TeleCommunication Systems, Inc. and
NextGen Communications, Inc.
d/b/a Maryland TeleCommunication Systems, Inc.
275 West Street – Suite 400
Annapolis, MD 21401

July 30, 2010

Mike Hybl
Executive Director
Nebraska Public Service Commission
300 The Atrium - 1200 N Street
Lincoln, NE 68508

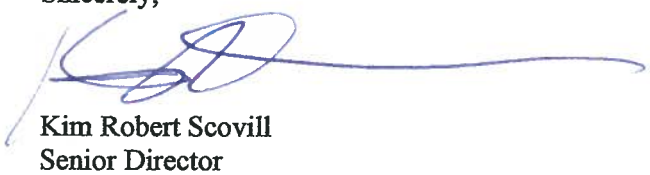
RE: Application No. 911-045/PI-166

Dear Director Hybl:

Pursuant to the Commission's Order of June 2, 2010 in this matter, attached please find one (1) original and eight (8) copies of the comments of NextGen Communication Systems, Inc. d/b/a Maryland TeleCommunication Systems, Inc. in this matter. An email copy has also been filed with the Commission at brandy.zierott@nebraska.gov pursuant to the instructions contained in the Order.

Please contact me if you should have any questions. Thank you.

Sincerely,



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COMMENTS OF
MARYLAND TELECOMMUNICATION SYSTEMS, INC.

NextGen Communication Systems, Inc. d/b/a Maryland TeleCommunication Systems, Inc. ("MTS")[1], hereby submits its comments in the above-captioned proceeding. MTS, as a subsidiary of TeleCommunication Systems, Inc. ("TCS"), is one of the two primary nationwide providers of unregulated Wireless E9-1-1 services and VoIP E9-1-1 services, and is one of several vendors of IP-based Next Generation 9-1-1 services.[2]

The Nebraska Public Service Commission ("Commission") is to be commended for its foresight in seeking comments on the appropriate implementation of advanced Next Generation 9-1-1 services. To aid this goal, TCS has recently published a white paper, *Recommendations for Implementing NG9-1-1 Components*, ("*Recommendations*") its independent comments and checklist for the implementation of Next Gen 9-1-1, and incorporates this document, attached hereto, by reference where relevant in these comments.[3]

Regarding the specific aspects of Next Generation 9-1-1 identified in the Order, MTS provides the following responses:

1) Please provide information regarding the necessary statewide wireless and landline network elements and specification for the development of an Emergency Services IP Network (ESINet) necessary for the implementation of Next Gen 9-1-1.

1a. Should a statewide network be established or should regional ESINets be coordinated?

MTS response: MTS refers the Commission to its *Recommendations* paper for a brief description of the high-level components of an NG9-1-1 system, a discussion of how to select operators for the various components, and a description of how multiple ESINets may be initially

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[1] NextGen Communications, Inc., d/b/a Maryland TeleCommunication Systems, Inc., ("MTS") is a wholly-owned subsidiary of TeleCommunication Systems ("TCS") (NASDAQ: TSYS) (www.telecomsys.com). MTS has received certificates of public convenience and necessity in seventeen states, has 9 more state applications pending, and was certified in Nebraska on January 26, 2010. This filing represents the combined comments of both organizations.

[2] MTS utilizes the facilities of TCS which is a leading provider of unregulated wireless, VoIP, and MLTS E911 solutions in the United States and Europe. TCS is also a world leader in highly reliable and secure mobile communication technology. TCS infrastructure forms the foundation for market leading solutions in E9-1-1, text messaging, commercial location, and deployable wireless communications. TCS is at the forefront of new mobile cloud computing services providing wireless applications for navigation, hyper-local search, asset tracking, social applications, and telematics.

[3] *Recommendations for Implementing NG9-1-1 Components,* posted June 4, 2010, http://info.telecomsys.com/NG9-1-1-recommendations-whitepaper/ Provided as Attachment A hereto.

supported. While regional or smaller ESINets may be useful at a developmental stage, MTS recommends a statewide ESINet funded and managed by a single central state authority. The level of reliability required for an ESINet (99.999% available) is so great that local /regional ESINets are often not configured for the task. Even if the local networks are fully redundant and reliable, the added level of complexity in managing disparate networks is a liability. MTS recommends a single NOC with authority over the entire network and dedicated maintenance staff with the complete access that is generally only achievable with a centralized ESINet.

1b. To what extent are these components currently in place?

MTS response: MTS has no facilities in place in this jurisdiction and therefore cannot comment at this time.

1c. What upgrades in the statewide telephonic and broadband network are needed, if any?

MTS response: The ESINet will replace the legacy 911 telephonic network and so there is no payback for implementing any upgrades to the legacy 911 components at this time. There will be a period of time during which the ESINet will operate parallel with the legacy networks, but it should be the obligation of the Next Gen 911 Service Providers to build their solutions in a manner that will integrate with legacy systems without legacy upgrades. MTS has no comment as to any specific telephonic or broadband network upgrade that may be required in Nebraska.

1d. What costs may be incurred to establish or upgrade the necessary networks?

MTS response: MTS has no additional comments at this time.

1e. What costs may be attributable to the provision of wireless E9-1-1 services?

MTS response: The Next Gen 911 system is not driven by any advantages or disadvantages inherent in the current wireless E911solution. Wireless carriers will have to integrate with the Next Gen solution in the same way they integrate with the existing legacy 911 solution (except using an IP interface). But landline carriers (including the ILECs) will also have to integrate into the Next Gen solution. It can no longer be assumed that the ILEC will be the provider of 911 services. If Nebraska provides cost recovery to wireless carriers or landline carriers, there will be costs to the state for the conversion. It is probable, however, that carriers will be able to drop their CAMA trunks to legacy selective routers in lieu of IP connections to the Next Gen 911 Service provider. It remains to be seen whether this would result in a net increase or decrease in the state's or PSAPs' financial obligations. If the state does not provide cost recovery, then all

wireless and wireline carriers will be obligated to connect to the ESINet and the Next Gen 911 Service Provider at their own expense, in accordance with standards dictated by the 911 Service Provider, just as they connect today to the legacy 911 Service provider.

2) At the individual PSAP level, what equipment, software, and network elements are necessary for the implementation and operation of Next Gen 9-1-1?

MTS response: Please see the *Recommendations* Paper for this discussion.

2a. To what extent are the PSAPs properly equipped?

MTS response: PSAPs will require Next Gen-capable CPE, which is not necessarily the same as "IP-capable" CPE. Most CPE on the market today is IP-capable and most CPE vendors are developing Next Gen-capable CPE. Most NG 9-1-1 Service Providers offer backwards-compatible solutions so that PSAPs can continue to use legacy equipment until it is replaced through normal attrition schedules. Additional discussion of the PSAP's needs for integrating with NextGen 9-1-1 network elements is contained in our *Recommendations* paper.[4]

2b. What upgrades may be necessary for individual PSAP equipment and software or network infrastructure to the PSAP?

