

PUBLIC SAFETY DISPATCH

Response paging as an alternative to voice paging, digital paging, and cellular dispatch.

With more than two-thirds of first responders being volunteers, public safety dispatch systems serve a critical role in the protection of life and property in the United States. 911 centers often rely on voice paging, digital paging, and cellular alerting to dispatch volunteers; however, these approaches suffer several shortcomings in terms of reliability, performance, and cost. Another option, ***response paging****, dispatches directly from high-power transmitters, confirming who receives each message, who reads it, and who will respond.*

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CriticalResponse SYSTEMS

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OVERVIEW



Public safety uses various radio dispatch technologies to protect life and property in the counties, cities, and municipalities they serve.

911 call centers process over half a million events each day in the United States, with 87% of the responding agencies relying in some capacity on volunteers.[1] Volunteer responders typically do not carry two-way radios, and dispatchers must alert volunteers across a far greater geographical area than their full-time counterparts. This places difficult requirements on public safety dispatch systems, which must maintain a careful balance of reliability, performance, and cost.

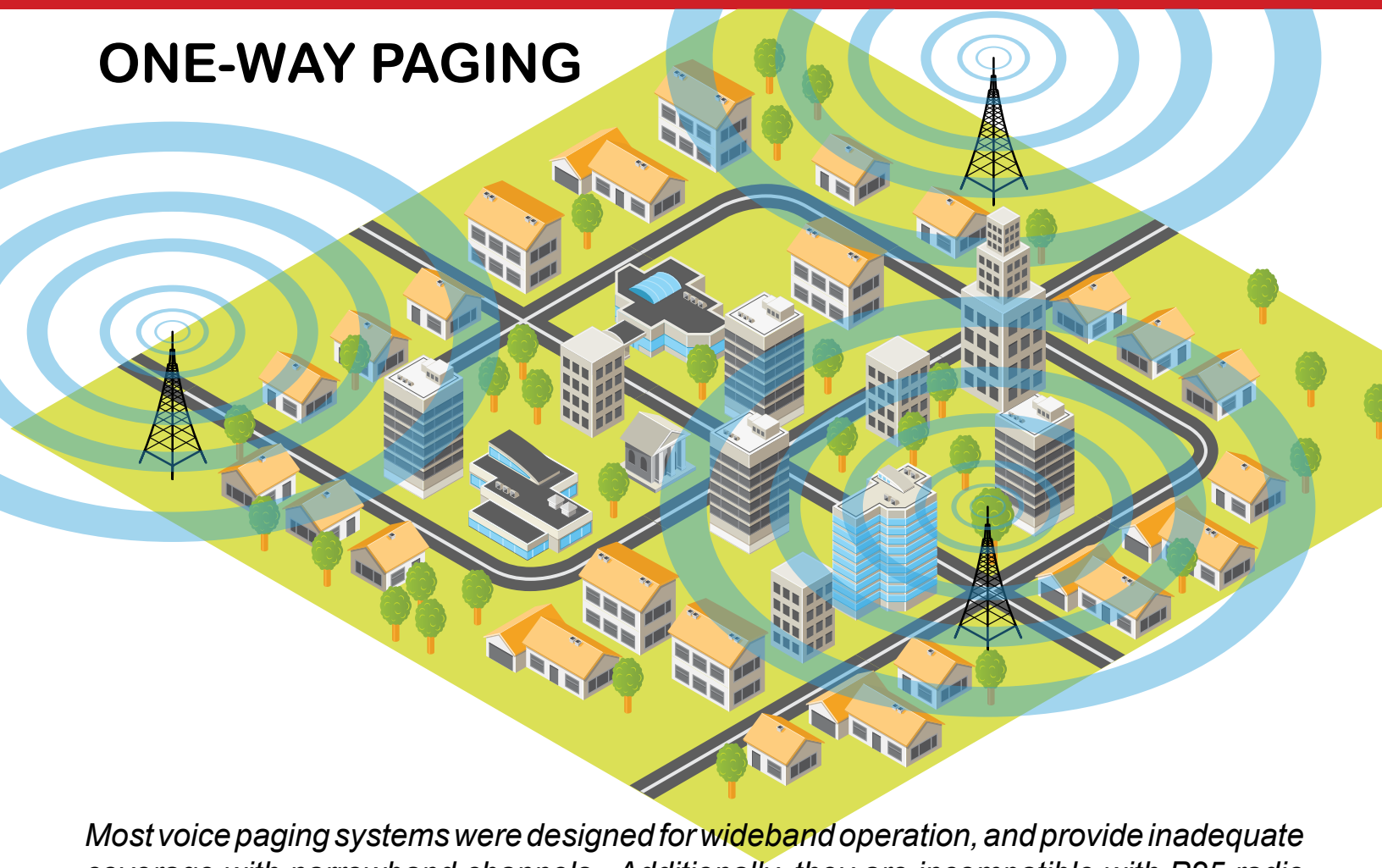
While volunteer dispatch solutions often involve voice paging, digital paging, and cell phones, these approaches each have serious limitations. Most notably, voice paging and digital paging lack any form of response capability, leaving dispatchers and incident commanders with no idea who received the alert and who missed it until responders arrive at the station. And while cellular-based alert systems do offer message confirmation, they are susceptable to unpredictable delays an do not pass ISO muster as a solution reliable enough for primary dispatch.

