DYNAMIC COMMUNICATIONS FOR THE SMART GRID
Driving smarter energy management and usage
DYNAMIC COMMUNICATIONS FOR THE SMART GRID

The power grid is vital to delivering the energy that people have come to expect in their personal and professional lives. Ensuring the safe and reliable delivery of high-quality power is the utility’s primary objective. While utilities have for many years met this goal very successfully, factors such as aging power grids, increasing demand and the incorporation of renewable energy are now leading many of them to transform the way they do business.

To enable this transformation utilities are looking closely at a different kind of power – the power of the smart grid using Information and Communications Technologies (ICT), to sustain and improve the security, reliability and efficiency of the grid. These technologies can be put into three general categories: sensing and control devices, applications, and the communications networks that bridge it all together. Utilities take then full advantage of innovations, driving smarter energy management and usage.
POWER UTILITIES IN A CHANGING WORLD

The world has changed dramatically since most power grids were built. Today’s power utilities face a host of challenges that aging and traditional infrastructure solutions simply cannot support – issues that vary according to unique requirements and economic situations within different regions. These range from consumer expectations of uninterrupted electricity delivery regardless of the circumstances, to bridging the constantly growing electricity demand deficit with a constrained budget. The figure below highlights the projected increase in peak demand in all regions. This is being driven by numerous factors such as the increased penetration of air conditioning, which has a significant seasonal and time-of-day demand variation. Consumers 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.

Smart meters that collect real-time usage data directly from the point of consumption – at the businesses and households using the power – allow customers to help flatten demand peaks by taking a more active role in managing their own energy. Volt/VAR Optimization, FLISR (Fault Location, Isolation and Service Restoration), and feeder protection and control enable utilities to reduce outages and maximize efficiency in electricity distribution networks. Supervisory Control and Data Acquisition (SCADA), protective relays, remote switching and metering provide capabilities for Substation Automation. Syncrophasors enable utilities to manage system-wide grid stability. However, none of these are possible without the common foundation of a dynamic, secure, and highly adaptable mission-critical communications network.

Also, the challenges of managing the growing and fluctuating demand for power are compounded by political and regulatory pressure to increase the use of renewable energy sources, such as wind and solar, in order to reduce the power utility’s carbon footprint. This renewable component typically involves small-scale, remotely located power generation resources that tend to be connected to the least automated part of the grid – the medium-voltage and especially the low-voltage parts of the distribution network. The input of new energy sources at varying points of the grid can introduce the risk of destabilization if they are not managed using real-time communications.

Many utilities recognize that addressing these challenges effectively will require a holistic approach – transforming their communications networks to provide a common foundation to support all the applications in a smart grid.

![Estimate Peak Load Reference](image1)

![World Electricity Supply and Demand by Sector](image2)

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DYNAMIC COMMUNICATIONS FOR THE SMART GRID ALcatel-Lucent Brochure


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, as well as between the utility and its suppliers, partners and customers. The communications plane is one of the intelligent layers in a smart grid, providing a bridge between the power delivery and intelligent applications planes. It connects meters with meter data management, sensors with Supervisory Control and Data Acquisition (SCADA) systems, distribution management systems with Data Acquisition (DA) devices, workers with dispatch and customers with utility services.

Smart grid applications rely on a Dynamic Communications network that is secure, highly scalable and always available. Such a network must reach out to the periphery of the smart grid to enable end-to-end visibility and control for the utility. 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 the monitoring and management of millions of devices and smart meters in real time. And it must be cost effective.

As the enabler for smart grids, the Dynamic Communications network forms the foundation for smart grid evolution and enhanced power utility grid control.
The Alcatel-Lucent Service Router product family integrates the scalability, resilience and predictability of MPLS along with the bandwidth and economics of Ethernet and a broad selection of legacy interfaces to enable a converged network infrastructure. This includes the 7705 Service Aggregation Router, a repeat award winner of the UTC Telecom “Best telecom Equipment Award”, the TMC “Smart Grid Product of the Year 2011” award and “The Best Carrier Ethernet Mobile Backhaul Product” award.

“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

ENHANCING YOUR BUSINESS CONTROL

A smart grid supported by a Dynamic Communications architecture enables utilities to ensure reliable power delivery and quality, support renewable energy sources, improve operational efficiency and engage with customers. This communications network is the bridge between the utility and its assets, workforce, customers and partners.

ENSURING RELIABLE POWER DELIVERY AND QUALITY

A mission-critical wide area network infrastructure based on IP and Multiprotocol Label Switching (IP/MPLS), combined with the appropriate sensors in the distribution network, allows power utilities to collect and transport increased volumes of real-time usage data that enable DA and Substation Automation (SA). With this visibility, power utilities can more accurately respond to rising or falling consumption. System management and demand response applications can 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 fault detection, allowing protection applications to take immediate and automatic actions to limit its spread, and then dispatch the right workforce with the best tools and most accurate information to restore power as soon as possible.

