EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Information and Communication Technology

Annual Program Review

January 2020

Contents

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Electric Power Research Institute

3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA

800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com

Matt Wakefield
Director,Information, Communication Technology and Cyber Security (ICCS)
942 Corridor Park Blvd
Knoxville, TN 37932
email: mwakefield@epri.com

The ICT program provides information and tools that are designed to provide members with immediate value while it conducts longer-term R&D to help guide the industry toward a highly connected, interoperable future.

Utilities are deploying communications, computing, and information technologies to enable grid modernization applications, such as wide area monitoring and control, asset management, distribution automation, integration of distributed energy resources (DER), and demand response. Companies face significant challenges when deploying these technologies, including:

- Selecting the technologies that best meet current and future business needs 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
- Managing the tremendous amount of data generated
- Creating pervasive, resilient communications networks that can enable multiple applications

Research focus areas are: Interoperability, Telecommunications, Enterprise and Grid Architecture, Advanced Metering, Utility Systems Integration of Intelligent Edge Devices Consumer Internet of Things (IoT), Data Management and Geospatial Informatics Research and Development.

Near term Research Value

- IT departments may reduce the time and cost of integration and management from guides that provide best practices for enterprise architecture, systems integration, and substation and AMI data management.
- Telecommunications departments may reduce cost and the risk of early obsolescence of equipment by applying best practices for network operation, maintenance, and management, and tools for effectively planning and designing multi-technology communication networks.
- Metering departments that plan to implement advanced metering systems may receive value when developing their procurement from the industry AMI database and resource center. They may also reduce cost and risk by using the Wi-SUN reference meter tool. Companies that have already deployed AMI systems may reduce operation and maintenance costs by applying the information from the program's suite of best practice guides.

Long Term Research Value

Members can benefit from R&D and industry leadership to advance interoperability standards for advanced metering systems, DER, demand response, and enterprise system integration. This could reduce capital and integration costs and reduce the risk of vendor lock-in.

The purpose of this program review is to help members stay informed of our research activities, quickly review research highlights from the year, and identify valuable results to apply at their utility.

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Approach

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

- **Tracking and Analysis**
  Builds on ICT staff involvement in standards development and industry activities to provide insight and analysis of items in the technology development pipeline.

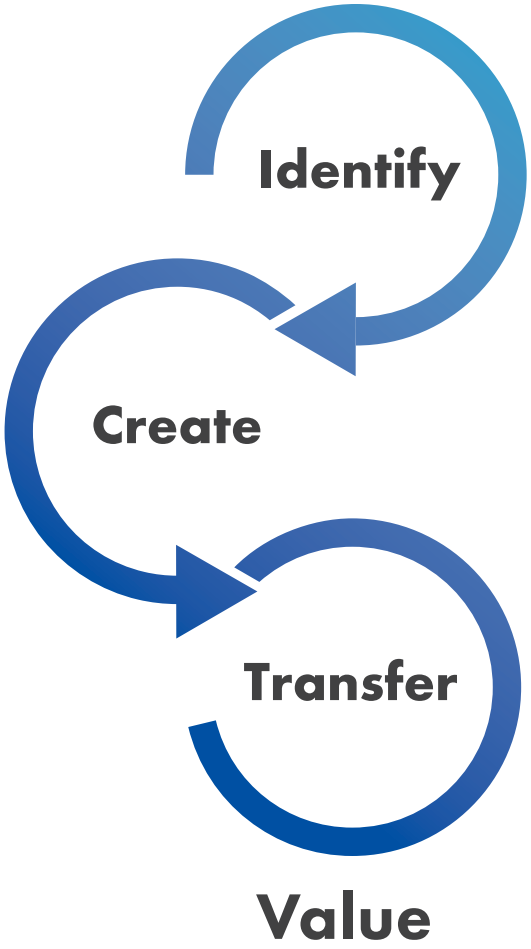
- **Requirements Development**
  The program defines the functional and non-functional requirements for advanced applications such as the coordinated control of groups of DER devices and the next generation of advanced metering systems. This typically requires the gathering of a significant group of diverse stakeholders to develop and analyze use cases

- **Advancing Standards Development, Certification and Adoption**
  The ICT staff leads or participates in many industry standards development activities, often accelerating standards development through technical contribution. Staff participate in industry alliances and user groups that are working to develop interoperability profiles and certification test scripts. The program has developed a list of open-source references
  to help vendors implement emerging standards.

- **Technology Evaluation, Laboratory Testing and Field Demonstrations**
  The program conducts work in EPRI laboratories where staff take part in assessment of emerging standards, equipment, and communications architectures. The program also performs field demonstrations of emerging standards and technologies in coordination with utilities.

- **Industry Case Studies, Best Practices and Guidebook Development**
  The program documents utility experiences as they implement early-generation technologies and applications. Experiences are captured through utility immersions, interviews, and case studies. The program also develops go-to reference books to help utilities plan for, design, deploy, and maintain new technologies or applications.

- **Technology Transfer**
  The program uses a variety of approaches to share research results, including technical reports, white papers, newsletters, webcasts, and workshops.



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2019 Accomplishments and Look Ahead to 2020

This project set 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.

Project Set 161A: Emerging Technologies and Technology Transfer

Don Von Dollen
Senior Program Manager
email: dvondoll@epri.com

Project Number and Name	2019 ACCOMPLISHMENTS	2020 PLAN
161.033: **Smart Grid Standards Tracking and Analysis**	**3002016415** - Summary of Interoperability Tracking and Reporting 2019 Summary – Includes presentations on: Network Model Management, EPRI OpenDRMS Platform, DLMS/COSEM, DER Standards Update, Telecom Standards Update, CIM Update, IEC 61850 Interoperability Test.	Standards tracking and analysis - provides up-to-date information on key standards development activities and an analysis on the impact that these activities can have on electric utilities. Results will be presented through monthly webcasts that will focus on a specific standard, technology, or application and provide members with a forum for exchanging concerns and ideas with their peers.
161.035: **White Papers on Emerging Information and Communication Technology**	White Papers – White papers on urgent topics associated with smart grid implementations with advisor input on topics - 5G Technology Roadmap for the Utility FAN **3002016411,** The Business Case for Telecommunications **3002016412**, Deploying Advanced Metering Infrastructure **3002016413,** The Business Case for Telecommunications: What Are Examples of Utilities Taking a Proactive Approach to Invest with a Positive Business Case **3002016412**	White Papers - Two or three papers that investigate emerging ICT related issues and technologies that may impact utility investments. White paper topics will be identified in coordination with advisors in early 2020.

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2019 Accomplishments and Look Ahead to 2020

Project Set 161A: Emerging Technologies and Technology Transfer

Project Number and Name	**2019 ACCOMPLISHMENTS**	**2020 PLAN**
161.058**: Technology Transfer for the ICT Program**	ICT Program Newsletter - provides brief articles on program activities and research project results. Tech Transfer Webcasts - Each webcast will focus on the results from a specific project. ICT 2019 Annual Program Review **3002017844** - provides a summary of the research results produced by the ICT program, and success stories on how members have used and benefited from ICT program results. Videos – brief summaries of key research results	Continuation of ICT Program Newsletters, Tech Transfer Webcasts, Annual Program Review and Video R&D highlights.

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2019 Accomplishments and Look Ahead to 2020

The goal of this project set is to identify and mitigate barriers in the communications, control, and monitoring of smart solar, storage, and loads, to enable a cross-functional, integrated architecture capable of meeting demands of the modern grid.

Project Set 161D: Applied ICT for Distribution Energy Resources and Demand Response

Don Von Dollen
Senior Program Manager
email: dvondoll@epri.com
Interim 2020 Project Set Lead

Project Number and Name	**2019 ACCOMPLISHMENTS**	**2020 PLAN**
P161.049: **Enabling Open, Interoperable DER – Standards, Testability, and Pairing to DER/DR Abilities**	**3002016139** 2019 PS161D Webcast Summary. **3002016335** Enhancing Grid Resiliency Through Improving Capabilities to Manage Communicating Energy Storage and Solar Systems. **3002016144** Test Procedure for Validating DNP Application Note AN2018-001 in Distributed Energy Resources. **3002015355** Open Source DER Outstation for DNP Application Note AN2018-001: Reference Implementation of DNP Application Note AN2018-001. **3002016138** EPRI DER/DR Integration Toolkit.	Informational Webcasts Summary shares progress and key lessons learned on activities outside of the program about Government, Technology Innovation, Standards Activities, Working Groups. EPRI DER/DR Integration Toolkit 2020 Update: this ongoing deliverable is a compilation of test tools designed to support the development and testability of control systems, including DERMS and DRMS systems and devices (solar, storage, and demand response technologies). The team will update the summary report each year to reflect the latest capabilities of the tools.
P161.050: **Evaluating Communication Interfaces and the State of the Art for DER**	**3002016140** Protocol Reference Guidebook – 3rd Edition **3002016141, 3002016099, 3002016142** reports are State-of-the-Art Guidebooks for Interoperability for Demand Response, DER, and DERMS and Industry Evaluation.	Protocol Reference Guidebook – 4th Edition provides a 1:1 comparisons of specific aspects of the protocol, including where a protocol fits into the greater communication architecture and the types of DER/DR it currently supports. Evaluating the State of Functional and Communications Interoperability in Inverter-based DER/DR

2019 Accomplishments and Look Ahead to 2020

Project Set 161D: Applied ICT for Distribution Energy Resources and Demand Response

Project Number and Name	**2019 ACCOMPLISHMENTS**	**2020 PLAN**
P161.051: **Utility Case Studies in DER Architecture – Experiences, Best Practices, and Barriers**	**3002017103** Business Justifications for Communications to DER. Key drivers include operations and system efficiency that identify the need to embrace DER. This includes a decreasing lower threshold for communications. It is becoming more cost-effective to communicate with smaller DER.	Utility Case Studies: An Ongoing Study of Successes and Barriers in Utility Deployments of Communicating DER/DR .
P161.052: **DER and DR Management Systems – ICT Systems for Aggregation Monitoring and Management (2020 title)**	**3002016143** Communications Architecture Requirements for Near-Term Smart Inverter Use Cases: Study of the Communications Requirements for Utilities to Realize the Benefits from Grid-Ready Smart Inverters.	Communication Architecture Requirements for Smart Inverter Use Cases—Phase Two - collaborative research between PS161D; PS161G, Telecommunications; and PS174B, Smart Inverters and Grid Supportive Devices.

