

The Compelling Case for Standards-Compliant Interworking

Catalyst Communications Technologies, Inc.

Tools to Migrate Gracefully to FIRSTNET™

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Introduction

FirstNet™, the first high-speed, nationwide wireless broadband network dedicated to public safety, promises improved capabilities for first responders. Under development through a partnership between the federal government and AT&T, it will offer the larger coverage footprint and increased data-carrying capacity of long-term evolution (LTE), which greatly exceeds that of current land mobile radio (LMR) systems.

With FirstNet™ comes the need for mission-critical push-to-talk (MCPTT) over LTE cellular networks. The migration from LMR to LTE will be gradual, however, necessitating push-to-talk (PTT) voice communications between the two systems for the foreseeable future. This type of interoperability between LMR and LTE networks, called “interworking,” requires new technologies to facilitate communications during emergency operations.

Critical for first responders is that *standards-compliant* interfaces on both the LMR and LTE sides be used to establish interworking. Protocols for LTE and other mobile telecommunications are developed by an international group of standards organizations under the umbrella of the 3rd Generation Partnership Project (3GPP). For LMR, the relevant standards interfaces for North America are within Project 25 (P25) and Digital Mobile Radio (DMR).

Products that offer PTT over cellular (PoC) technologies have been available to first responders for some time. As proprietary systems, these pre-MCPTT solutions are neither mission critical nor generally compatible with each other and the universal interoperability FirstNet™ promises. Despite their limitations, these products demonstrate that LTE and other broadband networks, including Wi-Fi and 5G, provide advantages over LMR systems.

This paper describes why interworking between LMR and LTE networks must be based on evolving standards developed for this purpose. It proposes a standards-compliant interworking solution to support users as they migrate their current LMR systems to FirstNet™ and other LTE networks. Catalyst Communications Technologies created its solution, Intellilink™, through research and development funded through the US Department of Homeland Security (DHS) Science and Technology Directorate (S&T).

The Problem with Proprietary Solutions

With any LTE-based solution targeted to the first responder community, existing LMR subscribers and users of new PTT solutions on LTE networks such as FirstNet™ must be able to communicate among each other effectively. This is vital both during the transition and for decades ahead because some agencies may never move to LTE.

After the FirstNet™ contract was awarded to AT&T in 2017, carriers with PoC technologies began to expand their products and marketing efforts towards the public safety sector. Some offer “enhanced” PTT (EPTT), most often using technology from Kodiak Networks. Others offer PTT solutions referred to as “over the top” (OTT), a technology that, unlike EPTT, operates as a

layer over the general mobile phone provider network, allowing communications between different carriers.

The primary issue with these products, which were not designed from-the-ground-up as mission-critical voice communications, is that EPTT solutions are not interoperable between different carrier networks or with OTT solutions. Both require that all users employ the same vendor's application. For example, a Harris BeOn PTT system can neither directly communicate with a Motorola Wave PTT system nor communicate with an ESChat OTT system.

Other issues with proprietary PoC products include the following:

- Lack of situational awareness tools – Most current products do not allow for integration with critical complementary tools critical for first responders, such as video and alarms from sensors that detect gas, flood water levels, motion, etc. Manufacturers of these tools would likely integrate with a single standards-based solution, but not with multiple proprietary ones.
- Lack of meta data – The rudimentary interface of some proposed LTE PTT networks merely passes the voice as baseband analog audio, which lacks critical meta data currently available with LMR networks. Such data include subscriber and group identification, emergency status, subscriber location, and other crucial attributes of the caller.
- Poor audio quality – Analog to digital conversions, as opposed to digital format end-to-end, degrade audio quality at a time when clear communications are imperative.
- Require Inter Sub-System Interface (ISSI) – Some products require use of the Project 25 (P25) standard ISSI to interact with LMR systems. While this interface overcomes many of the shortcomings cited above and provides additional high-level features, only a minority of organizations have deployed a P25 network and of these, only a handful have implemented the expensive ISSI interface. Of those with ISSI, licensing often limits the allowed capacity.
- Cost – Without products and components that can directly interoperate with other manufacturers, these products are not incentivized through competition to drive down costs, making their use more expensive than necessary.

Because of these issues, the international mobile communications standards community in 2018 designated MCPTT features and capabilities as a defined project for the 3GPP committees responsible for defining LTE and other mobile communications standards. In addition to 3GPP, US organizations including the Telecommunications Industry Association (TIA), the National Institute of Standards and Technology, NPSTC, the Alliance for Telecommunications Industry Standards (ATIS) and others began investigating a standards-compliant solution to interworking.

