EPRI | ELECTRIC POWER RESEARCH INSTITUTE

IntelliGrid Newsletter

About the Newsletter

The IntelliGrid Program conducts research, development and demonstrations on the information and communications technologies that enable Smart Grid applications. Research areas include interoperability, communications, data management and Smart Grid implementation. The program provides results that can meet the near-term needs of our members and make contributions that will advance the industry towards an interoperable, integrated Smart Grid.

This newsletter provides results from on-going and recently completed projects, status reports on current projects, plans for future projects and information on relevant industry activities.

Save the date

IntelliGrid Advisory Meeting, July 16-18 in Knoxville, Tn. The meeting will include demonstrations of IntelliGrid projects, a tour of EPRI's laboratory, utility presentations on implementation of IntelliGrid results, status updates on current project, and more.

INFRASTRUCTURE AND TECHNOLOGY FOR CUSTOMER INTEGRATION

EPA ENERGYSTAR "Connected" Update

The Environmental Protection Agency (EPA) is in the process of developing new ENERGYSTAR criteria for residential products. Part of these new criteria introduces a "connected" option, which provides a reduction in energy efficiency requirements for products that can be communication-connected with the grid. The EPA is working to define these new criteria one device type at a time; however, they have expressed the intention to replicate the communication elements of the documents (the "connected" criteria) across all types. The EPRI IntelliGrid and Energy Utilization programs have been monitoring and providing technical comments into this process, with the objective of making sure that the options supported in the standard provide openness and flexibility for interfacing with the full range of utility demand response and energy management programs.

Important aspects of the feedback that EPRI provided included:

1. That the communication interface to the end-device should be based on open standards.

2. That it should be possible to communicate to end-devices with or without a separate Energy Management Console or "hub" device in the home.

3. That an open standard communication interface (such as the CEA-2045) ought to be an allowed option for manufacturers to choose from.

The EPA incorporated many of these principles into their latest draft documents, but then received pushback from the Association of Home Appliance Manufacturers (AHAM) who prefer that every home must have a hub, and that only they can provide the downstream communication to the appliances (i.e. the hub function cannot be provided by some other company or incorporated into some existing device).

In response to this, EPRI was asked to facilitate a discussion between utilities and the EPA by inviting representatives from the utility industry to come to Washington, D.C. to meet with the EPA and discuss the industry's needs face-to-face. This meeting occurred on Friday, April 27th. A follow-up meeting has also been scheduled, to meet with EPA and representatives from AHAM, on Friday, May 11th.

EPRI views this as very high priority issue. It determines the nature of products that will soon appear in customer homes; whether or not utilities are asking for them, providing incentives, or approving of their characteristics. The technical details in these EnergyStar specifications will determine to a great extent the cost and difficulty to integrate these devices with the grid at a future time. EPRI staff will continue to stay involved in this process and will report-out on key issues and milestones. Our contributions will remain technical in nature, and will reflect the mutual needs of the diverse utility membership. This issue appears to be one that will benefit greatly from direct utility participation, and members are encouraged to become involved

For more information, please contact Brian Seal at (865) 218-8181 or bseal@epri.com.

EPRI Green PHY Evaluation Kit

At the beginning of 2012, EPRI began looking at finding a quick and simple method of evaluating the capabilities of a new technology for home area networking (HAN) called Green PHY. According to the HomePlug Powerline Alliance, Green PHY targets smart grid / smart energy applications with an estimated cost 75% lower than HomePlug AV, 75% less power consumption combined with IPv6 support and a minimum of 1 Mbps effective data rate.

EPRI is interested in examining Green PHY to evaluate its capability to communicate over greater distances than Wi-Fi or ZigBee. If successful, this could be utilized for communication in a variety of challenging environments, such as from a meter in the back of a big box store to a vehicle charging station at the front of a parking lot, or from a meter in the basement of an apartment building to devices in the upper floor units. To aid in this evaluation, EPRI developed a toolkit that makes it convenient for utilities. The toolkit may be used to support field testing at the application layer in a range of real world environments.

