The Commonwealth of Kentucky

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NG9-1-1 Standards Report

Prepared by

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1.1 Purpose of the Document

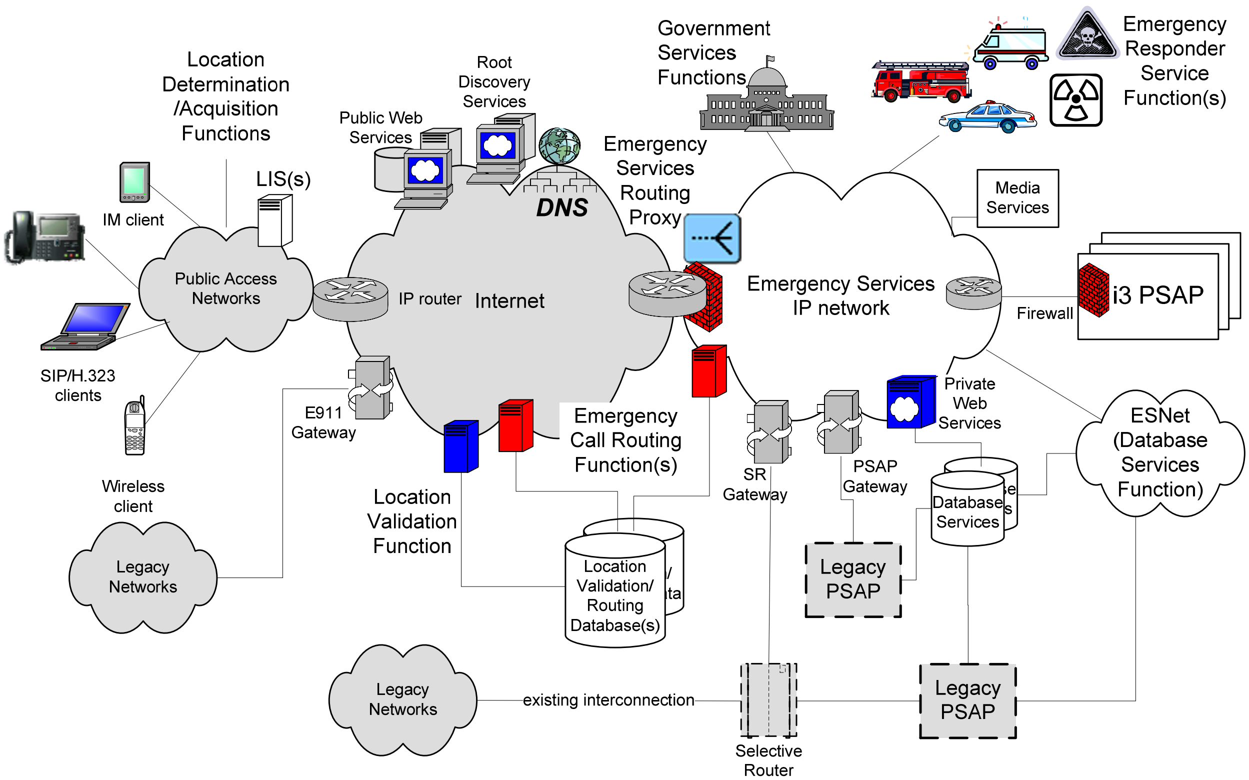

Figure 1 Next Generation 9-1-1 ESINet

This document describes the elements of design enabling Next Generation 9-1-1 (NG9-1-1) services within the Commonwealth of Kentucky (the Commonwealth). This document should be viewed as a "living" document and therefore be amended at such times that further definition is available from the actual deployment or as derived from the body of work currently underway within the standards setting bodies developing the international scope of NG9-1-1.

In its pure state, "NG9-1-1" refers to a fully deployed nationwide network of individual IP based 9-1-1 networks. Building a network at this moment to accomplish this goal is an impossibility due to the lack of sufficiently developed standards. Therefore, agencies wishing to avail themselves of the capabilities of such an IP based network define their work using the NENA "i3" standard. For the purposes of this report, the terms NG9-1-1 and i3 should be read as interchangeable terms.

Standards are at the very heart of NG9-1-1. They serve to assure the ability to communicate across distance in a reliable and predictable manner. While many such standards have been published, the Commonwealth is well served by designing a system based on those portions of a NG9-1-1 solution as currently available. This should not dissuade anyone from moving forward with deployment. Enough of the baseline network is available as a standard to assure success. Much of the remaining standards work involves the definition of new technologies and, in fact, technologies that are "over the horizon". This report reflects the current available standards and should serve as a foundation for moving forward.

This document reports on the needs of each major component of NG9-1-1 including the PSAP, network, data and legislative aspects of deployment. The proper execution of deployment requires parallel efforts for each of these four major components. From standards, deployment strategies emerge. This document then is the precursor to the Kentucky 9-1-1 State Plan, which is attendant to, though separate from, this body of work.

This report divides the processes between the major components. Following is a brief explanation of the issue and the approach being taken to address these issues:

1.2 Overview of NG9-1-1 Requirements

1.2.1 NG9-1-1 Capabilities

NG9-1-1 provides a wealth of enhanced emergency (9-1-1) request processing and response capabilities including:

- Support for present and future handset technology such as the delivery of text messages, video, and images to Public Safety Answering Points (PSAPs) and emergency responders

- Support for the delivery of telematics device information (automatically detected automobile accidents, health alarm monitors, and other emergency detection devices) directly to a PSAP without having to go through an intermediary call center

- Support for VoIP emergency calls

- Pre-validated location information delivered with the emergency request rather than after the emergency request is delivered to a PSAP

- Robust emergency request routing that supports the automatic re-routing of emergency requests (9-1-1 calls) if the destination PSAP is inoperable or busy

- Incorporation of policy rules and procedures that will automatically route an emergency request to an appropriate telecommunicator and/or emergency responder. For example, NG9-1-1 supports routing critical information regarding an automatically detected automobile accident to an appropriate emergency responder (EMS, Fire, and/or law enforcement) without requiring telecommunicator intervention, or routing a Spanish speaking emergency call automatically to an available Spanish speaking call taker.

- Access to supplemental incident information available on emergency databases, law enforcement/crime databases, medical databases, records management, hospital, court, jail management, and other relevant systems that are interfaced to each other through the NG9-1-1 network.

- Speeding up the delivery of emergency requests to the appropriate PSAP
- Cost and operational efficiencies gained through the use of standardized interfaces among disparate systems and databases
- Rapid support for emerging technologies in emergency request processing and response

These enhanced capabilities are available under NG9-1-1 while support for existing 9-1-1 capabilities such as basic 9-1-1, enhanced 9-1-1, phase I wireless, and phase II wireless are maintained.

1.2.2 NG9-1-1 Components

The enhanced capabilities of NG9-1-1 are enabled through the implementation of the following components:

A. NG9-1-1 Network – in order to support the technology of NG9-1-1, a privately managed, emergency IP network (ESInet) should be implemented. The ESInet typically covers an entire state, can be composed of sub-state regional networks, should be linked to adjacent state's ESInets, and to any national ESInets. PSAPs can tie in directly to a statewide ESInet or to a regional ESInet, which is connected to the statewide ESInet. Internet Protocol (IP) enables many of the enhanced capabilities of NG9-1-1 and is critical to the implementation of a properly functioning ESInet. The reliability and availability of an ESInet should be at least as reliable as the PSTN 9-1-1 network's standard of a P.01 grade of service, which translates to an ESInet availability of 99.999 percent (99.999%) with regard to individual components.

B. NG9-1-1 Applications – unlike the PSTN 9-1-1 network that relies on selective routers to deliver an emergency call to the appropriate PSAP and emergency responder, NG9-1-1 utilizes applications resident on the ESInet to deliver emergency requests to the appropriate PSAPs and emergency responders, to protect itself from outside attacks, and to enable enhanced capabilities. Some of these applications may be resident on the edge of the ESInet or within PSAPs, but they should exist in one place or another in order to support NG9-1-1.

C. Policy rules and procedures – default emergency request routing, how to handle emergency outages at specific PSAPs, security access, how to handle emergency NG9-1-1 enhanced requests destined to legacy PSAPs, how to handle calls destined to busy PSAPs, and other numerous situations are handled through policy rules and procedures resident in the databases used by NG9-1-1 applications. Some of these policies should be implemented at a state level, others at regional levels, and still others at the local PSAP level. Security privileges control who has access to these rules and procedures and the security profile database should be setup and maintained for the system to operate smoothly.

