

Private LTE Networks Position Utilities for Industry Transformation

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Richelle Elberg
Principal Research Analyst

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The Foundation Should Be Standardized and Ubiquitous

Utilities are increasingly considering private LTE (PLTE) networks for their advanced smart grid connectivity needs. They understand a more holistic networking approach is needed as the industry transforms and that silo-based, application-centric networks—often relying on unlicensed spectrum bands—will no longer effectively serve their shifting requirements. PLTE offers a robust and future-proof networking protocol supported by a global ecosystem and enjoys mature economies of scale.

Burgeoning distributed energy resources (DER) are driving greater emphasis on infrastructure efficiency and resiliency. At the same time, the cyber risk to an increasingly digitized grid represents a substantial and growing threat. It is a time of unprecedented operational challenges for the utility industry—but also opportunity.

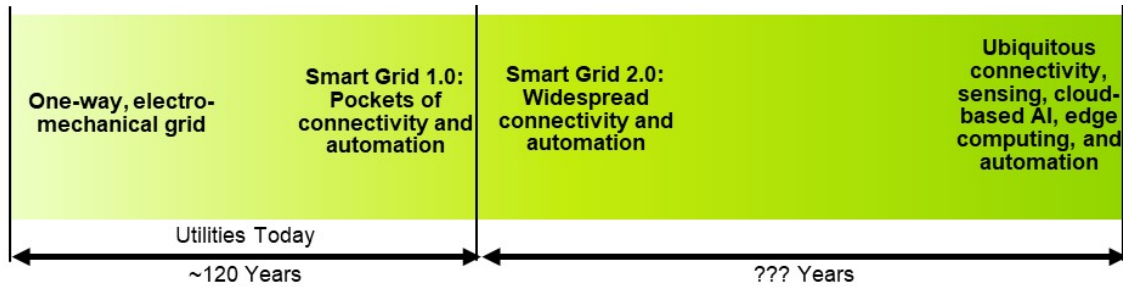
The industry can maximize the value of these new opportunities by banding together to embrace the concept of compatible PLTE networks. Guidehouse Insights believes there is potential for a collective network effect (i.e., enhanced incremental value creation for each network participant) to develop across the US as more electric utilities build out compatible, interoperable PLTE networks.

Utility leadership has been challenged to drive investment in robust, broadband networks for their individual operational requirements; however, they must also have a clear vision for what opportunities those investments may enable in the future. By acting together to promote standardization around the most suitable technologies, the industry as a whole will be best served.

Grid of the Future Represents a Paradigm Shift

The smart grid investments made over the last decade represent only a fraction of the radically enhanced power grid ecosystem Guidehouse Insights sees emerging in coming years and decades. Efforts to date have resulted in a still largely mechanical transmission and distribution network, one enhanced by pockets of digital automation, connectivity, and coordinated IT and OT systems.

Figure 1 Grid Evolution: Past, Present, and Future



(Source: Guidehouse Insights)

The envisioned grid of the future provides a vastly more powerful platform of hard and soft assets. It leverages ubiquitous connectivity, the cloud, robotics, AI, edge computing, and pervasive sensing to perform a variety of real-time energy and non-energy applications. This grid of the future is the ultimate goal for grid modernization, transforming legacy infrastructure into a platform that supports a plethora of new capabilities and service offerings.

In the grid of the future, data and intelligence reside largely in the cloud, managing the intersection of distributed generation assets and other DER (e.g., solar, wind, microgrids, EVs, demand response programs) with energy customers, buildings, transportation infrastructure, city systems, and more. Asset ownership is diverse, and communication between utilities and third parties will be necessary for real-time coordination of energy supply and demand.

In a nutshell, the world’s largest machine—the grid—will have a brain. It replaces outdated network assets and centralized systems with multifunction infrastructure that interacts with distributed, cloud-based intelligence. A reconfiguration of the distribution grid enables new network functions and eliminates assets rendered obsolete by widespread distributed solar, community microgrids, or virtual power plants.

Deep customer involvement and choice will become the norm, and new premium services will be offered. Energy and non-energy-tied offerings will be available from a variety of actors in the ecosystem. Utilities and third parties such as telcos, tech giants, DER service and product vendors, and new startups will maneuver to grab market share.

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Residential and commercial end users will also participate. Those with their own generation capabilities will be enabled to provide energy or other micro services, much as Uber and Airbnb enabled new revenue streams to individuals with cars or a spare bedroom.

