White Paper

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The impact of LTE on the LMR Industry

Introduction

One of the hottest topics in the Land Mobile Radio (LMR) industry today is the use of private Long Term Evolution (LTE). Although there is a plethora of information available regarding LTE and how it will affect the LMR industry, many questions remain unanswered. One of the most common questions that is being asked is: "Does the emergence of LTE mark the beginning of the end for traditional LMR Standards such as P25 and TETRA?" While, this is a difficult question to answer, most experts do not believe this to be the case. However, many believe that a profound transformation is going to happen, and everyone in the LMR community needs to understand what these changes may be.

This paper will delve into the LTE/LMR discussion and will present some facts so that readers can determine for themselves what impact LTE will have on them. Every segment of the LMR industry will be affected in some way, but exactly how much LTE will affect an individual or organization will depend on what that individual's or organization's roles are. For instance, frontline users; such as the firefighters and police officers on the streets will probably not care about LTE all that much. All they are concerned with is that whatever equipment they are given works reliably every time. It doesn't matter if the underlying technology is LTE, P25, TETRA, or analog. They just need a communications system that will be there when their safety is on the line.

LTE is well established in the consumer market, but enhancements to the standard to specifically address the needs of Public Safety/Critical Communications are required. The 3rd Generation Partnership Project (3GPP) is in charge of the LTE standards and has been working hard over the past several years to incorporate the necessary changes to the LTE standards to address the needs of the Public Safety community.

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The driving factor for adopting LTE in the LMR industry is the increased need for broadband data applications. For instance, many police departments are outfitting their officers with video cameras both for their safety and to document encounters in case there are questions or lawsuits that arise from an incident. Most of these devices can only record the events and cannot stream the video in real time. There is a strong desire for real time situational awareness, and an LTE enabled recording device can relay the live video stream back to a command center where commanders can maintain real time tactical situational awareness.

All of the leading LMR equipment manufacturers such as Motorola, Harris, Tait, Kenwood, Hytera, etc. have already embraced LTE. Many of these manufacturers have either already released or is about to release combined LTE/LMR solutions. With the rise in hybrid LTE/LMR devices, operators and maintainers will require test equipment to test both LTE and LMR equipment.

Why is there a demand for LTE?

Public safety professionals need a reliable broadband communications system to aid them in their life saving missions. Many tasks require broadband services such as when these first responders need to access data intensive applications, search databases, or share videos. Today, smartphones on cellular networks are much more powerful communications devices than the typical LMR systems used by the public safety community. There is a clear need for rugged, easy-to-use devices designed to meet public safety requirements and to provide advanced features and services that enhance their ability to do their jobs.

On February 22, 2012, the United States Congress created the First Responder Network Authority (FirstNet) with the "Middle Class Tax Relief and Job Creation Act", which allocated 20 MHz of 700 MHz spectrum and $7 billion US dollars to support the creation of a nationwide broadband network. The law mandates FirstNet to build, operate and maintain the first high-speed, nationwide wireless broadband network dedicated to public safety. The network must be an interoperable platform used for emergency and daily public safety communications.

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Enhanced data services is one of the main driving forces that makes LTE attractive for Public Safety. LTE technology enables very high-speed data communications that is not possible with current LMR technologies. LTE was designed to deliver high bandwidth mobile data which allows mobile devices to stream video or to transfer large amounts of data quickly. The three most influential public-safety organizations in the United States; the Association of Public-Safety Communications Officials (APCO), the National Emergency Number Association (NENA) and the National Public-Safety Telecommunications Council (NPSTC), have endorsed LTE as the technological standard for the FirstNet national broadband network for first responders.

LTE adoption is not limited to the United States. It is being adopted throughout the world as the technology of choice for nationwide broadband public safety networks. For instance, in the United Kingdom, the Emergency Services Mobile Communications Programme (ESMCP) is using LTE to as their next generation communication system for the 3 emergency services (police, fire and rescue, and ambulance) and other public safety users. In July 2014, the South Korean government adopted plans to build a nationwide LTE broadband public safety network to be deployed by 2017. The Australia government has also allocated spectrum for a nationwide broadband LTE public safety network.

