



FirstNet Interoperability Whitepaper

Interoperability Considerations between P25 and LTE Networks



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Introduction

Interoperability consistently ranks as one of the most important Public Safety communications issues year after year. It affects an agency's ability to efficiently respond to events, as well as protect personnel safety during joint response efforts. Public Safety entities, throughout the country, continue to wrestle with this issue to varying degrees of success. Now, with the emergence of FirstNet and Public Safety broadband communications on the horizon, new complexities will be added to the existing challenges that have plagued agencies for years.

These new systems have the potential to provide advanced capabilities that agencies have desired for some time and ultimately have the potential to provide new tools in addressing a single, interoperable solution for Public Safety users nationwide. However, these new networks will roll out over a period of time and bring levels of technical complexity that have never been experienced in the Public Safety arena. As agencies adopt this new technology, a key theme will be to continue a layered approach to interoperability challenges. As these new strides in technology will bring benefits, it will also only add complexity to current interoperability challenges.

Every year, high profile events demand high levels of communications interoperability, inclusive of natural disasters, mass shootings, or terrorist attacks. These events demand significant responses from multiple disparate agencies and require close coordination and support.

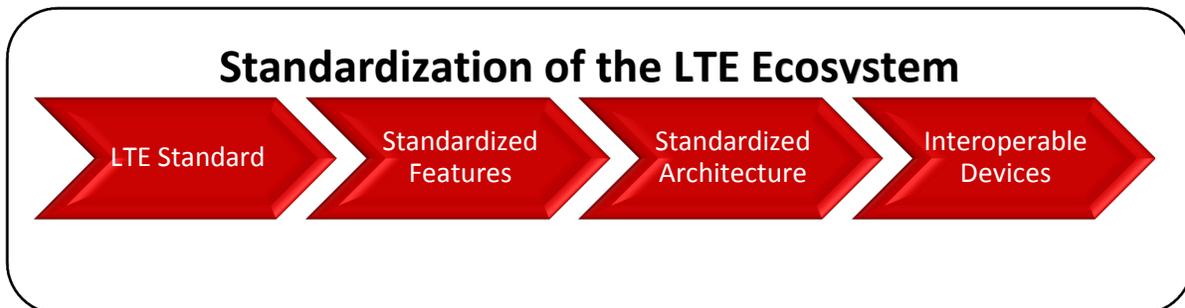
Over the past decades, a high degree of focus and effort has been made by Federal, State, and Local agencies, in partnership with industry to develop standards, and planning that enhance interoperable capabilities. Project 25 (P25) was a major step in moving toward a common standard that all agencies could utilize. P25's suite of standards, along with new developments in radio technology, have brought about the prevalence of multi-band radios that now allow for a single radio to communicate with a radio network across multiple bands, whether VHF, UHF, 700 and 800 MHz. This has allowed users to overcome the barriers that existed between systems that utilized differing bands, which previously required the use of inefficient methods such as multiple radios or bridging systems with shared coverage areas.

With the emergence of FirstNet and the forthcoming build-out of the National Public Safety Broadband Network (NPSBN), yet another new technology will be added to the mix that while only utilized for data applications at first, will ultimately need to interface to existing LMR networks to create a total comprehensive communications solution. The future capability to deliver mission critical voice over LTE will bring a significant new capability to agencies to provide an integrated voice and data network to a single subscriber device. Strategies for properly integrating these new networks with existing communications systems to properly complement, and in some cases, migrate, existing LMR networks, will be critical and involve additional levels of technical complexity, adding to an already thorny issue.

National Public Safety Broadband Network (NPSBN)

The Middle Class Tax Relief and Job Creation Act of 2012 created the First Responder Network Authority (FirstNet), an independent authority established within the National Telecommunications and Information Administration (NTIA). FirstNet is responsible for not only the management of the 700 MHz spectrum, but also for the planning, design, and build-out of the NPSBN. The needs of Federal, State, Local and Tribal Public Safety agencies are all being considered by the FirstNet board in an effort to address as many different needs and concerns of the user community as possible. After concluding a process of consulting with representatives in each region and state, Requests for Proposal will be issued for the deployment of the network in regions throughout the country. The states can choose to either accept (opt-in) or reject (opt-out) the build-out plan, though any state that decides to opt-out has 6 months to develop and complete its own procurement for a LTE RAN, and has to receive FCC approval of its plan.

