FROST & SULLIVAN

Private LTE for the Smart Grid

A Frost & Sullivan White Paper

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INTRODUCTION

The time is right for the energy sector to build end-to-end intelligence into the electricity distribution network. Increasing volumes of distributed generation in many regions of the world need a dynamic infrastructure that can handle bidirectional and unpredictable power flows. At the same time, new consumption patterns are emerging with the introduction of electric vehicles. A mass market for EV is not far away, and the grid must be ready to meet future charging needs.

To meet these challenges, distribution network operators (DNOs) are extending connectivity to their field assets to create a truly automated grid. They are also extending downstream to the customer with advanced metering and tariffs to control peak loads. The combination of distribution automation (DA) and advanced metering infrastructure (AMI) means fewer and shorter outages, lower operating costs, potential for new tariffs and revenue streams, and the ability to take full advantage of distributed generation and storage.

THE COMMUNICATIONS NETWORK MUST BE AS DYNAMIC, SECURE AND RELIABLE AS THE POWER GRID.

However, the smart grid needs equally smart communications to deliver these benefits. The communications network must be as dynamic, secure and reliable as the power grid as the two become increasingly interdependent.

In this paper, Frost & Sullivan examines the major trends in communications and the smart distribution grid. We identify how grid operators can benefit from important developments in cellular wireless. Standards-based LTE is now mature, with proven performance in the world's most demanding commercial telecom markets. Utilities looking for suitably low-risk and future-proof investments are assessing the benefits of private LTE broadband and narrowband in licensed and unlicensed spectrum.

Ownership of the communications network is the most direct way to maintain full control of the grid at a time when 'keeping the lights on' has never been so complex. With a growing range of choices available, each utility needs to assess the benefits against their own automation roadmap and business goals.

LIGHTING UP THE SMART GRID

CHANGING PATTERNS OF GENERATION AND CONSUMPTION ARE MAKING UNPRECEDENTED DEMANDS ON THE POWER INFRASTRUCTURE.

For over 100 years, the electricity power grid has developed to meet the needs of industry and households for stable, secure and reliable supply. Until recently, much of the distribution network was still 'dark' and only partial connectivity was necessary for day-to-day operations. Today's environment is much more challenging. Changing patterns of generation and consumption are making unprecedented demands on the power infrastructure. Distributed generation, in the form of large-scale wind and solar and micro-grids, is as intermittent and unpredictable as the weather. Frost & Sullivan calculates that the global generating capacity of distributed energy rose by over 10% between 2015 and 2016 to reach 8.5% of total installed generation in 2016, or 491.5GW.

Patterns of consumption are also changing radically. Heat pumps and electric vehicle (EV) charging piles will add considerable load when consumers adopt these carbon-reducing technologies in high volumes. This is expected soon; in July 2017, Volvo pledged to phase out traditional vehicles by 2019, the first automotive OEM to do so.

Government policy underlies many of these trends in the form of commitments to reduce carbon emissions and pollution, and targets for smart meter roll-outs. The European Union is on course to exceed its 20-20-20 target to reduce emissions by 20% by 2020 from 1990 levels. It is also close to sourcing 20% of its energy from renewable sources by the same year. Although Germany and Poland still produce substantial emissions from coal, these are offset by progress in southern countries such as Portugal, which ran for four days in 2016 solely on wind, hydro and solar generation.

This trend is ongoing. Frost & Sullivan expects distributed generation to contribute as much as 12% of total worldwide capacity by 2025.

AN ADVANCED GRID MANAGEMENT PARADIGM

Distribution network operators (DNOs) recognise that advanced and dynamic management is needed to cope with these multiple stresses on the grid. Many are investing in distribution automation (DA)—an intelligent, connected infrastructure that provides real-time visibility and control.

Advanced metering infrastructure (AMI) brings this close control to end-customer premises. Smart meters provide insight into retail consumption patterns and help to shave peaks by enabling tariffs based on time of use and real-time local demand. As end points on the grid, meters with 30-minute or even 15-minute intervals can also provide early warnings of power fluctuations, outages and fraudulent activity.

The advanced communications networks that deliver these benefits must be equally as dynamic, secure and reliable as the automated grid. However, the choices are complex, and each utility needs to assess the benefits against their own roadmap for automation and business goals.

