110	102	(Local significance only)	010	1001	41
110	1111	111	(Local significance only)	010	1001	41
111	1111	127		111	1111	127

Note 2: INS1500 is Point to Point only.

Note 3: INS1500 does not support Facility IE.

Note 4: INS1500 does not support TNS IE.

Note 5: Cause value 16 is mapped to cause value 21 and cause location is mapped transparently before answer. Cause value 16 is mapped transparently and cause location is mapped to user after answer.

-continued-

Table 6-49
Cause mapping: (INS 1500 →ANSI7+ ISUP) (Continued)

Note 6: These cause values listed above are defined cause values. If an undefined cause value (e.g. causes 04, 05, 06) is received then it is mapped to 31 with the cause location which is datafilled in table TRKSGRP (INS 1500 trunk).
Note 7: Cause values 03, 58 and 69 are mapped to ANSI ISUP cause 00 and cause locations are mapped transparently as these causes are not expected by the INS-1500 Network side.

Table 6-50
Cause mapping: (ANSI7+ ISUP →INS 1500)

ANSI7+ ISUP	INS 1500
Coding standard, octet 1 00 CCITT standard	Type of number, octet 3 00 CCITT standard
Location, octet 1 (Note 1) 0000 user 0001 private network serving local user 0010 public network serving local user 0011 transit network 0100 public network serving remote user 0101 private network serving remote user 0111 international network 1010 network beyond interworking point	Location, octet 3 0000 user 0001 private network serving local user 0010 public network serving local user 0011 transit network 0100 public network serving remote user 0101 private network serving remote user 0111 international network 1010 network beyond interworking point
Note 1: Location is mapped transparently except for cause values 16, 127 location mappings depend on TRKSGRP datafill on INS 1500 trunk.	
Recommendation, octet 1a is not mapped	
-continued-	

Table 6-50
Cause mapping: (ANSI7+ ISUP →INS 1500) (Continued)

ANSI7+ ISUP				INS 1500		
Cause value, octet 2				Cause value, octet 4		
Class	Number	Value	(Note 2,3,4)	Class	Number	Value
000	0001	1		000	0001	1
000	0010	2		000	0010	2
000	0011	3		001	1111	31
000	0100	4		001	1111	31
000	0101	5		001	1111	31
001	0000	16		001	0000	16
001	0001	17		001	0001	17
001	0010	18		001	0010	18
001	0011	19		001	0011	19
001	0101	21		001	0101	21
001	0110	22		001	0110	22
001	1011	27		001	1111	31
001	1100	28		001	1100	28
001	1101	29		001	0000	16
001	1111	31		001	1111	31
010	0010	34		010	0010	34
010	0110	38		010	0110	38
010	1001	41		010	1111	47
010	1010	42		010	1010	42
010	1011	43		010	1011	43
010	1100	44		010	1100	44
010	1100	45	(Note 2)	Autovon Trunks only		
010	1111	47		010	1111	47
011	0010	50	(Unsupported cause: Note 3)	010	1111	16
011	1001	57		011	1111	63
011	1010	58		011	1001	57
011	1111	63		011	1111	63
100	0001	65		100	0001	65
100	0010	66		100	0010	66
100	0110	70		100	0110	70
100	1111	79		100	1111	79
101	0001	81		101	0001	81
101	1000	88		101	1000	88
101	1011	91	(Unsupported cause: Note 3)	001	0000	16
101	1111	95		101	1111	95
110	0001	97		110	0001	97
110	0011	99		110	0011	99
110	0100	100		110	0100	100
110	0110	102	(Unsupported cause: Note 3)	001	0000	16
110	0111	103		001	0000	16
110	1111	111		110	1111	111
111	1111	127		001	0000	16

-continued-

Table 6-50
Cause mapping: (ANSI7+ ISUP →INS 1500) (Continued)

ANSI7+ ISUP	INS 1500
Note 2: These cause values listed above are defined cause values as recommended in ANSI T1.113. The cause value 45 (Preemption) is applicable in the REL message to AUTOVON trunks only. If an undefined (eg. causes 06,07) ANSI7+ ISUP cause value is received then it is mapped to 16 and the cause location is mapped transparently. (Continued)	
Note 3: Unsupported ANSI 7+ISUP cause values are mapped to cause 16 and cause locations are mapped transparently.	
Note 4: The cause values which are defined in IBN7 INTERFACE SPECIFICATION but not defined in ANSI T1.113 are not listed in this table. They are cause value 30 is mapped to 16 and cause value 46 is mapped to 63	

3.3.5 Progress indicator and forward indicator

Table 6-51
Progress indicator to Forward indicator mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP
Coding standard, octet 3 is not mapped	
Progress descriptor, octet 4	Forward call indicators
No *Progress indicator* information element	`Bit D = 0` No interworking encountered `Bit I = 1` Originating access is ISDN
`000 0001` Call is not end-to-end ISDN	`Bit D = 1` Interworking encountered `Bit I = 0` Originating access is non-ISDN
`000 0011` Originating address is non-ISDN	`Bit D = 0` No interworking encountered `Bit I = 0` Originating access is non-ISDN
	Bit D is the interworking indicator Bit I is the ISDN access indicator

Table 6-52
Forward indicator to Progress indicator mapping: (ANSI7+ ISUP →INS 1500)

ANSI7+ ISUP	INS 1500
Forward call indicators	Progress descriptor, octet 4
`Bit D = 0` No interworking encountered `Bit I = 1` Originating access is ISDN	No *Progress indicator* information element in *Setup* message
`Bit D = 0` No interworking encountered `Bit I = 0` Originating access is non-ISDN	`000 0011` Originating address is non-ISDN
`Bit D = 1` Interworking encountered `Bit I = 0` Originating access is non-ISDN	`000 0001` Call is not end-to-end ISDN
`Bit D = 1` Interworking encountered `Bit I = 1` Originating access is ISDN	`000 0001` Call is not end-to-end ISDN
Bit D is the interworking indicator Bit I is the ISDN access indicator	

