THE STATUS OF NG911 DEPLOYMENT IN THE UNITED STATES

A RESEARCH STUDY PREPARED FOR

iCERT
Industry Council for Emergency Response Technologies

by Dr. Walt Magnussen
Director, Internet2 Technology Evaluation Center (ITEC) at Texas A&M University

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  Vice President for Public Safety Policy
  Verizon
- Craig Donaldson
  iCERT Board Treasurer and Member of iCERT Policy Committee
  Senior Vice President, Regulatory, Government & External Affairs
  Regulatory Counsel
  Intrado Inc
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FOREWORD

Across the nation, in times of intense personal crisis and community-wide disasters, 911 is the first access point for those seeking emergency response. Communications personnel receive calls and expertly dispatch emergency service professionals and equipment to render life-saving assistance to those in need. We rely on this process and system to assure the public's safety every day. The resources needed to construct, maintain, staff and update 911 communications centers and field operations are significant, particularly given the need to move to Next Generation 911 (NextGen 911 or NG911), which includes Internet Protocol-based emergency calling and data processing.

This historic time in the emergency communications industry presents unique challenges as well as opportunities. Public safety agencies are in catch-up mode after witnessing the prevalence of advanced technology in commercial and consumer markets over many years. Emergency communications continues to be susceptible to sweeping changes in the broader communications industry. Legal and policy changes lag behind technological advances, and for 911, the prospect of modernizing is compounded by the fact that the industry is comprised of multiple public and private stakeholders that often operate independently from one another, unintentionally interrupting potential for consensus. As a result, the overall 911 industry lacks a coherent strategy for regulatory, legal and funding changes necessary for NextGen 911 implementation on a widespread, eventually nationwide, scale. NextGen 911 is inevitable, but a successful nationwide rollout will require a level of collaboration never seen before.

In addition to these challenges, the burgeoning development of a nationwide public safety broadband network, for data, video and eventually voice communications between and among first responders and emergency call centers and control rooms, poses questions regarding myriad prospects of coordination, funding, resource sharing and interoperability yet to be fully explored. These matters must be weighed in conjunction with investments to be made for improving emergency calling and establishing NextGen 911 networks and systems.

This study – the first in a sequence of related reports that will follow – is intended to provide public and private sector stakeholders with a clearer understanding, based on empirical research, of the current state of the nation's transition from legacy 911 systems to NextGen 911, based on financial, strategic, technological, and policy-related readiness, as well as present activities. Through this initial study, and subsequent research, analysis and reporting, iCERT seeks to add clarity to these and other issues affecting the nation's emergency calling system and, thereby, help position the system solidly for the future.

Our nation's public safety professionals make technology investment decisions every day. Available funding resources help guide these decisions as agencies look to improve their systems and ensure effective deployment of emergency services. Absent the requisite resources, no emergency communications agency, center, program, or plan can reach its potential or position itself effectively for the future.

We trust the reader will find the information that follows to be noteworthy and of value.

George Rice
Executive Director
iCERT

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EXECUTIVE SUMMARY

In fall 2014, iCERT contracted with the Texas A&M University Internet2 Technology Evaluation Center (ITEC) for an NG911 industry study. The purpose of conducting the study is to evaluate the current status of NG911 transitions in states across America, to assess the anticipated cost of the transition on both a state and national level, to review existing funding levels to determine whether they are adequate to support a transition of this magnitude, to identify obstacles to completing the transition, and to consider the impact of external factors that might influence the transition timeline.

The data shows that most of the states had not yet begun the transition to NG911.

This study was conducted between September 2014 and January 2015. The process involved conducting interviews with key decision-makers in nine states, and performing a comprehensive review of other studies, reports and plans.

The supporting data can be found in the subsequent pages of this report. Below is an overview of the findings:

- The data shows that most of the states had not yet begun the transition to NG911. The time that the process takes, from planning through project completion, could be as much as eight to ten years. A number of the states have not yet authorized the appropriate agency or department to begin the transition process. A study completed by iCERT in 2007 (then the 911 Industry Alliance) entitled "Health of the US 911 System" noted that "One basic conclusion of our investigation is that states with effective oversight bodies are able to provide 911 services far more effectively than those without oversight. To be sure, merely having a state entity involved is not a panacea. As we explain, a state must offer incentives and effective guidance to spur PSAP technology upgrades. A state body without such tools will typically face considerable challenges with certain PSAPs that, for one reason or another, have failed to invest in technological upgrades." Unfortunately, not much progress has been made in this area in some states in the last eight years.

While current funding levels appear adequate to sustain existing NG911 networks, they are not sufficient to fund the capital requirements and the increased operational costs resulting from the obvious need to support two separate networks during the transition period.

- Telephony industry trends show an ongoing transition of the underlying e911 infrastructure, from legacy circuit-switched networks to Internet-based communications. Service providers that are updating their networks to reduce operating costs drive this transition. As these updates are completed, likely within the next decade, the costs of supporting continued legacy technology operations will significantly increase. This intensifies the urgency of completing the NG911 transition.

- While current funding levels appear adequate to sustain existing NG911 networks, they are not sufficient to fund the capital requirements and the increased operational costs resulting from the obvious need to support two separate networks during the transition period. Unless 911 fee collections are increased significantly, one-time funding support will be required from either states or the federal government.

- Current public safety funding and grants are managed in silos that include 911 call taking, police, fire, emergency medical services (EMS) and other areas. Since the transition to IP-based communications will enable sharing of information across these silos, leveraging funding and grants across these areas will result in a multiplier effect of available funds. One example of this would be for state NG911 transition planners to coordinate planning efforts with the FirstNet SLIGP grant recipients as they locate available resources to support rural build-out. The 911 call center upgrade in the Stafford County, Virginia, Sheriff's Office, is an example. Cumulative funding for this $800,000 project came from a $150,000 grant, maintenance budgets and capital reserves.[1]

- The areas of discussion where needed legislative support was indicated involve:

[1] http://www.policeone.com/Grants/articles/8238795-Va-grant-will-partially-fund-next-generation-911-system/

- establishing a central state authority with oversight of the NG911 transition in those states where one does not currently exist;

- normalizing collection rates of 911 fees across technologies (wireline, wireless, VoIP and pre-paid services); and

- gaining project funding commitments not subject to reduction by local or state legislatures or administrations, in that the transition may take as long as a decade to complete, and since most state financial commitments cannot cross legislative boundaries.

