TR 50010

TECHNICAL REFERENCE

AT&T ISDN

BASIC RATE INTERFACE

REFERENCE GUIDE

Issue 2.1
December 1997

NOTICE

This Technical Reference is published by AT&T as a guide for the designers, developers, manufactures, consultants, suppliers and others of systems and equipment which would meet the described interface. AT&T reserves the right to revise this Technical Reference for any reason, including, but not limited to, conformity with standards promulgated by ANSI, EIA, ITU-T (formerly CCITT), ISO or similar agencies, use of new advances in the state of technical arts, or to reflect changes in the requirements of communication systems or equipment. Liability for difficulties arising from technical limitations is disclaimed. AT&T makes no claims and representations and assumes no responsibilities beyond those set forth in the applicable tariffs.

No license under AT&T's intellectual property rights (including, in particular, patents and copyrights) or intellectual property rights of others are provided by the furnishing of this document, nor does the furnishing of this document indicate that the use of any information contained in it will be free of infringement of any intellectual property rights.

The provisions of planned network capabilities as described in this document requires certain business decisions and regulatory agency approvals. Note that, as of the date of publication of this document, many of these business decisions may not have been made nor regulatory approval received or requested.

Specifications contained in this document are current as of the date of this publication. They may be superseded by information published in related AT&T Technical References and subject to the effective date of these publications. All AT&T Technical References are subject to change, and their citation in this document reflects the most current information available at the time of printing.

If further information is required, please Contact:

Developmental Relations Group
Room 5356C3
295 N. Maple Avenue
Basking Ridge, NJ 07920

To order copies of this document:

Call: AT&T Customer Information Center
USA: (800) 432-6600
EUROPE: 010-1-317-322-6416
FAR EAST: 010-1-317-322-6389
AMERICAS/MID EAST/AFRICA: 010-1-317-322-6646

Write: AT&T Customer Information Center
2855 North Franklin Road
P.O. Box 19901
Indianapolis, IN 46219

For more information about AT&T documents, see:

CATALOG OF COMMUNICATIONS TECHNICAL PUBLICATIONS

Publications Catalog (10000)

AT&T ISDN BASIC RATE INTERFACE REFERENCE GUIDE

ISSUE 2.1

December 1997

TABLE OF CONTENTS

LIST OF TABLES

1. INTRODUCTION

This Technical Reference (TR) is provided to support AT&T's digital services over Integrated Services Digital Network (ISDN) Basic Rate Interface (BRI). The intent of the document is to be a reference guide to BRI terminal developers who will provide customer premises equipment (CPE) in support of AT&T digital services. This document directs BRI terminal equipment developers to the specification of each ISDN BRI central office switch under consideration and provides in Appendix 1 recommended network termination (NT) device enhancements to facilitate end-to-end maintenance of ISDN BRI based services.

This document updates and replaces in its entirety AT&T Technical Reference TR50010, dated September 1996. The major change/addition contained in this document is the addition of Appendix 1. This document also updates and replaces in its entirety AT&T Technical Reference TR50010, Issue 2 dated October, 1997. The changes contained in this document are described in the Introduction Section of Appendix 1. There is no change to the TR with regard to references on BRI central office switch specifications.

The information in the main body of this technical reference directs BRI terminal developers to the specification of each central office switch under consideration. The TR currently focuses on CO switches manufactured by Lucent Technologies (formerly AT&T), Northern Telecom, and Siemens Stromberg-Carlson. Respectively, these switches are the 5ESS®, DMS-100®, and EWSD®. It is not the intent of this section of the document to provide new or updated information over and above that provided in each of the referenced specifications.

In each instance the referenced specification defines the requirements for the Physical Layer (Layer 1), the Data Link Layer (Layer 2) , and the Network Layer (Layer 3). All specifications adhere to the ITU-TS (formerly CCITT) definition of a Basic Rate Interface. As such, the interface is defined as a bi-directional 144 Kbps digital subscriber loop segmented such that there are two 64-Kbps B-channels and one 16-Kbps D-channel. The B-channels transport user voice and/or data while the D-channel transports signaling and packet data.

The BRI central office switch specifications have their basis in the CCITT ISDN Recommendations, Series I , Q, and X, the Bellcore TRs and SRs, and the ANSI T1 Standards. Each specification represents the switch manufacturer's interpretation and subsequent implementation of the standards. As the interpretations are not unique, and as manufacturers wish to provide service differentiators, there are some variations in the realization of the interface and the type of services provided.

2. BRI CENTRAL OFFICE SWITCH IMPLEMENTATION

2.1 Physical Layer

The maturity of the standards and the industry's experience with the Layer 1 portion of the interface is such that there is little variation in implementation across the switches. The U and S/T reference points are supported in all cases. For the U reference point the implementations are consistent with ANSI T1.601-1991. At the S/T reference point, ANSI T1.605-1991 and ITU-TS Recommendation I.430 are adhered to.

2.2 Data Link Layer

As in the case of the Physical Layer, there is little variation in implementation of Layer 2 across the switches. The implementations are consistent with ITU-TS Recommendations Q.920 (I.440) and Q.921 (I.441), and with ANSI T1.602-1988. All support point-to-point and broadcast data links, modulo 128 operation, and manual and automatic Terminal Endpoint Identifier (TEI) assignment.

The 5ESS, in addition, supports two LAPD extensions that are not covered in the ITU-TS Recommendations, exchange identification (XID) audit and parameter notification. Multiple D-channel signaling and packet links also are supported on the 5ESS.

2.3 Network Layer

The Bellcore TRs and SRs are the primary drivers of the specifications at Layer 3. By committing to support National ISDN the switch vendors have agreed to develop interfaces that are consistent with National ISDN-1 (NI-1), NI-2, and NI-3[1]. The realization of these National ISDN offerings has had the greatest impact on the CO switches at Layer 3. Modification of the protocol, feature interaction, and service offering to the end-user has had to occur at this layer in the transition from proprietary (custom) ISDN to National ISDN. The specifications are fully self-contained. However, it may be beneficial to have the Bellcore documents in Table 1 available.

Document Number	Service	Title
SR-NWT-001953	NI-1	Generic Guidelines for ISDN Terminal Equipment on Basic Access Interfaces
SR-NWT-002120	NI-2	Generic Guidelines for National ISDN 2 Basic Access Interfaces
SR-NWT-002457	NI-3	Generic Guidelines for National ISDN 3 Basic Access Interfaces

Table 1. Bellcore's NI Special Reports - Primary Drivers of Layer 3

The Lucent Technologies 5ESS, the Siemens EWSD, and the Nortel DMS-100 support NI-1, NI-2, and NI-3.

2.3.1 Service Differentiators

The switch vendors are able to differentiate their BRI service offering at this layer. Basic Call Control, the big four Supplementary Services (HCDT - Hold, Conference, Drop, and Transfer) and a number of the NI-3 features have been implemented by the switch vendors. However, the vendors have

[1] Recall that NI-1 defines the protocol at the user-network interface (UNI) with little attention to feature operation on the different vendor switches. In NI-2 , the feature operations are standardized across the switches. NI-3 then defines a minimum set of features to be offered at the UNI by all the switch vendors.

distinguished their service offering by providing enhancements to the Supplementary Services or by providing value-added features not defined in NI-3.

2.3.1.1 Lucent Technologies

The 5ESS provides additional services in the following Supplementary Services areas: Non-Initializing Terminals (NITs), Supplementary Data Services, and Personal Communication Services (PCS)/ISDN interworking.

2.3.1.2 Northern Telecom

The DMS-100 provides additional services in the following Supplementary Services areas: Call Park, Call Request, Ring Again (Automatic Call Back), Key Short Hunt, Loudspeaker and Radio Paging Access, and Release. Additionally, the DMS-100 facilitates manual and terminal backward compatibility automatic (via D-channel signaling) through the use of Protocol Version Control (PVC).

2.3.1.3 Siemens Stromberg-Carlson

The EWSD provides additional services in the following Supplementary Services area: PCS/ISDN interworking.

3. REFERENCE CO SWITCH SPECIFICATIONS

The subsequent listing of specifications are for those switches over which AT&T could potentially support ISDN BRI service. In general, these interfaces are under consideration as they are currently the most widely deployed throughout the regions. In each case some degree of backward compatibility is indicated. Generics earlier than those represented are not discussed as support for them is limited or non-existent. For information on the earlier generics contact each vendor at the number provided.

Table 2 designates each vendor and their corresponding ISDN BRI specification document number. It is recommended that the document number and not the title be used when ordering the specifications.

