

Intergraph®'s Solution for a Smarter Grid

Smart Grid Operations Command-and-Control Center
Gives You the Power to See, Control, and Respond

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1. What is the Smart Grid?

The rising demand for electrical energy to fuel the global economy now commands increased attention from both the public and policymakers. Utilities must meet energy demands amid concerns about global warming and the need to mitigate energy's impact on our environment. As a result, the term smart grid is now part of our regular vocabulary. The smart grid is a concept that is gaining international attention and is becoming synonymous with the modernization of our global electrical power distribution infrastructures. Smart grid technologies will help utilities incorporate new energy sources to meet the global demand as well as provide "smart" devices that will give consumers more choices in managing their energy usage.

Smart grid, however, means different things to different people. In the most basic terms, you can describe smart grid as changing three major areas from how electric utilities operate today:

- Two-way communications between the utility and the customer
- Smart in-home devices to better manage energy usage
- Advanced information and control systems to manage a modernized electric grid

Smart grid will have a significant impact on the electrical utility industry and society. Some experts go so far as to compare smart grid's potential impact on society to the revolutionary effect of the Internet and cell phone technology. The potential benefits of smart grid are far reaching. A key benefit is better utilization of the existing electric utility power delivery infrastructure. The demand for electrical energy continues to increase worldwide. With smart grid technologies, including "self-healing" network technologies that automatically reroute power and optimize grid loading, the energy delivery capacity of existing infrastructure (utility poles, wire, cable) can be increased anywhere from 100 percent to 300 percent. Modernization of our existing power delivery infrastructure can help meet our growing demand and slow the need to build more infrastructure to meet that demand.

Demand-side management is a major aspect of smart grid. The electrical energy delivery model pioneered by Thomas Edison in the late 1800s, and a model we continue to follow today, is a centralized generation of electrical power and delivery to customers. Each customer was metered for his or her usage. With a smart grid, "smart meters" at the customer premises will enable two-way communications between the utility and the customer. Intelligent devices at the customer premises will control appliances and home energy use to take advantage of time-of-day rate changes. The ability to implement demand-side management technologies at the customer premises is expected to drive home energy savings of 10 percent or more.

Smart grid will also help to introduce and distribute alternative energy sources. These include the integration of solar and wind energy into the grid. With a smarter grid, consumers with electric vehicles can plug them in and provide the grid with battery capacity. With solar panels or wind energy, consumers can feed energy back into the grid. Combining the energy savings of smart grid, the ability to integrate alternative energy sources and the improved utilization of the existing electrical infrastructure will reduce the growing need for fossil fuel generation. This reduces our growing carbon footprint and creation of greenhouse gases (CO₂) that are warming our atmosphere. Smart grid also promises to create a more reliable and resilient energy infrastructure. Smart grid technologies will result in fewer power outages and more rapid restoration of power. When an unavoidable outage does occur, advanced information systems designed for the smart grid will provide immediate problem identification and allow the utility to deploy personnel with pinpoint accuracy. Smart grid is far reaching and touches all aspects of operations, creating a more resilient and reliable power delivery system.

Intergraph®'s solution for the smart grid focuses on a sometimes overlooked yet crucial aspect of the smart grid – the operations command-and-control center and the human operator who will monitor and control grid operations and who will continue to manage and dispatch utility field personnel to maintain and operate the grid.

2. The Operating Challenges of Smart Grid

Most industry experts agree that technology can improve the reliability of power delivery systems. A modern grid can become more secure, more efficient, safer, and less costly to maintain with advancements in technology. However, smart grid technologies will also bring more complexity to the distribution grid and the operations center. Electric utilities approaching their operating limitations today will see those limitations further challenged with the coming of the smart grid.

Demand-side management technology at the customer premises will require advanced system controls and monitoring. The customers' meters will require additional monitoring, which will increase expectations of the operator. Smart grid will also introduce the challenge of managing alternative energy sources connected to the grid. Consumers may have solar panels or battery storage that can return power to the grid. The power delivery system will be more complex and will require advanced systems for monitoring and operations.

Custom-based demand response requires and will create vast amounts of data. Smart grid will generate an abundance of new operating data from multiple sources. Data from smart meters and other demand-side management technology will generate more detailed and continuous consumer energy use data. There will be more information to consider, analyze, and store for rate-setting and for routine operations and planning.