As the industry transforms, the incumbent status of utilities does not guarantee them a leading role. The unidirectional value chain that serves a captive audience in the monopoly utility model of today will be

replaced by a multidirectional platform that allows a wide diversity of market participants and asset owners to benefit. Those that ignore these longer-term trends risk marginalization—or worse.

Ubiquitous Wireless Broadband Connectivity Will Be Foundational

A private 4G LTE network with a seamless path to next-generation 5G capabilities is the logical choice for the industry. Utilities have long understood that connectivity needs throughout their territories are growing exponentially. Considerable fiber investment has and continues to be made. But fiber to the home is not an option for most utilities, for financial and often regulatory reasons.

A robust, secure, broadband wireless network at the grid edge is needed to ensure utilities sustain their leadership role as an orchestrator in this new platform-based energy economy. Forward-thinking utilities such as Ameren, Southern California Edison, and others have already announced plans for PLTE deployment.

If the broader industry standardizes on PLTE technology, building a compatible, interoperable network of networks across the country, it will be better prepared for the competitive stresses that transformation brings. Not only will widespread utility PLTE investment benefit from economies on pricing and availability of standardized equipment, but the more utilities that participate in this network of networks, the more powerful the resulting network effect will be.

Network Effect Forms in Platform-Based Businesses

The network effect accelerates the value of products or services exponentially with increased participation. Examples include many gig economy businesses—Uber, AirBnB, Facebook—but basic telephony was one of the earliest examples. When only a few people had a telephone, there was little incremental value to having one. The more people who joined the network, the greater the value of the network to everyone. Today, millions of apps have been created for the mobile network platform, and smartphones are infinitely more valuable than when devices offered only voice service.

To harness the power of the network effect and scale the business, platform-based models must be designed in a way that creates unique and differentiated value for each set of users.

Guidehouse Insights believes the transition to a platform-based model for energy services is not a question of if but when. Those that embrace the model early and converge on the best technology standards will succeed. Those that delay or decide to take divergent paths regarding business models and technology investments risk becoming Betamax rather than VHS. With burgeoning competition from the likes of Google or Tesla, utilities must embrace the new paradigm and band together around certain standards to maximize long-term value.

As a multitude of incompatible, application-specific, siloed utility networks age out across the country, now is the time for the industry to converge on a robust, future-proof networking technology. Deployment

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of PLTE wireless offers the most flexible and powerful solution. PLTE allows utilities to control the security, footprint, and operations of their network and to benefit from standardization across the industry.

Guidehouse Insights believes multiple network effect benefits—value pillars—could emerge over time as large utilities deploy PLTE networks across their footprints. These value pillars and how they emerge are described in more detail in the following section.

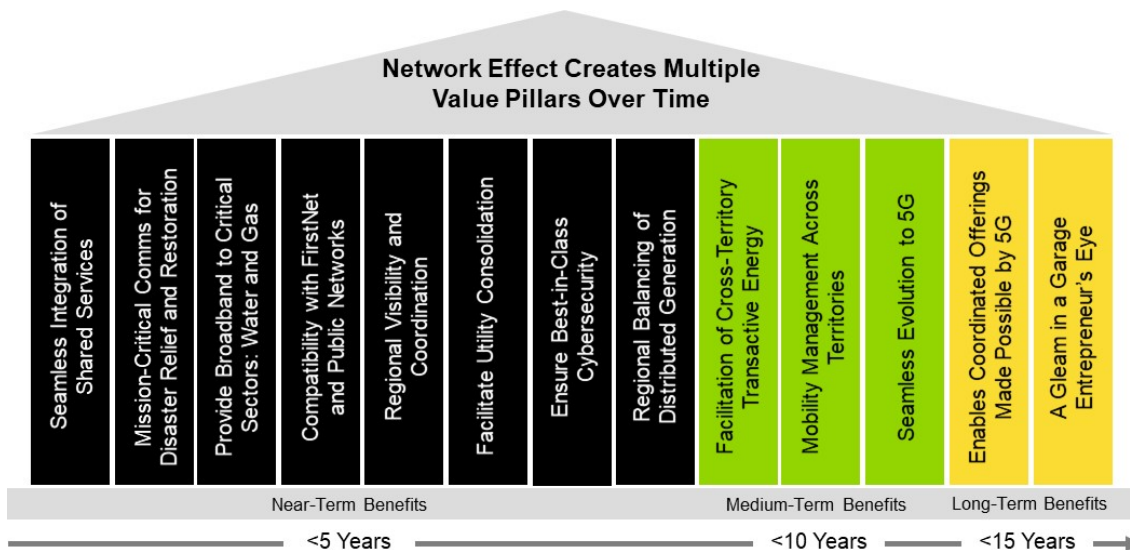
Value Pillars Form as More Utilities Deploy PLTE

As a highly regulated industry, utility management has been primarily dedicated to addressing internal operating needs and shareholder interests. That said, utilities have previously come together in collaborative efforts such as for transmission network expansion and coordination successfully. The industry should make a similar effort to proactively extend connectivity to the grid edge in a coordinated way.

