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An Introduction to Long Term Evolution (LTE)

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Introduction

On February 22, 2012 the President of the United States signed into law the Middle Class Tax Relief and Job Creation Act of 2012 (H.R.3630). This legislation contains landmark language that allocates space in the 700 MHz radio spectrum (the "D-Block") to public safety agencies, which provides the necessary radio spectrum to build a nationwide public safety wireless broadband network and finally achieve full interoperability for our nation's first responders. Public safety will use this network to enhance its communication and data-exchange capacities, for both day-to-day operations and during large-scale emergency events calling for coordinated public safety responses. Along with allocating the spectrum, the legislation also apportions $7 billion to build the national network and provide grant funds to help state and local agencies integrate infrastructure and equipment with the national network.

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On the federal level, these efforts were a culmination of a strong partnership led by the Vice President's Office working collaboratively with the Departments of Commerce, Homeland Security, Justice (DOJ), and the National Institute of Standards and Technology (NIST). Together, these federal partners worked in tandem with state, local, and tribal public safety officials to establish the legislative framework and to facilitate eventual passage of the bill that will enable the building of a truly interoperable nationwide wireless broadband network. This had been a long anticipated vision and was formally identified as an urgent public safety need in *The 9-11 Commission Report*, published in July 2004.

This milestone D-Block legislation resulted from a partnership of state, local, and tribal public safety officials working with federal agencies in a coordinated strategy. This first ever nationwide wireless network for public safety will finally be a reality.

Long Term Evolution (LTE): The Standard for Nationwide Interoperability

Long Term Evolution (LTE), commonly referred to as 4G[1]—or next generation wireless communications—is the new standard for nationwide public safety broadband. This standard will allow access to digital technologies and deliver expanded capabilities to public safety practitioners in the field. LTE is the avenue for bringing public safety fully into the digital age. Technology devices and applications now being released on a daily basis, rival those that could be run only on in-office servers and desktops a few short years ago. This network will foster further development of applications customized for public safety and help make first responders' operations more effective and efficient.

The LTE standard supports fast speeds and holds great promise for first responders, yet there are limitations to using the associated technology in the public safety arena. The transition to LTE will not be as simple as flipping a switch. It will involve an extensive and complex build-out as well as an implementation process that will unfold over the years to come. It will require a great deal of coordination and adjustment among current public safety broadband users now operating across a patchwork of commercially and publicly supported networks on non-contiguous bands of spectrum. Ultimately, however, LTE and the nationwide network will help even the playing field, enabling agencies of all sizes—including those in remote rural jurisdictions without current wireless coverage—to leverage emerging broadband technology and to access increasingly powerful devices running operationally relevant applications. Unlike the current wireless environment, where interoperability among public safety devices and across jurisdictions is deficient, the nationwide network built on the LTE standard will provide true nationwide interoperability. This network will foster further development of applications customized for public safety and help make first responders' operations more effective and efficient.

This Issue Brief discusses the advantages and limitations of LTE technologies for public safety and provides an overview of the current state of affairs in this crucial transition period.

Historical Context

Public safety land mobile radio (LMR) use began with voice-only radios back in the early 1940s. Although data transmissions were eventually possible over LMR systems, data speed limited use to simple text-based applications using dedicated "dumb" terminals and later, laptop PCs. Large data files, photographs, videos, and large map files could not be viewed on early mobile data computers (MDCs) because data speeds on these networks were generally limited to 19.2 Kbps or slower speeds. Early use of data over LMR was limited to computer-aided dispatch (CAD), textual incident information, responders changing their location or making status changes such as from "busy" to "available," car-to-car messaging, text-based license plate queries, and so on. Today, speeds and data transfer capabilities we would have only expected at our desktop a few short years ago, are available to the public safety responder in the field.

Let's examine the LTE standard and related technology, and discuss how this new technology can enhance public safety response to emergencies.