MTS response: PSAPs will require last mile IP connectivity to the ESINet. MTS has no information regarding the individual needs of Nebraska's PSAPs.

2c. What costs may be incurred to properly equip PSAPs and their respective networks?

MTS response: MTS has no comment at this time.

2d. What training may be necessary to ensure proper handling of increased information available through Next Gen 9-1-1?

MTS response: New media inputs such as video and text-to-911 feeds will evolve along with Next Gen 9-1-1 and mandate new skills for PSAP managers and dispatchers. Training will be required. However, there exists among many dispatchers a fear that they will be overwhelmed by data inputs above that which is available today. In fact, there will be more and better data available, but most Next Gen CPE manufacturers and Service Providers have designed their solutions to stage auxiliary data off-screen, visible to the dispatcher only if and when he/she needs it and calls for it.

[4] *Recommendations* at P. 9

On the other hand, some 911 authorities have noted that that failure to call forth all available data may render the PSAP vulnerable to liability issues. MTS suggests that the Commission assess this issue, seek specific industry and public safety comments, and make regulatory and legislative recommendations regarding this and related liability questions.

Funding for necessary training is always at issue. MTS notes that the Commission currently does not permit the Fund to reimburse for certain training.[5] The decision may need to be revised in the context of a Next Gen conversion.

2e. How may smaller PSAPs be uniquely affected?

MTS response: Next Gen holds the promise of helping to equalize call management for so-called "smaller" PSAPs. NG technology is designed to increase the ability for dispatchers to work from remote or "virtual" locations (even from home or a disaster backup site) and consolidate PSAP resources, seamlessly transfer calls and data to other PSAPs during "night mode" or disasters, assist with overflow call volume situations, and related call routing techniques.

3) In implementing Next Gen 9-1-1, what 911 databases will be required?

3a. In what way will Next Gen 9-1-1 affect the exiting Master Street Address Guide?

MTS response: MTS provides an extensive discussion of the impact of ESINet operation and Next Gen implementation on legacy database operations in its *Recommendation* paper.[6] Next Gen standards envision the concept of reverse geocoding, which could eliminate the MSAG. In practice, however, that has proven problematical and at least one Next Gen 9-1-1 Service Provider has retained the ability to route calls using MSAG tables. Maintenance of the

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[5] "Additionally, administration, personnel and training costs will not be considered eligible expenses at this time." *In the Matter of the Nebraska Public Service Commission, on its own motion, to implement provisions of LB 1222 [2006] and to establish a permanent funding mechanism for wireless enhanced 911 service,* Application No. 911-019/PI-118 ORDER RELEASING AMENDED MODEL AND APPLICATION PROCESS FOR COMMENT AND SETTING HEARING, Entered: December 15, 2009, at P. 6.

[6] *Recommendations* at PP. 6- 11

MSAG may or may not change[7]. An additional topic that should be addressed in this inquiry is appropriate role for the Commission's GIS database efforts in the conversion to Next Gen.[8]

3b. Who will be responsible for maintaining and creating the various databases required?

MTS response: If the NENA i3 standard[9] is followed, there will be a number of databases maintained by a number of entities. MTS reviews three potential approaches to Next Gen 9-1-1 and related database implementation; prime contractor, Public Safety, or a "hybrid" approach, in the *Recommendations* paper.[10] Each has its respective strengths, including the approach to database creation and management. MTS recommends the approach that presents the Commission, in its judgment, with the most flexibility in implementing Next Gen.

4. Please comment regarding the appropriate state or local authorities to direct and coordinate the implementation of Next Gen 9-1-1 with respect to the receiving and processing of 911 calls. In commenting, please also provide the following:

4a. The basis of their authority;

MTS response: Experience has shown that states with an empowered, centralized state authority are more successful in deploying new 911 technologies than states with localized 911 authority structures.

4b. Funding available to the entity;

MTS response: MTS has no comment at this time.

4c. The level of technical expertise needed and currently available.

MTS response: MTS has no comment at this time.

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[7] Currently, the industry has several options for MSAG management. PSAPs may have direct access into the MSAG via web portals by which they will update their own MSAGs and assume full responsibility for its accuracy. PSAPs may own their own MSAG management tool and 911 Service Providers may have to dynamically access the PSAP's database for each call. Or, a third party could manage the MSAG using any number of procedures, and the 911 SP would have to access the third party database.

[8] "Status of GIS Data in Nebraska -The ability to locate wireless callers depends on having accurate and complete geographical data. GIS (Geographical Information System) data has been developed for the purpose of plotting Phase II wireless 911 calls. A repository has been created to house statewide GIS data. After the GIS data is developed, on-going maintenance is required, often on a daily basis for high-growth areas. This process could potentially create an undue burden for the PSAPs, their vendor and staff of the Commission to manage the data because of its frequently changing nature. The repository will allow each PSAP to extract the updates relevant for their county and any map data for surrounding counties that they need." *Status of 911 in Nebraska, Article on website of KETV.com*, August 20, 2007, and cited as being provide by the Nebraska Public Service Commission. ("*Article*")

[9] http://www.nena.org/standards/technical/voip/functional-interface-NG911-i3

[10] *Recommendations* at P. 2

5. Please comment regarding the various funding sources that may be available for the implementation of Next Gen 9-1-1.

MTS response: The topic of 911 funding, including Next Gen, has been the subject of multiple national reports and national legislation. These are too voluminous to be summarized here. Instead, MTS has included cites to several examples for Commission review including the Federal Communications Commission's National Broadband Plan.[11]

6. Please comment regarding any statutory changes that may be necessary to implement Next Gen 9-1-1.

MTS response: To the extent that the Fund or any other funding source has a statutory "cap" on the end-user or access line fee, the Commission may wish to ask for the flexibility to seek an increase and/or rate flexibility among classes of services subject to the fee(s). MTS has no additional comments at this time.

7. Please comment as to any other issues that should be addressed related to the implementation, coordination, and funding for the implementation of Next Gen 9-1-1.

MTS response: The Commission should review current ILEC tariffs and Commission rules that may or may not allow incumbent ILECs and/or CLECs to ignore Next Gen interconnection, and to retain their legacy ALI and selective routing until they retire them on their own timelines. Just as all communications providers are today required to connect to the legacy selective routers and to add their customer records to the legacy ALI, similar support should be required when Next Gen transition plans are implemented so that all legacy carriers will connect to the Next Gen ESINet in whatever manner and format the ESINet provider directs and will add their customer records to the Next Gen ALI or equivalent. Next Gen is a replacement for all 911 services, not a parallel 911 technology designed only for wireless and VoIP.