3.3.6 Progress indicator and backward indicator

Table 6-53
Progress indicator to Backward indicator mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500		ANSI7+ ISUP	
Coding standard, octet 3 is not mapped			
Progress descriptor, octet 4		Backward call indicators	
No *Progress indicator* information element		`Bit I = 0` `Bit M = 1`	No interworking encountered Terminating access is ISDN
`000 0001`	Call is not end-to-end ISDN	`Bit I = 1` `Bit M = 1`	Interworking encountered Terminating access is ISDN
`000 0010`	Destination address is non-ISDN	`Bit I = 0` `Bit M = 0`	No interworking encountered Terminating access is non-ISDN
Bit I is the interworking indicator		Bit M is the ISDN access indicator	

Table 6-54
Backward indicator to Progress indicator mapping: (ANSI7+ ISUP →INS 1500)

ANSI7+ ISUP		INS 1500	
Backward call indicators		Progress descriptor, octet 4	
`Bit I = 0` `Bit M = 1`	No interworking encountered Terminating access is ISDN	No *Progress indicator* information element	

`Bit I = 0`
`Bit M = 0`
`Bit DC= 01`
	No interworking encountered
	Terminating access is non-ISDN
	Subscriber free
		`000 0010`	Destination address is non-ISDN
			(*Alerting* message)

`Bit I = 0`
`Bit M = 0`
`Bit DC= 00`
	No interworking encountered
	Terminating access is non-ISDN
	No indication
		`000 0010`	Destination address is non-ISDN
			(*Progress* message)

`Bit I = 1`
`Bit M = 0`
`Bit DC= 01`
	Interworking encountered
	Terminating access is non-ISDN
	Subscriber free
		`000 0001`	Call is not end-to-end ISDN
			(*Alerting* message)

`Bit I = 1`
`Bit M = 0`
`Bit DC= 00`
	Interworking encountered
	Terminating access is non-ISDN
	No indication
		`000 0001`	Call is not end-to-end ISDN
			(*Progress* message)

`Bit I = 1`
`Bit M = 1`
`Bit DC= 01`
	Interworking encountered
	Terminating access is ISDN
	Subscriber free
		`000 0001`	Call is not end-to-end ISDN
			(*Alerting* message)

`Bit I = 1`
`Bit M = 1`
`Bit DC= 00`
	Interworking encountered
	Terminating access is ISDN
	No indication
		`000 0001`	Call is not end-to-end ISDN
			(*Progress* message)

Bit I is the interworking indicator		Bit M is the ISDN access indicator	

3.3.7 Progress indicator and event information

Event information is contained in the Call Progress message (CPG) in ANSI7+ ISUP.

Table 6-55
Progress indicator to Event information mapping: (INS 1500 →ANSI7+ ISUP)

INS 1500	ANSI7+ ISUP
Coding standard, octet 3 is not mapped	
Progress descriptor, octet 4	Bits GFE DCBA in Event indicator
Alerting message	000 0001 Alerting
Progress message	000 0010 Progress
000 1000 In-band information or an appropiate pattern is now available	000 0011 In-band information or an appropiate pattern is now available

Table 6-56
Event information to Progress indicator mapping: (ANSI7+ ISUP →INS 1500)

ANSI7+ ISUP	INS 1500
Bits GFE DCBA in Event indicator	Progress descriptor, octet 4
000 0001 Alerting	*Alerting* message
000 0010 Progress	*Progress* message
000 0011 In-band information or an appropiate pattern is now available	000 1000 In-band information or an appropiate pattern is now available
Any other value	CPG message ignored

Chapter 6-4: INS 1500-to-PTS trunk interworking

INS 1500-to-PTS trunk interworking is very different than the two cases discussed in the earlier chapters. The PTS trunk signal protocol supports data or voice signals that are sent through the network with very little other information. Calls in networks that support PTS trunks are set up using dialled digits that are passed in-band through the network. For interworking to occur therefore, the INS 1500 trunk has to pick up these signals and build a *Setup* message that can be used to set up the call in the INS 1500 network.

In the reverse direction, the *Setup* message has to be decoded and translated into digits that can be transmitted as in-band signals in the PTS trunk.

Many of the information elements that are associated with the INS 1500 network messages are created from defaults that are associated with the INS 1500-to-PTS trunk interworking code in the DMS-100.

4.1 Interworking message flow diagrams

4.1.1 Successful call set up procedures

During call set up procedures, the following INS 1500 messages may be sent or received:

