ICT NEWSLETTER

An EPRI Progress Report for Information and Communication Technology (Program 161)
June 2019

INTRODUCTION

Welcome to the June 2019 Information and Communication Technology (ICT) Program Newsletter. The data needed to operate the grid reliably, securely and efficiently is provided by monitoring utility assets. Featured is an article highlighting a current state assessment of numerous remote device management functions. We're pleased to include an update to the work EPRI has been doing for the past 7 years developing a Distributed Energy Resource Management System (DERMS) testing platform. We've also provided an overview of the recent distributed intelligence research focused on the control architecture through the lens of two applications, volt-VAR control and FLISR. A comprehensive summary of ICT Program webcasts and deliverables for 2019 completes this newsletter issue.

Don Von Dollen, Senior Program Manager, Information and Communication Technology

Remote Device Management Assessment

Electric utilities are continuing to deploy ever increasing numbers of intelligent electronic devices (IEDs) across their systems with growing capabilities to capture, process, store, and communicate a wide range of data types. These IEDs fulfill a critical function by monitoring utility assets to provide the utilities with the data needed to operate the grid reliably, securely and efficiently. Historically there have been and continue to be challenges associated with both real-time and non-real-time communications, and the communications of non-real-time data with and between IEDs remains a difficult challenge. The difficulty is due to a number of factors, including disparate data types, multiple vendors with different solutions, lack of standards, the remote location of the devices, the need for secure communications, and the growing range of device management tasks that must be performed. Non-real-time data includes device management data, pass-through communications, and a variety of measurement-related data such as fault records.

Across the industry there is growing recognition of the substantial reductions in operations and maintenance costs, as well as improved security and reliability that can be achieved with effective Remote Device Management (RDM). Recent EPRI research focused on the data types involved which may be referred to as Secure Remote Access, Remote Substation Access, or Remote Device Management. For the purposes of this article we will use the term Remote Device Management (RDM). The goal of an RDM system is to fully manage, update, secure, monitor and analyze all the remote IEDs of all types at all locations. Currently, at many utilities there is limited or no RDM capability deployed. Therefore, field personnel may be required to drive to the substation, possibly in remote areas, to retrieve IED event files for fault location and event analysis. This additional activity can hamper restoration efforts and ultimately affect overall reliability performance. Other challenges include the lack of standard protocols for some functions and the lack of industry consensus on requirements, leading to a wide range of approaches between suppliers, and even with a single supplier's products.

Another challenge is to simply capture the current configuration, settings, firmware version and other data of a remote device without having to visit the device physically in the field. Other domains such as telecommunication, satellite and Internet service providers have eliminated the need to verify in the field the state of an asset and they regularly deploy updates remotely and confirm successful actions.

EPRI recently performed a current state assessment of RDM as implemented by the leading suppliers in this area. The following key functions were investigated:

- Asset discovery
- Asset inventory
- Configuration management
- Firmware / patch management (this report)

- Password management
- Pass-through or proxy connection for engineering access
- Data collection (including alarms and alerts)
- Device health
- Compliance reporting
- Ability to manage all available IEDs
- Comprehensive security features
- Support of NERC compliance

To implement a modern RDM system several elements are required including the IED, substation gateway or data concentrator, communications and/or network components, one or more communication paths, secure remote access server, file repository (optional) and a secure remote access client. This method provides significant advantages over the other methods above in that this approach comes closer to the ideal RDM system allowing for more complete management and the device and retrieval of data.