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[11] A) *REPORT TO CONGRESS ON STATE COLLECTION AND DISTRIBUTION OF 911 AND ENHANCED 911 FEES AND CHARGES* Submitted Pursuant to Public Law No. 110-283 FEDERAL COMMUNICATIONS COMMISSION Julius Genachowski, Chairman JULY 22, 2009, www.fcc.gov ; B) *Emergency Communications: The Future of 911,* by Linda K. Moore, Specialist in Telecommunications Policy March 16, 2010, Congressional Research Service 7-5700 www.crs.gov RL34755; C) The National Broadband Plan and Public Safety Grants, http://www.broadband.gov/plan/16-public-safety/ D) *Funding 9-1-1 Into the Next Generation*, by the NENA NG Partner Program March 2007.

Conclusion

The Commission's goal of Next Generation wireless and wireline E911 services is of incalculable value to all the citizens of Nebraska for their personal safety, the protection of their property, and their homeland security. This inquiry is an important and necessary first step in this process. MTS encourages the Commission to maintain an open mind and seek flexibility as it plans for the introduction of Next Gen 9-1-1, and looks forward to participating in this matter.

July 30, 2010

Respectfully submitted,

RH Dickinson

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ATTACHMENT A

Recommendations for Implementing NG9-1-1 Components

June 4, 2010

Author: Todd Poremba
Product Marketing Manager for NG9-1-1

TCS TeleCommunication Systems
Enabling Convergent Technologies®

Contents

Figures

Abbreviations and Acronyms

ACD	Automatic call distribution
ALI	Automatic location identification
BCF	Border control function
COTS	Commercial off-the-shelf
CPE	Customer premise equipment
DBMS	Database management system
E9-1-1	Enhanced 9-1-1
ECRF	Emergency call routing function
ESGW	Emergency services gateway
ESInet	Emergency services internet protocol network
ESRP	Emergency services routing proxy
ESZ	Emergency service zone
GIS	Geographical informationsystem
GMLC	Global mobile location centers
i2	NENA 08-001 Interim VoIP Architecture for Enhanced 9-1-1 Services
i3	NENA i3 (Long Term Definition) Standard
IETF	Internet Engineering Task Force
IP	Internet protocol
IT	Information technology
LATA	Local access and transport area
LEC	Local exchange carrier
LIS	Location information server
LNG	Legacy network gateway
LPG	Legacy PSAP gateway
LVF	Location validation function
MPC	Mobile positioning center
MPLS	Multi-protocol label switching
MSAG	Master street address guide
NENA	National Emergency Number Association
NG9-1-1	Next Generation 9-1-1
PRF	Policy routing function
PSAP	Public safety answering point
PSTN	Public switched telephone network
QoS	Quality of service
SOI	Service order input
TCS	TeleCommunication Systems, Inc.
TDM	Time division multiplexing
TN	Telephone numbers
URN	Universal resource name
USPS	United States Postal Service
VoIP	Voice over internet protocol
VPC	VoIP positioning center
VSP	Voice service provider

Introduction

Next Generation 9-1-1 (NG9-1-1) services are defined largely by the National Emergency Number Association (NENA) and other key standards development organizations such as the Internet Engineering Task Force (IETF). One of the key advantages of the NENA standards is that they grant Public Safety the choice to directly control services that were previously leased from private sector companies. Another important advantage offered by the NENA standards is that many NG9-1-1 functions may now be performed by commercial off-the-shelf (COTS) hardware and software, an advantage that broadens the range of vendors and technical support options Public Safety may employ when deploying a NG9-1-1 system. Public Safety itself also has options for the operation of the physical network: available options include networks operated by state, regional, county, or city government agencies.

This white paper will elaborate on what is required for each functional element of the ESInet and will recommend possible ownership and placement of each element within the network.

Implementing an NG9-1-1 service begins with determining the NG9-1-1 services required in a given jurisdiction and determining which Enhanced 9-1-1 (E9-1-1) features must be supported. Once a 9-1-1 jurisdiction makes these determinations, it then must determine who provides which services. Depending on Public Safety's needs, the traditional landline phone company that originally provided 9-1-1 and E9-1-1 may not be the best choice for all NG9-1-1 related services. The determination of these roles is essential to the successful implementation of a NG9-1-1 solution. The 9-1-1 jurisdiction determines how the NG9-1-1 system will be built and operated. The 9-1-1 jurisdictions may be organized by the state 9-1-1 authorities or by a joint powers agreement creating a single governance body between multiple E9-1-1 jurisdictions. Whether the organizing entity is a state 9-1-1 office, a regional consortium of counties, or some other large entity, each 9-1-1 jurisdiction needs to determine its own path given the fiscal realities each faces.

This white paper provides a brief description of the high-level components of an NG9-1-1 system, discusses how to select who operates the various components, and offers a description of how multiple emergency services internet protocol networks (ESInets) may be supported.

Models for NG9-1-1 Implementation and Operation

There are three basic approaches to implementing and operating NG9-1-1:

1. A prime contractor provided solution
2. A Public Safety owned and operated solution
3. A hybrid solution that combines contracted services and Public Safety owned and operated systems

In the first model, the prime contractor purchases or subcontracts various elements of the NG9-1-1 system. In second model, Public Safety buys the components themselves and operates the system. Public Safety could contract specific support services. In the last model, Public Safety contracts some services and purchases and operates other components themselves. Any one of these three models is feasible on its own, and all models are compatible with one another.

Whether the distinct NG9-1-1 systems share local Public Safety Answering Point (PSAP) boundaries or the systems are located across the country from one another, the NENA standards define how the NG9-1-1 systems can inter-operate. In NENA's standards, the centralized NG9-1-1 systems that route calls, validate locations and provide carrier access and the necessary security are collectively called an ESInet (emergency services internet protocol network). By implementing NENA's standards-based approach, it is possible for multiple separate ESInets to operate in the same jurisdiction provided they share the same essential data for call routing and location validation.

Depending on Public Safety's needs, the traditional landline phone company that originally provided 9-1-1 and E9-1-1 may no longer be the best choice for all NG9-1-1 related services.

These three options, however, are not equal. Each has its own value and feasibility, strengths, and weaknesses:

1. **Prime contractor provided solution:** Using a prime contractor limits choices to the subcontractor(s) used by the prime contractor. This limitation is more likely to result in proprietary solutions and under-performing components that cannot be easily replaced. Many PSAPs today purchase call taking, computer aided dispatch, logging, or reporting systems directly from the vendor rather than from the E9-1-1 selective router operator. This trend away from a single provider will continue as the technology used in 9-1-1 converges with the commercial sector. The perceived advantage of this model is that Public Safety receives answers to all questions from a single vendor. Whether this is actually an advantage, however, is far from certain, since different points of view supplied by multiple vendors on a question may provide a more complete, accurate answer.

2. **Public Safety owned and operated solution:** Purchasing and operating all components provides unlimited choices and ultimate control. Given the staffing and technical support models used in many PSAPs today, however, such a large shift in responsibility could be difficult to manage.
3. **Combination solution:** A hybrid solution—one in which Public Safety mixes contracted services with systems owned and operated by Public Safety—better ensures flexibility regarding which vendors can be selected and when an under-performing vendor can be replaced. Over time, it also allows Public Safety to take on more operational responsibility at a rate best suited to each individual 9-1-1 jurisdiction.

