IntelliGrid - Program 161

Program Overview

Program Description

Utilities are increasingly deploying advanced monitoring, communications, computing, and information technologies to support smart grid applications such as wide area monitoring and control, integration of bulk or distributed renewable generation, distribution automation, and demand response. Companies face significant challenges when deploying these technologies, including

- selecting technologies that best meet current and future business needs and regulatory requirements, while minimizing the risk of early obsolescence and vendor lock-in;
- creating an overall architecture that integrates the many intelligent devices, communications networks, and enterprise systems to utilize resources and provide information to all users;
- managing the tremendous amount of data that is generated by smart grid technologies, converting data into actionable information, and effectively presenting the information to the people who need to take action;
- managing a growing network of intelligent devices that have different capabilities and that use different protocols and data formats in a way that optimizes performance; and
- ensuring that the workforce has the skills necessary to design, operate, and maintain equipment and systems that use new technologies.

The IntelliGrid program addresses these challenges by

- tracking federal government and regulatory activities relating to standards and communications and interpreting the impact that these actions will have on the utility industry;
- promoting interoperable systems by contributing to the development of key smart grid standards, assessing emerging standards, conducting interoperability tests of products that implement key standards, and providing information to utilities on how to implement standards;
- providing tracking and analysis of emerging communications technologies, conducting research on emerging technologies such as TV white space and other lightly licensed spectrum, and conducting field demonstrations of 4G technology for utility operations;
- performing basic research into the nature and structure of utility data, where data is required, and how data is turned into actionable information; and understanding the cost of poor data quality to the utility; and
- facilitating smart grid demonstration projects around the world to better understand and advance the use of distributed energy resources in smart grids.

Research Value

With the knowledge acquired through this research program, members will have access to information that can help them with

- development and support of standards-based approaches for achieving interoperability of technologies that make up a smart grid,
- an understanding of the impact that federal government and regulatory activities relating to standards and communications will have on the utility industry,
- utility implementation approaches and results for smart grid technologies and systems,
- roadmaps for implementing a smart grid, and
- an understanding of communications and information system architecture requirements and technologies to support a smart grid.
Approach

Electric Power Research Institute (EPRI) research in the IntelliGrid program will yield a variety of data and knowledge that will be beneficial to members of the program. This information will come in a number of forms and is expected to include:

- white papers on utility experience with adopting standards and migrating from one standard to another,
- reports on lessons learned and best practices when deploying applications,
- training material on key standards like the Common Information Model as well as implementation and migration strategies, and
- contributions of technical reports to standards development organizations and industry groups.

Accomplishments

In the past, the IntelliGrid program has delivered valuable information that has helped its members and the industry in numerous ways. Some examples include the following:

- *IntelliGrid Annual Program Review 2011 (1024708)* provides a summary of activities for each of the projects in the program and offers case study examples of how information from the projects is being applied. The review also lists all of the deliverables over the last five years.
- *California Utility Vision and Roadmap for the Smart Grid of 2020 (1022220)* documents the smart grid vision from the perspective of the three California investor-owned utilities and provides technology maturity roadmaps in key technologies such as communications, storage, integration of renewable resources, and grid operations and control.
- *Common Information Model Primer (1024449)* provides an introduction to the Common Information Model (CIM) from an operations perspective. The primer attempts to make CIM accessible and decrease the cost and risk of a CIM implementation.
- *Concepts to Enable Advancement of Distributed Energy Resources (1020432)* highlights a shift in approach from using "command and control" to "inform and motivate," which would allow the customer and the grid to interoperate with full transparent, extensible, and scalable interoperability.
- *Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects (1020342)*, completed with the U.S. Department of Energy (DOE), presents a framework for estimating the benefits and costs of smart grid demonstration projects and a step-by-step approach for making these estimates.
- *Smart Grid Interim Interoperability Roadmap Report*: The National Institute of Standards and Technology (NIST) awarded EPRI a contract to engage smart grid stakeholders and develop a draft interim standards roadmap, which NIST has used as a starting point in developing a NIST interim roadmap for smart grid interoperability standards. EPRI technical experts compiled and distilled stakeholder input, including technical contributions made at two EPRI-facilitated two-day public workshops.

Current Year Activities

Research results will address near-term needs and make contributions that will advance the industry toward open, standards-based systems and devices that are interoperable and secure. Specific objectives include:

- development and harmonization of the Common Information Model and IEC 61850, as well as educational material and implementation strategies of the key smart grid standards;
- applications based on the CIM such as the Network Model Manager, Field Force Data Visualization, and Standards-Based Data Integration;
- interoperability evaluation of consumer-focused standards including Green Button and Smart Energy Profile 2.0;
- tracking and analysis of developments in smart grid standards and communications technologies;
- development of standards and technology for open and interoperable AMI systems; and
- development of tools to help utilities improve the quality of Geospatial Information System (GIS) data.
Summary of Projects

PS161A IntelliGrid Coordination, Analysis, and Technology Transfer (063528)

Project Set Description

This project set provides utilities with tools and information to help them plan, design, and implement smart grid infrastructure and applications. It provides tracking and analysis of the rapid advances in smart grid standards and communications technologies so that utilities can minimize risk when planning and procuring equipment. It also provides utilities with lessons learned from industry smart grid deployments, including cost/benefit assessment case studies and best practices, and provides members a forum to share experiences with roadmap development and maintenance.

The project set also provides the overall industry coordination and high-level technology transfer activities related to the information and communications technologies needed to support smart grid applications.

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<tr>
<th>Project Number</th>
<th>Project Title</th>
<th>Description</th>
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<tbody>
<tr>
<td>P161.019</td>
<td>Smart Grid Cost and Benefit Assessment and Roadmapping</td>
<td>EPRI will leverage its experience working with utilities to develop company-specific smart grid roadmaps and in planning and implementing smart grid demonstration projects to provide utilities with tools and information that will help them plan, design, and implement their smart grid infrastructure and applications. Tools will include cost/benefit analysis information, white papers on lessons learned and best practices for smart grid implementations, and the annual Smart Grid Roadmap Workshop.</td>
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<tr>
<td>P161.020</td>
<td>Smart Grid Standards and Communications Technology Tracking and Analysis</td>
<td>This project will:</td>
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<td>• Track communications technology advances and their impact on utility applications.</td>
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<td>• Make contributions of EPRI R&amp;D results to relevant industry and government efforts, such as the NIST Smart Grid Interoperability Panel (SGIP), Open SG, and standards development activities.</td>
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P161.019 Smart Grid Cost and Benefit Assessment and Roadmapping (073548)

Key Research Question

Utilities are increasingly deploying advanced monitoring, communications, computing, and information technologies to support smart grid applications such as wide area monitoring and control, integration of bulk or distributed renewable generation, distribution automation, and demand response.
Planning, designing, and building the information and communication technology infrastructure to support smart grid applications is complex and cuts across the entire utility organization. The infrastructure will be built out over time and will differ depending upon the applications that are a priority to the utility. Utilities need tools and information to help them efficiently plan, design, and build their smart grids.

EPRI has been working with utilities to develop company-specific smart grid roadmaps since 2007 and developed the Smart Grid Roadmap Guidebook in 2012. EPRI has also been working with utilities to plan and implement smart grid demonstration projects since 2009.

This project's objective is to leverage EPRI’s past experience to develop tools that will help utilities plan their smart grid deployments and provide a forum for utilities to share experiences and lessons learned.

