HISTORY OF 911
And What It Means for the Future of Emergency Communications

With the implementation of Next-Generation 911 well underway, effective policy making should be based on lessons learned throughout the history of emergency communications.

iCERT
Industry Council for Emergency
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THE
911 EDUCATION
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Across America, 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. This reliance persists as a key feature of our society, as it should. Yet, with advances in technology vastly outpacing those in the policy arena, the path forward for 911 as a critical service is unclear.

This is a historic time in the emergency communications industry that presents unique challenges as well as great opportunities. Public safety agencies are in catch-up mode—often as a result of being unable to keep pace with the widespread innovations that have redefined technology in the commercial and consumer markets over many years. What is more, this unfortunate technology gap has the potential to become a dangerous chasm because necessary 911-focused legislative and policy changes lag behind the broader technological advances. The prospect of modernizing is further hindered by the fact that the industry is comprised of multiple public and private stakeholders that often operate independently from one another thereby complicating the potential for consensus. As a result, the emergency communications industry lacks a coherent strategy for regulatory, legislative and funding changes necessary for the implementation of Next-Generation 911 (NextGen 911) on a widespread, eventually nationwide, scale. NextGen 911 is inevitable; but a successful nationwide rollout will require a level of collaboration never before seen in the industry.

This report is intended to provide public and private sector stakeholders with a clear understanding of the history of 911 in America—its genesis, implementation, ongoing enhancements, and potential for further development in relation to technological and regulatory considerations as NextGen 911 becomes a nationwide reality.

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INTRODUCTION

The legacy 911 system came into existence in the late 1960s; but the first voice-generated emergency request for assistance dates back to the earliest years of the twentieth century.

In the early 1900s, the founders of communications giant Ericsson Incorporated recognized that people needed a way to easily and effectively communicate when they had an emergency. To answer this challenge, they developed a portable phone handset and crank that could be hooked to the bare phone wires that facilitated early telephony. Utilizing an extension wand, two metal hooks were placed over the wires to form a connection and the handbox was cranked to create a signal that would hopefully be answered by someone on the line. While this early innovation would not meet today's rigorous 911 standards for reliability, it was successfully used to report a train robbery around 1907, contributing to the arrest of the outlaws.[1]

The origins of emergency communications can be traced back to this small-scale, isolated incident, but it was the large-scale catastrophe of the Titanic that highlighted the need for essential principles of disaster communications. At the time of the Titanic disaster, ship-to-ship and ship-to-shore radio communications were a well-established technology, though without regulation or operational mandates. As a result, when the Titanic radio operator signaled for help, the only corresponding operator on the nearest ship capable of offering aid was off duty and the signal was never received.[2] In response to this tragic loss of life, the United States Congress passed the Radio Act of 1912 requiring all seagoing vessels to have a licensed radio operator on duty at all times continuously monitoring distress frequencies.[3] This landmark piece of legislation set the precedent for international and federal regulation of wireless communications and established the relationship between emergency communications and governance.

More than five decades later, in response to the public's need for consistent, reliable emergency telephone service, state legislatures and regulators established a public/private arrangement by granting incumbent local exchange carriers (ILECs) a regulated monopoly over 911 service overseen by state utility commissions. In exchange for their role as the provider of local exchange service, ILECs were guaranteed a specified rate of return on costs to operate the service[4], and in that role, ILECs also agreed to provide 911 service that was paid for by public safety agencies.[5] It made perfect sense for legislators to establish state control over this locally delivered public safety service so as to ensure uniformity among varying jurisdictional arrangements in any given state. However, economists and technologists that may have been consulted at that time, would have predicted that this arrangement—with its lack of competitive pressure and its concentration of market power—would stagnate innovation and, if prolonged, would lead to a significant technology gap between modern and emergency communications.[6]

[1] Farnham, John W. (2006) Disaster and Emergency Communications Prior to Computers/Internet: A Review. National Center for Biomedical Technology. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1550843/

[2] Ibid.

[3] http://earlyradiohistory.us/1912act.htm

[4] Funds are derived from what regulators refer to as "the rate base" or "rate payers," i.e., regulators allow ILECs to recover their costs plus a reasonable profit based upon the number of subscribers of local telephone service. Subscribers receive a monthly bill for the service, thus ensuring the ILECs' rate of return.

[5] Typically, public safety agencies have purchased 911 services from ILECs' through state regulated tariffs and paid for the services in part from funds remitted to agencies by ILECs who receive funds from 911 surcharges collected from rate payers-with a small percentage retained for administrative costs-and in some cases from general tax revenues allocated to local government.

[6] Other economic distortions occurred as well, e.g., ILECs sometimes sought other regulatory relief from or found themselves at odds with state regulators who engaged in the practice of extracting promises or concessions in the form of discounted or free upgrades to the 911 system in exchange for the requested regulatory relief or in lieu of a fine. This resulted in certain rate elements of 911 to be dramatically undervalued or valued at zero which in turn distorts the real cost of the service as well as the price paid by agencies.

