Utilities

Cutting the wires: 4G for the Smart Grid

Peter Johnson assesses the opportunity for LTE systems in the utility industries

By the time you read this, Everything Everywhere will have become the first UK mobile telecoms operator to promise country-wide 4G (fourth generation) mobile communications services and the 4G capable iPhone 5 will be in the shops. Everything Everywhere adds to a rapidly growing list of almost 100 commercial 4G deployments around the world.

4G services are predominantly based on Long Term Evolution (LTE) technology which is enabling the high-speed, high-bandwidth applications such as video streaming and online gaming being demanded by the hungry hordes of smartphone and tablet users. The growing maturity of LTE is starting to attract the attention of other communities that depend on communications to run their operations, such as public safety agencies, rail operators and, of course, utilities. This maturity is represented by regulatory and technological stability (i.e. LTE is here to stay), coupled with intense competition that is lowering prices for 4G devices and services.

With many electricity providers investigating or actively deploying new communications technology in line with their Smart Grid objectives, is there a role to play for LTE? To help answer that question, we need to understand what exactly LTE is, what it can do for electricity providers and how they can get it.

The A to Z of LTE

At its simplest, wireless technology is the most cost-effective way – and in some cases the only way – of providing connectivity. Mobile technology is nothing new for utilities, of course. Cellular has been used widely for backhaul connections and professional mobile radio (PMR) is commonplace. So let's first examine some of the technical properties of LTE and their potential uses in the Smart Grid.

Every new generation of mobile technology brings increases in speed, reliability and capacity, generally with reduced costs of deployment. LTE is no exception but it brings a lot more besides.

Better performance

LTE uses multiple-input multiple-output (MIMO) technology that puts several antennas – rather than one – on a single tower or terminal, which significantly improves both capacity and coverage. Orthogonal frequency division multiple access (OFDMA) means LTE is better than previous technologies at maximizing the use of available spectrum. As such, LTE is able to deliver tens of Mbit/s.

The bottom line for utilities: the Smart Grid depends on information, and lots of it. With LTE, voluminous amounts of information can be exchanged from anywhere, instantly, in many ways.

Simplified, IP-based architecture

LTE is based on simplified all-IP (Internet Protocol) architecture. This simplification means fewer network elements which results in lower costs as well as greater efficiency and lower latency. All-IP means LTE is also extremely scalable and flexible, which makes it easy to connect a significant number of devices and have redundant routeing between nodes for increased reliability.

The bottom line for utilities: the Smart Grid contains potentially millions of different devices at different levels in the distribution network. LTE can be a single network supporting more simultaneous communications carrying more data from more devices. In other words, every device on a Smart Grid can be supported as well as most communication applications used in a utility's operations.

Low latency

Thanks to the simplified architecture and the optimized framing of the LTE air interface, LTE delivers very low latency (10–15 ms). This is very important when it comes to voice communications or video streaming and for applications that require very fast access setup.

The bottom line for utilities: with LTE, the ability to serve extremely demanding applications will open the door to many functions that are not possible with current networks. For example, a utility may opt to use video-enabled drones to carry out routine inspections on transmission lines.

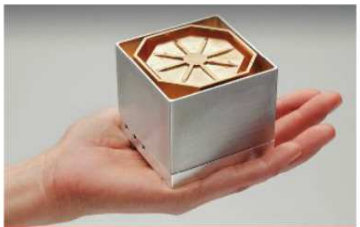
Security

LTE makes use of some of the most advanced security mechanisms available. Air interface security protects against attacks originating in the wireless domain while network security protects against security attacks generated in the wired parts of the network. Mutual authentication between the network and devices ensures system integrity.

The bottom line for utilities: the Smart Grid is perceived as opening up utility companies to potential cyber-attacks. The level of security in LTE, combined with its low latency, means LTE can be considered for mission-critical (e.g. replacing Tetra) as well as non-mission critical (e.g. meter-reading) applications.

Quality of service, prioritization and pre-emption

With its all-IP architecture the LTE network relies on sophisticated QoS controls to serve the different types of applications with differentiated and guaranteed QoS and to ensure appropriate prioritization/pre-emption in the event of congestion. QoS functions are spread



Alcatel-Lucent's revolutionary LightRadio puts the power of LTE in a cube

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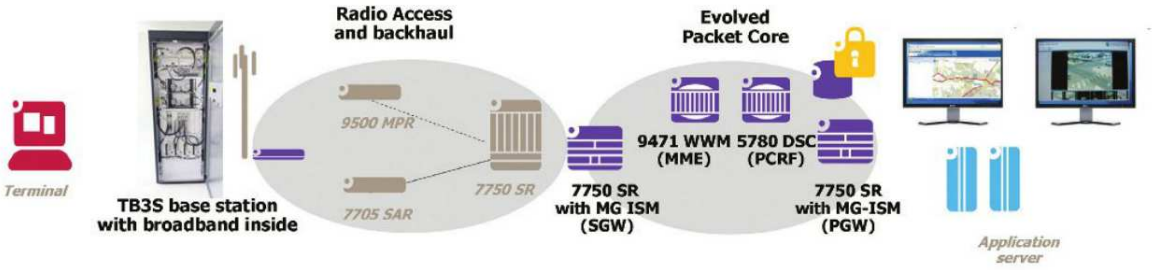

Evercor, from Alcatel-Lucent and Cassidian, brings LTE to the 400MHz frequency band used by many utilities for mobile radio

across the whole LTE network, including the backhaul segments, for a true end-to-end QoS management.

