Dynamic Communications for Smart Grid

Driving smarter energy management and usage

Alcatel-Lucent
The power grid is vital to delivering the energy that people have come to expect in their personal and professional lives. And ensuring the safe, reliable and secure delivery of high-quality power is the power utility’s primary objective. While they have done this very successfully for many years, aging power grids, combined with increasing demand, are now leading many power utilities to transform the way they do business by using smart grid technologies. To enable this transformation, power utilities are taking a closer look at a different kind of power — the power of their communications network to enable the smart grid and its real-time applications.
Power utilities in a changing world

The world has changed dramatically since most power grids were built. Today, power utilities face a host of challenges that aging and traditional infrastructure solutions simply cannot support.

A major part of the problem is that people expect access to as much electricity as they want, whenever they want it — particularly during heat waves. Responding to sudden spikes in energy demand is expensive and inefficient, and can threaten the delivery of reliable, high-quality power. While power utilities do have very sophisticated systems to predict demand and monitor supply, many rely on historical data rather than real-time usage information.

Figure 1 highlights the changing power demands over the last 20 years in northern Europe.

Collecting real-time usage data by going straight to the source of the challenge — the businesses and households generating the demand — and empowering people to take a more active role in managing their own energy use will help flatten demand peaks. However, delivering the combination of secure, real-time communications, applications and services required to make this customer connection is another significant hurdle that must be overcome.

The challenges of managing increasing and fluctuating demand are compounded by political and regulatory pressure to shift to renewable energy sources that will reduce the power utility’s carbon footprint. That shift creates the need to add small-scale, remotely located power resources that are typically connected to the least automated part of the grid — the medium- and sometimes low-voltage parts of the distribution network that are not currently covered by the communications network. And intermittent energy sources, such as wind and solar, cannot be allowed to destabilize the local grid.

As their difficulties continue to mount and converge, many power utilities are realizing that the answers to their challenges can be found by transforming the grid at the heart of their operations to a smart grid.

“Utility operating environments are changing rapidly, reflecting the impact of a number of key environmental and economic trends. To continue to serve the public well, and provide for future economic prosperity, utilities must adapt. They must redeploy resources — human, financial, and technical — in ways that continue to provide reliable, affordable service in a world that is becoming increasingly carbon-constrained. This is the context within which we should consider smart grids: they will be useful, and will constitute good investments; to the extent they help utilities address strategic trends and issues.”

SOURCE: “SMART GRID ECONOMICS, MAKING THE BUSINESS CASE FOR SMART NETWORK TECHNOLOGIES”, COPYRIGHT © 2009 UTILITIES TELECOM COUNCIL
The crucial role of communications in a smart grid

A smart grid leverages information and communications technology (ICT) to interconnect and enable the flow of real-time information within the power utility, between the power utility and its suppliers and partners, and between the power utility and its business and domestic customers.

Smart grids and their applications rely on a robust communications network that is secure, highly scalable and always available. As illustrated in Figure 2, the communications network must now reach out to the periphery of the smart grid and into every home and business. It must support the smart grid’s potential to generate massive amounts of real-time data. And it must enable the distribution network to support monitoring and management of millions of devices and smart meters in real time.

As the enabler for smart grids, the communications network forms the basis for smart grid transformation and a revitalized power utility.

Alcatel-Lucent customer EnergyAustralia recognizes the connection between ICT and achieving its business objectives.

“Integrating information and communications technologies into our existing electricity supply networks opens up a realm of possibilities for improving supply reliability and for putting more options for energy efficiency in our customers’ hands.”

GEORGE MALTABAROW, MANAGING DIRECTOR, ENERGYAUSTRALIA
Revitalizing your business

With a smart grid supported by a smart and secure communications network, power utilities will have the infrastructure, applications and services required to deliver non-stop, high-quality power safely and efficiently. They will be able to support distributed, renewable energy sources that offer small-scale, intermittent production. And they will have the reach and real-time communications needed to engage consumers in energy conservation.

Ensuring reliable power delivery

A mission-critical wide area network infrastructure based on IP and Multiprotocol Label Switching (IP/MPLS), combined with the appropriate power sensors in the distribution network, allows power utilities to collect and transport increased volumes of real-time usage data. With this visibility, power utilities can more accurately respond to rising or falling consumption. They can also dynamically adjust electricity supply to meet demand and better predict when and where there could be a weakness or a failure in the grid.

In case of an outage, an IP/MPLS infrastructure enables smart grid applications to take immediate and automatic actions to limit the spread of the outage and to dispatch the right workers with the right tools and the right information to restore power as soon as possible.

The carrier-grade characteristics of an IP/MPLS infrastructure — 99.999 percent reliability, guaranteed Quality of Service (QoS) and full redundancy — also allow power utilities to safely and securely shift crucial Supervisory Control and Data Acquisition (SCADA) and teleprotection applications onto a common infrastructure as they gradually migrate to an all-IP network that supports both existing and new services.

