IntelliGrid - Program 161

Program Overview

Program Description

Utilities are increasingly deploying monitoring, communications, computing, and information technologies to enable grid modernization 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 the 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 leverage resources and provide information to all users;
- mining and managing the tremendous amount of data that is generated, converting the 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 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

- promoting interoperable systems by leading an industry effort to develop open, interoperable advanced metering systems, contributing to the development of key standards such as the Common Information Model (CIM), assessing emerging standards such as Open ADR, conducting interoperability tests of products that implement key standards, and providing training and information to utilities on how to implement standards;
- providing tracking and analysis of emerging communications technologies, investigating synchrophasor communications infrastructure to support grid control, conducting research on emerging technologies such as TV white space and other lightly licensed spectrum, and conducting field demonstrations of 4G technologies for utility operations;
- performing research into the nature and structure of utility data—where data is required, how data is turned into actionable information and effectively presented to a user—and understanding the cost of poor data quality to a utility;
- capturing best practices and lessons learned from utility deployments of grid modernization technologies and applications; and
- tracking federal government and regulatory activities relating to standards and communications, and interpreting the impact these actions will have on the utility industry.

Research Value

With the knowledge acquired through this research program, members will be able to lower costs and reduce risks as they implement grid modernization technologies and applications. Specifically, members will have access to information that can help them

- implement standards-based approaches for achieving interoperability of devices and systems that make up a smart grid infrastructure,
- understand the impact that new standards and communications technologies will have on utilities,
- apply lessons learned from utility implementations of grid modernization technologies and systems,

- understand communications and information system architecture requirements and technologies to support grid modernization applications,
- understand the impact that federal government and regulatory activities related to standards and communications will have on the utility industry.

Approach

The approach for providing value in the IntelliGrid program involves multiple strategies:

- Tracking and Analysis—Build on IntelliGrid staff involvement in industry-related activities to provide insight and analysis to members.
- Industry Best Practices and Lessons Learned—Document utility experiences as they implement early-generation technologies and applications and core grid-modernization technologies. Experiences are captured through utility immersions, interviews and case studies.
- Industry Leadership—Help advance the industry toward open and interoperable devices and systems.
- Laboratory Testing—Conduct work in EPRI laboratories that enables detailed assessment of emerging standards, equipment and software performance and communications architectures.
- Field Demonstrations—Perform full-scale deployments of emerging standards and communications technologies.
- Technology Transfer—Utilize a variety of approaches to share research results, including technical reports, white papers, newsletters, webcasts, and workshops.

Accomplishments

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

- *EPRI IntelliGrid Program 2012 Annual Review (3002000046)* provides a summary of activities for each project 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.
- *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.
- *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.
- *Future Role of Retail Broadband for Grid Integration (1024306)* investigates the role that retail broadband networks can play as a primary or alternate means of providing connectivity for applications related to residential customer integration.
- *GIS Data Improvement (1024303)* provides utilities with an adaptable template and set of tools that can be used to assess, improve, and ensure ongoing GIS data quality.
- *Transition from Legacy Protocols to IEC 61850 (1024300)* provides both near-term and long-term guidance on how to successfully transition to an IEC environment from a planning and engineering point of view.
- *Smart Grid Roadmap Guidebook (1025470)* describes the methodology that EPRI has created to develop roadmaps and documents lessons learned and best practices collected from the eight utility-specific roadmap development projects EPRI conducted between 2008 and 2012.

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 deliverables include

- newsletters that track and provide analysis on the most significant developments in interoperability and communications standards;
- information on the actual costs and realized impacts of advanced metering deployments;
- industry best practices in Enterprise Architecture;
- development and harmonization of the Common Information Model 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;
- development of an overall plan to create an open and interoperable AMI system; and
- development of tools to help members improve the quality of Geospatial Information System (GIS) data.

Estimated 2014 Program Funding

$3.9M

Program Manager

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Summary of Projects

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

Project Set Description

This project set provides members 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 members can minimize risk when planning and procuring equipment. It provides tools and best practices that will help them advance their enterprise architecture practice. It also provides utilities with lessons learned from industry smart grid deployments, including documentation of actual costs and realized benefits from deployments of smart grid applications and technologies. In addition, the project set provides the overall industry coordination and high-level technology transfer activities related to the information and communications technologies needed to support smart grid applications.