Fortunately, *response paging* can address these shortcomings. Response paging systems alert first responders within 5 seconds, and then inform incident commanders who receives the message, who reads it, and who is responding. Response paging systems use dedicated, high-power base stations, avoiding the unpredictability of cellular phone networks. And because response paging is based on newer technology, its performance is better, and its installed cost is less, than narrowband voice and digital paging solutions.

1 National Fire Department Census: US Fire Administration, FEMA. http://apps.usfa.fema.gov/census/summary.cfm

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ONE-WAY PAGING



Most voice paging systems were designed for wideband operation, and provide inadequate coverage with narrowband channels. Additionally, they are incompatible with P25 radio channels and provide no message delivery confirmation.

VOICE PAGING

In a typical application, an agency assigns voice pagers to volunteers, tuned to a primary dispatch radio channel. When dispatching the agency, specific prefix tones cut the dispatcher's voice directly through to responders' pagers as live voice. While this has worked reasonably well for years, there are two recent technical challenges with voice paging: the migration to digital trunked radio systems, and the FCC narrowbanding mandate.

As radio systems migrate from analog to P25 technologies, the transmitted voice modulation changes from analog FM to digital FSK or QPSK. This creates a problem for voice pagers, which cannot demodulate this type of signal. To counter this, many dispatching organizations keep one analog channel open specifically to serve voice pagers, but this suffers from the other challenge, narrowbanding. In 2009, the FCC mandated that all radio systems move to 12.5 KHz-wide channels, called narrowband channels. These channels have half the analog bandwidth of the previously established 25 KHz channels, and in a practical sense have half the analog performance. As a result, radio systems converting to narrowband spacing often lose 30% of their voice paging coverage[1], creating coverage problems where there were none before. Agencies can either live with poor coverage or spend an enormous amount of money erecting new towers and purchasing new base transmitters.

Even before digital radio and narrowbanding, voice paging suffered other limitations. When a dispatch is configured to alert multiple agencies, the tone out period can be long, even approaching

1 National Fire Department Census: US Fire Administration, FEMA http://apps.usfa.fema.gov/census/summary.cfm

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a minute. This causes dangerous delays before first responders hear any information concerning the dispatch and how it applies to them. Additionally, the usable bandwidth – the number of voice pages that can happen over a single channel -- is severely limited. Only one dispatch can occur at a time with a voice paging system, and delays are commonplace when multiple events happen simultaneously. Also voice pagers are relatively expensive, often over $300, and their battery only lasts a few days at best. Lastly, unlike the two-way radio systems they monitor, voice pagers offer no way to confirm receipt of a dispatch or to signal status. Command staff must wait until personnel show up on scene or at the station to assess turnout and make appropriate tactical decisions concerning mutual aid and second alarms.

