WHITE PAPER / **UTILITY-GRADE PRIVATE LTE**

OVERCOMING PRIVATE LTE HURDLES: SETTING A STANDARD AND PICKING SPECTRUM

BY Nick Mozer

Facing rapid changes in generation, transmission and distribution of electricity, utilities are contemplating how the deployment of private wireless long-term-evolution (PLTE) communications infrastructure can improve monitoring and control of critical systems that make up the grid.

By building standards-based private networks in an approved spectrum band, utilities can achieve cost certainty and better control over an ever-expanding and increasingly diverse network of critical assets at the far reaches of their system.

Telecommunications carriers are facing a technology revolution that disrupts longstanding business models and pushes them toward continual upgrade cycles just to keep up with customer expectations. The transition to 5G wireless broadband is just one example of the ever-changing nature of the evolving landscape. As public telecom carriers upgrade and push the limits of their networks, utilities are sometimes caught in the forward momentum, rushed into upgrades and early life cycle replacement of communications gear.

As the carriers rapidly build out their networks and retire their legacy assets, utilities are seeking opportunities to gain better forecasting and price certainty of devices deployed on these carriers' infrastructure. With some utilities presently managing over 500 truck rolls per month to install new cellular devices in the grid, the need for a long-term wireless strategy is clear. Considering PLTE makes the equation for life-cycle costs more predictable and introduces a new level of control to the balance sheet.

LTE is the wireless standard commonly associated with "4G" or "5G" wireless communications. This worldwide standard has been developed by the cellular industry consortium called the 3rd Generation Partnership Project (3GPP). This "long-term evolution" technology is indeed exemplary of its name and continues to evolve. Improvements on the technology to increase speeds, lower latency, improve spectrum utilization and capacity, as well as increase security, are constantly being made to support the vast device ecosystem.

As the push toward utilizing LTE technology moves into the private sector, more and more spectrum is being allocated for the LTE bands. As utilities have long asked for special spectrum allocations, the Federal Communications Commission (FCC) has made clear that it will not allocate spectrum for any specific industry but will allow new allocations to go into the open market. In

the first half of 2020, the FCC approved re-banding 6 MHz of the 900 MHz narrowband spectrum for broadband private LTE communications. This ruling, along with the Citizens Band Radio Service (CBRS) auction, has sparked increased interest from utilities that until recently had limited spectrum options.

DIVERGING PRIORITIES DRIVING THE MOVE TO LTE

The communications infrastructure overlaid on the power delivery infrastructure is a key component to providing reliable electric service. Therefore, reliability of grid communications coincides with delivering reliable electric power. Historically, utilities have had to rely on public carriers for many last-mile communications needs. It was simply too expensive to build out that last-mile infrastructure for a single use case. As consumer demand for streaming, virtual reality gaming and other services that require enormous bandwidth has increased, the public carriers have shifted focus to align with customer demand for higher capacity. They are moving away quickly from the low-bandwidth, highly reliable circuits utilities need toward next-generation wireless services available to tens of millions of customers. Utilities are left with a daunting choice: to keep up with the public carrier refresh cycles while fighting public carrier diverging priorities for the ordinary consumer market or to gain control by building out their own networks.

Though carrier 5G service offers the potential for ultra-fast speeds and low latency, utility network planners are becoming increasingly concerned they will not receive priority from the carriers when issues arise. This lack of priority and ability to manage repairs after a natural disaster continues to accentuate the need for utility private networks.

Electric utilities require extensive communications networks along their transmission and distribution lines. On the largest high-voltage lines, for example, end-to-end communication is a necessity to comply with regulatory fault clearing times. If a power line breaks or a fault occurs on any sector, every fraction of a second to isolate and shut off the line matters. A delay beyond even a few milliseconds can result in extensive damage taking months to repair at significant cost. Massive wildfires in California exemplify this need; in 2020, San Diego Gas & Electric (SDG&E) piloted providing low-latency connections to achieve rapid fault clearing. LTE provides the high-speed and low-latency data communications while moving computing to the edge — such as the mid-span of a transmission line — to meet these stringent requirements.

On distribution systems, the one-way power flow has given way to bidirectional flows of energy due to new demands such as distributed solar generation, wind, and electric vehicle charging. The changing distribution grid requires increased automation and control points at significant scale and density, improved system visibility, and a level of network prioritization that the public carriers don't guarantee. Additionally, utilities are beginning to consider advanced metering applications with the LTE radio embedded into the meter itself. This will require millions of endpoints and capacity that only an industry standards-based network can provide.

