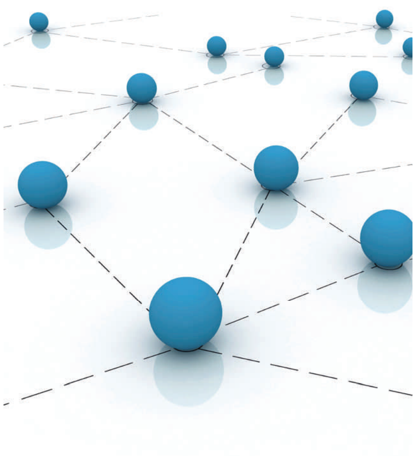

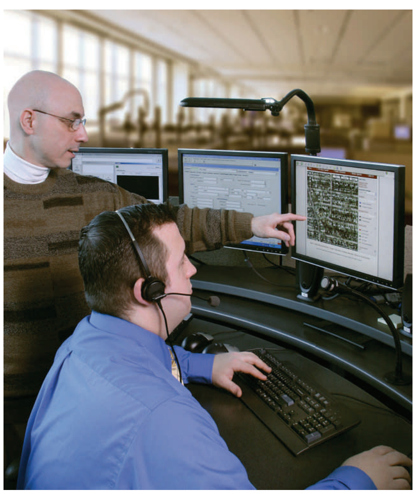

Plan for

Next Generation 9-1-1 (NG9-1-1)

prepared for

State of Maine Emergency Services Communication Bureau

January 2011 ©

L.R.Kimball[SM]

TARGETED RESULTS. EXPERTLY MANAGED.
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1. INTRODUCTION

L.R. Kimball respectfully submits this Next Generation 9-1-1 (NG9-1-1) Plan to the State of Maine (State) Emergency Services Communication Bureau (ESCB).

The ESCB is proactively looking at the future of 9-1-1 in Maine. The current contract for enhanced 9-1-1 (E9-1-1) services with Fairpoint Communications is ending. The equipment provided under that contract is nearing end of life and will require a technology refresh. This combination makes this the perfect situation for planning the next evolutionary step for 9-1-1 in Maine: NG9-1-1.

NG9-1-1 is a system-of-systems that makes use of many different services and components to receive 9-1-1 calls and data from call origination providers, and then route the calls to the proper PSAPs. NG9-1-1 systems use open standards and protocols to allow interoperability between systems and equipment.

1.1 Project Purpose

The intent of this document was to prepare a high-level migration plan for the deployment of NG9-1-1 services in a statewide system for Maine. This document is intended to aid in the delivery of ubiquitous service throughout the state. The State has successfully managed the migration to new technologies in the past, and will continue to do so into the future. The major aspect of that success has been the ESCB's planning and monitoring of the 9-1-1 system as new technologies have been introduced.

This document will provide an initial, high-level road map the ESCB may use moving forward. Once the selection of the NG9-1-1 service provider is completed, a detailed NG9-1-1 master plan should be developed to include detailed governance, operations and management policies and procedures.

1.2 Methodology

L.R. Kimball created this document using the following methods:

- **Standards** – L.R. Kimball is an active participant in several standards development organizations (SDOs) and tracks progress of NG9-1-1 standards. This knowledge is used to identify options that would be appropriate for Maine.
- **Data Gathering** – Data gathered from previous projects with the State and meetings with the ESCB staff and stakeholders. This information allowed the recommendations in the document to reflect the needs of the ESCB and stakeholders.
- **Industry Experience** – L.R. Kimball used the experience of working with the SDOs, Internet Protocol (IP) network and system implementations, and NG9-1-1 planning and development to provide the ESCB with this migration plan.
- **Assumptions** – The following assumptions were made during the completion of this plan:
  - The deployment will be at the state level, and no regional systems will be used

- NG9-1-1 and customer premise equipment (CPE) procurements will be in a single procurement
- The final system will be open standards-based
- The basic NG9-1-1 functions are described, regardless of the location and number of public safety answering points (PSAPs)

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2. CURRENT ENVIRONMENT

In March 2008, FairPoint Communications, Inc. (FairPoint) acquired the assets and service areas from Verizon New England (Verizon). FairPoint is now both a local exchange carrier (LEC) and the E9-1-1 service provider for the state. E9-1-1 services include automatic location identification (ALI) functionality and database management, CPE, 24/7 support and maintenance of all components and training for PSAP staff.

In Maine, 9-1-1 calls originate from three sources: wireline, wireless, or Voice over Internet Protocol (VoIP). In each case, calls route through the FairPoint Communications 9-1-1 system to the appropriate PSAP. Verizon originally designed and maintained the network for wireline (landline) E9-1-1 calls. The system was adapted in 2003 for wireless calls, with VoIP capability added in 2007.

FairPoint's dedicated time division multiplexing (TDM) network with analog centralized automatic message accounting (CAMA) trunks deliver 9-1-1 calls to the appropriate PSAP. FairPoint has two redundant E9-1-1 tandem offices in the state. Both tandems connect to each of the 26 PSAPs. FairPoint contracted with Intrado for call routing and call data delivery database management. Intrado uses a multi-protocol label switching (MPLS) network, which provides diverse routing from the two tandems to their two redundant database centers. Four Intrado switches provide redundant paths by using two different networks for each pair of switches.

2.1 Current MSAG and GIS Maintenance

The ESCB contracts with the Maine Office of GIS (MEGIS) to maintain both the Intrado master street address guide (MSAG) and the mapped data. This office frequently compares the tabular MSAG and the GIS road network to improve the synchronization of valid address data. MEGIS maintains the road network with address ranges based on update information from the approximately 500 organized towns in Maine and also from the 16 counties who have responsibility for the unorganized areas of Maine. MEGIS maintains polygon datasets for PSAP jurisdictions for wireline, wireless, and VoIP as well as emergency service zone (ESZ) boundaries. Additionally, emergency responder points are maintained in an informal manner. Other mapped data provided to the PSAPs are town and county boundaries, aerial photography, trails (snowmobile, ATV, hiking, and non-911 private roads), hydrants, lifeflight landing sites, common place names, boat landings, camp sites, and water bodies.

2.2 Wireline, Wireless and VoIP

In 2009, the PSAPs in Maine received 647,691[1] E9-1-1 calls.

[1] Call count was obtained from individual PSAPs. Municipal and county wireless call counts include many calls received and counted at the four DPS PSAPs and transferred to the municipal and county PSAPs.

9-1-1 Call Type	# of 9-1-1 Calls	% of Total
Landline	257,913	40 %
Wireless	369,778	57 %
VoIP	~20,000	3 %
Totals	647,691	100 %

2.2.1 Wireline Service

Wireline phones connect to the LEC's central office (CO), which provides connectivity to the public switched telephone network (PSTN). When a 9-1-1 call is placed, the CO automatically sends the call to one of the two 9-1-1 tandems. 9-1-1 calls made in southern Maine use the southern tandem as their primary tandem, and the northern tandem as their secondary, and vice versa for northern Maine. Competitive local exchange carriers (CLEC) and incumbent local exchange carriers (ILEC) connect to the 9-1-1 tandems via CAMA or signaling system 7[2] (SS7) trunking.

When a wireline 9-1-1 call reaches the tandem or selective router, the telephone number, also called automatic number identification (ANI), directs the call to the appropriate PSAP. The PSAP receives the call (voice) and the ANI on their CPE. Upon receipt of the call, the CPE automatically queries the ALI database, maintained by Intrado, for the name and location associated with the ANI. The ALI screen displays the ANI callback number, company identification (ID), class of service, customer's name and address and emergency responders for that location.

Based on the location displayed on the ALI screen, MapStar automatically plots the address of the caller. According to the ESCB, approximately 1,071,000 wireline records, provided by FairPoint, the CLECs, and other ILECs, are in the ALI database. Carriers validate customer addresses with Intrado in order to activate phone service to new customers. After the address is validated, the customer name and address is added to the ALI database.

2.2.2 Wireless Service

Wireless or cell phones use radio technology for communications. Wireless service providers (WSP) have developed a network of radio towers to provide their customers with mobile communications. When a wireless call is initiated, the cell phone locks onto an open radio channel on a nearby cell tower antenna. The radio channel connects to the carrier's mobile switching center (MSC), which sends the call, via SS7 trunking, to one of the two 9-1-1 tandems. As a wireless user moves across a geographical area, the network hands the live call to the next available cell site antenna. As long as the WSP has radio coverage in an area, a wireless call can take place. Some rural areas of Maine have little or no cellular service, which limits wireless usage.

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[2] An out-of-band signaling system used to provide basic routing information, call set-up and other call termination functions. Signaling is removed from the voice channel itself and put on a separate data network. - **NENA Master Glossary of 9-1-1 Terminology, p.88.**

As with wireline, wireless calls from southern Maine use the southern tandem as primary and the northern tandem as the secondary, and vice versa.

Five WSPs operate in Maine: AT&T, Sprint/Nextel, T-Mobile, US Cellular and Verizon Wireless (includes Rural Cellular). Each carrier is wireless Phase II deployed, providing caller location to the PSAPs. WSPs' systems include MSCs, service control points (SCPs), and mobile positioning centers (MPCs).

To deliver wireless 9-1-1 calls to the correct PSAP, wireline routing technology must be used. A wireless routing database record is created for each sector of every cell tower for all WSPs.

The E9-1-1 service provider assigns a range of routing numbers, or emergency service routing keys (ESRKs) to each WSP, who in turn assigns a unique ESRK range to each PSAP in Maine. Within the wireless routing database, ESRKs identify the primary PSAP for each wireless call.

When a wireless 9-1-1 call reaches the tandem or selective router, the ESRK or pseudo ANI (pANI) routes the call to the appropriate PSAP. The PSAP receives the call (voice) and the pANI on its CPE. Upon receipt of the call, the CPE automatically queries Intrado's ALI database for the information needed or for steering data to a third-party database.

The MSC sends the cell tower sector and address information, the ESRK (pANI), the caller's telephone number and the cell tower latitude and longitude coordinates to the WSP's SCP. The SCP queries a third-party MPC for the caller's location. The MPC provider receives the location from either their equipment attached to the WSP's wireless network or from the cell phone's global positioning system (GPS) technology. The location information received is in the form of latitude and longitude coordinates and will replace the cell tower's latitude and longitude in the ALI record.

The WSP's system provides Intrado with ESRK/pANI, WSP ID, class of service, cell site address, and latitude and longitude of the cell site or caller's location and callback number.

The location of the caller, which is based on the MPC, may not be available until after the call has been answered by the PSAP. The key to identifying if a wireless call is providing the caller's location is the class of service designation in the ALI screen. If the class of service is WPH1 (Phase 1), the latitude and longitude represent the cell tower address; if the class of service is WPH2 (Phase 2), the latitude and longitude represent the approximate location of the caller. A manual re-bid of the ALI database during the call may be required.

MapStar automatically plots the latitude and longitude coordinates provided.

The legacy 9-1-1 system can only provide a limited amount of data to the PSAP CPE. The customer name and home address associated with the wireless number are not delivered with a wireless call.

2.2.3 VoIP Service

VoIP is the routing of voice conversations over the Internet or through any other IP-based network. Devices can be used anywhere as VoIP phone service utilizes the Internet for connectivity.

In May 2005, Federal Communications Commission (FCC) Order 05-116[3] was adopted. This rule required providers of interconnected VoIP services to supply 9-1-1 emergency calling capabilities to their customers as a mandatory feature of the service by November 28, 2005. "Interconnected" VoIP services allow a user to receive and make calls by connecting to the traditional telephone network.

Under FCC rules, interconnected VoIP providers must deliver all 9-1-1 calls to the local emergency call center; deliver the customer's callback number and "registered location" information, where the emergency call center is capable of receiving it; and inform their customers of the capabilities and limitations of their VoIP 9-1-1 service.

VoIP service providers (VSP) are allowed to satisfy this rule through a CLEC, third-party partners (VoIP E9-1-1 database providers), or any other providers that have an E9-1-1 solution.

Only VoIP subscribers with static addresses can make emergency calls using the existing 9-1-1 network. In some areas of Maine, cable companies provide VSPs with connectivity by using CLECs to deliver 9-1-1 calls to the PSAP through the wireline system. A VSP that uses dynamic routing must connect to the 9-1-1 tandems through a VoIP (third-party) database provider. In order to route these calls, VoIP database providers obtain a range of numbers called emergency service query keys (ESQK) from the LEC. VSP database providers assign specific ranges of ESQK to each PSAP. After a VoIP subscriber provides the address where the device is located, the VoIP database provider will verify the address by comparing it to postal, geographic information system (GIS), and the MSAG databases. After the address is confirmed, the appropriate ESQK range is assigned to the customer's ALI record. These ESQK (pANI) are used to route the call to the proper PSAP. At the time a 9-1-1 call is made, the VoIP switching center assigns a specific ESQK (pANI) from the assigned range to the call.

In Maine, most VoIP providers using VoIP database providers also plot the subscriber's address using a mapping solution. The resulting latitude and longitude coordinates are added to the customer's record maintained by third- party database providers.

Upon receipt of the call, the CPE automatically queries Intrado's ALI database for additional data. The VSP supplies Intrado with ESQK/pANI, VoIP service or database provider's company ID, class of service, customer name and address, latitude and longitude, and callback number.

MapStar automatically plots the caller's location using the longitude and latitude provided by the VSP.

VoIP 9-1-1 service is dependent upon customer-provided addresses and address changes. If the subscriber moves or is mobile, he or she can use his or her VoIP phone if Internet access is available. If he or she

[3] http://www.fcc.gov/cgb/voip911order.pdf

fails to change his or her address, a 9-1-1 call will be delivered to the PSAP designated by the last address registered with the VoIP provider. Address changes also delay 9-1-1 service because the VSP must verify and accept the new address through their database provider before a 9-1-1 call can be delivered to the correct PSAP.

2.3 Public Safety Answering Points and Dispatch-Only Sites

Of the 26 PSAPs statewide, 13 are county government-based, four are operated by the Department of Public Safety (DPS), and nine are operated by municipalities. PSAP annual call counts range from 5,100 to 157,431. The four PSAPs operated by DPS receive most of the wireless calls in the state. When necessary, wireless 9-1-1 calls are transferred to county and municipal PSAPs.

The ESCB provides the PSAPs with an interconnected statewide system, which includes the equipment and services listed below.

- 9-1-1 Trunking
  Each PSAP has 9-1-1 trunking to FairPoint's two tandem offices, with two trunks for each 9-1-1 position. For example, if a PSAP has two 9-1-1 positions, then it has four trunks. The trunks are split evenly between the two tandem offices. In the above case, two trunks are from each office. All PSAP trunking is configured the same. Twenty PSAPs have between four and eight 9-1-1 trunks, while the remaining six have either 12 or 16 trunks.

- CPE
  CPE for all PSAPs is provided by Plant/CML. CPE delivers the 9-1-1 call and the corresponding call data to the call taker. Twenty of the smaller PSAPs, with two to five answering positions, have Vesta Pallas equipment. Six PSAPs, with 8 to 16 answering positions, have Vesta Meridian with automatic call distribution (ACD).

- ALI Links
  Each PSAP has ALI links back to each 9-1-1 tandem office. These links provide each PSAP with redundant access to the ALI database. During a 9-1-1 call only a limited amount of data (ANI or pANI) can be delivered with voice to the PSAP. For a wireline call, it is the customer's phone number. CPE uses the ANI (pANI) to query the ALI database for the location of the caller via the ALI links.

- Mapping
  The Orion MapStar system is provided by Plant/CML. MapStar automatically plots the location of the caller based on the ALI information received on the CPE at the PSAP. Mapping data is regularly updated by the Maine Office of GIS and pushed to the PSAPs over the managed services network.

- Call Record Management System
  Plant/CML MagIC is a call record management system provided at each PSAP. This system makes a record of each incoming and outgoing call through the CPE at the PSAP. MagIC

provides ESCB and PSAP staff with a variety of reports and query ability based on call data, such as PSAP and individual activity and performance levels.

- Managed Services
  The statewide network is a frame relay network that uses a T-1 connection as a conduit to each PSAP. The network hosts Maine's National Crime Information Center (NCIC) network and the 9-1-1 managed services network. The 9-1-1 managed services network, supported by Plant/CML Monitoring and Response service for FairPoint, is used for system updates, monitoring, disaster recovery and mapping updates by the Maine Office of GIS. Access is gained through a firewall at two diverse entry points.

  The FairPoint Emergency Response Center (FERC) and Network Operations Center (NOC) are located in Manchester, New Hampshire. The FERC takes trouble calls from the PSAPs, dispatches emergency service technicians, and also monitors uninterruptible power supply (UPS) alarms at each PSAP. The NOC is responsible for FairPoint's telecommunications network in Maine, New Hampshire and Vermont.

Should a 9-1-1 call need to be transferred between PSAPs, the transfer occurs within the 9-1-1 system. The voice and routing number (ANI or pANI) are transferred and the corresponding call data delivered via Intrado's ALI database. This allows the receiving PSAP to update location information for wireless calls.

Currently, there is category 5 (Cat-5) cabling at the PSAPs. End office-to-PSAP (last mile) connection is via copper. Interoffice connections are via fiber. The Central Maine Regional Communications Center (CMRCC) has fiber for the last mile.

There is no IP connectivity available at the PSAPs at this time. FairPoint is proposing two network projects: broadband for home use and a core IP transport network for 9-1-1 across all three states. According to FairPoint, the target date for completion is 2011.

In addition to the 26 PSAPs, there are 47 dispatch-only sites, according to ESCB records. Thirty-three of these sites are municipal police departments or Sheriffs' Offices. These agencies are on the same NCIC network that also provides managed services to the 26 PSAPs

The dispatch-only sites are not connected to the 9-1-1 system, and have no CPE or ALI links. A 9-1-1 call transferred to one of these sites arrives via the PSTN. The dispatch center receives voice and, if the center subscribes to caller ID services, caller ID. The location and nature of the emergency must be delivered verbally by the PSAP or caller.

During the 2005-2007 PSAP consolidation efforts, the number of PSAPs was reduced from 48 to 26. Originally, 18 of the 22 closed PSAPs opted to continue dispatch services for their agencies. Currently, 13 of the 18 are still dispatching.

In an effort to provide ALI data to the dispatch centers that no longer have CPE, the ESCB offered a one-time grant that provided the dispatch site with an interface between their designated PSAP's computer aided dispatch (CAD) system and the dispatch site's CAD system. If the PSAP's CAD was not compatible with the dispatch site CAD, the ESCB paid to install the dispatch CAD at the PSAP. Incoming calls that need to be transferred to a dispatch center require a manual data download to the correct CAD by the call taker. Nine PSAPs and 14 dispatch-only locations received the CAD interface grant. During the 2010 Optimum PSAP Reconfiguration study, there were several complaints from dispatch focus groups regarding the speed and reliability of the CAD interface.