Aware of the limitations of current products, DHS S&T solicited proposals from vendors to research a standards-compliant interworking solution. Catalyst Communications Technologies, an industry leader in radio interface technology, was one of two vendors selected for this research. A companion white paper published in August 2019 from Catalyst, available at <https://www.catcomtec.com/download-interworking-white-paper/>, provides details of the research. The entire research report is available by contacting Catalyst at info@Catcomtec.com.

Standards-Compliant Interworking – Practical Applications

Consider a situation that requires mutual aid or other cross-organizational communications. When first responders from both organizations have standards-compliant MCPTT LTE devices, any emergency personnel can be added to the conversation and benefit from mission-critical communications with peers. Contrast that scenario with one in which the initial group of responders use standards-compliant devices while the other has non-standard PoC devices. The latter cannot be added to the conversation, potentially adding confusion and chaos to an already tense situation. If both groups use non-standard devices, the two can communicate only if they have the same proprietary PoC product.

Interworking between standards-compliant MCPTT PoC users and first responders equipped with LMR portable radios is also easier. Provided the LMR users are communicating on the same frequency as the requesting organization, communications between the two are automatically heard on that frequency.

With a standards compliant PoC solution, each department can increase efficiency by choosing the tools that best meet its operational needs. Moving some workers off the LMR system reduces loading on that system, eliminating bottle necks during critical events, and providing bandwidth for data applications to LMR devices.

Either natural or human-made disasters can disable even the most robust LMR systems. Cellular networks have demonstrated that, in many cases, alternative wireless communications platforms are valuable backups for LMR.

FirstNet™ and The Mandate for Standards-Compliant Interworking

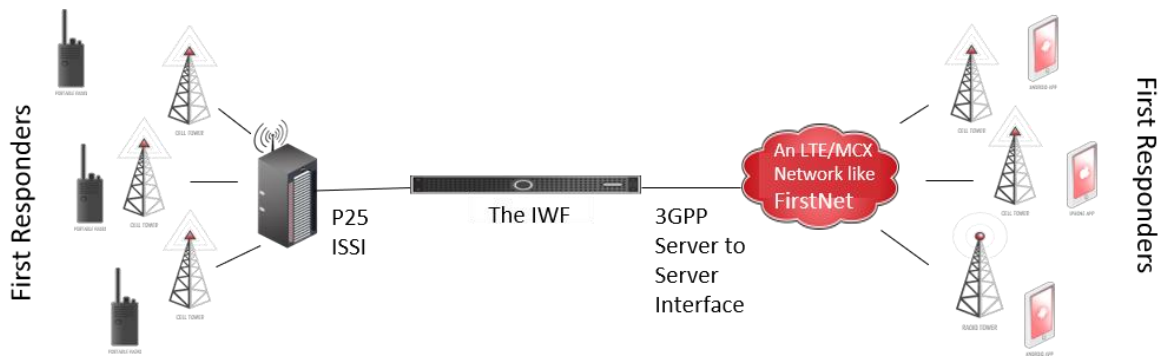
In contrast to the conditions under which current carrier-based PoC and OTT products were developed, AT&T is contractually obligated to provide standards-compliant interworking solutions between LMR and LTE networks. AT&T's initial roadmap of FirstNet™ focused on LTE's data transport capabilities, which support applications not feasible or highly constrained on LMR, such as video, data, location, presence, and others. The immediate feedback from first responders, however, was that voice communications were a higher priority. With that response, it became clear that interoperability between existing land mobile radio users and new users on the FirstNet™ LTE network would be required. The U.S. Department of Commerce, which oversees the FirstNet™ contract through the FirstNet Authority, has identified interworking as a key essential capability for the voice communications domain of the roadmap.

The Interworking Function

Initial 3GPP MCX definitions specify a comprehensive system-to-system interface between LMR and LTE, known as the interworking function (IWF). TIA and ATIS began work on standards for the North American LMR side of the IWF interface in 2012 through a joint project committee known as JLMRLTE. Standards for this part of the interface are related to P25

conventional, P25 trunking and TIA-603-based conventional analog frequency modulation (FM) service. The JLMRLTE’s work was put on hold in 2014 while 3GPP completed standards for the LTE side of MCPTT. Work on the project resumed in late 2017, and these 3GPP MCX standards documents were introduced in Release 15 and the work continues in Release 16. The initial focus of JLMRLTE and TIA is on the P25 ISSI to the radio system and a 3GPP MCX server-to-server interface to the LTE system, as shown in the diagram below.