Factors Affecting NG9-1-1 Functional Operation

Before addressing each ESInet function, it is important to consider the following basic factors that can affect the operation of NG9-1-1 functions:

1. The entity that operates or assists in the operation of a given emergency service function in today's 9-1-1 environment
2. The entity that operates or assists in the operation for systems similar to those needed for NG9-1-1 in other industries or applications
3. The service availability required for each of the ESInet functions
4. The level of support, if any, provided by current 9-1-1 funds for similar services in today's E9-1-1 system.

Before addressing each ESInet function, it is important to consider four basic factors that can affect the operation of NG9-1-1 functions.

While other factors may affect one or several components within the ESInet, these four factors affect all implementation choices and must be considered before implementation begins.

The ESInet

Figure 1 shows the elements that NENA defines within its VoIP i3 documents as being a part of the ESInet (i3 is the term used to encompass the first iteration of NG9-1-1). This section of the white paper will elaborate on what is required for each functional element of the ESInet and will recommend possible ownership and placement within the network. Specifically, this section will discuss the following elements within the ESInet:

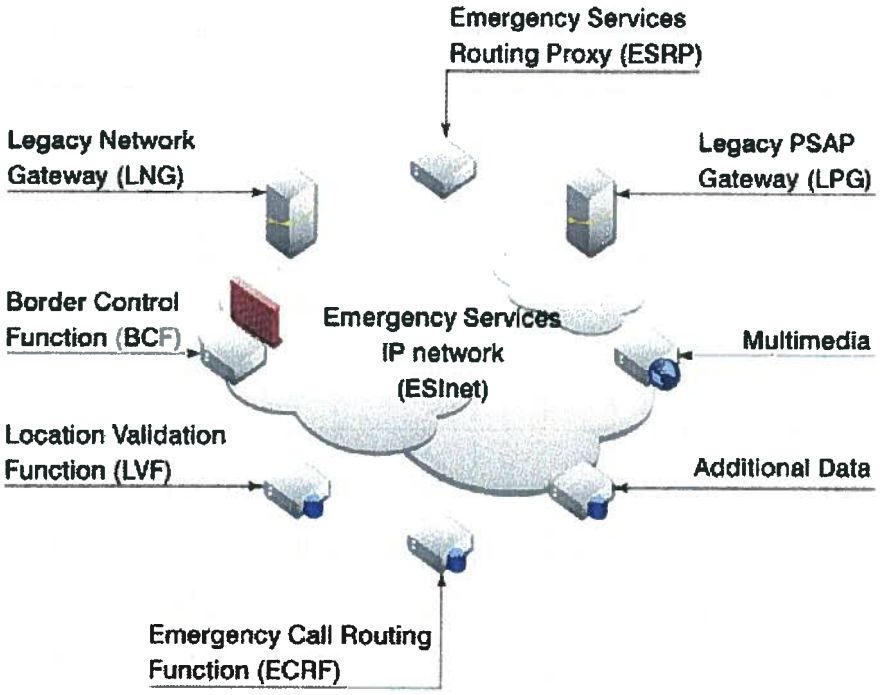

Figure 1. The NENA ESInet diagram

- Location validation function (LVF)
- Location information server (LIS)
- Emergency call routing function (ECRF)
- Emergency services routing proxy (ESRP)
- Border control function (BCF)
- Legacy network gateway (LNG)
- Multimedia and data servers
- A physical network for IP communication
- Legacy PSAP gateway (LPG)

It should be noted that the LIS is not specifically shown within the NENA ESInet. The idea commonly promoted is that the LIS should be in the various private access networks that connect to the ESInet. This assumption and the alternatives are discussed below.

Location Validation Function

The location validation function (LVF) validates that a given description of a location is both precise enough to route a 9-1-1 call and is recognizable

by dispatchers. In the NENA i3 specifications, valid locations are routable locations and do not need to be master street address guide (MSAG) addresses; they could be latitude/longitude or United States Postal Service (USPS) addresses. It is assumed that the data source that defines validation by the LVF will be based on geographical information system (GIS) data sources. Additionally, there is an assumption that this same data source drives the ECRF and that the locations, once validated, will be stored in an LIS located in a commercial network.

In ideal conditions, these LVF systems should suggest alternative addresses, such as the dispatch-capable equivalent of a USPS address. However, the communication protocol currently defined to provide the LVF does not support the actions of indicating that an address is MSAG valid or of suggesting alternative addresses.

In the current 9-1-1 environment, local exchange carriers (LECs) work with the various 9-1-1 addressing authorities to maintain a single authoritative source of the MSAG for their jurisdiction. Public Safety currently defines new, changed, and deleted entries in the MSAG, and many counties have at least one department with GIS specialists. Some states and counties contract with private companies that provide aerial photography services to aid in creating highly accurate digital maps for their region.

The best solution for many 9-1-1 jurisdictions is to purchase or lease a LVF system that can provide many, if not all, of the functions of a DBMS for E9-1-1.

Ideally, the required service availability for the LVF should be greater than normal business hours. However, since the LVF is not designed to be used at emergency call time, it does not require 99.999% availability. To compare the LVF to the system most similar to it, the current service order input (SOI) system often requires 48 hours to complete a request. Again, since the LVF is not used at call time, the LVF simply needs to provide a consistent service level with few multi-hour interruptions. The desired goal for the LVF should be to maintain a level of availability higher than that of an SOI system, even though such availability is not typically required.

In many jurisdictions, 9-1-1 funds can support addressing authorities and GIS support. In many other areas, however, these services are paid for through general funds. To implement NG9-1-1, the addressing authorities will need to work with the GIS support personnel, and the GIS support personnel will likely require more funding. For example, one task that requires collaboration is associating the dispatch address (MSAG address) with the various other address alternatives and aliases commonly used, including the USPS address version(s). The resulting increase in funding needs may be offset by not having to pay a vendor for database management system (DBMS) or MSAG services.

The best solution for many 9-1-1 jurisdictions is to purchase or lease a LVF system that can provide many, if not all, of the functions of a DBMS for E9-1-1. The 9-1-1 jurisdiction can perform most of the necessary operation themselves with assistance from a state, regional, county, city, or contracted information technology (IT) support service. Eventually, higher-level LVFs may direct voice service providers (VSPs) to the correct local LVF.

Location Information Server

The location information server (LIS) stores validated locations for subscribers and network nodes. Initially, the LIS provides either a reference to the caller's location or the location itself. This information is placed into the call setup signaling. PSAP call-taking equipment can display the location information once received.

The LIS does not contain many of the legacy data fields found in an automatic location identification (ALI) database record, such as class of service and type of service. These data elements are not specific to the location. In NENA i3 specifications to date, this data can be stored in additional data servers, sometimes called call information databases, that contain additional data associated with a call or a caller.

Taking these matters into account, the best solution for many 9-1-1 jurisdictions is to purchase or lease a LIS system or contract with a vendor who provides LIS service.