In recent years, a competitive 911 service economy has emerged driven by advancements in modern communications, pent-up demand from public safety agencies and an ever-growing number of providers with 911-focused products and services. This shifting marketplace dynamic is further fueled by innovations in Internet Protocol (IP)-based communications that allow an entirely new emergency communications infrastructure known as Next-Generation 911 (NextGen 911). With the introduction of Next-Generation 911 based on IP technology, the entire emergency communications landscape is in flux.

Next-Generation 911 envisions advanced services and collaboration capabilities across an emergency communications ecosystem employing a network of inter-connected emergency services IP-based networks (ESInets) on a national scale. The proposed next-generation advancements are the most sweeping changes this industry has ever seen, dwarfing the work done to implement wireless Phase I and Phase II functionality. These are changes that will expand the number and scope of stakeholder groups, encompass ever-evolving new technologies, aggregate functionality across diverse geographic areas, impact operations, shift core system responsibilities, further facilitate a competitive marketplace, require new funding mechanisms and redefine 911 governance.

All would agree that emergency communications is a public good for which some level of government oversight is appropriate. But determining how much oversight, the right balance of local, state and federal governance and the role of the free market are not decisions that should be made without a proper understanding of how we arrived at our current crossroads. In order to modernize our country's emergency communications so it can and will meet the needs of the people it is designed to serve, it is imperative that we first look at all aspects of 911 history, evaluate the successes and failures that happened along the way, study the impact of 911 governance, fully comprehend where we are today and assess the goals for Next-Generation 911.

911 in Retrospect

BASIC 911

Before the designation of 911 as the nationwide three-digit emergency call number, if someone had an emergency, s/he dialed "0" for an operator. This could be an incredibly stressful situation—and often ineffective—not only for the calling party but also for the telephone company operator who did not necessarily have the best tools to perform emergency call assistance services. By the mid 1950s, there was a rising awareness that this system was inadequate to meet the emergency communication needs of the public, and in 1957, the National Association of Fire Chiefs reportedly suggested the need for a single telephone number for reporting fires.[7] While no action was taken at the time, the concern of the firefighting community set the groundwork for future governmental action.

In 1967, President Lyndon Johnson's Commission on Law Enforcement and Administration of Justice issued a report recommending that citizens have the ability to contact police departments utilizing a single telephone number. The report stated, "The Commission recommends: Wherever practical, a single police telephone number should be established, at least within a metropolitan area and eventually over the entire United States..." On January 12, 1968, AT&T—the provider of telephone service throughout most of the United States—announced its designation of 911 as a universal emergency number. Just 35 days later, Senator Rankin Fite completed the first 911 call, over a GTE telephone line, in Haleyville, Alabama.[8] While this event introduced the concept of Basic 911 (B911) service[9] to the American public, it was not until the Public Safety Act of 1999 that 911 was officially established as the nation's emergency calling number.

At the time of Senator Fite's groundbreaking call, the telephone company was the most appropriate entity to provide 911 service, as competition for communications services was not yet on the horizon, eliminating the free marketplace as a viable option. In response, state legislatures and regulators established a public/private arrangement with ILECs to create a regulated monopoly of 911 service overseen by state utility regulators, thus establishing the precedent for state control over this locally delivered public service. Under this arrangement, public safety agencies typically purchased 911 services through ILECs' 911 state-regulated tariffs. The funds to make those purchases came from 911 surcharges placed on bills for residential and commercial wireline local exchange services and, in some cases, from taxes collected from the general public to support government services.

ON JANUARY 12, 1968, AT&T—THE PROVIDER OF TELEPHONE SERVICE THROUGHOUT MOST OF THE UNITED STATES—ANNOUNCED ITS DESIGNATION OF 911 AS A UNIVERSAL EMERGENCY NUMBER.

[7] Allen, Gary. (2015, April). Haleyville: Where 911 Began. Dispatch Magazine On-Line. Retrieved from http://www.countyofunion.org/site/cpage.asp?cpage_id=180009766&sec_id=180003667

[8] Ibid.

[9] Basic 911 is normally thought of as the routing of a 911 call, absent location or other information, to a pre-designated public safety call-taking location. At its inception, Basic 911 included no new features beyond the three-digit calling code. Later forced hold, ring back and forced disconnect became standard features.

From an infrastructure standpoint, B911 service created a direct connection between a central telephone office and a single corresponding public safety answering point (PSAP). This early structure was built by reconfiguring the same wireline, analog, circuit-switched technology that was used within the public switched telephone network (PTSN). The challenge was to ensure that the switches, built to process seven-digit telephone numbers for local exchange service, were capable of processing the shorter three-digit 911 number and sending it to the designated emergency agency.

