A Report on Technical and Operational Issues Impacting The Provision of Wireless Enhanced 911 Services

Prepared for the

Federal Communications Commission

By

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Executive Summary

The purpose of this report is to convey the results of an independent inquiry into the technical and operational issues affecting the deployment of wireless Enhanced 911 ("E911") services in the United States. The inquiry was carried out by the author on behalf of the Federal Communications Commission ("Commission") over a six month period beginning on April 15, 2002.

Before turning to my principal findings and recommendations, I would like to offer three preliminary comments:

First, the importance of 911 as the Nation's universal emergency assistance number has long been recognized. That importance was acknowledged with the passage of the Wireless Communications and Public Safety Act of 1999. Subsequent developments, e.g., the tragic events of September 11, 2001 and growing dependence on wireless networks, serve to further emphasize the importance of E911 in general, and wireless E911 in particular, to the safety of life and property and homeland security. The automatic provision of location information with wireline and wireless 911 calls – i.e., E911" – is critical to those emergency services.

Second, over the past several years, the center of attention of the industry has clearly shifted from discovering, developing, evaluating and selecting the ways of locating mobile units in wireless systems to integrating the location information into the existing E911 system. I regard this as very good news as it indicates that there is no longer any real disagreement regarding the technical feasibility of providing wireless E911 to the approximately 130 million wireless subscribers in the United States. The challenge now is to successfully complete the implementation of wireless E911, a process that has really just begun.

Third, one over-arching issue that immediately emerged in my inquiry is that the existing wireline E911 infrastructure, while generally reliable, is seriously antiquated. Indeed, it turns out that the existing wireline E911 infrastructure is built upon not only an outdated technology, but one that was originally designed for an entirely different purpose. It is an analog technology in an overwhelmingly digital world. Yet it is a critical building block in the implementation of wireless E911.

From a national policy perspective, this latter observation is troubling for a number of reasons. It is troubling because it means that the additional network elements and functionalities necessary to handle the increasing volume of wireless E911 calls are being built upon a platform or foundation that has serious limitations in terms of speed, scalability, and adaptability. Additionally, it is troubling because these limitations not only burden the development of wireless E911 services, but they will also constrain our ability to extend E911 access to a rapidly growing number of non-traditional devices (e.g., PDAs), systems (e.g., telematics) and networks (e.g., voice networks that employ Voice-over-the-Internet Protocol -- VoIP). Finally, it is troubling because of uncertainty surrounding the willingness and ability of Public Safety Answering Points ("PSAPs") to

pay for wireless E911, let alone the other, long term upgrades to the local exchange carriers' networks and their own customer premises equipment necessary to provide E911 access to these emerging devices, systems, and networks.

With respect to the specific technical and operational issues relating to the implementation of wireless E911 services, I have reached six principal findings or conclusions.

- *First*, I find that there is a strong Federal interest in the implementation of wireless E911 and that that interest has increased as a result of the tragic events of September 11, 2001. I further conclude that existing Federal programs to encourage the implementation are fragmented and that the most visible program, while very commendable, does not totally reflect the broader implications of wireless E911 for the safety of life and property and homeland security. My concern about this issue is compounded by the fact that a number of states have failed to establish a state-wide coordination body and/or appropriate cost recovery mechanisms.

- *Second*, I find that the deployment of wireless E911 in the U.S. is an extremely complex undertaking and that a variety of critical technical and operational choices – including critical decisions relating to network architectures – must be made to ensure the reliable and seamless E911 system contemplated by Congress when it passed the 911 Act. Because of the total number of stakeholders involved, the complexity of the inter-relationships among the stakeholders, and the incentives and constraints on those stakeholders, I conclude that an unusually high degree of coordination and cooperation among public and private entities will be required if that vision is to be realized.

- *Third*, in light of my second finding, I conclude that for the efficient, timely, and cost-effective deployment of wireless E911, there is a need for increased coordination among stakeholder groups in three areas: overall systems engineering, implementation/project management and the development and adoption of standards.

- *Fourth*, unless corrective steps are taken, I find that the rollout of wireless E911 services will continue to be constrained by what I refer to in shorthand as PSAP "fatigue," the lack of cost recovery and other funding mechanisms, and the lack of a "champion" within the Federal government. I also conclude that, even when good faith efforts are made on all sides, PSAP awareness and readiness remains a potential detriment to the rapid and efficient rollout of wireless E911 services.

- *Fifth*, I find that the incumbent local exchange carriers ("ILECs") play a critical role in the deployment of wireless E911 service in the reliable and seamless manner contemplated by Congress when it passed 911 Act. I also find that, in the past, the ILECs were not fully included in the development of wireless E911 and that their responsibilities for supporting wireless E911 deployment were not well defined. I further conclude that the prices charged by the ILECs for the cost of upgrading their existing wireline E911 system to support wireless E911 may impede the rollout of the

emergency service, especially in those states that do not have a cost recovery mechanism in place.

- *Sixth*, I find that (a) the lack of well-accepted, standardized tests for determining whether the various position location systems selected by the wireless carriers comply with the accuracy requirements set forth in the Commission's rules, (b) uncertainty over the interaction between delay and accuracy in obtaining position location information, and (c) uncertainty as to the area over which the test results can be averaged may cause delay in the deployment, acceptance and certification of wireless E911 systems.

In order to resolve some of the issues and concerns raised during the course of my inquiry, I have included a number of recommendations. These recommendations include suggestions that:

- The Commission should work more closely with other Federal agencies to ensure that accurate location information for emergency calls is gathered, delivered, accepted and made available for use in the dispatching of first responders. I further recommend that the Commission suggest to the Administration that a "National 911 Program Office" be established within the proposed Department of Homeland Security to coordinate with, and be a resource for, local and state public safety first responders and other stakeholders.

- Because of the importance of E911 to the safety of life and property and to homeland security and the critical nature of the network architecture and industry structure choices being made, and because of the overall complexity of the situation, I recommend that the Commission maintain or even increase its oversight of the rollout of wireless E911 services in the U.S. over the next several years.

- In order to respond to the need for increased coordination in the rollout of wireless E911 and the evolution of E911 more generally, I recommend that the Commission (a) establish, or cause to have established, an advisory committee that would address the technical framework for the further development and evolution of E911 systems and services, (b) continue to urge the creation of organizations at the state, regional and local levels of government that can act as a coordinating body in the rollout of wireless E911 services, (c) encourage the creation of a national level clearinghouse to the collect, store, and disseminate status information on the rollout of wireless E911, and (d) charge the advisory committee recommended above with conducting an overall review of the standards situation as related to wireless E911 while continuing to encourage industry-based voluntary standards activities.

- Because PSAPs are on the frontlines in the Nation's defense against the threat of terrorism as well as in responding to more conventional emergencies, I recommend that the Commission actively coordinate with and support the U.S. Department of Transportation's Wireless E911 Initiative and other formal and informal efforts at all levels of government to educate state and local governments and PSAPs on the

benefits and importance of wireless E911 services. On a longer term basis, I would recommend that the National E911 Program Office (whose creation I urged above) take on the role of educating and advocating for PSAPs at the Federal level of government. I also recommend that the Commission continue to support the efforts of the Emergency Services Interconnection Forum (jointly sponsored by the National Emergency Number Association and the Alliance for Telecommunications Industry Solutions) to address the issue of PSAP readiness. In the text of the full report, I also suggest the possibility of some form of an independent third party process for certifying PSAP readiness.

- During the period of my inquiry, the Commission requested that the largest ILECs provide certain critical information regarding their readiness to carry out their role in wireless E911 deployment and committed itself to monitoring the situation to see whether additional obligations are necessary. This action is consistent with my recommendation concerning the creation of national clearinghouse of such information. I further recommend that the Commission work closely with individual state regulatory commissions and their association, the National Association of Regulatory Utility Commissioners, in resolving issues relating to ILEC cost recovery and pricing.

- The Commission should urge the stakeholders to cooperatively develop industry-wide procedures for testing and certification (and recertification) of wireless E911 to ensure that they meet (and continue to meet) the accuracy requirements specified in the Commission's rules.

Certain other issues were raised during the course of my inquiry. These other issues included concerns about the need for end-to-end testing of wireless E911 systems, conveying confidence/uncertainty information associated with position determination and routing choices, accommodating new requirements and requirement "creep," the impact of future technological developments, consumer expectations, the implications of commercial location based services, and the need for a more adaptable regulatory approach. Recommendations concerning these issues and more details regarding the recommendations recorded above are contained in the main body of the report.

Acknowledgements and Disclaimer

The author would like to thank Leon Jackler, Attorney Advisor in the Commercial Wireless Division of the Wireless Telecommunications Bureau at the Federal Communications for his tireless help and wise counsel in the conduct of this inquiry and in the preparation of this report. The author would also like to acknowledge the help of his research assistant, Sukumar Dwarkanath, in carrying out the study.

The analyses and opinions contained in this report are strictly those of the author and do not necessarily reflect the views of the University of Colorado or any other institution with which the author is affiliated.

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1 Introduction

1.1 Background

On November 20, 2001, the Federal Communications Commission ("FCC" or "the Commission") issued a news release announcing that the author of this report, Dale Hatfield, had been retained by the agency to lead an inquiry into the technical and operational issues affecting the deployment of Wireless Enhanced 911 Services.[1] Subsequently, on March 5, 2002, the Wireless Telecommunications Bureau ("WTB") of the Federal Communications Commission ("FCC" or "the Commission") released a Public Notice announcing the details of the inquiry.[2] In doing so, the Commission opened a separate docket for the inquiry, WT Docket No. 02-46.

1.2 Purpose of the Inquiry and Report

As described in the Public Notice, the purpose of the inquiry was to identify technical and operational problems in wireless E911 deployment. After identifying the entities involved and reviewing certain claims regarding the barriers in deploying wireless E911, the Public Notice more specifically laid out the purpose of the inquiry as follows:

> The purpose of this inquiry is to obtain an expert, informed, unbiased assessment of these and other technical and operational issues that impact wireless E911 deployment. We anticipate that the scope of the inquiry will be as broad as appropriate to perform that assessment. Information will be gathered and evaluated from many sources, including from technology vendors, network equipment and handset manufacturers, carriers, the public safety community, and other knowledgeable sources concerning technology standards issues, development of hardware and software, and supply conditions. This inquiry also will address the provisioning by LECs of the facilities and equipment necessary to receive and utilize E911 data elements. The focus of the inquiry will be on the future of wireless E911 deployment including any obstacles to deployment and steps that might be taken to overcome or minimize them.

The purpose of this report is to convey the results of the inquiry that I carried out on behalf of the Commission.

1.3 Methodology

This inquiry began with an initial meeting of the principal stakeholders on April 15, 2002 at the Commission's offices in Washington, DC. Over the next 100 days or so, further

[1] News Release, "FCC Announces Dale Hatfield to Lead Inquiry of Technical and Operational Issues Affecting Deployment of Wireless Enhanced 911 Services, rel. Nov. 20, 2001.

[2] Public Notice, "Wireless Bureau Announces Details of Inquiry on Technical and Operational Wireless E911 Issues, DA 02-523, rel. March 5, 2002.

meetings were held with individuals and representatives of these stakeholder groups. At the initial meeting and subsequent individual meetings, participants were asked to identify the major technical and operational obstacles to the successful and timely rollout of wireless E911 systems. In accordance with the Public Notice, emphasis was placed upon those obstacles that remained rather than on rehashing issues that may have arisen in the past but that are no longer a major impediment. Particular attention was paid to identifying steps that could be taken by the Commission—or by stakeholder groups acting on a voluntary basis—that would minimize the prospects for litigation or the need for time-consuming Commission rulings.

In addition to being asked to identify the obstacles and to suggest steps that could be taken to facilitate the rollout of wireless E911 systems, participants were also asked to identify other organizations or individuals that might have information to contribute to the process. In-person or telephone interviews were then arranged with many of the groups or organizations so identified. Finally, an on-line search for relevant materials was conducted. This included a search for relevant "White Papers" and other materials published by vendors and other industry groups as well as a search for professional journal articles on the topic of E911. Over a roughly 100-day period stretching from April 15, 2002, until the latter part of July 2002, dozens of separate interviews were conducted involving well over one hundred individuals.

1.4 Timeliness of the Recommendations

Given the importance of wireless E911 implementation to the nation, it is not surprising that the Commission and the various stakeholder groups have pressed forward to resolve some of the issues described in this report. Consequently, some of the recommendations contained herein may have been overtaken by events. Nevertheless, it is my hope that the descriptions and analyses provided will prove to be useful background as the rollout of wireless E911 proceeds.

1.5 Organization of the Balance of the Report

The balance of this report is divided into three sections. Section 2 provides basic background on both wireline and wireless 911 systems and a brief description of the current status of wireless E911 deployment. Section 3 contains the principal findings and recommendations of the inquiry. It is divided into six subsections corresponding to each principal conclusion and the associated recommendation. Section 4 contains descriptions of other issues that were raised during the course of the inquiry along with observations or recommendations concerning them. A brief biographical sketch of the author is attached as an appendix.

2 History and Overall Status

2.1 History of Wireline 911/E911 Systems

It is widely agreed that the first-ever 911 call was placed in Haleyville, Alabama in 1968. In the early implementations of wireline 911, the processor associated with the switching machine in the local telephone company Central Office or End Office interpreted or translated the dialed 9-1-1 sequence and routed the call to a single Public Safety Answering Point ("PSAP").[3] A PSAP is a facility equipped and staffed to receive 911 calls.[4]

While this arrangement assured that a subscriber dialing the easily remembered abbreviated dialing sequence 9-1-1 would be connected to a PSAP and had the advantage of requiring little modification or additions to the LEC's network, it suffered from a number of limitations. *First*, it provided no automatic means of identifying the origin of the call (e.g., the calling number) and thus no way for the PSAP operator to identify the caller or a way to reach the caller in the event the call was disconnected (callback). Without knowing the origin of the call, there was also no way of knowing the location of the caller. This meant that the PSAP operator had to waste valuable time eliciting this information from the caller with no assurance that the caller would, in fact, be able to convey the information accurately. *Second*, the geographic area served by a telephone company End Office was (and is) unlikely to match the relevant political boundaries. For example, in some cases, there may be several political jurisdictions within the area served by the switching machines in a single End Office and, in other cases, one large jurisdiction may encompass the geographic areas served by multiple End Offices. These two situations complicate the problem of correctly and efficiently delivering the call to the proper PSAP.

The first limitation was overcome by introduction of Automatic Number Identification ("ANI"). It allowed the delivery of the calling party's telephone number along with the emergency call itself. The calling number is an example of control information and it can be carried on the signaling network (rather than the associated "conversation" or information network) if it is capable of doing so.[5] At the time basic 911 services were

[3] The discussion which follows draws directly from an undated hardcopy of a presentation entitled "9-1-1 Tutorial" and presented by Billy Ragsdale, Bob Gojanovich, Barb Thornburg, and Roger Hixson at a NENA Technical Development Conference.