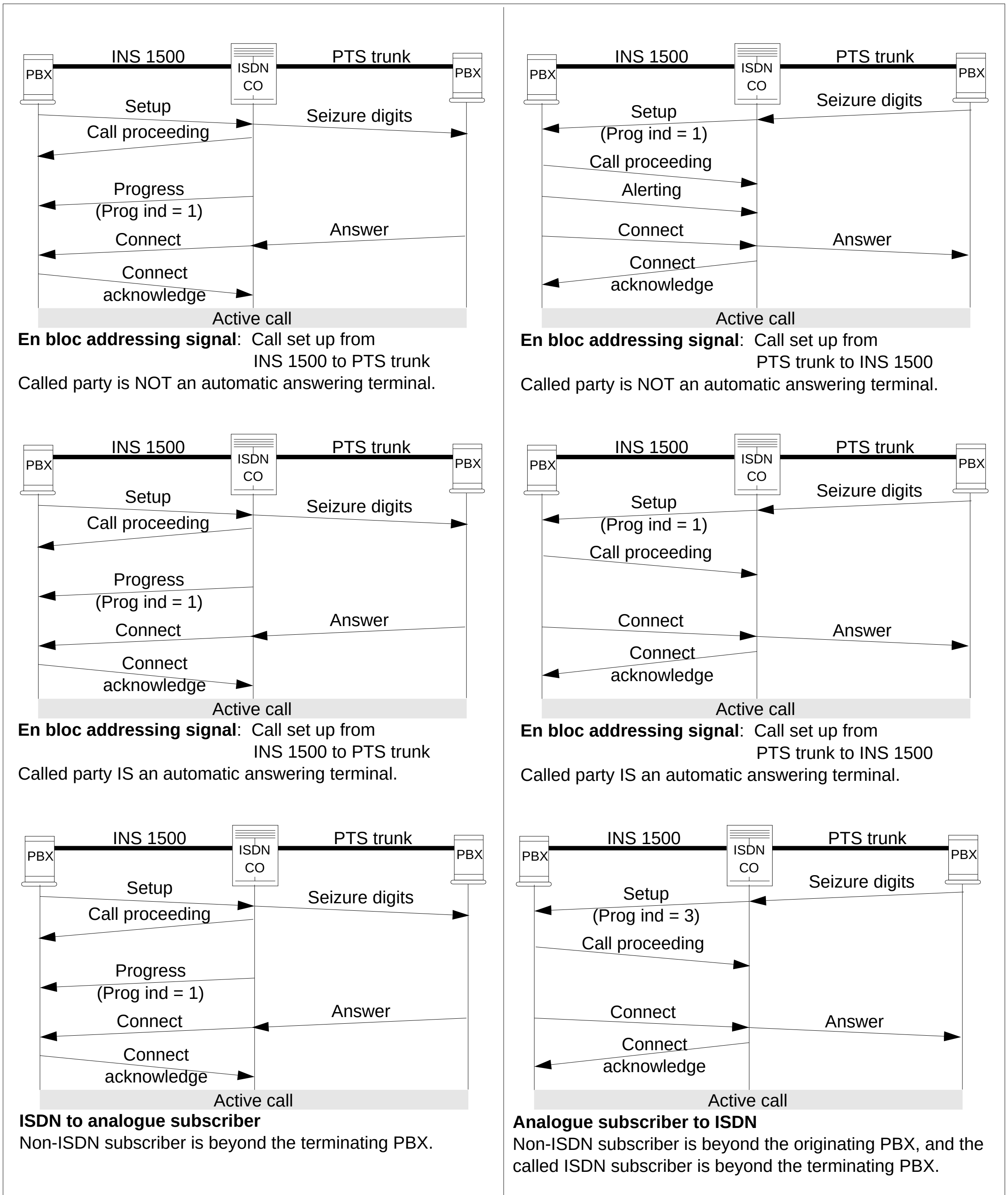
- *Setup*
- *Call proceeding*
- *Alerting*
- *Connect*
- *Connect acknowledge*
- *Progress*

The messages *Call proceeding* and *Connect acknowledge* have local significance only. They do no impact interworking. The INS 1500 protocol supports only enbloc sending and receiving. Figure 6-11 and Figure 6-12 show the different message flows that can occur for typical successful call set ups.

Progress description numbers are included in the following diagrams. These refer to the message codes found in octet 3 of the *Progress indicator* information element (see Chapter 4-4:"Layer 3 message formats"). The coding is reproduced here for convenience.

7 6 5	4 3 2 1	Desc. no.	
0 0 0	0 0 0 1	**1**	Call is not end-to-end ISDN
0 0 0	0 0 1 0	**2**	Destination address is non-ISDN
0 0 0	0 0 1 1	**3**	Origination address is non-ISDN
0 0 0	0 1 0 0	**4**	Call has returned to the ISDN network
0 0 0	1 0 0 0	**8**	In-band information or pattern is now available

Figure 6-11
Message flow sequence diagram: Successful call setup procedures

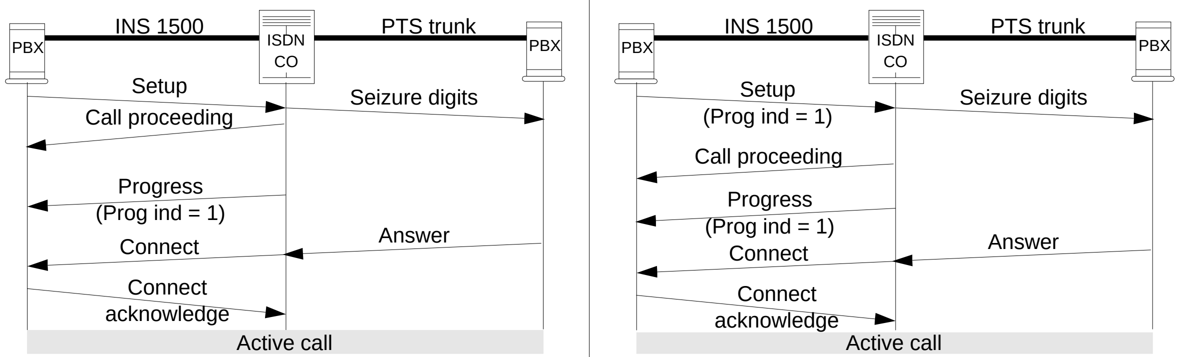


KEY:

(Prog ind = 1) Progress indicator value #1 “Call is not end-to-end ISDN” in *Setup* or *Progress* message

(Prog ind = 3) Progress indicator value #3 “Originating address is not ISDN” in *Setup* message

Figure 6-12
Message flow sequence diagram: Successful call setup procedures



Call originating in ISDN:
Interworked between ISDN and PSTN. Non-ISDN terminating equipment is beyond the terminating PBX.

Call originating in ISDN:
Interworked between PSTN and ISDN. Call originates in the PSTN. Non-ISDN originating equipment is beyond the originating PBX.

