Overview of Standards for Integrating Distributed Energy Resources

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Integrated Grid Vision

Power System that is Highly **Flexible, Resilient and Connected** and Optimizes Energy Resources
The Integrated Grid is about Enabling the Customer

The integrated grid allows Local Energy Optimization to become part of Global Energy Optimization.
Roadmaps provide path to the vision – Standards are critical
Outline

1. Defining the Architecture
2. Communications Infrastructure
3. Cyber Security
4. Information Models
5. Planning and Operations Tools and Systems
6. Enterprise Integration
7. Next Generation – Open Application Platform
8. Testing is Critical
Smart Grid Architecture
Communications Infrastructure Standards

LAN
- IEEE 802.3 Ethernet
- IEEE 802.11 Wi-Fi

WAN
- SONET/SDH
- Ethernet 1000BASE-X
- MPLS

FAN
- 3GPP HSPA, LTE
- IEEE 802.16 WiMAX
- IEEE 802.11 Mesh

NAN
- RF Mesh: 802.15.4g WiSUN
- IEEE 802.11ah
- PLC: G3, PRIME, Echelon

Devices
- IEEE 802.11 Wi-Fi
- IEEE 802.15.4 ZigBee
- IEEE 1901 HomePlug
Communications Protocols

|------------|------------------|-------------------------------|----------------------------------|------------|------------|-----|-----------|--------|

<table>
<thead>
<tr>
<th>Network Functionality</th>
<th>Routing – RPL</th>
<th>IPv6 / IPv4</th>
<th>Addressing, Multicast, QoS, Security</th>
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<tr>
<th>Comm. Network Layer</th>
<th>802.1x / EAP-TLS based Access Control Solution</th>
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<tr>
<th>Phy / MAC Functionality</th>
<th>6LoWPAN (RFC 6282)</th>
<th>IETF RFC 2464</th>
<th>IETF RFC 5072</th>
<th>IETF RFC 5121</th>
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<tbody>
<tr>
<td>IEEE 802.15.4 MAC</td>
<td>802.15.4e MAC enhancements</td>
<td>IETF RFC 2464</td>
<td>IETF RFC 5072</td>
<td>IETF RFC 5121</td>
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<tr>
<td>IEEE 802.15.4 MAC (including FHSS)</td>
<td>IEEE 802.11 Wi-Fi</td>
<td>IEEE 802.16 WiMax</td>
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<tr>
<td>IEEE 802.15.4g FSK, DSSS, OFDM</td>
<td>IEEE 802.3 Ethernet</td>
<td>IEEE P1901.2 MAC</td>
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<td>IEEE 802.15.4g FSK, DSSS, OFDM</td>
<td>IEEE P1901.2 PHY</td>
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- Standardization at all levels to ensure interoperability and reduce technology risk for utilities
- Enables common application layer services over various wired and wireless communication technologies
Including Cyber Security – IEC 62351

IEC TC57 Communication Standards

- IEC 60870-6: TASE.2 (ICCP)
- IEC 61850 over MMS
- IEC 61850 GOOSE & SV
- IEC 60870-5-104 & DNP3
- IEC 60870-5-101 & Serial DNP3

IEC 62351 Security Standards

- IEC 62351 Part 1: Introduction
- IEC 62351 Part 2: Glossary
- IEC 62351 Part 3: Profiles including TCP/IP
- IEC 62351 Part 4: Profiles including MMS
- IEC 62351 Part 5: IEC 60870-5 & Derivatives
- IEC 62351 Part 6: IEC 61850 Profiles
- IEC 62351 Part 7: Object Models for Network Management
- IEC 62351 Part 8: Role-Based Access Control (RBAC)
- IEC 62351 Part 9: Key Management
- IEC 62351 Part 10: Security Architecture Guidelines for TC57 Systems
Application Layer Protocols

- MDMS
- OMS
- GIS
- Markets

DER Enterprise Integration

- DMS
- DERMS
- DRAS

Sensors, Switches, Capacitors, Regulators

- SOLAR
- BATTERY
- PEV

- IEC CIM 61968 61970
- IEC 61850-90-7
- DNP3
- OpenADR 2.0b
- ANSI C12
- DLMS COSEM
- SunSpec ModBus
- IEEE P2030.5 SEP2.0
- CEA 2045
Example – AMI Integration
Integration Process – Smart Inverter Example

1. Identify Needed Functions
2. Select a Specific Way to Implement each Function
3. Represent Information in Standard Information Model (IEC 61850)

- Interest Group, Demonstrations, PAP7, IEEE 1547
- Focus Group, Others
- Focus Group, IEC Working Group

Map to Protocols:
- DNP3
- Modbus
- 61850 MMS, Web Services, Other

Standards Groups
Model Integration is a key requirement

Distribution Management System Applications

- Distribution SCADA
- Distribution Automation (outage mgt)
- Voltage and Var Control
- Optimize Losses
- DG and Microgrids
- Demand Management (and EV mgt)
Example of Next Generation Opportunity – Open App Platform

Central Intelligence vs Edge Intelligence

The Advanced Metering Example
Understanding the Value
Testing Labs

- SCE Advanced Technology Labs
- PG&E Technology Center
- SDG&E Integrated Test Facility
- Ameren T&D Test Bed
- Duke Energy Envision Center
- AEP Dolan Labs
- EPRI Distribution Test labs
- ENEL Smart Grid Test System
- NEETRAC
- NREL ESIF
- Sandia National Labs DETL
- IREQ (Hydro Quebec)
- PowerTech Labs (BC Hydro)
- Fraunhofer DERLab
- Iberdrola Bidelek Sareak Test Bed
- EDF Concept Grid
- Strathclyde Power Networks Demonstration Centre
DER/DR Architecture
Important Coordinating Efforts and Documents

- NIST Smart Grid Interoperability Framework 3.0

- European Smart Grids Technology Platform and 2035 Research Agenda
  - [http://www.smartgrids.eu/](http://www.smartgrids.eu/)

- IEC TC8 (Systems Aspects of Smart Grid)
  - WG 5: “Methodology and Tools”
  - WG 6: “Generic Smart Grid Requirements”
  - WG 7: “General Planning, Design, operation and Control of the Micro-Grid”
  - PT 62786: “Demand Side Energy Source Interconnection with the Grid”

- IEC TC57 (Communications and Information Integration)
  - WG 10 Power system IED communication and associated data models
  - WG 13 Energy management system application program interface (EMS - API)
  - WG 14 System interfaces for distribution management (SIDM)
  - WG 15 Data and communication security
  - WG 16 Deregulated energy market communications
  - WG 17 Communications systems for distributed energy resources (DER)

- IEEE 2030 - [http://grouper.ieee.org/groups/scc21/2030/2030_index.html](http://grouper.ieee.org/groups/scc21/2030/2030_index.html)

- IEEE 1547 revision - [http://grouper.ieee.org/groups/scc21/1547/1547_index.html](http://grouper.ieee.org/groups/scc21/1547/1547_index.html)

Working together!