Text Messages in a PSAP Environment

APCO Emerging Technologies
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Overview of the technology currently in use to facilitate text messages into a PSAP environment. Discuss the status of interim options and provide example deployments and the potential human and operational aspects of the options and deployments.
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Acronyms and Abbreviations*

For the purpose of this white paper, the following definitions of acronyms and abbreviations apply:

APCO  Association of Public-Safety Communications Officials
API   Application Programming Interface
CSC   Common Short Code
CSCA  Common Short Code Administrator
CTI   Computer Telephony Integration
CTIA  Cellular Telecommunications & Inter Association
E9-1-1 Enhanced 9-1-1
EENA  European Emergency Number Association
IETF  Internet Engineering Task Force
IM    Instant Messaging
MO    Mobile Originating
MT    Mobile Terminated
NENA  National Emergency Number Association
OSI   Open System Interconnection
PSAP  Public Safety Answering Point
RTT   Real-Time Text
SIP   Session Initiation Protocol
SMPP  Short Message Peer-to-Peer
SMS   Short Message Service
SMSC  Short Message Service Center
SMTP  Simple Mail Transfer Protocol
TCP   Transmission Control Protocol
TDD   Telecommunication Device for the Deaf
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Introduction

Scope

This paper evaluates various interim 9-1-1 text solutions, including the technology, operational implications and lessons learned from early deployments. The intent of this paper is to provide the reader with an overview of current text technologies that should be considered for eventual Next Generation 9-1-1 (NG9-1-1) solutions. However, the questions involving other multimedia (e.g. picture, video messaging, or over the top applications) and other associated technology are not addressed at this time. While TTY/TDD is delivered in both ASCII and Baudot formats the interim solution to deliver text to 9-1-1 via TTY/TDD focus on Baudot.

Background Information

Text messaging is a form of non-verbal communication between two entities via an electronic interface, most commonly a mobile electronic device. In the public safety context, the communication may be conducted in any number of formats, including Teletypewriter (TTY), Telephone Device for the Deaf (TDD), Short Message Service (SMS), Instant Messaging (IM), or Real-time Text (RTT). Each of these formats has unique attributes; however, all provide the ability for a caller to communicate non-verbally with a 9-1-1 call taker. In today’s E9-1-1 infrastructure sending a text message from a mobile device direct to a PSAP is not supported.1

On June 9, 2009, the Black Hawk County Iowa 9-1-1 Service Board announced that the Black Hawk Consolidated Public Safety Communications Center became the first PSAP to “successfully receive text messages sent directly to 9-1-1”.2 Through cooperation between several vendors, the PSAP was able to incorporate text messaging into their facility. However, their efforts were focused mainly on those with speech and hearing impairments and cautioned that “a voice call remains the best way to contact 9-1-1.”3 It is important to note that the ability to text to 9-1-1 is limited to a single wireless carrier and currently does not facilitate automatic location information in the form of an address as a landline call or WPH2 latitude/longitude data of wireless devices.

On August 3, 2011, the Durham Emergency Communications Center (DECC) became the second PSAP in the country to implement a text-to-9-1-1 solution for a six-month trial. The implementation involved only a single wireless carrier. In order to send a text to DECC, the “customer must be in range of cell towers in the Durham County area”.4

While both instances of an implementation of a text-to-9-1-1 solution are outstanding achievements, public safety stakeholders, both public and private, are still faced with the conundrum of trying to identify and implement solutions that are workable on a national scale.

On May 4, 2012, Verizon announced that, in cooperation with Telecommunication Systems, beginning as early as 2013, it is planning to launch SMS-to-9-1-1 service nationwide.5 This is the first major step by private companies working to provide this technology. At first, this will only be offered to select PSAPs,

2 http://www.racom.net/newsletter_files/Press_release_6_8_09.pdf
3 Ibid
4 http://www.newsobserver.com/2011/08/03/1388411/durham-verizon-customers-can-now.html
using its existing CDMA SMS network for 9-1-1 text notifications and only to Verizon wireless customers with a text-capable phone and service plan. To increase flexibility for the PSAPs, the program will be offered in three different methods:

- Client Backend delivering content to a PSAP via a secure web browser.
- Client API to support existing CPE equipment required by PSAPs.
- ToIP/TTY Gateway connectivity.

**Definitions**

**Application Programming Interface (API)** - is a source code-based specification intended to be used as an interface by software components to communicate with each other. An API may include specifications for routines, data structures, object classes, and variables. API is an essential feature too. An API specification can take many forms.

**Common Short Codes (CSC)** - are short numeric codes to which text messages can be addressed from a wireless device. Common short codes are easy to remember and they are compatible across all participating carriers. CSCs are either five-digit or six-digit numbers and can be leased by anyone interested in interacting with over 200 million wireless consumers. Wireless subscribers send text messages to short codes to access a wide variety of mobile content for delivery to their wireless devices. Applications of CSCs include sweepstakes, tele-voting campaigns, mobile coupons, in venue, and other promotions as well as a wide range of additional interactive wireless services.

**Common Short Codes Administrator (CSCA)** – CTIA administers common short codes

**Computer Telephony Integration (CTI)** - involves integrating computer systems with telephony resources to augment an organization’s communications capabilities. In the last several years, the definition of CTI has grown to include call routing, the integration of multiple media channels—such as Web, voice, and e-mail—and integration with interactive voice response (IVR) units.

**Cellular Telecommunications & Inter Association (CTIA)** - CTIA-The Wireless Association is an international nonprofit membership organization that has represented the wireless communications industry since 1984. Membership in the association includes wireless carriers and their suppliers, as well as providers and manufacturers of wireless data services and products. The association advocates on behalf of its members at all levels of government. CTIA also coordinates the industry’s voluntary efforts to provide consumers with a variety of choices and information regarding their wireless products and services. This includes the voluntary industry guidelines; programs that promote mobile device recycling and reusing; and wireless accessibility for individuals with disabilities.