- Since NG911 is based on an hierarchical architecture, and since all current funding and operations are managed at the state level, there must be a plan to operate and fund a national backbone to interconnect the state network.

- One obstacle to deployment that arose in the discussions is a lack of support for all of the NG911 required features; in some cases, resulting from a lack of standards needed to support them. For more than four years the National Emergency Number Association (NENA) has supported interoperability testing events that have proven a high level of maturity and interoperability in and among NG911 devices. When a standard is found to be lacking, the steering committee refers the issue back to the standards committee representative for further action. Emerging wireless LTE technology has similarly-perceived issues of immaturity and lack of capability, yet that technology seems to benefit from the deployment of public safety broadband networks, thereby taking advantage of the advanced capabilities of a less than perfect architecture even before it is fully mature. For example, the LTE roadmap has the current network implemented on either the R10 or R11 revisions of the architecture, while R15's upcoming capabilities, at least six to eight years out, are being finalized. The NG911 industry could consider adopting the same stance.

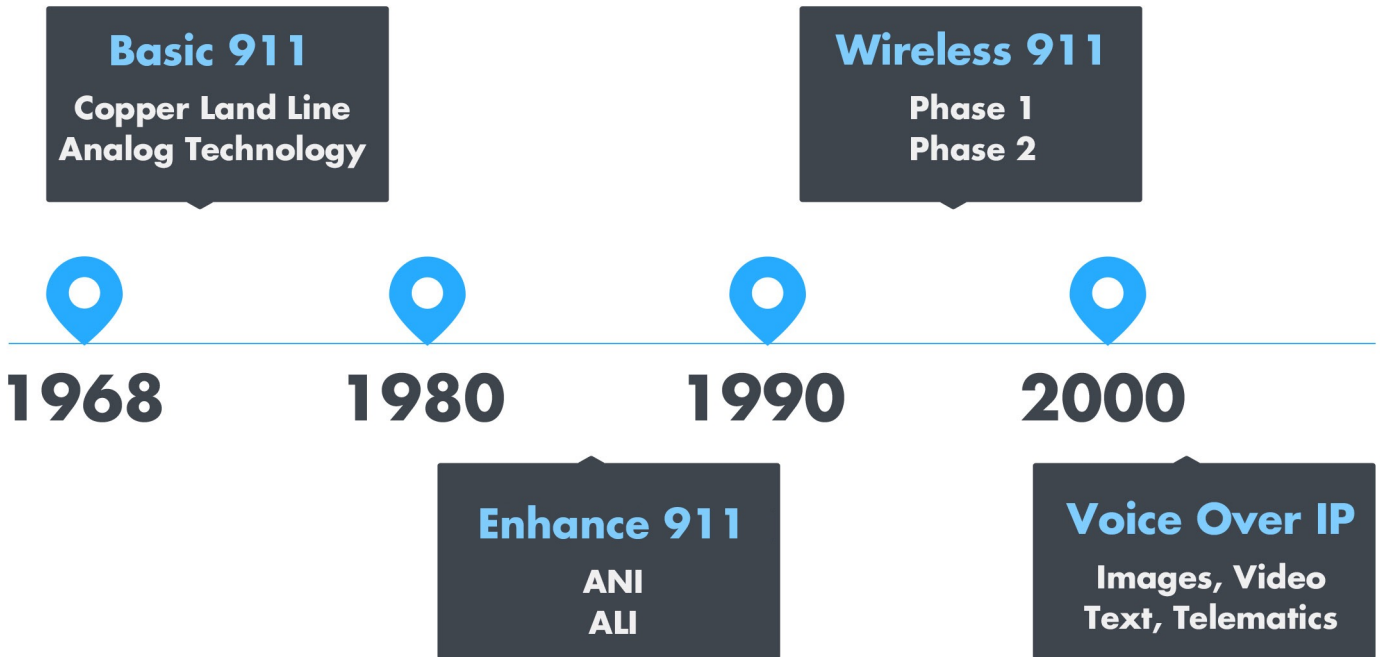
The findings of this study are consistent with those of the "2014 National 911 Progress Report" released in March 2015 by the National 911 Program Office of the NHTSA.[2] Their report found that in 2103, 15 of 39 states reported having an NG911 strategic implementation plan. This number was up from 9 in 2011. The fact that about 11 of the states did not respond is indicative of findings in this report that several states do not have a central 911 authority, since this would be the agency or organization responsible for reporting such data. The progress report also found that two states and

[2] http://www.911.gov/pdf/National-911-Program-2014-ProfileDatabaseProgressReport-031315.pdf

two provinces reported a 100% NG911 transition, but then they further noted that these were states that have implemented a text-to-911 system. This seems to indicate a belief that text-to-911 is, at least in part, synonymous with NG911, which is not the case. This is a misunderstanding that could negatively impact the nation's overall transition to NG911.

BACKGROUND & HISTORY OF NG911

In 2004, NENA began the process of formalizing elements for standards associated with NG911. The need to transition to a more robust network had been apparent for several years; setting standards was the impetus for that journey. The history of 911 is best depicted in this United States Department of Transportation timeline.[3]



Having a single national number to call for emergency services – 911 – actually began in the United States during the 1960s when Congress enacted legislation mandating such. The architecture to implement this service was based upon existing telephony equipment. The first generation of 911 only had the ability to route a call to an emergency call center, commonly referred to as a "Public Safety Answering Point", or "PSAP". In the 1970s, as the SS7 signaling system became prevalent, it became possible for the network to convey the telephone number of the calling party to the PSAP; this would, in turn, trigger a location lookup in a database. The process of conveying the telephone number was called "Automatic Number Identification", or "ANI", and the database that contained the associated

[3] http://transition.fcc.gov/pshs/advisory/csric/1stmeeting-ng911.ppt.ppt

location was referred to as the "Automatic Location Information", or "ALI". The addition of this capability triggered the second generation of 911 referred to as "e911", or "enhanced 911".