Project Number	Project Title	Description
P161.020	Smart Grid Standards and Communications Technology Tracking and Analysis	This project will: · Track industry and government activities relating to smart grid interoperability and communications standards, and provide an analysis of how these activities could impact utilities and how they can best prepare. · Track communications technology advances and their impact on utility applications. · Contribute 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.
P161.028	Realized Impacts and Benefits from Smart Grid Deployments	The objective of this project is to work closely with utilities that have deployed smart grid technologies or applications and capture the actual costs and realized impacts and benefits of the deployment. The initial technology that will be studied under this project is Advanced Metering Infrastructure (AMI).
P161.029	Utility Enterprise Architecture	This project will capture best practices from utilities that have been successful with Enterprise Architecture (EA) and apply that learning to utilities that are just getting started to accelerate the adoption and benefits of EA. Project results, such as guiding principles, use cases, data models, and standards, will be posted to an online repository.

P161.020 Smart Grid Standards and Communications Technology Tracking and Analysis (073549)

Description

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 likely 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 of how these activities could impact utilities and how they can best prepare;
- track communications technology advances and their impact on utility applications; and
- contribute 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

This project tracks relevant activities at NIST, the Federal Energy Regulatory Commission (FERC), the Federal Communications Commission (FCC), SGIP and standards bodies to provide members 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 throughout the entire industry. Coordination is achieved through sharing of use cases, member forums, webcasts, newsletters, and workshops.

Impact

Most utilities do not have the resources to actively participate in industry standards development activities. This project will provide tracking information on those activities. The analysis of the impact that these activities will have on utilities will help members plan smart grid deployments and minimize risk when selecting technologies.

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.

2014 Products

Product Title & Description	Planned Completion Date	Product Type
Smart Grid Standards Tracking and Analysis Monthly Webcasts: Monthly webcasts that describe activities on smart grid standards development or adoption and provide an analysis of the impact that the activity will have on utilities.	12/31/14	Workshop, Training, or Conference
Smart Grid Standards Tracking and Analysis Newsletter: A newsletter published twice a year that provide a summary of the progress made on smart grid standards development and implementation, as well as analysis of the impact that the developments could have on utilities	12/31/14	Technical Resource
Communications Technology Tracking and Analysis Newsletter: A newsletter published three times a year that provides updates and new developments from communications standards and industry groups, as well as analysis of the impact that the developments could have on utilities.	12/31/14	Technical Resource

P161.028 Realized Impacts and Benefits from Smart Grid Deployments (105313)

Description

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

Many utilities have developed business cases to justify the implementation of these technologies. While many of these business cases have been made publically available, there is very little information available that documents the actual costs of deployment and the realized impacts and benefits of implementation.

The objective of this project is to work closely with utilities that have deployed smart grid technologies or applications and capture the actual costs and realized impacts and benefits of the deployment.

Approach

The initial technology that will be studied under this project is Advanced Metering Infrastructure (AMI). IntelliGrid staff will work closely with utilities that have deployed AMI systems to:

- document how AMI systems and AMI data are currently being used by the utility (i.e., determine the applications that AMI systems and AMI data are currently being used for);
- identify applications that the utilities anticipate using their AMI systems and AMI data for in the near future;
- document the realized impacts and resulting value chains for the current applications;
- where possible, determine approaches for monetizing the benefits of the value chains; and
- document the actual costs of AMI deployments.

Impact

Results from this project will be valuable for members who have not yet deployed AMI systems or other smart grid applications and technologies, and who want better understanding of the uses, costs, impacts and benefits that they can expect from such systems. Utilities that have already deployed these technologies and applications will benefit from understanding how other companies use and derive value from the systems.

How to Apply Results

Information will be conveyed to project funders through a technical report and a workshop. Members will be able to directly apply the project results when planning, designing, and implementing their smart grid infrastructure and applications.