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7 http://www.ctia.org/business_resources/short_code/
E9-1-1 – The E9-1-1 feature provides Enhanced 9-1-1 service capabilities and optional PSAP customer services for completing and handling 9-1-1 calls. It provides the capability for the E9-1-1 tandem office to serve several PSAPs within the E9-1-1 service area. The main characteristic of E9-1-1 service is the capability of the E9-1-1 tandem office to selectively route a 9-1-1 call originated from any station in the E9-1-1 service area to the correct primary (or controlling) PSAP designated to serve the originating station’s location.  

Emergency Services IP Network (ESInet) – An ESInet is a managed IP network that is used for emergency services communications, and which can be shared by all public safety agencies. It provides the IP transport infrastructure up which independent application platforms and core functional processes can be deployed, including, but no restricted to, those necessary for providing NG9-1-1 services. ESInets may be interconnected at local, regional, state, federal, national and international levels to form an IP-based inter-network (network of networks).

Internet Engineering Task Force (IETF) - The mission of the IETF is to make the Internet work better by producing high quality, relevant technical documents that influence the way people design, use, and manage the Internet.

Instant Messaging (IM) – refers to the transfer of messages between users in near real-time. These messages are usually, but not required to be, short. IMs are often used in a conversational mode, that is, the transfer of messages back and forth is fast enough for participants to maintain an interactive conversation.

In Network – with the network coverage area

Internet Protocol (IP) - is the method or protocol by which data is sent from one computer to another on the Internet. Each computer (known as a host) on the Internet has at least one IP address that uniquely identifies it from all other computers on the Internet. When you send or receive data (for example, an e-mail note or a Web page), the message gets divided into little chunks called packets. Each of these packets contains both the sender's Internet address and the receiver's address. Any packet is sent first to a gateway computer that understands a small part of the Internet. The gateway computer reads the destination address and forwards the packet to an adjacent gateway that in turn reads the destination address and so forth across the Internet until one gateway recognizes the packet as belonging to a computer within its immediate neighborhood or domain. That gateway then forwards the packet directly to the computer whose address is specified.

Mobile Originating (MO) – messages sent by a mobile handset

Mobile Terminated (MT) – messages sent to a mobile handset

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11 http://www.ietf.org/
12 http://www.ietf.org/rfc/rfc3428.txt
13 http://searchunifiedcommunications.techtarget.com/definition/Internet-Protocol
Next Generation 9-1-1 (NG9-1-1) - A system comprised of hardware, software, data and operational policies and procedures to:

- Provide standardized interfaces from call and messaging services
- Process all types of emergency calls including non-voice (multimedia) messages
- Acquire and integrate additional data useful to call routing and handling
- Deliver the calls/messages and data to the appropriate PSAPs and other appropriate emergency entities
- Support data and communications needs for coordinated incident response and management

OSI Transport Layer (Open System Interconnection) - The transport layer ensures that messages are delivered error-free, in sequence, and with no losses or duplications. It relieves the higher layer protocols from any concern with the transfer of data between them and their peers. Typically, the transport layer can accept relatively large messages, but there are strict message size limits imposed by the network (or lower) layer. Consequently, the transport layer must break up the messages into smaller units, or frames, prepending a header to each frame.

Public Safety Answering Point (PSAP) - A facility equipped and staffed to receive emergency and non-emergency calls requesting public safety services via telephone and other communication devices. Emergency calls are first answered, assessed, classified, and prioritized. The FCC further defines a primary PSAP as a facility to which 9-1-1 calls are routed directly from the 9-1-1 Control Office. A secondary PSAP is defined as a facility to which 9-1-1 calls are transferred from a primary PSAP.

REACH112 (Responding to All Citizens needing Help) - a project partially funded by the European Commission under the Information and Communication Technologies Policy Support Programme (ICT PSP). It represents partners from all over Europe, including user organizations and major global telecommunications companies. In five countries, it will deploy a new communication solution to allow people to communicate in video, voice and text simultaneously, with special focus on people with disabilities. The project will offer access to relay services to help connecting users with different abilities to others and will also provide access to the emergency services. Ultimately the service will benefit all citizens.

RFC4103 - defines a payload type for carrying text conversation session contents in RTP [2] packets. Text conversation is used alone or in connection with other conversational facilities, such as video and voice, to form multimedia conversation services. Text in multimedia conversation sessions is sent character-by-character as soon as it is available, or with a small delay for buffering. The text is intended to be entered by human users from a keyboard, handwriting recognition, voice recognition or any other input method.

Real-Time Text (RTT) – Conversational text that is sent and received on a character by character basis. The characters are sent immediately (in a fraction of a second) once typed and are also displayed.

15 http://support.microsoft.com/kb/103884
17 http://datatracker.ietf.org/doc/rfc4103/?include_text=1
immediately to the receiving person(s). This allows text to be used in the same conversational mode as voice.  

**Real-Time Transport Protocol (RTP)** - provides end-to-end network transport functions suitable for applications transmitting real-time data, such as audio, video or simulation data, over multicast or unicast network services. RTP does not address resource reservation and does not guarantee quality-of-service for real-time services.  

**Session Initiation Protocol (SIP)** is an IETF-defined signaling protocol widely used for controlling communication sessions such as voice and video calls over Internet Protocol (IP). The protocol can be used for creating, modifying and terminating two-party (unicast) or multiparty (multicast) sessions. Sessions may consist of one or several media streams.  

**Short Codes** – See Common Short Codes.  

**Short Message Peer-to-Peer (SMPP)** – An open, industry-standard protocol for sending text message (SMS) data over the internet. It is used primarily for connecting third-party services with SMS centers, enabling various types of automated SMS services. It is also used to link SMS center gateways, enabling inter-carrier messaging.  