In the late 1980s and early 1990s changes in telephony technology once again inspired changes within the 911 system. This change was the adoption of wireless services from cellular carriers. For 911 service providers to support this new technology, a solution to the mobility aspect of the telephone was absolutely necessary. The 911 industry solved the mobility issue by using a combination of fixed cellular tower locations to route the 911 calls, with a combination of cellular tower triangulation of the cellular telephone, and location acquired by the cellular telephone via GPS services to accurately locate the caller.

During the 1990s, data traffic exceeded voice traffic on the network for the first time, and for telecommunications companies, supporting two separate networks in the long term was cost-prohibitive.

That method worked well until about the turn of the century, when another change in both technology and in the way people communicate compelled additional transformations. In the technology change, all telephone network infrastructure from the legacy circuit-switched architecture created in the early 1900s evolved rapidly to a packet-based architecture built on the "Internet Protocol", or "IP".

During the 1990s, data traffic exceeded voice traffic on the network for the first time, and for telecommunications companies, supporting two separate networks in the long term was cost-prohibitive. Further, voice networks and e911 networks were built on an infrastructure designed to carry only voice traffic. As for the consumer communication style-change, around the year 2000, telephony traffic began to carry significant amounts of other formats, including text messaging, video messaging, email communications, and eventually, even machine-to-machine information. If 911 was to continue to be a viable service, it must support these other formats.

As already noted, in 2004 public safety leaders, mindful of the changes in the industry, began to plan for a transition. This process has resulted in the development of dozens of specifications such as the NENA Detailed Functional and Interface Specification for the i3 Solution – Stage 3.[4] These

[4] https://c.ymcdn.com/sites/www.nena.org/resource/resmgr/Standards/08-003_Detailed_Functional_a.pdf

specifications are developed by committees through a vetting process, subsequently approved by NENA's Board of Directors, and intended to cover all aspects of an NG911 network. These aspects include architecture definition, requirements for functional elements, data dictionaries, and interface specifications. In an effort to minimize the time and cost of transition, the industry relied heavily on widely accepted standards to support the architecture. These include standards from the Internet Engineering Task Force (IETF), 3rd Generation Partnership Program (3GPP – the cellular industry standards body), and the International Telecommunication Union (ITU-T).

With initial drafts of the i3 specification complete, in 2008 the National 911 Program Office of the US Department of Transportation undertook a proof-of-concept project. Contributing organizations included two major consultancies, along with Texas A&M University and Columbia University, in addition to NENA. The tasks of the project included documenting the NG911 architecture, providing transition cost analysis, and completing an NG911 proof-of-concept test.[5] The proof-of-concept piece involved the design, construction, installation and testing of an NG911 system in five PSAPs and three laboratories in the United States. During these tests, 47 requirements were identified and tested, with 39, or 82%, of the requirements passing. While it was stated at the time that this was a low level of success – attributed to the lack of maturity of the technology at the time – it should be noted that the features that were not supported were all capabilities not available in today's e911 networks.

Between 2008 and 2010, several firms began to implement some of the functional elements required in an NG911 architecture, and it became clear that 1) a network would likely be comprised of elements made by several manufacturers; and 2) a venue was needed where these firms could complete interoperability testing. Responding to this need NENA established "Industry Collaboration Events" (or "ICE") where companies that build NG911 functional elements participated in scenario-based exercises for testing interoperability of specific elements.[6] Each ICE event focuses on one specific functional area. ICE-1 was held November 4-5, 2009 and, to date, seven ICE events have been held. The most recent, ICE-6, was held at the Illinois Institute of Technology November 9-14, 2014. More than 20 commercial sector providers completed 73 tests. Of these tests, 55 were successful for a completion rate of 76%.[7] The concentration for ICE-6 was "comprehensive end-to-end functionality, interaction between vendor elements (external interfaces) and interoperability testing". This ICE event included testing of a complex ECRF hierarchy, over-the-top video and quality of service. The success

[5] http://www.its.dot.gov/ng911/pdf/NG911_POCTesTReport091708.pdf

[6] http://www.nena.org/default.asp?page=NG9-1-1_ICE

[7] http://www.nena.org/?ICE6

rate of end-to-end testing in this multi-vendor environment demonstrates that the lack of maturity noted in the 2008 proof-of-concept project is no longer an issue. The technology is now mature enough for reliable full-scale deployments. (Note again that the features that were not supported were all capabilities not available in today's e911 networks.)

RESEARCH METHODOLOGY

With a little more than a decade of NG911 industry planning and testing, the yet unanswered questions are:

1. What is the status of implementation of NG911 in America?
2. What impediments are there to completion?

The Industry Council commissioned a study that was awarded to the Texas A&M University Internet2 Technology Evaluation Center (ITEC) in 2014 to answer these questions. The methodology involved a comprehensive literature search and review, along with a survey and subsequent interviews of selected state 911 officials.

Literature sources included documents created by public safety associations, the United States Department of Transportation, the United States Federal Communications Commission, and various states. Information gathered from literature searches created the foundation of the study questions and aided in the validation of research findings.

A questionnaire was devised and presented to, as well as discussed with, individuals from 16 states who were identified as having a primary emergency communications leadership role. A draft survey was developed in October 2014, and presented to the iCERT research working group for comment. The insights gleaned were used to refine the survey, which was then given to the Executive Director of the Texas Commission on State Emergency Communications to validate ahead of an interview to discuss the questionnaire's elements. During this interview, the Director recommended a few additional questions be added and, upon approval from iCERT, the survey instrument was deemed complete.

Of the 16 state 911 leaders contacted to complete the survey, nine responded. The survey was presented via conference call; each call lasted about one hour and was conducted during November and December 2014. The survey questions were submitted to the respondents approximately one week in advance.