2014 Products

Product Title & Description	Planned Completion Date	Product Type
Realized Applications, Impacts, Benefits and Costs from AMI Implementations: This technical report will document the actual costs of AMI deployments from around the world and will describe how utilities are actually using these systems and the impacts and monetary benefits that they are realizing	12/31/14	Technical Report

P161.029 Utility Enterprise Architecture (105314)

Description

As utilities invest in systems to support grid modernization, it is imperative that they use methodologies to evaluate their Information Technology (IT)/Operations Technology (OT) landscapes to reduce risk, preserve investments where possible, consolidate systems, and help future-proof their acquisitions. Enterprise architecture (EA) is a methodology that utilities are increasingly adopting that facilitates achieving these goals, and helps tie execution to strategy.

EA is a disciplined process of translating business vision and strategy into effective enterprise change by creating, communicating, and improving the key requirements, principles, and models that describe the enterprise's future state and enable its evolution. EA as a practice has evolved over the last couple of decades. Several frameworks for developing enterprise architecture have been used either generically, such as 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). In fact, due to its success, the federal government now requires all projects to comply with the FEAF.

Utilities share many common systems and business practices that are also unique for their operating environment. This suggests that there would be value in creating an online repository of resources to help a utility advance its EA practices. Additionally, while there have been gains made in the number of utilities that take advantage of EA, and some that have leading EA practices, there continue to be many utilities that have no EA function or are just getting started.

The objective of this project is to capture best practices from utilities that have been successful with EA and apply that learning to utilities that are just getting started to accelerate the adoption and benefits of EA.

Approach

This project will use multiple qualitative approaches to capture EA best practices, including case studies, observations, and document reviews that will conclude with recommended or implemented changes in utility EA practice.

This project will closely coordinate with others within EPRI, member participants, and utility groups such as the Smart Grid Interoperability Panel (SGIP) Architecture Committee (SGAC) and the GridWise Architecture Council (GWAC), various standards working groups (i.e., IEC TC57 Working Groups 13, 14, and 19), as well as industry discussion forums.

This project will collect and organize existing artifacts and develop new 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 artifacts will be collected and made available to members through an online repository. The repository will also point to relevant existing standards, such as those evaluated and contained in the SGIP catalog.

The repository will follow TOGAF with a focus on the first four phases: Architecture Vision, Business Architecture, Information Systems Architecture, and 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.

Impact

The repository that will be built out as result of this research combines many existing EA-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. Members that may have less-mature practices will have an entire repository available to help them “hit the ground running” and make their own efforts more actionable.

TOGAF has identified the benefits of a successful EA practice as

- a more efficient business operation,
- a more efficient IT operation,
- better return on existing investment and reduced risk for future investment, and
- faster, simpler, and cheaper procurement.

How to Apply Results

Business, solution, and enterprise architects will be able to apply the findings from this work to their own enterprises. Additionally, members will be able to either use the repository developed through this project in its entirety or, optionally, export artifacts as Unified Modeling Language (UML) into their enterprise architecture tool of choice.

2014 Products

Product Title & Description	Planned Completion Date	Product Type
Industry Best Practices in Enterprise Architecture Version 2.0: This report is an update to the 2013 report that documents industry best practices in enterprise architecture. These best practices are captured through case study, interviews, and document reviews.	12/31/14	Technical Report

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.

Project Number	Project Title	Description
P161.003	Common Information Model (CIM) for Transmission—Development and Implementation	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 the 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 members interested in applying the CIM.

Project Number	Project Title	Description
P161.022	Synchrophasor Communications Infrastructure and Data Management	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 summarize the pros and cons of each method. Actual lessons learned will be documented and communicated.
P161.030	Integration of Internal and External Data Sources to Support Transmission Operations, Planning and Maintenance	The Integration of Internal and External Data Sources to Support Transmission Operations, Planning and Maintenance project will investigate business enhancement opportunities that arise through the integration of data sources in support of transmission system operational functions including planning, operations, and maintenance. These opportunities may benefit normal day-to-day functions as well as event-related functions such as storm response or outages. Central to this effort is geospatial information and the relationship between the location-specific impacts. The objective is to uncover location-specific trends, influences or other causalities that are not apparent through other data analytic methods.