Switch Vendor	Document Number	Document Title
Lucent Technologies	235-900-341	National ISDN Basic Rate Interface Specification
Northern Telecom	NIS S208-6	ISDN Basic Rate User-Network Interface
Siemens Stromberg-Carlson	Book 0740	ISDN Basic Rate Interface User-Network Interface Specifications

Table 2. ISDN BRI Specifications

Table 3 indicates the software generics supported by each specification, including backward compatibility. The table provides also contact information for ordering purposes.

Document Number	Supplier	Switch	Current Generic	Backward Compatible To	Interface Type	To Obtain Contact
235-900-341	AT&T	5ESS	5E10	5E8, 5E9(1), 5E9(2)[2]	NI-1/2/3, Custom	Cust. Info. Ctr. (CIC) 1-800-432-6600
NIS S208-6	Northern Telecom	DMS-100	BCS 34	BCS 29, BCS 32[3]	NI-1/2, Custom	Nortel 1-800-684-2273
Book 0740	Siemens Stromberg -Carlson	EWSD	Release 13.0	Release 10.5/11.0/ 12.0[4]	NI-1/2/3	SSC 1-407-955-6493

Table 3. Profile and Ordering Information

[2] Limited support is provided for earlier generics of the 5ESS switch. The specifications for 5E5, 5E6, and 5E7 are 235-900-311, 235-900-321, and 235-900-331 respectively. These are custom (proprietary) interfaces and the specifications can be obtained from the CIC .

[3] As in the case of the 5ESS, some support is available for earlier generics of the DMS-100. NIS S208-4 and NIS S208-5 are the proprietary specifications for BCS 29 and BCS 32. The documents can be obtained by contacting Nortel at the above telephone number.

[4] All generally available generic Releases of the EWSD software have been in support of National ISDN. As appropriate, Release 13.0 provides full backward compatibility.

GLOSSARY

ANSI	American National Standards Institute
BRI	Basic Rate Interface
CO	Central Office
CPE	Customer Premises Equipment
ISDN	Integrated Services Digital Network
ITU-TS	International Telecommunication Union - Telecommunication Section
LAPD	Link Access Protocol for D-channel
NI	National ISDN
NIT	Non-Initializing Terminal
PCS	Personal Communication Services
PVC	Protocol Version Control
TEI	Terminal Endpoint Identifier
TR	Technical Reference
XID	Exchange Identification

TR 50010

TECHNICAL REFERENCE

AT&T ISDN BASIC RATE INTERFACE

REFERENCE GUIDE

Appendix 1

RECOMMENDED NT DEVICE

ENHANCEMENTS TO FACILITATE

END-TO-END MAINTENANCE OF ISDN

Issue 2.1
December 1997

AT&T ISDN BASIC RATE INTERFACE REFERENCE GUIDE

Appendix 1

RECOMMENDED NT DEVICE ENHANCEMENTS TO FACILITATE

END-TO-END MAINTENANCE OF ISDN

Issue 2.1
December 1997

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

1. INTRODUCTION

To more efficiently maintain ISDN Basic Rate Interface (BRI) based services within North America, AT&T recommends that enhanced operations functionality should be incorporated into Network Termination (NT) devices at the U-interface. This functionality should be incorporated into such devices as NT1s, NT2s, NT12s and ISDN Terminal Equipment. Four "user initiated" functions are specified in this appendix: (1) a mandatory B-channel loopback, (2) an optional D-Channel message log buffer, (3) optional M-channel performance analysis buffers, and (4) an optional device identification message. The B-channel loopback function is similar in many respects to the loopback function defined in ANSI T1.601-1992 Clause 8.3.4b entitled *Operate B_1- channel (or B_2-channel) loopback*.[5]

This document updates and replaces in its entirety Appendix 1 contained in AT&T Technical Reference TR50010, Issue 2 dated October, 1997. The changes contained in this document are as follows: Section 4.2.2.3.1 adds a requirement on the order of transmitting the least and most significant bits of Enhanced Operation Mode Active (EOMA) code. Sections 6.1.3, 6.2.3, 6.3.3, 6.4.3, and 6.5.3 extends the list of "Calling Party Number" "Number Digits" that should be recognized as an enhanced operation function code.

2. SCOPE

This recommendation is intended to apply to all AT&T ISDN BRI as specified in the main body of this Technical Reference.

3. DEFINITIONS

The various standards and recommendations cited in the main body of this Technical Reference contain provisions, which through reference in this text, constitute provisions in this recommendation. However, for clarity, a few fundamental definitions are reiterated here. Figure 1 and accompanying definitions were derived in part from ANSI T1.601-1992 (clause 3).

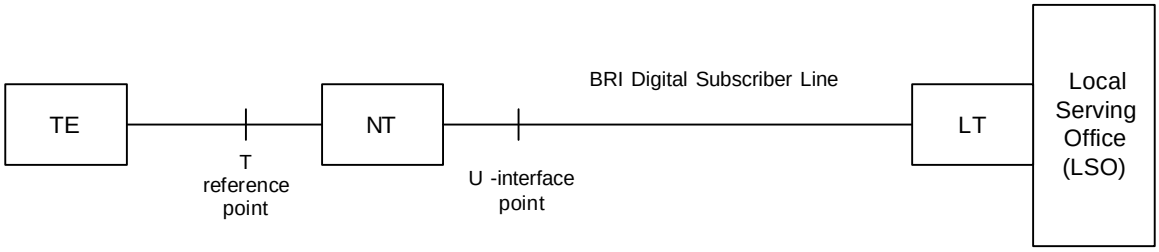


Figure 1: A BRI DSL with respect to the NT

Digital Subscriber Line (DSL): A technology that provides full-duplex service on a single twisted metallic pair at a rate sufficient to support ISDN basic access (2B+D) and additional framing, timing recovery, and operations functions. The physical termination of the DSL at the network end is the LT; the physical termination at the user end is the NT.

Line Termination (LT): The equipment that terminates the access line at the network end.

[5] It is intended, for ease of implementation, that the same U-interface chip sets designed to provide EOC functions can be used under microprocessor control to activate the loopback specified here.

Network Termination (NT): In this recommendation the NT is the equipment that terminates the DSL on the customer side of the interface. The NT function may be incorporated in an NT1, an NT2, or Terminal Equipment. An NT1 is a network termination of an access line that provides only physical layer functionality. An NT2 is a network termination with functionality that can include interfacing higher layer protocols.

Network Or Network Side: In this recommendation these terms represent the network side of the U-interface or the network functions as seen from the U-interface.

Terminal Equipment (TE): In this recommendation the customer terminal equipment which provides the NT2 and other higher layer protocol functionality on the user side of the T-reference point.

U-Interface Point: The location of the interface of the access line with the NT. The location of the interface is on the customer's premises at a location mutually agreed upon by the telephone company or administration and the customer.

User or User Side: In this recommendation these terms represent the TE side of the T reference point or the TE functions as seen from the interface.

4. ENHANCED MODE OF OPERATION

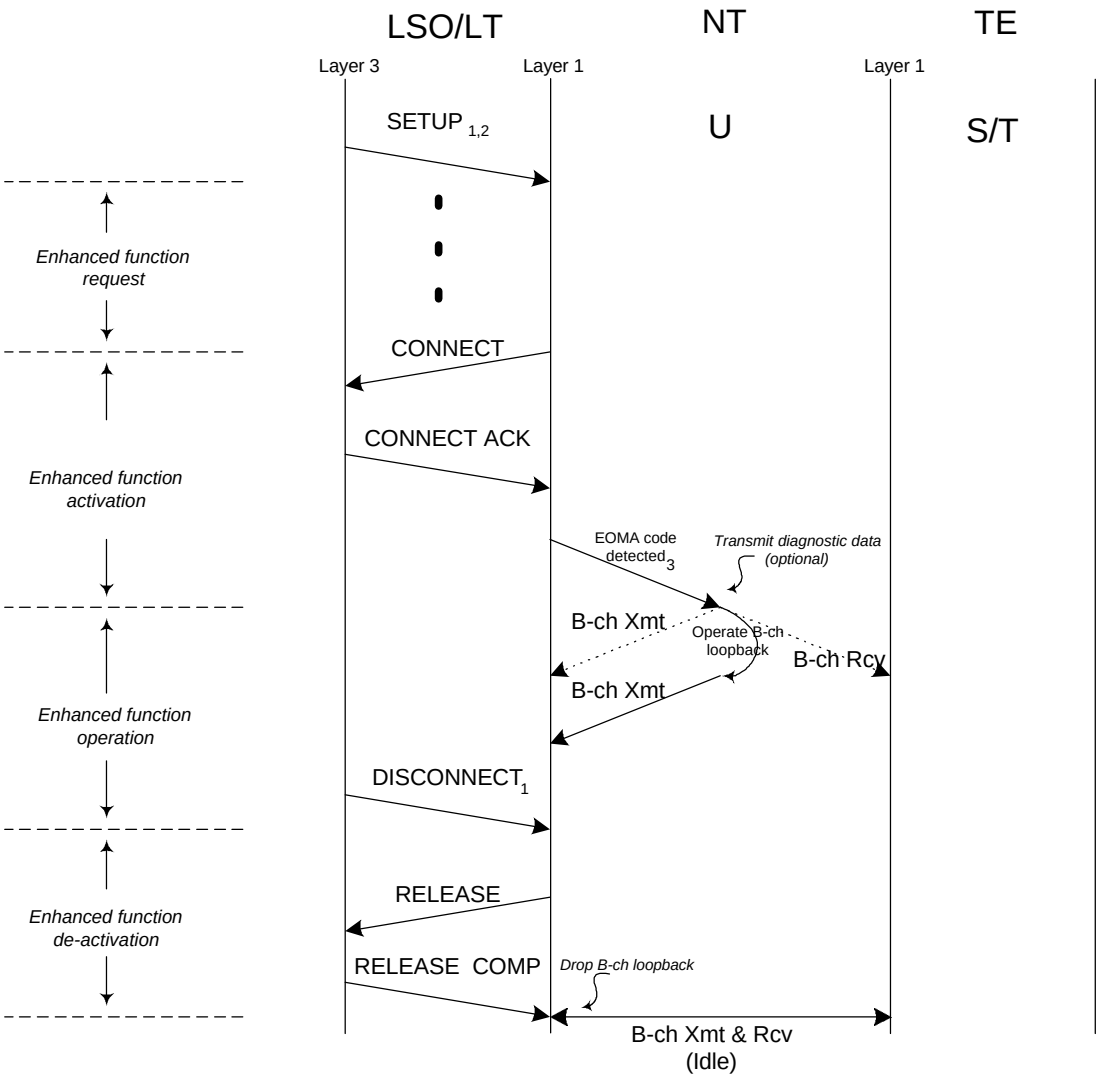
4.1 Definition of Normal and Enhanced Modes of Operation