D. Geographic Information System (GIS) data – NG9-1-1 relies on current, complete, and accurate geographic information system data in order to validate and route emergency requests to the appropriate PSAPs and emergency responders. The MSAG is not used in NG9-1-1. The appropriate 9-1-1 authority should transition from its current MSAG to the GIS data required by NG9-1-1 using standard GIS tools and technology.

   Two main types of GIS data are required: street centerline and polygon boundaries. The street centerline along with the required supporting information (properly structured attribute information, address points, common landmarks, etc.) is used for validating civic address information and for converting civic addresses to x,y coordinate locations. Polygon boundaries are required to identify PSAP jurisdictional boundaries and to identify emergency service agency boundaries. The polygon boundaries are used to determine initially which PSAP should receive an emergency request and then to determine which response agency should handle the emergency event.

   The Location Validation Function (LVF) uses street centerline information, address point information, and relevant polygons that should be in a prescribed format to first validate a civic location (address, street intersection, common landmark, etc.), and then to convert the location to an x,y coordinate. The Emergency Call Routing Function (ECRF) uses the emergency request's x,y coordinate to route the request to the appropriate ESInet (state, region, etc.), then to the appropriate PSAP, and finally it can be used to determine the appropriate emergency response agency (EMS, Fire, and Law Enforcement) to handle the emergency.

1.3 PSAP

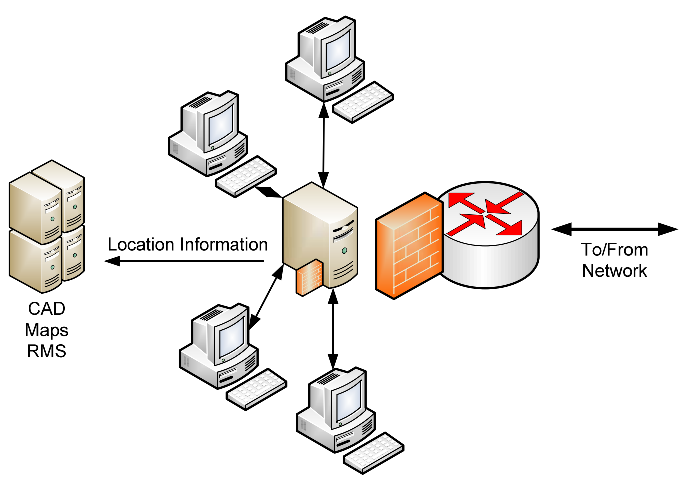

Figure 2 i3 PSAP

The Public Safety Answering Point (PSAP) is the receiving end of NG9-1-1 call delivery. Legacy

9-1-1 systems were all about flat data files enabling routing of calls and the identification of caller location and emergency response zones. NG9-1-1 takes this legacy and advances it into the environment of the internet, offering the citizens entry into emergency notification from a plethora of devices delivering information in forms heretofore unimaginable in a legacy format.

In the future, our PSAPs can expect call “content” to mimic that, which is available today on the World-Wide-Web (WWW). Video, pictures, text, and voice will be delivered in combination or individually to notify emergency providers of an incident. This shift is profound and should be treated as such. The personnel who accept our calls to 9-1-1 will be challenged as never before and it is imperative we create the tools and training with which they will process these calls in an effective and efficient manner.

Connectivity among our PSAPs will likewise mature. No longer bound by legacy routing, calls for service can be sent virtually anywhere a connection to the ESInet exists and operational parameters permit. Call overflow can be mapped to alternate PSAPs by the governing bodies. The simple act of “conferencing” a cadre of resources will greatly increase the ability to serve the public. Translation services, HazMat, state and federal resources are to name a few. With the flexibility of the network, our PSAPs can expect to remain local in service, global in nature.

All of this will require dedication and training among our call takers. Time and again, it has been proven, these professionals can rise to a challenge and accomplish their mission but it will require the support and training of our communities in order to assure a well-trained work force enabled with the tools to provide this service within our communities.

1.4 ESInet Requirements and Conceptual Design

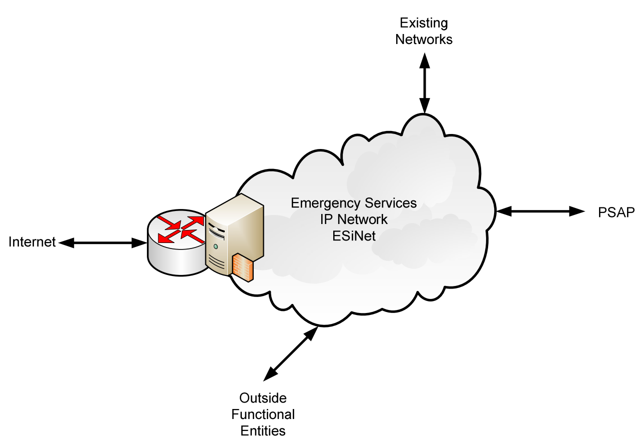

Figure 3 i3 Network Simplified

Minimum requirements are contained within the report allowing certain assumptions to be made that lead to an ESInet conceptual design. Based upon known elements of NG9-1-1 and the underlying i3 models the design requirements also draw upon real world IP based network deployments having the same critical needs of emergency services.

It is essential to understand the nature of the i3 model and how it affects its deployment within the Commonwealth. As used within this document, i3 includes not only the network but also the servers, appliances and databases required to receive, route and deliver an emergency notification.

This design ***is not*** just network but includes these associated functions to create a complete network capable of functioning under a definition of NG9-1-1.

Networks and systems used by public safety are typically designed to a five-9's (99.999) percentage of component availability. In the conceptual design of this network, much of this has been calculated with the exception of the "last mile". The last mile is that portion of the network that is a spur off of the larger network backbone. The completion of the last mile and the ability to provide such elements such as diversity and redundancy will be the result of direct negotiations with a system provider at the time of acquisition.

The Commonwealth model requires the design include the termination of the transport (network) at a point within each of the state's PSAPs. The point where the network terminates is commonly called a demarcation. Usually these points of demarcation are contained within a telephone or communications room and share common space with other telephony based circuitry. This plan does not, however, examine each PSAP for available space, grounding, climate or other installation based parameters and instead assumes a reasonable accommodation for network termination equipment.

1.5 GIS Data Analysis and Requirements

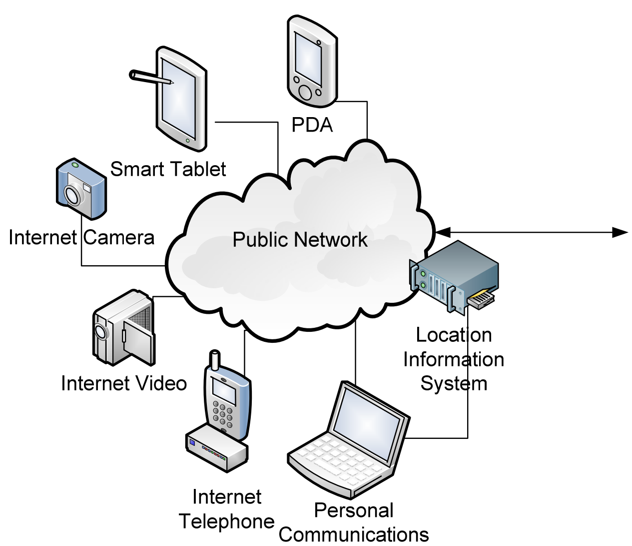

Figure 4 Nomadic Devices

Historically 9-1-1 has relied upon flat data files. These files commonly known as the, Daily Service Orders (DSO), Master Street Address Guide (MSAG) and Selective Router Database (SRDB) have been a collaborative effort between the PSAP and the system service provider.

NG9-1-1 introduces a high reliance upon Geographic Information Systems (GIS) and their form of data.

GIS data attempts to define the world in three dimensions. It has a strong component of expressing location in terms of not only United States Postal Service (USPS) addressing but longitude/latitude as well. It is this ability to express a caller's location in both terms that creates the critical role of GIS within NG9-1-1.

As public safety discovered with wireless 9-1-1, locating a person based upon some obscure x,y or longitude/latitude was nearly impossible for the mortal human. GIS solved this dilemma by its ability to interpret the x,y into a meaningful location by either graphical display or an interpretation of a USPS type address.

NG9-1-1 will require a seamless state GIS set of data to properly route a call to the appropriate PSAP and give the location, especially from nomadic callers, in a manner consistent with emergency response. The process for acquiring this data, validating the same and uploading it to the state network requires definition of data and responsibility.