LTE Services Now Available

LTE describes the standard for the over-the-air (or *airlink*) component of mobile broadband. It is the standard that is supported by public safety and has been adopted by the Federal Communications Commission (FCC) as the technology platform for public safety broadband in the 700 MHz band (this segment of spectrum is often referred to as the "D Block").[2] LTE was first used in the commercial broadband world, with all of the major wireless carriers adopting the standard. Simply stated, LTE networks are much faster than previous networks used within public safety, with speeds up to 10 times faster than 3G networks.[3]

1. http://en.wikipedia.org/wiki/4G.

2. Interoperability Planning for Wireless Broadband, www.safecomprogram.gov/library/lists/library/DispForm.aspx?ID=331.

3. www.itworld.com/mobile-amp-wireless/126045/just-what-4g-speed-and-how-are-us-carriers-offering-it.

At present, until the nationwide broadband network is fully developed and deployed, the public safety community has two basic choices for implementing LTE:[4]

- **Lease services** from commercial wireless service providers
- **Build** 700 MHz private wireless networks on their own or as regional systems[5]

With the passing of the D-Block legislation, however, agencies are now being encouraged and incentivized to participate in migration planning to leverage future Nationwide Public Safety Broadband Network opportunities.

The Advantages of LTE

LTE-based networks have upload and download speeds unheard of in the past. LTE opens the gate for many new, exciting, and more robust public safety applications. For example:

- Real-time video will become more robust and widely available in the field on mobile terminals, tablet devices, and smartphones, resulting in increased situational awareness for first responders.
- Police officers will be able to view and exchange digital photographs (e.g., mug shots) and fingerprint technology, greatly improving on-the-spot suspect identification and resulting in savings of time and resources.
- Fire personnel will have digital access to "as-built" building drawings and mapping programs in real time to improve fire ground situational awareness.
- Incident commanders and emergency managers will communicate through enhanced incident management software that will bridge the gap from the incident to the emergency operations center, greatly improving decision-making.
- Applications such as automated license plate recognition (LPR) systems and GPS-enabled navigation systems will provide real time notifications and alerts, including emerging hazards and geographically specific be-on-the-look-out (BOLO) transmissions, all contributing to improvements in officer and civilian safety.

With LTE and the nationwide network, first responders will gain access to innovative tools to assist them with their critical missions. They will be in a better position to take advantage of fast changing digital technology. LTE will revolutionize the way public safety responds to emergencies. Figure 1 illustrates how data speeds are enhanced through LTE technology.

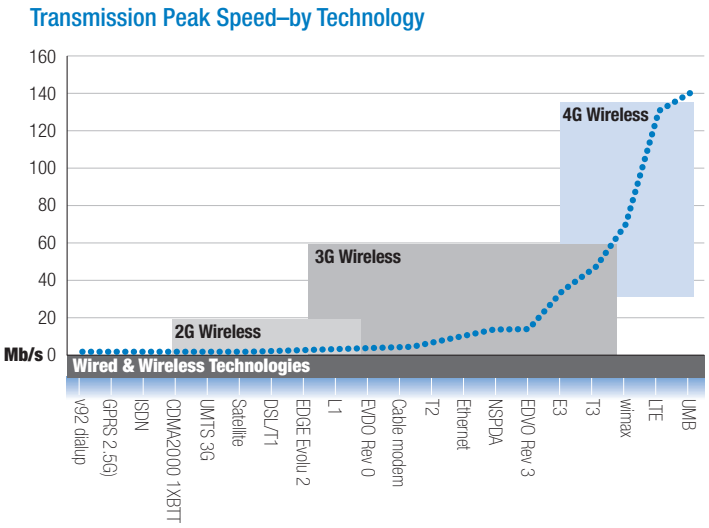

Figure 1: Transmission Peak Speed by Wired/Wireless Technology

Source: As adapted from SEARCH Group, Inc.

