

TECHNICAL REFERENCE

AT&T INTEGRATED SERVICES DIGITAL NETWORK (ISDN) PRIMARY RATE INTERFACE SPECIFICATION

July 1989

**Director - AT&T Information Network Architecture-
AT&T Bell Laboratories**



NOTICE

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The provisions of the interface capabilities as described in this document requires certain business decisions, and possibly regulatory agency decisions. Note that, as of the date of publication of this document, many of these business decisions have not been made, nor has regulatory action been requested.

If further information is required, please contact:

Director - AT&T Information Network Architecture
AT&T Bell Laboratories
Holmdel NJ 07733

AT&T ISDN PRIMARY RATE INTERFACE SPECIFICATION

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TR 41449
Issue 2.0
July 1989

PART I

AT&T ISDN PRIMARY RATE INTERFACE SPECIFICATION - OVERVIEW

1. Introduction

This Technical Reference contains a detailed specification of the physical interface structure and message-oriented signaling procedures of the AT&T ISDN Primary Rate Interface. The ISDN Primary Rate Interface is supported by a planned family of AT&T ISDN Products and the AT&T Communications Network.

The ISDN Primary Rate Interface is a multi-purpose, high speed multiplexed digital interface based on the 1988 CCITT ISDN Recommendations¹. These Recommendations specify the use of a 1.544 Mbps (DS-1) digital interface, structured to contain bearer channels for the transport of end user information (e.g., voice, customer data, etc.) and a message-oriented out-of-band signaling channel used to control the bearer channels. The message-oriented signaling channel follows a layered protocol structure, based on the CCITT I.441 (LAPD) and I.451 Recommendations for Layers 2 and 3, respectively.²

Because of its multi-purpose nature, the ISDN Primary Rate Interface described here can be used in a range of applications, including:

- the interconnection of Customer Premises Equipment (CPE) having ISDN Primary Rate Interfaces within a single building;
- the interconnection of CPE having ISDN Primary Rate Interfaces using DS-1 private line transmission facilities, (such as Accunet® T1.5 Service), for geographically separated locations; and
- the interconnection of CPE having an ISDN Primary Rate Interface to an ISDN Switched Common Carrier Network, such as the AT&T Communications Network or a Local Exchange Carrier Network.

This document is published as a guide for the designers, manufacturers, consultants, and suppliers of systems and equipment which would meet the AT&T ISDN Primary Rate Interface. It contains a comprehensive detailed specification of the ISDN Primary Rate Interface for the variety of applications suggested. However, since individual AT&T ISDN products and services may serve differing applications, specific aspects of this interface specification may not be applicable to a particular product or network interface. Additional AT&T documentation describing a particular AT&T product or network interface should be used in conjunction with this specification to determine:

- i. the applicability of the various protocol elements, procedures, and capabilities described in this specification to a particular AT&T product or network interface;

-
1. The ISDN Primary Rate Interface is one of two ISDN interfaces defined by the 1988 CCITT Recommendations. The other interface is referred to as the ISDN Basic Rate Interface. Reference [5] contains the AT&T specification of the Basic Rate Interface as of the date of this publication.
 2. The Layers 2 and 3 Recommendations are also called Q.921 and Q.931, respectively. These Q-Series Recommendations are identical to the respective I-Series Recommendations, but have been numbered differently by CCITT Study Group XI that developed them. The I-series Recommendations are from CCITT Study Group XVIII that oversees all of the ISDN standardization activities.

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- ii. the feature and service capabilities offered by that product or network; and
- iii. the product or network specific codings and procedures for those features or services.

The following AT&T ISDN Primary Rate Interface product or network interface description documents exist as of the date of this publication.

- AT&T Network Integrated Services Digital Network (ISDN) Primary Rate Interface ^[1]
- AT&T 5ESS® Switch ISDN Primary Rate Interface Specification, 5E6 Generic Program ^[2]
- AT&T Digital Multiplexed Interface (DMI)³ Technical Specification ^[3]

Consistent with AT&T's intent to follow international standards, this Technical Reference is based upon the 1988 CCITT Recommendations and subsequent standards activities within both the CCITT and the ANSI accredited T1S1 committee of the Exchange Carriers Standards Association (ECSA). Extensions and clarifications have been made as necessary to support additional capabilities and clarify areas where the existing standards are vague or undefined.

2. Summary of the ISDN Primary Rate Interface Characteristics

2.1 Background

Recent international standardization efforts by the organizations composing The International Telegraph and Telephone Consultative Committee (CCITT) have led to recommendations for Integrated Services Digital Networks (ISDN). These recommendations are contained within Volume III of the 1988 CCITT Blue Books listed in Reference ^[4]. CCITT Recommendation I.120 describes the principles upon which the ISDN standardization efforts have been based.

A key objective of the ISDN concept is the support of a wide range of service capabilities, including voice and non-voice applications, using a limited set of efficient, multi-purpose interfaces. These interfaces support the provision of end-to-end digital connectivity, and enriched signaling capabilities. The ISDN Primary Rate Interface is one of the two standardized interfaces described in the CCITT ISDN Recommendations.

The ISDN Primary Rate Interface is a 1.544 Mbps digital interface containing bearer channels for the transport of end user information (e.g., voice, customer data, etc.) and a signaling channel for the control of the bearer channels. Three bearer channel types are defined for information transfer. They are referred to as B, H₀, and H₁₁ channels when supporting information transfer rates of 64, 384, and 1536 Kbps respectively.

An out-of-band signaling channel, called the D-Channel, uses a sophisticated message-oriented protocol that controls the channels used for information transfer, and provides capabilities to support advanced telecommunications applications.

A layered protocol approach has been adopted for specifying the ISDN Primary Rate Interface. For the transfer of end user information over Bearer Channels, only Layer 1 (physical layer) characteristics are

3. The DMI Technical Specification is available under the terms of a DMI License Agreement. For further information, refer to the contact listed in the reference section.

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defined in this document. Layers 1, 2, and 3 are specified for signaling over the D Channel. The majority of this specification covers the Layer 2 and Layer 3 procedures for D-Channel signaling.

An overview of each Layer is briefly discussed in the following subsections, and in detail in the corresponding section of this Technical Reference.

2.2 Interface Layers

2.2.1 Layer 1 (Physical Layer)

Part II describes the physical layer of the ISDN Primary Rate Interface. It is based on the use of a standard DS-1 (1.544 Mbps) interface and CCITT Recommendations I.211, I.412, and I.431. Requirements (or references to appropriate documents) are provided for electrical characteristics, channel structure, line coding, pulse density, clear and restricted channel operation, and the use of bit-inverted HDLC on restricted 64 Kbps channels subject to any HDLC processing by AT&T products or the AT&T Communications Network.

2.2.2 Layer 2 (Link Layer)

Part III describes the Link Access Procedures on the D-Channel (LAPD), for D-Channel signaling on the ISDN Primary Rate Interface. It is based on CCITT Recommendations I.440 and I.441. LAPD provides for the provision of one or more logical data link connections over the 64 Kbps D-Channel. In addition, it provides a robust information transfer path - isolating the layer 3 protocol from transmission errors, and providing sequence and flow control, etc.

2.2.3 Layer 3 (Network Layer)

Part IV specifies the message-oriented signaling procedures on the D-Channel for the control of circuit switched and packet connections. It is based on CCITT Recommendations Q.931.

The Layer 3 signaling procedures use a set of functional messages to establish, maintain, and terminate connections between ISDN entities. The messages are composed of Information Elements that convey the information used in the signaling process. Besides basic call control, the Layer 3 messages can also convey additional information used for numerous applications, such as passing the identity of the calling party, passing information regarding terminal compatibility, allowing the redirection of calls, etc. The ability to convey "User to User" information while signaling for circuit switched calls is also discussed.

2.3 Configurations

The multi-purpose nature of the ISDN Primary Rate Interface allows it to be used for many different applications, divided into the two categories of interconnection shown in Figures I-1 and I-2.

- In Figure I-1, Customer Premises Equipment (CPE), such as a PBX or Host Computer with an ISDN Primary Rate Interface, is connected to a common carrier's ISDN. This configuration is referred to as a "Switched Network Connection" in Part IV of this document.
- In Figure I-2, CPE with the ISDN Primary Rate Interface is directly connected to another ISDN CPE, either within the same building or remotely over a DS-1 private line transmission facility. Typical examples might be a Host Computer directly connected to a PBX or Local Area Network, or a Private Network involving two or more PBXs. This configuration is referred to as a "Private Line" or

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"Symmetrical" Connection in Part IV of this document.

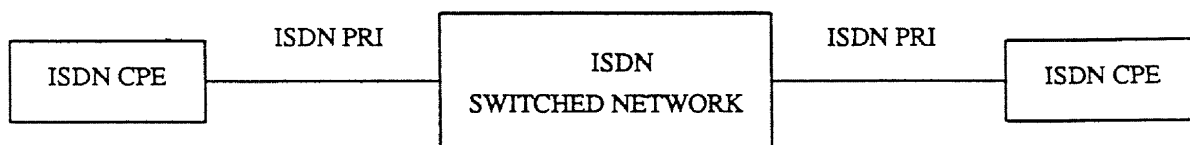


Figure I-1. ISDN Switched Network Configuration

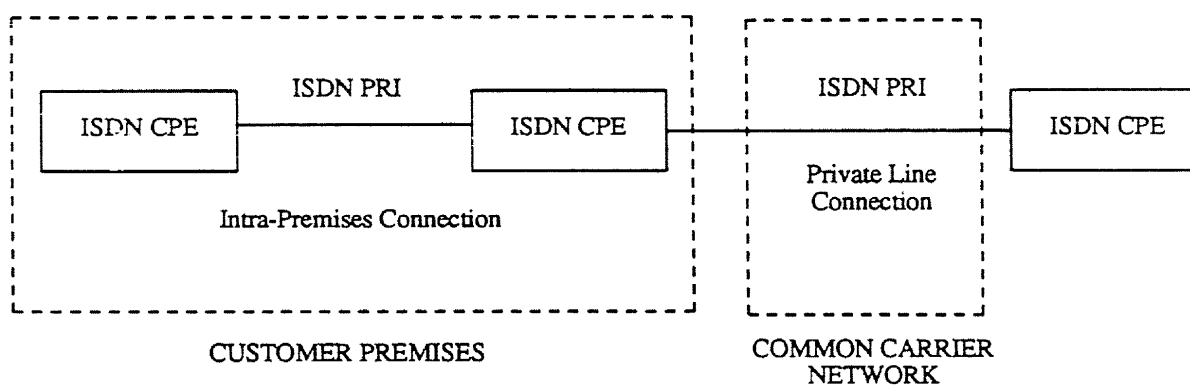


Figure I-2. ISDN Private Line Configurations

Part IV of this Technical Reference defines the signaling procedures for the above configurations. Two similar sets of procedures are defined; the first set specifies signaling procedures that only allow ISDN CPE to operate in Switched Network Configurations. The second set of signaling procedures allows ISDN CPE to operate in both Switched Network Configurations and in Private Line Configurations.

The Switched Network Procedures are the essential procedures that ISDN CPE must implement in order to communicate properly over circuit switched connections through ISDN Switched Networks. Following these procedures the complexity of the ISDN CPE is less than the Private Line Procedures because the common carrier ISDN assumes the burden of error recovery for the Layer 3 signaling procedures. This means that the ISDN CPE is not required to implement Layer 3 timers and only performs limited state matching. However, with these procedures, ISDN CPE cannot be directly connected to another ISDN CPE, either within the same building or remotely over a DS-1 private line.

The Private Line (also called Symmetrical) Procedures allow ISDN CPE to operate in all of the configurations discussed. The ISDN CPE may be connected to an ISDN Switched Network, or directly to another ISDN CPE following the symmetrical signaling procedures. These procedures require that the ISDN CPE implement Layer 3 timers and perform complete state matching.

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These distinctions are necessary due to a slight asymmetry of the Layer 3 call control procedures, as noted in Section 1.5 of CCITT Recommendation I.450. *ISDN CPE, desiring to interface with AT&T products or network interfaces in both the Switched Network and Private Line Configurations, should implement the procedures defined for Private Line Connections.* These procedures allow compatible operation with both Switched Networks, and direct connections to other ISDN CPE following the same procedures. Part IV of this Technical Reference should be consulted for additional details.

Figure I-3 summarizes the above and illustrates the configurations that ISDN CPE can operate in depending on the procedures followed.

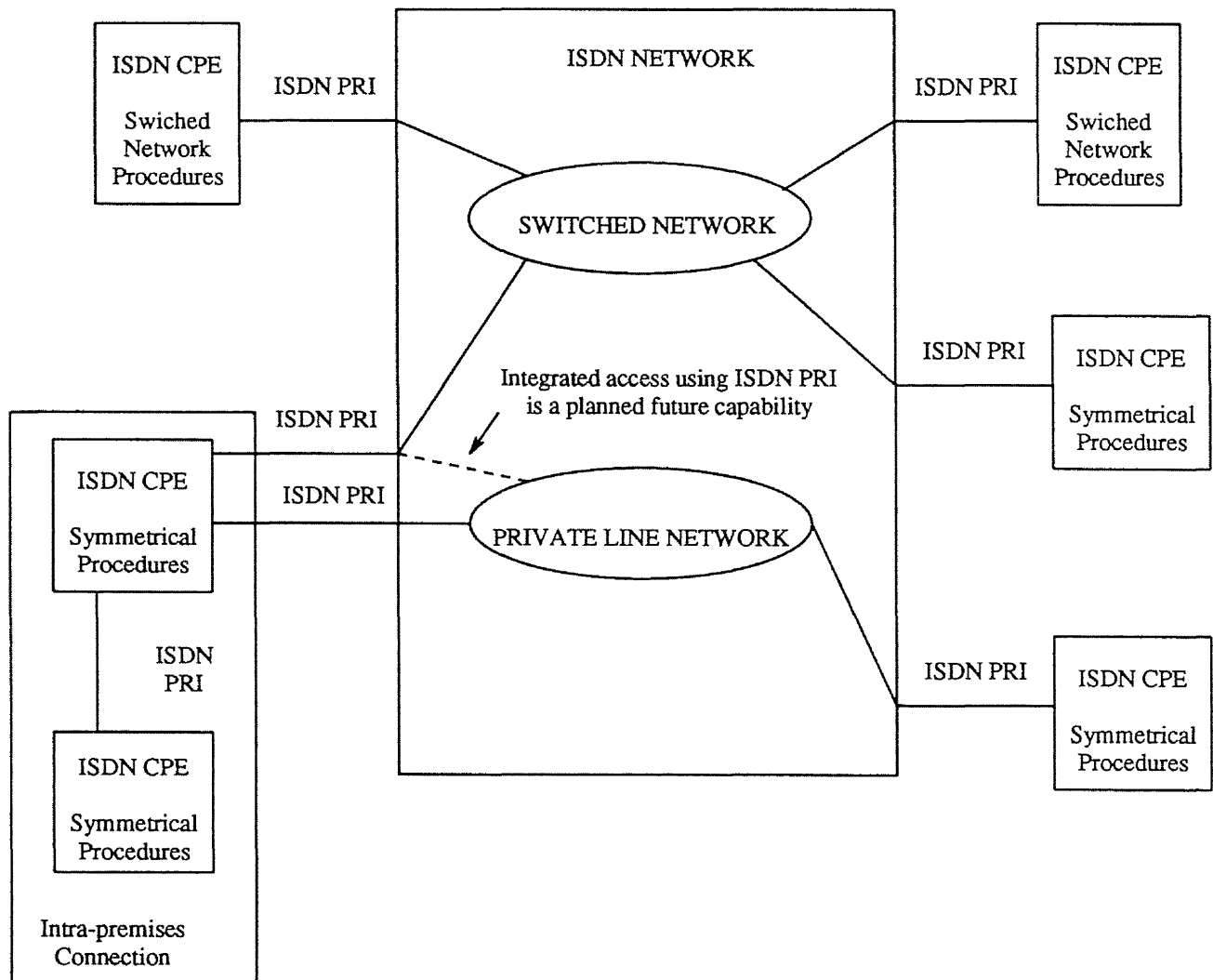


Figure I-3. Configurations Supported by the AT&T ISDN Primary Rate Interface

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1. AT&T Technical Reference, AT&T Network Integrated Services Digital Network (ISDN) Primary Rate Interface and Special Application, User-Network Interface Description Technical Reference 41459, April 1989
2. AT&T 5ESS® Switch ISDN Primary Rate Interface Specification, 5E6 Generic Program, AT&T 5D5-900-322, December 1988
3. AT&T Digital Multiplexed Interface Technical Specification Issue 3.1, August 1986, Available under the Terms of the DMI License Agreement. For further information, please contact

Product Manager - DMI
AT&T
Room 1F302
307 Middletown-Lincroft Road
Lincroft, New Jersey 07738

4. 1988 CCITT Recommendations of the I Series, Volume III - Fascicle III.5
5. AT&T ISDN Basic Rate Interface Specification, Technical Reference, 5E6 Generic Program, AT&T 801-802-100, May 1989

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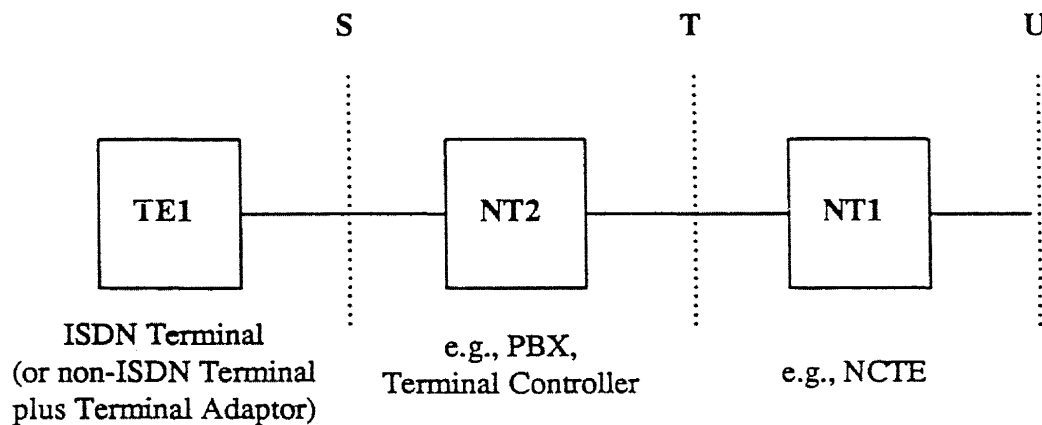
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PART II

AT&T ISDN PRIMARY RATE INTERFACE SPECIFICATION - PHYSICAL LAYER

1. Summary of Physical Layer Specification

The physical layer specification is based on the use of standard DS-1 Interface with Extended Superframe (ESF) or D4 framing and on CCITT Recommendations I.412, I.431 and I.211^[1]. The specifications include requirements on electrical characteristics, channel structure, AMI and B8ZS line coding, pulse density, clear and restricted channels and the use of bit-inverted HDLC on certain restricted channels.



Note: NT1, NT2, and TE1 are functional or logical units and are not necessarily physically discrete. The reference points S, T, and U are demarcation points between the functional units. Functions may be merged within equipment. For example, the NT1 function may be absorbed within a PBX in which case there may be no physical interface at T. Likewise, the Terminal Adaption function may be provided within a PBX in which case there may be no physical interface at S.

Figure II-1. Reference Configuration for ISDN Primary Rate Interfaces

The physical layer specifications are for DS-1 interfaces at ISDN reference points S, T and U shown in Figure II-1. In particular,

- The electrical specifications for the S/T and U reference points are based on the DSX-1 interface and the CPE - network interface, respectively.
- ESF and D4 framing as well as AMI and B8ZS line coding are allowed as customer/network options. The evolutionary goal is ESF framing and B8ZS line coding.
- The 4 kbps ESF data link is used for Yellow Alarm signals. Optional uses are discussed in PUB 54016.

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- A customer access arrangement must have at least one D channel. A D channel, when present on a primary rate interface, must be in time slot 24.
- The interface allows a single H_{11} channel or any combination of B and H_0 channels. Time slots can be flexibly assigned to B and H_0 channels.
- Restricted channels are supported when B8ZS is not available.
- An encoding method is specified for restricted channels that use HDLC requiring processing by the network. The method requires bit inversion and suppression of all-zero octets. It is elementary and achieves full data throughput despite the restricted nature of the transfer capability.

2. Electrical Interface

This section gives the electrical specifications for interfaces at reference points T, S and U. The specification for the T and S reference points are identical except for "timing" considerations.

The material in this section is based on existing AT&T practices. The electrical specifications are, however, being actively debated in the various Subcommittees of T1 Committee (Telecommunications) of the Exchange Carriers Standards Association. As a consequence, the electrical standards might change, at least in the form if not the details of the specifications. Future issues of this publication will track the changes in the standards arena.

2.1 Interface at Reference Point T

The electrical requirements for the interface at reference point T are based on specifications at a physical point located between the NT1 and NT2. This physical point is called the cross-connect point although no physical equipment (e.g., cross-connect frame, connector, etc.) is necessarily located there. The location of this point, if not specified, is assumed to be half way between the NT1 and NT2.

The electrical requirements are partly based on DSX-1 cross-connect specifications in Technical Advisory No.34⁽²⁾ and are summarized in Figure II-2.

Line Rate:	1.544 Mbps +/- 32 ppm (see text)
Line Code:	Bipolar 8 Zero Substitution (B8ZS); or Alternate Mark Inversion (AMI) with minimum ones density (see text).
Test Load:	100 ohms resistive
Pulse Shape:	An isolated pulse shall fit the template, shown in Figure 3 of Technical Advisory No. 34, at the cross-connect point. The pulse amplitude shall be between 2.4 and 3.6 volts and may be scaled by a constant factor to fit the template.
Power Levels:	For an all-ones transmitted pattern, the power in a 2 kHz band about 772 kHz shall be 12.6 to 17.9 dBm and the power in a 2 kHz band about 1544 kHz shall be at least 29 dB below that in a 2 kHz band about 772 kHz.
Pulse Imbalance:	There shall be less than 0.5 dB difference between the total power of the positive pulses and of the negative pulses.

Figure II-2. DSX-1 Interconnection Specification

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For most applications of existing equipment, the maximum allowable loss between the cross-connect point and the NT2, and between the cross-connect point and the NT1, is 6 dB at 772 kHz. The corresponding maximum distance depends upon the physical medium.

The input port on each side of the reference point must be able to receive a digital signal with the above characteristics modulated by jitter. The jitter specifications are being reviewed within AT&T and are being studied by a AdHoc Group on Jitter and Wander sponsored by Subcommittee T1X1 of T1. In the interim period, the jitter specifications given in AT&T PUB 43801^[3] will apply.

The 32 ppm tolerance on line rate is required for compatibility with Digital Synchronization Network Plan^[4]. This tolerance applies to the receive capability on each side of the reference point. It also applies to the free running transmit capability of the NT2. This free running mode is relevant, for example, (i) if a loop-timed NT2 needs to send an alarm signal when there is a loss of the incoming signal from the NT1; (ii) if the NT2 uses a network service whose timing cannot be traced to a network clock.

If the NT2 uses a network service whose timing can be traced to a network clock, then the network will normally be the timing master with the NT2 transmit clock slaved to it. The NT2 may also operate plesiochronously based on a stratum 1 clock^[4]. Such operation may be necessary when the NT2 is connected to more than one (public or private) synchronous network.

Further information on synchronization and timing can be found in^[4].

2.2 Interface at Reference Point S

The electrical requirements for the interface at reference point S are the same as those for reference point T (Section 2.1) with the possible exception of timing considerations. The primary rate ISDN terminal or Terminal Adaptor (TA) will typically derive its transmit clock by loop timing. The 32 ppm transmit tolerance applies to the ISDN terminal or TA if it is capable of sending a Yellow Alarm signal (see Section 9).

When the NT2 is absent, the S and T reference points coalesce. In this case, the ISDN terminal or TA is connected directly to the NT1 and all requirements for the T reference point given in the preceding subsection apply.

2.3 Interface at Reference Point U

The electrical requirements are specified in AT&T PUB 62411, Accunet® T1.5 Service Description and Interface Specification^[5]. The jitter and frequency specification are the same as those specified for the T reference point in Section 2.1 and not as in PUB 62411. The transmit tolerance of 32 ppm does not apply to the NT1 unless it is determined that the NT1 has an alarming (see Section 9) or other maintenance function which requires a free running clock.

3. Framing Format

The recommended framing format for the ISDN interface is ESF. Robbed bit (in-band) signaling will not be supported in the D4 and ESF formats. Yellow Alarms are discussed in Section 9.

The D4 format is extensively described in PUB 62411^[5]. Each frame contains 24 consecutive eight-bit time slots preceded by the Framing (F) bit for a total of 193 bits per frame.

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The D4 format is not recommended for general ISDN applications because there are potential problems of false framing and Yellow alarm emulation when this format is used to carry non-random bit streams. When the D4 format is used in ISDN applications the Ft framing pattern, (101010... in the same bit position in alternate time slots as specified in ^[5]), should not be stably emulated in any fixed bit position. In addition, the Yellow alarm signal (bit 2 of each time slot equal to 0 for greater than 335 milliseconds as specified in ^[5]), should not be allowed to occur spuriously due to customer data.

Due to these restrictions, the D4 format should only be used when the Extended Framing Format (ESF) is not available.

The Extended Superframe Format is evolving as the AT&T standard for DS-1 level equipment that frames on a pattern contained within the framing bit position of the DS-1 signal. Before the ESF can be used, both transmit and receive equipment must possess the appropriate hardware and software capabilities. Where these capabilities do not exist, the D4 format will be used. ESF redefines the 8 kb/s (framing bit position) pattern used in the D4 format into a 2 kbps stream for framing and 24-frame superframing, a 2 kbps stream for error-checking using a Cyclic Redundancy Check code and a 4 kb/s stream for a data link (see Figure II-3). The Extended Framing Format is fully described in PUB 54016^[6].

The ESF data link must support the ESF Yellow Alarm signal (Section 9). As an implementation option, the data link may also be used to support the enhanced facility maintenance functions as defined in AT&T Communication PUE 54016^[6]. This PUB specifies the use of an X.25 level 2 protocol on the data link. If this implementation option is not supported, then continuous ones must be transmitted in the data link when the Yellow Alarm signal is absent.

4. Channel Structure

In ISDN terminology a channel is a specified portion of the information bearing capacity of one *interface*¹. This capacity is structured into 24 eight-bit time slots, as is usual for framed DS-1 signals, forming the following possible channels:

D channel	1 slot	64 kbps
B channel	1 slot	64 kbps
H ₀ channel	6 slots	384 kbps
H ₁₁ channel	24 slots	1536 kbps

A customer access arrangement can consist of more than one interface. At least one interface must have a D channel. When present on a primary rate interface, a D channel must be in time slot 24.

On a primary rate interface, the time slots available for B, H₀, and H₁₁ channel use are 1 to 23 or 1 to 24 depending on the presence or absence of a D channel. These available time slots can, in general, be used for any channel on a per call basis. In certain early implementations, however, limitations may be placed on slot assignment; e.g., an interface may have an overlaid channel structure wherein all channel types are supported but an H₀ channel, when present, must occupy slots 1-6, 7-12 or 13-18.

1. Note that this is not typical telecommunications usage where a channel is a transmission path between geographically distant points.

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ESF Frame Number	ESF Bit Number	F-Bit Assignment		
		FPS	FDL	CRC
1	0	-	m	-
2	193	-	-	CB1
3	386	-	m	-
4	579	0	-	-
5	772	-	m	-
6	965	-	-	CB2
7	1158	-	m	-
8	1351	0	-	-
9	1544	-	m	-
10	1737	-	-	CB3
11	1930	-	m	-
12	2123	1	-	-
13	2316	-	m	-
14	2509	-	-	CB4
15	2702	-	m	-
16	2895	0	-	-
17	3088	-	m	-
18	3281	-	-	CB5
19	3474	-	m	-
20	3667	1	-	-
21	3860	-	m	-
22	4053	-	-	CB6
23	4246	-	m	-
24	4439	1	-	-

FPS - Framing Pattern Sequence (...001011...)

FDL - 4 kbps Facility Data Link (message bits m)

CRC - CRC-6 Cyclic Redundancy Check (check bits CB1-CB6)

Figure II-3. Extended Superframe (ESF) Format

As a customer/network option, the full information bearing capacity of an interface need not be provisioned. For example, a customer having a primary rate interface can have service limited to the use of only 13 time slots with one D channel and a mixture of B and H_0 channels on the remaining 12 "subscribed" slots.

As a network option, a customer access arrangement consisting of multiple interfaces can be partitioned into groups of interfaces, each group having exactly one D channel whose domain covers all interfaces within, and only within, its group. As a network option, a customer may be required to do such partitioning in order to limit the maximum number of channels within the domain of a D channel and hence meet certain performance requirements.

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5. Line Coding and Pulse Density

Customer equipment must comply with the line code supported by the access transport used. This line code may be either B8ZS or AMI.

The use of B8ZS line coding is recommended when a choice of access transport is available, in order to allow the support of both clear and restricted channel operation. AMI line coding will only support restricted channel operation.

A sufficiently high pulse density must be maintained in order to ensure adequate timing recovery at digital regenerators.

The pulse density is automatically sufficient when B8ZS line coding is used.

When AMI line coding is used, the following restrictions must be met.

- a. A time slot used for a D, B or H_0 channel must not contain the all-zero octet.
- b. For an H_{11} channel, there are two possible restrictions.
 1. The all-zero octet must not be present in any of the 24 time slots of the H_{11} channel.
 2. There must be at least N ones in any window of $8(N+1)$ bit positions for every $N=1, 2, \dots, 23$. This restriction is imposed on the 1536 kbps stream of the H_{11} channel. Alternatively, the restriction must be met by the gross 1544 kbps stream transmitted by the primary rate interface containing the H_{11} channel.

Restriction b1 is more constraining than b2. The applicable restriction for an H_{11} channel can depend on network implementations and on the switched/nonswitched nature of the 1536 kbps service. AT&T product or network interface description documentation should be consulted to determine which restriction applies for specific applications.

6. Restricted and Clear Channels

A channel which must meet the appropriate (a; b1 or b2) restriction specified in the preceding section is called a restricted channel. When the absence of any restriction is pertinent or needs emphasis, the channel is called an unrestricted or clear channel.

When using a restricted channel, the customer may use any zero suppression method suitable for the customer application. However, the inverted HDLC method specified in Section 8.1 must be used for restricted channels that use HDLC requiring processing by AT&T products or network interfaces (e.g., the D-channel).

B8ZS line coding is an interface requirement for a clear channel. A clear circuit-mode service requires a clear channel at each endpoint of the service and clear network transport connecting the end points.

7. Idle Code

The physical layer idle code is the code transmitted across the interface when the physical layer *itself* is idle. It is not necessarily the code that would be transmitted when the physical layer is serving an entity (e.g., voice encoder on a B-channel, layer 2 on a D channel, etc.) which is in an "idle" condition. This code must be transmitted on

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- Every time slot that is not assigned to a channel (e.g., slots awaiting channel assignment on a per-call basis, residual slots on an interface that is not fully provisioned, etc.)
- Every channel that is not allocated to a call.

The physical layer idle code is

- In the direction from an NT1, NT2 or TE toward the network, a pattern of at least 7 contiguous ones
- In the direction from the network toward an NT1, NT2 or TE, a periodic eight bit pattern with at least four bits equal to one.

The physical layer idle code applies equally to restricted channels, i.e., the bit pattern is *not* inverted prior to transmission (see Section 8).

The receiving side of an interface should deduce the layer 1 idle status of a time slot or channel from the D-channel signaling messages or the customer subscription profile. The layer 1 idle status should not be deduced from the incoming bit streams of the bearer channels.

The above idle code does not necessarily apply when the interface or a portion thereof (e.g., a time slot) is being tested.

8. HDLC Coding

The methods described here pertain to a channel which uses HDLC (e.g., LAPB, LAPD) at layer 2 and whose stream is subject to *any* HDLC processing by the network.

8.1 HDLC Encoding for Restricted Channels

The encoding method requires that, prior to transmission on the restricted channel, the HDLC stream be bit inverted and possibly subject to some other "processing". The receiving side merely inverts bits prior to normal HDLC processing. This method is, in particular, mandatory for restricted D channels.

With the two exceptions of HDLC abort and HDLC idle signals, an HDLC stream has at most six contiguous ones. Hence, barring these exception signals, bit inversion suffices to meet the channel restriction on the maximum density of zeros.

The HDLC abort signal consists of seven to fourteen contiguous ones and the HDLC idle signal consists of fifteen or more contiguous ones. (This count of contiguous ones refers to the stream received by the peer layer 2 entity and hence includes any trailing contiguous ones in the frame being aborted.) Therefore, in addition to bit inversion prior to transmission, some signal "processing" or mechanism to constrain zeros is required in order to satisfy the channel restriction. Two possible solutions are:

- a. The transmitting layer 2 entity does not use the HDLC idle and implements the HDLC abort by transmitting exactly seven contiguous ones (i.e., transmitting 01111110). Zero suppression is not needed since the all-zero octet never occurs.
- b. Bit inversion is followed by zero suppression. The zero suppressor monitors the (non time-slot oriented) inverted HDLC stream, or the octet to be placed in the time slot, for a pattern of eight contiguous zeros; when such a pattern is found, the last zero to be transmitted is changed to one. (Currently, the seventh rather than the eighth bit is set to one when zero suppression is used in conjunction with Mu-law PCM.) This method will transform the HDLC idle signal into a sequence of successive abort indications. Some layer 2 receiving entities, however, may have problems

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handling such multiple abort indications.

A transmitting entity can avoid using the HDLC abort signal but can emulate an abort function by sending a frame which will be read as an Invalid frame by the receiving entity (e.g., by using a false Frame Check Sequence). Repeated use of this mechanism could cause problems with maintenance procedures if, for example, these procedures interpret the occurrence of an Invalid frame as a transmission error.

It should be noted that the LAPD specification in Part III does not allow an HDLC idle pattern for a D channel on a primary rate interface, and has deferred for further study the subject of transmitting the abort signal.

It is worth noting that, using the methods described in this subsection, the data throughput is totally unaffected by the restricted nature of the transfer capability because unaborted frames are transparently recovered at the receiving end.

8.2 Interframe Time Fill

Whenever a (restricted or clear) channel stream uses HDLC at layer 2 which requires any HDLC processing by the network, then the interframe time fill must be contiguous flags. These flags will, of course, be inverted prior to transmission on a restricted channel whose stream is subject to some HDLC processing by the network.

9. Alarms

The discussion of alarms is facilitated by referring to the two sides of the interface as A and B.

The receiver on side A may be unable to maintain frame synchronization either because of an internal failure or because of the nature of the received signal. Examples of received signals that the receiver cannot frame on are: loss of signal, severely errored signal, signal without a framing pattern (such as an all-ones signal) and signal with the wrong framing pattern. If the absence of frame synchronization persists for 2 to 3 seconds, side A enters the Red Alarm state. Side A leaves this state when it re-acquires frame synchronization and maintains it for 10 to 20 seconds.

When in the Red Alarm state, side A must transmit a Yellow Alarm signal to side B. Side A must stop sending the Yellow Alarm signal when it leaves the Red Alarm state.

The pattern of the Yellow Alarm signal depends on the framing format. If the D4 format is used, the second bit is forced to zero in all 24 slots. If the ESF format is used, the 16-bit pattern of 8 bits of ones followed by 8 bits of zeros is sent in the data link. When the ESF format is used, any simulation of the D4 Yellow Alarm signal is ignored. Side B must be able to detect the presence of a Yellow Alarm Signal within 335 to 1000 milliseconds. It then enters the Yellow Alarm state.

A side of an interface is said to be in the Carrier Group Alarm (CGA) state when it is in a Red or a Yellow Alarm state. Actions (in addition to those specified above) to be taken while in the CGA state are discussed in Part IV, Section 8.

The alarming functions described above apply at T and U reference points. Hence, these functions must be implemented in the network and in the NT2 (side facing T reference point).

The alarming functions apply optionally at the S reference point. When this option is elected, the function must be implemented in the primary rate ISDN terminal or TA and in the NT2 (side facing S reference point).

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When a primary rate ISDN terminal or TA is connected directly to an NT1 without an intervening NT2, the T and S reference points coalesce and the ISDN terminal or TA must act like an NT2 for purposes of alarming.

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PART III

AT&T ISDN PRIMARY RATE INTERFACE SPECIFICATION - LINK LAYER

1. General

This specification defines the frame structure, elements of procedure, format of fields and procedures for the proper operation of the Link Access Procedure on the D-channel, LAPD, for the AT&T ISDN Primary Rate user-network interface. It is based on CCITT Recommendation Q.921 (I.441)^[1].

The concepts, terminology, overview description of LAPD functions and procedures, and the relationship with other Recommendations are described in general terms in CCITT Recommendation Q.920 (I.440)^[2].

Appendices A1 and A2 contain the SDL diagrams that describe the protocol interactions in an overall manner.

As discussed in Section 2.3 of Part I, the ISDN Primary Rate Interface applies to both Switched Network configurations and Private Line configurations. When an ISDN CPE is interfaced with a common carrier ISDN, the common carrier switch always follows the *network side* procedures described in this LAPD specification. When two ISDN CPE are interconnected in a Private Line configuration, the ISDN CPE must mutually agree which one will follow the *network side* procedures, while the other follows the *user side* procedures.

1.1 Summary of Capabilities

- Acknowledged Multiple Frame mode of operation only for information transfer.
- Modulo-128 sequencing.
- TEI Value of "0" supported. This is assigned at subscription time.
- No support for Automatic TEI Assignment procedures.
- Link supervision with supervisory command frames RR/RNR, P=1.
- Default parameter values used:

N201 = 260 octets

T200 = 1 second

K = 7

T203 = 30 seconds.

- TEI check using UI frames (SAPI=63, TEI = Group TEI (127), Ai = 0)

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2. Frame Structure for peer-to-peer communication

2.1 General

All data link layer peer-to-peer exchanges are in frames conforming to one of the formats shown in Figure III-1. Two format types are shown in the figure; Format A for frames where there is no information field and Format B for frames containing an information field.

2.2 Flag Sequence

All frames shall start and end with the flag sequence consisting of one "0" bit followed by six contiguous "1" bits and one "0" bit. The flag preceding the address field is defined as the opening flag. The flag following the FCS field is defined as the closing flag. The closing flag for one frame can also serve as an opening flag for the next frame.

2.3 Address Field

The address field shall consist of two octets as illustrated in Figure III-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 Section 3.2.

2.4 Control Field

The control field shall consist of one or two octets. Figure III-1 illustrates the two frame formats (A and B), each with a control field of one or two octets, depending upon the type of operation being used.

The format of the control field is defined in Section 3.4.

2.5 Information Field

The information field of a frame, when present, follows the control field (see Section 2.4) and precedes the frame check sequence (see Section 2.7). The contents of the information field shall consist of an integer number of octets. See Section 3 and 4 of Part IV for the coding and grouping of bits in the information field as defined in this Specification.

The maximum number of octets in the information field is defined in Section 5.9.3.

2.6 Transparency

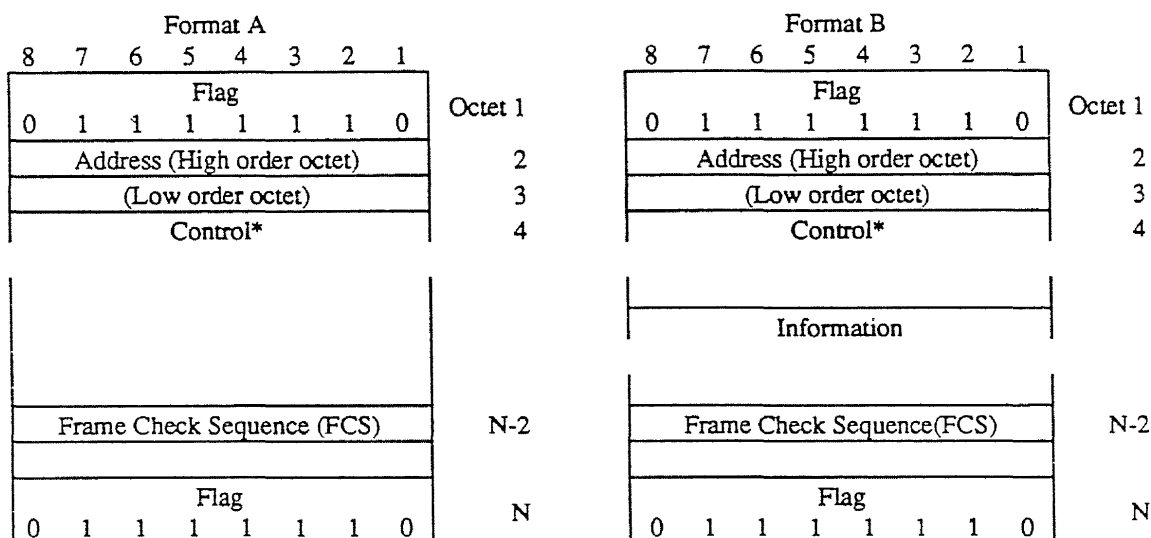
A transmitting data link layer entity shall examine the frame content between the opening and closing flag sequences, (address, control, information and FCS fields) and shall insert a "0" bit after all sequences of five contiguous "1" bits (including the last five bits of the FCS) to ensure that a flag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

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* Unacknowledged operation: 1 octet

Multiple frame operation: 2 octets for frames with sequence numbers
(modulo 128) 1 octet for frames without sequence numbers

Figure III-1. Frame Formats

2.7 Frame Checking Sequence (FCS) Field

The FCS field shall be a sixteen-bit sequence. It shall be the ones complement of the sum (modulo 2) of:

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

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2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ of the serial incoming protected bits and the FCS, will be "0001 1101 0000 1111" (x^{15} through x^0 , respectively) in the absence of transmission errors.

2.8 Format Convention

2.8.1 Numbering Convention

The basic convention used in this Specification is illustrated in Figure III-2. The bits are grouped into octets. The bits of an octet are shown horizontally and are numbered from 1 to 8. Multiple octets are shown vertically and are numbered from 1 to n.

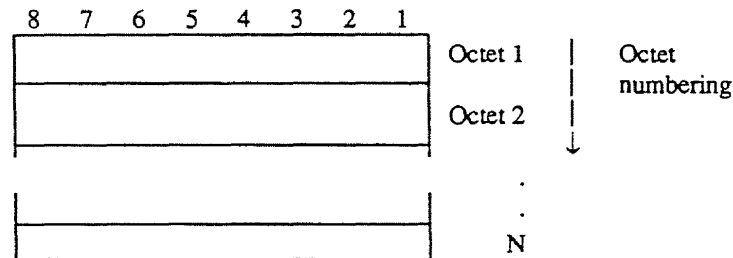


Figure III-2. Format Convention

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 III-3 illustrates 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).

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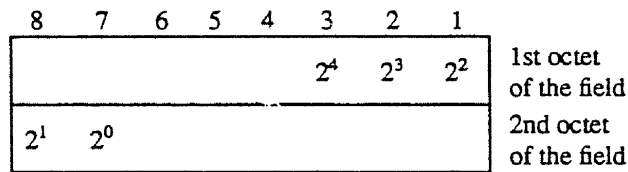


Figure III-3. Field Mapping Convention

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 III-4).

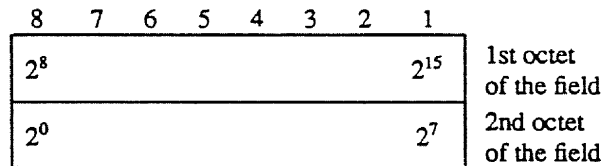


Figure III-4. FCS Mapping Convention

2.9 Invalid Frames

An invalid frame is a frame which:

- a) Is not properly bounded by two flags, or
- b) for unnumbered format frames, has fewer than 5 octets between flags of frames, and for I (Information) and supervisory format frames, fewer than 6 octets between flags, or
- c) does not consist of an integral number of octets prior to zero bit insertion or following zero bit extractions, or
- d) contains a frame check sequence error.

Invalid frames shall be discarded without notification to the sender. No action is taken as the result of that frame.

2.10 Frame Abort

Receipt of seven or more contiguous "1" bits shall be interpreted as an abort and the data link layer entity shall ignore the frame currently being received.

3. Elements of Procedures and Formats of Fields for Data Link Layer peer-to-peer Communication

3.1 General

The elements of procedures define the commands and responses that are used on the data link connections carried on the D-channel.

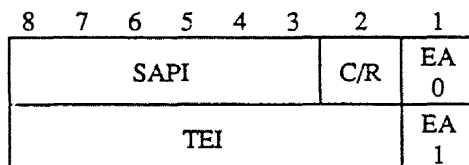
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Procedures are derived from these elements of procedures and are described in Section 5.

3.2 Address Field Format

The address field format shown in Figure III-5 contains the address field extension bits, a command/response indication bit, a data link layer service access point identifier (SAPI) subfield, and a terminal endpoint identifier (TEI) subfield.



EA Address field extension bit
C/R Command/response field bit
SAPI Service Access Point Identifier
TEI Terminal Endpoint Identifier

Figure III-5. Address Field Format

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 shall have bit 1 of the first octet set to "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 shall send commands with the C/R bit set to "0", and responses with the C/R bit set to "1". The network side shall do 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 III-6.

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	Network side C/R value	User side C/R value
Commands from	1	0
Responses to	1	0
Commands to	0	1
Responses from	0	1

Figure III-6. C/R Field Bit Usage

In conformance with HDLC rules, commands use the peer data link layer entity's address while responses use the own data link layer entity's address. According to these rules, both peer entities on a point-to-point data link connection use the same Data Link Connection Identifier (DLCI) composed of a SAPI-TEI.

3.3.3 Service Access Point Identifier (SAPI)

The service access point identifier (SAPI) identifies a point 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 service access points to be specified, where bit 3 of the address field octet containing the SAPI is the least significant binary digit and bit 8 is the most significant. The SAPI values are allocated as follows:

SAPI Value	Related Layer 3 or Management Entity
0	Call Control Procedures
1	Reserved for Packet Mode Communication Protocols Using the Q.931 Call Control Procedures
16	Packet Communication Procedures (X.25)
32-47	Reserved for National Use
63	Management Procedures
All others	Reserved for future standardization

3.3.4 Terminal Endpoint Identifier (TEI)

The terminal endpoint identifier (TEI) for a point-to-point data link connection may be associated with a single terminal (TE). A TE may contain one or more TEIs. The TEI for a broadcast data link is associated with all user side data link layer entities containing the same SAPI. The TEI subfield allows 128 values 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 following conventions shall apply in the assignment of these values.

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3.3.4.1 TEI for Broadcast Data Link Connection

The TEI subfield bit pattern "111 1111" (=127) is defined as the group TEI. The group TEI is assigned to the broadcast data link connection associated with the addressed SAP.

3.3.4.2 TEI for Point-to-Point Data Link Connection

A TEI value of 0 shall be used for point-to-point links. This shall be assigned at subscription time.

3.4 Control Field Formats

The control field identifies the type of frame, which will be either a command or response. The control field will contain sequence numbers, where applicable.

Three types of control field formats are specified: numbered information format transfer (I format), supervisory functions (S format), and unnumbered information transfers and control functions (U format). The control field formats for modulo 128 operation are shown in Figure III-7.

3.4.1 Information Transfer Format - I

The I format shall be used to perform an information transfer between layer 3 entities. The functions of N(S), N(R) and P (defined in Section 3.5) are independent; that is each I frame has an N(S) sequence number, an N(R) sequence number which may or may not acknowledge additional I frames received by the data link layer entity, and a P bit that may be set to "0" or "1". The use of N(S), N(R) and P is defined in Section 5.

3.4.2 Supervisory Format - S

The S format shall be used to perform data link supervisory control functions such as: acknowledge I frames, request retransmission of I frames, and request a temporary suspension of transmission of I frames. The functions of N(R) and P/F are independent; that is, 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 and a P/F bit that may be set to "0" or "1".

3.4.3 Unnumbered Format - U

The U format shall be used to provide additional data link control functions and unnumbered information transfers for unacknowledged information transfer. This format does not contain sequence numbers. It includes a P/F bit that may be set to "0" or "1".

3.5 Control Field Parameters and Associated State Variables

The various parameters associated with the control field formats are described in this section. The coding of the bits within these parameters is such that the lowest numbered bit within the parameter field is the least significant bit.

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Control field bits (modulo 128)	8	7	6	5	4	3	2	1	
I format	N(S)							0	Octet 4
	N(R)							P	5
S format	X	X	X	X	S	S	0	1	Octet 4
	N(R)							P/F	5
U format	M	M	M	P/F	M	M	1	1	Octet 4

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

Figure III-7. Control Field Formats

3.5.1 Poll/Final Bit

All frames contain P/F, the Poll/Final bit. The Poll/Final (P/F) bit serves a function in both command frames and response frames. In command frames the P/F bit is referred to as the P bit. In response frames it is referred to as the F bit. The P bit set to "1" is used by a data link layer entity to create (poll) a response from the peer data link layer entity. The F bit set to "1" is used by a data link layer entity to indicate the response frame transmitted as a result of a soliciting (poll) command.

The use of the P/F bit is described in Section 5.1.

3.5.2 Multiple Frame Operation - Variables and Sequence Numbers

3.5.2.1 Modulus

Each I frame is sequentially numbered and may have the value 0 through "n" minus 1 (where "n" is the modulus of the sequence numbers). The modulus is 128 and the sequence numbers cycle through the entire range, 0 through 127.

3.5.2.2 Send State Variable V(S)

Each point-to-point data link connection endpoint shall have an associated send state variable (V(S)) when using I frame commands. The send state variable denotes the sequence number of the next in-sequence I frame to be transmitted. The send state variable can take on the value 0 through modulus minus 1. The value of the send state variable shall be incremented by 1 with each successive I frame transmission, and shall not exceed V(A) by more than the maximum number of outstanding I frames k. The value of k may be in the range of $1 \leq k \leq 127$ for extended (modulo 128) operation.

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3.5.2.3 Acknowledge State Variable V(A)

Each point-to-point data link connection endpoint shall have an associated acknowledge state variable (V(A)) when using I frame commands and supervisory frame command/responses. The acknowledge state variable identifies the last frame that has been acknowledged by its peer. (V(A)-1 equals the N(S) of last acknowledged I frame). The acknowledge state variable can take on the value 0 through modulus minus 1. The value of the acknowledge state variable shall be updated by the valid N(R) values received from its peer (see Section 3.5.2.6). A valid N(R) value is one that is in the range $V(A) \leq N(R) \leq V(S)$.

3.5.2.4 Send Sequence Number N(S)

Only I frames contain N(S), the send sequence number of transmitted I frames. At the time that an in-sequence I frame is designated for transmission, the value of N(S) is set equal to the value of the send state variable V(S).

3.5.2.5 Receive State Variable V(R)

Each point-to-point data link connection endpoint shall have an associated receive state variable (V(R)) when using I frame commands and supervisory frame commands/responses. The receive state variable denotes the sequence number of the next in-sequence I frame expected to be received. The receive state variable can take on the value 0 through modulus minus 1. The value of the receive state variable shall be incremented by one with the receipt of an error-free, in-sequence I frame whose send sequence number N(S) equals the receive state variable V(R).

3.5.2.6 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. At the time that a frame of the above types is designated for transmission, the value of N(R) 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 Commands and Responses

The following commands and responses are used by either the user or the network data link layer entities and are represented in Figure III-8. Each data link connection shall recognize the full set of commands and responses. Frames associated with an application which is not implemented are treated as invalid frames and ignored by the receiver as defined in Section 2.9.

For purposes of the LAPD procedures, the supervisory function bit encoding "11" and those encodings of the modifier function bits in Figure III-7 not identified in Figure III-8 are identified as "undefined" command and response control fields.

The commands and responses in Figure III-8 are defined as follows:

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Format	Commands	Responses	Encoding							
			8	7	6	5	4	3	2	1
Information transfer	I (information)		N(S)							
			N(R)							
Supervisory	RR (receive ready)	RR (receive ready)	0	0	0	0	0	0	0	1
			N(R)							
	RNR (receive not ready)	RNR (receive not ready)	0	0	0	0	0	1	0	1
			N(R)							
	REJ (reject)	REJ (reject)	0	0	0	0	1	0	0	1
			N(R)							
Unnumbered	SABME (set asynchronous balance mode extended)		0	1	1	P	1	1	1	1
		DM (disconnected mode)	0	0	0	F	1	1	1	1
	UI (unnumbered information)		0	0	0	P	0	0	1	1
	DISC (dis-connect)		0	1	0	P	0	0	1	1
		UA (unnumbered acknowledgement)	0	1	1	F	0	0	1	1
		FRMR (frame reject)	1	0	0	F	0	1	1	1
	XID (exchange identification) *	XID (exchange identification)	1	0	1	P/F	1	1	1	1

0

* Note: There are no procedures presently defined which use the XID command/response frame in Primary Rate Interfaces. Primary Rate applications treat received XID frames as *invalid frames* and will discard these frames without notification to the sender.

Figure III-8. Commands and Responses - Unacknowledged and Multiple Frame Acknowledged (modulo 128) Operation

3.6.1 Information (I) Command

The function of the information (I) command is 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.

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3.6.2 Set Asynchronous Balanced Mode Extended (SABME) Command

The SABME unnumbered command is used to place the addressed user side or network side into modulo 128 multiple frame acknowledged operation.

No information field is permitted with the SABME command. A data link layer entity confirms acceptance of an SABME command by the transmission at the first opportunity of a UA response. Upon acceptance of this command, the data link layer entity's send state variable V(S), acknowledge state variable V(A), receive state variable V(R), and retransmission counter are set to "0". The transmission of an SABME command indicates the clearance of all exception conditions.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged and are discarded. It is the responsibility of a higher level (for example, layer 3) or the management entity to recover from the possible loss of the contents of such I frames.

3.6.3 Disconnect (DISC) Command

The DISC unnumbered command shall be transmitted to terminate the multiple frame operation.

No information field is permitted with the DISC command. Prior to actioning the command, the data link layer entity receiving the DISC command confirms the acceptance of a DISC command by the transmission of a UA response. The data link layer entity sending the DISC command terminates the multiple frame operation when it receives the acknowledging UA or DM response.

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

3.6.4 Unnumbered Information (UI) Command

When a layer 3 or management entity requests unacknowledged information transfer, the UI unnumbered command shall be used to send information to its peer without affecting data link layer variables. UI command frames do not carry a sequence number, therefore, the UI frame may be lost without notification to the management entity if a data link exception occurs during transmission of the command.

3.6.5 Receive Ready (RR) Command/Response

The receive ready (RR) supervisory frame is used by a data link layer entity to:

- a) Indicate it is ready to receive an I frame;
- b) acknowledge previously received I frames numbered up to and including $N(R) - 1$ (as defined in Section 5);
- c) clear a busy condition that was indicated by the earlier transmission of an RNR frame by the 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" may be used by the data link layer entity to ask for the status of its peer data link layer entity.

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3.6.6 Reject (REJ) Command/Response

The reject (REJ) supervisory frame is used by the 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 I frames numbered up to and including $N(R) - 1$. New I frames pending initial transmission shall be transmitted following the retransmitted I frame(s).

Only one REJ exception condition for a given direction of information transfer shall be established at a time. The REJ exception condition is cleared (reset) upon the receipt of an I frame with an $N(S)$ equal to the $N(R)$ of the REJ frame.

The transmission of a REJ frame shall also indicate the clearance of any busy condition in the sending data link layer entity that was reported by the earlier transmission of an RNR frame by the same data link layer entity.

In addition to indicating the status of a data link layer entity, the REJ command with 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 Receive Not Ready (RNR) Command/Response

The receive not ready (RNR) supervisory frame shall be 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 $N(R)$ in the RNR frame acknowledges I frames numbered up to and including $N(R) - 1$. Acknowledgement of I frame $N(R)$ and subsequent I frames received, if any, will be indicated in subsequent exchanges.

In addition to indicating the status of a data link layer entity, the RNR command with 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.

3.6.8 Unnumbered Acknowledgment (UA) Response

The UA unnumbered 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 actioned until the UA response is transmitted. No information field is permitted with the UA response. The transmission of the UA response indicates the clearance of any busy condition that was reported by the earlier transmission of an RNR frame by that same data link layer entity.

3.6.9 Disconnected Mode (DM) Response

The DM unnumbered response is used by a data link layer entity to report to its peer that the data link layer entity is in a state such that multiple frame operation cannot be performed. No information field is permitted with the DM response. A data link layer entity shall transmit a DM response to any valid command received which it cannot action.

3.6.10 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 conditions, which results from the receipt of a *valid* frame:

- a) The receipt of a command or response control field that is undefined (e.g., not identified in Figure III-8).

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- b) the receipt of a frame with an information field which is not permitted or the receipt of a supervisory or unnumbered frame with incorrect length; (Note this refers to a valid frame - if a frame was too short to qualify (Sec III-2.9), it would have been discarded.)
- c) the receipt of an invalid N(R); or
- d) the receipt of an I frame with an information field which exceeds the maximum established length.

An undefined control field is any of the control field encodings that are not identified in Figure III-8.

A valid N(R) value is one that is in the range $V(A) \leq N(R) \leq V(S)$.

If the frame being rejected has an undefined control field or if it is a response with an invalid N(R) field, then the Final bit of the FRMR should be set to "0". Otherwise, the final bit of the FRMR should be set to the value of the poll bit of the rejected frame.

An information field which immediately follows the control field and consists of five octets for modulo 128 extended operation, is returned with this response and provides the reason for the FRMR response. This information field format is given in Figure III-9.

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8	7	6	5	4	3	2	1	
Rejected Frame								Octet 5
Control Field								6
V(S)							0	7
V(R)							C/R	8
0	0	0	0	Z	Y	X	W	9

- Rejected frame control field is the control field of the received frame which caused the frame reject. When the rejected frame is an unnumbered frame, the control field of the rejected frame is positioned in octet 5, with octet 6 set to "0000 0000".
- V(S) is the current send state variable value on the user side or network side reporting the rejection condition.
- C/R is set to "1" if the frame rejected was a response and is set to "0" if the frame rejected was a command.
- V(R) is the current receive state variable value on the user side or network side reporting the rejection condition.
- W set to "1" indicates that the control field received and returned in octet 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 is a supervisory or unnumbered frame with 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 capacity (N201) of the user side or network side reporting the rejection condition.
- Z 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, shall be set to "0".

Figure III-9. FRMR Information Field Format - Extended (modulo 128) Operation

3.6.11 Exchange Identification (XID) command/response

There are no procedures presently defined which use the XID command/response frame in Primary Rate Interfaces. Primary Rate applications treat received XID frames as *invalid frames* and will discard these frames without notification to the sender.

4. Elements for Layer-to-Layer Communication

4.1 General

Communications between the data link layer and the management layer entity, and the data link layer and Layer 3, are accomplished by means of primitives.

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Primitives represent, in an abstract way, the logical exchange of information and control between the data link 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:

XX - Generic name - Type: Parameters

where XX designates the layer providing the service. For example, DL for the data link layer, PH for the physical layer, or MDL for the management entity to the data link layer interface.

4.1.1 Generic Names

The generic name specifies the activity that the identified layer should perform. Figure III-10 illustrates the primitives defined in this Specification. Note that not all primitives have associated parameters.

The primitive generic names that are defined in this Specification are:

4.1.1.1 DL-ESTABLISH

The DL-ESTABLISH primitives are used to request, confirm and indicate the outcome of the procedures for establishing multiple frame operation.

4.1.1.2 DL-RELEASE

The DL-RELEASE primitives are used to request, confirm and indicate the outcome of the procedures for terminating a previously established multiple frame operation, or for reporting an unsuccessful establishment attempt.

4.1.1.3 DL-DATA

The DL-DATA primitives are used to pass layer 3 messages to and from the data link layer which are to be transmitted, or have been received, using acknowledged operation.

4.1.1.4 DL-UNIT-DATA

The DL-UNIT-DATA primitives are used to pass layer 3 messages to and from the data link layer which are to be transmitted, or have been received, using unacknowledged operation.

4.1.1.5 MDL-ASSIGN

The MDL-ASSIGN-REQUEST primitives are used by the 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(s). The MDL-ASSIGN-INDICATION primitive is used by the data link layer to indicate to the management entity the need for a TEI value.

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4.1.1.6 MDL-REMOVE

The MDL-REMOVE primitives are used by the management entity to request that the data link layer remove the association of the specified TEI value with the specified connection endpoints. The TEI and connection endpoints are specified by the REMOVE primitive message unit.

4.1.1.7 MDL-ERROR

The MDL-ERROR primitives are used to notify the management entity that an error has occurred, associated with a previous management function request or detected as a result of 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.

4.1.1.8 MDL-UNIT-DATA

The MDL-UNIT-DATA primitives are used to pass management entity messages to and from the data link layer which are to be transmitted, or have been received, using unacknowledged operation.

4.1.1.9 PH-DATA

The PH-DATA primitives are used to pass to and receive from the physical layer, message units containing frames used for data link layer peer-to-peer communications.

4.1.2 Primitive Types

The primitive types defined in this Specification are:

4.1.2.1 REQUEST

The REQUEST primitive type is used when a higher layer is requesting a service from the next lower layer.

4.1.2.2 INDICATION

The INDICATION primitive type is used by a layer providing a service to notify the next higher layer of activities related to the REQUEST primitive type.

4.1.2.3 RESPONSE

The RESPONSE primitive type is used by a layer to acknowledge receipt, from a lower layer, of the INDICATION primitive type.

4.1.2.4 CONFIRM

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

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4.1.3 Parameter definition

4.1.3.1 Priority indicator

Since several SAPs may exist within a network or a user, protocol message units sent by one SAP may contend with those of other service access points for the physical resources available for message transfer. The priority indicator is used to determine which message unit will have greater priority when contention exists.

4.1.3.2 Message unit

The message unit contains additional layer-to-layer information concerning actions and results associated with requests. In the case of the data primitive, 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 data link layer-layer 3 boundary shall be such that the layer sending the DATA or UNIT DATA primitive can assume a temporal order of the bits within the message unit and that the layer receiving the primitive can reconstruct the message with its assumed temporal order.

Generic	Type				Parameters		Message contents
	Request	Indication	Response	Confirm	Priority Indicator	Message unit	
L3 <--> L2							
DL-ESTABLISH	X	X	*	X	*	*	
DL-RELEASE	X	X	*	X	*	*	
DL-DATA	X	X	*	*	*	X	network layer peer-to-peer message
DL-UNIT DATA	X	X	*	*	*	X	
M <--> L2							
MDL-ASSIGN	X	X	*	*	*	X	TEI value
MDL-REMOVE	X	*	*	*	*	X	TEI value
MDL-ERROR	*	X	X	*	*	X	Reason for error mess.
MDL-UNIT DATA	X	X	*	*	*	X	Management function peer-to-peer message
L2 <--> L1							
PH-DATA	X	X	*	*	X	X	Data link layer peer-to-peer message

X - Currently Defined * For further study

L3<-->L2: Layer 3/data link layer boundary
 L2<-->L1: Data link layer/physical boundary
 M <-->L2: Management entity/data link layer boundary

Figure III-10. Primitives Associated with the Data Link Layer

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5. Definition of the Peer-to-Peer Procedures of the Data Link Layer

The procedures for use by the data link layer entities are specified in the following sections.

The elements of procedures (frame types) which apply are:

- a) not implemented on primary rate (Section 3.6.11)

XID command/response

- b) for unacknowledged information transfer (Section 5.2)

UI-command

- c) for multiple frame acknowledged information transfer (Section 5.7 to 5.10)

SABME-command

UA-response

DM-response

DISC-command

RR-command/response

RNR-command/response

REJ-command/response

I-command

FRMR-response

5.1 Procedure for the use of the P Bit

5.1.1 Unacknowledged Information Transfer

With unacknowledged information transfer, the P-bit is not used and shall be set to "0".

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", shall set the F bit to "1" in the next response frame it transmits as defined in Figure III-11:

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

Figure III-11. Use of P/F Bit: Immediate Response Operation of P/F Bit

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5.2 Procedures for Unacknowledged Information Transfer

5.2.1 General

The procedures which apply to the transmission of information in unacknowledged operation using the UI frame are defined below.

No data link layer error recovery procedures are defined for unacknowledged operation.

5.2.2 Transmission of Unacknowledged Information

Note - The term "transmission of a UI frame" refers to the delivery of a UI frame to the physical layer by the data link layer.

Unacknowledged information is passed to the data link layer by layer 3 or management entities using the primitive DL-UNIT-DATA-REQUEST or MDL-UNIT-DATA-REQUEST, respectively. The layer 3 or management message should be transmitted in a UI command frame.

For broadcast operation, the TEI value in the UI command address field shall be set to 127 (binary "111 1111", the group value).

For point-to-point operation, the appropriate TEI value shall be used.

The P-bit shall be set to "0".

5.2.3 Receipt of Unacknowledged Information

On receipt of a UI command with a SAPI which is supported by the receiver, the contents of the information field shall be passed to the layer 3 or management entity using the primitive DL-UNIT-DATA-INDICATION or MDL-UNIT-DATA-INDICATION respectively. Otherwise the UI command frame shall be discarded.

5.3 Administration of Terminal Endpoint Identifier (TEI)

For the Primary Interface, a TEI value of "0" is assumed to be assigned at subscription time. Automatic TEI assignment procedures are not supported. Conceptually, the Management Entity delivers the TEI value of "0" to the data link layer entity via the MDL-ASSIGN-REQ primitive, thereby causing the data link layer entity to enter the TEI Assigned State. Likewise, conceptually upon loss of power or other similar condition, the Management Entity instructs the data link layer entity to remove the TEI value "0" using the MDL-REMOVE-REQ primitive in order to place the data link layer entity into the TEI Unassigned State. As with TEI assignment, no procedures are actually supported for removing TEI values on the Primary Rate Interface.

The network may use the TEI Check Routine Procedure (Section 5.3.3) to check the existence of this presubscribed TEI.

5.3.1 Reserved for Future Use

5.3.2 Reserved for Future Use

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5.3.3 Check Routine Procedure

5.3.3.1 Use of the Check Routine Procedure

The check routine procedure may be used for audit and recovery procedures.

5.3.3.2 Operation of the Check Procedure

The check routine procedure is illustrated in Figure III-12.

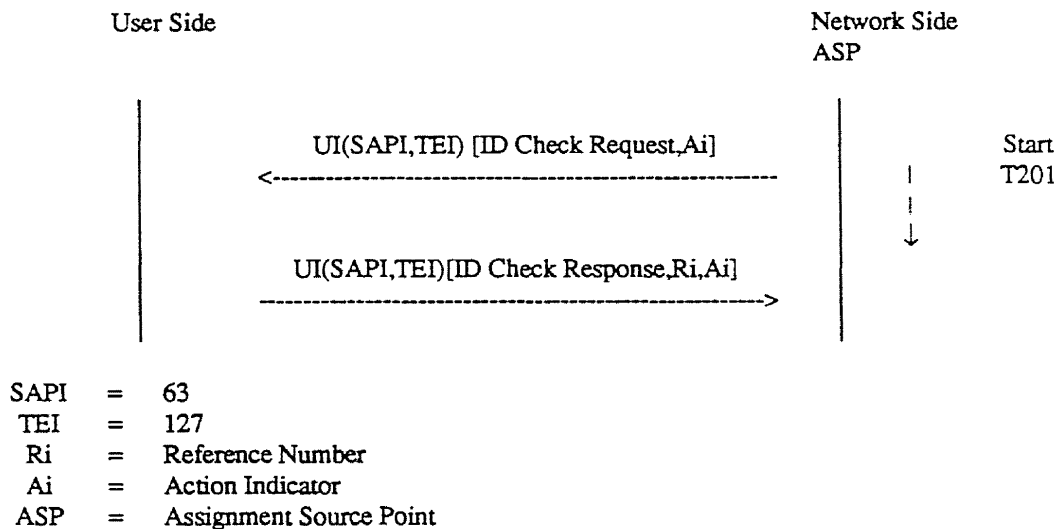


Figure III-12. Check Routine

The management entity on the network side, referred to as the Assignment Source Point (ASP) shall transmit a message containing the following elements:

- Message type = identity check request; and
- The TEI value to be checked in the Ai field, or if all TEI values are to be checked, the value of Ai = 127. For the primary interface, Ai can only take on the value of 0.

Timer T201 shall be started.

If any user equipment has been assigned the TEI value specified in the check message, it shall respond by transmitting a message containing the following elements:

- Message type = Identity check response
- The TEI value in the Ai field
- Reference number (Ri)

The Identity check response informs the ASP that the specific TEI value is already assigned.

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If no Identity check response is received within T201 the request shall be repeated once and T201 restarted. (T201 is defined in Section 5.9.6).

5.3.4 Reserved for Future Use

5.3.5 Formats and Codes

5.3.5.1 General

All messages used for TEI assignment procedures are carried in the information field of UI command frames with a SAPI value set to 63 (binary "11 1111") and TEI value set to 127 (binary "111 1111").

All messages are of fixed length and have the following structure:

8	7	6	5	4	3	2	1	
Management entity identifier								Octet 1
Reference								2
Number								3
Message type								4
Action indicator							1	5

Fields that are not used in a specific message are coded all zeroes. The coding of each field for the various messages is specified in Figure III-13.

	Message name	Management entity Identifier	Reference number Ri	Message type	Action Indicator Ai
network to user	Identity check request	0000 1111	Not used (coded 0)	0000 0100	Ai = 0 TEI value to be checked 127 = check all TEI values
user to network	Identity check response	0000 1111	0-65535	0000 0101	Ai = 0 TEI value in use

Figure III-13. Codes for Messages Concerning TEI Administration

5.3.5.2 Management Entity Identifier

Octet 1 contains the management entity identifier. Its use is for further study. For TEI Administration procedures, the Management entity identifier is 0000 1111.

5.3.5.3 Reference Number (Ri)

Octets 2 and 3 contain the reference number (Ri). When used, it can assume any value between 0 and 65535.

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5.3.5.4 Message Type

Octet 4 contains the message type. The purpose of the message type is to identify the function of the message being sent.

5.3.5.5 Action Indicator (Ai)

Octet 5 is coded as follows:

- a) Bit 1 shall be coded "1";
- b) bits 2 to 8 contain the action indicator.

The purpose of the action indicator is to identify the concerned TEI values.

5.4 Reserved for Future Use

5.5 Procedures for Establishment and Release of Multiple Frame Operation

5.5.1 Establishment of Multiple Frame Operation

Modulo-128 sequencing shall be used for acknowledged multiple frame mode of operation.

5.5.1.1 General

These procedures shall be used to establish multiple frame operation between the network and a designated user entity.

Layer 3 will indicate a request for establishment of the multiple frame operation by the use of the DL-ESTABLISH REQUEST primitive. Re-establishment may be initiated as a result of the data link layer procedures defined in Section 5.7. All frames other than unnumbered frame formats received during the establishment procedures shall be ignored.

5.5.1.2 Establishment Procedures

A data link layer entity shall initiate a request for the multiple frame operation to be set by transmitting the Set Asynchronous Balanced Mode Extended (SABME) command. All existing exception conditions shall be cleared, the retransmission counter shall be reset, and timer T200 shall then be started (timer T200 is defined in Section 5.9.1). All mode setting commands shall be transmitted with the P bit set to "1". The establishment procedure implies the discard of all outstanding DL-DATA REQUESTS and I frames in the queue.

A data link layer entity receiving an SABME command shall, if it is able to enter multiple frame mode of operation:

- respond with an Unnumbered Acknowledgement (UA) response with the F bit set to the same binary value as the P bit in the received SABME command;
- set the send state variable V(S), receive state variable V(R) and acknowledge state variable V(A) to 0;

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- enter the multiple-frame-established state and inform Layer 3 using the primitive DL-ESTABLISH INDICATION;
- reset the retransmission counter;
- clear all existing exception conditions;
- clear any existing peer receiver busy condition; and
- start timer T203, if implemented.

If the data link layer entity is unable to enter the multiple-frame-established mode, it shall respond to the SABME command with a DM response with the F bit set to the same binary value as the P bit in the received SABME command.

Upon reception of the UA response with the F bit set to "1", the originator of the SABME shall:

- reset timer T200;
- start timer T203, if implemented;
- set the send state variable V(S), receive state variable V(R) and acknowledge state variable V(A) to 0; and
- enter the multiple-frame-established state and inform the layer 3 using the primitive DL-ESTABLISH CONFIRM.

Upon reception of a DM response with the F bit set to "1", the originator of the SABME shall indicate this to layer 3 by means of the primitive DL-RELEASE INDICATION and reset timer T200. It shall then enter the TEI-assigned state. DM responses with F=0 shall be ignored.

5.5.1.3 Procedure on Expiry of Timer T200

If timer T200 expires before the UA or DM response is received, the data link layer entity shall:

- retransmit the SABME command as above;
- restart timer T200; and
- increment the retransmission counter.

After retransmission of the SABME command N200 times, the data link layer entity shall indicate this to layer 3 and the management entity by means of the primitives DL-RELEASE INDICATION and MDL-ERROR INDICATION, respectively, and enter the TEI-assigned state, after discarding all outstanding DL-DATA-REQUESTS and I frames in the queue.

The value of N200 is defined in Section 5.9.2.

5.5.2 Information Transfer

Having either, transmitted the UA response to a received SABME command or received the UA response to the transmitted SABME command, I frames and supervisory frames shall be transmitted and received according to the procedures described in Section 5.6.

If an SABME command is received while in the multiple-frame-established state, the data link layer entity shall conform to the re-establishment procedure described in Section 5.7.

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On receipt of a UI command the procedures defined in Section 5.2 shall be followed.

5.5.3 Termination of Multiple Frame Operation

5.5.3.1 General

These procedures shall be used to terminate the multiple frame operation between the network and a designated user entity.

A layer 3 entity shall indicate a request for termination of the multiple frame operation by the use of the DL-RELEASE REQUEST primitive.

All frames other than the unnumbered frames received during the release procedures shall be ignored.

All outstanding DL-DATA-REQUESTS and I frames in the queue shall be discarded.

5.5.3.2 Release Procedure

A data link layer entity shall initiate a request for release of multiple frame operation by transmitting the Disconnect (DISC) command with the P bit set to "1". Timer T200 shall then be started and the retransmission counter reset.

A data link layer entity receiving a DISC command while in the multiple-frame-established state shall transmit a UA response with the F bit set to the same binary value as the P bit in the received DISC command. A DL-RELEASE INDICATION shall be passed to Layer 3 and the TEI-assigned state shall be entered.

If the originator of the DISC command receives either:

- a UA response; or
- a DM response

with F bit set to "1" indicating that the peer data link layer entity is in the TEI-assigned state, it shall enter the TEI-assigned state and reset timer T200. A DL-RELEASE-CONFIRM primitive will be issued to layer 3.

The data link layer entity which issued the DISC will now be in the TEI-assigned state. The conditions relating to this state are defined in Section 5.5.4.

5.5.3.3 Procedure on Expiry of Timer T200

If timer T200 expires before a response is received, the originator of the DISC command shall:

- retransmit the DISC command;
- restart timer T200; and
- increment the retransmission counter.

If the data link layer entity has not received the correct response as defined above after N200 attempts to recover, the data link layer entity shall indicate this to the management entity by means of the primitive MDL-ERROR INDICATION and enter the TEI-assigned state. A DL-RELEASE-CONFIRM primitive is sent to layer 3.

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The value of N200 is defined in Section 5.9.2.

5.5.4 TEI-assigned State

While in the TEI-assigned state:

- the receipt of a DISC command shall result in the transmission of a DM response with the F bit set to the value of the received P bit;
- the receipt of an I frame or supervisory frame with the P bit set to "1" may result in the transmission of a DM response with the F bit set to "1" (as defined in Section 5.1);
- the content of any received I frame shall be discarded;
- on receipt of an SABME command, the procedures defined in Section 5.5.1.2 shall be followed;
- on receipt of UI commands, the procedures defined in Section 5.1 shall be followed;
- on receipt of an unsolicited UA response, issue an MDL-ERROR-INDICATION;
- all other frame types shall be discarded.

5.5.5 Collision of Unnumbered Commands and Responses

Collision situations shall be resolved in the following way:

5.5.5.1 Identical Transmitted and Received Commands

If the transmitted and received unnumbered commands (SABME or DISC) are the same, the data link layer entities shall send the UA response at the earliest possible opportunity. The indicated state shall be entered after receiving the UA response. The data link layer entities shall each notify its respective layer 3 entity, by means of the appropriate confirm primitive.

5.5.5.2 Different Transmitted and Received Commands

If the transmitted and received unnumbered commands (SABME or DISC) are different, the data link layer entities shall issue a DM response at the earliest possible opportunity. Upon receipt of a DM response with F bit set to "1", the data link layer shall enter the TEI Assigned state and notify layer 3 by means of the appropriate primitive. The data link layer entity receiving the DISC shall notify its respective layer 3 entity by means of the DL_RELEASE_INDICATION primitive, and the other by means of the DL_RELEASE_CONFIRM primitive.

5.5.5.3 Unsolicited DM Response and SABME or DISC Command

When a DM response with the F bit set to "0" is issued by a data link layer entity at the user side, a collision between an SABME or DISC command and the unsolicited DM response may occur. This is typically caused by a terminal applying a protocol procedure according to X.25 LAPB [9], to ask for a mode-setting command.

In order to avoid misinterpretation of the DM response received, a data link layer entity shall always send its SABME or DISC command with the P bit set to "1".

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A DM response with the F bit set to "0" colliding with an SABME or DISC shall be ignored.

5.6 Procedures for Information Transfer In Multiple Frame Operation

The procedures which apply to the transmission of I frames are defined below.

Note - The term "transmission of an I frame" refers to the delivery of an I frame to the physical layer by the data link layer.

5.6.1 Transmitting I Frames

Information received by the data link layer entity from layer 3 by means of a DL-DATA REQUEST primitive shall be transmitted in an I frame. The control field parameters N(S) and N(R) shall be 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) shall be incremented by 1 at the end of the transmission of the I frame.

If timer T200 is not running at the time of transmission of an I frame, it shall be started. If timer T200 expires, the procedures defined in Section 5.6.7 shall be followed.

If the send state variable V(S) is equal to V(A) plus k (where k is the maximum number of outstanding I frames - see Section 5.9.4), the data link layer entity shall not transmit any new I frames, but may retransmit an I frame as a result of the error recovery procedures as described in Sections 5.6.4 and 5.6.7.

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

When the network side or user side is in the frame rejection condition, it shall stop transmitting I frames.

5.6.2 Receiving I Frames

When a data link layer entity is not in a receiver busy condition and receives a valid I frame whose send sequence number is equal to the current receive state variable V(R), the data link layer entity shall:

- pass the information field of this frame to layer 3 using the primitive DL-DATA-INDICATION;
- increment by 1 its receive state variable V(R), and act as indicated below.

5.6.2.1 P Bit Set to 1

If the P bit of the received I frame was set to "1", the data link layer entity shall transmit an RR response with the F bit set to "1" (as defined in Section 5.1), if the data link layer entity is still not in an own receiver busy condition. It shall transmit an RNR response with the F bit set to "1", if the data link layer entity is now in an own receiver busy condition.

* In the following text in this Specification, the term own/peer receiver busy refers to the peer-to-peer flow control state in the the data link layer entities.

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5.6.2.2 P Bit Set to 0

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

- a) 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 shall transmit 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 shall transmit the I frame with the value of N(R) set to the current value of V(R) as defined in Section 5.8.1.
- b) if on receipt of this I frame the data link layer entity is now in an own receiver busy condition, it shall transmit an RNR response with the F bit set to "0".

When the data link layer entity is in an own receiver busy condition, it shall process any received I frame according to Section 5.6.6.

5.6.3 Sending and Receiving Acknowledgement

5.6.3.1 Sending Acknowledgement

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

5.6.3.2 Receiving Acknowledgement

On receipt of a valid I frame or supervisory frame (RR, RNR or REJ), even in the own receiver busy or timer recovery condition, the data link layer entity shall treat the N(R) contained in this frame as an acknowledgement for all the I frames it has transmitted with an N(S) up to and including the received N(R) - 1. The value of the acknowledge state variable V(A) shall be set to the value of N(R). The data link layer entity shall reset the timer T200 on receipt of a valid I frame or supervisory frame with the N(R) higher than V(A) (actually acknowledging some I frames), or a REJ with an N(R) equal to the V(A).

Note 1 - If a supervisory frame with P bit set to "1" has been transmitted and not acknowledged, timer T200 shall not be reset.

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

If 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 shall restart timer T200. If timer T200 then expires, the data link layer entity shall follow the recovery procedure as defined in Section 5.6.7 with respect to the unacknowledged I frames.

If timer T200 has been reset by the receipt of a REJ frame, the data link layer entity shall follow the retransmission procedures in Section 5.6.4.

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5.6.4 Receiving Reject

On receipt of a valid REJ frame, the data link layer entity shall act as follows:

- a. if it is not in the timer recovery state:
 - clear an existing peer receiver busy condition;
 - set 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;
 - stop timer T200;
 - start timer T203, if implemented;
 - transmit the corresponding I frame as soon as possible, as defined in Section 5.6.1, taking into account the items 1) to 4) and the paragraph at the end of this section; and
 - notify a protocol violation to the management entity by means of the primitive MDL-ERROR-INDICATION, if it was an unsolicited REJ response frame with the F bit set to "1".
- b. if it is in the timer recovery state and it was a REJ response frame with the F bit set to "1":
 - clear an existing peer receiver busy condition;
 - set its send state variable V(S) and its acknowledge state variable V(A) to the value N(R) contained in the REJ frame control field;
 - stop timer T200;
 - start timer T203, if implemented;
 - enter the multiple-frame-established state; and
 - transmit the corresponding I frame as soon as possible, as defined in Section 5.6.1, taking into account the items 1) to 3) and the paragraph at the end of this section.
- c. if it is in the timer recovery state and it was an REJ frame other than a REJ response frame with the F bit set to "1":
 - clear an existing peer receiver busy condition;
 - set its acknowledge state variable V(A) to the value of the N(R) contained in the REJ frame control field; and
 - if it was a REJ command frame with the P bit set to "1", transmit an RR or RNR supervisory frame, as appropriate, with the F bit set to "1".
See note 2 in Section 5.6.5.

Transmission of I frames shall take account of the following:

1. if the data link layer entity is transmitting a supervisory frame when it receives the REJ frame, it shall complete that transmission before commencing transmission of the requested I frame;
2. if the data link layer entity is transmitting an SABME or DISC command or an UA, DM or FRMR response when it receives the REJ frame, it shall ignore the request for retransmission;
3. if the data link layer entity is not transmitting a frame when the REJ is received, it shall immediately commence transmission of the requested frame.

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4. it may terminate the I frame so long as it does not cause an FRMR condition at the receiver.

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

5.6.5 Receiving RNR Frames

After receiving a valid RNR command or response, if the data link layer entity is not engaged in a mode setting operation, it shall set a peer receiver busy condition and then:

- if it was an RNR command with the P bit set to "1", it shall respond with an RR response with the F bit set to "1" if the data link layer entity is not in an own receiver busy condition, and shall respond with an RNR response with the F bit set to "1" if the data link layer entity is in an own receiver busy condition; and
- if it was an RNR response with the F bit set to "1", an existing timer recovery condition shall be cleared and the N(R) contained in the RNR response shall be used to update the send state variable V(S).

The data link layer entity shall take note of the peer receiver busy condition and not transmit I frames to the peer which indicated the busy condition.

Note 1 - The N(R) in any received supervisory command (including RNR) with a P bit set to "1" will not be used to update the send state variable V(S).

The data link layer entity shall then:

- treat the receive sequence number N(R) contained in the received RNR frame as an acknowledgement for all the I frames that have been (re)transmitted with an N(S) up to and including N(R) minus 1, and set its acknowledge state variable V(A) to the value of the N(R) contained in the RNR frame; and
- restart timer T200 unless a supervisory response frame with the F bit set to "1" is still expected.

Upon expiry of timer T200 the data link layer entity shall:

- if it is not yet in a timer recovery condition, enter the timer recovery condition and reset the retransmission count variable; or
- if it is already in a timer recovery condition or status enquiry add one to its retransmission count variable.

The data link layer entity shall, if the value of the retransmission count variable is less than N200, transmit an RR or REJ command as appropriate (see Note 2 below) with the P bit set to "1" if the data link layer entity is not in an own receiver busy condition, and an RNR command with the P bit set to "1" if the data link layer entity is in an own receiver busy condition:

- and restart timer T200; or
- if the value of the retransmission count variable is equal to N200, it shall initiate the re-establishment procedure described in Section 5.7. The management entity shall be notified via the MDL-ERROR-INDICATION primitive. (N200 is a system parameter, see Section 5.9.2).

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The peer data link layer entity receiving the supervisory frame with the P bit set to "1" shall respond, at the earliest opportunity, with a supervisory response frame (RR, RNR, or REJ) with the F bit set to "1", to indicate whether or not its own receiver busy condition still exists.

Upon receipt of the supervisory response with the F bit set to "1", the data link layer entity shall reset timer T200, and:

- if the response is an RR or REJ response, the peer receiver busy condition is cleared and the data link layer entity may transmit new I frames or retransmit I frames as defined in Section 5.6.1 or 5.6.4 respectively; or
- if the response is an RNR response, the data link layer entity receiving the response shall proceed according to this Section 5.6.5, first paragraph.

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 inquiry process, the data link layer entity shall:

- if the supervisory frame is an RR or REJ command or response frame with the F bit set to "0", clear the peer receiver busy condition and transmit the appropriate supervisory response frame (see Note 2 below) with the F bit set to "1", if the supervisory frame was a command with the P bit set to "1". However, the transmission or retransmission of I frames shall not be undertaken until the appropriate supervisory response frame with the F bit set to "1" is received, or
- if the supervisory frame is an RNR command or response frame with the F bit set to "0", retain the peer receiver busy condition. The inquiry of the peer status shall be repeated following the expiry of timer T200, or after expiry of timer T200 following the receipt of the RNR response with the F bit set to "1".

Should the received supervisory command contain the P bit set to "1", the appropriate response frame (see Note 2 below) with the F bit set to "1" must be transmitted before the data link layer entity can action the received frame.

Receiving an SABME command the data link layer entity shall clear the peer receiver busy condition.

Note 2 -

- If the data link layer is not in an Own Receiver Busy Condition and is in a Reject exception condition (i.e., N(S) sequence error has been received), and/or a REJ frame has been transmitted, but the requested I frame has not been received, the appropriate supervisory command is the RR command.
- If the data link layer entity is not in an Own Receiver Busy condition, but is in an N(S) sequence error exception condition, (i.e., an N(S) sequence error has been received but a REJ frame has not been transmitted), the appropriate supervisory command is the REJ command.
- If the data link layer entity is in its Own Receiver Busy condition, the appropriate supervisory command is the RNR command.
- Otherwise, the appropriate supervisory command is the RR command.

5.6.6 Data link layer own receiver busy condition

When the data link layer entity enters an own receiver busy condition, it shall transmit an RNR frame at the earliest opportunity. The RNR frame may be either:

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- an RNR response with the F bit set to "0"; or
- if this condition is entered upon receiving a command frame with the P bit set to "1", an RNR response frame with the F bit set to "1"; or
- if this condition is entered upon the expiry of timer T200, an RNR command with the P bit set to "1".

All received I frames with the P bit set to "0" shall be discarded, after updating the acknowledge state variable V(A).

All received supervisory frames with the P/F bit set to "0" shall be processed, including updating the acknowledge state variable V(A).

All received I frames with the P bit set to "1" shall be discarded, after updating the acknowledge state variable V(A). However, an RNR response frame with the F bit set to "1" shall be transmitted.

All received supervisory frames with the P bit set to "1" shall be processed including updating the acknowledge state variable V(A). An RNR response with the F bit set to "1" shall be transmitted.

To indicate to the peer data link layer entity the clearance of the own receiver busy condition, the data link layer entity shall transmit an RR frame or, if a previously detected N(S) sequence error has not yet been reported a 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 the clearance of the own receiver busy condition.

5.6.7 Waiting Acknowledgement

The data link layer entity shall maintain an internal retransmission count variable.

If timer T200 expires the data link layer entity shall:

- if it is not yet in the timer recovery condition, enter the timer recovery condition and reset the retransmission count variable; or
- if it is already in the timer recovery condition add one to its retransmission count variable.

The data link layer entity shall then:

- a. if the value of the retransmission count variable is less than N200:
 - restart timer T200; and either
 - transmit an appropriate supervisory command (see Note 1 below) with the P bit set to "1"; or
 - retransmit the last transmitted I frame (V(S) - 1) with the P bit set to "1"; or
- b. if the value of the retransmission count variable is equal to N200, initiate a re-establishment procedure as defined in Section 5.7 and indicate this by means of the primitive MDL-ERROR-INDICATION to the management entity.

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 received supervisory frame N(R) is within the range from its current state variable V(A) to its current send state variable V(S) inclusive, it shall set its send state variable V(S) to the value of the received N(R). Timer T200 shall be reset if the received supervisory frame response is an RR or REJ response, and then the data link layer entity shall resume with I frame transmission or retransmission, as appropriate (see Note 1 below). Timer T200 shall be reset and restarted

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if the received supervisory response is an RNR response, to proceed with the enquiry process according to Section 5.6.5.

Note 1 -

- If the data link layer entity is in its Own Receiver Busy condition and is in a Reject exception condition (i.e.; N(S) sequence error has been received), and/or a REJ frame has been transmitted, but the requested I frame has not been received, the appropriate supervisory command is the RNR command.
- If the data link layer entity is not in an Own Receiver Busy condition, but is in an N(S) sequence error has been received but a REJ frame has not been transmitted), the appropriate supervisory command is the REJ command.
- If the data link layer entity is not in its Own Receiver Busy condition, the appropriate supervisory command is the RR command.
- Otherwise, the appropriate supervisory command is the RR command.

5.7 Re-establishment of multiple frame operation

5.7.1 Criteria for re-establishment

The criteria for re-establishing multiple frame operation are defined in this section and are initiated by the receipt of the DL-ESTABLISH-REQUEST from layer 3 or by the following conditions:

- the receipt, while in the multiple-frame mode of operation, of an unsolicited UA or DM (F=1) response; (this is an implementation option)
- the receipt of a frame with procedure errors as defined in Section 5.8.5;
- the receipt, while in the multiple frame established state, of an unsolicited DM response with F bit set to "0";
- the receipt, while in the multiple frame established state, of an FRMR response (see Section 5.8.6);
- the receipt of an invalid N(R) (see Section 5.8.2);
- N200 retransmission failures while in the timer recovery condition (see Section 5.8.3);
- the receipt, while in the multiple frame established state, of an SABME command.

5.7.2 Procedures

If a data link layer entity initiates a re-establishment procedure, this shall be indicated to the management entity by means of the primitive MDL-ERROR-INDICATION and the contents of all I queues will be discarded.

In all re-establishment situations, the procedures defined in Section 5.5.1.2 shall be used. After successful re-establishment initiated by the data link layer, the primitive DL-ESTABLISH-INDICATION shall be used to inform layer 3. In case of layer 3 initiated re-establishment or if a DL-ESTABLISH-REQUEST occurs pending re-establishment, the primitive DL-ESTABLISHMENT CONFIRM shall be used.

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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 this section.

5.8.1 N(S) Sequence Error

An N(S) sequence error exception condition occurs in the receiver when a valid I frame is received which contains an N(S) value which is not equal to the receive state variable V(R) at the receiver. The information field of all I frames whose N(S) does not equal the receive state variable V(R) shall be discarded.

The receiver shall not acknowledge (nor increment its receive state variable) the I frame causing the sequence error, nor any I frames which may follow, until an I frame with the correct N(S) is received.

A data link layer entity which receives one or more I frames having sequence errors but otherwise error-free or subsequent supervisory frames (RR, RNR and REJ) shall use the control field information contained in N(R) field and the P or F bit to perform link control functions; for example, to receive acknowledgement of previously transmitted I frames and to cause 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 and P bit that are updated from, and therefore different from, the ones contained in the originally transmitted I frame.

The REJ frame is used by a receiving data link layer entity to initiate an exception recovery (retransmission) following the detection of an N(S) sequence error.

Only one REJ exception condition for a given direction of information transfer shall be established at a time.

A data link layer entity receiving a REJ command or response shall initiate sequential transmission (retransmission) of 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, is received.

5.8.2 N(R) Sequence Error

An N(R) sequence error exception condition occurs in the transmitter when a valid supervisory frame or I frame is received which contains an invalid N(R) value.

A valid N(R) is one that is in the range $V(A) \leq N(R) \leq V(S)$.

The data link entity shall inform the connection management entity of this exception condition by means of an MDL-ERROR-INDICATION primitive, and initiate re-establishment according to Section 5.5.1.

5.8.3 Timer Recovery Condition

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

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The data link layer which transmitted the unacknowledged I frame(s) shall, on the expiry of timer T200, take appropriate recovery action as defined in Section 5.6.7 to determine at which I frame retransmission must begin.

5.8.4 Invalid Frame Condition

Any frame received which is invalid (as defined in Sections 2.9 and 3.6) shall be discarded, and no action shall be taken as a result of that frame.

5.8.5 Frame Rejection Condition

A frame rejection condition shall be established upon the receipt of an error-free frame with one of the conditions listed in Section 3.6.10.

At either side, this frame rejection condition may optionally be indicated by transmission of an FRMR response for appropriate action, by the other side, followed by the transmission of an SABME or DISC command.

Once the frame rejection condition has been established, no additional I frames or supervisory frames shall be processed (except for examination of the P bit) until the condition is reset.

Alternatively, the data link layer entity may initiate re-establishment directly by transmitting an SABME command.

5.8.6 Receipt of an FRMR Response Frame

Upon receipt of an FRMR response frame in the multiple-frame mode of operation, the data link entity shall:

- issue an MDL-ERROR-INDICATION primitive; and
- initiate re-establishment (see Section 5.7).

5.9 List of System Parameters

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

5.9.1 Timer T200

The default* value for timer T200 at the end of which transmission of a frame may be initiated according to the procedures described in Sections 5.5 and 5.6 shall be one second.

* The term default implies that the value defined should be used in the absence of any assignment of alternative values.

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5.9.2 Maximum Number of Retransmissions (N200)

The maximum number of retransmissions of a frame (N200) is a system parameter. The default value of N200 shall be 3.

5.9.3 Maximum Number of Octets in an I Field (N201)

The maximum number of octets in an I field (N201) is 260 octets for both signaling and packet data (See also Section 2.5).

5.9.4 Maximum Number of Outstanding I Frames (k)

The maximum number (k) of sequentially numbered I frames that may be outstanding (that is, unacknowledged) at any given time is a system parameter.

— For a SAP supporting signaling, the default value shall be 7.

5.9.5 Timer T203

Timer T203 governs the maximum period of link inactivity (as defined in Section 5.10.2). Its default value shall be 30 seconds. Note that the value of this timer is largely an implementation-dependent option. A recommended range is 15-60 seconds.

5.9.6 Timer T201

The minimum time between retransmission of the TEI-identity check messages (T201) is a system parameter which shall be set to T200 seconds.

5.10 Status Inquiry Procedure

5.10.1 Introduction

This procedure allows link supervision to be performed in the multiple frame established state.

5.10.2 Data link layer supervision in the multiple frame established state

This connection verification is a service provided by 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 be more efficient than a procedure based on the involvement of layer 3.

The procedure specified here is based on supervisory command frames (RR command, RNR command) and a timer T203 and operates in the multiple-frame-established state as follows.

If there are no frames being exchanged on the data link connection (neither new nor outstanding I frames or no supervisory frames with a P bit set to "1", etc.), there is no means to detect a faulty data link connection condition or if a TE has been unplugged. 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 to start a STATUS ENQUIRY. Such a status enquiry is protected against transmission errors, making use of the normal timer T200 procedure including retransmission count and N200 attempts.

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5.10.3 Connection verification procedures

5.10.3.1 Handling of timer T203

5.10.3.1.1 Start of Timer T203

The timer T203 is started

- when the multiple frame established state is entered
- in the multiple frame established state whenever T200 is stopped.

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

5.10.3.1.2 Restart of Timer T203

Upon receiving an I or supervisory frame, timer T203 will be restarted if timer T200 is not to be started.

5.10.3.1.3 Stop of Timer T203

The timer T203 is stopped

- when in the multiple frame established state, the timer T200 is started;
- upon leaving the multiple frame established state.

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

5.10.3.2 Expiry of timer T203

Timer T203 supports a supervisory mechanism to detect a faulty data link connection condition or if a TE has been unplugged during intervals when there are no outstanding frames in either direction. It represents the maximum time allowed without frames being exchanged on a data link layer connection.

If timer T203 expires, the data link layer entity will act as follows (it should be noted that timer T200 is neither running nor expired):

1. set the retransmission count variable to 0;
2. enter timer recovery state;
3. transmit a supervisory command with the P bit set to "1" as follows:
 - if there is not a receiver busy condition (own receiver not busy), transmit an RR command; or
 - if there is a receiver busy condition (own receiver busy), transmit an RNR command; and
4. start timer T200.
5. retransmit the supervisory command (P bit = 1) up to N200 times
6. Attempt re-establishment if above step fails.
7. If re-establishment attempt fails after N200 retransmissions, transmit MDL-ERROR_INDICATION to the management entity, and a DL-RELEASE-INDICATION to the layer 3 entity.

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APPENDIX III.A

AN SDL REPRESENTATION OF THE POINT TO POINT PROCEDURES OF THE DATA LINK LAYER

A.1 INTRODUCTION

The purpose of this appendix is to provide one example of an SDL representation of the point-to-point procedures of the data link layer, to assist in the understanding of this Specification. This representation does not describe all of the possible actions of the data link layer entity, as a non-partitioned representation was selected in order to minimize its complexity. The SDL representation does not therefore constrain implementations from exploiting the full scope of the procedures as presented within the text of this Specification. The text description of the procedures is definitive.

A.1.1 An Overview of the States of the Point-to-Point Data Link Layer Entity

The SDL representation of the point to point procedures is based on an expansion of the three basic states identified in Figure 9-Q.920 to the following eight states:

1. TEI unassigned
2. Assign awaiting TEI
3. Establish awaiting TEI
4. TEI assigned
5. Awaiting establishment
6. Awaiting release
7. Multiple frame established
8. Timer recovery.

For the Primary interface, state 1 (TEI_UNASSIGNED) is relevant due to the reasons described in Section III-5.3. On power-up, it is assumed that the management entity issues an MDL_ASSIGN_REQ primitive to the data link layer entity with the TEI value of "0", thus causing the data link layer entity to enter the TEI_ASSIGNED state. Since automatic TEI assignment procedures are not supported for the primary rate interface, states 2 and 3 are not relevant to the Primary interface. The receipt of an establish request in the TEI assigned state (state 4) will cause the initiation of the establishment procedures and the transition to the awaiting establishment state (state 5). Completion of the LAP establishment procedures takes the data link layer entity into the multiple-frame-established state (state 7). Peer initiated establishment causes a direct transition from the TEI assigned state (state 4) to the multiple-frame-established state (state 7). In the multiple-frame-established state (state 7), acknowledged data transfer requests can be serviced directly subject to the restrictions of the procedures. Expiry of the timer T200, which is used in both the flow control and data transfer aspects of the data link layer entity's procedures initiates the transition to the timer recovery state (state 8). Completion of the timer recovery procedures will return the data link layer entity to the multiple-frame-established state (state 7). In states 7 and 8 of the SDL representation, the following conditions which are identified within the specification are observed:

1. Peer receiver busy

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2. Reject exception

3. Own receiver busy

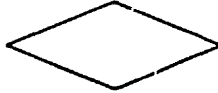
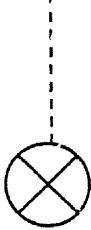
In addition other conditions are used in order to avoid identification of additional states. The complete combination of both of these categories of conditions with the eight states of the SDL representation, is the basis for the state transition table description of the data link layer entity. A peer initiated LAP release will take the data link layer entity directly into the TEI assigned state (state 4), whilst a release request will be via the awaiting release state (state 6). TEI removal will cause a transition to the TEI unassigned state (state 1).

A.1.2 Cover Notes

The following symbols are used within this description. A full description of their meaning and application can be found in the CCITT Z series Recommendations.

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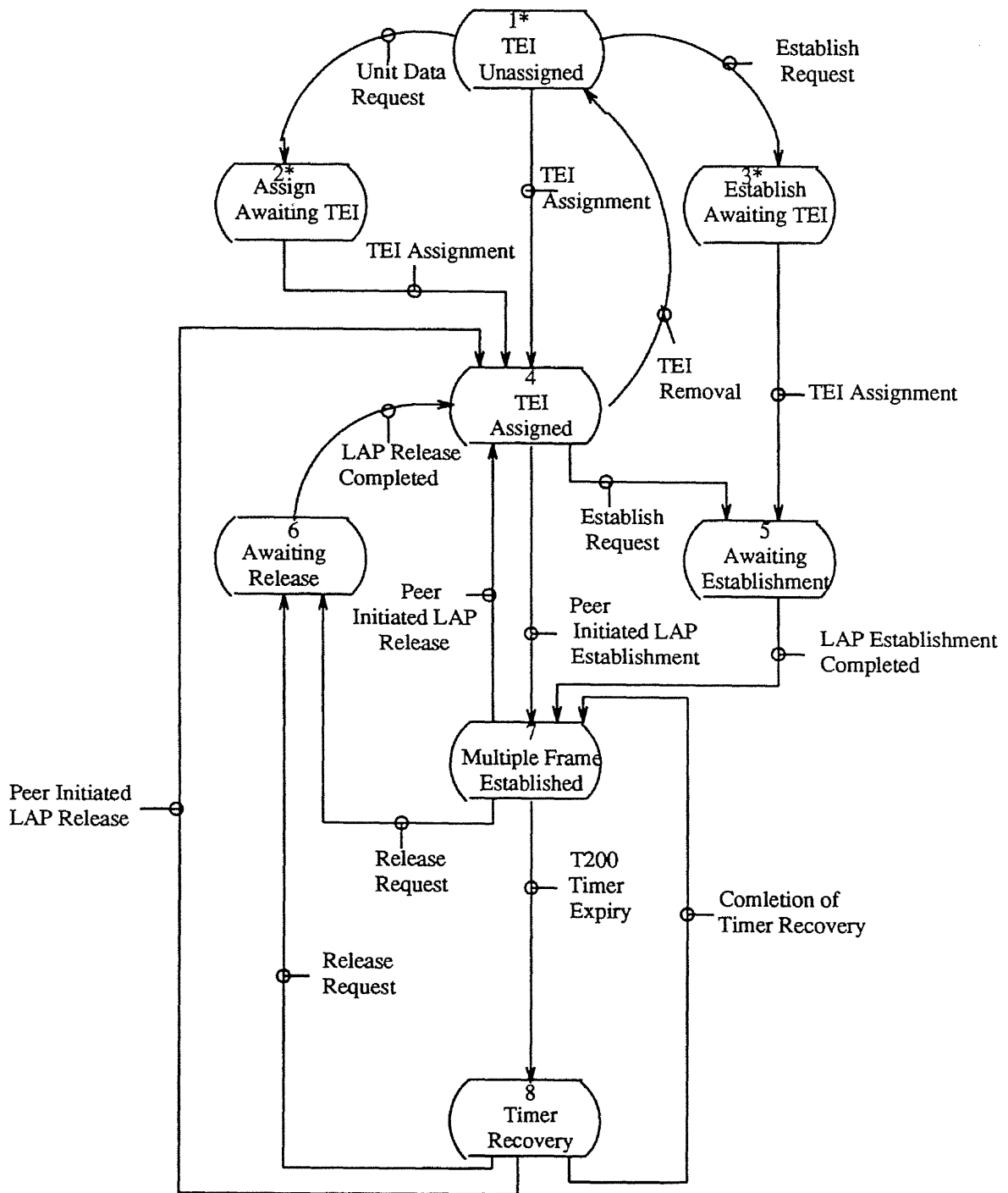
1.  State
 2.  Event occurrence.
 3.  Signal generation (which will lead to an associated event occurrence).
 4.  Save an event (until completion of a transition).
 5.  Process description.
 6.  Test
 7.  Procedure call.
 8.  Implementation option.
 9.  Procedure definition.
- 
10. * To mark an event or signal required as a result of the representation approach adopted which is local to the data link layer entity.

