NRIC VII

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FOCUS GROUP 1B

Long Term Issues for Emergency / E9-1-1 Services

Report 4

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1 Results in Brief

Focus Group 1B believes that lives can be saved through the incorporation of new 9-1-1 call[1] elements and functions. Before this can occur, however, changes will be required in the 9-1-1 infrastructure as it currently exists. This report provides a set of specific recommendations regarding future emergency communications network properties, and their capability by 2010 to support the exchange of voice, data, text, photographs and live video through the 9-1-1 network to the Public Safety Answering Point (PSAP) and beyond. In addition, this report also considers universal access by people with disabilities to Enhanced 9-1-1 (E9-1-1), E9-1-1 as it applies to satellite communications systems and E9-1-1 access from Multi-line Telephone Systems (MLTS).

Fundamental and significant change is required to move toward an infrastructure that offers enhanced capabilities and increased change capacity to accommodate both current and future emergency services operations.

The existing 9-1-1 infrastructure is based on technologies and conventions that were established over 30 years ago. The communications industry has adapted the infrastructure to business needs over time but has not been able to implement more advanced capabilities. Thus, the infrastructure will not readily adapt to emerging communication products. Because the communications industry is moving toward packet data versus circuit switched communications, the existing infrastructure is a barrier to creating an integrated national emergency call management infrastructure. The business models of emerging communications require innovative technology solutions and the 9-1-1 network must be able to adapt quickly in order to harness the added value these innovations offer for emergency response improvement. Historically, telecommunications systems and 9-1-1 systems have rarely been upgraded rapidly or uniformly, driving a requirement for long term maintenance of otherwise outdated solutions in order to maintain backward compatibility.

Emerging technologies are already pushing the emergency response envelope. The disconnected nature of local networks on a national scale, or alternatively, the lack of a fully inter-connected national 9-1-1 network, creates unique

[1] In this document we refer to calls and specifically 9-1-1 calls. This term should be understood to include a wide range of requests for help made via a myriad of devices and media including short messages, instant messages, video, packet data, etc.

challenges for various types of emergency calls (e.g. those initiated from a Federal agency, a remote call center or via a dial-up to a remote VPN).

Throughout this report, there is a clear reliance upon new standards activities to achieve uniformity and interoperability through the introduction of new technology. Legislation and regulation play a role in providing intent and direction, but standards activities are essential to getting it done in a practical way. New attention is needed to manage 9-1-1 service standards development from an end-to-end perspective in order to support a seamless evolution to new technology at many different points within the network and to avoid a degradation of service to the public or loss of efficiency to public safety operations.

A new approach is required to accommodate the many ways that emergency services can be requested and the response provided by the emergency service community. The roles of the PSAPs, responders and related entities are expected to expand beyond traditional 9-1-1 services with higher levels of interaction, managed situational intelligence, enhanced capabilities, and more comprehensive communication and coordinated response services.

Another area of concern is access by people with disabilities, including those disabilities that become more common as one ages. Access to 9-1-1 is currently eroding for this group. New technologies offer the possibility of greatly improved access to 9-1-1 over the current situation, which is limited to access via analog TTYs and PSTN relay services. However, people with disabilities who have moved to the new broadband and wireless text technologies for communication find they are cut off from 9-1-1. This has become a dangerous situation. Access to 9-1-1 in the long term requires an end-to-end standard solution for IP text as well as voice communication so that text and voice can be mixed on a call if desired, while retaining backward compatibility to the old analog TTY format. There is also an urgent need for consumers to be able to use new relay service technologies for 9-1-1 calls, with location identification and improved call-handling technology to eliminate long connection delays between the consumer and PSAP when a relay service is required.

Satellite systems have historically been treated differently from wireline and wireless networks with regard to E9-1-1 requirements. Some systems, notably MSS systems that provide conventional switched voice calling services, are now obligated to support 9-1-1 through call centers. Ultimately, Focus Group 1B believes that all satellite systems that support services that may reasonably be expected to support 9-1-1 calls should be able to support such calls with location and call back information as do other networks. The reality is, however, that retrofit of existing systems to accommodate such capabilities is not practical.

Furthermore, there is a wide range of mechanisms and services that are provided over satellites and a uniform standard for all satellite systems would not be appropriate.

Accurately locating the caller behind a Multi-line Telephone System (MLTS) in order to direct emergency responders to callers requires effort by MLTS owners, PSTN carriers, and emergency response providers. In many cases one or more of these is lacking. While some states have adopted legislation requiring the location of the caller to be made available to the PSAP, legislation is inconsistent across states, sometimes worded in technically infeasible ways and compliance is spotty. A focused effort by the FCC should bring about more consistency and encourage compliance such that emergency agencies have a better opportunity to respond effectively to emergency calls originated by users behind MLTS.

1.1 Future Reports

The final 1B report to the Council will include:

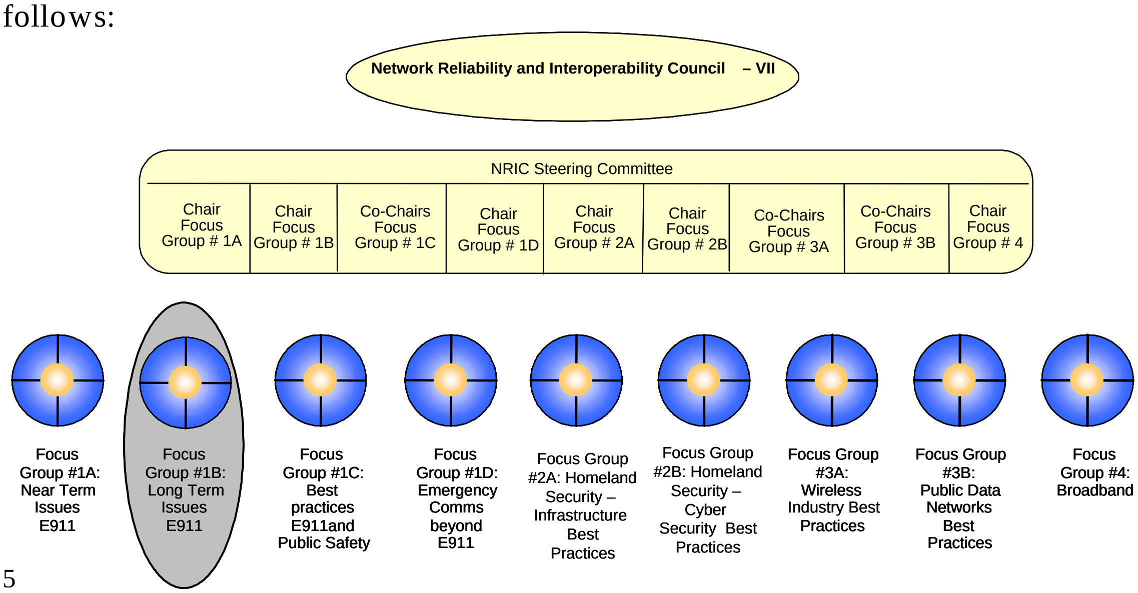
- Final recommendations for E9-1-1 network evolution

2 Introduction

This report documents the efforts undertaken by the Network Reliability and Interoperability Council (NRIC) VII Focus Group 1B. The key areas of consideration included are the properties that network architectures should meet by the year 2010, extending E9-1-1 to satellite telephony and identifying generic architectures to support video and advanced services. Other topics included maintaining or restoring emergency services and communication to those with disabilities and access to E9-1-1 from MLTS.

2.1 Structure of NRIC VII

The structure of the Network Reliability and Interoperability Council is as follows:



2.2 *Focus Group 1B Team Members*

The Focus Group members listed below participated in the development and editing of this report.

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3 Objective, Scope, and Methodology

3.1 Objective

The objective of this document is to identify the properties that network architectures should meet by the year 2010, including the access requirements and service needs for emergency communications by the year 2010, extending E9-1-1 to satellite telephony, identifying generic architectures to support video, advanced services and disability access. This report also addresses network transition and access to E9-1-1 from MLTS.

3.2 Scope

The scope of this document is the communications network between people needing help, and the communications centers who are the coordinators of that help: the PSAPs. This includes the networks within the PSAP, but does not include those that extend from the PSAP out to the responders, which are the subject of Focus Group 1D. It is understood that both functions may occur on a common network. It also addresses the satellite and terrestrial communications networks between people needing help and the PSAPs.

3.3 Methodology

To develop the contents of this report, the Focus Group was initially split into subcommittees with a chair appointed for each. The areas of focus for these subcommittees were: Current Requirements, Policy and Governance, Future Requirements, Network Requirements, and Data Requirements. These subcommittees held weekly meetings to examine their specific areas of focus through brainstorming, review and sharing of existing documentation, and working towards consensus on the recommendations.

On a regular basis, the full Focus Group met to assimilate the results from all of the subcommittees. In addition to offline revisions made to the document, the full Focus Group held in-person meetings to develop and finalize the document.

When Focus Group 1B considered satellite communications, disability access, network transition and MLTS, the entire committee worked on this report as a single body.

4 Background & Analysis

4.1 *Current Network Architecture*

4.1.1 PSAP and 9-1-1 System Characteristics

Today, approximately half of the calls coming to 9-1-1 call centers (Public Safety Access Points, PSAPs) are from wireless subscribers (although only a small fraction of these would be via Mobile Satellite Services). Despite seven years of work towards deployment of advanced wireless 9-1-1 features only 48 percent[2] of the PSAPs have been upgraded to receive callback and location information with the 9-1-1 calls. While public safety authorities are struggling with both funding and implementation of advanced wireless 9-1-1 technologies, newer and more challenging communication services are knocking on PSAP doors for access into the "traditional and native 9-1-1 call delivery path". Emerging mobile, satellite, VoIP and other IP enabled communications services do not fit into public policy requirements that set out 9-1-1 governance, funding and access to the 9-1-1 networks for the delivery of callback and location information.

Accessing the 9-1-1 network for newer advanced services is not the only issue affecting PSAPs nationwide. The existing E9-1-1 infrastructure has many undesirable and limiting characteristics. The existing infrastructure limits the potential models for handling emergency calls and does not extend to handling emergency situations on a broad geographic scale or to different communication technologies. The existing infrastructure may be viewed as a barrier to advancing emergency service capabilities and creating a national response capability. However, the existing infrastructure has many positive capabilities that must be preserved or reproduced in future networks.

The existing infrastructure does not extend beyond the local jurisdictional focus under which it was developed. It is based on communications switching technology that does not adapt to transporting information with the emergency service request and does not extend to support enhanced information types such as (non-real-time) text, images, and video. It is generally not possible to transfer a call with Automatic Location Identification (ALI) between two PSAPs that are not supported by the same infrastructure elements. PSAPs are often connected to the Public Switched Telephone Network (PSTN) with CAMA trunk technology that is relatively slow and antiquated, with limited data transmission capability. Call congestion management is based on local switch interconnections, locally available call takers, is limited to regional switching complexes and does not give communities broad enough options in directing

[2] NENA estimate for number of PSAPs receiving Phase II location data from at least one wireless carrier as of 8/11/05.

calls to alternate PSAPs. The existing infrastructure simply does not have the basic capabilities to gracefully expand to meet future needs.

Advancing emergency services within the United States requires establishing an infrastructure that allows integration of communication, emergency management, and emergency response capabilities across the country. This future infrastructure will be flexible and capable of handling varying public access communication technology. It will provide local communities with the options to run their emergency response efforts effectively and according to their special needs, while also integrating with regional, State, and national infrastructures, emergency response capabilities, and information intelligence services. The future emergency service infrastructure needs to be made up of an Internetwork[3] of emergency service networks to achieve manageability and to be engineered to withstand attacks and abuse.

As with most current generation communications networks, the 9-1-1 system currently has two separate but coordinated networks, a circuit switched network (which includes voice and real-time text via TTY) and a data network. The data network is presently limited to implementing the location determination mechanism, although it is agreed that much more data is really needed. As with most networks, convergence of the existing circuit switched and data networks will occur. Work is underway in National Emergency number Association (NENA), Alliance for Telecommunications Industry Solutions (ATIS), and the Internet Engineering Task Force (IETF) to provide the standards required to fully converge circuit switched (voice and text) and data networks into one packet network, based on IP. Unfortunately the ability to communicate in text wherever one can communicate in voice is in danger of being lost in the implementation of IP technologies.

It should be noted that the current system functions very well for the majority of day-to-day handling of emergency calls. It is important to not lose any of the good characteristics of the current systems as they evolve in the future. Additionally, telecommunications systems are rarely upgraded rapidly or uniformly. In the timeframe of this report, up to 2010, it is unlikely that all systems will have been upgraded uniformly and it will be necessary to maintain backwards compatibility for a significant time beyond 2010.

[3] We use the term "internetwork", as is it used in the NRIC VII Focus Group 1d report to refer to a collection of managed networks which are interconnected, often at multiple points. While these interconnected networks are not part of the public Internet, they may be connected to it through carefully managed firewalls.

4.1.2 Current Wireline and Wireless Network Design

The current 9-1-1 system is based on a series of telephone switches called "Selective Routers" (S/R). Wireline calls to 9-1-1 are detected at the local central office serving the caller and are directed to a specific S/R. The S/R uses the telephone number of the caller to look up in a database which PSAP should receive the call. The call is then routed to a trunk in the designated trunk group for that PSAP. Within the PSAP calls are sometimes queued in a switch, often a traditional enterprise PBX, and directed to a call taker using mechanisms common in any call center. When the call is answered, the phone number of the caller (identified using ANI) is automatically looked up in an "Automatic Location Identification" (ALI) database (DB) that responds with the address associated with the caller. This address and other related information is then displayed to the call taker. In addition, the ALI textually identifies the police, fire and EMS responders that serve the caller's address and the actual transfer numbers are stored in the S/R. If necessary, the Selective Router is used to transfer the call to another PSAP or another emergency assistance agency (e.g. poison control).

The carrier serving the customer provides the contents of the ALI-DB. The address data is validated before being placed in the ALI by comparing it against a Master Street Address Guide (MSAG), which is maintained with all of the known street address ranges for a given set of communities. The MSAG determines an emergency service zone, which maps to the primary PSAP to receive the call, and the emergency service transfer points (typically police, fire, and medical). Where data is provided in civic (street address) form, it should be validated against a version of the Master Street Address Guide. In the present system, the Master Street Address Guide is a database that lists all valid address ranges, along with other information about those addresses such as a code for the PSAP and responders that serve it. Currently the boundary described by an MSAG typically conforms to community or PSAP jurisdictional boundaries, which may be maintained at a State, county or city level, etc. Sometimes MSAG boundaries are maintained at the level of the E9-1-1 System Service Provider (E9-1-1 SSP)[4].

Wireless systems use somewhat different mechanisms. Location of a wireless caller is measured either by having GPS receivers in the handsets or by using triangulation of the radio signal from multiple towers. Sometimes both methods are combined to perform location determination. The location is determined using longitude and latitude rather than a street address. In ANSI networks, an entity called a Mobile Positioning Center (MPC) is the interface between the

[4] An E9-1-1 System Service Provider (SSP) is an entity contracted by the local 9-1-1 system administrators to manage a portion of the 9-1-1 system, most often including the Selective Router and Master Street Address Guide.

mobile network and the PSAP. The MPC compares the reported location against a database of PSAP service areas to determine which PSAP services the area of the caller. The MPC assigns an Emergency Services Routing Key (ESRK) to the call to be used instead of a telephone number to route the call to the correct PSAP. Calls are introduced into the same Selective Routers, but with the ESRK as the key to the routing database. The MPC also uses a specialized interface to a mapping database to provide the caller's actual location that can be pulled by the PSAP when the call is answered. In GSM networks similar functions are performed through interactions among the Mobile Switching Center (MSC), Gateway Mobile Location Center (GMLC) and a Serving Mobile Location Center (SMLC).

4.1.3 9-1-1 Concepts to be retained During Network Evolution

The current 9-1-1 infrastructure is based on several basic concepts that must be retained in some form in any future emergency call services infrastructure although methods may change.