By adopting LTE as a standard, the NPSBN will utilize existing commercial standards and adopt them for Public Safety. This has the potential to bring economies of scale when purchasing equipment and provide the opportunity for interoperating with commercial networks and partnering with existing network to extend capabilities. Taking this capability and adopting it for Public Safety will be a primary concern to the Public Safety user community. The regional and state outreach meetings that are being sponsored by FirstNet will serve as a forum to express needs and concerns that can be adapted into the final design. User groups will need to ensure their needs are presented to FirstNet in these forums so that the system can be designed to meet the unique needs of users in a given area.



The key objective of the NPSBN is to provide a single, interoperable broadband data network solution to Public Safety responders, at all levels of Government across the country, providing advanced capabilities via a hardened, secure infrastructure. During catastrophic events, such as the Boston Marathon bombings, the rapid exchange of video feeds from surveillance cameras, drones, or other aerial units, is critical to the apprehension of suspects. The NPSBN network has the potential to provide the means to manage and disseminate this information between Public Safety agencies at all levels.

P25 and LTE Interoperable Standards

P25's suite of standards for digital radio communications has been in use by Federal, State and Local public safety agencies since its creation in 1989. The Association of Public-Safety Communications Officials International (APCO) has driven the evolution and growth of this standard in an attempt to create single standard for Public Safety voice communications. P25 has formed the foundation for interoperable communications for LMR networks today. P25 has continued to evolve to include new features and capabilities, such as the Inter Sub-System Interface (ISSI), which provides connectivity of P25 and non-P25 networks for seamless interoperable operations.

In this same way as APCO has managed the P25 standard, the 3rd Generation Partnership Project (3GPP) has been responsible for the development of the LTE standard. As with P25, as new standards documents are developed, each manufacturer takes responsibility to produce equipment that meets this standard. Further, while these standards define the over the air interface, much of the high application level interfaces are not defined and are left to individual application standards (such as video or voice applications).

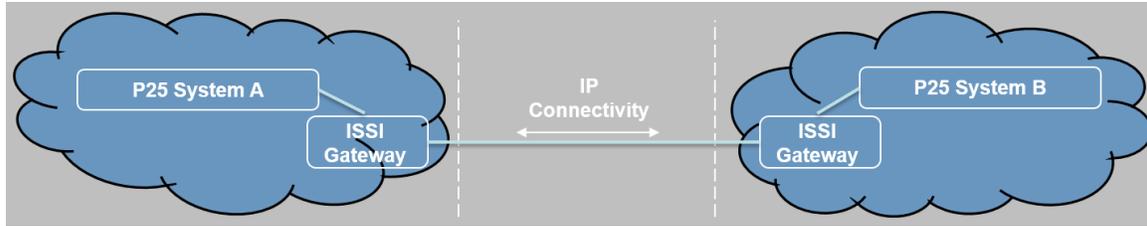
New standards for applications that would provide P25 Mission Critical Voice of LTE networks are still in development. So, while the goal of the FirstNet network would be to provide a consolidated voice and data network, it may be years before these services are reliably available over the NPSBN. Once NPSBN networks are providing enhanced Public Safety services, there will still be many legacy P25 LMR networks in use that will require interface for interoperability.

P25 Functionality Over LTE

Other standards governing other Public Safety functions over LTE are still being developed, such as group call and direct modes. It will be important to distinguish between Mission Critical Voice required by Public Safety and other voice services such as Voice Over LTE (VoLTE) that are being trialed and deployed by carriers in the future. Public Safety requires a functionality, responsiveness, reliability and survivability utilized in today's networks, through hardened infrastructure and facilities that is not required in standard carrier networks. These standards will need to address functionality, such as PTT group call, emergency call, PTT ID, encrypted and direct modes of operation. These features are of limited value to carriers and will need significant development to bring these capabilities to market for the Public Safety community. This will impact the vision of a single converged network transmitting both voice and data that could ultimately replace existing P25 networks.

