NENA/USD0T Wireless E9-1-1 Technical Issues

(Working Draft in process)

Table of Contents (to be added)

Introduction

This White Paper discusses the technical issues confronting the implementation of Wireless E9-1-1 Phase II, in a sequence similar to the actual call process – from processing the 9-1-1 dialed call origination, through voice and data management and delivery, and data impacts at the PSAP. Some of the functions involved occur in parallel with others; the sequence of discussion does not necessarily indicate a serial process.

The technical issues for each call step are also defined, where applicable, at two levels: direct technical problems, and less prominent, but significant impacts on design, operations, or management of service. Preferable solutions, where known, or optional solutions are then described. These issues are discussed from the perspective of 9-1-1 public safety, and may generate other perspectives from other parties.

Wireless Number Pooling and Portability

Wireless number pooling and portability have brought a unique set of challenges to E9-1-1, particularly with delivery of the correct callback number to the PSAP.

Wireless number pooling began November 24, 2002 in most of the top 100 metropolitan areas of the United States. By the end of 2003, it will have spread across the 50 states, plus Puerto Rico and the District of Columbia. It is a number conservation method that primarily includes the assignment of numbers to telephony service providers in blocks of 1,000 rather than 10,000.

In order to implement pooling and wireless number portability (which allows customers to change service providers and retain a phone number, taking effect November 24, 2003), the wireless industry chose a procedure that separated the mobile identification number (MIN) and the mobile directory number (MDN) into two different numbers. For CDMA, TDMA and AMPS carriers, these numbers were previously identical. This permitted 9-1-1 calls to include delivery of the correct callback number without any registration processing. The MIN in the phone for a valid customer was also the callback number (MDN), therefore it could be delivered without any database table lookup or other verification.

With MIN/MDN separation, a database table lookup becomes part of the E9-1-1 process so that the correct callback number is delivered to the PSAP. This has required wireless network changes, including switch vendor and 9-1-1 third party vendor software. During the changeover, some 9-1-1 testing has been conducted utilizing various scenarios that NENA, working with various industry groups, has been involved in establishing.

Various software adjustments and settings needed to be made in certain instances so that 9-1-1 calls were routed to PSAPs correctly and the phase I and phase II E9-1-1 process worked properly to deliver the proper callback number..

As these changes have been discovered, NENA has worked with industry groups to disseminate the information and ensure that wireless carriers and their vendors nationwide could implement them and prevent any interruption or degradation to E9-1-1 service.

If a wireless carrier does not implement the appropriate MIN/MDN separation changes within its network, it is unable to deliver the correct callback number for phase I and II E9-1-1. The FCC has twice, in 2002 and 2003, issued WNP orders that have included footnotes re-affirming that wireless service providers are to deliver the correct call back number to PSAPs for a phase I/II 9-1-1 call, regardless of whether they have implemented the MIN/MDN separation compliant software changes.

It currently remains unknown how many other wireless carriers have not implemented MIN/MDN separation and are therefore unable to support roaming of pooled customers and delivery of the correct callback number to PSAPs for these customers. NENA continues to work this issue both in the technical and regulatory arenas.

In addition to MIN/MDN separation, there are other technical 9-1-1 issues related to wireless number pooling and portability.

Mixed service is when a customer has both a wireless and wireline phone active with the same phone number during the porting process (moving from one carrier to another while retaining an existing phone number). Both phones are capable of calling 9-1-1, however, only one can actually receive inbound calls. This is dependent upon certain technical steps during the porting process. This issue continues to be worked within NENA technical and operational committees with input from various industry groups and carriers.

The NENA Public Education committee has completed a consumer education project related to this mixed/dual service and the 9-1-1 limitations. The project includes a document package being distributed to wireless service providers. The package includes suggested language for handouts or other media to present 9-1-1 information to consumers who are changing service providers and retaining their phone numbers. It also includes suggested training documentation for sales associates/marketing representatives so that they can answer 9-1-1 related questions concerning the porting process. The basic

consumer message is to remind customers to stay on the line when calling 9-1-1 until all the information needed has been provided to the call taker and the caller is advised that she/he can hang up. There is a brief explanation advising consumers that during the porting process interval both phones (old and new service provider's) are capable of calling 9-1-1 and being routed/answered, however, only one of the two phones can be called back by the 9-1-1 call taker. This is dependent on which industry databases have or have not yet been updated.

The entry of wireless service providers in number pooling and portability processes also impacts wireline carriers and the existing 9-1-1 ALI (automatic location identification) database, and other 9-1-1 databases. Certain database processes had been created in the late 1990s and were implemented as wireline carriers began porting and pooling.

