TECHNICAL REFERENCE 41459

AT&T Network

Integrated Services Digital Network (ISDN)

Primary Rate Interface

and

Special Application Specification

User - Network Interface Description

June, 1999

DIRECTOR – Switched Network Architecture and Planning Center

AT&T NETWORK INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

PRIMARY RATE INTERFACE

AND

SPECIAL APPLICATIONS SPECIFICATION

USER-NETWORK INTERFACE DESCRIPTION

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OVERVIEW

AT&T NETWORK ISDN PRIMARY RATE INTERFACE

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GLOSSARY

64C	64 Kbps Clear
64R	64 Kbps Restricted
ANI	Automatic Number Identification
B8ZS	Bipolar with 8 Zero Substitution
BN	Billing Number
CA TSC	Call Associated Temporary Signaling Connection
CBC	Call-By-Call
CCF	Concentrated Calling Feature
CCITT	International Telegraph and Telephone Consultative Committee (replaced by ITU-T)
CED	Caller Entered Digits
COLI	Connected Line Identification
CPE	Customer Premises Equipment
CPN	Calling Party Number
CPS	Calling Party Subaddress
DDS	DATAPHONE® Digital Service
ESF	Extended SuperFrame
ESP	Enhanced Service Provider
HDLC	High Level Data Link Control
II Digits	Information Indicator Digits
ISDN	Integrated Digital Services Network
ITU-T	International Telecommunications Union - Telecommunication Standardization Sector
LAPD	Link Access Procedure on the D-Channel
LATA	Local Access and Transport Area
MA UUI	Message Associated User-to-User Information
NANP	North American Numbering Plan
NCA TSC	Non-Call Associated Temporary Signaling Connection
NCTE	Network Channel Terminating Equipment
NFAS	Non-Facility Associated Signaling
OLI	Originating Line Information
PRI	Primary Rate Interface
SDI	Switched Digital International Service
SDN	Software Defined Network
SID	Station Identification
TG	Trunk Group
USBS	User Signaling Bearer Service

1. Introduction

This Technical Reference describes the service-related capabilities and features which will be supported by the AT&T Switched Network in its implementation of Integrated Services Digital Network (ISDN) Primary Rate Interface (PRI).

The ISDN Primary Rate Interface is a multi-purpose, high speed multiplexed digital interface based on International Telecommunication Union - Telecommunication Standardization Sector (ITU-T, formerly CCITT) ISDN Recommendations[1]. 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 ITU-T I.441 (LAPD) and I.451 Recommendations for Layers 2 and 3, respectively[2].

The key feature of the ISDN Primary Rate Interface is the use of out-of-band message-oriented signaling, carried in a separate digital channel on the access and/or egress facility. This feature will enable AT&T to provide end-to-end services, over service-independent access channels, at 64 Kbps and certain multiples of 64 Kbps. It also allows for a wide variety of vertical features on existing and planned services.

The ISDN Primary Rate Interface supports the AT&T network features and services described in the following sections and serves as a foundation for many other special access services. Users with this ISDN Primary Rate Interface can communicate across the AT&T Network with those users who do not use ISDN Primary Rate Interface, subject to the limitations of their network interfaces and premises equipment.

Because of its multi-purpose nature, the ISDN Primary Rate Interface 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.

Only the interconnection of CPE having an ISDN Primary Rate Interface to an ISDN Switched Common Carrier Network will be discussed in this document.

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

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1. The ISDN Primary Rate Interface is one of two ISDN interfaces defined by the ITU-T Recommendations. The other interface is referred to as the ISDN Basic Rate Interface.

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 ITU-T Study Group 11 that developed them. The I-series Recommendations are from ITU-T Study Group 13 that oversees all of the ISDN standardization activities.

comprehensive 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:

- the applicability of the various protocol elements, procedures, and capabilities described in this specification to a particular AT&T network interface;
- the feature and service capabilities offered by that product or network; and
- the product or network specific codings and procedures for those features or services.

Consistent with AT&T's intent to follow international standards, this Technical Reference is based upon the ITU-T Recommendations and subsequent standards activities within both the ITU-T 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.

TR 41459 will be updated to specify future additional AT&T network features and/or to reflect future changes resulting from ongoing standards activities, such as those in the ITU-T Standardization Sector and ANSI-Accredited Committee T1 - Telecommunications. This document does not cover Network Interconnect capabilities. A glossary of acronyms is provided at the beginning of this Overview.

The AT&T Primary Rate Interface is compatible, subject to feature set differences, with other announced or future AT&T products as specified in other external AT&T publications.

1.1 Introduction to this Issue of TR 41459

This issue of Technical Reference (TR) 41459, dated June 1999, includes all of the material from the previous issues as well as material formerly contained in Technical Reference (TR) 41449, the former companion to this document. As of the publishing of the August 1995 issue of TR 41459, TR 41449 was no longer maintained by AT&T. Modifications have been made to provide feature and service enhancements, changes in standards, and feature revisions. Please note that all changes and additions to the text are marked with a vertical dash. The implementation described here is backward compatible, where possible, with the previously described implementation.

The format of Layer 3 (Network Layer) in Part III of this issue aligns with the format in the ITU-T Recommendation Q.931. The Layer 3 section adopts similar sectioning and layout mechanisms in presenting the protocol information as accepted in the standards community (e.g. ITU-T). This continues to demonstrate AT&T's commitment and efforts to conform with external standards.

This issue contains four appendices:

- Appendix 1 - Service Specific Capabilities
- Appendix 2 - Alternate Destination Call Redirection
- Appendix 3 - Vari-A-Bill (previously known as Flexible Billing)
- Appendix 4 - Enhanced Service Provider-Credit Checking Application

Briefly, changes included in this document since the last issue are as follows:

◊ Descriptions of the following new circuit-switched call control procedures:

- Support for receipt of multiple PROGRESS messages from user to network.
- Error handling for individual B-Channel status mismatch.

◊ Support for the Transit Network Selection Information Element.

◊ Description of dial-around capability for AT&T Digital Link Customers.

◊ Enhanced descriptions of the following ISDN PRI features:

- Procedures for invoking Access to Operator Services.
- Coding rules for Vari-a-Bill service.

2. Summary of the ISDN Primary Rate Interface Characteristics

2.1 Background

International standardization efforts by the organizations composing the ITU-T have led to recommendations for Integrated Services Digital Networks (ISDN). ITU-T 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 ITU-T 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.

B-Channels are single time slots used for voice or data (circuit or packet mode).

H0 channels are groupings of time slots 1-6, 7-12, 13-18 or 19-24 (provided that time slot 24 has not been provisioned as a D-Channel) within a single interface. H0 channels can carry calls at a data rate of 384 Kbps. An H11 channel is a grouping of the entire twenty-four time slots within a single interface (without a D-Channel). An H11 channel can carry calls at a data rate of 1.536 Mbps.

While the time slots comprising an H0 or H11 channel are fixed, these time slots may alternatively serve as time slots for other channel types. For example, if all the time slots of an H11 channel are idle, the time slots can be used as four individual H0 channels or 24 individual B-Channels or any combination of the above. This scheme is referred to as a channel overlay structure, or an overlaid interface.

Channel overlay is optional. Any time slot grouping serving as an H0 or H11 channel may be dedicated to carrying calls of that bandwidth if the customer so chooses through service provisioning.

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. D-Channels are single time slots which, when present in a DS1 interface, must be in time slot 24. An ISDN customer location must have at least one D-Channel. When multiple DS1s are provided to a given customer location, the ratio of B-Channels to D-Channels will be engineered. The number of D-Channels in a multi-DS1 arrangement can be tailored to meet a given customer's cost/performance requirements. Furthermore, to reduce the impact of facility failure with non-facility associated signaling (NFAS), the customer can optionally provision one or more D-Channels, and each D-Channel can have one backup D-Channel associated with it.

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 H0 channels on the remaining 12 "subscribed" slots.

Each Layer is briefly discussed in the following subsections, and in detail in the corresponding sections of this Technical Reference.

2.2 Interface Layers

2.2.1 Layer 1 (Physical Layer)

Part I 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 ITU-T 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 II describes the Link Access Procedure on the D-Channel (LAPD), for D-Channel signaling on the ISDN Primary Rate Interface. It is based on ITU-T Recommendations I.440 and I.441. LAPD provides for 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, supervisory frames and providing sequence and flow control, etc.

2.2.3 Layer 3 (Network Layer)

Part III, based on ITU-T Recommendation Q.931, specifies the message-oriented signaling procedures on the D-Channel for the control of circuit switched and packet connections.

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.

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 Figure O - 1 and Figure O - 2.

- In Figure O - 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."

Figure O - 1. ISDN Switched Network Configuration

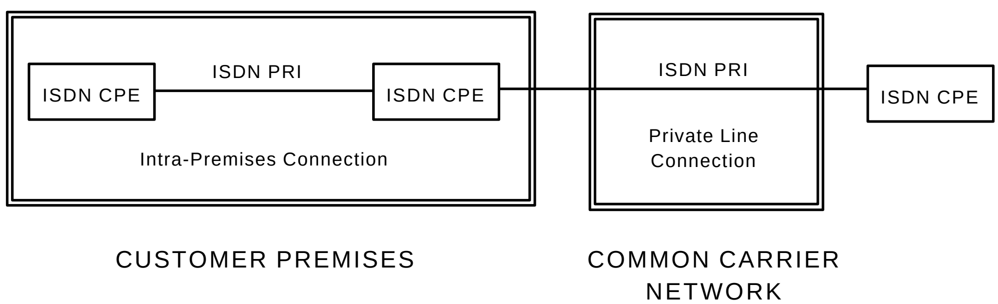

Figure O - 2. ISDN Private Line Configurations

- In Figure O - 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 "Symmetrical" Connection. Symmetrical connections are not discussed in this Technical Reference.

Part III of this Technical Reference defines the signaling procedures for Figure O - 1. These procedures specify signaling procedures that allow ISDN CPE to operate in Switched Network 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 most of the burden of error recovery for the Layer 3 signaling procedures. However, with switched network 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.

These distinctions are necessary due to a slight asymmetry of the Layer 3 call control procedures, as noted in Section 1.5 of ITU-T 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.

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

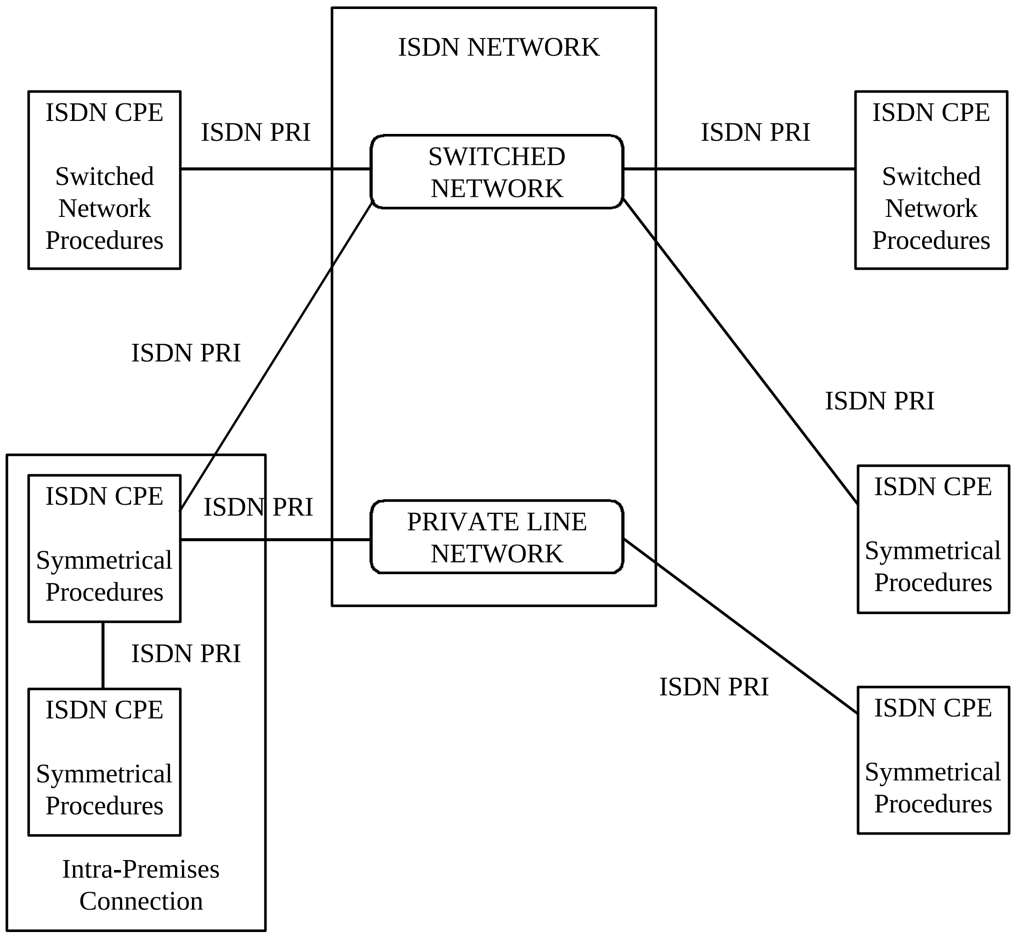

Figure O - 3. Configurations Supported by the AT&T ISDN Primary Rate Interface

3. Feature Descriptions

3.1 64 Kbps Clear/Restricted

Switched end-to-end digital connections will be supported at a data rate of 64 Kbps Restricted (64R) or at 64 Kbps Clear (64C). With 64R the customer must not transmit the all-zero octet in any time slot. If the all-zero octet is transmitted, one of the bits will be changed to a one, thereby corrupting user information. 64C channel connections will be supported where Bipolar with 8 Zero Substitution (B8ZS) coding and the Extended Superframe (ESF) format are available end-to-end. 64C allows the use of the entire 64 Kbps of a time slot for user information with no restrictions on the time slot content.

Call originations of 64 Kbps and higher will not be delivered from the network if the egress route does not support 64 Kbps connections. Channels provisioned for 64R data will only be allowed to terminate 56 or 64R calls. 64C calls will not be delivered from the network to channels provisioned for 64R data. In this case, a DISCONNECT message with Cause #65, "Bearer capability not implemented" and Location Code "Transit Network" will be returned to the originator.

3.2 Wideband Switching

The capability to switch calls at 384 Kbps and 1.536 Mbps rates across the network will be supported, subject to appropriate end-to-end connectivity.

An H0 channel must be designated in the Channel identification information element via the slot map (see *"Channel Identification"* in Part III). For a B or H11 channel the slot map is not used. For an H11 channel, the interface identifier must be designated in the Channel identification information element. 384 Kbps and 1.536 Mbps switched end-to-end digital connections will be supported. As with 64C Kbps connections, 384 Kbps and 1.536 Mbps clear channel connections will be subject to the availability of the B8ZS coding and ESF format end-to-end.

The network will support RESTART, RESTART ACKNOWLEDGE, SERVICE, and SERVICE ACKNOWLEDGE messages for all channel types (B, H0, and H11 overlaid or non-overlaid) on an individual B-Channel basis only. Wideband channel maintenance is done by sending the appropriate messages for the individual B-Channels which comprise the wideband channel.

3.3 Call-by-Call (CBC) Service Selection

The user can designate the desired service to the network, on a Call-by-Call (CBC) basis by using various information elements in the SETUP message for a given channel. Similarly, when offering a call to a user, the network will indicate on a call-by-call basis the service type of the incoming call. CBC will eliminate the need for dedicated channels for each service. If desired by the customer, however, dedicated channels can be provided.

The CBC Service Selection feature applies to H0 and H11 channels as well as B-Channels. For example, an H0 channel could carry a 384 Kbps call associated with one of several services. Note that when channel overlay is employed, the underlying B-Channels must be a call-by-call group.

3.3.1 Service Provisioning Options

The customer may specify, at service provisioning, that all or some of the (switched) channels will be CBC channels (service-independent channels). Additionally, the customer may dedicate one or more subsets of the channels to particular switched services. A "service configuration" designates which channels are allocated to which services. The service configuration may be changed via a service order.

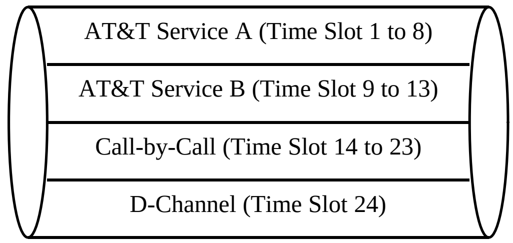

Figure O - 4. Sample Configuration of a DS1 between Customer Premises and AT&T Network ISDN

Figure O - 4 shows a sample configuration that a customer, who has a single DS1 access, might choose. This customer has chosen to dedicate 13 time slots to specific AT&T services and 10 time slots (labeled call-by-call) can be used to carry calls of any service that the customer subscribes to. Note that this customer cannot place or receive an H0 call on time slots 7 to 12 or 13 to 18 since a single call cannot cut across time slots dedicated to different services. Similarly, this customer cannot place or receive an H11 call on this DS1.

3.3.2 CPE Management of a CBC Pool of Channels

Instead of dedicating specific time slots to specific services, the customer may choose to treat some or all time slots as belonging to the call-by-call pool. The Customer Premises Equipment (CPE) can choose to limit the maximum number of simultaneous calls of each type on the call-by-call pool. By choosing suitable limits for each call type, the CPE can ensure that no individual call type can adversely affect the traffic volume of other call types. This can be done transparently to the network by CPE with appropriate development. It could be used to achieve the same effect as dedicating time slots for a particular call type without the need to reconfigure (e.g., via a service order), while still gaining some traffic efficiency.

3.3.3 Subscription Screening

For each subscribed service, the customer must have either a pool of channels dedicated to that service, or the CBC pool of channels must be provisioned to carry calls of that service, or both. The network will screen every call initiated by the customer. The call will be rejected if the customer is not provisioned to carry calls of the requested service on the pool of channels on which the call arrives. See Sections 4 and 5 for the AT&T domestic and international switched services supported via ISDN PRI.

3.4 Service Identification

3.4.1 Service Identification on Access

When the Network-specific facilities information element indicates unrecognized facilities, the network shall send a RELEASE COMPLETE message with cause 50, “requested facility not subscribed.”

For calls on CBC Trunk Groups (TG)[3], services are identified by using the Network-specific facilities, Bearer capability, Channel identification, and Called party number information elements. If the contents of the Network-specific facilities, Called party number, Channel identification and Bearer capability information elements are inconsistent, the call will be rejected. See Table III-75 in Part III for codings for nodal services.

There will be no default treatment of calls when a Network-specific facilities service coding is absent in a SETUP message on a CBC TG. In this case, the network returns a RELEASE COMPLETE message with cause 96, "mandatory information element missing."

3.4.2 Service Identification on Egress

On egress, the network will choose a channel to the user based on the terminating customer’s service configuration (see Section 3.3.1). The associated service may be specified using the Network-specific facilities, Bearer capability, Channel identification, and Called party number information elements in the SETUP message to the terminating user. CPE may use this information to generate traffic reports, size TGs on the user-network interface, and customize call handling by services on CBC TGs.

3.5 Service Screening

3.5.1 Screening on CBC TG

See Section 3.3.3 , “Subscription Screening.”

3.5.2 Screening on Single Service TG

For calls on dedicated TGs, the Network-specific facilities information element, if present, must indicate the same service to which the TG belongs. If the SETUP message for a call attempt on a dedicated TG contains a Network-specific facilities information element with unrecognized facilities, the network will reject the attempt with cause 50, "requested facility not subscribed."

3.6 Channel Hunt Algorithm

In order to increase the efficiency and utilization of an access interface the network will employ the following channel-hunt algorithm.

1. The network will attempt to hunt an idle channel beginning with the first non-overlaid interface, if the customer has any. If no channel of the appropriate bandwidth is available on any non-overlaid interface, the network will make a second pass over all the customer’s interfaces, overlaid and non-overlaid, in order, for an idle channel. This strategy also applies to hunts for H0 and H11 channels.

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3. A trunk group is a grouping of channels provisioned with identical capabilities.

The hunt order will always be in the forward direction [4](i.e., from the lowest numbered available channel to the highest numbered channel).

2. On an overlaid interface, when hunting an idle B-Channel, the network will first search for an idle time slot in an already partially occupied H0 time slot grouping. This method is used in order to keep totally unoccupied H0 time slot groupings open as long as possible for 384 Kbps calls. A similar strategy is employed to retain available H11 channels, when hunting H0 channels in overlaid interfaces. Again, the hunt order will always be in the forward direction.[5]

It is recommended that customer premises equipment employ a complementary channel-hunt strategy, hunting from the highest numbered available channel to the lowest while preserving unoccupied H0 groupings, to maximize the fill and minimize glare on a PRI or group of interfaces.

As with a CBC pool of channels, the customer may wish to manage call flow on overlaid channels according to bandwidth as well as service. Again, this may be done, transparently to the network, by CPE.

3.7 Calling Party Number (CPN) to the Network

For ISDN PRI customers originating calls to the AT&T Network, Calling Party Number (CPN) is the number provided by a user in the number digits field of the Calling party number information element in the SETUP message. The availability of CPN to the network makes it feasible to offer new network services. Also, this feature, combined with the "CPN/BN Privacy Optioning" feature (Section 3.8) and the "CPN/BN to the Terminating End" feature (Section 3.9) makes new user and terminal-based services feasible.

The customer or the originating local network can provide a CPN of 15 or fewer digits. The network may pad the CPN by inserting zeroes for unused digits, if the number of digits is less than 15. For domestic calls, the network will not check whether the CPN will be meaningful for the terminating user. If the CPE sends a CPN of longer than 15 digits, the CPN may be discarded.

For outgoing international calls, if the type of number is "national" and the numbering plan is "ISDN/telephony" the total length of the CPN must be 10 digits and the first digit must not be 0. These restrictions for outgoing international calls do not apply if the CPN is a private number. Note that a private number is indicated by the "subscriber number" in the type of number field and the "private numbering plan" in the numbering plan identification field.

3.8 CPN/BN Privacy Optioning

As stated in Section 3.7, CPN is the number provided by the user in the Calling party number information element in the SETUP message. BN is a customer billing number stored at the originating AT&T Network Switch.

Note: BN delivery is only applicable to the following services:

- Software Defined Network

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4. Note that the numbering of channels can be decided at service provisioning and may not always correspond to the numbering of the time slots on a DS1.

5. See previous note.

- Toll Free Services (e.g. Toll Free MEGACOM®)
- MultiQuest®
- Call Redirection Service

With the CPN/BN Privacy Optioning feature, AT&T PRI callers can reflect their preference regarding the presentation of either CPN or BN to the called users (including international endpoints). At service provisioning, the default value is CPN/BN Presentation Allowed on a per TG basis for both CPN and BN.

Originating PRI customers may override this default value on a per call basis (with or without sending digits in the Calling party number information element). This is done by specifying the Presentation Restricted codepoint in the Presentation Indicator field of the Calling party number information element in the SETUP message. The network will not deliver the CPN to the called user if the Presentation Restricted codepoint is indicated. The network will deliver the BN and Presentation Indicator, regardless of the Presentation Indicator contents, to the called user only for the services mentioned previously.

3.9 CPN/BN to Terminating End

With this feature the terminating user may be provided with the caller's CPN or BN[6]. The CPN or BN will be delivered to the terminating user via either the SETUP or the FACILITY ACKNOWLEDGE message[7]. A 3-Digit BN may be delivered in some cases when a complete CPN/BN is not available (and when subscribed to at provisioning).[8]

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/3-Digit BN provided on every call when available; or

2. CPN/BN/3-Digit BN provided per call upon request.

If the customer wishes to receive CPN/BN/3-Digit 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) *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.

c) *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.

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6. Note: BN delivery is only applicable to the following services: Software Defined Network, Toll Free Services (e.g. Toll Free MEGACOM®), MultiQuest®

7. See CPN/BN privacy optioning in previous section.

8. A 3-Digit BN consists of the originating NPA.

d) *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.

e) *BN Only* and *3 - Digit Billing Number delivery when a complete BN is not available.* If a complete BN is not available, the 3 - Digit BN is delivered to the terminating customer.

f) *BN Preferred* and *3 - Digit Billing Number delivery when a complete BN is not available.* If a complete BN is not available and a CPN is not available a 3 - Digit BN is delivered. If a CPN is available and a complete BN is not available, the CPN is sent.

g) *CPN Preferred* and *3 - Digit Billing Number delivery when a complete BN is not available.* If a CPN is not available and a complete BN is not available a 3 - Digit BN is delivered to the terminating customer. If a CPN is available, the CPN is sent.

If CPN/BN/3-Digit BN is desired on all calls by the terminating user, and it is available, the number is placed in the SETUP message to the terminating user. The number is delivered in the Calling party number information element.

To request CPN/BN on a per-call basis, the terminating user sends a FACILITY message containing a Network-specific facilities information element specifying CPN/BN preferred/only. CPN/BN, if available, will be returned in a FACILITY ACKNOWLEDGE message. In some cases, the CPN/BN may be unavailable, e.g., a call which has originated in a local network that does not support Equal Access. The network will then inform the user by sending a FACILITY REJECT message with an appropriate cause value.

Customers who desire per-call delivery of a 3 - Digit BN when a complete BN is not available must subscribe to the provisioning options "3 - Digit Billing Number delivery when a complete BN is not available" and "per-call CPN/BN delivery."

On a CBC trunk group, the network has the capability to handle CPN treatment individually for (a) Toll Free MEGACOM® and (b) all other services over that pool of channels including inbound international toll free calls.

See *"CPN/BN to Terminating End"* in Part III of this document for additional information.

3.10 Information Indicator (II) Digits Delivery

With this feature the terminating user may receive Information Indicator (II) Digits in the Originating Line Information (OLI) information element (Codeset 6) in the SETUP or FACILITY ACKNOWLEDGE message. The II Digits contain information about the originating line (e.g. coin, cellular service, special operator handling).

This feature supports all II Digits assigned and administered by North American Numbering Plan Administrator. Lockheed Martin Corporation, in its role as North American Numbering Plan Administrator, publishes a list of II Digits on the following World Wide Web site: http://www.nanpa.com.

Subscription to this feature requires subscription to the CPN/BN to Terminating End feature described above. If the customer does not subscribe to one of the CPN/BN delivery options, the Network will not deliver any II Digits.

See *"Information Indicator Digits Delivery"* in Part III for additional information.

3.11 Delivery of the Dialed Number for AT&T ISDN Direct Egress Services

AT&T PRI customers may subscribe at service provisioning to receive the originally dialed number (typically 10 digits) in the Called Party Number information element.[9]

3.12 Connected Line Identification (COLI) Presentation

COnnected Line Identification (COLI) Presentation is a feature offered to a calling user. It allows the called user to include the connected number in the CONNECT message sent back to the calling user. The network does not verify the connected number. The connected number is passed in the Connected number information element in the CONNECT message sent to the calling user.

This capability does not apply to NCA-TSC (see Section 3.13.3), and can only be used by calls that have end-to-end ISDN connectivity. The network will not notify the calling user if the Connected number is not available. See *"Connected Line Identification Presentation"* in Part III for additional information.

3.13 User-to-User Information (UUI) Exchange

User-to-User Information exchange is an ISDN network capability supporting virtual packet-oriented channel data connections between two ISDN users. The types of UUI capabilities are:

1. Message Associated User-to-User Information (MA UUI),

2. Call Associated Temporary Signaling Connection (CA TSC), and

3. Non-Call Associated Temporary Signaling Connection (NCA TSC).

For full details refer to "User-to-User Signaling Procedures" in Part III. A brief description of the concepts is given here.

3.13.1 Message-Associated User-to-User Information (MA UUI)

Message-Associated User-to-User Information (MA UUI) refers to the user-to-user information that may be placed in the User-user information element in the SETUP, ALERTING, CONNECT or DISCONNECT messages[10]. MA UUI can also be included in the first expected clearing message for a Non-Call Associated Temporary Signaling Connection (NCA TSC) which could be RELEASE or RELEASE COMPLETE. MA UUI also refers to the end-to-end transport of the user data information elements (i.e., Called party subaddress, Calling party subaddress, High layer compatibility, Low layer compatibility, Redirecting number, *locking* Shifts and Codesets 6 and 7 information elements) in the call control messages where they may appear. Up to 198 octets of MA UUI can be carried by any of the above messages. The individual information elements which comprise MA UUI will be screened for valid information lengths. Any user data information element with an invalid length will be dropped. The total

9. The delivery of the network terminating number or the abbreviated version of the network terminating number (e.g., Dialed Number Identification Service [DNIS]) will continue to be available for a PRI customer.

10. In the situation where both users disconnect nearly simultaneously, delivery of MAUUI in a clearing message is not guaranteed.

length of all user data information elements combined, except the User-user information element, is checked for compliance with a 129 octet limit. If the length is exceeded, the information elements will be dropped according to an information element dropping algorithm specified in *"User-user Signaling Procedures"* of Part III.

Note that as indicated in all cases described above, MA UUI refers to the user-to-user information exchange within Q.931 call control messages.

For international calls, the MA UUI information elements are defined as Calling party subaddress, Called party subaddress, Low layer compatibility, High layer compatibility and User-user information elements.

In these cases, initially the support of MA UUI on a call depends on the availability of appropriate network resources and the capabilities of the Terminating Equipment (TE). When network resources are not available to support the MA UUI feature on a call, or the terminating user is non-ISDN, any MA UUI in the message will be dropped but the network will still attempt to complete the call. The sending user will know that delivery of MA UUI is not possible on a requested call by receiving a STATUS message with Cause 43, "access information discarded." However, the network will not notify the sending user that MA UUI was dropped by the receiving user even when a STATUS message with Cause 43, "access information discarded," was sent by that user. Higher layer protocols must be used between users to guarantee the delivery and sequencing.

If the originating user desires MA UUI to be transported in the ALERTING, CONNECT, or DISCONNECT message on a call but has no MA UUI to be sent in the SETUP message, the originating user should still place an 'empty' UUI-type information element[11] in the SETUP message in order to obtain a suitable network connection to ensure MA UUI transport.

See *"User-user Signaling Procedures"* in Part III of this document for more detail.

3.13.2 Call Associated Temporary Signaling Connections (CA TSC)

A Call Associated Temporary Signaling Connection (CA TSC) refers to user-to-user information exchange associated with a circuit-switched connection. The Call Associated TSC can be established in two ways:

- a TSC is requested at call setup time, and
- a TSC is requested after call setup.

To request a CA TSC at call setup time, the user indicates this request using the SETUP message. If the network and the terminating user accept the request, then the virtual D-Channel connection is set up in addition to the circuit-switched connection. The network notifies the user of a successful CA TSC request by sending a FACILITY ACKNOWLEDGMENT message. If, as the call progresses through the network, it is not possible to select facilities necessary to support the CA TSC, the network will still attempt to complete the call, but will drop the CA TSC request; it will also indicate to the originating user that the CA TSC request is rejected (see *"User-user Signaling Procedures"* in Part III for more detail).

After the CA TSC is established, the two users may exchange information transparently through the network. At disconnect time, the circuit-switched call and the CA TSC are released simultaneously.

11. The ITU-T recommends the User-user information element for this purpose.

To request a CA TSC after call setup, the user indicates this request by sending a FACILITY message after initiating the call with a SETUP message. If the network can support this capability (i.e., if the call was routed using compatible signaling facilities) and if the distant user accepts the CA TSC request, then the CA TSC is established identically to the description above. If the CA TSC request is successful, the user is notified explicitly through receipt of a FACILITY ACKNOWLEDGMENT message.

See *"User-user Signaling Procedures"* in Part III for more information.

3.13.3 Non-Call Associated Temporary Signaling Connection (NCA TSC)

This feature allows users to communicate by means of user-to-user signaling without setting up a circuit-switched connection. The originating user requests a Non-Call Associated Temporary Signaling Connection (NCA TSC) by using the SETUP message.[12] The called party number indicated in the SETUP message is translated the same way as for a circuit-switched call, except that no circuit switched connection is established. If the terminating user accepts the NCA TSC, a signaling connection is established when the requesting user receives a CONNECT message. Since no B-Channel connection is involved, a NCA TSC is disconnected by the sending of a RELEASE message.

See *"User-user Signaling Procedures"* in Part III for more information.

3.14 B-Channel Negotiation (B-Channel Selection - Destination)

The B-Channel Negotiation protocol feature enables CPE to choose the B-Channel for an incoming call. If the channel indicated by the network in the SETUP message is acceptable to the CPE, it can reserve it for the call. Otherwise, if the user subscribes to this feature, the CPE can search for another channel and indicate this to the network in the first response to the SETUP message (which, in this case, must be CALL PROCEEDING). If the alternate channel suggested by the CPE is available, and can be used to carry calls of the particular call type (e.g. voice), the network completes the call on the alternate channel. Otherwise the call is cleared.

Channel Negotiation applies only to B-Channels controlled by the same D-Channel (or D-Channel backup pair).

3.15 Causes and Diagnostics

See *"Cause"* in Part III for the set of Causes and associated Diagnostics this interface will support.

For the following causes of local use generated by the network, the associated diagnostics will be sent to the user: 29, 50, 96, 97, 98, 100 and 102. When a call cannot complete, a relevant cause will be sent to the originating user from the network. Optionally, the network may choose to play an appropriate inband tone or announcement which corresponds to the cause. A PROGRESS message indicating that the user should cut through the B-Channel connection will precede such a tone or announcement, if cut-through has not already occurred.

Causes of end to end significance will be supported in the following manner. Cause values generated by a user will be passed unchanged by the network. The associated diagnostics, however, will not be passed by the network to the remote user.

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12. The Non-Call Associated Temporary Signaling Connection (NCA-TSC) feature is also known as User Signaling Bearer Service (USBS) in ITU-T Recommendation Q.931 1992.

For calls at all transmission rates, when clearing is initiated other than as described above, the network may generate a cause to be contained in an appropriate message and/or the network may choose to play an appropriate tone or announcement on the corresponding information channel, depending upon the circumstances. See *"Cause"* in Part III for the cause values that initiate tones and announcements.

3.16 1+ and 0+ Call Redirection

This capability allows a caller (non-PRI user) to dial some special access code numbers to redirect a 1+ or a 0+ call to an Enhanced Service Provider (PRI user) when the call does not complete to answer for any of the following reasons:

– A called party busy, ring / no answer, or an AT&T or terminating LEC network announcement,

– Congestion in the call terminating LEC's network, or

– Congestion in the AT&T network.

Refer to *"1+ and 0+ Call Redirection"* in Part III of this document for additional information.

3.17 Information Forwarding 3 (INFO 3)

The INFO 3 feature allows Enhanced Service Providers (ESPs) to collect Caller Entered Digits (CED) from a calling party, request redirection from the network and forward CED to a toll free customer (of choice). The ESP sends CED information to the network using out-of-band signaling over ISDN PRI facilities. The ESP disconnects, the network establishes redirection and delivers CED via out-of-band signaling over ISDN PRI facilities to the toll free customer.

The toll free customer must subscribe to INFO 3 service and designate the ESP that will collect the CED.

See *"Information Forwarding 3 (INFO 3)"* in Part III of this document for additional information.

3.18 Caller Information Forwarding (CINFO)

The CINFO feature provides toll free customers the ability to collect and forward Caller Entered Digits (CED) or Customer Database Provided Digits (CDPD) to a direct connect PRI destination. The network collects the CED, uses it for cooperative call processing, in conjunction with a subscriber-provided database to collect CDPD, then forwards the information along with the call to the subscriber.

See *"Caller Information Forwarding (CINFO)"* in Part III of this document for additional information.

Access To Operator Services

The Access to Operator Services feature enables customers to gain access to the Operator Services provided by the network. The network will support the following when a customer is subscribed to this feature:

- 0- calls for direct operator access,

- 0+ 7 digit or 10 digit calls, and

- 01 + CC + NN[13] international operator calls.

See Part III of this document for more information about Access to Operator Services.

3.20 AT&T Toll Free Transfer Connect(SM) Service

AT&T Toll Free Transfer Connect(SM) Service allows subscribers to transfer or redirect an answered call to another location.

Once a toll free service call is in the active state at the terminating interface, the network will monitor the call for the appropriate ISDN PRI messages or DTMF tones required to invoke the feature. MA UUI may be used to transfer additional information between ISDN PRI users. Additional information regarding this feature may be found in AT&T TR 50075[3].

3.21 Dial-Around Capability for AT&T Digital Link

AT&T Digital Link is a digital dedicated DS-1 service that allows SDN and MEGACOM customers to combine inward and outward local, IntraLATA, long-distance, and international service on AT&T ISDN PRI, T1, T45, or ACCU-Ring dedicated access

The AT&T Digital Link dial-around capability allows users making local calls to request an alternate toll carrier for long-distance calls on a per-call basis. This is accomplished by including a Transit Network Selection Information element with the Carrier Identification Code of the desired toll carrier in a SETUP message sent to the AT&T Network.

See “Dial-Around for AT&T Digital Link” in Part III of this document.

4. AT&T Domestic Switched Services Supported via ISDN PRI

The domestic switched services supported via AT&T Network ISDN PRI and their access arrangements include the following:

1. Access to and egress from Software Defined Network (SDN),

2. Access to and egress from Software Defined Data Network (SDDN),

3. Egress from Toll Free MEGACOM® (formerly referred to as MEGACOM® 800),

4. Access to MEGACOM®,

5. Access to and egress from ACCUNET® Switched Digital Service,

6. Egress from AT&T MultiQuest®,

7. Toll Free Multimedia Services (formerly referred to as WorldWorx (SM) 800),

8. Egress from Terminating Switched Acecss Arrangement (TSAA),

13. CC+NN stands for Country Code appended with National Number.

9. Access to and egress from AT&T Digital Link service.

The following section describes each of these services:

SDN offers premises-to-premises voice and voice-grade data transport, and a rich set of customer controllable call management and monitoring features.

SDDN provides high-speed bandwidth for many sophisticated data networking applications. The service is available to SDN subscribers through AT&T ISDN PRI. SDDN offers service at 64 Kbps Restricted, 64 Kbps Clear, 384 Kbps Clear and in the future 1536 Kbps.

Toll Free MEGACOM® is a service offering for customers that receive sufficient volumes of toll free calls to economically justify special-egress arrangements between the customer's location and an AT&T Service Node.

MEGACOM® is a high volume, outward calling service that uses the AT&T Switched Network to transmit voice and permissive voice-band data communications. This service offers AT&T customers an outward calling capability similar to Outward Wide Area Telecommunications Service (OUTWATS).

ACCUNET® Switched Digital Service provides end-to-end full duplex circuit-switched digital capabilities. Switched 56/64 allows an AT&T PRI customer to send data at a rate of 56/64 Kbps. There are two types of Switched 64 service: Restricted (64R) and Clear (64C). Switched 384/1536 allows an AT&T PRI customer to send data at a rate of 384/1536 Kbps.

AT&T MultiQuest® is a terminating service that offers premium billed interactive voice service between callers and AT&T MultiQuest® service providers.

Toll Free Multimedia Service allows customers to receive data calls and voice calls on the same toll free number. It is a dial up service for multimedia offerings which are various combinations of video, voice and data on a single connection. The service will support originating access by:

- 64 Kbps clear connection on an ISDN Basic Rate Interface ordered from the Local Exchange Carrier, where available.
- any form of switched 56 Kbps service (e.g. AT&T ACCUNET® Switched Digital Services) tested by the Local Exchange Carrier for use with AT&T Toll Free Multimedia Service.
- voice.
- 384 Kbps connection on an ISDN Primary Rate Interface (planned).

TSAA is a special arrangement which allows calls to be completed directly from the AT&T network to the Customer's Premises Equipment. The access facility used to terminate the calls is owned by the Called Party, who is known as an TSAA access provider. An access provider is compensated for the use of their facilities to complete some types of calls.

AT&T Digital Link is a digital dedicated DS-1 service that allows SDN and MEGACOM customers to combine inward and outward local, IntraLATA, long-distance, and international service on AT&T ISDN PRI, T1, T45, or ACCU-Ring dedicated access. Digital Link offers Direct Inward Dialing (DID) and Direct Outward Dialing (DOD for the following call types:

- Local calls
- X11 dialing (911, 411, 611)*
- Originating toll-free calls*
- Directory Assistance*

* These Call types are available only in selected areas.

See Table III-75 of Part III for detailed information element codings for these services.

5. AT&T International Switched Services Supported via ISDN PRI

The international switched services supported via AT&T Network ISDN PRI include the following:

1. Access to and egress from Switched Digital International Service (SDI),[14]

2. Access to and egress from Global Software Defined Network (GSDN),

3. Egress from International Toll Free Service, and

4. Access to International MEGACOM® Service.

A general description of each service is provided below:

SDI is an extension of the domestic ACCUNET® Switched Digital Service (i.e., an ACCUNET® Switched Digital Service customer will be able to initiate and receive international switched 56 and 64 Kbps clear calls). In addition, SDI calls can support exchange of both MA UUI and CPN/BN, subject to network connectivity. SDI will use the same Network-specific facilities codings as domestic ACCUNET® Switched Digital Service.

GSDN is targeted at meeting multinational customers' international virtual private networking needs. GSDN is a two-way voice, voice-grade data, and high speed data service implemented on the international Public Switched Telephone Network (PSTN) to some countries and on dedicated TGs to other countries. GSDN will use the same Network-specific facilities coding as domestic SDN.

Inbound International Toll Free service allows callers at points within Canada, the Caribbean, and Non-World Zone 1 to reach AT&T subscribers in the U.S., usually at no cost to the caller (some foreign countries may charge the caller a local charge for this service). This service will be identified by the Network-specific facilities service codepoint "I800" in the SETUP message.

International MEGACOM® will be provided as an add-on to the inter-state MEGACOM® outward calling service to destinations in dialable countries. The Network-specific facilities service code point for "MEGACOM®" will be used. The "type of number" field of the Called party number information element will be either national or international. The type of number field should be set to "national" for World Zone 1 calls with a called party number of the form 1+NPA+XXX-XXXX (including North American Numbering Plan (NANP) numbers in Canada and Caribbean areas accessed using the 809 NPA), and be set to "international" for non-World Zone 1 and International World Zone 1 areas accessed with a called party number of the form CC+NN.

See Table III-75 of Part III for detailed information element codings for these services.

14. Switched Digital International (SDI) was previously known as International Switched Digital Services (ISDS).

6. Call Processing

6.1 Number Digits

For any call which terminates in the domestic United States (U.S.), seven or ten digits (depending on the service) are expected in the Called party number information element sent to the network. For calls originating in the U.S. but terminating internationally, the type of number field in the Called party number information element must be set to "international" if the numbering plan identification field is E.164 or "subscriber" if the numbering plan identification field is private. In this case, "standard" inband "011" number prefix associated with the E.164 international number shall not appear in the number digits field of the Called party number information element; only the Country Code (CC) and the National Number (NN) shall appear in the number digits field. If the type of number and numbering plan identification fields in the Called party number information element are both set to “unknown”, the “011” prefix associated with an international number must be included in the number digits field in addition to the CC and NN.

No "pseudo" number digits[15], either prefixed or suffixed, will be permitted in the number digits field; however certain prefixed number digits[16] are permitted in the number digit field of a Called party number information element for feature activation purposes. The number digits field of the Called party number information element should allow a maximum of 17-digit public or private numbers.

Number digits in the Calling party and Called party number information elements will be specified in IA5 characters. Only characters 0 through 9 will be allowed for the calling or called number ’digits’. The network will discard a Calling party number information element with number digits/characters other than 0-9.

In the Called party subaddress and Calling party subaddress information elements, the user can specify a subaddress in any manner since this information is passed transparently by the network. Likewise, the Redirecting number and Connected number information elements may contain any characters in any alphabet.

6.2 Cut Through

For voice band calls, the network will cut through the circuit-switched connection upon receiving a PROGRESS, ALERTING or CONNECT message from a terminating ISDN PRI user, or upon outpulsing all number digits to a user who does not have ISDN PRI. The originating location should cut through the connection before or upon receipt of ALERTING or PROGRESS in order to hear inband ringing from the far end, other call progress tones from the network or end user, or network service announcements.

For all switched digital calls, the network will cut through the connection only when a CONNECT message has been received from the terminating user.

15. Examples are "*", "#", etc.

16. For example, to activate GSDN service the number digit prefixes include but may not be limited to 001, 002, 111, and 112.

6.3 Call Progress Tones

The network will supply the usual inband call progress tones (e.g., network busy, reorder) in case of call attempt failures due to the network, no response from the terminating user, or based on causes received from the terminating user. The network or a terminating ISDN PRI user may supply a busy tone, depending on the indication the terminating user gives to the network. The terminating user is always expected to supply inband ringing (i.e., the network will not). As is presently done when the network delivers a call to an inband user, that user equipment (CPE) must supply any call progress tones.

Because the network or terminating CPE will maintain a connection on a failed call in order to supply call progress tones, the originating user may not receive any Cause information regarding the nature of the failure.

6.4 Message Length Constraints

The maximum length of any Layer 3 message is 255 octets. Any combination of user data information elements (i.e. User-user, Called party subaddress, Calling party subaddress, High layer compatibility, Low layer compatibility, Redirecting number, *locking* Shift and Codeset 6 and 7 information elements) in the call control messages where they may appear, may not exceed 198 octets in total length.[17] Otherwise, an information element dropping algorithm is employed to meet this requirement (see Section 3.13.1 and “User-to-User Signaling Procedures” in Part III for additional information). Call processing will continue. The user will be notified that user data was discarded only if all user data information elements are dropped, and the message is not a clearing message.

6.5 Glare Resolution

"Glare" occurs when the user and the network simultaneously attempt to seize the same channel. The call incoming to the user takes precedence in the glare condition. The network, upon recognizing the glare condition, shall send a RELEASE COMPLETE in response to the SETUP from the user and proceed normally with the setup of the call incoming to the user.

6.6 Fast Connect

The network supports Fast Connect on circuit-switched calls.[18] If the terminating user sends a CONNECT not preceded by ALERTING in response to a SETUP, the network may send the originating user an ALERTING or PROGRESS preceding a CONNECT.

7. Operations, Administration and Maintenance

7.1 Failure Procedures and Maintenance

Network fault management techniques rely on several capabilities at the customer premises.

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17. Note that the total length of the user data information element in the USER INFORMATION message can be up to 251 octets.

18. Fast Connect means that the terminating user generates a CONNECT without a prior ALERTING message.

Performance monitoring and threshold exception reporting for DS1 facilities provide early, non-service disruptive indications of potential service impairment. DS1 monitoring is more effective if the ESF format is used and the termination at the customer premises complies with Technical Reference 54016 [4].

AT&T strongly recommends that the customers assign a line appearance in the CPE to a 64 Kbps (non-inverting) digital loopback. Such a loopback can be addressed from the network in the same manner as any other extension on the CPE. The customer shall make the address of the loopback available to AT&T personnel. This will permit operational and bit error rate tests from the network without the need for customer interaction. The loopback should preserve byte alignment, i.e., the most significant bit of the byte looped back corresponds to the most significant bit of the byte received, and so forth. The loopback could be provided as a stand-alone device or it may be integrated into the switching network of the CPE. Test calls will be established by the network analogously to a normal call, except that certain prespecified numbers will identify the call as a test call. Such test calls will also be accepted by the network from the user when the B-Channel is in the In Service or Maintenance state (see *"Maintenance and Management"* in Part III). Note that in order to request a test call, the CPE needs to include in its SETUP message a valid Network-specific facilities information element for CBC TGs.

It is planned for the network to support customer test calls to a 64 Kbps (non-inverting) loopback described above.

If the CPE detects a DS1 alarm affecting B-Channels, and the D-Channel is still functioning, the CPE should remove the affected B-Channels from In Service status as described in "*Maintenance and Management"* in Part III. (Note: Use of a digital crossconnect, in order to combine both ISDN and non-ISDN circuits on a given DS1, may block the detection of DS1 alarms by the network). The CPE should return B-Channels to service, when the alarm clears, unless there are additional reasons for not returning the B-Channels to service. The network will follow a similar strategy, but service robustness is enhanced if the CPE behaves as described above.

Network sectionalization is improved if customer premises equipment has the capability to loop back the D-Channel for use in link checks. Link check involves transmission of specific frames by the network D-Channel termination which can be looped back at several different intermediate points.

If the D-Channel is to be removed from service for maintenance purposes, use of the following procedure will ensure that the removal is a graceful one.[19] CPE should clear all calls under the control of the D-Channel which are already established by sending Layer 3 DISCONNECT messages for those calls. After all the calls have been cleared, the D-Channel may be removed from service by sending a DISC frame at Layer 2. This procedure will also avoid confusion on the part of the network as the network monitors Layer 2 protocol exceptions for D-Channel maintenance. As long as the CPE is unable to re-establish the D-Channel, it should respond with a DM frame to any SABME frame received from the network. It is desirable that the CPE re-establish Layer 2, or allow it to be re-established as soon as possible as described in Part III.

If a B-Channel is to be removed from service, a SERVICE message must be sent to the network to avoid a possible mismatch of the B-Channel status.

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19. The customer should coordinate shutdown of an ISDN CPE with the network work center to avoid causing network alarms. The customer should request the network work center to place the D-Channel in the manual out-of-service state, prior to CPE shutdown. If the DS1 termination to the CPE is to be turned down, the customer should also loop the DS1 back toward the network at the point of interface.

Layer 3 messages and procedures exist that will be used for channel reinitialization in extreme failure situations and for identifying channels for maintenance or removal from service. These messages and procedures are described in *"Maintenance and Management"* in Part III.

7.2 D-Channel Backup

The D-Channel backup feature permits a customer continued access to the AT&T network even if one of the D-Channels were to fail by transferring most of the signaling information to a backup D-Channel. D-Channel Backup allows a customer to designate at provisioning a pair of D-Channels in separate DS1 facilities as a mated pair.

In a typical D-Channel failure scenario, both the CPE and the network must recognize failure of the active D-Channel at Layer 2 for a backup to be initiated. In order to minimize switchover time, it is recommended that timer T203 at the CPE be set to 15 seconds. Once one end or both have detected the failure, they can exchange messages recognizing the other D-Channel as active for signaling messages. Annex B contains detailed procedures for this feature.

AT&T NETWORK ISDN PRIMARY RATE INTERFACE

AND SPECIAL APPLICATIONS

SPECIFICATION

User-Network Interface Description

PART I

LAYER 1 IMPLEMENTATION - PHYSICAL LAYER

CONTENTS

LIST OF FIGURES

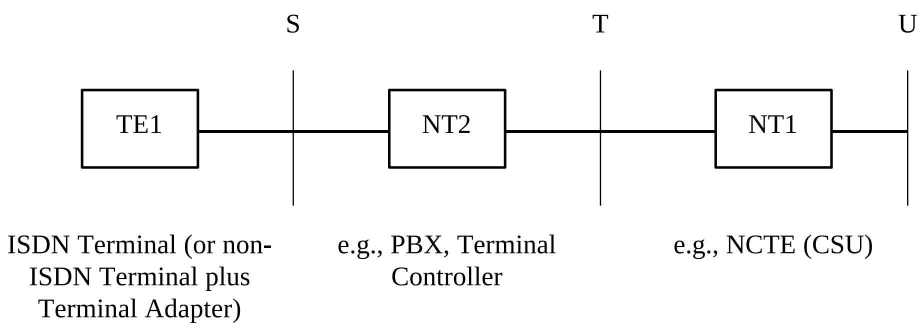
1. Physical Layer Specification

1.1 Introduction

The AT&T Network ISDN Primary Rate Interface conforms to the physical layer specification for DS1 interfaces, as detailed in this section and Technical Reference (TR) 62411 [1]. While this section provides the high level specifications for the ISDN reference points S, T and U, it is the U reference point, the CPE-network interface, which is the interface between the CPE and the AT&T network. For the complete physical layer specifications for DS1 interfaces, see TR 62411.

1.2 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 ITU-T Recommendations I.412, I.431 and I.211 [2]. 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 I - 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 I - 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[1].

1. See TR 62411.

- 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 TR 54016[3].
- 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 H11 channel or a combination of B and H0 channels. Time slots can be flexibly assigned to B and H0 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.

1.3 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.

Further information on synchronization and timing can be found in TR 60110[4]. Also, additional requirements on synchronization can be found in TR 62411.

1.3.1 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. Further information can be found in TR 62411.

1.3.2 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 0) with the possible exception of timing considerations. The primary rate ISDN terminal or Terminal Adapter (TA) will typically derive its transmit clock by loop timing.

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.

1.3.3 Interface at Reference Point U

The electrical requirements are specified in PUB 62411, ACCUNET® T1.5 Service Description and Interface Specification.

1.4 Framing Format

The recommended framing format for the ISDN interface is ESF. Robbed bit (in-band) signaling is not used on a Primary Rate Interface. Yellow Alarms are discussed in Section 0.

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

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 transport digital data services. 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 TR 62411), 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 then 335 milliseconds as specified in TR 62411), 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 Kbps (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 Kbps stream for a data link. The Extended Framing Format is fully described in TR 54016.

The ESF data link must support the ESF Yellow Alarm signal (Section 0). As an implementation option, the data link may also be used to support the enhanced facility maintenance functions as defined in TR 54016, which specifies the use of a simplified 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.

1.5 Channel Structure

In ISDN terminology a channel is a specified portion of the information bearing capacity of one ***interface***[2].

The user-network "interface arrangement" supported by AT&T Network ISDN PRI consists of one or more DS1 interfaces. Within an interface arrangement, the capacity of each DS1 interface is structured into 24 eight-bit time slots, and can support D, B, H0, and H11 channel types.

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

D Channel	1 slot	64 Kbps
B Channel	1 slot	64 Kbps
H0 Channel	6 slots	384 Kbps
H11 Channel	24 slots	1536 Kbps

Each interface arrangement must have at least one D-Channel in time slot 24 of one DS1 interface.

A customer access arrangement consisting of multiple interfaces can be partitioned into groups of interfaces, each group having exactly one D-Channel, as described below. 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. The following interface arrangements will be supported:

(23B+D) This configuration is the usual Primary Rate Interface. Up to three H0 channels may be overlaid on top of the 23 B-Channels, occupying slots 1-6, 7-12, and 13-18. A customer may provision multiple interfaces of this type.

(47B+D) This configuration is the minimum interface arrangement (consisting of two DS1 facilities) which supports the use of an H11 channel. Up to seven H0 channels may be overlaid on top of the 47 B-channels and H11 channel, occupying time slots 1-6, 7-12, 13-18, and/or 19-24 (if no D-Channel is present on that DS1 interface). A single H11 channel may be defined on the DS1 interface which does not contain the D-Channel; 24 B-Channels and/or 4 H0 channels may be overlaid as well.

n(mB+D) This configuration is a generalized multi-interface arrangement. H0 and/or H11 channels may also be overlaid as described above. A customer may provision multiple (mB+D) interfaces in order to meet availability or performance needs. A single D-Channel may signal for as many as 28 DS1 interfaces (m<=671). Since one and only one D-Channel is associated with a single interface arrangement, a Primary Rate ISDN customer may provision multiple interfaces (n=1, 2, 3...).

In order to increase the efficiency and utilization of an access interface, the network will employ the channel hunt algorithm described in the Overview. For information concerning Non-Facility Associated Signaling (NFAS), see Annex B.

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 H0 channels on the remaining 12 "subscribed" slots.

1.6 Line Coding and Pulse Density

Bipolar with 8-Zero Substitution (B8ZS) is the preferred line coding method, since it assures adequate pulse density without imposing any constraints on user data. However, B8ZS access facilities may not be available from all access providers at this time.

If B8ZS access is not available, Alternate Mark Inversion (AMI) may be used instead. AMI line coding will support voice and data on a restricted channel. When AMI line coding is used, the CPE must enforce pulse density on a per-timeslot basis.

a) A time slot used for a D, B or H0 channel must not contain the all-zero octet.

b) For an H11 channel, the all-zero octet must not be present in any of the 24 time slots of the H11 channel.

1.7 Restricted and Clear Channels

A channel which must meet the appropriate (a, b) 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 0 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.

1.8 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:

- Every time slot that is not assigned to a channel (e.g., slots awaiting channel assignment on a per-call basis, residual slots on a 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 0).

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.

1.9 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.

In the interface configuration supported by AT&T, a D-Channel is the only 64 Kbps data channel whose bit stream is subject to processing by the network. Thus, the HDLC encoding as described in here is mandatory only for D-Channels. The network places no further requirements on what can be carried on B-Channels except that for restricted B-Channels, the all-zero octet may not be sent.

Because LAPD, as specified in Part II of this document, does not allow an HDLC idle pattern on a Primary Rate Interface, neither the network nor the user will send or receive the HDLC idle code on the D-Channel.

Section 0 describes two possible methods for implementing the HDLC abort pattern. Neither side of the user-network interface need inform the other of the method chosen, only success in passing the HDLC abort sequence is important. Regardless of which method is used to implement the HDLC abort signal, an abort sequence must be followed by a flag.

1.9.1 HDLC Encoding for Restricted D-Channels

The encoding method requires that, prior to transmission on a restricted D-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.

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 011111110). 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 eight 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 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 II 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.

1.9.2 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 HDLC processing by the network.

1.10 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 1 to 15 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.

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).

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.

Note that in the event of a DS1 facility failure, the user may receive a channel code of "11111110" on each time slot of that DS1 facility. This code may be interpreted as a series of HDLC aborts on D-Channels whose bit stream is not subject to bit-inversion (i.e., Clear D-Channels).

To facilitate trouble isolation in the network, transmission impairments (such as frame errors, frame losses, and signal losses) should not be propagated by the CPE in the transmit direction.

REFERENCES

[1] AT&T Communications Technical Reference, PUB 62411, “ACCUNET® T1.5 Service Description and Interface Specification", December 1990.

[2] ITU-T Study Group XVIII, Recommendation I.412, "ISDN User-Network Interfaces, Interface Structures and Access Capabilities"; Recommendation I.431, “Primary Rate User-Network Interface - Layer 1 Specification"; Recommendation I.211, "Bearer Services Supported by an ISDN", October 1984.

[3] AT&T Communications Technical Reference, PUB 54016, “Requirements for Interfacing Digital Terminal Equipment to Services Employing the Extended Superframe Format", October 1984.

[4] AT&T Communications Technical Reference, PUB 60110, “Digital Synchronization Network Plan”, December 1983.

AT&T NETWORK ISDN PRIMARY RATE INTERFACE

AND SPECIAL APPLICATIONS

SPECIFICATION

User-Network Interface Description

PART II

LAYER 2 IMPLEMENTATION - LINK LAYER

CONTENTS

LIST OF FIGURES

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1. Layer 2 Implementation

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 ITU-T 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 ITU-T Recommendation Q.920 (I.440)[2].

Appendix II-A contains SDL diagrams that describe the protocol interactions.

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 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 = 15 seconds.
- TEI check using UI frames (SAPI=63, TEI = Group TEI (127), Ai = 0)

2. Frame structure for peer-to-peer communication

All data link layer peer-to-peer exchanges are in frames conforming to one of the formats shown in Figure II - 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.

2.1 Flag sequence

All frames shall start and end with the flag sequence consisting of one 0 bit followed by six contiguous 1 bits and one 0 bit. The flag preceding the address field is defined as the opening flag. The flag following the Frame Check Sequence (FCS) field is defined as the closing flag. The closing flag may also serve as the opening flag of the next frame, in some applications. However, all receivers must be able to accommodate receipt of 1 or more consecutive flags.

Note: Products should transmit consecutive flags that do not share "0"s. For compatibility purposes, it is suggested, but not required that products should be able to receive consecutive flags that share "0"s.

2.2 Address field

The address field shall consist of two octets as illustrated in Figure II - 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 0.

Format A

8 7 6 5 4 3 2 1	
Flag 0 1 1 1 1 1 1 0	Octet 1
Address (high order octet)	Octet 2
Address (low order octet)	Octet 3
Control a)	Octet 4
Control a)	
FCS (first octet)	Octet N-2
FCS (second octet)	Octet N-1
Flag 0 1 1 1 1 1 1 0	Octet N

Format B

8 7 6 5 4 3 2 1	
Flag 0 1 1 1 1 1 1 0	Octet 1
Address (high order octet)	Octet 2
Address (low order octet)	Octet 3
Control a)	Octet 4
Control a)	
Information	
FCS (first octet)	Octet N-2
FCS (second octet)	Octet N-1
Flag 0 1 1 1 1 1 1 0	Octet N

a) Unacknowledged operation - one octet (reserved for future use)

Multiple frame operation - two octets for frames with sequence numbers; one octet for frames without sequence numbers

Figure II - 1. Frame formats

2.3 Control field

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

The format of the control field is defined in Section 0.

2.4 Information field

The information field of a frame, when present, follows the control field (see Section 0 above) and precedes the frame check sequence (see Section 0). The contents of the information field shall consist of an integer number of octets.

The maximum number of octets in the information field is defined in Section 0.

2.5 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.

2.6 FCS field

The FCS field shall be a 16-bit sequence. It shall be the ones complement of the sum (modulo 2) of:

a) the remainder of (x^k) $(x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^9 + x^8 + x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + x + 1)$ divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k is the number of bits in the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency, 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) on the address, control and information fields; the ones 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 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.

2.7 Format convention

2.7.1 Numbering Convention

The basic convention used in this Recommendation is illustrated in Figure II - 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.

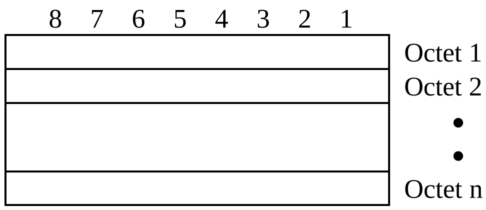


Figure II - 2. Format convention

2.7.2 Order of bit transmission

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

2.7.3 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 within each octet progressively decreases as the octet number increases. The lowest bit number associated with the field represents the lowest 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 II - 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).

8	7	6	5	4	3	2	1	
					2^4	2^3	2^2	1st octet of field
2^1	2^0							2nd octet of field

Figure II - 3. Field mapping convention

An exception to the preceding field mapping convention is the data link layer 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 II - 4).

8	7	6	5	4	3	2	1	
2^8							2^{15}	1st octet of field
2^0							2^7	2nd octet of field

Figure II - 4. FCS mapping convention

2.8 Invalid frames

An invalid frame is a frame which:

a) is not properly bounded by two flags, or

b) has fewer than six octets between flags of frames that contain sequence numbers and fewer than five octets between flags of frames that do not contain sequence numbers, or

c) does not consist of an integral number of octets prior to zero bit insertion or following zero bit extraction, or

d) contains a frame check sequence error, or

e) contains a service access point identifier (see Section 0) which is not supported by the receiver.

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

2.9 Frame abort

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

3. Elements of procedures and formats of fields for data link layer peer-to-peer communication

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

Procedures are derived from these elements of procedures and are described in Section 0.

3.1 Address field format

The address field format shown in Figure II - 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.

8	7	6	5	4	3	2	1	
SAPI						C/R	EA 0	Octet 2
TEI							EA 1	Octet 3

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

Figure II - 5. Address field format

3.2 Address field variables

3.2.1 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 a 0 and bit 1 of the second octet set to 1.

3.2.2 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 Table II - 1.

In conformance with HDLC rules, commands use the address of the peer data link layer entity while responses use the address of their own data link layer entity. 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 where SAPI and TEI conform to the definitions contained in Sections 0 and 0 and define the data link connection as described in Recommendation Q.920, Section 0.

Command/Response	Direction	C/R Value
Command	Network side → User side	1
	User side → Network side	0
Response	Network side → User side	0
	User side → Network side	1

Table II - 1. C/R field bit usage

3.2.3 Service access point identifier (SAPI)

The 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 shown in Table II - 2.

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

Table II - 2. Allocation of SAPI values

Note: the reservation of SAPI values for experimental purpose is for further study.

* Implementation of SAPI 63 is optional.

3.2.4 Terminal endpoint identifier (TEI)

The TEI for a point-to-point data link connection may be associated with a single Terminal Equipment (TE). A TE may contain one or more TEIs used for point-to-point data transfer. The TEI for a broadcast data link connection 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.

3.2.4.1 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 Service Access Point (SAP).

Note: The implementation of TEI 127 is optional.

3.2.4.2 TEI for point-to-point connection

The TEI subfield bit pattern 000 0000 (=0) will be used for the point-to-point data link connections associated with the addressed SAP. This value shall be assigned at subscription time.

3.3 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 transfer (I format), supervisory functions (S format), and unnumbered information transfers and control functions (U format). The control field formats are shown in Table II - 3.

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

Table II - 3. Control field formats

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

3.3.1 Information transfer (I) format

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 0) 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 0.

3.3.2 Supervisory (S) format

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.

3.3.3 Unnumbered (U) format

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 does include a P/F bit that may be set to 0 or 1.

3.4 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.

3.4.1 Poll/Final (P/F) bit

All frames contain the Poll/Final (P/F) bit. The 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 solicit (poll) a response frame 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 0.

3.4.2 Multiple frame operation - variables and sequence numbers

3.4.2.1 Modulus

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

Note: All arithmetic operations on state variables and sequence numbers contained in this Recommendation are affected by the modulus operation.

3.4.2.2 Send state variable V(S)

Each point-to-point data link connection endpoint shall have an associated V(S) when using I frame commands. V(S) denotes the sequence number of the next I frame to be transmitted. The V(S) can take on the value 0 through n-1. The value of V(S) shall be incremented by 1 with each successive I frame transmission, and shall not exceed V(A) by more that the maximum number of outstanding I frames, k. The value of k may be in the range of
$1 <= k <= 127$.

3.4.2.3 Acknowledge state variable V(A)

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

3.4.2.4 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 V(S).

3.4.2.5 Receive state variable V(R)

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

3.4.2.6 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 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.

3.4.3 Unacknowledged operation - variables and parameters

No variables are defined. One parameter is defined, N201 (see Section 0).

3.5 Frame types

3.5.1 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 Table II - 4. Each data link connection shall support the full set of commands and responses for each application implemented. The frame types associated with each of the two applications are identified in Table II - 4.

Frame types associated with an application not implemented shall be discarded and no action shall be taken as a result of that frame.

For purposes of the LAPD procedures in each application, those frame types not identified in Table II - 4 are identified as undefined command and/or response control fields. The actions to be taken are specified in Section 0.

The commands and responses in Table II - 4 are defined in Sections 0 - 0.

Application	Format	Commands	Responses	8	7	6	5	4	3	2	1	Octet
				Encoding								
	Information transfer	I (Information)						N(S)			0	4
								N(R)			P	5
	Supervisory	RR (receive ready)	RR (receive ready)	0	0	0	0	0	0	0	1	4
								N(R)			P/F	5
		RNR (receive not ready)	RNR (receive not ready)	0	0	0	0	0	1	0	1	4
								N(R)			P/F	5
		REJ (reject)	REJ (reject)	0	0	0	0	1	0	0	1	4
								N(R)			P/F	5
Unacknowledged and multiple frame acknowledged information transfer	Unnumbered	SABME (set asynchronous balanced mode extended)		0	1	1	P	1	1	1	1	4
			DM (disconnected mode)	0	0	0	F	1	1	1	1	4
		UI (unnumbered information)		0	0	0	P	0	0	1	1	4
		DISC (disconnect)		0	1	0	P	0	0	1	1	4
			UA (unnumbered acknowledgment)	0	1	1	F	0	0	1	1	4
			FRMR (frame reject)	1	0	0	F	0	1	1	1	4
Connection Management		XID (exchange identification) See Note	XID (exchange identification) See Note	1	0	1	P/F	1	1	1	1	4

Table II - 4. Commands and responses - modulo 128

Note - Use of the XID frame other than for parameter negotiation procedures (see Section 0) is for further study. There are no procedures presently defined which use XID frames in PRI applications. PRI applications treat XID frames as invalid frames.

3.5.2 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.

3.5.3 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 V(S), V(A), V(R), and retransmission count 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 processed 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.

3.5.4 Disconnect (DISC) command

The DISC unnumbered command is used to terminate the multiple frame operation.

No information field is permitted within the DISC 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 processed 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.

3.5.5 Unnumbered information (UI) command

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

3.5.6 Receive ready (RR) command/response

The 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 0); and

c) clear a busy condition that was indicated by the earlier transmission of an RNR frame by that same data link layer entity.

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

3.5.7 Reject (REJ) command/response

The REJ supervisory frame is used by a data link layer entity to request retransmission of I frames starting with the frame numbered N(R). The value of N(R) in the REJ frame acknowledges 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 is 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 within the sending data link layer entity that was reported by the earlier transmission of an RNR frame by that same data link layer entity.

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

3.5.8 Receive not ready (RNR) command/response

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

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

3.5.9 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 processed 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.

3.5.10 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 is in a state such that multiple frame operation cannot be performed. No information field is permitted with the DM response.

3.5.11 Frame reject (FRMR) response

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

a) the receipt of a command or response control field that is undefined or not implemented;

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;

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 not identified in Table II - 4.

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

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 (modulo 128 operation) is returned with this response and provides the reason for the FRMR response. This information field format is given in Figure II - 6.

8	7	6	5	4	3	2	1	
			Rejected Frame					Octet 5
			Control Field					Octet 6
			V(S)				0	Octet 7
			V(R)				C/R	Octet 8
0	0	0	0	Z	Y	X	W	Octet 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 octets 5 and 6 was undefined or not implemented.
- X set to 1 indicates that the control field received and returned in octets 5 and 6 was considered invalid because the frame contained an information field which is not permitted with this frame or 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 information field length (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 II - 6. FRMR information field format **-** extended (modulo 128) operation

3.5.12 Exchange identification (XID) command/response

Reserved for future use.

4. Elements for layer-to-layer communication

Communications between layers and, for this Recommendation, between the data link layer and the layer management are accomplished by means of primitives.

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 interface across which the primitive flows. For this Recommendation, XX is:

- DL for communication between layer 3 and the data link layer;
- PH for communication between the data link layer and the physical layer;
- MDL for communication between the layer management and the data link layer; or
- MPH for communication between the management entity and the physical layer.

4.1.1 Generic names

The generic name specifies the activity that should be performed. Table II **-** 5 illustrates the primitives defined in this Recommendation. Note that not all primitives have associated parameters.

Table II - 5. Primitives associated with Recommendation Q.921

Generic name	Type				Parameters		Message unit contents
	Request	Indication	Response	Confirm	Priority indicator	Message unit	
L3 ↔ L2							
DL-ESTABLISH	X	X	-	X	-	-	
DL-RELEASE	X	X	-	X	-	-	
DL-DM-RLS See Note	X	-	-	-	-	-	
DL-DATA	X	X	-	-	-	X	Layer 3 peer-to-peer message
DL-UNIT DATA	X	X	-	-	-	X	Layer 3 peer-to-peer message
M ↔ L2							
MDL-ERROR	-	X	X	-	-	X	Reason for error message
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

L3 ↔ L2: Layer 3/data link layer boundary

L2 ↔ L1: Data link layer/physical layer boundary

M ↔ L2: Management entity/data link layer boundary

Note: DL_DM_RLS: This is an optional primitive type used between layer 3 and layer 2. It is required for implementing D-Channel backup for non-facility associated signaling.

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

4.1.1.1 DL-ESTABLISH

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

4.1.1.2 DL-RELEASE

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

4.1.1.3 DL-DATA

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

4.1.1.4 DL-UNIT DATA

The DL-UNIT DATA primitives are used to request and indicate layer 3 messages which are to be transmitted, or have been received, by the data link layer using the unacknowledged information transfer service.

4.1.1.5 MDL-ASSIGN

Reserved for future use.

4.1.1.6 MDL-REMOVE

Reserved for future use.

4.1.1.7 MDL-ERROR

The MDL-ERROR primitives are used to indicate to the connection 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. The layer management entity may respond with an MDL-ERROR primitive if the layer management entity cannot obtain a TEI value.

4.1.1.8 MDL-UNIT DATA

The MDL-UNIT DATA primitives are used to request and indicate layer management entity messages which are to be transmitted, or have been received, by the data link layer using the unacknowledged information transfer service.

4.1.1.9 MDL-XID

Reserved for future use.

4.1.1.10 PH-DATA

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

4.1.1.11 PH-ACTIVATE

Reserved for future use.

4.1.1.12 PH-DEACTIVATE

Reserved for future use.

4.1.1.13 MPH-ACTIVATE

Reserved for future use.

4.1.1.14 MPH-DEACTIVATE

Reserved for future use.

4.1.1.15 MPH-INFORMATION

Reserved for future use.

4.1.1.16 DL_DM_RLS

The DL_DM_RLS primitive is used by layer 3 to put layer 2 in the TEI_ASSIGNED state similar to a DL_RELEASE_REQ. However, once in the TEI_ASSIGNED state, the layer 2 entity will respond to received SABME commands with a DM response. The primitive is used by layer 3 when in the Maintenance Busy or Manual Out-of-Service state while performing a D-Channel backup procedure. See Section 0.

4.1.2 Primitive types

The primitive types defined in this Recommendation are:

4.1.2.1 REQUEST

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

4.1.2.2 INDICATION

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

4.1.2.3 RESPONSE

The RESPONSE primitive type is used by layer management as a consequence 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.

Figure II - 7 illustrates the relationship of the primitive types to layer 3 and the data link layer.

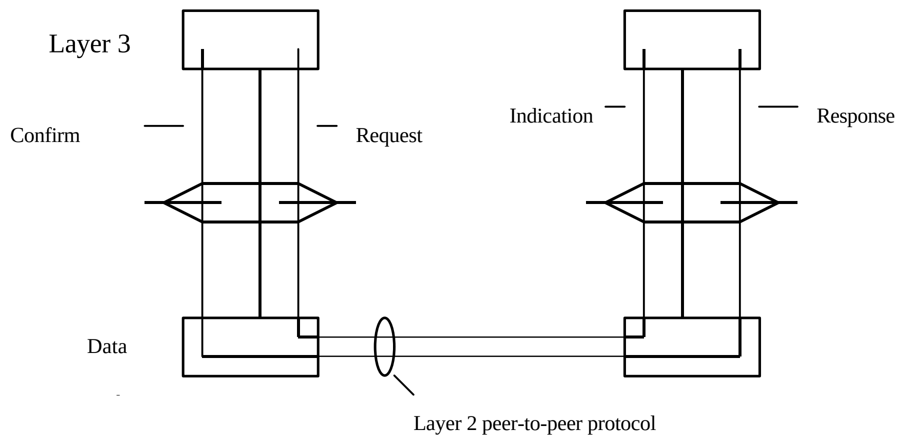


Figure II - 7. Relationship of the primitive types to layer 3 and the data link layer

4.1.3 Parameter definition

4.1.3.1 Priority indicator

Since several SAPs may exist on the network side or user side, protocol messages 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. The priority indicator is only needed at the user side for distinguishing message units sent by the SAP with a SAPI value of 0 from all other message units.

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 primitives, the message unit contains the requesting layer peer-to-peer messages. For example, the DL-DATA message unit contains layer 3 information. The PH-DATA message unit contains the data link layer frame.

Note - The operations across the data link layer/layer 3 boundary shall be such that the layer sending the DL-DATA or DL-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.

4.2 Primitive procedures

4.2.1 General

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

In the scope of this Recommendation the interactions between layer 3 and the data link layer are specified.

4.2.2 Layer 3 - data link layer interactions

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

Data link connection endpoint states are defined as follows:

a) Broadcast data link connection endpoint:

   – Reserved for future use.

b) Point-to-point data link connection endpoint:

   – *link connection released* state.

   – *awaiting establish* state.

   – *awaiting release* state.

   – *link connection established* state.

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

This section defines the constraints on the sequences in which the primitives may occur. The sequences are related to the states at one point-to-point data link connection endpoint.

The possible overall sequences of primitives at a point-to-point data link connection endpoint are defined in the state transition diagram, Figure II - 8. The *link connection released* and *link connection established* states are stable states whilst the *awaiting establish* and *awaiting release* states are transition states.

The model illustrates the behavior of layer 2 as seen by layer 3. This model assumes that the primitives passed between layers is implemented by a first in first out queue. In this model, "collisions" of REQUEST and INDICATION primitives can occur thereby illustrating actions that seem to be in conflict with the actual layer 2 protocol description. In some implementations, these collisions could occur.

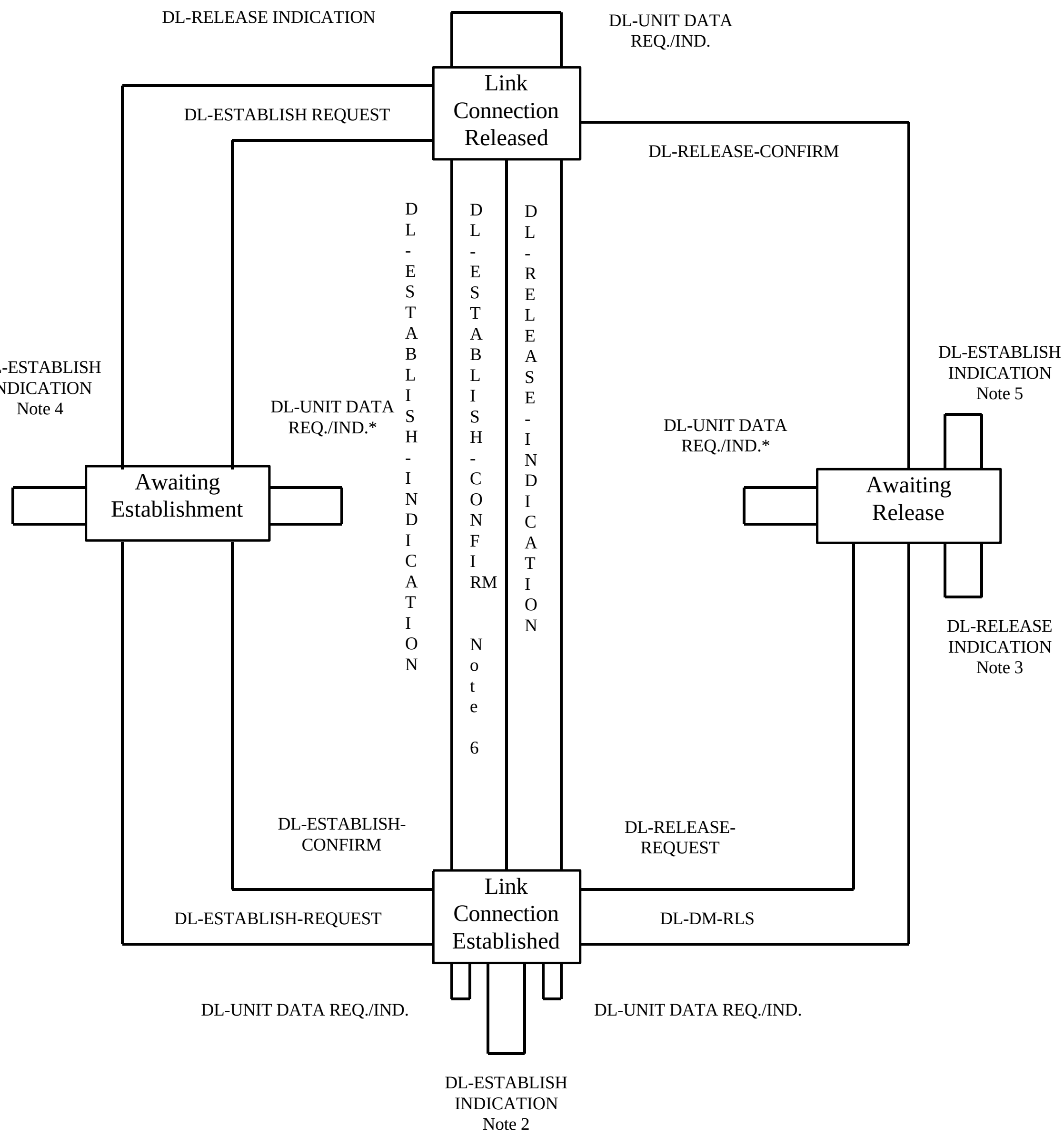


Figure II - 8. State transition diagram for sequences of primitives at a point-to-point data link connection as seen by Layer 3 (Note 1)

Notes to Figure II - 8:

Note 1 - If the data link layer entity issues a DL-ESTABLISH-INDICATION (this applies to the case of data link layer initiated or peer system initiated re-establishment), DL-RELEASE-CONFIRM or DL-RELEASE-

INDICATION, this indicates the discard of all the data link service data units representing DL-DATA-REQUESTS.

Note 2 - This primitive notifies layer 3 of link re-establishment.

Note 3 - This primitive will occur if a DL-RELEASE-REQUEST collides with a DL-RELEASE-INDICATION.

Note 4 - This primitive will occur if a DL-ESTABLISH-REQUEST collides with a DL-ESTABLISH-INDICATION.

Note 5 - This primitive will occur if a DL-RELEASE-REQUEST collides with a DL-ESTABLISH-INDICATION.

Note 6 - This primitive will occur if a DL-ESTABLISH-REQUEST (this applies to the case of layer 3 initiated re-establishment) collides with a DL-RELEASE-INDICATION. Since this DL-RELEASE-INDICATION is not related to the DL-ESTABLISH-REQUEST, the data link layer will establish the link and issue a DL-ESTABLISH-CONFIRM.

5. Definition of the peer-to-peer procedures of the data link layer

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

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

a) for unacknowledged information transfer (Section 0):

UI-command

b) for multiple frame acknowledged information transfer (Sections 0 to 0):

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/F bit

5.1.1 Unacknowledged information transfer

For unacknowledged information transfer the P/F 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 Table II - 6.

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

Table II - 6. Immediate response operation of P/F bit

5.2 Procedures for unacknowledged information transfer

5.2.1 General

The procedures which apply to the transmission of information in unacknowledged operation 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 by the data link layer to the physical layer.

Unacknowledged information is passed to the data link layer by layer 3 or management entities using the primitives DL-UNIT DATA-REQUEST or MDL-UNIT DATA-REQUEST, respectively. The layer 3 or management message unit shall 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 TEI value ‘0’ shall be used.

The P bit shall be set to 0.

5.2.3 Receipt of unacknowledged information

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

5.3 Terminal Endpoint Identifier (TEI) management procedures

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 0) to check the existence of this presubscribed TEI. This procedure is optional.

5.3.1 General

TEI management is based on the following procedural means:

– TEI assignment procedures (see Section 0)

– TEI check procedures (see Section 0)

– TEI removal procedures (see Section 0)

A user equipment in the *TEI-unassigned* state shall use the TEI assignment procedures to enter the *TEI-assigned* state. Conceptually, these procedures exist in the layer management entity. The layer management entity on the network side is referred to as the Assignment Source Point (ASP) in this Specification.

The purpose of these procedures is to:

a) allow automatic TEI equipment to request the network to assign a TEI value that the data link layer entities within the requesting user equipment will use in their subsequent communications;

b) allow a network to remove a previously assigned TEI value from specific or all user equipment;

c) allow a network to check:

  – whether or not a TEI value is in use, or

  – whether multiple-TEI assignment has occurred;

The user side layer management entity shall instruct the user data link layer entities to remove all TEI values when it is notified that the terminal is disconnected at the interface (as defined in Recommendation I.430).

Additionally, the user side layer management entity should instruct the user data link layer entity to remove a TEI value for its own internal reasons (for example, losing the ability to communicate with the network). The layer management entity shall use the MDL-REMOVE-REQUEST primitive for these purposes.

Typically, one TEI value would be used by the user equipment (for example, a data link layer entity which has been assigned a TEI value could use that value for all SAPs which it supports). If required, a number of TEI values may be requested by multiple use of the procedures defined in Section 0. It shall be the responsibility of the user to maintain the association between TEI and SAPI values.

