

NG911 & FIRSTNET

Emergency Communication Centers Provide the Critical Link



Special White Paper researched
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INTRODUCTION

The emergency communications centers that answer calls to 9-1-1 and dispatch law enforcement, fire service and emergency medical responders face a wide variety of challenges including budget constraints, staffing shortages and rapidly changing technology. Two specific technologies, Next Generation 9-1-1 (or NG9-1-1) and the Public Safety Broadband Network (or FirstNet), have captured significant attention as emergency communications center leaders seek strategies to integrate these technologies into their operations. This whitepaper explores the similarities, differences and inter-relationships between these two emerging technologies. We will look at the appropriate roles and responsibilities for each technology, and consider strategies to create interoperability between these networks while also sustaining operational best practices and security in the emergency communications center.

THE 9-1-1 CHALLENGE

The rapid pace of change in consumer technology can create intense pressures on public safety communications centers. For example, as mobile phones became the preferred method of voice communication in America, an increasing proportion of calls to 9-1-1 now originate from these devices. Often the callers in these situations are not aware of their specific location or are unable to provide the emergency communications center with a dispatchable address. This has created the need for rapidly evolving 9-1-1 caller location and call routing technologies to improve on the process of routing calls to the proper emergency communications center, and to provide emergency call-takers with useful location information that will allow them to dispatch the appropriate response agencies.

Similarly, the expansive use of text and multi-media messaging in the smartphone era creates the need to develop effective mechanisms for the public to utilize these technologies in relation to emergency communications centers. Once again, legacy 9-1-1 networks and technologies are ill equipped to deal with these capabilities, and the public continues to perceive public safety communications capabilities as behind the times. A common refrain goes something like this...“How come I can order a ride from a smartphone app and the driver knows my exact location, but when I call 9-1-1 they don’t have a clue where I am?”

The good news in all of this is that the public safety technology environment is finally catching

up with the public’s technology appetite. In recent years considerable effort has gone into defining the fundamental strategies, functional capabilities and technologies for NG9-1-1 networks. These networks will ultimately evolve into the nationwide connected networks based on industry standard Internet Protocol (IP) technologies and public safety-specific standards, capable of supporting a wide range of information

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THE PUBLIC SAFETY COMMUNICATIONS CHALLENGE

transfers between members of the public in need of emergency services and the emergency communications center responsible for dispatching those services. While these standards continue to evolve, they are leading to a highly interoperable 9-1-1 communications environment built to interact with the prevailing communications devices and services utilized by the general population.

Life in the fully completed NG9-1-1 world will likely go far beyond efficient text-to-9-1-1 services or the ability to send a photo or video clip to the emergency communications center. Interactive multi-media technologies can provide live-streaming of interactions between the person calling 9-1-1 and the emergency communications center. In-vehicle telematics systems can provide automatic crash notifications with significant event data that can pinpoint the location of the crash, and assist in determining the severity of the incident and the potential for injuries. Health telemetry systems can combine location and health data to automatically initiate a request for emergency medical services response.

All of these potential intersections with the emergency services sector, along with many more not yet envisioned, will require ongoing standards development for NG9-1-1 and a concerted effort to refresh and evolve the standards in a quick and efficient manner. This will drive enhancements in both NG9-1-1 networks and the emergency communications center's systems that support receiving and processing of the public's calls for emergency assistance. Over time, NG9-1-1 networks and systems will evolve into highly specialized environments that provide emergency communications centers with a wealth of data and information about each emergency call they receive.

Similar to the 9-1-1 environment, the technologies used to communicate between emergency communications centers and their responding agencies have undergone profound technological change. For years it was sufficient to have a well-functioning two-way voice radio system (often referred to as land mobile radio, or LMR, system) to provide dispatch and response communications. But these systems were often deployed across a mix of frequency bands designated for public safety use, creating complex interoperability challenges. Further, as digital voice radio technologies emerged, there were additional challenges as technology incompatibilities further complicated interoperability.

