Introduction

The purpose of this report is to provide an initial, high-level governance road map for State leaders to use in creating a comprehensive Next Generation(NG9-1-1) governance structure. The report was compiled by reviewing NG9-1-1 planning documents created by other states and then providing recommendations relevant and consistent with the vision and goals identified in Virginia's Implementation Plan for NG9-1-1 (the *Implementation Plan*).

The Implementation Plan identifies that the deployment of NG9-1-1 in Virginia is dependent upon a cohesive and robust governance model, which at a minimum, should provide for the following requirements:

- A designated 9-1-1 entity with the authority and responsibility for comprehensive statewide NG9-1-1 governance and coordination;
- Widespread stakeholder participation in NG9-1-1 planning and implementation;
- Incentives to facilitate working relationships between the 9-1-1 community and groups within the Commonwealth that interact with 9-1-1; and,
- Resource sharing through multi-jurisdictional agreements for efficiency and affordability.

In order to accomplish this, the report makes two assumptions. First, the deployment of NG9-1-1 will be at the state level and that no regional systems will be used. And second, basic 9-1-1 functions will be the same for all 9-1-1 Communication Centers throughout the Commonwealth.

Furthermore, the Implementation Plan identifies the E-911 Services Board (the *Board*) as the most appropriate governance entity for NG9-1-1 in the Commonwealth of Virginia. This Plan recommends that the Board establish procurement guidelines and an implementation process for NG9-1-1 applications, but only provide assistance with the management and operation of an overall statewide IP-based communications system. This statewide system, upon which NG9-1-1 will depend, will need to support more than NG9-1-1 to maximize economies of scale, and will require its own governance. A complete description of this governance is beyond the scope of this study.

Problem Statement

Advances in consumer communication technologies is creating a data-rich environment. Text messaging and instant messaging are becoming a more common method of communicating than traditional two-way voice communications. Pictures and videos are increasingly shared through the use of smart phones. Video and text based communications are now the norm for the deaf and hard of hearing.

No doubt, this increasing dependence on new communications technology will change consumers' expectations of how they wish to communicate with 9-1-1 in the future. However, a more immediate issue exists in the form of two widespread, significant limitations with the current 9-1-1 system, which impact the level of 9-1-1 service that Virginia citizens receive today. These limitations are as follows:

- Length of 9-1-1 call set up time
- Limited ability to transfer 9-1-1 calls statewide

In Virginia, the current 9-1-1 system, based on legacy analog technologies that were established decades ago, is approaching the end of its useful life. Despite the fact that this system has been extremely reliable in the past, challenges such as recent 9-1-1 outages and massive call events related to winter storms are calling into question the future survivability of the overall system. In addition, this antiquated system cannot accept not deliver to Virginia 9-1-1 Call Centers any of the data-centric information described above.

Seconds count in 9-1-1. Frequently, if an individual dials 9-1-1 from a cell phone, there is a noticeable delay between dialing the three digits, pressing the send button, and hearing the phone ring. In addition, there is a delay between the caller dialing 9-1-1 and the information presenting itself to a 9-1-1 Call Center. Presently, 9-1-1 Call Centers are unable to transfer the data associated with a 9-1-1 call to another Center. Focusing on overcoming these two limitations would bring about a vast improvement in the service currently delivered to Virginia citizens and establish a technological foundation from which to begin the migration to NG9-1-1.

Development and Implementation

The foundation of a NG9-1-1 system is an "emergency services IP network," or ESInet. An ESInet is based on a private, secure, and highly resistant IP network that is used to carry the call and call information. In a NG9-1-1 network, all 9-1-1 Call Centers are connected via IP communications. Aside from special precautions that are taken to ensure this IP network's security, reliability, and its ability to handle "real-time" traffic, the IP network is otherwise unremarkable. It is much like any other typical enterprise, regional, or state-level IP network.

The second major component of a NG9-1-1 system is the various applications and devices that are needed for NG9-1-1 to operate effectively. In a NG9-1-1 model, the call processing functions occur in software running on the network. These services or software implemented functions provide for the delivery of "next generation" calls and data to 9-1-1 Call Centers. This allows for resiliency and redundancy not currently available in the nine independent analog 9-1-1 networks that serve Virginia citizens today. The end result will be a 9-1-1 system with greater potential for survivability in future disasters.