DIGITAL PAGING

Digital pagers, which display text instead of voice, offer several technical improvements over voice paging. They are smaller, less expensive, have a longer battery life and greater coverage range in most operating conditions. They also have far greater multi-agency performance than voice paging systems. A single channel can support hundreds or thousands of groups, tens of thousands of user, and dozens of concurrent events. Additionally being text based, they provide responders a means to quickly revisit messages. For instance responders can quickly review a street address or other detail as needed without listening to the entire message again.

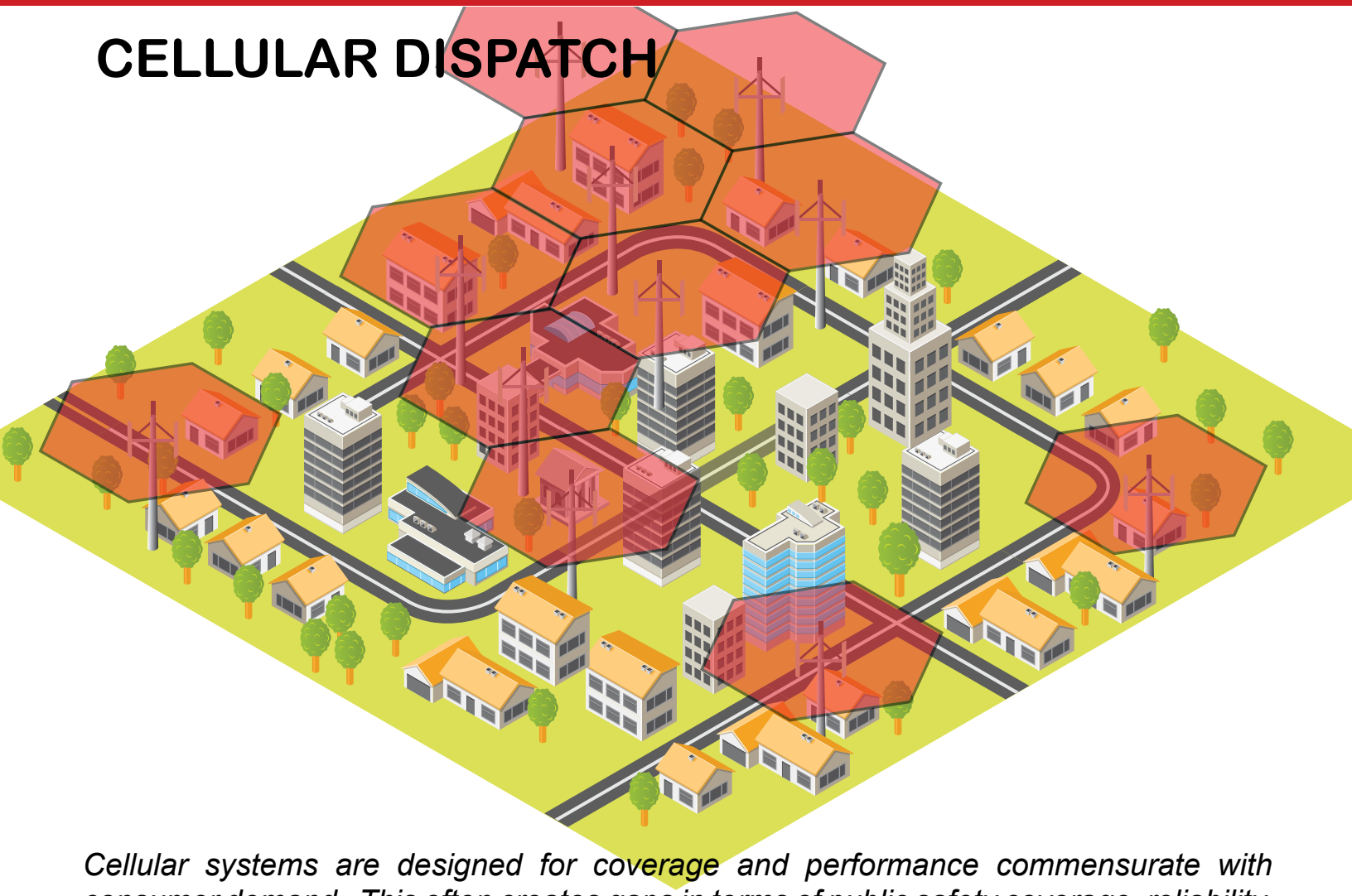
Digital paging systems are also affected by the FCC narrowbanding mandate, although the effects are typically not as severe. However, digital paging suffers the same basic shortcoming of voice paging in that message delivery is not confirmed.