There is a very important aspect of 911 service that was established at its inception: 911 is a local service. From a governance standpoint, 911 systems that aggregate and deliver emergency calls to PSAPs have historically been regulated by state utility commissions with service levels and operations overseen by state and/or local 911 officials. 911 is an intrastate calling service over which state government has jurisdiction.[10] On a more human level, in many ways, emergency response is a service rendered to one's own "neighbors." With that comes a level of familiarity that is often critical to the timely arrival of first responders as well as pride and ownership that elevates quality of service. In addition, the value of local knowledge relative to such things as geography, weather, population density and cultural mores is something that cannot be measured. Local control over 911 allows emergency communication as well as emergency response to be customized in ways that best suit the needs of the community being served.[11]

ENHANCED 911

While B911 was a vast improvement on dialing the operator in the event of an emergency, there was an ever-growing need for faster, more accurate emergency response. As B911 service became more widely established across the country in the early 1970s, 911 call takers began to see the value of having automatic access to the name, address and phone number of the emergency caller instead of relying on the caller, who was often not able to provide that information during the call. And as the 911 system expanded to include more PSAPs, the network needed a way to automatically route 911 calls to the appropriate agency. This led to the establishment of Enhanced 911 (E911) services in the mid 1970s that originally included 911 selective routing, automatic location information (ALI) and automatic number identification (ANI). E911 eventually evolved to include selective transfer, fixed transfer, alternate routing, default routing, PSAP evacuation (abandonment) routing and call detail record.

Location-based functionality remains at the center of our legacy 911 system today. When a 911 call is made, it arrives at the appropriate PSAP after it is routed across the PTSN to a special, often dedicated, telephony switching platform called a selective router. The selective router is usually a class 4 or 5 telephone switch or tandem office. To determine routing, the tandem office 911 selective router queries the selective routing database (SRDB) using the ANI to match the location of the caller to the emergency service number (ESN), which defines the appropriate PSAP. The ESN is predetermined for each possible originating telephone number using the

[10] The Federal Communications Commission's jurisdiction is limited to interstate and foreign communications. The FCC itself has determined that calls originating and terminating in the same state are intrastate in nature regardless of whether the voice or data elements of the call cross state borders. This is often the case with E911, where voice and data traffic crosses state lines for selective routing, location, and the caller's phone number in a state other than where the caller and PSAP are located, as discussed in more detail below.

[11] Some states require a 911 call made in the state to be received by designated local agencies and specify what agencies are to do with such calls.

master street address guide (MSAG). When the voice call with its associated ANI is delivered to the PSAP, another query is made from the PSAP's equipment to the ALI database, again using the ANI as a search key. The associated ALI record is then returned to the PSAP where the customer premise equipment (CPE) displays the location on the call taker computer display.[12]

WIRELESS ENHANCED 911

When wireless telephone service emerged and began to sweep the country in the early 1990s, the legacy 911 network faced another challenge. At that time, wireless phones were not usually used for wireline replacement but rather for mobile calling typically outside of a building. In the E911 system, location information was based on the fixed installed-location address of an originating telephone number. Because wireless devices have no fixed service location, new technologies had to be created in order to provide E911 services to all wireless callers.

In 1996, the Federal Communications Commission (FCC) responded to this need by issuing the Wireless Enhanced 911 Rules. This order established and required enhanced wireless 911 services. In order to provide carriers with a staged implementation, the FCC ordered wireless carriers to provide the service in two phases. Under Phase I, within six months of a valid request by a PSAP, wireless carriers had to deliver the 911 caller's voice and originating cell site location to the most appropriate PSAP.[13] Phase II required wireless carriers, as of October 1, 2001 and within six months of a PSAP request for location information, to improve the location information used for call routing and caller location by providing the 911 system with the latitude and longitude of callers. Carriers were allowed to choose handset-based location technology using global positioning systems (GPS)—or similar technology within individual wireless phones—or networked-based location technology using cell-tower triangulation.

The order also set technical and accuracy requirements for carriers based on the type of implementation they chose. Location accuracy for handset-based technology had to be within 50 meters for 67 percent of calls and within 150 meters for 90 percent of calls. Location accuracy for network-based solutions had to be within 100 meters for 67 percent of calls and within 300 meters for 90 percent of calls.[14]

[12] It should be noted that the ALI contains the address where service was installed. At one time, this created challenges with multi-line telephone systems and party-line phones where the installed address may not be where the caller was located. This situation was rectified through local and state regulation changes.

[13] The voice transmits over the carriers' CMRS network, and the cell-site location information is not part of the call path. It is delivered using the ALI system.

[14] Requirements were variable depending on the PSAP's coverage area or population. The FCC recently ordered wireless carriers to make improvements on location accuracy. See, FCC 4th Report and Order, PS Docket No. 07-114 FCC 15-9.

While the intent of the wireless Enhanced 911 rules was to expand 911 access for wireless callers, the reality of achieving this was riddled with challenges, including:

- Cost: The National Emergency Number Association (NENA) estimated the cost of nationwide Phase II at as much as $8 billion[15] with no established cost recovery mechanism.[16]

- Number Portability: No one anticipated a scenario in which non-local numbers would be calling 911 with a number requiring an area code.