LMR technology was also utilized to support mobile data technologies, allowing the computer aided dispatch (CAD) systems at the emergency communications centers to send information to mobile data terminals or mobile computers in emergency response vehicles. While initial technology and bandwidth constraints limited these systems primarily to textual information, the extension of commercial 3G and Long Term

Interactive multi-media technologies can provide live-streaming of interactions between the person calling 9-1-1 and the emergency communications center.

Evolution (LTE) data to field-based first responders significantly amplified their capabilities and changed how emergency communications centers structured their work flows and processes.

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In recent years, the land mobile radio domain has undergone considerable shifts in technology. As the number of digital and trunked radio systems continued to expand, the need for standards-based interoperability became essential. Through efforts initiated by the Association of Public-Safety Communications Officials (APCO) a set of standards known as Project 25¹ (P 25) slowly emerged. While these standards have ultimately resulted in interoperability improvements between public safety's digital radio systems and devices, they did not address the continuing challenge of public safety communications being spread over multiple frequency bands. They also didn't address the increasing demand for effective mobile data solutions becoming ubiquitous in public safety response strategies.

As progress continued toward standards-based land mobile radio solutions, an unprecedented and highly effective campaign by all the major public safety associations² created an opportunity for Congress to allocate a section of broadband wireless spectrum specifically for public safety use. This spectrum allocation, along with governance and funding mechanisms created the framework for establishing the Nationwide Public Safety Broadband Network that would bring industry-standard mobile voice and data capabilities, coupled with nationwide interoperability and high levels of system capacity management and reliability, to all public safety agencies across the country. This network, now called FirstNet Built with AT&T³ is now in use by more than 5,200 public safety agencies and is being rapidly expanded and adopted throughout the nation.

While many of the initial uses of FirstNet have focused on broadband data functionality, voice communications capabilities are built into the infrastructure as well, and this functionality is already providing useful services for many public safety users of FirstNet. As standards and technologies evolve, FirstNet will supplement,

and perhaps for some agencies, replace the voice communications capabilities now handled over LMR systems. This coupling of voice and data communications, across a seamless nationwide broadband network, creates opportunities for the public safety community to totally rethink how voice communication, images, video and data can be structured to support their emergency response strategies. Further, since the standards process for the underlying technologies is driven at a global level — and responsive to a larger consumer marketplace — it will evolve more rapidly to meet ever-changing needs.

THE EMERGENCY COMMUNICATIONS CENTER BRINGS IT ALL TOGETHER

Next Generation 9-1-1 networks are coming into existence at an increasingly fast pace, and continual progress is being made in creating the connected networks that will allow the public to report emergencies and request emergency assistance with combinations of voice and data information. These Emergency Services IP Networks (ESInets) will increasingly coalesce around an expanding body of industry standards⁴ so that high levels of interoperability will be created between the originating service providers (the wireline and wireless carriers used by the public) and the emergency communications centers that handle emergency call receiving and dispatching across the country. Similarly, as the functionality and utilization of FirstNet continues to expand, our emergency communications centers and public safety agencies will have increasing access to best-in-class digital data, multi-media and voice communications to further enhance their emergency response capabilities.

¹The Project 25 digital radio standards are now maintained through the Telecommunications Industry Association (TIA) www.tiaonline.org

²The Public Safety Alliance was formed by: the Association of Public-Safety Communications Officials International (APCO); the International Association of Chiefs of Police (IACP); the International Association of Fire Chiefs (IAFC); the National Sheriff's Association (NSA); the Major Cities Chiefs Association, the Major County Sheriff's Association, the Metropolitan Fire Chiefs Association, the National Emergency Management Association; and the National Association of EMS Officials.

