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Private Mobile Networks - A New Service Option for Enterprise Wireless Connectivity

Understanding Enterprise Needs and Use Cases for Private LTE/5G Services

A Technical Paper prepared for SCTE•ISBE by

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1. Introduction

Just in the last few years, a multitude of new technologies and methodologies have emerged that are forcing cable telecom engineers to reevaluate their networking architectures and service offerings, particularly those targeting the enterprise. Whether it is 5G, the Internet of Things (IoT), low-power wireless protocols, open source hardware, or some combination of these new tools, there is little doubt that big changes are coming to wireless service offerings for Multi-Service Operators (MSOs) and cable operators of all kinds. The viable application of these technologies vary widely, and it is up to MSOs to sort near-term practicality from marketing vaporware.

One recent development that has immediate potential for MSOs is the decision earlier this year by the FCC to make the Citizens Broadband Radio Service (CBRS) spectrum band available for use by businesses. The net result is that MSOs/cable operators now have a new option for predictable mobility that can serve a variety of needs on mission-critical infrastructure for enterprises across a broad swath of industries, from outdoor campuses, to healthcare, manufacturing, logistics/transportation, higher education, and more. This new option is called a private mobile network and it is poised to change how MSOs view wireless networks in their environments.

2. What is a Private Mobile Network?

First, let's provide some background on what we mean by a private mobile network in the context of enterprises. We all know that enterprises heavily rely on wireless connectivity both indoors and outdoors, two different environments that present separate challenges for different types of wireless technologies. For the last two decades, "wireless" for the enterprise setting meant two things; Wi-Fi or a public cellular network.

The advent of private mobile networks is something new. They are very similar to the public cellular network that most of us use every day with our smartphones and tablets. They are built on technologies like LTE and 5G as the wireless protocols for connectivity, but the networks themselves are not owned and operated by wireless service providers like Verizon, AT&T, and others. A private mobile network is an LTE or 5G network that is owned and operated by a single organization and geographically bound by that company's property (like a smart factory, hospital, university campus, or shipyard). In the U.S. these networks use the CBRS spectrum band between 3.55-3.7Ghz and can be used by enterprises to give them their very own LTE or 5G network, but managed as easily as the Wi-Fi network.

So why add a new wireless option? First, a private mobile network based on CBRS spectrum operates within a dedicated and interference-free spectrum by FCC regulations in the United States. Not only does this significantly reduce the ongoing operational expenses and support costs, it makes a private mobile network ideal for applications that need to be up and running at all times. Solutions like IoT devices and systems need ultra-reliable connectivity in order to perform their core functions and, from a wireless perspective, private mobile networks are the only option capable of delivering on that requirement.

In addition to reliability, CBRS-based networks provide the type of latency that businesses need for both current systems and future applications. Even if based on LTE, a private mobile network can provide specific performance guarantees at an established Quality of Service (QoS). Today's networks deliver 20ms latency one-way. That latency will be even further reduced for private mobile networks based on 5G. This is a critical requirement for any type of factory automation task and for many Industrial IoT applications.

Another benefit of this new spectrum-based "traffic lane" is that it ensures the enterprise data traffic is kept local and separate from networks that may be used by guests or other personnel that do not need access to secure data. That built-in security can be a critical element for business and safety reasons, as well as a big reason that enterprises will avoid services leveraging public cellular networks delivered by the traditional wireless operators.

CBRS-based private mobile networks are also ideal for connectivity across outdoor settings such as university campuses, transportation yards, outdoor warehouse locations, or manufacturing site parking lots. With the ability to cover one million square feet of outdoor space with a single outdoor wireless access point (AP), a private mobile network significantly reduces the amount of outdoor cabling required to support a wireless network infrastructure - reducing a good chunk of an enterprise's capital expense and thus making a private mobile network service attractive.