Supporting the Next Generation of DER Interoperability Standards

A key component of grid modernization is leveraging distributed resources to address consumer and/or power grid constraints and needs. The breadth of devices, makes, and models and communications diversity from vendor solutions makes this inherently difficult because of the vast number of combinations of possible integration needs, which leads to inefficiency and high costs. To address this, the industry has spent considerable efforts to develop communications standards to allow power grid and customer systems to interoperate and interconnect with utility management systems. EPRI has made an impact to these efforts by providing research context that is important for embracing utility-focused use-cases and delivering the key lessons learned from pilots, demonstrations, and other studies to scale adoption.

EPRI's Information and Communication Technology (ICT) program has specifically contributed and/or lead the initial development and subsequent updates to communication standards including IEEE 1815 (DNP), IEEE 2030.5 (Smart Energy Profile 2.0), IEC-619850, SunSpec Modbus, IEC 62746-10-1:2018 or Energy Interoperation 1.0 (OpenADR 2.0), and CTA-2045 standards. In addition to contributing to the standards ability to exchanges bits and bytes, they also provide utility-specific context to ensure the information communicated over these standards meets the requirements for utility use-cases today and tomorrow. EPRI has also contributed to development of new "connected criteria" standards – a term coined by the Department of Energy's Energy Star program – which pull together requirements and

Interim 2020 Project Set Lead:
Don Von Dollen
email: dvondoll@epri.com

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standards around information exchange, location of an interface (cloud versus on-premise), context and use-case specific requirements, and the intent of the information to achieve end-to-end interoperability. EPRI has contributed to efforts including Northwest Energy Efficiency Alliance, Consortium of Energy Efficiency, Air-Conditioning, Heating, & Refrigeration Institute, Environmental Protection Agency's ENERGY STAR® Program, Washington State, IEEE Std. 1547-2018, California Rule 21, and others currently in development.

Duke Energy Experience

Duke Energy aims to achieve net-zero carbon emissions by 2050[1]. As Duke Energy rolls out their roadmap to support this goal, it is clear that solar, wind, energy storage, electric vehicles, and other technologies are a key component of achieving this goal. In addition, grid-modernization is needed to support resiliency, increased penetration of renewables, outage mitigation, and customer choice and control. At the heart of many of these applications is a communication and control infrastructure to facilitate their broad DER fleet.

EPRI is supporting Duke Energy in a few ways. Duke Energy is involved in EPRI's CTA-2045 demonstration projects[2]. A key goal in this project has been to develop, demonstrate, improve, and support the CTA-2045 standard through the development of test tools to support member utilities and their vendors. Duke Energy is also involved in EPRI's DER Communication Standards and Protocols Harmonization Project[3]. The goal of this project is to understand utility DER roadmaps and host a working group to develop a harmonization plan to help utility members, standards organizations, industry members, regulatory agencies, and others to work together to realize their collective end-goals.

"EPRI was instrumental in the success of Duke Energy's CTA-2045 demonstration project. EPRI worked with the participating utility members of the CTA-2045 collaborative to develop functional specifications, which map the CTA-2045 commands to the functionality of individual appliances to achieve customer-focused demand response. EPRI also assisted in the collaboration between the utilities, communication module manufacturers and appliance manufacturers, including developing tools for testing the communications between the devices. The contributions by EPRI helped Duke Energy identify and solve many issues during the lab testing phase of our demonstration. This enabled our successful field testing of CTA-2045 technology in load switches, thermostats, water heaters, mini-split HVACs, pool pumps and Electric Vehicle Chargers (EVSE)."

Mike Rowand
Director, Technology Development
Duke Energy

1 https://news.duke-energy.com/releases/duke-energy-aims-to-achieve-net-zero-carbon-emissions-by-2050

2 Collaborative Research on CTA-2045 Standard Deployment and Adoption. 3002009307

3 Distributed Energy Resources Communication Standards and Protocols Harmonization Project. 3002014601

2019 Accomplishments and Look Ahead to 2020

The research of this project set aims to put the best tools and techniques into the hands of enterprise architecture practitioners, with an eye to the unique needs and operating environments of utilities.

Project Set 161E: Enterprise Architecture and Integration

Gerald Gray
Senior Technical Executive
email: ggray@epri.com
2019 Project Set Lead

Sean Crimmins
Principal Project Manager
email: scrimmins@epri.com
2020 Project Set Lead

Project Number and Name	**2019 ACCOMPLISHMENTS**	**2020 PLAN**
P161.029: **Enterprise Architecture (EA)**	**3002015911** Utility Enterprise Architecture Guidebook, 4th Edition **3002016061** Top Ten Indicators of EA Maturity **3002016062** Application of Strategic EA Metrics **3002016038** LEAPworx - Library of Enterprise Architecture Patterns **3002015916** Digital Transformation: Aligning IT and Operations 2nd Edition	Utility Enterprise Architecture Guidebook 5th Edition: New sections on EA repository, reference architectures and anti-patterns Top Ten Indicators of EA Maturity: 5th annual survey. Common Information Model Primer 6th Edition: Extensions, case studies. LEAPworx, 2nd Ed: New reusable architecture patterns.
P161.041: **Enterprise Systems Integration**	**3002015915** Utility Cloud Integration Guidebook, 4th Edition: New section on governance. **3002016064** Business Capability Model Builder: Reusable capabilities and associated elements to accelerate building a model and maps.	Utility Cloud Integration Guidebook, 5th Edition: New reference architectures and patterns. Business Capability Model Builder, 2nd Edition: More capabilities and business functions.

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2019 Accomplishments and Look Ahead to 2020

Project Set 161E: Enterprise Architecture and Integration

Project Number and Name	**2019 ACCOMPLISHMENTS**	**2020 PLAN**
P161.045: **Common Information Model (CIM) Testing**	**3002015918** Common Information Model Primer: Fifth Edition: Includes updates on compliance efforts and new case studies. **3002016452** Common Information Model Primer: 4th Edition published in 2018 *(Spanish Translation)*	Project discontinued. CIM Primer moved to the core EA project in 161E.
P161.057: **Architectural Impacts of Disruptive Technologies**	**3002017358** Architectural Impacts of Disruptive Technologies: Business Impact Assessment Methodology using containers as an example.	Architectural Impacts Disruptive Technologies: Additional technology

Digital Transformation: An Information Technology and Operations Success Story

EPRI has been conducting research on information technology and operations convergence since 2014.

At various times this research has reviewed the organizational pressures that have resulted from the convergence of skill sets and the need to align them for most modern utility projects. Research has looked at strategy, critical success factors, cost-benefit analysis, portfolio management, and has been involved in conversations with thought leaders at the highest level of utility organizations – those that lead the IT and operational departments of their respective utilities.

However, EPRI advisors have been uncomfortable with the naming of this effort, previously "IT/OT convergence", with implications that the very name divides the constituents.

An opportunity to explore this further occurred at an EPRI advisory meeting when a presenter from Salt River Project (SRP), Dawn Jurgensmeier presented on a use case at SRP where the information technology staff and the operations staff could have been better aligned on some projects for improved performance. It was asked if EPRI, given their expertise in maturity models, could develop such a model to better align IT and operations. But, given the sensitivity to the naming, settled on "Digital Transformation", hence, the Digital Transformation Maturity Model or "DXMM" concept was born.

Project Set Lead: Sean Crimmins,
scrimmins@epri.com

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"After a lively discussion at an advisory meeting on IT/OT convergence challenges, EPRI took the lead in facilitating the creation of a digital transformation maturity model. This model is the result of a collaboration of numerous utilities and will be hugely valuable in helping us understand our maturity as an integrated IT/OT organization, and what we need to do to improve."

Dawn Jurgensmeier
Information Technology Services
Grid Modernization Services
(ITS GMS)
Salt River Project (SRP)

EPRI, coordinating with utility subject matter experts (SMEs), and leveraging their prior maturity model experience, conducted three workshops:

1st workshop hosted by SRP

2nd workshop as part of the Enterprise Architecture Collaboration Group task force meeting hosted by American Electric Power (AEP),

3rd session at the EPRI advisor meeting in Nashville.

The model attempts to identify those attributes that a utility can invest in to see improved execution across information technology and operations domains, leveraging the leading practices of each, to achieve better outcomes related to projects and investments.

Domains coincide with the categories of people, process, technology, and governance, and use a common "five tiers" maturity model that evolves from Level 1 – ad hoc, to Level 5, Industry Leading.

Although this is the first version of the model and will likely see updates, this was an example of EPRI being able to quickly turn around a specific request from a utility and put this need into action.

This model is reflected in the deliverable, Digital Transformation: Aligning Information Technology and Operations, 2nd Edition, **3002015916.**

2019 Accomplishments and Look Ahead to 2020

This project aids utilities in optimizing existing system utilization and in discovering the full value of AMI-collected data; accelerates and guides the development of emerging standards and architectures to enhance interoperability, innovation, and marketplace competition; and identifies best practices for the support of system operations and monitoring of systems.