EPRI gained limited access to firmware to re-flash off-the-shelf NETGEAR Powerline AV 200 modules to convert them to Green PHY operation. Two additional modules were created using a single board computer, one to send UDP Ethernet packets and one to receive
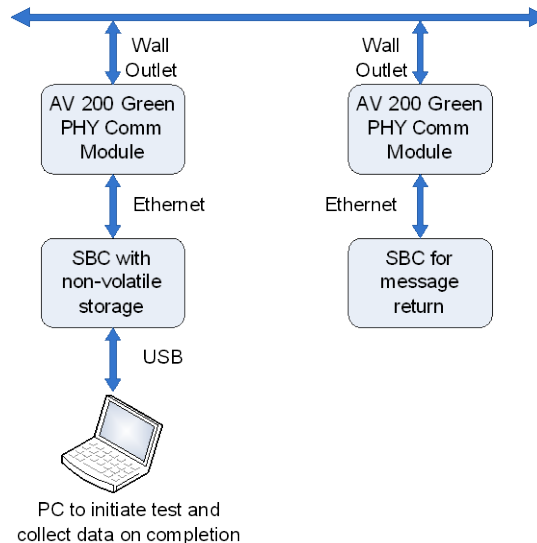
and return the packets back to the sender. The message generation unit collects and records the data on the number of messages sent, the number of messages successfully received and time required for each message to perform the loop. The equipment arrangement is shown below:

Green PHY evaluation kits pictured to the right have been provided to six utilities so far with two returning initial test results. To establish a base line, the two SBC modules were connected to the same switch and the test protocol was executed. Over 97% of the messages were handled within 1 millisecond with the remaining messages handled within 2 ms. The Green PHY modules were added, both connected into the same outlet. The test was again executed with similar results, 85% of the messages were handled within 5 ms, 99% were handled within 6 ms and the remaining 1% taking up to 18 ms to complete.

This test is only reflective of the application layer and does not tell the whole story. Without information on the number of retries and other lower layer metrics, the connection could be on the verge of passing no data with little indication. EPRI would like to extend this investigation if members are interested in doing so.

Please contact Gary Aumaugher at gaumaugher@epri.com or (865) 218-8047 for additional information.

Search for Secure, Cost-Effective Sub-Metering

The emergence of solar photovoltaic systems and plug-in electric vehicles is heightening utility interest in a secure and yet cost-effective approach to sub metering. The need to sub-meter certain loads downstream of the utility meter is not new, and has been done for many years for things like water heating or other end-uses for which a utility may want to offer a separate incentive or rate. Solar photovoltaic systems could bring the additional sub-metering interest of tracking for renewable energy credits, and electric vehicles could bring an interest for tax purposes.

EPRI's IntelliGrid Program, in coordination with the Renewables Integration Program, are performing a scoping study to address this question. The study has been designed to engage stakeholders from the utility, metering, solar, and electric transportation industries so that the findings are broadly informed. The study is one of scoping – working to categorically identify the full range of options, and to capture the advantages (capabilities) and disadvantages (limitations) of each. The end goal is to identify those approaches that are most viable so that future research might investigate each more thoroughly.

On May 1st, the first workshop for this initiative was held at the CS Week conference in Dallas, Texas. This conference draws the metering and AMI industries. The workshop was a great success, with a solid list of options and architectures identified, and pros/cons for each. IntelliGrid members are invited to attend the second workshop on this topic, scheduled for Wednesday, July 11th, at the Intersolar conference in San Francisco, CA. A formal invitation will be sent prior to the event. This workshop will naturally include the makers of solar inverters and systems, and utilities and makers of electric vehicles and charging equipment will also be invited.

The findings of these workshops will form the basis for the report later in the year, and an interim update will be provided by webcast.

For more information, please contact Brian Seal at (865) 218-8181 or bseal@epri.com.