[4] National Emergency Number Association (NENA), *NENA Master Glossary of 9-1-1 Terminology*, NENA-01—002, March 1998. http://www.nena.org/9-1-1TechStandards/Standards_PDF/NENA_01-002.pdf. (NENA Glossary)

[5] Besides conveying the subscriber's actual telephone message or conversation, a telephone network must also convey other information associated with setting up, disconnecting, and otherwise controlling the call itself. The transmission and reception of such control information between the customer and the network or between elements (e.g., switching machines) interior to the network is called signaling. Signaling is

introduced, the Public Switched Telephone Network ("PSTN") did not typically carry the calling number in interoffice signaling and Caller Identification services were not offered. However, the calling number was needed to properly bill for long distance toll calls and a special signaling system known as Centralized Automatic Message Accounting ("CAMA") was devised for this (billing) purpose. This system, CAMA, was adapted to deliver the calling party's telephone number to the PSAP. CAMA uses in-band, analog MF signaling and, as a consequence, suffers from significant limitations. The limitations of these legacy systems continue to hinder the provision of efficient wireline 911 services and, as we will see later, to haunt the rollout of wireless E911 systems, the subject of this report.

Since the local telephone company must, by necessity, be able to associate a particular telephone line and telephone number with the subscriber's name and address, it is possible for the network to deliver this information to the PSAP as well. The database that contains the necessary information is known as the Automatic Location Identification ("ALI") database. If the necessary modernization has occurred, it is easy to see that the processor in the End Office could query the ALI database and have delivered back the name and address to the PSAP using modern digital, common channel signaling techniques. Because of constraints imposed by the legacy analog CAMA system and legacy equipment employed in the equipment at the PSAP, this technique has apparently not been widely used. Instead, the equipment at the PSAP – known as Customer Premises Equipment or "CPE" – is connected to the ALI database over a separate data circuit.[6] When an incoming call is received at the PSAP, the CPE uses the calling number delivered over the CAMA network to compose and send a query to the ALI database over this data circuit. The software in the ALI database then returns the name and address of the caller thus greatly facilitating the handling of the emergency call.

Recall that the second limitation of the original basic 911 service is that a single PSAP may be responsible for a geographic area that encompasses the areas served by multiple telephone company End Offices or a single End Office may serve an area that encompasses multiple political jurisdictions. With regard to the former, just as it is often uneconomical to directly connect every End Office to every other End Office or Interexchange Carrier ("IXC") Point-of-Presence ("POP") for the carriage of ordinary telephone calls, it is often uneconomical to directly connect all end offices in a large jurisdiction to a single PSAP. Instead, the emergency calls from a number of End Offices are concentrated at a Tandem Office and then delivered over a single group of trunks to

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necessary for the establishment and control of connections – including 911 calls – through the network (e.g., the PSTN) or collection of networks (e.g., a wireless cellular network and the PSTN). It is separate and distinct from the telephone message or conversation itself. An example of signaling information would be the telephone number (network address) of the called party or an indication that the called party has "gone off hook" or answered the call. Control information is needed, for example, to route the call and to properly bill for it. The signaling network is sometimes referred to as the nervous system of the telephone network for the critical role it plays in its functioning.

[6] Customer Premises Equipment or CPE is a general term for the terminal equipment installed on the customer's premises that is connected to the telephone network. In the context of 911, the term CPE normally refers to the equipment used by the PSAP to receive and process 911 calls.

the PSAP. If, as in the case of the latter, there are multiple PSAPs in areas served by the End Offices subtending the Tandem Office, then some means must be provided to route the 911 calls to the proper PSAP. This additional functionality performed at the Tandem Office – referred to as Selective Routing – routes the 911 call to the proper PSAP based upon the caller's location.

The Selective Routing functionality is what distinguishes Enhanced 911 ("E911") from Basic 911. In other words, Basic 911 may or may not involve the delivery of number (ANI) and name and location (ALI) information. E911 includes the necessary network switching, database and CPE elements for delivering the voice call to the proper PSAP along with the associated ANI and ALI information. The switching machine that provides the tandem switching of 911 calls is known as the E911 Control Office.[7] Note that two things must happen in E911: the voice call must be routed to the correct PSAP – the one serving the geographic area where the caller is located – and the location (i.e., ALI) information must be delivered to the PSAP. In order to accomplish the first, the E911 Control Office must have access to a database, referred to as the Selective Router Data Base. The data base and associated logic maps the telephone numbers served by its subtending End Offices to the proper PSAP. This, in turn, requires the creation of a database called the Master Street Address Guide that links the street address associated with a telephone number to a particular PSAP. So to summarize, with E911, the emergency call – the conversation – is delivered via the End Office and E911 Control (Tandem) Office to the proper PSAP along with the ANI information. The proper PSAP is determined by the Selective Router through a query to the Selective Router Data Base. The CPE at the PSAP then utilizes the data link to the ALI database to retrieve the name and address information associated with the telephone number. Note that, as before, these functions could be performed more efficiently with modern digital, common channel signaling techniques that, among other things, eliminate many of the constraints associated with CAMA signaling on the trunks between the E911 Control Office/Selective Router and the PSAP.

According to the NENA Report Card to the Nation, there are approximately 190 million calls to 911 each year.[8] According to the same report, wireline 911 service is available to 97.9 percent of the U.S. population. However, the report goes on to note that there are over 200 counties in the United States that are without even basic 911 services. Among the population currently receiving service, the report does not distinguish between Basic 911 and Enhanced 911 services.

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[7] *NENA Glossary.*

[8] National Emergency Number Association, "NENA Report Card to the Nation: The Effectiveness, Accessibility and Future of America's 9-1-1 Service," 2001, p. 18 (available at http://www.nena9-1-1.org/initiatives/RCN/rcn_final.pdf) (NENA Report Card to the Nation).

2.2 History of Wireless E911

2.2.1 Early Regulatory Developments[9]

The regulatory interest in extending E911 services to wireless mobile subscribers started when the Commission began developing rules for the broadband Personal Communications Service ("PCS") in 1993. In that proceeding, the Commission urged the industry and standards setting bodies to direct their attention to E911 access, including the automatic location of callers. In 1994, the Association of Public-Safety Communications Officials ("APCO"), the National Emergency Number Association ("NENA"), the National Association of State Nine One One Administrators ("NASNA"), and the Personal Communications Industry Association issued an "Emergency Access Position Paper" which they filed as an *ex parte* filing in the PCS proceeding. Later in 1994, representatives of the wireless telecommunications community and emergency service and public safety community convened a Joint Experts Meeting (JEM) which included representatives from various affected groups including vendors.

The outcome of this meeting was a JEM Report that included a prioritized list of PSAP service requirements, the mapping of emergency service features to evolutionary paths showing which features need to be upgraded, identification of information elements transferred between the wireless system and the emergency service system, and the identification of radio location techniques that might provide wireless ALI. According to the Commission, the JEM meeting and report did not, however, produce wireless E911 standards or any firm plan or schedule for implementing wireless E911.

Subsequently, on October 19, 1994, the Commission issued a Notice of Proposed Rulemaking[10] in which it proposed to require that mobile radio transmitters supplied to wireless customers provide the same level of access to 911 as available to wireline customers. Although the proceeding dealt with a wide range of issues, much of the focus was on the most crucial E911 feature; namely, the ability to report the caller's location to the PSAP. While there was general support for the goals set forth in the wireless E911 Notice of Proposed Rulemaking, the wireless industry and public safety groups differed with regard to the schedule for E911 deployment and the need for Federal regulation. Early in 1996, after the closing of the formal comment cycle, the CTIA and three national public safety organizations filed a Consensus Agreement with the Commission. The Consensus Agreement proposed a two-step implementation schedule for wireless E911. The Commission ultimately adopted rules reflecting such a phased approach for the introduction of wireless E911. Also during this period, subcommittee TR-45.2 of the

[9] The initial part of this subsection draws directly from *Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, CC Docket No. 94-102, Report and Order and Further Notice of Proposed Rulemaking, 11 FCC Rcd. 18676 (1996)("First E911 Report and Order and FNPRM").

[10] *Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, CC Docket 94-102, RM-8143, Notice of Proposed Rulemaking, 9 FCC Rcd. 6170 (1994) (E911 NPRM).

Telecommunications Industry Association ("TIA") and Committee T1P1, sponsored by the Alliance for Telecommunications Industry Solutions ("ATIS"), began developing technical solutions for wireless E911. These activities eventually led to the publication of joint TIA/T1 standards J-STD-034 and J-STD-036.

In 1996 the Commission adopted the wireless E911 rules.[11] The rules established schedules for wireless carriers to provide both basic and enhanced 911 services. As explained by the Commission in the Public Notice establishing this inquiry, under those rules, PSAPs that are able to utilize E911 information must request wireless carriers to implement Phase I and Phase II E911 in order for those carriers' E911 obligations to be triggered. Under Phase I, which PSAPs could request beginning April 1, 1998, wireless carriers must provide PSAPs with a callback number and the location of the cell site/sector receiving a 911 call. Under Phase II, the wireless carriers were required to provide to PSAPs the location of all 911 calls by longitude and latitude beginning October 1, 2001. At the time the Commission adopted its original rules, it was anticipated that the wireless carriers would use network-based location technologies for meeting the Phase II ALI requirement. It established a location accuracy requirement of 100 meters for 67 percent of the calls and 300 meters for 95 percent of the calls.

Subsequently, technological advances allowed for the development of handset-based solutions. On October 6, 1999, the Commission revised its rules to accommodate these developments but, in doing so, imposed a more stringent accuracy requirement for handset-based solutions; namely, 50 meters for 67 percent of calls and 150 meters for 95 percent of calls.[12] It also established separate deployment schedules for network-based and handset-based solutions. Generally speaking, once a wireless carrier has received a request for Phase II service, it has six months to install the necessary equipment and begin delivering the service to the requesting PSAP. In the case of network-based solutions, the wireless carrier must provide Phase II service for at least 50 percent of the PSAP's coverage area or population with the six month period and for 100 percent of the PSAP's coverage area or population within 18 months

2.2.2 Wireless Communications and Public Safety Act of 1999

On October 26, 1999, the Wireless Communications and Public Safety Act of 1999 ("911 Act") was enacted into law.[13] The law was enacted "to promote and enhance public safety through the use of 9-1-1 as the universal emergency assistance number, further deployment of wireless 9-1-1 service, support of States in upgrading 9-1-1 capabilities and related functions, encouragement of construction and operation of seamless, ubiquitous, and reliable networks for personal wireless services and for other purposes."

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[11] *E911 First Report and Order and FNPRM.*

[12] *Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, CC Docket No. 94-102, Third Report and Order, 14 FCC Rcd 17388 (1999).

[13] Wireless Communications and Public Safety Act of 1999, Pub. L. No. 106-81, enacted Oct. 26, 1999, 113 Stat.1286.

Subsequently, the Commission initiated a proceeding to implement to implement the Act. On August 24, 2000, the Commission adopted an order that, among other things, designated 911 as the universal emergency telephone number in the U.S., sought comments relating to the rollout of 911 services in which 911 service is not available, and sought comments on the steps the Commission might take to encourage and support States in their efforts to extend and improve their emergency communications infrastructure.[14]

2.2.3 Subsequent Commission Actions

Since the Commission adopted its original wireless E911 rules in 1996 and revised them in 1999 to accommodate the development of handset-based solutions, it has taken a number of further actions – including enforcement actions – to achieve the agency's fundamental goal of seeing wireless E911 deployed throughout the country. In a set of Orders adopted in September 2000 and October 2001, the Commission granted waivers to six major national carriers of certain of the initial Phase II deadlines, based on carrier specific Phase II compliance plans.[15] As part of its efforts to ensure compliance with the revised schedules, the Commission imposed detailed reporting requirements on the nationwide carriers regarding their implementation of both Phase I and Phase II services.

Also in October 2001, in response to a petition filed by the City of Richardson, Texas, the Commission amended its rules to clarify what steps need to be taken by PSAPs in order to make a valid request for Phase I and II E911 service.[16] In May 2001, the Chief of the Commission's Wireless Telecommunications Bureau, in response to an earlier letter from the King County (Washington) E911 Program Office, clarified the responsibility for certain network and data base costs associated with the provision of Phase I service.[17] In November 2001, the Commission took further steps to implement the 911 Act and, among other things, it adopted rules governing the transition to 911 as the universal emergency telephone number in those areas of the country where the 911 abbreviated

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[14] Implementation of the 911 Act, The Use of N11 Codes and other Abbreviated Dialing Arrangements, CC Docket No. 92-105 and WT Docket No. 00-110*, Fourth Report and Order and Third Notice of Proposed Rulemaking, and Notice of Proposed Rulemaking*, 15 FCC Rcd 17079 (2000).

[15] See *Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, CC Docket No. 94-102, Fourth Memorandum Opinion and Order, 15 FCC Rcd 17442 (2000) (*E911 Fourth Memorandum Opinion and Order*). See *also e.g., In the matter of Revision of the Commission's Rules To Ensure Compatibility with Enhanced 911 Emergency Calling Systems Request for Waiver by AT&T Wireless Services, Inc.,* Order, 16 FCC Rcd. 18253.

[16] *Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, *Petition of City of Richardson, Texas,* CC Docket No. 94-102, Order, FCC 01-293 (rel. Oct 17, 2001). (*City of Richardson Order).*

[17] *See* Letter from Thomas J. Sugrue, Chief, Wireless Telecommunications Bureau, to Marlys R. Davis, E911Program Manager, Department of Information and Administrative Services, King County, Washington (May 7,2001). See also, *Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems Request of King County, Washington*, CC Docket No. 94-102, Order on Reconsideration, FCC 02-146, rel. July 24, 2002.

dialing code is not in use. It also set forth the steps it would take to encourage and support State efforts to deploy comprehensive emergency communications networks.[18] Recently, the Commission also addressed the issues of non-initiated handsets[19] and TTY compatibility.[20] In July 2002, the Commission reluctantly granted non-nationwide Tier II (mid-sized regional carriers) and Tier III (small carriers) temporary, limited relief from the Phase II implementation deadlines.[21] Summaries of the Commission's wireless E911 requirements and decisions that led to them are available on the agency's web site (http://www.fcc.gov/enhanced/).

2.2.4 Technical Description of Wireless E911

In Section 2.1, above, I described the basic steps that must occur in delivering an E911 call on the wireline network. A similar set of thing must happen in handling a wireless E911 call. Basically, four things have to happen: the subscriber has to be located, the PSAP serving that location must be determined, the voice conversation has to be routed to that PSAP and finally the callback number/mobile directory number and location information must be delivered to the PSAP. As I indicated before, in the wireline environment, an ordinary telephone number is associated with a particular line (local loop) that serves a particular physical address. While the telephone number associated with a particular loop serving a given address may change from time-to-time (e.g. when subscribers move) the associated data bases are comparatively static. This is clearly not the case with mobile wireless where the location of the customer may be continuously changing even within the duration of a single call.