Project Set 161F: Advanced Metering Systems

Ed Beroset
Principal Technical Leader
email: eberoset@epri.com

Project Number and Name	**2019 ACCOMPLISHMENTS**	**2020 PLAN**
P161.032: **Achieving Open, Interoperable Advanced Metering Systems**	**3002015769** CIM to DLMS/COSEM open source translation demonstration software – implements a sample mapping of DLMS/COSEM objects to CIM (IEC 61968-9). **3002015770** Report on Metering and Common Information Model (CIM) describes the current state of metering protocols and how those protocols may be mapped to CIM IEC 61968-9.	Reference implementation of DLMS/COSEM wireless access point. Report describing Wireless Access Point Functions and Requirements.
P161.043: **Advanced Metering Systems Operations and Management**	**3002015773** Advanced Metering Infrastructure (AMI) Summit Meeting Results 2019 – A summary of the Advanced Metering Infrastructure Summit meeting held at the EPRI Charlotte office in September.	Guidebook for Revenue Protection, 2nd Edition Revenue protection refers to the broad set of processes that utilities employ to prevent, detect, and respond to energy theft and other unaccounted for energy.
P161.044: **Optimizing Advanced Metering System Value and Utilization**	**3002015774** Guidebook for Advanced Metering Infrastructure (AMI) Data Analytics – documents the technical approaches to AMI data analytics using eight open source software packages, and describes organizational strategies.	AMI Data Analytics Survey Gathering data from vendors and operators of AMI data analytics software to describe currently available tools: how they work, and how they compare to each other.

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2019 Accomplishments and Look Ahead to 2020

Project Set 161F: Advanced Metering Systems

Project Number and Name	**2019 ACCOMPLISHMENTS**	**2020 PLAN**
P161.032: **Achieving Open, Interoperable Advanced Metering Systems**	**3002015769** CIM to DLMS/COSEM open source translation demonstration software - work implements a sample mapping of DLMS/COSEM objects to CIM (IEC 61968-9). **3002015770** Report on Metering and Common Information Model (CIM) - describes the current state of metering protocols and how those protocols may be mapped to CIM IEC 61968-9.	Reference implementation of DLMS/COSEM wireless access point. Report describing Wireless Access Point Functions and Requirements.
P161.043: **Advanced Metering Systems Operations and Management**	**3002015773** Advanced Metering Infrastructure (AMI) Summit Meeting Results 2019 - A summary of the Advanced Metering Infrastructure Summit meeting held at the EPRI Charlotte office in September.	Guidebook for Revenue Protection, 2nd Edition Revenue protection refers to the broad set of processes that utilities employ to prevent, detect, and respond to energy theft and other unaccounted for energy.
P161.044: **Optimizing Advanced Metering System Value and Utilization**	**3002015774** Guidebook for Advanced Metering Infrastructure (AMI) Data Analytics - documents the technical approaches to AMI data analytics using eight open source software packages, and describes organizational strategies.	AMI Data Analytics Survey– Gathering data from vendors and operators of AMI data analytics software to describe currently available tools: how they work, and how they compare to each other.

Advanced Metering Infrastructure (AMI) Research helps to Understand and Maintain Industry Standard Knowledge

EPRI has been conducting research on interoperability in the Advanced Metering Infrastructure (AMI) industry and continues to be an important goal for utilities. While it would be very beneficial to be able to install a new meter that, seconds after the device is powered on, seamlessly joins an existing network made up of equipment from different vendors without further intervention, currently this interoperability scenario is an unrealized ideal for existing AMI networks and systems.

In September of 2019, EPRI hosted an AMI Task Force meeting at EPRI's facilities in Charlotte, North Carolina.

The meeting, spread over two days, included participants from both utility and vendor communities to engage in a collaborative discussion around the future of the AMI industry. This year's theme was "interoperability" and the participants engaged in detailed discussion starting with what interoperability really means in the context of AMI. The group then discussed interoperability successes, challenges and next steps.

EPRI's Ed Beroset manages the AMI (161F) project set and engages in standards activities within the industry. This includes conducting research into the state of the industry, technical aspects

Project Set Lead: Ed Beroset, *eberoset@epri.com*

"At an AMI specific Southeastern Electric Exchange meeting in Ashville, N.C., Ed presented on the current state of specific standards that will help drive compatibility in future AMI systems. Without projects like Advanced Metering Systems, it would be difficult, if not impossible to maintain the standard knowledge. This research helps drive future standards to the goal of having interoperability among AMI systems."

Derl Rhoades
Principal Engineer
Alabama Power

of metering standards, and education activities of what has been learned within the 161F project set as well as over the course of decades spent in the AMI industry. This yields advantages to member utilities and to the public by promoting better interoperability among AMI devices and systems to enhance the value of the systems and to reduce integration complexity.

While the most obvious benefit for participating utilities are the research results, there are often additional benefits. As Derl Rhoades of Alabama Power relates, "Being part of the EPRI Advanced Metering Systems (161F) project set is beneficial in many ways. One particular example comes to mind when Ed came and presented to an AMI specific Southeastern Electric Exchange meeting in Ashville, N.C. He presented on the current state of standards in the industry, specifically speaking on standards that will help drive compatibility in future AMI systems. Without projects like Advanced Metering Systems, it would be difficult, if not impossible to have someone have and maintain the standard knowledge. The knowledge and the sharing of such, helps drive the future standards to the ultimate goal of having interoperability among AMI systems."

While EPRI's research activities and results are important, the ability to be able to reach out to an impartial industry expert is another of the many benefits that come from the support of EPRI's Advanced Metering Systems (161F) project set.

A full report of the meeting **3002015773** Advanced Metering Infrastructure (AMI) Summit Meeting Results is available on epri.com. The next meeting will be held in March 2020 in Dallas, Texas.

2019 Accomplishments and Look Ahead to 2020

Telecommunication is essential to utilities and has an increasingly critical role in the operation of the integrated grid. The project set addresses challenges that utilities face with respect to telecommunications in a rapid changing environment.

Tim Godfrey
Program Manager
email: tgodfrey@epri.com

Project Set 161G: Telecommunications

Project Number and Name	2019 ACCOMPLISHMENTS	2020 PLAN
P161.053: **Wide Area Networks**	**3002015940** Strategic Fiber Handbook/ Fiber Survey focuses on utility owned fiber optic networks. The objective of this project is to answer these questions and provide relevant case studies as examples. **3002015941** Teleprotection over Packet Guidebook. MPLS lab testing, options for replacing retiring leased circuits, and guidelines for specifying commercial leased packet-based services available for teleprotection. **3002015939** Telecom Data Isolation Techniques and North American Electric Reliability Corporation Critical Infrastructure Protection Standards Requirements.	Teleprotection over Packet Guidebook Review of equipment vendors products (SEL VSN and TSN), review of service provider roadmaps for leased circuits. Surveys and case studies of best practices and challenges in packet transition. Evaluation of interference potential for 6 GHz Microwave links – evaluate susceptibility of equipment used in the 6-GHz band to interference from unlicensed systems, assessment of proposed AFC protection mechanisms, and development of mitigation and monitoring strategies.
P161.054: **Field/ Neighborhood Area Networks**	**3002016143** Communications network requirements for DER applications – Evaluation of the communications requirements for different smart inverter use cases. **3002015944** Additional FAN Performance Testing – continues research started in 2018 by evaluating additional FAN technologies. **3002015943** Design and Deployment of Private LTE – Overview of LTE technology, standards, spectrum options, and use cases for the utility FAN. **3002017361** FAN: Evaluation of 5G for Direct Transfer Trip for DER (Lab Testing). Evaluation of 5G eMBB in DTT use case.	Communications Network Requirements for advanced DER, Phase 2 – continued development of communications network requirements for advanced DER applications. Evaluation of Commercial and Private NB-IoT for FAN Use Cases – analysis and testing of commercial and private NB-IoT with selected FAN use cases to determine applicability and available performance. Next-Generation FAN Testing Platform update and extend FAN test platform with new capabilities and expand documentation. FAN Capacity Offload - evaluate FAN augmentation with bands such as 3.65-GHz CBRS, 4.9-GHz Public Safety, and 5.8-GHz ISM for selective capacity expansion while maintaining a primary licensed control channel. FAN: Evaluation of 5G for Direct Transfer Trip for DER (Field Testing). Phase 2 with 5G URLLC.

