North Carolina NG9-1-1 Concept of Operations

November, 2015

Executive Summary

The basis of North Carolina's 9-1-1 service is currently a legacy E9-1-1 environment. There are 119 primary Public Safety Answering Points (PSAPs) and six additional call taking centers capable of receiving 9-1-1 calls and funded by the NC 911 Board. These centers range in size from two positions to 67 positions.

Primary PSAP's	119
Other Call centers	6
TOTAL	**125**

In 2014 the state of North Carolina PSAPs handled 7,294,803 calls and answered over 90% of those within 10 seconds.

The legacy 9-1-1 system has been a reliable and effective solution for emergency calls for almost 50 years. During that time it has been augmented, and modified to adopt new technologies and has continued to perform at a high level. However, due to the rapid adoption of technological advancements, the legacy 9-1-1 system may decline in its ability to meet demand.

PSAPs throughout the State are connected via Centralized Automatic Message Accounting (CAMA) trunks from a local telecommunications provider for all call delivery. CAMA has been a long utilized and very useful method of delivering 9-1-1 calls to the PSAP. CAMA trunks are analog, have limited bandwidth, cannot be scaled effectively, and are often a barrier to Next Generation 9-1-1 (NG9-1-1) implementation. The PSAPs currently utilize 880 total CAMA trunks for service. The State will replace these over time with broadband capable Internet Protocol (IP) connections.

The PSAPs receive all calls through four local exchange carriers (LEC) that handle 9-1-1 call routing. These providers support 9-1-1 call delivery through selective routing calls to the appropriate PSAP.

- AT&T – 9 Selective Routers
- Centurylink – 4 Selective Routers
- Frontier – 2 Selective Routers
- Windstream – 1 Selective Router

While the LEC providers connect to the individual PSAPs they may partner with a 9-1-1 system service provider.

What follows is a summary of findings.

- The 9,943,964 people living in the State generate approximately 7,294,803 9-1-1 calls every year, or about 0.73 calls per person per year. The national average is approximately 0.82 calls per person per year.
- 76% of the total calls were delivered wirelessly, 7% were Voice over IP (VoIP) and 17% were from landlines, which is consistent with national call trends.
- The State has 840 9-1-1 answering positions, about one for every 11,300 persons. No national figures are available for comparison of this statistic.
- Disparate 9-1-1 equipment, networks and processes at the county / city level discourages sharing of systems and resources. This creates a siloed infrastructure that increases duplication of infrastructure.
- The radio systems in the State consist of disparate networks (different frequency bands and different non-compatible technologies), making interoperability on the dispatch side of 9-1-1 (calls forwarded) challenging, and most PSAPs cannot dispatch to other PSAPs first responders.
- A more effective and efficient method for allowing PSAPs to back each other up in an emergency is imperative.

The limitations of the legacy 9-1-1 system stem from its foundation on 1970s circuit-switched network technology. Over the course of time the 9-1-1 system has been modified, augmented and patched to meet new technology advancements. While this approach has been carried out with great care and has proven to be effective for the most part, it has created gaps within the system. A wireline network comprising fixed locations and fixed addresses form the basis of the current 9-1-1 system. The mobility of today's users and their devices can quickly overwhelm the complex arrangements created to meet these technologies. The current 9-1-1 technology is reaching obsolescence in the evolving technological environment.

Each PSAP is responsible for planning and design of their own 9-1-1 systems. Some of these 9-1-1 systems are approaching the end of their useful life. Some of these 9-1-1 systems using legacy telecommunications technology to deliver 9-1-1 calls have been augmented, modified and retrofitted to allow additional data, additional "bolted on" systems to deliver wireless/cellular voice, and VoIP 9-1-1 to the PSAP.

This can create a barrier to internetworking 9-1-1 systems. A new network based upon current technology would assist PSAPs in communicating with each other and callers

while enhancing the ability for law enforcement, fire departments, and emergency medical services to respond.

An advanced NG9-1-1 system would also provide the ability to quickly and easily reroute emergency calls to another call center when the primary answering point is unavailable or overloaded.

The collection of these advanced capabilities will enhance the ability to provide more efficient, effective and dynamic emergency responses; however, major changes will be required in the 9-1-1 system. The new system is referred to as Next Generation 9-1-1, or NG9-1-1.

As each new technology adopted by consumers will require an adjustment through the technology model as shown in Table 1.

Table 1 – E9-1-1 vs. NG9-1-1 Comparison

E9-1-1/NG9-1-1 Comparison		
	Today's E9-1-1	**NG9-1-1**
Networks	Complex Analog Trunking and Data Network to meet IP	Managed Private Emergency Services IP Network (ESInet)
Routing	Class 5 Switch for Selective Routing, limited forwarding of calls	IP Routers, call forwarding more dynamic and flexible
Accepted Media	Voice Calls Only	Integrated Voice, Text, and Video
Integration	Complex Interfaces	Standard IP Interfaces
Data	20 Character Data Limit	Broad Data Bandwidth
Location/Call Routing	Complex translations based on tabular data (MSAG), Location fix occurs at back end of call	Geo-Location/Routing, Location fix more precise and happens at front end of call

Costs of products and services will continue to increase placing greater demand on the fund. Some of this is because PSAPs procure systems individually. Raising the procurement and operation of systems and services to a statewide level can enhance economies of scale and save costs.

In addition, this Concept of Operations offers a guideline for overcoming some limitations that can be a barrier to NG9-1-1 including:

- Current networks built for wireline 9-1-1 and fixed locations
- Limited to Local Area Transport Areas (LATA) as defined by the regulated telephone companies
- Multiple connections required to increase bandwidth and capability
- Siloed applications and systems
- Duplication without diversity or redundancy
- Excessive capacity or stranded bandwidth
- Higher costs for replacement, support and sustainability
- Multiple maintenance and management arrangements
- Lack of interoperability

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1. Introduction

The North Carolina 9-1-1 Board is preparing for the implementation of NG9-1-1 strategically to ensure cost control, efficiency, and effective oversight. The Board engaged Federal Engineering to review the current state of 9-1-1 operations, provide insight into options and strategies, and assist the Board with mapping the future of NG9-1-1 in the State. The purpose of this document is to provide a Concept of Operations baseline for Next Generation 9-1-1 (NG9-1-1) for the state of North Carolina.

The state of North Carolina aligns with the standards bodies in believing that an NG9-1-1 System is a method of increasing the capability of 9-1-1 to allow users access to 9-1-1 through any wired, wireless, or Internet Protocol (IP)-based device. An NG9-1-1 system is generally an “ecosystem”, comprising transport networks, routers, switches, applications, and intelligent services such as policy routing and security tools.

This *North Carolina NG9-1-1 Concept of Operations* is a formal document that provides a vision of NG9-1-1 in the state of North Carolina in the context of an emergency services internetwork that provides for Administrative, Operational, Tactical and Strategic objectives to increase the efficiency and effectiveness of NG9-1-1 for the state of North Carolina.

An undertaking such as this should not commence without clearly defining the purpose and intent. The North Carolina 9-1-1 Board established the following goals (in no particular order) as the purpose for undertaking this study:

- Improve public safety for the citizens of and visitors to the state of North Carolina.
- Improve operations and control costs by creating a State-wide strategy for NG9-1-1 as opposed to implementing individual NG9-1-1 systems by PSAP.
- Increase the functionality for all PSAPs providing greater equality of capabilities across the State. (Murphy to Manteo)
- Provide a consistent high level of service across the state of North Carolina for all 9-1-1 callers regardless of where they are calling from.
- Improve call transfer functionality and introduce the ability to forward calls to another PSAP to share information across jurisdictions, including Local Access and Transport Area (LATA) boundaries.
- Improve communications between PSAPs.

- Facilitate an ability to share Geographical Information System (GIS) information across jurisdictional boundaries.
- Enable PSAPs to receive multimedia messages including (telematics, text, video, VoIP).
- Improve reliability and redundancy in the 9-1-1 systems.
- Facilitate a cooperative project initiative involving all stakeholders and other potential partners in North Carolina.

This document provides a common understanding of how the program plans to proceed into a NG9-1-1 environment in several key areas, enumerated and defined in the *Overview* section of this document.

2. Overview of the Strategic Vision for NG9-1-1 in NC

The North Carolina 9-1-1 Board presently operates a $71M fund for 9-1-1 throughout the state of North Carolina. This budget is used for the expenditures of PSAPs and has been diligently maintained for over 15 years, first as a wireless 9-1-1 board and since 2004 as an overall 9-1-1 board. The fund is currently undergoing a change via HB730[1] that will impact the overall fund balance going forward. This change, which allows for the Board to withhold 10% of the fund for NG9-1-1 purposes, will be used to establish the strategy defined throughout this Concept of Operations. As PSAPs pursue NG9-1-1 on the local level and seek reimbursement, the fund may find difficulty keeping costs under control.

The Board recognized that the 9-1-1 program and funds may incur a shortfall if all 119 PSAPs choose to implement individual NG9-1-1 solutions. Therefore it is necessary to strategically align a plan for ensuring that the program is not exhausted during the transition into NG9-1-1.

Key operational considerations:

1. Control costs of NG9-1-1 implementation
2. Create standardized procurement measures
3. Ensure standard NG9-1-1 requirements are met
4. Avoid deployment of disparate NG9-1-1 systems
5. Minimize duplication and siloed implementations
6. Normalize NG9-1-1 implementation
7. Increase interoperability among PSAPs across existing boundaries
8. Increase the technical support to PSAPs
9. Minimal disruption to existing PSAP operation

In 2014, the North Carolina 9-1-1 Board published a Request for Information (RFI) to gather feedback from prospective vendors for a statewide NG9-1-1 solution. The RFI was the initial step in defining a strategy for how NG9-1-1 would be implemented across the state of North Carolina. Thirteen prospective vendors submitted responses describing how their solution would support a statewide NG9-1-1 capable solution.

In parallel, the North Carolina 9-1-1 Board identified the need for a comprehensive strategy and Concept of Operations to ensure that the path forward into NG9-1-1

[1] http://www.ncga.state.nc.us/gascripts/BillLookUp/BillLookUp.pl?Session=2013&BillID=H730; accessed 10/29/2015

achieves the intended results. The Concept of Operations is important in defining required changes and future focus areas.

The Board defined their approach to NG9-1-1 into 6 specific areas.

- **Network / Emergency Services IP Network (ESInet)** – the definition of, and strategic design for a statewide network to support emergency services, applications and supporting systems that includes the NG9-1-1 functional elements

- **GIS** – the strategy for GIS data integration to support all PSAPs throughout the state for the purpose of call routing in NG9-1-1

- **Network Monitoring and Assistance Center (NMAC)** – the implementation of a facility that includes a Network Operations Center (NOC), Security Operations Center (SOC), and help desk to provide oversight and technical support of the statewide infrastructure, applications, security, services and systems

- **Hosted Call Handling solution** – the design of a hosted Customer Premise Equipment (CPE) solution(s) within the ESInet to include a hosted recording platform(s) and Computer Aided Dispatch (CAD) platform(s)

- **CAD Interoperability** – the design and implementation of a hosted CAD solution

- **Radio Interoperability** – the strategy for increasing radio interoperability statewide

To ensure standardization throughout the State, the State will only pursue NG9-1-1 capable systems. The National Emergency Number Association (NENA) and the Association of Public-Safety Communications Officials (APCO) are standards organizations that typically endorse NG9-1-1 standards, including the following features:

1. Provides or supports a foundation for NG9-1-1 and is designed to support or interoperate with core i3[2] functionality

2. Are secure and resilient to cyber-attack, penetration, abuse or misuse

3. Provides the ability to alarm, report, monitor, manage and support on a 24x7x365 basis

[2] https://www.nena.org/?page=i3_Stage3; accessed 10/29/2015

4. Provides or supports increased fault tolerance, reliability, resiliency and disaster recovery, route diversity and redundancy

5. Provides or supports clear demarcations of responsibility and accountability in the handling of all traffic related to an emergency request originating from the public and delivered to a PSAP via the NG9-1-1 ecosystem

6. Provides or supports a seamless infrastructure proactively managed and administered which delivers a consistent and equitable level of service to PSAPs, enabling PSAPs to improve the quality of service to the public

7. Provides for or supports Enterprise-wide call accounting and data collection

8. Allows for complete integration of Network, i3 functional elements, and hosted services

NG9-1-1 solutions will be designed in modular fashion based on open standards and industry best practices to facilitate the addition of new functionality as it becomes available without requiring a major revision of the underlying system.

Some existing networks may influence this strategy. Networks such as FirstNet may present an opportunity for collaboration.

FirstNet

In February of 2012, the Middle Class Tax Relief and Jobs Creation Act of 2012 (Act) was signed into law, and created the First Responder Network Authority (FirstNet), fulfilling the last of the 9/11 Commission recommendations.[3] This law provided FirstNet a blueprint for its mission to design and deploy a nationwide broadband network to meet fundamental needs of the public safety community in all 56 states and territories. The law also allocated spectrum in the 700 MHz band (which the FCC subsequently licensed to FirstNet), and provided initial funding for planning and network procurement.

2.1 Administration

Creating a method for administration of NG9-1-1 in the state of North Carolina, may be require operational modification in some areas. These changes are necessary to ensure proper management of the implementation of NG9-1-1 across the State. As a result, this section focuses on the following key areas:

- Administrative support framework once NG9-1-1 is implemented state-wide

[3] http://www.9-11commission.gov/report/911Report.pdf

- Governance to support NG9-1-1
- Legislative changes necessary to support NG9-1-1 activities
- Enhance the ability of the program to determine eligible expenses
- Align NG9-1-1 program with National 9-1-1 Program efforts

2.1.1 Administrative Support Framework Following NG9-1-1 Statewide Implementation.

The current model used by the NC9-1-1 Board is functional for legacy 9-1-1 purposes. A well-organized board and technical committee are already in place. As the NG9-1-1 project progresses both the Board and Committee will remain a key component in defining the strategy for implementation and ongoing service management.

2.1.2 Governance to Support NG9-1-1

Presently, the Board controls funding for the PSAP's. To extend a governance model that reflects NG9-1-1 but does not supersede statutory commitments, the Board should consider employing policy directives. Policy directives can be a useful tool to further define the strategic efforts and influence the desired outcomes. Other States have utilized this approach to great success while ensuring alignment with the statute.

Policy directives are often used to provide common briefings relating to technical, operational, tactical and administrative decisions by the Board. Their ability to influence strategy is useful in assuring that the PSAPs align with the common strategy. Typically these policy directives are useful in establishing rules and guidelines for PSAPs to follow when they procure new equipment, services or systems. As an example, a policy could provide definitions for all equipment and direct that it must be NG9-1-1 capable.

2.1.3 Legislative Changes Necessary to Support NG9-1-1 Activities

The first and most important step to support NG9-1-1 was completed by the passage of HB730 to create a protected allocation for NG9-1-1. The funds received from this effort will begin accruing in January 2016 and will be used specifically for NG9-1-1 implementation.

2.1.4 Enhance the Program's Ability to Determine Eligible Expenses

The program operates by paying for eligible expenses at the PSAP level defined in the approved eligibility list. The eligibility of products and services purchased by PSAPs must be NG9-1-1 compliant.

2.1.5 Align NG9-1-1 Program with National 9-1-1 Program Efforts

NG9-1-1 is not restricted to a single state. We must be prepared to align our NG9-1-1 program efforts with other state and national 9-1-1 efforts. This will ensure that NG9-1-1 installed in each individual state can interoperate and may join together in a nationwide NG9-1-1 framework.

2.2 Operation

The Federal Engineering team reviewed the existing PSAP operational environment to gain an understanding of current practices, technology and administrative functions. The following key areas are:

- Establish best practices and oversight for all NG9-1-1 activities across the State including network operation, service management and documentation.
- Provide direction for capabilities for NG9-1-1 including security and recognition of disruptions, mitigation, recovery of outages and avoidance of trouble.
- Conduct periodic technical and operational audits to ensure NG9-1-1 conformance to ensure performance objectives are met.
- Increase collaboration between PSAPs including sharing of resources across the NG9-1-1 platform.