Recall that in Phase I, the location information is simply the cell site/sector receiving a 911 call. In Phase I implementations, a set of unique pseudo telephone numbers is assigned to each cell site/sector. In a mobile wireless network, the equivalent of a wireline carrier's End Office is known as a Mobile Switching Center ("MSC"). When a MSC receives a 911 call, a processor associated with the switch knows the cell site/sector where the call is coming from and selects an unused pseudo telephone number from the set associated with the cell site/sector. The MSC then forwards the call and pseudo telephone number to the E911 Control Office. The Selective Router Data Base contains

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[18] Implementation of the 911 Act, The Use of N11 Codes and other Abbreviated Dialing Arrangements, *Fifth Report and Order* CC Docket No. 92-105, *First Report and Order* WT Docket No. 00-110, M*emorandum Opinion and Order on Reconsideration* CC Docket No. 92-105 and *Order* WT Docket No. 00-110, FCC 01-351 (2001)

[19] *Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, *Non-Initialized Phones,* CC Docket No. 94-102, Report and Order, FCC 02-120 (rel. April 29, 2002). Non-initialized handsets are those phones for which there is not an existing service agreement.

[20] *Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, CC Docket No. 94-102, Order, FCC 02-1540 (2002).

[21] See *Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems Phase II Compliance Deadlines for Non-Nationwide CMRS Carriers* , CC Docket No. 94-102, Order to Stay, FCC 02-210, rel. July 26, 2002.

information that associates the pseudo telephone number (and its associated cell site/sector) with a particular PSAP. The E911 Control Office or Selective Router then forwards the call with the pseudo telephone number to the PSAP's CPE. When the MSC forwards the call to the E911 Central Office, the associated processor also sends (or "pushes") the call back number of the mobile unit and Phase I location information to the ALI data base. When the PSAP's CPE receives the call and pseudo telephone number from the E911 Control Office it queries the ALI data base using the pseudo telephone number and receives in return the call back number and cell/site sector information. The call back number and location information is then displayed to the dispatcher.[22]

Before I turn to Phase II implementations, two observations are in order. First, because of the use of pseudo telephone number, the existing E911 infrastructure can be used for Phase I implementations with minimal or no modifications. The pseudo telephone number is simply substituted for the ANI information and everything else essentially operates as it did for wireline E911. This is not the case with Phase II implementations. Second, as noted before, these functions could be performed more efficiently with modern digital, common channel signaling techniques that eliminate many of the limitations associated with CAMA signaling. Stated more directly, the wireline E911 system, while reliable, was jury-rigged upon a dead-end CAMA technology that continues to constrain the evolution of wireless E911 service.

In Phase II, the wireless carrier must deliver the callback number and the location (latitude and latitude or "XY" coordinates) of the caller. As I will discuss in more detail later, much of the early activity in wireless E911 was associated with discovering/inventing, developing, evaluating and selecting methods for locating mobile units to meet the Phase II requirements. Broadly speaking, there are two basic types of solutions – network-based solutions and handset-based solutions. In the case of network-based solutions, receivers at known locations (i.e., at base stations) measure the direction or, more typically, the time of arrival of the signal emitted by the mobile unit. In the case of the latter, having a timing reference and knowing the speed that the radio signal travels is a constant (i.e., the speed of light), it is possible to estimate the range of the mobile unit from the base station. With three base stations at known locations making the measurements, it is possible to unambiguously estimate the location of the mobile unit. There are many refinements to this basic triangulation technique including using combinations of angle-of-arrival (direction) and field strength, for example. Systems like this are referred to as network-based solutions for the rather obvious reason that the measurements and calculations are done in the network.

In a handset-based solution, the situation is reversed with the handset making the measurements and the calculations. In one approach, the handset measures the time of arrival of signals transmitted from Global Positioning System ("GPS") satellites and uses a similar triangulation techniques to calculate its position. In the most commonly used

[22] The description contained in the paragraph is intended to be illustrative only. The description generally reflects what is called the Non-Call Path Associated Signaling ("NCAS"). Other solutions include Call Associated Signaling ("CAS") and Hybrid CAS.

approach, some of required processing is actually carried out in the network to improve the performance of the system. The system I am referring to is known as Assisted GPS ("A-GPS"). Likewise, another commonly used approach, known as Enhanced Observed Time Difference of Arrival ("E-OTD"), is regarded as a hybrid system because the required measurements are distributed between the handset and the network.

The delivery of the location or XY information to meet the Phase II requirements is more complicated than the delivery of Phase I information. It is more complicated for several reasons. First, unlike the cell site/sector information, the geographic coordinates may not be immediately available because of the time it takes to perform the required measurements and calculations. Second, the amount of information to be transferred (the geographic coordinates and, possibly, confidence information) is greater and, third, the location data may need to be refreshed during the call in order to improve the accuracy or to follow a caller that is moving. Because the existing, underlying E911 network is typically unable to carry the additional information due to constraints in the signaling network or Selective Router or to handle refresh requests and responses, a separate data link and interface is required between the ALI data base and wireless carrier's Mobile Positioning Center ("MPC"). Implementation of this data link requires selection and installation of an interface and various data base upgrades.

Although the details vary depending upon the capabilities of the legacy network elements and the interface or interfaces chosen, call processing in Phase II implementations is similar to that described for Phase I since the same basic steps are required. When a wireless carrier's MSC receives a 911 call, the Position Determination Equipment ("PDE") locates the mobile terminal either at the start of the call or while the call is in progress. The MPC uses the XY coordinates to interrogate a Coordinate Routing Data Base ("CRDB"). The CRDB returns the information necessary to forward the call to the proper E911 Control Office or Selective Router. The MSC forwards the call and Phase I pseudo telephone number to the E911 Control Office. The E911 Control Office uses the information stored in the Selective Router Data Base to deliver the call and pseudo telephone number to the proper PSAP. When the MPC locates the mobile terminal, it also pushes the pseudo telephone number, call back number and location information (XY coordinates) to the ALI data base over the separate data link. When the PSAP's CPE receives the call and pseudo telephone number from the E911 Control Office or Selective Router, it queries the ALI data base using the pseudo telephone number. The ALI data base returns the call back number and Phase II location information which is then processed and made available to the dispatcher. Note that during the call, the location information can be refreshed over the data link between the MPC and the ALI data base.[23]

[23] As in the case of the Phase I, the description contained in this paragraph is intended to illustrative only. The details vary depending upon the protocols chosen and other factors. The process described assumes routing based upon the Phase II information but routing on Phase I information is also possible as described in Section 4.2 below

2.3 Overall Status of Wireless E911

The clear impression that I received at the initial kickoff meeting of this inquiry was that the center of attention of the industry had shifted from discovering, developing, evaluating and selecting the ways of locating mobile units to integrating the location information into the existing E911 system. That is, with location technologies selected and with the pressure of the Commission deadlines, the focus has shifted increasingly to actual implementation. My inquiry confirmed that impression and, with two exceptions, which I will deal with momentarily, the initial discovery, development and evaluation phase seems largely completed. This, in turn, has focused increased attention on implementation issues which, among other things, include PSAP readiness, which I address in Section 3.4, and on ILEC readiness, which I deal with Section in 3.5.
The two exceptions I referred to immediately above are (1) issues surrounding the ability of smaller/rural carriers to meet the Commission's requirements and (2) issues surrounding the ability of E-OTD systems to achieve the accuracy requirements specified in the Commission's rules. With regard to the former, representatives of rural/smaller carriers pointed to a number of technical and operational problems that make it more difficult for them to implement wireless E911 services.

For example, they noted that for network-based solutions, the layout of base station sites in rural areas was often far from ideal. That is, base station coverage areas are often larger with the result that signals are frequently weaker and that base stations may often be located along highways in a ribbon or "string of pearls-like" configuration that makes triangulation difficult. They claimed that adding base stations solely for the purpose of providing more accurate position fixes was uneconomical. They also said that larger carriers serving both urban/suburban and rural areas could average the accuracy results in areas with better performance (i.e., generally speaking areas with higher density of base stations) with the results in areas with poorer performance.[24] They claimed that this puts smaller/rural carriers at a disadvantage. They also noted that rural carriers tended to be more dependent upon analog and TDMA technology for which their vendors are providing less support as those technologies are phased out. They also claimed that they were at a disadvantage in terms of purchasing power compared to larger carriers when they are acquiring the necessary equipment and handsets.

The representatives of smaller/rural carriers raised other issues as well. However, in the period between the initial meetings and the preparation of this report, the Commission, in late July 2002, took action to delay the deployment schedule for wireless E911 by non-nationwide, smaller carriers. In taking the action, the Commission explicitly recognized the deployment problems attributable to third-party vendors. Some of the other technical and operational issues remain, however, and I will deal with them in a broader context in other sections of this report.

[24] The issue of averaging is discussed in Section 3.6 which deals with the lack of well-designed, standardized tests for compliance.

The other exception to the observation that the initial discovery, development and evaluation phase had been completed involves issues surrounding the ability of E-OTD systems to achieve the ultimate (50/150) accuracy requirements specified in the Commission rules. These issues are important because E-OTD is the technology chosen by several carriers that are in the process of converting their existing networks to the GSM standard and who collectively account for a significant fraction of the mobile wireless market in the U.S. During the course of my inquiry this issue was raised repeatedly and became a common thread throughout my discussions.

It was claimed by some stakeholders that the interest in E-OTD as a position location technology was primarily of European origin and that this had a number of implications. For example, it was argued that successfully implementing E-OTD in the U.S. would be more difficult because the density of base station sites is typically greater in Europe than it is here. It was also suggested that European regulators were pursuing a less aggressive approach to the rollout of emergency services and were relying more upon the development of commercial location based services to drive the technology and the associated accuracy requirements.[25] Critics of E-OTD claimed that the U.S. still represents a very small fraction of the total, worldwide, GSM market and that, as a consequence, it would be difficult for GSM carriers here to drive the market, at least in the short to medium term.

No doubt some of these allegations regarding the ultimate ability for the E-OTD technology to meet the Commission's accuracy requirements were motivated by intense commercial rivalry in a market that has some characteristics of a "winner-takes-all" situation (at least within a segment of the market using one air-interface standard). On the other hand, the Quarterly Reports filed by carriers utilizing the E-OTD technology reflect to a greater or lesser degree their own uncertainty as to the ultimate ability of E-OTD to meet the Commission's accuracy standards in the required timeframe.[26] This suggests the need for the Commission to closely monitor the evolution of the E-OTD technology during this critical final development and testing phase lest the agency be forced -- as a practical matter given the size of the capital expenditures involved -- to differentially relax its accuracy requirements. Such a relaxation would not only have implications in terms of the quality of the emergency services delivered to the public but raise significant equity and competitive issues as well.[27]

Before I turn to my principal findings and recommendations, I would like to identify and comment on one additional, longer-term, over-arching issue that came out clearly in the initial kickoff meeting and in balance of my inquiry. The issue is, simply, that, by and

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[25] Helios Technology Ltd., Caller Location in Telecommunications Networks in view of enhancing 112 Emergency Services: Recommendations towards a European policy and implementation plan, 30 April 2002.

[26] *See e.g.,* AT&T Wireless Services, Inc., Quarterly Report, CC Docket 94-102, filed August 1, 2002.

[27] The issue of equity and competitive fairness also points to the importance of the procedures used to test for compliance with the Commissions requirements. I deal with this issue later in Section 3.6.

large, the existing wireline E911 infrastructure is seriously antiquated. As I noted earlier, the rollout of wireline 911 service began in the late 1960s and a majority of the installations occurred from 1970 through 1990.[28] As pointed out in a paper by one industry participant, the 911 network is fundamentally unchanged since its inception in the 1970s and remains "…a separate network burdened with point-to-point analog circuits, in-band signaling, and low speed analog data lines."[29] In fact, one key part of the architecture – the use of CAMA-based selective routers and trunks to deliver ANI information to the PSAPs – was designed for an entirely different purpose. While the Nation should be forever grateful to the engineers and others who designed the original 911 system, it must be recognized that it was – and remains – somewhat of a "kluge."[30] In the ensuing decades, the technology that they so cleverly relied upon has been overtaken by such developments as digital transmission, fiber optic rings, digital common channel signaling, Intelligent Network technology, and broadband digital data circuits. As stated in the same paper referenced earlier:

> In a period of unparalleled technological advances, our public safety network, on which American lives and property so greatly depend, finds itself trapped by an architecture that can no longer adapt to change. The existing 9-1-1 infrastructure is in no condition to accommodate the pervasive use of wireless technologies, the Internet, or the many other product offerings that invite or demand access to 9-1-1 services.[31]

Even though the industry has made enormous strides in developing the necessary technology to integrate wireless subscriber location information into the existing E911 system, it has the appearance of patching into an existing system that has serious limitations going forward. Note that I am not suggesting that the result system will be unreliable. But, as NENA observes, while the 911 system gets high marks for reliability, it "…must be 'reinvented' to accommodate new technologies, increased competition and other institutional changes…"[32]

While the focus of my inquiry was to be on wireless E911, I would be remiss in my duty if I did not point out the serious limitations in the foundation upon which it is being built – namely the existing, underlying E911 system. Moreover, modernization of the

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[28] *NENA Report Card to the Nation.*

[29] SCC Communications Corp., 9-1-1 Networks in the 21st Century – The Case for Competition, February 20, 2001, p. 1. (Note that SCC Communications is now known as Intrado Inc.)

[30] A kluge can be defined as "An improvised, technically inelegant solution to a problem" (http://web.dexter.k12.mi.us/tech_resource/tec_tue/tt156.htm or "...an awkward or clumsy (but at least temporarily effective) solution to a programming or hardware design or implementation problem" (http://whatis.techtarget.com/definition/0,,sid9_gci212446,00.html).

[31] SCC Communications Corp., 9-1-1 Networks in the 21st Century – The Case for Competition, February 20, 2001, p. 2.

[32] *NENA Report Card to the Nation*.

underlying infrastructure has cost and funding implications that go beyond the cost and funding issues associated with the implementation of wireless E911. In the balance of this report, I will focus much of my attention on short and medium term issues specifically associated with wireless E911, but the over-arching issues associated with the existing public safety platform cannot and should not be overlooked.

3 Principal Findings and Recommendations

3.1 Importance of E911 in General and Wireless E911 in Particular to the Safety of Life and Property and Homeland Security

3.1.1 Background

Even before the events of September 11, 2001, the importance of wireless E911 to those who must react to emergencies was clear and increasing. PSAPs, and the public safety community, are on the front lines in the defense against these emerging threats, as well as in handling conventional emergencies. Accurate position reporting is essential in both types of situations. In the case of terrorist activity, for example, accurate position information is essential to allowing law enforcement units to respond quickly to reports of suspicious activity. Indeed, a timely response to a call conveying such a report could make the difference between a foiled or successful attack. In the event of an actual attack, it is almost certain that a large number of emergency calls would be placed to the PSAP. Once again, accurate position information is important because it helps the PSAP screen calls that may be placed in response to the same event. In the case of more conventional emergencies involving the safety of life and property, the recent spate of child abductions illustrates the importance of location information when multiple PSAP boundaries are crossed.