Approach

EPRI will use the work that it has done with individual utilities to develop their smart grid implementation and R&D roadmaps and demonstration projects to develop tools that will support utilities in smart grid planning, design, and implementation. Tools will include best practices and lessons learned, based on the experiences of utilities that are deploying smart grid applications, cost/benefit assessments, and roadmapping templates and use cases. The project will also support the Annual Smart Grid Roadmap workshop that gathers the people who are responsible for their company’s roadmaps to discuss experiences and lessons learned.

Impact

Project funders will benefit by learning from the experiences of utilities that are deploying smart grid infrastructure and applications. Information will include cost/benefit analysis case studies and white papers on lessons learned and best practices.

How to Apply Results

Information will be conveyed to project funders through white papers, reports, webcasts, and a workshop. Members will be able to directly apply the lessons learned when planning, designing, and implementing their smart grid infrastructure and applications.

2013 Products

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<tr>
<td><strong>Smart Grid Roadmap Workshop:</strong> The Smart Grid Roadmap Workshop will bring together the people who are responsible for developing and maintaining their company’s smart grid roadmap to share experiences and lessons learned.</td>
<td>12/31/13</td>
<td>Workshop, Training, or Conference</td>
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<tr>
<td><strong>Cost / Benefit Analysis Tools and Case Studies:</strong> Develop tools for utilities to use when conducting cost/benefit analyses for smart grid applications and infrastructure. Provide case studies of cost/benefit analysis based on available information from utility deployments.</td>
<td>12/31/13</td>
<td>Technical Update</td>
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<tr>
<td><strong>Lessons Learned from Smart Grid Deployments:</strong> Reports will capture lessons learned and best practices from utility implementations of smart grid infrastructure and applications.</td>
<td>12/31/13</td>
<td>Technical Update</td>
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P161.020 Smart Grid Standards and Communications Technology Tracking and Analysis (073549)

Key Research Question
Smart grid interoperability standards and the communications technologies that enable smart grid applications are evolving rapidly. Utilities that are deploying smart grid applications such as wide-area monitoring and control, distribution automation, and demand response need to understand

- the capabilities and risks of existing standards and technologies,
- how the standards and technologies will evolve in the future,
- how government or regulatory actions could impact smart grid deployment decisions, and
- if there are disruptive technologies on the horizon and how they will impact utility deployment decisions.

This project's objectives are to:

- track industry and government activities relating to smart grid interoperability and communications standards, and provide an analysis on how these activities could impact utilities and how they can best prepare;
- track communications technology advances and their impact on utility applications; and
- make contributions of EPRI R&D results to relevant industry and government efforts, such as the NIST Smart Grid Interoperability Panel (SGIP), Open SG, and standards development activities.

Approach
Numerous smart grid efforts are under way at individual utilities, DOE, various standards organizations, and internationally. This project tracks relevant activities at NIST, the Federal Energy Regulatory Commission (FERC), the Federal Communications Commission (FCC), and standards bodies to provide funders with information and analysis. The project also provides coordination across all these efforts so that members can take advantage of important developments and lessons learned across the entire industry. Coordination is achieved through sharing of use cases, member forums, webcasts, newsletters, and workshops.

Impact
Many utilities do not have the resources to actively participate in industry activities. This project will provide tracking information on those activities. The analysis of the impact that these activities will have on utilities will help utilities in planning their smart grid deployments and will help minimize the risk when selecting technologies. The smart grid roadmap interest group and workshop will provide lessons learned and experiences from a large group of utilities.

How to Apply Results
Utility executives responsible for “grid of the future” planning, information technology (IT) architects designing the infrastructure to support the future grid, and project engineers deploying systems can use the information, analysis, and lessons learned from this project. Results will be presented through webcasts, newsletters, and technical updates.

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<tr>
<td>Smart Grid Standards Tracking and Analysis Monthly Webcasts</td>
<td>12/31/13</td>
<td>Workshop, Training, or Conference</td>
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每月网络研讨会，描述智能电网标准的发展或采用活动，并提供分析这些活动对智能电网的影响。
PS161B Information and Communications Technology for Smart Transmission Systems (063437)

Project Set Description
The Infrastructure for Intelligent Transmission Systems project set focuses on the communications and information technology (IT) infrastructure needed to close technology gaps and achieve the interoperability required to support the transmission system of the future. It also addresses the migration strategies that will be essential to the successful transition from the systems of today to the systems of the future. The transmission system is already using extensive and sophisticated instrumentation and applications. This project set will assess additional possible communications needs for real-time applications and will identify strategies to migrate from the existing communications and data models to interoperable, common database models and communications standards by developing enterprise-wide use cases for advanced transmission applications.

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<tr>
<td>P161.003</td>
<td>Common Information Model (CIM) for Transmission - Development and Implementation</td>
<td>This project develops requirements for integrating smarter transmission applications within industry-defined areas of interest. These requirements serve as the basis for the development of data and device models for demonstration solutions such as The Standards-Based Integration Specification and Network Model Manager and Repository. This, in turn, validates the readiness of the CIM and IEC 61850 standards and contributes to standards activities within key industry organizations such as IEC, IEEE, NIST and others. Additionally, this project provides educational resources to utilities interested in applying the CIM.</td>
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<tr>
<td>P161.021</td>
<td>IEC 61850 Implementation and Transition</td>
<td>IEC 61850 implementation has its challenges, and this project will effectively break down the implementation phases into clear concise parts, with the benefits of each described. The transition that is most beneficial is utility specific, depending on their specific needs and capabilities. The benefits need to be carefully considered within the context of the substation, control center, and enterprise. The project will also look at existing tools that can be used to help manage the infrastructure.</td>
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<tr>
<td>P161.022</td>
<td>Synchrophasor Communications Infrastructure and Data Management</td>
<td>This project will evaluate and document synchrophasor communications and data management methods implemented by participating members and provide recommendations to improve the operational efficiency and management of the infrastructure. EPRI will also assess the various approaches implemented and provide the pros and cons of each method. Actual lessons learned will be documented and communicated.</td>
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P161.003 Common Information Model (CIM) for Transmission - Development and Implementation (063286)

Key Research Question
Robust and highly integrated communications and computing infrastructures will be needed to create a smarter transmission grid. These infrastructures need to facilitate interoperability across vendor equipment and applications deployed throughout the enterprise. Achieving the necessary level of interoperability requires the development and industry adoption of a tightly coupled suite of standards. The Common Information Model (CIM) represented by IEC 61968 and IEC 61970 provides a common language for integrating applications across the enterprise and is a foundational standard for smart grids. IEC 61850 and the Internet Protocol (IP) also are key standards.

Approach
This project will develop requirements and explore solutions for integrating applications that are key to the deployment of smarter transmission technologies. Examples of these applications include the Asset Health Center, the Network Model Manager and Repository, Substation Intelligent Electronic Device (IED) Data Utilities, or other industry-suggested applications that align with the smarter transmission direction. This project will be utility driven and will move beyond the theoretical world into the practical world, focusing on supporting successful deployments of the CIM and IEC 61850 standards. Any identified issues will be presented to the appropriate standards body for consideration during their review cycle. A central part of this project is the application of the existing portions of the standards and demonstration of the value to the business enterprise that will create the necessary momentum to continue the path forward.

In addition to the focus on the practical application of standards development, this project will also provide information and education on the CIM to utilities considering deployment of a CIM-based solution.

