NENA Technical Information Document on Network Interfaces for E9-1-1 and Emerging Technologies

Prepared by:
National Emergency Number Association (NENA)
Emerging Technologies Working Group of the
Non Traditional Communications Technical Committee

Published by:
NENA
Printed the U.S.A.

NENA
TECHNICAL REFERENCE

NOTICE

This Technical Information Document (TID) is published by the National Emergency Number Association (**NENA)** as an information source for the designers and manufacturers of systems that are used for the purpose of processing emergency calls. It is not intended to provide complete design specifications or parameters or to assure the quality of performance for systems that process emergency calls.

NENA reserves the right to revise this TID for any reason including, but not limited to, conformity with criteria or standards promulgated by various agencies, utilization of advances in the state of the technical arts or to reflect changes in the design of network interface or services described therein.

It is possible that certain advances in technology will precede these revisions. Therefore, this TID should not be the only source of information used to implement Emerging Technologies (e.g., Voice over Packet (VoP), Voice over Internet Protocol (VoIP), etc.) specifications when managing and handling emergency calls and the associated information. **NENA** members are advised to contact their Telecommunications Carrier representative to ensure compatibility with the 911 network.

Patents of some Corporations or others may cover the specifications, techniques or network interface/system characteristics disclosed herein. No license expressed or implied is hereby granted. This document is not to be construed as a suggestion to any manufacturer to modify or change any of its products, nor does this document represent any commitment by **NENA** or any affiliate thereof to purchase any product whether or not it provides the described characteristics.

This document has been prepared solely for the voluntary use of E9-1-1 service providers, network interface and system vendors, participating telephone companies, etc.

By using this document, the user agrees that the **NENA** will have no liability for any consequential, incidental, special, or punitive damage that may result.

The NENA Non-Traditional Communications Committee Emerging Technologies Working Group has developed this document. Recommendations for change to this document may be submitted to:

National Emergency Number Association
Attention: Executive Director
422 Beecher Rd.
Columbus, OH 43230

Acknowledgments:

The following industry experts and their companies are recognized for their contributions in the development of this document.

Non-Traditional Committee Chair: Tony Busam, RCC Consultants, Inc.

Members:	Company
Nadine Abbott	Telcordia
Charles Bell	Sprint
Tom Breen	BellSouth
Bernard Brabant	Bell Canada (Chair)
Richard Bzdega	TELUS
Cindy Clugy	Intrado
Elizabeth Colunga	WorldCom
Carol De Fazio	Telcordia
Mark Drennan	Intrado
Kenneth Easley	Proctor
Jerry Eisner	Intrado
David Froneberger	MCI Worldcom
Deborah Guyton	Telcordia
Tom Hinkelman	WinStar Communications
Dave Irwin	State of Washington
Scott Keagy	Cisco System
Kevin Kearns	King County
Denise Kellner	SBC
Gord Kelly	CML Technologies Inc.
Mark Knox	Intrado
Marc Linsner	Cisco System
Peter Macpherson	Xwave
Steve Marzolf	Virginia Department of Telecommunications
Nick Nickerson	BroadBand Office
Nancy Pollock	Metropolitan 911 Board
Terry Reese	Telcordia
Gary Rhodenizer	Aliant - MTT
Robert Russo	SBC - Pacific Bell
Terry Ryan	Tel Control Inc.
Bob Sherry	Intrado
Steve Sipple	Nortel Networks
Paul Stoffels	Ameritech
Atul Thaper	Telcordia
Bob Tilden	SBC - Pacific Bell
Wesley Tilley	Nortel Networks
Nate Wilcox	State of Vermont
Ron Whitehurst	Cbeyond

TABLE OF CONTENTS

13. GLOSSARY The terms used within this document are specific for this TID. A full glossary can be viewed in the NENA Master Glossary of 911 Terminology (NENA 01-002).

FIGURES

TABLES

1. INTRODUCTION

1.1 General

This NENA Technical Information Document (TID) provides a reference to network interfaces for users, manufactures and providers of E9-1-1 in an Emerging Technologies (e.g., Voice over Packet (VoP), Voice over Internet Protocol (VoIP), Voice over Digital Subscriber Line (VoDSL), etc.) environment.

E9-1-1 is a system designated and authorized to manage emergency calls requiring one or more public services (Police, Fire, EMS or all three).

1.2 Purpose and Scope of Document

This document is a guide for designers, manufacturers and service providers of Emerging Technologies network interfaces used with or implemented in an E9-1-1 environment.

It is not intended to provide complete design specifications for Emerging Technologies network interfaces to 9-1-1 systems. It shall neither ensure the quality of the performance of the network interfaces nor shall 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 and Features
Section 3 - Voice Using Emerging Technologies Packet Based Applications
Section 4 - Network Interfaces
Section 5 - Call Progress Signals and Messages
Section 6 - PSAP Feature Requirement Specifications
Section 7 - Power Requirements
Section 8 - Installation, Maintenance and Administration
Section 9 - Registration Requirements
Section 10 - Quality and Reliability
Section 11 - Technical References
Section 12 - Acronyms
Section 13 - Glossary

1.4 Document Terminology

The terminology used in this document has been aligned to designate definitions used within the American National Standard for Telecommunications technical standard T1.628 Emergency Calling Service, issued by the Alliance for Telecommunications Industry Solutions (ATIS).

1.5 Reason for Issue

This document is issued to serve as a NENA Technical Information Document and a guide for Emerging Technologies network interface in an E9-1-1 environment.

The purpose of this Emerging Technologies TID is to identify some architectural arrangements and designs, minimum requirements, desirable requirements for Emerging Technologies network interfaces, as well as to identify requirements for future Emerging Technologies network 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 Date 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 a date/time change 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. 2. ENHANCED 9-1-1 SYSTEM AND FEATURES

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 Public Safety Answering Point (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, Emergency Medical Service, 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. In traditional networks, this feature provides the capability for the E9-1-1 tandem switch to serve several PSAPs within the E9-1-1 service area. The main characteristic of E9-1-1 service is the capability of the E9-1-1 tandem to selectively route a 9-1-1 call originated from any devices in the E9-1-1 service area to the correct primary (or controlling) PSAP designated to serve the originating devices' location. In emerging network architectures, the functions provided by the E9-1-1 tandem in traditional networks may be provided by different network elements, e.g., the Selective Router function and database may be separate from the network elements that provide the network access interfaces to the PSAPs.

Next are some services and features that are available with E9-1-1 and shall be supported by all network configurations:

- Data Management System (DMS)
- Automatic Location Identification (ALI)
- Automatic Number Identification (ANI)
- Selective Routing
- 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)
- Call Back
- Call Control (e.g., Forced Disconnect and optional Call Hold and Ringback features)
- Flashing ANI
- Automatic Call Distribution (ACD)
- Night Service

The 9-1-1 features that shall be supported in an Emerging Technologies environment are further described in detail in other NENA standard documents and Industry Standard Organization Libraries.

While some 9-1-1 systems do not provide the following items at a minimum, as they utilize direct trunking (with or without class marking), the traditional Enhanced 9-1-1 service provides the following items:

- Pre-defined service provider, NENA **company ID**, **24x7 contact**, etc., **emergency trace** procedure available, etc.,
- Bi-directional **voice grade quality line**,
- **ANI/KEY** information used for call routing and data display query and which identifies the caller's location source. (Traditionally, ANI referred to the caller's billing number, often the same as the caller's telephone number, and has been used as the call routing and location information.),
- **Call Back –** A 9-1-1 PSAP should be able to call back the caller's telephone number at the displayed ANI/KEY, no matter where the caller is located or what type of interface is being used, if possible. In some networks and for some customer configurations, this may not be possible (e.g., An NCAS arrangement where the key is not a call back number and is displayed at the ANI display for 9-1-1 or a Customer PBX that only provides a main company telephone number for the ANI/KEY),
- Ability to **echo call progress tones** (i.e., ringback) to caller,
- Must follow local, state, and federal rules, including **authorization** to operate, **surcharge** remittance, etc.,
- **Call Delivery** - Service and network must deliver the caller's 9-1-1 emergency voice call to the Selective Router (network element that provides the Selective Routing function) designated for the **caller's local area**. If 9-1-1 calls are supported for that caller, the Selective Router should route the call to the appropriate terminating network access element for delivery to the correct 9-1-1 Public Safety Answering Point (PSAP). Note that this document is developed with the SR architecture approach, knowing there still exists direct PSAP's trunking challenges,
- Must deliver call to the 9-1-1 Selective Router with the **correct NPA** for the caller's area,
- **Call Routing –** The 9-1-1 selective routing database table must be programmed to match the caller's ANI.KEY with an Emergency Service Number (ESN) in order for the Selective Router to route the 9-1-1 call to the correct PSAP. There is a limitation of Number Plan Digit (NPD) correlation to Number Plan Area (NPA) for a 9-1-1 Selective Router, where 8-digit CAMA and Line to Digital Trunk (LDT) interfaces to the PSAP are used, that can be assigned to any given CAMA/LDT PSAP (maximum of 4 NPD per Selective Router),
- **Caller Hold and Ring Back –** Enhanced 9-1-1 options in Canada and various places in the USA require that when the 9-1-1 call originator hangs up, the call will not be released until the 9-1-1 call taker releases the call. The 9-1-1 call taker shall be able and allowed to make the caller's telephone ring (on-hook condition) or to provide a howler tone (off hook condition). If the caller tries to make another call prior to being released by the 9-1-1 call taker, there shall be no dial tone. The caller shall still be connected to the 9-1-1 call taker,
- **Address Location Information –** The caller's ANI/KEY (e.g., telephone number or Emergency Location Identification Number (ELIN)) must correspond with a correct and pre-loaded Address Location Information (ALI) in the 9-1-1 database. ALI usually relates to a static address,
- **Reverse ALI Search** - where provided and legal under the local law,
- Could provide an **XY coordinate** that comports to the wireless Phase II interface standards, "relative" portable technologies might want to use dynamic **Global Positioning System-based (GPS-based)** approach to determine the caller location and pass it on, and

- **Default routing when ANI/KEY is not available**, **default PSAP** vs. **alternate PSAP**.

2.2 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 a primary E9-1-1 Selective Router (a.k.a. E9-1-1 Tandem) for all 9-1-1 calls. This E9-1-1 Selective Router serves all PSAPs in the E9-1-1 service area and can provide Selective Routing (SR) functionality for incoming 9-1-1 calls from other nodes. While many PSAPs usually run off one SR, it is not uncommon for a PSAP to have trunks from more than one SR. This is due to several reasons, for instances two telephone companies providing SR services, LATA boundaries, suburban/rural areas where there is fringe overlap with a metro area served by a distinct SR. In the current network architecture, incoming E9-1-1 traffic travels over dedicated facilities to the E9-1-1 Selective Router.

This NENA Emerging Technologies TID specifies the capabilities required to support the passing of location and callback information associated with the caller to a Public Safety Answering Point (PSAP) attendant, to provide network routing and transfer features associated with emergency service calls, and to deliver control indications (e.g., flashing display) to the PSAP attendant. These capabilities allow emergency service calls to be completed through the network to an appropriate emergency service attendant, and to provide the PSAP attendant with location information (if available) regarding the caller.

A network, including an Emerging Technologies network, shall include a provision for priority routing of an emergency call so that even in times of network congestion, emergency calls be able to complete to a PSAP attendant. It shall also allow for the transport and identification of emergency service calls with or without the use of dedicated facilities. In addition, the network provides additional capabilities (e.g. the transfer of location information) when the attendant conferences with or transfers the call to any other attendant in the emergency serving area.

Where provided, Emerging Technologies shall allow capabilities needed for supporting E9-1-1 Call Hold and Ringback.

This TID document also looks at the delivery of location information to a PSAP over an Emerging Technologies interface. In addition, receipt of location information for calls originating from an Emerging Technologies Network Interface is addressed. An emergency 9-1-1 call may originate from a wireline or wireless user.