REGIONAL TRENDS IN SMART GRID CONSTRUCTION

National smart grids are at different stages of development. In the most advanced countries, utility-owned fibre backbones connect between primary and large secondary substations. Fibre is easily installed alongside grid cabling and many utilities have a lucrative business in leasing surplus dark fibre to third parties.

The main barrier to extending connectivity into the distribution grid is the relatively high cost of covering such a wide geographic area. Frost & Sullivan estimates that monitoring of a typical feeder costs $250,000-$300,000 to implement, plus another $10,000/year for maintenance. Therefore, the first priority is to connect feeders that supply many customers or that are exposed to hazards, such as demand overload or extreme weather conditions.

AMI deployment trends have more variety within the region, as government intervention is invariably necessary to overcome short-term economic barriers. China's state grid alone represented over 60% of global smart meter shipments in 2016, owing to its exceptionally strong domestic supply chain, government support, and integrated ownership of utilities. The rest of Asia accounted for 14% of global shipments, while 12% were shipped to Europe and 10% to North America. South America, Africa, Russia, the CIS and the Middle East make up the remaining 4% of the market and are at the early stage of smart meter deployment.

Regional Trends in DA

Utilities in the top OECD countries are extending connectivity from the data transport backbone to assets further out in the field, such as pole-top transformers and switches, Ring Main Units (RMUs) and the feeder itself. Europe's western and southern countries are currently the biggest spenders. European Union (EU) targets for DER have put considerable pressure on the distribution grid. Generation often exceeds demand, so DNOs urgently need advanced protection to cope with reverse power flows.

European utilities are also gathering data about EV adoption to understand how demand for charging will impact their infrastructure in the future. UK Power Networks, for example, is using detailed consumption data from smart meters to predict which households in its London region are most likely to purchase hybrid and fully electric vehicles.

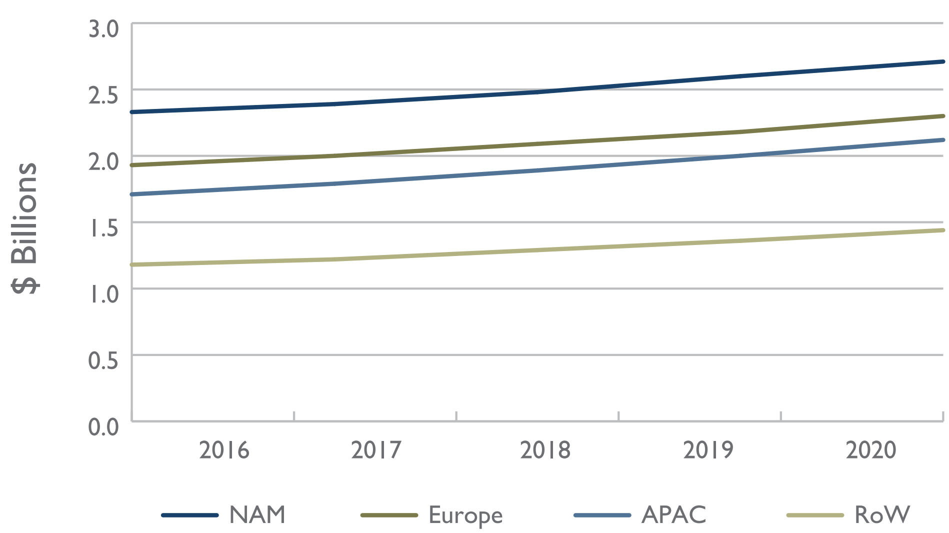
In contrast, in fast-growing economies smart grid spending is a response to rapid economic development, that is undermined by unstable electricity supplies. Urbanisation in modernising economies is therefore driving demand for DA, notably in Asia-Pacific (APAC). Malaysia is an energy-intensive economy with surging power demand. Regional governments are aiming to improve operational efficiency and reduce losses from T&D. Meanwhile, Thailand and other Southeast Asian countries are evaluating the benefits of DA through pilot projects.

Africa has underinvested in distribution over the years. African utilities, therefore, stand to gain the most from grid modernisation as T&D losses typically range from 30-40% across the continent. However, a lack of funds, transmission capacity constraints, and inadequate government policy are significant barriers.

Brazil is in a similar situation. Despite consistent policy support for renewable energy, projects have been delayed due to inadequate transmission and a weak national economy. However, with more private participation in the distribution segment (over 60 private distribution companies are now in Brazil) the potential for DA is improving.

Elsewhere in the region, pilot projects in Chile and utility reforms in Mexico are encouraging the modernisation of the distribution grid.