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2019 Accomplishments and Look Ahead to 2020

Project Set 161G: Telecommunications

Project Number and Name	2019 ACCOMPLISHMENTS	2020 PLAN
P161.055: **Telecommunications Planning and Management Systems**	**3002015946** Optimizing Provisioning and Device Management - evaluate techniques to manage the process and internal support model needed to accommodate orders of magnitude increases in the numbers of communicating endpoints being deployed.	NNMS and MOM capabilities, metrics, and interconnections - evaluation of Network Management System (NMS) and Manager of Manager (MOM) systems, metrics and interfacing capabilities. Multi-technology provisioning architecture - develop a reference architecture for implementation of 3GPP standards for provisioning GSMA eSIM and related services on the equipment of non-3GPP network technologies. IP network planning and architecture for IPv4 and IPv6 - develop, document, and evaluate best practices for IP network planning and architecture to support the concurrent use of IPv4 and IPv6.
P161.056: **Telecommunication Standards Tracking and Analysis**	**3002015952, 3002015954** Smart Grid Communications Intelligencer, Spring 2019 and Fall 2019 – two technical newsletters that highlight key activities and progress of participation and tracking of standards development related to wireless telecommunications standards. **3002015951** Telecommunication Standards Guidebook, 1st edition - high-level description of telecom and communications standards, their roadmap, utility applications, and interrelationships.	Comms Intelligencer newsletters - development of two technical newsletters that highlight key activities and progress of participation and tracking of standards development related to wireless telecommunications standards Telecom Standards Guidebook – second annual update, adding new information and updating existing standards. A high-level description of telecom and communications standards, their roadmap, utility applications, and interrelationships

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Field Area Network Testing Platform Helps Utilities in Technology Selection Process

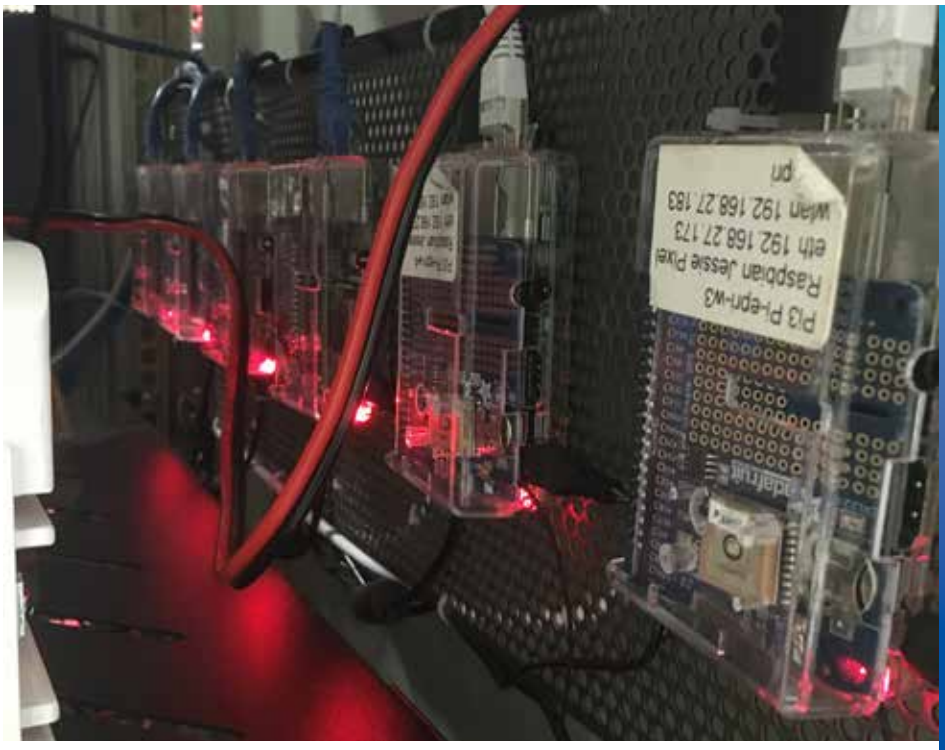
The Field Area Network (FAN) is an essential feature of the modernized grid, providing ubiquitous connectivity to an increasing number and variety of devices. Many utilities are deploying their first FAN, or upgrading an existing FAN. Many technology solutions from vendors are available for FAN deployments. The type of equipment is dependent on the type of wireless spectrum the FAN operates in. Unlicensed spectrum is one option used for certain FAN use cases where shared access and less predictable performance is acceptable. Licensed spectrum is desirable due to the exclusive ownership and access to the spectrum, which allows for a more reliable and predictable network. Licensed FAN spectrum can be broadly divided into two type. Where the spectrum allocation can support a pair of channels of at least 1.4 MHz, private LTE is the preferred solution. Where the spectrum is smaller, there are multiple options on the market, based on standardized or proprietary wireless technologies.

The EPRI Field Area Network Testing Platform has been developed by the 161G project set over the past several years. It is applicable to all types of FAN equipment, technology, and spectrum types. The platform has been used by EPRI members to evaluate and test private LTE networks, FAN technologies operating in the 700 MHz Upper A block spectrum, and operation in unlicensed spectrum such as the Wi-SUN FAN.

The EPRI FAN Testing Platform provides several benefits:

- Open source software – can be edited, adapted, and applied to many types of technology and vendor equipment. No software cost or licensing issues.
- Open platform – the test servers run on the Raspberry Pi, which is widely

Project Set Lead: Tim Godfrey,
tgodfrey@epri.com



"During 2019, Portland General Electric was conducting testing and evaluation of radio systems for the Field Area Network (FAN). The EPRI FAN Testing Platform, which is developed as part of the 161G Telecom Project Set, was well suited to PGE's testing needs, providing in-depth automated testing of the radios for throughput and latency. EPRI provided assistance and guidance configuring and using the FAN test platform. The results were valuable to PGE in making the vendor selection for the PGE Field Area Network."

Melvin Sam Charuvilayil
Substation & Grid Integration - Telecom
Portland General Electric

available, small, and low-cost. The control server runs on Linux, and can be a local physical machine, a virtual machine, or cloud hosted.

The FAN testing platform has a unique architecture that makes it well suited for FAN testing in the lab or field. The data sent to and from the devices under test is on a separate test network, independent from the control network used to orchestrate the testing. The test network carries only the actual testing payload data. This prevents the data used for managing the test and reporting the results from affecting the measurements in any way. Another benefit of the separate control network is for testing at remote sites. If the operator reconfigures a radio to a setting that causes the link to lose communication, the settings can be reconfigured remotely over the control network. Without the independent control and test networks, a remote radio that loses communication would require a site visit to recover. The control network can be distributed over a wide area to support testing in the field. The test servers can be integrated with cellular modems and connected to the control network over a VPN. The automated testing process measures throughput and one-way latency under a variety of conditions. Various packet sizes and repetition rates are used to fully exercise the radios across a range of actual operating conditions. The platform supports testing with multiple Quality of Service (QoS) packet priorities, to verify the proper support of QoS in the products.

In the 2020 portfolio for 161G, the FAN Test Platform will be upgraded and updated. The primary focus will be on improving ease of use and operation. The number of configuration settings will be reduced, and an improved user interface for the control server will be developed. The documentation will be expanded. Project Set members will provide input on features and functions during the upgrade.

The FAN Testing Platform provides value to EPRI members by facilitating and automating the FAN testing and evaluation process, providing consistent, actionable data to enable making the best choices for designing and deploying a FAN.

New Project Set for 2020

The Geospatial (Geographic) Informatics project set is designed to help EPRI members advance their geodata management practices and geospatial services in support of grid modernization. This is a new project set for 2020.

Project Set 161H: Geospatial (Geographic) Informatics

Randy Rhodes
Technical Executive
email: rrhodes@epri.com

Project Number and Name	**PREVIOUS EPRI RESEARCH IN THIS AREA**	**2020 PLAN**
161.059: **Geographic Information Systems (GIS) Data Practices**	**2016 – 3002007921** Electric Utility Guidebook for Geographic Information Systems Data Quality: Metadata **2015 – 3002006006** Electric Utility Guidebook for GIS Data Quality: Conflation **2014 – 3002003036** Electric Utility Guidebook on Geospatial Information System (GIS) Data Quality	Geospatial Informatics Guidebook will consolidate key content from past guidebooks on GIS Data Quality, into a report suitable for annual updates in the future. Next-Generation GIS -Technical Resource A fully digital and interactive deliverable for educating electric utility GIS professionals and their internal customers on the expanding role of GIS.
P161.060: **Geographic Information (GIS) Applications**	**2019 – 3002016147** Geospatial Data Integration in Augmented Reality Solutions for Electric Utilities **2019 – 3002016148** Evaluating Machine Learning for Asset Recognition and Geolocation **2019 – 3002014695** Using Virtual Reality to Train Utility Workers to Assess Storm Damage **2018 – 3002013117** Reality Computing: A Guide to Augmented Reality, Mixed Reality, Virtual Reality, and Extended Reality	Geospatial Requirements for XR Applications will identify future requirements for utility GIS systems in light of emerging augmented reality, mixed reality, and virtual reality applications. The report will recommend specific actions necessary to support enterprise-level standards for integration.