Recommended ESInet Core Functions and Services

Calls presented to the ESInet must follow many of the protocols standards promulgated by the Internet Engineering Task Force (IETF). Furthermore, services and devices used to make emergency calls must also be built to IETF emergency calling protocol standards. The IETF protocol standards are consensus standards incorporating requirements from a wide variety of nations, carriers, industry associations and vendors. The IETF emergency calling protocol standards applied to specific NG9-1-1 requirements

provide the core functionality of the ESInet. The recommended ESInet Core functions and services are listed below:

- Emergency Services Routing Proxy (ESRP)

The state level ESInet acts as the primary input for all calls for the Commonwealth. The state level ESRP is the first element to make routing decisions. The ESRP determines routing based on location and policy, and forwards the call to the next hop.

- Border Control Function (BCF)

The BCF acts as the security clearinghouse for the ESInet for all incoming calls and data. It is expected that every ESInet will deploy a BCF at its edge and firewalls will be deployed at the edge of every 9-1-1 Call Center.

- Emergency Call Routing Function (ECRF)

The Internet Engineering Task Force (IETF) emergency call protocol standard requires calling devices to make its location information available such that when calls are presented to ESInets, location information comes with them. In the ESInet, the ECRF uses the IETF Location to Services Translation (LoST) protocol to determine the route of the call based on the location of the calling device. The ECRF database is map based and provisioned using Geospatial Information System (GIS) layers.

- Policy Routing Function

Policy Routing refers to the determination of the next hop of a call based on the policy of the 9-1-1 Call Center which would normally receive the call.

- Location Validation Function

Communications service providers that provide service location information in civic address format must validate the civic address prior to use in a call. Like the ECRF, the LVF database is map based and provisioned with GIS layers for parcels, municipal boundaries and zip codes, and /or GIS points that represents civic addresses. The LVF database is the authoritative address database.

- Legacy Network Gateways (LNG)

Placed logically outside the ESInet, the LNG converts legacy wireline/wireless 9-1-1 calls from analog into SIP (Session Initiation Protocol), attaches the caller's location information, and presents the call to the ESInet. The legacy carriers will be responsible for transporting the calls to the interconnection point at the LNG.

- NG9-1-1 Database Services

To enable data storage and information sharing across jurisdictional boundaries, the database architecture must support an interoperable hierarchical network of databases that aggregate and consolidate data from 9-1-1 entities and their local sources.

  - *Geographic Information Systems (GIS)*

GIS is defined as the primary database for NG9-1-1, where all location data is derived. The mechanism that replicates layers from the GIS to external databases is standardized and will be used to position geographic data to the ECRF/LVF provisioning interface. Authorized ECRF/LVF operators will acquire the necessary geospatial data from a secured authoritative source, as will access or call network operators. The single authoritative source must provide for near real time updates of the geospatial data via enterprise GIS web services.

System Design Variables

The development and implementation of the shared components of the NG9-1-1 System, primarily the state level ESInet, its core functions and services, and NG9-1-1 databases, can be approached through one of the following design variables:

- Do Nothing

Doing nothing is an option. Maintaining the status quo is certainly a possibility, but this would mean that none of the short or long-term benefits associated with NG9-1-1 would be realized.

- Turn Key Solutions

Another design option to consider is one in which a single vendor offers a "turn key" solution. Turn key meaning that one vendor will serve as the system provider in its entirety, wholly and conclusively. There will be no coordinating by the Board. Turn key vendors offer a one stop shop for all things that make up the system, to include design, engineering, procurement, provisioning, installation, testing, and operation. Additionally, a turn key vendor provides for the necessary databases, system monitoring, and maintenance.

The primary advantage of this approach is that it requires the least participation by the Board since the vendor takes care of everything under a negotiated contract for service. The disadvantage to a turn key system would be the pricing.

- Transport Network

Transport network is a solution option where the Board may take responsibility to provide or contract certain elements of the system and have other elements provided by one or more vendors. This is sort of a semi-turn key solution. The Board could additionally obtain the services of a database vendor, a maintenance vendor and a vendor to provide for monitoring, troubleshooting and repair. The transport medium is under separate contract with a data transport provider that has an existing network and may

have other types of traffic currently on the network. The Board may find it prudent to contract for use of this network but take on the responsibility of connectivity of the 9-1-1 Communication Centers through other means and utilize still other means for maintenance and support.

