NENA
Recommended
Generic Standards for
E9-1-1 ISDN PSAP
Equipment Utilizing Basic
Rate Interface (BRI)

NENA Technical Reference
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Recommended Generic Standards for E9-1-1 ISDN PSAP Equipment Utilizing Basic Rate Interface (BRI)

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National Emergency Number Association (NENA) PSAP CPE and Network Technical Committees.

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TECHNICAL REFERENCE

NOTICE

This Technical Reference is published by NENA as a guide and recommendation for the designers and manufacturers of customer-premise systems that are used for the purpose of processing emergency calls at an Integrated Services Digital Network Basic Rate Interface (ISDN BRI) Public Safety Answering Point (PSAP). It is not intended to provide complete design specifications or parameters nor to assure the quality of performance of such equipment.

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This document has been developed by the **NENA** PSAP CPE and Network Technical Committees. The **NENA** Executive Board has recommended this document for industry acceptance and use. For more information about this document, contact:

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1. INTRODUCTION

1.1 General

This NENA Technical Reference NENA-04-003 defines the Integrated Services Digital Network BRI (ISDN BRI) Public Safety Answering Point (PSAP) equipment requirements intended for use by users, manufacturers and providers of E9-1-1 Customer Premise Equipment (CPE).

The PSAP is a designated agency that receives and responds to emergencies such as Police, Fire, EMS, etc.

1.2 Purpose and Scope of Document

This Technical Reference addresses an ISDN Basic Rate Interface (BRI) between the E9-1-1 Tandem and an ISDN capable PSAP. This reference can be used as a guide for designers and manufacturers of ISDN PSAP equipment. It identifies engineering and technical requirements to be met before the NENA membership shall consider purchase of such equipment; it may also be of value to purchasers, maintainers and users of such equipment.

This document is not intended to provide complete design specifications for ISDN PSAP equipment. It will neither ensure the quality of the performance of the equipment nor should it serve as an exclusive procurement specification.

1.3 Organization of Document

This document is organized into the following major sections:

Section 1 - Introduction
Section 2 - E9-1-1 System Description and Features Definitions
Section 3 - ISDN (Integrated Services Digital Network) Overview
Section 4 - CPE Interfaces
Section 5 - Call Control Messages
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1.4 Document Terminology

The terms "shall", "must" and "required" are used throughout this document to indicate required parameters and to differentiate from those parameters that are recommendations. Recommendations are identified by the words "desirable" or "preferably".

1.5 Reason for Issue

This document is issued to serve as a NENA standard and guide for E9-1-1 ISDN PSAP equipment.

The purpose of this standard is to identify the minimum requirements as well as desirable requirements for ISDN PSAP equipment and interfaces provisioned today as well as to identify requirements for future ISDN BRI PSAP equipment and interfaces.

1.6 Reason for Reissue

NENA reserves the right to modify this technical reference. Whenever it is reissued, the reason(s) will be provided in this paragraph.

1.7 Year 2000 Compliance

All systems that are associated with the 9-1-1 process shall be designed and engineered to ensure that no detrimental, or other noticeable impact of any kind, will occur as a result of the date change to the year 2000, or any date up to 30 years subsequent to the manufacture of the system. This shall include embedded application, computer based or any other type application.

To ensure true compliance the manufacturer shall upon request provide verifiable test results to an industry acceptable test plan such as Telcordia GR-2945 or equivalent.

2. ENHANCED 9-1-1 - SYSTEM DESCRIPTION AND FEATURES DEFINITIONS

2.1 E9-1-1 System and Feature Overview

The 3-digit telephone number 9-1-1 has been designated for public use throughout the United States and Canada to report an emergency, request emergency assistance, or both. This number is intended as a nationwide, universal telephone number to provide the public with direct access to a PSAP. A PSAP is an agency or group of agencies designated and authorized to receive and respond to emergency calls requiring one or more public services (police, fire, EMS or all three).

The E9-1-1 feature provides Enhanced 9-1-1 service capabilities and optional PSAP customer services for completing and handling 9-1-1 calls. This feature provides the capability for the E9-1-1 Tandem office to serve several PSAPs within the 9-1-1 service area. The main characteristic of E9-1-1 service is the capability of the E9-1-1 Tandem office to selectively route a 9-1-1 call originated from any station in the 9-1-1 service area to the correct primary (or controlling) PSAP designated to serve the originating station's location. The following are some of the services which are available with the E9-1-1 feature in addition to those available in the basic 9-1-1 feature:

- Selective Routing (SR)
- Default Routing
- Alternate Routing for PSAPs that are traffic busy, on night service or have a power failure
- Central Office Transfer (selective, fixed and manual)
- Automatic Number Identification (ANI)
- Automatic Location Identification (ALI)/Data Base Management System (DBMS)
- Forced Disconnect
- Night Service
- Automatic Call Distribution (ACD)

2.1.1 General Feature Assignments

E9-1-1 service is provided on a per-system basis.

In an E9-1-1 service area, typically one switching office is designated as an E9-1-1 tandem office for all 9-1-1 calls.

This E9-1-1 tandem office serves all PSAPs in the E9-1-1 service area and can provide Selective Routing (SR) for incoming 9-1-1 calls from other offices.

Dedicated E9-1-1 ISDN BRI lines are equipped in the E9-1-1 tandem office for each PSAP served.

2.2 Selective Routing

Selective Routing (SR) is the routing of a 9-1-1 call to the proper PSAP based upon the location of the caller. Selective routing is controlled by the ESN which is derived from the customer location.

2.3 Default Routing

Default Routing is a standard service which allows a 9-1-1 call to be routed to a default PSAP when the call cannot be selectively routed.

2.4 Alternate Routing

Alternate Routing is a standard service which allows the E9-1-1 Tandem Office to route a 9-1-1 call to a pre-designated alternate PSAP if the primary or controlling PSAP is unable to accept the call.

2.5 Central Office Transfer

Central Office Transfer is a standard service available for each PSAP. This service provides the capability for an established 9-1-1 call to be transferred by the PSAP call taker, via the E9-1-1 Tandem office, to another PSAP or some other destination. A call transfer is accomplished at the E9-1-1 Tandem office via a 3-way conference connection. This permits a simultaneous 3-way connection for the calling party, primary PSAP call taker, and the desired destination, which may be another PSAP or some other Directory Number (DN).

Three types of Central Office transfer services: selective, fixed and manual are available individually or in combination for a PSAP.

2.5.1 Selective Transfer

Selective transfer is an optional service which allows an established 9-1-1 call to be selectively transferred by the E9-1-1 Tandem office from the primary ISDN BRI PSAP to the correct secondary PSAP associated with the calling station number (CSN). This transfer occurs without the primary ISDN BRI PSAP call taker having to determine and manually dial the digits for the correct destination. Each primary ISDN BRI PSAP may have several secondary PSAPs associated with it for this transfer feature. To initiate selective transfer to the correct secondary PSAP, the ISDN BRI PSAP call taker operates a key associated with the particular type of emergency service desired (e.g., a fire department). The E9-1-1 Tandem office automatically determines the designated secondary PSAP (e.g., fire department A) to serve the calling station, and selectively transfers the 9-1-1 call to that secondary PSAP. 9-1-1 calls can also be selectively transferred to non- PSAP locations (e.g., Poison Control Centers).

Note: Typically, a PSAP is designated as primary or secondary; the designation refers to the order in which 9-1-1 calls are directed for answer. Primary PSAPs respond first; secondary PSAPs receive calls only on a transfer basis.

2.5.2 Fixed Transfer

Fixed transfer is a service that allows an established 9-1-1 call to be transferred by the ISDN PSAP call taker to another PSAP destination (e.g., fire department A). By the operation of a transfer key or a speed dial code, fixed transfer uses the Speed Calling feature of the E9-1-1 Tandem office. 9-1-1 calls can also be transferred to non- PSAP locations (e.g., Poison Control Centers).

Fixed transfer provides for call transfer to any limited number of destinations. The PSAP call taker determines the desired destination and operates the particular key associated with that destination.

2.5.3 Manual Transfer

With manual transfer, the PSAP call taker determines the desired destination and manually dials the number of the destination or associated Speed Call code (if Speed Calling is provided).

2.6 Calling Station Number

The 10-digit Calling Station Number (CSN) of the calling party is automatically forwarded to the ISDN BRI PSAP and displayed at the call taker position. This number (traditionally called ANI) may represent either the caller's actual call back number, billing number, or Emergency Service Routing Digits (ESRD).

The calling party number is delivered to the ISDN BRI PSAP as caller ID information. The network shall not permit the caller to block calling party identification if the caller dialed 9-1-1.

2.7 Automatic Location Identification (ALI)

ALI provides location information and dispatch information associated with the CSN to be displayed at the answering ISDN BRI PSAP. (For further details, refer to NENA 02-001 Recommended Formats For Data Exchange).

2.8 Forced Disconnect

Forced disconnect is an inherent capability of E9-1-1 service that prevents a calling station which remains off-hook from indefinitely holding the connection to a PSAP. It allows a PSAP call taker to release a 9-1-1 call connection even though the calling party has not hung up, thereby preventing a tie-up of dedicated 9-1-1 facilities.

2.9 Night Service

Night service is a standard feature available for each ISDN PSAP. When night service is in effect, all 9-1-1 calls to that PSAP are automatically forwarded to the assigned alternate DN. This alternate DN may be associated with a secondary PSAP or some other destination.

2.10 Automatic Call Distribution (ACD) CPE or Central Office Based

When an ACD is used as the primary answering device for emergency calls the ACD shall follow the same guidelines as outlined in sections 3.2, 4.2, 4.11, 6.1, 6.15.

3. ISDN (INTEGRATED SERVICES DIGITAL NETWORK) OVERVIEW

3.1 ISDN as an E9-1-1 Interface

There are two types of interfaces predominant in today's E9-1-1 network. The majority of North American PSAPs are served by trunk-type connections based on Telcordia TR-TSY-000350. This type of connection is a standard MF "CAMA" type trunk with signaling which is unique to E9-1-1.

In recent years, line-side connections to the E9-1-1 Tandem have become available. There is no existing standard for these types of interfaces. In general, these interfaces are based on the existing Centrex interface options from the major switch vendors.

The benefits of ISDN as an E9-1-1 interface are:

- Faster call setup time
- Ability to combine data capabilities with the voice connection
- Interoperability between equipment vendors

3.2 Basic Rate Interface (BRI)

The ISDN user can access various data systems since the communication link is switchable through the E9-1-1 Tandem switch. The call taker can originate and terminate voice calls without disconnecting the data connection. Access to voice features does not disrupt data communications.

Modems are not required to send and receive data over ISDN lines. ISDN terminal equipment is either voice only, data only, or simultaneous voice and data. ISDN services are delivered to the ISDN terminal equipment via a basic rate interface (BRI) which is the ISDN line from the E9-1-1 Tandem switch. A BRI provides three digital channels: two 64 kb/s channels (B channels) used for circuit switched digitized voice, circuit switched data or packet switched data and one 16 kb/s channel (D channel) used for packet switched data. The D channel is also used as a signaling channel so a B channel is not required for signaling between the ISDN terminal equipment and the E9-1-1 switch.

ISDN terminals are equipped with directory numbers (DN) which are used to address one or more call appearances (CA) on the ISDN station. An ISDN station requires one primary DN and may have one or more secondary DNs. The term "multiple DNs" refers to the capability of the ISDN station to have two or more DNs assigned. Each DN assigned has one or more CA on that station. The station's primary DN is used for 9-1-1 call delivery.

Each CA must be associated with a DN. The term "multiple CAs" means that a given DN has more than one CA.

Directory numbers (DNs) do not have to be limited to just one ISDN station. The term "shared DN" refers to the capability to share a DN across multiple ISDN stations. This allows a mode of operation similar to key telephone systems.

An E9-1-1 switch directly accesses an ISDN station in the PSAP by its assigned DN. As with all directory numbers, the switch is responsible for the assignment of a variety of features that impact the delivery of the voice and/or data component. ISDN stations have two types of features:

- DN features
- Station features

An ISDN PSAP station is capable of having a maximum of 64 such DNs, with features assigned to each number independently. However, only one of these assigned numbers (primary DN) can be the recipient of 9-1-1 calls.

Features may also be assigned to the ISDN BRI station. These features will apply to all DNs.

The minimal network switch voice feature requirements for an ISDN BRI PSAP are:

- Conference
- Drop (or Release)
- Transfer
- Hold

Another group of desirable network switch voice features would include:

- Speed Call
- Call Forwarding
- Calling Party Hold and/or Re-ring

Finally, the method of 9-1-1 network switch call distribution to an ISDN BRI position could be:

- Direct
- Hunt Group
- ACD System
- Electronic Key Telephone System (EKTS)

NOTE : The above listed network features may also be provided by the CPE

If the 9-1-1 switch that "controls" these features is located in the central office, these features are referred to as Centrex features. Central Office based 9-1-1 is considered a Centrex feature. Some features may be considered "switch independent" features; such as REDIAL and are considered as "PSAP/CPE-Internal" features. These features must not conflict with existing switch-based assignments.

The ability of ISDN to access or receive data out of band, or transfer data independent of voice must be a consideration in both feature assignment and PSAP architecture. PSAP data transfer may be achieved by a LAN/Server system or via the switch to a central location. A unique BRI may be required if multiple locations are required for access or data transfer. An example of data features available for ISDN include, but are not limited to:

- Data Hunt Distribution (Circuit Switched)

- Individualized Dialing for Data Distribution
- Centrex Group (controlled data)
- D Channel Packet (X.25)
- B Channel Packet
- Data Call Forwarding
- X.25 to T1
- X.25 to PRI

Additional information regarding the capabilities of ISDN BRI may be found in Appendix B of this document.