LTE has been adopted as a global standard because:[6]

- It increases the capacity and speed of wireless data networks
- It has lower data transfer and connection set-up latency
- It has improved support for devices that are in vehicles moving at high speeds

Public safety has adopted LTE because, as a global standard, the network components and user devices are readily available and less expensive. A portable radio for public safety to be used on a LMR system may cost upwards of $7,000. By comparison, smart devices capable of accessing broadband LTE networks may cost only a few hundred dollars.

The Challenges of LTE

Like any technology, LTE-based technology has both pros and cons. Public safety planners will face many challenges as they deploy this new technology in an ever-changing environment. Planners will need to give careful consideration to these challenges listed below.

Costs are always a major concern for first responders, but particularly so in the present economy. Currently, commercial LTE broadband network service is available from most wireless carriers. These commercial services have monthly recurring fees that can prove expensive for large agencies.

Commercial networks also are not sufficient for first responder needs because they are not built to be "mission critical." Tower sites are often built without any kind of

4. http://transition.fcc.gov/pshs/public-safety-spectrum/700-MHz/safetyband.html.
5. www.fcc.gov/encyclopedia/700-mhz-spectrum.
6. http://en.wikipedia.org/wiki/3GPP_Long_Term_Evolution.

hardening to protect the network components, and without generators and such to sustain them during long power outages. Similarly, commercial LTE networks are built for public use. In times of emergency, commercial networks become congested with consumer traffic, making the network unreliable and of compromised access—at the particular times when public safety needs it most. Public safety does not receive priority access on these networks. Using commercial broadband services for public safety is easily deployable since it does not require investing in infrastructure; however, services on these networks presently should be limited to those that are not mission critical.

In contrast, when considering deploying a private broadband network, additional considerations apply. A private network requires a considerable capital investment. LTE networks require more infrastructure than those needed to support only LMR. LTE requires a high-density network, as coverage area per site is less. Therefore, LTE coverage over a large geographic area will be more expensive than LMR. LTE networks require a more robust fiber or microwave backhaul network due to the large files being transported. By developing a nationwide broadband network many of the resource considerations can be offset by regionalizing resources and the economy of scale that come with a true nationwide network.

Before the passage of the D-Block legislation, efforts to deploy private networks were stymied by these limitations and high overall system costs. LTE devices are low power and have very short range. In-building coverage is limited. While rugged laptops are generally available, rugged handheld devices are not. Likewise, intrinsically safe and secure devices are not yet available, largely because there is not yet a critical volume of demand for them. The nationwide network built on the LTE standard was conceived and promoted as a remedy to the limitations of the two existing options, using commercial services and building private networks.

LTE Is Not a Replacement for LMR

The convergence of mission-critical voice and broadband data service on the same public safety network is coming, but it is still some years away. As the nationwide public safety broadband network is being planned, public safety agencies must carefully consider whether to upgrade or replace their aging LMR systems in anticipation of using this nationwide public safety broadband network for voice. Public safety and government representatives will need to work together on a host of requirements and specifications before this convergence can occur:[7]

- Although approximately $7 billion dollars have been apportioned along with the allocation of the D-Block to public safety for planning and build-out purposes, details of the funding for the nationwide network must still be specified, including methods to disseminate those funds, establish local match requirements, and to support the necessary development of national standards.
- A governance entity and process defined in the legislation as the *First Responder Network Authority* must be established, officers selected, and its business processes developed.
- The *First Responder Network Authority* must establish the research, development, testing, and evaluation protocols necessary to support the network and subscriber devices.

The *First Responder Network Authority* will be comprised of representatives from local, state, and tribal first responders, broadband vendors and application developers, and federal authorities. This governance group will be responsible for ensuring that the nationwide network includes the following critical elements and features:

- Public safety users must have guaranteed access.
- Quality of service must be adopted to high standards.
- The network must be resilient and reliable.
- Subscribers must be able to roam.
- Coverage requirements must be determined.
- The amount of spectrum and network capacity needed must be determined.
- Devices must be capable of "talk-around," or operating in simplex mode.
- Devices must be developed to be rugged and intrinsically safe.