Impact
This project could have the following impacts:

- Demonstrate true interoperability, and enable integration of applications across the enterprise via systems built to open standards
- Verify standards that enable open enterprise applications, and utilize this openness across utilities
- Enable improved life-cycle savings by demonstrating the value of “end-to-end” business process streamlining of data management

How to Apply Results
Utility control center information technology project managers, automation project engineers, operators, and transmission planners will use the tools and knowledge produced by this project to apply the CIM standard within their organization. Results from this project will help members plan for future requirements involving upgrades to their energy management systems, and substation data managers, and also for the procurement of next-generation transmission operations equipment such as relays and protection equipment.
The Standards-Based Integration Specification: This product will continue to refine the efforts to bring together work from several areas to demonstrate the potential value of correlating multiple sources of asset-related information, to help support intelligent decisions regarding the operation and maintenance of assets. For example, EPRI has developed algorithms to assess the health of large power transformers. This assessment, while effective, is somewhat static in its application. Through the efforts of this project, a real-time assessment process will be demonstrated that integrates necessary information from applicable systems and provides the appropriate information to utility staff across the enterprise. Additionally, there are data from various asset health sensors typically installed to collect data remotely from major pieces of equipment across the transmission system. This sensor data, translated into IEC 61850, could be integrated into a CIM-based integration environment and provided on a near real-time basis to appropriate field personnel, equipment experts, and asset managers. They can use these data to perform forensic analysis and to enhance their asset-management strategies (such as repair or replace, life extension, sparing strategies, maintenance strategies, and specification for replacement equipment). Grid operators can use the data to enhance their decision making.

The CIM and IEC 61850 standard interfaces required by this project are substantially complete in their design, but have not yet been field tested. Any identified issues will be presented to the appropriate standards body for consideration during their review cycle.

Network Model Manager and Repository: This product will continue the effort started in 2012 to reduce the duplication of effort in maintaining multiple transmission system network models in disparate applications. This challenge facing utilities will grow more complex as the number of applications dealing with network models increases. Applications supporting substation automation configuration, protection scheme definitions, and interfaces to distribution system models will be added to the current planning applications and energy management systems that contain transmission system network models. This product focuses on the definition of requirements and a solution demonstration for a Network Model Manager and Repository that will support the life cycle of the transmission network (from planning through construction, configuration, and commissioning to reconfiguration and retirement). A Network Model Manager and Repository would be used to maintain transmission models used by all other applications in EPRI’s Smart Grid Substation Lab. Data export would use CIM (61970 and 61968)-defined interfaces and would utilize both “flat file XML” and integration bus approaches. Any identified issues will be presented to the appropriate standards body for consideration during their review cycle.

CIM Education: This product will continue to provide support for a variety of CIM users group (CIMug) activities, including meeting summaries and training materials. It also will provide a venue for complementary CIM training; access to reference information about the CIM standards; and learning about CIM deployment experiences, CIM-based products, and implementation resources.
**Future Year Products**

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<td><strong>The Standards Based Integration Specification</strong>: This product will continue to refine the efforts to bring together work from several areas to demonstrate the potential value of correlating multiple sources of asset-related information, to help support intelligent decisions regarding the operation and maintenance of assets. For example, EPRI has developed algorithms to assess the health of large power transformers. This assessment, while effective, is somewhat static in its application. Through the efforts of this project, a real-time assessment process will be demonstrated that integrates necessary information from applicable systems and provides the appropriate information to utility staff across the enterprise. Additionally, there are data from various asset health sensors typically installed to collect data remotely from major pieces of equipment across the transmission system. This sensor data, translated into IEC 61850, could be integrated into a CIM-based integration environment and provided on a near real-time basis to appropriate field personnel, equipment experts, and asset managers. They can use these data to perform forensic analysis and to enhance their asset-management strategies (such as repair or replace, life extension, sparing strategies, maintenance strategies, and specification for replacement equipment). Grid operators can use the data to enhance their decision making.</td>
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<td><strong>Network Model Manager and Repository</strong>: This product will continue the effort to reduce the duplication of effort in maintaining multiple transmission system network models in disparate applications. This challenge facing utilities will grow more complex as the number of applications dealing with network models increases. Applications supporting substation automation configuration, protection scheme definitions, and interfaces to distribution system models will be added to the current planning applications and energy management systems that contain transmission system network models. This product focuses on the definition of requirements and a solution demonstration for a Network Model Manager and Repository that will support the life cycle of the transmission network (from planning through construction, configuration, and commissioning to reconfiguration and retirement). A Network Model Manager and Repository would be used to maintain transmission models used by all other applications in EPRI’s Smart Grid Substation Lab. Data export would use CIM (61970 and 61968)-defined interfaces and would utilize both “flat file XML” and integration bus approaches. Any identified issues will be presented to the appropriate standards body for consideration during their review cycle.</td>
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P161.021 IEC 61850 Implementation and Transition (073550)

Key Research Question

The recent elevated interest in improved data sources and sensors promoted by smart grid conferences within the industry have prompted many utilities to review their approach to IEC 61850. While many companies have installed microprocessor relays capable of IEC 61850, that capability has gone untapped. This project's objective is to provide the basis for how to approach such an evaluation and guidance for determining how much of the IEC 61850 standard to embrace and what to leave for another time. The new learning is in understanding the various implementation-phased approaches, the benefits and drawbacks of each, and also exactly what capabilities various approaches enable.

Approach

Implementing IEC 61850 within a utility is not necessarily easy or straightforward. While transitioning electromechanical relays to microprocessors is a relatively straightforward process, taking advantage of the entire suite of benefits enabled by IEC 61850-enabled devices is another matter altogether. Identifying the approach that is most beneficial, as well as at what point should a utility consider adoption of the process bus, object models data, communication protocol transition, among others is needed. Each of these features brings benefits that need to be carefully considered within the context of the rest of the substation, control center, and enterprise.

In this project, EPRI will evaluate and assess various implementation strategies from the perspective of "how to deal with all the IED data" and the benefits and drawbacks of various approaches applied in the field. The project will also look at what tools exist to help manage the data.

Impact

The results of this project should provide members with improved knowledge on implementing IEC61850 and benefits of different phased approaches.

How to Apply Results

Members will be able to apply the knowledge gained from the project to their internal initiatives focused on IEC 61850 implementation. This could be for both new installations of retrofit situations where IEC 61850-capable devices are already installed but not function in that mode.