Private mobile networks are an ideal extension of another new networking architecture that is quickly establishing itself in the enterprise sector - edge computing. As demands for low latency and computing intelligence increase, most IT network architects are looking for the means to place at least some of this functionality physically closer to applications themselves, thus making the "edge" of the network closer to the "action" so to speak. Analytics, information applications, business processes and other functions will likely still reside in the cloud or in an onsite data center, but private mobile networks can extend operational technologies and thus the network edge to the enterprise for security applications, computer vision apps, system automation, delivering predictable communications for guided vehicles, and guaranteeing reliable voice communications for staff.

3. Determining Enterprise Needs and Technical Requirements

In evaluating the enterprise market for private mobile network services, it's clear that there are businesses that do NOT yet need a private mobile network. If they are not pushing the limits of their current wireless network or if they are not looking at business process automation or the Industrial IoT, it's possible they do not have a need for this technology yet.

However, based on the demand we're seeing here at Celona, there are definitely many horizontal service applications for private mobile networks that are being currently evaluated, so let's discuss what MSOs need to consider when implementing services based on this technology. There will likely be many different ways of providing private mobile networks, each depending on the specific needs of the organization's IT department. Some groups will want to have this supplied to them and managed by a third party, like an MSO, wireless operator, or channel partner. Others may wish to simply purchase an end-to-end system and install and manage it themselves.

Regardless of the go-to-market model, in order for private mobile networks to truly fulfill their potential for the enterprise, they need to evolve their basic architectures to leverage the devices and apps that are primarily used "at work" and integrate with existing device and network-level access policies and provide enterprise IT full ownership of data, analytics and insights. Such an architecture would be tightly integrated to the existing enterprise network underlay and deployed as fast as you would deploy an enterprise Wi-Fi solution today with the primary goal of serving apps that demand guaranteed service levels. With a flexible IT-friendly approach, managed private mobile networks can enable custom implementations across islands within the enterprise: on the road, across remote sites, at the branch locations and within the campus - indoors and outdoors. By making such a solution IT-friendly, MSOs can ensure their offering will stand out compared to those from a telecom-oriented background (such as a wireless operator).

One of the biggest issues is figuring out the total number of indoor and outdoor CBRS LTE access points (AP), an enterprise might need at a facility given size, geo-location, density and performance requirements. Let's look at one scenario for an indoor factory and what would be required for establishing total network coverage, but also then designing that network to provide maximum capacity as well.

With the ability to cover 1M SQFT of outdoor space with a single outdoor wireless AP, a private mobile network significantly reduces the amount of outdoor cabling required to support a wireless network infrastructure - reducing a good chunk of your capital expense.

Additionally, if you are designing for coverage, CBRS spectrum availability does not impact the number of APs required in the network. In standard mode of operation, since all traffic flows in the download and upload direction to an LTE radio is scheduled by the infrastructure, even a single channel of 10MHz across all APs will work. If you are designing for network capacity, as you move from the maximum possible 150MHz of CBRS spectrum availability across the entire network to 80MHz - which happens to be the worst case scenario for any environment in the United States - you are looking at about only 10-15% increase in the total AP count in a given enterprise network.

If we consider an indoor facility size about one million square feet, there is a reasonable chance most facilities this size will have around 2500 devices (give or take a few dozen) activity simultaneously. In this scenario, we would require around 43 APs to ensure highly-reliable coverage of the entire facility. If you're designing for capacity, we've included a chart below that details what kind of infrastructure will be needed, assuming a download capacity of 3 Mbps and an uploaded capacity of 1 Mbps.