3GPP Enhancements to LTE for Critical Communications

LTE networks currently deliver extremely fast data, but current voice services do not have all the features required for mission critical communications. As LTE technology evolves, it will include mission critical voice communications as well.

For the past several years, 3GPP has been working with LMR industry groups such as the Association of Public-Safety Communications Officials (APCO - P25), European Telecommunications Standards Institute (ETSI - TETRA), TETRA and Critical Communications Association (TCCA), US National Institute of Standards and Technology (NIST) to ensure broad representation on adding necessary features to support mission critical applications for the public safety community. Releases 12 [1][2] and 13 [3][4] of the 3GPP LTE specification adds significant features for true mission critical functionality.

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Release 12 is one of the biggest standards that 3GPP has ever released with a significant portion (about 70%) of the new features directly enhancing mission critical applications in one way or another. Two main features have been added to address public safety applications: Proximity Services and Group Call System Enablers. In addition, many new security features have been added to protect the system from unauthorized users, eavesdropping, denial of service attacks, and other security risks.

Proximity Services allow mobiles to identify other mobiles in physical proximity and enables optimized Direct Device-to-Device calls (one-to-one). Direct Device-to-Device calls allow first responders to communicate with each other even when the network is down or where no network exists. Direct communication means mobiles can connect without transiting via the network, which saves valuable network resources. The 3GPP definition of proximity services also includes some features that are exclusively for public safety applications. The feature "User equipment to network relay", allows one mobile to act as a relay for another and provides access to network services outside the normal network coverage area. Another feature, "User equipment to user equipment relay", allows one mobile to act as a relay point between two others and allows communication to take place without going via the network even if the communicating mobiles are out of range for direct communication.

Another important feature required for Public Safety/Critical Communications is Mission Critical Push-To-Talk (MCPTT), which is included in LTE Release 13 and was "frozen" by the 3GPP standards body in March of 2016 in Sweden. Mission Critical PTT is expected to have the features and functionality equivalent to current LMR systems. Commercially available products generally follow about two years after a standard is finalized, so the first systems with MCPTT may be available as early as 2018.

3GPP is continuing to adding more public safety features to LTE. Work has already started on LTE Release 14, which could define mission-critical video and data. Release 14 has a targeted completion date of June 2017.

Will LTE replace Traditional LMR Technologies?

The major LMR vendors are shifting their focus to LTE, but does that mean the end of innovation and support for LMR technologies? The consensus of industry experts is NO. LMR is not going to be replaced by LTE any time soon and all the venders will continue to innovate and support LMR technologies for the foreseeable future. There are many factors in favor of LMR staying relevant for a very long time. It is likely that LTE will augment instead of replace LMR for at least a decade or more.

The number one factor for LMR staying relevant is cost. Many LMR operators have just finished converting from analog systems to digital systems such as P25, TETRA, and DMR. P25 and TETRA have been around for over 20 years (P25 was introduced in 1989 and TETRA in 1995) and yet, many operators are just now transitioning over to a digital standard or are still running analog systems. A major reason for the slow adoption rate is cost. This will be the same for system owners considering LTE. The more likely scenario will be augmenting existing LMR voice systems with LTE for data services. In fact, in the initial roll out of FirstNet, LTE is considered to be a complementary enabler to public safety systems that will sit on top of existing LMR voice systems. In addition to the cost of new equipment and infrastructure, LTE requires much more bandwidth than narrow band LMR systems and the need for sufficient spectrum is a barrier for scalable deployments throughout the world.