4. CPE INTERFACES

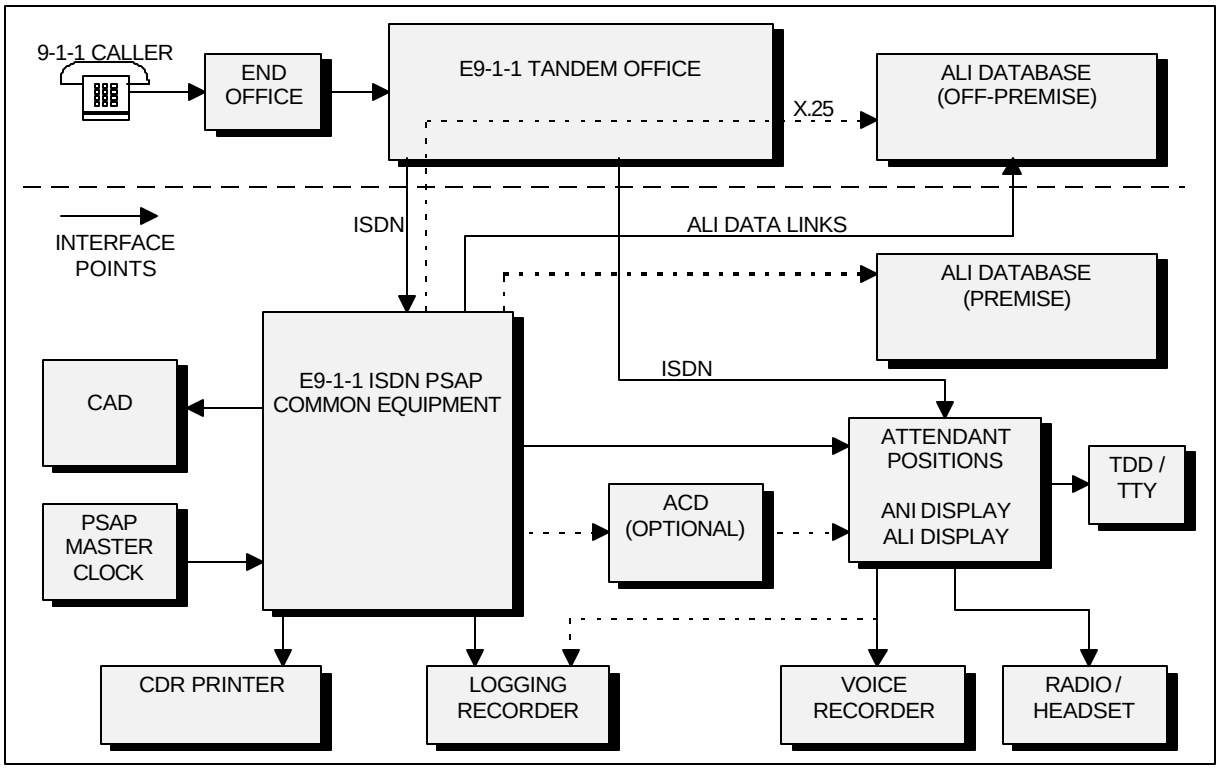


FIGURE 1
ISDN CUSTOMER PREMISES SYSTEM INTERFACE EXAMPLES

The ISDN PSAP equipment will provide several interfaces in accordance with the following interface specifications.

4.1 ISDN Interfaces

The ISDN lines from the E9-1-1 Tandem switch are connected to ISDN Terminating Equipment (ITE) in the ISDN PSAP. The terminating equipment may be individual PSAP call taker positions or the ISDN lines may be terminated in the ISDN PSAP common equipment which then provides the interface to the call taker positions. An intelligent work station (IWS) may be part of the CPE configuration.

At a minimum, the ISDN interface provides the CSN for the call and a voice connection to the 9-1-1 caller.

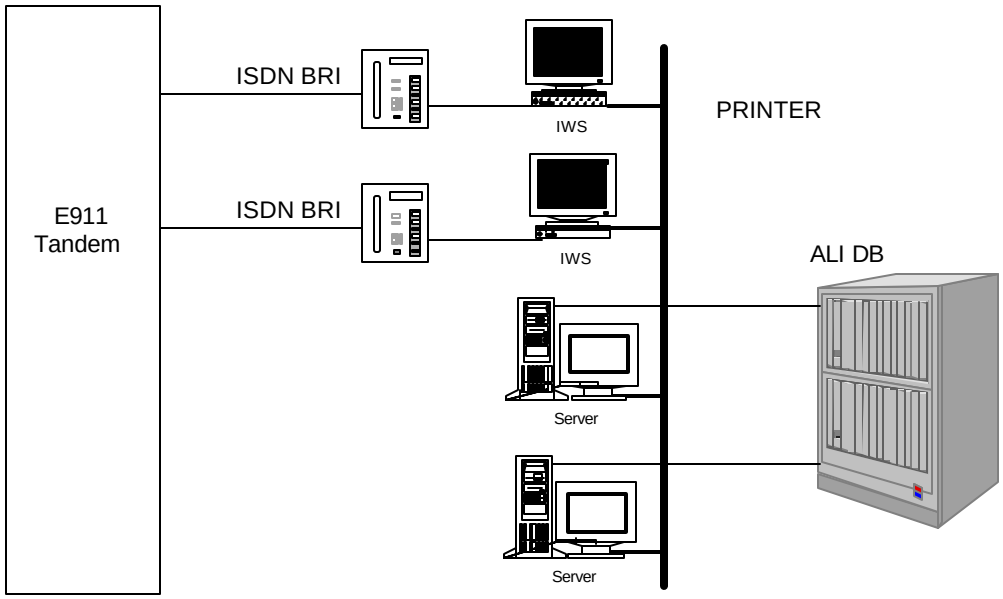


FIGURE 2
EXAMPLE OF BRI INTERFACE WITH TERMINATION PER POSITION

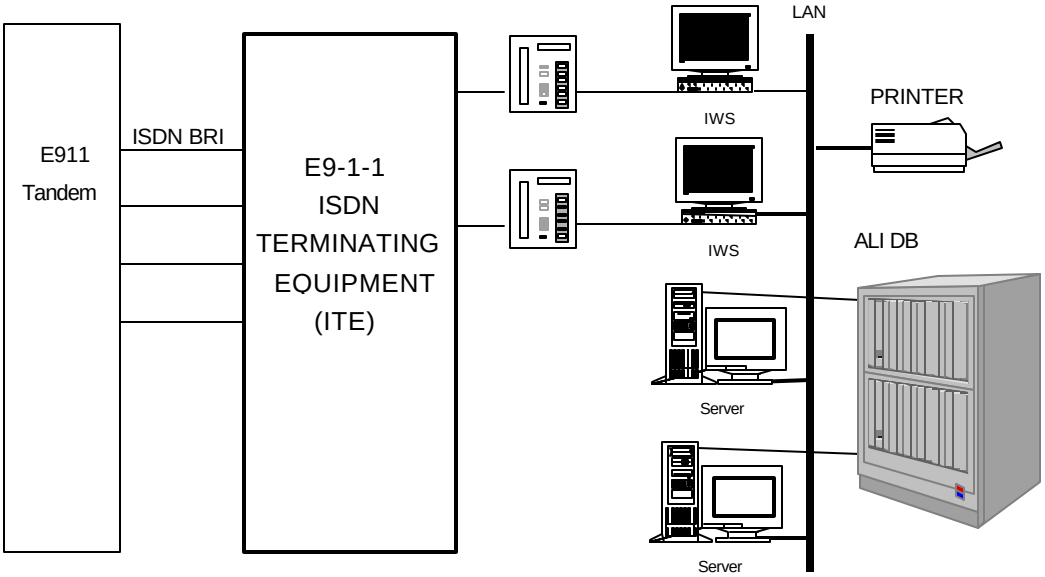


FIGURE 3
EXAMPLE OF BRI INTERFACE WITH COMMON EQUIPMENT TERMINATION

For additional information on the interface between the E9-1-1 Tandem switch and the ITE, refer to Section 5.

4.2 Audible Feedback To Caller & Ringing Signal To The Call Taker Position

The E9-1-1 network shall provide audible ringing to the 9-1-1 caller and the ISDN BRI PSAP equipment shall provide ringing signal or a "ZIP" tone (if in an ACD arrangement) to the 9-1-1 call taker attendant position. In many ACD systems the "ZIP" tone is provided by the switch.

4.3 ALI Delivery

4.3.1 Overview

ISDN PSAP equipment interfaces to an ALI Database in order to request ALI (automatic location identification) information for the 9-1-1 caller based on the received CSN. This document describes one ALI delivery format common in conventional PSAPs. For the latest information on ALI delivery formats, refer to NENA 02-001 Recommended Formats For Data Exchange.

The ISDN BRI PSAP equipment issues 'ALI requests' to the ALI database under the following conditions:

- Requests issued automatically for 9-1-1 calls with valid CSN.
- Request issued automatically for 9-1-1 calls received with CSN= XXX-911-XXXX.
- Request issued automatically for 9-1-1 calls received with no CSN or partial CSN. Zeros shall be substituted in place of a valid CSN.
- Requests issued as a result of a manual retransmit request issued by a 9-1-1 call taker position.
- Requests issued as a result of a manual database request issued by a 9-1-1 call taker position.

The ISDN PSAP equipment shall interface to either an Off-Premise ALI Database or a Premise ALI Database or both as described below.

- Conventional E9-1-1 Off-Premise ALI Database Interface
- ALI Interface on ISDN B channel
- ALI Interface on ISDN D channel
- Premise ALI Database Interface

4.3.2 Conventional E9-1-1 Off-Premise ALI Data Base Interface

The following describes the interface protocol between the ALI database and the ISDN PSAP equipment.

Physical

For reliability reasons, two communication links are required between the ALI database and the ISDN PSAP equipment.

Each communication link has the following default physical interface requirements:

Serial Interface:	EIA RS-232C Asynchronous
Code:	ASCII
Data bits:	8
Parity bit:	N

Stop bits:	1
Baud rate:	1200 bps minimum (9600 bps or higher recommended)
Communication:	Full Duplex
Facilities:	4 wire lines
Modems:	As provided or specified by ALI Service Provider

Apart from the default interface requirements, it is desirable that the ISDN PSAP equipment allow the programming of the baud rate (1200 bps or higher), data bits(7,8), parity (O,E,N), and stop bits (1,2).

The ISDN PSAP equipment must detect the presence of the carrier detect signal from the modem on each communication link and must provide local and/or remote alarming if the carrier signal is lost.

Protocol

When both links are operational, the ISDN PSAP equipment transmits each 'ALI request' on both links simultaneously. The maximum delay between the transmissions on both links is 200 ms.

If a trouble condition results in the temporary loss of one link, the ISDN PSAP equipment shall continue to issue requests only on the operational link.

ALI Requests

The ALI request consists of fourteen or sixteen ASCII characters sent in one of the following formats:

<NPD><NXX><TN><POS><TRK><CHECK><CR> or
<NPA><NXX><TN><POS><TRK><CHECK><CR>

where:

NPA: Three digits given by the Tandem office and used by the ALI database to identify the caller's area code

NPD: One digit given by the Tandem office and used by the ALI database to identify the caller's area code

NXX: Three digits given by the Tandem or end office to identify the caller's Telco exchange

TN: Four digits given by the Tandem or end office to identify the caller's directory number

POS: Two digits given by the ISDN PSAP equipment to identify the request. Range 01 to 99 (decimal)

TRK: Two digits given by the ISDN PSAP equipment to identify the "ISDN BRI LINE" number over which the call was received. Range 01 to 94 (decimal) for automatic lookup and 95 to 99 (decimal) for manual lookup.

CHECK: One digit checksum given by the ISDN BRI PSAP equipment to verify the integrity of the message. The value of this digit is calculated such that when it is added to the sum of the previous digits, the total sum is evenly divisible by 8.

CR: Carriage Return character (hex 0D) inserted by the ISDN PSAP equipment to signal the end of the request.

The ISDN PSAP equipment shall convert the NPA to the corresponding NPD digit if required by the ALI database system.

Response to an ALI request

The ALI database responds to an 'ALI request' with an ACK (hex 06) or a NAK (hex 15) to acknowledge the positive or negative receipt of the message.

The ISDN PSAP equipment shall retransmit a request upon reception of a NAK from both data links. The ISDN PSAP equipment shall also detect and report a link failure condition if 3 or more consecutive NAKs are received on a given link. Upon detection of a link failure condition, the ISDN PSAP equipment shall stop sending new requests on that link and shall issue 'heartbeat' messages until an ACK is received from the ALI database. The ISDN PSAP equipment must also provide local and/or remote alarming of this condition.

Once the ALI database processes the 'ALI request', the ALI database returns an 'ALI response' message on one of the two communication links.

'ALI response' message

The ALI database returns an 'ALI response' message with the following format:

<STX><TYPE><POS><TEXT><ETX>

where:

STX:	One character (hex 02) which represents a 'start of message' signal.
TYPE:	One digit message type as described below assigned by the ALI database.
POS:	Two digit position number as received in the POS field of the ALI request.
TEXT:	Up to 511 characters, as formatted by the ALI Service Provider (512 characters are not supported by some CRT's or Terminals).
ETX:	One character (hex 03) which represents an 'end of message' signal.