The Commonwealth enjoys a unique position in this matter. The state currently assigns values to GIS data that prescribes how PSAPs construct their data models and requires compliance. Few other states within the union have this level of sophistication, making the transition to an i3 network more easily accomplished within the Commonwealth than most other states. This report will identify the requirements expressed as standards as they apply to NG9-1-1. Again, due to the relationship that exists within the Commonwealth the move to these standards should be accomplished with a minimum of interruption.

One final thought regarding location information involves the MSAG. These files, in their current state will continue to be integral for years to come. Integral to selective routing, these files will continue to be used for those PSAPs that have not connected to the ESINet and/or receive calls from the Public Switched Telephone Network (PSTN) via existing CAMA trunking. As PSAPs convert to the ESINet the need to continue their MSAG maintenance will decrease based upon the final deployment plans enacted by the Board. Only until such time that the entire state has migrated completely to an i3 solution will the need for an MSAG cease.

1.6 Legislative and Administrative Regulations

The ability to deploy and manage an i3 network requires specific authorizations and rules. Each public stakeholder should have a clear understanding and authorization for the role they play. Therefore, this report addresses the known changes required of either statute or regulation as they apply to this process.

2. PSAP

This section identifies PSAP system and operational requirements to support NG9-1-1. Upon implementation of the Statewide ESInet, PSAPs will be required to replace or upgrade some of their existing PSAP equipment to be compliant with the NG9-1-1 standards and take full advantage of the features of NG9-1-1. Current thinking indicates that these upgrades may be limited, for a variety of reasons, indicating a need for a “phased” implementation. If there are any limitations for the PSAPs to upgrade their systems, they can still access the ESInet via legacy network gateways that will allow them to receive E9-1-1 calls over the ESInet without any of the NG9-1-1 features. Other requirements for system upgrade or replacement include hardware interfaces, operational considerations (e.g. training), and supported PSAP software applications.

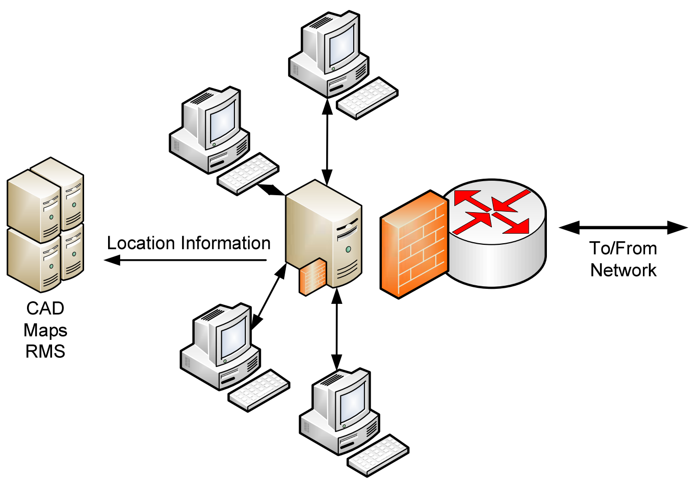

Figure 5 Typical PSAP Configuration

2.1 PSAP System Requirements to support NG9-1-1

2.1.1 NG9-1-1 Network Connection[1]

PSAPs require connection to the ESInet. IP-Capable PSAPs should connect directly to the ESInet via a local firewall and router. Legacy PSAPs (non-IP-capable) would connect to the network via external legacy network gateway that provides signal conversion to/from the NG9-1-1 system.

Where possible, physical circuit redundancy could be accomplished by duplicating PSAP entrance facilities. This could mitigate Network disconnections due to physical damage to the Network Entrance (i.e., damage to entrance cable caused by excavation equipment).

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[1] The network to CPE connection standard is still under consideration and is anticipated to be available from NENA by 3rd quarter 2009.

2.1.2 Call Handling Appliances/GIS

Call Handling Appliances within the PSAP will connect to mapping/GIS systems. Typically, the CPE will transfer caller location data to the mapping system to provide graphic presentation of the caller's location.

2.1.3 Call Handling Appliances/Public Safety Dispatch Systems

Data from the 9-1-1 calls will continue to be captured by public safety dispatch systems within the PSAP. This will require connection between Call Handling Appliances and the following dispatch system components (at a minimum).

1. Computer Aided Dispatch
2. Records Management System
3. Logging System

Standards for interfaces with these systems are forthcoming from communications standards development bodies (i.e., APCO, ITU, NENA, TIA, etc.).

These systems will potentially require modification to support the capture of additional data transmitted with new 9-1-1 calls (i.e., text, pictures, and video).

2.1.3.1 Computer Aided Dispatch (CAD) System[2]

Obviously, new data will be available for the CAD system to capture and process. For example, at PSAPs where the CAD system is used to display caller location, the CAD GIS will have to receive and process LON/LAT data instead of a local x,y coordinate system.

The NG9-1-1 system will also allow telecommunicators to transmit CAD data to other PSAPs to support call transfers and mutual aid responses.

Ideally, each CAD system should track neighboring agency field units to facilitate mutual aid operations.

PSAP management personnel should be encouraged to upgrade CAD systems to support these operations and/or require these CAD system functions in new system procurements.

2.1.3.2 Records Management System (RMS)

The ESInet will facilitate the sharing of RMS data among public safety agencies Statewide (and eventually beyond). This will require a digital connection, an "outbound" query-access interface

[2] APCO is currently working on standards for CAD-to-CAD messaging.

to allow RMS data to be shared on the ESInet, and an “inbound” query-access interface to allow users to query the local RMS.

Each agency will have to develop and implement policies governing which RMS data elements to make available to the ESInet. Strict security will also be required to control who accesses the data on the ESInet.

Agency command personnel should be encouraged to upgrade RMS systems to support these operations and/or require these RMS interfaces in new system procurements.

2.1.3.3 Logging System

Voice logging systems may be required to capture more than just voice recordings. Text, video, and telematic “calls” received at the PSAP will also have to be recorded, time stamped, and available for replay. Captured call information should also be transferrable to other agencies for call transfers and mutual aid responses, via the ESInet.

2.2 PSAP Training Modifications to address NG9-1-1

The implementation of NG9-1-1 will have a tremendous impact on 9-1-1 operations. All 9-1-1 system users will require training on the new system functionality. These “users” include: PSAP calltakers/dispatchers, third-party service providers, public safety responders, as well as the general public.

2.2.1 PSAP Call Takers/Dispatchers Training

A dramatic increase in call/incident information will come with the implementation of NG9-1-1. Public Safety Call Takers will be receiving emergency information in the form of voice calls, TTY/TDD calls, cell phone calls, VoIP calls as well as text messages, video, and still pictures.

To prepare for the efficient processing of these new call types, call takers will require additional training (and screening). The following new processes and procedures should be addressed:

1. Process text messages. Call takers will be required to receive and respond to text messages received from the public. Citizens who are proficient in “texting” use an abbreviated language that reduces keystrokes (i.e., ttyl – talk to you later, lol – laughing out loud, etc.) and thus increases message efficiency if both parties are familiar with this text language. Call takers will need to learn this text language or require the caller to type normal speech.

2. Advanced call transfers. 9-1-1 Calls will be received from potentially anywhere in the world. In the event that VoIP calls are routed incorrectly, they will need to be transferred to the correct call center. Call takers will have to make these call transfers.

3. Further, call takers may be required to transfer 9-1-1 callers to responder agencies so additional information can be provided by the reporting party.

4. Caller location. Caller location may not be included in the call data stream. The call taker may be required to access location databases to pinpoint callers.

5. Video/photographic triage. Call takers will be receiving pictures and videos of incident scenes and expected to interpret what response is required for the pictured incident.

6. Advanced information gathering. Call takers/dispatchers will have additional access to information and will be expected to access this information to assist in dispatching the appropriate personnel and equipment to an incident.

7. Graphic Incident Information. Call takers will be exposed (via photos and video) to traumatic incidents and will be required to perform upon such exposure. For example, a call taker may receive a video of someone committing suicide. Call takers will require special training in order to handle these stressful calls.

2.2.2 Third-Party Service Providers Training

Third-party service providers (i.e., language translators) will receive visual information along with calls. These personnel should be trained to transfer this information efficiently to the PSAP. This will also require training in the area of maintaining caller privacy.

2.2.3 Responders Training

Public Safety Responders will be given additional call information prior to and during incident responses. These Responders will require training to process this additional information, maintain caller privacy, etc.