Another import factor is the technical challenges installers, maintainers, and operators will face. One of the reasons LTE was selected as the technology of choice for broadband communications for the public safety sector is because it is the same technology being rolled out by commercial operators, so it should be well understood and easy to install, use, and maintain. However, keep in mind that LTE systems for Critical Communications have special features and requirements that the commercial networks don't have to worry about. The primary concern being that it needs to be much more reliable as lives are at stake. It also has to operate in conjunction with existing LMR networks which are often times in the same frequency bands. This can present challenging interference issues for system designers, installers, and maintainers. Other technical challenges include RF coverage and other system considerations. LMR handsets typically transmit with 3-5 Watts of power, whereas, an LTE handset may only be capable of transmitting with about 1 Watt. This translates directly into longer range for LMR systems. So, for an LTE network to provide the same coverage area as an LMR network, operators will need to install many more sites spaced closer together resulting in higher equipment and maintenance costs. Because of infrastructure costs, a broadband network at 700MHz will not be able to replace LMR in many locations across the US due to RF propagation properties and matching LTE to LMR coverage and reliability is just too cost prohibitive.

In areas where there is existing LTE infrastructure, you may question why there is a need to build a 2nd private network when the community already has an LTE network in place. The fundamental reasons is that although commercial LTE works, it is not built to mission critical standards of reliability. Another important consideration is that when there is a major incident, many civilians will get on the network and take up valuable network resources leaving no bandwidth for the public safety professionals. In a worst case scenario, the public may overwhelm the network and all communications will be lost. This has happened many times in large disasters. There is no way to give preemptive priority to public safety traffic so a dedicated private network for public safety is necessary.

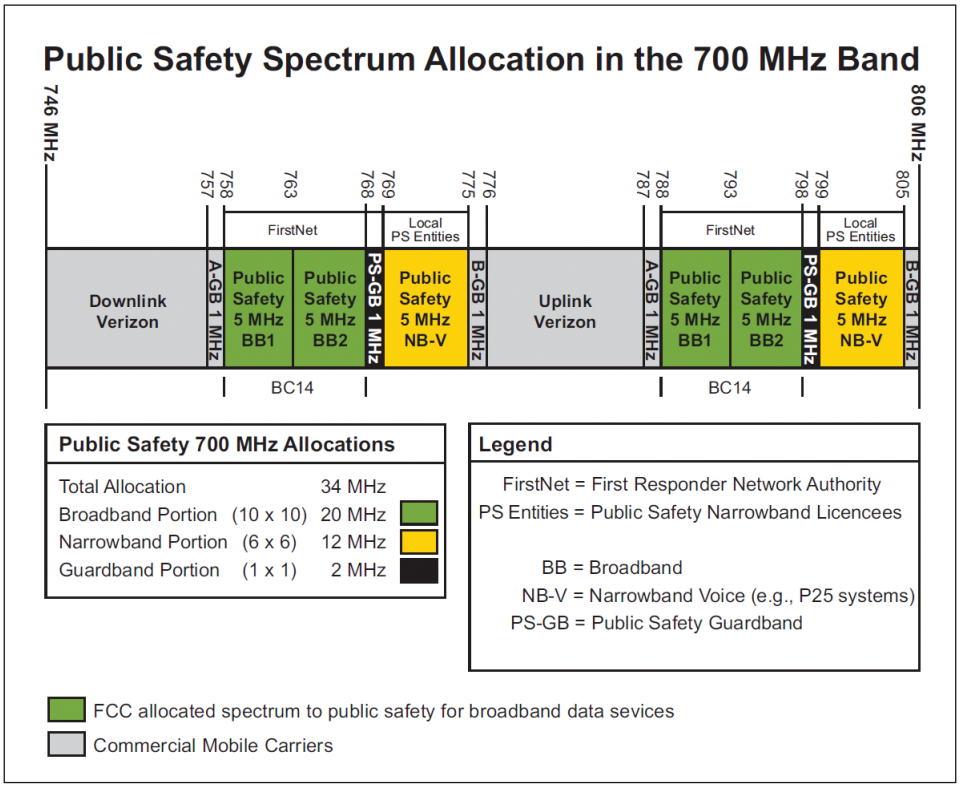
There are many questions and concerns by the end users about LTE that must be addressed before it is accepted. LMR systems are a known quantity and reliable voice communications is the number one requirement for any public safety system. Beyond reliability, one basic questions is how well will LTE be able to handle voice and data. These questions can only be answered with empirical evidence once actual systems are in operation.

