EPRI / SNL PV-Storage Inverter Communication Project

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Electric Power Research Institute (EPRI)
EPRI Smart Inverter links:
- ftp://PVCommunication:Member@ftp.epri.com/

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National Institute of Standards and Technology
NIST Smart Grid and PAP7 links:
- http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PAP07Storage
- http://www.nist.gov/smartgrid/
A Vision for “Smart Inverters”

Communication-Connected Distributed Solar and Storage Systems Serving as Beneficial Distribution System Assets
Breaking Down the Need

Interoperability – Many devices in distribution systems. Diverse types, diverse manufacturers. Serving as active parts of distribution management.

Ability to Communicate - Standard Languages as appropriate for the domain in which the devices are integrated.

Standard Information – What specific pieces does the Utility need to pass to the devices and visa-versa?

Common Functions – What are the basic grid-supportive functions that distributed resources are expected to perform?
Working Back toward the Goal of Interoperability

Step 1: Identifying Common Functions – Using NIST, IEEE, SunSpec, & the interest group to identify needs.

Step 2: Standard Model - Representing the Information to be exchanged on IEC 61850-7-x

Step 3: Mapping to Protocols – Field: DNP3 (IEC 61400-25-4), MMS (IEC 61850-8-1), Webservices, Customer: SEP 2.0, others

Step 4: Demonstration – Prototyping, Laboratory Testing, and field demonstration projects to prove-out best uses and to determine value.
The NIST Role


In cooperation with the DoE, NEMA, IEEE, GWAC, and other stakeholders, NIST has “primary responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems...”
US Government Roles in Smart Grid

Federal

- Office of Science & Technology Policy; National Economic Council; & Council on Environmental Quality
- Smart Grid Task Force / National Science & Technology Council Smart Grid Subcommittee
- Other Federal Agencies
- FCC
- Federal Energy Regulatory Commission
- NIST
  National Institute of Standards and Technology
  U.S. Department of Commerce

State

- FERC – NARUC
- Smart Response Collaborative

Public Utility Commissions
NIST Smart Grid Interoperability

- **Framework and Roadmap**
  - published January 2010
  - Smart Grid Reference Model
  - identified 75 key standards
  - 16 Priority Action Plans (PAP)

- **Cyber Security Document**
  - published August 2010

- **SG Interoperability Panel (SGIP)**
  - public-private partnership
  - created November 2009
  - 600 member organizations
  - 1700 participants

- **Coordinates over 20 Standards Development Organizations**
PAP 7: Distributed Generators and Storage

Task 0: Scoping Document
Prioritized timeline for ES-DER standards

Task 1: Use Cases
Define requirements for different scenarios

Task 2: IEEE 1547.4 for island applications and IEEE 1547.6 for secondary networks

Task 3: Unified interconnection method with multifunctional operational interface for range of storage and generation/storage.
IEEE 1547.8 PAR
(a) Operational interface
(b) Storage without gen
(c) PV with storage
(d) Wind with storage
(e) PEV as storage

Task 4: Develop and Harmonize Object Models
IEC 61850-7-420: Expanded to include
- Multifunctional ES-DER operational interface
- Harmonized with CIM & MultiSpeak
- Map to MMS, DNP3, web services, & SEP 2

Task 5: Test, Safe and Reliable Implementation
UL, NEC-NFPA70, SAE, CSA and IEC
Role of EPRI/SNL Smart Inverter Initiative

- Identify Needed Functions
- Select a Specific Way to Implement each Function
- Represent Information in Standard Information Model (IEC 61850)
- Map to Protocols
  - DNP3
  - Smart Energy Profile
  - MMS, Web Services, Other

Interest Group Demonstrations PAP7, IEEE 1547
Focus Group, Others?
Focus Group IEC Working Group
Standards Groups, Funded Efforts
Collaborative Industry Initiative Formed in 2009

More than 450 individuals contributing to the initiative

- 40 PV & Storage equipment providers
- 60 utilities
- 12 National labs and research organizations

Coordinating with PAP7
To Align with IEEE 1547
Functions Addressed and Planned Next

Phase 1 Functions:

• Connect/Disconnect – Non Islanding
• Max Generation Level Control
• Smart VAR Management and PF
• Storage Management
• State/Status Monitoring
• Event Logging
• Time Adjustment

Phase 2 Functions:

• Voltage Sag Ride-Through
• Watt-Voltage Management (transient and steady-state)
• Watt-Frequency Management
• Islanding
• Additions to State/Status Monitoring
Connect/Disconnect

Management of this Switch

• Not the same as Power = 0
• Randomizable
Advanced Volt-Var Control

Volt/Var Mode 1 – Normal Regulation
Simple Broadcast

Volt/Var Mode 2 – Transmission VAR Support
Storage Management

- Randomization
- Minimum Charge
- Maximum Rate of Charge/Discharge

Charge/Discharge Command (%)
Charge/Discharge Schedule

Price Setting
Price Schedule

Charge Profile
Energy Price

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Monitoring & Logging

Monitoring

39 specific status items covered, touching the following areas:

- General Status Information
- Power Measurements
- Battery Storage Status
- Nameplate and Settings

Logging

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Data Reference</th>
<th>Data Value</th>
<th>Event Code</th>
<th>Descriptive Text (optional)</th>
</tr>
</thead>
</table>

![Diagram for the data structure](https://example.com/diagram.png)
DNP3 Mapping – What it Could Provide

• Mapping protocol draft completed and being reviewed.

• An inverter provider could design to these documents and be compatible with multiple types of monitoring and management software/systems.

• A DER management software provider could design to these documents and be compatible with multiple types of resources and inverters.

• An interoperability testing or compliance certification facility could evaluate products of all kinds with one another and against the specification.
SEP2 Mapping

• Mapping currently in process. Expected to be available for public review from the SEP people by the end of the year.

• The SEP2 protocol is the most prominent for residential HAN integration in the US.

• Coordinated with SunSpec prior to starting the mapping – included Phase 1 functions plus extensive status/monitoring points defined by SunSpec.
Work Products of Smart Inverter Initiative

**PHASE 1**

- 3 major industry workshop and reports
  - Whitepaper 1020435-2009
  - Whitepaper 1020906-2010
  - Project Technical Specification 1021674-2010

**DEFINING STARTING SET OF STANDARD FUNCTIONS (COLLABORATIVE ACTIVITY)**

- Use Case and Requirements Contributions to PAP7
- Use Case Summary for Distributed PV and Storage 1022238

**REPRESENTING THE INFORMATION IN TERMS OF IEC 61850 MODELS**

- Contributions to IEC 61850 where gaps were identified
  - IEC 61850-90-7

**MAPPING TO DNP3 (FUNDED BY EPRI)**

- Result an open DNP3 standard

**MAPPING TO SEP2.0 (FUNDED BY EPRI)**

- Result a SEP standard

**OTHERS (OPENADR)?**

- Published EPRI Report (Publicly Available)
- Direct Contribution to Standards Activities

**PHASE 2**

- Define additional needs — from PAP7, Denver workshop, P1547.8, etc.

**REPRESENTING THE INFORMATION IN TERMS OF IEC 61850 MODELS**

- More contributions to IEC TC57

**EXTEND MAPPING TO DNP3**

- Result to be a DNP3 standard

**EXTEND MAPPING TO SEP2.0**

- Result to be a SEP standard

**OTHERS (WEB SERVICES)?**