2.3 Automatic Number Identification (ANI)/KEY

The term Automatic Number Identification (ANI)/KEY is used herein to define the call routing path and to retrieve the location information associated with the ANI/KEY (i.e., information that may aid in retrieving call routing and location information for the caller from an internal or external database). The ANI/KEY may also be referred to as the calling party number, charge number, Calling Line Identification (CLID), cell site/sector identification, geographic location information (e.g., latitude and longitude), or Emergency Location Identification Number (ELIN) (i.e., the number used to identify the location of the calling terminal within the context of the E9-1-1 call). In the course of an E9-1-1 call, the ANI/KEY of the caller is used to determine the designated PSAP serving the user's location and for assisting the responding agency in physically locating the caller.

In this document, ANI/KEY is used to identify the digits necessary to selectively route the emergency call and where applicable to poll the ALI database or to provide to the ALI database the calling location information. During an E9-1-1 call, the Emerging Technologies interface/network shall include an ANI/KEY representing calling party number digits to display even if the presentation restriction indicator is invoked.

2.4 Automatic Location Identification (ALI)

ALI provides location and dispatch information associated with the ANI/KEY to be displayed at the answering PSAP. (For further details, refer to NENA Database Standards Document). Location determination data must be supplied as deemed appropriate for the type of end-customer's technology (e.g., residential, PBX, wireless, etc.). Various technologies are used including XML protocol.

2.5 TTY / TDD Interface and Compatibility

Interface and Compatibility specifications associated to Teletype (TTY) and Telecommunications Device for the Deaf (TDD) at the answering PSAP are detailed in NENA 04-001 - Generic Standards for E9-1-1 PSAP Equipment.

2.6 Busy Line Verification (BLV) / Busy Line Interrupt (BLI)

Public Switched Telephone Network (PSTN) users have the ability to contact an operator to request the operator to verify that a line is busy, and in special circumstances or emergency situations, to interrupt a conversation, if necessary. When an operator receives a request for verification or operator interrupt, the operator accesses the local end office serving the line number (either directly or through another operator), verifies the busy/idle status of the line, and if the line is busy, the operator may interrupt the conversation to relay a message.

The following example illustrates a scenario in which an emergency services provider such as a Public Safety Answering Point (PSAP) might wish to request an operator to verify that a line is busy and/or interrupt a conversation. After a caller and PSAP have disconnected from an emergency call, the PSAP agent may discover that additional information is needed. If the PSAP tries to call back and gets a busy signal, the PSAP may wish to have the operator verify and possibly interrupt the line to get this additional critical information.

An operator can provide verification and operator interrupt service only if the local end office serving the line gives the operator access to specific functionality, e.g., to check the busy/idle status of a specified line and to bridge onto conversations in progress. (It is assumed that any capabilities needed to scramble conversations for privacy during verification, or to allow the operator to interrupt the conversation are provided by the operator [system], rather than the local end office.) In traditional networks, operator access for verification is typically provided over dedicated facilities and special verification trunks that interconnect local offices and operator systems. The facilities at the end office normally used for verification are dedicated for that use and are accessible only by operators or craft persons making tests. The originating or operator end of the verification facility is arranged to exclude the requesting customer from access to the line being verified. The interconnecting trunk facilities used for advancing the verification request may terminate directly at a cord board or be terminated via a private network to a cord board or a remote operator system. The incoming trunks at the end office arranged to handle verification traffic are referred to as no-test trunks. Each end office should have a minimum of two no-test trunks assigned for verification service. Traditionally, these trunks have used reverse battery loop or E&M lead supervision, with Multi Frequency (MF) or Dial Pulse (DP) signaling, although other types of trunks (e.g., SS7 ISUP trunks) could be adapted for this purpose.

It should be noted that Busy Line Verification/Busy Line Interrupt might not be applicable for all call types. For example, the operator may not be able do busy line verification on a PBX DID station or a telematics call. A DID station may have continuity from the local office to the customer premises PBX and the PBX is providing busy, as opposed to the local office. In addition, a telematics call may not have a number to verify.

2.7 Other Technical Specifications

From time to time, State Officials pass laws that require network features to be provided to support the PSAP. As an example, in some States it is required that Busy Line Verification and Busy Line Interrupt be provided at the PSAP's request. (For specific details, refer to State's Public Utility/Service Commissions (PSC/PUC) web site).

3. VOICE USING EMERGING TECHNOLOGIES PACKET BASED APPLICATIONS

This section provides a high level overview of Emerging Technologies and basic requirements for 9-1-1 interface and interconnection arrangements.

3.1 Voice over Packet (VoP)

The generic term that includes the popular acronym VoIP is Voice over Packet (VoP). This can mean at a minimum:

- VoATM – Voice over Asynchronous Transfer Mode which is being used extensively by incumbent and new service providers
- VoFR – Voice over Frame Relay
- VoDSL – Voice over Digital Subscriber Line
- VoIP – Voice over Internet Protocol
- Etc.

The reasons for using each of the above is not elaborated on, except that the use depends on network availability and requirements. Of the above list VoIP is the common denominator because it can theoretically be transported over all the others and delivered to an end-user such as an E9-1-1 PSAP.

3.2 Voice over Internet Protocol (VoIP) versus Voice over the Internet

VoIP is an organized effort to standardize IP telephony. IP telephony is an important part of the convergence of data, voice and broadband services such as, computers, telephones, and video into a single integrated information environment. Voice over IP is a term used in IP telephony for a set of facilities for managing the delivery of voice information using the Internet Protocol (IP). The voice information is transmitted in discrete packets over shared bandwidth rather than over the traditional circuit driven protocols seen in the traditional Public Switched Telephone Network (PSTN).

There is a distinction between the terms **VoIP** and **Voice over the Internet** used in this standard.

- VoIP means using a controlled environment that can provide traditional “toll” Quality of Service (QoS) and support mission critical services like E9-1-1.
- Voice over the Internet will transmit voice but with varying consistency depending on overall traffic and the engineering of the Internet circuits. The Internet was not designed to provide “toll” quality voice but the delivery of data packets by best effort.

IP telephony service providers include or soon will include local telephone companies, long distance providers, cable TV companies, Internet service providers (ISPs), wireless service providers and fixed wireless local loop service operators. IP telephony services may also in the future affect customer premises equipment (CPE) vendors of traditional hand-held devices. IP telephony is making the most progress in the core networks and the Enterprise markets.

VoIP is being driven to some extent from the VoIP Forum (an activity group of the International Multimedia Teleconferencing Consortium (IMTC)), an effort by major equipment providers, to promote the use of International Telecommunications Union (ITU) - ITU-T H.323 protocol. This is a standard for sending voice (audio) and video using IP on the public Internet and within Intranets. The Forum also promotes the use of directory service standards so that users can locate other users and the use of touch-tone signals for automatic call distribution and voice mail. It should be noted that H.323 alone does not provide the necessary requirements for ensuring the QoS required for mission critical services such as E9-1-1.

In addition to IP, VoIP uses the real-time protocol (RTP and other evolving Internet Engineering Task Force (IETF) protocols) to help ensure that packets get delivered in a timely way. Using public networks, it is currently difficult to guarantee Quality of Service (QoS). Better service is possible with private networks managed by an enterprise or by an Internet Telephony Service Provider (ITSP).

3.3 IP Standard Protocols

Although ITU-T H.323 is a standard that is supported by many products there are other standards being worked to improve and/or correct deficiencies of ITU-T H.323 such as:

- MGCP – Media Gateway Control Protocol
- SIP – Session Initiation Protocol
- MPLS – Multi-Protocol Label Switching, which allows integration of IP network overlaid on Asynchronous Transfer Mode (ATM) infrastructure. While MPLS can operate on ATM switch fabric, it is not compatible with existing ATM Forum standards. It can also support IP and FR layer 2 protocols. MPLS is a framework that uses existing protocols

However, as with all Internet related development there is constant change and evolution. What is here now will likely be added to, changed or put aside within six months. Table 1 gives an idea on how some of the protocols of interest fit together in the Open Systems Interconnection (OSI) layered architecture model. It's all a matter of protocols and how they are nested within the OSI layered architecture.

Table 1 - Layered Protocols (OSI)

<table>
<tr><td rowspan="3">Levels 7 to 5 (Application, Presentation, Session)</td><td colspan="2">G.711 and others</td></tr>
<tr><td>H.323, MGCP</td><td rowspan="4">MPLS</td></tr>
<tr><td>RTP, RTCP, RSVP, SIP</td></tr>
<tr><td>Level 4 - Transport</td><td>TCP, UDP</td></tr>
<tr><td>Level 3 - Network</td><td>IP</td></tr>
<tr><td>Level 2 - Data Link</td><td colspan="2">ATM, FR, xDLC, 802.x</td></tr>
</table>

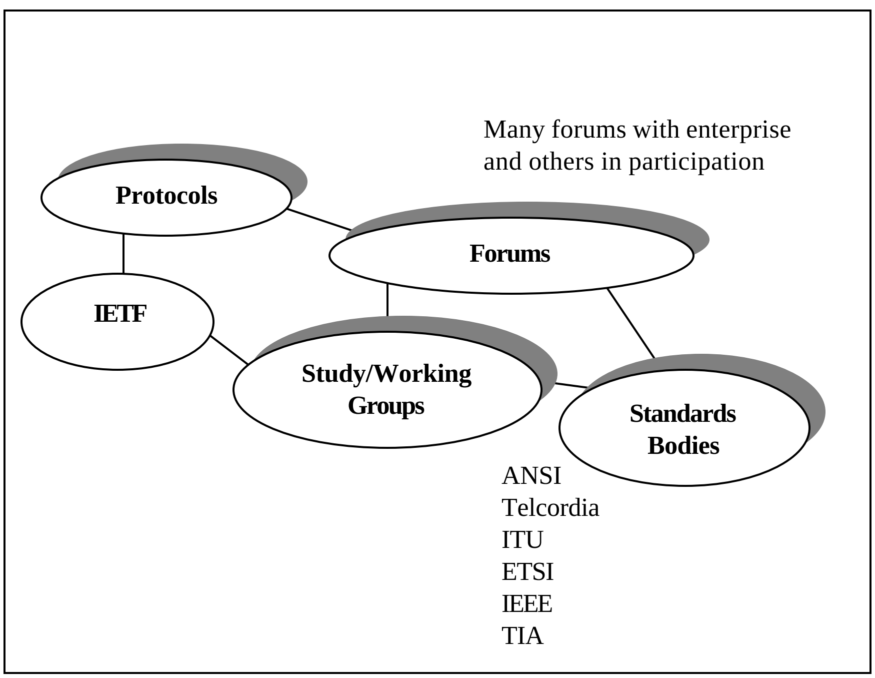
Level 1 - Physical	SONET, coaxial, copper, fiber, wireless, …

IP is designed to be a logical inter-network protocol that connects different types of physical networks, labeled sub-networks. Consequently, one sub-network could be based on Frame Relay, a second based on Ethernet, a third based on X.25, and yet a fourth based on Asynchronous Transfer Mode (ATM), and nevertheless all could communicate with each other given IP routers connected at the edges of each physical network.

3.4 Industry Standard Organizations

IP/Internet Protocols are continually being introduced and evolved through the Internet Engineering Task Force (IETF). The IETF has managed to introduce Internet standards at a fast rate that matches the speed of Internet development. This has allowed products to be rapidly introduced into the world market. These standards are also being adopted by world and national standard bodies at a much faster rate than has traditionally occurred in the past. This has been aided by the formation of a number of Forums (such as the VoIP Forum mentioned previously) created by enterprises and other interested bodies that promote the use of new standards while at the same time influencing standard organizations to accept them. How this all interrelates is shown in Figure 1. The study groups shown are there to work on the standards and make standardization happen in months rather than years (though it would be interesting to see if this is actually the case in fact).

