Northern Telecom DMS-250

ISDN
Primary Rate Interface (PRI)
User-Network Interface
Specification

ISDN Primary Rate User-Network Interface Specification

This document constitutes the Northern Telecom specification for the Primary Rate Interface (PRI) interface to the DMS-250 ISDN Switching System.

This interface specification is intended for application between the Northern Telecom DMS-250 switch and PBXs designed for Primary Rate Interface.

This specification is based on the Primary Rate Interface (PRI) defined in standards for ISDN access promulgated by the International Telegraph and Telephone Consultative Committee (CCITT) and by the Exchange Carrier Standards Association (ECSA) T1S1 committees. As defined by CCITT and T1S1, the Primary Rate Inteface consists of n * 64 kbps B-channels for voice and data and at least one 64 kbps D-channel for signaling. Two D-channels may be used when the procedures outlined in Annex F "D-channel Backup Procedures" are followed.

This document describes the capabilities provided by the DMS-250 Switching System to support ISDN access, and interworking between ISDN and non-ISDN environments. It also describes various services available on the DMS-250 which can be distributed across the network by Primary Rate Interface.

It is expected this specification will be revised in the future to reflect domestic and international standards as they evolve, and DMS-250 service and feature enhancements. Northern Telecom reserves the right to alter or modify this specification or the equipment to which it relates at any time without notice and without liability.

It is the intent of Northern Telecom to make submissions to standards bodies and adopt domestic and international standards. The contributions currently being discussed at ECSA T1 committees and CCITT study groups will be monitored and incorporated into future programs whenever appropriate.

Notice

This draft specification is provided as a guide for network planners and suppliers of systems and equipment designed to meet the requirements of Northern Telecom's Primary Rate Interface specifications. Northern Telecom reserves the right to revise the contents of this guide for any reason, including, but not limited to, conformity with standards promulgated by any public standards agency, advances in technology, or to reflect changes in requirements of communication networks, systems or applications. The provision of any capabilities described in this document is dependant on certain business decisions, resolution of which may also result in changes to, withdrawal of, or addition to, any or all of the capabilities herein.

This specification is based on the Primary Rate Interface interface designed in standards for ISDN access promulgated by the International Telegraph and Telephone Consultative Committee (CCITT), and by the Exchange Carrier Standards Association (ECSA) T1S1 committees. As defined by CCITT and T1S1, the Primary Rate Interface interface consists of n * 64 kbps B-channels for voice and data, and at least one 64 kbps D-channel for signaling, where two D-channels may be used for redundancy purposes (refer to Annex F).

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1. GENERAL

1.1. Scope

This protocol specification defines the Northern Telecom generic specification for Primary Rate Inteface (PRI) interface to the NT DMS-250 switching system.   The interface specification is intended for applications between Northern Telecom DMS-250 and PBXs designed for Primary Rate Interface.   This DMS-250 specification will maintain a generic approach to reflect features up through BCS.31.   Every attempt has been made to identify development current through BCS32, but no claim is made to the accuracy of this information (specifically noted as "Supported in BCS.32."). Addendums may be provided at a later date to reflect additional BCS up-dates as they occur.

Protocol issues relative to specific networks and service requirements which involve transport of service applications and supplementary service information are not included.   However, references will be made to *Network Profile Supplements that do contain specific protocol issues (encoding) and service applications that are directly related to specific network profile.   Additionally, references may be made to the appropriate MCDN feature specification.to provide further details of supplementary services*

It is expected that this specification will be revised in the future to reflect domestic and international standards as they evolve, and DMS-250 services and feature enhancements.   Northern Telecom reserves the right to alter or modify this specification or the equipment without notice and without liability.

1.2. Background

The messages, procedures and parameter encodings described here are based on those specified in CCITT Recommendation Q.931.   Additional messages, procedures and parameter encodings have been provided in order to satisfy the signaling, requirements of the interface.   This additional signaling functionality has been added in such a way so as to align with the directions being taken in the relevant standardization bodies (i.e., CCITT and T1), where clear directions have been given.

1.3. Conformance

Products claiming conformance to this specification will support all mandatory information elements and procedures specified in sections 2 to 6 of this specification, except those identified with the note "Not supported in BCS.31".   Those items which are identified with the note "Supported in BCS.32" are optional at this time, but conformance to these items is encouraged to avoid discrepencies between products and release BCS.32.

1.4. User-side and Network-side Equipment

To maintain consistency with various standards, the terms 'user-network' and 'user-side' and 'network-side' are also used in this specification.

In any application, the equipment on one side of the interface will be designated the 'network-side' equipment. In the PBX to DMS-250 applications the DMS-250 will be designated the 'network-side' equipment.

2. OVERVIEW OF CALL CONTROL

2.1. Circuit-switched Calls

2.1.1. Call States at the User-side of the Interface

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

2.1.1.1. Null State (U0)

No call exists.

2.1.1.2. Call Initiated (U1)

This call state exists for an outgoing (from the user) call, as a result of user action requesting call establishment.

2.1.1.3. Outgoing Call Proceeding (U3)

This state exists for an outgoing (from the user) call when the network has acknowledged receipt of the information required for the call to proceed and the user is awaiting further network response.

2.1.1.4. Call Delivered (U4)

This state exists for an outgoing (from the user) call, when the network has completed processing the call to the point of receiving alerting from the user-network interface indicated by the called address, or an alternate interface specified either by the called user or the network.

2.1.1.5. Call Present (U6)

This state exists for an incoming (to the user) call after receipt of the SETUP message.

2.1.1.6. Call Received (U7)

This state exists for an incoming (to the user) call when a response/answer from the called user is awaited while alerting.

2.1.1.7. Connect Request (U8)

This state exists for an incoming (to the user) call while awaiting receipt from the network of a connect acknowledgement.

2.1.1.8. Incoming Call Proceeding (U9)

This state exists for an incoming (to the user) call when the user has acknowledged receipt of the information required for the call to proceed and the network is awaiting further user response.

2.1.1.9. Active (U10)

This state exists when a call is in the end-to-end communication mode.

2.1.1.10. Disconnect Request (U11)

This state exists in response to a request by the user to disconnect a call, prior to acknowledgement by the network.

2.1.1.11. Disconnect Indication (U12)

This state exists when the network has indicated disconnect and the user has not yet indicated release.

2.1.1.12. Release Request (U19)

This state exists in response to a release request, prior to acknowledgement by 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 N0)

No call exists.

2.1.2.2. Call Initiated (N1)

This state exists for an outgoing (from the user) call when the network has received a SETUP message.

2.1.2.3. Outgoing Call Proceeding (N3)

This state exists for an outgoing (from the user) call when the network has acknowledged receipt of the information required for the call to proceed, and the user is awaiting further network response.

2.1.2.4. Call Delivered (N4)

This state exists for an outgoing (from the user) call when the network is aware that compatible user equipment exists at the called user interface which can accept the call.

2.1.2.5. Call Present (N6)

This state exists for an incoming (to the user) call when the call has been indicated by the network but the user has not yet responded.

2.1.2.6. Call Received (N7)

This state exists for an incoming call after user equipment has indicated the start of user alerting.

2.1.2.7. Connect Request (N8)

This state exists when an incoming call is awaiting a response to a connect message to the user.

2.1.2.8. Incoming Call Proceeding (N9)

This state exists for an incoming call when the user has acknowledged receipt of the information required for the call to proceed and the network is awaiting further user response.

2.1.2.9. Active (N10)

This state exists when a call is in the end-to-end communication mode.

2.1.2.10. Disconnect Request (N11)

This state exists after a user has indicated disconnect and the network has not yet cleared the connection.

2.1.2.11. Disconnect Indication (N12)

This state exists when the network has indicated disconnect and the user has not yet indicated release.

2.1.2.12. Release Request (N19)

This state exists when the network has initiated the release of a call (that is, release of the B-channel and the call reference) and is awaiting user acknowledgement.

2.2. Circuit-Switched Packet Data

Circuit-switched packet data will be supported in the B-channel. The call states of the previous section are therefore applicable for the establishment of the B-channel connection. Procedures for circuit switched packet data are identical to those of circuit switched data, and references should be made to sections describing circuit switched connections for information.

3   MESSAGE FUNCTIONAL DEFINITIONS

Each definition includes:

a) a brief description of the message direction and use;

b) a table listing the information elements contained in the message. For each information element, the table indicates:

1) the section of this Specification describing the information element,

2) the direction in which it may be sent, i.e., user to network ('u-->n'), network to user ('n-->u') or both,

3) whether inclusion is mandatory ('M') or optional ('O'); some explanatory notes are provided to indicate when optional information elements are required to be included in the message,

4) the length(s), in octets.

The information elements are listed in order of appearance in the message. The relative order of information elements is the same for all message types.

c) further explanatory notes, as necessary.

3.1 Messages for Circuit-Mode Connections

The following table summarizes the messages for circuit-mode connections.

Messages for Circuit-mode Connection

Call establishment messages	Reference
ALERTing	3.1.1
CALL PROCeeding	3.1.2
CONNect	3.1.3
CONNect ACKnowledge	3.1.4
PROGress	3.1.6
SETUP	3.1.11

Call disestablishment messages	
DISConnect	3.1.5
RELease	3.1.7
RELease COMplete	3.1.8
RESTart	3.1.9
RESTart ACKnowledge	3.1.10

Miscellaneous messages
Maintenance messages

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[2] The maintenance messages are currently not supported in CCITT or ANSI standards.

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.

ALERTing Message Content

Message type: ALERTing
Direction: Both

Information Element	Reference	Direction	Type	Length
Protocol Discriminator	4.2	both	M	1
Call Reference	4.3	both	M	2 - 3
Message Type	4.4	both	M	1
Channel Identification	4.5.12	both (Note 1)	O	5 -6
Progress Indicator£	4.5.21	u->n	O	4
Redirecting Number¥	4.5.22	both (Note 2)	O	4 - 16
Redirection Number¥	4.5.23	both (Note 3)	O	4 - 16
User-user Information¥	4.5.26	both (Note 4)	O	3 - 130
Locking Shift Codeset 5¥	4.5.2	both (Note 5)	O	1
Codeset 5 IE's¥	4.5.2	both (Note 5)	O	2 - *
Locking Shift Codeset 6¥	4.5.2	both (Note 6)	O	1
Codeset 6 IE's¥	4.5.2	both (Note 6)	O	2 - *
Locking Shift Codeset 7¥	4.5.2	both (Note 7)	O	1
Codeset 7 IE's¥	4.5.2	both (Note 7)	O	2 - *

Note 1- CHANNEL IDENTIFICATION is mandatory if it is the first message in response to SETUP.

Note 2- REDIRECTING NUMBER is included if the call has been redirected and the address of the terminal that redirected the call is known.

Note 3- REDIRECTION NUMBER is included if the call has been redirected and the address of the terminal to which the call has been redirected is known.

Note 4- USER-USER INFORMATION is included in the user-to-network direction when the called user wishes to return user information to the calling user. User-user information is included in the network-to-user direction if the called user included user information in the ALERTing message.

Note 5- Locking shift to codeset 5 provides for the national-standard inormation elements, which are defined by North American standard T1.607. Support of codeset 5 IE's are a network-dependant implementation.

£ This is supported in BCS.32.

¥ This is not supported in BCS.32.

Note 6- Locking shift to codeset 6 provides for network-specific information elements, which are defined by the network profile supplement of NIS A211-4. Support of codeset 6 IE's are a network-dependant implementation.

Note 7- Locking shift to codeset 7 provides for user-specific information elements, which are defined by the individual CPE manufacturer. Support of codeset 7 IE's are a network-dependant implementation.

3.1.2 CALL PROCeeding

This message is sent to indicate that the requested call establishment has been initiated, and no more call establishment information will be accepted.

<p align="center">CALL PROCeeding Message Content</p>

Message type: CALL PROCeeding
Direction: Both

Information Element	Reference	Direction	Type	Length
Protocol Discriminator	4.2	both	M	1
Call Reference	4.3	both	M	2 - 3
Message Type	4.4	both	M	1
Channel Identification	4.5.12	both	M	5 - 6
Progress Indicator£	4.5.21	u->n	O	4

3.1.3 CONNect

This message is sent by the called user to the network and by the network to the calling user to indicate call acceptance by the called user.

<p align="center">CONNect Message Content</p>

Message type: CONNect
Direction: Both

Information Element	Reference	Direction	Type	Length
Protocol Discriminator	4.2	both	M	1
Call Reference	4.3	both	M	2 - 3
Message Type	4.4	both	M	1
Channel Identification	4.5.12	both (Note 1)	O	5 - 6
Connected Number¥	4.5.13	both (Note 2)	O	4 - 16
User-user Information¥	4.5.26	both (Note 3)	O	3 - 130

£ This is supported in BCS.32.

¥ This is not supported for BCS.32.

Note 1- CHANNEL IDENTIFICATION is mandatory if it is the first message in response to SETUP.

Note 2- CONNECTED NUMBER must be included if the connected number is known and is different from the original Called Party Number.

Note 3- USER-USER INFORMATION is included in the user-to-network direction when the answering user wishes to return user information to the call originator. User-user information is delivered by the network when the called user submitted user-user information in its CONNect message.

3.1.4 CONNect ACKnowledge

This message is sent by the network to the called user and may also, optionally, be sent by the calling user to the network.

CONNect ACKnowledge Message Content

Message type: CONNect ACKnowledge
Direction: Both

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

3.1.5 DISConnect

This message is sent by either the user or the network as an invitation to release the channel and call reference. The channel and call reference are still retained at this time.

DISConnect Message Contents

Message type: DISConnect
Direction: Both

Information Element	Reference	Direction	Type	Length
Protocol Discriminator	4.2	both	M	1
Call Reference	4.3	both	M	2 - 3
Message Type	4.4	both	M	1
Cause	4.5.10	both (Note 1)	O	4 - 6
User-user Information¥	4.5.26	both (Note 2)	O	3 -130

Note 1- CAUSE is optional only in the sense that if it is missing or truncated or having invalid contents, then the actions taken shall be the same as if a

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¥ This is not supported for BCS.32.

DISConnect message with cause value # 31, "normal, unspecified" was received.

Note 2- USER-USER INFORMATION is included in the user-to-network direction when the user which initiates clearing of the call wishes to pass user information to the remote user at call clearing time.

3.1.6 PROGress

This message is sent from the network or the user to indicate the progress of a call.

PROGress Message Content

Message type: PROGress
Direction: Both

Information Element	Reference	Direction	Type	Length
Protocol Discriminator	4.2	both	M	1
Call Reference	4.3	both	M	2 - 3
Message Type	4.4	both	M	1
Cause	4.5.10	both (Note 1)	O	4 - 6
Progress Indicator	4.5.21	both	M	4
User-user Information¥	4.5.26	both (Note 2)	O	3 -130

Note 1- *CAUSE is supplied when there is in-band treatment applied to the call and there is a cause which corresponds to that in-band treatment; otherwise, it is not included.*

Note 2- *USER-USER INFORMATION is included in the user-to-network direction when the user which initiates clearing of the call wishes to pass user information to the remote user at call clearing time.*

¥ This is not supported for BCS.32.

3.1.7 RELease

This message is sent, from either the user or the network, to indicate that the equipment sending the message has disconnected the channel and intends to release the call reference, and that the receiving equipment should release the channel and call reference and abort any call with that call reference in the process of being setup.

RELease Message Contents

Message type: RELease
Direction: Both

Information Element	Reference	Direction	Type	Length
Protocol Discriminator	4.2	both	M	1
Call Reference	4.3	both	M	2 - 3
Message Type	4.4	both	M	1
Cause	4.5.10	both (Note 1)	O	4 - 6
User-user Information¥	4.5.26	both (Note 2)	O	3 -130

Note 1- CAUSE is mandatory if this is the first clearing message; otherwise, it is not included. If this is the first clearing message and the cause is missing, truncated or invalid then the actions taken shall be the same as if a RELease message with a cause value #96, "mandatory information element is missing" is sent.

Note 2- USER-USER INFORMATION is included in the user-to-network direction when the user which initiates clearing of the call wishes to pass user information to the remote user at call clearing time.

¥ This is not supported for BCS.32.

3.1.8 RELease COMPlete

This message is sent, from either the user or the network, to indicate that the equipment sending the message has released the channel and call reference, the channel is available for reuse, and the receiving equipment shall release the channel and call reference.

RELease COMplete Message Contents

Message type: RELease COMplete
Direction: Both

Information Element	Reference	Direction	Type	Length
Protocol Discriminator	4.2	both	M	1
Call Reference	4.3	both	M	2 - 3
Message Type	4.4	both	M	1
Cause	4.5.10	both (Note 1)	O	4 - 6
User-user Information¥	4.5.26	both (Note 2)	O	3 -130

Note 1- *CAUSE is mandatory if this is the first clearing message; otherwise, it is not included. If this is the first clearing message and the cause is missing, truncated or invalid then the actions taken shall be the same as if a RELease message with cause value #96, "mandatory information element is missing" is sent.*

Note 2- *USER-USER INFORMATION is included in the user-to-network direction when the user which initiates clearing of the call wishes to pass user information to the remote user at call clearing time.*

¥ This is not supported for BCS.32.

3.1.9 RESTart

This message is sent from one side of the interface to the other to request the recipient to restart (i.e., return to an idle condition) the indicated B-channel or interface. The RESTart message is of local significance and uses the global call reference defined in Section 4.3.

RESTart Message Contents

Message type: RESTart
Direction: Both

Information Element	Reference	Direction	Type	Length
Protocol Discriminator	4.2	both	M	1
Call Reference	4.3	both	M	2 - 3
Message Type	4.4	both	M	1
Channel Identification	4.5.12	both (Note 1)	O	5 - 6
Restart Indicator	4.5.24	both	M	3

Note 1- CHANNEL IDENTIFICATION is mandatory only if a single channel or a single interface (e.g., nB+D) controlled by a D-channel is to be restarted. If all the channels associated with a D-channel are to be restarted, it is not included.

3.1.10 RESTart ACKnowledge

This message is sent to acknowledge the receipt of the RESTart message and to indicate that the requested restart is complete. The RESTart ACKnowledge message is of local significance. It uses the global call reference defined in Section 4.3.

RESTart ACKnowledge Message Contents

Message type: RESTart ACKnowledge
Direction: Both

Information Element	Reference	Direction	Type	Length
Protocol Discriminator	4.2	both	M	1
Call Reference	4.3	both	M	2 - 3
Message Type	4.4	both	M	1
Channel Identification	4.5.12	both (Note 1)	O	5 - 6
Restart Indicator	4.5.22	both	M	3

Note 1- CHANNEL IDENTIFICATION is mandatory only if a single channel or a single interface (e.g., nB+D) controlled by a D-channel is to be restarted. If all the channels associated with a D-channel are to be restarted, it is not included.

3.1.11 SETUP

This message is sent by either the user or the network, to initiate call establishment.

SETUP Message Contents

Message type: SETUP
Direction: Both

Information Element	Reference	Direction	Type	Length
Protocol Discriminator	4.2	both	M	1
Call Reference	4.3	both	M	2 - 3
Message Type	4.4	both	M	1
Bearer Capability	4.5.4	both	M	4 - 6
Channel Identification	4.5.12	both	M	5 - 6
Progress Indicator	4.5.21	both (Note 1)	O	4
Network-specific facilities	4.5.18	both (Note 2)	O	5 - 6
Display	4.5.14	both	O	3 - 16
Calling Party Number	4.5.8	both (Note 3)	O	4 - 16
Calling Party Subaddress£	4.5.9	both	O	2 - *
Called Party Number	4.5.6	both	M	4 - 27
Called Party Subaddress£	4.5.7	both	O	2 - *
Original Called Number[1]	4.5.20	both	O	4 - 15
Redirecting Number[1]	4.5.22	both	O	4 - 15
Transit Network Selection¥	4.5.25	both (Note 4)	O	6
Lower Layer Compatibility£	4.5.16	both	O	2 - *
Higher Layer Compatibility£	4.5.15	both	O	2 - *
User-user Information¥	4.5.26	both	O	3 - 130
Locking Shift Codeset 5£	4.5.2	both (Note 5)	O	1
Codeset 5 IE's£	4.5.2	both (Note 5)	O	2 - *
Locking Shift Codeset 6£	4.5.2	both (Note 6)	O	1
Codeset 6 IE's£	4.5.2	both (Note 6)	O	2 - *
Locking Shift Codeset 7£	4.5.2	both (Note 7)	O	1
Codeset 7 IE's£	4.5.2	both (Note 7)	O	2 - *

Note 1- PROGRESS INDICATOR is mandatory if in-band tones are required to be provided, otherwise it is not included.

Note 2- NETWORK-SPECIFIC FACILITIES is included if facilities other than public ISDN facilities are to be used for the call. Refer to the Network Profile Supplement for additional information pertaining to specific network implementation and protocol related issues.

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[1] This information element is currently supported. In BCS.32, the network has the additional ability to provide, on a subscription basis, the ability to   transfer the information element between users without network   interpretation or interaction.
¥ Not Supported in BCS.32.
£ This will be supported in BCS.32.

Note 3- *CALLING PARTY NUMBER is required, in the user-to-network direction, if the calling party number to be used is not the default number for the interface. Delivery of this information in the network-to-user direction may be based on subscription parameters.*

Note 4- *TRANSIT NETWORK SELECTION is present only if the user wishes to specify a transit network other than the user's default transit network, otherwise it is not included.*

Note 5- *Locking shift to codeset 5 provides for the national-standard inormation elements, which are defined by North American standard T1.607. Support of codeset 5 IE's are a network-dependant implementation.*

Note 6- *Locking shift to codeset 6 provides for network-specific information elements, which are defined by the network profile supplement of NIS A211-4. Support of codeset 6 IE's are a network-dependant implementation.*

Note 7- *Locking shift to codeset 7 provides for user-specific information elements, which are defined by the individual CPE manufacturer. Support of codeset 7 IE's are a network-dependant implementation.*

3.1.12 <u>STATUS</u>

This message may be sent from either the user or the network at any time during a call when an unexpected message is received or to report other conditions of the call.

STATUS Message Contents

Message type: STATUS
Direction: Both

Information Element	Reference	Direction	Type	Length
Protocol Discriminator	4.2	both	M	1
Call Reference	4.3	both	M	2 - 3
Message Type	4.4	both	M	1
Cause	4.5.10	both	M	4 - 6
Call State	4.5.5	both	M	3

3.1.13 STATUS ENQuiry

This message is sent from either the user or the network at any time during a call to solicit a STATUS message from the peer layer 3 entity.

STATUS ENQuiry Message Contents

Message type: STATUS ENQuiry
Direction: Both

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

3.2 Maintenance

This section presents the maintenance procedures[2] to be used with the messages defined in section 3.2. Since the maintenance messages are symmetric they can be initiated from either side of the interface.

The maintenance messages will follow the same structure as the call control messages defined in section 3.1. These procedures use two proprietary messages identified as SERVice and SERVice ACKnowledge.

3.2.1 SERVice

This message is sent from either the user or the network and is used to change the current status of a channel to one of the following states: In Service, Maintenance, or Out of Service.

SERVice Message Contents

Message type: SERVice
Direction: Both

Information Element	Reference	Direction	Type	Length
Protocol Discriminator	4.2	both	M	1
Call Reference	4.3	both	M	2 - 3
Message Type	4.4	both	M	1
Change Status	4.5.11	both	M	3
Channel identification	4.5.12	both *(Note 1)*	O	3 - 8

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[2] These maintenance messages are currently not supported in CCITT or ANSI standards.

3.2.2 SERVice ACKnowledge

This message is sent by either the user or the network and is used as the acknowledgement for the change of state indicated in the SERVice message.

SERVice ACKnowledge Message Contents

Message type: SERVice ACKnowledge
Direction: Both

Information Element	Reference	Direction	Type	Length
Protocol Discriminator	4.2	both	M	1
Call Reference	4.3	both	M	2 - 3
Message Type	4.4	both	M	1
Change Status	4.5.11	both	M	3
Channel identification	4.5.12	both	O	3 - 8

3.3 Supplementary Service Control Messages

3.3.1 NOTIFY

The NOTIFY message is sent by the called user to the network, and by the network to the calling user to convey information pertaining to a call across the interface.