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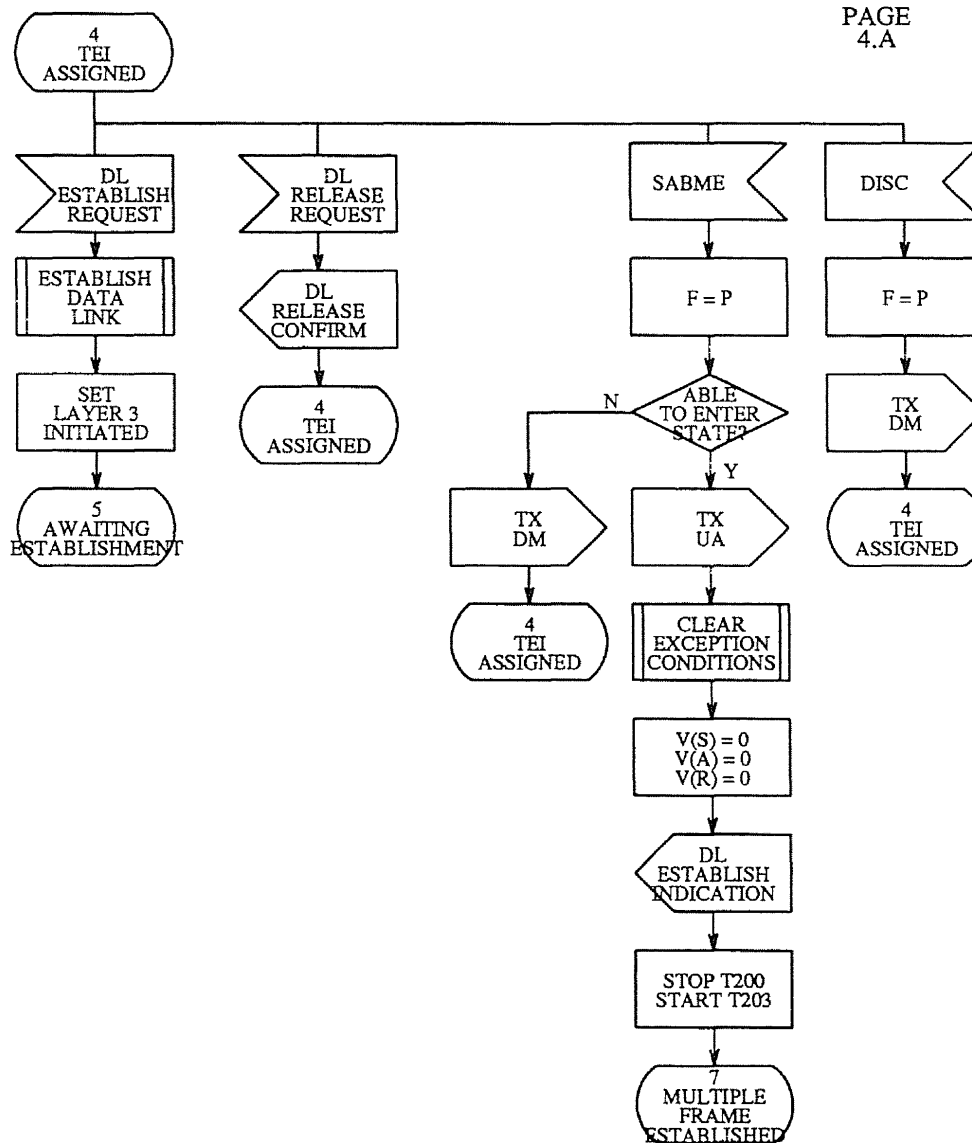


* States 1, 2, and 3 are not relevant to the primary interface.

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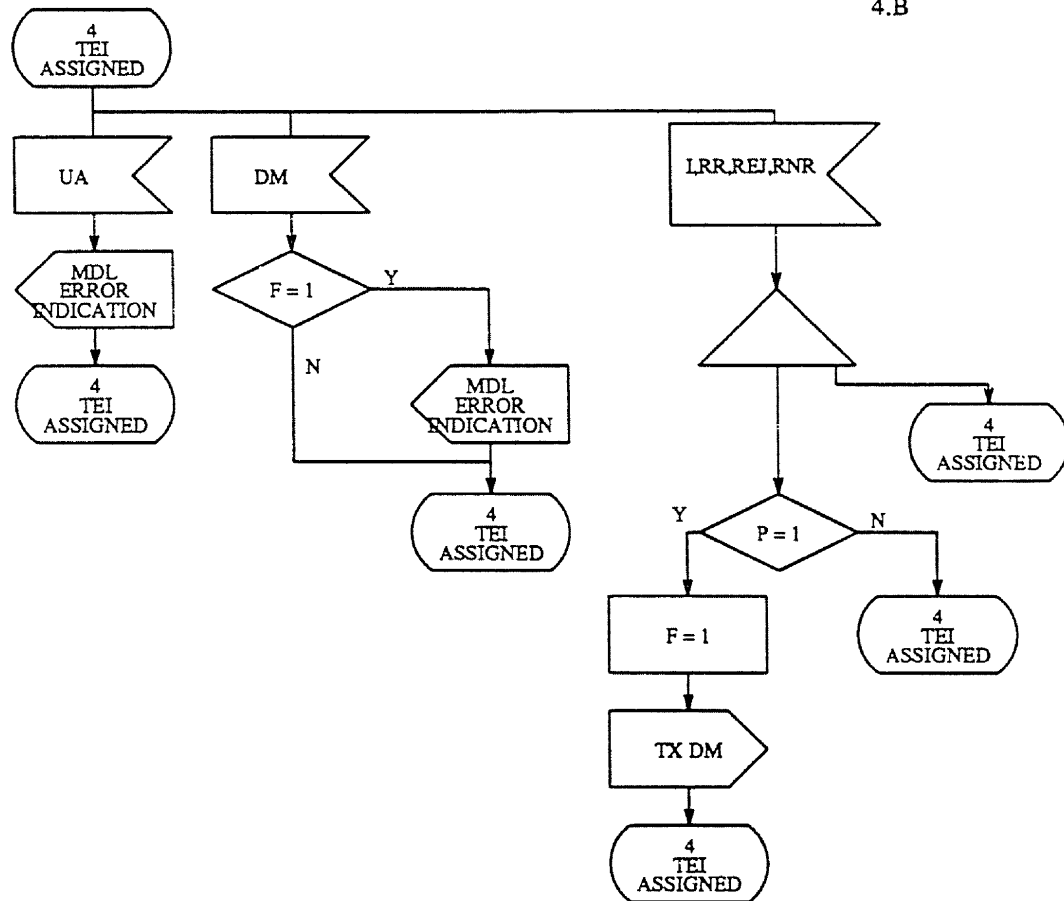


AN SDL REPRESENTATION OF THE POINT TO POINT PROCEDURES OF THE DATA LINK LAYER

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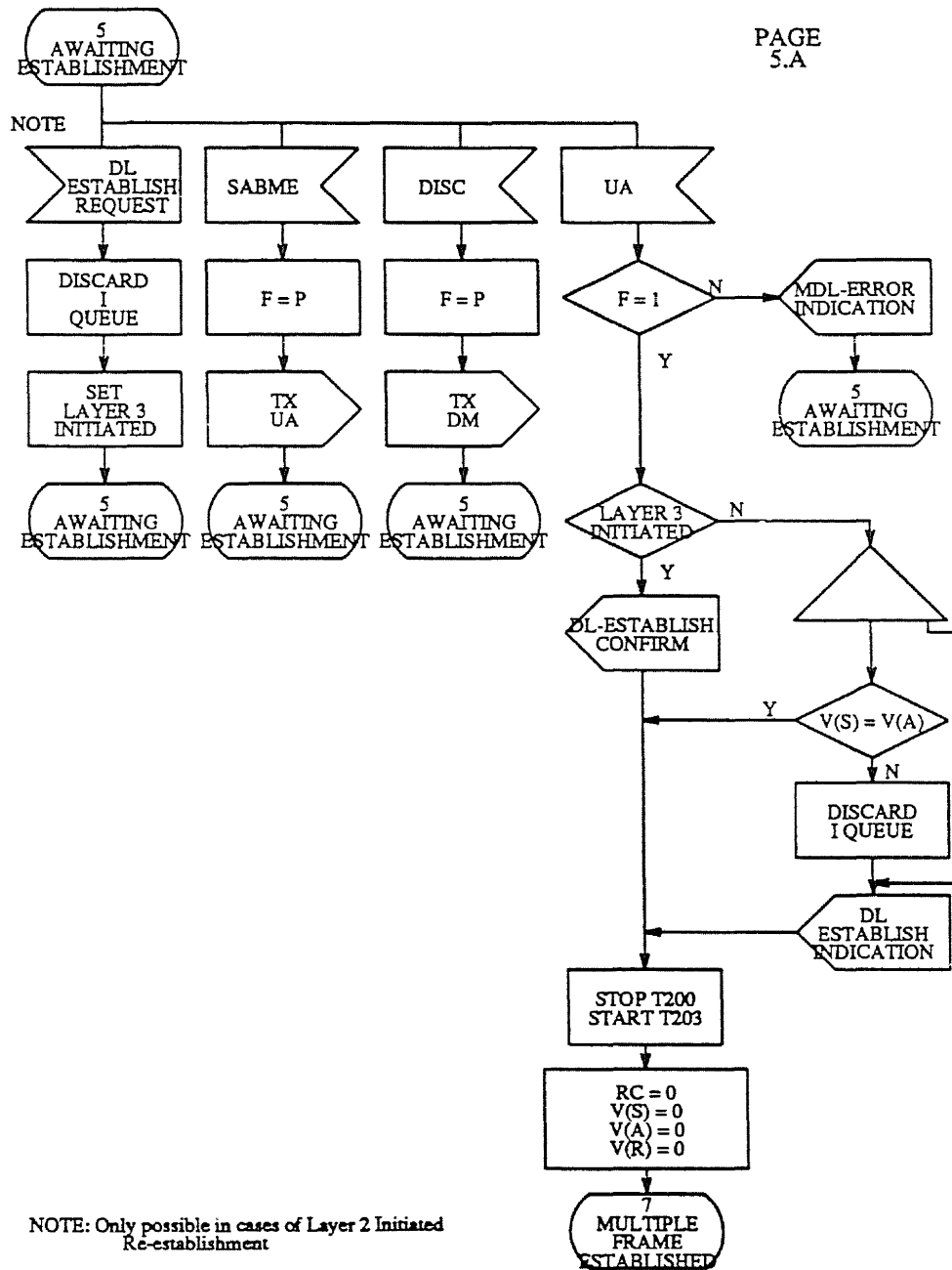
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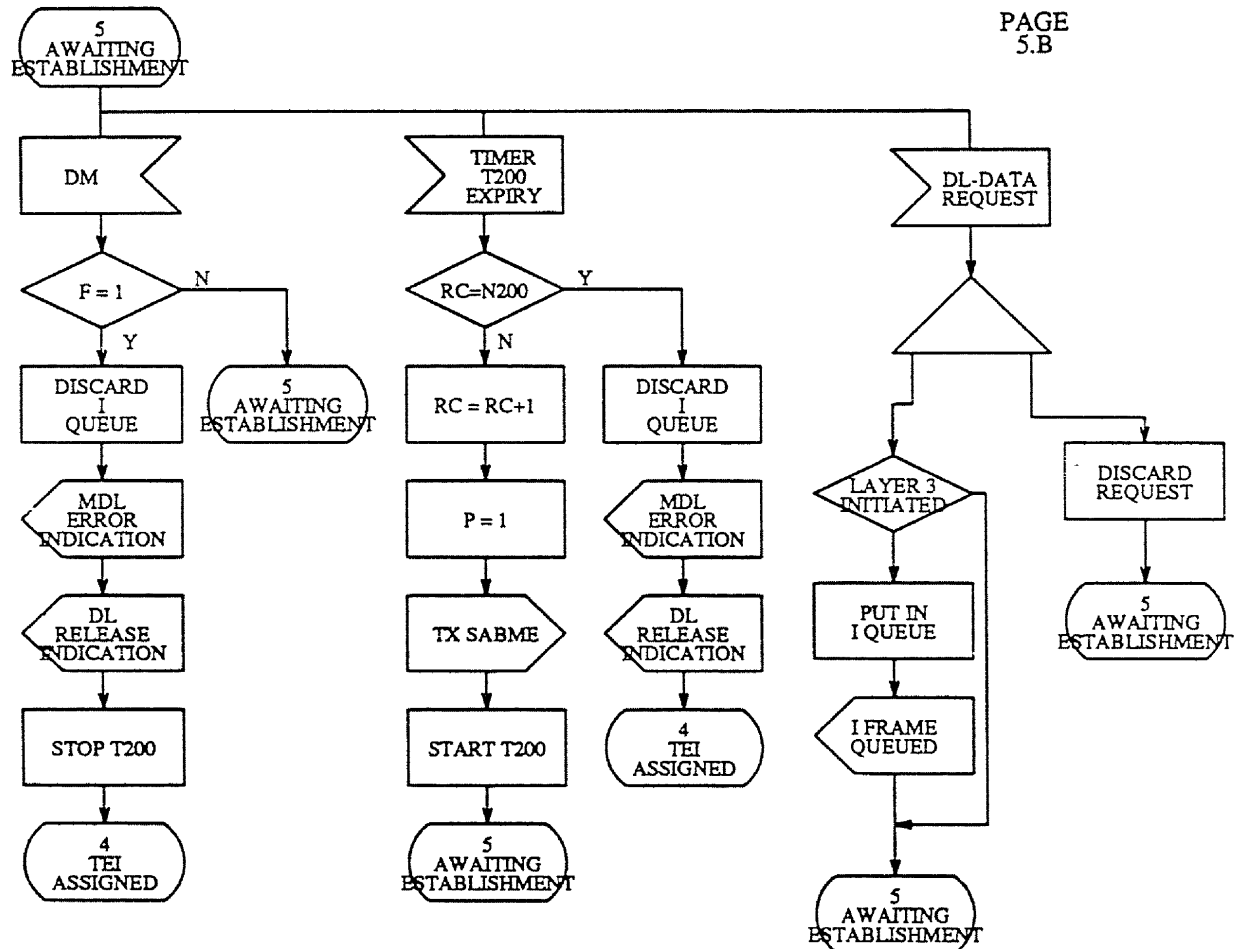
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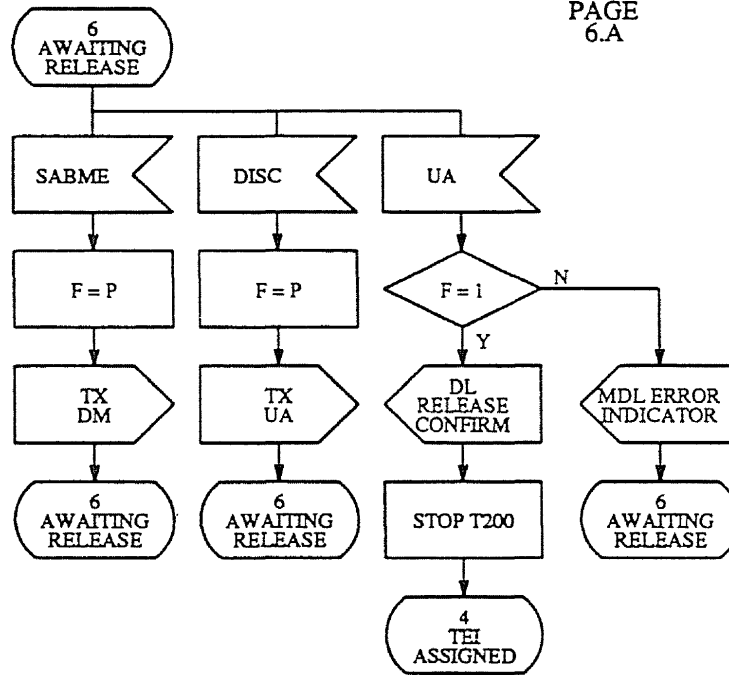
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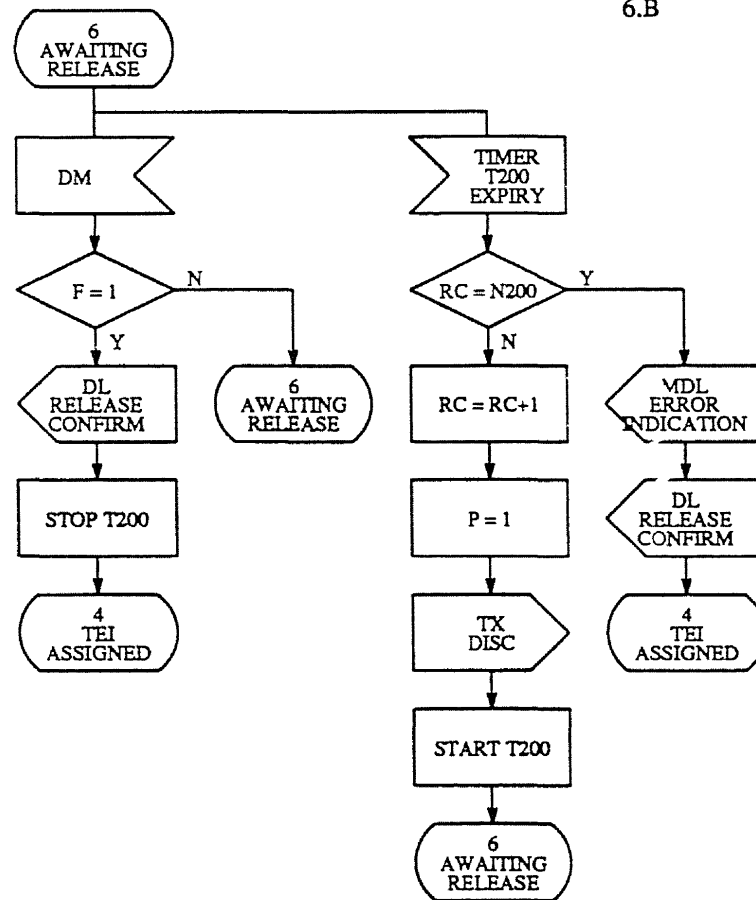


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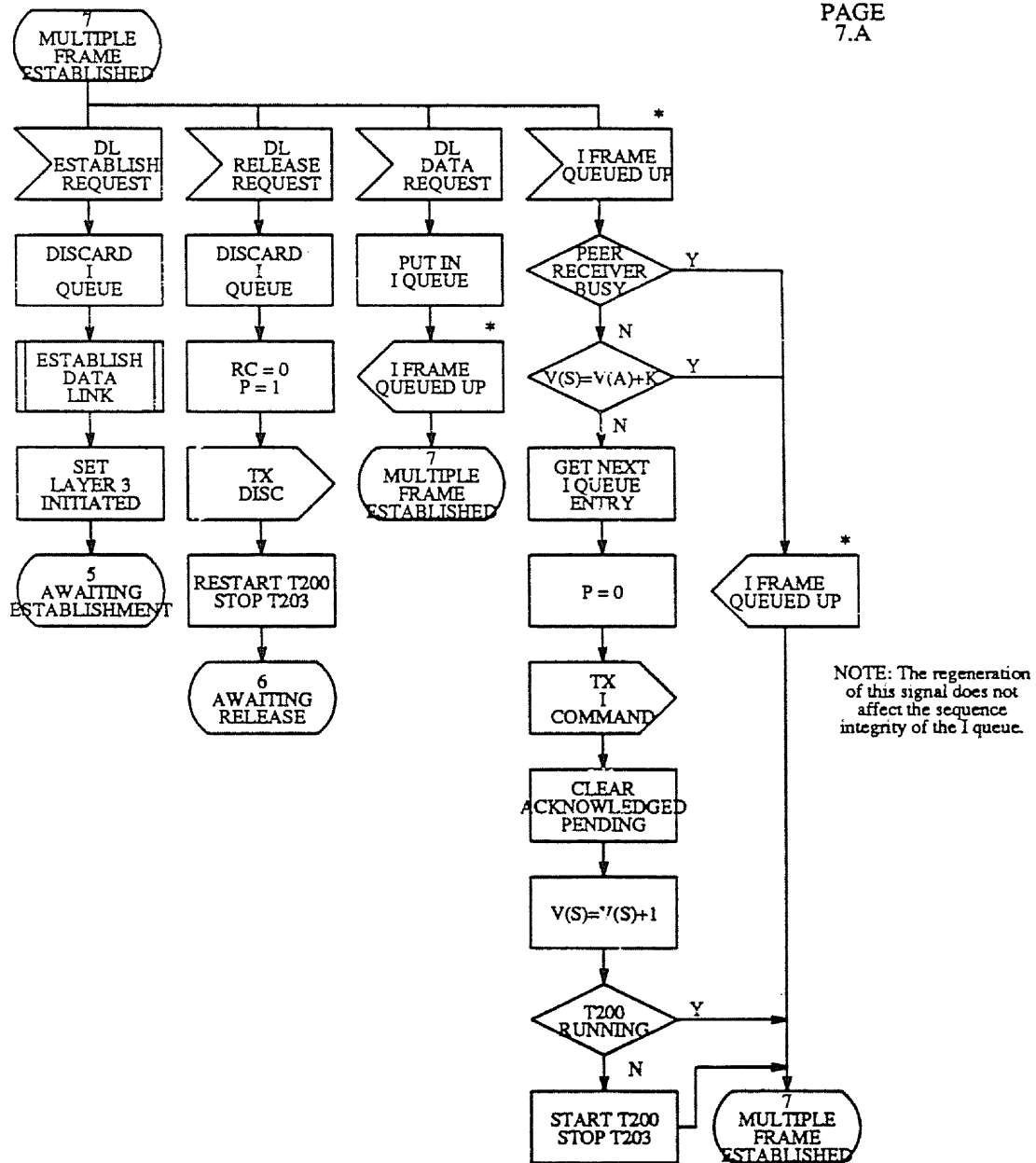
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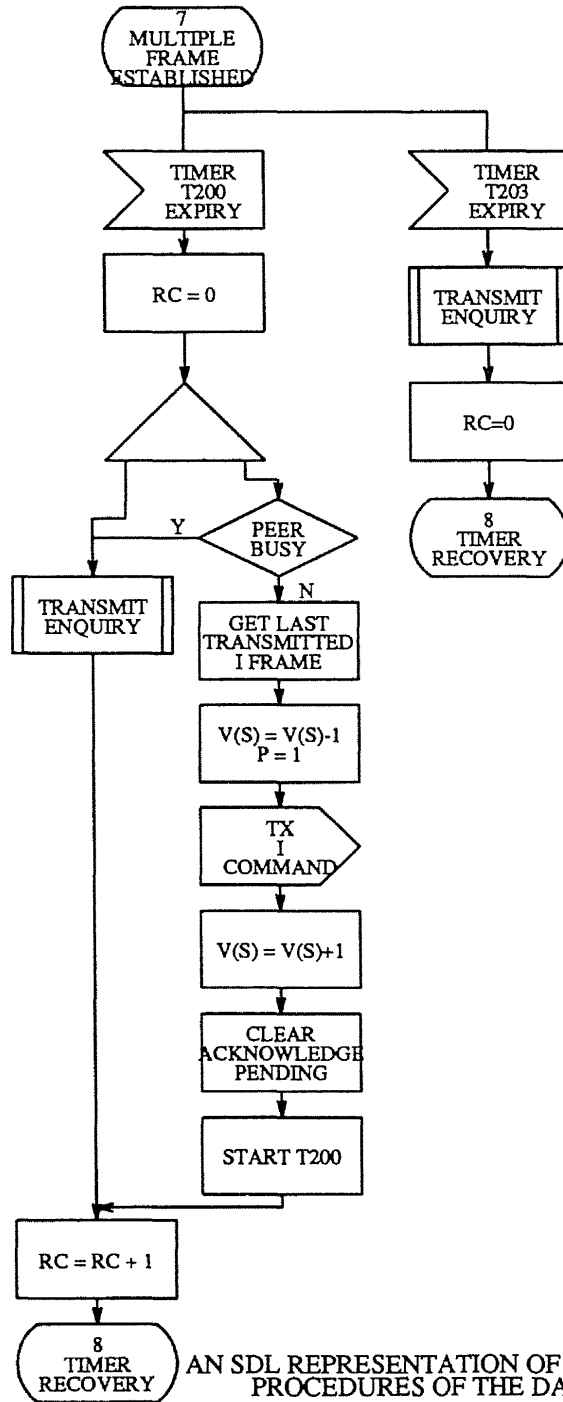
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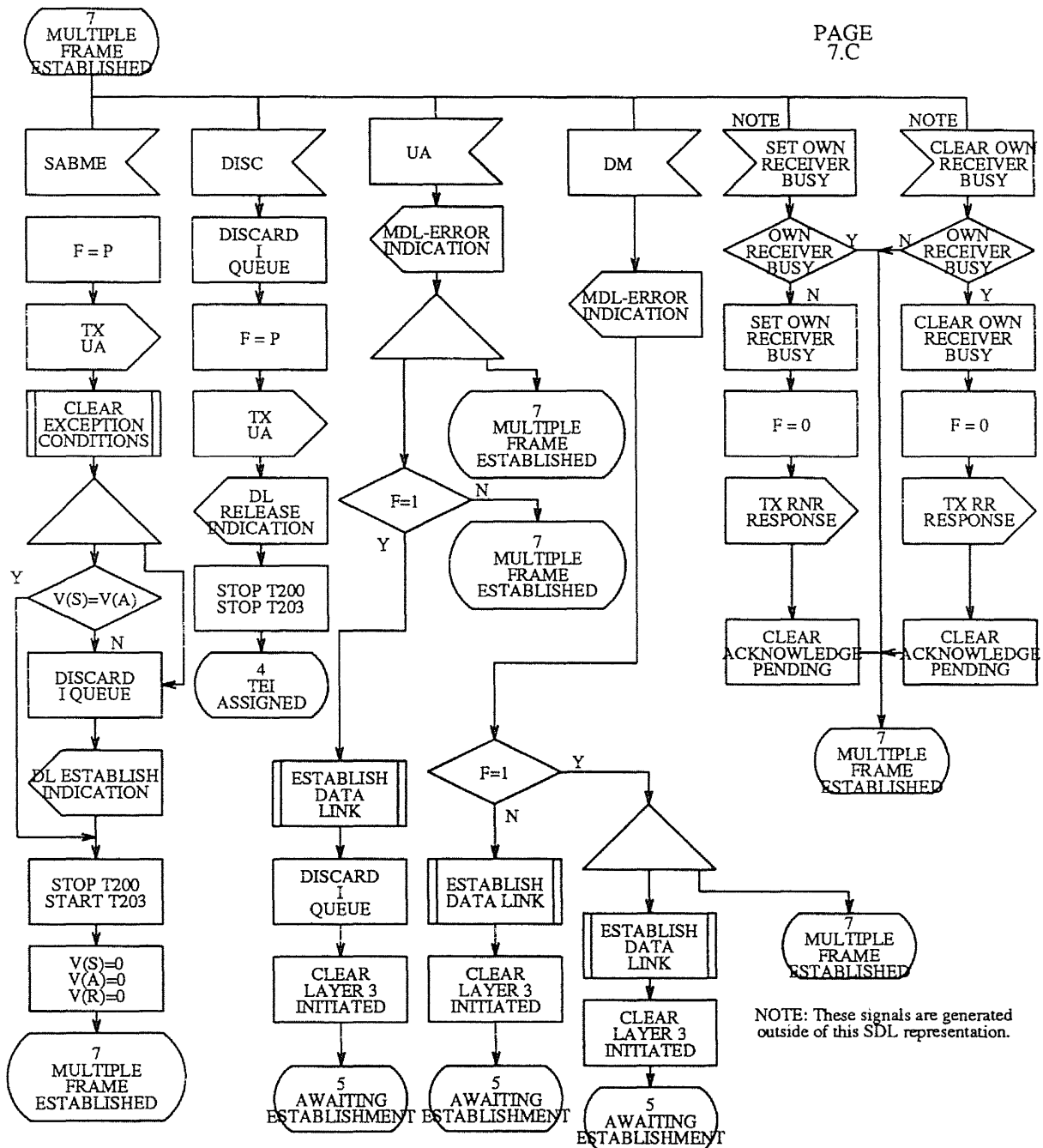


AN SDL REPRESENTATION OF THE POINT TO POINT
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NOTE: These signals are generated outside of this SDL representation.

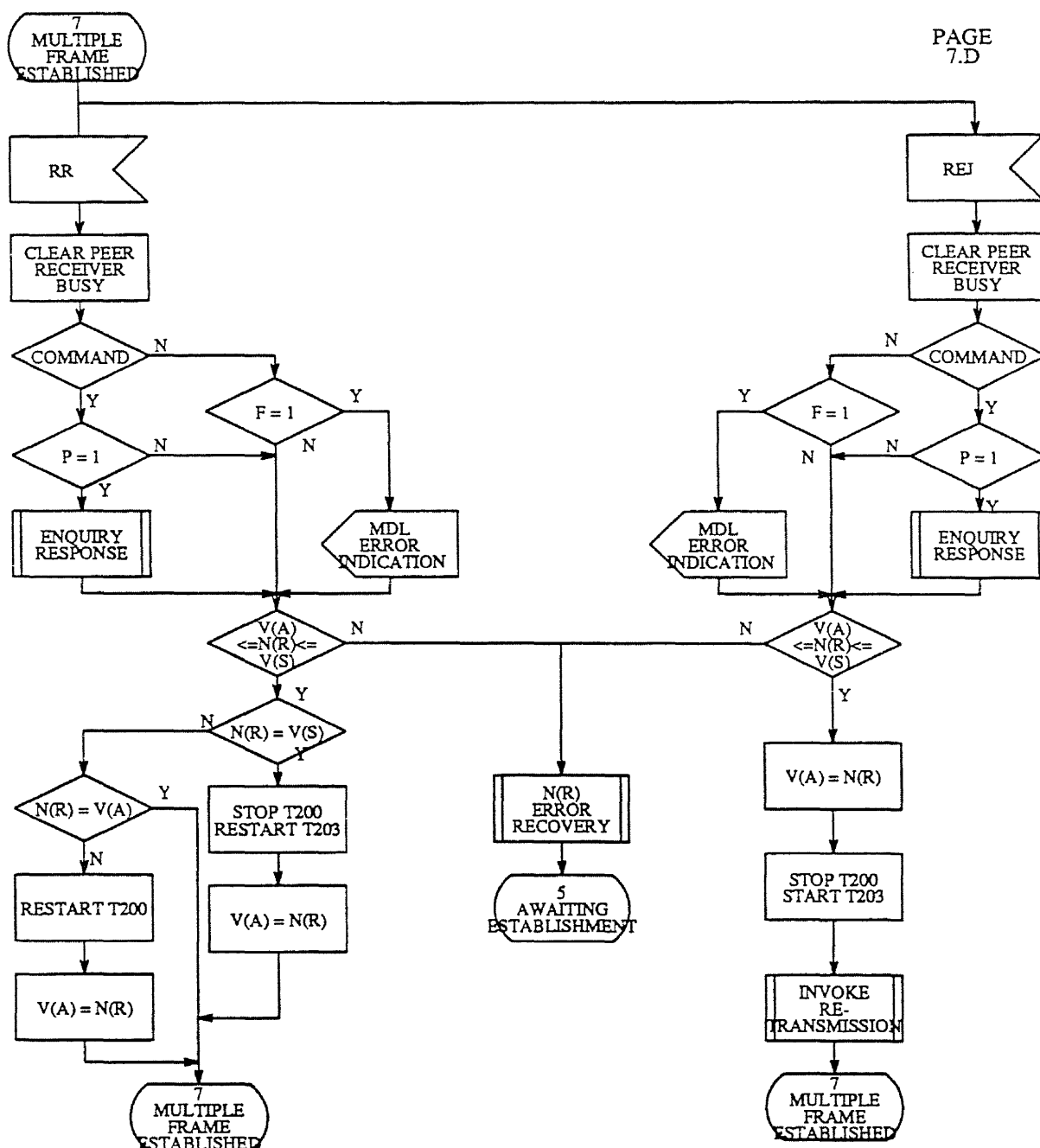
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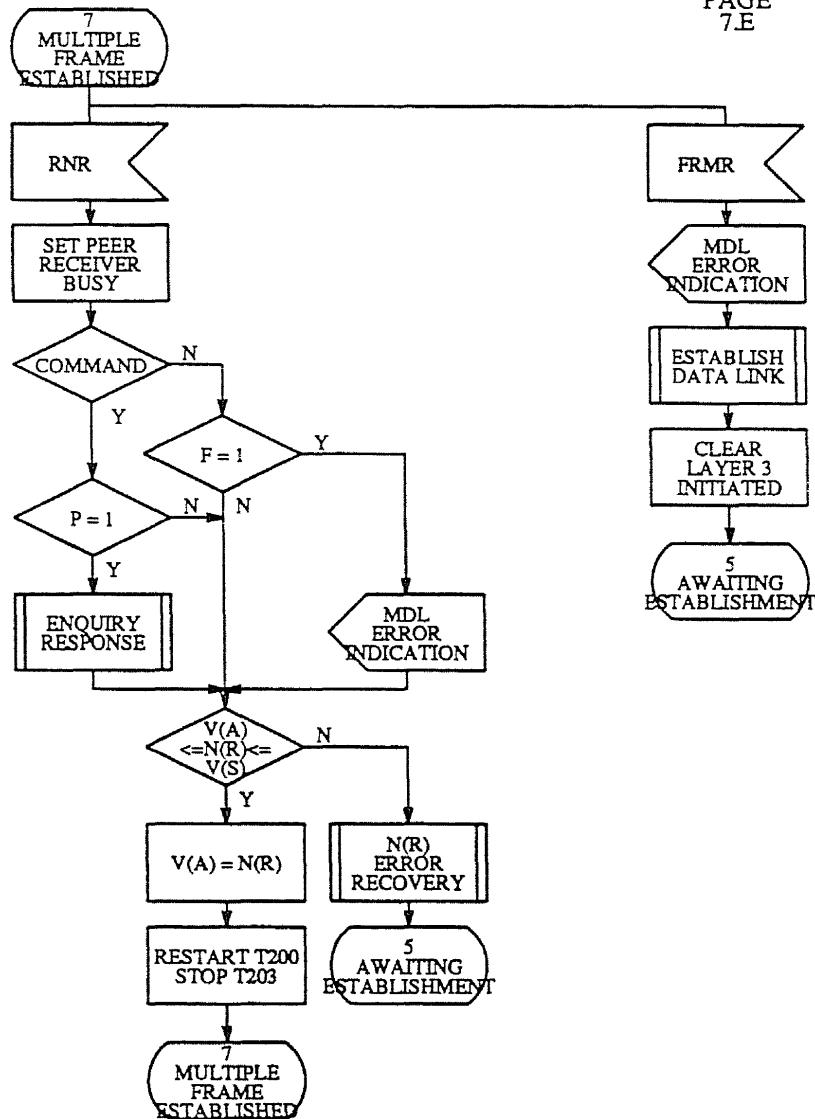
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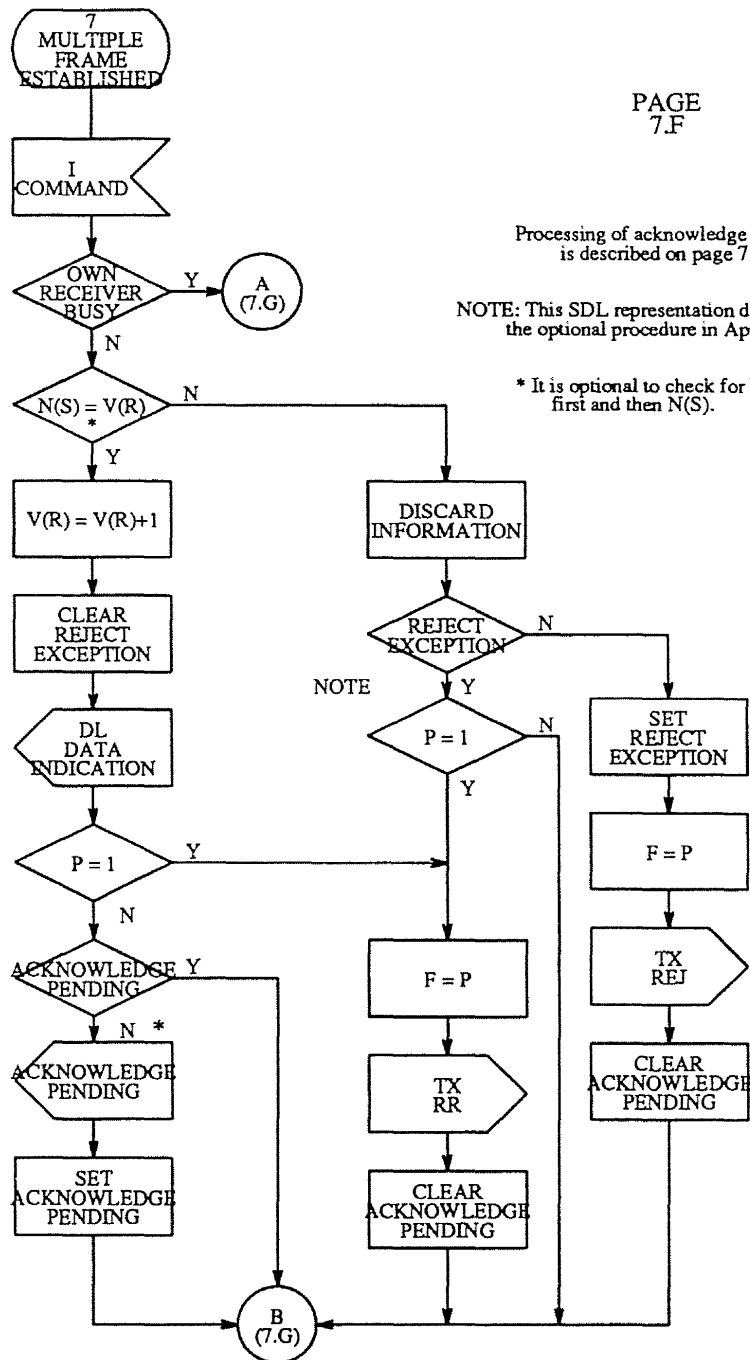


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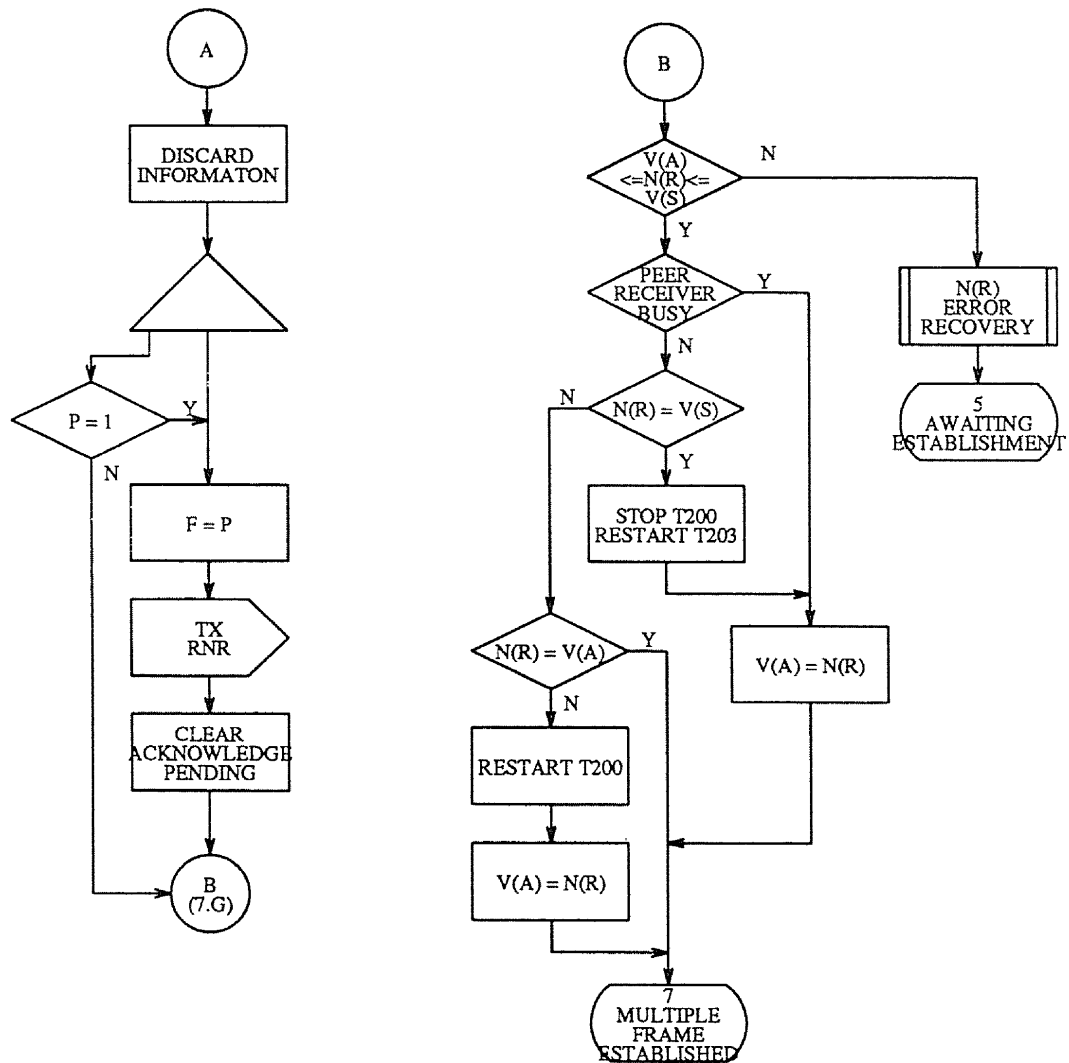


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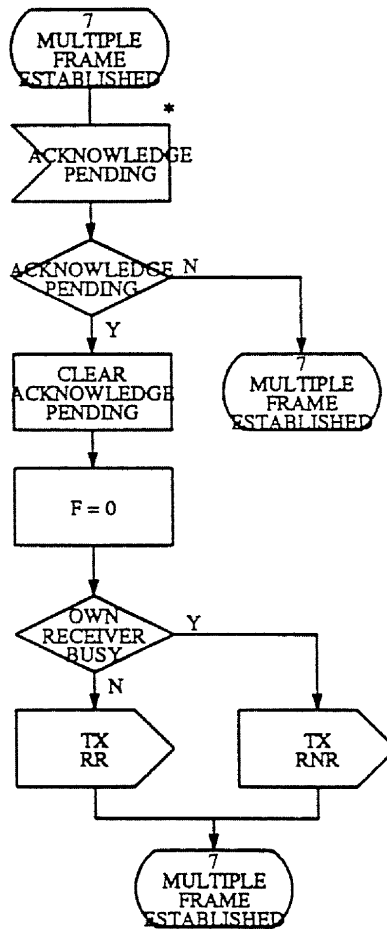
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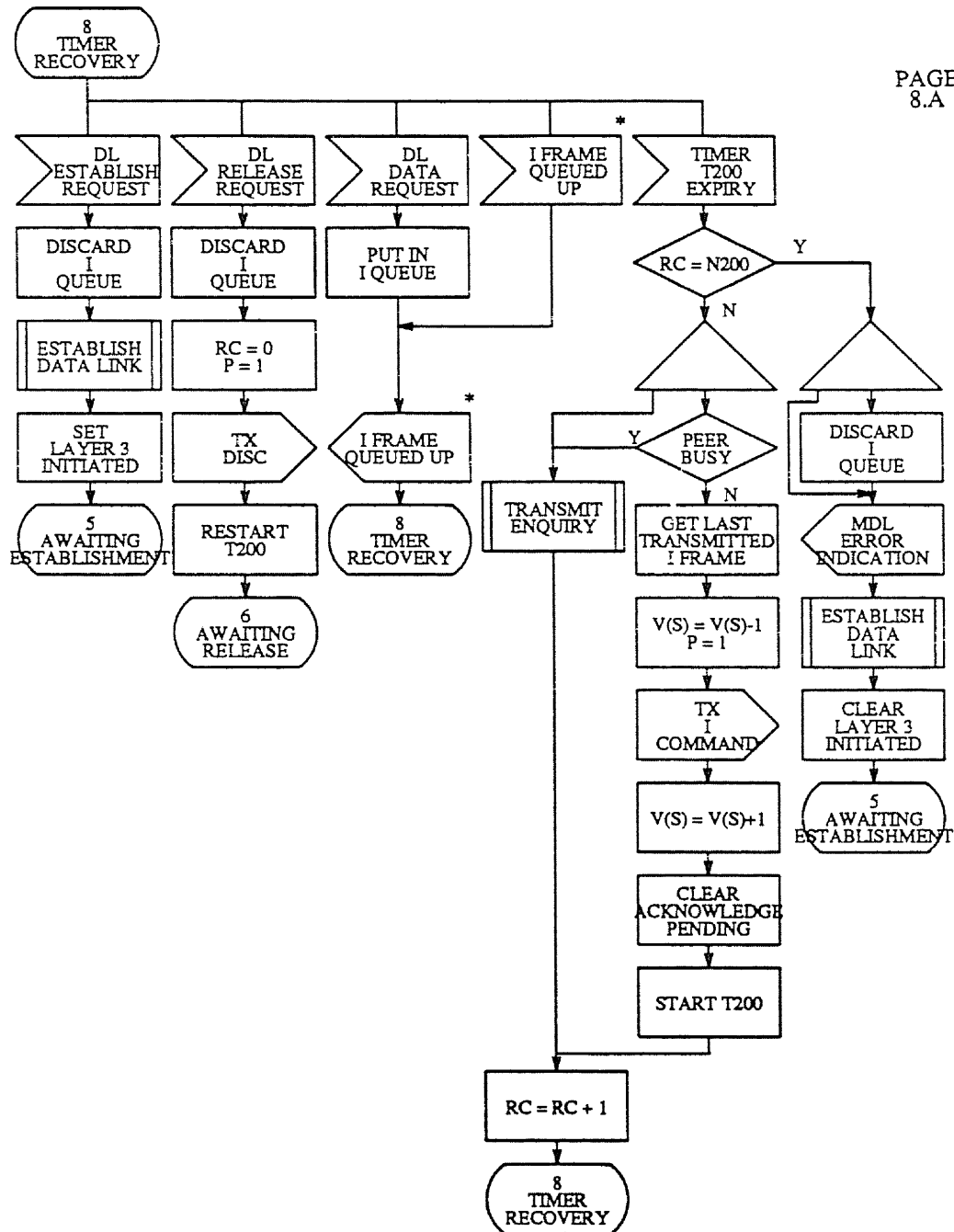
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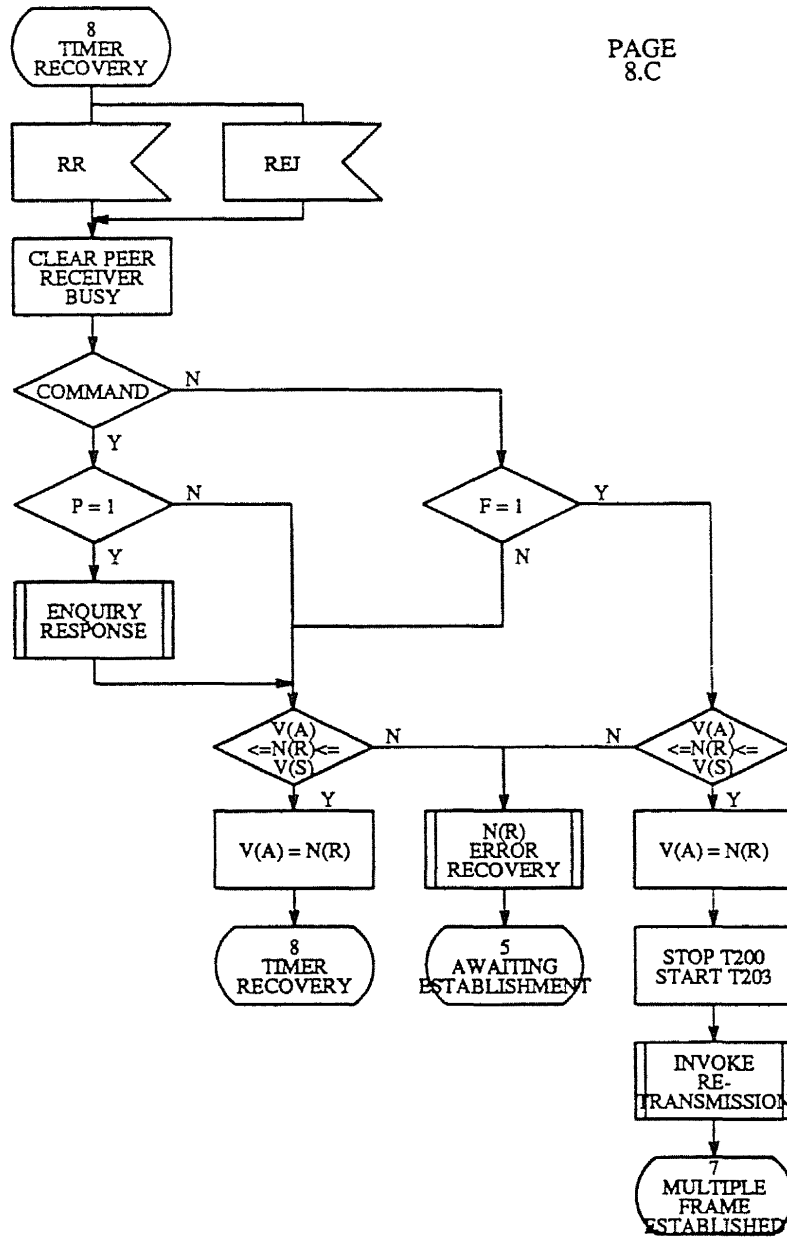
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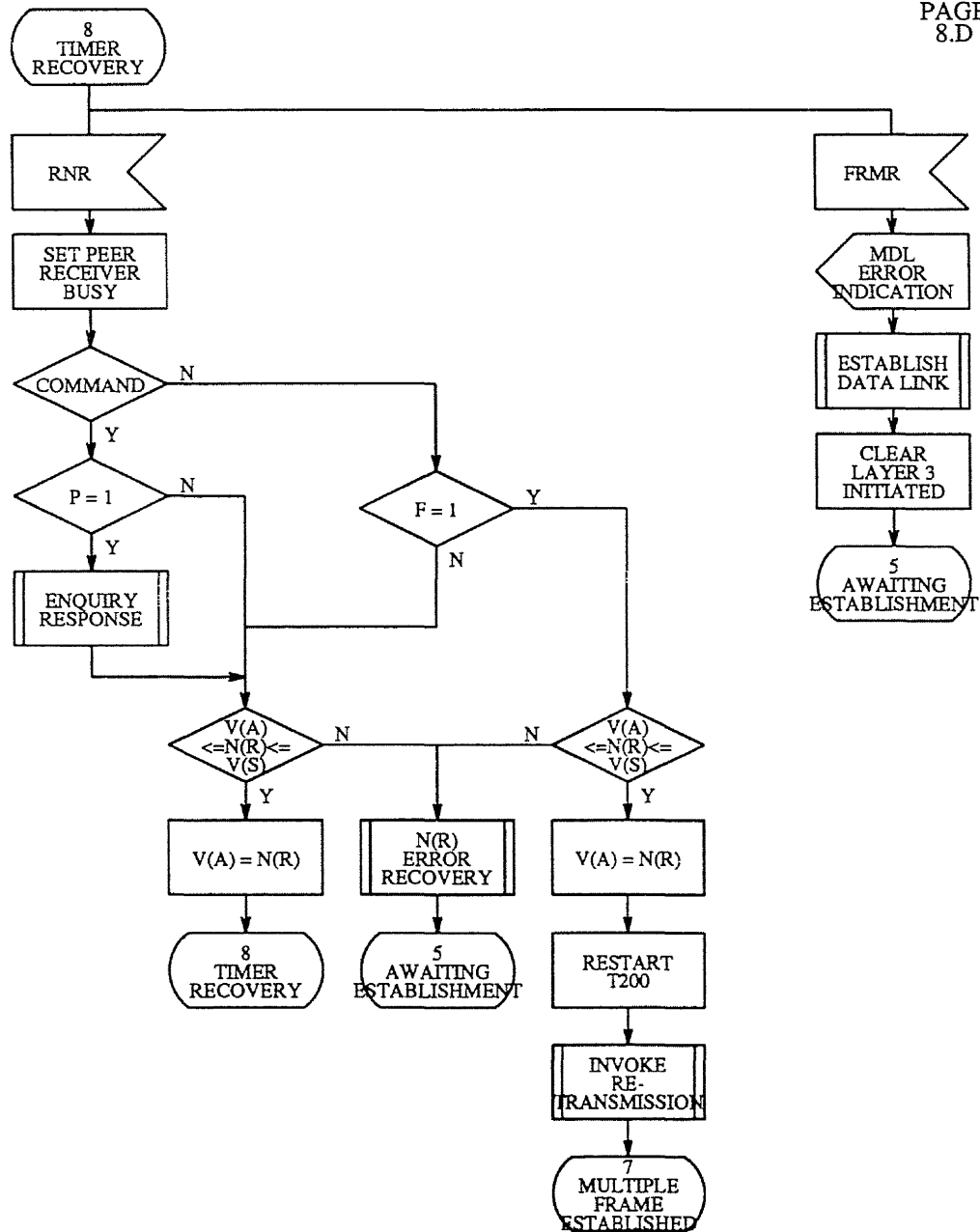




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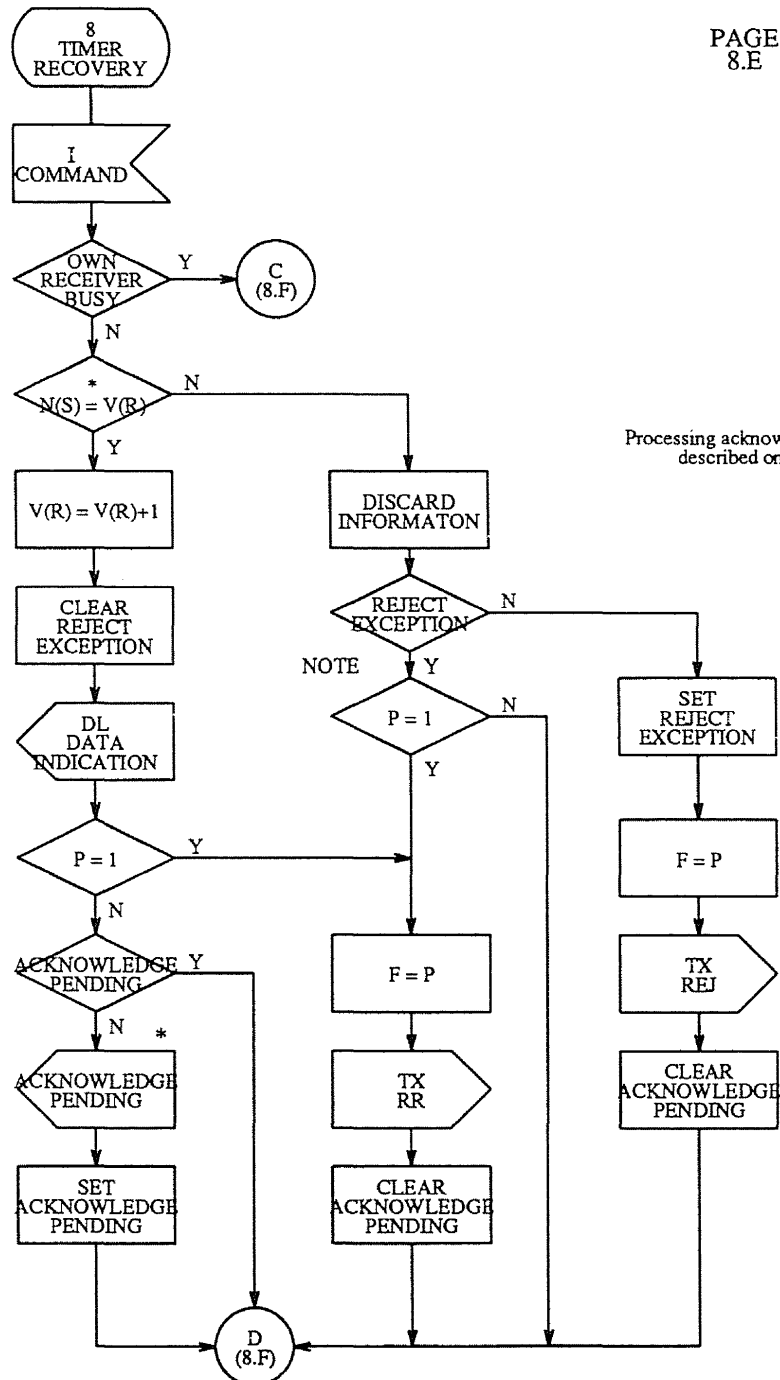


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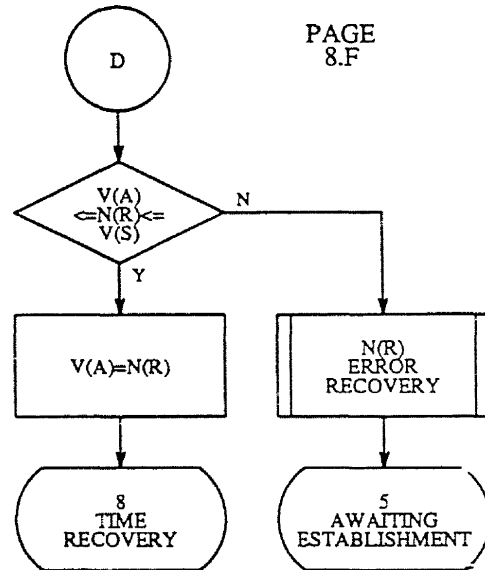
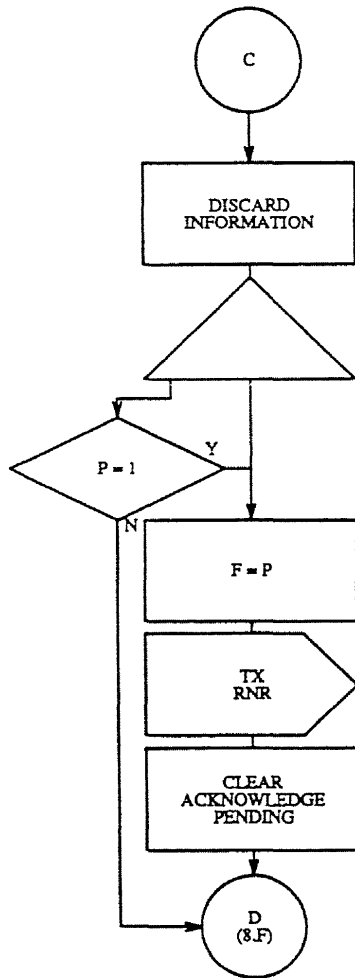
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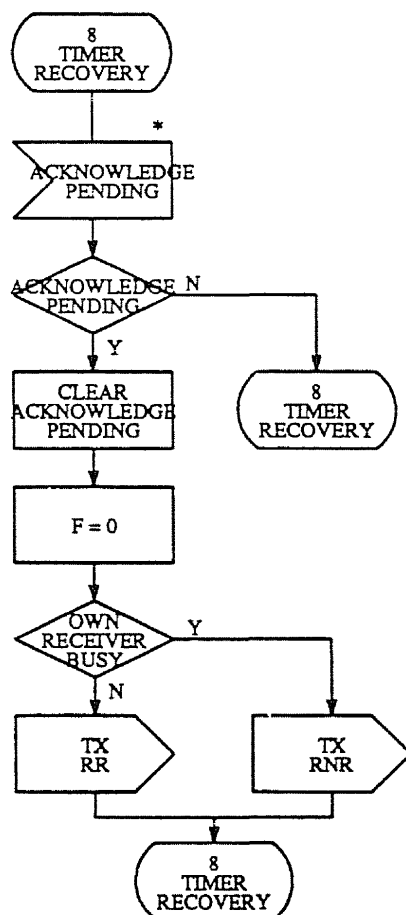
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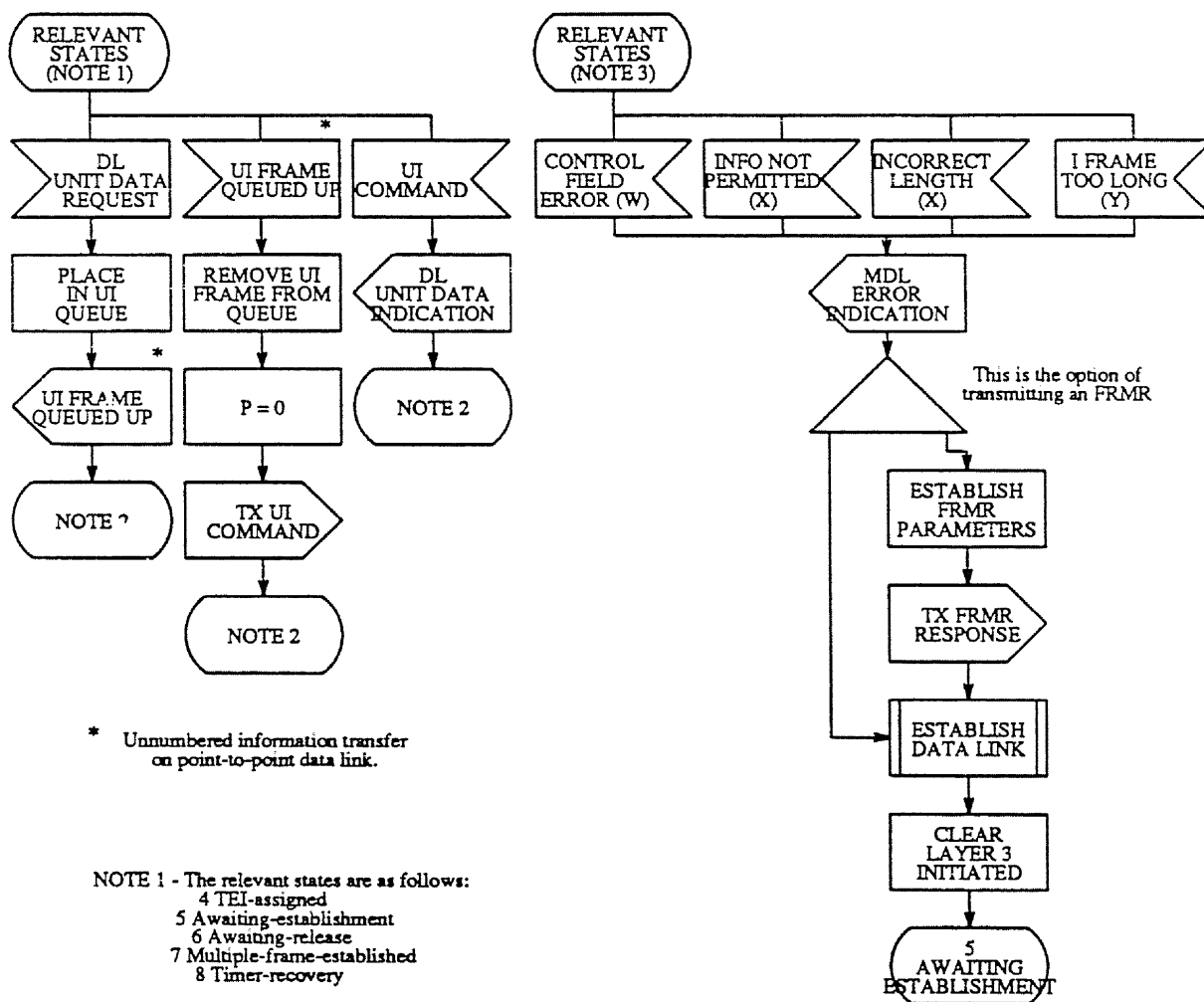


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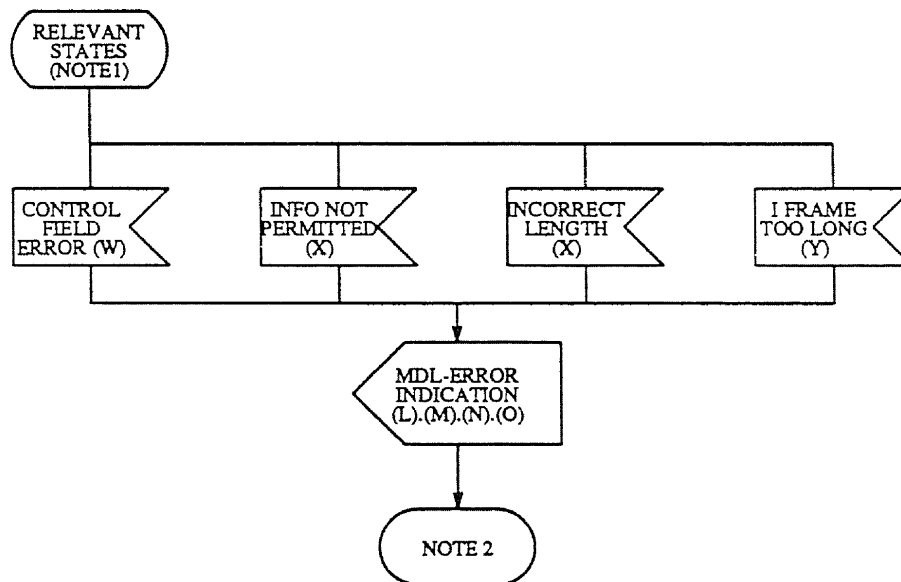


Receiving frame with incorrect format or
frame not implemented (FRMR events)

AN SDL REPRESENTATION OF THE POINT TO POINT PROCEDURES OF THE DATA LINK LAYER

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NOTE 1 - The relevant states are as follows:

- 4 TEI-assigned
- 5 Awaiting-establishment
- 6 Awaiting-release

NOTE 2 - The data link layer returns to the state it was in prior to the events shown

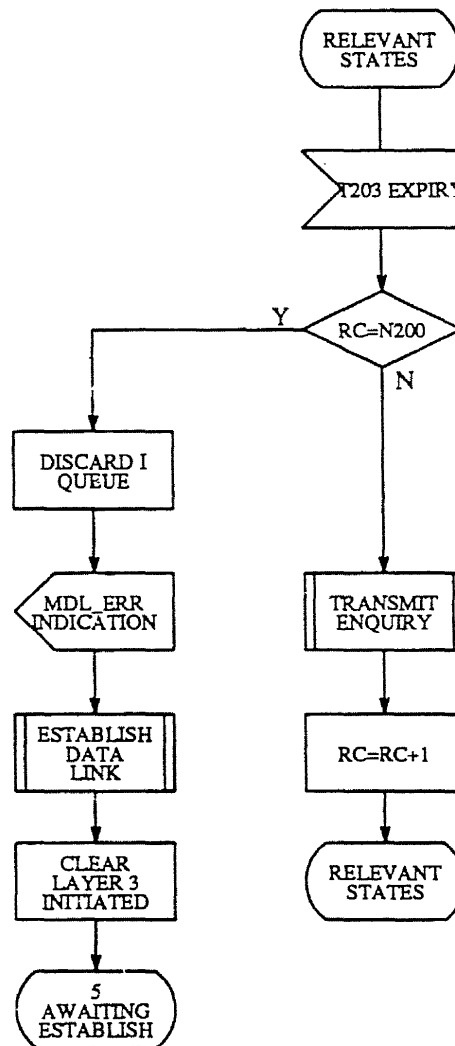
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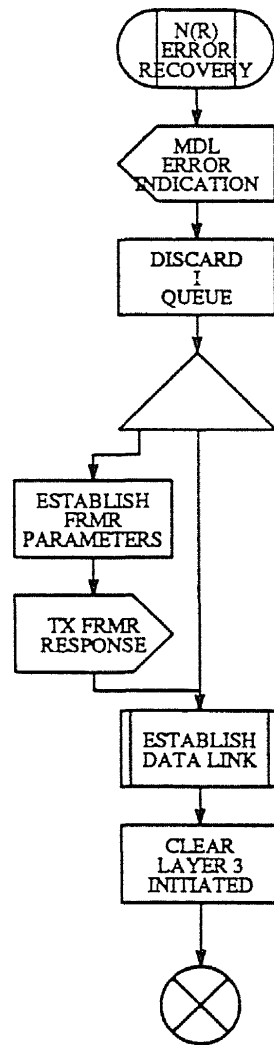
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AN SDL FOR POINT-TO-POINT PROCEDURES OF THE DATA LINK LAYER
STATUS INQUIRY PROCEDURE FOR PRIMARY INTERFACE

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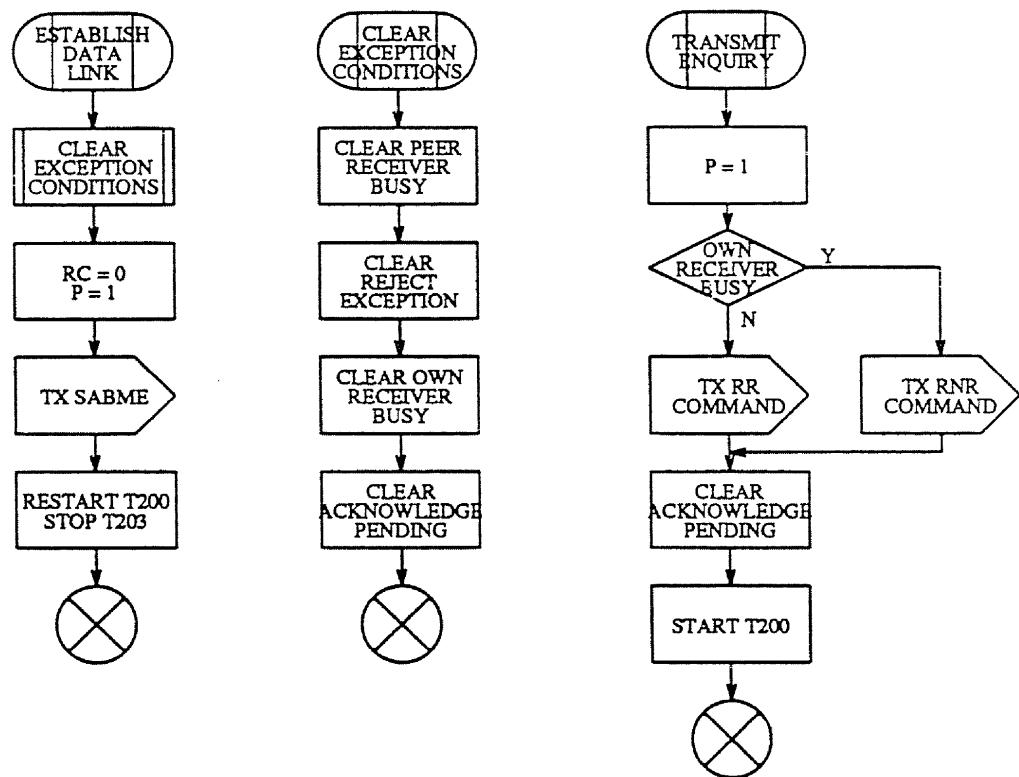
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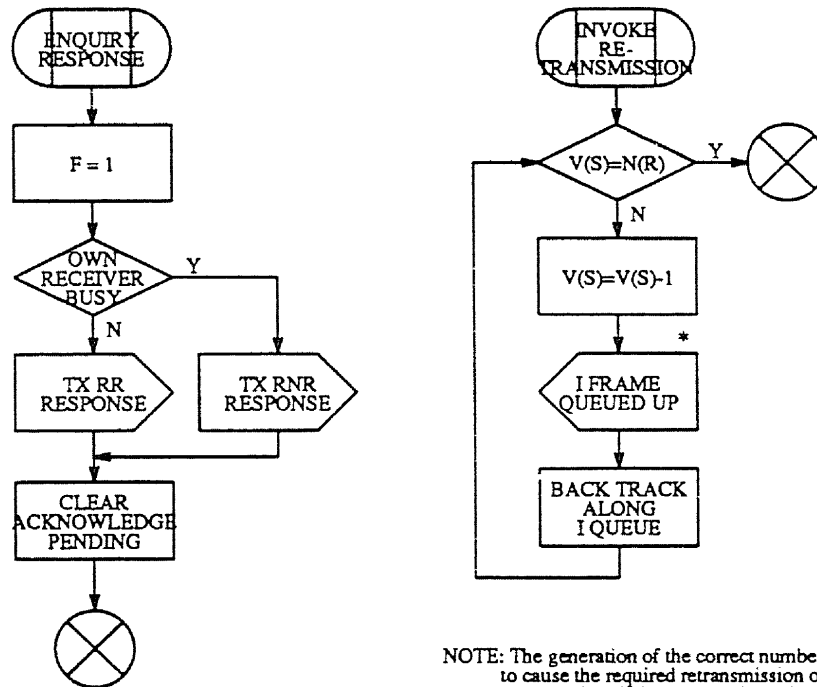
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which may be called (page 1 of 2)

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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.

POINT-TO-POINT DATA LINK: Definition of the "SDL procedures" which may be called (page 2 of 2)

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REFERENCES

1. CCITT Recommendation Q.921 (I.441), "ISDN User-Network Interface Data Link Layer Specification".
2. CCITT Recommendation Q.920 (I.440) ISDN user-network interface data link layer - General aspects.

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ISDN USER-NETWORK INTERFACE LAYER 3 SPECIFICATION FOR BASIC CALL CONTROL

1. General

The format for Layer 3 is aligned with the 1988 CCITT Q.931 Recommendation. In particular, where possible the section numbering, layout (e.g., messages, information elements), and text of the CCITT Recommendation have been followed.

This document specifies the procedures for the establishing, maintaining, and clearing of network connections at the ISDN user-network interface. These procedures are defined in terms of messages exchanged over the D-channel of primary rate interface structures. The functions and procedures of this protocol, and the relationship with other layers, are described in general terms in Recommendation Q.930 (I.450) (1).

Note: This document will specify the essential features, procedures, and messages required for call control in the D-channel.

1.1 Scope

The procedures described in this specification are for the control of circuit-switched connections, user-to-user signalling connections, packet-switched connections and supplementary services.

Note 1: The term "layer 3" is used for the functions and protocol described in this specification (see Recommendation Q.930 (I.450)). The terms "data link layer" and "layer 2" are used interchangeably to refer to the layer immediately below layer 3.

1.2 Application to Interface Structures

The layer 3 procedures apply to the interface structures defined in Recommendation I.412 [2]. They use the functions and services provided by layer 2.

The Layer 3 procedures request the services of layer 2 and receive information from layer 2 using the primitives defined in Part III. These primitives are used to illustrate the communication between the protocol layers and are not intended to specify or constrain implementations.

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2. Overview of Call Control

In this specification the terms "incoming" and "outgoing" are used to describe the call as viewed by the user side of the interface.

In the sections which follow states are defined for circuit switched calls in Section 2.1 (call states), for packet mode access connections in Section 2.2 (access connection states). For temporary signalling connections in Section 2.3 (call states) and for the interface in Section 2.4 (global call reference states).

Table IV-2-1a contains a summary of the call states.

Table IV-2-1a
Summary of Call States

States		Circuit Switched Calls	Packet Mode Access Connections	Temporary Signaling Connections	States Associated with the global call reference
U S E R	Null State (U0/Rest 0)	√	√	√	√
	Call Initiated (U1)	√	√	√	N/A
	Overlap Sending (U2)	x	N/A	x	N/A
	Outgoing Call Proceeding (U3)	√	√	√	N/A
	Call Delivered (U4)	√	√	x	N/A
	Call Present (U6)	x	x	x	N/A
	Call Received (U7)	√	√	N/A	N/A
	Connect Request (U8)	√	√	√	N/A
	Incoming Call Proceeding (U9)	√	√	√	N/A
	Active (U10)	√	√	√	N/A
	Disconnect Request (U11)	√	√	N/A	N/A
	Disconnect Indication (U12)	√	√	N/A	N/A
	Suspend Request (U15)	x	N/A	N/A	N/A
	Resume Request (U17)	x	N/A	N/A	N/A
	Release Request (U19)	√	√	√	N/A
	Overlap Receiving (U25)	x	N/A	x	N/A
	Tone Active (U18)	√	N/A	N/A	N/A
	Wait for Network Response (US1 & US2)	√	N/A	N/A	N/A
	Restart Request (Rest 1)	N/A	N/A	N/A	√
	Restart (Rest 2)	N/A	N/A	N/A	√
N E T W O R K	Null State (N0/Rest 0)	√	√	√	√
	Call Initiated (N1)	x	√	x	N/A
	Overlap Sending (N2)	x	N/A	x	N/A
	Outgoing Call Proceeding (N3)	√	√	√	N/A
	Call Delivered (N4)	√	√	x	N/A
	Call Present (N6)	√	√	x	N/A
	Call Received (N7)	√	√	√	N/A
	Connect Request (N8)	√	√	√	N/A
	Incoming Call Proceeding (N9)	√	√	x	N/A
	Active (N10)	√	√	√	N/A
	Disconnect Request (N11)	√	√	N/A	N/A
	Disconnect Indication (N12)	√	√	N/A	N/A
	Suspend Request (N15)	x	N/A	N/A	N/A
	Resume Request (N17)	x	N/A	N/A	N/A
	Release Request (N19)	√	√	√	N/A
	Call Abort (N22)	x	√	x	N/A
	Overlap Receiving (N25)	x	N/A	x	N/A
	Tone Active (N18)	√	N/A	N/A	N/A
	Wait for CPN/BN (NS1, NS2 & NS3)	√	N/A	N/A	N/A
	Wait for Continuity (NS4)	√	N/A	N/A	N/A
	Restart Request (Rest 1)	N/A	N/A	N/A	√
	Restart (Rest 2)	N/A	N/A	N/A	√

Legend: √ — Supported, x — Reserved for Future Use, N/A — Not Applicable.

This section 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 signalling 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.

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Note: Additional states and SDL diagrams may be defined when new procedures are developed.

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

A standard reference model is used to describe the connections between ISDN entities. In this model, User endpoint A is assumed to call User endpoint B. (User endpoints A and B may be a PBX, Host Computer, or other products that interface with both switched common carrier networks and private line configurations.) Two scenarios are considered:

- 1) User endpoints A and B are connected through an intervening switched common carrier network, hereafter also referred to as a "switched network" (see Figure IV-2-1a).
- 2) User endpoints A and B are directly connected by a private line connection (see Figure IV-2-2a).

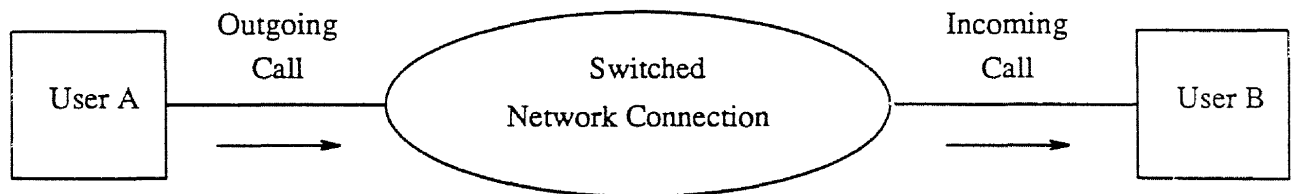


Figure IV-2-1a Call From A to B via a Switched Network Connection

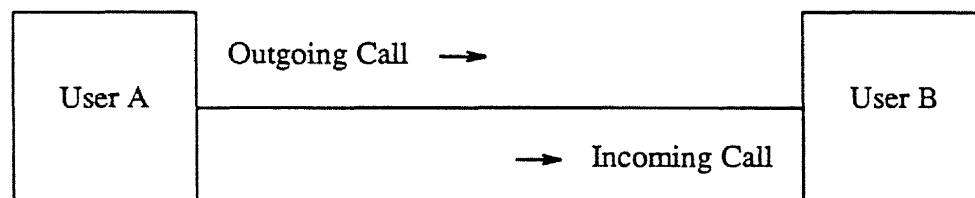


Figure IV-2-2a Private Line Connection Between A and B

Consider the switched network scenario depicted in Figure IV-2-1a. When User endpoint A calls B, the outgoing call originated by A (also known as the originating entity) provides it with access to services provided by the switched network (also known as the terminating entity with respect to the particular interface). The incoming call to User endpoint B is originated by the network to complete the call initiated by A. Figure IV-2-1a can be decomposed into two parts which show the access and egress interfaces between the switched network and the User endpoints A and B. Specifically, an outgoing call from a User endpoint A to the switched network is shown in Figure IV-2-3a. Figure IV-2-4a shows the corresponding

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arrangement for an incoming call from the switched network to the User endpoint B.

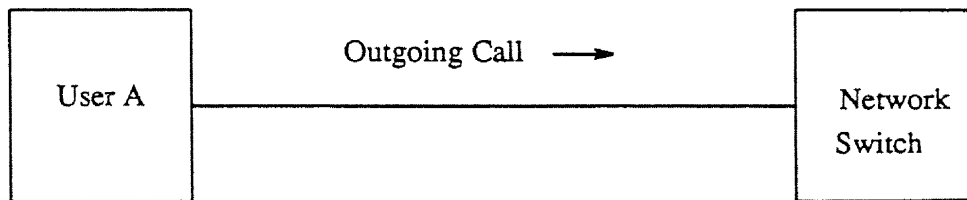


Figure IV-2-3a Switched Network Access for an Outgoing Call from A

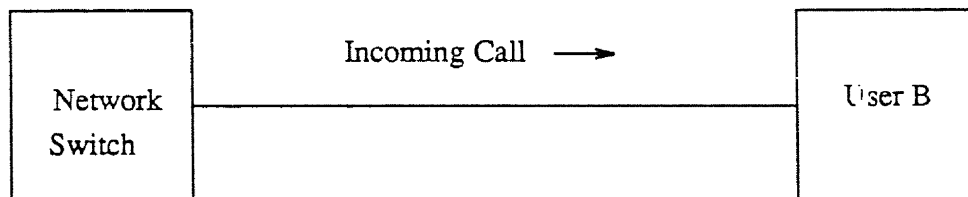


Figure IV-2-4a Switched Network Egress for an Incoming Call to B

For the situation where User endpoints A and B are directly connected by a private line connection, the outgoing call originated by User endpoint A is the same as the incoming call terminated by User endpoint B (see Figure IV-2-2a).

2.1 Circuit Switched Calls

This section defines the basic call control states for circuit switched calls. The procedures for call control are given in Section 5.

Annex D contains optional procedures (as an extension to the basic procedures) to allow symmetric signalling. These states are defined in Annex D.

2.1.1 Call States at the User Side of the Interface

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

2.1.1.1 Null State (U0)

No call exists.

2.1.1.2 Call Initiated (U1)

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

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2.1.1.3 Overlap Sending (U2) - Reserved for future use

2.1.1.4 Outgoing Call Proceeding (U3)

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

2.1.1.5 Call Delivered (U4)

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

2.1.1.6 Call Present (U6) - Reserved for future use

2.1.1.7 Call Received (U7)

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

2.1.1.8 Connect Request (U8)

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

2.1.1.9 Incoming Call Proceeding (U9)

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

2.1.1.10 Active (U10)

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

2.1.1.11 Disconnect Request (U11)

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

2.1.1.12 Disconnect Indication (U12)

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

2.1.1.13 Suspend Request (U15) - Reserved for future use

2.1.1.14 Resume Request (U17) - Reserved for future use

2.1.1.15 Release Request (U19)

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

2.1.1.16 Overlap Receiving (U25) - Reserved for future use

2.1.1.17 Wait For Network Response (States US1 and US2)

These states exist when a user has requested a facility from the network and has chosen to wait for a response from the network.

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2.1.2 Network Call States

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

2.1.2.1 Null State (N0)

No call exists.

2.1.2.2 Call Initiated (N1) - Reserved for future use

2.1.2.3 Overlap Sending (N2) - Reserved for future use

2.1.2.4 Outgoing Call Proceeding (N3)

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

2.1.2.5 Call Delivered (N4)

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

2.1.2.6 Call Present (N6)

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

2.1.2.7 Call Received (N7)

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

2.1.2.8 Connect Request (N8)

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

2.1.2.9 Incoming Call Proceeding (N9)

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

2.1.2.10 Active (N10)

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

2.1.2.11 Disconnect Request (N11)

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

2.1.2.12 Disconnect Indication (N12)

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

2.1.2.13 Suspend Request (N15) - Reserved for future use

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2.1.2.14 Resume Request (N17) - Reserved for future use

2.1.2.15 Release Request (N19)

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

2.1.2.16 Call Abort (N22) - Reserved for future use

2.1.2.17 Overlap Receiving (N25) - Reserved for future use

2.1.2.18 Tone Active (N18)

This state exists when a network disconnect request is received (the call establishment attempt failed) and the network desires to play an announcement or a tone.

2.1.2.19 Wait For CPN/BN (NS1, NS2, and NS3)

These states exist while the network is waiting for CPN/BN address information about the originating caller from somewhere within the network. For state NS1, the user has not yet been notified of the existence of the call. For states NS2 and NS3, the network is waiting on CPN/BN information but will leave this state upon receiving a message of any type from the user.

2.1.2.20 Wait For Continuity (NS4)

This state exists when a circuit is being checked for continuity somewhere within the network and the network is waiting for the results of the continuity test before delivering the SETUP message to the user.

2.2 Packet Mode Call

This section defines the basic packet mode call control states for access to DMI and Frame Relay Data services. The procedures for access connection control are given in Section 6.

2.2.1 Call States at the User Side of the Interface

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

2.2.1.1 Null State (U0)

No access connection exists.

2.2.1.2 Call Initiated (U1)

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

2.2.1.3 Outgoing Call Preceding (U3)

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

2.2.1.4 Call Present (U6) - Reserved for future use

2.2.1.5 Call Received (U7)

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

2.2.1.6 Connect Request (U8)

This state exists for an incoming access connection when the user has accepted the access connection and is waiting to be awarded the access connection.

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2.2.1.7 Incoming Call Proceeding (U9)

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

2.2.1.8 Active (U10)

This state exists for an incoming access connection when the user has received an acknowledgement from the network that the user has been awarded the access connection. This state exists for an outgoing access connection when the user has received an indication that the local network has completed the access connection.

2.2.1.9 Disconnect Request (U11)

This state exists when the user has requested the local network to clear the access connection and is waiting for a response.

2.2.1.10 Disconnect Indication (U12)

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

2.2.1.11 Release Request (U19)

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

2.2.1.12 Call Delivered (U4) - Reserved for future use

2.2.2 Access Connection States at the Network Side of the Interface

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

2.2.2.1 Null State (N0)

No access connection exists.

2.2.2.2 Call Initiated (N1) - Reserved for future use

2.2.2.3 Outgoing Call Proceeding (N3)

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

2.2.2.4 Call Present (N6)

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

2.2.2.5 Call Received (N7)

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

2.2.2.6 Connect Request (N8)

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

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2.2.2.7 Incoming Call Proceeding (N9)

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

2.2.2.8 Active (N10)

This state exists for an incoming access connection when the network has awarded the access connection to the called user. This state exists for an outgoing access connection when the local network has indicated that the access connection has been completed.

2.2.2.9 Disconnect Request (N11)

This state exists when the network has received a request from the user to clear the access connection.

2.2.2.10 Disconnect Indication (N12)

This state exists when the network has sent an invitation to disconnect the user-network access connection.

2.2.2.11 Release Request (N19)

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

2.2.2.12 Call Abort (N22) - Reserved for future use

2.2.2.13 Call Delivered (N4) - Reserved for future use

2.3 Temporary Signalling Connections

This section defines the basic call control states for user-to-user signalling not associated with circuit switched calls. The procedures for call control are given in Section 7.2.

2.3.1 Call States at the User Side of the Interface

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

2.3.1.1 Null State (U0)

No call exists.

2.3.1.2 Call Initiated (U1)

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

2.3.1.3 Overlap Sending (U2) - Reserved for future use

2.3.1.4 Outgoing Call Proceeding (U3)

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

2.3.1.5 Call Delivered (U4) - Reserved for future use

2.3.1.6 Call Present (U6) - Reserved for future use

2.3.1.7 Connect Request (U8)

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

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2.3.1.8 Incoming Call Proceeding (U9)

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

2.3.1.9 Active (U10)

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

2.3.1.10 Release Request (U19)

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

2.3.1.11 Overlap Receiving (U25) - Reserved for future use

2.3.2 Network Call States

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

2.3.2.1 Null State (N0)

No call exists.

2.3.2.2 Call Initiated (N1) - Reserved for future use

2.3.2.3 Overlap sending (N2) - Reserved for future use

2.3.2.4 Outgoing Call Proceeding (N3)

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

2.3.2.5 Call Delivered (N4) - Reserved for future use

2.3.2.6 Call Present (N6) - Reserved for future use

2.3.2.7 Call Received (N7)

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

2.3.2.8 Connect Request (N8)

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

2.3.2.9 Incoming Call Proceeding (N9) - Reserved for future use

2.3.2.10 Active (N10)

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

2.3.2.11 Release Request (N19)

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

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2.3.2.12 Call Abort (N22) - Reserved for future use

2.3.2.13 Overlap Receiving (N25) - Reserved for future use

2.4 States Associated with the Global Call Reference

This section defines the states that the protocol may adopt using the global call reference. The procedures for use of the global call reference for restart are contained in Section 5.5.

There is only one global call reference per interface.

2.4.1 Call States at the User Side of the Interface

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

2.4.1.1 Null (Rest 0)

No transaction exists.

2.4.1.2 Restart Request (Rest 1)

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.

2.4.1.3 Restart (Rest 2)

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.

2.4.2 Call States at the Network Side of the Interface

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

2.4.2.1 Null (Rest 0)

No transaction exists.

2.4.2.2 Restart Request (Rest 1)

This state exists for a restart transaction when the network has sent a restart request but has not yet received an acknowledgement response from the user.

2.4.2.3 Restart (Rest 2)

This state exists when a request for a restart has been received from the user and a response has not yet been received from all locally active call references.

2.5 Summary of Call States for Switched Network and Private Line Access Configurations

A summary of the call states that apply to the different access configurations is provided in Figure IV-2.5a.

Call State	Switched Network Access (Figure IV-2-3a)		Switched Network Egress (Figure IV-2-4a)		Private Line Connection (Figure IV-2-2a)	
	O.E.	T.E.	O.E.	T.E.	O.E.	T.E.
Call Request	1	0	6	0	1	0
Call Proceeding	3	3	9	9	3	9
Call Delivered	4	4	7	7	4	7
Connect Request	N/A	N/A	8	8	8	8
Active	10	10	10	10	10	10

Figure IV-2.5a Call Establishment States for Different ISDN Configurations

Note: The terms O.E. and T.E are respectively the originating entity and terminating entity. The originating entity initiates call establishment by sending a SETUP message. The recipient of a SETUP message is the terminating entity. The term N/A means Not Applicable.

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3. Message Functional Definitions and Content

This paragraph provides an overview of the message structure, which highlights the functional definition and information content (i.e., semantics) of each message. Each definition includes:

- a. A brief description of the message direction and use, including whether the message has:
 1. Local significance, i.e., relevant only in the originating or terminating access;
 2. Access significance, i.e., relevant in the originating and terminating access, but not in the network;
 3. Dual significance, i.e., relevant in either the originating or terminating access and in the network; or
 4. Global significance, i.e., relevant in the originating and terminating access and in the network.
- b. A table listing the codeset 0, codeset 6, and codeset 7 information elements in the order of their appearance in the message (same relative order for all message types). For each information element the table indicates:

1. the section describing the information element;
2. The direction in which it may be sent; i.e., user to network (u -> n), network to user (n -> u), or both;

Note: The user-network terminology in Section 3 refers to the TE-TE, TE-NT2, and NT2-ET interface structures. For NT2-NT2 connections (e.g. PBX-PBX and PBX-Host) u->n indicates that the message may be sent by the originating entity to the terminating entity. Annex D contains a description of the information element usage for symmetric NT2-NT2 interfaces.

3. whether inclusion is mandatory (M) or optional (O), with a reference to notes explaining the circumstances under which the information element shall be included;
4. the length of the information element (or permissible range of lengths), in octets. AT&T products will not support more than the maximum length shown. For the actual maximum length supported by a particular AT&T product, consult the product specific documentation.

Note: Certain messages may contain information elements from codesets 6 and 7 and corresponding locking shift information elements which comply with the coding rules specified in Sections 4.5.2-4.5.4. These information elements are listed in the appropriate tables in Section 3.

- c. Further explanatory notes, as necessary.

3.1 Messages for Circuit Mode Connection Control

Table IV-3-1 summarizes the messages for circuit-mode connection control.

TABLE IV-3-1

Messages for Circuit-Mode Connection Control

Call establishment messages:	Reference
ALERTING	3.1.1
CALL PROCEEDING	3.1.2
CONNECT	3.1.4
CONNECT ACKNOWLEDGE	3.1.5
PROGRESS	3.1.10
SETUP	3.1.16
CALL information phase messages:	
USER INFORMATION	3.1.23
Call clearing messages:	Reference
DISCONNECT	3.1.6
RELEASE	3.1.11
RELEASE COMPLETE	3.1.12
Miscellaneous messages:	Reference
CONGESTION CONTROL	3.1.3
FACILITY	3.1.7
STATUS	3.1.18
STATUS ENQUIRY	3.1.19

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3.1.1 Alerting

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

TABLE IV-3-2

Alerting Message Content

Message type: ALERTING

Significance: global

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Channel identification	4.5	both	O (Note 1)	4 - 8
Progress indicator	4.5	both	O (Note 2)	4
Redirecting number	4.6	both	O (Note 7 & 15)	3 - 20
User-user	4.5	both	O (Note 7)	Note 8
Shift to codeset 6	4.5	both	O (Note 7 & 11)	1
Network-specific(codeset 6)	4.6	both	O (Note 7 & 12)	1 - 128
Shift to codeset 7	4.5	both	O (Note 7 & 13)	1
User-specific(codeset 7)	4.6	both	O (Note 7 & 14)	1 - 128

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

Note 2: Included in the event of interworking. Included in the network to user direction in connection with the provision of in-band information/patterns. Included in the user to network direction in connection with the provision of in-band information/patterns. (See Annex N)

Notes 3 through 6 have been intentionally deleted.

Note 7: Included in the user-to-network direction when the called user wants to return user data information to the calling user or in the network-to-user direction if the called user included a user data information in the ALERTING message. Conditions for this transfer are described in Section 7.

Note 8: The minimum length is 3 octets; the maximum length is 131 octets.

Notes 9 and 10 have been intentionally deleted.

Note 11: Any codeset 6 information element must be preceded by this information element.

Note 12: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 6 information element must be provided first.

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Note 13: Any codeset 7 information element must be preceded by this information element.

Note 14: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 7 information element must be provided first.

Note 15: Used to identify address of redirection.

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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 will be accepted. See Table IV-3-3.

TABLE IV-3-3

Call Proceeding Message Content

Message type: CALL PROCEEDING

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Channel identification	4.5	both	M	4 - 8
Shift to codeset 6	4.5	both	O (Note 5)	1
Network specific (codeset 6)	4.6	both	O (Note 6)	1-128

Notes 1 through 4 have been intentionally deleted.

Note 5: Any codeset 6 information element must be preceded by this information element.

Note 6: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 6 information element must be provided first.

3.1.3 Congestion Control

This message is sent by the user or the network to indicate the establishment or termination of flow control on the transmission of USER INFORMATION messages. See Table IV-3-4.

TABLE IV-3-4

Congestion Control Message Content

Message type: CONGESTION CONTROL

Significance: local (Note 1)

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Congestion level	4.5	both	M	1
Cause	4.5	both	M	4 - 22

Note 1: This message has local significance, but may carry information of global significance.

3.1.4 Connect

This message is sent by the called user to the network and by the network to the calling user to indicate call acceptance by the called user. See Table IV-3-5.

TABLE IV-3-5

Connect Message Content

Message type: CONNECT

Significance: global

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Connected Number	4.6	both	O (Note 9 & 17)	3 - 18
Channel identification	4.5	both	O (Note 1)	4 - 8
Progress indicator	4.5	both	O (Note 2)	4
Redirecting number	4.6	both	O (Note 9 & 16)	3 - 20
User-user	4.5	both	O (Note 9)	Note 10
Shift to codeset 6	4.5	both	O (Note 9 & 12)	1
Network-specific(codeset 6)	4.6	both	O (Note 9 & 13)	1 - 128
Shift to codeset 7	4.5	both	O (Note 9 & 14)	1
User-specific(codeset 7)	4.6	both	O (Note 9 & 15)	1 - 128

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

Note 2: Included in the event of interworking. Included in the network to user direction in connection with the provision of in-band information/patterns. Included in the user to network direction in connection with the provision of in-band information/patterns. (See Annex N)

Notes 3 through 8 have been intentionally deleted.

Note 9: Included in the user-to-network direction when the called user wants to return user data information to the calling user or in the network-to-user direction if the called user included a user data information in the CONNECT message. Conditions for this transfer are described in Section 7.

Note 10: The minimum length is 3 octets; the maximum length is 131 octets.

Note 11 has been intentionally deleted.

Note 12: Any codeset 6 information element must be preceded by this information element.

Note 13: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 6 information element must be provided first.

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Note 14: Any codeset 7 information element must be preceded by this information element.

Note 15: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 7 information element must be provided first.

Note 16: Used to identify address of redirection.

Note 17: Used to identify address of the connected user.

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3.1.5 Connect Acknowledge

This message is sent by the network to the called user to indicate the user has been awarded the call. It may also be sent by the calling user to the network to allow symmetrical call control procedures. See Table IV-3-6.

TABLE IV-3-6

Connect Acknowledge Message Content

Message type: CONNECT ACKNOWLEDGE

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1

3.1.6 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. See Table IV-3-7.

TABLE IV-3-7

Disconnect Message Content

Message type: DISCONNECT

Significance: global

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	M	4 - 22
User-user	4.5	both	O (Note 7)	Note 8
Shift to codeset 6	4.5	both	O (Note 7 & 9)	1
Network-specific(codeset 6)	4.6	both	O (Note 7 & 10)	1 - 128
Shift to codeset 7	4.5	both	O (Note 7 & 11)	1
User-specific(codeset 7)	4.6	both	O (Note 7 & 12)	1 - 128

Notes 1 through 6 have been intentionally deleted.

Note 7: Included when the user initiates call clearing and wants to pass user data information to the remote user at call clearing time. Conditions for this transfer are described in Section 7.

Note 8: The minimum length is 3 octets; the maximum length is 131 octets.

Note 9: Any codeset 6 information element must be preceded by this information element.

Note 10: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 6 information element must be provided first.

Note 11: Any codeset 7 information element must be preceded by this information element.

Note 12: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 7 information element must be provided first.

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3.1.7 Facility

This message is defined in Section 3.5.1

3.1.8 Information - Reserved for future use

3.1.9 Notify - Reserved for future use

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3.1.10 Progress

This message is sent by the user or the network to indicate the progress of a call in the event of interworking or in relation with the provision of in-band information patterns. See Table IV-3-10.

TABLE IV-3-10

Progress Message Content

Message type: PROGRESS

Significance: global

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	O (Note 1)	4 - 22
Channel identification	4.5	u -> n	O (Note 6)	4 - 8
Progress indicator	4.5	both	M	4

Note 1: Included by the user or the network to provide additional information concerning the provision of in-band information/patterns.

Notes 2 through 5 have been intentionally deleted.

Note 6: Mandatory if this message is the first message in response to SETUP.

3.1.11 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. See Table IV-3-11.

TABLE IV-3-11

Release Message Content

Message type: RELEASE
Significance: local (Note 1)
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	O (Note 2)	4 - 22
User-user	4.5	both	O (Note 7)	Note 8
Shift to codeset 6	4.5	both	O (Note 9)	1
Network-specific (codeset 6)	4.6	both	O (Note 10)	1-128
Shift to codeset 7	4.5	both	O (Note 11)	1
User-specific (codeset 7)	4.6	both	O (Note 12)	1-128

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.

Notes 3 through 6 have been intentionally deleted.

Note 7: Included when the RELEASE message is the first call clearing message, and the user initiates call clearing and wants to pass user information to the remote user at call clearing time. Conditions for this transfer are described in Section 7.

Note 8: The minimum length of the User-user information element is 3 octets; the standard maximum length is 131 octets.

Note 9: Any codeset 6 information element must be preceded by this information element.

Note 10: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 6 information element must be provided first.

Note 11: Any codeset 7 information element must be preceded by this information element.

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Note 12: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 7 information element must be provided first.

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3.1.12 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 shall release the call reference. See Table IV-3-60.

TABLE IV-3-60

Release Complete Message Content

Message type: RELEASE COMPLETE

Significance: local (Note 1)

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	O (Note 2)	4 - 22
User-user	4.5	both	O (Note 7)	Note 8
Shift to codeset 6	4.5	both	O (Note 9)	1
Network-specific (codeset 6)	4.6	both	O (Note 10)	1-128
Shift to codeset 7	4.5	both	O (Note 11)	1
User-specific (codeset 7)	4.6	both	O (Note 12)	1-128

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.

Notes 3 through 6 have been intentionally deleted.

Note 7: Included when the RELEASE COMPLETE message is the first call clearing message, and the user initiates call clearing and wants to pass user information to the remote user at call clearing time. Conditions for this transfer are described in Section 7.

Note 8: The minimum length of the User-user information element is 3 octets; the standard maximum length is 131 octets.

Note 9: Any codeset 6 information element must be preceded by this information element.

Note 10: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 6 information element must be provided first.

Note 11: Any codeset 7 information element must be preceded by this information element.

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Note 12: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 7 information element must be provided first.

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3.1.13 Resume - Reserved for future use

3.1.14 Resume Acknowledge - Reserved for future use

3.1.15 Resume Reject - Reserved for future use

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3.1.16 Setup

This message is sent by the calling user to the network and by the network to the called user to initiate call establishment. See Table IV-3-16.

TABLE IV-3-16

Setup Message Content

Message type: SETUP

Significance: global

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Bearer capability	4.5	both	M	4 - 8
Call identity	4.5	both	O (Note 29)	3-10
Channel identification	4.5	both	M	4 - 8
Progress indicator	4.5	both	O (Note 6)	4
Network specific facilities	4.5	both	O (Note 7)	4 - 25
Calling party number	4.5	both	O (Note 14)	3-19
Calling party subaddress	4.5	both	O (Note 15 & 21)	3 - 23
Called party number	4.5	both	M	3-18
Called party subaddress	4.5	both	O (Note 17 & 21)	3 - 23
Redirecting Number	4.6	both	O (Note 21 & 27)	3-20
Transit network selection	4.5	u -> n	O (Note 18)	3-6
Low layer compatibility	4.5	both	O (Note 19 & 21)	3-16
High layer compatibility	4.5	both	O (Note 20 & 21)	3 - 5
User-user	4.5	both	O (Note 21)	Note 22
Shift to codeset 6	4.5	both	O (Note 21 & 23)	1
Network-specific(codeset 6)	4.6	both	O (Note 21 & 24)	1 - 128
Shift to codeset 7	4.5	both	O (Note 21 & 25)	1
User-specific(codeset 7)	4.6	both	O (Note 21 & 26)	1 - 128

Notes 1 through 5 have been intentionally deleted.

Note 6: Included in the event of interworking or in connection with the provision of in-band information/patterns.

Note 7: Included by the calling user to the network to indicate network specific facilities information (see Annex E). See product specific documentation.

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Notes 8 through 13 have been intentionally deleted.

Note 14: May be included by the calling user or the network to identify the calling user.

Note 15: Included in the user-to-network direction when the calling user wants to indicate the calling party subaddress. Included in the network-to-user direction if the calling user included a Calling party subaddress information element in the SETUP message.

Note 16 has been intentionally discarded.

Note 17: Included in the user-to-network direction when the calling user wants to indicate the Called party subaddress. Included in the network-to-user direction if the calling user included a Called party subaddress information element in the SETUP message.

Note 18: Included by the calling user to select a particular transit network. (See Annex C).

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

Note 20: Included in the user-to-network direction when the calling user wants to pass High layer compatibility information to the called user. Included in the network-to-user direction if the calling user included a High layer compatibility information element in the SETUP message.

Note 21: Included in the user-to-network direction when the calling user wants to pass user data information to the called user. Included in the network-to-user direction if the calling user included a user data information in the SETUP message. Conditions for this transfer are described in Section 7.

Note 22: The minimum length of the User-user information element is 3 octets; the maximum length is 131 octets.

Note 23: Any codeset 6 information element must be preceded by this information element.

Note 24: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 6 information element must be provided first.

Note 25: Any codeset 7 information element must be preceded by this information element.

Note 26: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 7 information element must be provided first.

Note 27: Used to identify address of redirection.