The current P25 ISSI standard, which was developed to connect disparate P25 networks together, may provide one avenue for connections between LTE and P25 networks. Vendors are demonstrating the capability to place P25 calls from an LTE connected device to a P25 radio using an ISSI connection between systems. This illustrates the power of standards-based technology to connect these disparate networks together and will be a necessary tool as LTE networks and subscribers deploy to maintain connection with legacy P25 LMR networks. While this technology is showing the promise of connecting these disparate networks, it will be some time before standards development and widespread adoption occurs.

Interoperability Considerations Between P25 and LTE Networks



Even once standard protocols are in place and commercial product is available, many of the same challenges for connecting LMR networks arise in the LMR/LTE scenario:

- Do both networks have coverage in the area of operation?
- What units have the interoperable resources programmed?
- What is the security and approval protocols for users to access these resources?
- What are the protocols for dispatch in the mixed system scenario?

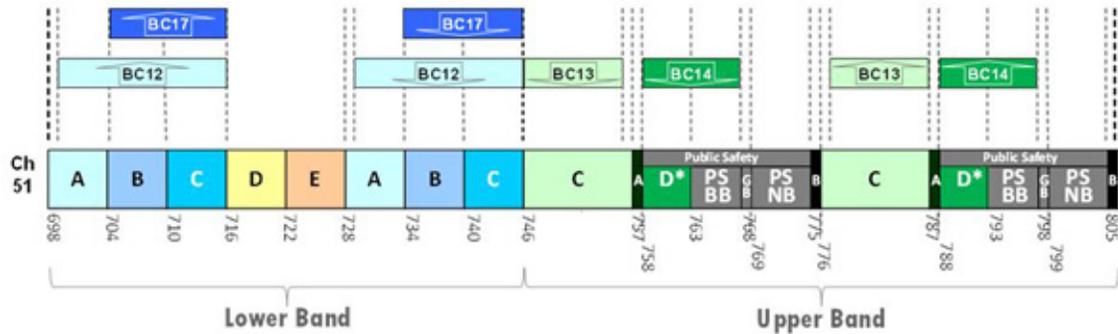
Many of the lessons learned from combining LMR networks addressing these and other issues will be carried forward to the hybrid LMR/LTE. As with many interoperable solutions, the operational and procedural issues can sometimes present more challenges than the technical issues and will need to be thoroughly planned out by agencies seeking to combine networks.

Spectrum Challenges

Public Safety users have constantly faced spectrum challenges both in the everyday usage of their systems as well as providing barriers to interoperability. Each of the differing bands (VHF, UHF, and 700/800 MHz) provides different operating characteristics that are appropriate to different user groups, but these varying bands create yet another barrier in addition to technological and operational barriers that also need to be overcome. This will also be true of FirstNet subscribers as the new network rolls out. Like the P25 standard, LTE stipulates a common protocol for over the air interoperability of devices, and similarly to P25, LTE can be implemented across a multitude of frequency bands, creating barriers to device interoperability.

The 3GPP standards group established 4 different band classes for LTE equipment operating at 700 MHz (FDD 12, 13, 14, and 17). The current spectrum allocation for Public Safety is in band FDD14, which also in the 700 MHz frequency band, but different from the spectrum used by Verizon Wireless (FDD13) and AT&T (FDD17). Device interoperability across carrier networks is a current challenge and source of debate among carriers and equipment manufacturers today.

700 MHz Band Plan & 3GPP Band Classes



The FCC’s National Broadband Plan recommends that "the FCC should explore other ways to encourage the deployment of public-safety devices that transmit across the entire broadband portion of the 700 MHz band (i.e., band 12, band 13, band 14 and band 17)." This would create a simpler ecosystem of devices for users, but presents technical challenges that are being debated and addressed by equipment manufacturers currently. These issues could mean that devices would only support a single carrier for roaming, locking users into a specific roaming agreement, additional device costs, or both.