2.2.1 Establish Best Practices and Oversight for All NG9-1-1 Activities

Establishing best practices across the State include network operation, service management and documentation. Typically, National Emergency Number Association (NENA) standards direct the development of best practices for NG9-1-1. The state of North Carolina will utilize the standards for the technical and operational components of the ESInet to ensure that their NG9-1-1 is a standards-based implementation.

Creating a review and best practices approach will encourage participation on the network from the PSAPs and ensure that products and services comply with the NG9-1-1 system. The ESInet will facilitate a great deal of interaction that is not available today. This requires the additional coordination to the PSAPs that are moving toward or have already implemented fully functional or partially functional NG9-1-1 systems. Furthermore, coordination efforts to create the NG9-1-1 program can ensure achievement of the most effective and efficient method for deployment.

Service management is another important consideration for the NG9-1-1 program. Following implementation of the NG9-1-1 solution it is necessary to meet the demands of

the PSAPs through appropriate operation, maintenance and continual improvement of the service.

2.2.2 Capabilities Direction

Providing direction for capabilities for NG9-1-1 include security, recognition of disruptions, mitigation, recovery of outages and avoidance of trouble. Standards will be utilized and PSAPs will be required to verify and validate that their local networks follow applicable NG9-1-1 standards.

Direction of capabilities statewide must also include implementation of a statewide solution for network and service management including a help desk function, trouble ticketing and Service Level Agreement (SLA) oversight.

The NMAC is a single point of contact that monitors the network from a service level across all providers, suppliers and resources. This approach ensures that one point of contact is in place for any incident, problem or trouble.

2.2.3 Periodic Technical and Operational Audits

Conducting periodic technical and operational audits ensures NG9-1-1 conformance with standards and safeguards that performance objectives are met. Development of an approved equipment list specifically designed for NG9-1-1 components, equipment and services purchased through a statewide agreement(s) will aid the performance of these audits.

A contract vehicle for common purchase agreements to enhance the financial efficiency can be used to benefit all PSAPs. This solution will increase the coordination among procurements and ensure that purchases are all within the technical and financial threshold expected.

2.2.4 Increased Collaboration among PSAPs

Increased collaboration among PSAPs, including sharing of resources across the NG9-1-1 platform will aid in removing duplication of equipment, services and technology. In addition, sharing will enhance the ability to eliminate or minimize silos that exist from PSAP to PSAP. That is, each PSAP is treated as a single entity with many purchasing the same equipment and services. By collaborating more effectively, a system of sharing to support multiple PSAPs across the NG9-1-1 system can be created.

HB730 enables the Board to provide additional support for the implementation of NG9-1-1 systems and services as PSAPs transition into the NG9-1-1 ecosystem.

2.3 Finance

Financial control of the State's 9-1-1 funds are an important consideration since the same fund will pay expenditures for both the legacy 9-1-1 and NG9-1-1. Much of this section relates to the accompanying Cost Analysis report.

The following are additional areas for consideration:

- Funding and distribution of funds
- Review of NG9-1-1 from a capital expenditure (CAPEX) and operational expenditure (OPEX) perspective to ensure cost of ownership type model

2.3.1 Funding and Distribution of Funds

Funds are distributed directly to the PSAP's to cover expenditures at the PSAP level. This method will not require a change initially, but will necessitate a change at some point. The reason to implement a change is to ensure that the NG9-1-1 program is the focus for future services and solutions. The stresses placed on the ability to fund both NG9-1-1 and the PSAPs will require an adjustment in priority. At this time there is no specific change identified, but as with all funding programs NG9-1-1 costs may offset common PSAP expenditures.

2.3.2 Cost of Ownership Model

Review of NG9-1-1 from a capital expenditure (CAPEX) and operational expenditure (OPEX) perspective will ensure a cost of ownership type model. Presently, the review of legacy 9-1-1 expenditures occurs on an annual basis and plans for NG9-1-1 include the same review schedule. Reviews of Capital and Operational expenditures will ensure the sustainability of funding for NG9-1-1 and the PSAPs. The resulting dollar amounts provide a baseline / benchmark for what NG9-1-1 may cost.

2.4 Strategy

Strategically, NG9-1-1 must be implemented in a cost effective manner that increases the capabilities for 9-1-1 at the PSAP level. This section focuses on the following key areas:

- Increasing situational awareness and providing greater disaster recovery options
- Enhancing the ability to seamlessly interconnect services efficiently and effectively

- Maximizing efficient distribution and use of resources across multiple jurisdictions
- Sharing existing broadband networks where possible to increase the connectivity options and expand redundancy
- Advancing interoperability through increasing coordination between PSAPs
- Conceptual network designs and models for 9-1-1 applications

2.4.1 Situational Awareness and Disaster Recovery

One of the primary benefits of NG9-1-1 is the additional situational awareness opportunities gained through better network coordination and collaboration. More information will be available through NG9-1-1 than the existing 9-1-1 system. The ability to receive additional supportive and supplemental data from an emergency including the sharing of information between PSAPs will allow for greater visibility and increased collaboration

Disaster Recovery is another benefit of the NG9-1-1 network. The ability to reroute traffic and share resources among PSAPs can increase the ability to avoid, mitigate and recover from outages that affect 9-1-1.

2.4.2 Seamless Interconnectivity

With 119 primary PSAPs in the State, the potential for having a variety of NG9-1-1 systems and configurations is likely. While standards will ensure the interconnection of each configuration, some integration work may still be required to enable internetworking of stand-alone NG9-1-1 systems efficiently and effectively.

2.4.3 Distribution and Use of Resources

The distribution of funds will continue to support the PSAPs as always; however, the alignment of the distribution of funds to NG9-1-1 concept of operations will aid PSAPs that are pursuing stand-alone NG9-1-1 systems. This will occur by increasing the ability to share the system across multiple PSAPs. Maximizing the efficient distribution and use of resources across multiple jurisdictions may result in cost efficiency gained by PSAPs using the ESInet though sharing these resources and minimizing silos.

2.4.4 Sharing Existing Broadband Networks

Existing broadband networks purchased for other state agencies should always be considered as a potential connectivity option. Existing networks with bandwidth that is

available or scalable to meet NG9-1-1 capacity requirements may provide transport for an NG9-1-1 connection. In addition these networks may be useful for a secondary or backup network in the event of a disruption of the primary NG9-1-1 path.

Networks such as these may provide the opportunity to share transport and infrastructure to aid in the cost efficiency for the NG9-1-1 solution.

2.4.5 Advancing Interoperability

Interoperability is a common goal for all NG9-1-1 strategies. Some PSAPs currently interoperate without an NG9-1-1 network. While others already share resources or work together to share functions in the current legacy 9-1-1 model, but this is typically limited to geographic area. The NG9-1-1 network removes geographic restrictions to increase the ability to interoperate.

2.4.6 Conceptual Network Designs and Models for 9-1-1 Applications

The high level conceptual designs for each of the focus areas are presented in later sections of this document. These conceptual designs are at a high level and presented to serve as an outline for establishing the strategy necessary for the Concept of Operations. The next phase of the project will further refine each design.

3. Approach

NG9-1-1 implementations across the country began through many different approaches. Most commonly the planning, design and procurement of an ESInet is the first step into NG9-1-1. This method allows a network to be configured and become operational prior to deployment of any NG9-1-1 functions or hosted applications. ESInets can be a catalyst enabling greater flexibility than legacy systems and may provide an architecture capable of supporting the capabilities provided by NG9-1-1. Many consider NG9-1-1 an ecosystem that utilizes the ESInet to establish the functionality and value identified by the NENA standards for implementation. A key advantage of an “ESInet first” approach is the ability to remove legacy boundaries and extend the reach beyond a specific geographic limit.

A proactive approach to avoid a disparity of NG9-1-1 implementations at the PSAP level is to implement a common ESInet. Presently, several ESInets and NG9-1-1 capable solutions already exist across the State. These will require integrated into the state-wide ESInet. Figure 1 provides the status of each county with regard to the degree of integration into NG-1-1. Table 2 provides the characteristics of typical ESInet models.

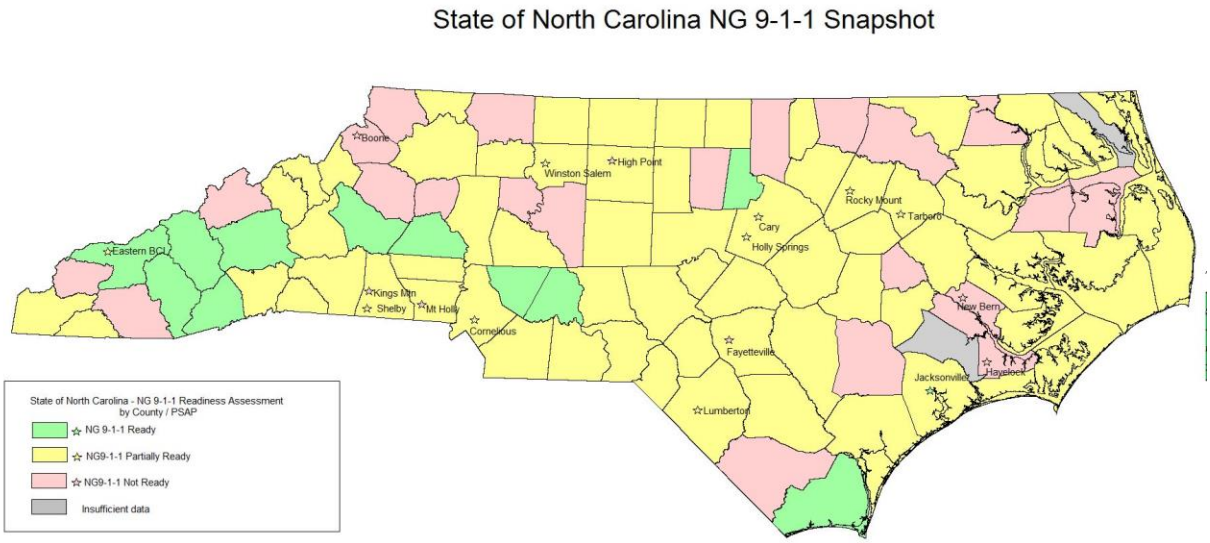

Figure 1 – Current NG readiness by PSAP

Table 2 – Characteristics of ESInet implementations

Typical ESInet Models	Characteristics	Advantages	Caveats
Statewide	An IP network connected to all desired locations. May be provided by a single provider or be an interconnected system comprising local and regional networks.	Standardization across all networks	Can increase monitoring and maintenance challenges
		Statewide control of policies	May include multiple service providers
		Standardization of SLA's	Service management
Regional	An IP network connecting a specific region; or collection of PSAPs.	Distribution networks can be seamless	Multiple operational processes and procedures
		Internetworking can be expedited	Multiple providers may not interoperate efficiently
		Standards based	Scalability
Local	An IP network connected within a single PSAP boundary.	Easily implemented	Local policies and procedures can limit ability to scale
		Cost advantages to smaller PSAPs	Often smaller service provider footprint
		Rapid deployment	Limited operational management

Working from a top-down approach, a statewide solution can greatly enhance the effectiveness of an NG9-1-1 implementation. Statewide NG9-1-1 networks can increase the value generated by existing ESInets and allow for the internetworking of solutions.

The strategy provided within this concept of operations supports a statewide ESInet and policy for all network configurations. In order to ensure that this can remain functional this Concept of Operations document focuses on the statewide ESInet and NG9-1-1 platform from an overarching perspective.

NG9-1-1 supports new technical opportunities but also affects the operation and governance of 9-1-1. Migration to a statewide NG9-1-1 ecosystem in the state of North Carolina requires that all policies, procedures and operational methods are capable of supporting the transition. A consistent approach that ensures that the technical and operational capabilities can be integrated in a cost efficient and technically effective manner is the objective.

The deployment of a statewide ESInet that can internetwork the NG9-1-1 functional elements will allow all PSAPs to support broadband communication technologies unlike the current legacy 9-1-1 system.

4. NC NG9-1-1 Roadmap

4.1 Roadmap

In this roadmap, the ESInet is essential for NG9-1-1 and will be designed to provide connections to the PSAP's. The configuration of the ESInet will also to support the Next Generation Core Services such as Hosted Call Handling (CPE), GIS services, Network Monitoring and Assistance, and eventually Radio and CAD interoperability.

For these reasons, the roadmap provides a high level timeline and plan to support the gradual implementation of the features and functions required. During the implementation the Board must continue to provide coordination activities with the PSAP community.

4.2 Phased Implementation

This Concept of Operations presents a phased implementation that provides the basis for an organic growth into a fully implemented statewide NG9-1-1 network. An assessment of the state of North Carolina operational and technical information shows that this approach aligns with the State's objectives and provides a method for implementing NG9-1-1 gradually. Many states have utilized a similar approach to great success and North Carolina is poised to duplicate the success as they move forward.

A phased approach also allows PSAPs to make use of the capabilities as they progress into the fully functioning network.

In a phased approach, the following are the most common and successful phases for achieving NG9-1-1 in other efforts:

1. Implementation of an ESInet
2. Installation of a Hosted Call Handling platform with Legacy Network Gateway, Legacy PSAP Gateway and/or Legacy Selective Router Gateway
3. Implementation of a service management solution that includes a Network Operations Center (NOC) responsible for monitoring, management and maintenance of the ESInet and hosted call solution
4. Implementation of GIS and Geo-based call routing services and data to support NG9-1-1 call routing

5. Implementation of the NG9-1-1 core services functional elements and functions (Border Control, Emergency Services Routing Proxy, Policy Routing Function, Emergency Call Routing Function)

6. Establishment and implementation of an interoperable radio solution that utilizes the NG9-1-1 system as appropriate

7. Establishment of an interoperable CAD solution that allows the PSAPs to share records in a more efficient manner through a common CAD platform

Table 3 provides a roadmap and sample timeline for implementing NG9-1-1.

Table 3 – Roadmap

	Task	2015		2016												2017											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Phase I	Esinet specifications							RFP				Award															
	Hosted Call Handling specification							RFP				Award															
	GIS specification							RFP				Award															
	Network Monitoring and Assistance Center specification										RFP			Award													
	Contract Negotiation ESInet, Hosted call handling, GIS																										
	Contract Negotiation NMAC																										
Phase II	ESInet implementation																										
	Hosted call handling implementation																										
	GIS implementation																										
	Network Monitoring and Assistance Center implementation																										
	Radio interoperability specifcation																				RFP			Award			
	CAD interoperability specification																					RFP			Award		
	ESInet / Hosted call handling / GIS test and acceptance																										
	ESInet / Hosted call handling / GIS system soak																										

4.2.1 Emergency Services IP Network (ESInet)

An ESInet is Internet Protocol (IP) based and offers the capability to meet current challenges with broadband communications and deliver a high degree of service level to meet future technology enhancements. IP has proven capability, reliability, resiliency, and scalability. The Internet Engineering Task Force (IETF) defines IP standards. The IETF also defines related protocols used on the public Internet and that may be adopted for use on private IP networks, including public safety IP networks.

Over the past several years, a number of ESInets have been deployed to support the need for meeting the challenge of the public safety market. These networks are commonly private networks that utilize IP as a transport protocol. Typically, ESInets are built for the purpose of providing 9-1-1 and other public safety services at the local level and at the state level.

NENA has led the way in developing best practices and standards for ensuring configuration of ESInets in a manner that supports effective delivery of emergency calls and related public safety data while easing the interconnect to ESInets and has the potential to create an interconnected, national ESInet. In addition, NENA produced standards that directly apply to the functional elements and Next Generation Core Services that migrate call delivery from a Public Switched Telephone Network (PSTN) model into an IP-based system. Use of these directives and standards ensure the alignment of all NG9-1-1 implementations.

4.2.2 Hosted Call Handling

All PSAPs have equipment specifically purposed for handling 9-1-1 calls and the associated data. The industry name for this equipment is Customer Premise Equipment (CPE). It performs the functions of 9-1-1 call handling. Call handling is the process of setting up, delivery and tear down of a communications and data transmission path specifically for a 9-1-1 call between a caller and a PSAP (and specifically a dispatcher). The CPE is designed within a PSAP to link to the PSTN network interfaces, applications and services that are necessary for 9-1-1. This includes directly interfacing to the Selective Routers within the PSTN and connecting to the databases to capture call number (Automatic Number Identification (ANI)) and location (Automatic Location Identification (ALI)). CPE is often referred to as an ANI/ALI controller.