Note 28 has been intentionally deleted.

Note 29: See product specific documentation.

3.1.17 Setup Acknowledge - Reserved for future use

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3.1.18 Status

This message is sent by the user or the network in response to a STATUS ENQUIRY message or at any time during a call to report certain error conditions listed in Section 5.8. See Table IV-3-18.

TABLE IV-3-18

Status Message Content

Message Type: STATUS

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	M	4 - 22
Call state	4.5	both	M	3

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3.1.19 Status Enquiry

This message is sent by the user or the network at any time to solicit a STATUS message from the peer layer 3 entity. Sending a STATUS message in response to a STATUS ENQUIRY message is mandatory. See Table IV-3-19.

TABLE IV-3-19

Status Enquiry Message Content

Message type: STATUS ENQUIRY

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1

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3.1.20 Suspend - Reserved for future use

3.1.21 Suspend Acknowledge - Reserved for future use

3.1.22 Suspend Reject - Reserved for future use

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IV - 3-23

3.1.23 User Information

This message is sent by the user to the network to transfer information to the remote user. This message is also sent by the network to the user to deliver information from the other user. This message is used if the user-to-user transfer is part of an allowed information transfer as defined in Section 7.1.7 or 7.2. See Table IV-3-23.

TABLE IV-3-23

User Information Message Content

Message type: USER INFORMATION

Significance: access

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
More data	4.5	both	O (Note 1)	1
User-user	4.5	both	M	Note 2
Shift to codeset 6	4.5	both	O (Note 3)	1
Network-specific (codeset 6)	4.6	both	O (Note 4)	1 - 128
Shift to codeset 7	4.5	both	O (Note 5)	1
User-specific (codeset 7)	4.6	both	O (Note 6)	1 - 128

Note 1: Included by the sending user to indicate that another USER INFORMATION message pertaining to the same message block will follow.

Note 2: The minimum length of the User-user information element is 3 octets. The maximum length is 251 octets.

Note 3: Any codeset 6 information element must be preceded by this information element.

Note 4: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 6 information element must be provided first.

Note 5: Any codeset 7 information element must be preceded by this information element.

Note 6: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 7 information element must be provided first.

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3.2 Messages for Packet Mode Call Control

Table IV-3-24 summarizes the messages for packet-mode call control. The message tables in this section should be used for DMI and Frame relay data services.

TABLE IV-3-24

Message for Packet-mode Access Connection Control

<u>Access Connection establishment messages:</u>	<u>Reference</u>
ALERTING	3.2.1
CALL PROCEEDING	3.2.2
CONNECT	3.2.3
CONNECT ACKNOWLEDGE	3.2.4
PROGRESS	3.2.6
SETUP	3.2.9
<u>Access Connection clearing messages:</u>	<u>Reference</u>
DISCONNECT	3.2.5
RELEASE	3.2.7
RELEASE COMPLETE	3.2.8
<u>Miscellaneous messages:</u>	<u>Reference</u>
STATUS	3.2.10
STATUS ENQUIRY	3.2.11

3.2.1 Alerting

This message is sent by the called user to the network and by the network to the calling user to indicate that called user alerting has been initiated. See Table IV-3-25.

TABLE IV-3-25

Alerting Message Content

Message type: ALERTING

Significance: global

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	u -> n	M	1
Call reference	4.3	u -> n	M	2 - 3
Message type	4.4	u -> n	M	1
Channel identification	4.5	u -> n	O (Note 1)	4 - 8
Progress indicator	4.5	u -> n	O (Note 4)	4
Shift to codeset 6	4.5	u -> n	O (Note 3)	1
Logical Link Identifier	4.7	u -> n	O (Note 1)	2 - 4

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

Note 2 has been intentionally deleted.

Note 3: Any codeset 6 information element must be preceded by this information element.

Note 4: Included in the event of interworking or in connection with the provision of in-band information/patterns.

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3.2.2 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. See Table IV-3-26.

TABLE IV-3-26

Call Proceeding Message Content

Message type: CALL PROCEEDING

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Channel identification	4.5	both	M	4 - 8
Shift to codeset 6	4.5	u -> n	O (Note 3)	1
Logical Link Identifier	4.7	u -> n	O (Note 1)	2 - 4

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

Note 2 has been intentionally deleted.

Note 3: Any codeset 6 information element must be preceded by this information element.

3.2.3 Connect

This message is sent by the called user to the network and by the network to the calling user to indicate call acceptance by the called user. See Table IV-3-27.

TABLE IV-3-27

Connect Message Content

Message type: CONNECT

Significance: global

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Channel identification	4.5	u -> n	O (Note 1)	4 - 8
Progress indicator	4.5	both	O (Note 9)	4
Shift to codeset 6	4.5	both	O (Note 5)	1
Link Layer Parameters	4.7	both	O (Note 6)	2 - 18
Logical Link Identifier	4.7	both	O (Note 1)	2 - 4
Packet Layer Parameters	4.7	both	O (Note 7)	2 - 12
Throughput Class	4.7	both	O (Note 8)	2 - 6

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

Notes 2, 3 and 4 have been intentionally deleted.

Note 5: Any codeset 6 information element must be preceded by this information element.

Note 6: Included to describe agreed to link layer parameters.

Note 7: Included to describe agreed to packet layer parameters.

Note 8: Included to describe agreed to throughput class.

Note 9: Included in the event of interworking or in connection with the provision of in-band tones/announcement.

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3.2.4 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 control procedures. See Table IV-3-28.

TABLE IV-3-28

Connect Acknowledge Message Content

Message type: CONNECT ACKNOWLEDGE

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1

3.2.5 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. See Table IV-3-29.

TABLE IV-3-29

Disconnect Message Content

Message type: DISCONNECT

Significance: global

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	M	4 - 22

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3.2.6 Progress

This message is sent by the user or the network to indicate the progress of an access connection establishment in the event of interworking within a private network. See Table IV-3-30.

TABLE IV-3-30

Progress Message Content

Message type: PROGRESS

Significance: global

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	O (Note 1)	4 - 22
Progress indicator	4.5	both	M	4

Note 1: Included by the called user to provide additional information.

3.2.7 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. See Table IV-3-31.

TABLE IV-3-31

Release Message Content

Message type: RELEASE
Significance: local (Note 1)
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	O (Note 2)	4 - 22

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.

3.2.8 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 shall release the call reference. See Table IV-3-32.

TABLE IV-3-32

Release Complete Message Content

Message type: RELEASE COMPLETE

Significance: local (Note 1)

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	O (Note 2)	4 - 22

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.

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3.2.9 Setup

This message is sent by the calling user to the network and by the network to the called user to initiate call establishment. See Table IV-3-33.

TABLE IV-3-33

Setup Message Content

Message type: SETUP

Significance: global

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Bearer capability	4.5	both	M (Note 1)	4 - 8
Channel identification	4.5	both	M	4 - 8
Progress indicator	4.5	both	O (Note 24)	4
Calling party number	4.5	both	O	3-19
Calling party subaddress	4.5	both	O	3 - 23
Called party number	4.5	both	M	3-18
Called party subaddress	4.5	both	O	3 - 23
Low layer compatibility	4.5	both	O (Note 25)	3 - 16
Shift to codeset 6	4.5	both	O (Note 19)	1
Link Layer Parameters	4.7	both	O (Note 20)	2 -18
Logical Link Identifier	4.7	both	M	2 - 4
Packet Layer Parameters	4.7	both	O (Note 21)	2 - 12
Throughput Class	4.7	both	O (Note 22)	2 - 6

Note 1: May be used to describe a CCITT telecommunication service involving packet-mode access connections, if appropriate.

Notes 2 through 18 have been intentionally deleted.

Note 19: Any codeset 6 information element must be preceded by this information element.

Note 20: Included to request link layer parameters.

Note 21: Indicates requested layer 3 parameter values to be used for the call.

Note 22: Indicates requested information transfer rate to be used during the information transfer portion of the call.

Note 23 has been intentionally deleted.

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Note 24: Included in the event of interworking or in connection with the provision of in-band information/patterns.

Note 25: Included in the user-to-network direction when the calling user wants to pass low layer compatibility information to the called user. Included in the network-to-user direction if the calling user included a Low layer compatibility information element in the SETUP message.

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3.2.10 Status

This message is sent by the user or the network in response to a STATUS ENQUIRY message or at any time during a call to report certain error conditions listed in Section 5.8. See Table IV-3-34.

TABLE IV-3-34

Status Message Content

Message Type: STATUS

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	M	4 - 22
Call state	4.5	both	M	3

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3.2.11 Status Enquiry

This message is sent by the user or the network at any time to solicit a STATUS message from the peer layer 3 entity. Sending a STATUS message in response to a STATUS ENQUIRY message is mandatory. See Table IV-3-35.

TABLE IV-3-35

Status Enquiry Message Content

Message type: STATUS ENQUIRY

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1

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3.3 Messages for Non-Call Associated Temporary Signaling Connection Control

Table IV-3-36 summarizes the messages for the control of non-call associated temporary signalling connections and the transfer of user-user information.

TABLE IV-3-36

Messages for Temporary Signalling Connection Control

<u>Call establishment messages:</u>	<u>Reference</u>
CALL PROCEEDING	3.3.2
CONNECT	3.3.4
CONNECT ACKNOWLEDGE	3.3.5
SETUP	3.3.9
<u>Call information phase messages:</u>	<u>Reference</u>
USER INFORMATION	3.3.13
<u>Call clearing messages:</u>	<u>Reference</u>
RELEASE	3.3.7
RELEASE COMPLETE	3.3.8
<u>Miscellaneous messages:</u>	<u>Reference</u>
CONGESTION CONTROL	3.3.3
STATUS	3.3.11
STATUS ENQUIRY	3.3.12

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3.3.1 Alerting - Reserved for future use

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3.3.2 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 will be accepted. See Table IV-3-38.

TABLE IV-3-38

Call Proceeding Message Content

Message type: CALL PROCEEDING

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Channel identification	4.5	both	O (Note 2)	3 - 4

Note 1 has been intentionally deleted.

Note 2: May be sent to indicate D-channel.

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3.3.3 Congestion Control

This message is sent by the user or the network to indicate the establishment or termination of flow control on the transmission of USER INFORMATION messages. See Table IV-3-39.

TABLE IV-3-39

Congestion Control Message Content

Message type: CONGESTION CONTROL

Significance: local (Note 1)

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Congestion level	4.5	both	M	1
Cause	4.5	both	M	4 - 22

Note 1: This message has local significance, but may carry information of global significance.

3.3.4 Connect

This message is sent by the called user to the network and by the network to the calling user to indicate call acceptance by the called user. See Table IV-3-40.

TABLE IV-3-40

Connect Message Content

Message type: CONNECT

Significance: global

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Channel identification	4.5	u -> n	O (Note 1)	3 - 4

Note 1: May be sent to indicate D-channel.

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3.3.5 Connect Acknowledge

This message is sent by the network to the called user to indicate the user has been awarded the call. It may also be sent by the calling user to the network to allow symmetrical call control procedures. See Table IV-3-41.

TABLE IV-3-41

Connect Acknowledge Message Content

Message type: CONNECT ACKNOWLEDGE

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1

3.3.6 Information - Reserved for future use

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3.3.7 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. See Table IV-3-43.

TABLE IV-3-43

Release Message Content

Message type: RELEASE
Significance: Global
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	O (Note 2)	4 - 22
User-user	4.5	both	O (Note 5)	(Note 6)
Shift to codeset 6	4.5	both	O (Note 7)	1
Network-specific(codeset 6)	4.6	both	O (Note 8)	1 - 128
Shift to codeset 7	4.5	both	O (Note 9)	1
User-specific(codeset 7)	4.6	both	O (Note 10)	1 - 128

Note 1 has been intentionally deleted.

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

Notes 3 and 4 have been intentionally deleted.

Note 5: Included when the RELEASE message is the first call clearing message, and the user initiates call clearing and wants to pass user information to the remote user at call clearing time. Conditions for this transfer are described in Section 7.

Note 6: The minimum length of the User-user information element is 3 octets; the standard maximum length is 131 octets.

Note 7: Any codeset 6 information element must be preceded by this information element.

Note 8: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 6 information element must be provided first.

Note 9: Any codeset 7 information element must be preceded by this information element.

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Note 10: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 7 information element must be provided first.

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3.3.8 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 shall release the call reference. See Table IV-3-44.

TABLE IV-3-44

Release Complete Message Content

Message type: RELEASE COMPLETE

Significance: local (Note 1)

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	O (Note 2)	4 - 22
User-user	4.5	both	O (Note 5)	(Note 6)
Shift to codeset 6	4.5	both	O (Note 7)	1
Network-specific(codeset 6)	4.6	both	O (Note 8)	1 - 128
Shift to codeset 7	4.5	both	O (Note 9)	1
User-specific(codeset 7)	4.6	both	O (Note 10)	1 - 128

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.

Notes 3 and 4 have been intentionally deleted.

Note 5: Included when the RELEASE COMPLETE message is the first call clearing message, and the user initiates call clearing and wants to pass user information to the remote user at call clearing time. Conditions for this transfer are described in Section 7.

Note 6: The minimum length of the User-user information element is 3 octets; the standard maximum length is 131 octets.

Note 7: Any codeset 6 information element must be preceded by this information element.

Note 8: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 6 information element must be provided first.

Note 9: Any codeset 7 information element must be preceded by this information element.

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Note 10: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 7 information element must be provided first.

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3.3.9 Setup

This message is sent by the calling user to the network and by the network to the called user to initiate call establishment. See Table IV-3-45.

TABLE IV-3-45

Setup Message Content

Message type: SETUP

Significance: global

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Bearer capability	4.5	both	M (Note 2)	4 - 8
Channel identification	4.5	both	M	3 - 4
Network specific facilities	4.5	both	O (Note 3)	4 - 25
Calling party number	4.5	both	O (Note 7)	3-19
Calling party subaddress	4.5	both	O (Note 8)	3 - 23
Called party number	4.5	both	O (Note 9)	3-18
Called party subaddress	4.5	both	O (Note 10)	3 - 23
Low layer compatibility	4.5	both	O (Note 12)	3-16
High layer compatibility	4.5	both	O (Note 13)	3 - 5
User-user	4.5	both	O (Note 14)	(Note 15)
Shift to codeset 6	4.5	both	O (Note 16)	1
Network-specific(codeset 6)	4.6	both	O (Note 17)	1 - 128
Shift to codeset 7	4.5	both	O (Note 18)	1
User-specific(codeset 7)	4.6	both	O (Note 19)	1 - 128

Note 1 has been intentionally deleted.

Note 2: The Bearer capability may be used to describe a CCITT telecommunication service, if appropriate.

Note 3: Included by the calling user or the network to indicate network specific facilities information (see Annex E). See product specific documentation.

Notes 4 through 6 have been intentionally deleted.

Note 7: May be included by the calling user or the network to identify the calling user.

Note 8: Included in the user-to-network direction when the calling user wants to indicate the calling party subaddress. Included in the network-to-user direction if the calling user included a Calling party

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subaddress information element in the SETUP message.

Note 9 has been intentionally deleted.

Note 10: Included in the user-to-network direction when the calling user wants to indicate the Called party subaddress. Included in the network-to-user direction if the calling user included a Called party subaddress information element in the SETUP message.

Note 11 has been intentionally deleted.

Note 12: Included in the user-to-network direction when the calling user wants to pass low layer compatibility information to the called user. Included in the network-to-user direction if the calling user included a Low layer compatibility information element in the SETUP message.

Note 13: Included in the user-to-network direction when the calling user wants to pass High layer compatibility information to the called user. Included in the network-to-user direction if the calling user included a High layer compatibility information element in the SETUP message.

Note 14: Included in the user-to-network direction when the calling user wants to pass user information to the called user. Included in the network-to-user direction if the calling user included a User-user information element in the SETUP message. Conditions for this transfer are described in Section 7.

Note 15: The minimum length of the User-user information element is 3 octets; the maximum length is 131 octets.

Note 16: Any codeset 6 information element must be preceded by this information element.

Note 17: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 6 information element must be provided first.

Note 18: Any codeset 7 information element must be preceded by this information element.

Note 19: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 7 information element must be provided first.

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3.3.10 Setup Acknowledge - Reserved for future use

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3.3.11 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 certain error conditions listed in Section 5.8. See Table IV-3-47.

TABLE IV-3-47

Status Message Content

Message Type: STATUS

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	M	4 - 22
Call state	4.5	both	M	3

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3.3.12 Status Enquiry

This message is sent by the user or the network at any time to solicit a STATUS message from the peer layer 3 entity. Sending a STATUS message in response to a STATUS ENQUIRY message is mandatory. See Table IV-3-48.

TABLE IV-3-48

Status Enquiry Message Content

Message type: STATUS ENQUIRY

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1

3.3.13 User Information

This message is sent by the user to the network to transfer information to the remote user. This message is also sent by the network to the user to deliver information from the other user. See Table IV-3-49.

TABLE IV-3-49

User Information Message Content

Message type: USER INFORMATION

Significance: access

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
More data	4.5	both	O (Note 1)	1
User-user	4.5	both	M	3 - 251
Shift to codeset 6	4.5	both	O (Note 2)	1
Network-specific(codeset 6)	4.6	both	O (Note 3)	1 - 128
Shift to codeset 7	4.5	both	O (Note 4)	1
User-specific(codeset 7)	4.6	both	O (Note 5)	1 - 128

Note 1: Included by the sending user to indicate that another USER INFORMATION message pertaining to the same message block will follow.

Note 2: Any codeset 6 information element must be preceded by this information element.

Note 3: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 6 information element must be provided first.

Note 4: Any codeset 7 information element must be preceded by this information element.

Note 5: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 7 information element must be provided first.

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3.4 Messages used with the global call reference

Table IV-3-50 summarizes the messages which may use the global call reference defined in Section 4.3.

TABLE IV-3-50

Messages used with the global call reference

Messages:	Reference
RESTART	3.4.1
RESTART ACKNOWLEDGE	3.4.2
STATUS	3.4.3
SERVICE	3.4.4
SERVICE ACKNOWLEDGE	3.4.5

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3.4.1 Restart

This message is sent by the user or the network to request the recipient to restart (i.e., return to an idle condition) the indicated channel(s) or interface. See Table IV-3-51.

TABLE IV-3-51

Restart Message Content

Message type: RESTART

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M (Note 1)	2 - 3
Message type	4.4	both	M	1
Channel identification	4.5	both	O (Note 2)	5 - 6
Restart indicator	4.5	both	M	3

Note 1: This message is sent with the global call reference defined in Section 4.3.

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

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3.4.2 Restart Acknowledge

This message is sent to acknowledge the receipt of a RESTART message and to indicate that the requested restart is complete. See Table IV-3-52.

TABLE IV-3-52

Restart Acknowledge Message Content

Message type: RESTART ACKNOWLEDGE

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M (Note 1)	2 - 3
Message type	4.4	both	M	1
Channel identification	4.5	both	O (Note 2)	5 - 6
Restart indicator	4.5	both	M	3

Note 1: This message is sent with the global call reference defined in Section 4.3.

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

3.4.3 Status

This message is sent by the user or the network in response to a STATUS ENQUIRY message or at any time during a call to report certain error conditions listed in Section 5.8. See Table IV-3-53.

TABLE IV-3-53

Status Message Content

Message Type: STATUS

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M (Note 1)	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	M	4 - 22
Call state	4.5	both	M	3

Note 1: This message may be sent with the global call reference defined in Section 4.3.

3.4.4 Service

This message is used to change the current status of the interface or channel to one of the following states: *In Service*, *Maintenance*, or *Out of Service*. The channel identification information element is used to identify a specific channel instead of an interface. See Table IV-3-53a.

TABLE IV-3-53a

Service Message Content

Message Type: SERVICE

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2 (Note1)	both	M	1
Call reference	4.3	both	M	2
Message type	4.4	both	M	1
Change status	4.5	both	M	3
Channel identification	4.5	both	M	3-6

Note 1: The AT&T maintenance message protocol discriminator (00000011) is used for this message.

3.4.5 Service Acknowledge

This message is used to acknowledge the change of state indicated on the SERVICE message. See Table IV-3-53b.

TABLE IV-3-53b

Service Acknowledge Message Content

Message Type: SERVICE ACKNOWLEDGE

Significance: local

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2 (Note1)	both	M	1
Call reference	4.3	both	M	2
Message type	4.4	both	M	1
Change status	4.5	both	M	3
Channel identification	4.5	both	M	3-6

Note 1: The AT&T maintenance message protocol discriminator (00000011) is used for this message.

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3.5 Messages for AT&T Supplementary Services

This section defines the messages used for AT&T Supplementary Services.

Table IV-3-54 summarizes the messages used for requesting and acknowledging AT&T supplementary services.

TABLE IV-3-54

Messages for AT&T Supplementary Services

Messages:	Reference
CONGESTION CONTROL	3.5.1
FACILITY	3.5.2
FACILITY ACKNOWLEDGE	3.5.3
FACILITY REJECT	3.5.4
REGISTER	3.5.5
RELEASE COMPLETE	3.5.6
USER INFORMATION	3.5.7

3.5.1 Congestion Control

This message is sent by the user or the network to indicate the establishment or termination of flow control on the transmission of USER INFORMATION messages. See Table IV-3-55.

TABLE IV-3-55

Congestion Control Message Content

Message type: CONGESTION CONTROL

Significance: local (Note 1)

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Congestion level	4.5	both	M	1
Cause	4.5	both	M	4 - 22

Note 1: This message has local significance, but may carry information of global significance.

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3.5.2 Facility

A FACILITY message is utilized when a service interaction is desired and it is not appropriate to send a call control message (e.g., in the active state of a call).

This message may be used in two ways:

- By including the Network specific facilities information element (in codeset 0) the FACILITY message may be sent by a user to the network to request a facility, or by the network to a user to request acceptance of an end-to-end facility.
- By including the *AT&T standardized facilities* information element (in codeset 6) this message may be used to invoke a service or respond to an invocation of a service.

See Table IV-3-56.

TABLE IV-3-56

Facility Message Content

Message Type: FACILITY

Significance: local

Direction: both

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2-3
Message type	4.4	both	M	1
Channel identification	4.5	both	O (Note 1)	4-12
Network-specific facilities	4.5	both	O (Note 2)	4-25
Shift to codeset 6	4.5	both	O (Note 3)	1
AT&T standardized facilities	4.6	both	O (Note 2)	4-186

Note 1: Inclusion of the Channel identification information element is mandatory if this message is the first response to a SETUP from the network.

Note 2: Either the Network-specific facilities or the AT&T Specific Facilities information element must be present. See product specific documentation.

Note 3: Any codeset 6 information element must be preceded by this information element.

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3.5.3 Facility Acknowledge

This message is sent by either the network or the user to indicate acceptance of a facility request. See Table IV-3-57.

TABLE IV-3-57

Facility Acknowledge Message Content

Message Type: FACILITY ACKNOWLEDGE

Significance: local

Direction: both

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2-3
Message type	4.4	both	M	1
Network-specific facilities	4.5	both	O (Note 1)	4-25
Calling party number	4.5	both	O (Note 1)	3-19

Note 1: Either the Network-specific facilities or calling party number information element, or both, must be present.

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3.5.4 Facility Reject

This message is sent by either the network or the user to indicate the rejection or failure of a facility request. See Table IV-3-58.

TABLE IV-3-58

Facility Reject Message Content

Message Type: FACILITY REJECT

Significance: local

Direction: both

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2-3
Message type	4.4	both	M	1
Cause	4.5	both	M	4-22
Network-specific facilities	4.5	both	O (Note 1)	4-25

Note 1: The Network-specific facilities may be present to indicate rejected facility.

3.5.5 Register

This message is sent to initiate registration to a networked service provided by an entity (e.g., PBX, network switch, adjunct) This message is used to assign a call reference value for the duration of the networked service interaction and to convey the identity of the services being requested. See Table IV-3-59.

TABLE IV-3-59

Register Message Content

Message Type: REGISTER

Significance: local

Direction: both

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2-3
Message type	4.4	both	M	1
Shift to codeset 6	4.5	both	M	1
AT&T standardized facilities	4.6	both	M	4-186

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3.5.6 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 shall release the call reference. See Table IV-3-60.

TABLE IV-3-60

Release Complete Message Content

Message type: RELEASE COMPLETE

Significance: local (Note 1)

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
Cause	4.5	both	O (Note 2)	4 - 22
User-user	4.5	both	O (Note 7)	Note 8
Shift to codeset 6	4.5	both	O (Note 9)	1
Network-specific (codeset 6)	4.6	both	O (Note 10)	1-128
Shift to codeset 7	4.5	both	O (Note 11)	1
User-specified (codeset 7)	4.6	both	O (Note 12)	1-128

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.

Notes 3 through 6 have been intentionally deleted.

Note 7: Included when the RELEASE COMPLETE message is the first call clearing message, and the user initiates call clearing and wants to pass user information to the remote user at call clearing time. Conditions for this transfer are described in Section 7.

Note 8: The minimum length of the User-user information element is 3 octets; the standard maximum length is 131 octets.

Note 9: Any codeset 6 information element must be preceded by this information element.

Note 10: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 6 information element must be provided first.

Note 11: Any codeset 7 information element must be preceded by this information element.

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Note 12: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 7 information element must be provided first.

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3.5.7 User Information

This message is sent by the user to the network to transfer information to the remote user. This message is also sent by the network to the user to deliver information from the other user. This message is used if the user-to-user transfer is part of an allowed information transfer as defined in Section 7.1.7 or 7.2. See Table IV-3-61.

TABLE IV-3-61

User Information Message Content

Message type: USER INFORMATION

Significance: access

Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2 - 3
Message type	4.4	both	M	1
More data	4.5	both	O (Note 1)	1
User-user	4.5	both	M	(Note 2)
Shift to codeset 6	4.5	both	O (Note 3)	1
Network-specific(codeset 6)	4.6	both	O (Note 4)	1 - 128
Shift to codeset 7	4.5	both	O (Note 5)	1
User-specific(codeset 7)	4.6	both	O (Note 6)	1 - 128

Note 1: Included by the sending user to indicate that another USER INFORMATION message pertaining to the same message block will follow.

Note 2: The minimum length of the User-user information element is 3 octets. The maximum length is 251 octets.

Note 3: Any codeset 6 information element must be preceded by this information element.

Note 4: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 6 information element must be provided first.

Note 5: Any codeset 7 information element must be preceded by this information element.

Note 6: Multiple occurrences of these information elements may be present, however, a locking shift to codeset 7 information element must be provided first.

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4. GENERAL MESSAGE FORMAT AND INFORMATION ELEMENTS CODING

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

4.1 OVERVIEW

Within this protocol, every message shall consist of the following parts:

- a. protocol discriminator;
- b. call reference;
- c. message type;
- d. other information elements, as required;

Information elements a), b) and c) are common to all the messages and shall always be present, while d) information elements are specific to each message type.

This organization is illustrated in the example shown in Figure IV-4-1.

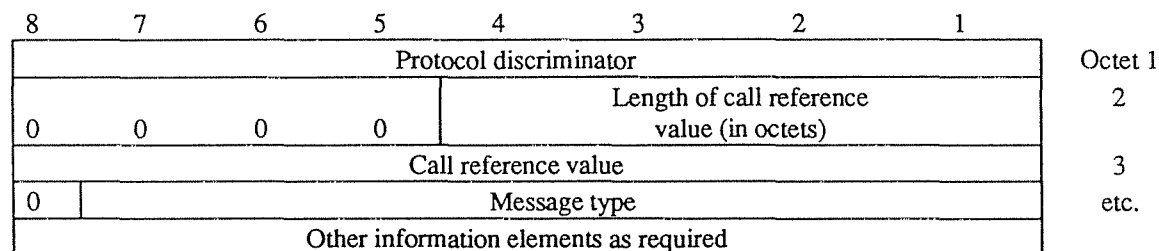


FIGURE IV-4-1

General message organization example

A particular message may contain more information than a 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 may be 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.

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

See product specific documentation for the limitations on the lengths of layer 3 messages that can be sent or received by AT&T products.

4.2 Protocol discriminator

The purpose of the protocol discriminator is to distinguish messages for user-network call control from other messages such as maintenance.

For AT&T products, only the call control and maintenance values are allowed on SAPI 0.

Note - A protocol discriminator field is also included in the user-user information element to indicate the user protocol within the user information; however, the coding of the protocol discriminator in this is shown in Section 4.5.29.

The protocol discriminator is the first part of every message. The protocol discriminator is coded according to Table IV-4-1.

8	7	6	5	4	3	2	1	
0	0	0	0	1	0	0	0	Octet 1
Q.931(I.451) user-network call control messages protocol discriminator								

FIGURE IV-4-2

Protocol Discriminator

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TABLE IV-4-1

Protocol discriminator

8 7 6 5		4 3 2 1	
0 0 0 0	through	0 0 0 0	) assigned in Section 4.5.29: not available for use in the message protocol discriminator.
0 0 0 0		0 0 1 0	
0 0 0 0		0 0 1 1	AT&T maintenance messages
0 0 0 0	through	0 1 0 0	) assigned in Section 4.5.29: not available for use in the message protocol discriminator.
0 0 0 0		0 1 1 1	
0 0 0 0		1 0 0 0	Q.931(I.451) user-network call control messages.
0 0 0 1	through	0 0 0 0	) reserved for other network layer or layer 3 protocols, including Recommendation X.25. (Note 1)
0 0 1 1		1 1 1 1	
0 1 0 0	through	0 0 0 0	) reserved for national use.
0 1 0 0		1 1 1 1	
0 1 0 1	through	0 0 0 0	) reserved for other network layer or layer 3 protocols, including Recommendation X.25. (Note 1)
1 1 1 1		1 1 1 0	
all other values are reserved			

Note 1 - These values are reserved to discriminate these protocol discriminators from the first octet of a X.25 packet including general format identifier.

4.3 Call reference

The purpose of the call reference is to identify the call or facility registration/cancellation request at the local user-network interface to which the particular message applies. The call reference does not have end-to-end significance across ISDNs.

The call reference is the second part of every message. The call reference is coded as shown in Figure IV-4-3. The length of the call reference value is indicated in octet 1, bits 1-4. The element may be two or three octets long. All equipment should be designed to accept both 1 and 2 octet call reference values.

The call reference information element includes the call reference value and the call reference flag.

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 two logical link connection. The

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call reference value is assigned at the beginning of a call and remains fixed for the lifetime of a call. After 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 two logical link connection may be used when each value pertains to a call originated at opposite ends of the link.

All endpoints must recognize call reference values of 0 to 32767, but may place an upper limit on the number of simultaneous active call references for any D-Channel. The upper limit is an implementation option.

The call reference flag can take the values "0" or "1". The call reference flag is used to identify which end of the layer two logical link originated a call reference. The origination side always sets the call reference flag to "0". The destination side always sets the call reference flag to a "1".

Hence the call reference flag identifies who allocated the call reference value for this call and the only purpose of the call reference flag is to resolve simultaneous attempts to allocate the same call reference value.

Note 2 - The numerical value of the global call reference information element is zero. A two octet global call reference information element is coded with the first octet "0000 0001" and the second octet "F000 0000," where F is the call reference flag. The three octet global call reference information element is coded first octet "0000 0010," second octet "F000 0000," and third octet "0000 0000." 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. See figure IV-4-5.

If in the case of RESTART and RESTART ACKNOWLEDGE, when the Channel Identification Information Element is included, equipment receiving a such a message shall interpret the message as pertaining to all call references associated with the channel or interface specified in the Channel Identification Information Element. When the Channel Identification Information Element is absent, the message shall be interpreted as pertaining to the interface containing the D channel.

Note that in accordance with the remark made in Section 4.1, a call reference may be equivalently described in either two or three octets. This may be accomplished by setting bits 7 through 1 of octet 2 and bit 8 of octet 3 of the call reference described in three octets to zero, and then setting bits 7 through 1 of octet 3 identical to bits 7 through 1 of octet 2 of the call reference described in two octets. In other words, one can convert the call reference value to a binary number of either length 7 bits or length 15 bits. In both cases, the lowest bit of the highest octet is the least significant bit.

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

Call reference flag (octet 2)

bit

8

0 the message is sent *from* the side that originates the call reference.

1 the message is sent *to* the side that originates the call reference.

FIGURE IV-4-3

Call reference information element

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

a) - One octet call reference value.

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

b) - Two octet call reference value.

FIGURE IV-4-5

Examples of the encoding for global call reference

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4.4 Message type

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

The message type is the third part of every message. The message type is coded as shown in Figure IV-4-6 and Table IV-4-2.

Bit 8 is reserved for possible future use as an extension bit.

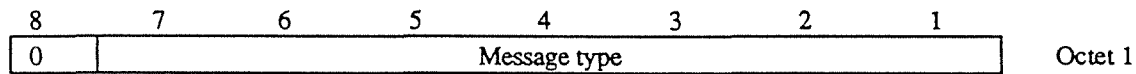


FIGURE IV-4-6

Message type

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TABLE IV-4-2

Message types

8	7	6	5	4	3	2	1	
0	0	0	-	-	-	-	-	Call establishment message:
			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	0	1	-	-	-	-	-	Call information phase message:
			0	0	0	0	0	- USER INFORMATION
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:
			1	1	0	0	1	- CONGESTION CONTROL
			0	0	0	1	0	- FACILITY
			1	1	1	0	1	- STATUS
			1	0	1	0	1	- STATUS ENQUIRY
								AT&T Extensions
0	1	1	-	-	-	-	-	Miscellaneous messages:
			0	1	0	1	0	- FACILITY ACKNOWLEDGE
			1	0	0	1	0	- FACILITY REJECT
			0	0	1	0	0	- REGISTER
0	0	0	-	-	-	-	-	Maintenance messages (Protocol Discriminator 00000011)
			0	1	1	1	1	- SERVICE
			0	0	1	1	1	- SERVICE ACKNOWLEDGE

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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 equipment which processes a message to find information elements important to it, and yet remain ignorant of information elements not important to that equipment.

Two categories of information elements are defined:

- a) single octet information elements (see Figure IV-4-7);
- b) variable length information elements (see Figure IV-4-7).

For the information elements listed below, the coding of the information element identifier bits is summarized in Table IV-4-3. AT&T products will not support more than the maximum length shown. For the actual maximum length supported by a particular AT&T product, consult the product specific documentation. See Appendix III for a summary of the core messages (for all AT&T products) and their associated information elements for circuit-mode connections.

The descriptions of the information elements below are organized in alphabetical order. However, there is a particular order of appearance for each information element in a message within each codeset (see Section 4.5.2). 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. Two types of single octet information elements have been defined. Type 1 elements provide the information element identification in bit positions 7, 6, 5. The value "0 1 0" in these bit positions are reserved for Type 2 single octet elements.

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 implementation, messages should not be rejected simply because a spare bit is 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 (i.e. the length starting with octet 3). It is the binary coding of the number of octets of the contents, with bit 1 as the least significant bit (2^0).

An optional variable-length information element may be present, but empty. 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 (octets 3 etc):

- a. The first digit in the octet number identifies one octet or a group of octets.
- b. Each octet group is a self contained entity. The internal structure of an octet group may be defined in alternative ways.

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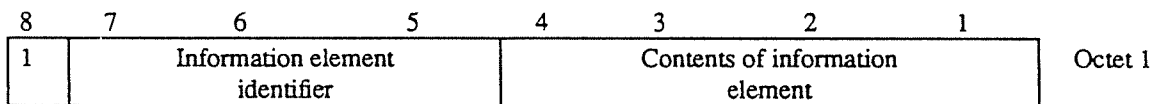
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An octet group is formed by using some extension mechanism. The preferred extension mechanism is to extend an octet (N) through the next octet(s) (Na, Nb, etc.) by using bit 8 in each octet as an extension bit. The bit value "0" indicates that the octet continues through the next octet. The bit value "1" indicates that this octet is the last octet. If one octet (Nb) is present, also the preceding octets (N and Na) must be present.

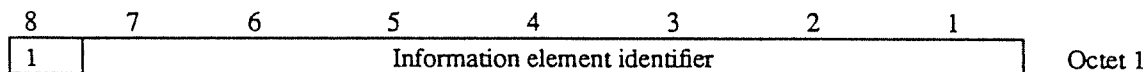
In the format descriptions appearing in Section 4.5.5 etc., bit 8 is marked "0/1 ext" if another octet follows. Bit 8 is marked "1 ext" if this is the last octet in the extension domain.

Additional octets may be defined later ("1 ext" changed to "0/1 ext") and equipments shall be prepared to receive such additional octets although the equipment need not be able to interpret or act upon the content of these octets.

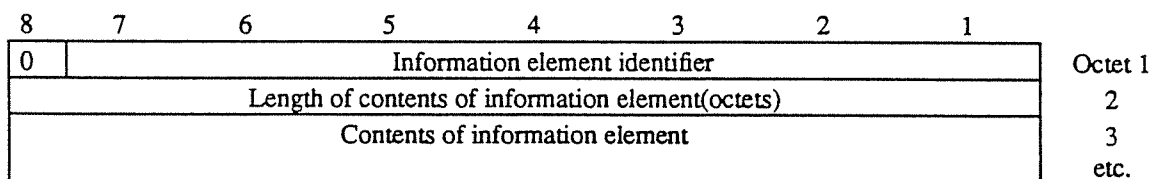
- d. In addition to the extension mechanism defined above, an octet (N) may be extended through the next octet(s) (N.1, N.2 etc.) by indications in bits 7-1 (of octet N).
- e. The mechanisms in c) and d) may be combined.
- f. Optional octets are marked with asterisks(*)



- a) Single octet information element format (type 1).



- b) Single octet information element format (type 2).



- c) Variable length information element format.

FIGURE IV-4-7

Formats of information elements

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TABLE IV-4-3
Codeset 0 Information element identifier coding

8 7 6 5 4 3 2 1		Section reference	Maximum length (octets)
1 : : : - - -	Single octet information elements:		Note 1
0 0 0 - - -	reserved		
0 0 1 - - -	Shift (Note 2)	4.5.3—4.5.4	1
0 1 0 0 0 0	More data	4.5.19	1
0 1 1 - - -	Congestion level	4.5.14	1
0 : : : : :	Variable length information element:		
0 0 0 0 1 0 0	Bearer capability	4.5.5	8
0 0 0 1 0 0 0	Cause	4.5.12	22
0 0 0 1 1 0 0	Connected number	4.6.6	18
0 0 1 0 0 0 0	Call identity	4.5.6	10
0 0 1 0 1 0 0	Call state	4.5.7	3
0 0 0 0 0 0 1	Change status (Note 9)	4.5.30	3
0 0 1 1 0 0 0	Channel identification	4.5.13	8
0 0 1 1 1 1 0	Progress indicator	4.5.22	4
0 1 0 0 0 0 0	Network specific facilities (Note 2)	4.5.20	25
0 1 1 0 1 0 0	Signal (Note 2)	4.5.27	3
1 1 0 1 1 0 0	Calling party number	4.5.10	19
1 1 0 1 1 0 1	Calling party subaddress	4.5.11	23
1 1 1 0 0 0 0	Called party number —	4.5.8	18
1 1 1 0 0 0 1	Called party subaddress	4.5.9	23
1 1 1 0 1 0 0	Redirecting number	4.6.7	20
1 1 1 1 0 0 0	Transit network selection	4.5.28	6
1 1 1 1 0 0 1	Restart indicator	4.5.24	3
1 1 1 1 1 0 0	Low layer compatibility	4.5.18	16
1 1 1 1 1 0 1	High layer compatibility	4.5.16	5
1 1 1 1 1 1 0	User-user	4.5.29	131
All other values are reserved. (Note 5)			

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Note 1 - The length limits described for the variable length information elements below take into account only the present CCITT standardized coding values. Future enhancements and expansions to this specification will not be restricted to these limits.

Note 2 - This information element may be repeated.

See product specific documentation.

Notes 3 and 4 have been intentionally deleted.

Note 5 - The reserved values with bits 5-8 coded "0000" are for future information elements for which comprehension by the receiver is required (see Section 5.8.7.1).

Note 6 has been intentionally deleted.

Note 7: Codeset 7 information elements that are not recognized may be tandemmed to another ISDN interface, if applicable. See product specific documentation.

Note 8: Codeset 6 information elements that are not recognized may be tandemmed to another ISDN interface, if applicable. See product specific documentation.

Note 9: The Change status information element is only used with the AT&T maintenance message protocol discriminator.

8	7	6	5	4	3	2	1	Section reference
0	:	:	:	:	:	:	:	Variable length information elements:
0	0	1	1	1	0	1		AT&T Standardized Facilities 4.6.8.1
0	0	1	1	1	0	0		Facility 4.6.8.14
0	1	0	1	0	0	1		Connection description 4.6.8.15
1	0	0	0	0	0	0		Link layer parameters 4.7.8.1
0	0	1	1	0	1	0		Logical link identification 4.7.8.2
0	1	0	1	0	1	0		Subchannel identification 4.6.8.17
0	1	0	1	0	0	0		Display 4.6.8.2
1	0	1	0	1	0	1		Reserved
0	1	0	1	0	1	0		Reserved
0	1	1	1	1	1	0		Packet Layer Parameters 4.7.8.3
1	0	0	0	1	1	1		Reserved
1	1	0	0	0	1	0		Throughput Class 4.7.8.4
0	0	0	1	0	0	0		Traveling Class Mark 4.6.8.4
1	1	1	1	0	1	1		Lookahead interflow 4.6.8.3
1	0	1	0	1	0	0		Reserved
1	0	1	0	1	1	1		Reserved
0	0	0	1	1	0	0		Subnetwork trunking 4.6.8.9
0	0	0	1	0	1	0		Trunk identification 4.6.8.10
0	0	0	1	0	1	1		Trunk group/Trunk Status 4.6.8.11
0	0	0	0	0	1	0		User code 4.6.8.12
1	0	0	1	0	0	0		Feature 4.6.8.16

All other values are reserved.

Figure IV-4-2a Codeset 6 Information Element Identifier Coding

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8	7	6	5	4	3	2	1		Section reference
0	:	:	:	:	:	:	:	Variable length information elements:	
	0	1	0	1	0	0	0	Display	4.6.8.2
	0	0	0	1	0	0	0	Traveling Class Mark	4.6.8.4
	1	1	1	1	0	1	1	Lookahead interflow	4.6.8.3

Figure IV-4-3a Codeset 7 Information Element Identifier Coding

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4.5.2 Extensions of codesets

There is a certain number of possible information element identifier values using the formatting rules described in Section 4.5.1; 128 from the variable length information element format and at least 8 from the single octet information element format.

One value in the single octet format is specified for shift operations described below. One other value in both the single octet and variable format is reserved. This leaves at least 133 information element identifier values available for assignment.

It is possible to expand this structure to eight codesets of at least 133 information element identifier values each. One common value in the signal octet format is employed in each codeset to facilitate shifting from one codeset to another. The contents of this Shift information element item identifies the codeset to be used for the next information elements or elements. The codeset in use at any given time is referred to as the "active codeset". By convention, codeset 0 is the initially active codeset.

One codeset shifting procedure is supported: locking shift.

Codeset 6 is reserved for information elements specific to the local network (either public or private).

Codeset 7 is reserved for user-specific information elements.

The coding rules specified in Section 4.5.1 shall apply for information elements belonging to any active codeset.

Transitions from one active codeset to another (i.e. by means of the locking shift procedure) may only be made to a codeset with a higher numerical value than the codeset being left.

A user or network equipment shall have the capability to recognize a shift information element and to determine the length of the following information element, although the equipment need not be able to interpret and act upon the content of the information element. This enables the equipment to determine the start of a subsequent information element.

Codeset 7 information element shall be handled according to the procedures for unrecognized information elements (see Section 5.8.7.1) by the first exchange in the local network, unless allowed by a future service definition, bilateral agreement, or provision is made to support this across the local network for a specific user.

Codeset 6 is reserved for information elements specific to the local network (either public or private). As such they do not have significance across the boundaries between local networks, or across a national, or international boundary. Therefore, codeset 6 information elements shall be handled according to the procedures for unrecognized information element (See Section 5.8.7.1).

4.5.3 Locking shift procedure

The locking shift procedure employs an information element to indicate the new active codeset. The specified codeset remains active until another locking shift information element is encountered which specifies the use of another codeset. For example, codeset 0 is active at the start of message content analysis. If a locking shift to codeset 6 is encountered, the next information elements will be interpreted according to the information element identifiers assigned in codeset 6, until another shift information element is encountered.

This procedure is used only to shift to a higher order codeset than the one being left.

The locking shift is valid only within that message which contains the locking Shift information element. At the start of every message content analysis, the active codeset is codeset 0.

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The locking Shift information element uses the single octet information element format and coding shown in Figure IV-4-9 and Table IV-4-4.

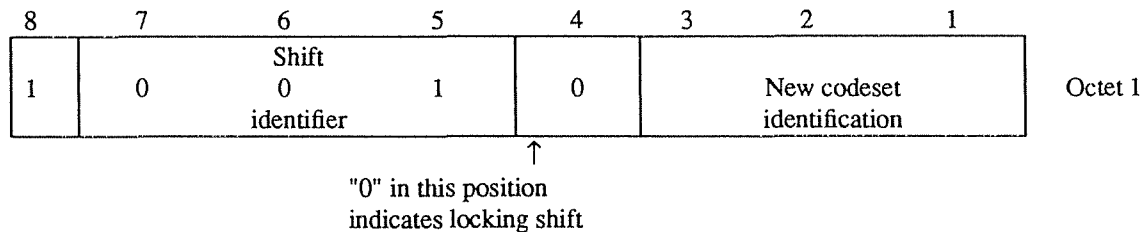


FIGURE IV-4-9

Locking Shift information element

TABLE IV-4-4

Locking Shift information element

Codeset identification (bits 3 to 1):			
3	2	1	
0	0	0	not applicable
0	0	1	reserved
to	}		
1	0	1	
1	1	0	codeset 6: information elements specific to the local network (either public or private)
1	1	1	codeset 7: user-specific information elements

Note 1: A user or network equipment shall have the capability to recognize shifts to codesets 1 through 7. For codesets 1 to 5, the locking shift information element is not passed and the information elements that follow will be treated as unrecognized optional information elements as described in the error recovery procedures sections. For codesets, 6 and 7, the error recovery procedures are given in the error recovery procedures section. See product specific documentation.

4.5.4 Non-locking shift procedure - Reserved for future use

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4.5.5 Bearer capability

The purpose of the Bearer capability information element is to indicate a requested Recommendation I.231 bearer service to be provided for the call by the network. It contains only information which may be used by the network, see Annex L. The use of the bearer capability information element in relation to compatibility checking is described in Annex B.

The Bearer capability information element is coded as shown in Figure IV-4-11 and Table IV-4-6.

Examples of the coding of the Bearer capability information element is shown in Annex H.

No default Bearer capability may be assumed by the absence of this information element.

The maximum length of this information element is 8 octets when CCITT standard coding is used.

8	7	6	5	4	3	2	1	
0	Bearer capability							Octet 1
0	0	0	0	0	1	0	0	
Information element identifier								
Length of the bearer capability contents								2
1 ext	coding standard		information transfer capability					3
0/1 ext	transfer mode		information transfer rate					4
0/1 ext	structure			configuration		establishment		4a*
1 1	symmetry		information transfer rate (destination ----> origination)					4b* (Note 1)
0/1 ext	0	1	user information layer 1 protocol					5*
layer 1 indent								
0/1 ext	synch. asynch.	spare 0	user rate					5a (Note 4)
1 ext	1	0	user information layer 2 protocol					6*
layer 2 indent								
1 ext	1	1	user information layer 3 protocol					7*
layer 3 indent								

FIGURE IV-4-11

Bearer capability information element

Note 1 - If default values are used for all fields of octets 4a and 4b, then these octets may not be included. When octets 4a and 4b are included, they can only be coded as per the defaults.

Notes 2 and 3 have been intentionally deleted.

Note 4 - This octet may be present if octet 5 indicates either of the CCITT standardized rate adaptations V.110/X.30 or V.120.

TABLE IV-4-6

Bearer capability information element

Coding standard (octet 3)

Bits		
7	6	
0	0	CCITT standardized coding as described below
1	1	standard defined for the network (either public or private) present on the network side of the interface (Note)

Note - These other coding standards should be used only when the desired bearer capability can not be represented with the CCITT - standardized coding.

Information transfer capability (octet 3)

Bits					
5	4	3	2	1	
0	0	0	0	0	speech
0	1	0	0	0	unrestricted digital information
0	1	0	0	1	restricted digital information
1	0	0	0	0	3.1 kHz audio

All other values are reserved.

Transfer mode (octet 4)

Bits		
7	6	
0	0	circuit mode
1	0	packet-mode

All other values are reserved.

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TABLE IV-4-6

Bearer capability information element

Information transfer rate (octet 4 and 4b, bits 5 to 1)

Bits 5 4 3 2 1	Circuit mode	Packet-mode
0 0 0 0 0	-	This code shall be used for packet-mode calls. (Note 4)
1 0 0 0 0	64 kbit/s	-
1 0 0 0 1	2 x 64 kbits/s	-
1 0 0 1 1	384 kbit/s	-
1 0 1 0 1	1536 kbit/s	-
1 0 0 0 1	128 kbit/s (2) (Note 3)	
0 0 0 0 1	192 kbit/s (3) (Note 3)	
0 0 0 1 0	256 kbit/s (4) (Note 3)	
0 0 0 1 1	320 kbit/s (5) (Note 3)	
0 0 1 0 0	448 kbit/s (7) (Note 3)	
0 0 1 0 1	512 kbit/s (8) (Note 3)	
0 0 1 1 0	576 kbit/s (9) (Note 3)	
0 0 1 1 1	640 kbit/s (10) (Note 3)	
0 1 0 0 0	704 kbit/s (11) (Note 3)	
0 1 0 0 1	768 kbit/s (12) (Note 3)	
0 1 0 1 0	832 kbit/s (13) (Note 3)	
0 1 0 1 1	896 kbit/s (14) (Note 3)	
0 1 1 0 0	960 kbit/s (15) (Note 3)	
0 1 1 0 1	1024 kbit/s (16) (Note 3)	
0 1 1 1 0	1088 kbit/s (17) (Note 3)	
0 1 1 1 1	1152 kbit/s (18) (Note 3)	
1 1 0 0 0	1216 kbit/s (19) (Note 3)	
1 1 0 0 1	1280 kbit/s (20) (Note 3)	
1 1 0 1 0	1344 kbit/s (21) (Note 3)	
1 1 0 1 1	1408 kbit/s (22) (Note 3)	
1 1 1 0 0	1472 kbit/s (23) (Note 3)	

All other values are reserved.

Note 1 - When octet 4b is omitted, the bearer capability is bidirectional symmetric at the information transfer rate specified in octet 4. When 4b is included, the information transfer rate in octet 4 refers to the origination --> destination direction.

Note 3 - When this codepoint is selected, octet 3 must be coded 1 1 (standard defined for the network present on the network side of the interface).

Note 4 - The throughput rates for packet mode calls are included in the Throughput class information element in Section 4.7.8.4.

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Structure (octet 4a)

Bits
7 6 5

0 0 0 default (see Note 1)

Note 1 - If octet 4a is omitted, or the structure field is coded "000", then the value of the structure attribute is according to the following:

Transfer mode	transfer capability	structure
circuit	speech	8 kHz integrity
circuit	unrestricted digital	8 kHz integrity
circuit	restricted digital	8 kHz integrity
circuit	audio	8 kHz integrity
circuit	video	8 kHz integrity
packet	unrestricted digital	service data unit integrity

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TABLE IV-4-6

Bearer capability information element

Configuration (octet 4a)

Bits
4 3
—

0 0 point-to-point

All other values are reserved.

Note - If octet 4a is omitted, the configuration is assumed to be point-to-point.

Establishment (octet 4a)

Bits
2 1
—

0 0 demand

All other values are reserved.

Note - If octet 4a is omitted, the method of establishment is assumed to be "demand".

Symmetry (octet 4b)

Bits
7 6
—

0 0 bidirectional symmetric

All other values are reserved.

Note - If octet 4b is omitted, bidirectional symmetric is assumed.

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TABLE IV-4-6

Bearer capability information element

User information layer 1 protocol (octet 5)

Bits

5 4 3 2 1

0 0 0 0 1	CCITT standardized rate adaption V.110/X.30. This implies the presence of octets 5a
0 0 0 1 0	Recommendation G.711 u-law
0 0 1 0 0	Recommendation G.721 32 kbit/s ADPCM and Recommendation I.460
0 0 1 1 1	Non-CCITT standardized rate adaption. This implies the presence of octet 5a and, optionally, octets 5b, 4c and 5d. The use of this codepoint indicates that the user rate specified in octet 5a is defined in accordance with the non-CCITT standardized rate adaption scheme. Additionally, octets 5b, 5c, and 5d, if present, are defined consistent with the specified rate adaption
0 1 1 0 0	5 frame subrate data (Note 2)
0 1 1 0 1	10 frame subrate data (Note 2)
0 1 1 1 0	20 frame subrate data (Note 2)
0 1 1 1 1	enhanced 20 frame subrate data (Note 2)

All other values are reserved.

Note 1 - If the transfer mode is "circuit mode"; and if the information transfer capability is "unrestricted digital information" or "restricted digital information", and if the user information layer 1 protocol is not to be identified to the network, octet 5 shall be omitted. If the transfer mode is packet mode, octet 5 may be omitted. Otherwise, octet shall be present.

Note 2 - When this codepoint is selected, octet 3 must be specified as 1 1 (standard defined for the network present on the network side of the interface); the octet 5 extension bit must be coded "0", and octet 5a must be coded as specified below.

Synchronous/asynchronous (octet 5a)

Bit

7

—

0 Synchronous

Negotiation (octet 5a, Bit 6 = 0) - Reserved for future use

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TABLE IV-4-6

Bearer capability information element

User rate (octet 5a)

Bits					
5	4	3	2	1	
0	0	0	1	1	2.4 kbit/s Recommendation V.6 and X.1
0	0	1	0	1	4.8 kbit/s Recommendation V.6 and X.1
0	1	0	0	0	9.6 kbit/s Recommendation V.6 and X.1
0	1	1	1	1	56 kbit/s Recommendation V.6

All other values are reserved.

Octet 5b - Reserved for future use.

Octet 5c - Reserved for future use.

Octet 5d - Reserved for future use.

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TABLE IV-4-6

Bearer capability information element

User information layer 2 protocol (octet 6)

Bits
 5 4 3 2 1

0 0 0 1 0 Recommendation Q.921 (I.441)
 0 0 1 1 0 Recommendation X.25, link level

All other values are reserved.

Note - If the transfer mode is "packet mode", octet 6 shall be present. For other cases, if the user layer 2 protocol is to be identified to the network, the octet 6 shall be present; otherwise octet 6 shall be omitted.

User information layer 3 protocol (octet 7)

Bits
 5 4 3 2 1

0 0 0 1 0 Recommendation Q.931(I.451)
 0 0 1 1 0 Recommendation X.25, packet layer

All other values are reserved.

Note - If the user information layer 3 protocol is to be identified to the network, octet 7 shall be present; otherwise octet 7 shall be omitted.

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4.5.6 Call identity

The purpose of the Call identity information element is to correlate an incoming SETUP message with a previous routing transaction.

The Call identity information element is coded as shown in Figure IV-4-12.

The default maximum length of this information element is 10 octets.

8	7	6	5	4	3	2	1	
Call identity								Octet 1
0	0	0	1	0	0	0	0	
Information element identifier								
Length of call identity contents								2
Call identity (any bit pattern allowed e.g. IA5 characters)								3 etc.

FIGURE IV-4-12

Call identity information element

4.5.7 Call state

The purpose of the Call state information element is to describe the current status of a call, (see Section 2.1) or an access-connection (see Section 2.2).

The call state information element is coded as shown in Figure IV-4-13 and Table IV-4-7.

The maximum length of this information element is three octets when CCITT standard coding is used.

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

FIGURE IV-4-13
Call state information element

TABLE IV-4-7
Call state information element

Coding standard (octet 3)

Bits
8 7

0	0	CCITT standardized coding, as described below
1	1	standard defined for the network (either public or private) present on the network side of the interface (Note)

Note - These other coding standards should be used only when the desired call state can not be represented with the CCITT-standardized coding.

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TABLE IV-4-7

Call state information element

Call state value (octet 3)

Bits						user state	network state
6	5	4	3	2	1		
0	0	0	0	0	0	U0 - Null	N0 - Null
0	0	0	0	0	1	U1 - Call Initiated	
0	0	0	0	1	1	U3 - Outgoing Call Proceeding	N3 - Outgoing Call Proceeding
0	0	0	1	0	0	U4 - Call Delivered	N4 - Call Delivered
0	0	0	1	1	0		N6 - Call Present
0	0	0	1	1	1	U7 - Call Received	N7 - Call Received
0	0	1	0	0	0	U8 - Connect Request	N8 - Connect Request
0	0	1	0	0	1	U9 - Incoming Call Proceeding	N9 - Incoming Call Proceeding
0	0	1	0	1	0	U10 - Active	N10 - Active
0	0	1	0	1	1	U11 - Disconnect Request	N11 - Disconnect Request
0	0	1	1	0	0	U12 - Disconnect Indication	N12 - Disconnect Indication
0	1	0	0	1	1	U19 - Release Request	N19 - Release Request
0	1	0	0	1	0	U18 - Tone Active	N18 - Tone Active

Global interface state value (octet 3) Reserved for future use

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4.5.8 Called party number

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

The Called party number information element is coded as shown in Figure IV-4-14 and Table IV-4-8.

The maximum length of this information element is 18 octets.

8	7	6	5	4	3	2	1	
0	Called party number							Octet 1
1	1	1	1	0	0	0	0	
Information element identifier								
Length of called party number contents								2
1	Type of number			Numbering plan				3
ext				identification				
0	Number digits							4
	(IA5 characters - see Note)							etc.

Note - The number digits appear in multiple octet 4's in the same order in which they would be entered, that is, the number digit which would be entered first is located in the first octet 4. In some cases, number digits may not be required. See product specific documentation.

FIGURE IV-4-14

Called party number information element

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TABLE IV-4-8
Called party number information element

Type of number (octet 3) (Note 1)

Bits

7 6 5

0 0 0	unknown (Note 2)
0 0 1	international number (Note 3)
0 1 0	national number (Note 3)
1 0 0	subscriber number (Note 3)
1 1 0	abbreviated number

All other values are reserved.

Note 1 - For the definition of international, national and subscriber number, see Recommendation I.330.

Note 2 - The type of number "unknown" is used when the user or the network has no knowledge of the type of number, e.g. international number, national number, etc. In this case the number digits field is organized according to the network dialing plan; e.g., prefix or escape digits might be present.

Note 3 - Prefix or escape digits shall not be included.

Numbering plan identification (octet 3)

Numbering plan

Bits

4 3 2 1

0 0 0 0	unknown (Note)
0 0 0 1	ISDN/telephony numbering plan (Recommendation E.164/E.163)
1 0 0 1	private numbering plan
0 0 1 0	Telephony numbering plan (E.163)

All other values reserved.

Note - The numbering plan "unknown" is used when the user or the network has no knowledge of the numbering plan. In this case the number digits field is organized according to the network dialing plan; e.g., prefix or escape digits might be present.

Note - The ISDN/telephony numbering plan codepoint (0 0 0 1) is the preferred coding for E.163.

Number digits (octet 4, etc.)

This field is coded with IA5 characters, according to the formats specified in the appropriate numbering dialing plan.

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Bits <u>7 6 5 4 3 2 1</u>	Number 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
0 1 0 1 0 1 0	*
0 1 0 0 0 1 1	#
1 1 0 0 0 0 1	a
1 1 0 0 0 1 0	b
1 1 0 0 0 1 1	c
1 1 0 0 1 0 0	d

Note - See product specific documentation for the number of digits and the digit values.

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4.5.9 Called party subaddress

The purpose of the Called party subaddress information element is to identify the subaddress of the called party of a call. For the definition of subaddress see Recommendation I.330.

The Called party subaddress is coded as shown in Figure IV-4-15 and Table IV-4-9.

The maximum length of this information element is 23 octets.

8	7	6	5	4	3	2	1	
0	Called party subaddress							octet 1
1	1	1	0	0	0	1		
Information element identifier								
Length of called party subaddress contents								2
1 ext	Type of subaddress			odd/ even indic.	0	0	0	3
Subaddress information								4 etc.

FIGURE IV-4-15

Called party subaddress information element

TABLE IV-4-9

Called party subaddress information element

Type of subaddress (octet 3)

Bits		
7	6	5
0	0	0
NSAP (X.213/ISO 8348 AD2)		
0	1	0
User specified		

All other values reserved.

Odd/even indicator (octet 3)

Bit	
4	
0	even number of address signals
1	odd number of address signals

Note - The odd/even indicator is used when the type of subaddress is "user specified" and the coding is BCD.

Subaddress information (octet 4, etc.)

The NSAP X.213/ISO 8348 AD2 address, shall be formatted as specified by octet 4 which contains the Authority and Format Identifier (AFI). The encoding is made according to the "preferred binary encoding" as defined in X.213/ISO 8348 AD2. For the definition of this type of subaddress, see Rec. I.334.

For user-specified subaddress, this field is encoded according to the user specification, subject to a maximum length of 20 octets. When interworking with X.25 networks BCD coding should be applied.

Note - It is recommended that users apply the NSAP subaddress type since this subaddress type allows the use of decimal, binary and IA5 characters in a standardized manner.

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4.5.10 Calling party number

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

The Calling party number information element is coded as shown in Figure IV-4-16 and Table IV-4-10.

The maximum length of this information element is 19 octets.

8	7	6	5	4	3	2	1	
0	Calling party number							octet 1
	1	1	0	1	1	0	0	
Information element identifier								
Length of calling party number contents								2
0/1 ext	Type of number			Numbering plan identification				3
1 ext	Presentation indicator		0	0	0	Screening Indicator		3a
0	Number digits (IA5 characters)							4

FIGURE IV-4-16

Calling party number information element

Note 1: It is an implementation option whether to send octet 3a, however all equipment shall be designed to receive it. If octet 3a is omitted, then the calling party number shall be assumed user provided (with no network screening) and presentation to the terminating user is permitted.

Note 2 - The address digit in octet 4 precedes the digit in octet 5, etc. The address digit which would be dialed first is located in octet 4.

TABLE IV-4-10
Calling party number information element

Type of number (octet 3) (Note 1)

Bits

7 6 5

0 0 0	unknown (Note 2)
0 0 1	international number (Note 3)
0 1 0	national number (Note 3)
1 0 0	subscriber number (Note 3)
1 1 0	abbreviated number

All other values are reserved.

Note 1 - For the definition of international, national and subscriber number, see Recommendation I.330.

Note 2 - The type of number "unknown" is used when the user or the network has no knowledge of the type of number, e.g. international number, national number, etc. In this case the number digits field is organized according to the network dialing plan; e.g., prefix or escape digits might be present.

Note 3 - Prefix or escape digits shall not be included.

Numbering plan identification (octet 3)

Numbering plan

Bits

4 3 2 1

0 0 0 0	unknown (Note)
0 0 0 1	ISDN/telephony numbering plan (Recommendation E.164/E.163)
1 0 0 1	private numbering plan
0 0 1 0	Telephony numbering plan (E.163)

All other values reserved.

Note - The numbering plan "unknown" is used when the user or the network has no knowledge of the numbering plan. In this case the number digits field is organized according to the network dialing plan; e.g., prefix or escape digits might be present.

Note - The ISDN/telephony numbering plan codepoint (0 0 0 1) is the preferred coding for E.163.

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TABLE IV-4-10

Calling party number information element

*Presentation indicator (octet 3a)*Bits
7 6
—

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

Note - At the originating user-network interface, the presentation indicator is used for indicating the intention of the calling user for the presentation of the calling party number to the called user. This may also be requested on a subscription basis. If octet 3a is omitted, and the network does not support subscription information for the calling party number information restrictions, the value "00 - presentation allowed" is assumed.

*Screening indicator (octet 3a)*Bits
2 1
—

- 0 0 User-provided, not screened
- 0 1 User-provided, verified and passed
- 1 0 User-provided, verified and failed
- 1 1 Network provided

Note - If octet 3a is omitted, "0 0 - User provided not screened" is assumed.

Number digits (octet 4, etc.)

This field is coded with IA5 characters, according to the formats specified in the appropriate numbering/dialing plan.

Bits <u>7 6 5 4 3 2 1</u>	Number 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
0 1 0 1 0 1 0	*
0 1 0 0 0 1 1	#

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4.5.11 Calling party subaddress

The purpose of the Calling party subaddress is to identify a subaddress associated with the origin of a call. For the definition of subaddress, see Recommendation I.330.

The Calling party subaddress information element is coded as shown in Figure IV-4-17 and Table IV-4-11.

The maximum length of this information element is 23 octets.

8	7	6	5	4	3	2	1	
0	Calling party subaddress							octet 1
1	1	0	1	1	0	1		
Information element identifier								
Length of calling party subaddress contents								2
0/1 ext	Type of subaddress			odd/ even indic.	0	0	0	3
Subaddress information								4 etc.

FIGURE IV-4-17

Calling party subaddress information element

TABLE IV-4-11

Calling party subaddress information element

Type of subaddress (octet 3)

Bits

7 6 5

0 0 0 NSAP (X.213/ISO 8348 AD2)

0 1 0 User specified

All other values reserved.

Odd/even indicator (octet 3)

Bit

4

0 even number of address signals

1 odd number of address signals

Note - The odd/even indicator is used when the type of subaddress is "user specified" and the coding is BCD.

Subaddress information (octet 4, etc.)

The NSAP X.213/ISO 8348 AD2 address, shall be formatted as specified by octet 4 which contains the Authority and Format Identifier (AFI). The encoding is made according to the "preferred binary encoding" as defined in X.213/ISO 8348 AD2. For the definition of this type of subaddress, see Rec. I.334.

For user-specified subaddress, this field is encoded according to the user specification, subject to a maximum length of 20 octets. When interworking with X.25 networks BCD coding should be applied.

Note - It is recommended that users apply the NSAP subaddress type since this subaddress type allows the use of decimal, binary and IA5 characters in a standardized manner.

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4.5.12 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 IV-4-18 and Tables IV-4-12 and IV-4-13.

The maximum length of this information element is 22 octets.

The margin codes indicate that a product will send the cause value.

8	7	6	5	4	3	2	1	
0	Cause							Octet 1
0	0	0	0	1	0	0	0	
Information element identifier								
Length of cause contents								2
0/1 ext	Coding standard		0 Spare	Location				3 (Note 3)
1 ext	Cause value							4
Diagnostic(s) (if any)								5* (Note 2)

FIGURE IV-4-18
Cause information element

Note 1 has been intentionally deleted.

Note 2 - Diagnostic octets may be omitted.

Note 3 - See product specific documentation.

TABLE IV-4-12
Cause information element

Coding standard (octet 3)

Bits

7 6

—

0 0 CCITT standardized coding, as described below
1 1 standard specific to identified location (Note)

Note - These other coding standards should be used only when the desired cause can not be represented with the CCITT-standardized coding. See product specific documentation.

Location (octet 3)

Bits

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 networks
1 0 1 0 network beyond interworking point

All other values are reserved.

Note 1 - Depending on the location of the user, the local public network and remote public network may be the same network.

Note 2 - Examples of location values to be used for various busy congestion conditions appear in Annex J.

Recommendation (octet 3a) Reserved for future use.

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TABLE IV-4-12

Cause information element

Cause value (octet 4)

The cause value is divided in two fields, a class (bits 5 through 7) and a value within the class (bits 1 through 4).

The class indicates the general nature of the event.

- Class (000) : normal event
- Class (001) : normal event
- Class (010) : resource unavailable
- Class (011) : service or option not available
- Class (100) : service or option not implemented
- Class (101) : invalid message (e.g. parameter out of range)
- Class (110) : protocol error (e.g. unknown message)
- Class (111) : interworking

The cause values are listed in Table IV-4-13 below, and defined in Annex G and Appendix I.

Diagnostics (octet 5)

Diagnostic information is not available for every cause, see Table IV-4-13 below. The inclusion of diagnostics is optional. When available the coding of diagnostic(s) is the same as for the corresponding information element in Section 4.

TABLE IV-4-13
Cause information element

Cause value		Cause number	Cause	Diagnostics
Class	Value			
7 6 5 0 0 0	4 3 2 1 0 0 0 1	1.	Unallocated(un-assigned) number	-
0 0 0	0 0 1 0	2.	No route to specified transit network	Transit network identity (Note 11)
0 0 0	0 1 1 0	6.	Channel unacceptable	-
0 0 1	0 0 0 0	16.	Normal clearing	-
0 0 1	0 0 0 1	17.	User busy	-
0 0 1	0 0 1 0	18.	No user responding	-
0 0 1	0 1 0 1	21.	Call rejected	-
0 0 1	0 1 1 0	22.	Number changed	New destination (Note 5)
0 0 1	1 1 0 0	28.	Invalid number format (Incomplete number)	Facility identification (Note 1)
0 0 1	1 1 0 1	29.	Facility rejected	
0 0 1	1 1 1 0	30.	Response to STATUS ENQUIRY	
0 0 1	1 1 1 1	31.	Normal, unspecified	
0 1 0	0 0 1 0	34.	No circuit/channel available	-
0 1 0	0 1 1 0	38.	Network out of order	-
0 1 0	1 0 0 1	41.	Temporary failure	-
0 1 0	1 0 1 0	42.	Switching equipment congestion	-
0 1 0	1 0 1 1	43.	Access information discarded	-
0 1 0	1 1 0 0	44.	Requested circuit channel not available	-
0 1 0	1 1 0 1	45.	Pre-empted	-

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TABLE IV-4-13

Cause information element

Cause value		Cause number	Cause	Diagnostics
Class	Value			
7 6 5 0 1 1	4 3 2 1 0 0 1 0	50.	Requested facility not subscribed	Facility identification (Note 1)
0 1 1	0 1 0 0	52.	outgoing calls barred	-
0 1 1	0 1 1 0	54.	incoming calls barred	-
0 1 1	1 0 1 0	58.	Bearer capability not presently available	-
0 1 1	1 1 1 1	63.	Service or option not available, unspecified	-
1 0 0	0 0 0 1	65.	Bearer service not implemented	Facility identification (Note 1)
1 0 0	0 0 1 0	66.	Channel type not implemented	
1 0 0	0 1 0 1	69.	Requested facility not implemented	
1 0 1	0 0 0 1	81.	Invalid call reference value	-
1 0 1	0 0 1 0	82.	Identified channel does not exist	Channel identity
1 0 1	1 0 0 0	88.	Incompatible destina-	

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TABLE IV-4-13

Cause information element

Cause value		Cause number	Cause	Diagnostics
Class	Value			
7 6 5 1 1 0	4 3 2 1 0 0 0 0	96.	Mandatory information element is missing	Information element identifier(s) (Note 6)
1 1 0	0 0 0 1	97.	Message type non-existent or not implemented	Message type
1 1 0	0 0 1 0	98.	Message not compatible with call state or message type non-existent or not implemented	Message type
1 1 0	0 1 0 0	100.	Invalid information element contents	Information element identifier(s) (Note 6)
1 1 0	0 1 1 0	102.	Recovery on timer expiry	Timer number (Note 9)
1 1 1	1 1 1 1	127.	Interworking, unspecified	-

All other values are reserved.

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Note 1 - The coding of facility identification is network dependent.

Notes 2 through 4 have been intentionally deleted.

Note 5 - New destination is formatted as the called part number information element, including information element identifier. Transit network selection may also be included.

Note 6 - Locking shift procedures described in Section 4.5 are applied. In principle, information element identifiers are ordered in the same order as the information element in the received message.

Note 7 - The following coding is used:

Bit 8: Extension bit
Bit 7-5: spare
Bit 4-1: according to the table 57b octet 3.2, channel type.

Note 8 - When only locking shift information element is included and no variable length information element identifier follows, it means that the codeset in the locking shift itself is not implemented.

Note 9 - The timer number is coded in IA5 characters, e.g., T308 is coded as "3""0""8". The following coding is used in each octet.

Bit 8: Spare "0"
Bit 7-1: IA5 character

Note 10 - Examples of cause values to be used for various busy/congestion conditions appear in Annex J.

Note 11 - The diagnostic field contains the entire Transit network selection or Network specific facilities information element, as applicable.

A system may use the cause values to determine the appropriate tones and announcements to the calling party. Figure IV-4-4a contains the tone and announcement treatment for these causes.

Switch Tone or Announcement treatment	Cause number (s)
busy tone	17
reorder tone (fast busy)	06, 18, 31, 34, 41, 41, 42, 44, 58, and 82
intercept tone (siren)	01, 02, 22, 28, 29, 50, 52, 54, 65,66, 69, 81, 88, 96,97, 98 and 100
no circuit announcement	34, 42 and 54
vacant code announcement	01, 22, 28, 65 and 66

Note: The default tone for the other causes will be a reorder announcement.

Figure IV-4-4a Tone and Announcement Treatment for Cause

Messages which contain the Cause information element may be propagated through a network. However, not all the cause values have end to end significance. Some only have meaning for the local interface and are referred to as local causes. When a switch receives a message containing one of the local causes given in Figure IV-4-5a and determines that the message contents must be propagated to another switch, the cause value in the propagated message should be changed to 31 - normal, unspecified. For other cause values, the received cause information element should be passed in the propagated message.

Local cause value
02
06
30
44
52
81
82
96
97
98
100

Figure IV-4-5a Local Cause Values

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4.5.13 Channel identification

The purpose of the Channel identification information element is to identify a channel within the interface(s) controlled by these signaling procedures.

The Channel identification information element is coded as shown in Figures IV-4-20 and IV-4-21 and Table IV-4-15.

The default maximum length for this information element is 8 octets.

8	7	6	5	4	3	2	1	
0	Channel identification							Octet 1
0	0	0	1	1	0	0	0	
Information element identifier								
Length of channel identification contents								2
1 ext	Int. id present	Int. type	0 spare	Pref. Excl.	D-chan- nel ind.	Info channel selection		3
0/1 ext	Interface identifier							3.1* etc. (Note 1, Note 5)
1 ext	Coding standard		Number Map	Channel type Map element type				3.2*
Channel number/slot map (Note 3)								3.3* (Note 4)

Note 1 - When the "interface identifier present" field in octet 3 indicates "interface implicitly identified" octet 3.1 is omitted. Octet 3.1 must be present for Non-facility Associated Signaling interfaces.

Note 2 has been intentionally deleted.

Note 3 - When channel number is used, bit 8 is reserved for use as an extension bit and is thus set to 1.

Note 4 - When channel number is used, this octet may be repeated to indicate multiple channels.

Note 5 - Octet 3.1 may be omitted; Octet 3.2 and 3.3 will be absent for H11 channels or if D-channel is indicated channel (e.g. SERV or NCA-TSC). Bit 8 of Octet 3.3 is reserved for extension when the Channel Number option is selected, and should be set to 1 in this instance.

FIGURE IV-4-20
Channel identification information element

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TABLE IV-4-15

Channel identification information element

Interface identifier present (octet 3)

Bit
7

- 0 interface implicitly identified (Note 1)
- 1 interface explicitly identified in one or more octets, beginning with octet 3.1.

Note 1 - The interface which includes the D-channel carrying this information element is indicated.

Interface type (octet 3)

Bit
6

- 1 other interface

Note - The type of interface should be understood because the interface is identified by the "interface identifier present" field (octet 3, bit 7) and the interface identifier field (octet 3.1), if any.

Preferred/Exclusive (octet 3)

Bit
4

- 0 indicated channel is preferred
- 1 exclusive

Note - Preferred/exclusive has significance only for B-channel selection.

D-channel indicator (octet 3)

Bit
3

- 0 the channel identified is not the D-channel
- 1 the channel identified is the D-channel

Note - D-channel indication has significance in D-channel use. No other information affects D-channel use.

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TABLE IV-4-15

Channel identification information element

Information channel selection (octet 3)

Other interfaces	
Bits	
<u>2 1</u>	
0 0	no channel
0 1	as indicated in following octets

Note - The information channel selection does not apply to the D-channel.

Interface identifier (octet 3.1)

Binary code (0 to 31) assigned to the interface at subscription time.

Note - When the interface is implicitly identified, octet 3.1 is omitted.

Coding standard (octet 3.2)

Bits	
<u>7 6</u>	
0 0	CCITT standardized coding as described below
1 1	standard defined for the network (either public or private) present on the network side of the interface (Note)

Number/Map (octet 3.2)

Bit	
<u>5</u>	
0	channel is indicated by the number in the following octet
1	channel is indicated by the slot map (Map) in the following octet(s)

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Channel type/Map element type (octet 3.2)

Bits			
4	3	2	1
0	0	1	1
B-channel units			
0	1	1	0
H0-channel units			
1	0	0	0
H11-channel units			

All other values are reserved.

Channel Number (octet 3.3)

Binary number assigned to the channel. For B-channels, the channel number equals the time slot number. See Recommendation I.431.

Note - Either "Channel Number or "Slot map" is used exclusively, depending on the "Number/Map" information.

Slot map (octet 3.3)

Bit position(s) in slot map corresponding to time slot(s) used by the channel is set to 1.

The length of the slot-map is three octets. See product specific documentation.

8	7	6	5	4	3	2	1
24	23	22	21	20	19	18	17
16	15	14	13	12	11	10	9
8	7	6	5	4	3	2	1

Octet 3.3.1
3.3.2
3.3.3

1544 kbit/s

a) Primary rate interface, map element = B-channel
FIGURE IV-4-21

Slot map field

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4.5.14 Congestion level

The purpose of the Congestion level information element is to enable the user or network to notify the other side of the user-network interface that its ability to receive USER INFORMATION messages has changed. It is a single octet information element coded as shown in Figure IV-4-22 and Table IV-4-16.

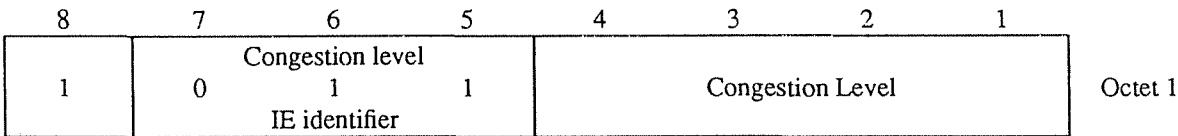


FIGURE IV-4-22

Congestion level

TABLE IV-4-16

Congestion level

Congestion level (Octet 1, Bits 4 through 1)

Bits				
4	3	2	1	
0	0	0	0	receiver ready
1	1	1	1	receiver not ready

4.5.15 Display - See Section 4.6.8.2

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4.5.16 High layer compatibility

The purpose of the high layer compatibility information element is to provide a means which should be used by the remote user for compatibility checking. See Annex B.

The High layer compatibility information element is coded as shown in Figure IV-4-24 and Table IV-4-17.

The maximum length of this information element is 5 octets.

Note - The high layer compatibility information element is transported transparently by an ISDN between a call originating entity e.g., a calling user and the addressed entity, e.g., a remote user or a high layer function network node addresses by the call originating entity. However, if explicitly requested by the user (at subscription time), a network which provides some capabilities to realize teleservices may interpret this information to provide a particular service.

8	7	6	5	4	3	2	1	
0	High layer compatibility							Octet 1
	1	1	1	1	1	0	1	
Information element identifier								
Length of the high layer compatibility contents								2
1 ext	coding standard		Interpretation			Presentation method of protocol profile		3
0/1	High layer characteristics identification							4
1	Extended High layer characteristics identification							4a (Note)

Note - This octet may be present when octet 4 indicates Maintenance and Management.

FIGURE IV-4-24

High layer compatibility information element

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TABLE IV-4-17

High layer compatibility information element

Coding standard (octet 3)

Bits

7 6

0 0	CCITT standardized coding as described below
0 1	reserved for other international standards (Note)
1 0	national standard (Note)
1 1	standard defined for the network (either public or private) present on the network side of the interface (Note)

Note - These other coding standards should be used only when the desired high layer compatibility can be represented with the CCITT standardized coding.

Interpretation (octet 3)

Bits

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 be able to indicate how the "High layer characteristics identification" in the information element shall be interpreted when multiple "High layer characteristics identifications are used and exact relationship among them needs to be indicated (e.g. sequential usage, alternative list, simultaneous usage). Such enhancements in conjunction with the possible negotiation procedures is left for further study.

Presentation method of protocol profile (octet 3)

Bits

2 1

0 1	High layer protocol profile (without specification of attributes)

All other values are reserved

Note - Currently, "Presentation method protocol profile" has only a single value; i.e. a "profile value" is used to indicate a service to be supported by high layer protocols as required. Necessity of other

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presentation methods, e.g. service indications in the form of layer-by-layer indication of protocols to be used in high layers, is left for further study.

TABLE IV-4-17

High layer compatibility information element

High layer characteristics identification (octet 4)

Bits							
7	6	5	4	3	2	1	
0	0	0	0	0	0	1	Telephony (Recommendation G.711[10])
0	0	0	0	1	0	0	Facsimile Group 2/3 (Recommendation T.62[28])
0	1	0	0	0	0	1	Document Application Profile for Group 4 Class 1 Facsimile (Recommendation T.503[29])
0	1	0	0	1	0	0	Document Application Profile for formatted Mixed-Mode (Recommendation T.501[30])
0	1	0	1	0	0	0	Document Application Profile for Processable-form (Recommendation T.502[31])
0	1	1	0	0	0	1	Teletex (Recommendation T.62[28], T.70[32])
0	1	1	0	0	1	0	Document Application Profile for Videotex interworking between Gateways (Recommendation T.504[33])
0	1	1	0	1	0	1	Telex
0	1	1	1	0	0	0	Message Handling Systems (MHS) (Recommendation X.400)
1	0	0	0	0	0	1	OSI application (Recommendation X.200)
1	0	1	1	1	1	0	Reserved for maintenance (Note 4)
1	0	1	1	1	1	1	Reserved for management (Note 4)
1	1	1	1	1	1	1	Reserved

All other values are reserved

Note 1 - The coding above applies in case of "Coding standard" = "CCITT standard" and "Presentation method of protocol profile" = "High layer protocol profile".

Note 2 - Further compatibility checking will be executed by the OSI high layer protocol.

Note 3 - Codepoints are added only to those services for which CCITT Recommendations are available. See also Recommendation I.212[34].

Note 4 - When this is included, octet 4 may be followed by octet 4a.

Extended high layer characteristics identification (octet 4a)

<u>7 6 5 4 3 2 1</u>	
0 0 0 0 0 0 1	Telephony (Recommendation G.711)
0 0 0 0 1 0 0	Facsimile Group 2/3 (Recommendation T.62[28])
0 1 0 0 0 0 1	Document Application Profile for Group 4 Class 1 Facsimile (Recommendation T.503[29])
0 1 0 0 1 0 0	Document Application Profile for formatted Mixed-Mode (Recommendation T.501[30])
0 1 0 1 0 0 0	Document Application Profile for Processable-form (Recommendation T.502[31])
0 1 1 0 0 0 1	Teletex (Recommendation T.62[28], T.70[32])
0 1 1 0 0 1 0	Document Application Profile for Videotex interworking between Gateways (Recommendation T.504[33])
0 1 1 0 1 0 1	Telex
0 1 1 1 0 0 0	Message Handling Systems (MHS) (Recommendation X.400 series)
1 0 0 0 0 0 1	OSI application (Recommendation X.200 series)
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

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4.5.17 Keypad facility - Reserved for future use

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4.5.18 Low layer compatibility

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

If Low layer compatibility negotiation is allowed by the network (see Annex M), the Low layer compatibility information element is also passed transparently from the addressed entity to the originating entity.

The expected encodings for DMI data service are given in Annex H, Figure H-4a.

The Low layer compatibility information element is coded as shown in Figure IV-4-26 and in Table IV-4-17. The maximum length of this information element is 16 octets.

8	7	6	5	4	3	2	1	
0	Low layer compatibility							Octet 1
	1	1	1	1	1	0	0	
Information element identifier								
Length of the low layer compatibility contents								2
0/1 ext	coding standard		information transfer capability					3
1 ext	Negot.0 indic.	0	0	0	0	0	3a	
0/1 ext	transfer mode		information transfer rate					4
0/1 ext	structure			configuration		establishment		4a*
1	symmetry		information transfer rate (destination ---> origination)					4b* (Note 1)
0/1 ext	0	1	user information layer 1 protocol					5*
	layer 1 indent							
0/1 ext	synch. asynch.	negot spare 0	user rate					5a (Note 4)
0/1 ext	intermediate rate		NIC on Tx	NIC on Rx	Flow cont. on Tx	Flow cont. on R~	0 Spare	5b* (Note 2)
1 ext	Hdr no Hdr	Multi frame supp.	Mode	LLI negot.	Assig- nor Assig- nee	in- band out- band negot.	0 Spare	5b* (Note 3)
0/1 ext	number of stop bits		number of data bits		Parity			5c* (Note 2)
1 ext	duplex mode	modem type						5d* (Note 2)
1 ext	1	0	user information layer 2 protocol					6*
	layer 2 indent							
1 ext	Optional layer 2 protocol information							6a
1 ext	1	1	user information layer 3 protocol					7*
	layer 3 indent							
1 ext	Optional layer 3 protocol information							7a

FIGURE IV-4-26
Low layer compatibility information element

Note 1 - If default values are used for all fields of octets 4a and 4b, then these octets shall not be included. If default values are used for all fields of octet 4b, but not for one or more fields of octet 4a, then only octet 4a shall be included. Otherwise, both octets 4a and 4b shall be included.

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Note 2 - This octet may be present only if octet 5 indicates CCITT standardized rate adaption V.110 [7]/X.30 [8].

Note 3 - This octet is present only if octet 5 indicates CCITT standardized rate adaption V.120 [9].

Note 4 - This octet may be present if octet 5 indicates either of the CCITT standardized rate adaptations V.110/X.30 or V.120.

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TABLE IV-4-17

Low layer compatibility information element

Coding standard (octet 3)

Bits

7 6

0 0	CCITT standardized coding as described below
0 1	reserved for other international standards (Note)
1 0	national standard (Note)
1 1	standard defined for the network (either public or private) present on the network side of the interface (Note)

Note - These other coding standards should be used only when the desired low layer compatibility can not be represented with the CCITT standardized coding.

Information transfer capability (octet 3)

Bits

5 4 3 2 1

0 0 0 0 0	speech
0 1 0 0 0	unrestricted digital information
0 1 0 0 1	restricted digital information
1 0 0 0 0	3.1 kHz audio
1 0 0 0 1	7 kHz audio
1 1 0 0 0	Video

All other values are reserved.

Negotiation indicator (octet 3a)

Bit

7

0	out-band negotiation not possible
1	out-band negotiation possible

Note 1 - See Annex M for description of Low layer compatibility negotiation.

Note 2 - When octet 3a is omitted, "out-band negotiation not possible" shall be assured.

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Transfer mode (octet 4)

Bits
7 6

0 0 circuit mode

1 0 packet-mode

All other values are reserved.

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TABLE IV-4-17

Low layer compatibility information element

Information transfer rate (octet 4 and 4b, bits 5 to 1)

Bits					Circuit mode	Packet-mode
5	4	3	2	1		
0	0	0	0	0	-	This code shall be used for packet-mode calls.
1	0	0	0	0	64 kbit/s	-

All other values are reserved.

Note 1 - When octet 4b is omitted, the low layer compatibility is bidirectional symmetric at the information transfer rate specified in octet 4. When 4b is included, the information transfer rate in octet 4 refers to the origination --> destination direction.

Note 2 - When the information transfer rate 2 x 64 kbit/s is used the coding of octet 3 and 4 refer to both 64 kbit/s channels.

Note 3 - The throughput rates for packet mode calls are included in the Throughput class information element in Section 4.7.8.2.

Structure (octet 4a)

Bits		
7	6	5
0	0	0
default (see Note 1)		
0	0	1
8 kHz integrity (Note 2)		
1	0	0
service data unit integrity		
1	1	1
unstructured		

Note 1 - If octet 4a is omitted, or the structure field is coded "000", then the value of the structure attribute is according to the following:

Transfer mode	transfer capability	structure
circuit	speech	8 kHz integrity
circuit	unrestricted digital	8 kHz integrity
circuit	restricted digital	8 kHz integrity
circuit	audio	8 kHz integrity
circuit	video	8 kHz integrity
packet	unrestricted digital	service data unit integrity

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TABLE IV-4-17

Low layer compatibility information element

Configuration (octet 4a)

Bits

4 3

—

0 0 point-to-point

All other values are reserved.

Note - If octet 4a is omitted, the configuration is assumed to be point-to-point.

Establishment (octet 4a)

Bits

2 1

—

0 0 demand

All other values are reserved.

Note - If octet 4a is omitted, the method of establishment is assumed to be "demand".

Symmetry (octet 4b)

Bits

7 6

—

0 0 bidirectional symmetric

0 1 bidirectional asymmetric

1 0 unidirectional (origination --> destination)

1 1 unidirectional (destination --> origination)

All other values are reserved.

Note - If octet 4b is omitted, bidirectional symmetric is assumed.

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TABLE IV-4-17

Low layer compatibility information element

User information layer 1 protocol (octet 5)

Bits					
5	4	3	2	1	
0	0	0	0	1	Mode 2 / Mode 3 Adaptive (Note 2)
0	0	0	0	1	CCITT standardized rate adaption V.110/X.30. This implies the presence of octets 5a and optionally octet 5b, 5c and 5d as defined below.
0	0	0	1	0	Recommendation G.711 u-law
0	0	1	1	1	Non-CCITT standardized rate adaption. This implies the presence of octet 5a and, optionally, octets 5b, 4c and 5d. The use of this codepoint indicates that the user rate specified in octet 5a is defined in accordance with the non-CCITT standardized rate adaption scheme. Additionally, octets 5b, 5c, and 5d, if present, are defined consistent with the specified rate adaption

All other values are reserved.

Note 1 - If the transfer mode is "circuit mode"; and if the information transfer capability is "unrestricted digital information" or "restricted digital information", and if the user information layer 1 protocol is not to be identified to the network, octet 5 shall be omitted. If the transfer mode is packet mode, octet 5 may be omitted. Otherwise, octet shall be present.

Note 2 - The Coding standard field (octet 3, bits 7 through 6) must be coded network specific when this codepoint is used.

Synchronous/asynchronous (octet 5a)

Bit	
7	
—	
0	Synchronous
1	Asynchronous

Note - Octets 5b-5d may be omitted in case of synchronous user rates.

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negotiation (octet 5a)

Bit

6

—

0 In-band negotiation not possible

1 In-band negotiation possible

Note - See recommendations V.110 and X.30.

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TABLE IV-4-17

Low layer compatibility information element

User rate (octet 5a)

Bits

5 4 3 2 1

0 0 0 0 0	rate is indicated by E-bits specified in Rec. I.460
0 0 0 0 1	0.6 kbit/s Recommendation V.6 and X.1
0 0 0 1 0	1.2 kbit/s Recommendation V.6
0 0 0 1 1	2.4 kbit/s Recommendation V.6 and X.1
0 0 1 0 0	3.6 kbit/s Recommendation V.6
0 0 1 0 1	4.8 kbit/s Recommendation V.6 and X.1
0 0 1 1 0	7.2 kbit/s Recommendation V.6
0 0 1 1 1	8 kbit/s Recommendation I.460
0 1 0 0 0	9.6 kbit/s Recommendation V.6 and X.1
0 1 0 0 1	14.4 kbit/s Recommendation V.6
0 1 0 1 0	16 kbit/s Recommendation I.460
0 1 0 1 1	19.2 kbit/s Recommendation V.6
0 1 1 0 0	32 kbit/s Recommendation I.460
0 1 1 1 0	48 kbit/s Recommendation V.6 and X.1
0 1 1 1 1	56 kbit/s Recommendation V.6
1 0 1 0 1	0.1345 kbit/s Recommendation X.1
1 0 1 1 0	0.100 kbit/s Recommendation X.1
1 0 1 1 1	0.075/1.2 kbit/s Recommendation V.6 and X.1 (Note)
1 1 0 0 0	1.2/0.075 kbit/s Recommendation V.6 and X.1 (Note)
1 1 0 0 1	0.050 kbit/s Recommendation V.6 and X.1
1 1 0 1 0	0.078 kbit/s Recommendation V.6 and X.1
1 1 0 1 1	0.110 kbit/s Recommendation V.6 and X.1
1 1 1 0 0	0.150 kbit/s Recommendation V.6 and X.1
1 1 1 0 1	0.200 kbit/s Recommendation V.6 and X.1
1 1 1 1 0	0.300 kbit/s Recommendation V.6 and X.1
1 1 1 1 1	12 kbit/s Recommendation V.6

All other values are reserved.

*Octet 5b**Octet 5b V.110 [7]/X.30 [8] rate adaption*

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Intermediate Rate (octet 5b)

Bits		
7	6	
0	0	Not used
0	1	8 kbit/s
1	0	16 kbit/s
1	1	32 kbit/s

Network Independent Clock (NIC) on Transmission (Tx) (octet 5b) (Note 1)

Bit		
5		
0		Not required to send data with Network Independent Clock
1		Required to send data with Network Independent Clock

Note 1 - Refers to transmission in the forward direction of the call.

Note 2 - See Recommendations V.110 and X.30.

Network Independent Clock (NIC) on Reception (Rx) (octet 5b) (Note 1)

Bit		
4		
0		Cannot accept data with Network Independent Clock (i.e., sender does not support this optional procedure)
1		Can accept data with Network Independent Clock (i.e., sender does support this optional procedure)

Note 1 - Refers to transmission in the backward direction of the call.

Note 2 - See Recommendations V.110 [7] and X.30 [8].

Flow Control on Transmission (Tx) (octet 5b) (Note 1)

Bit		
3		
0		Not required to send data with flow control mechanism
1		Required to send data with flow control mechanism

Note 1 - Refers to transmission in the forward direction of the call.

Note 2 - See Recommendations V.110 and X.30.

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Flow Control on Reception (Rx) (octet 5b) (Note 1)

Bit	
<u>2</u>	
0	Cannot accept data with flow control mechanism(i.e., sender does not support this optional procedure)
1	Can accept data with flow control mechanism (i.e., sender does support this optional procedure)

Note 1 - Refers to transmission in the backward direction of the call.

Note 2 - See Recommendations V.110 and X.30.

Octet 5b for V.120 [9] rate adaption

Rate adaption header/no header (octet 5b)

Bit	
<u>7</u>	
0	rate adaption header not included
1	rate adaption header included

Multiple Frame establishment support in Data link (octet 5b)

Bit	
<u>6</u>	
0	Multiple Frame establishment not supported. Only UI frames allowed.
1	Multiple Frame establishment supported.

Mode of operation (octet 5b)

Bit	
<u>5</u>	
0	Bit transparent mode of operation
1	Protocol sensitive mode of operation

Logical Link Identifier Negotiation (octet 5b)

Bit	
<u>4</u>	
0	Default, LLI = 256 only
1	Full protocol negotiation (Note)

Note - A connection over which protocol negotiation will be executed is indicated in bit 2 of octet 5b.

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Assignor/Assignee (octet 5b)

Bit	
<u>3</u>	
0	Message originator is "Default assignee"
1	Message originator is "Assignor only"

In-band/out-band negotiation (octet 5b)

Bit	
<u>2</u>	
0	Negotiation is done with USER INFORMATION messages on a Temporary Signalling Connection
1	Negotiation is done in-band Using Logical Link zero

Octet 5c

Number of Stop Bits (octet 5c)

Bits		
<u>7 6</u>		
0	0	Not used
0	1	1 bit
1	0	1.5 bits
1	1	2 bits

Number of Data Bits Including Parity Bit if Present (octet 5c)

Bits		
<u>5 4</u>		
0	0	Not used
0	1	5 bits
1	0	7 bits
1	1	8 bits

Parity Information (octet 5c)

Bits			
<u>3 2 1</u>			
0	0	0	Odd
0	1	0	Even
0	1	1	None
1	0	0	Forced to 0
1	0	1	Forced to 1

All other values are reserved

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Octet 5d

Duplex mode (octet 5d)

Bit	
7	
0	Half duplex
1	Full duplex

Modem type (octet 5d)

Bits 6-1 coded according to network specific rules.

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TABLE IV-4-17

Low layer compatibility information element

User information layer 2 protocol (octet 6)

Bits					
5	4	3	2	1	
0	0	0	1	0	Recommendation Q.921 (I.441)
0	0	1	1	0	Recommendation X.25, link level
0	0	1	1	1	CCITT Recommendation X.25 Multilink
0	1	0	0	0	Extended LAPB: for half duplex operation (T.71 [37])
0	1	0	0	1	HDLc ARM (ISO 4335) [38]
0	1	0	1	0	HDLc NRM (ISO 4335)
0	1	0	1	1	HDLc ABM (ISO 4335)
0	1	1	0	0	LAN Logical link control (ISO 8802/2) [39]
0	1	1	0	1	CCITT Recommendation X.75 [40]. Single Link Procedure (SLP)

All other values are reserved.

Note - If the transfer mode is "packet mode", octet 6 shall be present. For other cases, if the user layer 2 protocol is to be identified to the network, the octet 6 shall be present; otherwise octet 6 shall be omitted.

User information layer 3 protocol (octet 7)

Bits					
5	4	3	2	1	
0	0	0	1	0	Recommendation Q.931 (I.451)
0	0	1	1	0	Recommendation X.25, packet layer
0	0	1	1	1	ISO 8208 [41] (X.25 packet level protocol for data terminal equipment)
0	1	0	0	0	ISO 8348 [42] (OSI connection oriented network service specific subset of ISO 8208 and CCITT X.25)
0	1	0	0	1	ISO 8473 [43] (OSI connectionless service)
0	1	0	1	0	CCITT Recommendation T.70 [32] minimum network layer
0	0	1	1	1	ISDN Packet Mode (DMI Mode 3) (Note 2)

All other values are reserved.

Note 1 - If the user information layer 3 protocol is to be identified to the network, octet 7 shall be present; otherwise octet 7 shall be omitted.

Note 2 - The Coding standard field (octet 3, bits 7 through 6) must be coded network specific when this code point is used.

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4.5.19 More data

The More data information element is sent by the user to the network in a USER INFORMATION message, and delivered by the network to the destination user(s) in the corresponding USER INFORMATION message. The presence of the more data information element indicates to the destination user that another USER INFORMATION message will follow, containing information belonging to the same block.

The use of the More data information element is not supervised by the network

The More data information element is coded as shown in Figure IV-4-27.

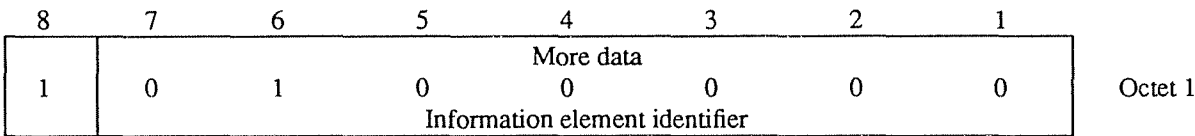


FIGURE IV-4-27

More data information element

4.5.20 Network-specific facilities

The purpose of the Network-specific information element is to indicate which network facilities are being invoked. The Network-specific facilities information element is coded as shown in Figure IV-4-28 and Table IV-4-18. No more than two Network-specific facilities information elements may be included in a single message. For further details, see product specific documentation.

The maximum length of this information element is 25 octets.

Within a Network specific facilities information element, multiple binary facilities and/or one parameterized facility can be specified. When a parameterized facility is included it must be the last facility within that element.

8	7	6	5	4	3	2	1	
0	0	1	0	0	0	0	0	Octet 1
Network-specific facilities Information element identifier								
Length of network-specific facilities contents								2
Length of network identification								3
1 ext	Type of network identification			Network identification plan				3.1*
0 Spare	Network identification (IA5-Characters)							3.2*
Parameterized/ Binary	1 Exp	Feature/ Service	Facility coding Value					4
0 Spare	Parameterized Field							5

FIGURE IV-4-28

Network-specific facilities information element

Note 1 - Octets 3.1 and 3.2 are only present when the length in octet 3 is non-zero.

Note 2 - Octets 3.2 may be repeated as appropriate.

Note 3: Octet 5 is present only for parameterized facilities. It may be repeated.

TABLE IV-4-18

Network-specific facilities information element

Length of network identification (octet 3) (Note 1)

This field contains the length, in octets, of the network identification found in octet 3.1 and the repetition of octet 3.2. If the value is "0000 0000", then the default provider (see Annex E, Section E.1) is assumed and octets 3.1 and 3.2 are omitted.

Type of network identification (octet 3.1)

Bits

7 6 5

0 0 0	user specified
0 1 0	national network identification

All other values are reserved.

Network identification plan (octet 3.1)

Bits

4 3 2 1

0 0 0 0	unknown
0 0 0 1	Carrier Identification Code (Note)
0 0 1 1	Data network identification code (Recommendation X.121)

All other values reserved.

Note - Carrier Identification Codes may be an appropriate method of identifying the network serving the remote user.

Network identification (octet 3.2, etc.)

These IA5 characters are organized according to the network identification plan specified in octet 3.1. Identification of Carrier Identification Code (CIC) networks shall be by the 3 digit code assigned to ICs by Bell Communication Research. The CIC code assigned to AT&T is 288.

Parametrized/Binary (Octet 4, Bit 8)

0 : There are parameters associated with the requested facility and they are specified in the following octets.

1 : The requested facility is a "binary facility" and hence there are no parameters.

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Expansion bit (Octet 4, Bit 7)

1 : The coding value of the facility is in the following 6 bits.

Feature/Service (Octet 4, Bit 6)

0 : The requested facility is a feature.

1 : The requested facility is a service.

Binary Facility coding value (Octet 4, Bits 5 through 1) For complete codings, see product specific documentation.

Parameterized Facility coding value (Octet 4, Bits 5 through 1) For complete codings, see product specific documentation.

Parameterized Field (Octet 5, bits 7 through 1) For complete codings, see product specific documentation.

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4.5.21 Notification indicator - Reserved for future use

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4.5.22 Progress indicator

The purpose of the Progress indicator information element is to describe an event which has occurred during the life of a call.

The Progress indicator information element is coded as shown in Figure IV-4-30 and Table IV-4-20. The default maximum length of this information element is 4 octets.

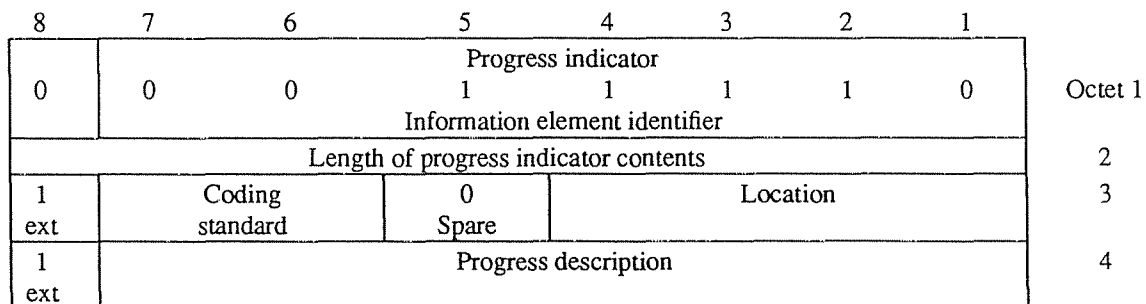


FIGURE IV-4-30

Progress indicator information element

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TABLE IV-4-20

Progress indicator information element

Coding standard (octet 3)

Bits

7 6

0 0 CCITT standardized coding, as described below

Location (octet 3)

Bits

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 1 0 0	public network serving the remote user
0 1 0 1	private network serving the remote user
0 0 1 1	transit network

All other values are reserved.

Note 1 - Depending on the location of the user, the local public network and remote public network may be the same network.

Progress description (octet 4)

Bits

7 6 5 4 3 2 1 No.

0 0 0 0 0 0 1	1.	Call is not end-to-end ISDN; further call progress information may be available in-band
0 0 0 0 0 1 0	2.	Destination address in non-ISDN
0 0 0 0 0 1 1	3.	Origination address in non-ISDN
0 0 0 0 1 0 0	4.	Call has returned to the ISDN
0 0 0 1 0 0 0	8.	In-band information or appropriate pattern now available.

All other values are reserved.

Note - The use of the different progress descriptions is further explained in Annex I.

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4.5.23 Repeat indicator - Reserved for future use

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4.5.24 Restart indicator

The purpose of the Restart indicator is to identify the class of the facility (i.e., channel or interface) to be restarted.