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<tr>
<td>IEC 61850 Implementation Phases: This product will consider what approach to the transition phases is most beneficial: at what point should a utility consider adoption of the process bus, object models data, communication protocol transition, and more. Each of these features bring benefits that need to be carefully considered within the context of the rest of the substation, control center, and enterprise.</td>
<td>12/31/13</td>
<td>Technical Update</td>
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<td>IEC 61850 Data Management: This product will evaluate the data aspect of IEC 61850 and the embedded object models. The value of these data to the utility enterprise can be significant if properly managed. This product will investigate the type of data available and its relevance to the utility enterprise. It will also establish a value matrix so that the technology implementer can make informed decisions around what data to bring out of the substation.</td>
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Future Year Products

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<td><strong>IEC 61850 Implementation Phases:</strong> This product will continue the work stated in 2013 on implementing IEC 61850 within a utility. The product will further the evaluation process and take into consideration lessons learned from more recent implementations. This product will consider what approach to the transition phases is most beneficial: at what point should a utility consider adoption of the process bus, object models data, communication protocol transition, and more. Each of these features bring benefits that need to be carefully considered within the context of the rest of the substation, control center, and enterprise.</td>
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<tr>
<td><strong>IEC 61850 Data Management:</strong> This product will continue the evaluation the data aspect of IEC 61850 and the embedded object models. The value of these data to the utility enterprise can be significant if properly managed. This product will investigate the type of data available and its relevance to the substation. It will also establish a value matrix so that the technology implementer can make informed decisions around what data to use elsewhere within the substation.</td>
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P161.022 Synchrophasor Communications Infrastructure and Data Management (073551)

**Key Research Question**

While synchrophasor technology has been available for quite some time, the expansion of the technology has flourished in the industry since the American Recovery and Reinvestment Act (ARRA) provided funding for their installation. With the installations nearing completion, the industry will for the first time have extensive wide area coverage of the grid with synchrophasors. The objective of this project is twofold: first, to continue to monitor and assess the adequacy of the communications infrastructure put in place; and second, to investigate data management issues that may arise. The new learnings are expected to be in the area of wide area communications challenges such as reliability of the communications infrastructure, ease of use, and other operational issues. With over 1000 synchrophasors installed and constantly streaming data, there are expected to be new challenges in managing and using the data and other similar issues.

**Approach**

This project will assess and document the various approaches utilities to have used to implement synchrophasor communications and data management methods. EPRI will also look at the various approaches implemented by various utilities and assess their pros and cons. Actual lessons learned will be documented and communicated.

**Impact**

The results of this project should provide members with improved knowledge for transporting of synchrophasor data and also short- and long-term storage, usage, and archiving, thereby improving operational efficiency and reducing operating costs.

**How to Apply Results**

Members will be able to apply the knowledge gained from the project to improve their communications and data management infrastructure.
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<td><strong>Synchrophasor Communication Infrastructure</strong>: This product will evaluate the benefits of various approaches to wide-area communications used for the transport of synchrophasor measurements. This will include transport within and outside the utility to external entities such as Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs). The project will also assess the NASPInet concept developed by the North American Synchrophasors Initiative's Data and Network Management Task Team being implemented by the ARRA award winners. This product may include demonstration of the NASPInet concepts within EPRI's Smart Grid Laboratory as appropriate, as well as evaluation of the tactical development of the various components.</td>
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<td><strong>Synchrophasor Data Management</strong>: This product will assess the benefits of various approaches to Synchrophasor Data Management. This will include the effectiveness of real-time access and usage by operations and other staff, along with archival storage and subsequent retrieval. The product will also investigate the need for linkage to other data sources such as power system models, fault records, generation dispatch, and other operating information.</td>
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<td><strong>Synchrophasor Communication Infrastructure</strong>: This product will continue to evaluate the benefits of various approaches to wide-area communications used for the transport of synchrophasor measurements. This will include transport within and outside the utility to external entities such as RTOs and ISOs. The project will also begin to assess the suitability of the infrastructure for operational controls such as oscillation damping.</td>
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<tr>
<td><strong>Synchrophasor Data Management</strong>: This product will continue to assess the benefits of various approaches to Synchrophasor Data Management. This will include both the effectiveness of real-time access and use by operations and other staff, along with archival storage and subsequent retrieval. The product will also investigate and possibly test in a lab setting the need for linkage to other data sources such as power system models, fault records, generation dispatch, and other operating information.</td>
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<td>Technical Update</td>
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PS161C Information and Communications Technology for Smart Distribution Systems (063438)

Project Set Description

The Infrastructure for Intelligent Distribution Systems project set focuses on the communications and IT infrastructure necessary to achieve fully integrated distribution operations. The research is focused on obtaining, sharing, using, and updating information that is critical for distribution applications. The standards for back-office application integration and communications are evolving rapidly. This project set seeks to track this evolution and provide value to the participating members with analysis and ancillary information in the form of training, tools, and media. The project set further seeks to utilize back-office standards and communications protocols to provide near-term value to utilities in the form of tools and techniques for using information.

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<thead>
<tr>
<th>Project Number</th>
<th>Project Title</th>
<th>Description</th>
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<tbody>
<tr>
<td>P161.005</td>
<td>Common Interface Model (CIM) for Distribution - Development and Implementation</td>
<td>This project supports cost-effective utility integration of distribution applications by advancing CIM-based design, implementation, and interoperability testing. The project will focus on accelerating CIM development and developing guidelines for the application of the standards to real back-office integration.</td>
</tr>
<tr>
<td>P161.018</td>
<td>Geospatial Information System (GIS) Data Management</td>
<td>This project intends to provide utilities with an adaptable template and set of tools that can be used to assess, improve, and ensure ongoing GIS data quality.</td>
</tr>
<tr>
<td>P161.024</td>
<td>Robust IT Architecture Development</td>
<td>This project will use multiple qualitative approaches to develop this topic, including a case study, observations, and document review that will conclude with recommended or implemented changes in utility enterprise architecture practice.</td>
</tr>
</tbody>
</table>

P161.005 Common Interface Model (CIM) for Distribution - Development and Implementation (065546)

Key Research Question

Basic messaging utilizing the Common Information Structure is necessary to develop a smarter, more efficient grid. Gaps in the Common Interface Model (CIM) standards still exist, and the standards that make up the CIM have yet to reach their full potential. The project will focus on accelerating CIM development and developing guidelines for the application of the standards to real back-office integration.

Approach

The Electric Power Research Institute (EPRI) will conduct a series of workshops to identify the basic messaging needs of back-office applications. The goal of these workshops is to accelerate the standard development process for the CIM standards. To make the existing standards more accessible to utilities, EPRI will update the CIM Primer that was produced in 2011 and complete the CIM – IEC 61850 harmonization efforts that were started in 2009. EPRI will also monitor the progress of the CIM for distribution standard as a whole. EPRI will assess the progress and convey to the funders the impact of the CIM development on their day-to-day business functions. EPRI will survey the state of the industry of CIM integration and will provide guidance as to the viability of implementing parts of the CIM or CIM-like semantic models.

Impact

As the standards become more developed, utilities will be able to take the outputs of this project (primer, harmonization documents, and draft standards) and begin to develop their semantic model for back-office integration.
How to Apply Results

Distribution system architects, application developers, and information technology managers can use the knowledge and products produced by this project for designing, developing, testing, and maintaining distribution applications.

2013 Products

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<tr>
<th>Product Title &amp; Description</th>
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</thead>
<tbody>
<tr>
<td><strong>CIM – IEC 61850 Harmonization</strong>: This deliverable will complete the work done by EPRI in 2009 and will be pivotal in the implementation of both standards.</td>
<td>08/30/13</td>
<td>Technical Report</td>
</tr>
<tr>
<td><strong>CIM Development Workshops</strong>: Series of workshops that bring together utilities, vendors, and standards development organizations to accelerate the writing of new CIM messages for back office integration.</td>
<td>10/31/13</td>
<td>Workshop, Training, or Conference</td>
</tr>
<tr>
<td><strong>CIM Primer, 2nd Edition</strong>: The CIM Primer will be expanded and updated to reflect the latest progress in the CIM standard. Content will be delivered using a variety of media.</td>
<td>12/31/13</td>
<td>Technical Report</td>
</tr>
<tr>
<td><strong>CIM Case Studies</strong>: Case studies and activity in the development of the CIM will be reported.</td>
<td>12/31/13</td>
<td>Technical Update</td>
</tr>
</tbody>
</table>

P161.018 Geospatial Information System (GIS) Data Management (072073)