Transferring power across the grid requires a higher level of system awareness. The consequences of any operator actions or errors will be magnified. Operators will analyze more information than ever before and will need to make quicker decisions. In human factors, engineering studies of other advanced automated systems, including nuclear power plant control rooms and studies in aviation cockpit design, the increasing complexity of highly automated systems has been shown to increase the potential for human error. This can be related to information overload and reduced time for decision-making. With the increasing complexity of the smart grid, the human operator may become the weakest link in the advanced power delivery system unless this is factored into the design for smart grid operations.

Utilities will continue to face pressure to provide reliable power and manage costs. They are also faced with the graying of the current workforce and an experience drain as many near retirement. With the introduction of younger, less experienced operating personnel, utilities need to consolidate and simplify operations to make it easier to learn how to operate systems effectively.

In addition, the threat of terrorism and natural disasters heightens the need for systems that facilitate multi-agency coordination between the utility and public safety agencies. Critical infrastructure protection (CIP), cyber security, and emergency management response are key areas of interest. Geographic information systems (GIS), mobile workforce management (MWFM), and automated vehicle location (AVL) technologies can improve coordination and response between agencies and stakeholders mobilizing resources over large geographic service areas. Integrating these advanced information technologies in control room operations to improve physical security and resiliency of utility response in the face of these events are important considerations in the planning of the smart grid control room of the future. All of these factors will steadily increase the challenges to operations, along with the rising expectations of the public that accompany the implementation of smart grid technologies.

3. Intergraph's Solutions for the Smart Grid

Intergraph's solution for the smart grid focuses on an overlooked and crucial area – the smart grid operations center (Figure 1). When considering the breadth of smart grid technologies and their impact, attention is currently focused on modernization of the grid and the impact of smart grid on the customer. Smart meters, automated metering infrastructure (AMI), and the necessary communications infrastructure are usually the first and most visible investment made toward the implementation of a smart grid. However, it is a mistake for utilities to move forward with smart meter infrastructure without considering the impact on operations and the necessary supporting information systems.

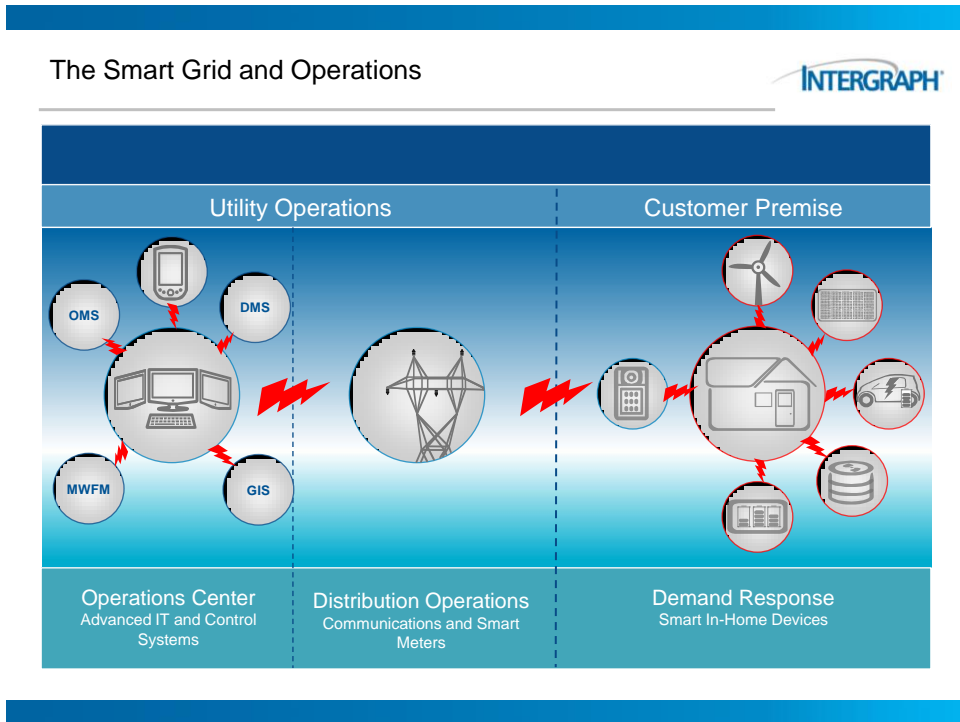


Figure 1: Intergraph's smart grid solution focuses on the impact new technologies will have on the operations center.