HIGH-SPEED IP COMMUNICATIONS NETWORK POWERS ALTALINK’S NEXT-GENERATION NETWORK STRATEGY

With an Alcatel-Lucent IP communications network linking its 270 substations, AltaLink in Canada is improving its power system management and enabling more efficient electricity delivery.

The new network will support AltaLink’s mission-critical applications, including teleprotection and SCADA, and data requirements. It will also allow AltaLink to continue increasing the resiliency, availability and efficiency of its internal data networks. Together, these capabilities will help ensure AltaLink can offer its customers reliable power, when they need it, at the most economical price.

“By engineering the network to support critical applications such as SCADA and teleprotection, the Alcatel-Lucent IP/MPLS solution plays a key role in our next-generation network strategy aimed at combining and improving service delivery and positions us for future growth and network expansion.”

CLINTON STRUTH, PRINCIPAL ENGINEER, NETWORK COMMUNICATIONS, ALTALINK
Maintaining power quality
The same communications infrastructure that helps power utilities ensure reliable power delivery also helps them maintain power quality.

By combining smart meters at the periphery of the grid and smart sensors embedded in the grid with a robust communications infrastructure, distribution operators can deliver consistently high-quality power despite the increase in distributed power sources, motorized appliances and other factors that could reduce quality. Operators gain visibility into the quality of energy delivered, receive immediate signals when quality deviates from acceptable norms and can pinpoint and proactively resolve problems at their source.

Without these smart grid and communications capabilities, power quality issues such as voltage surge, sag and flicker can occur in remote reaches of the grid, while the problem remains masked at higher levels as different loads are aggregated.

With an increased ability to maintain power quality, power utilities can also ensure regulatory compliance and minimize the adverse impact of problems to reduce costs. And they can identify consumers or producers who are creating a problem and proactively mitigate the effects of their activities.

Supporting renewable energy sources
Reliable and high-quality power delivery must also now include non-traditional energy sources. It used to be that electricity flowed in one direction — from the large-scale generation plant through transmission lines into distribution lines and out to consumers. With renewable energy sources, electricity is now also coming onto the grid and flowing in all directions.

A communications network that extends to remote locations on the edges of the distribution network and an IP-based core network that is highly reliable, fast and secure allow power utilities to rapidly transport the data required to manage these more complicated electricity flows. These networks can also support the additional real-time data generated by renewable energy sources.

The speed and reliability of the communications network also help support the automation, applications and state-of-the-art storage facilities required to smoothly manage the irregular power supply and mitigate the risks to power quality.
improving operational efficiency

As they explore new solutions for reliability, quality and renewable energy, power utilities are under increasing pressure from their stakeholders to improve their operational efficiency. In some regions, they are also challenged by an aging workforce that is taking critical skills into retirement with them. These factors are leading power utilities to consider how they can transform their operations.

A robust communications network based on IP/MPLS is central to transforming operations and improving efficiency.

For example, with highly reliable communications, power utilities can significantly improve monitoring of assets to determine those that are stressed or under-utilized and analyze how best to optimize use of the grid.

The communications network also allows the power utility to capture and provide centralized access to the knowledge and skills of their entire staff to ensure that valuable knowledge is not retired along with long-serving and senior staff members. With direct access to documentation and the knowledge of skilled personnel, lower-skilled field staff can complete their assignments faster and resolve more challenging issues.

GRDA COMBINES LEGACY AND NEW TECHNOLOGIES TO PAVE THE WAY FOR THE FUTURE

The Grand River Dam Authority (GRDA), a state-owned power generation and transmission utility in Oklahoma, the United States, needed to answer two questions: "Where are we?" and "Where do we need to be?"

The answers led GRDA to select Alcatel-Lucent IP/MPLS switches and routers, digital microwave technology, Wi-Fi® wireless networking and a voice over IP (VoIP) communications system to support its needs today and in the future.

“The greatest challenge we faced in upgrading our network was how to bring multiple legacy and future technologies onto a single platform and manage it. Alcatel-Lucent helped us work through this by presenting a complete, end-to-end solution that is highly reliable, highly scalable, easy to manage and is built on an open architecture."

JIM FraLEY, DIRECTOR INFORMATION TECHNOLOGIES, GRAND RIVER DAM AUTHORITY
Empowering consumers

Power utilities cannot fully address their challenges without engaging and empowering consumers. A smart grid and smart communications network extends right to businesses and households to enable the collection of real-time usage information from smart meters. With smart meters, meter data management systems and web-based access to real-time usage details, power utilities can give businesses and households the information and incentives they need to reduce their energy use during peak times and to shift energy use to non-peak times.

By interconnecting the communications network with business support systems (BSSs), power utilities can feed smart grid data into customer management systems, use energy pricing to influence consumer behavior and automate outage management and energy purchasing systems to create a self-activating, highly reliable smart grid for energy delivery.