TYPE designations:

'1' (hex 31)	Data retrieved, only on path available
'2' (hex 32)	Data retrieved, both paths operational
'3' (hex 33)	Broadcast message from ALI database (text may or may not be included)
'5' (hex 35)	Broadcast message from ALI database indicating host going out of service
'9' (hex 39)	No address information found message Text portion of message is of the form "NPA-NXX-TN No Record Found"

Heartbeat Messages

The ISDN PSAP equipment must transmit a 'heartbeat' message to the ALI database on each operational link at least once every two minutes of communication silence on the given link.

The message consists of the character 'H' followed by a carriage return.

Upon detection of a single NAK or no response to a heartbeat, the ISDN PSAP equipment shall stop sending new requests on that link and shall issue 'heartbeat' messages within 10 seconds intervals until an ACK is received from the ALI database. The ISDN PSAP equipment shall detect and report a link failure condition if 3 consecutive NAKs and/or no response are received for a heartbeat on a given link. The ISDN PSAP equipment must also provide local and/or remote alarming of this condition.

It is desirable that the ISDN PSAP equipment allows the idle heartbeat message time interval to be programmable.

Manual ALI Request

For manual ALI requests the TRK field shall be between 95 and 99. The Position number shall be the valid position number of the call taker issuing the request. The ISDN PSAP equipment user interface shall allow the call taker to enter a 10 digit number (NPA + NXX + TN). The ISDN PSAP equipment shall convert the NPA to the corresponding NPD digit if required by the ALI database system.

4.3.3 ALI Interface On ISDN D or B Channel

The following describes the interface protocol between the ALI database and the ISDN PSAP equipment when using an ISDN D or B channel.

Physical

When the ISDN PSAP equipment is initialized, it issues Q.931 commands on the D channel to establish a packet switched data connection to the ALI database on a B or D channel. It may be desirable to use the B channel for the ALI Database Interface since it has a greater bandwidth than the D channel.

If the connection is lost between the ALI Database and the ISDN PSAP, the ISDN PSAP equipment shall detect the Q.931 DISCONNECT message and shall attempt to reestablish the connection and provide local and/or remote alarming.

A minimum of two virtual data links shall be established between the ISDN PSAP and the ALI Database. The data connection shall be maintained on a permanent basis.

ALI Requests

Refer to the Protocol information of Section 4.3.2 for a detailed description.

Note: Additional information on ISDN data characteristics can be found in the following Telcordia documents, bulletins, supplements and revisions:

TR-TSY-000846, ISDN X.25 Supplementary Services

TR-TSY-000301, Public Packet Switched Network Generic Requirements (PPSNGR)

Section 12 of SR-3888, 1997 Version of National ISDN Basic Rate Interface Terminal Equipment Generic Guidelines

4.3.4 X.25 Packet Connection

The ISDN PSAP may use the ISDN BRI to establish X.25 signaling connections between itself and other entities, e.g. an automatic location identification (ALI) database. The E9-1-1 tandem shall support X.25 packet bearer service protocol and procedures, in particular the requirements for establishing and clearing X.25 packet signaling connections (refer to TR-TSY-000268, GR-301-CORE and TR-TSY-000846).

4.3.5 Premises ALI Database Interface

As an alternative to the E9-1-1 ALI database, ISDN PSAP equipment can interface to a Premise ALI Database in order to request ALI (automatic location identification) information for the 9-1-1 caller based on the received CSN.

Unless the premises ALI database is directly integrated into the ISDN PSAP equipment, to maintain compatibility with existing ISDN PSAP equipment, the Premises ALI Database protocol must comply to the E9-1-1 Off-Premises ALI database protocol described above, in section 4.3.2.

4.4 Computer Aided Dispatch (CAD) Interface

The CAD interface allows other system devices to interface with emergency call information. At a minimum it will provide the retrieved ALI for an emergency call as well as the answering position identification on an ASCII RS-232C or TIA/EIA-574 port.

4.4.1 Physical Interface

The interface connector from the ISDN PSAP equipment shall be TIA/EIA-232 or TIA/EIA-574 and is desirable to be configured as DCE DB25 female connector. See appendix (Section 14.5) for pin out information.

Note: The CAD provider is responsible for wiring any hardware flow control signals required by the CAD equipment.

4.4.2 Electrical

The electrical interface shall comply with the TIA/EIA-232 or TIA/EIA-574 standards.

4.4.3 Serial Interface

Minimum Baud Rate:	1200 bps
Recommended Baud Rate:	9600 bps or Higher
Communication Link:	Asynchronous Full Duplex
Bits per character:	7 or 8
Parity:	Odd, Even, or None
Synchronization :	1 Start bit, 1 or 2 Stop bits.

4.4.4 Protocol

Following is a basic description of the recommended protocol.

4.4.4.1 Messages Exchange

Positive Acknowledgment (ACK) or negative acknowledgment (NAK) are sent after the reception of the block check character (BCC) of the message by the CAD to accept or reject data. ACK character value is decimal 06 and NAK value is decimal 21.

If a NAK is received by the E9-1-1 ISDN PSAP Equipment, it shall retransmit the message. The message will be lost if this retry is not successful.

If an ACK/NAK is not received within 1 second by the E9-1-1 ISDN PSAP Equipment, it shall retransmit the message. The message will be lost if this retry is not successful.

It is desirable for the CPE to have an option not to expect ACK/NAK from the CAD system and dump the message one time.

Note: From a maintenance perspective this is least desirable.

4.4.4.2 ALI response message

The E9-1-1 ISDN PSAP Equipment shall send the ALI information within a block framed with a start of text character (STX) and an end of text character (ETX). The STX character value is decimal 02 and ETX value is decimal 03.

The format of the ALI response message shall be :

STX-TYPE-POS1-POS2-ALI TEXT-ETX-BCC

TYPE:	ASCII digit from decimal 49 to 57 reflecting the ALI condition.
POS1, POS2:	Two ASCII digits representing the call taker position in decimal.
ALI TEXT:	ALI text format negotiated by the database provider, CPE vendor and their customer prior to the installation. The ALI text shall not include ACK, NAK, STX or ETX characters.
BCC :	A block check character shall immediately follow the ETX character. It shall have a value of decimal 0 to decimal 255. It is obtained by taking the continuous Exclusive OR (XOR) of all characters preceding the BCC, but does not include the STX character.

4.4.4.3 Heartbeat message

The ISDN PSAP equipment shall send a heartbeat message at least once every two minutes during idle conditions. It is desirable that the ISDN PSAP equipment support the option to disable the transmission

of heartbeat messages. If the ISDN PSAP equipment does not support this disable option, the ISDN PSAP equipment shall continue transmitting new messages to the CAD even if it does not receive an ACK in response to the heartbeat messages.

The format of the heartbeat message shall be :

STX-H-ETX-BCC

4.4.4.4 Erase message

The E9-1-1 ISDN PSAP Equipment shall send this message in order to indicate the call taker has released the call or put the call on hold.

The format of the erase message shall be :

STX-E-POS1-POS2-ETX-BCC

4.4.4.5 Flow control

If the CAD system transmits an XOFF character (decimal 19), transmission from the E9-1-1 ISDN PSAP Equipment shall suspend for 2 seconds or until the CAD transmits an XON character (decimal 17). At the end of the 2 seconds, transmission from the E9-1-1 ISDN PSAP Equipment shall resume as if an XON character has been sent by the CAD.

4.5 Interfaces To The Call Taker Position Audio

Each ISDN call taker position shall have an analog interface to connect to but not limited to the following devices unless integrated as part of the overall system architecture.

- Radio
- Voice Recorders
- Headset
- TDD/TTY

4.6 Telephone Audio Interface

4.6.1 Overview

The Telephone Audio Interface (TAI) provides a two wire analog interface between the selected call appearance of the call taker position and ancillary devices such as TDD/TTY devices, recall recorders, fax/modems, etc.

The call taker position provider shall be capable of providing the TAI regardless of whether it is built into the call taker position or an external device that is attached to the call taker position.

4.6.2 Operation

When the user selects a call appearance, the call taker position provides an audio path between the telephone audio and the TAI. The connection is maintained until the call is placed on hold or released.

Note: In ISDN CPE Technology Voice Recording (Instant Recall and Logging) may be a concern in certain applications or PSAP Operation requirements.

4.6.3 Requirements

The TAI shall provide a two wire analog interface to ancillary devices.

It is desirable that the TAI provide an optional mode in which battery feed is supplied to ancillary devices connected to the TAI.

4.6.4 Electrical Interfaces

Telephone Audio Interface (TAI)

Voltage:	
Line not selected:	Open Circuit
Line selected & off-hook:	
Dry Mode:	0 VDC
Battery Feed Mode:	As per FCC part 68 (The telephone set shall not present any ringing voltage on the TAI.)
AC Impedance:	600 ohms + 2.2uF (as per FCC part 68)
Signal Characteristics:	Bi-directional analog audio in voice band frequency range
Insertion Loss:	Total loss of all ancillary equipment connected to the TAI shall not exceed 3db.

Ancillary Devices

Must comply to FCC part 68 and part 15.

AC Impedance	
Bridged:	> 10,000 ohms
Terminated:	600 ohms +2.2uF
DC Resistance	
Bridged:	> 10 M ohms
Terminated:	200 ohms nominal

4.6.5 Physical Interfaces

RJ11, 14, 21, 35, 45 with the following pin-outs:

1 - Off-hook Signal Contact Pair #1 - lead 1
2 -TAI (Tip) - lead 1
3 -TAI (Ring) - lead 2
4 - Off-hook Signal Contact Pair #1 - lead 2

Properly identified screw terminals are also acceptable.

Note: The Off-hook Signal Contact pair need not be physically on the same connector as the Telephone Audio Interface.

4.7 Voice Recording Interface

4.7.1 Overview

Logging and recall recorders are used by the Public Safety Answering Point to record 9-1-1 conversations.

4.7.2 Logging and Recall Recorder Requirements

As a minimum, each emergency telephone line or each emergency answering position must be recorded on a logging recorder.

It is desirable that the logging recorder be equipped with dual decks / drives such that the failure or unavailability of one deck / drive will cause the other deck / drive to automatically take over the recording function.

Per FCC docket # 20840, federal law grants specific exemption of warning tones on calls made to telephone numbers published for emergency services.

WARNING: Unless required by local or state law, there shall not be recorder warning tones on emergency and administrative lines since this may disrupt TDD/TTY communications and DTMF dialing.

If warning tones are required, they must be generated in accordance with the following FCC requirements (per FCC docket #6787 of 11/26/47 and 5/20/48):

Tone frequency	1400 Hz +/- 10%
Tone duration	200 ms +/- 20%
Tone repetition interval	12 to 18 seconds
Tone level	Average telephone talk level (-30 to -20 dBm)

In situations where the logging and recall recorders are not directly integrated into the ITE they shall connect to one of the following audio interfaces:

1. Direct connection to BRI line (T interface).
2. The ISDN terminal equipment audio interface.
3. The ISDN telephone set's analog handset/headset interface receiver signal.

Note: Refer to sections 4.6 and 4.10 for telephone set interface requirements.

Regardless of the interface connection, the logging and recall recorders shall satisfactorily reproduce the recorded audio signals.

4.7.3 Recorder Start Signal

The logging and recall recorders shall have one or more of the following means of activating and deactivating the recording function:

1. Record continuously
2. Record during voice activity (VOX)
3. Record while the Off-hook Signal Contact is closed
4. Record while telephone line voltage indicates off-hook

VOX activation/deactivation is the least preferred alternative.

Note: Recorders which use the Off-hook Signal Contact for activation shall have a Recorder Start Signal Pair per channel. Refer to section 4.9 for specification of Off Hook Signal Contact Pairs

4.7.4 Electrical Interfaces

4.7.4.1 Audio Pair

The analog audio input of the recording equipment must meet FCC Part 68.

AC impedance:	Greater than 10,000 ohms at 1000 Hz
DC resistance:	Greater than 10 M ohms

4.7.4.2 Recorder Start Signal Pair

The recorder start signal must provide a signal source and signal input which, together, comply to the Off-hook Signal Contact Pair rating identified in section 4.9.

4.7.4.3 Physical Interfaces

The interface can be RJ11, RJ21 with the following pin-out:

1 Recorder Start Signal Pair - lead 1
2 Audio Pair - lead 1
3 Audio Pair - lead 2
4 Recorder Start Signal Pair - lead 2

Properly identified screw terminals are also acceptable.

4.7.4.4 Synchronization Clock Interface

If the recorder uses amplitude modulated IRIG as the synchronization source then it is desirable that it accept a mark signal level range of 2 to 7 volts peak-to-peak.

It is desirable that recorders using IRIG as a source have an IRIG input impedance greater than 2000 ohms to accommodate multiple recorders bridged across the source signal.

4.8 Radio / ISDN Call Taker Position Headset Interface

4.8.1 Overview

The Radio/Telephone Headset Interface (RTHI) is used for applications where it is desired to use one headset for both ISDN call taker position audio and radio communications.

This interface provides connectivity and control signaling between the radio console and the ISDN call taker position.

Typically, the headset is connected to the radio console. The radio console RTHI circuit detects a closure of the Off-hook Signal Contact Pair by the ISDN call taker position which causes the headset audio to be switched from the radio console to the ISDN call taker position.

4.8.2 ISDN Call Taker Position Requirements

When a user goes off hook, the ISDN call taker position or an external audio device that attaches to the ISDN call taker position closes the Off-hook Signal Contact causing the RTHI circuit to pass the headset audio to and from the ISDN call taker position. The headset audio remains connected to the ISDN call taker position until the call is released at which point the ISDN call taker position opens the Off-hook Signal Contact and the RTHI circuit returns the headset audio to the radio console.