2.2.4 Public Education

The public will require information regarding the NG9-1-1 system's capabilities and limitations. Figure 6 is an example of a public education flyer advising users of the limitations of the current 9-1-1 system operation.

Figure 6 Harris County (TX) 9-1-1 Public Education Flyer (front and back)

2.3 Future PSAP Applications to Access the ESInet

The backbone of the NG9-1-1 Network is called an Emergency Services IP Network (ESInet). Implementation of a Statewide ESInet will enable public safety agencies to share data as never before.

It should be noted that the Kentucky State ESInet would eventually connect with other state ESInets to form the national Next Generation 9-1-1 network.

CAD Data

Depending on the level of data sharing participation of connected agencies, the ESInet will allow agencies to query CAD system data throughout the Commonwealth to assist in their performance of local services. Example: Nearby agency CAD systems could be accessed to see if available mutual aid personnel/equipment is available.

Query interfaces will have to be developed for each CAD system in order to provide this level of data sharing capabilities. Agencies should be encouraged to include such interface requirements in new system procurement specifications.

RMS/JMS Data

Again, depending on the participation of the agencies, records management systems throughout the Commonwealth could be accessed to aid in the performance of public safety services. The following are just a few examples of benefits of an ESInet:

1. Detectives can access person, vehicle, and article data from RMS systems Statewide to assist in solving crimes. This would include accessing Jail Management System to see if a person of interest is in jail somewhere in the Commonwealth.

2. BOLOs can be broadcast to CAD systems statewide to aid in locating people of interest.

3. Detention centers can run Statewide warrant checks prior to releasing an inmate.

3. ESINET SIZING AND CONCEPTUAL DESIGN

3.1.1 Network Sizing

RCC has performed calculations to determine the size of the network links required for the Commonwealth NG9-1-1 network. Network connections have been sized for each PSAP, as well as for "front end" links from the carrier to the ESInet, and connections among data centers.

The size of the network connection is determined by the number of call takers or the number of 9-1-1 trunks, whichever is greater. RCC initially simply used the number of call takers/trunks as provided by the Commonwealth, and ran the calculations. More recently, we requested additional information from CMRS regarding call quantities and call durations. We have used this information to confirm that the number of 9-1-1 trunks is, in fact, adequate to handle the call volumes. In the majority of cases, the number of 9-1-1 trunks is appropriate. The spreadsheet below shown in Table 1 depicts the current number of trunks, the calculated number of trunks based on the call volume and call duration and the bandwidth requirement for the ESInet links.

RCC used its own networking knowledge and experience, combined with input from service providers whose equipment may be used in NG9-1-1 applications. Since each system is unique in terms of how it uses network resources, RCC used the most generous/conservative approach to ensure that the network links are adequate to handle worst-case scenarios.

The formula for sizing PSAP links is that each call taker/trunk requires a minimum of 128 kbps[3] of bandwidth to handle voice calls. A T1 (1.544 Mbps) will support 10 call takers/trunks. The difference between 1.544 Mbps and 1.280 Mbps (128 kbps x 10 call takers/trunks) is due to network overhead. Most PSAPs have fewer than 10 call takers/trunks, and so a single T1 will handle the current voice call load.

It is critical to note that this sizing is based on current call volumes and assumes voice calls only. No estimate has been made regarding the impact of text messaging, video or other types of calls that will be made possible with the new technology. Since the carriers can easily upgrade or increase the size of the network links, the Commonwealth will be in a position to respond quickly as this type of traffic develops.

For the sizing of links from the data centers to the ESInet, RCC again used the 128kbps per call taker/trunk identified above. As noted in the IP Network Conceptual Design section, this sizing insures that the P.01 grade of service will be met. The network service provider will be required to monitor traffic volumes and adjust the size of the links to maintain a minimum P.01 grade of service. In this case, based on call volumes and durations provided by the Commonwealth, there are 492 9-1-1 trunks required. This equates to approximately 63 Mbps of bandwidth

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[3] Based on RCC discussions with different ESInet applications vendors, RCC used 128 Kbps as the bandwidth requirement for a voice call. Different vendors use different metrics but the 128 Kbps was the highest of all per a voice call.

required. Since the link to the data centers will handle both incoming 9-1-1 call traffic from the carrier and outgoing 9-1-1 call traffic to the PSAP, RCC would initially estimate that the links into each data center be sized at 200 mbps. In addition to handling 9-1-1 calls, this capacity is also capable of handling database synchronization among the data center servers. . Typically, such database synchronization will be a scheduled activity to occur during periods with low 9-1-1 call volumes so as not to interfere with emergency calls. Furthermore, database synchronization functions will be assigned a lower priority within the QoS structure, insuring that 9-1-1 calls are treated as the highest priority.

Table 1 Trunk and Bandwidth Calculation[4]

		9-1-1 Trunks			Call Taker	9-1-1 Call Quantities			Agents	Agents	Trunks	Link
PSAP #	PSAP	Wireline	Wireless	Total	Positions	Wireline	Wireless	Total	Calc (AVG)	Calc (peak)	Calc (peak)	
1	Adair County 911 Center	2	2	4	2	9,588	15,048	24,636	2	3	4	1 - T1
2	Barren-Metcalfe 911 Center	15	3	18	7	9,501	12,731	22,232	2	3	4	2 - T1
3	Bath Co 911	2	2	4	2	3,078	2,996	6,074	2	2	3	1 - T1
4	BEATTYVILLE LEE CO. 911	2	2	4	2	322	3,072	3,394	2	2	2	1 - T1
5	Boone County PSCC	9	9	18	5	18,527	52,244	70,771	3	5	6	2 - T1
6	Bowling Green Police Department	4	4	8	7	16,375	43,637	60,012	3	5	5	1 - T1
7	Bracken County E-911	4	2	6	2	1,025	2,497	3,522	2	2	2	1 - T1
8	Breckinridge County Dispatch Center	2	2	4	2	32,759	4,380	37,139	3	4	4	1 - T1
9	Butler County	2	0	2	4	1,458	4,660	6,118	2	2	3	1 - T1
10	Campbell County Consolidated Dispatch Board	9	0	9	5	20,341	41,494	61,835	3	5	5	1 - T1
11	Campbellsville 9-1-1 Communications	4	2	6	5	4,751	8,076	12,827	2	3	3	1 - T1
12	Carlisle County Emergency Services	4	2	6	2	1,900	932	2,832	2	2	2	1 - T1
13	Carroll County 911	2	2	4	2	1,968	6,134	8,102	2	2	3	1 - T1
14	Carter County Enhanced 911	4	2	6	2	15,467	9,300	24,767	2	3	4	1 - T1
15	CASEY COUNTY E-911	8	2	10	3	3,000	565	3,565	2	2	2	1 - T1
16	Clinton County 911	2	2	4	3	595	1,608	2,203	2	2	2	1 - T1
17	Covington Communications	8	0	8	7	141,662	38,341	180,003	5	8	9	1 - T1
18	Cumberland County 911	2	2	4	2	1,200	888	2,088	2	2	2	1 - T1
19	Cynthiana/Harrison Co E-911	2	2	4	3	62,803	5,552	68,355	3	5	6	1 - T1
20	Danville-Boyle 911 Center	2	2	4	3	5,831	13,523	19,354	2	3	4	1 - T1
21	Daviess County 911	3	4	7	6	83,634	20,384	104,018	4	6	7	1 - T1
22	Erlanger PSCC	5	0	5	6	11,402	30,826	42,228	3	4	5	1 - T1
23	ESTILL COUNTY 911	2	2	4	2	5,637	2,747	8,384	2	2	3	1 - T1
24	FLEMING COUNTY E911	5	0	5	3	6,000	2,400	8,400	2	2	3	1 - T1
25	Frankfort/Franklin Co E911	5	3	8	5	9,635	17,261	26,896	2	3	4	1 - T1
26	GALLATIN CO. 911	5	0	5	2	2,163	4,693	6,856	2	2	3	1 - T1
27	Georgetown Scott County 911	8	1	9	6	13,988	7,534	21,522	2	3	4	1 - T1
28	Greensburg/Green Co. E911	2	4	6	2	1,360	1,592	2,952	2	2	2	1 - T1
29	Greenup County E911	4	2	6	3	12,863	12,296	25,159	2	3	4	1 - T1
30	HANCOCK CO 911 CENTER	2	0	2	2	3,544	619	4,163	2	2	3	1 - T1
31	Hardin County E-911 Center	12	5	17	4	16,148	29,993	46,141	3	4	5	2 - T1
32	Henderson Emergency Communications Center	5	2	7	5	14,386	22,721	37,107	3	4	4	1 - T1
33	Jessamine Co Central Communications	6	4	10	4	9,246	18,634	27,880	2	3	4	1 - T1
34	Kentucky State Police Post 1 - Mayfield	8	4	12	4	8,229	25,169	33,398	3	4	4	2 - T1
35	Kentucky State Police Post 10 - Harlan	2	3	5	4	5,591	15,187	20,778	2	3	4	1 - T1
36	Kentucky State Police Post 11 - London	0	3	3	3	0	21,326	21,326	2	3	4	1 - T1

[4] This information was provided by the CMRS board and was complied in April, 2009.