NOTIFY Message Content

Message type: NOTIFY
Direction: Both

Information Element	Reference	Direction	Type	Length
Protocol Discriminator	4.2	both	M	1
Call Reference	4.3	both	M	2 - 3
Message Type	4.4	both	M	1
Notification Indicator	4.5.19	both	M	3
Information Request[2]	4.5.17	both	O	3 - 5
Calling Party Number	4.5.8	both (Note 1)	O	4 - 16
Connected Number[2]	4.5.13	both (Note 2)	O	5 - 12
Redirecting Number[2]	4.5.22	both	O	4 - 16
Redirection Number[2]	4.5.23	both	O	4 - 16
Cause	4.5.10	both	O	4 - 6
Display[2]	4.5.14	both (Note 3)	O	3 - 16
Progress Indicator	4.5.21	both (Note 4)	O	4

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[2] This information element is currently supported. In BCS.32, the network has the additional ability to provide, on a subscription basis, the ability to transfer the information element between users without network interpretation or interaction.

Locking Shift Codeset 5¥	4.5.2	both (Note 5)	O	1
Codeset 5 IE's¥	4.5.2	both (Note 5)	O	2 - *
Locking Shift Codeset 6¥	4.5.2	both (Note 6)	O	1
Codeset 6 IE's¥	4.5.2	both (Note 6)	O	2 - *
Locking Shift Codeset 7¥	4.5.2	both (Note 7)	O	1
Codeset 7 IE's¥	4.5.2	both (Note 7)	O	2 - *

Note 1- *CALLING PARTY NUMBER is required, in the user-to-network direction, if the calling party number to be used is not the default number for the interface. In the network-to-user direction, this information is made available to the called user upon subscription to the corresponding ISDN supplementary service.*

Note 2- *CONNECTED NUMBER must be included if the connected number is known and is different from the original Called Party Number.*

Note 3- *Display is included in the user-network direction if the user has display information which should be passed to the far-end user. It is included in the network-user direction if received from the remote user. As a BCS.32 network option, the Dispaly IE can be passed from user to user without network interpretation or interaction.*

Note 4- *PROGRESS INDICATOR is mandatory if in-band tones are required to be provided, otherwise it is not included.*

Note 5- *Locking shift to codeset 5 provides for the national-standard inormation elements, which are defined by North American standard T1.607. Support of codeset 5 IE's are a network-dependant implementation.*

Note 6- *Locking shift to codeset 6 provides for network-specific information elements, which are defined by the network profile supplement of NIS A211-4. Support of codeset 7 IE's are a network-dependant implementation.*

Note 7- *Locking shift to codeset 7 provides for user-specific information elements, which are defined by the individual CPE manufacturer. Support of codeset 7 IE's are a network-dependant implementation.*

3.4 Messages for Other Types of Connections

Not applicable to this specification.

¥ This is not supported in BCS.32.

4. MESSAGE STRUCTURE

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

This section defines the encoding of all information elements contained within the protocol messages. Only those information elements whose use is currently defined within this document are included. Other information elements that are currently not used in this description, will be included when required. The encoding of a specific information element may only be a subset of the complete encoding defined in CCITT or T1S1 standards, until the complete encoding is required.

4.1. Overview

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

1. Protocol Discriminator;

2. Call Reference;

3. Message Type;

4. Other Information Elements, as required;

Items 1, 2 and 3 are common to all the messages and must always be present, while item 4 is specific to each message type.

The maximum message length for BCS.31 will be 56 octets. This will be increased to 260 octets in a future release.

A particular message may contain more information than a particular equipment needs or can understand. All equipment should be able to discard any extra information present in a message, which is not required for the proper operation of that equipment. For example, the calling party number may be discarded by the recipient if that number is of no interest to the receiver.

In general, a particular information element may be present only once in a given message. The exceptions to this rule are specifically noted as they apply.

A particular information element may be present, but empty. For example, it is allowed to send a Calling Party Number information element with no entries except for the Information Element Identifier and Length of Information Element fields.

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 that field.

Bits Octet	8	7	6	5	4	3	2	1
1	Protocol Discriminator							
2	0	0	0	0	Length of Call Reference Value			
3	Call Reference Value							
4	0	Message Type						
5 +n	Other Information Elements as Required							

General Message Organization Example

4.2. Protocol Discriminator

The purpose of the protocol discriminator is to distinguish messages for call control and maintenance (service) from other messages.

The protocol discriminator is the first part of every message.

Bits Octet	8	7	6	5	4	3	2	1
1	Protocol Discriminator							

Protocol discriminator

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

4.3. Call Reference

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

The call reference is the second part of every message. The call reference value may be one or two octets long. The default maximum length of the call reference value for a primary rate user-network interface is two octets. The term "default" shall be interpreted as in 4.1.

The DMS-250 may accept one octet call references for in coming calls from the PRI interface. However, the DMS must always issue a two octet call reference for outgoing calls to the user.

The call reference information element comprises two fields: the call reference value and the call reference flag.

Call reference values are assigned by the origination side of the interface for a call. These values are unique to the origination 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. A call reference value may be equivalently described by either 1 or 2 octets. After a call ends the associated call reference value may be reassigned to a later call. By the use of the call reference flag 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.

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".

The numerical value of the global call reference is zero. The equipment receiving a message containing the global call reference should interpret the message as pertaining to all call references associated with the appropriate data link connection identifier. The global call reference value shall not be used for a call. **Note:** The call reference flag is not used for global call references, and is set to 0 by the DMS, whether it is originating or responding to the call reference.[1]

---

[1] This restriction will be removed in BCS.32, in which the DMS-250 will respond to   global call reference values with the flag set to indicate that the message is to   the side which initiates the call reference.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	0	0	0	Length of CR Value			
2 / 3	Flag	Call Reference Value						

Call Reference Information Element

<u>Reference Flag</u>

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.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	0	0	0	Length of CR Value			
					0	0	0	0

Figure 1.   Dummy Call Reference (NOT Supported or Required for ISDN Primary Rate Interface)

The following 4 figures provide actual Call Reference encoding examples as they pertain to Primary Rate Interface.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	0	0	0	Length of CR Value			
					0	0	0	1
2	Flag 0	0	0	0	0	0	0	0

Figure 2.   Global Call Reference (1-octet value)[2]

---

[2] As mentioned previously, the DMS will correctly utilize the flag field of the global   call reference beginning in BCS.32.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	0	0	0	Length of CR Value 0	0	1	0
2	Flag 0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0

Figure 3.   Global Call Reference (2-octet Value)

Bits / Octet	8	7	6	5	4	3	2	1
1	0	0	0	0	Length of CR Value 0	0	0	1
2	Flag 0 / 1	0	0	1	1	1	0	1

Figure 4.   Call Reference with value 1-Octet long

Bits / Octet	8	7	6	5	4	3	2	1
1	0	0	0	0	Length of CR Value 0	0	1	0
2	Flag 0 / 1	0	0	0	0	0	0	0
3	0	0	0	1	1	1	0	1

Figure 5.   Call Reference with value 2 Octets long (default length)

4.4. Message Type

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

The message type is the third part of every message. The message type is coded as shown in the following tables.

Bits / Octet	8	7	6	5	4	3	2	1
1	Message Type							

Message Types

```
8 7 6 5 4 3 2 1
0 0 0 - - - - -        Call establishment messages:
        0 0 0 0 1      -    ALERTing
        0 0 0 1 0      -    CALL PROCEEDING
        0 0 1 1 1      -    CONNect
        0 1 1 1 1      -    CONNect ACKnowledge
        0 0 0 1 1      -    PROGress
        0 0 1 0 1      -    SETUP

0 1 0 - - - - -        Call disestablishment messages
        0 0 1 0 1      -    DISConnect
        0 1 1 0 1      -    RELease
        1 1 0 1 0      -    RELease COMplete
        0 0 1 1 0      -    RESTart
        0 1 1 1 0      -    RESTart ACKnowledge

0 1 1 - - - - -        Miscellaneous messages
        1 1 1 0 1      -    STATus
        1 0 1 0 1      -    STATus ENQuiry
        0 1 1 1 0      -    NOTIFY

0 0 0 - - - - -        Maintenance messages
        0 1 1 1 1      -    SERVice
        0 0 1 1 1      -    SERVice ACKnowledge
```

4.5. Other Information Elements

4.5.1. Coding Rules

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

The descriptions of the information elements below are organized in alphabetical order. However, there is a particular order of appearance for each information element. The code values of the information element identified 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.

Note: Information elements shall be transmitted in ascending order of information element identifier value. All information elements belonging to the CCITT Q.931 codeset shall appear at the beginning of each message.

Where the description of information elements in this Specification contains spare bits, these bits are indicated as being coded to "0". In order to allow compatibility with future implementation, messages should not be rejected simply because a spare bit is set to "1".

In the Information Element format descriptions 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.

The second octet of every variable length information element is the "Length of Information Element" field. This field is encoded as a binary value equal to the number of octets in the information element that follow the length field. Therefore the information element identifier field and the length field are not counted in this number.

Bits Octet	8	7	6	5	4	3	2	1
1	0	Information Element Identifier						
2	Length of Information Element (oct ets)							
3 + n	Contents of Information Element							

Variable Length Information Element Format

Formats of Information Elements

Information Element Identifier

```
    Bits
    8  7  6  5  4  3  2  1  Single Octet Information Elements
    1  0  0  1  0  -  -  -  Locking Shift£


    8  7  6  5  4  3  2  1  Variable Length Information Elements
    0  0  0  0  0  1  0  0  Bearer Capability
    "  0  0  0  1  0  0  0  Cause
    "  0  0  0  1  1  0  0  Connected Number
    "  0  0  1  0  1  0  0  Call State
    "  0  0  1  1  0  0  0  Channel Identification
    "  0  0  1  1  1  0  0  Facility3
    "  0  0  1  1  1  1  0  Progress Indicator
    "  0  1  0  0  0  0  0  Network-Specific Facilities
    "  0  1  0  0  1  1  1  Notification Indicator
    "  0  1  0  1  0  0  0  Display
    "  1  1  0  0  0  0  1  Called party subaddress£
    "  1  1  0  1  1  0  0  Calling Party Number
    "  1  1  0  1  1  0  1  Calling party subaddress£
    "  1  1  1  0  0  0  0  Called Party Number
    "  1  1  1  0  0  1  1  Original Called Number
    "  1  1  1  0  1  0  0  Redirecting Number
    "  1  1  1  0  1  1  0  Redirection Number
    "  1  1  1  1  0  0  0  Transit Network Selection¥
    "  1  1  1  1  0  0  1  Restart Indicator
    "  1  1  1  1  1  0  0  Lower Layer Compatibility£
    "  1  1  1  1  1  0  1  Higher Layer Compatibility£
    "  1  1  1  1  1  1  0  User-User Information¥
```

Information Element Identifier Encoding

4.5.2. Locking Shift Procedures£

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 5 is enountered, the next information element will be interpreted according to the information element identifiers assigned in codeset 5, until another Shift information element is encountered.

As a network and subscription option, information contained in the SETUP message which is not in codeset 0 may be passed transparently between users without network interaction or

---

3 In BCS.32, the Facility IE can be carried end-to-end in ALERTING messages without
      network interpretation or interaction. The use of the Facility IE for
      supplementary services is network-dependant, and references should be made   to the
network profile supplement for clarification.

£ Supported in BCS.32 for the SETUP message. Not supported for other message types.

¥ Not supported in BCS.31.

interpretation.   Further use of the locking shift is a subject of the network profile supplement
to this specification.

This procedure is used only to shift to a higher order codeset than the one being left.

The locking shift is valid only within that message which contains the locking Shift information
element.   At the start of every message content analysis, the active codeset is codeset 0.

The locking Shift information element uses the single octet information element format.

Bits Octet	8	7	6	5	4	3	2	1
1	1	0	Shift 0 Identifier	1	0	X New codeset	X identification	X

"0" in this position
indicates locking shift

New codeset identification
```
     Bits
     3 2 1
     0 0 0    not applicable

     0 0 1    reserved
to   1 0 0       "

     1 0 1    codeset 5:  information elements used in ANSI standard T1.607, T1.608
     1 1 0    codeset 6:  information elements specific to the network
     1 1 1    codeset 7:  user-specific information elements
```

4.5.3 Non-locking Shift Procedures

The use of non-locking shift procedures is not supported in this release.

4.5.4. Bearer Capability

The purpose of the Bearer Capability information element is to indicate provision by the network of one of the bearer capabilities as defined in CCITT Recommendation I.211.

No default bearer capability may be assumed by the absence of this information element.

Octet \ Bits	8	7	6	5	4	3	2	1
1	0	Bearer Capability 0 0 0 0 1 0 0 Information Element Identifier						
2	Length of Bearer Capability Inform ation Element							
3	1	Coding Standard		Information Transfer Capability				
4	1 Ext.	Transfer Mode		Information Transfer Rate				
5	0/1 Ext.	Multiplier/ Layer Id.		Bearer Capability Multiplier Protocol Identification				
5a	1	0 0 spare		Rate				

Note 1 (against octet 4), Note 2 (against octet 5), Note 3 (against octet 5a)

Bearer Capability Information Element

Note1:   Althought CCITT and ANSI standards specify the use of extension octects to octet 4 (extension octets 4a and 4b), the DMS-250 will never send these octets to the user. It will, however, receive and ignore these octets if the user sends them to the DMS.

Note 2:   This octet may be omitted.

Note 3   This octet is present if octet 5 is set to 0010 0001, indicating rate adaption.

Coding standard (Octet 3)
Bits
7 6
0 0   CCITT standard as in Recommendation Q.931

Information Transfer Capability (Octet 3)

```
Bits
5 4 3 2 1
0 0 0 0 0    Speech
0 1 0 0 0    Unrestricted Digital Information
             or 56 Circuit Switched[3]
0 1 0 0 1    Restricted Digital Information(Note 1)
1 0 0 0 0    3.1 kHz audio[4]
1 0 0 0 1    7 kHz audio
```

Transfer Mode (Octet 4)

```
Bits
7 6
0 0     circuit mode
```

Information Transfer Rate (Octet 4)

```
Bits
5 4 3 2 1
1 0 0 0 0   64 kbit/s (used for circuit mode)
```

Octet 4a and 4b, specified in CCITT and T1S1, are omitted, implying default values are to be assumed. The value of the structure attribute is assumed to be:

Transfer Mode	Transfer Capability	Structure
circuit	Speech	8 KHz integrity
circuit	Unrestricted digital	8 KHz integrity
circuit	56 Circuit Switched	8 KHz integrity
circuit	Restricted digital(Note 1)	8 KHz integrity
circuit	3.1 kHz[4]	8 KHz integrity
circuit	7 kHz	8 KHz integrity

Note 1 - *ZCS encoding is used and all-zero octets are not allowed. The all-zero octet restriction can be accomplished if LAPD is used on the bearer channel, and the HDLC is inverted.*

The configuration is assumed to be point-to-point and the method of establishment is assumed to be "demand".

The bearer capability is assumed to be bi-directional symmetric at the information transfer rate specified in octet 4.

Layer and Protocol Identification (Octets 5, 5a)

---

[3] The interpretation of Transfer Capability value 8 depends on the Access Data Rate (ADR) field, which must be used in conjunction with this ITC field to represent 56k circuit switched. Octet 5a is encoded '10001111' in this case.

[4] 3.1 KHz audio will receive identical handling as speech.

This field identifies the protocols and data rate adaption used on the user information on the access channel at the user/network interface.

Layer and Protocol Identification (Octet 5)

Bits
7 6
0 1   Layer 1

Bits
5 4 3 2 1
0 0 0 0 1   Rate Adaption based on CCITT I, X,and V Series. (To indicate the   data
                rate, bit 8 octet 5 is set to 0 and the following octet indicates   the   user
                information data rate. See encoding of octet 5a).
0 0 0 1 0   Recommendation G.711 Mu-law Speech
0 0 1 0 1   Recommendation G.722 and G.725 7 kHz audio

Access Data Rate (Octet 5a)

Bit
8
1   Last octet of this layer and protocol identification information element

Bits
7 6
0 0   Spare

Bits
5 4 3 2 1   Synchronous Rate
0 1 1 1 1   56 kbit/s

4.5.4.1. Examples of Encoding[4]

The encodings of this information element, for the bearer services supported by DMS-250 are:

ATTRIBUTE   ENCODING OCTET

(1) Speech

                                                    Bits
                                                    8 7 6 5 4 3 2 1 Octet
Transfer capability = speech   1 0 0 0 0 0 0 0 3
Transfer mode and rate = circuit-mode, 64 kbit/s 1 0 0 1 0 0 0 0 4
Layer 1 protocol ID = Mu-law   1 0 1 0 0 0 1 0 5
Octet 5a not present

---

[4] All other encodings of the bearer capability will be rejected by the DMS-250.

(2)   64 kbit/s unrestricted digital, rate adapted from 56 kbit/s

	Bits								
	8	7 6	5	4	3	2	1	Octet
Transfer capability = unrestricted digital	1	0 0	0	1	0	0	0	3
Transfer mode and rate = circuit-mode, 64 kbit/s	1	0 0	1	0	0	0	0	4
Layer 1 protocol ID = Rate adaption	0	0 1	0	0	0	0	1	5
Data rate = 56 kbit/s	1	0 0	0	1	1	1	1	5a

(3)   64 kbit/s clear, unrestricted digital, circuit-mode

	Bits								
	8	7 6	5	4	3	2	1	Octet
Transfer capability = unrestricted digital	1	0 0	0	1	0	0	0	3
Transfer mode and rate = circuit-mode, 64 kbit/s	1	0 0	1	0	0	0	0	4

Octets 5 and 5a are not present

(4)   64 kbit/s restricted, circuit-mode

	Bits								
	8	7 6	5	4	3	2	1	Octet
Transfer capability = restricted digital	1	0 0	0	1	0	0	1	3
Transfer mode and rate = circuit-mode, 64 kbit/s	1	0 0	1	0	0	0	0	4

Octets 5 and 5a are not present

(5) 3.1 kHz Audio

	Bits								
	8	7 6	5	4	3	2	1	Octet
Transfer capability = 3.1 kHz	1	0 0	1	0	0	0	0	3
Transfer mode and rate = circuit-mode, 64 kbit/s	1	0 0	1	0	0	0	0	4
Layer 1 protocol ID = Mu-law	1	0 1	0	0	0	1	0	5

Octet 5a not present

(6) 7 kHz Audio

	Bits								
	8	7 6	5	4	3	2	1	Octet
Transfer capability = 7 kHz	1	0 0	1	0	0	0	1	3
Transfer mode and rate = circuit-mode, 64 kbit/s	1	0 0	1	0	0	0	0	4
Layer 1 protocol ID = G.722 and G.725 7kHz audio	1	0 1	0	0	1	0	1	5

Octet 5a not present

4.5.5. Call State

The purpose of the Call State information element is to describe the current status of the call.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	Call State 0 0 1 0 1 0 0 Information Element Identifier						
2	0	Length of Call State Value 0 0 0 0 0 0 1						
3	Call State Value (State value is encoded in binary: see below)							

Call State Information Element

State No.	User State	Network State
0	Null	Null
1	Call Initiated	Call Initiated
3	Outgoing Call Proceeding	Outgoing Call Proceeding
4	Call Delivered	Call Delivered
6	Call Present	Call Present
7	Call Received	Call Received
8	Connect Request	Connect Request
9	Incoming Call Proceeding	Incoming Call Proceeding
1 0	Active	Active
1 1	Disconnect Request	Disconnect Request
1 2	Disconnect Indication	Disconnect Indication
1 9	Release Request	Release Request

4.5.6. Called Party Number

The purpose of the Called Party Number information element is to identify one called party of a call.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	1 1 1 0 0 0 0 Called Party Number Information Element Identifier						
2	Length of Called Party Number Information Element							
3	1 Ext.	Type of Address			Numbering Plan Identification			
4, etc.	0 Spare	Number Digits						

Called Party Number Information Element

Note 1- The number digit in octet 4 precedes the digit in octet 5, etc. The address digit which would be "dialed" first is located in octet 4.

Type of Number (octet 3)
```
Bits
7 6 5
0 0 0     unknown
0 0 1     international  number¥
0 1 0     national  number¥
1 0 0     local (directory)  number¥
```

All other values are reserved.

Numbering plan identification (octet 3)
```
Bits
4 3 2 1     Numbering plan
0 0 0 0     Unknown
0 0 0 1     ISDN/Telephony numbering plan (Rec. E.164)
1 0 0 1     Private numbering plan
```

All other values are reserved.

¥ Not supported in BCS.31.

Number digits (octets 4, etc.)

```
Bits
7 6 5 4 3 2 1            Address digit value
0 1 1 0 0 0 0                    0
0 1 1 0 0 0 1                    1
0 1 1 0 0 1 0                    2
0 1 1 0 0 1 1                    3
0 1 1 0 1 0 0                    4
0 1 1 0 1 0 1                    5
0 1 1 0 1 1 0                    6
0 1 1 0 1 1 1                    7
0 1 1 1 0 0 0                    8
0 1 1 1 0 0 1                    9
0 1 0 1 0 1 0                    *
0 1 0 0 0 1 1                    #
```

4.5.6.1. Examples of Encoding

The following table specifies examples of the Called party number information element encoding based on the public network dialing plan.

Public Network Dialing Plan	Called Party Number		
	Type of Number	Number Plan	Digits
NXX-XXXX	unknown	Private	NXX-XXXX
NPA-NXX-XXXX	unknown	E.164	NPA-NXX-XXXX
0	unknown	E.164	0
0+NXX-XXXX	unknown	E.164	0+NXX-XXXX
0+NPA-NXX-XXXX	unknown	E.164	
1+NXX-XXXX	unknown	E.164	
1+NPA-NXX-XXXX	unknown	E.164	
01+CC+NN	unknown	E.164	
011+CC+NN	unknown	E.164	

Notes:

- *N represents digits 2-9*

- *X represents digits 0-9*

- *NPA' represents a string of 3 digits which are comprised of:*

  1. 'N' represents digits 2-9
  2. 'P' represents either '0' or '1'
  3. 'A' represents digits 2-9

4.5.7. Called Party Subaddress£

The purpose of the Called Party Subaddress is to allow the originating user to further identify the called user.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	1	1	0	0	0	0	1
		Called Party Subaddress Information Element Identifier						
2	Length of Called Party Subaddress							
3.+.n	Called Party Subaddress Information							

As a subscribtion option, the called party subaddress is passed transparently from the calling user to the called user without network interpretation or interaction.

4.5.8. Calling Party Number

The purpose of the Calling Party Number information element is to identify the origin of a call.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	1	1	0	1	1	0	0
		Calling Party Number Information Element Identifier						
2	Length of Calling Party Number Information Element							
3	0/1 Ext.	Type of Address			Numbering Plan Identification			
3a*	1 Ext.	Presentation Indicator		0 0 0 Spare			Screen Indicator	
4, etc.	0 Spare	Number Digits						

Calling Party Number Information Element

£ Supported in BCS.32.

* This octet may be omitted

Note 1 -   The contents of this information element, other then octet 3a and the complete IA5 characters in octet 4, are coded as shown for the Called Party Number.

Presentation Indicator (octet 3a)

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

Note 2 -   If octet 3a is omitted then "Presentation allowed" is assumed in both directions.

Screening Indicator (octet 3a)

Bits	
2 1	
0 0	User-provided, not screened
1 1	Network-provided

Note 3 -   If octet 3a is omitted "User-provided, not screened" is assumed.

4.5.9.   Calling Party Subaddress[£]

The purpose of the Calling Party Subaddress is to allow the originating user to further identify the calling user.

Bits Octet	8	7	6	5	4	3	2	1
1	0	1	Calling Party Subaddress 1 0 1 1 0 1 Information Element Identifier					
2	Length of Calling Party Subaddress							
3.+.n	Calling Party Subaddress Information							

As a subscribtion option, the calling party subaddress is passed transparently from the calling user to the called user without network interpretation or interaction.

4.5.10.   Cause

[£] Supported in BCS.32.