Automated Demand Response and Ancillary Service Demonstration Project

The EPRI Automated Demand Response and Ancillary Services 3-Year Demonstration had its kickoff meeting on April 3rd and 4th at the EPRI office in Knoxville, TN. 15 utilities and ISO's represented in attendance. The meeting was held in conjunction with the OpenADR Alliance interoperability testing. A valuable joint-session with the OpenADR Alliance provided visibility into the development of certified "Clients" and "Servers" that vendors are producing. It is encouraging to see a large number of vendors developing Demand Response devices that can work in any utility or ISO service territory that adopts the standard. The meeting began with a project overview by EPRI and a review of the OpenADR standard and technology by Rish Ghatikar of the Lawrence Berkeley National Laboratory and Rolf Bienert and Barry Haaser of the OpenADR Alliance. The meeting participants provided their perspectives on automated demand response (AutoDR) during a round table session. Important points and questions were brought up by the participants. Including:

- Recognizing the importance of a common approach in developing a standardized ecosphere for Automated Demand Response that OpenADR is enabling.

- Utilities and ISOs may find other uses for a Demand Response Automation Server (DRAS) for which migration and system strategies will be required.

- Pricing, emergencies, and capacity are reasons to use DR. However, with the integration of intermittent resources such as solar, there will be other roles for DR.

- There is a need for OpenADR to work with legacy systems and stranded assets such as the paging network which is going away in California.

- There is also a need to consider making OpenADR compatible with Energy Management Systems (EMS) and Demand Management Systems (DMS) to balance reactive power.

- OpenADR has capabilities for measurement and verification (M&V) with "Feedback" but research questions exist on how reliable that information will be if it is not directly from a utility meter.

- The OpenADR Alliance is including the security of the message between the client and the server in their scope.

The second day of the meeting began with a presentation and demonstration of the EPRI Open Source OpenADR server by Chuck Thomas of EPRI. EPRI will be supporting the deployment and use of the Open Source Server and Client for all members of the demonstration to perform basic testing within their service territory even if they are not a host-site.

This demonstration project will have utility "Host-Sites" where EPRI will support research at real-world installations that are deploying certified OpenADR v2.0 servers and clients. There are 5 basic requirements for a host-site to ensure projects will answer research questions that will benefit the project funders and the industry.

For more information, please contact Ingrid Bran, ibran@epri.com or at (650) 855-1064 or download the Project Information at: http://my.epri.com/portal/server.pt?Abstract_id=000000000001023317

COORDINATION, ANALYSIS AND IMPLEMENTATION

Enterprise Architecture: A methodology for aligning IT and OT

Consider a situation where an organization decides to invest in Distribution Energy Resources (DER). One place to start would be the EPRI reports *Architecture Reference Design for Distributed Energy Resource Integration* or *Smart Grid Reference Guide to Integration of Distributed Energy Resources,* but this only gets the reader so far. The report should be considered in the context of the

organization. Smart grid assets have become smarter and smarter and now use more technologies that were once the domain of the back-office and supported by IT. For example, DER may be managed by some sort of system, but it also exchanges information with other back-office systems using various standards or proprietary-based means. The systems integration may be the domain of IT, while the operation of DER the domain of the OT people. As devices become smarter and require more IT-based support there is a growing need for convergence of IT and OT.

The challenges of convergence are as much cultural as they are technical. However, an enterprise architecture practice can help deal with the issues of IT and OT convergence while also ensuring that smart grid efforts stay aligned with business strategy. In our DER example both IT and OT need to be included in determining what the requirements are, and which systems and standards might be used.

Enterprise architecture is an iterative methodology for developing architecture. A common analogy is that it is "city planning for IT". However, this is somewhat of a misnomer because the methodology considers organizational vision and business architecture, as well as application, data, and technology architecture one would expect in IT. Enterprise architecture uses a framework to guide the architecture development. There are several frameworks available such as the Zachman, The Open Group Architecture Framework (TOGAF), and frameworks in use by the U.S. government, including Department of Defense and Federal Enterprise Architecture Framework.

EPRI is leading a Smart Grid Enterprise Architecture Interest Group that will focus on building a repository of smart grid related artifacts that utilities can reuse. This effort will utilize TOGAF and contain artifacts such as data models from the IEC Common Information Model (CIM) and MultiSpeak®, use cases, guiding principles, and references to the NIST catalog of standards. This interest group will have contributions by leading enterprise architects in the utility industry and there is no cost to participate.