Digital paging systems cover a larger area than voice paging systems, and they are less affected by narrowbanding. However, they provide no message confirmation.

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CELLULAR DISPATCH



Cellular systems are designed for coverage and performance commensurate with consumer demand. This often creates gaps in terms of public safety coverage, reliability, and performance in violation of NFPA-1221.

COMMERCIAL CELL SERVICE

Cell phone alerting systems deliver dispatch messages to first responders cell phones as text messages and allow users to respond. While these responses represent very useful tactical information, cellular alerting is in many ways the least appropriate solution for public safety dispatch.

First, cellular system's performance is neither consistent nor predictable. All cellular messaging applications rely on the short messaging service (SMS), either to deliver the message directly or to deliver notification that a message is pending. Cellular systems usually deliver SMS messages to a recipient's phone in just a few seconds, or complete a group message in a minute or so. However, cellular companies do not publish SMS performance standards, and these service levels are not predictable. Studies have shown that as many as 9% of SMS messages are delayed more than five minutes, with 5.1% never being delivered at all.[1] Additionally, SMS messages are routed through remote Mobile Switching Centers and SMS Centers, which routinely queue emergency codes behind social media updates and bulk advertising loads. This creates unpredictable delays during periods of distant network congestion.

1 Xiaoqiao Meng, Petros Zerfos, Vidyut Samanta, Starsky H. Y. Wong, and Songwu Lu, "Analysis of the Reliability of a Nationwide Short Message Service," NEC Laboratories America/Deutsche Telekom Laboratories/UCLA Computer Science Department, p. 4, <http://www.cs.ucla.edu/~hywong1/paper/infocom07/infocom07.pdf>.

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The NFPA-1221 Standard prohibits the use of commercial cellular networks for primary dispatch.

Secondly, cellular systems do not offer the same level of reliability as dedicated public safety systems. Cell phones depend on switching centers, base stations, and the public switched telephone network, as well as other local and regional network components. Smart phones have these same dependencies, and also require additional components such as the Apple App Store™, Push Notification Services, the Internet, and e-mail. One server crash can prevent smart phone apps from operating correctly, and natural or man-made disasters can bring down local, regional, or national cell phone services in unpredictable ways, for unpredictable lengths of time. Thus, a cellular-based dispatch system is inherently susceptible to local or distant problems well beyond the agency's ability to control or repair. This is true even if the system uses dedicated county base stations because the underlying control systems invariably reside in remote data centers many miles away from the county.

The public record contains many examples describing how these dependencies translate into serious real-world problems:

• *In 2004 and 2005, several hurricanes and tropical storms caused repeated cell phone outages in Florida, some lasting 3 weeks or more and severely disrupting critical communications for hundreds of police, fire, and EMS services.*[2]

• *In August 2005, Hurricane Katrina wiped out cell service to every person, hospital, and public safety agency within a several thousand square mile footprint, with outages lasting into the following year.*[3]

• *In August 2011, Hurricane Irene destroyed 130 cell towers and left another 215 towers without power, leaving 12,000 people and dozens of hospitals without cell phone service for several days in several states.*[4]

• *In August 2011, a minor earthquake struck Northern Virginia, causing a spike in call volume and social media that disrupted AT&T, T-Mobile, and Verizon Wireless networks in several states for several hours.*[5]

• *In October 2011, a hardware failure in a RIM server facility disabled the entire Blackberry network in several countries for three days.*[6]

• *In June 2012, a fast-moving weather storm (derecho) brought down cellular systems in Ohio, Kentucky, Indiana, Pennsylvania, Virginia, and West Virginia, disconnecting 9-1-1 call centers for several days.*[7]

• *In October 2012, hurricane Sandy flattened cellular networks in several states and disrupted cell phone communications far beyond storm-affected areas for a week or more.*[8]

The National Fire Protection Association (NFPA), together with the Insurance Services Office (ISO), creates and maintains minimum

2 Florida Department of Transportation. Hurricane Response Evaluation and Recommendations, February 11, 2005, at 39.

3 Independent Panel Reviewing the Impact of Hurricane Katrina on Communications Networks. Report and Recommendations to the Federal Communications Commission, June 12, 2006.