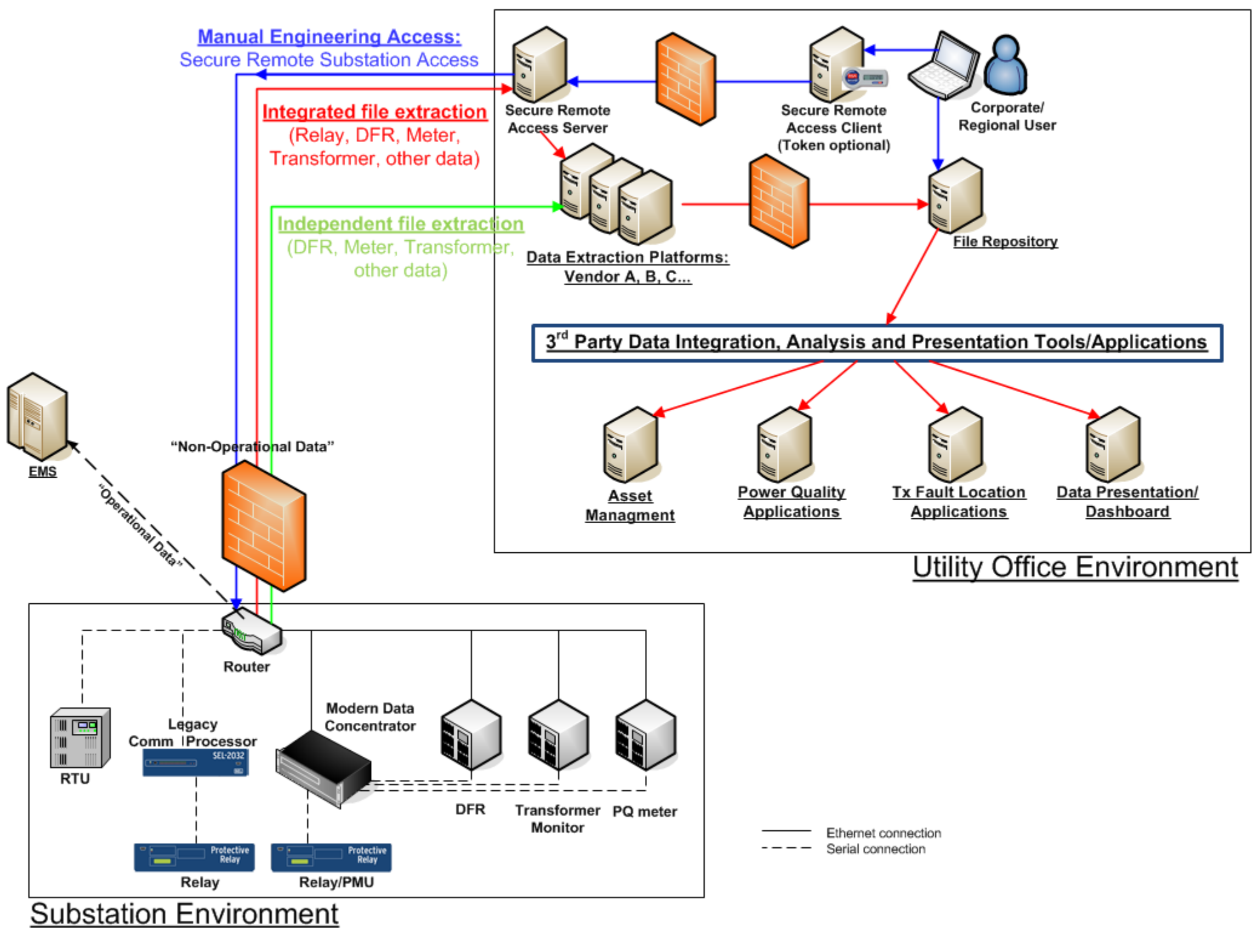

Figure 1 Example RDM system architecture

The figure below shows the internal and external communications connections of a typical substation with a wide range of devices installed and that supports RDM using the Supervised Switch Method.

For further information, the results of this research can be found in EPRI report, Remote Device Management Assessment (3002012588).