Figure 1 - Inter-relationships



3.5 IP Telephony and E9-1-1

9-1-1 network elements may interact with IP-based Emerging Technologies in various arrangements like:

- IP to a traditional 9-1-1 network (standalone or Selective Router arrangement)
- Traditional 9-1-1 network to an IP-based PSAP
- End to end IP-based 9-1-1 network
- Legacy Customer Premises Equipment limiting factor

3.5.1 IP Telephony and Quality of Service (QoS)

A concern with 9-1-1 communications is to guarantee an end to end Quality of Service (QoS) for the caller and the call taker, the utmost availability of an accurate location of the caller to the call taker, and an accurate call back number so the call taker can re-contact the caller if disconnected. It is assumed that a network is engineered for sufficient bandwidth and no discernable packet loss.

The prime QoS parameters are;

- Delay (a.k.a. Latency) - anything that may delay transmission of the packets such as protocol conversion, queuing, etc.
- Jitter - packets arriving at a non consistent rate
- Echo

QoS can be implemented using such techniques as Differentiated Services (Diff-Serv) or Integrated Services (Int-Serv). Diff-Serv is a broad QoS mechanism for aggregated traffic while Int-Serv provides QoS down to the packet flow or application level.

The **Quality of service (QoS)** is important for VoIP, whether or not the audio path is compressed. Ensuring that the IP transport provides consistent packet throughput with low delay and delay variation is a function of IP network design. There are numerous technical issues that must be addressed to provide adequate QoS for voice, but there are design/configuration mechanisms to address all of these issues. It is extremely important that whoever designs the IP network has a solid understanding of QoS considerations (queuing methods, fragmentation/interleaving techniques, header compression techniques, traffic-shaping, etc.), or you may experience poor voice quality when using VoIP on this network. How good VoIP calls sound is dependent on the IP network design.

Talker Echo, also referred to as echo return, (see ITU Recommendation G.131) can adversely affect voice quality in traditional or IP Telephony environments. Talker echo is caused when speech signals from a talker are reflected in the audio path back to the talker. The points in the audio path where talker echo generally occur are (1) acoustic feedback in a telephone or speakerphone endpoint; and (2) electrical "hybrids" that convert bi-directional 2-wire audio paths into a 4-wire audio paths with separate uni-directional paths for send and receive.

While IP QoS is not a factor in the creation of echo, a VoIP network with high delay can cause existing echoes to be more objectionable. The degree to which echo is annoying is a function of the loudness and the delay period of the echoes (see ITU Recommendation G.131). IP QoS does not affect signal reflections that cause the echoes, nor does it increase the loudness of the echoes.

There are a variety of other issues that affect voice quality in VoIP systems (low bitrate codecs in tandem, silence suppression, background noise, input audio levels, etc.), and in general the issues of voice quality should be separated from IP QoS issues.

3.5.2 IP Telephony and Network Interworking

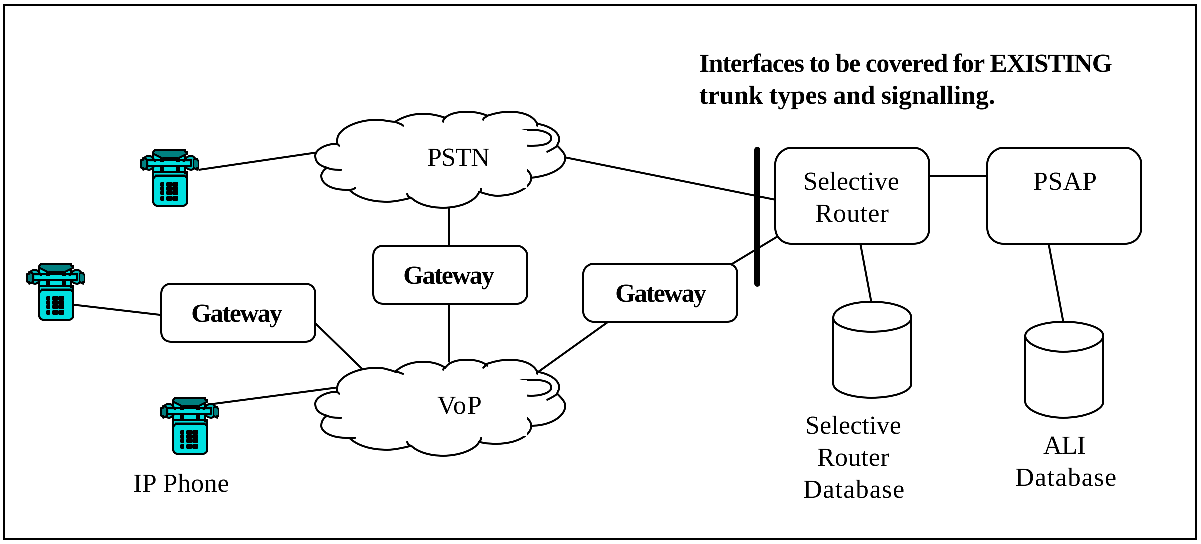
VoIP could be used with:

- private networks managed by an enterprise,
- an Internet Telephony Service Provider (ITSP),
- public networks managed by a Cable company,
- a Wireless Service Provider (WSP),
- a Competitive Local Exchange Carrier (CLEC),
- a Digital Subscriber Line (DSL) provider,
- the incumbent local and long distance carriers.

3.5.3 Gateway

VoIP interconnection to the Public Switched Telephone Network (PSTN), and therefore with the 9-1-1 networks, is achieved by using a gateway or equivalent. The gateway sends/receives packetized voice transmissions and call control from within the IP network and routes them to the PSTN network using a trunk interface. An example of this is shown in Figure 2.

Figure 2 - High Level VoP Network View

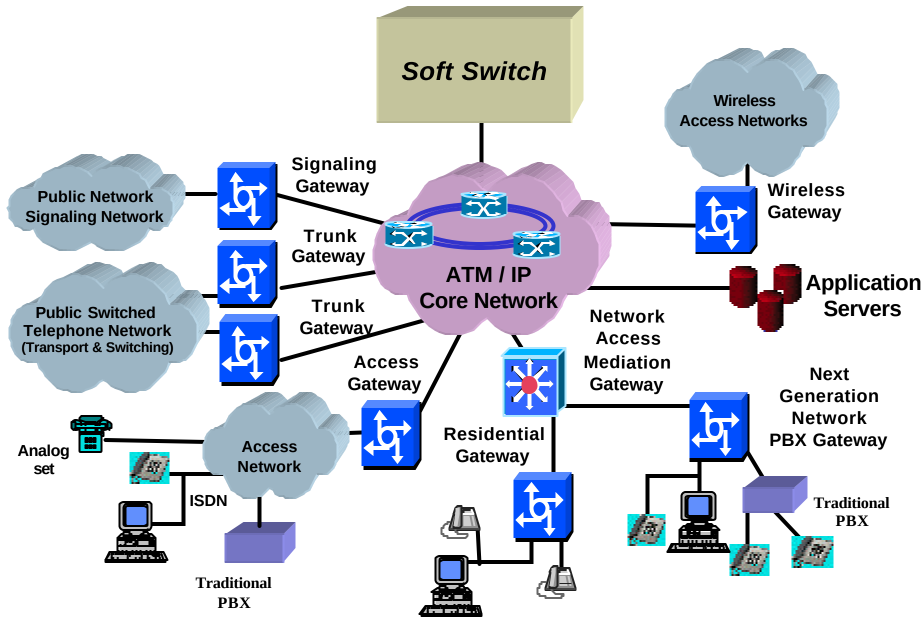


There are various types of gateways. The following list shows some of them:

- Trunking gateways, that interface between the telephone network and a Voice over IP network for ISUP, MF signaling. Such gateways typically manage a large number of digital circuits. Note that VoIP networks may pass MF signaling tones in-band using standard G.711 voice coding techniques, or alternatively may pass the MF signaling information out of band when low bit rate voice CODECS (e.g. G.723.1) are employed.
- Voice over ATM gateways, which operate much the same way as voice over IP trunking gateways, except that they interface to an ATM network.
- Residential gateways, that provide a traditional analog (RJ11) interface to a Voice over IP network. Examples of residential gateways include cable modem/cable set-top boxes, xDSL devices like the Integrated Access Device (IAD) and broadband wireless devices.
- Access gateways, which provide a traditional analog (RJ11) or digital PBX interface to a Voice over IP network. Examples of access gateways include small-scale voice over IP gateways.
- Business gateways, that provide a traditional digital PBX interface or an integrated "soft PBX" interface to a Voice over IP network.
- Network Access Servers (NAS), which can attach a "modem" to a telephone circuit and provide data access to the Internet. We expect that, in the future, the same gateways will combine Voice over IP services and Network Access services.
- Circuit switches, or packet switches, which can offer a control interface to an external call control element.

Figure 3 - Gateways and Carrier Class IP Telephony

3.5.4



Network Functionality to Support

With the advent of VoIP, internetworking technology shall support common protocols, which can work over a variety of physical networks. For example, devices would become completely mobile and always be in communication with a LAN/Network. That should include fixed “wire”, wireless, infrared, etc. The challenge shall be to provide accurate locations for any "call" types to 9-1-1.

The requirements of VoIP are to support large scale routing and addressing. It requires an Internet Protocol that imposes a low overhead and supports auto configuration and phone device mobility as a basic element. These may require having to enhance a 9-1-1 network elements’ capability to support interoperability and interconnectivity.

The PSTN continues to evolve over time to become more VoP centric with new startup carriers using VoP from day one. What must be done is to ensure that E9-1-1 calls are not compromised and that new and emerging technology provides sustaining benefits to the PSAP in such a way that the call takers are able to process E9-1-1 calls without being concerned about the technology being used.

3.5.5 9-1-1 Specific Functionality to Support

Other 9-1-1 functionality that also need to be ensured:

- Call Delivery to enable an IP source to identify the jurisdiction's designated 9-1-1 selective Router(s) and deliver the complete 9-1-1 voice packets,

- Call Routing to enable an IP source to deliver a routable number for the jurisdiction's designated 9-1-1 Selective Router in order to manage the 9-1-1 voice packets selective routing,
- Call Priority to enable an IP source to identify the desired call delivery priority of the 9-1-1 voice packets,
- Selective Routing and transfer to enable an IP Selective Router to deliver a call to the appropriate PSAP using internal IP network parameters,
- Security (confidentiality of voice communication/data content),
- Call trace capability to enable an IP source to identify the calling device no matter the electrical condition at the source and at an intermediary device,
- Location Determination and Identification (potentially using Dynamic Location Information using datagram exchange),
- Call Back to enable an IP source to allow the 9-1-1 Selective Router to initiate a recall to the IP user,
- Interface and Compatibility specifications to support Teletype (TTY) and Telecommunications Device for the Deaf (TDD) using an IP source to make, to route and to deliver a 9-1-1 call, including a potential recall,
- Where required, Busy Line Verification and Busy Line Interrupt be provided at the PSAP's request,
- Where provided and legal under the local law, Reverse ALI Search be supported at the PSAP request.
- Call Party Hold and Ringback (line supervision functions)

Some functionality may require coordination efforts with Telematics and Automatic Collision Notification (ACN) arenas for Selective Router's and PSAP's service areas determination.

3.6 IP Telephony and the Regulators

Currently, unlike traditional phone service, IP telephony service is relatively unregulated by government.

In the United States and in Canada, the Regulators (Federal Communications Commission (FCC)) and the Canadian Radio-television Telecommunications Commission (CRTC)) regulate phone-to-phone connections, but indicated that they do not plan to regulate connections between a phone user and an Internet Service Provider (ISP). ISPs and Internet Telephony Service Providers (ITSP) acting as Local Exchange Carrier (LEC) are regulated. DSL providers not acting as a LEC may not be regulated. Further, in many States, the Public Utility Commission (PUC)/Public Service Commission (PSC) has regulations in place for 9-1-1 service that may apply to Emerging Technologies.

From a regulatory/legal point of view, IP telephony providers must be sensitive to the ability to collect and remit 9-1-1 service fees in accordance with established legislations and procedures used for PSTN based circuit switched clients. PSAPs are extremely sensitive to processing 9-1-1 calls from users who do not support financially the 9-1-1 system.

Note to administrators: IP Services may require legislative action in order to assure equity and surcharges collection and remittal.