Normal Mode Of Operation: In this recommendation this will refer to the mode of operation for an NT with respect to the implementation of the Physical Layer (Layer 1), Data Link Layer (Layer 2), and Network Layer (Layer 3) as defined in the Implementation Section (Section 2) of this Technical Reference.

Enhanced Mode Of Operation: In this recommendation this will refer to the mode of operation for an NT, with respect to the implementation of the Physical Layer (Layer 1), Data Link Layer (Layer 2), and Network Layer (Layer 3) during which it will be capable of performing enhanced operations functions as described in Section 5 of this Appendix. The NT will enter an enhanced mode of operation after recognizing an "enhanced function request" for either of the two B-channels. The NT will remain in an enhanced mode during "enhanced function activation," "enhanced function operation" and "enhanced function de-activation." While in the enhanced mode, the NT should be able to service enhanced function requests for both B-channels at the same time. The NT will not return to the normal mode of operation until all enhanced mode functions have been de-activated for each B-channel. While in the enhanced mode, the NT will return to the normal mode of operation if: (1) at any time the NT loses the ability to communicate with the network at either Layer 1 or Layer 2, (2) at any time the TE reinitializes Layer 2 (e.g. as a result of power cycling the TE or disconnecting and reconnecting the physical connection to the NT), (3) any of the Layer 3 messaging deviates from the specifications described in Section 4.2 of this Appendix, and (4) at any time while in the enhanced mode of operation that idle code is received from the network over the associated B-channel for a period of at least 30 seconds.

4.2 Enhanced Mode Phases

Figure 2 illustrates the phases of the enhanced mode of operation at Layers 1 and 3. A description of each phase for Layers 1, 2, and 3 are described in the sub-sections which follow.



Note 1: Layer 3 messages are circuit switched bearer mode and may be associated with either channel B_1 or B_2.

Note 2: The SETUP message must contain a properly encoded "Called party subaddress" and/or "Calling party number" information element in order to be recognized as a valid enhanced function request (Section 6).

Note 3: Enhanced Operation Mode Active (EOMA) code is defined in Section 4.2.2.3.1.

Figure 2: Enhanced Mode Operation Phases for Layer 1 and 3

4.2.1 Enhanced Function Request

The receipt of a circuit-switched bearer services SETUP message from the network containing a valid enhanced operations function code (Section 6) should be recognized by the NT as an enhanced function request for the associated B-channel as shown in Figure 2. Once a valid request is recognized the following procedures apply for each layer.

4.2.1.1 Layer 3

An enhanced function request begins when the NT receives a SETUP message from the network containing either: (1) a "Called party subaddress" information element with its "Subaddress Information"

fields encoded with one of the enhanced operation function codes (Section 6); or (2) a "Calling party number" information element with the "Number digits" matching one of the enhanced operation function codes (Section 6). A SETUP message may contain enhanced operation function codes in one or both of the Called party subaddress and the Calling party number information elements. If enhanced function codes are present in both information elements, they must match in order for the function request to be considered valid by the NT; otherwise, the NT should remain in the normal mode.

The SETUP message containing the enhanced function request, and all subsequent Layer 3 messages required prior to enhanced function activation for the associated B-channel, should ***not be passed*** by the NT toward the TE.

The NT should respond with the appropriate Layer 3 messages[6], as implied in Figure 2, that will allow the call to be connected (i.e. allow for enhanced function activation).

If there is an available B-channel and a second SETUP message containing the enhanced function request is received by the NT from the network, then the same procedures shall apply for processing the call.

All other Circuit Switched Bearer Services SETUP messages received by the NT from the network, except those which contain a valid enhanced function request when there is a B-channel available, should be rejected. Those SETUP messages, and all subsequent associated Layer 3 messages, should not be passed by the NT toward the TE.

All other Layer 3 messages received by the NT from the network, should be passed transparently to the TE.

Layer 3 messages received by the NT from the TE, irrespective of the B-channel specified, may be passed transparently toward the network. However, it is recommended that, depending upon the LSO switch type (i.e. the 5ESS, DMS-100, or EWSD), the particular BRI implementation (e.g. National ISDN-1) and provisioning (e.g. Point-to-Point), the NT should reject messages from the TE which the network would determine to be incompatible with the current call state of the B-channels.

4.2.1.2 Layer 2

The NT should operate in the normal mode of operation with respect to Layer 2 with the exception of the following important procedures:

4.2.1.2.1 Use of Valid Terminal End-Point Identifiers (TEIs)

Upon initializing Layer 2 the NT will request assignment of TEIs from the LSO/LT. The NT, however, is responsible for Layer 2 management of the TE and for assuring that messages passed between the TE and the LSO/LT have valid TEIs. The method devised to ensure this may be dependent upon the LSO switch type (i.e. the 5ESS, DMS-100 or EWSD) and the particular BRI implementation (e.g. National ISDN 1).

4.2.1.2.2 LSO/LT to TE Numbered Information Frame Number Sequence Integrity

Certain Layer 3 enhanced function operation messages received from the LSO/LT will not be passed transparently from the NT to the TE. In addition, certain Layer 3 enhanced function operation messages transmitted to the LSO/LT will be originated by the NT and not the TE. Because of this, the frame numbering for any numbered information frames could be out of sequence between the LSO/LT and TE when the NT returns to the normal mode of operation. It will be necessary for the NT to provide a mechanism that ensures that number sequence integrity is maintained between the LSO/LT and the TE.

[6] The Layer 3 message sequence and message encoding may be dependent upon switch type and the Layer 3 implementation.

4.2.1.3 Layer 1

The NT should operate in the normal mode of operation with respect to Layer 1.

4.2.2 Enhanced Function Activation

The NT should send a CONNECT message to initiate enhanced function activation. Upon moving to the Active call state, the NT will begin monitoring the B-channel at Layer 1 for the receipt of the "Enhanced Operations Mode Active" (EOMA) (see Section 4.2.2.3.1) code from the network. At the instant the NT successfully detects EOMA (as described in Section 4.2.2.3), enhanced function activation is complete and enhanced function operation begins.

Note: If the EOMA code is not detected within 15 seconds, the call should be disconnected by the NT and the NT should then return to the normal mode of operation.

4.2.2.1 Layer 3

Enhanced function activation begins with the NT sending a CONNECT[7] message and concludes with the receipt of a CONNECT ACKNOWLEDGE from the network. The CONNECT ACKNOWLEDGE should ***not be passed*** by the NT toward the TE.

If there is an available B-channel and a second SETUP message containing the enhanced function request is received by the NT from the network, then the same procedures shall apply for processing the call as described in Section 4.2.1.1.

Once enhanced function activation begins, all other Circuit Switched Bearer Services SETUP messages received by the NT from the network, except those which contain a valid enhanced function request when there is a B-channel available, should be rejected. Those SETUP messages, and all subsequent associated Layer 3 messages, should not be passed by the NT toward the TE.