As wireless phones have become ever more widespread, the percentage of wireless-originated calls to PSAPs has risen dramatically. Some estimates put the current figure at well over one third of all emergency calls. With the dropping cost and increased convenience of wireless service, many users have replaced – or are contemplating replacing -- their wireline service entirely. In addition, the number of pay telephones has been dramatically reduced in some areas further increasing the dependency on wireless services.

Without accurate location information for this increasing volume of wireless calls, a PSAP operator must determine the caller's position by verbally querying the caller. This can take tens of seconds and is prone to error if the caller is under duress or is a visitor in an unfamiliar area. In fact, PSAP operators report that many callers are unable to provide their location at all, either because they do not know themselves, are physically unable to speak, or are under duress. In these cases, dispatching first responders becomes very difficult, resulting in a potential loss of life and/or property. In addition to the potential loss of life and/or property, the added time required to process each call can place a major – and as the percentage of wireless calls goes up – increasing strain on PSAP resources. Compounding the problem is the observation that a high percentage of calls to PSAPs

from wireless phones are duplicates or non-emergency calls. Consequently, as a higher percentage of calls are made from wireless phones and as PSAP resources are stretched thin, the likelihood of a caller not being able to complete an emergency call becomes a very real possibility.

As I noted above, the importance of E911 services in general, and wireless E911 services in particular, was recognized prior to the events of September 11th. This observation is confirmed by the simple fact that, as reported earlier, the Congress passed the E911 Act in 1999 – approximately two years prior to September 11th. Subsequent developments, i.e., the events of September 11th, the increased emphasis being placed on homeland security, the critical role played by E911 systems and services in assuring homeland security, and the increased dependence on wireless networks, make the automatic provision of location information with wireless emergency calls as much a national priority as a local one. That is, while immediate emergency response is, almost by necessity, primarily a local government responsibility and while emergency response services like E911 must be tailored to reflect local conditions and requirements, there is a strong Federal interest in the performance of such systems, especially where homeland security is involved.

During the course of my inquiry, I asked the various stakeholder groups about Federal government programs aimed at guiding and assisting stakeholders in meeting these new challenges. While I cannot claim that my review of such programs was either thorough or exhaustive, it became apparent that the available programs were scattered among various agencies and tended to be uncoordinated and not well funded given the magnitude of challenge.

Perhaps the most visible of the Federal programs is the U.S. Department of Transportation's ("USDOT") Wireless E911 Initiative which is part of the agency's efforts in Intelligent Transportation Systems ("ITS"). The goal of the initiative is "…to accelerate the availability of wireless emergency location services across the United States and thereby enhance transportation safety and security."[33] The initiative includes efforts (a) to bring national leadership and attention to the E911 issue, (b) to provide technical assistance and guidance and training to accelerate PSAP readiness for wireless E911, and (c) to engage the Nation's leading information technology experts in a fundamental reexamination of the technological approach to E911. Based upon the interviews that I conducted, there seemed to be a significant amount of support among stakeholder groups for the USDOT Wireless E911 Initiative and great appreciation for the funding that had been provided to public safety groups to enable them to, for example, better coordinate their efforts to accelerate E911 readiness among PSAPs. Nevertheless, some reservations were expressed.

Among the broad reservations that were expressed was a concern that USDOT efforts in wireless E911 were, understandably perhaps, being overshadowed by broader aspects of transportation (e.g., airport and airline) safety and security. It was also suggested that a

[33] *See* http://www.itsdocs.fhwa.dot.gov/press/fhw0702_1.htm

lot of the agency's attention stemmed from its interest in telematics[34] and the role that the technology can play, for example, in hastening the clearing of accidents on major highways during congested periods. The point was that, although wireless location information is important – even vital – to transportation safety, security and efficiency, it has implications for the safety of life and property and homeland security on a broader scale. Accordingly, some stakeholders suggested the possibility of shifting and consolidating some of the Federal level, Executive Branch interests in E911 to an agency with a broader mandate.

3.1.2 Findings

Based upon my inquiry and the analysis provided above, I conclude that there is a strong Federal interest in the implementation of wireless E911 and that that interest has been increased by the tragic events of September 11, 2001. I further conclude that existing Federal programs to encourage the implementation are fragmented and that the most visible program, while very commendable, does not totally reflect the broader implications of wireless E911 for the safety of life and property and homeland security.

3.1.3 Recommendations

Given the strong federal interest in the implementation of wireless E911, I recommend that the Commission, with proper regard for its status as an independent regulatory agency, work more closely with other federal government agencies such as Federal Emergency Management Agency ("FEMA"), the U.S. Department of Justice ("USDOJ"), the USDOT, and the Office of Homeland Security to ensure that accurate location information for emergency calls is gathered, delivered, accepted and made available for use in the dispatching of first responders. After all, it is these agencies, and not the Commission, that have an ongoing, substantive, and, frequently, operational relationship with the public safety community. Finally, I recommend that the Commission suggest to the Administration that a "National 911 Program Office" be established within the proposed Department of Homeland security to coordinate with, and be a resource for, local and state public safety first responders and other stakeholders.

[34] Telematics has been defined as "…the use of location technology and wireless communications to enhance the functionality of motor vehicles, and to provide wireless data applications in vehicles. Telematics services provide a number of automotive and mobile applications, including safety and productivity services. Among the applications are automatic crash notification systems that have the capability to automatically call the appropriate emergency dispatch for help." See *Year 2000 Biennial Regulatory Review – Amendment of Part 22 of the Commission's Rules to Modify or Eliminate Outdated rules Affecting the Cellular Radiotelephone Service and other Commercial Mobile Radio Services* WT Docket 01-108, Report and Order, FCC 02-229 (rel. Sept. 24, 2002).

3.2 Complexity of the Task Facing the Nation

3.2.1 Description of the Issue

In the subsection immediately above, I stressed the importance of wireless E911 to the safety of life and property and to homeland security, especially in the wake of the events of September 11, 2001. As a preliminary matter, I believe it is also important to stress that the deployment of wireless E911 services in the United States is an extremely complex matter. Despite my long experience in the industry and my general familiarity with the issues surrounding the deployment of wireless E911, I did not fully appreciate the complexity of the task facing the Nation until I undertook this inquiry. There is complexity in every dimension.

First, there is complexity introduced because of the sheer number of local, state, and Federal agencies who are either directly involved or who have a strong stake in the deployment. Moreover, this complexity is exacerbated by jurisdictional divisions of authority not only between the federal, state, and local governments, but at the federal level between the executive branch departments and the Commission as an independent agency. Further, the Communications Act of 1934, as amended, splits jurisdiction over local exchange carriers between the Commission and its regulatory counterparts at the state level.

Second, not only are there a large number of governmental agencies involved (including approximately 8,000 PSAPs), but there are also thousands of commercial entities with a stake in the outcome. These commercial stakeholder groups include, among others, (a) the Commercial Mobile Radio Service ("CMRS") providers who are subject to the Commission's rules on wireless E911, (b) hundreds if not thousands of local exchange carriers, including both the established incumbent local exchange carriers ("ILECs") and the emerging competitive local exchange carriers ("CLECs"), (c) a host of equipment suppliers, including not only traditional suppliers of network infrastructure equipment to the wireline and wireless industry but also the developers and suppliers of wireless position location hardware and software and the Customer Premises Equipment ("CPE") utilized by PSAPs in the handling of E911 calls, (d) a large group of wireless handset manufacturers, (e) a number of entities that offer wireless E911 services on a third party basis, and (f) a raft of system integrators, consultants, and advisors that are employed in various capacities throughout the industry to support the rollout of wireless E911.

The complexity associated with working with the vast number of PSAPs is further exacerbated by the fact that law enforcement and other public safety functions are very decentralized and split among multiple agencies (e.g., local police departments, state highway patrol organizations, and county sheriff offices, plus their counterparts in fire and emergency medical services). In addition, PSAPs range in capabilities from very large, sophisticated operators with substantial technical and financial resources to very small, less sophisticated systems with very limited resources. Moreover, there seems to be a wide variation from state to state in terms of the level of state or regional E911 coordination and the power of the statewide E911 coordinator if one is present.

Third, the complexity of the undertaking is increased by the fact that the wireless carriers in the U.S. (a) employ several different technologies with different air interfaces in the provision of their services and (b) operate across multiple radio frequency bands utilizing channels of varying bandwidth. Moreover, these systems differ in their architectural details, including employing different network elements with different functionality and interfaces. On the wireline side and PSAP side, the complexity is increased by the presence of a large, and, in many cases, aging, embedded base of equipment that is already being used in the provision of wireline E911 services.

To further complicate the situation, the PSTN system itself has evolved from a largely analog network with in-band signaling to a digital network with common channel signaling (SS7) and is evolving even further from a circuit switched world to a packet switched world with increased reliance on the suite of Internet Protocols (TCP/IP). The wireless networks have gone through – and are going through – a similar evolution from analog, first generation ("1G") systems, to second generation ("2G") digital systems with advanced signaling, and to 2.5G and 3G systems that offer a wider range of higher speed, packet switched, multimedia services. Among other things, what this means is that carriers and their suppliers must support multiple generations of equipment across, in the case of the wireless carriers, multiple frequency bands and air-interfaces. It also means that, in the not too distant future, subscribers will not only be able to make emergency "calls" through an ordinary voice handset but through a variety of other terminals such as laptop computers and PDAs.

The situation is also complicated by the network changes needed to implement wireless number portability and number pooling. The complexity is increased by the presence of multiple, contending position location systems and the fact that these position systems are evolving and will continue to evolve. Finally, the situation is complicated by the increasingly international nature of the wireless business. This means, for example, that a handset vendor producing a tri-band, international handset must assure proper operation not only in the U.S., but in many other markets as well. Functionality introduced into handsets for the U.S. market must not cause malfunctions in other markets and *vice versa*.

Fourth, the situation facing the Nation in the rollout of wireless E911 is further complicated by the current economic stress on the wireless industry and the telecommunications sector more generally. Growth in the number of wireless subscribers has slowed and capital market constraints have limited capital expenditures and placed an increased pressure on all sectors of the industry to achieve or maintain positive cash flow.

Fifth, within this complex environment, critical network architecture choices are being made that will have a profound and lasting impact on the public's interest in a robust and seamless E911 system. These choices will also have a major impact on the extent to which competition develops in the provision of E911 services and hence, on the speed of innovation in emergency communications systems. As Professor Lawrence Lessig and

others have argued, "architecture matters."[35] The choice of network elements – both hardware and software – and the associated degree of modularity influences performance and the extent to which competition can develop. Similarly, network designs based upon open architecture principles and standardized rather than proprietary interfaces between network elements can facilitate competition but can also raise issues of security and privacy.[36] Choices as to who owns or controls the necessary intelligence (e.g., the processor-based logic used to provide E911 services) and the associated data bases (e.g., the ALI data base described earlier) and where that intelligence and information resides influence network performance, including network reliability and availability, in fundamental ways. This ownership or control will also influence the development of competitive commercial location based services and telematic systems more generally.

These critical choices are being exercised in both the public and private spheres and are being shaped by public and private entities with varying degrees of influence and control. For example, it has been observed that, in some instances at least, the ILECs still have significant market power in the provision of 911 call routing, transport, and data base management.[37] It has been further argued that the resulting lack of competition and the lack of adequate financial incentives have produced "a public safety network that is fundamentally unchanged since its inception in the 1970s…" and one that is "antiquated and inflexible."[38] It has also been observed that once a PSAP chooses an E911 service provider, wireless carriers are essentially forced to deal with that entity, thereby diminishing their bargaining power. Or, to take another example, some states and/or localities have failed to provide the necessary funding or funding mechanism to allow the necessary upgrades of PSAP equipment to accept and utilize wireless location information. In some cases, states have even used funds collected for E911 modernization for other, unrelated purposes.

3.2.2 Findings

Based upon my inquiry and the analysis provided above, I conclude that the deployment of wireless E911 in the U.S. is an extremely complex undertaking and that a variety of critical technical and operational choices – including critical decisions relating to network architectures – must be made to ensure the reliable and seamless E911 system contemplated by Congress when it passed the 911 Act. Because of the total number of stakeholders involved, the complexity of the inter-relationships among the stakeholders, and the incentives and constraints faced on those stakeholders, I conclude that an

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[35] Lessig, Lawrence, The Future of Ideas, Random House, (2001), p. 35.

[36] SCC Communications Corp., 9-1-1 Networks in the 21st Century – The Case for Competition, February 20, 2001.

[37] For example, an ILEC provider of E911 service with marker power could, through pricing, steer PSAPs and wireless carriers towards a particular architecture or interface that would benefit the ILEC strategically.

[38] *Id* at p. 1.

unusually high degree of coordination and cooperation among public and private entities will be required if that vision is to be realized.

3.2.3 Recommendations

Because of the importance of E911 to the safety of life and property and to homeland security as described in Section 3.1, the critical nature of the network architecture and industry structure choices being made, and the overall complexity of the situation as explained above, I recommend that the Commission maintain or even increase its oversight of the rollout of wireless E911 services in the U.S. In making this recommendation, I am well aware of the budgetary and personnel constraints that the Commission faces. However, at least three factors tend to militate against such concerns. First, as noted earlier, the Commission need not take on the full burden of such coordination and support. Other agencies, such as the proposed Department of Homeland Security, can play a large role. Second, facilitating increased coordination among stakeholder groups does not necessarily have to be resource intensive. In some cases it simply means providing fora for the efficient exchange of information among stakeholder groups. Third, and finally, the increase need not be permanent. It is the next few years that are particularly important to the future of wireless E911 and a temporary increase in resources may be all that is necessary. In the sections which follow, I will provide more specific recommendations on steps the Commission might take to facilitate the high degree of coordination and cooperation among disparate entities that must be affected to achieve the vision set forth in the E911 Act.

3.3 Need for Increased Coordination Among Stakeholder Group

3.3.1 Introduction

In the remainder of this subsection, I provide more specific descriptions, findings and recommendations concerning the need for increased coordination in three areas: overall systems engineering, implementation/project management, and adoption of standards. During the course of my meetings with the various stakeholders, it was often stated that the goal of increased coordination should be to get to a stage where the implementation of wireless E911 would become more of a "plug and play" approach. That is, enough information would be available (e.g., on interface standards supported) that a wireless E911 system could be dropped in with minimal need for custom-tailoring and reduced risk of technical and operational incompatibilities.

3.3.2 System Engineering

3.3.2.1 Description of Issue

A system is generally thought of as an assembly, set or combination of interrelated elements (objects or people) that work together to reach a common objective. In an E911 system, the common objective is to deliver emergency calls made by dialing 9-1-1 to the proper PSAP along with the callback number and location of the calling party. As

described above, a wireless E911 system is a large and technically complex collection of hardware, software, and human elements that allow the delivery of emergency messages, callback number and location information for calls made from wireless subscriber devices like cellular telephones.