2.4 Call Handling Procedures

Wireline and VoIP 9-1-1 calls are handled in the same manner. However, the level of service varies from area to area due to various PSAP and dispatch configurations. The configurations and key service points are as follows:

- Full service PSAP (Call taking and dispatch)
    - No transfers
    - No delays
    - Caller's location plots to map software
    - Call data and callback number readily available

- PSAP-to-PSAP transfers
    - Call transfer and call data delivery arrive at the receiving PSAP simultaneously
    - Minimal delay
    - Re-interview streamlined because of available call data
    - Caller's location plots to map software

- PSAP–to-Dispatch-only with CAD interface
    - Dispatch receives call data and location information at the time of data transfer
    - Minimal delay
    - Re-interview streamlined because of available call data
    - If the call is terminated or lost, dispatch will have the callback number available, if needed
    - If dispatch center has mapping software and it is interfaced with CAD, caller's location will plot to the map

- PSAP-to-Dispatch with no CAD interface
    - PSAP needs to provide callback number and location information verbally
    - Re-interview of the caller required
    - Manual CAD data entry required, to include nature and location of the emergency and callback information for the caller

- If the call is terminated or lost, dispatch may have to call the PSAP for a callback number if it is not noted during the initial call transfer

Repeating information during an emergency is frustrating for the caller. The name, location, and callback number are all automatically delivered in an E9-1-1 PSAP.

Wireless 9-1-1 calls create additional transfers in the emergency communications system. The four DPS PSAPs receive the majority of the wireless calls. Lincoln County, Lewiston/Auburn 9-1-1 and Portland Police Department also receive a significant number of wireless calls. The PSAPs in Franklin, Knox, Somerset, Cumberland, and Waldo Counties and Scarborough Police Department receive wireless calls directly from US Cellular only. Sanford receives calls directly from US Cellular and Verizon Wireless.

By definition, wireless callers are mobile. The coverage quality varies by location, carrier, device, and battery strength. If the connection is weak or severed before an accurate location is given by the caller or the WSP location system, the PSAP will have to reconnect with the caller, if possible.

Wireless call handling varies greatly in the current environment. The various processes are as follows:

- Full service PSAP (Call taking and dispatch)
  - No transfers
  - No delays
  - Caller's location plots to map software
  - Call data and callback readily available

- PSAP-to-PSAP transfers
  - The call transfer and call data delivery arrive at the secondary PSAP at virtually the same time
  - Minimum delay
  - Re-interview streamlined because of available call data
  - ALI data updates for mobile caller available to secondary PSAP
  - Caller's location plots to map software

- PSAP-to-Dispatch with CAD interface
  - Dispatch receives call data and location information at the time of data transfer
  - Minimal delay
  - Re-interview streamlined because of available call data
  - If PSAP exits the call, dispatch center will not be able to get any location updates electronically. Verbal updates from the caller are needed
  - If the call is terminated or lost, dispatch will have the callback number available, if needed
  - If dispatch center has mapping software and it is interfaced with CAD, the caller's location at the time of data transfer will plot to the map

- PSAP-to-Dispatch with no CAD interface
  - PSAP needs to provide callback number and location information verbally

- Re-interview of the caller required
- Manual CAD data entry required, to include nature and location of the emergency and callback information for the caller
- If caller is coherent, reliable and familiar with their location, data from the PSAP may not be needed
- If PSAP exits the call, no confirmation of location information is available
- If the call is terminated or lost, dispatch may need to call the PSAP for a callback number, if it is not noted during the initial call transfer

A major advantage of E9-1-1 is the ability to verify caller-provided information with the ALI data, which is a reliable independent source.

3. CONCEPTUAL SYSTEM DESIGN

NG9-1-1 is a system-of-systems composed of one or more IP networks, protocols, applications, databases, servers, and user devices and makes use of many different networks, services, and components. These networks, services, and components are explained to assist in understanding the conceptual system design.

3.1 NG9-1-1 System Overview

The Maine ESCB NG9-1-1 system should be developed using open standards that will allow for interoperability with call origination systems, PSAPs, and other NG9-1-1 systems. These open standards are being developed by several SDOs. Two primary SDOs with respect to open NG9-1-1 standards are the National Emergency Number Association (NENA) and the Internet Engineering Task Force (IETF).

Additionally, the National Information Exchange Model (NIEM), a partnership of the Department of Justice (DOJ) and the Department of Homeland Security (DHS), defines standard XML formats to enable critical information sharing among jurisdictions. NG9-1-1 CAD and dispatch systems are expected to be NIEM-compliant.

To facilitate interoperability, the Maine NG9-1-1 system will be based on the NENA NG9-1-1 standards that are commonly referred to as i3. These standards are built on standards from other organizations such as the IETF.

This section will describe the networks, services, and components of the NG9-1-1 system following the typical call flow.

One of the components of the NG9-1-1 system is an “emergency services IP network,” or ESInet, or simply, “the system”. An ESInet is based on a private, secure, and highly resilient IP network that is used to carry the call and call information. Aside from special precautions that are taken to ensure this IP network’s security, reliability, and its ability to handle “real-time” traffic, the IP network is otherwise unremarkable. It is otherwise much like any other typical enterprise, regional, or state-level IP network.

A second major component of the NG9-1-1 system is the various applications and devices that are needed for NG9-1-1 to operate effectively. These services or software-implemented functions provide for the delivery of “next generation” calls and data to PSAPs. In an NG system, a call is any request for emergency assistance, be it a voice, text, picture, automated data, or video call. Emergency calls can originate from a variety of sources, including wireline and wireless telephones. Applications and devices of NG9-1-1 will permit the system to be changed and modified in the future. Applications can be added to perform specific functions with limited impact to the systems as new technology is introduced.

The IP-based services that route, setup, disconnect, and otherwise control emergency calls through the ESInet IP network will be discussed later. However, these services all speak a common language, both to each other and to the call originating and call terminating equipment. This common language permits standardized and interoperable communication between and among NG9-1-1 systems and between and among system elements connected to the ESInet.

In addition to the IP and IP network-related protocols, the language of the NG9-1-1 services includes three IETF protocols: Session Initiation Protocol (SIP), Real-time Transport Protocol (RTP), and the Location-to-Service Translation (LoST) protocol. It also includes the Presence Information Data Format – Location Object (PIDF-LO), which is an XML-based data format. By definition, an IP-based 9-1-1 system that does not utilize these standard protocols and formats is not an NG9-1-1 system.

3.1.1 Call Origination

Calls into the system will originate from both traditional and non-traditional sources. The ESCB must establish policies and requirements for interconnection to the system for the purpose of receiving calls from these sources. Points of interconnection (POIs) must be provided, through the ESCB's contracted network operator, to which communications service providers can establish connections in order to deliver emergency traffic to the system.

3.1.1.1 Direct IP Interconnection

Some service providers may be able or may choose to provide 9-1-1 calls by direct connection to the IP network, using the standard IP and NG9-1-1 formats and protocols. Direct interconnection between IP networks will also be the interconnection mode between the State NG9-1-1 system and other NG9-1-1 systems.

The ESCB must establish security and technical requirements policies appropriate to direct IP interconnection. The interconnecting service providers or networks may also have security policies of their own pertaining to this type of interconnection.

The ESCB and/or the interconnecting entity may require the use of some type of firewall, security appliance, or session border controller to adequately protect both the public safety IP network and the call originating network from accidental damage or malicious attack. These devices or functions may also be of assistance resolving differences in IP addressing schemes or dial plans between the two parties.

The required interconnection device(s) are in the interest of both the ESCB and the interconnecting party. A particular interconnection device will almost certainly be owned, operated, and located on the side of the demarcation point by the party that requires the use of the device or function.

The following drawing illustrates direct IP interconnection between several possible types of call origination networks and the ESInet.

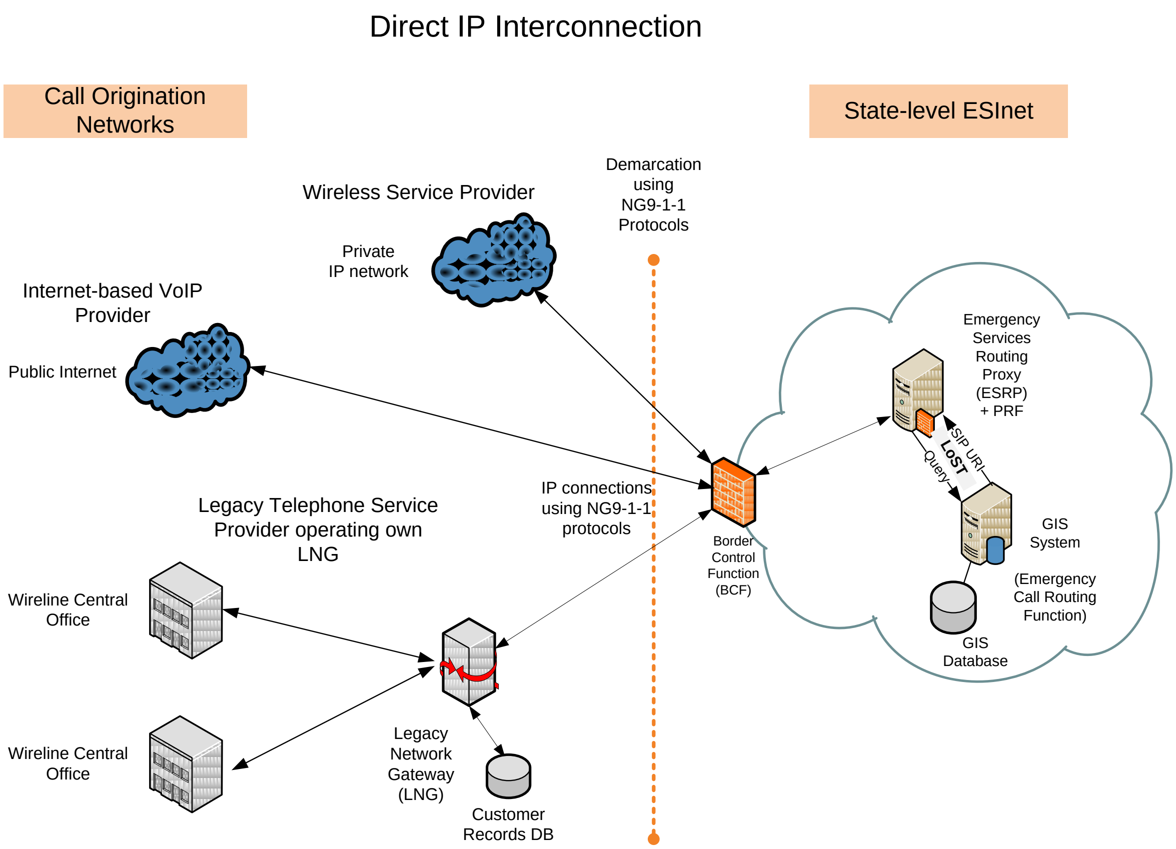

Figure 1 – Direct IP Interconnection

3.1.1.2 Legacy Networks

In order to connect calls from traditional PSTN 9-1-1 trunks to the NG9-1-1 system, a device called a legacy network gateway (LNG) is used. The LNG is itself composed of two principle elements: the gateway device and the ALI-to-PIDF-LO conversion software.

The LNG device connects directly to the traditional trunks and to the IP network. The gateway device converts the legacy call signaling and media from the traditional trunk into the standard SIP and RTP protocols used in NG9-1-1.

The LNG also contains a software element that receives the SIP message from the LNG gateway device. This software performs a traditional ALI query using the ANI arriving with the call and contained within the SIP message. The software encodes the ALI response into the PIDF-LO and then encapsulates this information into a SIP message, thereby implementing SIP location conveyance. At this point, the incoming call appears to be a fully standard NG9-1-1 protocol call. The LNG then forwards the NG9-1-1 call to the ESInet's NG9-1-1 services for further call processing.

The functions do not have to be performed in a single device. The implementation of the LNG may physically and geographically separate the IP conversion element from the LNG ALI-to-PIDF-LO conversion element. The ALI-to-PIDF-LO software may run as a process on a server somewhere on the network. These elements would then use the IP network itself to communicate with each other.

Since the software element of the LNG performs an ALI query, each instance of this element must have connection(s) to the appropriate legacy ALI databases.

Some LNG implementations may be able to consolidate such queries back through the IP network to concentration points, thereby avoiding the need for multiple ALI connections to any specific ALI database beyond those required to achieve high reliability.

Of course, the LNG must implement defaults in case it does not obtain a timely ALI response for some reason. The default is typically a default "location," ideally selected by the incoming trunk. This allows a call without location data to be default-routed similarly as in a legacy network.

3.1.1.3 Legacy Network Interconnection Options

Consideration must be given to the location of POIs between the traditional 9-1-1 network and the LNG device elements. Location refers not only to the geographic location of a POI, but also at what point in the call handling process the handoff from the legacy network to the LNG occurs.

3.1.1.3.1 Interconnecting with Legacy 9-1-1 Tandems

The LNG can connect to trunks originating from the existing 9-1-1 tandems/selective routers. This arrangement leaves the legacy wireline and wireless 9-1-1 network largely in place, and available to use as a fallback and/or as a fail-over network. This approach is relatively simple to implement and will require the fewest number of interconnections at a minimum number of locations.

By connecting the LNG device to the outgoing (PSAP) side of an existing 9-1-1 tandem, the other telephone companies and wireless carriers connected to the input side of that same 9-1-1 tandem do not have to do anything. The legacy 9-1-1 tandem can consolidate all the trunks from the individual exchanges and carriers into smaller number of "shared" trunks. This choice of POI reduces the number of LNG device ports and perhaps the number of LNG devices required.

In this interconnection arrangement, the ESInet appears to the incumbent LECs to be simply a large "consolidated" PSAP. Therefore, incumbent LECs will have less controversy with this arrangement than with other interconnection arrangements.

Transfers among and between PSAPs that remain connected to the 9-1-1 tandem are not impacted.

A downside of connecting LNGs to a legacy 9-1-1 tandem is that there is little or no cost savings realized from the operation of the traditional 9-1-1 network. The traditional 9-1-1 network continues to operate pretty much unchanged. Allowing WSPs and other non-LEC carriers to connect to an LNG also provides little incentive for these operators to move to a direct ESInet interconnection.

Because of the speed, simplicity, and safety of this type of interconnection arrangement, it may be considered for the purpose of getting the ESInet rapidly into production status, but this type of interconnection arrangement should be viewed as temporary. The following drawing shows interconnection of the ESInet with a legacy selective router using an LNG:

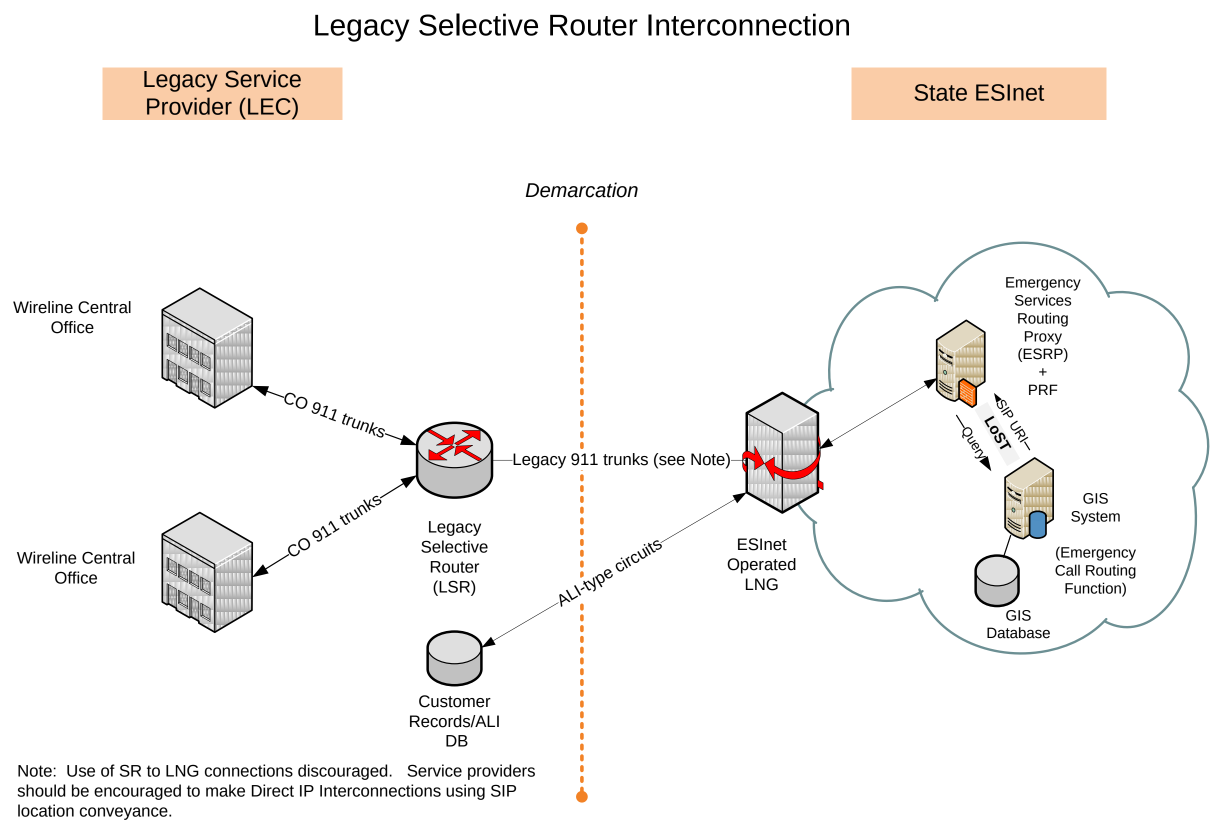

Figure 2 – Legacy Selective Router Interconnection

3.1.1.3.2 Interconnecting via Legacy Exchange Trunks

An alternate interconnection strategy is to connect individual telephone exchanges or host CO switches directly to an LNG element, ahead of and bypassing the traditional 9-1-1 tandem.

This type of legacy 9-1-1 trunk connection approach saves the costs associated with using the 9-1-1 tandem for emergency traffic originating from such LNG-connected exchanges or host switches.

Depending on geographic LNG device location(s), such direct connections may or may not reduce trunk costs overall. The cost of bringing the legacy trunks to the LNG device site should be compared to the cost of connecting the LNG device(s) to the public safety IP network from the LNG device site.

The following drawing depicts legacy exchanges bypassing the selective router. This is possible because the location-based routing function of the ESInet will provide the routing function previously provided by the selective router.