Expanding Beyond Limited Spectrum

In order to develop a nationwide public safety broadband network, public safety needs an allocation of spectrum that can serve large bandwidth needs and meet geographic coverage requirements. Before passage of D-Block legislation, public safety already had access to 10 MHz of the 700 MHz spectrum, as depicted in Figure 2. The D Block provides a much needed additional 10 MHz of spectrum and creates a continuous block of 20 MHz of spectrum with which to build the nationwide public safety network (Figure 2).

7. Adapted from "Interoperability Planning for Wireless Broadband," U.S. Department of Homeland Security, November 2011. See www.safecomprogram.gov/library/lists/library/DispForm.aspx?ID=331.

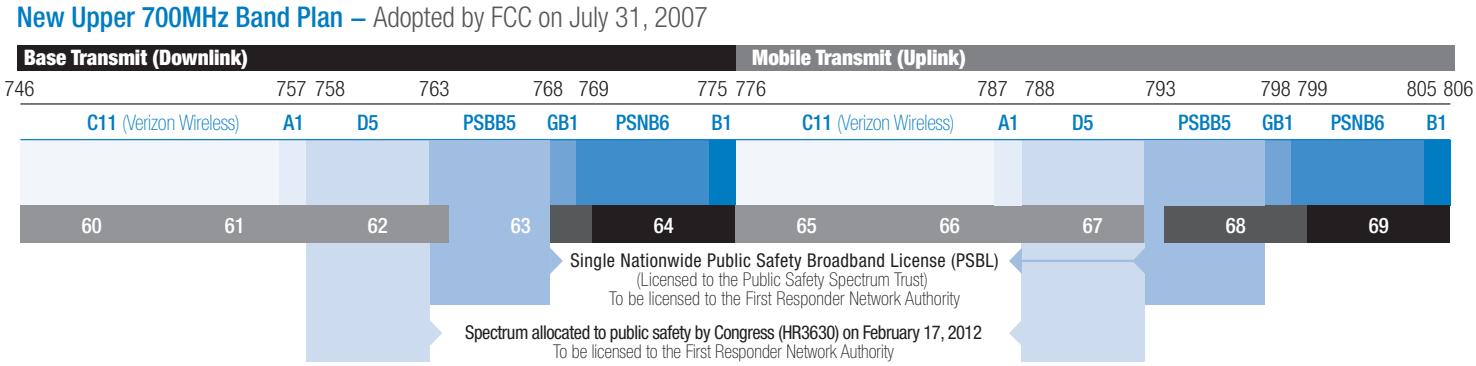

Figure 2: Upper 700MHz Band Plan

With this allocation, public safety now controls 20MHz of spectrum and can begin to address the creation of a network to initially handle data needs. Business needs in 10–20 years cannot be predicted with precision; so the amount of spectrum and network capacity that will be needed in the future has yet to be determined.

The Nationwide Public Safety Broadband Network[8]

The Nationwide Public Safety Broadband Network that is now being designed calls for creating a truly interoperable wireless network dedicated to first responders. Its core mission is clear:

- To allow first responders anywhere in the nation to send and receive critical voice, video, and data to save lives, reduce injuries, and prevent acts of crime and terror
- To ensure all Americans can access emergency services quickly, sending and receiving vital information to public safety, regardless of how it is transmitted
- To revolutionize the way Americans are notified about emergencies and disasters so they receive information vital to their safety
- To reduce threats to e-commerce and other Internet-based applications by ensuring the security of the nation's broadband networks[9]

Public safety agencies across the nation have long awaited the D-Block legislation and with the passing H.R. 3630, planning for a National Public Safety Broadband Network is underway. However, agencies anxious to position themselves to take advantage of the network must wait for the rules, standards, and processes called for by the legislation to be determined and vetted. Details about the governance, security, roaming, the network's final architecture, and a build-out plan are not yet complete.

In the midst of these processes, local planning should include:

- Analyzing and assessing existing agency equipment capabilities, including backward/forward compatibility
- Analyzing and assessing vendor equipment capabilities, and determining which vendors are on a path to be able to participate in the nationwide public safety broadband network
- Determining state, regional, and local agency migration paths to establish where they are now and where they will need to be as the time comes to transition to the nationwide broadband.