Key Research Question

Utilities continuously struggle with the quality of geospatial information system (GIS) data. With the advent of the smart grid and advanced metering infrastructure, utilities are facing increased pressure to resolve data quality issues. GIS quality issues are primarily related to:

- Gaps, e.g., certain key data is missing
- Redundancies with other systems, e.g., data is captured in many systems and it is inconsistent or requires duplicate data entry to update
- Workflows pertaining to new construction and maintenance
- Lack of currency with system “as-built”, e.g., untimely work order completion/backlog
- Inaccuracies with the field, e.g., GIS has data but does not represent the actual system in the field
- Inaccurate or unavailable land-base, e.g., varying degrees of accuracy of land-base data based on the source
- Customer-to-transformer connectivity by phase is in doubt
- GIS model itself allows for “bad” data
- Data dependencies and the “ripple effect” of bad GIS data
- What is included in the GIS, level of detail, best practices
- The use of GIS to track communications infrastructure

Approach

With the advent of advanced metering infrastructure (AMI), DMS, distributed energy resources (DER), and the smart grid, distribution companies can no longer ignore poor data quality. In many cases, utilities are finding that their capital-intensive smart grid investments are not yielding anticipated benefits simply because the utility does not have an adequately accurate representation of the distribution system. In more extreme cases, the safety of employees and the public has been compromised due to misrepresented facilities in the GIS.

Previously utilities lamented but tolerated data issues. The need for accuracy has become an imperative with the widespread acceptance of AMI, increasing higher penetration of DER and the need for data for advanced distribution automation. This has brought GIS data quality to the forefront of utilities' preoccupations. Utilities
need a robust and reliable model from customer to transformer, through protective devices to the substation by phase that is accurate and timely. This project will provide participants with

- a means of performing a self-assessment of data quality, what is needed, how accurate it should be, and where they are in comparison to peers;
- identify processes, strategies, tactics, and tools to resolve existing data challenges;
- provide processes and methods to ensure that data quality continues to improve once the initial data rationalizing of cleansing has taken place; and
- offer software tools specific to key utility GIS to assess, correct, and ensure ongoing data quality.

The project will provide utilities with an adaptable template and set of tools that can be used to assess, improve, and ensure ongoing data quality. The project will serve as a seminal reference to data quality for utilities. Utilities following the recommendations of the report and using the associated tools will be able to achieve a strong foundation to ensure ongoing data quality.

**Impact**

Geospatial Information System (GIS) acts as the “hub” around which the engineering and operations application revolve. In an ideal world, the GIS feeds critical information to the other applications in the distribution environment. This ideal has been hampered by the lack of complete and accurate data. By cleaning up the data in GIS, a utility that relies on that data could expect immediate improvement in the accuracy of Outage Management Systems (OMS), power systems modeling, DMS, and other mission critical applications.

**How to Apply Results**

Information Technology (IT) and engineering departments will be able to apply the findings of this work to their business processes. The results of this research will be written as a series of actionable steps that taken individually or collectively should be able to mitigate the GIS data issues that utilities actually face.

**2013 Products**

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<tr>
<th>Product Title &amp; Description</th>
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<tbody>
<tr>
<td>GIS Data Improvement: Processes, strategies, tactics, and tools to resolve existing GIS data challenges and help prevent future issues.</td>
<td>12/31/13</td>
<td>Technical Resource</td>
</tr>
</tbody>
</table>

**P161.024 Robust IT Architecture Development (073552)**

**Key Research Question**

Enterprise architecture as a practice has evolved over the last couple of decades. Several frameworks for developing enterprise architecture have been used either generically, (Zachman, The Open Group Architecture Framework [TOGAF®]) or for specific domains such as the Department of Defense Architectural Framework (DoDAF) or the federal government’s Federal Enterprise Architecture Framework (FEAF). Utilities share many common systems and business practices that are also unique for their operating environment. An enterprise architecture repository specific to utilities could be of great value, especially as utilities continue to invest in smart grid-related assets. Rather than explore architectures of common enterprise resource planning (ERP) systems (systems that have well-established architecture and processes), only those systems that might be impacted by smart grid investments will be explored; for example, impacts to Asset Management architecture, customer-facing systems, or perhaps Outage Management Systems (OMS).

This project will utilize artifacts where they already exist (i.e., guiding principles, standards, or data models such as those like the International Electrotechnical Committee [IEC] Common Information Model [CIM], and MultiSpeak®), and combine them with new artifacts developed during the course of this project, such as use cases or common smart grid-related application architectures.
Approach
This project will use multiple qualitative approaches to develop this topic, including case study, observations, and document review that will conclude with recommended or implemented changes in utility enterprise architecture practice.

This project will closely coordinate with others within EPRI, member participants, and utility forums such as the Smart Grid Interoperability Panel (SGIP) Architecture Committee (SGAC), UCA® International Users Group (UCAIUG) Open Smart Grid (OpenSG) task force, and various standards working groups (i.e., IEC Working Groups 13, 14, and 19).

This project will collect and organize existing artifacts and develop new artifacts into a comprehensive enterprise architecture repository. The repository will follow TOGAF with a focus on the first four phases: A) Architecture Vision, B) Business Architecture, C) Information Systems Architecture, and D) Technology Architecture. While TOGAF specifies additional phases, they tend to be more implementation specific, so this effort will focus on the phases that will be most useful to utilities to ramp up or mature their own enterprise architecture efforts. Additionally, this project will coordinate the sharing and development of best practices that can also be developed into artifacts such as document templates, application architecture AS-IS and TO-BE designs, or a use-case library (building on existing libraries and refining new use cases). The repository will also point to relevant existing standards, such as those evaluated and contained in the NIST catalog.

Impact
As utilities make more investments in systems to support smart grid systems and deployments, it is imperative that they use methodologies to evaluate their IT/OT landscapes to reduce risk, preserve investments where possible, consolidate systems, and help future-proof their smart grid acquisitions. The repository that will be built out as result of this research combines many existing enterprise architecture-related artifacts such as guiding principles, use cases, data models, and standards, into a consolidated whole. An enterprise architecture team will be able to use the artifacts in this repository to complement their own enterprise architecture developments in their organizations. Utilities that may have less-mature practices will have an entire repository to leverage to “hit the ground running” and make their own efforts more actionable.

How to Apply Results
Business, Solution, and Enterprise Architects will be able to take the findings from this work and be able to apply it to their own enterprise. Additionally, using the capabilities of the tool used to develop and maintain the repository, SparxSystems Enterprise Architect, users will be able to either use the repository in its entirety, or optionally, export artifacts as Unified Modeling Language (UML) into their enterprise architecture tool of choice.

2013 Products

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<tbody>
<tr>
<td>Cost Benefit Analysis of Robust Architecture: Establishing the metrics needed to justify the investment in “robust” network architectures at utilities.</td>
<td>08/30/13</td>
<td>Technical Report</td>
</tr>
</tbody>
</table>
PS161D Information and Communications Technology for Customer Integration Including Metering and Demand Response (063439)

Project Set Description
This project set addresses the communication integration of customers with the utility, including advanced metering, load management, distributed energy resources (DERs) such as photovoltaic (PV) and battery storage, and other general information exchange. In the past, the customer interface was primarily limited to monthly metering, but advances in communication, measurement, and control technologies have transformed the landscape of customer integration, bringing many new possibilities but also many challenges. This project set addresses these challenges by evaluating technologies and architectures, identifying standards gaps and accelerating development, identifying lessons learned and best practices, and demonstrating capabilities in both laboratory and field environments.