1. ***Call delivery***
   Calls and data are delivered by an access network to the emergency services network. After someone has called 9-1-1, an emergency call center will be notified of their call back number and location information, even if the caller disconnects before the call rings at the PSAP.

2. ***Call location determination (static and mobile)***
   Wireline caller location is determined based on a static relationship between the telephone number and the service address. Mobile telephony introduced a fundamental change in that location is based on geographic coordinates as determined by the communications service provider. Additional services, such as VoIP and satellite telephony, have yet to finalize how location (which may change during the call) will be determined in all possible scenarios.

3. ***Call back number determination***
   Determining the call back number is usually routine. However, to accommodate mobile telephony, the delivery of the call back number may require additional steps at a PSAP.

4. ***Address validation***
   The address is known and valid such that services can be dispatched to the given location. Current communications service providers (primarily the emergency services infrastructure

provider) work with communities to define a Master Street Address Guide that contains all of the valid street names and address number ranges for a given area. This form of address validation is based on a static relationship between the location and a given address for wireline users, and for wireless cell tower locations. Wireless networks deliver location information as longitude and latitude geospatial coordinates validated by the wireless carrier as being authentic.

5. ***PSAP selection algorithm***
   Calls are routed to the correct PSAP based on various parameters such as caller location, PSAP ability to receive the call, and possible alternate call taker sites that could receive the call. For wireline callers, an extension of the MSAG is used to facilitate PSAP selection. The MSAG contains an Emergency Service Number (ESN) that maps a given address range to a primary PSAP and a set of emergency service providers (police, fire, medical, etc.). For wireless callers, the wireless communications carrier assigns an appropriate ESRK to select the correct PSAP which can be based on the cell tower location or longitude and latitude.

6. ***Routing of call to the PSAP***
   Once a PSAP has been selected to receive the emergency call request, the network must route the call to the PSAP. After the call is sent to the appropriate call center, the PSAP may utilize automatic call distribution (ACD) products to balance call load across their available call takers. Today's selective router switches use the caller's telephone number to determine the ESN, and then use the ESN to determine the PSAP, and then the S/R selects the appropriate communications trunks on which to route the call.

7. ***Automatic Number Identification (ANI) delivery***
   The telephone number of the caller, or an identifying key, is delivered to the PSAP over the voice or data channel and that number is used to retrieve location information.

8. ***Automatic Location Identification (ALI) delivery***
   ALI information is delivered over a separate data channel. For fixed location wireline telephones this is simply a database record retrieval based on the phone number. For mobile telephony an electronic message is sent to the mobile communications service provider's equipment so that geographic coordinates (longitude and latitude) can be determined.

9. ***Emergency service provider selection (police, fire, medical, poison control, etc.)***
   Calls are often transferred (especially in metro areas) to a different call taker for dispatch of emergency services. The choice of emergency service provider is usually based on the location of the caller, but it is expected that future implementations may add other parameters.

10. ***Call transfer to the emergency service provider (police, fire, medical, poison control, etc.)***
   Calls are sometimes transferred to another call taker and the caller's call back number and location information is displayed at the subsequent entity. Preferably, call taker notes are also transferred from the originating PSAP to the subsequent entities, but today that can only occur when those entities are interconnected and are using the same call-handling product. In many cases, the original call taker stays on the call to provide additional support.

11. ***Ability to use text conversation wherever there is voice conversation***
   Using Baudot TTYs, individuals who are deaf can communicate in text over any voice communication on the PSTN. This includes the ability for call takers to receive and transfer TTY calls using their regular equipment as well as the ability to take calls from relay operators.

These capabilities, listed above, exist in the current 9-1-1 infrastructure. However, they were designed and built in an era with much different challenges than we face today. These capabilities were put in place to support fixed location landline telephones provided by a ubiquitous communications service provider. The current capabilities are insufficient to meet many of today's and tomorrow's needs. As an example, the ALI and S/Rs have inherent limitations exacerbated by number portability. Current systems have been designed based on many assumptions about area codes and exchange codes that are no longer valid, or will not be valid in the future.

Wireless networks present serious challenges to the PSAP because the location of a caller is not fixed. The solution which has evolved is to query the wireless network for the current location of the caller. In addition, the wireless network may be queried for an updated location if there is a possibility that the caller has moved. Mobile location for Phase 2 is reported in longitude and latitude rather than street address form. This has necessitated creation of Geographical Information Systems (GIS) that can display the location on a map, and in some circumstances, translate from geodetic to civic form for dispatch.

4.1.4 Challenges

The public safety community is faced with a number of challenges that cannot easily be overcome with the current system design. They include:

- While voice+ real-time text is essential, and will remain essential for emergency communications, there are a myriad of other information sources and media streams that are useful to the PSAPs and the responders. These sources cannot traverse the Public Switched Telephone Network (PSTN), and particularly cannot be accommodated by the selective routers, PBXs and other voice-centric equipment in the current network.

- Present routing mechanisms are very limiting. Current systems have very limited ability to route calls to alternate locations, and they assume that alternate routes will be relatively local to the original destination. The characteristics of richer communications networks such as Voice over IP, relay services over IP, and telematics call centers require that routing of calls be made by many more entities and be more flexible and interoperable across geography. These entities need access to the routing databases. An increasing number and variety of communication devices need the ability to deliver calls to the emergency services network, have the call directed to an appropriate PSAP, and provide corresponding location and caller information to the PSAP.

- Caller location determination and verification of the location information are not uniform between existing and emerging communication technologies. Past methods of determining location do not extend to current and future situations such as nomadic and mobile VoIP, intermediate call centers (including relay services) and satellite. In many situations, a new method is required for determining a caller's location and validating the location information such that it can be trusted for emergency service dispatch.

- Existing call congestion and call distribution methods across PSAPs are limited in geography and existing TDM interoffice trunks. While future technologies could deliver an almost unlimited number of calls toward a PSAP or the emergency services network in general, this creates a significant challenge for the design and coordination of call centers with limited resources.[5] This leads to many aspects of change, in both technology and procedural arenas, which warrant further investigation in the areas of geographic remote communication between PSAPs, dispatch centers, and emergency service providers.

- Callers can move before they initiate an emergency request and they can move during the call. Previous techniques and approaches that assumed fixed location devices do not readily extend to a mobile world. In addition to determining the initial location at the time of an emergency request, technology should be able to determine the location of the caller as needed to support emergency service response. The appropriate emergency services need to be determined based on the location of the caller when services are dispatched and not necessarily the location of the caller when the emergency call was initiated.

- Conversion techniques between civic location and geographic coordinate location information are not consistent between processing elements. Base maps or land maps should provide accurate representation of location characteristics, emergency service capabilities, and mapping of geographic coordinates. A PSAP may get more than one representation of location and could receive multiple, possibly conflicting, addresses for a given emergency call. To resolve the potential conflicts PSAPs will need sophisticated tools to determine appropriate responses.

- Accepting calls from networks other than the PSTN, as well as the interconnection of the PSTN to computers on the Internet opens the emergency call system to more “hacker” attacks as well as more routes for more organized attacks to infiltrate the system. Yet, the public is increasingly deploying devices that are more vulnerable. These devices should have access to full 9-1-1 services while protecting the emergency networks through appropriate firewalls and other active defenses.

- With older text conversation technologies (i.e., TTY) PSAP operators cannot interrupt someone typing on at TTY to calm the person, or to ask a question if they don't understand or they aren’t getting needed information. TTY also doesn’t always fare well if part of journey is over IP Network. A standard for IP text that is supported natively from end to end in the network will be needed to support reliable real-time text conversation Text conversation was overlooked in the initial voice channel design for digital wireless resulting in costly and awkward

[5] The ultimate goal is to provide the caller with meaningful assistance and local coordination of the congestion control process is critical to this goal.

retrofitting. In setting up future E9-1-1 systems it will be important to incorporate modern text conversation support from the start, so that it is a natural and integral part of both the infrastructures and technologies rather than requiring a costly and difficult to maintain retrofit at a later time.

- The pace of change of the emergency calling network is very slow relative to the rest of the communications networks today and the implementations are non-uniform. It is not uncommon to wait 10 plus years from first deployments to having most systems upgraded for new capabilities. Indeed there are some areas of the country that do not yet have 9-1-1 systems at all.

4.1.5 Efforts to Address Shortcomings

There are a number of groups with efforts underway to address some of the shortcomings noted above.

NENA has an active effort underway to define new architectures for the emergency calling network. Starting from their "Future Path Plan" for generic improvements to E9-1-1, through current work on Migratory interface to current E9-1-1 and then evolution to Long Term IP-based E9-1-1. Documentation and position papers are available on their web site, www.nena.org.

Additionally, NENA has put out a position paper on how VoIP calls should interact with the PSAP.

The Internet Engineering Task Force (IETF) defines most IP standards. IETF has active efforts on multimedia sessions, and has a small group working on emergency call requirements and solutions.

The ComCare Alliance's Emergency Provider Access Directory (EPAD) effort is a directory service to provide notification of emergency events to affected agencies.

The Alliance for Telecommunications Industry Solutions (ATIS) has created working groups to define next generation telecommunications networks that include capabilities of and interconnection with emergency services networks [Reference 15].

The US Department of Transportation (USDOT) has announced a major new initiative designed to support the development of and migration to next generation 9-1-1 infrastructure. Building upon an historical interest in public safety, the National Highway and Traffic Safety Administration (NHTSA) within USDOT is spearheading the effort.[6]

Within the broader world of emergency communications and response a variety of initiatives are currently underway dealing with data and information sharing, and communications interoperability—all of which may be synergistic with the substance of this Report's discussion.[7]

4.1.6 Background on Standards as they Impact E9-1-1

This section of the report will be completed in the final issue of the report in December.

4.2 PSAP Characteristics

In the United States today there are currently in excess of 6100 primary and secondary PSAPs.[8] Whether that is too many or too few, the number does reflect the historical State and local nature of 9-1-1 and emergency response.

The current PSAP structure revolves around the layout of local governmental jurisdictions and the geographic areas they serve. In general these reflect the concept of an Emergency Services Zone (ESZ) which is based upon the dispatch of common first responder services, including police, fire and EMS. In some instances consolidated PSAPs may serve multiple ESZs, municipalities or jurisdictions based upon political decisions or funding sources. Cooperation among PSAPs, e.g. across jurisdictions, occurs based upon exceptional circumstances or the need for resource not available at the requesting PSAP (e.g. multiple alarm fire, specialized equipment, etc.). Changes in the organization structure of PSAPs would require a realignment of political policies, funding allocations, etc.

4.2.1 Overflow Considerations

There are three primary reasons that calls may be "overflowed" from one PSAP to another. First the primary PSAP may receive more calls than it can handle (i.e. all trunks are busy or all call takers engaged in an active 9-1-1 call). The second is where the primary PSAP is not staffed 24 hours a day and when the PSAP is out of service (e.g. night closure) an alternate PSAP handles the calls. The third is

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[6] Along with National Telecommunications and Information Administration (NTIA), NHTSA is also responsible for supporting the National Implementation Coordination Office (ICO), pursuant to the Enhance 9-1-1 Act of 2004. At the time of this report, pending legislation in Congress would also assign NG9-1-1 coordination responsibility to the ICO.

[7] Including, for example, the Global Justice Information Sharing Initiative (US Department of Justice, through the Institute for Intergovernmental Research), and SAFECOM, the Department of Homeland Security's initiative to insure effective and efficient interoperable wireless communications.

[8] Based on the most current figures maintained by the National Emergency Number Association, 5413 of the 6176 PSAPs are primary in nature.

where the primary PSAP has technical difficulties and is not capable of receiving calls. Calls will be overflowed to the alternate PSAP.

Relationships among PSAPs have evolved over time based upon cooperative agreements and the need of one PSAP to support another PSAP under certain circumstances. These cooperative agreements are pre arranged to allow one PSAP to accept calls for another. There are procedures in place at the transferred to PSAP to handle the overflow or rerouting of calls. For example the PSAP must be connected to the same ALI database and have direct access to the first responders. In some cases the cooperating PSAPs might also need to be on the same Selective Router.

4.2.2 Technical Infrastructure

Evolution of existing PSAP equipment is limited by the restrictive voice and data network in place. Some PSAPs incorporate sophisticated PBX functionality that take advantage of advanced ACD capabilities but must still use CAMA signaling to receive calls and a limited ASCII text ALI protocol to retrieve location information. The structural evolution of the PSAP is made difficult by these inhibiting limitations. For example, the ability to distribute PSAP call takers geographically or take advantage of a remote worker that could take calls is prohibited by the limitations of the network, including the limitations of the network used to communicate with the first responders (usually radio). The data aspects within the PSAP are becoming more sophisticated by incorporating LANs, integrated workstations that manage both call handling and CAD, and take advantage of advances state-of-the-art data management. However, these are the exception rather than the rule for how the PSAP is evolving.

4.2.3 National PSAP

This section of the report will be completed in the final issue of the report in December.

4.2.4 Characteristics of IP Based Systems

Focus Group 1B foresees numerous advantages associated with transitioning to an IP based E9-1-1 system. First, PSAPs would have the opportunity to add new functionalities in a number of areas. For example, an end-to-end IP E9-1-1 network could allow calls from IP handsets which have been set up to recognize the caller’s preference for Spanish as their primary language to be automatically routed to call takers who speak Spanish, or automatically arrange to include a Language Line agent to translate if the PSAP couldn’t otherwise support Spanish. It would also allow the incorporation of data (text, video, etc.) that originates external to the 9-1-1 network to be associated with the call and response (e.g. traffic cameras).

Second, it would allow a much richer set of conversation modes to be used (voice, captioned voice, text, sign) to allow effective (reliable) and efficient (faster) communication with people who have disabilities and with an increasing number of older persons who do not hear well and cannot effectively use today's text technologies.

Third, an IP E9-1-1 network would create opportunities to automatically share information between PSAPs and other regional or national emergency response facilitating entities (e.g., local and state transportation agencies). By programming the system with certain thresholds or triggers, emergency call information could automatically be sent to state Emergency Management agencies or, if the incident met certain criteria, it could simultaneously be routed to national emergency response functions, such as FEMA or similar agencies. These notifications would save the call taker time through automation while providing agencies outside the PSAP with the earliest possible warning that their assistance or action might be needed. These new capabilities would enhance the effectiveness of existing regional cooperation agreements. They would also enable a closer tie between national entities (FEMA, DHS, DoD, etc.) and local responders. Although these external agencies could be "added in" to the information flow in this manner it would be impractical for them to assume any of the traditional PSAP functions, which are largely based upon local knowledge of the geography and immediately available resources.

Finally, by moving to an IP-based E9-1-1 network, PSAPs will be able to more readily upgrade their systems as new capabilities and functionalities are deployed. Further, PSAPs could choose to share centralized IP servers rather than paying for locally maintained equipment. Thus, when upgrades are necessary the cost would be shared by all of the users of the central server, leaving the PSAP with only the cost of upgrading their local workstations as they see the need to do so.

These are but a few of the potential advantages Focus Group 1B sees for moving to an IP-based E9-1-1 network. We absolutely expect that innovation will continue in the public safety IP space, generating countless opportunities for improved efficiency and effectiveness while improving the service provided to the public.[9]

[9] The "NENA IP Capable PSAP Features and Capabilities Standard" (NENA Document 58-001, February 1, 2005) notes that "IP based 9-1-1 systems that maintain an open architecture offer more opportunities to share infrastructure, work load, and call-related data throughout the 9-1-1 and other public safety networks. This will allow PSAPs to work together cooperatively in ways that the current systems do not allow. The open architecture will also allow PSAPs to receive call-related data directly from multiple data sources such as telematics service providers or Internet based telephone service providers, rather than being restricted to access to a single database (ALI) as in the current 9-1-1 system. This should reduce overall costs and increase efficiency."

4.2.5 Background considerations in Disability Access

Currently people with disabilities contact 9-1-1 in one of two ways: PSTN direct communication or through a PSTN telecommunications relay service.