It is very likely that it will be many years, maybe even a decade before the transition to LTE is made and it may never fully replace LMR. It may just converge into a new hybrid LTE/LMR technology.

Test Considerations

LMR and LTE are very different technologies and require different tools for testing and maintenance. LTE is definitely going to be used in the Public Safety/Critical Communications world. As previously discussed, it is more than likely that LTE and LMR systems will coexist for quite a while. Supporting two separate networks can become challenging both in terms of personnel requirements and test equipment requirements.

FirstNet public safety LTE in the United States will occupy two blocks of spectrum at 758-768 MHz and its duplex spectrum offset +30 MHz away at 788-798 MHz. These frequency bands are adjacent to public safety narrowband spectrum for LMR at 769-775 MHz and its duplex pair +30 MHz away at 799-805 MHz. A recent study conducted by the US Department of Homeland Security [5] suggests that LMR and LTE systems operating at the frequency bands above can coexist with proper engineering design practices and careful frequency management. Interference issues may still be of concern as the guard band between the LTE and LMR spectra are only 1 MHz wide.



FirstNet Spectrum Allocation in the 700 MHz band

Where both LTE and LMR systems are deployed along side of each other, maintainers now have to be proficient in two very different technologies. This means additional training for installers and maintainers or possibly even employing two separate crews, one dedicated to LTE and one to LMR.

LTE is a highly complex technology with its variable channel bandwidths and use of both MIMO and OFDMA to support high data rates. Both LTE and LMR systems have to contend with problems such as multipath and fading which degrades signal quality. Handheld test equipment that can deal with both the complexity of testing LTE networks and mapping bit error rate (BER) and modulation fidelity of LMR networks is critical to providing technicians and engineers that install and maintain public safety communications systems with confidence that these networks will work as expected. Such measurements often require a number of different tools, all of which must be carried into the field.

The Anritsu S412E LMR Master is the industry's first and only battery-powered LMR field analyzer capable of testing both broadband LTE and narrowband LMR. It accomplishes this by combining many of the tools needed to install, maintain and certify LTE and LMR systems into a single instrument with a single user interface. The S412E includes: a 2-port vector network analyzer (500 kHz to 1.6 GHz upgradable to 6 GHz), spectrum analyzer (9 kHz to 1.6 GHz upgradable to 6 GHz), LMR signal generator (500 kHz to 1.6 GHz), and internal power meter (10 MHz to 1.6 GHz). Users can also add optional features like an interference analyzer, coverage mapping (indoor and outdoor), and an internal GPS receiver. With such functionality, this compact, handheld multi-function analyzer significantly reduces the number of different tools technicians and engineers need to verify operation of wireless network infrastructure and to diagnose problems in the field.

For LTE networks, the LMR Master features a family of optional LTE measurement capabilities that can be used for FDD LTE test on the downlink. An RF quality analyzer can be used to make a range of RF measurements including channel spectrum (channel power and occupied bandwidth), reference signal power, and spectral emission mask. Understanding how the LTE resources are being utilized over time is critical; modulation displays such as Power vs. Resource Block are used to confirm signal level, utilization, and other critical parameters. The LMR Master also supports Over-the-Air (OTA) scanner measurements for measuring LTE DL coverage quality, including six sync power levels and dominance greater than 10 dB. The OTA scanner validates sectors present in a given location.

The Anritsu S412E LMR Master is the only solution on the market today that provides a quick, easy, and cost-effective means of verifying the operation of both narrowband LMR and broadband LTE networks, and when necessary, diagnosing problems.

Next-generation public safety communications will more than likely pair narrowband LMR networks for voice with broadband LTE networks for high speed data. Ensuring these networks are properly installed and maintained is critical to ensuring mission-critical public safety communication and keeping the public safe. The Anritsu S412E LMR Master is the only solution on the market today that provides a quick, easy, and cost-effective means of verifying the operation of both narrowband LMR and broadband LTE networks, and when necessary, diagnosing problems.

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