Both business and residential consumers gain the ability to control and lower their own energy costs. And the power utility can take proactive actions to reduce the risk that demand will outstrip supply and cause brownouts or blackouts. It can also save the significant costs associated with bringing additional power generation sources online or buying power from other utilities during periods of peak demand.

Going one step further, power utilities can put remotely monitored and controllable technology, such as thermostats, in homes and businesses. With this approach, they can automatically adjust consumers’ usage by an agreed-upon amount to help flatten demand peaks in real time.

ASK YOURSELF: WHAT DO CONSUMERS WANT?

→ I want to see my electricity use in real time, not every few months, so I can make smarter decisions about how I use electricity.
→ I want to be rewarded when I make an effort to reduce my energy consumption or change the way I use electricity.
→ I want smarter appliances that help me manage my electricity consumption and save money.
→ I want a simple way to balance energy economy and home comfort.
→ I want the option to choose how my electricity is generated.
“The combination of the Meter Data Management System with an Operational Support System provided by the Alcatel-Lucent solution is an important cornerstone of a professional smart metering architecture.”

GERALD OBERNOSTERER, HEAD OF OPERATIONAL COMMUNICATION, KELAG NETZ GMBH, AN AUSTRIAN POWER AND GAS SUPPLIER AND ENERGY NETWORK OPERATOR BASED IN CARINTHIA

Smart grids bring financial benefits

As described in the Utilities Telecom Council (UTC) research paper, “Smart Grid Economics, Making the Business Case for Smart Network Technologies,” the financial benefits of smart grids and smart metering are substantial for utilities. The UTC, a United States-based global trade association for utilities involved in telecommunications, developed a financial model for an electric utility with one million smart meters deployed over 3 years. As illustrated in Figure 3, which shows a 10-year forecast period, the financial benefits for the utility could easily exceed 100 million United States dollars once the system is fully built.

Figure 3. A smart grid and smart metering have the potential to deliver significant financial benefits

Although the deployment capital requirements are significant, the benefits are strong enough to provide a positive value proposition. The Net Present Value (NPV) or the project is a positive $292.7 million and the Internal Rate of Return (IRR) is calculated at 13.8%. Note the following modeling considerations:

- Customer satisfaction values are not included in the analysis. Doing so would increase the IRR from 13.8% to 55.5%.
- The enhanced value from DOE stimulus funding is not included either. Reducing the capital outlay due to matching funds will have a material impact on the rate of overall return of the project.

Source: Smart Grid Economics – UTC Research and Shpigler Group
Alcatel-Lucent is the trusted partner of power utilities around the globe and works closely with them to understand their challenges, objectives and priorities and to develop a joint strategy for smart grids.

Throughout the partnership, we maintain a strong focus on power utilities’ priorities for safety, reliability, security and efficiency. We also recognize the importance of planning a gradual, flexible and scalable transformation that considers legacy technologies and provides positive return on investment (ROI). To increase the value of the partnership, our capabilities include helping power utilities establish new processes and train their workforce to support new technologies and processes.

**Securing the smart grid and the communications network**

The smart grid, the communications network and the information the network carries must be protected from unauthorized access at all times — for public safety, personal privacy and regulatory compliance.

Based on a deep understanding of cyber security requirements, Alcatel-Lucent provides security consulting services, advice on selecting and deploying firewalls and gateways and the know-how required to implement IP-based video surveillance and access control across the smart grid and communications network.

“In our very high-voltage, high-stakes project, Alcatel-Lucent worked closely with our teams, showed great flexibility and initiative and understood that our operating constraints must prevail at all times.”

_Gérard Pellerin, Operations and Control Director of RTE, France’s High-Voltage Transmission Grid Operator._
“Smart grid technology will benefit our customers, our employees and our shareowners. It will enable us to make better use of our existing infrastructure and help our customers use their power more wisely.”

KEN GRANT, MANAGING DIRECTOR OF OG&E’S SMART GRID PROGRAM.
OG&E: OKLAHOMA’S LARGEST ELECTRIC UTILITY

Supporting power utilities in every step of their transformation

Alcatel-Lucent is trusted with the design and integration of some of the most complex networks in the world. Our global team of experts uses carrier-proven processes and tools to mitigate risk and reduce costs in multivendor, multi-technology environments — from the earliest planning stages through end-to-end network integration and network operations.

The ability to partner with power utilities in every step of their transformation is one of the main reasons power utilities around the world choose Alcatel-Lucent as their smart grid partner.

• Network consulting services help power utilities evaluate their options, determine the best course of action and select the right technologies from the right vendors.

• Design and architecture services, project management services and network deployment services take power utilities from consulting to execution.

• End-to-end integration and migration services ensure new IP/MPLS networks are seamlessly integrated with existing fiber and microwave networks and with middle-mile WiMAX, Long Term Evolution (LTE) or unlicensed wireless networks.

• Network operations services take the pressure off the power utility so they can focus on their core mandate.

For more information about Alcatel-Lucent solutions for smart grids, please visit www.alcatel-lucent.com/smartgrid