4. 4 NETWORK INTERFACES

This section defines several network interconnection arrangements used in an Emerging Technologies environment. Some may have an impact on 9-1-1 systems.

4.1 Network Interface Categories

The TID covers network interface categories for Emerging Technologies more specifically as they relate to Voice over Packet (VoP) applications that require NENA's attention. They include:

- Voice over the Internet
- Inter-exchange replacement
- Local Exchange replacement
- Enterprise Networks (e.g. Centrex-IP, IP-enabled PBXs, etc.)
- Cable TV/Telephony
- Digital Subscriber Line (DSL)
- VoP-enabled E9-1-1 Call Handling Equipment

4.1.1 Voice over the Internet

If the Internet Service Provider (ISP) is not a registered local dial tone provider it shall not allow 9-1-1 calls to egress to an Emergency Service Network.

4.1.2 Inter-Exchange Routing

At this time 9-1-1 calls do not travel over the inter-exchange (toll) networks. Indeed, dedicated circuits are used to traverse the inter-exchange network (e.g., transporting wireless 9-1-1 traffic to the SR). The evolution to packet switching is of no immediate consequence to E9-1-1.

It is logical that someday an inter-exchange network could carry 9-1-1 calls, as inter-networking arrangements develop between providers to allow a call to enter someone's E9-1-1 "system" at a point far away from the destination PSAP. Then, it shall be necessary to send that call through an inter-exchange network (legacy or next generation) for it to be handled by the "local" E9-1-1 system for final delivery to the PSAP. Other features like alternate routing, default routing, transfer, etc. shall also be coordinated.

When appropriate, NENA Inter-Networking Working Group shall make sure that specifications for appropriate treatment are identified. For instance, Selective Routing occurs in the originating and terminating Selective Routers only. The intermediate switches simply pass the call and associated messages along. For more information, please refer to NENA Recommendation for the implementation of Inter-Networking, E9-1-1 Tandem to Tandem (NENA 03-003).

4.1.3 Local Exchange Replacement (including CLECs)

Local Exchange Replacement should be a registered local dial tone provider and shall be required to follow the existing recommendations for access to Emergency Services. The Local Exchange Carrier (LEC) uses an IP-based switch to provide local service and interconnect with a designated 9-1-1 tandem switch using appropriate trunk and signaling gateways. It shall cover for the vast majority of IP end-users for whom the type of voice device (an analog phone plugged into an adapter, an ISDN phone, a PC workstation with integrated handset or an IP telephone) will not be mobile. Impacts to 9-1-1 service shall be kept to a minimum. An IP-based LEC will most likely interface to a Selective Router via SS7.

4.1.4 Enterprise Networks (e.g., Centrex-IP, IP-enabled PBXs, etc.)

These systems present challenges to E9-1-1 systems in several ways. These are the mobile users who can carry an IP voice device from one company location to another, plugging it in at any of several locations on an extended, but essentially private, IP Enterprise Network. This will represent a small percentage of users.

There are two identifiers associated with an IP telephone user - a telephone number and a static or non-static IP address. Essentially, the IP address is associated [permanently, randomly or temporarily] with the interface (jack) into which the device/phone is plugged, which usually is a fixed and known location. There are instances where the device would connect using a wireless or infrared interface.

Where the Enterprise Network Provider manages the "cloud", containing the class 5 switch and the IP interface system, it shall keep track of the relationship between the telephone number and the IP address. When the voice device is moved, it identifies itself to the network and the association of TN or IP address and the physical location of the interface (jack) is updated dynamically. Specifications for Enterprise Networks using network-based Centrex-IP application need further assessments.

Another category within the Enterprise Networks is the really mobile user (a.k.a. the Road Warrior), who logs into the company IP network, via dialup or Internet, from hotel rooms, etc.)

An IP-enabled voice device can move around the business complex, and even from the complex to the individual's home. NENA Private Switch ALI (PS-ALI) Working Group shall look at specifications for IP-enabled PBXs. That working group has recommended that such network design follow the spirit of the Model Legislation and provide Emergency Response Locations (ERLs) and Emergency Location Identification Number (ELIN). For further references, see the NENA Technical Information Document on Model Legislation Enhanced 9-1-1 for Multi-line Telephone Systems (*no number*).

It is important not to violate NENA recommendations and standards, if the user's "mobile" device does not disconnect the current session and connect locally to complete the 9-1-1 call in lieu of service denial.

4.1.4.1 Example of an Alternative Approach for Determining the Location Information

This sub-section describes an alternative approach for determining the location information for IP devices on IP Enterprise Networks. That approach for the association between the IP device and the physical location information requires additional capability in the IP device, but does not require the Call Connection Manager (CCA), termed a Call Agent in PN3-4726, to be aware of customer Local Area Network (LAN) private IP addresses, or to provide a Network Address Translation (NAT) translation for IP addresses sent in Telephony Application Protocol Interface (TAPI) messages sent between the CCA and the Local Location Information Server (LIS).

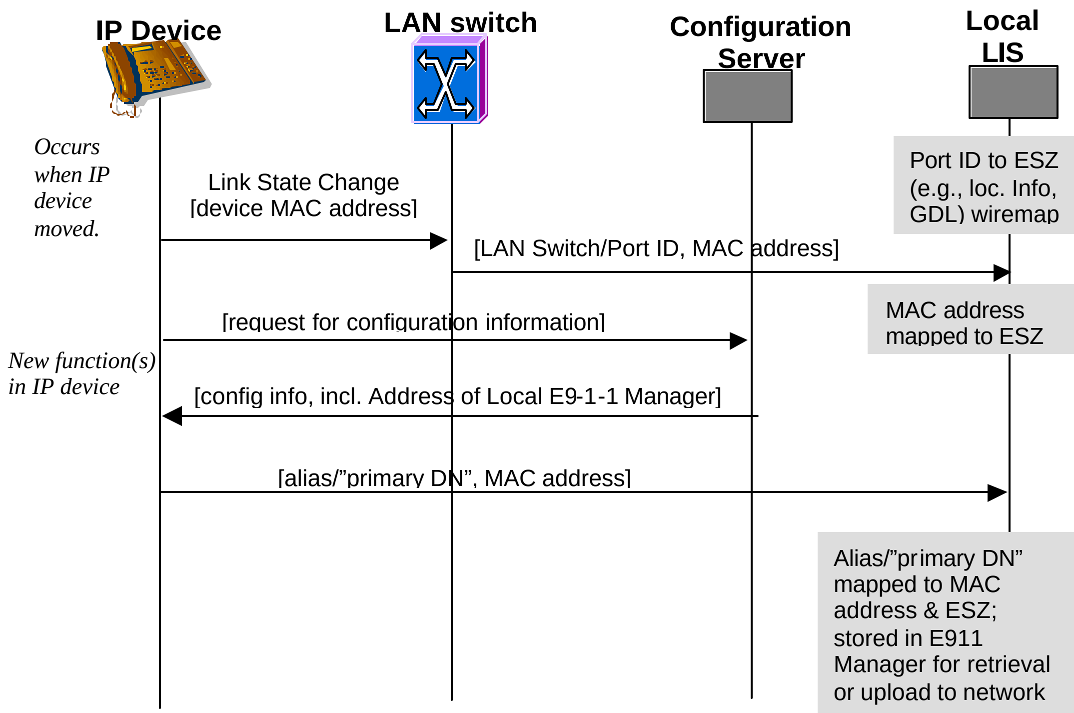
In this approach, the Ethernet switches and the Local LIS on the Enterprise LAN follow the procedures described in PN-3-4726 for trapping the MAC Address of an IP device and associating that MAC Address with location information in the database on the Local LIS.

The following new requirements are placed on the IP devices:

? The IP devices on the Enterprise LAN should be able to be configured automatically with the IP address of the Local LIS (e.g., via a web server).

? After an IP device is moved to a new location (plugged in to a physical jack) and is registered with the serving IP Centrex CCA, the IP device must signal its MAC address and its Telephone Number (i.e., primary DN, if more than one DN is supported) to the Local LIS. This could be done via a TAPI application, or possibly via a "call" to the Local LIS. (If the IP device does not know its DN(s), then it sends another unique identifier that is known to the Centrex network provider, for example, a global/public IP address or in the case of H.323 architecture, its H.323 "alias.")

Figure 4 - Alternate Method to Determine Location Information



When the Local LIS receives the MAC address and TN of the IP device, it can make the association between that TN and the location information that corresponds to the physical location that corresponds to the indicated LAN switch port ID.

In some IP Centrex architectures, the Local LIS may not be aware of the TN associated with the IP device. In these architectures, it is assumed that the Local LIS is aware of a unique identifier for the IP device that is also known to the Network LIS, for example, a global IP address or an H.323 "alias". It is assumed that a Network LIS will be configured with information to correlate this unique identifier with a TN.

4.1.5 Cable TV/Telephony

These shall be registered as local dial tone providers and follow the existing interconnection specifications for access to Emergency Services. A Cable TV/Telephony LEC will most likely interface to a Selective Router via SS7.

4.1.6 Digital Subscriber Line (DSL)

With the growth in deployment of Digital Subscriber Line (DSL) accesses across the world, a new technology was conceived in the latter half of 1999 that uses data transmission capacity provided by the DSL technologies to provide voice channels in addition to the data channel.

DSL is a technology that uses digital transmission techniques to increase the transmission capacity available on the copper pair that is used for services between a subscriber and the serving network.

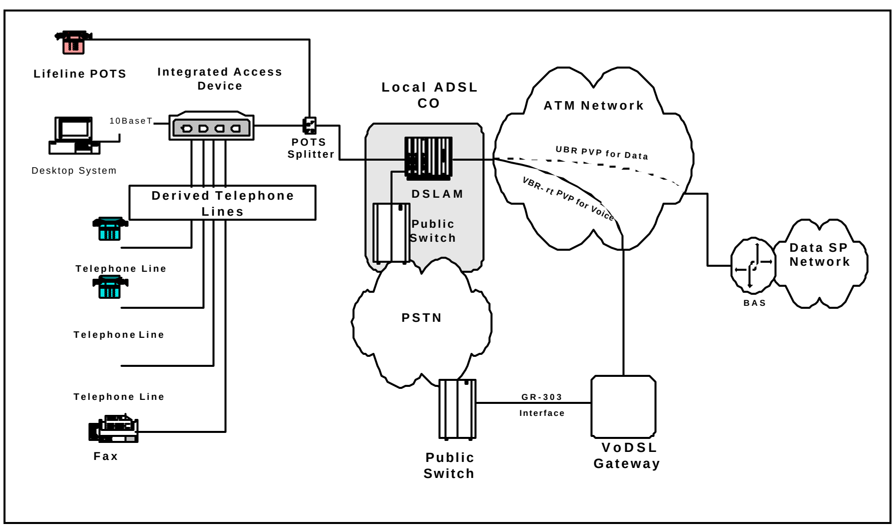
There are different forms of Digital Subscriber Line (DSL) technology including ISDN DSL (IDSL), Symmetrical DSL (SDSL), Asymmetrical DSL (ADSL), High bit rate DSL (HDSL) and Very high-speed DSL (VDSL). One of the most commonly deployed DSL technologies – ADSL takes advantage of unused transmission capacity on the copper pair used to deliver basic telephone service. Asymmetrical describes the apportionment of the transmission capacity in the downstream (from the network to the user) and upstream (from the user to the Network) directions.

ADSL is based on ITU-T (G.992.1 and G.992.2) and ANSI (T1-413 Issue 2) standards. These standards define the use of DMT (Discrete Multi Tone) encoding for the transmission of the data in the frequency band above the 0-4 khz used by the voice band telephony service. Unlike the traditional analog modem technology, which allows for either voice or data/fax (not simultaneously) over a single copper pair, ADSL allows for simultaneous use of voice and data over the single copper pair.

Many of the standard DSL technologies use ATM (Asynchronous Transfer Mode) as the Layer 2 transport for the data transfer. One of the advantages of using ATM on the DSL line is ATM's inherent ability to support multiple logical connections on the same physical connection. Although other options such as Frame Relay are used in some DSL deployments, ATM is predominantly used in most DSL access networks.

