June, 2014

WORKING GROUP 1
Next Generation 9-1-1
Task 1 Subtask1

Final Report – Investigation into Location Improvements for Interim SMS (Text) to 9-1-1

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1 Results in Brief

1.1 Executive Summary

The concept of locating an individual making an emergency call to 9-1-1 in order to appropriately route the call to a Public Safety Answering Point ("PSAP") and dispatch first responders is a fundamental principle of our nation's 9-1-1 system. With the exception of wireline calls to 9-1-1, identifying the location of an emergency caller has posed technical challenges for all modes of communication introduced into the 9-1-1 system, including wireless voice calls, interconnected Voice over Internet Protocol ("VoIP"), and, now, short message service ("SMS") text messages to 9-1-1. This report reviews the approaches to provide enhanced location information and evaluates the associated limitations and challenges for SMS text to 9-1-1 services.

All industry, Public Safety and government stakeholders share the goal of locating anyone who contacts 9-1-1, including via text messages, but each stakeholder's views are informed by their knowledge of prior experiences with Enhanced 9-1-1 ("E9-1-1") location technologies and commercially available location technologies for text messages. Wireless service providers seek to offer the best available location information within existing network capabilities for native[1] SMS text to 9-1-1. Public safety representatives seek to receive location information with SMS text to 9-1-1 services that is consistent with the presentation and accuracy provided for wireless E9-1-1 voice calls, and uniformly provided across carriers. All stakeholders recognize that the current deployment of SMS text to 9-1-1 is an interim solution on the path towards Next Generation 9-1-1 ("NG9-1-1").

With these considerations in mind, this report reviews the different uses of location information and approaches to provide PSAPs with consistent and actionable location information for SMS text to 9-1-1 services. Ultimately, this report concludes that there is no solution for generating enhanced location in an SMS text to 9-1-1 session for any currently deployed systems that does not require user equipment ("UE") changes, network changes, or both. However, there are actions that could be taken to provide information during SMS text-to-911 sessions that may be helpful to PSAP Telecommunicators. Thus, the Communications, Security, Reliability, Interoperability Council ("CSRIC") IV Working Group 1 recommends:

- It has been determined that the use of coarse location[2] is preferred for routing SMS text messages to 9-1-1 and it is recommended that the Federal Communications Commission ("FCC") continue to support the use of the Alliance for Telecommunications Industry Solutions ("ATIS")/the Telecommunications Industry Association ("TIA") J-STD-110 which calls for the use of coarse location for routing an SMS text to 9-1-1.

- While the development and deployment of location solutions for SMS text to 9-1-1 should be encouraged, it should also be recognized that some existing technologies, upon which the SMS text to 9-1-1 service is based, face challenges and provide for extremely limited additional standards development. Therefore, it is recommended that the FCC refrain from wireless E9-1-1 Phase II[3]-like mandates for SMS text to 9-1-1 service and

[1] Native refers to carrier supplied underlying basic SMS service that comes with the mobile device.
[2] Definition of coarse location is found on page 10 of this document.
[3] FCC requires wireless carriers to provide Phase II location information for 911 calls, within six months of a valid

instead encourage further development and implementation of more robust Multimedia Messaging Emergency Services ("MMES") solutions based on Long Term Evolution ("LTE")/Internet Protocol ("IP") Multimedia Subsystem ("IMS") as Public Safety evolves towards NG9-1-1 solutions.

- Enhanced location[4] is important in SMS text to 9-1-1 for the dispatching of emergency service resources. Although not all location platforms may be capable of delivering enhanced location information, when such information is available it should be delivered with uncertainty[5] and confidence[6] values. It is recommended that the FCC encourage appropriate standards development organizations to incorporate confidence and uncertainty values into existing standards for enhanced location when it can be provided. Additionally, though location estimates may vary, the confidence values for SMS text to 9-1-1 should be consistent with wireless E9-1-1 voice calls.

- Carrier contact information is critical to resolving emergency situations and, as such, is provided during E9-1-1 voice calls. However, the current ATIS/TIA J-STD-110 standard does not define the provisioning of this information for SMS text to 9-1-1. It is recommended that the FCC encourage standards development organizations to address this issue so that appropriate carrier information is provided to PSAPs when receiving an SMS text to 9-1-1.

- This report has identified two types of location estimates for SMS texts to 9-1-1 requests, coarse and enhanced. However, currently there is only one SMS text to 9-1-1 Class of Service ("CoS") in ATIS/TIA J-STD-036. Because it has been determined that it is important for PSAPs to distinguish between coarse and enhanced location estimates, the need for additional CoS has been identified. Thus, it is recommended that the FCC encourage standards development work in regards to creating additional service classes for SMS text to 9-1-1.

2 Introduction

In December 2010, the FCC issued a Notice of Inquiry ("NOI") entitled "Framework for Next Generation 911 Deployment" seeking comment on NG9-1-1 deployment (PS Docket 10-255).[7] As part of that NOI, the FCC asked questions about technologies that could bridge the gap between legacy 9-1-1 and NG9-1-1, including the use of SMS for 9-1-1 communications. Since that time, the issue of wireless consumers being able to send emergency text messages to PSAPs has been a topic at the forefront of discussions among various stakeholders, including Public Safety, wireless carriers, the deaf, hard of hearing and speech impaired communities, equipment and network services providers, regulators and the public at large. As a product of this dialogue, on December 6, 2012, the four national wireless carriers (AT&T, Sprint, T-Mobile and

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request by a PSAP, as the latitude and longitude of the caller. This information must meet FCC accuracy standards, generally to within 50 to 300 meters, depending on the type of technology used.

[4] Definition of enhanced location is found on page 10 of this document.

[5] Definition of uncertainty is found on page 22 of this document.

[6] Definition of confidence is found on page 22 of this document.

[7] *Framework for Next Generation 911 Deployment*, Notice of Inquiry, FCC 10-200, 26 FCC Rcd. 17869 (2010) ("*Next Generation 911 NOI*").

Verizon), the Association of Public-Safety Communications Officials ("APCO") and the National Emergency Number Association ("NENA") entered into a Voluntary Agreement by which the four carriers committed to make available SMS text to 9-1-1 service to requesting PSAPs nationwide no later than May 15, 2014 ("Voluntary Agreement").[8] This service was and is intended to be an interim, best effort service to fill a specific gap of emergency communications until the deployment of NG9-1-1.

Since the announcement of the Voluntary Agreement, stakeholders have moved forward to develop SMS text to 9-1-1 standards (ATIS/TIA J-STD-110 and ATIS/TIA J-STD-110a), write implementation guidelines for carriers (ATIS/TIA J-STD-110.01), develop planning and implementation guidelines for Public Safety (Ad hoc Service Coordination Group),[9] and engage in campaigns to educate the public about the service. In conjunction with these efforts, the FCC has continued exploring ways to make the text to 9-1-1 experience as consistent as possible with the E9-1-1 voice call experience. As part of this exploration, one of the issues being investigated is the generation of enhanced location estimates for wireless subscribers texting to 9-1-1. Specifically, the FCC has posed the question of whether Phase II voice E9-1-1 equivalent information can be provided to PSAPs during text to 9-1-1 sessions.[10]

As part of the effort to examine the provision of Phase II equivalent information for text to 9-1-1, the FCC charged its CSRIC IV Working Group 1: Next Generation 911 to study the matter. In order to do so, Working Group 1 was divided into tasks, with Task 1 being text to 9-1-1. This task was further subdivided, with Subtask 1 investigating enhanced location estimate generation and providing additional information consistent with E9-1-1 voice calls for texts to 9-1-1. The Subtask 1 team consisted of a cross section of stakeholder participants that encompassed a wide breadth of industry, government and Public Safety knowledge on issues related to 9-1-1. This report is the result of Subtask 1's investigation of SMS text to 9-1-1 enhanced location estimate generation and providing additional information consistent with E9-1-1 voice calls for SMS texts to 9-1-1.