Direct text communication with disabled callers is required of PSAPs under Title II of the Americans with Disabilities Act. The only standard form of text communication on the PSTN is the TTY, or text telephone, and TTY is currently the primary method of communicating with 9-1-1. TTYs send and receive text characters encoded as audio tones. The voice channel is used for both voice and text. Voice can be alternated with text so that the disabled caller can either speak and read text typed from the PSAP (in the case of a person who cannot hear well but can speak), or type and listen to the speech of the PSAP call-taker (in the case of someone who can hear and type but not speak well). It is important to note that the voice channel is used and that TTY characters can be intermixed with voice.

Telecommunications relay services that are based in the PSTN are required to place calls to 9-1-1 at the request of disabled callers. This is a two step process in which the caller contacts the relay service and requests that a call to 9-1-1 be placed and relayed. TRS centers are regional, and must look up a ten-digit number for the most appropriate PSAP based on the caller's ANI. The ANI is passed verbally to the PSAP, which looks up the location of the caller.

There are now several varieties of relay services, including "traditional" TTY relay services, Internet text relay services, video relay services, CapTel™ relay services and speech-to-speech[10] relay services. Internet text relay services provide a web interface for text and sometimes Voice Carry Over (VCO)[11] calls. Video relay services provide a video connection and sign language interpretation of phone calls. CapTel provides simultaneous speech and transcription ("captioned telephone"). Speech-to-speech relay services assist people who can hear but not speak well to be understood by the other voice party on the call.

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[10] Speech to speech is a form of relay service for people who can hear and speak but not speak clearly. They can call a speech-to-speech relay operator and the operator, who is trained to understand impaired speech, listens and repeats whatever the person says to the person at the other end.

[11] Voice carry over refers to a technique where one person is talking in one direction but receiving text in the other direction. People who are deaf (or severely hard of hearing) but can speak are primary users. They can talk to the person and have the person type back to them. VCO is much faster and easier (particularly for older people.) than using text in both directions. VCO can be used in via Relay Service or person to person (e.g., a direct call to 9-1-1). Hearing Carry Over (HCO) is the complement of VCO and is what occurs at the other end of a VCO call. A person with a speech disability can also use HCO (with VCO on the other end).

Access to 9-1-1 currently varies by the type of relay service. Internet text relay services are waived[12] from handling calls to 9-1-1 until January 1, 2008. Video relay services are waived until January 1, 2006. CapTel[13], a PSTN service, can call 9-1-1 directly (on one line) or the user can call 9-1-1 and then conference in the CapTel™ relay service on a second line, if the consumer has one. Thus the only relay services that can reach 9-1-1 are those that require the use of TTY or a CapTel phone.

Over the past ten years, many traditional users of TTY have increasingly begun using broadband IP services and wireless data services (e.g., e-mail, IM, and some wireless relay services) and are now beginning to abandon analog landline services and TTY. The IP-based relay services are increasing while the PSTN TTY relay services are flat or declining. Still, some people with disabilities still do rely solely on TTY, especially where broadband is not available or where the cost of broadband is prohibitive compared to landline service.

In wireless telecommunications, the decline in TTY use has been pronounced, except in rural areas where people do not have access to wireless data services. Wireless phones can be used with TTYs, but the size and expense of the separate TTY discouraged use. Many people who use text for communication have come to relay on a variety of wireless IP text media (e-mail, IM, IP relay services). Unfortunately these media cannot be used to call into a 9-1-1 system because PSAPs do not receive any form of IP text and location information is not passed through to PSAPs from devices using wireless data channels. Coverage for data services is also not as comprehensive as coverage for voice.

For people with disabilities who rely on text and video for communication, 9-1-1 access has therefore been eroding quickly over the past five years and will continue to do so. There is therefore an urgent need to take steps to rectify this problem.

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[12] PSTN relay services are required to relay calls to 9-1-1 and pass through the phone number of the caller. Newer relay services operating on the Internet are waived from this requirement for a period of time due to problems with location identification on Internet-based devices. The waivers are in effect until January 1, 2006 for VRS and January 1, 2008 for Internet text relay services.

[13] CapTel is a proprietary form of Telephone Call Captioning which is a new from of relay service. With Telephone captioning, both users could speak and hear but one use also gets captions for all of the other person's speech. The captions appear on their phone so that they can listen and see what the person on the other end is saying throughout the call. With CapTel the captioning is accomplished by having the CapTel Relay Operator repeat everything that is said by one party carefully into a speech recognizer that produces the captions that are then sent on to the user with a hearing disability.

4.3 Current Satellite Architecture

4.3.1 Mobile Satellite Services (MSS) Architecture

Even without 9-1-1 service enhancements, satellite phones can be an indispensable and invaluable tool in an emergency because they are most often used where no other telecommunications option is available. The FCC acknowledged how this service differs from terrestrial wireless systems and considered its unique technological and economic factors when it exempted satellite services from the current E9-1-1 rules for terrestrial wireless. Any new rules or regulations should balance the economic viability of the industry with the needs of subscribers to obtain enhanced emergency services.

Based on current spectrum allocations, MSS systems cannot provide high speed data services due to their lower bandwidths and (resulting) system designs. They now provide only very limited if any SMS and no other multimedia services.

Additionally, LEO, GEO and MEO systems have significantly different architectures, technologies, and life expectancies for the current and future satellite networks. Thus, one unified satellite 9-1-1 recommendation cannot be made in this report.

Because major changes to the orbiting elements of satellite systems are not easily or frequently made, grandfathering the existing systems for varying periods of time may be necessary. It should be noted that the estimates for implementation of second generation satellite systems are based primarily on the life expectancy of existing satellites and may not necessarily coincide with the year 2010, which is the scope of this report. Grandfathering may continue to be required beyond 2010, dependent upon the actual useful life of current systems. Next generation systems may include new satellite phone designs as well, which might facilitate E9-1-1 capabilities; however, compared to terrestrial wireless handsets, satellite phones are much more expensive and their turnover is historically much lower.

4.3.2 Fixed Satellite Services (FSS) Architecture

Fixed Satellite Services spacecraft owner/operators typically lease or sell their satellite capacity to third party entities that configure the capacity for onward sale to end-users, or that use the capacity for their own corporate needs. These services simply lease transponder capacity, rather than provide a complete access network.

Most FSS network services providers employ Very Small Aperture Terminals (“VSATs”) which are the user antennas (remotes) that range in size from 0.74 to

1.8 meters in diameter and are generally mounted at fixed locations on the end-user premises. VSATs communicate through an FSS satellite and large hubs (which often measure 4 to 30 meters in diameter) that in turn “switch” communications to other VSATs within a corporate network, into the Internet, or to other service providers.

VSATs allow for one- or two-way data or video transmissions between geographically disparate VSAT locations, usually within a defined VSAT network. Today, VSATs are heavily used by retailers, restaurants, gas stations, automotive manufacturers, financial institutions and other closed-user groups such as large and multinational corporations. Services provided via FSS include heavy trunking applications, credit and debit card approval, inventory control, electronic funds transfer, and other enterprise support services. In addition, video distribution companies (e.g., ABC, CNN) acquire capacity to distribute video programming to cable head-ends and broadcasting centers. In recent years, residential Internet services via FSS have also begun development in the United States.

FSS systems are also exemplified by a diversity of business relationships which complicate assigning responsibility to support emergency calling and location determination for emergency calls that operate over an FSS link.

4.3.3 Current Support of E9-1-1 by Satellite Systems

In October, 1994, the FCC issued its *Big LEO Report and Order* promulgating technical, licensing, and operational rules for the Big LEO Mobile Satellite Service (MSS).[14] At that time, these systems had already progressed in design and the first MSS satellites were launched in 1995. Up to that point, there had been no major consideration by the FCC of E9-1-1 service for MSS, because the agency was still working on establishing the service for terrestrial wireless systems. The current, operational Mobile Satellite Services required billions of dollars to implement. Much of the infrastructure of the MSS systems is in orbit, was placed in operation before the FCC issued E9-1-1 rules, and is largely inaccessible for technical modification. MSS operators have already deployed PSAP database call centers for routing 9-1-1 traffic.

FSS systems do not currently have any requirements to support E9-1-1.

[14] Amendment of Section 2.106 of the Commission’s Rules to Allocate the 1610-1626.5 MHz and the 2583.5-2500 MHz Bands for Use by the Mobile-Satellite Service, Including Non-geostationary Satellites, *Report and Order*, 9 FCC Rcd 536 (1994), *modified by* 10 FCC Rcd 3196 (1995).

4.4 Background Considerations for Multi-Line Telephone Systems (MLTS)

This section of the report will be completed in the final issue of the report in December.

4.5 Background on Evolution and Transition Topics

4.5.1 Data Evolution

As with other aspects of emerging communications technology, the handling of data critical to emergency services will evolve. Data critical to emergency services includes, but is not limited to, location information, telematics information, hazmat, etc.

4.5.1.1 Data and Data Element Classification

NENA's Future Path Plan (FPP) provides a useful classification of data that may be used for call handling and dispatch. It proposes three categories:

- Tier 1 (Essential)
- Tier 2 (Supportive)
- Tier 3 (Supplemental)

Tier 1 information is defined as "data that supports call delivery and adequate response capability." Examples include callback number and caller location ID. Tier 2 information is defined as information beyond essential data that may support call handling and the dispatch of a call. An example of this type of data may be vehicle information such as "vehicle rolled." Tier 3 information may supplement the call handling and dispatch, but is not necessary to complete the handling of the situation. An example may be personal medical information.

In addition, the report from Focus Group 1D discusses categories of data.[15] They define (a) Call data – data relative to a specific 9-1-1 call; (b) Location data – data related to a location that does not change from call to call, or incident to incident (e.g. HAZMAT, surveillance camera, etc); (c) People data – data related to the person calling; (d) Incident data – data created during an incident that is shared among entities responding to the incident; (e) Service data – data related to entities responding to the incident; (f) Response education data – data which assists agencies in responding properly, such as procedures, protocols or training; and (g) data from decision support tools.

[15] Reference 13, pg. 25.

The specific purpose of classifying data is to determine what type of data should be available at each point during the handling of an emergency. Both NENA and Focus Group 1D recommend that Tier 1 Essential data (NENA) and Call data (Focus Group 1D) be delivered with the call where technically feasible. The other data should be available to the PSAP on an as needed basis.

Call origination will be provided by new sources, such as VoIP and telematics call centers, and utilize an IP network providing unprecedented data to the PSAP. In addition to voice, the PSAP will be able to receive video, interactive text, instant messaging, images and other media types that currently exist or are evolving.

The data should be delivered in accordance with standards developed jointly by appropriate standards bodies and industry organizations. This data should be delivered in such a way as to allow for receipt by the call takers, dispatchers and responders and should allow for updates as the incident progresses or as the PSAP requests supplemental information.

4.5.2 Governance and Policy

This section of the report will be completed in the December report.

5 Conclusions

5.1 Network Architecture and Enhancements by 2010

5.1.1 Discussion of Network Architecture by 2010

As with many other networks, Focus Group 1B foresees convergence of data, voice, text, and video networks, based on ubiquitous packet transports and using standard Internet Protocols. As 2010 will not see the end of the older TDM based equipment, Focus Group 1B advocates that the country should have IP-based E9-1-1 capability established nationwide, have IP-based services fully integrated with E9-1-1, and be well along the path of transition from the older TDM based services wherever technically feasible and commercially reasonable. Indeed, it is logical that the network architecture discussed and recommended in this report will ultimately provide an efficient and cost effective IP-based solution for Phase II wireless 9-1-1 services. While IP capable PSAP specifications are still in development and equipment and service is not yet available from vendors, it is clear that a significant part of the country's PSAP community will still be engaged in Phase II deployment in 2010.[16] Immediate action will be required on the policy, funding and operational issues identified in this document, including but not limited to, fostering a rapid completion of the specifications and development of PSAP systems and services involved.

Focus Group 1B believes that PSAPs should and will deploy IP networks within the PSAP, between the PSAP and the sources of calls coming into the system and between the PSAP and other responders and emergency service agencies. This communication infrastructure serving the PSAPs will comprise an Internetwork (federation) of managed and secured Emergency Service IP Networks. It is anticipated that such networks will mirror the 9-1-1 system authority level. In most areas, that would equate to a county or large city, but in some cases it would be an entire State, and in other cases a single large PSAP. The Emergency Services Network should in turn be interconnected to neighboring jurisdictions for mutual aid assistance, and the Internetwork formed by such connections would be aggregated at State or groups of States and further interconnected such that information can be sent reliably between any entities within this Internetwork across the country. National agencies, such as DHS, would connect

[16] The recent NENA SWAT Initiative and associated analysis noted that at the current pace of implementation, ". . .less than 50% and less than 70% [of PSAPs] will be Phase II capable by 2005 and 2007 respectively" (NENA SWAT, Monitor Group analysis, "Analysis of the E9-1-1 Challenge", December 2003). The 2007 figure represents less than 80% of the nation's population, and only reflects national progress associated with enhanced wireless 9-1-1 service, let alone the many other needs described in this report. Much of what complicates this process and the broader challenges ahead relate to policy, funding and operational issues that have to be addressed expeditiously.

to this Internetwork and thus would be able to both provide and access information on it. Many of those agencies do not have ready access to the emergency communications systems (E9-1-1 PSAPs) today. Allowing them to join this wider network will bring added value to the common cause of providing the best assistance possible in times of emergencies.

There must be a system of assigning multiple levels of priority to IP communications on the emergency services network both based on content and the identity of the sender. All elements of the Internetwork will have to honor the priority of the data. Existing IP standards such as DiffServ[17] can be used to implement this priority mechanism, but standards will need to be created to specify how to classify the data, precisely how to mark it, and precisely how the network should treat the different levels. “Barge-In”[18] facilities for all real-time media streams should also be uniformly implemented.

The networks will need to interoperate with legacy technologies to achieve specific functional behavior (e.g., selective transfer). Forward looking interfaces and capabilities will be defined, but many legacy systems will need protocol converters and gateways to operate with the newer protocols (i.e., MPC / GMLC E2 to PSAP location information delivery, and TTY conversion to interactive text over IP). Interactions between emergency services networks will be governed by local policy, and should consider security vulnerabilities in the connections between networks. Locally managed firewalls may help implement these policies. Since some calls will originate on the Internet, the access networks bringing calls into the PSAP should deploy firewalls capable of withstanding sustained, deliberate attacks on the infrastructure between the PSAP and other networks.

By 2010, those PSAPs that have upgraded to IP should deploy equipment with SIP as a call setup protocol. Calls using other call setup protocols may employ gateways or protocol converters. For calls originating on the PSTN, gateways between the originating central office and the PSAP access network should route calls much as they do now, but with improved routing and congestion control mechanisms. Additional protocols and conventions will emerge to facilitate advanced inter-PSAP communication and services, as well as allowing PSAPs to connect to other entities including intermediate call centers and to other information services.

The emergency services networks will evolve beyond simply providing interfaces to PSAPs. These networks will bridge together PSAPs, emergency

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[17] Differentiated Services is a mechanism in IP networks to provide different levels of Quality of Service treatment to different packets.

[18] The ability of management to break into a call.

service providers, jurisdictional oversight, management functions and others. Controlled access points or gateways should be deployed where entities do not reside on the Emergency Services Network itself but still need to collaborate, observe, and influence events within the network. Mechanisms should be defined and implemented to associate a given emergency service event across multiple service providers and across processing functions. Information should be provided to aggregating and analytical processing engines that implement broader and higher level functions.

The Emergency Services Network should accommodate a flexible services infrastructure where applications can be defined and introduced without requiring major overhauls to existing network service providing elements. Capabilities should include the ability for regional and national interests to monitor, impact, and participate in emergency events or emergency preparedness.

5.1.1.1 Location and its central role in Emergency Calls

Location information is the key data element of the emergency call. The location of the incident, the location of nearby resources or hazards, and the location of responders all affect how public safety responds. The first major upgrade of the existing E9-1-1 system delivered the location of the caller to the call taker automatically, rather than relying on the ability of the call taker to verbally elicit the caller's location. Countless lives have been saved because the location of the caller is delivered to the PSAP automatically. Location also determines which PSAP gets the call and which responders are dispatched.