This presents a challenge for potential users of FirstNet in that the NPSBN is not expected to attain the same levels of geographic coverage as the carrier networks, thus raising the potential need for roaming of these FDD 14 devices onto a carrier network. Users that need to travel through areas without NPSBN coverage would find themselves out of service without being able to roam on carrier networks, and the costs of maintaining a separate device purely for these scenarios would be prohibitive. Priority of Public Safety users roaming access to a carrier network must also be addressed. As subscriber equipment is produced by vendors, users will need to carefully research the spectrum capabilities of each device to determine suitability for their needs, including potential carrier roaming capabilities. Until these issues are fully addressed, users will not have the ability to roam onto a carrier network when outside of the NPSBN services area.

Connecting Networks Together

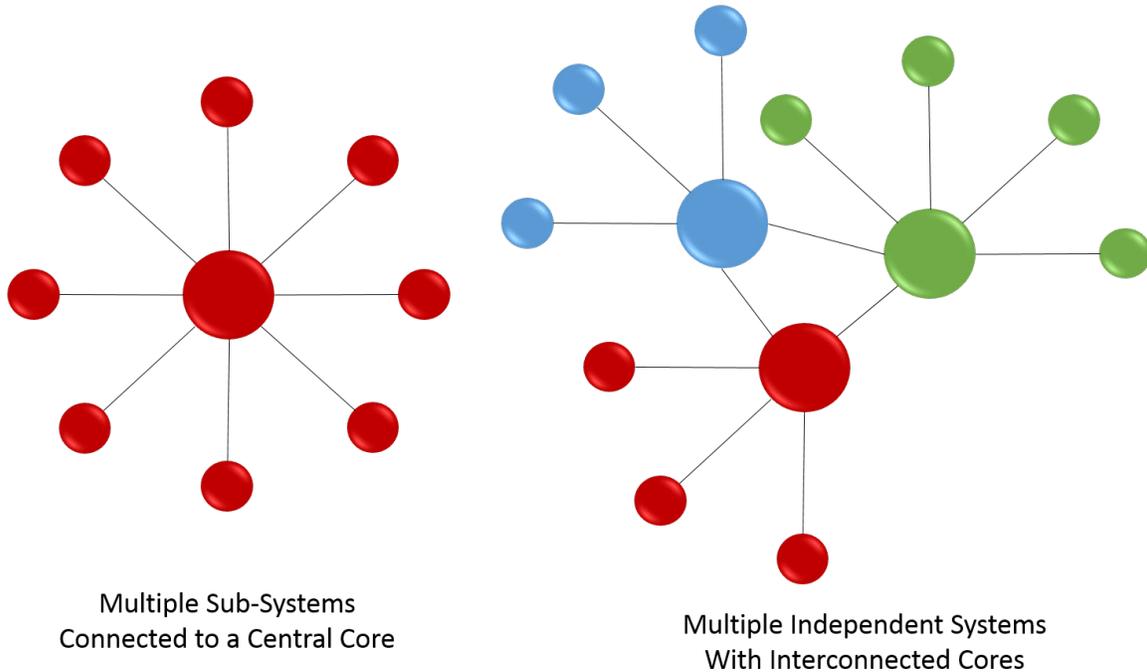
The “network of networks” has long been a goal of user groups to create a larger interoperable network, but technology, cost, and operational challenges have made this an ongoing challenge for agencies for years. There is clearly no “one size fits all” approach, and many different groups have to take different or a combination of multiple approaches to achieve the goal of connected networks within a given areas. This will hold true as FirstNet develops a plan for building out the network and addressing questions of centralized versus distributed architectures.

The centralized approach is a single network with a single network ID that in effect becomes a single service provider of wireless broadband to the Public Safety community at large. A user fee could be established to operate and maintain the network and the level of local control or administration of the network would be minimal, if any. Any roaming agreement with carrier

Interoperability Considerations Between P25 and LTE Networks

networks would be managed on a national basis with a single agreement that would cover all users of the NPSBN.

Among the challenges with this approach include the local input that can be critical for the network to meet the needs of different agencies across the country. Systems will need to be developed and deployed to provide a level of control to local agencies that have users operating on the NPSBN. The infrastructure vendors have limited capacity to incorporate such control currently. Ensuring that local agencies have the ability to manage local capacity, administrate users, and detect faults in the network are all critical issues that would need to be addressed in order for FirstNet to provide a satisfactory service to all agencies nationwide.