The CPE is primarily the switch that collects all 9-1-1 calls entering a PSAP and prepares the call and data for “ringing” to a call taker and dispatcher. In the state of North Carolina the majority of CPE implementations are designed to support the specific boundaries of a county. Historically, this method of implementation was the standard for 9-1-1. A

limitation of this type of configuration is the difficulty of transferring forwarded calls from one PSAP to another PSAP due to the boundary-based configuration. However, with the implementation of ESInets and movement toward NG9-1-1 systems, CPE can move into a hosted and shared model.

Hosted Call Handling can place the CPE inside the NG9-1-1 system and increase the ability for PSAPs to share a single CPE unit instead of each county having their own. The Hosted Call Handling approach will utilize the capabilities of the ESInet to create the paths necessary between the PSTN network and the NG9-1-1 functions. Another advantage of this configuration is the ability to increase the PSAPs' ability to interoperate. If PSAPs share a system through the NG9-1-1 system they can seamlessly transfer a 9-1-1 call with location information from one PSAP to another PSAP.

Other components that will be hosted within the ESInet include CAD and logging recorders.

4.2.3 GIS, Mapping, Geo-Based Call Routing

The state of North Carolina GIS is currently a local function handled by each county. Therefore the GIS capability will require a significant amount of attention to ensure that the GIS data provided by each county is usable in a state-wide GIS system.

GIS plays a fundamental role in NG9-1-1. In NG9-1-1, the caller's location is normally delivered as part of the original call-setup messages using the Session Initiation Protocol (SIP) protocol, carried over the IP network. All calls are routed to the appropriate PSAP based on the caller's location, which is based upon the GIS location of the caller. This is known as location-based routing and is performed through the GIS system. When a call arrives, the caller's location is identified and the location is plotted onto the GIS map. From there, the GIS utilizes additional "map layers" to determine the proper routing for the call. This effort determines which PSAP should get the call. This call routing solution is similar to the current selective routing done in legacy 9-1-1; however, it is much more dynamic and can be more efficient.

At the PSAP a call will be plotted on the GIS map identifying the location of the caller. Then through using the map layers the GIS has the ability to recommend a responder to dispatch for the call location. This information is then displayed on the map in various ways, or is available to the dispatcher with a mouse click.

GIS is extremely important in the NG9-1-1 system. In NG9-1-1 the information contained in GIS is used to route calls to the correct PSAP. Therefore, the PSAP of the future will rely on GIS and the data within GIS to ensure that calls reach the proper destination.

4.2.4 Network Monitoring and Management

The operation of an ESInet involves several network monitoring and management functions.

All ESInets require monitoring to ensure proper operation and performance. A monitoring system design and implementation should be able to make routine periodic checks on the ESInet to insure that the critical network elements and applications are operating as required. Monitoring system alerts are essential to notify the system administrator if a network element or application fails to meet the desired threshold or fails entirely.

The monitoring system should also have the ability to track traffic statistics and usage. If traffic becomes excessive on a part of the ESInet, the monitoring system should trigger an alarm to alert a system administrator of an anomaly that requires investigation. The monitoring system should also periodically log traffic loads, error rates, and other monitored parameters for trend analysis.

Network monitoring and management contains the following responsibilities

- Help Desk
- Trouble ticketing
- Incident management
- Problem management
- Availability management
- Capability management
- SLA management
- Security management
- Reliability management
- Capacity management
- Response and Recovery
- Escalation
- Trouble closure
- Logging and Reporting
- Documentation

While the ESInet itself requires monitoring, there must also be consideration for alarms and other environmental sensors located in the rooms/buildings within the NG9-1-1 system.

A Network Monitoring and Assistance Center (NMAC) will serve as a third party to manage all facets of the 9-1-1 infrastructure. The NMAC will be the primary monitoring and management function for all ESInet and NG9-1-1 related functionality, as well as a "help desk" for PSAPs. Individual vendors may include a monitoring component within their service, but the NMAC will be the primary point of contact for all.

4.2.5 Radio Interoperability

When a typical PSAP receives a 9-1-1 call that requires dispatching of first responders, the dispatcher uses local two-way radio networks for dispatch communications. Each PSAP, and in some cases, even each agency, uses a radio network. These networks provide radio communications in specific geographic areas local to the PSAP, city, or county served by the agencies, and may include voice and data, fire paging, fire station alerting, and siren activation. The systems in use on a daily basis for local dispatch are known as "operable" systems.

During emergency situations or large planned events it is necessary to provide communications between agencies/departments that normally do not talk to each other. Systems used in these situations are known as "interoperable" systems, and may take the form of "mutual-aid". Some agencies also use mutual-aid in non-emergency situations.

Under normal operable conditions, there is little need for radio interoperability. However, as noted above, in emergency situations and for large planned events, radio interoperability is a critical need to ensure safety for first responders and the public. Advancing interoperability has been a long-standing objective of State, and driven by Department of Homeland Security – Office of Emergency Communications (DHS-OEC) policy and guidelines. North Carolina's Statewide Interoperability Executive Committee (SIEC) has made substantial progress in advancing interoperability.

A unique case of radio interoperability is the NG9-1-1 requirement that when a PSAP forwards all its calls to another PSAP, the PSAP receiving the forwarded calls must be able to dispatch first responders of the PSAP sending the calls (dispatch to "follow forwarded calls"). This is based on the assumption that the PSAP forwarding calls is no longer staffed (PSAP evacuated), and may be out of service (local disaster). If time allows, the PSAP forwarding calls may be able to transfer their staff to the PSAP receiving the forwarded calls. While the development of an NC NG9-1-1 system using an ESInet may provide a transport network able to connect PSAPs together (for 9-1-1 calls), this ESInet does not address the radio dispatch of a PSAP's first responders from another PSAP. This is due to the numerous disparate radio networks in use in North Carolina. Radio networks across the State use various frequency bands, various technologies (analog, digital, conventional, trunked, and with some being proprietary to specific vendors), and

various radio control and backhaul methods. There is currently no statewide network accessible by all agencies.

There is no easily deployable single solution today that meets the States NG9-1-1 radio interoperability requirements.

The most obvious solution is to have all public safety in the State use a common standards-based radio system. However, as noted above, many different systems exist today, and this approach would require the replacement of many radio systems, including the portables and mobile radios now in use. This may be a long-term strategy for the State's consideration, but would require significant funding and time to implement.

Combining existing radio systems into a "system of systems" at the statewide level is possible, and would require the design and deployment of an IP-based gateway system. These gateways would need to connect all radio systems and dispatch consoles together, so that any PSAP could dispatch any user in the state. In this scenario, the NG9-1-1 ESInet could serve as the transport network, but would require "last mile" connections to each radio system. Due to the many different types of existing radio systems, the common denominator for interoperability would be voice communications for dispatch. Any overall solution must address the unique paging and alerting systems (such as fire paging, fire station alerting, and siren activation). As in the case of a common standards-based radio system mentioned above, this approach would require significant funding and time to implement.

Use of an existing statewide radio network could address interoperability between PSAPs for all PSAPs/agencies programmed for and using the statewide network. In North Carolina, the VIPER system is an existing statewide network, which could be used for interoperability under the NG9-1-1 requirement. The VIPER system also has a dedicated microwave network connecting all sites together in the state. Use of VIPER to meet the NC NG9-1-1 radio interoperability requirement may entail:

- Discussion with and approval from the state of North Carolina (who owns and operates the network)
- Proper planning and design, coordinated with the State
- Consideration of the ESInet as backup backhaul/transport to the VIPER microwave network
- Development of talkgroups on a statewide level (above and beyond the current statewide talkgroups)

- Radio system expansion sized to accommodate anticipated call volume (radio channels, base stations/repeaters, consoles, and microwave)
- Reprogramming or possible replacement of radio consoles at PSAPs
- Reprogramming or possible replacement of subscriber radios (portables and mobiles)
- Statewide System User ID numbering system configured to facilitate operations
- Development of operating procedures, training, and exercises
- Identifying and securing funding

PSAPs/agencies currently not using VIPER would not be part of this solution until those PSAPs/agencies implement VIPER ability. This could be accomplished over time, as the existing radio systems reach end-of-life, and agencies replace them.

4.2.6 CAD Interoperability

In a typical PSAP, the call taker/dispatcher generally deals with four or five screens at the answering position. There is a screen for the 9-1-1 system itself, listing incoming calls, calls in queue, and ALI data. There is a screen or console to operate the radio. There is a GIS/mapping system screen, and typically, a Computer Aided Dispatch (CAD) system display. And, there may be a separate Records Management System (RMS) display, unless this is already integrated with the CAD system.

In the GIS-centric PSAP, the information on the 9-1-1 display is all found on the GIS map screen, thereby eliminating the 9-1-1 display. Some systems overlay CAD information, such as current location of units and their status, on the map. These strategies may reduce call taker or dispatcher work load and reduce the number of displays the dispatcher has to monitor, which can reduce the chance for overlooking something important or other such errors.

The ESInet makes it possible for PSAPs to share and exchange more information. Some of this information may take the form of CAD records and systems. CAD systems provided by a single vendor are typically different in every installation throughout the State.

Systems are available that can integrate disparate CAD systems into a common format.

5. Emergency Services IP Network (ESInet)

5.1 Overview

An ESInet is the first step in the roadmap to NG9-1-1. The Concept of Operations employed by the Board focuses on developing the specifications for a statewide ESInet according to the NENA model and focuses on deploying a solution that meets the long term i3 standard. We describe many of those specifications here and further define them in the specifics of the Conceptual Designs for the state of North Carolina.

Essentially the ESInet is the transport infrastructure and intelligent routing framework to enable the NG9-1-1 capabilities. An ESInet on its own does not include the capabilities to deliver NG9-1-1 calls, rather it transports calls and data.

A typical NG9-1-1 solution begins with the implementation of the ESInet with the layering in of the functional elements to deliver calls via NG9-1-1.

ESInets offer the following advancements over legacy 9-1-1 systems:

- Increasing the reliability of network resources through enhancements to resiliency, security and service management
- Increasing the flexibility and scalability of the network to remove location based and sometimes physical site limitations
- Enabling the transfer of calls between all PSAPs connected to the ESInet
- Enhancing the ability to establish backup scenarios without requiring the deployment of a physical backup location.

Table 4 compares some of the physical attributes and functions of ESInets and NG9-1-1

Table 4 – ESInet and NG9-1-1

ESInet's	NG9-1-1 Functions
Physical connections - capabilities	Logical internetwork - functions
Routers / Switches	Functional elements
Interconnections	Internetworking - Network addressing (IP, SIP, etc)
Redundant networks and Security	Security
Bandwidth	Applications
The foundation for applications and functions	Utilization of the ESInet

Technically an ESInet is an IP-based system comprising the following elements:

- Managed networks
- Ability to replicate E9-1-1 features and functions

Practically an ESInet will:

- Improve access to emergency services for callers
- Improve the effectiveness and efficiency of emergency communications and response
- Allow migration into fully functional NG9-1-1

ESInets have demonstrated their effectiveness by allowing 9-1-1 enhancements to occur without requiring substantial changes to the underlying infrastructure. An ESInet can add capabilities to support changes for current and new types of Originating Service Providers and increase flexibility for the PSAPs. Lastly, the ESInet can add capabilities to integrate and interoperate with emergency entities beyond the PSAP.

Figure 2 and the bullet list that follows briefly describe the primary components of the ESInet necessary for NG9-1-1 functionality. These components of the network are necessary along with the network infrastructure to supply the bandwidth and instructions for routing 9-1-1 traffic in the NG9-1-1 system.

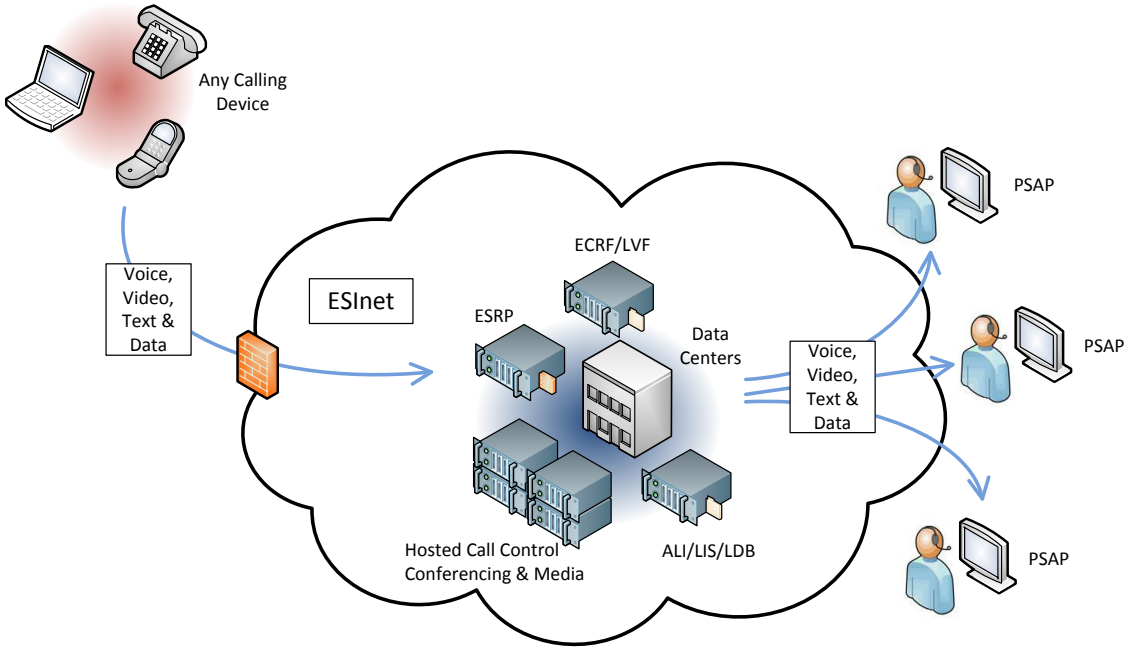

Figure 2 – ESInet Overview

An ESInet comprises several components that create the ability to progress to NG9-1-1. An ESInet is an efficient method of transitioning into NG9-1-1.

Typical ESInet components include the following:

- Routers and switches to create the IP network to transport information
- Legacy Network Gateway/Legacy Selective Router Gateway (LNG/LSRG) to connect to legacy networks and the legacy selective router for the ability to deliver calls
- Emergency Services Routing Proxy (ESRP) to create an ability to route emergency services such as calls and to route traffic to, from and within the ESInet
- Policy Routing Function (PRF) ability to create custom routing policies
- Emergency Call Routing Function (ECRF)/Location Validation Function (LVF) to enable geo-based and GIS routing
- Border Control Function (BCF) to enable a firewall component at all edges of the network

5.1.1 Purpose of the ESInet

The primary purpose of deploying an ESInet is to create a flexible, reliable, secure, and scalable network to serve all Emergency Service activities including 9-1-1. Configuration of the ESInet can arrange the interconnections necessary to integrate telecommunications providers, PSAPs and other agencies including administrative and government officers.

The ESInet is typically used for IP network communication between locations to hosts and services. In addition the ESInet can greatly enhance the capability for PSAP-to-PSAP and PSAP-to-emergency responder communications. Finally an ESInet can inherently support call transfers without boundary and include relevant call associated information.

An ESInet often aids in situational awareness. By using the logging functions within the ESInet the Board may be able to increase their visibility to events affecting the PSAP(s) and react quicker to potential areas of concern. Over time the implementation of an ESInet has become more or less mandatory for building the infrastructure required to support NG9-1-1.

Other ESInet factors include:

- Ability to replicate all features of E9-1-1 with IP-based, software and database versions
- Seamless support of all existing calling types through IP networking
- Foundation to minimize service disruption during transition
- Enhanced ability to transfer calls and data between PSAPs and other entities within the NG9-1-1 system
- Direct control of system functions and dynamic routing
- Sharing of applications and costs
- Disaster related call control
- Dynamic programming of the NG9-1-1 system to operate

5.1.2 New Communications Technologies

Many new communications technologies, such as text, email, instant messaging and social media applications have grown at a rapid pace. Existing legacy 9-1-1 networks have limited capability to deal with these new services and may not allow the communication of the valuable information available to the PSAP.