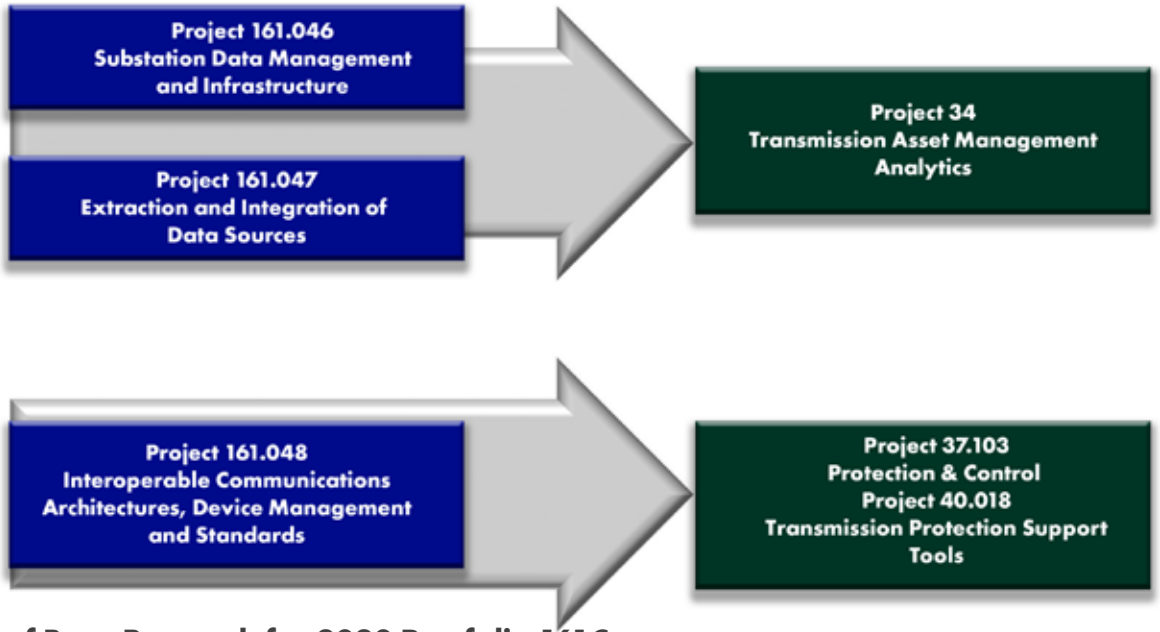
New Project Set for 2020

Project Set161H: Geospatial (Geographic) Informatics

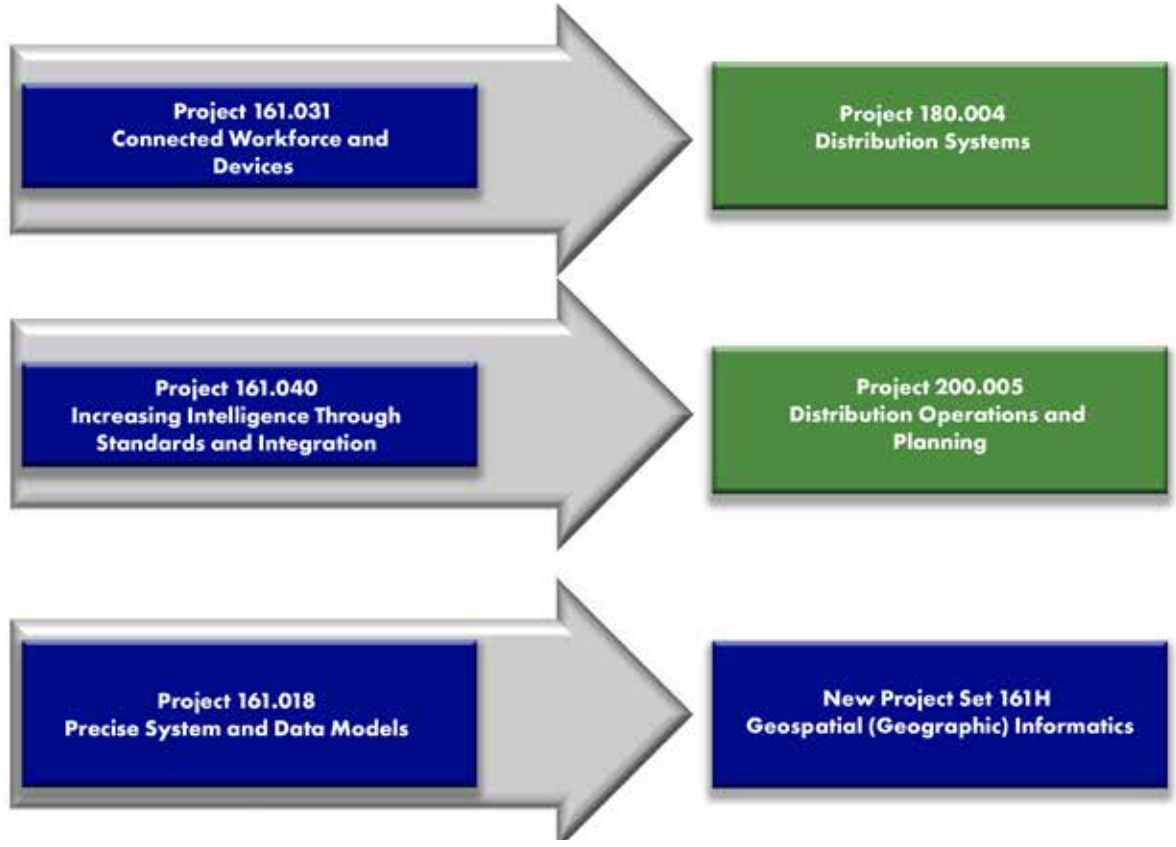
Project Number and Name	**PREVIOUS EPRI RESEARCH IN THIS AREA**	**2020 PLAN**
P161.061: **Geographic Information (GIS) Analytics and Visualization**	**2018 – 3002011007** Distribution Planning Guidebook for the Modern Grid **2016 – 3002007976** Distribution Modeling Guidelines: DER Modeling Recommendations for Distribution System Assessments	The GIS Modeling for Grid Analytics project is co-funded with P200E (Operations and Planning Analytics) with the goal of identifying requirements and best practices for GIS data management, as GIS supports the advanced analytics being deployed in grid operations and planning. Project deliverables include a survey, mid-year workshop, and a technical report.

Project sets 161B, "Applied Information and Communication Technology for Transmission," and 161C, "Applied Information and Communication Technology for Distribution," are sunsetting. The work being done in these project sets is being moved to the appropriate programs in the Transmission and Substations, Distribution and Grid Operations and Planning areas. A new Project Set—161H, "Geospatial Informatics"— has been launched. This new project set conducts R&D on geographic information systems (GISs) with a focus on geospatial data management. Projects will address the needs of GIS professionals and business users of geospatial services

Flow of Base Research for 2020 Portfolio 161B



Flow of Base Research for 2020 Portfolio 161C



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2019 Accomplishments and Look Ahead to 2020

This project set provides technical guidance for information and communication technology (ICT) items of interest to transmission-oriented organizations.

Project Set 161B: Applied ICT for Transmission

Paul Myrda
Senior Program Manager
email: pmyrda@epri.com

Project Number and Name	2019 ACCOMPLISHMENTS	2020 PLAN
P161.046: **Substation Data Management and Infrastructure** The work associated with this project has been accomplished under P161.047	Completed Substation Data Management Simulation Assessment and Results. **3002015873** Substation Data Extraction and Management: Case Study	Moving this portion of research to **Program 34 Transmission Asset Management Analytics** Program Manager Bhavin Desai, bdesai@epri.com P34.001: Transmission Asset Management Analytics: Principles, Practices and Technology
P161.047: **Extraction and Integration of Data Sources**	Completed Substation Data Mapping – Case study of substation data map using sample data. **3002015873** Substation Data Extraction and Management: Case Study	Moving this portion of research to **Program 34 Transmission Asset Management Analytics** Program Manager Bhavin Desai, bdesai@epri.com P34.001: Transmission Asset Management Analytics: Principles, Practices and Technology
P161.048: **Interoperable Communications Architectures, Device Management and Standards**	Completion of progression of the 3 projects: **3002015875** Remote Device Management: Utility requirements survey completed and interpreted Deliverable overview video Remote Device Management **3002015877** Common Substation Platform: Utility Requirements Survey **3002015876** IEC 61850 Working Group Activity 2019 Summary	Moving this portion of research to Project **Program 37.103 Protection & Control** Program Manager Gordon (Luke) van der Zel lvanderz@epri.com Project Lead Yuchen Lu ylu@epri.com **Program 40.018 Transmission Protection Support Tools** Program Manager Anish Gaikwad agaikwad@epri.com Project Lead Sean McGuinness smcguinness@epri.com **Protection in Planning Studies Protection Relay Settings & Logic Protection in Real-Time Operations**

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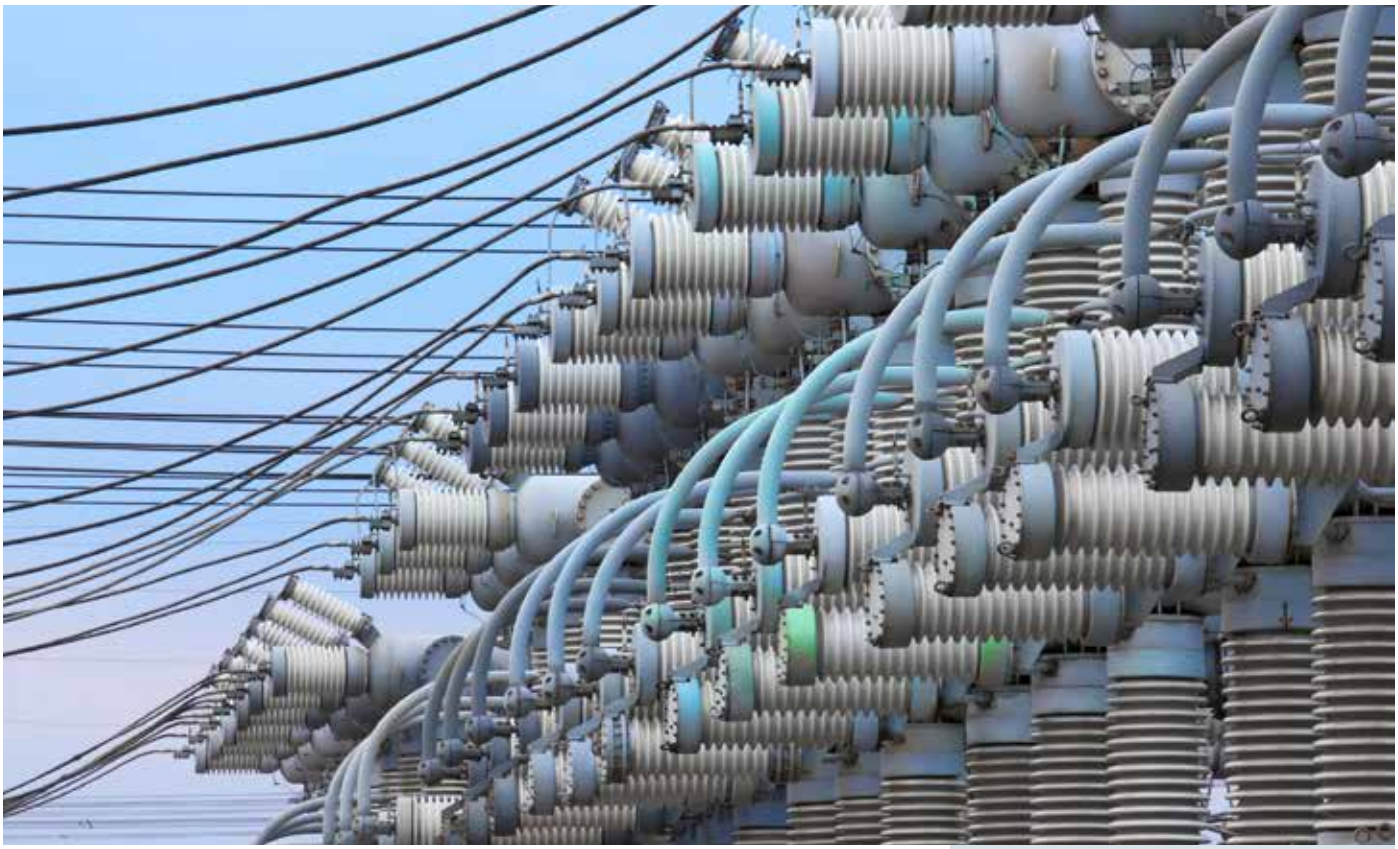