Follow-up discussion in January 2015 led to the addition of two questions to the survey relating to the importance of a nationwide NG911 ESInet. These questions were submitted to the nine respondents on January 27, 2015, with 911 leaders from two states responding to the additional questions. Since this instrument is more qualitative than quantitative, no statistical analysis was completed on the results. Two researchers, Dr. Walt Magnussen and Dr. Bob Arnold from the ITEC, were on each of the interview calls. The discussions were recorded and notes were taken during each interview. These notes were later tabulated into a spreadsheet. The recordings, the interview notes, and the spreadsheet are not a part of this study, in order to protect the anonymity of the respondents.

The survey included introductory statements outlining the purpose of the study. Following these comments were four sections of questions, for a total of 34 questions, collapsed into 28 for purposes of this report. These sections included:

1. Organizational questions – This section contains three questions about the organizational structure of the central 911 office within the state, and the legislative authority for this organization to oversee a network transition.

2. Strategic plan and deployment status – This section has 11 questions about the status of the state's strategic plan for NG911 and deployment status.

3. Funding questions – In this section are eight questions about current funding and the ability to fund an NG911 transition without additional funding sources.

4. Other questions – This section includes 10 questions about interaction between the planning process of the NG911 networks and the Public Safety Broadband Network (FirstNet), interaction of other state agencies, the planning process and other questions.

RESEARCH FINDINGS

The findings were grouped into the same four categories contained in the survey instrument. Since the responses varied drastically among the states, this section provides a high level summary of the responses while keeping the individual responses private.

Organizational Structure:

1. Q: Describe your organization, its role, funding, charter and governance.
   R: Of the states responding, five reported a limited role in the operational management of existing 911 networks. Four of them primarily managed 911 fund distribution and facilitated reporting. All but one had some sort of oversight or advisory council/board. The 911 offices were standalone cabinet level agencies in two of the states. In the others they were housed within the departments of public safety, the Governor's staff, or within the office of the state's CIO.

2. Q: Describe the nature of 911 operations in your state (centralized, regional, distributed, hybrid).
   R: In two of the states, the operational structure was a hybrid form with some of the 911 administration being centralized and some of it contained at the local level. In the other seven, operations were 100% distributed.
3. Q: Are there any consolidation discussions going on in your state?
   R: Of the nine states, one reported no centralization efforts currently underway, and eight had limited resource sharing, mostly driven by local consolidation efforts. One state did report that they provided incentives for local PSAPs that shared resources.

NG911 Strategic Plan and Deployment:

4. Q: Is there a strategic plan in place for NG911 in your state, and if so, where is it available?
   R: The survey revealed that four states reported having no strategic plan at this time, three states noted that a plan was either in progress or was funded and planned. Two states reported having a completed strategic plan at this time.

5. Q: Have there been any updates or discussions of updates to the plan since it was approved?
   R: The two states that reported having a strategic plan also reported that there was no plan to update it at this time.

6. Q: Was a consulting firm used for the development of the plan? If so, what firm and what was their role?
   R: All of the states that either have completed a strategic plan or have one pending reported the engagement a consulting firm for development. The states that have no plan pending reported that they intend to use consulting firm services.

7. Q: Is there an NG911 trial or early deployment effort going on in your state? If so, does it include:
   - Transport Network Plans (state network, carrier network, regional optical network)
   - ESInet functional elements (ESRP, LVF, BCF)
   - PSAP (i3 compatible)
   - Transitional elements (LNG, LPG)

   R: Six states reported involvement in trials over the past several years that were primarily focused on building a transport network (mostly without i3 functional elements), or GIS data projects. Most of these did not result in networks that were transitioned to the final NG911 solution; most respondents, however, agreed that these tests were invaluable learning experiences that shaped what their state is doing today.

8. Q: What is the funding level committed to this project?
   R: Funding levels for these projects included federal funding ranging from $200,000 to $1,700,000, with states providing matching funds of up to $1,700,000.

9. Q: What is the current status of this project?
   R: Three states reported that the trial project had concluded and that there is no current activity. The other six states reported either that they still have at least a small portion of the trial standing today or that it had led to other yet-ongoing activities.

10. Q: Which vendors or partners are assisting with the implementation?
    R: Three of the six states that reported being involved in trials have partnered with various service providers, while the other three worked with public safety consulting firms.

11. Q: Are there any lessons learned from this effort?
    R: Lessons learned included:
    - The costs of transition will be higher than originally anticipated;
    - Outreach is critical to the success of any trial or implementation; and
    - Integration of legacy networks is far more complex than had been expected.

NG911 Funding:

12. Q: What are your funding sources?
    R: By source as noted below:

State appropriations

R: Of the nine responses, one state reported $20 million appropriated by the state, one reported limited appropriations, and seven reported no state appropriations at this time with none expected in the future.

All of the states that reported trial projects also reported that funding from the DoT grant comprised a portion of their funding source

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911 fees (source and amount)

R: Since all of the states were either in the process of completing the required FCC collection reports, most of the respondents had the numbers on hand. Rather than use the numbers provided to us, since the FCC report[8] was released during this study, we chose to use the numbers provided in that report. These numbers appear in Appendix 1. Issues related to the fees are listed below.

- The fee per device varies greatly between $0.18 per month per device to $3.00 per month per device. The majority of the fees were in the $0.45 to $0.55 range.
- All nine of the responding states had a clear understanding of wireless collections. Some of the respondents were not clear about landline collections due to "bill-and-keep" arrangements with the service providers. Several of the states did not collect for VoIP provisioned telephone services.
- The collection rate was established at the state level for most respondents, but for a few the collection rate was established at the local level.
- In some of the states, the 911 office did not know what the total 911 collections were, since for landline devices, bill-and-keep arrangements with service providers were not reported to the 911 offices.
- There was a significant difference between the rates established for landline connections, wireless connections and VoIP connections.