The only method to truly meet the advancement of new technology is to implement a completely new system as a foundation comprising the capabilities and NG9-1-1 core services to support new communication services. An ESInet is the primary step to provide the bandwidth, flexibility, redundancy and scalability to support these applications of the telecommunication infrastructure.

Additional potential new communications include:

- Automatic Crash Notification
- Text – both Short Message Service (SMS) and Multimedia Message Service (MMS)
- Alarms and sensors
- Pictures and video
- Social Media (Facebook, Twitter, etc.)
- Email

5.1.3 Redundancy, Diversity and Self-healing

The basis of the traditional 9-1-1 network is “telephone-grade” central office equipment, and multiple analog and time-division multiplexing (TDM) digital circuits. This network was based on legacy telecommunications services and has required special attention to redundancy, diversity and the ability to self-heal itself in the event of a disruption.

ESInet designs retain the legacy telecommunications redundancy, diversity and self-healing framework. The ESInet design contains no single point of failure. This includes the diversity and fault tolerance measures to minimize disruptions.

An ESInet utilizes IP networking capabilities and can create a logical based routing and switching of packets. Instead of multiple low-bandwidth circuits the ESInet uses broadband IP to aggregate bandwidth.

5.1.4 Bandwidth and Quality of Service (QoS)

The ESInet design must include enough bandwidth to meet current demands. However, within the specification, an ESInet should also include the ability to scale to meet anticipated demands in the near and long term. A scalable ESInet is important to meet the potential growth of NG9-1-1 services.

Quality of Service (QoS) provides a method to govern bandwidth across and within the ESInet. QoS standards regulate and prioritize the network bandwidth that supports different applications through prioritizing the packets of information.

5.2 Assumptions / Constraints

The state of North Carolina ESInet will provide the following:

- Ability to enable SIP interfaces between remote locations and public / private networks via SIP delivering 9-1-1 calls and ANI/ALI to the Emergency Services System (e.g., Automatic Collision Notification (ACN), Poison Control, etc.)
- Interfaces to systems and databases not at the remote location that supply data and assistance in processing a call (e.g., Location to Service Translation (LoST), Emergency Call Routing Function (ECRF), etc.)
- Interfaces to systems that handle a call past the point where a call taker has exclusive control over it, such as the handoff to the Computer Aided Dispatch (CAD) system

- Interfaces to upper level management systems, such as disaster management systems, as well as peer remote locations
- Interfaces to other networks (e.g., public safety radio systems, other ESInets, etc.)

Minimum functions provided by the state of North Carolina ESInet:

- Legacy Network Gateway (LNG)/Legacy Selective Router Gateway (LSRG)
- Emergency Services Routing Proxy (ESRP)
- Policy Routing Function (PRF)
- Emergency Call Routing Function (ECRF)/Location Validation Function (LVF)
- Border Control Function (BCF) which consists of a Session Border Controller (SBC) and Firewall

We recognize that the use of CPE designed to support SIP-based calling will require specific features and functions of the ESInet. We assume that the ESInet will support commonly used Internet-based telecommunications, messaging, image, and video protocols in order to maintain interoperability with Internet applications. The network design must address IP quality of service (QoS) and security to ensure system reliability.

Adherence to industry accepted guidelines and best practices provides many advantages including future proofing, protection from obsolescence, improved supportability, reduced costs, and improved interoperability. The ESInet also meet, at a minimum, the following recommendations and guidelines.

5.3 Recommendations for ESInet

Statewide ESInet network design, management, and operation services provided by a standards-based solution supplies:

- Standards based:
  - ESInet that meets open standards and increase interoperability
  - System and component level monitoring, alarming, diagnostics and reporting services, disaster recovery and system restoration services including a 24/7/365 help desk, trouble ticketing and customer facing support services

- 24/7/365 Network Operations Center (NOC) monitoring services to include Security Operations Center (SOC) functions in accordance with NENA and State policy
- NENA i3 NG9-1-1 based standards for all core functions and capabilities
- Legacy 9-1-1 integration
- Text to and from 9-1-1 services based upon the Message Session Relay Protocol (MSRP)
- Elimination of any single point of failure where possible or provide an alternative to minimize the effect of a single point of failure where identified
- Utilization of a highly reliable and redundant architecture
- Availability, diversity, redundancy and resiliency focus for ESInet design
- Support the automatic adjustment of traffic priorities in order to meet established QoS levels as defined in NENA i3
- Ability to handle legacy 9-1-1 calls and ensure the capability of handling future call types

- Functional areas:
  - Minimum level of bandwidth to support delivery of calls and associated data from originating service providers or other integrated ESInets to the PSAPs
  - Ability to automatically reroute traffic to alternate routes or systems in order to avoid network outages and system failures
  - Ability to prioritize critical traffic at multiple levels by importance of applications or users
  - Scalability without adverse effects on performance or costs
  - Ability to ensure performance through the use of traffic shaping and traffic policing
  - Fully redundant ESInet connections to PSAP locations
  - Ability to allow peering arrangements, interagency agreements or mutual aid at local PSAPs following documented policies, or dynamically through custom changes to the routing policy within the network

- Location of equipment and network resources within the state of North Carolina at Data Centers selected with approval by the State

6. Hosted Call Handling

6.1 Overview

The ESInet design will include implementation of the CPE utilized for call delivery in a hosted environment. Hosted Call Handling may be used to support several PSAPs and can directly have a positive influence on the cost of purchasing and maintaining CPE systems. At the present time there are 119 primary PSAPs and each one contains some form of CPE. The present CPE framework serves 840 positions and handles 7,294,803 calls per year.

In a legacy network, typical rough order of magnitude (ROM) cost for a single site (non-hosted) for CPE is roughly $75K per position. The same cost when installing a hosted solution utilizing an NG9-1-1 infrastructure is more typically near $35K per position. This is due to the ability to share the NG9-1-1 infrastructure required to support a hosted CPE system. Hosting services inside of the NG9-1-1 system can generate financial efficiencies through economies of scale.

A Hosted Call Handling solution can allow the potential for housing multiple hosted CPE solutions. This will increase the choices of call handling systems at the PSAP and may streamline maintenance, repair and upgrade activities. The hosted systems, to some extent, will be capable of cross system communication using standard SIP signaling aligned with NENA i3. This will enhance the ability for PSAPs to transfer and forward calls between hosting solutions without having to rely on resources located outside of the ESInet.

The hosted solution will interface with administrative call handling systems located at the PSAPs as required. Support for standard call handling capabilities will be required and they should support multiple call delivery methods (ACD, Ring-all etc.). Figure 3 is a high-level diagram of a hosted solution.

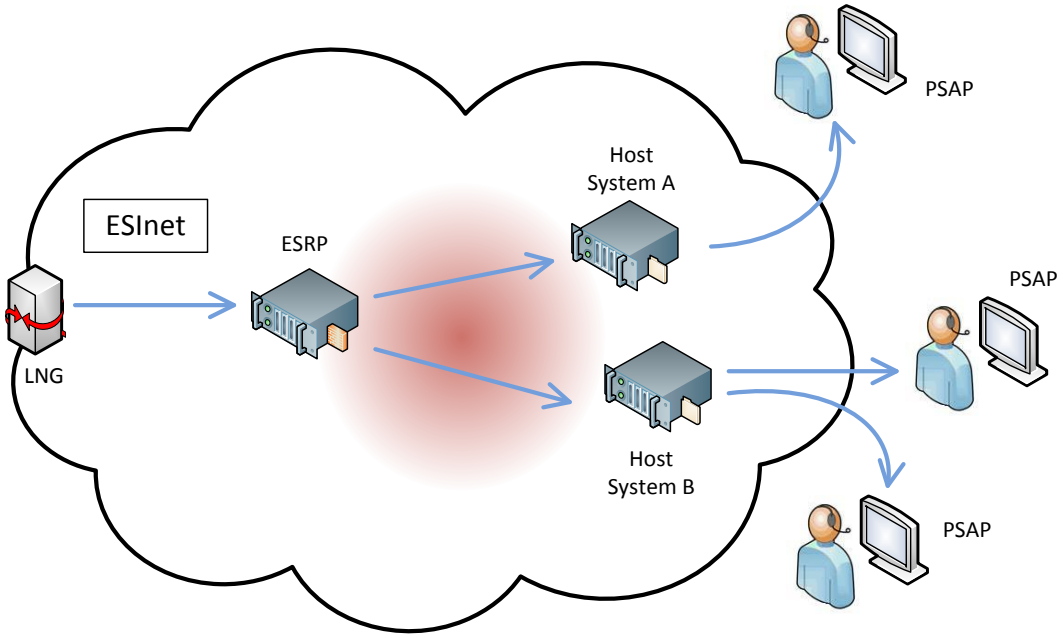

Figure 3 – Hosts operating within an ESInet

While this section primarily focuses on Hosted Call Handling, there are other potential hosted solutions that can offer additional benefits over stand-alone deployments. CAD, GIS, and Recording as well as a variety of individual PSAP applications may offer better service and support when hosted inside of the ESInet.

6.2 Assumptions / Constraints

All Hosted Call Handling solutions will use the Session Initiation Protocol (SIP) to handle all calls, data and information within the NG9-1-1 network. SIP is the call transport and delivery standard for NG9-1-1.

SIP is an application layer IP-based protocol for establishing, manipulating and tearing down communication sessions. SIP can be used to support instant messaging via text channels, contain geographic location data and even support supportive and supplemental data that arrives with a call.

The ESInet also provides an open source platform based on IP communications, designed to support many types of media calls and services without being tied to any one company's proprietary platform. NG9-1-1 will deliver all calls, using whatever network is native to a call, to the ESInet through gateway services. Following delivery of a call into the ESInet, the ESInet will route the call, based on its originating location, to the most appropriate PSAP over new and existing state-based IP networks.

Hosted Call Handling systems are being built around the use of SIP and the ESInet to treat calls in a similar fashion as they are within the PSTN. The 9-1-1 CPE systems will build upon their common foundational components of call handling, transport and delivery.

Hosted Call Handling can also provide greater geographic diversity by allowing multiple access points to a common host. Systems may choose to split redundant mission critical components and place them in different physical locations to lessen the risk of a failure (due to weather, power disruption or infrastructure damage) at any one site from seriously degrading system performance. IP-based 9-1-1 CPE connectivity is built around highly reliable and secure IP networks that, as long as they are connected, are unaffected by spreading out individual components that make up the CPE system in different physical locations.

Remote agent applications are being widely used in the call center industry to reduce costs associated with commuting to work for employees and are a natural fit for the 9-1-1 industry as an option for PSAP managers in inclement weather and heavy call volume scenarios. These proven systems can send calls to remotely located dispatchers just as easily as dispatchers located in the same building as the CPE system as long as the dispatchers have secure access to the network. Hosted Call Handling allows the idea of a PSAP location to become less about the building and more about getting the call to the most appropriate dispatcher regardless of that dispatcher's physical location.

6.2.1 Logging and Recording

While CAD interoperability will encourage greater collaboration and interaction among PSAPs, an area that can also be directly affected is logging and recording. Each PSAP contains a logging recorder within their local system. These recorders are highly secure and accessible only from the local network.

NG9-1-1 capabilities, and in particular the ESInet, permit the sharing of the function of logging and recording calls. Loggers and recording equipment may be moved into the data centers and sized appropriately to handle multiple counties. This may provide greater logging and recording abilities for many PSAPs and could result in quicker access to recording information by all.

6.3 Recommendations for Hosted Call Handling

A desirable Hosted Call Handling platform would have the following features:

- Equipment that meets all applicable NG9-1-1 standards, security requirements and recommended specifications

- Modular system architecture based on open standards and industry best practices to support the addition of new functionality as it becomes available without requiring a major revision of the underlying system code
- Hosted Call Handling equipment that meets the redundancy, resiliency and reliability concerns and provides continuity in operations to prevent the occurrence of any single point of failure in the equipment
- Ability for call takers to dial and receive calls across the ESInet including 9-1-1 calls, non-emergency/administrative calls, ring downs, VoIP and TDD
- Integration of stand-alone recording or a hosted logging recorder currently in use or that may be in use in the future
- Identification and retrieval of any calls in queue, easily and quickly
- Dynamic configuration of the distribution of calls across the ESInet
- Transference of calls to any other position internal to the system or externally along any provided secure network to another PSAP
- Allows for system administrators and/or users to save any system-wide configuration, per-user and/or per role
- Method for call takers to play back the recording of any call from their assigned workstation, provided they have the proper permissions, regardless of whether the call was answered at that workstation by the call taker or elsewhere in the system by a different call taker

7. GIS, Mapping, GEO-Based Call Routing

7.1 Overview

GIS serves many purposes in NG9-1-1. Most importantly, GIS is a component of creating the Emergency Call Routing Function (ECRF) data.

A GIS server typically contains the ECRF data used in NG9-1-1 to route calls based on geographic location. The critical nature of the ECRF and the eventual replacement of selective routing increases the emphasis on ensuring the consistency of GIS data and workflow processes to maintain, synchronize and join GIS information with the ECRF.

Although there are many steps to creating a GIS system; there are generally three primary roles of GIS in call routing.

- Call Routing
- Dispatch
- Workflow

Here we describe the importance of each of these GIS roles:

- **Call Routing –** All GIS addressing information, especially jurisdictional boundaries, become an integral part to the proper routing of 9-1-1 calls. During network design and implementation, a GIS authority should review current datasets, accuracy of data, processes for data maintenance and integration of data between systems with each PSAP. This may be a lengthy process to collect and join 100 county datasets and will most likely be an ongoing task.

- **Dispatch –** Computer Aided Dispatch (CAD) systems may also use GIS to assist the dispatcher in visually identifying the location of a call or event. Some CAD systems have their own GIS mapping tools that require integration with the GIS system once implemented.

- **Workflow –** Implementation of the GIS system into a larger statewide system must include consideration of the standards and policies required to ensure that the preparation of GIS data is consistent with future system guidelines. Specific workflows and policies may be necessary to effective data integration across the NG9-1-1 system.

With GIS at the heart of the NG9-1-1 database, public safety agencies need to continually focus on four key considerations to keep this data timely and accessible:

- **Accuracy –** In NG9-1-1, GIS uses road center lines, the addresses of buildings and jurisdictional boundaries as guides for deciding to which public safety answering point (PSAP) a call should be routed. Assuring the accuracy of this information in the GIS database is crucial to prevent erroneous routing and assure timely emergency responder responses.

- **Maintenance –** In NG9-1-1, address information must be updated and maintained regularly at the local level and then be pushed up to an emergency call routing function (ECRF) database server in the Emergency Services Internet-Protocol (IP) network (ESInet). The ECRF, which stores precise location data, determines the best route for the call, based on the location of the calling device. If the address information is not up to date, the whole routing process can degrade.

- **Standards –** In an NG9-1-1 system, data is likely to be received from a large number of agencies, PSAPs, counties and other jurisdictions that operate within the same ESInet. This data must be standardized for integration into the ECRF. For example, National Emergency Number Association (NENA) standards require the name of a street such as “West Main Street” to be stored in three separate fields: “W,” “Main” and “St.”, with “W” being the predirectional, “Main” being the street name and “St” being the street suffix or type. If a local agency stores it as “West Main” and “Street,” it may be unrecognizable to the ECRF because it does not adhere to the expected standards for addressing. Information must be entered consistently in all the database fields.

- **Policy and Governance –** Each PSAP jurisdiction will be evaluated to understand their policies on maintenance, workflow and assignment of new addresses and assure that staff members who update GIS data follow those policies. Policy and Governance must include documented decisions regarding the frequency of information update and who is responsible for carrying out this task. In some smaller communities, a planning department might assign addresses without GIS. Surrounding areas that have complete GIS addressing will lack these street names and addresses.

7.2 Assumptions / Constraints

This report assume that GIS capabilities will remain with the local entity currently responsible for GIS. GIS information will be collected, combined and stored within the ECRF server to allow 9-1-1 call routing.

The GIS must meet the NENA standards for:

- Spatial Accuracy
- Service Area Boundaries
- PSAP Boundaries
- Emergency Service Zones
- Point file (locations)

7.2.1 Remediation and Maintenance

Remediation activities on the GIS layers and data will remain a function of the local entity. The GIS department, Planning department or other entity responsible for updating and remediating the GIS data will continue to perform those tasks.

