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MARCH-APRIL 2007 Issue 2 • Volume 11

In this Issue

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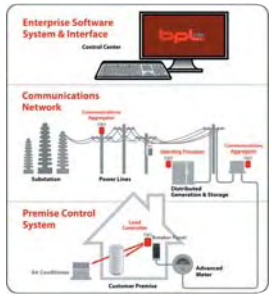
"CCAB/BPA WORLDWIDE MEMBERSHIP APPLIED FOR DECEMBER 2005"

Electric Energy T&D MAGAZINE

IN THIS ISSUE

Page 25



Page 38

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City of Lexington, NC Public Utilities Implements Full Complement of GIS Tools

Faced with a comprehensive GIS implementation plan, managers in the City of Lexington had a big decision to make: where to begin?

You might expect the City to start small, to choose an easy component of the plan for a quick win, and that thought crossed the minds of City leaders in Lexington, too. But that's not what they did. Instead, they chose the most difficult, meatiest part of the plan, the implementation of GIS in the Electric Department, and started there. As they say in Lexington, "We went whole hog".

"We knew mapping the electric system would be hard because we had so little data in electronic format and because electric systems are just by nature very complicated to map." said Sam Parcell, the Director of Operations for the City's Electric Department.

Making the project an even bigger challenge was the fact that the City's 20,000 electric customers were scattered over a 535-square mile area and no GIS data was currently maintained.

"Lots of people were watching the early GIS implementation to see how well the project went," said Lexington Assistant City Manager Alan Carson. "A successful start was key."

Network Administrator Brad Benson agreed that the Electric Department would be an ideal place to start. "We had a lot of gaps in information and a lot of the information we did have was in people's heads or, if we were lucky, on paper. Plus, there was so much enthusiasm for GIS in the Electric Department, they were eager to get underway. I wanted to capitalize on that momentum."

Bobby Curry, Operations Supervisor, was involved with the project from the beginning and compares Lexington's pre-GIS days to "trying to drive from here to California without a map." "Looking back, it seems like we were walking around in the dark. I knew what kind of GIS technology was out there, but reading about it and seeing it on paper is nothing compared to sitting down at your own computer, seeing the maps of your own facilities and using the technology to do your job. It's absolutely amazing."

Lexington utilized, Geographic Technologies Group (GTG), to spearhead the GIS implementation. A combination of ESRI based GIS tools was recommended including a field editing tool and an Intranet web browser application for organization-wide dissemination. The initial game-plan was full implementation for one substation. Field crews collected a full complement of data on each asset in the field and took a digital photograph of every pole. A customized electric data model was deployed.

Key to the success of this project was implementing an Intranet web-based data browser solution to view all collected data. Each Department in the City has a different entry point into the Intranet solution that has been optimized for their needs. In regards to electric they need to view the infrastructure and they needed to link to the City's customer information database, stored in their CIS database (Cayenta). GTG worked with Cayenta to create a seamless integration between the customer data and the Intranet application. "Viewing this live customer data in conjunction with all of our field assets has put us at a full sprint. Forget the walk before you can run adage", states Curry.

Critical to the success of this project was the ability to maintain the data. "Our consultant, GTG, worked with our staff to design a tool that allowed us to do live edits to our data in the field", Curry points out. An application was deployed that allows field staff to perform disconnected editing of the electric ArcSDE database. These edits are then brought back in from the field and the data is checked back into the data warehouse.

Like many long-time utilities employees, Curry knew where things were in the field like the back of his hand. But translating that into information the computer can use would have been endlessly time consuming.

"When the information is there, you find ways to use it you never even thought of before. The field work involved in data collection is extensive, but once you have it in your inventory, you can solve all kinds of problems," Curry said.

Curry said the technology has been invaluable in Lexington's new initiatives with local co-ops. "We can instantly see what we can serve and what we can't."

Before the GIS project, Carson said basic tasks associated with adding new customers were labor intensive and expensive.

"If a business customer called and said they needed to have natural gas, electricity and sewer hookups to their facility, we'd have to send someone to do the research, mark the lines and develop a plan. Now, all that can be done instantly without leaving the office," he said.

"With accurate data, you can do circuit studies and capacity studies on various wire sizes. We can determine whether we're using wire too small based on the loads, things like that. GIS is a great engineering tool," Parcell said.

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Sharon Allan, president
Elster Integrated Solutions

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He also said GIS provides Lexington Utilities with plant accounting values that would be critical if the utility ever moved into the regulated environment and needed to seek rate approval from the North Carolina Utilities Commission. "Without the information we've just gathered, it would be impossible for us to show the investments we've made in our infrastructure."

Curry appreciates the fact that the technology is so easy to learn and easy to use.

"Our consultant did a great job of making the work flows simple and intuitive. And I learned a long time ago, if you don't make technology simple, people will find a way not to use it, no matter how much you've paid for it or how much potential it has."

Curry states that the success of this project has been noticed by other Electric Utilities. "The integration with our existing customer service application and the overall ease-of-use is what everyone in the industry is looking for – our rapid success has revamped our entire utility operation." "Even the people who aren't using it yet have heard about it and are excited about it," Curry said. "I think we all see the possibilities. GIS streamlines our work, makes us more efficient and the customer is the ultimate beneficiary."

Background information:
Lexington, NC Public Utilities provides utility service for over 20,000 customers.
For a digital copy of the full Lexington success stories please email curt@geotg.com or call Curt Hinton at 919-759-9214.
More information on this project can be found at http://www.geotg.com

Circle **38** on Reader Service

Information technology helps build better community relations

by Mark Johannes, Don Gamble, Shawn Redden, and Katerina Kwon, Golder Associates

The development, expansion and upgrade of electrical transmission infrastructure is being driven by an increase in electrical demand in growing urban centres, an ageing transmission infrastructure, and requirements to supply reliable electricity to resource industries in remote areas.

At the same time, the planning and approval process has a requirement to examine and minimize potential adverse effects (social, environmental, cultural, terrain) across corridors linking hydro-power generation supplies to urban and remote areas. Communities and property owners near an existing or proposed electrical transmission line right-of-way often raise issues related to increased electric and magnetic field (EMF) effects, impacts on aesthetics and the environment, and even potential loss in property values. Environmental issues often relate to potential impacts to terrestrial habitats due to clearing required for the construction and maintenance of new rights-of-way and access roads, impacts on watercourses and riparian habitats due to stream crossings, and disturbance to cultural resources and Traditional lands in First Nations communities. Transmission corridors are often constructed in remote areas of steep terrain which are often prone to natural hazards (climate, terrain).

Developing, planning, and constructing these projects have multiple land, resources, and social challenges and issues. Transmission utilities and their partners look for opportunities to minimize potential project impacts, demonstrate good intentions, and effectively communicate and resolve issues as part of the decision making and approval process.

Information Technology (IT) and improved communication linking information, people and awareness can provide valuable tools to help plan and build efficient transmission projects and support community relations and values.

Good Data, Good Decisions

Effective planning for a large transmission corridor across a variety of terrain, natural and social conditions requires the most current data and tools to integrate information. It is like the analogy of driving on road with a poor map. Good decisions come from good data.

Large transmission projects need good planning data to make informed decisions across a variety of disciplines including social and the biological and physical environments. As a first step, planning large projects involves the use of current remote-sensing imagery from both aerial photography and satellite imagery to help plan for the corridor across a landscape. Current aerial photography and satellite imagery can be very precise and to show details for areas less than one square metre on the ground.

Good information and its interpretation can be used to properly site corridors and identify many important or sensitive issues before consulting communities or undertaking detailed ground surveys. The remote sensing information can include:

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- Colour and ground level aerial photography to detail and isolate objects;
- Infra-red and colour band imagery to identify geological faults, outcrops, and vegetation cover; and
- RADAR (radio waves) and LIDAR (lasers) imaging, to penetrate cloud and forest cover to develop bare earth topography.

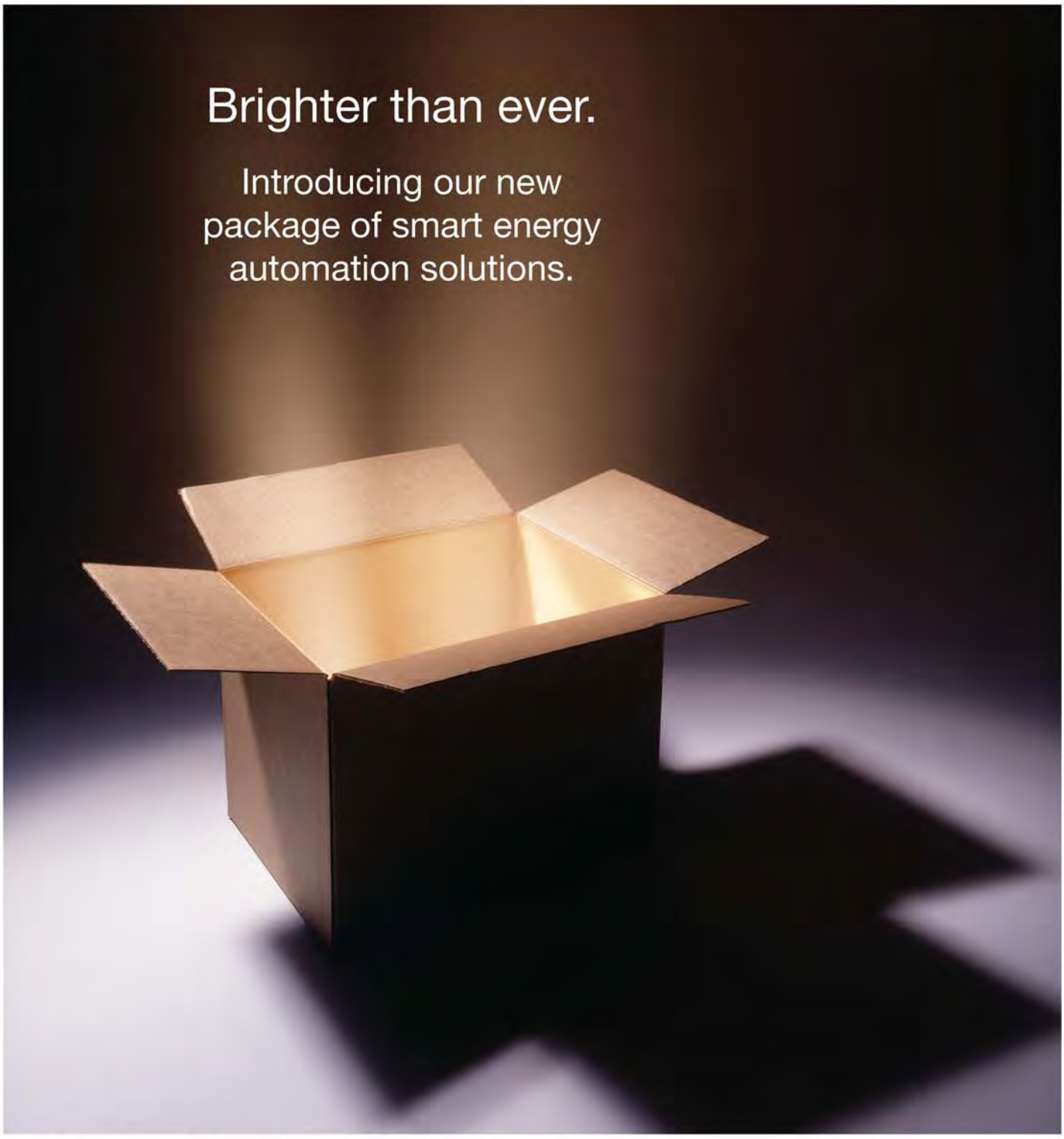
The second IT stage is to link remote-sensing imagery with existing background information and ground survey data through Global Positioning System (GPS) and Geographic Information System (GIS) technologies. The remote sensing data is used to pre-select and focus ground surveys. Ground level survey data for terrain, plants, wildlife, fisheries among many sets of information, can be collected and stored in hand-held GPS instruments which are tied to precise ground level coordinates and directly integrated into remote sensing data through GIS. This information is invaluable during planning and environmental assessments to identify, minimize risks and avoid inhabited areas, sensitive environmental habitats, difficult terrain and geology, natural hazards, and traditional areas of importance to First Nations. Good data and new planning tools are needed for transmission utilities and other industries to streamline costs and efforts to create plans, communicate effectively and make good decisions.

Communicating Detailed Information

Data for remote areas are often restricted to mixtures of fragmented hardcopy and electronic records across a diversity of areas and time periods, with few existing relational links between data, sources, planning and management. Decision makers, industry and local communities are often restricted to individual attributes or data pieces and opinion based ideas rather than well integrated information based ideas about the value and priority of resources, land use and project planning strategies. GIS tools help organize and integrate historic background data, ground survey assessments, and current remote sensing data to produce databases and analytical tools to support effective planning, communication and ultimately awareness for improved decision making and community and stakeholder relations.

Communicating to Create Awareness and Improve Decisions

One of the greatest benefits to the improved GIS systems is in its ability to present information in forms that people can readily understand. These forms can include atlases, maps, plans, detailed analyses, visualization, animation, even posters and brochures, in electronic and hardcopy forms which can be readily updated and distributed. Not all stakeholders and communities use the same type of information to develop an



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understanding of the issues. It is often the case that a picture is worth a thousand words, and different audiences need a variety information tools to create awareness of an issue and promote understanding to develop actions and decisions.

These are not new concepts. Some of techniques and tools however are new. The tools like GIS can create realistic imagery and visualizations to link remote sensing, field and historic information in forms which many audiences can appreciate and understand. These communication forms can include: realistic visualizations that look close to the "real thing" and create detailed depictions; accuracy of a rendition can take GPS, landscape and environmental data to produce a plan which is accurate; plans can be readily updated to reflect new information; and data storage, computing and printing speeds and the internet create flexible options for easy and efficient information exchange and communication.

IT can be used to compile information, communicate details, help plan, and develop informed decision making. Transmission project are using IT to support expert information systems consisting of databases, analytical tools, models and communication products to reliably examine potential impacts on social and environmental values and minimize and avoid risks to these values. The use of IT is intended to improve our ability to achieve balanced planning, management and decision making for development of effective power transmission projects.

For additional information:

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Shawn Redden is a Senior Fisheries Biologist and Group Leader of the Abbotsford office's Environmental Assessment Group.

Circle **39** on Reader Service

Circle **2** on Reader Service Card

Advanced metering infrastructure improves meter reading information for customers

FortisAlberta, the regulated, electrical distribution company in central and southern Alberta, announced today that it will implement Advanced Metering Infrastructure (AMI) technology in a phased approach to replace the Company's manual meter reading system.