Figure 1: Spending on Distribution Automation 2016-2020



Source: Frost & Sullivan, 2017

Regional Trends in AMI

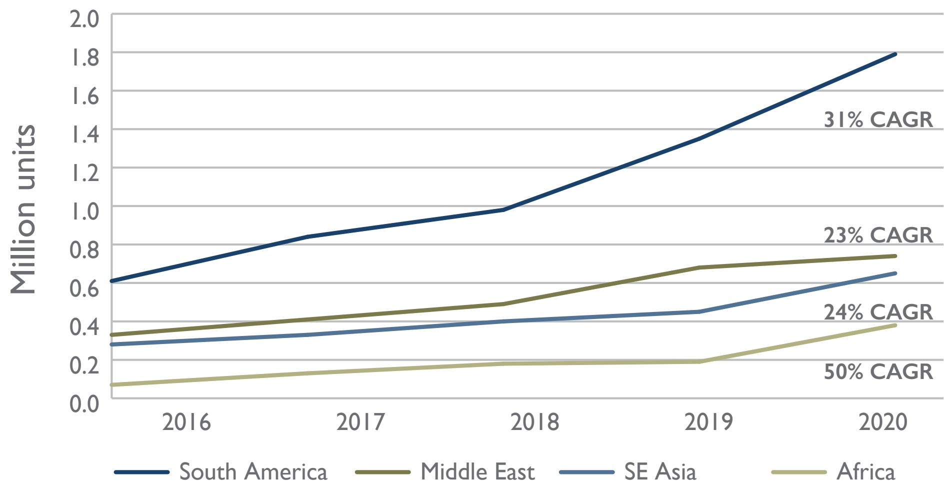
Smart metering in the North American market is slowing after a boom period as the government's stimulus funding has come to an end. About 8.5 million smart meters will be live in the United States by the end of 2017. In Europe, large-scale deployments are ongoing in France, the UK, and Spain.

China, South Korea and Japan are the leading adopters in APAC. South Korea is replacing all 15.2 million residential meters with smart devices by 2020. National utility KEPCO is implementing the country's ambitious plan for a nationwide smart grid.

Japan's largest utility, Tokyo Electric Power Co. (TEPCO), has pledged to install 27 million meters in the capital before the Olympic Games in 2020. The government is liberalising the power grid by separating transmission and distribution in an effort to lower electricity prices, which have soared since the Fukushima nuclear plant disaster in 2011. Smart metering is part of a wider programme of reforms impacting all 10 of Japan's electricity utilities.

The fastest-growing regions for smart metering are South America, the Middle East, Southeast Asia and Africa (Figure 2). Within each region, deployment of AMI is at different stages country by country, as government policy is the primary driver of spending.

Figure 2: Meter Shipments in Rapid-growth Regions 2016-2020



Source: Frost & Sullivan, 2017

Utilities have relied for decades on manual readings and advanced meter reading (AMR) in the form of one-way and drive-by communications for remote capture of digital readings. However, AMR provides only limited insight and contributes to the energy industry's reputation for poor-quality marketing and customer service. Moving from AMR to two-way AMI allows utilities to innovate in services beyond meter-to-cash. Regular 15-minute or 30-minute sampling intervals enable time-of-use (ToU) tariffs and peak-shifting of energy-intensive loads, such as heating and air conditioning. Furthermore, DNOs that are not retailers have an important stake in AMI as they gain accurate consumption data for grid planning and power quality metrics at the point of delivery.

However, the business case for AMI is often more prosaic in reality. Frost & Sullivan identifies three leading drivers: government targets; unusually high non-technical losses and customer debt; and commercial objectives to co-develop technology for export.

Electricity losses are a challenge across South America. Most countries in the region have double-digit revenue leakage, a significant proportion of which is non-technical. This loss of income hinders utilities' ability to invest in new generation and grid upgrades.

Mexico is explicitly targeting revenue leakage, which, according to the national utility, peaked at 35% in 2013. Private finance is partly supporting its smart metering roll-out to 75% of customer premises (over 30 million) by 2025. As in many other markets, metering is being deployed alongside complementary investments in DA, home energy management and battery storage.