If the call is placed on hold via the Hold button on the ISDN call taker position, the ISDN call taker position or external audio device shall open the Off-hook Signal Contact.

The Off-hook Signal Contact shall be disabled (remain opened) when a headset/handset is connected to the ISDN call taker position, regardless of line status. It is desirable that this function be performed automatically when a handset/headset is inserted into the ISDN call taker position. Alternatively, this function can be performed manually via a button on the ISDN call taker position.

The ISDN call taker position shall be equipped with a backup handset (not normally connected) which can be inserted into the ISDN call taker position in the event of radio console failure.

4.8.3 Radio Console Requirements

When the Off-hook Signal Contact is opened, the radio console shall isolate its audio paths from the RTHI transmit and receive pairs.

It is desirable that the radio console support an independent receive volume adjustment for the RTHI circuit and radio communications, independent of the volume control supplied by the headsets.

The radio console must support a headset receive volume control.

It is desirable the radio console support a microphone ON/OFF switch, especially if the ISDN call taker position set does not support this function.

4.8.4 Electrical Interfaces

4.8.4.1 Option 1: Direct Connection To The ISDN Call Taker Position Handset/Headset Interface

- Receive Pair (receive audio from ISDN call taker position to radio console)
  Impedance: 150 ohms
- Transmit Pair (transmit audio of radio console to ISDN call taker position)
  Impedance: 50 ohms

The interface shall comply to carbon compatible microphone standards.

The radio console shall provide a DC load, as needed by the ISDN call taker position's microphone bias circuit, capable of a minimum of 20 mA. (Consult the ISDN call taker position vendor for microphone bias circuit requirements.)

4.8.4.2 Option 2: Dedicated Radio/ISDN Call Taker Position Interface

- Receive Pair (receive audio from ISDN call taker position to radio console)
  Balanced, 600 ohms impedance
  0 VDC
  Electrically isolated
  The ISDN call taker position shall inject a 10 dB gain to the signal received from the line.
  The radio console shall accept a maximum signal level of 0 dBm.
- Transmit Pair (transmit audio of radio console to ISDN call taker position)
  Balanced 600 ohms impedance
  0 VDC
  Electrically isolated

The radio console shall output a maximum signal level of 0 dBm.
The ISDN call taker position attenuates the signal received from the radio console by 10 dB.
It is desirable that both the ISDN call taker position and radio console support a method of adjusting the transmit and receive signal levels.

4.8.4.3 Radio/ISDN Call Taker Position Headset Control Signal Pair

The radio console must provide a signal source and signal input which, together, comply to the Off-hook Signal Contact Pair rating identified in section 4.9.

4.8.5 Physical Interfaces

The interface can be RJ14, RJ45, RJ48 with the following pin-out:

- Off-hook Signal Contact Pair #2 - lead 1
- transmit to ISDN call taker position (microphone)
- receive from ISDN call taker position (earpiece)
- receive from ISDN call taker position (earpiece)

- transmit to ISDN call taker position (microphone)
- Off-hook Signal Contact Pair #2 - lead 2

Properly identified screw terminals are also acceptable.

Note: The Off-hook Signal Contact Pair need not be physically on the same connector as the transmit & receive pairs.

4.9 Off-Hook Signal Contact Pairs

4.9.1 Overview

The ISDN call taker position shall provide at least one Off-hook Signal Contact Pair used to activate and deactivate ancillary devices.

It is desirable that the ISDN call taker position support two independent Off-hook Signal Contact Pairs; Pair #1 used by ancillary devices connected to the audio interface (i.e. recorders) and Pair #2 used for the Radio/Telephone Headset Interface (RTHI).

4.9.2 Operation

When the user goes off hook, the ISDN call taker position closes the contact. When the call is released, the ISDN call taker position opens the contact.

4.9.3 Electrical Interfaces

4.9.3.1 Contact Pair

- The Off-hook Signal Contact Pair shall be a dry contact pair with a rating of 28VA (1A at 28VDC) or more.
- The minimum isolation voltage shall be 600V.
- When closed (off- hook condition), the contact resistance shall be less than 5 ohms
- When opened (on-hook condition), the contact resistance shall be greater than 5 M ohms

4.9.3.2 Signal Pair

- The telephone shall be considered off-hook when there is 50 ohms or less across the signal pair.
- The telephone shall be considered on-hook when there is 1 M ohms or more across the signal pair.
- The signal pair shall have no more than 60 volts DC or AC from signal-to-signal and from signal-to-earth ground.
- There shall be no more than 250 mA of current flow in the signal pair when shorted.
- It is desirable that the current flow in the shorted condition be between 5 and 50 mA to supply a sealing current for the contacts at the other end.

4.9.4 Physical Interfaces

The physical connections of the Off-hook Signal Contact Pairs #1 and #2 shall be provided on RJ11, 14, 21, 35 or 45 connectors or properly identified screw terminals.

It is desirable that the physical connections of the Off-hook Signal Contact Pairs #1 and #2 be provided with the Telephone Audio Interface (see section 4.6) and the Radio Headset Interface (see section 4.8) respectively.

4.10 Handset/Headset Interfaces

4.10.1 Overview

In integrated telephone radio applications, the headset should be connected to the radio console and the ISDN call taker position should be connected to the radio console via the radio/ telephone headset interface (RTHI) described in this document.

In non-integrated applications, the headset should be connected to the ISDN call taker position as described below.

4.10.2 ISDN Call Taker Position Requirements

It is desirable that the ISDN call taker position support two handset/headset interfaces.

It is desirable that each telephone headset interface be equipped with its own independent bias circuit to power the headset.

Each handset/headset jack must be equipped with independent receive volume adjustments.

The ISDN call taker position shall support a microphone mute function. Apart from using this function when the call taker needs to have a confidential discussion with another call taker, this function is also used in integrated radio console applications to prevent audio feedback from the radio speaker to the telephone handset/headset microphone.

4.10.3 Headset Requirements

If the ISDN call taker position headset interface is equipped to power the headset, the headset's own bias circuit should be disabled either by internal setting or by removing the batteries.

Although less desirable, if the ISDN call taker position does not support a headset bias circuit, a battery operated headset can be used.

It is desirable that the headset be equipped with a microphone mute function for applications where the ISDN call taker position or radio console does not support this feature.

4.10.4 Electrical Interfaces

<u>If the headset is to be connected to the ISDN call taker position</u>

To ensure compatibility and the best audio quality, consult the ISDN call taker position provider for recommended headsets.

If the headset is to be connected to the radio console:
To ensure compatibility and the best audio quality, consult the radio console provider for recommended headsets.

4.10.5 Physical Interfaces

It is desirable that the ISDN call taker position support a 4 wire modular handset/headset jack with the following pin-outs:

1 - transmit (microphone)
2 - receive (earphone)
3 - receive (earphone)
4 - transmit (microphone)

Alternatively, a dual prong headset jack could be used, compatible with a PJ327 plug or equivalent with the following pin-outs:

Tip 1 - transmit (microphone)
Tip 2 - transmit (microphone)
Sleeve 1 - receive (earphone)
Sleeve 2 - receive (earphone)

It is desirable that the ISDN call taker position support a 6 wire modular handset/headset jack option for telephone radio applications where the handset/headset is to be connected to the ISDN call taker position and PTT (push to talk) signals are required.

The following pin-outs are recommended for the 6 wire jack configuration:

1 - PTT
2 - transmit (microphone)
3 - receive (earphone)
4 - receive (earphone)
5 - transmit (microphone)
6 - PTT

Alternatively, a dual prong headset jack could be used, compatible with a PJ7 plug or equivalent with the following pin-outs:

Tip 1 - transmit (microphone)
Tip 2 - transmit (microphone)
Sleeve 1 - receive (earphone)
Sleeve 2 - receive (earphone)
Ring 1 - PTT
Ring 2 - PTT

4.11 ACD (Automatic Call Distribution) Interface

4.11.1 CPE-Based ACD

The interface connector from the ACD equipment shall be EIA RS-232-C or EIA/TIA - 574 and is desirable to be configured as DTE, DB25 male EIA connector. Refer to Appendix (Section 14.5) for pin out information.

Note: The ACD provider is responsible for wiring any hardware flow control signals required by the ACD equipment. Hardware leads shall be provided to detect an interface failure.

Electrical Interface

The electrical interface shall comply with the EIA-RS-232-C or EIA/TIA-574 standards.

Serial Interface

Minimum Baud Rate:	1200 bps existing
Recommended Baud Rate:	9600 bps or Higher in new installations
Communication Link:	Asynchronous Full Duplex
Bits per character:	7 or 8
Parity:	Odd, Even, or None
Synchronization :	1 Start bit, 1 or 2 Stop bits.

Minimum Record Content from ACD

Note: The following data must be output in real time and include call appearance and Position Number.

- Answer
- Disconnect
- Monitor / Barge-In

In addition the following items are desirable:

- Hold
- Log-on / Log-off
- Ready / Not Ready
- Abandoned
- Internal ACD Transfer

4.11.2 TDD/TTY Considerations in the ACD Environment

For detailed information refer to NENA 04-001 Recommended Standards For E9-1-1 PSAP Equipment.

4.11.3 Central Office Based Automatic Call Distributor Interface

In some cases Central Office based E9-1-1 service may offer automatic call distribution and CO based Management Information System (MIS). For this service, many of the features covered in this section may be performed through a Basic Rate Interface utilizing CO based functions rather than utilizing ISDN PSAP equipment. CO based E9-1-1 equipment as a minimum shall demonstrate the same or equivalent

features contained in their ISDN PSAP premises-based counterparts. For detailed information refer to NENA 04-001 Recommended Standards For E9-1-1 PSAP Equipment

4.12 Alarms

For detailed information refer to NENA 04-001 Recommended Standards For E9-1-1 PSAP Equipment.

4.13 CSN Display Interface

The CSN display unit (which may be displayed directly on the call taker position) is required to display the ten digit CSN of the station from which the 9-1-1 call originated. If the CSN is not available, then other associated data indicating the originating local office or call status may be displayed.

4.14 ALI Display / Interface (Current)

For detailed information refer to NENA 04-001 Recommended Standards For E9-1-1 PSAP Equipment.

4.15 Printer Interfaces

For detailed information refer to NENA 04-001 Recommended Standards For E9-1-1 PSAP Equipment.

4.16 ISDN PSAP Time Synchronization Interface

For detailed information refer to NENA 04-001 Recommended Standards For E9-1-1 PSAP Equipment.

4.17 Remote Data Transfer Interface

For detailed information refer to NENA 04-001 Recommended Standards For E9-1-1 PSAP Equipment.

4.18 Remote Maintenance Interface

For detailed information refer to NENA 04-001 Recommended Standards For E9-1-1 PSAP Equipment.

5. CALL CONTROL MESSAGES

5.1 General

This section describes the basic call control messages within the Q.931 recommendation, i.e. the establishment, connection and disconnection of the call. Other ISDN supplementary services may be invoked for call forwarding, call waiting, call transfer, and call hold and are part of the Q.932 recommendation. Both ISDN signaling protocols, Q.931 and Q.932, are based upon the exchange of digital messages on the D-channel of the Basic Rate interface (BRI), and exclude the use of analog in-band beeps and tones, as used on 9-1-1 analog trunks.

The E9-1-1 ISDN Termination equipment (ITE) shall transmit and receive Q.931 and Q.932 messages to and from the E9-1-1 Tandem switch in accordance with the National ISDN specifications.

Q.931 and Q.932 messages do not have fixed formats. The message is built with 1) the Message Type information element, 2) mandatory information element(s), and 3) optional information element(s). The message content varies upon the type of connection or application. Within this protocol, every message consists of the following parts:

8	7	6	5	4	3	2	1	(bits)
0	0	0	0	1	0	0	0	Protocol Discriminator (Q.931 and Q.932 = 8)
0	0	0	0	length of CR				CR=Call Reference
F	Call Reference (CR) Value							(F= CR flag)
0	Message Type							
Additional Information Elements (if any)								

The Protocol Discriminator, the Call Reference and the Message Type are common to all messages and must always be present. The content, or lack of, supplementary information elements is a function of the type of message being transmitted, and may consists of mandatory or optional fields. This interface supports a maximum of ISDN Layer-3 message size fixed at 244 octets.

The purpose of the Call Reference is to identify the call at the local user-network interface to which the particular message applies. The origination side of the interface assigns the Call Reference value at the beginning of the call; the Call Reference flag identifies the origination side of the interface.

The Message type identifies the function of the message being sent. Message types are defined in Q.931 and Q.932.

5.2 Call Connect

5.2.1 E9-1-1 Tandem to PSAP ISDN Call Connection

This section describes the ISDN Termination Equipment (ITE) requirements to accept an E9-1-1 call on an ISDN BRI E9-1-1 interface. Before these procedures are invoked, the PSAP ITE shall have 1) established a reliable data link in conjunction with the E9-1-1 tandem switch, and 2) accomplished terminal initialization.

Failure modes are discussed as they are applicable to a particular sequence.