4 Rosenthal B, Kang C, and Williams C. More than 1 million without power, phone service as Hurricane Irene advances, WASH POST, August 2, 2011

5 Conneally T. Virginia earthquake overloads cell networks from North Carolina to New York, Twitter takes over, betanews.com, October 2011

6 Sullivan, P. After Storm, 9-1-1, Phone Service Remains Spotty, WASH. POST, Jul. 2, 2012.

7 Impact of the June 2012 Derecho on Communications Networks and Services". Public Safety and Homeland Security Bureau, Federal Communications Commission. January 2013.

8 Reardon, Marguerite. Hurricane Sandy Disrupts Wireless and Internet Services. CNET News. CBS Interactive, 30 Oct. 2012. Web. 30 Oct. 2012.http://news.cnet.com/8301-1035_3-57542500-94/hurricane-sandy-disrupts-wireless-and-internet-services/

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While FirstNet will ultimately deliver valuable new capabilities to firefighters across the United States, it is unlikely to provide a useful solution for volunteer dispatch.

standards and requirements for fire prevention and suppression activities. The NFPA 1221 specification mandates the use of a private system for fire dispatching, and precludes the use of commercial cellular networks for this purpose.

700MHz BROADBAND AND FIRSTNET

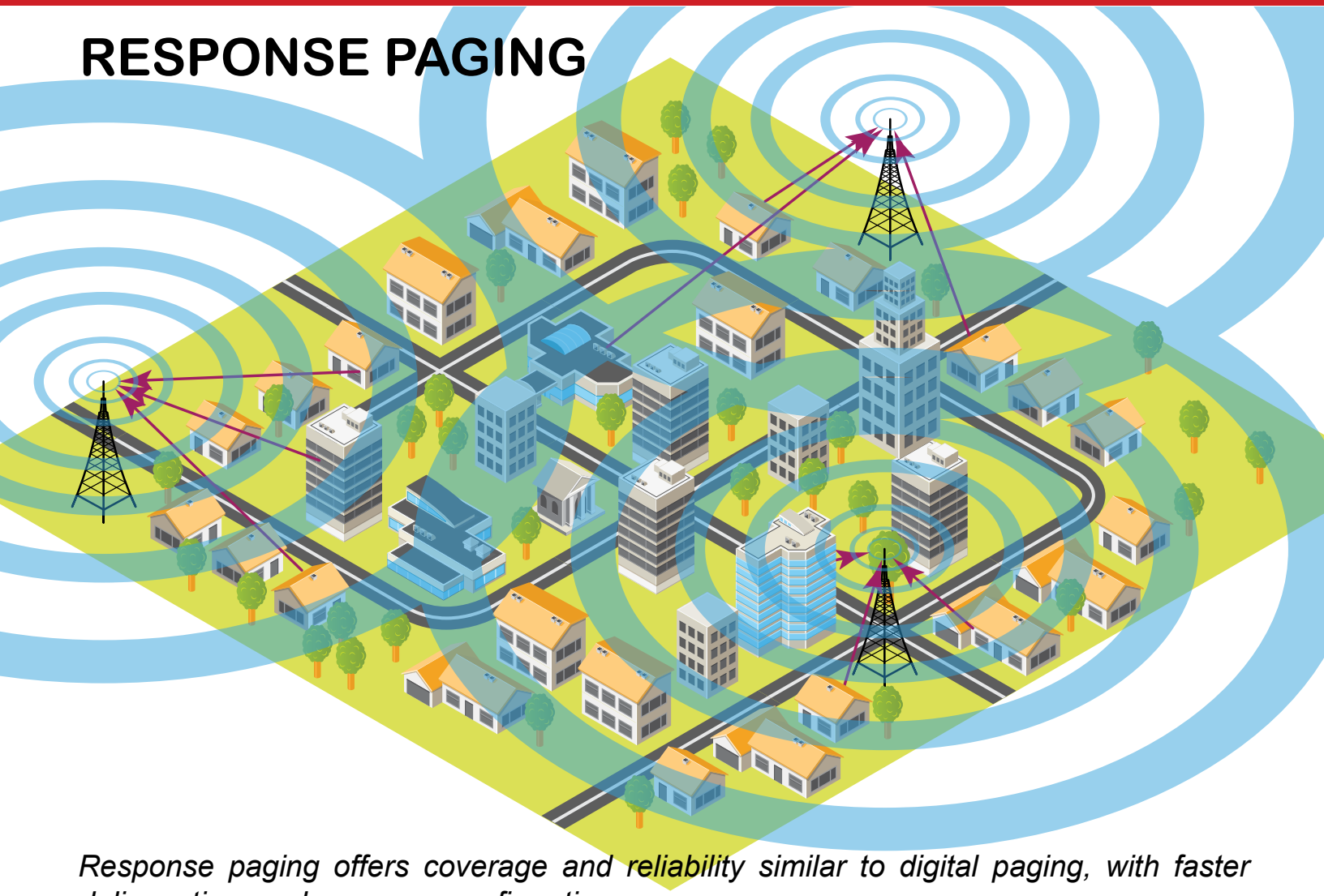
The U.S. Congress created FirstNet as part of the *Middle Class Tax Relief and Job Creation Act of 2012,* to provide a mechanism for first responders to access the features of smartphones without the aforementioned problems of commercial carrier networks. FirstNet holds promise to create a national LTE broadband network for use by federal, state, and local agencies. For their part, fire fighters will be able to stream live video, voice and data all simultaneously while assessing the best tactical approach to dealing with an incident. Unfortunately this network will come at a cost. In a Congress Research Service document the estimated project costs of the network build out will run roughly 7 billion dollars, with network operating costs budgeted at an additional 100 million for the first 10 years.[9] The build out time frame for this network is budgeted to last until 2022. All of these figures do not even include the hand-held device costs which will easily run into the thousand dollar price tag per unit.