KEY:

(Prog ind = 1)	Progress indicator value #1 “Call is not end-to-end ISDN” in *Setup* or *Progress* message
(Prog ind = 3)	Progress indicator value #3 “Originating address is not ISDN” in *Setup* message

4.2 Call clearing procedures

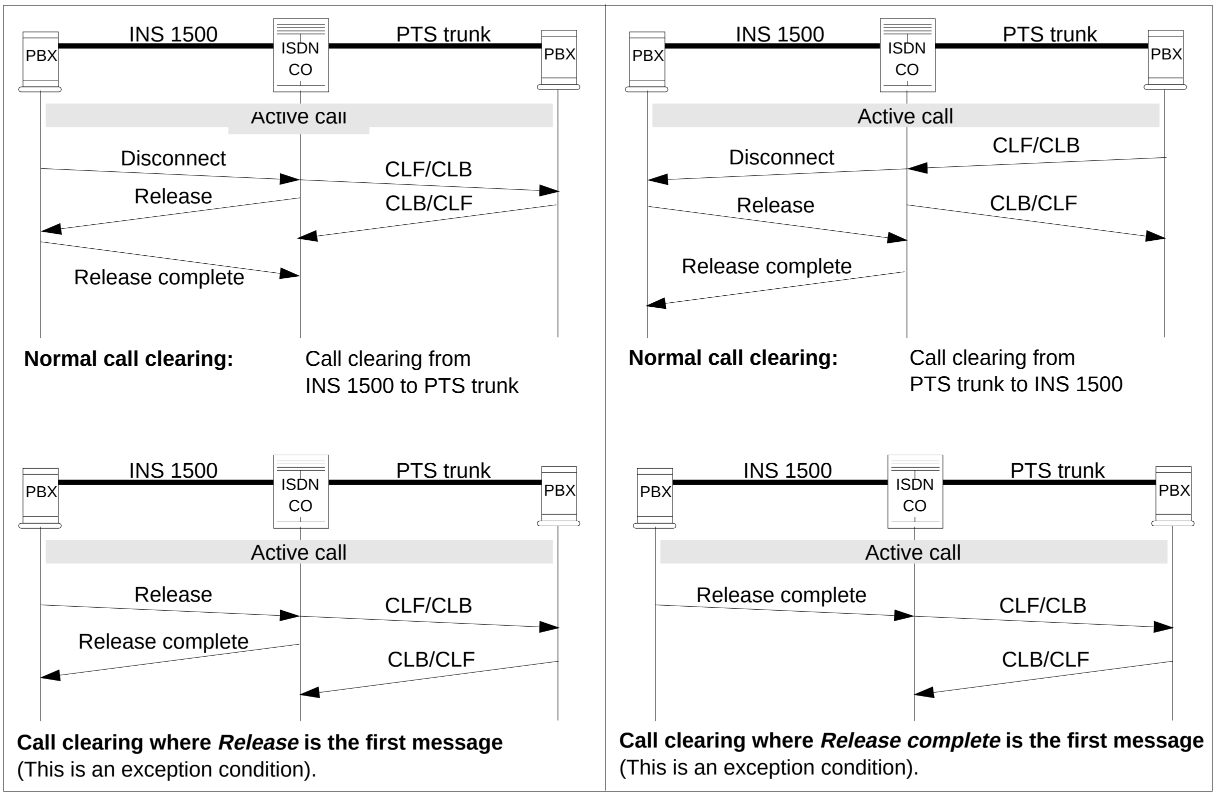
During call clearing procedures, the following INS 1500 messages may be sent or received:

- *Disconnect*
- *Release*
- *Release complete*

On the PTS trunks, the *Clear forward (CLF)* and the *Clear backward (CLB)* signals that are sent are dependent on the call setup direction

Figure 6-13 shows the different message flows that can occur for typical call clearing procedures.

Figure 6-13
Message flow sequence diagram: Call clearing procedures



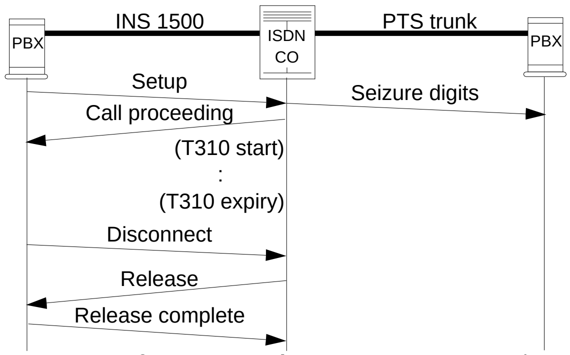
4.2.1 Unsuccessful call setup procedures

During unsuccessful call set ups, the following INS 1500 messages may be sent or received:

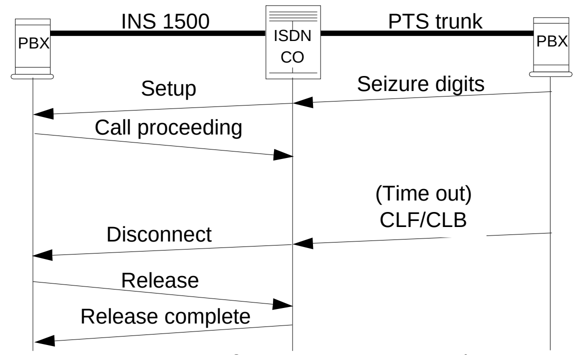
- *Setup*
- *Call proceeding*
- *Alerting*
- *Progress*
- *Release*
- *Release complete*
- *Disconnect*

The message *Call proceeding* has local significance only. It does not impact interworking. On the PTS trunks, the *Clear forward (CLF)* and the *Clear backward (CLB)* signals that are sent are dependent on the call setup direction. Logs are generated for unsuccessful call setups only if the call is routed to treatment locally. Figure 6-14 and Figure 6-14 show the different message flows that can occur for typical unsuccessful call set ups.