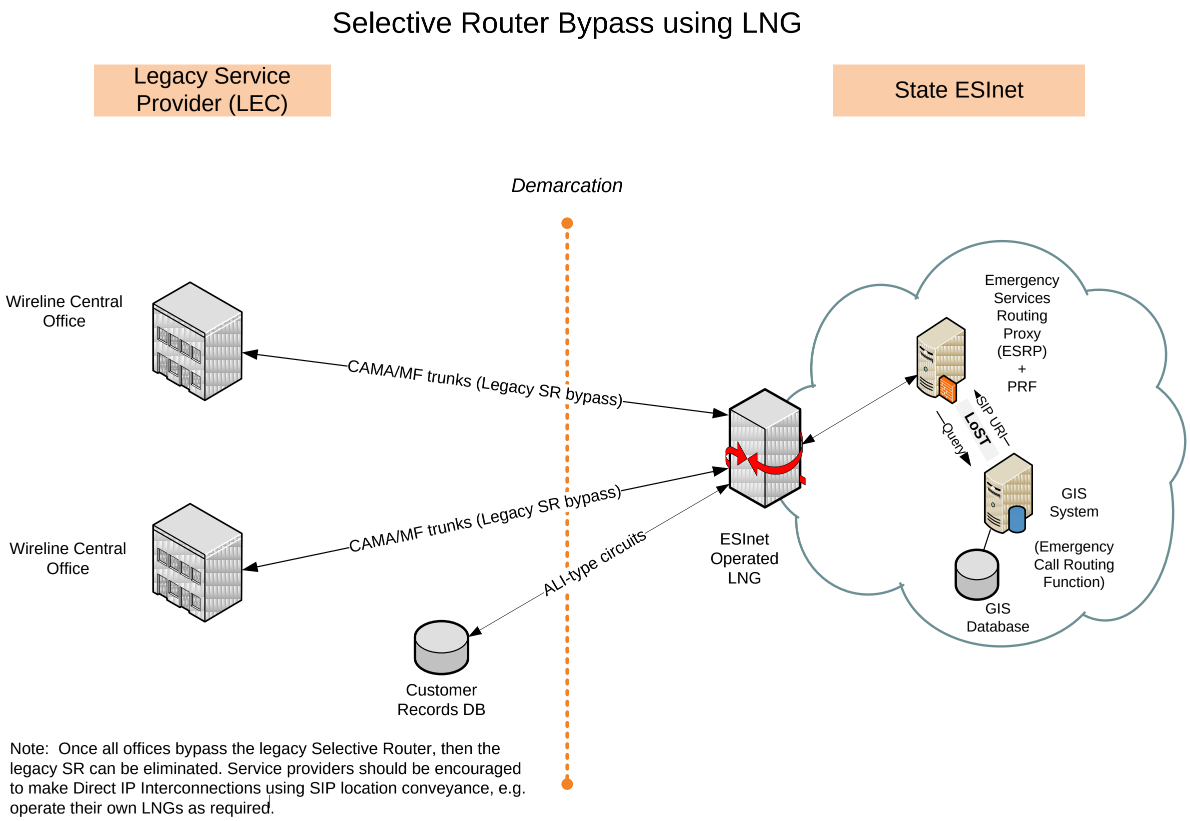

Figure 3 – Selective Router Bypass

Generally speaking, it will be less expensive to locate the LNG device element close to the source of the traditional trunks, perhaps even co-locating them in the originating CO if possible, in order to reduce the distance required for the traditional trunk circuits. As an alternative to co-location, the LNG device might be located at the geographically nearest site that is connected to the public safety IP network.

The greater the number of legacy 9-1-1 trunks that originate from the host, the greater the cost advantage of getting the LNG device geographically close to the host office. However, the actual location of the LNG device element is largely an economic consideration, and other considerations, such as LEC cooperation and accessibility to the gateway element by the LNG operator may also guide this design choice.

If the legacy network uses CAMA/multi-frequency (MF) trunks between the exchange/host switch and the 9-1-1 tandem, bypassing the 9-1-1 tandem will also improve call setup time, as one less ANI spill is required. ANI signaling on CAMA/MF type trunks normally requires about three to four seconds per ANI spill with current equipment.

Direct legacy connections may increase the total cost of the LNG itself, as more LNG ports will be required to terminate the many directly-connected exchanges. In this scenario, the legacy 9-1-1 tandem is no longer consolidating trunks for the ESInet.

Ultimately, if the traditional 9-1-1 tandem is to be fully eliminated, all carriers (including wireless carriers) that are presently connected to that tandem will need to make new interconnections to the ESInet. Accomplishing these new interconnections for many companies requires a significant investment of time, effort, and resources. Allowing WSPs and other non-LEC carriers to remain connected through the legacy 9-1-1 tandem also provides little incentive for these operators to move to a direct ESInet interconnection.

The willingness of upstream companies to bypass the legacy 9-1-1 tandem will be driven in part by the business relationship and costs between the upstream carrier and the 9-1-1 tandem operator. If the legacy connection involves considerable cost to the upstream carrier, then those carriers may be incented to move quickly to a direct interconnection to the ESInet. If, however, the existing connection is at low cost to the originating carrier, and the companies enjoy a pleasant working relationship, then convincing an upstream carrier to move from the legacy tandem to the ESInet may be problematic, short of a statutory requirement to do so, or other outside influence or pressure.

Total elimination of the legacy 9-1-1 tandem typically results in a network that is more robust and resilient, as the tandem itself (and the tandem site) are centralized points in the network, and become significant points-of-failure. If the LNG device elements are deployed at multiple sites, redundantly and diversely, then the resulting overall network will be more distributed, and therefore more resilient and survivable, than the legacy network.

3.1.2 Call Delivery and Routing

The NG9-1-1 services provide the call delivery and routing functions in the ESInet. These services are basically application-layer computer programs (software) that run on servers attached to the public safety IP network. Due to the high-availability requirements of public safety, these programs are normally duplicated, triplicated, or more, on servers located at geographically separated locations.

The system must be designed to provide automatic fail-over to other instances of the program in the event of a failure of a particular process, server, or node on the network. Several different schemes can be used to obtain high-availability among multiple program instances. Regardless of how it is achieved, high-availability is a requirement for all critical NG9-1-1 services.

The principle protocol used by NG9-1-1 services is SIP. SIP provides all call signaling and control functions in the ESInet, including the transportation of location, status, call type, or other relevant data. SIP negotiates and accomplishes the media stream setup between the endpoints in the IP network. SIP itself does not encompass the media stream.

The media streams set up by SIP use RTP. RTP is a stream of IP data packets that carry actual voice, video, or text messages. These messages are coded using a standard coding scheme that is compatible with both endpoints of the conversation.

Using SIP, the endpoints negotiate with each other to find and select a mutually compatible encoding scheme, according to the preferences of the endpoints. For example, a PSAP may be able to accommodate both voice connections, and prefer video to voice. If a call origination point contacts this PSAP, and the origination is capable of a compatible video encoding, then a video call will be set up. But if the origination point is capable of voice only or uses an incompatible video encoding, then a voice-only call is set up. This negotiation happens automatically. The endpoints use SIP to communicate with each other to perform this negotiation.

When a new encoding scheme is invented, no changes are required to the SIP protocol to utilize the new encoding scheme. A unique identifier is assigned to the new coding scheme, and then SIP can set up a connection between any two endpoints that both implement the new scheme. This separation of media from signaling is one of features of NG9-1-1 that makes the system flexible and adaptable to new communications technologies as they emerge in the future.

PIDF-LO is an XML-based data format that provides a standard way of transmitting location information over an IP network. The PIDF-LO can accommodate both "civic" (street address) locations and "geo" (geographical coordinate) locations such as latitude and longitude. The PIDF-LO accommodates civic addresses from countries from around the globe, as well as U.S. addresses. It is fully compatible with NENA-2 ALI data, and may include optional fields, such as the NENA ID and contact information that is used to identify the ALI database provider. Like all XML documents, the PIDF-LO can be extended without disrupting existing application software.

In NG9-1-1 call setup, the PIDF-LO is encapsulated into the SIP protocol messages, providing what is called SIP location conveyance. SIP location conveyance attaches location information (in the legacy 9-1-1 system, the ALI data) to the SIP messages that set up an NG9-1-1 call. In NG9-1-1, there is no ALI network separate from the voice network. All NG9-1-1 communications requirements are provided by the single public safety IP network infrastructure.

SIP location conveyance is a principle characteristic of NG9-1-1 services.

NG9-1-1 services use the LoST protocol to communicate with GIS. The GIS system is given, via LoST, both a requested type of service and a location. The GIS system responds, via LoST, with a list of one or more providers of the requested type of service appropriate to the given location.

The ESInet uses the LoST protocol to identify a PSAP appropriate to the caller's location. This requires a GIS database containing the jurisdictional boundaries of the PSAPs. The jurisdictional boundaries in the GIS should not have empty geographical "gaps" between jurisdictions, so that the system is always able to return at least one PSAP name for any location. In the NG9-1-1 system, the PSAP name that is returned is the SIP universal resource identifier (URI) of the PSAP, that is, the PSAP's emergency "telephone" number as expressed in SIP. In this way, the GIS, using the LoST protocol, provides a means of routing emergency calls based on the location of the caller.

It is worth noting that uses of the LoST protocol are not unique to emergency services. LoST could also be used to obtain contact, location, Web site addresses, or other data for nearby gas stations, hospitals, libraries, hotels, pizza parlors, or any other such "service types" for a given location, if such information is contained within the GIS database. The LoST protocol also uses the PIDF-LO data format to convey location data.

None of the IETF protocols listed are unique to public safety. SIP and RTP are already widely used on the public Internet as well as on private IP networks. The PIDF and PIDF-LO formats are being used today for determining the "presence" or status of persons or objects remotely located across IP networks, and their locations.

Only the LoST protocol was originally invented to satisfy the need for location-based call routing in the public safety network. However, the inventors of LoST have realized that LoST has broad applicability. There is a hope and expectation that LoST will also become widely used outside of public safety in the near future. If such uses of LoST become common, then public safety should benefit from the enhanced features and reduced cost of GIS software that implements LoST as these GIS systems are developed for markets other than just for public safety.

Just as the public safety IP network is built from commercial off-the-shelf (COTS) components and parts, the NG9-1-1 services use standard protocols and data formats, promoting standardized and interoperable systems and services.

3.1.2.1 ESInet

The IP network is constructed using readily available COTS parts and telecommunications services, which helps control its cost. However, the security, real-time, and reliability requirements of the public safety IP network make it somewhat more expensive than its generic cousins. Public safety IP networks are typically about twice as expensive as a generic IP network of similar size and capabilities.

The high-availability requirements of public safety also require that the IP network be continuously monitored for the proper operation of all of its components. Little benefit is achieved if a highly-reliable and redundant network is implemented only to have the failure of a redundant component go unnoticed. Provided the redundancy works correctly, a single failure should have little or no noticeable operational impact. However, the reliability of the network would be compromised as a result of the failure. Therefore, monitoring is required to detect failures, and to promptly restore fully redundant operation. This level of monitoring incurs a cost that goes beyond the cost of monitoring a more generic IP network.

The public safety IP network provides the infrastructure to carry NG emergency traffic, including traditional 9-1-1 telephone calls, from call origination points to PSAPs. Given care and due consideration for the special requirements of public safety, the IP network component of the ESInet can also be used for other public safety-related applications. Examples of such uses are NCIC terminal connections; radio system interconnections, state-wide emergency management uses, and GIS update distributions. These uses may result in a reduction of the "per-use" cost of the IP network component of the ESInet. The cost of the IP network may be shared across each use.

3.1.2.2 Border Control Function

A border control function (BCF) provides for security and call control for calls entering the ESInet from external IP networks.

BCF will consist of several components. It will include carrier-grade IP routers to accept connections from other IP networks. The routers (and/or additional equipment) will provide firewall functions and other security for protection. A back-to-back user agent (B2BUA), a function available on some IP routers, allows for isolation of IP address space and routing between the connecting network and the Maine ESInet. This occurs by terminating SIP calls from the originating network on one side of the B2BUA, and then re-originating the SIP call on the Maine ESInet on the other side of the B2BUA. The B2BUA may also terminate and re-initiate the RTP streams. The B2BUA interconnects the two sides via internal signaling and media paths that do not pass IP traffic. Then only explicitly allowed IP communications between the two networks can occur, in compliance with the NENA IP-Security (IP-SEC) recommendations.

As BCF must be a high-availability function, it will be replicated among multiple routers or devices distributed across the IP network. The economic balance between the number of BCF devices that are implemented and the amount of backhauling of connections must be determined after specific solutions have been proposed.

3.1.2.3 Emergency Call Routing Function

A SIP call controller, called a SIP proxy, provides some functions similar to a legacy telephone switch. In the legacy wireline telephone world, the telephone instrument itself is designed to be a comparatively simple device, and all of the intelligence of the telephone system is in the CO switch. This design was driven by the economics of providing large numbers of cheap telephone instruments to subscribers while using only a few expensive switches.

In the IP-networking world, typified by the public Internet itself, modern technology has made the "intelligence" of the computer chip very inexpensive compared to cost of the wires and fiber that comprise the network. The edge devices of the IP network, which are always some type of computer, are very "smart," while the core IP network, which simply routes and delivers IP packets from point to point, is comparatively simple.

This fundamental decentralization of intelligence and complexity in IP networks compared to legacy telephone networks underlies the current revolution in communications systems and methods.
The design of the SIP protocol also reflects this fundamental change. The endpoints of a SIP communications system are called user agents (UA). UAs are roughly analogous to the telephone instrument. But UAs are computer programs that are very intelligent. SIP UAs are present in SIP telephones, which in fact are computers built into a box that looks like a telephone. But SIP UAs are also

present in gateway devices, in routers, in "soft" (software) phones running on computers, in Internet-capable mobile phone applications and much more.

In the end, a SIP UA "talks" to another SIP UA: telephone-to-telephone, gateway-to-telephone, softphone-to-telephone, or in any other combination.

It is possible for SIP UAs to "talk" directly to other SIP UAs over an IP network with no intervening SIP proxy, if they know or are programmed with each other's IP address. However, UAs must be able to locate other UAs in some systematic way. Part of the purpose of the SIP proxy is to assist call-originating UAs in locating the desired or appropriate destination UA.

In the legacy telephone network, telephones are connected to other telephones by the telephone switch. The dialed digits define the target of the connection, and the telephone switch and network set up a path from the call originating telephone to the destination telephone. SIP proxies provide a similar function in the IP network.

Rather than telephone numbers, individual SIP UAs are identified by SIP URIs. SIP URIs can be name-based, as in: sip:john.doe@serviceprovider.com. SIP UAs are often set up with numbers in the URIs in order to ease interoperability with the PSTN and for the familiarity of the users, for example: sip:2075551212@voipprovider.com.

UAs can move around, disconnecting from the network here, and then reconnecting to the same or different network over there, even while the SIP URI for the UA remains unchanged. By using a UA registration process, SIP proxies may maintain a list of which SIP UAs are online, or registered, at any given moment, and record the IP address where each registered UA can be reached.

SIP proxies play a role similar to domain name service (DNS) in the public Internet. SIP proxies act as a "directory service" or clearing house for SIP UAs. The SIP proxy uses registration lists and dial plans to locate other UAs on behalf of a UA, or to forward requests to other SIP proxies, in order to reach a final destination.

SIP proxies can also perform other services, such as call forwarding, busy, ring-no-answer, or disconnected destination calls to other UAs according to some predefined rule(s). SIP proxies can also perform call detail recording of calls traversing the proxy.

For NG9-1-1 services, a SIP proxy is needed that has a 9-1-1 specific feature. The key feature a NG9-1-1 SIP proxy must implement is special call handling if the called number is sip:911 or urn:service:sos.

NG9-1-1 calls include the location information encapsulated in the SIP call setup message in the PIDF-LO. The 9-1-1 SIP proxy will then use the PIDF-LO to make a query to a GIS server, using the LoST protocol. The GIS server returns a reply containing the SIP URI of the PSAP that has jurisdiction at the caller's location. The proxy then forwards the call to the proper PSAP's URI, either directly or through another proxy, complete with the location data still encapsulated. In this way, the NG9-1-1 SIP proxy, together with the GIS server, performs location-based 9-1-1 routing.

A 9-1-1 SIP proxy must implement standard call forwarding functions, such as busy, ring-no-answer, or destination no-response. The 9-1-1 SIP proxy must also implement some sort of default scheme, in the event the GIS server does not respond to its LoST query in a timely fashion, or it receives a call to 911 that is missing or has faulty location information.

In NENA terminology, a SIP proxy exhibiting the required 9-1-1 features is called an emergency services routing proxy, or ESRP. The basic call forwarding functions, such as busy and ring-no-answer are part of the policy routing function (PRF) and are usually a sub-function within the ESRP itself.

3.1.2.4 Policy Routing Function

NG9-1-1 envisions the possibility of a much more sophisticated PRF system that routes calls based on other information in the SIP call setup messages, and/or based on information external to the call, such as information obtained from the IP network monitoring system.

For example, in the SIP message there is an optional "Language" parameter (called a "header" in SIP) that some SIP telephones will set according to the choice of language for the telephone's menus. So, if the telephone user has selected Spanish menus rather than English menus on the telephone, the SIP header will say: Language: Spanish. A sophisticated PRF could use this information to route the call to Spanish-speaking call takers, rather than to any call taker.

3.1.2.5 Public Safety Geographic Information Systems

The second foundational NG9-1-1 service is a GIS system that can respond to LoST queries. In order to accomplish this, the GIS system must include a GIS database with a map layer that defines the geographical jurisdictional boundaries of each PSAP. The boundaries should be without gaps in the geographical area, and probably without overlaps in PSAP jurisdictions.

One or more SIP URIs is associated with each PSAP service area. The GIS server looks up the location contained in the PIDF-LO, which is part of the LoST query, and returns the associated SIP URI to the SIP proxy or other requestor. The SIP proxy can then use the URI as the SIP dial string and so direct the call from the originating UA to the correct PSAP or PSAP UA, based on the caller's location.

The LoST query includes a service request type. For 9-1-1, the service request type is designated as "emergency", and the GIS system associates the emergency service request type with the map layer containing the PSAP jurisdictional boundaries. But it is possible to implement other service types. For example, police refers to a GIS layer that shows the boundaries of the police agencies, and fire the boundaries for fire department coverage areas. In this way, the PSAP can use the NG9-1-1 GIS system to determine the appropriate responder for the caller's location, and/or to effect "selective transfer," as in one-button police, one button fire, or one button ambulance call transfers based on the caller's location. In general, the GIS system can support additional GIS "layers" that provide additional information valuable to call takers, dispatchers, and emergency responders. For example, layers depicting the service boundaries of electric utility companies, railroad dispatch centers, and locations/contact information for special service providers, such as wrecker services, crane services, and bulldozer services, may be very useful to public safety operators and responders. This information, appropriate to a caller's location, can then be readily accessed by the PSAPs and other entities connected to the public safety IP network via the LoST protocol.

