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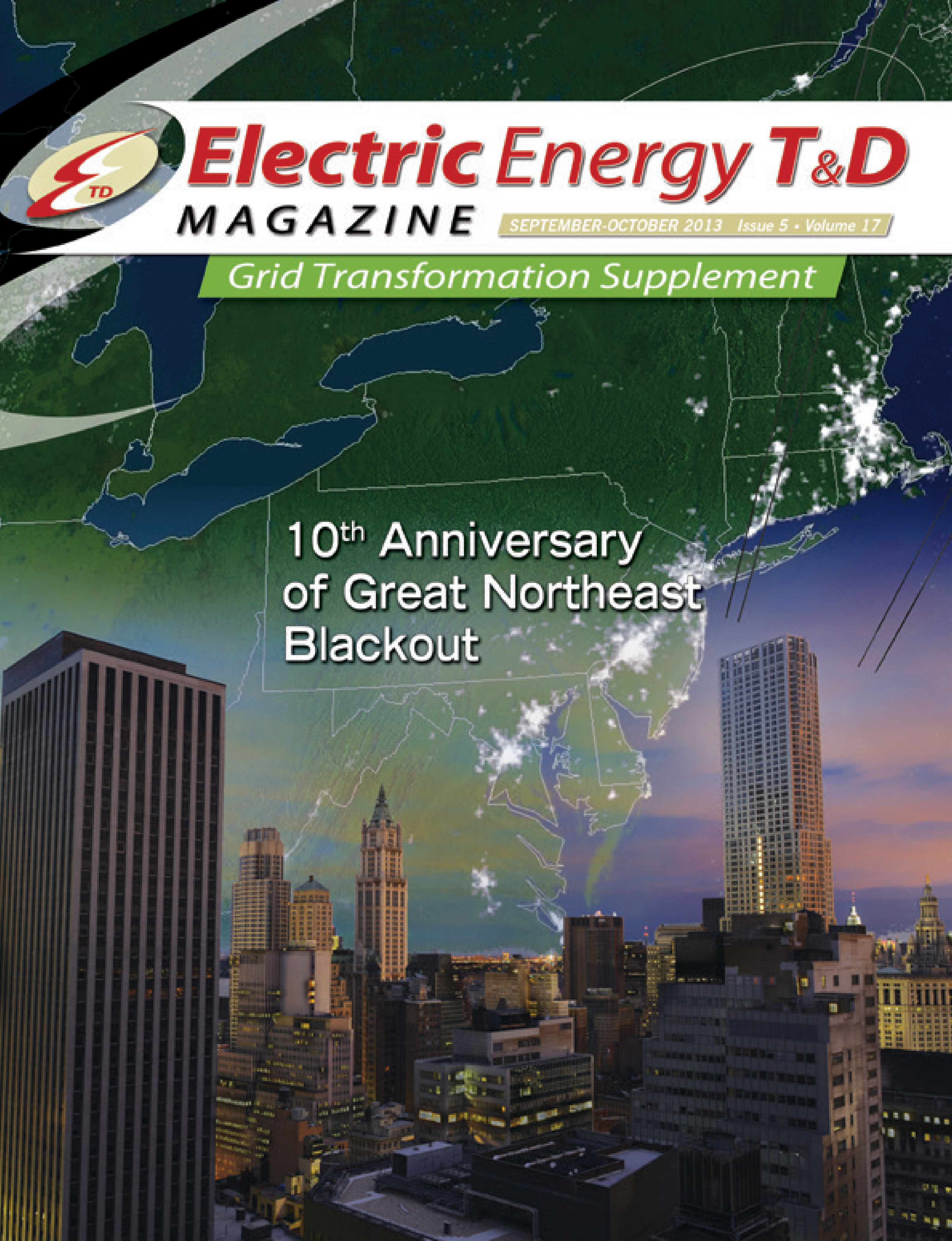
Grid Transformation Supplement

10th Anniversary of Great Northeast Blackout



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Grid Transformation Supplement

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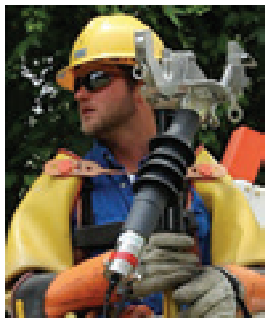

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10th Anniversary of Great Northeast Blackout

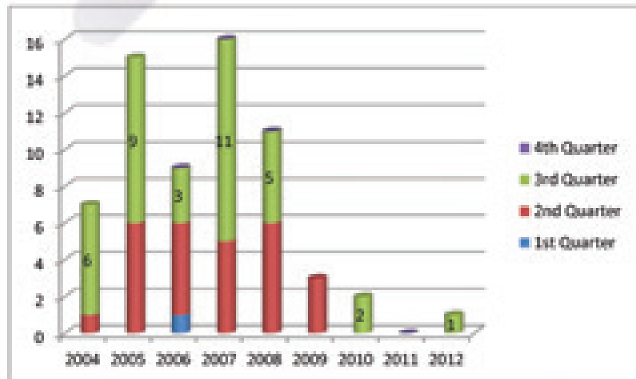
By Navin Bhatt and Paul Myrda
Electric Power Research Institute

On August 14, 2003, approximately 50 million people throughout the Midwest and Northeast United States and Ontario, Canada, experienced an electric power blackout. In the aftermath of the Great Northeast Blackout, the industry has been busy addressing the recommendations from the Blackout report released in April of 2004.

Several recommendations, related to institutional issues, have already been implemented. These include establishment of the Electric Reliability Organization (ERO) starting July 2006, with the North American Reliability Corporation (NERC) fulfilling the ERO role. Beginning June 2007, mandatory and enforceable compliance by the industry with reliability standards was instituted, along with penalties as well as requirement to fix the violations. Also, the Federal Energy Regulatory Commission (FERC) and NERC reviewed the reliability standards of that time, identified deficiencies, and have continued to revise, largely with the help of industry's practitioners and subject matter experts, these standards to address the deficiencies. Additionally, the role of Regional Transmission Organizations (RTOs), Independent System Operators (ISOs) and other reliability entities in maintaining bulk power system reliability has been clarified. These efforts have improved the industry's understanding of roles and obligations in maintaining reliable operation of the interconnected network, a lack of which contributed to the Blackout. A few of the specific recommendation areas are worth noting.