"Customers, regulators and consumer advocacy groups are raising the standards for bills so that they are easier to understand. With the implementation of this technology, FortisAlberta will be able to more easily anticipate customers' electricity needs, and more accurately report customer consumption to retailers based on actual usage instead of estimated usage," said Philip Hughes, FortisAlberta's President and CEO. "We're eager to take every opportunity to provide the benefits of this system to our customers."

The first phase to be implemented includes FortisAlberta's residential, farm, irrigation and commercial customers in FortisAlberta's

service territory including Leduc, Stony Plain, Vauxhall and Brooks.

FortisAlberta will install approximately 30,000 meters by mid-2007 as part of the first phase of AMI. "Pending regulatory approval, the AMI technology, once fully implemented across our service area by 2010, will also reduce the costs of the current manual meter reading practice resulting in cost savings to our customers," added Hughes.

FortisAlberta received approval to initiate the first phase of this project from the Alberta Energy and Utilities Board (EUB) as part of the Company's 2006/2007 Distribution Tariff Application. Based on the successful implementation of the first phase, the Company will seek approval for implementation of the AMI technology to its remaining 400,000 customers as part of its 2008/2009 Distribution Tariff Application.

For additional information, Fortis Inc. www.fortisinc.com.
Circle **40** on Reader Service

RuggedCom Introduces New NERC CIP Cyber Security Solution – RuggedCom Gauntlet

RuggedCom, a leading designer and manufacturer of "ruggedized" communications networking equipment for harsh environments, introduced a new NERC (North American Electric Reliability Council) CIP (Critical Infrastructure Protection) Cyber Security solution at the 2007 DistribuTECH show in San Diego. RuggedCom Gauntlet, designed specifically for the electric utility industry, is a 100% NERC-CIP compliant solution that provides an electronic security perimeter for effective cyber attack protection.All communication to substation devices is authenticated, controlled, and logged to prevent and detect unauthorized entry attempts. Also included are extensive reporting tools and the unique "Auto-Audit" feature that provides an easy "one-click" function that compiles all NERC-CIP required documents into a single report.

"With NERC compliance audits scheduled to begin in Q2 2007, utilities are looking for easy and cost effective solutions to protect their critical cyber assets", explains Roger Moore, VP of Engineering for RuggedCom. "RuggedCom has been the leading provider of substation hardened communications equipment and the introduction of this solution is a natural extension for us."

RuggedCom Gauntlet provides secure remote access to critical substation assets, with up-to-date support for the latest regulatory requirements, and gives public utilities a present-day solution that accommodates future security and regulatory audit requirements.

RuggedCom Gauntlet offers a number of unique features including:

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- Forced certificate & password expiration
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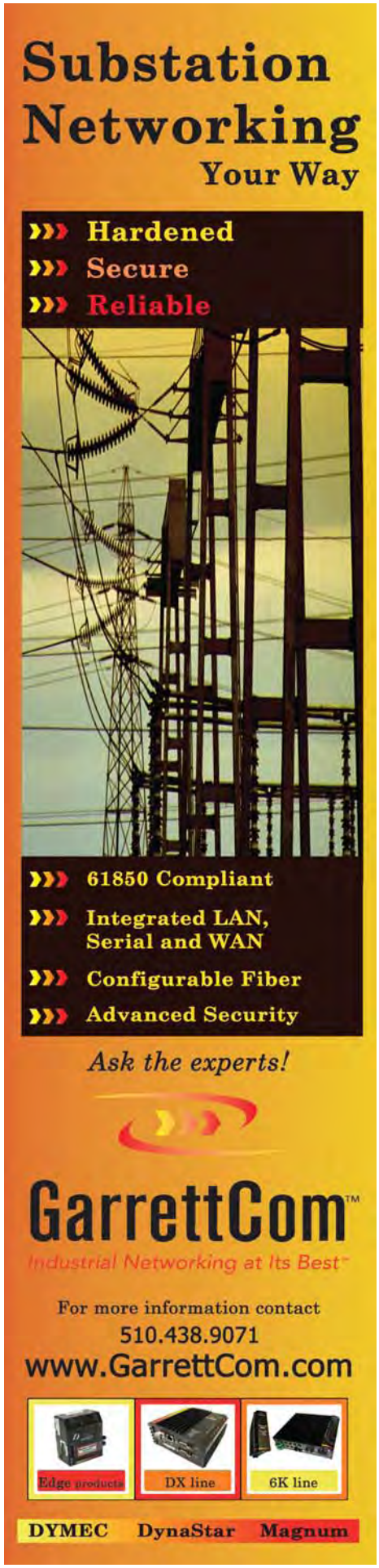
- Distributed architecture
- Comprehensive, centralized logging
- Extensive reporting capabilities
- Auto Audit reporting
- Protocol agnostic
- Remotely upgradeable
- Substation hardened hardware
- Renowned product quality
- Responsive technical support

RuggedCom Gantlet is a collaborative effort between RuggedCom and Teltone, a leading provider of enterprise communication solutions for the electric utility industry. Leveraging our combined experiences in the electric utility industry, this strategic partnership ensures that our solutions meet the demanding needs of our customers.

For additional information about the RuggedCom Gauntlet solution, please visit www.RuggedComGauntlet.com.
Circle **41** on Reader Service



Circle **12** on Reader Service Card

By Michael A. Marullo, Contributing Editor

The 'Madison Avenue' Factor

Around the time you read this I'll probably be uncorking a celebratory cold beverage to mark the beginning of my 24th year as an independent consultant on March 6th. I must say that it has been an enjoyable, rewarding and often challenging experience, but more importantly, the ride itself has been a very interesting and educational one. Over the years I've worked with clients ranging from (literally) a 1-man shop to multinational conglomerates and pretty much everything in between.

Yet despite the magnitude and diversity of experience I've gained over the years, I'm always surprised when something that should have been obvious for a long time surfaces as somewhat of a revelation. Just the other day in a conversation with a longtime client, it occurred to me why companies that are owned and/or managed by other than North American entities have such a hard time relating to the challenges here.

Okay, you're probably thinking: Is it really all that difficult to understand that other countries and regions of the world have a different market environment than we do? Well, no, it's easy to see that there are differences; it's identifying and understanding the underlying roots of those differences that create a challenge for many companies, especially those trying to interpret and relate the substance of those differences to non-domestic managers. To put this notion into proper perspective, let me offer a well-documented example of what I mean…

Anyone who has tried to market distribution-centric equipment here in North America has probably learned that differences in the topology of the distribution network in Europe (i.e., many customers connected to a single distribution transformer) is in stark contrast with the layout here where only a few customers are linked to a given transformer in all but the most unusual cases. This fundamental difference in distribution network architecture has for decades been an impediment to replicating the success of European-style power line carrier (PLC) based load management systems in this country. So, short of completely redesigning our distribution networks, we simply cannot apply European distribution metrics to domestic applications.

However, when it comes to differences in effective global marketing strategies, the underlying reasons for the differences between one region and another – especially the level of understanding their true impact – may not be as apparent as when purely technical issues are involved. (For some reason, developing a global mindset around technical issues sometimes seems to be easier than achieving consensus on market-related issues.) Indeed, such is the case with what I'll refer to here as market diversity. And, it was upon my further contemplation of this market diversity that I came to realize just how different the domestic utility market is from the rest of the world.

By market diversity, I mean that the North American utility marketplace has – and has always had – many more individual utility enterprises than any other part of the world. But, besides being a very large market with over 3,000 utility companies operating in the US, Canada and Mexico, it is also a very diverse market with large and small; public and private; monolithic and vertically integrated; and so forth. That's where my revelation really began to crystallize. For the first time, it hit me why companies whose ownership and/or management are located elsewhere often have such a hard time understanding what it takes to be successful here.

Marketing to a few prospective companies at any given time, as is usually the case in countries where there are just a few utilities, or sometimes only one, is a very different challenge from marketing to hundreds or thousands of potential buyers. While this might at first seem to be stating the obvious, I've found that a lot of international suppliers do not adjust their marketing strategies to accommodate the uniqueness and vast differences in the market diversity here compared to what they are used to dealing with in other parts of the world. In fact, I know they don't because several of my international clients are constantly having their marketing budgets squeezed by corporate management that can't understand why they need bigger budgets for market research, advertising and promotion here than their rest-of-world counterparts. The answer is simple, although it may not be readily apparent, especially to someone making the assessment from afar: We have Madison Avenue; they don't!

Whether you embrace or despise the endless stream of hyperbola that Madison Avenue cranks out daily in the name of advertising and promotion, the fact is, they do it for a good reason: it works. And the reason why it works is that marketing is a critical component of a diverse market like ours where differentiation is a fundamental ingredient in success. In my view, a higher

dose of marketing, market research, promotion, etc. is necessary in virtually any market where a substantial diversity of buyers, sellers or both is present. But nowhere else is it as vital to success as it is in North America where sameness is all around us.

Like it or not, we need help differentiating the whitening toothpastes from the breath-freshening ones, and of course, the two dozen or so that do both in a variety of flavors and colors. For whatever reasons – whether due to lack of time, interest, aptitude (ineptitude?) or other reasons – most of us are accustomed to being told why we should favor one product or service over another. While we might not think we want that – or even accept that we are influenced by it – the Madison Avenue factor is ever-present, a constant influence in much of our daily routine.

Thus, a key ingredient in the formula for succeeding in this unique North American marketplace is recognizing and pro-actively addressing the market diversity it represents. If dealing with this market diversity is not integral to your marketing strategy, you might want to look in the mirror to see if your toothpaste is really the best one for the job. I can assure you that the Madison Avenue factor will be there – can you really afford to ignore it?

- Mike

Behind the Byline

Mike Marullo has been active in the automation, controls and instrumentation field for more than 35 years and is a widely published author of numerous technical articles, industry directories and market research reports. An independent consultant since 1984, he is President and Director of Research & Consulting for InfoNetrix LLC, a New Orleans-based market intelligence firm focused on Utility Automation and IT markets. Inquiries or comments about this column may be directed to Mike at MAM@InfoNetrix.com.

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Determining AMI's Back Office Impact and a Provider's Readiness to Adopt It

By Trey Beasley, Vendor Alliance Manager, Alliance Data Corp.

Many utilities are rolling out Automated Metering Infrastructure (AMI) and are committing millions and collectively billions of dollars to do so. The challenge for utilities is not whether to roll out AMI, but rather how to turn AMI's new capabilities into positive customer experiences. AMI can create opportunities for new billing plans; energy management and load balancing programs and improved customer care around billing, usage, consumption, activation and repair. All of these capabilities can result in a positive customer experience, but operations and customer care groups must determine what changes they must make to exploit AMI's best capabilities.

Currently, most back offices are not prepared to handle the increased data volume AMI will drive. They may also lack the billing, customer care and remote management systems they need. If utility providers fail to assess the scope of AMI's impact on operations and the customer experience with AMI introduction is poor, they may risk run-ins with state PUCs at the end of the day. AMI, however, can and should provide an extremely positive experience for customers and help providers to engage with them more actively.

THE IMPACTS OF AMI'S INTRODUCTION

Simply stated, it won't be possible to leverage AMI's positive qualities if the right support isn't in place in the back office. One of the first challenges AMI brings is a massive increase in network connections to every location. These connections are required to collect the data that smart meters generate and to communicate with meters for remote management.

AMI can enable real-time connectivity to smart meters at all times. That kind of connectivity, which will make more sense as energy management advances, would require as many simultaneous connections as meters at all times. By today's standards, that's a massive network requirement. Moving to an hourly read would reduce that network requirement, perhaps by a factor of 30. Making the appropriate network decision will depend on how a utility wants to take advantage of smart meters and AMI's reporting capabilities. Factors such as back up networking; back up power; processes for network outages or instances where a device cannot be reached; and validation that all devices are reporting and reporting accurately must be considered as well. Though somewhat complex, the benefit of all of this networking will be improved monitoring, management and control for every customer location.

DATA VOLUME EXPLODES

AMI meters will collect and store data based on any interval a provider wants. The more granular the intervals, the more data records every device will produce, which has a multiplicative and potentially exponential effect on data volume. For example, hourly readings would mean 720 instances per month where the meter creates a record. 15 minute intervals would result in 2,880 instances per month, and so on. Ultimately it will be possible to collect information related not only to overall consumption, but also environmental factors, appliance usage, and diagnostic information. This expanded data set could add yet another multiplying variable to the data equation.

REMOTE MANAGEMENT IS INTRODUCED

Automated activation and disconnect is another capability set AMI will introduce. It has the potential to eliminate a great percentage of truck rolls, thus lowering cost and speeding service activation for customers. It also allows for rapid response to fraudulent use and bad debt, enabling service to be cut off in real-time from a remote system. The utility has to determine whether its existing systems can support functions like automated activation and whether these functions can be integrated directly to a call center desktop application. It is also important to understand the amount of new functionality and integration that will be required to put all of the right tools or controls in the right places.

Because AMI puts a smart meter at every customer location, it should enable visibility of outage status to the back office for each location. During outages, this kind of visibility can improve call routing based on the likely call type, and pinpoint likely points of failure on the system to expedite the dispatch of repair crews by identifying which meters are recording usage or receiving power and which are not. Utilities should not have to rely any longer on customer calls to identify and diagnose an outage, but rather should be able to reach out to customer proactively to provide repair or emergency information.

For load balancing purposes, a Management Maintenance System could provide detailed pictures, for example, of which locations or regions are consuming the most power and at what times of day. This can improve prioritization of investment in infrastructure to drive reliability. Eventually it should also enable detailed consumption reporting within each location to support more advanced energy management.

To realize these types of possibilities, AMI is an enabler, but the back office needs to have the right tools in place to translate AMI data into useful information and to access device capabilities for remote monitoring and control. The range of new possibilities AMI

introduces – including everything from new equipment to new billing plans – is a lot for a provider and for customers to take on all at once. Any strategy should include an analysis of what AMI can bring to the table; what progression makes sense for introduction; what process and systems changes are needed for support; and how customers will be oriented with them for a positive experience.

CUSTOMER CARE GAINS RESPONSIBILITIES

As an increasing percentage of AMI's capabilities are leveraged, there will be a growing impact on customer care operations. A significant increase in call volume can be expected simply due to smart meter installations. As these translate into more sophisticated billing plans and consumption management programs, customers will have more questions and will typically pick up the phone to have them answered. AMI is likely to continue to increase average call volumes to contact centers as it continually enables new capabilities. Because these calls will be somewhat non-standard in nature, their average handle times could be significantly longer at the outset as well. This volume must be handled, but alternate channels such as the Internet should be used to educate customers proactively and answer as many questions as possible before having them pick up the telephone. Given this alternate channel, many customers will choose not to call the contact center first.