For more information please contact Dr. Gerald R. Gray at (865) 218-8113 or ggray@epri.com.

White Paper Highlights EPRI's Coordinated Research for Field Data Integration for Asset Management and Grid Operations.

More data, received faster and from more types of field equipment and sensors promise to improve power delivery asset management and grid operations. The cost to communicate and process data continues to drop, but as the volume of information available grows, the processes related to acquiring, securing, transporting, storing, analyzing, accessing and visualizing the data increase in complexity. How can we make the "heap" of data becoming available useful to utilities? Understanding the capabilities of the technology, and developing processes and tools that make the data from these new technologies useable by grid operators and asset management personnel requires coordinated research across several technical domains.

EPRI's response to this challenge has been to develop numerous coordinated or cross-cutting research activities that foster the integration and synthesis that needs to take place as advanced technology is applied. EPRI's technical staff has developed a white paper (*1025000 Field Data Integration for Asset Management and Grid Operations: A Paper on EPRI's Coordinated Research*) that documents the range of these research, development and demonstration projects so that industry advisors can understand the opportunities presented by the range of programs in the EPRI portfolio.
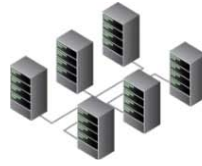
The white paper reviews research that covers the key technical domains related to field data integration for asset management and grid operations. These are sensing technologies, standards, communications, security, integration, algorithms, and visualization tools for asset staff and grid operators. (See figure below)

| Sensing Technologies | Information and Communications Technologies | Algorithms | Visualization & Tools for Asset Staff & Operators |

To date, EPRI results have included development of asset sensors, methods for sensor data collection, development of analytics and algorithms, approaches for sensor data integration, visualization and alarming, and demonstrations at EPRI member sites.

Background and details on the research being conducted is presented according to each critical technical domain, including a list of 2012 EPRI research activities.

The paper "Field Data Integration for Asset Management and Grid Operations: A Paper on EPRI's Coordinated Research" (1025000) can be downloaded from EPRI's website at http://my.epri.com/portal/server.pt?Abstract_id=000000000001025000

For more information, please contact Matt Wakefield at (865) 218-8087 or mwakefield@epri.com.

Industry Groups Tour EPRI Labs

On February 28, EPRI played host to fifty visitors from the OpenSG organiation that was meeting in Knoxville that week. OpenSG members toured EPRI's Knoxville laboratory, including the newley opened End-to-End Interoperability Lab followed by a barbeque dinner.

The OpenSG members saw demonstrations of EPRI research in energy efficiency, electric vehicles and lighting. In the interoperability lab various aspects of the Smart Grid were demonstrated in the transmission, distribution, and end use.

On March 21, the attendees of the Smart Grid Interoperability Panel meeting in Charlotte, North Carolina were given a tour of EPRI's lab in Charlotte. At the lab, they were given demonstration of novel techniques for identifying transmission insulators with cracks, non-destructive analysis of cracks in stainless steel pipes and experiments to characterize the effects of heating on transmission lines.
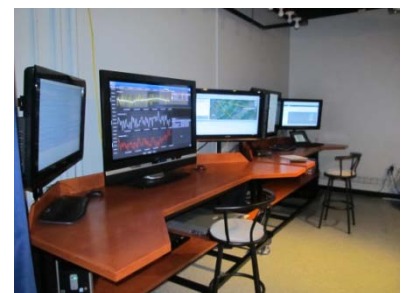
Integrated Network Model Management

Transmission engineers spending time manually updating network model databases instead of doing system engineering? Energy Management System model out of synch with study application models? No historic network model to match historic real-time data for post-event analysis? These are common problems facing Transmission operations and planning groups in utilities and regional reliability entities around the world. A new IntelliGrid supplemental project will address these issues as it analyzes the requirements and develops solution strategies for integrated transmission power system network model management.

This project will investigate the network model data needs of common transmission system applications and propose new approaches to coordinated transmission network model maintenance. It will evaluate the applicability of the common information model (CIM) as a semantic model and explore the business processes involved in the maintenance of shared network model information.

