Communication Standards for Demand Response and Distributed Energy Resources

EPRI ICT Staff
EPRI IntelliGrid Smart Grid Information Sharing Webcast
November, 2014
Reference Diagram
Field Communication for Demand Response
Applying OpenADR

• Provides non-proprietary, open, standardized DR communications
• Allows electricity providers to communicate DR signals directly to customers
• Uses a common language and existing communications (such as the Internet)

Source: LBNL

Interactions Between VTNs and VENs

OpenADR defines the interactions between Virtual End Nodes (VEN) and Virtual Top Nodes (VTN)

NOTE: VEN and VTN refers to the INTERFACE ONLY and not the machine

DRMS = DR Management System
NGR = Non-generating Resource
GEN = DER = Power Source
EPRI’s OpenADR2.0b Software

• Virtual Top Node (Server)
  – Certified by OpenADR Alliance
  – Available on SourceForge (>890 downloads)
  – EPRI PID 1026755

• Virtual End Node (Standalone Client)
  – Certified by OpenADR Alliance
  – Available on SourceForge (>880 downloads)
  – EPRI PID 1026751

• Virtual End Node C++ Library (Embeddable Client)
  – Undergoing EPRI QC Process
  – Will be available on SourceForge soon

Available on:
sourceforge
EPRI’s OpenADR Open-Source Software

<table>
<thead>
<tr>
<th>Role</th>
<th>VTN</th>
<th>VEN</th>
<th>VEN</th>
</tr>
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<tbody>
<tr>
<td>Design Use</td>
<td>DRMS</td>
<td>Desktop Client</td>
<td>Embedded Client</td>
</tr>
<tr>
<td>License</td>
<td>BSD 3-Clause</td>
<td>BSD 3-Clause</td>
<td>BSD 3-Clause</td>
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<tr>
<td>Profiles</td>
<td>2.0a and 2.0b</td>
<td>2.0b</td>
<td>2.0b</td>
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<tr>
<td>Data Models</td>
<td>Push or Pull (Poll)</td>
<td>Pull (Poll)</td>
<td>Pull (Poll)</td>
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<tr>
<td>Transports</td>
<td>HTTP, XMPP</td>
<td>HTTP</td>
<td>HTTP</td>
</tr>
<tr>
<td>Programming Language</td>
<td>JRuby, Java</td>
<td>C#</td>
<td>C++</td>
</tr>
<tr>
<td>Tested Operating Systems</td>
<td>Linux, Mac OS X</td>
<td>Windows 7, 8</td>
<td>C++</td>
</tr>
<tr>
<td>Available on</td>
<td><a href="http://www.SourceForge.net">www.SourceForge.net</a></td>
<td>Yes</td>
<td>Coming</td>
</tr>
<tr>
<td>Downloads</td>
<td>&gt;890 Downloads</td>
<td>&gt;880 Downloads</td>
<td></td>
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</tbody>
</table>
Enterprise Integration for Demand Response
Communication for Demand Response Markets

NIST PAP19 Activity

• PAP19 Purpose: An information model for wholesale DR communications based on the International Electrotechnical Commission (IEC) Common Information Model (CIM)
  – Which then mapped to other relevant profiles such as OpenADR 2.0b and MultiSpeak

• Principle issues addressed:
  – Standardize interfacing between ISOs/RTOs and wholesale market participants for DR signaling
  – Ensure adequate market coverage for DR
  – Eliminate the need for de facto proprietary interfaces
Communication for Demand Response Markets

• Completed in September 2012

• A proposed extension to the IEC Common Information Model

• Covers:
  – DR Deployment (and response)
  – DR Meter Data
  – DR Resource Enrollment
  – DR Resource Market Qualification
  – DR Resource Performance
  – DR Schedule Bid
  – DR Schedule Award

• TC57 WG16 is working on this for CIM
Implementation of the Market Interface for the EPRI OpenADR Server

- Building on prior success of the VTN, VEN open source codes
- Scope and use cases were taken from the PAP19
Connectivity to Devices for Demand Response
Modular Interface for Demand Response

The ANSI/CEA-2045 standard defines a modular port interface for demand response

Goals of the Standard:

• Support mass production by enabling products to be compatible with any communication system
• Minimize upfront product cost
• Networks can evolve over the life of the appliance
• Enable customer program installability, avoid truck rolls

Additional Information about the CEA-2045 standard: Report # 3002004020
Enabling Devices to be Network-type Neutral

Any Network

Examples:
- Water Heaters,
- Heat Pump Water Heater,
- Thermostats,
- Pool Pumps, EVSE,
- PV Inverters

Any End-use Device

Communication Module

Examples:
- Water Heaters,
- Heat Pump Water Heater,
- Thermostats,
- Pool Pumps, EVSE,
- PV Inverters
Example CEA-2045 Application

Utilities are Filed Testing CEA-2045 Based Products

Additional Information about the Field Demonstration Project: Report # 3002004009
Field Communication for DER
Field Communication for DER

IEC 61850-90-7 → IEC 61850-7-420

Standard Function Descriptions

Standard Information Model (IEC 61850)

Mapped to Protocols

- DNP3
- SunSpec
- Modbus
- SEP2.0
- 61850 MMS

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• Grid codes are laws that require that DG meet certain requirements
• Historically, grid codes have required only that inverters behave properly at the AC power connection
• IEEE P1547
• New grid codes are considering the DER communication interface too
• IEEE P1547.8 (recommended practice), P1547-2017 full revision
• CA Rule 21 Revisions
## References for Field Communication for DER