- Uninitialized Phones: These phones have no associated call-back number so no ANI information could be displayed.[17]

- Accidental Dialing: Phones that are carried in purses and pockets can be unintentionally dialed leading to substantial increases in PSAP workload and delayed response to valid requests for assistance.

VOIP ENHANCED 911

Of all the technologies that have been appended to the legacy 911 network, the introduction of Voice-over-IP (VoIP) was one of the most challenging from both a technology as well as a regulatory standpoint.

VoIP is a more flexible and mobile technology than traditional landline telephone service. Like wireless, Internet-based VoIP service can be nomadic in nature in that the caller's registered service address may not be the actual location from which a call is made, making it difficult to identify the location of a caller.[18] This created significant hurdles for the implementation of E911 VoIP service and prompted many VoIP providers to offer services that specifically excluded 911 capabilities.

In the early years of the VoIP industry, the FCC chose not to heavily regulate VoIP service so as to let the service mature with fewer impediments to innovation and to let the broader telephony marketplace benefit from competitive pressure. This lack of oversight, however, particularly with regard to 911, encouraged some VoIP services providers to not communicate the lack of E911 service to their customers. In time, these practices gained media attention when VoIP customers could not reach 911 in an emergency. As a result, in 2005, a lawsuit was filed against a major VoIP provider for deceptive marketing practices by not clarifying to its customers that they did not have access to the 911 system.[19]

[15] Dispatch Magazine On-Line. Retrieved from http://www.911dispatch.com/911/wireless911.html

[16] The FCC initially based a wireless carrier's obligation on its ability to obtain cost recovery; however, this caused delays in deployments. The FCC eventually eliminated the cost recovery requirement; thus, unless a carrier was entitled to cost recovery via state statute or was a party to a contract with a government agency that provided for carrier cost recovery, the carrier had to either absorb the cost of wireless E911 or pass it on to its subscriber base.

[17] It is also important to note that in the early days of wireless 911, uninitialized phones had no phone capabilities so wireless carriers systems had to be modified to actually process a 911 call from such phones.

[18] Some VoIP services are "fixed," e.g., some cable companies utilize VoIP with their co-ax cabling to the home, much like a traditional land-line phone, whereby 911 service is also fixed.

[19] Texas Attorney General Takes Legal Action to Protect Internet Phone Customers. (2005, March 22). Retrieved from https://www.texasattorneygeneral.gov/oagnews/release.php?id=850

That same year, the FCC redefined its policies regarding VoIP oversight and moved to impose 911 obligations on VoIP providers. The new requirements mandated that all "interconnected VoIP services" (VoIP that uses a broadband connection and that interconnects with the PSTN) must include 911 service, and service providers must notify customers about the 911-related limitations of the service. For example, the FCC required that Interconnected VoIP service providers warn their customers of the deficiency in E911 service unless a customer "self-provisioned" their location for 911 purposes, and providers had to consistently provide instructions on how to do so.

VoIP providers could establish access to the E911 system directly with the wireline E911 network, indirectly through a third-party provider such as a competitive local exchange carrier (CLEC) or by any other technical means. This, however, led to another obstacle. In order to provision E911 access, VoIP service providers had to have access to certain network elements and other capabilities that interoperate with the E911 system. In response to this challenge, Congress passed the New and Emerging Technologies 911 Improvement Act of 2008, granting access to these capabilities to all interconnected VoIP service providers.[20]

It is interesting to note that there has been substantial federal regulatory involvement with 911 in the last twenty years due to authority granted to the FCC by Congress over interstate services, including wireless and VoIP telephony. For example, the FCC has ordered that wireless and VoIP telephony subscribers must be given access to the 911 system typically operated by ILECs. The FCC has exercised limited authority over ILECs in their role as 911 service providers. This is in part due to the fact that Congress has limited the FCC's authority in this regard to the resolution of interconnection disputes between carriers; however, the FCC has taken no action to resolve any interconnection disputes among competing 911 service, which prolongs the ILEC monopoly of 911 services.

LOCKED STATE AND REASONS FOR CHANGE

It is important to note that during the ongoing evolution of E911, Wireless Phases I and II and VoIP E911, no substantial research and development work was conducted specifically for emergency communications by the wireline telephone companies that were providing 911 service. Based on the established business model and after the divestiture of the original Bell System, there was little profit motivation for ILECs. This created an environment in which 911 was incorporated into the standard technology development cycles somewhat as an accommodation. As a result, new feature functionality was generally developed using existing technologies and retrofitted onto the existing network. For example, the original ability to deliver ANI and location information was established using long-distance billing technologies. Despite the fact that the PTSN was experiencing significant advancements in technologies, the 911 network fundamentally remained unchanged. Today, we are faced with a critical emergency communication system that still encompasses its original 1968 technology. The aged-out technology includes manufacturer-discontinued parts and system components that no longer exist anywhere in modern communications.[21]

IN ORDER TO PROVISION E911 ACCESS, VOIP SERVICE PROVIDERS HAD TO HAVE ACCESS TO CERTAIN NETWORK ELEMENTS AND OTHER CAPABILITIES THAT INTEROPERATE WITH THE E911 SYSTEM.