Since the GIS layers and data will comprise the call routing function in the NG9-1-1 system, verification and validation of it the information on an ongoing basis is crucial. All quality assurance and quality control measures must in place prior to uploading any data to the State GIS system for utilization by the ECRF.

The GIS system will utilize the following as a best practice or guideline:

- NENA GIS and data standards
- Common workflow for uploading GIS information and synchronization of files for use with the ECRF
- Ensuring maintenance files are uploaded in a regular and routine manner
- Local entities will remain responsible for ALI, MSAG, and GIS maintenance, validation and synchronization

7.3 Recommendations and GIS priorities

All GIS activities regarding the data integrity required for 9-1-1 and NG9-1-1 will align with NENA standards. The GIS system will ensure that all boundary information is available in the correct format for call routing, dispatch functionality and PSAP utilization in NG9-1-1 including:

- Emergency Service Boundaries from the PSAPs and GIS data that identifies associated Emergency Service Zones (ESZ) and Emergency Service Numbers (ESN).

- PSAP boundaries that correspond to non-overlapping boundaries for PSAPs throughout the State
- Fire service agency boundaries that correspond to non-overlapping boundaries for fire dispatch areas throughout the State
- Law enforcement service agency boundaries that correspond to non-overlapping boundaries for all local, regional, and state law enforcement agencies (police and sheriff departments) throughout the State
- Emergency Medical Services agency boundaries that correspond to non-overlapping boundaries for all emergency medical services agencies throughout the State
- Applicable Master Street Address Guide (MSAG) community boundaries, within which number/street name are unique
- Applicable municipal, local and adjacent state boundaries.

The State may select a vendor to provide GIS data normalization services, including quality assurance and control services.

8. Network Monitoring and Assistance

8.1 Overview

The NG9-1-1 system will require a method for monitoring the system and assisting PSAPs in dealing with service activities. The intent behind a Network Monitoring and Assistance Center (NMAC) is to serve the function of a help desk or service desk that responds to calls and web queries for assistance. In addition, the NMAC will continually monitor the activity on the network and recognize patterns, trends and proactively interface to the provider when events, incidents and problems occur.

The NMAC will operate 24x7x365, staffed in a manner that ensures monitoring of all activities. The role of the NMAC is very important in assuring that the provider and suppliers of 9-1-1 service meet their SLAs. In addition, the NMAC will be responsible for assuring the bundling of the entire service and SLAs into an overarching service level framework for 9-1-1.

8.1.1 Network Monitoring and Assistance Center (NMAC)

The NMAC will be the primary Network Operations Center, Security Operations Center and Help Desk for the state of North Carolina NG9-1-1 program. The NMAC is the point-of-contact for stakeholders, such as PSAPs and service providers, to report trouble, request changes, or obtain information about the status of the network.

Providers may have their own NOC capabilities but the State will utilize the NMAC as an overarching management function for all elements of the NG9-1-1 operation. The NMAC will be reachable by several communications methods, including telephone, email, and web site. The NMAC will be the single point of contact when it comes to getting network issues diagnosed and resolved.

As the single point of contact (SPOC) for all NG9-1-1 system activities, the NMAC provides day-to-day interface with the provider and suppliers. The NMAC will perform the following functions:

- Handles incidents and resolves them before they create problems
- NMAC owns the escalation process between all entities
- Reports and manages problems
- Handles all service requests

- Provides information to all PSAPs and users as required
- Communicates with the Board, PSAPs and vendors regarding incidents, problems, trouble tickets, changes and potentially service affecting activities
- Manages all requests for change, including hardware and software updates/upgrades
- Manages the performance of the entire solution including the provider SLA metrics
- Monitors incidents and service requests against the SLA targets and provides reports to document the level of service achieved
- Monitors availability, reliability, and capacity
- Monitors and administers network and services cybersecurity

8.1.2 Help Desk

The Help Desk is the primary customer support point of contact for the NG9-1-1 system. The Help Desk does not eliminate the need for vendors to have their own service management system. The role of the help desk is to supply additional technical and operational support to the PSAPs.

The goal of the help desk is to provide better customer service across the State while increasing the level of technical support for PSAPs. The ability to correctly prioritize incidents based upon impact and urgency is a requirement for the Help Desk staff. The common goals within the Help desk include:

1. Increase in the focus on customer service for PSAPs
2. Ease of provisioning of support through a single point of contact
3. Provision of faster resolution of incidents, problems and the fulfillment of request of the service desk
4. Escalation point of contact for urgent activities
5. Reduction of potential impacts in the event of service affecting issues
6. Ensuring the accuracy of performance metrics associated with the service

The Help Desk is also concerned with restoration of service in the event of a failure. Other responsibilities of the Help Desk include:

- Logging all incidents and requests with the appropriate level of detail
- Categorizing incidents and requests for analysis
- Agreeing on the correct priority with the provider and user on impact and urgency utilizing the SLA where appropriate
- Investigating, diagnosing, and resolving incidents whenever possible
- Deciding upon the correct support team to whom to escalate the incident should the NMAC be unable to resolve it
- Communicating progress and resolution
- Confirming closure of resolved incidents with the user

8.1.3 Cybersecurity

The NMAC SOC function will monitor security standards enforcement within the NG9-1-1 system. The NMAC SOC will utilize the NENA NG-SEC 75-001 standard for all equipment, services and systems. The cybersecurity framework for NG9-1-1 will combine the NENA standard with the standards required by the state of North Carolina.

The NMAC will ensure the continual monitoring and management of security for the entire NG9-1-1 network according to the security plan.

Security addresses the following areas to protect the State and PSAP data and resources.

- Implement an Identity and Access Management tool, system and/or process to prevent unauthorized access to the NG9-1-1 system
- Provide firewall, intrusion detection and prevention capabilities
- Ensure implementation of proper encryption within the system
- Prevent interception and manipulation of data
- Establish a centralized reporting and monitoring capability within the NMAC
- Manage and coordinate the definition updates to Anti-Virus, Anti-Spam and Anti-Malware software

- Ensure the integrity of all software used within the NG9-1-1 system
- Log all security concerns and provide a report with measurements of security issues, breaches and resolved issues

8.1.4 Configuration and Network Change

As the ESInet grows and evolves, sites will be added, sites will be removed, or sites may move to a different location. Interconnections with service providers and with other IP networks will undergo similar changes. New applications will be added to the network, and existing applications modified. Security configurations will require modification to remain current. This will demand a diligent approach to minimize the vulnerabilities that may include malware, virus protection, and the continual monitoring of potential threats. Equipment will require upgrade or replacement.

Although a necessary activity, making configuration changes on an operating network contains elements of risk. For example, a simple incorrect configuration change in a backbone router may cause IP routing failures that may affect large portions of the network with potentially serious repercussions. The ESInet design and implementation will minimize the number of single points of failure. This includes physical and logical internetworking across the NG9-1-1 core backbone as well as access networks that reach out to the PSAP.

8.2 Assumptions / Constraints

The NMAC function will ensure consistent monitoring and management of the services provided (ESInet, Hosted Call Handling, GIS, Telecommunications, Radio, CAD, Recording, etc.) and quick resolution of any problem or trouble. Many vendors will offer a common method of managing their individual service; however, this can lead to multiple levels (and layers) of management contracts. The potential exists for contracts to overlap, supersede or contradict each other when considering the entire solution. The NMAC will oversee this process.

The NMAC will become the primary interface between the Board and all vendors. Implementation of this arrangement will ensure that vendors are held accountable for any potential incident, or problem.

The NMAC will govern all SLAs which must address:

- QoS, to include delay, packet loss and jitter on network elements
- Voice availability

- All hardware availability and reliability
- Applications availability
- Spares availability
- Network availability
- Maintenance down time
- Installation
- Denial of service
- Reports
- Administration and escalation
- Order processing
- Trouble response times
- Network security

8.2.1 Service Level Considerations

An NG9-1-1 system introduces a different level and a different type of service than that currently implemented in legacy 9-1-1. As discussed previously, multiple service levels will exist within the system and will need to be combined in a manner that serves the entire system and not the individual components. Service levels are a guarantee that the service will meet its intended threshold. Service levels affect the continuing performance, and response and repair times to correct an issue. A service level agreement also defines the liability and cost for exceeding the defined threshold.

The procurement process for the system will define the service levels to support the desired NG9-1-1 system. The ability of the NMAC to assemble an umbrella service level agreement is a necessary component of the NG9-1-1 management function.

The NMAC will be responsible for these functional areas:

- Accounting management
- Change management
- Configuration management, which includes release management
- Fault management, which includes network incident management and problem management

- Performance management, which includes capacity management and availability management
- Security management
- Service level management
- IT service continuity management

8.3 Recommendations and NMAC Priorities

This NMAC is the established single point of contact on a 24x7x365 basis and the primary notification point for all system issues such as the following.

- Continuously monitor the performance and availability of all devices, network connections, applications, CPE, and other functional elements throughout the NG9-1-1 system and network
- Monitor network performance, including throughput, latency, jitter, packet loss, and other parameters, including any performance criteria identified in a vendor supplied Service Level Agreement (SLA).
- Monitor the network for network intrusion attempts and potential security breaches, and issue alerts as required to protect the NG9-1-1 system and network.
- The network performance monitoring tools shall be industry standard platforms designed for and deployed by network operators on networks of the same size and complexity as the NG9-1-1 network.

The NMAC will allow for integration of diagnostic tools to monitor and manage the equipment, applications, appliances, services and alarms to alert the NMAC personal to an event, failure or disruption of the operation.

- The NMAC will provide system health monitoring and assurances that the system is functioning properly and in accordance with performance criteria.

The NMAC will include the requirements for operating as the SOC for the network, which may include:

- Accounting, Authentication and Authorization services

- The NMAC will also ensure that intrusion protection service and detection are performed in a proactive manner to minimize security threats.
- The NMAC will maintain security patch management, Anti-Virus, Anti-Spam, and Anti-Malware processes and products.
- The NMAC will perform operational reporting via statistical data to ensure real-time reports are consistent with expected service level and performance criteria.
- The NMAC will be the single point of contact for any changes or configuration modifications necessary within the system. These may include:
    - Software upgrades
    - Hardware changes
    - Access authorization
    - Change management and planning
- The NMAC will ensure software integrity controls throughout the life cycle, including during development, testing, and production.
- The NMAC will manage all encryption on all communications in coordination with the vendor.
- The NMAC will partner with the vendor to maintain a disaster recovery and continuity of operations plan.

9. Radio Interoperability

9.1 Overview

9.1.1 Radio Interoperability in an NG9-1-1 Environment

One of the advantages of an NG9-1-1 system is the ability to forward 9-1-1 calls (voice and data) from one PSAP to another PSAP. While this allows the forwarding of calls as a function of the NG network, there is an additional requirement that must be met – that of forwarding radio dispatch to the same PSAP, now answering the calls. This is to allow communications between the PSAP now answering the forwarded calls and the public safety users in the original area from which the calls originated. The NC NG9-1-1 Board is considering use of the NG9-1-1 ESInet as a backhaul network to facilitate this radio interoperability when calls are forwarded.

There are multiple types of radio systems in use in North Carolina, ranging from frequency band used (VHF, UHF, and 700/800 MHz) to technology used (analog, conventional, trunked, digital, P25, EDACS, and NXDN). Due to the disparate radio systems in use in North Carolina, and the fact that the radio systems are usually controlled by the individual dispatch center, limits methods for full interoperability at this time.

Current radio systems in NC consist of VHF (low-band and high-band), UHF, 700 MHz, and 800 MHz. Multiple vendors and technologies in use include proprietary technologies such as Motorola SmartNet® and SmartZone®, and Harris EDACS. There are also standards-based technologies in use such as APCO P25, and NXDN. NXDN is not currently considered mission-critical grade, and its use is driven more by cost than interoperability.

Information gathered by the PSAP Survey provided only high-level insight into radio systems in use, and lack the detail required to complete a full evaluation. Many responses from PSAPs included the type of radio control console used, and it is important to recognize that a significant quantity of these radio consoles are at end-of-life, and support from vendors has or will soon end. If the radio systems associated with these end-of-life consoles are of the same age, the radio systems may also be at end-of-life and need replacement in the near future.

9.1.2 Interoperability Guidelines

DHS-OEC (SAFECOM)[4] drives public safety interoperability. DHS-OEC published guidelines[5] describe how to approach this topic on a statewide basis. The foundation of interoperability is the Interoperability Continuum, as shown in Figure 4.

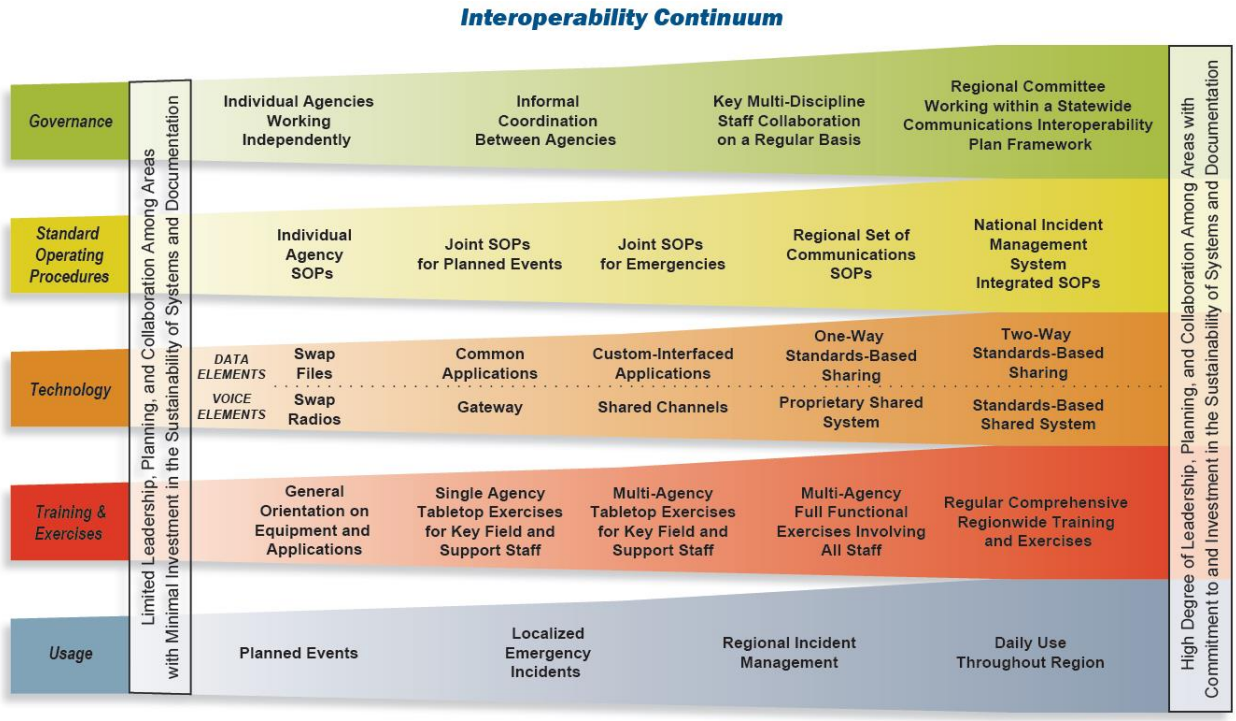

Figure 4 – Interoperability Continuum

The Interoperability Continuum consists five “lanes” which, addressed together, form a cohesive plan for the State. As each lane progresses from left to right, it describes the evolution of interoperability toward the DHS-OEC objective of full interoperability (far right). While interoperability dictates addressing all lanes for radio, the major focus for the NC NG9-1-1 project is the Technology lane, and moving as far to the right in the lane as possible. Within this lane the farther right you proceed, the more developed the interoperability.

9.1.3 North Carolina Interoperability

In compliance with the DHS-OEC Guidelines, most states, including North Carolina, developed Statewide Communication Interoperability Plans (SCIPs), and put into place governance structures to address interoperability. Part of this governance structure

[4] http://www.dhs.gov/safecom
[5] http://www.dhs.gov/safecom/planning

includes a Statewide Interoperability Coordinator (SWIC), responsible for advancing interoperability within the state and with adjacent states.