The new range of rate plans AMI data can enable is exciting for the business, but it will add tremendous complexity to legacy CIS systems. There is some risk of creating billing problems or inaccuracies. Confusion with new plans or bills can also lead to customer complaints and spark issues with state PUCs. Though extreme outcomes, what they suggest is that customer care and customer education are real priorities in AMI introduction. Customers are going to be asked to adapt to new ways of thinking about their energy usage and their interactions with their provider, and no change – no matter how beneficial for all involved - is ever simple or comfortable without repeated and proactive information and encouragement.

To educate customers, contact centers will need education on things like new rate plans and energy management initiatives. Agents will need to learn how to coach customers on taking advantage of special rates based on conservation incentives. New responsibilities may also move to the contact center, such as remote activation and disconnection, proactive outreach to customers during outages, and other possibilities. The question is not whether the contact center can handle it, but rather how the contact center will handle it.

EXAMINING OPERATIONS TO PREPARE FOR AMI

To move from today's operations practices to those that work best with AMI, a utility needs to ask the right kinds of questions, based on its AMI strategy, to determine its requirements. The critical areas that are likely to impact customers' experiences with AMI

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introduction include customer care; remote management; billing and rating as well as the relationship among all three.

CUSTOMER CARE

As mentioned earlier, the first two questions are how much of an increase in call volume and handle times to expect and whether the contact center can manage that level of volume. It is also necessary to examine whether the current agents in the call center are sophisticated enough to handle their new roles. If they are up to the task, how much new training they will require? AMI's capabilities can help to support contact centers agents. So, questions such as whether tools like IVRs are in place that can help automate outbound calling for outage or emergency reporting are critical.

It is also necessary to assess whether CIS systems can handle the new volume and types of data about the customer and make them accessible in ways that matter to the contact center agent. Can the CIS manage new rate plans and product offerings? How about new types of information about the customer that might be collected, like details on their daily consumption and household appliances? Additionally, what is the strategy that will drive customer queries to the web and what functionality customers will want to see there is critical to determine and a significant undertaking in and of itself.

REMOTE MANAGEMENT

As discussed, remote management capabilities are effective when they are made accessible to the right people within the right systems and processes. A utility must ask whether its CIS system, or another customer management application, can integrate remote management capabilities, like automated activation and disconnect. Similarly, is there a work management system that can take in AMI data and produce a live map of active and inactive locations and optimize outage troubleshooting and repair response? This information needs to be provided real time to the back and front office for better customer communication. Further, it may become necessary to install systems or processes that can validate that meters are reporting accurately while assuring that collected AMI data, billing and consumption management are all consistent in their view of each customer. As usage collection becomes dependent on the network, it may become increasingly important to validate billing accuracy. Billing inaccuracy can lead rapidly to a negative customer experience and complaints to the PUC.

BILLING AND RATING

Billing and rating will be impacted significantly because of both the volume and types of usage data that will become available. More billing variables, or more variables that drive discounts, translate into far more complex billing requirements. The first question is whether the billing system can even handle the new volume of data. If so, can it also handle rating for things like tiered usage, time of day, and support multiple plans per region or per customer? Further, can the billing system handle discounts based on usage parameters to support promotions or conservation incentives?

Related to billing are considerations for new forms of payment, like debit-based billing which can help reduce bad debt and float and give more flexible options to customers. Going further down the path, a utility might consider whether it ultimately wants to integrate billing and remote management to automate disconnects for non-payment, for example.

MAKING AMI INTRODUCTION POSITIVE FOR CUSTOMERS

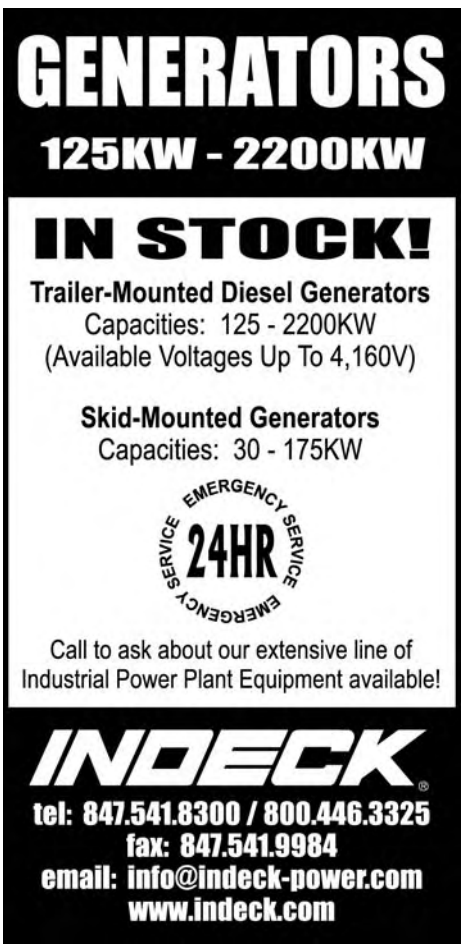
AMI brings many exciting promises with it, but they will only translate into a positive customer experience with the right operations and process approach. The volume of data that AMI generates, for example, can be seen as a challenge. But in reality, it creates opportunities to provide more options, more control and more information to customers that ever before. With foresight, utility providers have an opportunity to determine tools they need to take advantage of the strengths AMI can provide them and make the technology extremely positive for customers. Failing to do so, AMI could become very difficult to manage and lead to negative customer experiences and ultimately real challenges with their respective PUC's. ■

About the Author

Trey Beasley. *Trey is the Vendor Alliance Manager at Alliance Data and has worked in the energy industry for 16 years. Trey began his professional career as an engineer and Group Manager of Product Development at TXU in Dallas.*

He joined Alliance Data to help create a Solution Management organization focused on the development of services supporting Utility clients. Trey is now responsible for negotiating all key vendor contracts and the development of strategic partnerships at Alliance Data.

Trey holds a Bachelor's degree in electrical engineering from Texas A&M, a Masters degree in Finance and an MBA from the University of Texas at Dallas.



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LogicaCMG: Jeff Provine & David Price

Jeff Provine
President
Energy & Utilities
LogicaCMG

David Price
CTO
Energy & Utilities
LogicaCMG

This month's Automation/IT Leadership Series interview is with executives from LogicaCMG, one of the world's most prolific and successful providers of automation and information technology systems and services. I had the pleasure of first meeting Jeff Provine – president of LogicaCMG's Energy & Utilities Division in North America – nearly twenty years ago when we were both relatively new to the geospatial marketplace. Since then, Jeff has clearly remained on the cutting edge of automation/IT solutions. Joining him is David Price, consistently among the most insightful and visionary CTOs I've come across. Together, I think you will find their views on the business and technological issues and trends shaping the automation/IT industry in these exciting times both interesting and informative.

- Mike Marullo,
Automation/IT Leadership Series Editor

EET&D: The merger of Logica with CMG in 2002 – as well as several subsequent acquisitions – have taken place over the past several years. The most recent of those was the acquisition of Worksuite from Severn-Trent in 2006. In your view, what are the primary benefits that have accrued from these moves?

Provine: Our stated strategic direction is to establish LogicaCMG as a global top 10 provider in IT services. The acquisitions that have occurred since the original merger between Logica and CMG have moved us steadily toward that goal. Notably, we are now well into the top 20 globally and the top 5 in several European regions. The benefits to our customers are really a result of the scale we now possess and the financial stability that accompanies a profitable $6 billion global enterprise. For the Energy & Utilities division specifically, the benefits of our Global Service Delivery Model and the international lines of business for energy and utilities (which represents nearly 16% of revenue) are key to our success as well as that of our customers.

EET&D: Just a little over a year ago, in February 2006, you acquired the assets and products of WorkSuite from Severn-Trent. How would you characterize the principal objectives of that acquisition, how the merger has progressed and perhaps how it figures into your plans for the future?

Provine: Again, the primary benefit to our organization and, more importantly to our clients is one of scale. The combined company is fortunate to have half of the top 100 utilities in North America as clients under contract with LogicaCMG and our established position in the U.K. is now stronger than ever. Along with rapidly integrating the organizations, we moved very quickly to combine the product roadmaps of the two companies and immediately adjusted our development activities. In many cases product benefits are realized very late for customers. In our case, both sets of clients have realized immediate benefits from releases of newly integrated products less than a year after the companies were combined as well as the longer-term benefits derived from a family of integrated solutions.

EET&D: Do you feel that you now have all the pieces you need to go forward with a cohesive solution set for utilities, or are more acquisitions likely in the future?

Provine: While another acquisition is never out of the question, we are very nearly complete with the delivery of our overall Asset and Resource Management (ARM) product roadmap. The real focus for us over the next 24 months is on our customer base, which has nearly doubled through the Worksuite acquisition. We are very excited that the majority of our new Worksuite clients have contracted with us for long-term maintenance agreements and are committing to the roadmap. We still have a great deal of work ahead to help them all take full advantage of this product migration, but we're making steady progress toward that objective.

EET&D: You have very recently announced a comprehensive mobility solution that would seem to be a direct result of the aforementioned acquisition and internal development. Why all the emphasis on mobility?

Provine: It really wasn't a result of the acquisition; the acquisition simply gave us the ability to leverage the best technology from both companies in our resulting offerings and migration roadmap. Both organizations were already heavily invested in development and deployments of scheduling, dispatch and mobile and, as you know, we have been developing the next version of Real Time Asset & Resource Management (RTARM) with a group of our customers. If I were to add up all of the investments made in the development of this coordinated effort with our customers and partners, I'm sure the number would be quite substantial. However, the resultant benefits to our clients and the industry at large will also be very significant when we release the final product this spring… and definitely, well worth the investment.

EET&D: Obviously, there are a lot of mobility solutions out there. What do you feel are some of the more important dimensions of this burgeoning market from the utility perspective and what kinds of benefits can utilities expect to accrue from these applications that were previously unattainable?

Provine: The opportunity these new solutions create for users will center on flexibility, power and interoperability. For the first time it won't really matter what engine is managing work processes in the background, whether it's one of our own or any of several competitive work management products. The benefits of automating the office are well proven, but the real boost in productivity comes in how the work is scheduled, dispatched and managed in the field – that's where the real costs reside. Utilities can expect to see some very real cost efficiencies and performance gains once this new generation of solutions is deployed.

This would be a good time for David Price, our CTO, to add his insights about how we see the mobility market developing over the next several years and what can be realistically expected from this new wave of products and technology – some pretty exciting stuff, actually.

EET&D: (to David Price) Obviously there is much to be excited about with all of these new solutions on the immediate horizon, so perhaps you can offer some details about how users will benefit.

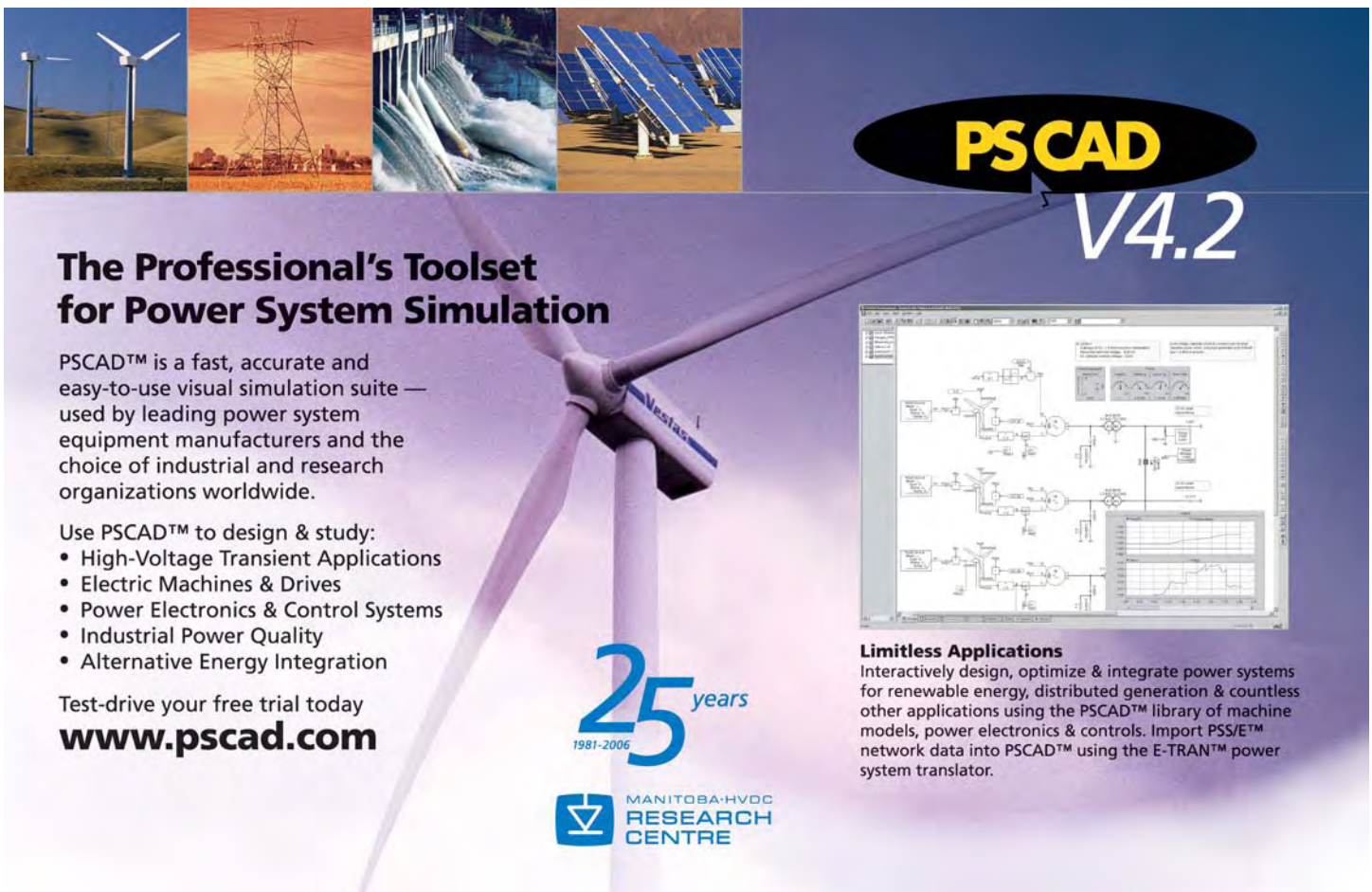
Price: From a resource perspective, an increasing number of our customers are seeking the next level of performance through uniting their field resources and re-deploying them in new, and as yet, unexplored ways. This is really a critical ingredient in their search to address increasing concerns about their aging workforce while also driving a step-function increase in overall productivity, most of which will necessarily take place in the field; not in the office.

EET&D: We hear a lot these days about the intricately interrelated issues of the aging workforce and productivity objectives. What can you tell our readers about how these concerns might manifest themselves in a mobility and/or work process context?