Clearly, NG9-1-1 is map-centric. The major administrative NG9-1-1 task is the maintenance of the GIS database. This task largely replaces the MSAG and ALI maintenance tasks of the legacy 9-1-1 systems. Modern GIS implementations should considerably ease some of the maintenance tasks of the legacy MSAG and ALI systems. For one example: the MSAG is a table-driven list of civic address ranges and associated emergency service numbers, or ESNs. To move the jurisdictional boundary, say, of an ambulance service requires identifying all the effected address ranges, and updating dozens, even hundreds, of records in the MSAG, followed by a reprocessing of many ALI records dependent on those MSAG entries. Performing the same task on a GIS system with a graphical user interface (GUI) requires accessing the appropriate GIS layer, then doing a drag and drop of the ambulance service boundary on the map, then saving the updated boundary.

The GIS system must be able to reliably convert civil (street) addresses to coordinate (latitude/longitude) locations, in order to correctly plot or map the location of the caller. The process is called geocoding. The NG9-1-1 GIS system must be tested against the traditional ALI database to verify high accuracy geocoding of the addresses in the ALI records. The ability to geocode a street addresse is the key to NG9-1-1 call routing.

3.1.2.6 Location Verification Function

Geocoding is critical to the successful location and routing of wireline and fixed communication services, such as VoIP (e.g. Vonage-like services), that specify location with civic addresses. However, geocoding can fail if the civic address does not actually exist, such as a non-existent street name.

Geocoding does not apply and is not required for wireless and mobile communications devices and/or networks that determine location dynamically and report location using geographic coordinates. The accuracy of the reported geographic location may be an issue; however, these locations are determined outside of the ESInet. The role of the ESInet is simply to communicate the reported location to the PSAP and to the call taker. It is always possible to plot a reported latitude/longitude on a map and to route the call accordingly, even if the latitude/longitude is not an accurate location for the caller, and so the call is routed to the wrong PSAP. In any event, no geocoding is required, so the geocoding process cannot fail.

In the legacy 9-1-1 world, the MSAG provided pre-validation of civic telephone service addresses, permitting many errors to be corrected before a 9-1-1 call is actually placed. The location verification function (LVF) provides a similar and equivalent validation function in the NG9-1-1 network.

The LVF also uses the LoST protocol and queries the GIS system. Rather than requesting the URI(s) of the service type, the query is for location validation. The validation function returns a message indicating if the specified civic address can be successfully geocoded. The return message indicates which elements in the civic address matched elements in the GIS database, which elements in the civic address failed to match the GIS system, and, in some cases, which elements were not verified, probably due to the failure to match other elements. For example, it makes no sense to validate the house number if the street name does not match anything in the database.

It is expected that service providers, end users, PSAPs, and any other interested parties will use the LVF to verify civic addresses, hopefully at the time a communications device is initially configured, installed, or powered up. For example, if an independent telephone company chooses to implement their own LNG using their own customer records for the LNG's ALI database, then that company could use the LVF to verify the validity of the civic addresses in their customer database at any time, but especially when a new address is added to the database, as when a customer orders service. Another example would be a customer of a VoIP service that self-provisions their own phone. The provisioning process could include a check of the civic address, perhaps even geocoding the address and plotting it on a map for the customer to verify that the location is indeed correct.

The LVF may, in fact, be built on the same GIS that responds to production LoST queries for routing purposes. However, due to security and high-availability, it is likely that at least one LVF will operate on a copy of the GIS database as a separate instance. This LVF may also be provisioned and available outside the private public safety IP network, such as at a www.Maine.gov Web site, so that it is readily accessible by the general public. Such an outside instance would not also be connected to the public safety IP network due to security considerations. Inside LVF queries may simply use the NG9-1-1 GIS / LoST system.

Since the LVF is not normally invoked at the time a 9-1-1 call is placed, the LVF may not be implemented with high-availability, as with foundational NG9-1-1 services. Never-the-less, implementing and using the services of an LVF is important to the reliable routing and operation of civic addresses in the ESInet.

3.1.3 Answering Points

The NG9-1-1 PSAP of the future, which no longer has to operate in the legacy 9-1-1 world, can use a SIP-based COTS telephone system, rather than a purpose-built 9-1-1emergency telephone system (ETS), as is common today.

Any SIP-based telephone system that fully complies with SIP standards and that satisfies the high-availability requirements of a PSAP is potentially suitable for PSAP use. This is because any standards-based SIP telephone system will pass the PIDF-LO location data (or a location URI) through the telephone system to the answering UA. The rules of SIP insure this, even if the telephone system is unaware of the purpose or content of the PIDF-LO, or of any other attachment to a SIP message.

The SIP standards and high-availability requirements may also be found in many enterprise and institutional telephone systems. Examples of these include agencies that manage the marine patrol, coast guard, forest rangers, and game wardens. Many SIP telephone systems potentially suitable for the PSAP are available today, and this number is sure to grow. The use of COTS equipment and systems has the potential to expand the vendor base and the support base for the NG9-1-1 PSAP telephone system.

The 9-1-1 specific aspect of the NG9-1-1 telephone system is in the SIP UA that runs at each emergency answering position. In addition to performing the standard and typical telephone functions, these SIP UAs must also be able to handle the SIP messages that implement SIP location conveyance.

The NG9-1-1 SIP UA, or associated call taker software, must provide these functions:

- Display the location data to the call taker
- Deliver the location data to typical public safety applications, such as CAD or mapping systems
- Query a NG9-1-1 GIS system via the LoST protocol to retrieve emergency service provider (police, fire, ambulance) information appropriate to the caller's location
- Provide "selective transfer" of a call to the appropriate responding agency
- Provide instant recall recording (IRR)
- Provide call logging / call detail recording (CDR)
- Perform other traditional and NG9-1-1 tasks

It is noteworthy that in NG9-1-1 all of these functions, many of which are performed by the legacy ETS and/or the ANI/ALI controller, may now be performed by the answering position software running on a typical desktop or notebook computer. The answering position computer is connected to the SIP telephone system using only an IP network connection.

This simple method of interconnecting the answering position also opens opportunities to easily and inexpensively implement backup PSAPs at alternate sites, or to implement "virtual" PSAPs, where the call takers are geographically dispersed.

In some instances the answering position software may report data to a centralized server over the local PSAP's IP network. For example, the NG9-1-1 answering position software may send CDR data to a centralized PSAP logging system. As another example, the NG9-1-1 answering position software may send the location data to a CAD server that is connected to the local network. These communications will themselves occur over the answering position's IP connection.

The answering positions can use COTS hardware, with the possible exception of small audio boxes needed to interconnect the answering position with legacy radio consoles, headsets, or similar such interfaces. All the NG9-1-1 specific functions are embedded in the software.

The actual selection of a PSAP's SIP telephone system will be guided by many factors. A prime consideration will be the support and interoperability requirements imposed by the vendor of the NG9-1-1 answering position software.

Some vendors may see value in supplying a product that interoperates with "generic" SIP telephone systems. The ability to use generic telephone systems should both broaden the appeal of the product and ease the need for the NG9-1-1 vendor to have workers in the field to support the SIP telephone system. In this scenario, the PSAP would obtain the SIP telephone system and service from another source, or perhaps procure both products through a third-party acting as an integrator. In any event, there should be a choice among a number of COTS SIP telephone systems that may be deployed.

However, other NG9-1-1 vendors may see the sale and support of the SIP telephone system as part of the product that they wish to market. These vendors may not be willing to "unbundle" the telephone system from the NG9-1-1 specific software, so the offering would be a "package" deal. Unfortunately, this approach may limit the use of the SIP telephone system to emergency calling only.

The deployment of NG9-1-1 systems is in a very early stage. It will be interesting to observe what arrangements will ultimately prevail in the market place. From a technical point-of-view, there is no barrier to providing NG9-1-1 solutions that work with a wide variety of generic SIP telephone systems. Regardless of the supplier and support arrangements, the use of a COTS standards-based SIP telephone system in the PSAP provides additional opportunities.

If deemed desirable, this same SIP telephone system can easily serve both administrative and emergency uses. Combining the administrative and emergency uses provides a level of integration between these two operations that is not often realized in the legacy PSAP that depends upon the ANI/ALI controller and dedicated emergency telephone system. Integration of administrative and emergency use is often particularly desirable at smaller PSAPs where the emergency call takers also perform non-emergency call taking functions.

SIP telephone systems at multiple PSAP sites can also be easily and readily linked over the public safety (or other) IP network, enabling easy answering position and/or dispatch position calling between PSAPs and independent from radio or PSTN communications.

The selection of the PSAP SIP telephone system will also be guided by desired features, such as ACD capabilities. ACD is particularly important at larger PSAPs where it is not reasonable to have every incoming emergency call appear at every answering position. The ACD features are also important should a PSAP choose to implement virtual answering positions, such as work-at-home call takers.

Other SIP telephone system selection criteria include functionality, price, quality, availability of service and support, and similar considerations typical of the selection of a telephone system in any enterprise or institution.

3.1.4 Dispatch Function

The PSAP call taker makes an initial determination of which responding agency(s) and other resources are required to deal with the emergency caller's report or situation.

If the call taker also provides dispatching functions, as in a combined call taker/dispatch position, then the call taker communicates directly with the required agencies and resources and accomplishes the dispatch.

Alternatively, the call taker may hand the call off to dedicated dispatchers who then execute the required communications and accomplish the dispatch.

In either case, the dispatch function involves the assignment of responder resources, tracking and coordinating responders, observing the status of responders, and other activities required to provide an appropriate and effective response. The dispatch function also provides a written and time-stamped log of dispatch and incident-related activities, as often required by law.

Communications is a key element of the dispatch function, which is where the call information is delivered to response personnel.

The concept of NG9-1-1 includes end-to-end information delivery. The public has information that is sent to the PSAP call taker and then through dispatch to the responders.

The location of the caller is usually the location of the emergency, and the location is the key piece of information required to get responders to the site of the emergency. The call taker also receives additional information from the caller, such as the nature of the emergency (accident, criminal activity, fire, medical emergency, etc.) and further details depending on the nature of the emergency (heart attack, traumatic injury, etc.)

A key feature of both legacy and NG9-1-1 systems is the automatic transmission of location information through the ETS. However, the legacy 9-1-1 system accomplishes this with dedicated, purpose-built networks and equipment that is quite costly. As a consequence, it is quite costly to provision full ALI systems at all dispatcher sites. Then location and other information must be communicated with responders via radio, telephone, FAX, or other communications systems, with attendant possibilities for delay, error, and use of communication bandwidth needed for other data.

The general purpose IP communications network utilized by NG9-1-1 is able to be used to communicate location as well as many other types of data, ultimately less expensively, to dispatchers. In particular, if a fully NG9-1-1 compliant PSAP transfers, via SIP over the IP network, an emergency call to a separate dispatcher, the location information that is embedded in the original call setup is also transferred as part of the call. If the dispatcher terminal equipment is running NG9-1-1 compliant software, then all the information that accompanied the call to the PSAP is also available to the dispatcher. As stated previously, it is ultimately expected that the terminal equipment and 9-1-1 software will be considerably less expensive than legacy 9-1-1 solutions because the hardware is COTS rather than purpose-built, and the 9-1-1 specific functions are entirely in software.

In addition to the data accompanying the call itself, future CAD applications may use the IP network to exchange CAD information among systems and workstations as these functions are developed by CAD software vendors.

The basis of the ability to exchange data between disparate systems is in the use of a standards-based interface. Just like the use of SIP for calls, the dispatch and location data will use a standard interface called XML. This is the same protocol that is used to convey location information in the PIDF-LO. NIEM will allow the systems to exchange and use data.

Currently, public safety CAD vendors have not shown that they are ready to embrace NIEM or other open standards-based data sharing protocols. Many view the move away from proprietary communications techniques as a disadvantage to their marketing and business models. However, if customers demand NIEM-compliance, and with pressure from DOJ and DHS in the near future, it is expected that some CAD vendors will step up, and the early adopters will enjoy a window of opportunity to market their products in a field of reduced competition. So once this process starts, it is likely to proceed rapidly.

Even in the short run, if CAD vendors release software using proprietary communications between instances of their software, the communications will occur over the IP network. The disadvantage of proprietary communications protocols is vendor “lock in,” and attendant high cost and lack of flexibility. Maine public safety agencies should encourage its CAD vendors to become NIEM-compliant as a condition for future acquisitions.

Dispatch entities will require a method to connect to the ESInet, and a system that will be capable of receiving and interpreting the information. The standard IP transport network will provide the connectivity. Due to the nature of this information and other delivery methods such as voice telephone or radio conversations, this network would not require the same level of high-availability unless that is chosen by the agencies.

3.2 Maine NG9-1-1 Conceptual System Design

The State should procure a single NG9-1-1 solution for the entire state. This should be a service provided by a single service provider. Should there need to be additional providers involved, they should be subcontracted by the single service provider. Based on the final functional requirements, the only exceptions may be the IP connectivity of the ESInet, and GIS database management, if not provided by the State.

The Maine ESInet should follow the recommendations from the NENA i3 document and referenced standard organizations, such as the IETF SIP, RTP, and LoST protocols.

In the legacy 9-1-1 system, the ALI query function, call distribution function, call logging, ALI display, and several related functions are located in built-for 9-1-1 equipment located at each individual PSAP. In the NG model, the call processing functions occur in software running on servers in the network. This allows for resiliency and redundancy that was not available in traditional 9-1-1 networks.

Server configurations will be set up to mirror each other in different geographic locations. If one server fails, the other can operate the network and the PSAPs will not incur any outage. This arrangement, along with redundant network links, allows for levels of redundancy and resiliency not available in current networks.

When the call processing functions occur within the NG network, other methods to backup PSAPs in outage situations can be investigated. Requests for 9-1-1 services from the public can be routed easily between PSAPs. Procedures to overflow calls from one PSAP to another in the case of a major emergency can be established.

In a NG9-1-1 network, all PSAPs are interconnected via IP communications. This allows for features and functionality not available with today's analog connections. Not only will NG functions traverse this network, but it can be configured to accept ancillary services along with NG services.

Depending on the selected vendor and how interconnections are developed to the various carriers, several scenarios for Maine's NG network are possible. While development of the ESInet may create significantly more monthly network charges than the analog network currently in place, it provides bandwidth and versatility not available on the analog network. Increased cost for network services can be offset with consolidation of call processing equipment from the individual PSAPs to servers in the network. This provides some cost offset since individual ANI/ALI controllers will not have to be purchased at each PSAP location.

In concept, the requests for 9-1-1 services will originate from several sources, be processed and directed to the correct PSAP. The following drawing is a general concept of a single ESInet environment where the interconnections to the service providers are all separate connections.

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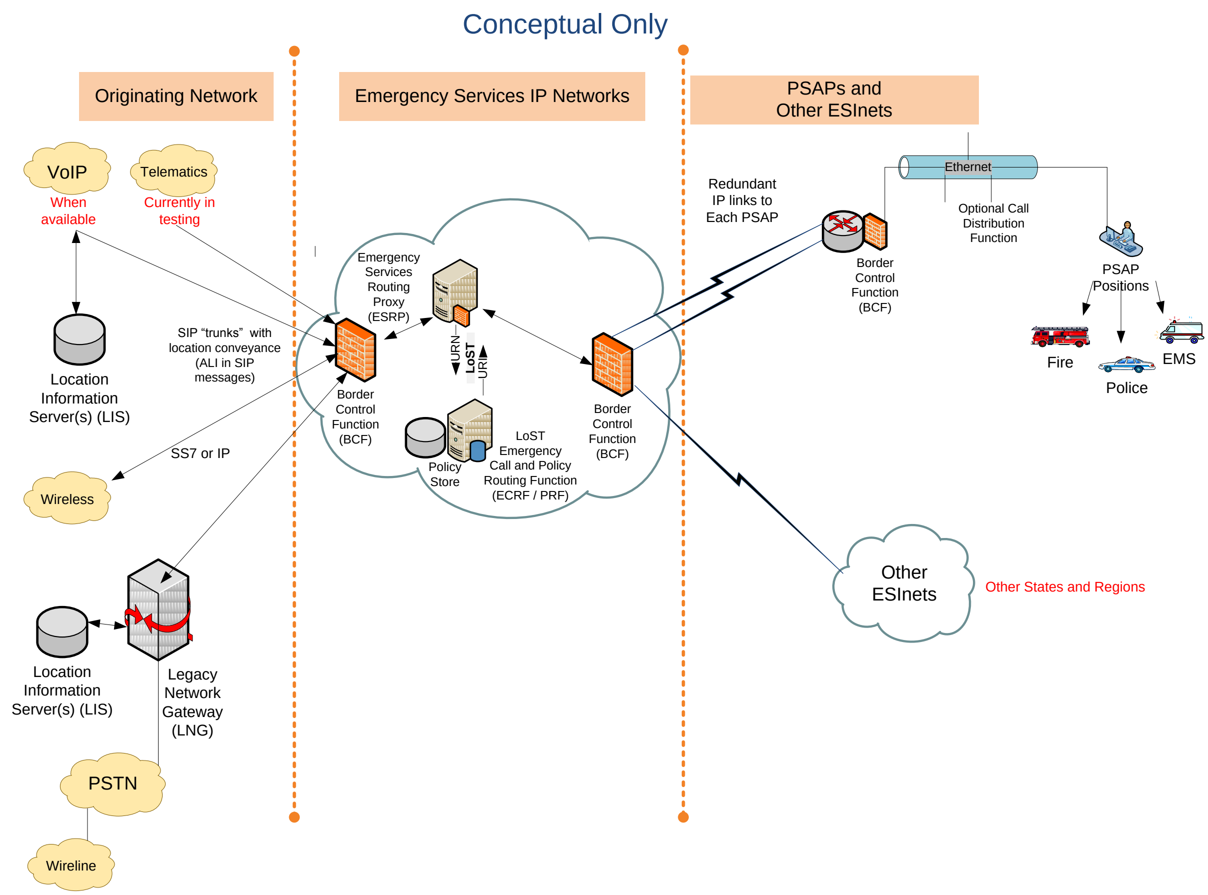

Figure 4 – Conceptual Design

3.2.1 Call Origination

Call origination is started on a network outside of the Maine NG9-1-1 system. The Maine system must provide a method to receive calls from these outside networks.

3.2.1.1 Direct IP Interconnection

The Maine NG9-1-1 system should include an arrangement for the originating providers to deliver calls to the ESInet in native IP format. This format should include all associated information about the call from the providers and be compatible with the NENA i3 and associated open standards and protocols. The interconnection should provide for the needed security and call controls as described later in BCF.

Such direct IP interconnections should be supported at any geographic system site that has been determined to have adequate bandwidth and facilities for the requested interconnection and as determined by the ESCB. The intent of this feature is to permit as much geographic diversity in network interconnections as possible. Greater diversity improves the overall resiliency and survivability of the system. It also supports more rapid recovery in the event of a disaster scenario by providing geographically dispersed options.

The Maine system should only allow IP direct connections from providers that agree to deliver complete required data elements to the system in a standard IP format. This connection should not be used to allow limited interconnections, such as a voice-only IP feed to the system.