[8] http://transition.fcc.gov/pshs/911/Net%20911/NET911_Act_6thReport_to_Congress_123014.pdf

Grants and contracts

R: In 2009, the United States Department of Transportation awarded $40 million to 30 states for NG911 related projects.[9] All of the states that reported trial projects also reported that funding from the DoT grant comprised a portion of their funding source (several states added matching funds from internal budgets).

Other sources

R: Eight of the states reported no other source of 911 funds. One reported that over 80% of the 911 costs were actually funded at the local level, mostly from real estate levies. Several noted that it is difficult to fully determine the true cost of 911. Since emergency call taking and dispatch services are often intermingled operationally, it is challenging to allocate costs to each service individually.

13. Q: Are there other sources that you feel are appropriate that are currently not in place?
    R: One state indicated that they were trying to identify other funding models at this time, but nothing has yet surfaced.

14. Q: Do you feel that existing funding will be sufficient once NG911 is in place?

15. Q: Do you feel that existing funding will be sufficient to support both the capital and operational costs of NG911 transition?

16. Q: Is there an idea of the amount of the deficiency, if any?
    R: (The responses for questions 14, 15 and 16 have been combined.) Of the nine respondents, three felt that the funds were adequate, three thought that funding is not adequate, and three indicated that they did not know. All nine did agree that they did not understand the actual costs well enough at this time to respond with any certainty.

Other Questions:

17. Q: Is there a relationship between NG911 planning and public safety broadband network (FirstNet) planning in your state?

[9] http://www.9-1-1.gov/grants.html

18. Q: Who is the FirstNet Single Point of Contact (SPOC) for your state, and what is the relationship between your organization and the SPOC (if they are not the same)?

19. Q: Is your office involved in the FirstNet planning grants?

    R: (The responses for questions 17, 18 and 19 have been combined.) Of the nine states, eight noted that there was a relationship between the NG911 transition planning process and the public safety broadband implementation planning process. In most cases, the two were under the authority of the same department at some level. In one case it was even the same person. For the one state that did not have interaction between the two, the respondent recognized this as an issue and was addressing it.

20. Q: Are there discussions of resource sharing between the state FirstNet network and the state NG911 network?

    R: The eight states that have a relationship between the two offices understand the importance of resource sharing.

21. Q: Are there any plans relating to connecting to a national NG911 ESInet?

    R: As we began the analysis phase of this study, we found that this question did not give us the desired information. The question was therefore modified and resubmitted to the respondents.

22. Q: Is there any other information that you feel would be important in the development of this study?

    R: Comments include:

    - One state noted that telephony carriers' selective routers are reaching end of life, and it is important to complete the transition before that equipment is decommissioned.
    - With the disappearance of landlines, existing infrastructure becomes unreliable.
    - One state noted that a lack of understanding of the issues by the public is preventing them from being a part of the solution.

23. Q: If you are working on an NG911 planning or implementation project, is your state CIO and/or IT department involved?

    R: Two states reported limited involvement of the state IT department. One state reported significant involvement.

24. Q: Does your NG911 planning department include an enterprise project management person? If so, is that individual an employee or a contractor?

    R: Four states reported that they planned to use external project management resources. The other five reported that they would either use internal resources or a combination of internal and external resources. One state noted that the exclusive use of external project management was a large contributor to the failure of their prior test project. This was one of the items mentioned as a lesson learned.

25. Q: Do you need special appropriations or approval if your project is to encompass several funding cycles?

    R: While no specific legislation was noted by any of the states, there were three potential problem areas that were discussed. These issues are:

    - In their specific state, 911 funds collected were not protected and could be swept and used for other non-911 services.
    - All states noted that the transition was going to take much longer than a period for which they could commit funds, due to the crossing of legislative budget cycles. Once a project has begun, there is no guarantee that it would be funded to completion.

26. Q: Is there any state legislation that would be beneficial to your NG911 transition project?

    R: Other than proposed legislation recommended elsewhere in this study, the only other recommendation related to governance issues. Four states noted that their office did not have either a legislative or administrative mandate, or even the authority to develop an NG911 transition plan, including a lack of authority to oversee such a transition. Without such authority, effectively implementing a transition to the new network would be impossible.

Follow-up Questions:

27. Q: How important to you is it that an optional nationwide ESInet exist, and why?

R: While we did not get as many answers to this question as others because it was a follow-up question, the consensus of those we spoke with was that a nationwide ESInet must exist if NG911 is to be fully functional.

28. Q: Would you be more likely to hasten the installation of your state's ESInet if such a backbone existed?

    R: Respondents noted that the existence of a nationwide backbone would increase both

confidence in the NG911 direction and validation that the states' transitions need to happen more quickly.

ANALYSIS OF DATA AND FINDINGS

This section of the study will take the information gleaned from the participants, and other published studies and documents, to summarize the major research questions asked at the outset of this study. These questions are:

- What is the current status of NG911 transition across the United States?
- Are there mitigating factors that might compel states and local governments to make this transition sooner rather than later?
- What are the costs of the transition, and do states have the ability to complete the transition within existing funding levels?
- Are there legislative changes that need to be made to facilitate transition?

What is the current status of NG911 transition across the United States?

During the interviews, respondents were asked to describe their current NG911 transition status. The following table reports the status on a respondent count basis.

	COUNT
PSAPs in Study	9
GIS Dataset established	2
PSAP CPE installed	1
Strategic Plan Developed	4
ESInet constructed	1
Authority to oversee NG911	6

In talking with the nine state leaders that were interviewed, there appeared to be several logical tasks that must be accomplished in order to complete a successful transition to NG911. While these tasks

need not be completed in any specific order, they were mentioned by each of those interviewed. These tasks include:

1. Authoritative organizational structure established – Within each state there must be one entity that holds overall authority and responsibility for the planning and implementation of an NG911 network. E911 allowed for the complete decentralization of the networks, but NG911 will not work if there is not a coordinated effort. A number of interviewees indicated that there was not an entity within their state that had such authority at this time. Whatever authority that does exist is contained within a central 911 office housed in a standalone cabinet-level agency in some cases, within the Governor's office in others, within central IT in yet others, and lastly, within the financial branch. The state leaders that reported not currently having this authority delegated to any one entity also report that no strategic plan exists or is currently being developed. Clearly, without authority and responsibility appointed to an entity, no such plan is likely to occur. How the authority is granted seems irrelevant, whether originating from an executive order or legislatively mandated. The importance is that such authority be granted.