Vegetation Management

One of the causes of the Blackout was failure 'to manage adequately tree growth in transmission rights-of-way.' Significant progress has been made in addressing the tree growth issue as NERC has developed, and enforced since 6/18/2007, vegetation management standards (FAC-003-1). The following figure from a NERC report shows vegetation related transmission outages reported to NERC under Category 1 (Grow-ins: Outages caused by vegetation growing into lines from vegetation inside and/or outside of the ROW). A downward trend in these outages can be seen during recent years.



Grow-In Outages Caused by Vegetation Growing Into Lines From Inside and/or Outside the ROW Courtesy – NERC

Situational Awareness

Inadequate situational awareness was identified as one of the Blackout causes. Situational awareness refers to ensuring that accurate, dependable, timely and comprehensive information on current system conditions is continuously available to operators. This includes information on the current state of bulk electric system as well as on the potential impact of contingencies, and of changing generation, load and power transfer scenarios.

Situational awareness became a popular industry term following the Blackout. The industry immediately started to develop novel situational awareness tools. Operators started installing in their control centers large, state-of-the-art, high-definition visualization screens to display information from their own as well as from neighboring systems. Research on human performance aspects was conducted to design screens for optimum human comprehension. For example, in 2008, the Electric Power Research Institute (EPRI) investigated the state of situation awareness in the power systems industry by examining the use of color, automation and predictive tools to support the highest levels of situation awareness, with the goal to identify design guidelines for situational awareness tools for power systems operations. Even today, finding ways, tools and innovative technology solutions to improve situational awareness remains a major goal for operators, energy management system (EMS) vendors and research community.

Synchrophasor Technology

Synchrophasor technology has demonstrated the potential to enhance situational awareness by providing high-resolution – 10 to 60 samples per second – view across a wide area of the power system, along with GPS-synchronized time stamping. Synchrophasor technology has been often referred to as an MRI of power system, as opposed to an X-ray provided by the SCADA technology. Tools have been developed to display synchrophasor data in real time, in order to provide an instantaneous view of power system quantities to operators. The quantities include transmission voltages, line currents and MW/MVAR flows, bus frequency and phase angles. When key quantities are monitored at important locations, the information can measure power system stress and foretell an impending system emergency.

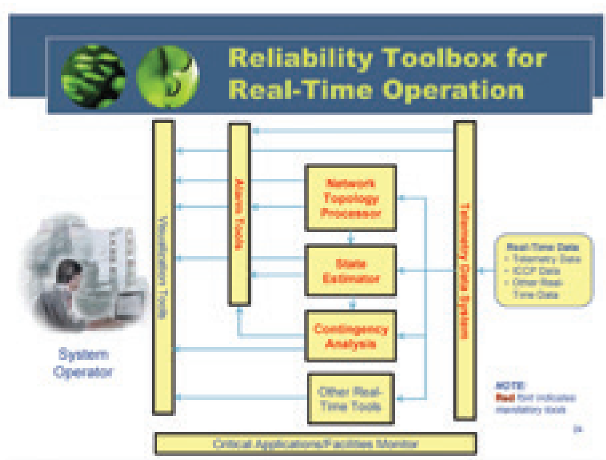
Synchrophasors are measured using devices called phasor measurement units (PMUs), which are typically installed at transmission stations. At the time of the Blackout, there were about 50 phasor measurement units connected to the U.S. grid. Today, over 1000 phasor measurement units are nearing final installation; this is a direct result of the Smart Grid Investment Grant funding and the continued leadership of the U. S. Department of Energy. The primary venue for the advancement of this technology has been the North American Synchrophasor Initiative (NASPI), which has brought together industry segments such as utilities, vendors, researchers and academics. With the near completion of the new synchrophasor infrastructure, the industry focus will now be shifting towards applications to capitalize on this new infrastructure. Many prototype applications have already been demonstrated as the industry continues to explore the use of synchrophasors in real time and off-line environments. An industry R&D effort is underway among the research community, end users (grid operators and planners) and EMS vendors to produce production-grade synchrophasors applications.

In recent years, transmission operators have expressed keen interest in having asset/equipment condition/health information available in control centers to improve their situational awareness and to facilitate their decision-making. With aging assets, concerns about critical equipment experiencing failures have increased. Equipment condition information can provide the operator with 'look ahead' capability to proactively plan ahead for potential security or emergency situations. Equipment information facilitates operator's decision making and operational risk management abilities. Equipment health diagnosis technologies, also known as sensor technologies, have made tremendous progress in recent years and it makes practical sense to utilize the emerging technologies for the benefit of grid operations where practicable and cost effective. Utilities are forming asset health centers, with the primary focus to provide venue for asset managers to be able to pursue prudent life-cycle management practices, and with secondary goal to provide pertinent asset information to the operators after that information has been vetted by asset managers.

Another cause for the Blackout was identified as inadequate system understanding, specifically referring to failures to maintain adequate reactive power support and to ensure operation within secure limits. Recommendations to address this cause included adopting better real-time tools, strengthening reactive power and voltage control practices, reevaluating system planning and operating criteria, and improving quality of system modeling data and data exchange practices. To address these recommendations, the utilities, RTOs/ ISOs, NERC, vendors and researchers have spent considerable efforts in enhancing reliability standards and criteria, study tools and techniques, and in implementing revised tools and operating procedures. A few examples of these efforts are summarized below.

Real Time Tools for Analysis and Control

In the summer of 2004, NERC formed the Real-Time Tools Best Practices Task Force (RTBPTF), made up of industry subject matter experts, to identify the best practices for real-time reliability tools used to build and maintain real-time network models, perform state estimation and contingency analysis, and maintain situational awareness in accordance with NERC Reliability Standards. The task force was also instructed to develop guidelines for minimally acceptable capabilities for these critical reliability tools and to recommend specific requirements to be included in reliability standards for these tools. The task force recommended five mandatory tools that should be viewed as core elements of an operator's 'reliability toolbox,' as shown in the figure below. With this guidance, many reliability entities have implemented these tools in their control centers.