The Restart indicator information element is coded as shown in Figure IV-4-32 and Table IV-4-22. The maximum length of this information element is three octets.

8	7	6	5	4	3	2	1	
0	1	1	1	1	0	0	1	Octet 1
Restart indicator information element identifier								
Length of restart indicator contents								2
1 ext	0	0	0	0	Class			3

FIGURE IV-4-32
Restart indicator information element

TABLE IV-4-22
Restart indicator information element

Class (octet 3)

Bits			
3	2	1	
0	0	0	Indicated channels (Note 1)
1	1	0	Single interface (Note 2)

All other values are reserved.

Note 1 - The channel identification information element must be included and indicates which channel is to be restarted. The channel to be restarted must be a B-channel.

Note 2 - If non-facility associated signaling is used, the channel identification information element must be included to indicate the interface to be restarted.

4.5.25 Segmented message - Reserved for future use

4.5.26 Sending Complete - Reserved for future use

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4.5.27 Signal

The purpose information element is to allow the network to optionally convey information to a user regarding tones and alerting signals.

The Signal information element is coded as shown in Figure IV-4-35 and Table IV-4-24. The length of this information element is three octets.

The signal information element may be repeated in a message.

8	7	6	5	4	3	2	1	
0	0	1	1	0	1	0	0	Octet 1
Signal Information element identifier								
0	0	0	0	0	0	0	1	2
Length of signal contents								
Signal value								3

Note - This information element does not appear in any message. It is used as a parameter to the AT&T Standardized Facilities.

FIGURE IV-4-35

Signal information element

TABLE IV-4-24

Signal information element

Signal Value (Octet 3)

Bits							
8	7	6	5	4	3	2	1
0	0	0	0	1	0	1	0
Recall Dial Tone							

All other values are reserved.

NOTE -- The use of these patterns is network-dependent

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4.5.28 Transit Network Selection

The purpose of the Transit network selection information element is to identify one requested transit network. See Annex C. This information element is included in a SETUP message only when the network-specific information element is not present and a transit network carrier other than the presubscribed is to be selected.

The Transit network selection information element is coded as shown in Figure IV-4-36 and Table IV-4-25.

The default maximum length of this information element is 6 octets.

8	7	6	5	4	3	2	1	
0	Transit network selection							Octet 1
	1	1	1	1	0	0	0	
Information element identifier								
Length of transit network selection contents								2
1 ext	Type of network identification			Network identification plan				3
0	Network identification (IA5 characters)							4 etc.

FIGURE IV-4-36

Transit network selection information element

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TABLE IV-4-25

Transit network selection information element

Type of network identification (octet 3)

Bits

7 6 5

0 0 0 User specified

0 1 0 national network identification

All other values are reserved

Network identification plan (octet 3)

Bits

4 3 2 1

0 0 0 0 unknown

0 0 0 1 Carrier Identification Code (Note)

0 0 1 1 Data network identification code (Recommendation X.121)

All other values are reserved.

Note - Carrier Identification Codes may be an appropriate method of identifying the network serving the remote user.

Network identification (octet 4)

These IA5 characters are organized according to the network identification plan specified in octet 3. Identification of Carrier Identification Code (CIC) networks shall be by the 3 digit code assigned to ICs by Bell Communication Research. The CIC code assigned to AT&T is 288.

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4.5.29 User-user

The purpose of the User-user information element is to convey information between ISDN users. This information is not interpreted by the network, but rather is carried transparently and delivered to the remote user(s).

The User-user information element is coded as shown in Figure IV-4-37 and Table IV-4-26. There are no restrictions on the content of the user information field.

In SETUP, ALERTING, CONNECT, DISCONNECT, RELEASE and RELEASE COMPLETE message, the User-user information element has a network dependent maximum size of 131 octets. The evolution to a single maximum value is the long term objective; the exact maximum value is the subject of further study (see Section 7).

In USER INFORMATION message sent in association with a circuit-mode connection, or a temporary User-user signaling connection, the user information field contained inside this information element has a maximum size equal to 251 octets.

Note -- The User-user information element is transported transparently by an ISDN between a call originating entity, e.g., a calling user and the addressed entity, e.g., a remote user or a high layer function network node addressed by the call originating entity.

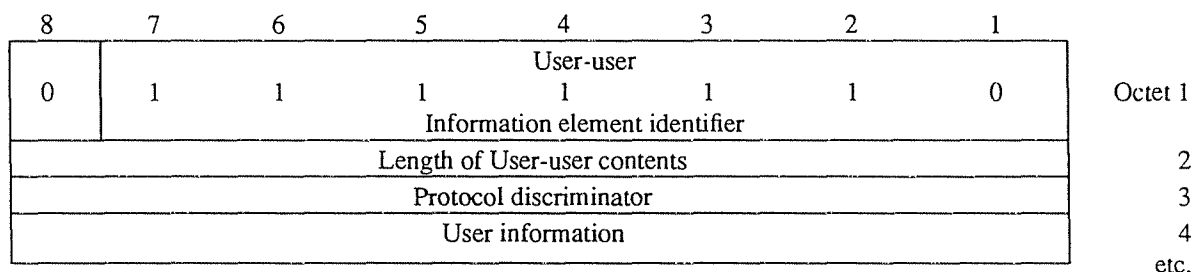


FIGURE IV-4-37

User-User Information Element

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TABLE IV-4-26

Protocol discriminator (octet 3)

Bits	
8 7 6 5 4 3 2 1	
0 0 0 0 0 0 0 0	User-specific protocol (Note 1)
0 0 0 0 0 0 0 1	OSI high layer protocols
0 0 0 0 0 0 1 0	X.244 (Note 2)
0 0 0 0 0 0 1 1	Reserved for System management convergence function or Maintenance Message
0 0 0 0 0 1 0 0	IA5 characters
0 0 0 0 0 1 1 1	Rec. V.120 rate adaptation
0 0 0 0 1 0 0 0	Q.931(I.451) user-network call control message.
0 0 0 1 0 0 0 0 through 0 0 1 1 1 1 1 1	} reserved for other network layer or layer 3 protocols, including Recommendation X.25. (Note 3)
0 1 0 0 0 0 0 0 through 0 1 0 0 1 1 1 1	} national use.
0 1 0 1 0 0 0 0 through 1 1 1 1 1 1 1 0	} reserved for other network layer or layer 3 protocols, including Recommendation X.25. (Note 3)

All other values are reserved

Note 1 - The user information is structured according to user needs.

Note 2 - The user information is structured according to Rec. X.244 which specifies the structure of X.25 call user data.

Note 3 - These values are reserved to discriminate these protocol discriminators from the first octet of a X.25 packet including general format identifier.

User information (Octet 4, etc)

The user information consists of IA5 characters.

4.5.30 Change status

The purpose of the change status information element is to change the current status of either an interface or channel to one of the following states: *In Service*, *Maintenance*, or *Out of Service*. The coding of the change status information element is shown in Figure IV-4-38 and Table IV-4-27. The change status information element is used with the AT&T Maintenance messages protocol discriminator.

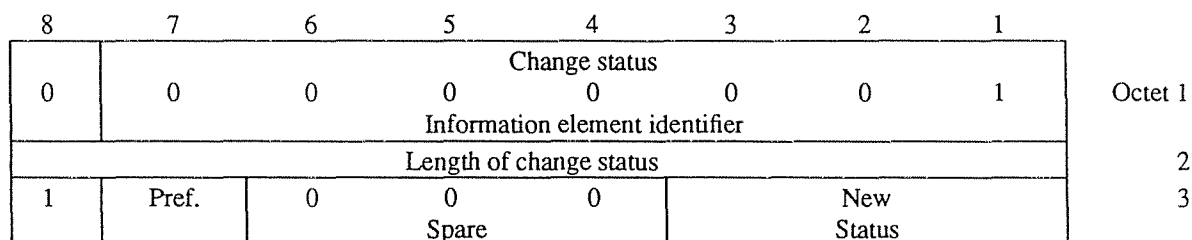


FIGURE IV-4-38

Change status information element

TABLE IV-4-27

Change status

Preference (Octet 3)

Bit 7	
0	Interface
1	Channel

New Status (Octet 3)

Bits	
3 2 1	
0 0 0	In Service
0 0 1	Maintenance
0 1 0	Out of Service

All other values are reserved for future use.

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4.6 Supplementary Services Information Element

4.6.1 Date/time - Reserved for future use

4.6.2 Facility - Reserved for future use

4.6.3 Feature Activation - Reserved for future use

4.6.4 Feature Indication - Reserved for future use

4.6.5 Switchhook - Reserved for future use

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4.6.6 Connected number

The purpose of the Connected number information element is to identify the connected party of a call. The bold and cross-out rules do not apply.

The Connected number information element is coded as shown in Figure IV-4-6a and Table IV-4-1a.

The maximum length of this information element is 18 octets.

8	7	6	5	4	3	2	1	
0	Connected number							Octet 1
0	0	0	0	1	1	0	0	
Information element identifier								
Length of call party number contents								2
1 ext	Type of number			Numbering plan identification				3
0	Number digits (IA5 characters - see Note)							4 etc.

Note - The number digits appear in multiple octet 4's in the same order in which they would be entered, that is, the number digit which would be entered first is located in the first octet 4.

FIGURE IV-4-6a

Connected number information element

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TABLE IV-4-1a
Connected number information element

Type of number (octet 3) (Note 1)

Bits	
7 6 5	
0 0 0	unknown (Note 2)
0 0 1	international number (Note 3)
0 1 0	national number (Note 3)
0 1 1	network specific number (Note 4)
1 0 0	subscriber number (Note 3)
1 1 0	abbreviated number
1 1 1	reserved for extension

All other values are reserved.

Note 1 - For the definition of international, national and subscriber number, see Recommendation I.330.

Note 2 - The type of number "unknown" is used when the user or the network has no knowledge of the type of number, e.g. international number, national number, etc. In this case the number digits field is organized according to the network dialing plan; e.g., prefix or escape digits might be present.

Note 3 - Prefix or escape digits shall not be included.

Numbering plan identification (octet 3)

Numbering plan

Bits	
4 3 2 1	
0 0 0 0	unknown (Note)
0 0 0 1	ISDN/telephony numbering plan (Recommendation E.164/E.163)
0 0 1 1	data numbering plan (Recommendation X.121)
0 1 0 0	telex numbering plan (Recommendation F.69)
1 0 0 0	national standard numbering plan
1 0 0 1	private numbering plan
1 1 1 1	reserved for extension
0 0 1 0	Telephony numbering plan (E.163)

All other values reserved.

Note - The numbering plan "unknown" is used when the user or the network has no knowledge of the numbering plan. In this case the number digits field is organized according to the network dialing plan; e.g., prefix or escape digits might be present.

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Note - The ISDN/telephony numbering plan codepoint (0 0 0 1) is the preferred coding for E.163.

Number digits (octet 4, etc.)

This field is coded with IA5 characters, according to the formats specified in the appropriate numbering/dialing plan.

Bits	Number digit
7 6 5 4 3 2 1	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
0 1 0 1 0 1 0	*
0 1 0 0 0 1 1	#

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4.6.7 Redirecting number

The purpose of the Redirecting number information element is to identify the number from which a call diversion or transfer was invoked.

The Redirecting number information element is coded as shown in Figure IV-4-7a and Table IV-4-2a.

The maximum length of this information element is 20 octets.

8	7	6	5	4	3	2	1	
0	Redirecting number							Octet 1
	1	1	1	0	1	0	0	
Information element identifier								
Length of redirecting number contents								2
0/1 ex	Type of number				Numbering plan identification			3
0/1 ext	Presentation indicator		0	0	0	Screening indicator		3a*
1 ext	0	0	0	Reason for redirection				3b*
	Spare							
0	Number digits (IA5 characters)							4 etc.

FIGURE IV-4-7a

Redirecting number information element

Note 1 - It is an implementation option whether to send octet 3a, however all equipment shall be designed to receive it. If octet 3a is omitted, then the calling party number shall be assumed user provided (with no network screening) and presentation to the terminating user is permitted.

Note 2 - The address digit in octet 4 precedes the digit in octet 5, etc. The address digit which would be dialed first is in octet 4.

TABLE IV-4-2a

Redirecting number information element

Type of number (octet 3) (Note 1)

Bits			
7	6	5	
0	0	0	unknown (Note 2)
0	0	1	international number (Note 3)
0	1	0	national number (Note 3)
0	1	1	network specific number (Note 4)
1	0	0	subscriber number (Note 3)
1	1	0	abbreviated number
1	1	1	reserved for extension

All other values are reserved.

Note 1 - For the definition of international, national and subscriber number, see Recommendation I.330.

Note 2 - The type of number "unknown" is used when the user or the network has no knowledge of the type of number, e.g., international number, national number, etc. In this case, the number digits field is organized according to the network dialing plan; e.g., prefix or escape digits might be present.

Note 3 - Prefix or escape digits shall not be included.

Note 4 - The type of number "network specific number" is used to indicate administration/service number specific to the serving network, e.g., used to access an operator.

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Numbering plan identification (octet 3)

Numbering plan

Bits				
4	3	2	1	
0	0	0	0	unknown (Note)
0	0	0	1	ISDN/telephony numbering plan (Recommendation E.164/E.163)
0	0	0	0	data numbering plan (Recommendation X.121)
0	0	0	0	telex numbering plan (Recommendation F.69)
1	0	0	0	national standard numbering plan
1	0	0	1	private numbering plan
1	1	1	1	reserved for extension
0	0	1	0	Telephony numbering plan (E.163)

All other values reserved.

Note - The numbering plan "unknown" is used when the user or the network has no knowledge of the numbering plan. In this case, the number digits field is organized according to the network dialing plan, e.g., prefix or escape digits might be present.

Note - The ISDN/telephony numbering plan codepoint (0 0 0 1) is the preferred coding for E.163.

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TABLE IV-4-2a

Redirecting number information element

Presentation indicator (octet 3a)

Bits

7 6

0 0	Presentation allowed
0 1	Presentation restricted

All other values are reserved.

NOTE -- At the redirecting user-network interface, the presentation indicator is used for indicating the intention of the redirecting user for the presentation of the redirecting number to the called user. This may also be requested on a subscription basis. If octet 3a is omitted, and the network does not support subscription information for the redirecting number information restriction, the value "00 - presentation allowed" is assumed.

Screening indicator (octet 3a)

Bits

2 1

0 0	User-provided, not screened
0 1	User-provided, verified and passed
1 0	User-provided, verified and failed
1 1	Network provided

NOTE -- If octet 3a is omitted, "0 0 - User provided not screened" is assumed.

Reason for redirection (octet 3b)

Bits

4 3 2 1

0 0 0 1	Call forwarding busy or called DTE busy
0 0 1 0	Call forwarding no reply
1 0 0 1	Called DTE out of order
1 1 1 1	Call forwarding unconditional or systematic call redirection
1 0 1 0	Call forwarding by the called DTE

All other values are reserved.

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Number digits (octets 4, etc.)

This field is coded with IA5 characters, according to the formats specified in the appropriate numbering/dialing plan.

Bits	Number digit
7 6 5 4 3 2 1	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
0 1 0 1 0 1 0	*
0 1 0 0 0 1 1	#

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4.6.8 Codeset 6 Information Elements

For specific service codings, consult product specific documentation.

4.6.8.1 AT&T Standardized Facilities

The purpose of the AT&T standardized facilities (ASF) information element is to indicate which of the AT&T standardized services is being requested or responded to. The functionality provided by this information element aligns with TCAP without incurring the overhead of that protocol. The ASF information element may be repeated in a message when multiple services are to be indicated. Please consult product specific documentation for further information on its coding and usage.

The AT&T standardized facilities information element is coded as shown in Figure IV-4-8a and Table IV-4-3a.

8	7	6	5	4	3	2	1	
0	0	0	AT&T Standardized Facilities 1 1 1 0 1					Octet 1
information element identifier								
Length of AT&T standardized facilities contents								2
1 Ext	Process Identifier							3
1 Ext	0	0	0	0	Control Type			4
Spare								
1 Ext	Correlated Process Identifier							4.1*
1 Ext	Service Element							5
Parameter description list for service element								6* etc.

FIGURE IV-4-8a

AT&T Standardized Facilities

Note: Octets with * are optional. Their presence is dictated by the presence of particular control types in octet 4.

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TABLE IV-4-3a

AT&T Standardized Facilities

Extension bit (Octets 3, 4, 4.1, and 5)

1 : last octet of the description

Process Identifier (Octet 3, Bits 7 through 1)

A binary field assigned by the sender of this information element when the control type in octet 4 indicates any of the three possible "invoke codings." For the other three control types (i.e., return result, return error, and reject), the "process identifier" corresponds to one received in an ASF information element with one of the invoke codings.

To avoid collisions of process identifiers (PIDs), it is recommended that odd numbered PIDs be assigned by the user side and even numbered PIDs be assigned by the network side of the interface. See section 11.1.4.3.1.4 for a more complete discussion of process identifier, correlated process identifiers and their interaction.

Control Type (Octet 4)

Bits		Definition
3	2 1	
0 0 1	invoke	Request the performance (e.g., action, status query) of the indicated service.
0 1 0	return result	Successful completion of the identified process.
0 1 1	return error	Requested process could not be performed but is understood.
1 0 0	reject	Requested process could not be performed due to protocol or coding violations or for reporting other failures.
1 0 1	invoke not last	Request the performance of the indicated service or report on the status of another process. Subsequent actions may be performed.
1 1 0	invoke last	Request the performance of the indicated service or final report on the status of another process. No more actions may be performed.

Correlated Process Identifier (Octet 4.1, Bits 7 through 1)

A binary field inserted by the sender of this information element when the control type in octet 5 indicates either "invoke not last" or "invoke last." The contents of this field identify a "process identifier" received in an ASF information element with one of the "invoke" control type codings.

Service Element (Octet 5)

This field identifies the service to be provided or being provided in conjunction with the control type. The field has different families associated with each of the control types of octet 5. This field may optionally be present when the control type in octet 5 is "return result".

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Control Type = Invoke, Invoke Not Last, Invoke Last, Return Result

Parameters for Service Element (Octet 6, etc.)

Parameters associated with a service are conveyed as information elements. In addition, parameters for a service element follow the rules for presentation of information elements in a call control message. Specifically,

- a. At the beginning of parameter presentation in the ASF information element, the active codeset is 0.
- b. Information elements are presented in increasing octal identifier.
- c. A shift to another codeset is not permitted until all information elements in a particular codeset are presented.
- d. Shifts to other codesets are permitted as long as the codeset has a higher number (i.e., from lower codeset to higher codeset).

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4.6.8.2 Display

The purpose of the Display information element (in codeset 6) is to convey calling and connected party names in order to generate displays at ISDN terminals. See Figure IV-4-9a.

The information element may be repeated two times.

8	7	6	5	4	3	2	1	
0	0	1	0	1	0	0	0	Octet 1
Display information element identifier								
Length of Display information element								2
Display information (IA5 characters)								3 etc.

FIGURE IV-4-9a

Display Information Element

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4.6.8.3 Lookahead interflow

The purpose of the Lookahead Interflow information element (in codeset 6), is to convey automatic call distribution information in a SETUP message. This information allows users to balance incoming traffic between multiple switches by redirecting calls to alternate locations. Without this information, the redirection party could not identify the correct queuing information for the call. Please consult product specific documentation for further information on its coding and usage.

The maximum length of this information element is 21 octets.

See Figure IV-4-10a.

8	7	6	5	4	3	2	1	
0	Lookahead interflow							Octet 1
	1	1	1	1	0	1	1	
Information element identifier								
Length of Lookahead interflow contents								2
1 ext	Priority Level				Type Interflow			3
1 ext	0	0	Time Stamp Hours					4
1 ext	0	Time Stamp Minutes						5
1 ext	0	Time Stamp Seconds						6
1/0 ext	DNIS Name Display IA5 Chars							7

FIGURE IV-4-10a

Lookahead interflow

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4.6.8.4 Traveling Class Mark

The purpose of the traveling class mark information element (in codeset 6) is to identify the call privileges of the calling user. See Figure IV-4-11a and Table IV-4-5a.

8	7	6	5	4	3	2	1	
0	Travelling class mark information element identifier							Octet 1
Length of Travelling class mark information element								2
1 Ext.	1	0	1	0	0	0	0	3
	Coding Standard		Change value	Spare				
0 Spare	Traveling Classmark (IA5 characters)							4
0 Spare	Satellite Hop Counter (IA5 characters)							5
1 Ext	End-to-End ISDN Indication							6

FIGURE IV-4-11a

Traveling Class Mark

TABLE IV-4-5a

Traveling Class Mark

End-to-End ISDN Indication (Octet 6, bits 1 through 7)

Bits							
7	6	5	4	3	2	1	
0	0	0	0	0	0	0	don't care
0	0	0	0	0	0	1	end-to-end ISDN required
0	0	0	0	1	0		end-to-end ISDN preferred

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4.6.8.5 Subnetwork trunking

This information element is used to convey instructions regarding proper outpulsing of digits in subnetwork trunking configurations. The digits which will be outpulsed appear in the Called party number information element. This information element allows for the outpulsing of a maximum of 31 digits which can be split into 4 groups. The number of digits in the first three groups may range from 0-15. The last group is allocated for the rest of the digits. Please consult product specific documentation for further information on its coding and usage.

8	7	6	5	4	3	2	1	
Subnetwork trunking								
0	0	0	0	1	1	0	0	Octet 1
Information Element Identifier								
Length of Information Element Contents								Octet 2
1	Spare			Pause Length				Octet 3
1	# Digits				Sig. Type			Octet 4
1	Spare			Pause Length				Octet 5
1	# Digits				Sig. Type			Octet 6
1	Spare			Pause Length				Octet 7
1	# Digits				Sig. Type			Octet 8
1	Spare			Pause Length				Octet 9
1	Spare				Sig. Type			Octet 10

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4.6.8.6 Trunk Group/Trunk Identification

The Trunk Group/Trunk identification information element is used to identify the physical trunk group and trunk on which a call is present or to identify a trunk group to route a call. This information element may also be used to identify a trunk group being audited. Refer to product specific trunk group status audit procedures.

8	7	6	5	4	3	2	1	
0	Trunk Group/Trunk identification							Octet 1
	0	0	0	1	0	1	0	
Information Element Identifier								
Length of Trunk Group/Trunk Identification								Octet 2
1	Direction				0	0	0	Octet 3
					Spare			
0/1 Ext.	Trunk Group Number							Octet 4 4a
0/1 Ext.	Trunk Number							Octet 5 5a

Note: Octet 5 may be omitted when a trunk group is being identified. Octets 4a and 5a may be omitted if the trunk group or trunk may be identified in 7 bits.

4.6.8.7 Trunk Group/Trunk Status

This Trunk group/trunk status information element is used to convey information about the busy/idle status of trunks. Refer to trunk group status audits product specific procedures.

8	7	6	5	4	3	2	1	
Trunk group/trunk status								
0	0	0	0	1	0	1	1	Octet 1
Information Element Identifier								
Length of IE Contents								Octet 2
1	In Use	Idle	Maint. Busy	Other Unavail.	Trans.	0	0	Octet 3
						Spare		
0/1 Ext.	Count of Highest Bit in Octet 3 with Status Requested							Octet 4 4a
0/1 Ext.	Count of Second Highest Bit in Octet 3 with Status Requested							Octet 5 5a
0/1 Ext.	Count of Third Highest Bit in Octet 3 with Status Requested							Octet 6 6a
0/1 Ext.	Count of Fourth Highest Bit in Octet 3 with Status Requested							Octet 7 7a
0/1 Ext.	Count of Fifth Highest Bit in Octet 3 with Status Requested							Octet 8 8a

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4.6.8.8 User Entered Code

The User entered code information element is used for requesting that a user code be collected. Please consult product specific documentation for further information on its coding and usage.

8	7	6	5	4	3	2	1	
0	0	0	0	0	0	1	0	Octet 1
User entered code Information Element Identifier								
Length of User Code Information Element								Octet 2
1	0	0	0	0	0	0	0	Octet 3
Type of User entered code								
1	Collect/ Collected Indication		Timeout Interval					Octet 4
1/0	User entered Code Digits							Octet 5 ... Octet n

4.6.8.9 Facility

This section defines the structure and the coding of the Facility information element in codeset 6. The purpose of the Facility information element is to indicate the invocation and operation of supplementary services. This information element from CCITT Recommendation Q.932 uses X.209 encoding with X.229 Protocol Data Units (PDUs).

The Facility information element may be repeated in a given message. The maximum length of the Facility information element is application dependent consistent with the maximum length of the message. The Facility information element is defined in Figure IV-4-A and Tables IV-4-a to IV-4-d.

8	7	6	5	4	3	2	1	
0	0	0	1	1	1	0	0	Octet 1
Facility information element identifier								
Length of facility contents								2
1 Ext	0	0	Service discriminator					3
Component (note)								4 etc.

Note - For PRI, we only allow one component to be generated or received.

Figure IV-4-A. Facility information element

Service discriminator (Octet 3)

Bits	
5 4 3 2 1	
1 0 0 0 1	Discriminator for supplementary service application

4.6.8.9.1 Components (Octets 4, etc.)

The encoding of components is based on Recommendation X.208 and X.209.

A component is a sequence of data elements each of which is made up of a tag, a length, and a contents. The component type is indicated by the first octet of the Facility information element component (octet 4). The component types defined for Facility information element are:

- Invoke
- Return result
- Return error
- Reject

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TABLE IV-4a. Invoke component

Invoke component	Reference	Mandatory Indication	Octet group
Component type tag	4.6.8.14.4	Mandatory	4
Component length (note 1)	4.6.8.14.3		5
Invoke identifier tag	4.6.8.14.5	Mandatory	6
Invoke identifier length	4.6.8.14.3		7
Invoke identifier	4.6.8.14.6		8
Linked identifier tag	4.6.8.14.5	Optional	9
Linked identifier length	4.6.8.14.3		10
Linked identifier	4.6.8.14.7		11
Operation value tag	4.6.8.14.8	Mandatory	12
Operation value length	4.6.8.14.3		13
Operation value	4.6.8.14.9		14
Argument (note 2)	4.6.8.14.12	Optional	15, etc.

Note 1 - The component length is coded to indicate the number of octets contained in the component (excluding the component type tag and the component length octets).

Note 2 - This is used to carry the parameter(s) of the invoke component.

TABLE IV-4b. Return result component

Return result component	Reference	Mandatory Indication	Octet group
Component type tag	4.6.8.14.4	Mandatory	4
Component length (note 3)	4.6.8.14.3		5
Invoke identifier tag	4.6.8.14.5	Mandatory	6
Invoke identifier length	4.6.8.14.3		7
Invoke identifier	4.6.8.14.6		8
Sequence tag	4.6.8.14.12	Optional (note 1)	9
Sequence length (note 4)	4.6.8.14.3		10
Operation value tag	4.6.8.14.8	Optional (note 2)	11
Operation value length	4.6.8.14.3		12
Operation value	4.6.8.14.9		13
Result (note 5)	4.6.8.14.12	Optional	14, etc.

Note 1 - If the return result component does not include any result, then the sequence and operation value must be omitted.

Note 2 - If a result is included, then the operation value is mandatory and is the first element in the sequence.

Note 3 - The component length is coded to indicate the number of octets contained in the component (excluding the component type tag and the component length octets).

Note 4 - The sequence length is coded to indicate the number of octets contained in the sequence

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(excluding the sequence type tag and the sequence length octets).

Note 5 - This is used to carry the parameter(s) of the return result component

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TABLE IV-4-c. Return error component

Return error component	Reference	Mandatory Indication	Octet group
Component type tag	4.6.8.14.4	Mandatory	4
Component length (note 1)	4.6.8.14.3		5
Invoke identifier tag	4.6.8.14.5	Mandatory	6
Invoke identifier length	4.6.8.14.3		7
Invoke identifier	4.6.8.14.6		8
Error value tag	4.6.8.14.10	Mandatory	9
Error value length	4.6.8.14.3		10
Error value (note 3)	__ervalue		11
Parameter (note 2)	4.6.8.14.12	Optional	12, etc.

Note 1 - The component length is coded to indicate the number of octets contained in the component (excluding the component type tag and the component length octets).

Note 2 - This is used to carry the parameter(s) for the return error component type.

Note 3 - Because Q.932 uses the same tag for error value and operation value, the error value must be one of the values in Table IV-4-j.

TABLE IV-4-d. Reject component

Reject component	Reference	Mandatory Indication	Octet group
Component type tag	4.6.8.14.4	Mandatory	4
Component length (note)	4.6.8.14.3		5
Invoke identifier tag	4.6.8.14.5	Mandatory	6
Invoke identifier length	4.6.8.14.3		7
Invoke identifier	4.6.8.14.6		8
Problem tag	4.6.8.14.11	Mandatory	9
Problem length	4.6.8.14.3		10
Problem	4.6.8.14.11		11

Note - The component length is coded to indicate the number of octets contained in the component (excluding the component type tag and the component length octets).

4.6.8.9.2 Data Elements

The contents of each data element is either one value (primitive) or one or more data elements (constructor) as shown in Figure IV-4-B.

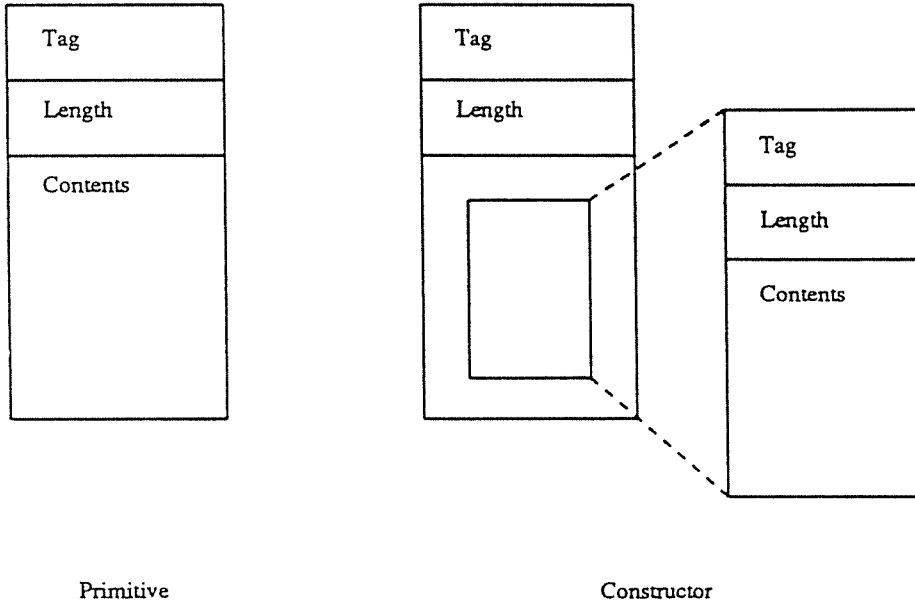


Figure IV-4-B. Type of contents

4.6.8.9.2.1 X.209 Tags

A data element is first interpreted according to its position within the syntax of the message. The tag distinguishes one data element from another and governs the interpretation of the contents. The tag is one or more octets in length. The tag is composed of *class*, *form*, and *tag code*, as shown in Figure IV-4-C.

8	7	6	5	4	3	2	1
Class		Form	Tag code (note)				

Note: In PRI, the length of the tag will only be one octet.

Figure IV-4-C. Format of tag

4.6.8.9.2.2 Tag class

All tags use the two most significant bits (8 and 7) to indicate the tag class. These bits are coded as shown in Table IV-4-e.

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TABLE IV-4-e. Coding of tag class

Class	Coding (Bits 8 and 7)
Universal	0 0
Application-wide	0 1
Context-specific	1 0
Private use	1 1

The universal class is used for tags that are exclusively standardized in Recommendation X.209 and are application independent types. Universal tags may be used anywhere a universal data element type is used. The universal class applies across all CCITT recommendations, i.e., across Q.932 facility information elements, CCITT Signaling System No. 7, ASEs, X.400 MHS, X.500 Directory Services, etc.

The application-wide class is used for data elements that are standardized across all applications (ASEs) using CCITT Recommendation Q.932 facility procedures for supplementary services.

The context-specific class is used for data elements that are specified within the context of the next higher construction and take into account the sequence of other data elements within the same construction. This class may be used for tags in a construction, and the tags may be reused in any other construction.

The private use class is reserved for data elements specific to a nation, a network, or a private user.

4.6.8.9.2.3 Tag Form of the data element

Bit 6 is used to indicate whether the data element is *primitive* or *constructor*, as shown in Table IV-4-6. A primitive element is one whose structure is atomic (i.e., one value only). A constructor element is one whose content is one or more data elements which may themselves be constructor elements.

Both forms of elements are shown in Figure IV-4-B.

TABLE IV-4-f. Coding of element form

Element form	Coding (Bit 6)
Primitive	0
Constructor	1

4.6.8.9.3 Length of Each Component or Their Data Elements

Lengths up to 127 octets are coded using the the short form of Recommendation X.209: bit 8 is set to zero and the remaining seven bits are a binary encoding of the length with bit 1 the least significant bit. (This length encoding is identical to that of Recommendation Q.931 for lengths up to 127 octets). This is illustrated in Figure IV-4-D.

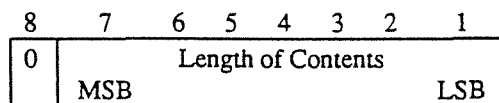


Figure IV-4-D. Format of the length field (short form)

If the length of the contents is greater than 127 octets, then the long form of the length of the contents is used. The long form length is from 2 to 127 octets long. Bit 8 of the first octet is coded 1, and bits 1 to 7 of the first octet encode a number one less than the size of the length in octets as an unsigned binary number whose MSB and LSB are bits 7 and 1, respectively. The length itself is encoded as an unsigned binary number whose MSB and LSB are bit 8 of the second octet and bit 1 of the last octet, respectively. This binary number shall be encoded in the fewest possible octets, with no leading octets having the value 0. This is illustrated in Figure IV-4-E.

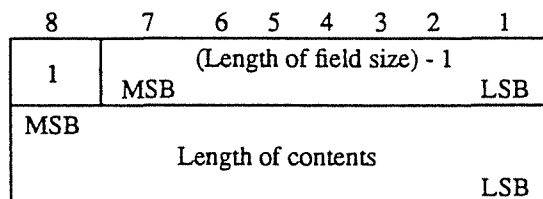


Figure IV-4-E. Format of the length field (long form)

Note - When the long form is used, the long form length will only be two octets long.

4.6.8.9.4 Component type tag

The coding of the component type tag is shown in Table IV-4-g.

TABLE IV-4-g. Component type tag

	8	7	6	5	4	3	2	1
Invoke	1	0	1	0	0	0	0	1
Return result	1	0	1	0	0	0	1	0
Return error	1	0	1	0	0	0	1	1
Reject	1	0	1	0	0	1	0	0

4.6.8.9.5 Component identifier tags

An invoke identifier is used to identify an operation invocation and is reflected in the return result or return error that responds to it. An invoke may refer to another invoke through the linked identifier. When a protocol error occurs, the invoke identifier is reflected in the reject component, but if it is not available, a null is returned. Invoke and linked identifiers are one octet long. The null has zero length. The coding of the component identifier tags is shown in Table IV-4-h.

TABLE IV-4-h. Coding of Invoke identifier tag

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	8	7	6	5	4	3	2	1
Invoke identifier	0	0	0	0	0	0	1	0
Linked identifier	1	0	0	0	0	0	0	0
Null	0	0	0	0	0	1	0	1

4.6.8.9.6 Invoke Identifier

The invoke identifier is a binary field assigned by the sender of the Facility information element when the Component type tag in octet 4 indicates *invoke*. For the remaining Component type tags (i.e., return result, return error, and reject), the "invoke identifier" corresponds to one previously received in a Facility information element with an invoke component type tag.

4.6.8.9.7 Linked Identifier

The linked identifier is a binary field inserted by the sender of the Facility information element when the Component type tag in octet 4 indicates *invoke* and octet 9 contains a linked identifier tag. The contents of the linked identifier identify an invoke identifier previously received in a Facility information element.

4.6.8.9.8 Operation Value Tag

The coding for the operation value tag is shown in Table IV-4-i.

TABLE IV-4-i. Coding of operation value tag

	8	7	6	5	4	3	2	1
Operation value tag	0	0	0	0	0	0	1	0

4.6.8.9.9 Operation Value

The operation value specifies the supplementary service application and operation being requested or responded to. Values are encoded as integers.

TABLE IV-4-j. Coding of operation value

8	7	6	5	4	3	2	1	
1	0	0	0	0	0	1	1	} RESERVED
1	0	0	0	1	1	0	1	
1	0	0	0	1	1	1	1	Request feature
1	0	0	1	0	0	0	0	} RESERVED
1	0	0	1	0	1	0	1	
1	0	0	1	1	0	1	0	RESERVED
1	0	0	1	1	0	1	1	RESERVED
1	0	1	0	0	0	0	0	RESERVED
1	0	1	0	0	0	0	1	RESERVED
1	0	1	1	0	0	0	0	RESERVED
1	0	1	1	0	0	1	0	} RESERVED
1	0	1	1	1	1	0	1	
1	0	1	1	1	1	1	0	Abort

4.6.8.9.10 Error Value Tag

Operations report errors as specified for each individual operation. Values are encoded as integers. The coding for the error value tag is shown in Table IV-4-k.

TABLE IV-4-k. Coding of error value tag

	8	7	6	5	4	3	2	1
Error value tag	0	0	0	0	0	0	1	0

4.6.8.9.11 Problem Tag

Protocol problems are indicated in groups. Table IV-4-l indicates the tags for these groups. The contents for each of these tags is indicated in Tables IV-4-m to IV-4-p. The contents of these tags are defined in Table IV-4-q.

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TABLE IV-4-l. Coding of problem tags

	8	7	6	5	4	3	2	1
General problem	1	0	0	0	0	0	0	0
Invoke problem	1	0	0	0	0	0	0	1
Return result problem	1	0	0	0	0	0	1	0
Return error problem	1	0	0	0	0	0	1	1

TABLE IV-4-m. Coding of general problem

	8	7	6	5	4	3	2	1
Unrecognized component	0	0	0	0	0	0	0	0
Mistyped component	0	0	0	0	0	0	0	1
Badly structured component	0	0	0	0	0	0	1	0

TABLE IV-4-n. Coding of invoke problem

	8	7	6	5	4	3	2	1
Duplicate invocation	0	0	0	0	0	0	0	0
Unrecognized operation	0	0	0	0	0	0	0	1
Mistyped argument	0	0	0	0	0	0	1	0
Resource limitation	0	0	0	0	0	0	1	1
RESERVED	0	0	0	0	0	1	0	0
RESERVED	0	0	0	0	0	1	0	1
RESERVED	0	0	0	0	0	1	1	0
RESERVED	0	0	0	0	0	1	1	1

TABLE IV-4-n. Coding of return result problem

	8	7	6	5	4	3	2	1
Unrecognized invocation	0	0	0	0	0	0	0	0
Result response unexpected	0	0	0	0	0	0	0	1
Mistyped result	0	0	0	0	0	0	1	0

TABLE IV-4-o. Coding of return error problem

	8	7	6	5	4	3	2	1
Unrecognized invocation	0	0	0	0	0	0	0	0
Error response unexpected	0	0	0	0	0	0	0	1
Unrecognized error	0	0	0	0	0	0	1	0
Unexpected error	0	0	0	0	0	0	1	1
Mistyped parameter	0	0	0	0	0	1	0	0

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TABLE IV-4-p. Problem code definitions

General-problem:

- unrecognized-component: signifies that the type of the component, as evidenced by its Type Identifier, is not one of the four defined by Recommendation X.229
- mistyped-component: signifies that the structure of the component does not conform to Recommendation X.229
- badly-structured-component: signifies that the structure of the component does not conform to the standard notation and encoding, defined in Recommendation X.208 and X.209

Invoke-problem:

- duplicate-invocation: signifies that the Invoke-identifier parameter violates the assignment rules of Recommendation X.219
- unrecognized-operation: signifies that the type of the operation argument supplied is not one of those agreed between the user and the network
- mistyped-argument: signifies that the type of the operation argument supplied is not that agreed between the user and the network
- resource-limitation: the performing user or network is not able to perform the invoked operation due to resource limitation
- initiator-releasing: the association-initiator is not willing to perform the invoked operation because it is about to attempt to release the application-association
- unrecognized-linked-identifier: signifies that there is no operation in progress with an Invoke-identifier equal to the specified Linked-identifier
- linked-response-unexpected: signifies that the invoked operation referred to by the Linked-identifier is not a parent-operation
- unexpected-child-operation: signifies that the invoked child-operation is not one that the invoked parent operation referred to by the Linked-identifier allows

Return result problem:

signifies that no operation with the specified Invoke-identifier is in progress

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- unrecognized-invocation:

- result-response-unexpected: signifies that the invoked operation does not report a result

- mistyped-result: signifies that the type of the Result parameter supplied is not that agreed between the client and the server

Return error problem:

- unrecognized-invocation: signifies that no operation with the specified Invoke-identifier is in progress

- error-response-unexpected: signifies that the invoked operation does not report failure

- unrecognized-error: signifies that the reported error is not one of those agreed between the client and the server

- unexpected-error: signifies that the reported error is not one that the invoked operation may report

- mistyped-parameter: signifies that the type of the error parameter supplied is not that agreed between the client and the server.

4.6.8.9.12 Parameters

The parameters included with a component (i.e., the argument with an invoke, the result with a return result, or the parameter with a return error) are indicated in the specification of the operation. They may include optional and default parameters. Parameters must be one of the following:

- a sequence of parameters
- a single parameter with its own tag
- nothing at all (i.e., absent)

When more than one X.209 parameter is required, they shall follow a sequence tag as per the specification of the operation. Please consult product specific documentation for encoding of the parameters.

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Coding of sequence tag

	8	7	6	5	4	3	2	1
Sequence tag	0	0	1	1	0	0	0	0

4.6.8.9.13 Treatment of Existing Q.931 Information Elements as Parameters

When existing Q.931 information elements (from codesets 0, 6, and 7) are to be passed as parameters for a component, a X.209 data element can be used to encapsulate them, thereby retaining the Q.931 coding for these information elements (note 1). When this option is elected, all the Q.931 information elements should be grouped together, as per the rules for Q.931 information elements in a message, as the content following the Recommendation Q.931 information elements tag. This is illustrated in Figure IV-4-F. The tag for encapsulating Q.931 information elements is given in Table IV-4-q. This data element may appear by itself or as a member of a sequence as indicated in section 4.6.8.14.12.

Note - Encapsulation of the Facility information element with Facility information elements shall not be used.

Q.931 information elements tag
Q.931 information elements length
First Q.931 information element
Second Q.931 information element
.
.
.
.
Last Q.931 information element

Figure IV-4-F. Encapsulation of Q.931 information elements

TABLE IV-4-q. Q.931 Information elements tag

	8	7	6	5	4	3	2	1
Q.931 information elements	0	1	0	0	0	0	0	0

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4.6.8.10 Connection Description

The Connection Description information element in codeset 6 is used to further describe a connection so that a network can make control decisions for the connection. These control decisions are based on the ability to automatically restore a connection in network failure or congestion (causing preemption) situations. This information element may be inserted in a SETUP message to initially describe a connection. Please consult product specific documentation its coding and usage.

8	7	6	5	4	3	2	1	
0	Connection Description information element identifier							Octet 1
Length of Connection Description information element								2
0 Spare	Restoration type					Allow preemption		3
1 Ext	Attempt preemption		Connection priority					4

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4.6.8.11 Feature

The feature information element specifies which feature is being requested. Please consult product specific documentation for its coding and usage.

8	7	6	5	4	3	2	1	
0	1	0	0	1	0	0	0	Octet 1
Information element identifier								
Length of Feature contents								2
1 Ext	Feature							3

4.6.8.12 Subchannel identification

This information element is used to convey information concerning subrate connections. Please consult product specific documentation for further information on its coding and usage.

8	7	6	5	4	3	2	1				
0	0	1	0	1	0	1	0	Octet 1			
Subchannel Identification											
Information element identifier											
Length of subchannel identification								2			
1	0	0	Number/ Map		Sub-Channel/Map element type			3			
		spare									
Sub-Channel number/Sub-Slot map											

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4.6.9 Codeset 7 Information Elements

4.6.9.1 Display

Coding for this information element is identical to the coding given in Section 4.6.8.2.

4.6.9.2 Traveling Class Mark

Coding for this information element is identical to the coding given in Section 4.6.8.4.

4.6.9.3 Lookahead interflow

Coding for this information element is identical to the coding given in Section 4.6.8.3.

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4.7 Information Elements for Data Communications

The information elements defined below are intended to be used in the support of data communications.

4.7.1 Information Rate - Reserved for future use

4.7.2 End-to-End Transit Delay - Reserved for future use

4.7.3 Packet Layer Binary Parameters - Reserved for future use

4.7.4 Packet Layer Window Size - Reserved for future use

4.7.5 Packet Size - Reserved for future use

4.7.6 Redirecting number - Reserved for future use for Data Communications

4.7.7 Transit Delay Selection and Indication - Reserved for future use

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4.7.8 Codeset 6 Data Parameters

For specific codings, see product specific documentation.

4.7.8.1 Link Layer Parameters

The purpose of the link layer parameters information element is to indicate requested layer 2 parameter values to be used for the frame relayed virtual call. The link layer parameter fields are binary-encoded.

The absence of this information element from a SETUP message signifies a request for the defaults for all parameters. The absence of a parameter from the SETUP message indicates a request for the default value of that parameter.

The absence of this information element or a parameter from a CONNect message signifies acceptance of values indicated by the SETUP message. To indicate a request for values other than the ones offered in the SETUP message, the user must indicate the value desired in the CONNect message.

When parameters are included, they must appear in the order indicated. The coding for this information element is shown in Figure IV-4-15a and Table IV-4-9a.

8	7	6	5	4	3	2	1	
Link layer parameters information element identifier								Octet 1
0	1	0	0	0	0	0	0	
Length of link layer parameters information element								2
k forward identifier								3 (Note 1)
0	0	0	0	0	0	1	0	
1	Forward value							3a (Note 2)
k backward identifier								4 (Note 1)
0	0	0	0	0	0	1	1	
1	Backward value							4a (Note 2)
N201 forward identifier								5 (Note 1)
0	0	0	0	0	1	0	0	
0/1 Ext	Forward value							5a (Note 2)
N201 backward identifier								6 (Note 1)
0	0	0	0	0	1	0	1	
0/1 Ext	Backward value							6a (Note 2)
T200 forward identifier								7 (Note 1)
0	0	0	0	0	1	1	0	
Forward value								7a (Note 2)
T200 backward identifier								8 (Note 1)
0	0	0	0	0	1	1	1	
Backward value								8a (Note 2)
CR indication identifier								9 (Note 1)
0	0	0	0	1	0	0	0	
Spare							C/R ind	9a (Note 2)

FIGURE IV-4-15a

Note 1: This octet may be omitted, unless the associated a octet is present.

Note 2: This octet may be omitted.

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TABLE IV-4-9a

Parameter values are as described below.

Parameter	Default value	Acceptable range of values
Acknowledgement timer (T200) value	1 sec.	0.1 - 25.5 sec.
Window (k) value	(Note 1)	1 - 127
Information field (N201) value	260	1 - 260 octets (Note 2)

Note 1: The default value supported will be 4. This value will be supported as the default until the external standards groups determine another value. At that time, all implementations using this information element will support the standard default value.

Note 2: The acceptable range of values listed here is applicable for packet transport mode. The acceptable range for circuit transport mode is user specific.

T200 is coded in tenths of a second.

Command/Response (C/R) indication parameter (Octet 9a; bit 1).

0 : Sender of field is taking A side role

1 : Sender of field is taking B side role

C/R Bit	B side	A side
0	frame is a response from	frame is a command from
1	frame is a command from	frame is a response from

Default values: originating user is A side, terminating user is B side.

Note: C/R bit is bit 2 of the first octet of the LAPD frame address field.

4.7.8.2 Logical Link Identification

The purpose of the logical link identification information element is to identify a logical link within a channel controlled by these signaling procedures for a frame relayed virtual call.

The absence of this information element in the SETUP message of a DMI Mode 3 call indicates a request for a default logical link value of 128.

The logical link identification information element is coded as shown in Figure IV-4-16a and Table IV-4-10a.

8	7	6	5	4	3	2	1	
0	Logical link							Octet 1
0	0	0	1	1	0	1	0	
Information element identifier								
Length of Logical link								2
0	Pref	Logical link value						3
Spare	Excl							
1	Logical link value							4
Ext								

FIGURE IV-4-16a

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TABLE IV-4-10a

Preferred/Exclusive

- 0 : Logical link indicated is preferred
- 1 : Logical link indicated is required (exclusive request)

Logical link value (Octets 3 and 4)

Octet 3: upper DLCI value
Octet 4: lower DLCI value

The DLCI value of 0 is reserved for signaling.

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4.7.8.3 Packet Layer Parameters

The purpose of the packet layer parameters information element is to indicate requested layer 3 parameter values to be used for the call. The packet parameter fields are binary-coded, except for the packet size value which is encoded $\log_2$.

The absence of this information element from a SETUP message signifies a request for the defaults for all parameters. The absence of a parameter from the SETUP message indicates a request for the default value of that parameter.

The absence of this information element or a parameter from a CONNECT message signifies acceptance of values indicated by the SETUP message. To indicate a request for values other than the ones offered in the SETUP message, the user must indicate the value desired in the CONNECT message.

When parameters are included, they must appear in the order indicated.

The coding for this element is shown in Figure IV-4-17a and Table IV-4-11a.

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8	7	6	5	4	3	2	1	
Packet layer parameters								Octet 1
0	0	1	1	1	1	0		
information element identifier								2
Length of packet layer parameters information element								
Binary parameters identifier								3 (Note 1)
0	0	0	0	0	0	0	1	
1	0	0	0	0	0	0	1	3a (Note 2)
Spare			Fast select	Exp data	Rec conf	Mod		
W forward identifier								4 (Note 2)
0	0	0	0	0	0	1	0	
1	Forward value							4a (Note 2)
W backward identifier								
0	0	0	0	0	0	1	1	5 (Note 2)
1	Backward value							
Packet size forward identifier								6 (Note 2)
0	0	0	0	0	1	0	0	
0/1 Ext	Forward value							6a (Note 2)
Packet size backward identifier								
0	0	0	0	0	1	0	1	7 (Note 2)
0/1 Ext	Backward value							

FIGURE IV-4-17a

Note 1: This octet may be omitted, unless the associated *a* octet is present.

Note 2: This octet may be omitted.

TABLE IV-4-11a

Fast select (Octet 3a; bit 4) (Note)

- 0: No request for restriction/request denied
- 1: Request for restriction indicated/request accepted

Expedited data (Octet 3a; bit 3) (Note)

- 0: No request/request denied
- 1: Request indicated/request accepted

Receipt Confirmation (Octet 3a; bit 2) (Note)

- 0: No request/request denied
- 1: Request indicated/accepted

Modulus (Octet 3a; bit 1)

- 0 Modulo 8 sequencing
- 1 Modulo 128 sequencing

Note: Definitions and procedures for these are included in Section 20 of the DMI Specification Document.

Parameter values are as follows:

Parameter	Default value	Acceptable range of values
Window size	(Note 1)	1 - 127 (Note 2)
Packet size	128	1 - (N201 - packet header)
Modulus	modulus 8	modulus 128 or 8

Note 1: The default value supported will be 3. This value will be supported as the default by 8 and 9 until the external standards groups determine another value. At that time, all implementations using this information element will support the new default value.

Note 2: Values of 8 through 127 are valid only for Modulo 128 operation

Note 3: For further information on Fast Select see Section 13.16 of ISO 8208.

For further information on Expedited Data see Section 14.5 of ISO 8208.

For further information on Receipt Confirmation (D-bit) see Section 6.3 of ISO 8208.

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4.7.8.4 Throughput Class

The purpose of the throughput class information element is to provide for user selection of the information transfer rate to be used during the information transfer portion of the frame relayed virtual call.

The throughput class information element is coded as shown in Figure IV-4-18a and Table IV-4-12a.

8	7	6	5	4	3	2	1	
0	Throughput class information element identifier						0	Octet 1
Length of throughput class information element								2
1 Ext	0 Spare	0 Spare	Incoming information rate					3
1 Ext	0 Spare	0 Spare	Outgoing information rate					4
1 Ext	0 Spare	0 Spare	Minimum incoming information rate					5
1 Ext	0 Spare	0 Spare	Minimum outgoing information rate					6

FIGURE IV-4-18a

TABLE IV-4-12a

Information rates (Octets 3 - 6; bits 5 through 1)

Bits					Rate (bits/s)
5	4	3	2	1	
0	0	0	1	1	75
0	0	1	0	0	150
0	0	1	0	1	300
0	0	1	1	0	600
0	1	0	0	0	2400
0	1	0	0	1	4800
0	1	0	1	0	9600
0	1	0	1	1	19200
0	1	1	0	0	48000
1	1	1	0	0	56000
1	1	1	1	0	64000

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5. Circuit-Switched Call Control Procedures

This section describes the procedures that define the flow of messages across a primary rate interface between any of the following: an ISDN user and the network, two PBXs, or a PBX and a Host. Circuit-switched calls between an ISDN user and the network may be either inter-exchange or intra-exchange in nature.

Before these procedures are invoked, a reliable data link connection must be established between the two sides of the ISDN interface.

The call states referred to in this section cover the states perceived by the network, states perceived by the user and states which are common to both user and network. Unless specifically qualified, all states described in the following text should be understood as common (see Section 2.1.1 and 2.1.2 for user and network call states, respectively).

Detailed specification and description language (SDL) diagrams for the procedures specified in this section are contained in Annex A. When there is an ambiguity in the narrative text, the SDL diagrams in Annex A should be used to resolve conflict. Where the text and the SDL are in disagreement, the text should be used as the prime source.

NOTE -- This section describes the sequence of message associated with the control of circuit-switched connections. Optional extensions to this basic protocol and exceptions that apply in the case of packet-mode connections or supplementary services are described elsewhere in this specification. Annex D also contains optional extensions to the basic call establishment procedures defined in Section 5 for symmetric signaling.

All messages in this specification contain one type of information element functional. Functional information elements are characterized as requiring a degree of intelligent processing by the CPE in either their generation or analysis.

5.1 Call Establishment at the Originating Interface

Before these procedures are invoked, a reliable data link connection must be established between the user (TE/NT2) and the network. All layer 3 messages shall be sent to the data link layer using a DL_DATA_REQUEST primitive. The data link services described in Part III.

5.1.1 Call Request

A user initiates call establishment by transferring a SETUP message across the user-network interface. Following the transmission of the SETUP message, the call shall be considered by the user to be in the Call Initiated state. The message shall always contain a call reference, selected according to the procedures given in Section 4.3. In selecting a call reference, the dummy call reference value shall not be used. The Bearer capability information element is mandatory in the SETUP message.

The SETUP message shall contain all the information required by the network to process the call, and, in particular, the called party address information, if present, is contained as follows:

- a) in the called party number information element possibly completed by the called party subaddress information element.

5.1.2 B-Channel Selection -- Originating

In the SETUP message, the user will indicate one of the following:

- a) channel is indicated, no acceptable alternative; or

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- b) channel is indicated, any alternative is acceptable; (Note)

Note: Some implementations will treat case b as case a.

In cases (a) and (b), if the indicated channel is available, the network selects it for the call.

In case (b), if the network cannot grant the preferred channel, it selects any other available B-channel associated with the D-channel.

The selected B-channel is indicated in the first message returned by the network in response to the SETUP message (i.e., a CALL PROCEEDING message). After transmitting this message, the network shall activate the B-channel connection.

The user need not attach until receiving a CALL PROCEEDING/PROGRESS/ALERTING message. Prior to this time, the network cannot assume that the user has attached to the B-channel. After this time, the user shall be connected to the B-channel, provided the equipment does not generate local tone. Upon receipt of the CONNECT message, the user shall attach to the B-channel (if it has not already done so).

In case (a), if the specified channel is not available, and in cases (b) if no channel is available, a RELEASE COMPLETE message with cause #44 "requested circuit/channel not available" or #34 "no circuit/channel available", respectively, is sent by the network as described in Section 5.3.

5.1.3 Overlap Sending - Reserved for future use

5.1.4 Invalid Call Information

If, following the receipt of SETUP message the network determines that the call information received from the user is invalid (e.g., invalid number), then the network shall initiate call clearing as defined in Section 5.3.4 with a cause such as one of the following¹:

- a) #1 "unassigned (unallocated) number",
- b) #28 "invalid number format (incomplete number)".
- c) #82 "Identified channel does not exist".

5.1.5 Call Proceeding

5.1.5.1 Call Proceeding, En-Bloc Sending

If the network can determine that access to the requested service is authorized and available the network shall: send a CALL PROCEEDING message to the user to acknowledge the SETUP message and to indicate that the call is being processed; and enter the Outgoing Call Proceeding state. When the user receives the CALL PROCEEDING message, the user shall enter the Outgoing Call Proceeding state.

Similarly, if the network determines that a requested service is not authorized or is not available, the network shall initiate call clearing in accordance with Section 5.3 with one of the following causes:

- a) #58 "bearer capability not presently available",
- b) #65 "bearer service not implemented".

1. See Section 5.8 for additional cause values

Note -- If a supplementary service is not authorized and is not available the procedure to be used is defined in the supplementary services control procedures Section 11.1.

5.1.5.2 Call Proceeding, Overlap Sending - Reserved for future use

5.1.6 Notification of Interworking at the Originating Interface

During call establishment, the call may leave an ISDN environment; e.g., because of interworking with another network, with a non-ISDN user, or with non-ISDN equipment within the calling or called user's premises. When such situations occur, a progress indicator information element shall be returned to the calling user either,

- a) in the ALERTING, CONNECT or PROGRESS message

One of the following progress description values shall be included in the progress indicator information element in the message sent to the user (for further information, see ANNEX I):

- a) #1 "call is not end-to-end ISDN; further call progress information may be available in-band",
- b) #2 "destination address is non-ISDN", or
- c) #4 "call has returned to the ISDN". Call is now end-to-end ISDN.

If the progress indicator information element is included in the PROGRESS message, a state change will occur and any supervisory timers shall be stopped. The user shall connect to (if not connected already) and then monitor the B-channel for further in-band information.

If the interface at which the progress indication originates is the point at which a call enters the ISDN environment from a non-ISDN environment, one or more of the following progress indicator information elements shall be included in the SETUP message sent to the network:

- a) #3 "origination address is non-ISDN".

In certain cases, the remote user may respond with a CONNECT message without sending an ALERTING message. See product specific documentation.

One or more PROGRESS messages may be received by the user between the receipt of the CALL PROCEEDING and an ALERTING or CONNECT messages. Receipt of a PROGRESS message does not necessarily indicate that an end-to-end connection exists at that time.

5.1.7 Call Confirmation Indication

Upon receiving an indication that user alerting has been initiated at the called address, the network shall: send an ALERTING message across the user-network interface of the calling address; and enter the Call Delivered state. When the user receives the ALERTING message, the user shall; enter the Call Delivered state.

5.1.8 Call Connected

Upon receiving an indication that the call has been accepted, the network shall: send a CONNECT message across the user-network interface to the calling user; and enter the Active state.

This message indicates to the calling user that a connection has been established through the network and stops a possible local indication of alerting.

On receipt of the CONNECT message, the calling user: shall stop any user-generated alerting indications; may optionally send a CONNECT ACKNOWLEDGE message; and shall enter the Active state. The network shall not take any action on receipt of a CONNECT ACKNOWLEDGE message when it perceives

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the call to be in the Active state.

5.1.9 Call Rejection

Upon receiving an indication that the network or the called user is unable to accept the call, the network shall initiate call clearing at the originating user-network interface as described in Section 5.3, using the cause provided by the terminating network or the called user. However, if the network desires to play an announcement before the call is cleared, it shall send a PROGRESS message to the user. On receipt of this message the user enters the Call Delivered state and monitors the information channel. At this time the network can play the announcement on the information channel. (See Section 5.4.)

5.1.10 Transit Network Selection

When the transit network selection information element is present, the call shall be processed according to Annex C.

5.2 Call Establishment at the Destination Interface

This procedure assumes that a data link connection providing services described in Recommendation Q.920 (I.440)[3] may not exist before the first layer 3 message (SETUP) is transferred across the interface. However, reliable data link connections must be established by each of the users (terminals and/or NT2s) at the interface before they respond to the SETUP message.

The SETUP message offered on a point-to-point data link shall be delivered to layer 2 using a DL_DATA_REQUEST primitive. The call reference contained in all messages exchanged across the user-network interface shall contain the call reference value specified in the SETUP message delivered by the network. In selecting a call reference, the dummy call reference value shall not be used.

Since call references only have significance for a particular interface and are not end-to-end, the call reference will likely not be the same as that used for call establishment at another ISDN interface. Note that the length of the call reference value in each message for a call at an interface need not be the same, only the value.

5.2.1 Incoming Call

The network will indicate 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. The number of calls presented in these circumstances may be limited.

In addition to the mandatory information elements, the SETUP message may include, as required, the information elements described in Section 3.1.16 (e.g., low layer compatibility).

Since the network has knowledge that a single-point configuration exists at the interface, a point-to-point data link shall be used to carry the SETUP message. After sending the SETUP message, the network starts timer T303; enters into the Call Present state.

Since en-bloc receiving is used, the SETUP message shall contain all the information required by the called user to process the call.

NOTE -- Users supporting en-bloc receiving procedure need not recognize the sending complete information element and may directly analyze the received SETUP message on the assumption that all the call information is contained in the message.

If no response to the SETUP message is received by the network before the first expiry of timer T303, the SETUP message will be retransmitted and timer T303 restarted.

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Some implementations send RELEASE COMPLETE at the first expiry of T303 (using double the standard value for this timer - 8 seconds) and hunt a new channel. A SETUP with a different call reference value is transmitted for this new channel. If T303 expires again, a RELEASE COMPLETE message is sent to the terminating user, the call is considered terminated and the network plays as an announcement to the originating user. See product specific documentation.

5.2.2 Compatibility Checking

A user receiving a SETUP message shall perform compatibility checking before responding to that SETUP message. Any reference to "user" in Sections 5.2.3 through 5.2.7 implicitly refers to a compatible user equipment. Annex B defines compatibility checking to be performed by user upon receiving a SETUP message.

Since the SETUP message is delivered via a point-to-point data link, an incompatible user shall respond with a RELEASE COMPLETE message with cause #88 "incompatible destination", and enter the Null state. The network shall process this RELEASE COMPLETE message in accordance with Section 5.2.5.3.

If the compatibility requirements indicated in the SETUP message (Bearer Capability information element or Low Layer Compatibility information element, if included) are not satisfied, a RELEASE COMPLETE message should be sent. The Cause information element should specify the cause value #65, "bearer capability not implemented", or cause value #88, "incompatible destination".

5.2.3 B-Channel Selection - Destination

5.2.3.1 SETUP Message Delivered By Point-To-Point Data Link

When the SETUP message is delivered by a point-to-point data link, negotiation for the selection of a B-channel will be permitted between the network and the user. Only B-channels controlled by the same D-channel will be the subject of the selection procedure. The B-channel selection procedures for symmetrical interfaces are in Section D.1.1. The selection procedure is as follows:

- a) In the SETUP message, the network will indicate one of the following cases:
 - 1) channel is indicated, no acceptable alternative;
 - 2) channel is indicated, any alternative is acceptable;
- b) In cases 1) and 2) above, if the indicated channel is acceptable and available, the user selects it for the call. If the indicated channel is invalid, the user clears the call by sending a RELEASE COMPLETE message with cause #82 "identified channel does not exist." Other error condition procedures are covered in Section 5.8.

If in case 1) the B-channel indicated in the first response message is not the channel offered by the network, it will clear the call by sending a RELEASE, DISCONNECT message with cause #6 "channel unacceptable" or RELEASE COMPLETE message with cause #88 "incompatible destination" (see Section 5.3.2[c]).

In 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. The user indicates the selected B-channel (coded as exclusive) in a CALL PROCEEDING message sent to the network. If the B-channel indicated in the CALL PROCEEDING message is invalid to the network, it will clear the call by sending a RELEASE COMPLETE message with cause #82 "identified channel does not exist." If the B-channel indicated in the CALL PROCEEDING message is unacceptable to the network, it will clear the call by sending

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a RELEASE COMPLETE message with cause #88 "incompatible destination", DISCONNECT message with cause #34 "no circuit/channel available" or RELEASE message with cause #6 "channel unacceptable." (see Section 5.3.2[c]).

- c) The channel identification information element has to be present in the first response message.
- d) When a B-channel has been selected by the user, that channel may be connected by the user.
- e) In case 1), if the indicated B-channel is not available, or in cases 2), if no B-channel is available and the user cannot proceed with the offered call, the user returns a RELEASE COMPLETE message with cause #44 "requested circuit/channel not available" or #34 "no circuit/channel available", respectively, and returns to the Null state.

5.2.3.2 SETUP Message Delivered By Broadcast Data Link - Reserved for future use

5.2.4 Overlap receiving - Reserved for future use

5.2.5 Call Confirmation

5.2.5.1 Response to En-Bloc SETUP

When the user determines that sufficient call setup information has been received and compatibility requirements (see Annex B/Q.931) have been satisfied, the user responds with either a CALL PROCEEDING, ALERTING, or CONNECT message and enters the Incoming Call Proceeding, Call Received or Connect Request state, respectively.

Some implementations may include a progress indicator information element in ALERTING and CONNECT messages (e.g., when an analogue terminal is connected to an ISDN PABX). See product specific documentation.

When the SETUP message was delivered via a point-to-point data link, an incompatible user shall respond by sending a RELEASE COMPLETE message with cause #88 "incompatible destination". The network processes this RELEASE COMPLETE message in accordance with Section 5.2.5.3.

A busy user which satisfies the compatibility requirements indicated in the SETUP message shall normally respond with a RELEASE COMPLETE message with cause #17 "user busy". The network processes this RELEASE COMPLETE message in accordance with Section 5.2.5.3.

If the user wishes to refuse the call, a RELEASE COMPLETE message shall be sent with the cause #21 "call rejected" and the user returns to the Null state. The network processes this RELEASE COMPLETE message in accordance with Section 5.2.5.3.

5.2.5.2 Receipt of CALL PROCEEDING, ALERTING or PROGRESS

Upon receipt of the CALL PROCEEDING message from a user, the network shall: stop timer T303; start timer T310; and enter the Incoming Call Proceeding state.

Upon receipt of the ALERTING or the PROGRESS message from a user, the network shall: stop timer T303 or T310 (if running); enter the Call Received state; and send a corresponding ALERTING or PROGRESS message to the calling user.

5.2.5.3 Called User Clearing During Incoming Call Establishment

If the SETUP message has been delivered on a point-to-point data link and a RELEASE COMPLETE or DISCONNECT message is received before a CONNECT message has been received, the network shall: stop timer T303 or T310 (if running); continue to clear the user as described in Section 5.3.3; and clear the call to the calling user with the cause received in the RELEASE COMPLETE or DISCONNECT message.

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5.2.5.4 Call Failure

If the network does not receive any response to the retransmitted SETUP message prior to the expiration of timer T303, then the network shall initiate clearing procedures toward the calling user with cause #18 "no user responding".

- i. If the SETUP message was delivered on a point-to-point data link, the network shall also initiate clearing procedures toward the called user in accordance with Section 5.3.4, using cause #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, then the network shall: initiate clearing procedures toward the calling user with cause #18 "no user responding"; and initiate clearing procedures toward the called user.

- i. If the SETUP message was delivered on a point-to-point data link, the called user shall be cleared in accordance with Section 5.3.4, using cause #102 "recovery on timer expiry".

5.2.6 Notification of Interworking at the Terminating Interface

During call establishment, the call may enter an ISDN environment, e.g., because of interworking with another network, with a non-ISDN user, or with non-ISDN equipment within the calling or called user's premises. When this occurs, the point at which the call enters an ISDN environment may cause a progress indicator information element to be included in the SETUP message to be sent to the called user:

- a) #3 "origination address is non-ISDN".

Note: No notification is given to the called user for the AT&T products that do not support the progress indicator information element in the SETUP message.

The user shall notify the calling party if the call has left the ISDN environment within the called user's premises, or upon the availability of in-band information/patterns. When such situations occur, a progress indication shall be sent by the user to the network:

- a) in the PROGRESS, ALERT, or CONNECT message

One of the following progress description values shall be included in the progress indicator information element in the message sent to the network (for further information, see Annex I/Q.931):

- a) #1 "call is not end-to-end ISDN; further call progress information may be available in-band",
- b) #4 "call has returned to the ISDN".

If the progress indicator information element is included in the PROGRESS message, a state change will occur and any supervisory timers shall be stopped.

5.2.7 Call Accept

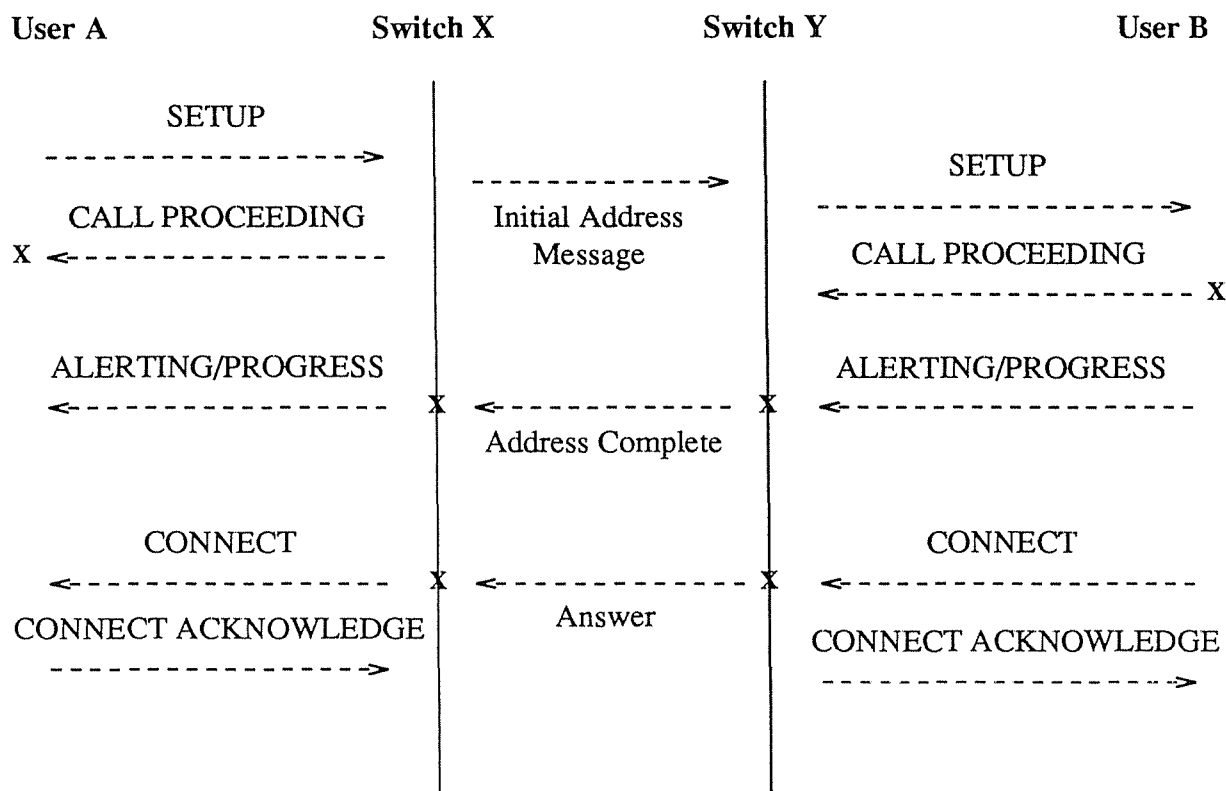
A user indicates acceptance of an incoming call by sending a CONNECT message to the network. Upon sending the CONNECT message, the user shall start timer T313 (the value of timer T313 is specified in Section 9.2).

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.

The words "forward direction" and "backward direction" used in describing the procedures for connecting to the designated information channel are defined below.

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Forward direction is from the originating user to the terminating user. Backward direction is from the terminating user to the originating user (See Figure IV-5-1a for Cut-Through Strategy).



Note: X-Denotes B-Channel Cut Through

Figure IV-5-1a Cut Through Strategy

For other than data calls, the access network switches will connect to the designated information channel in the backward direction on the receipt of an ALERTING, PROGRESS, or CONNECT message whichever is received first, so that any in-band tones or announcements can be heard throughout the connection. The information channel will be connected to in the forward direction on the receipt of the CONNECT message.

For data calls,² the information channel is connected to in both directions on the receipt of the CONNECT message.

The receipt of a PROGRESS message designates either an in-band tone/announcement or an interworking condition. It will cause immediate cut through back to the originator on the designated B-Channel if it has not already been done. Because data endpoints are not expected to monitor in-band tones and

². 56kbits clear and higher data rates.

announcements, they may choose to clear the call on the receipt of a PROGRESS message containing cause values other than 43 and 127.

Some implementations allow early connection (on the receipt of ALERTING or PROGRESS message) in the backward direction for both speech and data calls; whereas, some implementations support the delayed connection (on receipt of CONNECT message) for data calls only. See product specific documentation for supported options.

The network will return a CONNECT ACKNOWLEDGE message after a CONNECT message has been received and the cross-office connections have been completed.

Given the symmetrical nature of the Call Setup procedures and in order to maintain more uniform implementation, the user should cut through to the designated information channel either upon receipt of (on outgoing call) or initiation of (on incoming calls) a CALL PROCEEDING message. This will avoid the clipping either speech or data transmission³.

5.2.8 Active Indication

On receipt of the CONNECT message, the network shall: stop (if running) timers T303 and T310; complete the circuit-switched path to the selected B-channel; send a CONNECT ACKNOWLEDGE message to the called user; initiate procedures to send a CONNECT message toward the calling user; and enter 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 a calling user. Upon receipt of the CONNECT ACKNOWLEDGE message the user shall: stop timer T313 and enter the Active state.

When timer T313 expires prior to receipt of a CONNECT ACKNOWLEDGE message, the use shall re-transmit the CONNECT message and re-initialize timer T313. If time T313 expires prior to receipt of a CONNECT ACKNOWLEDGE message the user shall initiate clearing in accordance with Section 5.3.3.

A user which has received the SETUP via a point-to-point data link may connect to the B-channel as soon as channel selection has been completed.

5.2.9 Non-Selected User Clearing - Reserved for future use

5.3 Call Clearing

5.3.1 Terminology

The following terms are used in the description of 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.

3. Some implementations may cut through to the information channel at ALERTING or PROGRESS. This alternate plan is compatible with the described methods herein as no in-band tones or announcements are provided prior to ALERTING/PROGRESS. However, the cut through at CALL PROCEEDING is the best method to avoid clipping of speech/data/announcements.

- 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 Sections 5.3.3 and 5.3.4, respectively. The only exceptions to the above rule are as follows:

- a) In response to a SETUP message, the user or network can reject a call (e.g., 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 enter the Null state.
- b) Clearing of temporary signaling connections will be initiated by sending a RELEASE message as described in Sections 5.3.3 and 5.3.4.
- c) Unsuccessful termination of the B-channel selection procedure (see Sections 5.2.3.1 and 5.1.2) by the side offering the call is accomplished by sending a RELEASE, DISCONNECT or RELEASE COMPLETE message as described in Sections 5.3.3 and 5.3.4. The RELEASE message shall contain cause #6 "channel unacceptable".

5.3.3 Clearing Initiated by the User

Apart from the exceptions identified in Sections 5.3.2 and 5.8, the user shall initiate clearing by: sending a DISCONNECT message; starting timer T305 (the value of timer T305 is specified in Section 9.2); disconnecting the B-channel; and entering the Disconnect Request state.

Note -- When a user initiates call clearing by sending a RELEASE message, the procedures described in Section 5.3.4 are then followed.

The network shall enter the Disconnect Request state upon receipt of a DISCONNECT message. This message then prompts the network to disconnect the B-channel, and to initiate procedures for clearing the network connection to the remote user. Once the B-channel used for the call has been disconnected, the network shall: Send a RELEASE message to the user; start timer T308 (the value of a timer T308 is specified in Section 9.1); and enter 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 shall: cancel timer T305; release the B-channel; send a RELEASE COMPLETE message; release the call reference; and return to the Null state. Following the receipt of a RELEASE COMPLETE message from the user, the network shall: stop timer T308; release both the B-channel and the call reference; and return to the Null state.

If timer T305 expires, the user shall: send a RELEASE message to the network with the cause number #102 "recovery on timer expiry"; start timer T308; and enter the Release Request state.

If timer T308 expires for the first time, the network shall: retransmit the RELEASE message and timer T308 shall be restarted. In addition, the network may indicate the cause information element with cause #102 "recovery on timer expiry". If no RELEASE COMPLETE message is received from the user before timer T308 expires a second time, the network shall: place the B-channel in a maintenance condition (Section 5.5); release the call reference; and return to the Null state. In addition some implementations may send a RELEASE COMPLETE message to the user and restart procedures contained in Section 5.5 may be

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used on B-channels in the maintenance condition.

5.3.4 Clearing Initiated by the Network

Apart from the exception conditions identified in Sections 5.3.2 and 5.9, the network shall initiate clearing by: sending a DISCONNECT message; and entering the Disconnect Indication state. The DISCONNECT message is a local invitation to clear and does not imply that the B-channel has been disconnected at the user-network interface.

NOTE -- When the network initiates clearing by sending a RELEASE message, the procedures described in Section 5.3.3 are followed.

5.3.4.1 Clearing When Tones/Announcements Provided

See Section 5.4, "Tones and Announcements"

5.3.4.2 Clearing When Tones/Announcements Not Provided

When in-band tones/announcements are *not* provided, the DISCONNECT message does *not* contain progress indicator #8 "in-band information or appropriate pattern now available". The network shall initiate clearing by: sending the DISCONNECT message; starting timer T305; disconnects the B-channel; and enter the Disconnect indication state.

On the receipt of the DISCONNECT message without progress indicator #8, the user shall: disconnect the B-channel; send a RELEASE message; start timer T308; and enter the Release Request state.

On receipt of the RELEASE message, the network shall: stop timer T305; release the B-channel; send a RELEASE COMPLETE message; release the call reference; and return to the Null state.

If timer T305 expires, the network shall: send a RELEASE message to the user with the cause number originally contained in the DISCONNECT message; start timer T308; and enter the Release Request state. The RELEASE message will contain the cause information element with cause #102 "recovery on timer expiry".

5.3.4.3 Completion of Clearing

Following the receipt of a RELEASE COMPLETE message from the network, the user shall: stop timer T308; release both the B-channel and the call reference; and return to the Null state.

If a RELEASE COMPLETE is not received by the user before the first expiry of timer T308, the RELEASE message shall be retransmitted and timer T308 shall be restarted. 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 condition shall release the call reference; and return to the Null state.

Note - The restart procedures contained in Section 5.5 may be used on B-channels in the maintenance condition.

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 whilst in the Disconnect Indication state, the network shall: stop timer T305 or T306 (which ever is running); disconnect the B-channel (if not disconnected); send a RELEASE message; start timer T308; and enter the Release Request state. Similarly, when the user receives a DISCONNECT message whilst in the Disconnect Request state, the user shall: stop timer T305; send a RELEASE message; start timer T308; and enter the Release Request state.

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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 whilst within the Release Request state shall: stop timer T308; release the call reference and B-channel if appropriate; send a RELEASE COMPLETE message; and enter the Null state.

5.4 In-Band Tones and Announcements

Methods for providing ringback⁴, user busy, reorder (network busy) tones and network intercept announcements are essential to preserving the traditional human interface for telephony calls. 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. The following sub-sections will deal with the PBX/Network procedures for providing/responding to in-band tones and announcements for circuit-switched calls. Sections 5.4.1, 5.4.2 and 5.4.3 deal with calls that route through a pure ISDN path from an originating to terminating PBX.

5.4.1 Pure ISDN Network Call With Successful Completion To An Endpoint

The procedures for originating, terminating and network nodes are described in Sections 5.4.1.1 and 5.4.1.2. The message flow that corresponds to these procedures is found in Figure IV-5-1.

5.4.1.1 At The Originating PBX/Network

When a call that originates from a PBX/Network uses ISDN-PRI facilities, it will send a SETUP message and cut through to the designated B-Channel via the procedures described in Section 5.2.7. If the call completes end-to-end successfully, no in-band feedback will be provided to the user by the origination PBX/Network. In order to remain consistent with pre-ISDN implementations, the ringback will be provided by the terminating PBX/Network. This will provide a more uniform implementation of ISDN services as the protocol evolves.

5.4.1.2 At The Terminating PBX

If the calls proceeds through the network and is successful, the terminating PBX will:

- Respond to a SETUP message with a CALL PROCEEDING and cut-through to the designated B-Channel.
- Determine if the endpoint terminal designated by the Called Party number is available
- If the endpoint terminal is available, respond to the other end of the ISDN-PRI Interface with an ALERTING message and provide In-Band Ringback tone. (The Network node will cut-through to the designated B-Channel upon receipt of the ALERTING message and propagate ALERTING back towards the originating PBX/Network).
- When the terminal at the terminating PBX answers the call
 - Ringback is removed.
 - A CONNECT message is sent. (The CONNECT message is propagated back towards the originating PBX/Network.)

4. For PBXs, ringback refers to the ringback tone which is always provided to the originator of a call. For network switches, this term is synonymous with "audible ringing."

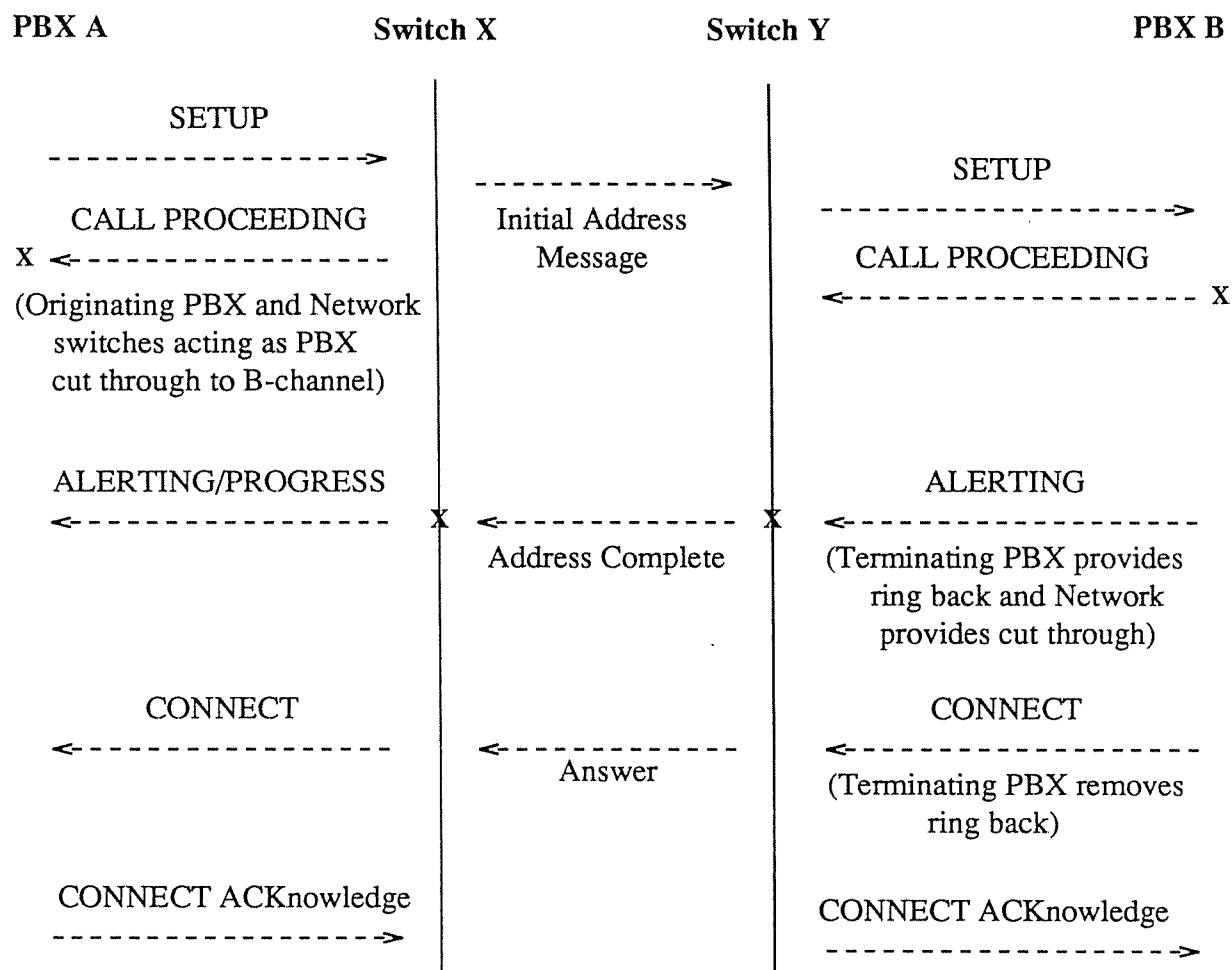


Figure IV-5-1. Pure ISDN Network/PBX Call With End-to-end Completion

5.4.2 Pure ISDN Network Call - End User/Terminal Busy

The procedures for originating, terminating and network nodes are described in Sections 5.4.2.1, 5.4.2.2, and 5.4.2.3. The message flow that corresponds to these procedures is found in Figure IV-5-2.

5.4.2.1 Originating Node Transmittal of SETUP

When a call that originates from a PBX/Network uses ISDN-PRI facilities, it will send a SETUP message and cut through to the designated B-Channel via the procedures described in Section 5.2.7.

5.4.2.2 At The Terminating PBX

The call will proceed through the network and arrive at the terminating PBX which will:

- Respond to a SETUP message with a CALL PROCEEDING and cut-through to the designated B-Channel.
- Determine if the endpoint terminal designated by the Destination Address is available
- If the endpoint terminal is not available (nor are any coverage points or other alternative destinations), respond to the other end of the ISDN-PRI Interface with a DISCONNECT message with Cause Value 17 (User Busy).
- The DISCONNECT message will be propagated as far back towards the originating PBX/Network as possible (i.e., the propagation may stop at an interworking node⁵) where the In-Band User Busy tone will be provided.

5.4.2.3 Originating Node Action on Indication of Clearing

If the Originating PBX/Network receives a DISCONNECT message with Cause Value 17 (User Busy), it will disconnect the designated B-Channel and provide In-Band User Busy Tone.

5.4.3 Pure ISDN Network Call - Congestion and Intercept Treatment

The procedures for originating, network, and terminating nodes are described in Sections 5.4.3.1, 5.4.3.2, and 5.4.3.3. The message flow that corresponds to these procedures is found in Figure IV-5-3.

5.4.3.1 At The Originating PBX/Network

When a call originates from a PBX/Network that uses ISDN-PRI facilities, it will send a SETUP message and cut through to the designated B-Channel via the procedures described in Section 5.2.7.

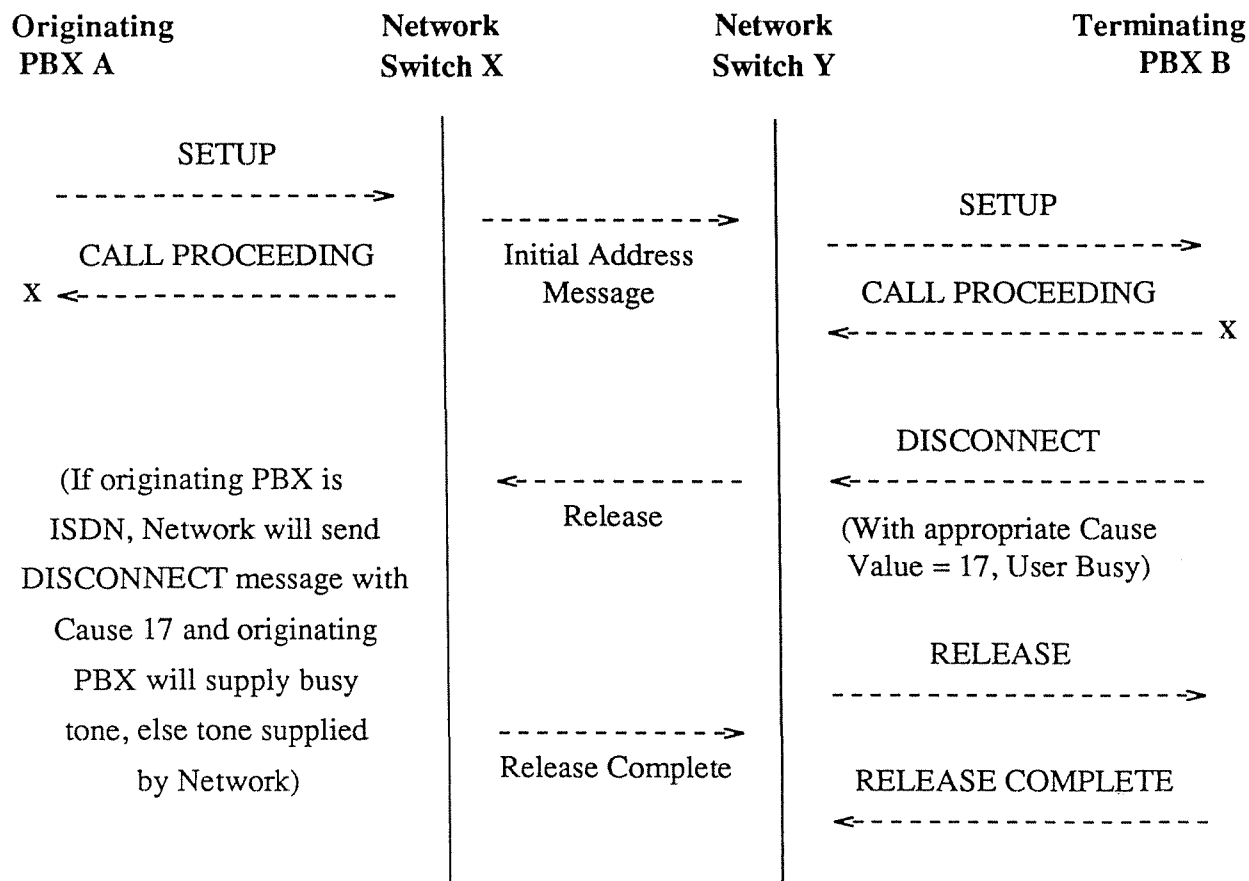
5.4.3.2 At A Network Node

Once the originating network switch has determined that the SETUP message contains valid information, the following sequence occurs:

- a CALL PROCEEDING message is returned to the originating PBX,
- the designated B-channel is cut through, and
- the call will proceed through the network.

If network congestion is detected by the network, the network will determine the source of this congestion. If the Cause value for network congestion is 34 (no circuit or channel available), the network will play the appropriate announcement.

5. It is also possible for the response to a SETUP message to be RELEASE COMPLETE with a Cause Value 17, (User Busy). In this case, the switch that originates the SETUP request will propagate the message as far back as possible. Either the originating PBX/Network or Interworking node will provide the user busy tone. This provides for the most efficient usage of the public or private network.



Note: X-Denotes B-Channel Cut Through

Figure IV-5-2. Pure ISDN Network/PBX Call With End User/Terminal Busy

Other Cause values indicate a No Circuit, Reorder or Vacant Code Intercept tones and announcements. The originating PBX/Network will not be required to provide tones locally in these cases. Instead, the node which detects the congestion condition will send a PROGRESS message (which will force cut through throughout the network) and play the appropriate tones and announcements⁶. A PBX might detect any of the causes mentioned above which initiate network announcements. However, the PBX initiated feedback will usually be in the form of tones (reorder/fast busy or intercept).

Figure IV-4-4a contains the Cause values that **initiate** tones and announcements.

6. Until channel negotiation is fully supported, if a SETUP message is received from the user side of the interface for a busy B-Channel (e.g., glare), the response is RELEASE COMPLETE. This means channel not available but an alternate channel may be selected by the originating (user) end of the interface. The appropriate tone would not be provided until alternate choices for an idle B-Channel are exhausted. A terminating node may, as an implementation option, choose to map other cause values to locally provided tones and disconnect the channel.

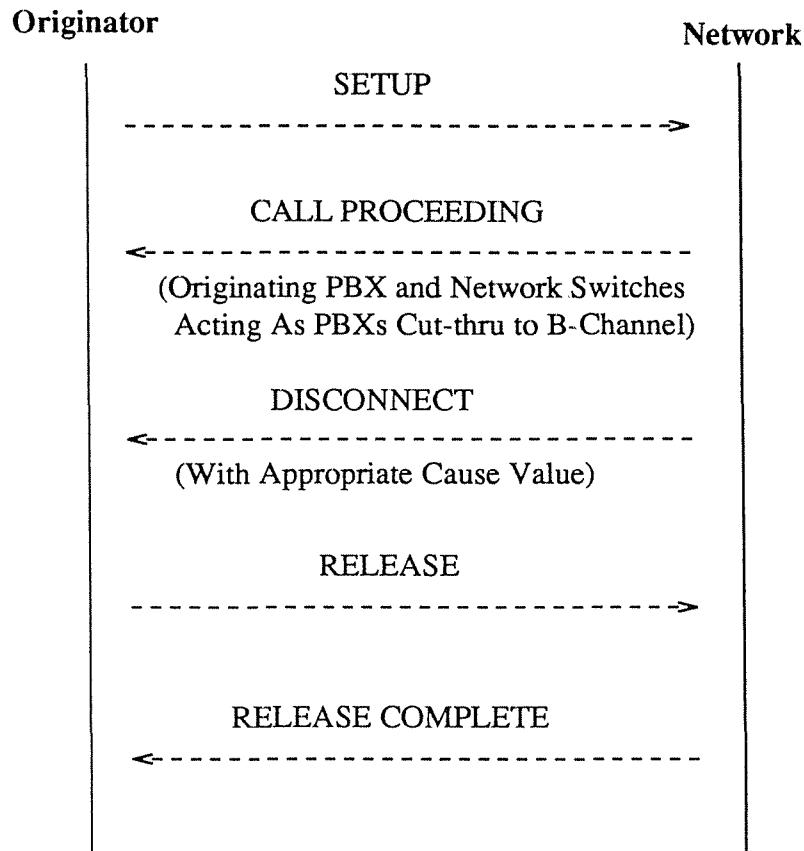


Figure IV-5-3. Pure ISDN Network/PBX Call With Network Congestion

5.4.3.3 Network Congestion At A Terminating PBX

Network congestion can also occur at a switch in a private network. A PBX could be configured to provide its own congestion announcements which correspond to those provided by the public network. However, a PBX handles announcements differently than the network. If a call "terminates" to an announcement in a PBX, the PBX would respond by sending a CONNECT message when the announcement "answers". In this case, no DISCONNECT message would be sent by the PBX until the announcement is completed. To the originating PBX/Network (in terms of ISDN message flow), the call would look like a normally answered call.

5.5 Restart Procedure

The restart procedure is used to return channels and interfaces to an idle condition. The procedure is usually invoked when the other side of the interface does not respond to other call control messages or a failure has occurred (e.g., following a data link failure, when a backup D-channel can be used; or following the expiry of timer T308 due to the absence of response to a clearing message).

NOTE -- Layer 3 procedures and resources associated with those data links with SAPI = "0000 000" should be initialized by the restart procedures.

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When,

- a) both the user and the network are aware of the configuration of the interface; and,
- b) the interface is a primary rate access (Recommendation I.431);

The user and the network shall implement the procedures of Section 5.5.

5.5.1 Sending RESTART

A RESTART message is sent by the network or user in order 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 to be returned to the idle condition. Absence of the channel identification information element indicates that the interface containing the D-channel is to be restarted.

Upon transmitting the RESTART message the sender enters the Restart Request state, starts timer T316, and waits for the RESTART ACKNOWLEDGE message. Receipt of a RESTART ACKNOWLEDGE message stops timer T316, frees the channels and call reference values for reuse, and enters the Null state.

If a RESTART ACKNOWLEDGE message is not received prior to expiry of timer T316, one or more subsequent RESTART message may be sent until a RESTART ACKNOWLEDGE message is returned. Meanwhile, no calls shall be placed or accepted over the channel or interface by the originator of the RESTART message. When this limit is reached, the network shall make no further restart attempts. An indication will be provided to the appropriate maintenance entity. The channel or interface is considered to be in an out-of-service condition until maintenance action has been taken.

The RESTART and RESTART ACKNOWLEDGE message shall contain the global call reference value (all zeroes) to which the Restart Request state is associated. These messages are transferred via the appropriate point-to-point data link in the multiple frame mode using the DL_DATA_REQUEST primitive.

5.5.2 Receipt of RESTART

Upon receiving a RESTART message, the recipient shall then initiate the appropriate internal actions to return the specified channels to the idle condition and call references to the Null state. Upon completion of internal clearing, a RESTART ACKNOWLEDGE message transmitted to the originator, and the Null state entered.

NOTE 1 -- Even if all call references are in the Null state, and all channels are in the idle condition, the receiving entity shall transmit a RESTART ACKNOWLEDGE message to the originator upon receiving a RESTART message.

NOTE 2 -- If the RESTART message is sent by a user, the network shall return to the Null state only those Q.931 calls which correspond to the specified channel(s) or interface.

NOTE 3 -- The response to a RESTART message specifying the entire interface is an implementation option. The following options are supported by AT&T products:

- Respond with a STATUS message indicating cause #100 "invalid information element contents".
- Respond with a RESTART ACKNOWLEDGE message specifying the interface.

The response to a RESTART message specifying an H0 or H11 channel is a STATUS message indicating cause #100 "invalid information element contents".

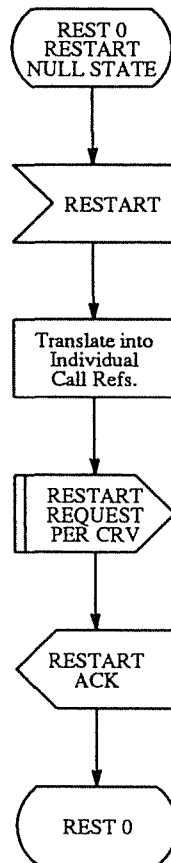


Figure A. Restart Call Control Detailed SDL Diagrams

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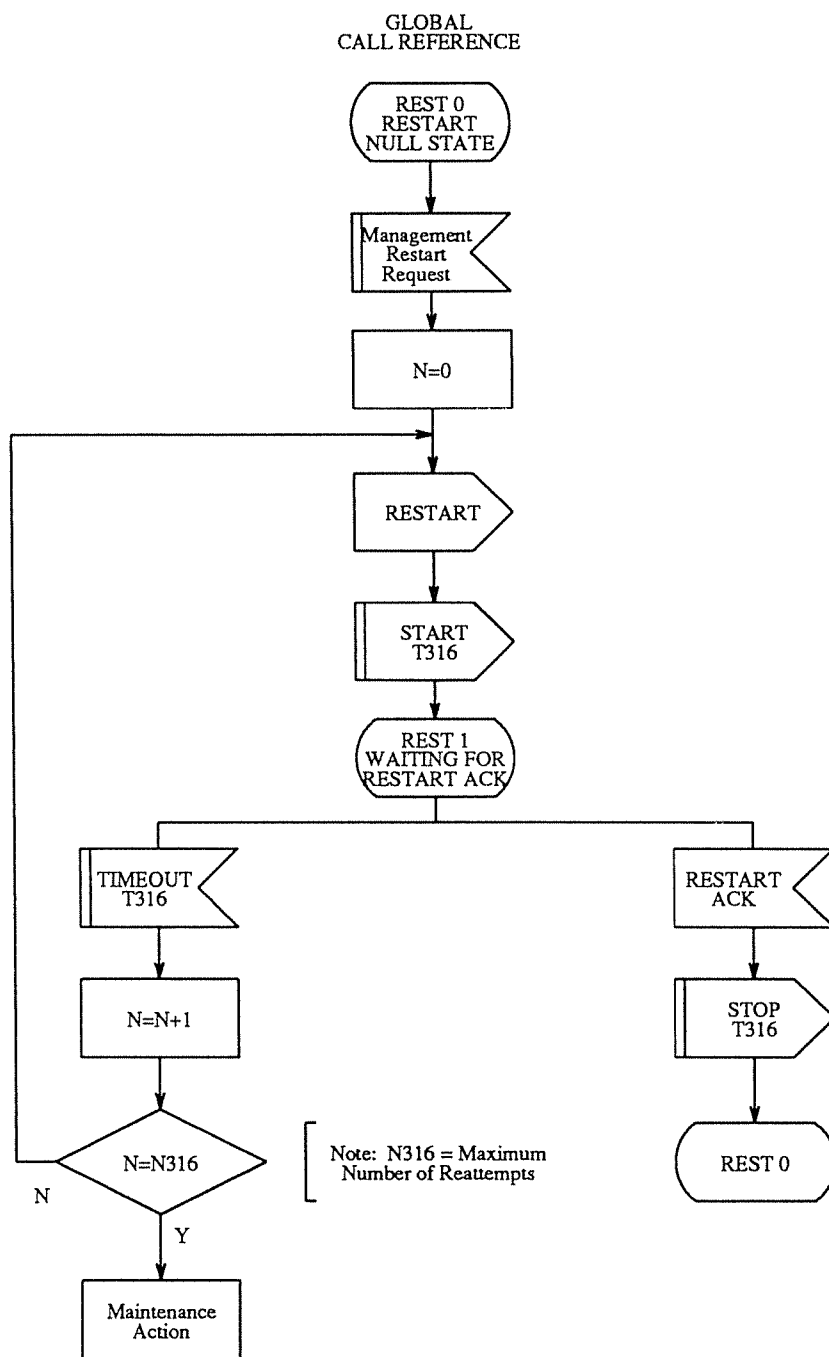


Figure B. Restart Call Control Detailed SDL Diagrams

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5.6 Call rearrangements - Reserved for future use

5.7 Call Collisions

Call collisions as such cannot occur at the network. Any simultaneous incoming or outgoing calls are dealt with separately and 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 channel selection mechanisms described in Sections 5.1.2 and 5.2.2.

In the case of such conflicts, the network shall give priority to the incoming call over the call request received from the user. It shall clear the outgoing call whenever the B-channel cannot be allocated by the network or accepted by the user originating the call.

5.8 Handling of Error Conditions

All procedures transferring signalling 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 Sections 5.8.1 through 5.8.7.

Sections 5.8.1 through 5.8.7 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 "Q.931(I.451) maintenance messages", that message shall be ignored. "Ignore" means to do nothing, as if the message had never been received.

5.8.2 Message Too Short

When a message is received that is too short (less than 4 octets) to contain a complete message type information element, that message shall be ignored.

5.8.3 Call Reference Error

5.8.3.1 Invalid Call Reference Format

If the Call reference information element octet 1, bits 5 through 8 do not equal 0000, then the message shall be ignored. See product specific documentation.

If the Call reference information element octet 1, bits 1 through 4 indicate a length greater than the maximum length supported by the receiving equipment (see Section 4.3), then the message shall be ignored. See product specific documentation.

5.8.3.2 Call Reference Procedural Errors

- a) Whenever any message except SETUP, 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, clearing is initiated by sending a RELEASE COMPLETE message with cause #81 "invalid call reference value" and remain in the Null state.
- b) When a RELEASE message is received that specified a call reference which is not recognized as relating to an active call or to a call in progress, a RELEASE COMPLETE message with cause #81 "invalid call reference value" is returned specifying the call reference in the received message.
- c) When a RELEASE COMPLETE message is received specifying a call reference which is not recognized as relating to an active call or to a call in progress, no action should be taken.

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- d) When a SETUP message is received specifying a call reference 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", this message shall be ignored or a RELEASE COMPLETE is sent to the user.
- e) When a SETUP message is received specifying a call reference which is recognized as relating to an active call or to a call in progress, this SETUP message shall be ignored.
- f) When any message except RESTART, RESTART ACKNOWLEDGE, SERVICE, SERVICE ACKNOWLEDGEMENT, or STATUS is received using the global call reference, no action should be taken on this message and a STATUS message using the global call reference with a call state indicating the current state associated with the global call reference and cause #81 "invalid call reference" shall be returned.
- g) When a STATUS message is received specifying a call reference which is not recognized as relating to an active call or to a call in progress, the procedures of Section 5.8.11 shall apply.
- h) The receiver of a STATUS ENQUIRY message specifying a call reference that is not recognized as in use shall return a STATUS message with cause value 30 (response to STATUS ENQUIRY) indicating call state 0 (null state).