All other Layer 3 messages received by the NT from the network, should be passed transparently to the TE.

Layer 3 messages received by the NT from the TE, irrespective of the B-channel specified, may be passed transparently toward the network. However, it is recommended that, depending upon the LSO switch type (i.e. the 5ESS, DMS-100, or EWSD), the particular BRI implementation (e.g. National ISDN-1) and provisioning (e.g. Point-to-Point), the NT should reject messages from the TE which the network would determine to be incompatible with the current call state of the B-channels.

4.2.2.2 Layer 2

The same procedures apply as described in Section 4.2.1.2.

4.2.2.3 Layer 1

The NT should operate in the normal mode of operation with respect to Layer 1 with the following notable exception:

Because the B-channel may be "cut through" from end to end asynchronously with respect to reception of the CONNECT ACKNOWLEDGE message by the NT, the NT will be required to non-intrusively monitor the B-channel at Layer 1 for an EOMA code. Upon detection of eight consecutive octets of EOMA code the enhanced function activation phase is complete and enhanced function operation begins.

[7] The Layer 3 message sequence and message encoding may be dependent upon switch type and the Layer 3 implementation.

Note: If the EOMA code is not detected within 15 seconds, the call should be disconnected by the NT and the NT should then return to the normal mode of operation.

4.2.2.3.1 Enhanced Operation Mode Active (EOMA) Code

The Enhanced Operation Mode Active code is shown in the table below. An EOMA code may be transmitted by the network or the NT singly, or in a continuous fashion, depending upon the appropriate Layer 1 operation procedures to be implemented. Each octet should be transmitted with the least significant bit (LSB) of each octet sent first and the most significant bit (MSB) sent last.

Enhanced Operation Mode Active (EOMA) code

Octet encoding

OCTET	FIELD	BITS	VALUE	MEANING
1	data	8-1	00000001	EOMA code

4.2.3 Enhanced Function Operation

Enhanced function operation begins at the instant the successful function activation sequence has completed. Operation will continue until an enhanced function de-activation sequence has completed as shown in Figure 2. The following procedures apply at each layer:

4.2.3.1 Layer 3

During enhanced function operation, if there is an available B-channel and a second SETUP message containing the enhanced function request is received by the NT from the network, then the SETUP message, and all subsequent Layer 3 messages required prior to enhanced function activation for the associated B-channel, should not be passed by the NT toward the TE. The NT should respond with the appropriate Layer 3 messages, as implied in Figure 2, that will allow the call to be connected (i.e. allow for enhanced function activation).

All other Circuit Switched Bearer Services SETUP messages received by the NT from the network should be rejected. Those SETUP messages, and all subsequent associated Layer 3 messages, should not be passed by the NT toward the TE.

All other Layer 3 messages received by the NT from the network, should be passed transparently to the TE.

During enhanced function operation, all Layer 3 messages received by the NT from the TE, irrespective of the B-channel specified, may be passed transparently toward the network. However, it is recommended that, depending upon the LSO switch type (i.e. the 5ESS, DMS-100, or EWSD), the particular BRI implementation (e.g. National ISDN-1) and provisioning (e.g. Point-to-Point), the NT should reject messages from the TE which the network would determine to be incompatible with the current call state of the B-channels.

4.2.3.2 Layer 2

The same procedures apply as described in Section 4.2.1.2.

4.2.3.3 Layer 1

The operation at Layer 1 will vary based upon the enhanced operation function code associated with the enhanced function request. See the appropriate "Layer 1 Operation Procedures" in Section 6.

4.2.4 Enhanced Function De-Activation

An enhanced function will be de-activated when the call for the associated B-channel is disconnected from the network side as shown in Figure 2. At the point that the disconnect sequence concludes, the NT should return to the normal mode of operation. The following procedures apply at each layer:

4.2.4.1 Layer 3

Enhanced function de-activation begins with the NT receiving a DISCONNECT message; the NT should respond to a DISCONNECT with a RELEASE message[8]; finally de-activation concludes with the receipt of the RELEASE COMPLETE. The DISCONNECT and RELEASE COMPLETE messages should ***not be passed*** by the NT toward the TE.

During enhanced function operation, all Layer 3 messages received by the NT from the TE may be passed transparently toward the network. However, it is recommended that, depending upon the LSO switch type (i.e. the 5ESS, DMS-100, or EWSD), the particular BRI implementation (e.g. National ISDN-1) and provisioning (e.g. Point-to-Point), the NT should reject messages from the TE which the network would determine to be incompatible with the current call state of the B-channels.

During enhanced function operation, if there is an available B-channel and a second SETUP message containing the enhanced function request is received by the NT from the network, then the SETUP message, and all subsequent Layer 3 messages required prior to enhanced function activation for the associated B-channel, should not be passed by the NT toward the TE. The NT should respond with the appropriate Layer 3 messages, as implied in Figure 2, that will allow the call to be connected (i.e. allow for enhanced function activation).

All other Circuit Switched Bearer Services SETUP messages received by the NT from the network should be rejected. Those SETUP messages, and all subsequent associated Layer 3 messages, should not be passed by the NT toward the TE.

All other Layer 3 messages received by the NT from the network, should be passed transparently to the TE.

4.2.4.2 Layer 2

The same procedures apply as described in Section 4.2.1.2 until de-activation concludes.

4.2.4.3 Layer 1

Layer 1 will continue to operate according to enhanced function operation procedures (Section 6) until function de-activation has concluded.

[8] The Layer 3 message sequence and message encoding may be dependent upon switch type and the Layer 3 implementation.

4.3 Transmission of Diagnostic Data

One of the capabilities associated with the enhanced operation functions of the NT is the transmission of diagnostic data toward the network on the associated B-channel. Data will be encoded as IRA[9] and transmitted in diagnostic data frames.

4.3.1 Diagnostic Data Frame

Diagnostic Data Frame **Octet encoding**				
OCTET	FIELD	BITS	VALUE	MEANING
n (n ≤ 255)	Diagnostic Data Message	__	ASCII	Diagnostic Data Message as defined in Sections 7.1.5, 7.2.5, and 7.3.3
n + 1	Diagnostic Data Message end-marker	8-1	00000010	End of the Diagnostic Data Message within the diagnostic data frame
n + 2	Checksum (nibble C1)	8 -1	ASCII Hex	Most significant nibble of 16 bit checksum
n + 3	(nibble C2)	8 - 1	ASCII Hex	2nd nibble of 16 bit checksum
n + 4	(nibble C3)	8 - 1	ASCII Hex	3rd nibble of 16 bit checksum
n + 5	(nibble C4)	8 - 1	ASCII Hex	Least significant nibble of 16 bit checksum

4.3.1.1 Diagnostic Data Message Format

The Diagnostic Data Message contents of a Diagnostic data frame should consist of one to 255 octets of IRA data. This includes all values from hexadecimal 00 to hexadecimal 7F with the exception of hexadecimal 01 (EOMA code) and hexadecimal 02 (Diagnostic Data Message end-marker - see table above).

4.3.1.2 16 Bit Checksum

The checksum is computed in standard fashion by adding the octets of the Diagnostic Data Message. Each nibble of the checksum will be Hexadecimal encoded as IRA with the most significant nibble (C1) being transmitted first and the least significant nibble (C4) transmitted last.

4.3.1.3 Diagnostic Data Frame Encoding Example

As an example, if the Diagnostic Data Message contents are “Hello\n” (i.e. Hello followed by a new-line character), the resulting Diagnostic Data Frame should be encoded as follows:

48 65 6c 6c 6f 0a 02 30 31 66 65

[9] International Reference Alphabet (IRA) *Information technology - 7-bit coded character set for information interchange*, ITU Recommendation T.50 (September 1992)

4.3.2 End-of-Message Diagnostic Data Frame

After all Diagnostic Data Frames containing information have been transmitted, End-of-Message Diagnostic Data Frames should be transmitted as described in Section 4.3.3. An End-of-Message Diagnostic Data Frame should be encoded as shown in the table on the next page.

End-of-Message Diagnostic Data Frame

Octet encoding

OCTET	FIELD	BITS	VALUE	MEANING
1	Diagnostic Data Message	8-1	00011010	Diagnostic Data Message used to indicate end-of-message.
2	Diagnostic Data Message End Marker	8-1	00000010	End of Diagnostic Data Message within the Diagnostic Data Frame.
3	Checksum (nibble C1)	8 -1	00110000	ASCII Hex 30 (IRA character “0”)
4	(nibble C2)	8 - 1	00110000	ASCII Hex 30 (IRA character “0”)
5	(nibble C3)	8 - 1	00110001	ASCII Hex 31 (IRA character “1”)
6	(nibble C4)	8 - 1	01000001	ASCII Hex 41 (IRA character “A”)

4.3.3 Diagnostic Data Transmission Procedures

At the instant that enhanced function operation begins (i.e. the NT has detected at least 8 consecutive octets of EOMA code from the network on the B-channel), Diagnostic Data should be transmitted by the NT toward the network according to the Layer 1 operation procedures associated with the appropriate enhanced operations function code (Section 6). Data is transmitted as diagnostic data messages within Diagnostic Data Frames encoded as described in Section 4.3.1.