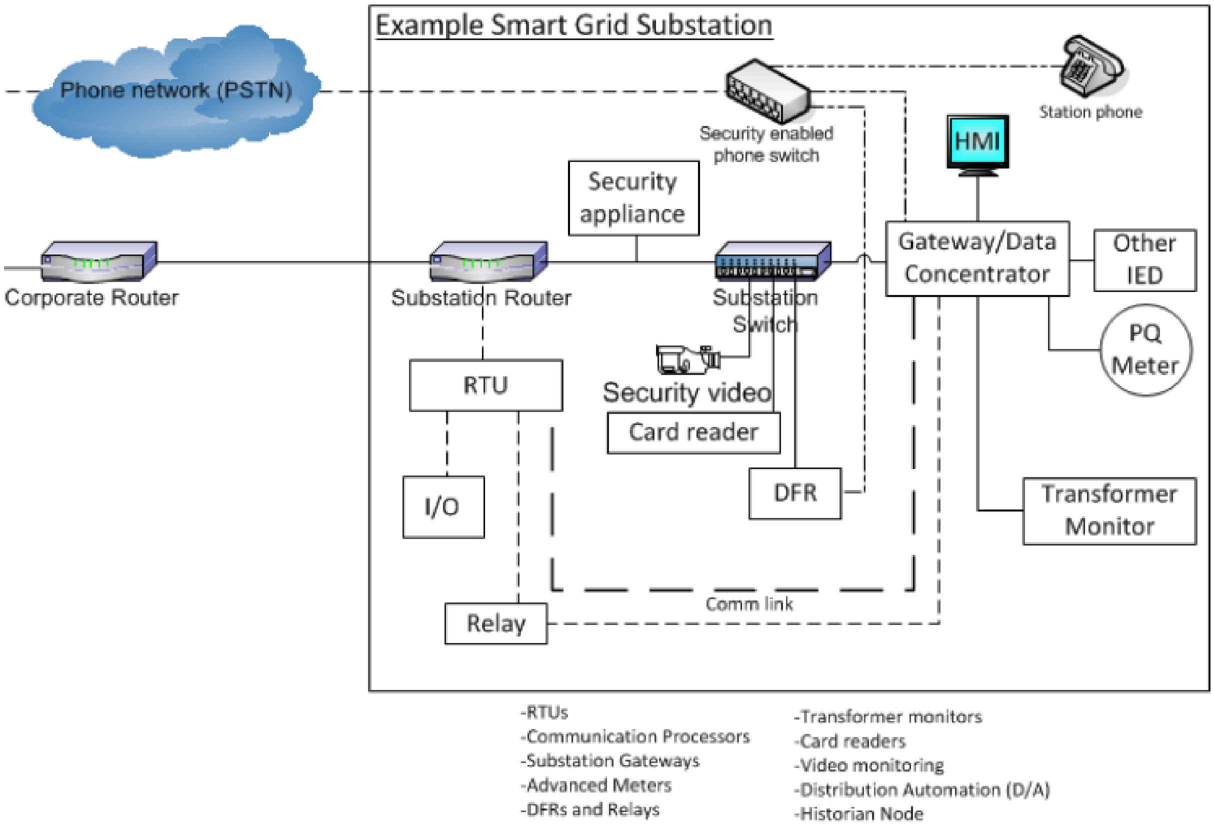

Figure 2 Internal and external communications connections of a typical substation

For more information, contact EPRI Senior Program Manager Paul Myrda (pmyrda@epri.com)

Role of ICT in Integrated DER Value – Tech Transfer webcast summary

One of the key technical challenges of Distributed Energy Resource (DER) deployment is enabling integrated DER technologies for devices, systems, and platforms (collectively termed *DER technologies*) to provide enhanced value to customers and the grid. This integration of DER technologies can be at two levels: 1) an individual DER technology (for example, Demand Response) integrated with utility systems and markets and 2) multiple DER technologies integrated among one another behind a customer meter or within an interconnection boundary and with grid operator systems and markets.

As shown in the figure, the information and communications technology (ICT) backbone (representations in green color) provides interoperable (of communication interfaces) and interconnected (of electrical interfaces) integration features to individual or multiple DER technologies.

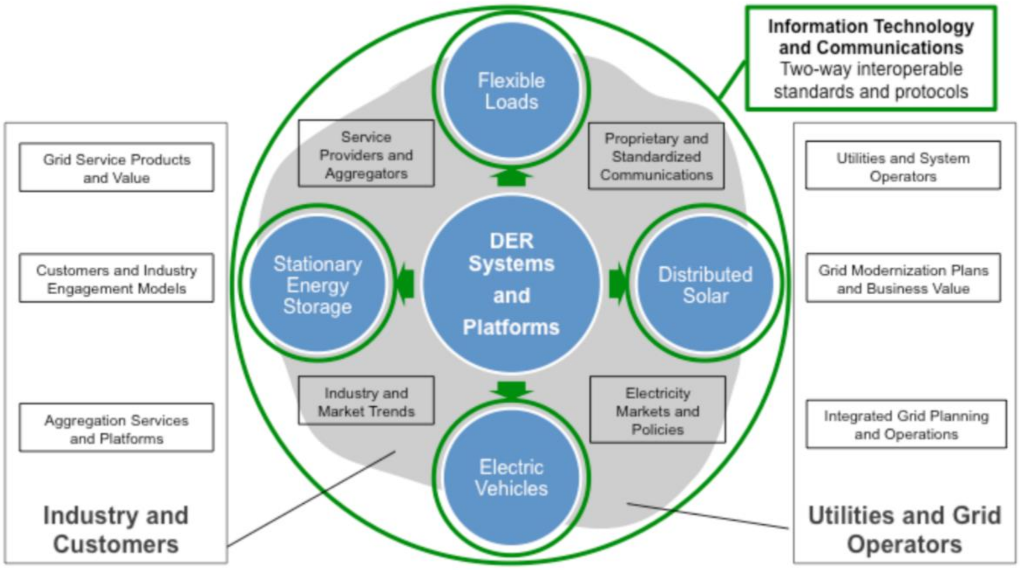

Figure 3 ICT backbone for DER technologies

The view from the lens of an integrated DER technology is an opportunity for electric utilities, grid operators, industry, and customers to enhance the value of DER deployment by integrating them with the electric grid systems and among individual DER technologies. The multiple value streams can be economic (for example, cost savings from DR program participation) along with enhanced grid reliability and stability (for example, energy storage to mitigate variability from renewable generation).