Looking ahead, utilities need to transform and compete with a variety of third parties. In some cases, utilities may also partner with them, leading to a co-competition scenario. In every case, the robustness of the platform and its underlying technology will have a considerable impact on the success of their transformed business model.

With an interoperable communications network of networks, utilities gain immediate benefits, such as seamless roaming and interoperable communications for crews during disasters. Even more interesting opportunities emerge as business model transformation takes place.

Figure 2 PLTE Network of Networks Supports Utility Transformation



(Source: Guidehouse Insights)

Network of PLTE Networks: Near-Term Benefits (<5 Years)

Certain benefits accrue to utilities adopting the network of networks concept as soon as the networks are built. These benefits are described in the following sections.

Seamless Integration of Shared Services

By sharing infrastructure and services and coordinating strategies, multiple electric (or water or gas) utilities can enjoy a lower overall cost structure and reduced operational complexity. They can benefit from complex LTE-based services such as voice over LTE and push-to-talk services. Furthermore, networking experts can be shared by all utilities in a region, lowering costs and ensuring optimal network performance across a broader region.

Applications that leverage the data generated by proliferating sensors, smart meters, and a multitude of other connected devices in the grid can also be shared across multiple utilities. For example, utilities in a region may each be developing internal analytics solutions for customer engagement, but the customer profile across several utility territories may be similar.

By folding in multiple utility customer bases, utilities can save on the upfront development (or purchase) costs and, over time, the intelligence generated by those analytics may be greater and yield better outcomes.

Services can be shared between utilities for internal applications as described above or for customer-facing offerings. If multiple utilities in a region implement a

smart thermostat program, they can gain economies on purchasing the devices and leverage a larger, more comprehensive regional dataset for better predictive analytics. As the business model transforms, such customer-facing coordination has growing importance to overall industry success in the face of new competition.

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Mission-Critical Communications for Disaster Relief and Restoration

During a disaster, distant utilities often send their crews to help affected utilities make repairs and restore service as quickly as possible. Because individual utilities use a variety of networks for their mobile workforce applications, precious time can be lost as disconnected visiting crew members are not coordinated through centralized dispatch. These visiting crew members also do not have access to vital data and information systems (such as asset management or outage management system data) that would facilitate optimal response and crew coordination.

A network of compatible networks allows seamless access to voice and data communications and prevents lost time for training. Mission-critical push-to-talk systems can be hosted in secure data centers with access limited to authorized utility crew members, ensuring they have priority for communications. If visiting crews depend on their cell phones and the public carriers, they will not have priority for their critical communications—if the public network is even operational. With weather and fire events growing in frequency and severity, these benefits will only grow in value over time.

Provide Broadband to Critical Sectors: Water and Gas Utilities

Large electric utilities may have hundreds of smaller water or gas utilities within their footprints, but territory boundaries do not often align. With water scarcity growing and the need for improved safety in water and gas distribution networks, a network of compatible networks provides cost savings and may even create an opportunity for revenue generation. Smart water and gas applications (which can reduce water losses through leaks, allow for tariffed billing where fixed rates are in place, and detect potentially catastrophic gas leaks, among many other applications) can be engineered to work across the power utility network for a monthly fee.

Billing across these various utilities could be consolidated. Regulators and consumer advocates will appreciate the notion that double or triple overbuilds are not occurring among their regulated utilities. Customers benefit—as will utilities seeking regulatory support for the PLTE build. Cybersecurity standards can also be ensured across these critical infrastructure verticals. Water utilities in particular have been subject to increased hacking events in recent years. Smart city applications may also be offered over this backbone network, creating yet another revenue opportunity for the utilities.

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Compatibility with FirstNet and Public Networks

A utility industry-owned and operated network of PLTE networks is compatible with the nationwide FirstNet public safety network. This compatibility is important because FirstNet has significant rural coverage nationwide, opening up the opportunity for facility sharing (towers and backhaul) while maintaining transmission priority and security through an independent spectrum band. Leveraging FirstNet provides utilities with rural coverage at a lower incremental expense. Utilities also own valuable rights of way that might provide another revenue source if the FirstNet network (operated nationwide by AT&T) needs to deploy additional infrastructure, such as fiber for backhaul.