The State Interoperability Executive Committee (SIEC) addresses public safety radio interoperability in NC. The SIEC is a subcommittee of the NC State Emergency Response Commission (SERC). Figure 5 shows the current governance structure.

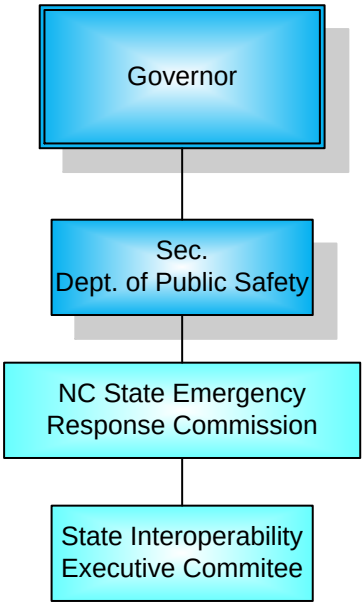

Figure 5 – Governance Structure in North Carolina

Within North Carolina, the current plan within the SCIP is to use the 700/800 MHz P25 VIPER system as a part of the interoperability solution. This system is a standards-based shared system (on the far right hand side for the voice communications half of the Technology lane in the continuum), which through appropriate system and radio programming, allows interoperability between all users.

Counties already partnered with NCDPS in use of the VIPER system include:

- Alamance County
- Beaufort County
- Bertie County
- Bladen County
- Brunswick County
- Buncombe County
- Durham County
- Edgecombe County
- Gaston County
- Gates County
- Graham County
- Granville County
- Pasquotank County
- Pender County
- Perquimans County
- Pitt County
- Rockingham County
- Sampson County

- Burke County
- Cabarrus County
- Caldwell County
- Carteret County
- Catawba County
- Cherokee County
- Chowan County
- City of Asheville
- City of Lenoir
- City of Mooresville
- Clay County
- Cleveland County
- Columbus County
- Craven County
- Cumberland County
- Dare County
- Duplin County
- Halifax County
- Harnett County
- Hertford County
- Hoke County
- Hyde County
- Iredell County
- Lee County
- Lenoir County
- Lincoln County
- Macon County
- Martin County
- Mecklenburg County
- Mitchell County
- Nash County
- New Hanover County
- Orange County
- Stanly County
- Stokes County
- Surry County
- Swain County
- Town of Chapel Hill
- Town of Creedmoor
- Town of Hudson
- Town of Plymouth
- Town of Seven Springs
- Town of Swan Quarter
- Tyrrell County
- Vance County
- Wake County
- Washington County
- Wilkes County
- Yancey County

Of the 67 partner counties using VIPER for interoperability, 37 of those use VIPER as their operable system. Use of the system as an “operable” system means that the county uses VIPER for communications all of the time. All EMS vehicles in the State have VIPER equipped radios. The VIPER system does not provide alerting (paging, fire stations alerting, or siren activation); these functions are provided at a local level.

The current VIPER system consists of:

- 214 planned sites across NC, with 210 operational and 2 additional sites funded and planned
- Approximately 78,000 users, across 268 public safety agencies

South Carolina has a similar interoperable system allowing NC and SC to talk to each other with the same radio equipment, if programmed appropriately.

NC Department of Public Safety (DPS) implemented a gateway-based system for interoperability, based on the concept that disparate agencies could use the gateway system to talk to each other and tie together radio channels or talkgroups. This solution represents the left-hand side of the continuum, and provides a lower level of interoperability than those solutions that are further to the right in the technology lane. Gateway systems usually provide voice interconnectivity only, but not radio IDs, emergency alarms, and aliases, unless the systems employ the same standard (such as P25). The current gateway system is able to pass data/metadata (User IDs, etc.), provided the sending and receiving sides in a "patch" use the same types of systems and signaling. This gateway system, implemented in 2003, has declined in use over the years as more agencies join VIPER. Also, the gateway system has had portions of the network decommissioned.

The purpose of the gateway is to patch (cross-connect) disparate radio systems and channels together. Note that while the systems/channels can be patched together, this method does not allow a user to roam into areas not served by the "home" network (unless the systems include shared radio channels common between the areas). Most current gateway systems rely on an IP interconnect of all resources in the gateway network (and the ESInet could serve this purpose). This method allows a dispatch location to communicate with users in different areas. This patching is a manual process and usually controlled by a separate console/PC position.

Gateway system configurations vary. If the gateway connects only to the dispatch console, only that dispatch console can cross-patch channels/talkgroups. If the gateways connect directly to the radio systems, remote access to the radio systems is possible from other locations. The more disparate radio systems added to the gateway system, the more complex operational procedures become.

9.2 Assumptions / Constraints

9.2.1 Radio Interoperability - Guidelines

All efforts for radio interoperability, including the specific requirement of NC NG9-1-1 to have dispatch follow the forwarding of 9-1-1 calls, need to be based on and follow the DHS-OEC Interoperability Continuum guidelines. With a focus on the Technology lane of the Continuum, solutions may be developed that affect the other lanes in the Continuum; therefore, all solutions must address their potential to affect other lanes. This will require coordination with other departments and agencies within North Carolina, and other partners such as adjacent states and federal agencies.

9.2.2 Existing Public Safety Radio Systems in Use

All candidate interoperability solutions must take into account the multiple types of radio systems and backhaul networks used to connect radio sites to dispatch centers. Figure 6 shows the backhaul methods currently in use in the State. Many of the PSAP survey respondents noted that they use multiple methods for backhaul (such as leased line with control stations for backup access).

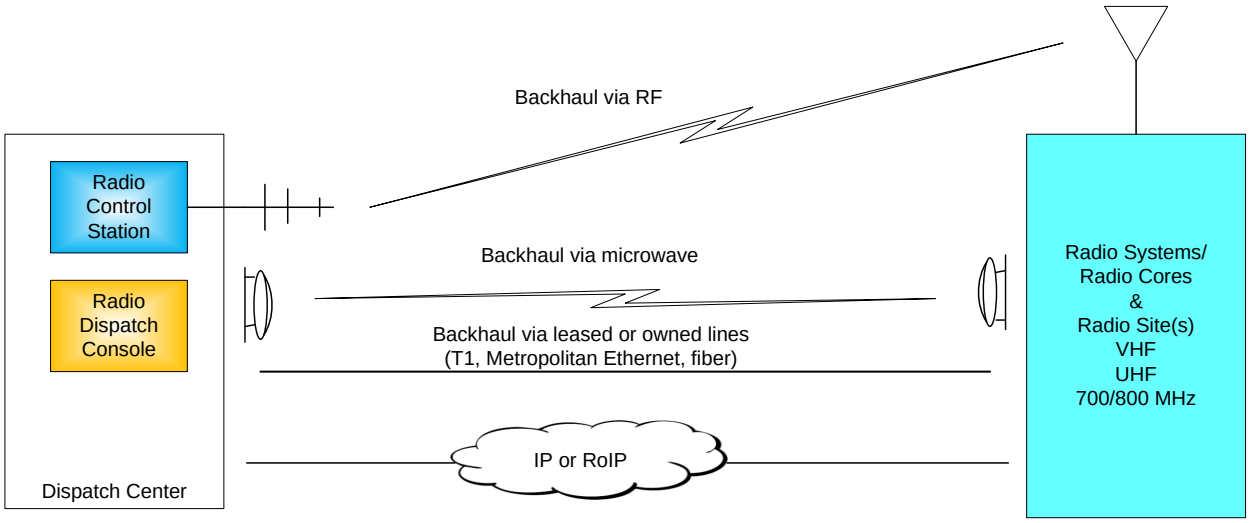

Figure 6 – Current Backhaul Methods in Use in NC

One constraint in forwarding dispatch to another PSAP/dispatch center will require establishing a parallel backhaul link between each of the radio sites to/from the PSAP for forwarding the 9-1-1 calls and dispatch. Considerations for such a backhaul include:

- Control stations: The PSAP must be within the radio range of the sites. If calls and dispatch are forwarded to a PSAP that is not with range of the radio sites, control stations cannot be used.
- Microwave: To be fully interoperable, the microwave system must be statewide, and all PSAPs connected to the microwave and radio systems.
- Leased or owned lines (T1, Metropolitan Ethernet, fiber): With the LECs moving away from T1 lines to IP based circuits, new circuits would need to be implemented between the radio sites and the dispatch center, and to the statewide interoperability network (VIPER, ESInet).
- IP or RoIP: Similar to the leased lines, circuits would be IP based, and need to connect radio sites and dispatch sites to the interoperability network.

9.2.3 State Initiatives

The Broadband Infrastructure Office (BIO) within the North Carolina Department of Information Technology (DIT) consolidates the foundational pieces of the NC Broadband effort, FirstNet, and other state broadband initiatives. DIT is directly and indirectly involved in the development, management, and operation of broadband networks for several different departments, agencies, and broadband policy and planning for the state.

- BIO continues the federally funded NC Broadband initiative to provide planning and technical services to communities, for economic development, and for education concerns within the State. Mapping of broadband availability in the State is provided, and available on the website - https://ncbroadband.gov and at @BroadbandIO

- FirstNet-NC is responsible for all activities in the State regarding the FirstNet initiative, including outreach and education, governance, consulting with FirstNet on State needs, and data collection efforts. Further information on FirstNetNC is found at firstnet.nc.gov

Since the NC NG9-1-1 project will include a new statewide ESInet, which is also a broadband IP-based network, how (and if) the BIO and FirstNetNC initiatives integrate with the ESInet are yet to be determined. Discussions are ongoing with FirstNet-NC to determine if any synergies are possible, and the form that they may take.

9.3 Conceptual Design(s)

The radio interoperability objective is to have the dispatch functions follow the 9-1-1 call forwarding from one PSAP to another PSAP, regardless of location of the PSAPs in the State.

In the interoperability solutions discussed below, none will provide 100% radio interoperability at the start of the project, based on the current radio systems in the State. Radio interoperability a phased approach. Radio interoperability may require upgrading, replacing or reprogramming some radio system equipment. Recognizing that achieving radio interoperability will be a multi-department/agency effort and require coordination between the NC NG9-1-1 community, VIPER, and the SIEC, is essential to the success of the project.

In any radio interoperable scenario, agreements between the users (PSAPs and individual agencies) must be in place, with adherence to the established State governance policies.

Based on the knowledge of radio systems currently in use, and the planned upgrades or replacements, a schedule can be developed for migration to a statewide fully interoperable network which has the functionality for radio dispatch to follow the 9-1-1 call forwarding. Surveys of the current radio systems in use will identify their potential role as part of the interoperability solution.

Success criteria will be the demonstration of radio dispatch following 9-1-1 call forwarding between PSAPs, in accordance with the developed schedule.

Because the FirstNet system is still in the planning process, the exact requirements for integration with the ESInet are unknown. However, the ESInet is flexible and can allow for future interconnections between the PSAPs and the FirstNet core. As the FirstNet network and use is defined, the requirements for the required ESInet bandwidth, security, and GIS interoperability may be defined.

9.3.1 VIPER Solution

If the NC VIPER system is to be used for interoperability throughout the State, it will be necessary to have each PSAP and each user agency part of the VIPER system in the future. This includes having the individual subscriber radios (portables and mobiles) of each agency able to communicate on the VIPER system. VIPER need not be the operable systems used by all agencies (the day-to-day radio system for the county/agencies), but must be part of the interoperable solution. This may require replacement of radio systems and subscriber radios (portables, mobiles).

The North Carolina SIEC and VIPER have been addressing public safety radio interoperability for decades. Interoperability is the main focus of the SIEC. To this end, the State implemented a statewide standards-based P25 network (VIPER) operating on 700/800 MHz. The VIPER network has the best potential to provide interoperability associated with the implementation of the NC NG9-1-1 network; however, using VIPER to provide interoperability for NG9-1-1 requires that VIPER satisfy specific conditions.

As an example, if PSAP 1 forwards 9-1-1 calls to PSAP 2, and both PSAPs/Counties are partners in VIPER (with consoles direct-connected to VIPER, and the subscriber radios able to communicate on VIPER), it is possible to have PSAP 2 dispatchers communicate with PSAP 1 radio subscribers (police, fire, EMS). Figure 7 shows the paths for communication in normal and 9-1-1 calls forwarded modes. The red lines show the communication path in the forwarded 9-1-1 call scenario. Noted that PSAP 1 does not need to be staffed or operational for this scenario. Currently only Motorola consoles are able to connect directly to VIPER, since the State has not purchased the Console SubSystem Interface (CSSI) equipment to allow connection of other manufacturer consoles.

VIPER uses microwave networks to interconnect the sites and dispatch locations. In the 9-1-1 call forwarding mode, the new NC NG9-1-1 ESInet is not required for backhaul. However, the ESInet could serve as a backup for backhaul, in the event of microwave system failures. This requires review and discussion with VIPER as well as identification and quantification of technical requirements.

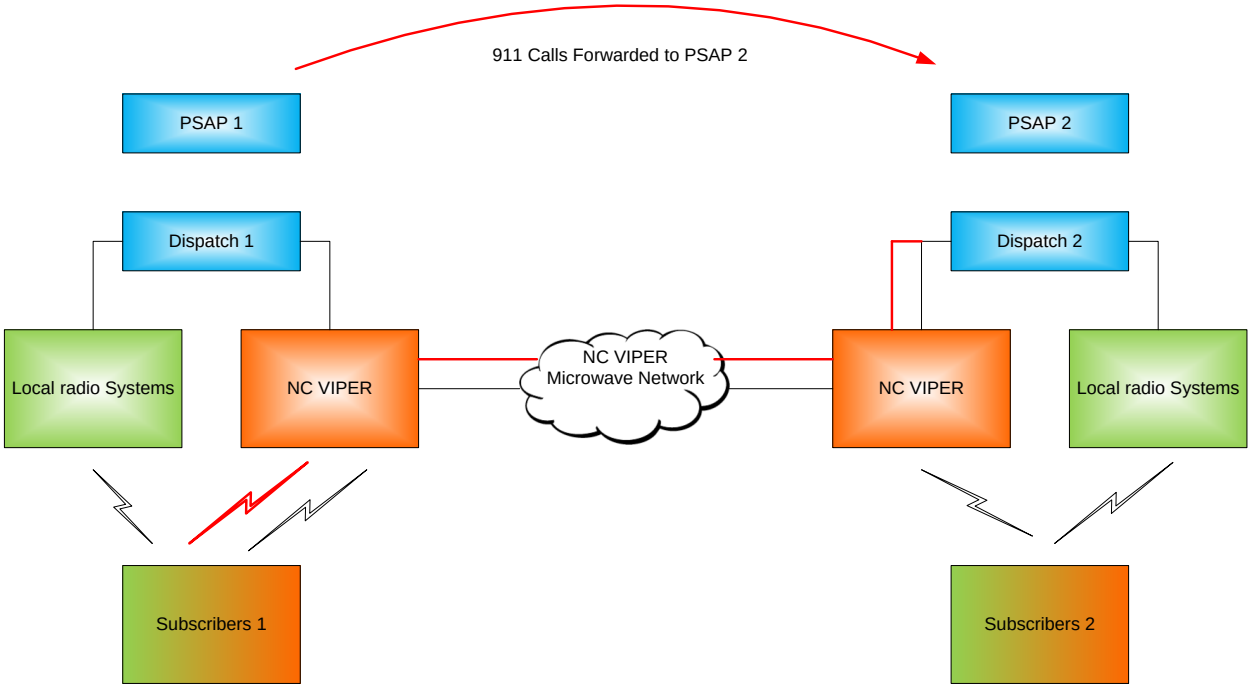

Figure 7 – Communication Paths in Normal and Calls Forwarded Modes

This method of operation requires the following:

- Revised governance to facilitate interoperability between all PSAPs and first responder agencies
- Coordination with VIPER for use of the VIPER network for interoperability, availability of microwave connectivity and capacity to all VIPER partners, and other technical issues
- Inclusion of only counties/agencies with subscriber access to VIPER and consoles direct-connected to VIPER
- Development of unique talkgroups for interoperable use in the 9-1-1 call transfer mode (the State implemented statewide talkgroups; however, their appropriateness for use is unknown at this time)

- Reprogramming of the system, radio consoles, and subscribers – to include all of the newly developed talkgroups (Development of new unique talkgroups for this use would provide statewide use of the talkgroups and control from any dispatch position)

- Development of operating procedures and training/exercises for the use of the new talkgroups

- Expansion of agreements (MOUs) between PSAPs and agencies to include this mode of interoperability

Counties/PSAPs not partnered with VIPER would not be part of this interoperability network. If counties/PSAPs partner with VIPER in the future, this would require investigation of replacement or reprogramming of their radio systems.

