4G Americas Technical Report

Analysis of Transitioning to NG9-1-1 from a Wireless Service Provider Perspective

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EXECUTIVE SUMMARY

In this white paper, 4G Americas provides perspective of the implementation path of wireless service providers' networks from existing emergency 9-1-1 (E9-1-1) voice services to Next Generation 9-1-1 (NG9-1-1) voice and multimedia services. Particular emphasis is given to the transition period during which a mix of legacy E9-1-1 and NG9-1-1 networks will co-exist. The report also identifies potential impacts of emergency services that could be provided by Over-the-Top (OTT) service providers using wireless access.

As next-generation emergency capabilities evolve, the changes in wireless devices and networks required to implement NG9-1-1 will have significant impacts on the entire emergency 9-1-1 ecosystem. It is expected that end user devices and origination networks will ultimately evolve, and that the NG9-1-1 solution will allow this evolution to take place over time. In addition to the wireless device and network changes, systems used by the Public Safety Answering Points (PSAPs) must also evolve in order to complete the NG9-1-1 transition. New end-to-end messaging relationships between origination networks and PSAPs must be established. Because not all networks, devices, and PSAPs will be enhanced at the same time, migration and interworking strategies must be considered.

NG9-1-1 migration strategies need to consider whether a seamless transition from legacy E9-1-1 service to long-term NG9-1-1 service is possible and, if so, how. Long-term NG9-1-1 standards have been developed and initial implementation is expected to begin over the next several years. However, even as NG9-1-1 starts to become available, for a considerable period of time it will be available only in certain service areas and even in those cases may not provide full multimedia services until a full transition is accomplished in all of the elements involved. It is not currently possible to forecast with accuracy the time period that will be required to achieve full deployment of NG9-1-1, but it is judged to be significant. During the extended window of transition between initial and full deployment, significant transition planning will be needed, engaging the participation of all emergency services stakeholders. During this transition period emergency callers can be expected to encounter significantly differing environments for emergency service capabilities. The resulting emergency services provided may be expected to range from today's voice 9-1-1 emergency calling, to limited non-voice capability, to partial NG9-1-1 Multimedia Emergency Services (MMES) capability, or, in some cases, to full NG9-1-1 MMES capability.

All stakeholders (e.g., origination wireless network providers, Public Safety interests, network operators, system vendors, etc.) must be involved in the careful planning and development of migration strategies. Consumers will remain dependent on 9-1-1 emergency services throughout the transition period and the impacts of the transition stages must effectively be conveyed to this constituent body.

NENA and ATIS have defined multiple stages of architecture for a Next Generation E9-1-1 Emergency Services Network that includes advanced communication services support for emergency calls. In a similar vein, 3GPP has defined IMS-based emergency calling for both voice and multimedia communications. These standards set the stage for NG9-1-1 and the applications that would be enabled with its fruition. However, until now there has been no coherent overall wireless service provider perspective for transitioning from existing E9-1-1 services to the NG9-1-1 services and environment. The challenge for wireless service providers is significant, since there will be no "flash cut" in which all PSAPs transition at once to the new architecture and supporting systems. Rather, the transition to NG9-1-1 is almost certain to occur on an individual PSAP basis, requiring close coordination among the parties. The importance of this cannot be overemphasized; for correct operation, a wireless origination network at the time an emergency call is routed needs to know whether only legacy voice is supported at a given location or if that location supports NG9-1-1 advanced communication services. Ultimately, the impact extends to

wireless subscribers who, unaware that there may be PSAP limitations in a given service area, may attempt to utilize advanced services in service areas where only legacy services are available.

1. INTRODUCTION

1.1. SCOPE

4G Americas initiated this project to provide a wireless service provider's perspective of transitioning their networks from today's E9-1-1 voice services to NG9-1-1 voice and multimedia services. Particular emphasis is placed on the transitional period when there will be a combination of legacy E9-1-1 and NG9-1-1 networks simultaneously deployed. The project also provides a perspective of potential impacts of emergency services that could be provided by Over-the-Top service providers and/or applications using wireless access.

NENA and ATIS have defined several stages of architecture for Next Generation E9-1-1 Emergency Services Networks that will include capabilities to support advanced communication services for emergency calls. Similarly, 3GPP has defined IMS-based emergency calls for both voice and multimedia. These standards set the stage for NG9-1-1 and the applications that would be enabled with its realization. However, there currently exists no overall wireless service provider perspective for transitioning from existing E9-1-1 services to the NG9-1-1 services and environment. The situation for wireless service providers is complicated by the fact that the transition to NG9-1-1 will in all likelihood occur on an ad hoc PSAP-by-PSAP basis. A wireless origination network, at the time an emergency call is routed, needs to have information as to what types of emergency services are supported at a given location (i.e., if only legacy voice is supported at the location or if NG9-1-1 advanced communication services are supported). This dynamic extends to wireless subscribers, who may not be aware of the capabilities or limitations of a PSAP serving a given emergency location; subscribers may fruitlessly attempt to utilize advanced services in service areas where only legacy emergency communications services are available. This 4G Americas white paper examines all of the foregoing issues, placing emphasis on transitioning aspects.

2. FACTORS IMPACTING WIRELESS SERVICE PROVIDER TRANSITIONING TO NG9-1-1

Myriad factors will impact a wireless service provider's transition to NG9-1-1. This section of the report provides a high-level description of these factors and additional information is provided in later sections. The topics discussed are in this section are:

- Wireless service provider and emergency services environments
- Interim solution for texting to 9-1-1
- Interconnection implications
- Mobile device implications
- End-user experience implications
- Statutes and regulations implications

Additional information and implications will be provided in the later sections of this technical report.

2.1. WIRELESS SERVICE PROVIDER AND EMERGENCY SERVICES ENVIRONMENTS

Evolution to NG9-1-1 and associated capabilities will occur independently in wireless service provider networks, emergency services networks, and PSAPs. Consequently, multiple combinations of network environments will exist for some time, and during that period subscribers moving from one geographic area to another can be expected to experience differing emergency services environments. It is possible that subscribers may even experience varying

environments within their home areas, for instance, as a subscriber travels from home to work and back home again. The following table summarizes potential combinations of the various environments during the transition to NG9-1-1. The various combinations of environments captured here are referenced in other sections of this report:

Table 1: Wireless Service Provider and PSAP Environments

		Wireless Service Provider Network	
		Pre-IMS-based	IMS-based
Emergency Services Network	Pre-i3 Based	**Environment A:** Voice: - Wireless Service Provider Network is TDM - Emergency Services Network is TDM Text Messaging: Teletype (TTY): - Supported by both Wireless Service Provider and Emergency Services Network. SMS: - SMS to 9-1-1 interim solution may be supported by Wireless Service Provider Network (SMPP or IP to Gateway) - SMS to 9-1-1 interim solution may be supported at PSAP via SMS to 911 Legacy Text Gateway. Instant Messaging: - Not supported by Wireless Service Provider or by Emergency Services Network Multimedia (other than voice and texting): - Not supported by Wireless Service Provider Network - Not supported by Emergency Services Network	**Environment B:** Voice: - Wireless Service Provider Network is IMS Voice over LTE with a media gateway for transcoding to TDM - Emergency Services Network is TDM Text Messaging: TTY: - Real-Time Text (RTT) from device would be converted to TTY in the Wireless Service Provider network towards the Emergency Services Network. SMS: - See Section 6 Need to determine if or how SMS to 9-1-1 would apply in LTE or IMS. Instant Messaging: - Supported by Wireless Service Provider using MSRP within an IMS SIP session. - Not supported by Emergency Services Network Multimedia (other than voice and text): - Supported by Wireless Service Provider Network - Not supported by Emergency Services Network

	i3 Based	**Environment C:** Voice: - Wireless Service Provider Network is TDM - Emergency Services Network is VoIP Text Messaging: TTY: - Supported by Wireless Service Provider and Emergency Services Network. SMS: - SMS to 9-1-1 interim solution may be supported by Wireless Service Provider Network (SMPP or IP to Gateway) - May be supported at PSAP via interim solution for SMS to 9-1-1 over the NENA i3 SIP interface Instant Messaging: - Not supported by Wireless Service Provider - Supported by Emergency Services Network Multimedia (other than voice and text): - Not supported by Wireless Service Provider Network - Supported by Emergency Services Network	**Environment D:** Voice: - Wireless Service Provider Network is IMS Voice over LTE - Emergency Services Network is VoIP Text Messaging: TTY: - Supported as RTT within IMS SIP session by Wireless Service Provider and Emergency Services Network. SMS: - See Section 6 Need to determine if or how SMS to 9-1-1 would apply in LTE or IMS. Instant Messaging: - Supported by Wireless Service Provider and Emergency Services Network using MSRP within an IMS SIP session. Multimedia (other than voice and text): - Supported by Wireless Service Provider Network and by Emergency Services Network

Environment A is the current/legacy network environment in which neither wireless service provider nor emergency services networks have transitioned to support NG9-1-1.

Environments B & C are transitional environments in which either wireless service provider or emergency services networks have evolved to their respective next-generation (i.e., to support NG9-1-1) networks. In Environment B, a wireless service provider network has evolved to a next-generation origination network in advance of the evolution (to NG9-1-1) of connecting emergency service networks. Environment C represents the opposite of Environment B; in environment C the emergency services network(s) has evolved to next-generation but the connecting wireless service provider network(s) has not yet evolved. Because the evolution of originating and emergency networks to NG9-1-1 will be independent of each other, both Environment B and Environment C can be expected to be encountered at any given point in time.

Under **Environment D**, both wireless service provider network(s) and emergency services network(s) have evolved to the respective next-generation networks.

The environments summarized are not exhaustive of all possible combinations, and other combinations can be expected to occur. For example, wireless operators may deploy both pre-IMS-based and IMS-based networks within the same market area in order to support both legacy devices and next-generation devices.

2.2. INTERIM SOLUTION FOR TEXTING TO 9-1-1

The FCC has indicated that it wants to see 9-1-1 emergency services texting capabilities implemented prior to the availability of the longer-term 9-1-1 text and multimedia solution enabled by MMES. A component of this objective is for the address for texting to emergency services to be the same three digit "9-1-1" address that has been standardized for voice calls. (For additional information, see Section 2.6. Statutes and Regulations Implications" and Section 4.3, "Transitioning to Multimedia Emergency Services.")

An interim 9-1-1 texting solution could be a precursor to the long-term texting solution enabled by MMES, but this should not be interpreted as meaning that an interim 9-1-1 texting solution would be only a short-term solution. Interim 9-1-1 texting solution(s) could include either or both of the following:

- Wireless operator native SMS-based
- Third party OTT text-based

The FCC Emergency Access Advisory Committee (EAAC) sponsored an exhibition fair of "text-to-9-1-1" technologies and applications[1] on March 28 and 29, 2012, at the FCC offices in Washington, D.C. At this exhibition, 10 vendors showcased various approaches that employed one or more of the two types of interim texting solutions. Various local and state jurisdictions have deployed several of the solutions demonstrated at the exhibition, as well as other solutions that were not exhibited.

Other factors that can impact wireless operator networks transition to 9-1-1 texting include:

- Lack of central coordination among local and state emergency services jurisdictions; 9-1-1 texting solutions may vary by city, county, state, or region, impacting the user experience for mobile wireless subscribers
- Lack of uniformity among PSAPs; a PSAP serving a wireless service subscriber's immediate location may or may not implement text capability
- Lack of control or visibility of OTT 9-1-1 texting solutions; third-party OTT-based solutions for text-to-9-1-1 are likely to be transparent to wireless operators, and those operators certainly have no control over such applications. On the other hand, the wireless user community is likely to misconstrue that wireless service providers control, support, maintain, and have responsibility for these solutions
- Some third party OTT-based text-to-9-1-1 solutions may be limited to only smartphones or a subset of the same if they require special applications or capabilities that are not available on other phones
- A full determination must be made as to any changes that may be required in wireless service providers' networks to support the three digit "9-1-1" address for text-to-9-1-1 services and whether there may be device limitations that could interfere with generating text messages to the "9-1-1" address
- A full determination must be made as to how to provide accurate caller location information for text-based emergency messages
- Consideration must be given as to how to determine, select and route to the appropriate text-capable PSAP for both wireless service provider-supported and third party OTT-based interim text-to-9-1-1 solutions

[1] FCC Public Notice DA-12-379A1, 9 March 2012, http://www.fcc.gov/document/eaac-exhibition-fair-text-911-technologies.

- Environment D (Section 2.1. Wireless Service Provider and Emergency Services Environments") is the only environment that supports the long-term MMES solution

The wireless industry is developing standards for an interim 9-1-1 texting solution to support capabilities for pre-IMS-based wireless service provider networks to interface with text-capable PSAPs. Choosing not to wait for a clear standards-based direction, some local and state jurisdictions have proceeded to implement a variety of interim ad hoc solutions. Although based on good intentions, the resulting potpourri of interim text-to-9-1-1 implementations presents significant issues for wireless service providers and potentially profound implications for wireless subscribers:

- Does/can the solution implemented by a local or state jurisdiction interconnect with the standards-based solution being developed by the wireless industry?
- How many varieties of text-to-9-1-1 solutions would need to be supported by wireless service provider networks? Can this be done? Would wireless service providers be expected to support these methods through any means, at any cost?
- As to OTT methods, how many text-to-9-1-1 applications must be loaded on subscriber mobile devices in order to cover all service areas in which each subscriber may need to make a text-to-9-1-1 emergency call? Do subscribers understand that a solution that works in one geographic area may not work in another?
- How can wireless service users know which text-to-9-1-1 solution, if any, to employ in any given geographic area?