The mission critical-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 SCADA and teleprotection applications onto a common infrastructure as they gradually migrate to an all-IP/MPLS network that supports both existing and new services.
Utility core applications traffic that affects grid reliability uses IP/MPLS that is commonly transmitted over a fiber optic infrastructure using high speed Gigabit Ethernet, and/or Wave Division Multiplexing (WDM) transport technologies. To reach remote sites, microwave transport with IP/MPLS, as well as WiMAX, and LTE technologies provide cost-effective wireless solutions for most mission-critical applications.

**DELIVERING HIGH-QUALITY POWER**

By combining a robust communications infrastructure with smart meters at the periphery of the grid and smart sensors embedded throughout, distribution operators can deliver consistent high-quality power despite the increase in distributed and variable power sources, motorized appliances and other factors that could reduce quality. Operators gain unprecedented visibility into the quality of energy delivered, receiving immediate notifications and alerts when that quality deviates from acceptable norms, allowing them to 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 remaining masked at higher levels as different loads are aggregated.

A Field Area Network (FAN) extends communications to sensors and meters as well as field technicians. Different communication network technologies may be used for FANs depending on three factors: technology availability, applications supported at the endpoints and costs.

Utilities typically deploy wireless- or wireline-based solutions, depending upon the terrain, network topology, application bandwidth requirements and spectrum/fiber availability. Wireless solutions include WiMAX, 3G and 4G-LTE with lightRadio™ technology. Gigabit Passive Optical Network (GPON) and Fiber to the x (where x can be a home – FTTH, neighborhood, etc) and PLC are two prominent wireline solutions.

With the increased ability to maintain power quality, utilities also can better ensure regulatory compliance while minimizing the adverse impact of problems, thereby reducing costs. Additionally, they can identify consumers or producers who are creating a problem and proactively mitigate the effects of their activities.

**Broadband Wireless**

Access to wireless spectrum can be a challenge and a large expense for broadband. In countries such as the United States, where spectrum has been dedicated to public safety 4G-LTE mobile broadband communications, utility partnerships for deploying and sharing such a network can make sense.
SUPPORTING RENEWABLE ENERGY SOURCES

Today’s reliable, high-quality power delivery includes energy from non-traditional sources. It used to be that electricity flowed in one direction – from the large-scale generation plant through transmission lines, into the distribution network and out to consumers. With renewable and intermittent energy sources, electricity on the grid now flows in all directions.

A FAN that extends communications to remote locations on the edges of the distribution network, connecting them to an IP/MPLS-based core network that is highly reliable, fast and secure, allows 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 enables the automation, applications and state-of-the-art storage facilities required to smoothly manage an irregular power supply and mitigate the inherent risks to power quality.

IMPROVING OPERATIONAL EFFICIENCY

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

“Wireless means more instant access, more convenience, so customers are going to expect to control consumption, communicate with the utility, view bills and more wirelessly. They’re going to be interacting with appliances in their homes wirelessly, which should reduce energy use.”

HAROLD DEPRIEST, PRESIDENT AND CEO, ELECTRIC POWER BOARD OF CHATTANOOGA (EPB)
“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, AUSGRID

The Alcatel-Lucent Service Portal Express puts the power in the hands of operational teams who can perform network management tasks without specific network knowledge using utility terminology. With a modular and extensible framework-based architecture, it maximizes the efficiency of the day-to-day mission, such as provisioning circuits for SCADA or protection, monitoring real-time status, troubleshooting problems, reporting on NERC-CIP asset inventory and validating service performance.

Using automation to improve asset management, grid maintenance and workforce dispatch is a key capability through which the smart grid improves operational efficiency, and a robust communications network based on IP/MPLS is central to supporting those operations. For example, with highly reliable communications, power utilities can significantly improve monitoring of assets to determine those that are stressed or under-utilized, providing real information, as opposed to engineering rules on paper, to support decisions related to maintenance or replacement. This means that utilities can maximize the use of existing assets and make smart investment decisions for replacing equipment. It also enables an efficient mobile workforce, so that when repairs are required, utilities can send the right person to the right place, with the right tools, to address the problem.

An advanced communications network also allows power utilities to capture and provide centralized access to the knowledge and skills of their entire staff while ensuring that valuable knowledge is not retired along with long-serving and senior employees. 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.

Service and network-level communications management capabilities also simplify operations and reduce operational cost. These include applications for integrated IP/MPLS and microwave network management, as well as intelligent and flexible self-serve and assisted customer care tools for enabling smart meters and additional applications within a residence.