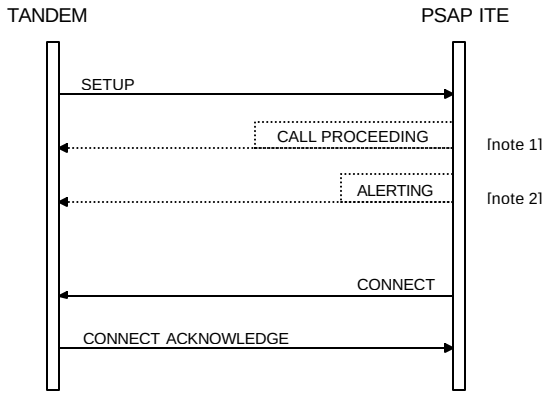


FIGURE 5.1 - Message exchange to establish a circuit-mode E9-1-1 call from the network to the PSAP equipment
note 1: optional (see 2. below)
note 2: optional (see 3. below)

1. The E9-1-1 Tandem office sends an ISDN **SETUP** message that contains at least the following information:

   - Call Reference Value (CRV), identifying the specific call to which this message applies.
   - Bearer Service capability (i.e. speech, 3.1-khz audio); the use of data bearer service capability has been requested of T1S1 but is an open issue that needs resolution.
   - Channel identification element (i.e. B-channel used for the call).
   - Calling Party Number information element of up to 15 digits containing the Calling Station Number (CSN)
   - Called Party Number information element containing the DN of the PSAP
   - A new information element has been proposed to T1S1 (standards body) to indicate either a “normal / steady” display or “flashing” display.
   - A new information element has been proposed to T1S1 to indicate test calls.
   - For FCC Phase I wireless calls, a *Generic Information* information element is coded to indicate "wireless cell site/sector identification". This field must contain supplementary information represented as a 10 digit number identifying the cell site and/or sector (i.e.

pANI). (In some cases, cell sites are not sectorized.) (ref: Telcordia GR-2967).

If the location information is not available or if the call is an anonymous Direct Call, the *Generic Information* information element is still included; it is then coded to indicate "wireless cell site/sector identification", but does not include any content.

- For FCC Phase II wireless calls, an additional *Generic Information* information element will need to be identified to contain x, y and possibly z coordinates.

  Notes for Calling Station Number substitution for Emergency Calls

  When the CSN is unavailable at the E9-1-1 Tandem office, because of ANI failure or garbled received digits, a fictitious NPA-NXX-XXXX CSN is sent as NPA-911-0TTT. The digits TTT indicate the E9-1-1 Tandem switch Central Office number (a.k.a. ESCO code) associated with the originating office. In this case, the Type of Number and Numbering Plan shall be set to "unknown number, unknown numbering plan". In the future, the digits TTT may need to be expanded to TTTT to sufficiently identify trunk groups.

  Notes for Calling Station Number substitution for Direct Calls

  000-911-0000 is sent when an anonymous call is made to an ISDN PSAP. An anonymous call is a call (non 9-1-1) to the DN of an ISDN PSAP. In this case, the Type of Number and Numbering Plan shall be set to "unknown number, unknown numbering plan".

  The **SETUP** message delivered to the ITE always contains the channel identification information element. Normally, the E9-1-1 tandem codes this information element to identify an exclusive B channel. The ITE shall determine if it can accept the call on the channel indicated in the channel identification information element.

  If the ITE cannot accept the call on the indicated channel, the ITE shall reject the call by sending a **RELEASE COMPLETE** message. It is recommended that the **RELEASE COMPLETE** message includes cause #44, "requested channel not available".

2. If more time is necessary either to begin alerting, or to connect the call to the called ITE, the E9-1-1 PSAP ITE shall send back a **CALL PROCEEDING** message to inform the network that the call request has been received and is being processed. This is important because the network has some timers running to prevent error conditions upon the non-reception of a response from the ISDN PSAP.

3. Upon the receipt of the complete call setup information, the PSAP ITE shall signal the call taker(s). If the call is not answered immediately, the PSAP ITE shall send an **ALERTING**

message to inform the network that the PSAP ITE has received the call request and is alerting at least one call taker. Note that this **ALERTING** message is part of the local interface, and does not get sent to the calling party. The **ALERTING** message also indicates to the network side that the network can now return audible (in-band) ringing to the originating line/calling party.

4. When the PSAP call taker accepts the call, e.g. by taking the handset "off-hook", via a button depression or with programmed software, the PSAP ITE shall send a **CONNECT** message to the network. When the network receives this **CONNECT** message, it stops its call setup timers and completes the switching of the circuit path on the designated bearer channel.

5. Once the network has completed the switching of the circuit path on the designated bearer channel, it sends a **CONNECT ACKNOWLEDGE** message to the PSAP ITE. The PSAP ITE shall connect the call to the answering call taker and display the appropriate information on the console display.

6. After the answer is detected, the E9-1-1 Tandem office supervises the call for disconnect or a PSAP transfer request.

5.3 Call Transfers

This section describes the process of transferring a call from a PSAP call taker position when 3 parties are involved (3-way conference circuit). The 3 parties involved are:

- the E9-1-1 caller
- the ISDN PSAP call taker and
- the party the call is to be transferred to.

It is desirable that a conference of greater than 3 participants be built and transferred. When a conference of more than 3 parties is used, please refer to section 5.4 Call Conferencing.

5.3.1 E9-1-1 ISDN PSAP Central Office Transfers

For the PSAP ITE, the E9-1-1 tandem shall support Flexible Calling features described in TR-TSY-000858. This provides a means for conferencing.

A request for transfer is initiated after a conference has been established between the calling party, the ISDN PSAP (controlling the conference) and the party the call is to be transferred to (e.g. secondary PSAP, Police or Fire) . For E9-1-1 call transfer capability, the PSAP ITE can be arranged to automatically generate and send Speed Calling codes of the form *XY, at a minimum *11 to *99, in order to establish the second call. Call transfer can also be accomplished by having the ISDN PSAP call taker dial the Speed Calling codes or the entire DN manually. The transfer occurs when the **DISCONNECT** message is received from the ISDN PSAP, keeping the calling party and the second call connected together.

For E9-1-1 service, there are three types of transfers:

1. Selective Transfer. With selective transfer, the list of secondary ISDN PSAP DNs is used to transfer an E9-1-1 call selectively according to the Emergency Transfer Digit (ETD) received. Selective transfer codes have the form of *1X, where X = 1 to 6.

2. Fixed Transfer. With fixed transfer, the prefixed 2-digit Speed Calling code has the form of *XY, where X = 2 to 9 and Y = 0 to 9.

3. Manual Transfer. With manual transfer, the call taker manually dials the DN or Speed Calling code.

For all transfer modes, if the routing DN leads to a secondary E9-1-1 ISDN PSAP, the CSN sent to the primary ISDN PSAP is also sent to the secondary ISDN PSAP.

Warning: Continuous loop situations may exist in certain applications where transfers occur between PSAPs which are mutual alternate routes of each other. As an example, if the secondary ISDN PSAP has alternate routing (for night service, traffic busy or both) which loops back to the ISDN PSAP requesting the transfer, it may be desirable to block the transfer (and send overflow tone (120 IPM) to the ISDN PSAP call taker to indicate that the transfer is not allowed) to avoid a "loop" condition.

Once the transfer is complete, all parties are connected at the E9-1-1 Tandem office until one of the parties disconnects from the call. While all three parties are connected, the primary ISDN PSAP can cause the secondary ISDN PSAP to be disconnected (drop off) by sending an **INFORMATION** message with a "drop" feature activator message to the E9-1-1 Tandem office. The E9-1-1 Tandem office will reestablish the call as a 2- party call between the calling party and the primary ISDN PSAP.

If a transfer request is not valid, an interrupted high tone (120 IPM) is returned to the ISDN PSAP call taker requesting the transfer.

5.3.2 E9-1-1 Call Transfer Sequence

To invoke an E9-1-1 call transfer (conference & drop): Refer to Figure 5.2

1. The ISDN PSAP sends an **INFORMATION** message with the feature activator value corresponding to "invoke conference calling" (the feature activator value is contained in the Feature Activation information element). The Call Reference value in the **INFORMATION** message corresponds to the call being transferred.

2. The E9-1-1 tandem responds with an **INFORMATION** message containing a Feature Indication information element coded with "feature indicator = conference, status=active".

3. The ISDN PSAP sends a **SETUP** message to establish a second call (e.g. to a secondary PSAP or other Emergency Service, such as Police or Fire). The E9-1-1 tandem recognizes the **SETUP** message as a request to conference the first and second call. The Called Party Number information element in this **SETUP** message is populated with the transfer destination, e.g. the DN of a secondary PSAP or with its speed dialing transfer code.

   Note: National ISDN currently does not support the "no hold conference" feature. Based on PSAP preference, the option for "no hold" conference shall be available. This option may be implemented by the E9-1-1 Tandem switch or the PSAP ITE. It is desirable that the PSAP call taker be able to choose a "no hold" conference on a per call basis.

4. The ISDN PSAP requests the completion of the call transfer by sending a **DISCONNECT** message. The original calling party and the secondary PSAP remain connected. The transfer is completed using the standard National ISDN release sequence (the E9-1-1 Tandem switch returns a **RELEASE** message and the PSAP follows with a **RELEASE COMPLETE** message).

   To drop the secondary PSAP from the call while still remaining connected to the original calling party, the ISDN PSAP shall send an **INFORMATION** message with the feature activator corresponding to “drop”. The E9-1-1 Tandem switch returns a **INFORMATION** message to acknowledge the drop.

Tandem (Network)	Message	PSAP ITE (user)
	<<< Active Call on CR1 >>>	
	INFOrmation <---------- {CR1} {FA = conference}	Invoke the conference feature on CR1
Confirm activation of conference feature	INFOrmation ---------->{CR1}{FI = conference; status = active}	
call request is valid	SETUP <---------- {CR2}{called party number} {Channel ID}	Initiate a second call on CR2
2nd call is receiving alerting treatment	CALL PROC ---------->{CR2}	
Call is bridged onto the conference; Call Reference {CR2}is merged with conference CR1	REL {CR2} ----------> <----REL COMPL	
	<<< 3 PARTY {CR1} CONFERENCE >>>	
transfer acknowledge	DISCONNECT <---------- {transfer request} REL---------->{CR1} <----REL COMPL	Feature activator= transfer request Call transferred
drop acknowledge	or INFORMATION <---------- {drop}{CR1} INFORMATION ---------->{status}	feature activator= drop second (last) call Active Call remains connected

FIGURE 5.2 CALL TRANSFER MESSAGE SEQUENCE

5.3.2.1 *Selective Transfer*

Selective Transfer provides the capability to transfer a call based on transfer information associated with the ESN (Emergency Service Number). The PSAP call taker initiates Selective Transfer by using transfer keys on a call taker position. The Called Party Number of the **SETUP** message of the second call establishment shall contain a prefixed 2-digit transfer code of the form *1X, where X={1,2,3,4,5,6}. In this case, the Type of Number/Numbering Plan is coded as "unknown number in unknown numbering plan".

When the E9-1-1 Tandem recognizes a Selective Transfer code, the routing DN corresponding with that transfer code is determined from the ESN associated with the call being transferred.

5.3.2.2 Fixed Transfer

Fixed Transfer provides the capability to transfer a call based on transfer information associated with a fixed transfer code. The PSAP call taker initiates Fixed Transfer by using transfer keys on a call taker position. The Called Party Number of the **SETUP** message of the second call establishment shall contain a prefixed 2-digit transfer code of the form *YX, where Y={2 through 9} and X={0 through 9}. In this case, the Type of Number/Numbering Plan is coded as "unknown number in unknown numbering plan".

When the E9-1-1 Tandem switch recognizes a Fixed Transfer code, the routing DN is determined from a list of transfer codes assigned in the E9-1-1 Tandem switch.

5.3.2.3 Manual Transfer

The PSAP call taker initiates a Manual Transfer by accessing a key and manually dialing the DN for the desired destination. In this case, the Called Party Number of the **SETUP** message of the second call establishment shall contain the DN of the transfer destination. Note that manually dialing the Speed Calling codes {*YX} is identical to the Fixed Transfer from the point of view of the E9-1-1 Tandem switch -- refer to the previous section.

5.4 Call Conferencing

The ISDN PSAP shall be able to support a conference of 3 or more parties, where one of the parties is an E9-1-1 caller. The ISDN PSAP shall be able to support the following functions:

- establish a conference call on an active E9-1-1 call;
- add a party to the conference;
- drop the last added-party from the conference;
- disconnect the call taker from the conference while the connection between the remaining conference parties is retained [implicit transfer].

The conference function is performed at the E9-1-1 tandem switch and no additional B-channel is required at the PSAP to establish the conference. Only one B-channel is involved on the BRI connected to the PSAP throughout the conference.

It is desirable that while performing any conference functions, the E9-1-1 caller is not to be put on hold.

In the process of adding a party to a conference or transferring a conference, the functionality of "Selective, Fixed and Manual Transfer" options shall be available, as described in the section 5.3 Call Transfers. The Calling Party Number (CPN) or the Keypad Information Element (KIE) of the message sent to add a party to the conference is populated with the added-call destination, i.e. either the manually dialed DN, or the speed dialing transfer code as described for Selective or Fixed Transfer.

While a conference is active, all PSAP call takers who have E9-1-1 call supervision can add parties to the conference, drop the last added-party from the conference or transfer the conference. This requirement applies throughout the duration of the conference, including all subsequent transfers of the conference.

When only 2 parties remain on the conference, the call connecting these two parties reverts to a 2-way call.

For a conference of no more than 3 parties, the conference feature activator may have a dual function: the first time used, to invoke a conference and the second time used (while the conference is active), to drop the last party added.

For a conference of more than 3 parties, it is necessary for the ISDN PSAP call taker to distinguish between 2 different features: one to invoke or add a party to the conference, the other to drop the last added-party from the conference.