Common Substation Platform: Utility Requirements Survey

Substations are becoming more complex both in the power delivery aspects but also in terms of the need to handle wide ranging data services, communication between devices in the substation, devices in the field and back to the corporate data and control centers. Historically a simple remote terminal unit was able to provide the needed functionality. However, with the continued emergence of inverter-based generation, micro grids and intelligent energy networks the need for robust, secure communications will expand.

New approaches are needed to overcome the challenges presented by this more complex grid in terms of both power delivery needs and also wide-ranging data and communication services. These needs go beyond what traditional Supervisory Control and Data Acquisition (SCADA) systems can provide. One approach is to install edge devices such as servers located in transmission and distribution substations that can collect all real-time data from sensor and intelligent electronic devices. These servers may be used to generate alarms and adjust control set points to rapidly respond to situations, continuously monitor the condition of equipment and generate historical trends of equipment behavior. These actions can help optimize the maintenance strategies and enable new operating modes during normal and emergency situations.

Project Set Lead: Paul Myrda, pmyrda@epri.com

"The Common Substation Platform: Utility Requirements Survey project was a necessary step in the process of determining the broad needs of the industry with regards to interfacing all the required data sources in the field securely and efficiently. More work needs to be done to fully define suitable architectures, computing platforms and other requirements. It is important that we leverage the expertise of our industry peers through effective collaboration and develop a solid roadmap toward implementation."

Glen Wilson
Principal Research Engineer
PD T&S
Southern Company – R&D

In light of the intelligent devices being deployed by electric utilities across the grid, EPRI is investigating how to gather, manage, and use the data generated more effectively. One option being tested by a southwest U.S. company is to install what is effectively a small yet robust computing platform—known as a common substation platform (CSP)—in their substation. The CSP is very similar to a data center but is smaller and hardened to survive in the substation environment. EPRI has been discussing this approach with several utilities and has decided to survey the industry. The purpose of this survey is to gather utility requirements assuming this CSP technology approach were to be adopted by other companies.

Areas covered in the survey include CSP time frame and implementation, real-time and cyber security support, intrusion detection, access control, network support, port enablement/disablement, wide area network (WAN) configuration, features and functionality, fault tolerance, software and firmware management, and infrastructure and scalability.

More than half of the nine responding companies had either implemented a CSP or planned to implement one within 1-3 years.

2019 Accomplishments and Look Ahead to 2020

The Applied Information and Communication Technology (ICT) for Distribution Systems project set sought to inform and provide utilities with the methods to capture and maintain accurate data, techniques to access the right data in the right location at the right time, interoperable standards, ability to integrate and connect legacy and modern devices, requirements to enable a mobile workforce, and value assessments for implementing research.

Project Set 161C: Applied ICT for Distribution

Jared Green
Senior Technical Leader
email: jgreen@epri.com

Project Number and Name	2019 ACCOMPLISHMENTS	2020 PLAN
P161.031: **Connected Workforce and Devices**	**3002017159** 2019 Extended Reality Guidebook: Digital Transformation for Training and Telemetry - Innovations with augmented reality are offering new methods of training and telemetry. **3002016150** PRE-SW: Open XR Web Application and Source Code (EPRI XT) v1.0 - open source product provides utilities with easy access to an Extended Reality website. To access EPRI XT, go to https://eprixr.epri.com	Moving this portion of research to **Program 180.004 Distribution Systems Program: Safety** Tom Short Senior Technical Executive tshort@epri.com
P161.040: **Increasing Intelligence Through Standards and Integration**	**3002016152** 2019 Distributed vs. Centralized Intelligence Guidebook - distributed algorithm improves reliability, efficiency, and grid operations.	Moving this portion of research to **Program 200.005 Distribution Operations and Planning: Smart Applications for Distribution Management Systems** Brian Deaver Senior Technical Executive bdeaver@epri.com
P161.018: **Precise System and Data Models** Completed research around Data Integrity Techniques for GIS and evaluation of new technologies.	**3002016148** 2019 Evaluating Machine Learning for Asset Recognition and on the data collection for use in locating aboveground utility assets and identifying critical changes in distribution grids using machine learning. **3002016149** 2019 Building out a GIS Model of an Underground Mesh Network Asset Identification and an adaptable guide with principles and set of tools that can be used to assess, improve, and ensure ongoing data quality related to the geolocation of distribution assets. **3002016147** Geospatial Data Integration in Augmented Reality Solutions for Electric Utilities - requirements for integrating geospatial data into AR-enabled utility solutions.	Moving this portion of research to new 2020 project set **Geospatial Informatics (161H)** Randy Rhodes Technical Executive rrhodes@epri.com

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Supplemental Projects

Supplemental Projects are research, development or demonstration projects offered outside of the annual research portfolio. These projects are often spearheaded in response to an immediate need by an individual or group of members. Supplementals are supported either through Tailored Collaboration or pooled member funds.

Status

Assessing GIS Data Quality Improvement Options 3002017823
Randy Rhodes, rrhodes@epri.com

This project builds on the seven years of 161C research projects focused on GIS data quality, as well as more recent GMDM project-funded research. Project participants will together synthesize metrics for GIS Data Quality.

3 utility participants required to start project. Project start expected early 2020.

Collaborative Research on CTA-2045 Standard Deployment and Adoption 3002009307
Chuck Thomas, cthomas@epri.com

Research Results to Develop Technical Requirements for Residential DR Programs and How Open Standards Improve Customer Experience. Project winding down in 2019.

Contributions to industry (alignment with other industry specifications and standards) is on-going. Contributions to Consumer Technology Association's CTA-2045 working group is on-going.

Common Substation Platform: Utility Requirements Assessment 3002017165
Paul Myrda, pmyrda@epri.com

Provides a robust and secure platform that reduces single-point solution boxes in creating a more scalable and adaptable platform with remote management and upgrade capabilities.

4 utility participants required. Project start expected early 2020.

Distributed Energy Resources Communication Standards and Protocols Harmonization Project 3002014601
Rish Ghatikar, gghatikar@epri.com

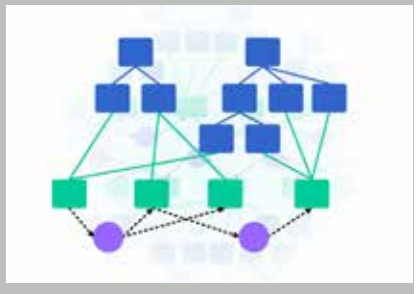
Member and industry collaboration, technical expertise, and guided roadmaps to address uncoordinated and siloed DER technologies and standards deployments that can lead to higher system integration costs, slower deployment momentums, and less secure electric grids.

Member and industry engagement have resulted in identifying the communications-related challenges to scale DER deployments and their integration with a diversity of electric grid stakeholders that includes transmission and distribution system operators, industry, and regulators. A preliminary roadmap is under development to guide utilities and industry toward standards centric DER implementations.

Distribution GIS & Grid Model Data Management 3002009807
Pat Brown, pbrown@epri.com

Develop a network model data mgmt. architecture for the electric distribution industry. Provide the data foundation to support the increasing need for grid simulations in planning, protecting and operating the distr. grid of the future.

Understanding of architectural requirements and solutions has been developed from 6 utility deep-dives; an architectural framework and preliminary architecture has been designed; research has been completed into geo-locating/IDing assets with 360-degree imaging and machine learning.



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Status

Enterprise Architecture Collaboration Group 3002007533

Gerald Gray, ggray@epri.com

Leverages the best practices of enterprise architects across the utility industry by developing a set of reusable architecture components, models, and patterns

Task force meeting was held, hosted by AEP in Columbus, OH. Topics EA management, and potential up-dates for the EA and cloud integration guidebooks, mapping of various architecture roles as defined by TOGAF. Kicked off new round of the Top Ten Indicators of EA Maturity, to be published in 2020. Business Capability Model Builder 3002016064 - a mechanism to build business capability models based on the APQC PCF, Utility models and other related elements has been published.

Grid Model Data Management (GMDM) Vendor Forum: An EPRI-Sponsored Vendor-Funded Collaborative Initiative 3002017776

Pat Brown, pbrown@epri.com

Engage software vendors in refining the network model data management architecture defined by the Distribution GIS & Grid Model Data Management project. Demonstrate the architecture's value and feasibility to the industry via an interoperability event.

8 vendors required to start project. Project anticipated duration 19 month.

High-Altitude Electromagnetic Pulse (HEMP) E1 Hardening of Bulk Electric Systems (BES) Communication Systems (offered in P161 and P37) 3002016974

Randy Horton, rhorton@epri.com, Tim Godfrey, tgodfrey@epri.com

Improved understanding of the potential impacts of HEMP E1 on Bulk Electric Systems communications systems.