With the emphasis on the deployment of smart grid technologies to modernize the grid and with the potential revolutionary effect smart grid is expected to have on consumers, the utility operations center is rarely mentioned. However, utilities should consider operations early in smart grid implementation and deployment planning. Operations centers play a key role in power delivery today and will play an even greater role in the future, as the smart grid becomes more sophisticated and there is a greater need for dynamic system control.

Intergraph offers a complete suite of solutions to support operations systems. With a solid history of innovation in computer graphics and visualization technology, the company provides geospatially powered solutions designed to meet the challenges and emerging needs of smart grid operations.

3.1. Unlocking the Power of Smart Grid

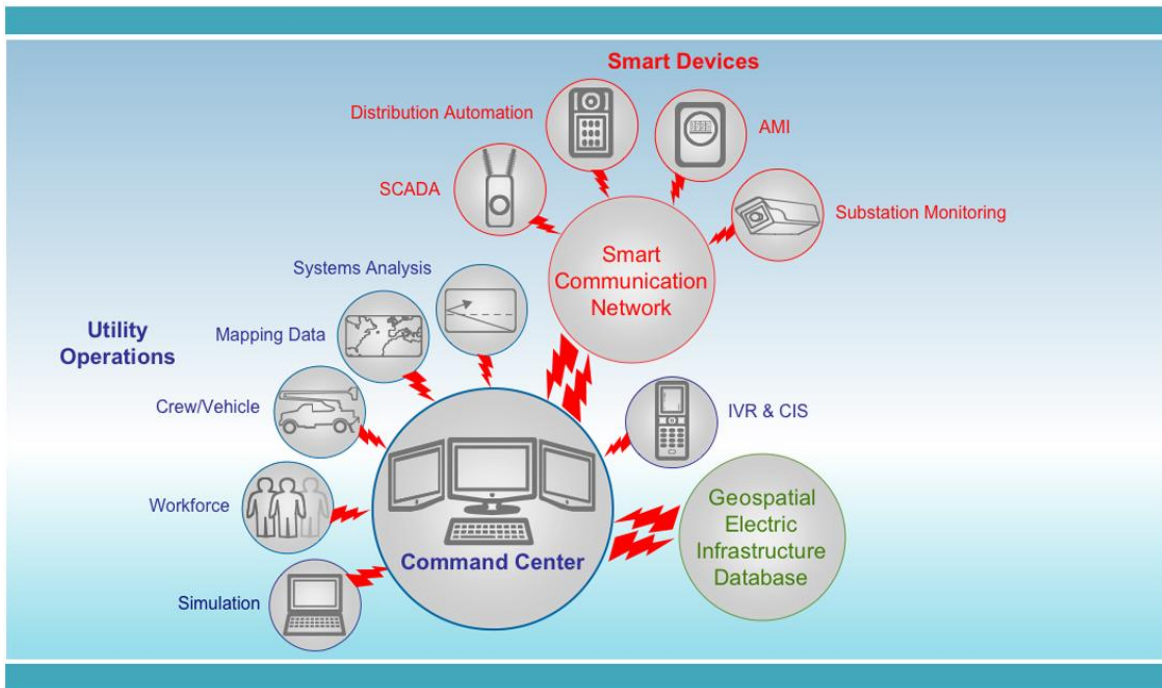


Figure 2: Intergraph's Smart Grid Operations Command-and-Control Center gives users control of the system through one consolidated user environment.

Intergraph's Smart Grid Operations Command-and-Control Center brings a common operating picture (COP) to the control room (Figure 2). This helps the system operator visualize and monitor the system with improved situation awareness, while also allowing control of the system through one consolidated user environment.

The command-and-control center provides the system operator and dispatch center with a unified environment to quickly analyze incoming customer trouble calls and customer smart meter service outage data. Intergraph systems help detect trouble locations on the distribution system and rapidly determine the appropriate response. Intergraph's solution consolidates outage management system (OMS) functionality, advanced distribution management system (DMS) functionality, and an integrated MWFM system to deliver an operations center that provides a common user environment and a single graphical user interface to monitor, control, and respond to system operating anomalies.