The initiation of TEI assignment procedures occurs on the receipt of a request for establishment or unacknowledged information transfer while in the *TEI-unassigned* state. The data link layer entity shall inform the layer management entity using the MDL-ASSIGN-INDICATION primitive. Alternatively, the user side layer management entity may initiate the TEI assignment procedures for its own reasons.

Note - In the case of initialization from a no power condition, the user equipment should postpone the start of the TEI assignment procedure until a layer 2 service that needs a TEI is to be provided.

All layer management entity messages used for these TEI management procedures are transmitted to, or received from, the data link layer entity using the MDL-UNIT DATA-REQUEST primitive, or the MDL-UNIT DATA-INDICATION primitive, respectively. The data link layer entity shall transmit management entity messages in UI command frames. The SAPI value shall be 63. The TEI value shall be 127.

5.3.2 TEI assignment procedure

Reserved for future use.

5.3.3 TEI check procedure

5.3.3.1 Use of the TEI check procedure

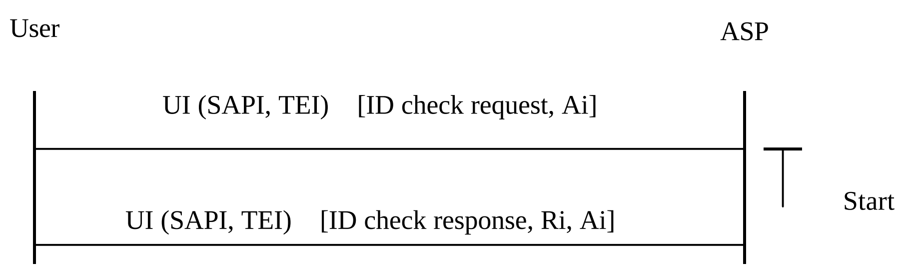
The TEI check procedure shall be used in the TEI audit and recovery procedures. The TEI check procedure allows the network side layer management entity either:

– to establish that a TEI value is in use; or

– to verify multiple-TEI assignment.

5.3.3.2 Operation of the TEI check procedure

The TEI check procedure is illustrated in Figure II - 9.



NOTE	:	
SAPI	:	SAPI = 63
TEI	:	Group TEI = 63
Ai	:	Action Indicator
Ri	:	Reference Number
( )	:	Contents of Data Link Layer Command Address Field
[ ]	:	Contents of Data Link Layer Information Field

Figure II - 9. TEI check procedure

The ASP shall transmit a message containing the following elements:

a) message type = Identity check request; and

b) Ai field which contains the TEI value to be checked or the value 127 when all TEI values are to be checked.

Timer T201 shall be started.

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

a) message type = Identity check response;

b) the TEI value in the Ai field; and

c) Reference number (Ri).

Note: The randomly-generated Ri is present in the Identity check response to ensure that in the case where more than one user equipment happens to commence transmission of the identity check response at precisely the same time (i.e., the first "0" bit of the opening flag coincides) due to different Ri values a collision at layer 1 (see ISDN user-network interfaces: layer 1 Recommendations [I.43x series] for clarification) occurs. The resolution of this collision results in multiple identity check responses.

When the TEI check procedure is used to verify multiple-TEI assignment:

– if more than one Identity check response is received within T201, then multiple-TEI assignment shall be considered present; otherwise the request shall be repeated once and timer T201 restarted;

– if more than one Identity check response is received within the second T201 period, multiple TEI assignment shall be considered present;

– if no Identity check response is received after both T201 periods, the TEI value shall be assumed to be free and available for (re)assignment;

– if one Identity check response is received in one or both T201 periods, the TEI value shall be assumed in use.

When the TEI check procedure is used to test whether a TEI value is in use, it is completed upon the receipt of the first TEI Identity check response message, and the TEI value is assumed to be in use. Otherwise:

– if no Identity check response is received within T201, the identity check request shall be repeated once and timer T201 restarted;

– if no Identity check response is received after the second Identity check request, the TEI value shall be assumed to be free and available for re-assignment.

If the Ai value in the Identity check request is equal to 127, it is preferred that the receiving user side layer management entity respond with a single Identity check response message that contains all of the TEI values in use within that user equipment. If an Identity check request with Ai equal to 127 is transmitted and an Identity check response is received making use of the extension facility, each Ai variable in the Ai field shall be processed as if received in separate Identity check responses for parallel Identity check requests.

5.3.4 TEI removal procedure

Reserved for future use.

5.3.5 TEI identity verify procedure

Reserved for future use.

5.3.6 Formats and codes

5.3.6.1 General

All messages used for TEI management 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 have the structure shown in Figure II - 10.

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

Figure II - 10. Messages used for TEI management procedures

Fields that are not used in a specific message are coded all zeroes, and are not to be processed by either side. The coding of each field for the various messages is specified in Table II - 7. E is the Action indicator field extension bit (see Section 0).

Message Name	Message entity identifier	Reference number Ri	Message type	Action indicator Ai
Identity check request	0000 1111	Not used (coded 0)	0000 0100	Ai = 127. Check all TEI values
Identity check response	0000 1111	0 - 65535	0000 0101	Ai = 0. TEI value in use

Table II - 7. Codes for messages concerning TEI management procedures

5.3.6.2 Layer management entity identifier

For TEI administration procedures, the layer management entity identifier octet is 0000 1111. Other values are reserved for further standardization.

5.3.6.3 Reference number (Ri)

Octets 2 and 3 contain Ri. When used, it can assume any value between 0 and 65535.

5.3.6.4 Message type

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

5.3.6.5 Action indicator (Ai)

The Ai field is extended by reserving the first transmitted bit of the Ai field octets to indicate the final octet of the Ai field.

Ai variables in the Ai field are coded as follows:

a) bit 1 is the extension bit and is set to 1.

b) bits 2 to 8 contain the Action indicator.

The purpose of the Action indicator is to identify the concerned TEI value(s).

5.4 Automatic negotiation of data link layer parameters

Reserved for future use.

5.5 Procedures for establishment and release of multiple frame operation

5.5.1 Establishment of multiple frame operation

The provision of extended multiple frame operation (modulo 128 sequencing) is required.

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 request 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 0. 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 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 0). All mode setting commands shall be transmitted with the P bit set to 1.

Layer 3 initiated establishment procedures imply the discard of all outstanding DL-DATA-REQUEST primitives and all I frames in queue.

A data link layer entity receiving an SABME command, if it is able to enter the *multiple-frame-established* state, shall:

– respond with an UA response with the F bit set to the same binary value as the P bit in the received SABME command;

– set V(S), V(R) and V(A) to 0;

– enter the *multiple-frame-established* state and inform layer 3 using the DL-ESTABLISH-INDICATION primitive;

– clear all existing exception conditions;

- clear any existing peer receiver busy condition;
- start timer T203 (timer T203 is defined in Section 0); and
- Reset the transmission counter.

If the data link layer entity is unable to enter the *multiple-frame-established* state, 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 command shall:

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

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

5.5.1.3 Procedure on expiry of timer T200

If timer T200 expires before the UA or DM response with the F bit set to 1 is received, the data link layer entity 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 connection management entity by means of the DL-RELEASE-INDICATION and MDL-ERROR-INDICATION primitives, respectively, and enter the *TEI-assigned* state, after discarding all outstanding DL-DATA-REQUEST primitives and all I frames in queue.

The value of N200 is defined in Section 0.

5.5.2 Information transfer

Having either transmitted the UA response to a received SABME command or received the UA response to a transmitted SABME command, I frames and supervisory frames shall be transmitted and received according to the procedures described in Section 0.

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 0.

On receipt of a UI command, the procedures defined in Section 0 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.

Layer 3 will request termination of the multiple frame operation by use of the DL-RELEASE-REQUEST primitive.

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

All outstanding DL-DATA-REQUEST primitives and all I frames in queue shall be discarded.

5.5.3.2 Release procedure

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

A data link layer entity receiving a DISC command while in the *multiple-frame-established* or *timer recovery* 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 primitive 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 with the F bit set to 1; or

– a DM response with the F bit set to 1, indicating that the peer data link layer entity is already in the *TEI-assigned* state,

it shall enter the *TEI-assigned* state and reset timer T200.

The data link layer entity which issued the DISC command is now in the *TEI-assigned* state and will notify layer 3 by means of the DL-RELEASE-CONFIRM primitive. The conditions relating to this state are defined in Section 0.

5.5.3.3 Procedure on expiry of timer T200

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

– retransmit the DISC command as defined in Section 0;

– restart timer T200; and

– increment the retransmission counter.

If the data link layer entity has not received the correct response as defined in Section 0, after N200 attempts to recover, the data link layer entity shall indicate this to the connection management entity by means of the MDL-ERROR-INDICATION primitive, enter the *TEI-assigned* state and notify layer 3 by means of the DL-RELEASE-CONFIRM primitive.

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 F bit set to the value of the received P bit;

– on receipt of an SABME command, the procedures defined in Section 0 shall be followed;

– on receipt of an unsolicited DM response with the F bit set to 0, the DM shall be ignored;

– on receipt of UI commands, the procedures defined in Section 0 shall be followed;

– on receipt of any unsolicited UA response or a DM with F bit set to 1, an MDL-ERROR-INDICATION primitive indicating a possible double assignment of a TEI value shall be issued; and

– all other frame types shall be discarded.

Note: 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 0).

5.5.5 Collision of unnumbered commands and responses

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 entity shall notify layer 3 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 the 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 entity receiving the DISC command will issue a DL-RELEASE-INDICATION primitive, while the other entity will issue a DL-RELEASE-CONFIRM primitive.

5.5.6 Unsolicited DM response and SABME or DISC command

When a DM response with the F bit set to 0 is received by a data link layer entity, a collision between a transmitted SABME or DISC command and the unsolicited DM response may have occurred. This is typically caused by a user equipment applying a protocol procedure according to X.25 LAPB 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.

A DM response with the F bit set to 0 colliding with an SABME or DISC command 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 by the data link layer to the physical 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 V(S) and V(R), respectively. 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 0 shall be followed.

If V(S) is equal to V(A) plus *k* (where *k* is the maximum number of outstanding I frames - see Section 0), 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 0 and 0.

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

Independent of a timer recovery condition, when a data link layer entity is not in an own receiver busy condition and receives a valid I frame whose N(S) is equal to the current V(R), the data link layer entity shall:

– pass the information field of this frame to layer 3 using the DL-DATA-INDICATION primitive;

– increment by 1 its 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 respond to its peer in one of the following ways:

– if the data link layer entity receiving the I frame is still not in an own receiver busy condition, it shall send an RR response with the F bit set to 1;

– if the data link layer entity receiving the I frame enters the own receiver busy condition upon receipt of the I frame, it shall send an RNR response with the F bit set to 1.

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; or

  – 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 0; or

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 0.

5.6.3 Sending and receiving acknowledgments

5.6.3.1 Sending acknowledgments

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

5.6.3.2 Receiving acknowledgments

On receipt of a valid I frame or supervisory frame (RR, RNR, or REJ), even in the own receiver busy, or timer recovery conditions, the data link layer entity shall treat the N(R) contained in this frame as an acknowledgment for all the I frames it has transmitted with an N(S) up to and including the received N(R) **-** 1. V(A) shall be set to 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 an REJ frame with an N(R) equal to V(A).

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

Note 2 **-** Upon receipt of a valid I frame, timer 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 0 with respect to the unacknowledged I frames.

If timer T200 has been reset by the receipt of an REJ frame, the data link layer entity shall follow the retransmission procedures in Section 0.

5.6.4 Receiving REJ frames

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 condition:

- clear an existing peer receiver busy condition;
- set its V(S) and its 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 0, taking into account the items 1) to 4) below and the paragraph following items 1) to 4); and
- notify a protocol violation to the connection management entity by means of the MDL-ERROR-INDICATION primitive, if it was an REJ response frame with the F bit set to 1.

Note: See Note 2 Section 5.6.

b) if it is in the timer recovery condition and it was an REJ response frame with the F bit set to 1:

- clear an existing peer receiver busy condition;

- set its V(S) and its 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 0, taking into account the items 1) to 3) below and the paragraph following items 1) to 3).

c) if it is in the timer recovery condition and it was an REJ frame other than an REJ response frame with the F bit set to 1:

- clear an existing peer receiver busy condition;
- set its V(A) to the value of the N(R) contained in the REJ frame control field; and
- if it was an REJ command frame with the P bit set to 1, transmit an appropriate supervisory response frame with the F bit set to 1 (see Note 2 in Section 0).

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 a SABME command, a DISC command, a UA, DM, or FRMR response when it receives the REJ frame, it shall ignore the request for retransmission; and
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 I frame.
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 transmitted. 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 this RNR response shall be used to update V(S).

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

Note 1 **-** The N(R) in any RR or RNR command frame (with the 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 N(R) contained in the received RNR frame as an acknowledgment for all the I frames that have been (re)transmitted with an N(S) up to and including N(R) - 1, and set its 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.

If timer T200 expires, 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 inquiry 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:

    – transmit an appropriate supervisory command (see Note 2) with a P bit set to 1;

    – restart timer T200; and

b) if the value of the retransmission count variable is equal to N200, initiate a re-establishment procedure as defined in Section 0, and indicate this by means of the MDL-ERROR-INDICATION primitive to the connection management entity.

The 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 (see Note 2) 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 Sections 0 or 0, respectively; or

– if the response is an RNR response, the data link layer entity receiving the response shall proceed according to this Section 0, 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 enquiry process, the data link layer entity shall:

– if the supervisory frame is an RR or REJ command frame or an RR or REJ response frame with the F bit set to 0, clear the peer receiver busy condition and if the supervisory frame received was a command with the P bit set to 1, transmit the appropriate supervisory response frame (see Note 2) with the F 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 frame or an RNR response frame with the F bit set to 0, retain the peer receiver busy condition and if the supervisory frame received was an RNR command with P bit set to 1, transmit the appropriate supervisory response frame (see Note 2) with the F bit set to 1. 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".

Upon receipt of an SABME command, the data link layer entity shall clear the peer receiver busy condition.

Note 2 -

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

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

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

Otherwise, the appropriate supervisory frame is the RR frame.

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:

– an RNR response with the F bit set to 0; or

– if this condition is entered on receiving a command frame with the P bit set to 1, an RNR response with the F bit set to 1; or

– if this condition is entered on 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 V(A).

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

All received I frames with the P bit set to 1 shall be discarded, after updating 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 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, an REJ frame with the N(R) set to the current value of 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 acknowledgment

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 2 in Section 0) 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 0 and indicate this by means of the MDL-ERROR-INDICATION primitive to the connection 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 V(A) to its current V(S) inclusive, it shall set its 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. Timer T200 shall be reset and restarted if the received supervisory response is an RNR response, to proceed with the enquiry process according to Section 0.

5.7 Re-establishment of multiple frame operation

5.7.1 Criteria for re-establishment

The criteria for re-establishing the multiple frame mode of operation are defined in this section by the following conditions:

– the receipt, while in the multiple-frame mode of operation, of an SABME;

– the receipt of a DL-ESTABLISH-REQUEST primitive from layer 3 (see Section 0);

– 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 occurrence of N200 retransmission failures while in the timer recovery condition (see Section 0);

– the occurrence of a frame rejection condition as identified in Section 0;

– the receipt, while in the multiple-frame mode of operation, of an FRMR response frame (see Section 0);

– the receipt, while in the multiple-frame mode of operation, of an unsolicited DM response with the F bit set to 0 (see Section 0);

– the receipt, while in the timer-recovery condition, of a DM response with the F bit set to 1.

5.7.2 Procedures

In all re-establishment situations, the data link layer entity shall follow the procedures defined in Section 0. All locally generated conditions for re-establishment will cause the transmission of the SABME.

In the case of data link layer, the data link layer entity shall:

– issue an MDL-ERROR-INDICATION primitive to the connection management entity; and discard all queues.

– After successful establishment, issue a DL-ESTABLISH-INDICATION primitive to layer 3, and discard all I queues.

In case of layer 3 initiated re-establishment, or if a DL-ESTABLISH-REQUEST primitive occurs pending re-establishment, the DL-ESTABLISH-CONFIRM primitive shall be used.

5.8 Exception condition reporting and recovery

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

The error recovery procedures which are available to effect recovery following the detection of an exception condition at the data link layer are defined in 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 V(R) at the receiver. The information field of all I frames whose N(S) does not equal the V(R) shall be discarded.

The receiver shall not acknowledge [nor increment its V(R)] 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 the N(R) field and the P or F bit to perform data link control functions; for example, to receive acknowledgment 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 value 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 condition 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 an 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 command 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)=N(R)=V(S).

The information field contained in an I frame which is correct in sequence and format may be delivered to layer 3 by means of the DL-DATA-INDICATION primitive.

The data link layer entity shall inform the connection management entity of this exception condition by means of the MDL-ERROR-INDICATION primitive, and initiate re-establishment according to Section 0.

5.8.3 Timer recovery condition

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

The data link layer entity which transmitted the unacknowledged I frame(s) shall, on the expiry of timer T200, take appropriate recovery action as defined in Section 0 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 0 and 0) 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 results from one of the conditions described in Section 0 or Section 0, items b, c and d.

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

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.

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 layer entity shall:

– issue an MDL-ERROR-INDICATION primitive; and

– initiate re-establishment (see Section 0).

5.8.7 Unsolicited response frames

The action to be taken on the receipt of an unsolicited response frame is defined in Table II - 8.

The data link layer entity shall assume possible multiple TEI assignment on the receipt of an unsolicited UA response and shall inform the layer management.

Unsolicited response frame	TEI Assigned	Awaiting Establishment	Awaiting Release	Multiple frame modes of operation	
				Established mode	Timer recovery condition
UA response, F=1	MDL-ERROR-INDICATION	Solicited	Solicited	MDL-ERROR-INDICATION	MDL-ERROR-INDICATION
UA response, F=0	MDL-ERROR-INDICATION	MDL-ERROR-INDICATION	MDL-ERROR-INDICATION	MDL-ERROR-INDICATION	MDL-ERROR-INDICATION
DM response, F=1	*Ignore or MDL-ERROR-INDICATION	Solicited	Solicited	Re-establish and/or MDL-ERROR-INDICATION	*Re-establish and MDL-ERROR-INDICATION or Solicited
DM response, F=0	Ignore	Ignore	Ignore	Re-establish MDL-ERROR-INDICATION	Re-establish MDL-ERROR-INDICATION
Supervisory response, F=1	Ignore	Ignore	Ignore	MDL-ERROR-INDICATION	Solicited
Supervisory response, F=0	Ignore	Ignore	Ignore	Solicited	Solicited

* Implementation Option

Table II - 8. Actions taken on receipt of unsolicited response frames

5.8.8 Multiple assignment of a TEI value

Reserved for future use.

5.9 List of system parameters

The system parameters listed below are associated with each individual SAP.

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

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 Section 0 shall be one second.

Note - The proper operation of the procedure requires that timer T200 be greater than the maximum time between transmission of command frames and the reception of their corresponding response or acknowledgment frames.

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 information field (N201)

The maximum number of octets in an information field (N201) is a system parameter (See also Section 0.). The default value shall be 260 octets.

5.9.4 Maximum number of transmissions of the TEI Identity request message (N202)

Reserved for future use.

5.9.5 Maximum number of outstanding I frames (k)

The maximum number (*k*) of sequentially numbered I frames that may be outstanding (that is, unacknowledged) at any given time is a system parameter which shall not exceed 127, for extended (modulo 128) operation.

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.

5.9.7 Timer T202

Reserved for future use.

5.9.8 Timer T203

Timer T203 represents the maximum time allowed without frames being exchanged. The value of timer T203 shall be in the range 10 - 60 seconds, with a default value of 15 seconds.

5.10 Data link layer monitor function

5.10.1 General

The procedural elements defined in Section 0 allow for the supervision of the data link layer resource. This section describes procedures which may be used to provide this supervision function.

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

The procedures specified herein propose a solution which is already identified in the HDLC classes of procedures. The 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 become more efficient than a procedure based on the involvement of layer 3.

The procedure is based on supervisory command frames (RR command, RNR command) and 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, nor supervisory frames with a P bit set to 1), there is no means to detect a faulty data link connection condition or a user equipment having 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 procedure is protected against transmission errors by making use of the normal timer T200 procedure including retransmission count and N200 attempts.

5.10.3 Connection verification procedures

5.10.3.1 Start timer T203

The timer T203 is started:

– when the *multiple-frame-established* state is entered; and

– in the *multiple-frame-established* state whenever timer T200 is stopped. (See note in Section 0)

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

5.10.3.2 Stop timer T203

The timer T203 is stopped

– when, in the *multiple-frame-established* state, the timer T200 is started (see Note); and

– upon leaving the *multiple-frame-established* state.

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

5.10.3.3 Expiry of timer T203

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):

a) set the retransmission count variable to 0;

b) enter *timer recovery* state;

c) 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

d) start timer T200; and

e) send MDL-ERROR-INDICATION primitive to connection management after N200 retransmissions, and a DL-RELEASE-INDICATION to the layer 3 entity;

f) retransmit the supervisory command (p bit = 1) up to N200 times.

5.11 D-Channel backup procedure

This procedure along with the DL_DM_RLS primitive is only required for D-Channel backup for non-associated signaling. Layer 3 will issue a DL_DM_RLS primitive to layer 2 when it enters either the Maintenance Busy or Manual Out-of-Service state. This primitive performs the same function as a DL_RELEASE_REQUEST, and sets a flag called M_BUSY (Maintenance Busy). When the M_BUSY flag is set, a layer 2 entity in the TEI_ASSIGNED state will respond to SABME commands with DM responses. After receiving a DL_DM_RLS primitive, layer 2 will send a DISC and then eventually go to the TEI_ASSIGNED state after receiving a UA, or after N200 retries of the DISC. Once in the TEI_ASSIGNED state the M_BUSY flag will prevent the link from entering the MULTI_FRAME_ESTABLISHED state when SABMEs are received. When a DL_ESTABLISH_REQUEST is received from layer 3 the M_BUSY flag is cleared, a SABME command is sent, and layer 2 enters the AWAIT_ESTABLISH state waiting for a UA.

APPENDIX II - A

AN SDL REPRESENTATION OF THE POINT TO POINT PROCEDURES

OF THE DATA LINK LAYER

1. INTRODUCTION TO APPENDIX II-A

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.

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
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).

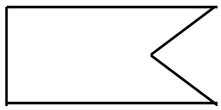
1.2 Cover Notes

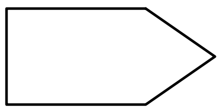
The following symbols are used within this description. A full description of their meaning and application can be found in the ITU-T Z series Recommendations.

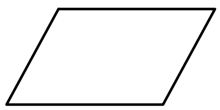
ABBREVIATIONS AND ACRONYMS USED IN RECOMMENDATION

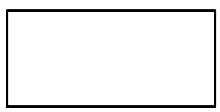
Abbreviation	Meaning
ASP	Assignment source point
Ai	Action indicator
C/R	Command/response field bit
CEI	Connection endpoint identifier
CES	Connection endpoint suffix
DISC	Disconnect
DL	Communication between layer 3 and data link layer
DLCI	Data link connection identifier
DM	Disconnected mode
EA	Extended address field bit
ET	Exchange termination
FCS	Frame check sequence
FRMR	Frame reject
I	Information
ID	Identity
ISDN	Integrated Services Digital Network
L1	Layer 1
L2	Layer 2
L3	Layer 3
LAPB	Link access procedure - Balanced
LAPD	Link access procedure on the D Channel
M	Modifier function bit
MDL	Communication between management entity and data link layer
MPH	Communication between system management and physical layer
N(R)	Receive sequence variable
N(S)	Send sequence variable
P/F	Poll/Final bit
PH	Communication between data link layer and physical layer
RC	Retransmission counter
REC	Receiver
REJ	Reject
RNR	Receive not ready
RR	Receive ready
Ri	Reference number
S	Supervisory
S	Supervisory function bit
SABME	Set asynchronous balanced mode extended
SAP	Service access point
SAPI	Service access point identifier
TE	Terminal equipment
TEI	Terminal endpoint identifier
TX	Transmit
U	Unnumbered
UA	Unnumbered acknowledgement
UI	Unnumbered information
V(A)	Acknowledge state variable
V(M)	Recovery state variable
V(R)	Receive state variable
V(S)	Send state variable
XID	Exchange identification

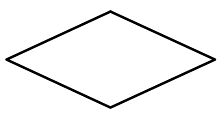
1.  State

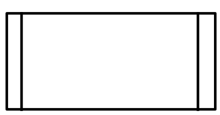
2.  Event occurrence.

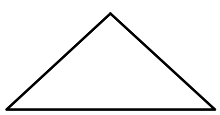
3.  Signal generation (which will lead to an associated event occurrence).

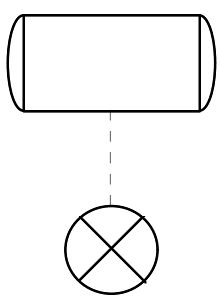
4.  Save an event (until completion of a transition).

5.  Process description.

6.  Test

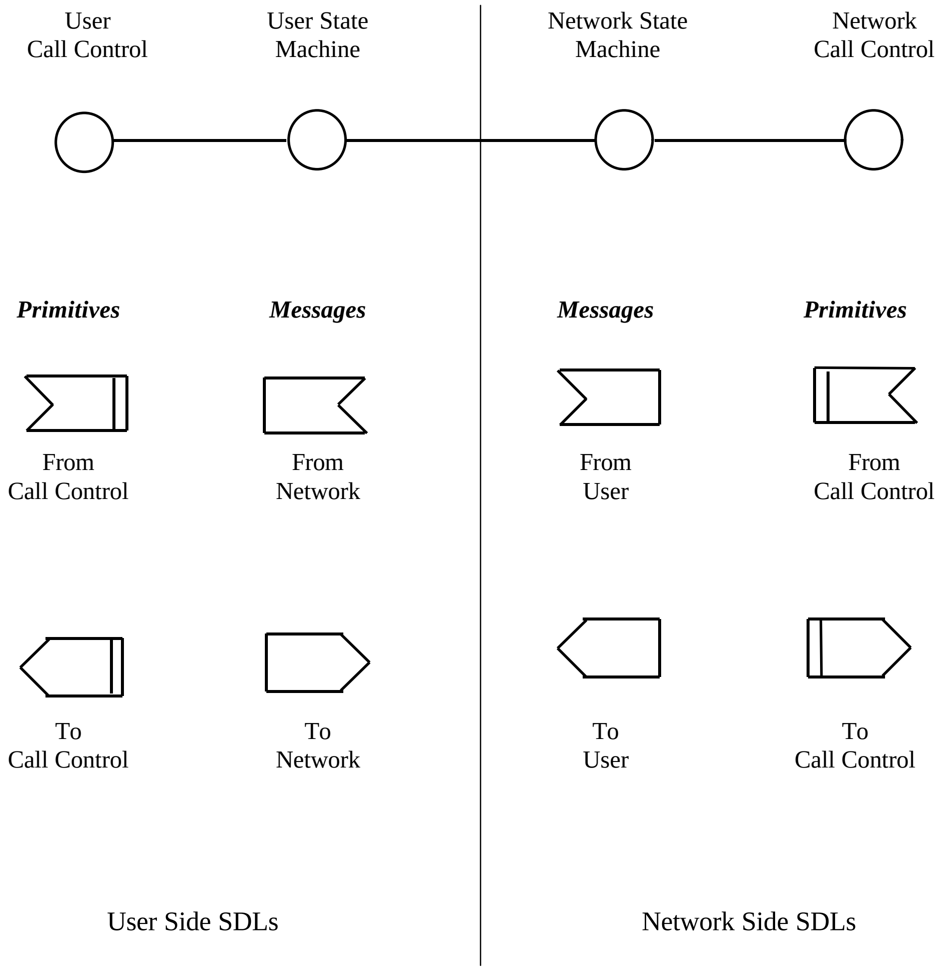
7.  Procedure call

8.  Implementation option

9.  Procedure definition

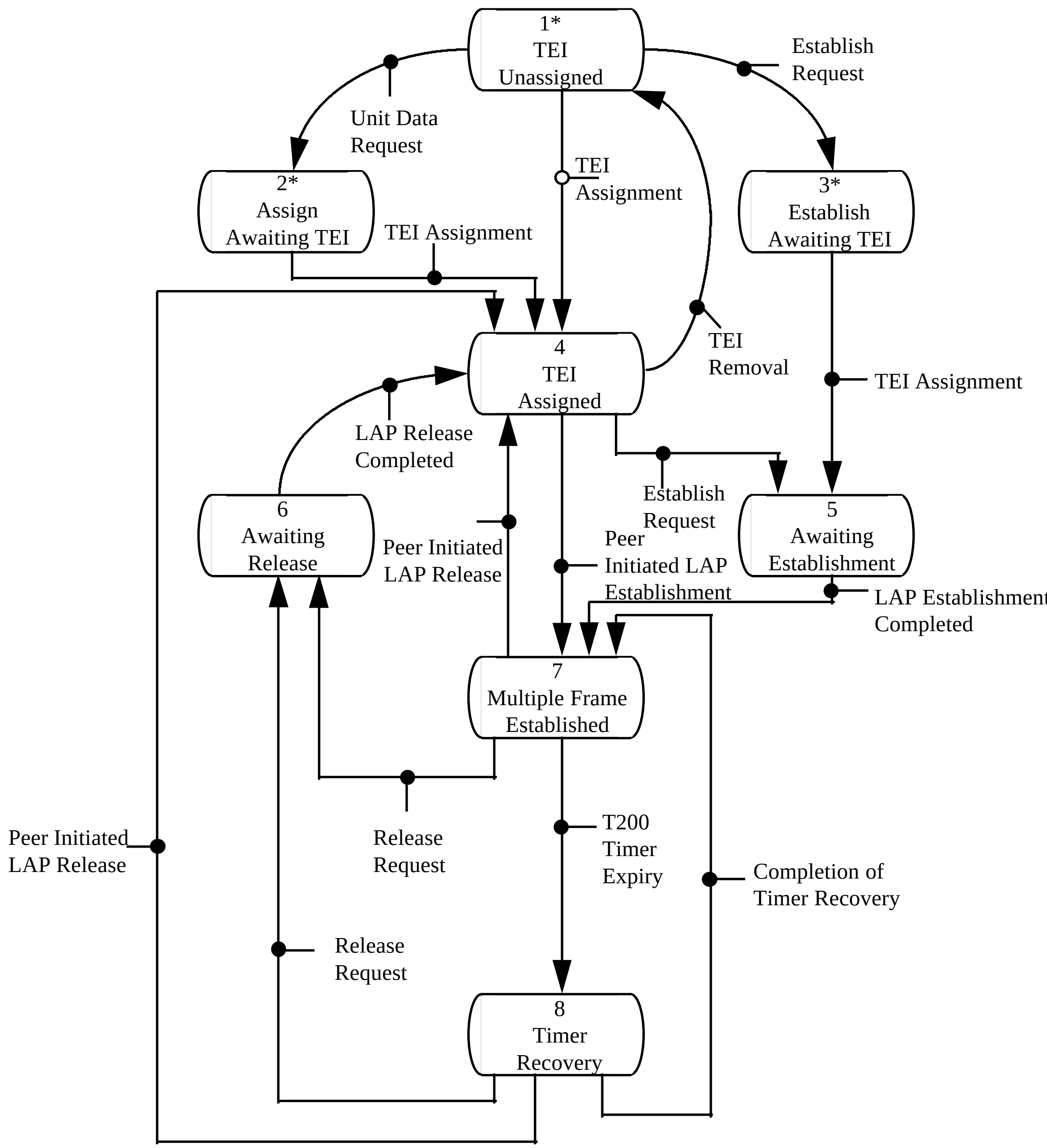
10. * To mark an event or signal required as a result of the representation approach adopted which is local tot he data link layer entity.

Symbols Used Within This Description (Part 1 of 2)



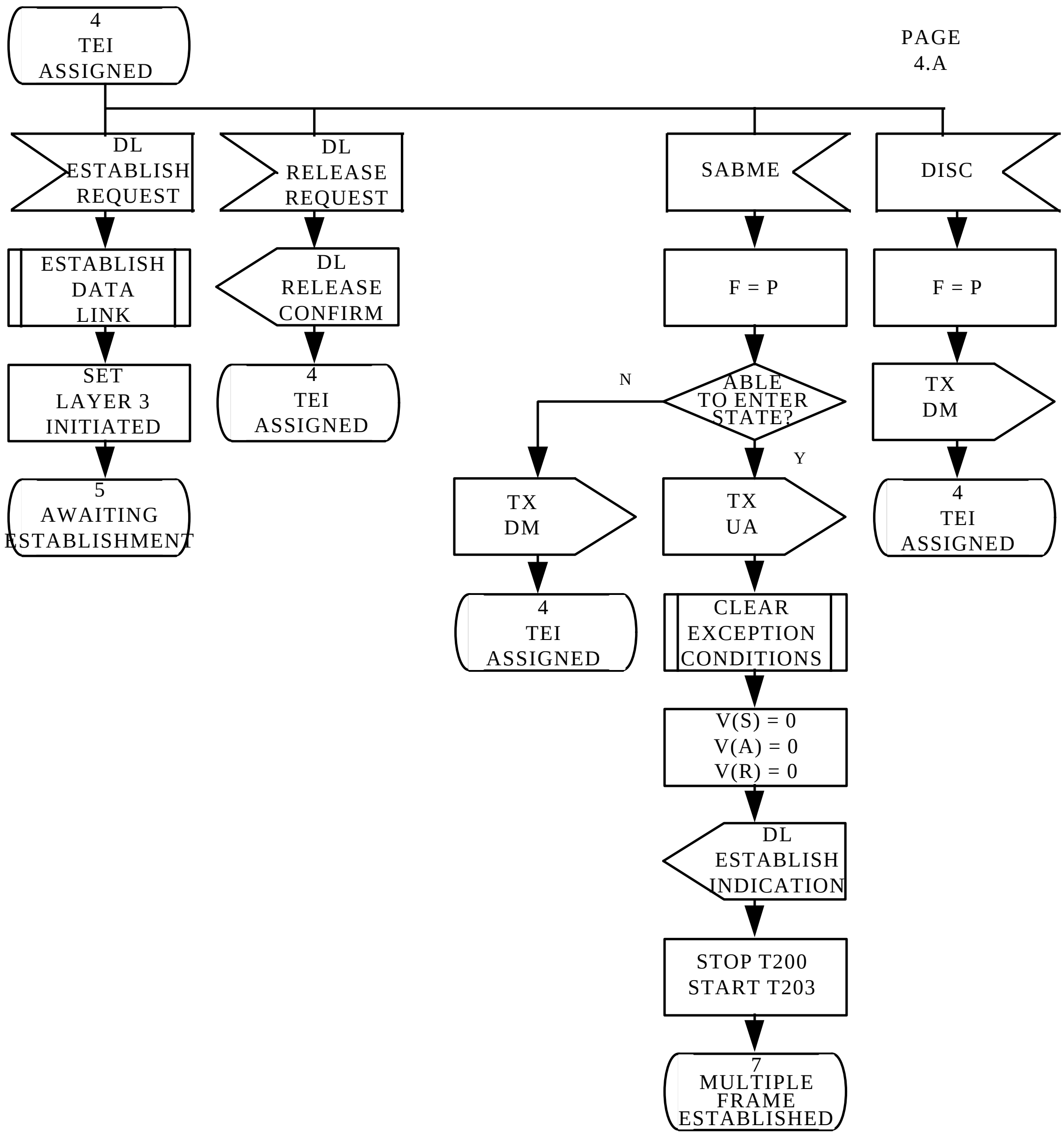
Symbols Used Within This Description (Part 2 of 2)

LINK LAYER



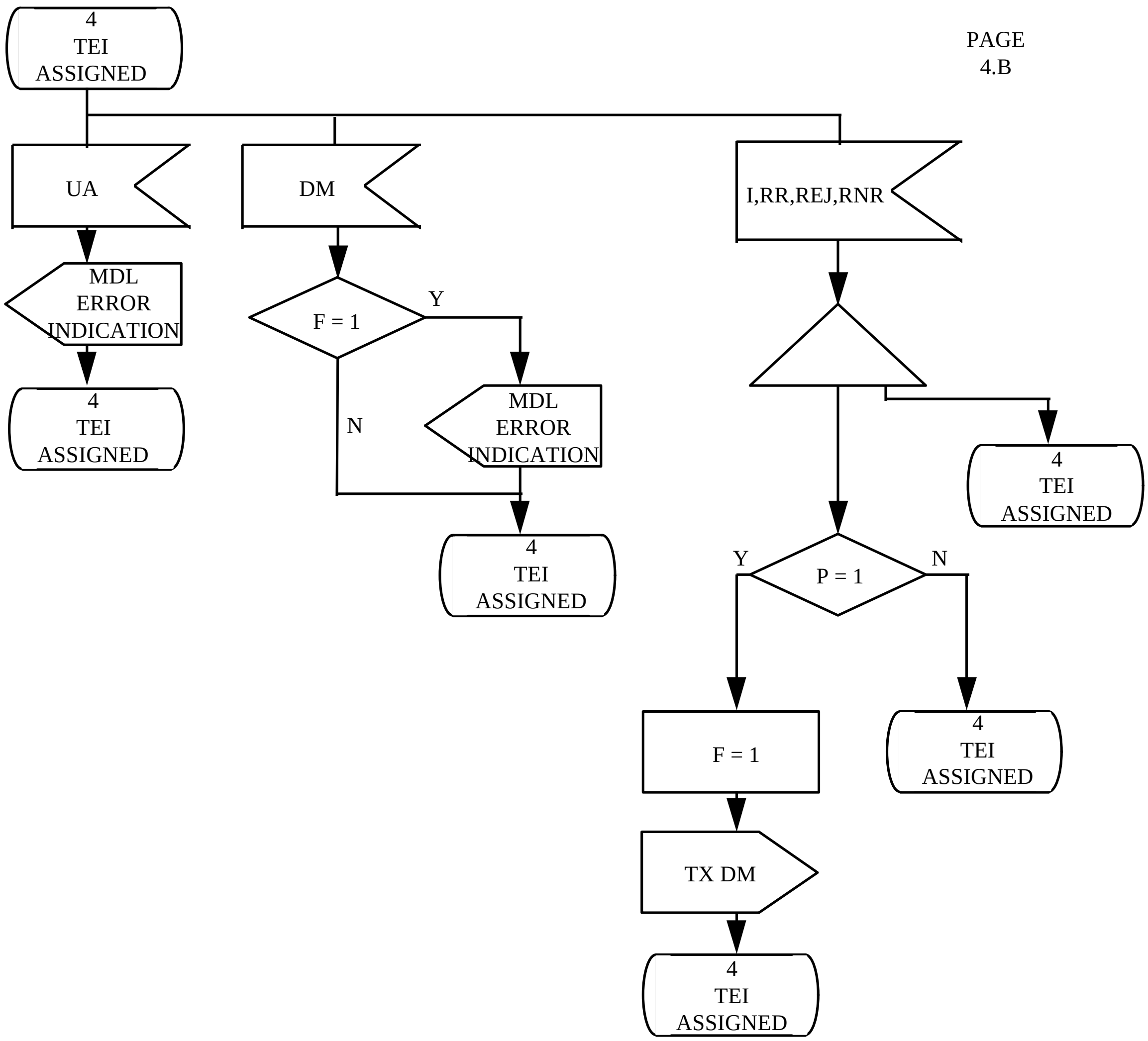
*States 1,2, and 3 are not relevant to the primary interface.

LINK LAYER



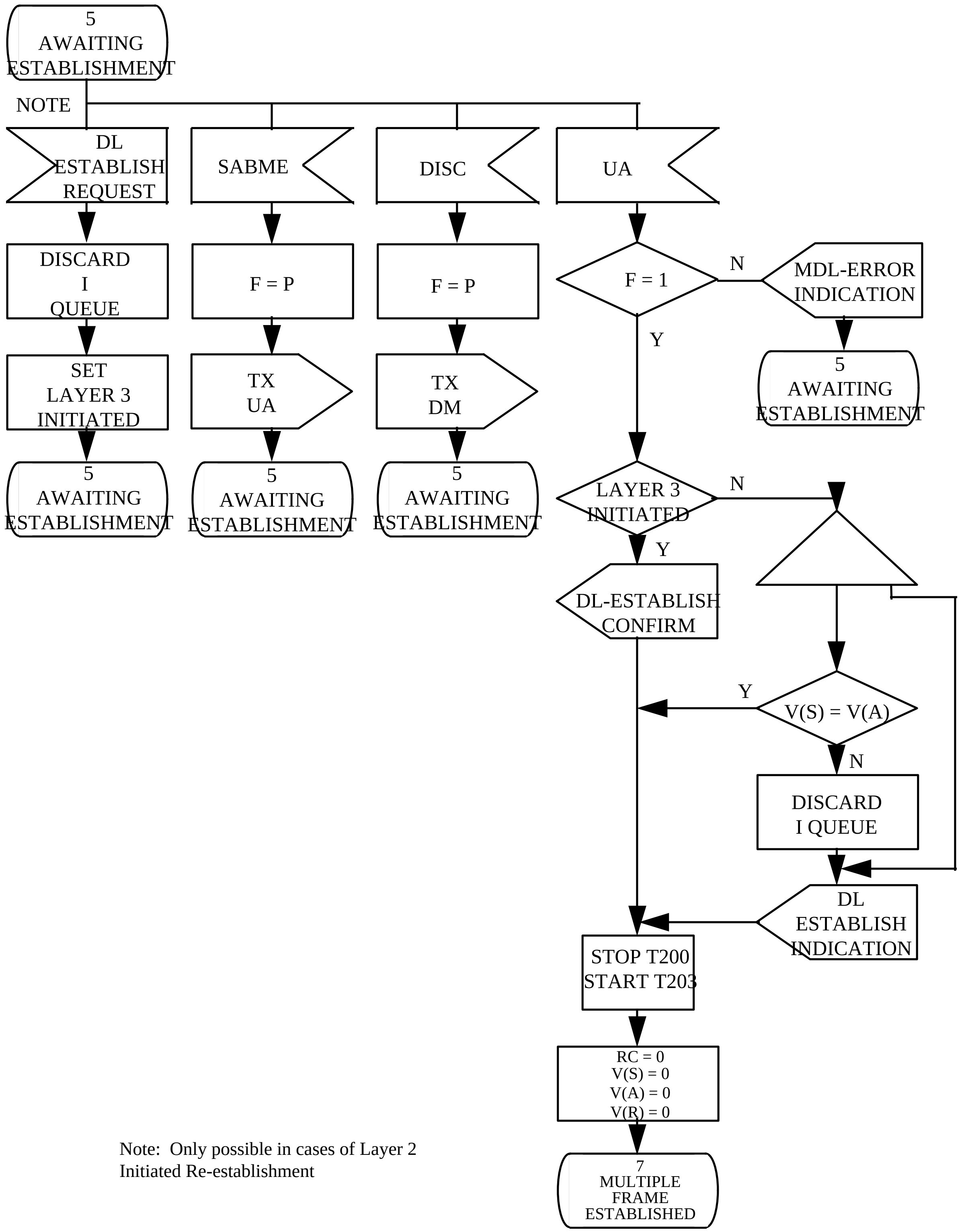
AN SDL REPRESENTATION OF THE POINT TO POINT PROCEDURES OF THE DATA LINK LAYER

LINK LAYER



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

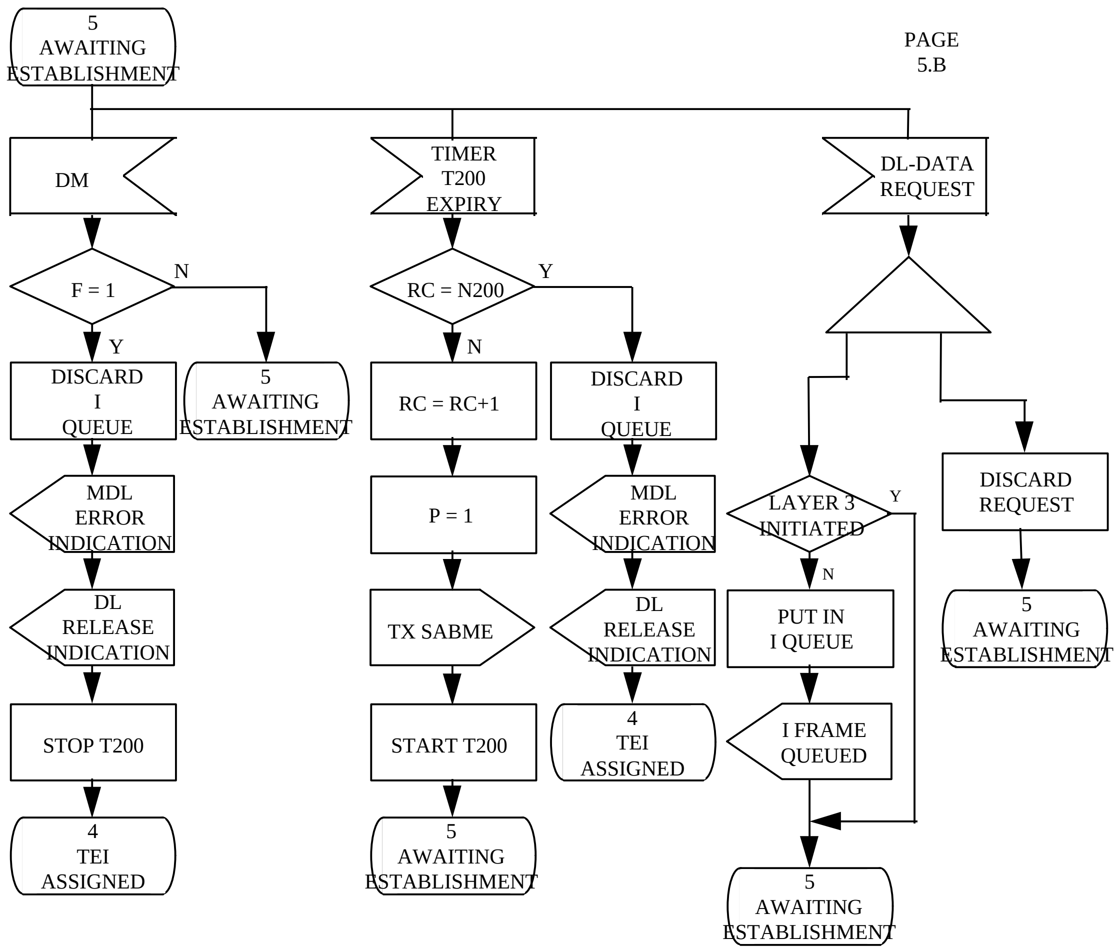
Page 5.A



Note: Only possible in cases of Layer 2
Initiated Re-establishment

An SDL Representation of the Point-to-Point Procedures of the Data Link Layer

LINK LAYER



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

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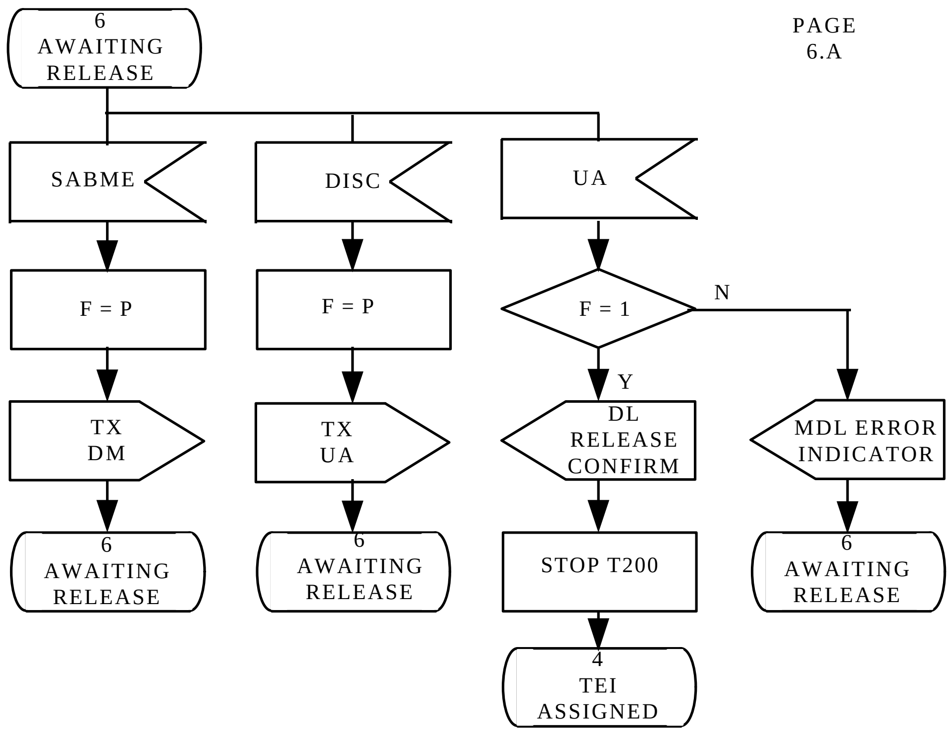
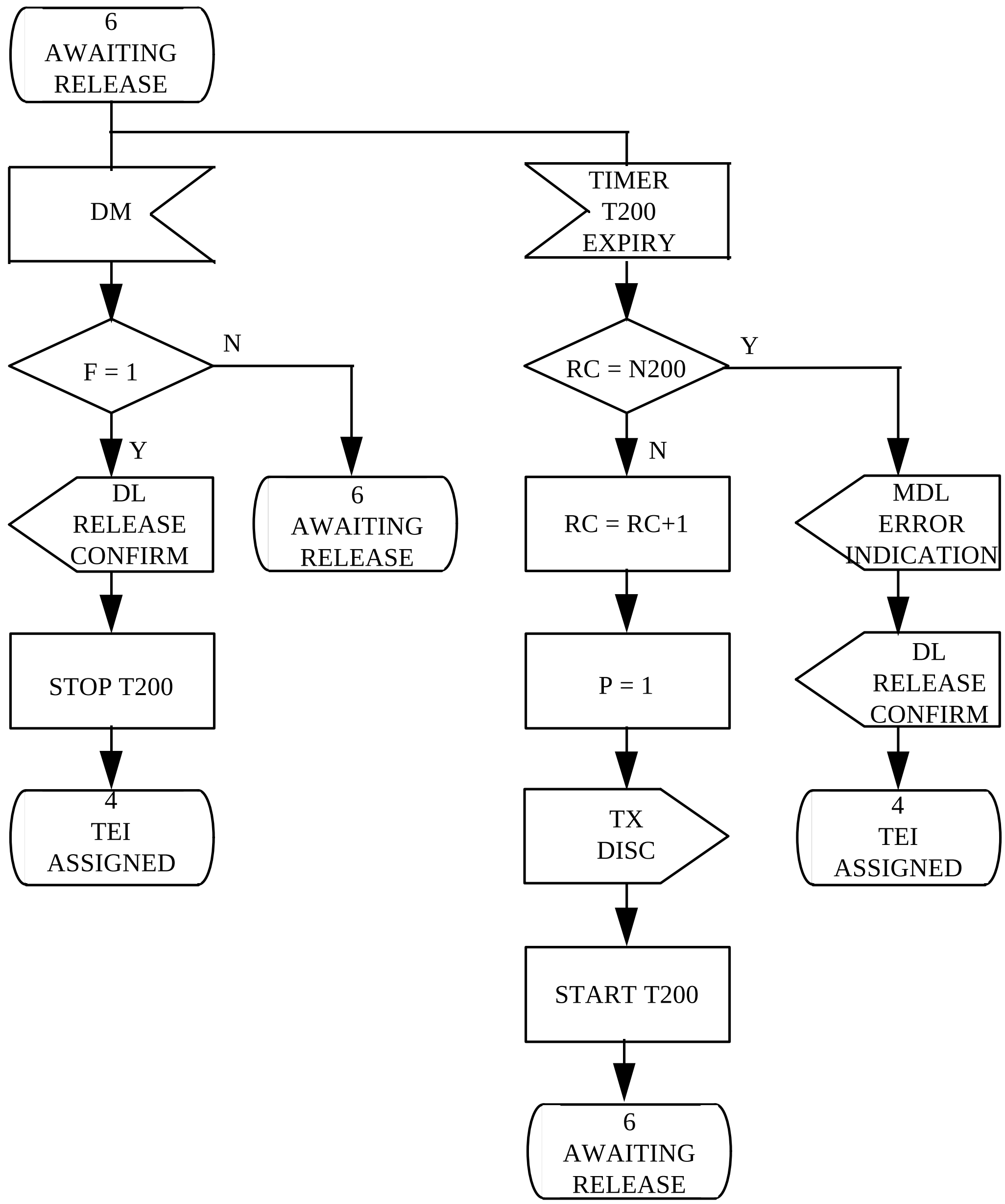


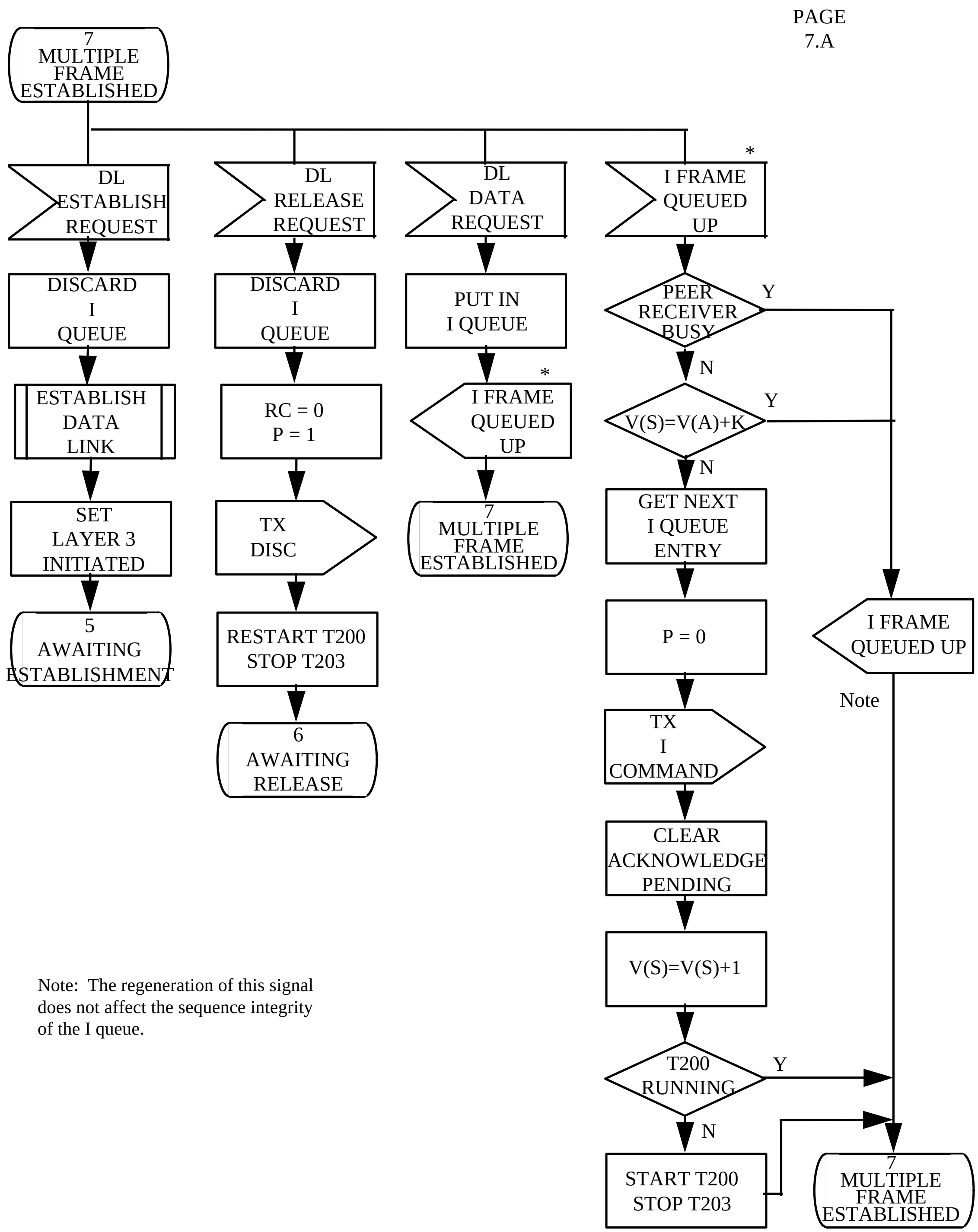
AN SDL REPRESENTATION OF THE POINT TO POINT PROCEDURES OF THE DATA LINK LAYER

Page 6.B



An SDL Representation of the Point-to-Point Procedures of the Data Link Layer

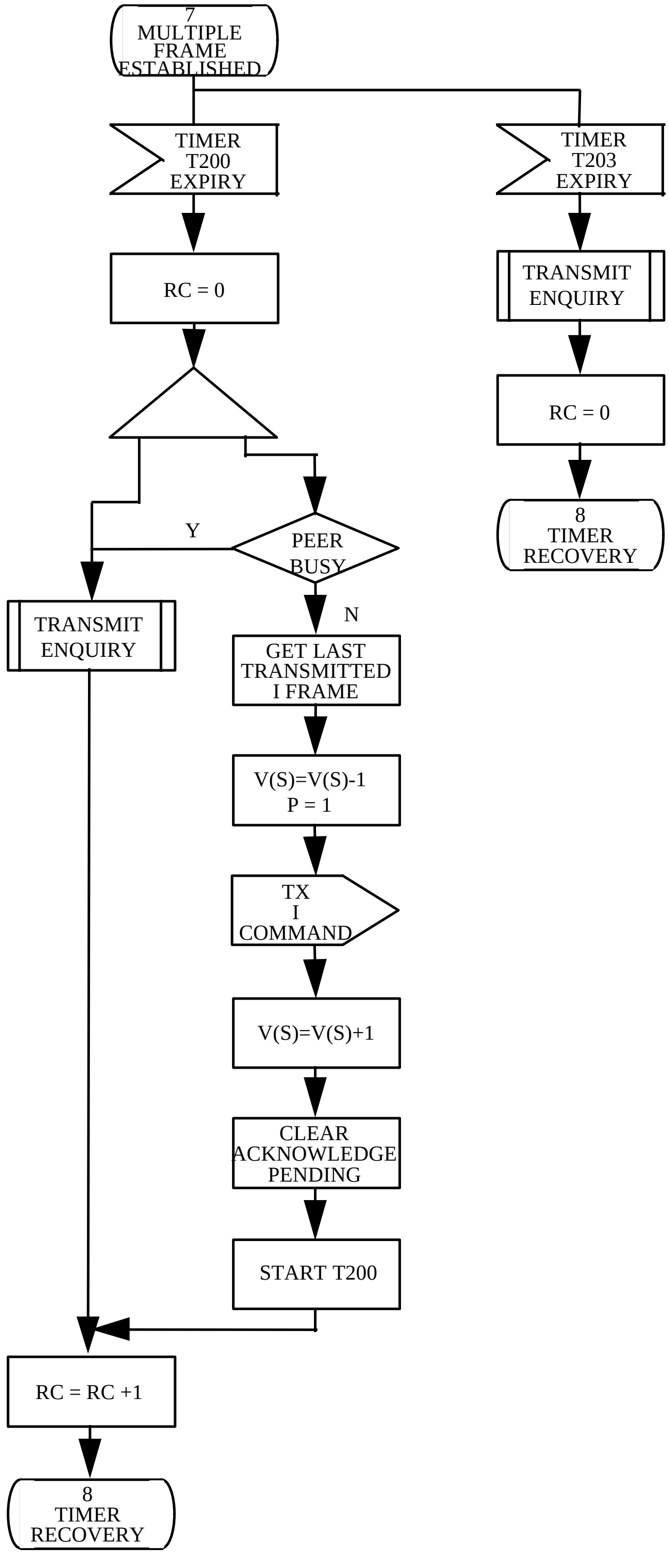
LINK LAYER



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

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

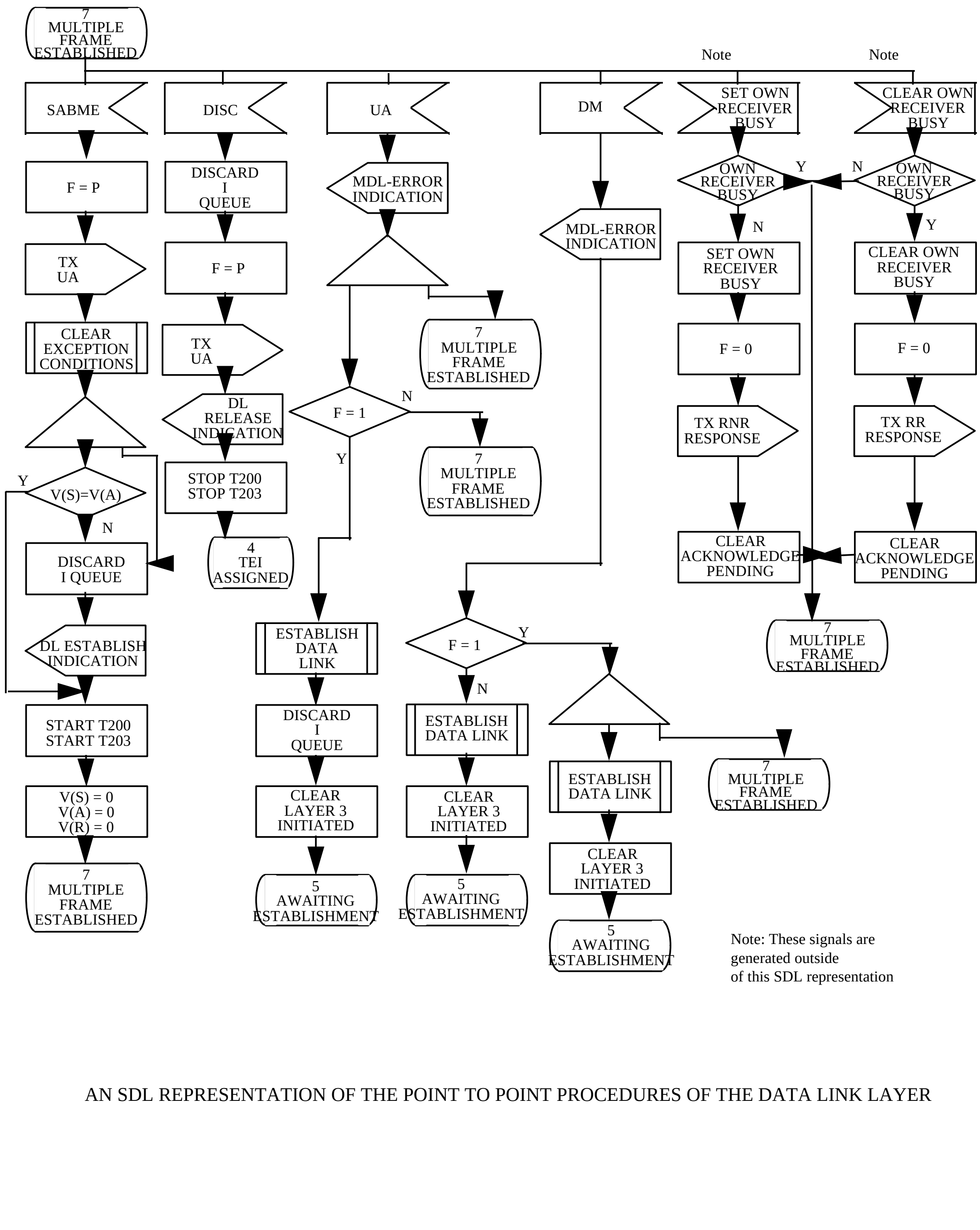
Page 7.B



An SDL Representation of the Point-to-Point Procedures of the Data Link Layer

LINK LAYER

PAGE
7.C



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

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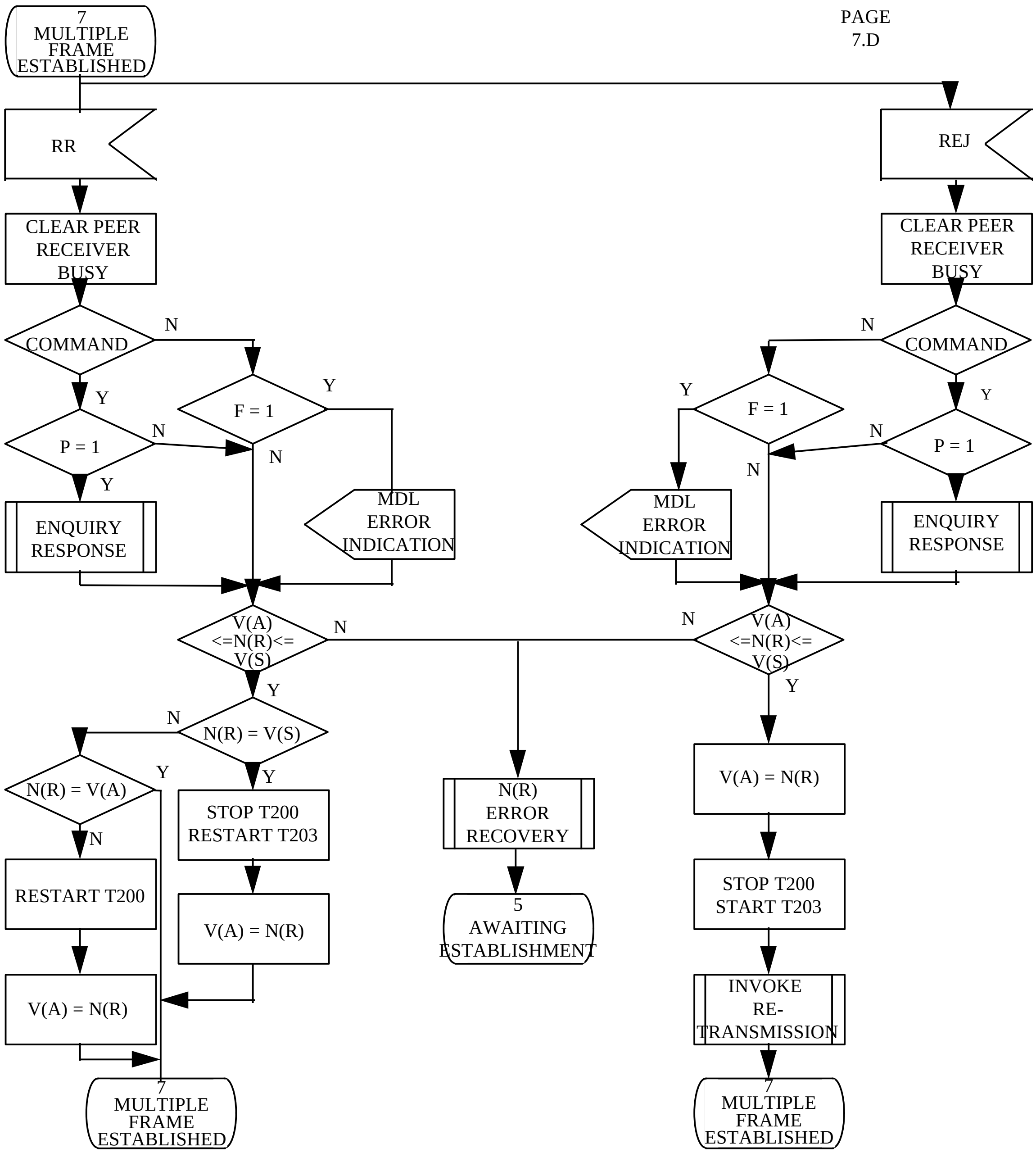

AN SDL REPRESENTATION OF THE POINT TO POINT PROCEDURES OF THE DATA LINK LAYER

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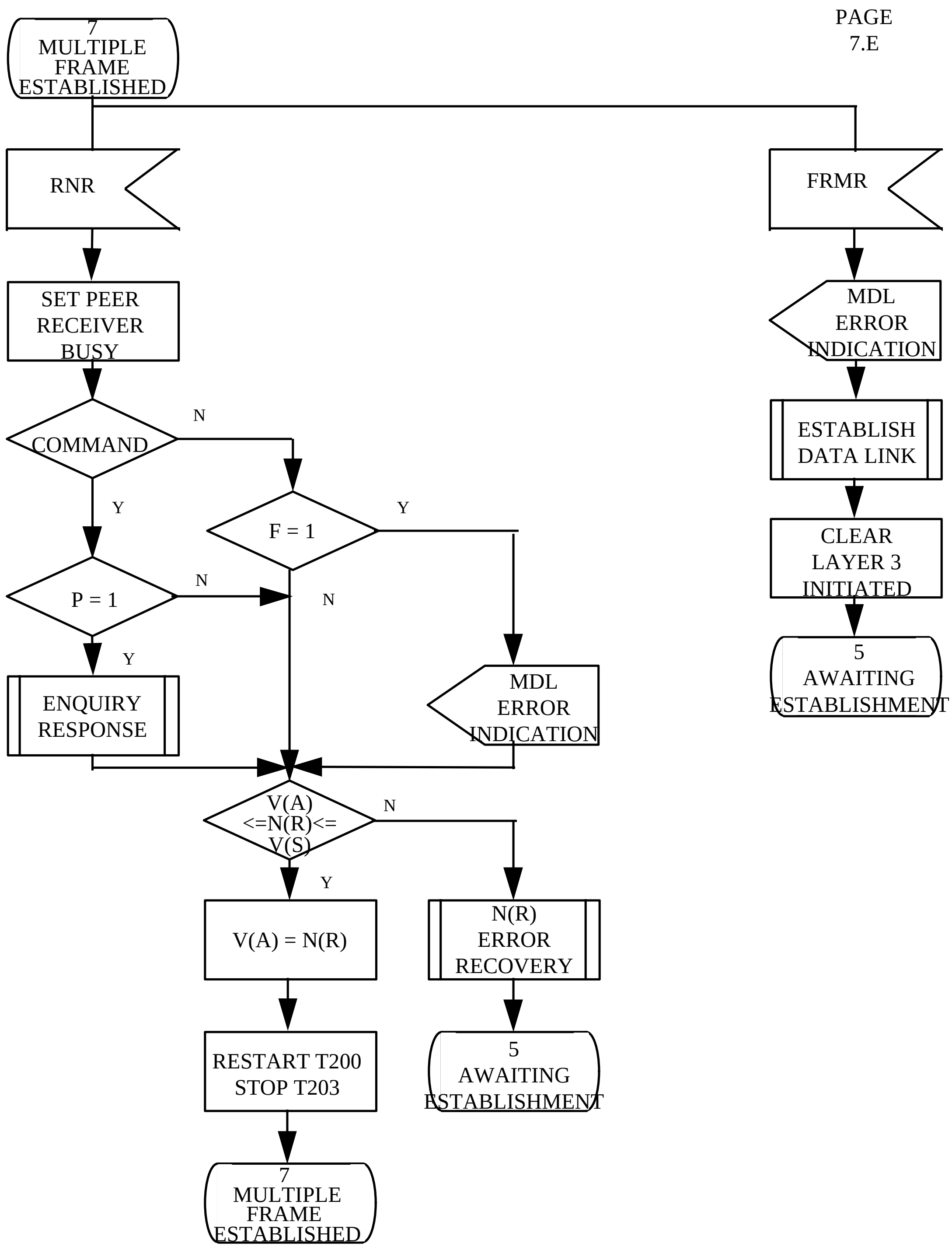

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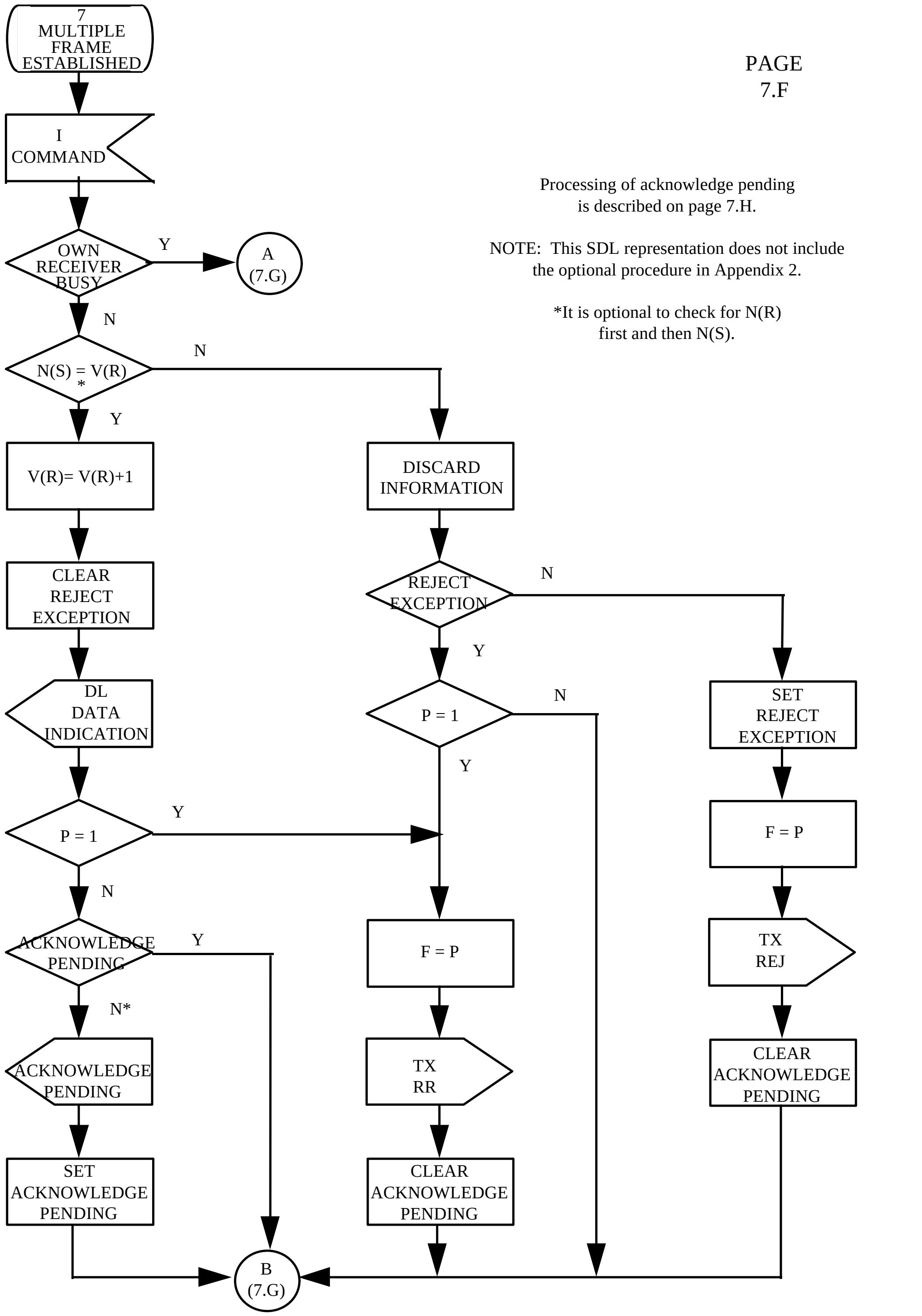

AN SDL REPRESENTATION OF THE POINT TO POINT PROCEDURES OF THE DATA LINK LAYER

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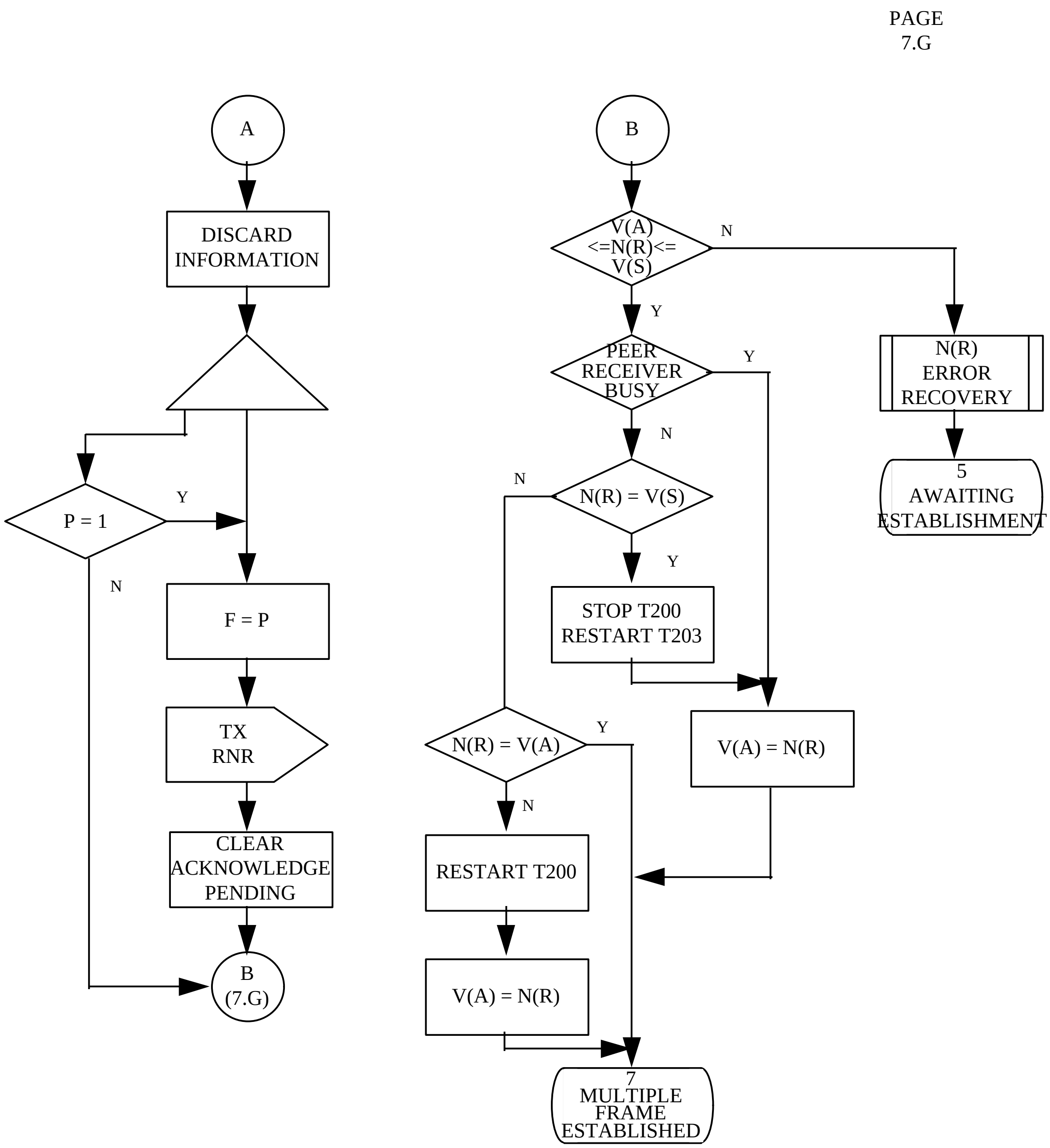
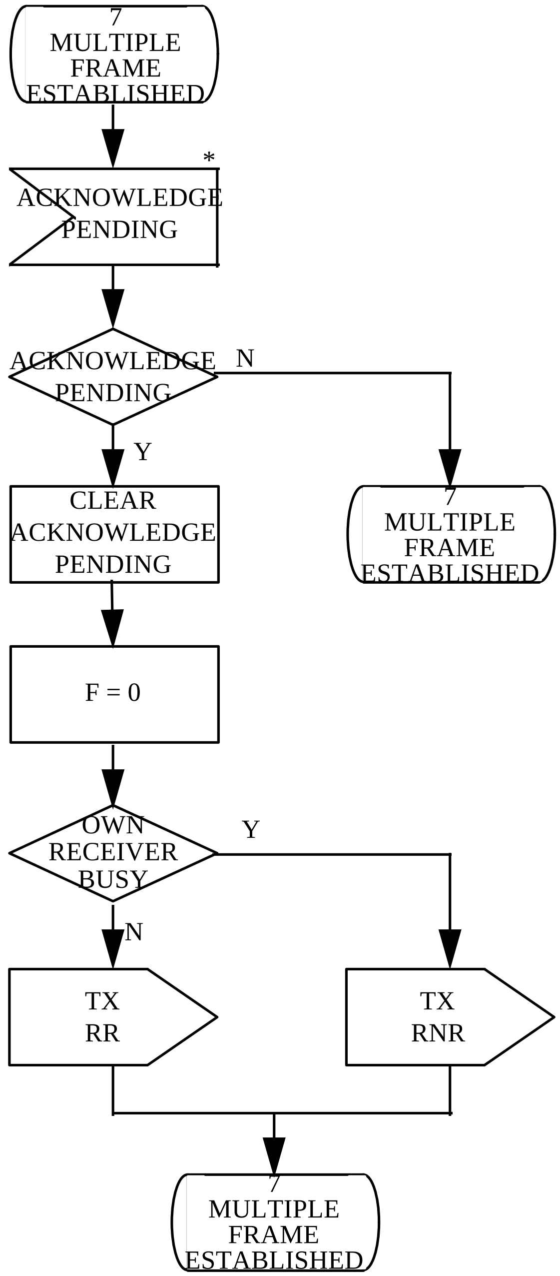


