Keeping the Signal Strong: A Practical Guide to FirstNet-Ready Connectivity for Public Safety Vehicles and Buildings

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Introduction

The FirstNet public safety communications network has taken a long, winding road since its creation was first discussed nearly two decades ago. But this nationwide LTE-based network dedicated to first responders is finally becoming a reality, and that means big things for design engineers and other professionals who work on in-vehicle and in-building connectivity.

There has been dramatic forward momentum of FirstNet implementations over the past year that turns the traditional narrative about a nationwide public safety wireless network upside down. Yes, it has been seven years since Congress officially created the FirstNet initiative – by establishing the First Responder Network Authority involving federal, private, and public safety representatives to oversee the building, deployment, and operation of a nationwide public safety broadband network. And yes, it has been 15 years since the 9/11 Commission issued the initial recommendations to create a secure, resilient LTE-based public safety communications network that is separate from public cell networks. But those bureaucratic delays are in the rearview mirror because progress has been dramatic since AT&T was awarded the contract for the FirstNet network implementation in 2017.

The 25-year contract gave AT&T the ability to aggressively move forward with an ambitious implementation plan for the dedicated LTE network that delivered a single platform for all communications and coordination by agencies at the local, state, and federal levels. AT&T officially announced that FirstNet was “live” a year ago and, so far, 9,000 state and local first responder agencies across the U.S. have subscribed to the network. This report by Government Technology Magazine summarizes the momentum, which includes 750,000 connections of personnel and public safety systems to the network, with 150,000 of those coming in the summer of 2019 alone. Another clear sign of momentum highlighted in the report is the success AT&T has had in resolving the divide that had emerged between states that were fully signing on to the specifications and requirements of FirstNet vs. those that were “opting out” in order to go it alone with their own version of a public safety LTE network. That divide has disappeared over the past year as a result of negotiations between the federal government AT&T and states, leading to all 56 states and territories officially becoming part of the FirstNet network.
The road to FirstNet was longer than expected, but the progress over the past two years has suddenly made the original vision imminent. All of those wireless towers are only one part of the equation though. Those towers will not truly support first responders unless police officers, firefighters, EMTs, and other public safety professionals have the right connectivity to take advantage of the LTE network when and where they need it. That is where in-vehicle and in-building FirstNet connectivity comes into play. In order for FirstNet to work, public safety vehicles and buildings must both have FirstNet-ready connectivity that is upgraded in a significant way from what each typically has today:

• Public safety vehicles have connectivity today but it tends to be low-frequency VHF-based and UHF-based systems rather than higher-frequency LTE systems that are compatible with FirstNet. FirstNet will therefore require upgrades to hundreds of thousands of public safety vehicles in order to truly be FirstNet-ready.

• The vast majority of multi-family residential buildings (e.g., apartments), office buildings, and public buildings lack in-building wireless or have inadequate indoor signal boosting to provide adequate connectivity for first responders to communicate effectively once they are inside the building.

The importance of FirstNet-ready connectivity in vehicles and buildings becomes even more critical when you look at FirstNet’s five-year plan for the expansion of uses, cases, and technology. The wide-ranging strategic vision includes expanding network functionality, expanding support for rural areas, increasing specialized support for public events that include large numbers of attendees (e.g. sporting events, music festivals, etc.), and more. The strategic vision also calls for the use of an increasing number of “deployables” – portable cell infrastructure that can immediately bolster telecommunications in areas of acute need. Scenarios where deployables may be used include wildfires in remote areas and areas hit by natural disasters where the existing infrastructure is damaged or inadequate for the required level of communication. This planned expansion of FirstNet capabilities will allow the network to support first responders for even more emergencies. However, the effectiveness of these enhancements is dependent on the ability of public safety vehicles to serve as powerful communication hubs and for buildings to play the same role when enlisted as public safety operations centers to respond to emergency situations.

The success of FirstNet is therefore heavily dependent on upgrades to connectivity in first responder vehicles and a wide range of buildings. Momentum of FirstNet is going to drive the urgency of enhanced in-vehicle and in-building wireless connectivity simultaneously as municipalities and state agencies seek to ensure that investments in FirstNet networks are not in vain – by enabling reliable connectivity for first responders on route to emergencies and once they enter the buildings where response activities are conducted.