In the current 9-1-1 environment, LECs or other 9-1-1 service providers work with the various VSPs to store all addresses in MSAG format in a centralized ALI database. In some areas, Public Safety owns and operates an ALI database for their immediate jurisdiction. In all cases, Public Safety works with the LEC and the VSPs to correct any database errors.

All subscription service companies, including VSPs, operate databases that include subscriber information. Most subscription service companies, however, do not make this information available to external entities with 99.999% availability. Nor do they provide this information in the correct, dispatch-capable address format. 9-1-1 funds currently provide for this service at a tariff rate per subscriber record in the ALI database.

Public Safety cannot control the timely deployment of LIS elements into the access service providers' networks. Additionally, VSPs and other communication companies that will have access to 9-1-1 in the future do not appear to be ready or willing to operate their own 99.999% available LIS. For these reasons, the 9-1-1 jurisdiction may require a "local" LIS. Given the association of the LVF with the LIS and the possible need for a call information database, these functions would best be supplied by the same vendor's solution in the first iteration.

Taking these matters into account, the best solution for many 9-1-1 jurisdictions is to purchase or lease a LIS system or contract with a vendor who provides LIS service. Where possible, the LIS services should reside in the physical network itself and in the same data centers as the network equipment. This placement reduces the points of risk. The LIS will most likely need to provide some call information database functions to supply the necessary backwards compatibility with ALI fields. The 9-1-1 jurisdiction can administer the LIS data themselves. For the 99.999% up-time requirement, some 9-1-1 jurisdictions may be able to receive support from a state, regional, county, or city department. Most, however, will need to contract a vendor who has experience providing such operational support.

Emergency Call Routing Function

The emergency call routing function (ECRF) provides 9-1-1 call routing based upon a given service universal resource name (URN) and location information received or retrieved in real time. The location information can be either an address or geo-coordinates (e.g., latitude/longitude). Like the LVF, it is assumed that the ECRF data source that defines call routing will be provided by a GIS data source. The data driving the ECRF must be the same as the data driving the LVF. A sample call flow is shown in **Figure 2**.

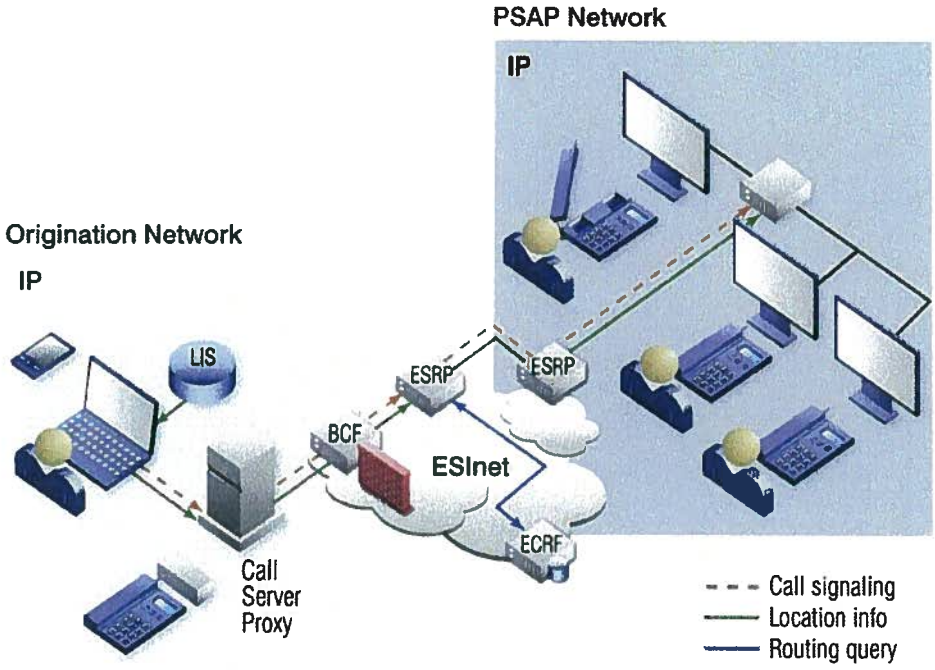

Figure 2. Sample IP call flow

In the current 9-1-1 environment, there is no matching system. Given the expectation to route based on MSAG address, USPS address, or latitude/longitude, mobile positioning centers (MPCs), global mobile location centers (GMLCs), and VoIP positioning centers (VPCs) in today's environment are most similar to what is required of an ECRF. Today's selective routers only route based on telephone numbers (TNs), and the routing data associated with those TNs is entered hours, months, or even years in advance. The data elements that drive all of the systems mentioned here are provided by Public Safety in the form of MSAG addresses, cell tower to emergency service zone (ESZ) definitions, and ESZ polygon shape files.

In the current commercial environment, many internet-based offerings provide real-time selection of a service based upon a user's current location. Most of these, however, are not considered critical services, and most do not meet Public Safety's requirements for a high level of availability.

The ECRF must be 99.999% available, as all call routing for 9-1-1 relies on these systems.

9-1-1 funds currently provide for this service through cost recovery mechanisms to wireless carriers or VoIP service providers. Cost recovery is supplied by a 9-1-1 tax charged to each subscriber and reflected on their service bill. In a similar system, the selective router is funded at a tariff rate per TN record in the landline database. This tariff rate is supplied by a 9-1-1 tax reflected on each subscriber's bill.

The best solution for many 9-1-1 jurisdictions is to purchase or lease an ECRF system or contract with a vendor who provides ECRF service. The 9-1-1 jurisdiction can administer the ECRF data itself since it should be the same data as the LVF data. In order to provide the 99.999% availability requirement, some 9-1-1 jurisdictions may be able to receive support from a state, regional, county, or city department. Most, however, will need to contract with a vendor who has experience providing such operational support.

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Emergency Services Routing Proxy

The emergency services routing proxy (ESRP) receives call setup signaling and performs various queries to other components to determine the intermediate or final destination for an emergency call. The ESRP also includes a policy routing function (PRF) to provide routing policies based on such parameters as hours of PSAP closure; languages and technologies supported; and overflow, alternate, and default agreements.

In the current 9-1-1 environment, Public Safety defines routing policies that are then implemented by the operator of the selective router, typically a LEC. Some PSAPs also use automatic call distribution (ACD) systems to provide features similar to the PRF. Customer premise equipment (CPE) vendors and CPE maintenance contractors configure the systems to the PSAP's specifications.

In the commercial environment, most VoIP telephony service providers and enterprises that use VoIP telephony operate call proxy systems that are similar to the ESRP. The majority of call proxies define policy rules for call completion. Since the ESRP is in the call setup path, it requires 99.999% availability.

9-1-1 funds currently provide for similar call setup signaling services through cost recovery mechanisms to wireless carriers and VoIP Service Providers. Another similar system, the selective router, is funded at a tariff rate per TN record in the landline database.