3.2.1.2 Legacy Networks

The system will include LNGs to allow legacy network service providers to continue to deliver 9-1-1 calls to the system via legacy protocols and facilities. Any legacy network service provider may provide and operate an LNG and then make a direct IP interconnection to the system as described above. Otherwise, no new service or service provider should be allowed to connect to the LNG in the future. Any new connections should be direct IP connections.

Any LNG acquired as a part of Maine NG9-1-1 effort should support distributed LNG elements and be scalable with respect to the number of trunk connections. The LNG should also consolidate ALI database links in order to minimize system cost. The LNG should be sized to handle the current level of PSAP trunking that is in place today. The LNG must support the legacy network call volume that is realized today. The LNG call volume is expected to decline as providers migrate to the IP interconnection.

3.2.1.3 Legacy Network Interconnection Options

Based on the plan to use a service offering rather than a built and owned system, the legacy network interconnections would be more economical at the provider's locations. These should be located at the current provider's legacy selective router locations or geographically nearby to reduce trunking charges based on mileage.

3.2.2 Call Delivery and Routing

3.2.2.1 ESInet

The Maine ESInet will be a redundant, high-availability IP network for the connectivity of the elements of the NG9-1-1 system. The required specifications will be developed in the procurement process based on size, location, and specific elements implemented. The network should be sized to allow for heavy use and allow for larger expansions as needed, without the need to replace the entire system.

Existing networks should be evaluated against the detailed functional requirements to determine if some or all of these networks can be used for the ESInet. Multiple interconnected networks should be used to achieve necessary high-availability and redundancy. These networks will need to meet specific requirements for availability and security. The detailed functional requirements will be developed prior to procurement or use.

3.2.2.2 Border Control Function

The Maine BCF will consist of several functions, to include a carrier-grade router to accept connection, firewall and other security for protection, a B2BUA for call control for SIP calls entering the system, and constant monitoring. Vendor proposals should be sought that will implement many or all of these functions into IP routers provisioned at POIs.

The implementation should include geographically dispersed POIs located at or near facilities shared by a large number of communications providers, that is, at carrier co-location facilities. This will permit the easiest and lowest cost interconnection with service providers and other ESInets. Ideally, such sites should implement full BCFs, but rather than limit the number of POIs due to BCF (economic) considerations, backhaul of IP connections via secure tunnels from smaller POIs to the BCFs will be considered.

3.2.2.3 Emergency Call Routing Function

The Maine system will have an ESRP based on the NENA standards to route calls as needed. As a key element of the NG9-1-1 system, the ESRP must be of a geographically dispersed, high-availability design.

To assist in the function of the ESRP, there must be a basic PRF, which may be implemented as a part of the ESRP or as a separate process invoked by the ESRP. The basic PRF must implement, as a minimum, the legacy ring-no-answer, busy, and failure call forwarding functions of the legacy 9-1-1 selective router.

The growth path for the PRF must support a more sophisticated future PRF, without disrupting the ESRP already in place. This more sophisticated PRF will provide routing policy store, policy editing, and test functions, allowing policies to be verified before being implemented in the operational NG9-1-1 system.

The GIS information needed for PSAP and responder jurisdictions will be developed from the present Maine GIS system. This data will be copied (mirrored) into the NG9-1-1 GIS data store used by the LoST protocol. The operational GIS system must also be of a geographically diverse, high-availability design.

The NG9-1-1 GIS system should be dedicated to the operation of the NG9-1-1 network, and should be implemented separately from other Office of Information Technology systems.

3.2.2.4 Public Safety Geographic Information Systems

The GIS database that is used for the emergency call routing should have an additional copy placed on a server that can be accessed from outside the ESInet for the purpose of location validation prior to the delivery of a call. There should be operational processes in place to ensure that this is kept updated to the same level as the GIS store in the ESInet to ensure proper validation of location data from users. LoST services should be configured with the database to perform the function of validation.

3.2.3 Public Safety Answering Points

The Maine system will include SIP-based call handling equipment at the answering points, and NG9-1-1 capable answering positions. This equipment must be capable of receiving and interpreting the data delivered with emergency calls transported to the PSAP by the Maine ESInet. The equipment must also provide standard interfaces to existing CAD and mapping applications.

Equipment functional requirements should be developed based on user needs and the needs of a NG9-1-1 call: both the SIP call setup and the media stream.

Since the acceptance of call information from the carriers and routing is occurring in the ESInet, the equipment and software at answering points do not have to perform those functions. Considerably less equipment will be required at the PSAP locations.

Most equipment manufacturers today state that they will include all new standards as they are developed, but as discussed above, the basic standards are in place today.

3.2.4 Dispatch Function

Dispatch-only centers may obtain information on calls several ways. The dispatch center may, at their option and expense, connect to the state-level ESInet at any POI. Most such connections would be at a POI close to the dispatch center unless strong reasons exist for making that connection elsewhere. It will be the dispatch center's option whether these connections are redundant and/or diverse.

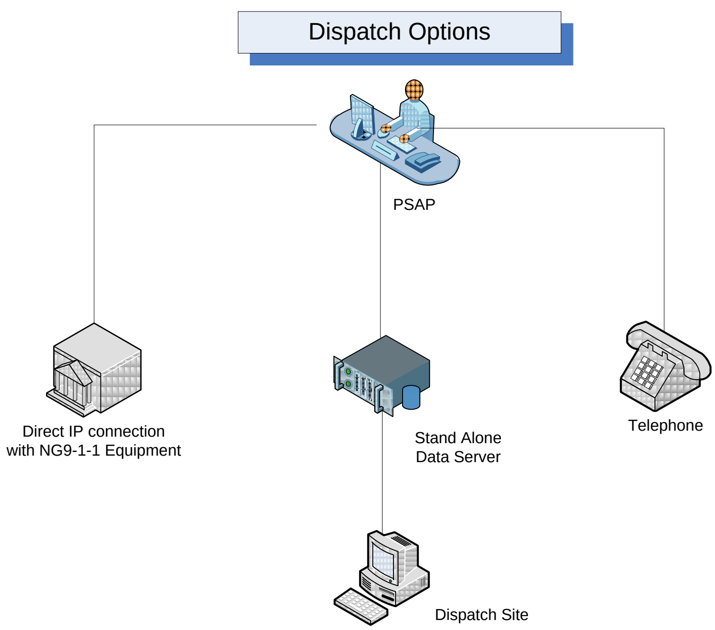

Figure 5 – Dispatch Options

A dispatch-only site could have a direct connection to the ESInet. This connection and the acquisition of compatible NG9-1-1 CPE or SIP telephones would be at their own expense. Full CPE will provide dispatch centers with access to full NG9-1-1 data and SIP telephone will only provide voice. This will allow the dispatch center to have the functions of a NG9-1-1 PSAP, but will also pose interconnection and security risks to the system that will need to be addressed.

To accomplish this type of connection, the ESInet BCF, emergency call routing function (ECRF), and POIs will need to be sized to support these connections. Additional security policies, monitoring, and possibly other equipment may be needed. This solution results in the dispatch-only center becoming another logical component of the ESInet. While the dispatch-only sites would procure their own equipment, supporting this option would still add expense to the overall system cost.

There is also the possibility of provisioning a web-based server to which location data for active calls would be pushed. Such a server would then be manually queried via a web browser, CAD, or other software running on a PC at a dispatch center's answering position. This server might be inside the ESInet, or provisioned on a private network.

The web-based server will make available location data and additional data for the call. This service will make the information available using SIP location conveyance and/or NIEM-based or Emergency Data eXchange Language (EDXL) data elements. The Maine governance structure will determine the data elements that will be made available.

Dispatch agencies must supply their own NG9-1-1 systems that will be able to subscribe to this data. To get the data, each agency must have a connection to the web-based server, and a system that can request, retrieve, and use the data. Each agency will be able to request some or all of the available data elements.

The PSAP CPE equipment is programmed to transfer calls to seven-digit PSTN numbers. It is then possible for a dispatch center to receive calls via the PSTN, and to use an inexpensive connection and PC to access location data via the Web-based server.

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4. MIGRATION PLAN

This section provides a road map for the State to move from the existing legacy 9-1-1 network, as described in Section 2, to an NG9-1-1 system, as described in Section 3. The details of this migration plan will become the basis for the technical specifications and requirements of a request for proposal (RFP) to be issued at a later date.

This migration plan considers the current work of the NENA NG Transition Planning Committee (NGTPC). The NGTCP currently has a *NENA NG9-1-1 Transition Plan Considerations Operational/Technical Information* document in draft form. This document outlines various transition scenarios. This migration plan is in alignment with transition scenarios in the NENA draft document that are likely to apply to Maine.

The migration plan provides an overall framework for the project and attempts to identify and separate the required tasks in a logical arrangement. Some details are under the control of the ESCB, while other details will be under the control of the selected NG9-1-1 provider. Therefore, this scheme is preliminary and subject to change as the project unfolds and as the future vendor provides additional input.

The migration plan consists of four major stages, executed approximately consecutively. The challenge for the migration strategy is to minimize the overlap, in both time and money, during which the State must pay for the operation of both the legacy network and the ESInet. To the extent possible, activities in each stage will need to be carried out concurrently in order to minimize the total migration interval.

The overlap clock starts ticking loudly soon after the start of Stage III, depending on the contractual arrangements with the selected vendor. The clock stops when migration is complete at the end of Stage IV.

1. Stage I – Preparation (up to one year)
    a. Product/services/vendor selection process
    b. Vendor contract negotiations
    c. ESCB standards, policy and administrative development
    d. Socialization of plans with all stakeholders
    e. Identify/select POIs (may be vendor-specific)
    f. Prepare GIS database

2. Stage II – NG9-1-1 Pilot Demonstration (six months)
    a. Selected vendor completes network designs and implementation schedule
    b. Vendor implements base public safety IP infrastructure to selected POIs
    c. NG9-1-1 CPE provisioned at selected PSAPs
    d. NG9-1-1 functions provisioned in the core network
    e. LNGs provisioned
    f. Agreements and arrangements with origination networks
    g. Test/demonstrate that the NG9-1-1 platform is serviceable

3. Stage III – ESInet Construction (six months)
    a. Vendor completes ESInet construction to all PSAP sites
    b. All PSAPs equipped and ready to handle NG9-1-1 traffic from the ESInet
    c. PSAP operator training
    d. Origination networks interconnect with ESInet at two or more POIs

4. Stage IV – Migration (up to two years)
    a. Origination networks move traffic from legacy selective routers to ESInet
    b. Legacy PSAP equipment moved as necessary
    c. Legacy network disconnection

A key concept of this plan is to build the NG9-1-1 network starting from the PSAPs and working back towards the call originating networks. The strategy is when a call is converted from legacy to i3 signaling and protocols, it should stay in i3 format. This strategy offers several advantages. It provides a clear path for implementation. It simplifies the migration, and simplification controls risks and reduces management requirements during the migration.

During the migration period, if call transfers from the new to the old network must occur, such transfers must occur back in the legacy 9-1-1 tandem. This has implications on the technical requirements for the LNG and for SIP signaling within the NG9-1-1 network that will need to be specified in the future RFP.

Alternatively, the ESInet contractor could provide a gateway (for call transfers only) back into the legacy network. Such back transfers may be problematic, however, if the legacy 9-1-1 tandem does not provide for “direct routing” of calls presented to it as transfer calls must not be selectively routed.

The call transfer issue could also be resolved by insuring that all PSAPs are reachable from the ESInet before live traffic is commissioned on the ESInet. This puts pressure on provisioning the PSAPs for NG9-1-1 as quickly as possible.

L.R. Kimball recommends that the RFP require that the contractor develop the migration plan and timetable, and that the contractor propose a solution for handling call transfers and other issues that they anticipate may arise during the migration period.

4.1 Migration Plan Stages

The following sections discuss the migration plan stage-by-stage.

4.1.1 Stage I - Preparation

Much of the work in the first stage falls on the ESCB. The ESCB will need to define state-wide standards for interconnection with the state-level public safety IP network.

On the call origination side, these standards will encourage call providers to move rapidly to NG9-1-1 interconnections, which will reduce the costs related to use of the legacy selective routers. On the PSAP and dispatch center side, establishing state-level standards will help insure that the desired future interoperability will be realized and provide economic incentives for consolidation, while simultaneously permitting a maximum level of local autonomy and control of CAD and other dispatch tools.

The ESCB may require additional skill sets for policy development, developing the technical requirements for an RFP, assisting with the vendor selection process, and socializing the ESInet plans with stakeholders.

4.1.2 Stage II – Next Generation 9-1-1 Pilot Demonstration

Stage II involves the construction of a pilot ESInet. As the POIs are identified, a small core ESInet should be initially implemented rapidly, interconnecting the selected POIs. Cooperative call originating networks that agree to participate in the pilot can then begin ordering facilities and making other preparations for direct IP connections to the ESInet. The goal is to get an early group of NG-capable PSAPs and the initial core ESInet/IP infrastructure completed at approximately the same time. This allows for testing and demonstrating that the ESInet is serviceable.

This pilot network need not span the entire state, nor implement full diversity or redundancy, as in its initial form it will carry only test and demonstration traffic. This controls cost and reduces the risk. The pilot insures that the vendor supplies and integrates all necessary elements and makes them work as one NG9-1-1 system. The trial may expose system problems that can be remedied before complete capital outlay is required to construct the entire system. Stage II is an opportunity for the vendor and the ESCB to verify and troubleshoot procedures and practices, and remedy any issues before complete deployment.

Stage II is complete when the vendor can successfully demonstrate NG9-1-1 functionality and the ESCB is satisfied the proposed system will work as expected. This stage could be priced at a flat rate so that the vendor carries any risks associated with delayed delivery of the demonstration network. Once the Stage II demonstration is accepted, full construction of the ESInet is completed.

4.1.3 Stage III ESInet Construction

The selected vendor will need to provide the implementation timeline. Should the construction take an estimated two weeks per PSAP site and be performed consecutively, the time required would be approximately one year. It is expected that the PSAP installations will need to be done two or more at a time to complete the implementation in the shortest possible time. The work in Stage II should pay off handsomely here, as at some level the design is “proven,” so that should accelerate the completion of Stage III. Most vendors will require some progress payments in this stage, so the overlap clock begins ticking even more loudly.

Work with call originating networks must not cease during Stage III. Carriers should complete all contracts and required paperwork and make connections to the new network at selected POIs.

At the end of Stage III, the new network should be fully functional and ready for traffic. There should be no need for transfers back to the old network and migration can proceed as rapidly as possible.

4.1.4 Stage IV - Migration

The most time consuming part of the entire effort is likely to be the actual migration of traffic from the old network to the new network by the call originating network operators. Most wireless carriers may wish to test each tower and sector with drive testers as traffic is moved. This may take days to accomplish.

As the new network comes on line, various incentives and penalties may need to be applied to assure their timely participation in this process. The goal is to reduce the cost of operating the legacy network as rapidly as possible. In almost every case, the originating networks will be interconnected to the legacy selective routers and to the ESInet for a period of time. If the cost of this dual interconnection is borne by the originating network operator, these operators will be more interested in reducing the overlap interval, providing an incentive to migrate quickly.

If the originating network has some ability to separate calls by geographical area (route calls), traffic can be moved by geographical area, rather than by the entire originating network. Often this will be the case for WSPs and small independent telephone host offices.

4.2 Technical Requirements

To the maximum reasonable extent, the technical requirements must be based on open standards that exist or substantially exist today. Some of these standards are in the final stages of review and approval. The Maine ESCB NG9-1-1 system will comply with the technical requirements incorporated in or referenced by the NENA i3 document, which references existing and pending IETF standards.

The NENA i3 specification is substantially complete and is currently in the public comment stage.[4] While some minor tweaking of this specification is to be expected, the overall methods and directions are clear. It is expected this work will be completed before mid-year 2011.

Similar comments can also be made concerning relevant IETF documents that are nearing final approval. *Best Current Practice for Communications Service in Support of Emergency Calling*[5] is one such document. This document defines SIP location conveyance as used in NG9-1-1. The document, which has been in process for several years, is on its sixteenth revision and is ready for "last call" review. While it is difficult to predict IETF timelines due to the ability of various parties to stall the process at several points, it is reasonable to expect that this document will become a request for comment (RFC) by mid or late 2011.

It is L.R. Kimball's judgment that these and related standards are sufficiently advanced that the future path is clear, and that they can be the basis for migration plans and near-term RFP specifications.

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[4]See: http://www.nena.org/story/NENA_i3_Stage3_for_review
[5]See: http://www.ietf.org/id/draft-ietf-ecrit-phonebcp-16.txt,

The NG9-1-1 GIS system will comply with Open Geospatial Consortium (OGC) recommendations for interfaces.[6] NENA also has a draft document in process on GIS interfaces. GIS data must be collected and maintained in accordance with NENA 02-014, with *Data Standards for Maine Geographic Information Systems* dated June 27, 2002, and as further specified by the ESCB.

The remainder of the migration plan is organized by following a typical call from call origination, call delivery and routing, to answering points and dispatch functions.

4.2.1 Call Origination

Call originating networks will connect to the Maine ESInet by making direct IP connections as described in section 3.1.1.1. While many aspects of call origination are outside the control of the ESCB, the ESCB can control standards and policies for interconnection to the Maine NG9-1-1 system. The ESCB must create interconnection policies. The ESCB may defer technical requirements to the contracted ESInet provider, but should maintain review and approval.

Policies should define who may interconnect, specify POIs, and set deadlines by which such interconnections must be accomplished. Policies should define the obligations and liability exposure of the call originating network operator. Sample interconnection agreements and detailed service level agreements may be offered to the ESInet service provider and call originating network operators. Policies must address the security needs of the ESInet, and define firewall or BCFs required for interconnection. Security policy should flow from a master security plan for the public safety IP network, which should be prepared for and adopted by the ESCB early in the schedule.

Timely migration to the ESInet will also require the ESInet initially accept legacy network interconnections via an LNG from the legacy 9-1-1 tandem. However, Maine should provide LNGs only for existing selective router interconnections. As originating network operators disconnect from the existing selective routers and send traffic directly to the ESInet, the new ESInet interconnections should be direct IP interconnections and not interconnections to the Maine-supplied LNG.

The rationale for this direct IP interconnection requirement is that for many originating network operators, particularly wireless operators, making connections to multiple legacy selective routers is a cost they bear today. Connecting to the ESInet, typically at two diverse POIs, should not be more expensive, and may be less expensive, than connecting to the two legacy selective routers in Maine. These originating network operators will have an economic incentive to make direct connections to the new ESInet. It is reasonable for the State to require that new connections be made using the new protocols and technologies of NG9-1-1, as this reduces the cost to Maine to operate the LNG.

Ultimately, the conversion of legacy protocols to NG9-1-1 protocols, where required, should be the responsibility of the originating network operator. If the originating network requires an LNG, they should supply and operate them.