[8] Letter from Terry Hall, APCO International, Barbara Jaeger, NENA, Charles W. McKee, Sprint Nextel, Robert W. Quinn, Jr, AT&T, Kathleen O'Brien Ham, T-Mobile USA, and Kathleen Grillo, Verizon, to Julius Genachowski, Chairman, Federal Communications Commission, and Commissioners McDowell, Clyburn, Rosenworcel and Pai; PS Docket 11-153, PS Docket No. 10-255 (Dec. 6, 2012). ("*Voluntary Agreement*").
[9] *See* ATIS and TIA, Joint ATIS/TIA Native SMS to 9-1-1 Requirements and Architecture Specification (March 2013) ("*ATIS/TIA J-STD-110*") *available at* https://www.atis.org/docstore/product.aspx?id=27924 (last visited April 29, 2014); NENA, Ad Hoc National SMS Text-to-9-1-1 Service Coordination Group (SCG), *Interim SMS Text to 911 Implementation Information and Planning Guide* (February 2014), *available at* http://www.nena.org/?page=textresources (last visited April 29, 2014).
[10] In the Matter of Facilitating the Deployment of Text-to-911 and Other Next Generation 911 Applications Framework for Next Generation 911 Deployment, PS Docket No. 11-153, PS Docket No. 10-255, *Policy Statement & Further Notice of Proposed Rulemaking*, (January 2014) ¶41-44 ("*Text-to-911 Policy Statement & FNPRM*").

2.1 CSRIC Structure

Communications Security, Reliability, and Interoperability Council (CSRIC) IV									
CSRIC Steering Committee									
Chair or Co-Chairs: Working Group 1	Chair or Co-Chairs: Working Group 2	Chair or Co-Chairs: Working Group 3	Chair or Co-Chairs: Working Group 4	Chair or Co-Chairs: Working Group 5	Chair or Co-Chairs: Working Group 6	Chair or Co-Chairs: Working Group 7	Chair or Co-Chairs: Working Group 8	Chair or Co-Chairs: Working Group 9	Chair or Co-Chairs: Working Group 10
Working Group 1: Next Generation 911	Working Group 2: Wireless Emergency Alerts	Working Group 3: EAS	Working Group 4: Cybersecurity Best Practices Working	Working Group 5: Server-Based DDoS Attacks	Working Group 6: Long-Term Core Internet Protocol Improvements	Working Group 7: Legacy Best Practice Updates	Working Group 8: Submarine Cable Landing Sites	Working Group 9: Infrastructure Sharing During Emergencies	Working Group 10: CPE Powering

Table 1 - Working Group Structure

2.2 Working Group 1 Task 1 Subtask 1 Team Members

Working Group 1 Task 1 Subtask 1 consists of the members listed below.

Name	Company
Eric Hagerson, Chair	T-Mobile
Wayne Ballantyne	Motorola Mobility, LLC
Terri Brooks	TruePosition
Kimberly Burdick	Chouteau County MT - Sheriff's Office
Brent Burpee	Verizon Wireless
Kirk Burroughs	Qualcomm
David Conner	US Cellular
Bruce Cox	NextNav
Jay English	APCO
Matthew Gerst	CTIA-The Wireless Association®
Jim Goerke	Texas 9-1-1 Alliance
Jeanna M. Green	Sprint Corporation
Sherri Griffith Powell	L.R. Kimball
Roger Hixson	NENA
Wink Infinger	Florida Department of Management Services
Gerald Jaskulski	Department of Homeland Security - OEC
Ryan Jensen	T-Mobile
Roger Marshall	TeleCommunication Systems, Inc.
Kathy McMahon	MCP
Christian Militeau	Intrado
Martin Moody	Metropolitan Emergency Services Board
Jerry Panagrossi	Invisitrack, Inc.
Ganesh Pattabiraman	NextNav
Gustavo Pavon	TruePosition
Raghavendhra Rao	AT&T
Glenn Roach	Winbourne Consulting
Roderic Robinson	TeleCommunication Systems, Inc.

Cheri Lynn Rockwell	Butte County, CA
Chuck Ronshagen	Cassidian Communications
Susan Sherwood	Verizon Wireless
Greg Schumaker	Sprint Corporation
Dorothy Spears-Dean	Virginia Information Technologies Agency
Kara Thielen	Viaero
Greg Turetzky	Intel Corporation
Kathy Whitbeck	Nsight
Bruce Wilson	Qualcomm

Table 2 - List of Working Group Members

3 Objective, Scope, and Methodology

3.1 Objective

The FCC provided several tasks to Working Group 1. One subtask, in relation to Task 1 text to 9-1-1, was charged with investigating enhanced location estimate generation and providing additional data consistent with E9-1-1 voice calls with texts to 9-1-1. Specifically, the ATIS/TIA J-STD-110 standard specifies the provision of cell site and cell sector location information. The Working Group was tasked to study and report on the technical feasibility for wireless carriers to include E9-1-1 Phase II-like location estimates and information in texts sent to 9-1-1 and make recommendations for including enhanced location information in texts to 9-1-1 requests.

The Subtask team members identified three specific areas for review. The first was location information that is used to route an SMS text to 9-1-1 to the appropriate PSAP. This report will review the current process as outlined in ATIS/TIA J-STD-110 and identify another possible method by which to get initial routing information. The second topic was updating location information during the SMS text to 9-1-1 session. This analysis will identify and review possible methods by which to provide end user location information that may be more accurate than the information used to route the SMS text to 9-1-1. The third area of study was providing additional data consistent with Phase II E9-1-1 voice information that PSAPs may find helpful. Recommendations, if appropriate, will be made for these review areas.

3.2 Scope

This document is based on the Voluntary Agreement to provide the SMS text to 9-1-1 service that was reached between AT&T, Sprint, T-Mobile, Verizon, APCO and NENA. As such, the focus is on native SMS text to 9-1-1 and does not include other Over-the-Top ("OTT") interconnected text providers.[11] This also means that there is no discussion of Non-Service

[11] "Over-the-top" generally refers to applications that operate on IP-based mobile data networks and that consumers can typically install on data-capable mobile devices. In contrast, SMS requires use of an underlying carrier's SMS Center ("SMSC") to send and receive messages from other users. Multi-media Messaging Service ("MMS")-based messaging makes use of the SMSC but also involves the use of different functional elements to enable transport of the message over IP networks. Over-the-top text applications enable consumers to send text messages using SMS, MMS or directly via IP over a data connection to dedicated messaging servers and gateways. Over-the-top texting applications may be provided by the underlying mobile wireless provider or a non-affiliated third-party, and may be

Initialized ("NSI") phones and roaming.

It is important to note that point 8 of the Voluntary Agreement was explicitly limited to the capabilities of the existing SMS service offered by participating wireless service providers. To do otherwise would require substantial 3rd Generation Partnership Project ("3GPP") and 3rd Generation Partnership Project 2 ("3GPP2") standards development work, requiring significant development costs and potentially lead to major operational impacts on existing network systems. Furthermore, there should be no requirements to make changes to existing end user devices or devices currently in carriers' development cycles. As a consequence, legacy devices may not be able to support any recommendations that may be made. Any suggestion that was identified as not comporting with these operational parameters was considered out of scope.

LTE and IMS, the standards of which include the implementation of MMES and Global Text Telephony ("GTT"), are not considered in this report. MMES and GTT both have their own envisioned methods by which text messages can be sent to Public Safety with location estimates included. As an interim solution with an expected end of lifespan of 5 to 10 years, carrier based SMS text to 9-1-1 is only supported by 2nd Generation ("2G") and 3rd Generation ("3G") networks.[12] As these legacy wireless networks are phased out of service, it is probable that SMS text to- 9-1-1 will be supplanted by newer texting technologies, especially as LTE devices with MMES and/or GTT capabilities are sufficiently embedded into carrier subscriber bases.

Therefore, any new functionality should be based on existing standards and be subject to each carrier's determination of the feasibility of any major changes to existing carrier originating network infrastructure.

3.3 Methodology

At the time of its formation, Working Group 1 Task 1 Subtask 1 was charged with investigating a service that had not yet been fully implemented by any carrier, namely SMS text to 9-1-1. As such, topical reference material was limited primarily to newly developed standards documents, the record of several FCC dockets[13] and the Voluntary Agreement.