Reliability Toolbox
Source: NERC RTBPTF Final Report, March 13, 2008

System Performance Assessment and Criteria

In 2004, FERC formed an interoffice staff team to develop the principles for efficient and reliable reactive power supply and consumption. On February 4, 2005, FERC issued the staff report, which contains a series of technical and market issues related to reactive power.

On March 8, 2005, FERC held a technical conference to address specific issues raised in the staff report. This effort by FERC and the utility industry provided a good foundation to address the adequacy of reactive power support for real time operations. Also, NERC revised and started enforcement of its Voltage and Reactive (VAR) reliability standards in 2011.

To understand system limitations for ensuring secure operation, operators and planners need to perform simulation studies to assess system performance under contingency conditions and compare the performance with performance criteria documented in NERC transmission planning (TPL) standards. NERC, with help from industry experts, initiated efforts to revise the transmission planning (TPL) standards in 2007. A phased enforcement of the revised TPL standards began in May 2009 and is still in progress. The industry continues to make progress in implementing simulation study procedures that call for maintaining adequate reactive power support and ensuring operation within secure limits. This includes studies in various timeframes, including long-term (one year or more), short-term (seasonal, within a year) and real-time. While a vast majority of real-time contingency analysis studies are performed to assess steady-state performance using power flow methods, selected reliability entities, such as PJM and CAISO, are making efforts to implement time-domain simulation capabilities to assess dynamic performance in real-time under contingency conditions.

The scope of modeling used for these studies is also an important aspect, which is a topic of considerable debate among, and interest to, the operators and planners. Reliability entities are utilizing resources to make sure the geographic scope of model used in real-time studies and the associated modeling data are adequate to simulate the system performance phenomena of interest.

Summary

A focus that has been emphasized after almost every important blackout event around the world has been the concept of the three T's – trees, tools, and training – as a key in being better prepared to minimize the impact of future events. We have discussed trees and tools. Training on all aspects of the issues described here is obviously critical and NERC-approved certification has become mandatory for operations staff of reliability entities.

In the aftermath of the 2003 Blackout, much has been done by the industry to enable it to improve planning, design, and management of the grid to reduce the likelihood of large cascading outage events. While the industry has come a long way, more still needs to be accomplished. As evident from the September 2011 Arizona-Southern California event, the industry still needs to be vigilant and proactive in securing necessary tools to assess and understand system limitations. The industry could seek, develop and implement new and innovative technologies to stay ahead of new challenges such as cyber security, environmental policies, changing generation mix and aging assets.

The grid continues to evolve and as it does, system operators are faced with new challenges and threats to the system. As more information and communication technologies are added to the grid infrastructure, cyber security will be a growing issue. The industry is focused on this today, but it is in its infancy in terms of understanding what will be the best ways to deal with the challenges information and communication technologies bring. Integrating renewable generation resources such as wind and solar brings a different set of challenges due to their variable nature and that wind resources, because of their remote locations, will require new transmission infrastructure. The industry is quickly learning more about how to best integrate and manage these resources, but it will be an evolving process.

As in the case of the 2003 Blackout, the industry has a history of responding effectively to its biggest challenges. Outages will always be a fact of life, but the more that is learned and the more prepared the industry becomes, the greater the chance that outages affecting tens of millions of people for long periods of time will become a thing of the past.

About the authors

Navin Bhatt is a Technical Executive with the Electric Power Research Institute (EPRI) where his activities focus on R&D in the smart transmission grid, and transmission operations & planning areas. Before joining EPRI, Dr. Bhatt worked at American Electric Power (AEP) for 33 years, where he conducted, managed and directed activities related to advanced analytical studies; managed AEP's transmission R&D program; participated in the development of NERC standards; and participated in Eastern Interconnection Phasor Project (EIPP) and North American Synchrophasor Initiative (NASPI) activities. Dr. Bhatt received a BSEE degree from India, and MSEE and PhD degrees in electric power engineering from the West Virginia University.

Dr. Bhatt is a Fellow of IEEE. He is a licensed Professional Engineer in Ohio. He has authored over 40 technical papers. Dr. Bhatt was a member of the NERC technical team that investigated the August 14, 2003 blackout on behalf of the US and Canadian governments. He was a co-author of an IEEE working group paper that received in 2009 an award as an Outstanding Technical Paper. Dr. Bhatt has chaired 3 NERC teams and 2 EIPP/NASPI task teams.

Paul Myrda is a Technical Executive with the Electric Power Research Institute working in the Power Delivery and Utilization Sector. Currently he is program manager for the Information and Communications Technology for Transmission. In this role Paul facilitates activities across the EPRI organization related to transmission Smart Grid. Paul is also involved in cyber security activities as an External Advisory Board (EAB) member of the Trustworthy Cyber Infrastructure for the Power Grid (TCIPG) Center. Paul represents EPRI on the Industrial Advisory Board for the Power Systems Engineering and Research Consortium and the Center for Ultra-Wide-Area Resilient Electric Energy Transmission Networks (CURENT).

Previously, Paul was Director of Operations and Chief Technologist overseeing planning and asset management functions for Trans-Elect's operating companies. He championed an innovative protection and control system upgrade project for the Michigan Electric Transmission Company an affiliate of Trans-Elect. This project fully leveraged the capability of IEC 61850, physical security, telecommunications and data warehousing technologies using EPRI's Common Information Model.

Paul has over 35 years of experience including leading edge technology implementations. His diverse background includes planning, engineering, information systems and project management. He has an MBA from Kellogg (2000) and MSEE and BSEE from Illinois Institute of Technology (1980 and 1977, respectively). He is a licensed professional engineer in Illinois, member of CIGRE and Senior Member of the IEEE.

Beyond the Meter
Mobility Powering Utility Operations

By Michael Brander and Joshua Haims

From advanced smart meters to mobile networks, the electric utility industry is undergoing a massive technological transformation.

With today's super-fast wireless machine-to-machine (M2M) communications, the colossal computational power in 'the cloud' and smart analytics, utility operators today have more information than ever before to transform operations and the service that is delivered to consumers.

Today's utility executive is faced with a myriad of challenges. Whether it is dealing with government regulations and mitigating risk to managing workers spread out in the field, there is no shortage of issues to keep utility managers awake at night.

Just as connected machines and mobile technologies are reshaping industries ranging from media to consumer electronics, they are also having a very real impact on the energy and utilities industry.