In turn, that pressure to ensure that vehicles and buildings are FirstNet-ready will fall squarely on the shoulders of design engineers who must quickly become effective in one of the hardest types of wireless implementations: high-frequency LTE antenna implementations in complex RF environments – which all patrol cars, apartment buildings, ambulances, office towers, and fire trucks represent.

The purpose of this white paper is to help you quickly become knowledgeable about FirstNet connectivity and simplify the complexity of LTE antenna implementation for public safety. As we discuss this topic, I offer a set of best practices that will help your in-vehicle and in-building FirstNet projects be successful as well as tips to avoid the most common missteps that could sidetrack these antenna projects.
Pressure Will Increase for Antenna Upgrades

I have included the numbers above not simply to bombard you with data, but because of each of those numbers is a leading indicator of the volume of demand (and aggressive deadlines) that will be driving a wave of FirstNet connectivity projects for design engineers this year and in 2020. All 56 states and territories are now officially on-board with FirstNet adoption, with 9,000 first responder agencies officially moving forward with FirstNet projects so far. But that is the tip of the iceberg. Tens of thousands of federal, state, county, municipal, and rural organizations nationwide will be moving forward with FirstNet initiatives to provide enhanced communications to millions of first responder employees and volunteers. This will drive an enormous volume of FirstNet connectivity implementations in the coming months and years.

This means a high number of antenna/connectivity upgrades in vehicles and in public and private buildings, driven by a combination of federal mandates, zoning mandates, fire code regulations, local directives, property owner decisions, and decisions within agencies across the spectrum of public safety. This combination of mandatory and self-directed upgrades will be a major driver for vehicle modifications and enhancements to indoor wireless systems. It would be one thing if these upgrades were simple “rip and replace” tasks using shrink-wrapped one-size-fits-all solutions, but FirstNet connectivity is complex. The performance of these antennas and gateways is highly influenced by the surface to which they are attached, the RF dynamics of the surfaces around them, and a number of other factors. Successfully upgrading vehicles and buildings with FirstNet-ready connectivity requires the right technology, but also the right strategy and tactics for ensuring that antennas and gateways perform as desired, particularly in the moments when they are most needed.

Here are a set of best practices to help your FirstNet connectivity projects succeed, as well as a set of caveats to help you avoid the kinds of missteps that could create obstacles:

Remember that FirstNet is More than Just LTE

LTE gets all of the attention because the FirstNet wireless network is based on the LTE standard, but it is critical to keep in mind that in-building antennas and in-vehicle FirstNet implementations must address the needs for a lot more than LTE. Police patrol cars and officers’ wearable technology are a perfect example of this. LTE provides the overall link to the FirstNet wireless tower, but the officer’s patrol car is a complex multi-band RF environment that must support connections for wearable Bluetooth technology, Wi-Fi for onboard computing systems, cell-based devices like smartphones and tablets, and a variety of other on-board wireless and wired sensors and systems. FirstNet antenna systems will often be required to not only serve as a multi-band hub for all of that equipment, but also operate in one of the most complex RF environments possible, with a cacophony of signals being reflected inside and outside of a vehicle made of metal surfaces that are notoriously unfriendly to wireless connectivity. The same need for antenna systems with multiple types of wireless technologies will exist in many buildings where upgrades may include not only support for the public safety wireless network, but also traditional cell connections and Wi-Fi access. When you combine those technologies in close proximity in indoor spaces with thick walls and many reflective surfaces, it can be an RF environment just as challenging as a patrol car or ambulance. The key for design engineers and wireless professionals is to discuss as early as possible the full range of wireless protocols that should be supported and to build steps into the process to determine how they will work effectively alongside one another in the environment where they will be deployed.
Do Not Forget about Legacy Technologies

This is a postscript to the discussion above, but worth calling out on its own. The FirstNet network is about moving forward on public safety communications, but many – if not most – first responder organizations may have older technologies and frequencies that they want to continue utilizing as part of their adoption of FirstNet. This means that new in-building and in-vehicle communication systems must co-exist and work with legacy technologies on current P25 Phase I and II public safety communication protocols to ensure a streamlined transition to a cellular NPSBN system. This means that backward compatibility is a key discussion topic to customize FirstNet projects for each customer; and the legacy technologies they wish to retain may have a dramatic impact on the requirements and complexity of the project.