Working Group 1 Task 1 Subtask 1 held biweekly conference calls between November 13, 2013, and April 30, 2014. These calls were occasionally supplemented with additional Subtask 1 team conference calls. Subtask 1 had a total of 15 conference calls. There were also two face–to-face meetings, February 18, 2014, and April 29, 2014. Some members of the subtask team participated in some or all of three smaller target teams which were focused on specific

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"interconnected" or "non-interconnected." *Text-to-911 Policy Statement & FNPRM at* ¶6 FN 14. *See also* 47 C.F.R. 20.18(n)(1) (defining "covered text providers" to include "…providers of interconnected text messaging services that enable consumers to send text messages to and receive text messages from all or substantially all text-capable U.S. telephone numbers, including through the use of applications downloaded or otherwise installed on mobile phones.") *and* Facilitating the Deployment of Text-to-911 & Other Next Generation 911 Applications, PS Dockets No. 11-153, 10-255, *Report and Order*, 28 FCC Rcd 7556 (2013) ("*Bounce-Back Order*") .

[12] This estimate includes not only Tier 1 carriers, but also Tier 2 and 3 carriers. It is possible that a carrier could migrate fully to 4th Generation (4G) LTE and IMS technologies, thereby decommissioning 2G and 3G networks, in a timeframe shorter than 5 years.

[13] *See* FCC, *Facilitating the Deployment of Text-to-911 and Other Next Generation Applications*, PS Docket No. 11-153 *and Framework for Next Generation 911 Deployment*, PS Docket 10-255.

areas identified for analysis.

The Working Group 1 Task 1 Subtask 1 effort was a collaborative and cooperative one which was based on substantial consensus. If substantial consensus was not achieved for a particular item, then it was not included in this report.

4 Background

The purpose of this section is to provide the reader with some contextual knowledge regarding text to 9-1-1. First, a brief history is provided discussing the events that led up to CSRIC IV Working Group 1 being tasked with generating this report. This is intended to provide technical and regulatory context. Second, the types of location estimates that can be generated during SMS text to 9-1-1 sessions are defined so that the reader can more fully understand the technical issues analyzed in Sections 5 through 7 of this report.

4.1 History of Text to 9-1-1

For much of their existence, the nation's 9-1-1 systems were based on fixed, landline telephone communications technologies on which an individual could originate a 9-1-1 emergency call from a fixed location that could be associated with a specific civic address. As wireless communications became a primary form of communications for many consumers, 9-1-1 systems were modified to accept wireless calls. While consumers inherently benefitted from being able to originate 9-1-1 calls from mobile devices, wireless 9-1-1 calls were unlike wireline 9-1-1 calls that afforded PSAPs with the ability to request and receive fixed, dispatchable address information from location databases. In order to address this issue, wireless location technologies were developed to dynamically calculate and transmit a wireless callers' estimated location to a PSAP. The FCC established rules for these technologies that are currently in a benchmarked process set to end in 2019. Currently, almost 98% of PSAPs have the ability to receive wireless E9-1-1 Phase II location information.[14]

Today, the nation's 9-1-1 systems face similar location challenges as wireless text communications are being made available for PSAPs to accept into existing 9-1-1 systems. The FCC has stated that text to 9-1-1 as an interim solution is a crucial next step in the ongoing transition from legacy 9-1-1 systems to NG9-1-1 systems.[15] However, unlike wireless voice telecommunications service, wireless text communication services were not developed with the expectation that text messaging would be used for 9-1-1 emergency communications. Wireless carriers deploying SMS text to 9-1-1 services have ensured that coarse location information is available to route SMS texts to 9-1-1 to the appropriate PSAP, but the availability of more granular location information with SMS text to 9-1-1 services has been a question of technical and economic feasibility.

As carriers begin to roll out and PSAPs begin to request SMS text to 9-1-1 services, the FCC requested that the CSRIC IV Working Group 1 – Next Generation 911 "study and report on the

[14] NENA, 9-1-1 Statistics, http://www.nena.org/?page=911Statistics (last visited Jan. 23, 2014).
[15] In the Matter of Facilitating the Deployment of Text-to-911 and Other Next Generation 911 Applications Framework for Next Generation 911 Deployment, PS Docket No. 11-153, PS Docket No. 10-255, *Further Notice of Proposed Rulemaking*, 27 FCC Rcd 15659, 78 FR 1799 (2012) ("*Text-to-911 Further Notice*").

technical feasibility for wireless carriers to include E911 Phase 2 [sic] location accuracy and information in texts sent to 911 and make recommendations for including enhanced location information in texts to 911."[16] In order to provide context for the Working Group's analysis and recommendations, it is helpful to appreciate how the issue of location information associated with text to 9-1-1 services has been addressed by the FCC and other relevant bodies to date.

In September 2011, the FCC released a Notice of Proposed Rulemaking ("NPRM") which proposed to accelerate the deployment of NG9-1-1 by enabling the public to send text, video and pictures to PSAPs. [17] Recognizing the benefits of NG9-1-1 as a long-term solution, the FCC suggested that text communications could be delivered to PSAPs in the near term through Teletype ("TTY"), SMS and IP based messaging services, among other technologies and mediums.

While the FCC suggested that these capabilities include "location information," the FCC acknowledged that a SMS-based text message may only be capable of providing cell tower information.[18] Specifically, the FCC's record in response to the NPRM indicated that SMS text to 9-1-1 has a number of technical limitations that affect its ability to support reliable emergency communication, including not providing the sender's location information.[19] The FCC then sought comment on whether the location information limitation could be overcome by a technologically feasible solution.

In December 2012, AT&T, Sprint, T-Mobile and Verizon entered into a voluntary agreement with NENA and APCO, to make SMS text to 9-1-1 available to their customers by May 15, 2014. While not specifically addressing the location accuracy issue, the Voluntary Agreement was premised on a wireless carrier's native SMS service that is "limited to the capabilities of the existing SMS service offered by a participating wireless service provider on the home wireless network to which a wireless subscriber originates an SMS message."[20]

In addition, the FCC released a Further Notice of Proposed Rulemaking ("FNPRM") to propose baseline requirements for all wireless carriers and OTT interconnected text message providers to enable text to 9-1-1 that were modeled on the Voluntary Agreement.[21] The FCC noted that their record indicated it was feasible to use cell sector location to route emergency texts to the appropriate PSAP, but it may be more difficult for Commercial Mobile Radio Service ("CMRS") providers, i.e. wireless carriers, to deliver more enhanced location information in connection with SMS text messages.[22] Specifically, the FCC stated:

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[16] CSRIV IV Working Group Descriptions and Leadership (updated July 29, 2013), *available at* http://transition.fcc.gov/pshs/advisory/csric4/wg_descriptions.pdf (last visited April 29, 2014) ("*CSRIC IV Charter*").
[17] In the Matter of Facilitating the Deployment of Text-to-911 and Other Next Generation 911 Applications, Framework for Next Generation 911 Deployment, PS Docket No. 11-153, PS Docket No. 10-255, Notice of Proposed Rulemaking, 26 FCC Rcd 13615 (2011) ("*Text-to-911 Notice*").
[18] *Text-to-911 Notice* at ¶ 31 (chart).
[19] *Text-to-911 Further Notice* at ¶ 114.
[20] *See Voluntary Agreement.*
[21] *Text-to-911 Further Notice* at ¶ 3.
[22] *Text-to-911 Further Notice* at ¶ 114.

> "The record in this proceeding indicates that providing enhanced location information in connection with text messages is technically feasible but could involve significant changes and upgrades to existing SMS-based text networks. We are therefore concerned that it could initially be overly burdensome to require CMRS providers to comply with the Commission's Phase II E911 location accuracy rules when transmitting text messages to 911. While we recognize the importance of providing enhanced location information to PSAPs, we believe that the benefits of enabling consumers, particularly consumers with hearing and speech disabilities, to send SMS-based or non-SMS-based text messages to 911 outweigh the disadvantages of being unable to provide enhanced location information. Accordingly, we propose that the Commission's Phase II E911 location accuracy requirements not apply to the initial implementation of text-to-911. Nevertheless, we encourage the voluntary development of automatic location solutions for text-to-911 that provide at least the same capability as Phase II location information for voice calls to 911, even if the location solution does not use the same underlying location infrastructure." [23]

As the FCC continued its exploration, ATIS and TIA released J-STD-110, *Joint ATIS/TIA Native SMS to 9-1-1 Requirements & Architecture Specification,* to define the requirements, architecture and procedures for text messaging to 9-1-1 emergency services using native wireless operator SMS capabilities for existing generation and next generation PSAPs.[24] ATIS/TIA J-STD-110 assumes that coarse location information is available for determining the appropriate PSAP to route text message content, but E9-1-1 Phase I and Phase II location accuracy requirements are not applicable to SMS text to 9-1-1.