Price: This productivity drive is actually resulting in a new set of criteria for mobile solutions. It calls for an enterprise solution that can not only support current mobility and work process demands but also an increased level of flexibility across the organization of the future as more applications are pushed out of the office and into the field where they really belong.

In terms of work execution, mobile solutions are seen as a means to both increase the productivity of both field employees and their field management teams while also reducing the overall life-cycle time and cost of collecting and processing data for the entire utility enterprise. In turn, this is driving an even greater level of mobility sophistication. We firmly believe that field validation and a better definition of the scope of data capture will be important components of any new mobile initiative.

An even more interesting part of this trend, however, is the recent move toward utilizing



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the entire field workforce as a cost effective data collection and validation team. We see this as a direct response to the rising demand for more accurate, timely and complete information about the utilities' distributed assets in support of increasingly challenging demands for better asset management and related decision-making from both a regulatory and utility business perspective.

EET&D: Perhaps you could elaborate a bit on what you mean by "…utilizing the entire workforce as a cost effective data collection and validation team". It certainly sounds positive, but what does that really mean in practice?

Price: First, most any utility would readily acknowledge that it's generally cost-prohibitive to operate a stand-alone data capture program in today's environment. Additionally, for a typical distribution business to improve, it is vital that the field staff have access to – as well as the ability to alter and update – the critical data in the field simultaneously with work execution. As an example, the asset data pushed out to the field needs to be supported by appropriate levels of data validation at the point of entry.

EET&D: It sure sounds like there will be a lot of new demands on the field force as this strategy plays out; should that be expected?

Price: Yes, that's true, but our vision for accommodating this growing need is to engage the entire field organization in an integral role in the asset management process of the future, thereby spreading the work across a broader set of personnel equipped with better and more powerful, yet affordable tools. But admittedly this will require the complete integration of asset data collection and retrieval capabilities into the day-to-day work execution and reporting activities; no small challenge for suppliers and utilities alike!

EET&D: Where do you see mobile evolving and how does it fit in with other automation/IT initiatives, especially as regards advanced metering infrastructure (AMI)?

Price: As the network itself becomes increasingly "self-aware" through pervasive instrumentation coupled with the implementation of AMI platforms, a large portion of the workforce previously associated with connects/disconnects and meter reading will no longer be needed. At the same time, other demands on mobile solutions will also increase as more and more business logic is pushed out to the field in an attempt to further improve the corporate lifecycle of data collection and validation.

Some believe that more intensive streaming of mobile data may underlie a wholesale move to a thin-client environment, where field users are accessing their host systems directly. While this capability will probably be revisited, we believe it's unlikely that stand-alone mobile applications capable of supporting key business logic in real-time or near real-time (i.e., even when disconnected from network communications) will be abandoned in mission critical applications such as those routinely used by utilities.

EET&D: What do you see happening with corresponding mobile field devices?

Price: We think that another future evolution will be towards truly hand-held business applications "slaved" from field fleet vehicles. In the interest of driving further productivity, this next generation of solutions will provide some pragmatic capabilities directly interfaced with the vehicle-mounted computer and facilitating efficient communications with the district or central office. Ultimately, this will allow the complete integration of work- and site-specific data collection devices into the broader mobile architecture of the business enterprise and automating the "last 50-100 feet" of the work process lifecycle.

EET&D: What does that say about potential longer-term changes now that the computing platforms employed in various automation/IT applications are far more standardized and interoperable than they were say, a decade ago?

Price: From a high-level integration standpoint, we should see some real progress towards the holy grail of establishing a common information model, particularly as more of the mainstream vendors adopt these standardized architectures going forward. It's also clear that the supplier consolidation is still ongoing. I think it's safe to say that utilities will actually benefit from a stronger – albeit reduced – set of suppliers, which will certainly include our team here at LogicaCMG. Moreover, improved market stability among suppliers and users alike will, in turn, allow the next generation of business processes to build on this new level of standardization and interoperability.

Finally, a new set of skills and processes - mostly centered on rapid diagnosis and repair of sophisticated network and data collection devices – will be required, driving consolidation of functions and a set of new applications infrastructure to support them.

EET&D: Jeff, David; thanks to both of you for taking time to share your thoughts, opinions and insights with our readers. Any parting words you'd like to add?

Provine: First, I want to thank you for this opportunity to share our thoughts and points of view with your readers. And please stay tuned; there is a lot more to come. Among other initiatives that will be unfolding soon, LogicaCMG will continue to bring best practices from around the globe in areas such as enterprise asset management, carbon trading and emissions management as well as vast experience in competitive utility markets and advanced metering infrastructure. We welcome the opportunity to visit further on any of these topics with you or your readers.

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TRANSFORMER WINDING HOT SPOT TEMPERATURE DETERMINATION

Jean-Noël Bérubé, Jacques Aubin – Neoptix Inc.
W. McDermid – Manitoba Hydro

Loading capability of power transformers is limited mainly by winding temperature. As part of acceptance tests on new units, the temperature rise test is intended to demonstrate that, at full load and rated ambient temperature, the average winding temperature will not exceed the limits set by industry standards. However the temperature of the winding is not uniform and the real limiting factor is actually the hottest section of the winding commonly called winding hot spot. This hot spot area is located somewhere toward the top of the transformer, and not accessible for direct measurement with conventional methods.

The temperature of solid insulation is the main factor of transformer aging. With temperature and time, the cellulose insulation undergoes a depolymerization process. As the cellulose chain gets shorter, the mechanical properties of paper such as tensile strength and elasticity degrade. Eventually the paper becomes brittle and is not capable of withstanding short circuit forces and even normal vibrations that are part of transformer life. This situation characterizes the end of life of the solid insulation. Since it is not reversible, it also defines the transformer end of life.

This process is well known to transformer owners and sustained efforts have been made to monitor the hot spot temperature to take advantage of cool ambient temperature, extend the transformer life while providing emergency overloading capabilities and taking advantage of market opportunities. Figure 1 shows the sensitivity of paper to temperature. Modern transformers make use of thermally upgraded paper that has been chemically treated to improve the stability of cellulose structure. The rated hot spot temperature for this kind of paper is 110°C and it can be seen that an increase of 7°C will double the aging acceleration factor. For older transformer built with normal Kraft paper, the rated hot spot temperature is either 95°C according to IEEE or 97°C according to IEC. This paper is also very sensitive to temperature and in case of emergency (assuming a hot spot temperature of 140°C) the aging acceleration factor is about 100, which means one hour in this condition is equivalent to 100 hours at the rated temperature.

Wet transformers (solid insulation showing more than 2% water content) incur an additional risk when operating at high temperature. It has been shown that the residual water trapped in paper may reach bubbling conditions and escape from paper under the form of water vapor bubbles. These bubbles may move with the oil flow, or get trapped in the winding and in both cases create a threat for insulation breakdown. No wonder that the transformer operator attempts to control the winding hot spot temperature with the best mean available.

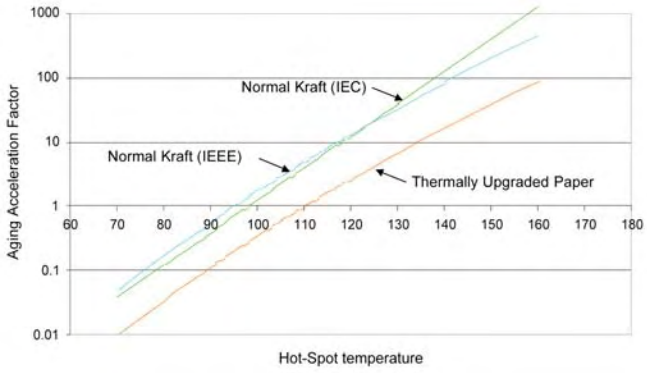

Fig. 1 Effect of temperature on paper aging rate

RECENT DEVELOPMENT ON WINDING TEMPERATURE CALCULATION METHODS

For several decades IEEE and IEC loading guides [1,2] have been providing guidelines for the calculation of the winding hottest spot temperature from data that can be conveniently measured and parameters derived from temperature rise test or manufacturer calculations. The basic calculation method relies on the measurement of oil temperature at the top of the transformer tank (top-oil temperature) and a calcultion of the temperature difference between the winding hottest spot and the top oil. This temperature rise is provided by the manufacturer, based on his modeling of oil flow and losses distribution in the winding. Thereafter the hot-spot temperature can be computed for any load using the standard relation:

$$\Theta_{HS} = \Theta_{TO} + \Delta\Theta_{HR}\left(\frac{I}{I_R}\right)^{2m}$$

Where:

Θ_{HS} = Hot-spot temperature
Θ_{TO} = Top-oil temperature
$\Delta\Theta_{HR}$ = Rated hot-spot temperature rise above top oil
I = Load current
I_R = Rated current
m = Winding exponent

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This simple formula was completed with an exponential function to account for the thermal inertia of the winding when a sudden load increment is applied. This calculation method has been around for several decades but a more frequent utilisation of transformer overload capability has shown the inadequacy of this method.

IEEE APPROACH

A revision of the loading guide for power transformers is currently in progress. It is noted that the traditional hot-spot temperature calculation method uses a number of assumptions that are not correct:

- Oil temperature in the cooling duct is assumed to be the same as the top oil temperature
- The change in winding resistance with temperature is neglected
- The change in oil viscosity with temperature is neglected
- The effect of tap position is neglected
- The variation of ambient temperature is assumed to have an immediate effect on oil temperature.

Moreover, experimental work has shown that at the onset of a sudden overload, oil inertia induces a rapid rise of oil temperature in the winding cooling ducts that is not reflected by the top oil temperature in the tank. Therefore alternate sets of equations are being developed, taking into account all these factors.

An additional important evolution is the disappearance of the guide on definition of transformer "Thermal Duplicate" that was often used to provide default values for winding temperature rise at rated load [3]. This reference will not be available anymore to provide support to the hot-spot temperature rise estimated by the manufacturer. This might reduce the credibility of transformer manufacturer in providing that critical thermal parameter.

IEC APPROACH

A new edition on the loading guide has recently been published [2]. It is now more clearly stated that the "H" factor relating the average winding to oil gradient to the hot-spot to top oil gradient can vary over a wide range depending on transformer size impedance and design. Here again the correct calculation of the critical temperature difference between winding hottest spot and top oil will depend on manufacturer ability to model properly the oil flow within the winding ducts, the distribution of losses along the winding, the heat transfer characteristics of the various insulation thickness used throughout the winding and the impact of local features restricting the oil flow.

It is also recognized that the dynamic response of the previous calculation method is not adequate as a sudden increase in load current may cause an unexpected high peak in the winding hot-spot temperature. To cover all type of load variations, an elaborate set of differential equations is provided, taking account the winding thermal time constant, the oil time constant and three new constants to characterize the oil flow.

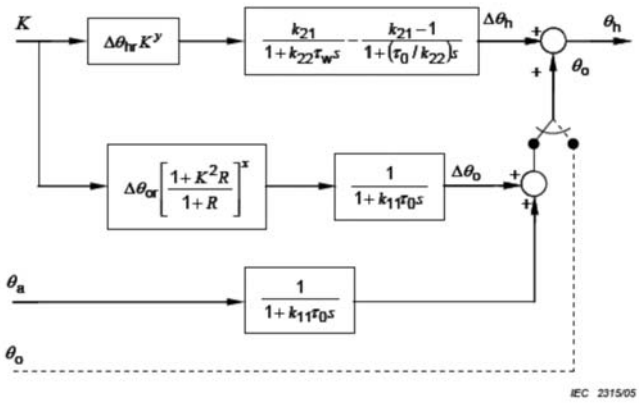

Fig. 2 Block diagram of IEC differential equation model for hot spot determination under dynamic loading conditions

All these changes in IEEE and IEC loading guides indicate that hot-spot temperature calculation methods previous known were not adequate to assess accurately winding hot-spot temperature. Wide use of computers now allows for sophisticated calculation methods but it demonstrates that the quest of winding hot-spot temperature is not trivial and it raises new doubts considering the number of additional values that need to be collected to run the calculation. No wonder that the direct measurement of winding temperature with fiber optic sensors is the recommended practice for critical transformers [2,4,5].

RECENT DEVELOPMENT ON DIRECT MEASUREMENT OF WINDING HOT-SPOT TEMPERATURE

For nearly thirty years, fiber optic temperature sensors have been available for measurement in high voltage transformer. First units were fragile and needed delicate handling during manufacturing. Over the past ten years, significant development took place to improve ruggedness and facilitate connection through tank wall.

The fiber optic probe on the Neoptix™ T/Guard system consists of a 200-micron solid-state optical fiber sheathed with a permeable protective PTFE Teflon sheath. This probe is designed to withstand manufacturing conditions including kerosene desorption as well as long term immersion in transformer oil. Permeability of the Teflon jacket allows for full impregnation under vacuum. The temperature-sensing element is based on the proven GaAs technology and is driven with an original algorithm to analyze the signal and provide repeatable and reproducible measurements.

In order to measure winding temperature, the sensor can be embedded in a spacer or attached directly onto any conductor that deserves temperature monitoring. Figure 3 shows an example of sensor directly in contact with a continuously transposed cable (CTC). The insulation must be removed locally and restored after sensor installation.

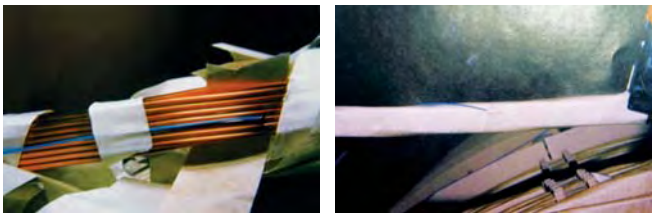

Fig. 3 Fiber optic sensor directly in contact with CTC cable

The more popular method is to insert the sensor in the spacer between successive disks. A slot is cut in the radial spacer and the sensor is glued in place as indicated in Figure 4. This method avoids the delicate task of breaking and restoring the conductor insulation. Since the spacer is actually preventing oil circulation at this location, the temperature gradient in the spacer is very small and the sensor reaches a temperature that is the average of the two disks. This is illustrated in Figure 5 where we compare temperatures from two sensors in contact with the winding and one sensor inserted in the spacer below the same winding. It can be seen that the temperature measured in the spacer is actually slightly higher than the measured conductor temperature.

