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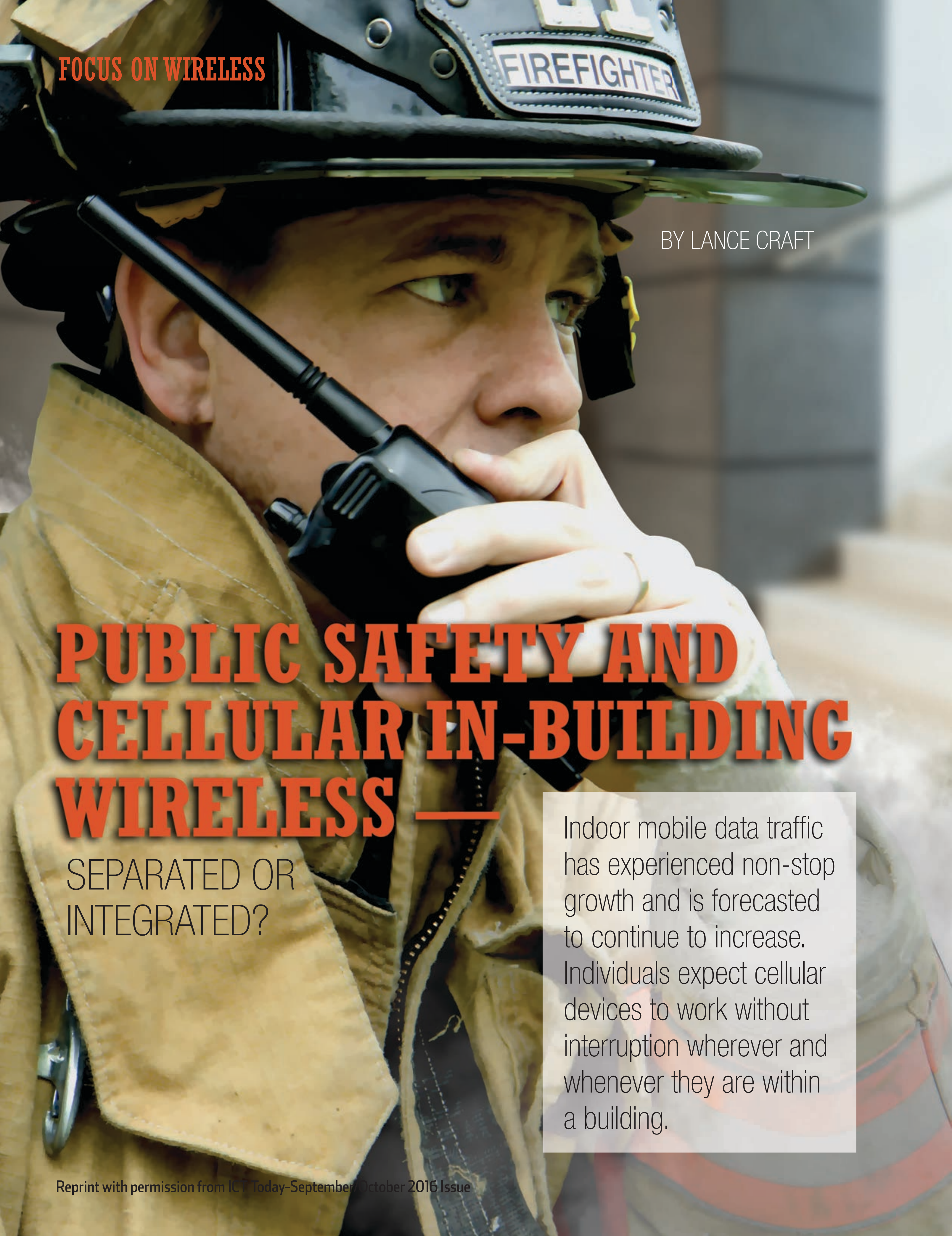


BY LANCE CRAFT

# PUBLIC SAFETY AND CELLULAR IN-BUILDING WIRELESS —

## SEPARATED OR INTEGRATED?

Indoor mobile data traffic has experienced non-stop growth and is forecasted to continue to increase. Individuals expect cellular devices to work without interruption wherever and whenever they are within a building.