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

The cause information element is coded as shown in the following figure. Diagnostic information is not available for every cause. Refer to Annex G "Cause Descriptions" for descriptions of the cause values supported.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	0	0	Cause 0	1	0	0	0
				Information Element Identifier				
2	Length of Cause Information Element							
3	1 Ext.	Coding Standard		0 Spare	Location			
4	1 Ext.	Cause Value						
		(Class)			(Value in Class)			
4a*	Length of Diagnostics Information							
5*	Diagnostics (if any)							

Cause Information Element

* This octet may be omitted.

Coding standard (octet 3)
    Bits
    7 6
    0 0   CCITT standard

General Location (octet 3)
    Bits
    4 3 2 1
    0 0 0 0   user
    0 0 0 1   private network serving the local user
    0 0 1 0   public network serving local user
    0 0 1 1   transit network¥
    0 1 0 0   public network serving the remote user¥

¥ Not supported in BCS.31.

0 1 0 1   private network serving the remote user¥
0 1 1 1   international network¥
1 0 0 0   network beyond interworking point¥
All other values are reserved

Cause Value (octet 4)

The cause value is divided in two fields, a class (bits 5-7) and a value within the class (bits 1-4).

The class indicates the general nature of the event.

class	(0 0 0)	: normal event
class	(0 0 1)	: normal event
class	(0 1 0)	: network congestion
class	(0 1 1)	: service or option not available
class	(1 0 0)	: service or option not implemented
class	(1 0 1)	: invalid message (e.g. parameter out of range)
class	(1 1 0)	: protocol error (e.g. unknown message)
class	(1 1 1)	: interworking

Cause Value	Cause Number	Cause	Diagnostics
Class Value 7 6 5 4 3 2 1			
0 0 0 0 0 0 1	1	unassigned number	
0 0 0 0 0 1 0	2.	no route to specified transit network	
0 0 1 0 0 0 0	16.	normal call clearing	
0 0 1 0 0 0 1	17.	user busy	
0 0 1 0 0 1 0	18.	no user responding	
0 0 1 0 1 0 1	21.	call rejected	
0 0 1 0 1 1 0	22.	number changed	
0 0 1 1 1 0 0	28.	incomplete number	
0 0 1 1 1 0 1	29.	facility rejected	
0 0 1 1 1 1 0	30.	response to STATUS ENQuiry	
0 0 1 1 1 1 1	31.	normal unspecified	
0 1 0 0 0 1 0	34.	no channel/circ available	
0 1 0 1 0 1 0	42.	switch equip congestion	

Cause Value							Cause Number	Cause	Diagnostics
Class			**Value**						
7	**6**	**5**	**4**	**3**	**2**	**1**			
0	1	0	1	0	1	1	43.	User information discarded	
0	1	0	1	1	0	0	44.	requested circ/channel not available	
0	1	0	1	1	1	1	47.	resource unavailable	
0	1	1	0	0	1	0	50.	requested facility not subscribed	
0	1	1	0	1	1	0	54.	incoming calls barred	
0	1	1	1	0	1	0	58.	bearer capability not presently available	
0	1	1	1	1	1	1	63.	service or option not available, unspecified	
1	0	0	0	0	0	1	65.	bearer capability not implemented	
1	0	0	0	0	1	0	66.	channel type not implemented	
1	0	0	0	1	1	0	70.	only restricted digital information bearer capability is available	
1	0	0	1	1	1	1	79.	service or option not implemented, unspecified	
1	0	1	0	0	0	1	81.	invalid call reference value	
1	0	1	0	0	1	0	82.	identified D-channel does not exist	
1	0	1	1	0	0	0	88.	incompatible destination	
1	0	1	1	0	1	0	90.	destination address missing, and direct call not subscribed	
1	0	1	1	1	1	1	95.	invalid message, unspecified	
1	1	0	0	0	0	0	96.	mandatory information element is missing	info. element identifier
1	1	0	0	0	0	1	97.	message type non existent or not implemented	message type
1	1	0	0	0	1	0	98.	message not compatible with state	message type
1	1	0	0	0	1	1	99.	information element nonexistent or not	info. element identifier implemented
1	1	0	0	1	0	0	100.	invalid information element contents	information element identifier
1	1	0	0	1	0	1	101.	Message not compatible with call state	
1	1	0	0	1	1	0	102.	Recovery on Timer Expiry	
1	1	0	1	1	1	1	111.	protocol error unspecified	
1	1	1	1	1	1	1	127.	interworking, unspecified	

All other values are reserved.

Note 1 - *In the diagnostic field the two diagnostics provided,   "Information element identifier" and "message type", are one octet long.*

4.5.11. Change Status

The purpose of the change status information element is to change the current status of an interface and D-channel to one of the following states: In Service, Maintenance, Out of Service.

Bits Octet	8	7	6	5	4	3	2	1
1	0	0	0	0	0	0	0	1
			Change Status Information Element Identifier					
2	Length of Change Status							
3	1	Pref.	0	0 Spare	0	New Status		

Change Status Information Element

Preference (Octets 3)
  Bit
  <u>7</u>
  1   Channel

New Status (Octet 3)
  Bits
  <u>3 2 1</u>
  0 0 0   In Service
  0 0 1   Maintenance
  0 1 0   Out of Service

4.5.12. Channel Identification

The purpose of the Channel Identification information element is to identify a channel within the interface controlled by these signaling procedures.

Bits Octet	8	7	6	5	4	3	2	1
1	0	0 0 1 1 0 0 0 Channel Identification Information Element Identifier						
2	Length of Channel Identification Information Element							
3	1 Ext.	Int. ID Pres.	1 Int. Type	0 Spare	1 Pref/ Excl	0 D-ch ind.	0 1 Info Ch Selection	
4*	1 Ext.	Interface Identifier (Note 1)						
5	1 Ext.	0 0 Coding Standard	Numb. Map	Channel Type/ Map Element Type				
6, etc.	Channel Number (Note 2)							

Channel Identification Information Element

* This octet's presence is dependent on the Interface Identification Present field.

Note1:   Currently, although the DMS-250 allows channel identification in which the interface is implicitly identified, it will always explicitly identify the interface for outgoing calls to the user, i.e., the interface identifier will always be present. when the requested interface is not the D channel.

Note2:   Currently, Channel Number will only be one octet in length.

Interface Identifier Present (Octet 3 - Bit 7)
    0   interface implicitly identified
    1   interface explicitly identified with one or more octets beginning in octet 4 (Interface Identifier).

Interface Type (Octet 3 - Bit 6)
    1   primary rate interface

Preferred/Exclusive (Octet 3 - Bit 4)

> 0   preferred- the indicated channel is preferred[5]
> 1   exclusive - only the indicated D-channel is acceptable

D-channel Indicator   (Octet 3 - Bit 3)

> 0   channel identified is not a D-channel
> 1   channel identified is the D-channel[6]

Information Channel Selection   (Octet 3)

Bits
2 1   Primary Interface
0 1   As indicated below

Interface Identifier   (Octet 4)

Binary code in the range 0 to 31 assigned to the DS-1 link at subscription time (i.e., discriminates between a number of DS-1 facilities).

Coding Standard (Octet 5)

Bits
7 6
0 0   CCITT Standard

Number/Map   (Octet 5)

Bit
5
0   channel indicated by number

Channel Type/Map Element Type (Octet 5)

Bits
4 3 2 1
0 0 1 1   B-channel units

Channel Number (Octet 6)

The binary number that is assigned to the channel.

The range of channel numbers supported is 1-24.

---

[5] The value "preferred", though accepted by the DMS-250, will be treated identically   to "exclusive".

[6] The D-channel may be selected only during D-channel backup procedures (refer to   Annex F - D-channel Backup Procedures)

4.5.13. Connected Number

The purpose of the Connected Number information element is to indicate which number is connected to a call. The connected number may be different from the calling or called party number(s) because of changes (e.g. call redirection) during the lifetime of the call.

As a BCS.32 subscription option, the Connected Number may be passed from user to user without network interpretation or interaction.

The connected number information element is coded as shown for the Calling Party Number.

Bits Octet	8	7	6	5	4	3	2	1
1	0	0	0	0	1	1	0	0
		Connected Number Information Element Identifier						
2	Length of Connected Address Information Element							
3	Type of Address				Numbering Plan Identification			
* 3a	1 Ext.	Presentation Indicator		0 0 0 Spare			Screening Indicator	
4, etc.	Number Digits IA5 Characters							

Connected Number Information Element

* This octet may be omitted.

Refer to "Calling Party Number" in section 4.5.5 for encoding details.

4.5.14. Display

The purpose of the Display information element is to supply display information that may be displayed by the user. The information contained in this element is coded in IA5 characters.

As a BCS.32 subscription option, the Display Information Element may be passed from user to user without network interpretation or interaction.

Bits / Octet	8	7	6	5	4	3	2	1
1	Display Information Element Identifier							
	0	0	1	0	1	0	0	0
2	Length of Information Element								
*3a	1 Ext.	Associated Information		Display Type			
3b	0 Ext.	Length of Display Element							
3c	0 Spare	Display Information (IA5 chars.)							
etc.	0 Spare	Display Information (IA5 chars.)							

Display Information Element

* This encoding of this information element is DMS-250 specific.

Note: *Octets 3b thru 3c may be omitted if the display information element does not carry name information.*

Associated Information (Octet 3a)

```
Bits
7  6  5
0  0  0    Undefined
0  0  1    Requested
0  1  0    Not Requested
0  1  1    Included
1  0  0    Not Included
1  0  1    Information Unavailable
1  1  0    Denied
1  1  1    Reserved
```

Display Type (Octets 3a)

```
Bits
4  3  2  1
0  0  0  0    Unknown
0  0  0  1    Original called party number
0  0  1  0    Calling party name
0  0  1  1    Called party name
0  1  0  0    Redirecting party name
0  1  0  1    Redirection party name
0  1  1  0    Connected party name
0  1  1  1    Message retrieval
1  0  0  0    Misc. display information
1  0  0  1    Electronic directory
```

All other values are spare

4.5.15. Higher   Layer   Compatibility[£]

The purpose of the Higher Layer Compatibility is to allow the originating user to identify specific requirements requested for upper layer functionality.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	High Layer Compatibility 1 1 1 1 1 0 1 Information Element Identifier						
2	Length of High Layer Compatibility							
3.+.n	High Layer Compatibility Information							

Higher Layer Compatibility Information Element

As a subscription option, the Higher Layer Compatibility is passed transparently from the calling user to the called user without network interpretation or interaction.

[£] Supported in BCS.32.

4.5.16 Lower Layer Compatibility£

The purpose of the Lower Layer Compatibility is to allow the originating user to identify specific requirements requested for lower layer functionality.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	1	1	1	1	1	0	0
		Low Layer Compatibility Information Element Identifier
2	Length of Low Layer Compatibility
3.+.n	Low Layer Compatibility Information

Lower Layer Compatibility Information Element

As a subscription option, the Lower Layer Compatibility is passed transparently from the calling user to the called user without network interpretation or interaction.

£ Supported in BCS.32.

4.5.17. Information Request

The purpose of the Information Request information element is to provide the capability for requesting additional information and signaling completion of the information requested.

As a BCS.32 subscription option, the Information Request Information Element may be passed from user to user without network interpretation or interaction.

Bits Octet	8	7	6	5	4	3	2	1
1	0	Information Request 0 1 1 0 0 1 0 Information Element Identifier						
2	Length of Information Request Information Element							
3	0 / 1 Ext	Info. Req. Ind.	General Type of Information					
3a	1 Ext.	Information Specific						

Information Request Information Element

General Type of Information

Bits 6 5 4 3 2 1	
0 0 0 0 0 0	Undefined
0 0 0 0 0 1	Authorization
0 0 0 0 1 0	Address Digits
0 0 0 0 1 1	Terminal Identification

Information Specifics

Bits 7 6 5 4 3 2 1	
0 0 0 0 0 0 0	Dialing Number (default)
0 0 0 0 0 0 1	Calling Party Number
0 0 0 0 0 1 0	Connected Party Number
0 0 1 0 0 0 0	Redirecting Number with Indicators
0 0 1 0 0 0 1	Redirection Number with Indicators
0 0 1 0 0 1 0	Redirecting Number without Indicators
0 0 1 0 0 1 1	Redirection Number without Indicators
0 1 1 0 0 0 0	Information denied
0 1 1 0 0 0 1	Information not available

4.5.18. Network-Specific Facilities

The purpose of the Network-Specific Facilities information element is to indicate which network facilities are being invoked at the specified network.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	\ Network-Specific Facilities						
		0	1	0	0	0	0	0
		Information Element Identifier						
2	Length of Network-Specific Facilities Information Element							
3	Length of Network Identification							
4 *	1 Ext	Type of Network Identification			Network Identification Plan			
5 *	0 Spare	Network Identification IA5 Characters						
6	0/1 Ext	1 Expan.	Serv/ Feat.	Binary Facility Coding Value				
6a	0/1 Ext	Service Identifier						

Network-Specific Facilities Information Element

* This octet will not be present in the network-to-user direction and will be ignored in the user-to-network direction.

Length of Network Identification (Octet 3)

This field shall have value 0, implying that octets 4 and 5, etc are absent. The local serving network will provide the requested facility.

Expansion (Octet 6, Bit 7)
    1

Service/Feature (Octet 6, Bit 6)
    1   Facility = "Service"

<u>Binary Facility Coding Value (Octet 6, Bits 1-5)</u>

Note: Refer to the Network Profile Supplement for additional information pertaining
to network-specific protocol and implementation related details.

<u>Service Identifier (Octet 6a)</u>
```
  Bits
  7 6 5 4 3 2 1
  0 0 0 0 0 0 0     Trunk/Route/CLLI  #
  0 0 0 0 0 0 1          "
  0 0 0 0 0 1 0          "
  0 0 0 0 0 1 1          "
  . . . . . . .
  . . . . . . .
  . . . . . . .
  1 1 1 1 1 1 1          "
```

4.5.19.   <u>Notification   Indicator</u>

The purpose of the Notification Indicator information element is to indicate or convey information pertaining to a call.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	0	Notification Indicator Information Element Identifier 1	0	0	1	1	1
2	Length of Notification Indicator Information Element							
3	0 / 1 Ext	Notification Description						

Notification Information Element

<u>Notification Description (octet 3)</u>
```
  Bits
  7 6 5 4 3 2 1
  0 0 0 0 0 0 0     User Suspended
  0 0 0 0 0 0 1     User Resumed
  0 0 0 0 0 1 0     Bearer Service Change
  1 1 1 0 0 0 1     Call  Information/Event
```

4.5.20. Original Called Number

The purpose of the Original Called Number information element is to identify the number from which the first redirection/diversion was invoked.

As a BCS.32 subscription option, the Original Called Number Information Element can be passed from user to user without network interpretation or interaction.

Octet \ Bits	8	7	6	5	4	3	2	1
1	0	Original Called Number Information Element Identifier 1 1 1 0 0 1 1						
2	Length of Original Address Information Element							
3	0/1 Ext.	Type of Number			Numbering Plan Identification			
*3a	0/1 Ext.	Presentation Indicator		0 0 0 Spare			Screen Indicator	
*3b	0/1 Ext.	0 0 0 Spare			Reason for Redirection			
*3c	1 Ext.	CFW no Reply	0 0 0 Spare			Redirection Counter		
4	0 spare	Number Digits (IA5 chars.)						

Original Called Number Information Element

* This octet may be omitted.

Type of Number (Octet 3)

```
Bits
7 6 5
0 0 0   Unknown
0 0 1   International Number
0 1 0   National Number
1 0 0   Local (directory) Number
```

All other values are reserved.

Numbering Plan Identification (octet 3)

Bits

4 3 2 1

0 0 0 0   Unknown
0 0 0 1   ISDN/Telephony numbering plan (Rec. E.164)
1 0 0 1   Private numbering plan

All other values are reserved.

Presentation Indicator (octet 3a)

Bits

7 6

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

Screening Indicator (octet 3a)

Bits

2 1

0 0   User-provided, not screened
1 1   Network-provided

Note: If octet 3a is omitted "User-provided, not screened" is assumed.

Reason for Redirection (octet 3b)

Bits

4 3 2 1   Numbering plan

0 0 0 1   Call Forwarding Busy
0 0 1 0   Call Forwarding No Reply
0 1 0 0   Call Transfer
0 1 0 1   Call Pickup
1 0 0 1   Called CPE out of order
1 0 1 0   Call Forwarding by the called CPE
1 1 1 1   Call Forwarding unconditional or systematic call redirection

Call Forwarding No Reply Indicator (octet 3c, bit 7)

Bit

7

0   False
1   True

Redirection Counter (Octet 3c)

Bits

3 2 1

0 0 0   Counter = 0 (default)
0 0 1   Counter = 1

```
0  1  0    Counter = 2
0  1  1    Counter = 3
1  0  0    Counter = 4
1  0  1    Counter = 5
```

4.5.21. Progress Indicator

The purpose of the Progress Indicator information element is to describe an event which has occurred during the life of a call.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	Progress Indicator 0　　0　　1　　1　　1　　1　　0 Information Element Identifier						
2	Length of Progress Indicator Information Element							
3	1 Ext.	Coding Standard		0 Spare	Location			
4,etc.	1 Ext.	Progress Description						

Progress Information Element

<u>Coding Standard (octet 3)</u>
```
Bits
7 6
0  0      CCITT Standard
```

<u>General Location (octet 3)</u>
```
Bits
4 3 2 1
0 0 0 0    user
0 0 0 1    private network serving the local user
0 0 1 0    public network serving local user
0 0 1 1    transit network¥
0 1 0 0    public network serving the remote user¥
0 1 0 1    private network serving the remote user¥
0 1 1 1    international network¥
1 0 0 0    network beyond interworking point¥
```
All other values are reserved

¥ Not supported in BCS.31.

Progress Description (octet 4)
Bits

7 6 5 4 3 2 1	#	Meaning
0 0 0 0 0 0 1	1.	Call is not end-to-end ISDN;[5] further call progress information may be available in-band
0 0 0 1 0 0 0	8.	In-band information or pattern is now available

4.5.22. Redirecting Number

The purpose of the Redirecting number information element is to identify the number from which call redirection/diversion was invoked.

As a BCS.32 subscription option, the Redirecting Number Information Element can be passed from user to user in an Alerting message without network interaction or interpretation.

Octet \ Bits	8	7	6	5	4	3	2	1
1	0	1	1	1	0	1	0	0
		Redirecting Number Information Element Identifier						
2	Length of Redirecting Number Information Element							
3	1 Ext.	Type of Address			Numbering Plan Identification			
3a*	1 Ext.	Presentation Indicator		0 0 0 Spare			Screen Indicator	
4, etc.	0 Spare	Number Digits						

Redirecting Number Information Element

Refer to "Calling Party Number" in Section 4.5.5 for encoding details.

---

[5] "Call is not end-to-end ISDN" refers to interworking trunk facilities.

4.5.23. Redirection Number

The purpose of the Redirection Number information element is to identify the number to which call redirection/diversion should be or has been invoked.

As a BCS.32 subscription option, the Redirection Number Information Element can be passed from user to user without network interpretation or interaction.

Bits Octet	8	7	6	5	4	3	2	1
1	0	Redirection Number 1 1 1 0 1 1 0 Information Element Identifier						
2	Length of Redirection Number Information Element							
3	0/1 Ext.	Type of Address			Numbering Plan Identification			
3a*	1 Ext.	Presentation Indicator		0 0 0 Spare			Screen Indicator	
4, etc.	0 Spare	Number Digits						

Redirection Number Information Element

* This octet may be omitted.

Refer to "Calling Party Number" in Section 4.5.5 for encoding details.

4.5.24. <u>Restart Indicator</u>

The purpose of the Restart Indicator information element is to identify the class of the facility (i.e. channel or interface) to be restarted.

Bits Octet	8	7	6	5	4	3	2	1
1	0	1	1 Restart Indicator Information Element Identifier	1	1	0	0	1
2	Length of Restart Indicator Information Element							
3	1 Ext	0	0	0	0	Class		

Restart Indicator Information Element

<u>Class (octet 3)</u>
Bits
<u>3 2 1</u>
0 0 0   Indicated D-channel (Note)
1 1 0   Single Interface£
1 1 1   All channels associated with the D-channel
All other values are reserved.

Note -   The Channel identification information element must be included and indicates which channel is to be restarted.

___

£ Supported in BCS.32. The DMS will never send this value, but will accept it from the user and restart the interface accordingly.

4.5.25. Transit Network Selection

The purpose of the Transit Network Selection[¥] information element is to request a transit network for call routing.

Bits / Octet	8	7	6	5	4	3	2	1
1	0	— Transit Network Selection Information Element Identifier (1 1 1 1 0 0 0)						
2	Length of Transit Network Selectio n Information Element							
3	1 Ext	Type of Network Identification			Network Identification Plan			
4	0 Spare	Network Identification (IA5 characters)						

Transit Network Selection Information Element

Type of Network Identification (Octet 3)
 Bits
 7 6 5
 0 1 0   National Network Identification

If the "Type of Network Identification" field indicates "National Network Identification", the following encoding is used:

Network Identification Plan (Octet 3)
 Bits
 4 3 2 1
 0 0 0 1 Inter-exchange carrier code

Network Identification (Octet 4)

This shall consist of a string of IA5 characters organized according to the rules of the network identification plan specified in octet 3. Identification of Interexchange Carrier (IEC) networks shall be the 3 digit code assigned to IECs by Bell Communications Research.

¥ Not supported in BCS.31.

4.5.26. User-to-User Information¥

The purpose of the User-to-User information element is to convey information between a users. This information is not interpreted by the network, but rather is carried transparently and delivered to the remote user(s).

Bits Octet	8	7	6	5	4	3	2	1
1	0	| User-User Information						
		1	1	1	1	1	1	0
		Information Element Identifier						
2	Length of User-User Information Information Element							
3,etc	User-User Information							

User-to-User Information Information Element

There are no restrictions on the contents of the user information field.

¥ Not Supported in BCS.31.

5. CALL CONTROL PROCEDURES

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 Sections 2.1.1 and 2.1.2 for user and network call states, respectively).

Circuit-switched calls are controlled by a sequence of messages flowing across the user-network interface. This section describes the sequence.

5.1. Call Establishment at the Originating Exchange

Before these procedures are invoked, a reliable data link connection must be established between the user (TE/NT2) and the network. The data link services described in the Layer 2 procedures are assumed.[1]

5.1.1. Call Request

a) General

A user initiates call establishment by transferring a SETUP message across the user network interface[2]. Following the transmission of the SETUP message, the call shall be considered by the user to be in the Call Initiated state. The message shall always contain a call reference (selected according to the procedures given in Section 4.3), the bearer capability information element, channel identification and called number.

After sending the SETUP message, the user will start T303. If no response (CALL PROCeeding) is received from the network within time interval T303, the SETUP message is re-transmitted and timer T303 is restarted. If no response is received before timer T303 expires the second time, the user shall send a RELease COMplete message, with cause #31 "normal, unspecified", to the network and start timer T308.

b) Call Information Sending

The SETUP message shall contain all the information required from the user by the network to process the call. For functional signaling, call information is included in functional information elements (e.g., Called Party Number). If analysis by the network indicates that all information necessary to effect call establishment has been received, the network sends a CALL PROCeeding message to the user to acknowledge

---

[1] Layer 2 procedures are not a subject of this document. The DMS-250 uses the common DMS-family layer 1 and 2 procedures, which are defined by document NIS A211-1. Note that the layer 3 procedures defined by NIS A211-1 do not apply to the DMS-250.

[2] Note that although procedures for user-side call control procedures are described, there is no implication that the DMS-250 supports these procedures. The DMS-250 should always be configured as a network node.

the SETUP message and to indicate that the call is being processed. The CALL PROCeeding message contains the B-channel allocated to the call and to which the user must be attached. At this point, the call enters the OUTGOING CALL PROCEEDING state.

When transmitting the CALL PROCeeding message to the user, the network shall connect to the allocated B-channel. Upon receipt of the CALL PROCeeding message, the user shall connect to the allocated B-channel.

If following the receipt of a SETUP message the network determines that the call information received from the user is invalid (i.e., invalid facility request or number), then the network shall initiate clearing by sending a RELease COMplete to the user as defined in Section 5.3.

c) <u>B-Channel Selection - Originating</u>

In the SETUP message, the user will indicate **an exclusive channel with no acceptable alternative.**[3]

If the requested channel is available, the network reserves it for the call.