The NT may divide Diagnostic Data to be transmitted to the network into any number of sequential Diagnostic Data Frames. These frames should then be transmitted toward the network according to the following procedures:

1. At least 16 octets of EOMA code (hexadecimal 01 - see Section 4.2.2.3.1) should be sent prior to the transmission of the first Diagnostic Data Frame.
2. The NT should transmit a Diagnostic Data Frame by transmitting each octet with the least significant bit (LSB) of each octet sent first and the most significant bit (MSB) sent last.
3. Following each Diagnostic Data Frame sent, at least one octet of EOMA code should be transmitted.
4. Subsequent Diagnostic Data Frames do not require additional octets of EOMA code to proceed prior to their transmission; however, there must be at least one octet of EOMA code between each Diagnostic Data Frame.
5. Following the transmission of the last Diagnostic Data Message Frame containing actual diagnostic information, the NT should transmit two End-of-Message Diagnostic Data Frames and the appropriate number of octets of EOMA code as described in steps 2 - 4 above.

4.3.3.1 Diagnostic Data Transmission Encoding Example

The following message "Hello\n Hello\n Hello\n" could be encoded as three Diagnostic Data Frames (with each frame containing one "Hello\n") as follows:

01 01 01 01 01 01 01 01 01 01 01 01 01 01 01 01	(Start of transmission - *16 octets of EOMA code*)
48 65 6c 6c 6f 0a 02 30 31 66 65	(*Diagnostic Data Frame 1: Hello\n*)
01	(*One octet of EOMA code*)
48 65 6c 6c 6f 0a 02 30 31 66 65	(*Diagnostic Data Frame 2: Hello\n*)
01 01	(*Two octets of EOMA code*)
48 65 6c 6c 6f 0a 02 30 31 66 65	(*Diagnostic Data Frame 3: Hello\n*)
01	(*One octet of EOMA code*)
1A 02 30 30 31 41	(*End-of-Message Diagnostic Data Frame)*
01	(*One octet of EOMA code*)
1A 02 30 30 31 41	(*End-of-Message Diagnostic Data Frame*)
01	(*One octet of EOMA code*)

5. Enhanced Operations Functions

5.1 Operate B-Channel Loopback

This enhanced mode function directs the NT to loopback an individual B-Channel, specified in the enhanced function request, toward the network.[10] The individual B-channel loopback may be either transparent or non-transparent[11]. It is non-inverting and should remain in-effect (i.e. not timed) until this enhanced function is de-activated.

5.2 Transmit D-Channel Message Log Buffer

This enhanced operations function directs the NT to transmit the contents of its D-Channel Message Log Buffer toward the network in the B-channel associated with the enhanced function request.

The NT should save in the Message Log Buffer at least the last 25 Layer 3, and some Layer 2, D-channel messages (Section 7.1.1), which are transmitted to or received from the network across the U-interface. The NT should provide an internal timing mechanism, initialized at power up, that will allow it to time stamp each message. In addition, the origination and destination end-points of the message along with the direction the message was transmitted should also be recorded (i.e. network to NT, NT to network, network to TE, or TE to network).

5.3 Transmit M-Channel Performance Analysis Buffers

This enhanced operations function directs the NT to transmit the contents of its M-Channel Performance Analysis Buffers toward the network in the B-channel associated with the enhanced function request.

Several performance parameters have been defined (Section 7.2.1) which will require the NT to observe the M-channel[12] transmitted to and received from the network at the U-interface. The NT should provide an internal timing mechanism, initialized at power up, that will allow it to keep track of the current time and to make second-by-second observations of the M-channel. From these observations parameters should

[10] It is intended, for ease of implementation, that the same U-interface chip sets designed to provide EOC functions can be used under microprocessor control to activate the loopback specified here.

[11] "Transparent" is the ITU term used to indicate that the bits toward the loop are passed onward as well as looped back. A "non-transparent" loopback will not pass bits on-ward but will instead transmit "idle code."

[12] ANSI T1.601 -1992 clause 6 and clause 8 define the M-channel and its bit functions.

be measured and then saved in the analysis buffers. Data should be saved in 15 minute bins for the current 24 hour period and then accumulated in 24 hour bins in order to save approximately one weeks worth of data (Section 7.2.2).

5.4 Transmit Identification Message

This enhanced operations function directs the NT to transmit a message providing device type information toward the network in the B-channel associated with the enhanced function request.

The Identification Message will be used to retrieve information about the connected device which provides the NT functionality. The information to be retained should include, but is not limited to: model, manufacturer, software revision level, and hardware revision level (Section 7.3.1).

6. Enhanced Operations Function Codes

This section specifies the valid enhanced operations function codes which should be recognized by the NT. The codes are transmitted within a Layer 3 SETUP message in either: (1) the "Subaddress Information" fields of a "Called party subaddress" information element; or (2) the "Number digits" of a "Calling party number" information element. A SETUP message may contain enhanced operation function codes in one or both of the Called party subaddress and the Calling party number information elements. If enhanced function codes are present in both information elements, they must correspond in order for the function request to be considered valid by the NT; otherwise, the NT should remain in the normal mode.

The encoding for the corresponding enhanced operations function code are shown below. In addition, the Layer 1 operation procedures which the NT should perform associated with these codes are described.

6.1 *Operate B-Channel Loopback*

6.1.1 Layer 1 Operation Procedures

Upon a successful enhanced function activation, the NT will operate the B-channel loopback (Section 5.1) for the associated B-channel.

6.1.2 Called Party Subaddress Encoding

Operate B-Channel Loopback: Called Party Subaddress Information Element

Octet encoding

OCTET	FIELD	BITS	VALUE	MEANING
1	Information element identifier	8-1	01110001	Called party subaddress
2	Length of contents	8-1	00000111	Length of information element contents
3	Extension	8	1	Description is extended through next octets
	Type of subaddress	7-5	010	User specified
	Odd/even indicator	4	0	Not used
	Spare	3-1	000	
4	subaddress information	8-1	01000000	IRA character "@"
5	subaddress information	8-1	00000000	All zeros to indicates address of NT
6	subaddress information	8-1	01001100	IRA character "L"
7	subaddress information	8-1	01101111	IRA character "o"
8	subaddress information	8-1	01101111	IRA character "o"
9	subaddress information	8-1	01110000	IRA character "p"

6.1.3 Calling Party Number - Number Digits

The NT should recognize the following "Calling party number", "Number digits" as the enhanced operation function code for:

Operate B-Channel loopback: 790 555 5700[13]

6.2 Transmit D-Channel Message Log Buffer/Operate B-Channel Loopback

6.2.1 Layer 1 Operation Procedures

Upon a successful enhanced function activation, the NT should transmit the current contents of its D-Channel Messages Log Buffers toward the network on the associated B-channel (Section 5.2). The Message Log Buffer data should be encoded as described in Sections 4.3.1 and 7.1.5 and transmitted as described in Section 4.3.3. Immediately following the transmission of the D-Channel Message Log Buffer data, the NT should operate the B-channel loopback for that B-channel (Section 5.1).

[13] If the network prepends any digits to the number digits specified (e.g. the country code prepended to the Calling party number on an international call) the NT should still recognize this number as a valid enhanced function code.

6.2.2 Called Party Subaddress Encoding

Transmit D-Channel Message Log Buffer/Operate B-Channel Loopback: Called party subaddress Information Element

Octet encoding

OCTET	FIELD	BITS	VALUE	MEANING
1	Information element identifier	8-1	01110001	Called party subaddress
2	Length of contents	8-1	00001100	Length of information element contents
3	Extension	8	1	Description is extended through next octets
	Type of subaddress	7-5	010	User specified
	Odd/even indicator	4	0	Not used
	Spare	3-1	000	
4	subaddress information	8-1	01000000	IRA character "@"
5	subaddress information	8-1	00000000	All zeros to indicates address of NT
6	subaddress information	8-1	01001100	IRA character "L"
7	subaddress information	8-1	01101111	IRA character "o"
8	subaddress information	8-1	01101111	IRA character "o"
9	subaddress information	8-1	01110000	IRA character "p"
10	subaddress information	8-1	01000100	IRA character "D"
11	subaddress information	8-1	01100100	IRA character "d"
12	subaddress information	8-1	01100001	IRA character "a"
13	subaddress information	8-1	01110100	IRA character "t"
14	subaddress information	8-1	01100001	IRA character "a"

6.2.3 Calling Party Number - Number Digits

The NT should recognize the following "Calling party number", "Number digits" as the enhanced operation function code for:

Transmit D-Channel Message Log Buffer/Operate B-Channel loopback: 790 555 5730[14]

6.3 Transmit M-Channel Performance Analysis Buffers/Operate B-Channel Loopback

6.3.1 Layer 1 Operation Procedures

Upon a successful enhanced function activation, the NT should transmit the current contents of its M-channel performance analysis buffers toward the network on the associated B-channel (Section 5.3). The analysis buffer data should be encoded as described in Section 4.3.1 and 7.2.5 and transmitted as described in Section 4.3.3. Immediately following the transmission of the M-Channel Performance Analysis Buffers data, the NT should operate the B-channel loopback for that B-Channel (Section 6.1).