Additional information about texting to 9-1-1 is provided in Section 4.2, "Implementing Text-Based Messaging Emergency Services."

2.3. INTERCONNECTION IMPLICATIONS

NG9-1-1 will require interconnection between various networks as shown in the following figure:

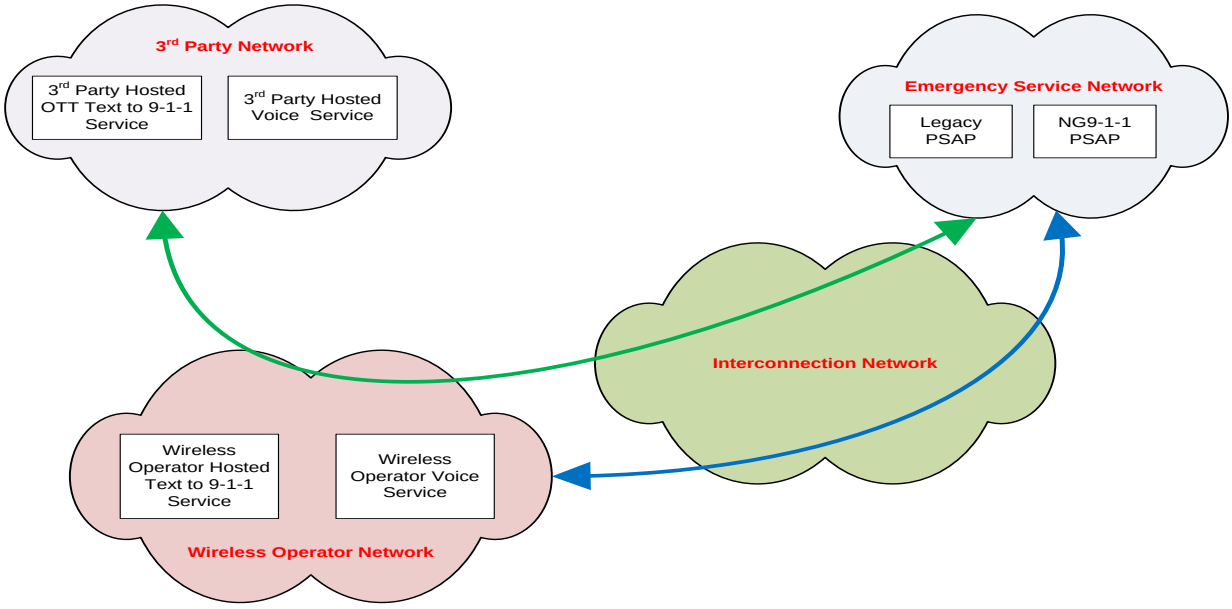

Figure 1: Network Interconnections
(Note: The third party network is utilizing the mobile broadband of the wireless operator)

Network interconnection complexities can be anticipated as a consequence of:

- Wireless service providers offering text-based and voice-based emergency communication services
- Third parties providing OTT text-based and voice-based emergency communication services
- The necessity to route emergency communications through Emergency Services Networks during the transition period to legacy PSAPs or to IP-capable (NG9-1-1) PSAPs

The Interconnection Network shown in the above figure needs to provide the following functions:

- Determine the appropriate PSAPs to which to route calls, according to the abilities of individual PSAPs to process voice and text-to-9-1-1 emergency requests
- Route voice emergency calls to the appropriate PSAPs
- Route text-to-9-1-1 messages to the appropriate PSAPs
- Route OTT emergency communications to the appropriate PSAPs, including:
    - Location determination
    - Location conveyance
- Determine appropriate demarcation points within interconnected networks
- Transcode voice calls
- Perform text message format conversions
- Perform protocol conversions between legacy protocols and NG9-1-1 i3 protocols
- Perform protocol conversions between IMS-based services and legacy PSAP systems

Wireless operators must address a number of issues relating to the Interconnection Network:

- Who owns, operates, and maintains the network elements of the Interconnection Network?
- How is the Interconnection Network funded?
- What changes are required in wireless service provider networks to connect with the Interconnection Network?

2.4. MOBILE DEVICE IMPLICATIONS

A variety of subscriber mobile devices will be in use during the transition to NG9-1-1. The following table lists potential consequences associated with various combinations of differing mobile devices and the environments defined previously in Section 2.1. Wireless Service Provider and Emergency Services Environments":

Table 2: Mobile Device Implications

Mobile Device Type	Implications of Transitioning to NG9-1-1	
	Feature Phone	**Smart Phone**
Legacy pre-IMS mobile device These devices operate only in environments A and C.	Text-to-9-1-1 may be supported via SMS only.	Text-to-9-1-1 may be supported via SMS or as mobile device applications.
IMS only mobile device These devices operate only in environments B and D.	May be able to support text-to-9-1-1 via MMES as RTT or as session-based instant messaging or via SMS; support for text-to-9-1-1 via SMS is to be determined (see Section 6).	May be able to support text-to-9-1-1 via MMES as RTT or as session based instant messaging or as mobile device applications or via SMS; support for text-to-9-1-1 via SMS is to be determined (see Section 6).
Multi-mode mobile device These devices are capable of operating in all four environments. An emergency service request will operate in only one specific mode at a time (legacy or IMS). The selection of the appropriate environment by the mobile device will be based upon the wireless operator's policies and procedures.	Legacy origination: May be able to support text-to-9-1-1 via SMS only. IMS origination: May be able to support text-to-9-1-1 via MMES as RTT or as session-based instant messaging or via SMS; support for text-to-9-1-1 via SMS is to be determined (see Section 6). IMS origination falling back to legacy mode during a session: Text may be dropped or in some cases interworked to legacy formats.	Legacy origination: Text to 911 may be supported via SMS or as mobile device applications. IMS origination: May be able to support text-to-9-1-1 via MMES as RTT or as session-based instant messaging or as mobile device applications or via SMS; support for text-to-9-1-1 via SMS is to be determined (see Section 6).

2.5. IMPLICATIONS FOR END USER EXPERIENCE

As a consequence of their mobility, subscribers can be expected to move between environments, for example:

- Subscribers cross a PSAP service boundary
- Subscribers cross boundary between IMS-based network and pre-IMS network
- Subscribers roam to another wireless service provider's network
- Subscribers move to another geographic area within their wireless service provider's network but under different network implementation

Thus, during this time of transition, emergency callers will encounter differing environments in which varying degrees of next-generation emergency service capabilities will be available. Emergency services available will range from voice-only 9-1-1 calling, to voice plus limited non-voice capability, to varying degree of multimedia capability, and finally to full multimedia capability.