For compatibility reasons, it is recommended that the method of activation, or key sequence, used to manually transfer a conference with ISDN – BRI should not be different than transferring on an MF trunk (carrying MF or enhanced-MF signaling); i.e. the call taker should be able to use the same key sequence for all signaling protocols. This implies the use of a key sequence initiated by a single common key -- the same way the key sequence initiator "flash" is used with E9-1-1 MF trunk transfer. For example, the same PSAP may provide answering position for a mix of MF trunks and ISDN lines. No operational difference shall exist for an E9-1-1call transfer over an ISDN line versus an MF trunk, i.e. the PSAP call taker shall be able to conference and transfer E9-1-1 calls the same way on both protocols.

5.5 Call Disconnect

5.5.1 Normal Calls

For an established E9-1-1 call, disconnect supervision is maintained at the E9-1-1 Tandem office. Disconnect actions depend on whether disconnect is received from the PSAP ITE or the local office first. When the ISDN PSAP call taker disconnects first, the PSAP ITE should send a **DISCONNECT** message to the E9-1-1 Tandem office. The ITE then disconnects itself from the B-channel. The network returns a **RELEASE** message to the PSAP ITE, to signify that a disconnect procedure is initiated at the network side, releasing the circuit. The PSAP ITE then completes the exchange of messages with a

RELEASE COMPLETE message. At this time, the tandem releases the B-channel towards the PSAP.

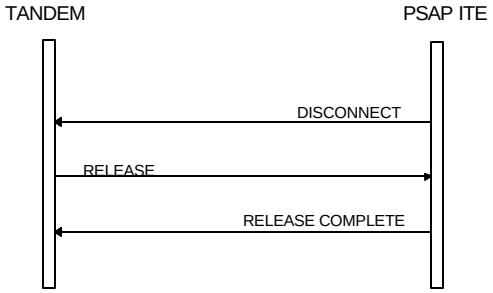


FIGURE 5.3 --ISDN Call disconnect when initiated by the ISDN PSAP

When the calling party disconnects first, the local office notifies the E9-1-1 Tandem office, which sends a **DISCONNECT** message towards the PSAP. The PSAP ITE answers this message by sending back a **RELEASE** message to the Tandem. The Tandem then releases the B-channel and completes the call by sending a **RELEASE COMPLETE** message back to the PSAP ITE. Similarly, a calling party directly connected to the E9-1-1 ISDN Tandem office will result in disconnect of the ISDN PSAP.

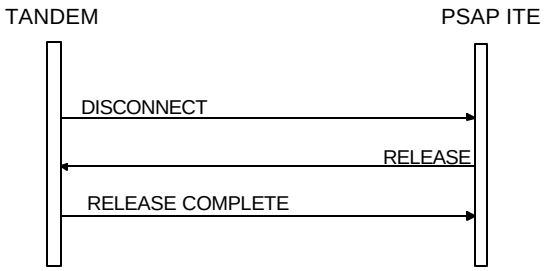


FIG 5.4 --ISDN Call disconnect when initiated by the calling party

Note: Called party control functionality is being investigated for implementation as an optional feature. This may impact the disconnect sequence described above.

Note: See section 6.7 for Abandoned Calls

5.5.2 Transferred Calls

5.5.2.1 Added Party Disconnect First

If the added call is ISDN and the added party initiates clearing of the connection of the conference, the E9-1-1 tandem drops the added party from the conference and re-establishes a 2-way connection between the caller and the ISDN PSAP. [GR-2967, R5-42]

Upon the reception of an “on-hook” indication from a non ISDN added call (GR-2967, R5-41) , the E9-1-1 Tandem office retains the three-way connection and begins timing for 10 to 11 seconds, as

described in section 4.2.4.2 of TR-TSY-000350. One of three events can occur, and is handled by the E9-1-1 tandem as follows:

1. If the added party returns "off-hook" before time-out occurs, timing is terminated and the added party remains on the 3-party connection.

2. If time-out occurs or if the controlling ISDN PSAP sends a request to "drop the added party", the added party is dropped from the conference and a 2-way connection re-established between the calling party and the controlling ISDN PSAP.

3. If the calling party or the primary ISDN PSAP disconnects before time-out occurs, the disconnect party is immediately released. Timing continues until either time-out occurs (all connections are released) or the added party goes "off-hook". In this case, the call is established as a 2-party call between the remaining parties.

5.5.2.2 Calling Party Disconnects First

Upon detection of calling party disconnect, the calling party connection is released at the E9-1-1 tandem. The ISDN PSAP remains connected to the added party until either the added party disconnects, the ISDN PSAP releases the added party, or the ISDN PSAP disconnects.

5.6 Test Calls

ISDN BRI lines are under constant surveillance by the switch which may negate the need for test calls. However, contributions have been submitted to T1S1 defining an information element to identify a test call. For an E9-1-1 ISDN PSAP, test calls can be made from the E9-1-1 Tandem Office using an information element which identifies the call as a test call. The E9-1-1 ISDN PSAP CPE should decode this information element as a test call.

6. ISDN PSAP FEATURE REQUIREMENTS SPECIFICATIONS

6.1 Call Distribution

The ISDN PSAP shall use one of the following call distribution methods:

- Hunt Group - Emergency calls are presented to the individual ITEs according to a predetermined algorithm (e.g., Uniform Call Distribution).
- ACD System - Incoming calls are usually presented to the call taker that has been idle the longest. The system may also take into account other criteria (e.g., 9-1-1 versus non-9-1-1 calls, call taker skills, etc.).
- Electronic Key Telephone System (EKTS) - The emergency call is presented to a specific DN where the DN is shared with other ITEs.
- Single Position PSAPs - Although possible, this is not recommended.

6.2 Call Appearances

The ITE shall support a minimum of two call appearances to be able to receive emergency calls and subsequently perform a transfer or conference. Typically, ITEs support several call appearances.

6.3 Feature Key Management Procedures

The ITE shall support feature key management procedures. Feature key management is the signaling protocol used between the ISDN switch and the ITE to invoke and control features. Typically, feature key management provides the means for a call taker to invoke a feature through a single action (e.g., select a feature key, click on an icon, etc.).

6.4 Call Taker Position Compatibility

At a minimum, the ISDN PSAP shall support the following functions either internally or through an external device:

- Computer Aided Dispatch
- Voice Recorder
- Telephone Audio
- TTY
- PSAP Master Clock Interface
- Radio / ISDN Terminating Equipment Headset Interface
- Handset / Headset Interfaces
- Printers
- Call Detail Recorder
- ALI Display
- CSN Display
- Alarms
- Automatic Call Distributor (Optional)

See Section 4 for interface specifications for devices that support the above functions.

6.5 Call Sequencing of 9-1-1 Calls

In EKTS configurations the ISDN PSAP shall provide some type of call sequence to signal which call has been in queue the longest. The priority shall be provided on a First-In-First-Out (FIFO) basis.

6.6 Distinctive Alerting

The ITE shall provide distinctive ring tones and/or visual indications to advise the 9-1-1 call taker on the nature of the incoming call to differentiate 9-1-1 calls from other types of calls.

6.7 Abandoned Calls

The ITE shall have the ability to detect abandoned calls. An abandoned call occurs when a 9-1-1 call is disconnected before the call taker answers. The ITE shall have the capability to present the abandoned call to the call taker and/or clear the call and report the incident to a central location (e.g., call record printer, supervisor's station, MIS, etc.). Notification to the call taker shall clearly identify when an abandoned call occurs. It can be visual and/or audible.

6.8 CSN Call Back

The ITE shall provide the ability to call back the 9-1-1 caller based on the received CSN. The call taker shall be able to invoke this feature through a single action (e.g., select a feature key).

6.9 Call Hold

The ITE shall provide the capability to place any active call on hold. When a 9-1-1 call is retrieved from hold, CSN and ALI information shall be automatically displayed to the call taker.

6.10 Audio Volume Adjustment

The ITE shall have a means for the call taker to manually control the volume of an active call. Each handset/headset jack shall provide independent receive volume adjustments. It is desirable to also have an independent transmit volume adjustment.

6.11 Conference/Transfer

The ITE shall provide a means for the call taker to initiate and establish the conference and transfer features.

6.12 CSN Manual Update on Transfer

It is desirable that the Calling Station Number (CSN) be manually updated from the PSAP call taker and this updated information be substituted in the Calling Party Number information field, part of the message asking for the call transfer. This is in case of a false, anonymous or unavailable CSN received from the initial setup call information, in order to prevent transferred PSAP call taker(s) having to verbally ask for the same type of information over the same Emergency call. This is similar to an Operator Services feature, not included in National ISDN today but recommended.

6.13 Speed Dial

It is desirable for the ITE to have a speed dial library of at least 16 telephone numbers (minimum capacity of 20 digits each). The call taker shall be able to invoke a speed dial through a single action (e.g., select a feature key).

6.14 Last Number Redial

It is desirable for the ITE to provide a means to automatically redial the last number dialed.

6.15 ISDN PSAP Login ID

When operating in the CO-based ACD mode, the ITE shall provide a means for the call taker to send a login ID to the switch.

6.16 PSAP ITE Alarm Indicators

The PSAP ITE shall support visual and/or audible indicators for:

- Line status (in or out of service)
- Call taker position status (in or out of service)
- ALI database links status (in or out of service)

6.17 Bridged Calls

When operating in the EKTS mode the ITE shall provide a means for the call taker to bridge onto an existing call (e.g., select an active call appearance).

6.18 Silent Monitor

It is desirable for a supervisor to bridge onto any active 9-1-1 call in their ISDN PSAP for the purpose of monitoring. The supervisor position shall mute the talk path so that the monitored station and the caller remain unaware of the supervisor's presence.

6.19 Headset/Handset Compatibility

The ITE shall support two handset/headset interfaces with independent bias circuits. See section 4.10 for interface specifications.

6.20 TDD/TTY Compatibility

Each ITE shall be capable of processing baudot TDD/TTY (Telecommunications Device for the Deaf /Teletypewriter) calls. This shall include the following capabilities:

- Auto-detect baudot TDD calls and provide audible and/or visual notification to the call taker
- Provide a minimum of 8 pre-programmed messages with a capacity of 32 characters each
- Display a minimum of 511 characters of text at the call takers position

- Toggle between voice and TDD mode to accommodate HCO/VCO calls
- Initiate a baudot TDD call
- Print out conversation text
- Initiate a baudot query in response to any silent call
- Use a keyboard for text interaction with the caller

Note: *At present, telephone emergency services must only be compatible with the Baudot format.* Until it can be proven that communications in another format can operate in a reliable and compatible manner in a given telephone emergency environment, public entity would not be required to provide direct access to computer modems using formats other than Baudot. (Reference: U.S. Department of Justice, Civil Rights Division, Office of the Americans with Disabilities Act, Title II Technical Assistance Manual)*

*Per EIA PN-1663 Draft 9

6.21 Voice Recording

It is desirable for the voice recorder to have the ability to play and record simultaneously such that a call taker may listen to a previous call while recording a current call.

6.22 Management Information System

It is desirable for the ISDN PSAP to have access to Management Information System (MIS) capabilities. The MIS shall provide information such as but not limited to:

- Number of calls offered
- Number of calls answered
- Number of abandoned calls
- Number of calls transferred
- Average time to answer
- Average length of call

The ability to create custom reports on an as needed or scheduled basis is also desirable.

6.23 CDR (Call Detail Record) Requirements

All ISDN PSAPs shall be equipped with a printer or a CDR database log to provide a CDR (Call Detail Record) at the end of each 9-1-1 call.

6.23.1 Minimum Field Requirements

The CDR for 9-1-1 calls shall include the following fields at a minimum:

- Ringing start time
- CSN

- Answer time
- Answering position number(s)
- Call appearance DN
- Call release time
- Time call was transferred
- Number that the call was transferred to
- Abandoned call indicator
- Direction of call release
- Time call was placed on hold
- Time call was taken off of hold and by what position number
- ALI (Complete record)
- Date*

**Note:* *The date does not necessarily need to be a part of each record. As a minimum, the date should be printed at least once per page.*

6.23.2 Physical Interface

If a printer is used see Section 4.15.

6.24 Remote Monitoring

The PSAP remote monitoring feature shall allow the maintenance provider to access the PSAP equipment from a remote test center or location to assist in trouble isolation, resolution and fault clearing.

The remote monitoring function shall:

- Accumulate data on PSAP CPE performance
- Trigger common alarms should the PSAP CPE require maintenance
- Enable remote or local programming of any function
- Take corrective action when possible
- Generate enhanced call record reports

7. POWER REQUIREMENTS

The NENA-04-001 document provides all recommendations for the power requirements of PSAP equipment, including ISDN PSAPs.

8. PHYSICAL AND ELECTRICAL ENVIRONMENT REQUIREMENTS

The NENA-04-001 document provides all recommendations for the physical and electrical environment requirements of PSAP equipment, including ISDN PSAPs.

9. INSTALLATION, MAINTENANCE AND ADMINISTRATION

The NENA-04-001 document provides all recommendations for the installation, maintenance and administration requirements of PSAP equipment, including ISDN PSAPs.

10. REGISTRATION REQUIREMENTS

The NENA-04-001 document provides all recommendations for the registration requirements of PSAP equipment, including ISDN PSAPs.

11. QUALITY AND RELIABILITY

The NENA-04-001 document provides all recommendations for the quality and reliability requirements of PSAP equipment, including ISDN PSAPs.