Intergraph's geospatially powered electric infrastructure management solution and proven incident management technology provide the foundation for a complete operations command-and-control center solution. Intergraph's G/Technology serves as the foundation for integrating spatially enabled data and the various operational systems that depend on it. G/Technology is an enterprise scalable GIS platform built entirely on the Oracle platform. The open solution supports the design and records management for the transmission and distribution assets of the utility, reducing the cost of maintaining records and making it easy to leverage asset data through a variety of applications.

3.2. Smart Grid Operations Command-and-Control Center

Intergraph responded to the emerging market demands and created an advanced information systems solution for operations that combines a proven OMS and MWFM product offering with network control and analysis products. Our Smart Grid Operations Command-and-Control Center is capable of managing

a smart grid network by integrating inputs from a variety of sources. Figure 3 provides an example of the input (detection) sources and types.

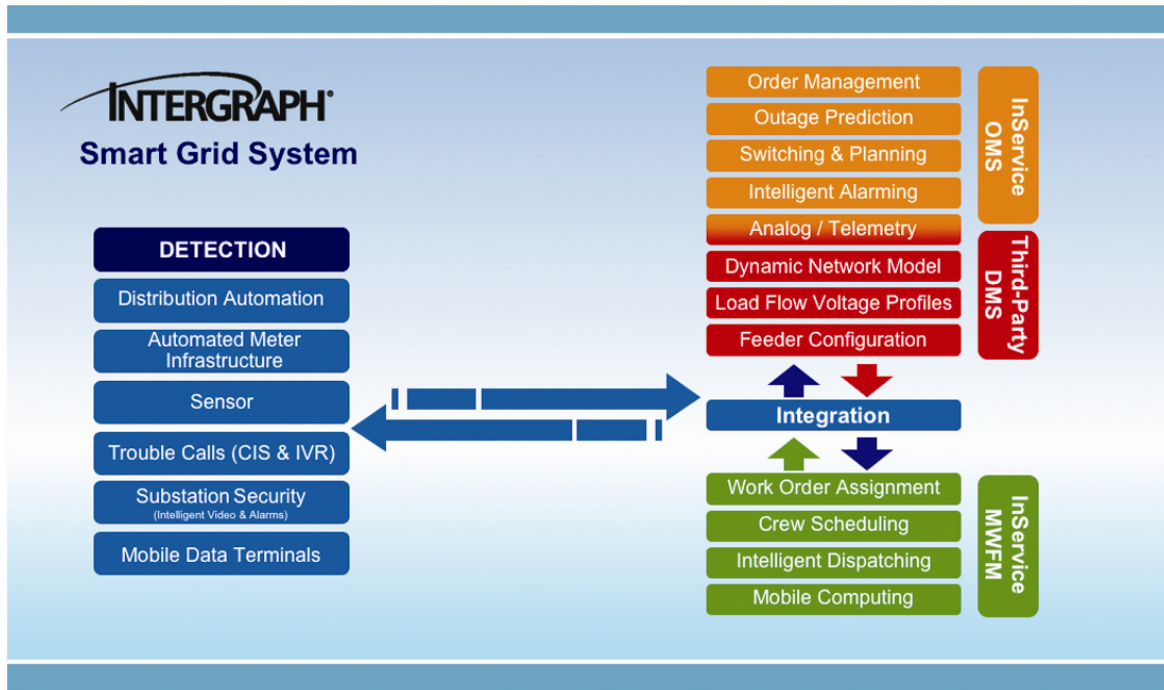


Figure 3: Intergraph's smart grid solution unifies data from multiple sources.

The Smart Grid Operations Command-and-Control Center solution uniquely provides a single operations console capable of managing the entire distribution network. This command-and-control application can gather data from a variety of detection sources and convert this information into alarms, events, and work orders. Intergraph's command-and-control center is capable of turning disparate complex data into manageable views of the same information.

This consolidation eliminates the need for multiple systems with multiple user interfaces. The command-and-control center has all of the same features of these other systems, such as switching and tagging. It does not replace supervisory control and data acquisition (SCADA) or network applications. Instead, the consolidated environment provides a single user interface to these systems. These existing applications have proven themselves as a reliable solution, and the command-and-control center will extend their usability, integrating them with OMS, MWFM, and advanced distribution management functionality.