When subscribers move among these environments, their experience with both voice and text emergency services may be dramatically impacted. A fundamental issue that must be resolved is: How will subscribers know if and how their emergency services are impacted as they move from one emergency services environment to another?

Table 3 below summarizes potential impacts on wireless users of the various emergency services environments defined in Section 2.1. Wireless Service Provider and Emergency Services Environments". For IMS environments, this document assumes that IMS subscribers have full IMS capabilities (e.g., voice, text, and video) activated in their subscription and supported on their device. If that were not the case, then only the IMS capabilities activated would be available for MMES.

Table 3: Subscriber Experience in Different Environments

Subscriber's Visited Environment	Subscriber's Home Environment: Environment A	Environment B	Environment C	Environment D
Environment A	No change in subscriber experience for voice emergency calls. SMS to 9-1-1 via interim solution may have been available but may no longer be available depending on PSAP and network capabilities (or vice versa). No change in subscriber experience for TTY. RTT, IM, & MMES are not available to subscribers.	No change in subscriber voice experience with multi mode phone as subscriber goes from VoLTE to TDM voice. No service for IMS only phone since not connected. SMS to 9-1-1 in IMS was TBD and now SMS to 9-1-1 via interim solution may be available depending on PSAP and network capabilities. TTY is available. RTT, IM, & MMES are not available to subscribers.	No change in subscriber voice experience as PSAP is reachable via TDM rather than VoIP. SMS to 9-1-1 via interim solution may have been available and now no longer available depending on PSAP and network capabilities (or vice versa). No change in subscriber experience for TTY. RTT, IM, & MMES are not available to subscribers.	Voice services available with multi-mode phone. No service for IMS only phone since not connected. SMS to 9-1-1 in IMS was TBD and now SMS to 9-1-1 via interim solution may be available depending on PSAP and network capabilities. TTY is available. RTT, IM, & MMES are not available to subscribers.
Environment B	No change in subscriber voice experience with multi-mode phone as subscriber goes from TDM voice to VoLTE. SMS to 9-1-1 via interim solution may have been available but in IMS is TBD. TTY is no longer available but RTT is available. No service for TDM-only phone since not connected. IM & MMES are not available to subscribers.	No change in subscriber voice experience. SMS to 9-1-1 via interim solution in IMS is TBD. No change in subscriber RTT experience. TTY, IM, & MMES are not available to subscribers.	No change in subscriber voice experience with multi-mode phone as subscriber goes from TDM voice to VoLTE. No service for TDM only phone since not connected. SMS to 9-1-1 via interim solution may have been available but in IMS is TBD. RTT is available. TTY, IM, & MMES are not available to subscribers.	VoLTE voice services available with VoIP or multi-mode phone. No service for TDM only phone since not connected. SMS to 9-1-1 via interim solution in IMS is TBD. No change in subscriber RTT experience. TTY, IM, & MMES are not available to subscribers.

	Subscriber's Home Environment			
	Environment A	**Environment B**	**Environment C**	**Environment D**
Environment C	No change in subscriber voice experience. SMS to 9-1-1 via interim solution may have been available but may no longer be available depending on PSAP and network capabilities (or vice versa). No change in subscriber experience for TTY. RTT, IM, & MMES are not available to subscribers.	No change in subscriber voice experience with multi mode phone as subscriber goes from VoLTE to TDM. No service for IMS only phone since not connected. SMS to 9-1-1 in IMS was TBD and now SMS to 9-1-1 via interim solution may not be available depending on PSAP and network capabilities. TTY is available. RTT, IM, & MMES are not available to subscribers.	No change in subscriber voice experience. SMS to 9-1-1 via interim solution may have been available but may no longer be available depending on PSAP and network capabilities (or vice versa). No change in subscriber experience for TTY. RTT, IM, & MMES are not available to subscribers.	Voice services available with multi-mode phone. No service for IMS only phone since not connected. SMS to 9-1-1 in IMS was TBD and now SMS to 9-1-1 via interim solution may be available depending on PSAP and network capabilities. TTY is available. RTT, IM, & MMES are not available to subscribers.
Environment D	No change in subscriber voice experience with multi-mode phone as subscriber goes from TDM to VoLTE. No service for TDM only phone since not connected. SMS to 9-1-1 via interim solution may have been available but in IMS is TBD. TTY is not available to subscribers. RTT is available. Subscriber with IMS or multimode phone can use RTT, IM, and MMES.	No change in subscriber voice experience with VoLTE or multi-mode phone. SMS to 9-1-1 via interim solution is TBD. No change in subscriber experience for RTT. No change in subscriber experience for IM. MMES is available . TTY is not available to subscribers.	No change in subscriber voice experience with multi-mode phone as subscriber goes from TDM to VoLTE. No service for TDM only phone since not connected. SMS to 9-1-1 via interim solution may have been available but in IMS is TBD. TTY is not available to subscribers. RTT is available. Subscriber with IMS or multimode phone can use RTT, IM, and MMES.	No change in subscriber voice experience. SMS to 9-1- via interim solution in IMS is TBD. No change in subscriber experience for RTT, IM, and MMES. TTY is not available to subscribers.

2.6. STATUTES AND REGULATIONS IMPLICATIONS

Current policies, rules, and regulations must be reviewed to ensure that they adequately address the implementation of next-generation emergency services. Policy and rule changes may be required to accommodate differences between voice, text to 911, and multimedia emergency services, and to provide certainty to developers, manufacturers, public safety interests, and next-generation emergency services end users.

Issues ranging from funding to staffing and operational choices must be addressed in order to provide confidence that the solution will be deployed nationally and as seamlessly as possible. Without decisive action the deployment of next-generation emergency services could stall for an indefinite period, frustrating end users unable to access next-generation emergency services and in some cases potentially jeopardizing emergency responsiveness.

With the introduction of Emergency Services IP networks (ESInets) some rules, regulations, and/or policies may need to be broadened to permit emergency call routing to be handled by different entities or in different ways than in legacy systems. Likewise, rules, regulations, and/or policies may need to be broadened to permit changes in emergency call protocols, media, and formats.

3. HIGH LEVEL DESCRIPTION OF END-TO-END EMERGENCY SERVICES COMMUNICATIONS

End-to-end emergency services communications include four key components: end user devices; origination service provider networks; emergency services networks; and PSAPs. These components must be able to interconnect (one network connecting to another), interoperate (different implementations working with each other), and interwork (translation between different protocols, formats, or systems) as specified to complete E9-1-1 or NG9-1-1 emergency calls.