The Catalyst position, determined through our research, is that the IWF in FirstNet™ is not only years away, but will also be cost-prohibitive for most organizations.



The interworking function interfaces to LMR through ISSI and to the LTE through the server-to-server interface.

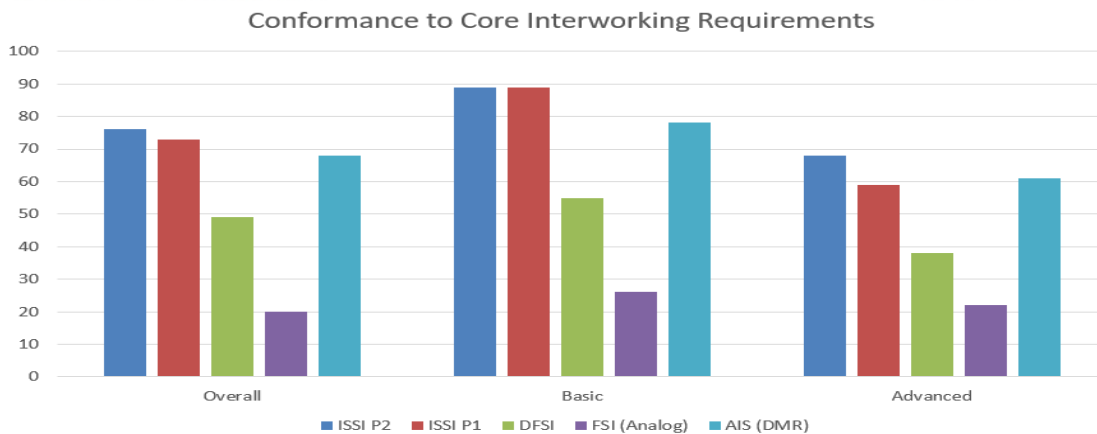
Catalyst’s Research

The DHS S&T Directorate asked Catalyst to determine whether existing standard interfaces would be sufficient for public safety interworking needs as documented in the National Public Safety Telecommunications Council (NPSTC) 2018 report titled “*Public Safety Land Mobile Radio (LMR) Interoperability with LTE Mission Critical Push to Talk.*”. Because the P25 Inter Subsystem Interface (ISSI) appeared to be a strong candidate for LMR to LTE communications, Catalyst examined P25, along with four other radio systems used by first responders, analyzing the conformance of each to the forty-six interworking requirements contained in NPSTC’s 2018 report.

In addition to confirming that a standards-compliant interworking solution was possible, Catalyst found that the type of radio system (P25 vs. digital mobile radio (DMR) vs. legacy trunked vs. analog, etc.) and the interface of that system dramatically impacted conformance. The diagram below illustrates the level of conformance for each system. Basic functionality includes group calls, emergency, user ID, the resolution of different audio codecs, late entry to a communication, and console support. Advanced functionality includes private calls, text messages, pre-emption, and location. Catalyst found the highest level of conformance in the Phase 2 P25 ISSI implementation to public safety’s requirements as documented in the NPSTC report.

Although technically robust, the P25 ISSI solution comes with serious constraints that limit its practical application. More than 70,000 police, fire, EMS and government organizations in the U.S. could potentially need interworking between their LMR networks and broadband networks like FirstNet™. The Project 25 Technology Interest Group estimates that only approximately 2,500 of these have implemented P25, and of those, very few ISSIs have been installed. The leading vendors of these systems charge thousands of dollars for the ISSI feature. Catalyst concluded that ISSI is therefore not an alternative for public safety organizations without a P25 radio system, and may be too expensive for many organizations that have P25 systems.

Your LMR System's Interworking Capabilities Will Differ From Others



Results from Catalyst research showed various levels of conformance to the NPSTC requirements.

Catalyst concluded that alternatives to the P25 ISSI interface were needed. We identified alternative standards-compliant interfaces in the P25 Common Air Interface (CAI) and DFSI as well as DMR's Application Interface Specification (AIS) and EIA Tone Control.

On the MCPTT side we identified an alternative standards-compliant interworking solution which uses the MCX *client interface* to deliver basic functionality between the two network systems sufficient for mission-critical first responder use. Catalyst was awarded a second contract from the S&T Directorate to develop an interworking prototype based on this model.

The Catalyst Solution

Catalyst has developed a product architecture and design that offers standards-compliant interworking between both MCPTT on broadband networks with P25 LMR networks and the vast majority of other public safety radio networks that are not P25.