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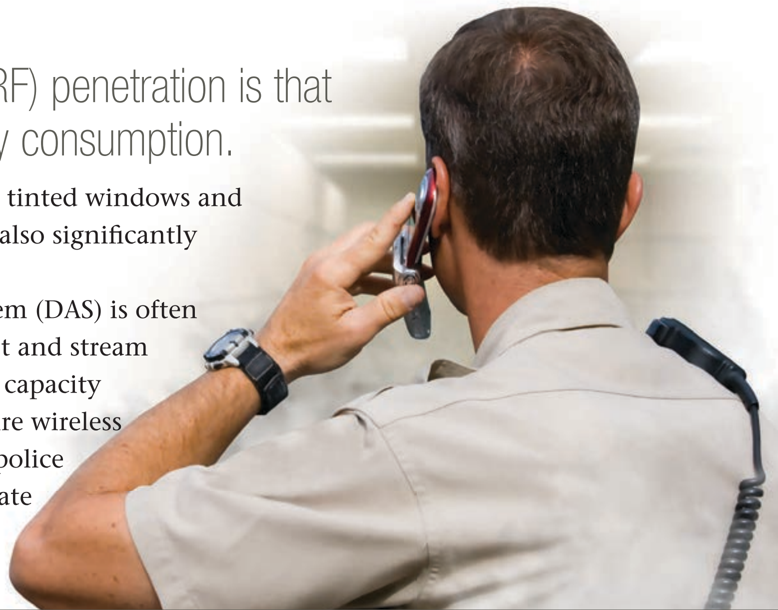
One of the reasons for poor radio frequency (RF) penetration is that new buildings are designed to minimize energy consumption.

These green buildings often incorporate additional insulation, tinted windows and other technologies that, while reducing energy consumption, also significantly attenuate in-building wireless signal penetration.

To help improve this situation, a distributed antenna system (DAS) is often installed to ensure that users can talk, text, browse the internet and stream videos without interruption. Not only is cellular coverage and capacity required; to add to the challenge, another group of users require wireless communications. Public safety personnel such as firefighters, police and other first responders depend on the ability to communicate to each other in the event of an emergency situation both for their own safety and the safety of the community they serve. New ordinances are being enacted throughout the United States that require dedicated first responder coverage. In many states, to obtain occupancy permits for new buildings, public safety coverage is required.



**Police officers, firefighters, paramedics and other public safety support personnel require a dedicated, clear and uninterrupted line of communicate to carry out time-sensitive tasks to keep the public safe.**

When exploring options to enhance their cellular networks and public safety networks, building owners and managers face several questions: Should public safety and commercial DAS be integrated? *Can* they be integrated? Or is it best to keep the two systems separated?

Both options are viable—public safety and cellular DAS can be integrated if necessary, or can be kept as two independent systems. Users must determine which option is most suitable for current needs and future requirements. Looking into the requirements of both cellular and public safety DAS will provide a better understanding of whether it is best to integrate these two systems.

## PUBLIC SAFETY FOCUS ON COVERAGE AND ACCESS

Emergency personnel's main priority is to handle time-sensitive and life-threatening tasks in the most efficient way possible. Clear, secure and uninterrupted access to communications throughout the entire building is vital. While regular mobile users are usually in public spaces and areas within the building, emergency personnel require access to areas in the building that are not commonly considered as primary coverage areas in a cellular DAS deployment. Concrete stairwells and utility rooms, for example, are frequently used in emergency situations by first responders, and they must be able to communicate while in these often overlooked spaces.

In addition, public safety in-building systems must comply with National Fire Protection Association (NFPA) and International Fire Code (IFC) requirements, as well as National Electrical Manufacturers Association® and IP66 enclosure requirements to stand up to harsh environ-ments. According to the NFPA, critical areas shall be provided with 99 percent floor area radio coverage and with a minimum inbound and outbound signal strength of -95 decibel-milliwatts, such as the fire command centers, fire pump rooms, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations and other areas deemed critical by the authority having jurisdiction, or AHJ. In addition, battery backup is also required under NFPA to ensure that first responders' communication won't be interrupted in the event of power failure. These requirements are based on current analog and P25 systems.

Besides quality of service (QoS), the availability of service is also one of the main requirements of the mission-critical communication system for emergency responders. The system cannot suffer loss of services due to single-point failures. Therefore, the in-building public safety distribution system should be designed and

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constructed with the required level of availability and survivability in mind.

In the event of a fire or water emergency or other unforeseen incidents, redundancy or fault tolerance is required to minimize the impact of component failure upon the operation of the whole system. If there is a failure point in the network, emergency personnel must still be able to communicate and continue to carry out their next steps. Having redundancy is particularly important for this reason. Common redundancy features include hot-standby equipment and secondary optical fiber links. Another important option is automatic equipment detection and switchover; when the remote detects a loss of signal, it automatically switches to the secondary optical link and standby equipment.

An additional feature to consider is redundant RF sources. One way to accomplish this is to share two off-air repeaters between two buildings and feed one of the off-air repeaters on one optical fiber path, and the other off-air repeater via a secondary path. To create diversity, the optical fiber paths should be separated either by using separate risers or by installing them on separate sides of the concrete service core of a building. The advantage of a concrete service core of a building over risers is survivability.