In March 2013, the FCC's Emergency Access Advisory Committee ("EAAC") recommended that an achievable interim method for SMS text to 9-1-1 was required until NG9-1-1 is fully developed, deployed and adopted by industry, Public Safety and consumers.[25] Among the EAAC's assumptions, the EAAC recognized that: "a short-term solution should not necessarily be subject to all of the requirements of either voice 9-1-1 calls or long-term solutions so that it can be implemented in the near term and without extensively reworking the carrier, handset, or PSAPs systems." The EAAC noted the challenges inherent in providing location information for an interim SMS text to 9-1-1 solution throughout its report but suggested that ATIS/TIA J-STD-110 was one solution that could address the issue of obtaining coarse location for routing an SMS text to 9-1-1.[26]

4.2 Types of Text to 9-1-1 Location Estimates

The following is a discussion of the types of location estimates that can be generated at the start of and during an SMS text to 9-1-1 session. These are referred to as coarse location and enhanced location.

[23] *See Text-to-911 Further Notice* at ¶ 123
[24] *See ATIS/TIA J-STD-110.*
[25] FCC, Emergency Access Advisory Committee, *Report of Emergency Access Advisory Committee (EAAC) Subcommittee 1 on Interim Text Messaging to 9-1-1,* Mar. 1, 2013 ("*EAAC Text-to-911 Report"*).
[26] *EAAC Text-to-911 Report* at 11.

4.2.1 Coarse Location

The following definition for coarse location is taken from ATIS/TIA J-STD-110 (which it should be noted uses the term precise location for the term enhanced location used in this document – see Section 4.2.2 below).

> "Coarse location in the context of mobile communications is typically the initial location estimate of the mobile device that is used only for the routing of emergency services communications (e.g., voice, text). A coarse location is considered as a "good enough" location used to determine routing to the appropriate PSAP (or other Public Safety entity) as compared to a precise (position) location needed for dispatching emergency services to a caller. Coarse location usually consists of the Latitude/Longitude (X/Y) coordinates representing the geographic center (centroid) of the cell site/cell site sector area currently associated with the mobile device where the emergency communication dialogue was initiated."[27]

4.2.2 Enhanced Location

4.2.2.1 Definition of Enhanced Location

The term enhanced location is used with SMS text-to-9-1-1 in order to differentiate a type of location estimate used for emergency dispatch purposes, apart from coarse location which is used for routing. There is currently no requirement within SMS text-to-9-1-1 as to the accuracy of an enhanced location, unlike as is stipulated for Phase II in wireless voice E9-1-1. Enhanced location is typically denoted as a dynamically measured position, as opposed to being a static, manually provisioned or derived value, and is represented as a set of geographic (geodetic) coordinates such as a latitude/longitude pair. When it is produced by means of measurement techniques, the result is referred to as a location (position) estimate that includes some type of uncertainty and confidence value.

The term enhanced location may also refer to any kind of location information that is more accurate than a coarse location and that is useful in dispatching necessary emergency resources to the user requesting help. This may include a manually provisioned location based on a site structure application on a map, or derived location from a geocoding operation or small cell calibrated range value.

4.2.2.2 Types of Enhanced Location

Technology has been developed to locate mobile devices according to different methods. The most widely deployed location method is Assisted GPS ("A-GPS"). A-GPS is also generally considered to offer accurate position results, at least in outdoor (open sky) environments.

Despite the broad acceptance of A-GPS for locating mobile devices, there are several challenges that remain as impediments to widespread use of A-GPS for SMS text-to-9-1-1 services. Some of these challenges include:

[27] *ATIS/TIA J-STD-110* at Section 3.1

- Location Based Service ("LBS") support for A-GPS – Not all carriers have location platforms capable of providing A-GPS location fixes to support the Text Control Center ("TCC").[28] This includes LBS platforms that are not deployed, differences between control plane[29] and user plane[30] solutions, as well as LBS platforms that don't support the necessary interfaces or messages to achieve an A-GPS fix.

- Handset dependencies to support A-GPS – Handsets used to perform A-GPS location must have the required hardware/software built-in and loaded. Though most of the current Original Equipment Manufacturer ("OEM") handsets contain A-GPS support in hardware (e.g., handset support for user plane), some handsets must be loaded with specific software in order to be compatible with the type of location platform used within a given carrier's network.

- A handset in an SMS text-to-9-1-1 session does not necessarily respond in the same way and with the same priority or features during a location message exchange as in a voice E9-1-1 call.

- User privacy settings – For commercial location platforms, whether control plane or user plane, user privacy settings must be considered or a workaround provided.

Besides A-GPS, enhanced position information determined by other methods may be available from a carrier's location platform, with varying degrees of accuracy. These include various location techniques, most specific to a particular carrier network technology or specific location platform, such as Uplink-Time Difference of Arrival ("U-TDOA"), Advanced Forward Link Trilateration ("AFLT"), Round Trip Time ("RTT"), Enhanced Cell Identification ("ECID") and Round Trip Delay ("RTD"). Even standalone GPS where assistance information is not available could be considered as an option.

5 Initial Location Acquisition for SMS Text to 9-1-1 Routing

The purpose of this section is to define and describe the initial routing of SMS messages to 9-1-1 from emergency callers to a PSAP enabled to receive SMS text-to-9-1-1 requests. The focus of this section includes a discussion of location acquisition involving 2G and 3G networks such as Code Division Multiple Access ("CDMA"), Global System for Mobile ("GSM"), Universal Mobile Telecommunications Systems ("UMTS"), and other 3GPP[31] networks and a description

[28] A TCC is a network routing functional element that acts as a gateway between carrier networks and PSAPs as defined per ATIS/TIA J-STD-110 specifically for this purpose.

[29] Control plane is defined as an approach of obtaining location information for a mobile device by sending and receiving messaging between the end device and a location server along a network path that includes carrier controlled and managed elements.

[30] User plane is defined as an approach of obtaining location information for a mobile device by sending and receiving messaging over an IP path established directly between the device and a location server.

[31] Please note: LTE is considered a 4G network. For the purposes of this document, LTE is considered outside the scope of this section. LTE messaging standards are not fully developed, therefore any discussions involving routing texts to 9-1-1 in a LTE environment should be proposed for future study. MMES and GTT for LTE are referenced in Section 3.2 of this report.

for standard routing mechanism for SMS text messages compared to the existing wireless voice E9-1-1 routing method. The following sections are referenced from ATIS/TIA J-STD-110, J-STD-110.a, and J-STD-110.01.[32]

5.1 Current Standard for Routing SMS Texts to 9-1-1

In order to gain a better understanding of the initial routing for SMS texts to 9-1-1, this section illustrates the transit of an SMS text-to-9-1-1 message through a SMSC in the CMRS provider home network over to a carrier-attached routing functional element, and ultimately routed to an appropriate Public Safety emergency services network and PSAP delivered over one of three interface options: TTY (digitized Baudot), Web Services [Hypertext Transfer Protocol Secure ("HTTPS")], or i3 [Session Initiation Protocol ("SIP")/Message Session Relay Protocol ("MSRP")] interface.

In general terms, when a mobile phone user initiates an emergency text to 9-1-1 request using a 911 short code via SMS, the message is received and processed by the SMSC in the CMRS home network. The SMSC then sends this message to the TCC.

In order for the TCC to route the SMS text-to-9-1-1 request to the appropriate PSAP, the TCC first obtains coarse location for the mobile device (e.g., serving cell sector) from a Location Server ("LS") within the home carrier's network, and determines routing instructions from a known Routing Server ("RS"), in order to forward the SMS text message to the appropriate text-capable PSAP. As the TCC-to-PSAP text communication is established, the PSAP customer premise equipment ("CPE") generally automatically requests the device's callback number and initial (coarse) location. After this stage, the PSAP initiates a text message back to the user.