In five major markets in Southeast Asia—Thailand, Vietnam, Philippines, Malaysia and Indonesia—smart meter shipments are expected to grow at more than 30% for the period 2015-2020. Non-technical losses are a driving factor, as is the opportunity to gain expertise in AMI and communications. Malaysia's vertically integrated utility has formed a co-development partnership with its AMI vendor to promote metering and smart city applications to the wider region. Taking advantage of AMI functionality, a proportion of over 9 million new meters will have prepayment provisioned in software.

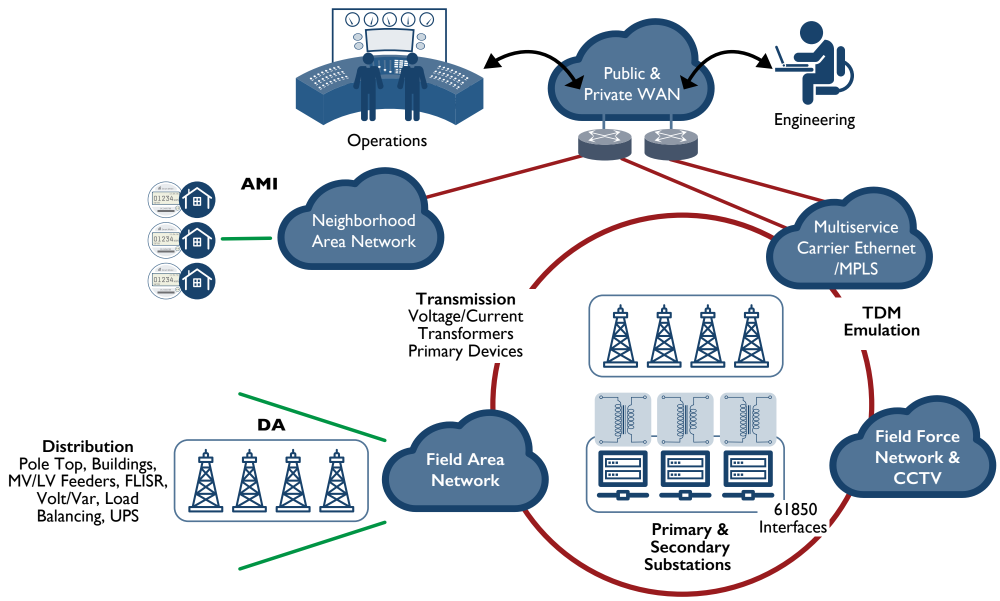
Utilities in Africa face multiple challenges of high non-technical losses and customer debt, capacity and generation limitations, and shortage of funds. Efforts to tackle fraud include putting meters high on poles in some neighbourhoods to avoid tampering. Others opt to deploy smart prepayment meters, which are cheaper than full AMI solutions. However, by selectively migrating from manual meters to one-way AMR, utilities are delaying the opportunity to benefit from full AMI. The opportunity cost includes the potential for new revenue streams from smart city services, such as street lighting and EV charging.

A lack of backhaul communications has been a barrier in the past. But with affordable, low-power wide-area (LPWA) wireless modules now on the market, utilities have the option to deploy long-range, narrowband wireless networks in unlicensed spectrum.

CO-EVOLUTION OF GRID AND COMMUNICATIONS

The distribution smart grid must be flexible, stable, resilient and secure—and the same qualities must be true of its communication network (Figure 3). High-performance communications are the key to the automated power infrastructure. Conversely, a failure in one could lead to a major outage in the other. These interdependences must be understood so that no single point of failure can arise.

Figure 3: Communications for DA and AMI



Source: Frost & Sullivan, 2017

Wireless is often the best solution to cover growing bandwidth needs across a wide footprint. LTE in licensed bands is becoming a viable option as the cost of modules falls and as mobile network operators (MNOs) begin offering 10- or even 15-year leases for shared access to their spectrum in remote areas. As a standards-based technology that is proven in the commercial mobile environment, LTE can meet many of the critical requirements of the power grid. For DA, LTE is a cost-effective alternative to new fibre, which is costly to deploy, and to proprietary microwave, which lacks bandwidth. LTE also performs more consistently than RF mesh in terms of latency and better than narrowband PowerLine Carrier in terms of flexibility and signal to noise.

For AMI, the narrowband LTE standard, NB-IoT, offers the benefits of standards-based, carrier-class functionality in licensed spectrum in FDD mode. The MulteFire Alliance, formed by leading vendors Qualcomm, Intel, Ericsson, Huawei, Nokia and others, aims to open this up further by standardising the use of NB-IoT in globally unlicensed or shared bands. The Alliance has developed 'NB-IoT-U' specifically for private enterprise, with both control and user planes in license-free bands. The sub-1GHz frequencies are the most valuable for the energy sector due to their greater penetration and range. Time division duplex (TDD) is also a practical option as it avoids the need for paired spectrum.