Systems engineering is a branch of engineering concerned with the development of such large and complex systems. Communications systems engineering is typically associated with "the translation of user requirements for the exchange of information into cost-effective and low-risk technical solutions."[39] It involves the definition of the overall network architecture and the associated identification and integration of the network elements, interfaces and data required to meet the specified requirements.[40] In the case of wireless E911, the basic requirements are set forth in the Commission's rules.

Early development of wireline 911 occurred prior to the divestiture of the Bell Operating Companies from AT&T in 1984. During this earlier period, the necessary system engineering functions were largely carried out within the Bell System in response to public safety requirements and with government encouragement. Since only the local telephone companies and their public safety customers were involved and since the provision of ordinary local telephone service was regarded as a monopoly service and regulated as such, the necessary system engineering could be carried out within the Bell System under traditional regulatory oversight.

As pointed out earlier, however, the situation today is much more complex. Not only are there more stakeholders involved, their interrelationships are much more complex and the stakeholders themselves have different incentives and varying degrees of ability to influence critical engineering choices. During my meetings with stakeholders and stakeholder groups, it was pointed out to me – often with a high degree of frustration – that there is no longer a single organization charged with the overall system engineering function. That is, while various entities have responsibility for parts of the system, there is no entity charged with examining how the parts fit together and how they might be redesigned or reconfigured to improve end-to-end performance or reduce the overall costs of meeting the requirements spelled out in the Commission's rules. Likewise, there is no single entity charged with carrying out the systems engineering studies necessary to develop the means to accommodate changing technology and changing requirements at minimal overall cost.[41]

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[39] Federal Standard 1037C, http://its.bldrdoc.gov/fs-1037.

[40] See http://www.atis.org/tg2k/_systems_design.html

[41] In a fully competitive market without externalities, these changes would occur automatically in response to marketplace forces. In wireless E911, the situation is more complex because of, among other things, the seeming lack of adequate commercial incentives to rollout position location services that meet the needs of public safety, the presence of residual market power among some of the stakeholders, and the occurrence of network externalities.

3.3.2.2 Findings

Based upon my inquiry and the analysis provided above, I conclude that the lack of an entity charged with the responsibility for the overall system engineering function will create an obstacle to the efficient, timely and cost-effective deployment of wireless E911 in the medium to long term. It will also hamper the Nation's ability to extend E911 access to a rapidly growing number of non-traditional devices, systems and networks.

3.3.2.3 Recommendations

Because of the lack of an entity charged with the responsibility of the overall system engineering function and obstacles that the lack may present to achieving the vision setout by Congress in the E911 Act, I recommend that the Commission establish – or cause to have established – such an entity. One possibility would be for the Commission to establish an advisory organization under the Federal Advisory Committee Act. During my inquiry, it was pointed out to me that the Joint Experts Meeting played what amounted to the system engineering role in the early deliberations over wireless E911 and it was suggested a formal advisory committee could play a similar role on an on-going basis. Clearly the advisory committee would not have the power to dictate changes in network architecture and design. However, it could create a technical framework for the necessary changes, including changes to the network elements, interfaces and data required to take advantage of improving technologies and changing requirements.[42] If resources were available, it might be desirable to provide the advisory committee with added analytical capabilities through an arrangement with an independent (of the stakeholders) non-profit entity such as Mitre or RAND.

3.3.3 Implementation/Project Management

3.3.3.1 Description of Issue

In the paragraphs immediately above, I concluded, for the reasons stated therein, that the lack of an entity charged with the responsibility for the overall system engineering function will create an obstacle to the efficient, timely and cost-effective deployment of a seamless wireless E911 in the medium to long term. To correct the situation, I recommended that the Commission establish, or cause to have established, an entity – perhaps an advisory committee – that would have that responsibility.

In the short-term, the actual rollout of wireless E911 service is beginning in earnest within the overall architecture or framework that has evolved out of the Joint Experts Meeting and subsequent, essentially *ad hoc*, efforts by providers, vendors and other stakeholders. However, the actual implementation of wireless E911 in a geographic area

[42] Anecdotal evidence of the need for an advisory committee or similar body was provided in comments following the initial kickoff meeting in this inquiry. Several participants mentioned that the meeting was useful beyond its intended purpose of educating the author because it allowed for the exchange of useful technical information among the disparate parties in attendance.

is a very challenging undertaking because of the number of entities involved and the complexity of both their technical and operational interrelationships. Just as the lack of an overall coordinating body creates an obstacle to the efficient, timely and cost-effective development of wireless E911 systems in the medium to long term, so does the lack of an entity with overall project management responsibility threaten their rollout in the short term.

Project management in a large and complex undertaking involves such steps as identifying the individual tasks that need to accomplished, identifying dependencies among the task (e.g., Task B cannot be started until Task A is completed), establishing the "critical path" or sequence of tasks that determine when the earliest the project can be completed, identifying tasks that can be carried out in parallel to shorten the schedule, assigning resources, and monitoring progress and making adjustments as needed. The project management function is most straight-forward when the project manager controls all, or, at least, the most critical resources needed to complete the project. With that control, the project manager has greater freedom to make adjustments that will accelerate the completion of the project or reduce the total cost of meeting a particular schedule.

In the case of wireless E911, there is no single entity that has that total control and there are clearly policy, legal and other barriers to the creation of such an entity. Nevertheless, during the initial group meeting and in subsequent individual meetings, various stakeholders described issues that had arisen and delays that had occurred because of the lack an overall project manager. Given this reality, it is perhaps not a surprise that entities have exercised what amounts to the project management function with the various stakeholders cooperating to varying degrees on essentially a voluntary basis. For example, it is my understanding that in some cases, the state E911 coordinator plays this role while in other states – those without such a coordinator or ones where the role of the coordinator is more limited by law – a vendor, a group of vendors, or a PSAP or an organization of PSAPs may play the role on an *ad hoc* or informal basis. It was pointed out to me on numerous occasions that the coordinator or "project manager" can produce significant benefits by, for example, aggregating PSAP requests in a way that it allows a wireless carrier to schedule fewer trips by installation crews freeing them up to speed installation elsewhere.

Even without an entity formally being assigned the role of project manager at a state, regional or local level, stakeholders I met with often noted that obstacles to the rollout of wireless E911 would be reduced if there was simply a greater flow of information among the groups involved in a particular area. In some cases the information needed was as simple as knowing the location of the Selective Router used to route the incoming E911 call to the proper PSAP or knowing what interfaces are being supported by a particular provider. In some cases, it was claimed that the needed information was available but not in a readily accessible form or location.[43]

[43] A significant portion of the information mentioned had to do with PSAP and ILEC readiness. Because of the importance (and controversy) surrounding those two topics, they will be dealt with separately below.

3.3.3.2 Findings

Based upon the discussion above, I conclude that the rollout of wireless E911 in a particular area is facilitated by the presence of an entity that acts as a coordinating body and takes on at least some of the roles of a traditional project manager. Because of the independence of the stakeholder groups involved (PSAPs, service providers, equipment vendors, etc.) this coordination must, I believe, be on a voluntary basis subject, depending upon the organization involved, to regulatory oversight. I also conclude that the rollout of wireless E911 in the short term would be facilitated by, at a minimum, a greater exchange of information among the stakeholders involved in implementing the service in a particular geographic area.

3.3.3.3 Recommendations

Because the rollout of wireless E911 in a particular area can be facilitated by an entity that acts as a coordinating body and takes on at least some of the roles of a traditional project manager, I recommend that the Commission continue to urge the creation of such entities. Indeed, the Congress itself recognized the importance of such entities in passing the E911 Act when it directed the Commission to "…encourage each state to develop and implement coordinated statewide deployment plans through an entity designated by the governor…" for the rollout of "…comprehensive end-to-end emergency communications infrastructure and programs…" I also recommend that the Commission encourage and support other voluntary coordination efforts among the stakeholders, especially in those states that have elected not to establish an E911 coordination or similar office. In both cases, I recommend that the Commission work closely with other government agencies such as FEMA, USDOJ, USDOT, and the Office of Homeland Security. In Section 3.1, above, I suggested that the Commission recommend to the Administration the creation of a "National E911 Program Office" within the proposed Department of Homeland Security. One important function of such an office could be to encourage additional cooperation and coordination in the rollout of E911 services in individual states and localities.

With regard to the need for increased information exchange among the stakeholders, I recommend that a national level clearinghouse be established to collect, store and disseminate status information on the rollout of wireless E911. The clearinghouse would serve at least two purposes. First, it would facilitate the needed exchange of information among the stakeholders. Where local, state, and/regional coordination already exists (e.g., through a state E911 coordination office), the clearinghouse would serve little more than a gateway to information that is already available. In areas where such coordination is lacking, the clearing house would be the primary source for basic technical and operational information needed to facilitate the rollout. I envision the clearinghouse collecting primarily status information – e.g., information on ILEC and PSAP readiness (as I will discuss separately later) and wireless carrier First Office Application ("FOA") information.

The second purpose of the clearinghouse would be to publish regular reports on the Nation's progress toward establishing a seamless, ubiquitous, reliable wireless E911 network. There is an old saying to the effect that "you can't manage what you don't measure" and that certainly applies to wireless E911. NENA and the public safety community have done a commendable job in reporting on the status of E911 in the past. Clearly the clearinghouse should build upon that tradition but I envision somewhat greater depth of coverage based upon the technical and operational information collected. For example, I believe it would be very useful to policymakers to know whether systems are still using outdated analog, in-band signaling or a more efficient and capable modern signaling format such as SS7.

In calling for the establishment of a national clearinghouse, I have not thus far made a recommendation as to where the clearinghouse should be located organizationally or how it might be funded. Certainly the Commission itself has existing systems to collect and make public on a routine basis the kind of information envisioned. Indeed, the Commission is already collecting some of the needed information. If funding were available, the clearinghouse function could also be contracted out to knowledgeable organization such as NENA or APCO although some issues might arise from the fact that NENA and APCO are parties in various proceedings involving E911 before the Commission. Another alternative would be the National E911 Program Office that I suggested earlier. Other, independent organizations are also a possibility. Once again, I recommend that the Commission work closely with FEMA, USDOJ, USDOT and the Office of Homeland Security as well as the various other stakeholder groups in establishing the location and funding for the clearinghouse function.

3.3.4 Adoption of Standards

3.3.4.1 Description of Issue

In the introduction to this subsection on the need for increased coordination, I noted that, in my meetings with various stakeholders, it was often stated that the goal of increased coordination should be to get to the stage where the implementation of wireless E911 in a given area would become essentially a routine event. I used the term "plug and play" to describe that environment while stakeholders sometimes use the term "cookie-cutter" to describe it.

During the initial group meeting and in subsequent individual meetings, various stakeholders stressed the importance of standards in reaching the plug and play goal. Without standards, the necessary interfaces must be designed and implemented on an individual *ad hoc* basis defeating the plug and play notion and making it difficult, costly and time consuming to rollout the service. A related problem is the possible proliferation of standards for a single interface. Multiple "standards" can be useful in responding to more specialized needs or local conditions, but can also raise costs for equipment and service vendors.

In addition, to the lack of standards and the potential proliferation of different standards in a few instances, some stakeholders also stressed the importance of establishing standards at all levels of the protocol "stack." In other words, standards are not only necessary to ensure that network elements can be interconnected at the physical and electrical layer, but that they also interact reliability in terms of data structures and software interactions at the service logic layer. Stakeholder groups also warned that, up until the present, much of the standards-making effort had focused on call process/information flow that is associated with actually delivering the location information etc. and that not enough attention has been devoted to the processes/interfaces associated with routine provisioning and other "back office" operational procedures.

3.3.4.2 Findings

Based upon my inquiry and the discussion above, I conclude that the proper development and implementation of standards can play a vital role in facilitating the rollout of E911 services. Stated another way, I conclude that standards, whether formal or informal, are crucial to ensuring the seamless emergency communications infrastructure and programs that we were envisioned with the passage of the E911 Act in 1999.

3.3.4.3 Recommendations

In Section 3.3.2, above, I recommended the establishment of an advisory committee or similar organization that would, on an open and consensus driven basis, be responsible for the overall system engineering function as related to wireless E911. While the recommended entity would not have the power to dictate changes in network architecture and or in network elements, interfaces and data structure and content, it would create a technical framework for such changes to take place.

If the Commission decides to proceed with the establishment of an advisory committee or similar organization, I would recommend that the Commission charge the advisory committee with, among other things, conducting an overall review of standards situation as related to wireless E911. The purpose of the review would be to identify areas where additional standards or different standards might be beneficial in the current environment, where multiple standards might be reduced in number without an adverse impact, and where additional standards might be needed to accommodate technological changes or changing requirements. If the Commission decides not to proceed with the establishment of such a committee, then, in the alternative, I would recommend that the Commission promptly convene a meeting (similar to the original Joint Experts Meeting) to specifically consider the issue of standards.

In neither case do I envision the advisory committee or the special meeting usurping in any way on-going standards-making activities in various fora. Rather the focus would be on voluntary coordination among different activities to help ensure that proper standards are in place to speed to rollout and evolution of wireless E911 services. In particular, I am well aware – as is the Commission – of the efforts of the Emergency Services

Interconnection Forum ("ESIF") organized by the ATIS and NENA to give stakeholders a forum for the identification and resolution of technical issues related to the interconnection of telephony and emergency service networks.[44] I am also aware of the continuing work of subcommittee TR-45.2 of TIA and Committee T1P1 of ATIS in terms of wireless E911 standards development. Indeed, I recommend that the Commission continue to support such voluntary initiatives by, among other things, having Commission staff participate and giving recognition to their activities as appropriate.

3.4 PSAP Readiness

3.4.1 Description of Issue

Earlier, I argued that PSAPs are on the frontlines in the Nation's defense against the threat of terrorism as well as in responding to more conventional emergencies. I concluded, as has the Congress and the Commission, that the provision of accurate (e.g., Phase II) location information for wireless emergency calls is crucial to PSAPs in carrying out their critical mission which is so essential to the safety of life and property and to homeland security.

Currently the wireless carriers that are subject to the Commission's rules are working to rollout E911 Phase II service pursuant to deadlines established by Commission order. As the initial step in the process, the PSAP must be aware of the importance of receiving and using the position information and must have requested E911 Phase II service from the wireless carrier. Following that, for a successful rollout to occur, all three of the major players in the delivery must be ready: the wireless carrier, the wireline E911 service provider (typically the ILEC), and the requesting PSAP. In terms of the latter, the PSAPs involved must actually be ready to receive and use the location information.