5.8.4 Message Type or Message Sequence Errors

Whenever an unexpected message, except RELEASE or RELEASE COMPLETE, or unrecognized message is received in any state other than the Null state, a STATUS message shall be returned with cause #98 "message not compatible with call state of message type non-existent or not implemented" and the corresponding diagnostic. If a network or user can distinguish between unimplemented (or non-existent) message types and implemented message types which are incompatible with the call state, then a STATUS message may be sent with the following cause:

- a) cause #97 "message type non-existent or not implemented"

Alternatively, a STATUS ENQUIRY message may be sent requesting the call state of the entity (see Section 5.8.10). No change in state shall be made in either case at this time.

However, two exceptions to this procedure exist. The first exception is when the network or the user receives an unexpected RELEASE message (e.g., if the DISCONNECT message was corrupted by undetected transmission errors). In this case no STATUS or STATUS ENQUIRY message is sent. Whenever the network receives an unexpected RELEASE message, the network shall: disconnect and release the B-channel; clear the network connection and the call to the remote user with the cause of the RELEASE message sent by the user or, if not included, cause #31 "normal, unspecified"; return a RELEASE COMPLETE message to the user; release the call reference; stop all timers; and enter the Null state. Whenever the user receives an unexpected RELEASE message, the user shall: disconnect and release the B-channel; return a RELEASE COMPLETE message to the network; release the call reference; stop all timers; and enter the Null state.

The second exception is when the network or the user receives an unexpected RELEASE COMPLETE message. Whenever the network receives an unexpected RELEASE COMPLETE message, the network shall: disconnect and release the B-channel; clear the network connection and the call to the remote user with the cause indicated by the user, release the call reference; stop all timers; and enter the Null state. Whenever the user receives an unexpected RELEASE COMPLETE message, the user shall: disconnect and release the B-channel; release the call reference; stop all timers; and enter the Null state.

When a message arrives with an active call reference value for which a response is not prescribed in the current state of the call, the message is considered to be unexpected. Error conditions due to such

unexpected messages are classified into 3 degrees and the actions that need to be taken for each degree are as follows:

1. Ignorable - by ignoring this message, the state machine can still operate in a trouble free manner;
2. Tolerable - receipt of an unexpected clearing message;
3. Violent - receipt of an unexpected message which is totally at odds with the current state of the call; in this case some kind of query needs to be issued to the other end.

For *ignorable* errors, the receiver shall ignore the arrival of this message. For *tolerable* errors, the receiver shall assume that it is allowable to receive this message and take the appropriate action. For example, if the network receives a RELEASE message in states other than N0, N12 and N19, it shall RELEASE the information channel, the call reference value, send a RELEASE COMPLETE to the user and move to N0. For *violent errors*, the receiver of an unexpected message must send a STATUS message to the other end specifying the state of the call at the receiver's side and the cause "message not compatible with call state" (cause value 98), diagnostics field containing the message type.

The *Disconnect request*, *Disconnect indication* and *Release request* states are defined to be clearing states and the DISCONNECT, RELEASE and RELEASE COMPLETE messages are defined to be clearing messages.

When an unexpected non-clearing message is received when the call is perceived to be in

- i) a non-clearing state then the receiver shall send a STATUS message (if the received message is a lately arriving or duplicated message, then the receiver shall ignore the receipt of the message), the Cause information element shall specify the cause value 98 - message not compatible with the call state, the location being the user or the local network (as is appropriate) and the diagnostics field shall specify the message type that was received;
- ii) a clearing state then the receiver shall ignore the receipt of the message.

When an unexpected DISCONNECT message is received when the call is perceived to be in

- i) a clearing state, then the receiver shall ignore the receipt of the message except as otherwise specified in Section 5.3);
- ii) a non-clearing state, then the usual clearing procedures as described in Section 5.3 shall be followed.

When a RELEASE message is received unexpectedly in a state other than *Release Request* state, the receiver shall Release the information channel and the call reference; furthermore the receiver also shall send a RELEASE COMPLETE message to the sender and move the call to the *Null* state.

When a RELEASE COMPLETE message is received unexpectedly, the receiver shall Release the information channel and the call reference; furthermore the receiver shall move the call to the *Null* state.

Figures IV-5-2a and IV-5-3a summarize Sections 5.8.3 and 5.8.4 and contains all possible messages.

Network's state	Message received by the network														
	S E T U P	C O N N A C K	C A L L P R O C	A L E R T	C O N N	D I S C	R E L	R E L C O M	R E S T	R E S T A C K	C O N	U S E R I N F O	P R O G	F A C	F A C R E J
0	*	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	I	*	I	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE
3	VE	VE	VE	VE	VE	*	TE	TE	*	*	*	*	VE	VE	*
4	VE	VE	VE	VE	VE	*	TE	TE	*	*	*	*	VE	*	*
6	VE	VE	*	*	*	TE	TE	*	*	*	*	*	*	*	I
7	VE	VE	VE	VE	*	*	TE	TE	*	*	*	*	VE/*	*	*
8	VE	I	VE	VE	I	*	TE	TE	*	*	*	*	VE	*	*
9	VE	VE	VE	*	*	*	TE	TE	*	*	*	*	*	*	*
10	VE	I	VE	VE	I	*	TE	TE	*	*	*	*	VE	*	*
11	***	I	I	I	I	I	TE	TE	*	*	I	I	I	I	I
12	***	I	I	I	I	*	*	TE	*	*	I	I	I	I	I
19	*	*	*	*	*	*	*	*	*	*	I	I	*	I	I

* : This Specification specifies the procedure
 *** : RELEASE COMPLETE sent
 CR DNE : Call reference does not exist (see Section 5.8.3)
 I : Ignorable error
 TE : Tolerable error
 VE : Violent error

Figure IV-5-2a Network Response on Receipt of a Message

Note: Consult product specific documentation to determine which messages are supported and subsequent action taken by particular AT&T ISDN products.

User's state	Message received by the user															
	S E T U P	C O N N A C K	C A L L P R O C	A L E R T	C O N N	D I S C	R E L	R E L C O M	R E S T	R E S T A C K	C O N C O N	U S E R I N F O	P R O G	F A C	F A C A C K	F A C R E J
0	*	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	I	*	I	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE
1	VE	VE	*	*	*	TE	TE	*	*	*	I	I	*	I	I	I
3	VE	VE	I	*	*	*	*	TE	*	*	*	*	*	*	*	*
4	VE	VE	I	*	*	*	*	TE	*	*	*	*	*	*	*	*
7	VE	VE	VE	VE	VE	*	*	TE	*	*	*	*	VE	*	*	*
8	VE	*	VE	VE	VE	*	*	TE	*	*	*	*	VE	*	*	*
9	VE	VE	VE	VE	VE	*	*	TE	*	*	*	*	VE	I	*	*
10	VE	I	VE	VE	VE	*	*	TE	*	*	*	*	VE	*	*	*
11	I	I	I	I	I	*	*	TE	*	*	I	I	I	I	I	I
12	I	I	I	I	I	I	*	TE	*	*	I	I	I	I	I	I
19	I	I	I	I	I	I	*	*	*	*	I	I	I	I	I	I

* : This Specification specifies the procedure
 CR DNE : Call reference does not exist (see Section 5.8.3)
 I : Ignorable error
 TE : Tolerable error
 VE : Violent error

Figure IV-5-3a User Response on Receipt of a Message

Note: Consult product specific documentation to determine which messages are supported and subsequent action taken by particular AT&T ISDN products.

5.8.5 General Information Element Errors

The general information element error procedures may also apply to information elements in codesets other than 0.

5.8.5.1 Information Element Out of Sequence

An information element which has a code value lower than the code value of the variable length information element preceding it shall be considered as an out of sequence information element.

If the network or user receives a message containing an out of sequence information element, it will ignore this information element and continue to process the message. If this information is mandatory and the network or user chooses to ignore the out-of sequence information element, then the error handling procedure for missing mandatory information elements as described in Section 5.8.6.1 shall be followed. If the ignored information element is non-mandatory, the receiver continues to process the message.

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5.8.5.2 Duplicated Information Elements

If an information element is repeated in a message in which repetition of the information element is not permitted, only the contents of information element appearing first shall be handled and all subsequent repetitions of the information element shall be ignored. When repetition of information elements is permitted, only the contents of permitted information elements shall be handled. If the limit on repetition of information elements is exceeded, the contents of information elements appearing first up to the limit of repetitions shall be handled and all subsequent repetitions of the information element shall be ignored. See product specific documentation.

5.8.6 Mandatory Information Element Errors

5.8.6.1 Mandatory Information Element Missing

When a message other than SETUP, DISCONNECT, RELEASE, or RELEASE COMPLETE is received which has one or more mandatory information elements missing, no action should be taken on the message and no state change should occur. A STATUS message is then returned with cause #96 "mandatory information element is missing".

When a SETUP or RELEASE message is received which has one or more mandatory information elements missing, a RELEASE COMPLETE message with cause #96 "mandatory information element is missing" shall be returned.

When a DISCONNECT message is received with the cause information element missing, the actions taken shall be the same as if a DISCONNECT message with cause #31 "normal, unspecified" was received (see Section 5.3), with the exception that the RELEASE message sent on the local interface contains cause #96 "mandatory information element is missing".

When a RELEASE, RELEASE COMPLETE message is received with a cause information element missing, it will be assumed that a RELEASE COMPLETE message was received with cause #31 "normal, unspecified".

5.8.6.2 Mandatory Information Element Content Error

When a message other than SETUP, DISCONNECT, RELEASE, or RELEASE COMPLETE is received which has one or more mandatory information elements with invalid content, no action should be taken on the message and no state change should occur. A STATUS message is then returned with cause #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 with cause #100 "invalid information element contents" shall be returned.

When a DISCONNECT message is received with invalid content of the cause information element, the actions taken shall be the same as if a DISCONNECT message with cause #31 "normal, unspecified" was received (see Section 5.3), with the exception that the RELEASE message sent on the local interface contains cause #100 "invalid information element contents".

When a RELEASE COMPLETE message is received with invalid content of the cause information element, it will be assumed that a RELEASE COMPLETE message was received with cause #31 "normal, unspecified".

Information elements with a length exceeding the maximum length (given in Section 3) will be treated as information element with content error.

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5.8.7 Non-Mandatory Information Element Errors

The following sections identify actions on information elements not recognized as mandatory.

5.8.7.1 Unrecognized Information Element

When a message is received which has one or more unrecognized information elements, the receiving entity shall proceed as follows:

Action shall be taken on the message and those information elements which are recognized and have valid content.

For the appropriate action for information elements in codeset 0, codeset 6, and codeset 7, see product specific documentation.

5.8.7.2 Non-Mandatory Information Element Content Error

When a message is received which has one or more non-mandatory information elements with invalid content, action shall be taken on the message and those information elements which are recognized and have valid content.

Information elements with a length exceeding the maximum length (given in Section 3) will be treated as an information element with content error except for non-mandatory information elements that are part of Message-Associated user-to-user information (see Section 7). AT&T products will not support more than the maximum length shown in Section 3. For the actual maximum length supported by a particular AT&T product, consult product specific documentation. For access information elements (e.g., User-user information element, Called party subaddress information element, see Section 7), a STATUS with cause #43 "Access information discarded" may be returned.

5.8.8 Data Link Reset

Whenever a Q.931 entity is informed of a spontaneous data layer reset by means of the DL_ESTABLISH_INDICATION primitives, the following procedures apply:

- a) For calls in the disestablishment phase (states N11, N12, N19, U11, U12, and U19) no action shall be taken.
- b) Calls in the establishment phase (states N3, N4, N6, N7, N8, N9, U1, U3, U4, U7, U8 and U9) and in the Active shall be maintained according to the procedures contained in other parts of Section 5.

5.8.9 Data Link Failure

Whenever a Q.931 entity is notified by its data link entity via the DL_RELEASE_INDICATION primitives that there is a data link layer malfunction, the following procedure shall apply:

- a) For any call without a timer running (see Section 9), a timer T309 shall be started. Note: If timer T309 is already running, it shall not be started.
- b) The Q.931 entity may request layer 2 reestablishment by sending a DL_ESTABLISH_REQUEST primitive if a call is not in the Null state. Otherwise, the Q.931 entity may clear internally.

NOTE -- If the transfer mode of the call is circuit-mode, the Q.931 entity may clear the calls.

When informed of layer 2 reestablishment by means of the DL_ESTABLISH_CONFIRMATION primitive, the following procedure shall apply:

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- 1) Stop timer T309.
- 2) Optionally, a STATUS message may also be sent to report the current call state to the peer entity. Alternatively, a STATUS ENQUIRY message can be sent to verify the call state of the peer entity.

If timer T309 expires prior to data link reestablishment, one of the following options will be implemented (See product specific documentation):

1. Call is cleared by the network side and billing is stopped
2. Call is not cleared and billing (if appropriate) continues.
3. Call is cleared by the user side and billing is stopped.

When a backup D-channel is available, the procedures in Annex F may be used.

NOTE 1 -- The implementation of timer T309 in the user side is optional. If timer T309 expires prior to data link reestablishment, the user shall: clear an attached connection (if any) with appropriate cause; disconnect and release the B-channel; release the call reference; and enter the Null state.

5.8.10 Status Enquiry Procedure

Whenever an entity wishes to check the correctness of a call state at a peer entity, a STATUS ENQUIRY message may be sent requesting the call state. This may, in particular, apply to procedural error conditions described in Sections 5.8.8 and 5.8.9.

Upon receipt of a STATUS ENQUIRY message, the receiver shall respond with a STATUS message, reporting the current call state and cause #30 "responding to STATUS ENQUIRY". Receipt of the STATUS ENQUIRY message does not result in a state change.

The sending or receipt of the STATUS message in such a situation will not directly affect the call state of either the sender or receiver. The side having received the STATUS message shall inspect the cause information element. If a STATUS message is received that contains cause #30 "response to STATUS ENQUIRY", the appropriate action should be taken based on the information in that STATUS message, relative to the current state of the receiver.

5.8.11 Receiving a STATUS message

In some implementations, the STATUS message will be ignored if no STATUS ENQUIRY message was sent.

On receipt of a STATUS message reporting an incompatible state, the receiving entity shall:

- a) clear the call by sending the appropriate clearing message or,
- b) take other actions which attempt to recover from a mismatch and which are an implementation option. Refer to Figures IV-5-4a and IV-5-5a for the details. It is an implementation option to decide which of the matchable states will be considered so. Matching tables for symmetrical user interfaces are in Section D.1.3.

Network's state	User's states	
	Matching	Matchable (Network's action)
3	3	none
4	4	none
6	none	none
7	7	none
8	8	none
9	9	none
10	10	1,3 and 4 if outgoing (CONNECT with channel id)
		8 if incoming (CONNECT ACKNOWLEDGE)
19	19	none

Figure IV-5-4a Network Action on Receipt of STATUS

USER state	Network State	
	Matching	Matchable (User's action)
1	none	none
3	3,9	none
4	4	none
7	7	6 and 9 (ALERTING)
8	8	6, 7 and 9 (CONNECT)
9	9	6 (CALL PROCEEDING)
10	10	none
19	19	none

Figure IV-5-5a User's Action on Receipt of STATUS

On receipt of a STATUS message specifying the global call reference and reporting an incompatible state in the Restart Request or Restart state, the receiving Q.931 entity shall inform layer management and take no further action on this message.

When in the Null state, then on receiving a STATUS message with the global call reference, no action shall be taken.

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NOTE -- Further actions as a result of higher layer activity (e.g., system or layer management) are implementation dependent (including the retransmission of RESTART).

Except for the above case, the error handling procedures, for the receipt of a STATUS message specifying the global call reference are an implementation option.

5.9 User Notification Procedure - Reserved for future use

5.10 Calling Scenarios

The figure in this section represents the interaction between the *Called party number*, *Network-specific facilities*, and *Transit network selection* information elements. Figure IV-5-6a shows typical dialing sequences that may be encountered from a user on a PBX or a network switch. For this figure the column "System Sending" indicates which AT&T products are affected by a particular row. When a blank appears in this column, it means that no AT&T product will send the user dialed sequence in column 3. However, this dialed sequence can be accepted by the indicated "System Receiving." This does *not* mean that all services are implemented in all initial implementations. However, these rules do apply to all future implementations of the services.

In Figure IV-5-6a, under the Network-specific facility heading,

OP means operator, and

OP/P means presubscribed transit network operator, as defined above.

MSB means Maximal Subscribed WATS Band.

"XXX" means a three digit transit network code. When "XXX" is shown under the Network-Specific Facilities heading, it is passed in that information element as part of the requested network facility. When "XXX" is shown in the Transit network selection column, it is passed in the Transit network selection information element. When not specified in either column, the transit network is not applicable or is not specified in the message.

For the type of Number field,

N is National,

I is International,

U is Unknown, and

S is Subscriber

In the Called party number information element, the numbering plan identification is assumed to be coded as "ISDN/telephony" (Recommendation E.163/E.164) except where noted.

Information Element Coding Interaction						
<i>System Sending</i>	<i>System Receiving</i>	<i>User Dialed Sequence</i>	<i>Type of Number</i>	<i>Transit Network Selection</i>	<i>Network Specific Facilities</i>	<i>Called Party Number</i>
PBX	CO	0-	N	-	OP	-
PBX	CO	00-	N	-	OP/P	-
PBX	CO	10XXX+0	N	-	OP XXX	-
	CO	010	I	-	OP	-
PBX	CO	10XXX#	N	XXX	-	-
ALL	ALL	3/7/10D	N	-	-	3/7/10D
PBX	IXC/CO	3/7/10D	N	XXX	-	3/7/10D
	IXCCO	10XXX+3/7/10D	N	XXX	-	3/7/10D
ALL	IXC/PBX	1+7/10D	N	-	-	7/10D
PBX	CO	1+3/7/10D	N	-	-	1+3/7/10D
	IXC	10XXX+1+7/10D	N	XXX	-	7/10D
	CO	10XXX+1+3/7/10D	N	XXX	-	1+3/7/10D
PBX	CO	10XXX+1+npa+555+4D	N	XXX	-	1+npa+555+4D
PBX	IXC	10XXX+1+npa+555+4D	N	XXX	-	npa+555+4D
PBX	IXC/CO	10XXX+npa+555+4D	N	XXX	-	npa+555+4D
PBX	CO	0+7/10D	N	-	OP	7/10D
PBX	CO	10XXX+0+7/10D	N	-	OP XXX	7/10D
PBX	IXC/CO	011+CC+NN	I	-	-	CC+NN
	IXC/CO	10XXX+011+CC+NN	I	XXX	-	CC+NN
PBX	CO	01+CC+NN	I	-	OP	CC+NN
	CO	10XXX+01+CC+NN	I	-	OP XXX	CC+NN
PBX	IXC	WATS 7/10D	N	-	MSB	7/10D
PBX	CO	WATS 7/10D	N	-	param. band or MSB	7/10D
PBX	IXC	WATS 1+7/10D	N	-	MSB	7/10D
PBX	CO	WATS 1+7/10D	N	-	param. band or MSB	1+7/10D
PBX	IXC	SDN 7/10D	N	-	SDN	7/10D
PBX	IXC	SDN 011+CC+NN	I	-	SDN	CC+NN
CO	PBX	INWATS 7-10D	N	-	INWATS	7-10D
IXC	PBX	MEGACOM 800 7-10D	N	-	MEGACOM 800	7-10D
PBX	PBX	ETN 4-7D	U	-	-	"Private" 4-7D
CO	PBX	ETN 7D	S	-	-	7D

Figure IV-5-6a Interaction of Selected SETUP Message Information Elements

5.11 Layer 3 Action for Layer 2 - Layer 3 Primitives

The Layer 3 actions for the various L2/L3 primitives are discussed here. Corresponding Layer 2 actions will be described in detail in Part III.

All Layer 3 timers are started when the corresponding information requests are issued to Layer 2. For example, Timer T305 is started when the DISCONNECT message is handed to Layer 2, and the DL_DATA_REQUEST primitive is issued.

5.11.1 Link Establishment Request

This primitive is used by the network layer to request the establishment of the data link for multiple frame acknowledge procedures. This is indicated as a parameter in the primitive. The link layer, on the receipt of this primitive, will attempt to establish the link using the Layer 2 procedures. The link layer notifies the network layer of the success or failure of the link establishment procedure by means of the DL_ESTABLISH_CONFIRM or the DL_RELEASE_CONFIRM, respectively. If establishment had occurred due to the other side, the primitives used are DL_ESTABLISH_INDICATION and DL_RELEASE_INDICATION, respectively.

5.11.2 Link Establishment Indication

This primitive is used by the link layer to notify the network layer that the link has been established. The criteria used by the link layer to decide when the link is established is determined by Layer 2 procedures.

If the network layer receives this indication in the midst of stable information transfer, all outstanding data requests may be considered lost.

5.11.3 Data Transfer

The network layer requests the link layer to transfer information by means of a DL_DATA_REQUEST primitive. The information to be transmitted is stored in a buffer. On receiving this request, the data link layer removes the information from the buffer and transmits an I (Information) frame over the appropriate logical link, in accordance with the Level 2 procedures.

When a data link layer determines that a valid error-free information frame has been received (as described in the Layer 2 procedures), it passes the information content of this frame to the network layer by means of the DL_DATA_INDICATION.

5.11.4 Link Release Request

This primitive is used by the network layer to request the link layer to release a logical link connection. On receiving this primitive, the link layer shall initiate the release of multiple frame operation on that link. When the link has been released, the network layer is informed by means of the DL_RELEASE_CONFIRM. If link release occurred due to the other side, the primitive used is DL_RELEASE_INDICATION.

5.11.5 Link Release Indication

The link layer uses this primitive to notify the network layer that a logical link connection has been released. The criteria used by the link layer in determining when a data link connection has been released is described in the Layer 2 procedures.

If the network layer receives this primitive in the midst of normal information transfer, it must assume that any outstanding data requests cannot be honored, and that data must be considered lost. This may happen, for example, if the peer link layer entity releases the link because of bad link facilities or equipment problems.

In addition, Timer T309 is started by layer 3 upon receiving this release indication from Layer 2. If an established indication is received from the link layer before the timer expires, then the network layer transmits a STATUS ENQUIRY message to its peer entity. On the other hand, if T309 expires before the

link is re-established, a DL_RELEASE_REQUEST primitive shall be issued to the link layer. The action taken by the network layer with respect to active calls is an implementation option as discussed in Section 5.8.9.

5.12 Procedures for Interworking with AT&T ISDN Basic Rate Interfaces

Central offices and PBXs that implement primary rate interfaces will support several types of terminal interfaces. This section documents the interworking required by these switches to support the AT&T ISDN Basic Rate Interface. Figure IV-5-7a defines the procedures required of a switch for such interworking.

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Originating Interface (O.I.)	Terminating Interface (T.I.)	Call State (Originating Interface)	Interworking Node Message or Stimulus Received	Action Taken by Interworking Node		Comments
				(O.I.)	(T.I.)	
BRI	PRI	3	No circuits available at terminating interface (T.I.)	PROGRESS (cause=no channel available, signal=net. congestion tone on) Apply network congestion tone	None	Wait for O.I. to disconnect (Sec. 5.1.4.1)
BRI	PRI	3	Clearing (user busy) from T.I.	PROGRESS (cause=user busy signal=busy tone on) Apply busy tone	Follow normal clearing (Sec. 5.1.4.1.)	Wait for user to disconnect
BRI	PRI	3	T303 expires first time at T.I.	None	Retransmit SETUP	
BRI	PRI	3	REL COMP (due to error condition) from T.I.	PROGRESS (cause and signal determined from REL COMP) Apply appropriate tone	None	
BRI	PRI	3	Second T303 expiration, or T310 expiration at T.I.	PROGRESS (cause=no user responding, signal=audible ringing tone on) Apply audible ringing	None	Wait for user to disconnect
PRI	BRI	3	T303 expires first time at T.I.	PROGRESS (cause=no user responding) Apply in-band audible ringing	Retransmit SETUP	
PRI	BRI	3	Second T303 expiry at T.I.	Continue to apply in-band audible ringing	RELease COMplete (cause=no user responding) Normal clearing	
PRI	BRI	3	T310 expiration at T.I.	DISCONNECT Cause=no user responding Apply appropriate tones	RELease COMplete (cause=no user responding) Normal clearing	
PRI	BRI	3	Clearing Message from T.I.	PROGRESS (Cause determined from clearing message) Apply appropriate tone	None	Tone determined from cause in clearing message
PRI	BRI	3	No circuits available at T.I.	DISCONNECT (cause=user busy) Normal clearing	None	Originating switch applies busy tone to O.I.
PRI	BRI	3	Clearing (cause=user busy) from T.I.	PROGRESS (cause=user busy) Apply audible ringing	None	Wait for user to disconnect
PRI	BRI	4	Clearing (cause=user busy) from T.I.	None (In-band audible ringing already being provided)	Continue clearing	Continue waiting for O.I. to disconnect

Figure IV-5-7a. Actions to be taken by BRI/PRI Interworking Node

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6. Packet Communication Procedures

This section is intended to explain the role of the D-channel signalling procedures in the support of packet communications in an ISDN. A complete description of terminal adaptor functions can be found in Recommendation X.31.

According to Recommendation X.31, the user may access packet facilities by means of one of the following alternatives:

- a. circuit-switched access to PSPDN services (case A)

by establishing a transparent circuit-switched access connection through the ISDN to the access port of a public network (e.g., PSPDN) referred to as "access unit (AU)" in the following sections. This connection may be initiated by the user or the AU. From the ISDN point of view, the circuit-switched call control procedures of Section 5 apply. Only the B-channel is used in this case.

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

The ISDN TA/TE1 implementation should embody the procedures described in PART III and PART IV for B- and D-channel connection establishment and control.

- b. For demand access connections, Sections 6.1 through 6.4 apply.

One type of semi-permanent connection on B- and D-channels is covered in this section.

1. data link and physical layers semi-permanently established between the terminal and the PH/AU (In this type, the network shall keep the data link layer in the established state).

When a PVC is used, there must exist a semi-permanent connection described above.

In the semi-permanent connection described above, only the procedures of Section 6.3.2 are followed for call establishment and release.

Semi-permanent connections are established via a provisioning process without Q.931 procedures.

This section also includes the procedures for the establishment, maintenance and clearing of virtual calls carried over a circuit transport mode access connection (see Section 5 for procedures for circuit transport mode connections).

- a. Circuit transport mode (non-packetized data):

Q.931 signaling, as described in Section 5, is used to establish, maintain and clear the access connection. Both subrate and 64 kbit/s transmission circuit transport modes are supported. Rate adaption may be used to send low speed data over circuit transport mode connections. The DMI Modes 0 and 1 refer to these specific transmission rate connections, Mode 0 provides for 64 Kbits/s while Mode 1 provides for 56 kbit/s transmission circuit transport mode. In addition, DMI Mode 2 refers to synchronous or asynchronous transmission for standard terminals (i.e., using rate adaption) using a 64 kbit/s transmission circuit transport mode. Rate adaption for rates higher than 64 kbit/s transmission circuit transport mode is not specified at this time.

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b. Circuit transport mode (LAPD packetized data):

For DMI Mode 3, Q.931 signaling, as described in Section 5, is used to establish both the access connection and the first virtual call simultaneously. Q.931 procedures are used to maintain and clear both the access connection and virtual calls. Mode 3 data transfer phase procedures are followed end-to-end.

This section also describes the procedures for the establishment, maintenance, and clearing of frame relayed virtual calls carried over a packet transport mode access connection. These procedures are defined in terms of Q.931 messages exchanged over the D-channel of the primary access interface. For frame relayed virtual calls on bearer channels, different options exist for the location of the virtual call control. Certain interfaces will place all virtual call control in the D-channel for CPE to CPE communications. Other interfaces may expect D-channel signaling for the establishment of a bearer channel to a packet handler and then signaling within that bearer channel to establish the virtual calls. Consult product specific documentation for further details on supported options.

a. Frame relay packet transport mode (B-channel and D-channel)

- On-demand access connections (B- and D-channel): Q.931 signaling is used to establish both the access connection and the first virtual call simultaneously. In addition, any subsequent virtual call establishment over the D-channel is done using Q.931 signaling. Q.931 procedures are also used to maintain and clear all virtual calls.

The user has the option of using any end-to-end protocols, with a restraint that the layer 2 protocol followed must be LAPD based and that the frames must include a LAPD address. DMI Mode 3 is one end-to-end protocol that specifies LAPD at layer 2 and X.25 data transfer phase at layer 3.

6.1 Outgoing Access

If the user selects an already established channel for the outgoing virtual call, then the procedures described in Section 6.3 apply. If the selected channel is not established to the AU/PH, then the procedures for activating a channel described in the following subsections are to be used before establishing the virtual call using the procedures of Section 6.3

For outgoing circuit calls, the user follows the procedures of Section 6.1.1.

Note - Some networks may not support every type of access. In the case of B-channel access, the network will clear a request for unsupported services by sending a RELEASE COMPLETE message with cause #65, "bearer service not implemented". In the case of a request for D-channel access (an SABME with SAPI=16), on a network port which does not support the service, no response is required of the network.

6.1.1 Circuit-Switched access to PSPDN service (Case A)

The B-channel connection between the user and the AU shall be controlled using the D-channel signalling procedures for call establishment described in Section 5.2. The specific B-channel to be used as a switched connection is selected using the channel selection procedures described in Section 5.2.2 and summarized in Table 6-1/Q.931.

TABLE 6-1

User requested channel and network response.
Outgoing access to either an AU or PH

Channel indication in the SETUP message user to network direction			Allowable network response network-user
Channel indication	Preferred or Exclusive	D-channel indication	
Bi	Exclusive	No	Bi
	Preferred	No	Bi

Key:

Bi - the indicated (idle) B-channel

Note 1 - All other encodings are invalid.

Note 2 - All columns under the heading "Channel indicated in the SETUP message" indicate possible user codings of the Channel identification information element contained in the SETUP message sent by the user to the network requesting a connection to an AU or PH (see Section 4.5.13). The column under "Allowable network response" refers to the allowable responses by the network to the user.

On the basis of the call set-up information (e.g., Called party number identifying an AU, Transit network selection, etc.) and/or a subscription time agreement, the network provides a connection to the appropriate AU. The Bearer capability information element included in the SETUP message shall be coded with:

— information transfer capability set to either:

- a) "unrestricted digital information", or
- b) "restricted digital information".

— transfer mode set to "circuit mode".

— information rate set to "64 kbit/s".

Note - Bearer capability information element octats 4a and 4b shall not be included.

The user may also specify the layer 1 (e.g., rate adaption), layer 2 (i.e., LAPB), and layer 3 (i.e., X.25) information transfer protocols in the low layer compatibility information element in the SETUP message (see Annex L).

6.1.2 Access to the ISDN virtual circuit service (Case B) - Reserved for future use

6.2 Incoming access

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6.2.1 Access from PSPDN service (Case A)

The ISDN signals the establishment of the circuit-mode connection using the procedures described in Section 5.3. The virtual calls are signalled between the user and the AU using the procedures described in Section 6.3.

6.2.1.1 General

The general procedures performed by the AU are those defined in Recommendation X.32.

6.2.1.2 Channel Selection

If the physical circuit desired by the AU does not exist between the terminal and the AU, the procedures for physical channel establishment described in the following sections apply.

The format of the SETUP message sent by the network to the user is in accordance with Section 3.1.

The bearer capability information element included in SETUP message shall be coded with:

- information transfer capability set to either:
 - a) "unrestricted digital information"; or
 - b) "restricted digital information".
- transfer mode set to "circuit mode"
- information rate set to "64 kbit/s".

Note - Bearer capability information element octets 4a and 4b shall not be included.

TABLE 6-2

Network requested channel and user response.
Incoming access from an AU

Channel indicated in the SETUP message network to user direction			Allowable user response user-network
Channel indication	Preferred or Exclusive	D-channel indication	
Bi	Exclusive	No	Bi
Bi	Preferred	No	Bi

Key:

Bi - indicated (idle) B-channel

Note 1 - All other encodings are invalid.

The B-channel connection to the called user shall be established by the network using the signalling procedures described in Section 5.3. The call is offered by sending the SETUP message on a point-to-point data link.

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The user responds to the SETUP as specified in Section 5.

6.2.2 Access from the ISDN virtual circuit service (Case B) - Reserved for future use

6.3 Virtual Call Establishment and Release

In all cases, once the physical channel has been selected and, if necessary, connected to the PH or AU, the virtual call is established according to the procedures below. Some networks may require some of the terminal identification procedures of Recommendation X.32 as well.

6.3.1 Link Layer Establishment and Release - Reserved for future use

6.3.2 Packet Layer Virtual Call Setup and Release

The packet layer procedures of X.25 will be used for layer 3 call set-up and release. The packet layer procedures will additionally be able to control and monitor the established or released state of the link layer.

6.4 Call Clearing

6.4.1 B-channel

The clearing of the switched connection shall be effected by using the D-channel signalling procedures for call clearing as specified in Section 5.4. For access to PSPDN services, no exceptions apply.

The B-channel may be cleared at any time by the user though, in general, it will be cleared following the clearing of the last virtual call over that B-channel.

6.4.2 D-channel - Reserved for future use

6.4.3 Additional Error Handling Information - Reserved for future use

6.4.4 Cause Mappings - Reserved for future use

6.5 Access Collision

When the network offers a packet mode call at the interface simultaneously with the user requesting a packet mode call, the network shall give priority to the completion of the incoming call. If the user determines that accepting the incoming call would meet the needs of its own outgoing call request, the user may clear the call request and accept the incoming call.

6.6 Call Control Procedures for DMI Mode 3 and Frame Relay

6.6.1 Circuit Transport Mode Virtual Call Specification

The procedures for establishing circuit transport mode connections used to transport packetized and non-packetized data are the same as those for a circuit transport mode call described in Section 5. This section includes the additional procedures for virtual call establishment.

6.6.1.1 Virtual Call Establishment

6.6.1.1.1 DMI Mode 3

The first virtual call is established simultaneously with the access connection.

6.6.1.1.2 Other Packet Protocols

The appropriate procedures specified by the protocols in use are followed to establish, maintain and clear the first and subsequent virtual calls over the connection.

6.6.1.2 B-channel Clearing

The call clearing procedures specified in Section 5 are applicable for clearing the B-channel connection. It is the user's responsibility to initiate channel clearing.

6.6.2 Frame Relay Packet Transport Mode Specification

The user-network packet transport services can be categorized into two groups : (1) permanent transport services and (2) on-demand transport services. At this time, the following subsections only describe the characteristics of the on-demand packet transport mode services on the D-channel.

Note that the procedures defined in this section specify a set of capabilities that enable the network to effectively meet the currently identified essential demand. It is the intent of AT&T to incorporate elements of procedure required to provide the OSI Network Service in future updates.

6.6.2.1 On-Demand Packet Transport Services

The general rules for message processing (including symmetric call establishment and clearing) as described in Section 5 are applicable and will not be repeated here.

6.6.2.1.1 Call Establishment at the Originating Exchange

The 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 SETUP message will contain a call reference, the bearer capability, the channel identification, and the called party number information. For D-channel virtual calls, the called party number may be chosen in a manner such that the network can determine that the call is requested to be routed via D-Channel connections in the network (i.e., a special numbering plan may be needed to indicate D-channel calls). In addition, the SETUP message may contain the Low layer compatibility information element and/or a locking shift to codeset 6 followed by the codeset 6 information elements (e.g., Logical link identification, Packet layer parameters, Link layer parameters and Throughput class information elements) at the end of the message. If the Low layer compatibility information element is not included, the desired service may not be provided. For on-demand frame relay calls the Logical link identifier information element must be included in the SETUP message or the default logical link number of 128 will be used.

6.6.2.1.1.1 En-bloc Sending Mode Only the En-bloc sending method is used on AT&T ISDN Primary Rate Interfaces. En-bloc sending occurs when the network receives sufficient address information in the SETUP message to process the call. The network responds by sending a CALL PROCEEDING message to the user to acknowledge the SETUP message and to indicate that the call is being processed. Upon receipt of the CALL PROCEEDING message at the user side of the interface, the call enters the Outgoing call proceeding state.

The CALL PROCEEDING message contains the channel and logical link allocated to the call and to which the user must be attached. If following the receipt of an en-bloc SETUP message the network determines that the call information received from the user is invalid (i.e., invalid facility request or address) then the network will clear the call by sending a RELEASE COMPLETE message.

6.6.2.1.1.2 Multiple Virtual Call Establishment SETUPS for second and subsequent virtual calls over a channel will be allowed when they conform to the following procedure.

- The channel indicated for subsequent calls must be in use for an active packet mode call as part of an end-to-end ISDN connection;

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- The exclusive channel option in the Channel identification information element must be used to indicate that this call setup is another packet mode session being established on the indicated channel;
- A unique logical link identifier for the current call setup must be chosen for that channel;
- The logical link identifier must be associated with a unique call reference value on that channel for that call;
- The packet mode parameters for the virtual call may be included along with all the other establishment related information.

6.6.2.1.1.3 Channel Negotiation The user must include a Channel identification information element in the SETUP message indicating one of the following channel options:

- exclusive option (i.e., a preferred channel with no acceptable alternative)
- a preferred channel with any alternative acceptable

In case i), the network may accept the call only on the specified channel. In case ii) the network has the option of placing the call on the specified channel, the D-channel, or a channel that is already in use for a frame relay call by that user.

In all cases, the channel selected is indicated in the first response to the SETUP message. In case i), if the specified channel is not available, and in case ii) if no channel is available, a RELEASE COMPLETE message with cause number 34 - no channel available is sent by the network.

6.6.2.1.1.4 Logical Link Negotiation The user should include a Logical link identification information element in the SETUP message indicating one of the following options:

- exclusive option (i.e., a preferred logical link with no acceptable alternative)
- a preferred logical link with any alternative acceptable
- and in the case where the user does not include a Logical link identification information element in the SETUP message, the default logical link number is assumed.

In case i), the network may accept the call only on the specified logical link. In case ii) the network has the option of placing the call on the specified logical link, or any other logical link in a channel which is available for frame relay data transport.

In all cases, the logical link selected is indicated in the first response to the SETUP message. In case i), if the specified logical link is not available, and in case ii) if no logical link is available, a RELEASE COMPLETE message with cause number 34 - no channel available is sent by the network.

6.6.2.1.1.5 Parameter Negotiation Parameters for the data transfer portion of the call may be conveyed between endpoints to ensure compatibility. The default values indicated in Section 4 are used when there is no parameter negotiation.

The user may request certain parameter values to be used for the call by including the appropriate information elements containing the desired parameters in the SETUP message. If no value is indicated for a particular parameter in the SETUP message, then the default value is assumed.

The network may accept the parameter values indicated in the SETUP message by including them in the SETUP message sent to the terminating interface. The network may choose not to accept the parameter values in the originators SETUP message and adjust these parameters to suitable values when passing the SETUP message to the terminating interface. Adjustment of parameters by the network or terminating user may be made in the direction of the default values, except for throughput class which is negotiated to lower

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values. If the terminating user accepts the parameter values that are included in the SETUP message, they will be echoed in the corresponding CONNECT message to the network (parameters with default values need not be echoed or sent). If the terminating user does not accept the parameter values from the SETUP message, then new values are included in the corresponding CONNECT message to the network. The network will pass these values, untouched (except as described in the following paragraph), to the originating interface so that it knows the values being used by the terminating user. The absence of a parameter in either message (SETUP or CONNECT) indicates a desire to use the default value for that parameter.

Optionally the network may choose to provide for connections that make use of different parameter values between the originating and terminating interfaces, by providing for conversions within the network. In this case it is the network's responsibility to send the appropriate parameter values in the SETUP and CONNECT messages.

The values indicated by the CONNECT message will be those used for the call. The user may refuse the values by sending a DISCONNECT message with the cause number 21 - call rejected.

6.6.2.1.1.6 Call Confirmation Upon receiving an indication that user alerting has been initiated at the called user, the network may transfer an ALERTING message across the user-network interface to the calling user. This message may cause initiation of a user generated alerting indication. At this time, the call enters the *Call delivered* state.

6.6.2.1.1.7 Call Connected Upon receiving an indication that the call has been accepted, a CONNECT message is sent across the user-network interface to the calling user. This message indicates to the calling user that a connection has been established through the network and stops a possible local indication of alerting. At this time, the call enters the *Active* state.

On receipt of the CONNECT message, the calling user may optionally generate a CONNECT ACKNOWLEDGE message. The network shall not take any action on receipt of this message when it perceives the call to be in the *Active* state.

6.6.2.1.2 Call Establishment at the Terminating Exchange

The network will indicate the arrival of a call at the user-network interface by sending a SETUP message. The call then enters the *Call present* state. After sending the SETUP message to the user, the network starts timer T303 (the value of timer T303 is specified in Section 5).

In addition to the mandatory information elements, the SETUP message may include, as required, any of the optional information elements described in Section 4.

6.6.2.1.2.1 Channel Negotiation Channel negotiation is the same as for the originating interface.

6.6.2.1.2.2 Logical Link Negotiation Logical link negotiation is the same as for the originating interface.

6.6.2.1.2.3 Parameter Negotiation The network may indicate parameter values other than the defaults in the SETUP message transmitted across the network-user interface. The user may accept these values or modify them in the direction of the defaults, or in the case of throughput class to lower values. Either the values in the SETUP message will be echoed back or new values will be indicated in the CONNECT message sent back to the network. If there is no value indicated in the CONNECT message for a particular parameter, the user is requesting the default. The values indicated by the CONNECT message are those used for the call.

If the user wishes to reject the call, it will clear the call with a RELEASE COMPLETE message with cause number 21 - call rejected.

The network may choose to operate with different parameter values at the originating and destination interfaces, in this case it is responsible for matching the differences.

6.6.2.1.2.4 Call Confirmation User's equipment that satisfies the compatibility requirements indicated in the SETUP message and that wishes to accept the call will respond with either an ALERTING, CALL PROCEEDING, or CONNECT message. If the first message sent is a CALL PROCEEDING message, the user proceeds by sending an ALERTING and/or CONNECT message.

The CALL PROCEEDING message, when it arrives at the network, cancels timer T303 and initializes timer T310; the call enters the *Incoming call proceeding* state. An ALERTING or CONNECT message, when it arrives at the network, cancels timer T303 or T310 (depending on which is active) and moves the call into the *Call received* or *Connect request* states, respectively. Receipt of the ALERTING or CONNECT message also causes the network to send the calling user a corresponding ALERTING or CONNECT message.

If the compatibility requirements indicated in the SETUP message are not satisfied or the user wishes to refuse the call, a RELEASE COMPLETE message will be sent.

6.6.2.1.2.5 Call Failure If no response to the SETUP message is received within the time interval T303, the network retransmits the SETUP message. If no response is received before the second expiry of T303, the network will initiate clearing in accordance with Section 5. Likewise, if the network does not receive an ALERTING or CONNECT message prior to the expiry of timer T310, the network moves the call to the *Null* state. The clearing cause number 18 - no user response, is sent to the calling user.

6.6.2.1.2.6 Call Acceptance A user indicates acceptance of an incoming call by transferring a CONNECT message across the user-network interface towards the network. If an ALERTING message had previously been sent to the network and parameter negotiation is not used, the CONNECT message will not contain the Channel identification information element or any parameter information elements.

If the user accepts a call using the channel and logical link indicate in the SETUP message and no user alerting is required, a CONNECT message may be sent without a previous ALERTING message.

6.6.2.1.2.7 Active Indication When the network receives a CONNECT message, the call enters the *Connect request* state. The network completes the connection of the selected physical channel/logical link and subsequently sends a CONNECT ACKNOWLEDGE message to the user. The CONNECT ACKNOWLEDGE message includes the call reference value specified. The network also initiates procedures to send a CONNECT message towards the calling user.

The CONNECT ACKNOWLEDGE message indicates completion of the connection. There may not be end-to-end communications until the CONNECT indication is received at the calling user. At this point, the call enters the *Active* state where it remains until clearing is initiated.

6.6.2.1.2.8 Call Collision The procedures are the same as described in Section 5.

6.6.2.1.3 Call Clearing Procedures

The clearing procedures for frame relay calls are similar to those for circuit switched calls described in Section 5. In addition, packet mode calls can fail if the packet mode capability is not implemented or unavailable. If the transfer mode requested in the SETUP message is packet mode and packet switching is not implemented then a RELEASE COMPLETE message with cause number 65 - bearer service not implemented is returned. When packet switching is supported but not currently available, a RELEASE COMPLETE will be sent with cause number 58 - bearer capability not presently available.

6.6.2.1.3.1 Normal Call Clearing

Under normal conditions, call clearing is initiated by the user or the network sending a DISCONNECT message and following the procedures defined in Section 5. However, because of the presence of layer 2 multiplexing the physical channel is cleared only when the last logical link associated with that physical channel is cleared. Since the D-channel also carries the signaling information, it will not be disconnected when all frame-relay calls have been cleared on that channel.

6.6.2.1.4 Handling of Error Conditions

The procedures in Section 5.8 are followed.

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7. User-to-User Signalling Procedures

7.1 Procedures for User-to-User Signalling Associated with Circuit-Switched Calls

7.1.1 General

The user-to-user signalling supplementary service(s) provides a means of communication between two users by using as a basis the layer 3 protocol defined in Section 5. User-to-user signalling is used to exchange information between two users to provide the services described in the I.257A Recommendations. The exchange of user-to-user signalling is limited by flow control procedures provided by the network or the user. The exchange of user-to-user information is not a network acknowledgement service. Any acknowledgement procedure shall be controlled at a higher layer between users. For the AT&T product involved, consult the product specific documentation.

Two user-to-user signalling services associated with circuit-switched calls that may be provided by the network to users are:

i. Message Associated UI (MA-UI):

user-to-user signalling exchanged during the setup and clearing phases of a call, within Q.931 call control messages

ii. Call Associated Temporary Signaling Connections (CA-TSC):

user-to-user signalling exchanged during or after call establishment, in USER INFORMATION messages. CA-TSC combines the capabilities of CCITT's services 2 and 3. One distinction should be noted is that CA-TSC allows USER INFORMATION messages to be exchanged before the ALERTING message is received by the calling user if the called user sends the FACILITY ACKNOWLEDGE message before sending the ALERTING message.

Both services may be used separately or in any combination in association with a single call.

For the AT&T services, user-to-user signalling is (are) NOT required for the call i.e., the call will be completed if user-to-user information cannot be passed.

7.1.2 Explicit Invocation Procedures (See Section 7.1.7)

7.1.3 User-to-User Signalling MA-UI

7.1.3.1 General Characteristics

MA-UI allows the users to communicate by means of user-to-user signalling by transferring user-to-user information within Q.931 call control messages during call establishment and clearing phases.

7.1.3.2 User-to-User Signalling - Implicit Service Request (Preferred, i.e., not required)

MA-UI may be implicitly requested by including any of the following user data information elements in the appropriate messages.

- Connected Number
- Redirecting Number
- Called party subaddress
- Calling party subaddress
- High layer compatibility

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- Low layer compatibility
- Shift to codeset 6 and any codeset 6 information elements that follow

NOTE -- Locking shift to codeset 6 and codeset 6 information elements that follow are considered user data information elements, and are included in the MA-UUI octet count only if they are transported transparently without interpretation or processing.

- Shift to codeset 7 and any codeset 7 information elements that follow.
- User-user

The Length restrictions for these information elements are described in Section 3. In addition, there is a combined total length restriction (See product specific documentation). These information elements are transported by the network and delivered unchanged included in the SETUP, DISCONNECT, and RELEASE messages transferred across the user-network interface at the called side as described in Sections 5.2 and 5.3. For invocation purposes, User-user information element must be at least three octets long as defined in Section 4.5.29.

Since contention by users for the incoming call is not allowed (e.g., when the SETUP message containing an implicit service invocation is delivered using a point-to-point link at the data link layer, user data information elements may be included in the ALERTING, CONNECT, DISCONNECT, RELEASE, and RELEASE COMPLETE messages transferred across the user-network interface at the called side as described in Sections 5.2.5 and 5.3. These information elements are transported by the network and delivered in the corresponding message(s) transferred across the user-network interface at the calling side as described in Section 5.1 and 5.3.

Note: The user may not be able to interpret incoming user-to-user information. In such situations the user should discard this information without disrupting normal call handling. No specific signalling is provided by the network to accommodate this situation.

Note: The called user may perform compatibility checking using the User data information element contents (see Annex B).

7.1.3.3 User-to-User Signalling in the Call Establishment Phase - Explicit Service Request (Preferred or Required) - Reserved for future use.

7.1.3.4 Interworking

In the case of interworking with a non-ISDN network, the return of a PROGRESS message to the calling user shall serve as indication that, in particular, the delivery of User data information elements in call control messages cannot be guaranteed.

In addition, the network may send a STATUS message with cause #43 "Access information discarded" to the user.

7.1.3.5 Rejection of Implicit Service Requests

Networks that cannot provide the service will not return a rejection indication.

However, if User-user information is discarded, the network may send a STATUS message with cause #43 "Access information discarded" to the user.

7.1.3.6 Rejection of Explicit Service Requests - Reserved for future use

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7.1.3.7 User-to-User Signaling in the Call Clearing Phase

User data information elements may be included in the first message used to initiate the normal call clearing phase (see Sections 5.3.3 and 5.3.4).

The information contained in such information elements is transferred to the remote user in the first clearing message (see Sections 5.3.3 and 5.3.4). Such a transfer is only performed if the information is received at the local exchange of the remote user before sending a clearing message to that user, otherwise, the information is discarded without sending any notification.

Since contention by users for the incoming call is not allowed (e.g., when the SETUP message is delivered using the point-to-point data link layer a User data information elements may be included in the first clearing message sent by the called user prior to entering the active state.

If the network is providing in-band information to the calling user, in conjunction with call clearing, the network shall include the User data information elements in the DISCONNECT message sent to the calling user.

Note: It is intended that this capability may be used to provide the clearing data transfer described in Recommendation X.213.

7.1.3.8 Unexpected user information in call control messages

The network will discard the respective unexpected user data information elements in the corresponding messages.

7.1.4 User-to-User Signaling Service 2 - Reserved for future use

7.1.5 User-to-User Signalling Service 3 - Reserved for future use

7.1.6 Unexpected USER INFORMATION Messages

7.1.6.1 Receipt of USER INFORMATION Messages in Incompatible Call States

Whenever a USER INFORMATION message is received from the user and the associated circuit switched call does not exist, the message will be discarded by the network. The network will respond with a RELEASE COMPLETE message with a cause #81 "invalid call reference value."

7.1.6.2 Receipt of Unexpected User INFORMATION Messages

Whenever a USER INFORMATION message is received by the network from the calling or called user and a CA-TSC has not been established (although a circuit-switch connection exists), the message will be discarded by the network. The network will respond with a STATUS message with cause #43 "access information discarded."

If the user discards a USER INFORMATION message it may send a STATUS message with cause #43 "Access information discarded", to the network.

7.1.7 Requesting User-to-User Signalling CA-TSC

7.1.7.1 General

Explicit CA-TSC is requested during or after the call setup request. During the call setup request, the CA-TSC service request is included in the SETUP message. After the call setup, the CA-TSC service request is included in the FACILITY message. The binary facility coding value of the Network specific facilities (NSF) information element is coded to request CA-TSC in the SETUP or FACILITY messages.

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7.1.7.2 Call Establishment

7.1.7.2.1 CA-TSC Requested at Setup Time

A CA-TSC is requested during call setup by including the CA-TSC codepoint in the Binary Facility Coding Value field of the NSF information element in the initial SETUP message. If resources are not available, the network will reject the CA-TSC request by sending a FACILITY REJECT message¹ to the user containing a Cause information element with an appropriate cause (see Section 7.1.7.3) and the NSF information element encoded as above. Note that processing of the B-channel connection request is unaffected by the CA-TSC rejection. If the CA-TSC request is not rejected by the network, it is delivered to the terminating user in a similarly encoded SETUP message. Responses to the CA-TSC request and subsequent actions are described in Sections 7.1.7.2 through 7.1.9.

7.1.7.2.2 CA-TSC Requested After Call Setup

A CA-TSC can be established after the B-channel connection has been setup.

The user requests the feature in a FACILITY message by coding the Network-specific facilities information element for "CA-TSC" as described in the previous section. If intervening switches are able to provide the CA-TSC, the CA-TSC request is delivered to the destination user in a similarly encoded FACILITY message.

The calling party can request a CA-TSC after having received the ALERTING message because the called party has implicitly acknowledged the call setup. The called party can request a CA-TSC after having sent the CALL PROCEEDING message that confirms the channel identity.

The destination user responds with either a FACILITY ACKNOWLEDGE or FACILITY REJECT message. From this point on, the procedure is exactly the same as that described for a CA-TSC requested at setup time.

7.1.7.2.3 Acknowledgment of the CA-TSC Request

The originating user (the user requesting the CA-TSC) must receive CA-TSC request acknowledgement from the destination user before sending USER INFORMATION messages. Note that a response to a CA-TSC request can be made at any time after CALL PROCEEDING has been sent.

A CA-TSC request is acknowledged in a FACILITY ACKNOWLEDGE message which includes the CA-TSC coding in the NSF information element. Acknowledgment of a CA-TSC does not change the state of a call.

7.1.7.3 Service Rejection

The FACILITY REJECT message is used as a negative acknowledgement to reject a CA-TSC. The CA-TSC may be rejected by any intermediate point in the CA-TSC path. Only a normal call clearing message will clear both the B-channel connection and the CA-TSC. If the CA-TSC request is rejected by a switch in the call path, the subsequent SETUP message continuing towards the terminating user must not include the CA-TSC request in the NSF information element. In this case, the call progresses without the CA-TSC request. When a CA-TSC request contained in a FACILITY message is rejected, the FACILITY message will not be tandemed past the switch rejecting the request.

1. Note that the network may respond with CALL PROCEEDING prior to sending FACILITY REJECT.

The FACILITY REJECT message² shall include the following:

- A Network Specific Facilities information element, encoded with the CA-TSC codepoint in the Binary Facility Value field.
- A Cause information element³ with a cause value chosen from:
 - 29 (facility rejected)
 - 21 (call rejected)
 - 42 (switching equipment congestion)

The acknowledgements have the following effect:

- A negative acknowledgement via the FACILITY REJECT message causes rejection of the CA-TSC request, but allows processing of the B-channel connection request to continue normally.
- A negative acknowledgement via the DISConnect message results in rejection of the CA-TSC request and clearing of the B-channel connection.

7.1.7.4 Transfer of USER INFORMATION Messages

The originating user (the user requesting the CA-TSC) can transfer USER INFORMATION messages after receiving acknowledgment of the CA-TSC request from the terminating user. The terminating user can transfer USER INFORMATION messages after sending acknowledgment of the CA-TSC request. The network provides for the transfer of such messages from the calling to the called side and vice versa. If user-to-user signaling is allowed, USER INFORMATION messages may be transferred in each direction.

The USER INFORMATION message includes the Call reference, the Protocol discriminator, and the User-user information elements as defined in Section 3.1.24. The More data indication information element may also be included by the source user to indicate to the remote user that another USER INFORMATION message will follow, containing information belonging to the same block. The use of the More data indication information element is not supervised by the network.

Sending or receiving of USER INFORMATION messages does not change the state of the call.

If a USER INFORMATION message exceeds the maximum allowable length, (see Section 3.1) the message will not be transmitted across the network, and a STATUS message with cause #43 "Access information discarded" will be sent to the user.

7.1.7.5 Congestion Control of USER INFORMATION Messages

The network or user will flow-control, when needed, the transfer of USER INFORMATION messages from a user or network by means of a CONGESTION CONTROL message containing a congestion level information element. Two indications of congestion level are specified: "receiver not ready" and "receiver ready." On receipt of the former, the user or network should suspend sending USER INFORMATION messages; on receipt of the latter, sending may recommence. After having sent a receiver not ready indication, the network or user shall discard USER INFORMATION messages which are subsequently

-
2. Some implementations may return a STATUS message with an appropriate cause, since the FACILITY REJECT message may not be supported.
 3. The Cause information element in the FACILITY REJECT message should be transported intact to the originating user. In particular, the location field should not be changed.

received. The network or user will send a CONGESTION CONTROL message with a receive not ready indication when the first USER INFORMATION message is locally discarded, if it is possible. The CONGESTION CONTROL message will also include a cause #43 "Access information discarded."

Congestion control procedure itself should be regarded as local. However, in a user-user network environment, the CONGESTION CONTROL messages have a global significance.

7.1.7.5.1 Network Strategy for CA-TSC

7.1.8 Summary of Actions to be taken by the Called Side and Subsequent Network Action - Not applicable

7.1.9 Clearing CA-TSC

Normal call clearing procedures (described in Section 5.4) are used to simultaneously disconnect the CA-TSC and the B-channel connection. The DISCONNECT message initiates the clearing procedure.⁴ The Cause information element associated with the messages above will be independent of the CA-TSC because these messages explicitly clear the B-channel connection. Only the FACILITY REJECT message will contain a Cause information element pertaining to the CA-TSC itself.

4. The use of other call clearing messages in error recovery situations (i.e., REL and REL COM) as described in Section 5.4 also clear the CA-TSC.

7.2 Procedures for User-to-User Signalling Not Associated with Circuit-Switched Calls (NCA-TSC)

7.2.1 General Characteristics

This feature allows the users to communicate by means of user-to-user signaling without setting up a circuit-switched connection. A temporary signaling connection is established and cleared in a manner similar to the control of a circuit-switched connection.

Users may transfer MA-UUI user information in the SETUP, and the first clearing message (RELEASE or RELEASE COMPLETE). Users may not request the CPN/BN service (see Section 11.1.4.1.2.1).

7.2.2 Call Establishment

Procedures for call establishment are as described in Sections 5.2 and 5.3 with the following modifications.

On call requests the calling user sends a SETUP message identifying, within the Bearer capability and Channel identification information elements, a temporary signaling connection to be established on SAPI=0. The SETUP message is encoded to indicate:

- Bearer capability information element
 - Unrestricted digital information in the information transfer capability field
 - packet mode in the transfer mode field
 - User information layer 2 protocol is Q.921 and user information layer 3 protocol is Q.931 in the layer and protocol identification field. (See product specific documentation.)
- Channel identification information element
 - Exclusive in the preferred/exclusive field
 - D channel in the D-channel indicator field
 - No channel in the channel selection field
- Some implementations may require the Network-specific facilities information element. See product specific documentation.

If the network determines that the requested temporary signaling connection service is not authorized or is not available, the network shall initiate call clearing in accordance with Section 5.4.2(a) or Section 5.4.2(c) with one of the following causes:

- a) #58 "bearer capability not presently available"
- b) #65 "bearer service not implemented"
- c) #29 "requested facility rejected"
- d) #42 "switching equipment congestion"
- e) #21 "call rejected"

The called user accepts the temporary signaling connection request by sending a CONNECT message towards the calling user. The called user may begin sending USER INFORMATION messages after issuing the CONNECT message. Once the calling user receives a CONNECT message, it can begin sending USER INFORMATION messages.

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Note that the network enters the Call Received state (N7) and starts Timer T310 after sending the SETUP message to the terminating user.

If the network receives a CALL PROCEEDING message, PROGRESS message, or an ALERTING message from the terminating user before the CONNECT or the RELEASE COMPLETE message, the network will ignore these messages locally. If a FACILITY message is received from the terminating user before a CONNECT or a RELEASE COMPLETE message, the network will respond with a FACILITY REJECT message.

7.2.2.1 Receipt of a STATUS message

Figures IV-7-1a, IV-7-2a, and IV-7-3a show the matchable states when a STATUS message is received.

Network's state	User's states	
	Matching	Matchable (Network's action)
3	3	none
7	7, 9	none
8	8	none
10	10	1, 3 if outgoing (CONNECT with channel id)
		8 if incoming (CONNECT ACKNOWLEDGE)

Figure IV-7-1a Network's Action on Receipt of STATUS for NCA-TSC

User's state	Network's State	
	Matching	Matchable (User's action)
1	none	none
3	3	none
8	8	7 (CONNECT)
9	7	none
10	10	none

Figure IV-7-2a User's Action on Receipt of STATUS for NCA-TSC

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Current state	Received State	
	Matching	Matchable (User's action)
1	none	none
3	9	none
8	8	1, 3, 7, 9 (CONNECT)
9	3	1 (CALL PROCEEDING)
10	10	none

Figure IV-7-3a Symmetrical User's Action on Receipt of STATUS for NCA-TSC

7.2.3 Transfer of USER INFORMATION Messages

Once a temporary signalling connection is established, both users can transfer information between themselves by transferring USER INFORMATION messages across the user-network interface. The network provides for the transfer of such messages from the called to the calling side and vice versa.

The USER INFORMATION message includes the Call reference, the Protocol discriminator, and the User-user information elements as defined in Section 3.1.23. The More data indication information element may also be sent by the source user to indicate to the remote user that another USER INFORMATION message will follow, containing information belonging to the same block. The use of the More data indication is not supervised by the network. (see Section 7.1.7.4)

7.2.4 Congestion Control of USER INFORMATION Messages

Congestion control procedures are the same as those described in Section 7.1.7.5.

7.2.5 Call Clearing

The clearing of an established temporary signalling connection can be initiated by the user or network by sending a RELEASE message towards the far end user. The clearing procedure followed and the timers involved are the same as those for clearing a circuit-switched connection as described in Sections 5.3.3 and 5.3.4.

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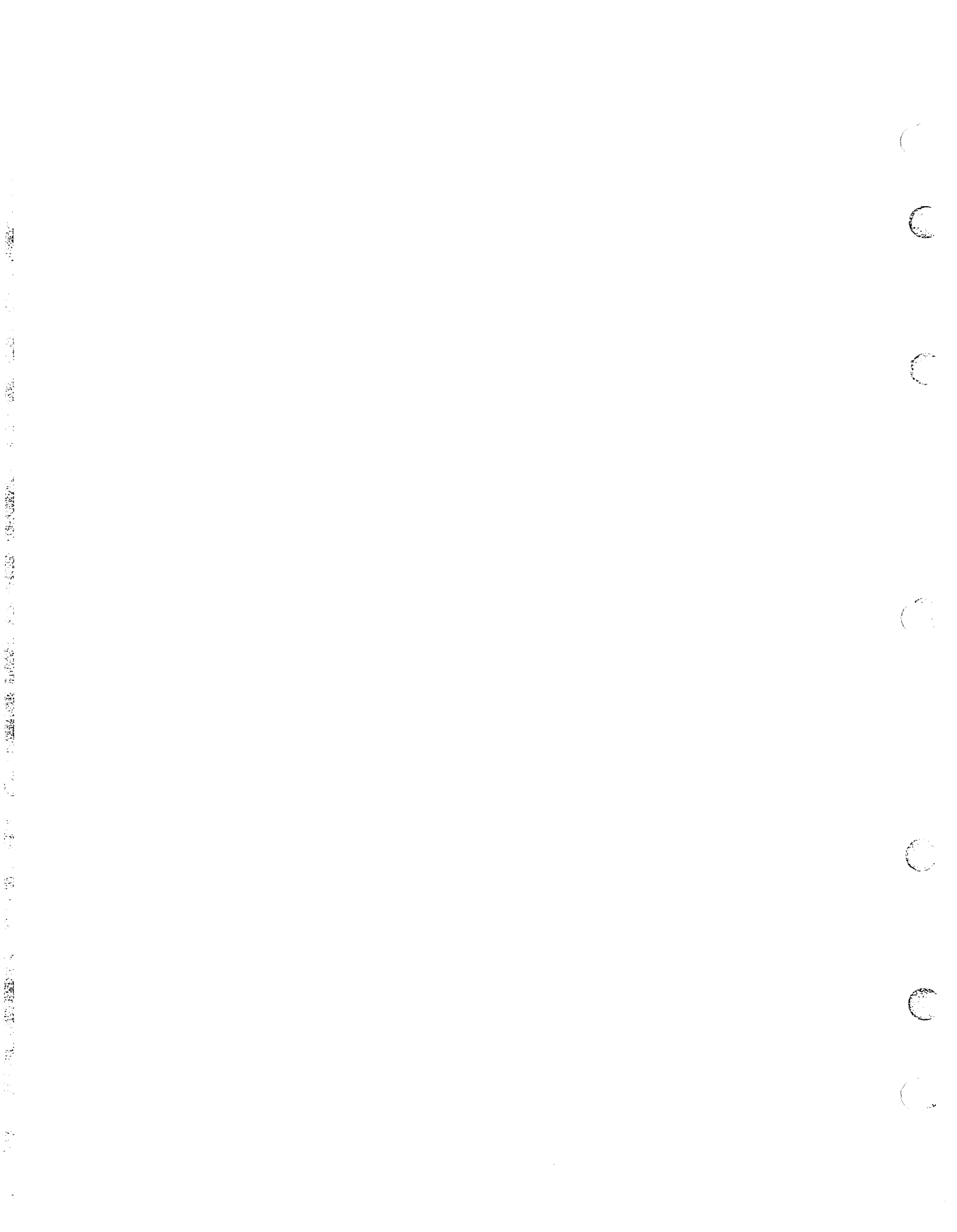
8. Application of circuit-switched supplementary services to terminals using stimulus procedures - Reserved for future use

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9. LIST OF SYSTEM PARAMETERS

The description of timers in the following tables should be considered a brief summary. The precise details are found in Sections 5 and 6, which should be considered the definitive descriptions.

9.1 Timers in the network side

The timers specified in Table 9-1/Q.931 are maintained in the network side of the interface.

TABLE 9-1 (1 of 6)

Timers in the Network Side

TIMER NUMBER	DEFAULT TIME-OUT VALUE	STATE OF CALL	CAUSE FOR START	NORMAL STOP	AT THE FIRST EXPIRY	AT THE SECOND EXPIRY	CROSS- REFERENCE
T303	4 s Note 1 Note 10	Call Present	SETUP sent.	ALERT, CONN, CALL PROC or PROG received. REL COMP received if SETUP sent on point-point data link.	Retransmit SETUP restart T303. If REL COMP has been received, clear the call. Note 10	Clear network connection. Enter Null state. Note 10	Mandatory.

TABLE 9-1 (2 of 6)

Timers in the Network Side

This table has been intentionally deleted.

TABLE 9-1 (3 of 6)

Timers in the Network Side

TIMER NUMBER	DEFAULT TIME-OUT VALUE	STATE OF CALL	CAUSE FOR START	NORMAL STOP	AT THE FIRST EXPIRY	AT THE SECOND EXPIRY	CROSS-REFERENCE
T305	4 s	Disconnect Indication	DISC	REL, DISC or REL COMP received.	Network sends REL	Timer is not restarted.	Mandatory.
T306	(Note 6)	Tone Active	PROGRESS	DISC received.	Stop the tone announcement. Send DISC.	Timer is not restarted.	Mandatory when in-band tones announcements are provided see Sec. 5.5, 5.4.4.1

TABLE 9-1 (4 of 6)

Timers in the Network Side

TIMER NUMBER	DEFAULT TIME-OUT VALUE	STATE OF CALL	CAUSE FOR START	NORMAL STOP	AT THE FIRST EXPIRY	AT THE SECOND EXPIRY	CROSS-REFERENCE
T308	4 s Note 1	Release Request	REL sent.	REL COMP received.	Retransmit REL and restart T308.	Place B-channel in maintenance condition. REL COMP sent Release call reference. Note 9.	Mandatory
T309	90 s Note 11	Any stable state.	Data link disconnection. Calls in stable states are not lost.	Data link reconnected.	Sec. 5.8.9	Timer is not restarted.	Mandatory.
T310	10 s Note 7	Incoming Call Proceeding	CALL PROC received.	ALERT, CONN, DISC or PROG received.	Send DISC	Timer is not restarted.	Mandatory.

TABLE 9-1 (5 of 6)

Timers in the Network Side

TIMER NUMBER	DEFAULT TIME-OUT VALUE	STATE OF CALL	CAUSE FOR START	NORMAL STOP	AT THE FIRST EXPIRY	AT THE SECOND EXPIRY	CROSS-REFERENCE
T316	2 mins.	Restart Request	REST sent.	REST ACK received.	REST retransmitted several times. Reinitialize T316	REST may be retransmitted several times. Restart T316	Mandatory when Sec. 5.5 is implemented.

TABLE 9-1 (6 of 6)

Timers in the Network Side

TIMER NUMBER	DEFAULT TIME-OUT VALUE	STATE OF CALL	CAUSE FOR START	NORMAL STOP	AT THE FIRST EXPIRY	AT THE SECOND EXPIRY	CROSS-REFERENCE
T3M1	120 s	Any state	SERV sent	SERV ACK received	Retransmit SERV and reinitialize T3M1	Retransmit SERV	Mandatory See Sec. 10.4.1.5.1
T321	40 s	Any call state.	D-channel failure.	Response to layer 3 message received. SERV or SERV ACK rec. on SBTY D-ch	Send DL_ESTABLISH_REQ on both D-channels. Place IS and SBTY D-ch OOS	Timer is not restarted.	Mandatory when ANNEX F is implemented.

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Note 1 - This default value assumes the use of default values at layer 2 (i.e., $[N200+1]$ times T200).

Notes 2 through 5 have been intentionally deleted.

Note 6 - The value of timer T306 may depend on the length of the announcement.

Note 7 - The value of timer T310 may be different in order to take into account the characteristics of a private network.

Note 9 - The restart procedures contained in Sec. 5.5 may be used on B-channels in the maintenance condition.

Note 10 - See product specific documentation.

Note 11 - The value of this timer is an implementation option. The value shall lie in the range of 30 to 120 seconds.

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9.2 Timers in the user Side

The timers specified in Table 9-2/Q.931 are maintained in the user side of the interface. Timers T305, T308 and T313 are mandatory for all user side implementations.

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TABLE 9-2 (1 of 4)

Timers in the User Side

TIMER NUMBER	DEFAULT TIME-OUT VALUE	STATE OF CALL	CAUSE FOR START	NORMAL STOP	AT THE FIRST EXPIRY	AT THE SECOND EXPIRY	CROSS- REFERENCE

TABLE 9-2 (2 of 4)

Timers in the User Side

TIMER NUMBER	DEFAULT TIME-OUT VALUE	STATE OF CALL	CAUSE FOR START	NORMAL STOP	AT THE FIRST EXPIRY	AT THE SECOND EXPIRY	CROSS- REFERENCE
T303	4 s Note 1 Note 6	Call Initiated	SETUP sent.	ALERT (ANNEX D), CONN (ANNEX D), CALL PROC, or REL COMP received.	Retransmit SETUP restart T303. If REL COMP was received, clear the call (ANNEX D).	Clear internal connection. Send REL COMP. Enter Null state.	Mandatory, when ANNEX D is implemented otherwise optional.
T305	4 s	Disconnect Request	DISC sent.	REL or DISC REL COM received	REL sent.	Timer is not restarted. REL COM may be sent	Mandatory.
T308	4 s Note 1	Release Request	REL sent.	REL COMP or REL received.	Retransmit REL restart T308.	B-channel placed in maintenance condition. Call reference released. Note 5	Mandatory.
T309	90 s	Any stable state.	Data link disconnection. Calls in stable states are not lost.	Data link reconnected.	Sec. 5.8.9	Timer is not restarted.	Optional.

TABLE 9-2 (3 of 4)

Timers in the User Side

TIMER NUMBER	DEFAULT TIME-OUT VALUE	STATE OF CALL	CAUSE FOR START	NORMAL STOP	AT THE FIRST EXPIRY	AT THE SECOND EXPIRY	CROSS-REFERENCE
T310	10 s Note 4	Outgoing Call Proceeding	CALL PROC received.	ALERT, CONN, DISC, or PROG received.	Send DISC.	Timer is not restarted.	Mandatory, when ANNEX D is implemented.
T313	4 s Note 1	Connect Request	CONN sent.	CONN ACKNOWLEDGE received.	Send DISC	Timer is not restarted.	Mandatory.

TABLE 9-2 (4 of 4)

Timers in the User Side

TIMER NUMBER	DEFAULT TIME-OUT VALUE	STATE OF CALL	CAUSE FOR START	NORMAL STOP	AT THE FIRST EXPIRY	AT THE SECOND EXPIRY	CROSS-REFERENCE
T316	2 mins.	Restart Request	REST sent.	REST ACK received.	REST retransmitted several times. Reinitialize T316	REST may be retransmitted several times	Mandatory, when Sec. 5.5 is implemented.
T3M1	120 s	Any state	SERV sent	SERV ACK received	Retransmit SERV and reinitialize T3M1	Retransmit SERV	Mandatory See Sec. 10.4.1.5.1
T321	40 s	Any call state.	D-channel failure	Response to layer 3 message received. SERV or SERV ACK rec. on SBTY D-ch	Send DL_ESTABLISH_REQ on both D-channels. Place IS and SBTY Dch OOS	Timer is not restarted.	Mandatory when Annex F is implemented.

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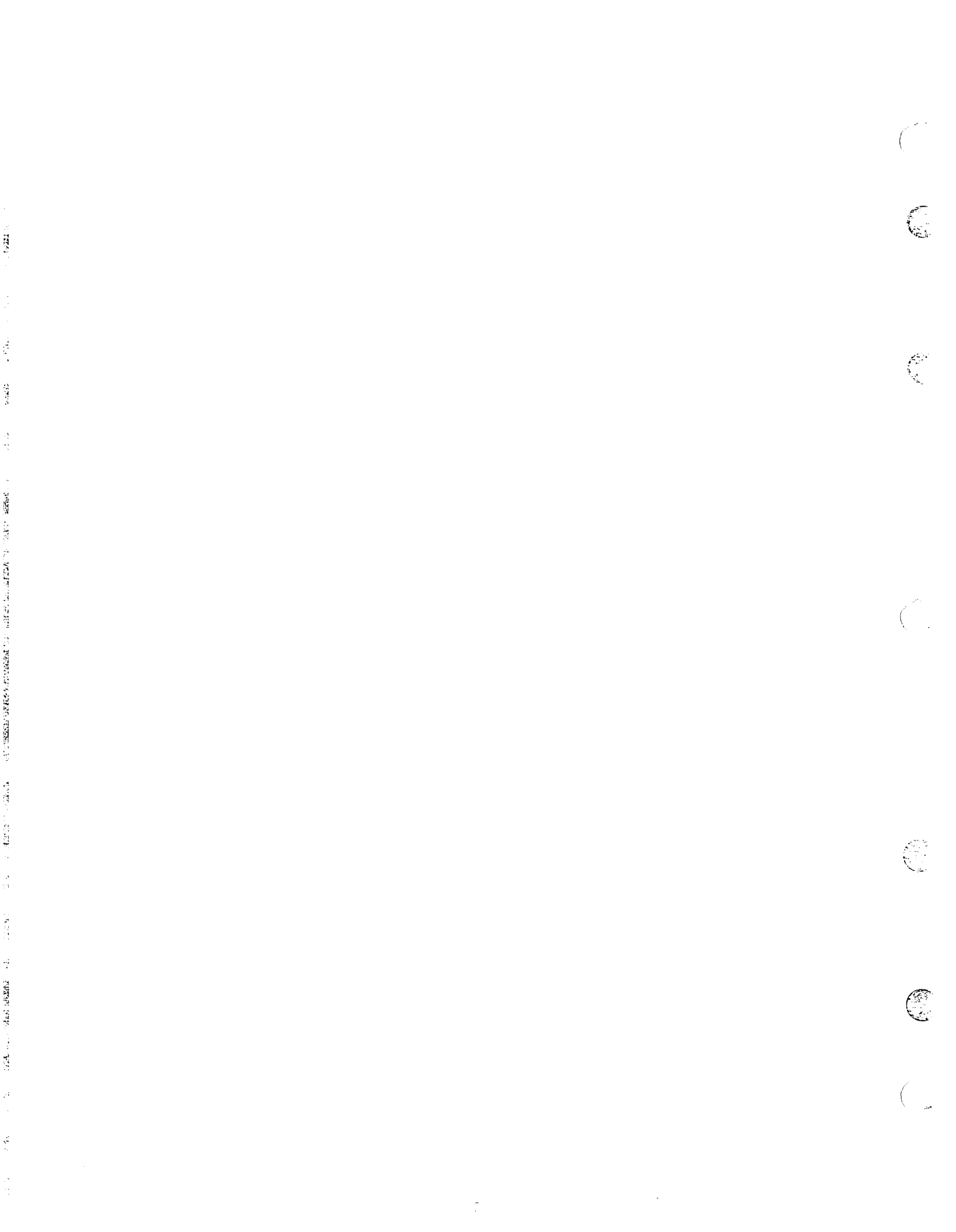
Note 1 - This default value assumes the use of default values at layer 2; i.e., $(N200 + 1)$ times T200.

Notes 2 and 3 have been intentionally deleted.

Note 4 - T310 is not started if a PROGRESS message has been delivered.

Note 5 - The restart procedures contained in Section 5.5 may be used on B-channels in the maintenance condition.

Note 6 - The value of this timer is an implementation option. The value shall lie in the range of 30 to 120 seconds.



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10. AT&T Maintenance and Management

10.1 Maintenance

This section lists the maintenance messages and procedures that will be supported between the two sides of the interface.

At Layer 2 of the D-channel, SAPI 0 will be used for maintenance activity. At layer 3, two class of maintenance activity have been defined. Maintenance messages will have a distinct protocol discriminator and follow the same structure as call control messages defined in Section 4.1. For the AT&T product involved, consult the product specific documentation.

10.1.1 Layer 2 Operation for Maintenance

The D-channel currently has SAPIs identified for signaling, packet data (X.25), and management function. SAPI 0 will be used for signaling maintenance of the interface connecting the user and network. Both the network and the user will use point-to-point operation for sending maintenance messages on SAPI 0.

10.1.2 Classes of Maintenance Activity

Two classes of maintenance of the user-network interface have been identified. They are:

1. SERVICE - This class is concerned with conveying changes in the status of a channel or interface (DS1). (Currently all systems work on a per B channel basis).
2. Test Calls - This class is concerned with the identification and verification of problems at the user-network interface.

10.1.2.1 Test Calls

Test calls are calls of a diagnostic nature that are placed to prespecified numbers across the user-network interface. Test calls are placed by normal call processing procedures and messages, following all coding rules given in Sections 3 and 4. This includes coding of a valid service in the Network specific facilities information element whenever a call by call trunk is being used. Test calls are identified as such calls by digit analysis, and may be placed when normal outgoing traffic is barred (see Maintenance Procedures below).

It is required that all systems implement a 64kb/s noninverting looping test line. This test line loops the incoming 64kb/s data from a B channel back out onto the same B channel outgoing. The address used for this test can be assigned locally at the user side of the interface. On the network side the standard test line numbers should be used.

Other test lines may optionally be implemented as needed. Calls to any valid test line are considered test calls.

The ability to place test calls is optional.

When a switch receives a call to a test line not supported by that switch, the call is cleared (as for any invalid address) via a RELEASE COMPLETE message with a cause of "Invalid Destination Address" as with any unknown destination.

10.1.3 Message Structure

Maintenance messages follow the same structure as that of call control messages. The benefits include simplicity and flexibility of the interface specification.

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10.1.4 Maintenance Messages

The following is a list of messages supported.

SERVICE

SERVICE ACKNOWLEDGE

10.1.5 Maintenance Procedures

This section presents the procedures to be used with the messages defined in Section 10.1.6. Since the maintenance messages are symmetric, these procedures can be initiated by either side of the interface.

10.1.5.1 SERVICE

Associated with the SERVICE class of maintenance messages are three status categories. They are, in order of decreasing availability: *In Service*, *Maintenance*, and *Out of Service*.

The procedure involving the SERVICE message changes the status of an interface or channel within the interface. The status change is accomplished by sending a SERVICE message across the interface indicating the channel or interface and the new status. Note that a SERVICE message cannot be used to change the status of the D Channel, except in the case of D Channel backup (see below). The acknowledgement to the change is conveyed in the SERVICE ACKNOWLEDGE message. The SERVICE ACKNOWLEDGE message returns the new status of the interface.

If no SERVICE ACKNOWLEDGE message is received within 120 seconds after one side of the interface has sent a SERVICE message (Timer T3M1 expires), this side may continue sending SERVICE messages at periodic intervals until a SERVICE ACKNOWLEDGE is returned. (If a SERVICE message is received during this time it is handled as specified in Section 10.1.5.5). In the meantime, the new status indicated in the initial SERVICE message shall take effect if the new status is less available than the current status. If the new status that has been requested is more available than the current status then the current status remains in effect (although it should be as a Far End subcategory) (see section 10.1.5.1.3 below for definition of "Far End").

10.1.5.1.1 Service Messages Specifying an Interface

AT&T PRI products do not generate SERVICE messages for entire interfaces. All SERVICE messages will specify individual B channels only.

The response to a SERVICE message specifying an entire interface is an implementation option. The following options are supported by AT&T products listed in order of decreasing preference:

- a. Respond with a SERVICE ACKNOWLEDGE message specifying the interface. In addition, in cases where not all channels in the interface can be placed in the service status specified in the SERVICE message, individual SERVICE messages will be returned for each such channel. Individual SERVICE ACKNOWLEDGE messages would then be required for each such channel.
- b. Respond with a STATUS message indicating Cause 100 (invalid information contents).
- c. Ignore SERVICE message

10.1.5.1.2 Status Definitions - D Channels.

SERVICE messages are not used to change the service status of D Channels with the important exception of D Channel Backup. The D Channel Backup procedures described elsewhere specify that a SERVICE *In*

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Service message is sent to activate a D Channel at Layer 3. SERVICE messages specifying *Out of Service* or *Maintenance* status are never sent for D Channels and are ignored if received.

10.1.5.1.3 Status Definitions - Bearer Channels.

This subsection will define the meanings of the three allowed bearer channel status categories. The allowed transition between the various bearer channel status categories are shown in the SDL diagrams in Figures IV-10-1 through Figure IV-10-10. The three are *In Service*, *Maintenance*, and *Out of Service* going from the most to the least available category. *Maintenance* and *Out of Service* are considered busy for normal call processing. Transitions from a more to a less available category occur without negotiation while transitions from a less to a more available category require both sides of the interface to agree on the transition. (However, notification of transitions from a more to a less available state should be made by the use of the SERVICE message protocol defined in this section).

As an aid to implementation, the *Maintenance* and *Out of Service* categories can be broken down further into Near End (NE) and Far End (FE) subcategories that signify whether the category was requested by the local system or the system on the other side of the interface. Systems may separately track the Near End and Far End states with Near End state procedures taking precedence over the those of the Far End state for status of the same category. The NE status reflects the view of the local system as to the service availability that it has of the channel or interface. If implemented in this way the categories/subcategories in order of decreasing availability are:

In Service	Most available
Maintenance/Far End	
Maintenance/Near End	
Out of Service/Far End	
Out of Service/Near End	Least available

Systems may move a channel or interface from the Near End to the Far End subcategory by attempting to place it into a more available category and having that request denied by the Far End. For example, suppose that a channel had been placed in the *Maintenance* status by side A of the interface (Maintenance/NE from side A's point of view). While in *Maintenance* a failure occurs within side B's maintenance domain which makes the channel inoperative. Side B places the channel into the *Out of Service* category (Out of Service/FE from side A's point of view). When the failure clears, side B will attempt to place the circuit *In Service* by sending a SERVICE message with a new status information element with a value of *In Service* across the interface. Side A may respond to this message by sending a SERVICE ACKNOWLEDGE message to side B with the new status information element set to a value of *Maintenance*. Side A will now have returned to the previous status with the channel in the *Maintenance* category with the subcategory of Near End. Alternatively, side A could respond to the request by sending a SERVICE ACKNOWLEDGE message to side B with a new status information element set to the value of *In Service* and return the channel to normal service.

If channel negotiation is employed, the service status which governs call processing is the service status of the second channel, that is, the channel to which the call is ultimately negotiated.

10.1.5.1.3.1 In Service A bearer channel that has *In Service* status can be assigned for a call by the signaling call control entity on either side of the interface. Such bearer channels may be used for a call when a request occurs at the ISDN interface. Both normal calls and test calls may use the channel in this state.

A channel that has *In Service* status may be moved to either the *Maintenance* or *Out of Service* status by either side of the interface.

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10.1.5.1.3.2 Maintenance A channel that has *Maintenance* status may *not* be assigned for normal outgoing traffic by either side of the interface. Both sides of the interface must continue to process incoming test calls. The response to non-test calls is an implementation option. Behaviors which have been implemented include, in order of decreasing preference:

- a. The arrival of a non-test call when in this status indicates a potential status misalignment and a status audit procedure (see below) is performed.
- b. The arrival of a non-test call in this category causes procedures to be initiated (*i.e* a SERVICE message is sent by the switch receiving the non-test call) to bring the circuit into the *In Service* category if the *Maintenance* category was originally requested from the Far End. (The non-test call is accepted in this case).
- c. Allow incoming calls only if the Far end placed the circuit into this category and do not perform any audit.

Collisions between SETUP messages for these calls will be resolved in the normal manner.

A channel that has *Maintenance* status may be moved to the *Out of Service* status by either side of the interface. A channel that has *Maintenance* status may be moved to the *In Service* status only if both sides of the interface agree to do so by exchanging a SERVICE message and a SERVICE ACKNOWLEDGE message with a Change Status information element (Section 10.1.7.1.4.1) indicating the *In Service* status.

As a standard maintenance procedure, if a side of the interface detects an error condition that is not within its maintenance responsibility or requires further testing to identify the source of the problem (such as an unacceptable error rate), it shall place the channel into the *Maintenance* status. If such conditions clear, an attempt should be made to return the channel to the *In Service* category.

10.1.5.1.3.3 Out of Service A channel or interface that is in the *Out of Service* status may not be assigned for outgoing traffic by either side of the interface. Neither side of the interface is required to process any incoming calls. If a SETUP is received in this state the response is an implementation option. Behaviors that have been implemented include, in order of decreasing preference:

- a. Respond with RELEASE COMPLETE (or DISCONNECT in the case of channel negotiation) with the local cause value 44, "Requested Channel Not Available."
- b. Respond with RELEASE COMPLETE (or DISCONNECT in the case of channel negotiation) with the end-to-end cause value 54, "Incoming Calls Barred." Use of this value should be phased out in favor of cause value 44.
- c. In addition to option "a" above, initiate a status audit procedure (see below).
- d. If the *Out of Service* status was originally requested by the Far End, accept the call, otherwise proceed according to "b" above.
- e. If the *Out of Service* status was originally requested by the far end, initiate procedures to bring the channel *In Service*, otherwise proceed according to "b" above.

A bearer channel or interface that is in the *Out of Service* status may be moved to the *In Service* status only if both sides of the interface agree to do so by exchanging a SERVICE message and a SERVICE ACKNOWLEDGE message with a Change Status information element (Section 4.5.30) indicating the *In Service* status. A bearer channel or interface that is in the *Out of Service* status may be moved to the *Maintenance* status only if both sides of the interface agree to do so by exchanging a SERVICE message and a SERVICE ACKNOWLEDGE message with a Change Status information element (Section 4.5.30) indicating the *Maintenance* status or a SERVICE message with a Change Status information element

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indicating the *In Service* status and a SERVICE ACKNOWLEDGE message with a Change Status information element indicating *Maintenance*.

As a standard maintenance procedure, if a side of the interface detects a failure condition that is identified as within its maintenance responsibility and requires no further testing to identify the source of the failure, it shall place the channel or interface into the *Out of Service* status. For example, digroup failures detected by a PBX should initially cause the affected channels to be placed into the *Maintenance* status since it is most likely that the failure is within the network's maintenance responsibility. If the problem was subsequently found to be due to local PBX component failures, then the circuits should be placed into the *Out of Service* status. If such conditions clear, an attempt should be made to return the channel or interface to the *In Service* category.

The following SDL diagrams describe expected maintenance procedures for B channels only. Exception conditions are discussed in the following sections.

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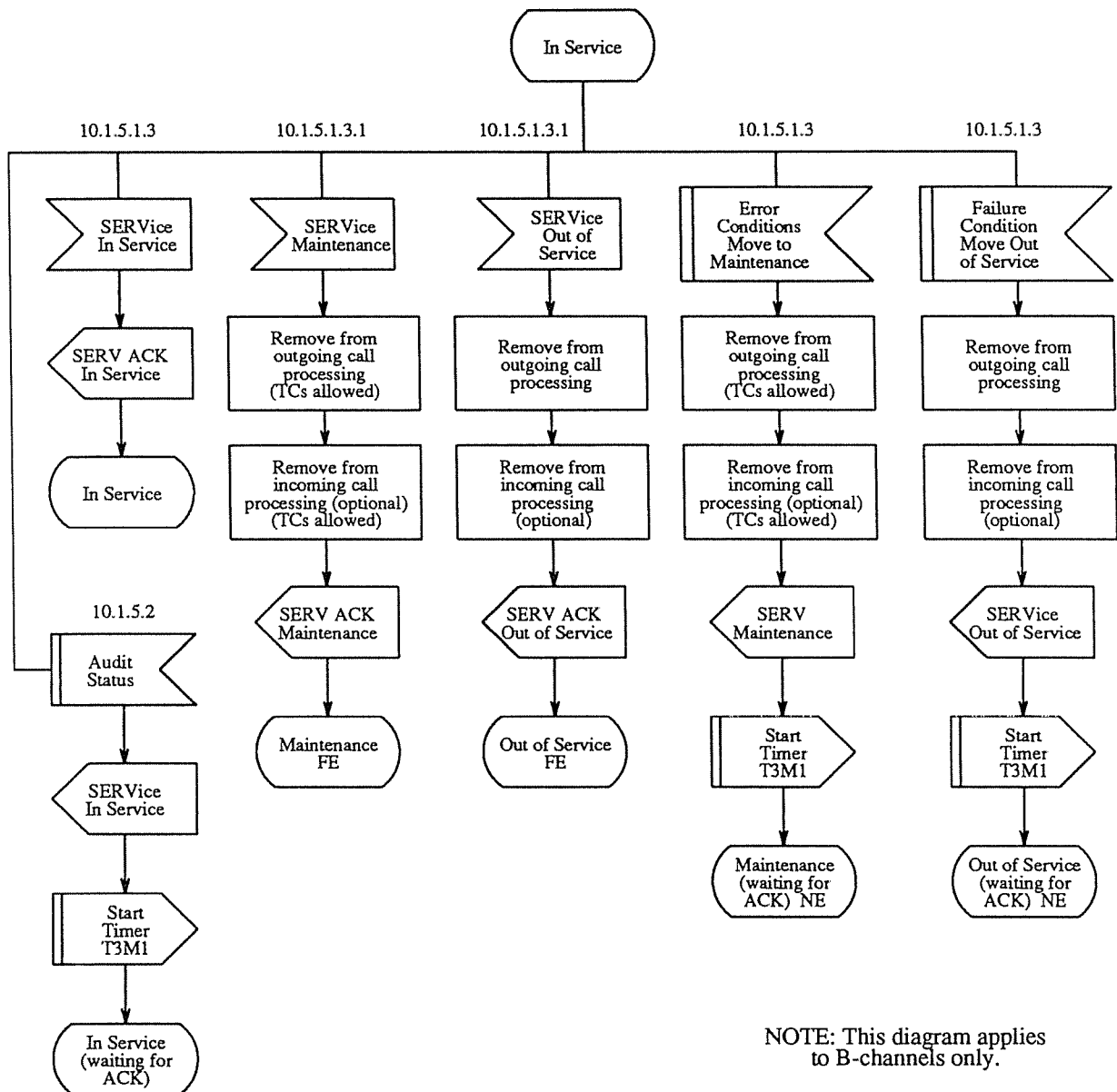
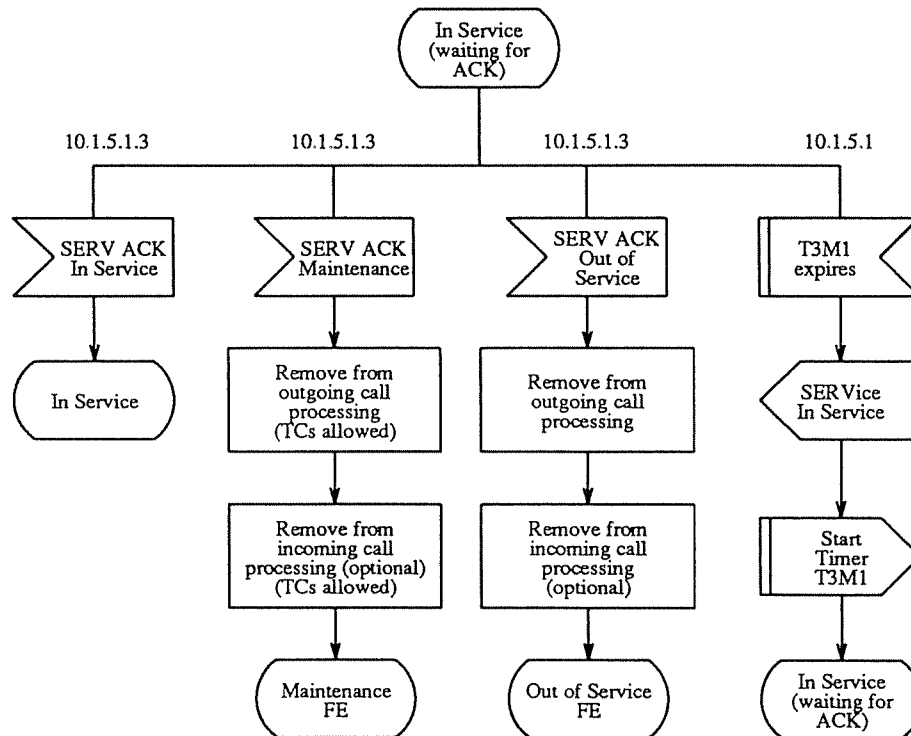


Figure IV-10-1. SDL SERVICE In Service (part 1 of 2)

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NOTE: This diagram applies
to B-channels only.

Figure IV-10-2. SDL SERVICE In Service (part 2 of 2)

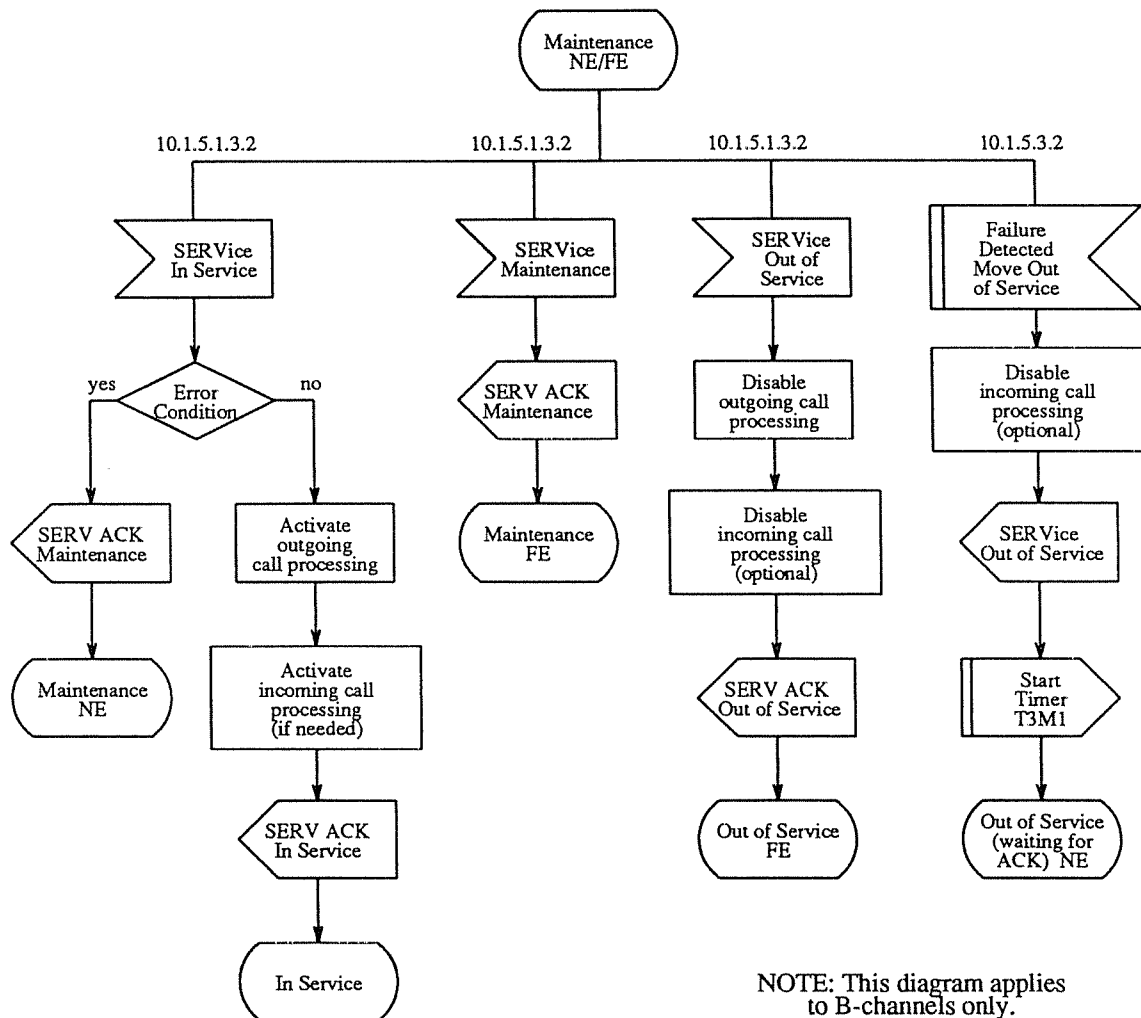


Figure IV-10-3. SDL SERVICE Maintenance (part 1 of 3)

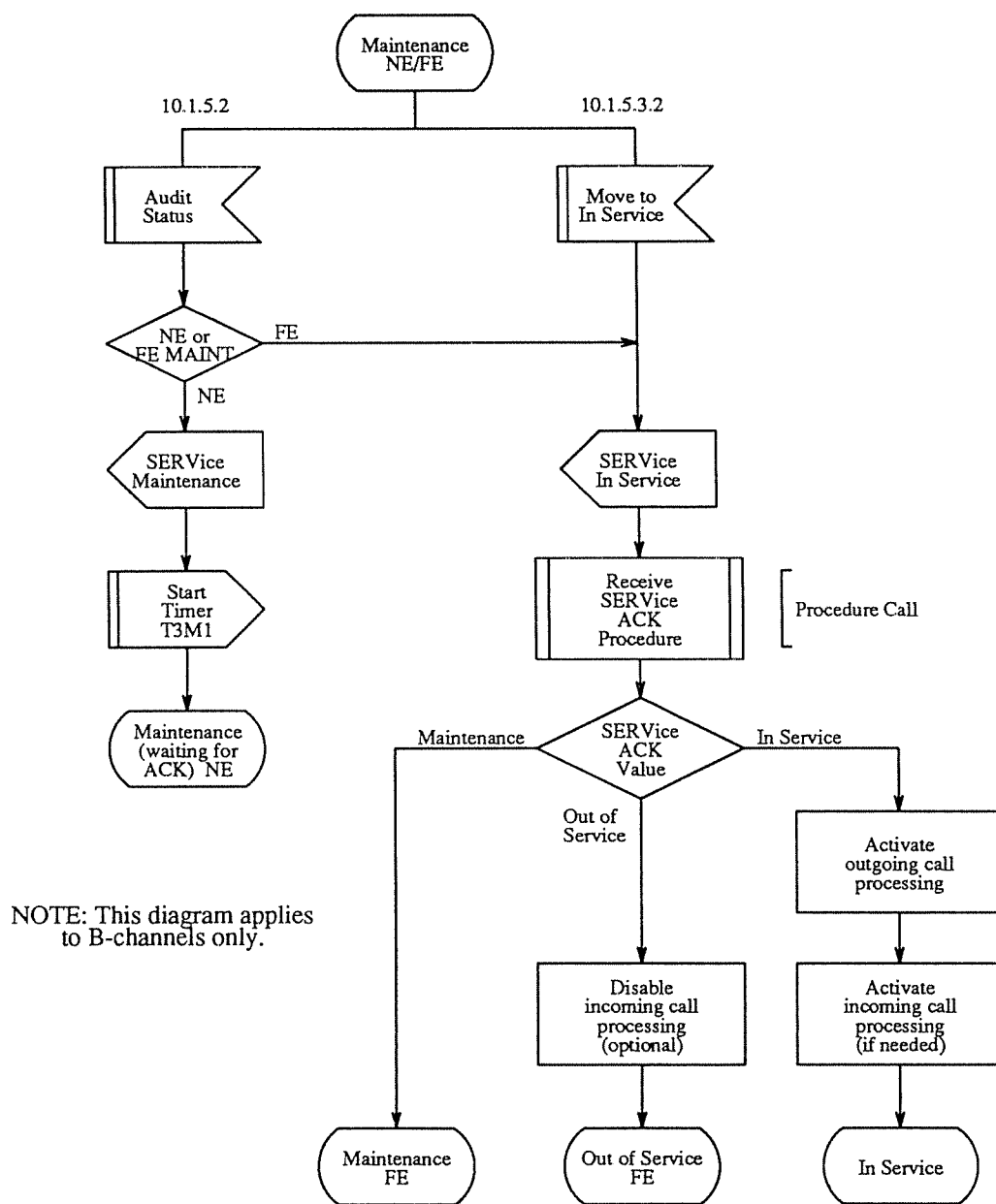


Figure IV-10-4. SDL SERVICE Maintenance (part 2 of 3)

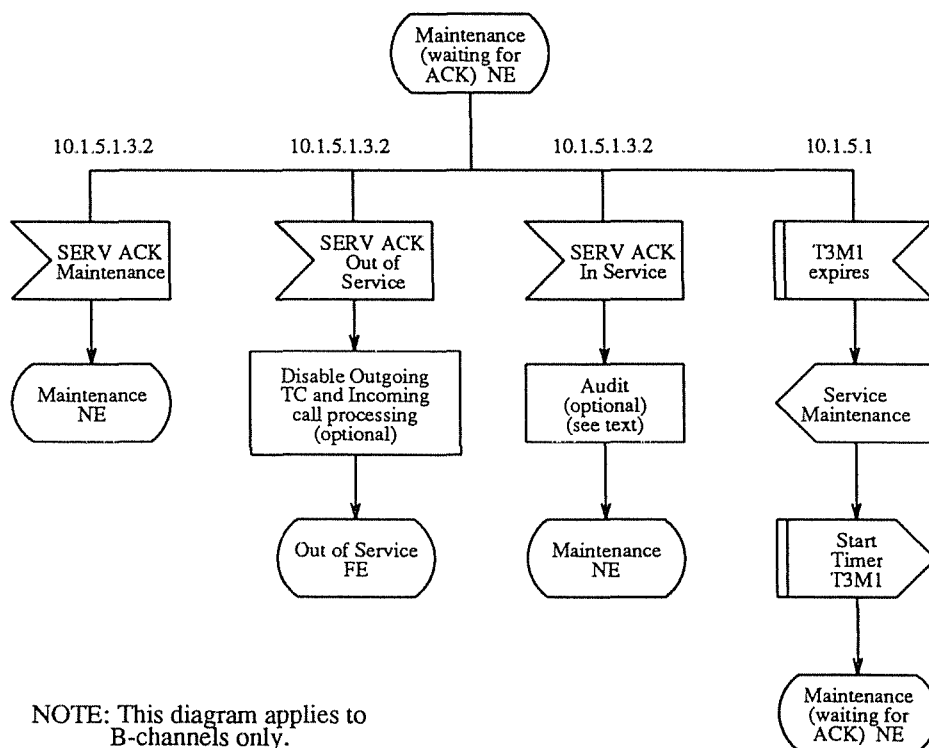
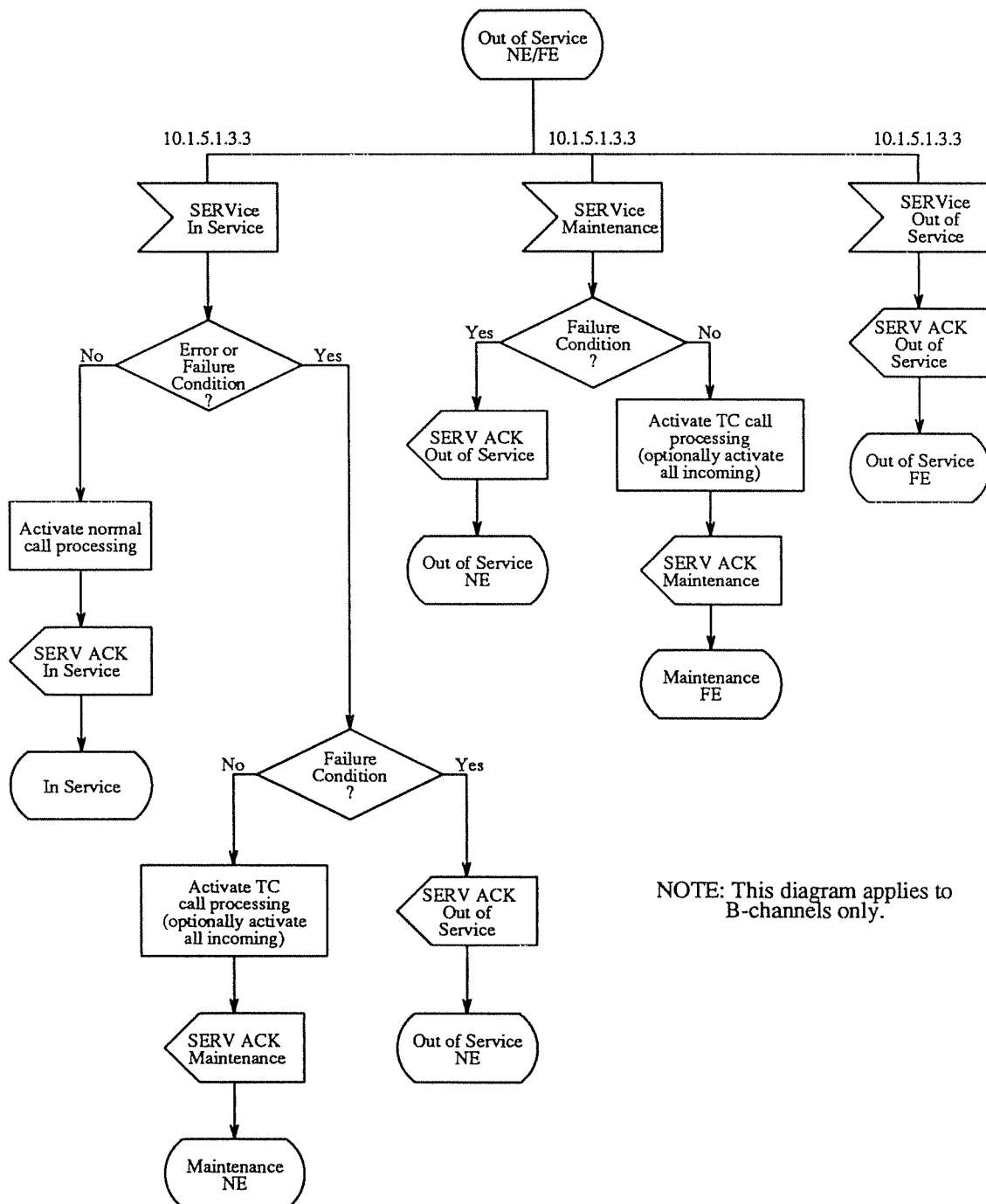


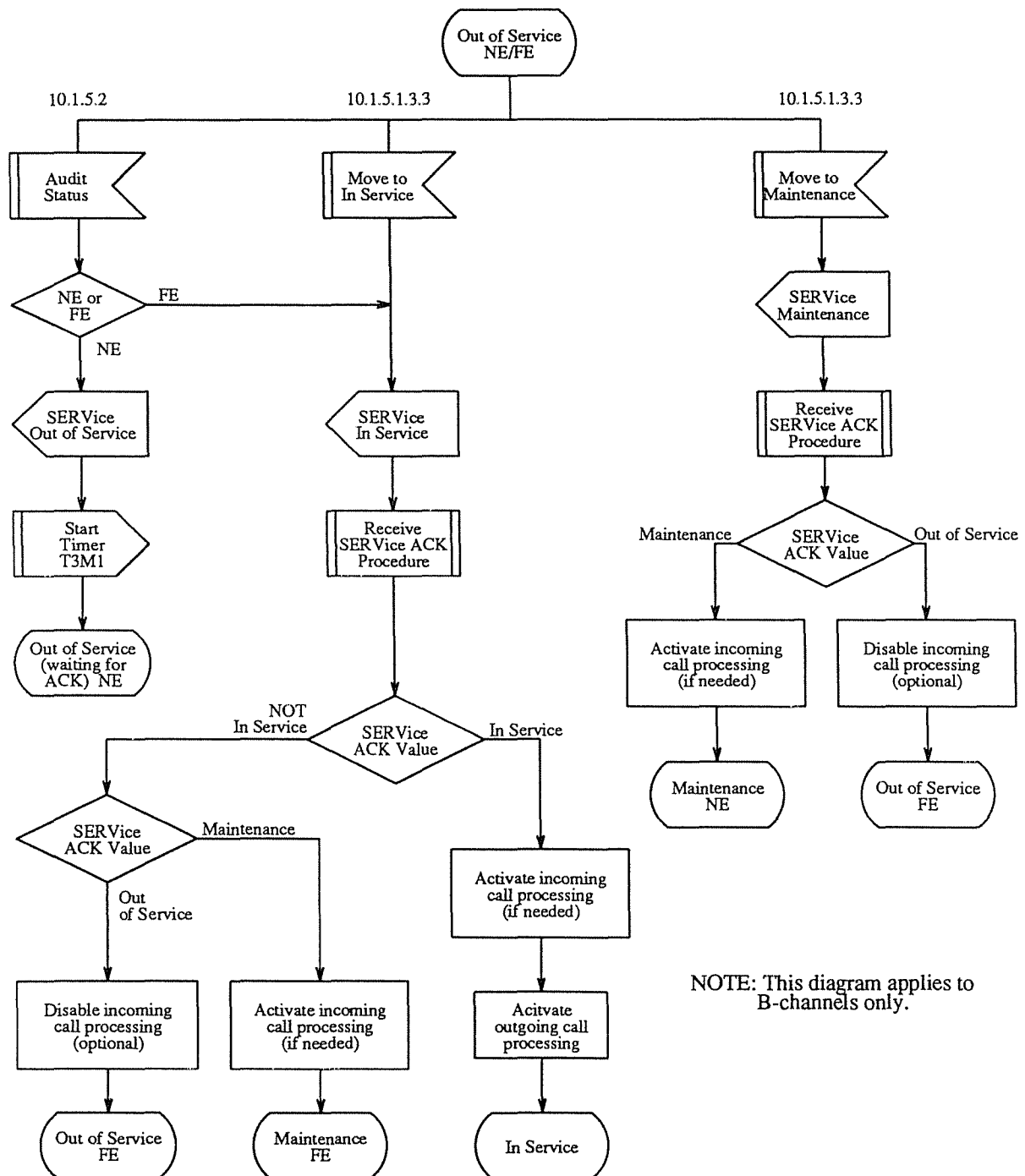
Figure IV-10-5. SDL SERVICE Maintenance (part 3 of 3)



NOTE: This diagram applies to B-channels only.