A collaborative presentation from EPRI program experts highlights a recently completed study that reviewed utilities' critical need for the state-of-the-art research in DER technology integration and the value they can provide at different spatial levels.[1] ***The study answers two key questions: Why should***

[1] *Assessment of Integrated Energy Technologies Research: Flexible Loads, Distributed Solar, Energy Storage, and Electric Vehicles. EPRI, Palo Alto, CA: 2018. 3002012960*

utilities care to integrate loads, PV, and energy storage systems? What value does DER integration provide to both grid and customers?

The presenters include the following members from multiple EPRI programs:

- P161: Rish Ghatikar and Ben Ealey
- P18: John Halliwell
- P94: David Stevens
- P174: Aminul Haque
- P204: Penn Zhao

Further information and the results of this research and outcomes can be found in EPRI technical report, *Assessment of Integrated Energy Technologies Research: Flexible Loads, Distributed Solar, Energy Storage, and Electric Vehicles*. EPRI, Palo Alto, CA: 2018. 3002012960.

For more information, contact Sr. Program Manager Rish Ghatikar (gghatikar@epri.com)

OpenDERMS Testing Platform: 2019 Update

EPRI has been developing a Distributed Energy Resource Management System (DERMS) testing platform since 2013. The focus on DERMS was the result of a meeting wherein system operators indicated that their “next big problem” was going to be the need to manage individual DER in aggregate; that they could not be sending commands to thousands (or potentially millions) of devices in their networks. From this driver, the functional requirements for grouping DER so that they could be managed in aggregate evolved, and the need emerged for a DERMS function to be created.

This need obviously resonated with the stakeholder community as evidenced by a walk down the main floor at DistribuTECH, held in New Orleans this year. Numerous vendors were now touting their DERMS applications and platforms. However, to distinguish between an existing product that has had the “DERMS” label slapped on it versus new products that will meet the requirements of systems operators, EPRI has identified four characteristics of a DERMS:

Translate
Individual DER may speak different languages, depending on their type and scale. DERMS handle these diverse languages, and present to the upstream calling entity in a cohesive way.

Aggregate
DERMS take the services of millions of individuals DER and present them as a smaller, more manageable, number of aggregated virtual resources that are aligned with the grid configuration.

Simplify
DERMS provide simplified aggregate services that are useful to distribution operations. Device-level settings, details and iterations are abstracted away as services are achieved and sustained.

Optimize

A given service to be provided by a DER group may be achieved in many ways. Different smart inverter functions may be best at different locations or times. DERMS manage the members of a DER group in the optimal way, saving cost, reducing wear, and optimizing asset value.

Over the years, as EPRI has worked with national labs, vendors, utilities, and the standards communities, we've identified the need to create a testing platform for DERMS, to ensure that these systems meet requirements and expectations of the stakeholder community. The high-level scope of such a system is shown in the figure below.

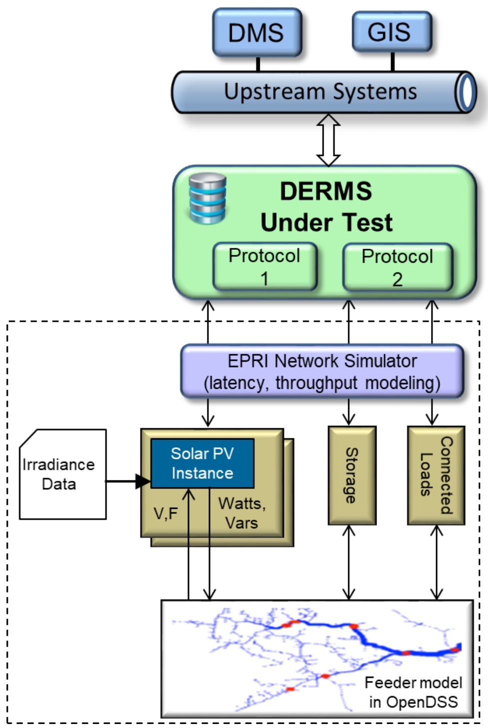

Figure 4 DERMS testing platform

As can be seen from the figure, the entire end-to-end architecture can be tested, from "upstream systems" such as Distribution Management System (DMS) or Energy Management System (EMS). DER grouping, control and management messages can be sent to a DERMS using IEC standard 61968-5. The "DERMS under test" can either be EPRI's OpenDERMS (perhaps if the tester wants to verify DMS vendor compliance to IEC 61968-5), or a vendors DERMS product, or perhaps the utility wants to test the outcomes of a particular algorithm. This coupled with a network simulator can emulate various network capabilities whether that be broadband or PLC, whether the traffic is clean or if there is noise and packet loss that impacts performance. EPRI can then couple the DERMS testing platform with various smart inverter simulators or vendor supported devices.