In order to gain a more detailed level of understanding of the three interface delivery options tied to initial routing for SMS messages to a PSAP, please reference ATIS/TIA J-STD-110.[33]

ATIS/TIA J-STD-110 states that the LS is responsible for obtaining the initial location used for routing the initial SMS text-to-9-1-1 message request. ATIS/TIA J-STD-110 is clear that the coarse location used for routing in existing deployments is equivalent with cell site location information.[34] This standard allows for the use of a commercial LBS ("cLBS") when obtaining either the coarse location or a more accurate, enhanced location.

Obtaining an actual location for initial message routing with SMS text to 9-1-1 is different from how wireless E9-1-1 voice routing is performed today. Wireless E9-1-1 relies on the ATIS/TIA J-STD-036 call procedures and call flows that are fundamentally different than how an SMS text message is initiated. Processing an E9-1-1 voice call invokes specialized emergency network functions of either an Mobile Positioning Center ("MPC") or Gateway Mobile Location Center ("GMLC"), that are specific to CMDA or GSM/UMTS networks respectively, to set up initial call routing that is based on serving cell site information, which is linked to a civic location, a specific PSAP and reference identifier information. All of this information is provisioned into

[32] For a complete definition of network architecture, procedures, and guidelines for SMS text –to-9-1-1 emergency services *see ATIS/TIA J-STD-110*, J-STD-110.a, J-STD-110.01 and Implementation Guidelines.
[33] *See ATIS/TIA J-STD-110* at Section 8.
[34] *See ATIS/TIA J-STD-110* at Section 7.2.2.

the MPC/GMLC ahead of time, through coordinated efforts between Public Safety, the CMRS carrier and, in many cases, a third party service provider.

The SMS text-to-9-1-1 solution requires a new network functional element defined as a TCC since an incoming SMS message is not routed in the same manner as a traditional E9-1-1 voice call. The TCC is responsible for receiving an incoming Short Message Peer to Peer ("SMPP") message, querying the CMRS network for initial (coarse) geographic location and for using that location to select an appropriate PSAP, based on jurisdictional boundary data provided by the PSAP.

A description of the routing mechanism used in ATIS/TIA J-STD-110, the functional element defined as the RS explains that the SMS text-to-9-1-1 may be routed based on coarse geographic location or even a finer grained (e.g., enhanced) geographic location, dependent on the capabilities and configuration of each carrier's LS.[35]

5.2 Alternative Routing Arrangement[36]

This section will present an alternative approach to acquiring coarse location for the purpose of routing SMS texts to 9-1-1 that is different from the location provided by a cLBS platform in order to support the routing of SMS messages to 9-1-1. In addition to the existing ATIS/TIA J-STD-110 (and the supplemental ATIS/TIA J-STD-110a and ATIS/TIA J-STD-110.01 implementation guidelines), the following alternative approach is not an industry standard but accepted as technically feasible. This is proposed as an alternative where a carrier may not have a cLBS platform.

5.2.1 Implementing Alternative Network Location Server Instead of a cLBS Platform

ATIS/TIA J-STD-110 defines the LS functional element that is representative of any location server, including a cLBS infrastructure within a CMRS carrier network. The role of the LS is to obtain the SMS text to 9-1-1 user's coarse location (and in certain cases an enhanced location where a cLBS platform is available and capable of generating an enhanced location with the appropriate end user device support). Based on a CMRS provider's existing network infrastructure, the availability to provide a cLBS platform can be limited or technically challenging. Using a control-plane commercial location server, such as an MPC or GMLC, is possible and therefore suggested as an alternative to a cLBS platform to retrieve coarse location, as long as it supports the Mobile Location Protocol ("MLP") interface specified within ATIS/TIA J-STD-110. In order to support this kind of location query, some existing MPC and GMLC platforms would have to undergo considerable development changes. Adapting a control-plane commercial MPC/GMLC to support ATIS/TIA J-STD-110 also has operational

[35] *See ATIS/TIA J-STD-110* at Section 7.2.3.

[36] TruePosition proposed an additional solution in this section which was not included due to lack of support from other members. TruePosition objected to this decision to not include the proposal.

risks that must be taken into account. The provisioning and interfacing of this "specialized" location server to the CMRS carrier network would require careful consideration to implement.

5.3 Findings – SMS Text to 9-1-1 Routing

At the present time not all CMRS providers can provide enhance location information. As discussed in Section 6, the availability of enhanced location information may vary. Therefore routing decisions based on the use of coarse location is still preferable to the use of enhanced location.

5.3.1 Coarse Location v. Enhanced Location Routing

Coarse location as used within ATIS/TIA J-STD-110 is a reference to a cell tower location that is serving a user's mobile device. Since the range that a mobile device can communicate over the air to a radio tower can be a fairly large distance, coarse location, while useful to route an emergency request to the right PSAP in most cases, is probably not sufficient to dispatch emergency resources with precise enough location information to locate the individual sending an SMS text to 9-1-1. In some cases, boundary conditions between jurisdictions impact routing actions. Because a mobile device's actual location may end up just beyond the edge of a cell tower's expected radio coverage area, a request made from one side of a jurisdictional boundary may end up routing to another PSAP of the adjacent jurisdictional boundary. This is an already known issue with wireless E9-1-1 voice calls. Because SMS text-to-9-1-1 is also mobile in nature, and because the actual routing mechanism is similar to that used to route wireless 9-1-1 calls, routing inconsistencies may occasionally happen.

Using enhanced location information to route 9-1-1 calls made via SMS text represents a challenge due to several factors:

- Routing based on enhanced location may not be technically feasible today for some carriers. In the context of location acquisition to support SMS text to 9-1-1, emergency message interaction (emergency mode) with the handset is not specified. This can result in limitations to override user location privacy settings and certain location capabilities (e.g., whether Global Position System ("GPS") is enabled on the handset).

- Enhanced location information takes time to generate. Finer-grained location information that is dynamically generated takes more time to generate compared to coarse location given the nature of real-time measurements and network latencies in processing a real-time position estimate. To rely on enhanced location information for the initial routing of an SMS text to 9-1-1 request would mean that the routing process would have to be delayed, perhaps up to 30 seconds, introducing additional risk to the person needing emergency assistance.

- Generating enhanced location information is challenging. Not all location platforms currently deployed have the underlying technology to generate an enhanced location. Even if the equipment exists in the carrier's network, enhanced location depends on a variety of measurement inputs – some which may not be available at the time location is

requested, impacting the overall yield of the location results. This is discussed further in Section 6.

ATIS/TIA J-STD-110 architecture is an interim solution which makes the baseline assumption that coarse location is used for routing, though ATIS/TIA J-STD-110 allows for routing based on a more accurate enhanced location.

5.4 Recommendations - Coarse Location Generation Methods Acceptable for Routing

Section 5 discusses the current industry procedures related to obtaining location used for routing as well as an alternative option used to support routing based on location generated a different way. To some, the options might appear to be substantially different from one another; however, the overall functionality of each option achieves the same result. Fundamentally, each option utilizes a LS to determine a network-calculated coarse location. In each case, the LS sends coarse location to the TCC based on an MLP request. The TCC uses this initial coarse location information to determine the routing to the appropriate PSAP. Even though carriers with different location platforms may provide somewhat different values for a coarse location based on network coverage and cell/sector placement, TCCs today are designed to consistently route each text request to the designated PSAP, based on the location provided - similar to how wireless E9-1-1 voice works today between diverse carriers' networks.

SMS text-to-9-1-1 routing itself varies somewhat from wireless E9-1-1 voice routing due mainly to the fact that wireless E9-1-1 voice calls are typically routed based on the civic location of a cell tower and sector specific information, whereas ATIS/TIA J-STD-110 routing of SMS text messages is based on the geographic location of a cell site sector. While each system may have the ability to support exception based routing rules for special geographies, the current SMS text to 9-1-1 Geographic Information System ("GIS") routing approach aligns with the future direction of routing within an NG9-1-1 environment. In addition, SMS text to 9-1-1 routing, given its cell sector routing capability, differentiates between sectors on the same tower based on cell/sector location provided and the geographic boundary the cell tower fits into (i.e., a point-in-polygon GIS approach). By contrast, wireless E9-1-1 routing is a database table-driven approach that provides civic location of the cell tower, and typically provides the latitude/longitude of the cell site tower, rather than of the cell sector centroid.