Determining the location of the caller is not a simple matter. In general, location is either measured (such as by a GPS receiver) or manually entered into some system by a human. Location for today's system is derived from a manual entry database kept by a local carrier who owns the wire plant, or, in the case of wireless, by a measuring system (GPS, or triangulation on the radio channel). In the PSTN, the carrier that owns the wire plant supplies the voice+text service, and thus can also supply the 9-1-1 system with the caller location information associated with the phone number.

With newer systems such as VoIP, the association of a telephone number to a specific location breaks down. The Access Infrastructure Provider (AIP[19]) is not necessarily the communications service provider (CSP). Indeed, there need not even be a CSP, and even if there is one, it may not be local, and thus not subject to local regulation. CSPs located in foreign countries can supply

[19] An Access Infrastructure Provider is the wire plant owner or the wireless radio access network provider, including enterprises.

communications service identical to that of a domestic service provider, and are not subject to FCC, State or local regulations.

Focus Group 1B observes that the AIP can almost always determine where an endpoint is; either by tracing the wire, or by deploying a measurement technique. While the AIP may not be providing voice services (it may not even be supplying data services; the wire may be leased to another provider who does), its infrastructure is being used to deliver emergency calls. The AIP is the only one who can determine location of the caller.

Focus Group 1B advocates that every[20] Access Infrastructure Provider, wireline or wireless, supply location information. Where the AIP is the voice service provider, the information can be supplied directly. Where the AIP is not the voice service provider, but is the data provider (the "Internet Service Provider" or equivalent), it can supply endpoints with location, and the endpoints can provide this location on the call signaling when placing an emergency call. Where the AIP is neither the voice nor data provider, it would need to have a relationship with the party that is, so they can supply location data to that provider. Note that PSTN and wireless telephony providers would meet this requirement already.

In every case, the FCC should consider the technical feasibility and commercial reasonableness of retrofitting existing deployed systems to meet new requirements. In many cases, such upgrades can reasonably be made in a relatively short time. In others, they may have to wait for significant system upgrades. Focus Group 1B wishes to emphasize that no AIP should be exempt[20]; although the timeline for compliance may vary widely.

Focus Group 1B recommends that an accuracy goal be established by the emergency service community, working together with industry technical experts, that reflects the actual need, balanced by technical realities. This goal should reflect the nature of the structure where the emergency exists. For example, it may be sufficient to resolve to a single-family house in a neighborhood of such houses, but it might be required to resolve to an apartment within a multistory residence. Altitude accuracy (i.e., which floor) may be more important than longitude and latitude accuracy. All systems should be required to meet this accuracy within the limits of available technology and without arbitrary regulatory deadlines.[21] This Focus Group recognizes the difficulty in reconciling

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[20] State and Federal regulations may exempt enterprises below some size from the requirement of deploying a location determination method (i.e., an IP-based MLTS covering less than 7,000 square feet.)

[21] Accuracy goals should be set with industry input and should be reasonably achievable based on available technology at the time when such goals are established.

goals, technical feasibility and financial impact, and Focus Group 1B recommends the establishment of a process to resolve such issues reasonably and in a timely manner. NENA has considered this issue and made some recommendations.

The original source of location determines the form in which it is supplied (geo or civic). The network needs to convert the information in some cases. For example, dispatch is always in civic, so if a geo is supplied, it must be converted to civic. Data is often best displayed on a map, and if civic is supplied, it must be converted to a geo for display on a map. Conversion requires a database, a Geographical Information System (GIS), and the advent of wireless has led many PSAPs to deploy GIS systems. Further, there are often several GIS systems deployed by various municipal entities, which are incompatible with each other. The GIS systems deployed by the emergency calling networks need to be especially accurate to dispatch reliably.

If upstream entities (such as the access network) that supply location (either a caller's location or location associated with other resources of interest to an emergency call) convert the data before transmitting the location, there is concern about the accuracy of the conversion database needs to be very accurate. Therefore, it is recommended that all location data be sent in its original format. Of course, it would be preferable for any governmental agency or group of agencies to have or contract for a common GIS base map, shared by all users, with accuracy sufficient for the emergency services network.

The initial location should be delivered in the signaling with the call. If a call is transferred to another PSAP or a responder, location should always be sent with the call. As some devices are completely mobile, location might have to be updated, sometimes frequently. Location reporting mechanisms should support tracking of moving callers if needed. Some measurement mechanisms do not create a "first fix" location in a timely manner. Often coarse-grained information (serving tower location for example) is the only information available with the call, with more accurate location information arriving later. PSAP systems should accommodate such situations with more flexibility than they can now; for example, they should be able to bridge a call from the original PSAP to the PSAP actually serving the current location of the caller, and then to the responder without disruption. Moving the call to the responders is addressed more fully by Focus Group 1D.

As with the current system, when location is provided in civic form, it must be validated prior to use for emergency calls. The validation data should be widely accessible, and the architecture should be deployed in a geographically diverse, fault tolerant manner. Some restructuring of the current verification databases

(MSAG) will be required in order to achieve uniform national coverage, accessible by all of the numerous entities that have a need to verify location.

Location data should be secure, managed and trusted such that data integrity is maintained. This is challenging in an environment such as VoIP where the location data must pass between multiple entities, some of which are not trusted and thus could modify the data in transit. Techniques such as digital signatures and other cryptographic techniques should be deployed. Nevertheless, it is unlikely that such techniques will be foolproof against a determined attacker.

The level of service achieved by the US 9-1-1 infrastructure is highly dependent on the quality of the information upon which the foundation is built. Mechanisms need to exist to support continuous improvement processes, including the identification, tracking, and resolution of data quality issues. In order to support such a continuous improvement process, the address information provided to a PSAP should identify the source provider of the information and the authority and mechanism used to validate address information. Location information sources should provide a means by which they can be contacted to be informed of inaccurate or otherwise insufficient location information. Quality metrics and change control tracking mechanisms should be in place to determine performance of a location information provider and these metrics should be available to PSAPs. During an emergency situation, location information providers may need to be contacted immediately to clarify location information that was provided to a PSAP.

5.1.1.2 Mobility Management and Emergency Service

Mobile communications are now an integral part of the American way of life.

- It is reasonable for the public to expect emergency services to be managed for mobile communications in the same manner as it is managed for any other communications service.

- It is also important for the PSAP to expect the public will have access to the equivalent emergency services and calling capabilities independent of access method - mobile or fixed.

These goals can be accomplished if E9-1-1 caller mobility is managed in a way that is equivalent to commercial mobile communications services. Caller mobility should be transparent to the caller and the PSAP call taker.

Commercial mobility service may be managed by some entity other than the provider of physical access to the network. For E9-1-1 service, the local access provider is responsible for originating the call to the appropriate PSAP and for providing location and callback information through a mobility application protocol without the involvement of a mobile subscriber's home service provider. It is appropriate, therefore, that access providers support all mobility management functions for emergency services that are technically feasible and commercially reasonable.

5.1.1.3 Real-Time Speech to Text, Text to Speech

In emergency situations (and especially for people with speech or hearing impairment), the ability to accurately convert, in real-time, speech from the originator to text for the recipient or text from the originator to speech for the recipient is invaluable. (In fact relay services perform this function manually.)While this capability is especially helpful to people with disabilities, it is also helpful to anyone communicating in an emergency situations where seeing or hearing may be generally impaired. This could be due to the nature of the incident (e.g., fire or explosion, sirens or screaming) or as a consequence of the incident (e.g., an injury affecting speech or hearing of a 911 caller).

To be economically viable, this capability needs to be generally available for ordinary calls. The public would then be familiar with the capability and would naturally use it for emergency calls as well, when needed. The capability would apply to mobile as well as fixed line communicators with phone displays. It would be useful in quiet areas where voice is not appropriate or dark areas where messaging is difficult. This includes libraries, trains, planes, school, theater, church, hunting or fishing in the wild, in the midst of noisy crowds or any location where seeing or hearing is difficult or inappropriate. This real-time capability would facilitate much clearer and timelier emergency communications.

5.1.1.4 Congestion Control

There are several circumstances when PSAPs will have more calls placed towards them than they have call takers to answer them. Disasters and deliberate attacks are two examples. When a PSAP is presented with more calls that it has call takers, the network should have a variety of responses it can provide, which must always be determined by local policy. Choices for handling these calls should include combinations of:

- Queuing calls for call takers
- Rerouting calls to pre-arranged alternate call centers that are able to effectively service the calls

- Connecting callers to Interactive Voice Response systems [22]
- Returning a fast busy signal

Today, in most cases, a relatively small number of calls would reach the call centers, and most callers would get the familiar busy signal, clearly indicating that they should fend for themselves or hang up and try again. The system is designed to block a sudden influx of calls from the same immediate disaster location. This feature of the system has a positive result: calls that are not related to the localized disaster represent a cross-section of callers in the area, because calls that are *not* related to the disaster are more likely to get through. Unfortunately, when calls are blocked in the localized disaster area, getting a call through that is not related to a disaster is better than a call related to the disaster. Responders have limited resources, but they can more effectively deploy those limited resources if they have a better understanding of where help is needed.

Networks should be engineered such that policy, rather than the bandwidth or routing limitations of the network, dictates what happens to calls. It is recognized that all networks have capacity limits and effective congestion control measures must be deployed at all possible congestion points in the network.[23] Data associated with the call should be captured and forwarded[24] to the appropriate entity in the Emergency Services Network even if the calls cannot all be answered.

Using public IP networks as one of the routes into the emergency services network is of particular concern because of the threat of deliberate attacks on the 9-1-1 system. Networks should be engineered to best current practice to protect the emergency services network, including deploying firewalls between the public IP networks and the emergency services network.

5.1.1.5 Routing

The new networks should have much more flexible routing mechanisms. The basic concepts that location determines the proper PSAP to receive the call, and location is further used within the PSAP to route the call to the proper responders, should remain. However, the mechanisms must be flexible and modifiable by jurisdictional authorities based on situational need such as night shutdown, overflow conditions, congestion control, response to major incidents, and response to disasters, etc. Specifically:

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[22] Wherever automatic messaging is given to callers, which includes Interactive Voice Response as well as ACD messaging, both voice and real-time interactive text must be supplied, so that persons with disabilities who are text users can understand what is happening to their call.
[23] NENA has recommendations for current PSTN based congestion control mechanisms
[24] Some system elements may not be able to forward to such information in real time

- Routing data for calls should be widely accessible, and the architecture should be deployed in a geographically diverse, fault tolerant manner.
- Routing must be controllable by PSAP management to handle call overflow. Choices may include: route calls based on location to alternate PSAPs, supply prerecorded announcements with Interactive Voice+text Response[25] or supply busy indication. Combinations of the above should be possible, subject to local policy.
- Routing for normal events ("night mode") should be possible to any PSAP which accepts such calls.
- Routing during disasters must accommodate shifting of calls to PSAPs who, by prearrangement, are able to effectively service the calls.
- While in the future network the condition of "ANI failure" will be mitigated by the use of an end-to-end digital network, it still will be desirable to specify default routing to a designated default PSAP. This PSAP may be chosen based upon where in the network the routing failure appears. Default routing is also required because of the shift to using location based routing concepts, rather than ANI based routing. When the location isn't known, or isn't believed to be accurate enough to use for routing purposes, a default decision will be needed. Routing failures may result in the wrong PSAP getting the call. In such circumstances it should be possible to transfer the call to the correct PSAP with all relevant data.

Origination of emergency calls and routing to the appropriate PSAP is currently limited by the geography of call origination and the disconnected nature of local 9-1-1 networks. Entities (e.g., individual callers, alternate call centers, PSAPs) today cannot originate calls remotely into distant 9-1-1 networks as a third party. Enhanced capability that would permit remote 9-1-1 network access would enable use cases such as the following:

- Telematics, Hazmat or call center dials 9-1-1 and wishes to reach the appropriate PSAP located near the vehicle that originated the call, not the one located near the alternate call center.
- Individual is on the phone with a relative across the country on a non-emergency call, when an emergency occurs. The individual wishes to reach the appropriate PSAP in the vicinity of the relative, not the one near the individual caller.
- Individual uses a video, Internet text, or other IP-enabled relay service to make a voice call to 9-1-1. The network should support a one-step process for invoking both 9-1-1 and the relay center on a call, so that time is not lost. The relay service needs to be immediately connected to the

[25] NENA and ESIF have both rejected "dynamically modifiable" recorded announcements

appropriate PSAP near the location of the caller, not the one located near the relay service.

- An individual on a MLTS extension in a branch office calls the enterprise's security department to report a problem. The security staff determine that the problem is more than they can handle alone, and use the MLTS' conference capability to add 911 into the call. The security staff wishes to reach a PSAP in the vicinity of the employee experiencing the problem, not in the vicinity of the security department's office.

5.1.1.6 Connecting Calls and Data from PSAPs to Responders

Emergency service response will be determined at the time of service dispatch by predicted location versus today's static determination based on the entry in the ALI. Directory functions[26] will assist PSAPs in contacting, collaborating, and engaging others within their jurisdictional IP network boundary or across boundaries. The directory functions will evolve to allow bi-directional and asynchronous emergency event communications. Where typically only police, fire and EMS services are directly associated with a location, it is expected that PSAPs will gather and provide a great deal of location information.

Focus Group 1B envisions that integrated information on locations will be compiled by all of the emergency services entities, including PSAPs and responders. Interior building layouts, hazardous material storage information, surveillance camera locations, alarm locations, building construction details, security contact data, etc. is but a small list of possible data that is tied to location. This data may be stored in Emergency Services databases, or it may be held by property owners and tenants, with pointers to such data stored in Emergency Services databases or directories. PSAPs and responders will all have access (authentication and authorization permitting) to such data.

Similarly, in some circumstances, Focus Group 1B envisions subscriber based supplemental information about callers to be available. VoIP phones and mobile phones have a concept of registration where it is possible to determine the subscription that is “logged in” to a phone. Data may be associated with the subscription and made available to the PSAP and responders, such as medical data, family members to be notified in emergencies, etc.

As responders are expected to share the same Emergency Services networks as the PSAP, it is expected that PSAPs will be able to connect callers directly to responders when appropriate. All available media streams and data should be

[26] In this context, a directory is a managed entity that lists agencies and or resources that can be used by other agencies to discover what resources are available and how to get them.

capable of being forwarded (or directly accessed) by responders assigned to an incident.

Although the convergence of circuit switched (voice and text) and data for emergency communications is expected to be on a single network, there is sometimes a natural dichotomy of treatment of these media. By the very nature of emergency response, live person-to-person communications (whether voice and/or text based) are constrained to being sequential in nature. For example, a call taker answers calls sequentially. Also an EMS responder would answer a call if necessary only after it has been processed through conversation between a caller and a PSAP call taker. Data on the other hand, can be transferred simultaneously to all relevant entities that requested to receive data on emergency incidents in their area. This inherent distinction between person-to-person conversation and data exchange should be leveraged to maximize efficacy of response. For example, PSAPs may find it useful to view location and emergency type for emergency calls currently in queue, as they make decisions to answer calls. For example, a Hazmat call would best be answered by an agent trained in hazmat or bio-terrorism response. Entities further down the information chain, e.g. responders and hospital staff, would prefer to receive data (in advance of or in lieu of voice and/or text conversation) on emergency patients headed their way.

5.1.1.7 Security

A uniform, comprehensive, cryptographically based security system must be deployed throughout the emergency communications system. Such systems should be based on ubiquitous authentication, authorization, integrity protection and privacy controls. No network elements should be deemed "secure"; rather, all elements should uniformly employ crypto. Such security mechanisms should be designed into the system in the first place, and not added on later.

Each authorized data provider should be responsible for accurate entry and updates of its data in the system. Authorization for read or write privileges for any data element should be explicit and defined by common system-wide mechanisms. In addition, business rule logic should be developed to define synchronization and edit override priorities for disparate authorized editors.