The reserved B-channel is indicated in the first message returned by the network in response to SETUP (i.e., CALL PROCeeding). After transmitting this message, the network shall connect to the B-channel connection. This message may also be used to trigger the terminal to connect to the B-channel.

If there is no channel available as requested, a RELease COMplete message, with cause #44 "requested circuit/channel not available", is sent by the network as described in Section 5.3.

If the channel requested in the SETUP message is in the maintenance busy condition, then a RELease COMplete message with cause value #82, "Identified Channel does not exist", will be returned to the calling user.

If a glare condition occurs, in which both the user and the network are attempting to use the same B-channel simultaneously, then the call will be handled as described in "Call Collision" section 5.6.

5.1.2.   Call Proceeding

After completion of channel selection, and when the network has received sufficient call information, it determines whether the call can be established as requested. If access to any services and facilities requested is not authorized for the user, the network initiates clearing of the call with a message sent to the user (see Section 5.3). Otherwise, the network will send a CALL PROCeeding message to the calling user and will enter the "Outgoing Call Proceeding" state. The user should also enter the "Outgoing Call Proceeding" state upon receiving this message.

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[3] Note that although the value of "Preferred channel" is accepted by the DMS,   it will be treated as if "Exclusive channel" had been received. The DMS   will never send "Preferred channel".

If access to requested services and facilities is authorized but not presently available, the network shall initiate clearing of the call by sending a message as described in Section 5.3.

If access to the requested service and facilities is authorized and available, the network proceeds with call establishment.

After sending the CALL PROCeeding message and before sending an ALERTing message, the network may send a PROGress message to the user. This indicates either an interworking situation has occurred or that a network announcement will be provided in the information channel. At this point, the user should connect to the bearer channel, if not already connected.

This message shall:

- have no effect on the protocol state when sent or received

- stop timer T310 (if started)

5.1.3.   Call Confirmation Indication

Upon receiving an indication that user alerting has been initiated at the called address, the network transfers an ALERTing message across the user-network interface of the calling address. This message may cause initiation of an user equipment generated alerting indication.

At this time, the call enters the Call-delivered state.

5.1.4.   Call Connected

Upon receiving an indication that the call has been accepted, a CONNect message is sent across the user-network interface to the calling user.

This message indicates to the calling user that a connection has been established through the network and stops a possible local indication of alerting. At this time, the call enters the Active state.

On receipt of the CONNect message, the calling user may optionally generate a CONNect ACKnowledge message. The network shall not take any action on receipt of this message when it perceives the call to be in the Active state.

5.1.5.   Call Rejection

Upon receiving an indication that the remote user (or network) is unable to accept the call, the network will initiate clearing as described in Section 5.3.

5.2. Call Establishment at the Destination Exchange

This procedure assumes that a data link connection providing services described in the Layer 2 procedures exists before the first layer 3 message (SETUP) is transferred across the interface.[4] The call reference contained in all messages relating to this call that are exchanged across the user-network interface shall contain the call reference value specified in the SETUP message delivered by the network.

5.2.1. Incoming Call

The network will indicate the arrival of a call at the user, network interface by transferring a SETUP message across the interface. This message indicates the B-channel to be used for the call if an idle B-channel exists. Since a point-to-point configuration exists at the interface, a point-to-point link is used to carry the SETUP message. The SETUP message should contain all information necessary to complete the call.

After sending the SETUP message, the call is in the Call Present state. The network initializes timer T303.

5.2.2. B-Channel Connection

In the SETUP message, the network will indicate the B-channel to be used with no acceptable alternative, for the call. If the indicated channel is acceptable, the user equipment reserves it for the call. If the indicated channel is not acceptable, the user equipment returns a RELease COMplete message, with cause #44 "requested circuit/channel not available", and returns to the NULL state.[5]

If the channel requested in the SETUP message is in the maintenance busy condition, then a RELease COMplete message with cause value #82, "Identified Channel does not exist", will be returned to the calling user.

5.2.3. Call Confirmation

a) Primary Rate Interface Structure

User equipment can respond to the SETUP message with an ALERTing, CALL PROCeeding, CONNect, or RELease COMplete message, followed by entering the Incoming Call Proceeding, Call Received, or Connect Request state (respectively). If the compatibility requirements indicated in the SETUP message are not satisfied, the user equipment shall respond by sending a RELease COMplete message with cause #88 "incompatible destination". Receipt by the network of a CALL PROCeeding message causes timer T303 to be cancelled and timer T310 to be initiated, at which point the network will enter the Incoming Call Proceeding state. The value of timer T310 is specified in "PROTOCOL TIMER VALUES" in section 6.0. Receipt by the

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[4] Layer 2 procedures are not a subject of this document. The DMS-250 uses the common DMS-family layer 1 and 2 procedures, which are defined by document NIS A211-1. Note that the layer 3 procedures defined by NIS   A211-1 do not apply to the DMS-250.

[5] Since the DMS will never send a channel identification value indicating "Preferred channel", the user must either accept the channel or clear   the call. The user does NOT have the option of channel negotiation.

network of an ALERTing or CONNect message subsequent to receipt of a CALL PROCeeding message causes a corresponding ALERTing or CONNect message to be sent to the calling user equipment, and timer T310 is cancelled. The user should start T301 after sending an ALERTing message to the network.

At the destination user to network interface, if an ALERTing, CALL PROCeeding, or CONNect message is the first response to a SETUP message, the Channel Identification information element is mandatory.£ Since the DMS-250 only supports exclusive channel selection, a channel identified in the response to SETUP which is not the channel identified in the SETUP message will result in a STATUS message being sent to the user. The STATUS message will contain cause #44, "channel unavailable", and with the state indicating the state at which the PROCeeding was received (no state change will occur).

At the destination user to network interface, if an ALERTing, CALL PROCeeding, or CONNect message contains a Progress Indicator Information Element, then this information will be ignored by the network.£'

Receipt by the network of an ALERTing or CONNect message in the case where no CALL PROCeeding message has been received causes a corresponding ALERTing or CONNect message to be sent to the calling user equipment and timer T303 to be cancelled, but timer T310 is not initiated.

b) <u>Call Failure Procedures</u>

If the network does not receive any response to the SETUP message within a time interval T303, the SETUP message is re-transmitted and Timer T303 is restarted. If no response is received before T303 expires the second time, the network initiates clearing by sending RELease COMplete to the called user, RELease to the calling user, starting T308 and moving into the Release request state (N19).

If the network receives a CALL PROCeeding message in response to a SETUP message, timer T303 is cancelled and timer T310 is initialized. If the network subsequently does not receive an ALERTing, PROGress, CONNect or DISConnect message prior to expiration of timer T310, it will initiate clearing procedures by sending a RELease message with cause "normal unspecified" and starting timer T308£. The clearing cause sent to the calling user equipment is cause #18, "no user responding". The value of T303 and T310 are specified in "PROTOCOL TIMER VALUES" in section 6.0.

If a RELease or RELease COMplete message is received while T303 is running, or if a RELease or DISConnect message is received while T310 is running, the cause shall be returned in a RELease or DISConnect message to the calling user equipment immediately, and the network shall proceed to clear the call as described in section 5.3.

£ This restriction is removed in BCS.32.

£' In BCS.32, this information will be accepted in CALL PROCeeding and ALERTing messages, and relayed to the originating user via a PROGress message.

£ In BCS.32, the DMS will recover from T310 expiry by sending a DISConnect message with cause #102 ("recovery on timer expiry"), before starting timer T308.

In the event that timer T301 expires (no CONNECT or DISCONNECT is received after ALERTING is received), ANSI specifies that the network is to send a RELease COMPlete message to the called user with the value "no answer from user (user alerted)." The DMS-250 does not support timer T301 and will therefore not follow these procedures. £'

5.2.4. Call Accept

A user indicates acceptance of an incoming call by transferring a CONNect message across the user-network interface towards the network. If an ALERTing (or CALL PROCeeding) message had previously been sent to the network, the CONNect message may contain only the call reference.

If a call can be accepted using the B-channel indicated in the SETUP message, and no user alerting is required, a CONNect message may be sent without a previous ALERTing message. In this case the CONNect message contains the channel identification information element. The CONNect message contains the call reference value specified in the SETUP message.

5.2.5. Active Indication

On receipt of the CONNect message, the network completes the circuit switched path to the selected B-channel (if not already connected) and subsequently sends a CONNect ACKnowledge message. The CONNect ACKnowledge message includes the call reference value specified. It is presumed that the B-channel that was agreed earlier is being used for the call. The network also initiates procedures to send a CONNect message towards the calling user.

The CONNect ACKnowledge message indicates completion of the circuit switched connection. There may not be end-to-end communications until the CONNect indication is received at the calling user. At this point, the call enters the Active state where it remains until clearing is initiated.

NOTE: For BCS.31, the CONNect ACKnowledge message is optional for the USER side and mandatory for the NETWORK side.

The user may connect to the B-channel as soon as channel negotiation has been completed (i.e., upon sending the first non-clearing message in response to the SETUP message).

5.3. Call Clearing

The following terms are used in the description of the clearing procedures:

- A channel is "connected" when the channel is part of a circuit-switched ISDN connection established according to this document.

£' The DMS-250 will support timer T301, and the associated call failure procedures, beginning in BCS.32.

- 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.

- A call reference that is "released" is available for reuse.

Under normal conditions, call clearing is usually initiated by the user or the network sending a DISConnect message and following the procedures defined in this section. Exceptions to this rule are as follows;

1. Call clearing due to protocol violations

   Clearing of calls due to protocol violations or protocol time-outs will be initiated by sending the DISConnect or RELease message.

2. Call rejection in response to SETUP

   The user or network may clear a call which is rejected by responding with a RELease COMPlete message and entering the null state, provided no other response has previously been sent. Otherwise a DISConnect message shall be sent.

3. Call rejection by network or destination user prior to answer.

   Calls may be rejected by the network or the destination user prior to answer, due to:

   - call progress failure in network, i.e., network congestion

   - no positive response by the destination user i.e., 2nd expiry of T303, expiry of T310

   - rejection of the call by the destination user who has responded with RELease COMplete, with cause value of user busy or call rejected

   - network determined user busy, or bearer service in compatibility with subscription options.

Under these conditions clearing of the call will be initiated by sending the RELease message.

5.3.1. Clearing by the User

a) Apart from the exceptions identified in Section 5.3 above, clearing is initiated by transferring across the user-network interface a DISConnect message. Timer T305 is started when the DISConnect message is sent. Following the receipt of a DISConnect message, the network shall consider the call to be in the Disconnect Request state (the user shall consider the call to be in the Disconnect Request state).

b) If the call is to be cleared immediately after receipt of the DISConnect message, the B-channel used in the call shall be disconnected and a RELease message shall be sent.

Following the transmission of the RELease message, timer T308 is started and the Release Request state is entered. On receipt of this RELease message, the side initiating the clearing shall, cancel timer T305, release the B-channel and the call reference, and send a RELease COMplete message. If no RELease message is received before expiry of timer T305, the B-channel is disconnected, a RELease message is sent, and timer T308 is started. Following the receipt of the RELease COMplete message timer T308 is cancelled, and both the B-channel and the call reference shall be released for future use. If a RELease COMplete message is not received before timer T308 expires, the RELease message shall be re-transmitted and timer T308 shall be restarted. If no RELease COMplete is received before timer T308 expires the second time, the call reference shall be released for future use, but the B-channel shall not be released for reuse until the status of this channel is cleared by use of the Restart procedures (see section 5.4). The values of T305, and T308 are specified in "PROTOCOL TIMER VALUES" in section 6.0.

If no RELease COMplete message is received before the second expiry of T308, the channel will be put into the maintenance busy condition by the network.

The RELease message has only local significance and does not imply an acknowledgement of clearing from the remote user.

c) In some cases, a RELease message may be received without having received a previous DISConnect message. In these cases, the receiver of the RELease message shall release the B-channel and call reference, and then return a RELease COMplete message to the originator of the RELease message and consider the call to be in the Null state.

5.3.2.   Clearing by the Network

As defined in section 5.3.1 "Clearing by the User" procedures.

5.3.3.   Clear Collision

Clear collision occurs when the user and the network simultaneously transfer a DISConnect message specifying the same call. Both the user and the network will respond by sending a RELease message and entering the Release Request state. The procedures in Section 5.3.1 will then apply.

It can also occur when both sides simultaneously transfer a RELease message related to the same call. The entity receiving such a RELease message while in the Release Request state (N19 or U19), shall stop T308, release the B-channel, return RELease COMplete and release the call reference and return to the Null state.

5.4. Restart Procedures

The Restart procedure is used to return channels and interfaces to an idle condition (the Null state). The procedure is invoked;

- on data link establishment at time of system initialization (optionally)

- after a data link reset following a data link failure (i.e., after T309 expiry)

- following expiry of T308 (2nd time) due to the absence of response to the RELease message (to restart that specific channel).

The Restart procedure may refer to a number of calls (call references) simultaneously, and so the global call reference is used. Note that a number of Restart messages may be sent and outstanding, referring to different B-channels. There are three states associated with the global call reference;

- Null state   No active calls or maintenance procedures in progress

- Restart Request   Awaiting acknowledge after requesting restart

- Restart   Restart being performed after receiving RESTart message

5.4.1. Sending Restart

A RESTart message is sent by the network or the user in order to return channels or interfaces to the Null state.

- Restarting a specified B-channel: the channel identification information element must be present in the RESTart message

- Restarting all interfaces associated with the D-channel: at this time the channels and call references identified by the RESTart message are   made available for use. This type of restart is identified by

   1.   absence of the channel identification information element in the RESTart message.

   2.   encoding the class field within the RESTart indicator information element to denote "All interfaces associated with the   D-channel"

- Restarting a single interface[£]: at this time the channels of the specified interface are made available for use. This type of restart is identified by

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[£] Supported in BCS.32.

1.   presence of the channel identification information element in the RESTart message, with the appropriate interface identifier   and no channel specified, or absence of the channel   identification information element, indicating that the interface   containing the D-channel is to be restarted.

2.   encoding the class field within the RESTart indicator information element to denote "Single Interface".

Upon transmitting the RESTart message the sender enters the Restart Request state, starts timer T316, and waits for a RESTart ACKnowledge message. Receipt of a RESTart Acknowledge message frees the channels and the call references for re-use.

If a RESTart ACKnowledge message is not received prior to expiry of timer T316 then the timer will be restarted and a RESTart message will be produced. After the second attempt, the appropriate maintenance entity will be notified, the channel or interface will be placed into the maintenance busy condition, and restart proceedures will be reattempted. Thus, when restarting an interface, the period between RESTart messages will be approximately 120 seconds. RESTart messages will be sent until a RESTart ACKnowledge message is returned. Meanwhile, no calls shall be placed or accepted (over the channel or interface identified in the RESTart message) by the originator of the RESTart message.

The RESTart and RESTart ACKnowledge messages shall contain the global call reference value (all zeros).

5.4.2.   Receipt of Restart

Upon receiving a RESTart message the recipient shall enter the Restart state associated to the global call reference. It shall then take appropriate internal actions to return the specified channels and call references to the Null state. When this is accomplished it shall send a RESTart ACKnowledge message to the originator.

An unsolicited RESTart ACKnowledge message will be discarded by the recipient (in order to keep up existing calls).

5.5. Handling of Error Conditions

Capabilities facilitating the orderly treatment of error conditions are provided for in this section.

The network may establish a threshold for the number of messages or information elements received which are either incorrect or not understood. The network may release calls if the thresholds are exceeded.

5.5.1.   Message Too Short

When a message is received with a truncated message header (e.g., less than 4 octets for a single-octet call reference value and 5-octets for a 2-octet call reference value), or truncated information element, then that message shall be discarded.

5.5.2.   Protocol Discriminator Errors

When a message is received with a protocol discriminator not in accordance with Section 4.2, that message shall be discarded.

5.5.3.   Call Reference Errors

If the call reference information element indicates a length greater than the maximum supported by the receiving equipment, then the message shall be ignored.

Whenever the network or user receives any message, except SETUP, RELease COMplete, STATUS, or STATUS ENQuiry, specifying a call reference which it does not recognize as relating to an active call or a call in progress, it sends a RELease COMplete message, using the call reference in the received message and the call enters the Null state. If a RELease COMplete message is received no action should be taken.

In all these clearing messages, cause value # 81, "invalid call reference value" shall be used.

Whenever a message is received with the dummy call reference or a message other than RESTart of RESTart ACKnowledge is received with the global call reference, no action will be taken and a STATUS with cause value #81, "invalid Call Reference Value", and the globabl call state value will be returned.

If a SETUP message is received with the flag value set to 1 or with a call reference recognized as relating to a call in progress, then the SETUP message shall be discarded.

If any message is received in which call reference octet 1, bits 5 to 8, are not equal to zero, then the message will be ignored.

If a STATUS ENQuiry message is received, with a call reference which is not recognized as a call in progress, then a STATUS message, with the state indicating the null state and cause value #30, "Response to Status Enquiry", will be returned.

5.5.4.   Message Type Errors

If a message is received containing a message type which is either not implemented or not understood, then no action should be taken on that message and no state change should occur. A STATUS message is returned with cause value # 97, "message type non-existent or not implemented".

Whenever an implemented message is received, at either side of the interface, specifying a call reference relating to a call which is considered to be in either the ACTIVE state or any of the states of call establishment or clearing, but for which a response is not prescribed by the procedures in 5.1.1 or 5.1.2, a STATUS message is returned with cause value #98, "message not compatible with state." The state returned in the status message will be the state in which the DMS-250 received the incorrect message. No state change will occur.

5.5.5.   Information Element Errors

When a message is received containing an information element repeated more times than the specified allowable maximum, the message shall be acted upon, ignoring the contents of occurrences of the information element beyond the maximum.

When an information element is received with unrecognized extended octet(s), the information element shall be discarded.

5.5.5.1. Mandatory Information Element Errors

When a SETUP or RELease message is received, which has one or more mandatory information elements missing or truncated or having invalid contents, then a RELease COMPlete message with the cause value #96 "mandatory information element is missing" or cause value # 100 "invalid information element contents" shall be returned.

If a message, other than SETUP, RELease or RELease COMPlete is received, which has one or more mandatory information elements missing or truncated or having invalid contents, then a STATUS message is returned with the cause value # 96 "mandatory information element missing" (for missing mandatory IE's) or cause value # 100 "invalid information element contents" (for invalid mandatory IE's), and optionally the diagnostic field specifying the identifier of the first missing information element may be returned. The state returned will be that in which the DMS-250 received the incorrect message, and no state change will occur.

When a DISConnect message is received with the cause information element missing or truncated or having invalid contents, then the actions taken shall be the same as if a DISConnect message with cause value # 31, "normal, unspecified" was received.£

When a RELease COMPlete message is received with the cause information element missing or truncated or having invalid contents, then the actions taken shall be the same as if a RELease COMPlete message with cause value # 31, "normal, unspecified" was received.£

5.5.5.2. Non-mandatory Information Element Errors

When the user or network receives a message containing optional information elements that it does not know how to act upon, or truncated information elements, it shall act on the message and those information elements that it can action. Optionally, the information not acted upon may be returned in a STATUS message.£'

As a network option, unrecognized information elements received in the SETUP message may be carried end-to-end without network interpretation or interaction. The support of unrecognized parameters in this manner is a BCS.32 characteristic.

£ In BCS.32, the cause used in this instance will be #96, "mandatory   information element is missing".

£' In BCS.32, the DMS will check to see if comprehension is required of the
        information element received. If comprehension is required, the   missing
element will be treated identically to "Mandatory information   element error".

5.5.6.   Data Link Reset

If the network side layer 3 entity is notified by its data link layer entity via the primitive DL-ESTABLISH-CONFIRM that the data link has been reset, it should send a STATUS ENQuiry message to all calls in the Active state (N10). Timer T315 is started and if any other timer is running, it should be cancelled.

Note: The entity issuing the STATUS ENQuiry should save its state in a variable associated with a timer to avoid comparing the STATUS response to a state which has changed since the time of issuing the request.

Call clearing procedures should be initiated for calls in states of network call establishment (States N1, N3, N4, N6, N7, N8 and N9) or user call establishment (States U1, U3, U4, U6, U7, U8 and U9) by sending the RELease message as outlined in Section 5.1.3.£

No action should be taken for calls in the Null state (State 0) or any of the states of call disestablishment (States N11, N12, N19).

When the network receives a STATUS message with cause value #30, "response to STATUS ENQuiry", it should cancel timer T315 and follow the procedures defined in the "Receipt of STATUS Message" section.

If T315 expires and no response to the STATUS ENQuiry message has been received, the network clears the call by sending the RELease message as outlined in Section 5.1.3.

5.5.7.   Data Link Failure

If the network side layer 3 is notified by its data link layer entity via the primitive DL-RELEASE-INDICATION that there is a data link layer malfunction, the following should apply;

1. Start timer T309 for all calls in the Active state (State N10).

2. Call clearing procedures should be initiated for calls in states of call establishment (States N1, N3, N4, N6, N7, N8 and N9) by sending the RELease message as outlined in Section 5.1.3.£'

3. No action should be taken for calls in the Null state (State 0) or any of the states of call Disestablishment-establishment (States N11, N12, N19).

£ In BCS.32, the data link layer will inform layer 3 via the DL-ESTABLISH-
      INDICATION primitive that the data link has been reset. This will result in calls that are in the clearing phase to be released, while all other   calls will be maintained.

£' In BCS.32, calls which have an existing timer running against them will
      continue with this timer. Therefore, they will be cleared in the event of the timer expiry, but will continue if the data link re-establishes prior   to timer expiry.

4. Network layer 3 entity shall request layer 2 re-establishment by sending primitive DL-ESTABLISH-REQUEST.

When informed via the primitive DL-ESTABLISH-CONFIRMATION that the data link layer is re-established, the network should stop T309, and follow the procedures defined in the case of Data Link Reset.

If timer T309 expires, internal clearing procedures should be initiated by the network. When informed via the primitive DL-ESTABLISH-CONFIRMATION that the data link layer is re-established, the network should initiate Restart procedures.

5.5.7.1. Status Enquiry Procedure

Upon receipt of a STATUS ENQuiry message, a STATUS message shall be returned indicating the state of the call. In this case, no state transition shall occur. The cause value #97, "message type non-existent or not implemented" will be sent in this case.£

If a STATUS ENQuiry message is received in the NULL state, then a STATUS message will be returned with cause value #30, "response to status enquiry", and the state indicating the null state.

5.5.7.2. Receipt of Status Messages

On receipt of a STATUS message the state reported shall be examined for compatibility. If compatible, no action shall be taken. If not compatible, the call shall be cleared by sending the RELease message containing the cause value #111, "protocol error unspecified".£'

The state number reported in the STATUS message matches only if it is equal to the value of the current state of the receiving state machine.

5.6. Call Collision

From the user perspective, channel selection conflicts should be resolved by giving priority to incoming calls, i.e., calls being established from the network to the called user.

5.7. Interworking With Existing Networks

Methods for providing audible ringback, user busy tones and 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

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£ This is supported in BCS.32.

£' In BCS.32, the cause value sent in this event will be #101, "message not compatible with call state".

preserve the same human interface for calls that are routed over these facilities, and to allow for interworking with non-ISDN interfaces.

These procedures identify the agent responsible for generating in-band busy and audible ringback tones. This pertains to calls purely within an ISDN environment as well as to calls between ISDN and non-ISDN networks.

Three call scenarios need to be considered:

1. The call has been delivered successfully to terminating user, who is being alerted.

2. The call is unsuccessful because of terminating user busy.

3. The call requires that network provided announcements be sent to the calling user.

Moreover, three call types need to be considered:

1. Within ISDN

2. From non-ISDN to ISDN

3. From ISDN to non-ISDN

These procedures indicate that the non-ISDN network continue to provide tones and announcements as currently implemented regardless of the call type and scenario. It also proposes that an ISDN exchange act in a manner that is independent of the three call types, i.e., independent of the possible existence and character of interworking.

The terms "originating exchange" and" terminating exchange" will be used to refer to equipment such as IEC switches which are closest to the respective end users. An intermediate exchange is an IEC switch situated between the originating and terminating exchanges.

5.7.1. Generation of Audible Ringback Tones

The terminating exchange (either ISDN or non-ISDN) shall be responsible for the generation of audible ringback tones for all three call types.