Compared to their circuit-switched counterparts, today's IP-based systems have more advanced, easier-to-use systems-management interfaces. With NG9-1-1, Public Safety can effectively self-manage the configuration data that drives the ESRP and PRF. Given the high availability requirement, support of the actual hardware and software will likely need to be provided by a state, regional, county, or city department with 24x7x365 operational support expertise or will need to be contracted to a vendor with that same level of operational support expertise.

The BCF is technically not provided in today's E9-1-1 networks but is nevertheless necessary for NG9-1-1.

Border Control Function , Legacy Network Gateway, and Multimedia and Additional Data Servers

The border control function (BCF), legacy network gateway (LNG), and multimedia servers all provide narrowly defined functions related to security, media conversion from time division multiplexing (TDM) to IP, and making other media sources available to Public Safety. An example of additional data servers would be call information databases. The additional data servers may store other useful information for Public Safety that is not provided by the E9-1-1 environment today, such as alternate phone numbers, other contact names and numbers, and photos. In the current 9-1-1 environment, none of these functions is consistently provided by the same entity.

The BCF is technically not provided in today's E9-1-1 networks but is nevertheless necessary for NG9-1-1. VSPs, VPC providers, as well as providers of media gateway services perform the necessary functions of

a BCF, but they do so on their own behalf and not on behalf of Public Safety. In some instances, PSAP CPE vendors or state, regional, county, or city IT departments provide IP-based security; however, they do not provide the depth and breadth of security required by the NG9-1-1 BCF.

The LNG function is very similar to the NENA i2 emergency services gateway (ESGW) function, except that the media conversion is reversed. That is, LNGs convert TDM to IP whereas ESGWs convert IP to TDM. Today's ESGW providers could become tomorrow's LNG providers. In this eventuality, Public Safety would pay for the services instead of the VoIP service providers. A sample LNG call flow is shown in **Figure 3**.

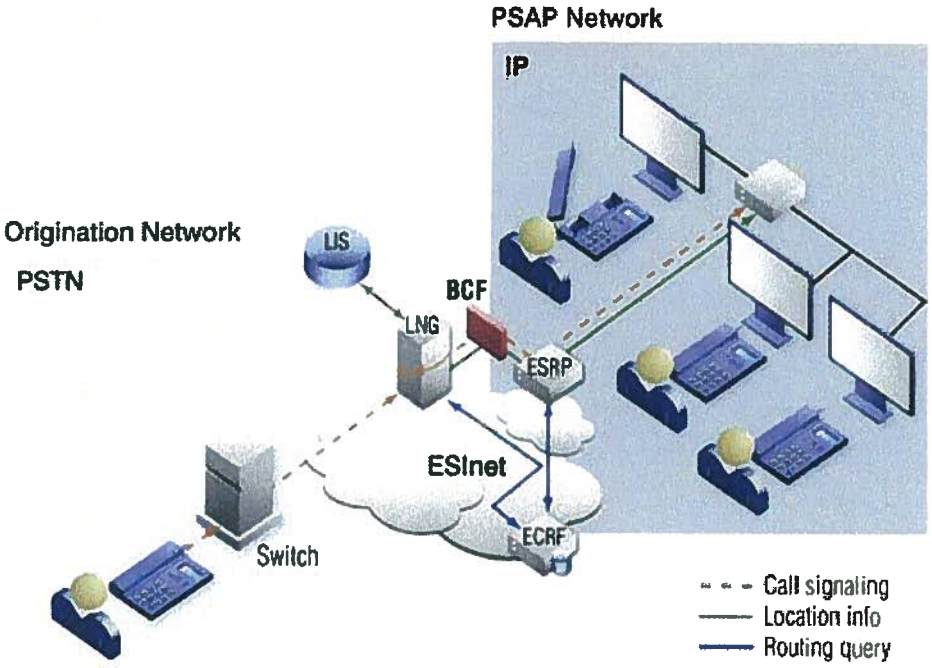

Figure 3. Sample legacy carrier call flow

In the commercial environment within the communications industry, IP and VoIP security (what the BCF provides but in a more specific capacity) is commonplace. Media conversion from TDM to IP, which is what the LNG provides but in a more specific capacity, is similarly commonplace among VoIP providers since they must interoperate with the public switched telephone network (PSTN) environment. Multimedia systems are often also found in large commercial environments and large government environments. In general, there are numerous engineers available in the job market who can support all of these functions.

Since the BCF and LNG are part of the call completion path, they require 99.999% availability. Multimedia services and services for additional data may not have as rigorous availability requirements depending on the factors involved, such as how these services are funded and what data is being transmitted.

Parameters for multimedia services and services for additional data, such as data types and protocols, will need to be defined by the local 9-1-1 jurisdiction if they are not defined by NENA. It is possible that some of the additional data can be categorized as essential subscriber- or call-related data. Other additional data may be categorized as supplemental. The parameters and categories will define availability requirements and likely operational ownership.

9-1-1 funding currently pays for networking and network equipment; however, multimedia and additional data do not have a clear funding source.

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Based on the foregoing, the BCF and the LNG will need to be provided by a state, regional, county, or city department with 24x7x365 operational support expertise or will need to be contracted to a vendor with that same level of operational support expertise.

Physical Network for IP Communication

The physical network used by Public Safety requires many types of diversity and redundancy in order to achieve high availability. Diversity includes broad geographic diversity (two data center locations unlikely to be affected by the same natural or human-made disaster). It is also strongly recommended that the Public Safety provide carrier diversity (two or more circuit providers), technology diversity (two or more media technologies, such as fiber and satellite), and vendor diversity (network equipment from two or more vendors). In addition to these diversities there should be local redundancy. Redundancy within a data center, for example, should include two or more network routers, network firewalls, power distribution systems, and so forth. End to end, there should be no single point of failure, although this is sometimes unavoidable since the circuits typically terminate to the same physical PSAP building. For example, the fiber trench or conduit may be such a single point of risk. A high-level sample network architecture is shown in **Figure 4**.