Emergency calls that originate as IP should deploy the protections specified in the relevant standards. For example, SIP, the IETF call control protocol for voice, interactive text, video and instant messaging should deploy the Transport Layer Security suite between all elements. It is not feasible to reliably authenticate all endpoints; such a problem would require a national Public Key Infrastructure, which is still an unsolved problem. However, all other elements can reasonably deploy some level of meaningful authentication, and all elements within the emergency service network can have strong authentication. For this purpose, Focus Group 1B recommends that appropriate national public safety agencies deploy a strong PKI for their constituencies, probably using a chain of "Certificate Authorities" with strong State and county agency participation to assure only bona fide agencies receive credentials.

All communications between endpoints, routing elements and emergency service elements should employ strong integrity protections. Where private data (e.g., such as location, medical data, etc.) is transferred, encryption of the data should be deployed. In most cases, the media streams should be encrypted.

5.1.1.8 Supporting Callers with Disabilities

The evolution of the Emergency Services Network can improve the services Public Safety can offer to people with disabilities. If properly implemented, IP provides a greatly superior capability for alternate complementary media streams such as interactive text, voice, and video. Implementation and deployment of interoperable standards beyond those driven by market forces will be necessary. Without such standards access for persons with disabilities is often overlooked during the design and implementation of new communications features, which normally focus on only the voice aspects of emerging systems.

As all data initially associated with the call can eventually be transferred with the call, employing relay services without losing location or other data could be possible. Video capability should allow sign language interpreters to be bridged into a call. Relay operators or interpreters could be bridged with call takers and responders to maintain communications between a disabled caller and all participants in an incident.

For these reasons, Focus Group 1B recommends that efforts be expended to offer persons with disabilities the opportunity to use newer IP based communications technologies for both direct and relayed E9-1-1 communication, wherever broadband is available. Widespread availability of wireless networks and other broadband services will make such systems increasingly widely deployable.

Backwards compatibility with existing TTY services will continue to be required until they are no longer in service. TTYs are still the only mechanisms that work on the PSTN, upon which many people and geographic locations still rely.

5.1.1.8.1 Real-time interactive text transmission for Emergency Communications on IP

Real-time interactive text, where a character appears on the opposite screen shortly after it is typed on the keyboard, is an essential mechanism for teleconversation for a large and growing population including people who are deaf, who are hard of hearing, and who have speech disabilities. This use of text parallels the use of voice and is different from messaging, email, document transmission, and other uses of text in communications. Messaging and other similar forms of asynchronous text communication are not sufficient for 9-1-1 and emergency responder communication (although, as discussed below, Focus Group 1B advocates support for messaging when voice+ real-time-text is not available).

Some limitations of messaging for 9-1-1 use include:

- Provides no ‘real-time connection’
- Provides uncertain message delivery (delays and drops)
- Doesn’t allow interjections on a timely basis without confusion
- Can result in crossed messages and answers (especially if person doesn’t reply immediately or types slowly)

Therefore, a reliable method for real-time interactive text that does not involve perpetuating the use of analog TTY signals on IP networks, needs to be established. It needs to be as interoperable and reliable as voice under emergency/crisis load conditions, and it must be able to travel freely wherever user voice travels. A single real-time interactive IP text format needs to be identified and universally adopted (in addition to any other formats used) so that all E9-1-1 and related services do not have to deal with multiple real-time text formats to ensure receipt and avoid interoperability issues with callers.

At the current time at least some satellite systems do not have provisions for connection and transmission of TTY signals and some do not have built in text or text messaging capabilities. As a result, it might be difficult to retrofit these existing satellite technologies with text communication capability in order to allow them to be usable by individuals who are deaf. However, where the systems can be easily adapted to transport text this should be done. Whenever the systems are retrofitted or updated to provide IP transmission of information, real-time conversational text capabilities should be built in, subject to technical and commercial feasibility and taking into account spectrum constraints. Support for video conversational communication should be built in whenever the bandwidth of the phones increases to the point necessary to support it.

5.1.1.8.2 Store and Forward Messaging

Although messaging technologies have the disadvantages noted above and would not eliminate the need for real-time voice or text, messaging can serve as an important method for communication when voice and/or real-time text are not available or cannot be used. For voice callers who do not have real-time text it can allow silent communication. For text users, it can act as an important method for communication using technologies that do not yet support real-time interactive text (e.g. cell phones, PDAs etc). Currently, messaging is the only widespread method for text communication on mobile technologies for people who are deaf.

5.1.1.8.3 Video and Text Relay and E9-1-1

Video Relay Services are now available that allow people who communicate primarily or exclusively in sign language to be able to communicate with voice telephone users over the phone. Many deaf and hard of hearing persons rely on Text Relay, both current TTY Relay and real-time interactive text over IP relay services, for communications assistance in conversing with voice users. It is important for the FCC to specify that a person who uses Video or Text Relay Services should be able to make a 9-1-1 call through their Relay that will automatically go to the correct PSAP with the Relay in the loop (including video / text pass-through to the PSAP). Also important is that location information be provided both to the 9-1-1 center and the Relay Service automatically.

5.1.1.8.4 Emergency use of telephones by people who have hearing, speech, or vision disabilities

Individuals who are deaf currently have to carry around special devices (TTYs) in order to make a text phone call on the PSTN. In emergencies they often do not have such devices with them. Today most all IP phones have some type of display of 12 characters or more. Such phones could, with the addition of minimal code and no hardware, be designed to display any incoming IP text (in the standard IP text format – see below). This would allow any people who are deaf but can speak to use any phone with a display to communicate in speech (out) and text (in). In addition, any 12 key telephone keypad can be used to send text using simple and standard routines. This would allow emergency outgoing text communication for those who cannot speak (due to speech impairment or deafness). Finally, individuals who are blind can use any phones with physical keypads where they can tactilely locate and differentiate the number keys. Phones available to the public for use should contain these features to allow people with disabilities to use them for emergency communication in the standard formats described in this report.

5.1.1.9 Reliability, Maintainability, Serviceability, Traceability

The emergency calling system should be designed to minimize service interruptions by employing management and continuous monitoring that detects anomalies immediately and generates alarms to the appropriate technicians, managers and service providers. These capabilities should detect outages, inability to communicate and invoke services, and other error conditions. Maintenance personnel should have access to both automatic and manual diagnostic tools that facilitate the isolation and repair of problems within the network and the access points to the network. Components of the network should be capable of being upgraded and removed for normal maintenance without disruption of service to PSAPs or other service entities. All elements of the network should be exercised periodically to assure their readiness for service if the need arises, including nominal processing and recovery processing functions. Management workstations should be provided to oversee the operation of the PSAP. Operations management staff should be able to allow supervisors to monitor calls as well as the overall system state. Some PSAPs may choose to outsource some or all of these network management responsibilities.

The Emergency Services Network should be designed such that no single failure or interruptive incident (i.e. a cable cut) will create a system outage. Redundancy and duplication should be augmented by distributing cooperating network elements and transport facilities in a geographically dispersed manner. Management and security functions will be integrated with core operations and services functions providing robust regional infrastructures that integrate at the national level.

Unlike current systems, with the new IP-based communications it is feasible to provide complete end-to-end test capability for each endpoint. It should be possible for each endpoint to periodically determine that it can signal a call to a PSAP, transfer media in all the forms of which it is capable, and get an indication of the location reported for the device.

Every event that occurs in a PSAP relative to an incident should be recorded, with traceability to the source. This includes external events and data, responses, data changes, and all media streams in and out. All data should be time stamped, and tagged so that it cannot be repudiated.

Event/Media recording systems should be integrated so that PSAP management and subsequent legal investigations can get a complete picture of the incident and what occurred. Since there will be many new kinds of data and media, recording systems will have to evolve rapidly.

Each source of data must be traceable to its originator. The identities of the originator should be positive, and wherever possible, authenticated. Where data is handled by intermediaries, each intermediary must be traceable, with a positive identity, and in almost every case, authenticated.

5.1.2 Analysis of Related Recommendations of other NRIC Focus Groups

This section of the report will be completed in the final issue of the report in December.

5.1.3 Conclusions on Standards Supporting E9-1-1

This section of the report will be completed in the final issue of the report in December.

5.2 PSAP Operations

This section of the report will be completed in the final issue of the report in December.

5.3 Satellites

NRIC VII Focus Group 1B recommends that the next generation MSS satellite communications systems be connected to the emergency services network and support a number of the properties associated with today's cellular emergency services. Satellite systems operators should explore technologies necessary to provide capabilities similar to those of any other terrestrially transported source of 9-1-1 calls as they roll out next generation satellite systems or significantly update current systems, where technically feasible and commercially reasonable.

Focus Group 1B recognizes the widely varying technical characteristics of MSS systems, and concludes that the FCC should evaluate each system individually to determine under what circumstances E9-1-1 capabilities could be achieved per the carrier's plans for existing and next generation systems. Therefore, NRIC VII Focus Group 1B recommends that each system operator should be required to prepare a detailed E9-1-1 feasibility and implementation plan for FCC review. The criteria for review should consider both the technical feasibility and commercial reasonability of meeting the properties that are detailed in this report for other services.

Because of the inability to change the satellites in orbit, as well as the relatively small turnover of handsets and ground systems, E9-1-1 upgrades should be considered for next generation satellite upgrades and thus, may only be deployed beyond 2010. No further requirements beyond the existing Order should be placed on current systems.

Fixed systems present even more difficulties in making recommendations because of widely varying service models. The owner/operators of FSS systems generally do not provide ground station services, and therefore, to that extent, FSS spacecraft owner/operators should be exempt from providing enhanced 9-1-1 services.

Satellite service providers who provide services over fixed satellite systems where the services could reasonably be expected to supply E9-1-1 capability should be obligated to evolve their services to provide them.

As FSS ground technology evolves and is updated, FSS systems operators and network service providers should look to develop the technology necessary to provide capabilities similar to those of other terrestrially transported sources of 9-1-1 calls, where technically feasible and commercially reasonable. Again, Focus Group 1B recommends each system operator being required to develop a plan, for FCC review, that shows how they will meet the requirements outlined in this report. Plans should be required of systems operators who provide IP services and end point terminals termination (who should be required to support location determination as do all other Access Infrastructure Providers), as well as operators who provide “switched” voice/video/text services (who will be responsible for providing interconnection to the E9-1-1 system, call back provisions, etc.) Again, Focus Group 1B does not advocate fixed deployment deadlines, but encourage operators to incorporate E9-1-1 upgrades as their systems are upgraded.

At the current time at least some satellite systems do not have provisions for connection and transmission of TTY signals and some do not have built in text or text messaging capabilities. Whenever the systems are retrofitted or updated to provide VoIP services, real-time conversational text capabilities should be built in, subject to technical and commercial feasibility, and taking into account spectrum constraints. Support for video conversational communication should be built in whenever the bandwidth of the phones increases to the point necessary to support it.

5.4 Multi-Line Telephone Systems

This section of the report will be completed in the final issue of the report in December.

5.5 Governance and Policy

Emergency communications and response is ultimately a public safety service—a service that depends upon the effective, timely and coordinated interaction of a variety of public and private sector stakeholders. Features of the above not only include the technical delivery and quality of the service itself, but also the governmental and public policy structure within which the service is provided, and ultimately funded.

9-1-1 has evolved in the US through various public policy structures, which established planning bodies, funding models and technological solutions that deliver information to PSAPs from wireline and wireless communication devices. The majority of the States have some form of 9-1-1 legislation that either establishes statewide 9-1-1 deployment programs or enables local governmental agencies to establish dedicated funding mechanisms for the deployment of 9-1-1. These State statutes often contain confidentiality and limitation of liability protections applicable to the parties involved in delivering emergency services. Historically the policy models involved established government stakeholders as planners, and wireline and wireless companies as commercial stakeholders through the definition of 9-1-1 Service Provider. This definition assumes service providers are either regulated through State Public Utility Commissions (PUC) or the Federal Communications Commission (FCC). This definition, combined with PUC or FCC regulations determines a company's ability to participate in the 9-1-1 network infrastructure and it also, in many cases, regulates the 9-1-1 network, database and PSAP equipment.

The above 9-1-1 public policy does not sufficiently accommodate any new, advanced communications companies that do not meet the definition of 9-1-1 Service Provider; therefore, the new companies potentially cannot access the 9-1-1 networks, nor are they afforded any participation in formal 9-1-1 governmental programs. Further, in the current regulatory environment 9-1-1 Service Providers have insufficient incentive to fund and deploy advanced architecture.

The convergence of an aging infrastructure, new technologies, changing market dynamics, and national priorities has created a situation where telecommunications, emergency services, and regulatory oversight must change. Policy must be adapted to meet the new evolution of technology and to ensure that the high quality of 9-1-1 service that is expected by the American public is retained, as well as to allow for the creation of additional emergency services features and capabilities. Focus Group 1B advocate that the successful implementation of highly-integrated locally-controlled networks that cross political boundaries for the realization of the advantages offered, be an overriding policy objective. Ultimately, the desire for local control must be balanced against the need for some degree of national interconnection and coordination. The regulatory and legislative frameworks should be technology-neutral and should encourage companies that provide communications to become "good 9-1-1 citizens" by allowing them access to advanced 9-1-1 networks. Additionally, the policy framework should encourage infrastructure companies, through beneficial financial models, to deploy advanced architecture to enable 9-1-1 service on the new communication service devices.

5.5.1 Governing Bodies

9-1-1 in the United States has evolved through the implementation of specific governmental policies at the local, State and Federal levels. The following information provides insight into these 9-1-1 governing bodies.

5.5.1.1 Federal

Prior to 1996, the Federal Government had minimal governing regulations for 9-1-1 service delivery. With the adoption of the FCC's Order in Docket 94-102 in 1996 and the passage of Senate Bill 800 (Wireless Communications and Public Safety Act of 1999), the FCC now maintains authority for 9-1-1 oversight of wireless deployments throughout the country. More recently, the FCC adopted rules requiring providers of interconnected voice over Internet Protocol (VoIP) service to supply enhanced 911 (E911) capabilities to their customers, and published a Notice of Proposed Rule Making (NPRM) seeking comments ". . .on what additional steps the Commission should take to ensure that providers of VoIP services that interconnect with the nation's PSTN provide ubiquitous and reliable E911 service." [27]

Through this all, the Federal Government has continued to respect States' rights and local control to manage, fund and deploy 9-1-1 services. However, some consideration should be given at the Federal level to influencing the advancement of next generation architecture for 9-1-1. As such, Federal policy bodies could encourage the establishment or adoption of industry standards for minimum service levels, or service and coordination related standards that would help insure the maintenance of fundamental elements.

To that end, Congress recently passed the "ENHANCE 911 Act of 2004" which established a joint national program office between the National Telecommunications and Information Administration (NTIA) and the US Department of Transportation (DOT) to administer a related new federal 9-1-1grant program, and, perhaps most important to this discussion, to facilitate coordination of emergency communications services between all levels of

[27] FCC 05-116, in the matters of IP-Enabled Services, E911 Requirements for IP-Enabled Service Providers,
adopted May 19, 2005. The term "interconnected" refers to the ability of the user generally to receive calls from and terminate calls to the public switched telephone network (PSTN), including commercial mobile radio service (CMRS) networks.

government.[28] Currently, Congress is also considering legislation that would specifically require the Implementation Coordination Office (sometimes called the national program office) to address Next Generation 9-1-1 (NG9-1-1) issues, planning and migration—something that the USDOT has already ventured into with a recently announced major initiative in this arena.[29]

To achieve even a fraction of the goals outlined in this document, the Implementation Coordination Office will have to take responsibility for organizing stakeholders, and supplying resources and guidance to the State and local 9-1-1 authorities. Focus Group 1B sees a limited Federal management role which continues to honor States' rights; however, coordination will be vital to achieve the vision presented here. If this could be done at a National level, it would greatly improve the consistency of service across the nation. Federal involvement in setting 9-1-1 policy would ensure that emerging communications technologies are proactively reviewed, 9-1-1 issues are anticipated and the appropriate State and local governing bodies are engaged to adopt the most effective 9-1-1 policies at all levels.