5.7.1.1. Calls Terminating on ISDN Facilities (Call Types 1 and 2)

This section describes procedures for calls of type 1 and 2.

In order to remain consistent with pre-ISDN implementation, audible ringback tone will always be provided by the terminating exchange.

For type 1 calls audible ringback will always be generated by the destination switch. The network assumes that the user will provide other tones and announcements and therefore will clear the call back to the originating user upon call failure. The user can,

as a subscription option¥ , subscribe to tones and announcements provision from the network.

For type 2 calls, the procedures described below are always executed. The terminating exchange determines it is a type 2 call by the presence of the Progress Indicator Information Element in the SETUP message, having progress description value # 1, "call is not end-to-end ISDN".

In these cases, if the call proceeds through the network and successfully reaches the terminating exchange, the terminating exchange will:

- Determine if the end point terminal is available.
- If so, alert end-user terminal, propagate the alerting indicator back to
the originating exchange and provide in-band audible ringback tone.
- When the terminal at the terminating exchange answers the call by sending a CONNect message or equivalent "off-hook" indication, audible ringback is removed, and the CONNect message is propagated back towards the originating exchange.

5.7.1.2. ISDN to Non-ISDN (Call Type 3)

In this call type, interworking occurs at interworking exchange. When the interworking condition is detected, it is the responsibility of the interworking exchange to forward a PROGress message with the Progress Indicator Information Element having progress description value # 3 "call is not end-to-end ISDN", towards the originating side of the interface. This is an indication that the call has left the ISDN and that audible ringback will be provided in-band from the terminating exchange. The PROGress message, in conjunction with interexchange signaling, will cause cut-through from the ISDN originating exchange to the interworking exchange. Further, it is the responsibility of the interworking exchange to monitor the outgoing non-ISDN trunking facilities for answer and disconnect supervision. These conditions, upon detection, will be translated into CONNect or DISConnect messages, respectively, for the ISDN side of the call.

5.7.2. Generation of Busy Tones

In-band busy tones shall be generated at a point as close as possible to the originating terminal, allowing network resources used to reach the terminating exchange to be released. The user can subscribe to have the network provide busy tone as a subscription option¥ .

5.7.2.1. ISDN to ISDN (Call Type 1)

Upon notification that the called user is busy, the terminating exchange generates a DISConnect message with value #17, "user busy" towards the originating side. In response to this message, the originating exchange disconnects the B-channel and generates the in-band busy tone locally.

¥ This is not supported for BCS.31.

¥ This is not supported for BCS.31.

5.7.2.2. Non-ISDN to ISDN (Call Type 2)

As above, upon notification that the called user is busy, the terminating exchange generates an appropriate clearing message towards the originating side. In response to this message from the ISDN network, the interworking exchange shall generate the busy tone towards the originating user.

5.7.2.3. ISDN to Non-ISDN (Call Type 3)

In this call type, the busy tone is generated by the terminating exchange as is done today. Note that in this call type a PROGress message has been sent towards the originating user by the interworking exchange indicating that the call is not end-to-end ISDN and that call progress information will be arriving only in-band. The PROGress message will cause cut-through from the ISDN originating exchange to the interworking exchange.

5.7.3. Network Provided Announcements

Calls within an ISDN may still have treatment applied, involving in-band information, e.g., tones or voice announcements.

The cut-through procedures ensure that in-band tones may be provided. Therefore, the network may insert in-band tones or announcements after returning or receiving the initial response to the SETUP message.

5.8. Channel Cut-through Procedures

The terminology of originating, intermediate and terminating exchanges is as in section 5.1.6. Cut-through should occur on receipt of the first message in response to the SETUP message, the cut-through procedures are simplified as described below.

5.8.1. Network Channel Cut-through

Originating and intermediate network switches shall connect to the agreed upon information channel upon receipt of the first response to the SETUP message. The terminating network switch shall connect to the agreed upon information channel upon receipt of "off-hook" indication (i.e., equivalent to the Q.931 CONNect message) from the end-user terminal.

Note: In some situations answer supervision may not be offered from non-ISDN networks. This information therefore will not be conveyed to the user.

5.8.2. User Channel Cut-through

The same procedures apply to the user equipment.

5.9. Maintenance Procedures

This section presents the maintenance procedures[2] to be used with the message defined in section 3.2. Since the maintenance messages are symmetrical, these procedures can be initiated by either side of the interface.

Note: These procedures are proprietary, and are not specified by current standards documentation.

Maintenance messages will follow the same structure as that of the call control messages. The benefits include the ability to mix and match components from each message set. The Channel ID information element is common to both sets. These procedures use two proprietary messages named SERVice and SERVice ACKnowledge.

5.9.1. Service Procedures

The procedures involving the SERVice message, change the status of a channel within the interface. The status change is accomplished by sending a SERVice message across the interface indicating the B-channel and its new status. The SERVice message can not be used to change the status of the D-channel[6]. The acknowledgment to the change is conveyed in the SERVice ACKnowledge message. The SERVice ACKnowledge returns the new status of the B-channel.

If a SERVice ACKnowledge message (response) is not received within 120 seconds after one side of the interface has sent a SERVice message, this side may keep on sending SERVice messages at periodic intervals until a SERVice ACKnowledge is returned. In the mean time, the new status in the initial SERVice message shall take effect.

5.9.2. Service Status Definitions

Associated with the SERVice message and class of maintenance are three status categories: In Service, Maintenance, Out of Service. This section defines the three allowed bearer channel (B-channel) status categories.

5.9.2.1. In Service

A bearer channel that is in the "In Service" status can be assigned by the signaling call control entity on either side of the interface. Such B-channels may be used for a call when a request occurs at the ISDN interface.

A bearer channel or interface (supported in later phase) that is in the "In Service" status may be moved to either the "Maintenance" or "Out of Service" status by either side of the interface.

---

[2] The maintenance messages are currently not supported in CCITT or ANSI standards.

[6] The Service messages will be used in the case of D-channel backup procedures, which are described in Annex F.

5.9.2.2. Maintenance

An interface or bearer channel that is in the "Maintenance" status may NOT be assigned for normal outgoing traffic by either side of the interface. Both sides of the interface should continue to process incoming calls. The purpose of this status is to place a B-channel in a condition in which it is not used for normal calls but may be used for special calls of a diagnostic nature (test calls).

A bearer channel or interface (supported in later phase) that is in the "Maintenance" status may be moved to the "Out of Service" status by either side of the interface.

A bearer channel or interface (supported in later phase) that is in the "Maintenance" status may be moved to the "In Service" status by either side of the interface, only if both sides agree. If both sides agree to do so, then SERVice and SERVice ACKnowledge messages are exchanged, with a change status IE indicating the "In Service" status.

5.9.2.3. Out Of Service

An interface or bearer channel that is in the "Out of Service" status may NOT be assigned for outgoing traffic by either side of the interface. Neither sides of the interface is required to process any incoming calls. If a SETUP message is received while calls are not being processed in this state, the receiving side shall respond with a RELease COMplete with cause "incoming calls barred" (cause value 54).

A bearer channel or interface (supported in later phase) that is in the "Out of Service" status may be moved to either the "In Service" or "Maintenance" status only if both sides of the interface agree to do so. By exchanging SERVice and SERVice ACKnowledge messages with a change status IE indicating the "In Service" or "Maintenance" status respectively, a status change will occur.

As a standard maintenance procedure, if a side of the interface detects an error condition that does not require further testing to identify the source of the problem, it shall place the B-channel into the "Out of Service" status.

5.9.3. Error Procedures

The network will ignore an unsolicited SERVice ACKnowledge message regardless of if the channel status agrees with that assumed by the network or whether the channel ID is correct. A solicited SERVice ACKnowledge message with the wrong channel ID will be ignored by the network and another SERVice message will be sent.

If any message is received with invalid contents the recipient will ignore this message.

5.10. Procedures for User-to-User Signaling[¥]

5.10.1. General

User-to-user signaling[¥] provides a means of communication between two users, using as a basis for information transfer the layer 3 protocol defined in Section 5.1.

The user-to-user information transfer service will be offered to users by the network in association with a circuit-switched (B-Channel) connection. User-to-user information elements may be included in certain call establishment (SETUP, CONNect, ALERTing) and clearing (DISConnect) messages.

The user-to-user information transfer service may be requested on a per call basis. This service may be invoked only if the originating user has included a user-to-user information element in the SETUP message.

The user-to-user information transfer service may not be available when the call encounters a non-ISDN signaling system in the network. If this occurs, a PROGress message will be sent to the user indicating "Call is not End-to-End ISDN". This implies to the user that any user-to-user information sent has been discarded.

User-to-user information has significance to the end-users only and is not interpreted by the network.

[¥] This is not supported for BCS.31.
[¥] This is not supported for BCS.31.

5.10.2. User-to-User Signaling Procedures

5.10.2.1. Call Establishment

A user-to-user information element may be included in a SETUP message transferred across the user-network interface at the calling side. The contents of this information element are transported by the network and delivered in the SETUP message transferred across the user-network interface at the called side.

A user-to-user information element may also be included in either the ALERTing or CONNect message, or both, and transferred across the user-network interface. The contents of this information element is transported by the network and delivered in the corresponding message(s) transferred across the user-network interface at the calling side.

5.10.2.2. Call Clearing

A user-to-user information element may be included in the DISConnect message. This information element will be transported and delivered to the remote user if possible. This will be completed successfully only if the information element is received at the network exchange serving the remote user before that exchange receives a clearing message from the remote user. Otherwise, the information will be discarded with no notification to the sending user.

6. PROTOCOL TIMER VALUES

6.1. TIMERS IN THE NETWORK SIDE

Timer Number	Timeout Value	State	Started	Normally Terminated	Action to be Taken When Timer Expires
T301£	180 s (minim)	N7	Alert Received	Connect Received	Clear Call
first T303	4 s	N6	On Sending SETUP	On Receiving CALL PROC, ALERT, CONN, REL COMP	Resend SETUP Restart T303
second T303	4 s	N6	On Resending SETUP	On Receiving CALL PROC, ALERT, CONN, REL COMP	Send RELease COMplete to called user. Send RELease to calling user. Start T308
T305	30 s	N12	On Sending DISConnect	On Receiving RELease, or DISConnect	Send RELease Start T308
first T308	4 s	N19	On Sending RELease	On Receiving REL COMP	Resend RELease Restart T308
second T308	4 s	N19	On Expiry of T-308	On Receiving REL COMP Enter State 0	Invoke RESTART procedures for that B-channel.
T309	90 s Stable	Any Calls in Stable State	DL disconnect State not lost	On DL Reconnect	Release Network connection
T310	10 s	N9	On Receiving CALL PROC	On Receiving ALERT, CONN PROG, DISC, or REL	Send DISConnect
T315	4 s	Any but N0, N11 N12, N19	On Sending STATUS ENQ	On Receiving STATUS	Initiate Call Clearing

---

£ This is supported in BCS.32.

T316	120 s	REST1	On sending RESTart	On Receiving RESTart ACK	Resend RESTart and restart T316
second T316	120 s	REST 1	On Resending RESTart	On Receiving RESTart ACK	Notify maintenance (system init.)
T321[7]	30 s	Any state	D-channel fail	L3 response received	DL_EST_REQ on both D-channels.

---

[7] Supported for D-channel Backup procedures (refer to Annex F).

6.2. TIMERS IN THE USER SIDE[8]

Timer Number	Timeout Value	State	Started	Normally Terminated	Action to be Taken When Timer Expires
T301[£]	180 s (minim)	U7	Alert Received	Connect Received	Clear call
first T303 (opt)	4 s	U1	On Sending SETUP	On Receiving CALL PROC, ALERT, CONN, REL COMP	Resend SETUP Restart T303
second T303 (opt)	4 s	U1	On Resending SETUP	On Receiving CALL PROC, ALERT, CONN, REL COMP	Send RELease COMplete Enter Null state
T305	30 s	U11	On Sending DISConnect	On Receiving RELease, or DISConnect	Send RELease Start T308
first T308	4 s	U19	On Expiry of T308	On Receiving REL COMP	Resend RELease Restart T308
second T308	4 s	U19	On Resending RELease	On Receiving REL COMP Enter State 0	Invoke RESTART procedures for that B-channel.
T309	90 s Stable	Any Calls in Stable State	DL disconnect Stable State not lost	On DL Reconnect	Release Network connection
T310 (opt)	10 s	U3	On Receiving CALL PROC	On Receiving ALERT, CONN PROG, DISC	Send DISConnect
T313	4 s	U8	On Sending CONNect	On Receiving CONNect ACK	Send RELease
T315	4 s	Any but U0, U11 U12, U19	On Sending STATUS ENQ	On Receiving STATUS	Initiate Call Clearing
T316	120 s	REST1	On sending RESTart	On Receiving RESTart ACK	Resend RESTart and restart T316
second T316	120 s	REST 1	On Resending RESTart	On Receiving RESTart ACK	Notify maintenance (system init.)
T321[9]	30 s	Any state	D-channel fail	L3 response received	DL_EST_REQ on both D-channels.

---

[8] Note that although user-side timers are specified, these are furnished for
    information only, and do not apply to the DMS-250.

[£] Supported in BCS.32.

[9] Supported for D-channel Backup procedures (refer to Annex F).

Annex A. SDL REPRESENTATION

The following sections provide two separate SDL representations for point-to-point call control procedures of the DMS-250. The first set of SDL sequences (section A.1) illustrate detailed call control procedures initiated from the user side[1]. The second set of SDL sequences (section A.2) illustrate detailed call control procedures initiated from the network side.

---

[1] Note that although user-side SDL diagrams are presented, these call control procedures are limited to customer-premise equipment. The DMS-250 should always be configured as a network-side, and thus these procedures do not apply.

A.1. SDL Procedures for the User Side

```
                              ┌──────────┐
                           ┌─┤NO│ NULL   │
                           │  └──────────┘
          ┌────────────────┴──────────────────────┐
     ╱─────────╲                            ╲──────────╱
    │ SETUP     │                            │ SETUP   │
    │ REQ.      │                            ╱──────────╲
     ╲─────────╱                                 │
          │                                      │
    ┌──────────┐                          ┌──────────┐
    │ ALLOCATE │                          │ SAVE     │
    │ CR       │                          │ CR       │
    └──────────┘                          └──────────┘
          │                                      │
     ╱────────╲         NO              ╱────────╲        NO
    ╱  Idle    ╲ ──────────────        ╱  Valid   ╲ ──────────────
    ╲ Channel  ╱                       ╲  Info.   ╱                │
     ╲ Avail. ╱                         ╲────────╱                 │
       ╲────╱                              YES                     │
   ╱────────╲  YES                    ╱────────╲        NO         │
  ╱ SETUP    ╲  ┌──────────┐         ╱   B-CH   ╲ ──────────────   │
 │ REJ. IND. │  │ SELECT   │         ╲  Avail.  ╱              │   │
  ╲──────────╱  │ B-CH     │          ╲────────╱               │   │
       │        └──────────┘             YES              ╱──────────╲
  ┌──────────┐   EXCL. │            ┌──────────┐         │ RELEASE   │
  │    U0    │    ╱──────────╲       │ RESERVE  │         │ COMPLETE  │
  └──────────┘   │ SETUP     │      │ B-CHANNEL │          ╲──────────╱
                  ╲──────────╱       └──────────┘               │
                       │                  │              ┌──────────┐
                 ╱──────────╲        ╱──────────╲        │ RELEASE  │
                │ START      │      ╱ SETUP       │      │ CR       │
                │ T303       │     │  IND.        │      └──────────┘
                 ╲──────────╱       ╲──────────╱              │
                       │                  │            ┌──────────┐
                 ┌──────────┐       ┌──────────┐       │    U0    │
                 │    U1    │       │    U6    │       └──────────┘
                 └──────────┘       └──────────┘
```

Call Control Detailed SDL Diagram (USER SIDE)

Call Control Detailed SDL Diagram (USER SIDE)

```
                    ┌─┐
                    │3│ OUTGOING
                    └─┘ CALL PROC
                          │
   ┌──────────────┬───────┴───────┬──────────────────────┐
   │              │               │                      │
EXPIRY        PROGRESS         ALERTING              CONNECT
T310
   │              │               │                      │
RELEASE         STOP            STOP                   STOP
                T310            T310                   T310
   │              │               │                      │
RELEASE        REPORT          REPORT                 SETUP
IND.           IND.            IND.                   CONF
               PROG            ALERT
   │              │               │                      │
START           U3              U4                   NO ◇ YES
T308                                                   RESP.
   │                                                      │
  U19                                            CONNECT
                                                 ACK
                                                     │
                                                    U10
```

```
                    ┌─┐
                    │4│  CALL
                    └─┘ DELIVERED
                          │
        ┌─────────────────┼──────────────────────┐
        │                 │                       │
      PROG              ALERT                  CONNECT
        │                 │                       │
     REPORT            REPORT                   SETUP
     IND.              IND.                     CONF
     PROG              ALERT
        │                 │                       │
       U4                U4                   NO ◇ YES
                                                RESP.
                                                    │
                                              CONNECT
                                              ACK
                                                  │
                                                 U10
```

Call Control Detailed SDL Diagram (USER SIDE)

```
        ┌─┬──────────┐
        │6│  CALL    │
        │ │ PRESENT  │
        └──────┬─────┘
               │
  ┌──────────┬─┴────────┬──────────────┐
  │          │          │              │

 REJECT    REPORT     PROCEED       SETUP
 REQ.      REQ.       REQ.          RESP.
           ALERT

 RELEASE   ALERTing    CALL         CONNECT
 COMPLETE              PROC

 RELEASE CR +  ( U7 )   ( U9 )      START
 B-CHANNEL                          T313

   ( U0 )                            ( U8 )
```

```
        ┌─┬──────────┐
        │7│  CALL    │
        │ │ RECEIVED │
        └──────┬─────┘
               │
  ┌────────────┼─────────────┐
  │            │             │

 REPORT     REPORT        SETUP
 REQ.       REQ.          RESP
 PROG       ALERT

 PROGRESS   ALERTing      CONNECT

  ( U7 )     ( U7 )       START
                          T313

                           ( U8 )
```

Call Control Detailed SDL Diagram (USER SIDE)

```
                    ┌─┐
                   ( 8│ CONNECT )
                    └─┘ REQUEST
                        │
         ┌──────────────┴──────────────┐
         │                             │
    ╲ EXPIRY │                    │ CONNECT ╱
    ╱ T313   │                    │ ACK     ╲
         │                             │
    │ RELEASE ╲                   ╱ STOP  │
    │         ╱                   ╲ T313  │
         │                             │
    ╱ START │                    ╱ CONNECT │
    ╲ T308  │                    ╲ IND.    │
         │                             │
    (  U19  )                    ( U10     )
                                 ( (Active))
```

```
                    ┌─┐
                   ( 9│ INCOMING )
                    └─┘ CALL PROC
                        │
       ┌────────────────┼────────────────┐
       │                │                │
   ╲ REPORT │       ╲ REPORT │       ╲ SETUP  │
   ╱ REQ.   │       ╱ REQ.   │       ╱ RESP.  │
     ALERT  │         PROG   │              │
       │                │                │
   │ ALERTING ╲     │ PROGRESS ╲    │ CONNECT ╲
   │          ╱     │          ╱    │         ╱
       │                │                │
   (  U7  )         (  U9  )         ╱ START │
                                    ╲ T313  │
                                         │
                                    (  U8  )
```

Call Control Detailed SDL Diagram (USER SIDE)

Call Control Detailed SDL Diagram (USER SIDE)

Call Control Detailed SDL Diagram (USER SIDE)