**Short Message Service (SMS)** – Enables users to send and receive short text messages (usually about 140-160 characters) on wireless handsets. Usually referred to as “text messaging” or “texting”. Although SMS is commonly used for Mobile to Mobile messages, it is also used today to send messages across multiple paths such as from a mobile device to a personal computer or other endpoints. For instance, in an SMS to E9-1-1 scenario, the path would typically be to/from a mobile device to a telecommunicator at the PSAP.  

**Short Message Service Center (SMSC)** – acts as a centralized store-and-forward device that accepts messages and buffers or retains those messages until a suitable deliver time (i.e., the cell phone is powered on and the location known).  

**Simple Mail Transfer Protocol (SMTP)** – A set of commands that authenticate and direct the transfer of electronic mail from one mail server to a receiving server.  

**Spoofing** – (A) The process of deception by which an individual or system alters its identity or creates additional identities, thereby causing another person or system to act incorrectly. (B) The process of deception by which an unauthorized person causes a transmission or message to appear to come from an authorized user in order to gain privileged access to computer or network resources. IP spoofing, an integral element of many types of network attacks, involves creating TCP/IP packets that use false addresses, perhaps stolen from others. (C) The process of deception by which a system alters its identify or creates additional identities, to impersonate another device in a communications session or

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19 http://www.ietf.org/rfc/rfc1889.txt  
21 http://www.ctia.org/advocacy/research/index.cfm/AID/10406  
23 http://www.sharpened.net/glossary/definition/smtp

**Telecommunicator** - The individual employed by a public safety agency as the first of the first responders whose primary responsibility is to receive, process, transmit, and/or dispatch emergency and non-emergency calls for law enforcement, fire, emergency medical, and other public safety services via telephone, radio, and other communication devices.

**Teletypewriter (TTY)** – also known as **Telecommunication Device for the Deaf (TDD)**, is a device capable of information interchange between compatible units using a dial up or private-line telephone network connection as the transmission medium. ASCII or Baudot codes are used by these units.

**Ten Digit Long Code** – are voice, SMS and fax enabled. They can be accessed from a mobile device, landline, chat window, email or web-based application. These are in the format of NPA-NXX-XXXX (ITU-T E.164 [International Dialing Plan] or ATIS-0300076 [The North American Numbering and Dialing Plan]). Although it has seen limited use, this format is being discontinued in favor of SMS Short Codes.

**Text Relay Service (TRS)** – A telephone transmission service that provides the ability for an individual who has a hearing or speech disability to engage in communication by wire or radio with a hearing individual in a manner that is functionally equivalent to the ability of an individual who does not have a hearing or speech disability to communicate using voice communications services by wire or radio. Such term includes services that enable two-way communication between an individual who uses a text telephone or other non-voice terminal device and an individual who does not use such a device, speech-to-speech services, video relay services and non-English relay services.

**Transaction Mode** – a SMSC may provide this option, where a transmission/text is tried only once, returning proof of delivery as part of the process.

**Transmission Control Protocol (TCP)** - is a transport layer protocol used by applications that require guaranteed delivery. It is a sliding window protocol that provides handling for both timeouts and retransmissions. TCP establishes a full duplex virtual connection between two endpoints. Each endpoint is defined by an IP address and a TCP port number. The operation of TCP is implemented as a finite state machine. The byte stream is transferred in segments. The window size determines the number of bytes of data that can be sent before an acknowledgement from the receiver is necessary.

**User Datagram Protocol (UDP)** - is defined to make available a datagram mode of packet-switched computer communication in the environment of an interconnected set of computer networks. This protocol assumes that the Internet Protocol (IP) is used as the underlying protocol. This protocol provides a procedure for application programs to send messages to other programs with a minimum of protocol mechanism. The protocol is transaction oriented, and delivery and duplicate protection are not

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24 [http://computer.yourdictionary.com/spoofing](http://computer.yourdictionary.com/spoofing)
guaranteed. Applications requiring ordered reliable delivery of streams of data should use the
Transmission Control Protocol (TCP).  

Voice over Internet Protocol (VoIP) - a technology that allows you to make voice calls using a
broadband Internet connection instead of a regular (or analog) phone line. Some VoIP services may only
allow you to call other people using the same service, but others may allow you to call anyone who has a
telephone number - including local, long distance, mobile, and international numbers. Also, while some
VoIP services only work over your computer or a special VoIP phone, other services allow you to use a
traditional phone connected to a VoIP adapter. 

Driving the Need for Text-to-9-1-1

Text messaging is the most common non-voice application via mobile devices used today. The average
person sends 41.5 messages per day, up from the 29.7 messages per day in 2009. If you then consider
those 18-24 years old, the average messages per day rises to 109.5, or 3,200 per month. At the same
time, the number of voice calls, made or received, via cell phone has remained steady at approximately
12.3 calls per day.  

Data presented by Neustar suggests that over 72% of wireless users have paid for
SMS packages and 57% of those over the age of 13 are considered regular text message users.

According to CTIA statistics (referenced in Figure 1 below), the number of SMS text messages has
increased to 2.30 trillion messages per year. Additionally, nearly 32% of households in the United States
have completely “cut the cord”, relying solely on mobile devices for telephone service – an over 400%
increase compared to six years ago.

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<th>Wireless Subscriber Connections</th>
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<th>Dec-01</th>
<th>Dec-96</th>
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<td></td>
<td>331.6M</td>
<td>233.0M</td>
<td>128.4M</td>
<td>44.0M</td>
</tr>
<tr>
<td>Wireless-Only Households (% of U.S. Households)</td>
<td>31.6%</td>
<td>10.5%</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

| Annualized Minutes of Use       | 2.29T     | 1.96T     | 456.96B   | 51.97B    |
| Annualized Yearly Text Messages | 2.30T     | 158.6B    | N/A       | N/A       |

E-911 Calls Per Day  

>400K      260K      139K      55K

In a 2010 study conducted by the American Red Cross, 52% of respondents indicated they would send a
text message to a response agency if it were available. The number of respondents who would send a
text message increases to 66% for those aged 18-34. To bring another perspective to the proliferation

31 http://www.fcc.gov/encyclopedia/voice-over-internet-protocol-voip  
33 http://www.ctia.org/advocacy/research/index.cfm/AID/10323  
Why do we need to look at enabling Text-to-9-1-1?