Think Hard about Profile and the Implementation Phase

Antennas and gateways come in many shapes and sizes. Upgrading from existing in-vehicle and in-building wireless to FirstNet-ready connectivity may involve a change in the shape and profile of the installation that will be surprising to non-engineering stakeholders in the process. There may be the mistaken preconception that these upgrades will just mean “popping out” the old solution and “popping in” a new one that looks the same. Simple, right? Well, the reality is that multi-band, FirstNet-ready antenna systems might have a very different size and shape than what they are replacing. In the case of a public safety vehicle, for example, the higher-frequency FirstNet antenna may have a far lower profile than the prior lower-frequency antennas, but it may need a larger opening into the vehicle and leave prior openings unused. This may require taking steps to prevent water penetration in no-longer-needed ports and expanding the single port that will be utilized. This can incur costs and require installation expertise that should be discussed early in the planning process. Similarly, for in-building installations, the size and profile of an upgraded connectivity hub in the ceiling or in the wall may have very different RF dynamics that require a new location or changes to the existing location. This will require time and resources that should be discussed as early as possible to ensure that no surprises delay timelines or lead to unexpected costs.

Modeling Is a Must-Have, not a Nice-to-Have

Given the kind of urgency that will be behind many of these FirstNet connectivity projects, there may be a temptation to skip two critical steps in any RF-related project: modeling and testing. Modeling is critical because wireless technologies are so powerfully affected by where they are located, what wireless signals are nearby, what surfaces the signals will bounce off of or need to travel through, and how the connectivity will be used. Modeling is critical because wireless technologies are so powerfully affected by where they are located, what wireless signals are nearby, what surfaces the signals will bounce off of or need to travel through, and how the connectivity will be used.
the other end of it. And, if someone places something in front of the wireless router, the signal dynamics can change in noticeable ways. The same is true in vehicles and buildings; not conducting RF modeling often leads to issues with signal range and signal reliability. This is a mild annoyance when it comes to Wi-Fi for your tablet on the couch, but it’s far more serious for public safety vehicles responding to an emergency or firefighters entering a building to perform a rescue. There is a misconception that RF modeling is too time consuming to be practical, but the reality is that it almost always saves time and money because it prevents the need for emergency adjustments late in project implementations. With the right partner who has expertise in modeling processes, this kind of modeling can shorten project timelines and lead to far better performance.

Be Sure to Test PIM in Particular

Passive intermodulation (PIM) poses a common challenge in cellular systems: Nonlinearities in a wireless system’s mechanical components may generate interfering signals. When two signals mix together (amplitude modulation) they produce new, different signals within the same band, causing interference. If these new signals fall in an operator’s uplink band, they can elevate the noise floor and degrade system performance. PIM can occur in antenna elements, coax connectors, coax cable, and grounds. It is caused by rust, corrosion, loose connections, dirt, oxidation, and other contaminations, as well as loose cable hangers behind the antenna or the close proximity of metal structures, such as metal roof flashing. Careful antenna placement and installation can reduce or eliminate PIM, as can an understanding of mechanical tolerances, coaxial design details, and connector materials used in cable assemblies. You should therefore work with a testing partner that can specifically assess the impact of PIM and provide remediation that ensures that FirstNet connectivity performs as expected.

Think about Certification Early and Often

Certification for cellular technologies is complex because of all of the regulatory bodies and processes involved. There are certifications with the national regulatory bodies such as the FCC. Then there are certifications with telecommunications industry associations. And there are certifications with individual carriers. In the case of FirstNet, AT&T is the national carrier and their organizational certification process is a key step in FirstNet implementations. Certification is fastest and simplest when it is an early discussion topic in a design process. Rather than late in the process. One of the most common mistakes engineers make is to assume that components are certified, particularly when they are marketed for specific use cases.

One of the most common mistakes engineers make is to assume that components are certified, particularly when they are marketed for specific use cases. The safer route is to be rigorous in identifying products that are pre-certified and working with wireless partners who help you ensure that the certification process is painless and absent of surprises that are setbacks to your project timeline.