In an April 15 news release, IT research and advisory company Gartner, Inc. listed machine-to-machine and communications technologies as among the top technology trends for the energy and utilities sector in 2013.

With industry smart grid projects and grid modernization efforts over the past few years, M2M technologies are driving change with devices on both the utility and consumer ends of the spectrum. Over the past several years, utilities have been rapidly deploying M2M solutions such as advanced metering infrastructure and automated meter reading to modernize operations while promoting conservation and reliability in grid operations.

Verizon's machine-to-machine connections play a key role in a sustainability initiative in Charlotte, North Carolina, known as Envision Charlotte. The company gathers the power usage data from a network of M2M devices and transports near real-time information to kiosks utilizing its 4G LTE network. The kiosks allow building occupants to track the city's energy conservation efforts. A similar program is being launched for water.

As the smart grid comes of age, utility operators are now looking beyond individual projects to target other ways to improve operations and customer service using mobile technologies.

Some utilities are now turning to mobile technologies to securely extend enterprise networks to service vehicles. One large utility created rolling vehicle hot spots by outfitting service vehicles with mobile routers connected to the 4G LTE network. The vehicle area networks – or VANs – provide connectivity for laptops and other handheld devices, giving technicians access to maps, customer accounts, and meter information. These technologies, combined with the utility's ongoing smart grid meter deployment, are effectively connecting the smart grid all of the way to the truck.

At the same time, telematics is starting to take hold. Generally, utility fleet managers with constantly rolling fleets are following the lead of their counterparts in other industries to adopt telematics.

Of course, virtually every utility already has access to information today about fleets, workers and work-orders. However, often the information comes in days or even weeks after the fact. In addition, it is especially important for utility fleets to stay on top of maintenance issues because vehicles are in constant use. Fleet telematics enables managers to anticipate problems and schedule maintenance.

Through Networkfleet, part of Verizon's Telematics portfolio, an array of fleet monitoring and management capabilities improves employee efficiency and customer service, cuts fuel use, and reduces overall mileage.

With Networkfleet, operations and risk managers use technology to improve operations by managing speed, fuel consumption, drivers, and vehicles while optimizing vehicle use and routes using diagnostics to help hold the line on maintenance costs. Key features include GPS fleet tracking, asset tracking, fleet maps, vehicle diagnostics with alerts, roadside assistance, preventative maintenance, and other fleet management tools.

For example, in 2012 Eugene Water and Electric Board – Oregon's largest customer-owned utility serving more than 87,000 customers – installed Networkfleet GPS tracking technology on its entire fleet of more than 220 vehicles. In the first year, the utility reduced fuel usage by 24 percent by lowering idle time and reducing unnecessary trips. After integrating GPS data and mapping, the utility found it could dispatch service trucks faster during power and water service interruptions.

The Eugene utility found that a key to reducing costs was the ability to monitor vehicle use. For example, the utility has 11 backhoes and only uses eight or nine of those regularly. By eliminating one 'spare' backhoe, the savings would more than pay for the entire GPS system for the year. With the web of sensors, meters, and advanced networks constantly gathering information, data is quickly becoming the utility company's most valuable asset. This data can provide new insights into consumption and load management and better serve changing customer requirements.

Enter the cloud. Rather than have data and information sit on utilities' servers, the introduction of cloud computing solutions and advanced communications solutions is changing the game. The cloud becomes an enabling platform that will help tie all of the pieces together for actionable data to help utilities make real-time decisions.

As customer and proprietary utility data increases, security will become more and more critical. Protecting the data – while managing access, identity, governance, risk, and compliance – is becoming increasingly important to utilities. In addition, the physical security of the components that make up this critical infrastructure must be secured as well.

It's a new day in the utility industry. Overall, the more the utility industry embraces technology – like M2M and telematics, the cloud and advanced communications -- the more it will be able to improve its efficiency, lower costs and serve its customers better.

About the authors

Mike Brander is vice president of sales for the energy and utilities practice in Verizon Enterprise Solutions, part of Verizon Communications. In this role, Mike leads a team that oversees the seamless delivery of enterprise solutions to some of the largest and most influential companies within the energy and utility industry. Mike and his team work with large energy and utility companies to identify, create, and deliver solutions to meet the unique traditional and emerging business needs of the industry by leveraging Verizon's world-class wireless and global Internet protocol networks, advanced machine-to-machine, telematics, cloud and security technology platforms, and professional consulting services.

Joshua Haims is general manager for Networkfleet at Verizon Telematics. Josh is responsible for collaboration and strategic direction and management of sales, marketing, business development, and product management of Networkfleet. Prior to joining Networkfleet, which was part of Hughes Telematics that Verizon acquired last year, Josh worked in a variety of corporate settings ranging from start-ups to established companies.

A Smarter Grid Begins with Smarter Lines

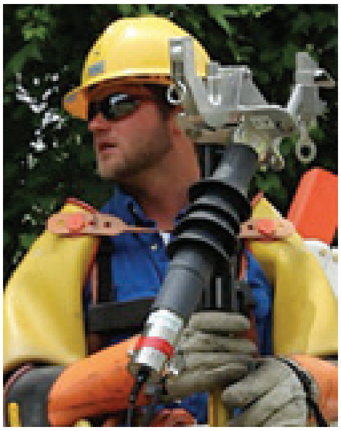
There are approximately 6.2 million miles of medium voltage distribution lines in North America. Of that, less than 5% of distribution circuits are equipped with upgraded communication, control, and information technologies that can manage outages, voltage levels, and reactive power in real time.

With up to 90 percent of all distribution system issues occurring between the substation and the service transformer, California utilities lost an estimated $2.4B in revenue from distribution line losses in 2008 alone.

Additionally, utilities worldwide are concerned about the technical challenges of distributed variable generation resources including voltage regulation, islanding, reverse power flow, and power compensation when variable renewable resources are unavailable.

Optisense Network

OptiSense Network LLC™ is a Smart Grid company that designs, produces, and delivers optical-based sensor solutions for medium voltage distribution systems.



OptiSense's optical-based sensor solutions are offered in four voltage classes (15kV, 25 kV, 35 kV & 46 kV).

Our optical sensors continuously monitor the distribution system's health and performance in real time – providing the control needed to improve reliability, increase efficiency, and extend the life of distribution assets.