The Figure below depicts at a high-level the architecture of an IMS origination network connected to an Emergency Services Network. This Figure indicates interfaces to Legacy ESN as well as i3 ESInet.

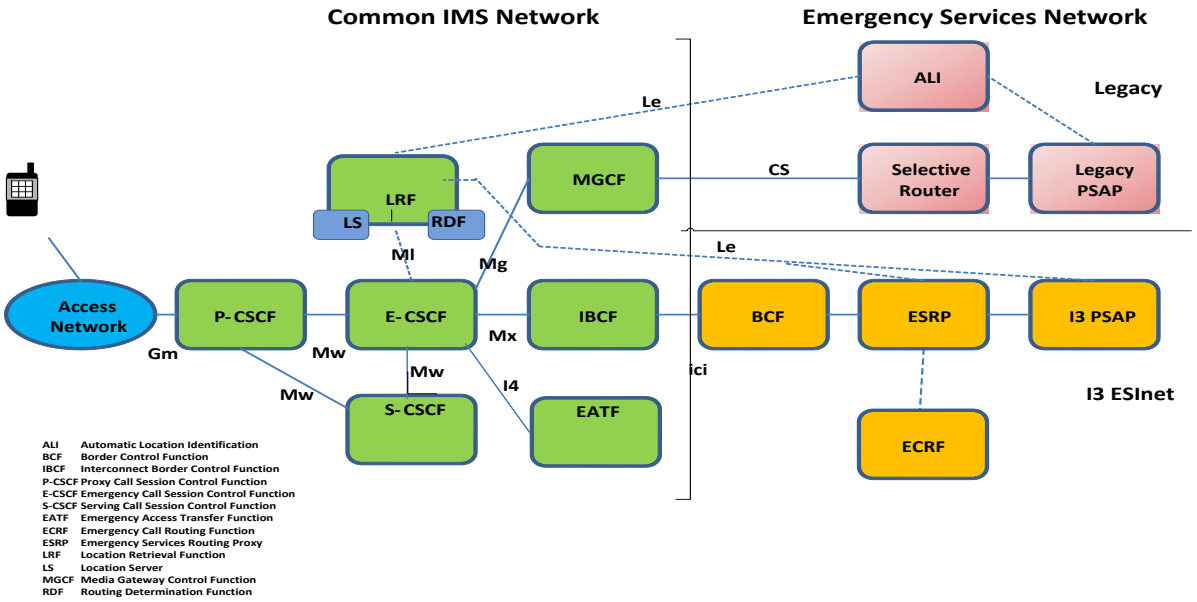

Figure 2: High Level Architecture Diagram

Brief descriptions of the elements of this diagram are as follows:

User Equipment (UE) is as defined in 3GPP TS 23.167.
The UE initiates a request (including an emergency indication) to the P-CSCF for establishment of an emergency session.

Proxy Call Session Control Function (P-CSCF) is as defined in 3GPP TS 23.167.
The P-CSCF receives the emergency session establishment request from the UE, detects the emergency indicator, and forwards the request to the E-CSCF.

Emergency Call Session Control Function (E-CSCF) is as defined in 3GPP TS 23.167.
The E-CSCF receives the emergency session establishment request from the P-CSCF, validates or obtains location information, determines or obtains routing information, and forwards the request in accordance with the routing information.

Serving Call Session Control Function (S-CSCF) is used here as defined in 3GPP TS 23.167.

Location Retrieval Function (LRF) is as defined in 3GPP TS 23.167 and its functionality is expanded within this standard. The LRF retrieves location information for a UE and obtains routing information for an emergency session of the UE from the Routing Determination Function (RDF).

Routing Determination Function (RDF) is as defined in 3GPP TS 23.167 and its functionality is expanded within this standard. The RDF provides routing information for an emergency session.

Media Gateway Control Function (MGCF) is as defined in 3GPP TS 23.167.
The MGCF determines if an incoming call is a PSAP call-back.

Emergency Access Transfer Function (EATF) is as defined in 3GPP TS 23.167.
The EATF supports session continuity (e.g., Handover) of an emergency call initially established using IMS when movement of the UE requires a change of access network from packet network (e.g., LTE) to circuit network (e.g., GSM or UMTS).

Interrogating Call Session Control Function (I-CSCF) is as defined in 3GPP TS 23.167.

Location Server (LS) is as defined in 3GPP TS 23.167.

Automatic Location Identification (ALI) is used to refer to a location database and the mechanisms for populating and accessing the database, and for associating a call with the caller's location. For fixed access, the database is pre-populated with the MSAG-validated civic address associated with the service. For mobile access, the database is dynamically populated with a temporary record. (See "NENA Master Glossary of 9-1-1 Terminology" for further details.)

Border Control Function (BCF) is as defined in NENA i3 and PTSC SBC TR. The BCF controls all traffic into and out of an ESInet. (Normally, originating networks have a secure private [or virtual private] connection to commonly used ESInets, but this does not bypass the BCF.)

Emergency Services Routing Proxy (ESRP) is as defined in NENA i3. The ESRP acts as a SIP proxy within the ESInet, somewhat analogous to an E-CSCF in the originating network.

Emergency Call Routing Function (ECRF) is as defined in NENA i3. The ECRF may be queried to learn how to route an emergency call.

Public Safety Answering Point (PSAP) can be either a legacy PSAP or NENA i3 PSAP. For legacy PSAPs the call is delivered and the PSAP must query for location. An i3 PSAP, on the other hand, is a SIP end point (client) within or connected through the ESInet. An i3 PSAP may either receive location information in the call request or may have to query for location. The human call taker at the PSAP communicates with the originating user.

Selective Router (SR) (also known as a Legacy Selective Router, Enhanced 9-1-1 Control Office, or 9-1-1 Selective Routing Tandem), routes emergency calls to the appropriate PSAP. (See "NENA Master Glossary of 9-1-1 Terminology" for further details.)

4. TRANSITIONING SERVICES TO NEXT-GENERATION EMERGENCY COMMUNICATIONS

The transition to IP-enabled 9-1-1 will be an evolutionary process involving technological, economic, and institutional change. The scope and scale of this effort will present challenges during the progression from a circuit-switched network environment to the IP-based architecture and operation. The paths and schedules for delivering IP-enabled 9-1-1 services to the public will be determined by the manner in which local, regional and State jurisdictions coordinate, deploy and operate their systems. Transition to future 9-1-1 services will also depend on the ability of originating service providers and their underlying networks to locate the origin of IP-enabled 9-1-1 calls and route them appropriately.