With the advent of wireless carriers porting and pooling, these technical processes have been revisited and, where appropriate, altered to help ensure the continued integrity of these needed 9-1-1 databases. NENA committees have developed data standard changes, which have been officially approved, and these alterations have been conveyed to the appropriate industry groups for input and action.

NENA has worked and continues to work with several industry groups, which have provided assistance and input in ensuring that technical and operational 9-1-1 issues are identified and dealt with. These groups include the LNPA-WG (Local Number Portability Administration Working Group, established by the North American Numbering Council (NANC)), WNPO (Wireless Number Portability Operations team), WTSC (Wireless Testing Subcommittee), WPTF (Wireless Pooling Task Force), NNPO (National Number Portability Operations team), OBF (Ordering and Billing Forum within ATIS, Alliance for Telecommunications Industry Solutions), INC (Industry Numbering Committee also within ATIS) and others.

NSI Phones and Caller Identification

Non-service-initialized (NSI) phones are a confusing category having various 9-1-1 impacts. For some people, NSI includes phones that have never been activated for customer service. For others, NSI includes that group plus those which have been de-activated for customer service. Due to call processing technical methods and other factors, various other phone groups are included. These include (not in priority nor intended to be all-inclusive), 9-1-1 only phones, some donated phones, some prepaid phones, and international roamers.

Also included are specific 9-1-1 call types. With these types, the handset is not in any of the various groups listed above, however, because of the nature of the call type, the 9-1-1 call is processed and treated similarly to the groups listed above. These call types include (1) strongest signal, in which the 9-1-1 call is delivered on a competitor's network and so the phone itself is not registered on the appropriate network and (2) cold start, in which

the phone is turned on to place a 9-1-1 call and there has been not enough time to complete the registration process.

These call types and the various groups listed earlier all comprise a category of non-registered phones at the time of a 9-1-1 call. All are treated the same within the wireless networks and processes. So, from here on, when the term NSI is used, it should be remembered that it includes all listed groups and call types, plus others. It includes phones that have never been used for wireless service, have been used and de-activated, currently belong to valid bill-paying, 9-1-1 surcharge paying customers, and others.

This broad category continues to be debated on various levels within the industry, the PSAP community and government. It has been a topic for several months within TR45.2, ESIF (Emergency Services Interconnection Forum, co-convened by NENA and ATGIS), and NENA technical leadership/committees.

In the late 90s, TR45.2 (a standards setting group within TIA, Telecommunications Industry Association) developed a specific standard regarding delivery of a phase II E9-1-1 call (and what data is included). In that standard, there was an option for what is to be delivered as a call back number in a phase II environment. In 2002, that same group modified the standard and changed that option to a requirement forthe phase II environment.

For NSI 9-1-1 calls (which includes all phone groups listed above and all call types listed above), the call back number delivered to the PSAP as part of phase II, is 9-1-1 plus the least seven digits of the Electronic Serial Number (i.e., 911-xxx-xxxx, where x = any single digit decimal number 0-9).

Some wireless service providers are delivering the same information for NSI 9-1-1 calls in a phase I environment, others are not. There is no industry standard either requiring this or even listing it as an option as part of phase I wireless E9-1-1.

In initial very preliminary statistics-gathering by NENA, it appears that about eight per cent (8%) of wireless 9-1-1 calls fall into this category. (The statistics were gathered from four PSAPs receiving phase II calls from multiple wireless carriers. Two month totals for each were provided. Monthly percentages varied from 0% to 15% among carriers and there were some similar differences with the same carrier on a month-to-month basis. However, all 4 PSAPs had a monthly statistical average in the 8-9% range and they were in separate geographic areas of the country. Considerably more work needs to be done, gathering similar statistics from several areas of the country and more PSAPs.) This preliminary percentage is significantly high; enough to justify additional work and attention paid to this topic (NSI and 9-1-1 call delivery/processing.

There remains at least one wireless technical issue related to the delivery of 911+last 7 digits of ESN for this broad NSI category. For many of the wireless 9-1-1 calls in the above groups and types, prior to implementation of the change to 9-1-1+last 7 digits of ESN, the call back number delivered was the MIN (mobile identification number) of the

caller, which could be the call back number of the current subscriber or a previous subscriber. This information could be used by a PSAP to obtain customer information (name, billing address), which could be of value in certain emergency situations or investigation of harassing/false call/fraudulent use incidences. Being able to take at least 7 digits of an ESN, along with date and time of 9-1-1 call(s) and link it to MIN so that customer (current/previous) information, if it exists, can be obtained on a timely basis, may be technically difficult for most wireless service providers.