P161.003 Common Information Model (CIM) for Transmission—Development and Implementation (063286)

Description

Cross-application data sharing is an essential foundation for successful operation of the transmission grid of the future. Highly integrated communications and computing infrastructures will be needed 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. Core among these standards is the Common Information Model (CIM) represented by IEC 61968 and 61970, which provides a common data model for integrating applications at the enterprise level. Leveraging the relationship between the CIM and 61850, an effort which is currently being explored in the IEC, will support integrated data sharing from field devices to enterprise applications.

Approach

This project will develop requirements and explore solutions for integrating data and applications that are key to effective operation of future transmission systems. These integration areas include the Asset Health Center, the Network Model Manager and Repository, and Substation Intelligent Electronic Device (IED) Data Utilities as well as other industry-suggested applications that align with the transmission grid of the future.

This project will be utility-driven and will focus on areas where utility need and standards maturity converge. It will move beyond the theoretical into the practical, focusing on supporting successful deployments of the IEC CIM and 61850 standards. Identified issues will be presented to the appropriate IEC Working Group for potential incorporation into the standard.

A central part of this project is the application of existing portions of the standards and demonstration of the value to the business enterprise that will create the necessary momentum to continue future standard development and refinement. As a complement to the practical application of the CIM, this project will also provide members with information and education on the CIM.

Impact

This project could have the following impacts:

- Refine and validate standards that enable open enterprise applications, and utilize this openness across utilities.
- Demonstrate true interoperability, and enable integration of applications across the enterprise via systems built to open standards.
- Enable improved life-cycle savings by providing a basis for interoperable vendor product development.
- Demonstrate the value of comprehensive data modeling and management.

How to Apply Results

Utility personnel engaged in managing or using data in the operation of transmission systems—from control center information technology project managers, to automation project engineers and transmission planners, to asset management personnel—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 understand and plan technology deployments that help organize data into information and allow the analysis of information to support decision making and action.

2014 Products

Product Title & Description	Planned Completion Date	Product Type
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.	12/31/14	Technical Update
Network Model Manager and Repository: 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	12/31/14	Technical Update

Product Title & Description	Planned Completion Date	Product Type
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.	12/31/14	Workshop, Training, or Conference

P161.022 Synchrophasor Communications Infrastructure and Data Management (073551)

Description

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; second, to investigate data management issues that may arise. The new learning is 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 more than 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 will provide members with improved knowledge for transporting synchrophasor data as well as 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.

2014 Products

Product Title & Description	Planned Completion Date	Product Type
Synchrophasor Communication Infrastructure: 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.	12/31/14	Technical Update
Synchrophasor Data Management: 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.	12/31/14	Technical Update

P161.030 Integration of Internal and External Data Sources to Support Transmission Operations, Planning and Maintenance (105315)

Description

Transmission business units of electric utilities are major consumers of data for a wide variety of operating functions. Data comes from both internal and external sources. Internal sources may include system operating parameters such as voltages, currents, circuit breaker status, digital fault records and others. External sources may include various aspects of weather data such as lightning intensity and location, wind speed, and warnings. Other external sources may include traffic reports, GPS-based public data such as Google Earth, and more. The objective of this project is to investigate business enhancement opportunities that arise through integrating these data sources to support transmission system operational functions including planning, operations and maintenance. These opportunities may benefit normal day-to-day functions as well as event-related functions such as storm response or outages. Central to this effort is geospatial information and the relationship between the location-specific impacts. The expected new learning is to uncover location-specific trends, influences or other causalities that are not apparent through other means. Additionally, regulatory compliance that requires location-specific assessments such as right-of-way requirements may also be investigated.

Approach

The project will develop a set of potential use cases that focus on the geospatial specific opportunities that participants consider as high value and high potential for achievability. This set of use cases will consider both normal day-to-day functions and event-related functions. The project will perform research on both research sample datasets and also sample utility datasets that may be provided. The objective will be to identify benefits and costs of implementing each use case investigated, including any effort to restructure the data to accommodate the geospatial information linkages.

Impact

The project is expected to provide benefits by enhancing the understanding and response to events. It will develop methods to assess, organize, and display geospatial representations of location-specific trends useful to planning, operations and events.