Figure IV-10-6. SDL SERVICE Out of Service (part 1 of 3)

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NOTE: This diagram applies to B-channels only.

Figure IV-10-7. SDL SERVICE Out of Service (part 2 of 3)

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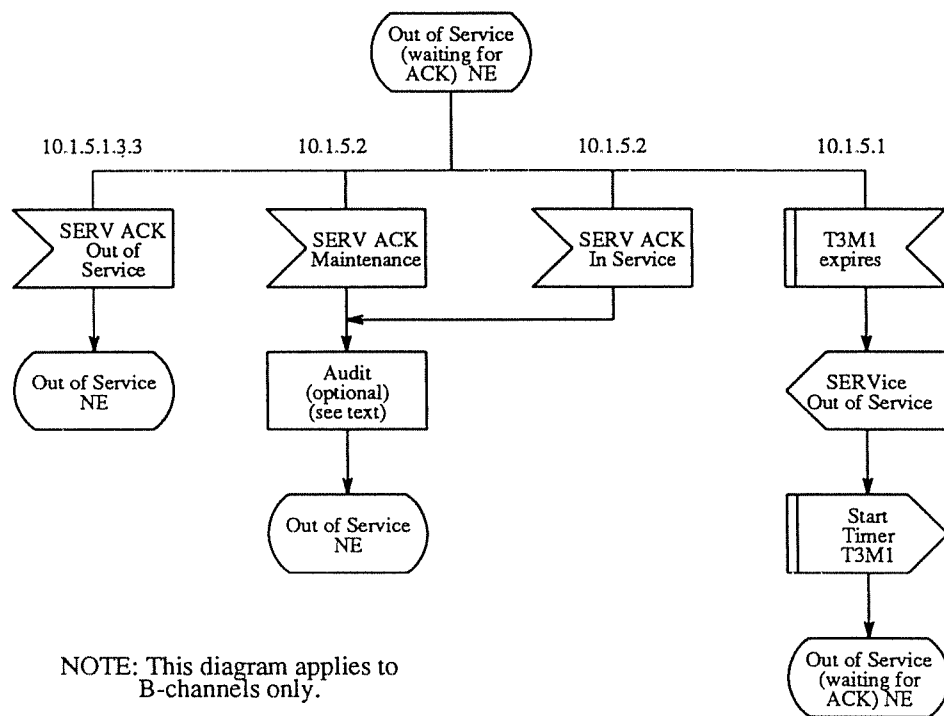


Figure IV-10-8. SDL SERVICE Out of Service (part 3 of 3)

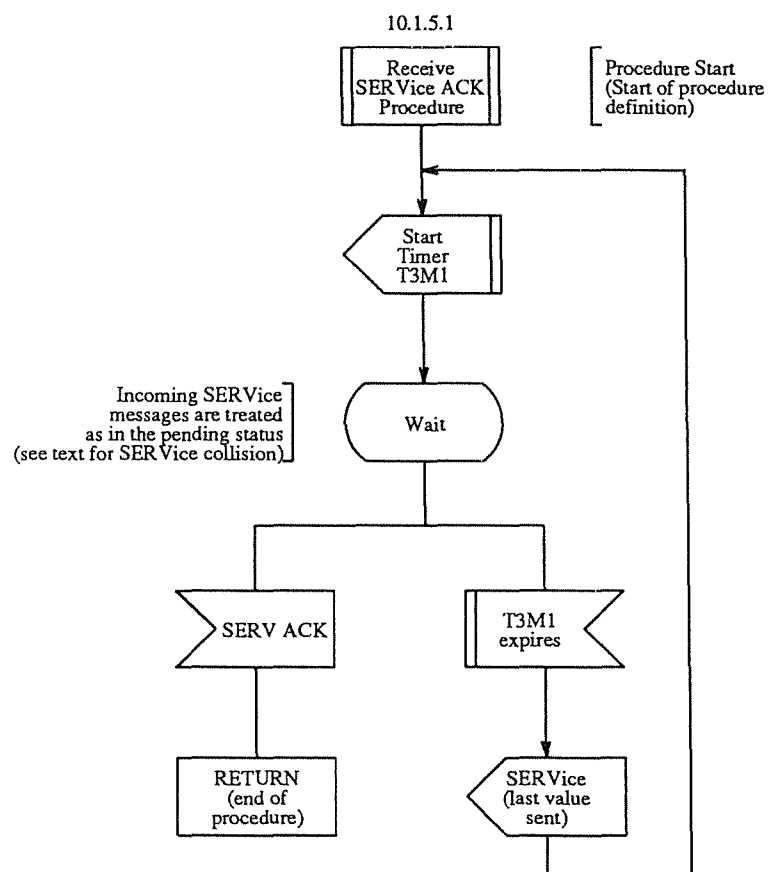


Figure IV-10-9. SDL SERVICE Receive SERVICE ACK

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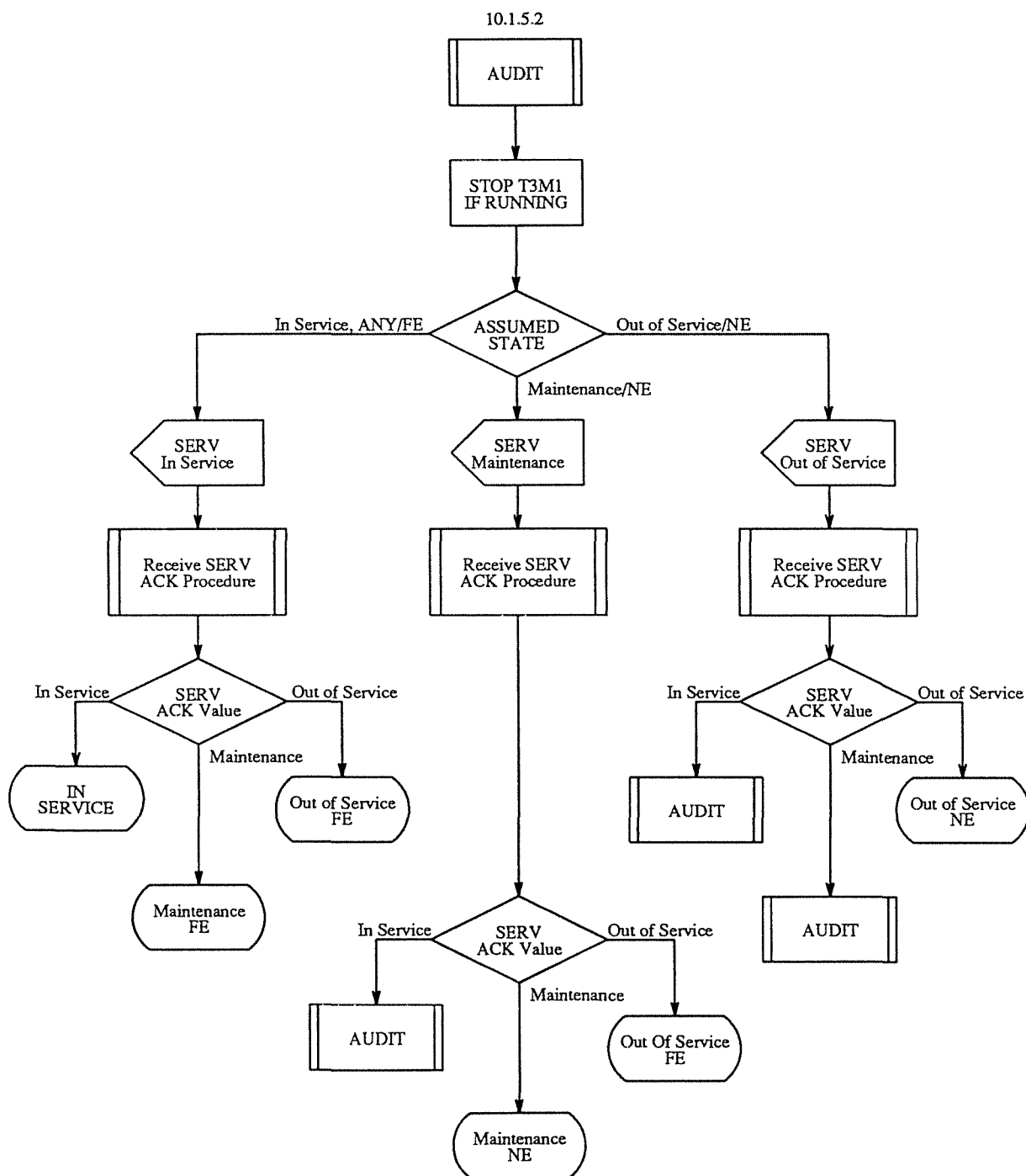


Figure IV-10-10. SDL SERVICE AUDIT

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10.1.5.2 Status Audits

The SERVICE status audit procedure allows either side of an interface to bring both sides of the interface to agreement on the status by an exchange of SERVICE and SERVICE ACKNOWLEDGE messages. The Change status information element in the SERVICE message should be set to the *In Service* value if the circuit is either in the *In Service* category or is in only a Far End subcategory of *Maintenance* or *Out of Service*. Otherwise the current category should be sent. This procedure will force the status to become aligned on each side of the interface and will return resources to service if possible.

Audits may be triggered periodically or by a variety of unexpected events. Triggers that have been implemented in the network are listed below. They are not mutually exclusive and are listed roughly in order of decreasing preference.

- a. Normal incoming calls while in the *Maintenance* status or any incoming call while in the *Out of Service* status.
- b. Unsolicited SERVICE ACKNOWLEDGE or unallowed responses to SERVICE messages (such as a request to place a circuit *Out of Service* resulting in a SERVICE ACKNOWLEDGE response of *In Service*).
- c. Receipt of Cause 44 on any call clearing message.
- d. On B Channels that were rejected by the channel negotiation process because there were *Out of Service*.
- e. Once every 24 hours on all channels
- f. Once every hour on all channels in *Maintenance/Far End* or *Out of Service/Far End* states.
- g. The SERVICE status audit procedure is not supported.

10.1.5.3 Initial Service Status

Newly provisioned channels are initially placed in the *Out of Service* category. Network switches should be in initial control of newly provisioned circuits. Therefore, the *Out of Service* States must be Near-End for the network switches and Far-end for CPE.

CPE may attempt to bring these circuits into service by sending a SERVICE message.

10.1.5.4 Relationship of SERVICE Status to Call Processing State

The exchange of SERVICE and SERVICE ACKNOWLEDGE messages do not of themselves change the call processing state of either a stable call or an in progress call. However, change in service status can have implications for call processing that may trigger the exchange of call processing messages.

Conversely, the exchange of call processing messages does not change the Service status category. However, call processing messages that are inconsistent with the current status category may trigger Service status audit procedures (see above) that result in the exchange of SERVICE messages that change the Service status category.

10.1.5.5 SERVICE Message Collision

Collision occurs when a SERVICE message is received in the period of time between when a SERVICE message is sent and its responding SERVICE ACKNOWLEDGE is received. When this occurs, the incoming SERVICE message is treated in the normal manner, *i.e.* the appropriate SERVICE ACKNOWLEDGE is sent. It should be noted that the following transitions are in effect when the SERVICE message is sent:

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- In-Service/Any -> Maintenance/NE
- In-Service/Any -> Out-of-Service/NE
- Maintenance/Any -> Out-of-Service/NE

where "Any" means Near End or Far End.

This means that when the transition is from a more to a less available status the SERVICE ACKNOWLEDGE sent in response to the colliding SERVICE message reflects the new less available status which is either *Maintenance/NE* or *Out of Service/NE*. Note that if the new status is *Maintenance/NE* and the glaring SERVICE message is requesting a transition to *Out of Service*, the transition to *Out of Service/FE* is made and the SERVICE ACKNOWLEDGE sent in response has the status of *Out of Service*.

When the transition is from a less to a more available status category, the SERVICE ACKNOWLEDGE sent in response to a colliding SERVICE message reflects the pending status; that is the SERVICE ACKNOWLEDGE sent is the one that would be sent if the confirming SERVICE ACKNOWLEDGE had been received. (For those systems that track the Near End and Far End status independently, this is the current Near End status).

If the pending transition is into the *In Service* status category from a less available status, then arriving SERVICE messages requesting *In Service* are responded to by a SERVICE ACKNOWLEDGE of *In Service* and the *In Service* status is entered. If the arriving SERVICE message requests the *Maintenance* or *Out of Service* category, then the responding SERVICE ACKNOWLEDGE reflects the *Maintenance* or *Out of Service* status and that status category is entered.

If the pending transition is into the *Maintenance* status category from the *Out of Service* category and the arriving SERVICE message requests the *In Service* status, then the responding SERVICE ACKNOWLEDGE reflects the *Maintenance* status category and the *Maintenance* status may be entered. If the arriving SERVICE message requests the *Maintenance* status, then the responding Service ACKNOWLEDGE reflects the *Maintenance* status category and that status is entered. If the arriving Service message requests the *Out of Service* status category then the responding SERVICE ACKNOWLEDGE reflects that status and the *Out of Service* status is entered.

10.1.5.6 Error Conditions

If a SERVICE or SERVICE ACKNOWLEDGE message is received without a global call reference value, a RELEASE COMPLETE shall be sent with cause "invalid call reference" (cause value 81).

If a SERVICE message is received with a missing Change Status or Channel Identification information element, or with invalid contents for either information element:

- The preferred response is to return a STATUS message with global CRV and Cause 100, "invalid information element content."
- Ignore the message.

10.1.5.6.1 Receipt of a Solicited Message with Invalid Contents

If a SERVICE ACKNOWLEDGE message is received with a missing Change Status or Channel Identification information element, or with invalid contents for either information element:

- The preferred response is to return a STATUS message with global CRV and Cause 100, "invalid information element content."
- Ignore the message.

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If the Channel Identification information element is recognized as referring to an unprovisioned or unadministered B channel,

- a. The preferred response is to return a STATUS message with global CRV and Cause 82, "identified channel does not exist," or
- b. ignore the message.

If a SERVICE ACKNOWLEDGE message is received without a Change Status information element:

- a. The preferred response is to return a STATUS message with Cause 100, "invalid information element contents," or
- b. ignore the message.

If a SERVICE ACKNOWLEDGE is received with a Change Status information element with invalid contents:

- a. The preferred response is to return a STATUS message with the current CRV, and call state for the indicated channel, and Cause 100, "invalid information element contents."
- b. Return a STATUS message with global CRV, call state 0, and Cause 100, "invalid information element contents."
- c. Ignore the SERVICE ACKNOWLEDGE message.

10.1.5.6.2 Receipt of an Unsolicited Message

If an unsolicited SERVICE ACKNOWLEDGE message is received:

- a. The preferred response is to ignore the message if the channel status agrees with that assumed by the recipient of the message. Otherwise perform a SERVICE status audit as described in Section 10.1.5.2.
- b. Treat the same as a solicited SERVICE ACKNOWLEDGE.
- c. Ignore it.

These responses are in order of decreasing preference.

10.1.6 Maintenance Message Definitions

10.1.6.1 Overview

The messages defined in this section can be sent by either the user or network. Each definition includes a brief description of the message use, and the information elements listed in order of appearance in addition to the Protocol discriminator, Call reference and Message type information elements which are always present. The indicated information elements must be present.

10.1.6.2 Maintenance Messages

10.1.6.2.1 SERVICE (See Section 3.4.4)

10.1.6.2.2 SERVICE ACKNOWLEDGE (See Section 3.4.5)

10.1.7 Message Structure

10.1.7.1 Overview

The messages identified for the maintenance of the User-Network interface follow the same structure as call control messages defined in Section 4.1. The message consists of the following parts:

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- a) protocol discriminator;
- b) call reference;
- c) message type;
- d) mandatory information elements, as required;
- e) additional information elements, when required.

In the following sections, each of the components will be discussed in turn.

10.1.7.1.1 Protocol Discriminator

The purpose of the protocol discriminator is to identify messages for maintenance of the interface. The coding for the protocol discriminator is shown in Figure IV-10-11.

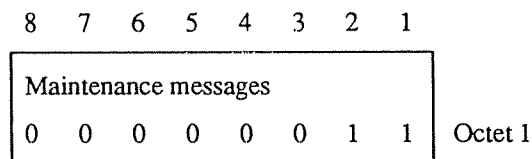


Figure IV-10-11. Protocol Discriminator

10.1.7.1.2 Call reference

The call reference is the second part of every message. For all specified maintenance messages, the global call reference will be used. It is two octets long with the first octet coded "0000 0001" and the second octet coded "F000 0000", where F is the call reference flag defined in Section 4.3. It is strongly recommended that equipment be able to accept a three octet global call reference value as described in section 4.3.

10.1.7.1.3 Message type

The purpose of the message type is to identify the function of the message being sent. The message type is the third part of every message. It is coded as shown in Figure IV-10-12.

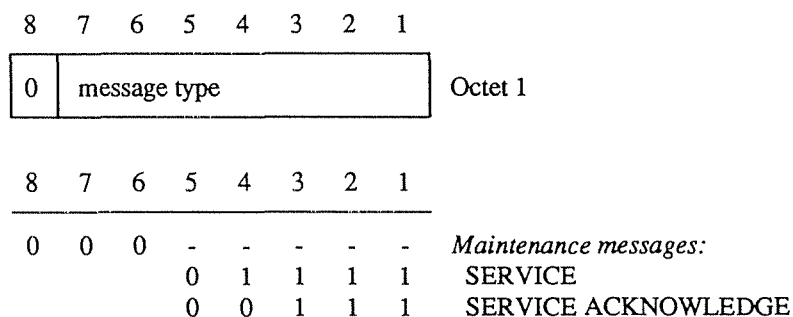


Figure IV-10-12. Message Types

10.1.7.1.4 Other information elements

10.1.7.1.4.1 Coding rules The coding of the Channel identification information element is given in Section 4.5.13. It may be between 3 and 6 octets long when appearing in the given Maintenance messages. The coding of the Change status information element is summarized in Figure IV-10-13. The one additional information element identified belongs to *codeset 0* as specified in Q.931.

8	7	6	5	4	3	2	1		<u>Section reference</u>
0	:	:	:	:	:	:	:	Variable length information elements:	
	0	0	0	0	0	0	1	Change status	4.5.30

Figure IV-10-13. Information Element Identifier Coding

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11. AT&T Services

11.1 Networked Services

11.1.1 Introduction

This section defines the methods used on the Primary Rate Interface to request services from ISDN Networks. These services are either (1) a capability requested of the ISDN network that supplements basic call control (e.g., identifying a service request such as MEGACOM® or WATS), (2) access a feature of a given interface (e.g., request BN on a call by call basis), (3) an end-to-end feature, that enhances a basic call (e.g., connected/calling name display), utilizing ISDN transport mechanisms to pass the information elements, or (4) a capability that does not require an associated B-channel call between the end-points of the signaling dialogue. For the AT&T product involved, see product specific documentation.

Different mechanisms are utilized to provide the services defined in this section. Services may be provided by the following methods:

1. On a subscription basis,
2. Implicitly by transferring an information element, and
3. Explicitly by transferring a functional service information element. This type of information element can identify multiple services and provides a general purpose mechanism for requesting services.

Methods 2 and 3 are accomplished by inserting appropriate information elements in Q.931 messages or by the establishment of (call and non-call associated) temporary signaling connections for passing service information between users. The procedures for requesting both call and non-call associated temporary signaling connections are documented in Section 7.

11.1.2 Subscription Services

11.1.2.1 Privacy Optioning at the Originating End (Presentation Restriction)

11.1.2.1.1 CPN Privacy Optioning

Calling Party Number (CPN)¹, is a number provided either by the originating user or the originating central office switch which identifies the originating line of the call.

The calling user can control the presentation of CPN to the called user on a subscription or per call basis (see Section 11.1.3.3). This capability prevents the terminating switch from passing CPN of the calling party to the terminating customer. If the CPN is available and is allowed to be delivered, the network will then deliver it in the SETUP message. The CPN Privacy Optioning is provisioned with one of the two values -- "CPN Presentation Allowed" and "CPN Presentation Restricted". However, these provisioned values may be overridden on a per call basis by the PRI customer. See Section 11.1.3.3 for more detail.

11.1.2.1.2 BN Privacy Optioning

Billing Number (BN), previously called Automatic Number Identification (ANI), is a customer billing

1. Station Identification (SID) is User Provided CPN

number stored in the originating switch.

Similar to CPN privacy capability, the calling user can control the presentation of BN to the called user on a subscription or per call basis (see Section 11.1.3.3). The BN Privacy Optioning is provisioned with one of the two values -- "BN Presentation Allowed" and "BN Presentation Restricted". However, these provisioned values may be over-ridden on a per call basis by the PRI customer. See Section 11.1.3.3 for more detail.

Currently, in some implementations, there is no mechanism in the network to carry the presentation restriction information for BN independently. Therefore, at the terminating switch, the presentation restriction value for CPN (either restricted or not restricted) will be assumed for the BN also. If the called customer has subscribed to receive BN and is allowed to be delivered, the network will then deliver it in the SETUP message.

11.1.2.2 CPN/BN to Terminating User: Optional

With this feature the terminating user may be provided with the caller's CPN or BN. The customer will choose, at service provisioning, whether to subscribe to this feature or not. For those who do subscribe, there are two service alternatives:

1. CPN/BN provided on every call when available; or
2. CPN/BN provided per call upon request.

See product specific documentation for options supported.

The CPN or BN will be delivered to the terminating user via either the SETUP or the FACILITY ACKNOWLEDGE message, depending on the situation: SETUP in case (1) above, and FACILITY ACKNOWLEDGE in case (2). See Section 11.1.2.2.1 and 11.1.2.2.2 for details on CPN/BN provided on every call when available, and AT&T product specifications for details on CPN/BN provided per call upon request.

11.1.2.2.1 Calling Party Number (CPN) to Terminating User: Optional

If the customer wishes to receive CPN for every call, then for each Trunk Group (TG), the customer must specify one of the following:

- a. *CPN only.* If CPN is available, it will be sent to the terminating customer and BN, although it may be available, will never be delivered.
- b. *CPN preferred.* If CPN is available, it will be sent to the customer and BN, although it may be available, will not be delivered. If CPN is not available then BN, if available, will be delivered to the customer.

If CPN is available and presentation is not restricted, the number is placed in the SETUP message to the terminating user. The number is inserted in the Calling party number information element. If the network does not provide octet 3a in the CPN IE when CPN is being provided, the default values for Presentation Indicator and Screening Indicator are "Presentation allowed" and "User provided not screened", respectively will be assumed. Octet 3a must be provided if other than default values must be conveyed.

In some cases, the CPN may be unavailable, e.g., a call which has originated in a local network that does

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not support Equal Access.

11.1.2.2.2 Billing Number (BN) to Terminating User: Optional

If the customer wishes to receive BN for every call, then for each Trunk Group (TG), the customer must specify one of the following:

- a. *BN only.* If BN is available, it will be sent to the terminating customer and CPN, although it may be available, will never be delivered.
- b. *BN preferred.* If BN is available, it will be sent to the customer and CPN, although it may be available, will not be delivered. If BN is not available then CPN, if available, will be delivered to the customer.

If BN is available and presentation is not restricted, the number is placed in the SETUP message to the terminating user. The number is inserted in the Calling party number information element. The screening indicator for BN is always coded "network provided".

In some cases, the BN may be unavailable, e.g., a call which has originated in a local network that does not support Equal Access.

11.1.3 Services Provided Implicitly by Information Element Transfer

The majority of these services are provided by relaying end-to-end information elements defined in codesets 6 or 7. The sole exception is the network option (see section on Presentation Restriction) to take appropriate action on the contents of the "Presentation Indicator" field in the Calling Party Number information element.

11.1.3.1 Traveling Class Mark

The Traveling Class Mark (TCM) information element in codeset 6 or 7 (see product specific documentation) identifies the call privileges of the calling user. It may be inserted in a SETUP message by a user or the PBX/Centrex switch serving the user. The TCM information element may be examined by intermediate private tandem nodes to determine call routing.

11.1.3.2 CPN to Network

The user sends the calling party number (CPN) in the Calling party number information element contained in the SETUP message. The calling user may specify "presentation restricted" in the Calling party number information element Presentation indicator and not allow the Calling party number (CPN) to be passed to a terminating customer (See Section 11.1.2.1). The user specified value in the Presentation Indicator field over-rides the switch stored default value for that call. The Screening indicator of the Calling party number IE indicates whether the CPN was user or network provided and whether a user provided number was verified. This field is always reset by the originating switch to the appropriate value. The network may perform validation screening of the CPN provided by the user.

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11.1.3.3 Privacy Optioning at the Originating End (Presentation Restriction)

The calling user can control the presentation of CPN/BN to the called user on a subscription (see Section 11.1.2.1) or per call basis². The Presentation indicator (bits 7 and 6) field in octet 3a of the Calling party number information element permits the originating user to pass an indication to the network concerning the delivery of the CPN/BN to the terminating user.

The content in the Presentation indicator field over-rides the provisioned value. If octet 3a is not included in the Calling party number information element and there is no provisioned value stored in the switch, then the default value "Presentation Allowed" will be assumed for that call.

11.1.3.4 Bearer Services

To select a particular service supported by the network, the user indicates this selection by including the appropriate coding of the bearer capability and channel identification information elements in the SETUP message.

The following sub-sections detail how access to various network provided services is provided.

11.1.3.4.1 56 Kbps Clear/Restricted

To request 56 Kbps service, the information transfer capability field in octet 3 must be coded for restricted or unrestricted digital information, the information transfer rate in octet 4 must be coded for 64 Kbps, the user information layer 1 protocol in octet 5 must indicate rate adaption, and extension octet 5a the 56 Kbps stream according to CCITT Recommendation I.463.

11.1.3.4.2 64 Kbps Clear/Restricted

To request a 64 Kbps clear/restricted channel, the user shall use the Bearer capability information element in the following manner:

- The Information transfer capability is set to unrestricted/restricted digital information.
- The Information transfer rate is set to 64 Kbps.

When the exchange offers this 64 Kbps clear/restricted call, it follows the same procedure.

11.1.4 Services Provided Explicitly by Functional Service Information Elements

Three functional service information elements are utilized on the Primary Rate Interface: Network-specific facilities (Codeset 0), Facility (Codeset 6), and AT&T standardized facilities (Codeset 6). For each element, its operation is detailed in this section (e.g., default treatment, messages it may appear in, procedures) along with a description of each service and the accompanying procedure to obtain the desired service. These information elements permit the user to request features of a desired provider. They differ in their operation and flexibility.

2. See product specific documentation for support of this option.

11.1.4.1 Network-Specific Facilities Information Element

11.1.4.1.1 Operation

11.1.4.1.1.1 General The content of the network-specific facilities (NSF) information element is defined in Section 4.5.20. The purpose of this information element, which may be present in a SETUP or FACility message, is to indicate which facilities are being requested of a particular network provider. The provider options supported in this specification are default provider (i.e., network side of the interface) and indicated provider (i.e., routing of information required to identified network). Depending on the service identified in the NSF information element, it may be delivered to the destination of a call.

11.1.4.1.1.2 Rules No more than two NSF information elements may be used in a SETUP message. When this information element is repeated, any binary facilities are present in the first information element and only a single parameterized facility is permitted in the second information element. If a user includes the NSF information element in the SETUP message, pre-subscribed default service treatment is overridden.

When the length of the network identification field is set to zero in the NSF information element, then the services identified are to be provided by the network side of the interface receiving the information element (default provider). If the NSF information element is recognized but the network facilities are not understood, then this information element is processed according to rules for non-mandatory information element content error. If the length of the network identification field is not zero, then an equal access carrier code (e.g., "288", CIC assigned to AT&T) is to be provided in the Network identification field.

11.1.4.1.2 Features

11.1.4.1.2.1 Call-Associated Temporary Signaling Connections (CA-TSC) See section 7.

11.1.4.2 Facility Information Element

11.1.4.2.1 Operation

11.1.4.2.1.1 General The content of the Facility information element is defined in section 4.6.8.14. The purpose of this information element, which may be present in any Q.931 message, is to indicate which service is being requested or responded to. Since the information element identifies the action (e.g., request, acceptance, denial, error) for a service, multiple dedicated messages (e.g. FACILITY ACKNOWLEDGE, FACILITY REJECT) for this information element in association with a B-channel call are not required. Due to this flexibility, the Facility information element is the appropriate vehicle for providing new services.

11.1.4.2.1.2 Invocation of Services Associated with a Call When a PBX or network switch desires a call related service that is not provided with the Network-specific facilities information element, it will either pass an indication identified in the Facility information element (see section 4.6.8.14) in an eligible call control message (i.e., SETUP, ALERTing, or CONNect) or in a USER INFORMATION message. A USER INFORMATION message is utilized when a service interaction is desired and it is not appropriate to send a call control message (e.g., in the active state of a call).

To request the desired service, an Facility information element is formulated with a *invoke identifier* that is unique (see section 11.1.4.2.1.4.1) to the call reference assigned for the call.³ The component type is set to *invoke*. The service desired is identified as a parameter of the Request Feature operation of the Facility information element. Any other parameters required for the capability are coded as Q.931 information elements and follow the "operation value" octet. The parameters provide additional information which when combined with the identified service define the overall capability to be provided. The rules for ordering of parameters is provided in section 4.6.8.14.

The response to the request identified in an Facility information element may be conveyed in an ALERTING, CONNECT, First Clearing, or USER INFORMATION message⁴. The Facility information element returned may contain the invoke identifier sent in the original Facility information element invoke. The three possible response component types are:

1. Return Result which implies *positive acknowledgement* to the request and the service desired will be provided.
2. Return Error which implies that the identified service *could not be provided* and a cause indicating the reason for failure may be returned.
3. Reject which implies that the original request was *not understood* (due to protocol or coding errors). This is similar to sending a STATUS message for unrecognized information elements with the addition of clearing out the request. A cause is sent to identify the reason for failure.

These component types terminate the interaction on the service request. See section 11.1.4.2.1.4.3 for a description of the release of invoke identifiers.

11.1.4.2.1.3 Invocation of Services Not Associated with a Call The procedures for this class build upon those defined in section 11.1.4.2.1.2 for the Facility information element and use a NCA-TSC. The procedure for providing services for which no B-channel call exists between the end-points follows the NCA-TSC procedures (see Section 7.2).

11.1.4.2.1.4 Invoke Identifiers / Linked Identifiers

11.1.4.2.1.4.1 Definition and Establishment Invoke Identifiers and Linked Identifiers are numbers which can be used to relate information received in a Facility information element to an ongoing transaction associated with a call.

A new process identifier is established whenever an Facility information element with an "invoke" component types is used. Either the user or the network may send an Facility with an invoke component type; thus, either the user or the network may establish a new identifier.

An Invoke identifier must be unique to the Q.931 Call Reference Value with which it is associated.

There is no restriction on the algorithm used to pick new invoke identifiers, and no requirement that invoke identifiers be used sequentially.

3. The same invoke identifier may be used for multiple call reference values that exist on an interface at a given time.

4. The selection of an appropriate message will depend upon what entity (e.g., far end user, PBX, network switch) responds to the request for a service.

11.1.4.2.1.4.2 Linking of Invoke Identifiers in Complex Interactions In a complex service interaction it is expected that several messages containing Facility information elements may be exchanged prior to completion of the service request. In such an interaction, an invoke identifier is assigned by a Facility information element containing an "invoke" component type. The response to the invoke component type might be another Facility information element containing an "invoke" component type which both establishes a new invoked identifier and returns a "linked identifier". The linked identifier is the invoke identifier in the Facility information element which is being responded to. If the interaction involves many messages containing Facility information elements with "invoke" component types being exchanged, the invoke identifiers in all these messages are linked, as in a chain. The following table illustrates a possible scenario. It assumes the interaction was initiated by the network side of the interface.

Message Initiator	Component Type	Invoke ID	Linked ID
Network	Invoke	0	-
User	Invoke	1	0
Network	Invoke	2	1
User	Invoke	3	2
Network	Invoke	4	3
User	Invoke	5	4
Network	Return Result	5	-

By virtue of the series of messages exchanged, all the process identifiers, 0 through 5 are linked. All the invoke identifiers are active and may not be re-used for another transaction associated with the same call until the invoke identifiers are cleared by the "return result".

11.1.4.2.1.4.3 Clearing of Invoke Identifiers An invoke identifier is considered cleared if it is no longer actively associated with a call and is available for re-use. An invoke identifier may be cleared and made available for re-use in either of two ways:

1. An invoke identifier may be cleared by sending an Facility with a return result, return error, or reject component type.
2. An invoke identifier may be cleared by clearing the Q.931 call reference value with which it is associated.

When an invoke identifier is cleared, all associated linked identifiers are also cleared and available for re-use.

11.1.4.3 AT&T Standardized Facilities Information Element

This information element is included in the specification only for SNC backward compatibility. This information element shall not be used for any other new or existing services; the Facility IE shall be used instead.

11.1.4.3.1 Operation

11.1.4.3.1.1 General The content of the AT&T standardized facilities (ASF) information element is defined in section 4.6.8.1. The purpose of this information element, which may be present in any Q.931 message, is to indicate which service is being requested or responded to. Since the information element identifies the action (e.g., request, acceptance, denial, error) for a service, multiple dedicated messages (e.g.

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FACILITY ACKNOWLEDGE, FACILITY REJECT) for this information element in association with a B-channel call are not required. Due to this flexibility, the ASF information element is an appropriate vehicle for providing many new services.

11.1.4.3.1.2 Invocation of Services Associated with a Call When a PBX or network switch desires a call related service that is not provided with the Network-specific facilities information element, it will either pass an indication identified in the ASF information element (see section 4.6.8.1) in an eligible call control message (i.e., SETUP, ALERTING, or CONNECT) or in a FACILITY message. A FACILITY message is utilized when a service interaction is desired and it is not appropriate to send a call control message (e.g., in the active state of a call).

To request the desired service, an ASF information element is formulated with a idle (i.e., not in use) *process identifier* that is unique (see section 11.1.4.3.1.4.1) to the call reference assigned for the call.⁵ The control type is set to *invoke*. The service desired is identified in an appropriate *service element* in octet 5 of the ASF information element. Any parameters required for the capability are coded as Q.931 information elements and follow the "service element" octet. The parameters provide additional information which when combined with the identified service define the overall capability to be provided. The rules for ordering of parameters is provided in section 4.6.8.1.

The response to the request identified in an ASF information element may be conveyed in an ALERTING, CONNECT, First Clearing, or FACILITY message⁶. The ASF information element returned will contain a process identifier, a control type, and optionally a service element with associated parameters. The process identifier utilized is the one sent in the original ASF information element with control type set to invoke. The three possible control types are:

1. Return Result which implies *positive acknowledgement* to the request and the service desired will be provided.
2. Return Error which implies that the identified service *could not be provided* and a cause indicating the reason for failure may be returned.
3. Reject which implies that the original request was *not understood* (due to protocol or coding errors). This is similar to sending a STATUS message for unrecognized information elements with the addition of clearing out the request. A cause is sent to identify the reason for failure.

These control types terminate the interaction on the service request. See section 11.1.4.3.1.4.3 for a description of the release of process identifiers.

11.1.4.3.1.3 Invocation of Services Not Associated with a Call The procedures for this class build upon those defined in section 11.1.4.3.1.2 for the ASF information element without the overhead of the Q.931 call control state machine.⁷ The procedure for providing services for which no B-channel call exists between the end-points of the service dialogue is as follows:

-
5. The same process identifier may be used for multiple call reference values that exist on an interface at a given time.
 6. The selection of an appropriate message will depend upon what entity (e.g., far end user, PBX, network switch) responds to the request for a service.
 7. For B-channel calls, there is a significant overhead associated with supporting layer 3 timers, full error recovery, mandatory messages, information elements for setting up a call (e.g., bearer capability, channel identification, and called/calling party numbers) and call clearing sequences.

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1. The service interaction is started with a REGISTER message with an *idle*⁸ call reference value, a locking shift to codeset 6, and one or more ASF information elements. Each ASF information element identifies a separate capability to be provided.
2. The rules for coding each ASF information element conveyed in a REGISTER message are the same as defined in section 11.1.4.3.1.2. A process identifier is assigned (see section 11.1.4.3.1.4.1) for each ASF information element and the control type is set to *invoke*. The service desired is identified in the service element octet of the ASF information element. Any parameters associated with the capability are passed in the parameter list of the ASF information element sent in the REGISTER message. A parameter may be included in an ASF information to define a companion capability to that identified in the "service element."
3. The response to the REGISTER message is either:
 - a. a FACILITY message with the same call reference value and an ASF information element with a control type indicating the response to the request. The possible control types are:
 - *return result* (i.e., success), *return error* (i.e., failure), or *reject* (i.e., protocol error). Use of these control types releases the process identifier conveyed in the ASF information element. Following transmission of the FACILITY message, a RELEASE COMPLETE message is sent by either side of the interface to release the call reference value.
 - When more than an initial response to the service request is called for, the possible control types are *invoke not last* or *invoke last*. The implications of these control types and the subsequent actions is detailed in items 4 thru 7.
 - b. a RELEASE COMPLETE message with the same call reference value and an ASF information with a control type indicating that no additional interaction is to occur on the requested service. The possible control types are *return result*, *return error*, and *reject*. The call reference value is released upon the processing of the RELEASE COMPLETE message and the service dialogue is concluded.
4. An ASF information element with a control type of *Invoke Not Last* implies that more than one response is possible for the service identified in the correlated process identifier. This control type is returned when additional information is needed to comply with the original request or to report on the status of a request. See sections 11.1.4.3.1.4.1, 11.1.4.3.1.4.2, and 11.1.4.3.1.4.3 for an explanation of correlated process identifiers and their relation to process identifiers.
5. *Invoke Last* is similar to *Invoke Not Last* with the exception that it is the final report on a capability that has been requested or requesting the cancellation of capability previously requested. This control type is useful for canceling an operation that has been started. This control type also requires the presence of a correlated process identifier in the ASF information element.
6. When a FACILITY message is received with a control type of *invoke not last*, subsequent FACILITY messages may be exchanged with this control type. When a FACILITY message is received with a control type of *invoke last*, the service dialogue is concluded by returning either a FACILITY or RELEASE COMPLETE message with a control type of *return result*, *return error*, or *reject* (see item 7).

8. A *idle* call reference value is one that is not currently assigned by the layer 3 entity to either call control applications or service applications independent of a call.

7. When the session is ready to be concluded, a RELEASE COMPLETE message is sent by the either side of the interface which will release any non-call related resources⁹ (e.g., call reference value). The RELEASE COMPLETE message will contain an ASF information element if there are process identifiers that have not been released.

11.1.4.3.1.4 Process Identifiers / Correlated Process Identifiers

11.1.4.3.1.4.1 Definition and Establishment Process Identifiers and Correlated Process Identifiers are numbers which can be used to relate information received in an ASF information element to an ongoing transaction associated with a call.

A new process identifier is established whenever an ASF information element with one of the "invoke" control types (invoke, invoke not last, invoke last) is used. Either the user or the network may send an ASF with one of the invoke control types; thus, either the user or the network may establish a new process identifier.

It is recommended that the user side, when establishing a new process identifier always use odd values, and that the network side always use even values.

A process identifier must be unique to the Q.931 Call Reference Value with which it is associated.

There is no restriction on the algorithm used to pick new process identifiers, and no requirement that process identifiers be used sequentially.

11.1.4.3.1.4.2 Linking of Process Identifiers in Complex Interactions In a complex service interaction it is expected that several messages containing ASF information elements may be exchanged prior to completion of the service request. In such an interaction, a process identifier would originally be initiated with an ASF information element containing an "invoke" control type. The response to the invoke control type would be an ASF information element containing an "invoke not last" or "invoke last" control type which both establishes a new process identifier and returns a "correlated process identifier". The correlated process identifier is the process identifier in the ASF information element which is being responded to. If the interaction involves many messages containing ASF information elements with "invoke not last" control types being exchanged, the process identifiers in all these messages are linked, as in a chain. The following table illustrates a possible scenario. It assumes the interaction was initiated by the network side of the interface.

9. Non-call related resources that can be released in this fashion include notification and status query. Releasing a call reference value does not terminate a process that was initiated or manipulated by the adjunct for which it is not a party (e.g., third party make call).

Message Initiator	Control Type	PID	COPID
Network	Invoke	0	-
User	Invoke Not Last	1	0
Network	Invoke Not Last	2	1
User	Invoke Not Last	3	2
Network	Invoke Not Last	4	3
User	Invoke Last	5	4
Network	Return Result	5	-

By virtue of the series of messages exchanged, all the process identifiers, 0 through 5 are linked. All the process identifiers are active and may not be re-used for another transaction associated with the same call until the process identifiers are cleared by the "return result".

11.1.4.3.1.4.3 Closing and Clearing of Process Identifiers A process identifier and its associated process identifiers (all those process identifiers which are linked together) can be considered closed if an ASF information element with an invoke last control type has been sent. No new interactions associated with those process identifiers may be initiated, however, reports of successful or unsuccessful completion of the request (i.e. return result, return error, reject) may be sent. When a process identifier is closed, it is still considered active and is **not** available for re-use. Note that none of the associated process identifiers are available for re-use.

A process identifier is considered cleared if it is no longer actively associated with a call and is available for re-use. A process identifier may be cleared and made available for re-use in either of two ways:

1. A process identifier may be cleared by sending an ASF with a return result, return error, or reject control type.
2. A process identifier may be cleared by clearing the Q.931 call reference value with which it is associated.

When a process identifier is cleared, all other process identifiers with which it is associated are also cleared and available for re-use.

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Annex A

User side and network side SDL Diagrams.

A. Annex A - User side and network side SDL Diagrams

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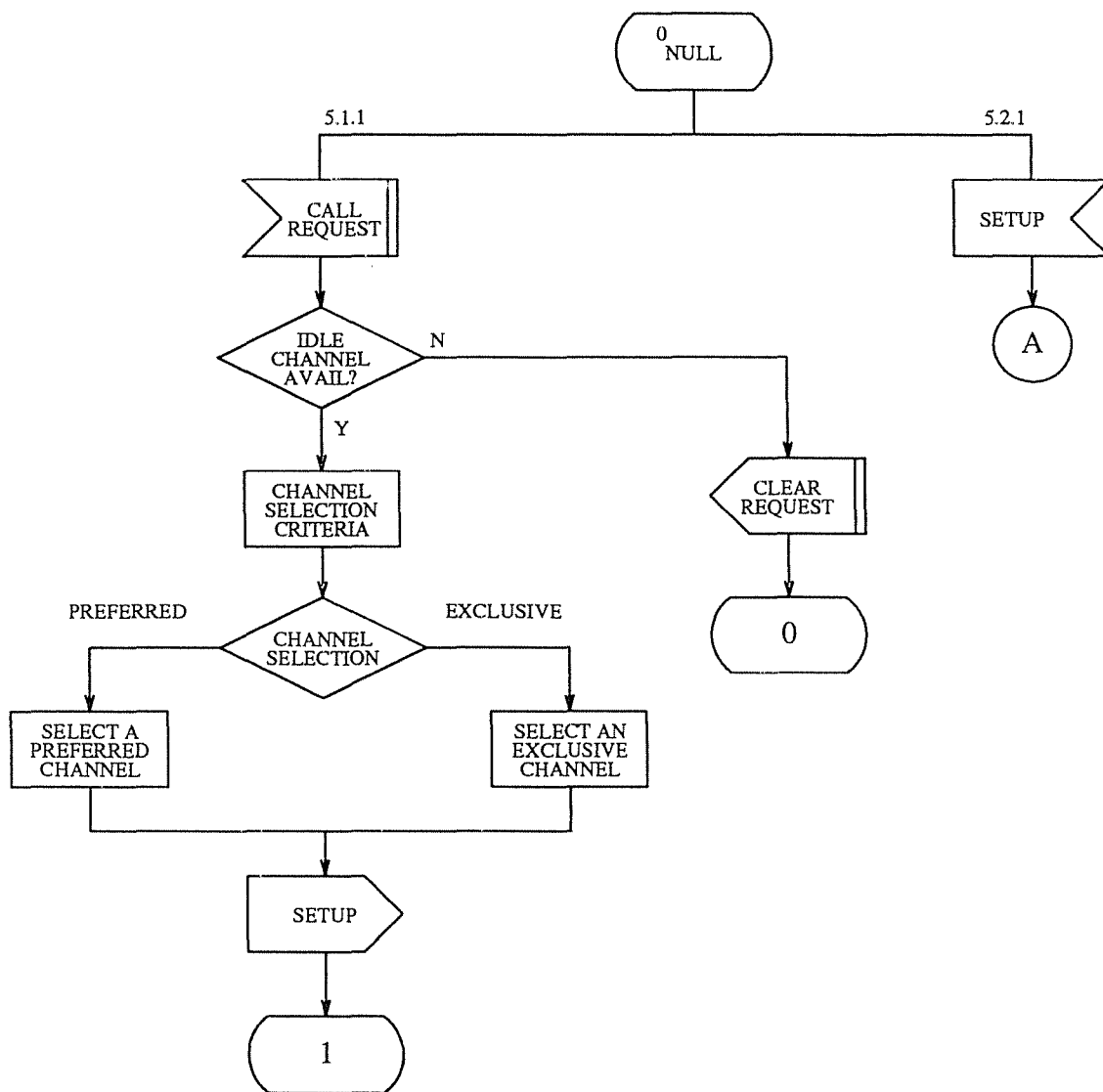


Figure IV-A-1. Call Control Detailed SDL Diagrams (User Side)

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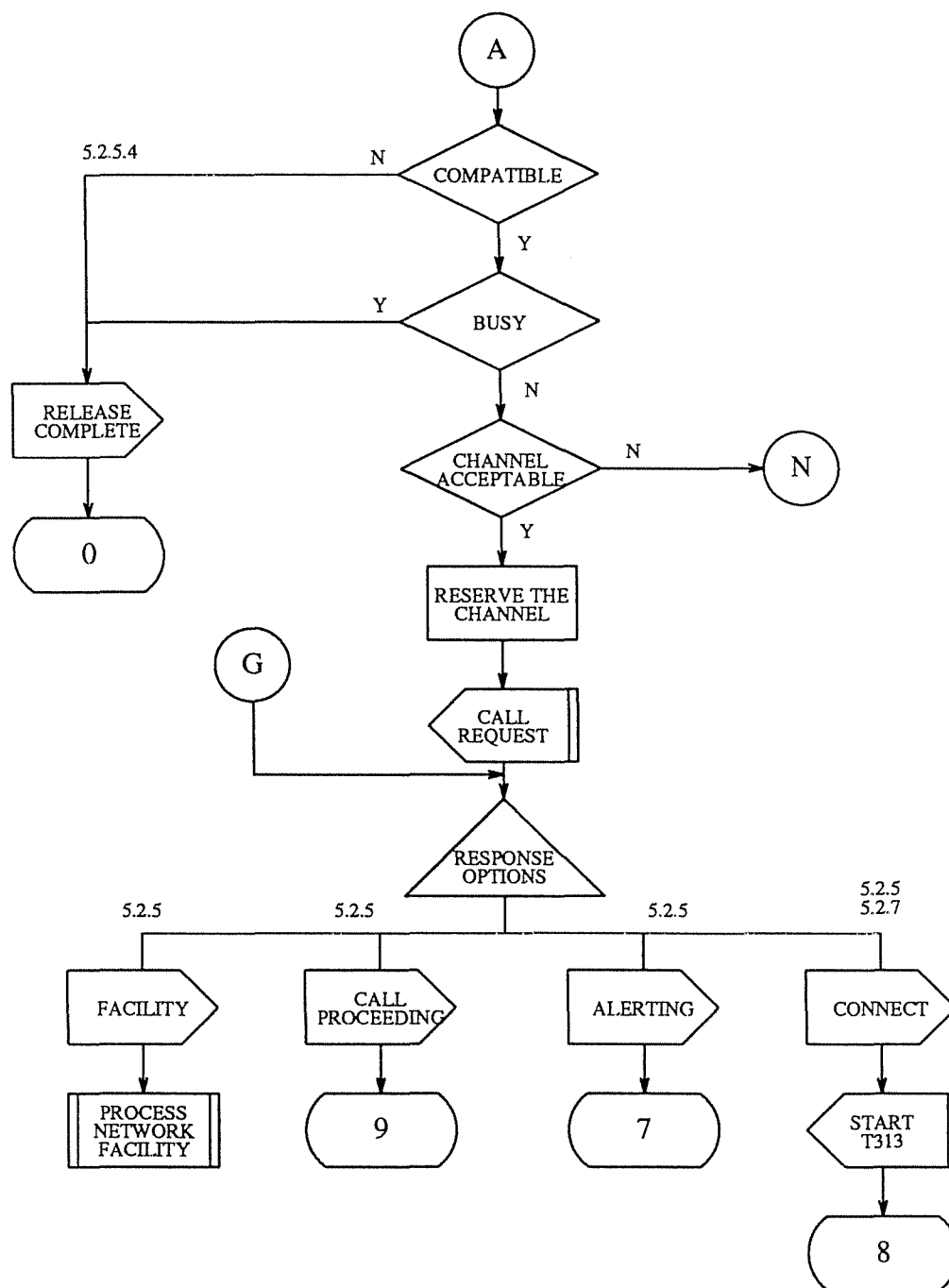


Figure IV-A-2. Call Control Detailed SDL Diagrams (User Side)

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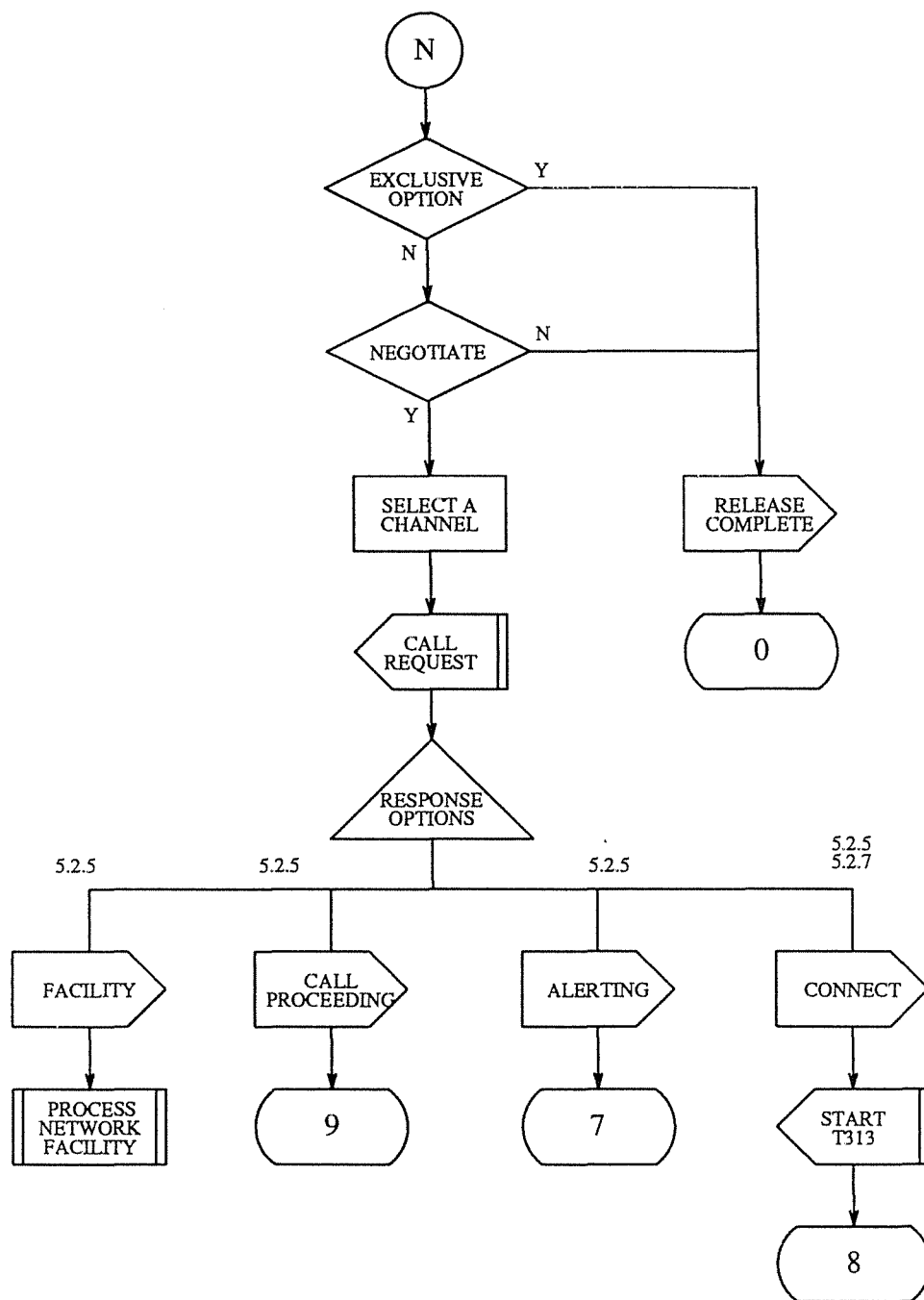


Figure IV-A-3. Call Control Detailed SDL Diagrams (User Side)

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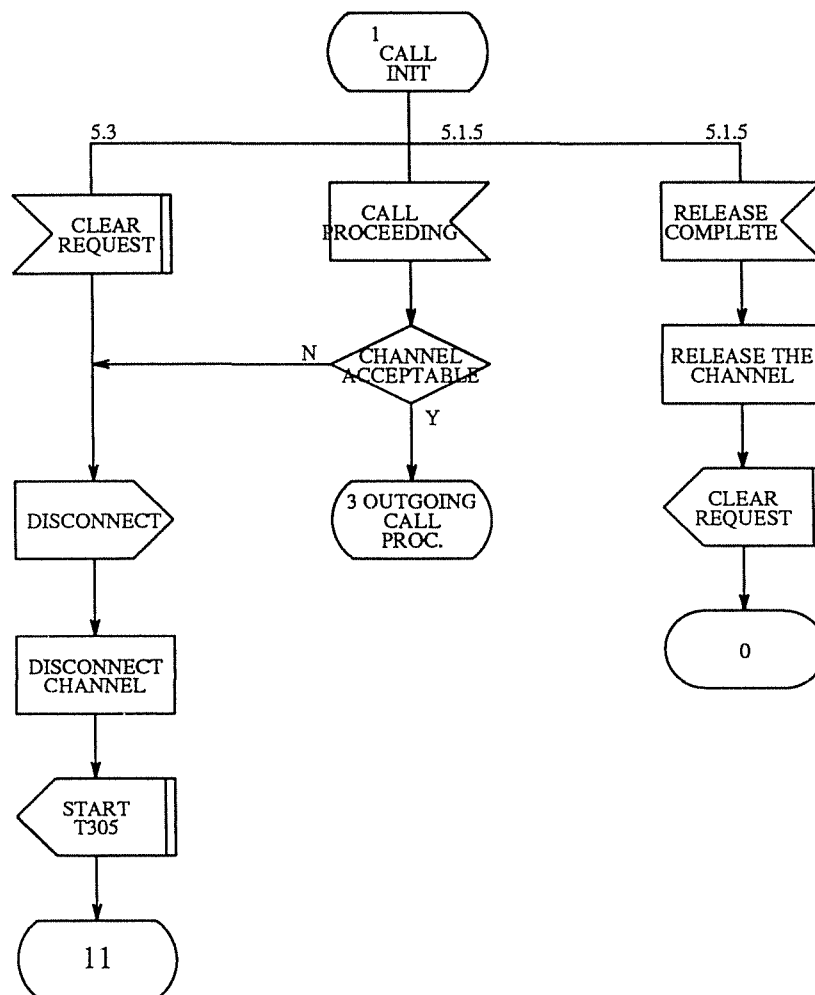


Figure IV-A-4. Call Control Detailed SDL Diagrams (User Side)

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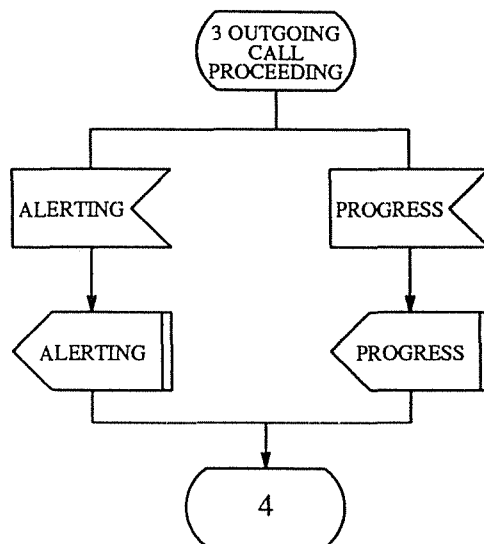


Figure IV-A-5. Call Control Detailed SDL Diagrams (User Side)

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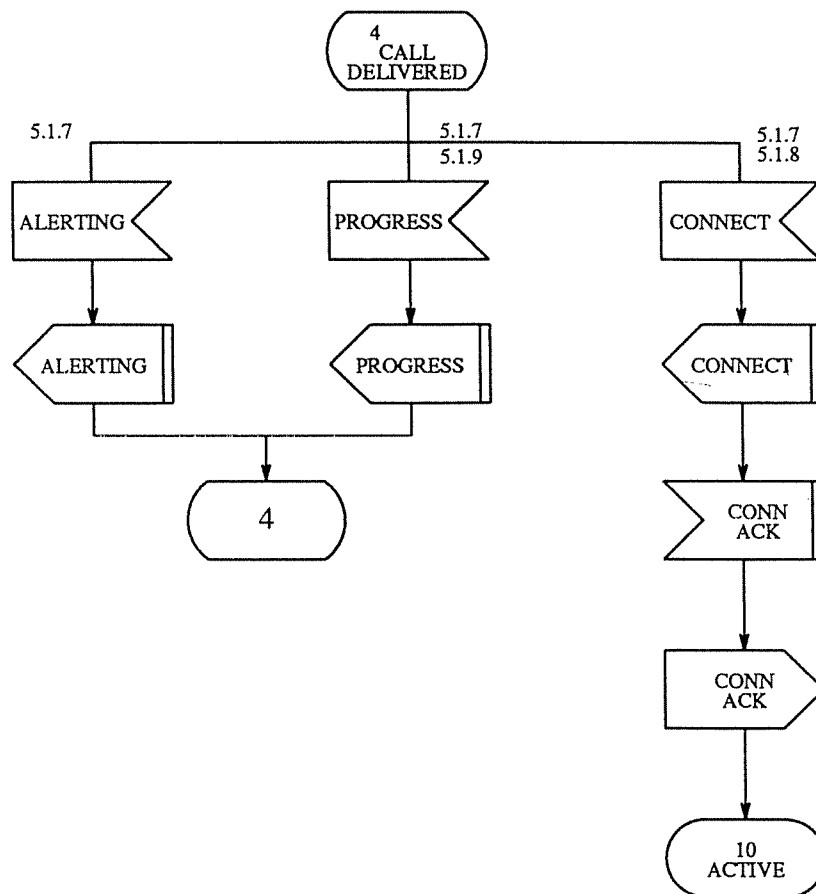


Figure IV-A-6. Call Control Detailed SDL Diagrams (User Side)

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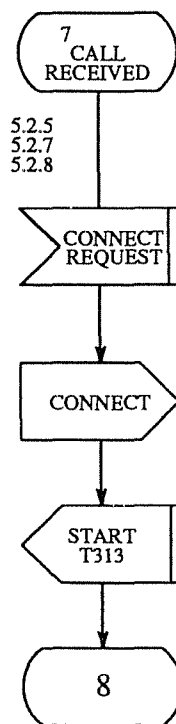


Figure IV-A-7. Call Control Detailed SDL Diagrams (User Side)

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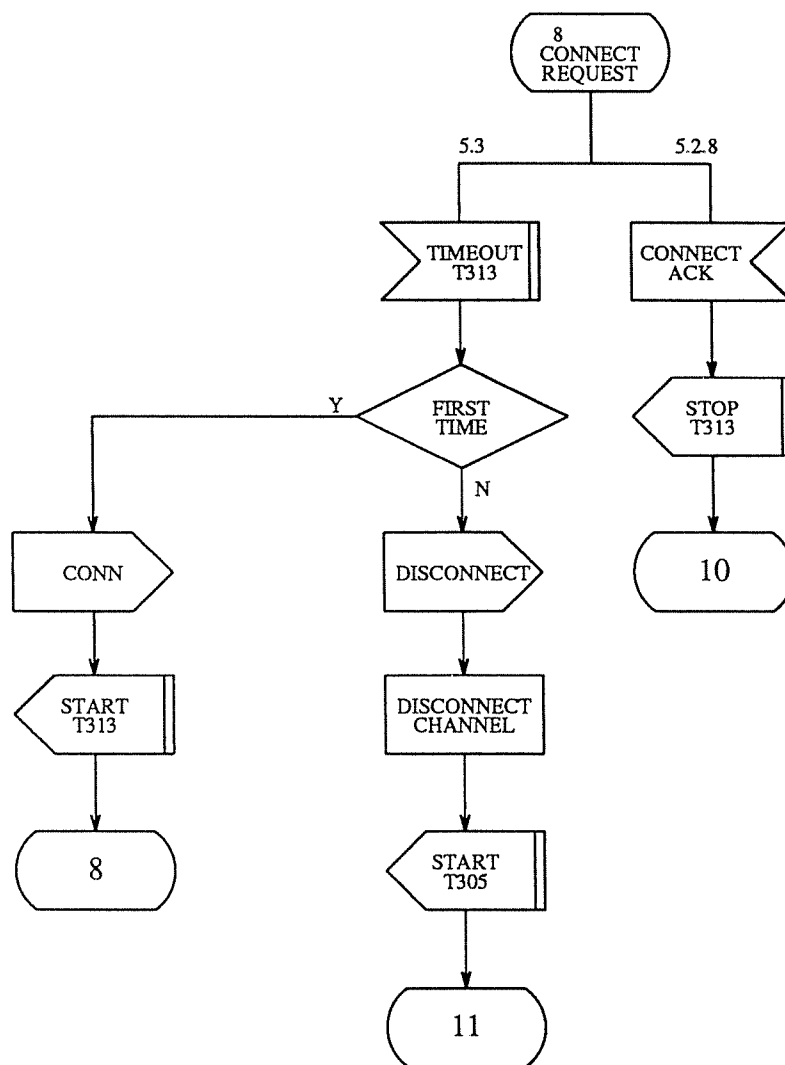


Figure IV-A-8. Call Control Detailed SDL Diagrams (User Side)

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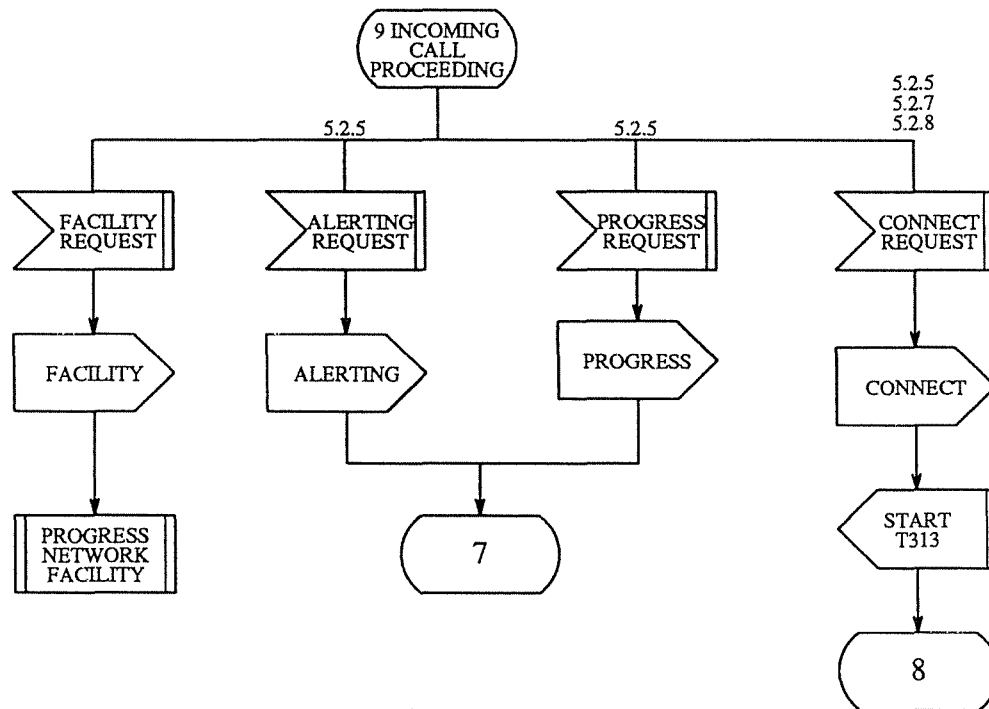


Figure IV-A-9. Call Control Detailed SDL Diagrams (User Side)

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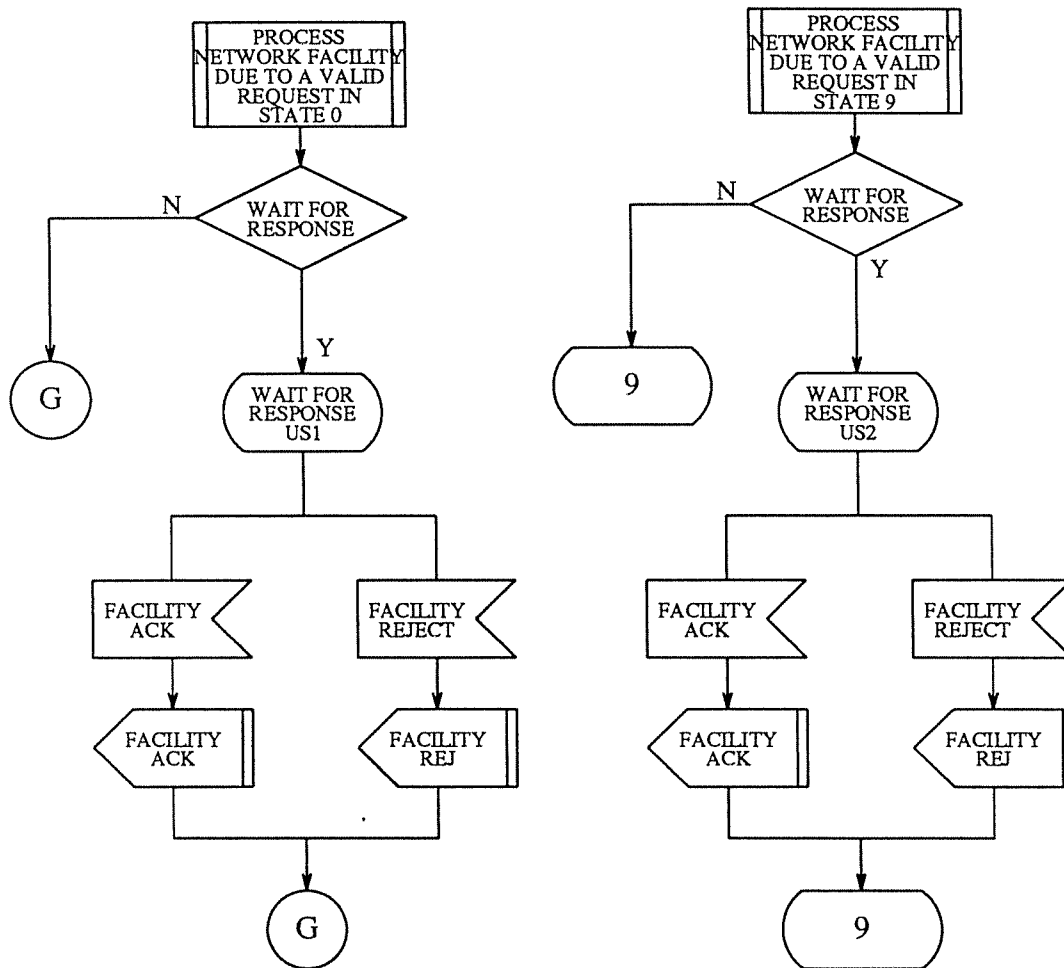


Figure IV-A-10. Call Control Detailed SDL Diagrams (User Side)

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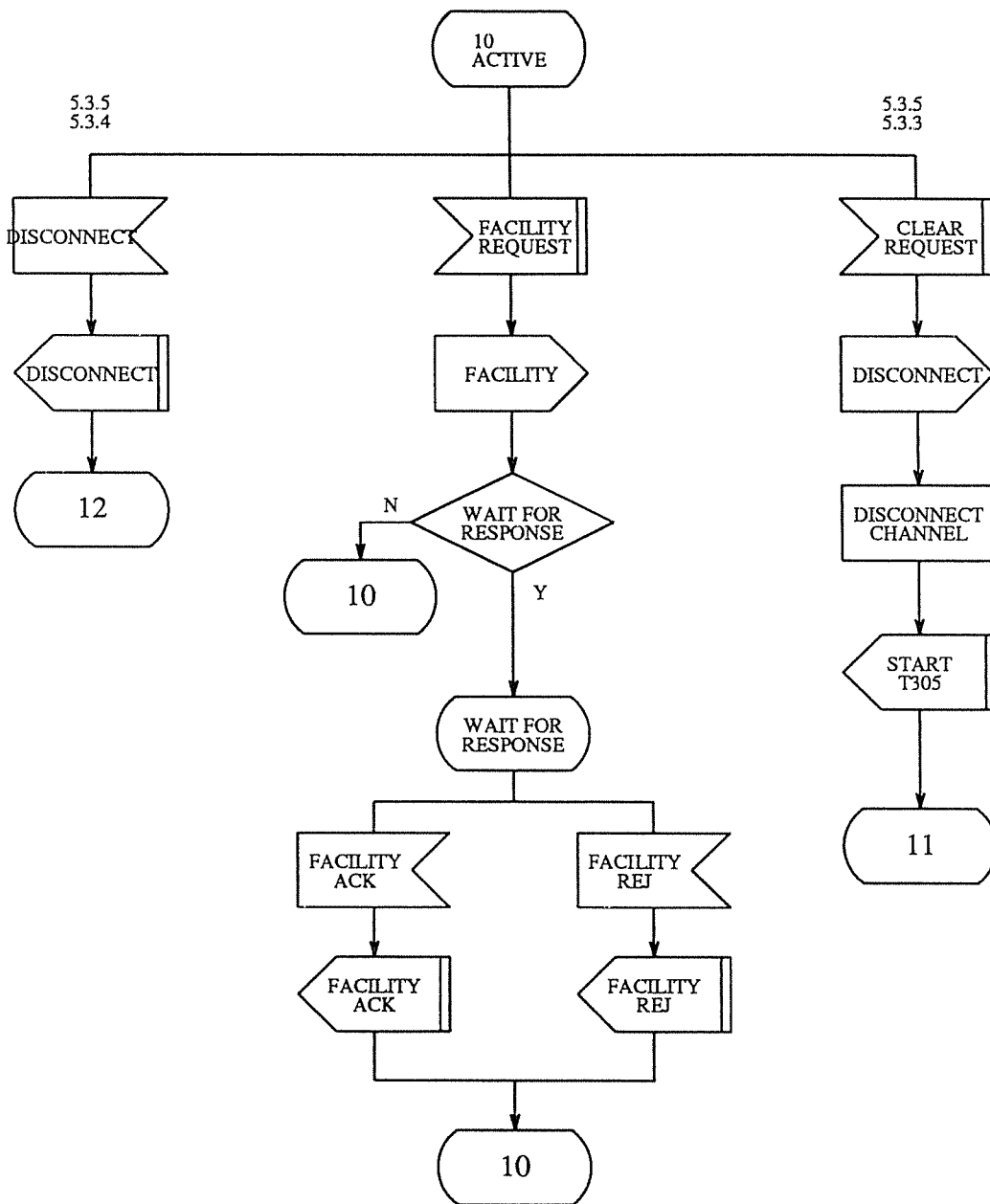


Figure IV-A-11. Call Control Detailed SDL Diagrams (User Side)

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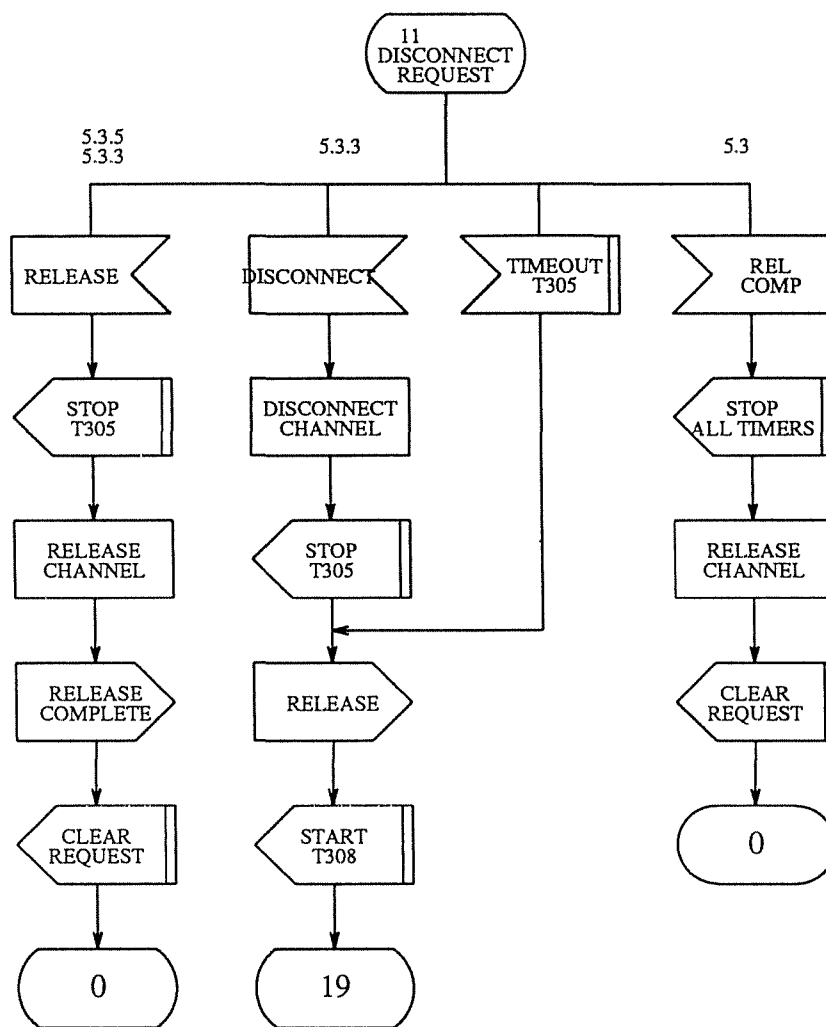
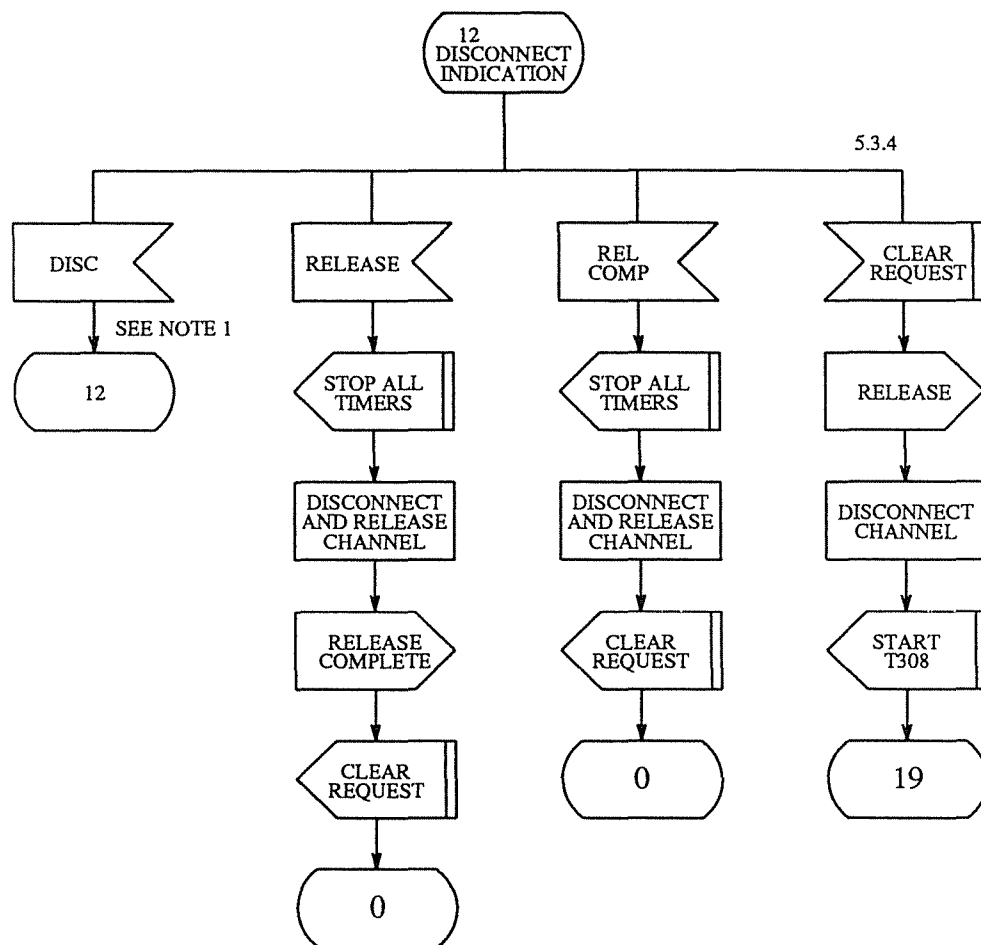


Figure IV-A-12. Call Control Detailed SDL Diagrams (User Side)

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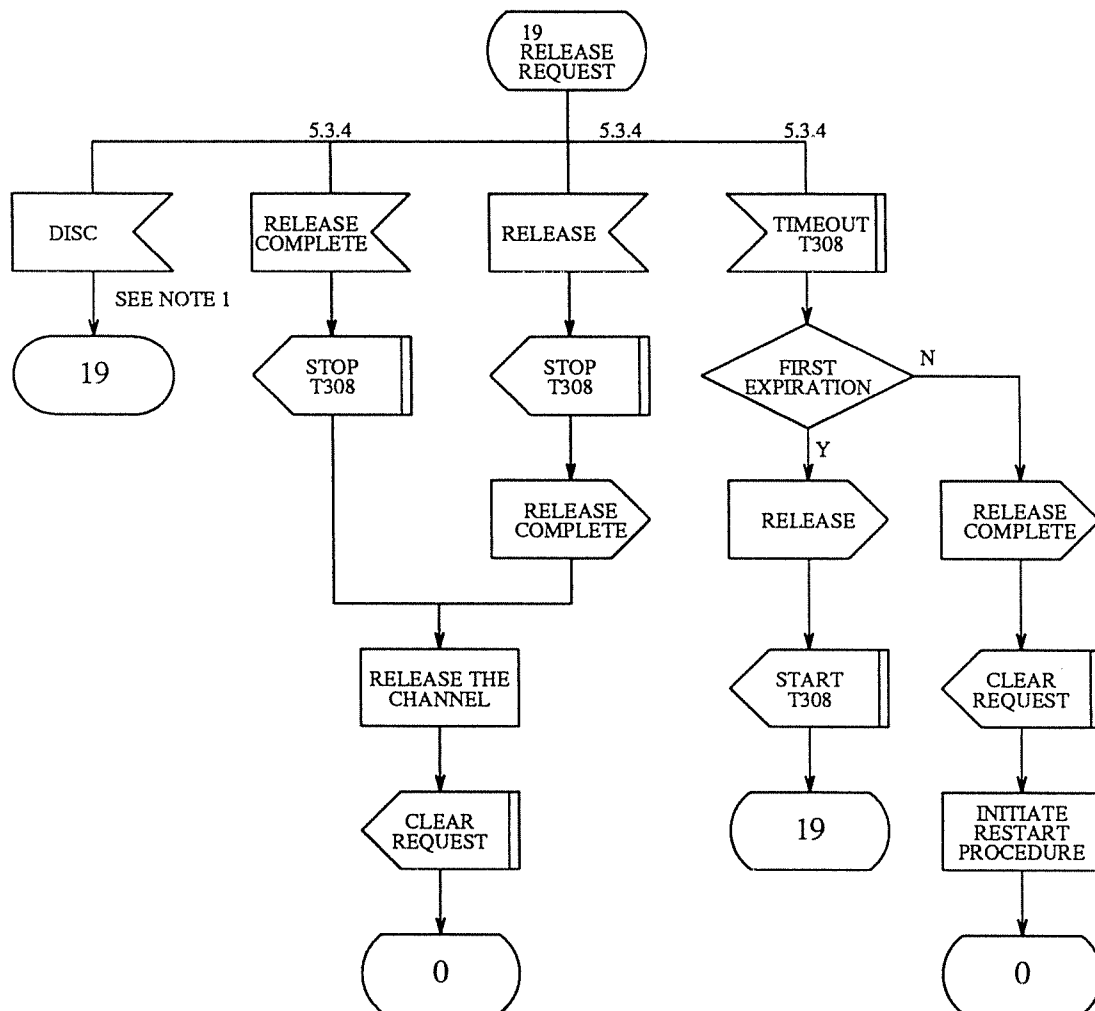
NOTE 1: Ignorable Error

Figure IV-A-13. Call Control Detailed SDL Diagrams (User Side)

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NOTE 1: Ignorable Error

Figure IV-A-14. Call Control Detailed SDL Diagrams (User Side)

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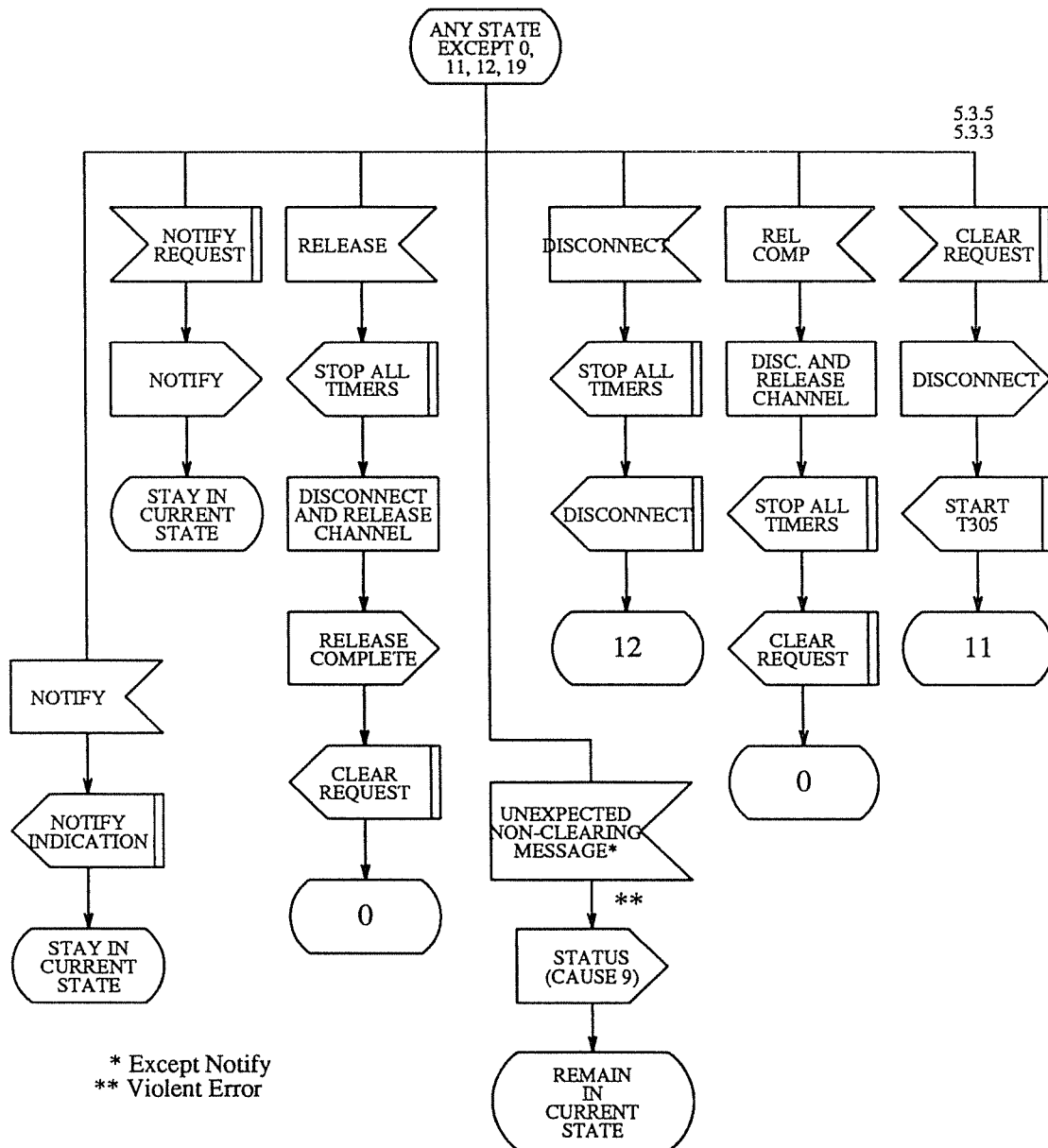


Figure IV-A-15. Call Control Detailed SDL Diagrams (User Side)

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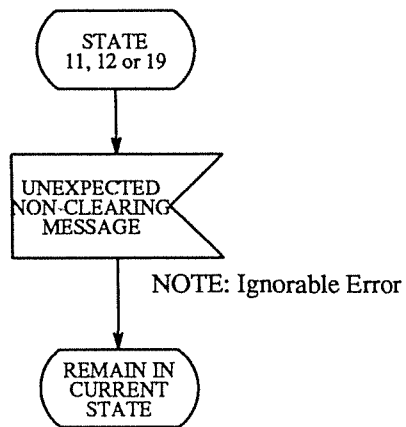


Figure IV-A-16. Call Control Detailed SDL Diagrams (User Side)

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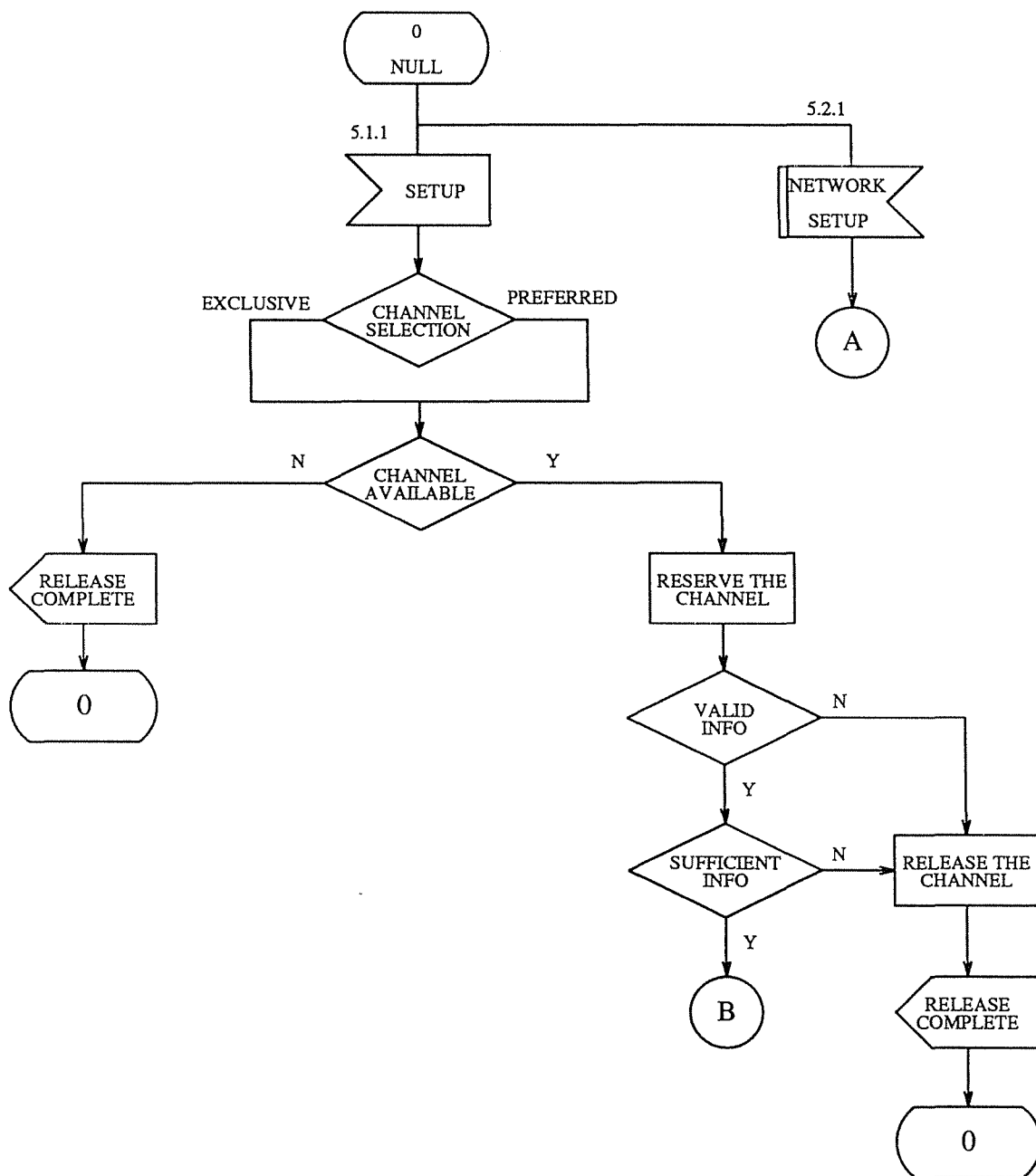


Figure IV-A-17. Call Control Detailed SDL Diagrams (Network Side)

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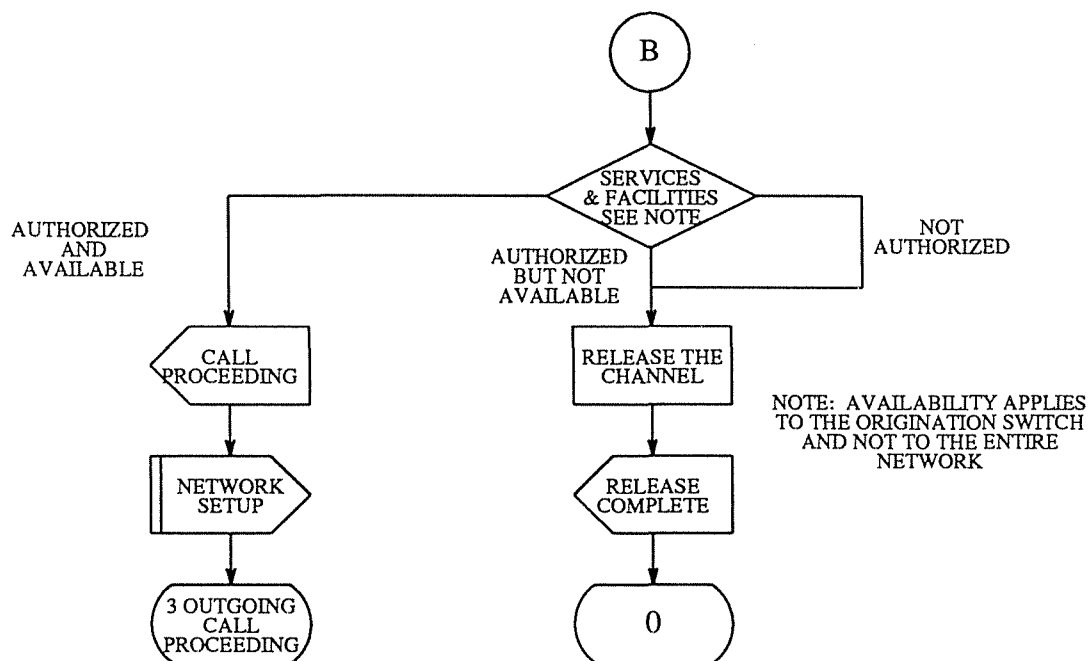


Figure IV-A-18. Call Control Detailed SDL Diagrams (Network Side)

AT&T ISDN Primary Rate Interface

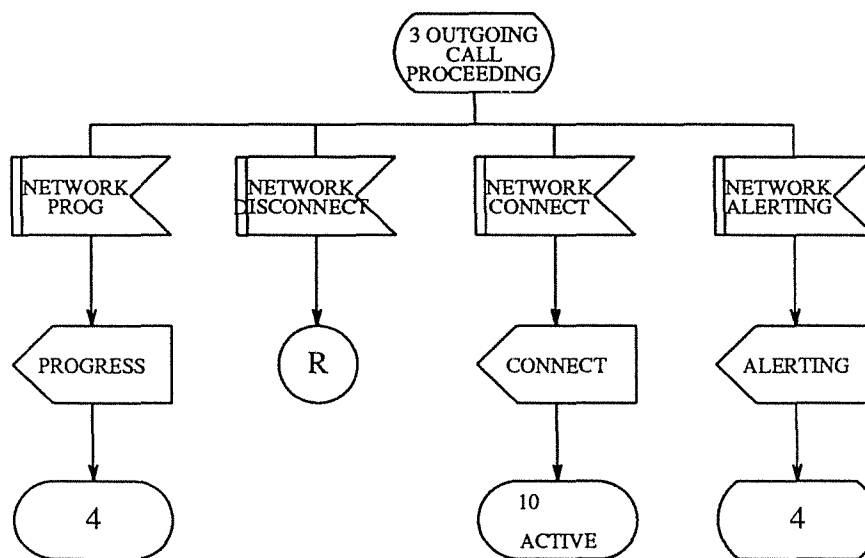


Figure IV-A-19. Call Control Detailed SDL Diagrams (Network Side)

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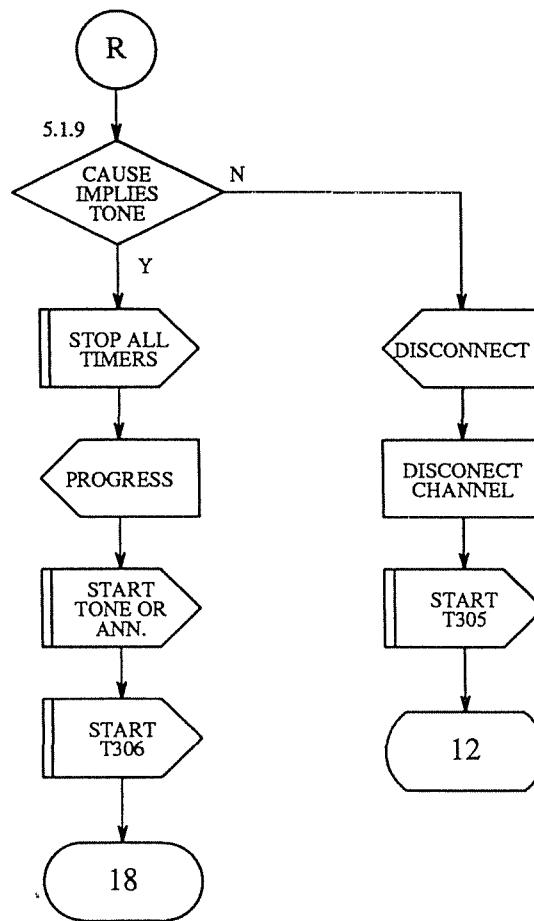


Figure IV-A-20. Call Control Detailed SDL Diagrams (Network Side)

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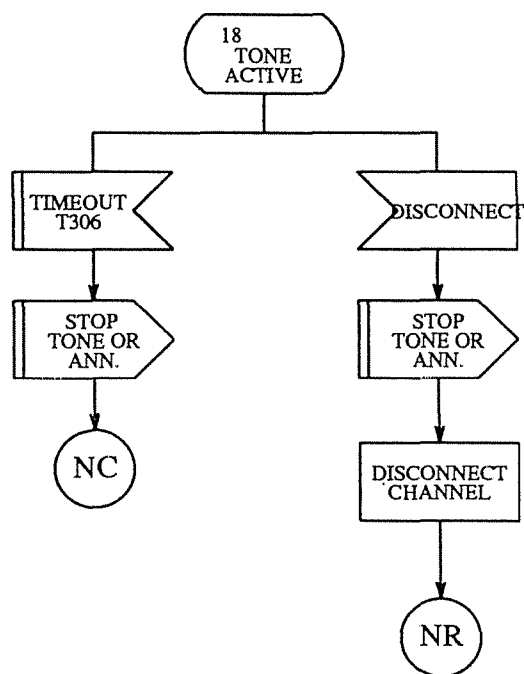


Figure IV-A-21. Call Control Detailed SDL Diagrams (Network Side)

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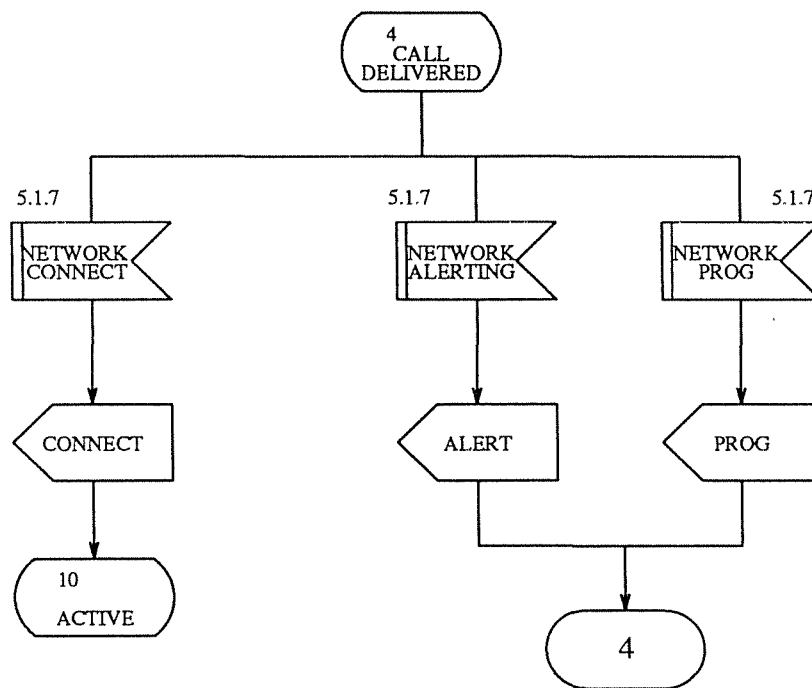