Additional Impacts on 9-1-1 calltaker and dispatch processes

Training/education materials for PSAP personnel concerning WNP and NSI have been provided and/or are currently being created/revised within the appropriate NENA groups.

With wireless number portability, there is an increased difficulty for PSAP personnel to correctly identify which service provider to call to seek customer information (name/address) in emergency situations and/or fraudulent use incidences. Prior to number portability/pooling, the service provider relationship to a phone number could be determined by the NXX (prefix) of a number. There are various internet sites that provide this information, including NANPA (North American Numbering Plan Administration) and others. With number portability/pooling, this NXX identification is no longer valid for phone numbers that have been ported and/or pooled.

In 1998, with the advent of wireline number portability, a service was created for 9-1-1 and public safety, known as the Neustar IVR (interactive voice response unit). This service permitted PSAP personnel or other public safety/law enforcement entities to call a special number, enter a numeric password, and then enter the 10 digits of a phone number. If the number was ported and/or pooled, the response would indicate the service provider company name and a 24/7 ten digit phone number to call in order to obtain the needed customer information.

With the advent of wireless number portability/pooling and the increased implementation of phase I/II wireless E9-1-1 across the country, there is a heightened need for PSAPs to receive such information on a timely basis. PSAP education regarding this currently-free service (system paid for by the telecommunications industry and management provided by Neustar free-of-charge), has been provided and continues to be done by NENA.

However, there are needs to (1) expand the capabilities of the system and (2) provide quicker means of access to it. For (1), the current system provides information only for ported/pooled numbers, so PSAP personnel must check it and, if no response, check elsewhere for the service provider of the NXX. Combining such inquiries into one would cut minutes off of this process, and since it is used in emergency situations, shortening the time can be of critical importance. For (2), there are better and quicker methods for obtaining such information than utilizing a telephony interactive voice response unit, such as utilizing an existing, very secure national law enforcement computer system, that

would cut, at minimum, several seconds from the process. It will also reduce time because it fits better in the current multi-tasking functions of most PSAPs.

This appears to require some federal intervention as to the funding of the system changes and the long-term administrative costs related to the system. This is being addressed within NENA and some federal law enforcement entities.

Call Management in the Mobile Switching Center

Congestion control in the MSC

Mobile Switching Center switches currently do not include the software features to manage congestion by limiting calls presented to the outbound network. See discussion under Network Design below. In order to provide equivalent 9-1-1 service capabilities across all 9-1-1 callers, this deficiency needs to be resolved. It would require design and development for the MSC software, which requires carrier interest in requesting these features from their switch manufacturers. This, in turn, requires that carriers recognize the need and appropriateness to support fundamental E9-1-1 service design.

Control server data completeness

When control server data bases, known as SCPs under Phase I and and MPCs in Phase II, have incomplete or inappropriate content, call routing and identification can be compromised. This involves such data factors as cell and sector ID assignments, routing definitions, class of service variations, etc. The primary resolution of these problems is based in carrier or vendor update and data management processes, supported by PSAP problem recognition and feedback. Improved and available standards, and best practices for PSAP personnel are needed to support these human processes.

Call control default assignments

Knowledge of what is involved and how to best assign default settings in the wireless 9-1-1 call environment is not well coordinated between wireless carriers/vendors and ILEC 9-1-1 system service providers. Conflicts in these settings cause inconsistency of call handling and confusion at the PSAP end of the system. Better analysis, knowledge and education for all parties are the keys to resolving this issue. This issue is currently being worked in both the NENA and ESIF groups.

Generation and Consistency of Call Related Data

Three major factors apply in this category: speed of caller location data availability, consistency/standardization of data delivery processes, and data interpretation issues.

Phase II caller location data is often not available to be delivered to the PSAP data equipment along with other 9-1-1 data, due to characteristics of the position

determination equipment currently available to wireless carriers and their vendors and other related timing issues within the overall E9-1-1 systems. The percentage of Phase II calls without corresponding caller location data is not clear – reports vary from 40% to as low as 15%. In these cases, PSAP calltaker rebid after 15 seconds usually acquires the missing information. This data delay condition appears to be diminishing over time as position identification equipment and processes improve; however, more focus on improvement would be welcomed by Public Safety.