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³Details on FirstNet can be found on their website at www.firstnet.com

⁴Including organizations such as the National Emergency Number Association (NENA) www.nena.org, the Association of Public Safety Communications Officials (APCO) www.apcointl.org, and industry bodies such as the Alliance for Telecommunications Industry Solutions (ATIS) www.atis.org, and the 3rd Generation Partnership Project (3GPP) www.3gpp.org

But this digital transformation creates one of the biggest challenges our emergency communications centers have ever faced. The potential explosion in content coming into these centers from ESInets and other sources of digital data will force our emergency communications centers to adapt their current systems and processes in a variety of ways. Similarly, as field responders expand their use of FirstNet and the ecosystem of devices, applications and functionality this will bring, new strategies for information exchange to and from field responders will also need to be established.

The diagram below offers a visualization of the challenges ahead. While NG9-1-1 ESInets and FirstNet are both “broadband” and “IP” networks, they are each designed and configured to perform unique and specialized functions. ESInets are uniquely designed and managed to maximize the capability for processing inbound voice and data elements from the public as requests for emergency services are made. FirstNet provides broadband voice and data capability from the communications center to first responders and among first responders. While each provides exceptional capabilities for their intended functions, it is the emergency communications centers and their systems that will provide the linkages and interoperability between these two specialized networks.

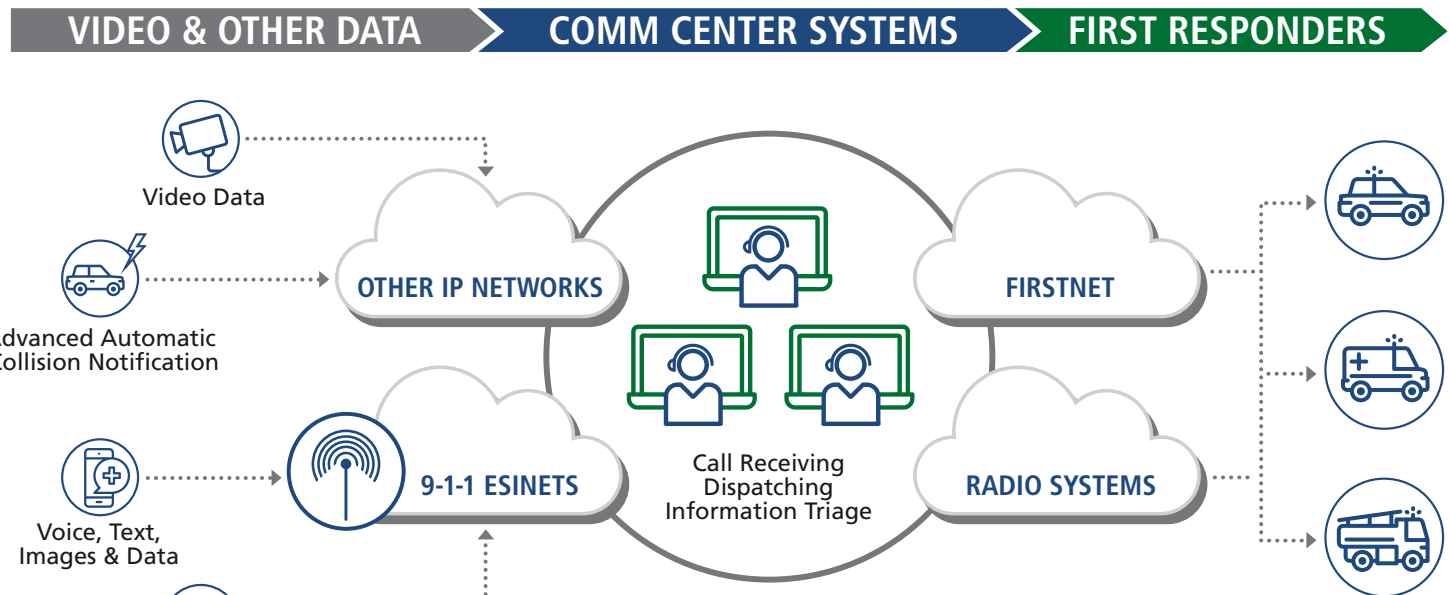
While there are certainly opportunities for some of the data sources on the left side of the diagram to be directly linked through to applications operating over the FirstNet infrastructure (for example video surveillance and monitoring technologies), the majority of

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the public’s interaction with emergency services will continue to flow through the emergency communications center. This will mean that the mix of technology systems utilized at these centers, including 9-1-1 call receiving systems, computer aided dispatch (CAD) systems, and logging/recording systems, will need to evolve beyond their traditional roles.