While the potential is great, the timetable of this network, its cost, and network coverage remain only estimates at this point. Eventually, FirstNet will become a great tool, but costs will slow its availability beyond major metropolitan areas and it is unlikely to ever become a viable solution for volunteer alerting.

9 The First Responder Network and Next-Generation Communications for Public Safety: Issues for Congress, Linda K. Moore Specialist in Telecommunications Policy March 5, 2013

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RESPONSE PAGING



Response paging offers coverage and reliability similar to digital paging, with faster delivery time and message confirmation.

Response paging combines the response capabilities of a cellular system with the reliability and performance of a digital paging system. Response paging systems use dedicated high power transmitters, and add base receivers for confirmation and response. Response paging systems use a channel pair instead of a single channel, both channels employing digital modulation synchronized together to optimize battery life and performance.

Response pagers include an embedded digital receiver and transmitter, along with a user-friendly interface and a variety of alerting and reply options. When a message arrives, the responder can read it and reply with a single button press. Pager batteries will last 2-3 weeks and can be quickly recharged with a cable or dock.

RELIABILITY

Like traditional paging, response paging is extremely reliable, with a history of operation even during extraordinary catastrophes. During the 9/11 terrorists attacks, paging systems continued operating properly even after serious infrastructure damage and peak congestion had rendered cellular networks useless.[1] During hurricane Katrina and its aftermath, response paging continued operating properly, despite extensive wind damage, power loss, and flooding that disabled virtually every other communication

1 Florida Department of Transportation. Hurricane Response Evaluation and Recommendations, February 11, 2005, at 39.

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9.4.2	***Radio Paging Systems and Pagers***
9.4.2.1	*The paging system shall be under the direct control of the AHJ where used as a method of emergency dispatch.*
9.4.2.2	*No part of the paging system shall utilize the public Internet for any portion of its operation when used as a method of emergency dispatch.*
9.4.2.3	*Page-encoding equipment shall be located in the communications center where used as a method of emergency dispatch.*
9.4.2.4	*The paging system shall comply with the general requirements for radio systems as outlined in this document.*

From NFPA-1221, 2010 Edition

system and service in the region.[2]

There are several reasons for this. First, unlike cellular systems, a response paging system is completely self-contained with minimal external dependency. An entire county-wide system typically fits in a few equipment racks with no external requirement except for power.