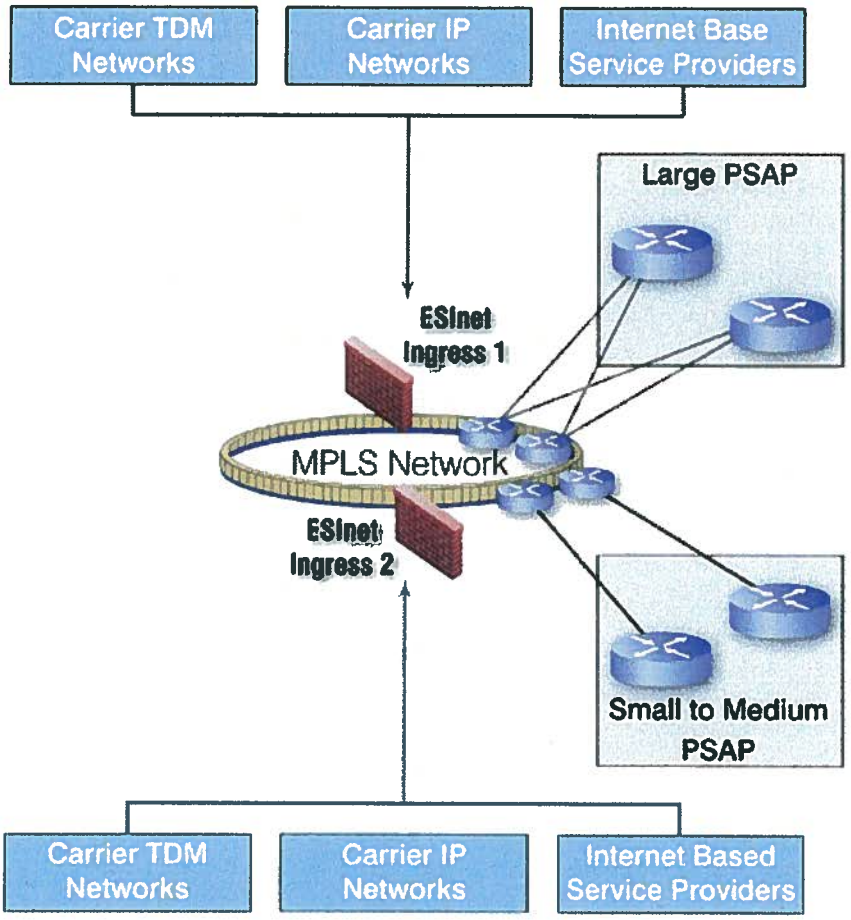

Figure 4. Sample high-level IP network diagram

The IP network enables all call routing; all call-related data delivery; and all voice, text, and video completion from end users to Public Safety. The IP network must be capable of supporting all protocols that use IP, though protocols that are connection-oriented and provide delivery guarantees end-to-end are much preferred for 9-1-1. Multi-protocol label switching (MPLS), as one example, can provide the appropriate level of intelligence within the network to support multiple uses of the network by Public Safety while still maintaining the appropriate quality of service (QoS) for voice calls.

In the current E9-1-1 environment, the network transport that services Public Safety is not IP-based. Generally, LECs operate TDM-based networks to carry voice and use serial connections over leased lines to deliver data. In some instances, however, LECs do deliver data over IP networks. MPCs, GMLCs, VPCs, and ESGW providers also operate extensive Public Safety networks. Some operators deliver data all the way

to the PSAP over IP networks, converting IP to serial communication at the PSAP premise. VPC and ESGW operators are the companies currently routing IP-based 9-1-1 calls. There are some state, regional, county, and city deployments of IP call routing as well.

In the commercial environment, most communications companies are providing or plan to provide mobile and nomadic service. They are actively adding more customer capabilities over IP-based networks.

The physical network and the IP communication services must be capable of 99.999% availability.

9-1-1 funding currently pays for networking and network equipment, though existing tariffs may not apply to IP circuits or bandwidth. Through consolidation of ingress points and elimination of charges associated with TDM circuits crossing local access and transport area (LATA) boundaries, it may be possible to reduce the recurring circuit charges currently paid and redirect these 9-1-1 funds to other sources, such as GIS departments, IT departments, and other areas where NG9-1-1 shifts work.

Based on this, the physical network and IP communications services will need to be provided by a state, regional, county, or city department with 24x7x365 operational support expertise or will need to be contracted to a vendor with that same level of operational support expertise. A single vendor owning the transport medium (the fiber or antennas/dishes) is not strictly necessary and is disadvantageous to carrier diversity.

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Legacy PSAP Gateway

The Legacy PSAP Gateway (LPG) converts IP media to TDM media to make current PSAP equipment compatible with IP-based ESInet services. The LPG enables an ESInet to support both IP-based PSAPs along with non-IP PSAPs within a state, region, county, or city that deploys an ESInet, yet has both types of PSAPs. The motivation for using an LPG is to receive more return on the PSAP equipment already purchased while receiving some of the benefits of an ESInet, such as diverse, redundant IP paths to the PSAP as well as receipt of additional content. In order to take as much advantage as possible from the ESInet, the LPG function should be supplied by redundant equipment at the PSAP itself. **Figure 5** depicts a sample LPG call flow.

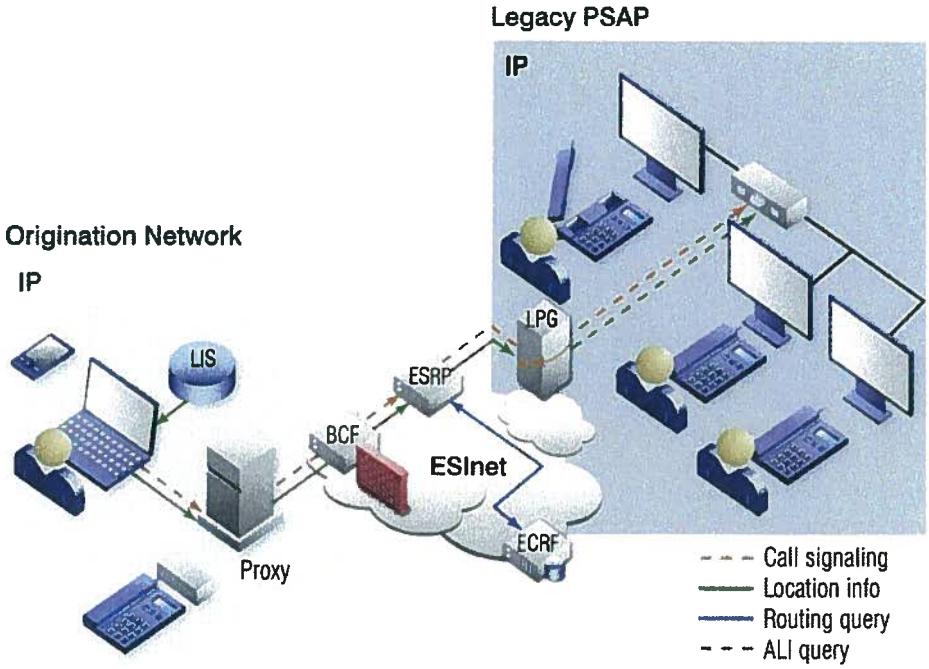

Figure 5. Sample legacy PSAP call flow

In the current 9-1-1 environment, this function is not provided. Some PSAPs use controllers that receive the TN over a TDM circuit and then perform a database query over an IP circuit; however, this conversion represents only a fraction of what an LPG must do. Like the LNG discussed above, the LPG function is very similar to the VoIP i2 ESGW function. The ESGWs, however, service large VoIP providers and not individual PSAPs.

In the commercial environment, many enterprises provide media conversion from TDM to IP and from IP to TDM (which is what the LPG provides but in a more specific capacity). The media conversion function is also commonplace among VoIP service providers. All entities using VoIP must interoperate with the PSTN environment. In general, there are numerous engineers available in the job market who can support this function.