With regard to the initial step, PSAP awareness, I am generally aware of some of the steps that public safety organizations have taken both individually and collectively and both formally and informally to educate state and local governmental officials and PSAPs on the benefits and importance of wireless E911 services. For example, through my inquiry, I learned more about APCO's Project LOCATE (Locating Our Citizens At Times of Emergency).[45] A major thrust of Project LOCATE are model PSAPs that serve as inspirations for other PSAPs and as case studies for identifying and resolving deployment issues. I also learned that NENA and APCO were receiving funding through USDOT's Wireless E911 Initiative for, among other things, performing such educational functions. I also became aware of efforts by state E911 coordinators to educate local PSAPs and to assist them in coordinating their requests for wireless E911 services. I also learned about cooperative efforts by groups of PSAPs to educate other, often smaller, PSAPs in those states that have not established an entity for such purposes.

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[44] See http://www.atis.org/atis/esif/esifhome.htm.

[45] See http://www.apcointl.org/gov/PDF/LOCATE2report.pdf.

Despite these educational efforts by the public safety community – as commendable as they are – I have concerns based upon my discussions with the various stakeholder groups. I have three interrelated areas of concern. I refer to the first as "PSAP fatigue." It was pointed out to me – and I directly observed – that much of the educational and coordination activity was being carried out on a volunteer basis. In other words, it was being carried out by PSAP personnel who still had full time responsibilities in their home agencies. It was noted to me that there were limits to how much you could expect the larger PSAPs in a state, for example, to help their smaller, often under-funded, under-staffed and less sophisticated colleagues. Similarly, there were concerns expressed regarding the ability of some agencies to carry out the needed upgrades to their own facilities while maintaining their day-to-day responsibilities. During my inquiry, I was constantly reminded of the disparity among PSAPs in terms of their size, funding and level of sophistication.

Clearly PSAP fatigue could be relieved to a large part if funding could be provided to allow additional personnel to be hired or consultants or other non-permanent personnel to be retained to assist in the process. This raises my second concern -- the broader financial issue. During the course of my inquiry, it was alleged that some PSAPs had pulled back from requesting wireless E911 once the full costs became known. As I will describe in more detail below, particular concern was raised in some cases about the recurring charges being proposed by ILECs for carrying out their role in the provision of wireless E911 service.

As stated at the outset, my inquiry focused primarily on technical and operational issues affecting the implementation of wireless E911 services rather than on funding issues *per se*. However, without adequate funding for the non-recurring and recurring costs involved, the rollout of wireless E911 will be delayed, perhaps significantly. In fact, under the Commission's rules, a wireless carrier is required to implement wireless E911 service within six months of a request by a PSAP but only if the PSAP can demonstrate that there is a funding mechanism in place to enable it to recover the costs for the facilities and equipment necessary to receive and use the E911 data.[46] Funding can come from a number of different sources and many states have adopted legislation providing for such funding, typically supported by a surcharge collected by the wireless carriers from their customers. However, a number of major states have failed to adopt legislation providing for such cost recovery systems and, even more troubling, in some states, E911 cost recovery funds have been used for other purposes.

In addition to PSAP fatigue and funding issues, my third concern relating to PSAP awareness of the importance of receiving and using position information involves the lack of a PSAP advocate or "champion" at the Federal level of government. In Section 3.1.3, I suggested that the Commission recommend to the Administration the creation of a National 911 Program Office within the proposed Department of Homeland Security. As I explained there, the purpose of the office would be to coordinate with, and be a resource for, local and state public safety first responders. A key function of the office or

[46] *City of Richardson Order*

similar organization would be to work with state and local entities to educate PSAPs on the importance of E911 in general and wireless E911 services in particular.[47]

Once the PSAP is aware of the importance of wireless E911 and a funding source has been identified, the rollout can proceed when, as I pointed out above, all three of the major players are ready. I will deal with the issue of ILEC readiness in Section 3.5 below. In its Richardson Order, the Commission amended its rules to clarify what constitutes a valid PSAP request that triggers a wireless carrier's obligation to provide E911 service to that PSAP. It is understandable that each of the three parties wants assurances that the other two parties are -- or will soon be -- ready before they commit significant effort or funds to the rollout for a particular PSAP or group of PSAPs. It is regrettable, but understandable, that a certain amount of finger-pointing will also go on when delays occur. For example, some stakeholders claim that the wireless carriers challenge the validity of PSAPs requests to "buy" more time to meet their obligation. Other stakeholders claim that some PSAPs claiming to be ready to receive and use location data are not. That is, a request turns out not to be valid after the fact.

For example, a wireless carrier described a situation where one PSAP acted as coordinator or lead for several other PSAPs in an area in order to make the rollout more efficient. The wireless carrier was very supportive of the initiative taken by the group of PSAPs to coordinate their efforts but, according to the carrier's representative, it turned out that several of the PSAPs in the group were not, in fact, ready to receive and use Phase II information. The representative claimed that the problem stemmed from the fact that, while several of the PSAPs had the same CPE as the lead agency, they had not ordered and installed the necessary software upgrades. The representative also intimated that these PSAPs did not have the depth of technical knowledge necessary to solve the problem quickly. This meant that the wireless carrier, could not afford to keep its own installation team in the area for the time necessary for the PSAPs to install and test the software upgrades. One wireless carrier claimed that only about one-half of the requesting PSAPs actually turned out to be ready when the rollout was to be started.

I heard other, similar stories and while I did not investigate them in-depth, they are consistent with the notion of PSAP fatigue and under-funding and under-staffing that I noted above. In listening to these anecdotes, what struck me about them was that they rarely involved allegations of bad faith.[48] I also heard about initiatives on the part of both the PSAPs and the carriers to reduce the chances of costly misunderstandings regarding readiness. I am also aware that ESIF has established a Study Group to address PSAP readiness issues. However, as I note below, my overall conclusion is that the rollout of

[47] I recognize that USDOT has contracted with NENA to develop tools, technical guidance, and training and outreach materials to facilitate implementation of the wireless E9-1-1 services throughout the 50 states. See http://dot.nena.org/scope.htm. I believe this is precisely the type of activity that needs to occur but on a larger scale.

[48] Since allegations of bad faith actions are better dealt with in an appropriate enforcement proceeding, I will focus my attention here on actions that are taken (or not taken as the case may be) in good faith.

wireless E911 service could be facilitated by focusing additional attention and resources on PSAP readiness.

3.4.2 Findings

Based upon my inquiry and the discussion above, I conclude that, unless corrective steps are taken, the rollout of wireless E911 services will continue to be constrained by what I refer to in shorthand as PSAP fatigue, the lack of cost recovery and other funding mechanisms, and the lack of an advocate within the Federal government. I also conclude that, even when good faith efforts are made on all sides, PSAP readiness remains a potential detriment to the rapid and efficient rollout of wireless E911 services.

3.4.3 Recommendations

In my analysis above, I stressed the importance of educating state and local government officials and PSAPs on the benefits and importance of wireless E911 services. I also pointed to the importance of both informal and informal efforts at all levels of government to perform this educational function. Clearly, those efforts need to be encouraged and continued. Nevertheless, I remain concerned about PSAP fatigue and the need for additional funding particularly in those states that have not adopted a state-wide coordinator and cost recovery and other funding mechanisms. In the short term, I recommend that the Commission support the efforts being taken in this regard through the USDOT's Wireless E911 Initiative. For the longer term and for the reasons I articulated earlier, I believe that the Commission should recommend to the Administration the creation of a National E911 Program Office as I advocated in Section 3.1 above. As I envision it, the National E911 Program Office would consolidate a number of existing E911 initiatives and, among other things, would identify and support national best practices (e.g., model state statutes) while recognizing and respecting the fact that, ultimately, immediate emergency response is primarily a local government responsibility.

I also remain concerned about the situation where a PSAP, in good faith, certifies it is ready to receive and use Phase II location information but, it turns out, is not ready. During the course of my inquiry, I asked stakeholders for information and ideas – recommendations – on how the problem of "false positives" could be addressed. One thing that was pointed out to me is that the PSAPs (and their vendors) want to be able to take advantage of the six month period that the wireless carrier has to implement E911 service following the request. In other words, there is a difference between saying "I will be ready" and "I am ready."[49] One recurring suggestion for reducing the number of false positives was to move toward some type of independent third party certification.

[49] One specific problem that was pointed out to me is that the PSAP is, in effect, put in the position of certifying that the ILEC will be ready but without having any real control over the performance of the wireline carrier. Because of the importance of ILEC readiness, I have addressed it in a separate subsection.

Third party certification could occur at either or both of two points. At the outset of the process, the third party could certify that the PSAP has taken all necessary and reasonable steps to ensure that it will be ready to accept and use the location information. This would trigger the start of the six month implementation period specified in the Commission's rules. Later, the third party could certify that the PSAP is, indeed, ready. This could be accomplished by reviewing paperwork and an on-site inspection or by actually testing the required interfaces. During my study, I met with a vendor who has developed equipment that, it claimed, could emulate and test a wide variety of equipment and interfaces employed in wireless E911 systems. Equipment of this type, if it were fact technologically feasible, could be used to verify readiness. Note that this testing could take place in both directions. That is, it could be used by the PSAP to demonstrate that it is ready to accept and use the location information. In the event that the PSAP is not ready, it could be used by the wireless carrier to demonstrate that it is capable of delivering the location information.

A number of variations on the third party certification approach were offered. It was suggested, for example, that (a) PSAPs that utilize third party certification be given priority in the rollout by the wireless carrier and/or (b) that wireless carriers not be penalized if delays occur in providing service to PSAPs who have not been certified as ready by an independent third party. It was also suggested that, in the states where they exist and have the requisite authority, the state-wide E911 coordinator could provide the independent certification. It was even suggested that giving priority to PSAPs that have been certified as ready by the state-wide coordinator might be a way of encouraging states to establish such an office as contemplated in the E911 Act.

As I noted briefly above, I am aware that ESIF has established a Study Group to address certain issues relating to PSAP readiness. I recommend that the Commission continue to encourage such voluntary industry efforts to reduce the risk that the PSAP is not ready after having made a formal request to the carrier involved. If significant numbers of false positives persist as the rollout of Phase II services accelerates, then I recommend that the Commission give consideration to establishing – with stakeholder cooperation – an independent third party certification process.

3.5 Local Exchange Carrier Readiness

3.5.1 Description of Issue

The incumbent Local Exchange Carriers play a vital role in the provision of wireless E911 services to the PSAPs. The ILECs essentially stand between the wireless carrier and the PSAP. As the dominant providers of wireline E911 systems in the U.S., they directly or indirectly control the Selective Routers, ALI data bases, trunks, and other facilities necessary to deliver the wireless emergency call and associated callback number and location information to the appropriate PSAP. In order for Phase II information to be delivered to the PSAP, interface standards must be agreed upon, upgrades to the Selective Routers, ALI data bases, and trunks made, facilities provisioned and tested, and tariff-based and/or contractual business relationships put into place. As pointed out earlier, the

primary focus in wireless E911 has shifted from selecting the technical means for determining the location of the wireless phone to actual implementation and rollout. Consequently, this shift has put increased emphasis on the actions that need to be taken by the ILEC to support the rollout of wireless E911 systems and services on a timely basis.

During the initial group meeting and in subsequent individual meetings, various stakeholders called attention to this issue which I refer to here in shorthand form as "ILEC readiness." Some stakeholders noted that the ILECs were not included in the original Consensus Agreement and that the regulatory requirements on the ILECs were not well defined in terms of their responsibilities for supporting wireless E911 deployment. They argued that the rollout of wireless E911 services could be significantly slowed by the lack of ILEC readiness. Others noted that the wireless carriers and the PSAPs were often negotiating individually with the ILEC involved and that a more coordinated approach was needed.

Broadly speaking, the concerns expressed fell into four inter-related categories. The first category dealt with technical issues like, for example, what interface standards that the ILEC would support. The second category dealt with when the needed upgrades to the ILEC systems and services would be completed to allow the rollout of wireless E911 on an end-to-end basis. The third category dealt with the operational issues following deployment while the fourth category dealt with the prices that the ILECs would charge for the needed facilities and services. During my inquiry, I also talked informally with state public utility commission personnel and found, at least in some cases, that the critical role played by the ILECs in the rollout of wireless E911 was not fully appreciated.

3.5.2 Findings

Based upon my inquiry and the discussion above, I reach the perhaps obvious conclusion that the ILECs play a critical role in the deployment of wireless E911 services in the reliable and seamless manner contemplated by Congress when it passed the 911 Act.

3.5.3 Recommendations

During the period of my inquiry, the Chief of the Wireless Telecommunications Bureau of the Commission requested that the largest ILECs provide certain critical information regarding their readiness to carryout their role in wireless E911 deployment.[50] The information submitted was placed in the public record and therefore available to other stakeholders. The letter requesting the information noted that while, to date, it had not imposed any special obligations on the ILECs in conjunction with the implementation of

[50] *See, e.g.,* letters from Thomas J. Sugrue, Chief, Wireless Telecommunications Bureau to ALLTEL Corporation, BellSouth Corporation, Qwest Communications, SBC Communications, Sprint Communications, and Verizon Communications., July 29, 2002.

wireless E911 services, it was committed to monitoring the situation to see whether additional obligations are necessary.

Since the Commission has already taken this action to increase its oversight of the ILECs' role in the rollout of wireless E911, I will limit the scope of my recommendations. However, I would note that the Commission's action is consistent with my recommendation in Section 3.3.3 regarding the establishment of a national level clearinghouse to improve information exchange among the stakeholders as part of the project management function. I would also note that information of this type will also be valuable to the organization performing the system engineering function on an advisory basis as I recommended in Section 3.3.2. The Commission's action is at least a first step in dealing with the first three categories of concerns regarding ILEC readiness that were expressed during my inquiry. The fourth area of concern relates to pricing. While the Commission's letter requested information on how the ILECs planned to recover the costs of the necessary upgrades to support wireless E911, it did not request specific tariff/pricing information. During the course of my inquiry, certain stakeholders alleged that some PSAPs had pulled back from requesting wireless E911 once the costs became known. Similar concerns were expressed by a wireless carrier regarding a proposed "dip" charge for transmitting ALI data base information to the PSAP and the impact of the alleged charge on the economic viability of wireless E911. The potential problem is magnified by the sheer number of emergency calls from wireless subscribers and the fact that multiple "dips" into the ALI data base may be required or desired because the caller is moving or because with certain position location systems, the accuracy of the measurement may improve over time.

In raising this concern regarding pricing, I am not arguing that the proposed prices may not be cost justified. I have only heard allegations of problems and clearly do not have the information necessary to make such a judgment. I merely seek to alert the Commission to this potential problem which could be especially severe in those states that do not have a cost-recovery program in place. The potential problem is compounded somewhat by what appears to be a wide range of techniques or plans for recovering the costs – e.g., by regular end-user tariff, interconnection tariff, special tariff, contract or some combination. In raising this concern, I am also not addressing the jurisdictional issues involved. However, as a minimum, I recommend that the Commission work closely with the individual state public utility commissions and their nationwide organization, the National Association of Regulatory Utility Commissioners ("NARUC") to alert them to the importance of the pricing issue to the rollout of wireless E911 on a nationwide basis.