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<thead>
<tr>
<th>Project Number</th>
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<th>Description</th>
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<tbody>
<tr>
<td>P161.016</td>
<td>Standards and Technology for Open, Interoperable AMI Systems</td>
<td>The project will conduct research to advance the state of the technology for metering communication systems, including functionality, performance, and employment of open standards. Ancillary uses, such as DER management and distribution controls, will also be evaluated. Best practices for life cycle management will be tracked and reported.</td>
</tr>
<tr>
<td>P161.025</td>
<td>&quot;Green Button&quot; Evaluation</td>
<td>This project will provide an assessment of the Green Button data exchange standard through direct evaluation of a sample set of products that employ the standard. The project seeks to provide insight into the ability of this data standard to provide consumers with workable and useful energy consumption feedback.</td>
</tr>
<tr>
<td>P161.026</td>
<td>Smart Energy Profile Analysis and Evaluations</td>
<td>This project will perform evaluations of the Smart Energy Profile (SEP2.0) communication specification and emerging residential products that employ this standard. The approach will include both technical assessment and laboratory tests.</td>
</tr>
<tr>
<td>P161.027</td>
<td>Integrating Smart Appliances for Demand Response</td>
<td>This project will research the methods and technologies by which utilities might integrate smart customer devices for demand response (DR-Ready appliances). This research will include state of the industry assessments, standards acceleration and evaluations, and laboratory testing.</td>
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P161.016 Standards and Technology for Open, Interoperable AMI Systems (072075)

Key Research Question
Utilities are deploying advanced metering infrastructure (AMI) in their service territories, creating two-way communication networks reaching customer premises. Although metering is the primary application of AMI, the systems are generally viewed as being multi-purpose, sometimes supporting demand response, distribution controls, and renewables integration. Presently, there are many providers of AMI systems, employing a wide range of technologies that include power-line communication, wireless, and wired broadband. Due to a lack of standards at many levels, these systems are mostly proprietary, and utilities are locked in to a particular vendor once they begin to deploy. AMI is evolving rapidly, with providers working to stay in step with changing utility needs and the availability of existing public infrastructure expanding. For most utilities, their next AMI system may bear little resemblance to their present system.
Objective evaluation of these systems is needed, understanding the potential for the different architectures to support the range of applications. Acceleration of standards development is also needed to improve the interoperability of systems and to foster competition by enabling multiple sources of supply.

The project will conduct research to advance the state of the technology for metering communication systems, including functionality, performance, and employment of open standards. Ancillary uses, such as distributed energy resources (DER) management and distribution controls, will also be evaluated. Best practices for life cycle management will be tracked and reported.

**Approach**

This project will coordinate with activities throughout the utility industry and other organizations. New applications and requirements identified in application areas, such as electric transportation, storage and renewables integration, advanced distribution, and demand response, will feed into this project. Specific demonstration projects will be collaboratively conducted and results shared.

This project will work with participating utilities to perform evaluations and conduct testing of AMI architectures and protocols, and it will document the results in EPRI technical reports. Industry contributions will be made with the goal of stimulating or accelerating the development of open standards by identifying gaps and recommending solutions. The project will seek to identify best practices for life cycle management of AMI technologies, studying the design, deployment, operation and end-of-life issues to reduce the total cost of ownership for utilities and to maximize the benefits to customers.

**Impact**

Members will contribute to establishing a long-term industry vision for AMI, providing valuable input to system providers as to the nature of next-generation products that will be needed and contributions to standards bodies regarding gaps and needs for the future. An understanding of outside influences in the 10-year horizon, including technology advancements, infrastructure availability, third-party applications, and evolving customer expectations, will help to shape the vision. This vision will serve as a foundation for a strategic plan that will help guide research in the IntelliGrid program going forward. Standards organizations (for example, IEC, ISO, ANSI, and NIST) may benefit from the results of this project.

**How to Apply Results**

Members will gain insight into the range of advanced metering technologies being offered, the capabilities afforded by each, and the system uses being considered by other utilities. These insights will help members execute their own assessment of various communication networks and plan what uses, in addition to metering, might be supported by their AMI.

Sharing of lessons learned will help member utilities to develop their own processes and will enable the compilation of best practices regarding system architecture, ancillary system uses, deployment, operations, upgradeability, and transition to next-generation systems.

**2013 Products**

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<tr>
<td><strong>Communication Framework for Open and Interoperable AMI:</strong> This project builds upon emerging industry standards such as the IEEE 802.15.4g to accelerate development and evaluation of a profile for advanced metering systems. As possible, the process will engage industry stakeholders and will be coordinated with the open AMI standards activities, such as those of the TIA, ZigBee Alliance, and IPSO Alliance. This research will advance the state of the art for AMI, with the ultimate goal of making it possible for utilities to build out networks using multiple sources of supply.</td>
<td>12/30/13</td>
<td>Technical Update</td>
</tr>
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</table>
Laboratory Evaluation of Advanced Sub Metering: This project builds upon the prior year scoping study for cost-effective, secure sub-metering. It will work with members to select one or more of the most attractive sub-metering architectures, develop a working prototype system, and evaluate it in a laboratory environment to determine performance and reliability.

P161.025 "Green Button" Evaluation (073553)

Key Research Question
Utilities have a long history of providing customers with visibility to their present and prior energy consumption to help them understand their bills and improve energy efficiency. As advanced metering systems have been deployed and interval data collected, it has become possible to provide additional data to customers, notionally providing additional insights and awareness.

The "Green Button" initiative is an industry effort to present energy consumption data in a standard format, such that a wide range of consumer products and software applications could exchange and use the data. As the name "Green Button" implies, the initiative is associated with a common green circular icon, with the idea that it would become familiar to the general public as a way to view individual consumption.

Approach
The Green Button initiative is expected to result in the availability of a number of consumer products, including both hardware and software, for processing and displaying consumption data. This project will evaluate a sample selection of these products to determine the extent to which they successfully interoperate.

Impact
Utilities will gain insight into the intent of Green Button products and the degree to which the emerging data standard succeeds in creating interoperable products. The learnings may help guide decisions regarding the provisioning of certain data to customers or the employment of certain methods for providing this data. Members may participate in the assessment and may provide or suggest technologies to be included in the assessment.

How to Apply Results
Members may apply the results of these evaluations to guide decisions regarding systems and software for customer consumption feedback. Expectations for interoperability of Green Button products may be established and an understanding gained as to the types of feedback mechanisms to deploy.

Green Button Interoperability Testing: This project will present the results of laboratory evaluations of a sampled set of software and/or hardware products designed to support the Green Button standard. Testing will focus on the degree of interoperability and ability to successfully handle data with a range of resolutions, interval sizes, and timings.
P161.026 Smart Energy Profile Analysis and Evaluations (073554)

Key Research Question

Communication technologies continue to evolve and improve and are becoming prevalent in a range of consumer products. Going forward, it is anticipated that residential end-use equipment will be increasingly capable of being networked and that residential customers will own and manage local networks that interconnect these devices. Among other consumer interests, these networks may be used to inform end devices of grid conditions to enable demand response.

The "Smart Energy Profile" is a communication specification created by the ZigBee Alliance for the purpose of exchanging energy-related information among devices in such residential networks. The latest version of this specification, called "Smart Energy 2.0," has been designed as an application-layer protocol that runs over Internet Protocol version 6 (IPV6) over any underlying physical medium. Most prominently, these physical layers include ZigBee, Wi-Fi, and HomePlug Green PHY.