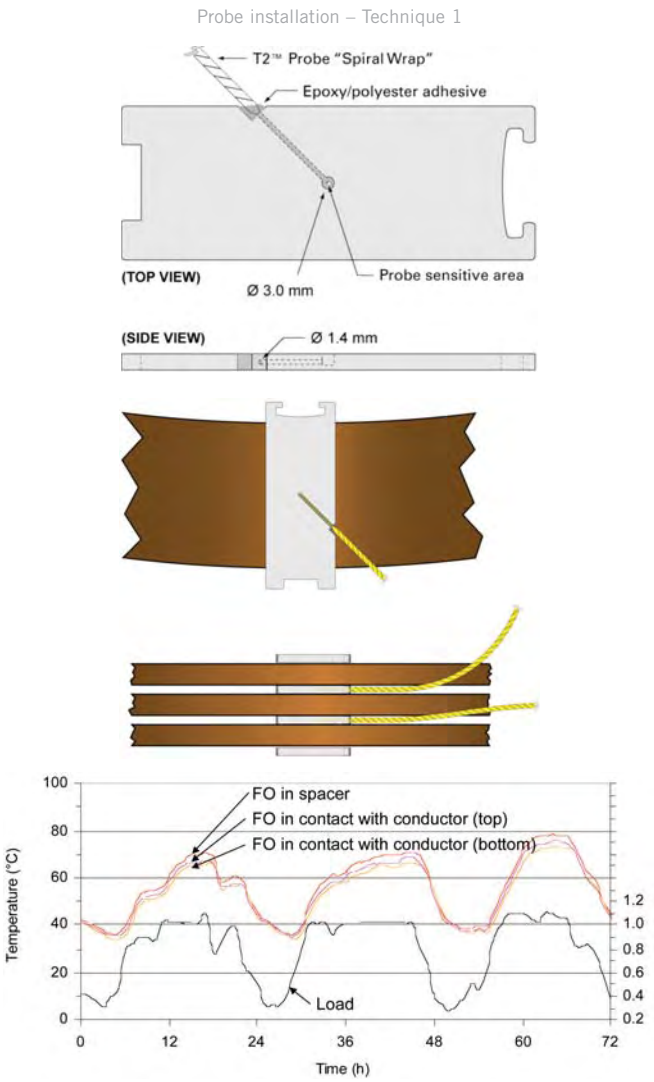

Fig.5 Discrepancy between temperature measurement for sensor on the conductor and sensor in the spacer

The installation of the fiber optic probe and the handling of this long fiber during manufacturing are certainly challenging to avoid sharp bends that could break the optical fiber. Among improvements that were introduced is the temporary spooling of the fiber as shown on Figure 6. Another improvement is the simplified through-wall connection shown in figure 7. This optical feedthrough has a simple design that provides both low-loss optical connection and leak-free operation. With these improvements the survival rate of fiber optic sensors is now better than 90%.

Fig. 6 Temporary spooling of fiber optic sensor

Fig. 7 Feedthrough fiber optic plate, with protection box

FIELD EXPERIENCE WITH FIBER OPTIC TEMPERATURE SENSORS

Since 1998, Manitoba Hydro has installed fiber optic temperature sensors in more than a dozen critical transformers, each of these transformer containing 8 probes. In one case the unit was equipped with 48 fiber optic sensors in the scope of a large investigation to provide the full picture of temperature distribution inside the transformer. The characteristics of this unit are summarized as follows:

- Type: Converter-transformer, ODAF cooling
- Rated power: 107 MVA, single-phase
- Line winding: 230/√3 kV, 810 A, grounded Y
- Valve winding: 127/√3 kV, 1468 A, Y
- Tertiary: 18.2 kV

The transformer is a directed-flow type, with oil forced directly in the windings. All pumps are continuously in service while the fans are set in two stages. One set is hand-operated and was continuously operated during the period reported here. The other set is in automatic mode and is turned on when the winding temperature reaches 50 °C. The transformer is shown in Figure 8. As part of its normal duty, this transformer undergoes significant load variations, as can be seen on Figure 9. The load demand fluctuations and the periodic connection of a large synchronous condenser result in a daytime load of typically 1

p.u. and nighttime load of 0.4 p.u. These wide load variations allow for a better evaluation of the dynamic behavior of the winding hot-spot temperature model proposed in the standards.

Figure 8 – Fiber optic temperature sensor on a 107MVA converter transformer

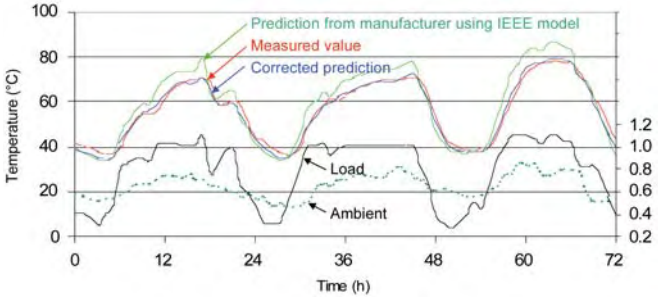

Figure 9 - Winding Hot-Spot Temperature Model on a 107-MVA Converter-Transformer

For this winding, the rated hot-spot rise above top-oil was estimated by the manufacturer to be 25 °C. For the winding exponent, the IEEE and IEC guides recommend for directed flow the use of m=1. It can be seen that with these values the winding hot-spot temperature calculated from manufacturer prediction and classical model can be off by about 7 degree at rated load. This would lead to about 14 degree at 150% overloading. Fiber optic temperature sensor provides a much more dependable temperature value. Even then, it might be useful to have a valid model for prediction purpose. This can be achieved by adjusting the rated hot-spot rise, the winding exponent and the winding thermal time constant. It is then possible to take full advantage of the loading capability, maintain service during contingency or to carry additional load to take advantage of market opportunity.

REINFORCEMENT OF OVERLOADING CAPABILITY

Most power transformers have inherently some margin of overloading capability. The rated capacity of a unit is basically the load level that will result in internal temperatures not exceeding the limits set forth by industry standard such as the IEEE and IEC. The application of loads in excess of the nameplate rating involves a degree of risk and accelerated aging. These effects are discussed at length in the IEEE and IEC loading guides [1-2] and can be summarized as follows:

- For long-duration overloads, the main consequence is the thermal aging of the solid insulation.
- For short-term transformer failures, the main risk is the reduction of dielectric strength due to the release of gas bubbles in regions of high electrical stress. The probability of occurrence of these bubbles is closely related to the winding hot-spot temperature and the moisture content of the insulating paper.
- Under overloading conditions, some components such as LTC contacts and bushing connections may develop high temperatures leading to thermal runaway.

It is generally recognized that the risks associated with overloading can be significantly reduced if the transformer conditions are closely monitored throughout the overload period [6-7]. Monitoring of winding hot-spot temperature and dissolved gas-in-oil and furan-in-oil provides a major support to the operator when the transformer faces overload conditions. On-line monitoring of winding temperature can provide a dynamic evaluation of insulation degradation and the relative loss of life can then be converted into cost. The cost attributed to loss of life needs to be subtracted from the apparent benefits achieved from transmitting this extra load. The loss of life cost can also be useful when calculating the cost of transmitting this additional amount of energy.

To quantify the benefit of continuous winding temperature monitoring, the additional loading margin provided by monitoring needs to be estimated. Field experience with transformer overloading is still limited, but as a first approximation, it can be conservatively assumed that if the parameters mentioned above are properly monitored, the transformer can carry an extra 10% loading with the same degree of confidence that would exist in operation without monitoring. Thus, the value of a monitoring system can be compared directly with the value of additional transformer capacity made available by the monitoring system. However this rough approach neglects the additional loss of life that would be incurred when operating at high temperature.

A better approach would be to calculate the economic benefit that would ensue from using the additional loading capability to take advantage of market opportunities. As a numerical example, assume that a 100MVA transformer could be requested to carry a 10% overload, for about 5% of the time, when the market condition are attractive. Assuming an ambient temperature of 30°C, the calculation of benefit, including allocation for loss of life would unfold as follows:

1	Transformer rated power (MVA)	100	
2	Overloading margin made available by monitoring (%)	10	
3	Probability of overloading opportunity (h/year)	450	
4	Financial benefit from energy transmitted ($/MWh)	80	
5	Replacement cost of transformer ($)	2,000,000	
6	Transformer normal life duration at 110°C (h)	150,000	
7	Assumed ambient temperature (°C)	30	
8	Estimated winding hot-spot temperature (°C)	127	
9	Aging acceleration factor during overload	5.5	
Yearly benefit from extra loading *(1 x 2 x 3 x 4)*			$360,000
Yearly cost for additional loss of life *(5 x 1/6 x 3 x 9)*			$33,000
Net yearly benefit from overloading with on-line monitoring			$327,000

This rough calculation assumes steady temperature conditions during overload but it allows us to show the magnitude of benefit that can be expected from using the transformer full loading capability under adequate control.

CONCLUSIONS

Loading capability of power transformers is limited mainly by winding temperature. It has been the practice to assess this temperature from a measurement of oil temperature at the top of the tank with an added value calculated from load current and winding characteristics. With more frequent occurrence of overloading, it has been found that this simplified approach is not suitable for several types of overload and transformer design.

In an attempt to close this gap, IEEE and IEC loading guides are being revised with more sophisticated models aiming at a better representation of oil temperature inside the winding, considering variations in winding resistance, oil viscosity and oil inertia. Still, direct measurement of winding temperature with fiber optic sensor provides a definitive advantage over a value calculated from uncertain parameters provided by the manufacturer and uncertain equations characterizing the cooling pattern.

In response to this important need, fiber optic sensors have significantly improved to the point that direct measurement of winding temperature is now becoming the preferred method to measure this critical parameter. Compatibility of fragile fiber optic sensor with transformer factory environment has been a problem in the past but is now resolved with sturdy fiber jackets, proper spooling of sensor during factory work, and simplified through-wall connection.

Fiber optic sensors have reached maturity for application in power transformers and should become a standard feature for new transformers. Immediate knowledge of winding hot-spot temperature provides the necessary confidence to carry through overload occurrences and reaps full benefit from this asset.

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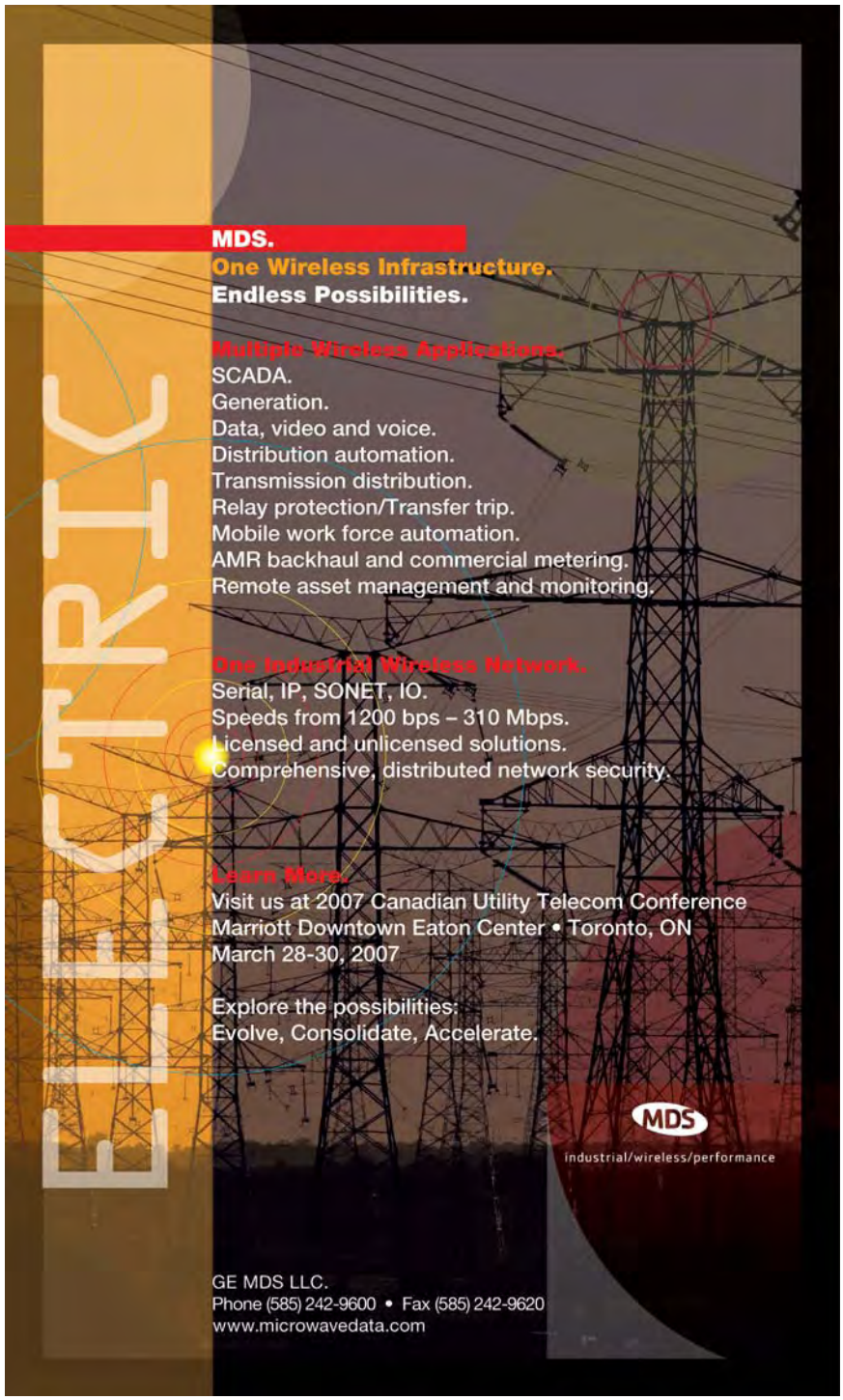

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The Essential Role of Cyber Security in the Smart Grid

by: Doug Westlund, President and Chief Executive Officer, N-Dimension Solutions Inc.

THE EXISTING ENVIRONMENT

Our electricity system has greatly evolved and now represents an essential contributor to our society's well-being. Power Generation and Transmission & Distribution Operators aim to deliver dependable service to their customers since business systems, healthcare systems, home comfort systems, etc. all rely on the availability of electricity. As the demand for reliable service grows, all Operators are faced with a challenging environment where they must deal with a great variety of elements:

1) The electric grid is under pressure, according to the North American Electric Reliability Council (NERC), which states that over the next 10 years while the demand for electricity is expected to rise by 19% in the United States and 13% in Canada, confirmed power capacity will increase by only 6% in the U.S. and 9% in Canada. Furthermore, total transmission miles are projected to increase by less than 7% in the U.S. and by only 3.5% in Canada.
2) The Power & Energy (P&E) industry faces billions of dollars in maintenance upgrades which have been deferred for many years.
3) Corporate governance standards and regulatory requirements, including Sarbanes-Oxley and NERC, have resulted in an environment where investments in new technologies must be made wisely, with those technologies being implemented according to specific deadlines. Furthermore, in jurisdictions such as the province of Ontario, Utilities must respond to government-mandated technological deployments, such as Smart Meters.
4) Utilities need to deliver excellent service while ensuring that costs are kept under control. They must also deliver on the cost-cutting expectations built into the recent mergers and acquisitions.
5) The P&E work force is aging rapidly and the industry needs to address this situation over the next 5 to 10 years.
6) Over the years, Operational Systems have been built around disparate technological platforms, creating "islands of technology" that cannot collaborate and cannot deliver the effectiveness and cost-efficiency required by Operators.
7) Due to ever increasing security threats from computer hackers who have chosen the Power & Energy sector as a target, Operators are having to combine their efforts to migrate to newer technologies with the essential deployment of Cyber Security measures for the legacy systems which were installed long before Cyber Security threats emerged.