THE MULTEFIRE ALLIANCE, FORMED BY LEADING VENDORS, HAS DEVELOPED 'NB-IOT-U' SPECIFICALLY FOR PRIVATE ENTERPRISE, WITH BOTH CONTROL AND USER PLANES IN LICENSE-FREE BANDS.

Communications Networks for DA

Spending on communications networks and software for DA represents typically about 12% of the total project value. This proportion is growing as hardware is increasingly packaged into total solutions.

DA covers a wide range of monitoring and control functions of critical assets, including:

- Switching stations, RMUs, and other field devices located outside substations;
- Pole-top transformers, capacitors and other equipment in feeder networks;
- Feeder cables condition;
- Fault Location, Isolation, and Service Restoration (FLISR);
- CCTV surveillance;
- Mobile robotics to assess maintenance needs;
- Teleprotection circuits between substations; and
- Synchrophasors for power quality measurement.

Wireless coverage in the distribution grid must meet stringent requirements for low latency, security and reliability. Additionally, the field area network (FAN) must allow sharing of data directly between devices at the edge. Edge processing is critical for protection functions, but also increasingly for automated decision making; for example, localised analysis for anticipating and routing around faults.

LTE is a good solution for point-to-multipoint connectivity for DA. It is backed by 3GPP standards and the global mobile telecom industry, and delivers carrier-class security and low latency. LTE-Advanced is proven in commercial networks to deliver high bandwidth and spectrum efficiency across multiple bands. Utilities that have access to sub-1 GHz frequencies, such as 400MHz, 450MHz and 700MHz, will require fewer eNodeB base stations than at higher frequencies for the same coverage, which keeps costs down. Furthermore, the core network can be virtualised and run on commodity hardware.

Given that LTE is designed for mobile voice and data services, some trade-offs are necessary, depending on the specific grid functionality and available budget. Whereas coverage is important for monitoring basic devices that are spread across a wide area, low latency is critical for protection switching. Reliability requirements may involve back-up diesel generators, and total capacity available will be determined by the capacity of backhaul links (Figure 4).

Figure 4: Typical Performance Requirements for LTE Field Area Network

Metric	Typical Requirements
Lifecycle	10-15 years
Critical metric 1	Latency < 50ms backhaul from substation to data centre
Critical metric 2	Minimal packet loss
Backhaul bandwidth	Several Mbps from substations; several Gbps backbone transport
Cell sites (macro)	1-3 cell sites per 10 sqr Km, depending on the terrain
Devices per macro cell	Thousands
Towers	Reuse, owned, shared or new construction
Backhaul	Mix of own fibre, leased fibre, microwave
Availability	99.999% (5 mins downtime/year)
Back-up power and redundancy	Diesel generator, dual path redundancy where feasible

Source: Frost & Sullivan

Communications Networks for AMI

AMI infrastructure includes smart meter hardware and software; communication networks from smart meters to local data concentrators; back-haul from these aggregation points to utility data centres; a meter data management system (MDMS); and integration into back-office software applications. AMI can also be considered to extend to the consumer's home area network (HAN).

AMI functions include:

- Collecting and sending usage data to the utility;
- Receiving rating data and firmware updates from the utility;
- Measuring grid feed-in from local distributed generation;
- Activating and deactivating accounts;
- Detecting power quality issues and outages;
- Reducing theft and detecting tampering;
- Offering advanced and time-of-day tariffs;
- Profiling individual households for marketing; and
- Profiling aggregate household consumption.

Data is collected and fed back for analysis centrally via the MDMS to customer service, billing and prepay, asset management and operations systems. In addition to the meter-to-cash function, the data can be used to alert operations systems if power levels or quality slip below an acceptable threshold. DNOs that are exploring non-regulated revenue streams can also reuse the AMI neighbourhood area network (NAN) to deliver smart city services, such as EV charging and smart lighting.

Spending on communications networks and software for AMI is typically about 12% of the total project value with another 35% for installation.