Wireless E9-1-1 data standards are incomplete, and those available are often not applied appropriately by carriers and vendors. Standards developed through 2002 were at a higher level than needed, and improvements have been reactive as individual problems were identified. NENA is attempting to coordinate needs and standards definition work through several initiatives: Phase I and II Features and Functions, Wireless ALI Content Team, and leadership of the ESIF Study Group on Wireless Standardized Messaging to the PSAP. These will lead into requirements to TR45.2, and PSAP requests for carrier and vendors to follow detailed standards, so that ALI data interpretation issues are mitigated. This will also drive improvements to ALI server data storage and delivery of complete data to the PSAP.

9-1-1 Trunking from MSC to the Selective Routing Switch

Network design – capacity

Excessive capacity is being designed into the 9-1-1 network by some carriers, and the needs of E9-1-1 service for call default control are sometimes not part of trunking design by wireless carriers. Where large scale trunk groups, often full 24 channel T1 facilities, are used to support calls for multiple Counties, normal E9-1-1 default call delivery controls are not possible. This also limits congestion control capabilities, allowing a different level of service for wireless compared to wireline calling. In cases where wireless carriers also install overflow from the MSC-SR trunk groups via call forwarding through the general dialed network, further disparities are possible. These methods seem to be driven by both lack of E9-1-1 design knowledge and incorrect interpretation of FCC mandate wording implying all calls must be delivered to the `PSAP'. [The FCC has informally clarified that this language was not meant to cause different treatment for wireless-originated 9-1-1 calls] A simple recognition that the `PSAP' referenced is the portion of the E9-1-1 system considered the financial responsibility of the Public Safety authority would clarify that the delivery requirement is to the MSC – SR trunk group connecting to the input side of the Selective Router, not the literal PSAP itself. Given that, the trunk group engineering process would fall into place and be consistent with normal E9-1-1 network engineering.

Network design – protocol

More efficient methods of 9-1-1 call delivery suggest that SS7 should be used for MSC to SR trunking, rather than the outdated CAMA type of trunking. Doing so would

accomplish two major improvements; 1) call handling on the order of 2-3 seconds faster than CAMA, and 2) a more mainstreamed technology, supporting multiple data items in the SS7 signaling protocol. Many MSC switch types require a special software package to support CAMA, whereas SS7 is typically the signaling type generally used and supported for all other voice network interactions. Using SS7 thus is less expensive overall than CAMA, and better supported from a switch maintenance perspective, both by the wireless carrier and the SR switch provider.

In addition, use of SS7 will set the stage for expanded E9-1-1 data support in conjunction with the call itself. SS7 supports sending both the pANI (ESRK or ESRD) and the caller's callback number into the E9-1-1 system, for direct transmission to the PSAP CPE, allowing recovery of the PSAP's ability to do normal one-button call back functions. (This also requires that the PSAP utilize 20 digit signaling from the SR to the PSAP – Enhanced MF or higher levels of signaling protocol) This also allows the PSAP to receive the callback number with the call, so that this critical capability is once again independent of any failures in the E9-1-1 data transport process. And, as E9-1-1 evolution continues, SS7 supports the delivery of additional data items, characterized as `Essential' data in the NENA E9-1-1 Future Path Plan (ref to Future Path Plan on www.nena.org).

Congestion control impacts

Since wireless MSCs have not been designed to support congestion control, outbound trunk group sizing based on normal 9-1-1 network engineering is the available method at this time.

SR control data completeness

As wireless E9-1-1 service is implemented and maintained, the fixed data base records in the ALI/SR data bases must be complete and then consistently updated so that call routing control is accurate. When ESRK or ESRD records are incomplete, call routing is compromised and can be inaccurate, leading to calls delivered to wrong PSAPs, sometimes over large distances. The solution to this issue is largely managerial, on the part of carriers and their vendors.

9-1-1 Trunking to the PSAP

Trunk group arrangements and sizing

The lack of carrier congestion control capabilities and incorrect MSC-SR trunk group engineering, as described above, in conjunction with the threat of short term peaks of wireless 9-1-1 calling from accident scenes and other emergency cases causes PSAPs to believe that they must protect their service capabilities. The typical approach is to provide separate SR-PSAP trunk groups for wireless calls, which avoids overload of in-place trunk groups, which become dedicated to wireline call delivery. This approach

causes total trunk quantity to exceed that really needed for overall call volumes, and at the same time limits trunking capacity for any given set of calls.

Call related data delivery and impacts

As E9-1-1 evolves to support new call and emergency messaging service types, call related data delivery needs suggest a more robust design. In order to restore full PSAP call handling capability, wireless calls need to be delivered across interfaces that support at least 20 digits of signaling information. This requires Feature Group D or SS7 from the MSC to the SR in today's system architecture, and Enhanced MF from SR to PSAP. NENA believes that IP based interfaces, especially to the PSAP, are the probable future method. Standards for this need to be developed as soon as possible, and NENA has recently established a full VoIP/Packet Technical Committee to build on previous IP interface work. This Committee currently has significant involvement and commitment from individuals prominent in IP-specific standards groups.