To deal with this challenging environment, today's forward-looking entities are formulating new strategies to considerably improve their Operational Systems. "The Smart Grid" has emerged as an evolution of the electric grid which allows Utilities to position themselves as proactive participants in the end-to-end generation and delivery of electricity. The replacement of the electro-mechanical grid with a digital Smart Grid creates vast opportunities for improved Operational Systems and increased overall success for Generation and Transmission & Distribution Operators. It must however be realized that the benefits of the Smart Grid are available only to those organizations who recognize that, in today's environment, computerized resources are threatened by increasingly sophisticated Cyber Security attacks. It is therefore essential that the deployment of the Smart Grid be accompanied by the establishment of a strong Cyber Security program that is integrated into Operational systems. Operators must also be pro-active in the protection of the legacy systems which very often still represent major underpinnings of our electric grid. Organizations that combine Cyber Security with the Smart Grid and with their legacy systems are best positioned to reap the numerous benefits to be derived from improved Operational Systems and from increased service reliability to their customers.

THE SMART GRID

The Smart Grid is an environment that supports not only the flow of electricity but also the flow of Operational information through a strong and reliable communications network. This fully digital, 2-way communication environment delivers considerable asset optimization and efficiency opportunities for participating entities. The Smart Grid allows operators to be pro-active in the detection of generation, transmission, and distribution problems, to isolate the problem areas, and to prevent cascading power outages. As per the U.S. National Energy Technology Laboratory, the main characteristics of the Smart Grid are:

- The Smart Grid is self-healing. It can detect, analyze, and respond to disturbances.
- The Smart Grid supports client equipment and usage behaviour.
- The Smart Grid is tolerant of physical and Cyber Security attacks.
- The Smart Grid delivers high-quality power to customers.
- The Smart Grid supports various power generation technologies.
- The Smart Grid supports competitive power markets.
- The Smart Grid delivers capital asset optimization while minimizing Operational costs.

The Smart Grid, that is the evolution of the electric grid from being electro-mechanical to becoming a digital, automated network, can clearly deliver great flexibility to Utilities in search of improved business methods and service offerings.

PROTECTING THE SMART GRID

To enjoy the Operational benefits derived from the implementation of the Smart Grid, Utilities must ensure that appropriate measures are in place to protect the extensive information flow and control signals intrinsic to the Smart Grid. In the current transition period, when elements of the Smart Grid and legacy system components co-exist in the electric grid, Cyber Security concerns are particularly relevant for the P&E sector which has been identified as being among the top industrial security targets.The U.S. Homeland Security organization, the U.S. Department of Energy, and the Canadian Energy Infrastructure Protection Division have all issued an urgent call to action for the protection of energy control systems since increasingly sophisticated cyber attacks have been launched against system components, telecommunication systems, and common operating systems with the goal of sabotaging control systems. Furthermore, the vulnerability of energy control systems continues to augment as these systems are increasingly networked with corporate systems, business partners, and other Internet-based resources. The Smart Grid is therefore exposed to several types of risks, including the typical risks listed below.

Typical Cyber Security Risks Associated with the P&E Sector

- Unauthorized access and breach of control systems
- Interception and manipulation of control data/signals
- Distributed/coordinated attack on system components
- Interception and manipulation of monitoring data
- Intentional and unintentional human intervention
- Impairment to application software
- Third-party intervention (interconnected partner, vendor)

Cyber Security is definitely a key component of an Operator's Smart Grid deployment and of its Service Reliability strategy. The development of a Cyber Security program for the Smart Grid should not be an afterthought; it should be an integral part of the planning and design process involved with the deployment of Smart Grid initiatives. The Cyber Security program should also ensure that legacy systems receive the protection they require. A properly planned Cyber Security strategy will result in a highly secure environment that still delivers the operational flexibility and efficiency so crucial to the successful implementation of new Operational systems. Utilities should therefore implement a comprehensive, integrated, well monitored, and frequently updated Cyber Security program to ensure they derive the full benefits available from the Smart Grid.

RISK ASSESSMENT

It is recommended that the Cyber Security program start with a comprehensive Operational Risk Assessment. This Assessment should be specifically tailored to a P&E Operational environment as its needs vary greatly from those of a corporate Information Technology environment. The Assessment allows an Operator to identify the potential problem areas from an Operational perspective and to then formulate a strong Cyber Security strategy.

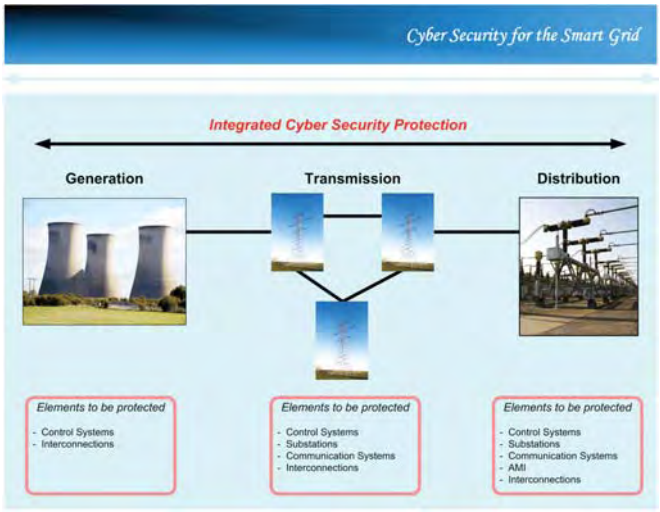
The first step in the Operational Risk Assessment is to conduct a Threat Risk Assessment (TRA) to determine the prioritization and focal areas for protection. After the TRA, the Operational Risk Assessment can include: an architecture review; an assessment of security devices, network devices, servers and workstations; a Cyber Security policy review; and a site audit, including a physical security audit. The Assessment can also be expanded to include the overall Cyber Security of an Operator, including its Information Systems, to ensure that overall productivity is protected from cyber attacks.

The Operational Risk Assessment should be based on Cyber Security Best Practices and on industry-specific security standards such as NERC CIP as well as on directives issued by the U.S. Department of Energy and by the U.S. Department of Homeland Security.

Smart Grid Risk Assessments differ from traditional Utility risk assessments in that they encompass both an internal and an external perspective, the latter being required due to control signal and monitoring interconnections. A layered "defense in depth" approach to security is therefore critical for P&E Operations as it is imperative that systems be protected at the point of interconnection as well as within the security perimeters.

EXTENSIVE CYBER SECURITY NEEDS

Cyber Security is needed for the various building blocks of the Smart Grid's Operational systems, including Operational Control Systems, SCADA Systems, Smart Meters, and Substations. The need for Cyber Security measures applies, of course, to all participants in the Smart Grid. As illustrated below, the need for Cyber Security applies for the Generation, Transmission, and Distribution sectors and a variety of elements need to be protected in each of those sectors. A robust, integrated Cyber Security protection is attained when Cyber Security measures are implemented in each sector.



CYBER SECURITY PROGRAM

Once the appropriate Risk Assessment activities have taken place, a comprehensive Cyber Security program should be established. The selected technology solutions should be based on Open standards so that the Smart Grid is protected by effective and cost-efficient technologies that are capable of complementing each other and of

collaborating in an integrated manner. The selected solutions also need to be interoperable with existing legacy Operational systems. In addition, the selection of solutions based on Open standards ensures that the Cyber Security program can expand, evolve, and adapt to new challenges as they arise.

Frequently, Managers are challenged to deploy strong solutions while, at the same time, having to deal with limited budgets and the imperative of accommodating innovative business solutions and improved competitiveness. Consequently, Managers should favour Cyber Security solutions that deliver:

- Extensive monitoring,
- Flexibility,
- Support of legacy systems,
- Migration to new devices,
- An environment rich in auditing, logging, and reporting capabilities,
- Compliance with relevant regulation,
- Reduced complexity,
- Integration with existing operations, and
- Cost-effectiveness.

When personnel resources and/or in-house Cyber Security expertise are limited, Operators may wish to seek assistance from external Cyber Security organizations. These groups can complement internal skill sets to ensure the utmost success for the Smart Grid deployment and to deliver results within expected deadlines.

As Cyber Security threats are constantly evolving, it is essential that the Cyber Security program be frequently updated. The Operator should be committed to continuous Cyber monitoring and to conducting periodic re-assessments of its environment to ensure that strong Cyber Security measures remain in place at all times.

CONCLUSION

All participants in the Power & Energy market face a most challenging environment and they therefore need to adopt new and improved operating methods to deliver highly reliable services to their customer base. The emergence of the Smart Grid represents an opportunity for forward-looking entities to bring new sources of productivity and profitability to their organization. However, the benefits offered by the Smart Grid will only be available to Operators who invest in a robust Cyber Security program as an essential element of their Operations. Such a program allows Operators to address the various threats that exist for interconnected computerized resources and to reinforce their organization's overall security and service reliability. While the complete Smart Grid is still emerging, many entities have already implemented some of its elements and it is imperative for those organizations to evaluate their Cyber Security position. Operators must begin the implementation of Cyber Security protection not only for Smart Grid elements but also for their existing legacy systems as the P&E sector has been identified as a major target for cyber attacks.

About the Author

Doug Westlund *is the co-founder of N-Dimension Solutions Inc., a leader in Cyber Security solutions for the Power & Energy market. Doug has over 20 years experience in process control, SCADA software development, network communications, and Cyber Security solutions. N-Dimension Solutions and their business partners are actively assisting North American Generation, Transmission, and Distribution Operators with Cyber Security solutions that address their portion of the Smart Grid. Doug can be contacted at: doug.westlund@n-dimension.ca, 905-707-8884 x.227.*

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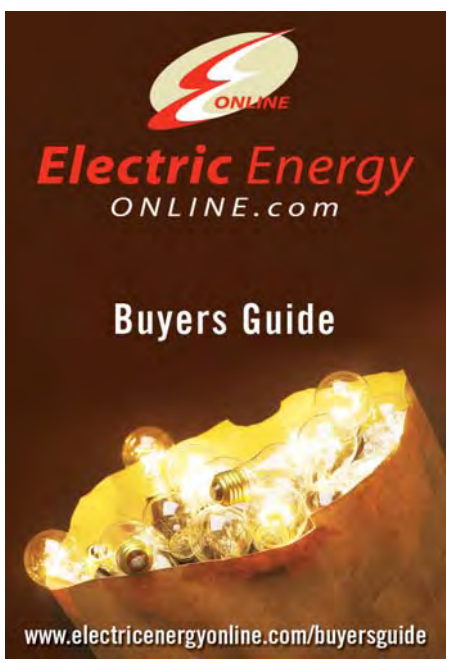

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Faye Hall, Sr Software Engineer
Enspiria Solutions, Inc

Geospatial Systems Integration Strategies

By: Faye Hall, Senior Software Engineer, Enspiria Solutions, Inc

In recent years, enterprises have invested heavily in their computer assets either through investing in their existing infrastructure, or through acquiring assets due to mergers and acquisitions. The impact of these investments and acquisitions have been significant, though unfortunately, many of these acquired assets sit in solitude, incapable of sharing their information with the rest of the enterprise. Fortunately, system integration facilitates the communication between disparate systems for the purpose of information sharing and process enhancements.

Due to the variety of systems and integration requirements, many common strategies can be implemented to support communication between these systems. Integration requirements may dictate techniques as simple as file sharing or could involve intricate middleware packages managing the messages between systems. The type and complexity of the strategy employed is dependent upon the interface restrictions and applications involved.

TWO LEVELS OF INTEGRATION

Within the realm of system integration, there are two general levels of integration: information-oriented and service-oriented. Information-oriented integration manages the exchange of information between systems. Service-oriented integration focuses on the sharing of business processes and methods to integrate applications.

INFORMATION-ORIENTED INTEGRATION

For decades, information-oriented integration has been employed in enterprises to exchange simple data between a variety of systems. Generally, this involves exchanging data at the database level or through information producing interfaces such as integration brokers. Some of the more common techniques utilized with GIS applications are:

- Common Format/File Transfer
- Extract, Transform, and Load (ETL)
- Data Replication

Since the integration is typically performed at the lowest common denominator of a system, this approach benefits from the limited amount of modification to the source and target systems that will be required. As a result, information-oriented integration is considered to be one of the simplest integration frameworks. However, its lack of complexity can be misleading. Depending on the systems to be integrated and restrictions or limitations imposed by these systems, the integration solution can easily increase in complexity.

COMMON FORMAT/FILE TRANSFER

As today's GIS applications become increasingly versed at reading a variety of file and data formats, it is becoming more and more common to have applications share data by simply utilizing data or files written directly from another application. The core of this strategy rests on the ability of one system to save or publish data to a format which can subsequently be consumed by the other system. For example, ESRI can currently consume AutoCAD's native DWG file format. Similarly, data stored by applications using the Oracle Spatial SDO geometry type can be accessed by many GIS and CAD applications.

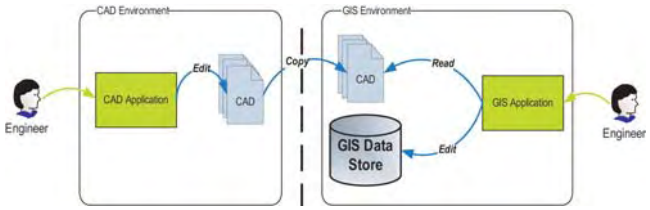

Figure 1. Common Format Example

The principal advantage to this strategy is its simplicity. In most cases, this technique requires very little, if any, additional technologies. If file transfers are required, the commands to copy files and create scheduled tasks are intrinsic operating system functions.

However, file size could be problematic. Files containing spatial data are often significantly larger than normal textual data thereby hampering network performance during the file transfer. Usage of common formats with direct access to the data does provide real-time data currency.

EXTRACT, TRANSFORM, AND LOAD (ETL)

Should you prefer the simplicity of the previous strategy of transferring files, but your system is unable to consume the data in the format provided or you need the data schema to be altered prior to loading into the destination system, then an ETL approach may be appropriate.