[6] See http://www.opengeospatial.org/

Of particular concern, however, are small local telephone companies that provide wireline service in one or a few telephone exchanges. In the first stage of the migration, these companies need to be informed of the intentions of the ESCB. They should be polled to determine their interest and capabilities to migrate to a direct IP connection to the new ESInet and operate their own LNG, if necessary. After this information is gathered, some modification to the LNG policy may be necessary, or a program put in place to assist these companies with the migration to a direct IP connection. An important question to the small LEC is the cost of implementing an LNG, particularly if they lack the resources with the skill sets to install and operate an LNG.

Today's wireless networks are evolving towards IP infrastructures and should be able to provide direct IP connections as they complete their network upgrades. Legacy wireline network operators may be slower to discard legacy analog 9-1-1 technologies. The ESCB may wish to set a deadline for the phasing out of the state-operated LNG once migration to an all NG9-1-1 system is complete.

4.2.2 Call Delivery and Routing

Call delivery and routing is the component of the NG9-1-1 system that receives and determines the proper delivery point for calls by voice video, text, or other means in the future.

4.2.2.1 ESInet

Since the ESInet will ultimately transport all or nearly all 9-1-1 calls in the state, it must be a high-availability (99.999 percent uptime or five-nines) network. It must survive the failure or destruction of any one facility or site without significant impact on the ability of the surviving network to complete 9-1-1 calls to a call taker. This level of availability is normally obtained by using redundant and diverse facilities, such as a fiber ring, and by using routing protocols at the IP level and/or lower level protocols such as SONET, that provide for automatic failover or rerouting around faults in the network. The selected ESInet service provider will select the method and practice of providing high-availability. Major NG9-1-1 services, such as the emergency SIP routing proxy and the ECRF, must also be part of this high-availability core, and must be high-availability services as well. The key point is that 99.999 percent of all 9-1-1 calls must be delivered to a call taker.

Although this plan does not presume a specific network design or topology, it is still worthwhile, for discussion purposes, to distinguish between the core network and the network parts that connect the core network to a particular site, such as a specific PSAP, herein referred to as site distribution.

The core network must be redundant, diverse, five-nines, provide several geographically distributed POIs, and eventually have the capacity and bandwidth to transport all 9-1-1 traffic in the state.

Distribution may not have to exhibit the same level of reliability as the core network in order to achieve 99.999 percent call delivery. If the core network and NG9-1-1 services are able to detect failed distribution links and route calls to an adjacent or overflow PSAP, calls can be completed even in the presence of a failed distribution link. For example, a particular PSAP may go off-line, yet 9-1-1 calls are still able to be completed to another PSAP with 99.999 percent reliability. In this scenario, the call taker may not have jurisdiction in the caller's location. Even so, the caller is able to speak with a trained call taker and the call taker is able to use the radio and other communication methods to work around the failure and get assistance to the caller as needed. Sending a call to the "wrong" call taker is not as serious a problem as the inability of the caller to complete the call in an emergency.

The RFP should specify a service level agreement for mis-routed calls. This requirement should distinguish between mis-routes due to issues within the control of the provider and those outside the control of the provider. Issues within the control of the provider include operational issues in the network services or infrastructure, such as failed links. Issues outside of the control of the provider include mis-routes due to GIS database problems. The goal should be for at least 99.9 percent of calls to be delivered to the correct PSAP, short of traffic overload situations. Mis-routes due to network (not database) issues should be held to a higher standard, such as 99.99 percent. Caller location information and GIS database accuracy should be the limiting factors in routing accuracy performance, not infrastructure or NG9-1-1 services issues.

The ESCB or bidders should explore the use of existing state-owned or operated networks as a method for providing redundancy or last mile connectivity. These networks could provide cost savings to the State for the ESInet.

For example, the State has a high quality IP-based radio network under development. The RFP for ESInet services could reference this network and suggest the IP-based radio network might be utilized as one of the redundant and diverse components of the ESInet. In order to assure security to all parties, ESInet use of the IP-based radio network may be separated via IP address space and routing, virtual local area network (VLAN), or other method, from other network use. Such methods create two independent virtual networks sharing a common infrastructure. The use of these facilities offers potential network cost savings to the State, at the cost of working out interdepartmental arrangements and agreements for the use and operation of this facility.

The Maine Fiber Company is another state asset that any prospective ESInet service provider should consider for implementation of the state-level ESInet. Maine Fiber Company makes dark fiber available to telecom providers at fair and equitable rates in what is known as the "Three Ring Binder" project. These high-quality, diverse fiber rings cover rural areas of Maine and provide exceptional facilities for a core ESInet infrastructure. However, dark fiber is a very high bandwidth resource, far exceeding what is required for the ESInet. The most economical use of these valuable resources will combine the ESInet application with other (commercial) services offered by the service provider.

The IP infrastructure should be sized based on current and projected 9-1-1 call traffic, with allowances for additional public safety applications. Sizing presents a tradeoff between current recurring costs and the time interval between bandwidth upgrades and use limitations. For example, video media streams put large demands on bandwidth compared to voice media streams. However, today video is not widely utilized and originating networks have limited capability, if any, for delivering video calls. It makes little sense, over the short-term, to provision the IP infrastructure to meet video bandwidth requirements today. The RFP must specify a requirement for the provider to conduct a regular bandwidth study and report the findings to the ESCB.

There should be network capacity for experimental testing of video, as lack of facilities is a prescription for insuring video is never implemented or at least pushed to the distant future. It is difficult to predict how and when video might be widely utilized and become an important element of public safety. Some foresee callers using video to relay information about an accident scene, while the reality may turn out to be that responders, rather than callers, will be the ones to find video most valuable.

L.R. Kimball's recommendation is that the core infrastructure be able to handle three times the projected daily 9-1-1 busy hour call volume and be able to support slightly more concurrent calls as dispatchers in the state. That is, the limiting factor should be call takers, not the network infrastructure. Additionally, the infrastructure should support a number of dedicated radio channels, the network monitoring system, GIS and other database updates, and the interchange of CAD data at rates comparable to typical call volume. Finally, the core infrastructure should be able to initially accommodate a small number of compressed video media streams, such as might be used by surveillance cameras.

This formula is likely to result in a rather generous initial bandwidth, as it is highly unlikely that these uses would occur at the same time. Standard available bandwidth sizes are used in this determination. One of the advantages of IP networks is that the bandwidth is not dedicated to any one task or application, but is available for any use up to the capacity of the network. The quality-of-service feature can be used to prioritize the access of any class of application to the bandwidth resource.

Based on approximately 650,000 emergency calls in 2009, the ESInet should be sized for approximately 2 million calls per year. This allows ample room for large-scale events, such as severe weather, that temporarily place unusual demands on the network. Two million calls per year is an average of approximately one call every 15 seconds. The average non-EMS call lasts less than 90 seconds, and the average EMS call is about 10 minutes. EMS calls are no more than 20 percent of the total. So the average call 9-1-1 is about 175 seconds (or almost three minutes) in length. This implies that at any moment there would be 12 active calls on the network.

There are an estimated 120 answering positions in the state. The ESInet core should be able to carry at least 120 voice calls concurrently. This is ten times the average number of active calls, based on 2 million calls per year run rate. This number will dictate the sizing of the ESInet core.

Allowing 250 kilobits per second per call (this allows as much bandwidth for the data channel as the media channel, which is very generous), this suggests the core bandwidth should be about 30 Mbps.

CAD data interchange is not currently implemented. The bandwidth requirements for such an application should be modest, slightly exceeding the bandwidth associated with ALI data. This is easily covered in the 250k/call bandwidth figure above.

Radio channels should be planned at about 32 kbps per channel. There is very little signaling overhead associated with radio, and the lower fidelity of radio channels supports the use of compression codecs. If there is one radio channel per answering position in simultaneous use, this adds slightly less than 4 Mbps to the core infrastructure. Not all radio channels will compete for the entire core bandwidth as these are often more locally provisioned.

GIS and mapping system updates are usually not time critical and are traditionally done over relatively low-speed networks, such as 56k frame relay networks. This application and terminal applications, such as NCIC, would have barely noticeable impact on the ESInet infrastructure.

Finally, a near broadcast quality video media stream consumes about 1 Mbps of bandwidth. Multiple low-frame rate surveillance video streams will fit in this same bandwidth. Field-based video, such as might be used on police cars, must operate in considerably smaller bandwidths to be transported via commonly available radio channels. An initial allocation of up to 5 megabits in the core ESInet for video would be generous.

The result of this calculation is that a core ESInet bandwidth of about 40 Mbps should serve Maine very well for the present and medium-term future. This bandwidth fits nicely in several standard bandwidths of the transport systems widely used in the telecom industry, such as the DS3 (about 45 Mbps), the STS1 or OC1 (about 50 Mbps). The cost for 23 Mbps of bandwidth is approximately the same as it is for 45 Mbps of bandwidth for these types of facilities. Therefore, little, if any, cost savings would be achievable for using less bandwidth. Since 23 Mbps is below the suggested minimum, there is little to be gained by utilizing the smaller bandwidth. The State should plan and specify that the ESInet Core will be a high-availability network operating at 45 to 50 Mbps.

The bandwidth requirement for the distribution system to any PSAP would be based primarily on the number of answering positions at the respective PSAP site and the chosen solution. An initial estimate can be determined using the formula of 250 kbps per answering position, plus a 20 percent allowance for other applications. For the 20 PSAPs in Maine with five or less positions, a DS1 circuit (1.5 Mbps) connection to the core network would satisfy this bandwidth requirement. There are likely to be two circuits to two different POIs on the core network, since most PSAPs will require multiple links to the core network for redundancy. For the remaining PSAPs, a third, and perhaps fourth, DS1 would be required to satisfy the bandwidth requirements. These additional facilities could be provisioned to provide additional redundancy and diversity, further enhancing the high-availability of the PSAP.

The POIs should be chosen for the quality of the facilities and at site, nearness to larger and multiple PSAPs, costs, availability of service personal and similar considerations. Many of these questions are best answered by the selected service provider, who should be involved in the selection of these sites.

One issue that must be addressed is identification of the ideal number of POIs. For diversity and redundancy, at least two are required. Due to the geographical size of Maine and distribution of PSAP as originating network service providers, additional POIs are almost certain to be provisioned. POIs represent a cost to equip and operate, which must be balanced with requirements such as high availability, keeping the distances of the access network down, and survivability and resiliency of the remaining network in the event of a large-scale catastrophe. This is a question best answered with the involvement of the contracted service provider.

4.2.2.2 Border Control Function

The ESInet will contain a BCF. The exact design of how this function is implemented in the ESInet is the discretion of the contracted service provider. This function should be distributed throughout the ESInet in some way to avoid creating a single point-of-failure, to realize the overall high availability requirement, and to avoid excessive backhaul and associated consumption of core IP network bandwidth. A BCF should be provided at major POIs throughout Maine.

The primary purpose of the BCF is to provide a security firewall between the state-level ESInet and other interconnecting IP networks, such as from a service provider. Other interconnecting IP networks include other state or regional ESInets, general purpose local area networks (LANs) at PSAPs, emergency responder, and governmental offices. Depending on the ESCB security policy and CPE vendor requirements, PSAP emergency call taking CPE may be connected to a separate, secure LAN and directly connect to the state-level ESInet, bypassing the BCF.

BCF can be provided by using IP routers that implement access control lists (ACLs). ACLs control which IP address/port may communicate with which other IP address/port through the router. Since interconnection of a LAN to the Maine ESInet would typically be via an IP router, this router, if it supports ACLs, can control the allowed communications between the ESInet and the LAN, and can provide at least part of the BCF.

To the extent ACLs are implemented, the contract with the ESInet service provider must make clear that the ESCB will provide policy and will control the use of ACLs. That is, the service provider must not use this mechanism to pursue plans that may be contrary to the objectives of the ESCB.

The B2BUA is a type of BCF that can provide a great deal of isolation between interconnecting networks and the Maine ESInet. These devices terminate SIP signaling and media paths on one side of the device, and re-originate the call on the other side in a different IP network. IP packets do not have to be directly forwarded from one network to another. B2BUAs can resolve many interface protocol issues between two distinct IP networks, including IP addressing conflicts, SIP protocol incompatibilities, IPv4 to IPv6 conversion, and transcoding media, that is, converting from one codec to another codec. B2BUA is an attractive way to interconnect service provider IP networks to the state-level ESInet. L.R. Kimball recommends this approach. B2BUAs are also a feature of some IP router software packages.

Due to the fact that SIP encapsulates IP addresses inside SIP messages, firewalls that utilize network address translation (NAT) can be quite problematic, particularly cone types of NAT devices that map multiple IP addresses to one IP address by changing IP port numbers. These devices are commonly used as firewalls to interconnect LANs to public Internets.

The NAT-type of BCF is to be avoided in the Maine ESInet. Some CPE vendors prohibit their use between the ESInet and IP-enabled CPE. If the Maine ESInet must interconnect with an IP network using NAT, a session border controller is required to properly carry SIP messages and media streams across the network-to-network interface. If such interconnection is required, it would be better to work with the interconnecting network operator to resolve the interconnection issues and then use a B2BUA, if needed.

L.R. Kimball recommends that, regardless of the approach to the implementation of BCF, it should conform to the recommendations outlined in the NENA Security for Next Generation 9-1-1 (NG-SEC) document.[7]

4.2.2.3 Emergency Call Routing Function

The NG9-1-1 system is based on location-based routing, at least to the extent location information is available at call setup time. If actual caller location is not available at call setup time, default locations must be assigned by the originating network or the LNG. Examples of default locations would be the address of the telephone office or cellular tower from which the call originates. This will provide reasonable default routing equal to or exceeding what is available in the legacy 9-1-1 network.

While the exact architecture of the ESInet location-based routing system will depend on the design provided by the selected service provider, the routing system must contain two functional elements as described in the NENA i3 document: the ESRP and a GIS database that supports queries via the LoST protocol, sometimes called the ECRF itself.

The ESRP will provide SIP call control. SIP endpoints, such as individual telephones, may register with the ESRP. Registration consists of providing a SIP user URI (equivalent to a telephone number) and optional registration credentials (password). The call controller verifies the registration credentials and records the registering device's IP address and SIP user URI in a table. When SIP messages are received that are destined to that URI, the call controller can forward those SIP messages to the device's IP address.

The Maine ESInet will almost certainly have a number of SIP endpoints that will register directly with the ESInet ESRP. Smaller PSAPs with two or three answering positions may use the ESInet ESRP in lieu of installing a local SIP telephone system. Some telephones used for inter-PSAP communications may also register directly to the ESInet ESRP and bypass local telephone systems.

Alternately, the ESRP can use a SIP URI routing table, sometimes called a dial plan, to forward all calls to a specified URI to the SIP call controller located at a PSAP site. In this case, no registration occurs. The IP addresses of the PSAPs are symbolically or hard-coded in the URI routing table.

If a PSAP SIP proxy is present, it performs further processing of the call, such as call distribution among call takers. In this scenario, the call taker SIP endpoints typically register with the PSAP SIP proxy, rather than with the core ESInet ESRP. This arrangement will usually be used if the PSAP wishes to combine administrative and emergency call taking into a single telephone system, or wants more PBX-like functions than are provided by the ESRP. The PSAP SIP proxy can be another ESRP, or more likely, simply a generic SIP telephone system. Either way, a PSAP SIP telephone system that handles ESInet

[7] See: https://www.nena.org/technical-standards

calls must observe IETF RFC 3261 standards and pass location information present in SIP messages to the answering position equipment.

The ESRP differs from a generic SIP proxy by implementing two special features. With the first feature, if a call is not to a specific PSAP, but is to 9-1-1 (or SOS), the ESRP queries the GIS system using the LoST protocol. The GIS system returns the SIP URI of the primary PSAP associated with the caller's location. The ESRP then forwards the call to that PSAP in same way it would forward a call specifically destined to that PSAP.

The second feature is invoked if the destination PSAP returns a (all) busy message, if the call rings with no answer, if the proxy is unable to contact the PSAP due to a failure, or the PSAP is otherwise unavailable. Typically, the ESRP will have a call forwarding table for each of these situations and will direct the call to a different "roll-over" or "fail-over" PSAP. These call forwarding tables are examples of a PRF.

At a minimum, the Maine ESInet ESRP must implement policy routing sufficient to duplicate the existing legacy 9-1-1 network functionality. However, additional information should be available in the SIP messages that set up an emergency call from a true NG9-1-1 source. This additional information opens the door to additional policy routing based on this information, such as the language preference set up in the caller's instrument. The ESInet service provider selection process should explore the PRF capabilities of potential service providers when making the selection.

NG9-1-1 provides several possible mechanisms for call transfers. In public safety, all call transfers must be via a conference bridge, so that all parties can hear each other during and after the transfer process until someone chooses to leave the call. PSAP CPE equipment can provide this function, or it can be provided in the core network or in some combination.

The Maine ESInet should provide a quality conference bridge capable of bridging multiple calls of at least five parties each. This conference bridge will require 9-1-1-specific features; namely, it must be possible for one party on the bridge to add other parties by dialing their number(s), and the number and location of the original caller must be forwarded to each party as they are added to the conference.

While some ESRP implementations process all emergency calls through a conference bridge, SIP also has the ability to move an established two-party call to a bridge mid-call. Additional parties can then be added to the bridge. Each approach has advantages and disadvantages. Routing all calls through a bridge adds expense and failure modes to all calls. It is L.R. Kimball's opinion that PSAP CPE, at least for larger PSAPS, initially provides transfer and bridging functionality. Otherwise, calls should be moved to a centralized bridge only when a transfer is to be effected.

The ESRP SIP routing table may also contain entries for other ESInets, such as in adjacent states. When connections to such ESInets become available, Maine PSAPs will be able to call and transfer calls to those networks, similarly to making calls and transfers within the Maine itself.

The ESRP must be a high-availability service within the ESInet. High-availability can be accomplished by standing up duplicate ESRPs at diverse network locations to provide 99.999 percent availability. Many SIP endpoints, such as telephones and gateway devices, can register to two or more SIP proxies at the same time and accept calls from any proxy. If the device attempts to originate a call with the first proxy and does not receive a timely response, it simply goes to the next proxy on the list and tries again. Current providers' routers, gateways, and telephones support multiple proxies. While the actual design of the high availability in the SIP call control system will be left to the contracted service provider, high availability should not be difficult or especially expensive to achieve.

GIS divides into two parts: the GIS server(s) and software that respond to LoST queries and provide administrative and provisioning interfaces, and the data in the GIS system itself. The ESInet GIS hardware and software will be provided by the ESInet service provider, but the ESCB and the State will need to be responsible for GIS data, or perhaps purchase this service from a vendor who specializes in GIS data, which is likely to be different from the ESInet service provider.

At a minimum, the GIS database must contain the jurisdictional boundaries of the Maine PSAPs and the the police, fire, and ambulance services in the state. In addition, the GIS system must be able to map (geocode) civic addresses as presently contained in all the ALI databases within Maine with a high degree of reliability. Preparation of the GIS database is a major task in the implementation of NG9-1-1 and must begin as soon as possible to avoid extending the overlap interval where Maine must operate both the legacy and the NG9-1-1 network.