[20] New and Emerging Technologies 911 Improvement Act of 2008, Pub. L. No. 110-283, SEC. 101. 47 U.S.C. § 615a-1. Retrieved from http://www.gpo.gov/fdsys/pkg/PLAW-110publ283/pdf/PLAW-110publ283.pdf This statute was supplemented by federal regulation: see In the Matter of Implementation of the NET 911 Improvement Act of 2008, FCC WC Docket No. 08-171, REPORT AND ORDER, Adopted: October 21. 2008 Released: October 21, 2008.

[21] Such parts and system components include PSAP CAMA trunks; 9600Kbps or 56Kbps ALI modems over dedicated point-to-point circuits between the ALI provider and the PSAP; and ALI delivery protocol that is a simple and primitive text based bid/response protocol where the ALI response is designed to paint a legacy ALI screen (512 bytes) "NENA Standard Data Formats for 911 Data Exchange & GIS Mapping/ NENA 02-010, Version 9, /February 2, 2011"

Further complicating the situation is the manner in which the existing network evolved. There was no master plan directing expansion and no clear delineation of responsibility. This has led to a system and business environment:

- with no clean boundaries and little change capacity

- that evolved based on what was possible rather than what was necessary

- that is insufficiently funded through tariffs

- that is not keeping pace with modern communications or public expectation

- where providing accurate location data is often challenging

- for which there is no viable business model for long-term maintenance

- that is paralyzed by regulatory deadlock

- where underlying costs are unclear and pricing has no basis in actual costs

The result is a legacy 911 infrastructure that is incapable of moving beyond its current functionality and that will soon become completely inadequate to serve the purpose for which it was created. The authors of *The 911 Industry Alliance* (now known as the Industry Council for Emergency Response Technologies – iCERT) *2008 Study on the Health of the United States 911 Emergency Network: A Call to Action on 911* outlined three motivating reasons why the existing legacy 911 system should be replaced by a new, modern architecture supported by an IP-based protocol:

1. Since the various technologies used today to access 911 have or will soon be utilizing an IP network, the 911 system must follow suit in order to ensure compatibility with the public.

2. It will become increasingly expensive and difficult to maintain traditional circuit-switched infrastructures because the technology is being abandoned across commercial communications.

3. The decentralized control provided by a digital technology, IP-based, open network allows network packets to be rerouted around network failures creating greater reliability and redundancy.[22]

[22] The 911 Industry Alliance 2008 Study on the Health of the United States 911 Emergency Network: A Call to Action on 911, pp. 38-39, December, 8, 2007 found at http://www.theindustrycouncil.org/publications/download_report.cfm.

The Origins of Next-Generation 911

As the federal agency responsible for reducing the human and financial toll of automobile accidents, the National Highway Traffic Safety Administration (NHTSA) of the U.S. Department of Transportation (USDOT) has long been an active proponent for efficient and effective emergency response. By the beginning of the 21st century, the shortcomings of the legacy 911 system were too significant to ignore. In response to this escalating crisis, in 2002, then U.S. Secretary of Transportation, Norman Mineta, sponsored a Technology Innovation Roundtable with telecommunications researchers and public safety and transportation representatives. The event was created to explore what the next generation of 911 should look like. This original think tank became the genesis of the 2004 U.S. Department of Transportation Next-Generation 911 (NextGen 911) Initiative.[23]

Working closely with a wide range of stakeholders, the Initiative focused on two critical areas: the research required to design an IP-based next-generation 911 infrastructure, and a transition model to provide options for deployment challenges. In 2007, the DOT released a NextGen 911 System Initiative: Concept of Operations in which it provides the earliest comprehensive definition and vision for NextGen 911:

IN 2007, THE DOT RELEASED A NEXTGEN 911 SYSTEM INITIATIVE: CONCEPT OF OPERATIONS IN WHICH IT PROVIDES THE EARLIEST COMPREHENSIVE DEFINITION AND VISION FOR NEXTGEN 911.

…USDOT views the NextGen 911 system as an evolutionary transition to enable the general public to make a 911 "call"[24] from any wired, wireless, or Internet Protocol (IP)-based device, and allow the emergency services community to take advantage of Enhanced 911 call delivery and other functions through new internetworking[25] technologies based on open standards. By enabling the general public to access 911 services through virtually any communications device, the NextGen 911 system provides a more direct ability to request help or share critical data with emergency services providers from any location. In addition, call takers at the public safety answering point (PSAP) will be able to transfer emergency calls to another PSAP and forward the location and other critical data, such as text messages, images, video, with the call.[26]

[23] The History of 911: The DOT Role in Advancing 911 Technology. Retrieved at http://www.911.gov/timeline.html

[24] The NextGen 911 System Initiative: Concept of Operations defines the term "call" as any real-time communication—voice, text or video—between a person needing assistance and a emergency communications call taker.