Every state with a strategic plan had used a consulting firm to help them develop the plan.

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2. Development of a Strategic Plan – Prior to the implementation of any NG911 network there must be a strategic plan created. This plan should describe the outcome, establish reasonable milestones, identify any resources that are required, quantify the total cost, identify the proposed revenue streams, specify the operational model, and recommend a governance structure. No state should begin a project of this size and importance without such a plan. Of the state leaders that were interviewed, three reported no such plan in place at this time, four had completed plans, and two reported strategic plans in process that should be completed in early to mid-2015. Every state with a strategic plan had used a consulting firm to help them develop the plan. Those that had completed plans reported that the development of these plans was a lengthy process with significant expense associated. All of the plans taken into consideration in the creation of this report relied heavily upon the involvement of stakeholders when compiling their strategies. During the interview process, it was made clear that even if central authority were granted to a single entity, the process would only be successful if the direction were established in an inclusive manner.

3. Creation of a central GIS repository – in e911, required data is maintained in the networks of service providers, in local planning offices, in ALI databases, and in many other various locations. This data is currently maintained in a multitude of incompatible formats, which are not accessible outside of the confines of the holder of the data. If NG911 ESInets are to be enabled, this data needs to exist in compatible formats that, with the proper authority, are available to the network elements. It is not required that this data be centrally managed or controlled, but it is necessary for the data to be standardized. This task should also address how data is to be maintained and validated, since incomplete or inaccurate data can result in lost calls. This task is probably one of the most complex and costly pieces of the NG911 transition.

4. Design of state ESInet(s) – Regardless of whether the end solution is a single state ESInet or a series of hierarchically connected regional ESInets with a state root ESInet, this process will also take significant effort. The functional elements that need to be supported in the ESInet(s) are:
    a. ESInet Backbone – This is the underlying data network that is the transport piece, or highway, of the network. It can often share existing state infrastructure, but is designed as a separate, virtual "walled garden" specialized Internet.
    b. Border Control Function (BCF) – These devices sit at the network perimeter to maintain security from devices outside the ESInet.
    c. Emergency Services Routing Proxy (ESRP) – These are the devices that make final call routing decisions based upon policy that is impacted by such things as call center failures, special service requirements or congestion avoidance.
    d. Emergency Call Routing Function (ECRF) – These are the devices that make initial call routing decisions based upon the location information of the emergency caller. These devices depend heavily on information derived from the GIS databases described above.
    e. Other Functions – While not specifically defined in the i3 architecture, there are other functions that are either noted or described by i3. These functions include such things as network monitoring and call logging, which can both be used to identify and isolate failures anywhere on the network.

    Only one of the respondents reported that this task was completed, but also noted the inability to "go live" yet due to the number of outstanding issues. Several of the states did report that this task had been implemented, at least in a limited area, because of funding provided by the United States Department of Transportation through trial grants.

5. PSAP CPE Installation – This piece of the NG911 transition includes the installation of the call takers' systems in PSAPs. This task could be managed at the state level or could be distributed and

delegated to individual PSAPs, depending upon the state strategy, since there is a high level of standardization and interoperability testing at this layer. In many instances, individual PSAPs may already have implemented this task due to system obsolescence and other operational issues. Provided that a system be either compatible with i3 specifications or that the manufacturer at least have an upgrade path, these investments can be protected in the end solution. If the ESInet is installed before the CPE is i3 compliant, or an i3 compliant CPE is installed prior to the implementation of the ESInet, the systems would still be able to interoperate through the use of transition devices such as Legacy PSAP Gateways (LPGs) or Legacy Network Gateways (LNG) also defined in the i3 specifications. The respondents reported that one state had completed the installation of the NG911 CPE but again, it was noted that it had not yet "gone live" due to outstanding operational issues.

Since the mid-1990s, service providers have either transitioned or are transitioning to IP technology for all of their equipment.

Are there mitigating factors that may compel a transition sooner rather than later?

One of the state 911 leaders noted during the interview that the lifespan of existing selective routers (SR), the call routing component of legacy e911 networks, was at most an additional ten years. These SRs are typically an integral part of the ILEC's legacy telephone networks, leaving the question, "How likely are service providers to maintain this technology following the lifespan of the systems?" To best understand the answer, look at trends of the service providers, the trends of the consumers, and the stated direction of the industry. Since the mid-1990s, service providers have either transitioned or are transitioning to IP technology for all of their equipment. The following diagram describes the ecosystem and where all of the elements sit in this transition. The green elements have either transitioned to IP, or were IP-based in the first place so no transition is required. The yellow elements are those in the transition phase and have made substantial progress towards that transition. The red element, public safety, has either not yet begun the transition, or has not made significant progress towards that transition at this time. Looking at this diagram, the question that jumps out is "When public safety is the only element that has not yet made the transition to IP networks, can we afford to remain where we are?"

THE SIP ECOSYSTEM

Long Distance Network
AT&T, Verizon, Century Link
Level3 etc.
VoIP Providers,
Vonage, etc.

Enterprise
Universities, Banks, etc.
Wireless Service Providers
Verizon, AT&T, Sprint, T-Mobile, etc.
Local Exchange Carriers
AT&T, Verizon, Century Link etc.

Public Safety Network and Services NG911
PSBN etc.

In order to meet the needs of consumers, the wireless service providers have moved to 4G Long Term Evolution (LTE) technology. In order to facilitate a complete move to LTE, service providers must migrate their voice traffic to IP or SIP services.