3.6 Lack of Well-Defined, Standardized Tests for Compliance

3.6.1 Description of Issue

Field testing is critical to both the pre-deployment selection of a position location system by a wireless carrier and to post-deployment demonstration of its compliance with the accuracy requirements specified in the Commissions rules. Oversimplifying somewhat,

in pre-deployment tests, the wireless carrier is primarily interested in verifying the inherent performance capabilities of a position location technology. Pre-deployment tests provide the basis for the objective comparison of competing systems and for ultimately selecting one for deployment.

Post-deployment testing is concerned with the performance of the system as deployed in an actual operating wireless network. Clearly the performance in the latter, "real world" environment can only approach the inherent performance characteristics of the technology in a more idealized environment. For example, in an actual operating network, the distances between base stations may be greater or their geometry may be far from ideal. Or a particular portion of a network may suffer from greater intra-system interference than in a more idealized, pre-deployment test bed. These "real world" conditions can prevent a terrestrial, network based solution from delivering the accuracy of which it is inherently capable. Similarly, the presence of dense foliage or "urban canyons" may prevent a satellite-based (i.e., GPS) system from achieving its full performance.

As described earlier, much of the attention of the industry has now shifted from the selection of a position location technology to implementation and deployment. Consequently, there is increased emphasis being placed on issues surrounding compliance testing and, hence, on Commission guidance on testing and certification.

While OET-71 establishes basic guidelines for determining whether position location systems comply with the accuracy requirements set forth in the rules, it does not specify standardized methods for verifying to the Commission's satisfaction that a deployed system meets the accuracy requirements. Indeed, in the Introduction to OET-71, it is stated that it is intended to provide guidance and to "…be helpful to groups and organizations working to establish standard test conditions and protocols."[51]

During the initial group meeting and in subsequent individual meetings, various stakeholders pointed out that OET-71 is not a complete test specification and that, as a result, there is significant room for interpretation and, therefore, disagreement. They went on to say that the lack of accepted, standardized test procedures could delay the rollout of wireless E911 location systems.

In addition to this general concern over the lack of accepted, standardized procedures for testing and certification of wireless E911 location systems, two specific issues relating to the tests came to my attention:

First, as pointed out earlier, the accuracy of a position determination at a particular location depends upon the signal-to-noise or signal-to-interference ratios of the received signals, the bandwidth of the signals, the geometry of the transmission/reception points, the number of measurements taken, and the integration or processing time allowed.

[51] OET Bulletin No. 71, Guidelines for Testing and Verifying the Accuracy of Wireless E911 Location Systems, Federal Communications Commission, April 12, 2000, p. 2.

Increasing the number of measurements taken and/or the processing time allowed improves the accuracy of the position determination. This means that, hypothetically at least, a location system that might not be able to meet the accuracy requirements with an initial "snapshot" could meet the accuracy requirement if allowed to delay either the initial delivery of the call itself or the subsequent delivery of the position information (i.e., the XY coordinates). Delay in the delivery of the call itself may cause the caller to abandon the call entirely or to abandon it and redial. Delay in the initial delivery of the position (Phase II) information itself may cause the call to be misrouted or timed-out by a switching machine.[52] Viewed in another way, it is not an "apples to apples" comparison if the time taken to deliver a position fix with a specified accuracy is not taken into consideration. Stakeholders alleged that disputes and, hence, delays in deployment could result from this issue.

Second, discussions with stakeholders revealed that there is uncertainty regarding the geographic area over which the accuracy measurements must be made. I was told in unequivocal terms that at least some of the systems being deployed could not meet the Commission's accuracy requirements on a PSAP-by-PSAP basis. Perhaps this is intuitively obvious, but the achieved accuracy over a particular geographic area will vary with, for example, the number and geometry of nearby base stations. This means, clearly, that a position determination system deployed over a wide area and serving multiple PSAPs may achieve the Commission's accuracy requirements *on average* but not meet the accuracy requirement in an area served by a particular PSAP or in another portion of the wireless carrier's coverage area. Stakeholders also alleged that disputes and, hence, delays in deployment could also result from this issue.[53]

3.6.2 Findings

Based upon my inquiry and the analysis provided above, I conclude that (a) the lack of well-accepted, standardized tests for compliance, (b) uncertainty over the interaction between delay and accuracy in obtaining position fixes, and (c) uncertainty as the area over which the test results can be averaged may cause delay in the deployment, acceptance and certification of wireless E911 systems.

3.6.3 Recommendations

Because of the potential for disputes and associated delay, I recommend that the Commission encourage the development of an industry-wide testing and certification (and re-certification) program. Such a voluntary program could be expected to create more uniform standards to help assure that wireless E911 service will be comparable to wireline E911 service and that wireless E911 service is "seamless" as suggested by the

[52] In the alternative, the call can be routed on the Phase I information with the Phase II information delivered later (but within the 30 seconds specified in OET-71). The issues raised by routing on Phase I versus Phase II information are discussed in Section 4.2.

[53] PSAP-by-PSAP or testing over smaller areas more generally may impact on the resources required to actually conduct the tests themselves. This is separate from the potential delays caused by disputes.

Congress in the passage of the 911 Act. It would also help ensure that test and certification methods developed for one technology are comparable to the methods used for other technologies.

During the course of my inquiry, I became aware of the efforts by NENA to develop a voluntary testing and certification program for wireless E911 technology. While I have not investigated the proposed program in depth, I believe it could form the basis for a program that could be recognized by the Commission as one method of satisfying the testing and compliance guidelines contemplated by OET-71.

Furthermore, I recommend that the Commission, with appropriate industry and public involvement, provide additional guidance with regard to both the "delay versus accuracy" and the "geographic averaging" issues identified above. This guidance could then be incorporated into the testing and certification programs as appropriate.

4 Other Issues Raised

4.1 Need for End-to-End Testing

In Section 3.2, I stressed the complexity of the task facing the Nation in deploying wireless E911 services on a ubiquitous basis. As pointed out there, wireless E911 service provision involves multiple technical interfaces between different network elements, multiple protocol layers associated with those interfaces, different technologies and architectures employed in the provision of the wireless mobile services themselves and in the position determination systems, and ownership of the various network elements scattered among multiple entities. In Section 3.3, I stressed the importance of standards in facilitating the rollout of wireless E911 services. However, the number and complexity of the interfaces involved, the number of entities associated with the provision of the service, and inevitable variations in the interpretation of the standards themselves significantly increases the risk of incompatibilities among devices and systems. Because of this risk, end-to-end testing of the entire system in each of the possible configurations is necessary to ensure proper operation of the wireless E911 system.[54] In other words, testing individual subsystems is not enough to ensure performance of the entire system on an end-to-end basis.

During the initial group meeting and subsequent individual meetings, stakeholders bemoaned the lack of test-beds for such end-to-end testing. Without such a test-bed, the developers of one part of the system – say handset manufacturers – and their customers are not able to ensure that their part of the system will actually work as intended in the full system. Lacking a test-bed for end-to-end "off-line" testing, the developers have little choice but to rely upon live testing on a working E911 system. As pointed out to me on numerous occasions, however, testing on a live system presents a certain amount of risk and a host of logistical problems. For example, quite understandably, PSAPs may

[54] Note that the testing I am referring to here is interoperability testing – not, *per se*, the compliance testing that I addressed in Section 3.6.

be reluctant to accommodate live end-to-end tests during their busy periods and they may need to suspend the tests in the face of an actual emergency. Limiting test periods to certain days of the week or certain times of the day such as early morning hours may lead to delays on the part of the vendors and exacerbate troubleshooting difficulties. Moreover, tests may not only be necessary with the initial deployment but to ensure proper operation after subsequent hardware or software modifications. Finally, it was pointed out to me that handset vendors who are not also infrastructure vendors are at a comparative disadvantage in testing their products since they may lack ready access to a network for testing.

Based upon my inquiry and the discussion immediately above, I believe that the lack of a test-bed (or test-beds) can hinder the initial deployment of wireless E911 services and its evolution to meet important new requirements as discussed in Section 4.3 below. I understand that groups of wireless carriers and their infrastructure providers using a particular air interface standard are working together to provide the necessary test environments in selected markets. While such efforts are clearly commendable, it is not entirely clear whether this approach is adequate in the long term. On the other hand, with the sheer number of combinations of wireless and wireline systems/interfaces involved, the practicality of other arrangements is not entirely clear either. Given the importance of end-to-end testing to the deployment and future evolution of wireless E911 systems and these uncertainties, I recommend that the Advisory Committee I proposed in Section 3.3.2 to address overall system engineering matters be charged with developing recommendations concerning the longer term need for neutral test-beds. It is possible that the National E911 Program Office that I suggested earlier could be the focal point for Federal government encouragement and support of such test-beds.

4.2 Confidence/Uncertainty and Routing Issues

During the course of my inquiry, I became aware of two other technical/operational issues that may impact on the rollout of wireless E911 services. The first deals with the potential inclusion of location reliability information in the delivery of the position location information to the PSAP. The second deals with certain routing issues. While neither of the two issues was significant enough to rise to the level of "principal findings," they are important enough to bear mentioning.

With regard to the first, the accuracy of the position location information delivered to the PSAP may vary for a host of reasons. As I described before, the accuracy depends upon, among other things, the strength of the received signal(s) used in the measurement relative to the noise or interference, the multipath conditions associated with that reception, the layout or configuration of the base stations or satellites involved in the measurement, and the number of samples ("integration time") that can be or are taken as part of the measurement. For Phase II measurements, the accuracy may vary depending upon whether the primary position location system or the back up system (e.g., NSS or AFLT) is being used. It may also vary from PSAP to PSAP if averaging over large regions is accepted as discussed in Section 3.6 above.

It appears that, in order to properly respond to a wireless E911 call, a PSAP could possibly benefit from some knowledge of the estimated accuracy of the position location information being delivered. For example, if the information was believed to be very accurate, the PSAP operator would be more confident in dispatching the nearest field unit. If there was more uncertainty in the location, the PSAP operator may want to dispatch additional field units to conduct the search for the calling party. It could also indicate to the dispatcher a need to ask for an additional measurement or "fix" from the PDE or to take additional time to verbally ask for more information from the caller.

From what I have been able to determine, neither OET-71 nor subsequent Commission rulings deal conclusively with whether or not the carriers involved must deliver uncertainty and confidence factors along with the basic location (XY) information. I am aware, however, that Study Group C of ESIF is addressing many aspects of the question under Issue 11 – "Phase 2 Location Reliability Factor." Based upon the results of my inquiry and the brief discussion presented above, I believe the Commission should encourage the industry to reach voluntary consensus regarding the usefulness of uncertainty and confidence factors and, if the consensus is positive, to reach voluntary consensus on the required standards for the determination, delivery, and utilization of that additional information. This could be done under the auspices of the ESIF and/or the Advisory Committee I recommended earlier.

With regard to the routing issues, recall that the position information is used for two purposes: to initially route the call to the proper PSAP and to provide the caller's location to that PSAP. An issue arises from the fact that different Phase II position location systems perform differently in terms of the time taken to provide the first fix (perhaps tens of seconds) and/or the accuracy of the fix may improve if multiple measurements are made over a similar period. This presents a rather classic form of tradeoff. Should the call be routed immediately based upon Phase I information to shorten the call setup time but risking the chance that the call may be misrouted? Or, should the call be held (i.e., not routed) until the more accurate Phase II information is available?[55] Waiting for more accurate location information may result in the caller abandoning the call and it may complicate certain timing issues across the network.[56] OET-71 specifies that the location information must be delivered within 30 seconds, which implicitly suggests that there is no requirement that routing be based on phase II information, but, from what I have been able to ascertain, neither it nor subsequent Commission actions have specifically addressed the issue outlined here.

Unlike the location uncertainty and confidence factor issue raised above, this question regarding routing on Phase I versus Phase II location data seems less appropriate to

[55] It was pointed out to me that potential misrouting problem increases if the coverage area includes tightly grouped PSAPs and if they are not served by the same selective router. If they are served by the same selective router, the PSAP receiving a misrouted call can relatively easily forward the call to the proper PSAP.

[56] Such timing interactions (e.g., switch "time-outs") are a major reason for conducting the end-to-end tests discussed in Section 4.1.

resolution by industry consensus without action by the Commission. This is because the issue has broader implications. For example, as I understand it, a wireline carrier must "port" a customer's existing telephone number to a wireless carrier if the customer requests it and the wireless carrier is able and willing to do so. From what I have been able to determine, there is no explicit requirement that wireless carrier be Phase II compliant in either instance. If there is no such requirement and the customer is substituting wireless service for traditional wireline service, he or she may not be aware that location information will not be provided to the PSAP when a 911 call is made. In addition, as explained in more detail in Section 4.5 below, if routing based upon Phase II information is used with an attendant delay, then consumer education may be needed to urge them not to prematurely abandon emergency E911 calls.

4.3 Accommodating New Requirements and Requirements "Creep"

In an engineering project of the size, scope and complexity of wireless E911, there is always a danger that constantly changing requirements will lead to scheduling delays. During the course of my inquiry, this possibility was raised in three different but related contexts. One stakeholder indicated that some PSAPs were requesting special configurations on a special or "one-off" basis. In the extreme, accommodating such special requests could delay the rollout of wireless E911 to other PSAPs. Similarly, I was told that, because of the very wide disparity in PSAP sophistication and resources, some of the early adopters were already pushing for additional functionality or capabilities beyond Phase II. Once again, accommodating these requests could lead to delays in the rollout of Phase II services in other areas. Finally, during the course of my inquiry, I was exposed to a whole host of issues regarding the further evolution of wireless E911 services. These included such issues as adapting the systems to accommodate third generation (3G) systems and services, accepting emergency messages from devices other than ordinary voice handsets (e.g., PDAs with wireless connectivity), mass calling to cell phones in a particular area (sometimes popularly, but erroneously, referred to as "reverse E911"), and interfacing to Automatic Crash Notification ("ACN") systems and other telematic and intelligent highway systems.

The tradeoff here between faster rollout of Phase II wireless E911 services and accommodating specialized and new requirements is apparent. While I am convinced that this is an issue worth mentioning because of the potential impact on the rollout of wireless E911 services in the short term, I am not convinced any formal Commission action is necessary. However, on balance, I do recommend that the Commission (a) avoid the addition of new requirements during this critical stage of the rollout, (b) encourage coalescence around standardized interfaces as discussed in Section 3.3.4, and (c) work with the industry, in conjunction with the system engineering entity recommended in Section 3.3.2, to prioritize the future evolution of wireline and wireless E911 in such a way that short term and long term priorities are properly balanced.