Second, response paging systems send messages directly to personnel and receive responses directly from personnel. Instead of multiple access points or base stations, a response paging system typically uses a one antenna per 100 to 300 square miles, simulcasted together to cover a city, county, or region. It operates using dedicated, protected, FCC-licensed channels, and the simplicity of this type of system permits affordable redundancy on all levels, providing additional protection against unforeseen circumstances.

Finally, response paging is compliant with the NFPA-1221 standard, and meets the ISO guidelines for a primary dispatch system.

Response paging is designed from the ground up for critical messaging applications such as public safety dispatch. It reliably delivers messages and returns responses, eliminating the reliability and performance compromises seen with comparable cellular approaches.

PERFORMANCE

A response paging system avoids the unpredictable performance of cellular by working in a fundamentally different way. First, it processes group messages natively, notifying one recipient or hundreds of recipients within 5 seconds. This technology, called confirmed data broadcast, operates at the hardware level (OSI layer 2), permitting multiple pagers to receive the same RF transmission simultaneously. Other solutions (such as cellular) must break group messages into a series of individual messages at the application layer (OSI layer 7), with delivery performance depending on group size.

ENHANCED FEATURES

Response paging provides personnel the ability to immediately update their general status with just the push of a button, providing valuable information to dispatchers and commanders

2 Independent Panel Reviewing the Impact of Hurricane Katrina on Communications Networks. Report and Recommendations to the Federal Communications Commission, June 12, 2006, at p.24

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prior to an event. Additionally, command staff has access to all response and status information, either on fire station monitors or mobile tablet computers or MDTs. Incident commanders have vastly increased situational awareness of who is responding and who cannot, so escalation calls can be made early in the event to save time and lives.

Additionally being a bidirectional data system, Response Paging provides administrators the ability to remotely monitor all aspects of network. All the remote site locations report temperature, internal voltages, RF output levels and overall channel utilization. Additionally RF monitoring units can be strategically placed around the coverage area to report the exact conditions in the field.. This information enables system operators to identify and address problems while they are still minor, long before they interrupt service.

COST ADVANTAGE

Not only does response paging provide public safety agencies a sophisticated, mission critical communication system, but does so at very low cost. In comparison to voice paging and even most digital paging systems, response paging provides equivalent coverage with fewer towers. Response paging systems use synchronous protocols with pilot codes, forward error correction, and GPS synchronization to stay exactly on channel. These systems are therefore able to make far better use of narrowband spectrum than digital (POCSAG) or voice paging. Once installed, the self monitoring of a Response Paging system will dramatically decrease the maintenance and support costs compared to other private systems.

When compared to cellular or smartphone based systems, a Response Paging system will show return on investment in as little as 12 months. Furthermore, the installed cost of a response paging system is often half that of a narrowband voice paging system, and about on parity with a digital private one-way paging system.

A response paging system offers features unavailable from voice pagers, digital pagers, or cellular dispatch approaches, at a comparatively low installed cost.

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CONCLUSION

While public safety agencies use voice paging, digital paging, and cell phone messaging for volunteer dispatch, each of these methods suffers several serious shortcomings. Voice and digital paging offer no message receipt confirmation or response options, and cell phones suffer from lack of reliability or ISO support. In contrast, *response paging* offers the reliability of digital paging with the confirmation capabilities of cell phones. Response Paging is the best balance of cost, performance, and reliability for dispatching volunteer first responders.



Response Paging is the best balance of cost, performance, and reliability for volunteer first responders dispatch.

ABOUT CRITICAL RESPONSE SYSTEMS, INC.

Critical Response Systems, Inc. (Norcross, GA) manufactures mission-critical communication systems, including response paging systems. Our systems deliver the benefits of response paging to hospitals, public safety agencies, and critical infrastructure companies, with additional enhancements to ensure five 9's availability, 5-second message delivery, privacy encryption, and customizable dashboard reporting tools to quickly assess alerting performance. For more information regarding response paging and public safety dispatch, please contact:

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