How to Apply Results

Members will be able to apply the knowledge gained from the project to their transmission business unit in the areas of transmission operations, planning and maintenance to facilitate process improvements and cost savings related to outage response time, maintenance improvements, and reductions in unplanned outages.

2014 Products

Product Title & Description	Planned Completion Date	Product Type
Data Integration to Support Transmission Operations, Planning and Maintenance: This report will document the integration activities around the initial use case selected by project advisors. The report will include the use case itself, the results of the data inventory assessment and a description of the model or demonstration integration.	12/31/14	Technical Update

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 information technologies (ICT) infrastructure needed to support the flexible and resilient distribution system of the future. This future system will integrate smart devices and back office systems such as distribution management systems, outage management systems, work management systems, and customer information systems. This project set will advance integration between field devices and back office systems by assessing communications and interoperability requirements. The project set will also address data quality, validation, and management for real-time applications.

Project Number	Project Title	Description
P161.005	Common Interface Model (CIM) for Distribution—Development and Implementation	The Infrastructure for Intelligent Distribution Systems project set focuses on the communications and information technologies (ICT) infrastructure needed to support the flexible and resilient distribution system of the future. This future system will integrate smart devices and back office systems such as distribution management systems, outage management systems, work management systems and customer information systems. This project set will advance integration between field devices and back office systems by assessing communications and interoperability requirement. The project set will also address data quality, validation and management for real-time applications.
P161.018	Geospatial Information System (GIS) Data Management	This project intends to provide members with an adaptable template and set of tools that can be used to assess, improve, and ensure ongoing GIS data quality.
P161.031	Guidebook for Advanced Distribution Automation Communications	This project will investigate the capability of different communications network technologies to support the communications requirements of different applications used for DA.

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

Description

Standardized messaging using the Common Information Model (CIM - IEC 61970 and 61968) reduces the time and cost to integrate enterprise systems. There are significant gaps in the CIM standards as well as barriers to their implementation.

The project will focus on accelerating CIM development and developing guidelines for the application of the standards to real back office integration.

Approach

The Infrastructure for Intelligent Distribution Systems project set will advance the development of the CIM standards as well as address utility implementation barriers. Specific activities include

- Conducting a series of workshops to identify the basic messaging needs of back office applications. The information that comes out of these workshops will be used to accelerate the development of CIM standards.
- Harmonizing the CIM and IEC 61850 standards to promote end-to-end interoperability from field devices to back office system.
- Tracking on-going developments in the CIM standard and analysis of the impacts these developments will have on utilities.
- Tracking CIM implementations to capture lessons learned and best practices.

Impact

Utilities that have implemented the CIM have reduced the time and cost required to integrate systems. The results of this project will increase these benefits by reducing the barriers for implementing the standard as well as filling in holes in the standard.

How to Apply Results

Distribution system architects, application developers, and information technology managers can use the results of this project for designing, developing, testing, and maintaining integration projects in support of real-time distribution automation.

2014 Products

Product Title & Description	Planned Completion Date	Product Type
Common Information Model Update for 2013: A report on EPRI research in CIM and CIM developments around the world with emphasis on impact to IT/OT convergence.	03/31/14	Technical Update
CIM – IEC 61850 Harmonization Report: Report summarizing EPRI's work to harmonize the CIM and IEC 61850 standards for distributed energy resources.	10/31/14	Technical Update
CIM Interoperability Test: Documentation of a CIM interoperability test in collaboration with system suppliers	11/30/14	Technical Update

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

Description

With the advent of advanced metering infrastructure (AMI), distribution management systems (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 its Geospatial Information System (GIS).

To take full advantage of grid modernization efforts, utilities need a comprehensive model of their grid that includes the customer-to-transformer connectivity, any grid-connected DER, protective devices, transformers, and conductors. This model must be both accurate and timely. This project will provide participants with

- a means of performing a self-assessment of data quality, including 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.

Approach

The project intends to provide members 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 on data quality for utilities. Following the recommendations of the report and using the associated tools will provide utilities with a strong foundation to ensure data quality on an ongoing basis.