The SMS text to 9-1-1 routing alternatives reflect the diversity in network configurations between each CMRS provider. Therefore, it is recommended that the FCC should continue support of ATIS/TIA J-STD-110 which results in the routing of SMS text to 9-1-1 based on coarse location routing.

6 Updating Location Information During SMS Text to 9-1-1 Sessions

6.1 Analysis – Updating Location Information

6.1.1 Current Process for SMS Text to 9-1-1 Sessions

Updated location information for SMS text-to-9-1-1 is supported by ATIS/TIA J-STD-110 for each of three delivery methods so long as location (coarse or enhanced) information is available from the carrier network. In other words, the TCC has the necessary interface requirements to support a location update request from a TTY, Web Services, or i3 (SIP/MSRP) implementation. ATIS/TIA J-STD-110 defines the TCC-to-LS interface used to relay the location update request as using MLP defined by Open Mobile Alliance ("OMA"). MLP has appropriate parameters to request updated location in addition to its support for initial location used in the routing step.

Whether or not enhanced location information is available (or can be made available) from within a carrier's network depends on technical and non-technical considerations. SMS text-to-9-1-1 already relies on coarse location from the carrier's location platform in order for the TCC to perform location based routing, but the ability to provide enhanced location information useful for emergency dispatch is significantly more challenging. Since carriers operate different types of access and core network technologies, location equipment and standards vary along with the types of wireless networks that are deployed. The type of network that a carrier has deployed also impacts the location technology architecture choices that are available. Different technologies, such as CDMA, GSM, or UMTS, each have specific elements and processes that are defined by standards.

Individual carrier implementation choices also impact the capabilities of specific location solutions, such as control plane verses user plane location architectures. Despite the fact that coarse location may be obtainable from a carrier's location platform, the ability to request or obtain an enhanced location is not necessarily available in a SMS text-to-9-1-1. Today, even in the early stages of SMS text-to-9-1-1 deployment, some carriers have enabled enhanced location technology, which makes it available to the TCC and to PSAPs; in some cases, UE firmware[37] changes will be required for these carriers' networks. Yet, in order to provide enhanced location information from a location platform within a CMRS network, there are several limitations and challenges that must be considered.

6.1.2 Possible Methods for Enabling Updated Location

The following subsections discuss possible methods by which to update location information during a SMS text to 9-1-1 session.

[37] Firmware typically refers to low level software in a wireless device, such as operating system, wireless modem, pre-loaded applications, or low level services software, that can only be changed by, or made available by, the OEM. The term firmware is used to differentiate from software applications that may be downloaded by the user in the field from any application provider.

6.1.2.1 Network Constraints and Scope of Change

Before proposing methods for providing enhanced location information for an SMS text to 9-1-1 session, it must be noted that text to 9-1-1 using SMS is considered an interim solution. Therefore, substantial changes to the existing carrier and Public Safety network elements supporting the E9-1-1 network infrastructure cannot be justified. These principles are summarized below:

1. It is highly desirable to avoid changes to the E9-1-1 emergency network entities supporting emergency voice calling.

2. It is highly desirable to avoid firmware changes to UEs currently deployed in the field. There are two reasons for this:

    a. For UEs no longer in firmware support (per agreement with the OEM and the carrier), any subsequent firmware changes are out of scope.

    b. Even if a firmware change is made available, to provide the desired modifications to generate enhanced location for a SMS text to 9-1-1 session, the end user may decline to download it.

3. No 3GPP or 3GPP2 standards changes should be required to accommodate enhanced location information support for an SMS text-to-9-1-1 session. The rationale for this is that 2G and 3G networks are not adding significant new features.[38]

4. Since LTE has its own MMES architecture, this document considers LTE and MMES to be out of scope, but may be considered for future study.[39]

The location solution architectures described below are exemplary of different architectural approaches to providing enhanced location for SMS text to 9-1-1. By no means are these examples meant to exclude other methods for determining location, but it is expected that any variants would fall into one of these architectural classes.

6.1.2.2 Network Based Location

Network based location, as compared to handset based location, describes a location determination technique that produces an estimate of the location of the handset by network elements alone, without regard to the type of handset being located. Use of network based location systems is an option that avoids emergency-related device-specific behavior[40] and can potentially provide an enhanced location estimate.

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[38] As discussed in Section 3.2 of this report on page 6, any 3GPP and 3GPP2 standards changes made to existing SMS service would likely be a lengthy process, incur significant development costs and potentially lead to major operational impacts on existing network systems. Such substantial changes, costs and network impacts are outside the scope of an interim solution.

[39] See Section 3.2 (Scope) for more discussion of this issue.

[40] For example, some handsets only permit the voice call function during a call to 9-1-1 and will not permit other functions, including sending or receiving SMS text messages.

Two network based location methods considered in this report are U-TDOA and Radio Frequency Pattern Matching ("RFPM"). 3GPP network based location methods based on U-TDOA make time or power measurements on the radio interface to determine the device position, which requires the handset to be in a radio frequency ("RF") transmit state for a brief period (about 1 second) of time, but SMS communication is not blocked during that interval.[41] UMTS has built-in procedures to bring the handset to a state in which it can be located using U-TDOA.[42] Another method, known as RFPM, relies on UE measurements that are reported to a server for location determination.

Network based location systems capable of supporting GSM and UMTS are available and do not require any modification to the handsets. Radio Access Network ("RAN") software and configuration changes pertaining to the necessary U-TDOA protocols may be needed to implement these network based location features. Additionally, certain network based location techniques may be currently employed for only certain CMRS technologies. For example, U-TDOA has so far been deployed for GSM only in the United States. It has not been deployed for UMTS or CDMA by any U.S. carrier at this point in time; doing so would require the addition of Location Measurement Units ("LMU") to the network, in addition to the RAN software changes alluded to above. Therefore, it would be extremely difficult to justify such a network upgrade for an interim SMS text to 9-1-1 location solution.

There are considerations that must be taken into account when applying a network based location solution to CDMA networks. To meet the FCC's 94-102 emergency caller location rules, CDMA networks primarily rely on handset based location solutions.[43] There are unique limitations to network based location solutions when applied to a CDMA environment. Currently CDMA networks support the existing ATIS/TIA J-STD-036 standard for emergency E9-1-1 wireless requirements. In order for network based location systems to be supported in a CDMA environment, new MLP interfaces may be required to support messaging for location queries from the TCC to the MPC/GMLC. Additionally new messaging between the MPC/GMLC, the Home Location Register ("HLR"), and Mobile Switching Center ("MSC") may be necessary. Each new interface needs to be developed and tested. New CDMA network interfaces pose a risk to the existing maintenance procedures and operational sustainability of the existing E9-1-1 emergency platform.

6.1.2.3 Handset Based Approaches

Handset based location technology, using cLBS methods, is currently being used by at least one U.S. CDMA carrier for network deployments supporting SMS text-to-9-1-1. This works effectively for obtaining a coarse location for routing to the appropriate PSAP. In order to obtain an enhanced location, the user must download a location agent application on legacy UEs, which supports location requests from the cLBS on behalf of the TCC. For some handset-

[41] U-TDOA in an SMS session has not been demonstrated in carrier trials, to this point.
[42] *See* 3GPP 36.305, "*Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Stage 2 functional specification of User Equipment (UE) positioning in E-UTRAN*", *available at* http://www.3gpp.org/DynaReport/36305.htm (last visited April 30, 2014).
[43] *Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, CC Docket No 94-102.

based carriers, newer UEs may have the location agent pre-loaded. By incorporating this approach for newer UE models, the OEM can develop, test, and validate enhanced location functionality. In addition to the location agent, the user must also have their location privacy settings turned off so that any commercial location service, including the location agent, may obtain the user location. (This approach does not currently work with all UE operating systems.)