[25] The NextGen 911 System Initiative: Concept of Operations defines the term "internetwork" as to go between one network and another; a large network made up of a number of smaller networks.

[26] The NextGen 911 System Initiative: Concept of Operations. (2007, April). p.5.

NEXT-GENERATION 911 GOALS

According to the Concept of Operations, the primary goal of NextGen 911 is "to save lives, health and property by improving emergency services access and response in the United States."[27] The document goes on to list the system objectives that would allow this goal to be achieved.

- Enable E911 calls from any networked communication device

- Enable geographic-independent call access, transfer and backup among and between PSAPs and other authorized emergency organizations

- Encourage a flexible, open, non-proprietary and secure architecture to facilitate the implementation of an interoperable internetwork (system of systems)

- Foster increased coordination and partnerships within the public safety community

- Encourage standards coordination and interoperability across the United States and with other emergency services network providers within North America (Canada and Mexico), recognizing the global impacts of routing emergency calls in an IP environment

- Maximize emergency services capital, operating and maintenance cost savings[28]

NEXT-GENERATION 911 ARCHITECTURE

In order to provide industry-wide technical guidance to the significant and necessary task of concepting a next-generation IP-based emergency communications environment, in 2011, the National Emergency Number Association (NENA) approved the i3 architectural framework. The adoption of this document was one of the key milestones on the road to nationwide Next-Generation 911 implementation. While the framework is not a "build-to" specification for a complete NextGen 911 system, it does carefully define an end-state vision for this important architecture.[29]

Using a Long-Term Definition (LTD) approach, the i3 framework outlines an architecture designed as an IP-based network of networks, which is separate from but parallel to the Internet, known as an ESInet. This nationwide network will be utilized by all agencies that may be involved in an emergency. This flexible communications infrastructure replaces legacy telecommunications transport technology, including CAMA trunks, analog signaling and selective routers. The modern IP infrastructure supports multiple public safety agencies to provide high availability, new advanced services and nationwide integration. The ESInet is the foundation for interfacing with external entities, transporting information and supporting advanced capabilities, such as security standards and rights of access. The i3 vision projects that there will eventually be numerous secure and redundant ESInets across the country as defined by regional 911 authorities that are linked together to provide seamless information sharing and improved operational continuity.

THE i3 FRAMEWORK OUTLINES AN ARCHITECTURE DESIGNED AS AN IP-BASED NETWORK OF NETWORKS, WHICH IS SEPARATE FROM BUT PARALLEL TO THE INTERNET, KNOWN AS AN EMERGENCY SERVICES IP-BASED NETWORK (ESINET).

[27] The NextGen 911 System Initiative: Concept of Operations. (2007, April). p.8.

[28] Ibid.

[29] Understanding NENA's i3 Architectural Standard for NG911, http://c.ymcdn.com/ sites/www.nena.org/resource/collection/ 2851C951-69FF-40F0-A6B8-36A714CB085D/ 08-003_Detailed_Functional_and_Interface_ Specification_for_the_NENA_i3_Solution.pdf

THE ADOPTED i3 DOCUMENT ESTABLISHES A CLEAR VISION FOR THE FUTURE AND A FOUNDATION ON WHICH SUCCESSFUL TRANSITIONS TO NEXT-GENERATION 911 SERVICE CAN BE BUILT.

In conjunction with the proposed architecture, i3 also recommended a set of technical requirements to guide the functions and interfaces between the various functional elements involved with an IP-based 911 public safety emergency services architecture. Among the most significant changes in a fully realized i3-based architecture will be how location information and call routing are achieved.

In this new environment, geographic information systems (GIS) and GIS data will assume an essential role at the center of 911 communications. Ultimately, the legacy MSAG, ALI, ESN and SRDB databases will be replaced by a series of next-generation functional elements and additional altered data paths that will utilize GIS-based data to ensure the accuracy of all location information and call routing. In fact, in a fully realized i3-based Next-Generation 911 environment, GIS will be a key foundational element and will function as the basis for all 911 location validation, call routing and mapping.[30]

While NENA states that there remains significant work to be done to provide end-to-end migration standards, the adopted i3 document "establishes a clear vision for the future and a foundation on which successful transitions to Next-Generation 911 service can be built."[31] Moving forward, it will be important to let the i3 vision mature in response to technology innovations and unforeseen challenges before introducing significant changes to the established long-term vision.

[30] NENA i3 Solution-Stage 3. June 14, 2011. National Emergency Number Association. Retrieved from https://www.nena. org/?page=i3_Stage3

[31] http://urgentcomm.com/psap-news/ nena-approves-i3-standard

Next-Generation 911 Today

While the initial conceptual interpretations of Next-Generation 911 were an important first step, the ideas surrounding this monumental undertaking have evolved over time. In fact, creating a universally agreed-upon definition has proven to be as challenging as the implementation of the network itself.