Regional Visibility and Coordination

As distributed generation and EVs proliferate, utilities' need for grid-edge visibility grows exponentially. Much like in the transmission network, as certain areas adopt these technologies more rapidly than others, a time will come when regional visibility, beyond utility borders, may be necessary. An interoperable network of networks can facilitate that visibility at a regional level; these regional datasets can then be rolled up to a national view, providing an unprecedented ability to dispatch or curtail generation in a more targeted way than can be done at the transmission level. While data can be shared over incompatible networks, security and data privacy can be more readily ensured with a utility owned and operated network of networks. Furthermore, the low latency of LTE networks guarantees access to the data in a more direct and timely way.

Facilitate Utility Consolidation

There are more than 3,000 utilities across the US, but fewer than 200 investor-owned utilities (IOUs) control more than 70% of all meters (customers). Consolidation among these IOUs has been occurring in recent years and is likely to continue—and perhaps even accelerate as investors and management seek to squeeze financial efficiencies out of what is, in many places, an already declining business. Compatibility and interoperability of core networks and systems vastly streamlines what can otherwise be expensive and complex integrations.

By standardizing around a common platform, utilities can ensure they all have state-of-the-art cybersecurity protection for their private networks. Resources can be shared and national cyber monitoring can be centralized.

Ensure Best-in-Class Cybersecurity

By standardizing around a common platform, utilities can ensure they all have state-of-the-art cybersecurity protection for their private networks. Resources can be shared and national cyber monitoring can be centralized; local and regional cyber managers can report attacks or intrusions to the oversight group, which can then alert everyone in the network.

Software-based upgrades can be made to all networks in a synchronized fashion to prevent an individual network from opening a backdoor for hackers due to limited expertise or resources. The broadband capacity of LTE makes these over the air upgrades fast and does not take the network out of service for critical grid functions unlike many networks, which can be down for hours or days when system upgrades are required.

The electric utility industry in the US has not experienced a major cyber event to date, but there is no doubt that vulnerabilities exist. A nationwide, coordinated approach to cybersecurity makes all network participants more secure. One might argue that interconnected networks also increase vulnerability; vigilant, highly advanced practices can be adopted in a blanket fashion to minimize this risk. Compared with the thousands of different networks managed by utilities—many of which leverage the public internet—the overall cyber risk should be vastly reduced in a private network of networks. This improved cybersecurity capability can also be shared with water and gas utilities or municipalities that lease access to the network.

Regional Balancing of Distributed Generation

There will come a day when certain regions of the country have substantial penetration of distributed and utility-scale solar generation. In some places, private third-party solar or microgrid developers will interconnect with the grid, taking large loads away from the utility, potentially reducing revenue even as grid management and maintenance becomes more complex.

Eventually, physical grid infrastructure management could separate from retail supply operations. Just as the equipment used for distribution of electrons is compatible and interoperable nationwide, the communications infrastructure should also be compatible to enable regional or national management of power supply and balancing, grid maintenance, and reliability. The need for (expensive) peaking plants could be drastically reduced, and regional rate design could be optimized for the characteristics of the

state or cluster of states in the coordinated region—for example, by orchestrating when EVs charge through rate incentives. A sort of distribution independent system operator (D-ISO) could emerge.

Data sharing—as opposed to network interoperability—could solve this challenge, but it will be a more complex, less secure process in the longer run. Access to data will be delayed whereas standardizing across technology and data protocols enables real-time use cases.

Network of PLTE Networks: Medium-Term Benefits (<10 Years)

True industry transformation will become a reality over the next one to two decades. The network effect benefits described in the following sections may not be the most immediate, but they have the potential to be the most impactful for the electric utility industry.

Facilitation of Cross-Territory Transactive Energy

Transactive energy, where individuals or businesses can directly participate in distributed energy markets, is still considered more hype than reality by some utility industry participants, but utilities are trialing technologies to enable this prosumer behavior. Much as the landline telephone industry never expected to become all but obsolete by the mobile industry, utilities risk dramatic and abrupt displacement if they fail to get in front of the transactive energy trend—and the interlopers looking to exploit these trends. By coming together across a region, utilities may be better prepared for competition from technology-oriented companies like Tesla, Amazon, or Google.