Plans for The OpenDERMS

With that context set, let's look at the OpenDERMS platform. EPRI's work with DERMS in 2013 started as an ad hoc approach as specific requirements for projects with national labs or utilities were worked on. Eventually the technical debt associated with this approach necessitated refactoring the platform taking a more modular approach as seen in the figure below.

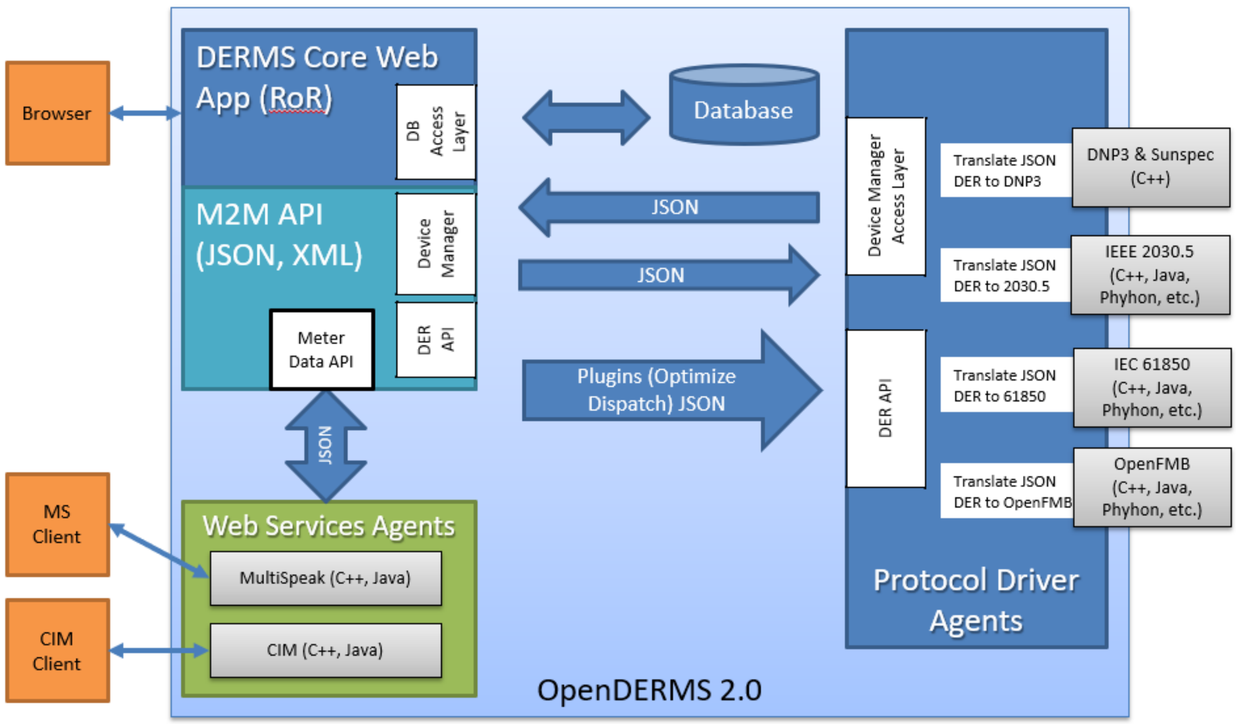

Figure 5 OpenDERMS schematic

This modular approach is setup such that messages can come in via IEC 61968-5 or MultiSpeak, then these are all converted internally into a consistent Javascript Object Notation (JSON) format. This format can then be mapped to specific protocols that may be spoken by individual DER. The first translator developed was for DNP3 – which also matched the first PV simulator that EPRI had also developed.

In 2019 there are two main efforts: IEC 61850 and OpenFMB.

For IEC 61850, EPRI has worked with Electricity de France (EdF) who has provided a IEC 61850 client. IEC 61850 uses XMPP as the network protocol so EPRI will be working to take the JSON mapping of inbound messages to the IEC 61850 object model, then transporting this over XMPP to a IEC 61850 device.

For Open Field Message Bus (OpenFMB), EPRI will be leveraging the IEC 61968-5 mapping to OpenFMB. OpenFMB uses a hybrid data model; a mix of IEC common information model (CIM) and

IEC 61850 data objects. However, OpenFMB supports many more devices than just smart inverters. However, OpenFMB is a logical bus. Each node in an OpenFMB network talks to its neighbor using a publish-subscribe message exchange pattern. Thus, if one node receives a DER device command, it passes it to each node in the logical bus. Thus, the smart inverter will eventually receive the commands for which it has subscribed.