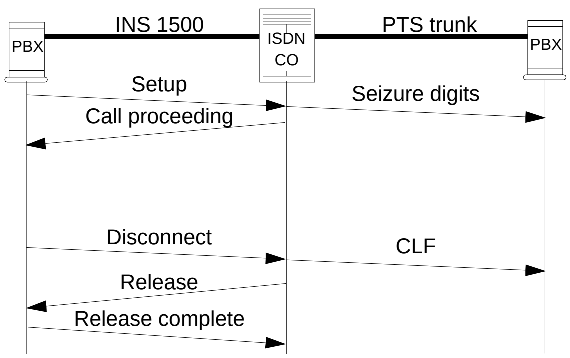
Figure 6-14
Message flow sequence diagram: Unsuccessful call setup procedures



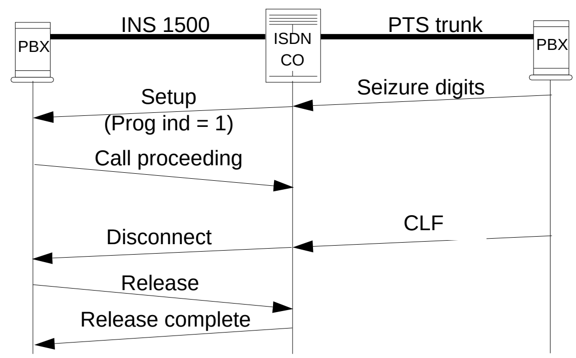
No response from PTS trunk: INS 1500 to PTS trunk
PTS trunk times out.



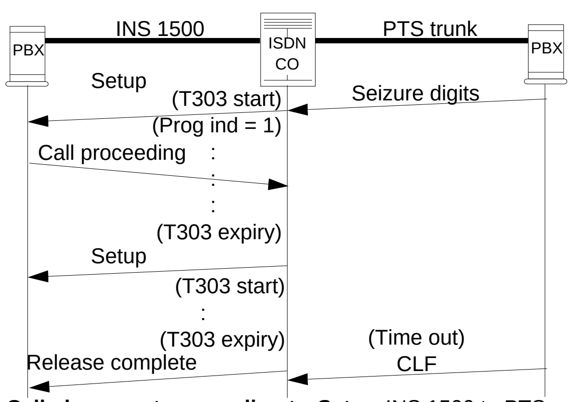
No *Connect* message from INS 1500: PTS trunk to INS-1500
PTS trunk times out.



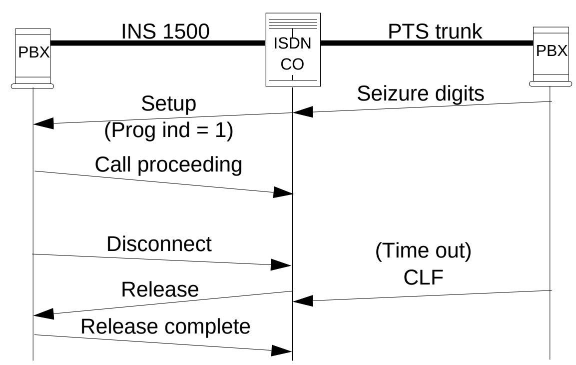
Premature release: INS 1500 to PTS trunk
Disconnect is received at originating exchange prior to any response from the called user.



Premature release: PTS trunk to INS 1500
On-hook is received at originating exchange prior to any response from the called user.



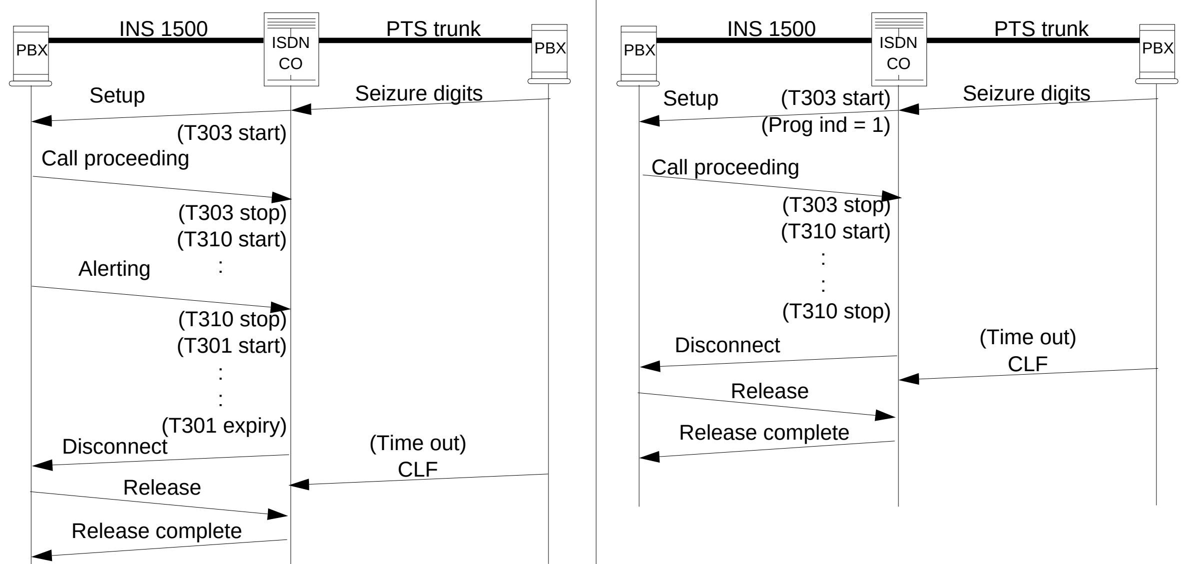
Called user not responding to *Setup*: INS 1500 to PTS
No response received to a re-transmitted *Setup* message.