Further, new technologies such as mass storage solutions, data analytics and video analytics are likely to be woven into communications centers’ technology architecture as well. The goal of all these technology transformations will be to expand the utilization of these improved “input” and “output” capabilities without burdening the center with functional and process changes that reduce their efficiency and effectiveness.

HOW NG9-1-1 AND FIRSTNET POWER THE MODERN COMM CENTER



SO HOW WILL ALL OF THIS HAPPEN?

A common notion exists that since all the transformations discussed so far are moving us toward an all-digital world it will be easy to tie all of this together in some sort of seamless interoperable environment. But the practical reality is that each system in an emergency communications center plays a very specific role in the overall functionality of the center, and that each will likely need to play a specific role as the digital transformation continues. Rather than the future being some sort of amorphous linking of networks, it will instead emerge through thoughtful and well-structured systems that interface with each other in ways that preserve system functional and security.

There will likely be several keys to success in this emerging technology landscape. First, the technology solution providers for the systems utilized by emergency communications centers and field responders will need to be engaged in the thought leadership and standards processes, and then embrace and utilize these standards, so that affordable interfaces between systems can be more easily defined and implemented. This will allow each focused technology solution to perform its function while simultaneously creating effective and secure mechanisms for sharing information with other systems when needed. One example of a standard related to the exchange of information in the NG9-1-1 environment is the **Emergency Incident Data Document (EIDD)**⁵ jointly developed by APCO and the National Emergency Number Association (NENA).

Another key to success will be establishing mechanisms for testing standards and interfaces before they are placed into service. This lesson was reinforced in the evolution of digital land mobile radio standards, where different technology solution providers

implementing the same technical standard still ended up with interoperability challenges when they tried to actually connect to each other. Through considerable effort and dedicated resources, processes are now in place to ensure that systems and services following the standards will in fact interoperate with each other as expected by end users.⁶ This same type of environment will be needed as we attempt to merge the expanding NG9-1-1 environment with the broadband capabilities of FirstNet.

It will also be important for the organizations that promulgate and test these standards to collaborate with each other rather than compete against one another. From the perspective of public safety professionals, it doesn't matter whose name is on a standard. What matters is that it works. The worst thing that can happen from a public safety responder's perspective is for voice and data communications to fail even though each of the systems in the chain conformed to one or more standards. Conformance to a standard is only a part of the solution. The more important focus should be on developing and testing standards that work well together.


The final key to success will be flexibility...flexibility by the technology solution providers that provide solutions for our emergency communications centers, flexibility at these centers to consider alternative strategies for how their systems interact and how work flows through the center, and flexibility on the part of public safety agencies to recognize that this transformation won't happen overnight.

There will likely be several keys to success in this emerging technology landscape.

- Standards are developed by stakeholders
- Establish mechanisms for testing standards and interfaces
- Public safety organizations collaborate on standards and testing
- Flexibility on the part of all stakeholders is key to success

⁵The 9-1-1 NG9-1-1 Emergency Incident Data Document (EIDD) Standard – APCO NENA 2.105.1-2017 is available for download at the APCO Standards site at www.apcointl.org/standards/standards-to-download/ or the NENA website at www.nena.org/general/custom.asp?page=EIDD

⁶Further information on Project 25 Compliance Assessment Program can be found at the following Department of Homeland Security web site: www.dhs.gov/science-and-technology/p25-cap



Mechanisms will also be needed to easily share that content with other systems and users such as the center's logging & recording system, the center's CAD system or mobile users attached to the CAD system.