Extract, Transform, and Load, otherwise known as ETL, will extract the data from its source format, transform the data, including data type, structure, or schema, and load the resulting data into a destination format or database. For instance, the attribution of a valve in an AutoCAD drawing may be separated in the GIS environment. An ETL scheme would have to separate the AutoCAD object data into the appropriate table and feature objects.

Another scenario may involve a SCADA system that utilizes AutoCAD files containing GIS data. Rather than maintain the same data in the GIS and the SCADA system, the data can be extracted from the GIS and manipulated to fit the AutoCAD template and layer definitions such that the SCADA system can utilize the resulting files.

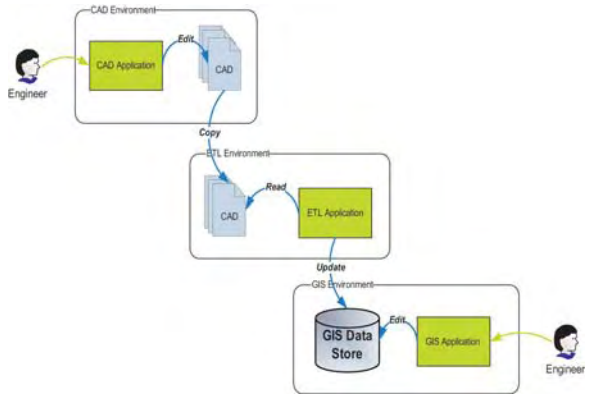

Figure 2. ETL Example

ETL provides more control and customization than a file transfer strategy because it allows data to be transformed and validated prior to being consumed by the destination system. However, another technology or product must exist (e.g. Safe Software's Feature Manipulation Engine) to perform the transformation. ETL is also plagued by network performance issues due to file sizes.

DATA REPLICATION

Replication is a mechanism for copying and distributing data from one database to another database while maintaining the consistency of the data between all databases. It allows for the distribution of data to a variety of locations such as remote or mobile users via local and wide area networks, wireless connections, and dial-up connections.

The type of replication chosen is dependant on several factors including the databases involved, the network over which the data will be transported, the minimum latency requirements, and the type and amount of data to be replicated. Each replication type has its own pros and cons to be considered.

Snapshot replication essentially truncates and replaces all existing data in the subscriber database with an exact copy from the publishing database. Though simple, this style is not preferable in situations where data is required at or near real time due to the possibility of overwhelming network demands.

Transactional replication minimizes the peak network demands by tracking and transmitting only the data that has been modified since the last broadcast. Due to the reduced amount of data being transferred, transactional replication is ideal for low latency requirements.

Merge or multi-master replication extends transactional replication by permitting each subscriber to update the replicated data. This type of replication allows many sites to work autonomously while maintaining a single enterprise view of the data. This method of replication possesses many of the advantages of transactional replication; however, it suffers from heavy management and control requirements and necessitates methods to manage conflict resolution.

Each replication type relies upon actions performed at the database level, thus consideration must be given to the location of the business logic. Should the business logic reside on the desktop or exist in code modules, it may be difficult for the replication scheme to process the data and invoke the business logic validation. Further, should the information being replicated fail validation, a mechanism for resolving errors will have to be incorporated. These schemes are therefore best suited for situations where the data can be consumed without having to pass validation tests at the subscriber.

In the scenario where asset data is maintained in an external application (e.g., Hansen Asset Management), yet the GIS would benefit from the existence of the data in a specific feature class in its database, replication could be used to copy the data from the asset management application database to the GIS. In this case, the asset management application has performed all the necessary business logic to deem the attribution valid. Therefore, the GIS must simply store the data related to the feature.

Another example is an environment where the asset data and the GIS data are both maintained in SQL Server databases, and the GIS data is ESRI version managed. A transactional replication scheme could be developed to transfer attribute modifications to a specific version of ESRI's multi-versioned views within the GIS. Once the edits are

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received into the default version, GIS editors would have the most recent data and be able to attach geometries to the new records.

GIS database environments often make replication difficult due to the spatial data storage format and the versioning schemes employed by the GIS. Some replication mechanisms, such as Oracle Streams, do not support the replication of objects with LOB attributes, object types that use type inheritance or binary objects, which are commonly used for spatial data storage. Another common issue is that the versioning mechanism employed by the GIS impedes the use of transactional replication mechanisms.

SERVICE-ORIENTED INTEGRATION

Service-oriented integration integrates applications by providing access to functions or services that are normally only available in specific applications. While this form of integration has existed for many years utilizing remote procedure calls and application programming interfaces, it has recently jumped onto the radar with the advent of web services and XML. In general, service-oriented integration wraps existing application functionality through exposed interfaces to create aggregate applications. By leveraging the behavior of other applications, data validation and business rules are enforced during the transactions. A service-oriented approach will provide all modifiable systems with access to the published services.

Service oriented integration techniques include:

- Remote Procedure Call Integration/Application Programming Interface (RPC/API)
- Web Services

REMOTE PROCEDURE CALL INTEGRATION/APPLICATION PROGRAMMING INTERFACE (RPC/API)

For interfaces that must invoke existing business rules, it may be necessary to rely on Remote Procedure Calls (RPC) or the Application Programming Interfaces (API). RPCs and APIs are often provided by an installed application, and can be utilized for communication between applications. For instance, when ESRI's ArcGIS software is installed, a very extensive set of objects and controls are loaded to aid development that will enrich the users experience and ESRI functionality. These objects allow for the development of integration tools to interact with the GIS.

Unlike previous integration strategies, which focused on publishing data to be interpreted by the destination applications, utilizing the API allows for leveraging the behaviors already implemented in the systems. It provides more flexibility for an enterprise than data publication since it is generally a custom tool or utility developed specifically for the environment. However, network to network limitations, the amount of development, resources, and skill sets required to build and maintain the integration software can be a concern for some enterprises.

WEB SERVICES

Should the environment and architecture provide for it, another viable integration alternative for leveraging remote methods and behaviors are web services. Web services refer to technologies that provide a standardized method for integrating applications over a network, independent of platform. They allow systems to communicate through firewalls, between networks, or the internet, without intimate knowledge of the underlying data structure or systems. Such is the case with Google Maps and their use of AJAX technology.

In an enterprise with disparate systems and operating systems, web services offer a means by which many systems can communicate, including the GIS. For instance, if human resources needed to know if a person lived within the city limits, a web service could be developed to perform a spatial query in the GIS with a person's address which would then return a yes or no response. Similarly, a capital improvements project portal could request maps or data from the GIS related to a buffered point, such as all addresses within a 5-mile radius. Web services provide reusability as all applications would be able to utilize the same web server to acquire the functionality. This also helps to further utilize capital investment in existing applications. Another feature of web services is their ability to work through firewalls to connect to disparate networks. As well, additional security features within web services can avail any concerns regarding corporate security policies.

INTEGRATING YOUR ENTERPRISE

While each integration technique has been described in isolation, it is rare to find an enterprise that has met its needs without taking on a multi-facetted integration approach. Figure 3 illustrates a scenario with the following combination of integration techniques:

- Web services to initiate work orders in work management applications
- Custom interfaces using APIs to integrate the work management/inspection & maintenance applications with GIS
- Data replication and ETL from external agencies and offices

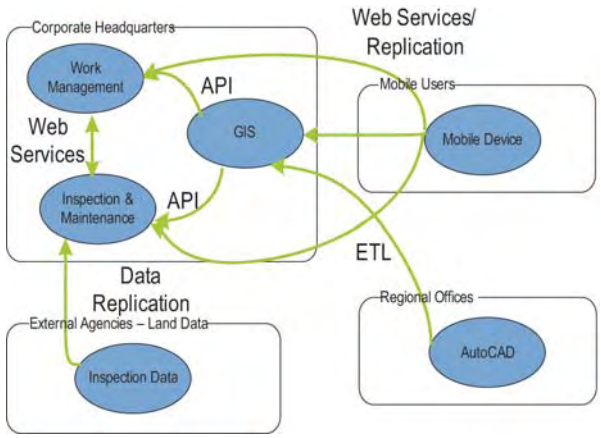

Figure 3. Example of Multiple Integration Techniques

A true enterprise integration framework can be achieved using an enterprise service bus to manage the requests for services to the various systems (Figure 4). This approach provides a bridge to allow functional older applications to interact with newer environments seamlessly. By leveraging off the shelf Service Oriented Architecture middleware, Business Intelligence product suites and adapters, Enterprise Oriented Architecture provides ease of integration, faster deployment windows, reusability, and reduced integration, implementation, and maintenance costs.

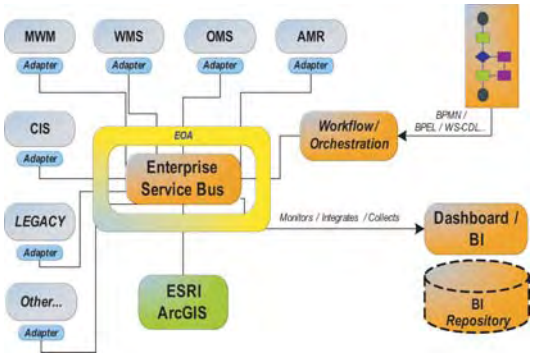

Figure 4. Enterprise Integration Framework

Rather than having various integration techniques randomly used to access diverse applications as in Figure 3, the Enterprise Oriented Architecture provides a central bus through which all communications are directed (Figure 5). Many diverse systems can utilize the same services thus increasing reusability and reducing implementation and maintenance costs. It allows an enterprise to introduce new technologies and immediately take advantage of the existing infrastructure and services.

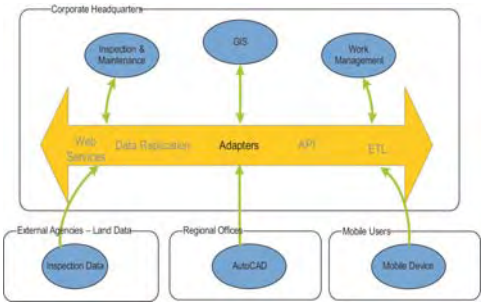

Figure 5. Enterprise Oriented Architecture

OTHER INTEGRATION CONSIDERATIONS

Every integration strategy will present some limitations and restrictions depending on the environment, the applications, and the latency requirements just to name a few. Some additional aspects commonly considered are:

- Application coupling versus cohesion
- Interface intrusiveness
- Manageability

Application coupling and cohesion refers to the level of dependency on each application's structure and interface that an integration strategy relies upon. A tightly coupled integration strategy is heavily reliant on the interfaces into the applications. As applications evolve, and interfaces are modified, the integration will need to be updated.

Another consideration is the intrusiveness of the interface that is being deployed. If the integration strategy being proposed requires alterations to the workflow of the business, how receptive will the business be to the solution?

The manageability of an integration solution should also be considered. Utilizing an Enterprise Oriented Framework which provides existing middleware solutions eases the maintenance burden that many integration techniques present.

Including these additional considerations when determining an integration solution will ensure a proper solution will be implemented for your enterprise.

SUMMARY

Systems integration allows information to be shared amongst disparate systems and enables your enterprise assets to realize their full potential. By taking an enterprise approach with your integration techniques, such as an Enterprise Oriented Architecture, you get all the advantages of the integration techniques along with increased reusability, reduced maintenance, and improved information accessibility. Its modular approach to systems integration, through the use of adapters and middleware, enables you to choose the degree of systems integration for your enterprise now, and in the future. ■

About the Author

Faye Hall *is a Senior Software Engineer with Enspiria Solutions, Inc. Faye designs and develops software applications to integrate Geographic Information Systems (GIS) and legacy systems for the utility industry and for local governments. She holds a Bachelors of Applied Science degree in Systems Design Engineering.*

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The Latest and Greatest Smart Grid Solutions Are Just That

Demand Dispatch Technology Offers a Timely Upgrade to Existing Demand Management Approaches

By: Jeff Tolnar, Chief Technology Officer, BPL Global & Heidi Caroline, Vice President, Smart Grid Applications, BPL Global

For too long, arguably 50 years, the term "state-of-the-art technology" has been conspicuously absent from the lexicon of the U.S. utility industry. Critics declare that aging technology is placing the industry in a position of escalating risk – both from a power delivery perspective and a financial viability perspective. The emerging imbalance between energy supply and demand in the U.S. and throughout the world threatens system stability and reliability, power quality, and the cost of power itself. But enough of the doom and gloom; there are viable technology solutions that offer attractive ROI waiting to be deployed, and yes, they are indeed "state-of-the-art."

At a very basic level, utilities require a fresh perspective that lends itself to better grid usage. Shifting the grid from its current reactive environment where a utility company too often has to rely on a customer call to be made aware of a problem to a dynamic two-way communication grid that can restore balance between energy supply and demand has been underappreciated for too long.

According to a recent Wall Street Journal article, "A report by the North American Electric Reliability Council warns demand for electricity is increasing three times as fast as resources are being added in the U.S., a trend that could shake electricity-system reliability in the coming decade. NERC counts 67,000 megawatts of resources in the works in the U.S. versus 141,000 megawatts of expected demand growth by 2015, leaving a shortfall of about 81,000 megawatts, an amount equivalent to 160 large power plants. One megawatt can power 500 to 1,000 homes. Increasingly, it is left to a deregulated market to determine whether and when new resources get built. Available resources are expected to fall below safe levels in many parts of the U.S. and Canada, such as New England, the Rocky Mountain region and Texas, in the next 2-3 years."

A similar story can be told in many countries around the world. To address the problem of unrelenting demand in a meaningful timeframe, technologies that delay the need for new generation capacity and more efficiently use distributed energy resources by trimming peak load are of increasing interest to the power industry, the public and regulators alike. The proverbial light at the end of the tunnel – yes, there is one – is that key constituency groups are more actively engaged than ever in the search for better solutions, and, ultimately, to harnessing technology to restore balance between energy supply and energy demand on existing grid infrastructure.

The late Nobel laureate Rick Smalley observed that even though our civilization has many problems, energy is central to all of them. While lingering cynicism in the utility industry that stems from scores of magic bullet solutions proffered over the last 30-years have stemmed progress, this cynicism is quickly being pushed aside by real power solutions that have merit from all sides. Many utilities are discovering that attractive alternatives to the status quo do exist.

DEMAND MANAGEMENT – AN EVOLVING SOLUTION

What can be done to mitigate the problem of a growing supply/demand imbalance?

Without a change in approach, this imbalance would have to be addressed by sinking hundreds of billions of capital dollars into new electric generation capacity. The expected increase in the supply side of the equation is necessary and will occur. The demand side of the equation has long been forgotten as generation resources were plentiful and sometimes viewed as inexhaustible. Technologies exist today that can now manage the demand side of the equation.

A variety of programs known as Demand Management have been developed to better match the higher cost of delivering at peak demand levels to the price charged. These programs encourage customers to react to the time-value of electricity and have the potential to rapidly even out demand at a relatively low cost, thereby freeing up existing peak load capacity to meet near term growth in demand, and mitigating the reliability and cost issues that arise from the imbalance.