Premature release: PTS trunk to INS 1500
Called user clears the call prior to the call being fully established.

KEY:
(Prog ind = 1) Progress indicator value #1 “Call is not end-to-end ISDN” in *Setup* or *Progress* message

Figure 6-15
Message flow sequence diagram: Unsuccessful call setup procedures - continued



Called user not responding after *Alerting*:
PTS trunk to INS 1500
No response received from called user after it has sent *Alerting* message.

Called user not responding after *Call proceeding*:
PTS trunk to INS 1500
No response received from called user after it has sent *Call Proceeding* message.

KEY:
(Prog ind = 1) Progress indicator value #1 “Call is not end-to-end ISDN” in *Setup* or *Progress* message

4.2.2 Active call procedures

No messages that require interworking are supported by INS 1500 or PTS trunk in the active call state.

4.3 Mapping at the message level

Some messages have interworking requirements when calls are being set up between networks that support INS 1500 and another network that supports the PTS trunk protocol. The tables in this paragraph detail the message mappings for those messages that are required to interwork between the different protocols.

4.3.1 Connect to Off-hook mapping

When the terminal on the INS 1500 side is ready to accept a call, it transmits a *Connect* message to the interface. This is translated by the DMS-100 at the interface to an off hook signal that is passed to the PTS trunk.

There is no mapping for the *Channel identification* or the *Progress indicator* information elements and hence no other information is signalled to the PTS side

4.3.2 Off-hook to Connect mapping

When the terminal on the PTS side goes off hook, a signal is sent to the interworking interface to indicate this fact.

The interface generates a *Connect* message to send to the terminal on the INS 1500 side to indicate that the other user is able to proceed with the call.

In the *Connect* message, there is no information from the PTS side except that side is off hook.

4.3.3 Disconnect to On-hook mapping

When a *Disconnect* message is sent from the INS 1500 side to the PTS side, this indicates that the terminal on the INS 1500 is terminating the call. The interface generates an on-hook tone that is sent to the PTS side to indicate that the other terminal has been disconnected. There is no mapping for the *Cause* information element and hence no other information is signalled to the PTS side.

4.3.4 On-hook to Disconnect mapping

When the terminal on the PTS side goes on-hook, a signal is sent back to the interworking interface to indicate this fact.

The interface generates a *Disconnect* message that is sent to the terminal on the INS 1500 side to indicate that the PTS side is on-hook and the call is complete. Generally, the *Disconnect* message contains a *Cause* information element, The interface will generate this element dependent on the cause that the DMS-100 can determine.

4.3.5 Release to On-hook mapping

When a *Release* message is sent from the INS 1500 side to the PTS side, this indicates that the terminal on the INS 1500 has terminated the call. Generally, this is an exception condition as a *Disconnect* message is normally used to signify a call down.

The interface generates an on-hook tone that is sent to the PTS side to indicate that the other terminal has been disconnected. There is no mapping for the *Cause* information element and hence no other information is signalled to the PTS side.

4.3.6 Release complete to On-hook mapping

When a *Release complete* message is sent from the INS 1500 side to the PTS side, this indicates that the terminal on the INS 1500 has terminated the call. Generally, this is an exception condition as a *Disconnect* message is normally used to signify a call down.

The interface generates an on-hook tone that is sent to the PTS side to indicate that the other terminal has been disconnected. There is no mapping for the *Cause* information element and hence no other information is signalled to the PTS side.

4.3.7 Setup to Off-hook mapping

When the INS 1500 side requires to make a call a *Setup* message is sent. At the interworking interface, the *Setup* message has to be read and the called party number recovered. This is entered into the translation algorithms on the DMS-100 and the equivalent PTS digits are determined. These are forwarded to the PTS trunk and are sent to the called terminal end to try to set up the call. This message also indicates to the DMS-100 that the calling terminal is “off-hook”

In all cases, it is assumed that the terminal at the called end has a speech bearer capability only. The terminal may be a modem and the signals to be transmitted may be data, but this is done using the speech bearer capability. Table 6-57 indicates the different mappings for the information elements that may be in the *Setup* message

Table 6-57
Setup to Off-hook mapping: (INS 1500 →PTS trunk)

INS 1500	PTS trunk	Reference
Bearer capability	Not mapped	
Channel identification	Not applicable	
Progress indicator	Not mapped	
Calling party number	Not mapped	
Calling party subaddress	Not mapped	
Called party number	The called party number is signalled in-band	see 4.4.2 on page 6-76
Called party subaddress	Not mapped	
Lower layer compatibility	Not mapped	
Higher layer compatibility	Not mapped	

Table 6-58
Off-hook to Setup mapping: (PTS trunk →INS 1500)

PTS trunk	INS 1500	Reference
	Bearer capability	see 4.4.1 on page 6-75
	Progress indicator	see 4.4.3 on page 6-77

4.4 Mapping at the parameter and bit level

The following tables detail the mapping between the INS 1500 and PTS trunk protocols at the bit level within the messages for calls through CCS7 networks.

4.4.1 Bearer capability and Off-hook mapping

When a call is being set up between a PTS trunk and a user on an INS 1500 network, no bearer capability information is available at the interface. However, the interface knows that the call originated on a PTS trunk and it assumes that the call has a speech bearer capability as indicated in Table 6-59. The bearer capability information is sent with all messages that require a bearer capability information element.

Table 6-59
Off-hook to Bearer capability mapping: (PTS trunk →INS 1500)

INS 1500
Coding standard, octet 3 00 CCITT standard
Information transfer capability, octet 3 00000 speech
Transfer mode, octet 4 00 circuit mode
Information transfer rate, octet 4 10000 64 kbit/s
Layer 1 identification, octet 5 01 Layer 1 identifier
Layer 1 protocol, octet 5 00010 Recommendation G.711 μ law
Access data rate, octet 5a 01111 56 kbit/s

For calls in the reverse direction, that is from the INS 1500 network to the PTS trunk, it is assumed that the bearer capability is as above and the information element is ignored at the interface.