The plan is for these new capabilities to be demonstrated at the "Mother of all Plug Fests", an event that EPRI is hosting the week of September 23rd, at the EPRI Charlotte campus. This event is sponsored by the Department of Energy and Duke Energy and is held in conjunction with the Utility Communications Architecture International Users Group (UCAIUG). This event will bring together researchers, government, national labs, and utilities, to watch or perform integration testing of Customer Information Model (CIM) - based standards, OpenFMB, and IEC 61850.

For more information about this event, or other OpenDERMS questions, please contact Dr. Gerald R. Gray (ggray@epri.com)

Distributed Intelligence – Tech Transfer webcast summary

Imagine the distribution system as an orchestra. The lowest layer is the individual musician or distribution equipment controller who plays or controls a specific instrument or asset based on the sheet music or control logic. The intermediate layer aggregates all the similar instruments or assets into a section. The section has some level of coordination, looking to the "1st chair" for direction or an intermediate control system. The top layer aggregates the entire orchestra and is managed by the conductor or an advanced distribution management system (ADMS). The conductor or ADMS does not "micro-manage" the individual musicians or controller nor does it tell them how to play or control their instruments or its assets. Also, the conductor or ADMS does not coordinate each individual section. The conductor or ADMS makes higher level decisions, like what music to play or optimization strategy to employ, when to start playing or optimizing, etc. The conductor may provide override controls, like when to raise the intensity or when to start/stop playing the piece, just like the ADMS provides oversight and controls to the sub controllers. The orchestra analogy is fitting of a hybrid distribution control strategy.

The webcast and associated report titled *A Guidebook to Centralized, Hierarchical, and Local Autonomous Intelligence for Distribution Systems* (3002013416) ponders the hybrid control architecture as well as the traditional centralized and localized control architecture through the lens of two applications, volt-VAR control and Fault Location Isolation Sectionalization and Restoration (FLISR) . The driver for the hybrid control architecture is the number of distributed energy resources and monitoring points on the grid of the future. This is illustrated in the figure below. The number of monitoring and control points have and will continue to grow at a rapid pace. Just a few years ago, there were tens of hundreds of points associated with a distribution circuit. In the near future, there will be tens of thousands with millions of points across a utility's service territory.

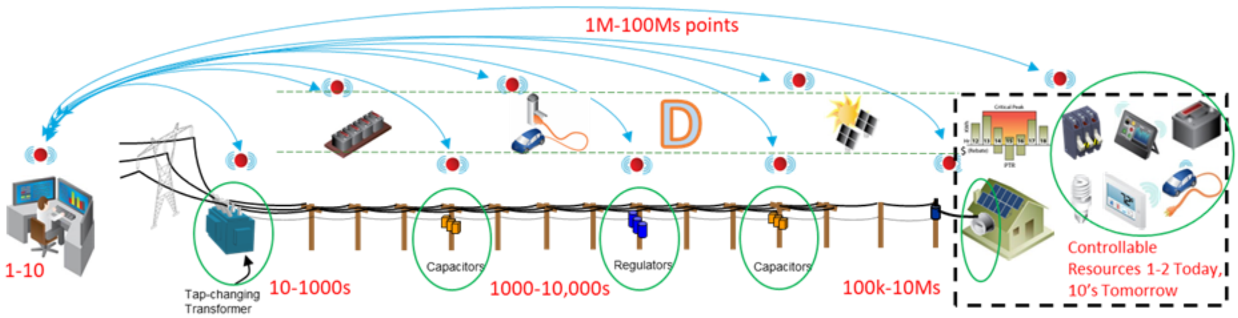

Figure 6 Number of distributed energy resources and monitoring points on the grid of the future

The key findings are as follows:

- A hybrid control architecture, one with local autonomous, hierarchical, and centralized control elements, can optimize grid operations.
- Communication bandwidth requirements can be reduced when planned in combination with system architecture.
- Segmentation of the feeder can increase system security if considered along with the overall architecture design.
- Grouping of distributed energy resources (DER), such as with a DER management system (DERMS), can allow a distribution management system (DMS) to focus on downstream groups as if they were a single entity, thereby reducing bandwidth from the DMS to the DERMS.
- An optimized control architecture can relieve the DMS of detailed data and status management and enable scalability.
- The optimal communication technology is greatly influenced by the requirements of the existing and future distribution applications and system.
- Linkage of applications to architecture and control strategies as well as grid functions is important.

In planning distribution system control architecture and the communication technology or technologies, a review of how the control architectural changes and the requirements of the systems and applications impact the communication requirements is needed. A look at the potential issues assists the utility in identifying and prioritizing the important elements of the distribution system control architecture. This will also help to understand how the communication system will handle future additions of DER, supporting applications, and when upgrades should be considered.