Development of next-generation emergency services standards is in process, as are various early ESInet deployments. However, implementation in origination networks is not expected to begin until three or four years from the time of the release of this report. Implementation of next-generation ESInet and PSAP deployments will without doubt vary significantly among regions. When and where next-generation emergency services become available, these solutions initially can be expected to vary considerably among and even within geographic areas. They may not for some time provide full multimedia services. During the protracted transition to full deployment of next-generation emergency services, coordinated transition planning involving all emergency services stakeholders will be essential. As noted previously in this report, emergency callers will encounter differing environments during this time of transition in which varying degrees of next-generation emergency service capabilities will be available. The available services will range from voice-only 9-1-1 emergency calling, to voice plus limited non-voice capability, to varying degrees of multimedia capability, and finally to full multimedia capability.

In order to ensure a seamless transition from the current legacy emergency services environment to the long-term NG9-1-1 solution, industry development of migration strategies will be required. Wireless service providers, ESInet providers, and PSAP authorities must collaborate to develop comprehensive transition plans. Consumers must be informed when transitions will impact the 9-1-1 emergency services available to them.

4.1. TRANSITIONING OF VOICE AND TTY EMERGENCY SERVICES

Today's familiar E9-1-1 voice and TTY emergency services must continue to function without interruption as the industry and emergency services providers progress toward next-generation services. ESInets must include gateways to provide for continuation of both legacy origination and PSAP connections. Such legacy gateways permit E9-1-1 originating networks to deliver legacy voice and TTY calls to ESInets and legacy PSAPs to receive voice and TTY emergency calls. E9-1-1/NG9-1-1 voice emergency services, whether by means of legacy or next-generation networks, must continue reliable, high-quality service to emergency callers without disruption.

4.2. IMPLEMENTING TEXT-BASED MESSAGING EMERGENCY SERVICES

The wireless industry recognizes the need to identify a near-term SMS-to-9-1-1 solution for pre-IMS-based networks (e.g., those deployed today) that will also be consistent with the long-term standards-based MMES solution.

MMES is an enhancement within 3GPP standards specifications for next-generation emergency services. Per 3GPP TS 26.114 "IP Multimedia Subsystem (IMS); Multimedia telephony; Media handling and interaction," MMES deployments will be capable of supporting text-based messaging utilizing: (1) RTT for real-time (character-at-a-time) service per RFC 4103 "RTP Payload for Text Conversation"; and (2) instant messaging (using MSRP per RFC 4975 "The Message Session Relay Protocol" within an IMS SIP session). NENA i3 ESInets will support both RTT and instant messaging using MSRP.

A strategy is required to transition from an SMS-to-9-1-1 interim texting solution to the next-generation MMES texting solution. Wireless service providers believe that, even after MMES 9-1-1 text services have been deployed, SMS-to-9-1-1 interim service will continue to co-exist with the next-generation MMES text services solution for a significant period of time.

4.2.1. INTERIM TRANSITION PLANS – SMS TO 9-1-1

At its March 30, 2012 meeting, the FCC EAAC adopted a resolution to support a SMS-to-9-1-1 solution in as short a time as possible and in advance of the availability of 3GPP MMES deployments. The SMS-to-9-1-1 service envisioned by the EAAC would allow a SMS text user to enter the three digit short code "911" as the address to be used for the emergency communication. The EAAC envisions a service without "relay" functions, i.e., there would be no requirement for human interception or intervention in the path between the end user texting to 9-1-1 and the "text taker" at the destination PSAP.

No special text-related applications are required in an end user device other than native SMS capability and a valid SMS texting subscription. If a subscriber has an SMS-capable phone but does not subscribe to an SMS texting service, the user cannot initiate SMS messages and so cannot participate in SMS-to-9-1-1. Also, an uninitialized phone cannot initiate SMS messages and so is unable to participate in SMS-to-9-1-1. Users with smartphones having the appropriate messaging applications may be able to use the smartphone for SMS-to-9-1-1 as long as the application is capable of sending 3GPP-defined (or 3GPP2-defined) SMS text messages.

The industry is addressing the subject of an interim approach for SMS to 9-1-1 in ATIS (ATIS Issue P0037), and a standards-based solution is expected by the end of the first quarter 2013. The NG9-1-1 migration plan will need to incorporate the (ATIS) recommendation for an interim SMS to 9-1-1 solution when it becomes available, and the industry will need to develop a migration strategy that provides a seamless transition between the interim and long-term NG9-1-1 solutions.

4.3. TRANSITIONING TO MULTIMEDIA EMERGENCY SERVICES

MMES is the term used by the telecommunications industry to identify standards development of next-generation emergency services utilizing multimedia capabilities. MMES is being developed to address the non-voice emergency service needs of the general public, as well as the long term needs of persons with disabilities.

MMES next-generation emergency services provide real-time sessions with the ability to utilize multiple forms of media such as text and voice, that are based on trusted applications in support of both voice and non-voice communications between citizens and emergency authorities. In addition to providing two-way voice emergency communication between citizens and emergency authorities (i.e., PSAPs), MMES supports secure transport of messaging, media content and location information.

MMES can support various forms of communication, in addition to voice, to an emergency services network:

- Text communications between end users and emergency services providers
- Real-time video sessions with emergency services
- Text communications with supplementary media (such as background audio and/or video)
- Communications using voice in one direction with text in the other direction to/from emergency services providers
- Non-streaming multimedia (e.g., pictures, video clips, audio clips) transfer to emergency services providers during a voice or non-voice session[2]

The services described above are supported by MMES in environments where all required components (UE devices, origination networks, emergency service networks, and PSAPs) have migrated to next-generation and support MMES.

Additional support may be required for some services. For example, sign language may require, in addition to full MMES support, standardized procedures for initiating calls (e.g., does the end user initiate an emergency call to a relay service or to 9-1-1, and if the latter, how is the specific requested language [such as ASL] communicated within the session set-up).

MMES offers significant new functionality, such as the ability to dynamically add media during a call. For example, an emergency session might start as text only but have a voice channel added to enhance communications or to allow the call taker to hear background sounds. These capabilities generally are not available during transition stages when one or more required components may not yet be capable of supporting MMES.

Though MMES has considerable potential to enhance next-generation emergency capabilities, it also will have significant impact on the entire next-generation 9-1-1 system as a result of the changes it requires in networks and devices. End user devices and origination networks are expected to eventually evolve to accommodate MMES, and the next-generation 9-1-1 solution recognizes that this evolution will take place over time. Many systems in emergency services networks and PSAPs will also need to adjust.