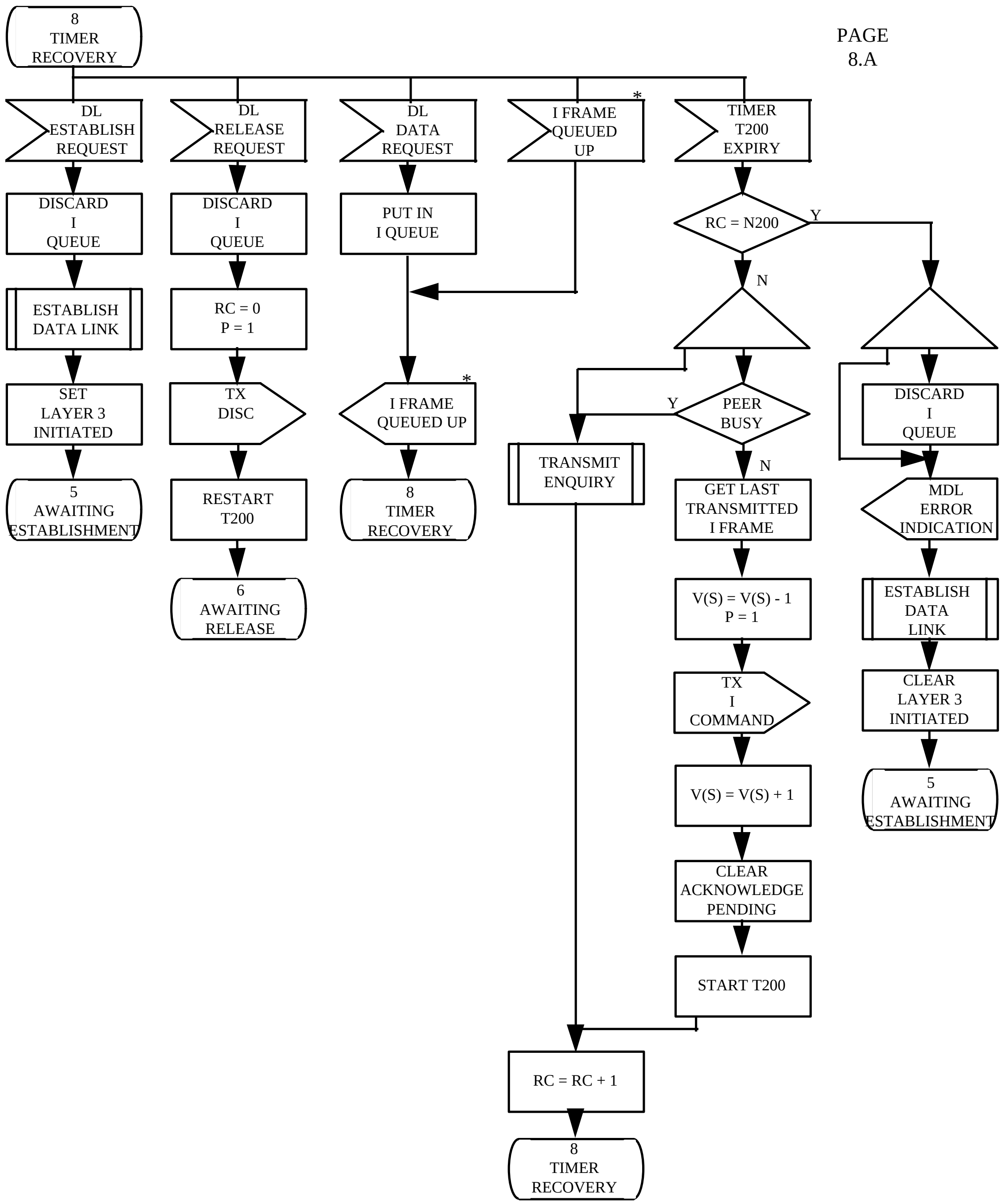
AN SDL REPRESENTATION OF THE POINT TO POINT PROCEDURES OF THE DATA LINK LAYER

Page 7.H



An SDL Representation of the Point-to-Point Procedures of the Data Link Layer

LINK LAYER



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

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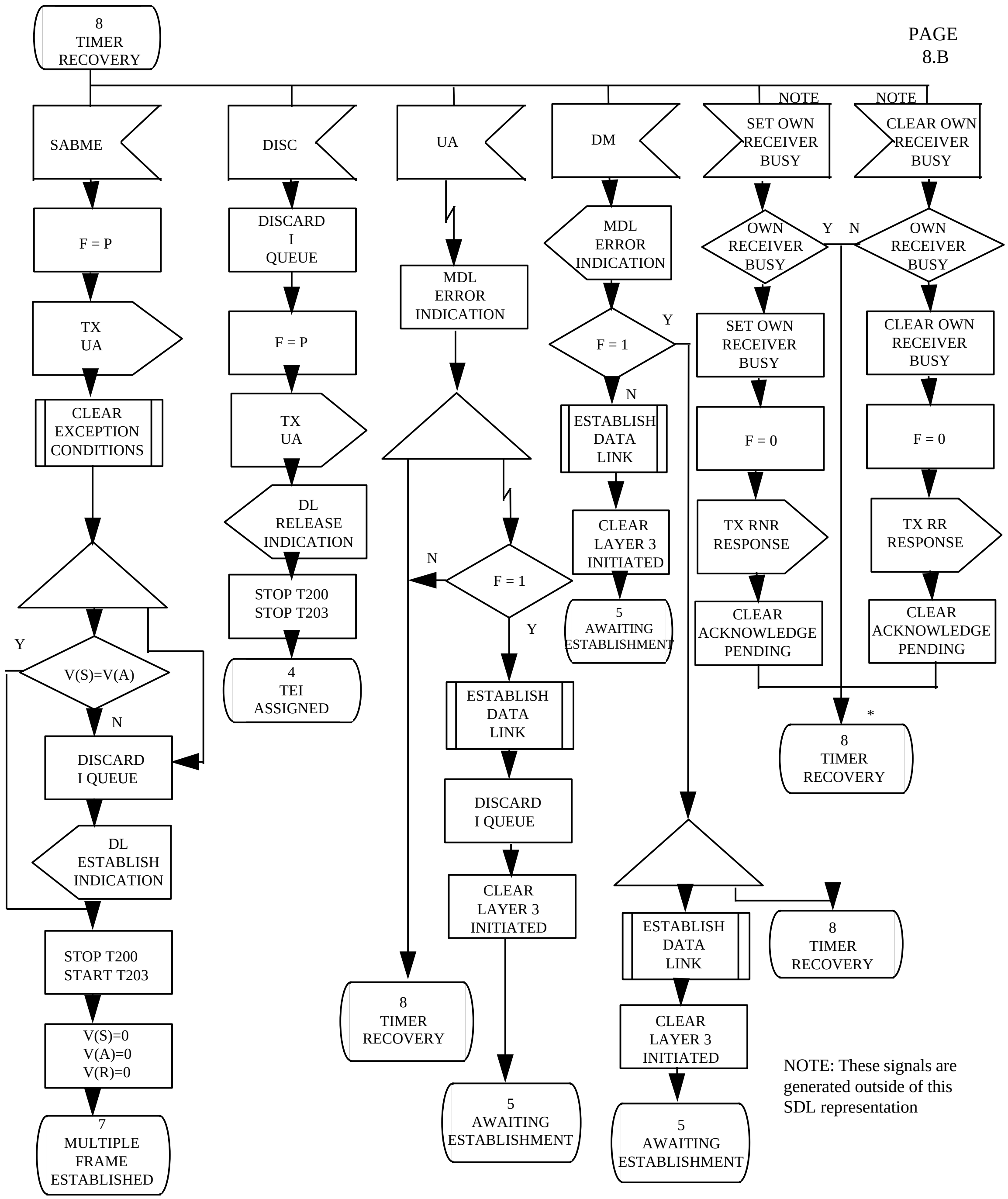

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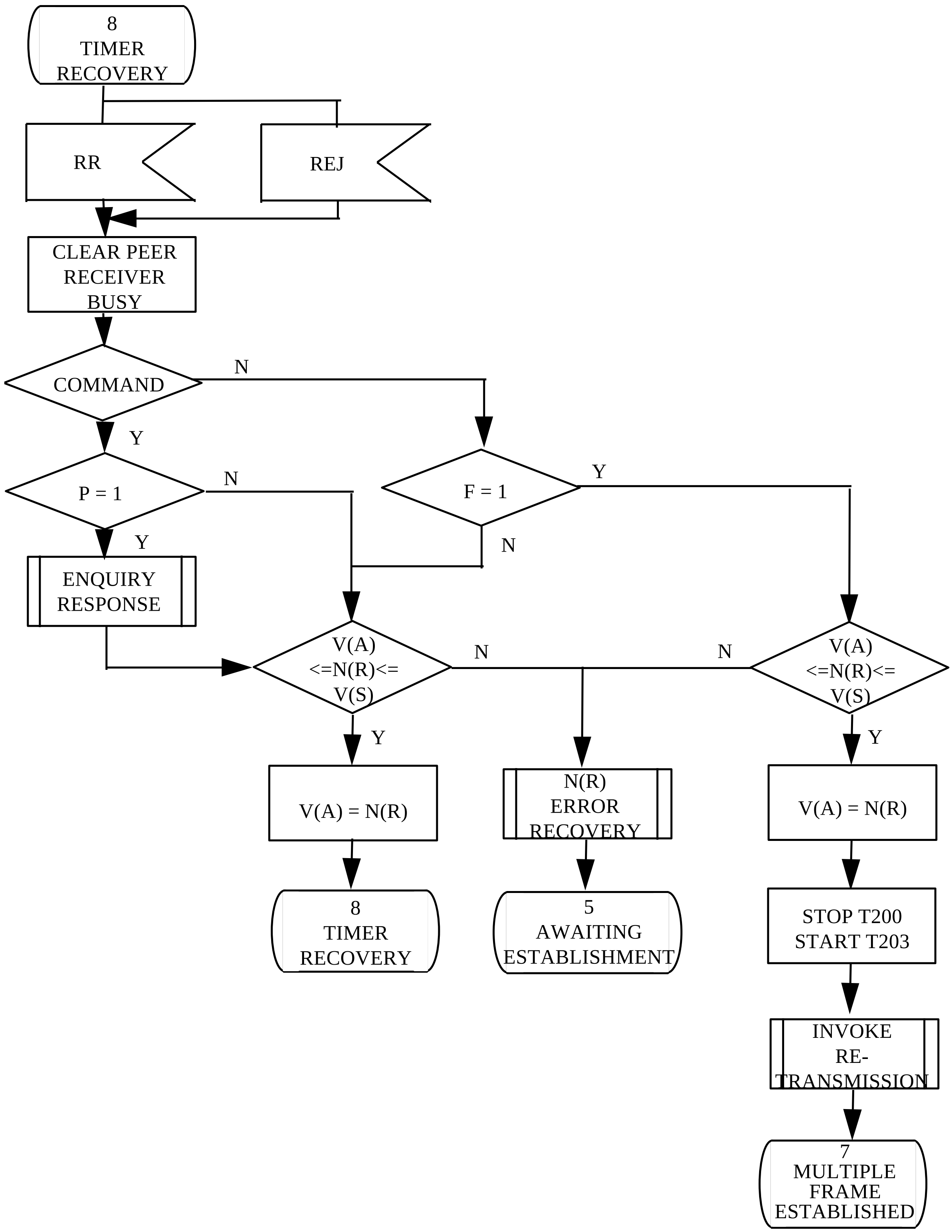
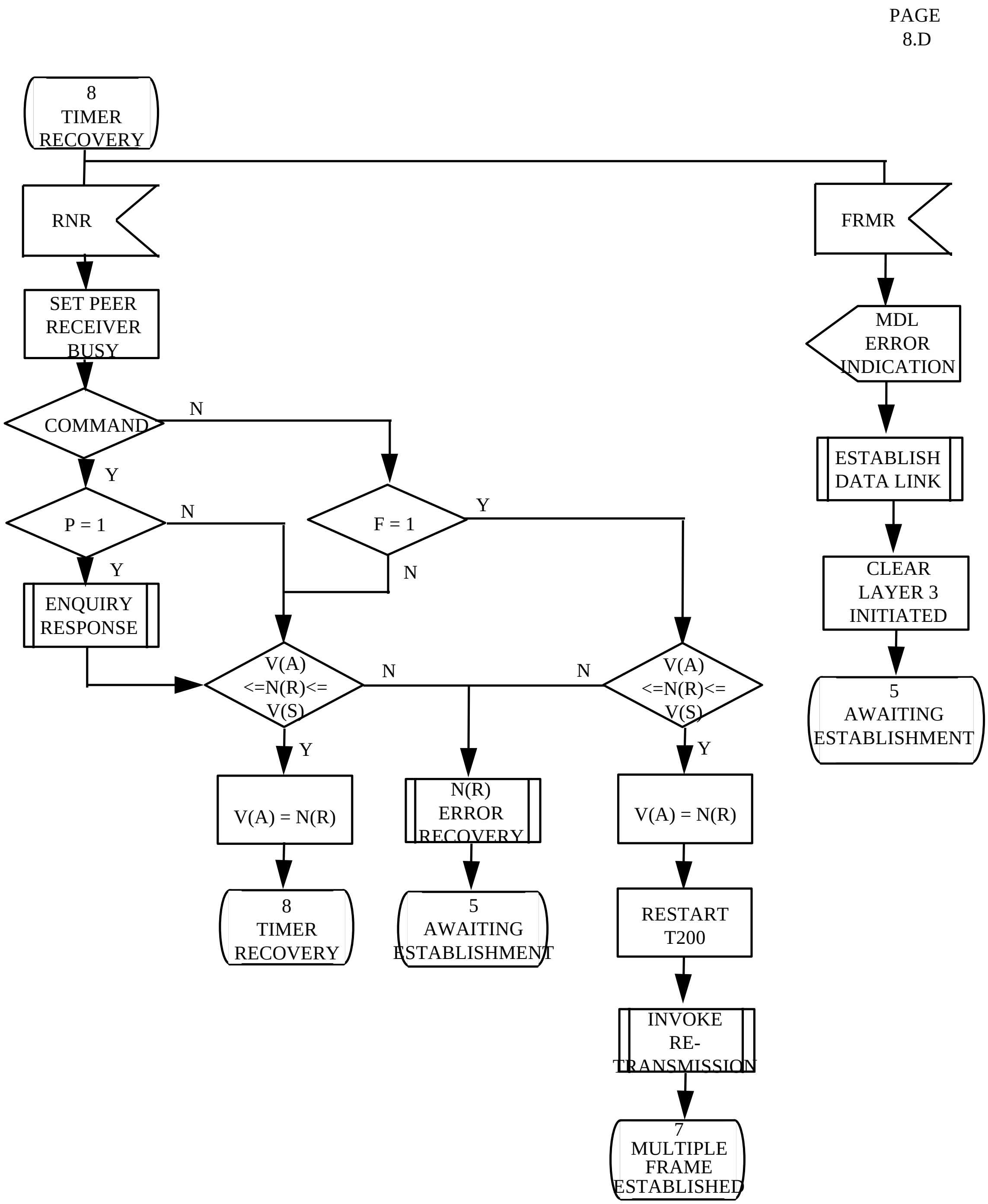

8
TIMER
RECOVERY
RR
REJ
CLEAR PEER
RECEIVER
BUSY
COMMAND
N
Y
P = 1
N
Y
F = 1
Y
N
ENQUIRY
RESPONSE
V(A)
<=N(R)<=
V(S)
N
N
V(A)
<=N(R)<=
V(S)
Y
Y
V(A) = N(R)
N(R)
ERROR
RECOVERY
V(A) = N(R)
8
TIMER
RECOVERY
5
AWAITING
ESTABLISHMENT
STOP T200
START T203
INVOKE
RE-
TRANSMISSION
7
MULTIPLE
FRAME
ESTABLISHED

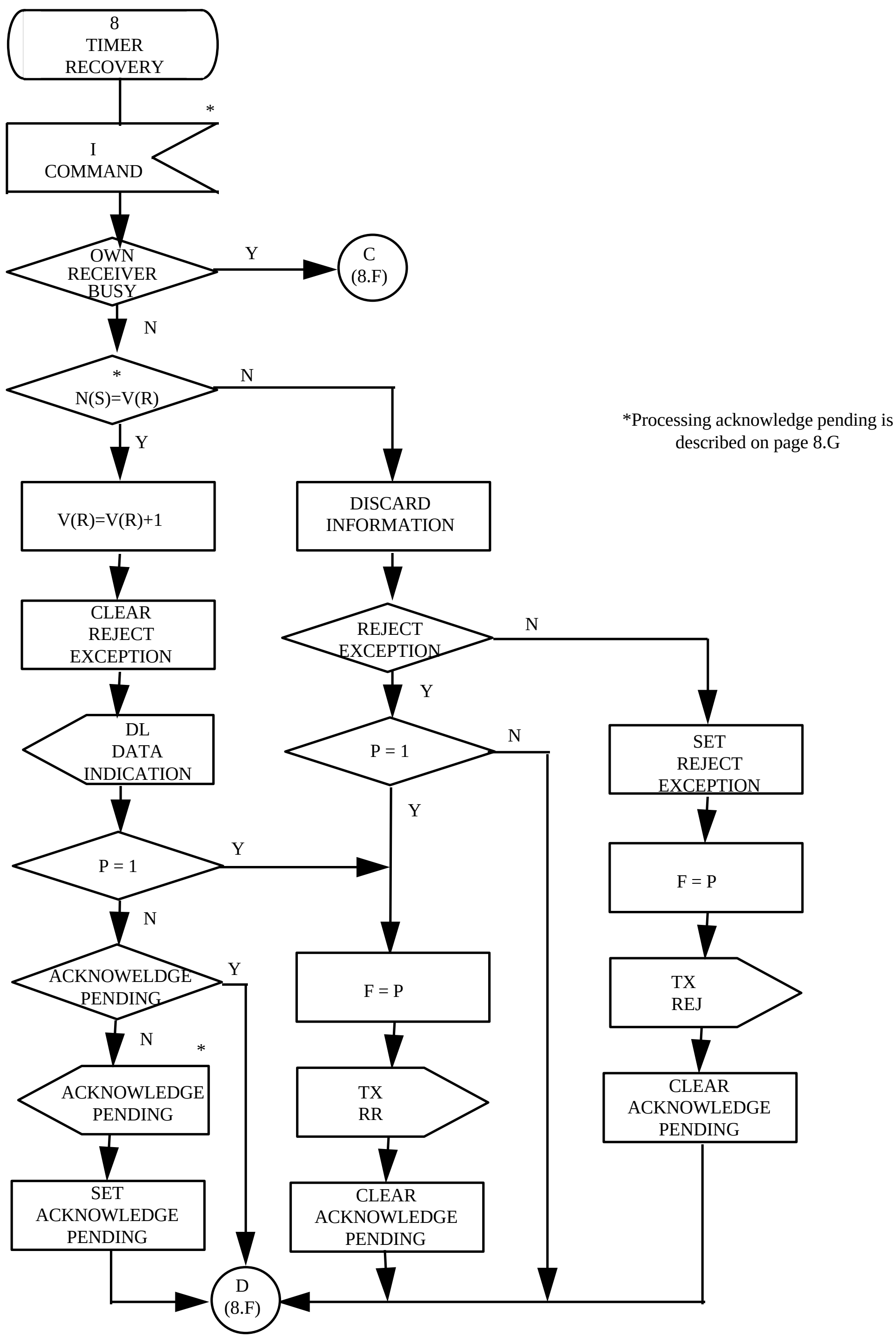
LINK LAYER



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

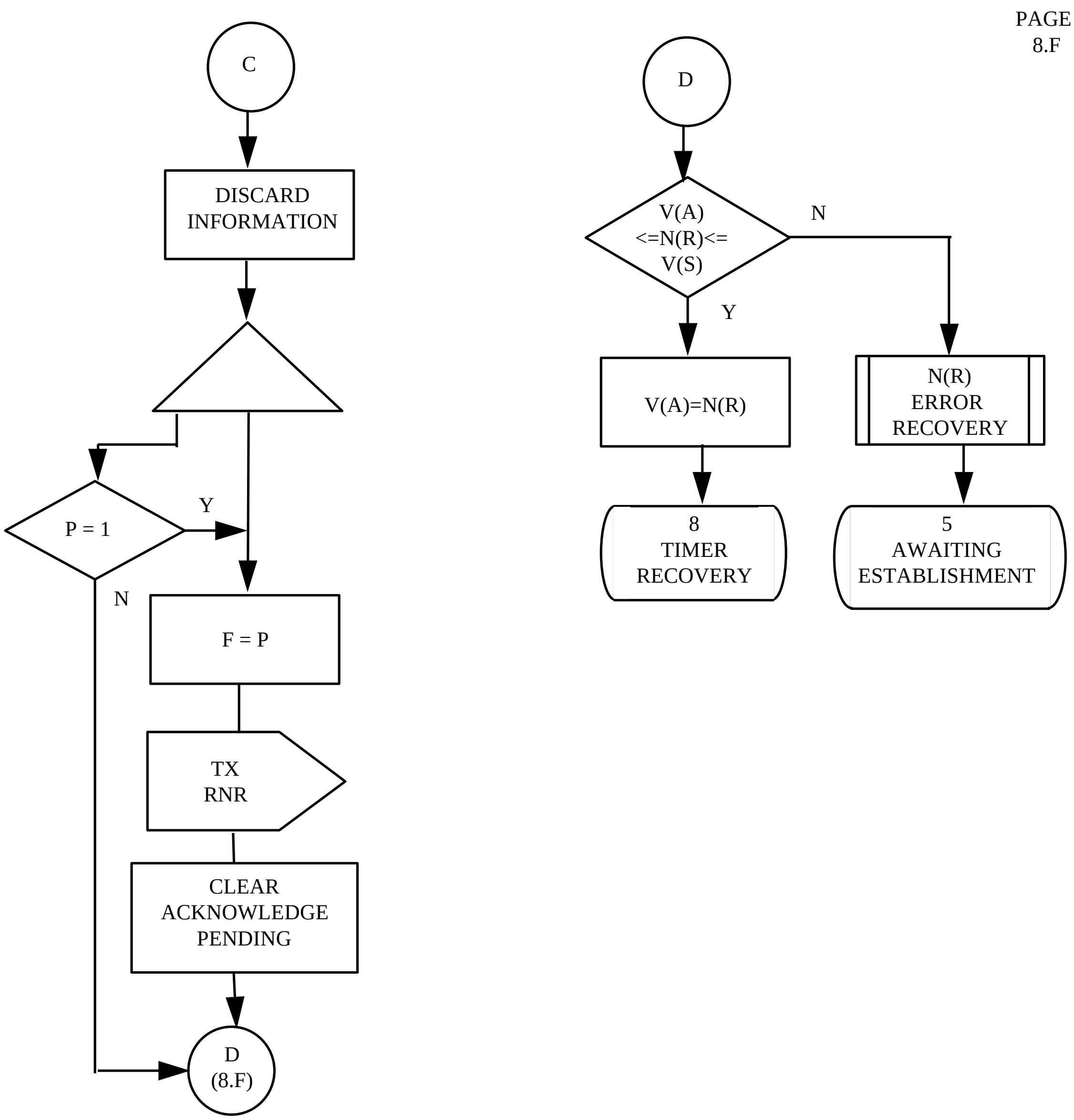
LINK LAYER

PAGE
8.E



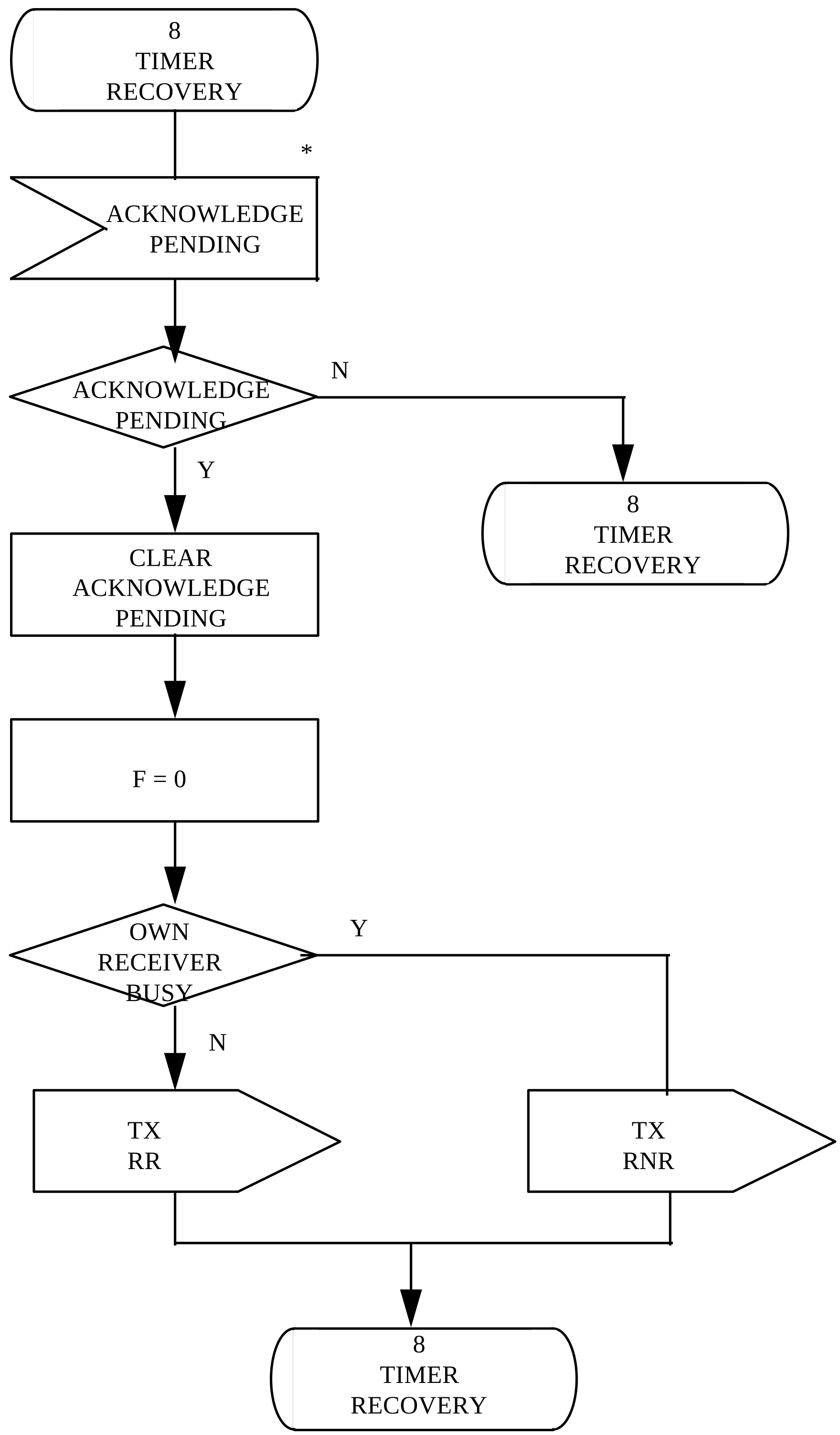
AN SLD REPRESENTATION OF THE POINT TO POINT PROCEDURES OF THE DATA LINK LAYER

LINK LAYER



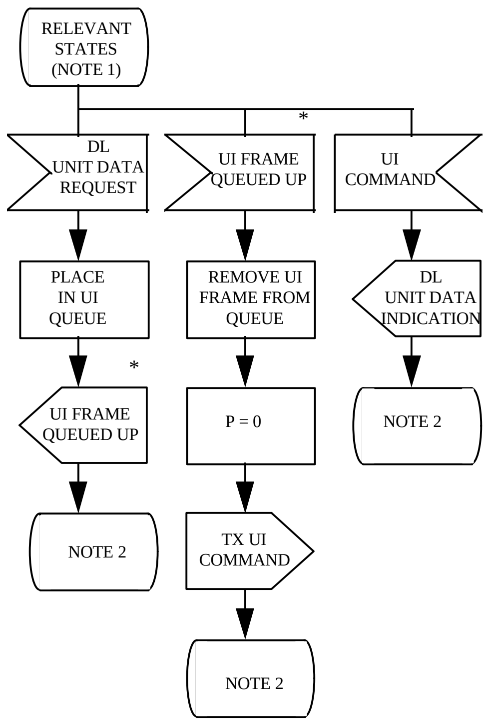
AN SLD REPRESENTATION OF THE POINT TO POINT PROCEDURES OF THE DATA LINK LAYER

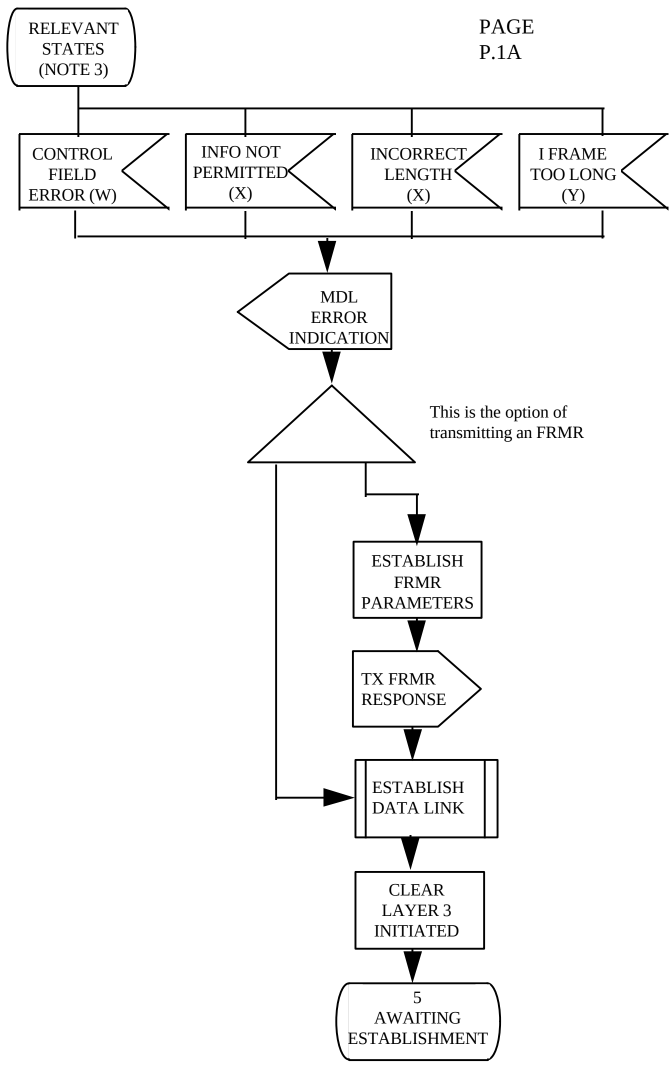
Page 8.G



An SDL Representation of the Point-to-Point Procedures of the Data Link Layer

LINK LAYER





* Unnumbered information trasnfer on point-to-point data llink.

NOTE 1 - The relevant states are as follows:
4 TEI-assigned
5 Awaiting-establishment
6 Awaiting-release
7 Multiple-frame-established
8 Timer-recovery

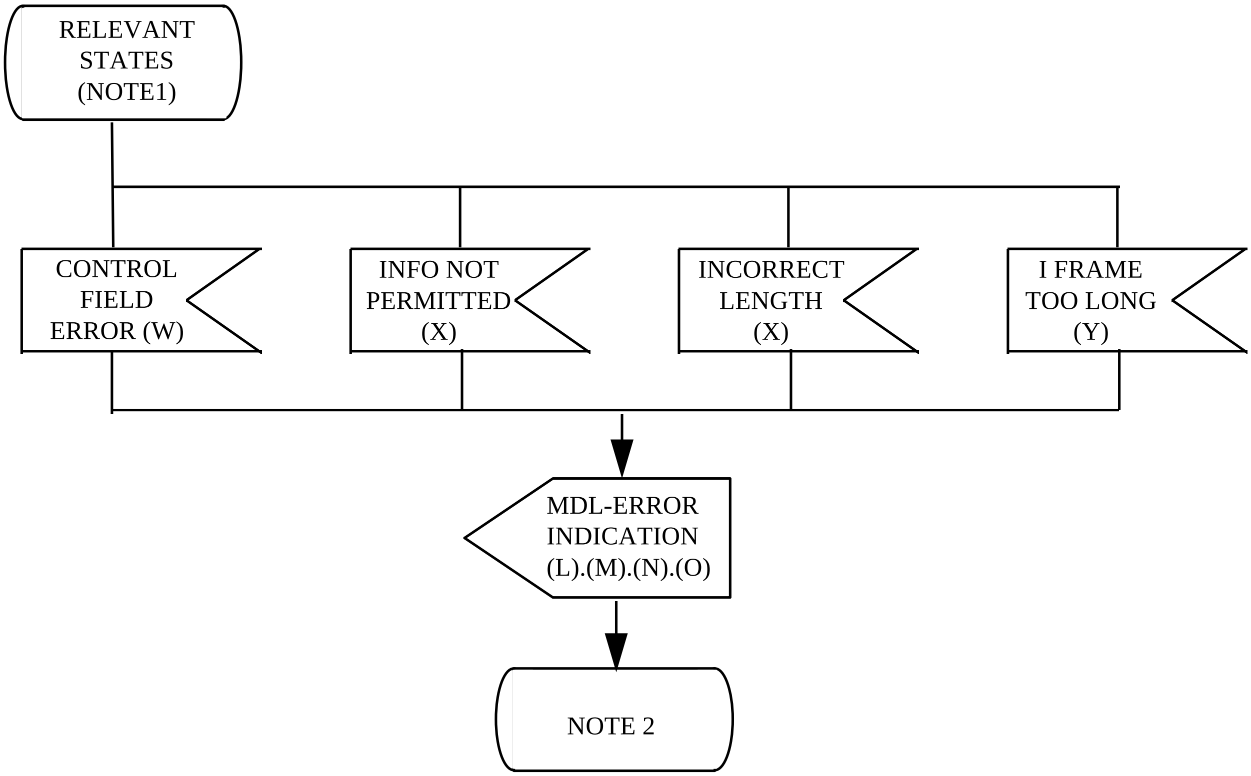
NOTE 2 - The data link layer returns to the state it was in prior to the events shown

NOTE 3 - The relevant states are as follows:
5 Awaiting-establishment
6 Awaiting-release
7 Multiple-frame-established
8 Timer-recovery.
(States 5 and 6 are optional and are for backward compatibility)

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

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

Page P.1B



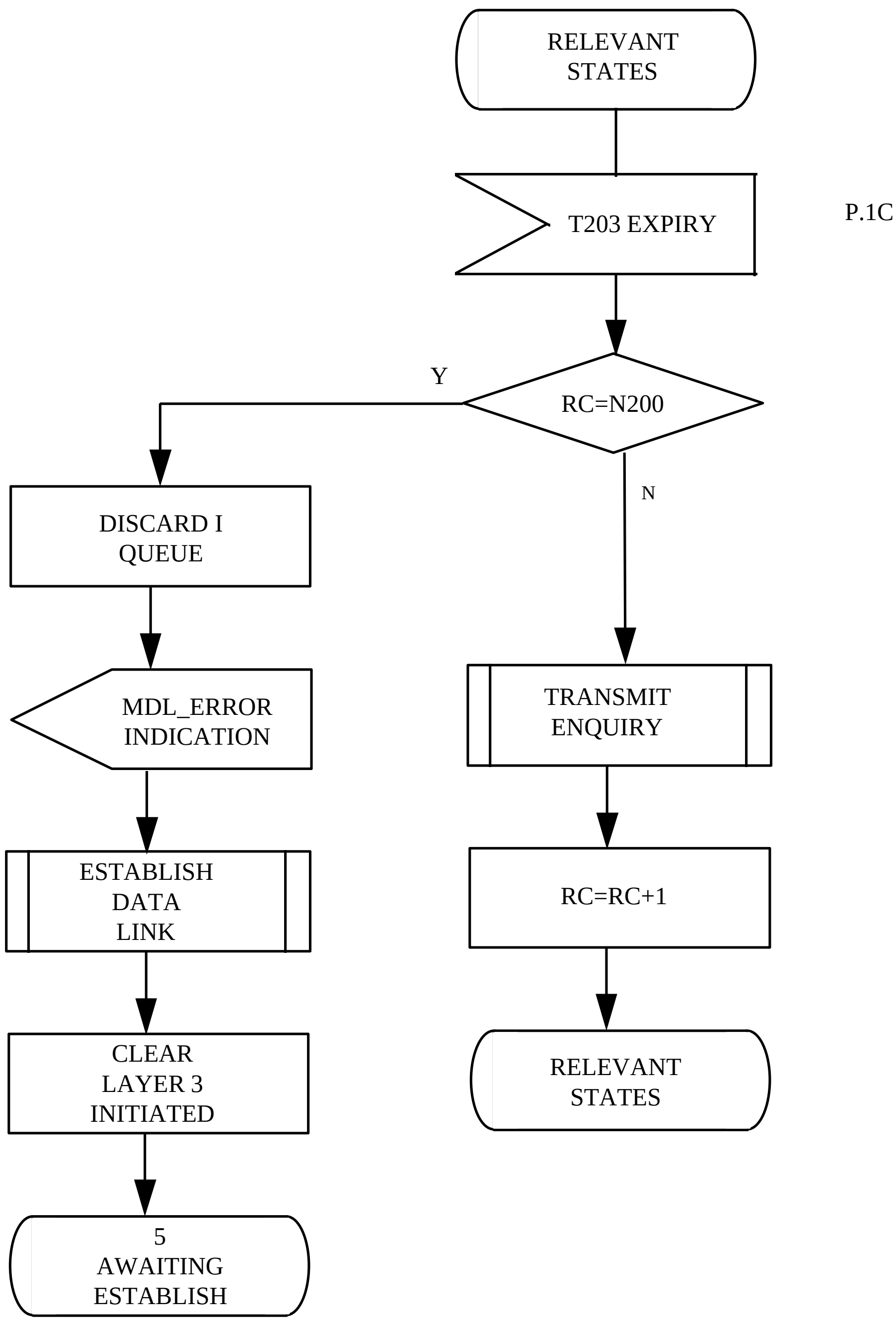
NOTE 1 - The relevant states are as follows:

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

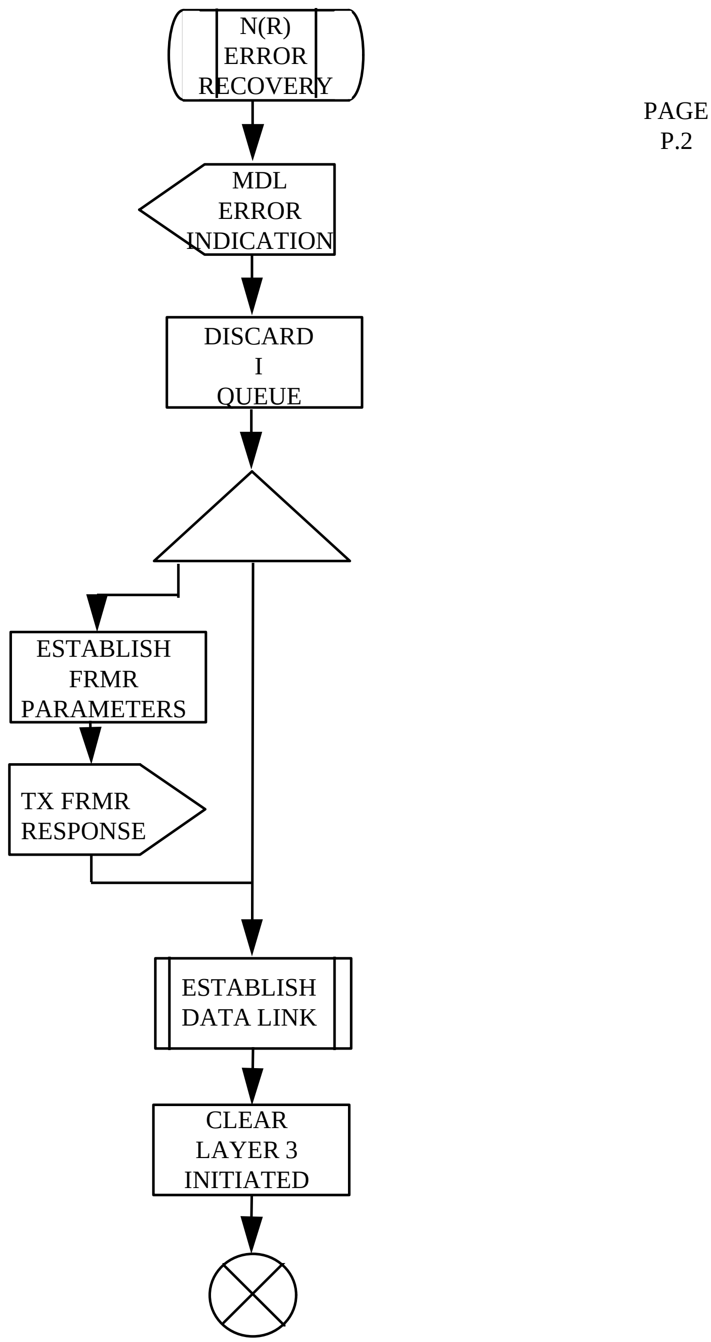
An SDL Representation of the Point-to-Point Procedures of the Data Link Layer

LINK LAYER



AN SLD REPRESENTATION OF THE POINT TO POINT PROCEDURES OF THE DATA LINK LAYER
STATUS INQUIRY PROCEDURE FOR PRIMARY INTERFACE

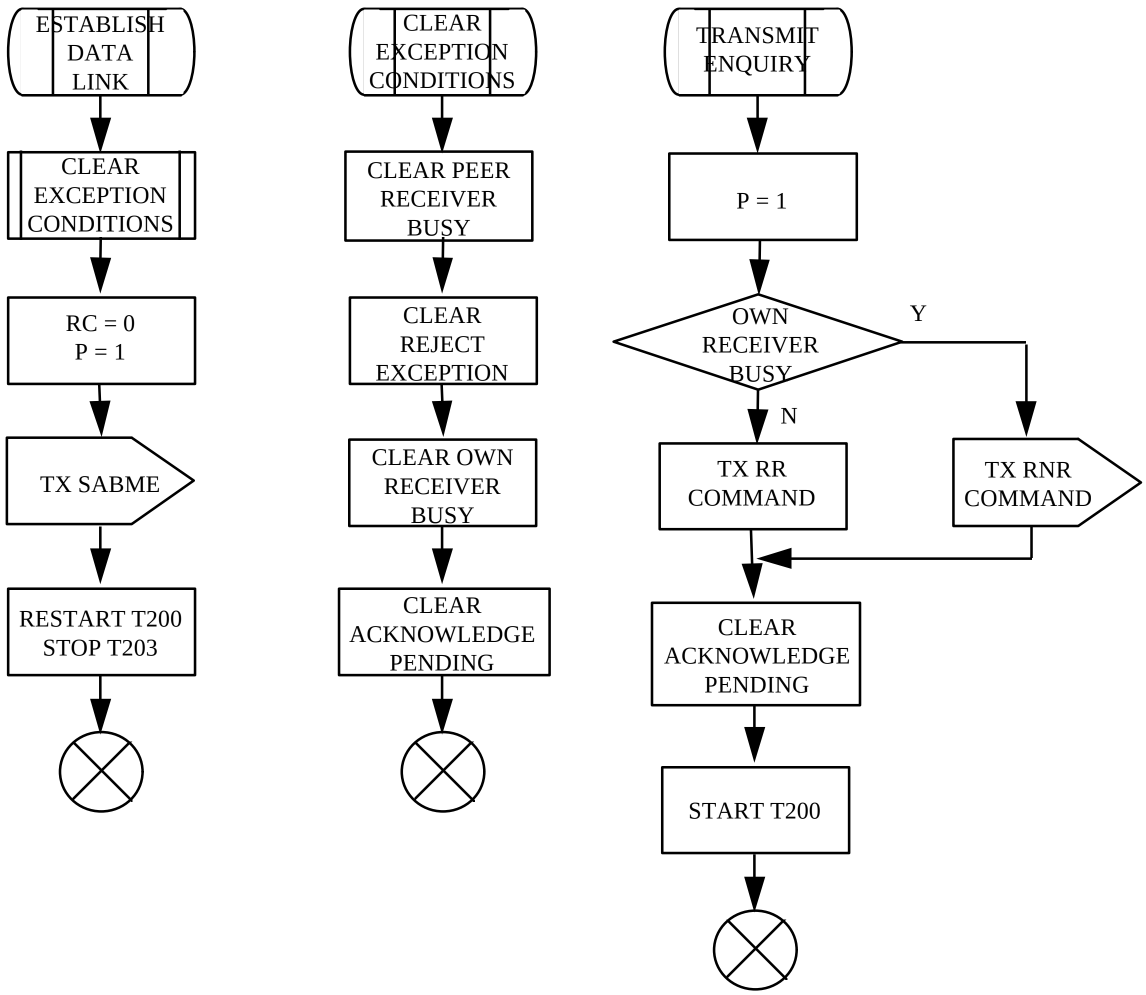
LINK LAYER



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

LINK LAYER

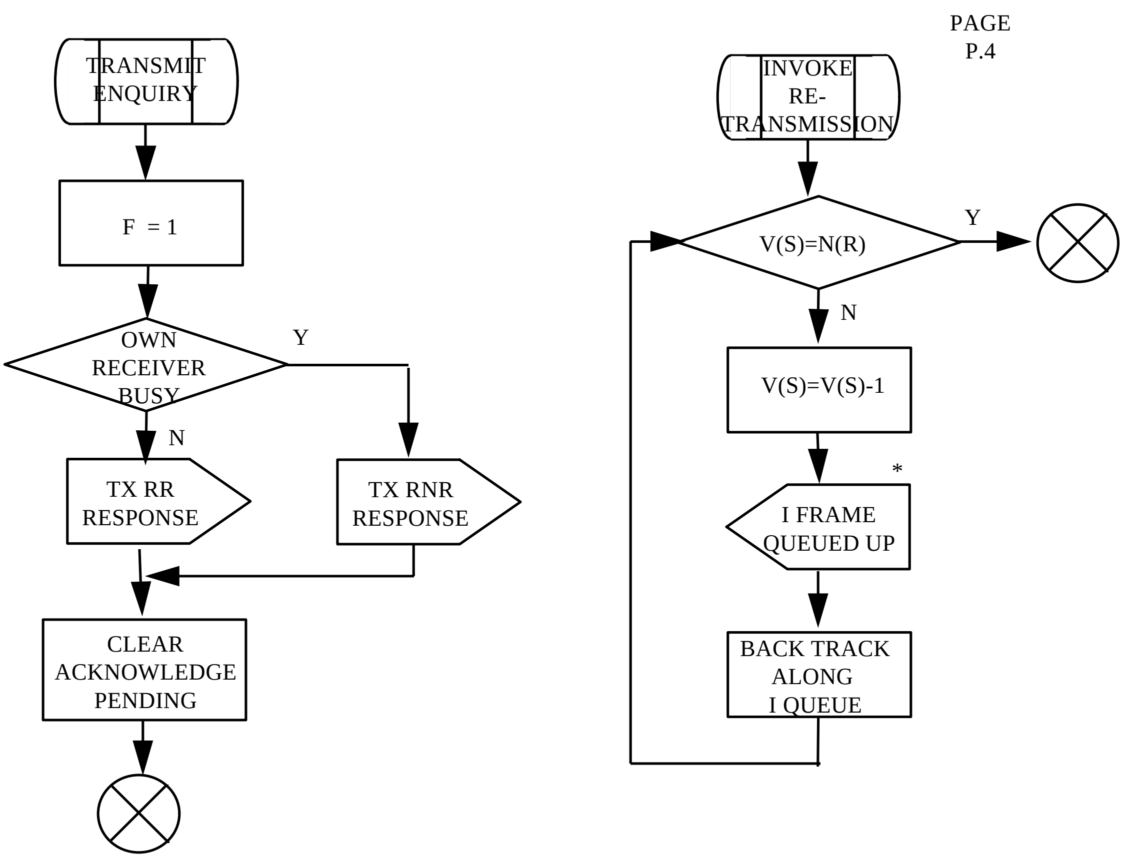
PAGE
P.3



POINT-TO-POINT DATA LINK: Definition of the “SDL procedures”
which may be called (page 1 of 2)

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

LINK LAYER



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)

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

REFERENCES

[1 ITU-T Recommendation Q.921 (I.441), "ISDN User-Network Interface Data Link Layer Specification."

[2] ITU-T Recommendation Q.920 (I.440), ISDN user-network interface data link layer - General aspects.

AT&T NETWORK ISDN PRIMARY RATE INTERFACE

AND SPECIAL APPLICATIONS

SPECIFICATION

User-Network Interface Description

PART III

LAYER 3 IMPLEMENTATION

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Introduction to Part III

This part of this Technical Reference defines the Layer 3 protocol options and service related procedures which will be supported by AT&T in its implementation of the ISDN Primary Rate Interface. The following sections will discuss the call states, messages, and information elements supported by this interface. The following sections also detail any implementation options supported by AT&T which affect call control procedures. These implementation options include, but are not limited to, procedures for accessing features and services supported by AT&T over an ISDN Primary Rate Interface.

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

1.1 Scope

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

Note : The term "Layer 3" is used for the functions and protocol described in this specification. 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[1]. 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 II. These primitives are used to illustrate the communication between the protocol layers and are not intended to specify or constrain implementations.

2. Overview of Call Control

The AT&T Network ISDN Primary Rate Interface supports switched network connections via the AT&T interexchange network.

In order to communicate properly over circuit-switched connections through the AT&T network, the switched network procedures are the essential procedures that CPE must implement. Under the switched network procedures, the AT&T network assumes most of the burden of error recovery for the Layer 3 signaling procedures. CPE is not required to implement all Layer 3 user-side timers and need only perform limited state matching (see sections 3.11.2 and 3.7.8.11).

The complexity of CPE which follows the switched network connection procedures is less than that required for CPE which follows the private line connection procedures. The procedures for private line connections require that the CPE assume some of the burden of error recovery by implementing all Layer 3 timers, and performing complete state matching. These private line connection procedures, when enhanced with the procedures for the FACILITY messages, provide maximum compatibility with all AT&T ISDN products and services, including those services and features provided by the AT&T network.

In this specification the terms "incoming" and "outgoing" are used to describe the call as viewed by the user side of the interface. The terms "public switched network connection," "switched network connection," and/or "the network" refer to the AT&T network.

In the sections which follow, states are defined for circuit switched calls in Section 2.1 (call states), for temporary signaling connections in Section 2.3 (call states) and for the interface in Section 2.4 (global call reference states).

Table III - 1 contains a summary of the call states.

Table III - 1. Summary of Call States

	States	Circuit Switched Calls	Packet Mode Access Connections	Temporary Signaling Connections	States Associated With The Global Call Reference
	Null State (U0/Rest 0)		N/A		
	Call Initiated (U1)		N/A		N/A
	Overlap Sending (U2)	x	N/A	x	N/A
	Outgoing Call Proceeding (U3)		N/A		N/A
	Call Delivered (U4)		N/A	x	N/A
U	Call Present (U6)	x	N/A	x	N/A
S	Call Received (U7)		N/A	N/A	N/A
E	Connect Request (U8)		N/A		N/A
R	Incoming Call Proceeding (U9)		N/A		N/A
	Active (U10)		N/A		N/A
S	Disconnect Request (U11)		N/A	N/A	N/A
I	Disconnect Indication (U12)		N/A	N/A	N/A
D	Suspend Request (U15)	x	N/A	N/A	N/A
E	Resume Request (U17)	x	N/A	N/A	N/A
	Release Request (U19)		N/A		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	
	Null State (N0/Rest 0)		N/A		
	Call Initiated (N1)	x	N/A	x	N/A
	Overlap Sending (N2)	x	N/A	x	N/A
	Outgoing Call Proceeding (N3)		N/A		N/A
	Call Delivered (N4)		N/A	x	N/A
N	Call Present (N6)		N/A	x	N/A
E	Call Received (N7)		N/A		N/A
T	Connect Request (N8)		N/A		N/A
W	Incoming Call Proceeding (N9)		N/A	x	N/A
O	Active (N10)		N/A		N/A
R	Disconnect Request (N11)		N/A	N/A	N/A
K	Disconnect Indication (N12)		N/A	N/A	N/A
	Suspend Request (N15)	x	N/A	N/A	N/A
S	Resume Request (N17)	x	N/A	N/A	N/A
I	Release Request (N19)		N/A		N/A
D	Call Abort (N22)	x	N/A	x	N/A
E	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 signaling on the D-Channel. Because several calls may exist simultaneously at a user-network interface, and each call may be in a different state, the state of the interface itself cannot be unambiguously defined.

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 (see Figure III - 1) 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 the switched network). User endpoints A and B are connected through an intervening switched common carrier network, hereafter also referred to as a "switched network".

Figure III - 1. Call From A to B via a Switched Network Connection

Consider the switched network scenario depicted in Figure III - 1. 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 III - 1 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 III - 2. Figure III - 3 shows the corresponding arrangement for an incoming call from the switched network to the User endpoint B.

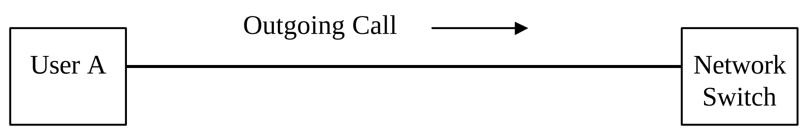


Figure III - 2. Switched Network Access for an Outgoing Call from A

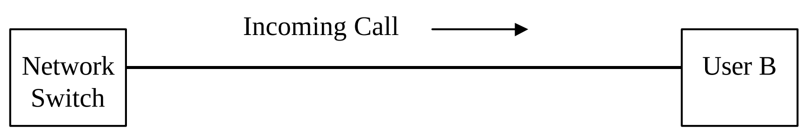


Figure III - 3. Switched Network Egress for an Incoming Call to B

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 3.7.

Individual calls on an interface may have any of the call states as defined in this section.

The network side states NS1, NS2, NS3, and NS4 as well as the user side states US1 and US2 are internal states for that side of the interface. Thus, no indication that the network or user is in one of these states would be returned in a STATUS message. The call state information element in the STATUS message will contain the call state from which the internal state was entered.

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 (UO)

No call exists.

2.1.1.2 Call Initiated (U1)

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

2.1.1.3 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 acknowledgment 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 acknowledgment 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 acknowledgment 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.

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 (NO)

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 acknowledgment 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 acknowledgment 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

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 - Not Applicable

2.3 Temporary Signaling Connections

This section defines the basic call control states for user-to-user signaling not associated with circuit switched calls. The procedures for call control are given in Section 3.7.

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 acknowledgment 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.

2.3.1.8 Incoming Call Proceeding (U9)

This state exists for an incoming call when the user has sent acknowledgment 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 acknowledgment 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 acknowledgment 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.

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 3.7.5.

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 acknowledgment 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 acknowledgment 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 Table III - 2.

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

Table III - 2. 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.

3. Layer 3 Message Functional Definitions and Content

Layer 3 aligns with the format in ITU-T Recommendation Q.931. This Layer 3 section adopts the similar sectioning and layout mechanisms in presenting the protocol information as accepted in the standards community (e.g. ITU-T).

This section provides an overview of the message structure, which highlights the functional definition and information content (i.e. semantics) of each message. Each definition follows the guidelines specified in this section .

a) A brief description of the message direction and use, including whether the message has:

- Local significance, i.e., relevant only in the originating or terminating access;
- Access significance, i.e., relevant in the originating and terminating access, but not in the network;
- Dual significance, i.e., relevant in either the originating or terminating access and in the network; or
- 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:

- The section describing the information element;
- 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.
- Whether inclusion is mandatory (M) or optional (O), with a reference to notes explaining the circumstances under which the information element shall be included;
- 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.

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 3.6.5.2 - 3.6.5.3. These information elements are listed in the appropriate tables in Section 3.6.

c) Further explanatory notes, as necessary.

3.1 Messages for Circuit Mode Connection Control

Table III - 3 summarizes the messages for circuit-mode connection control. Please refer to Section 3.12 for maintenance messages.

Table III - 3. 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 Message:	Reference
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

3.1.1 Alerting

This message is sent by the called user to the network and by the network to the calling user to indicate that called user alerting has been initiated.

Table III - 4. ALERTING Message Content

Message type: ALERTING
Significance: global
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Channel identification	3.6.5.12	u→n	O (Note 1)	4-8
Redirecting Number	3.6.6.7	both	O (Note 2)	3-20
User-user	3.6.5.28	both	O (Note 3)	3-131
Shift to codeset 6 (*locking*)	3.6.5.2	both	O (Notes 3, 4)	1
Network-specific (codeset 6)	3.6.6.8	both	O (Notes 3, 4)	1-128
Shift to codeset 7 (*locking*)	3.6.5.2	both	O (Notes 3, 4)	1
User-specific (codeset 7)	3.6.6.9	both	O (Notes 3, 4)	1-128

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

Note 2: Used to identify address of redirection.

Note 3: Included in the user-to-network direction when an incoming call is offered and the called user wants to return user information to the calling user. Included in the network-to-user direction if the called user included user information in the ALERTING message.

Note 4: Multiple codeset 6 and 7 information elements may be present. The appropriate *locking* Shift information element must precede any codeset 6 or 7 information elements.

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.

Table III - 5. CALL PROCEEDING Message Content

Message type: CALL PROCEEDING
Significance: local
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Channel identification	3.6.5.12	both	M	4-8

3.1.3 Congestion Control

This message is sent by the network or the user to indicate the establishment or termination of flow control on the transmission of USER INFORMATION messages. This message may NOT be sent with the global call reference defined in Section 3.6.3. See also Section 3.3.3 and Section 3.5.1.

Table III - 6. CONGESTION CONTROL Message Content

Message type: CONGESTION CONTROL
Significance: local (Note 1)
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Congestion level	3.6.5.13	both	M	1
Cause	3.6.5.11	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.

Table III - 7. CONNECT Message Content

Message type: CONNECT
Significance: global
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Connected number	3.6.6.6	both	O	3-18
Channel identification	3.6.5.12	u→n	O (Note 1)	4-8
Redirecting Number	3.6.6.7	both	O (Note 2)	3-20
User-user	3.6.5.28	both	O (Note 3)	3-131
Shift to codeset 6 (*locking*)	3.6.5.2	both	O (Notes 3, 4)	1
Network-specific (codeset 6)	3.6.6.8	both	O (Notes 3, 4)	1-128
Shift to codeset 7 (*locking*)	3.6.5.2	both	O (Notes 3, 4)	1
User-specific (codeset 7)	3.6.6.9	both	O (Notes 3, 4)	1-128

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

Note 2: Used to identify address of redirection.

Note 3: Included in the user-to-network direction when the answering user wants to return user information to the calling user. Included in the network-to-user direction if the user awarded the call included user information in the CONNECT message.

Note 4: Multiple codeset 6 and 7 information elements may be present. The appropriate *locking* Shift information element must precede any codeset 6 or 7 information elements.

3.1.5 Connect Acknowledge

This message is sent in response to a CONNECT message to indicate completion of the circuit-switched connection.

Table III - 8. CONNECT ACKNOWLEDGE Message Content

Message type: CONNECT ACKNOWLEDGE
Significance: local
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	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.

Table III - 9. DISCONNECT Message Content

Message type: DISCONNECT
Significance: global
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Cause	3.6.5.11	both	M	4-22
User-user	3.6.5.28	both	O (Note 1)	3-131
Shift to codeset 6 (*locking*)	3.6.5.2	both	O (Notes 1,2)	1
Network-specific (codeset 6)	3.6.6.8	both	O (Notes 1,2)	1-128
Shift to codeset 7 (*locking*)	3.6.5.2	both	O (Notes 1,2)	1
User-specific (codeset 7)	3.6.6.9	both	O (Notes 1,2)	1-128

Note 1: Included when the user initiates clearing and wants to pass user information to the remote user at call clearing time.

Note 2: Multiple codeset 6 and 7 information elements may be present. The appropriate *locking* Shift information element must precede any codeset 6 or 7 information elements.

3.1.7 Facility

This message is defined in Section 3.5.2.

3.1.8 Information - Not applicable.

3.1.9 Notify - Not applicable.

3.1.10 Progress

This message is sent to the user or the network to indicate the progress of a call in the event of interworking or to cause cut through. The network may require cut through to facilitate announcements before a call is cleared or to facilitate transmission of in-band information to the network. The receipt of the message may be an indication that the information channel needs to be monitored for call progress information, and/or to provide additional call information to the network[1].

Table III - 10. PROGRESS Message Content

Message type: PROGRESS
Significance: global
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Cause	3.6.5.11	both	O (Notes 1 and 2)	4-22
Channel identification	3.6.5.12	u→n	O (Note 3)	4-8
Progress indicator	3.6.5.21	both	M (Note 4)	4

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

Note 2: During the setup phase of a call this information element will be supplied by the network, in the network to calling user direction, if the call cannot be completed due to limitations within the network.

Note 3: This information element is mandatory if this message is sent as the first response to SETUP.

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1. Data endpoints are not required to monitor the information channel for in-band tones.

Note 4: When a PRI user sends more than one PROGRESS message to the network, the network will not deliver more than one PROGRESS message with the same Progress Indicator to the far end PRI user.

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 call reference, and that the receiving equipment shall release the channel (if any) and the call reference after sending the RELEASE COMPLETE.

Table III - 11. RELEASE Message Content

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

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Cause	3.6.5.11	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.

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.

Table III - 12. RELEASE COMPLETE Message Content

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

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Cause	3.6.5.11	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.

3.1.13 Resume - Not applicable.

3.1.14 Resume Acknowledge - Not applicable.

3.1.15 Resume Reject - Not applicable.

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.

Table III - 13. SETUP Message Content

Message type: SETUP
Significance: global
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Bearer capability	3.6.5.4	both	M (Note 1)	4-8
Channel identification	3.6.5.12	both	M	4-8
Network-specific facilities	3.6.5.19	both	O (Note 2)	4-9
Calling party number	3.6.5.9	both	O (Note 3)	3-19
Calling party subaddress	3.6.5.10	both	O (Note 4)	3-23
Called party number	3.6.5.7	both	M	3-20
Called party subaddress	3.6.5.8	both	O (Note 5)	3-23
Redirecting number	3.6.6.7	both	O	3-20
Transit Network Selection	3.6.5.27	u→n	O (Note 10)	7
Low layer compatibility	3.6.5.17	both	O (Note 6)	3-16
High layer compatibility	3.6.5.15	both	O (Note 7)	3-5
User-user	3.6.5.28	both	O (Note 8)	3-131
Shift to codeset 6 (*locking*)	3.6.5.2	both	O (Notes 8, 9)	1
Network-specific (codeset 6)	3.6.6.8	both	O (Notes 8, 9)	1-128
Shift to codeset 7 (*locking*)	3.6.5.2	both	O (Notes 8, 9)	1
User-specific (codeset 7)	3.6.6.9	both	O (Notes 8, 9)	1-128

Note 1: The Bearer capability and High layer and Low layer compatibility information elements may be used to describe an ITU-T telecommunications service, if appropriate.

Note 2: On call-by-call channels, the Network-specific facilities information element is mandatory in a SETUP message from an originating user and it must contain a valid binary service facility code point. On single service trunk groups, the Network-specific facilities information element is optional, but if it exists, it must contain a service coding which is valid for that trunk group. The Network-specific facilities information element may appear up to two times.

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

Note 4: 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 in the SETUP message.

Note 5: 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 in the SETUP message.

Note 6: 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 low layer compatibility information in the SETUP message.

Note 7: 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 high layer compatibility information in the SETUP message.

Note 8: Included in the user-to-network direction when the calling user wants to pass user information to the called user. Included in the network-to-user direction if the calling user included user information in the SETUP message.

Note 9: Multiple codeset 6 and 7 information elements may be present. The appropriate *locking* Shift information element must precede any codeset 6 or 7 information elements.

Note 10: Included in the user-to-nework direction to identify one requested transit network. This information element is included in a SETUP message only for AT&T Digital Link calls when the calling party selects a transit network carrier other than the presubscribed carrier.

3.1.17 Setup Acknowledge - Not applicable.

3.1.18 Status

This message may be sent at any time during a call when an unexpected message is received. This message is also used to respond to a STATUS ENQUIRY message. Sending a STATUS message in response to a STATUS ENQUIRY message is mandatory.

Table III - 14. STATUS Message Content

Message type: STATUS
Significance: local
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Cause	3.6.5.11	both	M	4-22
Call State	3.6.5.6	both	M	3

Note: The Cause information element (see 3.6.5.11) may be repeated and the Call reference may use a global call reference value.

3.1.19 Status Enquiry

The STATUS ENQUIRY message may be sent 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. The global call reference value may not be used in this message.

Table III - 15. STATUS ENQUIRY Message Content

Message type: STATUS ENQUIRY
Significance: local
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1

3.1.20 Suspend - Not applicable.

3.1.21 Suspend Acknowledge - Not applicable.

3.1.22 Suspend Reject - Not applicable.

3.1.23 User Information

The USER INFORMATION message is sent by a user to the network to transfer information to the remote user. This message is also sent by the network to a user to deliver the information from the other user.

Table III - 16. USER INFORMATION Message Content

Message type: USER INFORMATION
Significance: access
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
More data	3.6.5.18	both	O (Note 1)	1
User-user	3.6.5.28	both	M	3-251
Shift to codeset 6 (*locking*)	3.6.5.2	both	O (Note 2)	1
Network-specific (codeset 6)	3.6.6.8	both	O (Note 2)	1-128
Shift to codeset 7 (*locking*)	3.6.5.2	both	O (Note 2)	1
User-specific (codeset 7)	3.6.6.9	both	O (Note 2)	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: Multiple codeset 6 and 7 information elements may be present. The appropriate *locking* Shift information element must precede any codeset 6 or 7 information elements.

3.2 Messages for Packet Mode Access Connection Control - Not applicable.

3.3 Messages for Non-Call Associated Temporary Signaling Connection

Table III - 17 summarizes the messages for the control of Non-Call Associated Temporary Signaling (NCA-TSC) connections and the transfer of user-user information. Please refer to Section 3.12 for maintenance messages.

Table III - 17. Messages for Non-Call Associated Temporary Signaling Connection

Call Establishment Messages	Reference
CALL PROCEEDING	3.3.2
CONNECT	3.3.4
CONNECT ACKNOWLEDGE	3.3.5
SETUP	3.3.9

Call Information Phase Message:	Reference
USER INFORMATION	3.3.13

Call Clearing Messages:	Reference
RELEASE	3.3.7
RELEASE COMPLETE	3.3.8

Miscellaneous Messages:	Reference
CONGESTION CONTROL	3.3.3
STATUS	3.3.11
STATUS ENQUIRY	3.3.12

3.3.1 Alerting - Not applicable.

Note: For a NCA TSC, if the network receives this message in response to a SETUP message, this message will be ignored.

3.3.2 Call Proceeding

This message may be sent by the network to the calling user to indicate that the requested NCA-TSC establishment has been initiated, and no additional establishment information will be accepted. If the network receives this message in response to a SETUP message, this message will be ignored. See Table III - 5.

3.3.3 Congestion Control

This message is sent by the network or the user to indicate the establishment or termination of flow control on the transmission of USER INFORMATION messages. This message may NOT be sent with the global call reference defined in Section 3.6.3.

Table III - 18. CONGESTION CONTROL Message Content

Message type: CONGESTION CONTROL
Significance: local (Note 1)
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Congestion level	3.6.5.13	both	M	1
Cause	3.6.5.11	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.

Table III - 19. CONNECT Message Content

Message type: CONNECT
Significance: global
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Channel identification	3.6.5.12	u→n	O (Note 1)	3-4

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

3.3.5 Connect Acknowledge

This message is sent in response to a CONNECT message to indicate completion of the Non-Call Associated Temporary Signaling Connection.

Table III - 20. CONNECT ACKNOWLEDGE Message Content

Message type: CONNECT ACKNOWLEDGE
Significance: local
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1

3.3.6 Information - Not applicable.

3.3.7 Release

This message is sent by the user or the network to indicate that the equipment sending the message intends to release the call reference, and that the receiving equipment shall release the call reference after sending the RELEASE COMPLETE.

Table III - 21. RELEASE Message Content

Message type: RELEASE
Significance: global
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Cause	3.6.5.11	both	O (Note 1)	4-22
User-user	3.6.5.28	both	O (Note 2)	3-131
Shift to codeset 6 (*locking*)	3.6.5.2	both	O (Notes 2, 3)	1
Network-specific (codeset 6)	3.6.6.8	both	O (Notes 2, 3)	1-128
Shift to codeset 7 (*locking*)	3.6.5.2	both	O (Notes 2, 3)	1
User-specific (codeset 7)	3.6.6.9	both	O (Notes 2, 3)	1-128

Note 1: Mandatory in the first call clearing message.

Note 2: Included when the RELEASE message is the first call clearing message for a NCA TSC and the user initiates call clearing and wants to pass user information to the remote user at call clearing time.

Note 3: Multiple codeset 6 and 7 information elements may be present. The appropriate *locking* Shift information element must precede any codeset 6 or 7 information elements.

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 call reference and the receiving equipment shall release the call reference.

Table III - 22. RELEASE COMPLETE Message Content

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

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Cause	3.6.5.11	both	O (Note 2)	4-22
User-user	3.6.5.28	both	O (Note 3)	3-131
Shift to codeset 6 (*locking*)	3.6.5.2	both	O (Notes 3, 4)	1
Network-specific (codeset 6)	3.6.6.8	both	O (Notes 3, 4)	1-128
Shift to codeset 7 (*locking*)	3.6.5.2	both	O (Notes 3, 4)	1
User-specific (codeset 7)	3.6.6.9	both	O (Notes 3, 4)	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.

Note 3: The user data information elements are allowed only when the RELEASE COMPLETE message is the first response to a SETUP message on a NCA TSC.

Note 4: Multiple codeset 6 and 7 information elements may be present. The appropriate *locking* Shift information element must precede any codeset 6 or 7 information elements.

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.

Table III - 23. SETUP Message Content

Message type: SETUP
Significance: global
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Bearer capability	3.6.5.4	both	M (Note 1)	4-8
Channel identification	3.6.5.12	both	M	3-4
Network-specific facilities	3.6.5.19	both	O (Note 2)	4-9
Calling party number	3.6.5.9	both	O (Note 3)	3-19
Calling party subaddress	3.6.5.10	both	O (Note 4)	3-23
Called party number	3.6.5.7	both	M	3-20
Called party subaddress	3.6.5.8	both	O (Note 5)	3-23
Redirecting number	3.6.6.7	both	O	3-20
Low layer compatibility	3.6.5.17	both	O (Note 6)	3-16
High layer compatibility	3.6.5.15	both	O (Note 7)	3-5
User-user	3.6.5.28	both	O (Note 8)	3-131
Shift to codeset 6 (*locking*)	3.6.5.2	both	O (Notes 8, 9)	1
Network-specific (codeset 6)	3.6.6.8	both	O (Notes 8, 9)	1-128
Shift to codeset 7 (*locking*)	3.6.5.2	both	O (Notes 8, 9)	1
User-specific (codeset 7)	3.6.6.9	both	O (Notes 8, 9)	1-128

Note 1: The Bearer capability and High layer and Low layer compatibility information elements may be used to describe an ITU-T telecommunications service, if appropriate.

Note 2: On call-by-call channels, the Network-specific facilities information element is mandatory in a SETUP message from an originating user and it must contain a valid binary service facility code point. On single service trunk groups, the Network-specific facilities information element is optional, but if it exists, it must contain a service coding which is valid for that trunk group.

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

Note 4: 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 in the SETUP message.

Note 5: 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 in the SETUP message.

Note 6: 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 low layer compatibility information in the SETUP message.

Note 7: 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 high layer compatibility information in the SETUP message.

Note 8: Included in the user-to-network direction when the calling user wants to pass user information to the called user. Included in the network-to-user direction if the calling user included user information in the SETUP message.

Note 9: Multiple codeset 6 and 7 information elements may be present. The appropriate *locking* Shift information element must precede any codeset 6 or 7 information elements.

3.3.10 Setup Acknowledge - Not applicable.

3.3.11 Status

This message may be sent at any time during a call when an unexpected message is received. This message is also used to respond to a STATUS ENQUIRY message. Sending a STATUS message in response to a STATUS ENQUIRY message is mandatory. Note that the Cause information element (See Section 3.6.5.11) may be repeated and the Call reference may use a global call reference value.

Table III - 24. STATUS Message Content

Message type: STATUS
Significance: local
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Cause	3.6.5.11	both	M	4-22
Call state	3.6.5.6	both	M	3

3.3.12 Status Enquiry

The STATUS ENQUIRY message may be sent 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. The global call reference value may not be used in this message.

Table III - 25. STATUS ENQUIRY Message Content

Message type: STATUS ENQUIRY
Significance: local
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1

3.3.13 User Information

The USER INFORMATION message is sent by a user to the network to transfer information to the remote user. This message is also sent by the network to a user to deliver the information from the other user.

Table III - 26. USER INFORMATION Message Content

Message type: USER INFORMATION
Significance: access
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
More data	3.6.5.18	both	O (Note 1)	1
User-user	3.6.5.28	both	M	3-251
Shift to codeset 6 (*locking*)	3.6.5.2	both	O (Note 2)	1
Network-specific (codeset 6)	3.6.6.8	both	O (Note 2)	1-128
Shift to codeset 7 (*locking*)	3.6.5.2	both	O (Note 2)	1
User-specific (codeset 7)	3.6.6.9	both	O (Note 2)	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: Multiple codeset 6 and 7 information elements may be present. The appropriate *locking* Shift information element must precede any codeset 6 or 7 information elements.

3.4 Messages Used with the Global Call Reference

Table III - 27 summarizes the messages for circuit-mode connection control. Please refer to Section 3.12 for maintenance messages.

Table III - 27. Messages Used with the Global Call Reference

Messages:	Reference
RESTART	3.4.1
RESTART ACKNOWLEDGE	3.4.2
STATUS	3.4.3

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.

Table III - 28. RESTART Message Content

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

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M (Note 2)	2-3
Message type	3.6.4	both	M	1
Channel identification	3.6.5.12	both	M (Note 3)	5-6
Restart indicator	3.6.5.23	both	M	3

Note 1: This message may have global significance if sent on a channel which is carrying an active call.

Note 2: This message is sent with the global call reference defined in 3.6.3.

Note 3: The network will support RESTART messages for individual B channels only. Thus the Channel identification information element is mandatory.

3.4.2 Restart Acknowledge

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

Table III - 29. RESTART ACKNOWLEDGE Message Content

Message type: RESTART ACKNOWLEDGE
Significance: local
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M (Note 1)	2-3
Message type	3.6.4	both	M	1
Channel identification	3.6.5.12	both	M (Note 2)	5-6
Restart indicator	3.6.5.23	both	M	3

Note 1: This message is sent with the global call reference defined in Section 3.6.3.

Note 2: The network will support RESTART ACKNOWLEDGE messages for individual B-Channels only. Thus the Channel identification information element is mandatory.

3.4.3 Status

This message may be sent at any time during a call when an unexpected message is received. This message is also used to respond to a STATUS ENQUIRY message. Sending a STATUS message in response to a STATUS ENQUIRY message is mandatory. Note that the Cause information element (See Section 3.6.5.11) may be repeated.

Table III - 30. STATUS Message Content

Message type: STATUS
Significance: local
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M (Note 1)	2-3
Message type	3.6.4	both	M	1
Cause	3.6.5.11	both	M	4-22
Call state	3.6.5.6	both	M	3

Note 1: This message may be sent with the global call reference defined in Section 3.6.3

3.5 Messages for AT&T Supplementary Services

Table III - 31 summarizes the messages for supplementary services. By definition, a supplementary service is an add-on to a basic call for the purpose of manipulating a basic connection or transmitting additional connection-related information which may be transparent to the network or which the network may screen. Please refer to Section 3.12 for maintenance messages.

Table III - 31. 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
USER INFORMATION	3.5.6

3.5.1 Congestion Control

This message is sent by the network or the user to indicate the establishment or termination of flow control on the transmission of USER INFORMATION messages. This message may NOT be sent with the global call reference defined in Section 3.6.3.

Table III - 32. CONGESTION CONTROL Message Content

Message type: CONGESTION CONTROL
Significance: local (Note 1)
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Congestion level	3.6.5.13	both	M	1
Cause	3.6.5.11	both	M	4-22

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

3.5.2 Facility

This message is 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 (e.g., Call-Associated Temporary Signaling Connection).

Table III - 33. FACILITY Message Content

Message type: FACILITY
Significance: global
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Channel identification	3.6.5.12	both	O (Note 1)	4-8
Network-specific facilities	3.6.5.19	both	O (Note 2)	4-9
Shift to codeset 6 (*locking*)	3.6.5.2	both	O (Note 3)	1
Network-specific (codeset 6)	3.6.6.8	both	O (Note 3)	1-128

Note 1: The Channel identification information element is mandatory when the FACILITY is the first response to SETUP.

Note 2: The Network-specific facilities information element may appear up to two times.

Note 3: Locking Shift to codeset 6 and codeset 6 information elements are supported by certain specialized applications developed by AT&T as described in the appendices.

3.5.3 Facility Acknowledge

This message is sent by either the network or the user to indicate the acceptance of a facility request.

Table III - 34. FACILITY ACKNOWLEDGE Message Content

Message type: FACILITY ACKNOWLEDGE
Significance: dual
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Network-specific facilities	3.6.5.19	both	O (Note 1, 2)	4-9
Calling party number	3.6.5.9	both	O (Note 1)	3-19
Shift to codeset 6 (*locking*)	3.6.5.2	both	O	1
OLI (codeset 6)	3.6.6.8.5	n→u	O	3

Note 1: Either the Network-specific facilities information element or the Calling party number information element, or both, must be present unless this message contains the Shift to codeset 6 and OLI information elements from the Network. In this case the Network may omit both the Network-specific facilities and Calling party number information elements. This will occur when the Network responds to a CPE request for CPN/BN and CPN/BN is not available, but the user subscribes to II Digits and the II Digits for the OLI information element are available.

Note 2: The Network-specific facilities information element may appear up to two times.

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.

Table III - 35. FACILITY REJECT Message Content

Message type: FACILITY REJECT
Significance: dual
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Cause	3.6.5.11	both	M	4-22
Network-specific facilities	3.6.5.19	both	O (Note 1)	4-9

Note 1: The Network-specific facilities information element may appear up to two times.

3.5.5 Register

This message is supported by certain specialized applications developed by AT&T as described in the appendices.

Table III - 36. REGISTER Message Content

Message type: REGISTER
Significance: local
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
Shift to codeset 6 (*locking*)	3.6.5.2	both	M	1
Network - specific (codeset 6)	3.6.6.8	both	M	4-186

3.5.6 User Information

The USER INFORMATION message is sent by a user to the network to transfer information to the remote user. This message is also sent by the network to a user to deliver the information from the other user.

Table III - 37. USER INFORMATION Message Content

Message type: USER INFORMATION
Significance: access
Direction: both

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.6.2	both	M	1
Call reference	3.6.3	both	M	2-3
Message type	3.6.4	both	M	1
More data	3.6.5.18	both	O (Note 1)	1
User-user	3.6.5.28	both	M	3-251
Shift to codeset 6 (*locking*)	3.6.5.2	both	O (Note 2)	1
Network-specific (codeset 6)	3.6.6.8	both	O (Note 2)	1-128
Shift to codeset 7 (*locking*)	3.6.5.2	both	O (Note 2)	1
User-specific (codeset 7)	3.6.6.9	both	O (Note 2)	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: Multiple codeset 6 and 7 information elements may be present. The appropriate *locking* Shift information element must precede any codeset 6 or 7 information elements

3.6 General Message Format and Information Element Coding

This section describes message contents, and provides a guide to information element contents recognized by the network. 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.

3.6.1 Overview

Every message must consist of the following parts:

a) protocol discriminator

b) call reference

c) message type

d) mandatory information elements, as required

and may consist of additional optional information elements, when required.

The protocol discriminator, call reference, and message type information elements, in that order, appear in every message. All other information elements present in a message follow the message type information element. These information elements follow in increasing octal order, independent of whether an information element is mandatory or optional in that message.

The organization is illustrated in the example shown in Figure III - 4.

8	7	6	5	4	3	2	1	
Protocol Discriminator								Octet 1
0	0	0	0	Length of Call Reference Value (in Octets)				Octet 2
Call Reference Value								Octet 3
0	Message Type							etc.
Other Information Elements as Required								

Figure III - 4. 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.

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.

3.6.2 Protocol Discriminator

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

Two protocol discriminators will be supported in this implementation:

- Q.931 maintenance messages.

- Q.931 user-network call control messages.

These values of the protocol discriminator will be sent on SAPI 0.

The protocol discriminator is coded as follows:

8	7	6	5	4	3	2	1	
Q.931 User-network call control messages								
0	0	0	0	1	0	0	0	Octet 1

8	7	6	5	4	3	2	1	
Q.931 Maintenance messages								
0	0	0	0	0	0	1	1	Octet 1

3.6.3 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 and is coded as shown in Figure III - 5. The length of the call reference value is indicated in octet 1, bits 1-4. The call reference value may be one or two 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 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 - The two or three octets long global call reference information element will be supported in messages where it may properly appear.[2] For this implementation, the allowed messages are RESTART, RESTART ACKNOWLEDGE, SERVICE, SERVICE ACKNOWLEDGE, and STATUS.

Note that consistent with the rules for processing of other call reference values, the flag bit on the global call reference value will be set to "1" when it is sent in response to a previously received message.

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 III - 6.

Note, 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.

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							Octet 2
								Octet 3 (*Note 1*)

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 III - 5. Call reference information element

Note 1: Octet 3 is only present if the length of the call reference value is 2.

2. The network can accept 2-3 octets, but will only transmit 3 octets.

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

a) One octet call reference value

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

b) Two octet call reference value.

Figure III - 6. Examples of the encoding for global call reference

3.6.4 Message Type

The message type is the third part of every message. The message type is coded as shown in Figure III - 7 and Table III - 38. The purpose of the message type is to identify the function of the message being sent.

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

The messages which shall be supported by CPE are listed in Table III - 3, Table III - 17 Table III - 27 and Table III - 31 given earlier in this document. In addition, CPE must also support the SERVICE and SERVICE ACKNOWLEDGE messages described in Section 3.12.

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

Figure III - 7. Message type

Table III - 38. Message Types

8	7	6	5	4	3	2	1	Message Types
								Call Establishment Message:
0	0	0	0	0	0	0	1	Alerting
0	0	0	0	0	0	1	0	Call Proceeding
0	0	0	0	0	1	1	1	Connect
0	0	0	0	1	1	1	1	Connect Acknowledge
0	0	0	0	0	0	1	1	Progress
0	0	0	0	0	1	0	1	Setup
								Call Information Phase Message:
0	0	1	0	0	0	0	0	User Information
								Call Clearing Messages:
0	1	0	0	0	1	0	1	Disconnect
0	1	0	0	1	1	0	1	Release
0	1	0	1	1	0	1	0	Release Complete
0	1	0	0	0	1	1	0	Restart
0	1	0	0	1	1	1	0	Restart Acknowledge
								Miscellaneous Messages:
0	1	1	1	1	0	0	1	Congestion Control
0	1	1	0	0	0	1	0	Facility
0	1	1	1	1	1	0	1	Status
0	1	1	1	0	1	0	1	Status Enquiry
								AT&T Extensions
								Miscellaneous Messages:
0	1	1	0	1	0	1	0	Facility Acknowledge
0	1	1	1	0	0	1	0	Facility Reject
0	1	1	0	0	1	0	0	Register
								Maintenance Messages (Protocol Discriminator 00000011)
0	0	0	0	1	1	1	1	Service
0	0	0	0	0	1	1	1	Service Acknowledge

3.6.5 Other Information Elements

3.6.5.1 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 III - 8);

b) variable length information elements (see Figure III - 8).

There is a particular order of appearance for each information element in a message within each codeset (see Section 3.6.5.2). 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.

c) 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 3.6.5.4 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 an asterisk(*).

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

a) Single octet information element format (type 1)

8	7	6	5	4	3	2	1	
1	Information element identifier							Octet 1

b) Single octet information element format (type 2)

8	7	6	5	4	3	2	1	
0	Information element identifier							Octet 1
Length of contents of information element (octets)								Octet 2
Contents of information element								Octet 3 etc.

c) Variable length information element format.

Figure III - 8. Formats of information elements

CPE is recommended to support both single octet information elements as well as variable length information elements (including the information elements used with maintenance messages).

The following outlines which specific codings for those information elements will be recognized by the AT&T network for circuit-mode connection control. Please refer to Section 3.12 for specific codings for the information elements used with maintenance messages. Additional notes regarding the use of these information elements which pertain specifically to the AT&T implementation of the ISDN Primary Rate Interface are also provided.

The information elements listed below will be supported for circuit-mode connection control.

Table III - 39. Codeset 0 Information Element Identifier Coding

Single Octet Information Elements	**Reference**
Congestion Level	3.6.5.13
Shift	3.6.5.2
More data	3.6.5.18
Variable Length Information Elements	
Bearer capability	3.6.5.4
Call state	3.6.5.6
Called party number	3.6.5.7
Called party subaddress	3.6.5.8
Calling party number	3.6.5.9
Calling party subaddress	3.6.5.10
Cause	3.6.5.11
Change status	3.13.6.7.1
Channel identification	3.6.5.12
Connected number	3.6.6.6
High layer compatibility	3.6.5.15
Low layer compatibility	3.6.5.17
Network-specific facilities	3.6.5.19
Progress indicator	3.6.5.21
Redirecting number	3.6.6.7
Restart indicator	3.6.5.23
Transit Network Selection	3.6.5.27
User-user	3.6.5.28

The AT&T Standardized facilities information element in codeset 6 is supported by some specialized applications developed by AT&T as described in the appendices to this document.

3.6.5.2 Locking Shift Procedure

The network will recognize the *locking* Shift information element and be able to transport the *locking* Shift to codeset 6 and the *locking* Shift to codeset 7 information elements and the codeset 6 or 7 information elements that follow.