4.4 Impact of Future Technological Developments

In Section 3.2.1, I touched upon some of the technological developments that are impinging upon the wireline and wireless networks and how those changes increase the complexity of task facing the Nation in the rollout of wireless E911. In Section 4.2, I mentioned in passing the changes in the wireless market that may influence the further evolution of wireless E911 services. One major technological and marketplace development that is impacting on both the wireline and wireless industries is the growing interest in voice over IP – that is, voice delivered using the Internet Protocol (VoIP).[57] This development has a number of implications. For example, third-generation (3G) wireless networks are expected to rely upon the Internet Protocols within their infrastructures.[58] But, as I explained earlier, the Selective Routers that handle E911 calls may not even be able to handle modern common channel signaling protocols like SS7, let alone a protocol like the Session Initiation Protocol ("SIP") widely used in VoIP. This means that an additional network element may be needed to accomplish the necessary protocol conversion with attendant cost and performance penalties and loss of advanced capabilities. For example, using the multimedia capabilities and advanced signaling protocols associated with 3G and IP, it would be possible for a caller to send a picture of a vehicle involved in a hit-and-run accident along with a voice message. Or, stated more generally, the use of IP protocols could provide emergency systems with "…expanded services, more resilient networks, and faster response times."[59]

Another implication of VoIP is associated with what is often referred to as one its chief benefits; namely, "end station mobility and location independence."[60] This means that a IP phone can be connected to a Local Area Network ("LAN") at any handy Ethernet jack without the usual administrative hassles associated with "moves and changes" in a traditional voice telephony environment. Just like a laptop, these VoIP devices become "floating" in nature and can connect to the network from any point.[61] Thus, they may be connected temporarily at any point in a large office building or campus complex or even at an organization's location across the country. Moreover, the IP phone or similar device may be given a temporary Internet address by a DHCP server – further disassociating the IP address with a physical location. The point of this is that both VoIP devices and wireless phones share similar challenges in terms of emergency services because of their mobility. A recent article in a general circulation computer magazine

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[57] Telegeography, Statistics of IP Telephony, http://www.telegeography.com/resources/statistics/telephony/tg02_VoIP_summary.html

[58] http://www.itu.int/ITU-D/tech/imt-2000/warsaw/pdf/2_3_McCarthy.pdf

[59] IEEE Internet Computing, "Providing Emergency Services in Internet Telephony", Henning Schulzrinne and Knarig Arabshian, May/June 2002.

[60] Krapf, Eric, "Cisco Bulks Up VoIP Product Line," Business Communications Review, December 2001,pp 54-55 (available at http://www.bcr.com/bcrmag/2001/12/p54.asp).

[61] White Paper, "SIP at the Desktop – Intelligence at the Edge", Release 1, Sep 2001, http://www.sipcenter.com/files/SIP_at_the_Desktop.pdf.

reviewed an IP phone that could be plugged into a typical home network served by a broadband cable modem or DSL connection. After a generally favorable review of the product, the article concluded by noting "…you can't dial directory assistance from the IP phone or, alarmingly, 911."[62] [Emphasis added.]

While there are ways of associating an IP address and a physical location (say with a particular Ethernet jack in an office building), the ways of doing so share many similarities with – and the challenges of – wireless E911. The issues become even more tightly intertwined with the rapidly growing popularity of wireless LANs (e.g., WiFi/802.11b). The addition of Quality of Service capabilities to these wireless LANs will allow them to be used for VoIP calls as well. While the range of these systems is typically much less than the range of a single cellular base station, they do add additional uncertainty as to the exact physical location of the end user making an emergency call.

Even though the overall deployment of VoIP has been slower than many observers initially foresaw, the trend is clear and the implications for emergency services are significant. Clearly, the long term network architecture and other issues associated with the movement towards VoIP could be addressed by the Advisory Committee or other entity with overall system engineering responsibilities that I recommended in Section 3.3.2. As I envision it, that entity would work with the Commission and the various wireless, wireline, and Internet standards groups to facilitate the necessary exchange of information to reach the necessary consensus to ensure a seamless E911 system in an increasingly IP-oriented national infrastructure.

4.5 Consumer Expectations

With its long history, consumers have become used to relying upon E911 emergency services and, according to recent report based upon a Harris Poll, the American public is satisfied with the current level of service when dialing 911.[63] Stated another way, consumers have grown to have certain expectations regarding E911 services. However, especially during the early years of the rollout of wireless E911 services, there will be significant differences between the performance of wireless and wireline emergency calling systems. During the course of my inquiry, these differences became increasingly apparent to me. Users of wireless E911 systems may need to adjust their expectations – and even purchasing decisions -- accordingly. I believe this is especially important as more consumers substitute a wireless phone for a wired phone.

For example, to subscribers on a particular wireless network, Phase II service may not be available anywhere in their region or it may be available in only selected areas where the PSAP can accept and use the more accurate location information. Even in those areas where it is available the performance may differ because of the normal vagaries of radio propagation, the configuration of base stations/satellites being used for triangulation, and

[62] "Communications," PC Magazine, September 17, 2002, p. 100.

[63] *NENA Report Card to the Nation.*

whether the primary or backup position location system is being used. Moreover, subscribers used to having wireless E911 service available on their home system may not realize that it is unavailable when they are roaming on a distant system. The user of a non-initialized wireless phone may not realize that the PSAP may not receive their call back number. As explained in Section 4.1, above, the setup time for a wireless E911 call may be longer than the call setup time for an non-emergency call or an emergency call made on a landline telephone. A user of a VoIP device connected to a wireless LAN (or to a regular LAN for that matter) may not realize that no E911 service is available at all or that it may perform in unpredictable ways depending upon where the gateway between the VoIP network and the PSTN happens to be located.

Based upon the results of my inquiry and the brief discussion above, I believe that there is a significant risk of consumer confusion that may delay the rollout of wireless E911 and/or reduce its acceptance by the general public. Accordingly, I recommend that the Commission take at least informal steps to encourage the industry to properly educate consumers on the performance to be expected from wireless E911 systems and use its own educational resources (e.g., its own website) to inform wireless consumers as well.

4.6 Implications of Commercial Location Based Services

During the course of my inquiry, various stakeholder groups pointed to the relationship between wireless E911 and various commercial location based services. It is a two-way, potentially symbiotic relationship.

In one direction, the requirement on wireless carriers to deploy position determination systems to meet the Commission's E911 service mandates is likely to spur the development of other location based services. In addition to emergency services, there are three other major categories of location based services: location based information, location sensitive billing and tracking.[64] For example, by utilizing position information the subscriber could be provided with the location of the nearest coffee shop of a particular chain or a drop-off location for a particular courier service. One carrier and software supplier recently announced a service that allows users to "…look at a map displayed on a mobile phone to find driving directions, other users and the location of business contacts."[65] According to some observers, these types of personalized services are apt to be a major impetus behind the growth of the wireless industry and, in particular, in the rollout and adoption of 3G services.

In the other direction, the rollout of commercial location based services may spur more rapid development and deployment of wireless E911 services by reducing the cost burden associated with meeting the Commission's mandates. It is this latter relationship that is relevant to my inquiry. Policies and regulations that facilitate or, at least, do not

[64] See http://www.mobilein.com/location_based_services.htm.

[65] Reuters, "Microsoft, ATT Wireless Unfold Mobile Map Service," (http://www.forbes.com/technology/newswire/2002/09/18/rtr724707.html).

unnecessarily constrain the successful development and deployment of commercial location based services may well have the effect of accelerating the refinement and deployment of position determination systems by wireless carriers. Given this relationship, I recommend that the Commission be especially vigilant in identifying and eliminating any policies or regulations that may unnecessarily hinder the growth of commercial location based services. In this regard, I take note of the fact that the Commission recently addressed the issue of location privacy as customer proprietary network information ("CPNI"). While declining to initiate a rulemaking, the Commission stressed that section 222 of the Communications Act, as amended, [66] imposed clear legal obligations and protections for consumers. The Commission stated its intention to vigorously enforce those protections, and to monitor developments with an eye toward initiating a rulemaking if a need to do so was clearly demonstrated.[67]

4.7 Need for a More Adaptable Regulatory Approach

In meetings with wireless carriers during the course of my inquiry, a number made impassioned pleas to the effect that the were acting in good faith in trying to meet the Commission's mandates for the rollout of wireless E911 and that their good faith efforts were not being adequately recognized. In making these arguments they pointed to the complexity of the situation along the lines that I outlined it in Section 3.2. They pointed to problems with ILEC and PSAP readiness – problems that they claimed were often outside their control. They made the case that there were situations where slipping the scheduled rollout in one area could lead to significant cost savings and more than offsetting scheduling gains in another. They pointed to differences in technology and differences in business models among different carriers that make a "one size fits all" regulatory approach economically inefficient.

For example, one carrier using a handset based solution claimed that it was being unfairly penalized for the fact that it had a lower churn rate than other carriers. Essentially their argument was that their lower churn rate was a sign of customer satisfaction and that, in order to meet handset deployment requirements, they would have to offer deeper discounts on handsets to meet their rollout targets. They claimed, in effect, that they were being penalized for their success. Other carriers using a handset based solution claimed that more expensive location-capable handsets would be discarded before the location capability could actually be used. Carriers and some vendors also pointed to the difficult capital market in telecommunications and claimed that those difficulties made any increased subsidization of handsets particularly problematic. Carriers also made the argument that the recent publicity surrounding financial reporting irregularities at some

[66] 47 U.S.C. § 222(f)(1) and 47 U.S.C. § 222(h)(1)(A) (The 911 Act amended the definition of CPNI at section 222(h) to include "location" among a customer's information that carriers are required to protect under the privacy provisions of section 222).

[67] *See* Request by Cellular Telecommunications and Internet Association to Commence Rulemaking to Establish Fair Location Information Practices, *Order,* FCC 02-208, (rel. July 24, 2002)

publicly traded companies made them especially vulnerable to regulatory issues even when they are acting in good faith.

Based upon these claimed inefficiencies and inequities, the wireless carriers and some vendors argued for a more adaptable regulatory approach with more flexibility in the rules. During the meetings at which these arguments were made, I typically asked for specific recommendations assuming, for the sake of the argument, that more flexibility could actually speedup the rollout while reducing costs. Three major recommendations resulted from these inquiries. The first suggestion was that a Commission employee be assigned to each wireless carrier (or perhaps group of wireless carriers). These employees – which were analogized to "special masters" in complex court proceedings – would have the power to render on the spot decisions regarding the Commission's rules. After consulting with the effected parties, the Commission employee might, for example, decide that a short delay in the rollout of wireless E911 service in one area might be justified because of added efficiencies or because of a more than offsetting speedup in another area. According to some carriers, they are hesitant to make good faith adjustments – even after consulting with other stakeholders – if the adjustment would result in a technical violation of the rules.

The second, and closely related suggestion, was that the Commission adopt some form of expedited processing that would allow stakeholders to submit and receive prompt action on requests for waivers of the Commission's rules. One party likened it to the "rocket docket" process adopted by the Commission several years ago. The third suggestion was that the Commission shift from a strict rule-based approach to a more voluntary approach that would emphasize fuller disclosure on the part of the wireless carriers and, perhaps, other parties as well.[68] The party making this suggestion believed that the additional disclosures, coupled with the rivalry among the carriers and the emergence of commercial location based services, would be sufficient to drive the rollout of wireless E911 services given the initial impetus that has already been provided by the Commissions rules. The proponent of this approach said that an example of an additional disclosure would be a list of PSAPs that are already receiving and utilizing Phase II information from at least one wireless carrier. With this list, other wireless carriers serving that PSAP's jurisdiction would have little or no ability to deny that they can rollout Phase II service in the area.

Based upon the representations made during these meetings, the brief analysis presented above, and the scope of the assignment that was given me, I have several observations to make regarding these suggestions for a more flexible regulatory approach. First, as a threshold issue, and especially with regard to the more voluntary approach, I believe that recommendations regarding such a wholesale departure from the existing regulations are beyond the scope of my charter. I have focused my attention on technical and operational issues that have arisen – or may arise – within the current regulatory framework. Nevertheless, I agree with the notion that additional flexibility – rather than rigid rules – may, in some cases at least, actually facilitate the rollout of wireless E911 services. In

[68] As noted earlier, it has been suggested that Europe, through the European Commission, is moving toward a more voluntary market-driven" approach.

Section 3.3.3, I recommended that the Commission continue to urge the creation of entities at the state or local level that can coordinate schedules and perform other project management functions. Coupling these coordinating bodies with the notion of special personnel or processes at the Commission to expedite limited waivers of the rules could lead to more flexibility without abandoning the existing approach. In Section 3.3.3, I also recommended a greater exchange of information among stakeholders and that recommendation fits with the idea of additional disclosure discussed in this section.

Finally, I would also note that the Commission has, on numerous occasions, adjusted its rules to fit specific circumstances. Indeed, it has different rules for carriers adopting network based solutions and handset based solutions and it has recognized the special challenges facing rural and small carriers. In addition, in its enforcement and waiver proceedings, it has recognized some of the differences among carriers. In conclusion to this section, I would recommend that the Commission consider the "special master" or "expedited waiver" approaches as discussed herein while continuing to adjust its actual rules to fit specific circumstances as appropriate.

Appendix

Dale N. Hatfield

Dale N. Hatfield is currently an independent consultant and Adjunct Professor in the Department of Interdisciplinary Telecommunications at the University of Colorado at Boulder. Between December 2000 and April 2002, Hatfield served as Chair of the Department.

Prior to joining the University of Colorado, Hatfield was the Chief of the Office of Engineering and Technology at the Federal Communications Commission and, immediately before that, he was Chief Technologist at the Agency. He retired from the Commission and government service in December 2000. Before joining the Commission in December 1997, he was Chief Executive Officer of Hatfield Associates, Inc., a Boulder, Colorado based multidisciplinary telecommunications consulting firm. Before founding the consulting firm in 1982, Hatfield was Acting Assistant Secretary of Commerce for Communications and Information and Acting Administrator of the National Telecommunications and Information Administration. Before moving to NTIA, Hatfield was Chief of the Office of Plans and Policy at the FCC.

Hatfield was the founding director of the Telecommunications Division at the University College at the University of Denver and, for many years, taught telecommunications policy on an adjunct basis at the University of Colorado a Boulder. While in Washington, DC, Hatfield taught telecommunications technology on an adjunct basis at Georgetown University. He has nearly four decades of experience in telecommunications policy and regulation, spectrum management and related areas. He has also taught and consulted in many other countries including those in Central and Eastern Europe, Africa, the Caribbean, South America, and Asia.

In 1973, Mr. Hatfield received a Department of Commerce Silver Medal for contributions to domestic communications satellite policy and, in 1999, he received the Attorney General's Distinguished Service Award. In 2000, he received the PCIA Foundation's Eugene C. Bowler award for exceptional professionalism and dedication in government service and the Federal Communications Commission's Gold Medal Award for distinguished service. More recently, he received the Distinguished Engineer award from the University of Colorado at Boulder. He currently is a Fellow of the Radio Club of America.

In February 2001, the Federal Trade Commission appointed Hatfield Monitor Trustee in the AOL/Time Warner merger. Currently, Mr. Hatfield is serving on the board of directors of Crown Castle International and KBDI TV-12 Public Television in Denver.

Hatfield holds a BS in electrical engineering from Case Institute of Technology and an MS in Industrial Management from Purdue University.