[2] Support for non-streaming media within an emergency session requires further standardization; see Section 6. ADDITIONAL CONSIDERATION OF KEY TRANSITION AREAS

5. TRANSITIONING DEVICES & NETWORKS TO NEXT-GENERATION EMERGENCY COMMUNICATIONS

As next-generation emergency capabilities are developed and deployed, there will be impacts on the entire emergency service system, with significant impacts resulting from the changes in networks and devices. It is expected that end user devices and origination networks will ultimately evolve, and that the next-generation 9-1-1 solution will allow this evolution to take place over time. However, not all networks, devices, and PSAPs will be enhanced at the same time. Many systems in the PSAPs must eventually change. New end-to-end messaging relationships between origination networks and PSAPs must be established.

5.1 END USER DEVICES

The transition to NG9-1-1 will include facilities that will allow legacy mobile devices to interwork with next-generation emergency voice services. However, legacy devices will not be capable of supporting multimedia emergency services. End users will therefore require MMES-capable mobile devices in order to place multimedia emergency calls and take full advantage of the services available.

Because originating networks, emergency services networks, and PSAPs will be converting to support NG9-1-1 on independent schedules, possession of an MMES-capable device will be necessary but in and of itself not sufficient for the end user to be able to complete an MMES call. Local network or other facilities may not yet have transitioned, thus limiting the overall service capabilities. The ability to establish an MMES call will depend on the specific circumstances present during each call.

Several capabilities have been identified within 3GPP standards to help an emergency caller ascertain whether a MMES-capable end user device can complete an MMES call in a given instance:

- The end user device will provide an indication to the device user as to whether or not each requested media was successfully established
- If none of the media requested by the end user device is successfully established, the IMS multimedia emergency session will fail and the device will provide to the user an IMS multimedia emergency session failure indication
- In the case of network handover of an IMS multimedia emergency session where other media is dropped when IMS multimedia emergency session is not supported, the end user device will indicate to the end user that the other media is not supported in the subject service area

5.2 IMS ORIGINATION NETWORK

IMS origination networks are based on ATIS and 3GPP specifications/standards. Within North America, specifications for interconnection to both legacy emergency service networks and next-generation emergency services networks are based on ATIS standards. For 3GPP standards (specifically 3GPP TS 23.167 and 3GPP TS 24.229), consideration must be given to how the specific aspects of the 3GPP standards apply within the context of the North American architecture.

IMS-based origination networks originate emergency calls and route such calls to a terminating NENA i3/NG9-1-1 ESInet (initial ingress ESInet) or legacy selective router. As a function of call handling within the IMS origination network, the location (or a location estimate) of the originating device is determined and is used to route the call to an appropriate ESInet entry point or to a PSAP via a legacy Selective Router. The initial location information, or

an updated and possibly more accurate version (via re-bid), is made available to PSAPs for dispatching emergency responders.

IMS emergency call origination includes the use of fixed, nomadic, and mobile UEs, routing an emergency call using geographic location or cell site/sector towards a legacy or an IP capable PSAP, and determination and delivery of UE location information either by value or by reference. The specifications for Common IMS-based origination networks support all classes of service; IMS aspects are mostly access-independent and not limited to mobile.

When an emergency call originates on an IMS network and terminates at a legacy PSAP, protocol interworking and media translation are required. Such cases support voice media, do not support video, and may support some forms of text in some uses as discussed throughout this document. The protocol and media interworking and translation may occur within the IMS origination network in the case of terminating via legacy selective router, or in a legacy PSAP gateway in the case of terminating via ESInet.

5.3 EMERGENCY SERVICES NETWORKS

ESInets are managed IP networks that are used for emergency services communications and and can be shared by public safety agencies. ESInets provide the IP transport infrastructure upon which independent application platforms and core functional processes can be deployed, including, but not restricted to, those necessary for providing NG9-1-1 services. ESInets may be composed of dedicated facilities, shared facilities, or a mixture of both types.

ESInets are expected to be deployed at state or regional levels. Each ESInet serves PSAPs within its service area and provides call routing, termination and other services. ESInets may be interconnected at local, regional, state, federal, national and international levels to form an IP-based inter-network (network of networks). It is expected that state and/or local/regional authorities will deploy ESInets that will geographically and administratively encompass PSAPs at state or regional levels. The responsibility for deploying and administering ESInets will fall under the aegis of such authorities.

Originating networks deliver emergency calls to an appropriate ESInet. The selected ESInet uses policy-based routing, taking into consideration the location or location estimate, possibly along with other factors such as PSAP status and potentially call attributes (such as media or language needs), to route the call to a PSAP or another ESInet.

The NENA i3 ESInet architecture is the current framework for next-generation emergency services networks. The interfaces used by the functional elements that reside on the next-generation NENA i3 ESInet are based largely on IETF specifications referenced by NENA specifications.

5.3.1 FUTURE EMERGENCY SERVICES NETWORK CONSIDERATIONS

For some time, Common IMS standards have been undergoing development and enhancement in 3GPP. However, from a next-generation emergency services network perspective, the Common IMS architecture currently only defines emergency service call processing for originating networks and has not specified any NG9-1-1 unique support for emergency services terminating networks (ESInets). This includes data processing, call processing, transport, or delivery of emergency service calls to the appropriate PSAP.

Now that 3GPP has developed Common IMS standards and applied them to originating service providers' networks and the emergency services they support, it is reasonable to consider the application of Common IMS standards to emergency services networks. For service providers who are deploying Common IMS in their networks and are also deploying emergency services terminating networks, efficiencies could be gained and additional capabilities supported by deploying Common IMS elements in both networks. ATIS ESIF has begun the standards work needed to define an IMS-based emergency services terminating network that would enable network service providers to interconnect their common IMS origination networks to PSAPs through an ESInet based on Common IMS.

As this work continues, one goal is to consider support of i3 functionality in a Common IMS environment in a manner that is transparent to PSAPs. When Common IMS provides sufficient support for NG9-1-1 in an emergency services terminating network, ESInet providers could choose whether to build their emergency services networks with generic SIP components or with Common IMS components.

In the end, the distribution of functionality among Common IMS network elements may be different from that of ESInet implemented with generic SIP elements. However, the required external interfaces will need to be compatible, so that any structural differences are transparent to PSAPs.

It is recognized that applying the Common IMS architecture to emergency services networks may highlight gaps in the Common IMS specifications that will need to be addressed. In addition, applying Common IMS architecture to emergency services networks may also result in the identification of additional capabilities not available in the current NENA i3 architecture.

Common IMS-based emergency services networks will need to interconnect with emergency services terminating networks based on NENA i3 to support interworking for the exchange of critical information.

5.4 PSAPS

This report has emphasized that NG9-1-1 will not be accomplished as a "flash cutover." Until the final conversions are completed, there will be legacy PSAPs that must be able to interoperate with ESInets and with PSAPs that have migrated to NG9-1-1.