VoDSL is a variant of the VoATM technology; however, unlike the main application for VoATM, VoDSL connections are mainly used as an alternative PSTN access technology to implement voice lines between DSL customers and a voice switch.

Figure 5 - DSLAM Architecture with VoDSL



The VoDSL application is based on the addition of two new elements to the current ADSL architecture. These two new elements are a Voice over DSL Gateway (VoDSL Gateway) [*Central Office based*] and an Integrated Access Device (IAD) [*Customer premises based*].

The Integrated Access Device (IAD) replaces the standard DSL modem at the customer premises. This device typically has a built-in standard DMT based DSL modem, an Ethernet Interface for the PC or any other data device and anywhere from 4 to 12 analog ports for phones. Various CPE vendors have developed different types of IADs designed for Residential, Small Office/Home Office (SOHO) applications and business market segments.

Unlike the DSL modem, which is typically installed close to the PC, greater consideration must be given to the placement of the IAD, so that the Inside Wire within the customer premises can be used for the multiple voice-lines. It is possible that a DSL provider provides local services to multiple tenants using a single IAD.

The voice lines provided by a VoDSL solution are typically referred to as **"derived" voice lines** to differentiate the VoDSL voice lines from the voice service provided by the packetized elementary stream. The term derived is used because the VoDSL voice lines are derived from the data portion of the ADSL line. As the IAD is typically **locally powered**, it requires a **UPS system** to provide life-line support for the derived voice lines.

The derived voice lines preserve all the current features and functionality of existing voice services. The phone numbers associated with the derived lines are assigned out of the Class 5 switch that the VoDSL Gateway connects to, not the office where the Digital Subscriber Line Access Multiplexer (DSLAM) connects to. Standard analog phone sets, small key-systems, Group III facsimile machines and voice band modes can be supported by VoDSL technology.

Depending on the service delivered (residential, single business or Centrex), all custom calling features pertaining to these services are expected to be preserved by this technology. This preservation of features has yet to be confirmed by Lab tests and technology trials.

A **centralized VoDSL gateway** can be used to support VoDSL lines from many wire centers. In doing so, the customer's normal wire center/switch does not deliver the voice service for the VoDSL derived lines. This is commonly referred to as a "Remote Exchange (RX)".

Remote exchanges have potential implications for 9-1-1 services. The customer's derived lines could be connected to a switch in a different rate center. The NNX of the telephone number traditionally implies a geographic location for the customer. This is no longer true when a VoDSL Gateway is serving voice lines from multiple wire centers. This would have to be considered for telephone numbers assigned to VoDSL lines similar to what is done for LNP and cell phones today. A centralized VoDSL gateway with T1's back-hauled to foreign rate centers is a potential solution to overcome some of the 9-1-1 issues.

Other potential issues may exist with VoDSL. They relate to capacity to perform call trace especially during a power failure condition impacting a derived line served by an IAD. Calls placed from a derived telephone line during a power failure that may carry the wrong ANI/KEY/ALI, and others issues like network capacity, sizing and call blocking between the DSLAM and the VoDSL Gateway if not provisioned adequately.

4.1.7 VoP-enabled E9-1-1 Call Handling Equipment

Vendors have started designing the Next Generation IP-based Selective Router and PSAP. These call for futuristic call handling functions and equipment. NENA CPE guidelines would need to be modeled to manage function increments using enhanced packet capabilities.

4.2 Network Interconnection Arrangements

The 9-1-1 Network may be comprised of various interconnection arrangements for traditional and Emerging Technologies-based network interface.

The following depicts the next layer of impacts and interactions of Emerging Technologies interfaces when dealing with E9-1-1 service.

As Emergency Services Networks evolve toward new Emerging Technologies, there will be a need to support interoperability and interconnectivity between these new technology devices/switches and the traditional (legacy) equipment. Usually, that shall require Emerging Technologies products to secure "gateways" that interwork with the legacy Emergency Service Network. These gateways shall convert from the packet technology protocols to standard Public Switched Telephone Network (PSTN) protocols. In addition, as Emerging Technologies products are deployed they should have the capabilities to interconnect through newly defined internetworking protocols. The interconnections should have the same reliability and grades of service that are supported today.

The rest of this section highlights the network interconnection of Network Elements based upon segments of the network evolving to Voice over Packet.

4.2.1 End Office to Selective Router Interconnections in a Mixed Technologies Environment

For this scenario the end office may be managed by the Emergency Service Provider, another LEC, a CLEC, a Cable TV/Telephony provider, etc. One of the switches is assumed to be an Emerging Technologies switch while the other is a legacy switch with traditional signaling. Whichever switch is the Emerging Technologies switch must implement a gateway functionality that interworks with the traditional signaling switch. For example, if the End Office is an Emerging Technologies switch that is working into a traditional Selective Router, the End Office must incorporate a trunk gateway to deliver E-9-1-1 calls to the Selective Router using traditional signaling. The corollary is also true. If the Emergency Service Provider has upgraded its Selective Router to an Emerging Technologies switch, that switch must have a gateway to interoperate with existing End Offices.

The signaling interfaces for this network connection are SS7, FG-D and CAMA. The signaling element that is passed is the ANI/KEY of the caller. For some architecture arrangements, a port/device's ELIN may need to be passed as the ANI/KEY, along with the caller's call back number.

4.2.2 End Office to Selective Router Interconnections using Compatible Packet Technologies

In this scenario, both the End Office and the Selective Router are Emerging Technologies switches and could interconnect via the internetworking protocol of that technology. The only requirement is that ANI/KEY and location determination data, if applicable, is passed in the call setup such that the data can be used by the Selective Router for routing and can be delivered to the PSAP. Interoperability with external 9-1-1 databases must be supported.

4.2.3 Enterprise Network to Selective Router Interconnections using Mixed Technologies

In this section and section 4.2.4, Enterprise Networks are defined here to include both customer premises-based PBX switches and network-based Centrex-like services. Additional references on recommended practices to manage call routing and data display for private switches are available in "PS911" designated Technical Information Document (TID) to be posted at the NENA web. It is expected that the PBX owner/operator shall build and maintain records in the 9-1-1 database for each and every station's telephone number that the PBX might pass as station's Calling Line Identification (CLID) on a 9-1-1 call. If a PBX passes a CLID without building a record per number in 9-1-1 database, it degrades the 9-1-1 service functionality rather than enhancing it.

4.2.3.1 Enterprise Network PBXs

The Enterprise Network PBX scenario infers that either the PBX or the Selective Router is assumed to be an Emerging Technologies switch while the other is a legacy switch with traditional signaling. Whichever switch is the Emerging Technologies switch must implement a gateway functionality that interworks with the traditional signaling switch. If the PBX is an Emerging Technologies switch it must incorporate a gateway to interwork with the legacy Selective Router. The corollary is also true. If the Emergency Service Provider has upgraded its Selective Router to an Emerging Technologies switch, that switch must have a gateway to interoperate with existing PBXs.

The signaling interfaces for this network connection are PRI and CAMA. It is recommended that the PBX pass station ID or an Emergency Location Identification Number (ELIN), representing the Emergency Response Location (ERL) and a valid call back number. If not available, the PBX or end office shall assign the main telephone number, billing number, etc. and pass it along to the Selective Router in the call setup.

4.2.3.2 Enterprise Network Centrex-like Services

The Enterprise Network Centrex-like Services scenario infers that either the Centrex-like switch or the Selective Router is assumed to be an Emerging Technologies switch while the other is a legacy switch with traditional signaling. Whichever switch is the Emerging Technologies switch must implement a gateway functionality that interworks with the traditional signaling switch. If the Centrex-like is an Emerging Technologies switch it must incorporate a gateway to interwork with the legacy Selective Router. The corollary is also true. If the Emergency Service Provider has upgraded its Selective Router to an Emerging Technologies switch, that switch must have a gateway to interoperate with existing Centrex-like services.

The signaling interfaces for this network connection are SS7, FG-D and CAMA. It is recommended that the Centrex-like service passes the caller's telephone number as the ANI/KEY. If the caller's number is not available, an Emergency Location Identification Number (ELIN) representing the Emergency Response Location (ERL) shall be passed to the Selective Router, along with a valid call back number.

4.2.4 Enterprise Network to Selective Router Interconnections using Compatible Packet Technologies

4.2.4.1 Enterprise Network PBXs

In this Enterprise Network PBXs scenario, both the PBX and the Selective Router are Emerging Technologies switches and could interconnect via the internetworking protocol of that technology. It is recommended that the PBX pass station ID and/or an Emergency Location Identification Number (ELIN), representing the Emergency Response Location (ERL), and a valid call back number. If not available, the PBX or end office shall assign the main telephone number, billing number, etc. and pass it along to the Selective Router in the call setup.

4.2.4.2 Enterprise Network Centrex-like Services

In this Enterprise Network Centrex-like Services scenario, both the Centrex-like switch and the Selective Router are Emerging Technologies switches and could interconnect via the internetworking protocol of that technology. It is recommended that the Centrex-like service passes the caller's telephone number as the ANI/KEY. If the caller's number is not available, an Emergency Location Identification Number (ELIN) representing the Emergency Response Location (ERL) and a valid call back number (e.g., a "main" telephone number) shall be passed to the Selective Router.

4.2.5 Emerging Technologies Network Access for Traditional PSAP

If the Emergency Service Provider upgrades its network to serve a PSAP with an Emerging Technologies network architecture, it must incorporate a gateway to work with legacy PSAPs. This network must have the ability to support access gateways that can handle CAMA, Enhanced MF, ISDN BRI and/or ISDN PRI interfaces to PSAPs equipment, as provided by the Emergency Service Provider network.

Standard tones (dial, busy and reorder) shall be provided by a network element (e.g., the gateway) for an incoming E9-1-1 call. The PSAP attendant must receive an audible and/or visual signal of the termination of the call. In some cases, e.g., CAMA or MF PSAP interfaces, an audible ringing indication shall be returned to the E9-1-1 calling party from the E9-1-1 PSAP CPE. In other cases (where an explicit indication of alerting is provided to the serving network by the PSAP, e.g., ISDN), audible ringing may need to be provided by the access gateway to the caller.

4.2.6 Emerging Technologies Selective Router to Emerging Technologies PSAP

This scenario implies that the Emergency Service Provider has upgraded the network to use an Emerging Technologies switch and the PSAP has incorporated Emerging Technologies into its architecture. While the definition of Emerging Technologies PSAP is beyond the scope of this document, this interface must, at a minimum, have the equivalent functionality of the existing interfaces such as CAMA, Enhanced MF and/or ISDN.

Standard tones (dial, busy and reorder) shall be provided by a network element (e.g., access gateway) for an incoming E9-1-1 call. The attendant must receive an audible and/or visual signal. An audible ringing indication shall be returned to the E9-1-1 calling party from the E9-1-1 PSAP CPE. Alternatively, audible ringing could be provided by a network element, as long as the PSAP CPE provides an explicit indication that it is alerting to the network.

4.3 End Office Based E9-1-1 Interface

End Office based E9-1-1 service may offer alternative emergency call handling functionality (e.g. EO based automatic call distribution). For this service, many of the features may be performed through a different interface, utilizing EO based network interface to perform functions, which could otherwise be performed at the PSAP.

4.4 Busy Line Verification (BLV) / Busy Line Interrupt (BLI)

In a Voice over Packet network, the following minimum set of capabilities would need to be supported by the network to provide verification and operator interrupt:

? Support for verification access from an operator system with verification capacity equivalent to a minimum of two “no-test” trunks.
? Ability to accept requests for verification of a particular address (i.e., directory number/E.164 address).
? Ability to determine if the requested line is busy, idle, or in a permanent signal condition (i.e., off-hook but not involved in a stable call or call origination).
? Ability to bridge the operator on to an existing call, if the requested line is busy.
? Ability to interwork multiple operators service platforms.