LTE'S PROVEN INDUSTRY STANDARDS

While utilities have unique circumstances to be considered when deploying private networks such as communications towers co-located with electric substations, they can still leverage cellular deployment standards developed by the large public carriers. The telecommunications industry has already expunged most of the "means and methods" pitfalls to a new network build-out over decades of execution.

Standards for communication towers, shelters, antennas, remote radio heads, backhaul, power requirements, and others are used almost universally to construct communications sites. Utilities can leverage these standards to support their own PLTE build-outs by adopting the proven standards already established by the industry, rather than developing new standards to accommodate the utility's presently preferred method of operations. Utilities that adopt the four decades of industry innovation can improve system reliability and abundantly save on research and development costs for a first-generation deployment.

As an example of a common conundrum, wireless carriers tend to place radio heads at the top of the tower behind the antennas, whereas utilities might prefer those radios to be mounted in a shelter so that maintenance personnel can access the equipment without the need of a tower crew. This convenience comes at a hidden cost, however. The wireless industry has standardized the top of the tower placement as it allows lower power radios to produce higher effective radiated power and diminishes the number of cable runs required up the tower — just one hybrid cable versus up to 24 individual cables in a future 8x8 multiple-input and multiple-output (MIMO) system based at ground level. This standard top of tower deployment should be strongly considered by utilities; the carriers have already aligned the cost versus benefit to such a challenge. Utilities need to be open to adjusting their operations methodology to conform with the standards in practice and developed over decades in the commercial industry.

Benefits can be realized from newly configured private LTE networks. For example, more robust land mobile radio (LMR) communications systems are being developed to include both voice and data functionalities. This functionality can be built out on the same network as controllers for reclosers on the distribution system and security systems for transmission substations, thus consolidating two previously disparate networks into one converged communications solution.

Data prioritization is no longer a risk as operators have the power to deem what is delivered first without competition from public users. Fault-clearing is prioritized over voice traffic, for example. Not only would system operators benefit from consolidation of all utility communications needs, but PLTE can give the utility full control of performance and security. Network build-outs can even be phased to accommodate a seamless transition from the public carrier if needed.

SPECTRUM ACQUISITION

A private wireless network cannot operate without spectrum. Filling this necessity has historically been one of the largest pieces of the LTE puzzle when starting up a network. While spectrum comes at a price, it can be a positive on the balance sheet as a long-lived intangible asset that appreciates in market value over time.

Options arise from frequencies as low as 600 MHz (known as "sub-1 GHz") to as high as 39 GHz (mmWave) and can be bought at a government auction or purchased from another holder in the secondary market. As a third option, the utility can even operate on shared bands of frequencies in the Citizens Broadband Radio Service (CBRS). Figure 1 describes the wide landscape of low- and mid-band spectrum for LTE.

Spectrum costs can vary greatly. After all, there are only so many desirable frequencies and demand is high. Generally, lower-band frequencies such as 900 MHz are the most expensive. While suitable for large coverage areas, these channels are bandwidth constrained and offer less total throughput.

Mid-band frequencies such as CBRS (3.5 GHz) allow for a higher rate of data transfer but are far more costly to deploy for scale and coverage. The infrastructure costs can be anywhere from three to nine times more costly than deploying the same coverage using a sub-1 GHz channel. High-band frequencies such as mmWave offer promises of wireline-like speeds but do not propagate past a few blocks. When selecting spectrum, it is important to weigh all of the factors and use cases — both present and future. There is a big difference in supporting a multitude of low data rate SCADA applications versus streaming simultaneous live video feeds for security.

Consider that end devices may not be compatible with all spectrum bands. The devices are typically the highest cost of a network deployment due to deployment density, so settling on spectrum outside of 3GPP specifications can greatly limit network growth to a specific vendor or technology.

There are more spectrum options for utilities to choose from in the market today than there historically have been. With these options, LTE can make sense as a business case for utility networks. Considerations should be made for the trade-offs within all parts of their service territory. What works well in rural areas will exhibit much different results in a dense urban environment.

By focusing on the spectrum that best meets the utility's needs, the investment in spectrum now may pay dividends in the future as network capacity demands and device density continue to grow. Utilities not in a position to purchase spectrum may choose to operate or fill in coverage gaps with shared spectrum using a general use license on the Citizens Broadband Radio Service (CBRS) band. This public spectrum is an added benefit of LTE's open standardization and private carrier development and is already being implemented on devices in the mainstream cellular market.