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 information element and any subsequent codeset 6 and 7 information elements may appear in a message only after all codeset 0 information elements in that message have been presented.

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.

When a *locking* Shift to codesets 1, 2, 3, 4, or 5 is encountered, the *locking* Shift information element and all other information elements that follow that *locking* Shift until the next *locking* Shift, or the end of the message, whichever occurs first, are dropped.

The *locking* Shift information element uses the single octet information element format and coding shown in Figure III - 9 and Table III - 40.

8	7	6	5	4	3	2	1	
	Shift identifier				New codeset identification			
1	0	0	1	0				Octet 1

↑

“0” in this position indicates locking shift

Figure III - 9. Locking Shift information element

Table III - 40. Locking Shift information element

Codeset identification (bits 3 to 1):			
3	2	1	
0	0	0	Not applicable
0 1	0 to 0	1 1	Reserved
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.

3.6.5.3 Non-locking Shift Procedure

The network will recognize *non-locking* Shift (NLS) information element but the NLS procedure is not being supported. When the network receives a NLS information element in a Layer 3 message, the network will recognize the information element and discard both the NLS information element and the information element which follows the *non-locking* Shift information element. A *locking* Shift information element shall not follow directly on a *non-locking* Shift information element. If this combination is received, it shall be interpreted as though only a *locking* Shift information element was received.

Coding for the *non-locking* Shift information element is the same as the *locking* Shift information element, except bit 4 of the *non-locking* Shift information element is coded 1 to indicate *non-locking* Shift. The *non-locking* Shift information element also supports Codeset 0, coded as 000 in bits 3 to 1 of the identification value field.

3.6.5.4 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.

The Bearer capability information element is coded as shown in Figure III - 10.

Examples of the coding of the Bearer capability information element are shown in Annex D.

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 ITU-T standard coding is used.

OCTET	FIELD	BITS	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	0000100	Bearer capability
2	Length of contents	8-1	binary	Length of information element contents
3	Extension	8	1	last octet of the description
	Coding standard	7-6	00	ITU-T standardized in this Specification
	Information transfer capability	5-1	00000	speech
			01000	unrestricted digital information
			01001	restricted digital information
			10000	3.1 KHz audio
4	Extension	8	0	description is extended through next octet
			1	last octet of the description
	Transfer mode	7-6	10	packet mode
			00	circuit mode
	Information transfer rate	5-1	00000	packet transport mode (Note 11)
			10000	64 kbit/s - circuit mode
			10011	384 kbit/s - circuit mode
			10101	1536 kbit/s - circuit mode
4a*	Extension	8	0	description is extended through next octet
			1	last octet of the description
	Structure (Note 5)	7-5	000	default (i.e., 8 KHz integrity) (Note 1)
	Configuration (Note 6)	4-3	00	point-to-point (Note 1)
	Establishment	2-1	00	demand (Note 7)
4b* (Note 4)	Extension	8	1	last octet of the description
	Symmetry	7-6	00	bidirectional symmetric (Note 8)
	Information transfer rate	5-1	same as octet 4	same as in octet 4 (Note 2)
5* (Note 3)	Extension	8	0	description is extended through next octet
			1	last octet of description
	Layer 1 identification	7-6	01	Layer 1 identification coding
	User information Layer 1 protocol	5-1	00001	rate adaption, octet 5a is required
			00010	ITU-T Recommendation G.711 mu-law
5a* (Note 3)	Extension	8	1	last octet of description
	Synch/Asynch	7	0	synchronous
	Negotiation	6	0	inband negotiation not possible
	User rate	5-1	01111	56 kbit/s Recommendation I.463
6* (Note 3)	Extension	8	1	last octet of description
	Layer 2 identification	7-6	10	Layer 2 identification coding
	User information Layer 2 protocol (Note 9)	5-1	00010	Recommendation Q.921 (I.441)
7* (Note 3)	Extension	8	1	last octet of description
	Layer 3 identification	7-6	11	Layer 3 identification coding
	User information Layer 3 protocol (Note 10)	5-1	00010	Recommendation Q.931 (I.451)

Figure III - 10. Bearer Capability Information Element

All other values reserved

Note 1: This is the default value if octet 4a is omitted.

Note 2: This is the default value if octet 4b is omitted.

Note 3: These octets may be omitted. The optional octet 5 and its extension, and octets 6 and 7 specify the layers 1, 2, and 3 protocol that will be used for the call.

Note 4: 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 5: 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

Note 6: If octet 4a is omitted, the configuration is assumed to be point-to-point

Note 7: If octet 4a is omitted, the method of establishment is assumed to be “demand”

Note 8: If octet 4b is omitted, bidirectional symmetric is assumed

Note 9: 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, octet 6 shall be present; otherwise octet 6 shall be omitted.

Note 10: 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 11: In octet 4, the Information transfer rate shall be “packet transport mode” for Non-Call Associated Temporary Signaling Connections.

3.6.5.5 Call Identity - Not applicable.

3.6.5.6 Call State

The purpose of the Call State information element is to describe the current status of a call (see Section 2.1).

The Call State information element is coded as shown in Figure III - 11.

The maximum length of this information element is three octets when ITU-T standard coding is used.

OCTET	FIELD	BITS	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	0010100	Call State
2	Length of contents	8-1	binary	Length of information element contents
3	Coding standard	8-7	00	ITU-T standardized coding
	Call state value	6-1	000000	0 - Null (U0, N0)
			000001	1 - Call Initiated (U1)
			000011	3 - Outgoing Call Proceeding (U3, N3)
			000100	4 - Call Delivered (U4, N4)
			000110	6 - Call Present (N6)
			000111	7 - Call Received (U7, N7)
			001000	8 - Connect Request (U8, N8)
			001001	9 - Incoming Call Proceeding (U9, N9)
			001010	10 - Active (U10, N10)
			001011	11 - Disconnect Request (U11, N11)
			001100	12 - Disconnect Indication (U12, N12)
			010010	18 - Tone Active (U18, N18)
			010011	19 - Release Request (U19, N19)

All other values reserved

Figure III - 11. Call State Information Element

3.6.5.7 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 III - 12

The maximum length of this information element is 20 octets.

OCTET	FIELD	BITS	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	1110000	Called party number
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	Last octet of the description
	Type of number (Note 3,5)	7-5	000	Unknown (Note 6)
			001	International number
			010	National number
			100	Subscriber number
	Numbering plan identification	4-1	0000	Unknown (Note 4)
			0001	ISDN/telephony numbering plan (Recommendation E.164/E.163) (Note 1)
			1001	Private numbering plan
4, etc.	Extension	8	0	Zero value expected
	Number digits (Note 2)	7-1	0110000	0
			0110001	1
			0110010	2
			0110011	3
			0110100	4
			0110101	5
			0110110	6
			0110111	7
			0111000	8
			0111001	9

All other values reserved

Figure III - 12. Called Party Number Information Element

Note 1: The network will accept the codepoint (0010) for Telephony numbering plan (Rec. E.163). However, the user is encouraged to use the ISDN/telephony numbering plan codepoint.

Note 2: The maximum number of digits that will be supported is 17. The number digits appear in multiple octet 4's in the same order in which they would be entered, that is, the number digit that would be entered first is located in the first octet 4.

Note 3: Prefix or escape digits shall not be included with the exception stated in Note 6.

Note 4: 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 5: For the definition of international, national and subscriber number, see Recommendation I.330.

Note 6: The three digit prefix “011” must be present for international direct-dialed calls when the Type of Number and Numbering Plan Identification are encoded as “Unknown.”

3.6.5.8 Called Party Subaddress

The network passes this information element transparently to the terminating entity. The network recognizes the information element identifier, and places no restrictions on the contents of the subaddress information. The network does not interpret the contents of the called party subaddress. The information element, when present in a message, may be from 3-23 octets in length.

OCTET	FIELD	BITS	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	1110001	Called party subaddress
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	last octet of the description
	Type of subaddress	7-5	000	NSAP (X.213/ISO 8348 AD2)
			010	User specified
	Odd/even indicator (Note 1)	4	0	Even number of address signals
			1	Odd number of address signals
	Spare	3-1	000	Spare
4, etc.	Subaddress information (Note 2)	8-1	binary	Subaddress information

All other values reserved

Figure III - 13. Called Party Subaddress Information Element

Note 1: The odd/even indicator is used when the type of subaddress is "user specified" and the coding is BCD.

Note 2: 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.

3.6.5.9 Calling Party Number

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

The maximum length of this information element is 19 octets.

OCTET	FIELD	BITS	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	1101100	Calling party number
2	Length	8-1	binary	Length of information element contents
3	Extension	8	0	description is extended through next octet
			1	last octet of the description
	Type of number (Note 5, 6)	7-5	001	international number
			010	national number
			100	subscriber number
	Numbering plan identification	4-1	0000	unknown (Note 7)
			0001	ISDN/telephony numbering plan (Recommendation E.164/E.163) (Note 1)
			1001	private numbering plan
3a	Extension	8	1	last octet of the description
	Presentation indicator (Note 2)	7-6	00	presentation allowed (Note 3)
			01	presentation restricted
	Spare	5-3	000	Spare
	Screening indicator	2-1	00	user provided, not screened (Note 3)
			01	user provided, verified and passed
			10	user provided, verified and failed
			11	network provided
4, etc.	Extension	8	0	Zero value expected
	Number digits (Note 4)	7-1	0110000	0
			0110001	1
			0110010	2
			0110011	3
			0110100	4
			0110101	5
			0110110	6
			0110111	7
			0111000	8
			0111001	9

All other values reserved

Figure III - 14. Calling Party Number Information Element

Note 1: The network will accept the codepoint for Telephony numbering plan (Rec. E.163). However, the user is encouraged to use this ISDN/telephony numbering plan codepoint.

Note 2: 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.

Note 3: This is the default value if octet 3a is omitted.

Note 4: The maximum number of digits that will be supported is 15. Prefix or escape digits shall not be included.

Note 5: Prefix or escape digits shall not be included.

Note 6: For the definition of international, national and subscriber number, see Recommendation I.330.

Note 7: 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.

3.6.5.10 Calling Party Subaddress

The network passes this information element transparently to the terminating entity. The network recognizes the information element identifier, and places no restrictions on the contents of the subaddress information. The network does not interpret the calling party subaddress information element. The information element, when present in a message, may be from 3-23 octets in length.

OCTET	FIELD	BITS	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	1101101	Calling party subaddress
2	Length	8-1	binary	Length of information element contents
3	Extension	8	0	description is extended through next octet
			1	last octet of the description
	Type of subaddress	7-5	000	NSAP (X.213/ISO 8348 AD2)
			010	User specified
	Odd/even indicator (Note 1)	4	0	Even number of address signals
			1	Odd number of address signals
	Spare	3-1	000	Spare
4, etc.	Subaddress information (Note 2)	8-1	binary	Subaddress information

All other values reserved

Figure III - 15. Calling Party Subaddress Information Element

Note 1: The odd/even indicator is used when the type of subaddress is "user specified" and the coding is BCD.

Note 2: 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.

3.6.5.11 Cause

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

The maximum length of this information element is 22 octets.

Cause definitions can be found in Annex C.

OCTET	FIELD	BITS	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	0001000	Cause
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	last octet of the description
	Coding standard	7-6	00	ITU-T standardized for this specification
			11	standard specific to identified location (network specific)
	Spare	5	0	Spare
	Location (Note 1)	4-1	0000	user
			0001	private network serving local user
			0010	public network serving local user
			0011	transit network
			0100	public network serving remote user
			0101	private network serving remote user
			0111	international network
			1010	network beyond interworking point
4	Extension	8	1	last octet of the description
	Cause value	7-1	binary	(Note 2)
5*, etc.	Diagnostics (Note 3)	8-1	binary	(Note 2)

All other values reserved

Figure III - 16. Cause information element

Note 1: Depending on the location of the users, the local public network and remote public network may be the same network. The network generates only “transit network” but passes all CPE generated location field values without alteration.

Note 2: See Table III - 41.

Note 3: Diagnostics octets may be omitted.

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

Diagnostic information is not available for every cause, see Table III - 41. The inclusion of diagnostics is optional. When available, the coding of diagnostic(s) is the same as for the corresponding information element in Section 3.6.

Table III - 41. Summary of Cause Values

Class 765	Value 4321	Cause Number	Cause	Diagnostics
000	0001	01	Unallocated (unassigned) number	None
000	0010	02	Calling party off hold	None
000	0011	03	Calling party dropped while on hold	None
000	0110	06	Channel unacceptable	None
001	0000	16	Normal call clearing	None
001	0001	17	User busy	None
001	0010	18	No user responding	None
001	0011	19	No answer from user (user alerted)	None
001	0101	21	Call rejected	None
001	0110	22	Number changed	New called party number
001	1011	27	Destination out of service	None
001	1100	28	Invalid number format	Number information element
001	1101	29	Facility rejected	Facility identification
001	1110	30	Response to STATUS ENQUIRY	None
001	1111	31	Normal, unspecified	None
010	0010	34	No circuit or channel available	None
010	1001	41	Temporary failure	None
010	1010	42	Switching equipment congestion	None
010	1011	43	Access information discarded	None
010	1100	44	Requested circuit/channel not available	None
010	1111	47	New destination (a network-specific Coding standard value only, see Appendix 2)	None
011	0010	50	Requested facility not subscribed	Facility identification
011	0100	52	Outgoing calls barred	None
011	0110	54	Incoming calls barred	None
011	1010	58	Bearer capability not presently available	None
011	1111	63	Service or option not available, unspecified	None
100	0001	65	Bearer capability not implemented	None
100	0010	66	Channel type not implemented	None
100	0101	69	Requested facility not implemented	Facility
101	0001	81	Invalid call reference	None
101	0010	82	Identified channel does not exist	Channel identification
101	1000	88	Incompatible destination	None
101	1011	91	Invalid transit network selection	None
110	0000	96	Mandatory information element is missing	Information element identifier
110	0001	97	Message type non-existent or not implemented	Message type
110	0010	98	Message not compatible with the call state or message type non-existent or not implemented	Message type
110	0011	99	Information element non-existent or not implemented	Information element identifier(s)
110	0100	100	Invalid information element contents	Information element
110	0110	102	Recovery on timer expiry	Timer 3XX that expired in IA5 characters
111	1111	127	Interworking, unspecified	None

The network recognizes or generates and sends to a user the above cause values. However, the network may generate a tone or announcement on the information channel that corresponds to a cause that has end-to-end significance. The following table shows the tone and announcement treatment for those causes.

Table III - 42. Tone and Announcement Treatment

Switch Tone or Announcement Treatment	Cause Number(s)
busy tone	17
no circuit announcement	34
vacant code announcement	01, 22, 28, 58, 65, 66, 88
reorder announcement	18, 21, 41, 42, 52, 54, 81, 82, 96, 97, 98, 100, 102

Note: The default treatment for the other causes will be a reorder announcement if appropriate.

Messages which contain the Cause information element may be propagated through the network. However, not all cause values have end-to-end significance. Some only have meaning for the local interface and are referred to as local causes. When the network receives a message containing one of the local causes and determines that the message contents must be propagated through the network, the cause value in the propagated message shall be changed to an appropriate cause value with end-to-end significance. The mapping of the local cause values to those with end-to-end significance is provided in the following table.

Local Cause	End-to-End Cause
Channel unacceptable (06)	Normal, Unspecified (31)
Response to STATUS ENQUIRY (30)	Normal, Unspecified (31)
Requested circuit/channel not available (44)	Normal, Unspecified (31)
Outgoing calls barred (52)	Call reject (21)
Incoming calls barred (54)	Call reject (21)
Service or option not available, unspecified (63)	Temporary failure (41)
Invalid call reference (81)	Temporary failure (41)
Identified channel does not exist (82)	Temporary failure (41)
Mandatory information element is missing (96)	Temporary failure (41)
Message type non-existent or not implemented (97)	Temporary failure (41)
Message not compatible with the call state or message type non-existent or not implemented (98)	Temporary failure (41)
Invalid information element contents (100)	Temporary failure (41)
Recovery on timer expiry(102)	Temporary failure (41)
Unrecognized cause value	Normal, Unspecified (31)

3.6.5.12 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 maximum length for this information element is 8 octets.

OCTET	FIELD	BITS	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	0011000	Channel identification
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	last octet of the description
	Interface identifier present (Note 1)	7	0	interface implicitly defined (interface which includes the D-Channel carrying this IE is indicated)
			1	interface explicitly defined
	Interface type	6	1	primary rate
	Spare	5	0	Spare
	Preferred/Exclusive (Note 2)	4	0	indicated channel is preferred
			1	exclusive; only the indicated channel is acceptable
	D-Channel indicator	3	0	the channel identified is not the D-Channel
			1	the channel identified is the D-Channel
	Information channel selection	2-1	00	no channel (Note 3)
			01	as indicated in the following octets
3.1	Extension	8	0	description is extended through next octet
			1	last octet of the description
	Interface identifier (Note 4)	7-1	binary	binary code assigned to the interface (Note 5)
3.2 (Note 6)	Extension	8	1	last octet of the description
	Coding standard	7-6	00	ITU-T standardized for this specification
	Number/Map	5	0	channel is indicated by the number in following octet
			1	channel is indicated by the slot map in the following octet(s) (Note 7)
	Channel type/Map element type	4-1	0011	B-Channel units (Note 8)
			0110	H0 channel units (Note 8)
			1000	H11 channel units
3.3 or 3.3 - 3.5 (Note 6, 11)	Channel number/Slot Map	8-1	binary	Binary number assigned to the channel (Note 9)
			binary	bit positions in slot map corresponding to time slots used by the channel are set to 1 (Note 10)

All other values reserved

Figure III - 17. Channel identification information element

Slot Map

Bit 8 Time Slot	Bit 7 Time Slot	Bit 6 Time Slot	Bit 5 Time Slot	Bit 4 Time Slot	Bit 3 Time Slot	Bit 2 Time Slot	Bit 1 Time Slot	
24	23	22	21	20	19	18	17	Octet 3.3
16	15	14	13	12	11	10	9	Octet 3.4
8	7	6	5	4	3	2	1	Octet 3.5

Figure III - 18. Slot Map Field

Note 1: Explicit identification must be used for H11 channels or in signaling for non-associated facilities.

Note 2: The network coding for this field value is Exclusive. This field value will be coded as Preferred during B-Channel Negotiation. For additional information see Section 3.7.2.3.

Note 3: This value is used for D-Channel Backup or Temporary Signaling Connections (TSCs).

Note 4: An interface arrangement may consist of more than one DS1 controlled by a single D-Channel or two D-Channels (in D-Channel Backup configuration). In either case, when signaling for a channel on a DS1 other than the one on which the D-Channel resides, the Interface Identifier in octet 3.1 is required. It is recommended that the CPE always provide the Interface Identifier. See Note 1. Additionally, CPE must accept the Interface Identifier.

Note 5: The range of Interface Identifiers supported will be 0-31.

Note 6: Octets 3.2 and 3.3 will be absent for H11 channels and Non-Call Associated Temporary Signaling Connections.

Note 7: The slot map will be used only when H0 channels are being requested.

Note 8: The AT&T Network will encode the Channel type/Map element type field as H0 channel units for H0 type calls. The AT&T Network will accept the codings of both B-Channel and H0-Channel units in the Map element type field for H0 calls.

Note 9: Binary number assigned to the channel. For B-Channels, the channel number equals the time slot number. The range of channel numbers supported will be 1-24.

Note 10: The slot map in octet 3.3 through 3.5 will be supported for H0 channels. For this implementation, H0 channels are constrained to occupy time slots 1-6, 7-12, 13-18, and 19-24 (if time slot 24 is not the D-Channel). The slot map field will always contain a B-Channel map. The length of the slot map is 3 octets.

Note 11: When channel number is used, bit 8 is reserved for use as an extension bit and is thus set to 1.

3.6.5.13 Congestion Level

The purpose of the congestion level information element is to indicate the congestion status of the call. It is a single octet information element and can take one of two values: receiver ready or receiver not ready.

OCTET	FIELD	BITS	VALUE	MEANING
1	Extension	8	1	last octet of the description
	Information element identifier	7-5	011	Congestion level
	Congestion level	4-1	0000	receiver ready
			1111	receiver not ready

All other values reserved

Figure III - 19. Congestion Level Information Element

3.6.5.14 Display - Not applicable.

3.6.5.15 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.

This information element is not interpreted by the network and is delivered to the distant user. Hence, the network only needs to recognize the information element identifier.

The maximum length of this information element is 5 octets.

Figure III - 20. High Layer Compatibility Information Element

OCTET	FIELD	BIT	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	1111101	High layer compatibility
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	last octet of the description
	Coding standard	7-6	00	ITU-T standardized coding
			01	reserved for other international standards (Note 1)
			10	National standard (Note 1)
			11	Standard defined for the network (public or private) present on the network side of the interface (Note 1)
	Interpretation (Note 2, 3)	5-3	100	First (primary or only) high layer characteristics identification (in octet 4) to be used in the call
	Presentation method of protocol profile	2-1	01	High layer protocol profile (without specification of attributes) (Note 4)
4	Extension	8	1	last octet of the description
			0	description is extended through next octet
	High layer characteristics identification (Notes 6,7,8)	7-1	0000001	Telephony (Recommendation G.711)
			0000100	Facsimile Group 2/3 (Recommendation T.62)
			0100001	Document application profile for Group 4 Class 1 Facsimile (Recommendation T.503)
			0100100	Document application profile for formatted mixed mode (Recommendation T.501)
			0101000	Document application profile for processable-form (Recommendation T.502)
			0110001	Teletex (Recommendation T.62, T.70)
			0110010	Document application profile for videotex interworking between Gateways (Recommendation T.504)
			0110101	Telex
			0111000	Message handling systems (MHS) (Rec. X.400)
			1000001	OSI Application (Recommendation X.200)
			1011110	Reserved for maintenance (Note 5)
			1011111	Reserved for management (Note 5)
			1111111	Reserved
4a (Note 9)	Extension	8	1	last octet of the description
	Extended high layer characteristics identification	7-1	0000001	Telephony (Recommendation G.711)
			0000100	Facsimile Group 2/3 (Recommendation T.62)
			0100001	Document application profile for Group 4 Class 1 Facsimile (Recommendation T.503)
			0100100	Document application profile for formatted mixed mode (Recommendation T.501)
			0101000	Document application profile for processable-form (Rec. T.502)
			0110001	Teletex (Recommendation T.62, T.70)
			0110010	Document application profile for videotex interworking between Gateways (Recommendation T.504)
			0110101	Telex
			0111000	Message handling systems (MHS) (Rec. X.400)
			1000001	OSI Application (Recommendation X.200)
			1011110	Not available for assignment
			1011111	Not available for assignment
			1111111	Reserved

All other values reserved

Note 1: These other coding standards should be used only when the desired high layer compatibility can be represented with the ITU-T standardized coding.

Note 2: "Interpretation" indicates how the "High layer characteristics identification" (in octet 4) should be interpreted.

Note 3: 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.

Note 4: 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 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.

Note 5: When this is included, octet 4 may be followed by octet 4a.

Note 6: The coding above applies in case of "Coding standard" = "ITU-T standard" and "Presentation method of protocol profile" = "High layer protocol profile".

Note 7: Further compatibility checking will be executed by the OSI high layer protocol.

Note 8: Codepoints are added only to those services for which ITU-T Recommendations are available. See also Recommendation I.212.

Note 9: This octet may be present when octet 4 indicates Maintenance and Management.

3.6.5.16 Keypad Facility - Not applicable.

3.6.5.17 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. Hence, the network only needs to recognize the information element identifier.

The maximum length of this information element is 16 octets.

OCTET	FIELD	BIT	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	1111100	Low layer compatibility
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	last octet of the description
			0	description is extended through next octet
	Coding standard	7-6	00	ITU-T standardized coding
			01	reserved for other international standards (Note 1)
			10	National standard (Note 1)
			11	Standard defined for the network (public or private) present on the network side of the interface (Note 1)
	Information transfer capability	5-1	00000	Speech
			01000	Unrestricted digital information
			01001	restricted digital information
			10000	3.1 KHz audio
			10001	7 KHz audio
			11000	Video
3a	Extension	8	1	last octet of the description
	Negotiation indicator	7	0	Out of band negotiation not possible (Note 2)
			1	Out of band negotiation possible
	Spare	6-1	000000	Zeros expected
4	Extension	8	1	last octet of the description
			0	description is extended through next octet
	Transfer mode	7-6	00	Circuit mode
			10	Packet mode
	Information transfer rate (Notes 3,4)	5-1	00000	Packet mode - code used for packet mode calls
			10000	Circuit mode - 64 Kbps
4a*	Extension	8	1	last octet of the description
			0	description is extended through next octet
	Structure	7-5	000	Default (Note 5)
			001	8 KHz integrity
			100	Service data unit integrity
			111	Unstructured
	Configuration	4-3	00	Point-to-point (Note 6)
	Establishment	2-1	00	Demand (Note 7)
4b* (Note 8)	Extension	8	1	last octet of the description
	Symmetry (Note 9)	7-6	00	Bidirectional symmetric
			01	Bidirectional asymmetric
			10	Unidirectional (origination → destination)
			11	Unidirectional (destination → origination)
	Information transfer rate (destination → origination)	5-1	00000	Packet mode - code used for packet mode calls
			10000	Circuit mode - 64 Kbps

5* (Note 10)	Extension	8	1	last octet of the description
			0	description is extended through next octet
	Layer 1 Identification	7-6	01	Layer 1 identification
	User information Layer 1 protocol	5-1	00001	Mode 2 / Mode 3 Adaptive (Note 11)
			00001	ITU-T standardized rate adaption V.110/X.30. (Note 12)
			00010	Recommendation G.711 u-law
			00111	Non-ITU-T standardized rate adaptation. (Note 13)
5a (Note 14)	Extension	8	1	last octet of the description
			0	description is extended through next octet
	Synch. / Asynch. (Note 15)	7	0	Synchronous
			1	Asynchronous
	Spare	6	0	Spare
	User rate	5-1	00000	rate is indicated by E-bits specified in Rec. I.460
			00001	0.6 kbit/s Recommendation V.6 and X.1
			00010	1.2 kbit/s Recommendation V.6
			00011	2.4 kbit/s Recommendation V.6 and X.1
			00100	3.6 kbit/s Recommendation V.6
			00101	4.8 kbit/s Recommendation V.6 and X.1
			00110	7.2 kbit/s Recommendation V.6
			00111	8 kbit/s Recommendation I.460
			01000	9.6 kbit/s Recommendation V.6 and X.1
			01001	14.4 kbit/s Recommendation V.6
			01010	16 kbit/s Recommendation I.460
			01011	19.2 kbit/s Recommendation V.6
			01100	32 kbit/s Recommendation I.460
			01110	48 kbit/s Recommendation V.6 and X.1
			01111	56 kbit/s Recommendation V.6
			10101	0.1345 kbit/s Recommendation X.1
			10110	0.100 kbit/s Recommendation X.1
			10111	0.075/1.2 kbit/s Recommendation V.6 and X.1
			11000	1.2/0.075 kbit/s Recommendation V.6 and X.1
			11001	0.050 kbit/s Recommendation V.6 and X.1
			11010	0.078 kbit/s Recommendation V.6 and X.1
			11011	0.110 kbit/s Recommendation V.6 and X.1
			11100	0.150 kbit/s Recommendation V.6 and X.1
			11101	0.200 kbit/s Recommendation V.6 and X.1
			11110	0.300 kbit/s Recommendation V.6 and X.1
			11111	12 kbit/s Recommendation V.6

5b* (Note 16)	Extension	8	1	last octet of the description
			0	description is extended through next octet
	Intermediate rate	7-6	00	Not used
			01	8 Kbps
			10	16 Kbps
			11	32 Kbps
	Network Independent Clock (NIC) on Transmission (Tx) (Note 17, 18)	5	0	Not required to send data with Network Independent Clock
			1	Required to send data with Network Independent Clock
	NIC on Reception (Rx) (Note 18, 19)	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)
	Flow control on TX (Note 17, 18)	3	0	Not required to send data with flow control mechanism
			1	Required to send data with flow control mechanism
	Flow control on Rx (Note 18, 19)	2	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)
	Spare	1	0	Spare
5b* (Note 20)	Extension	8	1	last octet of the description
			0	description is extended through next octet
	Header/No Header	7	0	Rate adaptation header not included
			1	Rate adaptation header included
	Multiple frame support in data link	6	0	Multiple frame establishment not supported. Only UI frames allowed
			1	Multiple frame establishment supported
	Mode of operation	5	0	Bit transparent mode of operation
			1	Protocol sensitive mode of operation
	Logical link identifier negotiation	4	0	Default. LLI=256 only
			1	Full protocol negotiation (Note 21)
	Assignor / Assignee	3	0	Message originator is “Default assignee”
			1	Message originator is “Assignor only”
	In-band / Out-of-band negotiation	2	0	Negotiation is done with USER INFORMATION messages on a Temporary Signaling Connection
			1	Negotiation is done in-band using Logical Link zero
	Spare	1	0	Spare

5c* (Note 16)	Extension	8	1	last octet of the description
			0	description is extended through next octet
	Number of stop bits	7-6	00	Not used
			01	1 bit
			10	1.5 bits
			11	2 bits
	Number of data bits including parity bit if present	5-4	00	Not used
			01	5 bits
			10	7 bits
			11	8 bits
	Parity	3-1	000	Odd
			010	Even
			011	None
			100	Forced to 0
			101	Forced to 1
5d* (Note 16)	Extension	8	1	last octet of the description
	Duplex mode	7	0	Half duplex
			1	Full duplex
	Modem type	6-1	binary	Coded according to network specific rules
6* (Note 22)	Extension	8	1	last octet of the description
			0	description is extended through next octet
	Layer 2 Identification	7-6	10	Layer 2 identification
	User information Layer 2 protocol	5-1	00010	Recommendation Q.921 (I.441)
			00110	Recommendation X.25, link level
			00111	ITU-T Recommendation X.25 Multilink
			01000	Extended LAPB: for half duplex operation (T.71)
			01001	HDLC ARM (ISO 4335)
			01010	HDLC NRM (ISO 4335)
			01011	HDLC ABM (ISO 4335)
			01100	LAN logical link control (ISO 8802/2)
			01101	ITU-T Rec. X.75. Single Link Procedure (SLP)
6a	Extension	8	1	last octet of the description
	Optional Layer 2 protocol information	7-1	binary	Optional Layer 2 protocol information

7* (Note 24)	Extension	8	1	last octet of the description
			0	description is extended through next octet
	Layer 3 identification	7-6	11	Layer 3 identification
	User information Layer 3 protocol	5-1	00010	Recommendation Q.931 (I.451)
			00110	Recommendation X.25, packet layer
			00111	ISO 8208 (X.25 packet level protocol for data terminal equipment)
			01000	ISO 8348 (OSI connection oriented network service specific subset of ISO 8208 and ITU-T X.25)
			01001	ISO 8473 (OSI connectionless service)
			01010	ITU-T Recommendation T.70 minimum network layer
			00111	ISDN Packet Mode (DMI Mode 3) (Note 23)
7a	Extension	8	1	last octet of the description
	Optional Layer 3 protocol information	7-1	binary	Optional Layer 3 protocol information

All other values reserved

Figure III - 21. Low layer compatibility information element

Note 1: These other coding standards should be used only when the desired high layer compatibility can be represented with the ITU-T standardized coding.

Note 2: When octet 3a is omitted, “out of band negotiation not possible” shall be assured.

Note 3: 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 4: 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 5: 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

Note 6: If octet 4a is omitted, the configuration is assumed to be point-to-point.

Note 7: If octet 4a is omitted, the method of establishment is assumed to be “demand”.

Note 8: 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.

Note 9: If octet 4b is omitted, bidirectional symmetric is assumed.

Note 10: 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 11: The Coding standard field (octet 3, bits 7 through 6) must be coded network specific when this codepoint is used.

Note 12: This implies the presence of octets 5a and optionally octet 5b, 5c and 5d.

Note 13: This implies the presence of octet 5a and, optionally, octets 5b, 5c and 5d. The use of this codepoint indicates that the user rate specified in octet 5a is defined in accordance with the non-ITU-T standardized rate adaptation scheme. Additionally, octets 5b, 5c and 5d, if present, are defined consistent with the specified rate adaptation.

Note 14: This octet may be present if octet 5 indicates either of the ITU-T standardized rate adaptions V.110/X.30 or V.120.

Note 15: Octets 5b-5d may be omitted in the case of synchronous user rates.

Note 16: This octet may be present only if octet 5 indicates ITU-T standardized rate adaption V.110/X.30.

Note 17: Refers to transmission in the forward direction of the call.

Note 18: See recommendations V.110 and X.30.

Note 19: Refers to transmission in the backward direction of the call.

Note 20: This octet is present only if octet 5 indicates ITU-T standardized rate adaption V.120.

Note 21: A connection over which protocol negotiation will be executed is indicated in bit 2 of octet 5b.

Note 22: 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.

Note 23: The coding standard field (octet 3, bits 7-6) must be coded network specific when this code point is used.

Note 24: 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.

3.6.5.18 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 in the corresponding USER INFORMATION message. This information element informs the destination user that more USER INFORMATION messages may be expected. The use of the More data information element is not supervised by the network.

OCTET	FIELD	BIT	VALUE	MEANING
1	Extension	8	1	Last octet of the description
	Information element identifier	7-1	0100000	More Data

All other values reserved

Figure III - 22. More Data Information Element

3.6.5.19 Network-Specific Facilities

The purpose of the Network-specific facilities information element is to indicate which network facilities are being invoked.

Two binary facilities may be requested by encoding octet 4 twice. When multiple binary facilities are present in a network-specific facilities information element, the facilities should be presented in increasing octal order.

The maximum length of this information element is 11 octets.

The following codings will be supported for this information element:

OCTET	FIELD	BITS	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	0100000	Network Specific Facilities
2	Length	8-1	binary	Length of information element contents
3	Length of network identification (Note 1)	8-1	00000000	0 Octets
			00000100	4 Octets
3.1	Extension	8	1	Last octet of description
	Type of network identification	7-5	000	User specified / Unknown
			010	National network identification
	Network identification plan	4-1	0001	Carrier identification code
3.2 (+ extensions)	Spare	8	0	Spare
	Network identification	7-1	binary	IA5 characters corresponding to AT&T Network code: 288 (Note 5)
4	Parameterized / Binary	8	0	There are parameters associated with the requested facility and they are specified in the following octets. (Note 2)
			1	The requested facility is a binary facility. (Note 3)
	Expansion	7	1	Coding of facility is in the following 6 bits
	Feature/Service	6	0	The requested facility is a feature
			1	The requested facility is a service
	Facility coding value	5-1	Binary	Parameterized (Note 2)
			Binary	Binary (Note 3)
5	Spare	8	0	Spare
	Parameterized field	7-1	Binary	Parameterized (Note 4)

Figure III - 23. Network-specific facilities information element

Note 1: This field contains the length, in octets, of the network identification found in Octets 3.1, 3.2 and the repetition of Octet 3.2.

Note 2: See Table III - 44 for Parameterized facility coding value.

Note 3: See Table III - 43 for Binary facility coding value.

Note 4: See Table III - 45 for Parameterized field.

Note 5: If a Network-Specific Facilties and a Transit Network Selection information element in the same SETUP message specify different Carrier Identification Codes, the Transit Network Selection information element shall take precedence for selecting an alternate carrier for AT&T Digital Link dial-around capability.

Table III - 43. Binary Facility Coding Values for the Network-Specific Facilities Information Element

Bits 5	4	3	2	1	Feature ***(Bit 6=0)***
0	0	0	0	1	CPN (SID) preferred
0	0	0	1	0	BN (ANI) preferred
0	0	0	1	1	CPN (SID) only
0	0	1	0	0	BN (ANI) only
0	1	0	0	1	Call Associated TSC
0	1	0	1	0	Notification of Call Associated TSC Clearing or Resource Unavailable
0	0	1	0	1	Operator
0	0	1	1	0	Pre-Subscribed Common Carrier Operator (PCCO)

Bits 5	4	3	2	1	Service ***(Bit 6=1)***	Comment
0	0	0	0	1	SDN (including GSDN)	access and egress
0	0	0	1	0	Toll Free MEGACOM®	egress only
0	0	0	1	1	MEGACOM®	access only
0	0	1	1	0	ACCUNET Switched Digital Service (including Switched Digital International)	access and egress
0	1	0	0	0	International Toll Free Service	egress only
1	0	0	0	0	AT&T MultiQuest®	egress only
0	0	1	1	1	Long Distance Service	access and egress
1	0	1	1	1	Call Redirection Service	egress only

Table III - 44. Parameterized Facility Coding Values for the Network-Specific Facilities Information Element

Bits 5	4	3	2	1	Feature (Bit 6=0)
0	1	0	0	1	Available Feature Indicator

Table III - 45. Parameterized Field for the Network-Specific Facilities Information Element

Bits 7	6	5	4	3	2	1	
0	0	0	0	1	1	0	Vari-A-Bill (Flexible Billing)
0	0	0	1	1	1	0	Network Managed Data (Toll Free Transfer Connect Service)

All other values are reserved.

Note: In future implementations, new codings may be added to this information element to accommodate new features and services supported by the AT&T network.

3.6.5.20 Notification Indicator - Not applicable.

3.6.5.21 Progress Indicator

The purpose of the Progress indicator is to describe an event which has occurred during the life of a voice or data call. The maximum length of this information element is 4 octets.

OCTET	FIELD	BIT	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	0011110	Progress Indicator
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	last octet of the description
	Coding standard	7-6	00	ITU-T standard coding
	Spare	5	0	Spare
	Location	4-1	0000	user
			0001	Private network serving the local user
			0010	Public network serving the local user
			0011	transit network (Note 1)
			0100	Public network serving the remote user
			0101	Private network serving the remote user
4	Extension	8	1	last octet of the description
	Progress description	7-1	0000001	#1. Call is not end-to-end ISDN and/or further call progress information may be available in-band (Note 2)
			0001000	#8. In-band information or appropriate pattern is now available (Notes 2 and 3)

All other values reserved

Figure III - 24. Progress Indicator Information Element

Note 1: This value is sent by the network. All other values will be accepted from the user and passed transparently through the network.

Note 2: Information may be delivered to the user or may also be requested by the network in-band.

Note 3: When the network sends a PROGRESS message to an originating user to indicate the need for network interaction, progress description value 8 will be sent.

3.6.5.22 Repeat Indicator - Not applicable.

3.6.5.23 Restart Indicator

The purpose of the Restart indicator is to identify the class of facility to be restarted.

OCTET	FIELD	BIT	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	1111001	Restart Indicator
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	last octet of the description
	Spare	7-4	0000	Spare (zeros expected)
	Class	3-1	000	Indicated Channel (Note 1)

All other values reserved

Figure III - 25. Restart Indicator Information Element

Note 1: The Channel identification information element must be included in the RESTART and/or RESTART ACKNOWLEDGE messages to indicate which channel is to be restarted. The channel to be restarted must be a B-Channel.

3.6.5.24 Segmented Message - Not applicable.

3.6.5.25 Sending Complete - Not applicable.

3.6.5.26 Signal - Not applicable.

3.6.5.27 Transit Network Selection

The purpose of the Transit network selection information element is to identify one requested transit network. This information element is included in a SETUP message only when a transit network carrier other than the presubscribed is to be selected.

If a Network-Specific Facilties and a Transit Network Selection information element in the same SETUP message specify different Carrier Identification Codes, the Transit Network Selection shall take precedence for purposes of selecting an alternate carrier.

The default maximum length of this information element is 7 octets.

OCTET	FIELD	BITS	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	1111000	Transit network selection
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	last octet of the description
	Type of network identification	7-5	000	User specified
			010	National network identification
	Network identification plan	4-1	0000	Unknown
			0001	Carrier Identification Code
			0011	Data network identification code (Recommendation X.121)
4, etc.	Extension	8	0	Description extends through the next octet
			1	Last octet of description
	Network identification	4-1	0000	IA5 Characters (Note 1)

Figure III - 26. Transit Network Selection Information Element

Note 1: 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 4 digit code assigned to Interexchange Carriers. The North American Numbering Plan Administration (NANPA), sponsored by Lockheed Martin Corporation, maintains a list of valid Carrier Identification codes at the following site on the world wide web: http://www.nanpa.com.

3.6.5.28 User-user

The purpose of the user-user information element is to convey information between two users who have requested this facility. This information is not interpreted by the network, but rather is carried transparently and delivered to the remote user. The network restriction on the length of this information element is 251 octets for the USER INFORMATION message and 131 octets for all other message types for which it is allowed.

OCTET	FIELD	BIT	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	1111110	User-user
2	Length	8-1	binary	Length of information element contents
3	Protocol discriminator	8-1	00000000	User-specific protocol (Note 1)
			00000001	OSI high layer protocols
			00000010	X.244 (Note 2)
			00000011	Reserved for System management convergence function or Maintenance Message
			00000100	IA5 characters
			00000111	Rec. V.120 rate adaptation
			00001000	Q.931 (I.451) user-network call control message
			00010000 Through 00111111	Reserved for other network layer or Layer 3 protocols, including Recommendation X.25. (Note 3)
			01000000 Through 01001111	National use
			01010000 Though 11111110	Reserved for other network layer or Layer 3 protocols, including Recommendation X.25. (Note 3)
4, etc.	User information	8-1		User information

All other values reserved

Figure III - 27. User-User Information Element

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.

3.6.6 Supplementary Services Information Elements

3.6.6.1 Date/Time - Not applicable.

3.6.6.2 Facility - Not applicable.

3.6.6.3 Feature Activation - Not applicable.

3.6.6.4 Feature Indication - Not applicable.

3.6.6.5 Switchhook - Not applicable.

3.6.6.6 Connected Number

Note that the ITU-T Recommendation Q.931-1992 refers to this information element as Connected address.

This information element, which is not interpreted by the network, indicates which address is connected to a call. The connected number may differ from the calling party or called party number because of facilities like transfer. The maximum length of this information element is 18 octets.

OCTET	FIELD	BITS	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	0001100	Connected number
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	Last octet of description
	Type of number	7-5	001	International (Note 2)
	(Note 1)		010	National (Note 2)
			100	Subscriber number (Note 2)
	Numbering plan identification	4-1	0000	Unknown (Note 5)
			0001	ISDN/telephony numbering plan (Recommendation E.164/E.163) (Note 3)
			1001	Private numbering plan
4, etc.				
(Note 4)	Extension	8	0	description is extended through next octet
	Number digits	7-1	0110000	0
	(IA5 Characters)		0110001	1
			0110010	2
			0110011	3
			0110100	4
			0110101	5
			0110110	6
			0110111	7
			0111000	8
			0111001	9

All other values reserved.

Figure III - 28. Connected Number Information Element

Note 1: For the definition of international, national and subscriber number, see Recommendation I.330.

Note 2: Prefix or escape digits shall not be included.

Note 3: The network will accept the codepoint for Telephony numbering plan (Rec. E.163). However, the user is encouraged to use this ISDN/telephony numbering plan codepoint.

Note 4: 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.

Note 5: 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.

3.6.6.7 Redirecting Number

The purpose of the Redirecting number information element is to identify the number from which a call diversion or transfer was invoked.

This information element may not be interpreted by the network.[3] Hence, the network may only need to recognize the information element identifier. The maximum length of this information element is 20 octets.

3. If Redirecting Number is user generated, then it is transported as MA UUI and will not be interpreted by the network. If it is network generated, then it is not transported as MA UUI and will be interpreted by the network.

OCTET	FIELD	BIT	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	1110100	Redirecting Number
2	Length	8-1	binary	Length of information element contents
3	Extension	8	0	description is extended through next octet
			1	last octet of the description
	Type of number (Note 2)	7-5	001	international number
			010	national number
			100	subscriber number
	Numbering plan identification	4-1	0000	unknown
			0001	ISDN/telephony numbering plan (Recommendation E.164/E.163) (Note 1)
			1001	private numbering plan
3a* (Note 4)	Extension	8	0	description is extended through next octet
			1	last octet of the description
	Presentation Indicator (Note 3)	7-6	00	Presentation allowed
			01	Presentation restricted
	Spare	5-3	000	Spare
	Screening Indicator	2-1	00	User-provided, not screened
			01	User-provided, verified and passed
			10	User-provided, verified and failed
			11	Network provided
3b*	Extension	8	1	Last octet of description
	Spare	7-5	000	Spare
	Reason for redirection	4-1	0000	unknown
			0001	call forwarding busy
			0010	call forwarding no reply
			0011	call forwarding network busy
4, etc.	Extension	8	0	Description extended through next octet
	Number digits (IA5 Characters)	7-1	0110000	0
			0110001	1
			0110010	2
			0110011	3
			0110100	4
			0110101	5
			0110110	6
			0110111	7
			0111000	8
			0111001	9

All other values reserved.

Figure III - 29. Redirecting Number Information Element

Note 1: The network will accept the codepoint (0010) for Telephony numbering plan (Rec. E.163). However, the user is encouraged to use this ISDN/telephony numbering plan codepoint.

Note 2: Prefix or escape digits shall not be included.

Note 3: 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.

Note 4: If octet 3a is omitted, the calling party number shall be assumed to be user provided (with no network screening) and presentation to the terminating user is permitted.

3.6.6.8 Codeset 6 Information Elements

If the Codeset 6 information element is not interpreted by the network, it may be passed transparently to the terminating entity for its use. The *locking* Shift to codeset 6 information element must precede any codeset 6 information elements. Only the codeset 6 information elements defined in this section are interpreted by the network.

3.6.6.8.1 Facility

The Facility information element indicates the invocation and operation of supplementary services. This information element from ITU-T 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 following values are supported for this information element under the specified fields herein.

OCTET	FIELD	BITS	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	0011100	Facility
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	Last octet of description
	Spare	7-6	00	Spare
	Service discriminator	5-1	10001	Discriminator for supplementary service application
4, etc. (Note 1)	Component	8-1	binary	See following tables for coding

Figure III - 30. Facility information element

Note 1: For PRI, only one component is allowed to be generated or received.

3.6.6.8.1.1 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

Table III - 46. Invoke component

Invoke component	Reference	Mandatory Indication	Octet group
Component type tag	3.6.6.8.1.4	Mandatory	4
Component length (note 1)	3.6.6.8.1.3		5
Invoke identifier tag	3.6.6.8.1.5	Mandatory	6
Invoke identifier length	3.6.6.8.1.3		7
Invoke identifier	3.6.6.8.1.6		8
Linked identifier tag	3.6.6.8.1.5	Optional	9
Linked identifier length	3.6.6.8.1.3		10
Linked identifier	3.6.6.8.1.7		11
Operation value tag	3.6.6.8.1.8	Mandatory	12
Operation value length	3.6.6.8.1.3		13
Operation value	3.6.6.8.1.9		14
Argument (note 2)	3.6.6.8.1.12	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 III - 47. Return result component

Return result component	Reference	Mandatory Indication	Octet group
Component type tag	3.6.6.8.1.4	Mandatory	4
Component length (note 3)	3.6.6.8.1.3		5
Invoke identifier tag	3.6.6.8.1.5	Mandatory	6
Invoke identifier length	3.6.6.8.1.3		7
Invoke identifier	3.6.6.8.1.6		8
Sequence tag	3.6.6.8.1.12	Optional	9
Sequence length (note 4)	3.6.6.8.1.3	(note 1)	10
Operation value tag	3.6.6.8.1.8	Optional	11
Operation value length	3.6.6.8.1.3	(note 2)	12
Operation value	3.6.6.8.1.9		13
Result (note 5)	3.6.6.8.1.12	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 (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

Table III - 48. Return error component

Return error component	Reference	Mandatory Indication	Octet group
Component type tag Component length (note 1)	3.6.6.8.1.4 3.6.6.8.1.3	Mandatory	4 5
Invoke identifier tag Invoke identifier length Invoke identifier	3.6.6.8.1.5 3.6.6.8.1.3 3.6.6.8.1.6	Mandatory	6 7 8
Error value tag Error value length Error value (note 3)	3.6.6.8.1.10 3.6.6.8.1.3 3.6.6.8.1.3	Mandatory	9 10 11
Parameter (note 2)	3.6.6.8.1.12	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 III - 55.

Table III - 49. Reject component.

Reject component	Reference	Mandatory Indication	Octet group
Component type tag Component length (note)	3.6.6.8.1.4 3.6.6.8.1.3	Mandatory	4 5
Invoke identifier tag Invoke identifier length Invoke identifier	3.6.6.8.1.5 3.6.6.8.1.3 3.6.6.8.1.6	Mandatory	6 7 8
Problem tag Problem length Problem	3.6.6.8.1.11 3.6.6.8.1.3 3.6.6.8.1.11	Mandatory	9 10 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).

3.6.6.8.1.2 Data Elements

The contents of each data element is either one value (primitive) or one or more data elements (constructor) as shown in Figure III - 31.

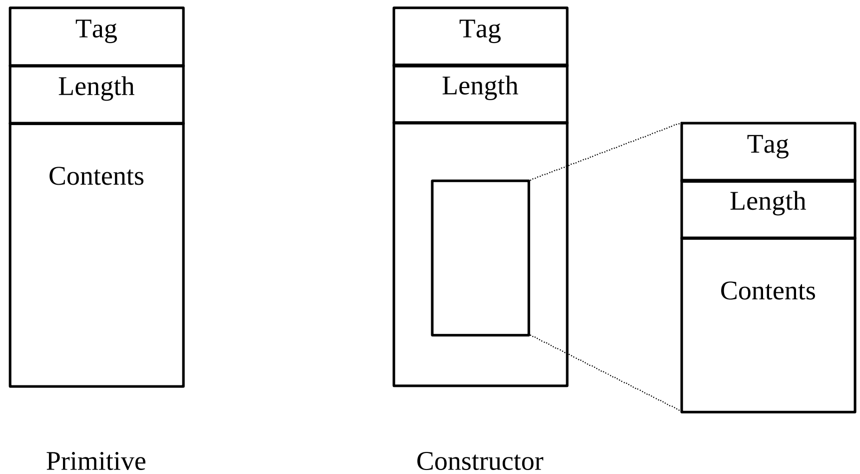


Figure III - 31. Type of Contents

3.6.6.8.1.2.1 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 III - 32

8	7	6	5	4	3	2	1
Class		Form	Tag Code (Note)				

Figure III - 32. Format of Tag

Note: In PRI, the length of the tag will only be one octet.

3.6.6.8.1.2.2 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 III - 50.

Table III - 50. Coding of tag class

Class	Coding (Bits 8 and 7)
Universal	00
Application-wide	01
Context-specific	10
Private use	11

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 ITU-T recommendations, i.e., across Q.932 facility information elements, ITU-T 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 ITU-T 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.

3.6.6.8.1.2.3 Tag Form of the data element

Bit 6 is used to indicate whether the data element is *primitive* or *constructor*, as shown in Table III - 51. 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 III - 31.

Table III - 51. Coding of element form

Element form	Coding (Bit 6)
Primitive	0
Constructor	1

3.6.6.8.1.3 Length of Each Component or Their Data Elements

Lengths up to 127 octets are coded using 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 III - 33.

8	7	6	5	4	3	2	1
0	Length of Contents						
	MSB						LSB

Figure III - 33. 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 III - 34.

8	7	6	5	4	3	2	1
1	(Length of field size) - 1						
	MSB						LSB
MSB			Length of Contents				LSB

Figure III - 34. Format of the length field (long form)

Note - When the long form is used, the long form length will only be two octets long.

3.6.6.8.1.4 Component type tag

The coding of the component type tag is shown in Table III - 52.

Table III - 52. 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

3.6.6.8.1.5 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 III - 53.

Table III - 53. Coding of Invoke identifier tag

	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

3.6.6.8.1.6 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.

3.6.6.8.1.7 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.

3.6.6.8.1.8 Operation Value Tag

The coding for the operation value tag is shown in Table III - 54.

Table III - 54. Coding of operation value tag.

	8	7	6	5	4	3	2	1
Operation value tag	0	0	0	0	0	0	1	0

3.6.6.8.1.9 Operation Value

The operation value specifies the supplementary service application and operation being requested or responded to. Values are encoded as integers.

Table III - 55. Coding of Operation / Error Value

Bits 8	7	6	5	4	3	2	1	
1	0	0	0	1	1	0	0	Value query
1	0	0	0	1	1	0	1	Set value
1	0	0	0	1	1	1	1	Request feature
1	0	1	1	1	1	1	0	Abort
1	1	0	0	1	1	1	0	Redirect call
1	1	0	0	1	1	1	1	Place calling party on hold
1	1	0	1	0	0	0	0	Retrieve calling party from hold
1	1	0	1	0	0	0	1	Drop target party
1	1	0	1	0	0	1	1	User data transfer
1	1	0	1	0	0	1	0	Application specific call status

3.6.6.8.1.10 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 III - 56.

Table III - 56. Coding of error value tag

	8	7	6	5	4	3	2	1
Error value tag	0	0	0	0	0	0	1	0

3.6.6.8.1.11 Problem Tag

Protocol problems are indicated in groups. Table III - 57 indicates the tags for these groups. The contents for each of these tags are indicated in Table III - 58 through Table III - 61. The contents of these tags are defined in Table III - 62.

Table III - 57. 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 III - 58. 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 III - 59. 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
Unrecognized linked identifier	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 III - 60. 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 III - 61. 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

Table III - 62. 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.
unrecognized-linked-identifier:	signifies that there is no operation in progress with an Invoke-identifier equal to the specified Linked-identifier.
Return result problem:	
unrecognized-invocation:	signifies that no operation with the specified Invoke-identifier is in progress.
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.

3.6.6.8.1.12 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.

	8	7	6	5	4	3	2	1
Sequence tag	0	0	1	1	0	0	0	0

Table III - 63. Coding of sequence tag

3.6.6.8.1.13 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 III - 35. The tag for encapsulating Q.931 information elements is given in Table III - 64. This data element may appear by itself or as a member of a sequence as indicated in section 3.6.6.8.1.12.

Note 1 - Encapsulation of the Facility information element with Facility information elements shall not be used.

Q.931 information element tag
Q.931 information element length
First Q.931 information element
Second Q.931 information element
• • • •
Last Q.931 information element

Figure III - 35. Encapsulation of Q.931 information elements

Table III - 64. Q.931 Information element tag

	8	7	6	5	4	3	2	1
Q.931 information elements	0	1	0	0	0	0	0	0

3.6.6.8.2 Generic Billing Data

The purpose of the Generic Billing Data information element is to indicate the Type of rate change and Amount of rate change requested.

OCTET	FIELD	BIT	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	1010110	Generic Billing Data
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	Last octet of description
	Type of Billing Data	7-1	0000010	RESERVED
			0001101	RESERVED
			0010000	New Rate (Note 1)
			0010001	Flat Rate (Note 1)
			0010010	Premium Charge (Note 1)
			0010011	Premium Credit (Note 1)
			0011000	Free Call (Note 1)
4	Extension	8	1	Last octet of description
	Encoding scheme	7-1	0000010	IA5
5, etc.	Billing Data	8-1	IA5	IA5 Characters

All other values are reserved.

Figure III - 36. Generic Billing Data Information Element

Note 1: See Appendix 3 for additional information.

3.6.6.8.3 Item

The purpose of the Item information element in codeset 6 is to indicate the value being queried in a value query operation.

OCTET	FIELD	BIT	VALUE	MEANING
1	Bit 8	8	0	Set value
	Information element identifier	7-1	1001101	Item
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	Last octet of description
	Item	7-1	0011110	Card Verification (See Appendix 4)
			0011111	Billing Change Request (See Appendix 3)

Figure III - 37. Item Information Element

3.6.6.8.4 Originating Access/Service Type

The purpose of the Originating access/service type information element is to convey information regarding the originating access to the network. It will be passed in the network-to-user direction.

OCTET	FIELD	BIT	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	1000011	Originating access / service type
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	Last octet of description
	ISDN access indicator	7-6	00	Non-ISDN access (Default)
			01	ISDN access
	Access type indicator	5-1	00001	Switched
			00010	Direct
			00011	International
			00100	0+ switched access
4	Extension	8	1	Last octet of description
	Service type indicator	7-1	0000001	SDN
			0000011	MEGACOM
			0000101	WATS
			0000111	Long Distance Service (previously known as Nodal LDS)

Figure III - 38. Originating Access/Service Type Information Element

3.6.6.8.5 Originating Line Information

The Originating Line Information information element in codeset 6 contains the II digits information, which indicates the specific characteristic of origination of a call (e.g., coin, cellular service, special operator handling), to the terminating customer.

OCTET	FIELD	BIT	VALUE	MEANING
1	Information element identifier	8-1	00000001	Originating line information
2	Length	8-1	binary	Length of information element contents
3	Information indicator	8-1	binary	Note 1

Figure III - 39. Originating Line Information Information Element

Note 1: Information Indicator (II) (octet 3). Octet 3 shall be coded as the eight-bit binary equivalent of the decimal representation of the II Digits, e.g. 27 shall be coded as 0001 1011. Lockheed Martin Corporation, in its role as North American Numbering Plan Administrator, publishes a list of II Digits on the following World Wide Web site: http://www.nanpa.com.

Specific Event

The Specific Event information element in codeset 6 is used to specify the call progress information or third party manipulation that has occurred.

OCTET	FIELD	BIT	VALUE	MEANING
1	Bit 8	8	0	Set value
	Information element identifier	7-1	1000111	Specific event
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	Last octet of description
	Event values	7-1	0100001	TCS Override (See Appendix 4)

Figure III - 40. Specific Event Information Element

3.6.6.8.7 User Entered Code

The user entered code information element in codeset 6 is used for requesting that a user entered code be collected. It is also used for conveying user-entered information after it has been collected.

The user entered code information element will support the transport of up to 30 User Entered Code digits beginning in octet 5 etc.

OCTET	FIELD	BIT	VALUE	MEANING
1	Bit 8	8	0	Set value
	Information element identifier	7-1	0000010	User entered code
2	Length	8-1	binary	Length of information element contents
3	Bit 8	8	1	Set value
	Type of user entered code	7-1	0000001	Account Codes
			0000010	Login Digits
			0000011	Subscription ID
			0000100	Authorization Code
			0000110	CCF Override Code
			0001000	Sub-account billing code
			0001010	INFO 3 Collected Data
			0001110	Third Party Number
			0010000	Caller Entered Digits
			0010001	Customer Database Provided Digits
			0100010	Redirection Number
4	Bit 8	8	1	Set value
	Collect/collected indication	7-6	10	Collected user entered digits contained in the following octets
	Timeout interval	5-1	00000	Timeout interval
5,etc.	Extension	8	0	Multiple octet element
			1	Last octet of description
	User entered code digits	7-1	IA5 Characters	Note 1

Figure III - 41. User Entered Code Information Element

Note 1: User Entered Code digits (octet 5, etc. bits 7-1) - This is an optional field and the format is determined by the type of user entered code specified. The user entered code value is encoded in IA5 characters.

3.6.6.9 Codeset 7 Information Elements

Codeset 7 information elements are not interpreted by the network and may be passed transparently to the terminating entity. Any codeset 7 information elements must be preceded by the *locking* Shift to codeset 7 information element.

3.6.6.10 Information Elements for Data Communications - Not applicable.

3.7 Circuit-Switched Call Control Procedures

This section describes the procedures that define the flow of messages across a primary rate interface between an ISDN user and the network. 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 Part II for user and network call states).

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 messages associated with the control of circuit-switched connections. Optional extensions to this basic protocol and exceptions that apply in the case of supplementary services are described elsewhere in this specification.

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.

3.7.1 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 are described in Part II.

The procedures in this section apply to the switched network access configuration as shown in Figure III - 42. 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 user. Note that the length of the call reference value need not be the same, only the value. See Section 3.6.3 for the equivalence of call reference values.

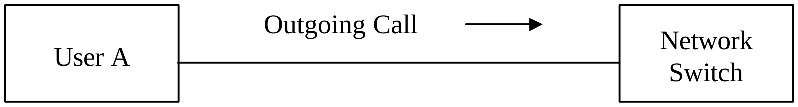


Figure III - 42. AT&T Switched Network Access for an Outgoing Call from A

3.7.1.1 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 user shall consider the call to be in the Call Initiated state. The message shall always contain a call reference, selected according to the procedures given in 3.7.8.3.2. In selecting a call reference, the global call reference value shall not be used. The Bearer capability, Channel identification, and Called party number information elements are mandatory in the SETUP message. See the SETUP message in Section 3.1.16 for other mandatory information elements.

The SETUP message shall contain all the information required by the network to process the call. The called party address information is contained in the Called party number information element possibly completed by the called party subaddress information element (Called party subaddress information element is treated as MA UUI).

In addition to the Called party number, the SETUP message is examined for:

1. the validity of the requested bearer capability;
2. the availability of the information channel requested by the user, and
3. authority for any facilities requested (if known)

Note that additional optional information elements may be present. If the information channel requested by the user is specified with an exclusive option and it is available, then the above second condition (the availability of the information channel requested by the user) is met and this information channel will be reserved for the call. When the user specifies the information channel with the *preferred* option, the network will treat this as though it were coded *exclusive*.

3.7.1.2 B-Channel Selection - Originating - Not Applicable

3.7.1.3 Overlap Sending - Reserved for future use

3.7.1.4 Invalid Call Information

If, following the receipt of a SETUP message the network determines that the call information received from the user is invalid, then the network shall initiate call clearing as defined in Section 3.7.3.4 with cause values such as indicated in Section 3.6.5.11.

3.7.1.5 Call Proceeding

3.7.1.5.1 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 3.7.3 with one of the following causes:

#34 “No circuit or channel available”

#50 “Requested facility not subscribed”

#63 “Service or option not available, unspecified”

#65 "Bearer capability not implemented".

3.7.1.5.2 Call Proceeding, Overlap Sending - Reserved for future use

3.7.1.6 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 in the PROGRESS message.

The following progress description value shall be included in the progress indicator information element in the message sent to the user: #1 “call is not end-to-end ISDN; further call progress information may be available in-band.”

When the PROGRESS message is received by the user, a change to the Call Delivered state should 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.

3.7.1.7 Call Confirmation Indication

Upon receiving an indication that user alerting has been initiated at the called user, the network shall: send an ALERTING message across the user-network interface of the calling user; and enter the Call Delivered state (if not already in that state). This message may cause initiation of a user equipment-generated alerting indication. When the user receives the ALERTING message, the user shall enter the Call Delivered state (if not already in that state).

In certain cases, the remote user may respond with a CONNECT message without sending an ALERTING message. In that case, the network will send either a PROGRESS or an ALERTING message to the originating user before it sends the CONNECT message.

One or more PROGRESS messages may be received by the user between the receipt of the CALL PROCEEDING and an ALERTING or CONNECT message. Receipt of a PROGRESS message does not necessarily indicate that an end-to-end connection exists at that time.

3.7.1.8 Call Connected

Receipt of a CONNECT message by the network cancels timers T303 or T310 if one is currently active and the call enters the Connect request state. Procedures are initiated to send a corresponding CONNECT message to the calling user.

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 the call to be in the Active state.

3.7.1.9 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 3.7.3. However, if the network desires to play an announcement before the call is cleared, it shall send a PROGRESS message to the calling user. On receipt of this message the calling 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 3.7.4.)

3.7.1.10 Transit Network Selection

AT&T Digital Link customers may send a Transit Network Selection information element in a SETUP message to the network. When the Transit Network Selection information element is present, the call shall be routed to the toll carrier identified by the Carrier Identification Code, if the carrier selection is valid for that call.

3.7.2 Call Establishment at the Destination Interface

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. In addition, this section applies to the switched network egress configuration described in Figure III - 43. The term *network* used in this section refers to the originating entity for the call.

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 global 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.

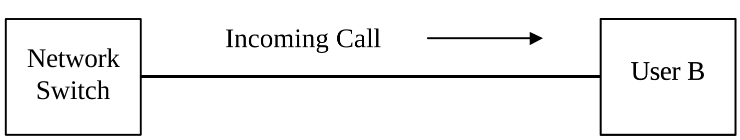


Figure III - 43. AT&T Switched Network Egress for an Incoming Call to B

3.7.2.1 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.

The SETUP message always includes the following information elements:

a) Call reference (whose value is allocated according to the procedures described in Section 3.6.3);

b) Bearer capability;

c) Channel identification (with preferred or exclusive option);

d) Called party number.

In addition to the mandatory information elements, the SETUP message may include, as required, the information elements described in Section 3.6 (e.g., low layer compatibility).

After sending the SETUP message, the network starts the network-side timer T303 and enters 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.

At the first expiry of T303 (network timer duration is 8 seconds, whereas the ITU-T value for this timer is 4 seconds), the network will send RELEASE COMPLETE and hunt a new channel. A SETUP with a different call reference value is transmitted for this new channel. If the network-side timer T303 expires again, a RELEASE COMPLETE message is sent to the terminating user, the call is considered terminated and the network plays an announcement to the originating user.

3.7.2.2 Compatibility Checking

A user receiving a SETUP message shall perform compatibility checking before responding to that SETUP message. Any reference to "user" in Sections 3.7.2.3 through 3.7.2.7 implicitly refers to a compatible user equipment.

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”. The network shall process this RELEASE COMPLETE message in accordance with Section 3.7.2.5.3.

3.7.2.3 B-Channel Selection - Destination

3.7.2.3.1 SETUP Message Delivered By Point-To-Point Data Link

When the SETUP message is delivered, 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 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 (i.e., Exclusive channel);

   2) channel is indicated, any alternative is acceptable (i.e., Preferred channel);

b) In cases 1) and 2) above, if the indicated channel is acceptable and available, the user selects it for the call.

   If in case 1) the B-Channel indicated in the first response message is not the channel offered by the network, the network will clear the call by sending a RELEASE message with cause #6, “channel unacceptable,” or a DISCONNECT message with cause #100, “invalid information element contents.”

   In case 2), if the user cannot grant the indicated channel, it selects any other available B-Channel associated with the D-Channel. 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 towards the called user by sending a RELEASE message with cause #6 “channel unacceptable,” or RELEASE COMPLETE with cause #34 “no circuit or channel available.”

   The network will also clear the call with a RELEASE COMPLETE message with cause #6, “channel unacceptable” if it specified an exclusive channel in the SETUP message and the PROGRESS, ALERTING or CONNECT message specifies a different channel.

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 case 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” and returns to the Null state.

3.7.2.3.2 SETUP Message Delivered By Broadcast Data Link - Reserved for future use

3.7.2.4 Overlap receiving - Reserved for future use

3.7.2.5 Call Confirmation

3.7.2.5.1 Response to En-Bloc SETUP

When the user determines that sufficient call setup information has been received and compatibility requirements 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. The FACILITY and PROGRESS messages can also be accepted as a first response.

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 3.7.2.5.3.

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 3.7.2.5.3.

3.7.2.5.2 Receipt of CALL PROCEEDING, ALERTING or PROGRESS

Upon receipt of the CALL PROCEEDING message from a user, the network shall: stop network-side timer T303; start network-side timer T310; and enter the Incoming Call Proceeding state.

Upon receipt of the ALERTING or PROGRESS message from a user, the network shall: stop the network-side timer T303 or T310 (if running); enter the Call Received state; and send a corresponding ALERTING or PROGRESS message to the calling user (if possible). Note that on the receipt of an ALERTING message in the Call Received state, the network responds with a STATUS message with cause #98 “message not compatible with the call state.”

Exception: If the call is in the Call Received state due to the receipt of a PROGRESS message, any subsequent ALERTING message would not cause the network to respond with a STATUS message.

Receipt of a CONNECT, without an ALERTING message, subsequent to receipt of a CALL PROCEEDING message causes ALERTING and then CONNECT messages to be sent by the network to the calling user, and the network-side timer T310 to be canceled. The network does not support fast connect.

Receipt of an ALERTING or CONNECT message in the case where no CALL PROCEEDING message has been received causes an ALERTING message or both an ALERTING and a CONNECT message to be sent by the network to the calling user and network-side timer T303 to be canceled.

3.7.2.5.3 Called User Clearing During Incoming Call Establishment

If the SETUP message has been delivered and a RELEASE COMPLETE or DISCONNECT message is received before a CONNECT message has been received, the network shall: stop network-side timer T303 or T310 (if running); continue to clear the user as described in Section 3.7.3.3; and clear the call to the calling user with the cause received in the RELEASE COMPLETE or DISCONNECT message.

3.7.2.5.4 Call Failure

If the network does not receive any response to the transmitted SETUP message prior to the first expiration of network-side timer T303 (8 seconds), the network sends a RELEASE COMPLETE using cause #102 “recovery on timer expiry” to the terminating user and rehunts a new channel[4]. A SETUP message with a different call reference value is transmitted for this new channel, and network-side timer T303 is reinitialized. Upon the second expiry of network-side timer T303, a RELEASE COMPLETE message with cause #102 is sent to the terminating user and the call is considered terminated. The

4. The network puts the original channel specified in the SETUP in Maintenance state and sends a RESTART message every 2 minutes on that channel until a response is received.

network sends a PROGRESS message and plays an announcement to the originating user before clearing the call. If the SETUP message was delivered, the network shall also initiate clearing procedures toward the called user in accordance with Section 3.7.3.4, 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 network-side 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 in accordance with Section 3.7.3.4, using cause #102 “recovery on timer expiry.”

3.7.2.6 Notification of Interworking at the Terminating Interface

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 in the PROGRESS message.

The following progress description value shall be included in the Progress Indicator information element in the message sent to the network: #1 “call is not end-to-end ISDN; further call progress information may be available in-band.”

If the Progress Indicator information element is included in the PROGRESS message, a state change will occur and any supervisory timers shall be stopped. Subsequent PROGRESS messages will not cause a state change, nor will they cause timers to be started or stopped.

When a PRI user sends multiple PROGRESS messages to the network, the network shall not deliver more than one PROGRESS message with the same Progress indicator to the originating PRI user.

3.7.2.7 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 user-side timer T313 (the value of timer T313 is specified in Section 3.11.2) and enter the Connect Request state. Procedures are initiated to send a corresponding CONNECT message to the calling user.

3.7.2.7.1 Network Information Channel Cut Through Strategy

Forward direction is from the originating user to the terminating user. Backward direction is from the terminating user to the originating user.

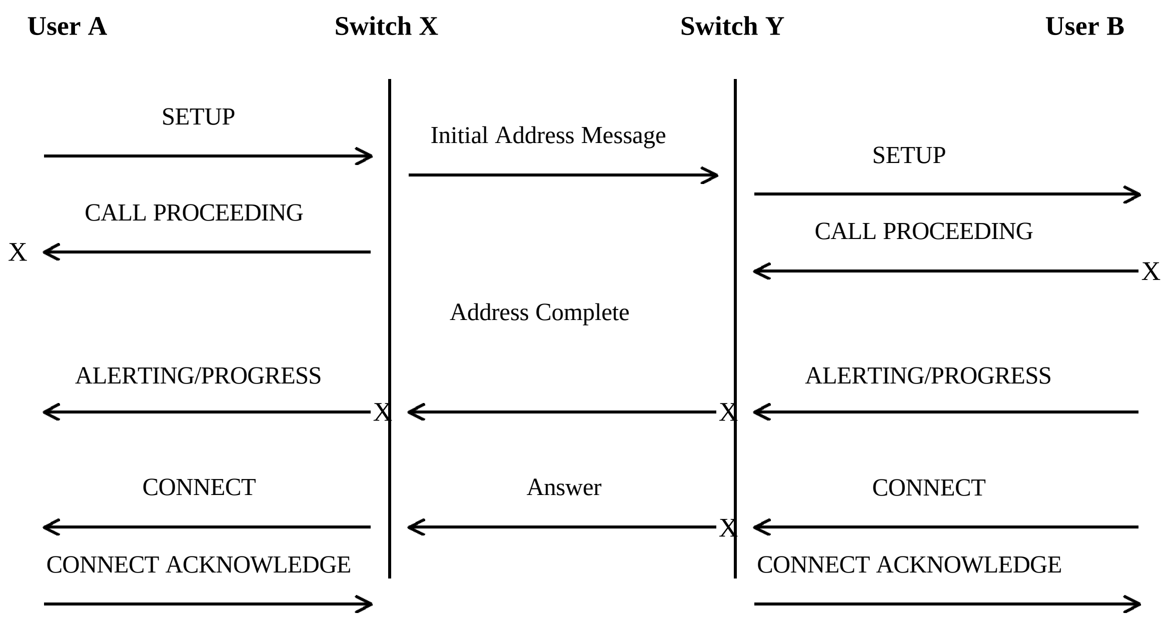
For data calls,[5] the information channel is connected in both directions upon receipt of the CONNECT message from the terminating user.

On all other call types, the access network switches will connect to the designated information channel in the backward direction on 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.

5. 56Kbps clear and higher data rates.

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.

The network will return a CONNECT ACKNOWLEDGE message after a CONNECT message has been received.



Note: X- Denotes B-Channel Cut Through. At egress switch Y, cut through for voice calls is at ALERTING/PROGRESS, for data calls - at CONNECT.

If User B responds with CONNECT without prior ALERTING/PROGRESS, the network will send ALERTING/PROGRESS to User A and cut through at Switch X.

Figure III - 44. Cut Through Strategy

3.7.2.7.2 User Information Channel Cut Through Strategy

Given the symmetrical nature of the Call Setup procedures and in order to maintain more uniform implementation, the user should, for other than data calls, cut through to the designated information channel either upon receipt of a CALL PROCEEDING message (on outgoing calls), or initiation of a CALL PROCEEDING message (on incoming calls). This will avoid the clipping of either speech or data transmission[6].

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6. 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

3.7.2.8 Active Indication

On receipt of the CONNECT message, the network shall: stop (if running) network-side 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 (as a result there may be clipping of communications). Upon receipt of the CONNECT ACKNOWLEDGE message the user shall: stop user-side timer T313 and enter the Active state.

When timer T313 expires prior to receipt of a CONNECT ACKNOWLEDGE message, the user shall either re-transmit the CONNECT message and re-initialize timer T313 or send a DISCONNECT message. If timer T313 expires a second time prior to receipt of a CONNECT ACKNOWLEDGE message, the user shall initiate clearing in accordance with Section 3.7.3.3.

A user which has received the SETUP may connect to the B-Channel as soon as channel selection has been completed.

3.7.2.9 Non-Selected User Clearing - Reserved for future use

3.7.2.10 Facility

If the user needs certain facilities from the network, then the identities of these facilities may be contained in the Network specific facilities information element in a FACILITY message. If a valid FACILITY message is received by the network while in the Call Present state, network-side timer T303 will be stopped while the facility request is being processed and reinitialized at the completion of processing. Network-side timer T310 will be handled in a similar manner if a valid FACILITY message is received while the network is in the Incoming Call Proceeding state.

The network shall check the availability of the requested facilities and shall respond with a FACILITY ACKNOWLEDGE message to confirm the availability of the facilities or a FACILITY REJECT message to deny the access to the facilities. In the latter case, the message will specify the reason for the rejection in the Cause information element, the possible cause values being #29, “Facility rejected”; #50, “Requested facility not subscribed”; or #69, “Requested facility not implemented.”

3.7.3 Call Clearing

3.7.3.1 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.

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clipping of speech/data/announcements since the user may be required to provide information required by the network at this time.

- A channel is "disconnected" when the channel is no longer part of a circuit-switched ISDN connection, but is not yet available for use in a new connection.

- A channel is "released" when the channel is not part of a circuit-switched ISDN connection and is available for use in a new connection. Similarly, a call reference that is "released" is available for reuse.

3.7.3.2 Exception Conditions

Under typical conditions, normal call clearing is usually initiated when the user or the network sends a DISCONNECT message and follows the procedures defined in Sections 3.7.3.3 and 3.7.3.4, 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 entering the Null state.

b) Clearing of Non-Call Associated (NCA) temporary signaling connections will be initiated by sending a RELEASE message as described in Sections 3.7.3.3 and 3.7.3.4.

c) Unsuccessful termination of the B-Channel selection procedure (see Section 3.7.2.3) by the side offering the call is accomplished by sending a RELEASE, RELEASE COMPLETE or DISCONNECT message as described in Sections 3.7.3.3 and 3.7.3.4. The RELEASE message shall contain cause #6 "channel unacceptable."

d) For some trunk maintenance test calls, only one side of the interface will be allowed to disconnect the call. In this situation, if a RELEASE message is received from the side of the interface without permission to disconnect, the other side of the interface will respond with a STATUS message. Call clearing will not be initiated.

3.7.3.3 Clearing Initiated by the User

Apart from the exceptions identified in Sections 3.7.3.2 and 3.7.8, the user shall initiate clearing by: sending a DISCONNECT message; starting user-side timer T305 (the value of timer T305 is specified in Section 3.11.2); 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 3.7.3.4 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 3.11.1); and enter the Release Request state.

Note: The RELEASE message has only local significance and does not imply an acknowledgment of clearing from the remote user.

If the user receives a RELEASE COMPLETE message with cause #81, “invalid call reference value” in response to a DISCONNECT message, the user must initiate Restart procedures on the appropriate channel. See Section 3.7.5.

On receipt of the RELEASE message the user shall; cancel user-side 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 network-side timer T308; release both the B-Channel and the call reference; and return to the Null state.

If user-side timer T305 expires, the user shall: send a RELEASE message to the network with the cause number originally contained in the DISCONNECT message; start user-side timer T308; and enter the Release Request state.

If network-side timer T308 expires for the first time, the network shall: retransmit the RELEASE message and network-side timer T308 shall be restarted. In addition, the network will indicate the cause information element with cause #102 "recovery on timer expiry". If no RELEASE COMPLETE message is received from the user before network-side timer T308 expires a second time, the network shall: send a RELEASE COMPLETE message to the user; release the call reference and B-Channel(s); send a RESTART message specifying the B-Channel of the call, and return to the Null state. In addition, the information channel will be marked as requiring maintenance and will not be used until its status is cleared with the Restart Procedure defined in Section 3.7.5.

3.7.3.4 Clearing Initiated by the Network

Apart from the exception conditions identified in Section 3.7.3.2, the network shall initiate clearing by: sending a DISCONNECT message; starting network-side timer T305; 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 3.7.3.3 are followed.

3.7.3.4.1 Clearing When Tones/Announcements Provided

See Section 3.7.4, "Tones and Announcements"

3.7.3.4.2 Clearing When Tones/Announcements Not Provided

The network shall initiate normal call clearing by: sending the DISCONNECT message; starting network-side timer T305; disconnecting the B-Channel; and entering the Disconnect Indication state.

On the receipt of the DISCONNECT message, the user shall: disconnect the B-Channel; send a RELEASE message; start user-side timer T308; and enter the Release Request state.

On receipt of the RELEASE message, the network shall: stop network-side timer T305; release the B-Channel; send a RELEASE COMPLETE message; release the call reference; and return to the Null state.

If network-side timer T305 expires, the network shall: send a RELEASE message to the user with the cause #102 "recovery on timer expiry"; start network-side timer T308; and enter the Release Request state.

3.7.3.4.3 Completion of Clearing

Following the receipt of a RELEASE COMPLETE message from the network, the user shall: stop user-side 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 user-side timer T308, the RELEASE message shall be retransmitted and user-side timer T308 shall be restarted. If no RELEASE COMPLETE message is received from the network before user-side timer T308 expires a second time, the user may: place the B-Channel in a maintenance condition; release the call reference; and return to the Null state.

Note: The restart procedures contained in Section 3.7.5 may be used on B-Channels in the maintenance condition.

3.7.3.5 Clear Collision

Clear collision occurs when both the user and the network simultaneously transfer DISCONNECT messages specifying the same call reference value. When the network receives a DISCONNECT message while in the Disconnect Indication state, the network shall: stop network-side timer T305; disconnect the B-Channel (if not disconnected); send a RELEASE message; start network-side timer T308; and enter the Release Request state. Similarly, when the user receives a DISCONNECT message while in the Disconnect Request state, the user shall: stop user-side timer T305; send a RELEASE message; start user-side timer T308; and enter the Release Request state.

Clear collision can also occur when both sides simultaneously transfer RELEASE messages related to the same call reference value. The entity receiving such a RELEASE message while within the Release Request state shall: stop timer T308; release the call reference and B-Channel if appropriate; send a RELEASE COMPLETE message; and enter the Null state.

3.7.4 In-Band Tones and Announcements

Methods for providing ringback[7], 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 3.7.4.1, 3.7.4.2 and 3.7.4.3 deal with calls that route through a pure ISDN path from an originating to terminating PBX.

3.7.4.1 Pure ISDN Network Call With Successful Completion To An Endpoint

The procedures for originating, terminating and network nodes are described in Sections 3.7.4.1.1 and 3.7.4.1.2. The message flow that corresponds to these procedures is found in Figure III - 45.

3.7.4.1.1 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 3.7.2.7. 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

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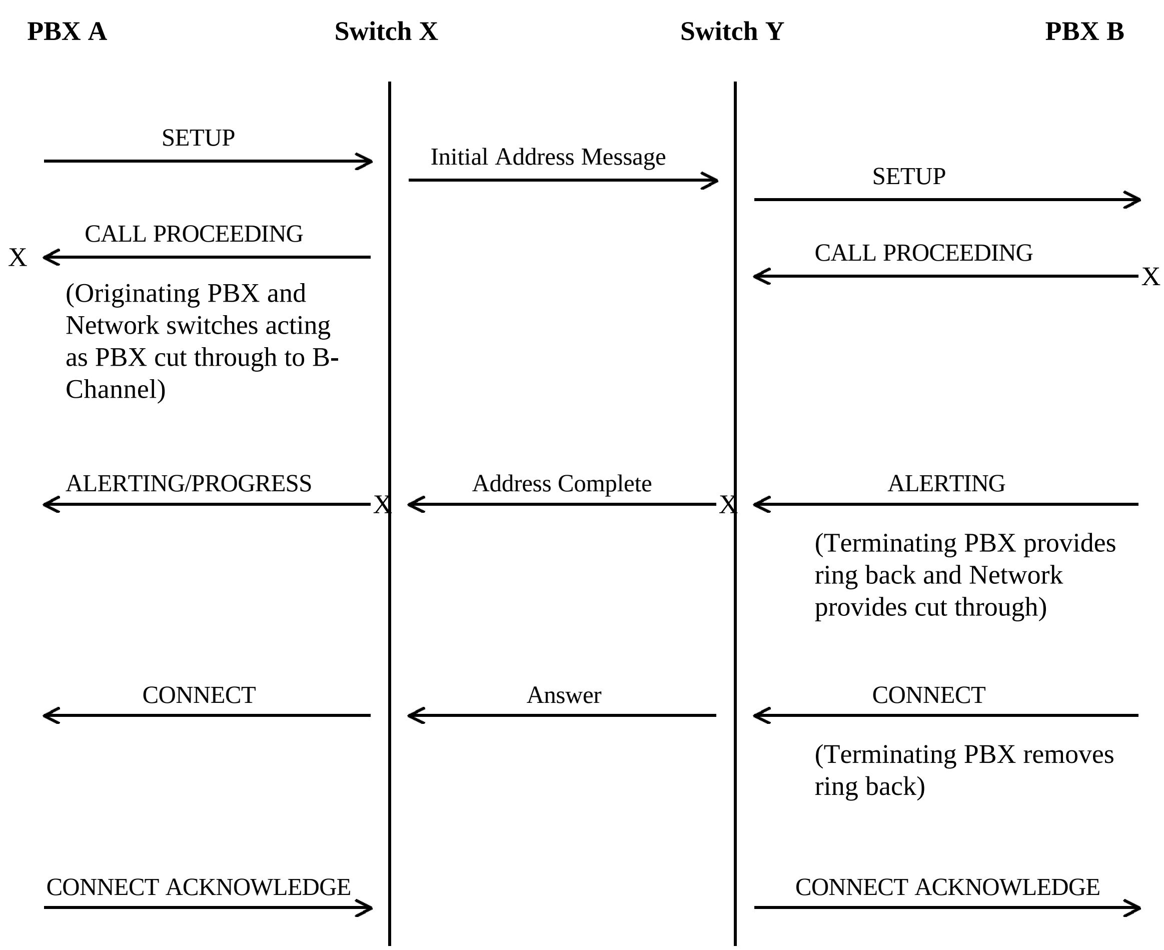
7. For PBXs, ringback refers to the ringback tone which is always provided to the originator of a call. For network switches, this term is synonymous with "audible ringing."

ringback will be provided by the terminating PBX/Network. This will provide a more uniform implementation of ISDN services as the protocol evolves.