EACH SYSTEM PLAYS A ROLE

Each of the systems utilized at emergency communications centers play a key role in managing the information and workflow of the center. Each will likely need to be transformed and/or utilized in new ways to manage the all-digital future.

9-1-1 TELEPHONE SYSTEMS

The telephone systems utilized at emergency communications centers have undergone significant changes in recent years. Once viewed as customer premise equipment (CPE) in the traditional wireline telephone system days, these systems have evolved into sophisticated computer networks capable of both voice and data functionality. For example, as Voice over IP (VoIP) technologies swept through the business telephone system domain, these capabilities found their way into emergency phone systems as well, creating opportunities for both technological and physical diversity in system infrastructure and operations. Similarly, as location technologies improved for wireless 9-1-1 calls, these systems expanded into mapping and Geographic Information Systems (GIS) functionality to better support the emergency call-taking process.

This technology progression will continue, and likely increase, as NG9-1-1 environments expand and mature. Even as an increasing number of ESInets are implemented to replace legacy circuit-switched emergency telephone systems, the full vision of NG9-1-1 functionality won't be reached until the originating service providers are delivering their traffic to these ESInets in formats that allow them to be seamlessly delivered to the emergency communications center.

Many of these centers have prepared themselves for this future (at least to the extent that current knowledge and standards allow) by selecting technology solution providers and systems capable of NG9-1-1 functionality as they have made normal life-cycle replacements of their 9-1-1 telephone systems.

The role of the 9-1-1 telephone system at the communications center could also potentially change in the NG9-1-1 environment, as could the nature of the interfaces between the 9-1-1 phone system and other systems in the center. For example, as inbound 9-1-1 calls become capable of including a variety of multi-media content such as photos, video clips or live streaming, secure mechanisms will be needed to receive, store and retrieve that content. Mechanisms will also be needed to easily share that content with other systems and users such as the center's logging & recording system, the center's CAD system or mobile users attached to the CAD system. This leads back to the earlier observations about the need for standardized mechanisms for all this information sharing and flexibility between technology solution providers to implement these interfaces effectively and economically for their customers.

Even with ESInets fulfilling their role of conveying all this information to the emergency communications center, and FirstNet fulfilling its role of providing the mechanisms to pass useful information on to emergency responders, the emergency communications center and its systems become the key link in making all this happen in a controlled, secure and manageable manner.

LOGGING & RECORDING SYSTEMS

For decades, the role of recording systems in emergency communications centers was confined to recording audio information from telephone calls and radio channels. As digital technologies improved, new capabilities were integrated into these systems allowing them to perform far beyond simply recording of analogue audio. Interfaces were created to allow direct recording from digital telephone and radio systems and totally new functionalities came into existence. It is now common to see the logging & recording system capturing a wide variety of audio and digital content from multiple systems in the emergency communications center such as keystroke logging and screen captures from 9-1-1 telephone systems and CAD systems.

The blending of this information in a common, time sequenced and coordinated manner creates an ability to perform event reconstruction across all the systems used in the call intake, processing and dispatching work flow processes. This significantly improves the quality assurance and incident reconstruction process of the emergency communications center, with the reviewer able to listen to the audio for 9-1-1 callers, dispatchers and responding units while simultaneously reviewing the CAD entries and activities of call receivers and dispatchers as the incident flowed through the center.

For many emergency communications centers, the CAD system will be the logical location to create new linkages between inbound NG9-1-1 information and responding units in field over the FirstNet broadband network.

With logging & recording systems that encompass these capabilities now already well entrenched in many of our emergency communications centers, it is easy to see how technology solution providers for these systems see an ever-increasing role for their products as NG9-1-1 functionality continues to expand. In many respects, the addition of content such as photos, video clips, live streaming, and the like are just a logical extension, of the role they already play in the center. Technology solution providers of these systems are already positioning themselves to take on these functional responsibilities, with some already advertising their ability to utilize the EIDD standard to facilitate data exchanges with other systems in the emergency call processing chain.