Having redundant sources shared between two buildings can cut costs significantly. With the redundant path and intelligent remotes with automatic equipment detection and switchover, at least one optical fiber path is always available. Therefore, if an incident disrupts any single floor, it will not interfere with the system as a whole.

Implementing a public safety system has many considerations. One common question is whether to implement an optical fiber-based system or an all-coaxial cable system. There are usually three factors involved in the decision: cost, size of deployment and redundancy. When cost is an over-riding factor, and when a venue is less than about 9,300 square meters (~100,000 square feet), usually an all-coaxial cable network is preferred.

However, if a redundant, resilient and survivable network is required, a digital optical fiber system is usually the preferred choice. This is because an all-coaxial cable system poses some design challenges including limited range, added system noise, limited topology options and physical plant consumption in multi-node deployments. In addition, to utilize a secondary building's off-air repeater as a redundant source, the distance between the two buildings can pose a major challenge with an all-coaxial cable system due to added noise over the cable run, which can degrade the communication between the first responders.

A properly designed redundant system avoids any interruption on the network and provides the optimal experience that public safety personnel require.

## THE INFLUENCE OF LTE AND FIRSTNET IN PUBLIC SAFETY

Public safety requirements are evolving to include improved methods by which emergency personnel communicate. Being able to transmit high-resolution imagery or real-time video footage, for example, would bring improvements in efficiencies and response time to further enhance methods to protect the public, and just as important, provide additional safety for first responders. For instance, those in dispatch centers who receive the real-time multimedia footage from front-line personnel would have more insight into what necessary steps should be taken to provide more timely and appropriate response and support.

Public safety agencies around the world are looking at the opportunity to leverage Long Term Evolution (LTE) technology for use in public safety communications. The evolution to broadband LTE-based public safety from the current narrowband systems such as P25 Phase I and II and TETRA will happen gradually.

In the United States, the First Responder Network Authority (FirstNet) was established and signed into law on February 22, 2012, to build, operate and maintain a high-speed, single interoperable wireless network, dedicated for public safety use for all states and territories within the United States[1]. FirstNet has been provided the spectrum and funding to do so; leaders of the effort are exploring ways to leverage the existing telecommunications infrastructure and are creating public and private partnerships to efficiently implement this network. Joint partnerships with other public safety organizations are providing support for this large undertaking to create a new and advanced nationwide wireless network providing public safety communication coverage[1].

FirstNet will build a new Band Class 14 network and use LTE to augment the current P25 Phase I and II public safety communication protocols. LTE, or 4G, in the commercial world is based on commercial wireless standards and was chosen as it is widely accepted and

| PUBLIC SAFETY REQUIREMENTS | COMMERCIAL REQUIREMENTS |
|---|---|
| Coverage | Capacity |
| Designed to accommodate everyone during incidents | Designed for specific Quality of Service (QoS) |
| 150, 450, 700, 800, 900 MHz | 700, 800, 850,1900, AWS, 2300, 2600 MHz |
| P25 Phase I & II, TETRA, LTE | 2G, 3G, 4G LTE, 5G, Wi-Fi |
| Comply with NFPA, IFC, NEMA 4X, IP65 | Generally less stringent requirements |
| Antenna placement for fault tolerance | Antenna placement to minimize interference |
| Battery backup | Battery backup |
| Security of data being transported | Security of data being transported |
| Redundancy/Fault Tolerant | |

**FIGURE 1:** Public safety and cellular in-building wireless requirements comparison (MHz = megahertz).

deployed in the United States. This will bring the benefits of lower costs, consumer-driven economies of scale, and rapid evolution of advanced communication capabilities[2].

The effort to provide nationwide communications for public safety will roll out by sending data, video, images and text. Following this, FirstNet plans to also carry location information and support streaming video[3].

## CAPACITY: THE MAIN FOCUS FOR CELLULAR IN-BUILDING WIRELESS

The cellular network is designed for specific QoS to ensure users have an optimal mobile experience. More than 85 percent of mobile traffic occurs indoors and the data traffic is not expected to slow down any time soon. Enterprises require more than just coverage for their users; capacity is also required to accommodate the increase in data consumption such as video streaming and internet surfing. To add to this complexity, mobile users are nomadic, and enterprises need a solution that can provide capacity where users are, when the users need it.

Oftentimes, commercial DAS deployment is planned with other surrounding buildings that have complementary traffic flow. For a convention center, for example, most of the daytime traffic is located in the building where a majority of the users are. In the evening, a majority of the traffic can be allocated to nearby hotels and restaurants to follow the density of users who have migrated locations. This so-called dynamic capacity allocation is used to maximize the usage of base-station resources to ensure that radio resources are consumed only when required and that none are wasted.