Each participant in this project will have the opportunity to develop an in-depth understanding of network model management issues and potential solution approaches based on its own requirements and those of other participating utilities. Implementing the integrated network model management strategy outlined by the results of the project could allow a utility to:

- Reduce network model maintenance labor

- Improve both the accuracy of individual application network model databases and the timeliness of their updates

- Better support the future and historic network model needs of study applications, including those used for post-event analysis

- Allow the addition, upgrade or replacement of planning or operation applications with reduced effort

- Improve its ability to comply with NERC requirements related to maintenance of updated models and inclusion of protection considerations in planning and operations

- Be better positioned for future exchange of network model information with its ISO or for data sharing with asset management or distribution system applications

For more information on this project, please contact Pat Brown at (913) 449-0736 or pbrown@epri.com.

Standards-based Data Integration

Capitalizing on the power of networking is one of the strengths of the internet. Leveraging this capability within your utility typically is problematic due to the design of legacy systems that tended to operate in organizational silos. However, today's workforce is much more adept to the benefits of collaboration or crowd sourcing. So how does a utility break down the barriers without breaking the bank. One approach is to develop a standards based approach to data integration. Some key standards that may support this approach are the object models defined within the Common Information Model (IEC61968 & 61970) and also IEC 61850. These standards encompass a wide array of object models suitable for a phased migration from legacy systems to an integrated information model. Recently EPRI has developed a

standards based information system pilot for transformers that served as the foundation for highly integrated set information displays for transformer performance. This information was made available to both desktop and tablet devices.   In this particular case information was integrated from 9 different systems that included transactional, geospatial and temporal data. The technology literally enables not only office staff but also field personnel near real-time access to asset performance and historical data on their tablet devices.

EPRI is continuing this work in 2013 under the supplemental project "Using Standards to Disperse Field Data across the Enterprise" that is currently still open to additional utility participation.

For more information on this project, please contact Paul Myrda at (708) 479-5543 or pmyrda@epri.com.

INFRASTRUCTURE FOR INITELLIGENT DISTRIBUTION SYSTEMS

EPRI Forms Geospatial Information System (GIS) Interest Group

EPRI has formed a GIS Interest Group to promote technology transfer amongst GIS professionals at utilities. The group holds monthly webcasts to discuss issues with GIS data quality. The group has met twice so far. At the first meeting, Tom Short gave talk on the use of AMI to determine which phase of a distribution feeder a meter is on. The technique can also be used to detect overloaded transformers and identify "lost" load, which may be a result of theft. The recorded webcast can be found here: GIS Interest Group Kickoff Meeting. At the second meeting, a presentation was given on likely sources of errors in GIS data. That webcast can be found here: GIS Interest Group Meeting, April 19.

Another aspect of the interest group is to participate in an EPRI study to monetize the cost of incorrect or missing GIS data. The members of the interest group were asked to complete a survey (EPRI GIS Data Quality Survey) to begin the process. The results of this survey will be analyzed and a second survey will be distributed to quantify the impact of GIS data quality.

For more information on the GIS Interest Group, please contact John Simmins at *865) 218-8110 or jsimmins@epri.com.

Common Information Model (CIM) Primer's Popularity Grows

The CIM Primer, which was published last year has become the de facto text book for CIM training with organizations such as the CIM User's Group. The Primer explains the basics of the CIM (IEC 61970, IEC 61968, and IEC 62325). Starting with a historical perspective, it describes how the CIM originated and grew through the years. The functions of various working groups of Technical Committee 57 of the International Electrotechnical Commission (IEC) are described. The process of how an IEC standard is created is also outlined.

The basics of the Unified Modeling Language (UML) are detailed to introduce the reader to the language of the CIM. Then, building on commonly understood objects (basic shapes), the concepts that underline the CIM are carefully built step by step. The reader is then transported into the world of power systems where the concepts that were developed previously are applied to the complexities of the electric grid.

For more information, please contact John Simmins at *865) 218-8110 or jsimmins@epri.com.