4.2.2.4 Data and Data Service

GIS plays a much more critical role within the NG9-1-1 environment. Within NG9-1-1, all calls will be routed based on location using GIS datasets to determine the proper routing to ESInets and PSAPS.

The NG9-1-1 call flow applies GIS data at the first stage of a call, instead of the final stage. The system assigns a street address or latitude and longitude coordinates at the very beginning stages of a call. The ECRF and LVF both access the same GIS datasets for routing and validating. These GIS datasets consist of service area boundaries and address location data for civic locations, such as addressed road centerlines and structure address points.

To prepare the data for NG9-1-1, a data readiness assessment should be completed. GIS data accuracy and data maintenance are critical factors to the successful routing of calls within a NG9-1-1 framework. A data readiness assessment can include the following:

- Determination of existing GIS data layers
- Determination of the data synchronization processes between GIS, MSAG and ALI as outlined in NENA technical standard 71-501 *Synchronizing GIS databases with MSAG and ALI*
- Determination of whether a data maintenance plan is in place and the frequency of GIS data updates
- Review of the State's data standards

The State will need to review and consider who will provide oversight of GIS data repositories. If an existing state agency has the resources to manage the oversight of the databases, including data quality control processes and replication workflows between the ESCB and the ECRFs, that agency should be considered for oversight.

Data management should include the review of current guidelines and oversight of specific accuracy and maintenance metrics. These metrics will assure that required data edits are performed on a timely basis and that data ultimately being replicated to the ECRF and LVF meet required industry standards for GIS data accuracy and proper routing of NG9-1-1 calls. These quality control measures include error reporting and error resolution workflows between the enterprise database, the State, and each addressing authority responsible for data updates.

4.2.2.5 Location Validation Function

LVF is used by the call origination systems to validate location information when a user registers a new device prior to making any call. LVF uses the same data as the ECRF. This data must be available outside the ESInet on a public database.

A recurring process to replicate data to a server outside the ESInet for use in validating locations will be implemented. This server will need to have the replicated current data and have applications to allow LoST queries. Access to this server can be open to the public or be from a subscription service.

The State should investigate using a subscription-type service for the use of LVF. This will allow the State to know who may be requesting location validations in the state. This is another method to identify the call origination services that provide service in the state. This subscription could be a free subscription, or may be set up a with a service fee.

4.2.3 Public Safety Answering Points

As the State develops the procurement documents for the NG9-1-1 system, PSAP answering equipment is a major component of the procurement. CPE that will work with the NG9-1-1 system should be procured and should be included in the NG9-1-1 contract for a single provider solution similar to what the State currently uses today.

The procurement documents should specifically list the needed functions of the CPE. A detailed list should be developed using open standards, and user needs and requirements documents, such as those from NENA and the USDOT NG9-1-1 Initiative. At a minimum, CPE must support NG9-1-1 call delivery and data exchange using NENA i3 standards. CPE must support legacy call delivery.

For the PSAP and dispatch center, the presence of state-level standards will help insure desired future interoperability will be realized and provide economic incentives for consolidation, while simultaneously permitting a maximum level of local autonomy and control of CPE functions, CAD procurements and vendors.

Currently, PSAPs in Maine procure their own CAD systems. It is recommended that any new CAD acquisitions be XML-capable. The State should develop guidance for PSAPs on recommended CAD functionality to exchange data with telephone CPE and other PSAPs or dispatch-only centers. A quality XML implementation should be able to load and utilize, within limits, various XML schemas. XML schemas are currently under development by NENA, APCO, NIEM, and the Organization for the Advancement of Structured Information Standards (OASIS); some work is being done jointly.

NG9-1-1 CAD and dispatch systems are expected to be NIEM-compliant. Current NENA work includes a schema for an emergency incident data document (EIDD) for data exchange in the NG9-1-1 environment. OASIS has defined an EDXL and completed work on several specific information elements, such as EDXL-RM (Resource messaging) concerning emergency equipment, supplies, and people, and EDXL-HAVE (Hospital AVailablity Exchange) concerning current hospital service, services, and resources.[8]

Another major component of the NG9-1-1 technology at the PSAP will be the need to log all data and new data streams. The traditional logging recorder was analog and voice centric. Most new logging recorders have expanded to include the capabilities to record other data; some will even record the keystrokes of the CAD or telephone CPE screens. An assessment of all PSAP logging recorder equipment should take place to determine if any will need to be replaced and should be completed after the final solution is selected or be included in the NG9-1-1 system procurement. The State should consider developing a guideline for the PSAPs on the minimal functional requirements the logging recorder should be able to perform. These recommendations should be for new procurements. PSAPs should not replace their logging recorders until the final solution is selected and specific detailed requirements are known.

4.2.4 Dispatch Function

The dispatch function is outside the control of the ESCB. This function is required to complete the process of assistance requests from the public. Dispatch-only centers can use the information received by the PSAPs.

CPE must be capable of sending location information to a stand-alone server or dispatch-only center equipment. Location information should be sent in an XML format using either PIDF-Lo or EIDD.

As CAD equipment is upgraded or replaced in the normal technology refreshment cycle, CAD should be procured with full XML functionality. To assist this process, the State would be best positioned to develop a guidance document for CAD procurement after the provider solution is chosen. This guidance document should provide the following:

[8] See http://en.wikipedia.org/wiki/EDXL

- Be vendor-neutral, making no mention of specific vendors
- List the specific XML elements that will be involved in the NG9-1-1 system
- Detail the process used to request data
- Detail the security requirements required to request data
- Detail the processes to request information from a stand-alone server and direct CAD-to-CAD interfaces

4.3 Security

Traditionally, 9-1-1 has been a closed system, thereby minimizing the risk and effectiveness of cyber-attacks. However, the IP-enabled, interconnected nature of NG9-1-1 radically alters the attack surface of the local PSAP and the overall NG9-1-1 system. This exponential increase in attack vectors is magnified by the attractiveness 9-1-1 systems offer cyber-attackers. It is critically important to ensure that cyber security controls are planned for and built into the system from the outset and over the course of the project. Cyber security should be architected into the Maine NG9-1-1 system and coordinated with the Office of Information Technology.

NENA released NG9-1-1 Security Standards (NG-SEC) in early 2010. These standards provide detailed requirements on how to secure NG9-1-1 systems. Presently, several states, cities, and counties have adopted, or are considering adopting, the NG-SEC standard as the core foundation of their security program. The vendor community has also expressed support for the standard. NG-SEC, when coupled with any additional customization of security controls necessary for a state like Maine can become a useful framework to build an effective security program.

In order to integrate cyber security into the Maine NG9-1-1 system, L.R. Kimball recommends establishing a security baseline of the current system by conducting a detailed security assessment. The security assessment should be based on NG-SEC standards and other applicable frameworks the State knows it intends to leverage in the Maine NG9-1-1 system.

4.4 Risks

All projects and systems have risks. Identifying these risks and developing mitigation steps can often assist in limiting the risks. A risk matrix can be found in Appendix B. This matrix is used to identify the major areas of risk when migrating to NG9-1-1. Each risk is stated, rated, and possible mitigation actions listed. Each risk is rated using the following categories:

- **Severity -** This is the effect on the project in the event that the risk occurs. This is rated on a scale of 1 to 5, with 1 being minimal impact and 5 being catastrophic impact.
- **Probability -** This is the measure of the likelihood of the risk occurring. This is rated on a scale of 1 to 5, with 1 being unlikely and 5 being almost a sure thing.
- **Exposure -** This is the measure of how long the risk is present during the project. If the risk is only present during a single phase, it may be low. This is rated on a scale of 1 to 4, with 1 being a short time and 4 being almost the entire project.

Risks should be reviewed on an on-going basis as they are in constant change.

4.5 System Considerations

As Maine starts to deploy a NG9-1-1 system, considerations should be addressed. Different issues will apply to the state and the PSAPs.

4.5.1 State

The State will need to address operational, economic and policy issues as the NG9-1-1 deployment takes place.

4.5.1.1 Operational

The State will need to address staffing and governance issues.

4.5.1.1.1 Staffing

The operation of an NG9-1-1 system requires technical and operational expertise. This expertise should come primarily from the contracted service provider, but there should be a staff person with the necessary technical and operational expertise to validate the activities of the service provider. This expertise may include:

- Networking
- Database maintenance
- Specific application maintenance
- Troubleshooting

During the implementation phase and up to an additional six months of follow up operations and testing, there may be need for a full time project manager. This person should be the primary interface with the contracted vendor and State to track progress and resolve issues. The project manager should be technically proficient in NG9-1-1. If an existing staff member is utilized for this, his or her regular duties may need to be covered by other staff.

4.5.1.1.2 Governance

The major change in the operations of the ESCB will be the operational aspects of the system. In the past, 9-1-1 systems were well-established and the provider would have a set service that could be procured. In NG9-1-1, the service has many different decision points that will need to be covered and which will change on a regular basis. A NG9-1-1 governance model should be put into place. The current processes used to manage the E-911 system is an example of a two-tier system. This model could work, but may require some changes based on the procured service.

4.5.1.1.2.1 Policy and Procedure Local Government

The policy and procedure tier of governance will be the existing ESCB under the Maine Public Utilities Commission. The ESCB will be tasked with developing policies for the development, interconnection and operation of NG9-1-1 system components. The ESCB will work with the Maine E-911 Council to establish the policies by seeking advice on the needs of the system.

4.5.1.1.2.1.1 Scope

The ESCB will develop strategic policies and procedures for the deployment, interconnection, and operation of the statewide NG9-1-1 system. These policies will be documented and promulgated as regulations.

4.5.1.1.2.1.2 Authority

The policy committee will promulgate rules through the existing authority to adopt rules and regulations pursuant to 25 M.R.S.A. § 2926.

4.5.1.1.2.2 Operations Local Governance

The operations tier of governance operates the components of the NG9-1-1 system. This tier will provide expertise to the policy and procedures level on the needs for the daily operation of the system. This tier will consist of several groups of people and agencies based on the components involved.

4.5.1.1.2.2.1 Scope

The operations tier of governance consists of the people and agencies that operate the components of the NG9-1-1 system. For example, PSAPs will determine the operational procedures within the PSAP and the system provider will determine the procedures for the system components. This tier will operate the system components in accordance with the procedures developed and approved by the ESCB. The operations tier will aid the ESCB in the development of system-based operational procedures that address operational needs and lessons learned.

4.5.1.1.2.2.2 Authority

The authority to operate the components of this system will come from several sources. The following are examples of some of the authorities that may be involved in the final system:

- Legislative – e.g.: The ESCB has the authority to operate a 9-1-1 system in 25 M.R.S.A. § 2926.
- Tariff – e.g.: Call origination providers may have tariffs that give them the authority to operate components of the system.
- Regulation – e.g.: Regulations promulgated by the PUC or other agencies will give authority or create restrictions on the operation of some components.
- Contractual – e.g.: The operation of some components may be outsourced to other agencies or companies. The contract will grant the level of authority the operator will have.

4.5.1.1.3 Policies and Procedures

This governance structure will need to develop policies and procedures to operate the NG9-1-1 system. Three major policy areas that will need to be addressed are:

- Interconnection
- Policy-based routing rules
- Security

4.5.1.1.3.1 Interconnection

Detailed interconnection policies and procedures will be developed that will define which entities can connect to the NG9-1-1 system directly and what that entity will need to do to connect. These policies and procedures should include:

- Interconnection location
- Interconnection protocol
- Required data elements
- Preferred data elements
- Security requirements
- Contract requirements
- Costs and the responsible parties

Having the State develop these policies and procedures rather than the contracted provider will allow a better control of who uses the system, and ultimately a better picture of the providers who should be remitting funds to the state.

4.5.1.1.3.2 Policy-based Routing

Policy based routing is a key differentiator of NG9-1-1 and is performed by creating a set of rules that the routing function in the NG9-1-1 system uses to determine the proper PSAP. There are several levels of rules that will need to be decided, from what information is allowed to transverse the system to the PSAP selecting its back up site as needed rather than statically.

These rules are created in a policy editor tool. There will be a policy and procedure that identifies who will have access to this tool to create these rules and who can implement them into the system. The policy editor tool should include a test process to make sure that a new rule will not cause an error to the system or conflict with another rule in the system.

These rules are generally developed by user input and implemented by the system operator. The state should control this function (rather than the contracted provider of the system) to define those rules that may be required statewide, and determine what can be configured at the PSAP level. This will help to maintain equal levels of service across the state and to set levels of service in the NG9-1-1 system.

4.5.1.1.3.3 NG9-1-1 Master Plan

The State should create a master NG9-1-1 plan. This plan will define the detailed goals, objectives and tasks required to effectively implement and operate a NG9-1-1 system. The master plan is developed using the information developed for this migration plan, combined with the data gathered in preparing the procurement documents, and procuring the NG9-1-1 system.

A NG9-1-1 master plan is used to document the current state, the envisioned state, and the steps needed to get to the envisioned state. This plan is a living document that requires continual updating to match the current environment. Components of the master plan should include:

- Current state of 9-1-1
- Future state of 9-1-1
- Goals
- Objectives
- Tasks
- Risks
- Risk mitigation
- Stakeholder communications
- Project team communications
- Security
- Migration
- Testing
- Service level criteria
- Interconnection requirements
- Schedule
- Change control
- Levels of authority
- Roles or responsibilities
- Legislative and regulatory status and changes
- Operational management of the system
- Operational impact to stakeholders
- Training of users and technical staff

4.5.1.2 Economic

The economic impact of this is difficult to measure. The State is planning to use a managed service solution where services are procured through a service provider. The equipment and recurring cost of the software and management of an NG9-1-1 system is heavily dependent on the solution and redundancy. In a managed service solution, the variable of the accounting procedures the selected vendor use to recoup the capital costs will change the way costs are calculated.

The Maine NG9-1-1 migration should have detailed NG9-1-1 master and transition plans. These can be used to develop cost plans based on the responses to the procurement process. This should be a measure to review the vendor's proposals. The impact of the costs and timing of those costs on the project will vary by vendor. Requesting a detailed timeline that will list the incurred costs as well as when current processes can be stopped as an item in the procurement will allow the State to measure the current costs, and when they will be reduced against the vendor's projected cost. This will allow the State to select the vendor with the least total implementation and operational expense to the State, not just the least expensive vendor.

4.5.1.3 Policy

A review of the Maine 9-1-1 statute shows that the state is well-positioned to deploy NG9-1-1. There are a few areas that should be reviewed for possible change. The current statute should be addressed first as it will most likely take the longest time. Later an update of the regulation can be done to follow the changes made in statute. This will allow for more flexibility as changes take place.

As noted in a recent publication of NENA's Next Generation Partner Program, statutes and rules "using terms such as 'calls', 'telephone service', 'emergency telephone system,' 'trunks', 'dials/dialed', etc. will need to be examined and modified as appropriate to cover the calling and messaging capabilities enabled by NG9-1-1."[9] L.R. Kimball offers an initial perspective on what should be undertaken in Maine.

A thorough review of the sections of statute in which the term "E-9-1-1" is used should be undertaken. The term E-9-1-1, as currently defined, may hinder deployment of NG9-1-1 if that definition is taken too literally. For example, the ESCB has the authority to "implement and manage E-9-1-1."

The continued use of this limited definition may not be needed now that the State has deployed both E9-1-1 as well as wireless E9-1-1.

If the State would prefer to take a conservative approach, one option would be to change the definition[10] of E9-1-1 to 9-1-1 and change to the following text:

9-1-1 services. "9-1-1 services" or "9-1-1" means a system consisting of routing 9-1-1 calls to the proper public safety answering points with the delivery of calling party identification and location information, which enables users of the public telecommunications' system to request emergency services via the 9-1-1 system.

Alternatively, modifying the definition of E9-1-1 in the following manner would also work:

Enhanced 9-1-1 services. "Enhanced 9-1-1 services" or "E-9-1-1" means a system consisting of routing 9-1-1 calls to the proper public safety answering points with the delivery of calling party identification and location information, which enables users of the public telecommunications system to request emergency services.

Other definitions that should be reviewed for possible changes or addition are:

- Automatic Location Information – Simple change to location information would allow the term to be defined in regulations and be changed as needed with technology changes over time.
- Automatic Number Identification – Change to calling party identification (this is to allow for more information and other types of identifiers than a traditional telephone number).
- ESInet – Use the NENA definition. This addition is important because it is the backbone network on which NG9-1-1 services are delivered and serves a different function than today's E9-1-1.
- Enhanced 9-1-1 Service – Update to reflect general information similar to above. Do not narrowly define it in terms of the legacy wireline features such as selective routing and ALI. Possibly change to one of the options presented above.
- Next Generation 9-1-1 (NG9-1-1) – Add to definitions if 9-1-1 is not made more general.
- Telecommunications Provider – Add to definitions. This term is defined in the immunity section, but may need to be refined to clearly identify who is covered (see further discussion of

[9] NENA Next Generation Partner Program, "Next Generation 9-1-1 Transition Policy Implementation Handbook" March 2010, page 14.
[10] 25 M.R.S.A. §2921 Sub-§6

immunity below). Note that changing this type of utility regulatory definition may have implications for other statutes unrelated to 9-1-1; therefore, a thorough legal review is recommended.

- The liability section should specifically allow providers of information and services for the NG9-1-1 system that may not be telecommunications providers to have equal liability protection
- 9-1-1 call – It would be prudent to consider adopting a broader definition for "9-1-1 call." The USDOT's NG9-1-1 initiative defined a 9-1-1 call broadly to mean "any real-time communication—voice, text, or video—between a person needing assistance and a PSAP call-taker." [11]

25 M.R.S.A. §2930, which deals with immunity, extends liability protections only to governmental entities and telecommunication providers, and restricts the latter to LECs and CMRS providers (and their employees and agents). National thought leaders on this matter recommend that liability protections should be extended to all entities that share the IP network; to all current and future originating service providers; to NG9-1-1 service providers; to emergency dispatchers and responders who may be recipients of transferred calling party identification and location information, or supportive and supplemental data as defined by NENA.

The confidentiality section should be reviewed based on the new data elements that may need to be added to the statute. Additionally, information on the system design and operation should be protected. The current statute specifies names, addresses, and telephone numbers. A review of the data elements defined in the final system design should be conducted to make sure these are adequate.

In 25 M.R.S.A. § 2933 the information required from the local exchange carriers is defined in legacy terms. This section should be reviewed and updated with more general terms to allow the flexibility to adjust these data elements as the system is deployed and new call origination systems are added. This section should also be updated to reflect any call origination or data providers not just local exchange carriers.

4.5.2 PSAPs

PSAPs will be impacted by the NG9-1-1 implementation.