DNOs have many available options for the NAN between meters and aggregation points. Their choice depends on the geographical terrain, density of buildings, cost of equipment, and economies of scale as a ratio of the concentrator to the meters it serves. Wired options include FTTH and DSL. PowerLine Communication (PLC) is a preference for utilities as it takes advantage of existing electricity cabling. However, cost advantages of PLC are less in areas with a lower density of meters. This is because additional equipment is needed to enable the PLC data to bridge each local transformer.

Wireless options are prevalent for reasons of cost and flexibility. RF mesh and 2G and 3G cellular have been the common choice in recent years. Low-power WAN (LPWA) technologies are now gaining ground as lower-cost options that are dedicated to narrowband, non-critical IoT applications such as metering. LPWA brings advantages of spectrum efficiency, low power and cost. The 3GPP organisation is starting to bring some proprietary and partially open LPWA under its standards umbrella, alongside LTE variant NB-IoT, which was formally accepted in 2016, and emerging unlicensed NB-IoT (known as NB-IoT-U), which is backed by the MulteFire Alliance.

Licensed NB-IoT is designed to meet carrier-grade standards of quality and security, and to require only a simple software upgrade on most existing LTE base stations. Therefore, it brings these additional advantages to the context of private utility networks. Additionally, NB-IoT-U in unlicensed bands, as promoted by the MulteFire Alliance, allows utilities to take advantage of LPWA technology as a private, standalone network.

Figure 5: Typical Performance Requirements for AMI Neighbourhood Area Network

Metric	Typical Values
Lifecycle	15 years
Critical metric 1	Penetration indoors for most meters
Critical metric 2	Latency < 1s meter to MDMS
Range	2-15 km
Bandwidth	Upload bursts of 1-10 kbps per household initially; ability later to carry auxiliary services such as smart lighting.
Meter sample interval	30-mins or 15-mins; long-term trend is towards real-time metering
Cell sites (macro or micro)	1-3 cell sites per 10 sqr Km, depending on the terrain
Devices per macro cell	Thousands
Towers	Reuse, owned, shared or new construction
Backhaul	% own fibre, leased fibre, wireless
Availability requirement	99%

Source: Frost & Sullivan, 2017

CHALLENGES OF CURRENT COMMUNICATIONS SOLUTIONS

A typical mid-sized utility supports dozens of communications networks in its daily grid operations. Each has its advantages and disadvantages, depending on whether the application is critical for the health of the grid, such as DA, or can tolerate lower performance, such as AMI.

A thorough risk assessment must include:

Access to fixed-line ducts and rights of way

The biggest challenge associated with optical fibre is the cost of running cable through underground ducts and gaining access for maintenance or to increase capacity. Much of the utility fibre under the world's most advanced cities was installed several decades ago. It now lacks capacity, but the cost of replacement can be prohibitive.

Scalability of costs

Pricing of communications services and technology licensing is typically based on the number of connected devices, data transactions, or volume of data transferred. As these grow over time, a third-party service could become expensive in relation to the business benefit. Private ownership of networks helps avoid this vulnerability.

Sunset of 2G/3G mobile wireless networks

Telecom operators continue to run M2M services over their GSM, CDMA and WCDMA networks. But as voice migrates to LTE, the motivation to maintain them reduces. Many operators have already given notice of their intention to switch off 2G and 3G.

Commitment of third-party communications providers

A hosted radio access network (RAN) gives enterprises access to a commercial carrier's spectrum and cellular coverage with the option to run their own virtualised core network. Although performance is subject to a service-level agreement, limited financial compensation is of little comfort to utilities if a critical outage occurs. Furthermore, coverage may be incomplete without national roaming. Ultimately, utilities may feel that telecom operators will always prioritise their smartphone users over enterprise IoT. In extreme conditions of political unrest or natural disaster, telecom services may experience congestion, shutdown or damage.

Future technology roadmap

Failure to consider the future roadmap of standards and proprietary technologies can be costly. Low-cost wireless metering modules with limited upload capability may need to be replaced if the DNO later wants to deploy advanced tariff plans or grid monitoring from the edge. Some utilities are running additional smart city services over their AMI networks, such as managed street lighting and monitoring of household waste collection. The ability to use spare capacity in the access network is, therefore, potentially valuable.

ADVANTAGES OF OWNING LTE WIRELESS ACCESS NETWORKS

The case for private network ownership

A smart distribution grid is wholly dependent on its communication network. For this reason, many DNOs feel they need direct control over both power and communication domains.

> MANY DNOS FEEL THEY NEED DIRECT CONTROL OVER BOTH POWER AND COMMUNICATION DOMAINS.