3.7.4.1.2 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.)



Note: X- Denotes B-Channel Cut Through

Figure III - 45. Pure ISDN Network/PBX Call With End-to-End Completion

3.7.4.2 Pure ISDN Network Call - End User/Terminal Busy

The procedures for originating, terminating and network nodes are described in Sections 3.7.4.2.1, 3.7.4.2.2, and 3.7.4.2.3. The message flow that corresponds to these procedures is found in Figure III - 46.

3.7.4.2.1 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 3.7.2.7.

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 that the channel is not available but an alternate channel may be selected by the originating (user) end of the interface. The appropriate tone should 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.

3.7.4.2.2 At The Terminating PBX

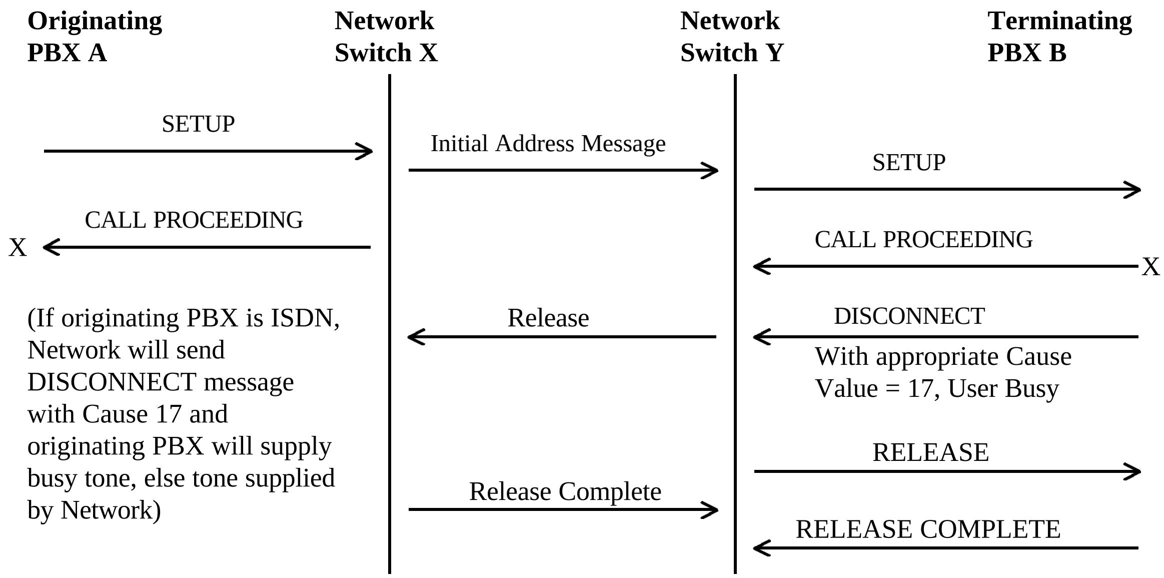
The call will proceed through the network and arrive at the terminating PBX which will:

- 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 Called Party Number 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 node) where the In-Band User Busy tone will be provided.[8]

3.7.4.2.3 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.

8. 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.



Note: X- Denotes B-Channel Cut Through

Figure III - 46. Pure ISDN Network/PBX Call With End User/Terminal Busy

3.7.4.3 Pure ISDN Network Call - Congestion and Intercept Treatment

The procedures for originating, network, and terminating nodes are described in the following sections. The message flow that corresponds to these procedures is found in Figure III - 47.

3.7.4.3.1 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 3.7.2.7.

3.7.4.3.2 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.

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 announcements[9].

Table III - 42 contains the Cause values that initiate tones and announcements.

3.7.4.3.3 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.

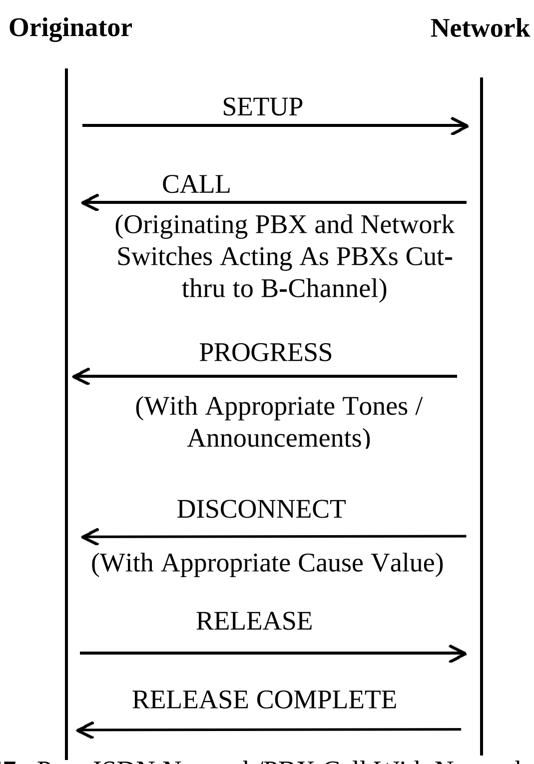


Figure III - 47. Pure ISDN Network/PBX Call With Network Congestion

9. If a SETUP message is received from the ’user’ side of the interface for a busy B-Channel, 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 should not be provided until alternate choices for an idle B-Channel are exhausted.

3.7.5 Restart Procedure

The restart procedure is used to return channels 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).

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 must implement the mandatory procedures of Section 3.7.5.

The network will support restart requests for individual B-Channels only. Thus, the channel identification information element is mandatory in a RESTART message to the network. A request to restart a wideband channel is effected by sending RESTART messages for all underlying B-Channels which comprise the wideband channel. Note that H0 and H11 dedicated channels are always viewed as underlaid for the purposes of restarting them.

A RESTART message sent by the user indicating a B-Channel which is not associated with the PRI will be ignored by the network (no response will be returned from the network).

3.7.5.1 Sending RESTART

A RESTART message is sent by the network or user in order to return channels to the Null state. The Channel identification information element must be present. All RESTART messages will specify individual B-Channels only.

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 messages may be sent until a RESTART ACKNOWLEDGE message is returned. Meanwhile, no calls shall be placed over the channel by the originator of the RESTART message.

If the network sends a RESTART and prior to receiving a RESTART ACKNOWLEDGE receives a SETUP message specifying the same channel and channel type, the SETUP message shall override, and the network will treat the receipt of the SETUP message as equivalent to the RESTART ACKNOWLEDGE message.

The RESTART and RESTART ACKNOWLEDGE message must contain the global call reference value to which the Restart Request state is associated.

3.7.5.2 Receipt of RESTART

Upon receiving a RESTART message, the recipient must enter the Restart state associated with the global call reference; it must then initiate the appropriate internal actions to return the specified channel to the idle condition and any associated call reference to the Null state. Upon completion of internal clearing, a RESTART ACKNOWLEDGE message must be 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 must transmit a RESTART ACKNOWLEDGE message to the originator upon receiving a RESTART message.

NOTE 2: If the RESTART message is sent by the user, the network shall return to the Null state only those calls which correspond to the specified channel.

NOTE 3: If a RESTART message specifying the restart of the entire interface (DS1 Facility) is received, the network will return a STATUS message, which contains the global call reference, indicating "invalid information element contents."

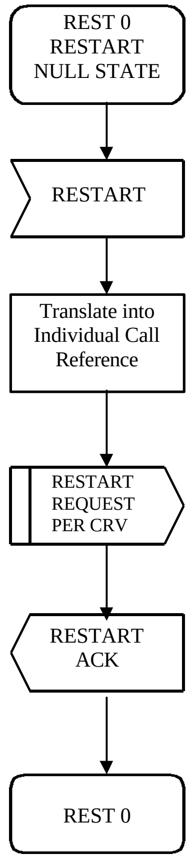
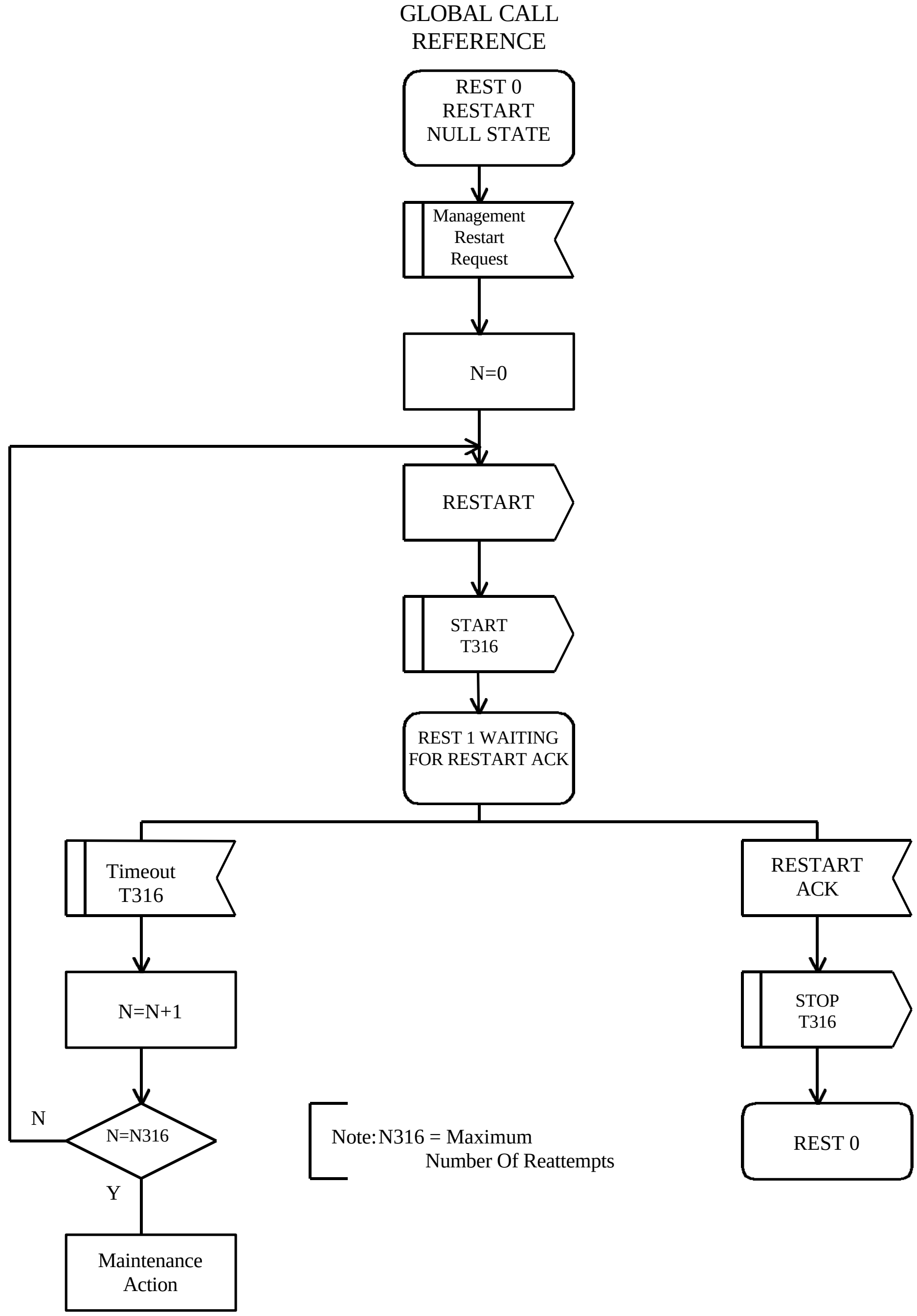


Figure III - 48. Restart Call Control Detailed SDL Diagrams (page 1 of 2)


GLOBAL CALL
REFERENCE
REST 0
RESTART
NULL STATE
Management
Restart
Request
N=0
RESTART
START
T316
REST 1 WAITING
FOR RESTART ACK
Timeout
T316
N=N+1
N
N=N316
Y
Maintenance
Action
Note: N316 = Maximum
Number Of Reattempts
RESTART
ACK
STOP
T316
REST 0

3.7.6 Call rearrangements - Reserved for future use

3.7.7 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 and outgoing call select the same channel. This is resolved by the network through channel selection mechanisms described in Sections 3.7.1.2 and 3.7.2.2.

In the case of such conflicts, the network shall give priority to the incoming call from the remote calling user over the outgoing call request received from the local calling user. It shall clear the outgoing call whenever the B-Channel cannot be allocated by the network.

3.7.8 Handling of Error Conditions

All procedures transferring signaling information by using the protocol discriminator of Q.931 user-network call control messages are applicable only to those messages which pass the checks described in Sections 3.7.8.1 through 3.7.8.7.

The following mandatory procedures must be implemented to allow for proper handling of error conditions:

1) the capability to send and receive STATUS and STATUS ENQUIRY messages,

2) respond to a STATUS ENQUIRY message with a STATUS message.

These procedures provide the vehicle to poll and to respond in a possible erroneous situation. Error handling procedures should be applied in the order listed in the following sections.

3.7.8.1 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.

3.7.8.2 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.

3.7.8.3 Call Reference Error

3.7.8.3.1 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.

If the Call reference information element octet 1, bits 1 through 4 indicate a length not equal to either 1 or 2 octets, the network shall return a RELEASE COMPLETE with cause #81 “Invalid call reference value”.

3.7.8.3.2 Call Reference Procedural Errors

a) Whenever any message except SETUP, RELEASE COMPLETE 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 RELEASE COMPLETE message with cause #81 "invalid call reference value" and remain in the null state. The diagnostics field within the Cause information element should contain the received call reference value.

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.

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, the message shall be ignored.

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 with cause #81 "invalid call reference value".

e) When the network receives a SETUP message with a call reference already in use, it will return a RELEASE COMPLETE message with cause #98 "message not compatible with call state" and send a RESTART message specifying the B-Channel associated with that call reference in question. It is mandatory that CPE implement the procedures followed by the network. If the call reference in question is associated with a Non Call Associated Temporary Signaling Connection (NCA-TSC), the network will return a RELEASE COMPLETE message with cause #98, "message not compatible with call state", and will clear the NCA-TSC.

f) When any message except RESTART, RESTART ACKNOWLEDGE, SERVICE, SERVICE ACKNOWLEDGE, or STATUS is received specifying the global call reference, no action should be taken on this message and a STATUS message specifying the global call reference with a call state indicating the current state associated with the global call reference and cause #81 "invalid call reference" must 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 3.7.8.11 must be implemented.

h) The receiver of a STATUS ENQUIRY message specifying a call reference that is not recognized as in use must return a STATUS message with cause #30 "response to STATUS ENQUIRY" indicating call state 0 (Null state) (see the "Message Type or Message Sequence Errors" and Status Enquiry Procedure" sections).

3.7.8.4 Message Type or Message Sequence Errors

Whenever an unexpected message, except RELEASE, RELEASE COMPLETE or STATUS, or an unrecognized message is received in any state other than the Null state, a STATUS message must be returned with cause #98 "message not compatible with call state" 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 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 3.7.8.10). No change in state shall be made in either case at this time.

However, four 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 network-side timers; and enter the Null state. Whenever the user receives an unexpected RELEASE message, the user must: disconnect and release the B-Channel; return a RELEASE COMPLETE message to the network; release the call reference; stop all user-side 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 network-side timers; and enter the Null state. Whenever the user receives an unexpected RELEASE COMPLETE message, the user must: disconnect and release the B-Channel; release the call reference; stop all user-side timers; and enter the Null state.

The third exception is when the network attempts to set up a call to a B-Channel, which the CPE believes to be busy. If B-Channel negotiation is supported, the CPE should negotiate the call to an idle channel. A STATUS ENQUIRY message for the Call Reference on the channel believed to be busy must be sent to the network. The network will respond with a STATUS message indicating that the specified Call Reference is in the Null state, and the CPE must therefore idle the channel. If the CPE does not support B-Channel negotiation it should clear the call with a RELEASE COMPLETE message with cause #44, “Requested circuit/channel not available” before sending the STATUS ENQUIRY message.

In the case when the network receives a RELEASE COMPLETE message with cause # 44, “Requested circuit/channel not available,” the network shall send a SERVICE message for the B-Channel indicating the network’s perceived status of that channel. If the response received in the SERVICE ACKNOWLEDGE message shows the B-Channel is in service, the network will send a RESTART message for that channel. If the network receives a SERVICE ACKNOWLEDGE showing the B-Channel is out of service or in maintenance state, the network will update its status of that channel and will not resart it. This capability shall apply only to call requests involving individual B-Channels (i.e., the network will not send SERVICE messages if the rejected call has a Bearer capability of 384 or 1536 Kbps).

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 may ignore the arrival of this message or return a STATUS message with an appropriate cause value. 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 cause #98, "message not compatible with call state." An exception to this rule is if the message received is a SETUP message with a call reference value already in use. In this case, a RELEASE COMPLETE message with cause #98, "message not compatible with call state" must be returned followed by a RESTART message specifying the B-Channel associated with the call reference in question.

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 must 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 cause #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 3.7.3;

ii. a non-clearing state, then the usual clearing procedures as described in Section 3.7.3 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 shall also 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.

Figure III - 49 and Figure III - 50 summarize Sections 3.7.8.3 and 3.7.8.4 and contain all possible messages.

Network State	Message Received By Network															
	SETUP	CONN ACK	CALL PROC	ALERT	CONN	DISC	REL	REL COM	REST	REST ACK	CON CON	USER INFO	PROG	FAC	FAC ACK	FAC REJ
0	*	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	I	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE
3	**	VE	VE	VE	VE	*	TE	TE	VE	VE	*	*	VE	VE	*	*
4	**	VE	VE	VE	VE	*	TE	TE	VE	VE	*	*	VE	*	*	*
6	***	VE	*	*	*	TE	TE	*	VE	VE	*	*	*	*	I	I
7	**	VE	VE	VE	*	*	TE	TE	VE	VE	*	*	VE	*	*	*
8	**	I	VE	VE	I	*	TE	TE	VE	VE	*	*	VE	*	*	*
9	**	VE	VE	*	*	*	TE	TE	VE	VE	*	*	*	*	*	*
10	**	I	VE	VE	I	*	TE	TE	VE	VE	*	*	VE	*	*	*
11	**	I	I	I	I	I	TE	TE	VE	VE	I	I	I	I	I	I
12	**	I	I	I	I	*	*	TE	VE	VE	I	I	I	I	I	I
19	*	*	*	*	*	*	*	*	VE	VE	I	I	*	I	I	I

*	This Specification specifies the procedure
**	See Note
***	RELEASE COMPLETE sent
CR DNE	Call reference does not exist (see Section 3.7.8.3)
I	Ignorable error
TE	Tolerable error
VE	Violent error

Figure III - 49. Network Response on Receipt of a Message for a Non-Global CRV and Non-Dummy Call Reference

Note: When the network receives a SETUP message with a call reference already in use, it will return a RELEASE COMPLETE message with cause #98 “message not compatible with call state” and send a RESTART message specifying the B-Channel associated with that call reference in question. It is mandatory that CPE implement the procedures followed by the network.

User State	SETUP	CONN ACK	CALL PROC	ALERT	CONN	DISC	REL	REL COM	REST	REST ACK	CON CON	USER INFO	PROG	FAC	FAC ACK	FAC REJ
	Message Received By The User															
0	*	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	I	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE	CR DNE
1	***	VE	*	*	*	TE	TE	*	VE	VE	I	I	*	I	I	I
3	**	VE	I	*	*	*	*	TE	VE	VE	*	*	*	*	*	*
4	**	VE	I	*	*	*	*	TE	VE	VE	*	*	*	*	*	*
7	**	VE	VE	VE	VE	*	*	TE	VE	VE	*	*	VE	*	*	*
8	**	*	VE	VE	VE	*	*	TE	VE	VE	*	*	VE	*	*	*
9	**	VE	VE	VE	VE	*	*	TE	VE	VE	*	*	VE	I	*	*
10	**	I	VE	VE	VE	*	*	TE	VE	VE	*	*	VE	*	*	*
11	**	I	I	I	I	*	*	TE	VE	VE	I	I	I	I	I	I
12	**	I	I	I	I	I	*	TE	VE	VE	I	I	I	I	I	I
19	**	I	I	I	I	I	*	*	VE	VE	I	I	I	I	I	I
US1	**	VE	VE	VE	VE	*	*	*	VE	VE	*	*	VE	VE	*	*
US2	**	VE	VE	VE	VE	*	*	*	VE	VE	*	*	VE	VE	*	*

*	This Specification specifies the procedure
**	See Note
***	Release reserved B-Channel, assign it to incoming call
CR DNE	Call reference does not exist (see Section 3.7.8.3)
I	Ignorable error
TE	Tolerable error
VE	Violent error

Figure III - 50. User Response on Receipt of a Message for a Non-Global CRV and Non-Dummy Call Reference

Note: When the network receives a SETUP message with a call reference already in use, it will return a RELEASE COMPLETE message with cause #98 “message not compatible with call state” and send a RESTART message specifying the B-Channel associated with that call reference in question. It is mandatory that CPE implement the procedures followed by the network.

3.7.8.5 General Information Element Errors

The general information element error procedures may also apply to information elements in codesets other than 0.

3.7.8.5.1 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 shall ignore this information element and continue processing the message. If this information element 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 3.7.8.6.1 shall be followed. If the ignored information element is non-mandatory, the receiver continues to process the message.

3.7.8.5.2 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 the 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 the information elements appearing first up to the limit of repetitions shall be handled and all subsequent repetitions of the information element shall be ignored.

Exception: If there are more than two Network-specific facilities information elements in the SETUP message to the network, the network will send a RELEASE COMPLETE.

3.7.8.6 Mandatory Information Element Errors

3.7.8.6.1 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 3.7.3).

When a 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.”

3.7.8.6.2 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 3.7.3).

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 no cause value specified.

Information elements with a length exceeding the maximum length will be treated as information elements with content error.

When the Network-specific facilities information element indicates recognized facilities which are not subscribed by that user, the call is cleared. When the Network-specific facilities information element is mandatory and indicates unrecognized facilities, the network will send a RELEASE COMPLETE message.

3.7.8.7 Non-Mandatory Information Element Errors

3.7.8.7.1 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 messages and those information elements which are recognized and have valid content. The unrecognized information element(s) in Codeset 0 will be dropped and no STATUS message will be returned. Any unrecognized information elements in Codesets 6 or 7 will be passed by the network.

3.7.8.7.2 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. No STATUS message is returned.

When the Network-specific facilities information element indicates recognized facilities which are not subscribed by that user, the call is cleared. When the Network-specific facilities information element is not mandatory and indicates unrecognized facilities, the network will send a FACILITY REJECT message.

Information elements with a length exceeding the maximum length 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. For access information elements (e.g., User-user information element, Called party subaddress information element), a STATUS with cause #43 “Access information discarded” shall be returned if all MA UUI is dropped.

3.7.8.8 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 state shall be maintained according to the procedures contained in other parts of Section 3.7.

3.7.8.9 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, a timer T309 shall be started.

NOTE: If timer T309 is already running, it shall not be restarted.

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:

1) Stop timer T309.

2) A STATUS message shall 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 network timer T309 expires prior to data link reestablishment, the call is not cleared and billing (if appropriate) continues.

When a backup D-Channel is available, the procedures in Annex B may be used.

NOTE 1: The implementation of timer T309 in the user side is optional.

NOTE 2: After a Layer 2 failure, Layer 3 will buffer messages for a maximum of three seconds. If the link has not been re-established by then, the buffer will be flushed.

Calls that are up at the time the Layer 2 failure occurs will remain up. It is the responsibility of the CPE to tear them down if so desired, but in doing so, the CPE must notify the network that the calls have been cleared.

The SERVICE status of the B channels should be unchanged as a result of a temporary failure of Layer 2. A SERVICE audit may be conducted by either side of the interface in order to eliminate possible misalignment of the status across the interface.

3.7.8.10 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 3.7.8.8 and 3.7.8.9.

Upon receipt of a STATUS ENQUIRY message, the receiver must 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 must be taken based on the information in that STATUS message, relative to the current state of the receiver.

If the call reference specified in the STATUS ENQUIRY message is not in use, the Null state is returned in the Call State information element in the STATUS message.

3.7.8.11 Receiving a STATUS message

If a STATUS message is received in a clearing state, then the receipt of the message shall be ignored.

If a STATUS message is received in a non-clearing state, and the state reported in the STATUS matches the current state, no further actions need be taken.

If a STATUS message is received in a non-clearing state, and the state reported does not match the current state, the network shall:

a) take actions which attempt to recover from the mismatch, if the states are matchable.

b) clear the call by sending the appropriate clearing message, if the states are not matchable.

If a STATUS message is received in a non-clearing state, and the state reported does not match the current state, the user must (in order of preference):

a) take actions which attempt to recover from the mismatch and which are an implementation option (see network procedure above) or,

b) clear the call by sending the appropriate clearing message.

c) ignore the message if no STATUS ENQUIRY message was sent.

Refer to Figure III - 51 and Figure III - 52 for details.

Network State	User State		
	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	1,3,4, (if outgoing)	Transmit CONNECT with Channel ID
		8 (if incoming)	Transmit CONNECT ACKNOWLEDGE

Figure III - 51. 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, 9	Transmit ALERTING
8	8	6, 7, 9	Transmit CONNECT
9	9	6	Transmit CALL PROCEEDING
10	10	none	

Figure III - 52. User's Action on Receipt of STATUS

Except for the following rules, the determination of which states are incompatible is left as an implementation decision.

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 take no further action on this message.

When in all other call states, then on receiving a STATUS message with the global call reference, no action shall be taken.

NOTE: Further actions as a result of higher layer activity (e.g., system or layer management) are implementation dependent (including the retransmission of RESTART).

3.7.9 User Notification Procedure - Reserved for future use

3.7.10 Calling Scenarios

The figure in this section represents the interaction between the *Called party number*, and *Network-specific facilities* information elements. Figure III - 53 shows typical dialing sequences that may be encountered from a user.

For the type of Number field,

N is National,

I is International.

In the Called party number information element, the numbering plan identification is assumed to be coded as "ISDN/ telephony" (Recommendation E.163/E.164).

System Sending	System Receiving	User Dialed Sequence	Type of Number	Network Specific Facilities	Called Party Number
ALL	ALL	3/7/10D	N	-	3/7/10D
ALL	IXC/PBX	1+7/10D	N	-	7/10D
ALL	IXC	011+CC+NN	I	-	CC+NN
ALL	IXC	MEGACOM 7/10D	N	MEGACOM	7/10D
ALL	IXC	MEGACOM 1+7/10D	N	MEGACOM	7/10D
ALL	IXC	SDN 7/10D	N	SDN	7/10D
ALL	IXC	SDN 011+CC+NN	I	SDN	CC+NN
ALL	IXC	SDS 10D	N	ACCUNET	700+7D
ALL	IXC	SDS 7/10D	N	ACCUNET	7/10D
ALL	IXC	SDS 011+CC+NN	I	ACCUNET	CC+NN

Figure III - 53. Interaction of Selected SETUP Message Information Elements

3.7.11 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 are described in detail in Part II.

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.

3.7.11.1 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.

3.7.11.2 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.

3.7.11.3 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.

3.7.11.4 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.

3.7.11.5 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 3.7.8.9.

3.8 Packet Communication Procedures - Not Applicable

3.9 User-to-User Signaling Procedures

3.9.1 Procedures for User-to-User Signaling Associated with Circuit-Switched Calls

3.9.1.1 General

The user-to-user signaling supplementary service(s) provides a means of communication between two users by using as a basis the Layer 3 protocol defined in Section 3.7. User-to-user signaling is used to exchange information between two users to provide the services described in the I.257A Recommendations. The exchange of user-to-user signaling is limited by flow control procedures provided by the network or the user. The exchange of user-to-user information is not a network acknowledgment service. Any acknowledgment procedure shall be controlled at a higher layer between users.

Two user-to-user signaling services associated with circuit-switched calls that may be provided by the network to users are:

1. Message Associated UUI (MA-UUI):

   user-to-user signaling exchanged during the setup and clearing phases of a call, within Q.931 call control messages

2. Call Associated Temporary Signaling Connections (CA-TSC):

   user-to-user signaling exchanged during or after call establishment, in USER INFORMATION messages. CA-TSC combines the capabilities of ITU-T'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 signaling is NOT required for the call i.e., the call will be completed if user-to-user information cannot be passed.

3.9.1.2 Explicit Invocation Procedures (See Section 3.9.1.7)

3.9.1.3 Message Associated User-to-User Signaling (MA-UUI)

3.9.1.3.1 General Characteristics

MA-UUI allows the users to communicate by means of user-to-user Signaling by transferring user-to-user information within Q.931 call control messages during call establishment and clearing phases.

3.9.1.3.2 MA-UUI - Implicit Service Request (Preferred, i.e., not required)

MA-UUI may be implicitly requested by including user data information elements in the appropriate messages.

User-to-user information may be placed in the SETUP, ALERTING, CONNECT and/or DISCONNECT messages. MA UUI can also be included in the first expected clearing message for a Non-Call Associated Temporary Signaling Connection (NCA TSC) which could be RELEASE or RELEASE COMPLETE.[10]

In addition to the User-user information element, the network may treat the following information elements as user data information elements when present in the appropriate messages (listed with their MA UUI length restrictions):

- Called party subaddress (3-23 octets),
- Calling party subaddress (3-23 octets),
- High layer compatibility (3-5 octets),
- Low layer compatibility (3-16 octets),
- Redirecting number (3-17 octets),[11]
- *Locking* Shift to Codeset 6 and any Codeset 6 information elements (1-129 octets), and
- *Locking* Shift to Codeset 7 and any Codeset 7 information elements (1-129 octets).

For international calls, in addition to the User-user information element only the following information elements will be treated as user data information elements:

- Called party subaddress (3-23 octets),
- Calling party subaddress (3-23 octets),
- High layer compatibility (3-5 octets), and
- Low layer compatibility (3-16 octets).

The calling or called user should only send the above user data information elements for international ISDN.

All UUI-type information elements have significance to the end-user only and are not interpreted by the network.

Initially, the support of MA UUI on a call depends upon the availability of resources in the common channel signaling network. Thus, if the originating user potentially desires MA UUI to be transported in the ALERTING, CONNECT, or DISCONNECT messages, but has no MA UUI to send in the SETUP

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10. When both users disconnect nearly simultaneously, delivery of MA UUI in a clearing message is not guaranteed. Note that the network will not pass MA UUI in a DISCONNECT message when it is sent prior to the call being in the active state.

11. If Redirecting number is user generated, then it is transported as MA UUI and will not be interpreted by the network. If it is network generated, then it is not transported as MA UUI and will be interpreted by the network.

message, the originating user should place a User-user information element in the SETUP message with length=1.

The total length of user data information elements defined in this section must also satisfy all of the following criteria:

1. the length of the User-user information element shall be 3 to 131 octets; and

2. the total length of all user data information elements except user-user, cannot exceed 129 octets; and

3. the combined length of (1) and (2) above cannot exceed 198 octets.

The individual information elements which comprise MA UUI will be screened for valid information lengths. Any user data information element with an invalid length will be dropped. A STATUS message with cause 43, "access information discarded," is sent to the user only if all user data information elements are dropped, and the message is not a clearing message.

If the total MA UUI length is exceeded, the following information algorithm is employed. The total length of all user data information elements, except the User-user information element is checked for compliance with the 129 octet limit. If the length is greater than 129 octets, the *locking* Shift to Codeset 7 and the Codeset 7 information elements are dropped. If still too long, then the *locking* Shift to Codeset 6 and the Codeset 6 information elements are dropped. Then if the MA UUI total length is still greater than 198 octets, the User-user information element is dropped and the remaining user data information elements are passed by the network. This capability also applies to NCA-TSCs. It is the responsibility of the users to perform any verification of receipt of individual user data information elements.

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 Signaling is provided by the network to accommodate this situation.

Note: The called user may perform compatibility checking using the User data information element contents.

3.9.1.3.3 User-to-User Signaling in the Call Establishment Phase - Explicit Service Request (Preferred or Required) - Reserved for future use.

3.9.1.3.4 Interworking

In the case of interworking with a non-ISDN network, the return of a PROGRESS message with the Progress indicator information element indicating #1, “call is not end-to-end ISDN, further call progress information may be available in-band,” 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.

3.9.1.3.5 Rejection of Implicit Service Requests

The network will not return a rejection indication if the service cannot be provided.

However, if User-user information is discarded, the network may send a STATUS message with cause #43 "Access information discarded" to the user.

3.9.1.3.6 Rejection of Explicit Service Requests - Reserved for future use

3.9.1.3.7 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 3.7.3.3 and 3.7.3.4).

The information contained in such information elements is transferred to the remote user in the first clearing message (see Sections 3.7.3.3 and 3.7.3.4). 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 element 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.

3.9.1.3.8 Unexpected user information in call control messages

The network will discard the respective unexpected user data information elements in the corresponding messages.

3.9.1.4 User-to-User Signaling Service 2 - Reserved for future use

3.9.1.5 User-to-User Signaling Service 3 - Reserved for future use

3.9.1.6 Unexpected USER INFORMATION Messages

3.9.1.6.1 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."

3.9.1.6.2 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.

3.9.1.7 Requesting User-to-User Signaling CA-TSC

3.9.1.7.1 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.

Call State	Requesting Entity	Message
0 Null	Originating	SETUP
4 Call Delivered	Originating	FACILITY
9 Incoming Call Proceeding	Terminating	FACILITY
10 Active	Either	FACILITY

Figure III - 54. TSC Requests By Call State

More details on establishing a CA TSC at or after setup time are given in the next two sections.

3.9.1.7.2 Call Establishment

3.9.1.7.2.1 CA-TSC Requested at Setup Time

A CA TSC is requested during call setup by including the CA TSC code point in the Binary facility coding value field of the Network-specific facilities 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[12] to the user containing one of the cause information elements described in Section 3.9.1.7.2.3 and the Network- specific facilities information element encoded as above. In addition, if resources are not available at the far end, the network will send a SETUP message to the far end user including the "Notification of CA TSC Clearing or Resource Unavailable" code point in the Binary facility coding value field of the Network-specific facilities information element. 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 3.9.1.7.2.3 through 3.9.1.8.

3.9.1.7.2.2 CA-TSC Requested After Call Setup

In this case the user first sets up a B-Channel connection, then requests a CA TSC at some time after the initial SETUP message. The calling party can request a CA TSC anytime after receiving the ALERTING message because the called party has implicitly acknowledged the call setup. The called party can request a TSC anytime after sending the CALL PROCEEDING message that confirms the channel identity.

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

12. Note that the network may respond with CALL PROCEEDING prior to sending FACILITY REJECT.

to provide the CA TSC, the CA TSC request is delivered to the destination user in a similarly encoded FACILITY message. 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.

3.9.1.7.2.3 Acknowledgment of the CA-TSC Request

An acknowledgment must be received from the distant user before USER INFORMATION messages may be transmitted in either direction. Note that a response to a CA TSC request can be made at any time after CALL PROCEEDING has been sent.

The positive acknowledgment is a FACILITY ACKNOWLEDGE message which includes the CA TSC coding in the Network-specific facilities information element.

A negative acknowledgment is needed because a rejected CA TSC *does not clear the call setup.* If the CA TSC request is rejected by a switch in the call path, the subsequent SETUP message continuing towards the terminating user will not include the CA TSC request in the Network-specific facilities 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.

The FACILITY REJECT message[13] shall include the following:

- A Network-specific facilities information element, encoded with the CA TSC code point in the Binary facility value field.

- A Cause information element with a cause value chosen from:

  - 21 (call rejected)

  - 29 (facility rejected)

  - 42 (switching equipment congestion)

  - 50 (requested facility not subscribed)

  - 69 (requested facility not implemented)

Figure III - 55 summarizes CA TSC acknowledgments. The acknowledgments have the following effect:

- A positive acknowledgment causes processing of the CA TSC request to proceed. Processing of the B-Channel connection request is unaffected.

- A negative acknowledgment via the FACILITY REJECT message causes rejection of the CA TSC request, but allows processing of the B-Channel connection request to continue normally.

13. CPE implementing previous generics may return a STATUS message with a valid cause, since the FACILITY REJECT message may not be supported.

- A negative acknowledgment via the DISCONNECT or RELEASE COMPLETE messages results in rejection of the CA TSC request and clearing of the B-Channel connection.

Request Message	Positive Acknowledge	Negative Acknowledge
SETUP	FACILITY ACKNOWLEDGE	FACILITY REJECT DISCONNECT RELEASE COMPLETE
FACILITY	FACILITY ACKNOWLEDGE	FACILITY REJECT

Figure III - 55. Response to CA TSC Requests

3.9.1.7.3 Transfer of USER INFORMATION Messages

USER INFORMATION messages may be sent by either user provided a TSC has been successfully established. After interpreting the first three information elements (protocol discriminator, call reference value, and message type), the network will transport the USER INFORMATION messages intact. Any syntax errors contained within the message, after the message type information element, must be resolved by the end users. If a USER INFORMATION message exceeds the maximum allowable length, the message will not be transmitted across the network, and a STATUS message will be sent to the user with cause value 43 (access information discarded).

The sending of USER INFORMATION messages does not change the state of the call.

3.9.1.7.4 Flow Control of USER INFORMATION Messages

The network will flow-control, when needed, the transfer of USER INFORMATION messages from a user by means of a CONGESTION CONTROL message containing the Congestion level information element. Two indications of congestion level are specified: "receiver not ready" and "receiver ready." On receipt of the former, the user should suspend sending USER INFORMATION messages; on receipt of the latter, sending may recommence. After having sent a "receiver not ready" indication, the network may discard USER INFORMATION messages that are subsequently received.

The user can also send CONGESTION CONTROL messages to shut off the flow of USER INFORMATION messages from the network. In this event the network will immediately inform the remote user by sending a CONGESTION CONTROL message. Any USER INFORMATION message received from the remote user will be discarded by the network.

The user or the network can resume flow by sending a CONGESTION CONTROL message indicating "receiver ready" across the user-network interface. This should only be done by the entity that sent the CONGESTION CONTROL message that initiated flow control.

A CONGESTION CONTROL message with the global call reference value will be interpreted as a message with an invalid call reference value.

To avoid network congestion, the Network may also flow control the transfer of USER INFORMATION messages from a user by limiting the rate at which the combined total length of USER INFORMATION messages are allowed to enter the Network on an individual TSC. In this case, upon receipt of a USER INFORMATION message, the Network may discard the USER INFORMATION message and respond to the user with a STATUS message with a cause value of 43 "access information discarded."

3.9.1.7.5 Congestion Control Strategy for TSCs

Temporary Signaling Connections may encounter congestion from either the network or the user. AT&T's ISDN network will provide flow control to ensure that no single user is allowed to monopolize network resources, thus affecting service for other users.

AT&T's congestion control strategy addresses both network congestion and user congestion.

- User congestion **-** When a user indicates to the network that it is congested by sending a CONGESTION CONTROL (receiver not ready) message, the network will immediately forward the congestion indication to the other TSC user.

- Network congestion **-** While a network element is congested, neither the near end nor far end of a TSC will be notified until an attempt is made to transfer user to user data, in which case, the user initiating the transfer may be notified of the congestion. The USER INFORMATION message may be discarded.

When the network congestion clears, the network may send Congestion Control (receiver ready) message autonomously.

The network assumes no responsibility for recovery of lost messages or for notification of congestion clearing in all cases. Rather, it is the responsibility of the end-users to recover from the loss of USER INFORMATION messages.

3.9.1.8 Clearing CA-TSC

Normal call clearing procedures are used to simultaneously disconnect the CA TSC and the B-Channel connection. The DISCONNECT message initiates the clearing procedure.[14] 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 TSC itself.

The network shall notify the CPE at both ends of a connection for each CA TSC that is torn down by the network. The network shall also notify the far end CPE, if the CA TSC is lost because of a D-Channel backup switchover. In both cases, the network shall send a FACILITY message containing a Network-specific facilities information element with a binary facility coding "Notification of Call Associated TSC Clearing."

Notification of Call Associated TSC clearing has no impact on the state of the circuit switched call, which will remain active as a default. The user can attempt to set up a new Call Associated TSC, associated with the original circuit switched call.

Until the reason for network tear down has been corrected, any attempt to set up a new CA TSC will be rejected with a cause value as described in Section 3.9.1.7.2.3.

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14. The use of other call clearing messages in error recovery situations (i.e., RELEASE and RELEASE COMPLETE) also clears the CA TSC.

3.9.2 Non-Call Associated Temporary Signaling Connections (NCA-TSC)

3.9.2.1 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.

3.9.2.2 Call Establishment

On call request, 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[15]
- 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
- Network-specific facilities information element
  - Binary facility coding = SDN or ACCUNET Switched Digital

3.9.2.3 Acknowledgment of the NCA TSC Request

As indicated previously, an acknowledgment must be received from the user opposite the NCA TSC request before USER INFORMATION messages may be transmitted in either direction. The acknowledgments are summarized in Figure III - 56. The terminating user and the network positively acknowledge the NCA TSC request with a CONNECT message.[16]

The network rejects the NCA TSC request when TSC resources are busy by sending a RELEASE or RELEASE COMPLETE message with a Cause information element indicating cause 29, "facility rejected" or 42 "Switching equipment congestion." The terminating user rejects a NCA TSC request by sending a RELEASE message with a cause information element indicating cause 29, "facility

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15. These field settings are currently ignored by the network, but may become mandatory.
16. Message Associated User-to-User Information should not be present in a CONNECT message used to acknowledge a NCA TSC request.

rejected." This message may be preceded by a CALL PROCEEDING message. The terminating user may also reject the NCA TSC request by responding to the SETUP message with a RELEASE COMPLETE message with a Cause information element indicating cause 29. Note that in both cases the originating user will receive these messages with cause value 21 "Call rejected."

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.

Request Message	Positive Acknowledge	Negative Acknowledge
SETUP	CONNECT	RELEASE
		RELEASE COMPLETE

Figure III - 56. NCA TSC Request Acknowledgments

3.9.2.4 NCA-TSC Call Reference Procedural Errors

When a SETUP message is received specifying a call reference which is recognized as relating to an active NCA-TSC, the network will respond to this SETUP message with a RELEASE COMPLETE message with cause #98. The network will then send a RELEASE message specifying the call reference associated with the NCA-TSC.

3.9.2.5 Receipt of a STATUS message

Figure III - 57 and Figure III - 58 show the matchable states and actions to be taken when a STATUS message is received. See Section 3.7.8.11 for general actions to be taken on receipt of a STATUS message.

Network State	User States		
	Matching	Matchable	Network’s Action
3	3	none	
7	7, 9	none	
8	8	none	
10	10	1, 3 if outgoing	Transmit CONNECT with channel ID
		8 if incoming	Transmit CONNECT ACKNOWLEDGE

Figure III - 57. 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	Transmit CONNECT
9	7	none	
10	10	none	

Figure III - 58. User's Action on Receipt of STATUS for NCA-TSC

3.9.2.5.1 Transfer of USER INFORMATION Messages

The procedures described in 3.9.1.7.3 apply, where the call reference applies to the signaling connection.

3.9.2.5.2 Flow Control of USER INFORMATION Messages

The procedures described in 3.9.1.7.4 apply.

3.9.2.5.3 Clearing the NCA TSC

Clearing of the NCA TSC connection is initiated by either entity using a RELEASE message. The other entity responds with RELEASE COMPLETE. A DISCONNECT message is not used since there is not a B-Channel to disconnect.

3.10 Application of Circuit-Switched Supplementary Services to Terminals Using Stimulus Procedures - Not applicable.

3.11 List of System Parameters

The description of timers in the following tables should be considered a brief summary. The precise details are found in Section 3.7, which should be considered the definitive description.

3.11.1 Timers in the Network Side

The timers specified in the following tables are maintained in the network side of the interface.

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	8s	Call Present	SETUP Sent	ALERT, CONN, CALL PROC, REL COMP or first PROG received.	Note 1	Note 1	Mandatory

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	4s	Disconnect Indication	DISC	REL, DISC or REL COMP received	Network sends REL	Timer is not restarted	Mandatory
T306	Note 2	Tone Active	PROGRESS	DISC received	Stop the tone announcement, Send DISC	Timer is not restarted	Mandatory when in-band tones, announcements are provided

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	4s (Note 3)	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 5)	Mandatory
T309	90s (Note 6)	Any stable state	Data link disconnection. Calls in stable states are not lost	Data link reconnected	See 3.7.8.9	Timer is not restarted	Mandatory
T310	10s (Note 4)	Incoming Call Proceeding	CALL PROC received	ALERT, CONN, DISC or first PROG received	Send DISC	Timer is not restarted	Mandatory

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 min.	Restart Request	REST sent	REST ACK received	REST Retransmitted several times. Reinitialize T316	REST may be retransmitted several times. Restart T316	Mandatory

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	120s	Any state	SERV sent	SERV ACK received	Retransmit SERV and reinitialize T3M1	Retransmit SERV	Mandatory (see Section 3.13.5.1)
T321	40s	Any call state	D-Channel failure	Response to Layer 3 message received. SERV or SERV ACK rec. on STBY D-CH	Send DL_ESTABLISH_REQ on both D-Channels. Place IS and STBY D-CH OOS	Timer is not restarted	Mandatory when Annex B is implemented

Note 1: For the AT&T Network, T303 is twice the standard value of T303, which is 4 seconds. At the first expiration of T303, the network sends a RELEASE COMPLETE, sends a RESTART on the channel, and hunts 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, a RESTART message is sent on the channel, the call is considered terminated, and an announcement is played. This procedural difference does not affect compatibility with equipment following the standard value of T303.

Note 2: The value of timer T306 may depend on the length of the announcement.

Note 3: This default assumes the use of default values at Layer 2 (i.e., [N200+1] times T200).

Note 4: The value of timer T310 may be different in order to take into account the characteristics of a private network.

Note 5: The restart procedures contained in Sec. 3.7.5 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.

3.11.2 Timers in the User Side

The timers specified in the following tables are maintained in the user side of the interface. Timers T305, T308 and T313 are mandatory for all user side implementations.

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	4s (Note 1)	Call Initiated	SETUP Sent	ALERT, CONN, CALL PROC or REL COMP received.	Retransmit SETUP, restart T303. If REL COMP was received, clear call	Clear internal connection. Send REL COMP. Enter Null state.	Optional
T305	4s	Disconnect Request	DISC sent	REL, DISC or REL COMP received	REL sent	Timer is not restarted. REL COMP may be sent	Mandatory

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	4s (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 2)	Mandatory
T309	90s (Note 3)	Any stable state	Data link disconnection. Calls in stable states are not lost	Data link reconnected	Section 3.7.8.9	Timer is not restarted	Optional

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	Implement ation dependent >10s (Note 4)	Outgoing Call Proceeding	CALL PROC received	ALERT, CONN, DISC, or PROG received	Send DISC.	Timer is not restarted	Optional
T313	4s (Note 1)	Connect request	CONN sent	CONN ACK received	Send CONN or DISC	Timer is not restarted. Send DISC	Mandatory. See Sec. 3.7.2.8

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 min.	Restart Request	REST sent	REST ACK received	REST retransmitted several times. Reinitialize T316	REST may be Retransmitted several times.	Mandatory when Section 3.7.5 is implemented
T3M1	120s	Any state	SERV sent	SERV ACK received	Retransmit SERV and reinitialize T3M1	Retransmit SERV	Mandatory (see Section 3.13.5.1)
T321	40s	Any call state	D-Channel failure	Response to Layer 3 message received. SERV or SERV ACK rec. on STBY D-CH	Send DL_ESTABLISH_REQ on both D-Channels. Place IS and STBY D-CH OOS	Timer is not restarted	Mandatory when Annex B is implemented

Note 1: This default value assumes the use of default values at Layer 2; i.e., (N200+1) times T200.

Note 2: The restart procedures contained in Section 3.7.5 may be used on B-Channels in the maintenance condition.

Note 3: The value of this timer is an implementation option. The value shall lie in the range of 30 to 120 seconds.

Note 4: T310 is not started if a PROGRESS message has been delivered. If T310 is implemented, it is recommended that the value selected be sufficiently large to insure against premature disconnect on international calls (due to delays encountered in some foreign networks), or on calls that terminate to a wireless location. To prevent such a disconnect, it is recommended that the value of T310 be set at 25 seconds.

3.12 AT&T Maintenance and Management

3.13 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 3.6.

3.13.1 Layer 2 Operation for Maintenance

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.

3.13.2 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. (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.

3.13.2.1 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 3.1 through 3.6. 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 3.13.5).

AT&T strongly recommends that all systems implement a 64kbit/s noninverting looping test line. This test line loops the incoming 64kbit/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.

3.13.3 Message Structure

Maintenance messages follow the same structure as that of call control messages. The benefits include simplicity and flexibility of the interface specification.

The protocol discriminator for maintenance messages has the value 0000 0011.

The global call reference value is used for all maintenance messages.

3.13.4 Maintenance Messages

The following two message types will be recognized by the network as maintenance messages.

- SERVICE

- SERVICE ACKNOWLEDGE

3.13.5 Maintenance Procedures

This section presents the procedures to be used with the messages defined in Section 3.13.6. Since the maintenance messages are symmetric, these procedures can be initiated by either side of the interface.

Test calls, SERVICE messages and procedures, and RESTART messages and procedures will be supported in both directions on time slots/B-Channels which underlay H0 and/or H11 channels which are otherwise dedicated to carrying calls of those bandwidths (384 Kbps and 1536 Kbps). Test calls, Service procedures and Restart procedures on the B-Channels will be used to indirectly affect testing, change status, and reset the H-channels. In order to request a test call, the CPE needs to include in its SETUP message a valid Network-specific facilities information element for CBC TGs.

The Service procedure and messages will only refer to B-Channels. The status of an H0 and H11 channel is the least available status of the underlying B-Channels. Note that H0 or H11 channels dedicated to carrying calls of those bandwidths will still be considered as underlaid by B-Channels for the purposes of supporting Service procedures.

All SERVICE messages will specify individual B-Channels only. The response to a SERVICE message specifying an interface is a STATUS message indicating cause 100 (invalid information contents).

Only test calls may be placed by either side of the interface on a channel that has *Maintenance/FE* status. If a non-test call is received for a channel that has *Maintenance/FE* status, a service audit is triggered.

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 message is received in this state:

a) Respond with a RELEASE COMPLETE (or DISCONNECT in the case of channel negotiation) with the cause value 44 ("requested channel not available").

b) If the *Out of Service* status was originally requested by the far end, the network will initiate procedures to bring the channel *In Service* and proceed as in "a" above.

3.13.5.1 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 a channel within the interface. The status change is accomplished by sending a SERVICE message across the interface indicating the channel 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. The acknowledgment 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 3.13.5.5). 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 3.13.5.1.3 below for definition of "Far End").

As noted in Section 3.7.8.9, the SERVICE status of the B-Channels should be unchanged as a result of a temporary D-Channel failure. Specifically, CPE should not take B-Channels out of service due to a D-Channel failure.

CPE may, for other reasons, wish to move a B-Channel from In Service to a less available state (Out of Service or Maintenance) while the D-Channel is unavailable. CPE must use a SERVICE message to notify the Network of the state change once the D-Channel comes back into service.

The CPE may receive a SETUP message from the network for a B-Channel in question, before the CPE has notified the Network of an intended state change. In this situation, the CPE shall negotiate the call to a different B-Channel (if B-Channel negotiation is supported) or clear the call with a RELEASE COMPLETE message containing cause #44, “Requested circuit/channel not available”. A SERVICE message indicating a change in the B-Channel status must follow.

The network must be notified via a SERVICE message of any change to the status of a B-Channel made by the CPE.

A SERVICE message sent by the user indicating a B-Channel which is not associated with the PRI will be ignored by the network (no response will be returned from the network).

3.13.5.1.1 Service Messages Specifying an Interface

The AT&T network does not support SERVICE messages for entire interfaces.

3.13.5.1.2 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 in Annex B specify that a SERVICE *In 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.

3.13.5.1.3 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. 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.

3.13.5.1.3.1 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.

3.13.5.1.3.2 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 3.13.6.5.1) 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.

3.13.5.1.3.3 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." If the network has not yet been notified of the change in B-Channel status, a SERVICE message must be sent indicating the Out-of-Service state.

b) In addition to option "a" above, initiate a status audit procedure.

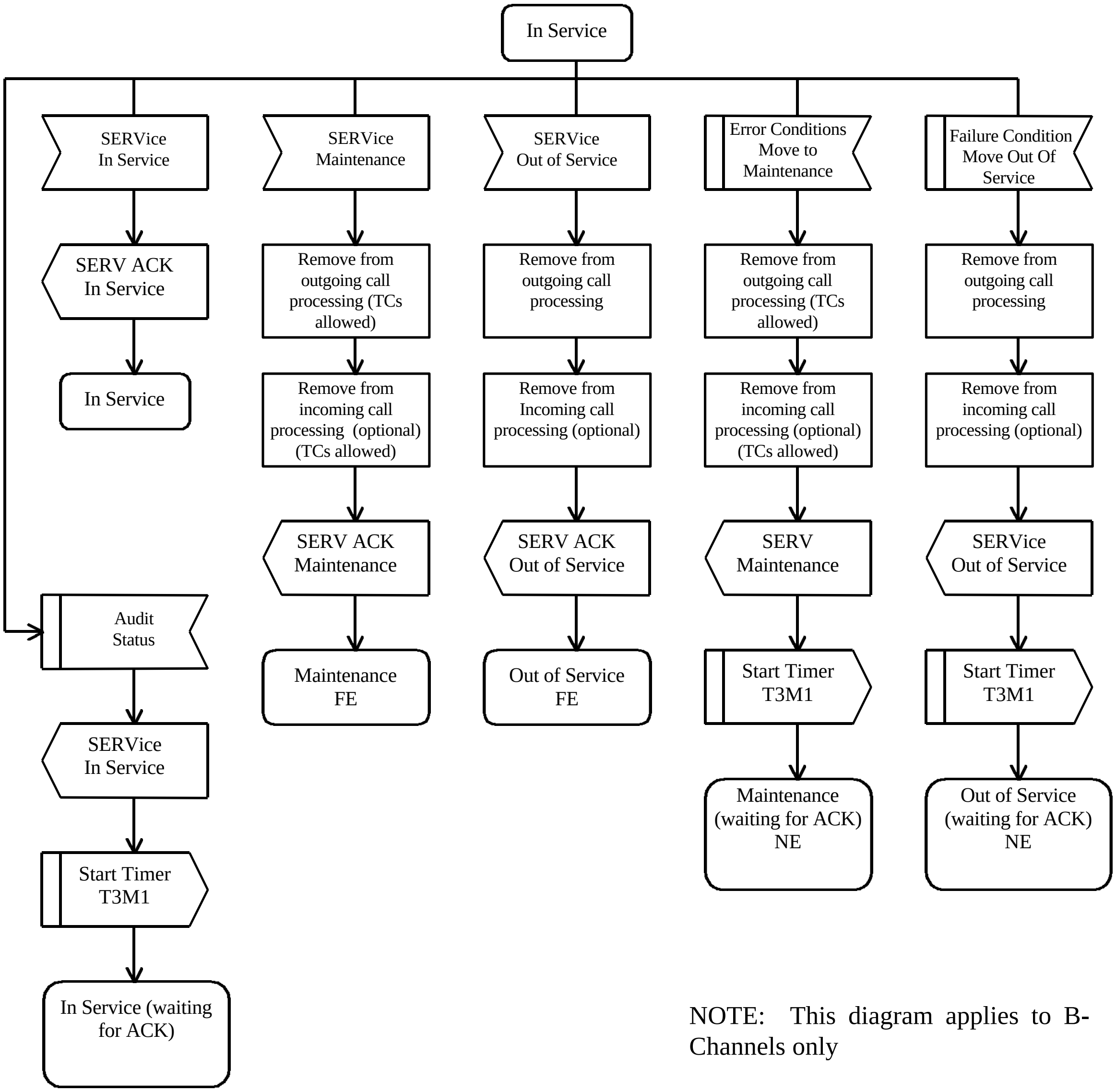
c) If the *Out of Service* status was originally requested by the Far End, accept the call, otherwise proceed according to "a" above.

d) 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 "a" above.

A bearer channel 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 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 indicating the *Maintenance* status or a SERVICE message with a Change Status information element 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 must 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 shall 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.

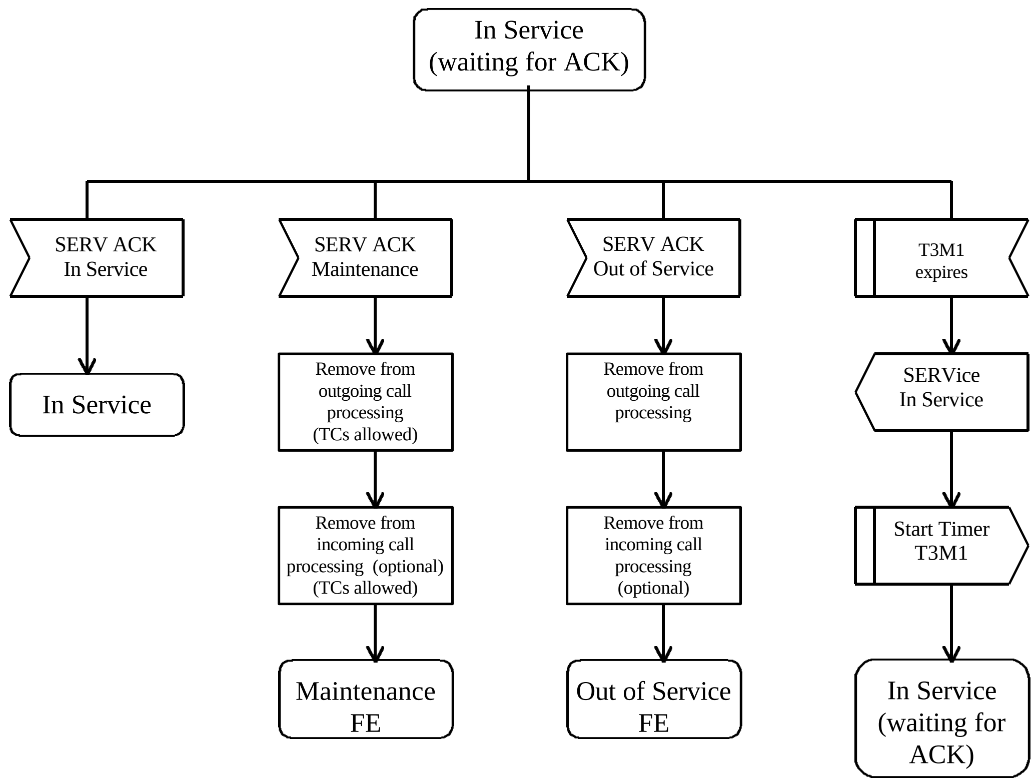
The following SDL diagrams describe expected maintenance procedures for B-Channels only (see Appendix II-A in Part II for symbol definitions). Exception conditions are discussed in the following sections.



NOTE: This diagram applies to B-Channels only

TC - Test Calls

Figure III - 59. SDL SERVICE In Service (part 1 of 2)



NOTE: This diagram applies to B-Channels only.

Figure III - 60. SDL SERVICE In Service (part 2 of 2)

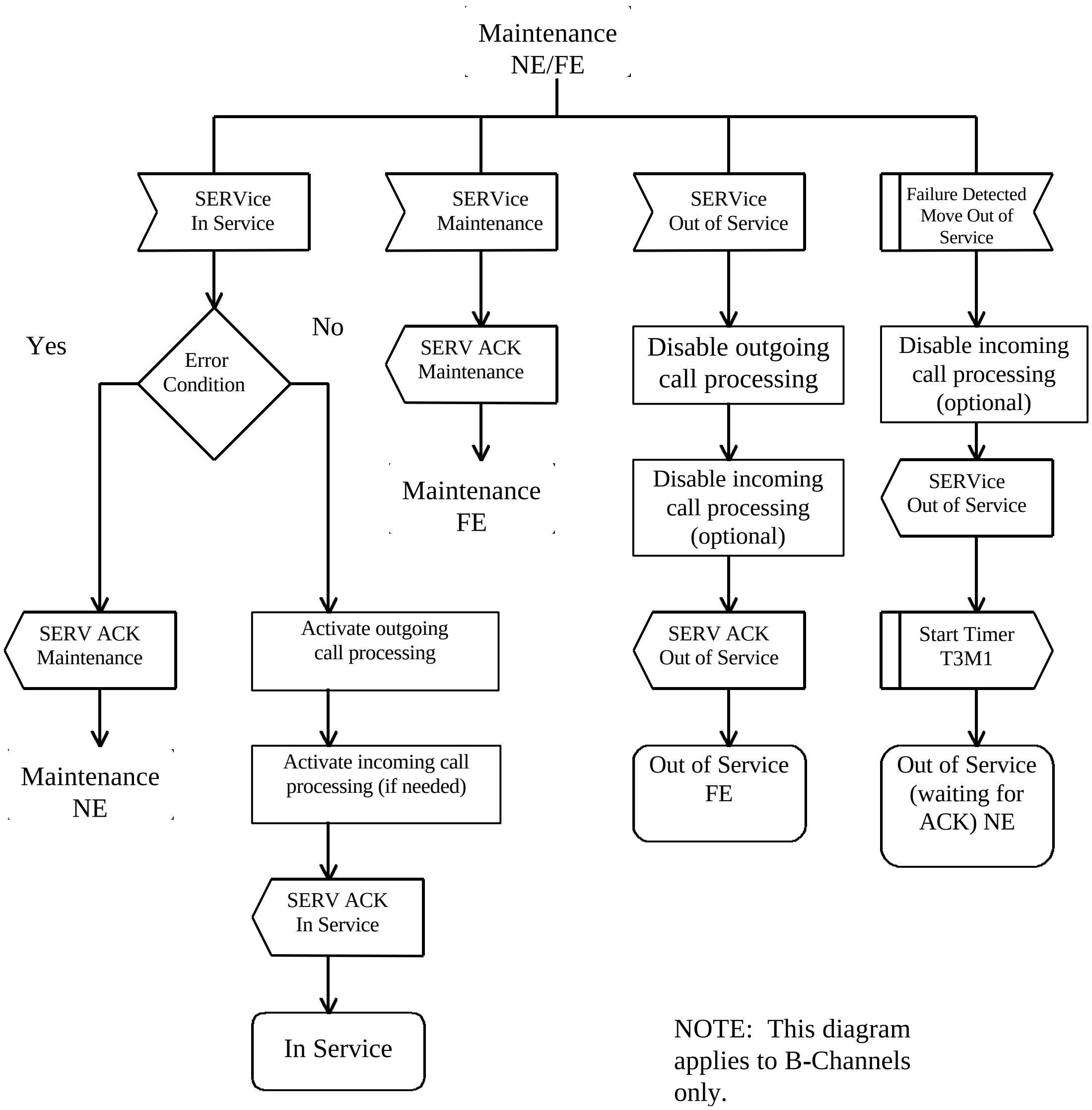
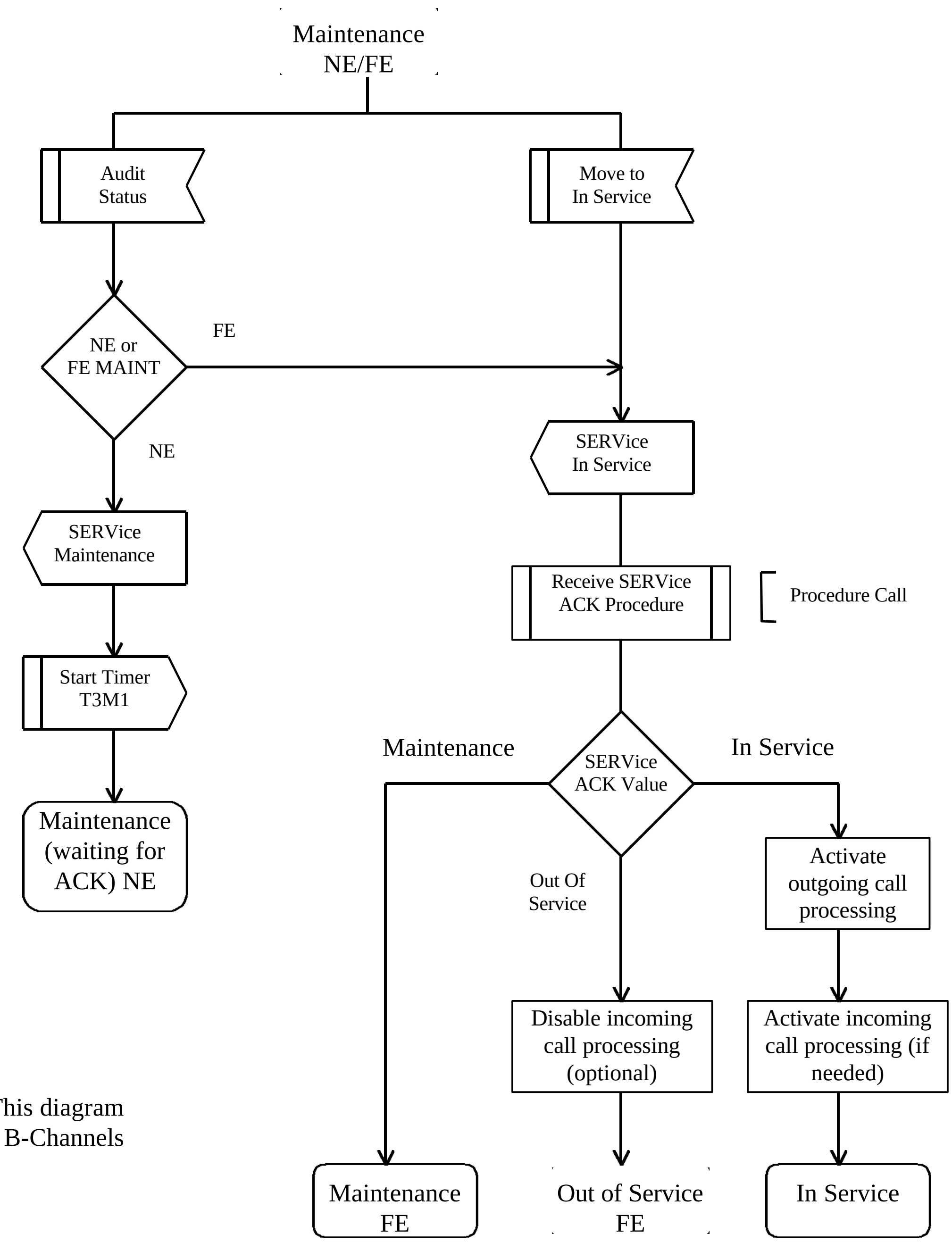
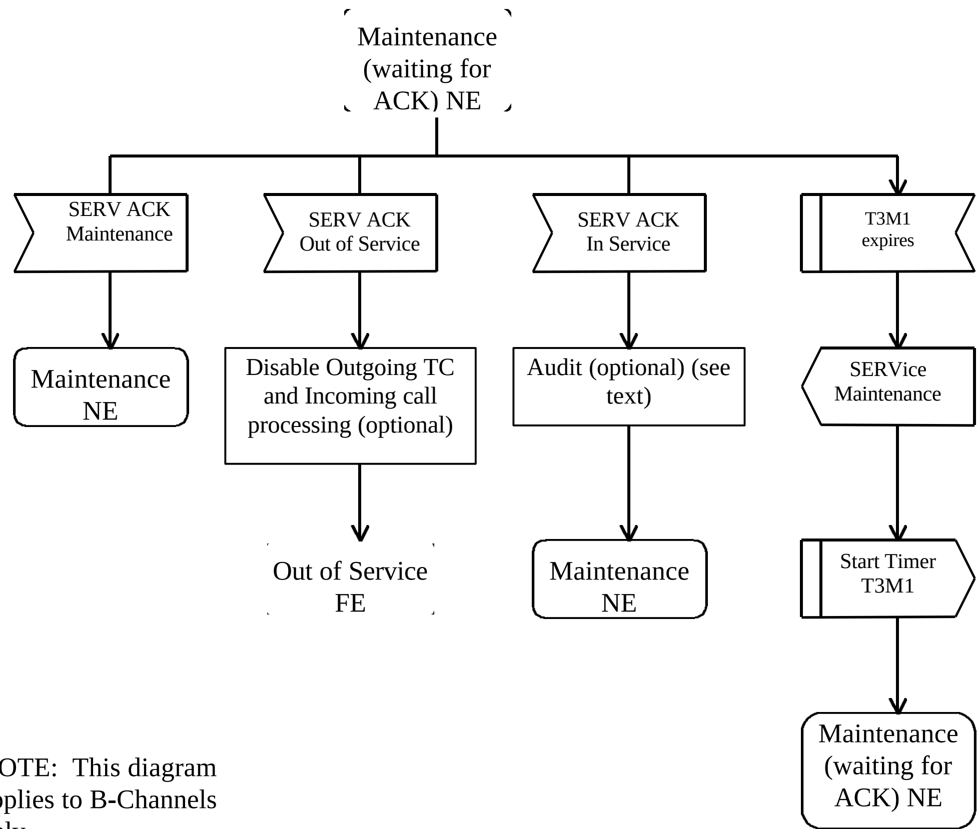


Figure III - 61. SDL SERVICE Maintenance (part 1 of 3)



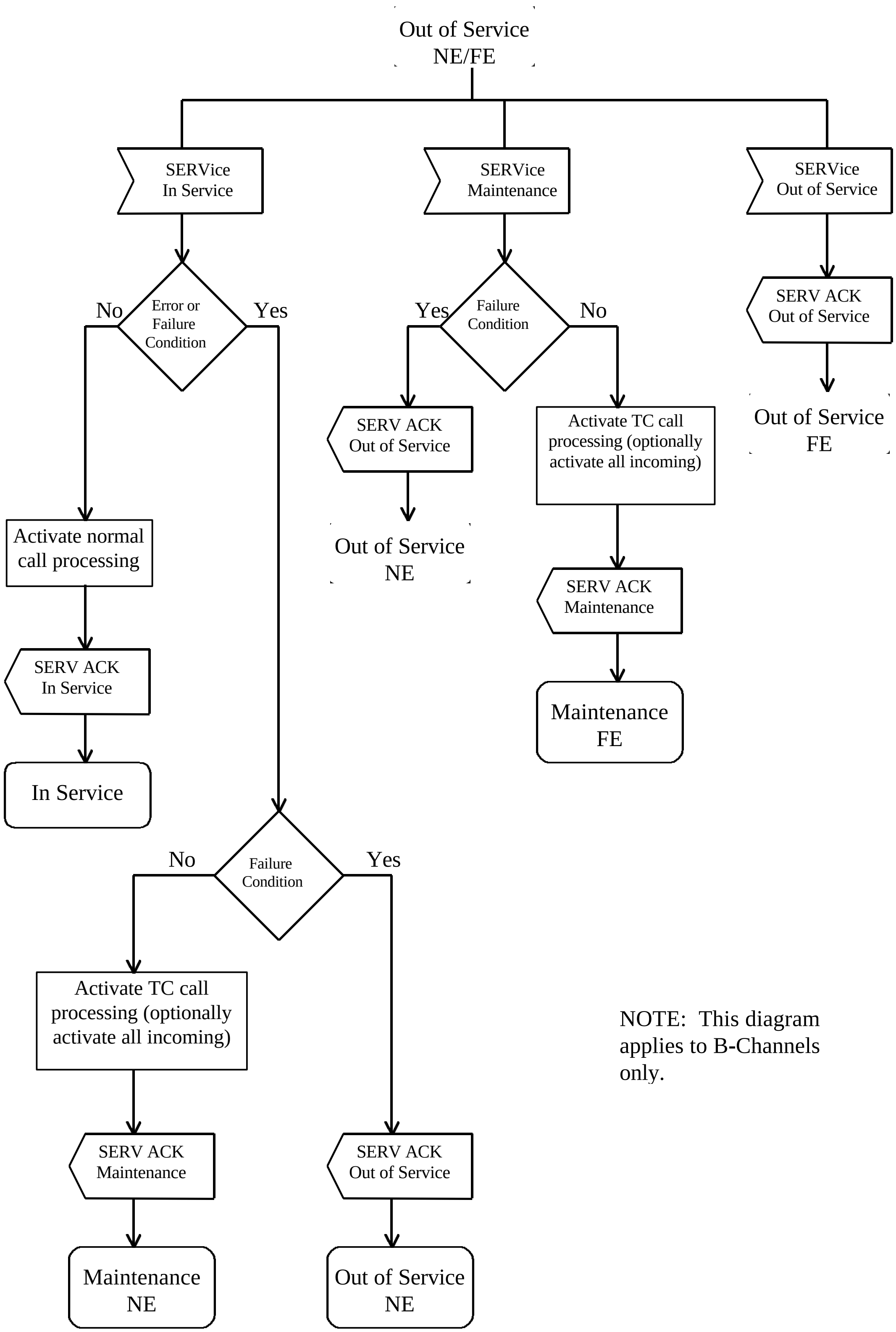
NOTE: This diagram applies to B-Channels only.

Figure III - 62. . SDL SERVICE Maintenance (part 2 of 3)



NOTE: This diagram applies to B-Channels only.

Figure III - 63. SDL SERVICE Maintenance (part 3 of 3)



NOTE: This diagram applies to B-Channels only.

Figure III - 64. SDL SERVICE Out of Service (part 1 of 3)

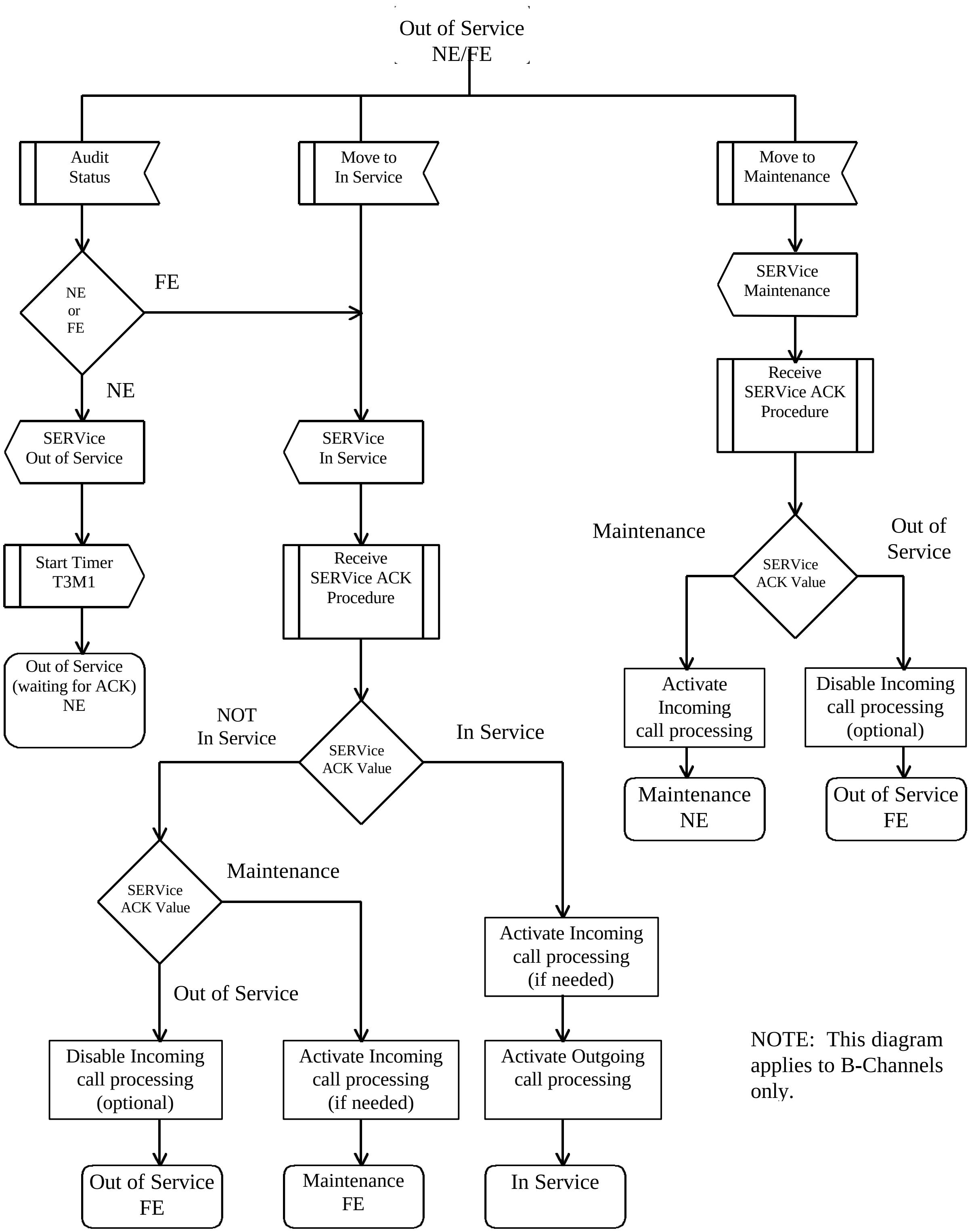


Figure III - 65. SDL SERVICE Out of Service (part 2 of 3)

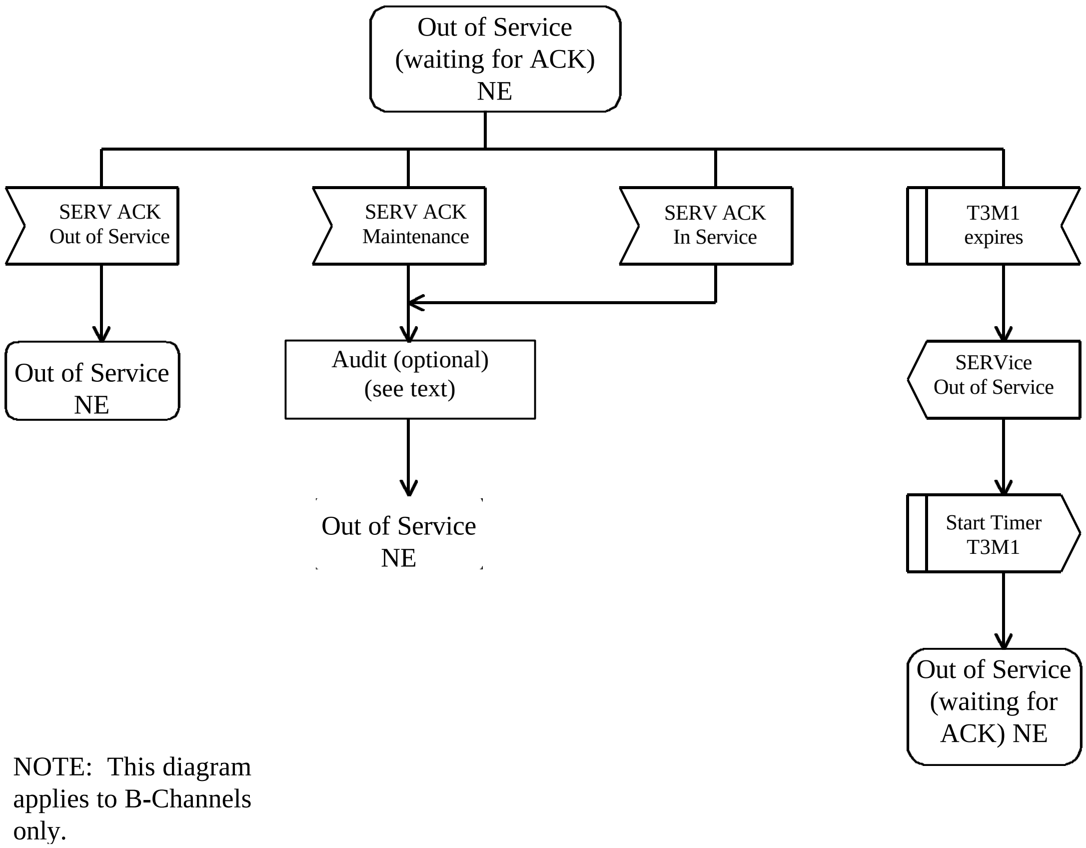


Figure III - 66. SDL SERVICE Out of Service (part 3 of 3)

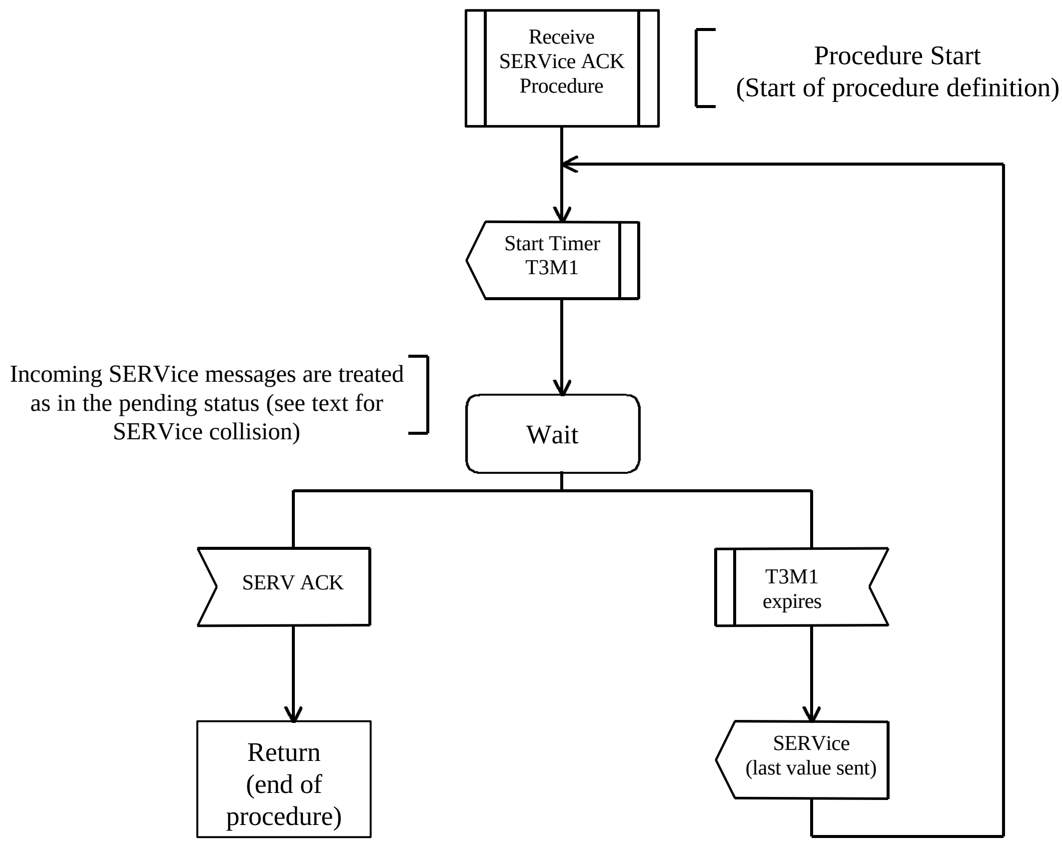


Figure III - 67. SDL SERVICE Receive SERVICE ACK

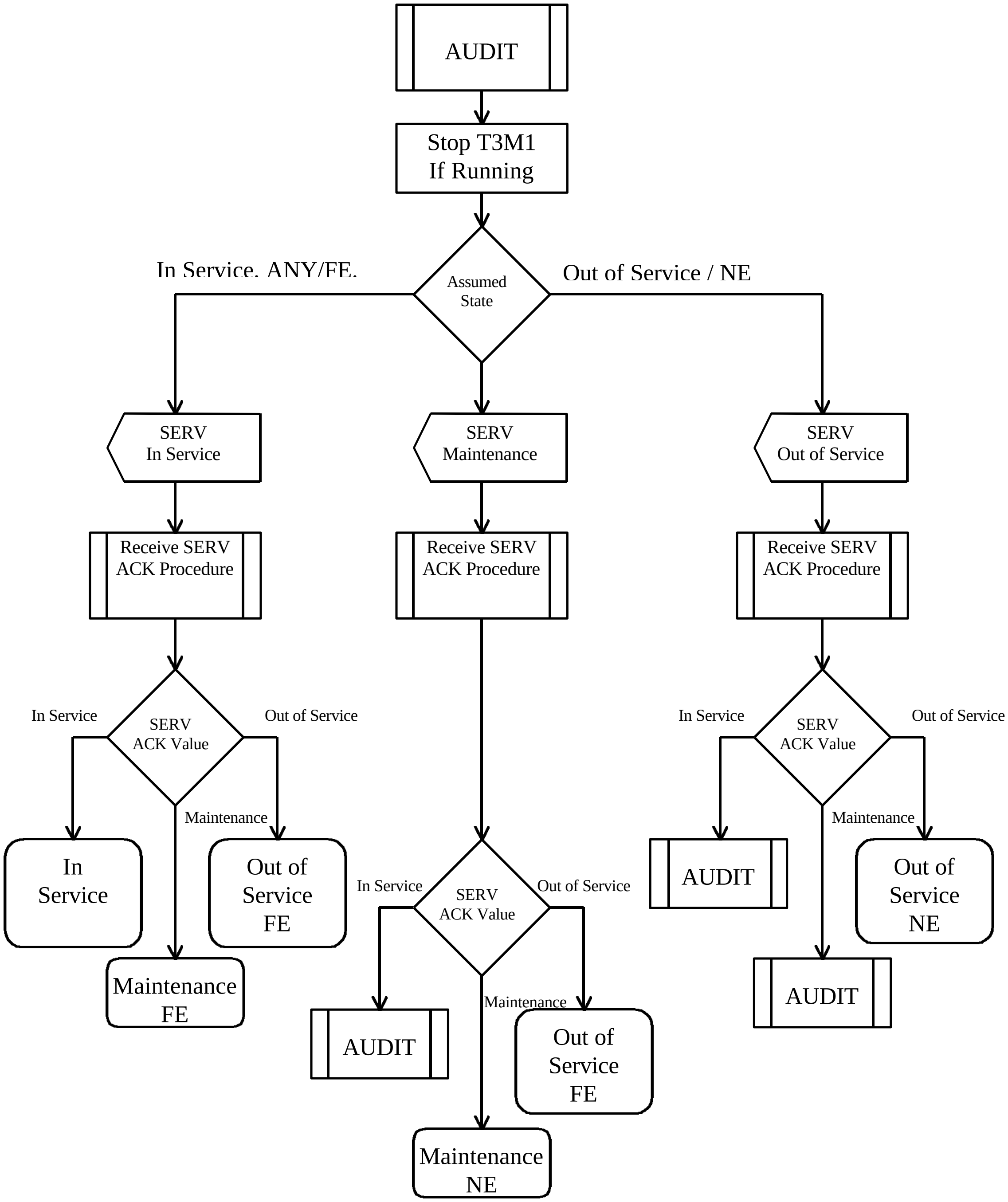


Figure III - 68. SDL SERVICE AUDIT

3.13.5.2 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.

a) Normal incoming calls while in the *Maintenance* status or any incoming call while in the *Out of Service* status.

b) Once every 24 hours on all channels

c) When CPE sends a RELEASE COMPLETE message with a Cause value of 44, “Requested circuit/channel not available” in response to a SETUP message for an individual B-Channel. If the response received in the SETVICE ACKNOWLEDGE messages shows the B-Channel is in service, the network will send a RESTART message for that channel. If the network receives a SERVICE ACKNOWLEDGE showing the B-Channel is out of service or in maintenance state, the network will update its status of that channel and will not restart it.