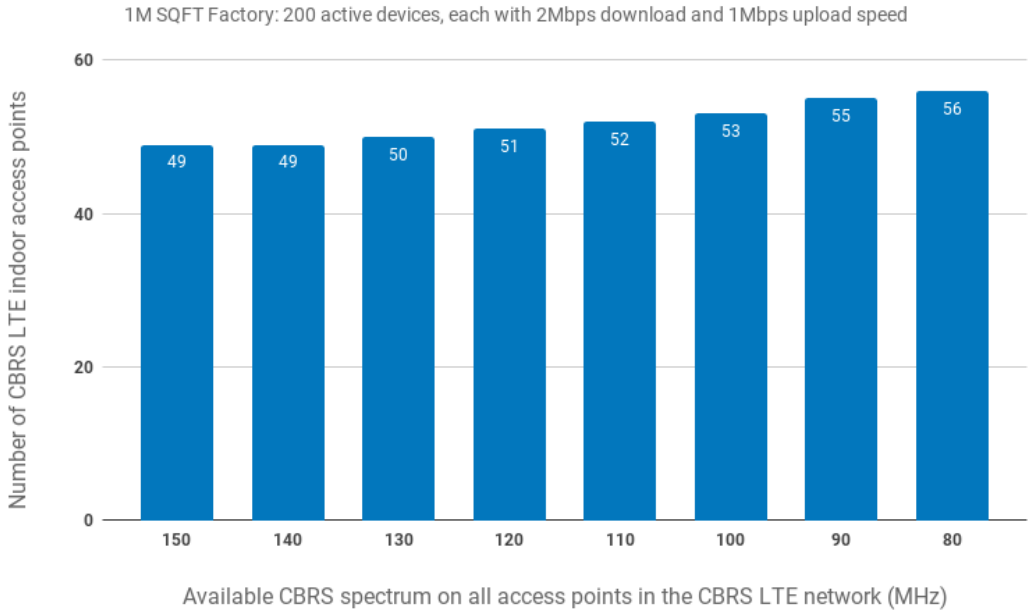

Figure 1 - CBRS LTE Network Design Tool

As you can see, the design scenarios for enterprises to implement private mobile networks are already well-defined and available. If you find this type of tool useful, Celona's network planner available at

https://planner.celona.io. There are others that would give you the ability to compare and contrast multiple solutions from different vendors, as any reasonable purchaser would need.

4. Use Cases

Now that we've established enterprise design requirements and general applications, let's take a closer look at specific vertical market use cases for private mobile networks.

4.1. Supply Chain and Logistics

The need for mobility for this industry is real with supply chain facilities going through significant changes in layout and product placement across aisles on an hourly basis. With its ability to "hold onto" the signal in challenging environments, a CBRS-capable device can support a new set of applications that require real-time response from the network. For instance, leveraging computer vision to automatically and wirelessly identify fleet vehicles as they enter and depart warehouse facilities for the purposes of inventory tracking and fleet management.

From my own personal experience, we are working with a major global supply chain firm that requires connectivity within a large, outdoor railyard. Using the public cellular network was not an option since this organization does not want their sensitive private data traveling across the operator network. Implementing a private mobile network - in this case based on LTE - the firm is planning to blanket the area with reliable wireless connectivity for video applications without breaking the bank.

The rise of private mobile networks are an inevitability for supply chain firms, but there will likely be many different ways of implementing them, depending on the specific needs of the supply chain management IT department. A solid percentage of these organizations will want to have this supplied to them and managed by a third party, including MSOs. The opening of the CBRS spectrum in the United States - with many variations of it on the horizon across different countries - has made private mobile network services for this market segment a real opportunity for many years to come.

4.2. Healthcare

Private mobile networks based on LTE and eventually 5G represent an entirely novel means of healthcare IT professionals delivering the predictable performance that modern medical facilities require in wireless communications. With security, privacy and reliability as core tenants, CBRS based LTE is available today to meet the connectivity needs for iOS and Android devices operated by the clinical staff.

As a result, healthcare institutions, including hospitals, clinics, campuses and even testing centers are actively evaluating private mobile networks as a potential solution for their wireless needs. The current pandemic has also uncovered new use cases that would require the deployment of private mobile networks using LTE or 5G in order to augment their existing wireless connectivity options. Beyond general enterprise connectivity, private LTE/5G opens the door to supporting mission-critical applications deployed via enterprise-owned devices on their own clean and dedicated lane of wireless communication. Thanks to CBRS spectrum availability in the United States via FCC's recent commercialization of the 3.5-3.7GHz spectrum, private mobile networks can enable critical mobile connectivity indoors and outdoors across hospitals, newly constructed make-shift healthcare treatment locations, and drive-through testing centers.