The advantage of this type of system would be that a network does not have to be provided or built by multiple vendors nor is it necessary to design or engineer a new network. A network is already in place and operating, The 9-1-1 Communication Centers simply need to be connected by installing the necessary connectivity components which may include Customer Premise Equipment (CPE) upgrades or replacements. A disadvantage to this type of system may include security concerns because other traffic may share the transport medium.

- Private Network

The Board has the option of provisioning a private network. This system would require the identification of various fiber optic cables (dark fiber) sources. Separate, long term contracts could be negotiated for the number of strands necessary to support traffic through multiple fiber cable sources.

The advantage of this type of system is that it is custom built to serve a client's special needs. It is scalable and can grow as client's needs increase. It can be built to be totally secure and dedicated for private traffic. The disadvantages of this system are the requirements of many contracts with multiple vendors. The Board would likely be responsible for each element of the system. For everything a turn key system is, a private network is just the opposite.

Technical Requirements

To the extent possible, technical requirements must be based on open standards that exist or substantially exist today. Some of the necessary standards for NG9-1-1 are in the final stages of review and approval. For implementing NG9-1-1 in the Commonwealth, it is recommended that the statewide NG9-1-1 system be in compliance with the technical requirements incorporated in or referenced by the NENA i3 document, which draws from existing or pending IETF standards. As the Board considers various approaches for a statewide NG9-1-1 system, these additional technical requirements are also recommended:

- The Board should create interconnection policies. The Board may defer technical requirements to the contracted ESInet provider, but should maintain review and approval.
- The Board or bidders should explore the use of existing state-owned or operated networks as a method for providing redundancy or past mile connectivity. Multiple interconnected networks should be used to achieve necessary high-availability and redundancy.
- The Board needs to consider who will be responsible for GIS data. The NG9-1-1 call flow applies GIS data at the first stage of a call, instead of the final stage. At a minimum, the GIS database must contain jurisdictional boundaries of the Commonwealth's 9-1-1 Call Centers and the police, fire, and ambulance services in the State. In addition, the GIS must be able to map (geocode)

civic addresses as presently contained in all the Automatic Location Information (ALI) database within the Commonwealth with a high degree of reliability. Preparation of the GIS database is a major task in the implementation of NG9-1-1 and should begin as soon as possible. It is recommended that data readiness assessment be completed.

- As the Commonwealth considers the procurement of a NG9-1-1 system, state contracts for 9-1-1 Call Center answering equipment should be evaluated.
- The presence of state-level standards will help insure desired future interoperability will be realized and provide economic incentives for consolidation, while simultaneously permitting a maximum level of local autonomy and control of CPE functions, CAD procurements and vendors.
- Currently, 9-1-1 Call Centers procure their own CAD systems. It is recommended that any new CAD acquisitions be XML-capable. The Commonwealth should develop guidance for 9-1-1 Call Centers on recommended CAD functionality to exchange data with CPE and other 9-1-1 Call Centers..
- NG9-1-1 CAD and dispatch systems are expected to be NIEM-compliant.

<u>System Management and Operation Considerations</u>

As Virginia begins to deploy NG9-1-1 technology, considerations specific to the Commonwealth and 9-1-1 Centers should be addressed.

Commonwealth

The Commonwealth will need to address operational, economic and policy issues throughout the NG9-1-1 deployment process. Consistent with the Implementation Plan, the recommendation of this study is for the Board to be responsible for the operational aspects of the NG9-1-1 system. As a result, the Board will need to take on the responsibility of developing policies in the development, interconnection, and operation of the NG9-1-1 system.

- Operational

The authority to operate the NG9-1-1 system will come from several sources:

  - Legislative – The Board will need the authority to operate a NG9-1-1 system
  - Tariff – Call origination providers may have tariffs that give them the authority to operate components of the system.
  - Regulation – Regulations promulgated by the SCC or other agencies will give authority or create restrictions on the operation of some components
  - Contractual – The operation of some components may be outsourced to other agencies or companies. The contract will grant the level of authority the operator will have.