9.3.2 Future Gateway Solution – IP Based

A gateway solution to interconnect the radio resources in the State is possible, and could follow-on to the gateway network deployed by VIPER (Tactical Solution).

At a high level, the gateway system would allow the interconnection of the existing disparate radio systems, providing control of the radio systems (and communications with the existing subscribers), if the system meets the following criteria.

- The gateway system is IP-based

- All critical radio resources in the State have gateway access (this would require the installation of gateways connected to all radio systems deemed “critical” by each PSAP area and public safety agencies)

- All PSAPs have gateway terminals (this would require the installation of gateways in each PSAP)

- All PSAPs have consoles with access to the gateway system (this would require gateways connected to all consoles in the State)

- All gateways reside on a common (or linked) IP network (such as the new planned ESInet)

- Each PSAP’s gateway users (logon) have appropriate access to link to any required resource in the State (accomplished through appropriate of the gateway consoles)

Figure 8 reflects a high-level statewide gateway network. The blue shaded blocks indicate the existing radio consoles and radio resources (base stations and repeaters), while the orange blocks indicate the additional gateway equipment needed to implement a full statewide gateway solution.

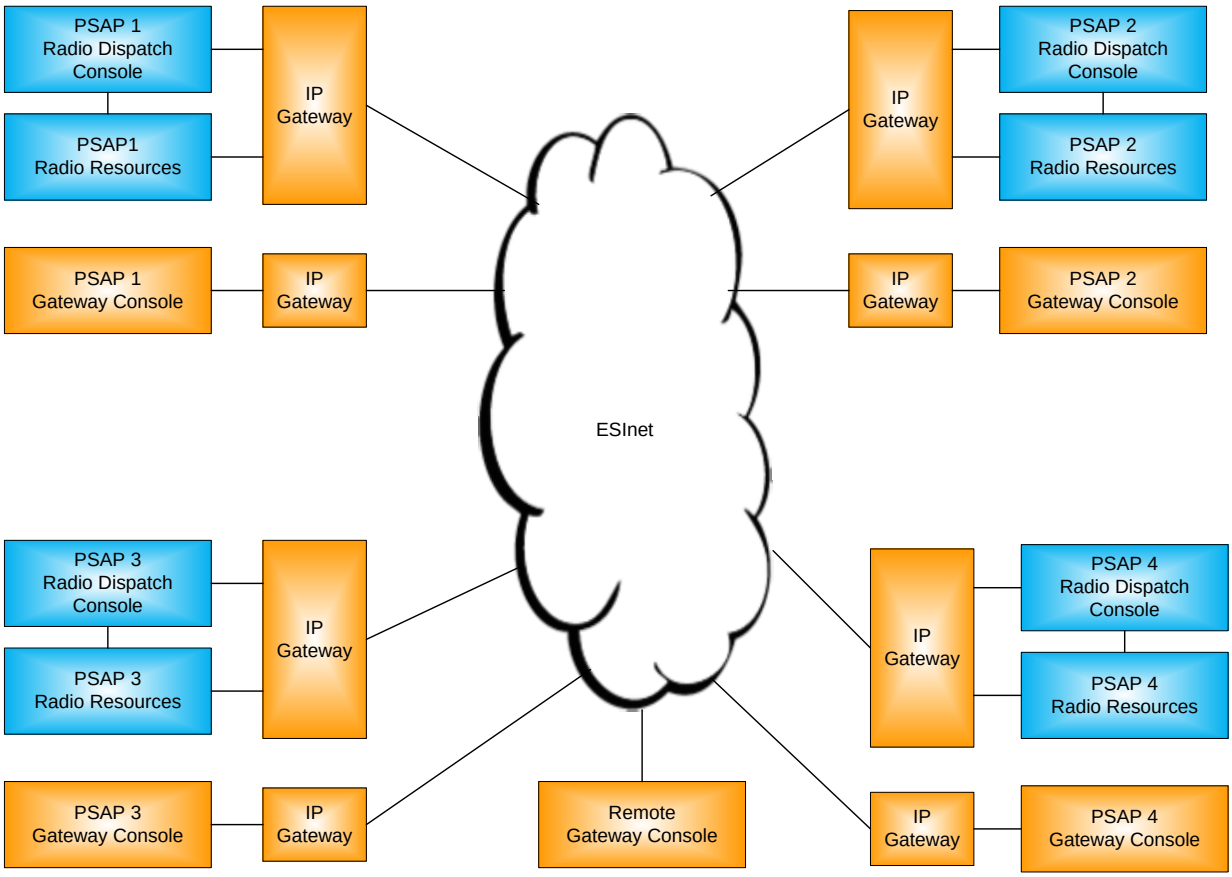

Figure 8 – High-Level IP Gateway Network

If a full statewide gateway network is implemented, each PSAP gateway console (or any gateway console installed and connected to the IP network) could control the patching of dispatch consoles to radio resources/radio consoles, and access any “critical” radio system in the State, permitting the radio dispatch to follow the 9-1-1 forwarded calls. While technically possible, this represents an additional operational complexity that would require the development of standard operating procedures, ongoing training and exercises, and a governance structure put into place.

Note also that the common denominator in the gateway network would be control of audio only. Determining the ability of the system to retain any data features (such as IDs, alarms, group calls, etc.) would require a detailed study.

9.3.3 Existing Gateway Network

The State has already implemented a gateway interoperable network to allow patching between disparate and legacy radio networks. This network, deployed in 2002/2003, uses Raytheon JPS ACU1000/ACU2000 master/slave equipment at 19 sites along the North Carolina State Highway Patrol (NCSHP) microwave backbone network, such that it can access all 100 counties of the State. Each fixed site contains radio equipment along with the ACU1000/ACU2000 that allows connections between county level law enforcement, fire and EMS personnel, both in county and across adjacent counties as well as to other external agencies called upon to respond. Provisions are also available to bridge between the tactical gateway network and strategic components of 800 MHz VIPER network. This gateway system has declined in use, as more agencies join VIPER. Also, several portions of the network have been decommissioned.

Administration and control of the network, including the set-up of patches is performed at the NCSHP Communications Centers. Patches are set up at the request of user agencies.

As this gateway system ages, limited efforts have been made to expand the network. Also, as more counties join the 800 MHz VIPER system, the necessity and use of the gateway network has diminished.

Figure 9 shows the locations of the Inter-Agency Interoperability Sites (this map may not show all applicable sites, due to recent changes).

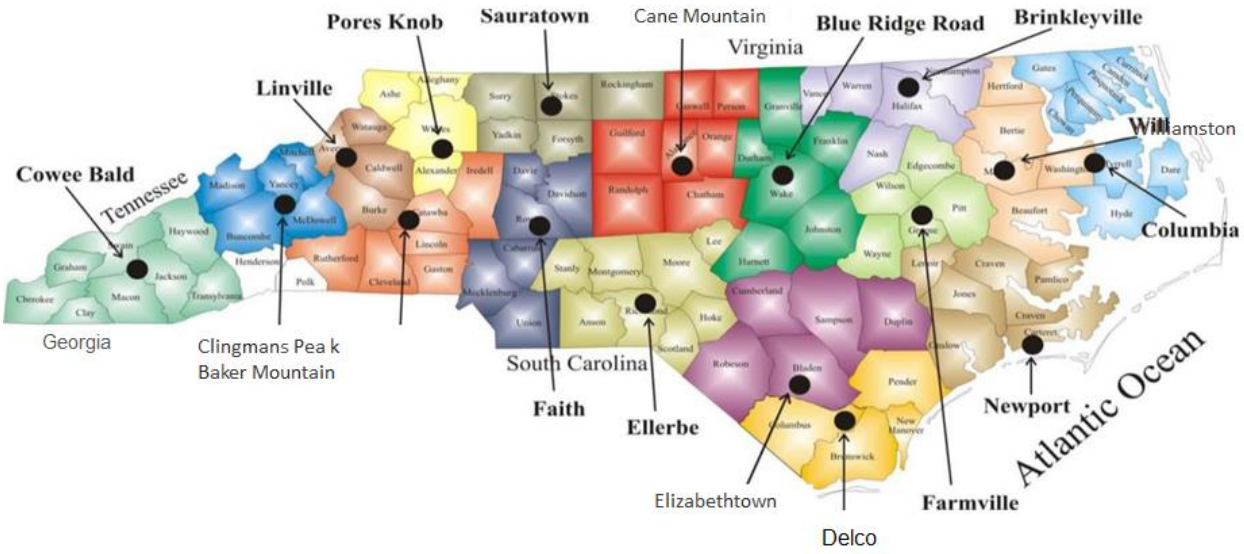

Figure 9– Inter-Agency Interoperability Site Locations[6]

[6] NC SCIP, dated April 2013, revised as of March 27, 2014

Either a new IP-based gateway network, or enhancements to the existing Raytheon JPS network will include requirements for new or replacement equipment. Resolution of governance for the network between multiple departments within the State is necessary. Along with the equipment, considerations must include new operational procedures, training, and exercises.

9.3.4 FirstNet – NC NG9-1-1 Synergies

As FirstNet planning continues, the State recognizes synergies between the NC NG9-1-1 and the FirstNet projects. FirstNet will provide prioritized broadband access to first responders, using new sets of applications, many of which still require definition. The State also recognizes that the PSAP of the future will be the nexus for not only 9-1-1 calls and radio dispatch, but also for communicating with first responders using FirstNet or other carriers.

Discussions with the NC Single Point of Contact (NC SPOC) for FirstNet identified that the connection between the FirstNet core and the PSAP could be done through the NG9-1-1 ESInet. Figure 10 shows a possible architecture with the FirstNet core connected via the ESInet to the PSAP.

FirstNet plans to release their RFP for the network and services by the end of 2015, and the target date for awards is mid-2016. At this point in time there are many unknowns about the FirstNet network, and the NC NG9-1-1 Board should continue to work with the NC-SPOC as the FirstNet planning continues. This will allow for proper sizing of the initial bandwidth requirements of the connection between the FirstNet core and the ESInet, as well as any effects on the ESInet bandwidth requirements.

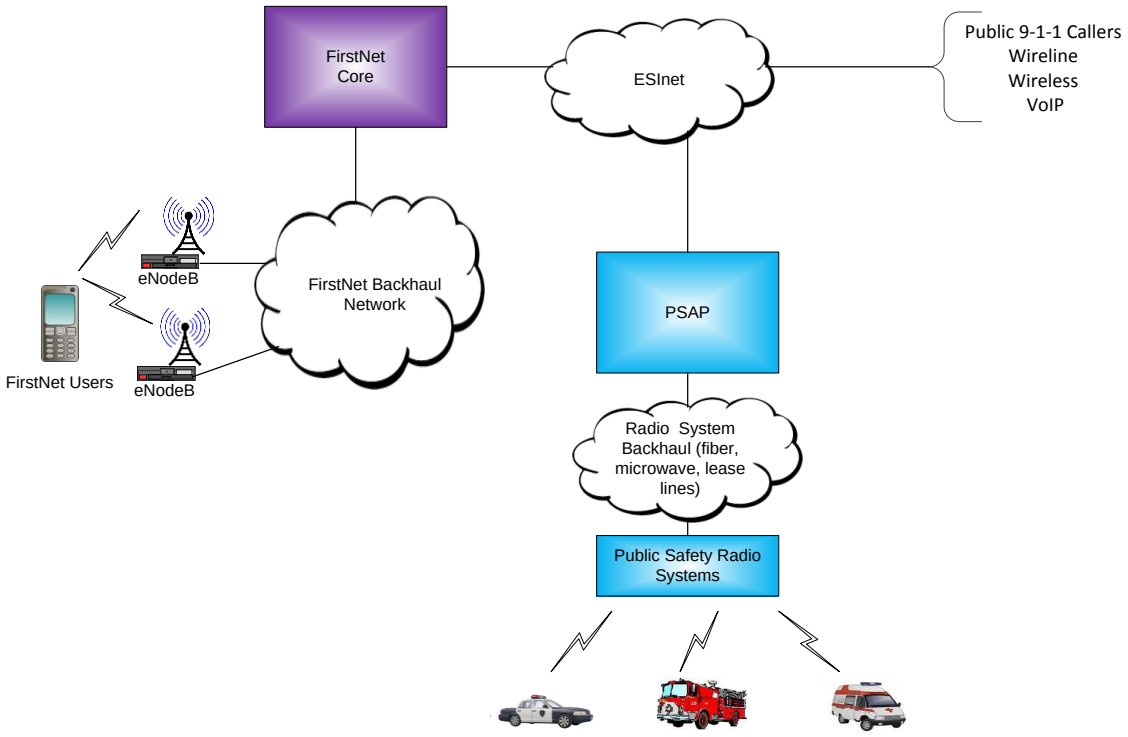

Figure 10 – Possible FirstNet – NC NG9-1-1 Network Connections

9.4 Operational Effects

Regardless of the radio interoperability solution implemented, there will be operational implications. The goal of having any PSAP provide radio dispatch for any other PSAP's first responders mandates development of new procedures, policies, and governance. These effects include:

- Integration with the State's ongoing radio interoperability efforts (this will require multiple State agencies to coordinate work efforts, specifically with the State SIEC).
- Development of new procedures and policies for use of PSAP radio interoperability
- Development of training, both initial and ongoing
- Exercises, as part of the State's interoperability plans

9.5 Recommendations for Radio Interoperability

The following are recommendations for Board consideration.

- Radio interoperability network design, implementation, management, and operation provided by standards-based solutions that supply:
    - The ability for PSAPs in the State to have the radio dispatch capabilities to first responders in any other PSAP area (radio dispatch “follows” forwarded 9-1-1 calls) to the greatest extent possible
    - The ability to perform paging, fire station alerting, and siren activation
    - The most cost effective and feasible combination of transport technologies available for connectivity (including use of ESInet where possible for connectivity)
    - Use a highly reliable and redundant architecture to the greatest extent possible to maximize availability
    - Scalability for adding new PSAPs without adverse effects
    - System and equipment level monitoring, alarming, diagnostics and reporting services, disaster recovery and system restoration services, coordinated with VIPER
- Formalization of a working relationship between the affected State agencies and departments (NC9-1-1 Board, SIEC, and VIPER) to develop a working solution and ongoing operations
- Development of required PSAP/agency migration plans for radio interoperability, coordinated with VIPER and the SIEC
- Vendor supplied installation, testing, optimization, and ongoing maintenance services
- Comprehensive vendor supplied Project Management services for all phases of the project
- Development of revised operating procedures for radio interoperability, coordinated with VIPER and the SIEC
- Continued development of FirstNet requirements for use of the ESInet as a transport network between the FirstNet Core and PSAPs, coordinated with the State’s FirstNet SPOC

10. CAD Interoperability

10.1 Overview

CAD interoperability is the functionality that allows disparate CAD systems to communicate. A common approach is the implementation of a third party application as a function of the ESInet. The primary goal is to allow PSAPs to utilize the ESInet and NG9-1-1 functions to share CAD records, data and call information that may be typically only available within their locally installed CAD system.

Increasing the ability for PSAPs to work together by sharing information also requires greater technical and operational support. CAD sharing and interoperability will enhance the visibility of events engaged across multiple PSAPs. CAD events will be visible to all PSAPs that are online in the system and may allow for the performance of specific dispatch capabilities relative to the event.

10.2 Assumptions / Constraints

10.2.1 Shared CAD Events

CAD events are often local to the PSAP where the call arrives; however, with the introduction of the internetworking through NG9-1-1, a PSAP has the ability to link to PSAPs beyond their boundaries. In a legacy network this was often not an option as the cost to create the connections were beyond the normal or standard operation of a PSAP. A properly designed and implemented ESInet and NG9-1-1 functionality removes this barrier and allows for a virtual network. The network provides the pathway to allow the applications (such as CAD) to be reached from a distant location.

CAD Interoperability is a solution that will permit the sharing of CAD events across the State in the event of a disruption at a PSAP. One solution is the implementation of an application that collects CAD events and translates them into a common CAD record and sends them to another CAD platform.