The following illustrates a standards-based approach for requesting updated, enhanced location information between a TCC and a commercial LBS server. To initiate a location update, the PSAP must send a request to the TCC (a function similar to an E9-1-1 voice call rebid) to obtain updated location information pertaining to the mobile device. The TCC queries the appropriate cLBS to obtain enhanced location information. The cLBS can determine the location fix by using either a Mobile Station ("MS") based[44] or MS assisted[45] methodology for calculating the location fix for the mobile device. The cLBS then responds to the TCC with updated, enhanced location. The TCC caches the location information and delivers the location fix to the appropriate PSAP.

It is important to keep in mind that there are three different delivery options for providing SMS text-to-9-1-1 location data to the PSAP. The TTY solution utilizes the Automatic Location Information ("ALI") query method to provide the PSAP with location. Both Web services based and i3 Emergency Services IP Network ("ESInet") solutions provide comparable approaches for updating the PSAP with location information. The Web based and i3 ESInet solutions integrate directly with the PSAP CPE to provide location updates, which means no ALI is required. Regardless of which delivery method is used, the TCC can utilize the same procedures described for obtaining enhanced location, via a network-initiated location request to the cLBS.

6.1.2.4 End-to-End Text to 9-1-1 With Location Embedded in SMS Message Using System SMS application

This entails the idea of embedding A-GPS location into the SMS message, once the 911 destination is detected. The fix would include latitude and longitude coordinates (also known as XY), confidence and uncertainty. The location would be appended at the end of the text message as soon as the user presses the SEND button (e.g., "GPS location = XY, unc = X m, @ X% confidence)". If the GPS or other enhanced location is not available when the user presses SEND, it would be sent in a follow-up text message as soon as it is available. The location would likely need a rigidly defined text format for the location, uncertainty, confidence and CoS values. For example, the location XY could be in the DDD.DDDDD format or whatever the preferred format is for a GMLC sending location to a PSAP.

The new functionality would be achieved via a modification of the embedded, or "System" SMS application that ships with the UE. This means that it would have to be provided for newer UE models having this functionality built into the embedded SMS application, or via an over the air ("OTA") firmware upgrade for recently shipped devices still under software support. Such an

[44] MS-Assisted – in this mode the location server provides assistance data to the MS and receives measurements from the MS. Using this data, the location server performs the position calculation.

[45] MS-Based – in this mode the location server provides assistance data to the MS. Using this data, the MS performs the position calculation.

approach assures that the OEM has developed the enhanced location insertion functionality and has properly validated it in a system test environment.

For this to work, either the user's device needs to have its GPS location privacy setting disabled, or the embedded SMS application must be able to override it once the "911" destination is detected. At this point it is surmised that operating system and modem firmware changes could be required, in addition to the modifications stated above for the System SMS application itself.

The advantages of this approach are:

- End-to-end delivery of GPS location embedded in the SMS message content itself, via the default interface to the PSAP, so no network changes needed.
- Embedded SMS application is validated by the OEM for the location insertion feature; this assures that the new functionality has been subjected to regression testing.

The drawbacks of this approach are:

- New UE software development is required for the SMS embedded application.
- A firmware upgrade is required for a legacy UE, making this not suitable for older UEs no longer in firmware support.
- Even where a firmware upgrade is feasible for the legacy UE, there is no practical method to force the user to upgrade.
- The ability to override privacy settings for the System SMS application may not be possible, depending on the smartphone operating system ("OS") and the OEM.
- The PSAP call taker screen or back end would have to be able to extract the location from the text message and link it to their resident GIS.
- ATIS/TIA J-STD-110 changes would be needed to define this delivery mechanism as well as the exact textual format for the location, confidence, CoS, and uncertainty.
- No carrier or PSAP trials of this approach have been performed.

6.1.2.5 End-to-End Text to 9-1-1 Using Location Embedded in SMS Message Using User-Downloadable Texting Application

This approach provides similar functionality to what is proposed in the section above, but not using the embedded SMS application. The SMS transport would still be used for a 9-1-1 session. Most of the pros and cons described in the section above for the System SMS application still apply. The advantage of this method is that the user could download the application for legacy UEs.

The drawbacks of this approach are:

- There is no practical method to force the user to download the application.
- The user-downloadable application will not be able to override location privacy settings, so it cannot be guaranteed to generate enhanced location in a SMS text to 9-1-1 session.
- The PSAP call taker screen or back end would have to be able to extract the location from the text message and link it to their GIS.
- ATIS/TIA J-STD-110 changes would be needed to define the exact textual format for the location, confidence, and uncertainty.
- The user, in a 9-1-1 emergency situation, would have to remember to use this application, as opposed to the embedded SMS application.
- User-downloadable applications are not validated by the OEM or the carrier. Thus, the user experience could be inconsistent, as well as the actual format of the enhanced location transmitted to the PSAP. The user-downloadable application could use Wi-Fi location or another location method, even if this has not been accepted by Public Safety or the carriers as suitable for E9-1-1.
- The prospect of downloadable applications to perform an end-to-end SMS text to 9-1-1 location solution raises further the concerns about rogue applications that attempt to override location privacy settings, and use the user location for malicious purposes.

6.2 Findings – Updating Location Information

There is no universal method for generating enhanced location in a SMS text to 9-1-1 session that does not require UE changes, network changes, or both. As noted, support for legacy devices cannot be guaranteed for most of the solutions described above; even for newer devices, the user must keep location access enabled for the solution to work. Wireless carriers have taken some effort to provide enhanced location in the interim solution time frame as demonstrated by at least one of the above four categories of solutions being deployed in a partial rollout. Going forward, enhanced location for SMS text to 9-1-1 could continue to be deployed on a subset of the devices and wireless networks, and new solutions may be developed. This is in fact very likely, but key stakeholders should primarily focus their energy on developing a universal next generation solution.

6.3 Recommendations – Updating Location Information

As stated above, it is recommended that the main focus be on a standardized IP-based messaging solution (e.g., MMES), since complex network architectural modifications for providing location in a SMS text to 9-1-1 session are not practical. The FCC should encourage the continued voluntary development of location solutions for SMS text to 9-1-1, but should recognize that some 2G/3G technologies and networks face greater challenges. Therefore, the

FCC should refrain from imposing Phase II-like location mandates for SMS text to 9-1-1, given the transitional nature of the service and legacy nature of the technology.

7 Providing Additional Data

7.1 Analysis – Providing Additional Data

The following additional information consistent with E9-1-1 voice calls has been identified as being important when evaluating location estimates for SMS texts to 9-1-1:

- Uncertainty
- Confidence
- Provider information
- CoS

Uncertainty refers to the radius of a circle centered at the reported position (latitude/longitude) within which the caller's actual location is expected to fall within a certain percentage. That percentage is referred to as the confidence level which is meant to represent the probability of a caller falling within the uncertainty circle. For example, if an uncertainty circle had a confidence level of 90%, then the probability of the caller being within that circle is 90%; there would be a 10% likelihood of the caller being located outside of said circle.

Another piece of information provided with voice E9-1-1 calls is contact information for the provider on whose network the call originated. This contact information is important because if there are issues with maintaining contact with the caller, then a PSAP may need to enlist the support of the provider to help contact or locate that person.

A new, single CoS value was added for SMS text to 9-1-1 in ATIS/TIA J-STD-036. The need to be able to provide an enhanced location estimate during an SMS text to 9-1-1 session, in addition to a coarse location estimate used for text routing, highlights an issue related to available CoS values. Since there is only one CoS for 9-1-1 texts currently, the Telecommunicator will have no idea whether he/she is being presented with enhanced or coarse location information upon a rebid (location update). This could be especially problematic if the texter is moving. Therefore, it may be highly desirable to define additional classes of service for SMS text to 9-1-1. This CoS extension may assist in determining the best way to use additional resources to locate a caller in the event the location is not provided or the location that is verbally provided is inaccurate.

7.2 Findings – Providing Additional Data

ATIS/TIA J-STD-110 incorporates the use of cLBS for SMS text to 9-1-1, which differs from the control plane location platforms used for wireless E9-1-1 voice. As such, different circumstances may come into play when addressing SMS text to 9-1-1 location estimate

calculations. For example, the cLBS platforms that are in the marketplace are not subject to the same regulatory requirements as wireless E9-1-1 voice systems. They vary widely based on a number of factors, e.g., carrier type, location technology, services.