Approach

This project seeks to evaluate this emerging standard in terms of its ability to support interoperable products and systems. The approach will include a combination of technical assessment (direct evaluation of the technical specification) and laboratory interoperability assessments of a sample set of emerging products.

Impact

Members will gain insight into the capabilities of this new specification, and the degree to which emerging products are found to be interoperable off-the-shelf. Evaluations in member laboratories may be linked into the EPRI evaluation, such that guidance is given as to which products might be included. The evaluation will include an assessment of the commissioning, securing, and utilization processes.

How to Apply Results

The results of this research may help members to make system architectural decisions or programmatic decisions regarding the piloting or employment of SE2.0 devices. Decisions to employ meters with built-in SE2.0 protocols may be informed by the findings of this research.

2013 Products

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<tr>
<td>Smart Energy Profile (SE2.0) Interoperability Evaluation: This Technical Update will be an installment in a series of ongoing evaluations and laboratory tests to determine the capabilities and sufficiency of the Smart Energy Profile (SE2.0) to enable interoperable devices and to support the range of consumer needs and utility interests.</td>
<td>12/30/13</td>
<td>Technical Update</td>
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</table>

P161.027 Integrating Smart Appliances for Demand Response (073555)

Key Research Question

Historically, residential products have not been capable of receiving signals from the utility or providing a demand response relative to such signals. This left the use of load control switches as the only option for managing residential load. This approach has had limited success for a variety of reasons, including the upfront cost of enrollment and poor customer experiences stemming from the lack of intelligent responses.

Going forward, the ability to communicate directly to residential devices is increasingly possible. This ability offers to improve on many of the present limitations, but also raises several new challenges.
### Approach
This project will research the methods and technologies by which utilities might integrate smart customer devices for demand response (DR-Ready appliances). This research will include state-of-the-industry assessments, standards acceleration and evaluations, and laboratory testing.

### Impact
Members will gain insight into the methods and technologies for the integration of this new generation of DR-ready communicating devices. The research may accelerate the identification and development of communication standards and information models needed for handling the range of product types and brands that will exist.

### How to Apply Results
This project will provide participants with understanding of emerging smart appliance technologies so that central office enterprises, field communication networks, and demand response programs can be designed today in a way that seamlessly integrates with DR-Ready appliances as they appear in the marketplace.

### 2013 Products

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<tbody>
<tr>
<td><strong>Integration Guide for DR-Ready Appliances</strong></td>
<td>12/31/13</td>
<td>Technical Update</td>
</tr>
<tr>
<td>This Technical Update will provide a guide to the integration of DR-Ready Appliances built with the CEA-2045 standard utility interface port. The update will cover a range of common DR program types and technologies, identifying for each the possible mapping and usages of the interface standard. This guide will provide members with useful drop-in language that can help produce specifications for communication technology partners and integrators.</td>
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IntelliGrid - Program 161
Supplemental Projects

Automated Demand Response and Ancillary Services Demonstration (072079)

Background, Objectives, and New Learnings

This demonstration project will perform research associated with emerging energy price and product messaging-protocol standards to take advantage of ubiquitous low-cost communication infrastructures that may be able to reliably perform automated demand response (DR) and ancillary services or fast DR functions. Internationally recognized standards for DR and ancillary services are a key enabler for the development of commercially available products that have largely been proprietary over the last 30 years.

Emerging standards development in this area from Lawrence Berkeley National Lab, the Organization for the Advancement of Structured Information Standards (OASIS), and the National Institute of Standards and Technology (NIST) have advanced sufficiently so that demonstrations are feasible and products are beginning to become commercially available. However, research questions remain about the level of quality of service, reliability, security, persistence, and scalability, as well as architectures in different market structures. Other issues include level of measurement and verification required, an understanding of the load characteristics, and methods of aggregation. This project will also research how resources may meet ancillary services requirements, including giving visibility to resources. In support of the research and advancement of this industry effort, EPRI will contribute to open source versions of Open Automated Demand Response (OpenADR) servers and clients that can be also be used by members of this project.

Project Approach and Summary

As a part of a path toward realizing the benefits of OpenADR, this project will focus on the interactions between and among various stakeholders (independent system operators [ISOs], Utilities, Aggregators, Retailers, and all customer classes) while validating OpenADR platforms and systems. Standardized DR automation is an important component of the smart grid to deliver dynamic price signals to achieve economic or reliability objectives. Via a standardized communications data model, utilities and ISOs can directly interface with building and energy management systems. This project will synchronize with the aforementioned groups to continue progress to automate DR programs and acceptance by a wide range of building and industrial controls manufacturers and individual device manufacturers.

OpenADR is currently defining/developing “Fast DR” capabilities for utilization where shorter cycle times are required to qualify for participating in ancillary service markets. The project seeks to validate fast DR technologies to qualify specific loads for regulating reserve, load following, and spinning reserves by field testing and demonstrations. The intent is to include demonstrations where commercial and industrial (C&I) customers can reduce power usage automatically and quickly to meet the desired target responses reliably and explore how residential products may participate in this market.

Benefits

This project may help to accelerate development of standards that automatically manage loads and distributed energy resources (DER) for DR and ancillary services requiring faster response. The use of standardized communication protocols for these functions will benefit the public by enabling the use of multiple types of low-cost ubiquitous communication networks, crossing many utility boundaries from distributor to ISOs and facilitating access to ancillary markets. In just the short development time of OpenADR v1.0, there are now over 60 energy management and control system vendors that offer OpenADR products (clients). This work is expected to increase market participation in the development of devices, eventually, with this functionality directly built in.
Electric utilities are expected to gain an understanding of the performance capabilities, load types, infrastructure requirements, product availability, and market opportunities associated with the advancement of this smart grid application.

Field Area Network Demonstration Project (072080)

Background, Objectives, and New Learnings

The field area network (FAN) is an essential layer of a utility’s smart grid communications infrastructure. The FAN concept is emerging to be a ubiquitous, high-per-formance, secure, reliable network providing “last mile” backhaul service for distribution supervisory control and data acquisition (SCADA) and advanced metering infrastructure (AMI) systems, as well as network access services for advanced distribution management and automation, distributed energy resources, and any future smart grid applications requiring connectivity from within and beyond the distribution substation.

FAN implementations may involve a range of technologies—from 3G/4G cellular infrastructure (including LTE and WiMAX™) and next-generation standards-based AMI networks to broadband options, including Industrial Wi-Fi™ and wired (copper and fiber) networks—for connecting major grid nodes, such as substations or wind farms, to the utility’s corporate network, or to provide backhaul for wireless infrastructure.

These heterogeneous networks will constitute a critical layer in the utility's smart grid network, supporting new applications and eventually migrating legacy operational applications such as distribution SCADA onto the FAN. Yet their reliability and performance characteristics are not well understood. Therefore, one objective of the project is to establish methods and metrics for assessing the reliability and performance of FAN technologies.

A second objective is to work with utilities to incorporate the evaluation of FAN reliability into their FAN field trials, using the metrics and methods established in the project. Evaluations may also include aspects of network management such as quality of service (QoS) and application prioritization.

A third objective is to raise the level of industry knowledge and practice around FAN reliability by publishing the results of FAN trials that the project will support. In particular, research will be published on high-reliability FAN architecture, design principles, and guidelines for implementation and operation.