Impact

GIS acts as the "hub" around which engineering and operations applications 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 OMS, power systems modeling, DMS, and other mission critical applications.

How to Apply Results

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

2014 Products

Product Title & Description	Planned Completion Date	Product Type
Electric Utility Guidebook on GIS Data Quality: A compendium of tools, processes, and techniques to achieve and maintain good GIS data.	10/31/14	Technical Report
GIS as a Situational Awareness Platform: A report on innovative uses of GIS in network operations	11/30/14	Technical Update

P161.031 Guidebook for Advanced Distribution Automation Communications (105316)

Description

A variety of protocols are in use for distribution automation (DA), including IEC 60870, IEC 61850, MODBUS, DNP3, and others. These higher layer protocols are carried over a physical communications network or networks. The set of applications and use cases that can use these protocols have differing requirements for the performance of the communication network. This project will investigate the capability of different communications network technologies to support the communications requirements of different applications used for DA.

Furthermore, many communications media are subject to temporary disruptions or performance degradation due to interference or signal quality issues. This project will also investigate the effect of these communications impairments on the higher layer protocols, including error recovery, and the ability of the applications and protocols to handle increased latency and delay.

Approach

Using the results of EPRI research and information gained across the industry, EPRI will develop a guidebook for the use of communication protocols, networks technologies, and the implications for advanced distribution automation (ADA). ADA communications systems are frequently based on field area networks, but there are exceptions. To quantify the specific scenarios, ADA use cases are examined in the contexts of the applications

themselves and the relevant communication protocols that are in use. From that understanding, the specific communications requirements for the set of use cases are established.

The types of communications systems available to meet those requirements, as well as their reliability and performance characteristics, are reviewed to determine their appropriateness for the applications and use cases. Since communications systems may be affected by storms, equipment problems, or interference (in the case of wireless), the effect of communication failures or network performance degradation on the protocols is also analyzed. Finally, the application of multi-path and redundant communication networks to improve the reliability and resilience of ADA systems is explored.

Impact

There are two intended audiences for this guidebook: first, the communication professional who seeks to learn more about the research being done in the field across the utility industry; second, the utility professional who seeks a beginner's understanding of the issues in utility communications in support of advanced distribution automation.

How to Apply Results

The guidebook is intended to serve as a resource for utility engineers evaluating or designing communications systems to support advanced distribution automation.

2014 Products

Product Title & Description	Planned Completion Date	Product Type
Guidebook for Advanced Distribution Automation Communications 1st Edition: A utility guide for implementing communications technologies for advanced distribution applications	12/31/14	Technical Report

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 (DER) 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.

Project Number	Project Title	Description
P161.032	Information and Communications Technology for Open, Interoperable Advanced Metering Systems	This project is supporting members in optimizing the utilization and value of their advanced metering systems and seeks to advance the state of the technology for these systems, including functionality, performance, and employment of open standards. Ancillary AMI uses, such as DER management and distribution controls, are also being evaluated. In addition, best practices for life-cycle management are being identified and tracked.

Project Number	Project Title	Description
P161.033	Information and Communications Technology for Demand Response Systems	This project is assessing communication architectures, technologies, and protocols to support members in the design, selection, and operation of demand response networks. These activities seek to accelerate the availability of open standards and interoperable systems with the aim of reducing utility costs and expanding program effectiveness.
P161.034	Information and Communications Technology for Customer-Sited Distributed Energy Resource Integration	This project is helping members to plan and prepare their information and communication systems for the integration customers with distributed energy resources such as solar photovoltaics, battery storage, and electric vehicles. Emerging standards are being evaluated and contributions made to standards organizations to improve industry readiness for DER.

P161.032 Information and Communications Technology for Open, Interoperable Advanced Metering Systems (105317)

Description

Many utilities are deploying or planning to deploy advanced metering infrastructure (AMI), creating two-way communication networks reaching customer premises. Although metering is a primary application of AMI, the systems are generally viewed as being multipurpose, possibly 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 networks is expanding. Future AMI systems will likely bear little resemblance to present systems.