		9-1-1 Trunks			Call Taker	9-1-1 Call Quantities			Agents	Agents	Trunks	Link
PSAP #	PSAP	Wireline	Wireless	Total	Positions	Wireline	Wireless	Total	Calc (AVG)	Calc (peak)	Calc (peak)	
37	Kentucky State Police Post 12 - Frankfort	0	3	3	3	0	12,669	12,669	2	3	3	1 - T1
38	Kentucky State Police Post 13 - Hazard	4	3	7	5	16,924	13,503	30,427	3	4	4	1 - T1
39	Kentucky State Police Post 14 - Ashland	0	3	3	3	0	0	0	1	1	1	1 - T1
40	Kentucky State Police Post 15 - Columbia	0	3	3	3	0	24,299	24,299	2	3	4	1 - T1
41	Kentucky State Police Post 16 - Henderson	2	3	5	3	3,180	6,296	9,476	2	2	3	1 - T1
42	Kentucky State Police Post 2 - Madisonville	2	2	4	3	997	4,417	5,414	2	2	3	1 - T1
43	Kentucky State Police Post 3 - Bowling Green	0	3	3	3	0	10,112	10,112	2	3	3	1 - T1
44	Kentucky State Police Post 4 - Elizabethtown	0	3	3	4	0	46,596	46,596	3	4	5	1 - T1
45	Kentucky State Police Post 5 - Campbellsburg	5	4	9	5	5,534	9,121	14,655	2	3	3	1 - T1
46	Kentucky State Police Post 6 - Dry Ridge	2	3	5	4	4,377	17,104	21,481	2	3	4	1 - T1
47	Kentucky State Police Post 7 - Richmond	0	3	3	3	0	9,124	9,124	2	2	3	1 - T1
48	Kentucky State Police Post 8 - Morehead	0	3	3	3	0	9,775	9,775	2	2	3	1 - T1
49	Kentucky State Police Post 9 - Pikeville	5	3	8	5	19,989	26,950	46,939	3	4	5	1 - T1
50	LaRue County E-911	6	2	8	2	2,613	4,186	6,799	2	2	3	1 - T1
51	Lawrence County E911	2	2	4	3	5,980	4,812	10,792	2	3	3	1 - T1
52	Lawrenceburg/Anderson County 911	2	2	4	2	2,496	5,590	8,086	2	2	3	1 - T1
53	Leslie County e-911	2	0	2	3	1,398	202	1,600	1	2	2	1 - T1
54	London-Laurel County 9-1-1	6	4	10	4	13,100	16,540	29,640	2	4	4	1 - T1
55	Louisville MetroSafe Consolidated Communications	30	0	30	12	245,178	473,469	718,647	10	20	20	3 - T1
56	Marshall County E-911	2	2	4	3	4,856	10,105	14,961	2	3	3	1 - T1
57	Maysville Police Dept	2	0	2	3	6,000	7,200	13,200	2	3	3	1 - T1
58	mclean co 911	2	0	2	2	1,767	2,888	4,655	2	2	3	1 - T1
59	Menifee Co. E-911	2	2	4	3	2,292	2,245	4,537	2	2	3	1 - T1
60	Monroe County E 911	3	2	5	3	1,677	2,597	4,274	2	2	3	1 - T1
61	Monticelo-Wayne County 911	2	0	2	3	130,479	43,493	173,972	5	8	9	1 - T1
62	muhlenber county central dispatch	4	0	4	4	8,752	16,396	25,148	2	3	4	1 - T1
63	Murray Police Department	2	2	4	2	450	0	450	1	1	2	1 - T1
64	Oldham County Central Dispatch	4	0	4	5	5,803	11,598	17,401	2	3	4	1 - T1
65	Paducah/McCracken County E-911	3	3	6	5	13,322	31,871	45,193	3	4	5	1 - T1
66	Paintsville/Johnson Co 911	3	2	5	3	7,665	7,608	15,273	2	3	3	1 - T1
67	Paris Bourbon County E911 and Central Communications	4	0	4	3	74,663	8,386	83,049	3	5	6	1 - T1
68	Perry County E911 center	4	2	6	4	11,630	12,845	24,475	2	3	4	1 - T1
69	Powell County 911	2	2	4	2	2,862	6,384	9,246	2	2	3	1 - T1
70	PRESTONSBURG E-911 CENTER	2	0	2	2	936	2,216	3,152	2	2	2	1 - T1
71	PULASKI COUNTY 9-1-1 CENTER	10	3	13	4	36,018	49,526	85,544	3	5	6	2 - T1
72	REGIONAL PUBLIC SAFETY COMMUNICATION CENTER/BOYD COUNTY 911	5	3	8	0	30,787	62,699	93,486	4	6	6	1 - T1

PSAP #	PSAP	Wireline	Wireless	Total	Positions	Wireline	Wireless	Total	Calc (AVG)	Calc (peak)	Calc (peak)	
73	Rockcastle County 911	3	2	5	2	22,056	5,000	27,056	2	3	4	1 - T1
74	Rowan County 911/Morehead Communication Center	2	2	4	3	4,507	9,438	13,945	2	3	3	1 - T1
75	Russell County 911 Center	2	0	2	2	14,862	3,486	18,348	2	3	4	1 - T1
76	Scottsville-Allen Co E911	2	2	4	2	5,457	2,218	7,675	2	2	3	1 - T1
77	Shelby County E911	4	2	6	3	6,069	14,963	21,032	2	3	4	1 - T1
78	Simpson Emergency Communications Center	2	2	4	3	2,317	6,238	8,555	2	2	3	1 - T1
79	Springfield Washington County	4	2	6	2	1,499	2,373	3,872	2	2	2	1 - T1
80	TODD COUNTY DISPATCH	2	0	2	2	3,036	1,469	4,505	2	2	3	1 - T1
81	Trigg County E-911	2	2	4	2	2,036	3,403	5,439	2	2	3	1 - T1
82	Versailles/Woodford County	6	2	8	3	3,511	7,039	10,550	2	3	3	1 - T1
83	WEBSTER CO. E911	3	2	5	2	2,335	6,294	8,629	2	2	3	1 - T1
84	Wolfe County 911	2	0	2	2	4,645	0	4,645	2	2	3	1 - T1

RCC used an Erlang-C analysis with busy-hour projections to define the minimum Agents (call takers) and Trunks required to provide a GOS of P.01 for 9-1-1 calls. Traffic of one Erlang refers to a single resource, in this case a call taker, being in continuous use, or two call takers being at fifty percent use. The Erlang-C formula assumes an infinite population of calls, but if all the call takers are busy when a request arrives from a source, the request is queued.

Table 1 presents required Agents and Trunks calculated based on the Commonwealth PSAP Report data. Required Agents were calculated for periods of average 9-1-1 traffic and for peak 9-1-1 traffic loading. Average 9-1-1 traffic loading was calculated by taking the total annual quantity of 9-1-1 calls and dividing that number by 365 to get the average daily quantity, then dividing by 24 to get the average hourly 9-1-1 call quantity (Total calls/365 days/24 hours = Average calls/hour). The averages calls/hr was multiplied by three to project the busy-hour traffic.

The Agent analysis inputs are: Grade of Service (P.01 – 99% of calls are answered without queuing), Service Time (6 seconds – the maximum delay before the call is answered), Busy-hour call quantity, and call duration (160 seconds – average of call durations provided by the Commonwealth PSAPs plus after-call work time).

The Trunks analysis inputs are: Available Agents (calculated), Busy-hour call quantity (calculated), and call duration.

3.1.2 Network Conceptual Design

An Emergency Services IP Network (ESInet) is a privately managed communications network dedicated for public safety use. An ESInet is designed such that it receives emergency calls from the public and delivers these emergency requests and corresponding data to emergency services providers via PSAPs. Properly designed, an ESInet facilitates communication between emergency service providers and other supporting entities not only through direct IP connectivity but also through applications that bring “intelligence” to the call delivery schema. An ESInet is a network allowing PSAPs to communicate with reporting parties (the public) and other emergency agencies or service providers (Fire, Police, EMS, secondary PSAPs, adjoining PSAPs, neighboring jurisdictions, etc.) and as such require databases, applications and servers to manage the network routing.