[14] If the network prepends any digits to the number digits specified (e.g. the country code prepended to the Calling party number on an international call) the NT should still recognize this number as a valid enhanced function code.

6.3.2 Called Party Subaddress Encoding

Transmit M-Channel Performance Analysis Buffers/Operate B-Channel Loopback: Called party subaddress Information Element

Octet encoding

OCTET	FIELD	BITS	VALUE	MEANING
1	Information element identifier	8-1	01110001	Called party subaddress
2	Length of contents	8-1	00001100	Length of information element contents
3	Extension	8	1	Description is extended through next octets
	Type of subaddress	7-5	010	User specified
	Odd/even indicator	4	0	Not used
	Spare	3-1	000	
4	subaddress information	8-1	01000000	IRA character "@"
5	subaddress information	8-1	00000000	All zeros to indicates address of NT
6	subaddress information	8-1	01001100	IRA character "L"
7	subaddress information	8-1	01101111	IRA character "o"
8	subaddress information	8-1	01101111	IRA character "o"
9	subaddress information	8-1	01110000	IRA character "p"
10	subaddress information	8-1	01001101	IRA character "M"
11	subaddress information	8-1	01100100	IRA character "d"
12	subaddress information	8-1	01100001	IRA character "a"
13	subaddress information	8-1	01110100	IRA character "t"
14	subaddress information	8-1	01100001	IRA character "a"

6.3.3 Calling Party Number - Number Digits

The NT should recognize the following "Calling party number", "Number digits" as the enhanced operation function code for:

Transmit M-Channel Performance Analysis Buffers/Operate B-Channel Loopback: 790 555 5760[15]

6.4 Transmit Identification Message/Operate B-channel Loopback

6.4.1 Layer 1 Operation Procedures

Upon a successful enhanced function activation, the NT should first transmit its Identification Message (Section 5.4) toward the network on the associated B-channel. This diagnostic data should be encoded as described in Sections 4.3.1 and 7.3.3 and then transmitted as described in Section 4.3.3. Immediately following the transmission of the Identification Message data, the NT should operate the B-Channel loopback for that B-Channel (Section 5.1).

[15] If the network prepends any digits to the number digits specified (e.g. the country code prepended to the Calling party number on an international call) the NT should still recognize this number as a valid enhanced function code.

6.4.2 Called Party Subaddress Encoding

Transmit Identification Message/Operate B-Channel Loopback: Called party subaddress Information Element

Octet encoding

OCTET	FIELD	BITS	VALUE	MEANING
1	Information element identifier	8-1	01110001	Called party subaddress
2	Length of contents	8-1	00001011	Length of information element contents
3	Extension	8	1	Description is extended through next octets
	Type of subaddress	7-5	010	User specified
	Odd/even indicator	4	0	Not used
	Spare	3-1	000	
4	subaddress information	8-1	01000000	IRA character "@"
5	subaddress information	8-1	00000000	All zeros to indicates address of NT
6	subaddress information	8-1	01001100	IRA character "L"
7	subaddress information	8-1	01101111	IRA character "o"
8	subaddress information	8-1	01101111	IRA character "o"
9	subaddress information	8-1	01110000	IRA character "p"
10	subaddress information	8-1	01001110	IRA character "N"
11	subaddress information	8-1	01010100	IRA character "T"
12	subaddress information	8-1	01001001	IRA character "I"
13	subaddress information	8-1	01000100	IRA character "D"

6.4.3 Calling Party Number - Number Digits

The NT should recognize the following "Calling party number", "Number digits" as the enhanced operation function code for:

Transmit Identification Message/Operate B-Channel Loopback: 790 555 6843[16]

6.5 Transmit all Diagnostic Data/Operate B-Channel Loopback

6.5.1 Layer 1 Operation Procedures

Upon a successful enhanced function activation, the NT should first transmit the current contents of its D-Channel Message Log Buffer (Section 5.2), then its M-Channel Performance Analysis Buffers (Section 5.3), and finally its Identification Message (Section 5.4) toward the network on the associated B-channel. The Analysis Buffer data should be encoded as described in Sections 4.3.1, 7.1.5, 7.2.5 and 7.3.3 and then transmitted as described in Section 4.3.3. Immediately following the transmission of this data, the NT should operate the B-channel loopback for that B-channel (Section 5.1).

[16] If the network prepends any digits to the number digits specified (e.g. the country code prepended to the Calling party number on an international call) the NT should still recognize this number as a valid enhanced function code.

6.5.2 Called Party Subaddress Encoding

Transmit All Diagnostic Data/Operate B-Channel Loopback: Called party subaddress Information Element

Octet encoding

OCTET	FIELD	BITS	VALUE	MEANING
1	Information element identifier	8-1	01110001	Called party subaddress
2	Length of contents	8-1	00001110	Length of information element contents
3	Extension	8	1	Description is extended through next octets
	Type of subaddress	7-5	010	User specified
	Odd/even indicator	4	0	Not used
	Spare	3-1	000	
4	subaddress information	8-1	01000000	IRA character "@"
5	subaddress information	8-1	00000000	All zeros to indicates address of NT
6	subaddress information	8-1	01001100	IRA character "L"
7	subaddress information	8-1	01101111	IRA character "o"
8	subaddress information	8-1	01101111	IRA character "o"
9	subaddress information	8-1	01110000	IRA character "p"
10	subaddress information	8-1	01000001	IRA character "A"
11	subaddress information	8-1	01101100	IRA character "l"
12	subaddress information	8-1	01101100	IRA character "l"
13	subaddress information	8-1	01100100	IRA character "d"
14	subaddress information	8-1	01100001	IRA character "a"
15	subaddress information	8-1	01110100	IRA character "t"
16	subaddress information	8-1	01100001	IRA character "a"

6.5.3 Calling Party Number - Number Digits

The NT should recognize the following "Calling party number", "Number digits" as the enhanced operation function code for:

Transmit All Diagnostic Data/Operate B-Channel Loopback": 790 555 5364[17]

[17] If the network prepends any digits to the number digits specified (e.g. the country code prepended to the Calling party number on an international call) the NT should still recognize this number as a valid enhanced function code.

7. Diagnostic Data

7.1 D-Channel Message Log Buffer

7.1.1 Messages To Be Saved

The NT should be able to recognize, and store in its analysis buffers, all Layer 3 messages defined in the Section 3, "Reference CO Switch Specifications" in the main body of this Technical Reference[18].

The following Layer 2 unnumbered U-frames commands should also be stored:

Set asynchronous balanced mode enabled (SABME)

Unnumbered information (UI): Include the following message types only:

Identity request (User To Network)

Identity assigned (Network To User)

Identity denied (Network To User)

Disconnect (DISC)

The following Layer 2 U-frame responses should be stored:

Disconnected mode (DM)

Unnumbered acknowledgment (UA)

Frame reject (FRMR)

7.1.2 Local Timing

The NT will be required to provide a local timing mechanism for time stamping D-channel messages to be saved as well as for determining the current time. The initial time, T_0, should be coincident with the point at which the NT is powered on unless battery backup is available.[19]

If the NT is allowed to run indefinitely it should be able to time stamp data for up to 999 days before the buffer resets. The NT should be able to provide 0.1 second (100 millisecond) accuracy when time stamping data, although 0.001 second accuracy (1 millisecond) accuracy is preferred.

7.1.3 Local Storage

The time and D-channel messages recorded by the NT should be saved locally as described below.

Current Time: The NT should save the current time, measured in seconds from time T_0 (see "Local Timing" Section 7.1.2).

Message Time Stamp: For each D-channel message recorded by the NT, it should associate a time stamp, measured in seconds from time T_0 (see "Local Timing" Section 7.1.2).

---

[18] While most Layer 3 messages will be contained within Layer 2 Information frames (I- frames), there may be instances where the messages are contained in Layer 2 Unnumbered frames (U-frames). Layer 3 information contained in either I-frames or U-frames should be logged.