An objective evaluation of these systems is needed to better understand the potential for different architectures to support the range of applications. Acceleration of standards development is also needed to improve the interoperability of systems, to foster competition by enabling multiple sources of supply, and to enable innovation in all aspects of the systems. This project is conducting research to advance the state of the technology for advanced metering systems, including functionality, performance, and employment of open standards. Ancillary uses, such as distributed energy resources (DER) management and distribution controls, are also being evaluated. Best practices for life-cycle management will be identified, tracked and reported.

Approach

This project will conduct research and 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 develop and maintain a roadmap for open, interoperable AMI, and provide technical leadership and coordination between utilities, standards development bodies, and industry organizations as the roadmap is implemented.

EPRI staff will work with participating members to perform technical evaluations and conduct testing of AMI architectures and protocols, and 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 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 contributing 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. In addition to the benefits to the industry as a whole, standards organizations (for example, IEEE, 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.

The sharing of lessons learned will help members develop their own processes and enable the compilation of best practices regarding system architecture, ancillary system uses, deployment, operations, upgradeability, and transition to next-generation systems. Members will benefit from the intermediate milestones in the overall roadmap toward interoperable AMI as products implementing the new standards become available.

2014 Products

Product Title & Description	Planned Completion Date	Product Type
Open Interoperable AMI: Implementation and Coordination: This Technical Update will be an installment in a series of ongoing updates on activities and milestones towards the implementation of the roadmap for Open, Interoperable AMI. It includes EPRI laboratory testing, updates on industry activities and events, as well as results from interoperability testing, and tests and trials of new AMI architectures and approaches.	12/31/14	Technical Update

P161.033 Information and Communications Technology for Demand Response Systems (105318)

Description

Advancements in semiconductor and communication technologies have made it possible for end-use devices and systems to be communication-connected and to have built-in demand responsive functionality. Increasingly, equipment with these advanced capabilities is becoming available for factories, small businesses, and even residential homes. Building on this availability, home and building automation systems are becoming more common, providing on-site coordination of loads and a single point of management for end users.

Open standards and interoperability are required to cost-effectively integrate these diverse products with utility demand response systems. Presently, a wide range of communication technologies and protocols are being used in this space, many of which are proprietary. Some end-use equipment makers are taking paths that block direct access to their equipment for demand response, employing proprietary technologies that avoid competition and inserting themselves as a required element in the communication path. Research is needed to identify technically viable and economically attractive networking options for compatibility with demand response systems. Candidate standards for demand response may be immature and not yet proven, and research is needed to evaluate and improve these standards.

Approach

This project is evaluating architectures, communication technologies, and protocols that are, or may be, used in demand response systems. The scope is comprehensive, including central office application integration, third-party aggregation, wide area communication networks (both public and private), in-premises connectivity, and metering for measurement and verification. These evaluations include laboratory testing of networking products and technologies, market assessments, and capturing lessons learned from field experiences.

Building on the evolving portfolio of utility use cases for demand response, this research will identify communication system requirements and map these requirements into candidate system architectures, technologies, and protocols to help members manage present systems and plan future changes.

Impact

This research aims to help members reduce cost and optimize the utilization of present and planned demand response systems by

- leveraging standards to architect open systems and avoid vendor lock-in,
- maximizing the overall capability and compatibility of systems,
- reducing the risk of premature obsolescence,
- improving system stability and reliability to reduce operational costs, and
- becoming aware of pitfalls discovered by other utilities.

Applicable results will be contributed to standards organizations so that future standards can be improved and industry needs met. Project activities and industry engagement will also provide equipment manufacturers with insight into the networking functional and performance requirements for compatibility with utility systems. This understanding is critical to the vision of a marketplace of end-use equipment that can economically and effectively perform demand response.

How to Apply Results

The results of this research aim to help members optimize the utilization of existing and planned investments in demand response systems, thereby expanding functionality, reducing maintenance, and extending usable service life.