The bottom line for utilities: intelligent sharing of air resources and network capacity and prioritization of traffic, for example, during incidents, ensures that critical communications continue to be carried over with the needed quality, reliability and efficiency.

Network sharing

The way LTE works with frequency bands and encryption allows different parties and applications to share the same network resources without interfering with each other.

The bottom line for utilities: utilities therefore have different deployment options. For instance, they can deploy their own private LTE network or instead share resources – and the costs – in a variety of business models.

Licence to bill

LTE is wireless and so it requires spectrum. Spectrum is finite and hence both hard to come by and extremely valuable. One's options for spectrum vary widely from country to country with licensing authorities having strict control over what is available to whom. For example, Industry Canada, the spectrum regulator in Canada, has set aside 30 MHz of spectrum specifically for use by utilities. In the US, 2×10 MHz of spectrum in the 700 MHz frequency has been reserved for public safety agencies with much talk recently of partnering with utilities to share this band and the costs of deploying LTE networks.

Across much of Europe, Middle East, Africa and many APAC countries, the 400 MHz band is reserved for PMR use among public safety and industry organizations, with recent technological developments making this a viable band for LTE. Incidentally, lower frequencies provide wider coverage and better penetration, which make them well suited to utilities' needing to cover wide areas and urban communications. The European Commission is investigating setting aside bandwidth for critical industries such as utilities.

Lastly, some unlicensed or lightly licensed frequency bands are available in certain countries, those these may be congested and therefore pose reliability concerns.

Getting in the LTE game

There are essentially three routes to adding LTE to your Smart Grid network, which must be considered in tandem with the spectrum issues.

Do it yourself

If you're lucky enough to have spectrum available – or rich enough to be able to buy some – then there is the attractive option of deploying a private LTE network. The downside of this approach is cost, both in terms of initial deployment (capex) and ongoing management (opex). There are strategies for reducing capex: for example, re-use of existing sites and infrastructure or outsourcing. Regardless, for many utilities the increased levels of security and control of a private network make the investment worthwhile.

The bottom line for utilities: a private LTE network gives complete flexibility, security and control, but at a cost.

Piggy-back

Most commercial mobile operators have services such as M2M (machine to machine) connectivity that are targeted at industries. There are also network managed services options that allow utilities to jump into LTE at a much lower capex. The downsides are increased opex, lack of control and, to an extent, reduced security. Of chief concern would be service reliability: if a commercial operator's network goes down or is congested, can a utility afford its applications to suffer?

Another factor is rural coverage; a commercial mobile operator generally does not reach as far into the population as a utility. However, service level guarantees can offset some of these concerns.

The bottom line for utilities: LTE provided as a service is one option for bringing LTE to the Smart Grid, providing a utility's business concerns – notably opex, coverage and reliability – are met.

Partner

As previously mentioned, there is a certain amount of debate about LTE network sharing between public safety agencies and utilities. In many respects utilities and public safety agencies make ideal bedfellows when it comes to sharing an LTE network: utilities are frequently involved in emergency situations, shutting off power lines at the request of rescue workers, for example, and so have existing relationships with public safety organizations.

Utilities also bring a lot to the table because they have infrastructure in place – such as power and transmission poles – to which they can add LTE equipment, as well as backhaul networks to connect all the pieces. Already many PMR systems are successfully shared by utilities and public safety, demonstrating the value of co-operation. And as we've seen, the technical characteristics of LTE overcome network sharing concerns such as capacity, reliability, security and traffic prioritization. Local authorities, rail operators or other organizations could also be potential partners based on similar criteria.

The bottom line for utilities: sharing the costs and sharing the resources with trusted partners is potentially an ideal way of having the level of control utilities require of their LTE networks at an affordable cost. Joining forces also strengthens both parties' position when lobbying for dedicated spectrum.

Persuasive

So the benefits of LTE as a Smart Grid technology are relatively simple to demonstrate and very persuasive. The trickier issues revolve around spectrum and a suitable deployment model. Solid business planning is essential, with a utility needing to look carefully at technical criteria, finance/investment options and, if appropriate, partnerships. But it's clear that LTE has the potential to play a leading role in transforming the way utilities manage energy distribution and consumption as part of an overall Smart Grid strategy.