Since the LPG is part of the call completion path, it requires 99.999% availability.

The 9-1-1 funding currently pays for call taking, data display, dispatch, and network equipment. The LPG is such equipment and is therefore included in the 9-1-1 funding.

The LPG will need to be provided by a state, regional, county, or city department with 24x7x365 operational support expertise or will need to be contracted to a vendor with that same level of operational support expertise. Logical options include the groups that provide general IT support at the PSAP, PSAP CPE support, or the IP network support. Other options may be equally viable.

ESInet Compatibility

One of the goals of NG9-1-1 and the migration to IP-based networks and open standards is that all PSAPs can pass information to other PSAPs. In a loose sense, then, there is one ESInet. In a more strict sense, there are multiple ESInets that use the same open standards and can thus easily communicate. A practical means for determining what constitutes a single ESInet, as opposed to two neighboring ESInets, is the security implemented between individual components. An ESRP should not need to pass through a security device to reach an ECRF in its native ESInet, but it should pass through a security device to reach an ECRF in a non-native ESInet. The neighboring ESRPs and ECRFs use the same open standard for communication, so they can be provided by different vendors and operated by different entities. The two ESInets could use the same IP network but with different security rules (e.g., different BCFs). To further emphasize the benefits of NENAs NG9-1-1 vision, since every ESInet needs all functions to be redundant and all functions to use open standards, it is even possible for systems from two different vendors to provide the same function within a single ESInet. Such diversity is akin to carrier diversity and vendor diversity in the physical network.

Figure 6 shows two ESInets (though component redundancy is only implied) sharing the same IP network but creating separate security zones. While NENA describes the LPG within the logical ESInet, in the example below the LPG is physically at the PSAP so that all PSAPs benefit from the resilience of redundant and diverse IP circuits. As the diagram suggests, another means of determining distinct ESInets is by the group of PSAPs directly connected to the same ESInet functions.

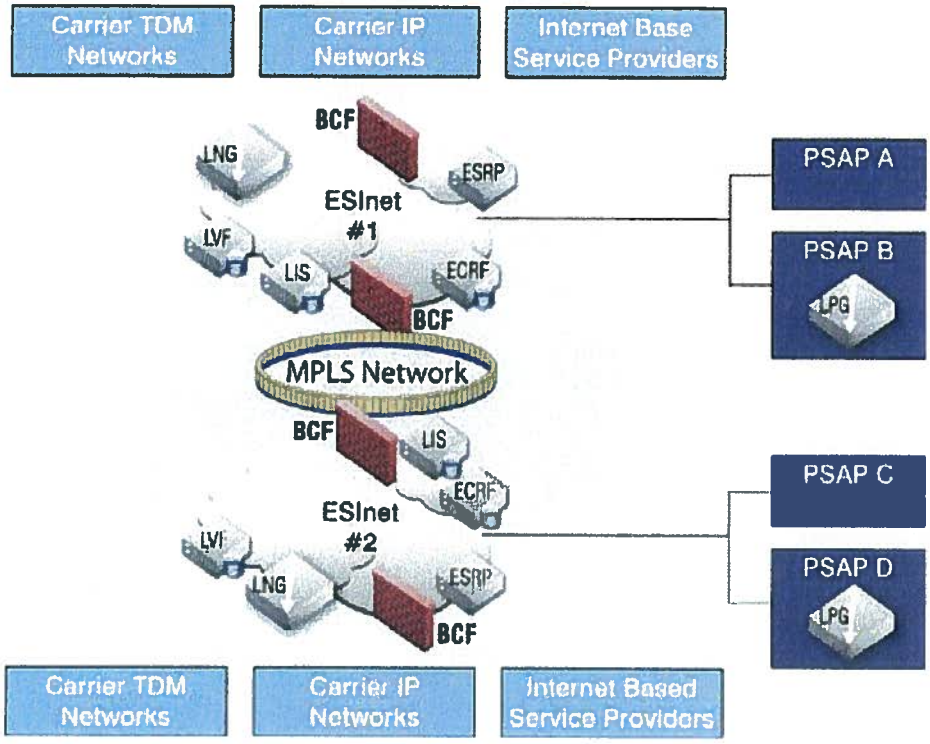

Figure 6. Diagram of separate ESInets on the same IP network

Since the LVF should be available over the internet to all users that require it, ESInets may share an LVF. The separate ESInets would store local copies of their GIS data in the LVF to operate the separate ECRFs.

Summary

Each 9-1-1 jurisdiction needs to determine which NG9-1-1 features are needed, when they are required, which E9-1-1 features must be retained, and how long the features must be retained. Each jurisdiction must then assess which implementation approach and operational model best meets their needs for a cost-effective, reliable 9-1-1 system. The three basic approaches to implement and operate NG9-1-1 are (1) a prime contractor provided solution, (2) a Public Safety owned and operated solution, and (3) a hybrid solution that combines contracted services on the one hand with Public Safety owned and operated systems on the other.

Additional factors to consider for operation of NG9-1-1 functions include (1) who operates or assists in the operation of the 9-1-1 function today, (2) who operates or assists in the operation of similar systems, (3) what level of service availability is required, and (4) how 9-1-1 funds support the function today.

ESInets will be built and operated as determined by the 9-1-1 jurisdiction. This will be organized at either the state level or the county level, or it will be organized through a joint-powers agreement that forms a single governance body amongst multiple E9-1-1 jurisdictions. A sole-source provider for NG9-1-1 will undermine the diversity, control, and accountability inherent in the NENA NG9-1-1 model. Nevertheless, it's unlikely that many 9-1-1 jurisdictions are ready to take over complete ownership and operation. Consequently, combining multiple contracts for service with ownership of certain elements allows the jurisdiction to meet its precise needs while retaining the flexibility to change or add subcomponents as needed. In the end, the increased vendor competition inherent in multiple contracts and system ownership will help Public Safety save money and save lives.

As a company that offers standards-based NG9-1-1 solutions, TeleCommunication Systems, Inc., provides individual ESInet components that can interoperate with other vendors' standards-based components.

About TeleCommunication Systems, Inc.

TeleCommunication Systems, Inc., (TCS) offers a modular, future-proof, NENA standards-based NG9-1-1 solution. As a company that offers such a solution, TCS provides individual ESInet components that can interoperate with other vendors' standards-based components. TCS offerings can be deployed as systems owned and operated locally, as services operated by TCS, or as a mix of the two. PSAPs can control the data in their TCS NG9-1-1 components regardless of the deployment model.

TCS entered the E9-1-1 industry in 1998 by serving wireless carriers for Phase 1 and Phase 2 of the FCC mandate. Thereafter, TCS became an ALI steering provider for many PSAPs and connected stand-alone ALI databases and PSAP CPE to various wireless E9-1-1 service nodes. More recently, TCS began providing E9-1-1 service to landline replacement companies that use VoIP.

Contact TCS today for further information on our NG9-1-1 solutions

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