After ESInets are deployed that can service them, PSAPs will eventually transition from existing legacy E9-1-1 PSAP interconnections to next-generation IP PSAP interconnections. Legacy TDM-based PSAPs will be connected to the ESInet via a gateway (the Legacy PSAP Gateway).

The NENA document "NENA NG9-1-1 Transition Plan Considerations (JID)" available at http://www.nena.org/resource/collection/C34466B1-DFD7-49F2-8908-ECA3F4BDA46B/NENA_77-501-v1_NG9-1-1_Transition_Plan_Considerations.pdf, contains significant detail, explanation, and useful guidance for all stakeholders.

PSAP transition from a 100 percent legacy environment to a completely next-generation environment will take time, and could involve multiple intermediate phases. In the beginning of the transition, legacy PSAPs are connected via TDM trunks to legacy Selective Routers, which are connected to legacy origination networks. At the end of the transition, next-generation PSAPs are connected via IP to one or more ESInets, which are connected via IP to one or more Common IMS Origination Networks. In the interim, many alignments are possible, including a Common IMS origination Network connected to a legacy Selective Router that is connected to legacy PSAPs, a

legacy Origination Network that is connected to an ESInet that itself may be connected to a legacy PSAP and/or an IP PSAP, and other combinations. However, Common IMS Origination Networks are not expected to connect directly to an IP PSAP without an ESInet.

It is likely that in any given area, an early step will be the deployment of an ESInet serving the region or state. Legacy PSAPs will connect to the ESInet by means of a Legacy PSAP Gateway, but may initially also maintain their connections to legacy Selective Routers. Legacy Origination Networks may connect to the ESInet via the Legacy Network Gateway and may likewise choose to maintain their connection to legacy Selective Routers. These legacy Selective Routers may themselves be connected to the ESInet through a Legacy Selective Router Gateway.

As PSAPs migrate to IP, they will be directly connected to one or more ESInets. As Originating Networks migrate to Common IMS, they too will be directly connected to one or more ESInets, but may maintain legacy connections for some period of time.

6. ADDITIONAL CONSIDERATION OF KEY TRANSITION AREAS

As defined in the Scope of this technical report, this project focuses on the transition to NG9-1-1, including the added impacts to emergency services being provided by OTT service providers using wireless access.

The following key areas of transition should be given further consideration:

- Ensure that the PSAP requirements for MMES in NENA 73-501, Use Cases and Suggested Requirements for Non-Voice Centric (NVC) Emergency Services are being adequately addressed in NENA 08-003, Detailed Functional and Interface Specification for the NENA i3 Solution – Stage 3

- Ensure that the end-to-end and other requirements for MMES in NENA 73-501, Use Cases and Suggested Requirements for NVC Emergency Services are adequately addressed in relevant standards developed by ATIS, 3GPP, IETF, and NENA. Examples include support for non-streaming media within an emergency session, conveyance and negotiation of language, and media needs, etc.

- Ensure that the origination network requirements for IMS Multimedia Emergency Services identified in 3GPP TS 22.101, 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Service Principles (Release 11), are being adequately addressed

- Ensure that the end user device requirements for IMS Multimedia Emergency Sessions identified in 3GPP TS 22.101, 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Service Principles (Release 11), are being adequately addressed.

- Develop an NG9-1-1 migration plan that will take into consideration interim SMS text-to-9-1-1 and provide a migration strategy that will accomplish a seamless transition to a long-term NG9-1-1 MMES solution

- The migration plan should also ensure that MSRP per RFC 4175 (see Section 4.2) is supported as the session mode instant messaging protocol

- The ATIS SMS to 9-1-1 project described in Section 4.2.1 should evaluate applicability of SMS to 9-1-1 for next-generation IMS subscribers. This evaluation should determine if an MMES capable device in an IMS network that supports MMES will also support SMS to 9-1-1 and if the same requirements for legacy devices and networks also apply to IMS devices and networks

- Address 3GPP requirements while maintaining compatibility with 3GPP Stages 2 and 3

- Ensure that a viable solution exists that can realistically be deployed to provide accurate and trustworthy location information for emergency calls placed using OTT service providers via wireless access

7. RECOMMENDATIONS AND CONCLUSIONS

Years of industry effort have resulted in significant progress towards complete and deployable standardization of next-generation emergency services. Because all aspects of the end-to-end architecture must be fully addressed, additional standardization work may be needed in some key areas of transition, as identified in Section 6 of this report. We believe that these areas can be addressed through additional industry standardization efforts as noted below:

- ATIS, in conjunction with its current JSMS-to-911 work on Issue P0037, should develop an NG9-1-1 migration plan that will take into consideration the interim SMS to 9-1-1 solution and provide a migration strategy for a seamless transition to a long-term NG9-1-1 MMES solution
- ATIS should ensure that MSRP is the standardized text messaging protocol for the long-term NG9-1-1 MMES solution
- ATIS, with its ongoing emergency services standardization work in the ESIF NGES subcommittee and the IMSESINET task group, should ensure that 3GPP IMS Multimedia Emergency Services requirements are being adequately addressed
- NENA should receive a copy of this technical report and ensure that emergency services network requirements for MMES have been taken in consideration in their next-generation emergency services development work.
- ATIS should ensure that the end-to-end and other requirements for MMES have been addressed by ATIS, 3GPP, IETF, or NENA

APPENDIX A. ACRONYMS AND DEFINITIONS

A.1 ACRONYMS

3GPP	3rd Generation Partnership Project
E9-1-1	Enhanced 9-1-1
ESInet	Emergency Services IP Network
FCC	Federal Communications Commission
HCO	Hearing Carry Over
IETF	Internet Engineering Task Force
MMES	Multimedia Emergency Services
NG9-1-1	Next Generation 9-1-1
NENA	National Emergency Number Association
PSAP	Public Safety Answering Point
RFC	Request for Comments
RTT	Real Time Text
SIP	Session Initiation Protocol
SMS	Short Message Service
TDD	Telecommunication Device for Deaf
TTY	Teletype
VCO	Voice Carry Over

A.2 DEFINITIONS

PSAP	A PSAP is a set of call takers authorized by a governing body and operating under common management, which receives 9-1-1 calls and asynchronous event notifications for a defined geographic area and processes those calls and events according to a specified operational policy.
MMES	Multimedia Emergency Services are next-generation emergency services providing real-time sessions with the ability to utilize multiple forms of media such as text as well as voice, that are based on trusted applications in support of both voice and non-voice communications between citizens and emergency authorities. MMES supports secure transport of messaging and media content, and location information of the reporting device to emergency authorities, in addition to providing two-way voice emergency communications between citizens and emergency authorities (i.e., PSAPs). MMES does not preclude the support of specialized emergency services designed for persons with disabilities without two-way emergency voice communications.

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