NG9-1-1 defines an infrastructure for multi-media communication with 9-1-1, but broad deployment of NG9-1-1 networks is years away. Even after network deployment, changes will have to be made to wireless carrier networks to facilitate delivering text messages into those networks in the manner prescribed by NG9-1-1.

The hearing and speech impaired communities are not able to effectively communicate via a mobile device with emergency services today. They represent a population of 54.4 million citizens who are not being provided parity of access to emergency services.

Situations also occur wherein a caller is not able to initiate a voice call to 9-1-1. Silent witness type scenarios represent valid use cases for text-to-9-1-1 outside the hearing and speech impaired communities. For example, Iceland’s 112 system, while deployed for the speech and hearing impaired communities, has been used to alert the police when people have been in cars where drugs are being sold and by people being subjected to domestic violence.

As text messaging becomes a standard communication tool, citizens increasingly expect to be able to send messages via text to 9-1-1.

Technology Overview

SMS

Short Message Service (SMS) allows the exchange of short messages between a mobile station and the wireless system, and between the wireless system and an external device capable of transmitting and optionally receiving short messages. The external device may be a voice telephone, a data terminal or a short message entry system. The term ‘SMS’ has become synonymous for all types of text messaging as ‘texting’ has become more and more commonplace and accepted in today’s society.

SMS Detailed Methodology: Typically, Mobile Originated messages are sent from a handset via a carrier’s network. The carrier network includes a Short message service center (SMSC) which provides a "store and forward" mechanism. The SMSC “stores” the message received and then attempts to “forward” that message to the intended recipient, also via the carrier network. The majority of SMS messages not delivered on a first attempt are because the phone is unreachable (e.g. turned off or temporarily off the network), not because of network congestion or failure as is commonly believed. Messages that are not delivered on the first attempt enter into a robust SMSC retry mechanism, which delivers the message as soon as the recipient becomes available. This proven method ensures that the vast majority of messages will be retransmitted and received successfully.

There has been a great deal of discussion, and even controversy, surrounding the reliability and resilience of SMS as a means to communicate a 9-1-1 emergency request. SMS delivery, while

considered a "best effort", has shown that the complete loss of a message is practically nonexistent and message delays are uncommon, typically affecting less than 1% of messages. Of interest to the PSAP community though, is that in an SMS to PSAP scenario, both the sending and receiving devices would, by definition, be “on,” “in network”, and “not blocked” since the entire emergency scenario begins with a person successfully texting for emergency support. By successfully texting an initial message to the PSAP, the sender ensures that their phone is on and network coverage is available.

If the carrier chooses to do so, SMSCs also provide for a "Forward and Forget" or “Transaction Mode” option where transmission is tried only once, returning proof of delivery as part of the process. These existing protocol methods allow the status of message delivery to the recipient to be presented to the PSAP immediately (e.g., confirmation that the message has been delivered, determination that the handset is not responsive or not reachable, or representation that there is a network error and of what type). With this knowledge, the telecommunicator can decide to take further action; for example, to resend the same message or to attempt to reach the subscriber by voice calling, or to dispatch emergency services based on the information already gathered by the PSAP.

**SMS via 10-digit long code**

The experience of using SMS via a 10-digit long code is what most of the US population is used to today, where a mobile subscriber sends a message (or a series of messages) to a 10 digit number (e.g. 555-555-1212). This is commonly referred to as ‘text messaging’ or ‘texting’. Billions of SMS messages via 10 digit long codes are sent monthly in the United States.

It is generally believed that SMS to E9-1-1 utilizing a 10-digit long code would not be feasible for a nationwide deployment. Some examples of potential deficiencies of this method are:

- 10-digits used for a regional SMS to E9-1-1 deployment strategy would need to be memorized and/or programmed into handsets (e.g. Time consuming and difficult for the vast majority of the population to configure correctly).
- Subscribers traveling outside of their normal coverage area would be expected to know the local 10-digit SMS to E9-1-1 sequence.
- The dynamic input of 10 digits into a device in order to contact the PSAP would be too costly in time and risk to the sender for large scale acceptance.

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- "The CU Team’s study tracked several hundred messages and found that all of the text messages sent were received by the cellular network, resulting in a “data loss rate” of 0% and a reliability level of 100%.”
  - Univ of CO research
- “Other researchers have tested the reliability of Short Message Service (SMS) texts and found that the “data loss rate” over several thousand messages was less than 1%, resulting in a reliability level of 99%. The statistical implication is that large samples might experience a small percentage of data loss, but overall the reliability for text messages is similar to that of voice calls.”
A possible method would be for a nationwide 10-digit (or shorter) number which is geo-targeted to the correct PSAP via carrier methods as discussed below.

**Text to TTY**

Conventional Tele-typewriters (TTY) have been used for many years by the hard of hearing or speech-impaired to communicate with one another and with PSAPs using a common protocol (code) referred to as Baudot. PSAPs are mandated by the federal government to provide 9-1-1 access via TTY for the hearing and speech impaired. However, legacy TTY technology has become antiquated with the inception and increase in popularity of wireless devices and VoIP. Many of the consumers who previously relied heavily on TTY communication now rely on other methods such as SMS. While there are many PSAPs that are willing to discuss how to implement more modern forms of text to 9-1-1 solutions, there is very little funding available to upgrade their systems to do so. Since TTY technology is already present at the PSAP, consideration has been given to converting incoming text, such as SMS to Baudot as an interim text solution. There are known Quality of Service (QoS) issues with Baudot that make any type of conversion to this technology less than desirable. Absent significant funding however, during challenging economic times, text to TTY will remain a consideration for PSAPs that have no other means of receiving text calls to 9-1-1.