Since outage management is just one of the applications a smart grid combines, consider other workflows that once required duplicate work. Many current operating solutions require manually creating and maintaining several network models to support SCADA, network analysis and design, and records management. With a smart grid solution from Intergraph, there is a [single network model](#). This master network model supports outage management, distribution management, network analysis tools, and SCADA. The integration of these applications with one consistent model of the current state of the system is particularly useful when utilities create and execute switching procedures. There are no duplicated models that need to be synchronized or maintained to support these workflows. The result is a single operator console that will permit network management, order creation and assignment, network analysis, and crew management.

3.3. Functionality/Benefits

Intergraph's complete solution redefines the operations center in the new realm of smart grid. The key features and benefits of Intergraph's system begin with the common user environment. The system provides a single console to help operators visualize real-time operating status and make better and faster decisions. Our COP eliminates various disparate maps and systems in the control room and dispatch center and helps improve situational awareness. Studies have shown that in the case of operating complex automated systems, improving situational awareness has a direct correlation with reducing human error and operating errors. Dynamic-based map display and symbols improve visualization of the network and systems.

Intergraph's Smart Grid Operations Command-and-Control Center also offers advanced OMS functionality. This includes full outage processing, trouble analysis, and advanced on-screen tagging capabilities. The system saves time in both diagnosing the cause of failure and assigning crews to dispatch to restore power. Overall, the system improves the ability to manage large volumes of customer calls and events and to respond efficiently and effectively. In production, the system has been tested to handle volumes up to 100,000 calls per hour without degradation of performance or loss of data integrity.

Our solution combines OMS with advanced DMS functionality. Advanced SCADA integration delivers the DMS functionality. The operator can monitor and control SCADA devices through the common user environment and single user interface. The system also includes other advanced real-time power systems analysis and simulation capabilities. Intergraph's solution integrates with SCADA and other third-party power systems analysis tools through an open architecture and open application programming interface. The system can be integrated with a number of SCADA and DMS vendors. Integration with Siemens DNA will be the first integration demonstrated.

In addition to OMS and DMS functionality, our solution offers a fully integrated MWFM system. The system enables full appointment management, automatic assignment, scheduling, and crew monitoring. The benefits include reduced time assigning work and less travel time. You can improve productivity when personnel with the right skills are dispatched to the right place at the right time to efficiently address customer service issues.

The command-and-control center also brings together a complete mobile application for the crews to receive job assignments, to see real-time job assignment information displayed geographically on a mobile map, and to update and close jobs in real time. In emergency situations, the ability to share a common map between the field crew and the dispatcher improves communication and safety, when it counts the most. During times when clear communication is vital, dispatchers and field crews can share the same picture to communicate clearly and unambiguously. The mobile applications replace paper tickets in the field, speed the time to complete jobs, and decrease radio traffic. Intergraph's integrated mobile applications can reduce your costs, increase efficiency, and significantly improve customer service.

4. Where Does the ROI Come From?

In today's economic climate, utilities demand a clear return on investment (ROI). Intergraph's smart grid solution offers measurable ROI in several key areas. This includes better customer service, decreased costs for work performed, improved communication and safety, and productivity enhancements in both the operations center and the field. While it may not be possible to prevent all outages, one measure of efficient utility operations is the time required to respond and restore power when there is an unavoidable outage. Numerous utilities around the world rely on Intergraph's proven solutions to positively affect operations, field productivity, and overall performance.