Waiting on additional funders. Project start expected early 2020.

Integrated Network Model Management (INMM) 3002008646

Sean Crimmins, scrimmins@epri.com

Streamline maintenance of transmission network models among grid operations, planning, and protection organizations within the utility. Improve network model accuracy and traceability. Enhance transmission model sharing with Independent System Operators or distribution applications.

SRP completed Visioning Workshop and published draft report summarizing existing NMM practices and proposing a more integrated approach. Hydro Quebec completed the Visioning Workshop and EPRI is working on the final report for Mid-February 2020 completion. PG&E is beginning in 2020 with work on the data flow diagrams and a Gathering Workshop planned first quarter 2020 Data.

Status

Leveraging Advanced Metering Infrastructure (AMI) for Direct Current (DC) Metering 3002017567

Ed Beroset, eberoset@epri.com

Advance the industry with standards-based DC metering standards that address utility use cases

4 utility participants required.
Project start expected early 2020.

Long-Term Evolution (LTE) Security 3002017271

Tim Godfrey, tgodfrey@epri.com

Evaluation of the security architecture of LTE, identified weaknesses and exploits, as applied to private LTE and commercial cellular networks. Identifies the optimum security architecture for LTE systems for utility use cases, reducing cost and complexity while ensuring effective and appropriate security

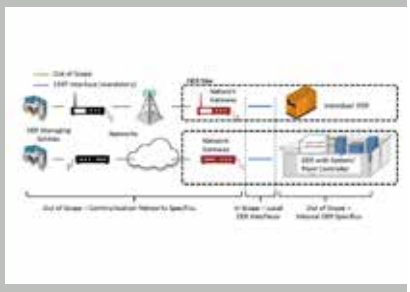
8 utility participants required.
Project start expected early 2020.

Low-Cost, Secure DER Network Gateways for Control Integration of Smart Inverters 3002017720

Ed Beroset, eberoset@epri.com

Working group to identify key DER gateway capabilities to supplement requirements in California Rule 21 and IEEE 1547-2018. Evaluate technical and economic feasibility of DER gateway platforms and associated features.

5 utility participants required.
Project start expected early 2020.



Next Generation Smart Meter Vision and Criteria 3002017235

Ed Beroset, eberoset@epri.com

Coordinated industry approach to understand features of smart meters (hardware and software) required to optimize data value.

5 utility participants required.
Project start expected early 2020.

Persistent Wi-Fi™ Platform for Connected Devices Demonstration Participant 3002011409 Observer 3002011495

Tim Godfrey, tgodfrey@epri.com

Develop and demonstrate approaches to implement a secure, persistent connection to devices, independent of customer's Wi-Fi network in a variety of use cases for utility adoption of connected devices for grid response.

A demonstration is based on emerging Wi-Fi Alliance standards for onboarding and provisioning devices. Implementing Wi-Fi Alliance DPP (Easy Connect) into Sky Centrics CTA-2045 module for pilot testing has taken longer. Project update webcast will be held in early 2020.

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Information and Communication Technology Transfer Activities January - December 2019

2 Advisory Meetings	**2,599 Deliverables Downloads (excludes public reports)**	**12 Deliverables Overview Videos**
8 Workshops/Conferences	**11,899 Member Center Visits**	**27 Technical Advisor Member Visits**
85 Webcasts	**15 Task Force Meetings/webcasts**	**John Hughes/Ameren Program Utility Chair**

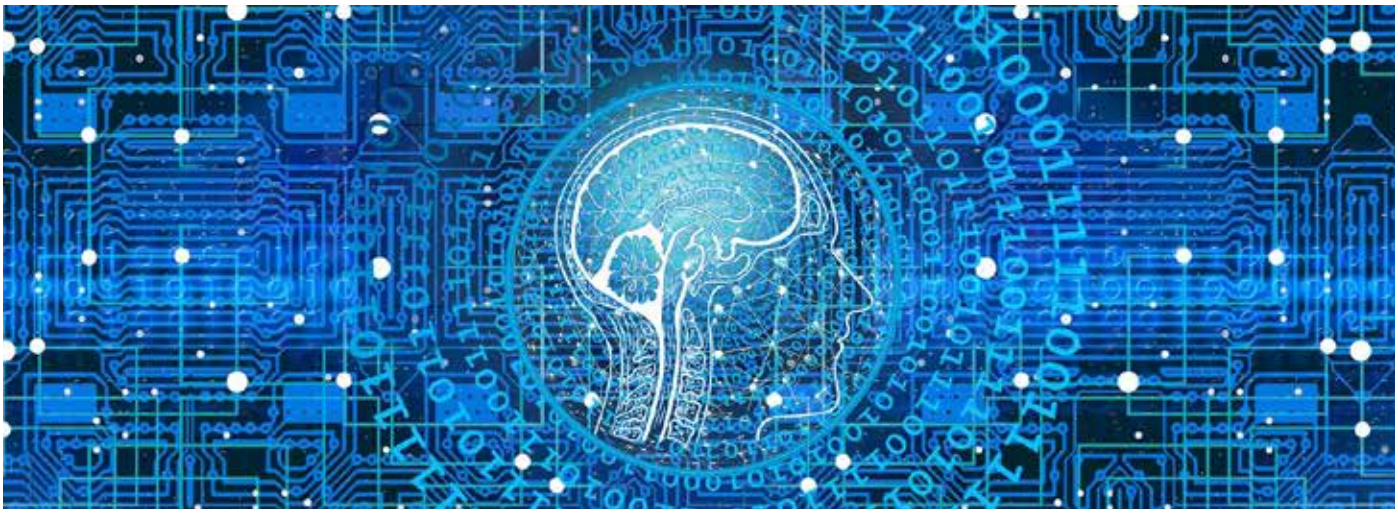
Information and Communication Technology Transfer Award Winners

Each year EPRI recognizes the leaders and innovators who transfer research into applied results. The people and companies honored with Technology Transfer Awards exemplify the collaboration and leadership that drive progress in the industry and benefit society. Nominees are an individual or group of individuals from our member companies who have championed the successful use of EPRI-sponsored research results over the 2018 - 2019 time period. Awards were selected in the Fall of 2019 and are presented at the following February Winter Advisory Meetings.

Nominees are judged on the following criteria:

- Successful application of research results,
- Magnitude of the problem solved,
- Impact and quantifiable benefits of the application to the company, customers, and/or society at large, and
- Leadership, innovation, and initiative demonstrated.

Winners	Technology	How Research was Applied
Ameren Service Co. Clark Allen John Hughes Jim Huss/Ameren Missouri Alex Rojas Hannah Schweiss Tim Spyers	EPRI DER Integration Toolkit	EPRI has been working with Ameren on the design of its Dorsett Inverter Validation Facility. The goal of the research is intended to provide Ameren with evaluation strategies for system architecture and security, testing tools, and methodologies to achieve scalable distributed energy resource integration. To learn more about EPRI's DER integration toolkit search for product **3002013623** on epri.com
FirstEnergy Corp. Tom Pryatel Lisa Rouse **International Member Sarawak Energy Berhad** Chen Shiun (Sarawak)	Grid Modernization R&D Roadmap	The combination of external drivers, such as integrating increasing numbers of distributed energy resources and the need to improve grid resiliency, the continued evolution of technologies, such as communications, sensors and power electronics, are causing many utilities to consider what a modernized grid will look like and how it will be created over time. Teams of EPRI researchers worked with each of the nominated utilities to understand external drivers, determine the current state, define the future state, identify gaps and develop an implementation plan for achieving the future state. To learn more about EPRI's distribution operations and planning R&D **3002013411** on epri.com.
Salt River Project Jeff Neuenfeldt Brian Zimmerman	Salt River Project (SRP) Field Area Network (FAN); First Utility to Procure/ Apply 700MHz A-block	SRP's proactive approach and EPRI's research and support enabled SRP to be the first US utility to procure licensing for the 700MHz A-block. Many utilities have followed. SRP will also be one of the first utilities to enable a ubiquitous, private point-to-multipoint wireless network across its service territory. The ability to support capable, reliable and secure telecommunications with grid assets will further enable advanced automation to address integration of renewables, enable new customer programs and ensure reliable electric service. For more information read **Navigating the 'Moving Parts' of Grid Telecommunications** on epri.com.



Knoxville Laboratory

Information, Communication Technology Evaluation, Laboratory Testing and Field Demonstrations

Applied ICT for Distribution Energy Resources and Demand Response 161D

2019 ACCOMPLISHMENTS

- In final development stage for first edition of test procedures for certifying universal communication modules of the CTA-2045 port, both AC and DC modules. The laboratory staff has been evaluating features like physical dimension, electrical voltage, logic signal (waveform, voltage, and timing), and data packet conformance.
- NYSERDA Demo deployment of smart grid devices such as water heaters and electric vehicle supply equipment (EVSE) out in the field using the CTA-2045 port as the communication between utility and end-device for a demand response program. The goal is to look at use cases for this technology, including testing these devices in the lab environment for interoperability issues using the functional test procedures developed by EPRI.
- Hardware evaluation that can provide Energy Management System (EMS) capabilities. Device hosted and ran the OpenADR (Virtual End Node) VEN developed by EPRI alongside the Voltron-enabled Home Energy Management System developed by Oakridge National Lab (ORNL). This system would provide the user details of a home's energy usage as well as providing utility services like Demand Response via its 4G LTE network and using Wi-Fi interface to manage CTA-2045 end devices.