Similarly, coordination is needed with the U.S. Department of Justice, which has oversight over PSAPs concerning access by people with disabilities under the Americans with Disabilities Act, Title II.

5.5.1.2 State

In 2005, thirty-eight (38) States had a statewide coordinating body that facilitated deployment of 9-1-1, reacting to the specific needs of their citizens. The concept of at least a State level administrative authority should be seen as a highly desired model for all States. In most cases this will allow for a more cost effective operational model than exists today. That type of centralized oversight will support the desired goal of ensuring that there is no degradation of fundamental elements that are essential to a highly reliable E9-1-1 system. It may also enable less populated areas to enjoy modern E9-1-1 call handling technologies that, under today's typical funding paradigms, they may otherwise not be able to afford on their own.

This State structure should still allow for local control (9-1-1 system authority) and the day-to-day operations of the PSAPs. However, Focus Group 1B

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[28] Public Law 108-494 (H.R. 5419, US Congress, passed December 9, 2004). The Act, in part, was founded on the "finding" that ". . .enhanced 911 is a high national priority and it requires Federal leadership, working in cooperation with State and local governments and with the numerous organizations dedicated to delivering emergency communications services."
[29] For example, pending S. 1063, US Senate. Regarding USDOT, see http://www2.eps.gov/spg/DOT/FHWA/OAM/Reference-Number-DTFH61-05-RFI-21705/listing.html

recognizes that funding and technology decisions work best when they are coordinated through a focal point at least at a State level.[30]

5.5.1.3 Local

Some State laws enable local jurisdictions to establish planning and deployment of 9-1-1 without the coordination of the State governing bodies. In States where this form of 9-1-1 policy exists exclusively, these jurisdictions are left without a statewide implementation, which primarily affects those citizens in the rural populated areas and potentially leaves them without either basic 9-1- 1 or E9-1-1 service.

It is very important to note that in the majority of the country, local government does retain ultimate responsibility for the management of all PSAP operations and response to 9-1-1 emergency calls for assistance. The only exception to this rule occurs in the states of Rhode Island and New Hampshire. In these areas, the State coordinating body is also the 9-1-1 answering center.

5.5.2 Policy

As 9-1-1 service has grown in its universality (capped by the 1999 Wireless Telecom Act which made its universality official), the public has come to expect that their 9-1-1 calls are not only answered by an appropriate PSAP, but that appropriate information is also automatically communicated to help facilitate emergency response. With this public expectation comes the assumption that any telecommunications device accessing the PSTN should function within a standard 9-1-1 environment.

Historically, consumers have not been afforded the opportunity to personalize or manage data or information used for these purposes. However, with the technical opportunity to functionally utilize greater and different types of data (medical data, special needs information, contacts to be called in case of emergency, etc.) to foster more positive outcomes to emergency incidents, public expectation is changing and should be recognized as a matter of public policy.

In order to satisfy the kind of public expectation described above, along with the demands of new technology, new communications and data services providers need advanced 9-1-1 architectures in order to deliver the minimum data elements required on a 9-1-1 call. Ideally, any device the public can reasonably expect to be used to summon help in an emergency situation should be capable of accessing 9-1-1 and delivering critical data. Such devices should also be usable by people with disabilities where readily achievable. Companies providing

[30] The 2004 Enhance 9-1-1 Act fosters planning and coordination, and requires, as a prerequisite to granting funds under the Act, the establishment of ". . .a plan for the coordination and implementation of E-911 services."

emergency services should be allowed interconnection to the 9-1-1 network to deliver these services independent from any other regulatory classification. The idea of being a “good 9-1-1 citizen” should be extended to all new communications technologies that provide consumers with the ability to summon help.

In order for public safety to function in a telecommunications world with no boundaries and respond to emergency calls being placed with new technologies that could be provided through national and international companies, 9-1-1 policy and regulation needs to be examined.

5.5.3 Funding

A new funding/financial model should be developed, as the existing one will not meet the needs of the future E9-1-1 environments. Indeed, in many instances the current model has difficulty supporting the current 9-1-1 system. Several new paradigms are being investigated, and all levels of government should support those activities as a means of identifying a nationally acceptable funding model that will be able to meet the needs of the E9-1-1 environment for many years into the future.

While funding is the most critical financial issue, it will likely not be the only financial issue that must be considered for the future. How publicly funded PSAPs will be charged for commercially facilitated emergency services must be considered in light of existing and future demarcation points between such providers and the PSAPs and future industry trends, regulations, and standards. For example, PSAPs and 9-1-1 system providers have historically been impacted by industry changes or practices over which the PSAP has little or no control (e.g., telephone deregulation, Local Number Portability, wireless E9-1-1, VoIP, agreements between providers, and industry practices). Changes to 9-1-1 funding mechanisms have typically lagged behind these industry changes.

Furthermore, how providers handle issues within their control as a matter of practice or industry standard may have an impact on PSAPs’ costs. For example, currently some providers may automatically put a record in the 9-1-1 database for each Direct Inward Dialing (DID) number associated with Primary Rate Interface (PRI) service or program their end office switches to send all the DID numbers as Automatic Number Identification (ANI). On the other hand, other providers may not automatically put all the DID records in the 9-1-1 database or may program their switches to send only the main billing number as ANI instead of all of the DID numbers. Which of these current practices is used by the providers may have a financial impact on 9-1-1 governmental entity PSAPs that currently pay for their 9-1-1 database services on a per "record" basis. This nexus between the industry and PSAP costs will likely continue into the future. The establishment of any funding mechanisms should consider what services will be needed by the PSAPs, how the PSAPs will be charged for the needed services, and what industry regulations or standards may be needed to ensure any adopted funding mechanism is sufficient to cover the costs associated with the services.

Additionally, the new funding/financial structure should encourage investment by the private sector in the 9-1-1 network, as well as provide a business model that affords them a financial opportunity to attain a reasonable return on investment. In order to ensure the development of an advanced 9-1-1 architecture that is able to deliver the minimum data elements required on a 9-1-1 call, such incentives are required. This will make the transition to the next generation a reality.

5.5.4 Planning and Deployment

Initiating the planning, deployment and funding of 9-1-1 emergency communication systems historically has been the responsibility of State or local government. However, the private sector partners play critical roles as stakeholders through their role as network, database and equipment service providers and should be equally represented as contributing members.

5.5.5 Government Stakeholder Roles and Responsibilities

As early as 1979, The US Department of Transportation, along with the US Department of Commerce, recognized the need for effective state presence in the deployment of 9-1-1. In a Federal guide designed to assist State's with understanding the need for assuming the responsibility of planning and implementing 9-1-1, the two Federal agencies noted:

> *It is the interest of the citizens of a State to see that a single emergency telephone number is established which a person anywhere in the State can call to report an emergency. Nor can a State rely on the voluntary efforts of local governments to make 9-1-1 a universal emergency number throughout the State. In many cases, local governments and institutions cannot be counted on to provide the impetus for establishing 9-1-1 service in their communities. The State is the logical source for the guidance and impetus necessary to bring local agencies together in developing and implementing 9-1-1 service. In order for the State's executive branch to play this role, the State legislature must first give it the authority to do so.*
>
> *Because implementation of 9-1-1 is a matter of statewide concern, guidance for it would be most effective if it came from State government level. Telephone companies cannot be expected to undertake central office modifications needed to implement 9-1-1 until agreements can be made*

> *among the State and local governments and their public safety agencies as to requirements. Legislation provides a firm base for articulating the State's 9-1-1 policy and specifying planning steps for policy implementation. . . . It calls for 9-1-1 planning at the State and local levels, places responsibility for 9-1-1 implementation in a "communications division" at the State level, deals with jurisdictional boundary problems, and addresses possible funding methods.*[31]

Twenty-five years after the above document was published, the US is still waiting for a number of State governments to assume responsibility for planning, implementing and funding 9-1-1. Existing State 9-1-1 policy should be re-examined and updated so that it is adaptable to current and future telecommunication trends. States without ubiquitous planning and deployment efforts should consider evaluating existing, successful State planning models and should structure their own public policy that affords all people access to 9-1-1 and emergency response.

5.5.6 Industry Stakeholder Roles and Responsibilities

Public policy today, from the FCC to State and local government, has generally been founded on the principle that any telecommunications service that can be used to dial 9-1-1 and request emergency assistance is, in fact, a "service provider" contributing to 9-1-1 services. To the extent technologically possible, all service providers should be required to adhere to all rules / laws / policies in place to provide for a highly-dependable, publicly-available system for handling emergency calls in an effective manner. Theoretically, the regulatory status of any entity should not be sufficient reason to exempt them from providing their customers / tenants / employees with substantially equivalent E9-1-1 services. Certainly that is the public's expectation.

How one achieves that goal, however, is the challenge in today's (and certainly tomorrow's) emerging communications arena (VoIP being an example). Faced with the specter of service providers located outside of the United States—providers not subject to US National, State or local rules and regulations—new ways to insure consistent and standardized 9-1-1 service must be explored.

To make this reasonable, the communications system must make it easy to comply. The requirements for devices and service providers must be straightforward, easily understood, and easily implemented. This argues for minimizing requirements on actual telecommunication service providers to the extent operationally feasible. Location reporting, as an example, should be ubiquitously passed from the access infrastructure provider to the data provider

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[31] The Emergency Telephone Number. 1979 USDOT NHTSA; USDC NTIA

to the media service provider. Routing should be simple, well understood, and only dependent on publicly available databases. That in turn, though, generates technical challenges that must be addressed. And, the latter requires time and expense. Ultimately "ease of compliance" is a factor that should be considered in those technical solutions developed to address the challenges involved. Obviously, it will be impossible to build compliant devices unless and until the public policy requirements are established.

5.5.7 Data Sources, Handling and Privacy Issues

There will be a myriad of data that can be made available to the PSAP and responders. This data will come from a great many sources, some of which are directly part of the telecommunications system, and others that are not connected at all. All data providers and the general public should have confidence that the information they provide will be kept confidential[32] when appropriate within the Emergency Services Network, and will only be used for emergencies or for supporting or enhancing the provision of emergency services. This principle should be supported by legislation where applicable and appropriate.

Where entities have an obligation to provide data, they should be able to provide the required information efficiently, securely, and in a timely manner. Standards should be developed that allow data to be provided as a consequence of other automated systems' activity, and the emergency services agencies should make an effort to use existing standards, or to develop new standards in close cooperation with the data providers to maximize the efficiency of and minimize errors in providing such data. We expect that at least some of this data may be collected over the Internet, with suitable security safeguards. Other data will be collected over the same privately managed network infrastructure used for carrying calls and their related data.

There will be a need for databases of various kinds in the future. For each database, the following needs to occur:

- Identify who will own the data, who will collect the data and who will maintain the data
- Determine the evolution path from the current data to the new data arrangements

As with many of the functions of the 9-1-1 system, entities that have responsibility for collecting and/or maintaining data may contract with a competent service provider to fulfill such responsibilities.

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[32] Some data may be considered "Private Health Information" (PHI) and subject to the Health Information Privacy Assurance Rule (c.f. http://www.hhs.gov/ocr/hipaa/finalreg.html). Other data may be subject to different privacy regulations.

Appropriate Governance and Policy structures must be identified. That may range from a local (e.g. County) focus, to State and / or multi-jurisdictional regions of the State, or Federal focus as appropriate and necessary. Regardless of where the lines of ownership and management are drawn, they will need to be drawn to prevent scattered pockets of unmanaged databases, or at worst databases that are managed to differing levels of quality and / or performance standards.

5.5.8 Network Operations

Each element in the Emergency Services Network should have an owner who is responsible for continuous reliable operation of that element. The network itself must be managed. Management can be directed by a government agency or, within the context of acceptable and appropriate standards, it can be contracted to a service provider. The network manager should publish a "Service Level Agreement" to its users that should be suitable for their use.

Focus Group 1B recommends that policy and funding agencies foster rapid completion of the specifications for and the development of IP-based PSAP systems and services. When standards based equipment and services are available, PSAPs that have not already started Phase II wireless migration should move toward those IP-based systems. It will be essential that such efforts be coordinated through local, State and national focal points, including, but not limited to the national Implementation Coordination Office.

6 Recommendations

6.1 Network Recommendations

6.1.1 Assumptions Regarding Recommended Properties

NRIC VII Focus Group 1B has a clear expectation that the emergency services network of 2010 will still support all of the desirable properties associated with today's existing emergency services network. In other words, nothing that is widely deemed desirable today will cease to exist on the emergency services network of 2010, so this list does not try to enumerate those commonly known and understood properties associated with today's emergency services networks.

With that understanding, below are the properties Focus Group 1B recommends that network architectures should meet by the year 2010. They are categorized by network properties, access requirements, and service needs.

6.1.2 Network Properties

- Have IP-based E9-1-1 capability established nationwide, have IP-based services fully integrated with E9-1-1, and be well along the path of transition for the older TDM based services. IP on satellites has not yet been tested or proven.
- Include as a basic function the exchange of voice+ text, other forms of text, data, photographs and live video into the 9-1-1 or emergency communications management center and to responders.
- Provide for real-time text transmission and handling wherever there is voice transmission and handling.
- Operate through the use of standard Internet Protocols among entities that are members of a federation of managed and secured Emergency Service IP Networks.
- Use SIP as the preferred call setup protocol including the ability to initiate use of the text channel in the midst of all voice channel connections. Calls using other call setup protocols could employ gateways or protocol converters.[33]
- Interoperate with legacy technologies. This includes provision of transcoding gateways from TTY to real-time interactive IP text at all edges of the IP network.
- Use a single or small number of standard video formats for Video Relay Services that are supported by PSAPs and Responders so that Video Relay calls can be forwarded or shared with PSAP and Responder personnel.
- Be engineered to adopted "best practices" (that are yet to be identified), for example, deploying firewalls between the public IP networks and the emergency services network to protect the emergency services network from degradation.
- Have very large bandwidth capabilities, but still be able to manage congestion control to levels that allow calls to be effectively handled by PSAPs.
- Have a uniform, comprehensive, cryptographically based security system, based on ubiquitous authentication, authorization, integrity protection and privacy controls.
- Accommodate a flexible services infrastructure where applications can be defined and introduced without requiring major overhauls to existing network service providing elements.
- Rely on the Access Infrastructure Provider (AIP), wireline or wireless, to supply location information.
- Have much more flexible routing mechanisms (see 3 for details).

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[33] Nothing in these recommendations is to be interpreted as prohibiting an emergency services network from owning equipment capable of receiving calls using other, possibly newer, call setup protocols.

- Evolve to allow bi-directional and asynchronous emergency event communications.
- Be designed to minimize service interruptions by employing management and continuous monitoring that detects anomalies immediately and generates alarms to the appropriate technicians, managers and service providers.
- Be designed such that no single failure or interruptive incident (e.g., a cable cut or Denial Of Service attacks etc.[34]) will create a system outage.
- Provide complete end-to-end test capability for each endpoint.

6.1.3 Access Requirements

- Support the Public Internet as one of the sources of calls coming into the 9-1-1 system.
- Support all 9-1-1 calls and emergency communications independent of the originating or access network technology. This allows access network and E9-1-1 system technology to evolve independent of each other through the use of open standards to provide assurance that service to the public will not be impaired through this evolution.
- Allow any device the public can reasonably expect to be used to summon help in an emergency situation to be capable of accessing 9-1-1 and delivering critical data (including voice+real-time text if applicable), including calls originated via satellite technology where technically feasible and commercially reasonable.
- Use a single industry standard for real-time IP text that provides for reliable (low error) transmission even under crisis load conditions (works reliably as long as voice works).
- Allow people who are blind, or have speech or hearing disabilities to use any public use VoIP telephones to call E9-1-1 using the standard phone keypad (or keyboard if one is supplied).
- Be engineered to allow incorporation of all FCC approved Video and Text Relay Services in E9-1-1 calls without loss of E9-1-1 functionality (including location) and with video and text pass-through to the PSAP.