Because different cLBS deployments have different functionalities, they may or may not provide enhanced location, including confidence and uncertainty values. Some carriers may not employ cLBS platforms. Handset privacy settings, which are generally not overridden by cLBS applications, may not allow for the utilization of location technologies that are part of E9-1-1 voice calls because of both technical and legal (privacy) reasons. Furthermore, cLBS platforms are not subject to the same carrier control, hence location estimates may or may not be as reliable or accurate as location technologies that are used for E9-1-1 voice calls.

The conveyance of provider information is not defined in ATIS/TIA J-STD-110. That means that while some SMS text to 9-1-1 solutions can and do supply provider information along with the SMS text to 9-1-1 service, other solutions may not. Since this information can prove invaluable, there is legitimate concern that provider information may not be available to PSAPs.

The inclusion of provider information and additional CoS to differentiate between coarse and enhanced location estimates will require further standards development.

7.3 Recommendations – Providing Additional Data

Based on the analysis and findings in this section, three recommendations are being made to the FCC regarding the providing of additional data.

First, the FCC should encourage appropriate standards development organizations to incorporate confidence and uncertainty values into existing standards for enhanced location when it can be provided. Additionally, though location estimates may vary, the confidence values for SMS text to 9-1-1 should be consistent with wireless E9-1-1 voice calls.

Second, the FCC should encourage relevant standards development organizations to investigate what may be necessary to support provider information, e.g., emergency contact number, being delivered with SMS text to 9-1-1 requests. This information can prove crucial in a successful resolution to an emergency text.

Third, the FCC should encourage the development of additional classes of service for SMS texts to 9-1-1 in order to differentiate between routable and dispatchable location values. As with the above recommendation, much of this work would need to occur in relevant standards development organizations. Knowing whether the location value is coarse or enhanced will assist PSAPs as they work to respond to emergency texts.

8 Conclusion

As SMS text to 9-1-1 service becomes more available across the country, the FCC asked the CSRIC IV Working Group 1 to examine the conveyance of location estimate and additional information for text to 9-1-1. Specifically, the Working Group was tasked with investigating whether it was technically feasible to include E9-1-1 Phase II-like location information for SMS

text to 9-1-1 and whether additional data consistent with E9-1-1 voice could also be provided. As the Working Group 1 Task 1 Subtask 1 team began to do its work, the scope of analysis was formulated by taking into consideration ATIS/TIA J-STD-110, the Voluntary Agreement and relevant parts of the FCC record in several dockets. As such, the solution investigated was native SMS text messaging, a technology that all stakeholders understand is a best effort, store and forward mechanism never designed for emergency communications. Furthermore, since SMS text to 9-1-1 is an interim solution, it is important to note that the Voluntary Agreement was explicitly limited to the capabilities of the existing SMS service offered by participating wireless service providers.

This Working Group divided its investigation into three study areas. The first, initial location acquisition for SMS text to 9-1-1 routing, was intended to investigate alternative ways to provide location information sufficient to route the SMS text to the appropriate PSAP. ATIS/TIA J-STD-110 bases location determination on cLBS. Since not every carrier has cLBS, an alternative method is needed in those instances to provide coarse location for SMS text to 9-1-1 routing. The second study area was focused on identifying methods to provide enhanced location estimates to PSAPs during SMS text to 9-1-1 sessions. Therefore, the feasibility of providing Phase II-like location estimates was examined. The third area of study focused on additional information consistent with E9-1-1 voice calls, such as confidence, uncertainty, CoS and provider information.

The following bullets summarize the recommendations made in this report:

- It has been determined that the use of coarse location is preferred for routing SMS text messages to 9-1-1 and it is recommended that the FCC continue to support the use of ATIS/TIA J-STD-110 which calls for the use of coarse location for routing an SMS text to 9-1-1.

- While the development and deployment of location solutions for SMS text to 9-1-1 should be encouraged, it should also be recognized that existing technologies, upon which the SMS text to 9-1-1 service is based, face challenges and provide for extremely limited additional standards development. Therefore, it is recommended that the FCC refrain from wireless E9-1-1 Phase II-like mandates for SMS text to 9-1-1 service and instead encourage further development and implementation of more robust MMES solutions based on LTE/IMS as Public Safety evolves towards NG9-1-1 solutions.

- Enhance location is important in SMS text to 9-1-1 for the dispatching of emergency service resources. Although not all location platforms may be capable of delivering enhanced location information, when such information is available it should be delivered with uncertainty and confidence values. It is recommended that the FCC encourage appropriate standards development organizations to incorporate confidence and uncertainty values into existing standards for enhanced location when it can be provided. Additionally, though location estimates may vary, the confidence values for SMS text to 9-1-1 should be consistent with wireless E9-1-1 voice calls.

- Carrier contact information is critical to resolving emergency situations and, as such, is provided during E9-1-1 voice calls. However, the current ATIS/TIA J-STD-110

standard does not define the provisioning of this information for SMS text to 9-1-1. It is recommended that the FCC encourage standards development organizations to address this issue so that appropriate carrier information is provided to PSAPs when receiving an SMS text to 9-1-1.

- This report has identified two types of location estimates for texts to 9-1-1, coarse and enhanced. However, currently there is only one SMS text to 9-1-1 CoS in ATIS/TIA J-STD-036. Because it has been determined that it is important for PSAPs to distinguish between coarse and enhanced location estimates, the need for additional CoS has been identified. Thus, it is recommended that the FCC encourage standards development work in regards to creating additional service classes for SMS text to 9-1-1.

9 Appendix 1 – Acronym Table

The following table lists the acronyms used in this report.

Acronym	***Definition***
2G	2nd Generation
3G	3rd Generation
3GPP	3rd Generation Partnership Project
3GPP2	3rd Generation Partnership Project 2
AFLT	Advanced Forward Link Trilateration
A-GPS	Assisted-Global Positioning System
ALI	Automatic Location Information
APCO	Association of Public Safety Communications Officials International
ATIS	Alliance for Telecommunications Industry Solutions
CDMA	Code Division Multiple Access
cLBS	Commercial Location Based Services
CMRS	Commercial Mobile Radio Services
CoS	Class of Service
CPE	Customer Premise Equipment
CSRIC	Communications Security, Reliability and Interoperability Council
CTIA	Cellular Telecommunications Industry Association
E9-1-1	Enhanced 9-1-1
EAAC	Emergency Access Advisory Committee
ECID	Enhanced Cell ID
ESInet	Emergency Service IP Network
FCC	Federal Communications Commission
FNPRM	Future Notice of Proposed Rulemaking
GIS	Geographic Information System
GMLC	Gateway Mobile Location Center
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GTT	Global Text Telephony
HLR	Home Location Register
HTTPS	Hypertext Transfer Protocol Secure
IMS	IP Multimedia Subsystem
IP	Internet Protocol
LBS	Location Based Services
LMU	Location Measurement Unit
LTE	Long Term Evolution
LS	Location Server

Acronym	***Definition***
MLP	Mobile Location Protocol
MMS	Multi-media Messaging Service
MMES	Multimedia Messaging Emergency Services
MPC	Mobile Positioning Center
MS	Mobile Station
MSC	Mobile Switching Center
MSRP	Media Session Relay Protocol
NENA	National Emergency Number Association
NG9-1-1	Next Generation 9-1-1
NPRM	Notice of Proposed Rulemaking
NSI	Non Service Initialized
OEM	Original Equipment Manufacturer
OMA	Open Mobile Alliance
OS	Operating System
OTA	Over the Air
OTT	Over-the-Top (here, a reference to 3rd party texting applications)
PSAP	Public Safety Answering Point
RAN	Radio Access Network
RF	Radio Frequency
RFPM	Radio Frequency Pattern Matching
RS	Routing Server
RTD	Round Trip Delay
RTT	Round Trip Time
SIP	Session Initiation Protocol
SMPP	Short Message Peer-to-Peer
SMSC	Short Message Service Center
SMS	Short Message Service
TCC	Text Control Center
TIA	Telecommunications Industry Association
TTY	Teletype
UE	User Equipment
UMTS	Universal Mobile Telecommunications Systems
U-TDOA	Uplink Time Difference of Arrival
VoIP	Voice over Internet Protocol
Wi-Fi	Wireless Fidelity