† NOTE: To prevent a RELease COMplete message being returned from the Network Side associated with this CR after the CR is reused for another call it would be advisable to wait at least until T308 would have expired before allowing the CR to be used.
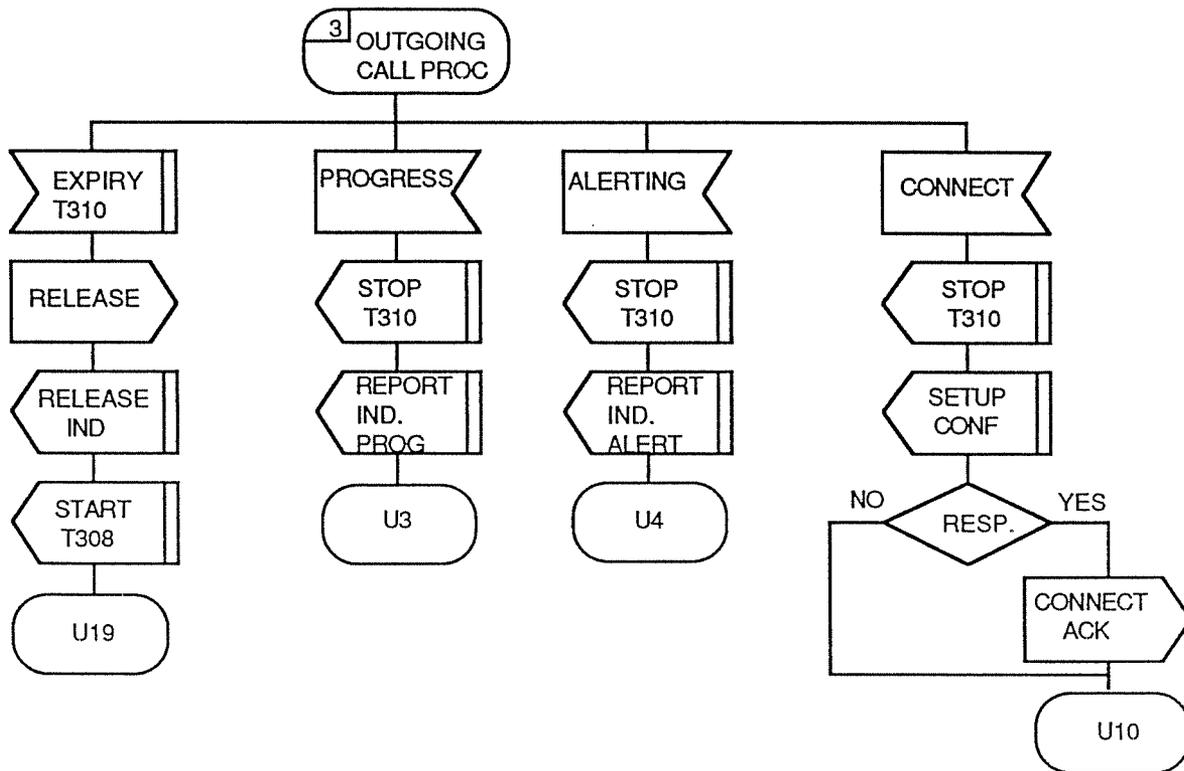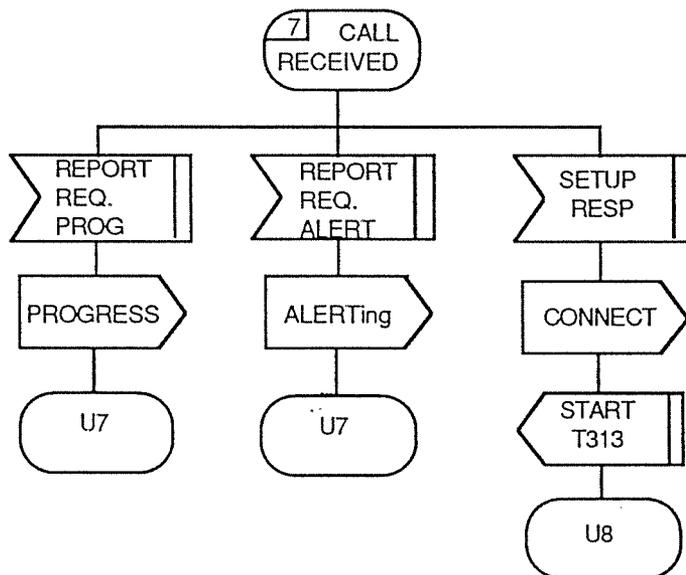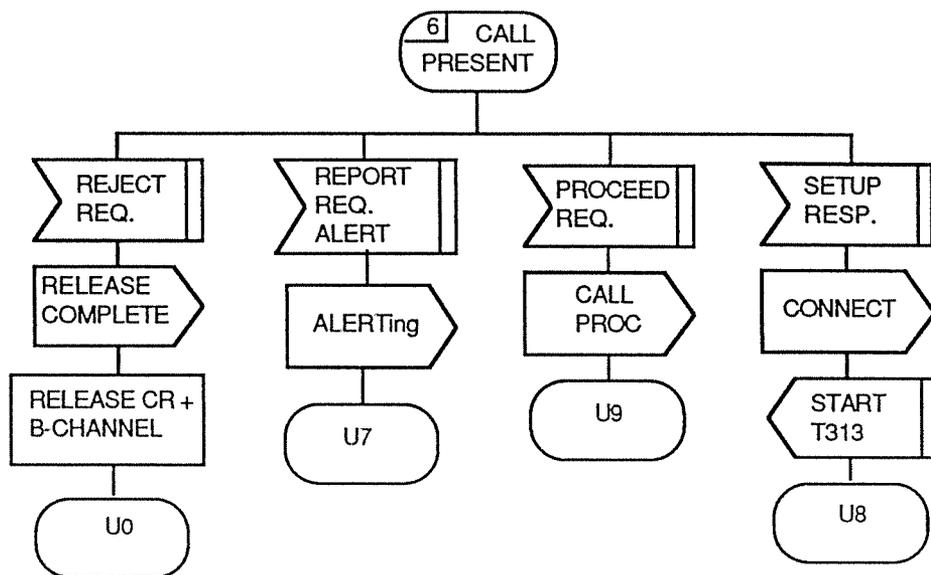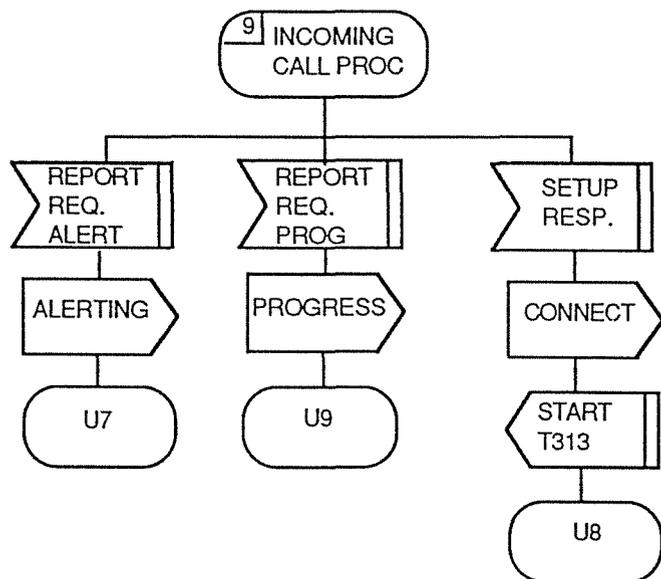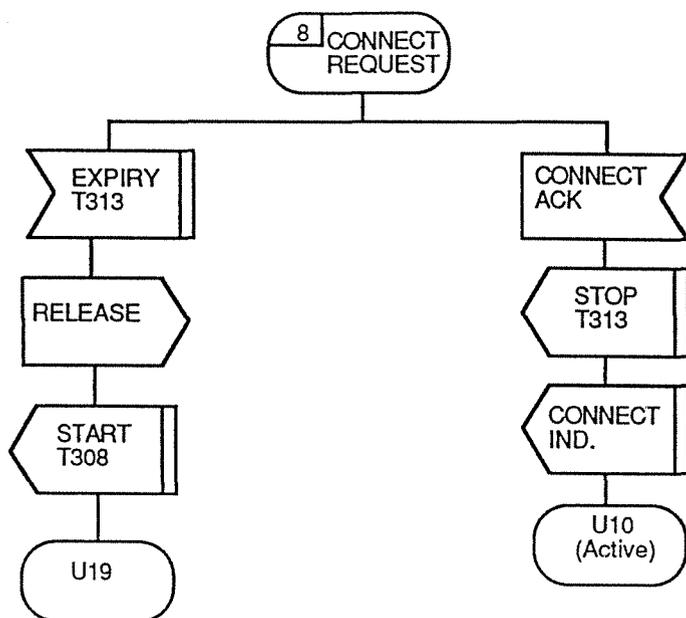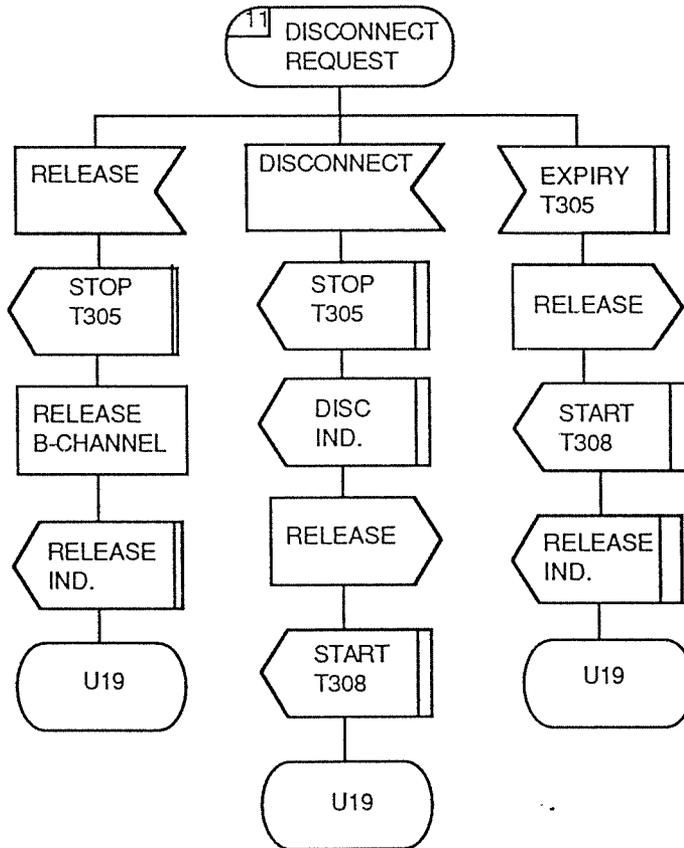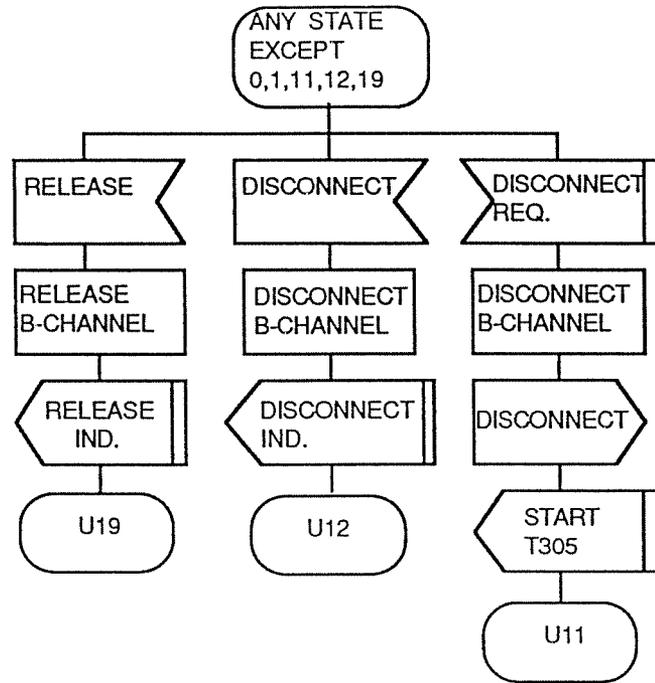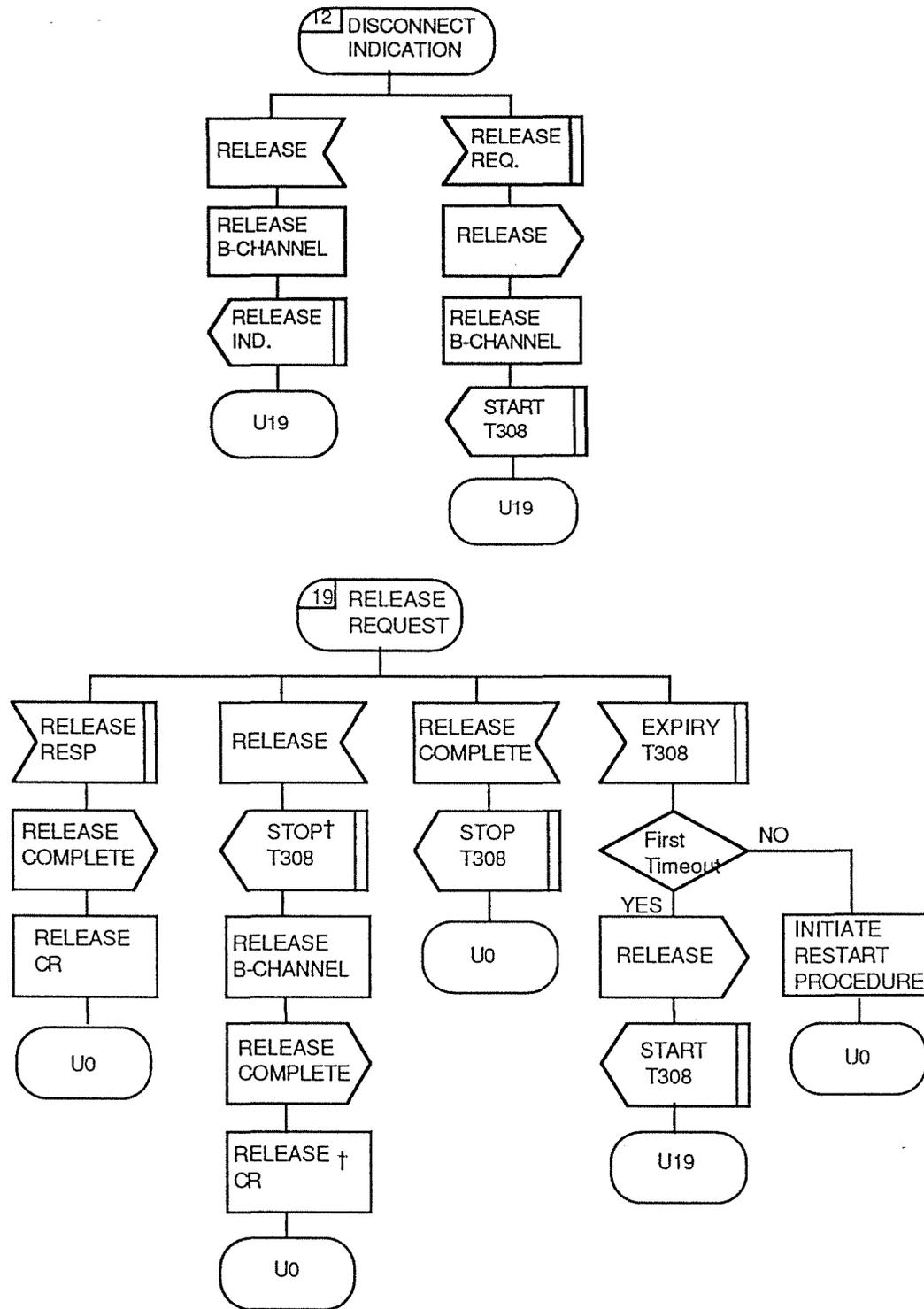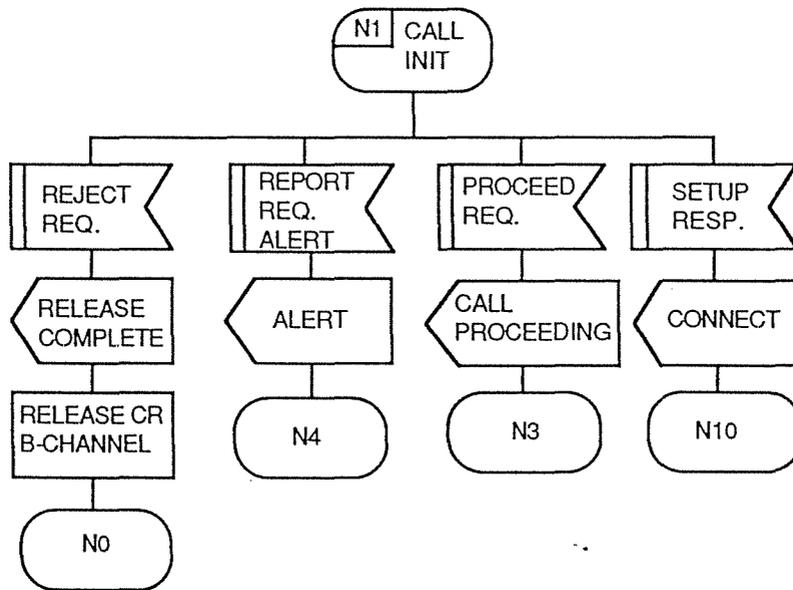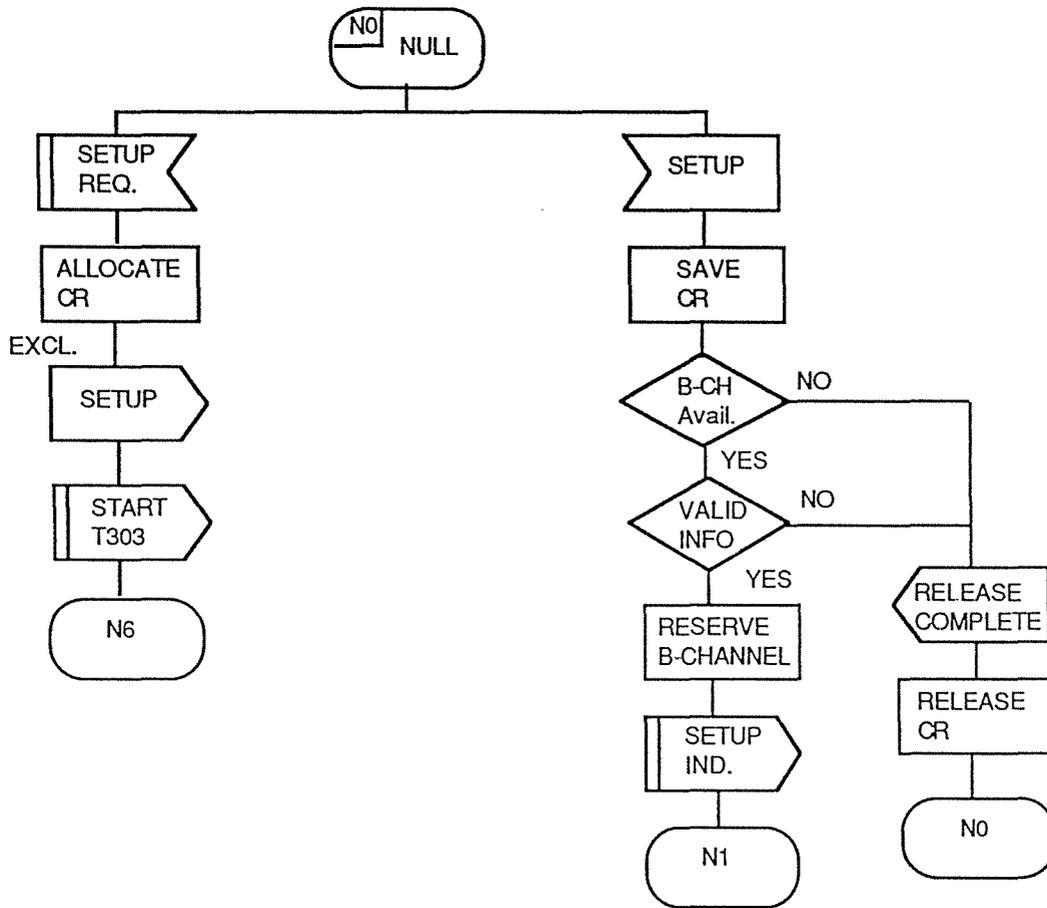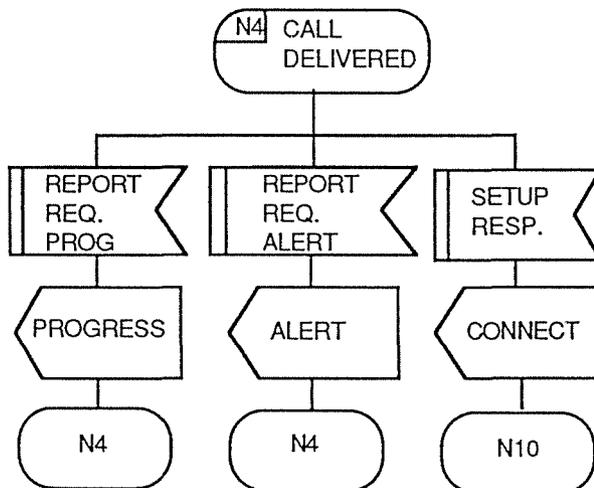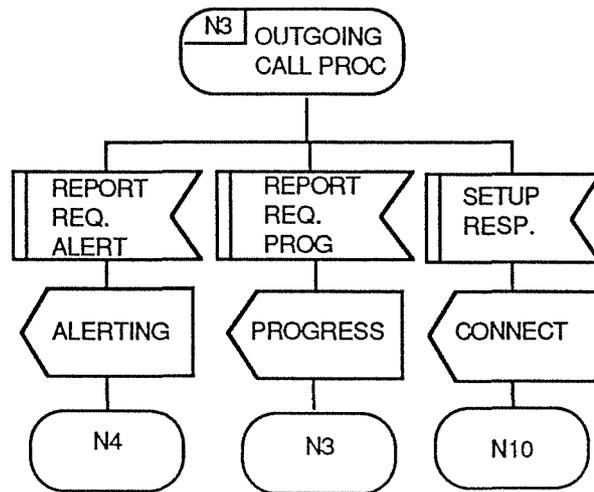
A.2. SDL Procedures for the Network Side

```
                              ┌──┐
                              │N0│  NULL
                              └──┴──────┘
                                   │
        ┌──────────────────────────┴──────────────────────────┐
   ┌────────────┐                                      ┌────────────┐
   │ SETUP      │                                      │ SETUP      │
   │ REQ.       <                                      >            <
   └────────────┘                                      └────────────┘
         │                                                   │
   ┌────────────┐                                      ┌────────────┐
   │ ALLOCATE   │                                      │ SAVE       │
   │ CR         │                                      │ CR         │
   └────────────┘                                      └────────────┘
  EXCL.  │                                                   │
   ┌────────────┐                                         ╱──────╲
   │ SETUP      │                                        ╱ B-CH   ╲    NO
   │            >                                        ╲ Avail.  ╱──────────┐
   └────────────┘                                         ╲──────╱            │
         │                                                   │ YES            │
   ┌────────────┐                                         ╱──────╲            │
   │ START      │                                        ╱ VALID  ╲    NO      │
   │ T303       >                                        ╲ INFO    ╱──────────┤
   └────────────┘                                         ╲──────╱            │
         │                                                   │ YES            │
      ┌──────┐                                        ┌────────────┐   ┌────────────┐
      │  N6  │                                        │ RESERVE    │   │ RELEASE    │
      └──────┘                                        │ B-CHANNEL  │   < COMPLETE   │
                                                      └────────────┘   └────────────┘
                                                            │                │
                                                      ┌────────────┐   ┌────────────┐
                                                      │ SETUP      │   │ RELEASE    │
                                                      │ IND.       >   │ CR         │
                                                      └────────────┘   └────────────┘
                                                            │                │
                                                         ┌──────┐        ┌──────┐
                                                         │  N1  │        │  N0  │
                                                         └──────┘        └──────┘
```

```
                              ┌──┐
                              │N1│  CALL
                              └──┴────┐ INIT
                              └──────────┘
                                   │
     ┌────────────────┬────────────┴────────────┬────────────────┐
┌──────────┐    ┌──────────┐            ┌──────────┐     ┌──────────┐
│ REJECT   │    │ REPORT   │            │ PROCEED  │     │ SETUP    │
│ REQ.     <    │ REQ.     <            │ REQ.     <     │ RESP.    <
└──────────┘    │ ALERT    │            └──────────┘     └──────────┘
      │         └──────────┘                 │                │
┌──────────┐         │              ┌──────────────┐   ┌──────────┐
│ RELEASE  │    ┌──────────┐        │ CALL         │   │ CONNECT  │
< COMPLETE │    │ ALERT    │        │ PROCEEDING   <   <          │
└──────────┘    <          │        └──────────────┘   └──────────┘
      │         └──────────┘                 │                │
┌──────────────┐     │                  ┌──────┐         ┌──────┐
│ RELEASE CR   │  ┌──────┐              │  N3  │         │ N10  │
│ B-CHANNEL    │  │  N4  │              └──────┘         └──────┘
└──────────────┘  └──────┘
      │
  ┌──────┐
  │  N0  │
  └──────┘
```
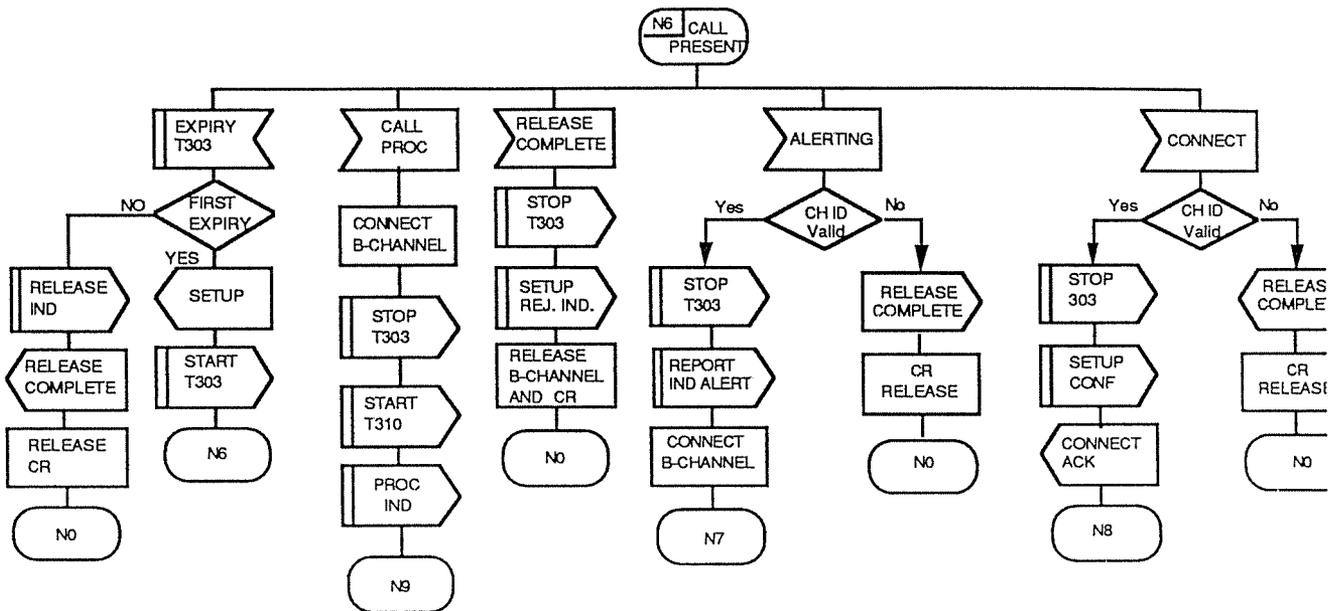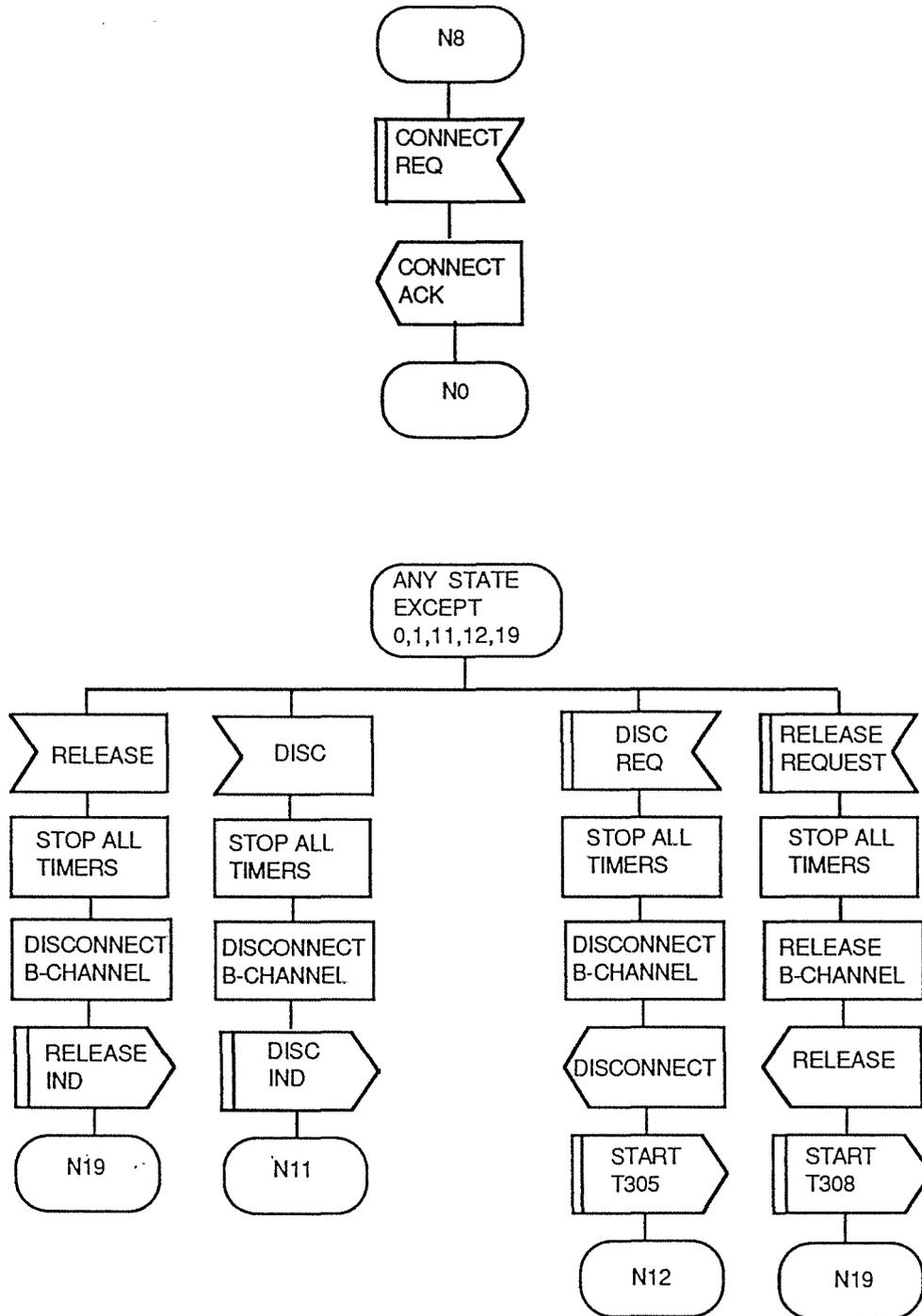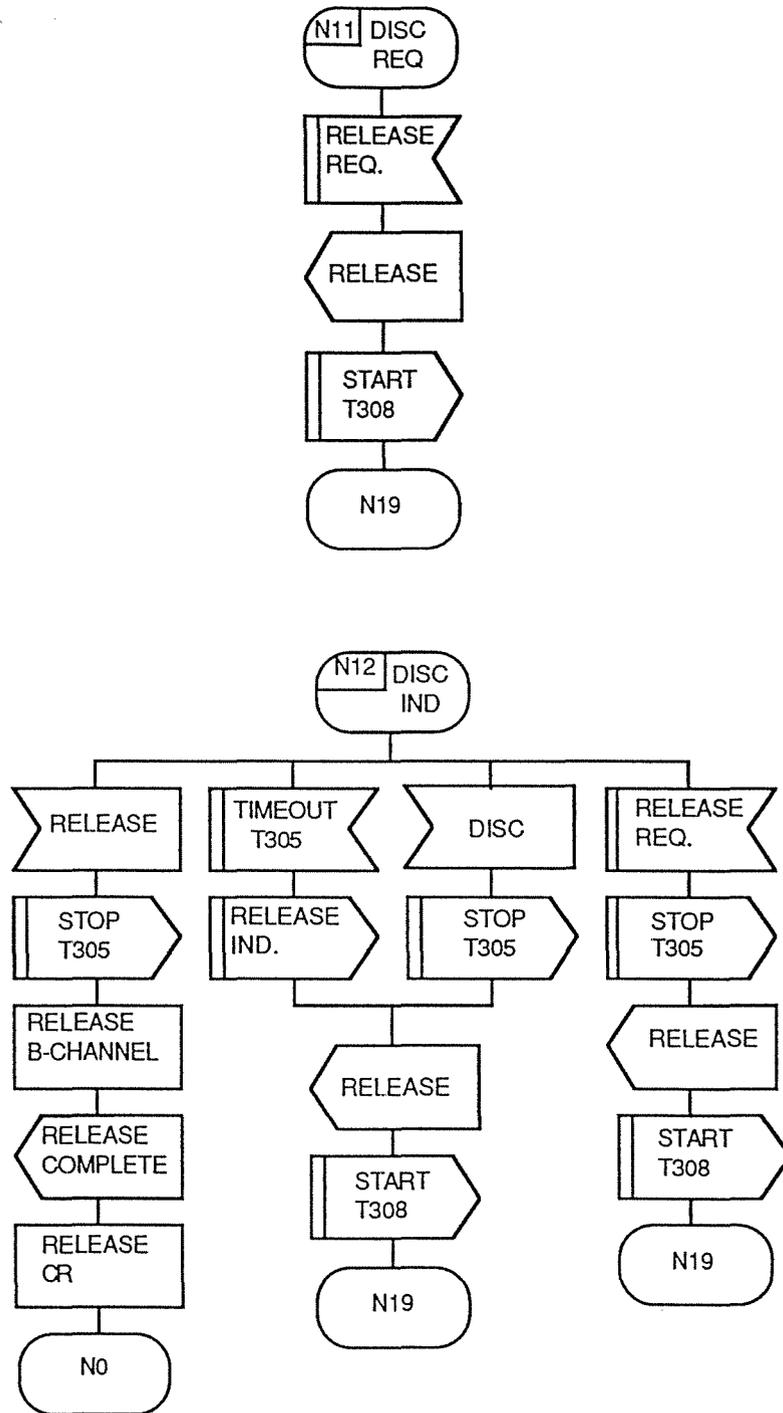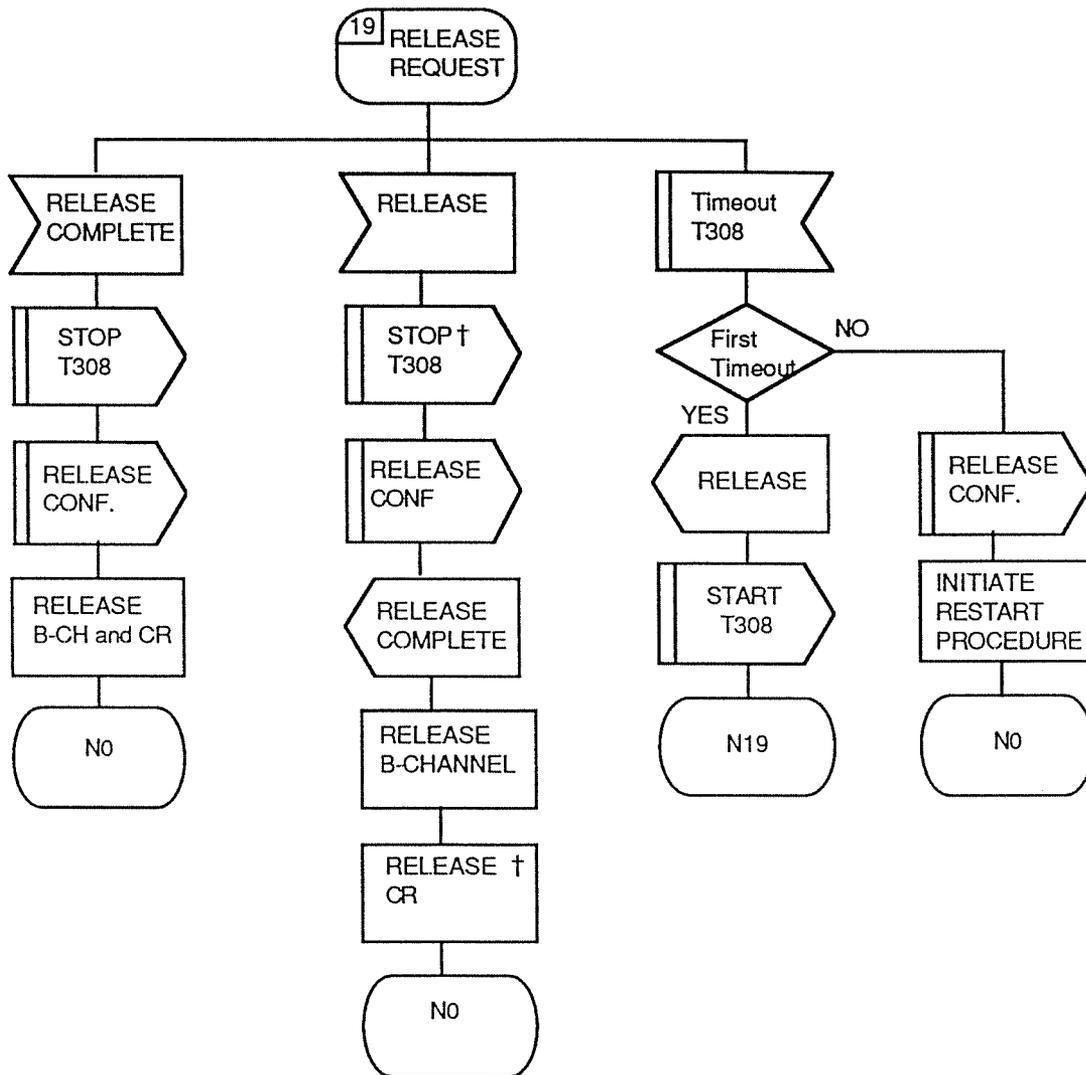
Call Control Detailed SDL Diagram (NETWORK SIDE)