4.5.2.1 Operational

The major impact to the PSAPs operations will be the new technology. This technology allows the PSAP more flexibility in the provisioning of 9-1-1, but requires new skills and monitoring. The first immediate

[11] U.S. Department of Transportation, Next Generation 911 System Initiative Concept of Operations, March 5, 2007, Version 2, Page 1. The state of Georgia at 46-5-122 (2.1) similarly defines "call" to mean "any communication, message, signal, or transmission." As a practical matter, there may be other ways to gain access to the 9-1-1 system than 'dialing the digits 9-1-1.' That access or connectivity will include dialing, but will also include some other sort of interfacing, initializing or otherwise activating the 9-1-1 system. See Michigan Compiled Laws (MCL) 484.1102,"communication service."

impact will be the ability to route calls based on more factors. This means that PSAPs will need to have a better understanding of the workings of the NG9-1-1 system to make good decisions as to the routing of the calls within the guidelines of the ESCB. These decisions may include developing back up plans, or setting threshold values of when to initiate back up plans.

The next immediate impact will be security. In the new interconnected system each PSAP is an entry point to the system and will need to have security in place and monitored. Not all PSAPs will have the required skills to perform this monitoring. PSAP staff must understand the impact of security at the PSAP has a large impact on the NG9-1-1 system.

In the future, new call origination systems will be delivering information to the PSAP. While it is hard to predict the actual impact of these new systems, some conclusions can be drawn from past deployments. When wireless was deployed and adopted by many people, the number of incidents reported by multiple parties increased drastically. It is not unusual to get multiple calls from the public on a major incident in a public venue.

With this in mind, new technologies will likely continue this trend where mobile technologies provide multiple calls per incident. In the future it will not be unusual to get pictures, videos, texts, and voice calls about an accident on the highway. Detailed monitoring of these deployments should be performed to identify the impact to PSAP operations as early as possible.

Training will be the primary method to deal with these issues. PSAP management and staff will need to be trained on the following:

- New equipment
- Security
- Call handling procedures for new technologies (video, text, etc.)
- Policies and procedures

4.5.2.2 Economic

There are two major economic impacts to the PSAP, equipment and staffing. The impact of the new equipment to receive the calls, log the associated data and audio, and CAD is hard to measure. A detailed requirements document should be developed and each PSAP should be compared to the requirements to determine the need for replacements or upgrades at each PSAP.

The staffing impact will consist of training existing staff and the need for additional staff. Training costs will apply to PSAP management and staff. The importance of training PSAP management cannot be overlooked. Without management support for the operational policies, they may not be followed to the extent needed to properly operate the NG9-1-1 system.

Some policies and procedures may require new skill sets from additional staff. Security, networking and database professionals can come from other departments within the PSAP's organization or be added to the PSAP staff. This will be heavily dependent on the size and complexity of the PSAP and its dispatch services.

Each PSAP will need to evaluate their staffing needs based on the required functions and available staff. There should be consideration of developing at a regional or state level a set of qualified staff to assist the smaller PSAPs that may not have the expertise. Larger PSAPs or other entities in a region could provide this assistance.

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APPENDIX A – GLOSSARY

TERM	DEFINITION
Access Control List (ACL)	A list of permissions attached to an object. An ACL may specify what operations a user or system process may perform on some system resource, such as creating, deleting, or modifying a file. In IP routers, ACLs control which IP addresses may communicate with which other IP addresses via the router.
Automatic Call Distributor (ACD)	Equipment or software features that automatically distributes incoming calls to available call takers in the order the calls are received, or queues calls until an attendant becomes available.
Automatic Location Identification (ALI)	The automatic display at the PSAP of the caller's telephone number, the address/location of the telephone and supplementary emergency services information of the location from which a call originates. Also, the caller location data.
Automatic Number Identification (ANI)	Telephone number associated with the access line from which a call originates. Legacy wireline 9-1-1 systems use the ANI to route the call to the preferred PSAP and as the retrieval key for the ALI information.
Association of Public Safety Communications Officials (APCO)	APCO is the world's oldest and largest not-for-profit professional organization dedicated to the enhancement of public safety communications.
Back-to-back User Agent (B2BUA)	A User Agent (UA) is an endpoint of a SIP conversation or communication. A B2BUA is located in the signaling and media paths between two SIP endpoints, and provides control and/or bridging functions. Typically a B2BUA is used to interconnect two disparate IP networks that wish to exchange SIP communications. A B2BUA is often a component in a SIP-aware firewall or border controller.
Border Control Function (BCF)	Provides a secure entry into the ESInet for emergency calls presented to the network. The BCF incorporates firewall, admission control, and may include anchoring of session and media as well as other security mechanisms to prevent deliberate or malicious attacks on PSAPs or other entities connected to the ESInet.
Computer Aided Dispatch (CAD)	A dispatching tool/application program used at many PSAPs.
Competitive Local Exchange Carrier (CLEC)	A Telecommunications Carrier (TC) under the state/local Public Utilities Act that provide local exchange telecommunications services. Also known as Incumbent Local Exchange Carriers (ILECs), Alternate Local Exchange Carriers (ALECs), Competitive Local Exchange Carriers (CLECs), Competitive Access Providers (CAPs), Certified Local Exchange Carriers (CLECs), and Local Service Providers (LSPs).
Commercial off-the-shelf (COTS)	Equipment, software, or services that are ready-made and available for sale in large markets and for widely varying applications. COTS is

	contrasted with purpose-built systems developed for a specific application and typically sold to a small market. Legacy 9-1-1 systems and PSAP CPE is purpose-built, and is therefore not COTS.
Customer Premise Equipment (CPE)	Communications or terminal equipment located in the customer's facilities – Terminal equipment at a PSAP.
Emergency Call Routing Function (ECRF)	Receives location information (either civic address or geo-coordinates) as input and uses this information to provide a URI that can be used to route an emergency call toward the appropriate PSAP for the caller's location. Depending on the identity and credentials of the entity requesting the routing information, the response may identify the PSAP, or an Emergency Services Routing Proxy (ESRP) that acts on behalf of the PSAP to provide final routing to the PSAP itself. The same database that is used to route a call to the correct PSAP may also be used to subsequently route the call to the correct responder, e.g., to support selective transfer capabilities.
Emergency Data eXchange Language (EDXL)	A suite of XML-based messaging standards that facilitate emergency information sharing between government entities and emergency-related organizations. EDXL is a royalty-free standard developed by OASIS.
EDXL Resource Message (EDXL-RM)	A sub-element of EDXL that defines a suite of standard messages that coordinate requests for emergency equipment, supplies, and people.
EDXL Hospital Availability Exchange (EDXL-HAVE)	A sub-element of EDXL that defines standard messages that communicates a hospital's status, services, and resources, such as bed capacity, emergency department status, and available services.
Emergency Services Communications Bureau (ESCB)	The state agency responsible for Enhanced 9-1-1 service in the state of Maine.
Emergency Incident Data Document (EIDD)	A standardized XML document/schema for the exchange of incident information between NG9-1-1 subsystems and/or agencies. The EIDD is currently under continued development by NENA, OASIS, NIEM and other SDOs.
Emergency Services Routing Proxy (ESRP)	An i3 functional element which is a SIP proxy server that selects the next hop routing within the ESInet based on location and policy. There is an ESRP within the ESInet. There is usually an ESRP at an NG9-1-1 PSAP. There may be additional ESRPs in the system.
Emergency Services IP Network (ESInet)	An IP-based inter-network (network of networks) shared by all agencies which may be involved in any emergency.
Emergency Telephone System (ETS)	A telephone system, typically installed at a PSAP, which provides 9-1-1 specific features in addition to standard PBX or key system features. Legacy ETS system features include the ability to terminate 9-1-1 trunks, decode ANI, and retrieve and present ALI to the call taker. Also sometimes referred to as a component of "PSAP CPE."
Fiber Optic Internet Service (FoIS)	A Verizon term meaning broadband service delivered by fiber optics.

Geographic Information System (GIS)	A computer software system that enables one to visualize geographic aspects of a body of data. It contains the ability to translate implicit geographic data (such as a street address) into an explicit map location. It has the ability to query and analyze data in order to receive the results in the form of a map. It also can be used to graphically display coordinates on a map i.e., latitude/longitude from a wireless 9-1-1call.
High-availability	A system design approach and associated service implementation that ensures a prearranged level of operational performance will be met during a contractual measurement period. Typically, "five-nines", or 99.999 percent uptime, is used for overall public safety system performance (not for individual components). To achieve five-nines, a system can be down for a maximum of five and a half minutes per year.
Incumbent Local Exchange Carrier (ILEC)	A telephone company that had the initial telephone company franchise in an area.
Internet Engineering Task Force (IETF)	The IETF is an open standards organization, with no formal membership or membership requirements. The IETF does not recognize businesses, governments, or any entities other than individuals. The goal and mission of the IETF is "to make the Internet work better" from an engineering point-of-view. The IETF develops and publishes technical documents and standards that influence the way people design, use, and manage the Internet. Despite the fact that the IETF has no governmental or commercial mandate, the IETF has great influence due to the widespread adoption of its standards and protocols. IETF publications are freely available to anyone via the Internet.
Internet Protocol (IP)	The method by which data is sent from one computer to another on the Internet or other networks.
Internet Service Provider (ISP)	Company that provides Internet access to other companies and individuals.
Legacy Network Gateway (LNG)	A subsystem that converts legacy public switched telephone network E9-1-1 calls into NG9-1-1/NENA i3 formats and protocols. Typically, an LNG converts calls arriving on analog CAMA/MF trunks into SIP and VoIP streams, performs an ALI database lookup based on the call's ANI, and converts the location data into a PIDF-LO document that is attached to the SIP call setup messages.
Location to Service Translation (LoST) Protocol	A protocol that takes location information and a service URN and returns a URI. Used generally for location-based call routing. In NG9-1-1, used as the protocol for the ECRF and LVF.
Location Validation Function (LVF)	Refers to the action of ensuring that a civic address can be used to discern a route to a PSAP.
Master Street Address Guide (MSAG)	A data base of dispatch-valid addresses and emergency service numbers used to validate addresses and determine call routing.
National Emergency	A membership-based SDO of public-safety related businesses, PSAPs,

Numbering Association (NENA)	and individuals to "...foster the technological advancement, availability and implementation of a universal emergency telephone number system (9-1-1)." While NENA has no governmental mandate, its standards and recommendations are widely adopted by PSAPs and the public safety industry in the United States.
Next Generation 9-1-1 (NG9-1-1)	NG9-1-1 is the next evolutionary step in the development of the 9-1-1 emergency communications system known as E9-1-1 since the 1970s. NG9-1-1 is a system comprised of managed IP-based networks and elements that augment present-day E9-1-1 features and functions and add new capabilities. NG9-1-1will eventually replace the present E9-1-1system. NG9-1-1 is designed to provide access to emergency services from all sources, and to provide multimedia data capabilities for PSAPs and other emergency service organizations.
Organization for the Advancement of Structured Information Standards (OASIS)	A membership-based non-profit consortium of international companies that promotes the development, convergence, and adoption of open standards for the global information society. Membership includes companies such as Boeing, Cisco, Fujitsu, Hewlett-Packard, Hitachi, IBM, Microsoft, Oracle, Red Hat, and the US Department of Defense.
Point of Interconnection (POI)	A site or location where two different networks meet for the purpose of interconnection.
Policy Routing Function (PRF)	A function in an NG9-1-1 system that modifies the location-based routing of a call based on other conditions or data, such as the time-of-day, the preferred PSAP too busy or unreachable, the caller's service type, or other criteria. The PRF may be implemented as a subsection of an ESRP, or as a separate process invoked by an ESRP.
Presence Information Data Format – Location Object (PDIF-LO)	An IETF standard (RFC 4999) for the exchange of civic address and geographical location information over IP networks. The PIDF-LO has uses beyond public safety, but is also part of NG9-1-1.
Primary Public Safety Answering Point (PSAP)	A PSAP to which 9-1-1 calls are routed directly from the 9-1-1 Control Office.
Session Initiation Protocol (SIP)	An IETF defined protocol (RFC3261) that defines a method for establishing multimedia sessions over the Internet. Used as the call signaling protocol in VoIP, i2 and i3.
SIP proxy	A SIP proxy is an intermediary service or process that receives and forwards SIP messages to endpoints and/or to other SIP proxies. A primary purpose of a SIP proxy is determining the routing of SIP calls and messages, but it may also be used for many other purposes, such as to authorize users, enforce policies, or collect call detail data. A proxy interprets, and, if necessary, modifies or rewrites specific parts of a SIP request message before forwarding it. A SIP proxy may play a role roughly equivalent to the function of a PBX with respect to SIP call control. Note, however, that the voice or media

	path does not traverse a SIP proxy.
Real-time Transport Protocol (RTP)	A standardized packet format for carrying voice, video, or similar "real time" media streams over an IP network. Endpoints (User Agents) negotiate the establishment of a call using SIP. Once the negotiation is complete the endpoints communicate voice or video streams directly to each other via the IP network using RTP. Each UA addresses the RTP packets with the other's IP address, as provided by SIP during the call setup.
Public Safety Answering Point (PSAP)	A set of call takers authorized by a governing body and operating under common management which receives 9-1-1 calls and asynchronous event notifications for a defined geographic area and processes those calls and events according to a specified operational policy.
Public Switched Telephone Network (PSTN)	The network of equipment, lines, and controls assembled to establish communication paths between calling and called parties in North America using common telephones and the national ten-digit dialing plan.
XML – eXtensible Markup Language	A way of encoding documents and data in clear text. XML is extremely flexible and is the basis for or shares features with many other markup protocols, including HTTP.
XML schema	A formal, machine readable description of the structure, grammar, and requirements of a specific XML document type. XML parsers can be created to read a schema and then recognize/validate an XML document of that type without revising/changing the parser's programming code.
Uniform Resource Identifier (URI)	A string of characters used to specify a name or locate a resource on the internet. All URNs and all URLs are examples of URIs. A number of IETF RFCs speak to various syntax and other rules for constructing URIs for various purposes.
Uniform Resource Locator (URL)	A URL specifies a specific internet resource, such as a web server or a SIP proxy. A URL is much like a person's address.
Uniform Resource Name (URN)	A URN specifies a name on the internet. A URN is much like a person's name, or the title of a book. Knowing a URN does not necessarily imply that one knows the present location of that object or an instance of that object.
User Agent (UA)	A logical endpoint that initiates and terminates SIP messages, in order to set up or end a call. Examples of UA devices are SIP telephones and SIP gateways. Contrast a UA with a SIP proxy, which receives and forwards SIP messages, but a proxy does not initiate or terminate a call on its own.

APPENDIX B – RISK MATRIX

The risk matrix may be found on the following pages.

Risk Weighting

Every risk has with it three variables that can be used to measure the importance of the risk.

Severity - This is the effect on the project in the event that the risk occurs. This is rated on a scale of 1 to 5 with 1 being minimal impact and 5 being catastrophic impact.

Probability - This is the measure of the likelihood of the risk occurring. This is rated on a scale of 1 to 5 with 1 being unlikely and 5 being almost a sure thing.

Exposure - Exposure is the measure of how long this risk is present during the project. If the risk is only present during a single phase, it may be low. This is rated on a scale of 1 to 4 with 1 being a short time and 4 being almost the entire project.

Severity		Probability		Exposure	
Score	Explanation	Score	Explanation	Score	Explanation
1	Little impact	1	20 percent likely	1	Less than 25 percent
2	Some Impact	2	40 percent likely	2	26 to 50 percent
3	Moderate Impact	3	60 percent likely	3	51 to 75 percent
4	Severe Impact	4	80 percent likely	4	76 to 100 percent
5	Catastrophic Impact	5	100 percent likely		

The ratings in these various categories are multiplied to develop at rating for each risk defined. These risk ratings can be used to mitigate the risks that have the most impact first or to set a priority for addressing the risk.

Caution must be used as all risks should be reviewed even if they have a low priority. Even low priority risks are still risks to successful project completion

Risk Matrix

Risk	Severity 1 to 5	Probability 1 to 5	Impact Score	Exposure 1 to 4	Exposure Timeframe	Score	Mitigation Method
Interconnection Agreements (IAs), which may have to be executed between the originating network operator and the ESInet service provider. Regulated LECs may be constrained in their ability to rapidly execute such IAs. The ability, willingness, and legal standing of the ESInet operator are considerations as to whether IAs will be required. Some call originating carriers may also require IAs for liability shields or other legal reasons.	4	3	12	1	Initiation	12	Review all interconnection agreements and tariff of the selected vendor and legacy providers. Develop a procedure to streamline AI requests and conflicts at the PUC.
NG9-1-1 technology is currently under development, with limited deployments to date. There is a risk that vendors may not be able to deliver fully serviceable NG9-1-1 products in a timely fashion, causing delays in the implementation.	4	3	12	1	Initiation	12	Select vendors with proven experience, and include contract language to implement future standards in the selected solution in the future with a set timeline such as 6 months after standard publication.
Some entities may resort to non-cooperation or legal action to slow the migration to the ESInet.	5	2	10	1	Initiation	10	Have all processes and procedures follow all legal requirements, and involve legal staff into the process early.
Data Exchange standards for CAD to CAD and passing information to Dispatch only sites may not be complete on time.	2	2	4	2	Initiation	8	Contingency options should be developed to forward information to the other entities. Detailed Procedures should be developed using multiple methods such as Voice, Fax, or messaging to forward information.
If the migration is delayed for any reason then costs may raise above budget due to the requirement to continue to operate the legacy network beyond the planned retirement dates.	3	2	6	2	Deployment	12	Develop detailed schedules and include penalties to contracts for missed deadlines
Originating network providers may encounter delays due to internal or external issues that will prevent the scheduled retirement of the legacy network.	3	3	9	2	Deployment	18	Investigate grant programs from federal agencies to encourage deployment of new technology. Build contingencies into schedule and budget.

Risk Matrix

Risk	Severity 1 to 5	Probability 1 to 5	Impact Score	Exposure 1 to 4	Exposure Timeframe	Score	Mitigation Method
A Legacy Selective Router Gateway, if used to send NG9--1-1 calls back into the legacy network, can create "routing loops" between the ESInet and the legacy network. If such loops are not detected and correctly managed then serious failures can occur in each network.	4	2	8	2	Deployment	16	Use a migration plan that avoids requiring sending NG9-1-1 calls back into the legacy network, or insure such loops can be detected and properly handled and develop a detailed change and configuration management procedures for such traffic.
IP based networks are susceptible to failures due to configuration errors such as in routing schemes, IP addressing, or during core network rearrangmentments.	5	1	5	4	On-going	20	Impact may vary from local to global depending on the nature of the error. Develop detailed change and configuration management procedures.
IP based networks are susceptible to attack	4	4	16	4	On-going	64	Develop detailed security policy, procedures, and active monitoring.

REFERENCES

www.nena.org
www.ietf.org
www.neim.gov
www.apco911.org
www.opengeospatial.org
www.oasis-open.org