Figure IV-A-22. Call Control Detailed SDL Diagrams (Network Side)

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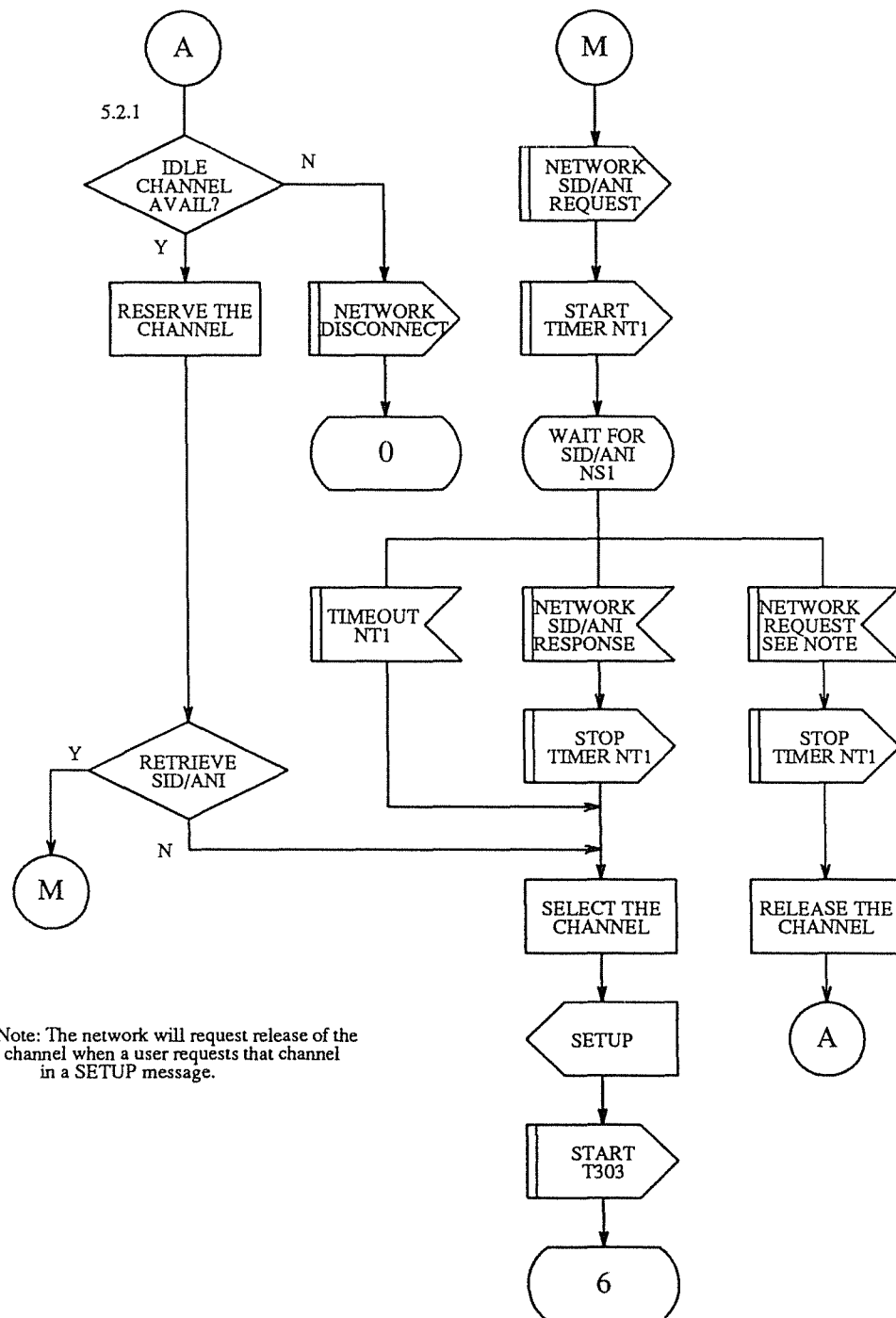


Figure IV-A-23. Call Control Detailed SDL Diagrams (Network Side)

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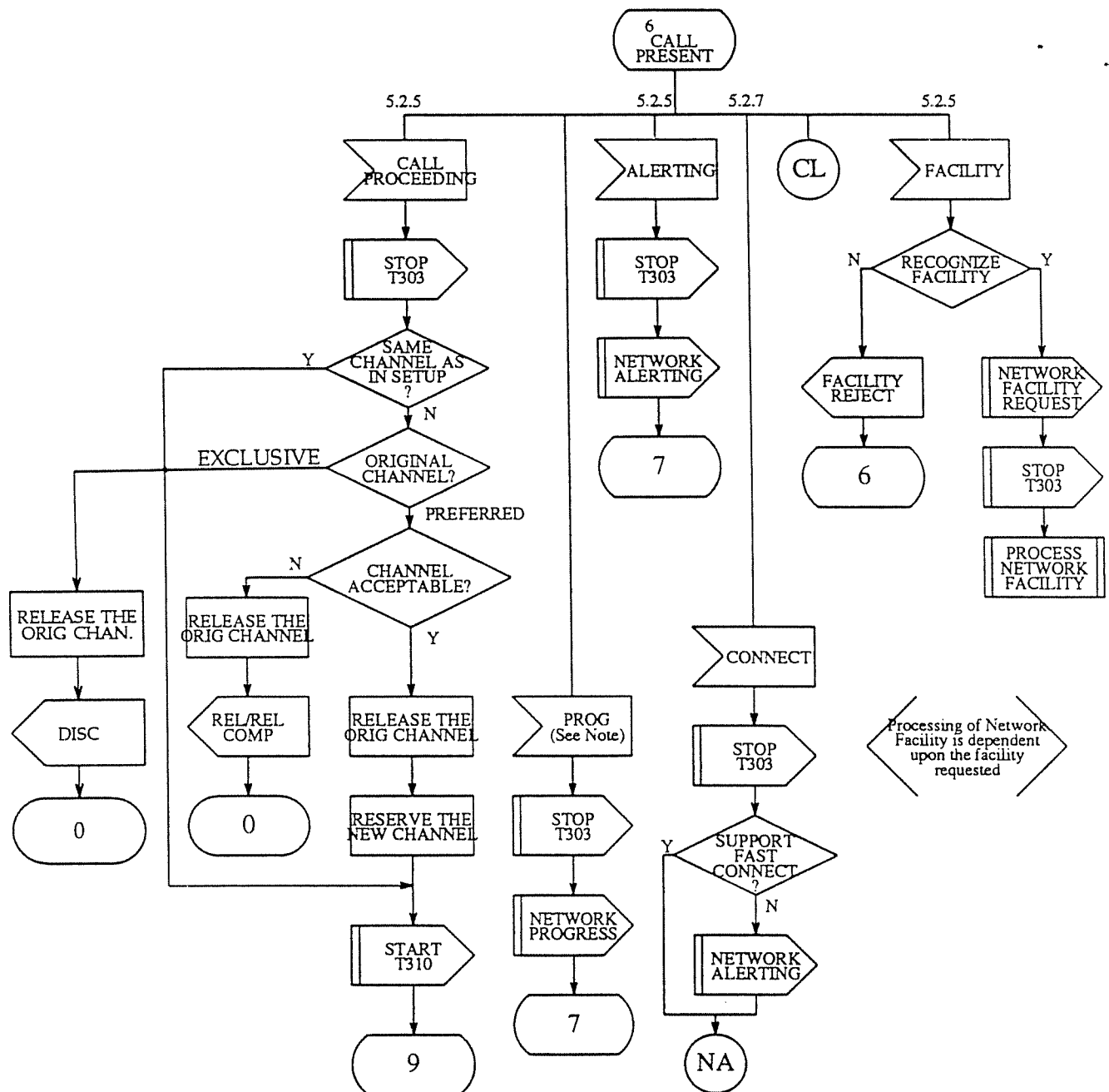


Figure IV-A-24. Call Control Detailed SDL Diagrams (Network Side)

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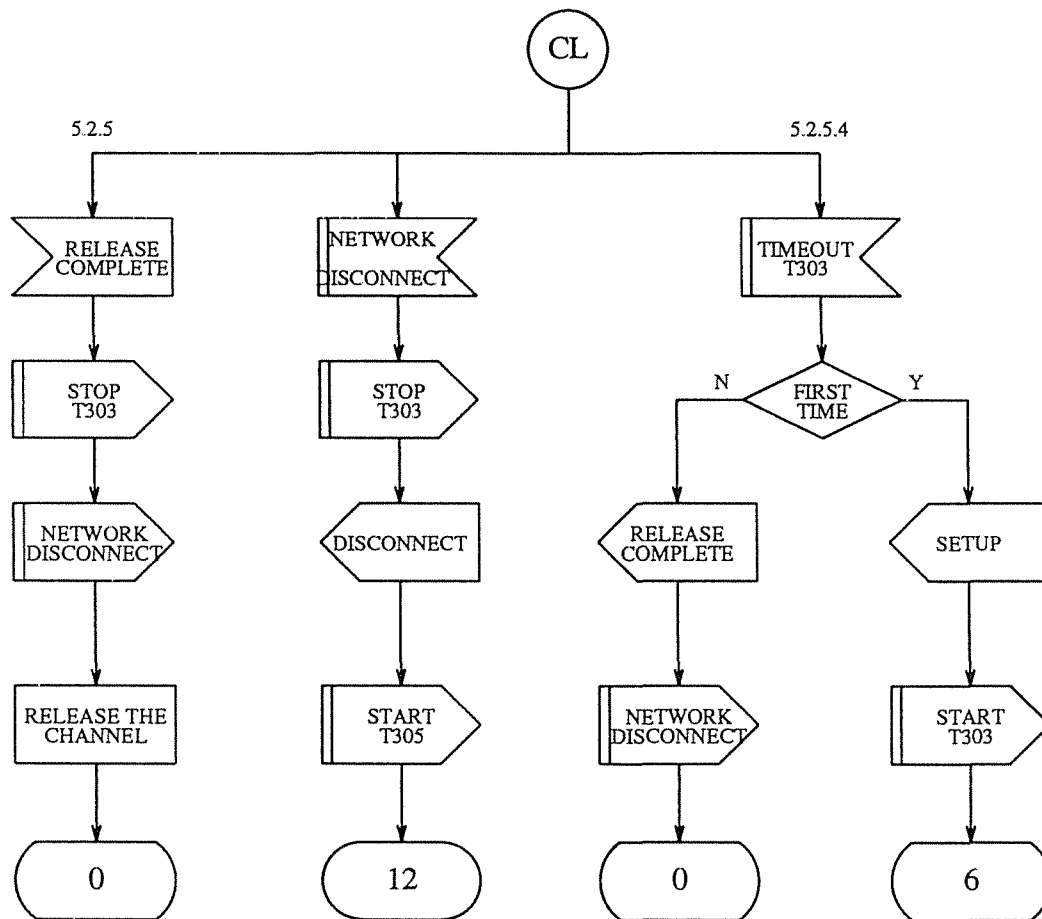


Figure IV-A-25. Call Control Detailed SDL Diagrams (Network Side)

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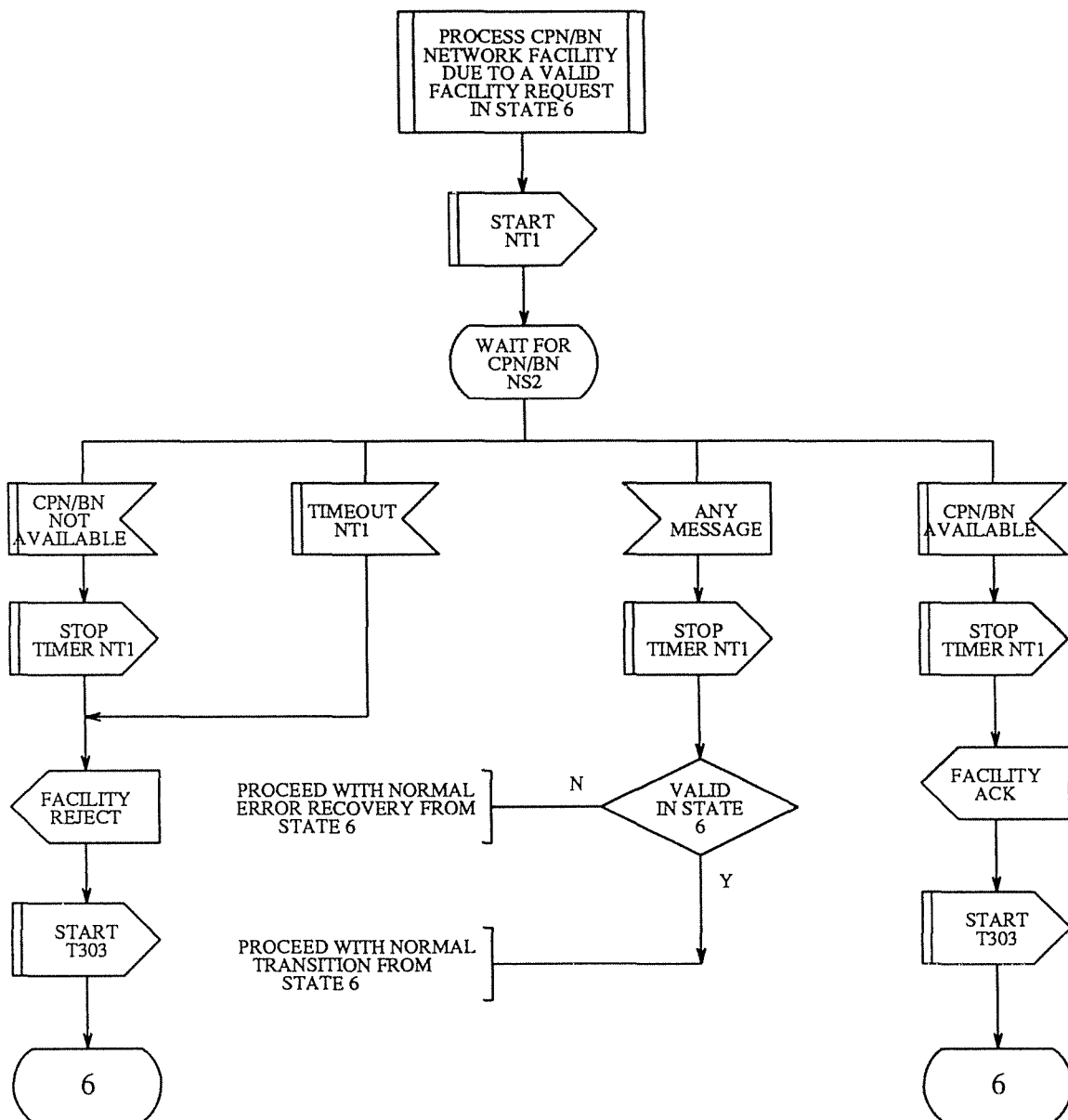
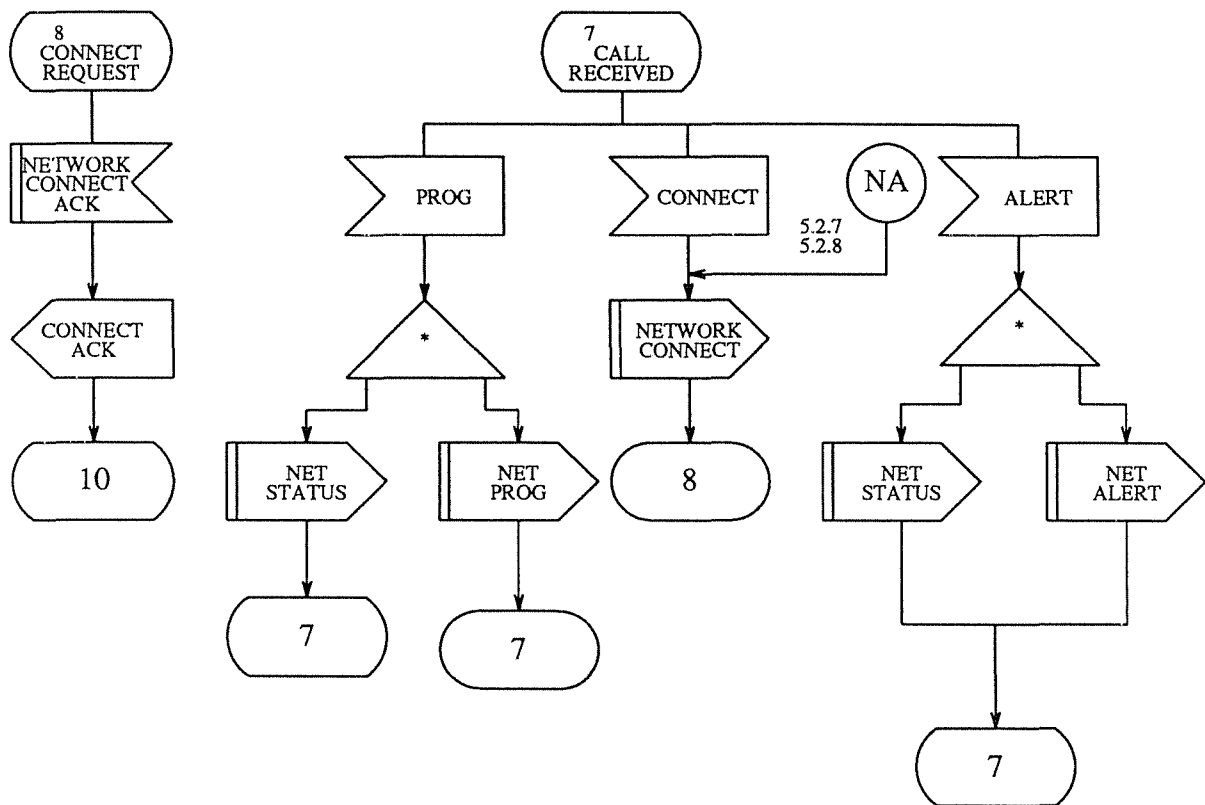


Figure IV-A-26. Call Control Detailed SDL Diagrams (Network Side)

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* Only one ALERTING message will be accepted by the network switch. See product specific documentation

Figure IV-A-27. Call Control Detailed SDL Diagrams (Network Side)

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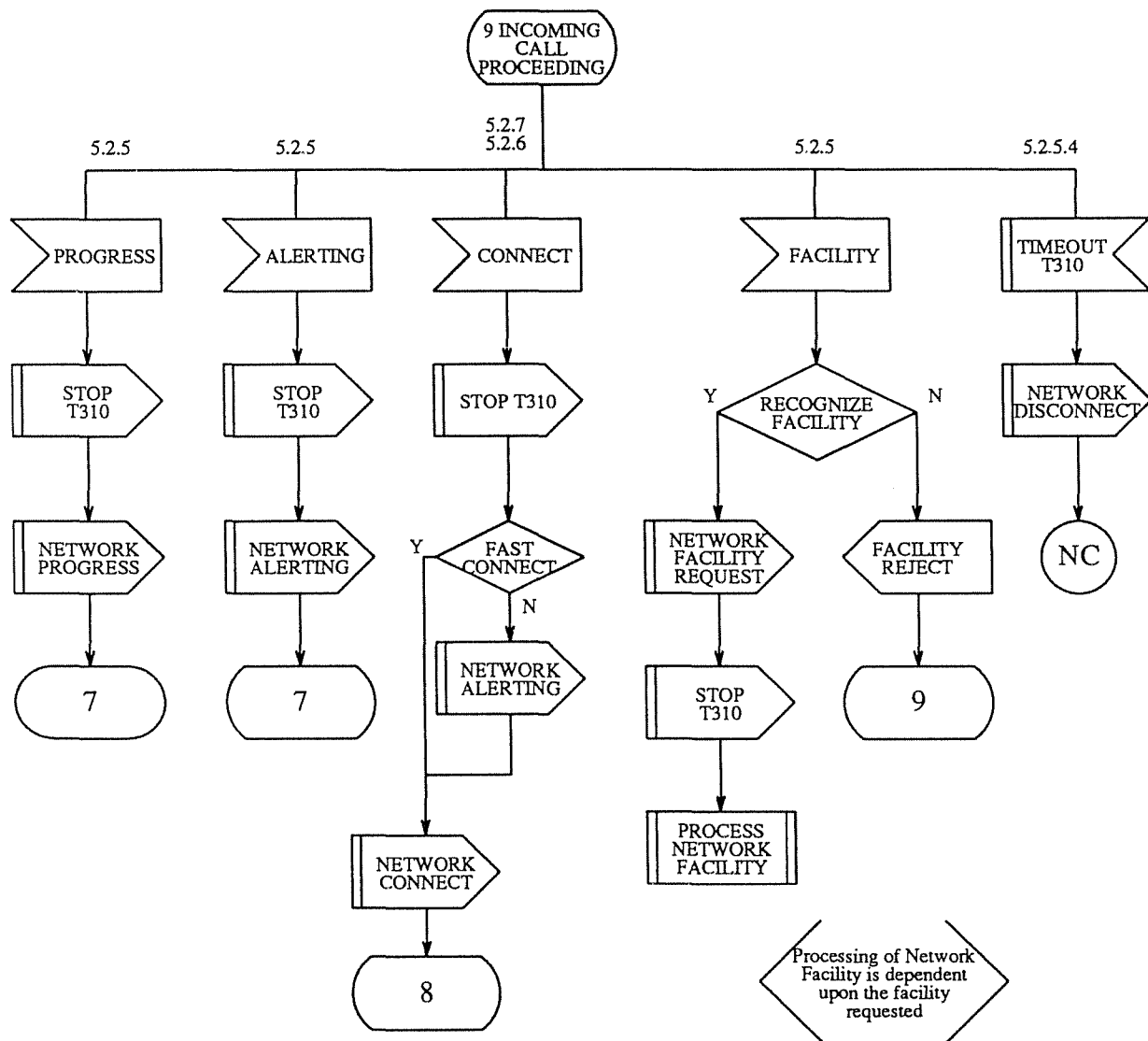


Figure IV-A-28. Call Control Detailed SDL Diagrams (Network Side)

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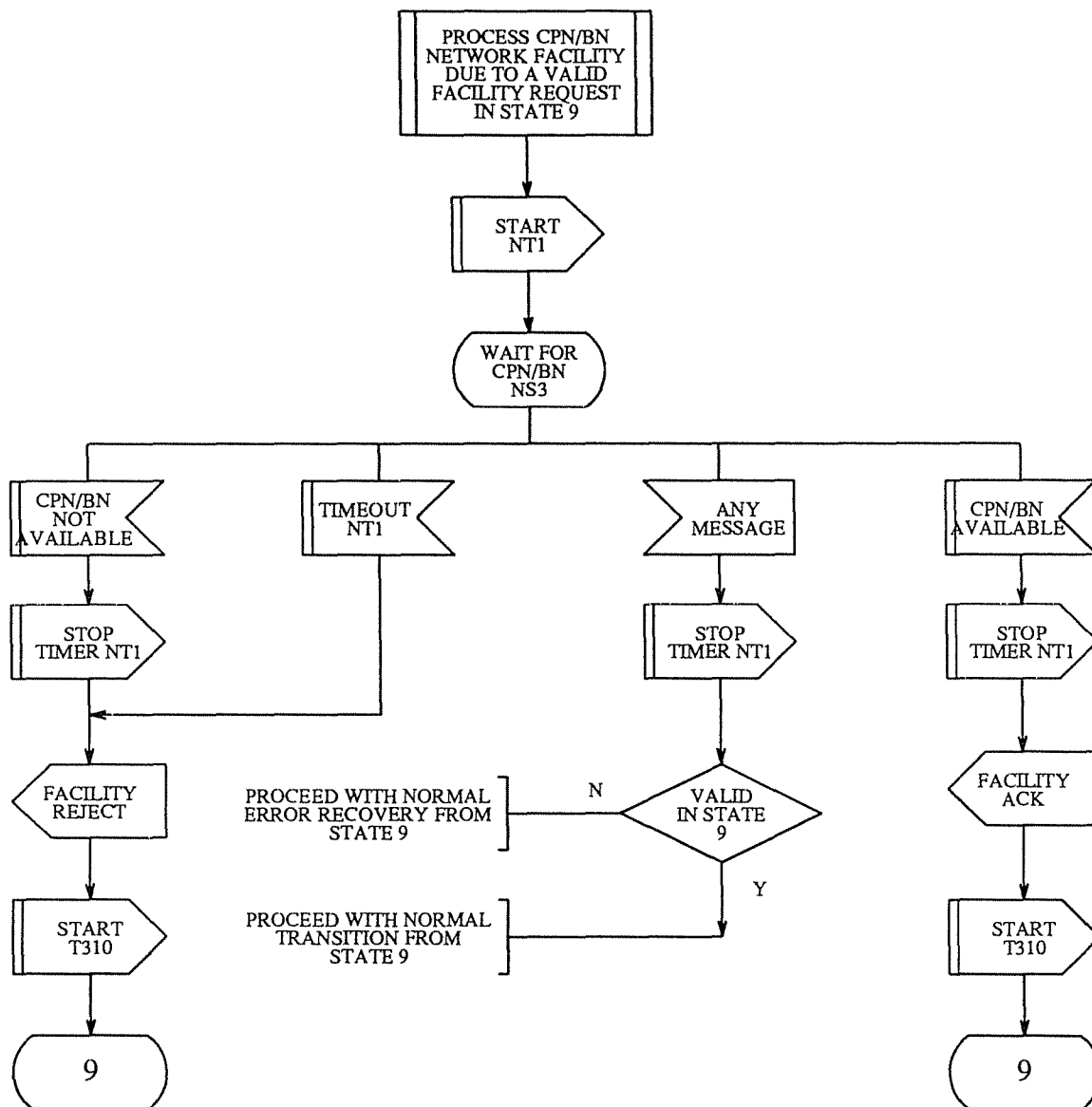


Figure IV-A-29. Call Control Detailed SDL Diagrams (Network Side)

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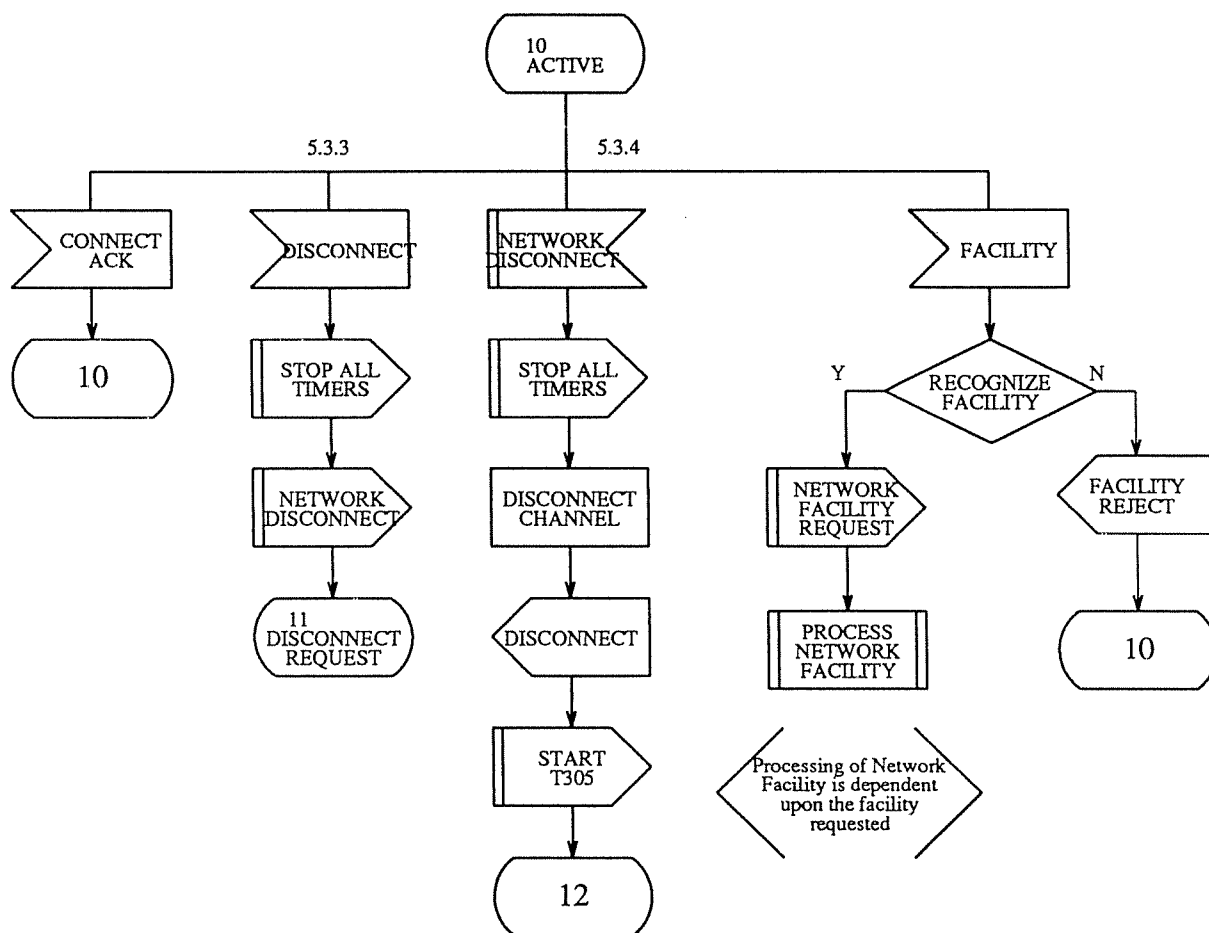


Figure IV-A-30. Call Control Detailed SDL Diagrams (Network Side)

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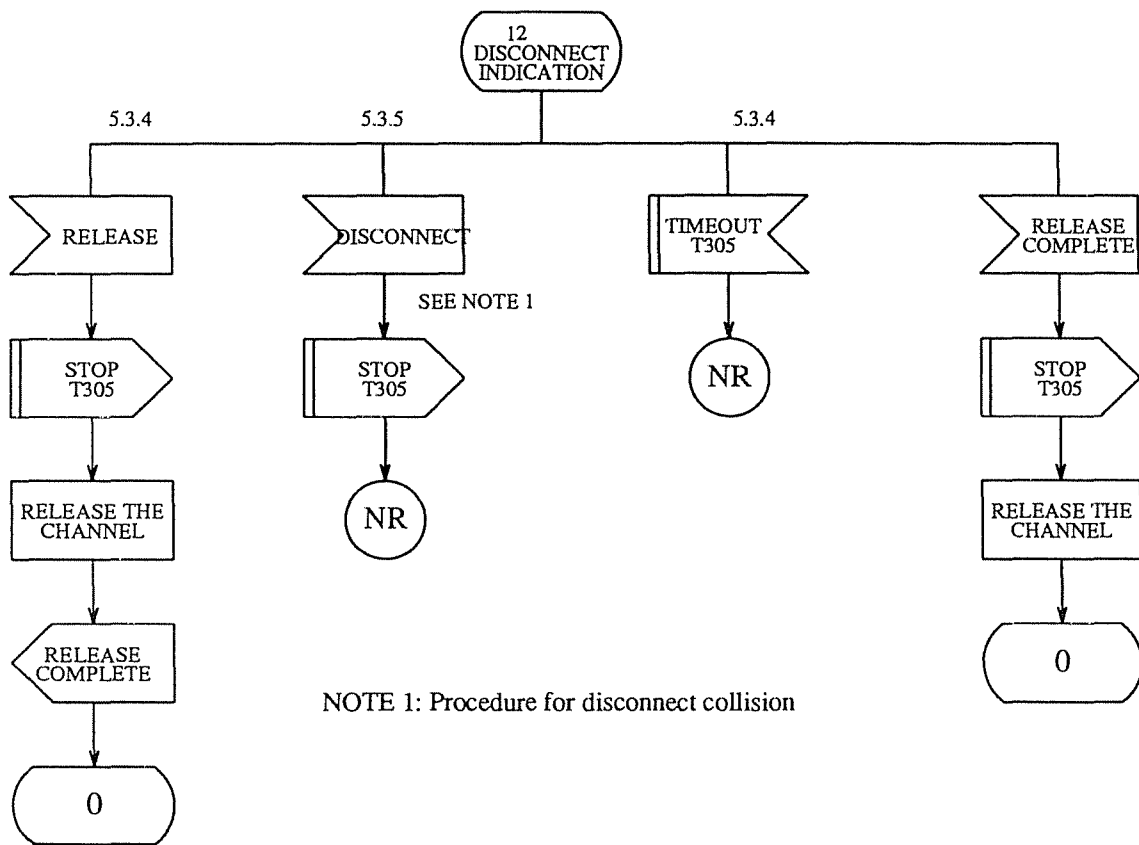


Figure IV-A-31. Call Control Detailed SDL Diagrams (Network Side)

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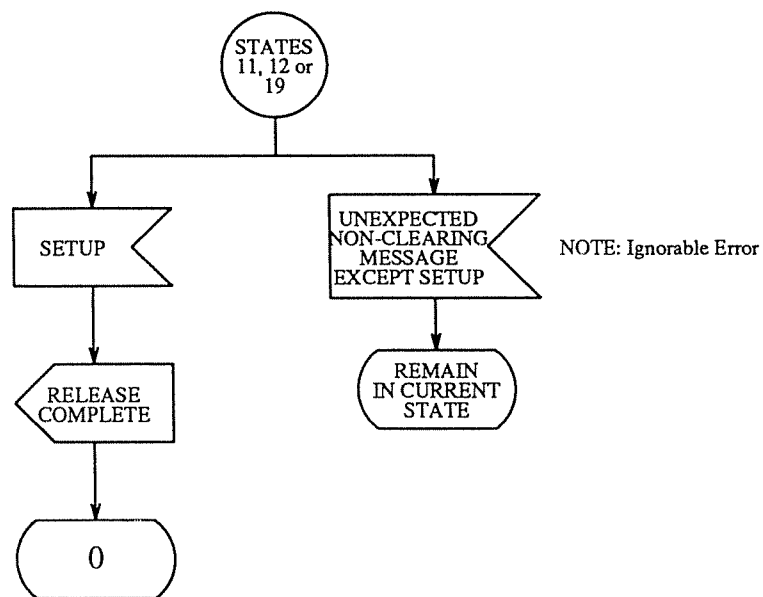
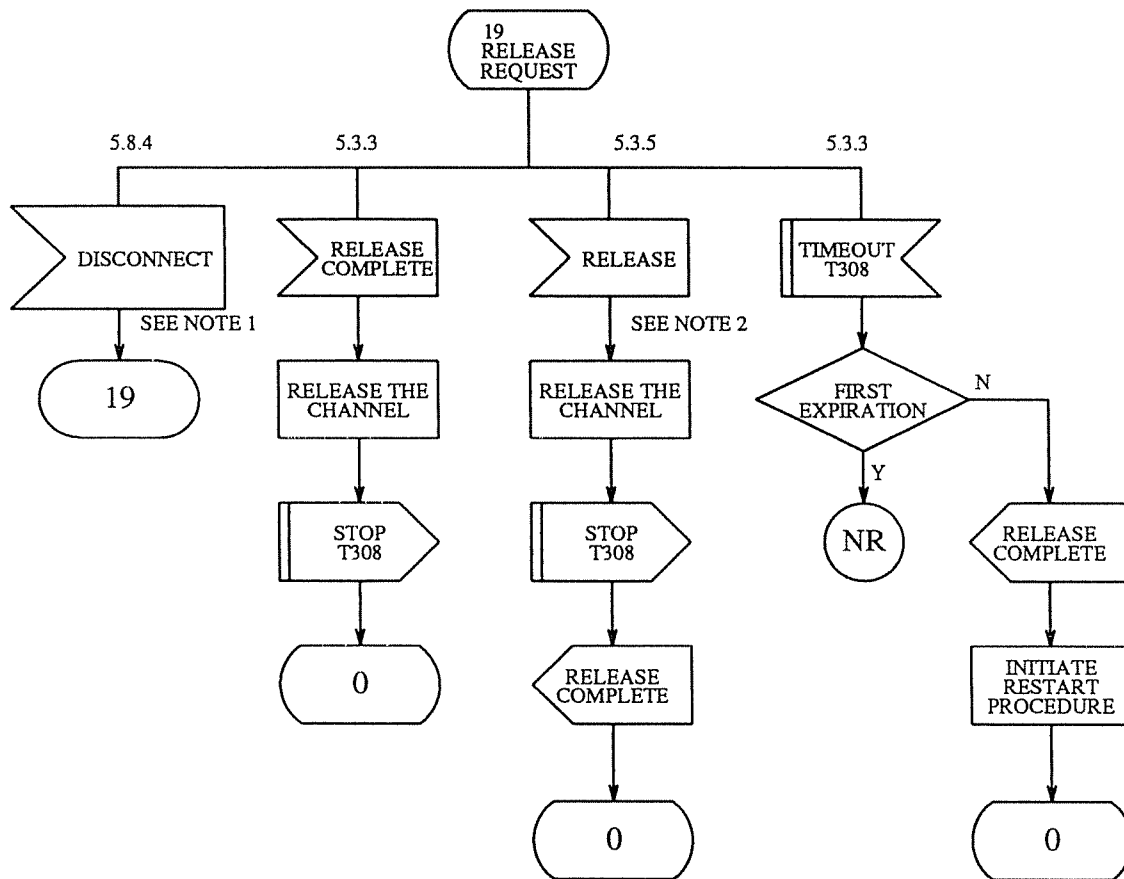


Figure IV-A-32. Call Control Detailed SDL Diagrams (Network Side)

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NOTE 1: Ignorable Error
 NOTE 2: RELease Collision

Figure IV-A-33. Call Control Detailed SDL Diagrams (Network Side)

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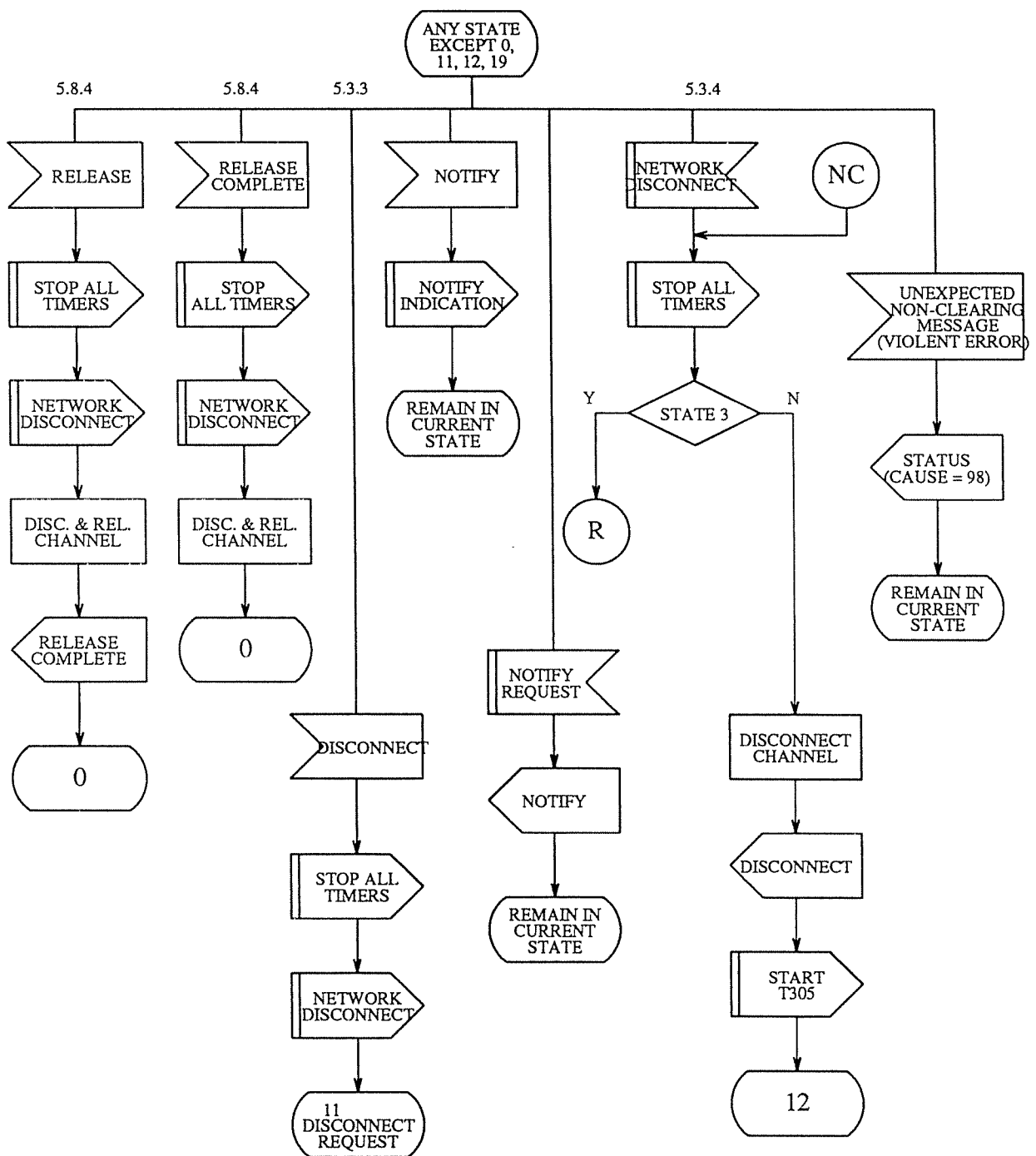


Figure IV-A-34. Call Control Detailed SDL Diagrams (Network Side)

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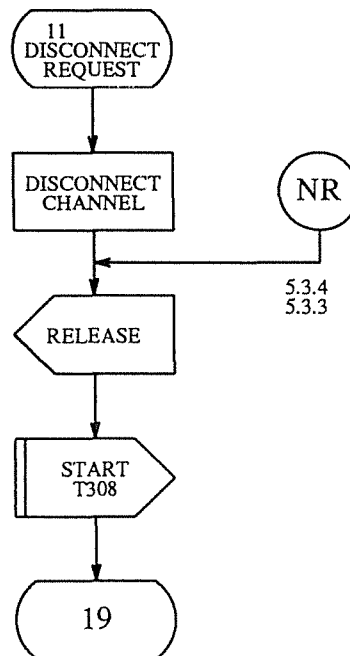


Figure IV-A-35. Call Control Detailed SDL Diagrams (Network Side)

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Annex B

Compatibility Checking

B. Annex B - Compatibility Checking

B.1 Introduction

This annex describes the various compatibility checks which should be carried out to ensure that the best matched user and network capabilities are achieved on a call within an ISDN.

This annex also covers interworking with existing networks.

Three different processes of compatibility checking shall be performed:

- i) at the user-to-network interface on the calling side (see B.2);
- ii) at the network-user interface on the called side (see B.3.2) and;
- iii) user-to-user (see B.3.3).

Note - In this context and throughout this annex the term "called user" is the end point entity which is explicitly addressed. This may be an addressed interworking unit (IWU), see I.500 Series Recommendations.

For details on the coding of the information required for compatibility checking, see Annex L.

B.2 Calling side compatibility checking

At the calling side, the network shall check that the bearer service requested by the calling user in the Bearer capability information element matches with the bearer services provided to that user by the network. If a mismatch is detected, then the network shall reject the call using one of the causes listed in Section 5.2.5.2.

Network services are described in the AT&T documentation identified in Part I as bearer services and teleservices, respectively.

B.3 Called side compatibility checking

In this section, the word "check" means that the user examines the contents of the specified information element.

B.3.1 Compatibility checking with addressing information

If an incoming SETUP message is offered with addressing information (i.e., either DDI or sub-addressing or the appropriate part of the called party number, e.g., for DDI) the following actions will occur:

- a) if a number (e.g., for DDI) or sub-address is assigned to a user, then the information in a Called party number or Called party sub-address information element of the incoming call shall be checked by the user against the corresponding part of the number assigned to the user (e.g., for DDI) or the user's own sub-address.

In the case of a mismatch, the user shall ignore the call. In the case of match, the compatibility checking described in Sections B.3.2 to B.3.3 will follow;

- b) If a user has no DDI number or sub-address, then the Called party number and Called party sub-address information element shall be ignored. The compatibility checking described in Sections B.3.2 and B.3.3 will follow.

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Note 1 - According to the user's requirements, compatibility checking can be performed in various ways from the viewpoint of execution order and information to be checked, e.g., first DDI number/sub-address and then compatibility or vice versa.

Note 2 - If an incoming call, offered with addressing information, is always to be awarded to the addressed user, all users connected to the same passive bus should have a DDI number or sub-address.

B.3.2 Network-to-user compatibility checking

When the network is providing a Bearer service at the called side, the user shall check that the Bearer service offered by the network in the bearer capability information element matches the bearer services that the user is able to support. If a mismatch is detected, then the user shall either ignore or reject the offered call using an appropriate cause.

B.3.3 User-to-user compatibility checking

The called side terminal equipment shall check that the content of the low layer compatibility information element is compatible with the functions it supports.

The low layer compatibility information element (if available) shall be used to check compatibility of low layers (e.g., from layer 1 to layer 3, if layered according to the OSI model).

Note - The bearer compatibility information element is also checked, see Section B.3.2. Therefore, if any conflict from duplication of information in the bearer capability and the low layer compatibility information elements is detected, this conflict shall be resolved according to Annex L, e.g., the conflicting information in the low layer compatibility information element shall be ignored.

If the low layer compatibility information element is not included in an incoming SETUP message, the bearer capability information element shall be used to check the compatibility of low layers.

The called terminal equipment may check the high layer compatibility information element (if present) as part of user-to-user compatibility checking procedures, even if the network only supports bearer services.

If a mismatch is detected in checking any of the information elements above, then the terminal equipment shall either ignore or reject the offered call using an appropriate cause.

With regard to the presence or absence of the High layer compatibility and Low layer compatibility information elements, two cases arise:

- a) Compatibility assured with the available description of the call

This is when all terminal equipment implement (i.e., understand the contents of) the High layer compatibility and Low layer compatibility information elements. Thus, based on the High layer compatibility and Low layer compatibility information element encoding, they are capable of accepting a call for which they have the requested functionality.

- b) Compatibility not assured with the available description of the call.

This is when all or some of the terminal equipment do not recognize (i.e., ignore) either the High layer compatibility or Low layer compatibility information elements. Without careful configuration or administration at the user's installation, there is a danger that a terminal equipment which has incorrect functionality will accept the call.

Therefore, in order to assure compatibility with incoming calls, it is recommended that the terminal equipment check the Low layer compatibility and High layer compatibility information elements.

Note - Some terminal equipment, upon bilateral agreement with other users or in accordance with other standards (e.g., Recommendation X.213) may employ the User-user information element for additional

compatibility checking. Such terminal equipment shall check the User-user information element in a manner identical to that described here for the High layer compatibility information element "compatibility assured" case.

B.3.4 User action tables

The following tables show the action which shall be carried out as a result of compatibility checking with the calling user's request for a bearer service and/or teleservice.

TABLE B-1

Bearer Capability Compatibility Checking

BC Mandatory info element	Point-to-point Data link
Compatible	Proceed
Incompatible	Reject (5.2.5.1)

TABLE B-2

*Low Layer & High Layer Compatibility checking: Compatibility
assured with the available Description of the Call*

LLC/HLC compatibility assured	Point-to-point data link
Compatible	Accept
Incompatible	Reject (5.2.5.1)

TABLE B-3

*Low Layer & High Layer Compatibility Checking: Compatibility
not assured with the available Description of the Call*

LLC/HLC compatibility not assured	Point-to-point Data link
HLC or LLC present	Accept or reject (Note 3)

Note 3 - Some terminal equipment on this interface may understand the High layer compatibility or Low layer compatibility information element and would reject the call if incompatible.

B.4 Interworking with existing networks

Limitations in network or distant user signaling (e.g., in the case of an incoming call from a PSTN or a call from an analogue terminal) may restrict the information available to the called user in the incoming SETUP message. A called user should accept limited compatibility checking (e.g., without the High layer compatibility information element) if a call is routed from an existing network which does not support High layer compatibility information element transfer.

In cases where the network cannot provide all incoming call information, or where the network is not aware of the existence or absence of some service information (such as compatibility information), the incoming SETUP message includes a progress indicator information element, containing Progress indicator No. 1 "Call is not end-to-end ISDN, further call progress information may be available in band" or No. 3 "Origination address is non-ISDN" (see Annex I).

The terminal equipment receiving a SETUP with a progress indicator information element shall modify its compatibility checking, the terminal equipment should regard the compatibility as successful if it is compatible with the included information, which as a minimum, will be the Bearer capability information element. A terminal equipment expecting information in addition to the Bearer capability information element in a full ISDN environment need not reject the call if such information is absent but a Progress indicator information element is included.

For additional information see Section 11.2.

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Annex C

Transit Network Selection

C. Annex C - Transit Network Selection

This annex describes the processing of the transit network selection information element.

C.1 Selection not supported

Some networks may not support transit network selection. In this case, when a transit network selection information element is received, that information element is processed according to the rules for unimplemented non-mandatory information elements (see Section 5.8.7.1).

C.2 Selection supported

When transit network selection is supported, the user identifies the selected Transit network(s) in the SETUP message. One Transit network selection information element is used to convey a single network identification.

As the call is delivered to each selected network, the corresponding transit selection may be stripped from the call establishment signaling, in accordance with the relevant internetwork signaling arrangement. The Transit network selection information element(s) is/are not delivered to the destination user.

When a network cannot route the call because the route is busy, the network shall initiate call clearing in accordance with Section 5.3 with cause No. 34 "no circuit/channel available".

If a network does not recognize the specified Transit network, the network shall initiate call clearing in accordance with Section 5.3, with cause No. 2 "no route to specified transit network". The diagnostic field shall contain a copy of the contents of the Transit network selection information element identifying the unreachable network.

A network may screen all remaining transit network selection information elements to:

- a) avoid routing loops, or
- b) ensure an appropriate business relationship exists between selected networks, or
- c) ensure compliance with national and local regulations.

If the Transit network selection is of an incorrect format, or fails to meet criteria a), b) or c) the network shall initiate call clearing in accordance with Sec. 5.3, with the appropriate cause value.

When a user includes the Transit network selection information element, pre-subscribed default transit network selection information (if any) is overridden.

The Network Specific Facilities information element may also be used, and specifies the transit network from which a service is requested. If both Network-specific facilities and Transit network selection information elements are supplied in a message, the transit network supplied in the Network-specific facilities information element should override that supplied in the Transit network selection information element.

For inter-LATA calls directed to a network switch, if there is no transit network selected in the Network-specific facilities information element, then the message will be examined for the presence of a Transit network selection information element. If no Transit network selection information element is found, the

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call will be routed to the presubscribed carrier.

For further information see Annex E.

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Annex D

Extensions for symmetric call operation

D. Annex D - Extensions for symmetric call operation

D.1 Additional message handling

In symmetric applications, the SETUP message will contain a Channel Identification information element indicating a particular B-channel to be used for the call. A point-to-point data link shall be used to carry the SETUP message.

The procedure described in Section 5 for the user side should normally be followed. Where additional procedures are required, they are detailed below.

D.1.1 B-channel selection - symmetric interface

Only B-channels controlled by the same D-channel will be the subject of the selection procedure. The selection procedure is as follows:

- a) the SETUP message will indicate one of the following:
 - 1) channel is indicated, no acceptable alternative, or
 - 2) channel is indicated, any alternative is acceptable.
- b) In cases 1) and 2), if the indicated channel is acceptable and available, the recipient of the SETUP message reserves it for the call. In case 2., if the recipient of the SETUP message cannot grant the indicated channel, it reserves any other available B-channel associated with the D-channel.
- c) If the SETUP message contains all information required to establish the call, the recipient of the SETUP message indicates the selected B-channel in a CALL PROCEEDING message transferred across the interface and enters the Incoming Call Proceeding state.
- d) In case 1) if the indicated B-channel is not available, or in case 2) if no B-channel is available, a RELEASE COMPLETE message with a cause value of No. 44 "requested circuit/channel not available" or No. 34 "no circuit/channel available" respectively is returned to the initiator of the call. The sender of this message remains in the Null state.
- e) If the channel indicated in the CALL PROCEEDING, ALERTING or CONNECT message is unacceptable to the initiator of the call, it clears the call in accordance with Section 5.3.

In cases 1) and 2), if the indicated channel is invalid, the recipient of the SETUP message clears the call by sending RELEASE COMPLETE message with cause # 82 "identified channel does not exist". Other error condition procedures are covered in section 5.8.

If in case 1) the B-channel indicated in the first message is not the channel offered by the initiator, it will clear the call by sending a DISCONNECT message with cause #34 "no circuit/channel available".

If in case 2) the B-channel indicated in the first response message is unacceptable to the initiator, it will clear the call by sending a DISCONNECT message with cause #34 "no circuit/channel available" (call processing error) or with cause #44 "requested circuit/channel not available" (maintenance state error).

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If in case 2) the B-channel indicated in the first response message is invalid or unprovisioned to the initiator, it will clear the call by sending a DISCONNECT message with cause #82 "channel identified does not exist". Other error condition procedures are covered in section 5.8.

D.1.2 Call confirmation

Upon receipt of a SETUP message, the equipment enters the Incoming call proceeding state. Valid responses to the SETUP message are an ALERTING, a CALL PROCEEDING, a CONNECT, or a RELEASE COMPLETE message.

If the indicated channel is acceptable to the initiator of the call, the initiator shall attach to the indicated B-channel.

Figure IV-D-1a summarizes sections 5.8.3 and 5.8.4 for symmetric signaling.

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Receiver's state	Message received by the symmetrical user																	
	S E T U P	C O N N A C K	C A L L P R O C	A L E R T	C O N N	D I S C	R E L	R E L C O M	R E S T	R E S T A C K	R E G	C O N C O N	U S E R I N F O	P R O G	N O T I F Y	F A C	F A C A C K	F A C R E J
0	*	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	I	*	I	*	CR DNE	CR DNE	CR DNE	CR DNE	+	+	+
1	**	VE	*	*	*	*	*	*	*	*	VE	I	I	*	*	+	+	+
3	VE	VE	I	*	*	*	*	TE	*	*	VE	*	*	*	*	+	+	+
4	VE	VE	I	*	*	*	*	TE	*	*	VE	*	*	*	*	+	+	+
7	VE	VE	VE	VE	VE	*	*	TE	*	*	VE	*	*	VE	*	+	+	+
8	VE	*	VE	VE	VE	*	*	TE	*	*	VE	*	*	VE	*	+	+	+
9	VE	VE	VE	VE	VE	*	*	TE	*	*	VE	*	*	VE	*	+	+	+
10	VE	I	VE	VE	†	*	*	TE	*	*	VE	*	*	VE	*	+	+	+
11	I	I	I	I	I	*	*	TE	*	*	VE	I	I	I	*	+	+	+
12	I	I	I	I	I	I	*	TE	*	*	VE	I	I	I	*	+	+	+
19	I	I	I	I	I	I	*	*	*	*	VE	I	I	I	*	+	+	+

* : This Specification specifies the procedure.

** : Appropriate response depends upon Layer 2 designated Network side (a) or User side (b).

(a) If the request is preferred (not exclusive), offer an alternative channel (subject to availability) and proceed as in Section 5.1.2.3; else, a REL COM response should be sent as in Section 5.1.4.

(b) Release reserved B-channel, assign it to the new incoming call and proceed as in Section 5.1.2.3.

† : This is a tolerable error when received by the calling user (who should respond with CONN ACK); however, it is a violent error for the called user.

CR DNE : Call Reference does not exist (see Section 5.1.6.1)

I : Ignorable error

TE : Tolerable Error

VE : Violent Error

+

Figure IV-D-1a Symmetrical User Response on Receipt of Message

Note: Consult product specific documentation to determine which messages are supported by particular AT&T ISDN products.

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D.1.3 Clearing by the called user employing user-provided tones/announcements

In addition to the procedures described in Section 5.3.3, if the bearer capability is either audio or speech, the called user or private network may apply in-band tones/announcements in the clearing phase. When in-band tones/announcements are provided, the called user or private network proceeds similarly as stipulated in Section 5.4.4.1 for the network.

D.1.4 Active indication

Upon receipt of a CONNECT message, the initiator of the call shall respond with a CONNECT ACKNOWLEDGE message and enter the Active State.

D.1.5 Receiving a STATUS message

Some implementation will ignore the STATUS message if no STATUS ENQUIRY message was sent.

On receipt of a STATUS message reporting an incompatible state, the receiving entity shall:

- a) clear the call by sending the appropriate clearing message or,
- b) take other actions which attempt to recover from a mismatch and which are an implementation option. Refer to Figures IV-D-2a and IV-D-3a for the details. It is an implementation option to decide which of the matchable states will be considered so. Any decision will have little impact on the protocol. The table gives the logical maximum.

Current state	Received State	
	Matching	Matchable (User's action)
1	none	none
3	9	none
4	7	none
7	4	1 and 9 (ALERTING)
8	8	1, 7 and 9 (CONNECT)
9	9	1 (CALL PROCEEDING)
10	10	8 if outgoing (CONNECT ACKNOWLEDGE)
19	19	none

Figure IV-D-2a User's Action on Receipt of STATUS

Current state	Received State	
	Matching	Matchable (User's action)
1	none	none
3	3,9	none
8	8	1, 3, 7, 9 (CONNECT)
9	3,7	1 (CALL PROCEEDING)
10	10	none

Figure IV-D-3a Symmetrical User's Action on Receipt of STATUS for NCA-TSC

D.2 Timers for call establishment

User endpoints implement the network side timers T303 and T310 along with the corresponding network side procedures for actions taken upon expiration of these timers. See Table 9-2/Q.931 for the call establishment user-side timers and procedures.

D.3 Call collisions

In symmetric arrangements, call collisions can occur when both sides simultaneously transfer a SETUP message indicating the same channel. In the absence administrative procedures for assignment of channels to each side of the interface, the following procedure is employed.

First, one side of the interface will be designated the "network" and the other side of the interface will be designated the "user". Second, for the three possible scenarios where the same channel is indicated by combinations of preferred and exclusive from the user and network sides, the following procedure is used:

- a) "network" preferred, "user" preferred:

The "network" preferred channel is awarded and an alternate channel is indicated in the first response to the "user" SETUP message.

- b) "network" exclusive, "user" exclusive:

The "network" exclusive channel is awarded and the "user" SETUP message is cleared with a RELEASE COMPLETE message with cause No. 34 "no circuit/channel available".

- c) "network" preferred, "user" exclusive; or "network" exclusive, "user" preferred:

The side of the interface with an exclusive indicator in a SETUP message is awarded the channel and an alternate channel is indicated in the first response to the side using a preferred indicator in the SETUP message.

Channel identification is allowed in both directions for ALERTING and CONNECT.

D.4 Symmetrical user side SDL diagrams.

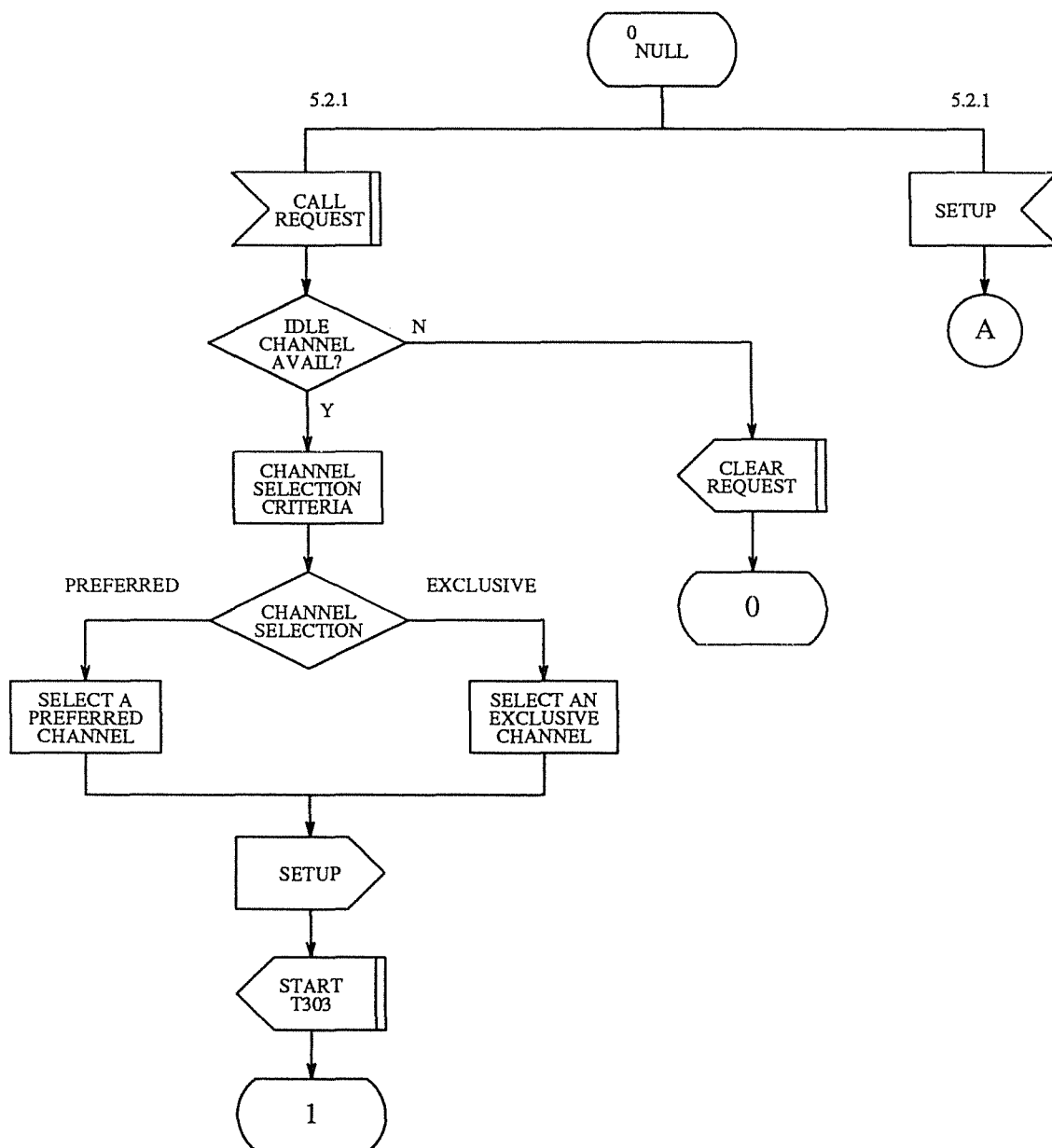


Figure IV-D-36. Symmetrical User Call Control Detailed SDL Diagram

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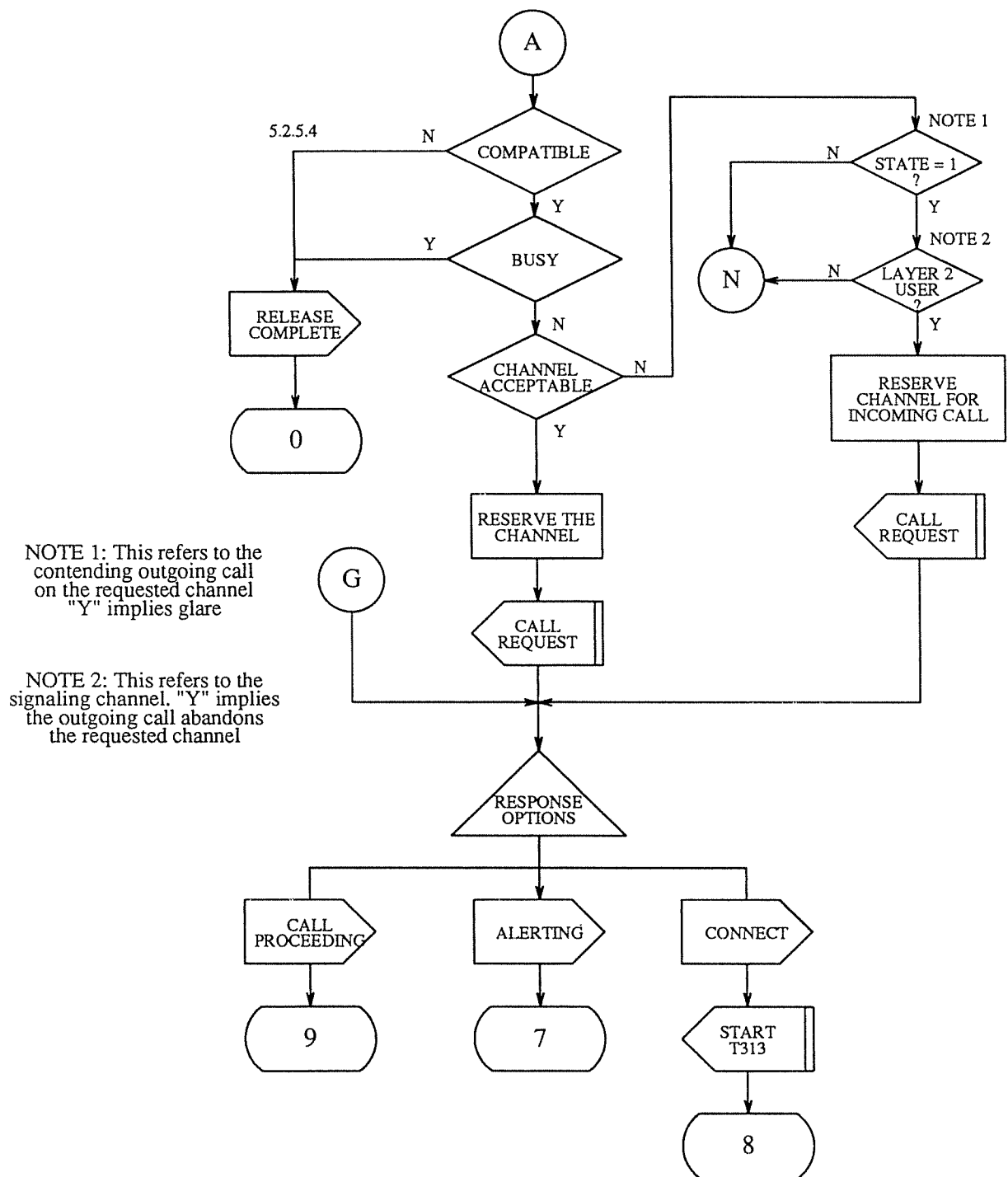


Figure IV-D-37. Symmetrical User Call Control Detailed SDL Diagram

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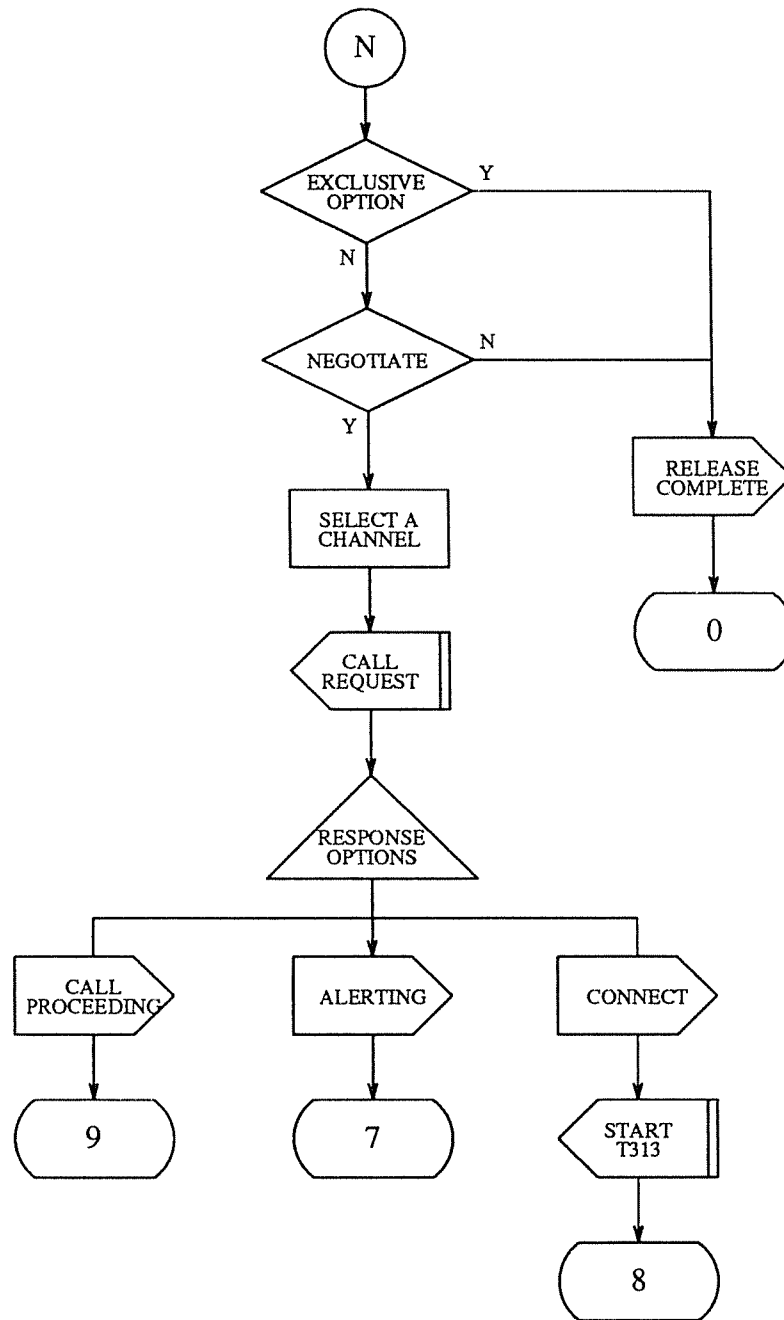


Figure IV-D-38. Symmetrical User Call Control Detailed SDL Diagram

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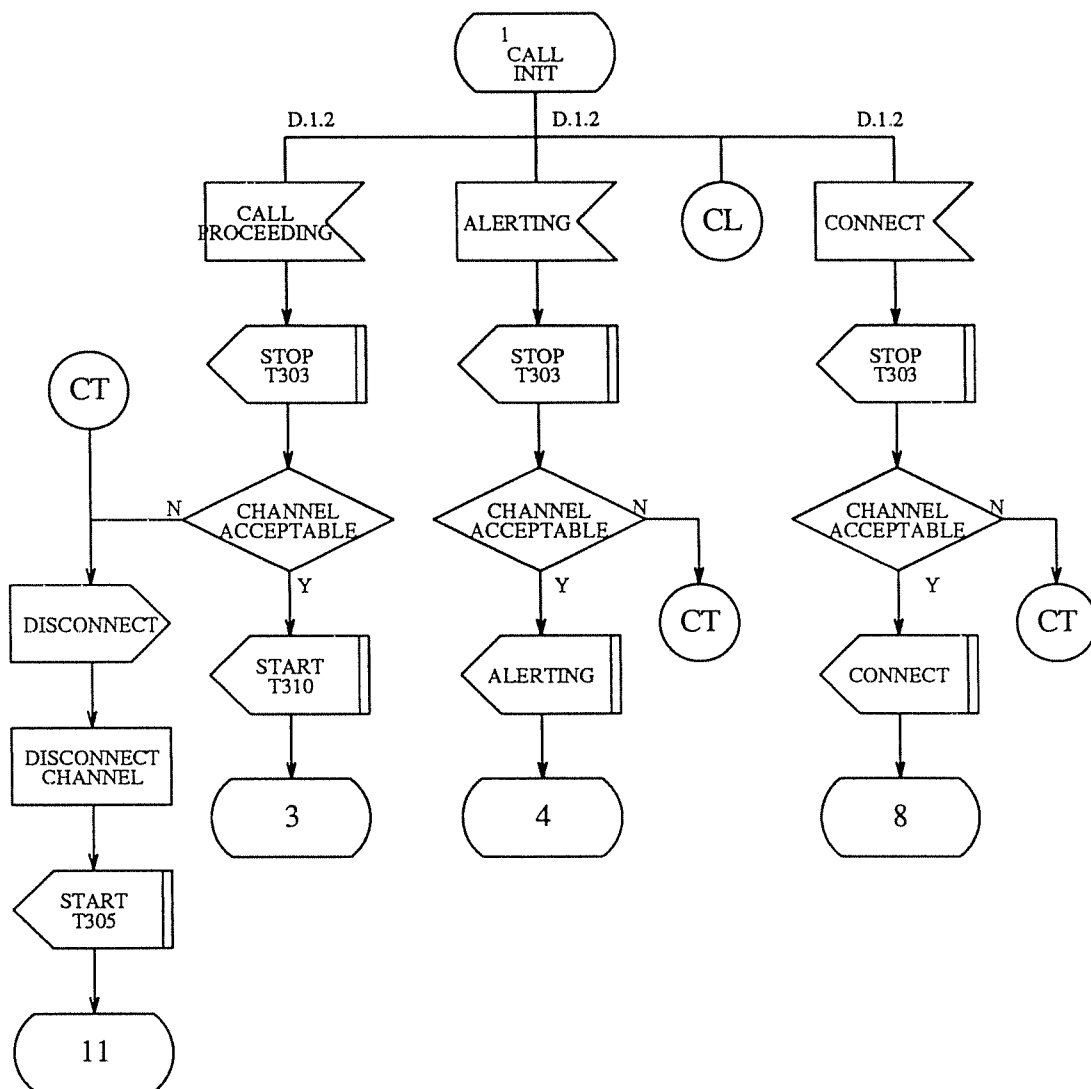


Figure IV-D-39. Symmetrical User Call Control Detailed SDL Diagram

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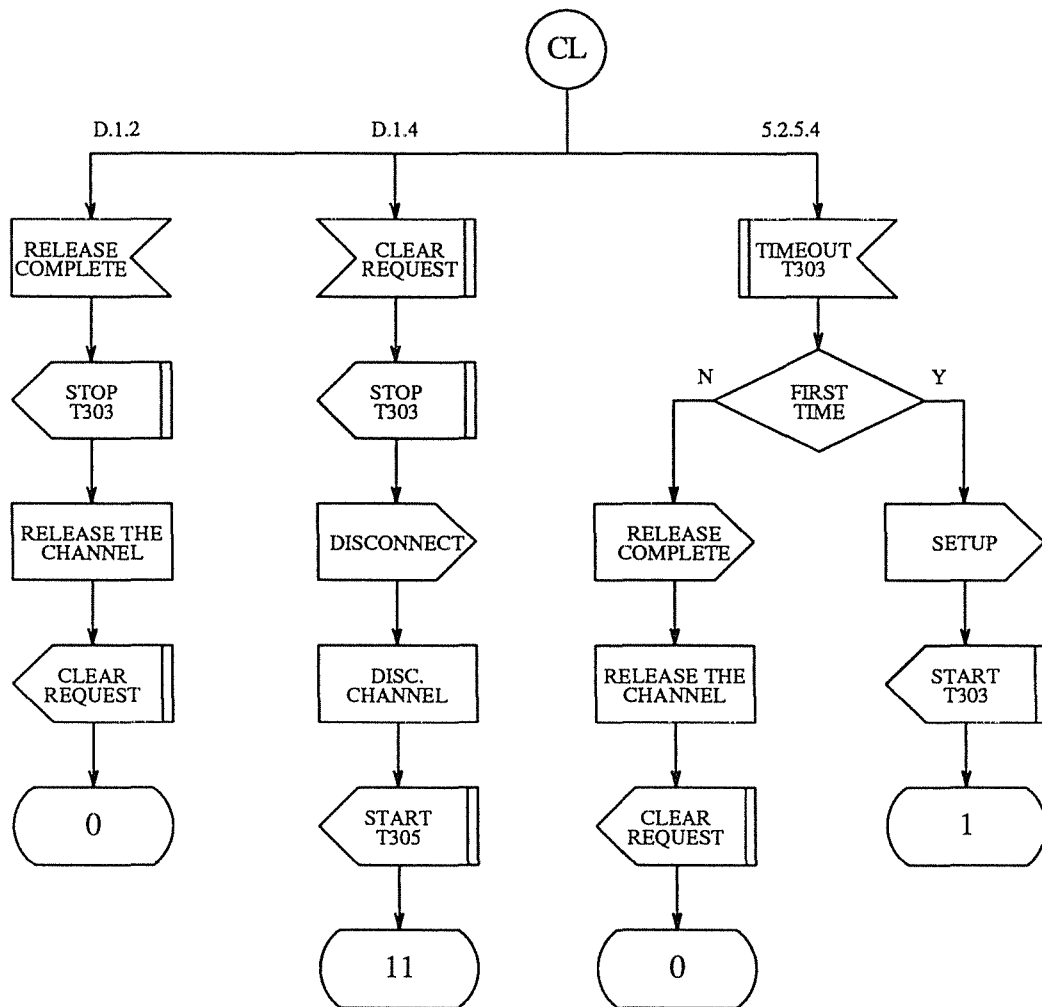


Figure IV-D-40. Symmetrical User Call Control Detailed SDL Diagram

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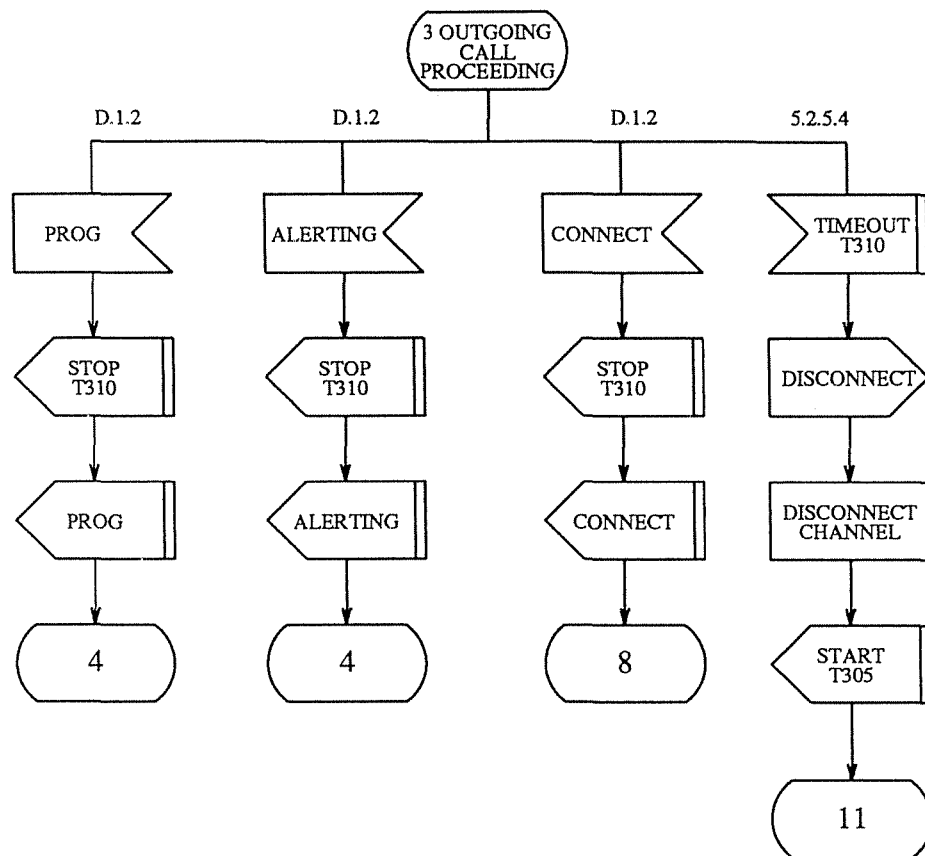


Figure IV-D-41. Symmetrical User Call Control Detailed SDL Diagram

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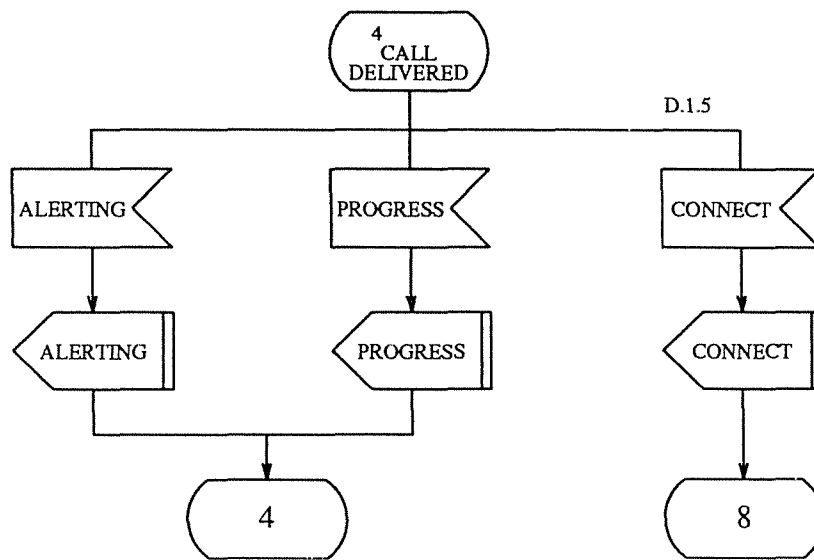


Figure IV-D-42. Symmetrical User Call Control Detailed SDL Diagram

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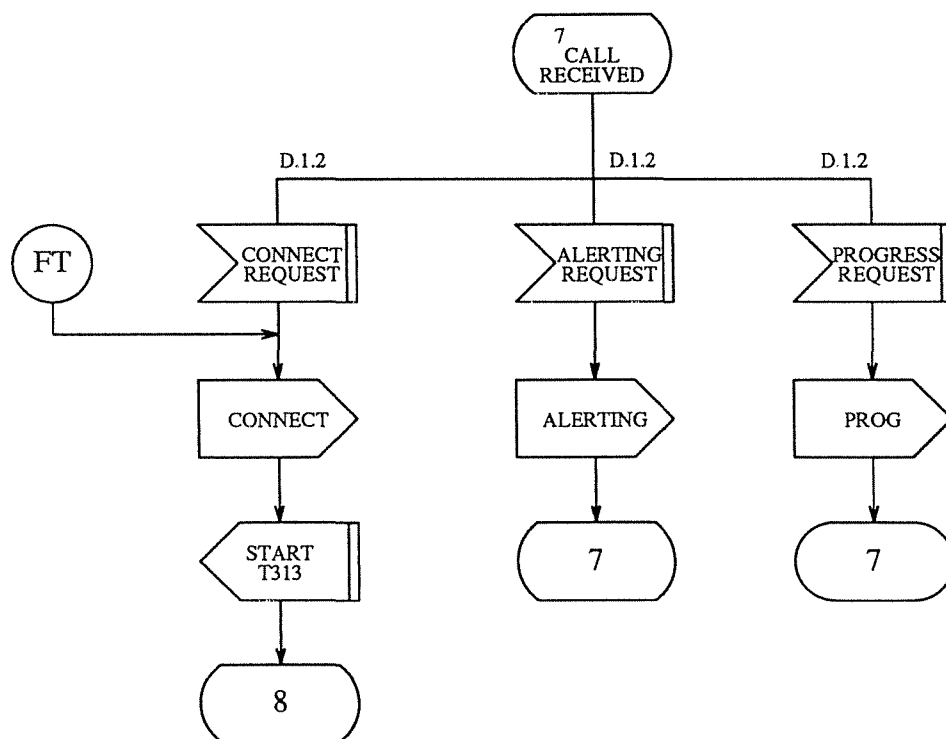


Figure IV-D-43. Symmetrical User Call Control Detailed SDL Diagram

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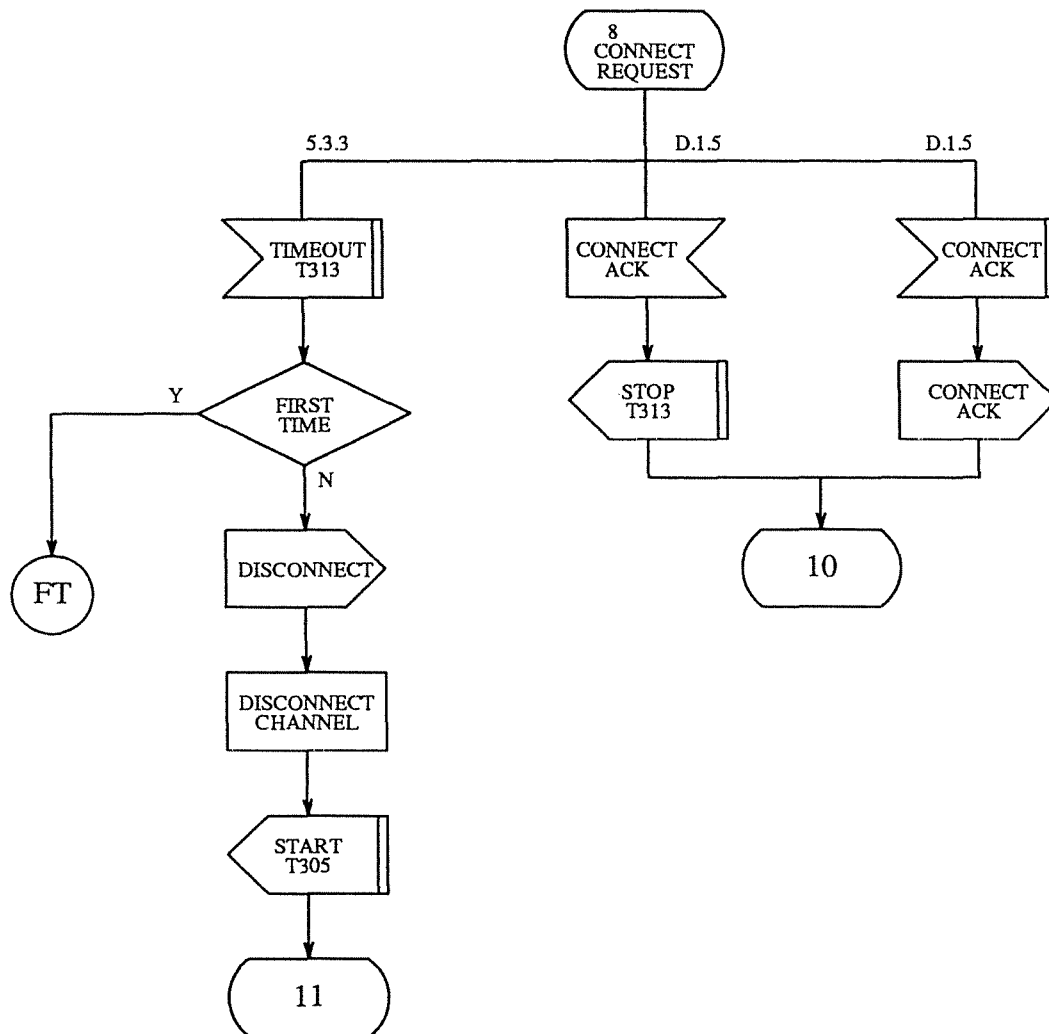


Figure IV-D-44. Symmetrical User Call Control Detailed SDL Diagram

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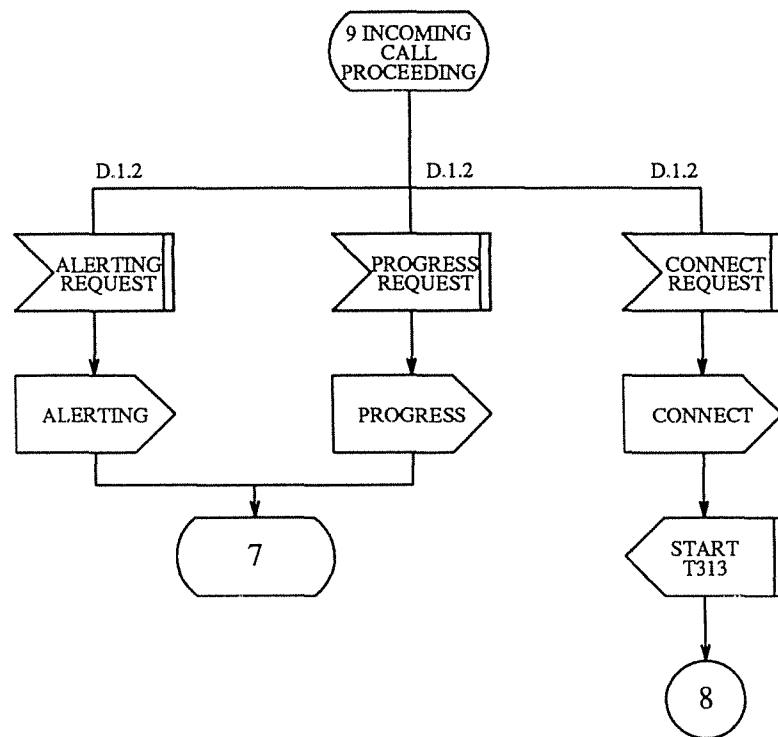


Figure IV-D-45. Symmetrical User Call Control Detailed SDL Diagram

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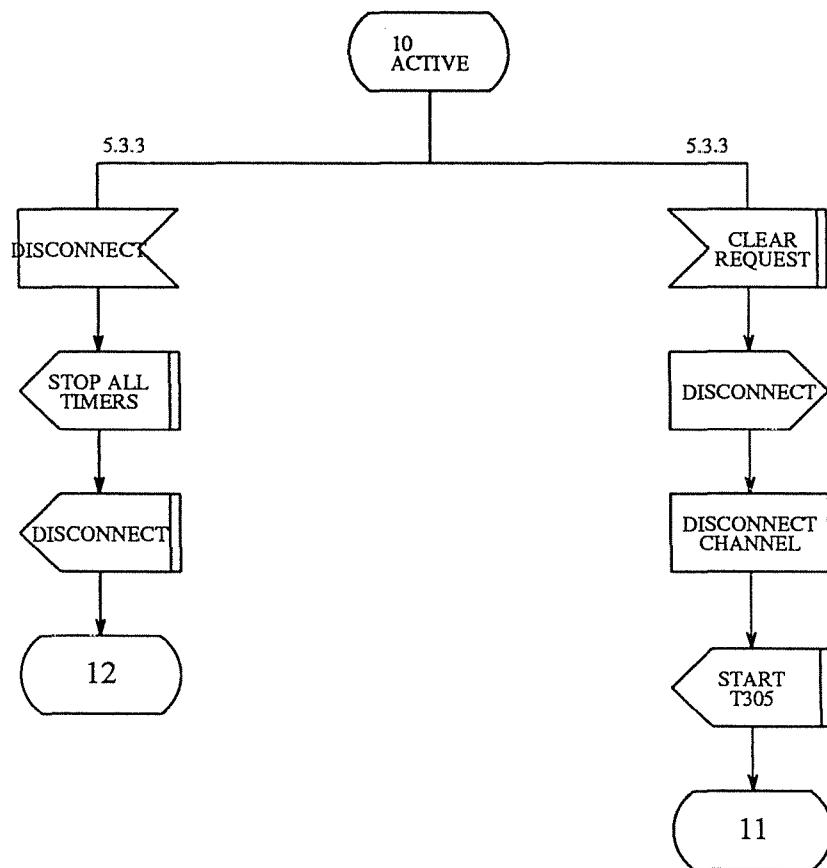
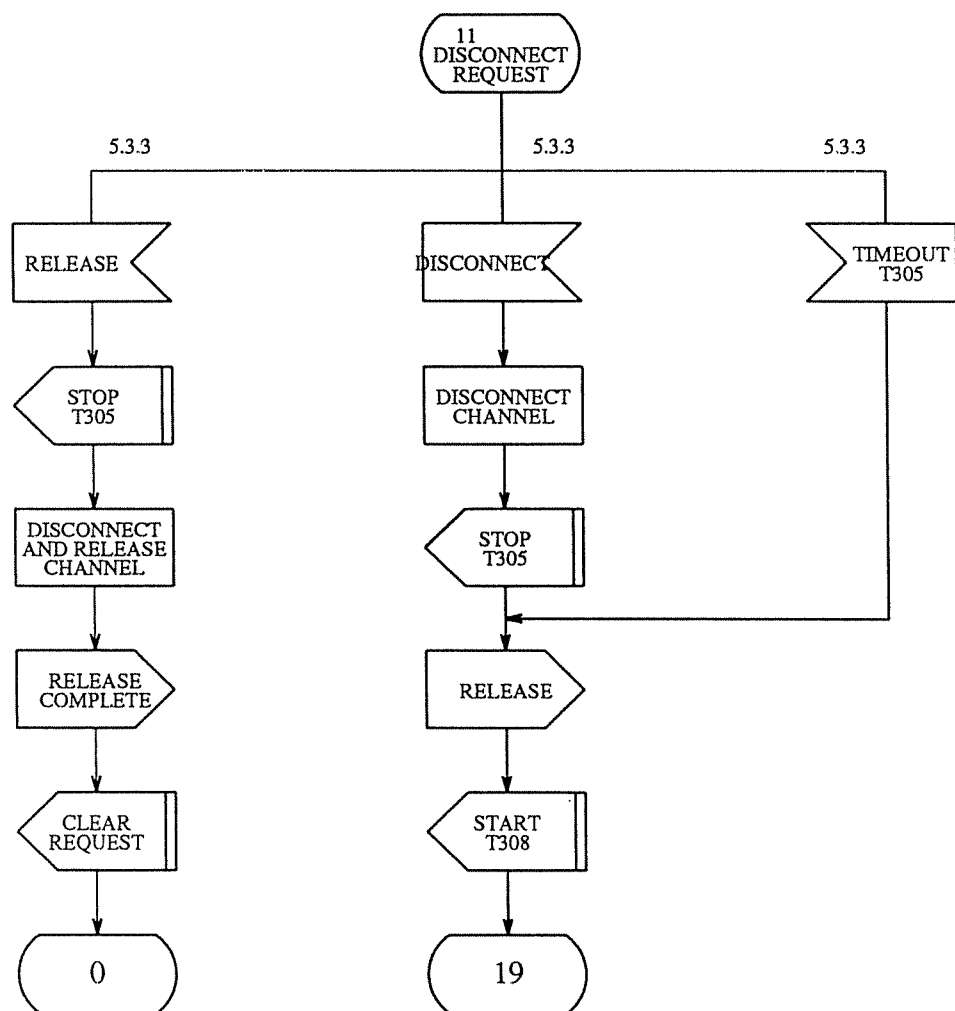


Figure IV-D-46. Symmetrical User Call Control Detailed SDL Diagram

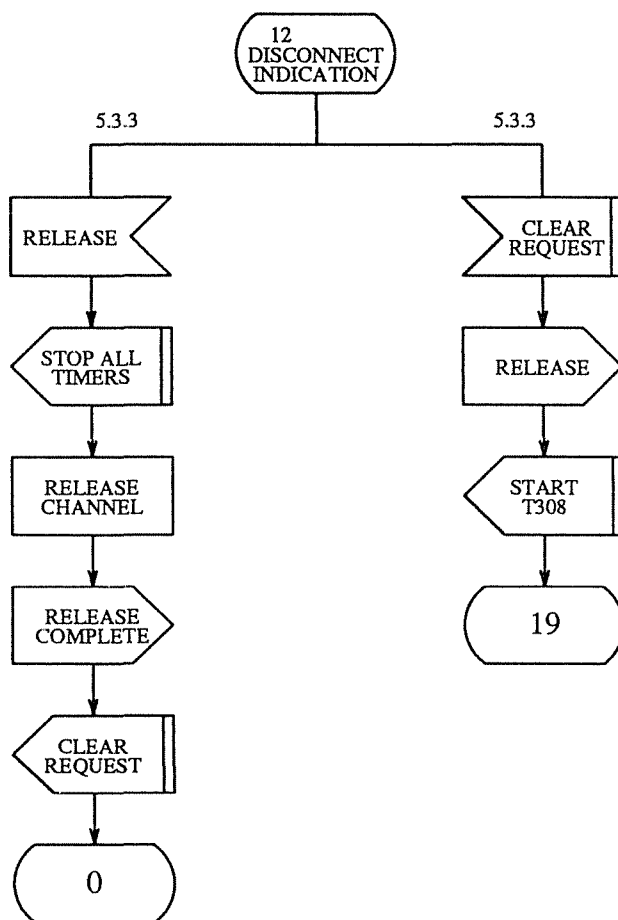
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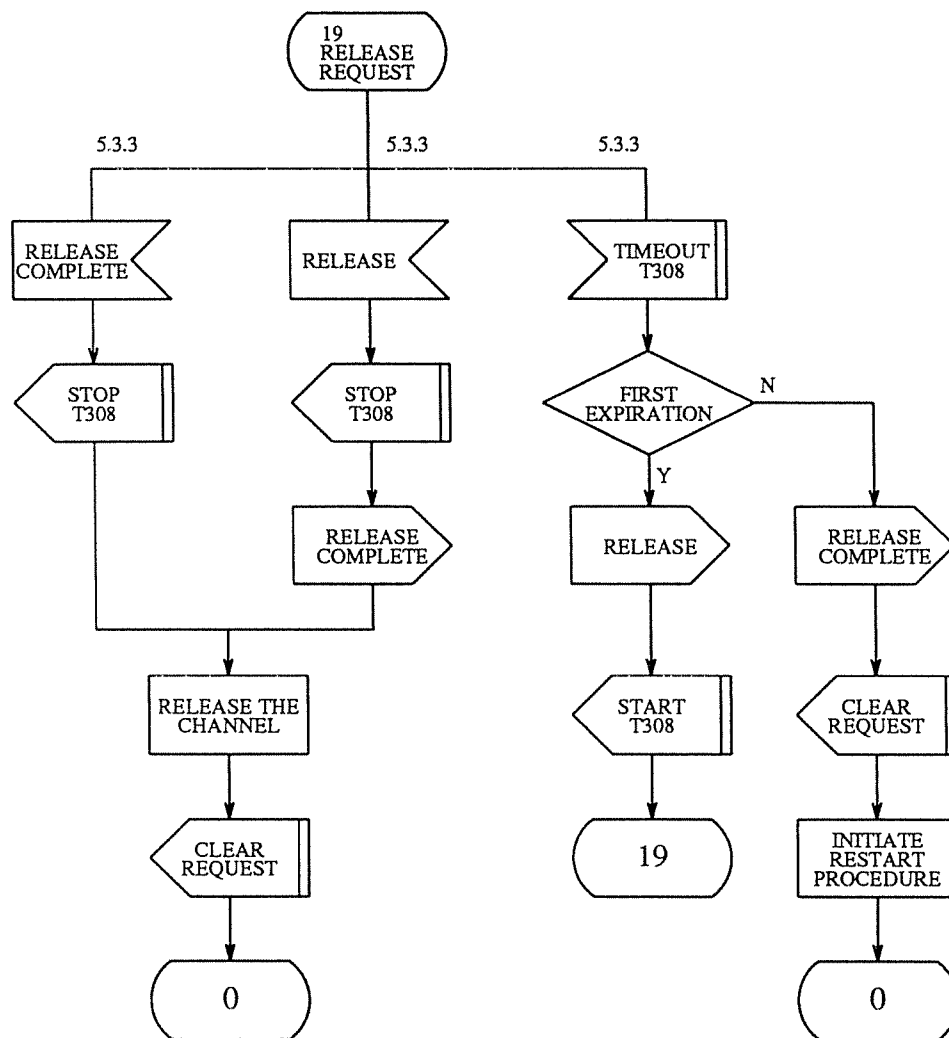


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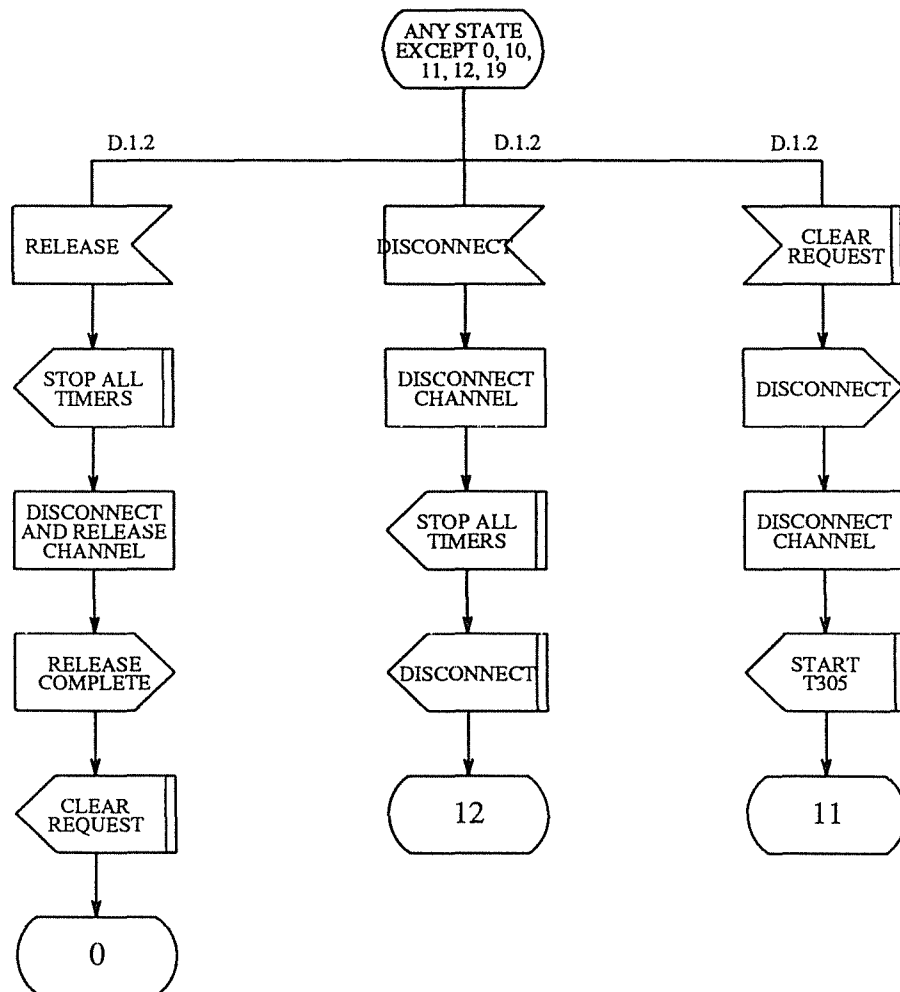


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Annex E

Network specific facility selection

E. Annex E - Network specific facility selection

This Annex describes the processing of the Network-specific facilities information element. The purpose of this information element is to indicate which network facilities are being invoked.

E.1 Default Provider

When the length of the network identification field is set to zero in the Network-specific facilities information element, then the services identified in this information element are to be provided by the network side of the interface receiving the information element (default provider). If the Network-specific facilities information element is recognized but the network facilities are not understood, then this information element is processed according to rules for non-mandatory information element content error (see 5.8.7.1).

E.2 Routing Not Supported

Some networks may not support the routing to the remote network of the contents of the Network-specific facilities information element. In this case, when a network-specific facilities information element is received, that information element is processed according to the rules for unimplemented non-mandatory information elements (see 5.8.7.1).

E.3 Routing Supported

When Network-specific facility information element routing is supported, the user identifies the network provider in this information element in the Q.931 SETUP message. One Network-specific facility information element is used to identify a network provider.

The user may specify more than one network provider by repeating the Network-specific facilities information element. Each identification is placed in a separate information element. The information is routed to the indicated network provider as long as the call is also handled by the network provider (see Annex C, Transit network selection). For example, if the user lists network providers A and B in separate Network-specific facilities information elements, there must be corresponding Transit network selection information elements in the SETUP message identifying those networks (or default call routing via A and B that was established prior to call establishment).

As the signaling messages containing Network-specific facilities information elements are delivered to the indicated remote network, they may be stripped from the signaling messages, in accordance with the relevant interworking signaling arrangement. The Network-specific facilities information elements may be delivered to the identified user.

No more than two Network-specific facilities information elements may be used in a SETUP message. (See product specific documentation). Further, there does not have to be a one-to-one correspondence between Network-specific facilities information elements and Transit network selection information elements.

If a network cannot pass the information to the indicated network provider, either due to:

--- The network indicated is not part of the call path, or

— No mechanism exists for passing the information to identified network

the network shall initiate call clearing in accordance with Section 5.4, with cause 2 "no route to specified transit network."

When a user includes the Network-specific facilities information element in the SETUP message, presubscribed default service treatment (if any) is overridden.