Recent developments in wireless mobile technology are making direct ownership of networks, once again, an attractive option. Standards-based LTE is mature following eight years of live telecom deployments. Furthermore, the ability to combine licensed and unlicensed frequency bands allows non-telecom sectors to leverage their existing spectrum holdings. Plus, the virtualisation of evolved packet core (EPC) networks is attracting new suppliers to the market and keeping prices down.

Utilities will weigh the advantages of LTE against the challenges of introducing yet another communications technology into their domain. Initially, LTE may be used in DA to provide redundancy for an existing fibre route or for non-critical applications such as CCTV surveillance. Over time, the benefits of high-capacity LTE-Advanced and optimised NB-IoT will migrate from MNO networks to become central to enterprise operations in many sectors, including the smart grid.

THE CASE FOR PRIVATE NETWORK OWNERSHIP

- Take full control and responsibility for reliability of communications.
- Connect grid assets located beyond the coverage of mobile operators' networks.
- Ensure that customer data is always protected.
- Avoid increasing managed services charges as data traffic volume grows.
- Take advantage of MNO offers to lease LTE spectrum for critical communications in areas of low population density.
- Avoid stranded assets when 2G/3G networks are switched off.

The Case for LTE

3GPP standards for LTE-A and NB-IoT have developed in several important directions that boost the capabilities of the technology for private networks:

- Support for high density of devices in a geographic area;
- Low latency and narrowband options;
- Different quality-of-service levels for different applications on the same network;
- Base stations acting as edge computing nodes;
- MIMO antennae for bi-directional capacity and resilience;
- Indoor coverage, including underground;
- Programmability to enable configuration in real time; and
- Security with two-way authentication, integrity protection, and transmission encryption up to AES-256.

A single licensed band, ideally sub-1 GHz in FDD mode, could be used across a LTE-based DA network and a NB-IoT-based AMI network, providing convenience and simplifying management. Alternatively, NB-IoT can be deployed in an unlicensed or lightly licensed ISM band in standalone mode for a lightweight AMI network.

THE CASE FOR LTE WIRELESS ACCESS NETWORKS

- Take advantage of a global standard backed by the 3GPP, the world's largest telcos and the MulteFire Alliance.
- Cover wide area of grid assets with a few base stations and without the need for repeaters.
- Meet requirements for coverage, configurable download and upload bandwidth, low latency, reliability, security, scalability, and spectrum efficiency.
- Reuse existing spectrum holdings.
- Ensure smooth evolution to 5G.
- Pay less for NB-IoT and NB-IoT-U modules as prices will fall with volume demand.

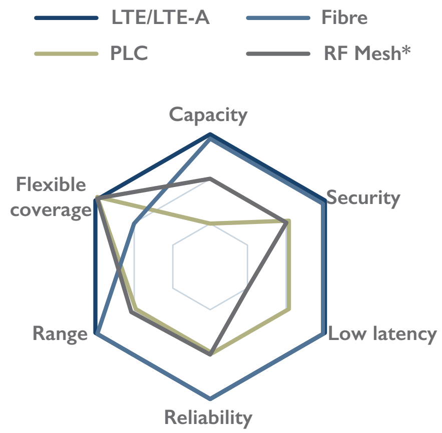
TECHNOLOGY CONSIDERATIONS

DNOs have several options available when assessing their communications needs. They should ask some key questions when making investments:

- Is the future roadmap of the technology clearly understood?
- How will my communications traffic change in the future?
- Does the vendor or third-party communications provider prioritise my interests?
- What is the total cost of capex and opex?

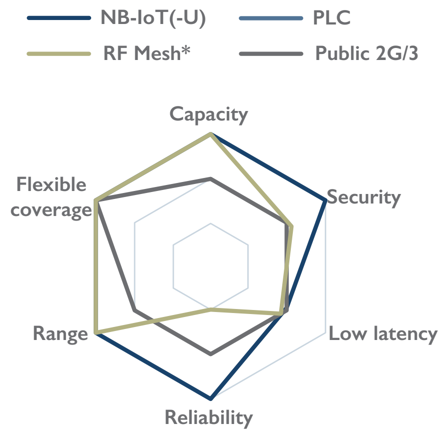
The answers follow from assessment of each technology's characteristics and performance, as illustrated in the comparisons below (Figures 6 and 7).