In addition, governance specific to the operation of the NG9-1-1 system will require the development of policies and procedures. Three major policy areas that will need to be addressed are:

- Interconnection
- Policy-based routing rules
- Security

Having the Commonwealth develop interconnection policies and procedures rather than the contracted provider will allow for better control of who uses the system, and ultimately provide a better picture of the providers who should be remitting funds to the Commonwealth. The method of interconnecting the 9-1-1 Call Centers also opens opportunities to easily and inexpensively implement backup Centers to alternate sites, or to implement "virtual" 9-1-1 Call Centers, where the call takers are geographically dispersed. This will be a key resource in responding to future disasters.

Policy based routing is a key differentiator of NG9-1-1 and is performed by creating a set of rules that the routing function in the NG9-1-1 system used to determine the proper 9-1-1 Call Center. The recommendation is for the Commonwealth to control this function, rather than the contractor of the system, to define those rules that may be required statewide, and determine what can be configured at the 9-1-1 Call Center level. This will help to maintain equal levels of service across the Commonwealth and to set levels of service in the NG9-1-1 system.

- Economic

At this time, the economic impact of a NG9-1-1 solution is difficult to measure. The Commonwealth has not yet determined a system design approach. The equipment and recurring cost of the software and management of a NG9-1-1 system will be heavily dependent on the solution selected and level of redundancy required. While development of the ESInet will create significantly more monthly network charges than the analog network currently in place, it provides bandwidth and versatility not available on the analog network. Increased cost for network services can be offset with consolidation of call processing equipment from the individual 9-1-1 Call Centers to servers in the network.

The migration to NG9-1-1 in Virginia should be supported by both Master and Transitional NG9-1-1 Plans. These can be used to develop cost plans based on the responses to the procurement process. Requesting a detailed timeline, that will list the incurred costs, as well as when current processes can be stopped, as items in the procurement process will allow the Commonwealth to measure the current costs, and when they will be reduced against the vendor's projected cost. This will allow the Commonwealth to select the vendor with the least total implementation and operational expense to the Commonwealth, not just the least expensive vendor.

- Policy

Commonwealth statutes and rules that use such terms as "calls", "telephone service", " emergency telephone system", " trunks", " dials/dialed", etc will need to be examined and modified as appropriate to cover the calling and messaging capabilities enabled by NG9-1-1. It is recommended that a thorough review of the sections of statute in which the term "E9-1-1" is used should be undertaken. The term E9-1-1 , as currently defined, may hinder deployment of NG9-1-1 if that definition is taken too literally.

In addition, the continued use of this limited definition may not be needed now that the Commonwealth has deployed both landline E9-1-1 and wireless E9-1-1.

Information required from local exchange carriers should not be defined in legacy terms. Relevant statutes and regulations should be reviewed and updated with more general terms to allow the flexibility to adjust these data elements as the system is deployed and new call origination systems are added. These sections should also be updated to reflect call origination or data providers not just local exchange carriers.

Other definitions that should be reviewed for possible changes and additions are:

- Automatic Location Information (ALI) – Recommend changing to "location information" to allow the term to be defined in regulations and updated as needed as technology changes over time.
- Automatic Number Identification (ANI) – Recommend changing to "calling party identification" to allow for more information and other types of identifiers than is currently associated with a traditional telephone number.
- ESInet – Recommend using the NENA definition. This addition is important because it is the backbone network on which NG9-1-1 services are delivered and serves a different function than today's E9-1-1 network.
- Enhanced 9-1-1 Service – Recommend updating the term to reflect comments above and to avoid narrowly defining in terms of the legacy wireline features, such as selective routing and ALI.
- Next Generation 9-1-1 (NG9-1-1) – Recommend that this term is added to definitions if 9-1-1 is not made more general.
- Telecommunications Provider – Recommend that this definition clearly identify who is covered. Changing this type of utility regulatory definition may have implications for other statutes unrelated to 9-1-1. As a result, a through legal review is recommended.
- Liability – Equal liability protection should be specifically allowed for providers of information and services to the NG9-1-1 system who are not currently defined as a telecommunications provider.
- 9-1-1 call – Recommend adopting a broader definition for a "9-1-1 call".

9-1-1 Call Centers

9-1-1 Call Centers will be impacted by the implementation of NG9-1-1 in the Commonwealth.