4.4.2 Called party number

INS 1500 to PTS trunk

For mapping of the INS 1500 called party digits into the PTS trunk format, the *Called party number* information element contained in the *Setup* message is analyzed and translated by the DMS-100. The digits that are out-pulsed from the DMS-100 onto the PTS trunk are dependent on the translation algorithms set up in the DMS-100.

Table 6-60
Called party number mapping: (INS 1500 →PTS trunk)

INS 1500	PTS trunk
Type of number, octet 3 000 unknown	
Numbering plan identification, octet 3 0000 unknown	
Number digit coding, octet 4 ... n 011 0000 digit 0 011 0001 digit 1 011 0010 digit 2 011 0011 digit 3 011 0100 digit 4 011 0101 digit 5 011 0110 digit 6 011 0111 digit 7 011 1000 digit 8 011 1001 digit 9	The number digits out-pulsed are a result of the translations

PTS trunk to INS 1500

When a call request is received at the DMS-100 at the PTS trunk to INS 1500 interface, the digits are buffered, and translated by the translation tables in the DMS-100. The *Setup* message is built as a result of these translations and the following data is placed in the *Called party number* information element.

Table 6-61
Called party number mapping: (PTS trunk →INS 1500)

PTS trunk	INS 1500
	Type of number, octet 3 000 unknown
	Numbering plan identification, octet 3 0000 unknown
	Number digit coding, octet 4 ... n
digit 0	011 0000 digit 0
digit 1	011 0001 digit 1
digit 2	011 0010 digit 2
digit 3	011 0011 digit 3
digit 4	011 0100 digit 4
digit 5	011 0101 digit 5
digit 6	011 0110 digit 6
digit 7	011 0111 digit 7
digit 8	011 1000 digit 8
digit 9	011 1001 digit 9

4.4.3 Progress indicator and Off hook mapping

No progress indicator information is contained in the PTS trunk data. However, certain messages to the INS 1500 network require the *Progress indicator* information element be included with the message. As in other messages, the interface determines the output since it knows that the interface is to a PTS trunk. In this case, the progress descriptor that can always be sent indicates that the call is not end-to-end ISDN. Thus, anytime a Progress indicator is required, this message is sent, as shown in the following table.

Table 6-62
Off-hook to Progress indicator mapping: (PTS trunk →INS 1500)

INS 1500
Coding standard, octet 3 00 CCITT standard
Location, octet 3 Based on datafill in table TRKSGRP
Progress descriptor, octet 4 000 0001 Call is not end-to-end ISDN

Appendix A: List of terms

Alarm indication signal (AIS)

A signal transmitted in lieu of the normal signal to maintain transmission continuity, and to indicate to the receiving terminal that there is a transmission fault which is located either at the transmitting terminal or upstream of the transmitting terminal. AIS is commonly called the Blue Alarm signal.

B-channel

A 64 kbit/s channel that carries customer information such as voice calls, circuit switched data, or packet switched data. A distinguishing characteristic is that a B-channel does not carry signaling information for control of circuit switching by the ISDN

Bipolar (alternate mark inversion) signal

A pseudo-ternary signal, conveying binary digits, in which successive “ones” (marks, pulses) are of alternating, positive (+) and negative (-) polarity, equal in amplitude, and in which a “zero” (space, no pulse) is of zero amplitude.

B8ZS (bipolar with 8-zero substitution)

A code where eight consecutive “zeros” are replaced with the sequence if the preceding pulse was +1, and with the sequence if the preceding pulse was -1, where +1 represents a positive pulse, -1 represents a negative pulse and 0 represents no pulse.

BCD

Binary coded decimal

Bipolar violation

In a bipolar signal, a one (mark, pulse) which has the same polarity as its predecessor.

C/R

Command/Response field bit

Carrier

An organization that provides telecommunications services to the public.

CCS7

Common channel signaling system no. 7

CDN

Called party number

CEI

Connection endpoint identifier

CES

Connection endpoint suffix

Clear channel capability

A characteristic of a transmission path in which the bit positions allocated for customer data may represent any combination of zeros and ones. For the DS-1 rate, the bits allocated for customer data are the last 192 bits of each frame.

CO

Central office

CGN

Calling party number

Customer installation (CI)

Consists of equipment and facilities at the customer’ s location on the customer side of the network interface.

Cyclical redundancy check (CRC)

A method of checking the integrity of received data, where the check uses a polynomial algorithm based on the content of the data.

D-channel

A channel that is primarily intended to carry signaling information for ISDN switching. For the primary rate interface, the D-channel transmission rate is 64 kbit/s.

DDI

Direct dialing inward

DISC

Disconnect

DL

Communication between layer 3 and data link layer

DLCI

Data link connection identifier

DM

Disconnect mode

DN

Directory number

DDO

Direct dialing outward

DS-1 (digital signal level 1)

A digital signal transmitted at the nominal transmission rate of 1.544 Mbit/s.

EA

Extended address field bit

Embedded operation channel (EOC)

An embedded operation channel (EOC) is provided on telecommunications facilities to support administration and maintenance. For the primary rate interface, the EOC is the extended superframe data link.

ET

Exchange termination

Extended superframe (ESF) terminal

The extended superframe (ESF) terminal is the source and sink of ESF framing, cyclical redundancy check (CRC 6) bits, and performance report messages (PRMs). The extended superframe terminal may be in a network terminal 2 (NT2) or terminal equipment (TE) functional group, or in equipment located within the network.