3.13.5.3 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.

3.13.5.4 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.

3.13.5.5 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:

- 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.

3.13.5.6 Error Conditions

3.13.5.6.1 Receipt of a Solicited Message with Invalid Contents

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, the message will be ignored.

If a SERVICE ACKNOWLEDGE message is received with an invalid or missing Channel identification information element, the message will be ignored.

If a SERVICE ACKNOWLEDGE message is received without a Change Status information element, the message will be ignored.

If a SERVICE ACKNOWLEDGE message is received with an invalid Change status information element, a Status message with cause 100, “invalid information element content,” will be returned. The call state information element will specify the current call state. The current call reference will be specified unless the current call state is null, in which case the global call reference value will be specified.

3.13.5.6.2 Receipt of an Unsolicited Message

The network response to an unsolicited SERVICE ACKNOWLEDGE message is to treat the message the same as a solicited SERVICE ACKNOWLEDGE message. The CPE responses to an unsolicited SERVICE ACKNOWLEDGE message is as follows:

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 3.13.5.2.

b. Treat the same as a solicited SERVICE ACKNOWLEDGE.

c. Ignore it. These responses are in order of decreasing preference.

3.13.6 Maintenance Message Definitions

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.

3.13.6.1 Overview

The messages identified for the maintenance of the User-Network interface follow the same structure as call control messages defined in Section 3.6. The message consists of the following parts:

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.

3.13.6.2 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 below.

Table III - 65. Protocol Discriminator

8	7	6	5	4	3	2	1	
Maintenance Messages								
0	0	0	0	0	0	1	1	Octet 1

3.13.6.3 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 3.6.3. It is strongly recommended that equipment be able to accept a three octet global call reference as described in Section 3.6.3.

3.13.6.4 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. It is coded as shown below.

Table III - 66. Message Types

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

8	7	6	5	4	3	2	1	
0	0	0	-	-	-	-	-	*Maintenance Messages:*
			0	1	1	1	1	SERVICE
			0	0	1	1	1	SERVICE ACKNOWLEDGE

3.13.6.5 Other Information Elements

3.13.6.5.1 Coding Rules

The coding of the Channel identification information element is given in Section 3.6.5.12. 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 below. The one additional information element identified belongs to *codeset 0* as specified in Q.931.

Table III - 67. Information Element Identifier Coding

8	7	6	5	4	3	2	1

0	:	:	:	:	:	:	: Variable Length Information Elements:
	0	0	0	0	0	0	1 Change Status

3.13.6.6 Maintenance Messages

3.13.6.6.1 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.

Table III - 68. SERVICE Message Content

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.13.6.2	both	M	1
Call reference	3.13.6.3	both	M	2-3
Message type	3.13.6.4	both	M	1
Change status	3.13.6.7.1	both	M	3
Channel identification	3.13.6.7.2	both	M (Note 1)	3-6 (Note 2)

Note 1: The network will support SERVICE messages for individual B-Channels only. Thus, the Channel identification information element is mandatory.

Note 2: The length of the Channel identification information element must be 3 or 4 for D-Channel backup procedures, and 5 or 6 otherwise.

3.13.6.6.2 SERVICE ACKNOWLEDGE

The SERVICE ACKNOWLEDGE message is used to return the new status of the channel.

Table III - 69. SERVICE ACKNOWLEDGE Message Content

Information Element	Reference	Direction	Type	Length
Protocol discriminator	3.13.6.2	both	M	1
Call reference	3.13.6.3	both	M	2-3

Message type	3.13.6.4	both	M	1
Change status	3.13.6.7.1	both	M	3
Channel identification	3.13.6.7.2	both	M (Note 1)	3-6 (Note 2)

Note 1: The network will support SERVICE ACKNOWLEDGE messages for individual B-Channels only. Thus, the Channel identification information element is mandatory.

Note 2: The length of the Channel identification information element must be 3 or 4 for D-Channel backup procedures, and 5 or 6 otherwise.

3.13.6.7 Other Information Elements

The information elements listed below will be supported. The following sections outline which specific codings will be recognized by the AT&T network.

- Change status
- Channel identification

3.13.6.7.1 Change Status

OCTET	FIELD	BITS	VALUE	MEANING
1	Extension	8	0	Multiple octet element
	Information element identifier	7-1	0000001	Change status
2	Length	8-1	binary	Length of information element contents
3	Extension	8	1	Last octet of description
	Preference	7	1	Channel
	Spare	6-4	000	Spare
	New Status	3-1	000	In Service
			001	Maintenance
			010	Out of Service

Figure III - 69. Change Status Information Element

3.13.6.7.2 Channel Identification

See Section 3.6.5.12 for the coding of this information element.

3.14 D-Channel Backup Procedures for Non-Facility Associated Signaling

These procedures are specified in Annex B.

3.15 Procedures for Accessing Network Features and Services

To select a particular service or facility supported by the network, the user can:

- indicate this selection by including the appropriate coding of information elements (e.g., Bearer capability, Channel identification, Network-specific facilities) in the SETUP message,
- subscribe to the service on a continuous basis, or
- request it by using a FACILITY message.

The following sections detail how access to various network provided services is provided. Table III - 70 shows the interplay of specific fields within the Bearer capability, Called party number, Channel identification, and Network-specific facilities information elements in requesting a service or feature from the network at call initiation via a SETUP message.

3.15.1 Calling Party Number (CPN) to the Network

The user sends the Calling party number (CPN) in the Calling party number information element contained in the SETUP message. See Overview for additional information.

3.15.2 CPN/BN Privacy Optioning

The calling user may override the default value (Presentation Allowed) of the Presentation Indicator field of the Calling party number information element. This is done by specifying the Presentation Restricted codepoint. The CPN will not be delivered by the network to the called user if the Presentation Indicator field specifies the Presentation Restricted codepoint. The BN will be delivered to the called user, with the Presentation Indicator, for the following services only:

- Software Defined Network (SDN)
- Toll Free MEGACOM®
- MultiQuest®
- Call Redirection Service

regardless of the status of the Presentation Indicator field.

3.15.3 CPN/BN to Terminating End

When CPN and/or BN is delivered to the terminating user, the Presentation indicator may be coded as "presentation allowed" or "presentation restricted" as determined in Section 3.15.2.

- CPN on a Subscription Basis: Optional. The called user may elect to have CPN delivered on all incoming calls. Whenever available, the network will deliver the CPN in the SETUP message. The screening indicator for CPN may be "user provided" or "network provided."
- BN on a Subscription Basis: Optional. The called user may elect to have BN delivered on all incoming calls. Whenever available, the network will deliver the BN in the SETUP message. The screening indicator for BN is always "network provided."

- 3 - Digit BN on a Subscription Basis: Optional. The called user may elect to have a 3 - Digit BN delivered on all incoming calls when a complete BN is not available for *BN only* subscription option and when neither a complete BN nor CPN is available for *BN preferred* and *CPN preferred* subscription options. The network will deliver the 3-Digit BN in the SETUP message. The screening indicator is "network provided."

- CPN/BN on a Per-Call Basis. The network may allow the user to request CPN/BN on a per-call basis. The user requests this information by sending a FACILITY message, containing the CPN/BN delivery request in Network specific facilities information element, to the network. The network will deliver this information, when available, by sending a FACILITY ACKNOWLEDGE message containing the calling party number information element. The screening indicator for BN is always "network provided," while for CPN it may be "user provided" or "network provided." The FACILITY message must be sent by the user before an ALERTING message (i.e., network will process the FACILITY message at either Network Call state 6 or 9). Note that before sending an ALERTING message, the user should wait for a FACILITY ACKNOWLEDGE or FACILITY REJECT response to the FACILITY message. Otherwise, the network may not return a FACILITY REJECT when CPN/BN is unavailable.

  If the information is unavailable, the network will inform the user by sending a FACILITY REJECT message with the Cause information element specifying the reason. The possible values include 29 "facility rejected," 50 "requested facility not subscribed," and 69 "requested facility not implemented." Sending of a FACILITY ACKNOWLEDGE or a FACILITY REJECT message does not make any state transition at the network side.

- 3 - Digit BN on a Per-Call Basis. A PRI customer may request delivery of a 3 - Digit BN on a per-call basis. To do so, a customer must subscribe to the "3 - Digit Billing Number delivery when a complete BN is not available" PRI provisioning option.

  Any PRI customer may request delivery of a complete CPN/BN on a per-call basis via a FACILITY message, as described above. However, only those customers subscribing to the "3 - Digit Billing Number delivery when a complete BN is not available" PRI provisioning option will receive a 3 - Digit BN (when a complete CPN/BN is not available) in response to their request for a complete CPN/BN.

  If the 3 - Digit BN is available, it is sent to the terminating customer in a FACILITY ACKNOWLEDGE message according to the per-call BN delivery procedures. If the 3 - Digit BN in not available, the network returns a FACILITY REJECT message with a cause value 29 - "Facility Rejected" to the terminating customer. See Overview for additional information.

3.15.4 Information Indicator (II) Digits Delivery

Subscription to this feature requires subscription to the CPN/BN to Terminating End feature described above. If the customer does not subscribe to one of the CPN/BN delivery options, then the network will not deliver any II Digits.

A customer may be provisioned for one of two options:

- CPN/BN/II provided on every call when available.

The network will deliver the II Digits in the Originating Line Information (OLI) information element (codeset 6) in the SETUP message when the II Digits are available.

- CPN/BN/II provided per call upon request.

  The network may allow the user to request CPN/BN/II on a per-call basis. The user requests this information by sending a FACILITY message, containing the CPN/BN delivery request in Network specific facilities information element, to the network. The network will deliver this information, when available, by sending a FACILITY ACKNOWLEDGE message containing the calling party number information element and the codeset 6 OLI information element. If neither CPN nor BN is available in accordance with the customer's subscription, but II Digits are available, then the network will respond with a FACILITY ACKNOWLEDGE message containing the codeset 6 OLI information element. When CPN/BN/II is not available the network returns a FACILITY REJECT message with cause value 29 - "Facility Rejected" to the terminating customer. See Overview for additional information.

3.15.5 56 Kbps

To request a 56 Kbps 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.
- The extension bit in Octet 5 is set to 0, the Layer identification is set to Layer 1 and the protocol identification is set to rate adaption.
- Octet 5a is set to the 56 Kbps stream according to CCITT Recommendation I.463.

3.15.6 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.

3.15.7 Wide Band Switching

To request a 384/1536 Kbps clear channel, use the Bearer capability information element as follows:

- the Information transfer capability is set to unrestricted digital information.
- the Information transfer rate is set to 384/1536 Kbps.

In addition, the Channel identification information element is used as follows:

- for 1536 Kbps service, the Interface identifier uniquely identifies the set of time-slots to be used.
- for 384 Kbps service, the Channel type is set to B-Channel or H0-channel units. To indicate the identities of the six contiguous 64 Kbps time-slots that make up a 384 Kbps unit, the B-Channel slot map will be used.

3.15.8 Connected Line Identification (COLI) Presentation

COnnected Line Identification (COLI) Presentation is a feature offered as a default to the calling party, including international endpoints, that provides the connected party's number to the calling party. The called user provides a connected number, coded as a national number, to the network by including it in the Connected number information element in the CONNECT message. If the called user does not wish to provide the connected number to the calling user, the Connected number information element should not be included in the CONNECT message to the network.

The Connected number information element does not support Octet 3a, which contains bit fields for a "presentation indicator" or a "screening indicator." The network will not notify the calling user if the connected number is not available. See Overview for additional information.

3.15.9 1+ and 0+ Call Redirection

By dialing a special access code, a calling party can redirect a 1+ or 0+ call to an Enhance Service Provider (ESP), a PRI user.

The originally dialed number may be delivered to the ESP in the Redirecting Number information element of the Q.931 SETUP message. The Originating Access / Service Type may also be delivered in a Codeset 6 information element. The Generic Billing Data information element can be used to indicate the type of billing used. In addition, for 1+ call redirection, Subaccount Billing Code and CCF Override Code may be delivered in the Codeset 6 User Entered Code information element. For 0+ call redirection, Subaccount Billing Code, Authorization Code, Account Code, Subscription ID, and Third Party Number may be delivered in the Codeset 6 User Entered Code information element.

3.15.10 Information Forwarding 3 (INFO 3)

INFO 3 feature allows a Toll Free customer with PRI to designate an Enhanced Service Provider (ESP) that will collect Customer Entered Digits (CED), redirect the call and forward calling party information to the INFO 3 subscriber.

The ESP must use the Q.931 DISCONNECT message sent to the network to request the redirection of the call and to forward CED. The calling party provided information must be included in the Codeset 6 User Entered Code Information Element with Type of User Entered Code field coded to "INFO 3 Collected Data." If the network receives Codeset 6 User Entered Code IE and Cause IE value is NOT # 63 ("service or option not available, unspecified"), then the network sets up a call to the toll free customer and includes calling party provided information in the Codeset 6 User Entered Code IE within the SETUP message.

3.15.11 Caller Information Forwarding (CINFO)

The CINFO feature enables a toll free customer to collect Caller Entered Digits (CED) or Customer Database Provided Digits (CDPD) in the network and forward them to a direct connect PRI termination.

The ASN includes collected user information in the Q.931 User Entered Code Information Element of the SETUP message, with Type of User Entered Code field coded to "Caller Entered Digits" or "Customer Database Provided Digits." Multiple User Entered Code IEs can occur in a single SETUP message.

3.15.12 Access To Operator Services

The Access to Operator Services feature enables customers, after subscribing to the feature, to gain access to the Operator Services provided by the network. For access to Operator Services, one Network-Specific Facilities Information Element shall be coded to request two binary facilities (one Feature and one Service) by including Octet 4 twice. Calls involving Operator Services should be initiated as follows:

Call Type	Information Element Coding Requirements
0- calls for direct operator access	Called Party Number = no digits Type of Number = National/Subscriber NSF (Feature) = Operator or PCCO NSF (Service) = LDS, MEGACOM or SDN
0+ 7 digit or 10 digit calls	Called Party Number = 7/10 Type of Number = National/Subscriber NSF (Feature) = Operator or PCCO NSF (Service) = LDS, MEGACOM or SDN
01+CC+NN international operator calls	Called Party Number = CC+NN Type of Number = International NSF (Feature) = Operator or PCCO NSF (Service) = LDS, MEGACOM or SDN

Figure III - 70. Coding Requirements for Access to Operator Services

3.15.13 Dial-Around for AT&T Digital Link

AT&T Digital Link is a digital dedicated DS-1 service that allows SDN and MEGACOM customers to combine inward and outward local, IntraLATA, long-distance, and international service on AT&T ISDN PRI dedicated access

The AT&T Digital Link dial-around capability allows users making local calls to request an alternate toll carrier for long-distance calls on a per-call basis. This is accomplished by including a Transit Network Selection Information element with the Carrier Identification Code of the desired carrier in a SETUP message sent to the AT&T Network.

If a SETUP message includes both a Transit Network Selection information element and a Network Specific Facilities information element that specify different Carrier Identification Codes, the Transit Network Selection shall take precedence when determining alternate carrier selection.

3.15.14 Facility Summary

The following table shows the interplay of specific fields within the Bearer capability, Called party number, Channel identification, and Network-specific facilities information elements in a SETUP message for Domestic and International switched services described in Overview. Note that the information contained in the table does not preclude other possible codings to support additional features or services.

Table III - 70. Information Element Codings for Nodal Services

Information Element	Field	Codings	DESIRED SERVICE							
			SDN / GSDN	MEGACOM / International MEGACOM	Toll Free MEGACOM	ACCUNET / SDI (56,64 C/R)	Wideband (384, 1536)	International Toll Free	AT&T MultiQuest	TSAA
Network-specific facilities	Binary facility coding values	SDN	M	X	X	X	X	X	X	
		MEGACOM	X	M	X	X	X	X	X	
		Toll Free MEGACOM	X	X	M	X	X	X	X	
		ACCUNET	X	X	X	M	M	X	X	
		Intl' Toll Free	X	X	X	X	X	M	X	
		AT&T MultiQuest	X	X	X	X	X	X	M	
		LDS	X	X	X	X	X	X	X	M
Called party number (Note 8)	Numbering plan	ISDN / Telephony	O (Note 1)	M	M	M	M	M	M	M
		private	O (Note 1)	X	X	X	X	X	X	X
	Type of number	national	O (Note 2)	*	M	**	**	M	M	M
		international	O (Note 2)	*	X	**	**	X	X	X
		subscriber	O (Note 3)	X	X	X	X	X	X	X
Bearer capability	Info. transfer capability	speech	O (Note 4)	O (Note 6)	O (Note 6)	X	X	O (Note 6)	O (Note 6)	O (Note 6)
		unrestricted digital info.	M (64C, 384C, 1536C) (Note 4) X (64R) O (56) (Note 7)	X	M (64C) O (56)(Note 7) (Note 9)	M (64C) X (64R) O (56)(Note 7)	M (384C,1536C)	X	X	X
		restricted digital info.	M (64R)(Note 4) X (64C, 384C, 1536C) O (56) (Note 7)	X	M (64R) O (56)(Note 7) (Note 9)	M (64R) X (64C) O (56)(Note 7)	X	X	X	X
		3.1 KHz audio	O (Note 4)	O (Note 6)	O (Note 6)	X	X	O (Note 6)	O (Note 6)	O (Note 6)
	Info. transfer rate	64 Kbps	M (56, 64 C/R, Voice)	M	M	M	X	M	M	M
		384 Kbps	M (384 C) X (56, 64 C/R, 1536 C, Voice)	X	X	X	M (384 C) X (1536 C)	X	X	X
		1536 Kbps	M (1536 C) X (56, 64 C/R, 384C, Voice)	X	X	X	M (1536 C) X (384 C)	X	X	X
	Protocol rate adaption	56 Kbps	M (56) X (64 C/R, Voice)	X	O (Note 10)	M (56) X (64 C/R)	X	X	X	X
Channel Identification	Interface Identifier		D (56, 64 C/R, 384 C, Voice) M (1536 C)	D	D	D	D (384 C) M (1536 C)	D	D	D
	Number/ Map	Number	M (56, 64 C/R, Voice) O (1536 C) X (384 C)	M	M	M	O (1536 C) X (384 C)	M	M	M
		Map	M (384 C) X (56, 64 C/R, 384 C, Voice)	X	X	X	M (384 C) X (1536 C)	X	X	X
	Channel type	B Channel	M (56, 64 C/R, 384 C, Voice)	M	M	M	M (384 C)	M	M	M
		H0 Channel	(Note 11)	X	X	X	(Note 11)	X	X	X
		H11 Channel	O (1536 C)	X	X	X	O (1536 C)	X	X	X

Legend:

X **-** Field coding is not permitted.

* **-** Field coding is either national or international

** **-** For 56, 64C,384, and 1536 calls, the field coding can be national or international. For domestic 64R calls, it must be national.

D **-** Field coding is optional for Facility Associated Signaling and is mandatory if the B-Channel is not on the interface containing the D-Channel in Non-Facility Associated Signaling.[17]

M **-** Field coding is mandatory.

O **-** Field coding is optional.

Note 1: either the "ISDN/Telephony" coding or the "private" coding must be specified.

Note 2: Field coding is either national or international depending upon destination location, if the coding for the Numbering plan field of the Called party number is "ISDN/Telephony."

Note 3: Field coding is mandatory if the coding for the Numbering plan field of the Called party number is "private."

Note 4: Either the "speech," "unrestricted digital info," "restricted digital info," or "3.1 KHz audio" coding must be specified.

Note 5: This table includes only selected fields of the information elements. Refer to text for complete coding information.

Note 6: Either the "speech" coding or "3.1 KHz audio" coding must be specified.

Note 7: Either the "restricted" or the "unrestricted" coding must be specified.

Note 8: To make an SDN/GSDN call with a private number, the "Private Numbering Plan" encoding is recommended for the Numbering Plan Identification field and the "Subscriber" encoding is recommended for the Type of Number field in the Called Party Number information element. See Overview for more information.

Note 9: Coding for AT&T Toll Free Multimedia Service

Note 10: Mandatory when AT&T Toll Free Multimedia Service 56Kbps data is specified.

Note 11: The AT&T Network will encode the Channel type/Map element type field as H0 channel units for H0 type calls. The AT&T Network will accept the codings of both B-Channel and H0-Channel units in the Map element type field for H0 calls.

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17. In Facility Associated Signaling, the D-Channel signaling entity can only assign calls to channels on the interface containing the D-Channel. In Non-Facility Associated Signaling, the D-Channel signaling entity can assign calls to channels on more than one interface (including the one containing the D-Channel).

REFERENCES

[1] ITU-T Study Group 13, Recommendation I.412, “ISDN User-Network Interfaces, Interface Structures and Access Capabilities”.

APPENDIX 1

AT&T NETWORK ISDN PRIMARY RATE INTERFACE

AND SPECIAL APPLICATIONS

SPECIFICATION

User - Network Interface Description

Service Specific Capabilities

TABLE OF CONTENTS

LIST OF TABLES

1. Introduction to Appendix 1

This document is an appendix to AT&T Technical Reference 41459 and serves to specify some service-specific capabilities supported by an ISDN Primary Rate Interface. It builds upon the ISDN interface described in this publication. The ISDN Primary Rate Interface and the service-specific capabilities described in this appendix apply to the FTS 2000 service. Other services may be supported later.

FTS 2000 serves the United States Government General Services Administration (GSA) under a contract awarded by a competitive bidding process. It replaces the existing voice and voice-band data telephone network, known as Federal Telecommunications System (FTS), with a new digital, integrated voice/data/video telecommunications network.

1.1 Introduction to this Issue of Appendix 1 to TR 41459

This appendix describes the ISDN Primary Rate Interface service specific capabilities of AT&T's FTS 2000 service.

1.2 Scope of the Specification

The purpose of this specification is to describe service-specific implementations of the AT&T ISDN Primary Rate Interface. Only the differences between the service-specific implementation and the ISDN Primary Rate Interface described in Parts I, II and III of this document are identified. Procedures and protocol elements used to access service-specific features not described in Parts I, II and III are also addressed in this appendix. Differences between Parts I, II and III of this document and this appendix are highlighted in ***bold italics*****.**

Section 1.4 covers new service-specific capabilities that are not covered in the Overview of this document. Section 1.5 describes the existing capabilities detailed in the Overview and how they pertain to the specific services.

Information about Layers 1, 2 and 3 of this interface is presented in Sections 2, 3 and 4, respectively. Layers 1 and 2 are compatible with that described in Parts I and II of this document, with a few changes. The approach in Layer 3 (Section 4) is to build upon the messages, information elements, and procedures described in Part III of this document. Consequently, this section will not duplicate material found in Part III unless there are significant differences.

1.3 Physical Interface

The physical interface conforms to AT&T Technical Reference 62411[1]. The Primary Rate Interface is a 1.544 Mbps (DS-1) facility organized into 24 time slots of 64 Kbps each with an 8 Kbps time slot for frame checking. Section 2 provides more details of the physical interface. Part I provides specifications for the ISDN reference points S, T, and U. ***The T reference point, between the NT2 (i.e., ISDN CPE) and the NT1 (i.e., network channel terminating equipment), is the interface between the CPE and AT&T's FTS 2000 network***.

Multiple DS-1 interfaces can be supported at the service node. Also, as an option, the full information bearing capacity of an interface need not be provisioned. For example, a customer with a Primary Rate Interface can have that ISDN PRI access limited to the use of 13 time slots for calls plus the necessary time slot for out-of-band signaling. Such an interface could share the 1.544 Mbps facility with inband-signaled private line channels.

1.4 New Capability Description

1.4.1 Authorization Codes

This capability involves entering an authorization code at the time of call setup. This authorization code may be used by the network to determine calling privilege and/or billing information. The codeset 6 User entered code information element contains the authorization code and is sent to the network in the SETUP message (see Section 4.4.6.1 of this Appendix). The dialing procedure that the user will follow in order to enter the destination number and the authorization code is dependent on the specific customer premises equipment.

1.4.2 B-Channel Permanent Packet Transport Service

This section describes the type of packet switched service supported over an ISDN PRI access. The B-Channel Permanent Packet Transport Service allows an ISDN user to have dedicated X.25 packet service over one or more B-Channels of a PRI. The service provides packet transport mode connections over which packetized data may be transmitted. It conforms with ITU-T Recommendation X.31.

Permanent B-Channel connections to the packet handling function are established and cleared via the service order process. In-band X.25 procedures are used to establish, maintain, and clear the individual virtual calls.

1.5 Existing Capabilities Description

1.5.1 Call Processing

1.5.1.1 Number Digits

The number digits supported are as specified in the Overview, ***with the following exceptions: The description about the use of the Called party subaddress, Calling party subaddress, Redirecting number, and Connected number information elements is not applicable since these information elements are not supported***.

1.5.1.2 Cut Through

The cut through procedures are as described in the Overview, ***with the following exceptions: A distinction is made between cut through in the forward direction and backward direction. In cutting through a call, forward direction is from the originating user to the terminating user and backward direction is from the terminating user to the originating user. Two subscription options for cut through are supported and are provided separately for circuit-switched voice calls and circuit-switched data calls***.

- ***Option 1: Cut through in the network will take place in both directions on the receipt of the CONNECT message.***

- ***Option 2: Cut through in the network will take place in the backward direction on the receipt of the ALERTING or PROGRESS message and in the forward direction on the receipt of the CONNECT message.***

Option 1 is only for circuit-switched data calls.

1.5.1.3 Call Progress Tones

The call progress tones are as described in the Overview.

1.5.1.4 Message Length Constraints

The maximum length of any Layer 3 message shall be 244 octets.

1.5.1.5 Glare Resolution

Glare resolution is as described in the Overview.

1.5.1.6 Fast Connect

The procedure for fast connect is supported. Fast connect occurs when the terminating user generates a CONNECT without a prior CALL PROCEEDING or ALERTING. In this case, the network would respond to the originating user by sending a CONNECT message without sending the ALERTING message.

1.5.2 64 Kbps Clear/Restricted

64 Kbps Clear/Restricted is supported as described in the Overview.

1.5.3 Calling Party Number (CPN) to the Network

Calling Party Number to the Network is supported as described in the Overview.

1.5.4 CPN/BN Privacy Optioning

CPN/BN Privacy Optioning is supported as described in the Overview ***with the following exception: When CPN and/or BN cannot be delivered because the presentation indicator is set to "presentation restricted," a Calling Party Number information element with the presentation indicator set to "presentation restricted" will be delivered, containing no digits.***

1.5.5 CPN/BN to Terminating End

CPN/BN to the Terminating End is supported as described in the Overview, ***with the following exception: The option "CPN/BN provided per call upon request" is not supported.***

1.5.6 Causes and Diagnostics

This interface supports the set of causes listed in Part III, ***with the exceptions as described in Section 4.4.5.6 of this appendix.***

1.5.7 Capabilities Described in Overview of this Document Not Supported

The following capabilities described in the Overview of this document are ***not*** *supported:*

- ***Non-Facility Associated Signaling***
- ***Wideband Switching***
- ***Call-by-Call Service Selection*** [1]
- ***Service Identification on Access/Egress***
- ***Service Screening***
- ***Channel Hunt Algorithm***
- ***Delivery of the Dialed Number*** [2]
- ***Calling Party Subaddress (CPS) Presentation and Restriction***
- ***Connected Line Identification (COLI) Presentation***
- ***User-to-User Information Exchange***
- ***B-Channel Negotiation***
- ***1+ and 0+ Call Redirection***
- ***Information Forwarding 3 (INFO 3)***
- ***Caller Information Forwarding (CINFO)***
- ***D-Channel Backup***
- ***Access to Operator Services***
- ***WorldWorx[(SM)] 800***
- ***Terminating Switched Access Arrangement (TSAA)***

1.6 Description of Layer 3 Protocol Additions to Part III

1.6.1 Services

The ISDN PRI described in this appendix is used by the FTS 2000 service.

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1. Call-by-Call Service Selection as described in the Overview is not supported. However, the ability for the originating ISDN CPE to request that a B-Channel be dynamically assigned on a per-call basis to carry either a circuit-switched voice call or a circuit-switched data call is supported, as described in Section 4.4.5.2 of this Appendix.

2. FTS 2000 supports the ability to deliver an abbreviated version of the dialed number to terminating AT&T PRI locations.

1.6.2 Messages and Information Elements

No new messages are introduced. However, some messages specified in Part III are not supported. Also, differences in some messages exist. Details on these can be found in Section 4.3.

Some information elements described in Part III are not supported. Also, differences in some information elements exist. Details on these can be found in Section 4.4.5.

2. Interface Specification for Layer 1

The ISDN Primary Rate Interface conforms to the physical layer specification for DS-1 interfaces as given in Part I of this document. However, certain differences exist. This section contains information and clarification regarding the physical layer implementation.

2.1 Framing Format

The data link is limited to transmitting the Extended Super Frame (ESF) Yellow Alarm signal.

2.2 Channel Structure

The ISDN PRI only supports an nB+D channel configuration, where n < 24. The following possible channels are supported:

- D-Channel (time slot #24), 1 slot, 64 Kbps.

- B-Channel, 1 slot, 64Kbps. The time slots available for B-Channel use are 1 to 23.

2.3 Idle Code

The physical layer idle code in both directions is identified by a repetition of one of the following patterns: "0111 1111" or "1111 1110."

3. Interface Specification for Layer 2

The data link layer specification is as described in Part II of this document.

4. Interface Specification for Layer 3

4.1 General

This section defines the Layer 3 protocol options and service-related procedures that are supported. Also detailed in the following sections are any implementation options which affect call control procedures and which are not described in Part III of this document.

4.2 Overview of Call Control

4.2.1 Circuit Switched Call States

The circuit switched call states supported are as described in Part III, ***with the following exceptions: The network side states NS1, NS2, NS3, and NS4 as well as the user side states US1 and US2 are not supported***.

4.2.2 Packet Mode Access Connection Control States

Only permanent B-Channel connections to packet-switched service are supported. Therefore, no control states for packet mode connections are supported.

4.2.3 Temporary Signaling Connections Call Control States

Temporary Signaling Connections are not supported.

4.2.4 States Associated with the Global Call Reference

Call states associated with the global call reference are as specified in Part III.

4.3 Message Functional Definition and Content

4.3.1 Messages for Circuit-Mode Connection Control

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

Table 1. Messages for Circuit-Mode Connection Control.

Call Establishment Messages	Reference
ALERTING	4.3.1.1
CALL PROCEEDING	4.3.1.2
CONNECT	4.3.1.3
CONNECT ACKNOWLEDGE	4.3.1.4
PROGRESS	4.3.1.6
SETUP	4.3.1.9
Call Clearing Messages	
DISCONNECT	4.3.1.5
RELEASE	4.3.1.7
RELEASE COMPLETE	4.3.1.8
Miscellaneous Messages	
STATUS	4.3.1.10
STATUS ENQUIRY	4.3.1.11

4.3.1.1 Alerting

This message is implemented as described in of Part III, ***with the following exceptions***:

Information Element	Direction	Type	Length
Channel identification	***both***	O (Note 1)	***5***
Progress indicator	***n®u***	O	4
Redirecting number	***Not Supported***		
User-user	***Not Supported***		
Shift to codeset 6	***Not Supported***		
Network-specific (codeset 6)	***Not Supported***		
Shift to codeset 7	***Not Supported***		
User-specific (codeset 7)	***Not Supported***		

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

4.3.1.2 Call Proceeding

This message is implemented as described in Part III, ***with the following exception:***

Information Element	Direction	Type	Length
Channel identification	both	M	***5***

4.3.1.3 Connect

This message is implemented as described in Section Part III, ***with the following exceptions:***

Information Element	Direction	Type	Length
Connected Number	***Not Supported***		
Channel identification	***both***	O (Note 1)	**5**
Progress indicator	***n®u***	O	4
Redirecting number	***Not Supported***		
User-user	***Not Supported***		
Shift to codeset 6	***Not Supported***		
Network-specific (codeset 6)	***Not Supported***		
Shift to codeset 7	***Not Supported***		
User-specific (codeset 7)	***Not Supported***		

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

4.3.1.4 Connect Acknowledge

This message is implemented as described in Section Part III.

4.3.1.5 Disconnect

This message is implemented as described in of Part III, ***with the following exceptions:***

Information Element	Direction	Type	Length
User-user	***Not Supported***		
Shift to codeset 6	***Not Supported***		
Network-specific (codeset 6)	***Not Supported***		
Shift to codeset 7	***Not Supported***		
User-specific (codeset 7)	***Not Supported***		

4.3.1.6 Progress

This message is implemented as described in Part III, *with the following exception:*

Information Element	Direction	Type	Length
Channel Identification	***Not Supported***		

4.3.1.7 Release

This message is implemented as described in Part III.

4.3.1.8 Release Complete

This message is implemented as described in Part III.

4.3.1.9 Setup

This message is implemented as described in Part III, ***with the following exceptions****:*

Information Element	Direction	Type	Length
Bearer capability	both	M	4-***6***
Channel identification	***both***	O	***5***
Progress indicator	***n®u***	O	4
Network specific facilities	***Not Supported***		
Calling party number	both	O	3-***19***
Calling Party Subaddress	***Not Supported***		
Called Party Number	both	M	3-***18***
Called Party Subaddress	***Not Supported***		
Redirecting Number	***Not Supported***		
Low layer compatibility	both	O	***4-6***
High layer compatibility	***Not Supported***		
User-user	***Not Supported***		
Shift to codeset 6	both	O	1
User entered code	***both***	***O***	***4-18***
Network-specific (codeset 6)	***Not Supported (Note 1)***		
Shift to codeset 7	***Not Supported***		
User-specific (codeset 7)	***Not Supported***		

Note 1: Except for User entered code as described above.

4.3.1.10 Status

This message is implemented as described in Part III.

4.3.1.11 Status Enquiry

This message is implemented as described in Part III.

4.3.2 Messages for Packet Mode Access Connection Control

No Q.931 messages are used since only B-Channel Permanent Packet Transport Service is supported.

4.3.3 Messages for Non-Call Associated Temporary Signaling

The messages for non-call associated temporary signaling connections, as described in Part III, are not supported.

4.3.4 Messages Used with the Global Call Reference

Table 2 summarizes the messages used with the global call reference.

Table 2. Messages Used with the Global Call Reference

Messages	Reference
RESTART	4.3.4.1
RESTART ACKNOWLEDGE	4.3.4.2
STATUS	4.3.4.3

4.3.4.1 Restart

This message is implemented as described in Part III, ***with the following exception:***

Information Element	Direction	Type	Length
Channel identification	both	***O***	***5***

4.3.4.2 Restart Acknowledge

This message is implemented as described in Part III, ***with the following exception:***

Information Element	Direction	Type	Length
Channel identification	both	***O***	***5***

4.3.4.3 Status

This message is implemented as described in Part III.

4.3.5 Messages for AT&T Supplementary Services

The messages for AT&T Supplementary Services, as described in Part III, are not supported.

4.4 General Message Format and Information Elements Coding

4.4.1 Overview

Unless otherwise stated, this implementation is as described in Part III.

4.4.2 Protocol Discriminator

This information element is implemented as described in Part III.

4.4.3 Call Reference

This information element is implemented as described in Part III.

4.4.4 Message Type

The messages that must be supported by CPE are summarized in Table 1 and Table 2 in Sections 4.3.1 and 4.3.4, respectively. The codings for the supported message types are defined in Part III.

4.4.5 Other Information Elements

The following sections outline codings for those information elements supported. This section assumes that information elements are formulated and presented in accordance with the coding rules identified in Part III.

The information elements listed below will be supported for circuit-mode connection control.

Table 3. Codeset 0 Information Element Identifier Coding

Single Octet Information Elements:	**Reference**
Shift	4.4.5.1
Variable Length Information Elements:	**Reference**
Bearer capability	4.4.5.2
Call state	4.4.5.3
Called party number	4.4.5.4
Calling party number	4.4.5.5
Cause	4.4.5.6
Channel identification	4.4.5.7
Low layer compatibility	4.4.5.8
Progress indicator	4.4.5.9
Restart indicator	4.4.5.10
User entered code	4.4.6.1

The remaining information elements as shown in Table III-38, of Part III are not supported. Any exceptions to the above information elements will be explained in the following sections.

4.4.5.1 Extensions of Codesets

The Locking shift information element is supported as described in Part III, ***with the following exception: The locking shift is supported only to shift to codeset 6 and is limited to the transport of the User entered code information element.***

4.4.5.2 Bearer Capability

The Bearer capability information element is supported as described in Part III, ***with the following exceptions:***

OCTET	FIELD	VALUES
4	Extension	description is extended through next octet
		last octet of the description
	Transfer mode	***packet mode - Not supported***
		circuit mode
	Information transfer rate	***packet transport mode - Not supported***
		64 kbit/s
		384 kbit/s - Not supported
		1536 kbit/s - Not supported
5	Extension	description is extended through next octet
		last octet of description
	Layer 1 identification	layer 1 identification coding
	User information layer 1 protocol	rate adaption (I.461), octet 5a is required
		recommendation G.711 u-law speech (00010)
5a	Extension	***description is extended through next octet - Not supported***
		last octet of description
	Synch/Asynch	synchronous
	Negotiation	inband negotiation not possible
	User rate	56 kbit/s Recommendation I.463
6	***Layer 2 ID - Not supported***	
7	***Layer 3 ID - Not supported***	

4.4.5.3 Call State

The Call state information element is supported as described in Part III.

4.4.5.4 Called Party Number

The Called party number information element is supported as described in Part III, ***with the following exceptions***:

OCTET	FIELD	VALUES
3	Type of Number	***Unknown (000)***
	Numbering Plan Identification	***Telephony (Rec. E.163)***

4.4.5.5 Calling Party Number

The Calling party number information element is supported as described in Part III***, with the following exceptions:***

OCTET	FIELD	VALUES
3	Type of Number	***Unknown (000)***
	Numbering Plan Identification	***Telephony (Rec. E.163)***
3a	Presentation Indicator	***Number not available due to interworking (10)***

4.4.5.6 Cause

The Cause information element is supported as described in Part III, ***with the following exceptions:***

OCTET	FIELD	VALUES
4	Cause Value	***(Note 1)***

Note 1: The cause values are supported as specified in Part III, ***with the following exceptions***:

Cause Number	Cause	Diagnostic
02	***No route specified to transit network. (000 0010)***	***Transit network identity***
06	***Not supported***	
19	***Not supported***	
21	***Not supported***	
29	***Not supported***	
44	***Not supported***	
47	***Not supported***	
63	***Not supported***	
99	***Not supported***	

4.4.5.7 Channel Identification

The Channel Identification information element is supported as described in Part III, ***with the following exceptions***:

OCTET	FIELD	VALUES
3	Interface identifier present	interface implicitly identified
		interface explicitly identified - not supported
	Preferred/Exclusive	indicated channel is preferred (Note 1)
		exclusive; only the indicated channel is acceptable
	D-Channel indicator	the channel identified is not the D-Channel
		the channel identified is the D-Channel - not supported
	Information channel selection	***no channel - not supported***
		as indicated in the following octets
3.1 Not Supported	***Extension***	***not supported***
	Interface identifier	***not supported***
3.2	Number/Map	channel is indicated by the number in the following octet
		channel is indicated by the slot map in the following octet(s) not supported
	Channel type/Map element type	B Channel Units
		H0 channel units not supported
		H11 channel units not supported
3.3	Channel Number/Slot Map	binary number assigned to the channel (Note 2)
		bit positions in slot map corresponding to time slots used by the channel are set to 1 - not supported

Note 1: A Preferred channel indication will be treated as Exclusive.

Note 2: The range of channel numbers supported is 1-23.

4.4.5.8 Low Layer Compatibility

The Low Layer Compatibility information element is supported as described in Part III, ***with the following exception: The maximum length of this information element is 6 octets.***

4.4.5.9 Progress Indicator

The Progress indicator information element is supported as described in Part III, ***with the following exceptions: The Progress indicator information element is supported in the network-to-user direction only in the Setup, Alerting, and Connect messages.***

OCTET	FIELD	VALUES
3	Extension	last octet of the description
	Coding standard	ITU-T standard coding
	Location	***user (0000)***
		local (0001)
		transit network
4	Extension	last octet of the description
	Progress description	Call is not end to end ISDN and/or further call progress information may be available inband
		Call has returned to the ISDN. (0000100)
		Inband information or appropriate pattern now available.

4.4.5.10 Restart Indicator

The Restart indicator information element is supported as described in Part III, ***with the following exceptions:***

OCTET	FIELD	VALUES
3	Class	***Single interface (110)***

4.4.6 Codeset 6 Information Elements

4.4.6.1 User Entered Code

This information element is used to carry the Authorization Code entered by the user. The structure of the User entered code information element is as described in Part III, ***with the following exceptions: Octet 4 is not supported. Only the value "0 0 0 0 1 0 0" in the Type of User entered code field is supported. This value indicates that an Authorization Code is included.***

4.5 Circuit Switched Call Control Procedures

The complete description of the procedures is as described in Part III. This section specifies the implementation options supported as well as any exceptions to the call control procedures.

4.5.1 Call Establishment at the Destination Interface

4.5.1.1 B-Channel Negotiation

B-Channel Negotiation is not supported at either call origination or call destination. When the case in which "channel is indicated, any alternative is acceptable," is requested, it is treated as "channel is indicated, no alternative is acceptable."

4.5.1.2 Call Confirmation

Call confirmation procedures are as described in Part III, ***with the following exception: The "fast connect" procedure is supported. Fast connect occurs when the terminating user generates a CONNECT without a prior CALL PROCEEDING or ALERTING. In this case, the network would respond to the originating user by sending a CONNECT message without sending the ALERTING message.***

4.5.1.3 Call Failure

The Call Failure procedures are as described in Part III, ***with the following exception: The value of timer T303 is 4 seconds.***

4.5.1.4 Call Clearing

Call Clearing procedures are as described in Part III, ***with the following exception: The exception listed for trunk maintenance test calls is not supported.***

4.6 Packet Communication Procedures

Packet communication procedures are not described in this document. The following sections outline specific procedures for packet communication supported.

4.6.1 B-Channel Permanent Packet Transport Service

The user and network establish permanent transport access connections at the time of subscription[3]. Any number of B-Channels may be provisioned for permanent packet transport service. The user and network use this type of data transport facility to convey virtual call and permanent virtual circuit data services.

The signaling for virtual call establishment and clearing is accomplished via standard X.25 call setup procedures.

4.7 User-to-user Signaling Procedures

User-to-user signaling procedures are not supported, with the following exception: The Low-layer Compatibility information element is supported as user data when present in the SETUP message.

4.8 Application of Circuit-Switched Supplementary Services to Terminals Using Stimulus Procedures - Not Applicable.

4.9 List of System Parameters

Description of various timers associated with circuit switched calls are summarized in Part III, ***with the following exception: The value of timer T303 is 4 seconds.***

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3. A B-Channel that is provisioned for permanent packet transport mode service will always be considered unavailable for other services.(i.e., the B-Channel is considered in use and is unavailable for circuit-switched transport mode.)

The values T1, T2, T3, N1 and N2, as defined in the X.25 Recommendation[2], are required for the implementation of packet transport mode service. These values are set during the service provisioning process.

4.10 Maintenance and Management

Both the SERVICE and SERVICE ACKNOWLEDGE messages are supported as described in Part III. These messages contain both the Change status and the Channel identification information elements on a mandatory basis as described in Part III.

The D-Channel backup procedures for non-associated signaling are not supported.

4.11 Procedures for Accessing Network Features and Services

Procedures for accessing network features and services are described in Part III, ***with the following exception: The ability to request services and/or facilities on a per-call basis through the use of the FACILITY message is not supported.***

The following features and services detailed in Part III are supported:

- Calling Party Number to the Network
- CPN/BN Privacy Optioning
- CPN/BN to Terminating End[4] ***with the following exception: The case where CPN and/or BN cannot be delivered because the presentation indicator is set to "presentation restricted" is treated differently from CPN and/or BN not available [5].***
- 56 Kbps
- 64 Kbps Clear/Restricted

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4. The per call option described in Part III is not supported.

5. When CPN and/or BN cannot be delivered because the presentation indicator is set to "presentation restricted," a Calling Party Number information element with the presentation indicator set to "presentation restricted" will be delivered, containing no digits.

REFERENCES

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[1] AT&T Technical Reference, ACCUNET® T1.5 Service Description and Interface Specifications, December 1988.

[2] 1984 ITU-T Recommendation X.25

APPENDIX 2

AT&T NETWORK ISDN PRIMARY RATE INTERFACE

AND SPECIAL APPLICATIONS

SPECIFICATION

User - Network Interface Description

Alternate Destination Call Redirection Feature

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1. Introduction to Appendix 2

This appendix to the AT&T Integrated Services Digital Network (ISDN) Primary Rate Interface and Special Applications publication TR 41459 expands the scope of the Technical Reference. This appendix describes Alternate Destination Call Redirection (ADCR), an interface feature between Customer Premises Equipment (CPE) and the AT&T Switched Network (ASN). The term "the network" when it appears in this appendix is synonymous with the term "AT&T Switched Network."

The Alternate Destination Call Redirection feature enables both ISDN and non-ISDN calls to be re-routed by the network to a predetermined secondary destination. The ISDN customer will have the capability, prior to call establishment, to redirect individual calls on a per call basis. When both the primary and secondary destinations are connected with ISDN PRI, all applicable ISDN features and services can be supported to the secondary destination.

1.1 Introduction to this Issue of Appendix 2 to TR 41459

This appendix to TR 41459 describes the AT&T ISDN PRI implementation of the ADCR feature and documents the messages and procedures required for it.

All additions or changes with respect to Part I, II and/or Part III of this Technical Reference are denoted in bold italic font.

1.2 New Capability Description

Alternate Destination Call Redirection is a network feature that allows a customer to redirect a call to a predetermined secondary destination established at the time of service provisioning. If a customer subscribes to this feature, call redirection will occur when the appropriate cause value in the first normal call clearing message (i.e., RELEASE COMPLETE or DISCONNECT) is received by the network. All calls to the primary destination, which receive an explicit call redirection request or normal ISDN busy call handling will be routed by the network to the secondary destination. ADCR will be supported from the primary to the secondary destination only. A particular call will be limited to one redirection attempt.

2. Interface Specification for Layer 1

2.1 Layer 1 - Physical Layer Protocol

The Layer 1 specification is as described in Part I of this Technical Reference.

3. Interface Specification for Layer 2

3.1 Layer 2 - Link Layer Protocol

The Layer 2 specification is as described in Part II of this Technical Reference.

4. Interface Specification for Layer 3

4.1 General Overview of Call Control

It is the customer's responsibility at the time of service provisioning to specify the primary and the secondary direct connect egress locations. If a customer subscribes to this feature, all calls to the primary destination which receive an explicit call redirection request or normal ISDN busy call handling, will be routed by the network to the secondary destination. Alternate Destination Call Redirection will be supported from the primary destination to the secondary destination only. Each call will be limited to one redirection attempt.

To support the explicit redirection of individual calls, the primary destination must have ISDN PRI connectivity. The secondary location must conform to either TR 41458[1] or TR 41459. When both the primary and secondary locations are connected with ISDN PRI, all applicable ISDN features and services can be supported to the secondary location.

4.2 General Message Format and Information Elements Coding

4.2.1 Layer 3 Messages for Alternate Destination Call Redirection

The Q.931 protocol message signaling between user and network is described in this section. Table 1 summarizes the messages referenced in Part III of this Technical Reference that will invoke the ADCR Feature:

Table 1. Messages for Alternate Destination Call Redirection

Message	Reference
DISCONNECT	Section 3.1 of Part III
RELEASE COMPLETE	Section 3.1 of Part III

4.2.2 Information Elements

4.2.2.1 Coding Rules

Refer to Part III of this Technical Reference for details on the coding rules for the information elements in this Appendix.

4.2.2.2 Cause

Refer to Part III of this Technical Reference for the structure of the Cause information element. ***A specific Coding standard field value and a new network specific Cause value number are supported for the ADCR feature.*** Refer to Table 2 and Table 3 for the feature specific codings of the Cause information element.

Table 2. Cause Information Element Content

OCTET	FIELD	VALUE(S) RECOGNIZED
3	Coding standard	***Standard specific to identified location***
4	Cause value	***(See Table 3)***

Table 3. Summary of Cause Values

Cause Number	Cause	Diagnostics
47	***New Destination***	***None***

4.2.3 Procedures for Accessing Network Features and Services

4.2.3.1 Alternate Destination Call Redirection Procedures

When the network attempts to establish a call, and the primary destination responds with a DISCONNECT or RELEASE COMPLETE message with cause value #17, "user busy" or the network specific cause value #47, "new destination" as specified below, the network will redirect the call to the secondary location. The initial call clearing message must be received in the appropriate network call state (i.e., N6 - "call present," or N9 - "incoming call proceeding"). A CALL PROCEEDING message must precede any DISCONNECT message.

Call redirection can be invoked by setting the cause value and coding standard field of the Cause information element of the initial clearing message, in either of two ways:

1. ***Cause value number #17, "user busy," in the cause value field in Octet 4 and the bit value 00, "ITU-T standardized for this specification," in the Coding standard field in Octet 3.***

2. ***Network specific Cause value number #47, "new destination," in the Cause value field in Octet 4 and the bit value #11, "Standard specific to identified location," in the Coding standard field in Octet 3.***

4.2.3.2 Handling of Error Conditions

The following are the minimal procedures which allow for proper handling of error conditions:

4.2.3.2.1 Messages with Inappropriate Cause Value

When the network receives the network specific cause value #47, "new destination" in other than an appropriate call clearing message (i.e., DISCONNECT or RELEASE COMPLETE) the network will handle the call as if the user had issued the message with a cause value #31, "normal unspecified."

When the network receives a call clearing message with the network specific cause value #47, "new destination," while in one of the appropriate network call states (i.e. N6 or N9), but the customer is not subscribed to the service, the network will handle the call as if the user had issued the call clearing message with a cause value #17, "user busy."

When the network receives a call clearing message with the network specific cause value #47, "new destination," but a PROGRESS, ALERTING, or CONNECT message preceded the appropriate call clearing message, meaning that the call is not in one of the appropriate network call states (i.e. N6 or N9), the network will handle the call as if the user had issued the call clearing message with a cause value #31, "normal unspecified."

Should any error conditions occur due to inappropriate use of cause value #17, "user busy," the network will handle the call as specified in Part III of this Technical Reference.

4.2.3.2.2 Call Failure at the Secondary Location

If the call fails on the redirection attempt to the secondary location, the network will clear the call normally, as specified in Part III of this Technical Reference.

4.2.4 Timer Values

Network timers are as specified in Part III of this document.

REFERENCES

[1] AT&T Technical Reference, Special Access Connections to the AT&T Communications Public Switched Network for New Service Applications, Technical Reference 41458, April, 1990.

APPENDIX 3

AT&T NETWORK ISDN PRIMARY RATE INTERFACE

AND SPECIAL APPLICATIONS

SPECIFICATION

User - Network Interface Description

Vari-A-Bill Feature

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1. Introduction to Appendix 3

This document is an appendix to the AT&T Integrated Services Digital Network (ISDN) Primary Rate Interface and Special Applications publication TR 41459 and serves to expand the scope of the Technical Reference. This appendix describes the Vari-A-Bill feature (previously referred to as Flexible Billing), an interface feature between Customer Premises Equipment (CPE) and the AT&T Switched Network (ASN). The term "the network" when it appears in this appendix is synonymous with the term "AT&T Switched Network."

1.1 Introduction to this Issue of Appendix 3 to TR 41459

This appendix to TR 41459 describes the AT&T ISDN PRI implementation of the Vari-A-Bill feature and documents the messages and procedures required for it. Part III of this Technical Reference contains the complete protocol specification for the ISDN Primary Rate Interface.

1.2 New Capability Description

The Vari-A-Bill feature enables a customer to change the charges for a call at any point while the call is in the active state (i.e. between answer and disconnect). Using an Integrated Services Digital Network (ISDN) Primary Rate Interface (PRI), the customer may send information to the AT&T Switched Network to modify the charges. This flexible billing capability is used to offer AT&T MultiQuest™ Vari-A-Bill service.

The customer may change to a different per minute-rate or flat (time-independent) charge for the remainder of the call, may specify a premium charge or credit to be added to or subtracted from the price of the call, or may make the entire call free.

2. Interface Specification for Layer 1

The Layer 1 specification is as described in Part I of this Technical Reference.

3. Interface Specification for Layer 2

The Layer 2 specification is as described in Part II of this Technical Reference.

4. Interface Specification for Layer 3

4.1 General Overview of Call Control

For each incoming call attempt, availability of Vari-A-Bill is determined by the AT&T Switched Network and is subsequently indicated to the customer within the SETUP message. The customer may initiate a billing change request, after call establishment, by issuing an appropriately coded FACILITY message to the network. The network responds to the customer with a FACILITY message.

4.2 General Message Format and Information Elements Coding

4.2.1 Layer 3 Messages for Vari-A-Bill

The Q.931 protocol message signaling between user and network is described in this section. Table 1 summarizes the messages referenced in Part III of this Technical Reference that will indicate per-call availability of the Vari-A-Bill feature and will invoke the Vari-A-Bill feature:

Table 1. Messages for Vari-A-Bill

Message	Reference
FACILITY	Section 3.5 of Part III
SETUP	Section 3.1 of Part III

4.2.2 Information Elements

4.2.2.1 Coding Rules

Refer to Part III of this Technical Reference for details on the coding rules for the information elements in this Appendix.

4.2.2.2 Network-Specific Facilities

This information element is implemented as described in Part III of this Technical Reference.

Vari-A-Bill will be supported by the Parameterized facility coding value and Parameterized field as follows:

Parameterized Facility Coding value (Octet 4, Bits 5 through 1)

Bits 5 4 3 2 1	Feature (Bit 6=0)
0 1 0 0 1	Available Features Indicator

Parameterized Field (Octet 5, Bits 7 through 1)

Bits 7 6 5 4 3 2 1	Service
0 0 0 0 1 1 0	Vari-A-Bill

4.2.2.3 Codeset 6 Generic Billing Data Information Element

This information element is implemented as described in Part III of this Technical Reference. Vari-A-Bill will support the Generic Billing Data information element as follows:

Type of Billing Data (Octet 3, Bits 7-1)

Bits 7 6 5 4 3 2 1	Type of Billing Data
0 0 1 0 0 0 0	New Rate
0 0 1 0 0 0 1	Flat Rate
0 0 1 0 0 1 0	Premium Charge
0 0 1 0 0 1 1	Premium Credit
0 0 1 1 0 0 0	Free Call

Encoding Scheme (Octet 4, Bits 7-1)

Bits 7 6 5 4 3 2 1	Encoding Scheme
0 0 0 0 0 1 0	IA5

Note: All other values are reserved.

Billing Data (Octet 5):

When the *Type of Billing Data* is encoded as New Rate, Flat Rate, Premium Credit, or Premium Charge, five Billing Data octets must follow. The contents of the Billing Data octets represent the amount of the billing change requested. The Billing Data octets must be encoded in IA5 format. IA5 coding is described in the following table:

Coding for IA5 Number Digits

Bits 8 7 6 5 4 3 2 1	Number digit
0 0 1 1 0 0 0 0	0
0 0 1 1 0 0 0 1	1
0 0 1 1 0 0 1 0	2
0 0 1 1 0 0 1 1	3
0 0 1 1 0 1 0 0	4
0 0 1 1 0 1 0 1	5
0 0 1 1 0 1 1 0	6
0 0 1 1 0 1 1 1	7
0 0 1 1 1 0 0 0	8
0 0 1 1 1 0 0 1	9

The first Billing Data octet represents hundreds of dollars, the second Billing Data octet represents tens of dollars, the third Billing Data octet represents single dollars, the fourth Billing Data octet represents tenths of dollars, and the fifth Billing Data octet represents hundredths of dollars. When the *Type of Billing Data* is encoded as Free Call, the Encoding Scheme octet may be omitted and no Billing Data octets must follow.

The following table shows the dollar values represented in each of the five Billing Data octets:

Octet	Dollar Value
5	Hundreds
5a	Tens
5b	Ones
5c	Tenths
5d	Hundreths

4.2.2.4 Codeset 6 Item Information Element

This information element is implemented as described in Part III of this Technical Reference. Vari-A-Bill will support the Item value as follows:

Item Value (Octet 3, Bits 7-1)

Bits 7 6 5 4 3 2 1	Item Value
0 0 1 1 1 1 1	Billing Change Request

4.2.2.5 Codeset 6 Facility Information Element

This information element is implemented as described in Part III of this Technical Reference. For specific usage of this information element, refer to section 4.2.3.

4.2.3 Procedures for Accessing Network Features and Services

4.2.3.1 Vari-A-Bill Procedures

4.2.3.1.1 Notification of Feature Availability

If Vari-A-Bill is available on a call, an indication will be contained in the SETUP message. The SETUP message will contain two occurrences of the Network-specific facilities information element. The first occurrence will indicate the AT&T Nodal Service carrying the call, as described in Part III of this Technical Reference. (Currently only AT&T MultiQuest™ Service offers Vari-A-Bill). The second occurrence will indicate that Vari-A-Bill is available, as described in Section 4.2.2.2 of this Appendix. The second occurrence of the Network-specific facilities information element will be coded as follows:

FIELD	VALUE(S) RECOGNIZED (Hexadecimal Representation)	OCTET
Length of Network ID	(00)	3
Parameterized/Binary Feature/Service Facility Coding Value	Available Feature Indicator (49)	4
Parameterized Field	Vari-A-Bill (06)	5

4.2.3.1.2 Billing Change Request

The terminating customer may request a billing change by issuing a FACILITY message indicating the billing change request in the codeset 6 Facility information element. The call must use a service that supports Vari-A-Bill and the call must be in the Active state. Note that a call is in the Active state after a valid CONNECT message is issued by the terminating customer.

In addition to the protocol discriminator, call reference value and message type information elements, the FACILITY message must contain the *locking* Shift to codeset 6 and the Codeset 6 Facility information element.

The Codeset 6 Facility information element must be coded as follows:[1]

FIELD	VALUE(S) RECOGNIZED	OCTET
Service discriminator	Supplementary service applications (91)	3
Component		
Component type tag	invoke (a1)	4
Component length		5
Invoke identifier		
Invoke identifier tag	universal, integer (02)	6
Invoke identifier length	(01)	7
Invoke identifier	odd number in binary format (range from 0-127) assigned by the user	8
Operation Value		
Operation value tag	universal, integer (02)	12
Operation value length	(01)	13
Operation value	set value (8d)	14
Argument		
Argument tag	Q.931 information element tag (40)	15
Argument length		16
locking shift to codeset 6	(96) (Note 1)	17
Item		
Item tag	Item IE identifier (4d)	18
Item length	(01)	19
Item value	billing change request (9F)	20
Generic Billing Data		
Generic Billing Data tag	Generic Billing Data IE identifier (56)	21
Generic Billing Data length		22
Type of billing data	(Note 2)	23
Encoding scheme	IA5 (82) (Note 3)	24
Billing data digits	(Note 4)	25-29

Note 1: See Part III of this Technical Reference for coding information.

Note 2: See Section 4.2.2.3 for coding information.

Note 3: If the type of billing data is "Free Call," then the encoding scheme octet is optional, but it is recommended that it not be sent. Otherwise, the encoding scheme octet is mandatory.

Note 4: If the type of billing data is "Free Call," then no billing data octets are allowed. Otherwise, 5 octets of billing data must be sent.

1. Octet 2 is the length of the Facility information element. Octets 9-11 are absent.

4.2.3.1.3 Acceptance of the Billing Change Request

When the network has ensured that the call is in the Active state and validated the format of the billing change request within the FACILITY message, the network issues a FACILITY message to the terminating customer. In addition to the protocol discriminator, call reference value and message type information elements, the FACILITY message will contain the *locking* Shift to codeset 6 and the Codeset 6 Facility information element. The Codeset 6 Facility information element will be coded as follows:[2]

FIELD	VALUE(S) RECOGNIZED	OCTET
Service discriminator	Supplementary service applications (91)	3
Component		
Component type tag	return result (a2)	4
Component length	(03)	5
Invoke identifier		
Invoke identifier tag	universal, integer (02)	6
Invoke identifier length	(01)	7
Invoke identifier	same as affected call	8

4.2.3.2 Handling of Error Conditions

Under certain circumstances the user will receive a Facility message indicating acceptance of a billing change request (as described in Section 4.2.3.1.3) even though no change is made to the caller's bill. These conditions include (1) calls with no Vari-A-Bill availability and (2) calls using a service that offers Vari-A-Bill but per call availability of Vari-A-Bill (see Section 4.2.3.1.1) was not indicated in the SETUP message.

When receiving a billing change request, the network does not validate that Vari-A-Bill is available on the call. Therefore to ensure that calls are billed correctly, the user must observe the indication of per-call availability in the SETUP message and only request a billing change on calls where Vari-A-Bill is available.

The following are the minimal procedures which allow for proper handling of error conditions:

4.2.3.2.1 Rejection of the Billing Change Request due to Invalid Facility Information Element Format

4.2.3.2.1.1 Unrecognized Component

The network validates the format of the Facility information element containing the billing change request. If the Facility information element Component is missing or improperly coded, the network issues to the user a STATUS message, with cause #96 ("mandatory information element is missing").

2. Octet 2 is the length of the Facility information element.

4.2.3.2.1.2 Unrecognized Operation

If the Facility information element Operation value is missing or improperly coded, the network issues a FACILITY message to the user. In addition to the protocol discriminator, call reference value and message type information elements, the FACILITY message will contain the *locking* Shift to codeset 6 and the Codeset 6 Facility information element. The Codeset 6 Facility information element will be coded as follows:[3]

FIELD	VALUE(S) RECOGNIZED	OCTET
Service discriminator	Supplementary service applications (91)	3
Component		
Component type tag	reject (a4)	4
Component length	(05)	5
Invoke identifier		
Invoke identifier tag	null (05)	6
Invoke identifier length	(00)	7
Problem		
Problem tag	general problem (80)	8
Problem length	(01)	9
Problem value	unrecognized component (00)	10

4.2.3.2.1.3 Unrecognized Argument

If the Facility information element Argument is incorrectly formatted, (i.e. the part of the Facility information element that follows the Operation Value,) the network issues a FACILITY message to the user. In addition to the protocol discriminator, call reference value and message type information elements, the FACILITY message will contain the *locking* Shift to codeset 6 and the Codeset 6 Facility information element. The Codeset 6 Facility information element will be coded as follows:[4]

3. Octet 2 is the length of the Facility information element.
4. Octet 2 is the length of the Facility information element.

FIELD			VALUE(S) RECOGNIZED	OCTET
Service discriminator			Supplementary service applications (91)	3
Component				
	Component type tag		reject (a4)	4
	Component length		(06)	5
	Invoke identifier			
		Invoke identifier tag	universal, integer (02)	6
		Invoke identifier length	(01)	7
		Invoke identifier	same as affected call	8
	Problem			
		Problem tag	invoke problem (81)	9
		Problem length	(01)	10
		Problem value	mistyped argument (02)	11

4.2.3.2.2 Rejection of Billing Change Request Due to Unsupported Service

The network validates that the billing change request corresponds to a call using a service that supports Vari-A-Bill. If the call does not use such a service, the network issues a FACILITY message to the user. In addition to the protocol discriminator, call reference value and message type information elements, the FACILITY message will contain the *locking* Shift to codeset 6 and the Codeset 6 Facility information element. The Codeset 6 Facility information element will be coded as follows:[5]

5. Octet 2 is the length of the Facility information element. Octets 9-11 are absent.

FIELD			VALUE(S) RECOGNIZED	OCTET
Service discriminator			Supplementary service applications (91)	3
Component				
	Component type tag		return error (a3)	4
	Component length			5
	Invoke identifier			
		Invoke identifier tag	universal, integer (02)	6
		Invoke identifier length	(01)	7
		Invoke identifier	same as affected call	8
	Error Value			
		Error value tag	universal, integer (02)	12
		Error value length	(01)	13
		Error value	set value (8d)	14
	Parameter			
		Parameter tag	Q.931 information element tag (40)	15
		Parameter length		16
		Q.931 Information element	Cause #29, “facility reject” (Note 1)	17, etc.

Note 1: The cause location will be coded as “Transit Network” (0011)

4.2.3.2.3 Billing Change Request Prior to Call Establishment

If a billing change request is issued for a call prior to the call being in the Active state, the network will issue a STATUS message to the user indicating feature rejection. The STATUS message will contain a cause IE with value #98, "message not compatible with call state."

4.2.3.2.4 Rejection of Billing Change Request Due to Invalid Billing Data Amount

The billing change request must include either 5 octets of billing data or zero octets of billing data, depending on the type of billing data (see Section 4.2.2.3). If the appropriate number of octets are not included in the billing change request (generic billing data information element), the network will discard the message and return a FACILITY message with "unrecognized argument" encoding as described in Section 4.2.3.2.1.3.

4.2.4 Timer Values

Network timers are as specified in Part III of this Technical Reference.

5. Service Options

Figure 1 illustrates the Vari-A-Bill service options, the allowed invocations of each option, and the final cost incurred to the caller. A description of the terms used in this figure are provided in Table 2.

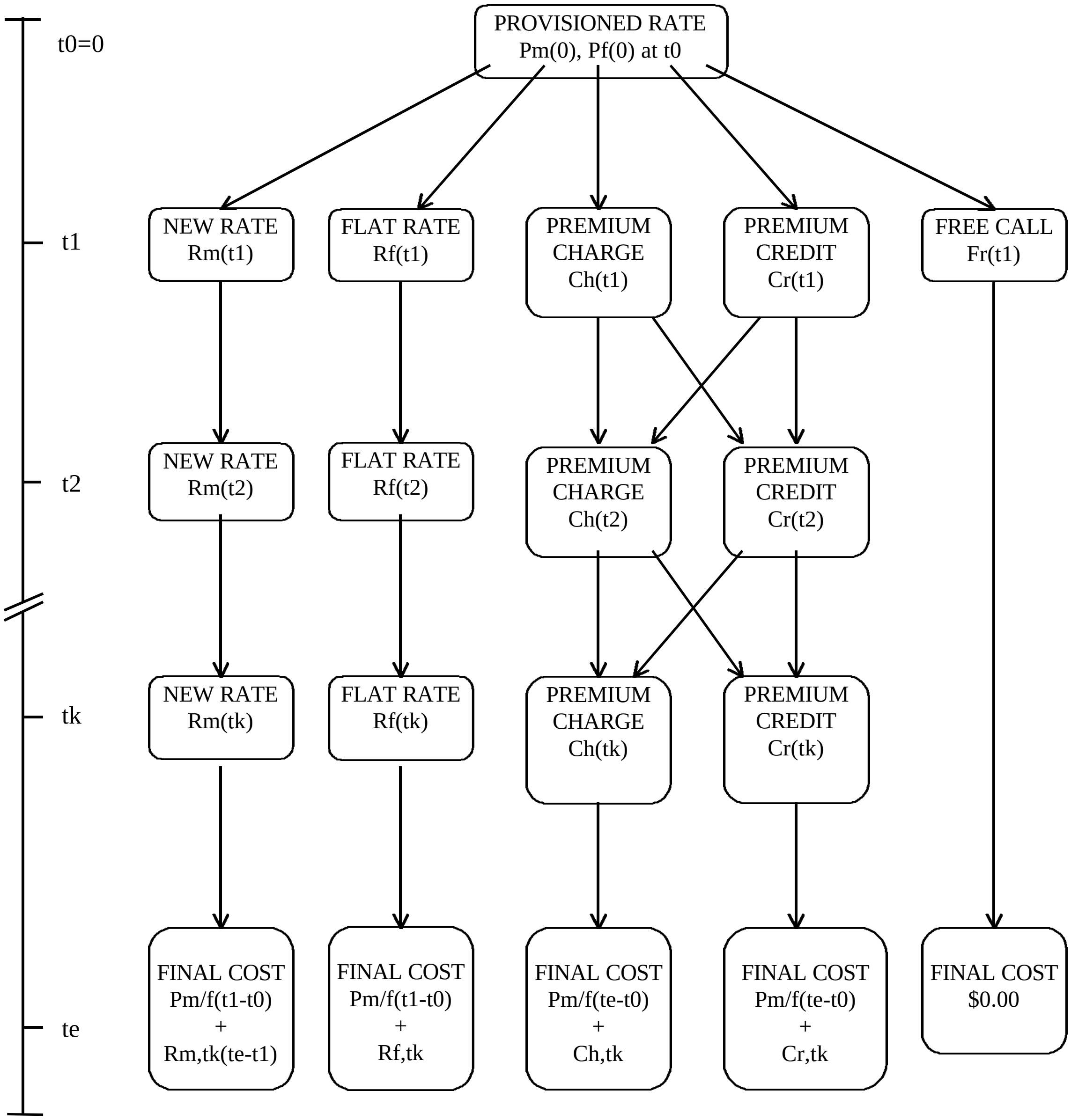


Figure 1. Allowed Rate Changes and Final Cost To The Caller.

Table 2. Description of Terms Used in Figure 1

TERMS	DESCRIPTION
t0	Time at which the MultiQuest® call originated
t1, t2, ...	Times at which the Vari-A-Bill service was invoked
tk	Last time that the Vari-A-Bill service was invoked
te	Time at which the MultiQuest® call terminated
Pm	Provisioned "per-minute" rate
Pf	Provisioned "flat" rate
Rm(t1)..Rm(tk)	Per-minute rate changes invoked at times t1..tk
Rf(t1)..Rf(tk)	Flat rate changes invoked at times t1..tk
Ch(t1)..Ch(tk)	Premium charge changes at times t1..tk
Cr(t1)..Cr(tk)	Premium credit changes at times t1..tk
Fr(t1)	A free call invoked at time t1
Pm/f(t1-t0)	Charges incurred between t1 and t0 based on Pm or Pf at t0
Rm, tk(te-t1)	Charges incurred between te and t1 based on per minute rate invoked at tk
Rf, tk	Flat charge invoked at tk
Pm/f(te-t0)	Charges incurred between te an t0 based on Pm or Pf at t0
Ch, tk	Premium charge invoked at tk
Cr, tk	Premium credit invoked at tk

APPENDIX 4

AT&T NETWORK ISDN PRIMARY RATE INTERFACE

AND SPECIAL APPLICATIONS

SPECIFICATION

User - Network Interface Description

Enhanced Service Provider Interface

Credit Checking Application Feature

TABLE OF CONTENTS

LIST OF TABLES

1. Introduction to Appendix 4

This document is an appendix to the AT&T Integrated Services Digital Network (ISDN) Primary Rate Interface and Special Applications publication TR 41459 and serves to expand the scope of this Technical Reference. Described in this appendix is Enhanced Service Provider (ESP) Interface/Credit Checking Application, an interface feature between Enhanced Service Provider (ESP) and the AT&T Switched Network (ASN). The term "network" when it appears in this appendix is synonymous with the term "AT&T Switched Network."

1.1 Introduction to this Issue of Appendix 4 to TR 41459

This appendix to TR 41459 describes the AT&T ISDN PRI implementation of the ESP/Credit Checking Application feature and documents the messages and procedures required for it. Part III of this Technical Reference contains the complete protocol specification for the ISDN Primary Rate Interface.

1.2 New Capability Description

The Enhanced Service Provider Interface/Credit Checking Application is a new capability that allows locations outside the AT&T Switched Network that sell products and services over the telephone (Enhanced Service Providers) to check the credit of their customer before the sale is completed.

In order for the credit card verification to be processed by the network, the ESP must have subscribed to the credit card verification capability.

Using this capability, AT&T will allow the Enhanced Service Provider (ESP) location to check the credit of the customer based on AT&T Customer Account Services (CAS) cards, non-AT&T 89C cards and AT&T accepted Commercial Credit Cards (CCC).

2. Interface Specification for Layer 1

Part I of this Technical Reference describes the Layer 1 Physical Layer Protocol.

3. Interface Specification for Layer 2

Part II of this Technical Reference describes the Layer 2 Link Layer Protocol.

4. Interface Specification for Layer 3

4.1 General Overview of Call Control

The Enhanced Service Provider will send to the network over the D-Channel the credit card information which it wants verified by transferring a FACILITY message. The network switch on receiving this information will send the credit card information to the appropriate network database. The network switch, on receiving the response from the network database, will formulate a response to the Enhanced Service Provider, which it will send to the ESP over the D-Channel using FACILITY message.

The ESP may originate or terminate calls to or from its customers, and may make credit card verification requests on either inbound or outbound calls. ESP clients may also request spontaneous transfer to the ESP following failure to complete either a 1+ or 0+ call.

4.2 General Message Format and Information Elements Coding

4.2.1 Layer 3 Messages for Enhanced Service Provider - Credit Checking Application

The Q.931 protocol message signaling between ESP and network is described in this section. Table 1 summarizes the messages referenced in Part III of this Technical Reference that will invoke the ESP/Credit Checking Application feature:

Table 1. Messages for Enhanced Service Provider - Credit Checking Application

Message	**Reference**
FACILITY	Section 3.1 of Part III

4.2.2 Information Elements

4.2.2.1 Coding Rules

Refer to Part III of this Technical Reference for details on the coding rules for the information elements in this Appendix.

4.2.2.2 Codeset 6 Facility Information Element

This information element is implemented as described in Part III of this Technical Reference.

4.2.2.3 Codeset 6 Item Information Element

This information element is implemented as described in Part III of this Technical Reference. ESP/Credit Checking will support the Item value as follows:

Item Value (Octet 3, Bits 7-1)

Bits 7 6 5 4 3 2 1	Item Value
0 0 1 1 1 1 0	Card Verification

4.2.2.4 Codeset 6 Specific Event Information Element

This information element is implemented as described in Part III of this Technical Reference. ESP/Credit Checking will support the Event value as follows:

Event Value (Octet 3, Bits 7-1)

Bits 7 6 5 4 3 2 1	Event Value
0 1 0 0 0 0 1	TCS Override

4.2.2.5 Codeset 6 User Entered Code Information Element

This information element is implemented as described in Part III of this Technical Reference.

4.2.3 Procedures for Accessing Network Features and Services

4.2.3.1 Enhanced Service Provider - Credit Checking Application Procedures

4.2.3.1.1 Capability Request by ESP

At any time while the call is in the **active** state[1], the ESP may request that the 4ESS validate a credit card number. The ESP requests a card validation by transferring a FACILITY message across the interface. In addition to the protocol discriminator, call reference value[2] and message type information elements, the FACILITY message contains the *locking* Shift to codeset 6 and the Codeset 6 Facility information element. The Codeset 6 Facility information element is coded as follows:[3]

1. A call is considered active when both calling and called parties are off-hook. This is true of calls which terminate and calls which originate at the ESP.
2. The call reference in the FACILITY message will be that of the active call.
3. Octets 9 - 11 are absent.

FIELD	VALUE(S) RECOGNIZED	OCTET
Service discriminator	Supplementary service applications (91)	3
Component		
Component type tag	invoke (a1)	4
Component length		5
Invoke identifier		
Invoke identifier tag	universal, integer (02)	6
Invoke identifier length	(01)	7
Invoke identifier	odd number in binary format (range from 0-127) assigned by the user	8
Operation Value		
Operation value tag	universal, integer (02)	12
Operation value length	(01)	13
Operation value	value query (8c)	14
Argument		
Argument tag	Q.931 information element tag (40)	15
Argument length		16
Calling party number (Optional)	(Note 1)	
Called party number (Mandatory)	(Note 1)	
locking shift to codeset 6 (Mandatory)	(96)	
User Entered Code (Mandatory)		
User Entered Code tag	User Entered Code IE identifier (02)	
User Entered Code length		
User Entered Code digits	(Note 2)	
User Entered Code (Mandatory)		
User Entered Code tag	User Entered Code IE identifier (02)	
User Entered Code length		
User Entered Code digits	(Note 2)	
Item (Mandatory)		
Item tag	Item IE identifier (4d)	
Item length	(01)	
Item value	Card Verification (9e)	

Note 1: See Part III of this Technical Reference for coding information

Note 2: One of the User entered code information element will contain the credit card number and the other will contain the PIN on the credit card to be verified.

4.2.3.1.2 Query Receipt

Upon receiving the request for a credit card verification from the ESP, the network screens the request to verify that the ESP has subscribed to the capability. In order for the credit card verification to be processed by the network, the ESP must have subscribed to the credit card verification capability for the D channel associated with the call.

When the subscription screening is successful, the network sends a query for the database.

4.2.3.1.3 Forwarding of Response to ESP

The network, upon receiving the response from the database, will forward the result to the ESP. The network will send the information to the ESP in a FACILITY message. In addition to the mandatory message type, protocol discriminator, and call reference value information elements, the FACILITY message will contain the *locking* Shift to Codeset 6 information element and the Codeset 6 Facility information element.

After the response is forwarded to the ESP, the transaction is concluded. Refer to Part III of this Technical Reference for Call clearing procedures.

4.2.3.2 Handling of Error Conditions

The following are the minimal procedures which allow for proper handling of error conditions:

4.2.3.2.1 Subscription Screening Failures

If the ESP requests the card number verification capability and has not subscribed to the capability for the D-Channel associated with the call, the network will reject the number verification request. The rejection will be conveyed to the ESP in a FACILITY message. In addition to the protocol discriminator, call reference value and message type information elements, the FACILITY message contains the *locking* Shift to codeset 6 and the Codeset 6 Facility information element. The Codeset 6 Facility information element is coded as follows:

FIELD			VALUE(S) RECOGNIZED	OCTET
Service discriminator			Supplementary service applications (91)	3
Component				
	Component type tag		return error (a3)	4
	Component length			5
	Invoke identifier			
		Invoke identifier tag	universal, integer (02)	6
		Invoke identifier length	(01)	7
		Invoke identifier	Set to the value received in the query	8
	Error Value			
		Error value tag	universal, integer (02)	12
		Error value length	(01)	13
		Error value	value query (8c)	14
	Parameter			
		Parameter tag	Q.931 information element tag (40)	15
		Parameter length		16
		Parameter value	Q.931 Cause IE #50, “requested facility not subscribed”	17, etc.

Note: The call is unaffected by this rejection.

4.2.3.2.2 Format Errors

4.2.3.2.2.1 Invalid Codeset 6 Facility Message Format

If a FACILITY message is received while the call is in the active state, and the FACILITY message contains both a Network-specific facilities information element and a Codeset 6 Facility information element, the switch will return a STATUS message to the user with cause #100, "invalid information element contents."

4.2.3.2.2.2 Invalid Codeset 6 Facility information element Format

Upon receiving a FACILITY message with an improperly formatted Codeset 6 Facility information element, the switch will return a FACILITY message containing a Codeset 6 Facility information element coded as follows:

FIELD			VALUE(S) RECOGNIZED	OCTET
Service discriminator			Supplementary service applications (91)	3
Component				
	Component type tag		reject (a4)	4
	Component length			5
	Invoke identifier (Note 1)			
		Invoke identifier tag		6
		Invoke identifier length		7
		Invoke identifier		8
	Problem			
		Problem tag	(Notes 2 & 3)	12
		Problem length	(01)	13
		Problem	(Notes 2 & 3)	14

Note 1: If the invoke identifier from the original Q.931 request is available, the invoke identifier tag is set to "invoke identifier" (02); otherwise, the "null" tag (05) is used, the invoke identifier length is set to 0 and no invoke identifier value is sent.

Note 2: General problem will be indicated if the information element is poorly formatted and the nature of request cannot be determined. In this case the Problem tag will be “General Problem” (80), and the Problem value will be “Unrecognized component” (00).