Additional desirable capabilities could include:
? Ability to connect the operator to an idle line (no ring is provided).
? Ability to notify the operator system that
    ? the verification capability is not available at this time for this line (e.g., busy tone).
    ? the serving network is temporarily unable to provide verification (e.g., reorder tone).
    ? the requested customer line is in a permanent signal condition.

4.5 ALI Database Interfaces

Emerging Technologies devices shall interface to either off premises ALI database or a premises-based ALI database. [*Based on the E9-1-1 network architecture, there are two ways to look at the ALI interfaces (PSAPs* ***pulling*** *data from the ALI or ALI* ***pushing*** *data to the PSAPs) and location determination*]

Customer Premises Equipment at the PSAP may need modification. Pushing data to the PSAP may present an issue regarding unsolicited bids, unless part of a closed user group arrangement.

4.6 Other External Database Interfaces

Emerging Technologies routing and/or location determination devices may be required to interface to an ALI database and/or selective router (*to provide dynamic routing and/or address location information or other*), to a Data Management System (*to create call routing information*) or if applicable to an external selective routing database.

The presumption of presentation to the Data Management System will necessitate real time updates to the selective routing database. Currently most 9-1-1 Data Management Systems run updates to the selective routing database in a batch mode. Emerging technologies will likely require modifications to the data and network components and processes to allow real time selective routing data be dynamically interjected into the 9-1-1 network.

4.7 New Message Formats (XML)

The ALI database will be connected to a routing device or other ancillary devices (e.g., location determination device) in the Emerging Technologies network. It is recommended that the messages between these devices utilize eXtensible Markup Language (XML) to communicate with each other. XML will allow the receiving device to select only the appropriate fields of data from the entire message and ignore the rest. This will allow the same message to be sent to multiple receiving devices who have different purposes without re-formatting the message. The Emerging Technologies network will also use XML messages from the ALI database to the PSAP, from the PSAP to the Data Management System, from the Data Management System to the ALI database system and between ALI databases systems.

The use of XML messages will allow developers to use a common Data Dictionary for the transmission and receipt and processing of data without having to use rigid data stream formats. The use of XML will increase the interoperability across vendors' platform as the need for proprietary data messages is diminished.

4.8 Teletype (TTY) and Telecommunications Device for the Deaf (TDD)

The interface specifications to support Teletype (TTY) and Telecommunications Device for the Deaf (TDD) using an IP source to make, to route and to deliver a 9-1-1 call, including a potential recall could be supported by two (2) call type scenarios:

A) **with compression**, where the TTY information must be passed "out of band" (e.g. in a TCP or UDP stream that is separate from the audio path), because the compression algorithm (G.729, G.723.1) is optimized for human speech, not TTY signals.

B) **without compression**, where the TTY information can be sent in-band just as it is in the public voice network. VoIP can use the G.711 codec (the normal method of encoding voice and in-band audio information in the PSTN, including faxes, modems, TTY) just like the PSTN uses it.

5. 5 CALL PROGRESS SIGNALS AND MESSAGES

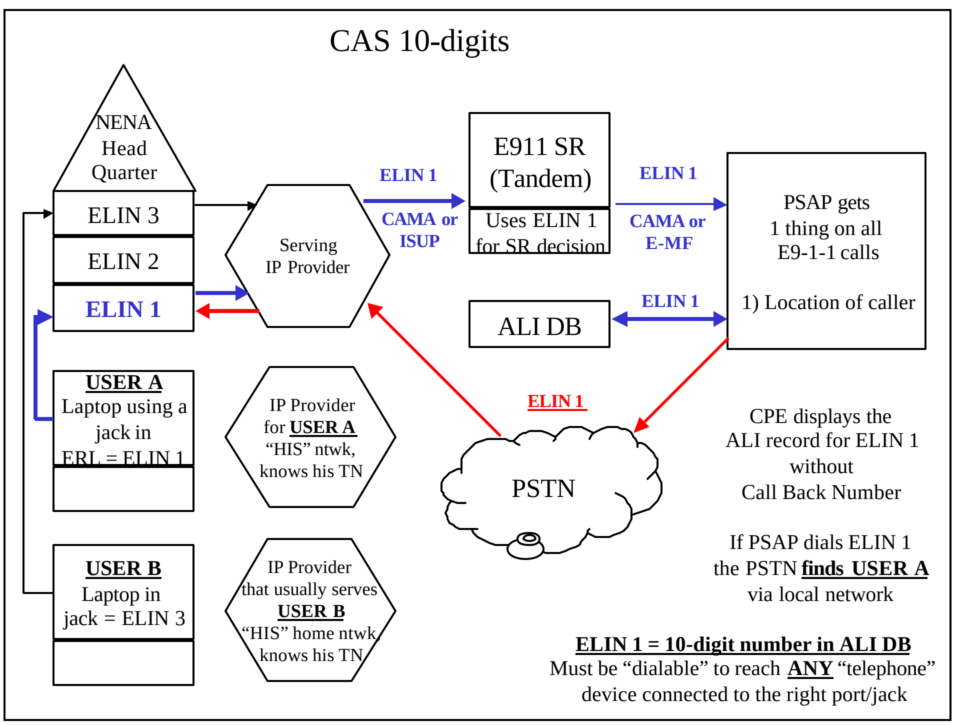
The Emerging Technologies device/network interface shall transmit call progress signals and messages to the E9-1-1 tandem switch in accordance with established routing requirements and signaling specifications. For networks where users are allowed to freely move their voice device from one location to another and from one network interface point to another, it is required to support E9-1-1 call routing and associated location determination elements. Shown next are included two call routing scenarios that help size some of the call routing and location determination requirements.

5.1 Call Associated Signaling Interface using 10-digit

This first scenario requires that each jack at the customer premises be configured using Emergency Response Location (ERL) zone. Each ERL shall be assigned an Emergency Location Identification Number (ELIN). Figure 5 depicts a call where only the ELIN (10-digit value) is transmitted to the PSAP along with the voice call.

Once a **CAS 10-digit** call is initiated at a mapped jack, the IP network assigns a **routable and dialable** Emergency Location Identification Number (ELIN) associated to that ERL's zone. The voice call progresses to the 9-1-1 system following established interconnection specifications. Due to the lack of a valid caller's callback ANI (i.e., the caller's telephone number), the PSAP shall be able to initiate a callback through the PSTN using the ELIN.

Figure 6 - Call Associated Signaling 10-digit



Within an Emerging Technologies network, the call routing and callback functions will benefit from new & powerful routing capabilities such as Provider Selection, Host Mobility (*route to current location*) and Auto-Re-Addressing (*route to new location*).

5.1.1 PSAP Callback to the Station

The IP provider network/switch shall be able to associate an incoming ELIN-based call with a jack currently assigned to the originating voice device. The call shall route to the jack where it initially originated, *providing that the device is still connected at the jack and that the period of time to retain ELIN-ERL correlation information has not elapsed*.

In cases where the user's voice device has moved to another jack [*mapped ERL location*], the IP system shall be able to perform auto-re-addressing (route the call to that new location).

5.1.1.1 Time Limits on Reservation of ELINs as Callback Numbers

How long the Enterprise Call Management function and/or the local Location Information Server (LIS) should reserve an ELIN to support callback calls after that ELIN has been substituted for a Calling Party Number on an emergency call.

If the Public Safety Answering Point (PSAP) agents that make use of the ELIN as a callback number and the implementers of the Auto Re-Addressing capability in the Call Management function have different expectations about how long the ELIN can be used for a callback, this could cause confusion for the PSAP agent.

The time that the ELIN can be reserved for callbacks needs to be traded off against the effect on the number of ELINs that would need to be assigned (e.g., to support other emergency calls from that same ERL. To be used for routing callback calls, dialable DNs would need to be used as ELINs, and these would not be available to be assigned for normal calling telephone numbers. DNs are a finite resource. The number of ELINs required in an Emergency Services Zone (ESZ) will also be dependent on the size and density of the ESZ. Whenever a dialable ELIN is used for call back purposes, it is imperative that the NPA NXX for that ELIN be accepted nationwide.

It is recommended that the time that an ELIN is reserved for callbacks be required to be a configurable parameter in the Call Management functional element and that that time be negotiated among the customer, the PSAP and the E9-1-1 network service provider.

5.1.2 PSAP can't Callback to the Station

For instances where the IP provider network/switch cannot associate an incoming ELIN-based call with the jack previously assigned to the originating voice device, the call shall route either to another telephone located within the same ERL zone or to a telephone number that can be dialed from the PSTN, which will be answered by the switchboard operator, attendant or designated personnel.

The IP provider network/switch shall support the capability for the attendant to identify the location of telephones that have previously dialed 9-1-1.

5.2 Call Associated Signaling Interface using 20-digit

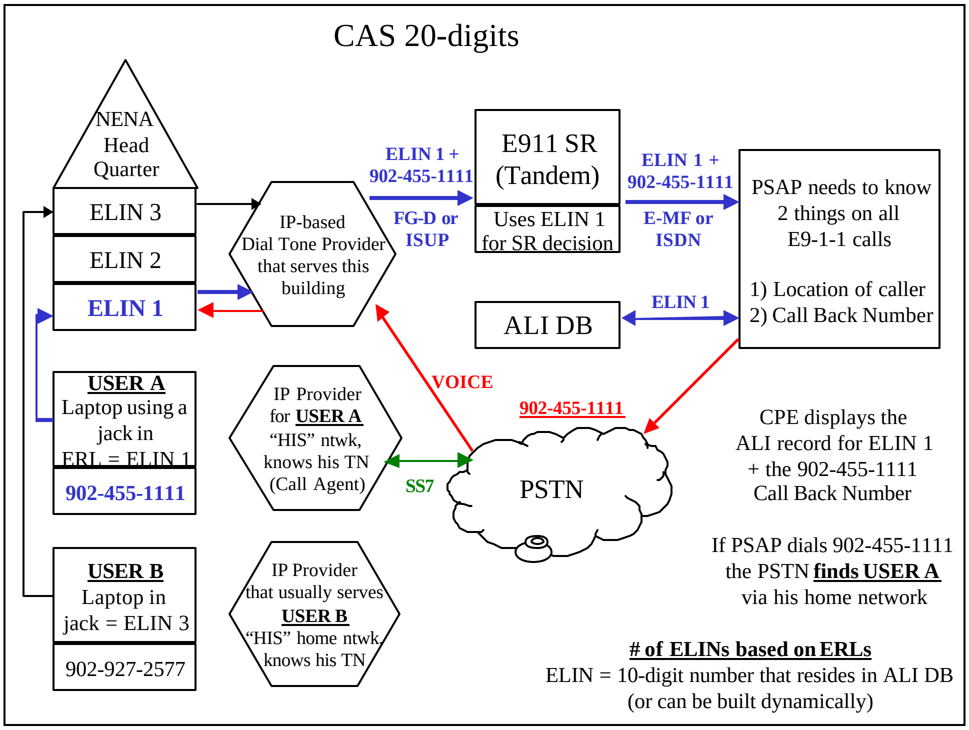
Similarly to the previous scenario, each jack at the customer premises is required to be mapped with the Emergency Resource Location (ERL) zones. Each ERL shall be assigned an Emergency Location Identification Number (ELIN).

This time a call is initiated at a mapped jack using **CAS 20-digit**. The Centrex IP, Enterprise IP, PBX-IP network/switch shall assign a **routable and non-dialable** (*could also be dialable*) Emergency Location Identification Number (ELIN) associated to that telephone device's ERL zone. The caller's telephone device ANI is also transmitted to the Selective Router. The voice call progresses to the 9-1-1 system following established interconnection specifications. As the PSAP is now receiving a valid caller's callback ANI, the call taker shall be able to initiate a callback using the incoming caller's ANI.

As indicated earlier for call routing and callback functions, the Emerging Technologies network will benefit from new & powerful routing capabilities such as Provider Selection, Host Mobility (*route to current location*) and Auto-Re-Addressing (*route to new location*).

Figure 6 depicts that call where both the ELIN (10-digit) and the Callback number (10-digit) are transmitted to the PSAP along with the voice call.

