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In 2001 the National Emergency Number Association, or "NENA", began a revolutionary process of transitioning the 911 emergency system developed in the 1960s from legacy technology to an Internet Protocol, or "IP-based" system. Two of the most noteworthy reasons necessitating this transition are:

- The entire private sector telecommunications industry was in the midst of a similar transition to IP technologies. The motivation for this transition was the elimination of dependence upon switching systems and infrastructure that was past end-of-product life--outdated technologies were significantly more expensive than the newer IP-based solutions, and service providers began to experience reliability issues with older equipment. The 911 community knew their dependence upon legacy infrastructure was at risk of causing service issues and ultimately being abandoned by service providers as they retired their legacy infrastructure.
- The 911 system effectively supported only voice calls and the association wanted to acknowledge changes in consumer technologies and communications practices. According to the FCC's Task Force on Public Safety Answering Point (PSAP) Optimization, or "TFOPA",[i] more than 240 million 911 calls are answered annually across the United States. While voice calling is still the most common practice, the reality is that we live in a world where support for video, images, text and data is becoming just as important as for voice. The IP-

based Next Generation 911 (or NG 911) architecture was designed from the beginning to support multimedia.

Since the early meetings in 2000 significant milestones have been achieved in the transition to NG 911. The Internet2 Technology Evaluation Center (ITEC) at Texas A&M University is a center that I direct, and we are honored to have been a part of these technologic milestones.

- 2001 – NENA released the "Path Forward" vision document. This document described an architectural framework and desired capabilities of the proposed network.
- 2006 – NENA released the first NG 911 architecture specification. This document, later referred to as "the NENA i3 specification", established the first architecture specification and standards for NG 911. The i3 specification, like any good standard, is a living document that undergoes continuing enhancements and modifications. The latest release of this document is dated September 10, 2016.
- 2008 – The U.S. Department of Transportation completed NG 911 Proof of Concept Project. This project built, deployed and tested the NG 911 architecture at five 911 centers across the United States[ii].
- 2009 – First NENA Industry Collaboration Event (ICE)[iii] - This is an ongoing industry interoperability event that allows equipment manufacturers to test their systems. Eight of these events have been held with each event involving about 30 industry participants.

- 2016 – The NG 911 NOW Coalition is formed. Members of this coalition include several emergency communications associations who have an expressed goal of pushing for a nationwide NG 911 transition by the year 2020.

In 2014 the ITEC[iv] released a study entitled, "The Status of NG 911 Deployment in the United States"[v]. This study examined the NG 911 transition status across representative states and discussed the transition process, status of the transition, and recommendations that could accelerate the transition. It described four steps required for any state to transition to NG 911. These four steps are:

- **State Coordination:** Creation of a state-level organizational agency to oversee and/or coordinate NG 911 efforts. In today's 911 environment, the telephone company networks provide interconnection between jurisdictions within the same state over their legacy networks. Interconnection in an IP environment requires significant coordination, not only within the states, but also between the states.
- **Geospatial Data:** Establishment of a geospatial or GIS dataset. Current 911 architecture relies upon local management of all location information. This information, also referred to as Automatic Location Information, or "ALI", worked well in legacy networks for fixed locations. For today's nomadic communications environment, with everyone having one (or more) wireless devices, we need a new method of routing 911 calls. NENA's i3 architecture resolved this issue through what is called the "Emergency Communications Routing Function" (ECRF). This new process is hierarchical in nature, providing local control of data while supporting the sharing of this data across other jurisdictions, regional, state, and even

nationwide. ALI data within each state must be converted to the i3 format to be consistent with ECRF requirements.

- **Broadband 9-1-1 Center Connectivity:** Establishment of standards-based, state-level Emergency Services IP Network, or ESInet, to connect to wireline, wireless and Voice Over IP (VoIP) service providers to rout emergency callers to the most appropriate 911 call center. Depending upon funding and jurisdictional boundaries, there may be one ESInet in a state, or there may be several regional networks. This broadband connectivity provides resource sharing between 911 centers and first responders, providing great backup flexibility for our 911 centers.
- **Call Handling Equipment:** Equipment acquisition for 911 call centers, including 911 "call handling equipment", provides the systems and technologies to gather caller information and get it to the right first responder. A study that the ITEC is currently working on estimates that there are approximately 40,000 call taker workstations located at nearly 6,500 911 centers across the United States.

Some states have already made significant progress toward the goal of transitioning to NG 911 using these four steps. While the order in which states complete each step is not rigid, if there are sufficient resources, these tasks may be implemented in parallel.