OptiSense's highly accurate (±0.5%) optical sensor solutions acquire real time voltage and current-related data (including high frequency components) on single and 3-phase medium voltage (MV) distribution lines.

Analyzing 15,000 measurements per second, our nodal analytics software suite returns 225 different power parameters in standard DNP3 format. OptiSense enables centralized (SCADA, DMS) and local control (capacitor bank controllers, relays, switches, and regulators) – from substation to destination. And unlike conventional distribution meters, such as CTs, PTs, and voltage dividers, OptiSensors™ are lightweight, affixed directly to conductors with a "shotgun stick" and require no service outage.

A Smarter Grid Begins With Smarter Lines

OptiSense's optical-based solutions provide real time system condition data for:

Distribution System Efficiency

- Power Factor Correction
- Voltage Optimization
- Dynamic Load Balancing
- Conservation Voltage Reduction

Distribution System Reliability

- Fault Location Detection
- Fault Isolation, System Reconfiguration & Optimized Service Restoration
- Power Quality
- Renewable Generation Management
- Sequence of Events

Distribution Asset Management

- Condition-Based Maintenance
- System Planning
- Feeder Diagnostics

Primary Metering

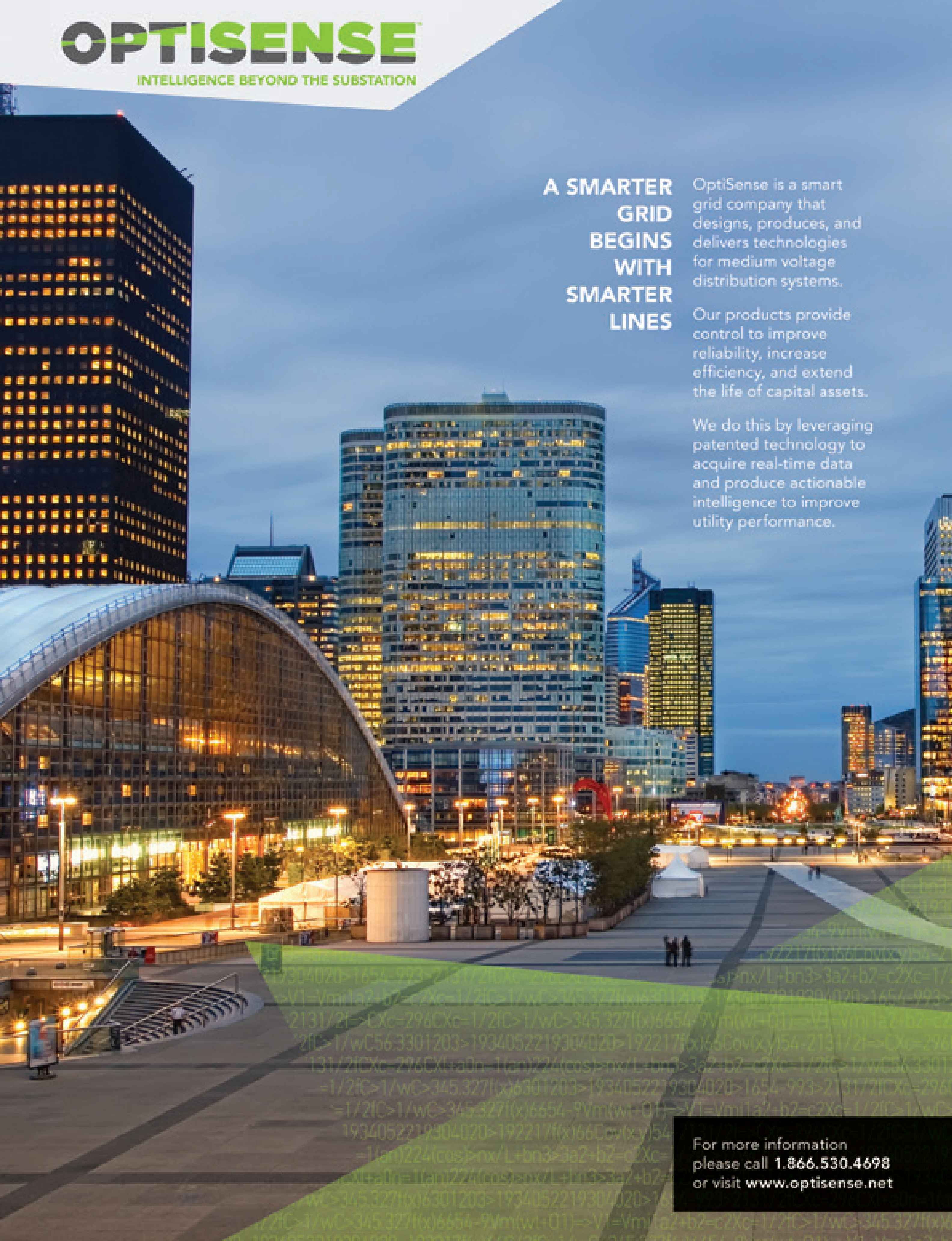
- Feeder Metering
- Metering Facility

OptiSense's intelligence beyond the substation has proven to increase distribution line efficiency up to 6%, reduce the frequency and duration of outages up to 20%, provide up to 15% savings through avoided capital & maintenance expenditures and deliver payback within as little as one year.

OptiSense solutions communicate with:

- SCADA Systems
- Distribution Management Systems
- GIS
- Managed Maintenance Systems
- Capacitor Control Systems

OptiSense Network, LLC™ (www.optisense.net) may be contacted at 866.530.4698 or at inquiries@optisense.net.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By Jamison Shaver
Senior Product Manager

Demand Optimization for Efficient Grid Operations

By recent estimates, the energy industry is expected to spend more than $51.1 billion improving the U.S. electric infrastructure by 2023.[1] Commentary from industry experts suggests this staggering amount can be explained by the state of our aging infrastructure and general macroeconomic trends. This realization, however, will undoubtedly cause policymakers and regulatory agencies to ask the question: Are we making the smart investments needed to meet tomorrow's energy challenges?