2020 PLAN

- Continue 2019 test evaluation to completion

Telecommunications 161G

2019 ACCOMPLISHMENTS

- The FAN Testing Platform was expanded to support additional equipment used in the testing for the "Additional Field-Area Network Performance Evaluations" report, product ID 3002015944.
- A Wi-SUN Field Area Network (FAN) testbed was built based on the design from the Wi-SUN Alliance. This testbed includes equipment from four different of vendors and has been used to evaluate WI-SUN performance characteristics and interoperability.
- As part of an evaluation of standalone Narrowband Internet of Things, an NB-IoT device designed for commercial networks was programmed to interface with the Field Area Network (FAN) Testing Platform. Test devices have been mounted in lab rack with the Wi-SUN testbed and the FAN Testing Platform.

2020 PLAN

- Update the FAN Testing Platform to include additional network interfaces to not only integrate with network technologies, but also to provide network redundancy and improved portability of the FAN Testing Platform in the field. These activities are part of a longer-term goal to develop a unified telecom test bed that contains multiple network types which can be configured to enable different, heterogeneous network test scenarios. Evaluate telecommunication requirements for field-based augmented reality (AR) applications.
- Long-Term Evolution (LTE) equipment testing - adding LTE components for security testing.

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Guidebooks

ICT guidebooks are developed as adaptable go-to reference books to help utilities with development of emerging standards and architectures to enhance interoperability, innovation, marketplace competition; and identify best practices for the support of system operations and monitoring of systems.

Project Set 161B Applied Information and Communication Technology for Transmisson

Title	PID#	Year
Electric Utility Guidebook on Integration of Internal and External Data Sources: Industry Risks, Technical Challenges, and Data Integration Methodologies	3002005118	2015
Electric Utility Guidebook on Using IEC Standards for Asset Health Data Management: Harmonizing Common Information Model (CIM) and IEC 61850 Asset Health Data Models	3002005119	2015
Guidebook on Synchrophasor Communications	3002005116	2015
Guidebook on Synchrophasor Data Management: Current State Update	3002005117	2015

Project Set 161C Applied Information and Communication Technology for Distribution

Title	PID#	Year
Distributed vs. Centralized Intelligence Guidebook - Distributed Algorithm Use Cases	3002016152	2019
Electric Utility Guidebook for GIS Data Quality: Conflation	3002006006	2015
Extended Reality (XR) Guidebook - Digital Transformation for Training and Telemetry	3002017159	2019
GIS Leading Practices Guidebook: Data Cleanup Methods with Cost-benefit Analysis Guidance	3002010509	2017
Guidebook for Advanced Distribution Automation Communications: An EPRI Information and Communications Technology Report	3002003021	2016
Reality Computing: A Guide to Augmented Reality, Mixed Reality, Virtual Reality, and Extended Reality	3002013117	2018

Project Set161D: Applied Information and Communication Technology for Distributed Energy Resources and Demand Response

Title	PID#	Year
DER Protocol Reference Guidebook – 3rd Edition: Understanding the Characteristics of Communications with Distributed Energy Resource (DER) and Demand Response Technologies	3002016140	2019

Project Set 161E Enterprise Architecture and Integration

Title	PID#	Year
Common Information Model Primer: Fifth Edition CIM Primer, 5th Edition	3002015918	2019
Information Technology – Operational Technology Convergence Guidebook: First Edition	3002012479	2018
Top Ten Indicators of Enterprise Architecture (EA) Maturity - 2018 Results (2019)	3002016061	2019
Utility Enterprise Architecture Guidebook, 4th Edition	3002015911	2019
Utility Cloud Integration Guidebook, 4th Edition: A Guide for Enterprise Architects	3002015915	2019

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Guidebooks

ICT guidebooks are developed as adaptable go-to reference books to help utilities with development of emerging standards and architectures to enhance interoperability, innovation, marketplace competition; and identify best practices for the support of system operations and monitoring of systems.

Project Set 161F Advanced Metering Systems

Title	PID#	Year
Guidebook for Advanced Metering Infrastructure (AMI) Data Analytics	3002015774	2019
Guidebook for Advanced Metering Infrastructure Prognostics and Health Management, Second Edition	3002005471	2015
Guidebook for AMI System Disaster Preparedness and Restoration, First Edition	3002010502	2017
Revenue Protection Guidebook, First Edition: Utilizing Advanced Metering Infrastructure	3002008943	2016

Project Set 161G Telecommunications

Title	PID#	Year
Private Long-Term Evolution Guidebook	3002015943	2019
Strategic Fiber Handbook / Fiber Survey	3002015940	2019
Telecommunication Standards Guidebook	3002015951	2019
Teleprotection over Packet Guidebook	3002015941	2019
Utility Telecom Planning Framework and Reference Guide	3002009805	2018

Project Set 161H Geospatial (Geographic) Informatics *(guidebooks previously released)*

Title	PID#	Year
Electric Utility Guidebook for Geographic Information Systems Data Quality: Metadata	3002007921	2016
Electric Utility Guidebook for GIS Data Quality: Conflation	3002006006	2015
Electric Utility Guidebook on Geospatial Information System (GIS) Data Quality	3002003036	2014
GIS Leading Practices Guidebook – Data Cleanup Methods with Cost-benefit Analysis Guidance	3002010509	2017

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Software

Software products to support member companies address complex issues

Title	PID#	Year
ICT Security Architecture for DER Architecture Patterns Repository	3002016232	2019
Open Source DER Outstation for DNP Application Note AN2018-001: Reference Implementation of DNP Application Note AN2018-001 – "DNP3 Profile for Communications with Distributed Energy Resources	3002015355	2019
OpenDERMS (IEC 61850 Client) Software	3002016305	2019
PRE-SW: DLMS/COSEM (Device Language Message Specification/Companion Specification for Energy Metering) to International Electrotechnical Commission (IEC) 61968-9 Mapping	3002015769	2019
PRE-SW: XR Web Application and Source Code (EPRI XT) v1.0	3002016150	2019
EPRI Virtual Reality Web Application and Source Code (EPRI VR) v1.0	3002014698	2018
Online Interconnection Documents Repository	3002012049	2018
Wi-SUN Meter Test Tool (WISUND), version 1.0	3002010501	2018
Advanced Metering Infrastructure Resource Center (AMI Status DB), version 3.0	3002010503	2017
CIM Identities Web Services, version 1.0	3002011464	2017
CTA-2045 UCM C++ Library (LIBCEA2045 - OPEN), version 1.0	3002009782	2017
CTA-2045 Desktop Simulator User's Manual: Version 16.12.07	3002009750	2017
OpenADR 2.0b Open Source Virtual Top Node (OADR2.0b VTN) Version 0.9.7.0	3002007431	2017
Use Case Importer Extension (UCI)	3002007875	2017
Advanced Metering Infrastructure Resource Center (AMI Status DB), Version 2.0	3002008944	2016
OpenADR 2.0b Virtual End Node C++ Library (OADRLIB), v0.7.0	3002007432	2016
Advanced Metering Systems Online Database (AMI Status DB) Version 1.1	3002005472	2015
AMI Industry Status Web Database	3002002860	2014
OpenADR C++ Library (OADRLIB) Version 0.0.5.3	1026753	2014
OpenADR 2.0b Open Source Virtual End Node - VEN v0.5.0	1026751	2014
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Technical Leads

Contact Name	Title	email
Matt Wakefield	Director, Information Communication Technology and Cyber Security for Power Delivery and Utilization	mwakefield@epri.com
Gerald Gray	Sr. Technical Executive	ggray@epri.com
Pat Brown	Technical Executive, EPRI Europe DAC	pbrown@epri.com
Rish Ghatikar	Sr. Program Manager	gghatikar@epri.com
Micah Tinklepaugh	Engineer/Scientist III	mtinklepaugh@epri.com
Don von Dollen	Sr. Program Manager ICT and Project Set Lead A	dvondoll@epri.com
Christina Huff	Engineer/Scientist II	chuff@epri.com
Chuck Thomas	Sr. Technical Leader	cthomas@epri.com
Don von Dollen	Sr. Program Manager ICT and *Interim Project Set Lead D*	dvondoll@epri.com
Jithendar Anandan	Engineer/Scientist III	janandan@epri.com
Doni Nastasi	Technical Leader	dnastasi@epri.com
Peyton Sizemore	Engineer/Scientist I	psizemore@epri.com
Simon Boka	Engineer/Scientist I	sboka@epri.com
Sean Crimmins	Principal Project Manager, Project Set Lead E	scrimmins@epri.com
Daniel Lowe	Engineer/Scientist I	dlowe@epri.com
Stephan Amsbary	Sr. Technical Leader	samsbary@epri.com
Ed Beroset	Principal Technical Leader, Project Set Lead F	eberoset@epri.com
Tim Godrey	Program Manager, Project Set Lead G	tgodfrey@epri.com
Jay Herman	Principal Technical Leader	jherman@epri.com
Norman McCollough	Sr. Technical Leader	nmccollough@epri.com
Joseph Estrada III	Engineer/Scientist II	jestrada@epri.com
Randy Rhodes	Technical Executive, Project Set Lead H	rrhodes@epri.com

Contact Name	Title	email
Annette Mosley	Technical Advisor II, WEST	amosley@epri.com
Chris Kotting	Technical Advisor II, EAST	ckotting@epri.com
Sujit Mandal	Sr. Manager, Member and Technical Services	smandal@epri.com

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TO JOIN OR FOR MORE INFORMATION, CONTACT THE FOLLOWING TECHNICAL ADVISORS:

West: *Annette Mosley, 972.556.6507; amosley@epri.com*

East: *Chris Kotting, 980.219.0146; ckotting@epri.com*

International: *Kevin East, International Director, +44 (1925) 450.207; keast@epri.com*

Product ID 3002017844 January 2020

Electric Power Research Institute
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com