Note 3: Invoke problem will be indicated if it can be determined that some operation was being invoked, but it was an operation to which the switch cannot comply. In this case, the Problem tag will be “Invoke Problem” (81), and the Problem value will be one of “Unrecognized operation” (01), “Mistyped argument” (02), or “Unrecognized link identifier” (05).

4.2.3.2.3 Unexpected Database Responses

4.2.3.2.3.1 Returned Queries

If the current request and all subsequent requests from the ESP are blocked due to "network failure", "subsystem congestion", or "subsystem failure", the network will deny the requests by sending a FACILITY message to the ESP. In addition to the protocol discriminator, call reference value and message type information elements, the FACILITY message contains the *locking* Shift to codeset 6 and the Codeset 6 Facility information element. The Codeset 6 Facility information element is coded as follows:

FIELD			VALUE(S) RECOGNIZED	OCTET
Service discriminator			Supplementary service applications (91)	3
Component				
	Component type tag		return error (a3)	4
	Component length			5
	Invoke identifier			
		Invoke identifier tag	universal, integer (02)	6
		Invoke identifier length	(01)	7
		Invoke identifier	same as affected call	8
	Error Value			
		Error value tag	universal, integer (02)	12
		Error value length	(01)	13
		Error value	value query (8c)	14
	Parameter			
		Parameter tag	Q.931 information element tag (40)	15
		Parameter length		16
		Parameter value	Q.931 Cause IE #41, “temporary failure”	17, etc.

4.2.3.2.3.2 ABORT or REJECT Message Returned from Database

If the switch receives an ABORT or REJECT message in response to the query, the switch will return to the ESP a FACILITY message. In addition to the protocol discriminator, call reference value and message type information elements, the FACILITY message contains the *locking* Shift to codeset 6 and the Codeset 6 Facility information element. The Codeset 6 Facility information element is coded as follows:

FIELD	VALUE(S) RECOGNIZED	OCTET
Service discriminator	Supplementary service applications (91)	3
Component		
Component type tag	return error (a3)	4
Component length		5
Invoke identifier (Note 1)		
Invoke identifier tag		6
Invoke identifier length		7
Invoke identifier		8
Error Value		
Error value tag	universal, integer (02)	12
Error value length	(01)	13
Error value	abort (be)	14
Parameter		
Parameter tag	Q.931 information element tag (40)	15
Parameter length		16
Parameter value	Q.931 Cause IE #31, “normal, unspecified”	17, etc.

Note 1: If the invoke identifier from the original Q.931 request is available, the invoke identifier tag is set to "invoke identifier" (02); otherwise, the "null" tag (05) is used, the invoke identifier length is set to 0 and no invoke identifier value is sent.

4.2.3.2.4 Request Prior to Active State of a Call

If the network receives a FACILITY message requesting credit card verification prior to the active state of the call, the switch should return a STATUS message to the user containing cause # 98, "message not compatible with call state."

4.2.3.2.5 Premature Clearing

If the ESP or other endpoint of the call clears the call prior to the response from the database, the network will be unable to forward the response to the ESP. Upon receiving the response from database, the network will ignore the response, and take no action either toward the database or toward the ESP.

4.2.3.2.6 Network Switch Congestion

If the switch receives a credit card verification request from the user and is unable to process the request because of switch congestion, the network will return a FACILITY message to the ESP. In addition to the protocol discriminator, call reference value and message type information elements, the FACILITY message contains the *locking* Shift to codeset 6 and the Codeset 6 Facility information element. The Codeset 6 Facility information element is coded as follows:

FIELD			VALUE(S) RECOGNIZED	OCTET
Service discriminator			Supplementary service applications (91)	3
Component				
	Component type tag		return error (a3)	4
	Component length			5
	Invoke identifier			
		Invoke identifier tag	universal, integer (02)	6
		Invoke identifier length	(01)	7
		Invoke identifier	same as affected call	8
	Error Value			
		Error value tag	universal, integer (02)	12
		Error value length	(01)	13
		Error value	value query (8c)	14
	Parameter			
		Parameter tag	Q.931 information element tag (40)	15
		Parameter length		16
		Parameter value	Q.931 Cause IE #42, “switching equipment congestion”	17, etc.

4.2.4 Timer Values

Network timers are as specified in Part III of this Technical Reference.

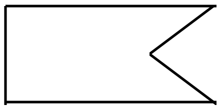
Annex A

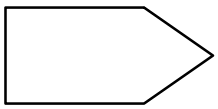
User side and network side SDL Diagrams

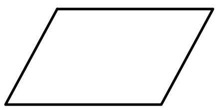
1. Annex A - User side and network side SDL Diagrams

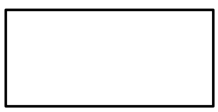
The following symbols are used within this description.

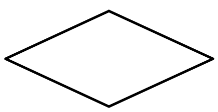
1.  State

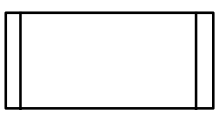
2.  Event occurrence.

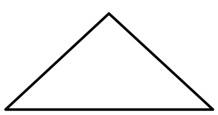
3.  Signal generation (which will lead to an associated event occurrence).

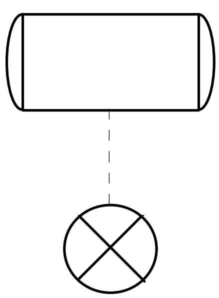
4.  Save an event (until completion of a transition).

5.  Process description.

6.  Test

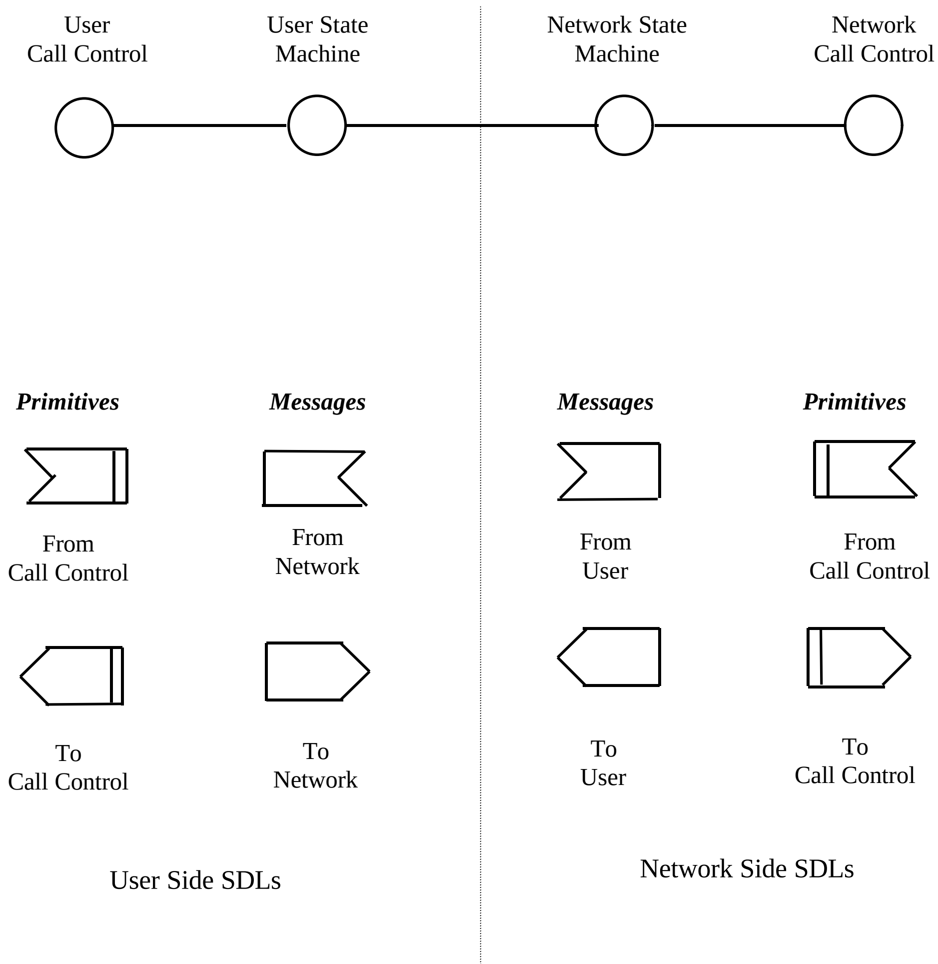
7.  Procedure call

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 tot he data link layer entity.

Symbols Used Within This Description (Part 1 of 2)



Symbols Used Within This Description (Part 2 of 2)

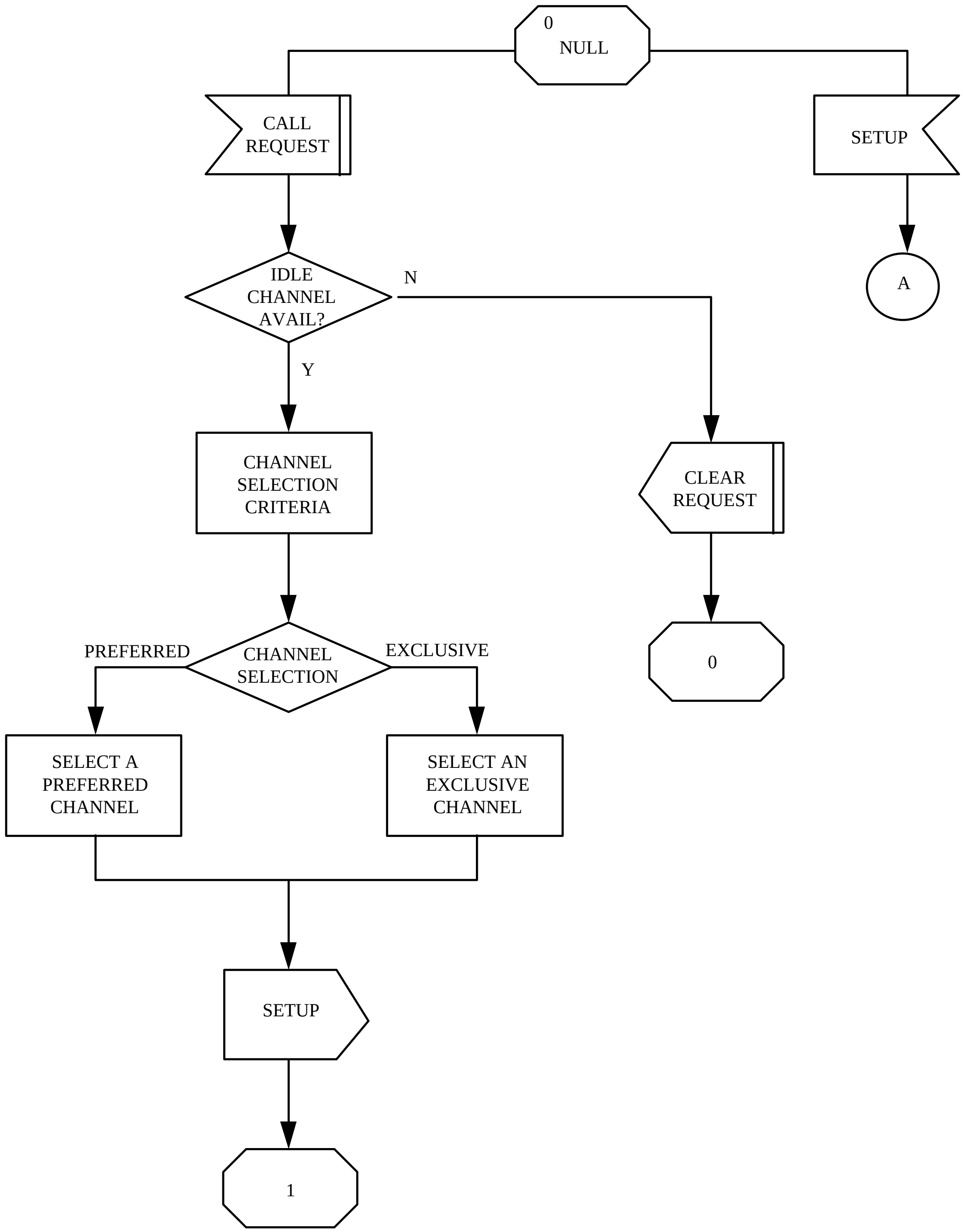


Figure 1. Call Control Detailed SDL Diagrams (User Side)

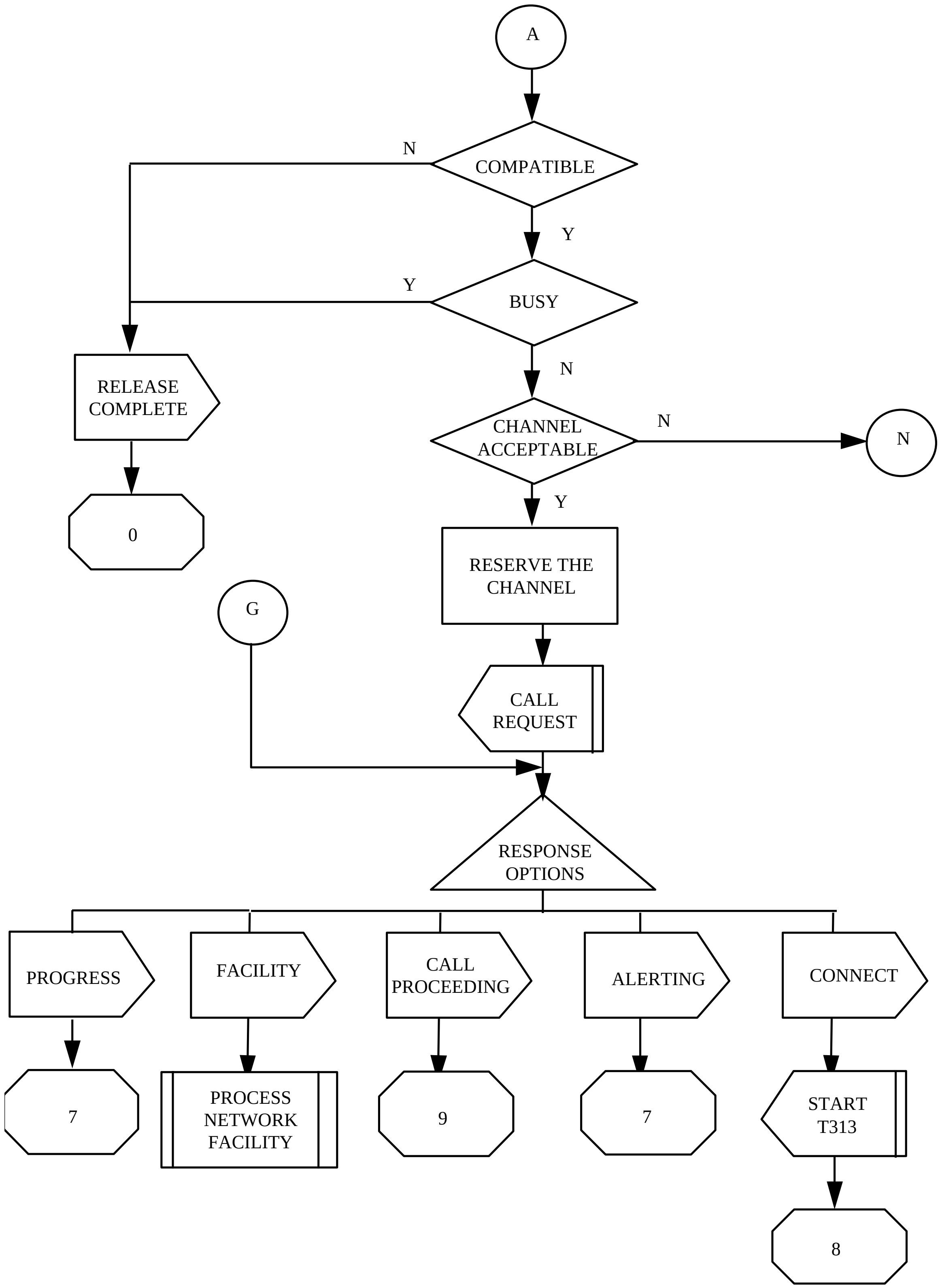


Figure 2. Call Control Detailed SDL Diagrams (User Side)

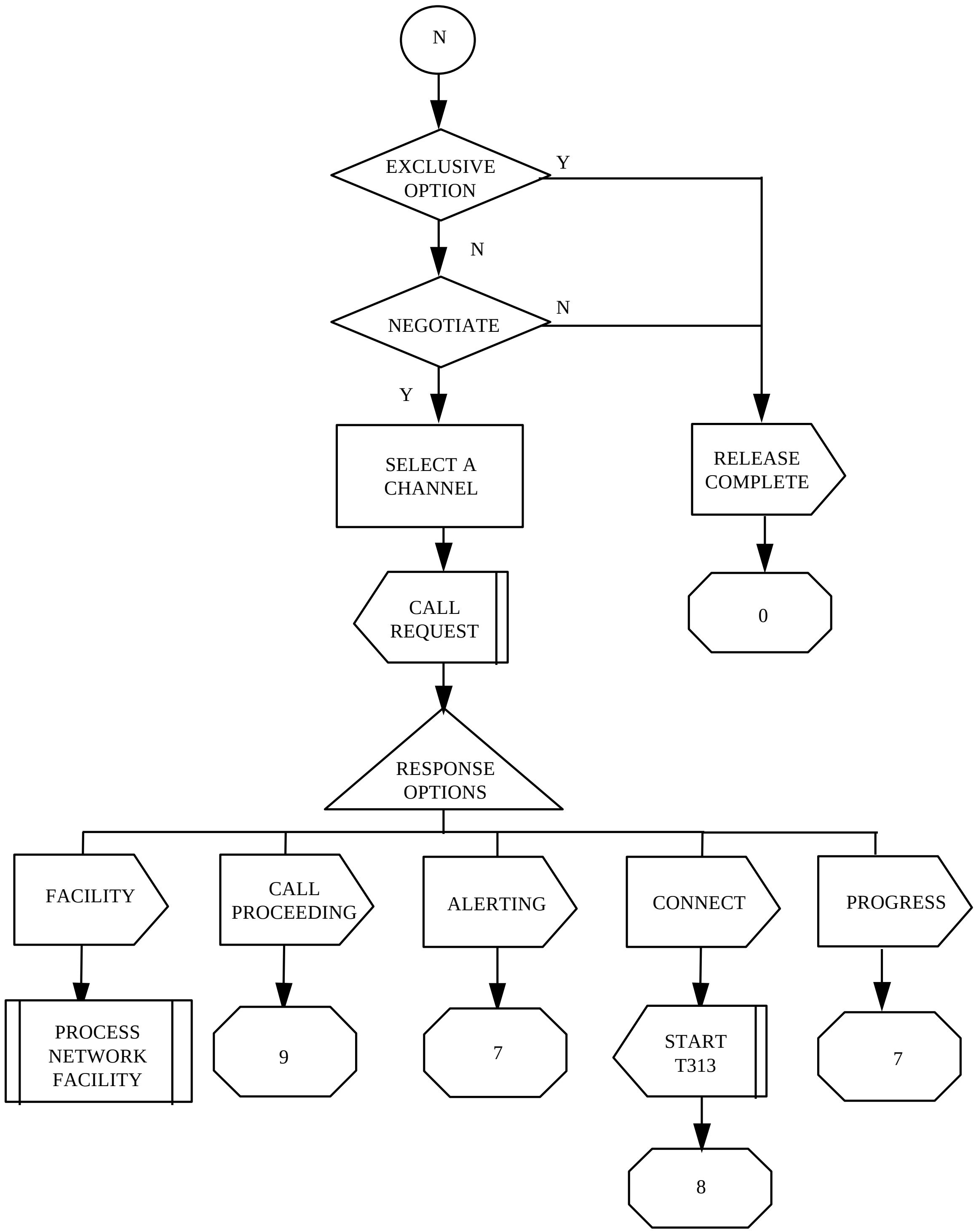


Figure 3. Call Control Detailed SDL Diagrams (User Side)

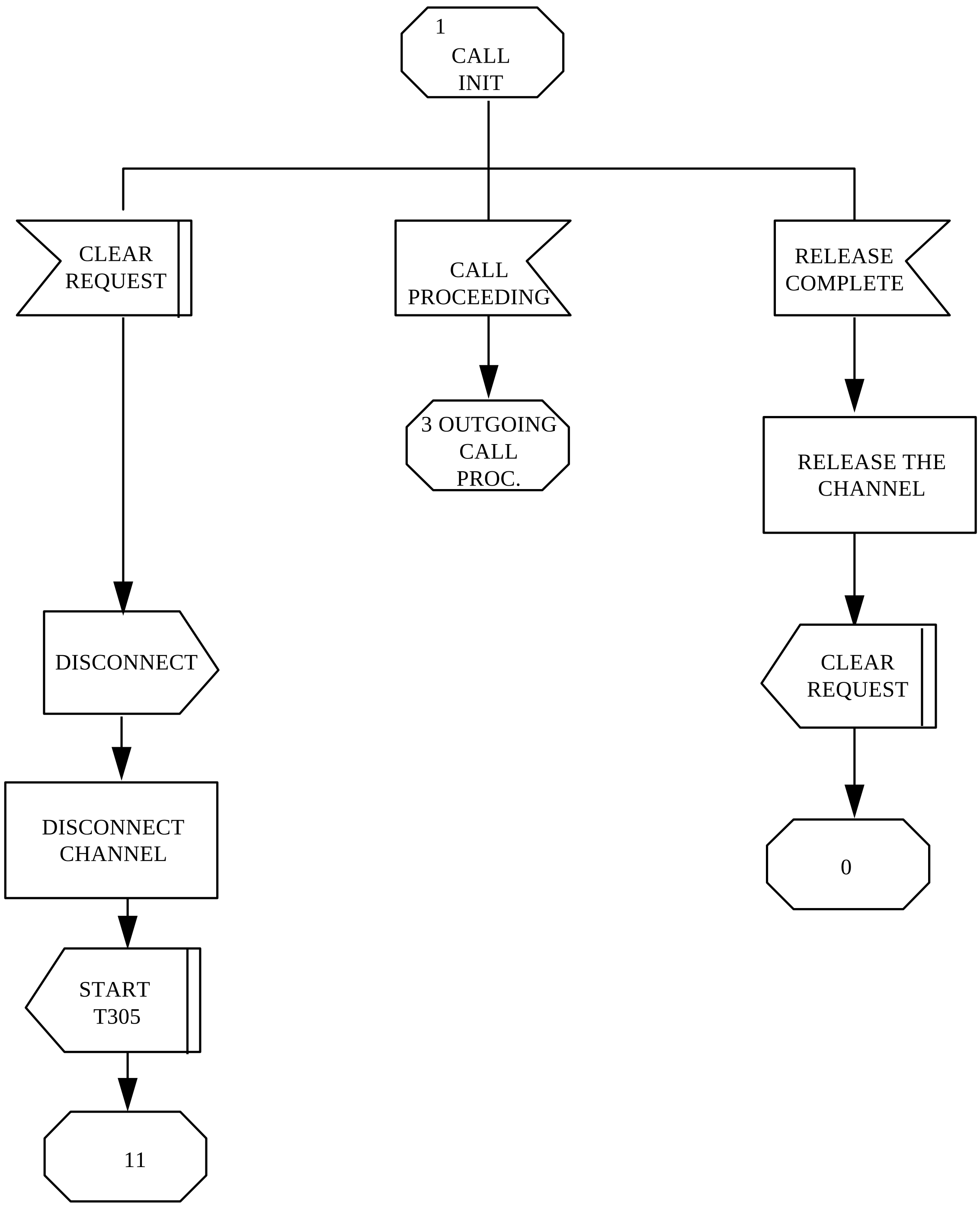


Figure 4. Call Control Detailed SDL Diagrams (User Side)

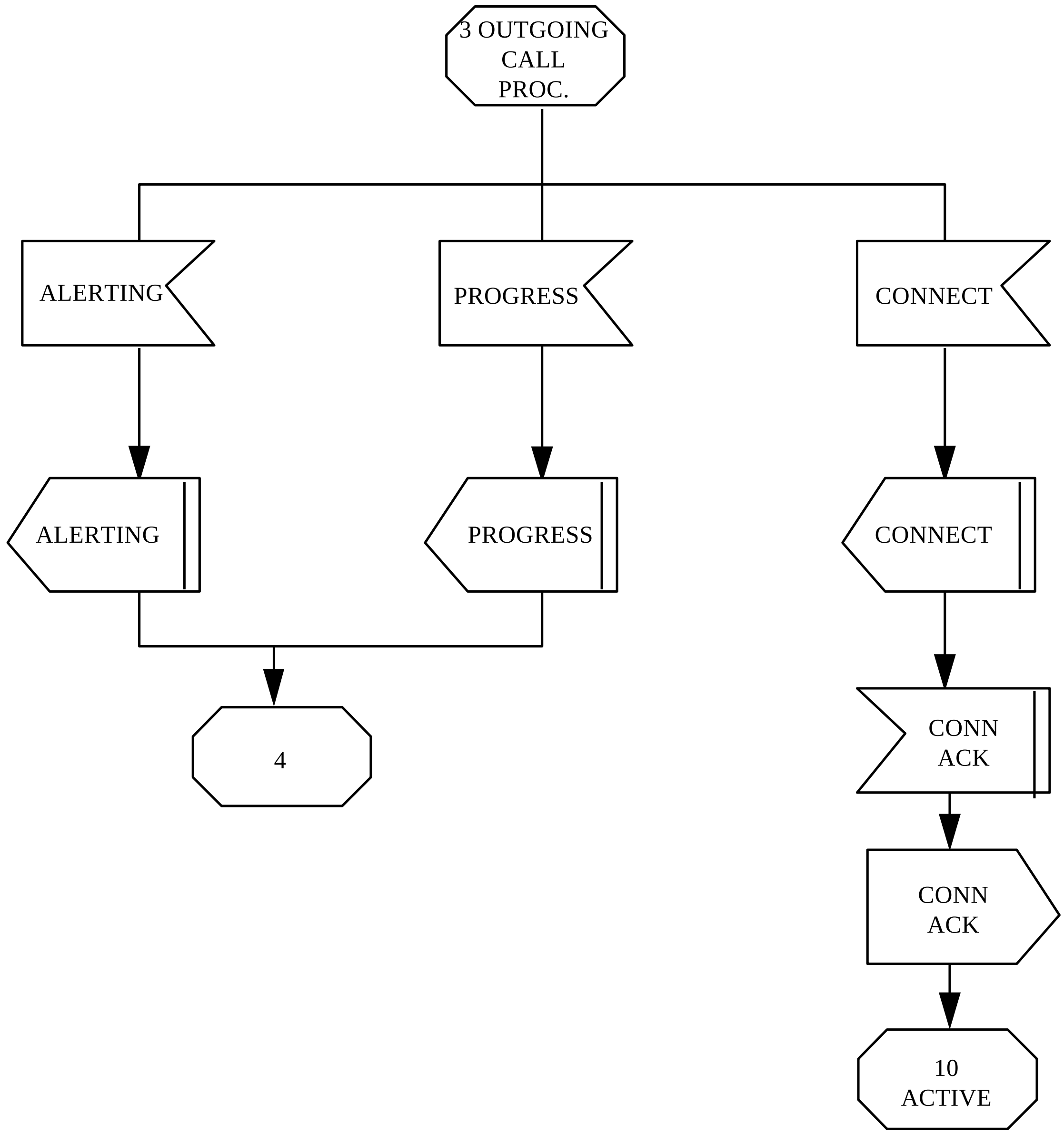
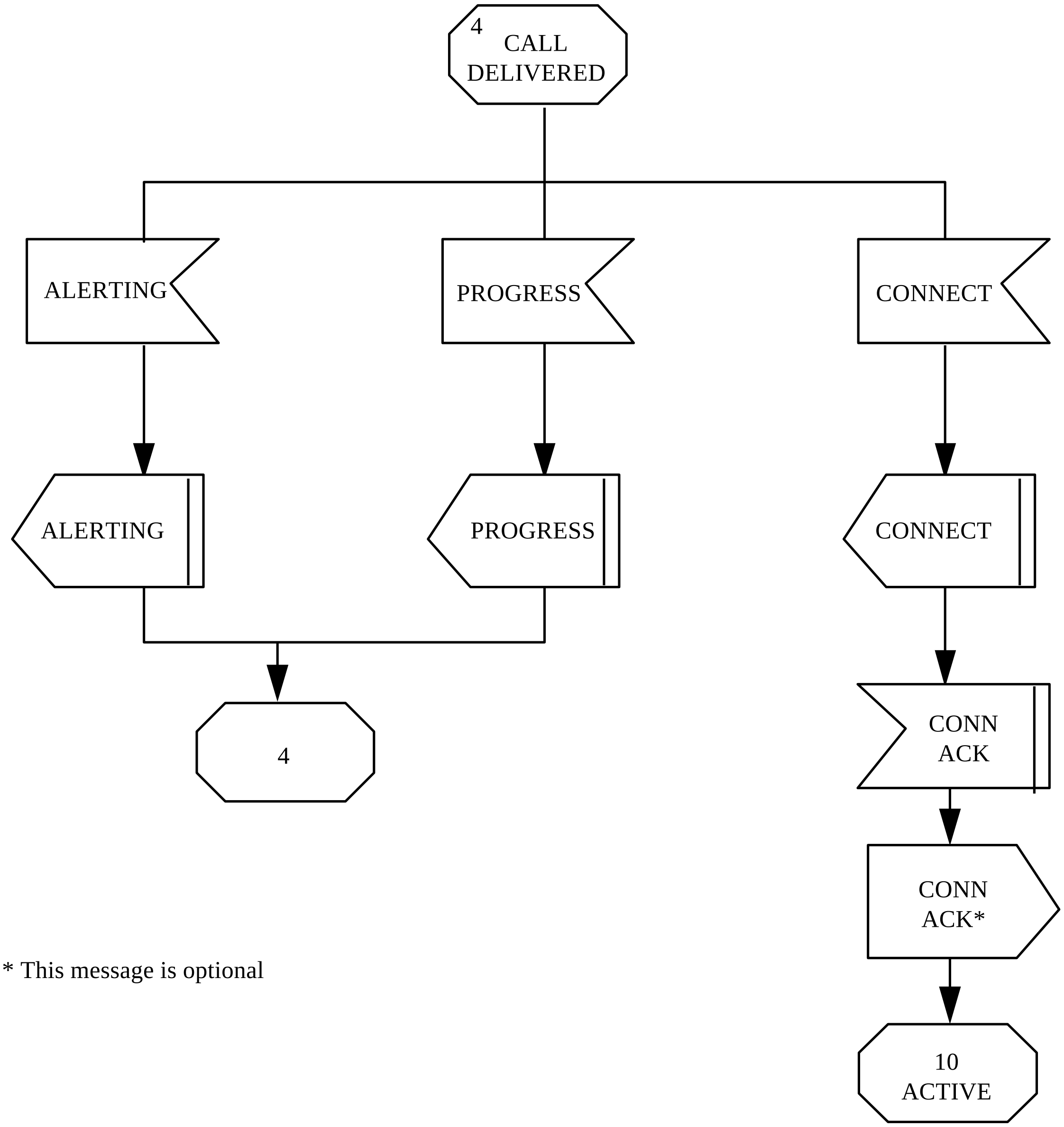


Figure 5. Call Control Detailed SDL Diagrams (User Side)



* This message is optional

Figure 6. Call Control Detailed SDL Diagrams (User Side)

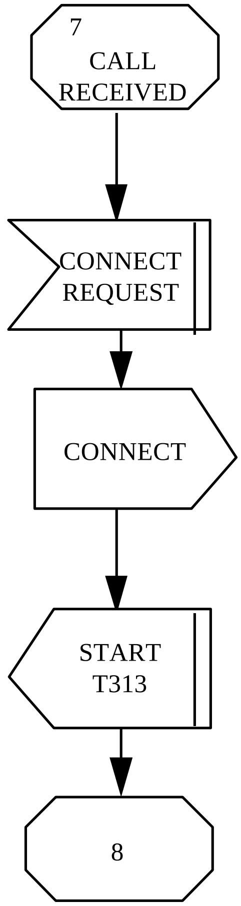
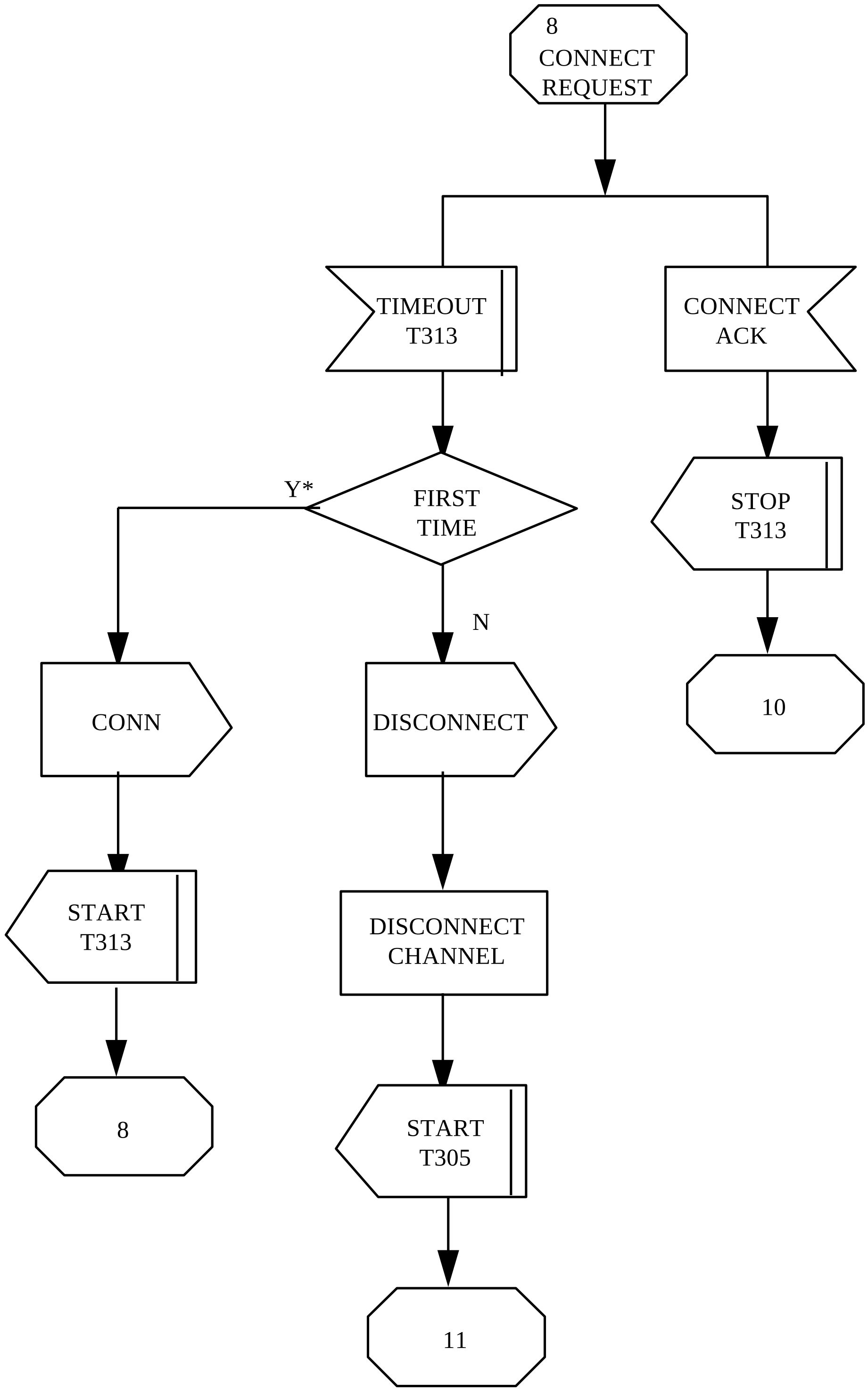


Figure 7. Call Control Detailed SDL Diagrams (User Side)



* This procedure is optional

Figure 8. Call Control Detailed SDL Diagrams (User Side)

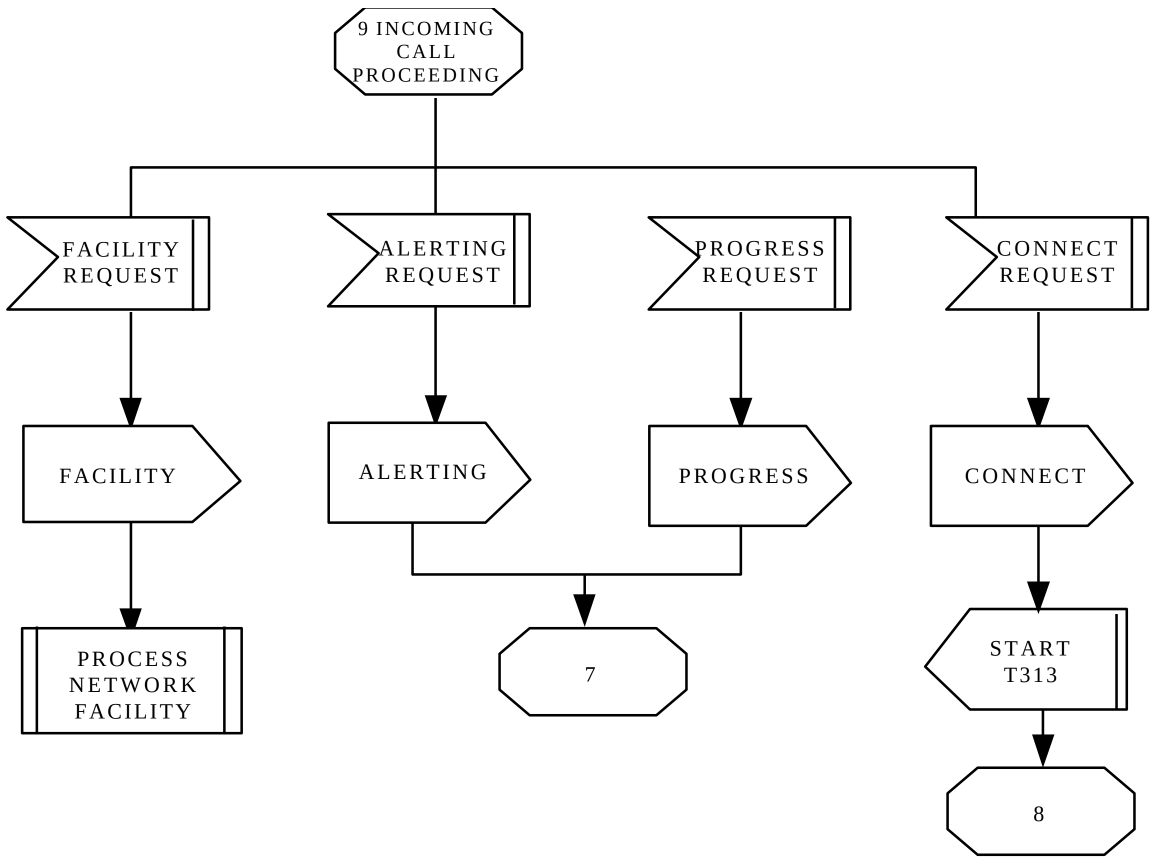


Figure 9. Call Control Detailed SDL Diagrams (User Side)

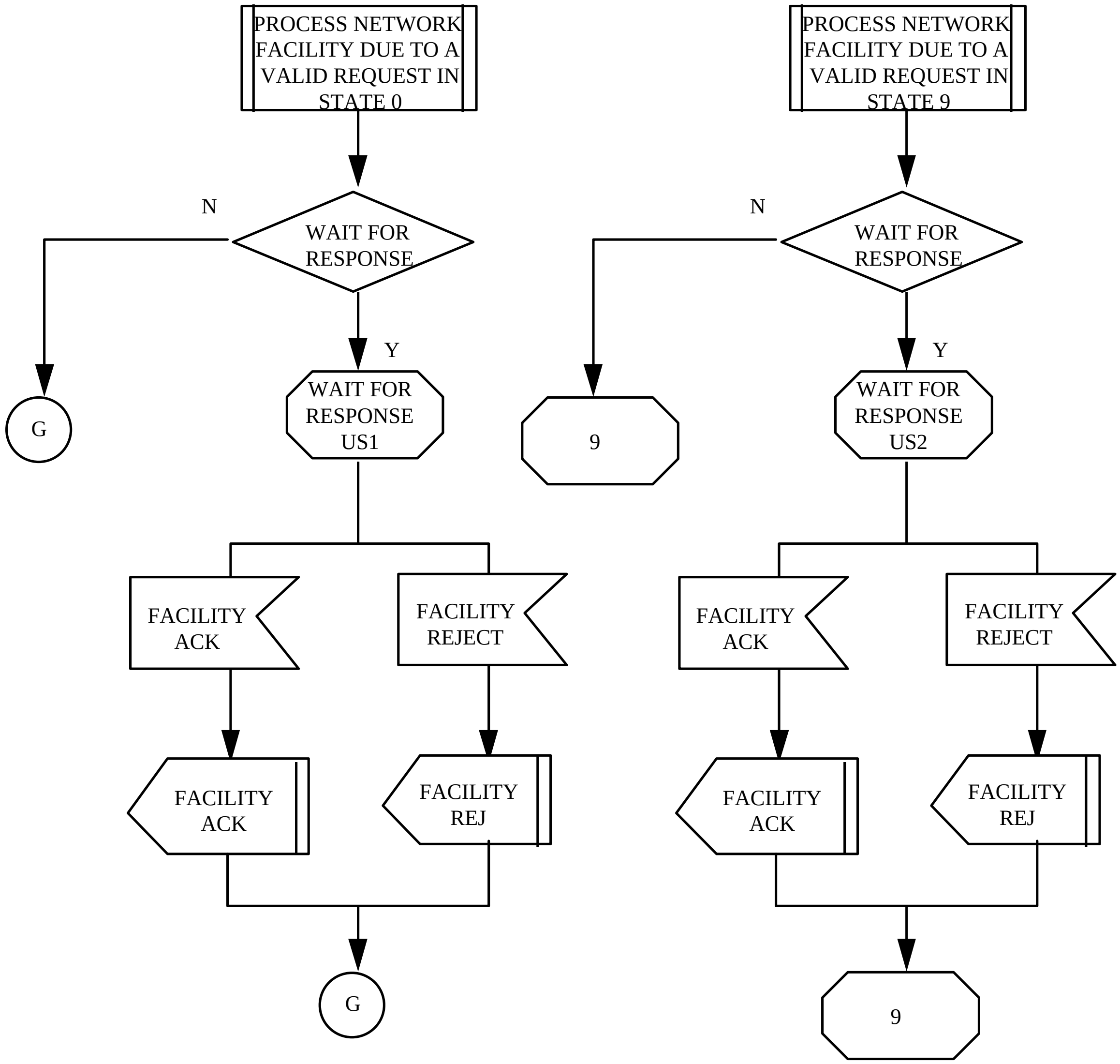


Figure 10. Call Control Detailed SDL Diagrams (User Side)

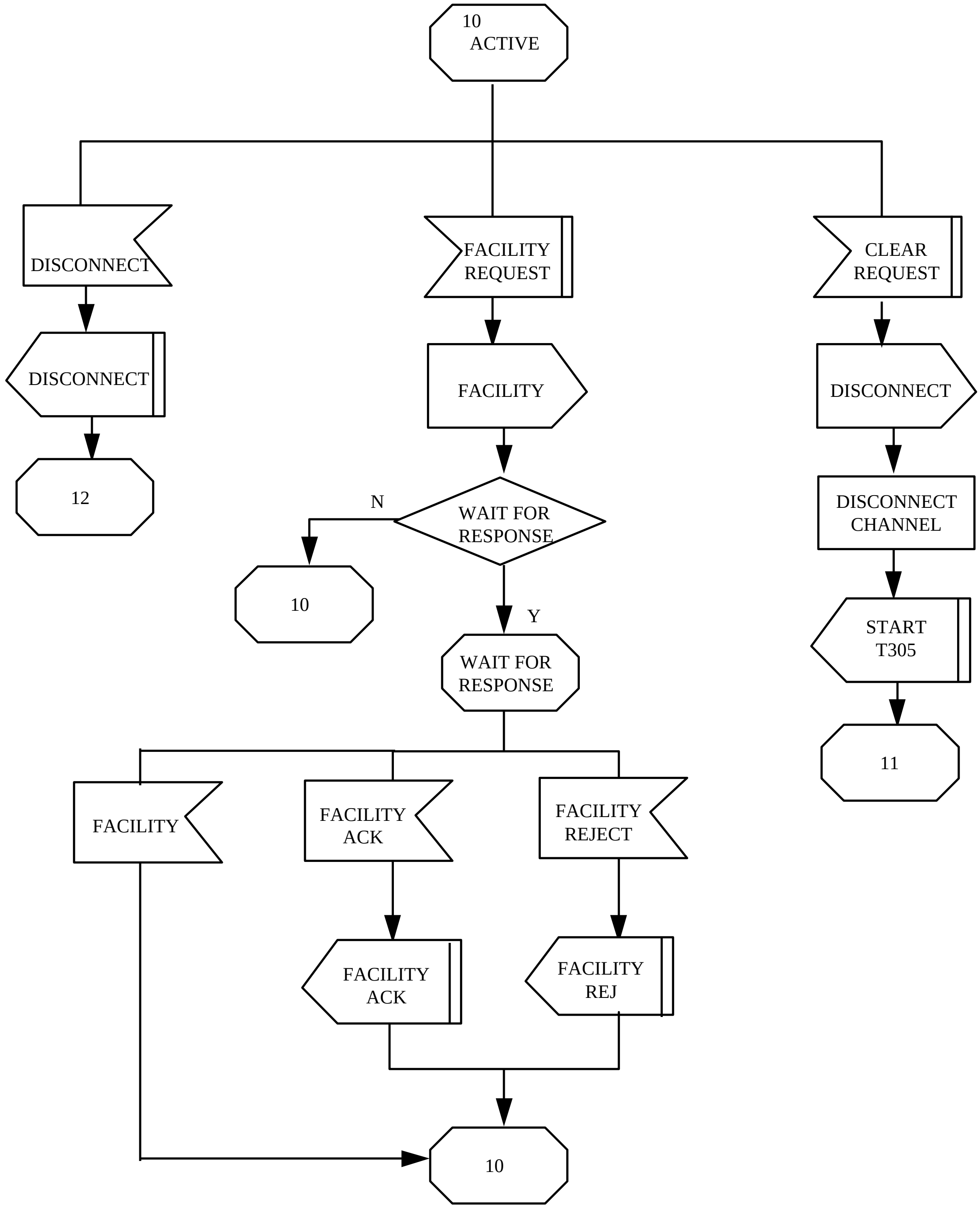


Figure 11. Call Control Detailed SDL Diagrams (User Side)

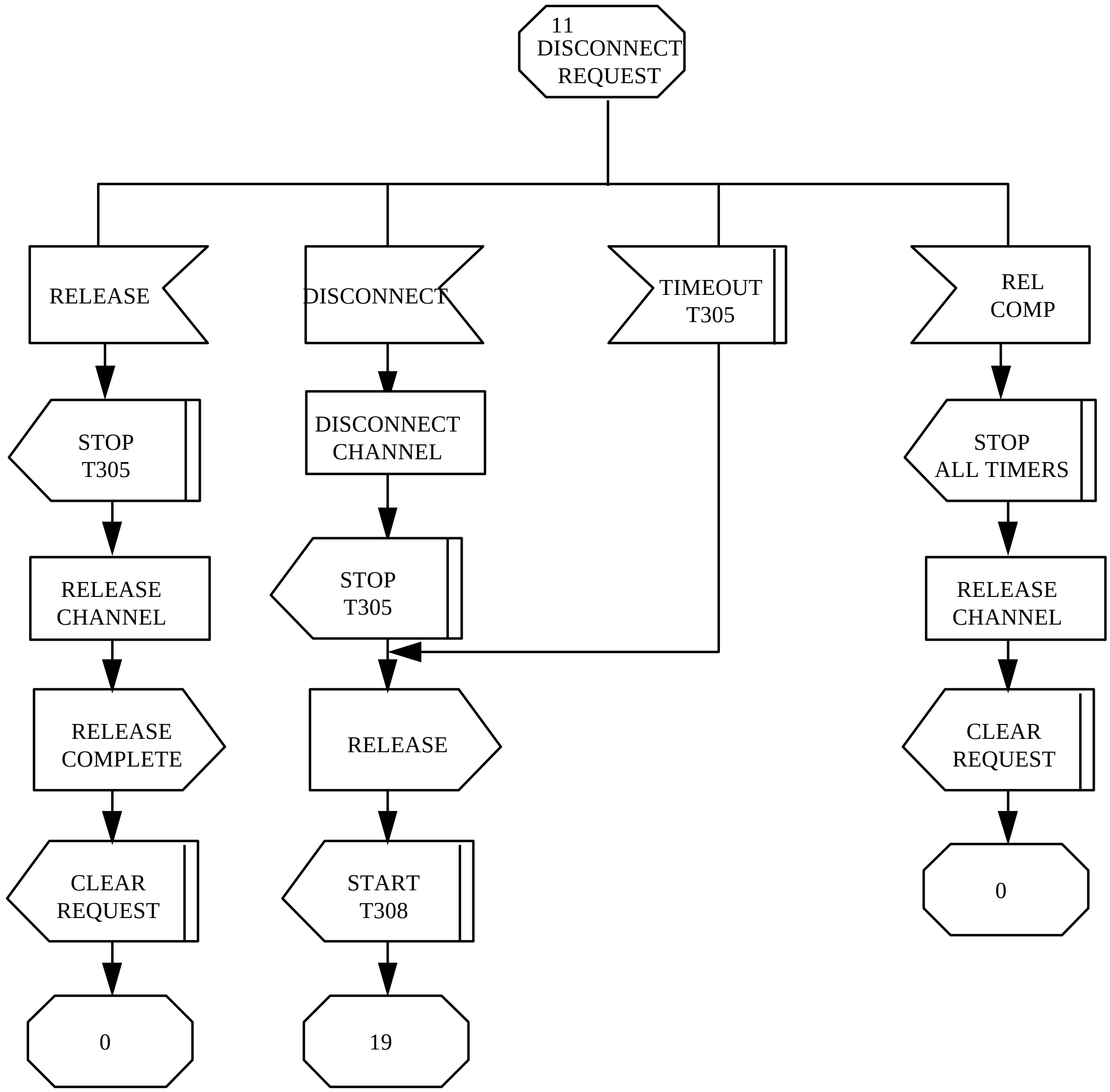
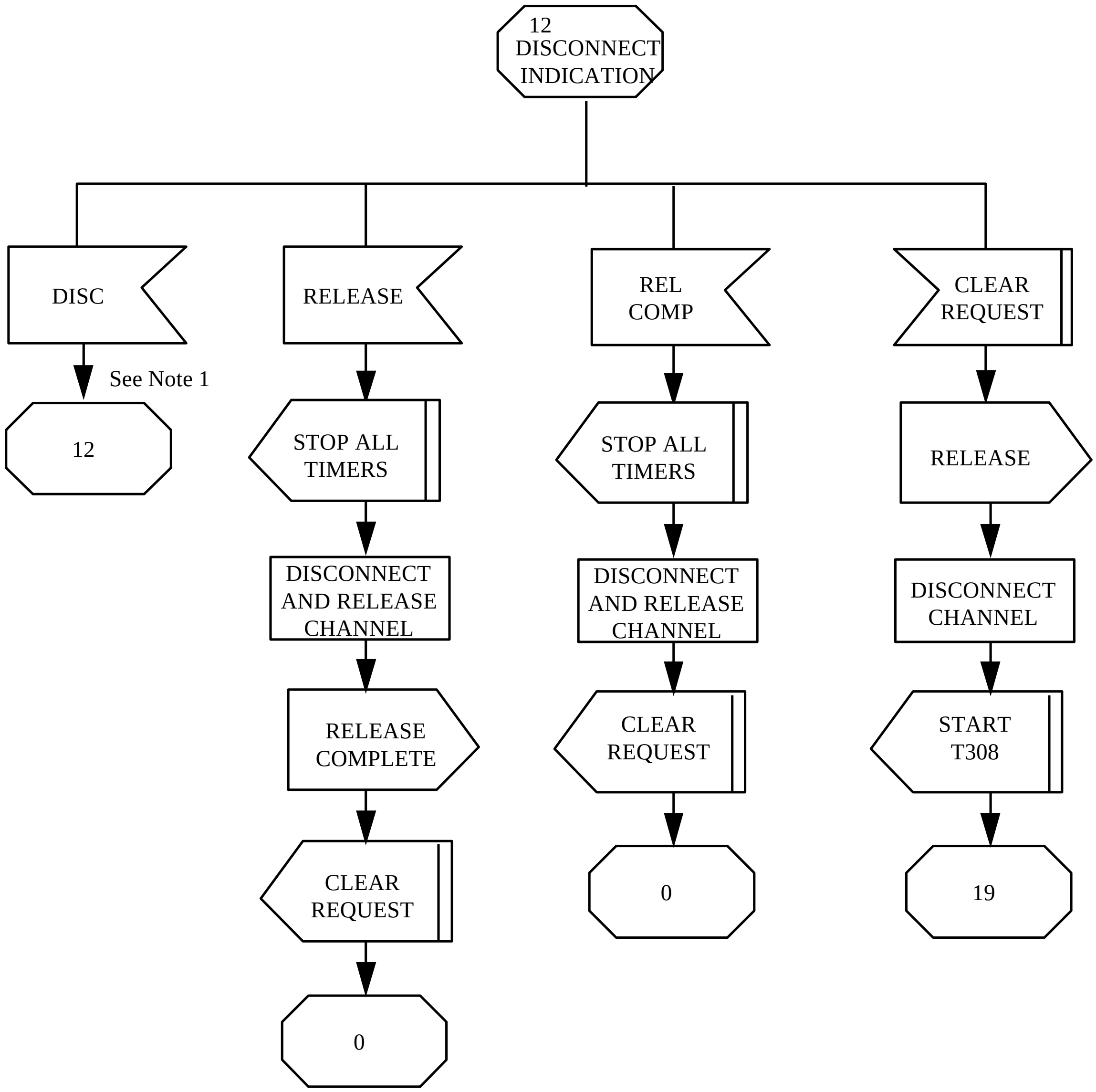


Figure 12. Call Control Detailed SDL Diagrams (User Side)



Note 1: Ignorable Error

Figure 13. Call Control Detailed SDL Diagrams (User Side)

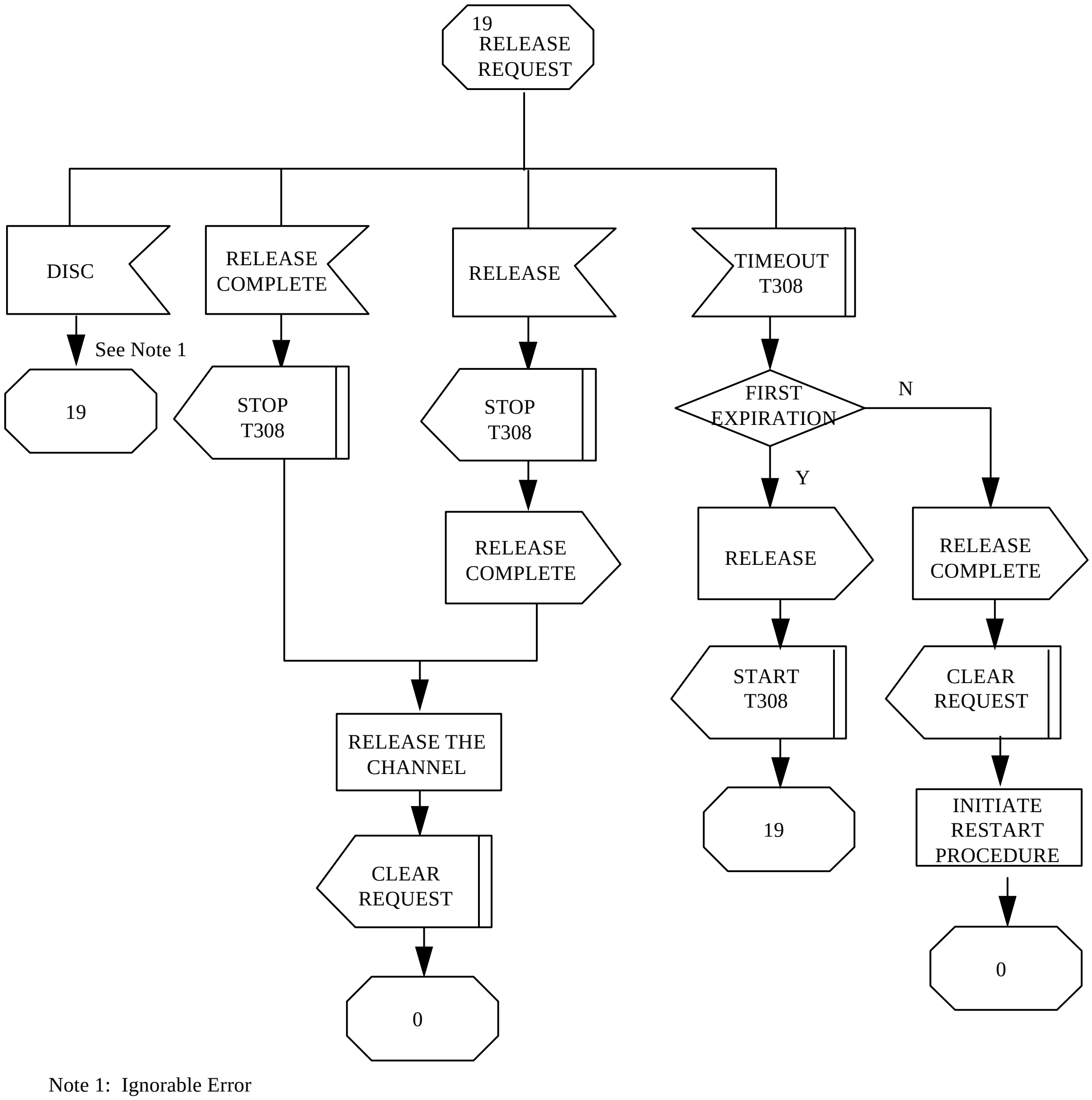
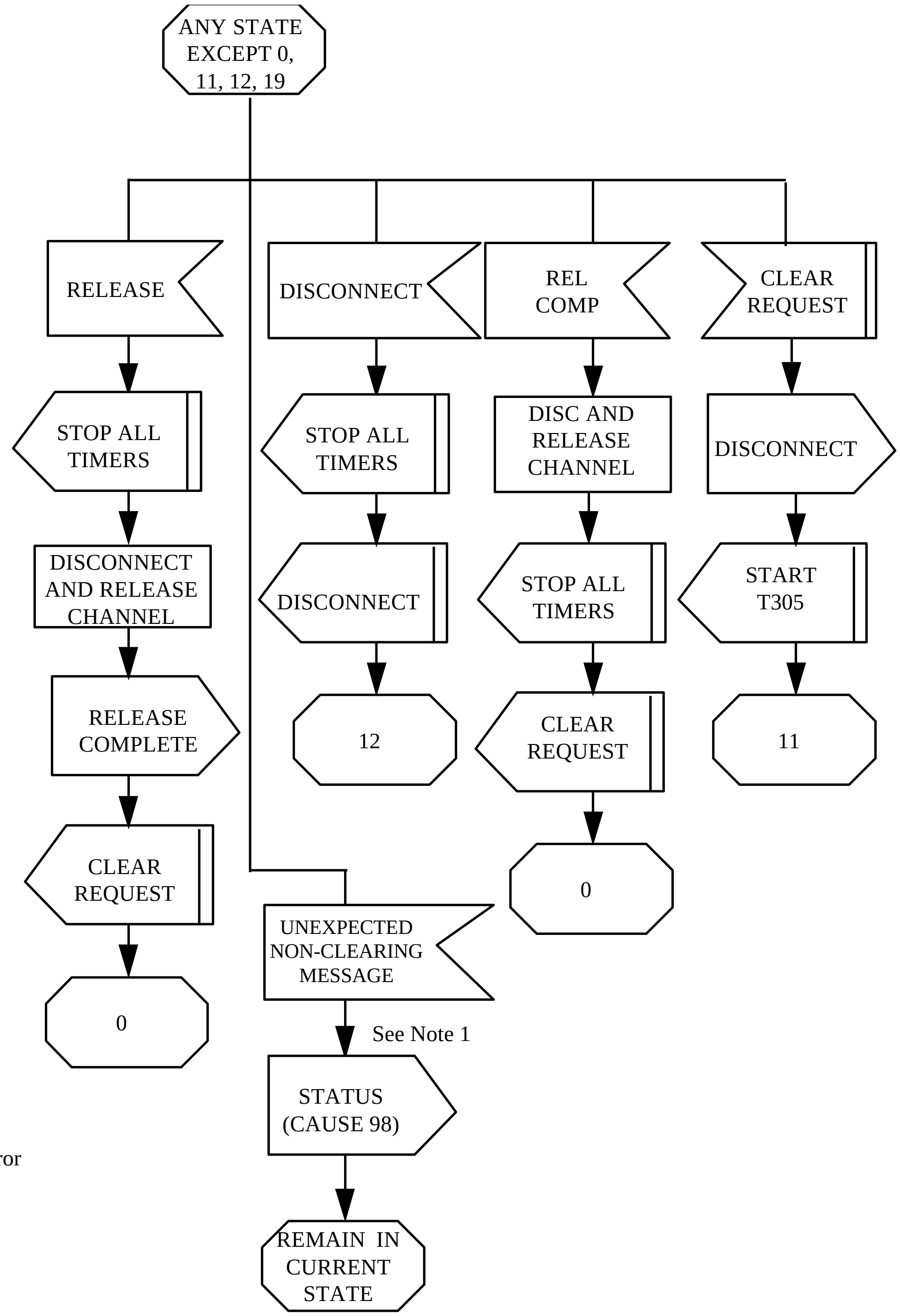
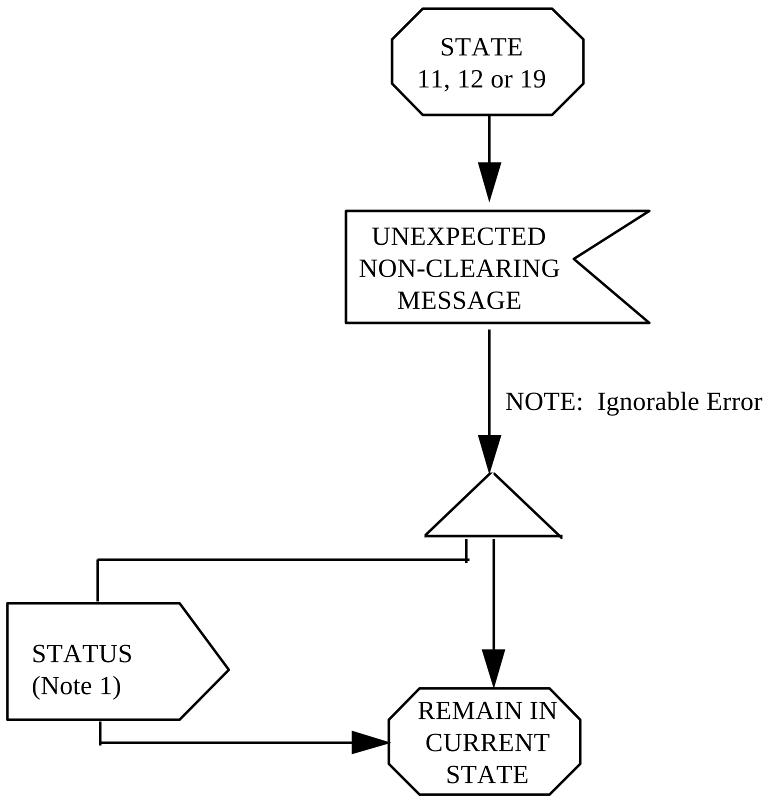


Figure 14. Call Control Detailed SDL Diagrams (User Side)



Note 1: Violent Error

Figure 15. Call Control Detailed SDL Diagrams (User Side)



Note 1: Optional

Figure 16. Call Control Detailed SDL Diagrams (User Side)

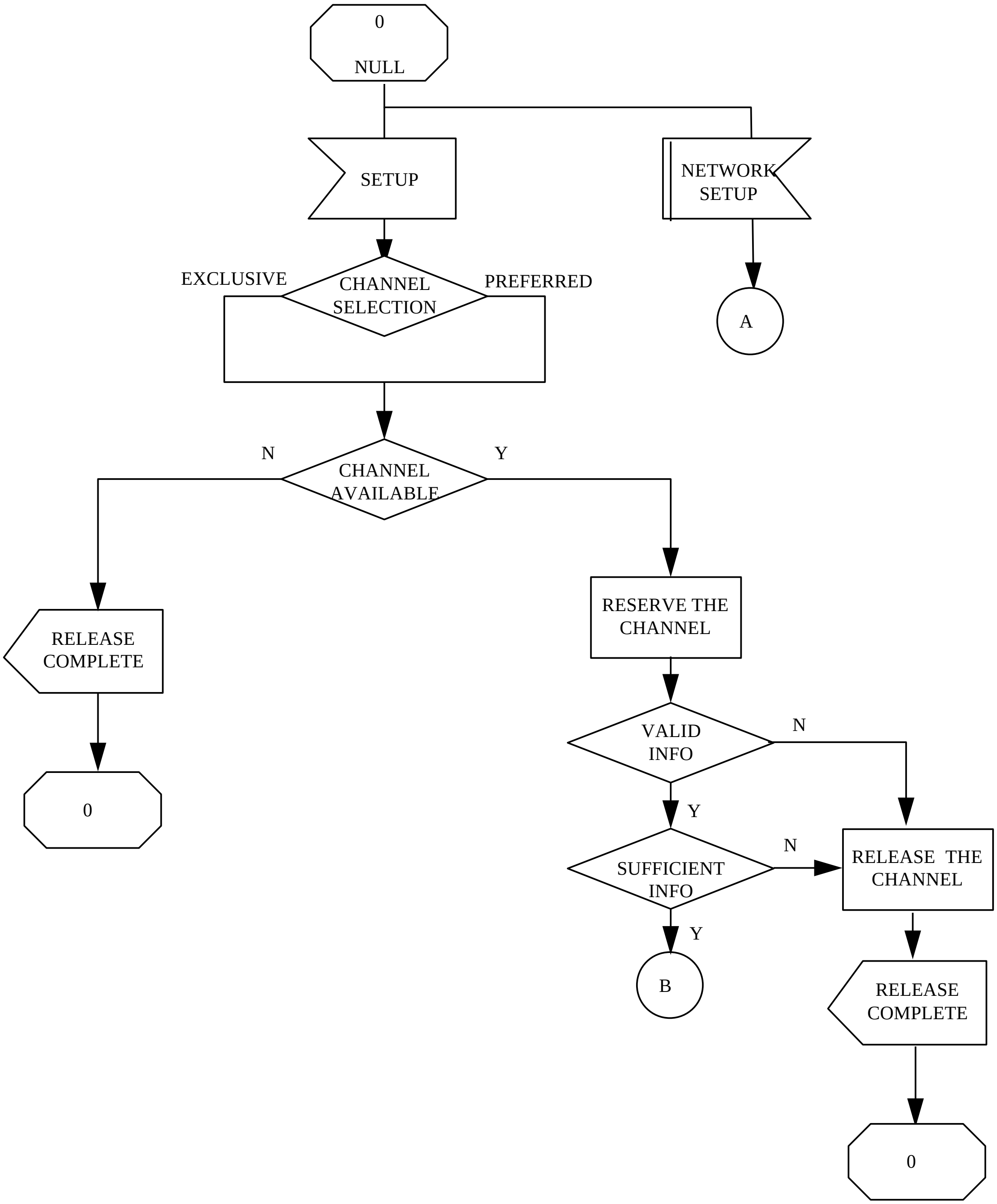


Figure 17. Call Control Detailed SDL Diagrams (Network Side)

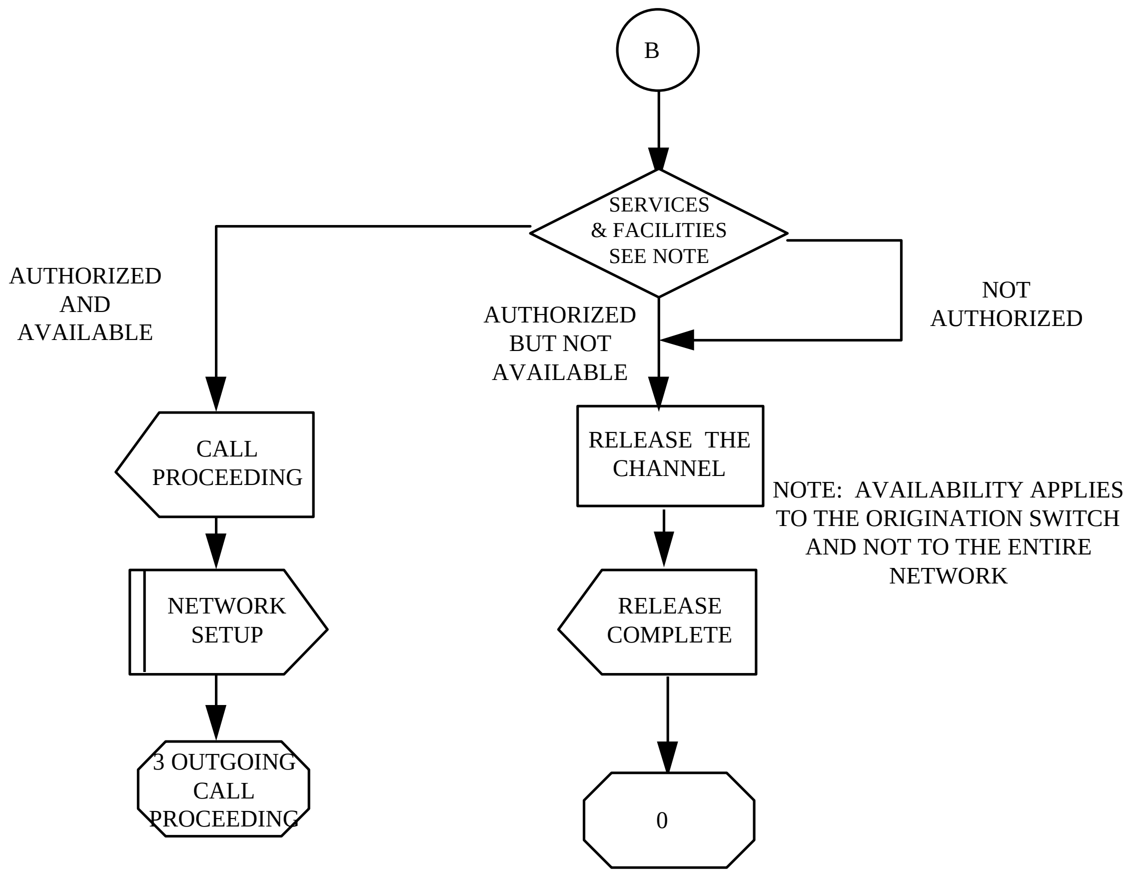


Figure 18. Call Control Detailed SDL Diagrams (Network Side)

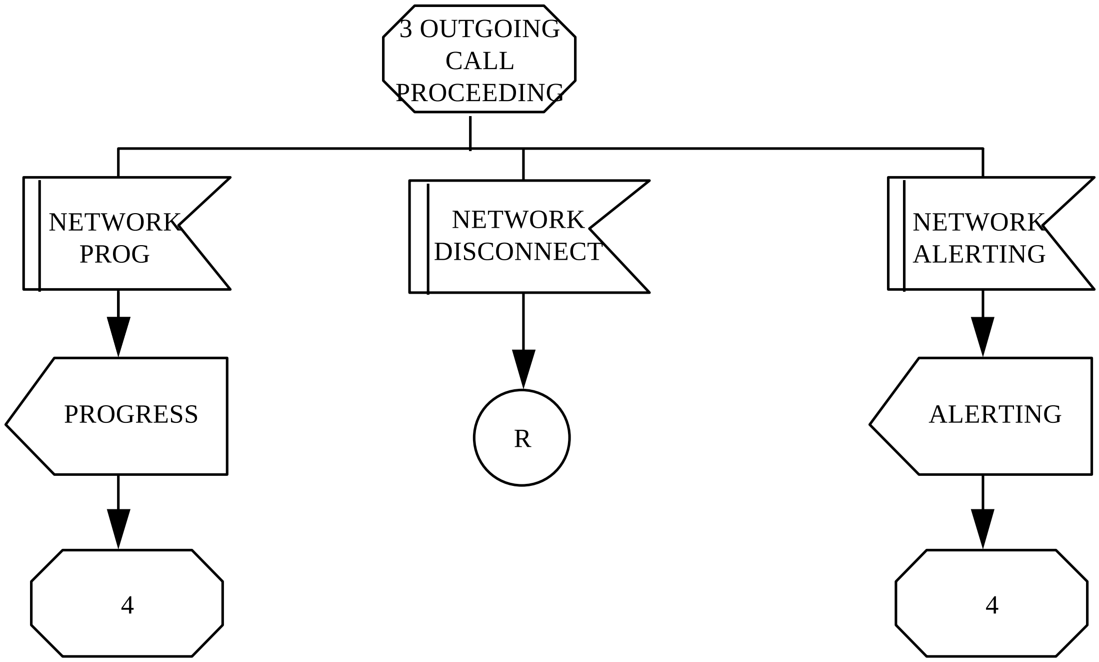


Figure 19. Call Control Detailed SDL Diagrams (Network Side)

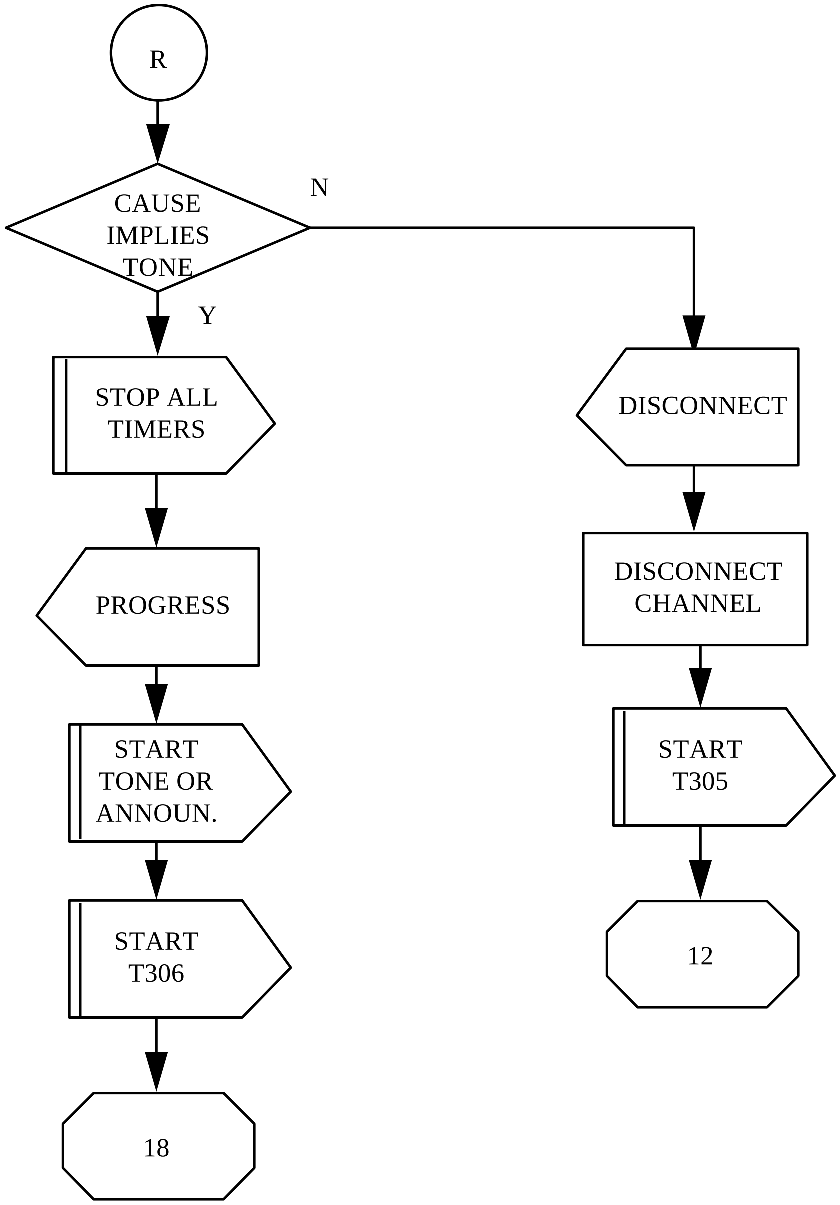


Figure 20. Call Control Detailed SDL Diagrams (Network Side)

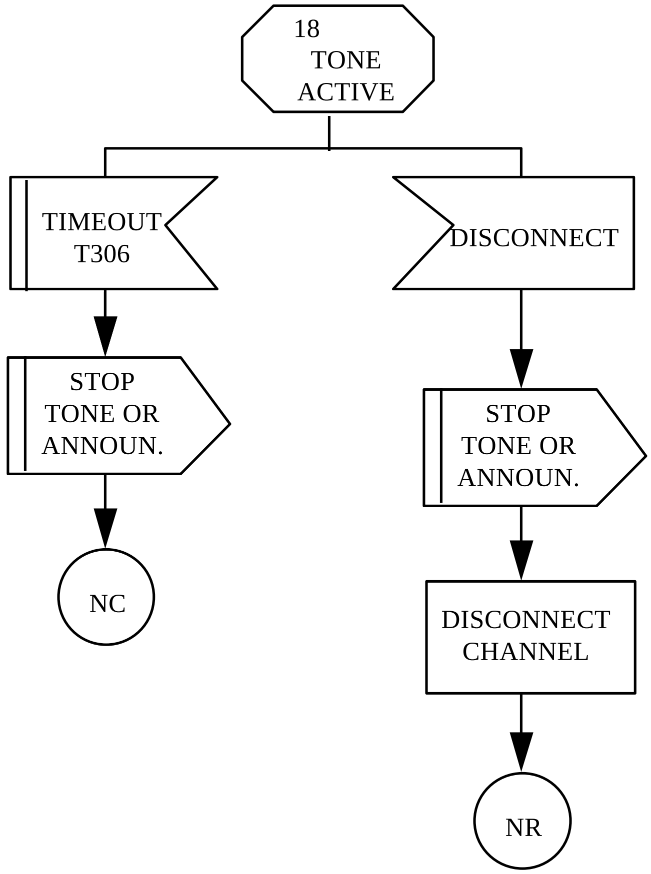


Figure 21. Call Control Detailed SDL Diagrams (Network Side)

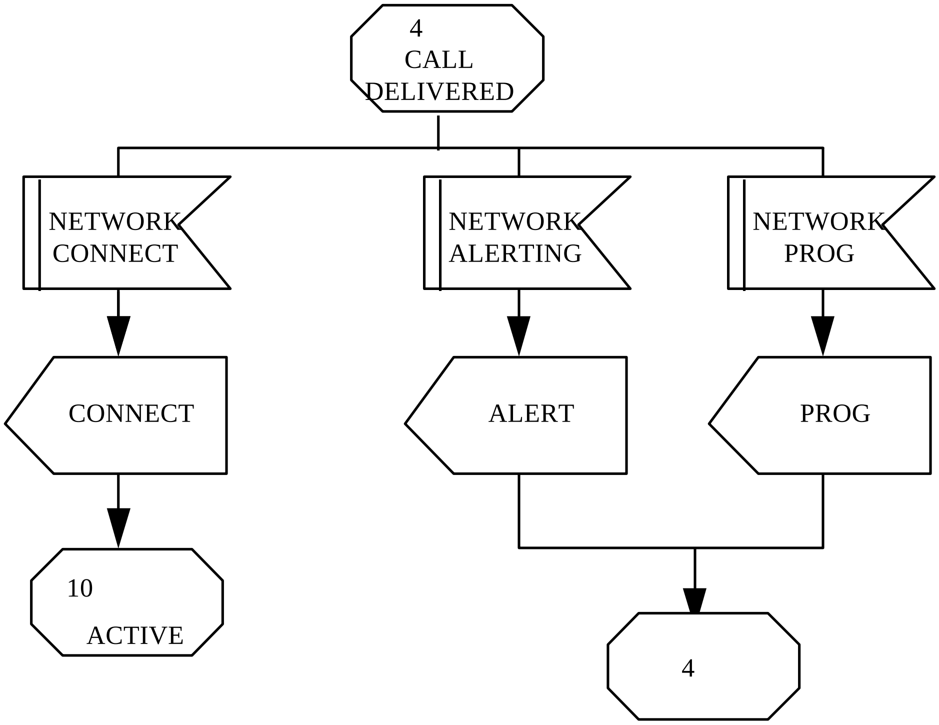
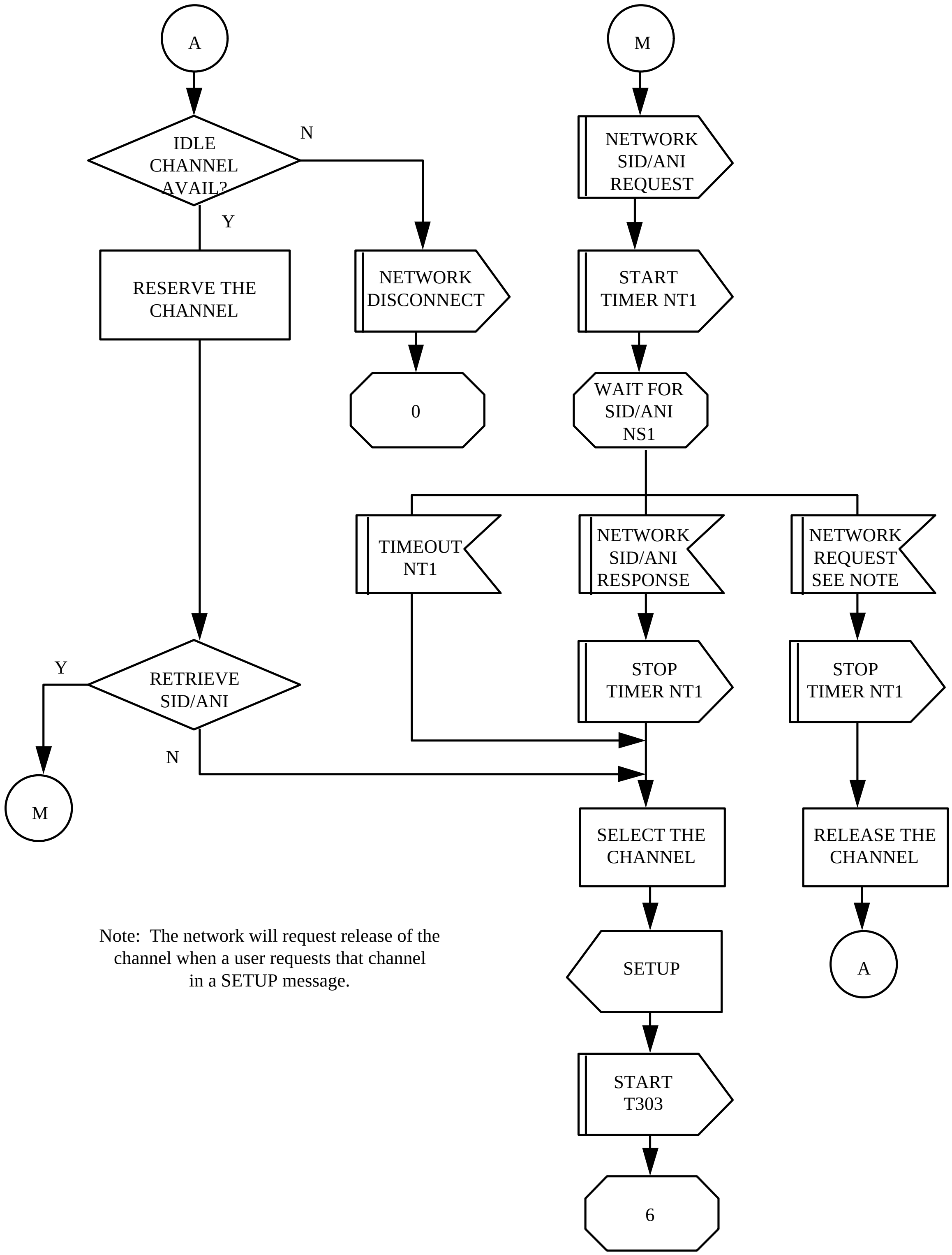


Figure 22. Call Control Detailed SDL Diagrams (Network Side)



Note: The network will request release of the channel when a user requests that channel in a SETUP message.