6.1.4 Service Needs

- Support ability to report emergencies via all real-time communications services, both mobile and fixed, generally available to the public to report an emergency.
- Support ability to report emergencies via instant messaging to IP enabled PSAPs.
- Be in compliance with the NENA Future Path Plan.

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[34] A single hacker once blocked access to an international ISP for a few hours. The same techniques could in theory block access to 911 for a major city.

- Support the use of NENA defined data formats.
- Deliver the initial location data in the signaling with the call (when possible).
- Be able to capture data associated with the call and forward (some system elements may not be able to forward such information in real time) it to the appropriate entity in the Emergency Services Network even if the calls cannot all be answered.
- Be designed so that each element in the Emergency Services Network will have an owner who is responsible for continuous reliable operation of that element. The network itself must be managed.
- Consist of highly integrated locally controlled networks that cross political boundaries where necessary to serve the public good.
- Be based on and built around a totally new funding paradigm. This will require immediate action on the policy, funding and operational issues identified in this document.

6.1.5 Network Architectures

- All systems and networks should be built on open architecture and compliant with national standards.
- All services (e.g. voice, data, video, etc) should be interoperable, end-to-end, independent of the access network technology.
- All systems should be able to negotiate the highest quality of service end-to-end in order to get the best audio, text and video available.
- All systems and networks elements (including terminal elements where applicable) should identify 9-1-1 calls and treat them on a priority basis.
- The best available methods to assure quality of service should be employed for 9-1-1 calls.
- Mobility should be supported for emergency services the same as for commercial services.
- Government spectrum allocation policies should support the above goals to achieve the highest quality 9-1-1 service system possible.
- IP PSAPs must have mechanisms that allow them to direct calls to other IP PSAPs and / or legacy PSAPs in circumstances where insufficient resources are available in the PSAP to receive the call. Solutions need to be identified to support the delivery of location data to the legacy PSAP.
- Ability to transfer IP calls to a traditional 9-1-1 PSAP, with data, to the extent the traditional 9-1-1 network supports connectivity. Solutions need to be identified to support the delivery of location data to the legacy PSAP.
- PSAPs should be able to receive and reply to e-mail, SMS and store and forward messages. However, because of their latency and unreliable delivery, such messaging is problematic for emergency communication

and users should be educated as to of limitations inherent to these services.

- The FCC should encourage IM vendors to deploy interoperable IM standards such that PSAPs can accept messages from any IM service. IM vendors should implement universally understood addresses, e.g. 9-1-1, for emergency services addressing. IM for emergency calls should include location and callback (e.g. user identification) and route like any other emergency call.
- Ability to link multiple PSAPs on a wide area network (WAN) and share 9-1-1 CPE infrastructure. This allows network infrastructure (common equipment) to be centralized and call takers decentralized. This facilitates dynamically adding call taker positions for a specific PSAP on a local area network (LAN), WAN, or highly secured VPN connection in order to meet workload requirements.
- Upon being given the indication that streaming video is available, PSAPs should have the capability to connect to the server providing streaming video. Examples of streaming video sources may be bank cameras, traffic cameras, etc.
- PSAPs should have the capability to share digital photography, digital audio, video, etc., with dispatchers and responders.
- IP-based text and video relay services will need to be updated to handle 9-1-1 calls, including location identification and routing to the caller's nearest PSAP. For this to occur, the Commission will need to authorize funding and set a timetable.

6.2 PSAP Recommendations

6.2.1 Recommendations for National/Regional PSAP Structure

This section of the report will be completed in the final issue of the report in December.

6.3 Recommendations for Satellite Systems

- Satellite system operators should explore and implement technologies necessary to provide similar capabilities to those of any other terrestrially transported source of E9-1-1 calls, as they plan their next generation satellite systems, where technically feasible and commercially reasonable.
- Based on the discussions in this report, it is recommended that the FCC not place any additional E9-1-1 rules on existing satellite systems beyond its existing order until next generation systems are being deployed.
- Each MSS satellite system operator should be required to prepare a detailed feasibility and implementation plan, to be individually evaluated by the FCC, considering how and whether it will be able to deliver calls,

with location and call back information, to the appropriate PSAP where technically feasible and commercially reasonable.

- MSS systems that currently deliver calls to PSAPs via PSTN lines should, where technically feasible and commercially reasonable, migrate their 9-1-1 call centers (MSS operators may contract out to an existing, qualified call center for these services) to technology which delivers such calls to Selective Routers or equivalent VoIP E9-1-1 call termination.
- Due to technical limitations discussed in this document, it may be necessary that existing wireline-based connectivity into the PSAPs remain an optional connection mechanism for MSS providers beyond the 2010 date.
- MSS operators should provide ANI (Automatic Number Identification) by 2010 in existing and/or future systems, where technically feasible and commercially reasonable.
- FSS based service providers who provide packet services should prepare a plan, to be evaluated by the FCC, detailing how and when it will be able to meet the requirements (where technically feasible and commercially reasonable) of delivering location to endpoints as does any Access Infrastructure Provider.
- FSS based service providers of "switched" [35] voice/text/video call services should prepare a plan, to be evaluated by the FCC, detailing how and when it will be able to meet the requirements (where technically feasible and commercially reasonable) of delivering calls, with location and call back information, to the appropriate PSAP.
- In most cases, this is expected to be completed coincident with next generation FSS satellite and network upgrades, and thus may be beyond 2010. No further requirements should be placed on current FSS systems.

6.4 Recommendations for MLTS

This section of the report will be completed in the final issue of the report in December.

6.5 Recommendations for Evolution and Transition

This section of the report will be completed in the final issue of the report in December.

[35] While IP based voice/video/text systems are not "switched" systems in the conventional sense, we include them in this category, but exclude service providers who simply provide transport of audio or video for TV/Radio networks and similar services where there is no reasonable expectation of E9-1-1 services

7 Appendix I - References

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8 Appendix II – Acronyms

AIP: Access Infrastructure Provider
ALI: Automatic Location Identification
ALI-DB: Automatic Location Identification Data Base
ANI: Automated Number Identification
APCO: Association of Public-Safety Communications Officials International
ATIS: Alliance for Telecommunications Industry Solutions
CAMA: Centralized Automatic Message Accounting
CBN: Call back number
CLEC: Competitive Local Exchange Carrier
CONUS: Continental United States
CSP: Communications Service Provider
DHS: Department of Homeland Security
DoS: Denial of Service Attack
E9-1-1 SSP: E9-1-1 System Service Provider
ELIN: Emergency Location Identification Number
EMS: Emergency Medical Services
ERL: Emergency Response Location
ESIF: Emergency Services Interconnection Forum
ESN: Emergency Services Number (code for the PSAP)
ESRK : Emergency Services Routing Key
FCC: Federal Communications Commission
GIS: Geographical Information System
GPS: Geo Positioning System
HAZMAT: Hazardous Material
IETF: Internet Engineering Task Force
ILEC: Incumbent Local Exchange Carrier
IP: Internet Protocol
ISP: Internet Service Provider
ITCO: Independent Telephone Company
IVR: Interactive Voice Response
MLTS: Multi-line telephony system
MPC / GMLC E2: Mobile Positioning Center (J-STD-036 network topology)
MSAG: Master Street Address Guide
NENA: National Emergency Number Association
pANI: pseudo Automated Number Identification
PBX: Private Branch Exchange
PKI: Public Key Encryption
POI: Points of Interest
PSAP: Public Safety Access Point
PSTN: Public Switched Telephone Network
SIP: Session Initiation Protocol

S/R (SR): Selective Router
TDM: Time Division Multiplex (trunks)
TN: Telephone Number (speed dial list)
TSP: Telecommunication Service Provider
TTY: Telephone Devices for the Deaf based on the old TTY codes (Baudot)
VoIP: Voice over Internet Protocol
VoP: Voice over Packet
VSATs: Very Small Aperture Terminal
VPN: Virtual Private Network
WiFi: Wireless Fidelity (industry organization promoting 802.11 wireless networks)

9 Appendix III - Key Definitions

Following are definitions of key terms referred to throughout the document. While most of these are not complex terms, it is important to understand how the Focus Group defined these terms in order to understand the context and scope of the recommendations.

- ***Access Infrastructure Provider (AIP)*** - Wire plant owner or the wireless radio access network provider, including enterprises
- ***Access Requirements -*** Technological and operational methods that are expected to be supported by the emergency service network and utilized by any service provider to deliver their customers' emergency calls into the emergency service network.
- ***ANI failure*** - Unroutable call to a PSAP
- ***Call center*** - Public Safety Access Point, Communication Center
- ***Call -*** Includes short message service, VoP, packet data, streaming data, etc., using PSTN, internet, satellite, etc.
- ***Crypto*** - Cryptographic
- ***Diffserv*** - Quality of Service mechanism used in IP networks to provide differentiated services often using a priority mechanism
- ***Directory*** - A managed entity that lists agencies and or resources that can be used by other agencies to discover what resources are available and how to get them.
- ecrit - (Emergency Context Resolution with Internet Technologies) is the work group within the IETF concerned with recognizing and routing an emergency call. Like all IETF work groups, ecrit will develop a single global standard for how all VoIP endpoints (phones) and routing proxies will recognize emergency calls from other calls (9-1-1 is not the emergency

number everywhere) and how the call will be routed based on the location of the caller to the correct PSAP.

- ***Emergency Services Network (ESN)*** -Trunks, routers, databases and other elements dedicated to 9-1-1 use
- ***Endpoint -*** A device with which one or more communication services may be accessed
- **FET**: Fixed Earth Terminal means fixed user satellite terminal
- **FSS**: Fixed Satellite Service means satellite service to fixed earth terminals. These systems can be in any orbit.
- **GEO**: Geostationary Earth Orbit means an orbit 22,300 miles above the equator where satellites can maintain a stationary position in relation to the earth.
- ***Infrastructure*** - Hardware and software supporting public communications networks
- **Intermediate call centers** - Call centers which may initially receive a 9-1-1 call but are not PSAPs, including relay services, telematics and satellite call centers.
- ***Internetwork*** - Collection of managed networks which are interconnected
- ***IP Text -*** Text encoded as text characters (Unicode) in a standard manner for transmission over an IP network
- **LEO**: Low Earth Orbit means an orbit 100 to 1,000 miles above the surface of the earth.
- **MEO**: Middle Earth Orbit means an orbit 6,000 to 12,000 miles above the surface of the earth.
- **MET**: Mobile Earth Terminal means mobile user satellite terminal.
- **MLTS**: **"**A Multi-line Telephone System (MLTS) comprised of common control unit(s), telephone sets, and control hardware and software. This includes network and premises based systems. i.e., Centrex and PBX, Hybrid, and Key Telephone Systems (as classified by the FCC under Part 68 Requirements) and includes systems owned or leased by governmental agencies and non-profit entities, as well as for profit businesses."
- **MSS**: Mobile Satellite Service means satellite service to mobile earth terminals. These systems can be in any orbit.
- ***Network Architecture -*** The overall design of the public and Emergency Services Networks
- ***Properties*** – "characteristics" that are the prominent, inherent features that are essential to the proper functioning of the emergency services network Focus Group 1B (collectively) envisions being in place by 2010, e.g., the use of Internet Protocol
- ***Public Safety Answering Point*** – A facility equipped and staffed to receive 9-1-1 calls. [sic-from NENA Master Glossary] (see also Primary and Secondary Public Safety Answering Point (PSAP))

Primary PSAP: A PSAP to which 9-1-1 calls are routed directly from the 9-1-1 Control Office. (see Public Safety Answering Point)
Secondary PSAP: A PSAP to which 9-1-1 calls are transferred from a Primary PSAP. (See Public Safety Answering Point)

- ***Real-time text*** – Generic term for continuous character by character conversational text. Includes TTY in analog networks but is used primarily in this report to refer to conversational text in IP networks.
- ***Softphone*** - a computer program that emulates the function of a telephone
- ***Voice+text*** – a term representing conversational communication. Voice+text conversation can occur in voice alone, or real-time character-by-character text alone, or a mixture of voice and text together. On PSTN this is accomplished with voice and TTY over the voice channel. In IP, it would be VoIP and IP text.

10 Appendix IV - Alternatives for Congestion Control

For a caller, busy is never a satisfactory result; it gives them one bit of information -- they aren't going to get help from this call attempt. This appendix describes a possible scenario that affords PSAPs the option, governed by local policy, to mutually assist each other so that, except in very widespread disasters, all calls to 9-1-1 are answered. Focus Group 1B does not necessarily advocate this concept. It is provided as an illustration of what might be possible.

Emergency responders have a well established procedure called "triage" that they would like to apply to requests for help. They want to have requests classified such that they attend to the greatest need first. Furthermore, responders want to communicate instructions to callers. They may order evacuations, for example, or they may request that people stay in place and not go outside. Finally, call takers may be trained to be able to offer some first aid instructions[36] to callers that can be used in some circumstances to aid callers to render help to themselves or others.

All of these are only possible if the call is answered. With 6000 PSAPs, there are perhaps 25,000[37] on duty call takers at any time, and with call-outs for off duty people and standby workstations, many call centers could probably double the number of available call takers nationwide in tens of minutes. It is well within the capabilities of the kinds of networks advocated in this report to route calls in

[36] Not all responders are trained, and in some jurisdictions, certification is required before call takers may give out first aid instructions
[37] There are no definitive studies of how many on-duty call takers there are in the United States at any time. This figure is simply a guess based on an average of 4 call takers per PSAP.

a disaster to any such call center. Prior arrangements would have to be made to do this of course. There could be large associations or groups of PSAPs who agree to assist each other in disasters. Such groups would publish procedures so that call takers could be trained to handle such contingencies.

Calls taken by a call taker far from the disaster would:

1. Extract the data associated with the call: location, telematics data, etc.
2. Confirm identity, location and nature of the call
3. Classify the call according to predetermined criteria to allow responders to triage
4. Provide instructions to callers provided by emergency management officials in the disaster area which could be communicated to the answering PSAP via the directory functions
5. Provide first aid instructions as appropriate
6. Provide a realistic expectation to the caller of what response is likely, based on information also provided by emergency management officials in the disaster area

Of course, the most important service rendered by the answering call taker, whether they are in the area, near it, or across the country, is the human to human connection that is so desperately desired by the caller. As we learned so poignantly on 9/11, even when no help is forthcoming, knowledge, sympathy, and compassion make a tremendous difference.

Disasters know no bounds. Real systems do. 50,000 call takers facing millions of callers for a widespread earthquake might overwhelm every PSAP in the country. But consider that at 10 minutes a call, and 50,000 call takers, a million calls can be completed in three hours. It still may be necessary to return busy in some circumstances, but it should only be when no humans are realistically available anywhere to answer.

The data collected by the call takers can be sent to the primary PSAP where it can be used by responders to best manage their resources. Call back numbers can be used to re-contact callers if circumstances dictate. Callers can be “tracked” if they call again, with call takers given the data extracted from prior calls.

Finally, consider using the same idea when a deliberate attack is launched on an emergency services network. While firewalls should be able to detect and stop most attacks, new vulnerabilities will be discovered continuously, and it is likely that some attacks will succeed for the time it takes to determine an attack signature and build a filter for the attack into the firewalls. In the intervening period, which may be a few minutes, a few hours or a day, bogus calls will be mixed with real calls in a way that cannot be separated. By spreading out calls to all available call takers, the good calls can be separated from the bad ones, and the good ones can be bridged back to the primary PSAP they were directed towards. Bogus calls can be detected by the call takers very quickly, and thus a deliberate attack can be effectively mitigated in many cases by using this technique. Again, it is always conceivable to overwhelm any real system.

11 Appendix V - E9-1-1 Technical Considerations for Satellite Systems

11.1 Issues Associated With Modifying Current Generation MSS to Launch an Industry-Wide E9-1-1 Solution

The current generation of systems providing Mobile Satellite Services (MSS) were conceived, designed, developed, launched and commenced commercial service during the period from the late 1980s to the late 1990's. During that timeframe the technical capabilities and policies for MSS E9-1-1 did not exist. Consequently, current generation MSS systems were not designed with the capability to perform location determination of user terminals to the accuracy level necessary to provide meaningful support to E9-1-1 services.