**SMS via 4, 5, or 6-digit short codes**

Short codes are special telephone numbers, significantly shorter than full telephone numbers, which can be used to address SMS messages from mobile phones which are sent to an application at the carrier for interpretation of the intended purpose and/or recipient. Short codes are designed to be easier to remember than normal telephone numbers (e.g. HELP = 4357, INFO = 4646, MAIL = 6245). Carriers often have agreements in place for ‘Common Short Codes’ which would allow a single code to be used in an SMS to E9-1-1 application across all carrier networks.

It is understood that SMS via a short code for E9-1-1 access would have more general acceptance by the public than 10 digit short codes (See above). In addition, the technology, procedures and infrastructure to facilitate the use of short codes are already in place in the United States.

Short code SMS messages are delivered via the SMPP protocol. The 4, 5, or 6-digit short codes allow the sender of a message to appear as the same “from” number across multiple carriers. They also enable a sender to utilize a single short code (e.g. 12345) to deliver an MO message to the desired recipient regardless of their wireless carrier. Common short codes (CSC), these short strings of numbers, are administered by a single CSC Administrator (CSCA) - the Cellular Telecommunications & Internet Association (CTIA) - for a group of U.S. wireless carriers. In addition, the CSCA oversees the technical and operational aspects of CSC functions and maintains a single database of available, reserved and registered CSC.

Using a mobile device, users can send a Mobile Originated (MO) message to a short code via SMS. Typically, the carrier utilizes the CSC database to determine where to forward the message. Often, these messages are routed through an aggregator that manages interfaces to a number of application providers. These aggregators fill the role of shielding the carriers from a large number of application providers.
For emergency service use, there are a few different options for short codes. The primary challenge is delivering the message to the correct 9-1-1 answering point, since the messages are not routed from the originating device on the 9-1-1 network. Once the message is delivered from the carrier to the “owner” of the short code, the message must somehow be delivered to the correct PSAP based on the caller’s location. Several options have been implemented:

1) Designate a specific 5-digit short code for a region. Any text to that short code is routed directly to a specific PSAP, regardless of the caller’s actual location.

2) Utilize keywords at the beginning of the text message. For example, New York City residents might send a text message with the prefix NYC. The SMS message is delivered to the owner of the short code who then recognizes the keyword and pushes the message to the correct PSAP.

3) Utilize an intermediary step. In this model an automated request for the caller to specify their location is triggered (e.g. “please type in your exact address”), or a human intermediary who interrogates to determine the location and routes the message to the correct PSAP.

A possible method of delivery currently under development is to deliver the text to a PSAP by commercial location based services versus the current E9-1-1 location based routing.

Once the call has been delivered to a PSAP, there must be a mechanism for answering and responding to the call, since the call is not delivered directly into the 9-1-1 network. Most solutions utilize a dedicated “web page” and workstation for the telecommunicator to communicate with the caller. Some sort of audible and visual alarm indicates a text call has arrived at the dedicated station. The telecommunicator then interacts with the caller via a 2-way SMS session routed through the application vendor. Other options include delivering the SMS text via baudot tones to existing TTY machines.

It should be noted that the integration of public networks such as the internet into secure ESInet applications does bring a certain level of risk to an otherwise secure local area network (LAN). [See page 20 – Text Messaging Vulnerability]

**SMS to 9-1-1**

SMS direct to 9-1-1 (i.e. 3-digit short code) is perceived to be very similar to the 4, 5 and 6-digit short codes as described above, and of course is generally believed to be the most effective method of SMS communication for the general public.

**SMS Location determination**

The SMSC platform currently supported by wireless carriers could be used to route SMS direct to PSAPs. SMS location determination may require additional integration at the carrier level in order to be consistent with existing methodologies used for 9-1-1 today (e.g. WPHI or WRLS, WPH2 ) to route calls to the correct PSAP. While 9-1-1 WPHII location determination would be complementary to a nationwide offering, this would require a separate discussion that is outside of the scope of this document.

**Text to 9-1-1 via Third Party Relay Service**

While the concept of a relay service is familiar to a PSAP through VRS, a TTY/TDD relay service, or language translation service, it may not be the most effective solution. A Text Relay Service requires the caller to contact a third party service to enable a conversation. The third party service must then determine the appropriate PSAP and, when connected, relay all information to and from the telecommunicator. The relay will most likely occur via a voice connection with the relay service and the
PSAP. Once a third party is introduced into the conversation, an inherent delay will exist and any delay in providing emergency services is unacceptable.

**RTT**

Real-Time Text (RTT) is conversational text that is sent and received on a character by character basis. The characters are sent immediately (in a fraction of a second) once typed and also displayed immediately to the receiving person(s). Unlike other forms of text messaging that are asynchronous, RTT can be used in a bi-directional mode similar to voice conversations.

At the core of this framework are SIP control and Real-Time Text transport using Real-time Transport Protocol (RTP) as described in RFC4103. SIP messages initiate sessions and manage the connection and registry between communication end points. RTP is usually transported via the same protocol as VoIP and Video-over-IP. As an IP-based means of communication, RTT requires the accessing device to have access to an IP network (or simply, a data connection). RTT applications can be natively built into the mobile device operating system, or operate as Over-the-Top applications loaded onto the device by the user.

### Status of Interim Options

**Text to TTY**

Currently, the ability to conduct a text conversation in the TTY environment exists once a wireless device is enabled for TTY functionality and if the receiving party has TTY capability or a TTY device. The TTY functionality for a wireless device may either be an option setting or may require hardware attached to the device via the standard 2.5mm headset jack. However, initiating a standard text conversation to or from a TTY device is not currently supported.

Interestingly, the FCC has received proposals from two separate vendors to provide text to TTY that may be used until further network and technological architecture allow more robust solutions.

The first solution is to convert the SMS into a TTY message and delivers to the PSAP via a gateway. Further, the proposal indicates WPH2 location information can also be provided to the PSAP. Essentially, the PSAP will receive the SMS in the same manner as a TTY call, including the Baudot tones associated. The system would also use the existing VoIP Positioning Center (VPC) and Emergency Services Gateway (ESGW) used by VoIP carriers.