The Catalyst solution implements technology at the LTE interface that mimics an MCPTT mobile phone. In contrast to the server-to-server interface envisioned for the IWF, use of the LTE client interface is a defined, mature standard today. Introduced in 2016 in 3GPP MCX Release 13, it has been used in LTE systems, including those deployed in South Korea, for many years. Compared to the server-to-server interface, it can be more easily implemented and managed, is much less expensive, and provides most of the capabilities needed by first responders.

Using the LTE client interface, interworking with a variety of LMR systems is possible. As our early research found, public safety grade interworking is highly effective for radio systems with some level of digital protocol control. Even conventional analog channels can be interworked with MCPTT, although the features will be severely limited.

Catalyst's IntelliLink™ interworking solution enables standards-compliant interworking for many radio interfaces, not just P25 ISSI. These include the P25 Digital Fixed Station Interface (DFS), P25 Common Air Interface, DMR Application Interface Specification (AIS), analog, and the proprietary interfaces of L3Harris EDACS™ and Kenwood's radio systems, including Nexedge™, LTR, and Fleetsync™.

Mission-Critical Interworking

In addition to compliance with standards, there are functional requirements for mission-critical communications between LMR and LTE users. PTT solutions that meet the 3GPP MCPTT standard are designed to also meet or exceed the performance of public-safety LMR standards. LMR users expect audio from an LTE MCPTT subscriber to be equal to or better than the audio from another LMR subscriber. Minimal delay, protection against lost syllables and words, meta data sent to dispatchers (and eventually between subscribers), and priority access to network resources are all critical.

The Catalyst approach meets each of these needs:

- Catalyst's technology protects against dropped syllables and hung channels. Especially for standards compliant radio networks, including P25, DMR, and certain proprietary radio systems with digital protocol control, including L3Harris and Kenwood, our technology is "aware" of the radio status and can, for example, buffer audio when the radio is busy and transmit only after a channel becomes available, preserving the entire communication stream.
- Catalyst's radio interface technology supports an array of LMR radio systems, not just P25 trunked systems with sufficient ISSI capacity.
- Catalyst's dispatch console (pictured below) includes the functions first responders expect, including Unit ID, Alias, and Emergency Indication. Establishing interworking between LMR and LTE talk groups is consistent with the way dispatchers currently establish LMR – LMR interoperability.

- For organizations with other dispatch console products, Catalyst provides a complementary, intuitive user interface for managing interworking.



The Catalyst dispatch console can be used to establish LMR LTE interworking.

The Compelling Case for Standards-Compliant Interworking

Nonstandard interworking solutions do not serve public safety organizations or the country. Government organizations need technology that is well understood and universally implemented, not unpublished, enigmatic approaches.

Until now, an acceptable standards-compliant interworking solution for LMR LTE public safety communications has not existed. Available proprietary PoC solutions have demonstrated the use of LTE and other broadband-based networks for first responders. However, they are not capable of interworking with LMR systems at the level emergency situations demand. They are generally incompatible with one another and often lack the meta data available on current LMR networks.

In contrast, MCPTT on public-safety-grade networks such as FirstNet™ are provisioned on networks that provide, or even exceed, the reliability and robustness of current first responder LMR networks. MCPTT provides meta data to subscribers and dispatchers consistent with advanced capabilities, including Unit ID, alias, and emergency indication, and can enhance these capabilities with new features, including location, presence, video, data, and others yet to-be developed. MCPTT is now a standard, and interworking between LMR and LTE networks is a necessity for mission-critical communications that align with the goals of FirstNet™ and other LTE networks.

Please contact Catalyst at 434-582-6146 or info@catcomtec.com for support with your specific interworking, dispatch, and interoperability needs.

Acronyms

3GPP	3 rd Generation Partnership Project
ATIS	Alliance for Telecommunications Industry Standards
DHS S&T	Department of Homeland Security Science and Technology (Directorate)
DMR	digital mobile radio
EPTT	enhanced push-to-talk
FM	frequency modulation
ISSI	Inter Subsystem Interface
IWF	the interworking function
JLMRLTE	a project committee jointly formed by the TIA and ATIS to develop standards for the land mobile radio side of the IWF
LMR	land mobile radio
LTE	Long-Term Evolution
MCPTT	mission-critical push-to-talk
MCVideo	mission-critical video
MCDData	mission-critical data
MCX	MCPTT, mission critical video (MCVideo), and mission critical data (MCDData), collectively
NPSTC	National Institute of Standards and Technology
OTT	over-the-top
P25	Project 25, a suite of standards for digital mobile radio communications designed for use by public safety organizations in North America
PoC	push-to-talk over cellular
PTT	push-to-talk
QoS	quality of service
TIA	Telecommunications Industry Association