[19] Battery backup of the D-Channel Message Log buffer is not required although it is strongly recommended. If battery backup is provided, initialization should only occur once unless the NT is reset through manual intervention (e.g. by disrupting the power backup) or local timing is disrupted.

Message End Points and Direction: For each D-channel message recorded by the NT, it should associate the transmit and receive end points as well as the direction the message traveled. The four message direction possibilities are:

> **Network to TE:** Indicates that the message was transmitted from the network to the terminal equipment.
>
> **TE to Network:** Indicates that the message was transmitted from the terminal equipment to the network.
>
> **Network to NT:** Indicates that the NT intercepted the message transmitted by the network.
>
> **NT to Network:** Indicates that the NT transmitted the message to the network.

Message Content: Any Layer 3 or Layer 2 messages to be saved (Section 7.1.1) should be recorded in binary exactly as they are observed at the U-interface. The storage requirements will vary based upon message type.

7.1.4 Buffer Initialization

The D-Channel Messages Analysis Buffers should be initialized (contents cleared) after NT power up and at the point that "transparency of the transmission" is provided on the network side of the NT (transparency is defined in ANSI T1.601-1992 clause 6.4.6.6). Buffer initialization will occur at some time after T_0 as defined in the Local Timing section above (Section 7.1.2).

7.1.5 Return of Diagnostic Data

During enhanced function operation, the time stamped D-channel messages, along with the current time[20], should be transmitted from the NT toward the network.

7.1.5.1 Modification of Number Digits

To ensure customer privacy, it is critical that the "Number digits" field of any "Called party address" or "Calling party address" information elements contained within saved Layer 3 messages ***are not returned*** in a diagnostic data message in their original format. Instead, each number digit should be replaced with a zero (0), encoded in the same format as the original number digits. As an example, if the saved original called party address number digits were "800 555 1212" then the number digits to be returned within the diagnostic data message would be "000 000 0000."

7.1.5.2 Diagnostic Data Message Encoding

The D-Channel Message Log Buffer data will be formatted into a report that consists of IRA lines of text. This report can then be divided into sequential Diagnostic Data Messages to be included in Diagnostic Data Frames and transmitted toward the network by the NT as specified in Section 4.3.

[20] In order that the current time that it is received by the network from the NT is as close to the current "real time" as possible, the value of the current time should not be encoded until the last possible moment prior to actual transmission of the diagnostic data frame.

7.1.5.2.1 Report Format

The D-Channel Message Log Report should be formatted as follows:

Report Header
D-channel message 1: End Point and Direction & Time Stamp
D-channel message 1: Contents
|
D-channel message N: End Point and Direction & Time Stamp
D-channel message N: Contents
Report Trailer

7.1.5.2.2 Report Header and Trailer Format

Report Header: This is the first line of the report and will be formatted as the text "RPT" followed by an IRA space character (' ') and the current time formatted as specified in Section 7.1.5.2.3. The header will end with an IRA new-line character.

Report Trailer: This is the last line of the report and will be formatted as the text "END" followed by an IRA space character (' ') and the current time formatted as specified in Section 7.1.5.2.3. The trailer will end with an IRA new-line character.

7.1.5.2.3 Message End Points and Direction & Time Stamp Format

For each D-channel message to be reported a line will proceed it which contains the message end point and direction followed by the message time stamp. An IRA space character (' ') should separate the two fields and the time stamp should be followed by an IRA new-line character.

Message end point and Direction: The format for reporting the message end point and direction is as follows:

Network to TE:	**NET->TE**
TE to Network:	**NET<-TE**
Network to NT:	**NET->NT**
NT to Network:	**NET<-NT**

Time stamps: The format for reporting the time is as follows:

DDD HH:MM:SS.mmm

Where:

DDD: the day (000 to 999)
HH: the hour (00 - 23)
MM: the minute (00 - 59)
SS: the second (00 - 59)
mmm: the millisecond (000-999)

Note: (1) the DDD field is followed by an IRA space character (' '); (2) the HH, MM and SS fields are separated by an IRA colon character (':'); and (3) the SS and mmm fields are separated by an IRA period character ('.').

7.1.5.2.4 Message Content Format

The format for reporting the contents of Layer 2 and Layer 3 messages should be Hexadecimal encoded as IRA. Each message is followed by an IRA new-line character.

7.1.5.3 Example D-Channel Message Log Report

An example of a D-Channel Message Log Report containing 10 D-channel messages exchanged between the network and the TE and decoded as IRA would be as follows:

RPT 090 00:01:05.512
NET<-TE 090 00:01:02.819
fcff030f566501ff
NET->TE 090 00:01:02.853
feff030f566502e9
NET<-TE 090 00:01:02.888
00e97f
NET->TE 090 00:01:02.914
00e973
NET<-TE 090 00:01:02.950
fcff030f0daa01ff
NET->TE 090 00:01:02.984
feff030f0daa02eb
NET<-TE 090 00:01:03.019
00eb7f
NET->TE 090 00:01:03.046
00eb73
NET<-TE 090 00:01:03.096
00e9000008007b3a09303030303030303030
NET->TE 090 00:01:03.229
02e9000208007b3b028181
END 090 00:01:05.994

7.2 M-Channel Performance

7.2.1 Definition of Performance Parameters

Performance measurements should be made on a per second basis by the NT through observation of the M-channel transmitted to and received from the network at the U-interface.

All parameters are measured "asynchronously" which implies that parameters are measured once a second based upon a local timing mechanism (Section 7.2.2) within the NT.

Loss Of Frame Second (LOFS): A second during which a loss of superframe synchronization is detected in either the transmit or receive direction.[21]

Network Alarm Indication Second (NAIS): A second during which the "Alarm Indication Bit (AIB)" received from the network transitions from the normal state of 1 to 0 and an LOF has not occurred. [22]

D-channel Unavailable Second (DUS): A second during which the "act" bit, in either the transmit or receive direction, transitions from a "1" to "0" and an LOF has not occurred.[23] This change of state of the

[21] Loss of superframe synchronization is defined in ANSI T1.601-1992 clause 6.2.5.

[22] The Alarm Indication Bit as defined in ANSI T1.601-1992 clauses 6 and 8.2.9 is set by the network to indicate the failure or interruption of an intermediate transmission system that transports the D or B channels. Such failures may include loss of signal, loss of frame synchronization, and transmission terminal failure (ANSI T1.601- clause 8.2.9).

[23] The act bit is defined in ANSI T1.601-1992 clauses 6, 6.4.6.6, and 8.2.2 and is used to indicate that both the network and the NT are ready to communicate at Layer 2. The act bit in the receive direction indicates the status on the network side of the U-interface, the act bit in the transmit direction indicates the status on the NT side of the U-interface. Whenever either end, for any reason, losses its readiness to communicate at Layer 2, that end shall set its act bit to 0.

act bit must occur in at least three consecutive superframes (Note: If the observation of the three consecutive occurrences crosses a measurement second boundary, then a DUS should be recorded for each of those seconds).

Near End Block Error Second (NEBES): A second during which one or more superframe "Cyclic Redundancy Check (CRC)" errors are detected in the receive direction and an LOF has not occurred.[24]

Far End Block Error Second (FEBES): A second during which the "FEBE" bit in the receive direction transitions from a "1" to a "0" and an LOF has not occurred.[25]

7.2.2 Local Timing

The NT will be required to provide a local timing mechanism for performance parameter measurement and for determining the current time. The initial time, T_0, should be set to be coincident with the point at which the NT is powered on unless battery backup is available. [26]

If the NT is allowed to run indefinitely it should be able to time stamp data for up to 999 days before the buffer resets. The NT should be able to provide 0.1 second (100 millisecond) accuracy when time stamping data, although 0.001 second accuracy (1 millisecond) accuracy is preferred.

7.2.3 Local Storage

The time and performance parameter measurements recorded by the NT should be saved locally as described below.

Current Time: The NT should save the current time, measured in seconds from time T_0 (Section 7.2.2).

96 Fifteen Minute Bins: For storage of the last 24 hours worth of data. Measurements begin at time T_0 and after each 15 minute period the contents of bin *i* should be moved to bin *i+1* with data from bin 96 being discarded.

> **15 Minute Parameter Values:** Since parameter values will range from 0 to 900, each parameter may be saved as a 10 bit unsigned integer.

Seven 24 Hour Bins: Data in these bins should be accumulated according to the following procedure: A 24-hour clock should be kept beginning with time T_0. At each 24 hour point, the measurements for each parameter contained in the 96 fifteen minute bins should be added together to derive a 24 hour total. These values are stored in the first 24 hour bin. Prior to over-writing the contents of the first bin, its contents should be moved to the second bin. The contents of bin *i* should be moved to bin *i+1* with data from bin 7 being discarded.

> **24 Hour Parameter Values:** Since parameter values will range from 0 to 86400, each parameter may be saved as a 17 bit unsigned integer.