For more information, contact Sr. Technical Leader Jared Green (jgreen@epri.com)

Webcast Dates: January – December 2019

161 Information and Communication Technology Program
Presentations and Recordings of all webcasts can be accessed thru the [member center]

Enterprise Architecture *Project Set 161E (kick-off)*	***January 16, 2019*** *(1:00 p.m. Eastern, 10:00 a.m. Pacific)* *Presenter: Gerald Gray*
Advanced Metering Systems *Project Set 161F (kick-off)*	***January 17, 2019*** *(1: 00 p.m. Eastern, 10:00 a.m. Pacific)* *Presenter: Ed Beroset*
ICT for Distribution *Project Set 161C (kick-off)*	***January 22, 2019*** *(4:00 p.m. Eastern, 1:00 p.m. Pacific)* *Presenter: Jared Green*
ICT for Transmission *Project Set 161B (kick-off)*	***January 23, 2019*** *(12:00 p.m. Eastern, 9:00 a.m. Pacific)* *Presenter: Paul Myrda*
ICT for DER and DR *Project Set 161D (kick-off)*	***January 23, 2019*** *(2:00 p.m. Eastern, 11:00 a.m. Pacific)* *Presenter: Ben Ealey*
Telecommunications *Project Set 161G (kick-off)*	***January 30, 2019*** *(11:00 a.m. Eastern, 8:00 a.m. Pacific)* *Presenter: Tim Godfrey*
Emerging Technologies and Technology Transfer *Project Set 161A (kick-off)*	***January 31, 2019*** *(11:00 a.m. Eastern, 8:00 a.m. Pacific)* *Presenter: Don Von Dollen*
Interoperability Webcast: *Network Model Management*	***March 7, 2019*** *(1:00 p.m. Eastern, 10:00 a.m. Pacific)* *Presenter: Sean Crimmins*
Interoperability Webcast: *EPRI OpenDERMS Platform*	***March 13, 2019*** *(11:00 a.m. Eastern, 8:00 a.m. Pacific)* *Presenter: Gerald Gray*
Technology Transfer Webcast: *Distributed Intelligence*	***May 15, 2019*** *(4:00 p.m. Eastern, 1:00 p.m. Pacific)* *Presenter: Jared Green*
ICT for Transmission *Project Set 161B (mid-year)*	***May 17, 2019*** *(11:00 a.m. Eastern, 8:00 a.m. Pacific)* *Presenter: Paul Myrda*

ICT for DER and DR
Project Set 161D (mid-year)

May 30, 2019 *(1:00 p.m. Eastern, 10:00 a.m. Pacific)*
Presenter: Ben Ealey

Emerging Technologies and Technology Transfer
Project Set 161A (mid-year)

June 4, 2019 *(4:00 p.m. Eastern, 1:00 p.m. Pacific)*
Presenter: Don Von Dollen

Technology Transfer Webcast:
Assessment of Integrated Energy Technologies Research for DER Value

June 5, 2019 *(4:00 p.m. Eastern, 1:00 p.m. Pacific)*
Presenter: Rish Ghatikar

ICT for Distribution
Project Set 161C (mid-year)

June 6, 2019 *(1:00 p.m. Eastern, 10:00 a.m. Pacific)*
Presenter: Jared Green

Enterprise Architecture
Project Set 161E (mid-year)

June 11, 2019 *(2:00 p.m. Eastern, 11:00 a.m. Pacific)*
Presenter: Gerald Gray

Interoperability Webcast:
DLMS / COSEM

June 12, 2019 *(2:00 p.m. Eastern, 11:00 a.m. Pacific)*
Presenter: Ed Beroset

Advance Metering Systems
Project Set 161F (mid-year)

June 20, 2019 *(11:00 a.m. Eastern, 8:00 a.m. Pacific)*
Presenter: Ed Beroset

Telecommunications
Project Set 161G (mid-year)

June 26, 2019 *(11:00 a.m. Eastern, 8:00 a.m. Pacific)*
Presenter: Tim Godfrey

Information and Communication Technologies P161 2020 ARP Rollout Webcast

July 1, 2019 *(11:00 a.m. Eastern, 8:00 a.m. Pacific)*
Presenter: Don Von Dollen

Technology Transfer Webcast:
Adaptive Substation Architecture

July 9, 2019 *(11:00 a.m. Eastern, 8:00 a.m. Pacific)*
Presenter: Paul Myrda

Interoperability Webcast:
OpenADR

August 13, 2019 *(4:00 p.m. Eastern, 1:00 p.m. Pacific)*
Presenter: Rish Ghatikar