## PUBLIC SAFETY AND CELLULAR IN-BUILDING WIRELESS VARYING REQUIREMENTS

Public safety in-building wireless' main goal is to provide seamless coverage for public safety responders to carry out time-sensitive tasks during mission critical situations and is designed to accommodate everyone during incidents. On the other hand, cellular in-building wireless' main goal is to provide coverage and capacity for users whenever and wherever, so they can stream videos and browse the internet without interruption, providing optimal QoS. With cellular networks, re-sectorization of capacity often takes place to accommodate users.

Another difference between the two systems may be found in antenna placement, due to the frequencies utilized in public safety and cellular environments. What's more, antenna placement is designed for fault tolerance in public safety; for cellular, it is designed to minimize interference (Figure 1).

## INSTALLING A SEPARATED OR INTEGRATED SYSTEM

Due to the conflicting nature of cellular and public safety requirements, including the increased security requirement inherent in public safety installations and the different coverage and capacity requirements, it is recommended that they be implemented as separate systems if budget permits (Figure 2).

When these two systems are implemented separately, it is also recommended that they be installed in parallel if feasible. It is beneficial to lay cable for each system at the same time. This reduces ceiling and riser work, which, in turn, provides cost savings when it comes to installation.

## SEPARATED

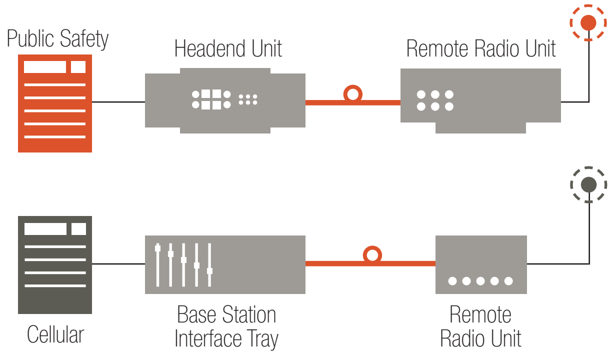


**FIGURE 2:** When these two systems are implemented separately, they should be installed in parallel if feasible. Laying cable for each system at the same time reduces ceiling and riser work.

## INTEGRATED

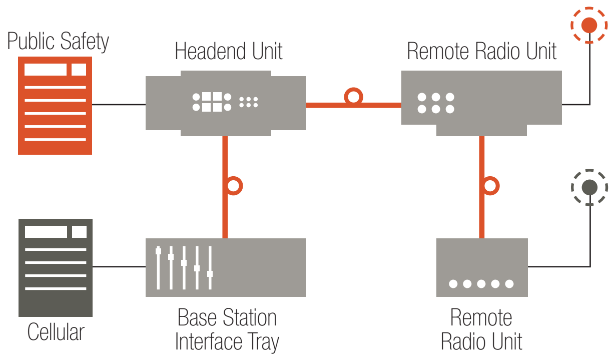


**FIGURE 3:** When designing an integrated system, the varying wavelengths from both public safety and cellular frequencies can be strategically designed to ensure that these RF signals are not competing or affecting each other negatively.

However, if enterprises want an integrated system, that is also possible (Figure 3). This is done by integrating the lower frequency public safety signals and cellular frequency bands in a single DAS infrastructure. When designing an integrated system, the varying wavelengths from both public safety and cellular frequencies can be strategically designed to ensure that these RF signals are not competing or affecting each other negatively. Interference can cause competing signals of the public safety and cellular networks and can cause dropped, distorted or lost communications. However, this can usually be avoided when installing a converged system.

Additionally, optical fiber, coaxial cabling and antenna infrastructure can all be shared and used between both cellular and public safety deployments. This can provide cost savings, which can be critical when budget is the key criteria.

## CONCLUSION

Whether users are in a hotel, hospital, stadium, airport or other venue, they expect to use their mobile device to talk, text, browse the internet and stream videos. If cellular coverage is weak or non-existent, user satisfaction can be dramatically influenced.

To add to the pressure on enterprises or facility owners, venues require not only cellular coverage and capacity but also public safety coverage. New ordinances being enacted throughout the United States require dedicated first responder coverage. During emergency situations, first responders depend on reliable coverage for their two-way radios to carry out time-sensitive tasks to help and protect the public.

As enterprises look for ways to handle the increasing number of mobile users on their network and to provide in-building public safety coverage for the first responders, they are searching for a solution which not only satisfies current requirements but can meet future requirements, as well. Enterprises want to ensure that the invested system is future-proof, without the need to be potentially replaced in the near future. Having a solution which can adapt to these rapidly evolving requirements is critical.

While seeking out the best way to improve the network, it is best to assess the full scope and goals of the desired improved network. Determining whether to integrate or separate cellular and public safety in-building wireless will depend on the goals, requirements and budget of the enterprise. ◀

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