10.3 CAD Interoperability Features

CAD interoperability between PSAPs contains the following list of features:

- Capability for PSAPs to share CAD information
- Enhanced ability for PSAPs to resolve incidents through better collaboration and coordination with each other

- Enhanced ability for multiple PSAPs to respond in a wide scale event
- Increased ability for PSAPs to proactively assist one another in time of need
- Greater communication between PSAPs
- Application-based or middleware product to create a CAD interoperability model that all PSAPs can utilize without affecting their current operational CAD system
- Minimization or elimination of the current PSAP barriers to sharing information and increasing backup scenarios

10.4 Candidate Solutions for Statewide CAD Services

10.4.1 Single Vendor CAD System for All PSAPs

On a robust ESInet a single vendor, single database CAD system is a technically feasible option. This option would require significant interagency, interjurisdictional, and interdisciplinary coordination, cooperation, and support. There are a number of implementations that are large, geographically diverse systems, but nothing that the authors are aware of at this time that would compare to the size and complexity a project that would encompass the entire state of North Carolina and all of its PSAPs and/or answering positions.

There are many considerations, such as the feasibility of every agency switching to the same vendor, the logistics and timing of such a proposed effort, and challenges of selecting a single vendor. However, from a cost/cost-savings perspective, this would probably be the least expensive for the following reasons:

- Consolidated/unified equipment and hardware
- Maximized buying power related to procuring modularity and licensing
- Interfaces to a single vendor versus a single interface to multiple vendors

10.4.2 Interfacing Multiple CAD System

Interfacing multiple CAD systems together entails integrating disparate system from multiple vendors using CAD-to-CAD interface technology. This type of implementation is highly complex and requires significant cooperation and coordination between the different vendors as well as the different jurisdictions. It requires detailed configuration commonalities and inter-agency alignment related to mutually acceptable procedures and system processing rules to be able to define the shared environment(s).

The National Capital Region (NCR) has such an operation, but it has taken many years to implement, and it is still under development and expansion to meet the needs of the agencies involved.

10.4.3 Middleware Solution

This option makes use of a middleware solution to interpret and present the various elements of multiple CAD systems. This allows a single vendor to interpret the information provided by multiple vendors' products. These middleware systems tend to have limited functionality (often inquiry only) and with limitations related to the amount of information shown. Examples of this would be middleware providers such as FATPOT, WebEOC, Knowledge Center™, and others. These vendors have many statewide and large regional projects. However, the authors are unaware of any implementations these vendors have that would be of a similar size and scope as a statewide North Carolina PSAP project. This option may be the quickest to implement and could have the smallest effect on individual jurisdictions/operations.

11. Definitions

9-1-1: A three-digit telephone number to facilitate the reporting of an emergency requiring response by a public safety agency.

9-1-1 Service Area: The geographic area granted authority by a state or local governmental body to provide 9-1-1 service.

9-1-1 System: The set of network, database, and CPE components required to provide 9-1-1 service.

24x7x365: twenty-four (24) hours a day, seven (7) days a week, three hundred sixty-five (365) days a year.

Applications and Appliances: the hardware and software required for 9-1-1 call and payload acceptance, processing, and delivery to a PSAP.

Automatic Location Identification (ALI): The automatic display at the PSAP of the caller's telephone number, the address/location of the telephone and supplementary emergency services information.

Automatic Number Identification (ANI): Telephone number associated with the access line from which a call originates.

Backup Public Safety Answering Point (PSAP): Typically a disaster recovery answering point which serves as a backup to the primary PSAP and is not co-located with the primary PSAP.

Board: the state of North Carolina 9-1-1 Board.

Call: a session established by signaling with two way real-time media that involves a human making a request for help or a non-human initiated call. Sometimes it is referred to as a "voice call", "video call" or "text call" when specific media is of primary importance. The term "non-human-initiated call" refers to a one-time notification or series of data exchanges established by signaling with at most one way media, and typically does not involve a human at the "calling" end. The term "call" may also be used to refer to either a "Voice Call", "Video Call", "Text Call" or "Data–only call", since they are handled the same way through most of Next Generation 9-1-1. It is an element of current and anticipated 9-1-1 payloads.

Call delivery: the capability to route a 9-1-1 call to the designated selective router for ultimate delivery to the designated PSAP for the caller's ANI.

Call Processing: the system and process that permits a PSAP to receive, process, and route a 9-1-1 call and other current and anticipated payloads to a PSAP within the defined environment providing complete payloads with callback and location information of the calling party to the call taker position. Call processing also includes the ability to identify and answer TDD/TT/TTY and abandoned and silent calls including complete and accurate ANI and ALI of the TDD/TT/TTY calls.

Call Transfer: The capability to redirect a call to another party.

Central Office (CO): The Local Exchange Carrier facility where access lines are connected to switching equipment for connection to the Public Switched Telephone Network.

Communication Services: includes any of the following: (a) the transmission, conveyance or routing of real-time, two-way voice communications to a point or between or among points by or through any electronic, radio, satellite, cable, optical, microwave, wireline, wireless or other medium or method, regardless of the protocol used; (b) the ability to provide two-way voice communication on the public switched network; (c) wireless enhanced 9-1-1 service; (d) wireline enhanced 9-1-1 service; (e) interconnected VoIP provider service as defined by the FCC regulations; (f) IP-enabled service; or (g) prepaid wireless service.

Computer Aided Dispatch (CAD): A computer-based system which aids PSAP attendants by automating selected dispatching and record keeping activities.

Customer Premises Equipment: (CPE) equipment at a PSAP.

DataBase: An organized collection of information, typically stored in computer systems, comprising fields, records (data) and indexes. In 9-1-1, such data bases include MSAG, telephone number/ESN, and telephone customer records.

Emergency Call: A telephone request for public safety agency emergency services, which requires immediate action to save a life, to report a fire or to stop a crime. May include other situations as determined locally.

Emergency Call Routing Function or ECRF: a functional element in an ESInet, which is a LoST protocol server where location information (either civic address or geo-coordinates) and a Service Uniform Resource Name (URN) serve as input to a mapping function that returns a Uniform Resource Identifier (URI) used to route an emergency call toward the appropriate PSAP for the caller's location or towards a responder agency.

Emergency Services Internet Protocol Network or ESInet: a managed IP network used for emergency services communications, and which can be shared by all public safety agencies. It provides the IP transport infrastructure upon which independent application platforms and core functional processes can be deployed, including, but not restricted to, those necessary for providing Next Generation 9-1-1 services. ESInets may be constructed from a mix of dedicated and shared facilities. ESInets may be interconnected at local, regional, state, federal, national and international levels to form an IP-based inter-network (network of networks).

Emergency Service Number (ESN)/ Emergency Service Zone (ESZ): An ESN is a three to five digit number representing a unique combination of emergency service agencies (Law Enforcement, Fire, and Emergency Medical Service) designated to serve a specific range of addresses within a particular geographical area, or Emergency Service Zone (ESZ). The ESN facilitates selective routing and selective transfer, if required, to the appropriate PSAP and the dispatching of the proper service agency (s).

Exchange: A defined area, served by one or more telephone central offices, within which a Local Exchange Carrier furnishes service.

FCC: the Federal Communications Commission.

Functional Element: major process, application, or appliance, including network bandwidth and bandwidth support.

Geographic Information Systems or 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 civic 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 9-1-1 call.

Interoperability: The capability for disparate systems to work together.

Legacy Network Gateway or LNG: a signaling and media interconnection appliance between legacy wireline/wireless originating networks and the Next Generation 9-1-1 provider's ESInet.

Legacy PSAP: a PSAP that cannot process calls received via i3-defined call interfaces (IP-based calls) and still requires the use of CAMA or ISDN trunk technology for delivery of 9-1-1 emergency calls.

Legacy PSAP Gateway or LPG: an i3 functional element that supports the interconnection of the ESInet with legacy PSAPs.

Legacy Selective Router Gateway or LSRG: This gateway facilitates the routing/transfer of emergency calls between the ESInet and the legacy emergency services network. The LSRG will have to interwork location infrastructure between Next Generation 9-1-1 and legacy emergency services environments.

Legacy System: the existing analog-based enhanced 9-1-1 systems in the state of North Carolina.

Local Exchange Carrier (LEC): A Telecommunications Carrier (TC) under the state/local Public Utilities Act that provides 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).

Location to Service Translation (LoST) Protocol: a protocol that takes location information and a Service URN and returns a URI; is used generally for location-based call routing and, in Next Generation 9-1-1, is used as the protocol for the ECRF and LVF.

Location Validation Function or LVF: function that provides sufficient location-based information to a PSAP that allows a 9-1-1 call taker to dispatch emergency responders to a 9-1-1 call scene. The location information is provided by civic based addresses or latitude/longitude data.

Logging Recorder: A voice-band audio recorder which records to and plays from a permanent storage media such as tape or disk. Logging recorders are typically multi-channel so as to simultaneously record from several sources.

Login: The process of identifying and authenticating oneself to a computer, ACD or E9-1-1 attendant position system.

Master Street Address Guide (MSAG): A data base of street names and house number ranges within their associated communities defining Emergency Service Zones (ESZs) and their associated Emergency Service Numbers (ESNs) to enable proper routing of 9-1-1 calls.

National Emergency Number Association (NENA): The National Emergency Number Association is a not-for-profit corporation established in 1982 to further the goal of "One Nation-One Number." NENA is a networking source and promotes research, planning and training. NENA

strives to educate, set standards and provide certification programs, legislative representation and technical assistance for implementing and managing 9-1-1 systems.

NENA i3 Standards or i3: NENA Next Generation 9-1-1 standards and requirements, including without limitation, the NENA Security for Next Generation 9-1-1 Standard and the NENA i3 Technical Requirements Documents, now available or as may become available in the future.

Next Generation 9-1-1: an enhanced 9-1-1 system that incorporates the handling of all 9-1-1 calls and messages, including those using IP-enabled services or other advanced communications technologies in the infrastructure of the 9-1-1 system itself.

Public Safety Answering Point (PSAP): A facility equipped and staffed to receive 9-1-1 calls. A Primary PSAP receives the calls directly. If the call is relayed or transferred, the next receiving PSAP is designated a Secondary PSAP.

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.

Real-Time: The availability of information at the exact time it is occurring.

Redundancy: Duplication of components, running in parallel, to increase reliability.

Repair: a permanent fix or repair, including replacement if necessary, of a broken, damaged, or failed network device, database, or CPE that allows such system or system component to be fully operational.

Response: a response from a Respondent to the Request for Proposals. A response shall include submissions commonly referred to as “bids,” “quotes,” or “proposals.”

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

Service Provider: An entity providing one or more of the following 9-1-1 elements: network, CPE, or database service.

Single Point of Failure: A hardware or software component or subsystem which experiences a failure causing more than 50% of the total system to fail. (Ref. NENA 04-001 Reliability Objectives)

Spatial: Relating to, occupying, or having character or space. Geographical information systems store spatial data in regional databases.

Synchronization: In the context of timing, synchronization means to bring clocks or data streams into phase so they agree with the PSAP master clock. (Ref. NENA 04-002)

TDD/TT/TTY: A telecommunications device consisting of modems that permit typed telephone conversations with or between deaf, hard of hearing or speech impaired people.

Teletypewriter (TTY): Also known as TDD. A device capable of information interchange between compatible units using dial up or private-line telephone network connections as the transmission medium. ASCII or Baudot codes are used by these units. (per EIA PN-1663)

Transfer: A feature which allows the PSAP call taker to redirect a 9-1-1 call to another location.

Trouble: Any event that: 1) affects the functioning or operations of a PSAP; or 2) is reported to the contractor's help desk by a PSAP or the State 9-1-1 Department.

Trouble Ticket: A tracking document that contains a concise, complete, and accurate history of the trouble from the time the trouble is reported to repair of the trouble. A trouble ticket shall include, but not be limited to, PSAP location, date and time of ticket opening, date and time of ticket closing, ticket number, detailed description of problem, all steps taken during repair efforts and reason for closing ticket.

Trunk: Typically, a communication path between central office switches, or between the 9-1-1 Control Office and the PSAP.

Trunk Group: One or more trunks terminated at the same two points.

Voice over Internet Protocol or VoIP: A type of IP-enabled service that allows for the two-way real-time transmission of voice communications and has access to the public switched network.

11.1 Standards and Sources

Common Standards	Location
ECRIT Standards:	http://ecrit.sourceforge.net
ECRIT Implementation	http://ecrit.sourceforge.net
NENA i3 ESIND 08-506	http://www.nena.org
NENA i3 Technical Requirements Document. September 2006	http://www.nena.org/standards/technical/voip/i3-requirements
NENA Functional and Interface Standards for Next Generation 9-1-1 (i3)	http://www.nena.org/standards/technical/voip/functional-interface-NG9-1-1-i3
NENA Detailed Functional and Interface Standards for NENA (i3) Solution Stage 3	http://www.nena.org/standards/technical/i3-solution
NENA IP-Capable PSAP Minimum Operational Requirements Standard.	NENA 58-001 June 9, 2007 Revised
NENA/APCO Human Machine Interface & PSAP Display Requirements (ORD). NENA 54-750 v1	http://www.nena.org/sites/default/files/54-750_20101027_v1.pdf
NENA GIS Data Collection and Maintenance Standards NENA 02-014, Issue 1, July 17, 2007.	http://www.nena.org/standards/technical/data/gis-data-collection-maintenance

Common Standards	Location
NENA Master Glossary of 9 1 1 Terminology, NENA 00-001—Version 13A, dated March 17, 2010,	http://www.nena.org/standards/master-glossary
Next Generation 9 1 1 (NG9 1 1) Architecture and Analysis Report. November 2007.	http://www.its.dot.gov/ng911/pdf/1.F2_FINAL_MED_ArchitectureAnalysis_v1.0.pdf
NRIC Best Practices	https://www.fcc.gov/nors/outage/bestpractice/BestPractice.cfm
The Shortcut Guide to Improving IT Service Support through ITIL. Herold, Rebecca, 2007. Real-time Nexus.	http://nexus.realtimepublishers.com/sgitil.php
IETF Standards:	http://www.ietf.org
IETF RFC 4346, The Transport Layer Security (TLS) Protocol, Version 1.1, April 2006	http://tools.ietf.org/html/rfc4346
IETF RFC 5491, GEOPRIV Presence Information Data Format Location Object (PIDF-LO) Usage Clarification, Considerations, and Recommendations, March 2009	http://tools.ietf.org/html/rfc5491
IETF RFC 4119, A Presence-based GEOPRIV Location Object Format, December 2009	http://tools.ietf.org/html/rfc4119
IETF, RFC 5222, LoST: A Location-to-Service Translation Protocol, August 2008	www.telcordia.com
Telcordia Standards	http://www.adc.com/Library/Literature/102264AE.pdf
TIA-942 Telecommunications Infrastructure Standards for Data Centers,	http://www.adc.com/Library/Literature/102264AE.pdf

11.2 Acronyms

Acronym	Meaning
ANI	Automatic Number Identification
BCF	Border Control Function
BGP	Border Gateway Protocol
CAMA	Centralized Automatic Message Accounting
CoS	Class of Service
CPE	Customer Premise Equipment
E9-1-1	Enhanced 9-1-1
ECRF	Emergency Call Routing Function
ESInet	Emergency Services Internet Protocol Network
ESRP	Emergency Services Routing Proxy
FCC	Federal Communications Commission
GIS	Geographic Information System
GPS	Global Positioning System
ID	Identification
IETF	Internet Engineering Task Force
IP	Internet Protocol
LNG	Legacy Network Gateway
LoST	Location to Service Translation
LVF	Location Validation Function
MSAG	Master Street Address Guide
NENA	National Emergency Number Association
NG9-1-1	Next Generation 9-1-1
NOC	Network Operations Centers
PBX	Private Branch Exchange
PRF	Policy Routing Function
PSAP	Public Safety Answering Point
PSTN	Public Switched Telephone Network
QoS	Quality of Service
SBC	Session Border Control
SIP	Session Initiation Protocol
SLA	Service Level Agreement
SMS	Short Message Service

Acronym	Meaning
SOC	Security Operations Center
TDM	Time Division Multiplex