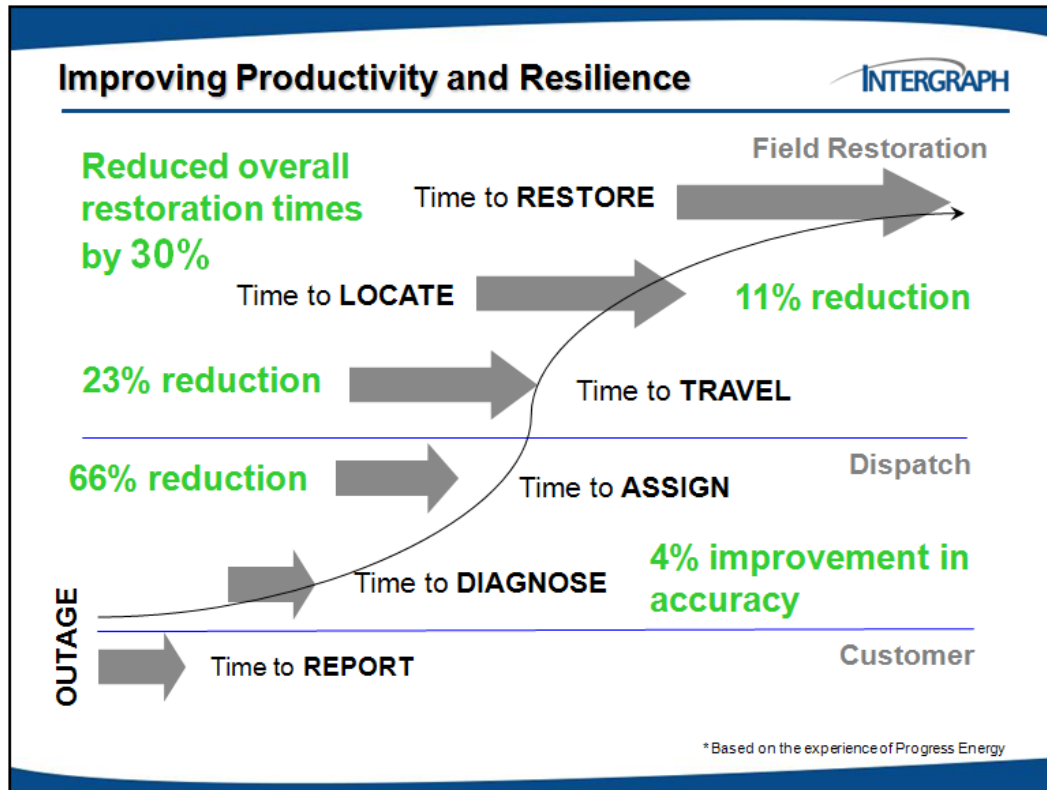


Figure 4: Intergraph solutions help utilities respond faster to outages and reduce the amount of time required to restore power.

Intergraph's Smart Grid Operations Command-and-Control Center is designed to improve operator situational awareness and reduce response time to system outages when they occur. This results in a more resilient power delivery system when combined with other smart grid modernization technologies. Intergraph customers have quantified savings as a result of improved trouble analysis and service restoration response. Using an integrated OMS and MWFM system, restoration times have been reduced by up to 30 percent, yielding significant productivity savings while dramatically improving customer service (Figure 4). In the case of Progress Energy in Florida, studies demonstrated improvements in accuracy in the time to diagnose a problem as well as a two-thirds reduction in the time needed to assign the correct crew. An integrated MWFM system optimized routes to reduce travel time by 23 percent. With problem areas identified more quickly, Progress realized a 30 percent reduction in overall restoration times and dramatic improvement in average customer interruption durations. Progress dropped its customer average interruption duration index (CAIDI) to below the national average with its Intergraph solution. Intergraph customers around the world are experiencing similar results in improved productivity and operating efficiency.

4.1. Customer ROI Testimonials

A long list of satisfied electric utility customers realize the benefit of using Intergraph solutions to improve their operations as well as their electrical design and asset management processes. Intergraph provides a complete suite of solutions, from managing the full geospatially enabled electrical model to the operational systems that use that model to pinpoint problems and to efficiently deploy and track field resources.

Oncor Electric Delivery operates the largest distribution and transmission system in Texas. Oncor provides power to three million electric delivery points through more than 120,000 miles of distribution and 14,000 miles of transmission lines. Currently, Oncor has deployed more than 600,000 smart meters and plans to deploy smart meters for all of their three million delivery points. Oncor views a consolidated user environment as the cornerstone of its smart grid strategy. Operators had previously used five or six different applications on multiple screens to get an overall picture of the electric grid. This made it more difficult for employees to quickly and efficiently respond to storms and other outage situations. Intergraph's Command-and-Control Center will eliminate the need for multiple applications and screens. Instead, Oncor will now see and control various critical applications through one unified system.

Hydro Ottawa in Canada uses an integrated GIS and OMS to reduce the amount of time employees spend searching for information. Previously, Hydro Ottawa used a number of different databases in many different locations to try to manage their electrical distribution system. They often spent hours searching for information each day. Intergraph's integrated operating and infrastructure management solutions have allowed them to access information about the grid in minutes rather than hours, dramatically improving productivity and responsiveness to customer needs.