An ESInet that meets NENA, ATIS and IETF emerging standards[5] along with other NG9-1-1 requirements provides a number of significant enhancements over traditional E9-1-1 emergency telephone systems including:

1. The ability to handle text messaging
2. The ability to handle images
3. The ability to handle streaming video
4. Direct support for telematics devices – automobile accident detection devices, heart monitoring systems, intrusion alarms, and other types of devices that are triggered by the occurrence of prescribed events, will be able to directly transmit emergency information to PSAPs
5. Pre-validation of fixed structure handsets – the civic location (address) of all handsets are geographically validated at the time that the service is placed, rather than during or after receipt of an emergency request / call.
6. Location information arrives with the request for emergency service. It does not normally have to be extracted or computed after the request arrives at the PSAP.
7. Provides Phase II Wireless location compliance including X, Y, and Z coordinate location of emergency requesting device.

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[5] NENA technical Standard 08-002: Functional and Interface Standards for NG9-1-1 (I3) and 08-751: I3 Requirements (Long Term Definitions); IETF technical standards: RFC 4119: A Presence-based GEOPRIV Location Object Format and RFC 5222: LoST: A Location-to-Service Translation Protocol. ATIS Standards Emergency Services Messaging Interface, (ESMI) (ATIS-0500002) and Emergency Information Service Interface (EISI) (ATIS-PP-0500006.200X)

8. Enhanced emergency back-up PSAP operations – Emergency requests can be automatically routed to back-up facilities upon PSAP failure/evacuation

9. Ability to route call based on Policies/Rules to appropriate PSAPs and Dispatch facilities – Busy calls can automatically be routed to non-busy PSAPs based on collaboratively developed rules and policies

10. Ability to setup virtual, geographically dispersed PSAPs

The ESInet should meet or exceed the standards for reliability, redundancy, and availability of traditional 9-1-1 emergency telephone systems. Although not readily transferable to IP network operations, the P.01 grade of service standard used to define the required number of available 9-1-1 trunks has to be met or exceeded by ESInet implementations. This means that an implemented ESInet should be designed and implemented so that no more than 1 out of 100 requests for emergency assistance fail to be delivered to the intended PSAP during the peak busy hours of operations. As such, the ESInet should be designed and implemented with availability and redundancy requirements for uninterrupted operations. The minimum acceptable level of availability for an ESInet is an operational status of 99.999 percent.

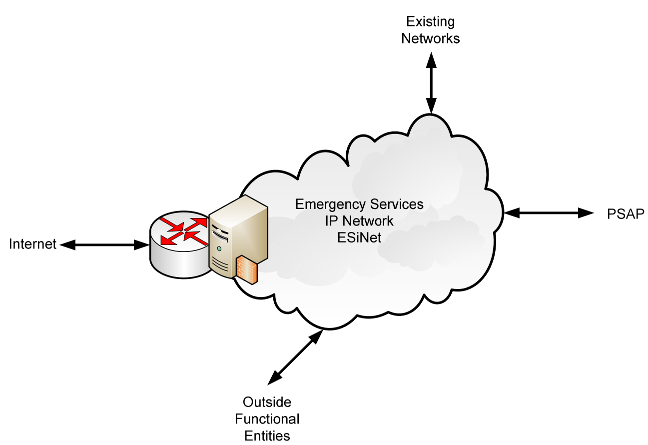

Figure 7 i3 Network Simplified

3.1.2.1 ESInet/NG9-1-1 Applications

The NG9-1-1 applications and the appliances they operate on enable the NG9-1-1 capabilities and normally lie in the path of all call signaling and media. Like the network, the applications should be efficient and highly reliable, meeting the same level of reliability, in order to support emergency operations without adding any significant delays to emergency request processing. The major applications that are resident on the ESInet include at least the following components:

- Border Control Function (BCF) – the BCF is located at every entry point to the ESInet. Its purpose is to protect the ESInet from viruses, service disruption, and any other deliberate and malicious attacks on the network. It provides secure entry into the ESInet for emergency requests and associated data, as well as for the proper transfer and routing of emergency request information to emergency responders. It also protects the ESInet from internal networks that may be connected at PSAP and/or other locations (e.g., municipal networks, Internet, etc.). The BCF incorporates firewall and admission control functions, as well as other security mechanisms to protect the ESInet.

- Emergency Call Routing Function (ECRF)6 – The ECRF uses the location information associated with an emergency call (i.e., the civic address or x,y Coordinate location of the call) to determine the PSAP to receive the call or if a call is not destined for a PSAP served by a specific ESInet, to determine the ESInet that should receive the call. ECRF uses the Location to Service Translation (Lost) protocol7 with its geospatial databases to determine the next logical hop for the emergency request (call). ECRF will be used recursively within the ESInet. For example, the ECRF will first determine the appropriate PSAP to receive the call. Once the call arrives at the proper PSAP, ECRF is used to determine the appropriate responding agency (Police, Fire, EMS, Poison control, etc.) to receive and handle the call.

  The Location to Service Translation (Lost) protocol uses a point in polygon (PIP) analysis to determine the proper ESInet8, PSAP, and finally emergency response agency to next receive the call. PIP uses a mathematical routine to determine which polygon of many potential non-overlapping polygons contains the call as referenced by the x,y coordinate (point) that represents the call's location. It is crucial that polygons in a specific layer (e.g., PSAP Boundary layer, Police boundary layer, Fire boundary layer, etc.) do not overlap and that no gaps exist between them in order for the point in polygon and ECRF to properly function. To serve this requirement, the ECRF will most likely contain polygon validation functions, which may have to be augmented by manual-based visual inspection, to examine all polygons layers submitted prior to their entry into its geospatial databases.

- Emergency Service Routing Proxy (ESRP) – The ESRP determines the address (URI) of the next logical hop for an emergency request (call). It accomplishes this by consulting the ECRF to determine the next logical destination (PSAP, other ESInet, etc.) for the call based on the call's location information. Once the location PSAP and/or ESInet is determined, the ESRP's Policy Routing Function (PRF) consults its database to extract

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[6] As of the date of this report, NENA has not finalized the full set of application for ECRF. Currently the draft standard is scheduled for release, review, comment and approval sometime in October of 2009.

[7] LoST is currently under final definition by the IETF and is anticipated to be published as a final standard by the end of 2009,

[8] As used herein, LoST may not be required in the initial application within Kentucky since there will not be a national need to route to the Commonwealth. Rather, providers will directly route to the BCF of Kentucky based upon their internal routing capabilities.

the status of the identified next hop along with other data such as time of day, network status, etc. to apply its routing policies to determine whether the call should be routed to the assigned destination or an alternate destination. A set of policies or rules allow the ESRP to decide to which PSAP or ESINET to route the emergency request (call). For example, if the normal destination PSAP for a call is busy or inoperable, a set of policy routing rules in the ESRP's database will be consulted to determine whether the call should be routed to an alternate or the original PSAP and to which alternate PSAP it should be routed.

- Location Validation Function (LVF)9 – most emergency requests (calls) will have location information associated with them. Calls originating from mobile devices will have x,y coordinates associated with their location. However, emergency requests (calls) originating from fixed location (e.g., wireline phones, VoIP fixed location calls, etc.,) will most likely contain civic locations (e.g., 123 Main Street, Any City, USA 12345). The LVF will first validate the civic location; meaning that it has one, and only one occurrence within its geospatial database for the civic address being validated. Then, the LVF will convert the Location to an x,y coordinate to be used by the ECRF for its analysis. Both ECRF and LVF use the LoST protocol to perform their validation and other geospatial analysis.

  LVF relies on a topologically structured street center line file to perform its validation functions. Valid address ranges and other information should be contained in this file in the proper format as described in NENA standard 02-010: Standard Data Formats for ALI Data Exchange and GIS Mapping. The street center line file may be augmented by address point files (e.g., parcel address files, structure location coordinates and addresses, etc.). The location information transmitted to and used by LVF should follow the PIDF-LO format described in IETF's RFC 4119.

  For fixed location devices such as telephones and VoIP phones, service providers will pre-validate their customer's location for a new handset/device at the time that it is ordered via the LVF function. It is critical that the same location validation function be used by the service providers as would be used once a call enters the ESInet. As such, this function and its databases should be available to service providers as required.