Today, in broad terms, NextGen 911 reflects an industry vision that defines advanced services and collaboration capabilities across emergency response entities employing interconnected i3 networks across the United States. During a citizen-initiated call for help, typical NextGen 911 processing activities include call handling, emergency response dispatch, the coordination of necessary services and the correlation of events that may be related to the 911 call as well as a wide variety of post-event activities ranging from log review and data sharing to evidence inquiries and forensics.

As we move forward with the implementation of this critical nationwide public service, it is important to understand that the concept of NextGen 911 encompasses far more than the IP-based architecture. In today's reality, NextGen 911 is the architecture plus an ever-evolving set of capabilities and innovations that will completely alter the way we perceive, define, approach and execute emergency communications.

IN TODAY'S REALITY, NEXTGEN 911 IS THE ARCHITECTURE PLUS AN EVER-EVOLVING SET OF CAPABILITIES AND INNOVATIONS THAT WILL COMPLETELY ALTER THE WAY WE PERCEIVE, DEFINE, APPROACH AND EXECUTE EMERGENCY COMMUNICATIONS.

THE ADVANTAGES OF NEXT-GENERATION 911

As more attention is paid to the migration to a next-generation IP-based architecture, it is important to understand that challenges will inevitably arise. The task will demand a significant amount of work, and it will bring change to the industry as well as to individual PSAPs. However, Next-Generation 911 is certainly a case in which the result justifies the effort. If implemented effectively with the proper regulatory oversight, the resulting benefits of this shift will bring improvements to the resiliency, reliability and overall performance of the emergency communications network while increasing the safety of first responders.

- Diverse IP paths will make 911 service more resilient and survivable.

- Static ESNs for call provisioning and routing will be replaced with methods that better accommodate modern communications devices with dynamic location information and no fixed service address.

- The ability to connect to remote PSAPs and command centers will improve intergovernmental operational continuity.

- Platform flexibility will improve interoperability with technologies and service providers and open the door to future advancements in functionality.

- Geographically distributed PSAPs and consolidated infrastructures will allow for remote call takers and expanded service.

- Cloud-based services, including correlation of events across many information sources, will allow for better incident intelligence and advanced services options to all stakeholders, including call takers, dispatchers and responders.

- The viability of multiple types of requests for assistance, including voice, text, alarms, personal devices and crash notification, will give emergency callers greater access to 911 emergency response services.

- The implementation of smart applications will protect public safety personnel, assist with emergency response and enhance situational awareness.

- The adaptability of solutions will allow for local and timely customization of 911 services.

- Increased modular change capacity will allow for faster deployment of solutions to meet public safety needs while reducing associated risks.

THE CURRENT STATE OF NEXT-GENERATION 911

IT IS ESSENTIAL TO UNDERSTAND THAT NEXTGEN 911 IS NOT A FINAL DESTINATION; IT IS AN ONGOING JOURNEY OF PHASED PROJECTS THAT WILL CARRY ON INDEFINITELY AS NEW TECHNOLOGIES CONTINUE TO EVOLVE AND INNOVATIVE NEW FEATURES ARE INTRODUCED.

One of the most beneficial aspects of the road to a Next-Generation 911 system is that it is not a singular linear path. Every local initiative will be different because it will reflect the unique circumstances surrounding that PSAP or public safety jurisdiction. Because of this flexibility, however, there is no comprehensive description of the current state of NextGen 911 nationwide.

Moving forward, it will be important to remember that the migration to a nationwide IP-based network of networks cannot and should not happen in a single monumental effort, and it will not happen consistently across the country. In fact, it is essential to understand that NextGen 911 is not a final destination; it is an ongoing journey of phased projects that will carry on indefinitely as new technologies continue to evolve and innovative new features are introduced.

By the very nature of the i3 infrastructure, there are multiple ways that a PSAP or jurisdiction can get started on the journey to NextGen 911 functionality. The most common starting points are implementing an ESInet, transitioning to IP-enabled CPE or implementing/upgrading the data used within GIS.[32]

[32] Meer, Stephen. (2012, April). Viewpoint: How to begin moving to next-generation 911. American City and County. Retrieved from http://americancityandcounty.com/blog/viewpoint-how-begin-moving-next-generation-911

As of today, the number of ESInets around the country is increasing, though most are not functioning as an intra-network yet, but rather as isolated networks capable of interconnecting with the legacy analog network. Some public safety agencies are enhancing their GIS data in preparation for the shift to the GIS-based location information and routing that will be at the heart of a fully realized, i3-based NextGen 911 infrastructure. It will be some time, however, before full GIS-implementation is a reality around the country simply because the data preparation is complex and labor intensive, requiring significant collaboration between PSAPs and multiple municipal, county or state governmental agencies. Probably the most common transition that PSAPs are making toward NextGen 911 is through the implementation of IP-enabled CPE and selective routing functionality.

CHALLENGES TO NEXT-GENERATION 911 IMPLEMENTATION

In the current NextGen 911 transitional phase, technology is not the barrier for wider implementation. Though it is complex, full IP interoperability is possible now. There are, however, a number of challenges that are proving to be significant impediments to this important journey.