Call Control Detailed SDL Diagram (NETWORK SIDE)

Call Control Detailed SDL Diagram (NETWORK SIDE)

N8

CONNECT
REQ

CONNECT
ACK

N0

ANY STATE
EXCEPT
0,1,11,12,19

RELEASE	DISC	DISC REQ	RELEASE REQUEST
STOP ALL TIMERS	STOP ALL TIMERS	STOP ALL TIMERS	STOP ALL TIMERS
DISCONNECT B-CHANNEL	DISCONNECT B-CHANNEL	DISCONNECT B-CHANNEL	RELEASE B-CHANNEL
RELEASE IND	DISC IND	DISCONNECT	RELEASE
		START T305	START T308
N19	N11	N12	N19

Call Control Detailed SDL Diagram (NETWORK SIDE)

N11 DISC REQ

RELEASE REQ.

RELEASE

START T308

N19

N12 DISC IND

RELEASE

TIMEOUT T305

DISC

RELEASE REQ.

STOP T305

RELEASE IND.

STOP T305

STOP T305

RELEASE B-CHANNEL

RELEASE

RELEASE

RELEASE COMPLETE

START T308

START T308

RELEASE CR

N19

N19

N0

Call Control Detailed SDL Diagram (NETWORK SIDE)

Call Control Detailed SDL Diagram (NETWORK SIDE)

† NOTE: To prevent a RELease COMplete message being returned from
the Network Side associated with this CR after the CR is
reused for another call it would be advisable to wait at least
until T308 would have expired before allowing the CR to be
used.

Annex B. <u>COMPATIBILITY CHECKING</u>

Compatibility checking, if supported, is a network-specific item. References should be made to the network profile supplement to determine what level of compatibility checking is supported.

Annex C. TRANSIT NETWORK SELECTION

Transit network selection is not supported by the DMS-250.

Annex D. EXTENSIONS FOR SYMMETRIC CALL OPERATION

It is assumed that the DMS-250 is connected to a user via a network-user relationship. As such, symmetric operation does not apply, and all operation is as described in previous sections.

Annex E. <u>NETWORK SPECIFIC FACILITIES SELECTION</u>

Network specific facilities selection is network-dependant. References should be made to the appropriate network profile supplement to determine what level of network specific facilities selection is supported.

ANNEX F: D-CHANNEL BACKUP

F.1   SERVICE DESCRIPTION

With *facility associated signaling*, the D channel signaling entity provides call control *only* for the channels on the physical facility which contains the D channel.

With *non-facility associated signaling*, the D channel signaling entity can provide call control for channels on more than one physical facility (including, but not limited to, the facility containing the D channel). The differences between facility associated and non-facility associated signaling are illustrated in Figure 1.1.
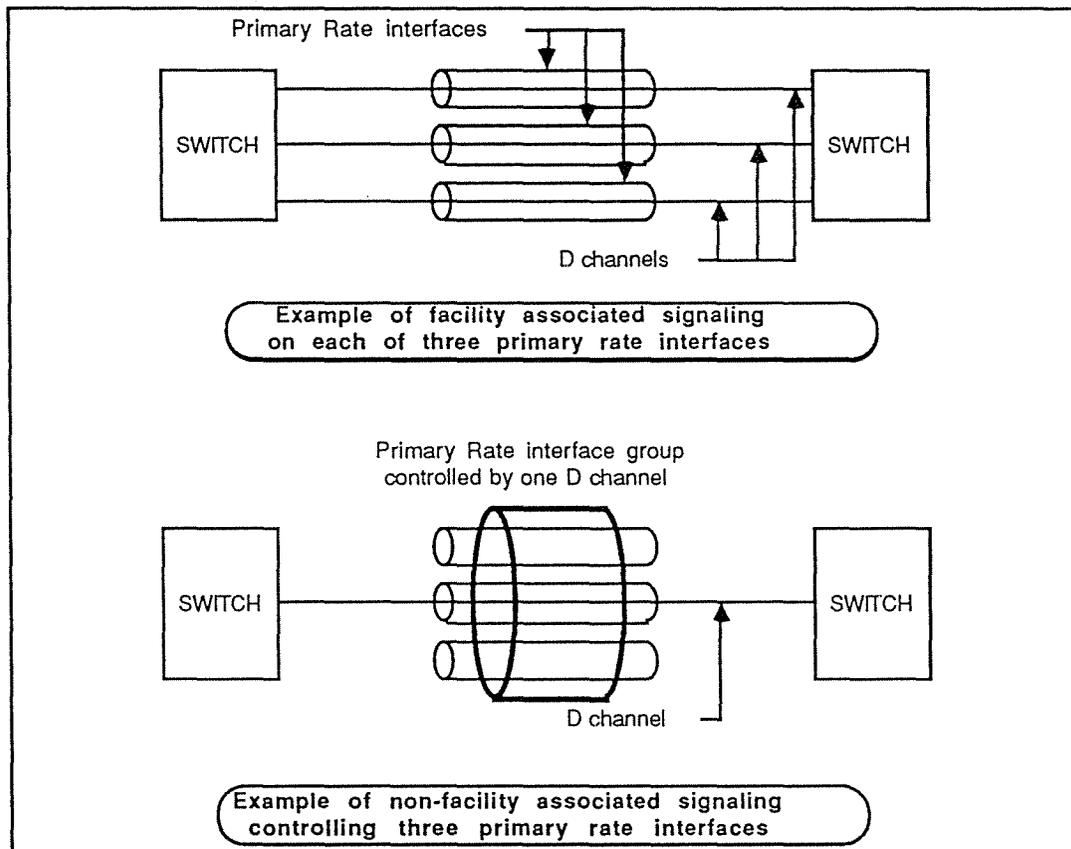
Figure 1.1   Associated vs. Non-Associated Signaling

This section specifies the protocol for D channel backup procedures which can increase the signaling reliability when non-facility associated signaling is used on primary rate interface (PRI) groups[1]. These procedures will employ a second, standby D channel.

Note that the procedures defined in this section do not support load sharing between two D channels--this functionality is left for further study. Also, the standby D channel cannot serve as a B channel when it is in a standby role. Finally, the backup D channel can only backup the signaling functions of a single D channel and not multiple D channels.

---

[1]   Where a "primary rate interface group" is simply multiple PRI's controlled by the same D Channel.

F.2 PROTOCOL DESCRIPTION

F.2.1 GENERAL

When a primary rate interface group connecting a network and a user is composed of two or more interfaces, a primary D channel is designated (labeled D1) and is always present on one interface. On a different interface in the group, a backup D channel is designated (labeled D2). These designations are made at pre-service provisioning time. Figure 2.1 illustrates this arrangement for an interface group composed of three interfaces.

Primary Rate interface group
controlled by one D channel w/ backup

Backup D channel   Primary D channel

Example of non-facility associated signaling
with backup D channel
controlling three primary rate interfaces

Figure 2.1   D Channel Backup Configuration

Figure 2.2 illustrates the D Channel Backup protocol architecture. Each switch contains two layer 2 entities providing service to a single layer 3 entity. The "unfolded" version in Figure 2.2(b) is used in this specification in order to simplify the illustration of message flows.

Figure 2.2 (a)

Figure 2.2 (b)

F.2.2   D CHANNEL STATES

The following Layer 3 state is **required** for implementation of the D Channel Backup protocol and applies to either D1 or D2:

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.

The following Layer 3 states are defined in order to simplify the task of specifying the D Channel Backup protocol; however, since these states are not visible at the external interface point, they are **not required** to be implemented for the D Channel Backup protocol. These states also apply to either D1 or D2:

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 signaling messages on logical link 0,0.

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 establish the link. A D channel will remain in the OOS state until one of the following occurs:

i.   After the transmission of SABME (Set Async Balanced Mode Extended), a UA (Unnumbered Acknowledgement) 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 (Disconnect 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.

Maintenance Busy (MB)

A D channel is termed *Maintenance Busy* when it is not in the multiple-frame-established state (e.g. TEI-assigned state) at layer 2. This state is entered automatically when an active (IS) D channel is declared failed. While in the MB state, receipt of a SABME by layer 2 will result in the transmission of a DM. A D channel which is placed in a MB state may be placed in the OOS state without craft intervention.

Manual Out-of-Service (MOOS)

A D channel is termed *Manual Out-of-Service* 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.

Wait (WAIT)

A D channel is termed as being in the *Wait* state when an attempt has been made by one side of the interface to establish layer 3 peer communication as part of the process of going to the IS state. This state is transitional in nature.

F.2.3   D CHANNEL BACKUP RULES

In Section F.2.3.1, we present an informal description of the D channel backup rules. A more detailed description is found in Section F.2.3.2. Finally, a formal state transition table is provided in Section F.2.3.3.

F.2.3.1   General Description

In the following, 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 is (IS, STBY).

1. If the states are initially (IS, STBY) then to switch over to D2:

   a) If D1 is not failed, send a layer 2 DISC on D1 and wait for a UA or time-out.

   b) Place D1 in a MB state, and start Timer T321. The suggested value of T321 is given in Section F.2.3.2.3.

   c) As an optional procedure, re-establish the link on D2 by sending a SABME and expect to receive a UA. If the user cannot establish D2 at Layer 2, put both D1 and D2 in the OOS state, referred to as (OOS, OOS).

   d) 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[1] on D2 with an indication that D2=IS (abbreviated as SERV(D2=IS)).

   e) If Timer T321 expires then go to (OOS, OOS).

   f) If the far end responds on D2 with either a SERV(D2=IS) or 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[2] 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).

---

[1]   For the coding of the SERVICE message in this procedure, see Section F.3.1.1.

[2]   The DMS-250 does not retransmit the message.

2. If the states are initially (OOS, OOS) then:

  a) 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 database by both sides.

  b) If D2 becomes established at layer 2 <u>before D1</u>, then send a SERV(D2=IS) message on D2, start Timer T321, and go to (OOS, WAIT).

  c) If Timer T321 expires then go to (OOS, OOS).

  d) If the far end responds on D2 with either a SERV(D2=IS) or SERV_ACK(D2=IS), <u>and</u> D1 has not been established at layer 2, then go to (OOS, IS). Receipt of any other message on D2 shall be ignored.

  e) If D1 <u>has</u> become established at layer 2 before the receipt on D2 of either a SERV(D2=IS) or SERV_ACK(D2=IS), then abandon the attempt on D2 and send a SERV(D1=IS) message on D1 and start Timer T321.

  f) If Timer T321 expires then go to (OOS, OOS).

  g) If the far end responds on D1 with either a SERV(D1=IS) or SERV_ACK(D1=IS), then go to (IS, OOS). Receipt of any other message on D1 shall be ignored.

3. Never go to (OOS, MB) or (MB, OOS) in order to avoid deadlock[1].

---

[1] Deadlock occurs when the two sides, A and B, do not agree on the D channel which is to be activated for carrying call-control signaling. The states (OOS, MB) or (MB, OOS) are especially important to avoid since no call-control signaling can occur while one of the D channels is held in MB and the other is ready but not yet activated at layer 2. This state is not prevented by the DMS-250, and is under craftsperson control.

F.2.3.2   Detailed Description

This section contains a detailed description of the protocol required to implement D Channel Backup. The state transition table which augments this description is found in Section F.2.3.3.

For the purposes of the following protocol description the initial conditions are (IS,STBY).

F.2.3.2.1   Switch-Over Procedure

Declaring D1 as Failed

During normal operation, call-control signaling on D1 follows LAPD and Q.931 procedures for information transfer in multiple frame operation. Timer T200 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 more times. Failing to get a response, layer 2 shall issue a MDL_ERROR_INDICATION to the connection management entity.

If an assumption is made for T200=1 second and N200=3, the active link will be declared as failed within:

  • eight (8) seconds during normal call-control signaling interaction (Figure 2.3(a)), and
  • a period equal to the value of T203 plus eight (8) seconds during idle call-control signaling traffic times (Figure 2.3(b)).
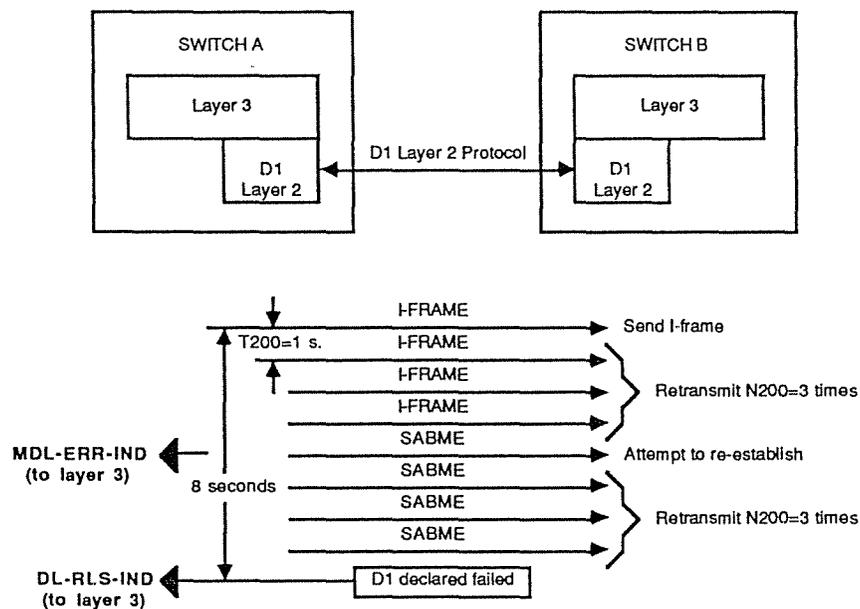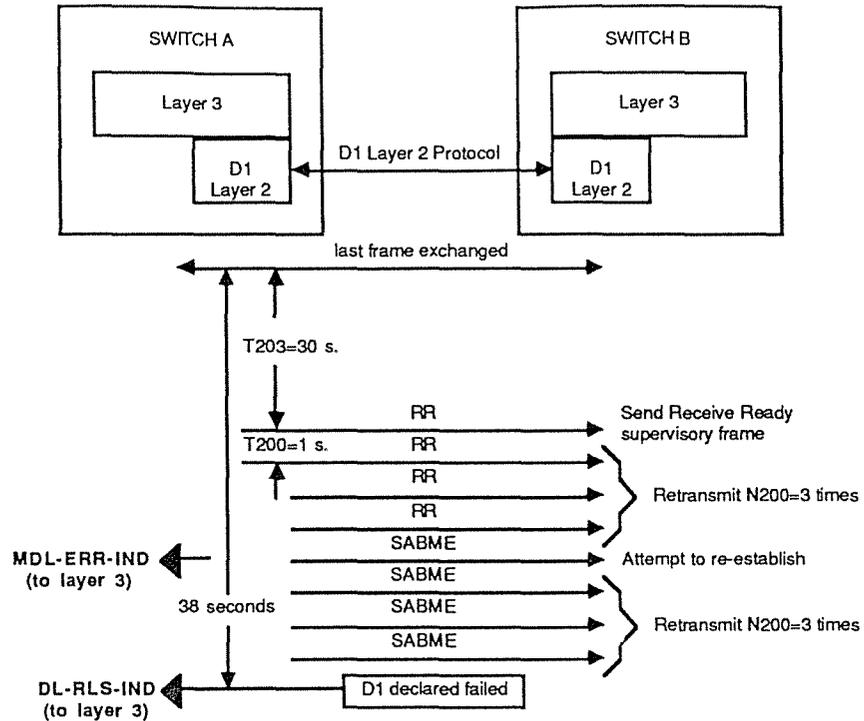

Figure 2.3 (a)

Figure 2.3 (b)

However, at any time during normal operation, D1 will be declared as failed when layer 2 receives:

- a DISC which requires a response of a UA.
- an unsolicited DM, in which case layer 2 shall initiate the procedure to insure layer 2 verification and to establish layer 3 peer communication on D2, as outlined below.