- Legacy Network Gateways – as discussed in the PSAP section of this report and in order to support legacy networks such as the Public Switched Telephone Network (PSTN), legacy network gateways are deployed to convert the emergency call information from ESInet formats and protocols into native signaling used by current CPE. The legacy network gateways are placed on the edge of the ESInet at the PSAP and convert IP based 9-1-1 calls into CAMA signaling and ALI data streams that can be

[9] As of the date of this report, NENA has not finalized the full set of application for LVF. Currently the draft standard is scheduled for release, review, comment and approval sometime in October of 2009.

directly connected to legacy CPE line cards. As a practical matter, most PSAPs will have such gateways until they upgrade to a pure IP appliance based call taking system.

- Business Rules – as currently under deliberation and from an operational perspective, a system of business rules will be used by the network to handle calls based on a variety of variables. Business rules can be described as "exceptions to the rules". For instance, one business rule defines how calls should be handled at times of overflow. When a major incident occurs many times, a PSAP is inundated with calls regarding that incident. In today's world calls can be placed in queue, alternately routed, receive a recorded message or issue a busy signal. Using business rule applications residing on the ESInet each PSAP would describe how and when to handle overflow conditions. These instructions are critical to the efficient use of the network and neighboring PSAPs effectively boosting the call taking capability of each PSAP. It is critical to understand that business rules are established on a PSAP-by-PSAP basis and reflect the local need and requirement.

Redundant and robust servers should be strategically[10] placed within the ESInet to host these applications. The servers may be located at a service provider's data center, or at an agency site, depending on the final network design, business model and service level agreements. As with the ESInet, the servers and applications should be implemented with an operational continuity availability of at least 99.999 percent.

3.1.2.2 IP Network Conceptual Design

RCC has developed a conceptual design for the Commonwealth ESInet that will meet the Commonwealth's requirements initially and be adaptable and scalable to the changing types of communications that NG9-1-1 is intended to support. At the core of the proposed network is a Multi-Label Protocol Switching (MPLS) backbone as provided by AT&T or Windstream. Each has implemented a high capacity and highly reliable statewide MPLS network that is capable of supporting the 9-1-1 call traffic and related inter-agency communications envisioned as the ESInet evolves in the future.

A primary design consideration is the location and quantity of data centers that will house the primary NG9-1-1 applications. At a minimum, two geographically diverse data centers are required. Each should have the capacity to handle the entire call volume, in case one of the data centers is off line for any reason thus a three center configuration is best practice which maintains redundancy even if one data center is unavailable, whether due to an emergency, preventive maintenance, hardware/software upgrade or any other reason.

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[10] Strategic placement implies geographic separation. A minimum of two interconnected sites should be considered with more being preferred for maintenance purposes.

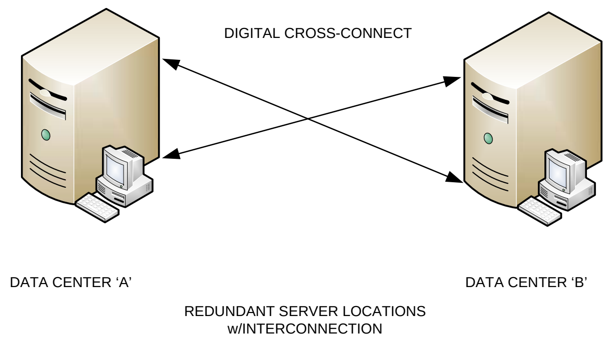

Figure 8 Data Center Diversity

As stated, each center shall have full capability of supporting the entire 9-1-1 call load for the Commonwealth. Full capability is defined as including Border Control Function, Routing and rules based servers. It is imperative that all calls being delivered to the Commonwealth can appear at each center with call management handled as "overhead" between the load sharing capabilities of these centers.

RCC recommends that the Commonwealth obtain MPLS services as a managed/routed solution. Among other things, this approach requires the carrier to implement routing protocols based on policies and direction decided by the Commonwealth. An example of this would be through the establishment of "load sharing" among the data centers. As one center may concentrate on a geographical area of the Commonwealth, the remaining centers are entirely capable of routing to any PSAP. Thus, the Commonwealth can concentrate on how and where it wants traffic routed, while the service provider is responsible for the technical elements of configuring and managing the configuration of the network and data center devices. In this case, for example, the Commonwealth would establish routing policies that require the carrier to automatically sense failure at a center or network route and re-route traffic through an alternate data center and data path if the geographically responsible data center fails; and the carrier would configure the routers to respond accordingly. The NENA i3 technical Requirements Document identifies Routing Information Protocol (RIP) as a minimum routing protocol; RCC recommends that the Open Shortest Path First (OSPF) routing protocol be used. RIP is a distance vector routing protocol, which looks solely at the number of hops in the connection in order to make routing decisions. Therefore, a single 56 kbps link between two points would be considered better than a two-hop link, even if the two hops were 100 Mbps links. OSPF is a "link state" routing protocol which responds (i.e., re-routes) more quickly to network changes, and is better suited for networks of the size and complexity of the Commonwealth's proposed ESInet.

As this is a conceptual design with multiple data centers, the Commonwealth will need to decide whether it wants a primary data center, and one or more backup data centers; or whether it wants to load balance all traffic among all data centers. Load balancing is more complex, but is feasible using OSPF. Routing all traffic to a primary data center, with the other data centers serving as hot standby is simpler to manage from a routing perspective but lacks the robust fail-over features of OSPF. RCC envisions that all 9-1-1 calls from all sources – landline, cellular, and VoIP – will be delivered to and aggregated by the selected network services provider, converted to IP traffic (packets), and routed to the data centers through the MPLS network. Routers at the carrier's location will route calls to the data centers based on rules developed by the Commonwealth (i.e., load balance among the data centers or select a primary data center to handle all traffic, and have the other data centers act in a backup role in the event of a failure of the primary data center or network link).

As noted in the Network Sizing section, RCC has calculated that the network links from the data centers to the ESInet should be sized at 200 Mbps initially. These links are intended to support the following traffic:

- Incoming 9-1-1 call traffic from the carrier's aggregation point
- Outgoing 9-1-1 call traffic to the PSAPs
- Database synchronization and backup functions

This bandwidth meets the P.01 grade of service based on existing call volumes. The SLA between the Commonwealth and the network service provider should include a requirement for the provider to monitor traffic loads and upgrade (or downgrade) the capacity of the network links in response to changing call volumes and types.

For PSAPs, the NENA i3 Technical Requirements Document recommends (but does not require) diverse, redundant links into each PSAP. RCC has asked each of the carriers about the feasibility of this recommendation. Both state that they will work with the Commonwealth to develop diverse routes, but such routes will be developed at the Commonwealth's cost. In addition, it may not be feasible for diverse routes to be established in all situations, and each case will require an engineering study to be performed by the carrier. Note that the engineering studies may also carry a cost, whether or not the Commonwealth opts to implement diverse routes. RCC recommends that the Commonwealth identify key PSAPs that handle high call volumes, and work with the selected carrier on a case-by-case basis to investigate diverse paths. Other PSAPs can meet redundancy requirements via partnerships and business rule routing during incidents that compromise service call receipt.

In the Network Sizing section, RCC has provided calculations to estimate the size of the links from the ESInet into each PSAP. In most cases, a single T1 will support the existing call volumes. In a small number of cases, multiple T1s are required. Note that the sizing estimates are intended to support the existing voice-only traffic into the PSAPs. The Commonwealth should consider implementing a minimum of two T1s at every PSAP to provide a level of redundancy, although this is not a NENA requirement. This alternative should be balanced against the increased costs for the 2nd T1. There is no empirical data upon which to base an estimate for future non-voice traffic. The network provider under consideration can quickly upgrade links or add bandwidth to support additional traffic when it occurs.

The proposed network will support traditional voice 9-1-1 traffic as well as video and data traffic.

Voice, data and video traffic, regardless of their source, are converted to data packets to be transmitted on the network. In order to maintain voice quality, voice traffic should be prioritized. Quality of Service (QoS) features should be implemented in the proposed network for this purpose. Specifically, NENA requires that the Differentiated Services (DiffServ) QoS protocol be implemented. This will be a requirement that the selected carrier will implement and manage in the network.

Network security will be critical to the successful operation of the proposed network. There are several security-related elements incorporated into the conceptual design.