An alternate method would be a less homogeneous approach that would allow for state or regional networks that can be deployed and then interconnected allowing for roaming of subscribers from one network to the next. This would reflect a network where a number of states chose to opt-out and then built their own networks that were then connected to the NPSBN. The current waiver holder's networks could be incorporated in this fashion, thus preserving the work that has already been done as part of the BTOP grants, and yet still achieve the goal of networking all these systems together. This approach is not without its own challenges however, including:

- More network core sites than minimally necessary to run the network
- Additional equipment at these core sites to ensure roaming between networks
- Overlapping coverage between different networks
- Varying user fee structures between different networks
- Inconsistent software revisions between different networks
- Multiple roaming agreements with carriers between each network

These items would increase the overall cost of the network and increase operational complexities. Given the challenges involved, it will be imperative for each Public Safety agency to become involved at the state and/or region level to ensure that their individual needs are heard and that they are involved in the process for addressing these issues.

Planning and Operations

As with other interoperability challenges faced with voice networks, technology is only a piece of the solution. There is no substitute for careful planning and preparation, including coordination with all internal agencies and adjacent jurisdictions. As with the other facets of communications discussed in this paper, the NPSBN adds another layer of complexity to preparing for interoperability in a disaster scenario.

Statewide or Regional Interoperable Communications Plans provide the framework for interoperable communications by establishing the governance model for agencies and stakeholders, as well as identifying technologies and communications assets currently in place and projected as part of a future plan. Bringing the NPSBN into this document touches all these elements and thus requires any agency with an existing plan to perform a thorough review and analyze the impact. NPSBN Agreements between agencies will require negotiation, including all network access and resources, logistics, leasing, and licensing that will permit Public Safety users' seamless roaming capabilities to meet their mission objectives.

New stakeholders will be introduced into the process, including FirstNet and carriers whose networks will be involved in any roaming or interconnection agreements. Within agencies, CIOs and IT Directors may become involved in the deployment of a mobile broadband network that may not have been involved in LMR communications previously. These new stakeholders bring different approaches and agendas that will differ from traditional public safety approaches for LMR. It will be of great importance to identify these individuals and involve them in the planning process early on to incorporate all input and address as many concerns as possible with the plans.

It will be important to perform an accurate assessment of new technology assets available as part of any new broadband network and how it will pair with any existing systems. It is virtually impossible for the coverage footprints for each of the two systems to be the same, therefore it will be important to understand areas where one system may work and not the other, and what is the mitigation plan for addressing the lack of one or the other system in that area, should an incident occur. Site on Wheels (SoW) or Cell on Wheels (CoW) have provided a means to address this type of issue in the past, but now these deployable solutions will need to connect to at least two networks in order to provide full wide-area connectivity to both. These issues are surmountable and need to be identified early on and added to the current plan.

Summary

As the rollout of the NPSBN network gets underway, the Public Safety community moves one step closer to the goal of a single, nationwide network for critical communications. Even under the most optimistic of scenarios, we are years away from significant deployments of the new network, and potentially a decade or more before large areas may be completely deployed.

Interoperability Considerations Between P25 and LTE Networks

Though the deployment may be slow, there will be steadily larger pockets of coverage coming online across the country starting with the waiver holders and expanding as FirstNet begins deployment of the NPSBN. As these networks become available on a limited basis, it will be important to understand the issues that come into play and begin to communicate with stakeholders and potentially trial these new technologies and use cases to understand performance capabilities and limitations in the local setting.

All of this knowledge will need to be applied to modify current interoperability plans throughout the country to ensure that current levels of interoperability can be met between LTE and LMR users and also to take maximum advantage of the new capabilities that the NPSBN will provide. As has been the case in years past, interoperability remains a complex issue that can follow best practices but must have a level of customization to fit local needs. Adding new LTE networks into this mix will only serve to complicate this issue further by involving new technologies and stakeholders in the existing Public Safety community. Harmonizing these new elements with existing plans and capabilities, Public Safety users can make the most of a potentially powerful new tool that will increase capabilities, improve response, and save lives.