A fourth objective is to research and demonstrate techniques and best practices for application integration and migration from legacy systems to the FAN. The ability of the FAN to support multiple smart grid applications is a key aspect of the cost benefit analysis.

A fifth objective is to promote and demonstrate FAN device interoperability, through a series of vendor forums and interoperability plugfests.

The new knowledge generated by this project is expected to include a reference communications architecture featuring the FAN as a common infrastructure for operational and smart grid applications; and a practical understanding of utility FAN characteristics, with a particular emphasis on models and empirical measures of reliability.

Project Approach and Summary

The project approach is modeled on and is very similar to EPRI's Smart Grid Demonstration Initiative. We plan to help utilities design their FAN projects and trials to include a reliability focus and will provide expert assistance in trial or pilot design, execution, and evaluation. The project will include a series of meetings among project participants for the dissemination of information, experience, and results. We plan to hold meetings at host sites to gain hands-on experience in high-reliability FAN design, implementation, and operation. We plan to model the expansion of trials and pilots into full-scale deployments across project member service territories.
In summary, participating utilities will be assisted and collaborate at every stage of the research, design, piloting, evaluation, and planning of a highly reliable FAN as the centerpiece of their next-generation smart grid infrastructure.

Benefits

Utilities may benefit by collaborating with others, thereby gaining knowledge and experience with a wide variety of approaches to high-reliability FAN design. They may also benefit from the ubiquity, performance, security, extensibility, and reliability of a FAN designed according to the architectures, principles, methods, and metrics that are explored or established in the project. These project features may drive risk and cost out of the utility's FAN planning and deployment process.

Society may benefit from higher reliability of energy supply and faster restoration of outages, especially due to a distribution system benefiting from the advanced applications that a FAN can support.

Using Standards to Disperse Field Data Across the Enterprise (072081)

Background, Objectives, and New Learnings

In EPRI's 2011 "A Smarter Transmission Grid" white paper, three technology pillars were identified as key to a smarter transmission grid: grid development and operation, asset lifecycle management, and information and communication technologies (ICT). Specifically, smart grid technologies will demand more analytical horsepower and data-handling capabilities. These data will be large in volume and scattered through the interconnected network. The data sources will be diverse, including equipment health sensors, phasor measurement units (PMUs), intelligent electronic devices (IEDs), and weather sensors, among many other types. Some of these data will be harvested in real time; others will be stored in a historian database. The challenge will be to deliver the information to end users and end-use applications with the specified accuracy, security, and speed.

Robust and highly integrated communications and computing infrastructures will be needed to create a smarter transmission grid. These infrastructures need to be interoperable across vendor equipment and throughout the enterprise. Achieving the necessary level of interoperability requires the development and industry adoption of a tightly coupled suite of standards. The Common Information Model (CIM) provides a common language for integrating applications across the enterprise and is a foundation standard for smart grids. IEC 61850 and the Internet Protocol (IP) also are key standards. The objective of this work will be to establish a diverse set of data sources that are representative of what may exist within a smarter transmission grid and apply a standards-based integration methodology to identify the gaps.

Work in 2011 targeted transformer health and was demonstrated within the EPRI Smart Grid Substation Lab using data extracts from utilities and buffered near-real-time data. This work will be continued and expanded through this supplemental project. This approach will provide very specific learning with respect to practical utility-centric integration of a variety of data sources and determine within the established scope the limitations of the current IEC 61850, 61968, and 61970 (CIM) standards from a data object perspective.

Project Approach and Summary

This project will continue the work started in 2012, which was related to transformer health data, into the control room. In that project, utility data, both static (such as nameplate) and near real time (such as transformer loadings) were brought into the EPRI Lab, transformed into the applicable standards models, analyzed, and reported back out to the utility. Interest areas may include other substation assets such as circuit breakers and potential transformers, or other well-monitored field assets.

In this project, the specific requirements for a utility-specified topic area from the applications specified in the white paper will be developed; applications such as Asset Health Center, Substation Intelligent Electronic Device (IED) Data Utilities, or other industry-suggested applications that align with the smarter transmission grid
direction. Through these various utility-specific supplemental projects, an overall data and integration strategy will emerge to provide utilities with an integrated approach to transmission smart grid information management.

Unlike previous CIM and IEC 61850 interoperability tests that tended to be bulk data exchange-centric, this project will be utility driven and focus on supporting successful deployments of the CIM and IEC 61850 standards. Any identified issues will be presented to the appropriate standards body for consideration during their review cycle.

**Benefits**

This project could have the following impacts:

- Facilitate true interoperability and enable integration of applications across the enterprise via systems built to open standards
- Facilitate standards that enable open enterprise applications and leverage this openness across utilities
- Provide benefit to the public through higher reliability by including more relevant information in the decisions process

**Field Force Data Visualization (072447)**

**Background, Objectives, and New Learnings**

As utilities begin to integrate systems that previously operated with little or no data interconnection, it becomes easier to link together related data. This can result in powerful diagnostic and management tools to be created that use this interconnected data to all engineers to better understand the network and the context of any unexpected behavior.

To show the power of data integration and modern human-computer interfaces it is proposed that emerging technologies from the mobile computing field be used to create a mobile integrated data access platform.

A key use-case is to allow an engineer or technician out in the field to be able to identify all relevant data for the network at his current location. Using this interface he could navigate through all the data displayed for a transformer or switching device, identify its location in the GIS, then be shown the down-stream circuit on a map, query into its history and execute a switching order, etc. Upon arriving at a location, the GIS and magnetometer (compass) built into a tablet would identify the location, and the tablet would allow the user to see in real-time a video of the area with data on the view, on a single line diagram and on the map. The crew could query the state of a switch, identify premises with outages, and automatically tag devices. This would all be possible with a properly integrated data environment and accurate GIS data.

Objectives of this project include

- developing a proof-of-concept for the current power of the Common Information Model (CIM) in a real application environment;
- creating a CIM-based, lightweight, mobile data platform using real utility data and systems; and
- creating a proof-of-concept for the capabilities of an inexpensive mobile data platform.

New learnings of this project include the following:

- Identification of important applications for the communication and information infrastructure that can benefit the utility community and society.
- Identification of important technological and research gaps critical to the utility industry to provide reliable power.
- Identification of future research needs, to provide more robust approaches for integration.
Project Approach and Summary

This project will extend existing technology, developed in the IntelliGrid(sm) program for field testing in actual utility environments. Initial systems capable of integration with the mobile data platform will be identified. EPRI will work with a limited set of vendors to create CIM-based APIs (Application Program Interfaces) and CIM messages to facilitate the transfer of data from the back office or control room to the field and back. Finally, EPRI will work with utility’s information technology and communication personnel to create a test environment for the project with the goal of creating a real-world, proof-of-concept using the project participant’s data and infrastructure.

Benefits

Through improved data quality, multiple benefits can be realized

- Understanding potential improved safety due to more accurate, real-time data to the field.
- Both audio and visual communication may be enhanced.
- Ability to have another compelling case for the investment in standards-based integration.
- Improved Outage Management Systems (OMS) and DMS benefits, such as the ability to visualize and mentally process large amount of disparate data from multiple sources in a timely manner; avoiding vendor “lock-in” for the purpose of visualizing and utilizing data; and utilizing investment in “best of breed” systems.
- Possible crew efficiencies due to improved system representation.
- The ability to explore the potential for reduced work order cycle times.