Figure 7 - Call Associated Signaling 20-digit



5.2.1 PSAP Callback to the Station

When a callback is initiated, the PSAP's serving network shall ultimately route the call to the IP network/switch where the caller is currently connected. The network shall use the SS7 signaling network to query the caller's device current location. Once the call enters the caller's currently serving network/switch, the Emerging Technologies network/switch (IP provider) shall be able to associate the incoming call with the jack currently assigned to the voice device's telephone number.

The call shall route to the jack where the caller's device is currently connected, no matter if the caller's voice device was moved to another jack after initiating the emergency call, the IP system shall be able to perform auto-re-addressing (route the call to that new location).

5.2.2 PSAP can't Callback to the Station

In the event that the IP provider network/switch cannot route the incoming call to either the jack from where a 9-1-1 call was previously initiated or to the new location for the telephone device that made the 9-1-1 call, the call shall route to another telephone located within the same ERL zone.

The IP provider network/switch shall support the capability for the attendant to identify and to match the location of telephones that have previously dialed 9-1-1.

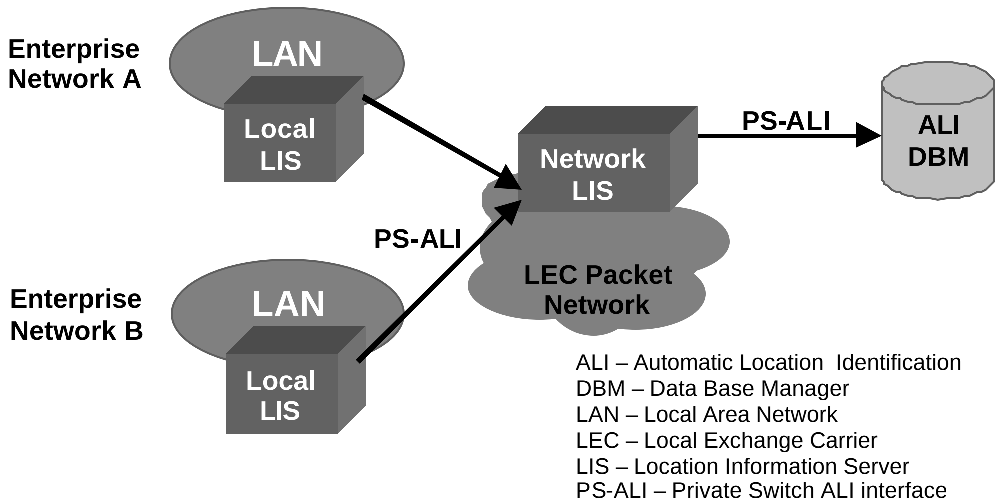
5.3 Non-Call Associated Signaling Interface for Location Information

This scenario describes a non-call associated approach to signaling location information for emergency calls from IP enterprises.

Once an association has been made between an IP device's telephone number and physical location information at the enterprise, the TN and this location information are sent via non-call associated signaling to the E9-1-1 service provider's network to support automated periodic updates of location change information to the ALI data base and selective routing data bases. For example, a Private Switch ALI (PS-ALI) interface could be used to upload location information updates to the ALI DBMS. It is assumed that the location information is of a form appropriate for inclusion in the ALI database.

To reduce the number of PS-ALI interfaces that must be supported by the ALI DBMS, the concept of a network-based Location Information Server (LIS) is introduced as a "front end" to collect the updates from a number of Local LISs and upload them periodically to the ALI DBMS. The Network LIS should provide the security functions of authenticating the sources, contents and formats of the information provided by the enterprise. Normal network procedures for updating selective routing information can be followed.

Figure 8 - Automatic Upload of Location Information



Then, when an emergency call is originated from an IP device in the enterprise and routed through the network, the Automatic Number Identification (ANI) information can be populated with the telephone number of the emergency caller's IP device. Existing selective routing procedures can be used, although a trend toward more frequent updates of selective routing information from the Data Management System would improve the probability that location information would be up-to-date, and emergency calls from IP enterprise networks properly routed.

With this approach, ELINs do not have to be allocated for location information / callback numbers, preserving DN resources.

5.3.1 PSAP Callbacks

PSAP callback calls can also be terminated normally to the IP device via the Callback Number that was provided as ANI with the emergency call, without any qualifications about how long the number can be available for callbacks.

5.4 Additional Information

For 9-1-1 networks where a Hybrid architecture is implemented, the above-mentioned scenarios would still be valid from the Emerging Technologies network/switch perspectives.

The Emerging Technologies device/network interface shall respond to the call process signals sent from the E9-1-1 tandem switch in accordance with established specifications. Specifications are available from NENA 03-004 standard document - NENA Recommendation for an E9-1-1 Functional Entity Model.

6. 6 PSAP FEATURE REQUIREMENT SPECIFICATIONS

Fundamental E9-1-1 PSAP equipment interface and interconnections specifications could be viewed in NENA Generic Standards for E9-1-1 PSAP Equipment document (NENA 04-001).

For PSAPs using Emerging Technologies equipment, it is expected that the Emerging Technologies provider shall follow the E9-1-1 PSAP Equipment Emerging Technologies interface specifications (**to be**) developed by the NENA CPE Technical Committee and/or Private Switch ALI Study Group.

Further PBX specific IP information shall be available from the Telecommunications Industry Association (TIA) TR 41.4 Study Group.

7. 7 POWER SPECIFICATIONS

7.1 Commercial Power

All Network Elements supporting Emerging Technology interfaces shall supply their own internal working voltage from a standard commercial source. All power sources shall comply with electrical safety standards and applicable building codes, as well as the environmental requirements.

7.2 Reserve Power

In addition to the commercial power source, a reserve battery power supply or UPS shall be available to provide a minimum of 15 minutes of emergency power for full functionality of the following listed elements of the E9-1-1 system. In most cases, 15 minutes is sufficient time to bring emergency generators on line. However, if budget permits, it is desirable to extend the 15 minutes to as much as 1 hour.

Emerging Technologies specific Network Elements supporting 9-1-1 functionality, at a minimum, requires uninterrupted power source. For example:

- Call Agent
- Directory Server
- 9-1-1 Call Manager
- Gateways
- DSLAM
- IAD
- Etc.

Further specifications and thorough requirements shall be included in the NENA Network Quality Working Group mimicking the Network Reliability and Interoperability Council (NRIC) Best Practices.

8. 8 INSTALLATION, MAINTENANCE AND ADMINISTRATION

8.1 Installation and Acceptance Testing

Each element of the Emerging Technologies network interfaces and E9-1-1 systems shall undergo a power up period and extensive testing before acceptance by a customer. If required, the Emerging Technologies vendor shall be prepared to provide qualified technicians to install and test all elements of the Emerging Technologies and E9-1-1 Systems. Vendor technicians shall also be available to witness and facilitate acceptance test procedures performed by the customer or customer's agent.

8.2 Maintenance

The Emerging Technologies-based system shall require minimal periodic maintenance. Examples of periodic maintenance may include:

- Batteries
- Fans
- Tape Drives
- Printers

An internal maintenance program shall be provided. This program will allow remote access to system maintainers and provide statistics on overall system performance.

The Emerging Technologies system shall be capable of determining the integrity of its internal software as part of a self-test routine. Upon detection of a defective software process, the unit shall signal the maintenance program and restart without external intervention.

8.3 Technical Support

The maintenance provider shall provide 24 hours per day, 7 days per week a hotline for emergency technical support. Maintenance provider shall have qualified repair technicians available to perform emergency repair.

8.4 System Security

Maintenance and administrative functions shall be protected by means of the requirement of appropriate passwords; this will ensure that system parameters and subscriber data are well protected.

WARNING:	*Security measures shall be taken to guard against unauthorized access into the E9-1-1 network interface and equipment. The maintenance provider along with the vendor shall develop a security plan for E9-1-1 access.*

8.5 Spares Provisioning

At a minimum, the maintenance provider shall have access to Emerging Technologies vendor recommended spares for emergency restoration.

Emergency parts turnaround shall be based on agreement between Emerging Technologies vendor and maintenance provider.

8.6 Training

The Emerging Technologies vendor / service provider shall provide comprehensive training programs for E9-1-1 network / system operators, administrators and maintenance personnel.

The Emerging Technologies system's operation course shall provide the necessary skills for everyday system operation. The administration course shall cover subscriber management, statistics gathering, etc. The maintenance course shall enable technicians to monitor system integrity and enable them to troubleshoot the majority of problems to the level of board replacement.

8.7 Documentation

Emerging Technologies suppliers provided documentation shall be organized and at a minimum include the following sections:

- Documentation Index
- Functional Description
- Installation Manual
- Maintenance Manual
- System Administration Manual
- Emerging Technologies-based PSAP Position Operator Manual
- Acceptance Test Procedure

8.8 Warranty

The Emerging Technologies-based PSAP manufacturer's hardware shall be covered for parts and labor.

9. 9 INDUSTRY FORUMS

9.1 Internet Working Groups

To achieve interworking between the worlds of IP/Internet and the PSTN, a number of industry bodies have been set up to develop the necessary standards and architectures, including:

- Working groups operating under the IETF (Internet Engineering Task Force) include:
  - SIP, dealing with Session Initiation Protocol
  - MEGACO, handling MEdia GAteway COntrol issues
  - PINT (PSTN/Internet Interworking) which is looking at ways in which Internet applications can use IN to interact with PSTN applications
  - IPTEL dealing with IP TELephony
  - SIGTRAN, focused on SIGnalling TRANsport
- ETSI has Project TIPHON (Telecommunications and Internet Protocol Harmonisation), focusing on optimum ways of delivering voice services across the Internet/Public Network boundary. Issues covered include quality of service, security, naming, numbering and addressing, architectures, charging and billing, and call control procedures.
- The ITESF (Internet Traffic Engineering Solutions Forum) deals with the issue of countering PSTN switch congestion caused by heavy Internet usage.
- The ITU's Study Group 16 has developed the H.323 standard for telephony to IP service translation.
- The Softswitch consortium, led by Level 3 and currently involving Telcordia, Nortel, Lucent and Cisco, is developing testing environments for IP applications on the PSTN.
- JAIN (Java in Advanced Intelligent Networks), started by Sun and heavily supported by Telcordia, is developing common interfaces at the applications level that will allow services to run anywhere in an operator's network. Currently working on initiatives that will allow IN applications to be portable across different network environments, the JAIN project holds the promise of using JavaBeans as building blocks to create new services. Eventually, users may be able to customise and run these advanced applications from their own handsets and terminals.

While Telcordia is deeply involved across many of these industry groups, it is also carrying out original development work with its IN portfolio of software products, creating new protocols and architectures that simulate IN functions, but over a packet network. The first of these, the Media Gateway Control Protocol (MGCP) is currently under consideration by the IETF and ETSI.

9.2 VoIP Forum - IMTC

VoIP Forum (an activity group of the International Multimedia Teleconferencing Consortium (IMTC)), an effort by major equipment providers, to promote the use of ITU-T H.323 protocol.

9.3 TIA - TR 41.4

Telecommunications Industry Association's (TIA) engineering subcommittee, TR-41.4, Internet Protocol (IP) Telephony Infrastructure and Interworking Standards. TR 41.4 deals with the voice-over-Internet-protocol (VoIP) standards aspects of enhanced 9-1-1. The subcommittee specifically focuses on VoIP connectivity and interoperability between endpoints within a single enterprise (PBX) and its service provider networks. The area of interest does not extend to the external service provider networks.

9.4 Regulators

- Federal Communications Commission (FCC)
- States' Public Utility Commission (PUC) / Public Service Commission (PSC)
- Canadian Radio-television and Telecommunications Commission (CRTC)
- Industry Canada (IC)

10. 10 QUALITY AND RELIABILITY

This section describes the generic quality and reliability requirements that shall be inherent to all Network Elements supporting Emerging Technologies network interfaces.

10.1 Reliability Objectives

No single point of failure in any hardware or software component of the Emerging Technologies/E9-1-1 system shall cause a complete isolation of no more than half of the system.