Failure of D1 is indicated to layer 3 through the primitive, DL_RELEASE_INDICATION, from the 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.

Initiating Switch-Over to D2

If D2 is STBY at layer 3, and D1 has been declared failed and placed in the MB state, then layer 3 shall start Timer T321, the Maintenance Busy timer. Layer 3 may then execute the *optional* procedure[1] 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, then layer 3 shall follow procedures to establish D2 as IS through layer 3 peer communication, as outlined in Section "Declaring D1 as Failed".

If D2 is in the OOS state when D1 is declared failed, layer 3 shall place D1 in the OOS state as well. D1 and D2 will now be in the (OOS, OOS) state and the procedure for initialization shall begin as outlined in Section F.2.3.2.2.

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.

Actions After Switch-Over

Establishing Layer 3 Call-Control Signaling

The message flows for a normal switchover from D1 to D2 are shown in Figure 2.4(a). The possible state transitions are shown in Figure 2.4(b)[2].

When D2 is deemed to be in 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) and start Timer T321. Layer 3 then enters the (MB, WAIT) state. From (MB, WAIT) one of the following events will occur:

1. T321 expires. Layer 3 shall then go to (OOS, OOS) and the procedures for initialization shall then apply, as specified in Section F.2.3.2.2.

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.*

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[1] Not implemented on the DMS-250.

[2] Note that Figure 2.3(b) assumes implementation of the optional states defined in Section F.2.2.
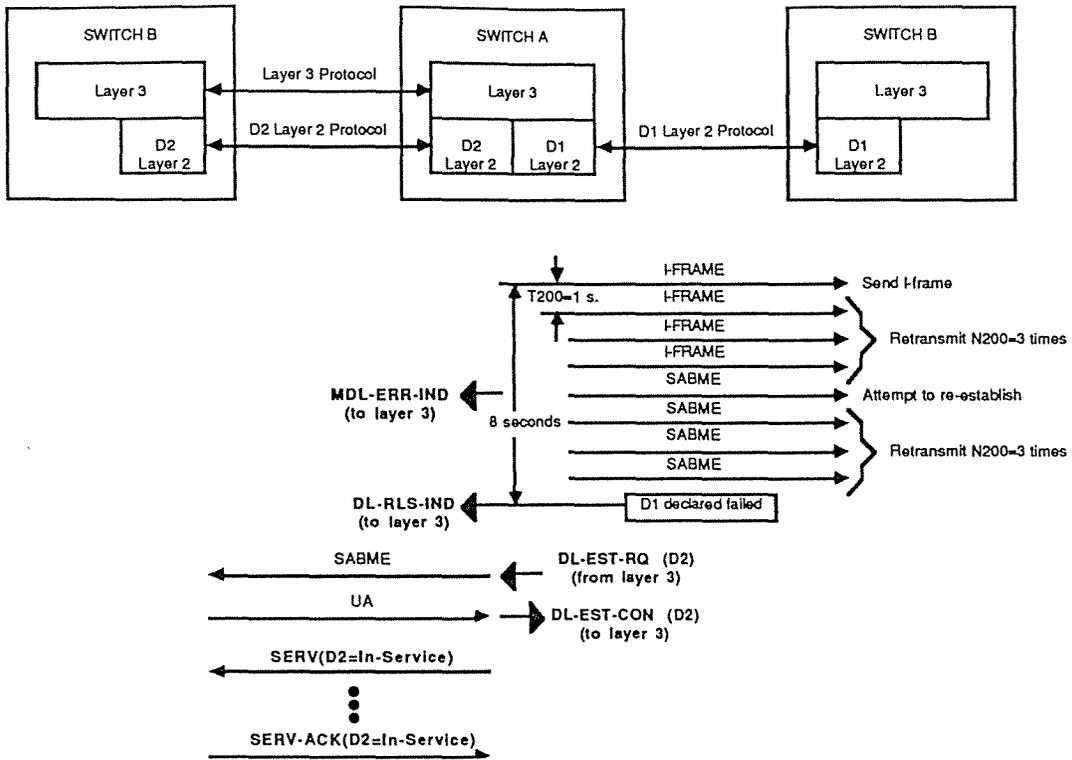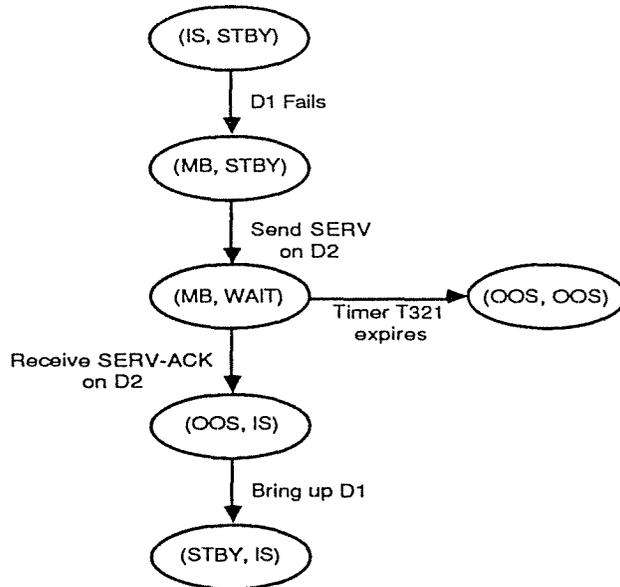
Figure 2.4(a) Message Flows

Figure 2.4(b) State Transitions

Figure 2.4 Normal D Channel Switch-Over

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 stopped and reset by layer 3.

Since Call Reference numbers are saved by the switch for stable calls, there is no need to initiate error recovery procedures at layer 3. (e.g. send a STATUS ENQUIRY for all call references).

Once D1 is placed in the STBY state (i.e. layer 2 on D1 goes to the multiple-frame-established state) the D channels are available for transmission again if initiated by a failure of D2, or by a maintenance switch-over request from a peer entity.

Manual Switch-Over

Release Procedure for 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 and notify the connection management entity and layer 3 through the MDL_ERROR_INDICATION and DL_RELEASE_CONFIRM primitives, respectively.

F.2.3.2.2   Initialization

The state transitions which may occur on initialization are shown in Figure 2.5[1].

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, then 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, then D1 is held in the OOS state. A SERV (D2=IS) message shall 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.
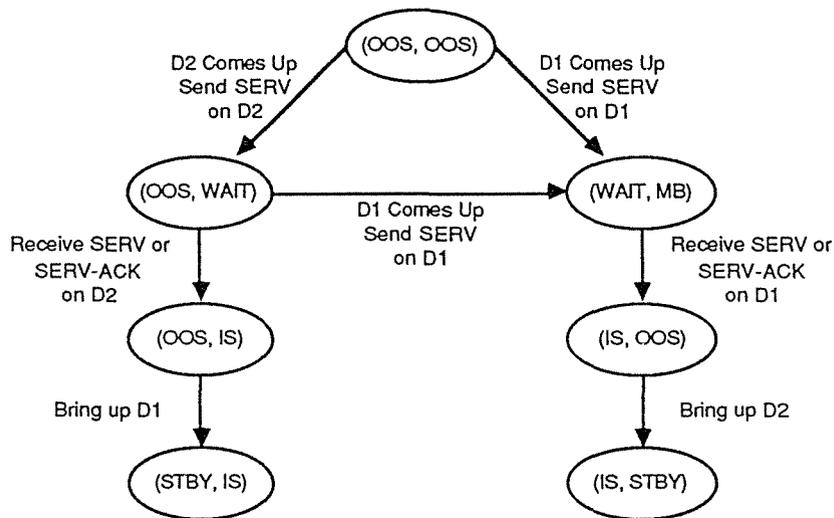

Figure 2.5 Initialization Procedure: State Transitions

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[1]   Note that Figure 2.5 assumes implementation of the optional states defined in Section F.2.2.

F.2.3.2.3   Value of System Parameters

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 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). The STBY D channel carries only layer 2 audit messages, according to Timer T203.

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[1].

Timer T203 is related to the time it takes to declare a D channel as failed. The value of T321 should be sufficiently 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.

The following table summarizes the values of these system parameters recommended in both the CCITT Blue Book and ANSI T1.607 (1990) specifications.

Parameter	Description	CCITT Default	ANSI Default	Recommended Range
N200	Max. number of retransmissions of a frame.	3	3	0-5
T203	Max. time allowed w/o frames being exchanged	10 s.	10 s.	0-30 s.
T321	Maintenance Busy timer.	30 s.	30 s.	0-40 s.

F.2.3.2.4   T309 Procedures

T309 is a layer 3 timer which specifies a wait interval after a failure of layer 2 before the affected B channels are removed from service.

When used with D channel backup, T309 procedures are applied only to the active D channel; i.e. it is only in the event that T309 expires for the active D channel that the affected B channels are removed from service.

---

[1]   DMS-250 uses the value of 40seconds for T321.

F.2.3.2.5   SERVice Messages

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.

There are three status categories associated with the SERVice class of maintenance messages. They are, in order of decreasing availability: *In Service, Maintenance,* and *Out of Service.* The D channel backup protocol uses only the *In Service* category for both layer 3 switchover and audit procedures: SERVice messages specifying *Out of Service* or *Maintenance* status are never sent for D channels and are ignored if received.

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.

The format and coding of the SERVICE and SERVICE ACKNOWLEDGE messages are detailed in Section F.3.1.

F.2.3.2.6   Coding of Channel Identification

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 Present 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 (present only if interface is explicitly identified).

The format and coding of the Channel Identification information element is detailed in Section F.3.2.

F.2.3.3   State Transition Table

NOTES:

1. 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 is (IS, STBY).

2. 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.

3. 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 [*].

4. XFER_REQ is a primitive which represents a near-end manual transfer request.

5. 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	Events	Actions	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 and D2:Send SERV(D2=IS) and Start T321	(MB, WAIT)
		OR (optionally) [*] Start T321 and 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) and D1:DL_EST_REQ	(OOS, IS)
	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) and	
		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 and 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_IND/CON	none	(IS, STBY)
	D2:DL_RLS_IND	D2:DL_EST_REQ	(IS, OOS)
	D1:DL_RLS_IND	D1:DL_EST_REQ (retry on D1)	(OOS, OOS)

Present State	Events	Actions	Next State
(OOS, OOS)	D1:DL_EST_IND/CON	D1:Send SERV(D1=IS) and Start T321 and D2:DL_DM_RLS	(WAIT, MB)
	D2:DL_EST_IND/CON	D2:Send SERV(D2=IS) and Start T321	(OOS, WAIT)
	other	D1:DL_EST_REQ and D2:DL_EST_REQ	(OOS, OOS)
(OOS, IS)	D1:DL_EST_IND/CON	none	(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)	D1: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:Rcv SERV(D2=IS)	D2:Send SERV_ACK(D2=IS)	(STBY, IS)
	D2:DL_RLS_IND or XFER_REQ	D2:DL_DM_RLS and D1:Send SERV(D1=IS) and Start T321 OR (optionally) [*] Start T321 and 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) and	
		D2:DL_EST_REQ	(IS, OOS)
	D1:Rcv any other layer 3 msg	Ignore	(WAIT, MB)
	T321 expires	D1:DL_RLS_REQ and D2:DL_EST_REQ	(OOS, OOS)
	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	none	(OOS, OOS)
	D1:DL_EST_IND/CON	D1:Send SERV(D1=IS) and Start T321 and D2:DL_RLS_REQ	(WAIT, MB)
	D2:Rcv any other layer 3 msg	Ignore	(OOS, WAIT)

F.3 FORMATS AND CODES

F.3.1 MESSAGES

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.

The format of the SERVice and SERVice ACKnowledge messages, as used for D Channel Backup, are as shown below.

F.3.1.1 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.

Message type: SERVice
Direction: Both

Information Element	Reference	Type	Length
Protocol Discriminator	3.2.1	M	1
Call Reference	3.2.2	M	2
Message Type	3.2.3	M	1
Change Status	3.2.4	M	3
Channel Identification	3.2.5	M	3 - 4

F.3.1.2 SERVICE ACKNOWLEDGE

This message is used to acknowledge the change of state indicated in the SERVICE message.

Message type: SERVice ACKnowledge
Direction: Both

Information Element	Reference	Type	Length
Protocol Discriminator	3.2.1	M	1
Call Reference	3.2.2	M	2
Message Type	3.2.3	M	1
Change Status	3.2.4	M	3
Channel Identification	3.2.5	M	3 - 4

F.3.2   INFORMATION ELEMENTS

F.3.2.1   Protocol Discriminator

The purpose of the protocol discriminator is to identify messages for maintenance of the interface. The coding for the protocol discriminator is as follows:

```
8  7  6  5  4  3  2  1
┌──────────────────────┐
│ Maintenance messages │
│                      │
│ 0  0  0  0  0  0  1  1│
└──────────────────────┘
```

F.3.2.2   Call Reference

The two octet global call reference is used. The numerical value of the global call reference is zero. The two octet global call reference is coded with the first octet "0000 0001" and the second octet "F000 0000," where F is the call reference flag. 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".

F.3.2.3   Message Type

The purpose of the message type is to identify the function of the message being sent. The message type is coded as follows:

```
8  7  6  5  4  3  2  1
┌──┬───────────────────┐
│ 0│   Message type    │
└──┴───────────────────┘
```

```
8  7  6  5  4  3  2  1

0  0  0  -  -  -  -  -        Maintenance messages:
0  0  0  0  1  1  1  1          SERVICE
0  0  0  0  0  1  1  1          SERVICE ACKNOWLEDGE
```

F.3.2.4   Change Status

The purpose of the Change Status information element is to change the current status of either an interface or channel to one of the following states: *In Service, Maintenance, or Out of Service*. The coding of the Change Status information element is as follows:

8	7	6	5	4	3	2	1		Octet

	8 7 6 5 4 3 2 1	Octet
	Change Status IE Identifier 0 0 0 0 0 0 1 1	1
	Length of Change Status 2	
	1 | P | 0 0 0 | New Status 3	

P: Preference (Octet 3)

    0 :   Interface
    1 :   Channel

New Status (Octet 3)

    0 0 0 :   In Service (this is the only value allowed for D Channel Backup)
    0 0 1 :   Maintenance
    0 1 0 :   Out of Service

F.3.2.5   Channel Identification

The coding of the Channel Identification IE for D Channel Backup purposes is as follows:

8	7	6	5	4	3	2	1		Octet
Channel Identification IE Identifier									
0	0	0	1	1	0	0	0		1
Length of Channel ID contents							2		
1 ext	Int ID present	Int type	0 spare	Pref/ Excl	D-ch ind.	Info Channel Selection			3
0/1 ext	Interface Identifier								3.1

Interface Identifier Present (Octet 3)

> Bit
> 7
> 0 : interface implicitly identified
> 1 : interface explicitly identified in one or more octets, beginning with octet 3.1.

> Either of these is allowed.

Interface type (Octet 3)

> Bit
> 6
> 1 : Primary rate interface.

Preferred/Exclusive (Bit 4, Octet 3)

> Since only applicable for B channel selection, this field is ignored.

D channel indicator (Octet 3)

> Bit
> 3
> 1 : the channel identified is the D channel.

Information channel selection (Octet 3)

> Bits
> 2 1
> 0 0 : no channel.

Interface identifier (Octet 3.1)

Binary code assigned to the interface (on which the D channel is located) at subscription time. Only present if interface is explicitly identified (see Octet 3, bit 7).

F.4 GLOSSARY

Acronym/Term	Meaning
ANSI	American National Standards Institute
BCS	DMS Software Generic Release
CO	Central Office
DISC	Disconnect
DM	Disconnect Mode
DMS	Digital Multiplex Switch
IS	In Service
LAPD	Link Access Procedures D Channel
MB	Maintenance Busy
MOOS	Manual Out of Service
MSL-1	Meridian SL-1 Digital PBX
MSL-100	Meridian SL-100 Digital PBX
NT	Northern Telecom
OOS	Out Of Service
PBX	Private Branch Exchange
PRA	Primary Rate Access (a.k.a. Primary Rate Interface)
SABME	Set Asynchronous Balanced Mode Extended
SS7, CCS7	CCITT Common Channel Signaling System #7
STBY	Standby
TEI	Terminal Endpoint Identifier
UA	Unnumbered Acknowledgement

Annex G. CAUSE DEFINITIONS

This annex provides definitions to the causes in section 4.5.8.

G.1 NORMAL CLASS

G.1.1 Cause 1 Unassigned (Unallocated) Number

This cause indicates that the destination requested by the calling user cannot be reached because, although the number is in a valid format, it is not currently assigned (allocated).

G.1.2 Cause 2¥ No route to specified transit network

This cause indicates that the equipment sending this cause has received a request to route the call through a particular transit network which it does not recognize. The equipment sending this cause does not recognize the transit network either because the transit network does not exist or because that particular transit network, while it does exist, does not serve the equipment which is sending this cause.

G.1.3 Cause 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.

G.1.4 Cause 17 User busy

This cause is used when the called user is unable to accept another call because another call or calls is occupying the resources required to handle the new call.

G.1.5 Cause 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.

G.1.6 Cause 21 Call rejected

This cause indicates that the equipment sending this cause does not wish to accept this call, although it could have accepted the call because the equipment sending this cause is neither busy nor incompatible.

G.1.7 Cause 22 Number changed

This cause is returned to a user when the called number, indicated by the calling party number, is no longer assigned.

¥ Not supported in BCS.31.

G.1.8   Cause 28   Incomplete Number

This cause indicates that the destination indicated by the calling user cannot be reached because the number is not in a valid format or is not complete.

G.1.9   Cause 29   Facility Rejected

This cause is returned when a facility requested by the user cannot be provided by the network.

G.1.10   Cause 30   Response to STATUS ENQuiry

This cause is included in the STATUS message when the reason for generating the STATUS message was the prior receipt of a STATUS ENQuiry message.

G.1.11   Cause 31   Normal, unspecified

G.2 NETWORK CONGESTION CLASS

G.2.1 Cause 34   Circuit/channel congestion

This cause indicates that there is no appropriate circuit/channel, presently available, to handle the call request.

G.2.2 Cause 42   Switching equipment congestion

This cause indicates that the switching equipment generating this cause is experiencing a period of high traffic.

G.2.3 Cause 43   User information discarded

This cause indicates that the network could not deliver user information to the remote user as requested. It is noted that the user information element identification as a diagnostic is optional.

G.2.4 Cause 44   Requested circuit/channel not available

This cause indicates that the circuit or channel requested by the user during local channel negotiation is not currently available (e.g., engaged or out of service for maintenance).

G.2.5 Cause 47   Resource Unavailable

This cause indicates that the user has requested a resource, such as a call reference, which is not available.

G.2.6 Cause 50   Requested facility not subscribed

This cause indicates that the user has not subscribed to this facility and therefore cannot access the facility at this time.

G.2.7 Cause 54   Incoming calls barred

This cause indicates that the called user will not accept the call delivered in the SETUP message.

G.3 SERVICE OR OPTION NOT AVAILABLE CLASS

G.3.1 Cause 58   Bearer capability not presently available

This cause indicates that the user has requested a bearer capability which is implemented by the equipment which generated this cause but which is not available at this time.

G.3.2 Cause 63   Service or option not available, unspecified

This cause indicates that the user has requested a service which is unavailable in the network.

G.4 SERVICE OR OPTION NOT IMPLEMENTED CLASS

G.4.1 Cause 65   Bearer capability not implemented

This cause indicates that the equipment sending this cause does not support the bearer capability requested.

G.4.2 Cause 66   Channel type not implemented

This cause indicates that the equipment sending this cause does not support the channel type requested.

G.4.3 Cause 70 Only restricted digital information bearer capability is available

This cause indicates that the user has requested an unrestricted bearer service but that the equipment sending this cause only supports the restricted version of the requested bearer capability.

G.4.4 Cause 79   Service or option not implemented, unspecified

This cause indicates that the user has requested a service or an option which has not been implemented at present.

G.5 INVALID MESSAGE (e.g., Parameter out of Range) CLASS

G.5.1 Cause 81   Invalid call reference value

This cause indicates that the equipment sending this cause has received a message with a call reference which is not currently in use on the user-network interface.

G.5.2 Cause 82   Identified channel does not exist

This cause indicates that the equipment sending this cause has received a request to use a channel not activated on the interface for a call. For example, if a user has subscribed to those channels on a primary rate interface numbered from 1 to 12 and the user equipment or the network attempts to use channels 13 through 23, this cause is generated.

G.5.3 Cause 88   Incompatible destination

This cause indicates that the equipment sending this cause has received a request to establish a call to a destination in which the required attributes can not be accommodated (e.g. data rate).

G.6 PROTOCOL ERRORS (e.g., Unknown Message) CLASS

G.6.1 Cause 90   Destination address missing, and direct call not subscribed

This cause indicates that the called party address is missing and direct call not subscribed.

G.6.2 Cause   95   Invalid Message, Unspecified

This cause indicates that the equipment has received a message with an invalid message type.

Cause 96   Mandatory information element is missing

This cause indicates that the equipment sending this cause has received a message which is missing an information element which must be present in the message before that message can be processed.

G.6.3 Cause 97   Message type nonexistent or not implemented

This cause indicates that the equipment sending this cause has received a message with a message type it does not recognize either because this is a message not defined or defined but not implemented, by the equipment sending this cause.

G.6.4 Cause 98   Message not compatible with call state

This cause indicates that the equipment sending this cause has received a message such that the procedures do not indicate that this is a permissible message to receive while in the call state, or a STATUS message was received indicating an incompatible call state.

G.6.5 Cause 99   Information element nonexistent or not implemented

This cause indicates that the equipment sending this cause has received a message which includes the information elements not recognized because the information element identifier is not defined or it is defined but not implemented by the equipment sending the cause. However, the information

element is not required to be present in the message in order for the equipment sending the cause to process the message.

G.6.6 Cause 100   Invalid information   element contents

This cause indicates that the equipment sending this cause has received an information element which it has implemented; however, one or more of the fields in the information element are coded in such a way which has not been implemented by the equipment sending this cause.

G.6.7 Cause 101 Message Not Compatible with Call State

This cause indicates that the message has been received which is incompatible with the call state.

G.6.8 Cause 102 Recovery on Timer Expiry

This cause indicates that a procedure has been initiated by the expiry of a timer in association with DMS error handling procedures.

G.6.9 Cause 111   Protocol error, unspecified

This cause indicates that an unspecified protocol error has occurred, for example, a DISConnect message is received in response to a SETUP message.

G.7 INTERWORKING CLASS

G.7.1 Cause 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.