- Firewalls – Firewalls should be included at all network ingress and egress points (i.e., at every PSAP and every data center), at a minimum. The ESInet will have connections to the Internet as well as to each PSAP. In general, firewalls are intended to block any unauthorized traffic from either entering or exiting a private network, based on parameters that the network operator determines. Properly configured, firewalls will protect the ESInet from denial of service attacks, viruses, spam, and other security attacks.

- Router security –

    - Access lists should be implemented on routers to filter network traffic by controlling whether routed packets are forwarded or blocked at the router's interfaces. Routers on the ESInet will be configured by the selected carrier to examine each packet to determine whether to forward or drop the packet, based on the criteria you specified within the access lists. Access list criteria could be the source address of the traffic, the destination address of the traffic, or other information.

    - OSPF Authentication insures that routing updates received by the routers on your network are legitimate based on authenticating the source of the routing update. This authentication is accomplished by the exchange of a password or key that is known to both the sending and receiving router.

- Physical security (data centers and PSAPs) – Security functions over the carrier-provided elements of the network will be the responsibility of the selected carrier, and will be subject to terms that will be negotiated into Service Level Agreements (SLAs). In many cases, highly sophisticated network security programs are defeated by the lack of simple physical security practices that should be maintained at data centers, and, more importantly, at each PSAP. Equipment components should be housed in safe, secure, clean environments. Cable routes should be secure and protected from accidental or intentional damage.

RCC's conceptual design complies with the recommendations made in the NENA i3 Technical Requirements Document dated September 2006.

4. GIS DATA ANALYSIS AND REQUIREMENTS

4.1 Overview of NG9-1-1 GIS Requirements

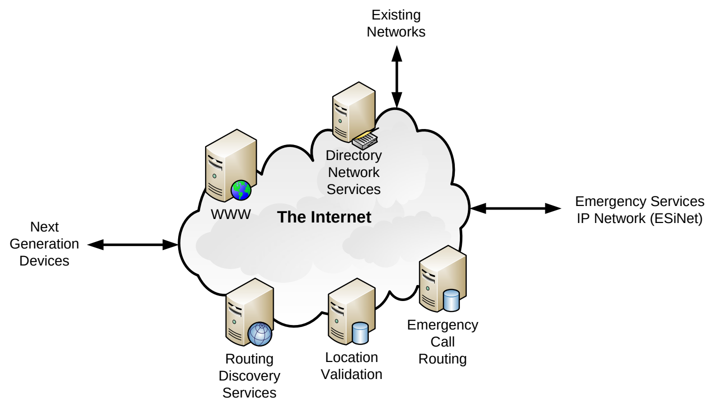

Figure 9 Location Technologies

In NG9-1-1, GIS becomes one of the central data stores for the delivery of emergency services. All call location and routing functions will be based on geospatial datasets that drive the major components of NG9-1-1, including the Location Information Server (LIS), Validation Database (VDB), Emergency Service Zone Routing Database (ERDB), Emergency Call Routing Function (ECRF), and Emergency Call Routing Proxy (ECRP). The traditional cornerstones of 9-1-1 operations, the Master Street Address Guide (MSAG) and Automated Location Information (ALI), will continue to be used during the migration and afterwards. They will be supplemented with digital street centerlines, polygons that define jurisdictions and service zones and points that represent structures and incidents.

Unlike the previous stages of 9-1-1 services that were centrally focused on the geography and operations of a single PSAP, NG9-1-1 necessitates the development and implementation of a seamless set of lines and polygons that span entire states and regions. This is a significant undertaking and will require an extensive commitment of resources and high level of cooperation. In the case of the Commonwealth, this entails fully integrating over 100 separate sets of data provided by the individual PSAP's.

The scope and value of the work that the National Emergency Number Association (NENA) and their numerous working groups are performing cannot be understated. They are providing the overall framework and detailed guidelines that will assist all emergency service providers to successfully move into NG9-1-1. Two (2) major publications that will assist states and their member PSAPs in this process are: GIS Data Collection and Maintenance Standards (02-014 v1) and the recently published, NENA Information Document for Synchronizing Geographic Information System databases with MSAG & ALI (2-001 v1). Both of these documents are contained in Appendix A.

4.1.1 State Level (ESInet) GIS Requirements

At a minimum, the Commonwealth will be responsible for the merging of the street centerlines and jurisdictional polygons that will route a call to the appropriate PSAP for call taking and dispatch. The steps in this process require that the caller location be identified either via x, y coordinates received directly from the device or carrier or that are generated by the address of the caller using the street centerlines for geocoding. This location will fall within a specific polygon that will determine which PSAP the call will be routed to.

To be successful, there will need to be a highly accurate set of street centerlines and jurisdictional boundaries that are coordinate on a statewide level.

4.1.2 PSAP Level GIS Data Requirements

The PSAP's will continue to have a central focus on the geographical features within their jurisdiction – street centerlines, emergency service zones (ESZ's), structure locations and other optional datasets (i.e. HAZMAT, etc.). Their critical responsibility however, is to recognize that their datasets are no longer standalone – they are part of a much larger mosaic that collectively represents their state and/or region. Special attention and effort should be focused on all areas that border other PSAPs and ensure that centerlines and other features are in fact seamless as they leave one jurisdiction and enter another.

Once again, NENA is laying out the groundwork and guidelines requiring PSAPs to update and enhance the accuracy of their street centerlines and ESZ's. The previously referenced "NENA Information Document for Synchronizing Geographic Information System Databases with MSAG & ALI" provides step-by-step instructions on how to address and complete this task.

It is at the PSAP level that much more detailed information about the location can be identified and relayed to responders. This is particularly important since x,y coordinates received from cell phones or generated by geocoding may not be as accurate as can be determined using structure features or aerial photography which is available at many PSAPs.

4.2 GIS Data Status

As presented in RCC's Data Summary report, the Commonwealth has a number of well-developed GIS resources including the CMRS Board and Geography Network websites. Another significant resource available to support this major undertaking is the Area Development Districts (ADD). Perhaps, more importantly, the CMRS has already begun to provide the structure, coordination and methodologies required to successfully implement NG9-1-1. There is, however, a significant amount of work that will have to be performed in order to reach compliance with NG9-1-1 standards.

4.2.1 State Wide GIS Data

The review and analysis of the statewide street centerlines and jurisdictional boundaries yielded mostly positive results. The centerlines generally crossed jurisdictional boundaries without gaps or misalignments. There was no evidence of gaps or overlaps in the jurisdictional polygons. Overall, the state has a geographically sound infrastructure to support NG9-1-1.

The major area of concern, as identified in the Data Summary report[11], is multijurisdictional roads – roads that traverse two (2) or more jurisdictions. In the sample that was analyzed, there were instances of street segments that were not dissected by the boundaries and therefore not being a part of each jurisdiction's set of street centerlines. This will be a critical issue at the PSAP level as they work to synchronize their GIS database and MSAG. The Commonwealth will play a significant role in overseeing and providing support for this undertaking.

Whereas the status of the attribute fields of the current statewide street centerlines were rated very good, it should be noted that there are a number of attribute fields that are currently not part of this file that are critical to NG9-1-1 requirements. Specifically, these attributes are those that identify MSAG community, postal community, emergency service zones, et al for both the left and right side of each segment. Once again this is a critical issue at the PSAP level; however, as the entity responsible for creating and maintaining the consolidated, seamless street centerlines, the state should provide support to the member PSAPs.

As mentioned earlier in this report, NENA and its working groups are providing leadership, guidance and detailed methodologies to support the Commonwealth's CRMS Board in their endeavor.

4.2.2 PSAP Level GIS Data

Each PSAP will be responsible for the synchronization of their current GIS datasets, MSAG and ALI. Each PSAP will have to work with their neighbors to identify and resolve any and all issues at their adjacent borders. While this will be a significant task for all in terms of time and manpower, the PSAPs have significant resources available to them through NENA, the CMRS Board, and the Area Development Districts to help in its successful completion.

4.3 Recommendations

Based on our review of the GIS data provided by the CMRS Board and our understanding of the requirements of NG9-1-1, RCC makes the following recommendations to the CMRS Board:

1. Complete the certification of the remaining PSAPs based on current standards.
2. Revise PSAP Audit and Survey process and materials to increase level of detailed information being provided.
3. Use tools and the communications network to introduce to PSAPs the advantages of data scrubbing via the comparison of GIS data, MSAG and ALI databases.
4. Further promote and develop the relationships between PSAPs and their respective

[11] The Data Summary report was the first deliverable that represented the data collected during the fact finding phase of the project.

Area Development Districts to support this effort.

5. Fully access and engage all support and assistance available through NENA.