Considering this question, an area that deserves attention is the integration of Demand-Side Management (DSM) strategies with the safe and reliable delivery of electricity. Utilities that dynamically understand and incorporate demand response into their planning and operations cycles will reach a level of efficiency in distribution and economic spend consistent with the smart grid vision. This accomplishment will marry the somewhat disparate worlds of Demand Response Management Systems (DRMS) and Advanced Distribution Management Systems (ADMS), as technology alignment will be a prerequisite to the alignment of overall business objectives.

Many of today's DMS strategies have been designed to address temporary supply-side gaps or improve reliability margins. For example, direct or interruptible load control programs are used to shed or shift load during 100+ hours of peak demand that occur during the winter or summer months. In other cases, time-of-use (TOU) and peak pricing programs charge higher rates to curb energy usage and accommodate the higher cost of peak generation. A more effective demand optimization or DSM strategy will account for the implications of reduced demand across the value chain, from supply and delivery to individual energy consumption. Consumer awareness of both energy efficiency and the increased costs of energy usage will continue to grow. As this happens, the landscape for how our transmission and distribution assets are planned and managed will change along with the technology required for delivery.

Demand Optimization across the Value Chain

This transformation in the industry has already begun as current practices are blending into an integrated approach that will combine previously separate responsibilities into a single business objective. For example, the vast amounts of meter data available can be summarized by performance analytics that provide insight into regional and segmented load growth trends. These analytics on consumer energy usage can therefore be a path to informing long-term capital investment needs or infrastructure needs. However, DRMS solutions also contain the critical aspects of a control system, in that many will incorporate the ability for fast load shedding or sending dynamic price events real-time. An effective DRMS will be designed around the integration of existing systems, then layer several advanced capabilities upon that platform before grid operations value can be demonstrated with an ADMS. The following are some of those key capabilities required:

- **Network Awareness:** Being able to synchronize the type and location of assets on the normal state of the electrical network is a critical first step. Only by controlling load at various states around the grid can a true operational capability beyond traditional bulk load shed be provided.

- **Customer Awareness:** Incorporating the various program and contractual arrangements of residential, commercial and industrial consumers will need to be centralized before decisions can be made. While an operations department will not require the details on an individual consumer basis, they need the assurance that a system is only releasing the load that can be appropriately reduced at the desired times.

- **Forecasting:** Calculations of consumer baseline and reduction forecasts from meter level data should also include consumer participation rates and various other policy factors. Not only does this method facilitate market and consumer settlements, but also statistics show behavior-based analytics are a stronger indicator of expected future performance than specific device calculations.

- **Visualization:** Providing grid operators with a view that provides contextual awareness of the available load resources and reduction scenarios needs to be presented and based on the information feeding in from several discrete sources.

By enabling each of these capabilities within a single DRMS platform, demand response will be positioned to provide value beyond what previous DSM strategies could anticipate. For example, the GE-designed PowerOn™ Precision DRMS uses these capabilities in a single demand response platform as part of an Asset Control suite of grid management solutions. This strategy naturally integrates the DRMS capabilities as part of an overall solution towards improving grid performance and increasing the reliability and efficiency of grid operations.

The benefits enabled by this type of integrated solution, including an ADMS built to use DSM strategies, can be used to build a very attractive business case. While many of these benefits may differ based on the user's organizational structure, they can be divided into two approaches that impact either investment or operational strategies.

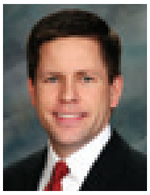
Reduce CAPEX: Reducing or limiting the load growth on various substation and power delivery assets can delay the cost of building additional generation and transmission assets. With careful planning, capital infrastructure investments could be adjusted to accommodate DSM strategies and align more closely with tightened budgets.

IVVC Control: While Volt/VAR control is often treated as a demand-side management strategy, accounting for these actions in coordination with consumer-controlled demand response strategies would provide new options to grid operators.

Improved Reliability: Evaluating demand response as load shed options in lieu of bulk load shed would improve options for maintaining reliability. The ADMS could take load reduction measurements by location in real-time to adjust the current load flow calculations.

Educating and engaging consumers about the societal benefits that can be achieved through their participation in DSM strategies can have a significant effect on our investment in asset management and control strategies for the smart grid. According to the FERC Assessment of Demand Response & Smart Metering report published last December, the potential demand response contribution has grown by 18 percent over the past two years and now represents 9.2 percent of U.S. peak demand.[2] By advancing the integration and use of DRMS capabilities through an ADMS strategy, grid operations will be in a better position to manage the transformation of energy delivery due to dynamic consumer demand.

About the author



Jamison (Jay) Shaver is the senior product manager for Digital Energy's Demand Optimization product line. Since 2009, he has led the business strategy and technology development of GE's demand response offering. Jay joined GE in 2008 through the Junior Officer Leadership Program where he successfully managed global projects across several platforms and technologies. He holds a Bachelor's degree from the U.S. Naval Academy in Annapolis, Maryland and received an MBA from Emory University.

[1] Edison Electric Institute, "Transmission Projects at a Glance" (March 2013)
[2] FERC Assessment of Demand Response & Smart Metering Staff Report (December 2012)

How SMUD Deals with Big Data: Correlate, Analyze and Visualize It

SMUD Implements Situational Intelligence to Facilitate Faster, Smarter Decisions

By Steve Ehrlich, Senior Vice President of Marketing and Product Management, Space-Time Insight.

The grid operations team at Sacramento Municipal Utility District (SMUD) has a tremendous amount of knowledge about the company's infrastructure. So much so that they were able to manage the SMUD grid using a paper wall map, partially accessed by a ladder, and cabinets filled with blueprints and other documents managed by internal knowledge. Then the smart grid arrived and SMUD encountered first-hand what the industry has come to know as 'the big data problem'

Serving a population of 1.4 million people, SMUD is the nation's sixth-largest electric utility that's owned by its customers. SMUD began delivering power to the Sacramento region in 1946 and since then has provided electricity for most of Sacramento County, as well as small portions of Placer and Yolo counties, powering the region's explosive growth and becoming a nationwide leader in green energy and conservation.