COMPUTER AIDED DISPATCH (CAD) SYSTEMS

For most emergency communications centers, the CAD system is the nerve center of the entire operation. As originally created, CAD systems automated the unwritten habitual and paper-based processes used in the center to evaluate the location and nature of the call, as well as assisting with the decision process for dispatching

law enforcement, fire and rescue service or medical resources. They also then simplified the process of capturing previously hand-typed entries into incident and unit history logs.



It didn't take long before these systems expanded functionality to include direct interfaces to 9-1-1 telephone systems to capture the Automatic Number Identification (ANI) and Automatic Location Information (ALI) data related to a call. CAD systems also use ANI/ALI data in conjunction with mapping and GIS data to define the appropriate agency or even specific unit to dispatch to an incident. These systems also interfaced with external data sources such as licensing, criminal history and records management systems to simplify the process of linking all this data to specific incidents and unit activities. They further facilitated the extension of all this data to mobile terminals and computers in responder vehicles. For many emergency communications centers, the CAD system will be the logical location to create new linkages between inbound NG9-1-1 information and responding units in field over the FirstNet broadband network. Whether the actual security vetting and storage of photo, video or related content is performed by the 9-1-1 telephone system or the logging & recording system, it is the CAD system that already has telecommunicators utilizing it for routine interactions with members of the public who report emergencies and the responders being sent to an emergency. So once again, the concept of standards-based interfaces and flexibility will come into play.

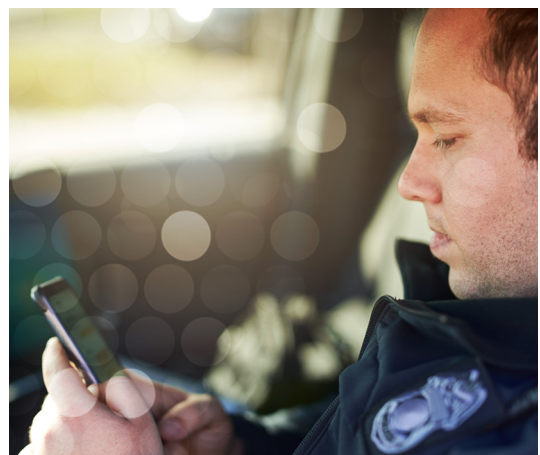
The data capture, storage and recall mechanisms established as part of an evolution to full NG9-1-1 capability will need to take into consideration that the call receiver or the dispatcher may not actually make use of this content.

WILL NEW SYSTEMS AND TECHNOLOGY BE NEEDED?

It is important to remember that there is more than a technological element to all of this. Even with additional content flowing into the emergency communications center over NG9-1-1 networks, not all of it will be of functional value in the call receiving and dispatching process. Staffing levels and operational protocols may prevent many centers from allocating time to review content accompanying 9-1-1 calls, so that center personnel can continue to focus on quickly ascertaining the location and nature of an emergency while creating the incident in CAD so units can be dispatched.

Therefore, the data capture, storage and recall mechanisms established as part of an evolution to full NG9-1-1 capability will need to take into consideration that the call receiver or the dispatcher may not actually make use of this content. It may be appropriate for some data to be disseminated directly to responding units so they can evaluate it using their in-vehicle or hand-held broadband devices. Some of it may simply need to remain in a communications center's systems and be available for field units or others as needed, based on how an incident progresses.

The common theme in these scenarios is that processes are needed in order to facilitate decisions on what data to push through, what to save so it can be pulled later, or perhaps even what to simply archive and maybe not act on at all. Due to affordability issues, most emergency communications centers and public safety agencies will not be able to create and staff data analysis units or similar real-time support systems to augment the emergency communications center's capacity to screen content and make distribution decisions.