- Operational

The major impact to the operations of 9-1-1 Call Centers will be from the new technology. The first immediate impact will be the ability to route calls based on more factors. This means that 9-1-1 Call Centers will need to have a better understanding of the workings of the NG9-1-1 system to make good decisions as to the routing of the calls within the guidelines established by the Board. The next

immediate impact will be on security. In the new interconnected system each 9-1-1 Call Center is an entry point to the system and will need to have security in place and monitored.

In the future, new call origination systems will be delivering information to Virginia 9-1-1 Call Centers. While it is hard to predict the actual impact of these new systems, some conclusions can be drawn from past technology deployments. With this in mind, new technologies will likely continue this trend where mobile technologies provide multiple calls per incident. Training will be the primary method to deal with these issues.

Training will be the primary method to deal with the above issues.

- Economic

There are two major economic impacts to Virginia 9-1-1 Call Centers, equipment and staffing. A detailed requirements document should be developed and each 9-1-1 Call Center should be compared to the requirements to determine the need for replacements or upgrades at each 9-1-1 Call Center. The staffing impact will consist of training existing staff and the need for additional staff. Some policies and procedures may require new skill sets from additional staff.

Migration

Coinciding with the solution options already discussed are the implementation or migration stages that need to be considered. The migration stages suggested in this section are designed to enable an incremental approach to NG9-1-1. Of particular importance is the ability to control the pace at which the implementation progresses. At the conclusion of any one of the stages, the Board has the option of stopping for whatever reason before moving on to the next stage. These various stages of implementation are particularly useful in controlling revenue and expenses and budgeting for continued migration.

Stage 1

This initial stage consists of building out a network through a one-time investment that provides access to all 9-1-1 Call Centers. All 9-1-1 Call Centers have connectivity to the network but have been upgraded to be IP capable. The network, or specifically the transport mechanism, is all digital and IP enabled, and IP routers have been provisioned in the network. Under this scenario all of the traffic on the network is digital until it gets to the 9-1-1 Call Centers. By being all digital, the network receives the benefits. Call set-up times are improved. The amount of circuits have been reduced, the number of selective routers have been reduced, connection points have been minimized, redundancy is in place, and the speed of moving traffic is greatly increased. Call delivery to the 9-1-1 Call Centers has greatly improved and the goal of reduced call set-up time has been achieved.

This stage is an opportunity to work with other public safety agencies and discuss interoperability. Emergency management, police agencies, fire departments, sheriffs and homeland security can

participate and utilize the network for a variety of overlapping needs. Interoperability between agencies is one of the more attractive features of an IP network. The network is now ready to accommodate new technologies, growth, and provide for interoperability and greater survivability in the face of future disasters.

Stage 2

This next stage is comprised of upgrading the 9-1-1 Call Centers to be IP enabled by changing out the CPE from legacy equipment to IP enabled CPE. After the 9-1-1 Call Centers have been upgraded, the real benefits of the IP network are realized. No longer does the digital signal have to be converted to analog at the 9-1-1 Call Center. Statewide transfers of voice and data are possible. The goal to improve call transfer functionality across jurisdictions, including LATA boundaries, has been achieved. Applications that leverage the data-rich environment brought about by advances in consumer communication technologies can now be introduced into the 9-1-1 system.

Stage 3

In this final stage, wireline 9-1-1 traffic is moved off the LEC provided system and onto the new IP system. At this stage the LECs are literally disconnected from 9-1-1 Call Centers and their service (9-1-1 service offerings) are no longer required. At this point, the Commonwealth is self reliant and providing the full host of 9-1-1 delivery that includes selective routing of wireless, wireline, and VoIP calls and is engaged in ALI database maintenance and hosting.

Conclusion

Based on the information in this report, the recommendation is for the Board to continue the necessary planning and preparation to implement a NG9-1-1 system for the Commonwealth of Virginia. Due to the fact that the one best solution is not known at this time, the issuance of a Request For Information (RFI) document to interested parties would be a useful strategy to determine the optimal solution. The results of the RFI would help define how a NG9-1-1 network infrastructure could be implemented in Virginia, with the stated purpose of increasing the future survivability of this network, providing improved services to Virginia citizens, and realizing technical and fiscal efficiencies. The Board will need to determine at what pace they wish to proceed to achieve their goals (e.g., wireless only, wireless and wireline, statewide ALI database) and decisions will likely be driven by costs.