2014 Products

Product Title & Description	Planned Completion Date	Product Type
Guidelines for Applying Open Standard Protocols in Demand Response Systems: This project will perform an analysis of the networking requirements for a variety of member demand response programs and interfaces. It will assess the extent to which these requirements are supported by standard communication protocols such as OpenADR, BACnet, SEP, and CEA-2045.	12/31/14	Technical Update

P161.034 Information and Communications Technology for Customer-Sited Distributed Energy Resource Integration (105319)

Description

In the future, customers will increasingly have some form of on-site distributed energy resources (DER). Improvements in solar photovoltaics, electric vehicles, fixed storage, and other technologies are adding to traditional forms of distributed generation and are reaching residential, commercial, and industrial customers.

These distributed resources have the potential to provide a range of consumer and grid-supportive benefits, many of which require communication connectedness. Success in making use of customer-sited DER depends on the ability to successfully establish and maintain functional communication links. This is particularly

challenging with DER because of the great diversity in types of resources, sizes, and brands, all of which must be cohesively integrated.

A range of communication architectures and technologies could be used for this purpose, but the requirements, in terms of latency, throughput and other factors, are largely unknown. Open protocol standards are needed, as well as proven communication techniques for successfully managing a mix of large and small systems. The communication technology must support standardized function sets, security, and addressability that will survive well into the future to provide a useful operational life.

Approach

This project will contribute to the development of DER-related protocols and standards. It will evaluate various communication systems and protocols in terms of their ability to perform the tasks required to support DER monitoring and management. The project activities will identify and address issues of importance to members including

- identifying architecture options and best practices for DER integration,
- identifying gaps and technical issues related to standards implementation,
- assessing the interoperability of products and communication systems,
- assessing the performance of various communication technologies for DER support, and
- compiling field experiences and lessons learned.

Impact

This research will simplify and accelerate the process of DER integration. It aims to reduce the overall complexity and cost of utility integration and preparedness for future integration of DER. The work products and demonstrations may help providers of communication systems (including AMI, SCADA, and customer networks) better understand the emerging requirements related to DER support.

How to Apply Results

This research aims to help members make system architectural and programmatic decisions regarding the integration of DER devices. Costs may be reduced by avoiding pitfalls identified by other utilities and by better understanding new communication system capabilities. Research results may be used by members to develop effective specifications for request-for-proposals (RFPs)and other system specifications.

2014 Products

Product Title & Description	Planned Completion Date	Product Type
Methods for Integrating Customer-Sited Distributed Energy Resource with Existing Utility Communication Systems: This Technical Update will identify effective methods for managing and monitoring DER using existing utility infrastructure. The opportunity for leveraging open standard protocols such as DNP3, SEP2, CEA-2045, and Modbus will be evaluated. Inverter and communication manufactures will be engaged in laboratory assessments.	12/31/14	Technical Update

Supplemental Projects

Field Area Network Demonstration Project (072080)

Background, Objectives, and New Learning

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-performance, 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™) 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 providing 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.

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, in addition to 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 and will include two options for participation: host sites and participants (non-host sites). Members that join the project as host sites will receive direct support from EPRI in the planning and analysis of their FAN communications demonstrations. Participants will receive the non-proprietary results from the host siite projects along with methods, tools, guidebook results, and joint participation in face-to-face meetings, vendor forums, and interoperability plugfests.

EPRI plans to help host site 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 to disseminate information, experience, and results. EPRI plans to hold meetings at host sites to gain hands-on experience in high-reliability FAN design, implementation, and operation. In addition, EPRI plans 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 collaborated with 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

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. A high-performance, high-reliability communications network enables utilities to restore service quickly, even in the case of infrastructure damage.

Utilities may benefit by collaborating with others, thereby gaining knowledge and experience with a wide variety of approaches to high-reliability FAN design. Utilities and the public 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 FAN planning and deployment process, benefiting the utility and the public.

Field Force Data Visualization (072446)

Background, Objectives, and New Learning

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 that use this interconnected data to help engineers better understand the network and the context of any unexpected behavior. To demonstrate the power of data integration and modern human-computer interfaces, this project proposes to use emerging technologies from the mobile computing field to create a mobile integrated data access platform.

A key use case is to allow engineers or technicians in the field to identify all relevant data for the network at their current location. Using this interface, they could navigate through all the data displayed for a transformer or switching device, identify its location in the GIS, then be shown the downstream 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 could 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

- 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; and
- 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 Application Program Interfaces (APIs) 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 members' 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.