<table>
<thead>
<tr>
<th>Document</th>
<th>Description</th>
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<tr>
<td>EPRI 1020435</td>
<td>Development of a Standard Language for PV and Storage Integration</td>
</tr>
<tr>
<td>EPRI 1020906</td>
<td>Standard Language Protocols Whitepaper</td>
</tr>
<tr>
<td>EPRI E237894</td>
<td>Common Functions for Smart Inverters, Update DNP3 Standard</td>
</tr>
<tr>
<td>IEC 61850-90-7</td>
<td>Information Model for DER + Standard Function Definitions</td>
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<tr>
<td>EPRI 1021674</td>
<td>Specification for Smart Inverter Interactions with the Electric Grid Using International Electrotechnical Commission 61850</td>
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<tr>
<td>EPRI 3002002233</td>
<td>Common Functions for Smart Inverters, Version 3</td>
</tr>
<tr>
<td>EPRI 1017909</td>
<td>Advanced Metering Infrastructure (AMI) Considerations for Distributed Renewables Integration</td>
</tr>
<tr>
<td>DNP AN2011-001</td>
<td>DNP3 Profile for Basic Photovoltaic Generation and Storage</td>
</tr>
<tr>
<td>DNP AN2013-001</td>
<td>DNP3 Profile for Advanced Photovoltaic Generation and Storage</td>
</tr>
<tr>
<td>Multiple</td>
<td>DRGS DEWG Documentation (<a href="http://www.sgip.org/distributed-renewables-generation-storage-drgs-dewg">www.sgip.org/distributed-renewables-generation-storage-drgs-dewg</a>)</td>
</tr>
<tr>
<td>SunSpec</td>
<td>Sunspec Alliance Specifications, Including Modbus mapping</td>
</tr>
<tr>
<td>IEEE P2030.5</td>
<td>Draft Standard for Smart Energy Profile 2.0</td>
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<tr>
<td>IEEE 1547</td>
<td>Standard for Interconnecting Distributed Resources</td>
</tr>
<tr>
<td>CA Rule 21</td>
<td>California’s Electric Tariff Rule 21, revisions in process</td>
</tr>
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</table>
Electric Vehicle Integration
Standards for Plug-in Electric Vehicles

• The Society of Automotive Engineers (SAE) - develops most vehicle standards and recommended practices
• SAE standards - not legally required to be followed in US unless mandated (usually through Federal Motor Vehicle Safety Standards – FMVSS)
• SAE standards being developed for:
  – Connectors and low level charging function (SAE J1772™)
  – Communications (SAE J2836 family of standards)
  – Wireless charging (SAE J2954)
  – Power Quality (SAE J2894)
  – PEV as distributed resource (SAE J3072 – on board inverter)
• UL safety standard for off board PEV inverter (UL 9741)
SAE J2836 Family of Documents

Use Cases
- Smart Charging (U1 – U5)
- DC Charging
- PEV as Distributed Energy Resource (DER) (U6 & U7)
- Diagnostics
- Customer to PEV and HAN/NAN (U8 & U9)
- Wireless Power Flow

Applications & Signals
- J2836/1™
- J2836/2™
- J2836/3™
- J2836/4™
- J2836/5™
- J2836/6™

Protocol Requirements
- J2847/1
- J2847/2
- J2847/3
- J2847/4

Internet
- J2931/5

IEEE 802.11n or 802.11p

PLC (BB OFDM)

On-board Inverter

Interoperability, Test Procedures
- J2953/1
- J2953/2

Security
- J2931/7

Rich Scholer - SAE Communication Task Force Status
6/19/2014- IWC Presentation

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Key Communications Standards

• SAE J2836/1, J2847/1, J2931/1 and J2931/4:
  – Utility to vehicle communications; based on use of SEP2.0
  – HomePlug GreenPHY

• SAE J2836/2, J2847/2, J2931/1 and J2931/4:
  – DC Charging communications; based on use of XML based protocol developed in Germany (under DIN 72121) and adopted into 15118 and J2847/2
  – HomePlug GreenPHY

• ISO does not plan to use SEP2.0 for utility communications
  – they will use elements built into 15118
ISO/IEC Has Parallel Standards

• Technical Committee 69
  – IEC 61851 series documents ~ J1772™
    – 61851-1 is general requirements
    – 61851-22 is AC charging
    – 61851-23 is DC charging
    – 61851-24 is PEV to charge station communication
• ISO 15118-1 similar to J2836 family of documents
• ISO 15118-2 similar to J2847 family of documents
• ISO 15118-3 similar to J2931 family of documents

Work continues to ensure harmonization of SAE and ISO/IEC standards
Enterprise Integration of DER
Enterprise Integration of DER
Developing CIM, MultiSpeak Support (2012-2014)

- Creation and management of groups and sharing of group definitions
- Capabilities discovery
- Monitoring of group status
- Dispatch of real and reactive power
- Forecasting of group capabilities

Report 3002001249
Enterprise Integration Functions for Distributed Energy Resources
Supporting Sequence Diagram Examples
Interoperability Testing

Tests conducted anytime, anywhere

Report 3002004681
Enterprise Integration Functions Test Plan for Distributed Energy Resources, Phase 1
Next Steps

• Finalize support in CIM and MultiSpeak
• Interest Group – take on the next round of needs
• Define and Document New Test Cases
• Update Test Harness
• Conduct 2nd Workshop
• Feedback to Standards Organizations
Discussion
Together…Shaping the Future of Electricity
Reference Materials
References for EPRI’s OpenADR Project