Depending on their design details (e.g., orbital altitude, number of satellites simultaneously in view, service link air-interface, etc.), current generation MSS systems have location errors that range from many miles to over a thousand miles. In addition, the current generation MSS air-interfaces do not support the derivation, encapsulation and transport of the high accuracy geo-location information that is necessary to support E9-1-1 services.

Furthermore, regulatory E9-1-1 requirements levied on existing MSS systems should consider the service life of these systems. In particular, given that the currently operational MSS were deployed in the mid-to-late 1990's, they will be reaching the end of their useful satellite lifetime(s) during the 2010-2014 timeframe[38]

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[38] It should be noted that the expected end-of-life dates for the current generation MSS systems vary from system to system and depend on many factors, including: system design / architecture, available on-orbit sparing hardware, and initial system deployment dates.

MSS present additional, unique technical challenges that should be carefully considered when codifying E9-1-1 requirements. One of the obvious E9-1-1 implementation challenges faced by MSS operators is the inaccessibility of a substantial portion of their network infrastructure for the purposes of implementing upgrades across the satellite constellation. Obviously, the physical inaccessibility of on-orbit satellites places significant constraints on an operator's ability to roll out network-wide upgrades.

Perhaps less obvious is the fact that this network inaccessibility extends beyond the satellite infrastructure to the subscriber products as well. That is, owing to the significant cost of MSS user terminals (satellite user equipment typically costs between one to several thousand dollars); most MSS subscribers seldom (if ever) replace their subscriber hardware over the life of their service subscription. This is in stark contrast to CMRS subscribers that have an average handset replacement rate of 18-24 months. Consequently, both the percentage and the number of MSS users that would be affected by additional E9-1-1 rules on current generation systems would ultimately be very low.

In addition, since MSS satellite handsets/terminals are typically sold through service providers (rather than directly by the satellite operator) the end-user records are typically not maintained within the satellite operator's existing data base. Nor do MSS operators have direct access to these users. This will further hamper efforts to replace subscriber products with upgraded E9-1-1 capable units.

Furthermore, each of the MSS systems currently in operation employ customized air-interfaces. In some instances they employ derivatives of CMRS standards (e.g., GSM or IS-95), but in other instances the air-interface is a purely custom solution. In as much as these unique architectural designs and custom air-interfaces prohibit standardized solutions, this will further complicate the development of unified E9-1-1 regulatory requirements. It is also noteworthy that some satellite operators do not have direct access to ANI information as it transits their network because the International Switching Centers often remove the data fields containing the ANI.

In addition, satellite systems are, by design, multi-regional to global in nature. Therefore, as other countries seek to develop E9-1-1 service requirements, MSS operators may be faced with requirements to support multiple, incompatible national standards. Clearly, conflicting regulatory requirements could prove extremely burdensome for an industry that is struggling to regain its financial standing.

As regards location determination, the incorporation of GPS-based geolocation functionality into current or next-generation MSS handsets may present difficult technical design challenges due to the low receive power levels of the current generation GPS signals coupled with the close proximity of many of the MSS system's operating bands to the GPS downlink frequencies. This proximity present a difficult transmit/receive isolation problem for the MSS subscriber equipment – particularly for in-call geolocation.

Lastly, as regards next generation MSS systems, to date no MSS system operator has incorporated Assisted-GPS (A-GPS) functionality into current generation systems. Given this, the technology roadmap/feasibility of a satellite based A-GPS location determination functionality (i.e., wherein the assistance signals and initial location estimates are provided by the MSS system – as opposed to the CMRS terrestrial infrastructure) is unclear.

11.2 Issues Associated With Modifying Current Generation FSS to Launch an Industry-Wide E9-1-1 Solution

Key features of FSS satellites and FSS service networks are:

1. Generally, FSS satellite owner/operators sell or lease capacity to others to develop services and service networks. FSS spacecraft are not used to provide services directly to members of the public, and therefore by definition, the spacecraft themselves are not enabled to provide enhanced 9-1-1 services.

2. FSS VSATs are not usually equipped with location determination capabilities. Such capabilities are not required for FSS network operation.

3. The majority of FSS-based networks are not interconnected to the public switched telephony network, and do not provide public telephony or other public communications services.

4. Where public satellite Internet services are provided, fixed VSAT sites communicate with the Internet without changes to the VSAT network and using normal Internet delivery protocols.

5. VoIP service providers using FSS satellite infrastructure manage their public end-user services without intervention by the satellite network provider. FSS VSATs are not usually equipped with telephone numbers. Additionally, access to FSS services, and information about FSS customers

and FSS VSATs, are not directly accessible by PSAPs or any entity outside the defined FSS network. In some cases, where the VoIP service provider is also the ISP, the VSATs do have phone numbers.

6. Most FSS VSATs are in fixed sites and are not re-locatable to emergency locations. There are a limited number of VSATs that are mounted on vehicles or specially designed to be deployed as transportable units in emergency situations. The services provided by a transportable FSS VSAT network, and the other VSAT communication points configured to operate with that network, are generally defined by the entity contracting for FSS network services, such as a State emergency management agency.

7. FSS satellite service provision is transparent to and does not impact end-user personal computer or other communications equipment which persons with disabilities already have available to them. FSS satellite services are generally delivered to an indoor modem which in turn communicates with the fully-equipped customer premises equipment.

For the reasons and system architecture limitations described above, the FCC has not placed any rules or obligations on FSS satellite systems or FSS networks to provide 9-1-1 connectivity.

11.3 Location Determination by Current Generation MSS Systems

11.3.1 Reviewing Terrestrial Wireless Location Determination Solutions and Their Applicability to MSS Systems

Terrestrial CMRS location determination (LD) solutions are typically classified as either Network Based or Handset Based. Both of these approaches present certain unique technical challenges when considered for implementation within a satellite based system.

11.3.1.1 Network Based LD Solutions (Terrestrial Triangulation)

Network based geolocation solutions utilize network infrastructure to perform most (if not all) of the geolocation processing / computations. Early network based geolocation solutions employed simple concepts like cell ID to provide coarse location information. Later network based approaches migrated to more elaborate techniques, such as tower triangulation.

However, many of these approaches have suffered from poor LD accuracy or location ambiguities. For example, when the cell site locations were not properly situated (e.g., towers spaced linearly along a rural road), location ambiguities and / or significant LD errors were prevalent.

Purely network based LD solutions, when viewed in the context of satellite systems, present unique challenges. For example, in an MSS system the coverage cell (analogous to a CMRS cell or sector) is a satellite beam. These beams range in size from a few hundred miles to over a thousand miles. Given this scope, location determination down to an MSS beam is obviously inadequate for provisioning E9-1-1 services.

Furthermore, since current MSS systems cover every part of the continental US, and in some cases the world, it is commercially infeasible for satellite operators to deploy a terrestrial network of ubiquitous, US-wide "triangulation towers" due to costs, terrain, and local zoning and environmental regulations.

11.3.1.2 Handset Based LD Solutions (Embedded GPS)

An alternative to network based LD approaches is handset based LD. In a pure handset based LD approach the MSS handsets performs both the underlying ranging measurements, and the actual (computation intensive) geolocation calculations. The resulting position can then be transferred by the handset to the network infrastructure – via the handsets air-interface.

The underlying range determination can, in theory, be based on either the system's existing air-interface, or based on ranging signals that are external to the MSS system (e.g., GPS signals).

However, many of the air-interfaces employed in current generation MSS systems are incompatible with high-precision LD (e.g., air-interfaces derived from GSM are inherently incapable of providing the necessary ranging accuracies). Given the infeasibility of augmenting current (narrow-band) MSS systems with wide-bandwidth Pseudo Noise (PN) ranging signals, this current class of MSS system would require the use of externally supplied ranging signals. Again, given the ubiquitous coverage of MSS systems, it is commercially infeasible for MSS operators to deploy US-wide infrastructure for the delivery of ranging signals.

The use of GPS signals as the source of external ranging signals is clearly a logical alternative. However, one of the key technical hurdles presented to CMRS LD solutions based on GPS is the interference with the reception of GPS signals and data caused by the cellular transmitter in the same handset. Given that the handset must provide GPS receiver sensitivities on the order of -150 dBm to -160 dBm, providing adequate transmit / receive isolation to perform positioning in-call has proven to be challenging - even for PCS band operation.

Given the significantly closer proximity of certain MSS operational frequency bands (e.g., the L-band and Big LEO MSS bands) to the GPS L-band frequencies, achieving sufficient isolation for in-call LD will very likely prove to be a significant design issue.

As discussed earlier, MSS handset/terminals typically cost between one and several thousands of dollars. Furthermore, MSS operators do not update each model more than a few times during the ten to fifteen year life of the satellite network. As such, the upgrade costs required to embed GPS functionality into current generation MSS systems would be apportioned across a very small number of new satellite telephony subscribers (most likely measured in the several thousands in the post-2010 period). These apportioned (per-user) cost impacts must be compared to the tens of millions of CMRS subscribers that have supported terrestrial cellular E9-1-1 upgrades.

As such, the per-user cost structure associated with designing and developing a new generation of handsets/terminals, and simultaneously upgrading the air-interfaces and Gateway infrastructures with embedded GPS functionality, would be prohibitive for current generation MSS systems.

11.4 Location Determination and Next Generation MSS System

Currently, the only next-generation MSS systems licensed by the FCC for launch and deployment are GEO-based system architectures (e.g., MSV, Terrestar and ICO). These MSS licenses cover two of the three existing MSS bands (i.e., the MSS L-Band and the newer S-Band MSS allocation).

11.4.1 Ranging Based Location Determination Solutions in GEO-Based MSS Systems

Clearly, location determination solutions that are limited to measurements solely from one or two GEO MSS satellites can not provide the accuracy necessary to support E9-1-1 services. That is, unambiguous location from a minimum of three independent locations is required to provide unambiguous location determination. As with GPS based LD, additional ranging points are desirable to provide both additional location determination accuracy, and improved spatial diversity to increase the availability of LD estimates. Given that the currently planned next-generation MSS system will provide visibility to at most two GEO satellites, the use of externally supplied ranging signals will be required – with GPS being the most obvious source.

11.4.2 Solutions Based on Received Signal Strength - in MSS-Only Coverage Areas

Next-generation GEO based MSS systems are based on state-of-the-art service link apertures on the order of 12-20 meters in diameter. In spite of the enormous size of these antennas, the “cells” (i.e., space-to-ground service beams) associated with these antennas, even when operated at diffraction limited resolution, will measure in excess of 100 miles wide.

Near the beam center, fractional parts of a dB in relative signal strength equate to tens of miles in location uncertainty. Therefore, handset or satellite implemented Location Determination that is implemented based on received signal strength measurements alone (whether satellite or handset based) would be limited to accuracies of approximately 20-50 miles (at best).

In light of the above considerations, Location Determination functionality over GEO based next-generation MSS systems would, in all likelihood, include an external ranging-signal augmentation. Furthermore, this augmentation must be US wide.

11.5 Handset/ Terminal GPS-Based Solutions for Next-Generation MSS Systems

Current generation MSS satellite systems were not designed with sufficient excess link margin to operate in dense urban or suburban areas. Similarly, GPS-only solutions are also known to not work well in these areas. As such, the CMRS industry has initiated development of several versions of Augmented GPS (A-GPS) solutions that typically provide augmentation signals to CMRS handsets. These augmentation signals are often designed to reduce the GPS signal search space, thereby allowing a more rapid synchronization and operation at reduced signal-to-noise ratios.

There are several types of augmentation data that can be provided, such as: coarse handset location information, estimate(s) of the GPS ranging signal Doppler, GPS satellite ephemeris, satellite clock error coefficients, satellite health / status, etc. Noteworthy, however, is the fact that these GPS augmentation signals are typically transmitted by the extensive CMRS infrastructure.

Migration of these approaches to next-generation MSS systems is an avenue that is worth further exploration. Notionally, the augmentation signals currently provided by the CMRS infrastructure could potentially be transmitted by the MSS satellites. It is important to note, however, that the technical feasibility of this MSS A-GPS approach has not been examined in detail. However, as previously mentioned, there are potentially significant design challenges associated with the close proximity of some of the MSS frequency bands to the GPS signals.

Next Generation MSS systems may implement an Ancillary Terrestrial Component (ATC) in parts of their service area. In systems equipped with an ATC component, the GPS augmentation signals may be supplied by the ATC infrastructure (i.e., in those limited areas where ATC is implemented). However, outside of the ATC coverage area the augmentation signals would not be available.

11.6 Call Back Number

Current MSS systems do not automatically provide a callback number. Modifications to current MSS infrastructure are often difficult, if not impossible, to implement, because there are only a few operators in the global market. Moreover, the few existing operators have different network components. Most of the current components of these operators' systems were built in the early to mid-1990s, and vendors for replacement components either no longer exist or no longer produce a similar product. Additionally, because the few existing networks are so different, hiring a new vendor to design one-off components can be prohibitively expensive.

11.7 ALI

If geolocation coordinates of the subscriber's Mobile Earth Terminal (MET) were available, in order to be able to pass them on to the PSAP, the MSS industry would first have to locate an MET vendor and then participate in the 12-24 month design and development stages as well as raise the many millions of dollars to support the effort.

Additionally the ground segment side (gateway) would require a similar 12-24 months of a design and development stage as well as millions of dollars and additional internal resources to support the effort.

11.7.1 ALI and the Mobile Terminal

If GPS could be embedded in the handset, due to legacy hardware restrictions along with space and interfacing issues for the software, the MSS industry would need to modify the subscriber equipment (physically replace critical components in the handsets) and load new software on all existing user equipment. Due to the fact that the subscriber handset usage characteristics and behaviors regarding handset churn are completely different from current cellular consumers, i.e. MSS subscribers don't exchange their handsets for a new model, this option quickly becomes impractical for currently deployed MSS systems.

12 Summary of States with MLTS Legislation Enacted

Note: List provided by RedSky Technologies, Inc. (www.redskytech.com) and current as of August 2005.

Authority	Implementation	Description
Arkansas	Broad Interpretation	Any exchange telephone service provider is required to send telephone number and street address to the PSAP, rules apply to broad base of entities.
Colorado	MLTS operators	MLTS operators that do not give the ANI, ALI or both shall disclose this in writing to their end-users and instruct them to provide their phone number and exact location when calling 911.
Connecticut	Business	Companies cannot prevent a 911 call from being made. But, call can be directed to on-site security answering points proven to be the same or better than PSAP.
Florida	Business	Any PBX installed after 1/1/2004 must be capable of providing ALI, automatic location identification, to the station level.
Illinois	Private Residential and Business Switch Service	Requirements vary based on residential vs. business and square footage. Generally, a distinct location needs to be provided per 40,000 ft^2 or each entity sharing a building.
Kentucky	Residential MLTS Only	MLTS operator must provide updated number and location identification for each phone dialing 911.
Louisiana	Business	Any PBX installed after 1/1/2005 must be capable of providing ALI, automatic location identification, to the station level.
Maine		
Minnesota	Business and Residential MLTS	Any owner/operator of a MLTS installed after 1/1/2005 must provide a call back number and emergency response location.
Mississippi	Service Suppliers and Shared Tenant Services	Service supplier must provide access to PSAP. Where technically available, service supplier must provide location and telephone number for each extension.
Texas	Tarrant County—Business, Multi-tenant services	Businesses utilizing a private or public phone switch to consolidate telephone service must provide a phone number and an accurate physical address of the caller. State of TX requires E-911 for residential MLTS.
Vermont	All Businesses	Businesses that own private telephone systems must provide ANI signaling, station identification and updates to the 911 databases.
Washington	Business and Residential MLTS	Businesses occupying over 25,000 ft^2, more than one floor or multiple buildings need to provide automatic location identification in a format compatible with the local 911 system.