The second solution is similar in nature, using a secondary gateway to deliver the SMS to TTY call to the PSAP. However, this solution requires the PSAP have IP-enabled workstations, an API for integration with the CPE vendor, in addition to TTY/TDD equipment. This solution would also provide for WPH2 location delivery.

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39 See the website for the Real Time Text Task Force (R3TF) at http://www.realtimetext.org/index.php?pagina=27
41 http://apps.fcc.gov/ecfs/document/view;jsessionid=TMbyPhPtdTb2C8CnMLjQFSJD338sd4BF3Tjr1dGZ4vTMvyyC59k4!-321460796!1471562840?id=7021899251. See Letter to Marlene Dortch, Secretary, Federal
Both proposed interim solutions provide for direct delivery of a call via a 9-1-1 trunk. These solutions may be more cost effective for the PSAP, as each uses the ubiquitous TDD/TTY equipment already present in almost all (if not all) PSAPs. This methodology requires, however, that the telecommunicator remain on that call for the duration of the incident, as TDD/TTY calls should not be placed on hold. The extended length of an SMS emergency call could have a significant operational impact on centers with a small number of telecommunicators or 9-1-1 trunks.

**SMS via 4, 5, or 6-digit short codes**

**Benefits**

- Allows anyone to send a message to anywhere on any phone.
- Utilizes an interface familiar to most populations.
- SMS as a communication vehicle has shown to be effective in network overload situations.

**Disadvantages**

- Depending on the implementation, may require different numbers to be remembered in different regions, potentially confusing callers.
- Not real time. Delivery times can vary widely from seconds to minutes (although clearly minutes are normally an extreme case). European experience shows that the average call taking time for a SMS-based emergency call is 11 minutes.
- Messages are asynchronous and can be delivered out of order, potentially confusing the telecommunicator or caller.
- Often requires messages to go through numerous aggregators and third parties, raising questions on audit trails.
- No guaranteed message delivery or feedback mechanism for lost Mobile Originated (MO) messages.
- Varying abilities to locate the caller depending on the implementation.

**Example Deployments**

In most instances currently deployed, short code is used for anonymous crime reporting through a third-party program that removes identifying information. There are numerous examples of this format in use today in both large and small metropolitan areas. The anonymity afforded the users promotes the use of such methodology for receiving information on incidents that may otherwise go unreported.

**Operational Learnings**

The same potential drawbacks to using SMS are also present under these circumstances: no location information; timeliness of information; additional equipment or programs required; character limitations that may present issues with understanding for lengthy, out of order, messages, etc.

**SMS to 9-1-1**

**Benefits**

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• Direct receipt of messages without a relay service.
• An avenue of communication available to all with a cellular telephone.
• SMS as a communication protocol has shown to be effective in network overload scenarios.

Disadvantages
• Only Phase I enabled at this time.
• Currently, no mechanism in place to provide for an indication that the response from the telecommunicator was received by the caller.
• Only an indication to the caller provided when the system is unavailable, not if the message was undeliverable – the call could remain in “limbo” without the caller being aware.
• Depending on the implementation, may require hardware changes at the PSAP to facilitate call handling.
• Requires changes to carrier infrastructure.
• Not real time. Delivery times can vary widely from seconds to minutes (although clearly minutes are normally an extreme case). European experience shows that the average call taking time for a SMS-based emergency call is 11 minutes.
• Messages are asynchronous and can be delivered out of order, potentially confusing the telecommunicator or caller.

Example Deployments
The Durham Emergency Communications Center, out of Durham, North Carolina, is in the process of a trial via a cooperative effort with several vendors. At the time of this writing, they have only received a single SMS to 9-1-1 call since starting this project in August 2010. This is not due to lack of advertisement having used a wide range of media to deliver the message to the community: Twitter, Facebook, list serve accounts, and other media sources. Further, this is less than expected in an area which includes Duke University and North Carolina Central University.

In order to facilitate the delivery of SMS to 9-1-1, the wireless carrier is passing all text messages through third-party gateway, which, in turn, then filters the SMS to 9-1-1 calls for delivery to the PSAP. The text is not delivered via the ACD system in place but comes into a separate queue button on the telecommunicator’s screen. The “call” rings at all stations and the available telecommunicator answers to initiate the process. The messaging is then handled via the TTY module incorporated into the CTI system. This methodology allows for pre-scripted messages to speed the receipt of pertinent information. Additionally, a telecommunicator is able to handle multiple text messages as well as phone calls aiding productivity.

All text messages are printed for record keeping purposes. The reporting system accompanying the CTI shows the answer time of the telecommunicator and the time of messages sent or received, but does not capture the time of the originating message. However, according to James Soukup, Director of the DECC, they have not been experiencing any delays in delivery during the twice-daily testing done by personnel.

Operational Learnings
Perhaps the greatest operational lesson in the Durham Emergency Communications Center is that we may not be overwhelmed with SMS to 9-1-1 calls.
Text to 9-1-1 via Third Party Relay Service

RTT

Benefits

RTT provides a number of key operational communication benefits:

- Provides real-time feedback – both the telecommunicator and caller can see that the other side has received and is responding to their message.
- There are a number of encryption options, ensuring message traffic is secure.
- There is no limit to the length of a message (SMS is limited to 160 characters).
- No message delay.
- Broad support for Video and picture messaging.

Disadvantages

- RTT requires a data connection. Currently these connections do not receive priority on the carrier communication networks. The coverage and effect of data connection loss is to be determined.
- Is not currently available natively on carrier devices or used in other common forms of communication. This means that users would have to install a separate application for emergency communication that may not be as familiar as other means of communication they use more frequently.
- Depending on the implementation, may require hardware changes at the PSAPs.
- Depending on the implementation, may require a phased roll out with different levels of service available in different geographic regions at different times.