Meaningful success of Demand Management initiatives depends upon the implementation of cost-effective solutions that can, within minutes, send signals to thousands of customers, confirm interruptible load shedding activities, or directly control loads or generation at customer sites. Supported by the right technology, Demand Management can be an effective hedge against reliability risks (such as generation shortfalls, transmission congestion and distribution shortcomings) and financial risks (such as wholesale price spikes).

Demand Management technology is a very viable alternative to the traditional method of energy imbalance remediation, which is the construction of new generation facilities which can take up to 15 years to construct and are extremely expensive. New generation facility construction capital expenditures average $1.6 million per Megawatt constructed. In addition, emissions from new generation capacity have a negative environmental impact, increasing carbon dioxide load on our environment.

The ability to control demand at very specific locations and isolate it to specific grid elements enables Demand Management to reduce significant operational risks including rolling blackouts, profit risk due to volatility of energy feedstock, risk to assets from overload conditions, risks to customers from outages and risk to the environment from CO2

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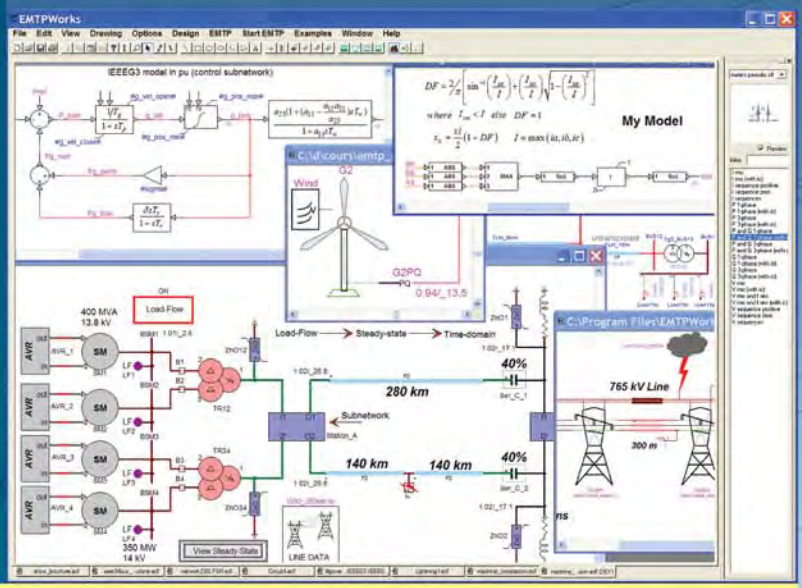

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emissions. The primary objectives of Demand Management are:

- System reliability: The Electric Power Research Institute (EPRI) has estimated that power interruptions and inadequate power supply already cause domestic economic losses of more than $100 billion annually. Demand Management programs can enhance reliability of the electric system by providing negotiated reductions in use during peak conditions.

- Cost effectiveness: Demand Management technology is all about cost avoidance and cost reduction. The major costs Independent System Operators (ISOs) avoid with Demand Management are energy and capacity. Additional savings include reducing line losses within the transmission and distribution system as well as reducing ancillary services such as Spinning Reserves needed to meet short-term load fluctuations and power quality requirements. Demand Management has the potential to reduce price volatility.

- System efficiency: Demand Management can also boost the efficiency of system capacity utilization by trimming peak load through the cycling of interruptible load.

- Risk management: Demand Management is a risk management tool and will allow utilities to offer customers pricing tools and risk management products that are financially effective and rapidly dispatchable.

- Environmental concerns: Electricity generation represents a challenging burden on the environment that is costly to mitigate.

Undoubtedly the approach to Demand Management that has received the most attention to date is Advanced Meter Infrastructure (AMI). AMI systems are based on smart meters that provide an automatic connect/disconnect feature and automatic meter reading (AMR). Some systems provide breakers to control load for the entire premise or relay limited pricing information to a utility's customers. The breaker method used mostly in international markets essentially turns off the customer once they exceed their current threshold. The customer must then manually reset the breaker. Non-AMI based systems have also been developed that control a limited number of high load devices, generally with industrial customers. These early attempts at Demand Management are inherently constrained.

Typically solutions have used one-way electronic broadcast or manual processes to relay price signals to customers. While many AMI solutions have limited two-way communications capability, communication from the premise back to the utility is slowed by the interval requirements of the solution provider's proprietary communications scheme. Therefore, a one-way broadcast (to advise a customer that peak conditions are being reached and some form of real time pricing will be in effect) is the extent of the communication.

The effectiveness of traditional Demand Management solutions is reliant on the customer's ability and willingness at the time of peak conditions to actually make a change in their consumption. Customer communications and timely availability about participation during peak load events often limit effectiveness.

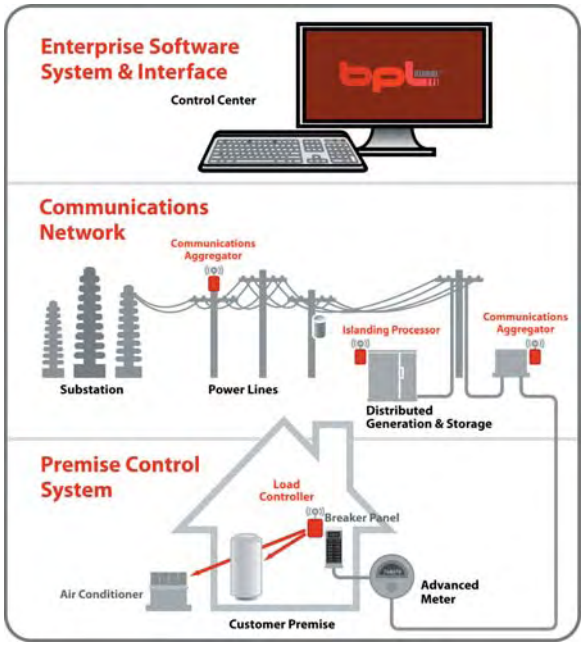
Under these circumstances, the utility has no way of knowing what non-critical load is available to be shed and has no way of receiving confirmation of how much load was shed. This leaves the utility operator in a "wait and see" mode during peak operational times. Typically the cost justification for a move to AMI has been heavily supported by the operational efficiencies and cost reductions associated with replacing human meter readers and automatic connect/disconnect functionality to avoid a truck roll for new activations or removals.

DEMAND DISPATCH – NEXT GENERATION DEMAND MANAGEMENT

A superior technology, called Demand Dispatch, sidesteps the unpredictable commitment shortfalls of consumers and avoids the implausible premise that "committed" customers will be at their premise to take an energy reduction action at the precise moment and time necessary.

Demand Dispatch technology allows for automated curtailment of energy usage as curtailment is needed. Using robust two-way communications and power system software to manage a network of premise controllers, Demand Dispatch technology can efficiently manage interruptible load in very granular way – device by device in a customer's premise.

For example, sensors at a customer's premise can communicate the use of non-essential, interruptible power (for volunteered appliances like pool pumps, air conditioners and water heaters). Small amounts of savings from individual premises can add up for impressive grid-wide shedding of non-essential loads on a real time basis.



How it works:

The system consist of four basic elements:

1) the enterprise software system,

2) the communications network,

3) the premise control system and

4) interface links to existing systems within the utility and/or ISO.

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The enterprise software system monitors each premise for temperature and load, stores all information related to usage programs by premise, sends dispatch instructions to premise controllers, and manages the network via Internet connections through multiple radio concentrator units. The communications network links the premise control devices to a central control room (operations center). The communications network can be fiber, wireless, power line or other broadband technology. The solution really is technology agnostic. Premise controllers are small devices placed into every participating end customer premise. Every premise control unit includes a radio for communication to the communications network then back to the central computer.

Utility Benefits: Utilities gain operational efficiencies and improved asset protection. The granularity of a demand dispatch system enables the utility to manage load at very specific points of its grid. Loads can be shed over an entire operating region to optimize generation needs or on a substation by substation level to protect assets. If a feeder or substation transformer is nearing its capacity then specific loads can be shed to take it within its operational threshold. The development of powerful management algorithms provides the utility with a much more automated approach to distribution automation and asset protection.

Customer Benefits: Customers gain more direct control over their electric bill. They can sign up for a "comfort range" within which air conditioning or heating devices can be interrupted. In return they benefit in the savings and contribute to a greener environment. As compared to 20 years ago, a much larger percentage of load is non-essential. The square footage per family home and person has doubled in the last 30 years. 100% of new homes in the Southern U.S. have air conditioning throughout. Many more homes have pools and pool pumps – all non-essential load devices that can be shed in peak energy usage periods, given a consumer's participation in the program. Demand Dispatch can communicate specifics about the type of load, pinpointing non-essential load and shedding it within the confines of the customer agreement. Utilities cannot be in the position of shedding load inappropriately (they wouldn't want to reduce power on a home dialysis system, for example), but with more intelligent sensors, they can shed load intelligently.

This robust system technology allows for a much more assertive pursuit of supply/demand imbalance remediation. Demand Dispatch gives a powerful meaning to real time. With Demand Dispatch technology, the communications technology provides the utility with information every few minutes, not only providing information about the size of the load, the additional information of type of load (essential or non-essential) will allow for blackout or peak buying risk aversion. This allows for service reliability and cost savings with a minimal impact on the individual user.

THE DEMAND DISPATCH ROI

The U.S. Department of Energy's Office of Electric Transmission and Distribution estimates that electric power outages and blackouts cost the nation about $80 billion annually. Even fleeting blackouts can cause massive losses to business, for example, Hewlett-Packard has estimated that a 15-minute outage at one of its chip factories would cost the company $30 million.

No company (and no utility) wants to provide less of the product it offers – it wants to meet system demand at all times, and at a margin consistent with overall business objectives. However, if service reliability is compromised, so is the company's relationship with its customers. Sometimes the investment in new generation and transmission to serve peak demand simply doesn't make good business sense. Therefore, Demand Dispatch must provide a good balance of reduced capital investment plus a strong return on investment for the utility.

Of significant importance to the value proposition of Demand Dispatch is the ROI outcome. Specific feasibility studies indicate that the implementation of Demand Dispatch

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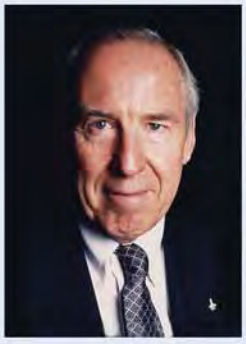

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Demand Dispatch deployed optimally will refocus the real issues related to supply and demand. Regulatory drivers are shifting focus from building more generation to using existing generation more strategically by managing non-essential loads more aggressively. Demand Management that includes Demand Dispatch functionality should be considered a must by utilities responsible for distribution and/or generation. It has the potential to reduce operating costs, delay capital investment in new generation capacity and improve grid reliability. It also allows utilities to serve energy consumers better:

- consumers would gladly exchange peak supply for lower electricity bills;
- business and industry will welcome a range of pricing plans and increased service reliability;
- utilities will gain improved operational efficiencies and improved asset protection;
- regulatory agencies will look favorably upon increased visibility into grid performance and real-time data that mitigates service interruptions;
- and environmental advocacy groups will welcome the measurable amount of energy savings that can be achieved with existing generation facilities.

A demand and load management system that includes the benefits of Demand Dispatch as described above has the potential to be an integral part of a transformation in the utility industry. We must find an improved way to generate, deliver and use power without the inefficiencies of today's system.

As the world's appetite for power accelerates, the pressure to solve this problem will increase. The need for significant new generation capacity over the next decade makes this a problem to be solved today. We have the tools in the emerging technologies of a Smart Grid. Utilities and regulators have the opportunity to take on this problem and address core issues faced by the industry.

Finally, Demand Management and/or Demand Dispatch aren't stand alone initiatives. They can impact many of the utility's operations and all are significant. Investments that can be positively affected along the way include asset protection and Spinning Reserve replacement. It is likely that new generation is not yet a necessary step in addressing today's imbalance of supply and demand. The first step is a more intelligent use of the existing resources, and the technology available to do so is here today. ■

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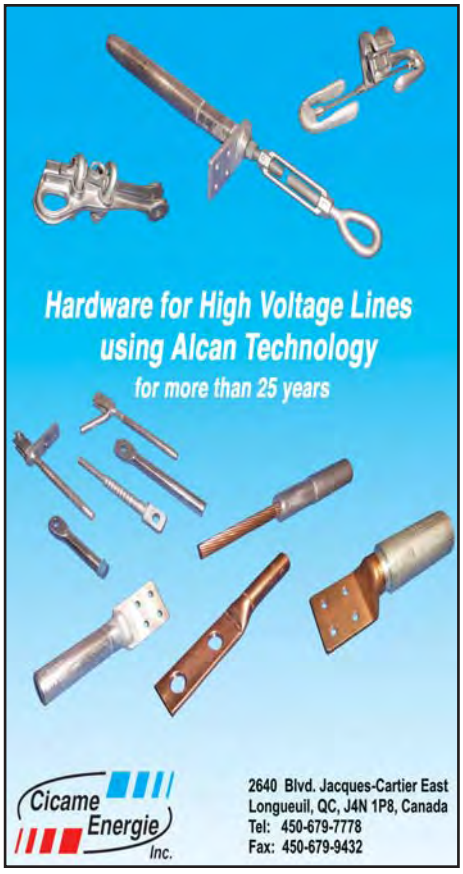

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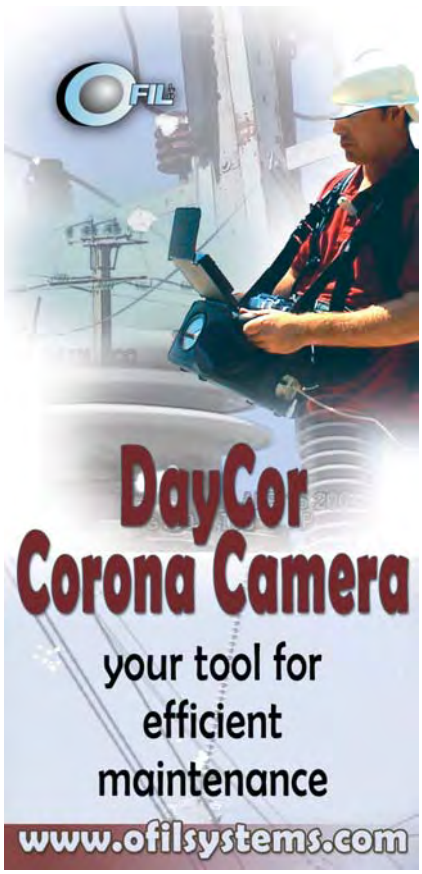

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SENSUS METERING SYSTEMS

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