Create a Checklist for Your Gateway

Gateways and antennas for FirstNet implementation require multiple ports designed for a wide range of connectivity options to offer agencies more communication choices. However, many gateways may have a long list of ports and capabilities that appears to be complete but should be verified even if there is a “FirstNet-ready” sticker on the box. Gateways and antennas must support 10/100/1000 Ethernet, RS-232 serial ports, DHCP server connectivity, USB, and general-purpose digital inputs. FirstNet gateways should also include support for a wide range of frequencies and bands, including LTE, WCDMA, EV-DO/CDMA, GSM/ GPRS/EDGE, and LTE Band 14. For rural areas without strong cellular coverage, a gateway with onboard support for satellite service via Ethernet is ideal.

Choose the Right Connectivity Partner for FirstNet Projects

The stakes are high with FirstNet implementations. It helps to have the right partner who can make each step in the FirstNet processes simpler, faster, and more cost-effective. This begins with a partner who can ensure the success of your planning process and continues with the complex technical specification and product selection process. A partner that can manage a comprehensive testing process and ensure certification plays a major role in keeping projects on time and within budget. The risks are high with a go-it-alone approach if your organization does not have deep experience with complex RF projects. The risks are also high when working with a wireless company that does not have adequate experience and resources to be a true partner in the process.
In-Building Public Safety DAS Antennas

Laird Connectivity has launched two new models of In-Building Public Safety DAS antennas. The CFSA35606P and the CMS38606. The CFSA model is ultra-low profile with an easy to mount design, as well as aesthetically pleasing and neutral. Laird Connectivity’s proprietary tools encourage optimized performance ensuring reliability in the product. This model has a low-PIM, indoor wideband, omnidirectional low-profile ceiling mount antenna.

The CMS38606 works with the CFSA35606P model. The CMS model also has a ceiling mount design but is less aesthetically pleasing due to its enhanced omni-pattern. The two can be used in combination for wider and better coverage. They are also designed to provide pattern coverage requirements at 350-520, 500-960, 1350-1550, and 1690-6000 MHz for the UHF, 4G LTE, 2G/3G Cellular, UMTS/AWS-3, CBRS, and the Wi-Fi frequency bands.

Learn More >

Vehicular Antennas

Laird Connectivity offers two FirstNet-ready vehicular antennas. Gar and Barracuda are both low-profile, multi-port MIMO antennas. They provide an excellent solution for Public Safety, Transportation and Aftermarket Fleet applications. They are both designed for industry-leading reliability, enabling public safety vehicles to function as communication hubs, and are 5G ready. Their sleek, IP67 low profile aerodynamic housing gives them an aesthetically pleasing look.

Gar is a 5-port antenna that comes configured for 2-port MIMO operation over the 3G/4G/ISM/CRBS bands. It also has 2-port MIMO operation over the low/high frequency Wi-Fi bands. It also features the ability to enable GNSS global navigation services which includes GPS, GLONASS, Galileo, Beidou, and other regional systems.

Barracuda is a 6-port antenna with the same form factor and capabilities as Gar. However, it is built with an additional port for MIMO operation over the low/high frequency Wi-Fi bands. Learn More >
About the Author:

Ted Hebron is a Senior Product Manager for Laird Connectivity, which provides a full range of embedded wireless modules and other solutions that simplify the process of using wireless technology. In his role, Hebron leads development of Laird Connectivity’s FirstNet-related solutions, among other families of connectivity products. Hebron has 36 years of experience in RF design and antenna engineering utilizing a range of wireless technologies including cellular, radar, AM/FM and Television Broadcast connectivity, as well as several years in the low observables technology space. He has managed engineering teams in six Laird Connectivity operations centers around the globe and his work prior to Laird Connectivity includes positions at Boeing and Harris Broadcast. He earned his BSEE degree from the University of Kansas.

About Laird Connectivity:

Laird Connectivity simplifies the enablement of wireless technologies with market-leading wireless modules and antennas, integrated sensor and gateway platforms, and customer-specific wireless solutions. Our best-in-class support and comprehensive engineering services help reduce risk and improve time-to-market. When you need unmatched wireless performance to connect electronics with security and confidence, Laird Connectivity delivers — no matter what.

Learn more at lairdconnect.com.