Although the technology is changing rapidly, we find that most of the findings of our 2014 study still hold true today. Some of the issues uncovered by the study may be improved through proposed legislation:

- *Incentivize states to establish a state oversight / coordinating authority*. The first step in transitioning towards a state NG 911 implementation is that of establishing a state oversight agency within each state. While many states have this type of organization already in place, our experience tells us that those states without 911 oversight face an uphill and inefficient journey, making the NG 911 transition take much longer and cost much more.
- *Require any federally-provided assistance to be linked to a NENA i3 NG 911 solution*. Since 2003, NG 911 equipment development, interoperability testing, and standards development have all been focused on the community-developed and adopted NENA i3 solution. The TFOPA recommendation does recognizes interim solutions based upon IP-based legacy technology as a viable solution, but the fact remains that these are interim solutions and are not recognized as NG 911. They do not support full industry standard, interoperable multimedia--a shortcoming which should not be overlooked. It is imperative that NG 911 standards and technology are adopted by the industry to ensure a successful transition to an open, non-proprietary NG 911 system. Introducing additional interim solutions will cause unnecessary costly delays and confusion and our 911 centers and first responders will be hampered in their ability to effectively share information.
- *Interim funding.* According to the FCC, 2015 collections of 911 fees reported nationwide was approximately $2.6 billion dollars[vi]. A small portion of these funds are being used for NG 911 transitions today. The report notes 13 states are working on the broadband connectivity portion of the transition. While this level of funding should be sufficient to maintain the infrastructure once it is in place, our study indicates that additional federal

and/or state funding will be required to get the industry through the transition. The funding will be needed to support legacy systems, NG systems and the transition elements connecting the two networks during the transition. Our ITEC center is finalizing an interim cost study, but the final funding amount, and the ways and means of funding distribution should be based upon the cost study currently underway by the U.S. Department of Transportation[vii], due out later in 2017.

- *Interstate network connectivity*. As was mentioned earlier, NG 911 is a hierarchal architecture. While most of the transitioning tasks will be accomplished within the state networks, there needs to be a national layer to interconnect the state networks before we can successfully complete the nationwide transition. Since this is a national issue, the issues of organizational ownership and funding of such a network must be determined. Some of this work has already begun through the efforts of the National 911 Program. Working with a handful of Midwestern states, an "Interstate Playbook" has been developed[viii] to help states identify and mitigate interstate 911 technology, operational, and policy issues. From a networking perspective, the ITEC staff priced out the national-level network, with interconnection points in every state, carried over an existing private backbone network. This interstate layer could have several benefits, in addition to the call routing that it must provide. It could provide interconnection points to national-level service providers, such as VoIP service providers. For example, one VoIP service provider that we are working with has six major switching centers across the United States. This national backbone could be used to connect this service provider to their six locations providing the redundancy required to ensure reliability while eliminating the need to connect at every state. It is

anticipated that many of the NG 911 services will be cloud-based services. If these services are directly connected to the national backbone, these services become a "private cloud" service which is more appropriate for public safety applications. This national backbone needs to be established as soon as possible.

- *Establish 911 Cyber Security Centers*. FCC's 2016 TFOPA report recommends the establishment of the Emergency Communications Cyber Security Centers (EC3) that would place monitoring "probes" within the state-level ESInets. The EC3 deployment is one area where cross state collaboration will provide significant operational and cost efficiencies. With the fundamental lack of cybersecurity professionals in today's society, centralizing cybersecurity operations may help protect our 911 centers. One recent study reported 209,000 unfilled cybersecurity positions in 2015, and that number is expected to rise to between one and two million by 2019[ix]. Proposed legislation could provide leadership in this area. Cybersecurity is an area of great concern for me and my colleagues across the industry and state-level 911 ESInets need to do more in this area. The FCC's 2016 State Collection and Distribution of 911 Fees report shows that 38 states reported ZERO expenditures for 911 cybersecurity.
- *Coordinate International NG 911 efforts.* Recent efforts involving the 911 International Border Coalition have been focused on calls being routed to a PSAP in the wrong country for international visitors in close proximity to the border. An estimated 100,000 calls per year are routed to the wrong country initially on the U.S. Mexican border alone. This is an issue specific to the way that e911 wireless calls are routed that could possibly be improved or

eliminated through NG 911. This issue should be studied for both the Mexican and Canadian border.

- In February 2016, the NG 911 NOW Coalition[x] called for "NG 911 by 2020". This date was not just arbitrarily selected, but based on timelines that many of our largest service providers, like AT&T and Verizon, have set as their goal for marking legacy wireline and wireless technologies as they transition to their own all-IP networks. As a 911 technologist, the time has come to make this transition to NG 911 and retire the decades-old technology that people like me worry about every day. Implementing NG 911 now provides our 911 call takers and first responders with the technology they so desperately need to help serve millions of 911 callers daily in their worst time of need. I look forward to working with you in making this goal a reality.

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[i] https://apps.fcc.gov/edocs_public/attachmatch/DA-16-179A2.pdf

[ii] https://www.its.dot.gov/research_archives/ng911/

[iiiiii] http://www.nena.org/?page=NG911_ICE

[iviv] https://itec.tamu.edu/

[v]https://www.theindustrycouncil.org/publications/iCERTReportontheStatusofNG911DeploymentintheUnitedStates.pdf

[vi] https://apps.fcc.gov/edocs_public/attachmatch/DA-17-61A2.pdf

[vii] https://www.911.gov/911connects/911-study-on-next-generation-911-costs.html

[viii] https://www.911.gov/docs/NG911-Interstate-Playbook-FINAL-111516.pdf

[ix] http://www.informationweek.com/strategic-cio/security-and-risk-strategy/cyber-security-skills-shortage-leaves-companies-vulnerable/d/d-id/1326463

[x] http://www.ng911now.org