12. TECHNICAL REFERENCES

12.1 NYNEX Technical References

NIP-74162	NYNEX Central Office Grounding Requirements Issue 1, June 1990
NIP-74165	Digital Switch Environmental Requirements and Checklist Issue 2, December 1989
NTR-74262	NYNEX Enhanced 9-1-1 Service and Technical Description Issue 1, October 1991
NTR-74325	NYNEX Generic Requirements for E911 PSAP Equipment Issue 1, April 1992

NYNEX Documents are available at nominal cost from:

Telesector Resources Group
Technical Information Management
120 Bloomingdale Road - 367A
White Plains, NY 10605
(914) 644-5428

12.2 Telcordia Technical References

GR-282-CORE	Software Reliability & Quality Acceptance Criteria (SRQAC) Issue 1, December 1994.
GR-2967-CORE	ISDN Basic Rate Interface (BRI) Generic Requirements: E9-1-1 Tandem to ISDN PSAP Interface Issue 1, July, 1997
SR-3875	National ISDN 1995, 1996, and 1997 Issue 2, May 1997.
SR-4288	Version of National ISDN Basic Rate Interface Terminal Equipment Generic Guidelines Issue 1, December 1997.
SR-NWT-001953	Generic Guidelines for ISDN Terminal Equipment on Basic Rate Interfaces Issue 1 + Revision 1 (December 1991)
TA-NPL-000912	Description of the Analog Voice-Band Interface Operating Company Network Interface Issue 1, February 1989

TA-NWT-000179	Software Quality Program Generic Requirements (SQPR) (A Module of RQGR, FR-NWT-000796) Issue 2, June 1993.
TR-EOP-000063	Network Equipment-Building System (NEBS) Generic Equipment Requirements Issue 4, July 1991
TR-NWT-000078	Generic Physical Design Requirements for Telecommunications Products and Equipment Issue 3, December 1991
TR-OPT-000839	Supplier-Provided Training Generic Requirements Issue 3, December 1991
TR-TSY-000064	LATA Switching Systems Generic Requirements (LSSGR), 1990
TR-TSY-000350	E911 Public Safety Answering Point: Interface Between a l/lAESS Switch and Customer Premises Equipment Issue 1, 1987
TR-EOP-000001	Lightning and 60-Hz Disturbances at the Bell Operating Company Network Interface Issue 2, June 1987
TR-NWT-000332	Reliability Prediction Procedure for Electronic Equipment (A Module of RQGR, FR-NWT-000796) Issue 4, September 1992.
TR-NWT-000357	Component Reliability Assurance Generic Requirements for Telecommunications Equipment. Issue 2, October 1993.
TR-NWT-001252	Quality System Generic Requirements for Hardware. Issue 1, December 1992

Telcordia Documents are available from:

Telcordia Customer Service
8 Corporate Place, Room 3A-184
Piscataway, NJ 08854-4156

1-800-521-CORE (2673) (USA and Canada)
(732) 699-5800 (all others)
(732) 336-2559 (fax)

12.3 ANSI Technical References

ANSI T1.607-1996 Telecommunications - Integrated Services Digital Network (ISDN) - Layer 3 Signaling Specification for Circuit-Switched Bearer Service for Digital Subscriber Signaling System, Number 1 (DSS1), (includes supplement ANSI T1.607a-1995)

ANSI T1.607a-1996 Telecommunications - Digital Subscriber Signaling System Number 1 (DSS1) - Layer 3 Signaling Specification for Circuit-Switched Bearer Services (supplement to ANSI T1.607-1990)

ANSI T1.610-1997 Integrated Services Digital Network (ISDN) - Digital Subscriber Signaling System, Number 1 (DSS 1) - Telecommunications - Generic Procedures for the Control of ISDN Supplementary Services.

12.4 NENA Recommended Standards

NENA-01-002 NENA Master Glossary of 9-1-1 Terminology

NENA-02-001 NENA Recommended Formats for Data Exchange

NENA-04-001 NENA Recommended Generic Standards for E9-1-1 PSAP Equipment

NENA-04-002 NENA PSAP Master Clock Standard

NENA-04-004 NENA Recommended Generic Standards for E9-1-1 PSAP Intelligent Workstations

12.5 Other Technical References

CCITT (ITU), Blue Book 1988, Vol VI - Fasc VI.11, Recommendations Q.931-Q.940

EIA RS-478 Multi-Line Key Telephone Systems (KTS) for Voice-band Applications July 1981

ISDN - Gary C. Kessler ISBN 0-07-034247-4 Published by McGraw - Hill

National Electric Code may be purchased from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02266

Part 1910 - Occupational Safety and Health Standards (Title 29 - Labor, Chapter XVII - OSHA, Department of Labor)

Part 68, Connection of Terminal Equipment to the Telephone Network, of the Federal Communications Commissions "Rules and Regulations" may be purchased from the Superintendent of Documents, Government Printing Office, Washington, DC 20402.

13. Glossary

1A2	A designation for Key Telephone Systems which utilize an "A" lead for control.
"A" Lead Control	A wire used to control the Key Telephone Unit in a 1A2 type key Telephone System. In some E9-1-1 systems it is used to identify the position connected to the trunk.
Alternate PSAP	A PSAP designated to receive calls when the primary PSAP is unable to do so.
American Standard Code for Information Interchange (ASCII)	This standard defines the code for a character set to be used for information interchange between equipment of different manufactures and is a standard for data communications over telephone lines. In the context of TDD/TTY this refers to both a binary code and modulation method used for 110/300 baud TDD/TTY communications.
Attendant Position	The Customer Premises Equipment (CPE) at which calls are answered and responded to by the Telecommunicator.
Automatic Call Distributor (ACD)	Equipment that automatically distributes incoming calls to available PSAP attendants in the order the calls are received, or queues calls until an attendant becomes available.
Automatic Location Identification (ALI)	The automatic display at the PSAP of the caller's telephone number, the address/location of the telephone and supplementary emergency services information.
Automatic Location Identification (ALI) Database	The set of ALI records residing on a computer system.
Automatic Location Identification (ALI) Multiplexer	A CPE component which performs the function of communicating with the ALI database. An ALI multiplexer typically works in conjunction with an ANI controller.
Automatic Number Identification (ANI)	Telephone number associated with the access line from which a call originates.
Automatic Number Identification (ANI) Controller	A stand-alone CPE component which provides the ANI decoding and function key control for 9-1-1 service.
Baud Rate	A measure of signaling speed in data communications that specifies the number of signaling elements that can be transmitted each second.
Baudot Code	A five bit encoding scheme that represents text and digits. It is the standard transmission signaling scheme used by TTY (TDD) devices. (per EIA PN-1663)

Call Sequencer	A unit which monitors incoming calls at a PSAP and indicates to the answering positions which of the incoming calls has been unanswered the longest.
Call Taker Position	(See Attendant Position)
Cathode Ray Tube (CRT)	Video monitor used for displaying information.
Central Office (CO)	The Local Exchange Carrier facility where access lines are connected to switching equipment for connection to the Public Switched Telephone Network.
Central Office (CO) Transfer	A service provided by the Central Office that allows an established call to be transferred to another location.
Central Processing Unit (CPU)	The part of a computer which performs the logical, computational and decision making functions.
Centrex	A business telephone service offered by some Local Exchange Carriers that provides PBX type features over access lines.
Computer Aided Dispatch (CAD)	A computer based system which aids PSAP attendants by automating selected dispatching and record keeping activities.
Customer Premises Equipment (CPE)	Terminal equipment at a PSAP.
Data Base Management System (DBMS)	A system of manual procedures and computer programs used to create, store and update the data required to provide Selective Routing and/or Automatic Location Identification for 9-1-1 systems.
Data Communication Equipment (DCE)	The devices and connections of a communications network that connect the Data Terminal Equipment (DTE) to the communication circuit. A modem is the most common kind of DCE.
Data Terminal Equipment (DTE)	A device which acts as the source and/or destination of data and which controls the communication channel. DTE can include terminals, computers, and printers.
Directory Number (DN)	A dialable 10-digit telephone number associated with a telephone subscriber or call destination.
Disk Operating System (DOS)	A personal computer operating system which manages the computer's resources.
Dual Tone Multi-Frequency (DTMF)	One of the methods used for signaling in the telephone network. Often referred to as TOUCH-TONE™.

Emergency Service Routing Digits (ESRD)	A telephone number used to support routing of wireless 9-1-1 calls. It may identify a wireless cell, cell sector or PSAP to which the call should be routed. Also known as routing number.
Enhanced 9-1-1 (E9-1-1)	An emergency telephone system which includes network switching, database and CPE elements capable of providing Selective Routing, Selective Transfer, Fixed Transfer, ANI and ALI.
Enhanced 9-1-1 (E9-1-1) Control Office	The Central Office that provides the tandem switching of 9-1-1 calls. It controls delivery of the voice call with ANI to the PSAP and provides Selective Routing, Speed Calling, Selective Transfer, Fixed Transfer, and certain maintenance functions for each PSAP. Also known as 9-1-1 Selective Routing Tandem or Selective Router.
Fixed Transfer	The capability of a PSAP attendant to transfer a 9-1-1 call to a pre-determined location by activating a single button.
Integrated Services Digital Network (ISDN)	A digital interface providing multiple channels for simultaneous functions between the network and CPE.
ISDN PSAP	A PSAP that receives 9-1-1 calls using an ISDN interface.
Key Service Unit (KSU)	Equipment which provides ringing, lamp voltages, conference, etc. for multi-line key telephone sets.
Key Telephone System (KTS)	A multi-line telephone system comprised of multi-line telephone sets, KTU's and KSU's.
Light Emitting Diode (LED)	Lamps used for display of information. Commonly used on telephone sets to indicate line status.
Logging Recorder	A voice-band audio recorder which records to and plays from a permanent storage media such as tape or disk. Logging recorders are typically multi-channel so as to simultaneously record from several sources.
Login	The process of identifying and authenticating oneself to a computer, ACD or E9-1-1 attendant position system.
Loopback	A type of diagnostic test in which a transmitted signal is returned to the transmitting device and then compared to the original signal.
Management Information System (MIS)	A program that collects, stores and collates data into reports enabling interpretation and evaluation of performance, trends, traffic capacities, etc.
Manual Transfer	The capability of a PSAP attendant to transfer a 9-1-1 call to another location by manually dialing the destination number or speed calling code.

Modem	An interface device which allows digital data signals to be transmitted over analog telephone lines.
Multi-Frequency (MF)	A type of signaling used on analog interoffice and 9-1-1 trunks.
Nationally Recognized Testing Laboratory (NRTL)	Any of several testing laboratories recognized by the U.S. testing in accordance with industry and municipal standards.
NNX / NXX	A three digit code in which N is any digit 2 through 9 and X is any digit 0 through 9. They are the second set of three digits in the North American Numbering Plan.
Non-blocking	A switching network designed to complete all call attempts.
North American Numbering Plan	Use of 10 digit dialing in the format of a 3 digit NPA, followed by 3 digit NXX and 4 digit line number. NPA-NXX-XXXX.
Number Plan Area (NPA)	An established three-digit area code for a particular calling area. It takes the form of NXX, where N is any digit from 2 through 9 and X is any digit from 0 through 9.
Numbering Plan Digit (NPD)	A component of the traditional 9-1-1 signaling protocol between the 9-1-1 Control Office and the PSAP CPE. Identifies 1 of 4 possible area codes.
Primary ISDN PSAP	(See Primary PSAP)
Primary Public Safety Answering Point (PSAP)	A PSAP to which 9-1-1 calls are routed directly from the 9-1-1 Control Office. (See PSAP)
Private Branch Exchange (PBX)	A private telephone system that is connected to the Public Switched Telephone Network.
Public Safety Answering Point (PSAP)	A facility equipped and staffed to receive 9-1-1 calls. A Primary PSAP receives the calls directly. If the call is relayed or transferred, the next receiving PSAP is designated a Secondary PSAP.
Real-Time	The availability of information at the exact time it is occurring.
Recall Recorder	A voice-band audio recorder which records to and plays from a media that may not be permanent (such as tape loop, fixed disk or RAM). Recall recorders are typically associated with each operator position for the purpose of recording and playing back their most recent conversations. Also known as Call Check or Instant Playback Recorder.
Redundancy	Duplication of components, running in parallel, to increase reliability.

RS-232C	An electrical and mechanical standard for the serial transfer of digital information between digital systems, such as computers, printers or communications equipment.
Secondary ISDN PSAP	(See Secondary PSAP)
Secondary PSAP	A PSAP to which 9-1-1 calls are transferred from a Primary PSAP. (See PSAP)
Selective Routing (SR)	The routing of a 9-1-1 call to the proper PSAP based upon the location of the caller. Selective routing is controlled by the ESN which is derived from the customer location.
Tandem Central Office (Tandem CO)	(See E9-1-1 Control Office)
Telecommunications Device for the Deaf (TDD)	Also known as TTY. See Teletypewriter (TTY)
Teletypewriter (TTY)	Also known as TDD. A device capable of information interchange between compatible units using a dial up or private-line telephone network connections as the transmission medium. ASCII or Baudot codes are used by these units. (per EIA PN-1663)
Transfer Key	A key which is programmed to dial a telephone number, a selective routing transfer code, or a speed dial code to accomplish the transfer of calls.
Trunk	Typically, a communication path between central office switches, or between the 9-1-1 Control Office and the PSAP.
Underwriters Laboratories (UL)	One of several nationally recognized testing laboratories (NRTL) whose testing specifications have been adopted as de facto industry standards.
Uninterruptible Power Supply (UPS)	An auxiliary power unit which provides continuous battery backup power in the event of a commercial power failure.