The Network Specific Facilities information element may also be used, and specifies the transit network from which a service is requested. If both Network-specific facilities and Transit network selection information elements are supplied in a message, the transit network supplied in the Network-specific facilities information element should override that supplied in the Transit network selection information element.

For inter-LATA calls directed to a network switch, if there is no transit network selected in the Network-specific facilities information element, then the message will be examined for the presence of a Transit network selection information element. If no Transit network selection information element is found, the call will be routed to the presubscribed carrier.

For further information see Annex C.

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Annex F

D channel backup procedures

F. Annex F - D-Channel Backup Procedures for Non-Facility Associated Signaling

F.1 General

In *facility associated signaling*, the D-channel signaling entity can only assign calls to channels on the interface containing the D-channel. When the D-channel signaling entity can assign calls to channels on more than one interface (including the one containing the D-channel), this is called *non-facility associated signaling*. Figure IV-F-3 is an example of facility associated signaling used on each of the three interfaces between a user (e.g. a PABX) and a Network. Replacing facility associated signaling with non-facility associated signaling on these interfaces results in the example shown in Figure IV-F-1.

When non-facility associated signaling is employed, the reliability of the signaling performance for the ISDN interfaces controlled by the D-channel may be unacceptable. To improve the reliability, a D-channel backup procedure employing a standby D-channel is necessary. The next section describes the backup procedure which is optional for end-points that use non-facility associated signaling.

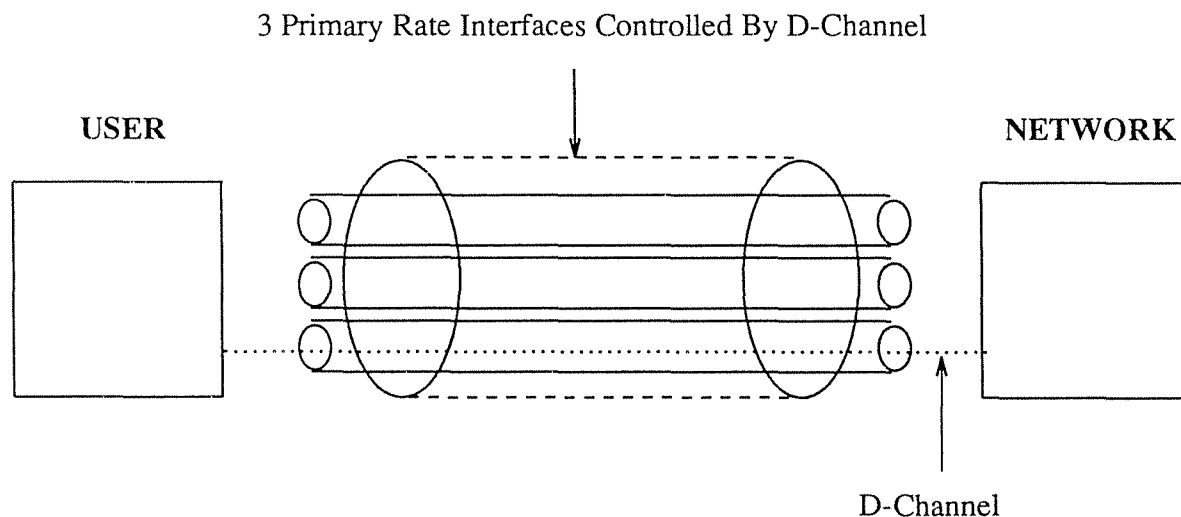


Figure IV-F-1. Example of Non-Facility Associated Signaling Controlling 3 Primary Rate Interfaces

F.2 D-Channel Backup Procedure

F.2.1 Role of Each D-Channel

The designated primary D-channel (always labeled D1) is always present on one DS1 facility. On a different DS1 facility, a backup D-channel (labeled D2) is present. Figure IV-F-2 shows the addition of a secondary (i.e., backup) D-channel to the arrangement shown in Figure IV-F-1.

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While one of the D-Channels (D1 or D2) is the active D-channel, it is used to send signaling packets across the user-network interface for multiple primary rate interfaces, including the primary rate interface containing the standby D-Channel.

While one of the D-Channels (D1 or D2) serves as the standby D-channel, it is in a stand-by role and is active at layer 2 only. All SAPI groups supported by the network and user (e.g., 0 and 63) can be active at layer 2. No layer 3 signaling packets are sent on logical link 0,0 of the standby channel while the active conveys signaling packets. While the standby is in a backup role, Layer 3 messages received on it shall be ignored. Following normal layer 2 procedures, at periodic intervals determined by the appropriate layer 2 timer associated with SAPI 0, a link audit frame will be sent on the point-to-point signaling link (0,0) of the standby D-Channel.

Since, at any given time, one of the D-Channels (D1 or D2) is in a standby role, load sharing between D1 and D2 is not possible. Neither D1 nor D2 can serve as a B-channel while designated as a backup D-channel. Any Layer 3 messages received on the standby D-Channel, shall be ignored. Lastly, the pair, D1 and D2, provide signaling for a pre-defined set of B-channels, and cannot backup any other D-channel(s) on a different interface.

At any point in time, only one of the D Channels, D1 or D2, will convey layer 3 B channel signaling information. At the point in time when a transition occurs, most stable calls, i.e., those calls which are in the Active state (Call State 10) would be preserved, although Message-Associated User-to-User Information (MA-UII) and both call-associated and non-call associated Temporary Signaling Connections (TSCs), may be lost. Some portion of stable calls may be lost.

F.2.1.1 Initialization

In order to avoid unnecessary signaling outages, a primary D Channel, which is always labeled as D1, is designated at pre-service provisioning time and entered into a data base by both sides of the interface.

When both D Channels are out-of-service, the designated primary (D1) has priority as the channel to carry call-control signaling. If D1 cannot be established, then D2 is chosen.

F.3 Manual Switch-over

The procedure to manually switch-over involves logically disconnecting layer 2 of the active D-channel, following normal layer 2 procedures for placing a link into the TEI-assigned state. Next, the two sides establish the standby D-channel as the channel for carrying call-control signaling.

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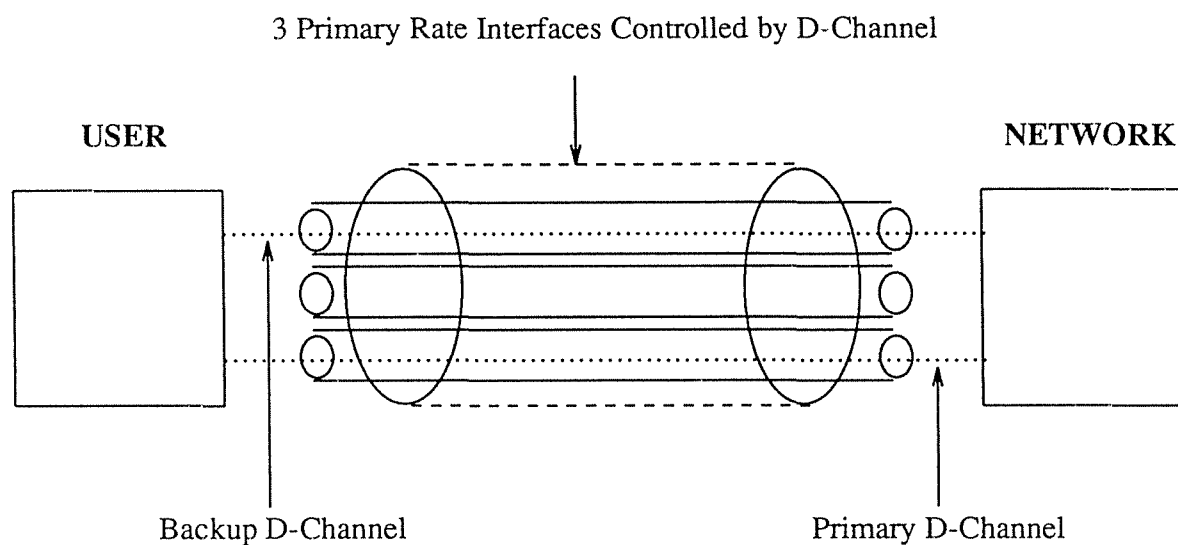


Figure IV-F-2. Example of Non-Facility Associated Signaling with Backup D-Channel Controlling 3 Primary Rate Interfaces

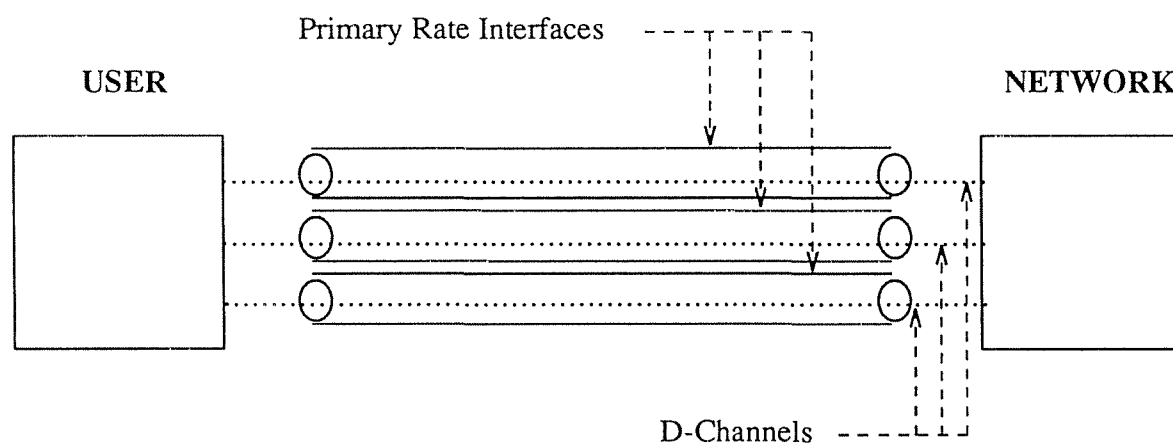


Figure IV-F-3. Example of Associated Signaling on Each of Three Primary Rate Interfaces

F.3.1 Protocol Description

F.3.1.1 D Channel States

For the purposes of the D Channel Backup procedure, the following states at layer 3 apply to either D1 or D2:

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1. In Service (IS) : A D Channel is termed *In Service* when it is in the multiple-frame-established state at layer 2 and carrying normal call-control signaling at layer 3. This state is also referred to as Active.
2. Standby (STBY) : A D Channel is termed Standby when it is in the multiple-frame-established state at layer 2, but not carrying any layer 3 call-control messages on logical link 0,0.
3. Out-Of-Service (OOS) : A D Channel is termed Out-Of-Service when it is in the TEI-assigned state at layer 2, but periodically requested by layer 3 to attempt to establish the link. A D Channel will remain in the OOS state until any one of the following occurs:
 - i. After the transmission of a SABME, a UA (Unnumbered Acknowledgment) is received by layer 2 which will cause the D Channel to be placed in the multiple-frame-established state at layer 2. If, instead, a DM (Disconnected Mode) is received by layer 2, then the D Channel will remain in the OOS state, with layer 3 periodically requesting layer 2 to establish the link.
 - ii. A craft request is made to place the D Channel in the MOOS state.
4. Maintenance Busy (MB) : A D Channel is termed Maintenance Busy (MB) when it is not in the multiple-frame-established state (e.g., TEI-assigned state) at layer 2. This state is entered automatically when an active (IS) D Channel is declared failed. While in the MB state, receipt of a SABME by layer 2 will result in the transmission of a DM. A D Channel which is placed in a MB state may be placed in the OOS state without craft intervention.
5. Manual Out-of-Service (MOOS) - A D Channel is termed Manual Out-Of-Service (MOOS) when craft intervention has caused it to be placed in the TEI-assigned state at layer 2. While in the MOOS state, receipt of a SABME by layer 2 will result in the transmission of a DM. Craft intervention is required to retrieve a D Channel from the MOOS state.
6. WAIT - A D Channel is termed as being in a WAIT state when an attempt has been made by one side of the interface to establish layer 3 peer communication as part of the process of going to the IS state. This state is transitional in nature.

F.3.2 Difference Between IS and STBY D Channels

During normal operation, the IS D Channel carries all call-control signaling at layer 3. A layer 3 call-control message must be acknowledged at layer 2 (within timer T200 (value = 1 sec.)) and may require a layer 3 response within a specified period of time (e.g., a SETUP message which requires a response before the expiry of Timer T303 (value = 4 sec.)). The STBY D Channel carries only layer 2 audit messages, according to Timer T203 (value = 15 sec.). Please see Figure IV-F-7 for a graphical depiction of normal operation on D1 and D2.

F.3.3 D Channel Backup Rules

The following rules are provided as a high level description of the procedure without the need for detailed protocol descriptions.

As a method of abbreviation, the states of D1 and D2 are represented as (D1 state, D2 state). For example, while D1 is active (IS) and D2 is standby (STBY), the notation used is (IS, STBY).

For the purposes of this subsection on D-Channel backup rules, initially D1 is IS and D2 is STBY. However, the procedure is entirely symmetrical; anything written about D1 can apply equally to D2, and vice versa.

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1. To Switch-over to D2 (i.e., D1 was IS):
 - i. If D1 is not failed, send a layer 2 DISC on D1 and wait for a UA or time-out.
 - ii. Place D1 in a MB state, start Timer T321. The suggested value of T321 is given in Section F.4.3.
 - iii. As an optional procedure, re-establish the link On D2 by sending a SABME and expect to receive a UA. If you cannot establish D2 at layer 2, put both D1 and D2 in the OOS state, referred to as (OOS,OOS).
 - iv. If the layer 2 of D2 has been re-established or is deemed to be already in the multiple-frame-established state, send a SERVICE message on D2, with an indication that D2=IS (abbreviated as SERV (D2=IS)). For the coding of the SERVICE message in this procedure, see Section F.4.5 below.
 - v. If Timer T321 expires then go to (OOS,OOS).
 - vi. If the far end responds on D2 with either a SERV (D2=IS) or a SERV ACK (D2=IS), then go to (OOS,IS). Receipt of any other message on D2 shall be ignored. The SERV (D2=IS) message should be retransmitted several times while Timer T321 is running, until the far end responds on D2 with either a SERV (D2=IS) or a SERV ACK (D2=IS). A suggested retry interval is 5 seconds. Eventually, D1 will become established at layer 2 and the states will become (STBY, IS)
2. If the states are (OOS,OOS), start by trying to establish D1 first, as the designated primary D Channel. The designated primary is identified at service provisioning time and entered into a data base by both sides. In practice, this means that if D2 comes up at layer 2 followed by D1 coming up, pick D1 as the channel to become IS, even if a SERV (D2=IS) has already been sent on D2.
3. NEVER go to (OOS,MB) or (MB,OOS) in order to avoid deadlock ¹.

F.4 Protocol Description at Layers 2 and 3

This section contains a detailed description of the protocol required to implement D Channel Backup. Figure IV-F-4 shows the state diagrams which augment the text in this section.

For the purposes of the following protocol description (i.e., all of Section F.2), initially D1 is IS and D2 is STBY. However, as noted above, the procedure is entirely symmetrical; anything written about D1 can apply equally to D2, and vice versa.

F.4.1 Switch-over Procedure

F.4.1.1 Declaring D1 as Failed

During normal operation, call-control signaling on D1 follows LAPD and I.451 procedures for information transfer in multiple frame operation. Timer T200 (value = 1 sec.) governs the response to I-Frames by either end. If a response (either a Layer 3 call-control message or a valid layer 2 message) is not received before T200 expires, layer 2 will retransmit the message N200 (value = 3 (three)) more times. Failing to

1. Deadlock occurs when the two sides, A and B, do not agree on the D-Channel which is to be activated for carrying call-control signaling. The states (OOS, MB) or (MB, OOS) are especially important to avoid since no call-control signaling can occur while one of the D-Channels is held in MB and the other is ready, but not yet activated, at layer 2.

get a response, layer 2 shall issue a MDL_ERROR_INDICATION to the connection management entity. In this scenario, the active link will be declared as failed within

- eight (8) seconds (see Figure IV-F-8 A), during normal call control signaling interaction, and
- a period equal to the value of T203 plus eight (8) seconds (see Figure IV-F-8 B), during idle call-control signaling traffic times.

However, at any time during normal operation, D1 will be declared as failed when layer 2 receives

- A DISC which requires a response of a UA.
- an unsolicited DM, in which case layer 2 shall initiate the procedure to insure layer 2 verification and to establish layer 3 peer communication on D2, as outlined below.

Failure of D1 is indicated to layer 3 through the primitive, DL_RELEASE_INDICATION, from the data link layer (i.e., layer 2); D1 is now in the TEI-assigned state at layer 2. Upon receipt of this primitive, layer 3 shall place D1 in the maintenance busy condition (MB) and initiate the procedure for putting D2 in the IS state.

F.4.1.1.1 Initiating Switch-over to D2

If D2 is STBY at layer 3, and D1 has been declared failed and placed in the MB state, layer 3 shall start Timer T321. For the value of T321, see Section F.4.3 below. Layer 3 may then execute the *optional* procedure of re-initializing layer 2 on D2 by issuing a DL_ESTABLISH_REQUEST to layer 2. In this case, if layer 2 is successful in re-establishing the link, it shall communicate this event to layer 3 through the DL_ESTABLISH_CONFIRM primitive.

When D2 is deemed to be in the the multiple-frame-established state, then layer 3 shall then follow procedures to establish D2 as IS through layer 3 peer communication, as outlined below in Section F.4.1.2.

If D2 is in the OOS state when D1 is declared failed, layer 3 shall place D1 in the OOS state as well. D1 and D2 will now be in the (OOS,OOS) state and the procedure for initialization shall begin as outlined in Section F.4.2.

If D2 is in the MOOS state, layer 3 shall issue a high priority indication to craft indicating that any tests being performed should be terminated. At that point, D1 should be placed in the OOS state by layer 3. Further, D1 and D2 shall stay in the (OOS,MOOS) state until craft intervention places D2 into an OOS state. Until that time, periodic attempts are made to bring D1 to IS.

F.4.1.2 Establishing Layer 3 Call-Control Signaling After Switch-over

When D2 is deemed to be in the the multiple-frame-established state, layer 3 shall issue a SERVICE message with the indication that D2=IS (abbreviated as SERV (D2=IS)), on logical link 0,0. Layer 3 then enters the (MB,WAIT) states for D1 and D2. From (MB,WAIT), one of the following events will occur:

1. The MB timer, T321, expires. Layer 3 shall then go to (OOS,OOS) and the procedures for initialization shall then apply, as specified in Section F.4.2
2. Layer 3 receives either a SERV ACK (D2=IS) or SERV (D2=IS) message on D2. This event will cause D2 to be placed into the IS state, thus allowing layer 3 call-control signaling to begin. In addition, D1 shall be placed in the OOS state. The state transition in this scenario will be from (MB,WAIT) to (OOS,IS) *Note: Any received call control signaling messages should be ignored until the SERV/SERV ACK exchange is successfully completed.*

3. Layer 3 receives any other message on D2. This event will cause D2 to remain in the WAIT state, and shall be ignored by layer 3. Periodically (e.g., every 5 seconds), layer 3 may retransmit the SERV (D2=IS) message on D2.

In all cases where one of the D-channels, D1 or D2, is established for call-control signaling, Timer T321 shall be reset by layer 3.

Since Call Reference numbers are saved by the switch for stable calls, there is no need to initiate error recovery procedures at layer 3. (e.g., send a STATUS ENquiry for all call references).

Once D1 is placed in the STBY state (i.e. layer 2 on D1 goes to the multiple-frame-established state) the D-channels are available for transition again if initiated by a failure of D2, or by a maintenance switch-over request from a peer entity.

F.4.1.3 Manual Switch-over: Release Procedure of an In Service D Channel

Release of multiple frame operation on a D Channel is initiated by layer 3 through the DL_RELEASE_REQUEST primitive to layer 2. The receipt of this primitive by the data link layer shall result in the transmission of a DISC.

A data link layer receiving a DISC command, while in the multiple-frame-established state, shall transmit a UA over the data link and notify layer 3 through the DL_RELEASE_INDICATION primitive. At that point, the TEI-assigned state shall be entered.

The originator of a DISC may receive either a UA or a DM. In either case, it shall enter the TEI-assigned state and will notify layer 3 through the DL_RELEASE_CONFIRM primitive.

If the originator of a DISC does not receive any response within timer T200, it shall retransmit the DISC up to N200 times. Failing to get a response, layer 2 shall enter the TEI-assigned state, notify the connection management entity and layer 3 through the MDL_ERROR_INDICATION and DL_RELEASE_CONFIRM primitives, respectively.

F.4.2 Initialization

At the time of service turn-up, or after an outage of both D1 and D2 (i.e., (OOS,OOS)), both sides shall proceed to bring up D1, the designated primary, first. By designating a primary D Channel, D1, the following procedures apply:

1. If D1 goes to the multiple-frame-established state at layer 2 before D2, D2 should be placed in the MB state until D1 goes to IS. That is, the states of D1 and D2 will go from (OOS,OOS) to (WAIT,MB) to (IS,OOS).
2. If D2 goes to the multiple-frame-established state before D1, D1 is held in the OOS state. A SERV (D2=IS) message shall then be sent on D2 and the (OOS,WAIT) state is entered. If, in the process of waiting for a response on D2, D1 goes to the multiple-frame established state at layer 2, D2 should be placed in the MB state, a SERV (D1=IS) message shall be sent on D1, and layer 3 shall place the D Channels into the (WAIT,MB) state.

F.4.3 Value of Timer T321

Timer T321 is used in the D-Channel Backup protocol as a MB timer to guard against a loss in signaling for an indeterminate period of time. The value of T321 is highly dependent upon the time it takes to declare a D-Channel as failed.

Timer T203 is related to the time it takes to declare a D-Channel as failed. The current suggested value of T203 in this specification is 30 seconds. The value of T321 should be enough larger than T203 to allow both sides of the interface to place the IS D-Channel in a MB condition before initializing the STBY D-channel. To meet this objective, the suggested value of T321 is 40 seconds, which allows for multiple SERV/SERV ACKs to be exchanged during switchover².

F.4.4 T309 Procedures

T309 is a layer 3 timer which specifies a wait interval after a failure of layer 2 before the B-Channels are removed from service. For D-Channel backup, T309 procedures are as follows:

- T309 should be used individually on both D-Channels, D1 and D2.
- While either D1 or D2 is *not* in the IS or STBY states, then T309 should be used individually on each of them.
- In the event that T309 expires for both D1 and D2, then the affected B-Channels should be removed from service.

F.4.5 SERVICE Messages in the D-Channel Backup Protocol

The purpose of this section is to explain the use and format of the SERVICE and SERVICE ACKNOWLEDGE messages in the context of D-Channel Backup.

In the D-Channel Backup protocol, SERVICE and SERVICE ACKNOWLEDGE messages are used for the following purposes:

- to bring the standby D-Channel into an IS condition.
- to perform audits on an IS D-Channel to ensure it is operating properly, and to avoid any possible deadlock conditions.

In either case, the format of the SERVICE and SERVICE ACKNOWLEDGE messages are as shown below.

F.4.5.1 SERVICE Message Format and Use in D-Channel Backup Protocol

Associated with the SERVICE class of maintenance messages are three status categories. They are, in order of decreasing availability: *In Service*, *Maintenance*, and *Out of Service*. The D-Channel Backup protocol uses only the *In Service* status category for both layer 3 switchover and audit procedures.

A SERVICE message is used to change the status of a channel in an interface, by transmitting a SERVICE message with an indication of the status and Channel identification. The SERVICE ACKNOWLEDGE message is used to respond to a SERVICE message. SERVICE messages may be sent at periodic intervals until a SERVICE ACKNOWLEDGE is received. Since the new "status" of a backup D-Channel is viewed as more available (i.e., IS vs. STBY), then a SERVICE ACKNOWLEDGE/SERVICE message must be received to explicitly confirm that the D-Channel indicated is ready to become active (IS) at layer 3.

In the case of a simplex D-Channel arrangement, note that a SERVICE message can not be used to change the status of the D Channel.

2. The suggested value of Timer T321 is based on the value of Timer T203 plus 10 seconds.

Further, SERVICE messages specifying *Out of Service* or *Maintenance* status are never sent for D Channels and are ignored if received.

For further information on the general use of the SERVICE and SERVICE ACKNOWLEDGE messages, see Section 8.1

F.4.5.2 Coding of Channel Identification in SERV/SERV ACK messages in D-Channel Backup Protocol

The Channel identification information element, as used in the D-Channel Backup protocol for SERVICE and SERVICE ACKNOWLEDGE messages is coded to indicate:

- Either explicit or implicit Interface identification in the Interface identifier field.
- Primary rate in the Interface type field.
- D-Channel in the D-Channel indicator field.
- No channel in the Channel selection field.
- Binary Interface id in the Interface Identifier field (only if interface is explicitly identified, according to the Interface identifier field mentioned above).

For further details on the format and coding of the Channel identification information element, please see Section 4.5.10.

Thus, while used for establishing a D-Channel as IS in the D-Channel Backup protocol, this information element will be 3 or 4 Octets long.

Figure IV-F-4. D-Channel Backup High Level State Diagrams

Nomenclature -

- The states of D1 and D2 are represented as (D1 state, D2 state). For example, while D1 is active (IS) and D2 is standby (STBY), the notation used is (IS, STBY).
- Primitives sent to or received from Layer 2 are represented as D-channel:Primitive. For example, the event D1:DL_RLS_IND means that the DL_RLS_IND primitive is received on D-channel D1.
- D-channel SERVICE messages sent or received by Layer 3 are represented by the notation D-channel: Event/Action SERV(D-channel=state). For example, D1: Send SERV(D1=IS) means a Layer 3 D-channel In SERVICE message is sent on D1.
- An optional SABME/UA exchange procedure is provided for during transfer to the STBY link. The actions and states which are used with this optional procedure are marked with an [*].
- XFER_REQ is a primitive which represents a near-end manual transfer request.
- DL_DM_RLS is a primitive sent from Layer 3 to Layer 2 which tells Layer 2 to: 1) DL_RLS_REQ and 2) respond to all further SABME requests with a DM. This primitive puts the link into the MB state.

Present_State	Event	Action	Next_State
(IS,STBY)	D1:Rcv SERV(D1=IS)	D1:Send SERV_ACK(D1=IS)	(IS,STBY)
	D1:DL_RLS_IND		
	or XFER_REQ	D1:DL_DM_RLS Start T321, D2:Send SERV(D2=IS)	(MB,WAIT)
(MB,STBY)		or []Start T321, D2:DL_EST_REQ	*(MB,STBY)
	D2:DL_RLS_IND	D2:DL_EST_REQ	(IS,OOS)
	D2:DL_EST_CON	D2:Send SERV(D2=IS)	(MB,WAIT)
	D2:DL_RLS_IND	D1:DL_EST_REQ	(OOS,OOS)
	D2:Rcv SERV(D2=IS)	D2:Send SERV_ACK(D2=IS)	(OOS,IS)
		D1:DL_EST_REQ	
(MB,WAIT)	D2:Rcv any other layer 3 msg T321 expires	Ignore D1:DL_EST_REQ	(MB,STBY) (OOS,OOS)
	D2:Rcv SERV(D2=IS)	D2:Send SERV_ACK(D2=IS)	(OOS,IS)
		D1:DL_EST_REQ	
	D2:Rcv SERV_ACK(D2=IS)	D1:DL_EST_REQ	(OOS,IS)
	D2:Rcv any other layer 3 msg T321 Expires	Ignore D2:DL_RLS_REQ	(MB,WAIT) (OOS,OOS)
		D1:DL_EST_REQ	
(IS,OOS)	D2:DL_RLS_IND	D1:DL_EST_REQ	(OOS,OOS)
	D2:DL_EST_IND/CON	Ignore	(MB,WAIT)
	D2:DL_EST_CON/IND		(IS,STBY)

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	D2:DL_RLS_IND D1:DL_RLS_IND	D2:DL_EST_REQ D1:DL_EST_REQ	(IS,OOS) (OOS,OOS)
(OOS,OOS)	D1:DL_EST_IND/CON D2:DL_EST_IND/CON D1:DL_RLS_IND/CON D2:DL_RLS_IND/CON	D1:Send SERV(D1=IS) Start T321, D2:DL_DM_RLS D2:Send SERV(D2=IS) Start T321 D1:DL_EST_REQ D2:DL_EST_REQ	(WAIT,MB) (OOS,WAIT) (OOS,OOS) (OOS,OOS)
(OOS,IS)	D1:DL_EST_CON/IND D1:DL_RLS_IND D2:DL_RLS_IND	D1:DL_EST_REQ D2:DL_EST_REQ	(STBY,IS) (OOS,IS) (OOS,OOS)
*(STBY,MB)	D1:DL_EST_CON D1:DL_RLS_IND D1:Rcv SERV(D1=IS) D1:Rcv any other layer 3 msg T321 expires	D1:SEND SERV(D1=IS) D2:DL_EST_REQ Send SERV_ACK(D1=IS), D2:DL_EST_REQ Ignore D2:DL_EST_REQ	(WAIT,MB) (OOS,OOS) (IS,OOS) (STBY,MB) (OOS,OOS)
(STBY,IS)	D2:DL_RLS_IND or XFER_REQ D1:DL_RLS_IND	D2:DL_DM_RLS Start T321, D1:Send SERV(D1=IS) or [*]Start T321, D1:DL_EST_REQ D1:DL_EST_REQ	(WAIT,MB) *(STBY,MB) (OOS,IS)
(WAIT,MB)	D1:Rcv SERV_ACK (D1=IS), D1:Rcv SERV(D1=IS) D1:Rcv any other layer 3 msg T321 Expires D1:DL_RLS_IND D1:DL_EST_IND/CON	D2:DL_EST_REQ D1:Send SERV_ACK(D1=IS), D2:DL_EST_REQ Ignore D1:DL_RLS_REQ D2:DL_EST_REQ D2:DL_EST_REQ Ignore	(IS,OOS) (IS,OOS) (WAIT,MB) (OOS,OOS) (OOS,OOS) (WAIT,MB)
(OOS,WAIT)	D2:Rcv SERV(D2=IS) D2:Rcv SERV_ACK(D2=IS) T321 Expires D2:DL_RLS_IND D1:DL_EST_IND/CON D2:Rcv any other layer 3 msg	D2:Send SERV_ACK(D2=IS), D1:DL_EST_REQ D2:DL_RLS_REQ D1:Send SERV(D1=IS) D2:DL_RLS_REQ , Start T321 Ignore	(OOS,IS) (OOS,IS) (OOS,OOS) (OOS,OOS) (WAIT,MB) (OOS,WAIT)

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ARCHITECTURE (CONCEPTUAL):

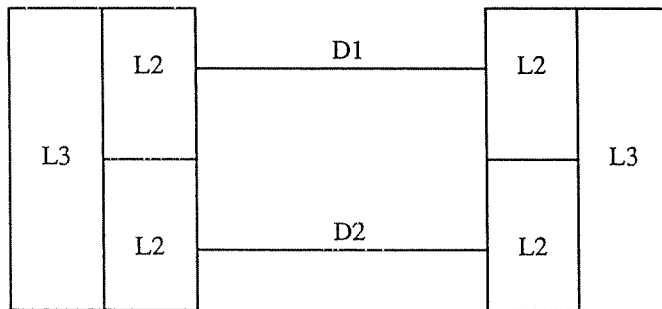


Figure IV-F-5. Architecture (Conceptual)

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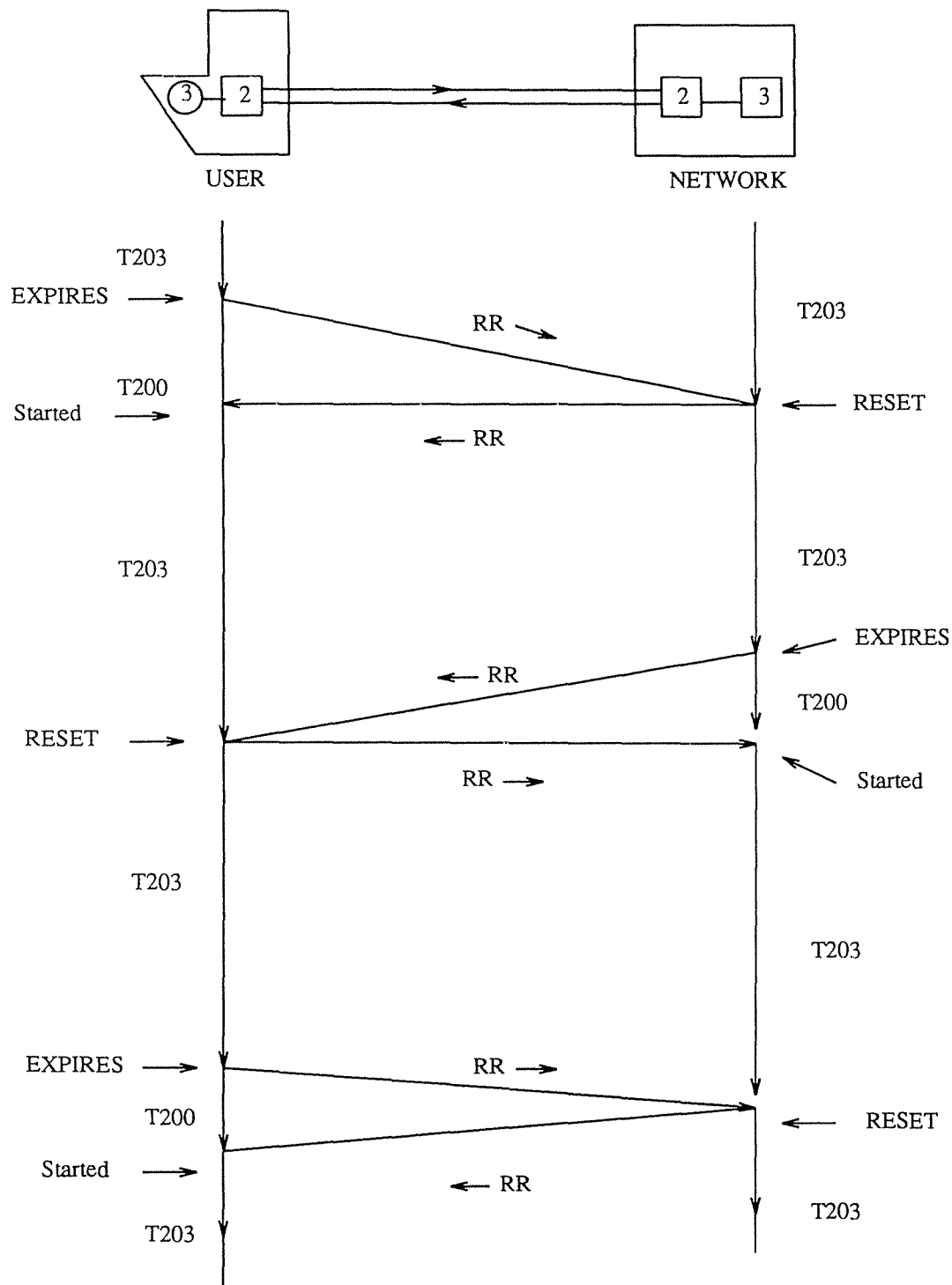


Figure IV-F-6. Connection Verification Procedure on D2

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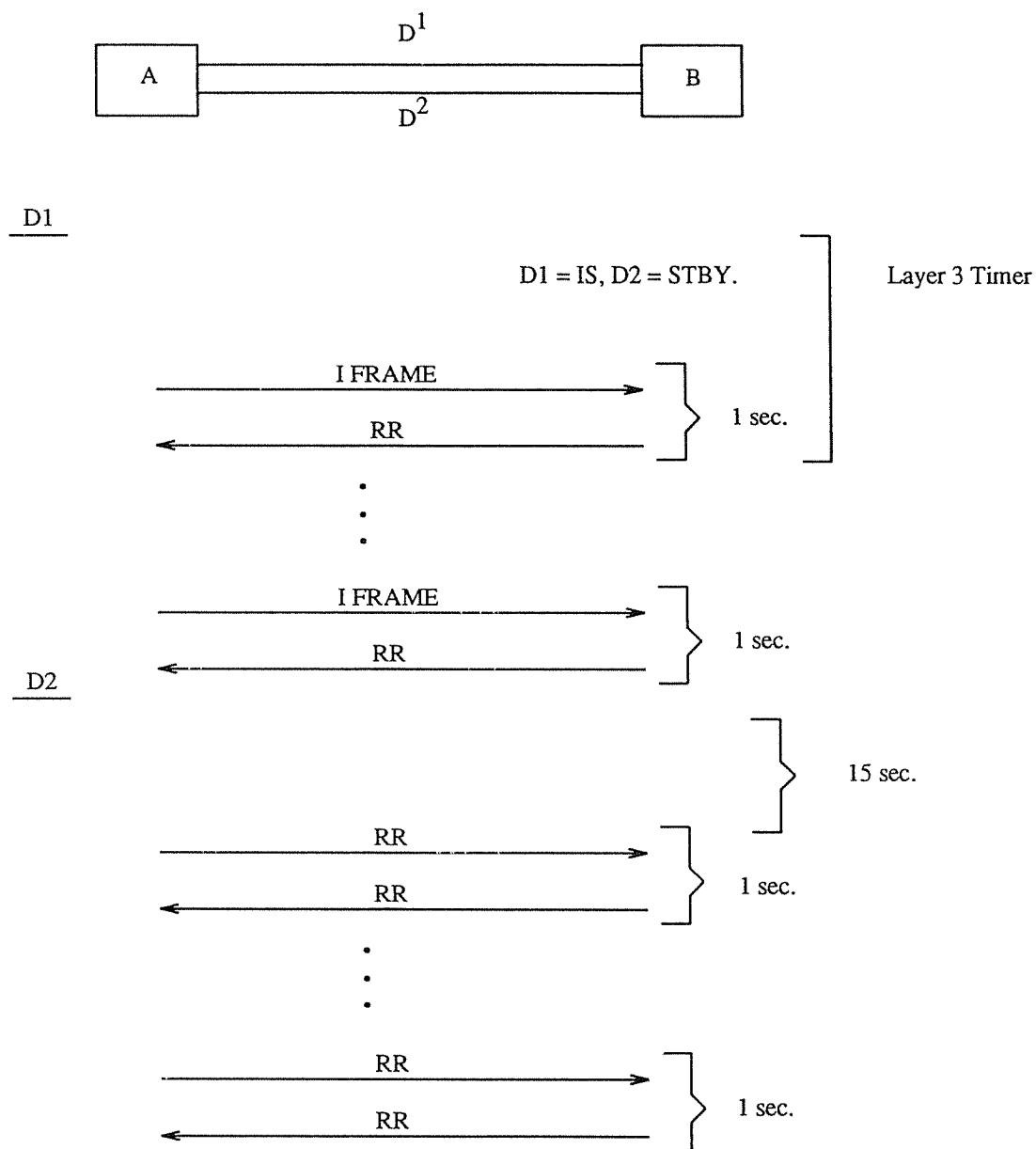


Figure IV-F-7. D Channel Backup-- Normal Operation

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D1 = IS
D2 = STBY

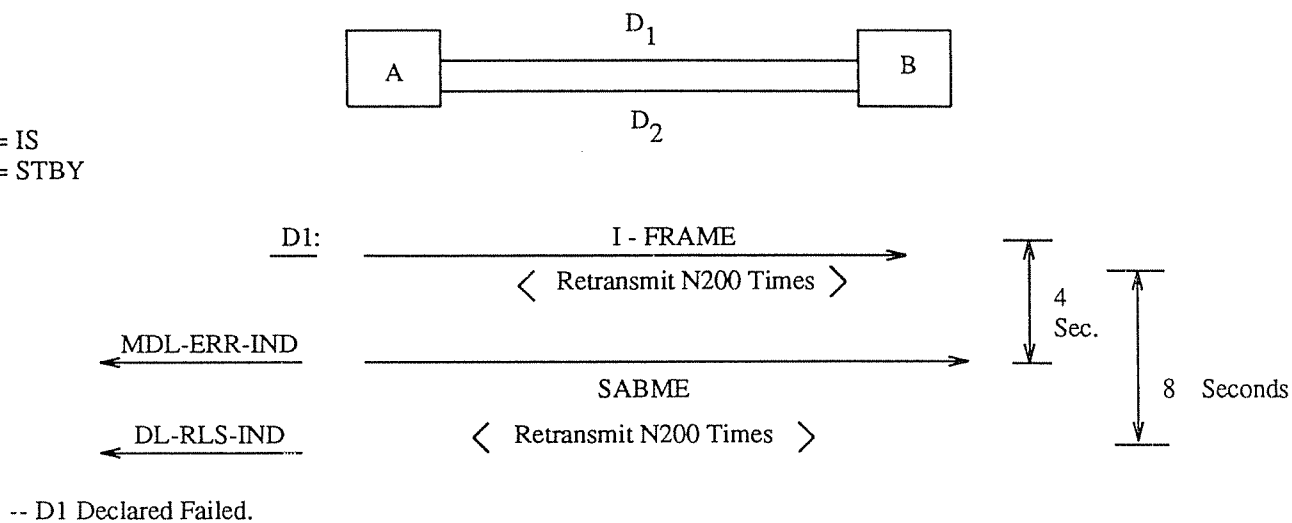


FIGURE A

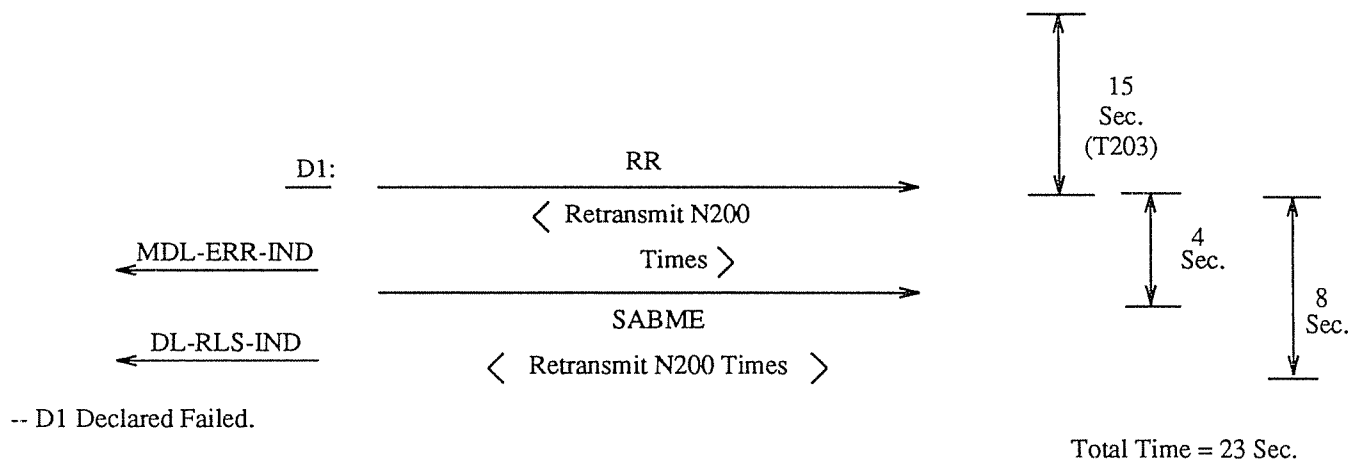


FIGURE B

Figure IV-F-8. Declaring a D-Channel as Failed

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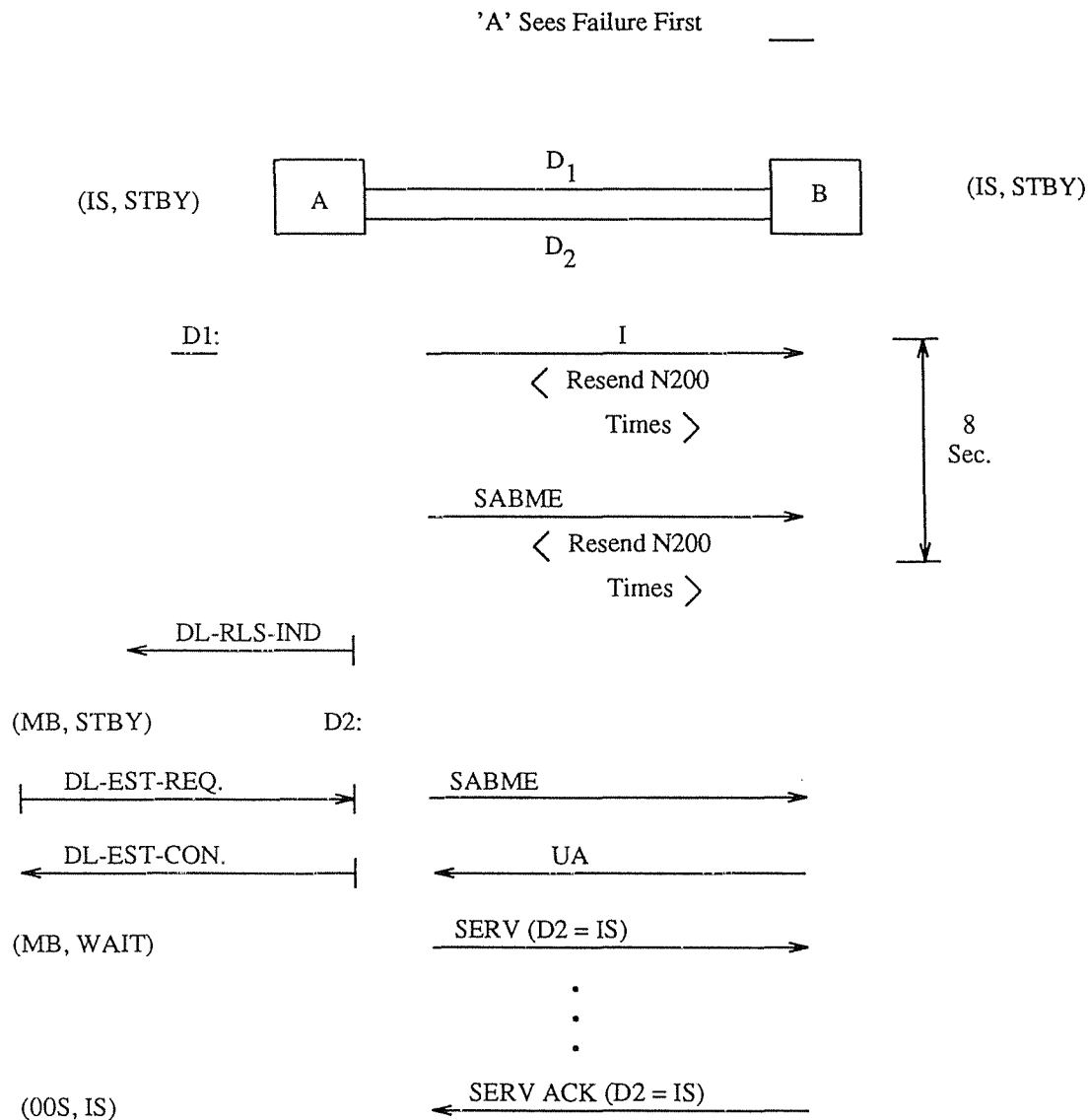


Figure IV-F-9. Normal Switch-over

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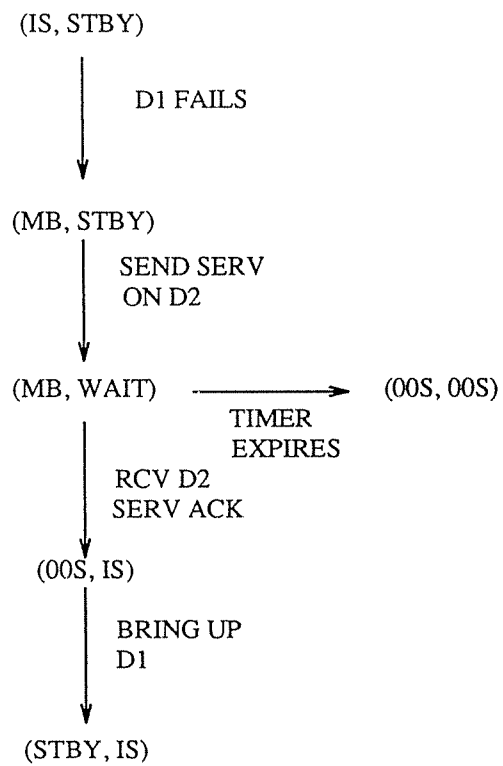


Figure IV-F-10. Normal Switch-over

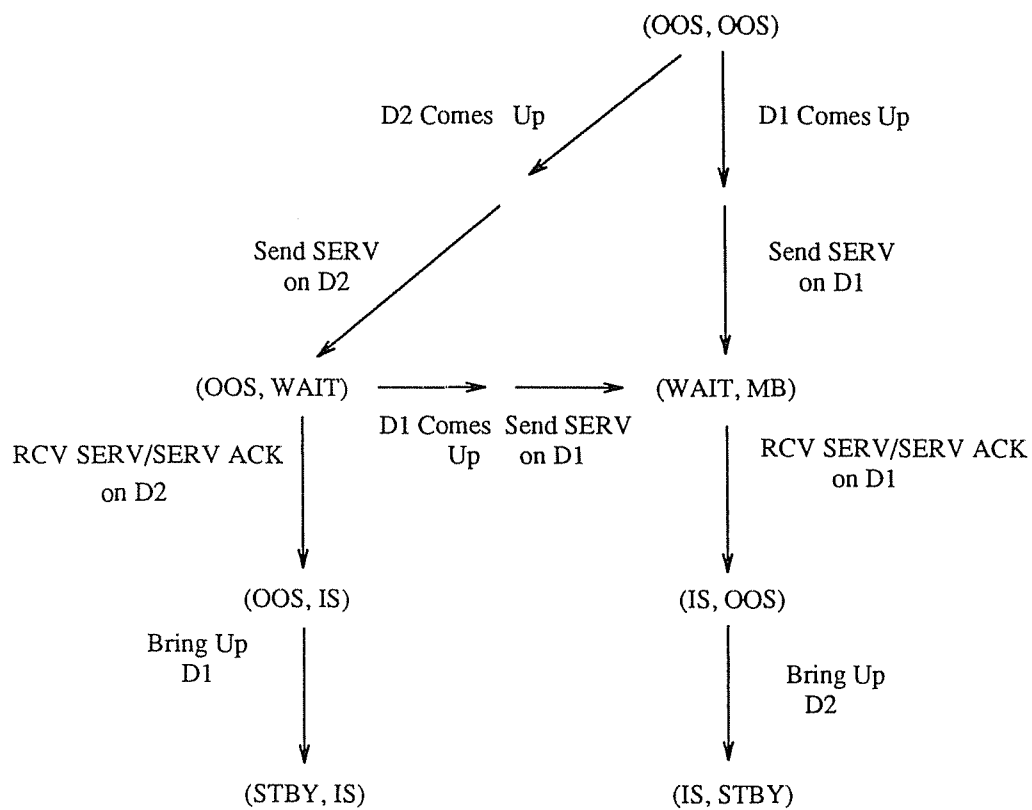


Figure IV-F-95. Initialization Procedure

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Annex G

Cause definitions

G. Annex G - Cause definitions

This annex provides definitions to the causes in Section 4.5.12. A table is provided in Appendix I Q.931 to indicate how these causes are used in the call control procedures.

See section 4.5.12 to determine which cause values are supported by AT&T implementations.

G.1 Normal class

G.1.1 Cause No. 1 "unallocated (unassigned) number"

This cause indicated 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 (allocated).

G.1.2 Cause No. 2 "no route to specified transit network"

This cause 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 network, while it does exist, does not serve the equipment which is sending this cause.

This cause is supported on a network-dependent basis.

G.1.3 Cause No. 3 "no route to destination"

This cause indicates that the called user cannot be reached because the network through which the call has been routed does not serve the destination desired.

This cause is supported on a network-dependent basis.

G.1.4 Cause No. 6 "channel unacceptable"

This cause indicates the channel most recently identified is not acceptable to the sending entity for use in this call.

G.1.5 Cause No. 7 "call awarded and being delivered in an established channel"

This cause indicates that the user has been awarded the incoming call, and that the incoming call is being connected to a channel already established to that user for similar calls (e.g., packet-mode X.25 virtual calls).

G.1.6 Cause No. 16 "normal call clearing"

This cause indicates that the call is being cleared because one of the users involved in the call has requested that the call be cleared.

Under normal situation, the source of this cause is not the network.

G.1.7 Cause No. 17 "user busy"

This cause is used when the called user has indicated the inability to accept another call.

It is noted that the user equipment is compatible with the call.

G.1.8 Cause No. 18 "no user responding"

This cause is used when a user does not respond to a call establishment message with either an alerting or connect indication within the prescribed period of time allocated (defined in Q.931 by the expiry of either timer T303 or T310).

G.1.9 Cause No. 19 "no answer from user (user alerted)"

This cause is used when a user has provided an alerting indication but has not provided a connect indication within a prescribed period of time.

Note -This cause is not necessarily generated by Q.931 procedures but may be generated by internal network timers.

G.1.10 Cause No. 21 "call rejected"

This cause indicates that 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 nor incompatible.

G.1.11 Cause No. 22 "number changed"

This cause is returned to a calling user when the called party number indicated by the calling user is no longer assigned. The new called party number may optionally be included in the diagnostic field. If a network does not support this capability, cause No. 1 "unassigned (unallocated) number" shall be used.

G.1.12 Cause No. 26 "non-selected user clearing"

This cause indicates that the user has not been awarded the incoming call.

G.1.13 Cause No. 27 "destination out of order"

This cause indicates that the destination indicated by the user cannot be reached because the interface to the destination is not functioning correctly. The term "not functioning correctly" indicates that a signaling message was unable to be delivered to the remote user; e.g., a physical layer or data link layer failure at the remote user, user equipment off-line, etc.

G.1.14 Cause No. 28 "invalid number format (address incomplete)"

This cause indicates that the called user cannot be reached because the called party number is not a valid format or is not complete.

G.1.15 Cause No. 29 "facility rejected"

This cause is returned when a facility requested by the user can not be provided by the network.

G.1.16 Cause No. 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.

G.1.17 Cause No. 31 "normal, unspecified"

This cause is used to report a normal event only when no other cause in the normal class applies.

G.2 Resource unavailable class

G.2.1 Cause No. 34 "no circuit/channel available"

This cause indicates that there is no appropriate circuit/channel presently available to handle the call.

G.2.2 Cause No. 38 "network out of order"

This cause indicates that the network is not functioning correctly and that the condition is likely to last a relatively long period of time; e.g., immediately re-attempting the call is not likely to be successful.

G.2.3 Cause No. 41 "temporary failure"

this cause indicates that the network is not functioning correctly and that the condition is not likely to last a long period of time; e.g., the user may wish to try another call attempt almost immediately.

G.2.4 Cause No. 42 "switching equipment congestion"

This cause indicates that the switching equipment generating this cause is experiencing a period of high traffic.

G.2.5 Cause No. 43 "access information discarded"

This cause indicates that the network could not deliver access information, low layer compatibility, high layer compatibility, or sub-address as indicated in the diagnostic.

It is noted that the particular type of access information discarded is optionally included in the diagnostic.

G.2.6 Cause No. 44 "requested circuit/channel not available"

This cause is returned when the circuit or channel indicated by the requesting entity cannot be provided by the other side of the interface.

G.2.7 Cause No. 45 "pre-empted"

This cause indicates that the equipment sending the cause has received a request to use a channel/circuit that is not in a proper maintenance state for the request to be processed.

G.2.8 Cause No. 47 "resource unavailable, unspecified"

This cause is used to report a resource unavailable event only when no other cause in the resource unavailable class applies.

G.3 Service or option not available class

G.3.1 Cause No. 49 "quality of service not available"

This cause is used to report that the requested quality of service, as defined in Recommendation X.213, cannot be provided, (e.g., throughput or transit delay cannot be supported).

G.3.2 Cause No. 50 "requested facility not subscribed"

This cause indicates that the requested supplementary service could not be provided by the network because the user has not completed the necessary administrative arrangements with its supporting network.

G.3.3 Cause No. 52 "outgoing calls barred"

This cause indicates that because of call screening provided by the network, the calling user is not permitted to make a call.

G.3.4 Cause No. 54 "incoming calls barred"

This cause indicates that the called user will not accept the call delivered in the SETUP message.

G.3.5 Cause No. 57 "bearer capability not authorized"

This cause indicates that the user has requested a bearer capability which is implemented by the equipment which generated this cause but the user is not authorized to use.

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G.3.6 Cause No. 58 "bearer capability not presently available"

This cause 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.

G.3.7 Cause No. 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.

G.4 Service or option not implemented class

G.4.1 Cause No. 65 "bearer capability not implemented"

This cause indicates that the equipment sending this cause does not support the bearer capability requested.

G.4.2 Cause No. 66 "channel type not implemented"

This cause indicates that the equipment sending this cause does not support the channel type requested.

G.4.3 Cause No. 69 "requested facility not implemented"

This cause indicates that the equipment sending this cause does not support the requested supplemental service.

G.4.4 Cause No. 70 "only restricted digital information bearer capability is available"

This cause indicates that one equipment has requested an unrestricted bearer service but that the equipment sending this cause only supports the restricted version of the requested bearer capability.

G.4.5 Cause No. 79 "service or option not implemented, unspecified"

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.

G.5 Invalid message (e.g., parameter out of range) class

G.5.1 Cause No. 81 "invalid call reference value"

This cause 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.

G.5.2 Cause No. 82 "identified channel does not exist"

This cause 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 those channels on a primary rate interface numbered from 1 to 12 and the user equipment or the network attempts to use channels 13 through 23, this cause is generated.

G.5.3 Cause No. 83 "a suspended call exists, but this call identity does not"

This cause indicates that a call resume has been attempted with a call identity which differs from that in use for any presently suspended call(s).

G.5.4 Cause No. 84 "no call suspended"

This cause indicates that the network has received a call resume request. The call resume request contained a Call identity information element which presently does not indicate any suspended call within the domain of interfaces over which calls may be resumed.

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G.5.5 Cause No. 86 "call having the requested call identity has been cleared"

This cause indicates that the network has received a call resume request. The call resume request contained a Call identity information element which once indicated a suspended call; however, that suspended call was cleared while suspended (either by network timeout or by the remote user).

G.5.6 Cause No. 88 "incompatible destination"

This cause indicates that the equipment sending this cause has received a request to establish a call which has low layer compatibility, high layer compatibility, or other compatibility attributes (e.g., data rate) which cannot be accommodated.

G.5.7 Cause No. 91 "invalid transit network selection"

This cause indicates that a transit network identification was received which is of an incorrect format as defined in Annex C/Q.931.

G.5.8 Cause No. 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.

G.6 Protocol error (e.g., unknown message) class

G.6.1 Cause No. 96 "mandatory information element is missing"

This cause 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.

G.6.2 Cause No. 97 "message type non-existent or not implemented"

This cause 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 defined but not implemented by the equipment sending this cause.

G.6.3 Cause No. 98 "message not compatible with call state or message type non-existent or not implemented"

This cause 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.

G.6.4 Cause No. 99 "information element non-existent or not implemented"

This cause indicates that the equipment sending this cause has received a message which includes 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.

G.6.5 Cause No. 100 "invalid information element contents"

This cause 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 such a way which has not been implemented by the equipment sending this cause.

G.6.6 Cause No. 101 "message not compatible with call state"

This cause indicates that a message has been received which is incompatible with the call state.

G.6.7 Cause No. 102 "recovery on timer expiry"

This cause indicates that a procedure has been initiated by the expiry of a timer in association with Q.931 error handling procedures.

G.6.8 Cause No. 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.

G.7 Interworking class

G.7.1 Cause No. 127 "interworking, unspecified"

This cause 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.

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Annex H

Examples of information elements coding

H. Annex H - Examples of information elements coding

This annex gives examples of the detailed coding of the following information elements:

- Bearer capability information element;
- Channel identification information element;
- Called/Calling party sub-address information element;
- Low layer compatibility information element.

H.1 Bearer capability information element

H.1.1 Coding for speech

8	7	6	5	4	3	2	1	
Bearer Capability								Octet 1
0	0	0	0	0	1	0	0	
Information element identifier								2
0	0	0	0	0	0	1	1	
Length								3
1 ext	0	0	0	0	0	0	0	
CCITT				speech				4
1 ext	0	0	1	0	0	0	0	
circuit mode				64 kb/s				5
1 ext	0	1	0	0	0	1	0	
layer 1				G.711 μ -law				

H.1.2 Coding for 3.1 kHz audio

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8	7	6	5	4	3	2	1	
Bearer Capability								1 Octet
0	0	0	0	0	1	0	0	
Information element identifier								2
0	0	0	0	0	0	1	1	
Length								3
1 ext	0	0	1	0	0	0	0	
CCITT		3.1 KHz Audio						4
1 ext	0	0	1	0	0	0	0	
circuit mode		64 kb/s						5
1 ext	0	1	0	0	0	1	0	
layer 1		G.711 μ -law						

H.1.3 Coding for unrestricted digital information

Type 1: Synchronous 64 kbit/s working

8	7	6	5	4	3	2	1	
Bearer Capability								1 Octet
0	0	0	0	0	1	0	0	
Information element identifier								2
0	0	0	0	0	0	1	0	
Length								3
1 ext	0	0	0	1	0	0	0	
CCITT		unrestricted digital info.						4
1 ext	0	0	1	0	0	0	0	
circuit mode		64 kb/s						

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Type 2: Synchronous rates less than 64 kbit/s with CCITT standardized rate adaption V.110/X.30; in-band negotiation not possible.

8	7	6	5	4	3	2	1	
Bearer Capability								1 Octet
0	0	0	0	0	1	0	0	
Information element identifier								2
0	0	0	0	0	1	0	0	
Length								3
1 ext	0	0	0	1	0	0	0	
CCITT		unrestricted digital info.						4
1 ext	0	0	1	0	0	0	0	
circuit mode		64 kb/s						5
0 ext	0	1	0	0	0	0	1	
layer 1		rate adaption						5a
1 ext	0 synch.	0 negot.	User rate					

H.1.4 Coding for case B X.31 packet mode access connections - Not applicable

H.2 Channel identification information element

H.2.1 Basic interface, circuit mode, B channel - Not applicable

H.2.2 Primary rate interface, circuit-mode, B-channel

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Example (a)

8	7	6	5	4	3	2	1	
Channel identification								Octet 1
0	0	0	1	1	0	0	0	
information element identifier								2
0	0	0	0	0	0	1	1	
Length								3
1 ext	1 Int. id. present	1 Int. type	0 Spare	0 Pref/ Excl	0 D-ch. id.	0 Ch. sel.	1	
1	0	0	0	0	0	1	1	3.2
Coding standard		No./Map		Ch. type / Map type				3.3
0	0	0	0	0	0	0	1	
Ch. number / Slot map								

- The channel is a B-channel
- The indicated channel is preferred
- The channel is located in the same interface which includes the D-channel
- The channel is identified by channel number.

Example (b)

8	7	6	5	4	3	2	1	
Channel identification								Octet 1
0	0	0	1	1	0	0	0	
information element identifier								2
0	0	0	0	0	1	0	1	
Length								3
1 ext	0 Int. id. present	1 Int. type	0 Spare	1 Pref/ Excl	0 D-ch. id.	0 Ch. sel.	1	
1	0	0	1	0	0	1	1	3.2
Coding standard		No./Map		Ch. type / Map type				3.3.1
0	0	0	0	0	0	0	0	
Ch. number / Slot map								3.3.2
0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	1	3.3.3

- Same as (a) but the channel is identified by slot may (time slot 1, 1544 kbits/s primary rate interface).

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Example (c) Not Applicable

Example (d)

8	7	6	5	4	3	2	1	
Channel identification								Octet 1
0	0	0	1	1	0	0	0	
information element identifier								2
0	0	0	0	0	1	0	0	
Length								3
1 ext	1 Int. id. present	1 Int. type	0 Spare	0 Pref/ Excl	0 D-ch. id.	0 Ch. sel.	1	
1	0	0	0	0	0	0	1	3.1
Interface identifier								3.2
1	0	0	0	0	0	1	1	
Coding standard		No./Map		Ch. type / Map type				3.3
0	0	0	0	0	0	0	1	
Ch. number / Slot map								

- Same as (a) except that the channel is located in a different interface than the D-channel.

H.2.3 Primary rate interface, circuit-mode, H0-channel

Example (a) Not Applicable

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Example (b)

8	7	6	5	4	3	2	1	
Channel identification								Octet 1
0	0	0	1	1	0	0	0	
information element identifier								2
0	0	0	0	0	1	0	1	
Length								3
1	0	1	0	1	0	0	1	
ext	Int. id. present	Int. type	Spare	Pref/ Excl	D-ch. id.	Ch. sel.		3.2
1	0	0	1	0	1	1	0	
Coding standard		No./Map		Ch. type / Map type				3.3.1
0	0	0	0	0	0	0	0	
Ch. number / Slot map								3.3.2
0	0	0	0	0	0	0	0	
0	0	1	1	1	1	1	1	3.3.3

- The channel is a H0-channel.
- Only the indicated channel is acceptable.
- The channel is located in the same interface as the D-channel.
- Channels indicated by slot-map (time slots 1-6, 1544 kbit/s primary rate system).

Example (c) Not Applicable

Example (d) Not Applicable

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Example (e)

8	7	6	5	4	3	2	1	
Channel identification								Octet 1
0	0	0	1	1	0	0	0	
information element identifier								2
0	0	0	0	0	1	1	0	
Length								3
1 ext	1 Int. id. present	1 Int. type	0 Spare	1 Pref/ Excl	0 D-ch. id.	0 Ch. sel.	1	
1	0	0	0	0	0	0	1	3.1
Interface identifier								3.2
1	0	0	1	0	1	1	0	
Coding standard		No./Map		Ch. type / Map type				3.3.1
0	0	0	0	0	0	0	0	
Ch. number / Slot map								3.3.2
0	0	0	0	1	1	1	1	
1	1	0	0	0	0	0	0	3.3.3

- The channel is located in a different interface than the D-channel.
- The channel is identified by slot map (time slots 7-12, 1544 kbits/s primary rate interface).
- Otherwise as for (b).

H.3 Called/Calling party sub-address information element

H.3.1 Coding of IA5 sub-address digits

8	7	6	5	4	3	2	1	
Called party subaddress								Octet 1
0	1	1	1	0	0	0	1	
information element								2
0	0	0	0	0	1	0	1	
Length								3
1 ext	0 NSAP (X.213/ISO 8348 AD2)	0	0	Odd/event indication (Note 4)	0	0	0	
AFI (Note 1)								4
0	1	0	1	0	0	0	0	
IA5 character (Note 2)								5
IA5 character								6
IA5 character								7

Note 1 - AFI code 50 (in BCD) indicates that the sub-address consists of IA5 characters (see ISO standard 8348 AD2).

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Note 2 - IA5 character according to CCITT Recommendation T.50/ISO 646.

Note 3 - The number of IA5 characters shown above is just an example. There may be up to 19 IA5 characters.

Note 4 - The value of this bit has no significance when the type of sub-address is "NSAP".

H.3.2 DMI codings for Bearer capability and Low layer compatibility information element

Figure IV-H-1a shows specific codings for the Bearer capability information element for X.31 packet transport mode access connections and DMI Mode 3 packet transport mode calls.

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

X.31 Packet Transfer Mode

8	7	6	5	4	3	2	1
0	0	0	0	0	1	0	0
0	0	0	0	0	0	1	1
1	0	0	0	1	0	0	R
1	1	0	0	0	0	0	0
1	1	0	0	0	0	1	0

DMI Mode 3 - Packet Transfer Mode

Note: The Mode 3 "R" bit in octet 3 will be set to 0 (unrestricted) or 1 (restricted).

Figure IV-H-1a Bearer Capability Coding for Packet Transport Mode Connections

Figure IV-H-2a shows the general coding for the Bearer capability information element for any circuit transport mode data calls.

8	7	6	5	4	3	2	1	Octet
0	0	0	0	0	1	0	0	1
length								2
1	0	0	info transfer capability					3
1	0	0	1	0	0	0	0	4
0	0	1	0	0	0	0	1	5 (note a)
1	0	0	0	1	1	1	1	5a (note a)

a) Either both octets are included or both are omitted.

Octet 2= 00000010 if not 56 kbit/s
 00000100 if 56 kbit/s rate adapted

Octet 3= 01000 unrestricted digital
 01001 restricted digital

Octets 5 and 5a must be present if there is rate adaption to 56 kbit/s; otherwise they should not be included.

Figure IV-H-2a Bearer Capability Coding for Circuit Transport Mode Data Calls

Figure IV-H-3a shows the specific coding of the Bearer capability information element for the DMI Modes.

8	7	6	5	4	3	2	1
0	0	0	0	0	1	0	0
0	0	0	0	0	0	1	0
1	0	0	0	1	0	0	R
1	0	0	1	0	0	0	0

DMI Mode 0

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

DMI Mode 1

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

DMI Mode 2

8	7	6	5	4	3	2	1
0	0	0	0	0	1	0	0
0	0	0	0	0	0	1	0
1	0	0	0	1	0	0	R
1	0	0	1	0	0	0	0

DMI Mode 3 - circuit transport mode

The R bit in octet 3 is set to 0 (unrestricted) or 1 (restricted).

Figure IV-H-3a Bearer Capability Coding for DMI Circuit Transport Mode Data Calls

In general, the coding of bearer capability for the different data applications is as follows.

Overview of Bearer Capability Coding for Data Calls

Data Application	Information Transfer Mode	User Information Layer 2	User Information Layer 3
DMI Modes 0, 1, and 2	Circuit	None specified	None specified
X.31 circuit-switched	Circuit	(Note 1)	(Note 1)
DMI Mode 3 circuit-switched	Circuit	(Note 1)	(Note 1)
X.31 packet-switched	Packet	Recommendation X.25 link level	Recommendation X.25 packet level
DMI Mode 3 packet-switched	Packet	Recommendation Q.921 (I.441)	(Note 2)

Note 1: This information may be included in the Low layer compatibility information element (i.e., octet 5 user information for layers 2 and 3 must not be included in bearer capability when the transfer mode indicated is circuit).

Note 2: This information is included in the Low layer compatibility information element (i.e., octet 5 user information for layer 3 is not included in bearer capability).

Overview of Low Layer Compatibility Information Element Coding for Data Calls

Data Application	Information Transfer Mode (Note 1)	User Information Layer 2	User Information Layer 3	Coding Standard (Octet 3)
DMI Modes 0, 1, and 2	Circuit	None specified	None specified	CCITT
X.31 Circuit-switched	Packet	Recommendation X.25 Layer 2	Recommendation X.25 Layer 3	CCITT
DMI Mode 3 Circuit-switched	Packet	Recommendation Q.921	Mode 3 packet level (Note 2)	Network specific
DMI Mode 3 Packet-switched	Packet	Recommendation Q.921	Mode 3 packet level (Note 2)	Network specific

Note 1: This field indicates the end-to-end transport mode being used and may differ from the bearer capability.

Note 2: The procedures for this, the data transfer phase of X.25, are included in the DMI Specification.

The specific coding of the Low layer compatibility information element is shown in Figure IV-H-4a.

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8	7	6	5	4	3	2	1
0	1	1	1	1	1	0	0
0	0	0	0	0	0	1	0
1	0	0	0	1	0	0	R
1	0	0	1	0	0	0	0

DMI Mode 0

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

DMI Mode 1

8	7	6	5	4	3	2	1
0	1	1	1	1	1	0	0
0	0	0	0	0	1	0	0
1	0	0	0	1	0	0	1
1	0	0	1	0	0	0	0
0	0	1	0	0	1	1	1
1	M	0	0	0	0	0	0

DMI Mode 2

8	7	6	5	4	3	2	1
0	1	1	1	1	1	0	0
0	0	0	0	0	1	0	1
1	1	1	0	1	0	0	1
1	0	0	1	0	0	0	0
1	0	0	0	0	0	0	1
0	0	1	0	0	1	1	1
1	M	0	0	0	0	0	0

DMI Mode 2/3 Adaptive

8	7	6	5	4	3	2	1
0	1	1	1	1	1	0	0
0	0	0	0	0	1	0	0
1	1	1	0	1	0	0	R
1	1	0	0	0	0	0	0
1	1	0	0	0	0	1	0
1	1	1	0	0	1	1	1

DMI Mode 3

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

X.31 - circuit transfer mode

Note: The Mode 2 "M" bit in octet 6 will be set to 0 (synchronous) or 1 (asynchronous). The "R" bit in octet 3 will be set to 0 (unrestricted) or 1 (restricted).

Figure IV-H-4a Low Layer Compatibility Coding for Data

Annex I

Use of progress indicators

I. Annex I - Use of progress indicators

This annex describes the use of the different progress indicator values defined in Section 4.5.22. Examples of use are given.

Progress indicator No. 1 indicates that interworking with a non-ISDN has occurred within the network or networks through which the call has traversed.

Progress indicator No. 2 indicates that the destination user is not ISDN.

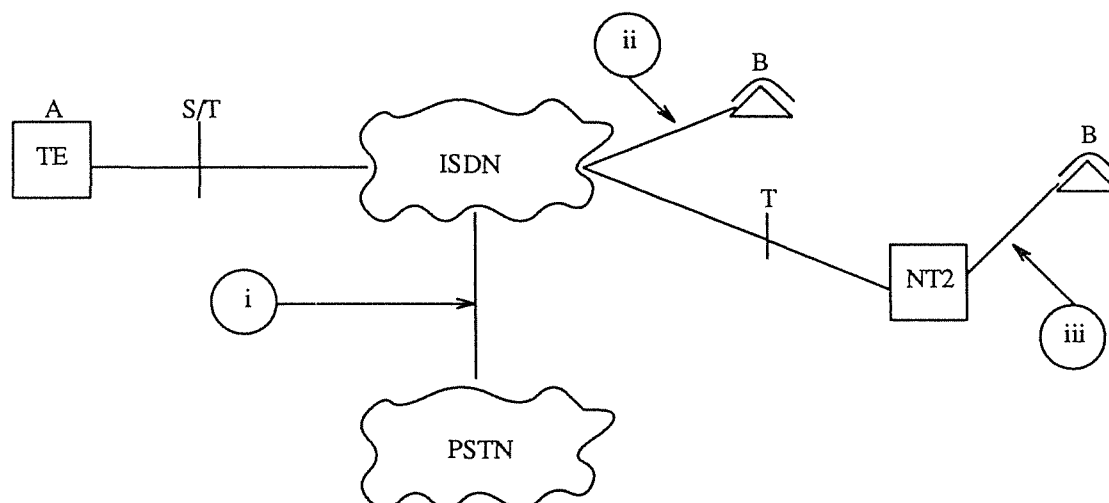
Progress indicator No. 3 indicates that the origination user is not ISDN.

Progress indicator No. 4 indicates that a call which had left the ISDN has returned to the ISDN at the same point it had left due to redirection within the non-ISDN. This progress indicator would be employed when a prior Recommendation Q.931 message resulted in a progress indicator No. 1 "call is not end-to-end ISDN" being delivered to the calling user.

The use of progress indicators Nos. 1, 2 and 3 is exemplified in the following.

Three interworking situations are identified in the figure below:

- i) interworking with another network;
- ii) interworking with a non-ISDN user connected to ISDN;
- iii) interworking with non-ISDN equipment within the calling or called user's premises.



As regards calls from A the following applies:

case i) - progress indicator No. 1 sent to A;

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case ii) - progress indicator No. 1 sent to A;

case iii) - progress indicator No. 2 sent to A (location sub-field - private network).

As regards calls towards A the following applies:

case i) - progress indicator No. 1 sent to A;

case ii) - progress indicator No. 1 sent to A;

case iii) - progress indicator No. 3 sent to A (location sub-field - private network)

The use of progress indicator No. 08 "in-band information or appropriate pattern now available" is described in Section 5.

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Annex J

Examples of cause value and location for busy condition

J. Annex J - Examples of cause value and location for busy condition

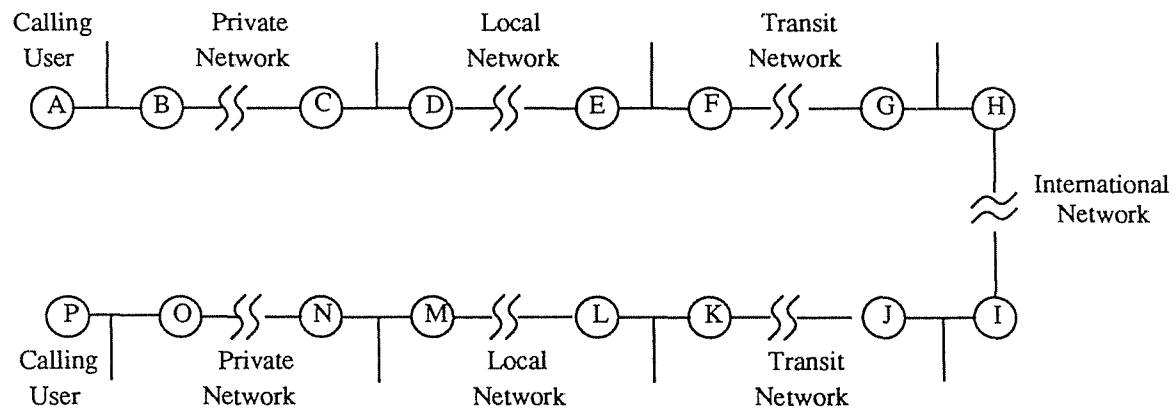
This annex gives examples on the detailed cause value and location to be sent in a Cause information element for the busy condition.

Figure J-1/Q.931 shows the reference configuration which identifies nodes where busy condition may occur and therefore a cause should be generated.

Table J-1/Q.931 shows

- a cause value and location to be generated at the point where the busy condition occurs; and
- a cause value and location to be delivered to the user (indicated as A) for each location (B - P) where the busy condition occurs.

As is indicated in the table, the cause value is not changed but the location may be changed in the receiving exchange, when the cause value crosses a network boundary.



Note - The interface A-B, C-D, M-N, and O-P are assumed to be Q.931.

FIGURE J-1/Q.931

Examples of cause values and location for busy condition

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TABLE J-1/Q.931

Location where busy occurs and the cause codings

Location where busy occurs	Cause at the point of generation	Cause received by user A
B incoming circuit	#34 or #44 LPN	)
B outgoing circuit	#34 LPN	)
C outgoing circuit	#34 LPN	)
		)
D incoming circuit	#34 or #44 LN	)
D outgoing circuit	#34 LN	)The same as left
E outgoing circuit	#34 LN	)
		)
F outgoing circuit	#34 TN	)
G outgoing circuit	#34 TN	)
		)
H outgoing circuit	#34 INTL	)
I outgoing circuit	#34 INTL	)
J outgoing circuit	#34 TN	#34 TN
K outgoing circuit	#34 TN	#34 TN
L outgoing circuit	#34 LN	#34 RLN
M outgoing circuit	#17 LN	#17 RLN
N incoming circuit	#34 or #44 LPN	#34 or #44 RPN
N outgoing circuit	#34 LPN	#34 RPN
O outgoing circuit	#17 LPN	#17 RPN
P incoming circuit	#34 or #44 U	#34 or #44 U
P call control	#17 U	#17 U

LPN : Private network serving the local user

LN : Public network serving the local user

TN : Transit network

INTL : International transit network

RLN : Public network serving the remote user

RPN : Private network serving the remote user

U : User.

Table J-1/Q.931 is for further study.

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Annex K

Message segmentation procedures

K. Annex K - Message segmentation procedures - Reserved for future use

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Annex L

Low layer information coding principles

L. Annex L - Low layer information coding principles

L.1 Purpose

This annex describes principles that shall be used when the calling user specifies information during call setup regarding low layer capabilities required in the network and by the destination terminal.

Note - In this context and throughout this annex the term "called user" is the end point entity which is explicitly addressed. This may be an addressed interworking unit (IWU) (see I.500-Series Recommendations and X.31 case A).

L.2 Principles

L.2.1 Definitions of types of information

There are three different types of information that the calling ISDN user may specify during call setup to identify low layer capabilities needed in the network and by the destination terminal:

- a) type I information is information about the calling terminal which is only used at the destination end to allow a decision regarding terminal compatibility. An example would be modem type. This information is encoded in octets 5 to 7 of the Low layer capability information element;
- b) type II information is the selection of bearer service from the choices of bearer services offered by the network to which the calling user is connected. This type of information is present even if no interworking occurs. An example is unrestricted digital information (UDI). This information is coded in:
 - i) octets 3 and 4 (including octets 4a and 4b if necessary) of the Bearer capability information element when the transfer mode required by the calling user is circuit mode;
 - ii) octets 3, 4, 6 and 7 (including 4a and 4b if necessary) of the Bearer capability information element when the transfer mode required by the calling user is packet mode;
- c) type III information is information about the terminal or intended call which is used to decide destination terminal compatibility and possibly to facilitate interworking with other ISDNs or other dedicated networks.

L.2.2 Examination by network

Type I information is user-to-user (i.e. not examined by network) while both types II and III should be available for examination by the destination user and the network. The Low layer capability information element is an information element which is not examined by the network while the Bearer capability information element is an information element which is examined by the user and the network.

L.2.3 Location of type I information

Type I information (i.e. terminal information only significant to the called user) shall, when used, be included in the Low layer compatibility information element.

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L.2.4 Location of types II and III information

Type II (i.e. bearer selection) information shall be included in the Bearer capability information element. Type III information, when used, is included in the Bearer capability information element. The network may use and modify the information (e.g. to provide interworking). The rationale for the user including some terminal related information in the type III information (interworking related) is shown by the following example.

Normally with UDI, the rate adaption technique chosen is related to the terminal. The specification of a particular rate adaption scheme with a UDI bearer service could allow a compatibility decision by the destination terminal in a purely ISDN situation. However, it could also conceivably be used to allow interworking with a PSTN, assuming that the appropriate functions (i.e. data extraction, modem pool) are available at the interworking unit.

If the rate adaption information is carried in the Low layer compatibility information element, and not in the Bearer capability information element, then interworking by the network providing the bearer capability would not be possible. However, if the rate adaption information is carried in the Bearer capability information element, interworking would be possible.

Hence, there is some terminal related information which may be considered interworking related. The consequence for the calling user of not including such terminal related information in the Bearer capability information element is that the call may not be completed if an interworking situation is encountered.

L.2.5 Relationship between Bearer capability and Low layer compatibility information elements

There shall be no contradiction of information between the Low layer compatibility and the Bearer capability at the originating side. However, as some Bearer capability code points may be modified during the transport of the call, this principle implies that there should be minimal duplication of information between Bearer capability information element and Low layer compatibility information element.

Note - If as a result of duplication, a contradiction occurs between the Bearer capability information element and the Low layer compatibility information element at the terminating side, the receiving entity shall ignore the conflicting information in the Low layer compatibility information element.

The following example, dealing with the specification of the encoding scheme used by the terminal for the speech or 3.1 kHz audio bearer services, shows the consequences of duplication.

It is expected that some ISDNs will support only A-law and some only μ -law, with conversion provided by the μ -law network. (See Recommendation G.711.) If the encoding scheme is specified in both the Bearer capability information element and the Low layer compatibility information element, interworking between two ISDNs might require a change of the user information layer 1 protocol in the Bearer capability information element (e.g. from A-law to μ -law), while the encoding scheme specified in the Low layer compatibility information element would presumably be forwarded to the destination unchanged. Since, to determine compatibility, the destination terminal examines both the Bearer capability information element and the Low layer compatibility information element, it would receive conflicting information regarding the encoding scheme used.

L.3 Information classification

The following are the examples of classifying low layer information currently identified. This information is provided to facilitate understanding of the characteristics of types II and III information.

L.3.1 Examples for speech and 3.1 kHz audio bearer services

- a) Type II information (common to all applications using these bearer services):
 - information transfer capability = speech or 3.1 kHz audio;
 - information transfer mode = circuit;
 - information transfer rate = 64 kbit/s;
 - user information layer 1 protocol = μ law.
- b) Type III information for interworking with CSPDN (3.1 kHz audio applications are assumed) = Figure L-1:
 - user information layer 1 protocol = rate adaption + user rate (Note);
Note - Only those profiles conforming to CCITT standardized rate adaption are allowed when only the above information is provided.
- c) Type III information for interworking with PSTN:
 - i) voice applications: Figure L-2:
 - user information layer 1 protocol = μ law;
 - ii) voice band data application: Figure L-3:
 - user information layer 1 protocol = μ law.

L.3.2 Examples for 64 kbit/s UDI circuit mode bearer service

- a) Type II information (common):
 - information transfer capability = unrestricted digital information;
 - information transfer mode = circuits
 - information transfer rate = 64 kbit/s.
- b) Type III information for interworking with PSPDN (packet application): Figure L-4:
 - no type III information is required.
- c) Type III information for interworking with PSTN:
 - i) voice applications: Figure L-5 - no type III information required;
 - ii) rate-adapted data applications: Figure L-5 - no type III information is required.
- d) Type III information for interworking with PSTN with end-to-end digital connectivity (data applications): Figure L-7:
 - user information layer 1 protocol = rate adaption + user rate (Note).
Note - The profile described in I.463 is allowed.

L.3.3 Examples for ISDN virtual-circuit bearer service

- a) Type II information (common):
 - information transfer capability = unrestricted digital information;
 - information transfer mode = packet;

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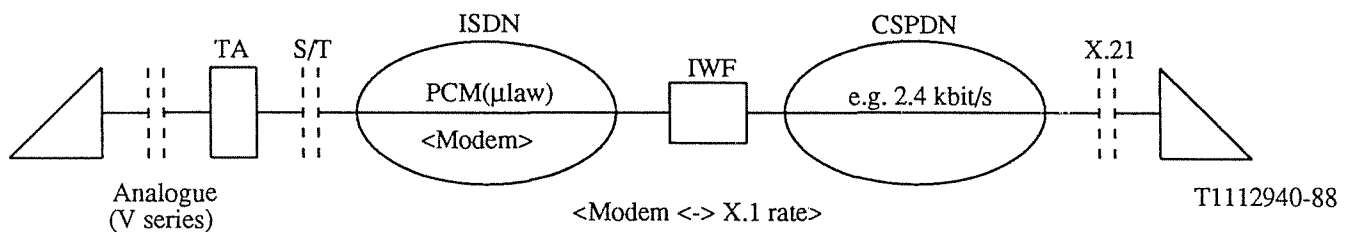
- information transfer rate = -----;
- user information layer 1 protocol = rate adaption + user rate (Note 1);
- user information layer 2 protocol = LAPB (Note 2);
- user information layer 3 protocol = X.25 packet layer protocol (Note 2);

Note 1 - This parameter is included only when user packet information flow is rate adapted. Only those profiles conforming to X.31 are allowed when only the above information is provided for layer 1 protocol.

Note 2 - Only those profiles conforming to X.31 are used. See Figures L-8, L-9 and L-10.

b) Type III information for interworking with PSPDN, CSPDN, PSTN:

- no type III information is necessary



Note 1 - Is user rate sufficient to specify the type of modem at IWF?

FIGURE L-1

BC = 3.1 kHz audio, voice band data -> CSPDN

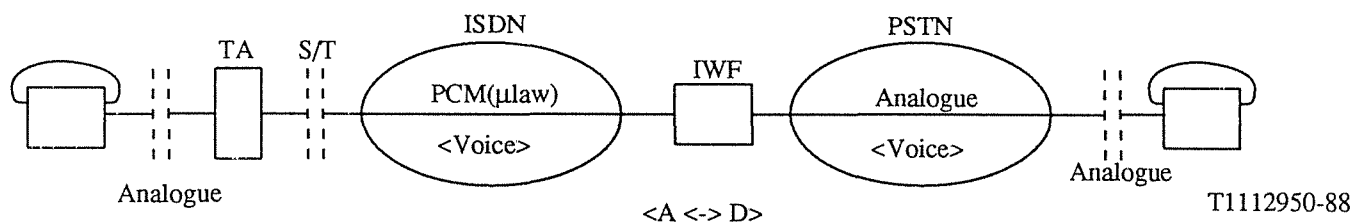


FIGURE L-2

BC = 3.1 kHz audio, voice -> PSTN

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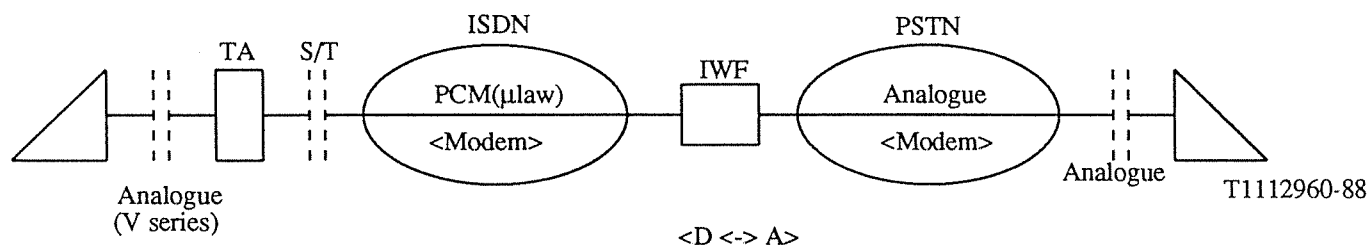


FIGURE L-3

BC = 3.1 kHz audio, voice band data -> PSTN

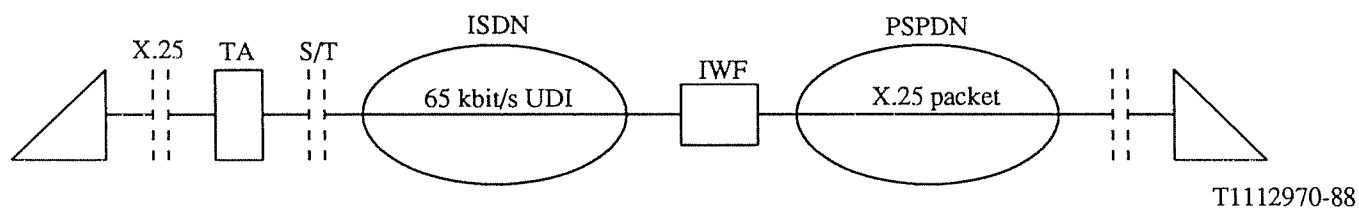


FIGURE L-4

BC = 64 kbit/s UDI, packet application -> PSPDN

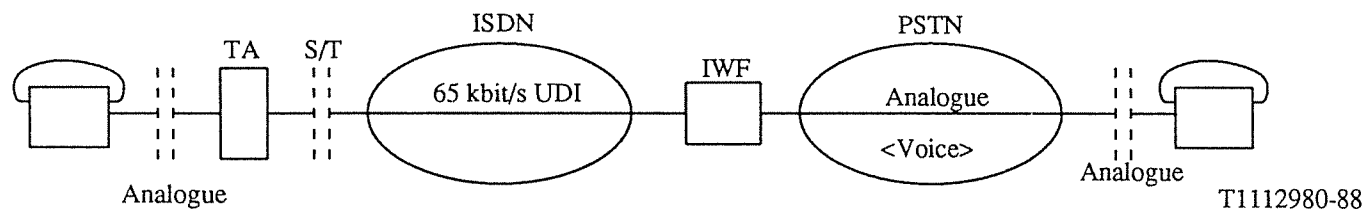


FIGURE L-5

BC = 64 kbit/s UDI, voice -> PSTN

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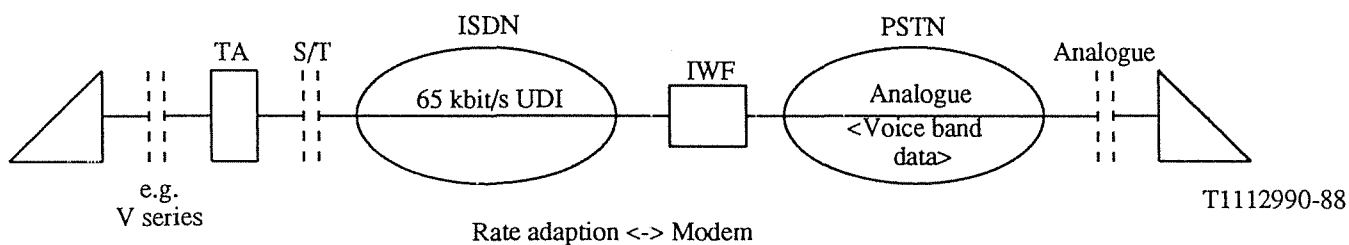


FIGURE L-6

BC = 64 kbit/s UDI, rate adapted data -> PSTN

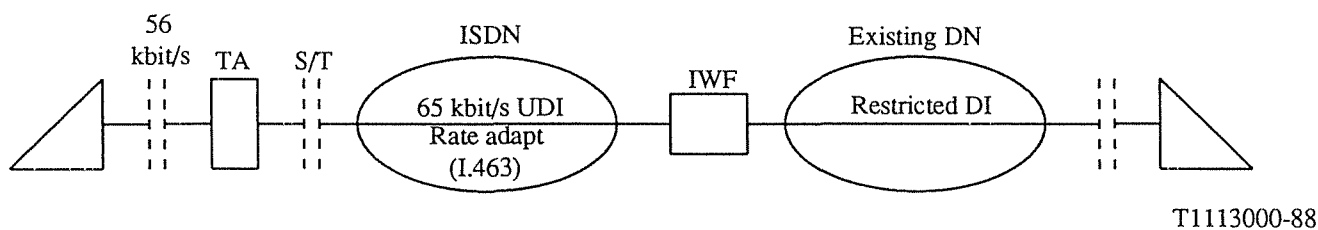


FIGURE L-7

BC = 64 kbit/s UDI -> existing digital network

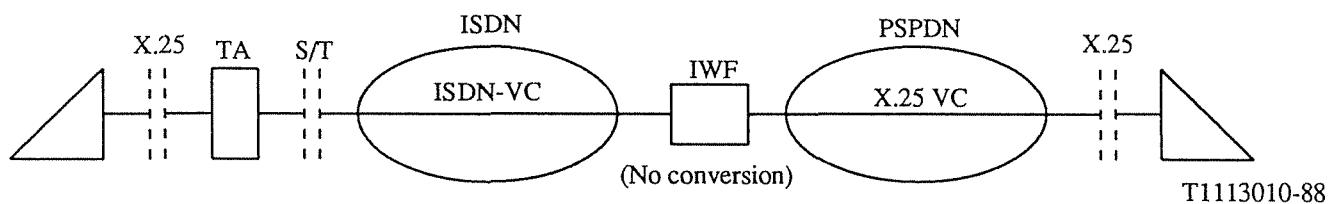


FIGURE L-8

BC = ISDN virtual circuit (VC) -> PSPDN

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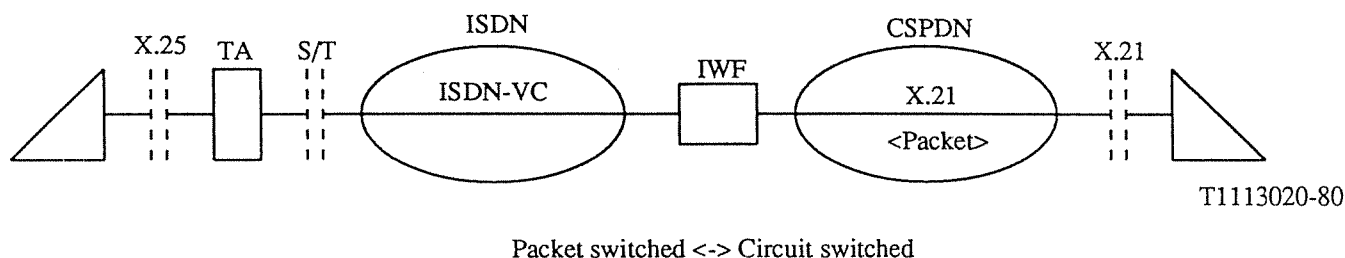


FIGURE L-9

BC = ISDN virtual circuit (VC) -> CSPDN

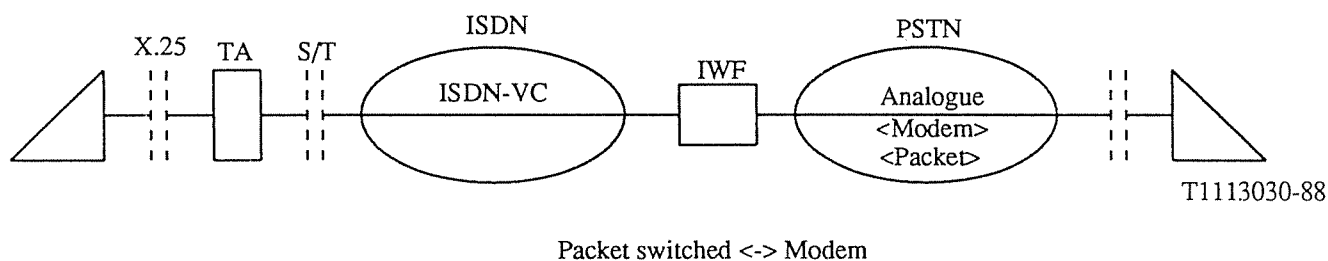


FIGURE L-10

BC = ISDN virtual circuit (VC) -> PSTN

L.4 Scenarios outside the scope of ISDN standardization

L.4.1 Examples for speech and 3.1 kHz audio bearer services

- a) Type II information (common):
 - information transfer capability = speech or 3.1 kHz audio;
 - information transfer mode = circuit;
 - information transfer rate = 64 kbit/s;
 - user information layer 1 protocol = A/μ law.
- b) Type III information for interworking with PSTN - voice band data applications - modem type conversion occurs: Figure L-11:
 - user information layer 1 protocol = rate adaption + user rate + other attributes (if required).

L.4.2 Examples for 64 kbit/s UDI circuit mode bearer services

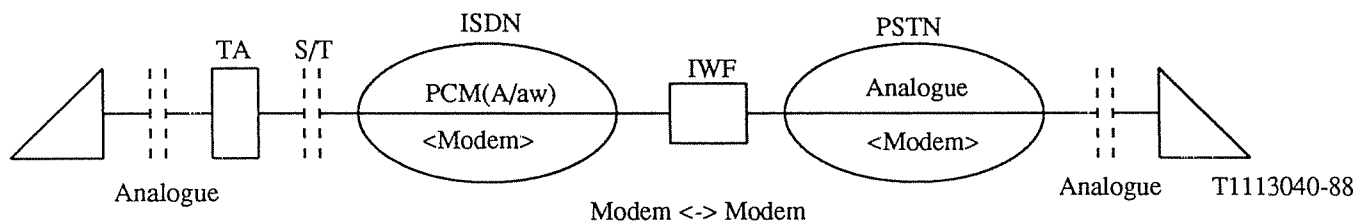
- a) Type II information (common):
 - information transfer capability = unrestricted digital information;

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- information transfer mode = circuit;
- information transfer rate = 64 kbit/s.

b) Type III information for interworking with PSTN - voice band data applications - Figure L-12:

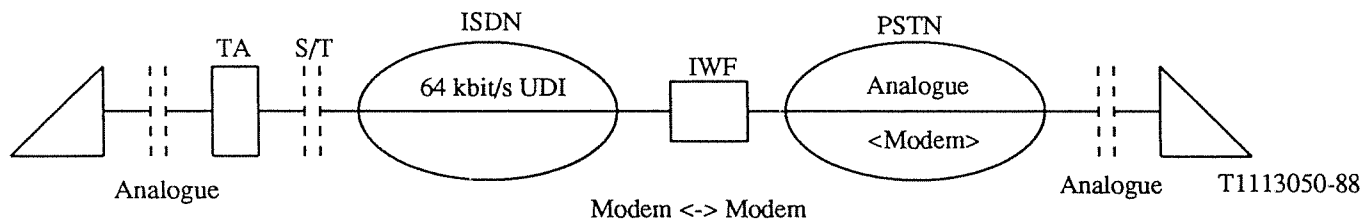
- no type III information is required.



Note - This scenario seems to be a part of PSTN services.

FIGURE L-11

BC = 3.1 kHz audio, voice band data -> PSTN



Note This scenario seems to be a combination of interworking with PSTN and a part of PSTN services.

FIGURE L-12

BC = 64 kbit/s UDI, voice-band data -> PSTN

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Issue 2.0
July 1989

Annex M

Low layer compatibility negotiation

M. Annex M - Low layer compatibility negotiation - Reserved for future use

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Annex N

Procedures for establishment of bearer connection prior to call acceptance

N. Annex N - Procedures for establishment of bearer connection prior to call acceptance

N.1 General

For some applications, it is desirable to allow the completion of the transmission path associated with a bearer service prior to receiving call acceptance. In particular, the completion of the backward direction of the transmission path prior to receipt of a CONNECT message from the called user may be desirable to:

- a) allow the called user to provide internally-generated tones and announcements that are sent in-band to the calling user prior to answer by the called user; or,
- b) avoid speech clipping on connections involving an NT2 where delays may occur in relaying the answer indication within the called user equipment.

The procedures described in this Annex are only applicable to the speech and 3.1 kHz audio bearer services.

N.2 Procedures

As a network option, completion of the transmission path prior to receipt of a call acceptance indication may be provided in one of three ways:

- a) On completion of successful channel negotiation at the destination interface; or,
- b) On receipt of a message containing an indication that in-band information is being provided; or
- c) Not at all: i.e., this option is not supported by the network.

When criteria (a) is used to determine that transmission path should be established, the network shall connect, as a minimum, the backward side of the transmission path upon receipt of either a CALL PROCEEDING message or an ALERTING message containing an acceptable B-channel indication.

When criteria (b) is used to establish the transmission path, the network shall connect, as a minimum, the backward side of the transmission path upon receipt of either an ALERTING message or a PROGRESS message containing progress indicator #8 "in-band information or appropriate pattern now available" or progress indicator #1 "call is not end-to-end ISDN; further call progress information may be available in-band," respectively.

The network providing the early completion of the transmission path in the backward direction may choose to support only one of methods (a) or (b) above. The network may choose to further restrict which message(s) will result in establishment of the transmission path. These restrictions may be imposed on a per interface basis to provide an administrative means for limiting potential misuse of the early connection capabilities.

See Section 5.2.7 for further information.

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Annex O

Optional procedures for bearer service change

O. Annex O - Optional procedures for bearer service change - Reserved for future use

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July 1989

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The attached is issued as Addendum 2 to AT&T's Technical Reference (TR) 41459 [AT&T Integrated Services Digital Network (ISDN) Primary Rate Interface and Special Application Specification, User - Network Interface Description] which bears an Issue Date of July 1989.

This Addendum provides Change Pages which update TR 41459 as follows :

<u>TR 41459 Pages</u>	<u>Replacement Pages</u> <u>From</u> <u>Addendum 2</u>
Title	Title
Notice	Notice
Contents	Contents
Part I Cover	Part I Cover
Part I Contents i/ii And iii/Glossary	Part I Contents i/ii And iii/Glossary
I - 1/2	I - 1/2
I - 3/4	I - 3/4*
I - 7/8	I - 7/8
I - 9/10	I - 9/10*
I - 11/12 Thru I - 17/18	I - 11/12 Thru I - 17/18
-----	I - 19 (Added Page)
Part II Cover	Part II Cover
Part II Contents i/ii Thru v/vi	Part II Contents i/ii Thru v/vi
II - 3/4	II - 3/4
II - 7/8	II - 7/8
II - 9/10 Thru II - 21/22	II - 9/10 Thru II - 21/22
II - 25/26 Thru II - 33/34	II - 25/26 Thru II - 33/34
II - 35/36	II - 35/36*
II - 37/38 And II - 39/40	II - 37/38 And II - 39/40
II - 41/42	II - 41/42*
II - 43/44 Thru II - 47/48	II - 43/44 Thru II - 47/48
II - 51/52	II - 51/52
II - 57/58	II - 57/58*
II - 59/60	II - 59/60*

* Pages were previously revised as a part of AT&T's January 1990 Addendum 1 to TR 41459.





TECHNICAL REFERENCE
TR 41459A2
[ADDENDUM 2]
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TR 41459 Pages
{Cont'd}

II - 61/62
Appendix I Contents i/ii And iii
Appendix I - 23/24

Replacement Pages
From
Addendum 2
{Cont'd}

II - 61/62
Appendix I Contents i/ii And iii
Appendix I - 23/24

Note: Lines including added or changed text are marked in
Right-Hand Margin with a Bar (|).

This Addendum updates, but does not supersede, TR 41459 of July 1989 and
supersedes TR 41459A1 of January 1990 only to the extent that Pages I-3/4,
I-9/10, II-35/36, II-41/42, II-57/58, and II-59/60 of that Addendum are
superseded.



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