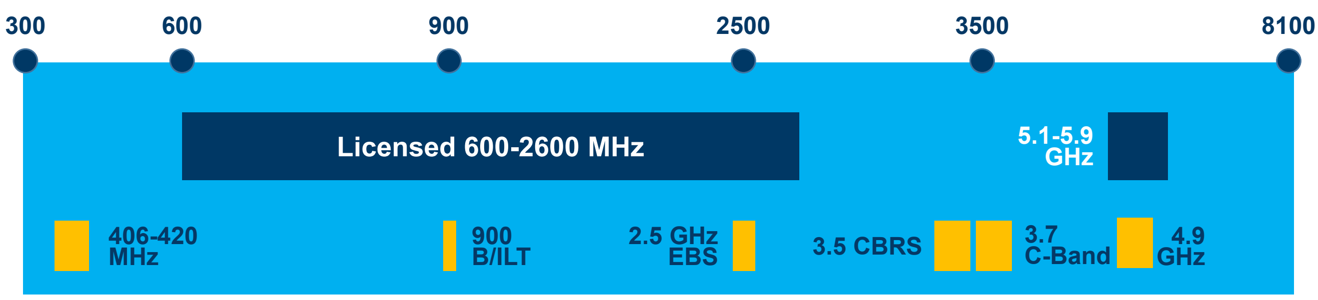

FIGURE 1: *Private LTE Low and Mid-Band Spectrum Landscape.*

There is no "one band fits all" approach to spectrum acquisition. The territory, end devices and required infrastructure all need review when selecting spectrum, and utilities should consider both short- and long-term needs to maximize the life of their private LTE network. Indeed, wireless networks often take a hybrid approach, placing the right spectrum with the right areas. With enough foresight, upfront expenses can be offset by lower long-term costs and intrinsic value in added function, reliability and safety.

PATHWAYS FORWARD

If LTE is to gain visibility as a viable option within utilities, it is imperative the IT/OT groups work with their internal customers to promote the benefits of a foundational LTE network where all utility communications depend on that single network for all new and existing applications. Touting the increases in reliability and personnel communications advances while providing room for growth when new applications and use cases come up make LTE an attractive choice. A well-prescribed and deployed underlying LTE network will be primed for new additions, allowing efficient and cost-effective deployment when new applications arise.

This process requires a partnership between the IT/OT groups and each internal customer to maximize the potential benefits and minimize diversion from industry-adopted standards. While some modifications will be necessary and unavoidable, each shift from the standard creates operational burden and cost that should be justified appropriately.

In the remote radio head placement scenario, there is a trade-off in adding a tower-climbing skill into the on-call maintenance pool, as the public carriers have done, versus sacrificing future growth and compatibility by placing the radio heads in the shelter. Project stakeholders should carefully review these options and aim to adopt industry standards rather than modify them. This will maximize the benefits gained from decades of LTE development.

LTE adds challenges to keep up with as new releases address cybersecurity and new use cases. Even so, migration from many disparate networks into a single private LTE network can be an operator's utopia with all services on one network, under full control, with the same or greater reliability to which they are accustomed. The question, then, is how to get there from we are today when wide-area utility networks are just maturing and leased public carrier circuits are being retired. Major hurdles to building out a private wireless network include standardization and spectrum acquisition. These steps, while important, can drag out the process and escalate operational spend. Fortunately, LTE offers solutions to both problems — which can expedite a build-out, allowing the utility to focus on how a new network can most benefit their stakeholders.

With LTE's promising capabilities, utilities are eager to recognize the benefits. Moving from drawing board to cutover requires great strategy and rigorous planning. A trusted partner with experience serving all stakeholders is key to fast-tracking a build-out. Combined with a shift in culture to allow adoption of LTE standards and proactive spectrum planning, utilities can leverage the developments within the public carrier space and build a private wireless network that serves the needs of the grid for years to come.

BIOGRAPHY

NICK MOZER is an electrical engineer focusing on private LTE projects in the utility sector for Burns & McDonnell. His experience includes design of wireless systems including cellular backup routers, distributed antenna systems (DAS) and Wi-Fi networks for densely populated buildings. He is also responsible for design and implementation of multiprotocol label switching (MPLS) networks and associated fiber-optic plant using GIS modeling.

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