The second trend that cannot be ignored is what consumers are doing. In the most recent FCC report,[10] it is noted that 34.0% of telephone lines in the United States have transitioned to a VoIP service. This has almost tripled from 13.4% in 2008, according to the FCC report. Not only is this trend prevailing in the wireline arena, but also for wireless services. As of March 2014, 68.8% of the wireless devices had transitioned to smartphones.[11] This number increased 6% from December 2013, just four months earlier. This increase is driven by consumers' insatiable appetite for wireless data. In order to meet the

[10] https://apps.fcc.gov/edocs_public/attachmatch/DOC-329975A1.pdf

[11] http://www.comscore.com/Insights/Market-Rankings/comScore-Reports-March-2014-US-Smartphone-Subscriber-Market-Share

needs of consumers, the wireless service providers have moved to 4G Long Term Evolution (LTE) technology. In order to facilitate a complete move to LTE, service providers must migrate their voice traffic to IP or SIP services. This is best accomplished by implementing Voice over LTE (VoLTE). In November 2014 Verizon announced that it is working with competitor AT&T to jointly offer advanced features powered by VoLTE.[12] Verizon now markets this new service as Advanced Voice 1.0.

These industry trends leave little doubt that the transition away from legacy network delivered services is going to be completed sooner than had been expected.

NG911 FUNDING

In most states the transition to NG911 is in its infancy and is a multi-year process. Well-documented telecommunications industry trends demonstrate a move away from the legacy technology supporting existing e911 services, so the emergency services community must develop a sense of urgency in implementing NG911. The next questions that arise are: (1) how much the transition is going to cost; and (2) is the cost of transition affordable under current funding levels.

Well-documented telecommunications industry trends demonstrate a move away from the legacy technology supporting existing e911 services, so the emergency services community must develop a sense of urgency in implementing NG911.

In the study interviews we attempted to discover:

- the level of funding available to 911 operations in those states;
- the anticipated costs of NG911 transition; and
- whether the funding level is sufficient both to sustain all of the other operational costs during the transition and to fund the transition itself.

Unfortunately, we were not able to arrive at any clear answers to these questions from the state leaders that were interviewed. Additional research cross-referenced with data gathered from the interviews was used to derive our conclusions. To determine the funding levels, the FCC funding report released in December 2014 was used. This report is based upon state collections from January to December

[12] http://www.verizonwireless.com/news/article/2014/11/verizon-and-att-move-toward-voice-over-lte-volte-interoperability.html

2013. These numbers are closely correlated with those provided during the interviews; this is understandable, since the states were all completing their reports during the same time period as the interviews were being held. The dollar amounts reported by each state are as follows.

Geographic Area	2014 Population Estimate (as of July 1)	Pop %	FCC Cost Study Option A 10 Year MRC plus NRC	FCC report 2013 911 collections
United States Total	318,857,056		$ 2,680,000,000	
California	38,802,500	12.17%	$ 326,135,797	$ 75,714,948
Hawaii	1,419,561	0.45%	$ 11,931,439	$ 9,599,983
Kansas	2,904,021	0.91%	$ 24,408,355	$ 20,573,217
Michigan	9,909,877	3.11%	$ 83,292,716	$178,224,858
Nebraska	1,881,503	0.59%	$ 15,814,071	$ 15,663,631
Ohio	11,594,163	3.64%	$ 97,449,174	$ 25,689,296
Pennsylvania	12,787,209	4.01%	$ 107,476,750	$192,779,782
Texas	26,956,958	8.45%	$ 226,573,777	$213,215,483
Virginia	8,326,289	2.61%	$ 69,982,627	$ 55,212,203

Clearly, the cost of the NG911 transition will require additional funding. In the case of California the transition is expected to equal the amount of approximately five years' annual 911 fee collections. It is important to remember that current collections will still be needed in order to fund the existing legacy 911 networks, office rental, utilities, salaries, training, overhead, and other costs during the transition period.

Funding could be increased in many states by simply eliminating the funding inconsistencies.

One of the state leaders mentioned that their strategic plan had been completed, and this plan includes a cost approximation. In the case of Nebraska, the strategic plan has a five-year cost of approximately $15,000,000 for the ESInet, including the PSAP access lines and ESInet functional elements. This amount is for both capital and operating expenses. Using their cost estimates and extending over ten years, the cost would be $25,000,000, if the capital equipment (which costs approximately $5,000,000) does not have to be replaced within ten years. This amount is twice the ten-year cost, using the state percentage of the FCC study method.

The study did identify funding inconsistencies among the states, within each state, and between voice service delivery networks (landline, VoIP, cellular and pre-paid). These inconsistencies can result in significant funding decreases as consumers migrate from landline to VoIP and wireless services. Some states support landline 911 services through a "bill and keep" method in which the local service provider bills for the 911 fees, then funds the service internally by keeping the funds collected. The method of funding landline services will complicate the transition process to NG911 where the legacy telephone network is no longer the core of the 911 network. Funding could be increased in many states by simply eliminating the funding inconsistencies.

Another potential source of funding for the NG911 transition is at the national level, derived from the same source that is currently funding the initial phases of the Public Safety Broadband Network (PSBN), or FirstNet. The Middle Class Tax Relief and Job Creation Act of 2012 set aside approximately $7 billion to establish the First Responder Network Authority and to build the network, to be funded through a spectrum auction. Some of these funds were allocated to the states for developing planning grants. The initial spectrum auction, which closed in January 2015, raised an unexpected $41.3 billion.[13] In early 2016 the FCC is anticipated to provision some of the 600 MHz spectrum; such spectrum is very valuable to wireless service providers due to its building penetration characteristics. [14]An allocation of $2 to $3 billion would fund the capital costs and planning for ESInets nationwide. If time limits for the implementation of an ESInet and state matching fund requirements were to be applied to the use of the funds, there would certainly be an acceleration in deployments of NG911 networks. Were these funds to be made available, we would further recommend that these funds be allocated to states either via formula-based block grants or via proposal-based grants. This would allow states to leverage any progress that has already been made rather than forcing a restart, which would only further delay the transition.

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[13] http://recode.net/2015/01/30/fcc-says-spectrum-auction-raised-41-3-billion/

[14] http://wireless.fcc.gov/incentiveauctions/learn-program/

The transition to NG911 will require that we leverage all existing funding mechanisms as much as possible.