Today, funding remains one of the most overwhelming obstacles that public safety agencies face. Due to the widespread use of wireless and VoIP services, the number of static telephone numbers is no longer an appropriate indicator of the complexity and cost associated with providing 911 service. As a result, legacy tariff-based funding mechanisms that depend on the number of traditional local exchange access lines will not support the ability to implement NextGen 911. While the cost of migration will vary depending upon the individual migration strategy, and though it can be controlled to some extent through the use of a phased approached, the financial burden of NextGen 911 will be significant for every public safety agency. With no universal cost recovery mechanism, PSAPs are limited to the existing 911 tariff models to fund the full migration—models that are often inadequate to cover the cost of legacy 911 service.

The ever-changing nature of IP technology is another challenge that the public safety community faces; and this is a reality that cannot be overcome. The NextGen 911 architecture will constantly be progressing, resulting in a high rate of churn within the network. Equipment will become obsolete more quickly, new features will become available, software upgrades will be necessary, and individual jurisdictions will respond to these changes at their own pace, which can be problematic on interconnected networks. Of course, the evolution means that the network is constantly improving, but the change rate can be a difficult dynamic to keep up with at ground level.

IN THE CURRENT NEXTGEN 911 TRANSITIONAL PHASE, TECHNOLOGY IS NOT THE BARRIER FOR WIDER IMPLEMENTATION. THOUGH IT IS COMPLEX, FULL IP INTEROPERABILITY IS POSSIBLE NOW.

With the extensive use of personally identifiable information (PII) within NextGen 911 and with increased sophistication of cyber threats to national infrastructure, security is a significant concern. Even though ESInet functions are deployed today within fairly closed networks, they are still vulnerable. As we move toward a completely interoperable next-generation architecture, 911 becomes a feature-rich environment in which public safety agencies will be exchanging information with non-public safety entities. As the greater network expands, so does the risk. NextGen 911 security design and maintenance must keep pace, or even out pace, the threat level.

Finally, the ever-shifting landscape of the 911 regulatory environment poses one of the most significant challenges to essential NextGen 911 deployments. For example, in 2007, the FCC declared VoIP to be an interstate service. This action established exclusive federal jurisdiction over VoIP telephony services, preempting states' ability to regulate it. However, the agency has yet to declare whether state regulation of IP-based 911 service—an intrastate calling service exclusively regulated by the states—frustrates the FCC's purpose in exercising such federal jurisdiction. Some argue that IP-based 911 is a subset of IP telephony (VoIP), thus justifying the idea of federal jurisdiction. Others, however, view IP as technical protocol rather than a service. If this is the case, the utilization of IP for NextGen 911 would not automatically or inherently make NextGen 911 an interstate service or inextricably part of VoIP, thus supporting the idea of state regulation. The answer to this question currently lies with the FCC—or with Congress if it is inclined to address it—and many fundamental issues surrounding NextGen 911 governance, such as interconnection rights, funding, technology-neutral policies, cost recovery and cost allocation depend on the answer.

Conclusion

The nationwide implementation of Next-Generation 911 is long overdue, and change is requisite to create a technical, financial and regulatory landscape that will enable emergency communications to keep pace with modern communications. However, because of the absolute essential nature of the system, it is not a task that should be pushed forward without proper due diligence. In order to progress in the most efficient and effective manner possible, it is essential that we make 911 innovation a communications priority and that we apply the lessons learned over nearly five decades of 911 evolution. Throughout the history of emergency communications, every new level of service brought challenges. But these obstacles were overcome through a combination of innovation, marketplace pressure and government oversight. The ongoing evolution of NextGen 911 will be no different. In order to ensure the long-term success of the country's essential emergency communications system, we must study the successes and failures of the past to determine the appropriate path forward for NextGen 911 standards and best practices, the role of the free market and the right balance of local, state and federal governance.

To understand where we are going, we must first understand where we have been.

ABOUT THE INDUSTRY COUNCIL FOR
EMERGENCY RESPONSE TECHNOLOGIES (iCERT)

The Industry Council for Emergency Response Technologies (iCERT or the Industry Council) is the voice of commercial enterprises in the field of critical communications. The Industry Council plays an important role in addressing public policy issues impacting the emergency calling, communications and response system. Industry Council members believe that business leaders' expertise can assist public policymakers and agency professionals as they address complex choices regarding advanced communications technology alternatives. Through advocacy, research and in coordination with the public sector, the Industry Council plays a vital role in the development and deployment of emergency response technologies.

Find out more at **www.theindustrycouncil.org**.

ABOUT THE 911 EDUCATION FOUNDATION

The 911 Education Foundation serves as a resource to public safety stakeholders as they look to next generation 911 technologies to improve emergency response in their communities. The Foundation provides a context to address questions about next generation 911 systems and economics, and raises awareness of, and educates policymakers, public safety stakeholders, and the general public on issues related to next generation 911 technologies, their deployment and operation.