Key Dates

NISTAC Webcast (60 minutes)	*May 31, 2012 (1 pm eastern)*
NISTAC Webcast (60 minutes)	*June 20, 2012 (1 pm eastern)*
IntelliGrid Summer Advisory Meeting (Knoxville)	*July 16-18, 2012*
NISTAC Webcast (60 minutes)	*July 25, 2012 (1 pm eastern)*
Project Set C (161C) (60 minutes)	*July 26, 2012 (11 am eastern)*
Project Set D Webcast (161D) (60 minutes)	*July 27, 2012 (11 am eastern)*
Smart Grid Roadmap Workshop (Palo Alto)	*August 7-8, 2012*
NISTAC Webcast (60 minutes)	*August 15, 2012 (1 pm eastern)*
Project Set A (161A) (60 minutes)	*August 23, 2012 (11 am eastern)*
NISTAC Webcast (60 minutes)	*September 13, 2012 (1 pm eastern)*
IntelliGrid Advisory Meeting (Atlanta)	*September 17-19, 2012*
NISTAC Webcast (60 minutes)	*October 11, 2012 (1 pm eastern)*
NISTAC Webcast (60 minutes)	*November 8, 2012 (1 pm eastern)*
Project Set B Webcast (161B) (60 minutes)	*December 4, 2012 (11 am eastern)*
NISTAC Webcast (60 minutes)	*December 5, 2012 (1 pm eastern)*
Project Set A (161A) (60 minutes)	*December 6, 2012 (11 am eastern)*
Project Set D Webcast (161D) (60 minutes)	*December 19, 2012 (11 am eastern)*
Project Set C (161C) (60 minutes)	*December 21, 2012 (11 am eastern)*

Please contact Ashley Eldredge for details regarding the key dates, aeldredge@epri.com.

Recently Released Deliverables

EPRI IntelliGrid Program Annual Review

1024708

The IntelliGrid program provides strategic and innovative research applying standards, communication technology, and advanced system integration to enable advanced Smart Grid applications for operational improvements with a strong emphasis on Informational and Operational Technology (IT & OT) Convergence.

Common Information Model (CIM) Users Group Fall 2011 Meeting Summary

1024596

For the first time, the Common Information Model Users Group (CIMug) meeting was held jointly with the other Utility Common Architecture International (UCAI) user groups (61850 Users Group, OpenSG Users Group, and UCAI Testing Committee). Combined attendance exceeded 200, with representation from 28 utilities, 26 vendors, 21 consulting companies, 3 universities, 14 research or standards groups, and 3 government or regulatory agencies. CIMug attendees heard CIM success stories from utilities around the world, learned about Enterprise Integration Strategies and Enterprise Information Management, and received updates on current CIM standards and testing work. Highlights from the combined opening and closing plenary sessions and from the three days of CIMug meetings are covered by this summary.

Universal Semantic Standard Test Harness v1.0

1023648

The EPRI interoperability test harness provides a novel platform through which vendors may easily evaluate communication interoperability between systems. The harness consists of a set of web service interfaces and corresponding database tracking/reporting.
This is a web application so most modern browsers are supported on any Windows™ platform. IE8 and later, FireFox 4 and later, Chrome v8 and later, Safari 5 and later. Windows™ XP sp2, 7, and Vista are all supported. **Link to Universal Semantic Standard Test Harness Version 1.0 website.**

Automated Demand Response Today

1025008

Demand response (DR) has progressed over recent years beyond manual and semi-automated DR to include growing implementation and experience with fully automated demand response (AutoDR). AutoDR has been shown to be of great value over manual and semi-automated DR because it reduces the need for human interactions and decisions, and it increases the speed and reliability of the response.

AutoDR, in turn, has evolved into the specification known as OpenADR v1.0 (California Energy Commission, PIER Program, CEC-500-2009-063 and LBNL-1779E) and the specification under development and imminent release at the time of publication of this paper, known as OpenADR v2.0. OpenADR is a subset of the Energy Interoperation Standard within the Organization for the Advancement of Structured Information Standards. OpenADR v2.0 presents the opportunity for the market to develop low-cost products that can be securely connected over existing communication infrastructures.

This white paper provides a review of DR, an examination of the accumulated experience with AutoDR, and an assessment of the current state of OpenADR. It also includes information on existing experience with bidding DR resources in the market for ancillary services.

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