Figure 23. Call Control Detailed SDL Diagrams (Network Side)

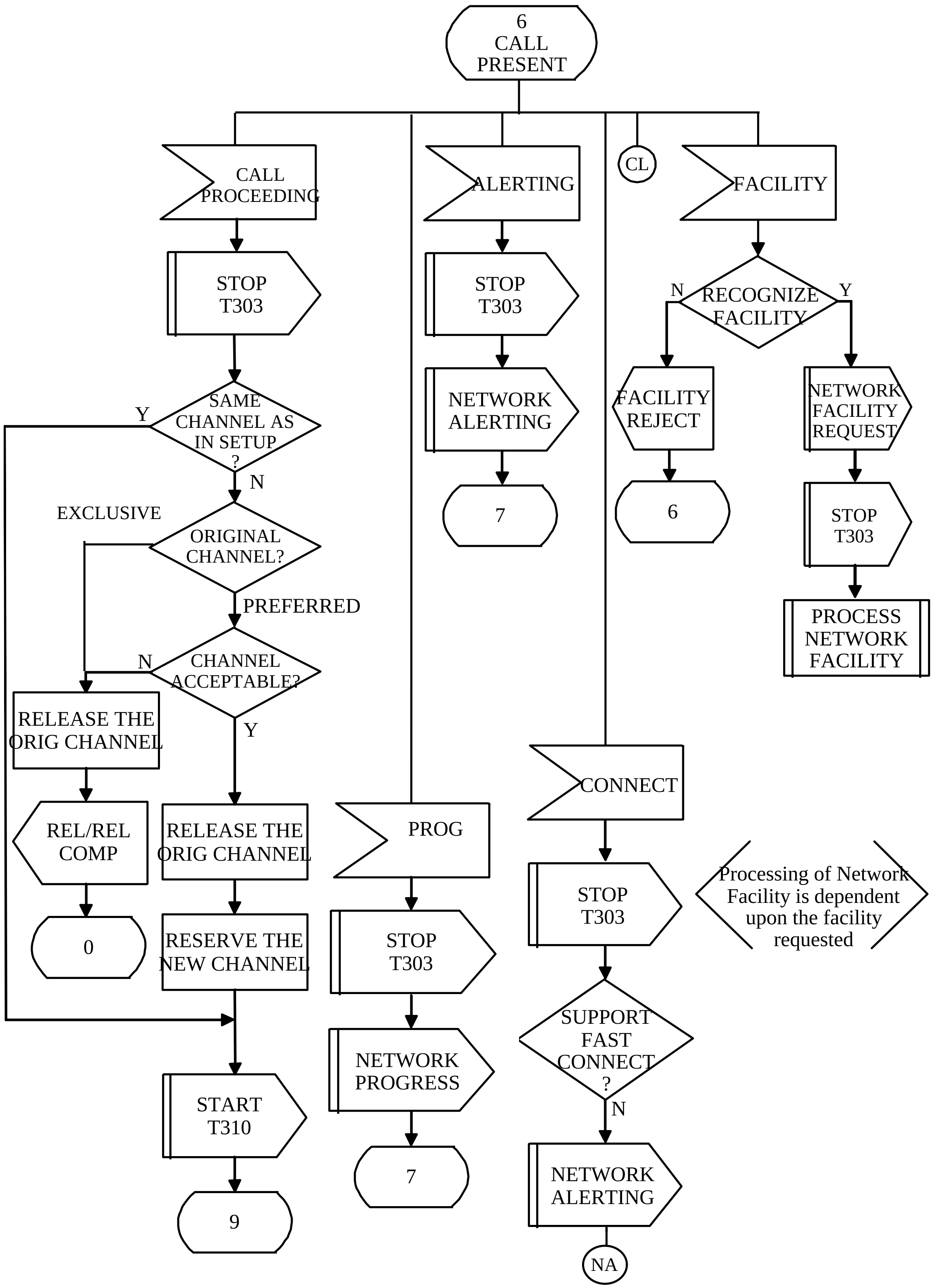


Figure 24. Call Control Detailed SDL Diagrams (Network Side)

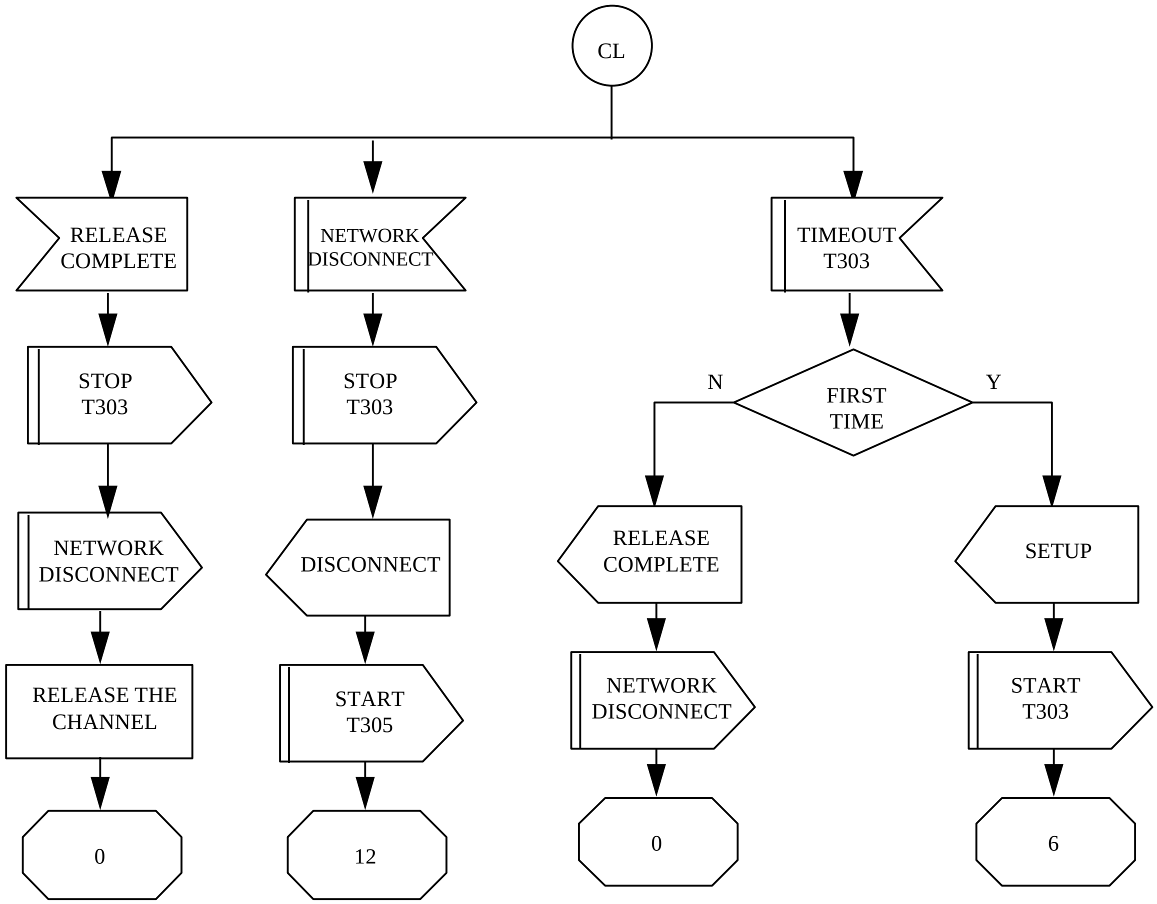


Figure 25. Call Control Detailed SDL Diagrams (Network Side)

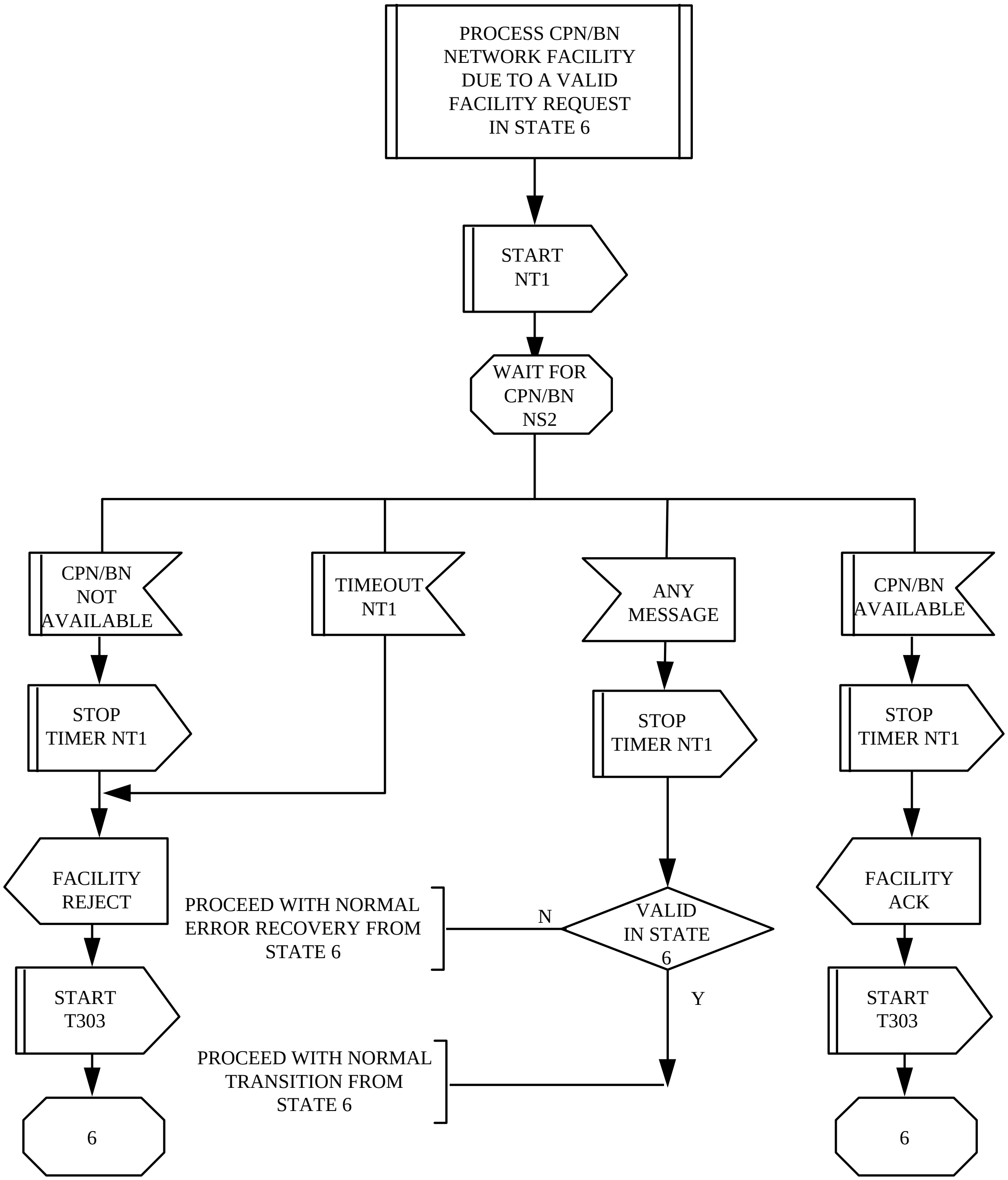
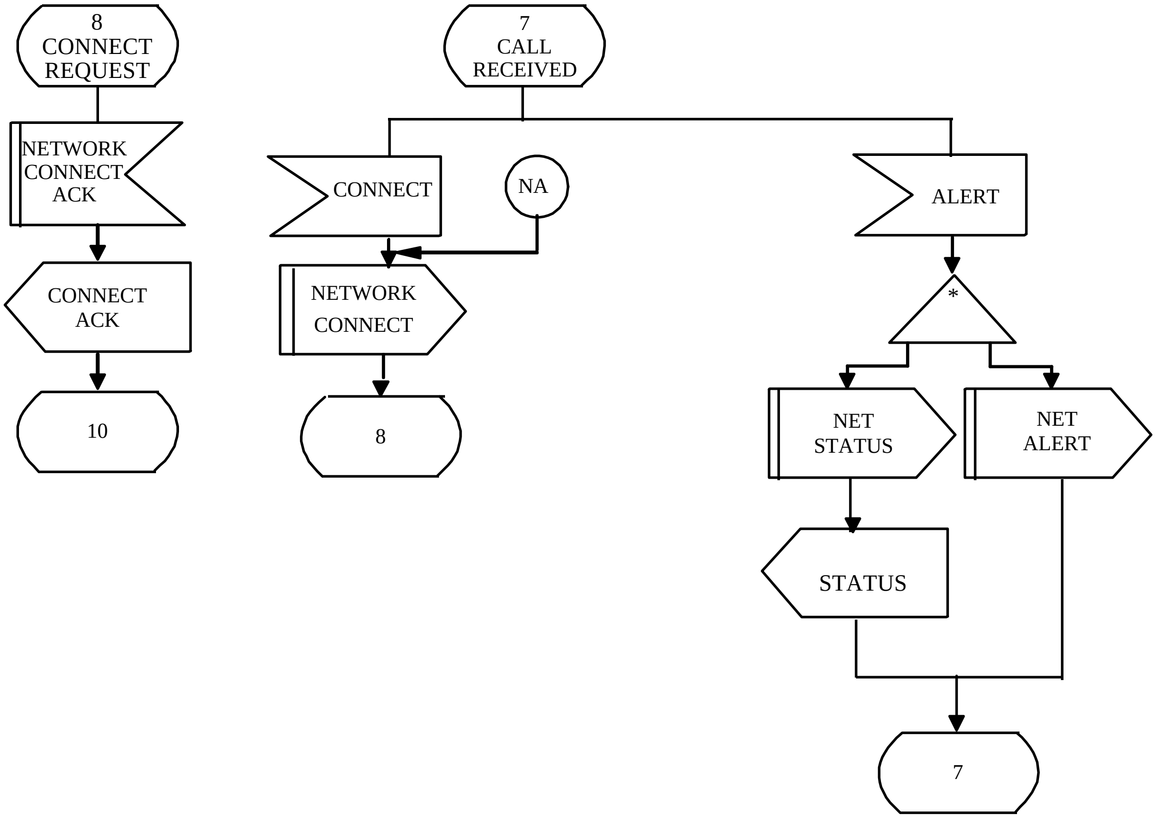


Figure 26. Call Control Detailed SDL Diagrams (Network Side)



* Only one ALERTING message (or PROGRESS message followed by an ALERTING message) will be accepted by the network switch.

Figure 27. Call Control Detailed SDL Diagrams (Network Side)

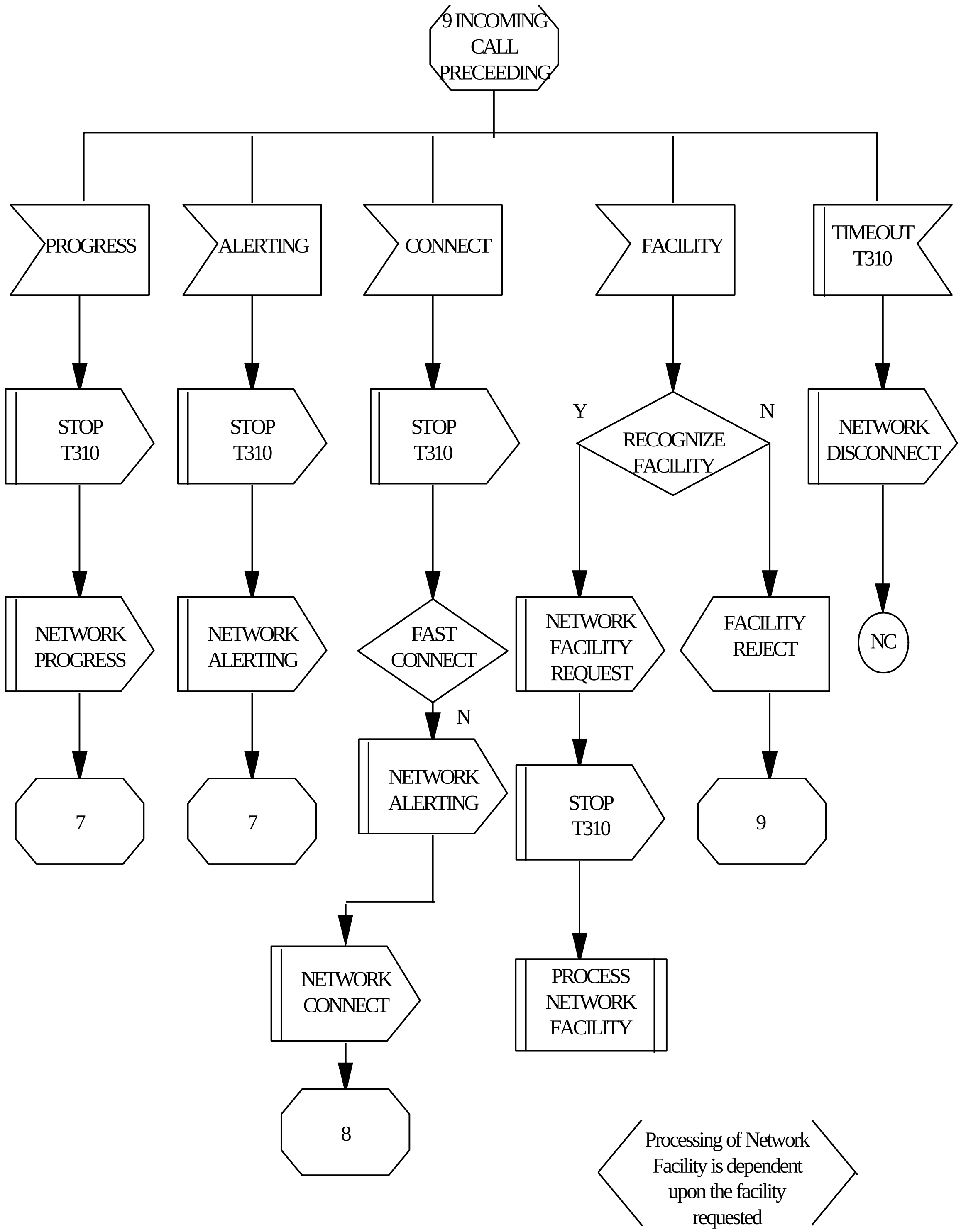


Figure 28. Call Control Detailed SDL Diagrams (Network Side)

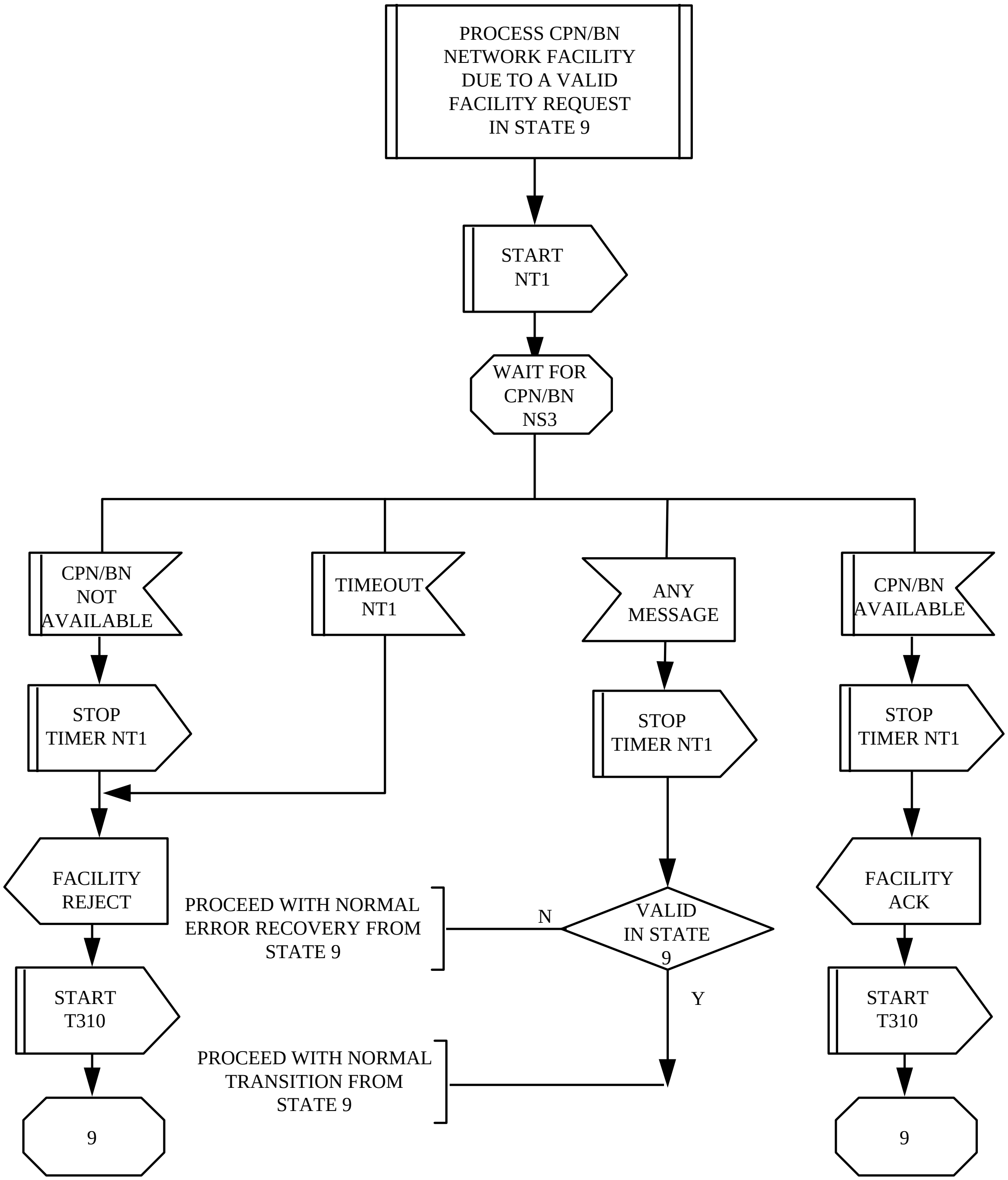


Figure 29. Call Control Detailed SDL Diagrams (Network Side)

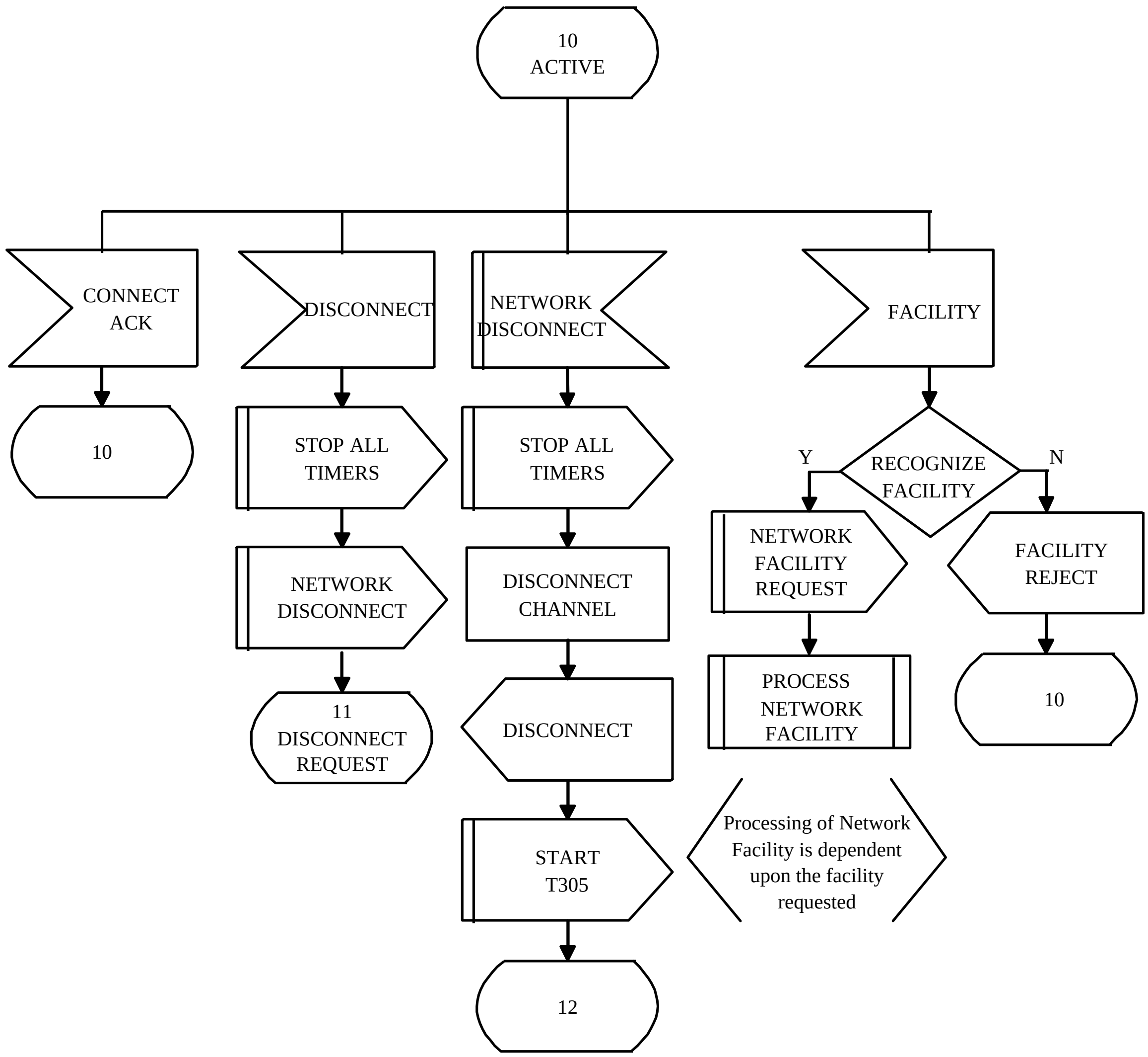


Figure 30. Call Control Detailed SDL Diagrams (Network Side)

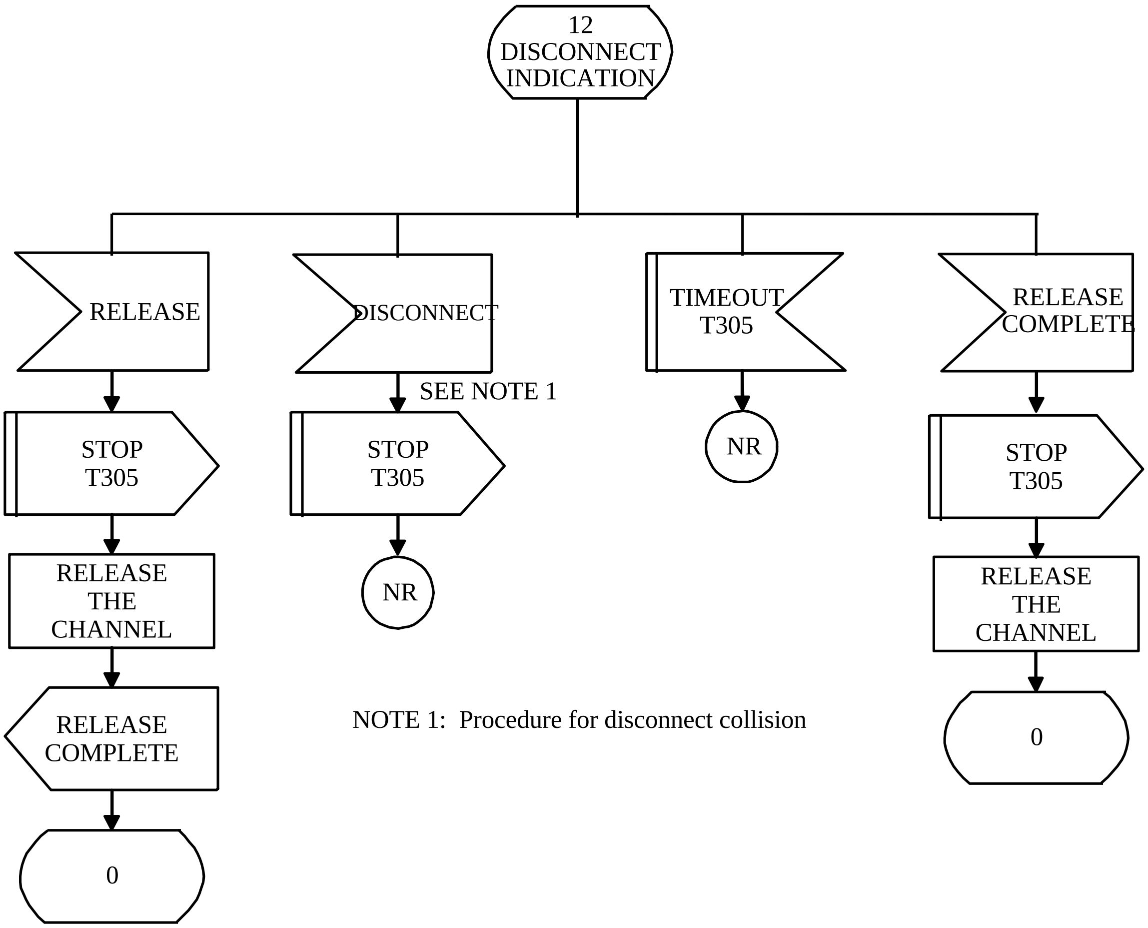


Figure 31. Call Control Detailed SDL Diagrams (Network Side)

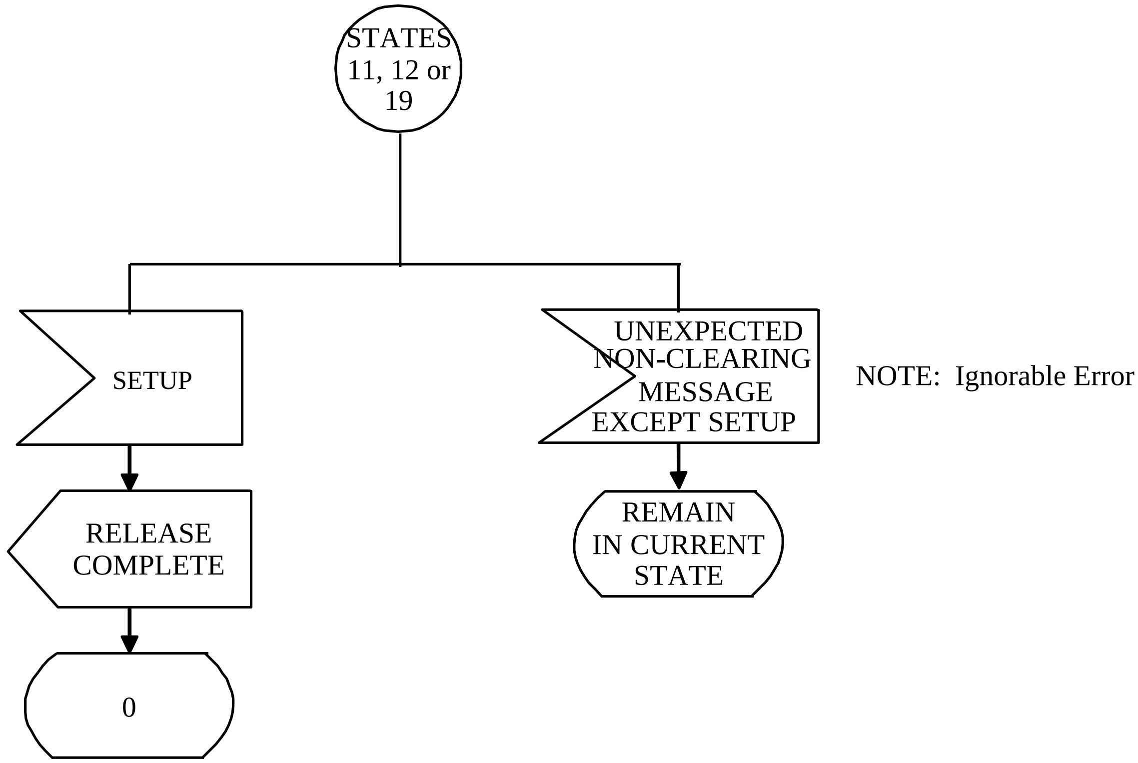


Figure 32. Call Control Detailed SDL Diagrams (Network Side)

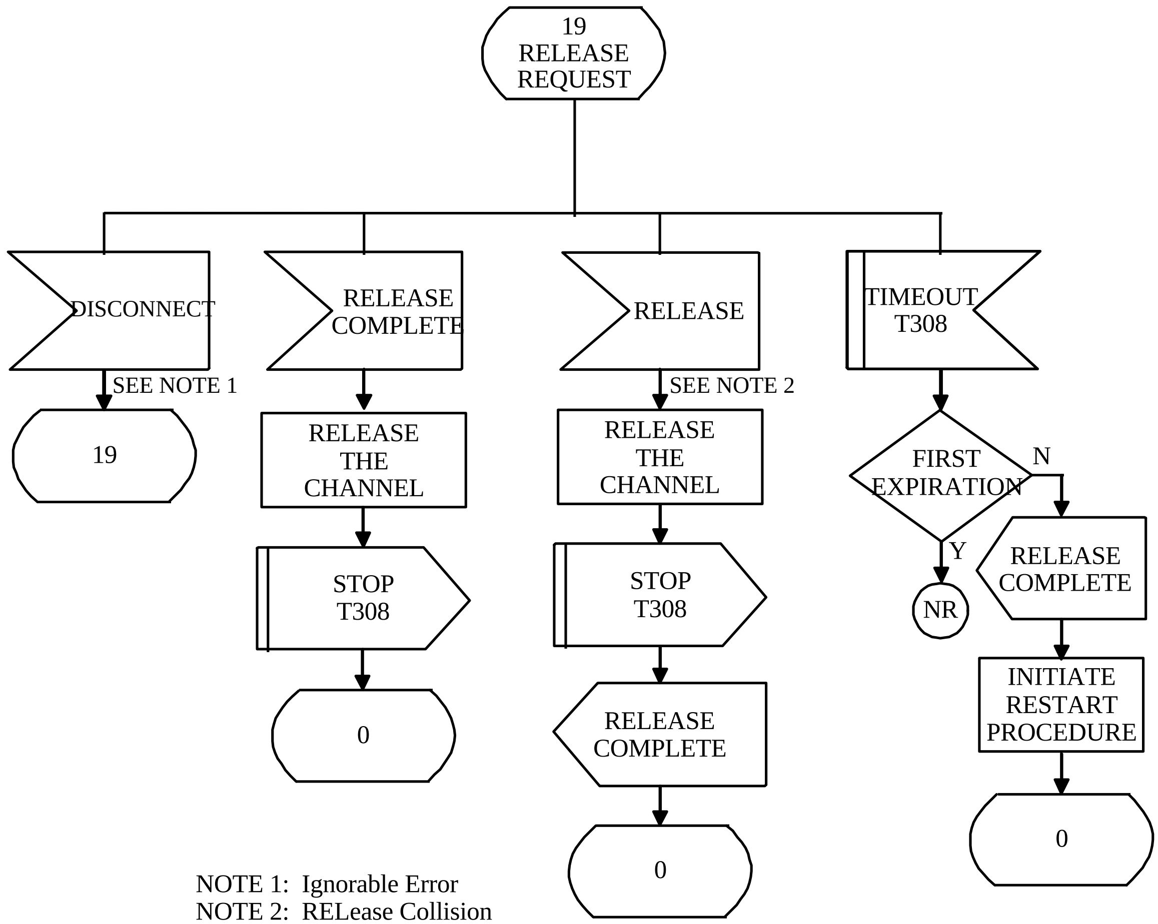


Figure 33. Call Control Detailed SDL Diagrams (Network Side)

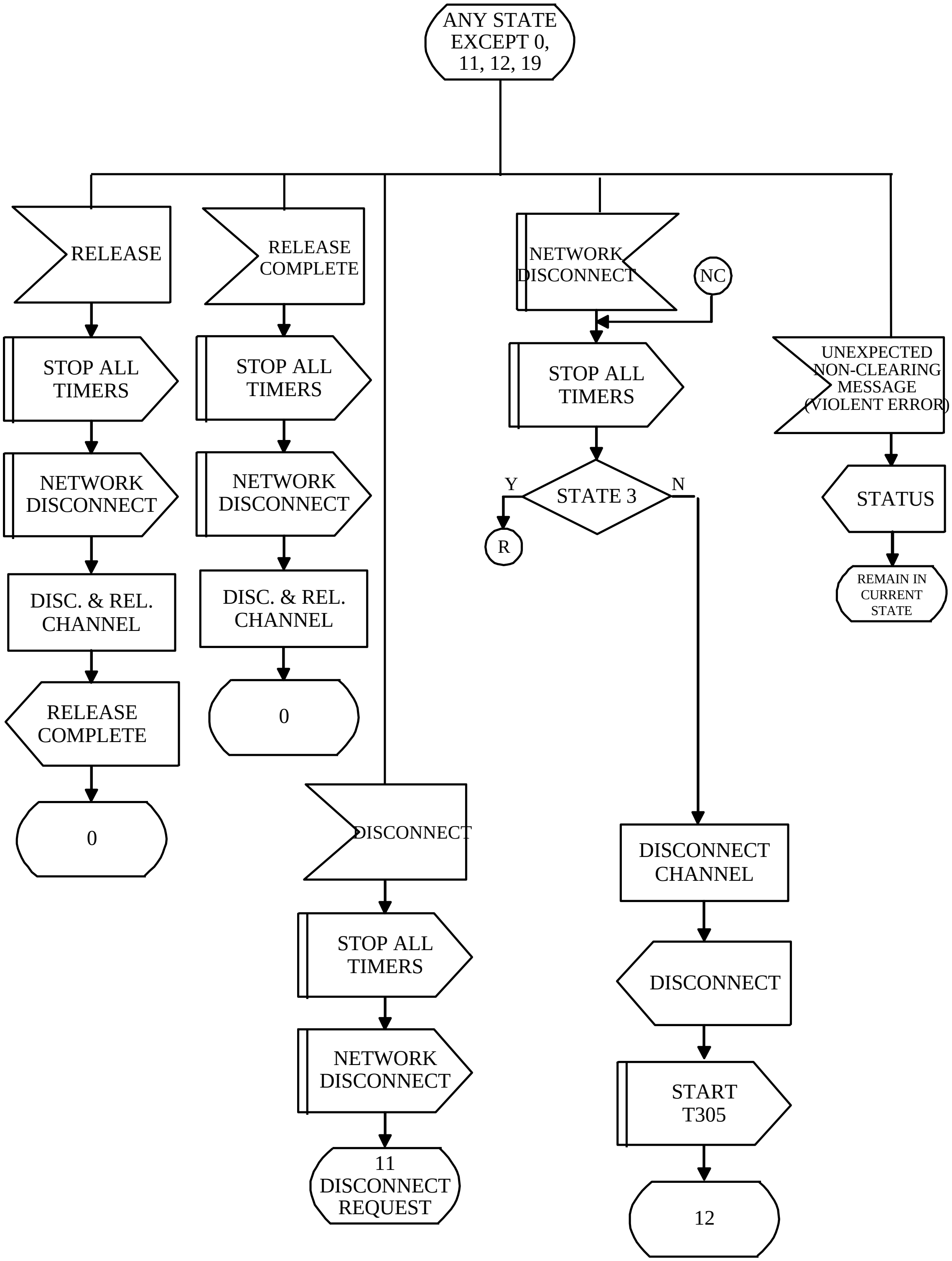


Figure 34. Call Control Detailed SDL Diagrams (Network Side)

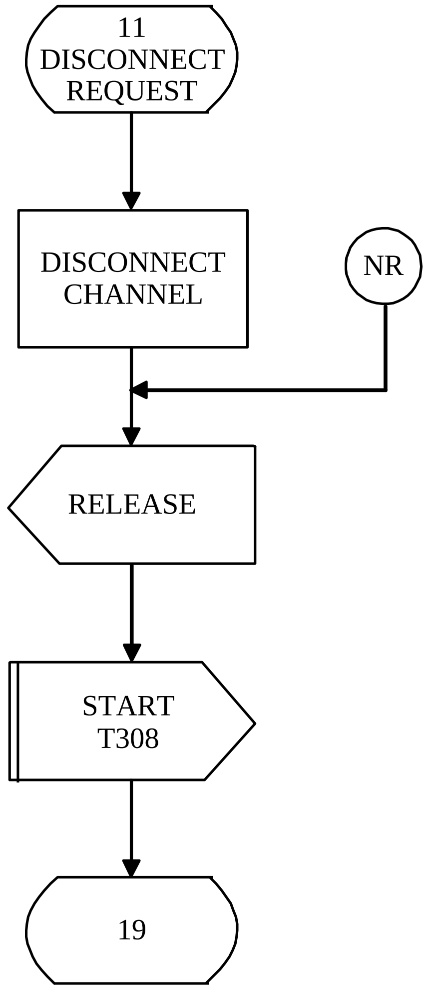


Figure 35. Call Control Detailed SDL Diagrams (Network Side)

Annex B

D-Channel Backup Procedures for Non-Facility Associated Signaling

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 (NFAS)*. Figure 3 is an example of facility associated signaling used on each of the three interfaces between a user (e.g. a PBX) and a Network. Replacing facility associated signaling with non-facility associated signaling on these interfaces results in the example shown in Figure 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 improved by employing a standby D-Channel. The next section describes the backup procedure which is optional for end-points that use non-facility associated signaling.

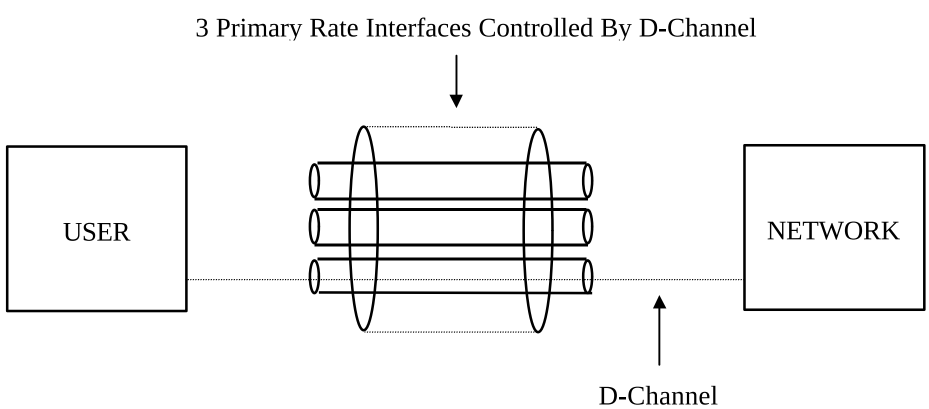


Figure 1. Example of Non-Facility Associated Signaling Controlling 3 Primary Rate Interfaces

2. D-Channel Backup Procedure

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 or standby D-Channel (labeled D2) is present. Figure 2 shows the addition of a secondary (i.e., backup) D-Channel to the arrangement shown in Figure 1.

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 standby 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 D-Channel 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. 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-UUI) and both call-associated and non-call associated Temporary Signaling Connections (TSCs), may be lost.

2.2 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.

2.3 Initialization

In order to avoid unnecessary signaling outages, a primary D-Channel 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, D1 has priority as the channel to carry call-control signaling. If D1 cannot be established, then D2 is chosen.

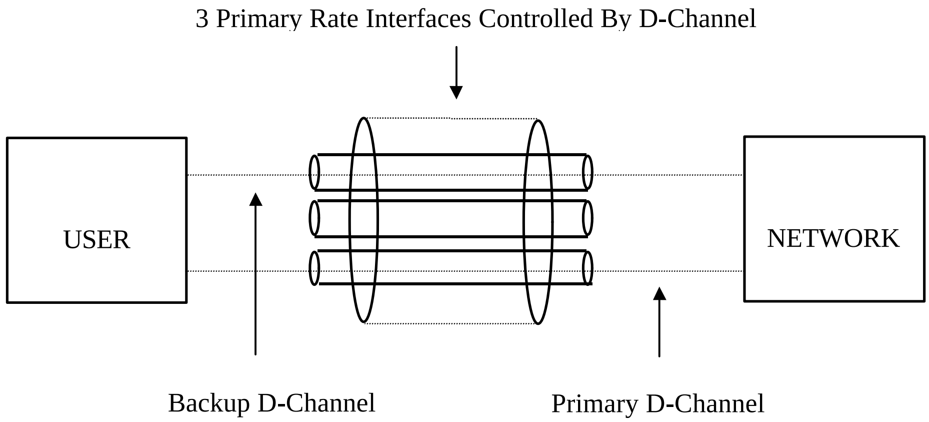


Figure 2. Example of Non-Facility Associated Signaling with Backup D-Channel Controlling 3 PRIs.

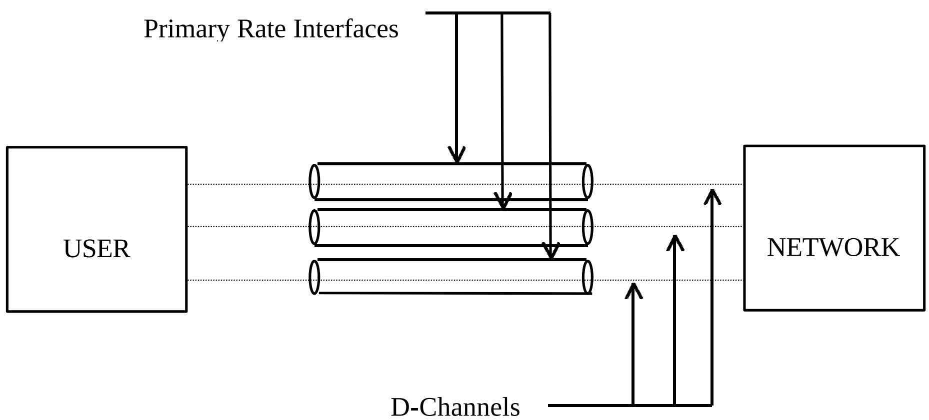


Figure 3. Example of Associated Signaling on Each of Three Primary Rate Interfaces.

3. Definitions and Rules

3.1 D-Channel States

For the purposes of the D-Channel Backup procedure, the following states at layer 3 apply to either D1 or D2:

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[1]. 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.

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 = 8 sec.)). The STBY D-Channel carries only layer 2 audit messages, according to Timer T203 (value = 15 sec.). Please see Figure 7 for a graphical depiction of normal operation on D1 and D2.

3.2 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).

---

1. It is acceptable to ignore a SABME when in Maintenance Busy or Manual Out-of-Service. The preferred method is to respond to a SABME with a DM when in Maintenance Busy or Manual Out-of-Service.

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.

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 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 4.5.

   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 [2].

4. Protocol Description at Layers 2 and 3

This section contains a detailed description of the protocol required to implement D-Channel Backup. Figure 4 shows the state diagrams which augment the text in this section.

For the purposes of the following protocol description, 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.

---

2. Deadlock occurs when the two sides, A and B, do not agree on the D-Channel that 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.

4.1 Switch-over Procedure

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 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 8 A), during normal call control signaling interaction, and
- a period equal to the value of T203 plus eight (8) seconds (see Figure 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 re-establish 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.

4.1.2 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 4.3. 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 multiple-frame-established state, layer 3 shall then follow procedures to establish D2 as IS through layer 3 peer communication, as outlined in Section 4.1.3.

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 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.

4.1.3 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 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 for stable calls are saved by the network, 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.

4.1.4 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.

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.

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 switchover[3].

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.

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.

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.

3. The suggested value of Timer T321 is based on the value of Timer T203 plus 10 seconds.

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.

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 Part III.

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, see Part III.

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 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)
		or	
		[*]Start T321, D2:DL_EST_REQ	*(MB,STBY)
	D2:DL_RLS_IND	D2:DL_EST_REQ	(IS,OOS)
*(MB,STBY)	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	
	D2:Rcv any other layer 3 msg	Ignore	(MB,STBY)
	T321 expires	D1:DL_EST_REQ	(OOS,OOS)

(MB,WAIT)	D2:Rcv SERV(D2=IS)	D2:Send SERV_ACK(D2=IS) D1:DL_EST_REQ	(OOS,IS)
	D2:Rcv SERV_ACK(D2=IS)	D1:DL_EST_REQ	(OOS,IS)
	D2:Rcv any other layer 3 msg	Ignore	(MB,WAIT)
	T321 Expires	D2:DL_RLS_REQ D1:DL_EST_REQ	(OOS,OOS)
	D2:DL_RLS_IND	D1:DL_EST_REQ	(OOS,OOS)
	D2:DL_EST_IND/CON	Ignore	(MB,WAIT)
(IS,OOS)	D2:DL_EST_CON/IND		(IS,STBY)
	D2:DL_RLS_IND	D2:DL_EST_REQ	(IS,OOS)
	D1:DL_RLS_IND	D1:DL_EST_REQ	(OOS,OOS)
(OOS,OOS)	D1:DL_EST_IND/CON	D1:Send SERV(D1=IS) Start T321, D2:DL_DM_RLS	(WAIT,MB)
	D2:DL_EST_IND/CON	D2:Send SERV(D2=IS) Start T321	(OOS,WAIT)
	D1:DL_RLS_IND/CON	D1:DL_EST_REQ	(OOS,OOS)
	D2:DL_RLS_IND/CON	D2:DL_EST_REQ	(OOS,OOS)
(OOS,IS)	D1:DL_EST_CON/IND		(STBY,IS)
	D1:DL_RLS_IND	D1:DL_EST_REQ	(OOS,IS)
	D2:DL_RLS_IND	D2:DL_EST_REQ	(OOS,OOS)
*(STBY,MB)	D1:DL_EST_CON	D1:SEND SERV(D1=IS)	(WAIT,MB)
	D1:DL_RLS_IND	D2:DL_EST_REQ	(OOS,OOS)
	D1:Rcv SERV(D1=IS)	Send SERV_ACK(D1=IS), D2:DL_EST_REQ	(IS,OOS)
	D1:Rcv any other layer 3 msg	Ignore	(STBY,MB)
	T321 expires	D2:DL_EST_REQ	(OOS,OOS)
(STBY,IS)	D2:DL_RLS_IND or XFER_REQ	 D2:DL_DM_RLS Start T321, D1:Send SERV(D1=IS) or [*]Start T321, D1:DL_EST_REQ	 (WAIT,MB) *(STBY,MB)
	D1:DL_RLS_IND	D1:DL_EST_REQ	(OOS,IS)

(WAIT,MB)	D1:Rcv SERV_ACK (D1=IS),	D2:DL_EST_REQ	(IS,OOS)
	D1:Rcv SERV(D1=IS)	D1:Send SERV_ACK(D1=IS),	(IS,OOS)
		D2:DL_EST_REQ	
	D1:Rcv any other layer 3 msg	Ignore	(WAIT,MB)
	T321 Expires	D1:DL_RLS_REQ	(OOS,OOS)
		D2:DL_EST_REQ	
	D1:DL_RLS_IND	D2:DL_EST_REQ	(OOS,OOS)
	D1:DL_EST_IND/CON	Ignore	(WAIT,MB)
(OOS,WAIT)	D2:Rcv SERV(D2=IS)	D2:Send SERV_ACK(D2=IS),	(OOS,IS)
	D2:Rcv SERV_ACK(D2=IS)	D1:DL_EST_REQ	(OOS,IS)
	T321 Expires	D2:DL_RLS_REQ	(OOS,OOS)
	D2:DL_RLS_IND		(OOS,OOS)
	D1:DL_EST_IND/CON	D1:Send SERV(D1=IS)	(WAIT,MB)
		D2:DL_DM_RLS, Start T321	
	D2:Rcv any other layer 3 msg	Ignore	(OOS,WAIT)

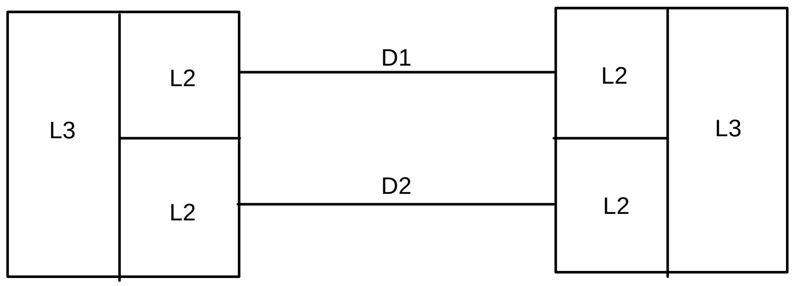


Figure 5. Architecture (Conceptual)

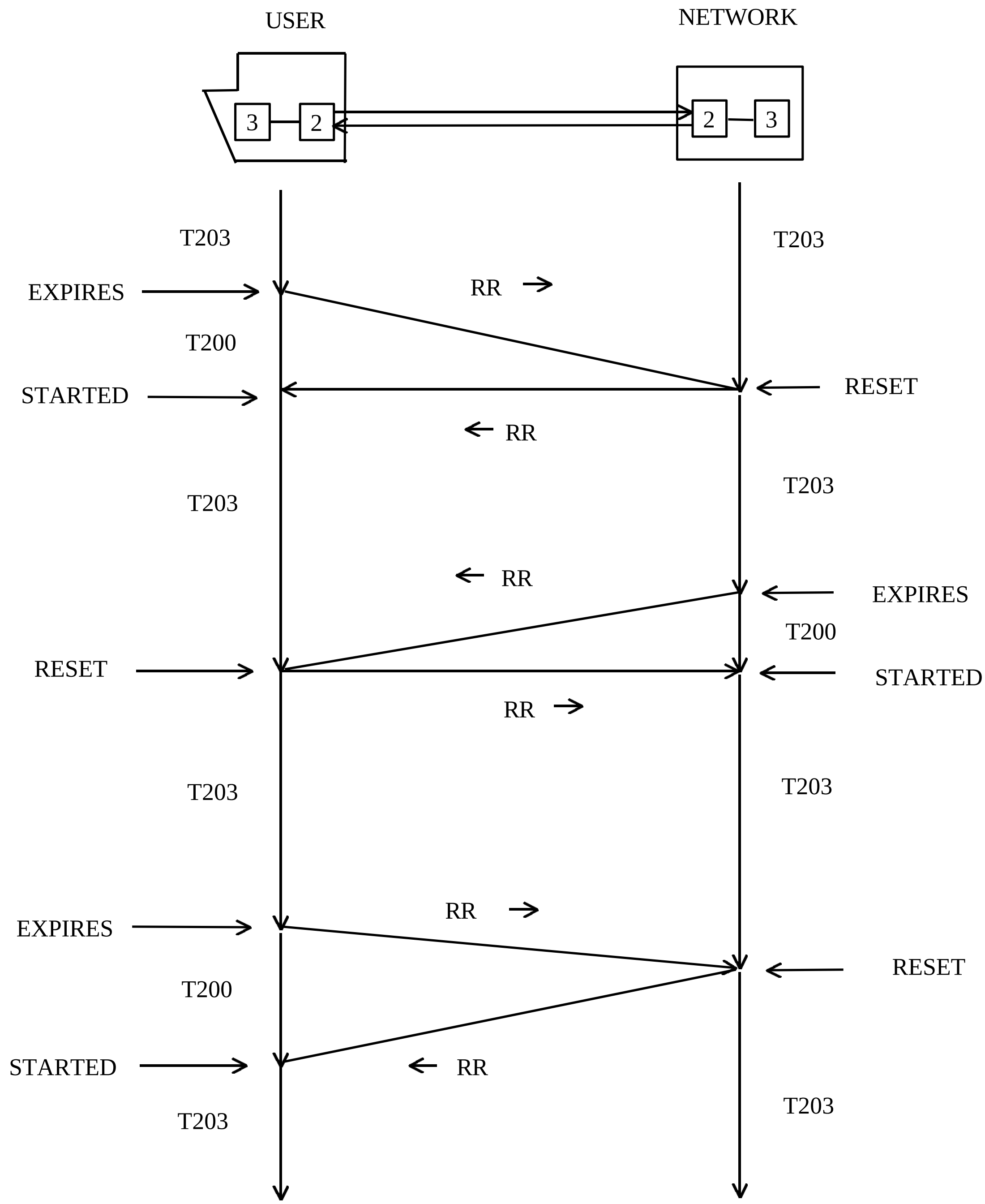


Figure 6. Connection Verification Procedure on D2

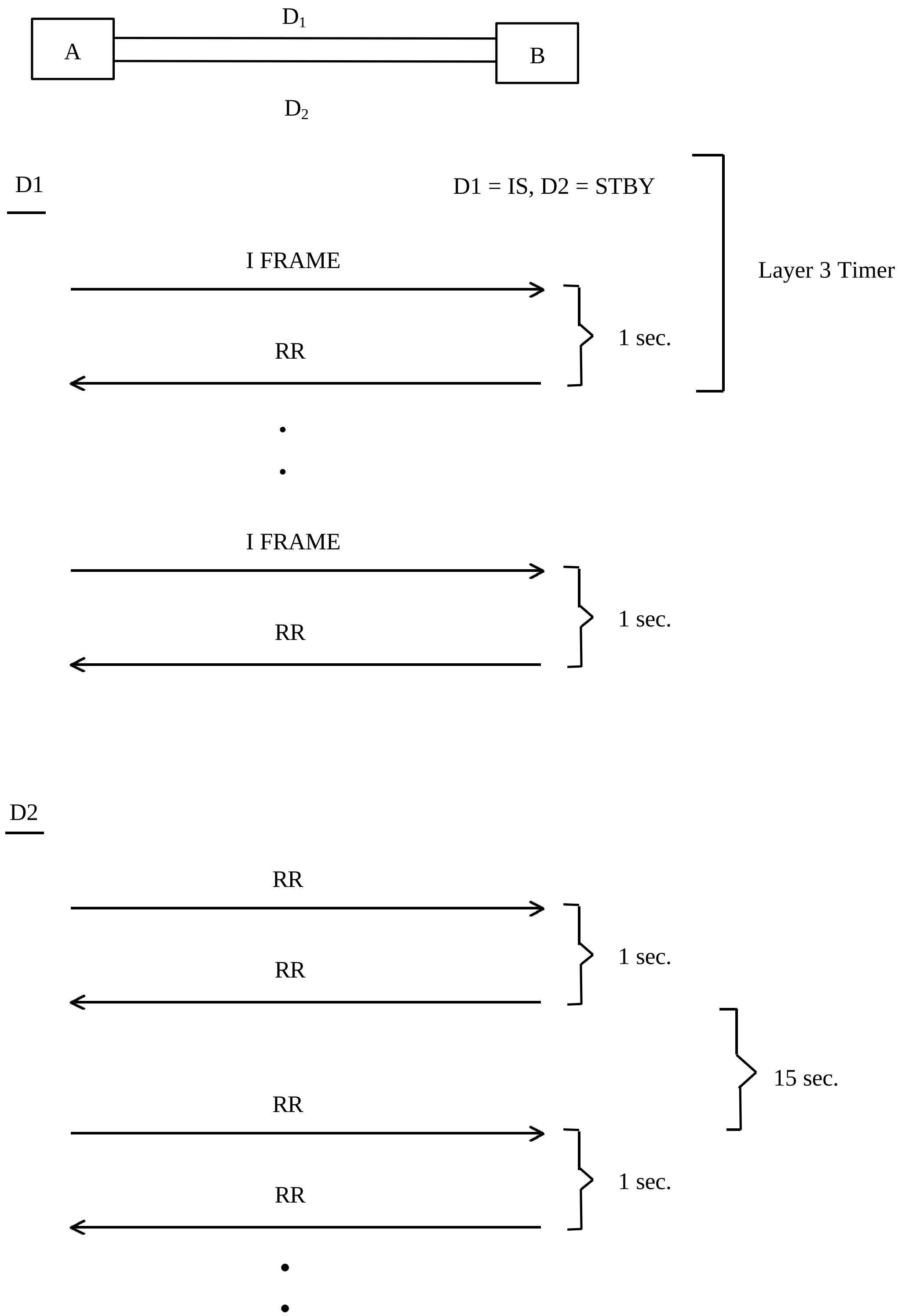
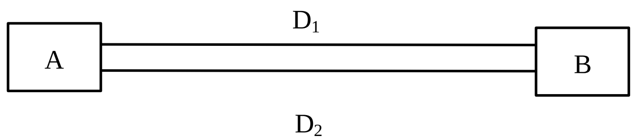


Figure 7. D-Channel Backup - Normal Operation



D1 = IS
D2 = STBY

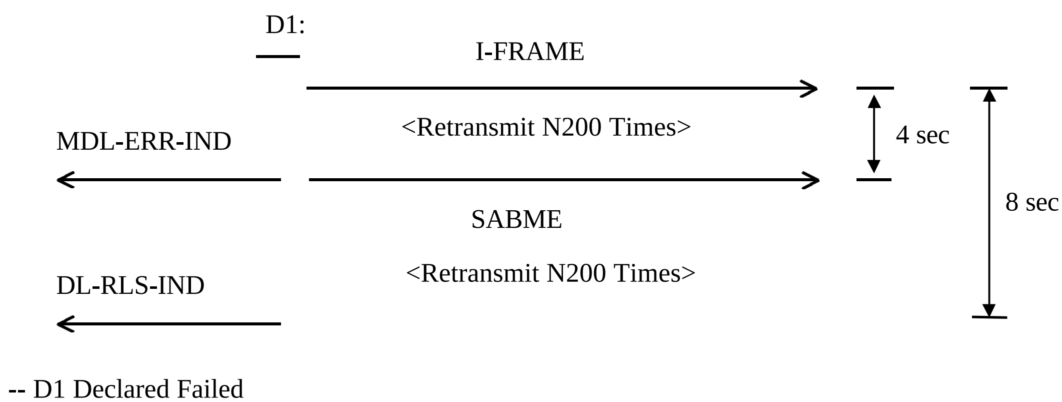


FIGURE A - Normal Call Control Signaling

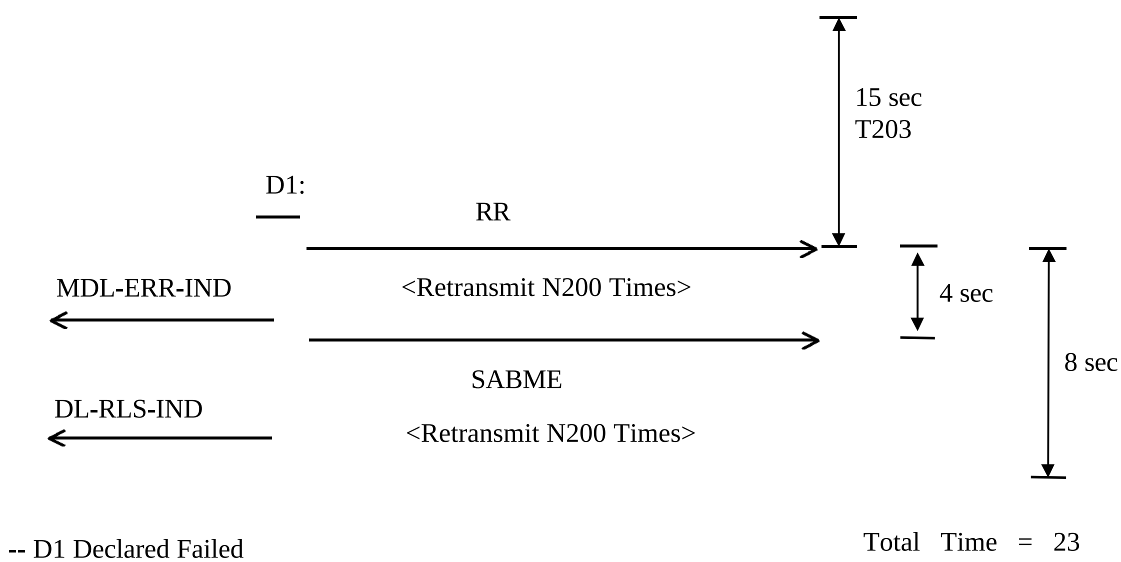


FIGURE B - Idle Call Control Signaling

Figure 8. Declaring a D-Channel as Failed

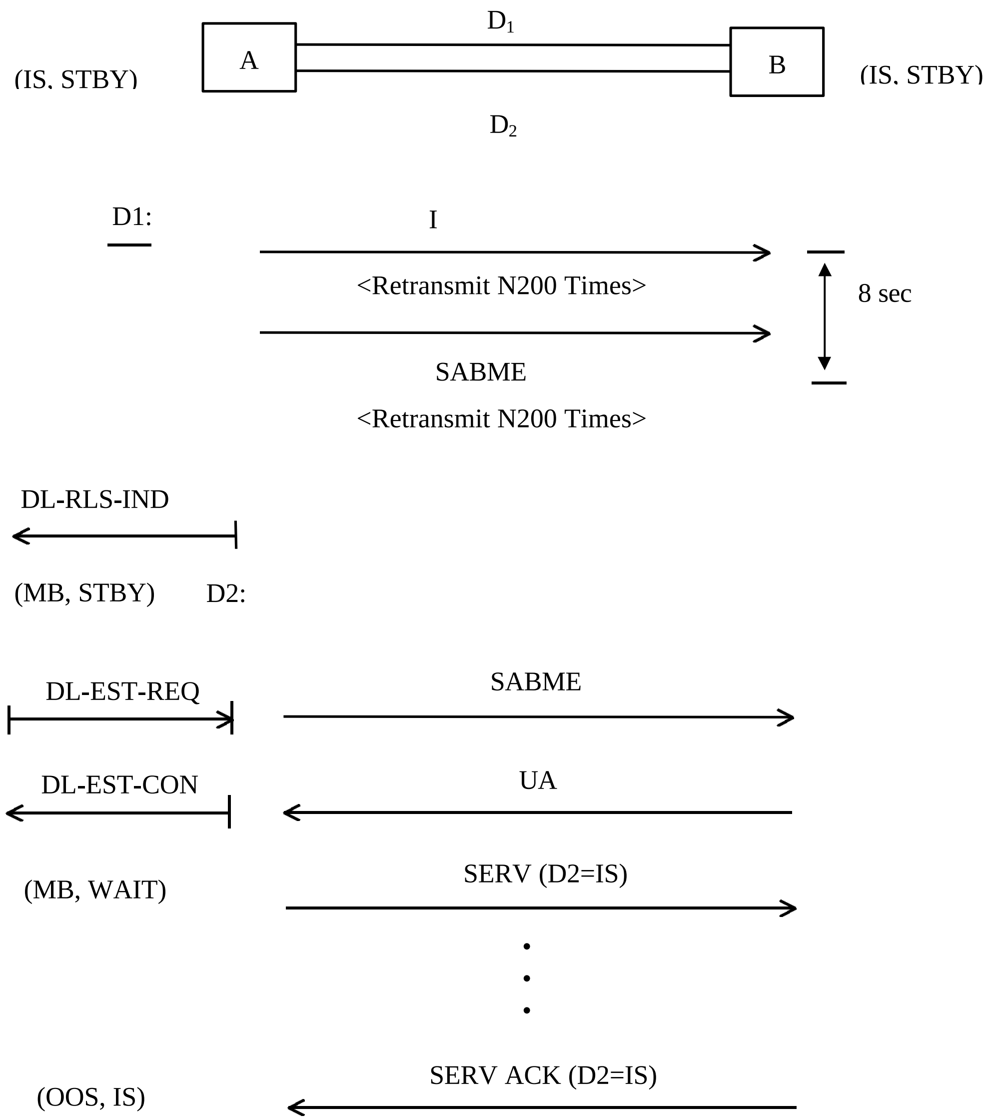


Figure 9. Normal Switch-over

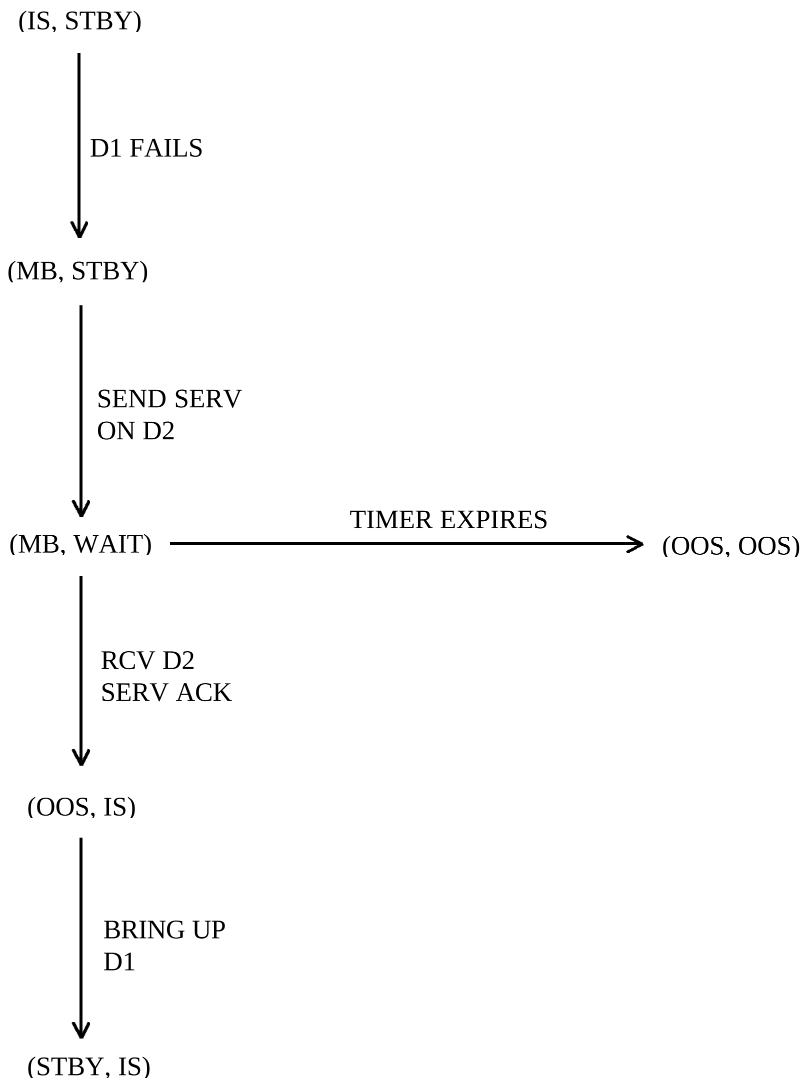


Figure 10. Normal Switch-over

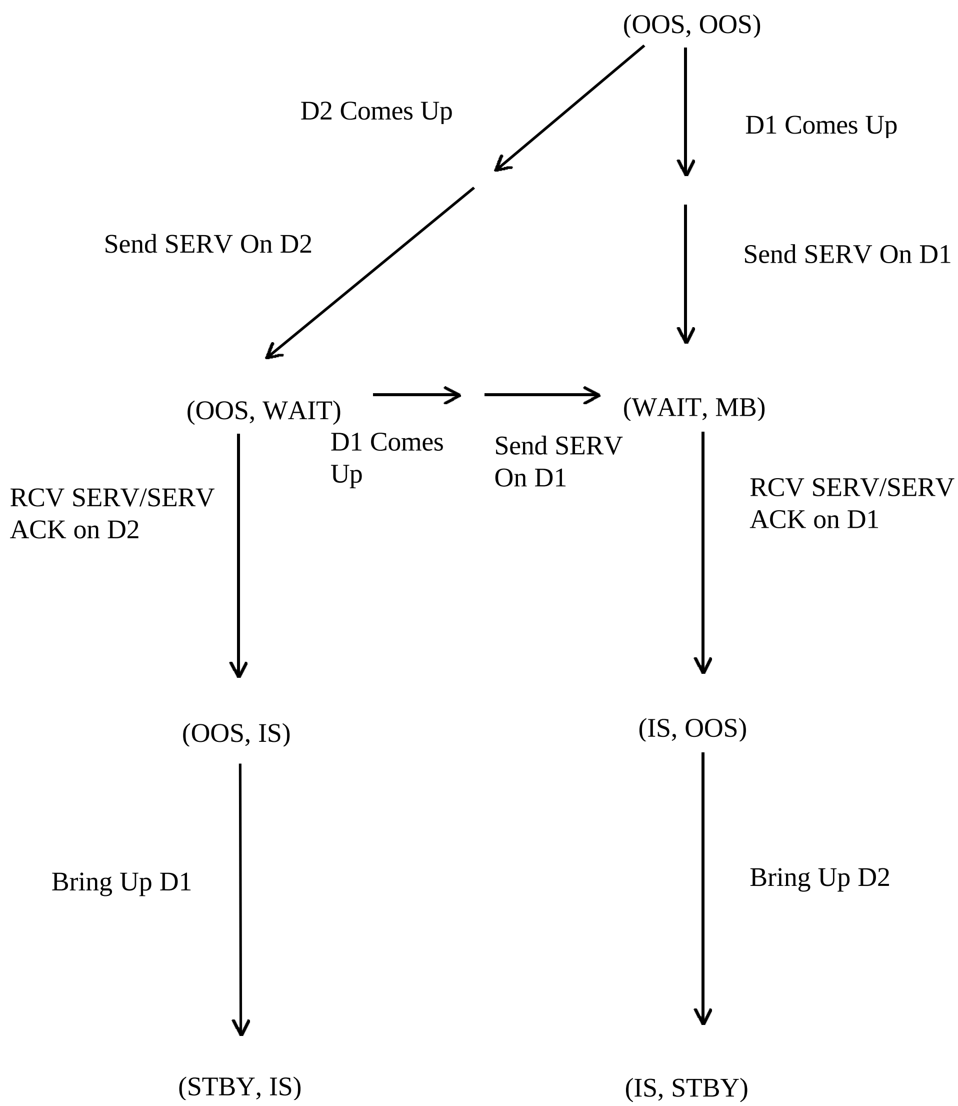


Figure 11. Initialization Procedure

Annex C

Cause Definitions

1. Annex C - Cause Definitions

This annex provides definitions to the causes in Part III.

1.1 Normal class

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).

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.

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.

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.

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).

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.

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.

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.

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.

Cause No. 29 "facility rejected"
This cause is returned when a facility requested by the user can not be provided by the network.

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.

Cause No. 31 "normal, unspecified"
This cause is used to report a normal event only when no other cause in the normal class applies.

1.2 Resource unavailable class

Cause No. 34 "no circuit/channel available"
This cause indicates that there is no appropriate circuit/channel presently available to handle the call.

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.

Cause No. 42 "switching equipment congestion"
This cause indicates that the switching equipment generating this cause is experiencing a period of high traffic.

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.

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.

Cause No. 47 "new destination"
This cause is used to indicate that the original destination is unavailable and to invoke redirection to a new destination.

1.3 Service or option not available class

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.

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.

Cause No. 54 "incoming calls barred"
This cause indicates that the called user will not accept the call delivered in the SETUP message.

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.

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.

1.4 Service or option not implemented class

Cause No. 65 "bearer capability not implemented"
This cause indicates that the equipment sending this cause does not support the bearer capability requested.

Cause No. 66 "channel type not implemented"
This cause indicates that the equipment sending this cause does not support the channel type requested.

Cause No. 69 "requested facility not implemented"
This cause indicates that the equipment sending this cause does not support the requested supplemental service.

1.5 Invalid message (e.g., parameter out of range) class

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.

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.

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.

1.6 Protocol error (e.g., unknown message) class

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.

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.

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.

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.

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.

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.

1.7 Interworking class

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.

Annex D

Examples of information element codings

1. Annex D - Examples of information element codings

This annex gives examples of the detailed coding of the following information elements:

- Bearer capability;
- Channel identification.

1.1 Bearer capability information element

1.1.1 Coding for speech

8	7	6	5	4	3	2	1	
Bearer Capability Information Element Identifier								
0	0	0	0	0	1	0	0	Octet 1
Length								
0	0	0	0	0	0	1	0	Octet 2
1	0	0	0	0	0	0	0	Octet 3
ext	ITU-T		Speech					
1	0	0	1	0	0	0	0	Octet 4
ext	Circuit Mode		64 Kbps					

1.1.2 Coding for 3.1 kHz audio

8	7	6	5	4	3	2	1	
Bearer Capability Information Element Identifier								
0	0	0	0	0	1	0	0	Octet 1
Length								
0	0	0	0	0	0	1	0	Octet 2
1	0	0	1	0	0	0	0	Octet 3
ext	ITU-T		3.1 KHz Audio					
1	0	0	1	0	0	0	0	Octet 4
ext	Circuit Mode		64 Kbps					

1.1.3 Coding for unrestricted digital information

Type 1: Synchronous 64 kbit/s

8	7	6	5	4	3	2	1	
Bearer Capability Information Element Identifier								
0	0	0	0	0	1	0	0	Octet 1
Length								
0	0	0	0	0	0	1	0	Octet 2
1	0	0	0	1	0	0	0	Octet 3
ext	ITU-T		Unrestricted digital information					
1	0	0	1	0	0	0	0	Octet 4
ext	Circuit Mode		64 Kbps					

Type 2: Synchronous rates less than 64 kbit/s with ITU-T standardized rate adaption V.110/X.30; in-band negotiation not possible.

8	7	6	5	4	3	2	1	
Bearer Capability Information Element Identifier								
0	0	0	0	0	1	0	0	Octet 1
Length								
0	0	0	0	0	1	0	0	Octet 2
1	0	0	0	1	0	0	0	Octet 3
ext	ITU-T		Unrestricted digital information					
1	0	0	1	0	0	0	0	Octet 4
ext	Circuit Mode		64 Kbps					
0	0	1	0	0	0	0	1	Octet 5
ext	layer 1		rate adaption					
1	0	0	0	1	1	1	1	Octet 5a
ext	Synch	negot.	User rate (56 Kbps)					

1.1.4

Coding for Non-Call Associated Temporary Signaling Connections (TSCs)

8	7	6	5	4	3	2	1	
Bearer Capability Information Element Identifier								
0	0	0	0	0	1	0	0	Octet 1
Length								
0	0	0	0	0	1	0	0	Octet 2
1	0	0	0	1	0	0	0	Octet 3
ext	ITU-T		Unrestricted digital information					
1	1	0	0	0	0	0	0	Octet 4
ext	Packet Mode		Packet mode					
1	1	0	0	0	0	1	0	Octet 6
ext	layer 2		Q.921					
1	1	1	0	0	0	1	0	Octet 7
ext	layer 3		Q.931					

1.2 Channel identification information element

1.2.1 Primary rate interface, circuit-mode, B-Channel

Example (a)

8	7	6	5	4	3	2	1	
Channel Identification Information Element Identifier								
0	0	0	1	1	0	0	0	Octet 1
Length								
0	0	0	0	0	0	1	1	Octet 2
1	0	1	0	0	0	0	1	Octet 3
ext	Int. ID present	Int. type	Spare	Pref/ Excl	D-CH ID	Ch. sel.		
1	0	0	0	0	0	1	1	Octet 3.2
	Coding standard		No./ Map	Ch. type / Map type				
Ch. number / Slot map								Octet 3.3
0	0	0	0	0	0	0	1	

- 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 (channel 1).

Example (b)

8	7	6	5	4	3	2	1	
Channel Identification Information Element Identifier								
0	0	0	1	1	0	0	0	Octet 1
Length								
0	0	0	0	0	1	0	0	Octet 2
1	1	1	0	0	0	0	1	Octet 3
ext	Int. ID present	Int. type	Spare	Pref/ Excl	D-CH ID	Ch. sel.		
1	0	0	0	0	0	0	1	Octet 3.1
	Interface identifier							
1	0	0	0	0	0	1	1	Octet 3.2
	Coding standard		No./ Map	Ch. type / Map type				
Ch. Number / Slot map								
0	0	0	0	0	0	0	1	Octet 3.3

- Same as (a) except that the channel is located in a different interface than the D-Channel.

1.2.2 Primary rate interface, circuit-mode, H0-channel

Example (a)

8	7	6	5	4	3	2	1	
Channel Identification Information Element Identifier								
0	0	0	1	1	0	0	0	Octet 1
Length								
0	0	0	0	0	1	0	1	Octet 2
1	0	1	0	1	0	0	1	Octet 3
ext	Int. ID present	Int. type	Spare	Pref/ Excl	D-CH ID	Ch. sel.		
1	0	0	1	0	1	1	0	Octet 3.2
	Coding standard		No./ Map	Ch. type / Map type (Note)				
Ch. number / Slot map								Octet 3.3.1
0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	Octet 3.3.2
0	0	1	1	1	1	1	1	Octet 3.3.3

- The channel is an 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 Kbps primary rate system).

Note: The AT&T Network will encode the Channel type/Map element field as H0-Channel units for H0 type calls. The AT&T Network will accept the codings of both B-Channel and H0-Channel units in the Map element type field for H0 calls.

Example (b)

8	7	6	5	4	3	2	1	
Channel Identification Information Element Identifier								
0	0	0	1	1	0	0	0	Octet 1
Length								
0	0	0	0	0	1	1	0	Octet 2
1 ext	1 Int. ID present	1 Int. type	0 Spare	1 Pref/ Excl	0 D-CH ID	0 Ch. sel.	1	Octet 3
1	0 Interface ID	0	0	0	0	0	1	Octet 3.1
1	0 Coding standard	0	1 No./ Map	0 Ch. type / Map type (Note)	1	1	0	Octet 3.2
Ch. number / Slot map								
0	0	0	0	0	0	0	0	Octet 3.3.1
0	0	0	0	1	1	1	1	Octet 3.3.2
1	1	0	0	0	0	0	0	Octet 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 Kbps primary rate interface).
- Otherwise as for (a).

Note: Note: The AT&T Network will encode the Channel type/Map element field as H0-Channel units for H0 type calls. The AT&T Network will accept the codings of both B-Channel and H0-Channel units in the Map element type field for H0 calls.

1.2.3 Coding for 1536K bits/s Calls

8	7	6	5	4	3	2	1	
Channel Identification Information Element Identifier								
0	0	0	1	1	0	0	0	Octet 1
Length								
0	0	0	0	0	0	1	0	Octet 2
1 ext	1 Int. ID present	1 Int. type	0 Spare	1 Pref/ Excl	0 D-Ch ID	0 Ch. sel.	1	Octet 3
1	0 Interface ID	0	0	0	0	1	0	Octet 3.1

- The channel is located in a different interface than the D-Channel.
- Exclusive; only the indicated interface is acceptable.

1.2.4 Coding for Non-Call Associated Temporary Signaling Connections or D-Channel Backup

8	7	6	5	4	3	2	1	
Channel Identification Information Element Identifier								
0	0	0	1	1	0	0	0	Octet 1
Length								
0	0	0	0	0	0	0	1	Octet 2
1	0	1	0	1	1	0	0	Octet 3
ext	Int. ID present	Int. type	Spare	Pref/ Excl	D-Ch ID	Ch. sel.		

- The channel is a D-Channel
- The indicated channel is the only acceptable channel
- The channel is located in the same interface which includes the D-Channel.