Deploying smart meter solutions cost-effectively across millions of households or thousands of sensors at points throughout the grid requires highly efficient and automated tools for managing machine-to-machine communications. The Motive M2M platform offers a powerful set of core capabilities: management of devices, applications, communications and data, as well as storage, analytics and application development.
This potent combination enables a secure end-to-end managed communication channel between applications and end devices, allowing utilities to optimally manage routing, priority setting, traffic control, QoS, event notification, etc. As such it enables utilities to scale to millions of devices at minimal cost. Additionally, this platform uses open and standardized protocols that allow easy integration into the smart grid ecosystem.

**ENGAGE WITH CONSUMERS**

Engaging and empowering consumers as participants in energy efficiency, peak demand reduction and renewable energy initiatives is another key way that the smart grid enables utilities to address today’s challenges. A smart grid and its Dynamic Communications network can extend all the way to businesses and households to collect 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 shift energy use from peak 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, while power utilities can take proactive actions to reduce the risk that demand will outstrip supply and cause brownouts or blackouts. Utilities also can save the significant costs associated with bringing additional power generation sources online or buying power from other utilities during periods of peak demand.

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“We see the Smart Grid as integrating utilities like ours much more into the lives of our residential customers and businesses. The communications network overlaid on top of the Smart Grid will provide people with options they haven’t had before.”

HAROLD DEPRIEST, PRESIDENT AND CEO, ELECTRIC POWER BOARD OF CHATTANOOGA (EPB)

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**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 it.”

“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.”
“With smart technology we’ve already reduced our costly outages by a third, and we think we can get that to over 40 percent."

HAROLD DEPRIEST, PRESIDENT AND CEO, ELECTRIC POWER BOARD OF CHATTANOOGA (EPB)

Going one step further, power utilities can put remotely monitored and controllable technology, such as smart 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.

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 implementing DA and deploying one million smart meters over three years. As illustrated in the figure below, which shows a 10-year forecast period, the financial benefits for the utility could easily exceed US$100 million once the system is fully built.

Although the deployment capital requirements are significant, the benefits are strong enough to provide a positive value proposition. The Net Present Value (NPV) of 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.

To make the right investment decisions, utilities benefit from the Economic Analysis research center of Bell Labs, which delivers advanced methods and tools for network planning and design, as well as financial optimization of network transformation and business modeling. With data analytics coming from multiple sources embracing a large eco-system, Bell Labs experts can evaluate the business and network economics, quantifying benefits and risks for better energy management and cost optimization, providing new revenue opportunity and decreased environmental impact.

A SMART GRID AND SMART METERING HAVE THE POTENTIAL TO DELIVER SIGNIFICANT FINANCIAL BENEFITS

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<th>Year</th>
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Source: Smart Grid Economics – UTC Research and Shpigler Group
One example of smart grid-driven financial benefits is the Electric Power Board of Chattanooga (EPB). EPB’s project includes both Smart Grid and Utility Telecommunications (UTelco) services that deliver voice, video and data to consumers as well as smart metering and smart grid applications. The University of Chattanooga projects that EPB’s smart grid project will support more than 2,600 new jobs, and new business investment totaling US$4 billion overall - thanks also to a 1Gbps fiber to the home (FTTH) network to a 600 square mile region.

REALIZING THE POWER OF A SMART GRID PARTNERSHIP

Alcatel-Lucent is the trusted partner of power utilities around the globe, working closely with them to understand their challenges, objectives and priorities in order to mutually develop technologies and processes for the strategic deployment of smart grids. Throughout these partnerships 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 a positive return on investment (ROI). We enhance the value of these partnerships further with workforce training to support all 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.

These services include options to further enhance the security capabilities built into technologies such as IP/MPLS and LTE communications solutions, in compliance with regulations and/or company policy, when they support specific mission-critical applications. For example, communications supporting DA and SA might include low latency encryption at the appropriate layer without impacting network performance. In addition, utilities can implement ongoing authentication to prevent unauthorized or manipulated traffic from reaching application servers, damaging equipment or disrupting service.

“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.”

RTE, FRANCE’S HIGH-VOLTAGE TRANSMISSION GRID OPERATOR
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 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. These transformation support services include the following:

• Bell Labs’ Advisory Service provides an analysis of the present communications network and operations/network management, along with the development of target network architecture consistent with a utility’s objectives and requirements.
• 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 Field Area Networks with technologies including WiMAX, Long Term Evolution (LTE), FTTH and PLC.
• 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

“Learning from our partners is an important part of project, adding skills to our organization. It’s an interesting evolution for the utility industry – allowing us to become more data-intensive, more high-tech, with better information from which to make business decisions. It’s opening a new age for utilities and how they manage their business.”

KEN GRANT, MANAGING DIRECTOR OF CUSTOMER SOLUTIONS, OGE