Example deployments

Early testing is being done in Spain, but the results of this deployed are not known. There are currently no announced deployments in the United States.

Operational Learnings

N/A

Europe’s REACH112 project

In addition to the current efforts in the United States, Europe has also been introducing the concept of texting to 112, the European emergency services number. The on going efforts in Europe have seen more instances of implementation than the U.S. and their processes and information are thereby useful for our purposes.

Example Deployments
Iceland, which operates a single PSAP for the country, has been receiving SMS messages to 112 since April 2006. As with other efforts, the intention is to address the needs of the Hearing Impaired community but has seen usage from others during some emergent situations. As with a normal TTY/TDD conversation, Iceland has developed predetermined responses for SMS messages in an effort to facilitate the communication process. Further, they encourage the deaf and hearing impaired that have an underlying medical condition to have prepared emergency SMS messages available for use.

Just as with a standard voice initiated call, all SMS messages receive a response from a telecommunicator. Since location information is not available via SMS, they are often required to contact the caller and request the caller telephone 112 directly. For 2008, it is estimated they received an average of 124 SMS messages a month. By general observation, Iceland has determined that approximately 3% of the total messages are truly emergency SMS contacts. However, even one that may provide valuable assistance is worth the time.

In Sweden, the implementation included RTT in addition to a video component called Total Conversation and is routed through two specific PSAPs. If the call is for another PSAP, the call is handled by the two PSAPs and the information is passed to the destination PSAP. Again, this system is mostly focused on the hearing and speech impaired community rather than a wholesale deployment. Each time a message is initiated, the caller is automatically connected to a relay service and a telecommunicator at the same time. Not only are the three parties connected for the text communication, the connection also includes a video component allowing the telecommunicator to assess the situation visually. This methodology requires extra hardware and an IP connection to the 112 facility, requiring additional time and resources to deploy.

**Operational Learnings**

One of the more common threads learned with SMS implementation is the additional length of time associated with processing a text. In an industry measuring seconds, 13 minutes is a lifetime.

**Text Messaging Vulnerability**

Any discussion regarding sending a text message into a PSAP must also consider potential security or veracity concerns. “Spoofing” is already a concern for consumers in regards to email messages but it also affects text messages in that a well-versed person may spoof the caller ID from whom the message was sent. Fortunately, for a standard voice call into a PSAP via analog lines, the caller information takes a different path and instances of ANI spoofing are non-existent. However, as PSAPs migrate to an IP-based infrastructure to allow for the messaging, the vulnerability to spoofing and other potentially malicious messages increase.

To help combat, or at least increase enforcement capabilities, the Truth in Caller ID Act was signed into law in 2010 expressly to prohibit “spoofing” of caller ID for malicious intent or to defraud. In the FCC’s paper on Caller Identification Information in Successor or Replacement Technologies, June 22, 2011,
issues concerning the vulnerability to spoofing that may occur, even in a PSAP, were further identified.\footnote{See Federal Communications Commission, Caller Identification Information in Successor or Replacement Technologies, DA 11-108, (filed June 22, 2011), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-11-1089A1.pdf} Furthermore, the 2010 white paper produced by the 4G Americas called \textit{Texting to 9-1-1: Examining the Design and Limitations of SMS}, also raises concerns about vulnerabilities.\footnote{See \textit{Texting to 9-1-1: Examining the Design and Limitations of SMS} (dated October 2010), by 4G Americas, available at http://www.4gamericas.org/documents/SMS%20to%20911%20White%20Paper%20Final%20October%202010.pdf}

There are many third-party services that are available to the public that offer the ability to change the originating number of an SMS. Such services do make users aware of the potential legal ramifications of their offering but generally do not monitor that activity of the user. This can be done either via a mobile device or through a home computer. Potentially, a message can even be generated via a provider’s website that allows messaging and does not verify the user’s input before sending.

One possible scenario is that an individual could generate a message to a PSAP that requires a large-scale response, such as a Special Weapons And Tactics (SWAT) unit. Not only would this potentially tie up valuable resources, it could endanger otherwise innocent parties.

An additional consideration for messaging may be addressing. When RTT becomes a reality on a broad scale, a user may send a message to 9-1-1 and other persons at the same time. If one of those other parties is not within the same area as the sender and replies to “All”, it may generate an additional message to another PSAP but not the original PSAP. Instead of a single PSAP responding to an incident, a second PSAP may inadvertently become involved.

The worst-case scenario for any implementation of messaging into a PSAP in an IP-based infrastructure would be the introduction of a virus into the network.

\section*{Human and Operational Aspects of NG 9-1-1}

While other sections of this white paper have addressed the pressing technological issues of Next Generation 9-1-1, no review of the subject would be complete without an assessment of the human and operational impact of the impending migration. The rapid progress of change during recent decades has presented PSAPs with a variety of challenges such as enhanced wireless 9-1-1 and Voice over Internet Protocol (VoIP.). However, none of these marks such a complete revision of the way we do business as the advent of true Next Generation 9-1-1 services.

A measurable portion of the current human challenge is to truly understand what NG is and what it takes to get there. Hopefully this document will shed some light on these issues; however, many telecommunicators – and even administrators – wrestle with grasping the concept as a whole. As such, there is misunderstanding, stress, and fear over what is the real cost (both in cash and impact upon
operations) and the timeline for implementation.\(^{44}\) At this writing, the committee is unaware of any 100% Next Generation Compliant PSAPs in the United States, nor is there a firm and codified “drop dead date” by which agencies must comply with providing all of the services associated with NG 9-1-1. Those facilities currently providing text to 9-1-1, for example, do not all share a common methodology, nor is there sufficient data available from these trials on which to accurately make projections nationwide. For example, Durham, NC, reports an extremely low usage of their 9-1-1 text service. While this trial is limited to a single carrier, this carrier has a significant market share and the region is known for both high-tech industry as well as several major universities. Given the latter, one might expect a higher than average usage, yet the experience speaks otherwise.\(^{45}\)