Technology Transfer Webcast:
Data Analytics for AMI Data

August 15, 2019 *(1:00 p.m. Eastern, 10:00 a.m. Pacific)*
Presenter: Ed Beroset

Interoperability Webcast:
DER Standards Update

Sept 19, 2019 *(1:00 p.m. Eastern, 10:00 a.m. Pacific)*
Presenter: Ben Ealey

Interoperability Webcast:
Telecom Standards Update

October 17, 2019 *(1:00 p.m. Eastern, 10:00 a.m. Pacific)*
Presenter: Tim Godfrey

Technology Transfer Webcast: *Private LTE*	***October 31, 2019*** *(2:00 p.m. Eastern, 11:00 a.m. Pacific)* *Presenter: Tim Godfrey*
Interoperability Webcast: *CIM Update*	***November 5, 2019*** *(1:00 p.m. Eastern, 10:00 a.m. Pac)* *Presenter: Gerald Gray*
Emerging Technologies and Technology Transfer *Project Set 161A (year-end)*	***November 19, 2019*** *(1:00 p.m. Eastern, 10:00 a.m. Pac)* *Presenter: Don Von Dollen*
Advanced Metering Systems *Project Set 161F (year-end)*	***November 21, 2019*** *(1:00 p.m. Eastern, 10:00 a.m. Pac)* *Presenter: Ed Beroset*
ICT for DER and DR *Project Set 161D (year-end)*	***December 3, 2019*** *(11:00 a.m. Eastern, 8:00 a.m. Pac)* *Presenter: Ben Ealey*
ICT for Distribution *Project Set 161C (year-end)*	***December 5, 2019*** *(1:00 p.m. Eastern, 10:00 a.m. Pac)* *Presenter: Jared Green*
Enterprise Architecture *Project Set 161E (year-end)*	***December 9, 2019*** *(11:00 a.m. Eastern, 8:00 a.m. Pac)* *Presenter: Gerald Gray*
Telecommunications *Project Set 161G (year-end)*	***December 11, 2019*** *(11:30 a.m. Eastern, 8:30 a.m. Pac)* *Presenter: Tim Godfrey*
ICT for Transmission *Project Set 161B (year-end)*	***December 13, 2019*** *(2:00 p.m. Eastern, 11:00 a.m. Pac)* *Presenter: Paul Myrda*
Interoperability Webcast: *IEC 61850 Interoperability Test*	***December 17, 2019*** *(1:00 p.m. Eastern, 10:00 a.m. Pac)* *Presenter: Paul Myrda*

Contact Linda Dabbs, tel (650) 855-8553 for details regarding webcasts and meetings.
Check All Meetings & Webcasts on the Information and Communications Technology cockpit at www.epri.com for webcast details and materials.

Deliverables: January – May 2019

Product ID	Title	Project Set	Published
3002015875	Remote Device Management: Utility Requirements	161B	29-May-2019
3002015918	Common Information Model Primer: Fifth Edition	161E	21-May-2019
3002015915	Utility Cloud Integration Guidebook, 4th Edition: A Guide for Enterprise Architects	161E	15-May-2019
3002016061	Top Ten Indicators of Enterprise Architecture (EA) Maturity - 2018 Results	161E	13-May-2019
3002016144	Test Procedure for Validating DNP Application Note AN2018-001 in Distributed Energy Resources: Example Test Procedure for Evaluating Conformance to DNP Application Note AN2018-001 – "DNP3 Profile for Communications with Distributed Energy Resources"	161D	08-May-2019
3002016335	Enhancing Grid Resiliency Through Improving Capabilities to Manage Communicating Energy Storage and Solar Systems: Expanding Standards and Developing Tools to Enable DNP3 Support of Storage Use Cases	161D	08-May-2019
3002016527	DER Attributes and Representation in Systems of Record: First Edition	161E	24-Apr-2019
3002012735	The Integrated Grid Demonstrations Initiative: 2018 Annual Report	161A	22-Apr-2019
3002016452	Common Information Model Primer: 4th Edition (Spanish Translation)	161E	11-Apr-2019
3002014851	EPRI Enterprise Architecture Workshop Proceedings: Atlanta, Georgia September 2018	161E	28-Mar-2019
3002015505	Common Information Model Activities Report: 2018 Results	161E	19-Mar-2019
3002013400	Next Generation Advanced Metering Infrastructure (AMI) System Design and Utilization: Case Studies in Utility Innovation	161F	14-Mar-2019
3002015355	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"	161D	25-Feb-2019
3002013397	PRE-SW: DLMS/COSEM Reference Implementation (DLMS/COSEM), v1.0 Beta	161F	21-Jan-2019

For additional information regarding Information, Communication Technologies contact your Technical Advisor:

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