A snapshot profile of SMUD includes:

- Population in their service area: 1.4 million
- Size of their service area: 900 square miles
- Residential customers: 529,695
- Business customers: 68,510
- Number of SMUD employees: 2,036
- Miles of power lines SMUD owns: 10,257

To ensure the ongoing delivery of exceptional service to its customers, SMUD identified and set out to address several challenges:

- With a goal of a balanced and sustainable mix of energy, SMUD gets power from hydropower, natural-gas-fired generators, renewable energy such as solar and wind power, and power purchased on the wholesale market. But with the advent of distributed generation, SMUD operators found they no longer had the ability to analyze distribution data as quickly as before. Apart from the need to correlate the real-time data from multiple sources, the data was in tabular format making it difficult to interpret in a timely manner, especially given the increase in volume.
- Sacramento, located in the hot Central Valley continues to grow and SMUD is particularly concerned with the impact that growth will have on peak demand. Peak demand occurs during the summer when temperatures soar to 100°F or more and customers crank up their air conditioners. Today, SMUD customers push the peak demand for energy to approximately 3,000 megawatts, a number which is expected to grow to 5,000 by 2050. With greater demands on the grid, the need to constantly monitor its health became paramount.
- While SMUD does not have to worry about hurricanes as on the east coast, the threat of fires is ever-present, and high winds constantly stress assets and create outages in certain areas. The utility's ability to prepare for and respond rapidly to those outages is a high priority, as is reducing outage durations and delivering more reliable service to customers. Understanding what outages have occurred, why they occurred, where they are, and who is working on them, were critical pieces of understanding needed to meet SMUD's goals.
- With the implementation of smart grid technology well underway, SMUD has experienced a massive increase in the volume of data available to users. Seeking to take advantage of all that data, SMUD found that extracting and correlating the data from myriad systems is not that easy, especially when it is updated at different times and in a variety of formats.

In addition, the implications of changes in one part of the grid on other assets became harder to assess, and planning the rollout of new assets involved a highly complex set of tasks. As Tim Van Blaricom, Manager, Grid Operations at SMUD summarized, "We simply needed a way to synthesize a huge amount of information."

Visualizing and Analyzing the Grid: Paper to Pixels

SMUD was quick to respond to the challenge and saw the newly generated data as an opportunity to make more efficient decisions, reduce operating costs, and improve reliability of the grid. "The volume of data generated by our smart assets made it clear that we had to continue to innovate to improve the reliability and safety of service to our customers," said Paul Lau, Assistant General Manager, Power Supply and Grid Operations at SMUD.

How SMUD Deals with Big Data: Correlate, Analyze and Visualize It

As part of its Situational Awareness and Visualization Intelligence (SAVI) initiative, SMUD sought out a situational intelligence solution to help extract data from its siloed systems and analyze and visualize it in one place. The system they implemented, from Space-Time Insight (www.spacetimeinsight.com), helps synthesize and visualize data from disparate sources at a new Distribution Operations Center, providing multi-functional access to correlated enterprise, grid and environmental data.

Smart grid data from a variety of sources is visualized through a set of intuitive interfaces

Situational intelligence is relatively new approach to visualization and analytics. It emphasizes the analysis of data not just in a traditional cube or grid, but also across space, time and node. This allows SMUD to not just visualize, for example, how assets, customers, and employees might be affected by weather and fires, but to also understand how the assets are related (or connected) and what the impact of environmental conditions are over a period of time.

Rather than pulling data from multiple data sources into a warehouse or analytics database (and hence creating yet another data silo), situational intelligence is also about extracting the data as needed from relevant sources and processing it in memory. This approach lends itself well to infrastructures where real-time data needs to be correlated with historical data, geospatial data, environmental data and data residing in enterprise applications.

SMUD's situational intelligence system, which was implemented in less than 7 months, offers geospatial correlation of data arriving at different speeds in a range of formats from numerous systems, helping users understand current operating conditions and to be better prepared for unplanned events. Historically, this time consuming effort was completed using tabular reports and ad-hoc queries. Now users are able to visually browse at any level desired, like reading a table of contents before diving into the detailed chapters of a book. "The situational intelligence system has established a unifying thread between organizations, improving productivity and filling gaps in communication," said van Blaricom.

Users can access work order and asset details and pinpoint their location on a map

Instead of relying on multiple systems, SMUD personnel now have interactive visual access, on the control center video wall and on their desktops, to real-time and historical data from smart grid, distribution, outage, fire and weather systems.

Smarter Grid, Smarter Decisions

A key benefit of the situational intelligence system is the speed at which decisions can be made and the confidence SMUD personnel have in making those decisions. Previously, users relied on historical data such as:

- Annual reports, experience; 'when the temperature exceeds one hundred degrees, these assets are more likely to fail'
- 'Tribal knowledge;'
- Gut instinct; 'that outage is probably caused by the temperature exceeding one hundred degrees and asset X overheating'.

The new system offers extensive representations of different weather and environmental data for the SMUD territory and gives users immediate access to real-time grid performance – some substation capacity and load data is updated every 2 seconds. And when that data can be correlated on-the-fly with weather, fire, or wind data, or information from other systems such as current outages and the placement of field personnel, users are empowered to make well-informed decisions. "The rapid correlation of weather data, emergencies, system load, and situations on the ground significantly improve the accuracy of, and speed the time to, decision making," added Van Blaricom.

The SAVI system also uses nodal analytics to understand how assets relate to others on the grid and to visualize the flow of electricity. Users can click on any two points on the geospatial display and trace the distribution circuits upstream and downstream from the selected points.

Situational Intelligence Going Places at SMUD

Since its deployment, interest for situational intelligence has grown within SMUD, with myriad other uses identified, from neighborhood design and transformer loading, to customer demographics for new programs, vegetation analysis, and understanding the impact of electric vehicles (EV's) on single circuits. A second phase of the situational intelligence system is being implemented to meet some of these demands.

"When you make data available across functional boundaries, it becomes a change advocate," noted Van Blaricom. As an example, he points to insight from estimated restoration times (ERT) that now alert operators when approaching the ERT of an outage, ensuring better communication with customers in a timely fashion.

Situational intelligence has elevated the speed and simplicity of managing and understanding complex data while helping SMUD make better decisions, faster. And these benefits will continue to pay dividends that address many of SMUD's operational needs well into the future.

Paul Lau seconds the observations of Van Blaricom, Manager of Operations. In Mr. Lau's words: "With common operational views, personnel across our organization can now implement more cost-effective asset planning and maintenance practices, collaborate as one team to respond rapidly to emergency situations and outages, and more readily understand the real-time impact of weather and fires on our daily operations."