Despite the lack of data concerning prospective volume, there are some relatively reliable assumptions that can be made based upon other experience and knowledge. Included here are:

- A text conversation will take longer to process than a voice conversation regarding the same amount of information.
- The ability to actively interact with the caller is of benefit to the telecommunicator.
- Unlike TTY/TDD usage, there is currently no “official” guide to abbreviations used in texting. Misinterpretation of abbreviations could lead to longer processing times and/or errors.
- Background noises, tone of voice, and other audio clues are often used by telecommunicators to gain additional knowledge regarding emergency calls. These will be absent in text calls, just as they are now in TDD/TTY.\(^{46}\)
- Processes to adequately deal with protocol driven interrogation will have to be adapted for use with Next Generation 9-1-1, as will policies for dealing with non-English speaking callers.
- Human friendly interfaces between the systems that receive Next Generation “calls” will need to be developed. While this may more properly fall under the realm of technology, these interfaces must be intuitive, and to the degree possible seamless, in order to be easily understood and used by telecommunicators. As the number and type of devices used to contact 9-1-1 increases, these interfaces must keep pace with the demand.\(^{47}\)
- The impact of clusters of Next Generation calls upon PSAPs must also be understood. We have seen the results of this phenomenon with regards to wireless telephony. How will this play out in the NG world?
- Both telecommunicator training and internal policy must reflect the ever changing world of Next Generation.\(^{48}\)


\(^{45}\) Soukup, James Director, Durham Emergency Communications Center, Durham, NC. Telephonic interview with committee members, 21 March 2012.


From a management point of view, administrators must find a way to acquire Next Generation technology and integrate it into daily operations. This is easier said than done. A myriad of legal, financial, and technical hurdles may often have to be crossed in order for this implementation to take place.

As part and parcel of this acquisition, training, quality assurance, and policy development must also occur. Public education will also become increasingly important, as it is likely that the nationwide implementation of Next Generation will not occur overnight. During the transition period agencies not having NG functionality will need to assure that their citizens understand this fact. As announcements of the implementation of Next Generation in other areas increase, this understanding becomes even more critical as the presence of these features may often be assumed through inference.

Management policies will also be needed for the retention, release, and legal presentation of Next Generation records. While some of this policy will need to be developed on the state level, PSAPs will still need to deal with these issues on the local level.

Finally, stress and liability rate high among the human concerns that must be addressed. While there is often discussion surrounding equal protection from liability for providers of 9-1-1 services, thought must also be given to liability incurred by the public sector as well. Do protections that may exist now remain? What legal pitfalls exist, if any, in these uncharted waters? Is new legislation required to address these and other issues associated to NG 9-1-1?49

The impact of stress upon telecommunicators has long been documented. However, the impact of Next Generation on stress still remains to be seen. Will the assumed increase in processing times create call backups in the 9-1-1 center, leading to frustration, pressure and hurried calls? Will the lack of human contact associated with text messaging play a role? And while the scope of this white paper relates solely to text messaging, will future generations of technology that import real time videos of horrific crime, fire, and accident scenes directly into the PSAP place a different type of stress on those charged with handling these calls? Regardless of the answers, the public safety telecommunications community must be ready to address these challenges.50

Summary of Operational Learnings

The road ahead still has issues that need to be addressed, issues that will not be resolved over night. However, the course is set and the functionality will be implemented in one form or another. With all of the available options, one may rise to the top as the most effective or the best result may be a combination of multiple solutions. Each of the solutions discussed has positives and negatives as no one solution can currently meet the needs and expectations of a PSAP. Whatever that solution becomes, we must ensure that we are prepared both technologically and personally.

Some of the deployment options have a limited scope and others have yet to be implemented. Efforts are continuing to refine the various solutions and make them effective for a PSAP. Will PSAPs be overwhelmed with messages? Based on the DECC project, possibly not. However, it is but one instance of many to come and, as public awareness grows, including the hearing and speech impaired communities, messages may become more prevalent. The time needed to process a message in the

49 Ibid.
50 http://911wellness.com/2012/02/21/frontline-dispatchers-voice-concern-re-ng911/
currently available forms will remain an issue for PSAPs. Telecommunicators pride themselves on being efficient and timely when processing calls, the addition of messaging will cause frustration by not being able to quickly obtain information.

Effective training of telecommunicators will be the key to a successful implementation of a solution. Administrators and training personnel must become versed in a methodology with which they may not be comfortable.

Security of any messaging system, whether from spoofing or viruses, will remain a concern. The public needs to be secure in the knowledge that their ability to communicate during a crisis situation is available at all times. Perhaps authentication processes can be developed to limit the impact of spoofing. Perhaps an increased or multi-level virus protection can be implemented at the provider level in addition to the PSAP level.

Through cooperative efforts of telecomm providers, both for emergency communication and for consumer communication, a solution can be achieved else this discussion would be pointless. For emergency communication the solution must be able to work with and around other operations. Simply forcing a solution just to have one is not effective and will most likely cause issues for telecommunicators and impact effective response. A telecommunicator must be able to grasp the concepts and limitations of the solution and use it to advantage. Consumer telecomm providers must also be aware of the limitations of the solution in addition to the budgetary limitations that impact a PSAP.

On February 9, 2012, the CTIA responded to the FCC’s NPRM on Text-to-9-1-1, and outlined these same arguments in addition to questioning the authority of the FCC to govern messaging. Essentially, since the FCC admitted in its own document that SMS was considered an informational resource and not an interconnected service which potentially limits its ability to regulate SMS, Clearly the CTIA is poised to combat what may be perceived as the FCC overstepping their authority and ruling prematurely on a technology that may not be quite ready to provide a viable solution. If the FCC does rule regardless of protest, the impending litigation and opposition may further delay the ability of a PSAP to receive any text-to-9-1-1 solution. Further, APCO also responded to the FCC’s NPRM reinforcing the idea that the FCC should focus on a long-term solution versus mandating any short-term and, potentially harmful solution.

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