FCS

Frame check sequence

FRMR

Frame reject

I

Information

Ia

Ia is the 4 wire (2 pair) bi-directional primary rate interface point on the network side of the termination equipment (that is, NT1, NT2, TA, and TE) including the equipment connecting cord or equivalent on the user side of the interface cable.

IA5

International alphabet No. 5

Ib

Ib is the 4 wire (2 pair) bi-directional primary rate interface point on the user side of the termination equipment (that is, NT and NT2) including the equipment connecting cord or equivalent on the network side of the interface cable.

ID

Identification

IE

Information element

Integrated services digital network (ISDN)

A network in general, evolving from an existing telephony network which provides end-to-end digital connectivity to support a wide range of both voice and non-voice services. User access to an ISDN is by way of a limited set of standard multipurpose interfaces.

IRQ

Information request

ISDN primary rate user-network interface specification

A collection of transmission and switching facilities used by a carrier to establish communication channels between various customer interfaces (CIs).

ISDN

Integrated services digital network

ISO

International organization for standardization

Isolated pulse

An isolated pulse is a pulse that is free from the effects of the other pulses in the same signal. (A suitable testing signal is a repetitive pattern of a single "one" pulse followed by seven "zero" pulses, {100000001000000010000000...}.)

ISUP

ISDN user part

Jitter

Jitter is a measurement of the short term variation of the significant instants of a digital signal from their ideal positions with respect to time. Short term implies that these variations are high frequency (greater than 10 Hz). (Compare with wander.)

Keep alive signal

A keep-alive signal is a signal that is transmitted instead of the normal signal to maintain transmission continuity on a particular channel.

L1

Layer 1

L2

Layer 2

L3

Layer 3

LAPB

Link access procedure -balanced

LAPD

Link access procedure on the D-channel

LDN

Listed directory number

Loopback

A loopback is a state of the transmission facility in which the received signal is returned towards the sender.

M

Modifier function bit

MCO

Message class of service

MDL

Communication between management entity and data link layer

MF

Multiple frequency (analog) signaling

Multiplexer

A multiplexer is a piece of equipment that is used for combining (multiplexing) two or more tributary signals into a single composite signal. In general, the multiplexer is also used to de-multiplex the composite signal. That is, to separate the composite signal into its component tributary signals.

N(R)

Receive sequence number

N(S)

Send sequence number

Network channel terminating equipment (NCTE)

Network channel terminating equipment (NCTE) is a device that connects to the network on one interface and to terminal equipment on another interface.

Network interface (NI)

The network interface (NI) is the point of demarcation between the network and the customer interface (CI).

NPI

Numbering plan identification

NT1

A functional group that provides the physical layer functions for access line termination.

NT2

A functional group that provides protocols above layer 1 for DS-1 path termination (for example, a private branch exchange (PBX) has an NT2).

P/F

Poll/Final bit

Payload

Payload is a term that is used to indicate the information data in a frame. For instance, the payload of a DS-1 frame consists of the 192 information data bits.

PBX

Private branch exchange

Performance report messages (PRM)

An autonomous report initiated by an ISDN primary rate interface terminal (ET or NT/TE) that provides an objective measurement of the quality of transmission incoming to the terminal.

Phase transient

An event which causes movement of the phase of the signal with respect to absolute time (for example, clock rearrangement).

Physical interface

An interface at the layer 1 level of the open system interface (OSI) reference model.

PI

Presentation indicator

Primary rate interface (PRI)

A term used to describe a DS-1 rate access to an ISDN network that supports standard combinations of channels with a 1.536 Mbit/s payload.

PTS

Per trunk signaling

Pulse density

A measure of the number of “ones” (marks, pulses) as a percentage of the total number of digital time slots transmitted.

Receive signal

The signal received across an interface Ia or Ib by the associated equipment.

Receiver

The sink or terminator of any signal in a transmission medium.

Reference point

A conceptual point at the conjunction of two non-overlapping functional groups. In a specific access arrangement, a reference point may correspond to a physical interface between pieces of equipment, although this is not always necessary. In some arrangements, there may be more than one physical interface associated with a reference point.

Regenerator

Equipment that reconstructs and retransmits a received pulse train.

REJ

REJect

Remote alarm indication (RAI)

A remote alarm indication (RAI) signal is transmitted in the outgoing direction when a terminal determines that it has lost the incoming signal. The RAI is commonly called the Yellow Alarm signal.

Ri

Reference number

RNR

Receive not ready

RR

Receive ready

S

Supervisory

S1

Supervisory function bit

SABME

Set asynchronous balanced mode extended

SAP

Service access point

SAPI

Service access point identifier

SI

Screening indicator

T1 line

A full duplex digital transmission facility that is composed of two twisted metallic pairs and regenerators that carry one DS-1 signal.

TE

Terminal equipment

TEI

Terminal endpoint identifier

Terminal equipment (TE)

Terminal equipment (TE) is a functional group that provides the operation of user access protocols. (Digital telephones, data terminal equipment, and integrated work stations are examples of equipment that provide the functions associated with TEs).)

TNS

Transit network selection

TON

Type of number

Transmit signal

The signal sent across an interface Ia or Ib from the associated equipment.

Transmitter

The source or generator of any signal in a transmission medium.

U

Unnumbered

UA

Unnumbered acknowledgment

UI

Unnumbered information

Unit interval (UI)

The nominal difference in time between consecutive significant instants of an isochronous signal. In wave theory, this is referred to as the period of a wave.

V(A)

Acknowledged state variable

V(M)

Recovery state variable

V(R)

Receive state variable

V(S)

Send state variable

Wander

Wander is a measurement of the long term variations of the significant instants of a digital signal from their ideal positions with respect to time. Long term implies that these variations are low frequency (less than 10 Hz). (Compare with jitter.)

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Digital Switching System

INS Net 1500

Primary Rate Interface Specification

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