Looking Forward

The new nationwide broadband network, when implemented, will greatly enhance interoperability and tear down previous communications barriers. This future network will provide nationwide "roaming," which will enable local responders to have full interoperability with their regional, state, and federal partners.

Meeting the needs of first responders and enhancing public safety is critically important. Development of the nationwide broadband network is accordingly ambitious. The National Telecommunications and Information Administration (NTIA) filed comments with the FCC that summarized several proposed objectives for this new network.

According to the NTIA, the network must:[10]

1. Deliver broadband communications meeting appropriate public-safety-grade levels of service that are reliable and secure

8. www.govtech.com/public-safety/Public-Safety-Broadband-Network-Wins-in-Tax-Cut-Deal.html
9. www.broadband.gov/plan/16-public-safety/.
10. www.ntia.doc.gov/files/ntia/publications/ntia_public_safety_network_comments_06102011.pdf.

2. Enlist the trust of public safety agencies that will migrate traffic to this new network
3. Enable seamless communications between public safety agencies and jurisdictions, as well as federal responders
4. Provide a platform for a wide range of affordable equipment and applications
5. Leverage commercial platforms and technologies that can evolve to take advantage of innovation on a cost-effective basis[11]

If you want to follow Nationwide Public Safety Wireless Broadband Network activities, the NTIA is a good source of information. www.ntia.gov

Very simplistically, the future network may look something like this (Figure 3):