Data delivery to the Calltaker

Expansion of delivered data due to wireless E9-1-1 feature evolution

Over the last 2-3 years, discovery of data availability and needs beyond the basic caller location latitude and longitude has occurred. Such items as calculated caller location confidence and uncertainty have driven work to determine applicability and standards detail, both among the carrier industry and vendors, and in the public safety arena. Expectations of caller speed and direction of travel data also come into play. Due to lack of pre-planning for these data areas, handling has been largely reactive, and capabilities to support delivery of added data items across the parties to wireless E9-1-1 vary greatly and have been largely reactive to date. ESIF, NENA, and TR45 group actions have been initiated to deal with this area.

Consistency of data handling

Due to lack of specific standards, and a great variation in user knowledge across the country, wireless implementations have generated variations in how wireless data is handled between different vendors and different public safety authorities. This has resulted in variations as to what data items appear in what data field, which affects how the data is displayed at the PSAP. This has driven complication and costs associated with customizing PSAP screen displays, CAD software, and mapping system software and parameters. Dealing with this situation nationally is the current objective of the NENA Wireless ALI Content Team, which will lead to more specific standards definition and implementation.

GIS data and mtce (to be added)

Description of standards and modification to meet user needs

Impact on 9-1-1 calltaker and dispatch process (to be added)
Applicability for dispatch and mapping systems (to be added)

Results from NENA's Technical Development Conference/Operations Development Conference (March 2004)

NENA formed a new workgroup in its Wireless Operations Committee to address Joint Wireline/Wireless Quality Assurance. The objectives of this workgroup are to:

- Review NENA's Data Technical Committee's recommendations on standardizing best practices for MSAG maintenance
- Develop operations standards for online MSAG and ALI database updates
- Develop Operations standards for base map updates
- Develop best practices for ALI feeds (often vary by carrier)
- Examine PSAP boundary maintenance (interval use and third party use)
- Develop data maintenance related best practices related to new cell tower additions, and
- Recommend call routing administration and maintenance procedures.

Issues Identified by Emergency Services Interconnection Forum (ESIF)

1). Phase II location reliability factor. Carriers can provide a measure of the reliability of a location estimate via a data field in the Phase II message to the PSAP. How should this data be represented in the estimate? Is 90% certainty in a larger area more useful for PSAPs, or is 70% certainty in a smaller area better? The desired result is identification of a consistent, national representation of the uncertainty factor accompanying the location estimate.

2). NENA's Wireless Technical Committee also developed a recommendation regarding Type 1 trunks. It is NENA's recommendation that Type 1 trunks not be used for Phase I or Phase II wireless E9-1-1 mobile switch to selective router interconnection. It is further recommended that any Type 1 trunks currently in use for Phase I or Phase II wireless E9-1-1 mobile switch to selective router interconnection be replaced as soon as possible with CAMA, SS7, ISUP or FG-D trunks. That recommendation was developed at NENA's Annual Conference in Tampa in June 2004.

New Challenges

Next generation cell technology - here is the issue in brief:

There has been an issue lurking off the radar of public safety and even wireless carriers that affects phase 1. This issue is smart-cell technology and the implementation of next

generation cell technology for both 3G and 4G needs. The impact to the 9-1-1 community at large could be huge. The essence is that phase 1 routing as we know it could become much less accurate, dramatically complicated, or made totally irrelevant at the cell sector level as we think of it today. The implications are that there is much industry and engineering work to be done to compensate for this. An example outcome could be that the cell tower is now the default level routing and not the sector. This of course opens a whole bag of worms.

Conclusions

As can be seen, there are a number of technical issues yet to be solved for Wireless E9-1-1, and more identified or on the horizon. There are a number of technical development groups involved, including NENA, TR45.2, AHES, and ESIF. Solutions are also dependent on involvement by the NENA 9-1-1 Center Operations Committee, NASNA, and APCO organizations. Better coordination of efforts, including identification and initiation of standards activities earlier, across the scope of wireless E9-1-1 functions is needed.

Appendix (to be added)

NENA Technical Committee structure – may be found on www.nena.org under Technical Committee

NENA Future Path Plan – may be found on www.nena.org under Technical Committee

ESIF Description – may be found at www.atis.org

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Inputs and review from:
NENA Wireless Technical Committee
Wireless Subcommittee of 9-1-1 Center Operations Committee

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