7.2.4 Buffer Initialization

All M-channel Performance Analysis Buffers should be initialized (set to zero) after NT power up[27] and at the point that "transparency of the transmission" is provided on the network side of the NT.[28] The status

---

[24] Near End Block Error Second (NEBES) is defined in ANSI T1.601-1992 clause 6 and 8.1.

[25] Far End Block Error Second (FEBS) is defined in ANSI T1.601-1992 clause 6 and 8.2.1.

[26] Battery backup of the D-Channel Message Log buffer is not required although it is strongly recommended. If battery backup is provided, initialization should only occur once unless the NT is reset through manual intervention (e.g. by disrupting the power backup) or local timing is disrupted.

of the user side of the NT should be ignored. Buffer initialization will occur at some time after T_0 as defined in the "Local Timing" section above (Section 7.2.2).

7.2.5 Return of Diagnostic Data

During enhanced function operation, the M-Channel Performance Analysis Buffers data, along with the current time[29], should be transmitted from the NT toward the network.

7.2.5.1 Diagnostic Data Message Encoding

The M-Channel Performance Analysis Buffer data will be formatted into a report that consists of IRA lines of text. This report can then be divided into sequential diagnostic data messages to be included in Diagnostic Data Frames and transmitted toward the network by the NT as specified in Section 4.3.

7.2.5.1.1 Report Format

The M-channel performance data report should be formatted as follows:

LOFS 15 minute and 24 hour parameter data section
NEBES 15 minute and 24 hour parameter data section
FEBES 15 minute and 24 hour parameter data section
DUS 15 minute and 24 hour parameter data section
NAIS 15 minute and 24 hour parameter data section
Report Trailer

7.2.5.1.2 15 Minute and 24 Hour Parameter Data Sections Format

For each of the parameters, the data will be formatted as follows:

Section Header: This is the first line of each section and consists of the name of the parameter followed by an IRA space character and the current time encoded as described in section 7.2.5.1.4 below.

15 Minute Data: The section header is followed by the text "15m:" indicating the 15 minute bins, and the 96 corresponding values, with each value encoded as three IRA digits with 16 values per line and consecutive values separated by an IRA space character (' '). The current value will be transmitted first and the least recent value will be transmitted last.

24 Hour Data: The 15 minute data values are followed by a line consisting of the text "day:" indicating the daily bins, and the seven corresponding values, with each value encoded as six IRA digits and consecutive values separated by and IRA space character (' '). The most recent value will be transmitted first and the least recent value will be transmitted last.

---

[27] Battery backup of the M-Channel Performance buffer is not required although it is strongly recommended. If battery backup is provided, initialization should only occur once unless the NT is reset through manual intervention (e.g. by disrupting the power backup) or local timing is disrupted.

[28] Transparency is defined in ANSI T1.601-1992 clause 6.4.6.6.

[29] In order that the current time that it is received by the network from the NT is as close to the current "real time" as possible, the value of the current time should not be encoded until the last possible moment prior to actual transmission of the diagnostic data frame.

7.2.5.1.3 Report Trailer Format

The report trailer is the last line of the report and will be formatted as the text “END” followed by an IRA space character (‘ ‘) and the current time formatted as specified in Section 7.2.5.1.4. The trailer will end with an IRA new-line character.

7.2.5.1.4 Time Stamp Format

The format for reporting the time is as follows:

DDD HH:MM:SS.mmm

Where:

DDD: the day (000 to 999)
HH: the hour (00 - 23)
MM: the minute (00 - 59)
SS: the second (00 - 59)
mmm: the millisecond (000-999)

Note: (1) The DDD field is followed by an IRA space character (‘ ‘); (2) the HH, MM and SS fields are separated by an IRA colon character (‘:’); and (3) the SS and mmm fields are separated by an IRA period character (‘.’).

7.2.5.2 Example M-channel performance data report

An example of an M-channel performance data report decoded as IRA would be as follows:

```
LOFS 010 00:21:57.116
15m: 000 03D 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
day: 000000 000000 000000 000000 000000 000000 000000
NEBES 010 00:21:57.713
15m: 000 001 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
day: 000000 000000 000000 000000 000000 000000 000000
FEBES 010 00:21:58.311
15m: 000 004 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
day: 000000 000000 000000 000000 000000 000000 000000
DUS 010 00:21:58.909
15m: 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
day: 000000 000000 000000 000000 000000 000000 000000
NAIS 010 00:21:59.504
15m: 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
    000 000 000 000 000 000 000 000 000 000 000 000 000 000 000 000
day: 000000 000000 000000 000000 000000 000000 000000
END 010 00:22:00.102
```

7.3 Identification Message

7.3.1 Definition of Identification Message Parameters

7.3.1.1 Mandatory Parameters

When transmitting the Identification Message, the following parameters must be included (even if their contents are null):

Model: The Model name for the NT device.

Manufacturer: The manufacturer of the NT device.

Software-Revision-Level: The revision level for the software resident in the NT device. The format of the revision level should be IRA , but is otherwise defined by the manufacturer of the NT device.

Hardware-Revision-Level: The revision level for the NT device hardware. The format of the revision level should be IRA , but is otherwise defined by the manufacturer of the NT device.

7.3.1.2 Optional Parameters

The NT device can include vendor-specific parameters other than those defined above. It is recommended that any parameter definitions should include some vendor-specific text in the parameter name in order to alleviate any conflict with parameter definitions that may be defined by future revisions of this specification.

The optional parameters portion of the Identification Message offers the vendor an opportunity to provide more detailed device-specific information, e.g. the serial number (see the example in Section 7.3.2.2). It also provides a mechanism for transmitting additional diagnostic information. For example: (1) a report of far-end disconnects due to a PAP/CHAP authentication failure and (2) a report of TCP (Transmission Control Protocol) connection failures.

7.3.2 Return of Diagnostic Data

During enhanced function operation, the Identification Message parameters, along with the current time[30], should be transmitted from the NT toward the network.

7.3.2.1 Diagnostic Data Message Encoding

The Identification Message data will be formatted into a report that consists of IRA lines of text. This report can then be divided into sequential diagnostic data messages to be included in diagnostic data frames and transmitted toward the network by the NT as specified in Section 4.3.

7.3.2.1.1 Report Format

The Identification Message should be formatted as follows:

Report Header
Mandatory and Optional Parameter Data Section
Report Trailer

[30] In order that the current time that it is received by the network from the NT is as close to the current "real time" as possible, the value of the current time should not be encoded until the last possible moment prior to actual transmission of the diagnostic data frame.

7.3.2.1.2 Report Header and Trailer Format

Report Header: This is the first line of the report and will be formatted as the text "NTID" followed by an IRA space character (' ') and the current time formatted as specified in Section 7.3.3.1.4 below. The header will end with an IRA new-line character.

Report Trailer: This is the last line of the report and will be formatted as the text "END" followed by an IRA space character (' ') and the current time formatted as specified in Section 7.3.3.1.4. The trailer will end with an IRA new-line character.

7.3.2.1.3 Mandatory and Optional Parameter Data Section Format

For each of the parameters, the data will be formatted as follows:

The Identification Message parameter name, an IRA colon character (':'), an IRA space character (' '), the value for the parameter, and an IRA new-line character. The order in which parameters are transmitted is not significant, although it is recommended that the mandatory identification message parameters be transmitted first.

7.3.2.1.4 Time Stamp Format

The format for reporting the time is as follows:

DDD HH:MM:SS.mmm

Where:

DDD: the day (000 to 999)
HH: the hour (00 - 23)
MM: the minute (00 - 59)
SS: the second (00 - 59)
mmm: the millisecond (000-999)

Note: (1) The DDD field is followed by an IRA space character (' '); (2) the HH, MM and SS fields are separated by an IRA colon character (':'); and (3) the SS and mmm fields are separated by an IRA period character ('.').

7.3.2.2 Example Identification Message Report

An example of an Identification Message report decoded as IRA would be as follows:

NTID 010 00:21:57.116
Model: ACME-222
Manufacturer: ACME Telecom, Inc.
Software-Revision-Level: 2.03
Hardware-Revision-Level: RevB
ACME-Mode-Setting: mode-7
Serial #: A121897
PAP/CHAP Failure: Far-End Disconnect at 009 00:09.23.03.239
END 010 00:21:57.250

8. REFERENCES

1. Integrated Services Digital Network (ISDN) - Basic Access Interface for Use on Metallic Loops for Application on the Network Side of the NT (Layer 1 Specification) ANSI T1.601 - 1992.

2. Recommendation T.50, International Reference Alphabet (IRA) (Formerly International Alphabet No. 5 or IA5), Information Technology - 7-Bit Coded Character Set for Information Interchange, CCITT Document, September 1992.