Emerging Technologies/E9-1-1 components can be defined as follows:

a) Power Supplies
b) Battery Backup
c) CPUs
d) Trunk Circuit Packs/Components/Servers
e) Position or Station Circuit Packs/Components/Workstations
f) System Network Circuit Packs/Components/Servers
g) Gateways/DSLAMs/IATs
h) System Physical Architecture and Distribution
   - Wiring
   - Back Planes
   - Power Buses
   - Data Buses
   - LAN/WAN
i) Fusing
j) Any electronic element or device within the Emerging Technologies/E9-1-1 system
k) Software associated with any of the above hardware components

The minimum acceptable service for an Emerging Technologies/E9-1-1 system in the event of a single component failure would be as follows:

a) At least 50 percent of the Emerging Technologies/E9-1-1 trunks and 50 percent of the Emerging Technologies-based attendant positions shall be operational and have the minimum following functionality:
   ? Audible and visual indication of incoming 9-1-1 call
   ? Voice communications with the 9-1-1 caller
b) It is desirable for the Emerging Technologies vendor to provide at least 50 percent of the Emerging Technologies/9-1-1 trunks and 50 percent of the Emerging Technologies-based attendant positions be operational and have the following additional functionality:
   ? ANI information
   ? ALI information

Protection switching to redundant components may be required to meet the above outage standards. If protection switching of any Emerging Technologies/E9-1-1 component is utilized, it must be performed on an automatic basis. There shall be no disruption in the minimum functionality of the calls in progress during switch over.

Note: Consult with Emerging Technologies Vendor(s) for specific operational impact.

10.2 Reliability Predictions

Upon request, the Emerging Technologies supplier shall provide reliability predictions performed in accordance with the latest issue of TR-NWT-000332 ("RELIABILITY PREDICTION PROCEDURE FOR ELECTRONIC EQUIPMENT"). Additional predictions based upon other methods or on other failure data may also be provided. Such data however, must be accompanied by supporting information explaining how the failure rates were extrapolated.

Note: Fibre, satellite, etc., not to be limited to electronic equipment.

Reliability predictions shall include:

- Estimates of downtime per year per component of the Emerging Technologies/E9-1-1 system.
- Computation of maintenance parameters. Because these predictions shall include all failures, regardless of whether or not they affect service, parameters such as overall maintenance frequency, failure rates of non-service-affecting elements, and unavailability of maintenance or performance monitoring functions are examples of maintenance parameters to be included. Estimates of contributions due to causes other than hardware failures shall also be included, if known.
- Steady state failure rates and interfaces withdrawing during first year of service multipliers for each element of Emerging Technologies/E9-1-1.

Sufficient supporting documentation must be provided to allow independent verification of the reliability prediction results.

Calculations of downtime and maintenance parameters shall be based on a fully equipped hardware configuration. If more than one such configuration is possible, predictions shall be provided for each significantly different configuration. The reliability model developed to estimate downtime and the assumptions used to construct the model shall be provided.

The description shall include the assumed fault coverage (percentage of faults detected automatically by the Emerging Technologies /E9-1-1 controller) and the assumed fault detection and repair times for any non-alarmed failures. These times include both technician dispatch and repair times and should be consistent with the Emerging Technologies service provider(s) maintenance history.

Emerging Technologies System description documents and architecture information shall be provided by the Emerging Technologies supplier to enable verification of the reliability model. This information shall include descriptions of the interactions between elements, the effect of an element failure on system operation, the fault detection and recovery schemes, and the effect of non-alarmed failures.

10.3 Hardware and Component Reliability

Emerging Technologies vendors shall be able to demonstrate their active involvement in hardware and component reliability process aimed at complying at established industry requirements.

The Emerging Technologies /E9-1-1 supplier shall, upon request, provide documentation that describes procedures, controls and standards utilized for component qualification, vendor qualification, incoming inspection, reliability screening, problem feedback and corrective action.

10.4 Software Quality

Emerging Technologies vendors shall be able to demonstrate their active involvement in a software quality assurance program aimed at complying at established industry requirements.

10.5 Manufacturing Quality Program

Emerging Technologies vendors shall be able to demonstrate their active involvement in a manufacturing quality assurance program aimed at complying at established industry requirements.

The manufacturing process, the test and inspection procedures, and the quality programs utilized to produce a Emerging Technologies /E9-1-1 system must be adequate to ensure that technical specifications and customer requirements are met on an on-going basis.

The supplier shall, upon request, provide documentation that describes procedures, controls and standards used for manufacture; in-process testing, final inspection, and testing of the product; calibration and maintenance of tools and test sets; control of non-conforming materials and products; periodic product qualification testing and all other aspects of the quality program.

The supplier shall, upon request, allow an on-site analysis to be performed with respect to the quality items. Such an analysis shall be conducted at the facilities where the Emerging Technologies /E9-1-1 elements are manufactured.

10.6 Customer Verification of Quality and Reliability

The supplier shall, upon request, permit an inspection to verify the on going reliability and quality. This inspection can consist of up to four major activities:

- Analysis of supplier's final test and inspection results that demonstrate conformance to the agreed upon requirements. Such data must be made available prior to the shipment of Emerging Technologies /E9-1-1 elements.
- Monitoring of supplier's quality program and process controls to assure implementation of the supplier's documented quality program.

- Inspection and test of samples of products which are ready for shipment. The sample size shall be based upon quality history and quantities submitted. Testing will be performed by the suppliers at their facilities in the presence of authorized personnel.
- Periodic product qualification testing to assure conformance to design requirements not normally tested in a routine quality control evaluation.

Along with reliability there is also availability. Reliability of a network element is when it will mathematically fail. Availability is when a network element fails how much of the system capacity goes with it.

While reliability of a network element is fixed by the design and components used, availability can be engineered to the required availability that for E9-1-1 is 99.999%.

If there are two links from an Emerging Technology network to a Selective Router and one link goes down, if there is sufficient bandwidth on each link to carry all the expected E9-1-1 traffic, there would be a zero loss of calls. Such arrangement support 50% VoIP trunks split when voice comes over a common medium in packets.

11. 11 TECHNICAL REFERENCES

11.1 Availability

Unless otherwise specified, Technical References, Standards and Specifications pertaining to the 9-1-1 features mentioned in this NENA TID are available from the Standard Organization Libraries (Telcordia, Telecommunications Industry Association (TIA), etc.)

For reference purposes only, Emerging Technologies proprietary documentation prepared by Telcordia Technologies for BellSouth and SBC related to 9-1-1 include:

SR-5158	Emergency Services Network Interconnection
	Target audience: Intended for use by VoP/NGN network providers that seek interconnection with client company Emergency Services Network providers to support the processing of E9-1-1 calls originated by VoP/NGN customers.
	Related documents: GR-2956-CORE, GR-3017-CORE, GR-905-CORE, GR-1432-CORE, GR-2863-CORE
SR-5121	Analysis of Impacts of Evolving Network Technologies on E9-1-1 Service Architecture
	Target audience : BellSouth Services and SBC E9-1-1 Service planners
	Related documents : GR-2956-CORE, GR-2967-CORE, GR-2968-CORE, GR-2953-CORE
TM-26015	Emergency Services Network Support for Next Generation PBXs and PSAPs
	Target audience : BellSouth Services and SBC E9-1-1 Service planners

Busy Line Verification / Busy Line Interrupt information prepared by Telcordia Technologies is:

GR-531-CORE	*LSSGR: Interoffice: Verification Connections (FSD 25-05-0903)*, Issue 1, June 2000
FR-271	*Operator Services Systems Generic Requirements (OSSGR*), FSD 80-01-0300

Generic Telcordia Documents are available from:	FCC Documents are available from:
Telcordia - Customer Service 60 New England Ave. - Room 1B252 Piscataway, NJ 08854-4196 Web site: www.telcordia.com 1-800-521-CORE (908) 699-5800	The Superintendent of Documents Government Printing Office Washington, DC 20402 Web site: www.fcc.gov

Other reference documentation includes:

NENA Enhanced 9-1-1 for Multi-line Telephone Systems Model Legislation is available from:

Web site: www.nena9-1-1.org

PN-3-4726	*IP Telephony Support for Emergency Calling* (a draft TIA/EIA Technical Specification Bulletin), November, 2001 draft.
TR-41.4/ 01-02-069	*Enterprise network-based solution for locating 911 caller using an IP phone*, Cisco Systems (Marc Linsner) February 2001.

12. 12 Acronyms

The following Acronyms as use in this document

AAL	ATM Adaptation Layer
ACD	Automatic Call Distributor
ACN	Automatic Crash Notification
ADSL	Asymmetrical Digital Subscriber Line
ALI	Automatic Location Identification
ANI	Automatic Number Identification
ASCII	American Standard Code for Information Interchange
ATIS	Alliance for Telecommunications Industry Solutions
ATM	Asynchronous Transfer Mode
BLI	Busy Line Interrupt
BLV	Busy Line Verification
CAMA	Centralized Automatic Message Accounting
CAS	Call Associated Signaling
CAS	Channel Associated Signaling
CBR	Constant Bit Rate
CLEC	Competitive Local Exchange Carrier
CLID	Calling Line Identification
CO	Central Office
CoS	Class of Service
CPE	Customer Premises Equipment
CRTC	Canadian Radio-television and Telecommunications Commission
CTX IP	Centrex-based Internet Protocol
DMS	Data Management System
DMT	Discrete Multi Tone
DN	Directory Number
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
E9-1-1	Enhanced 9-1-1
EIA	Electronic Industry Association
ELIN	Emergency Location Identification Number
ERL	Emergency Response Location

ESN	Emergency Service Number
FCC	Federal Communications Commission
FG-D	Feature Group D
GPS	Global Positioning System
HDSL	High bit rate Digital Subscriber Line
IAD	Integrated Access Device
ID	Identifier
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IMTC	International Multimedia Teleconferencing Consortium
IP	Internet Protocol
IPSec	IP Security
ISDL	ISDN Digital Subscriber Line
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
ITESF	Internet Traffic Engineering Solutions Forum
ITSP	Internet Telephony Service Provider
ITU	International Telecommunications Union
LAN	Local Area Network
LDT	Line Digital to Trunk (PSAP)
LEC	Local Exchange Carrier
LIS	Location Information Server
LSSGR	LATA Switching Systems Generic Requirements
MF	Multi-Frequency
MGCP	Media Gateway Control Protocol
MPLS	Multi-Protocol Label Switching
MPOA	Multi Protocol Over ATM
NAS	Network Access Server
NPA	Numbering Plan Area
NPD	Numbering Plan Digit
NRTL	Nationally Recognized Testing Laboratory
OSI	Open Systems Interconnection
PBX	Private Branch Exchange
PPP	Point-to-Point Protocol
PRI	Primary Rate Interface
PS-ALI	Private Switch ALI

PSAP	Public Safety Answering Point
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RSVP	Resource Reservation Protocol
RTP	Real-Time Protocol
SDSL	Symmetrical Digital Subscriber Line
SIP	Session Initiation Protocol
SLA	Service Level Agreement
SNA	System Network Architecture
SOHO	Small Office/Home Office
SPVC	Soft Permanent Virtual Circuit
SS7	Signaling System Number 7
SVC	Switched Virtual Circuit
TA	Technical Advisory
TCP	Transmission Control Protocol
TDD	Telecommunications Device for the Deaf
TDM	Time Division Multiplexing
TIA	Telecommunications Industry Association
TID	Technical Information Document
TR	Technical Reference
TTY	Teletypewriter
UBR	Unavailable Bit Rate
UL	Underwriters Laboratories
UPS	Uninterruptable Power Supply
VBRnrt	Variable Bit Rate non-real-time
VBRrt	Variable Bit Rate real-time
VDSL	Very high-speed Digital Subscriber Line
VoATM	Voice over ATM
VoIP,	Voice over Internet Protocol
VoP	Voice over Packet
VoATM	Voice over Asynchronous Transfer Mode
VoDSL	Voice over Digital Subscriber Line
VoFR	Voice over Frame Relay
VPN	Virtual Private Network
WAN	Wide Area Network
XML	eXtensible Markup Language