At Cobb Energy in Georgia, streamlined work processes and improved service efficiency were the strategic and quantifiable benefits of implementing a fully integrated solution of OMS, MWFM, and GIS technologies from Intergraph. Cobb Energy has stated that acquiring a complete integrated solution for OMS and MWFM on a single product platform from one vendor was a huge benefit.

Empire Electric, which serves 165,000 customers in Missouri, Kansas, Oklahoma, and Arkansas, experienced cost savings, better job performance, and improvements in customer service with the implementation of Intergraph infrastructure management and operating solutions. The entire organization can perform jobs more efficiently and effectively with an integrated mapping, outage management, mobile workforce management, and infrastructure management solution from Intergraph.

5. Building a Smarter Grid

Smart grid will change the face of utility operations. Two companies working with Intergraph to lead the industry in those changes are Oncor Electric Delivery system in Texas, United States, and Enersource Hydro Mississauga in Ontario, Canada.

While very different in size, both utilities share a common vision of an integrated and advanced smart grid operations command-and-control center as part of their smart grid strategies. Both projects have been underway since 2008 and are now delivering the first phases of their new command center control rooms through 2009. In both cases, the first implementations have involved the initial deployment of OMS and integrated MWFM capabilities. The phased smart grid implementation plans continue with the rollout of advanced and integrated DMS functionality through 2010.

DMS functionality for both client implementations is provided through a strategic partnership with Siemens Energy, which brings more than 150 years of Siemens' power systems engineering experience to the projects. Combined with Intergraph's leadership position in high-performance computer graphic visualization, geospatial information systems, outage management and integrated MWFM, this powerful and experienced team will help accelerate the adoption of the smart grid and advanced operations centers.

It is important to note that Intergraph's Smart Grid Operations Command-and-Control Center has been designed to be SCADA and DMS system agnostic. You can easily integrate the Intergraph solution with legacy SCADA and DMS systems, preserving your current investment in existing systems. This approach facilitates a smooth transition to a full system upgrade through a modularized design and support of a variety of phased system implementation and upgrade options.

6. The Power to See, Control, and Respond

In the last few years, multiple stakeholders have kept a close eye on the electric utilities market. Various areas of concern have drawn even greater attention to the vulnerability of our aging electric infrastructure. These issues include:

- Security threats to generation, transmission, and distribution
- Reliability of equipment in the field
- Accuracy and frequency of field data
- Emergency/outage responsiveness
- Environmental impacts
- Employee safety

The industry has acknowledged these stakeholder concerns by the adoption of a common vision. This vision has been appropriately named “smart grid” or “intelligent network.” The purpose of a smart grid is to provide more reliable power to the public using advancements in technology and to pave the way for a more modern electric grid, the impact of which will rival the lifestyle changes resulting from the Internet and ubiquitous cell phone technology.

Intergraph is leading the way in providing a smart grid command-and-control environment for electric system operations personnel that can monitor the health of the network and help make better and faster decisions. These decisions are facilitated by Intergraph's Smart Grid Operations Command-and-Control Center. Intergraph solutions supplement investments in hardware for grid modernization and in communications and metering, which lay the foundation for demand-side management by consumers. When utilities combine traditionally disparate operations support systems into a single user environment, they can more effectively understand and manage electric distribution operations and optimize their smart grid implementation.

A unified command-and-control center can complete the true vision of the smart grid for the utility industry. This ultimately translates into delivering power to customers more efficiently without unnecessary strain on the world's resources. Intergraph delivers the power to see, control, and respond. As smart grid technologies and standards continue to evolve and mature, Intergraph's Smart Grid Operations Command-and-Control Center will continue to adapt, will be a vital component in the delivery of reliable power, and will play a key role in the vision of smart grid.

7. Glossary

AMI – Automated metering infrastructure

AMR – Automated meter reading

AVL – Automated vehicle location

CAIDI – Customer average interruption duration index

CIP – Critical infrastructure protection

COP – Common operating picture

DMS – Distribution management system

GIS – Geographic information system

GPS – Global positioning system

MWFM – Mobile workforce management

NIMS – National Incident Management System

OMS – Outage management system

ROI – Return on investment

SCADA – Supervisory control and data acquisition

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