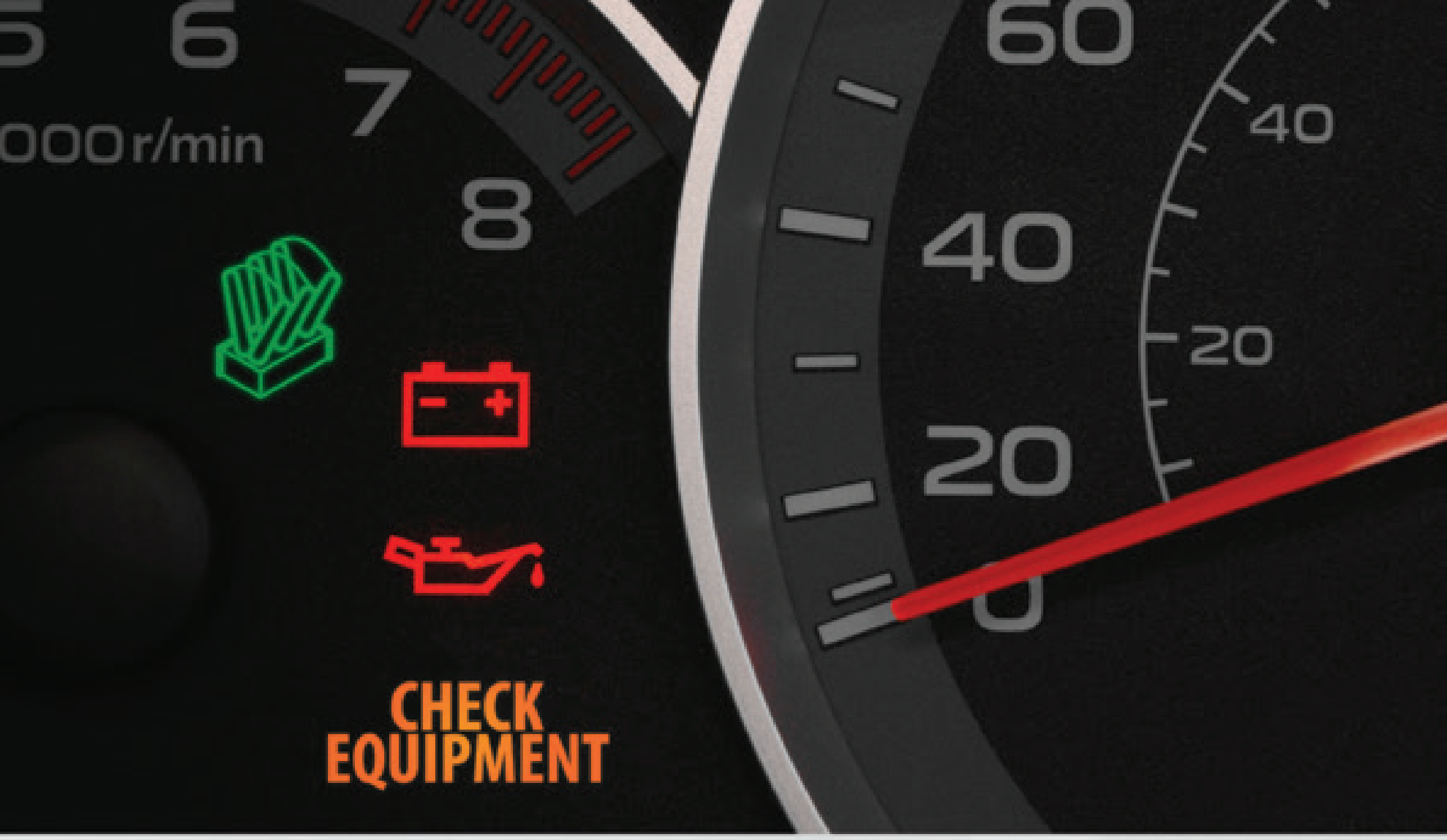
About the author

Steve Ehrlich is Space-Time Insight's Senior Vice President of Marketing and Product Management. With over 25 years of software industry experience and a passion for technology and all aspects of the marketing domain, Steve brings a wealth of product, marketing and executive management experience to the Space-Time Insight team. He previously co-founded and led marketing and product strategy for BUZ Interactive and played similar roles at Apptera, a speech applications provider. Prior to that, as Vice President of Marketing, Steve led speech recognition vendor, Nuance, from startup to market leadership and a successful initial public offering. Steve started his career at Oracle Corporation where he held a range of technical and product marketing management roles. Steve holds Bachelors and Honors degrees in Commerce from the University of the Witwatersrand in South Africa.

SMUD Facts

Profile: Sixth-largest community-owned electric utility in the U.S.
Serves 1.4 million across 900 square miles
Challenge: Use smart grid, enterprise, and environmental data to make faster and smarter decisions
Solution: Has implemented Space-Time Insight Situational Intelligence Suite for Utilities
Net Results:

- Real-time correlation, visualization, and analysis of smart grid, enterprise, and environmental data is driving faster decisions
- Cross-functional communication gaps have been filled, improving operational efficiency and service to customers
- Centralized visualization of data from multiple systems has uncovered opportunities for more effective planning
- Greater understanding of all factors surrounding a situation is improving reliability measures such as SAIDI and SAIFI, and providing greater safety for customers and employees, and protection for crews
- All distribution assets are now aggregated in one place including renewable generation, warming, cooling and building management



A CHECK ENGINE LIGHT FOR YOUR CRITICAL POWER EQUIPMENT

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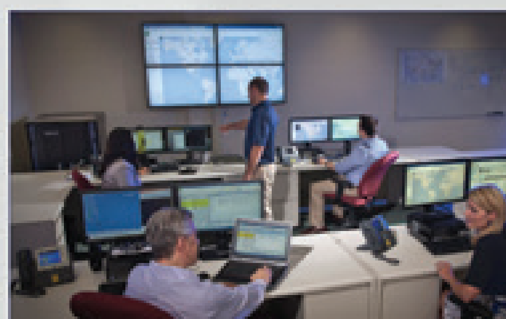

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