14. APPENDICES

Refer to NENA-04-001 document for the following appendices.

14.1 Appendix A - Automatic Location Identification and the Data Management System

14.2 Appendix B - Uninterruptible Power Supply

14.3 Appendix C - TVSS Selection Criteria

14.4 Appendix D - TDD/TTY Pre-Programmed Messages

14.5 Appendix E - EIA DB-25 and DE-9 Lead Designations

DB-25

FUNCTION	PIN	DTE — DCE
FRAME GROUND *	1	«
TRANSMIT DATA	2	®
RECEIVE DATA	3	¬
REQUEST TO SEND *	4	®
CLEAR TO SEND *	5	¬
DATA SET READY *	6	¬
SIGNAL GROUND	7	«
DATA CARRIER DETECT *	8	¬
+ TEST VOLTAGE *	9	«
- TEST VOLTAGE *	10	«
UNDEFINED *	11	
SEC. CARRIER DETECT *	12	¬
SEC. CLEAR TO SEND *	13	¬
SEC. TRANSMIT DATA *	14	®
TRANSMIT CLOCK *	15	¬
SEC. RECEIVE DATA *	16	¬
RECEIVE CLOCK *	17	¬
UNDEFINED *	18	¬
SEC. REQUEST TO SEND *	19	®
DATA TERMINAL READY *	20	®
SIGNAL QUALITY DETECTOR *	21	¬
RING INDICATOR *	22	¬
DATA RATE SELECTOR *	23	®
EXT. TRANSMIT CLOCK *	24	®
UNDEFINED (BUSY) *	25	®
* Optional		

DE-9

FUNCTION	PIN	DTE — DCE
DATA CARRIER DETECT *	1	¬
RECEIVE DATA	2	¬
TRANSMIT DATA	3	®
DATA TERMINAL READY *	4	®
SIGNAL GROUND	5	«
DATA SET READY *	6	¬
REQUEST TO SEND *	7	®
CLEAR TO SEND *	8	¬
RING INDICATOR *	9	¬
* Optional		

14.6 APPENDIX F - ISDN Primer

14.6.1 ISDN Definition

The Integrated Services digital Network, or ISDN, is an enhanced communications technology that provides simultaneous digitized voice and data over a common facility.

ISDN can provide the following services:

- Multiple vendor equipment compatibility

Through set of standards for voice and data, devised by the International Telecommunications Union - Telecommunications Standardization Sector (ITU-T, formerly known as CCITT). This standardization establishes a universal system architecture.

- Simultaneous voice and data transmission

Some examples would be talking on the phone to a customer while enhancing your conversation with graphics. While talking to a customer, download a product to her/his computer, etc.

- Digital end-to-end connectivity

In the past, analog voice communication was the only way to go. ISDN takes another step forward in the analog to digital evolution by providing the digital end-to-end connectivity.

- Simplified engineering and installation

Permits users to connect to the network by simply plugging into a telephone jack.

- Wide Area Network Capabilities

A Local Area Network or LAN, interconnects users within a limited geographic area to provide high speed, dedicated data communications. A LAN by definition is local, where each user is physically connected to the network making it impractical to include users across town or country.

ISDN has enhanced LAN technology by providing Wide Area Network (WAN) capabilities by using the existing telephone wiring.
Dynamic Bandwidth Selection
Future application of ISDN technology will allow users to increase the capacity of a transmission channel on demand. Some examples for the wider bandwidth application are: private network connectivity, graphic services, video services, high speed file transfer, etc.

14.6.2 ISDN Network Interfaces

ISDN capabilities are made possible by hardware and software at the Central Office switch and in Customer Premises Equipment.

ISDN technology enables a single phone line to be divided into 2 types of communication channels: Bearer Channel (B-Channel), Delta channel (D-channel). The B-Channel carries either voice or data at 64Kb/s rate. the D-channel is used to send the call control information for the B-Channels as well as the

low speed packet data. The D-channel operates at a fixed rates of 16Kb/s or 64Kb/s depending on different ISDN interfaces used.

14.6.2.1 Basic Rate Interface (BRI)

Basic rate interface consists of 2 B-channels and 1 D-Channel. The 2 B-channels can operate at a rate of 64Kb/s each, along with the 16Kb/s D-channel and 16Kb/s overhead totaling to a transmission rate of 160Kb/s.

Each basic rate line can support 2 B-Channel devices (voice and data) and up to 6 D-Channel devices (low speed packet data). This allows a total of up to 8 devices for line. Two devices accessing B-Channel can transmit simultaneously. However, the D-Channel terminals will have access one at a time only.

14.6.2.2 Primary Rate Interface (PRI)

Primary Rate Interface (PRI) is the ISDN trunking technology which enables the networking of multiple locations. It also allows access to a hybrid network of both public and private facilities.

PRI provides 23 B-channels and 1 D-channel. All channels operate at a rate of 64Kb/s, along with 8Kb/s overhead for a total capacity of 1.544Mb/s.

Each PRI trunk group requires one D-channel and can support multiple DS1s, up to a maximum of 479 B-channels distributed over 20 DS1 links.

14.6.3 Standards

International telecommunications Union (ITU) defines the ISDN standards in cooperation with several other international groups. These groups include the International Telecommunications Union - Telecommunications Standardization Sector (ITU-T, formerly known as CCITT) and International standards Organization (ISO). American National Institute (ANSI) does not issue standards, however, reviews the standards and specifies the US ISDN. Telcordia General references (GR's) define proposed generic requirements that are supplier independent and often lead to contributions to standards bodies. Other companies/carriers can issue their own implementations (i.e. 5E Custom, DMS-100 Custom, etc..).

14.6.4 National ISDN (NI) Process

NI specifications are compiled by Telcordia, Telcordia Client Companies, and Switch Manufacturers. User input is provided through the National ISDN User's Forum.

NI-1 capabilities have been widely deployed by local exchange carriers and specify a simple, generic Basic Rate Interface (BRI) capability that is supported by several switch providers. These include: Circuit Switched Voice and 56Kb/s data, D Channel Packet Mode Data, B Channel Packet Mode

data, Additional Call Offering, Call Hold, Flexible Calling, Electronic Key Telephone Service (EKTS), Call Forwarding, Multi-Line Hunt Groups, Call Pick-Up, etc.

NI-2 specifies a more robust, feature-rich BRI offer and also covers some foundational Primary Rate Interface (PRI). NI-2 Completes work started with NI-1 BRI. Provides simultaneous access to both B-Channels, supports up to 8 terminals on one loop (LEN) and on demand B-channel Packet. Also supports parameter downloading.

NI-3 will be phased across several years and will support both BRI and PRI capabilities.

The National ISDN numbering scheme has changed to a yearly scheme as of 1997 (NI-97). This process could undergo further changes.

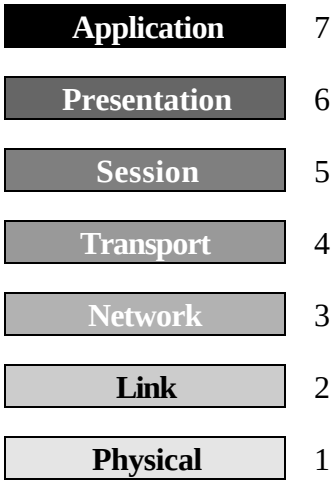
14.6.5 Open Systems Interconnection (OSI) Reference Model

ISO working in conjunction with ITU-T, has established a universal networking model called OSI Reference Model. The OSI reference model has set of rules for establishing communication between set of devices. The ISDN architecture abides by the standards established for the OSI model.

The OSI Reference Model is separated into 7 layers and each layer has certain rules of communication within them and/or between them.

If all parameters are not met, a call cannot take place.

Seven Layer Model:



14.6.6 Reference points

NT1: Network Termination 1 is a hardware device that provides universal user-to-network interface between customer premises equipment and the switch (or 23B+1D interface). NT1 alone, is used for BRI.

NT2: Network Termination 2, is a hardware device such as an ISDN PBX, that functions as an interface between customer premises equipment and the NT1. NT2 is mainly used for PRI.

TE1: Terminal Equipment 1, is an ISDN compatible device such as an ISDN telephone.

TE2: Terminal Equipment 2, is a non-ISDN compatible device, such as the personal computer in Figure 2.

TA: Terminal adapter, converts a non-ISDN device to an ISDN compatible device.

R - Reference Point: An R Reference Point is the connection between the non-ISDN device and the Terminal Adapter.

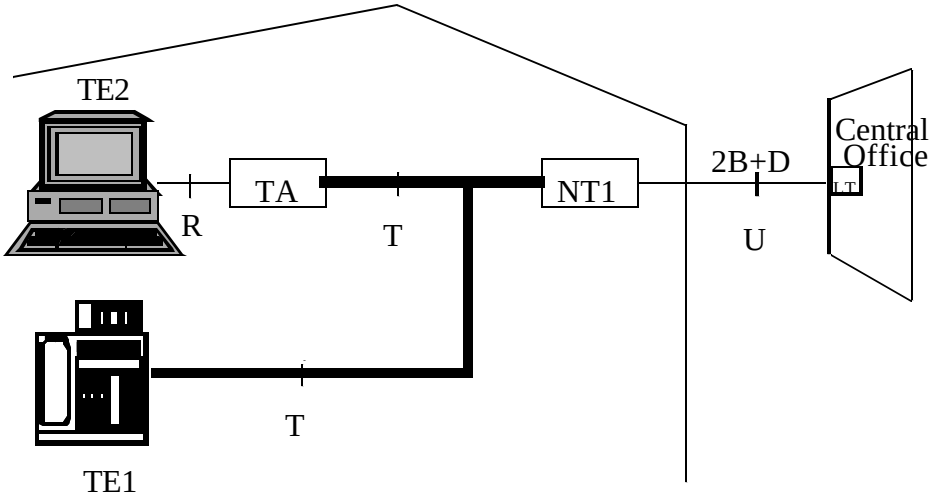
S/T - Reference Point: An S/T Reference Point, S/T bus, is a 4 wire connection between TE1 and an NT1 or a TA and NT1. A 2B+D ISDN TE1 or TA can be connected to NT1 across the T interface, or to an NT2 such as a PBX across the S interface. Since the specifications for an S and T interface are identical (ITU-T I.431), the term S/T interface is often used. It provides a transmission rate of 192Kb/s. Each BRI frame is 48 bits long and repeated 4000 times per second.

U- Reference Point: or U loop is a 2-wire (4-wire for PRI) loop linking Customer Premises Equipment to a Central Office ISDN node via an NT1. 2B1Q is the transmission technique on the U-loop. The 2B1Q U-loop allows for a total of 160Kb/s (64Kb/s B-Channel, 64Kb/s B-Channel, 16Kb/s D-channel, 16Kb/s Overhead). There are 12 B and D channels. Each B channel is 8 bits long and each D channel is 2 bits long (12 * (8+8+2) = 216, plus 6 bits for maintenance and 18 bits for synchronization, per frame, totaling to 240 bits per frame). For PRI, the U-Loop includes 24 channels operating at 64Kb/s each (23B+D) and 8 Kb/s overhead (used for DS1 framing).

14.6.6.1 BRI Reference Points

BRI has 4 equipment 3 link reference points:

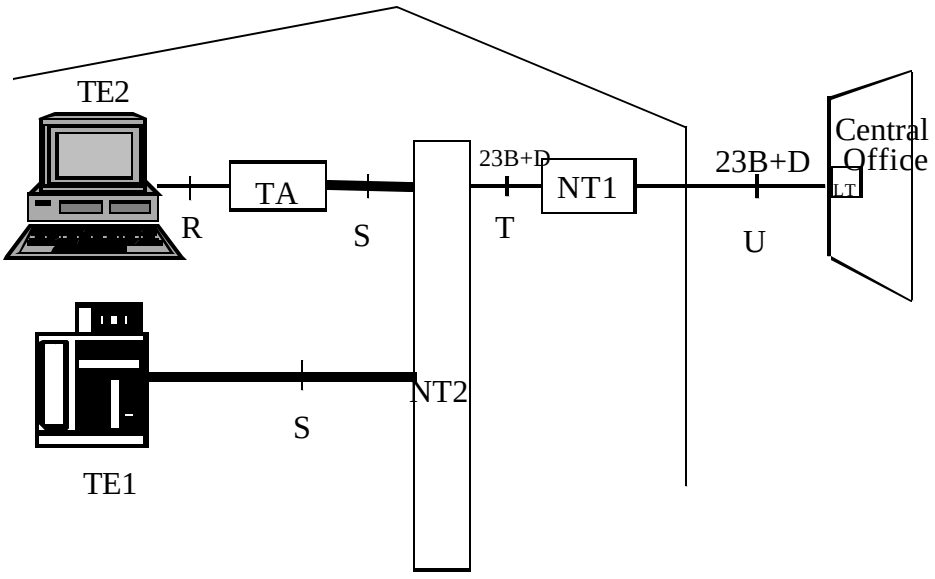
Equipment Reference Points	Link Reference Points
NT1	R
TE1	S/T
TE2	U
TA	



14.6.6.2 PRI Reference Points

PRI has 5 equipment and 4 link reference points:

Equipment Reference Points	Link Reference Points
NT1	R
NT2	S
TE1	T
TE2	U
TA	



I.430 is the ITU-T layer 1 specification for the ISDN BRI/PRI S/T interface.
ANSI T1.601 is the layer 1 specification for the ISDN BRI U interface.

I.431 is the ITU-T layer 1 specification for the ISDN PRI.

The other layers of the ISDN protocol are specified by various other standards documents.