While funding may be adequate to sustain the operational costs following transition to NG911, many states will require one-time funding to complete the transition within a reasonable time frame. The longer the time taken for transition, the higher will be the cost of transition And again, the cost of simultaneously supporting both the legacy network and the new NG911 network, combined with the ever- increasing costs of maintaining legacy networks as they are being decommissioned, will be financially onerous. In this study it appears that at least four of the nine states included in the study will require additional funding to complete their NG911 transition.

The transition to NG911 will require that we leverage all existing funding mechanisms as much as possible. Currently, much of public safety is funded in silos, applied separately to existing 911, police, fire, EMS and other emergency services agencies. Since the transition to IP-based communications will enable sharing of information across these silos, leveraging funding and grants across these areas would result in a multiplier effect of available funds. One example of this is the 911 call center upgrade in the Stafford County, Virginia, Sheriff's office. Funding for this $800,000 project came from a $150,000 grant, maintenance budgets and capital reserves.[15]

One of the largest benefits to migrating all emergency services communications to IP is that sharing information between these agencies becomes much easier to do. Communications issues are often mentioned as one of the top problems in after-incident reports for multijurisdictional responses.

An area of potential partnership in order to leverage funding is through the NTIA's State and Local Implementation Grants (SLIGP). In 2013 the NTIA announced $121.3 million in block grants to be awarded to states to assist in planning for the FirstNet network. These grants were to be awarded in two phases, the second of which was to assess availability of local resources, such as fiber and towers, to build the FirstNet network. Many of the resources needed to construct FirstNet, especially in the rural areas, could also be used to support the NG911 transition. Each state's NG911 transition team should therefore coordinate planning efforts with the state's FirstNet planning team.

[15] http://www.policeone.com/Grants/articles/8238795-Va-grant-will-partially-fund-next-generation-911-system/

What about the nationwide NG911 ESInet? ESInets are defined by the industry's i3 specification to be hierarchical in nature. Local and regional ESInets are designed to connect to each other through a state ESInet, and state ESInets are designed to connect to each other through a nationwide ESInet. The first step to completing an NG911 transition that was identified in this state-level study is that of establishing one single entity that has the responsibility and authority to oversee the transition. Just as this is the first step in establishing a state ESInet, it is also the first step in establishing a nationwide ESInet. Since current 911 funding is managed at the state level, creating a single authority at the national level will be a challenge. The only obvious solutions to this problem are either to give management authority over the operational network to a single agency (e.g., FCC, NTIA, DHS), or to identify or establish a nonprofit entity that can work with state leaders to establish a governance structure for funding and oversight of nationwide ESInet operations. In either case, actual day-to-day network operation would most likely be outsourced.

Follow-up - Two additional questions were submitted to the state survey respondents after the initial survey was completed, focusing on the importance of a nationwide ESInet. One respondent noted that "Our schedule for the implementation of the state-level ESInet could only be hastened by accelerated funding and the availability of commercially viable products and services. However, the existence of such a nationwide ESInet would add purpose and credibility to our state project, and could also encourage more rapid development of products and services by the private sector."

CONCLUSION

Thanks to the efforts of thought leaders in the industry – those who have contributed to this report – this study presents a unique glimpse into the current state of affairs regarding the nation's transition to NG911 technologies.

The main takeaway from this study is that a sense of urgency is needed for initiating the strategic planning process toward NG911 transition in states that have yet to begin. For states where a strategy is under development, planners must ensure that it provides for the timely and successful completion of the project. The time and funding required to transition to NG911 could be substantial, and circumstances are such that time is a commodity in short supply. Convergence of all aspects of communications to IP-based services is happening industry wide. Dependence on legacy technology will likely hamper the delivery of 911 services going forward, if NG911 transitions are not completed prior to industry's departure from these same legacy technologies.

The 911 community has always been one willing to share. It has shared strategies, lessons-learned, and even resources whenever possible. The 911 industry has managed other transitions since this service began in the 1960s. The community has successfully taken this vital service from basic 911 to e911, then on to wireless 911 and beyond. The transition from existing 911 networks to NG911 will be more complex than any other transition undertaken by this community to date. While in the past, 911 networks could be managed as stand-alone systems, the hierarchical network architecture that is the foundation of an NG911 system will require cooperation and collaboration at local, regional, state, national and ultimately global levels in degrees not previously experienced. With the history of cooperation within the 911 community, it seems certain that it will once again be ready for the challenge.

APPENDIX

Geographic Area	2014 Population Estimate (as of July 1)	Pop %	Number of PSAPs	PSAP %	FCC report 2013 911 collections	FCC Cost Study Option A 10 Year MRC plus NRC	FCC Cost Study Option B 10 Year MRC plus NRC	10 Year total funding from FCC Report
United States Total	318,857,056	100%	3362	100.00%		2,680,000,000	1,400,000,000	
California	38,802,500	12.17%	501	14.90%	$ 75,714,948	326,135,797	170,369,446	$ 757,149,480
Hawaii	1,419,561	0.45%	9	0.27%	$ 9,599,983	11,931,439	6,232,841	$ 95,999,830
Kansas	2,904,021	0.91%	150	4.46%	$ 20,573,217	24,408,355	12,750,633	$ 205,732,170
Michigan	9,909,877	3.11%	219	6.51%	$ 178,224,858	83,292,716	43,511,121	$ 1,782,248,580
Nebraska	1,881,503	0.59%	91	2.71%	$ 15,663,631	15,814,071	8,261,082	$ 156,636,310
Ohio	11,594,163	3.64%	353	10.50%	$ 25,689,296	97,449,174	50,906,285	$ 256,892,960
Pennsylvania	12,787,209	4.01%	91	2.71%	$ 192,779,782	107,476,750	56,144,571	$ 1,927,797,820
Texas	26,956,958	8.45%	634	18.86%	$ 213,215,483	226,573,777	118,359,436	$ 2,132,154,830
Virginia	8,326,289	2.61%	166	4.94%	$ 55,212,203	69,982,627	36,558,089	$ 552,122,030