Interviews were conducted with, and information gathered about, a variety of 9-1-1 technology solution providers regarding calling, logging & recording and CAD systems, as well as organizations that provide system integration and data analytics services.

Rather, this functionality may find its way into our communications centers in some form of data analytics applications utilizing machine learning or similar techniques to automate some of the screening and dissemination decisions. This capability may also find its way into CAD systems, since they already occupy a similar role in routine operations today. Or it may result in a new layer of technology for integration into the communications center. Regardless of where and how this functionality materializes, it will once again raise the importance of standards-based interfaces and flexibility by all the systems and technology solution providers.

Regardless of the systems and applications utilized, emergency communications centers will play a key role in linking inbound emergency information to the specific agencies and personnel involved in emergency responses. Even if data networking strategies can be created to directly route content from information sources such as sensors, cameras, and other Internet-of-Things (IoT) devices to responding units, it is the emergency communications center and its systems that will maintain the understanding of which agencies and responding units are associated with specific incidents.

A COMMON THEME

In developing this whitepaper, information and interviews were conducted with a wide variety of public safety communications leaders and technology solution provider representatives. As a result of these conversations, an interesting set of themes emerged.

From the leaders of emergency communications centers, we most often sensed a fairly high level of caution about how all of this will actually come into reality. Many expressed that current fiscal constraints make it challenging to even meet existing service-level expectations. They are deeply concerned that high volumes of content coming their way from the public as they report emergencies may actually decrease service levels rather than enhance them. In lieu of having well formulated strategies on how to plan and manage these technologies as they evolve in their centers, many expressed a belief that some combination of actions by technology solution providers and industry associations will help clarify matters well in advance of any need to implement changes to their systems and processes.

Interviews were conducted with, and information gathered about, a variety of 9-1-1 technology solution providers regarding calling, logging & recording and CAD systems, as well as organizations that provide system integration and data analytics services. These interviews resulted in a variety of perspectives. Some technology solution providers have very clear visions for how the NG9-1-1 and broadband worlds will intersect and are working to help establish thought leadership for the industry while also tailoring their





The common theme in all these views seems to be that everyone recognizes that significant changes are not just on our doorstep, they are already walking through the door and demanding that we deal with them.

solutions to meet those visions. Others seem to be “waiting for standards” to be developed or released so they can target their development activities to conform to those standards. Still others observed that communications centers’ needs and visions for the future of emergency calling are still too vague or ill-defined for them to target investments strategically.

The common theme in all these views seems to be that everyone recognizes that significant changes are not just on our doorstep, they are already walking through the door and demanding that we deal with them. Some emergency communications centers may choose to dive in aggressively and work with technology solution providers and industry associations to shape the visions, standards and products in ways that support their organizations’ needs. Others may seek to defer these changes for as long as possible due to a mix of staffing, operational or fiscal constraints.

But the number of agencies at each end of this continuum will be vastly outnumbered by the majority of centers between them, neither trying to lead but also not wanting to be left behind; each trying to find the most effective and affordable mechanisms to meet their own goals based on local needs and resources. This is the same pattern we’ve seen over the years as 9-1-1 technologies and land mobile radio technologies progressed. We’ll now live through it one more time as we move through the intersection of expanding NG9-1-1 capabilities and increased utilization of FirstNet broadband services.

While each of these technologies will provide exceptional capabilities for their intended purposes, it is the emergency communications center and its systems that will provide the linkages and interoperability that are appropriate for each individual center and the first responders they support.

One thing is certain. We’ve overcome all the challenges we’ve faced to get us to where we are today, and we’ll overcome these new challenges as well. We just need to work together and be flexible.

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Kevin Kearns is Director of Public Safety Consulting at IXP Corporation. With over 30 years of public safety experience prior to joining IXP in 2005, Kevin now leads IXP's consulting, technology and facilities projects for a wide variety of public safety and local government customers. More about IXP's services can be found at www.ixpcorp.com "Tackling the Toughest Challenges in Public Safety"