Figure 6: Comparison of private communications network technologies for DA



*typical installed base
Source: Frost & Sullivan, 2017

Figure 7: Comparisons of communications network technologies for AMI



*typical installed base
Source: Frost & Sullivan, 2017

Each technology option has its advantages—those under the 3GPP standards umbrella have already met the demands of the world's largest mobile operators. Therefore, utilities benefit from ongoing development of capacity (LTE-Advanced), spectrum efficiency (carrier aggregation) and narrowband optimisation (NB-IoT/NB-IoT-U). Furthermore, the flexibility to deploy in different licensed and unlicensed bands supports utilities' demands for flexibility and predictable total cost of ownership (TCO).

SPECTRUM DEVELOPMENTS

Spectrum is a hugely valuable resource for license-holders, customers and for government finances as data use continues to grow exponentially. Policymakers recognise that this value should be unlocked. Several solutions are emerging to address the need for greater efficiency. Instead of being exclusive, multi-year gatekeepers, mobile operators are encouraged to share their spectrum and RAN infrastructure with enterprise customers.

For utilities, the ability to reuse their existing spectrum holdings for LTE, ideally sub-1GHz bands, is an attractive opportunity. The European Utilities Telecom Council (EUTC) proposes the harmonisation of the 450MHz range for critical communications, which accommodates both 3GPP-standard LTE and NB-IoT. The propagation characteristics are positive for DA applications that need long range, bandwidth and resilience, and for in-building penetration of AMI. Ultra-high frequency creates large cells from few base stations, is resilient to interference, penetrates buildings and other obstacles, and propagates with minimal signal loss.

The challenge will be to ensure co-existence with existing users of public mobile radio in energy, public safety and transportation. As a roadmap is now agreed upon for folding advanced voice capabilities into the 3GPP LTE standard, the time may be right for utilities and public safety to agree on a migration path from PMR.

Several utilities are using 450MHz for grid and AMI applications. EDP in Portugal is trialling the band for smart grid purposes; European utility Alliander operates a 450MHz CDMA network in Germany. Ice.net is a Nordic telco providing 450MHz LTE to Vattenfall and Eon in the region.

Utilities are also considering use of 400MHz and 1.8GHz, where available, with TDD LTE for DA communications.

In China, 230MHz spectrum is allocated to utilities and grid operators have approval to use 1MHz for private wireless networks (40 separate frequency points each with 25kHz channel size). Additionally, 1.8GHz spectrum (from 1785MHz to 1805MHz) is allocated for vertical industries, such as metro transportation and energy sectors. Grid operators can apply for at least 5MHz continuous spectrum within this band in which to deploy a LTE network. The State Grid and China Southern Power Grid have deployed private LTE in dozens of provinces for DA and AMI services. In September 2017, the State Grid launched an alliance for private wireless networks formed of power companies, research institutes, integrators, telecom equipment and device vendors to work on standards and specifications for private LTE products.

While licensed LTE is best suited for critical grid operations, unlicensed NB-IoT-U is promising for AMI. Industrial Scientific and Medical (ISM) bands such as 902-928MHz in Latin America, 470-510MHz in China, and 863-870MHz in Europe are available worldwide and already in use for metering applications.

CONCLUSIONS - WHY PRIVATE LTE NETWORKS?

The distribution grid needs a dynamic infrastructure that can handle the radical changes occurring in generation and consumption. A truly smart grid needs equally smart communications to deliver these benefits. The communications network must be as dynamic, secure and reliable as the power network as the two become increasingly interdependent.

Private ownership of LTE networks allows a grid operator to take total control of its destiny and have confidence in a future-proofed and standards-based network that offers all the benefits of a global mainstream technology.

Why private networks?

- Configure networks to suit the dynamic conditions of the grid;
- Avoid escalating managed services charges as data traffic grows;
- Manage operations of all-IP network; and
- Ensure that grid and customer data is always secure.

PRIVATE OWNERSHIP OF LTE NETWORKS ALLOWS A GRID OPERATOR TO TAKE TOTAL CONTROL OF ITS DESTINY.

Why LTE?

- Connect distribution grid assets over a wide area for less cost than alternatives;
- Use LTE-Advanced to deliver bandwidth and spectrum efficiency;
- Ensure a smooth evolution to 5G; and
- Deploy in utilities' own licensed bands for critical functions and unlicensed bands for cost-effective AMI.

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NEXT STEPS

Schedule a meeting with our global team to experience our thought leadership and to integrate your ideas, opportunities and challenges into the discussion.

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