A typical drive through testing center like the one at 945 Sansom St. in Philadelphia covers an area of approximately 60,000 sq feet, which can be covered with a private LTE network of just 3 access

points. Due to its strong rate vs range performance, deployment and management of the radio infrastructure can also be accelerated. Private mobile networks, by design and per standard, come with configuration of service level objectives: latency, throughout, packet error rate and jitter metrics can be pre-defined against a given set of mission critical devices and/or applications – making sure that what's most important is protected.

4.3. Manufacturing

The manufacturing market segment often has connectivity needs similar to transportation and supply chain organizations, as both share large swaths of "non-carpeted" and outdoor facilities that require connectivity. These include vehicle-mounted devices, as well as other "ruggedized" devices including smartphones and tablets carried by staff. These devices require inference-free operation, so dedicated spectrum for devices from Samsung, Zebra, and Getac can be critical. In a factory setting, this may also include automated guided vehicles carrying out mission-critical tasks for which other solutions may not be reliable enough.

Manufacturers may also evaluate private LTE and private 5G networks for latency-sensitive operations that may include predictive maintenance and factory automation. These applications are often running non-stop twenty-four hours a day while simultaneously requiring real-time connectivity and response, making them ideal for the reliability and low-latency provided by 5G and LTE.

Many manufacturers are also evaluating private mobile networks for applications that include video surveillance for security. These video applications could also extend to computer vision cameras for inventory and other "parking lot" technology that might be utilized outside the manufacturing plant.

Finally, many manufacturers require interference-free connectivity for executive staff mobile devices and dedicated spectrum for new product lines that are currently under research & development that, due to their experimental nature, cannot be part of the existing Wi-Fi network.

4.4. Higher Education

Institutions of higher education have a unique set of needs that set them apart from standard enterprises when it comes to network architectures. Large amounts of outdoor areas, 24/7 operation of computer labs and research facilities, a high reliance on voice communications between staff members, and municipal-like requirements for parking lots, emergency response systems and video surveillance. These use cases combine to create multiple challenges for predictable performance for wireless networking - especially when the student Wi-Fi is the most important application for many and cannot be interrupted at any time.

Up until recently, higher education IT departments had two choices for outdoor wireless - Wi-Fi or public cellular networks. The FCC's recent decision to make the CBRS spectrum available for use in private mobile networks has now provided a novel solution for outdoors for critical infrastructure connectivity - university's very own LTE and 5G wireless infrastructure.

Given the coverage patterns of a CBRS LTE access point that reach up to million square feet, IT departments in higher ed can extend critical infrastructure connectivity across the campus without breaking the bank by digging up campus parking lots and other property to lay more fiber. Some of the outdoor use cases that our university customers are evaluating include public safety cameras, emergency phones, Internet backhaul for shuttle buses, outdoor lighting controls and monitoring solutions. Indoor use cases include everything from lighting controls and door locks to vending machines and panic buttons.

A big point for the higher education is that these IT departments want to extend reach to areas where Wi-Fi is not a fit and to keep Wi-Fi spectrum open for users and saving private LTE or 5G for infrastructure.

5. Conclusion

The bottom line is that private mobile networks offer a robust solution for multiple near-term enterprise needs. In an era in which we are assailed with far-off applications and nice-to-have functionality, private mobile networks deliver real performance with practical value today. If you're an MSO reading this now, I can also tell you that I am actively engaged with many of your likely competitors – from wireless operators to cloud service providers - as they are carefully evaluating different solutions from the multiple vendors in this market segment. What's clear is that for the enterprise, private LTE and 5G networks are going to be a critical option for enterprise connectivity going forward. If you plan on serving this market segment, you owe it to yourself to learn more.

Abbreviations

AP	access point
CBRS	Citizens Broadband Radio Service
IoT	Internet of Things
MSO	Multi-Service Operator