As described above, the network effect creates more value for all involved as more participants join. If a utility wants to create a transactive energy platform only in its own territory, it is limiting the upside potential for that network to grow and increase in value. Incompatible networks, or use of the internet for data sharing, makes that type of regional transactive energy market far more difficult to achieve, paving the way for third-party competitors to take the lead and garner significant market share.

Mobility Management Across Territories (EVs, Autonomous Vehicles, Drones)

EV penetration remains low in most parts of the country, but Guidehouse Insights expects adoption to grow exponentially over the coming decade. And while EV charging stations are connected, they typically transmit data over a public cellular or internet connection.

By the end of this decade, it is possible that utilities in some regions will need to manage EV energy consumption even when vehicles are in motion to use predictive analytics for load forecasting on a busy travel weekend like Thanksgiving. EVs also represent an energy storage asset that could be used if utilities know where they are. However, these vehicles are not likely to remain within a given utility's territory. Furthermore, the use of the public networks by charging stations makes that data vulnerable.

If they communicate over a single network, drones can be used by neighboring utilities for greater visibility, data sharing, and grid maintenance purposes—and for revenue generation by those that own the drone.

Drones are another emerging but expensive mobile device that utilities are using for inspection, asset management, and grid maintenance purposes. If they communicate over a single network, drones can be

used by neighboring utilities for greater visibility, data sharing, and grid maintenance purposes—and for revenue generation by those that own the drone.

Eventually, trains, long-haul trucks, and buses could all represent large, mobile energy-consuming vehicles for which utilities need real-time visibility for grid and generation resource management. Another platform business could also emerge around mobility, with owners using their vehicles as storage devices on behalf of the utility in exchange for payment or reduced electric rates.

Seamless Evolution to 5G

An important benefit to any utility deploying PLTE networks is the future potential for a seamless, software-based upgrade to 5G. 5G networks, when mature, offer utilities a vast array of new capabilities, the value of which is only beginning to be understood.

Much like applications such as Uber and video streaming were not easy to envision prior to 4G network deployments, the ability of 5G technology to support applications like virtual or augmented reality, autonomous vehicles, and dense sensor networks for real-time video monitoring and control will enable a multitude of beneficial next-generation applications that have not yet been described. Importantly, 5G networks are backward compatible with 4G PLTE, ensuring utilities will not face stranded assets in 5 or 10 years. 5G networks are expected to revolutionize industrial operations—perhaps even more so than consumer applications.

Network of PLTE Networks: Long-Term Benefits (<15 Years)

Enables Coordinated Offerings Made Possible by 5G

The network effect for these new, 5G-enabled applications further enhances the value to utilities that participate in this regional or nationwide network of networks. Coordinated offerings that cut across utility territories have the potential to radically change the business at all levels: at the retail level for behind-the-meter services; at the operational level for grid safety, resiliency, and security; and in a competitive environment that includes a multitude of new entrants.

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A Glean in a Garage Entrepreneur's Eye

It is difficult to envision all the ways the utility industry may evolve in this new technical paradigm, but smart, creative entrepreneurs are undoubtedly already drafting their ideas. A seamless, robust PLTE network of networks established in the near term can help the utility industry in the US to maximize its role in the future and become the provider of choice—i.e., the network orchestrator.

A Final Note: Data Sharing Is Optimized by Network Interoperability

Utilities, in a limited manner, share data; some of the value pillars described previously could be partially achieved through data sharing as opposed to the building of a large-scale network of PLTE networks. But, virtually all these benefits can be enhanced by a seamless, optimized, secure, and interoperable broadband network of networks with the ability to evolve into a more powerful, dedicated 5G network of networks built by and for energy industry participants. When one considers the inability to fully foresee all of the ways in which the industry will evolve over the next 20 years, it is incumbent upon utility

management to consider how their successors—the network orchestrators of the future—may be required to move quickly and seamlessly into new markets and business opportunities without difficult, costly, and time-consuming upgrades or integrations.

Conclusion

The US utility industry is at an inflection point, and decisions made today regarding technology investments will have ramifications for decades to come. By acting together to create a robust network of wireless networks based on PLTE protocols, utilities can save money, accelerate adoption, and enjoy the best outcomes with their deployments. They will be better prepared for a growing number of natural and made-made disasters and well positioned to exploit new business opportunities as the network orchestrator in a digital energy platform operating environment. This type of proactive coordination across the industry represents one of the most powerful protections utilities can put in place to ensure they remain agile and competitive in a rapidly transforming industry.

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1800 Tysons Blvd., 7th Floor
McLean, VA 22102 USA
www.guidehouseinsights.com

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