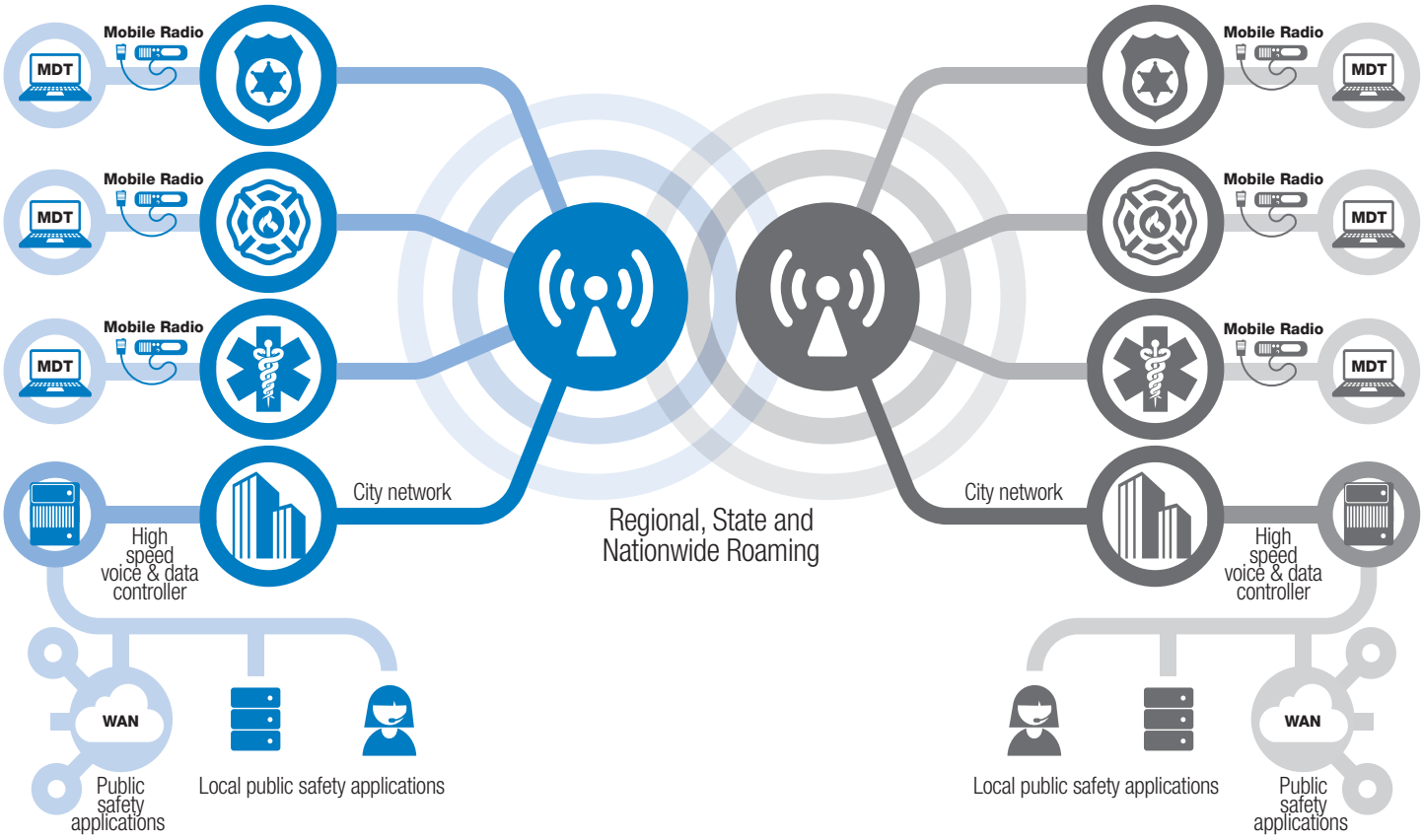

Figure 3: Future National Public Safety Broadband Network.

Source: As adapted from SEARCH Group, Inc.

11. Ibid.

Interoperability

Public safety needs to address interoperability now so that *before*—not after—we build a nationwide public safety wireless broadband network, we consider connectivity across systems, and utilize industry standards to make this connectivity easier. Without that cross-system connectivity, roaming will be difficult, upgrades and innovation will be limited, and we will not be able to have one universal network that serves the needs of public safety across the nation.[12]

Conclusion

Building a Nationwide Public Safety Wireless Broadband Network based on LTE standards for the wireless environment will enable public safety to greatly enhance both the efficiency and effectiveness of public safety response. Field responders and managers will share the same tools in the field as they currently have within the "wired environment" at their agency. Real-time video, photographs, mapping software, access to external databases, and a host of new applications can be brought directly to the field. However, careful planning of construction, security and encryption, and lifecycle replacement and funding is needed to ensure that LTE meets agencies' individual business needs.

Policy Development, Training, and Technical Assistance Resources

- **U.S. Department of Justice, Office of Community Oriented Policing Services (COPS Office):** The COPS Office is the component of the U.S. Department of Justice responsible for advancing the practice of community policing by the nation's state, local, and tribal law enforcement agencies. The community policing philosophy promotes organizational strategies that support the systematic use of partnerships and problem-solving techniques to proactively address the immediate conditions that give rise to public safety issues such as crime, social disorder, and fear of crime. The COPS Office does its work principally by sharing information and awarding grants to law enforcement agencies around the United States to hire and train community policing professionals, acquire and deploy cutting-edge crime-fighting technologies, and develop and test innovative policing strategies. See **www.cops.usdoj.gov**.
- **SEARCH, The National Consortium for Justice Information and Statistics:** SEARCH offers technical assistance to local and state justice agencies to develop, manage, improve, acquire, and integrate their automated information systems. SEARCH not only works with individual justice agencies (such as a police department that is implementing a new records management system, or a court acquiring a new case management system), but also works with multidisciplinary groups of justice agencies to assist them in planning for and integrating their information systems at local, state, and regional levels. For more than 4 decades, SEARCH assistance programs have provided both on-site and in-house, no-cost technical assistance to justice agencies throughout the country. See **www.search.org**.

12. Ibid.

This *Issue Brief* is part of a series that SEARCH developed for the public safety/justice community in partnership with the U.S. Department of Justice, COPS Office.

Questions, comments, or feedback: Please contact SEARCH at www.search.org/about/contact/.

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