Standards, Protocols, and Technologies for Building a Smart Grid in California

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May 14, 2009
Characteristics of the Modern Grid

• Enable active participation by consumers
• Accommodate all generation and storage options
• Enable new products, services, and markets
• Provide power quality for the needs of a digital economy
• Optimize asset utilization and operating efficiency
• Anticipate and respond in a self-healing manner
• Operate resiliently in disasters, physical or cyber attacks
Why Use Standards?

- Avoid re-inventing the wheel
- Learn from industry best practices
- Specify requirements more easily
- Reduce integration costs
- Prevent single vendor “lock-in”
- Vendors share a much larger market
Why Not Use One Standard Everywhere?

The Smart Grid is different than the Internet:

- The network must be absolutely reliable
- Endpoints must be much lower cost
- Device hardware can’t be upgraded often
- Can’t just ignore very rural customers
- Need security all the time, not just sometimes
- Applications are still being defined

- Network
- Application

Physical
Smart Grid Standards Framework

**SmartGrid Specifications and Standards Framework**
*(Examples)*

- **Economic Justification | Stakeholder Benefits | Business Case** *(Utility Specific)*

- **Utility/Stakeholder Needs**
  - **Concept of Operations** *(White Papers)*
  - **Use Cases**
    - SAE PEV Use Cases
    - SCE Use Cases
    - OpenHAN/ZigBee/HP
  - **Requirements**
    - UCA
    - OpenHAN SRS
    - AM-ENT SRS
    - AM-SEC SRS
    - IEC TC 8 SRS**

- **Platform Agnostic Standards**
  - **Application Standards** *(APIs)*
  - **Communication Standards**
    - ANSI C12.22
    - IEC 61850
    - IEC SmartEnergy
    - IETF
  - **Data Standards**
    - IEC 61970/68

- **Platform Specific**
  - **Equipment Standards**
    - ANSI C12.19
    - IEEE 1547
    - NEMA Class 5
  - **Platform Communication**
    - IEEE 1901
    - IEEE 802.15.4
    - IEEE 802.11
    - IEEE 802.16
  - **Component/Stack Communications** *(e.g., CAN)*

- **Certifying/Logo Organization**
  - ZigBee
  - HomePlug
  - WiFi
Smart Grid Standards Acceleration Challenges

- The number of stakeholders, range of considerations and applicable standards are very large and complex which requires a formal governance structure at a national level involving both government and industry, with associated formal processes to prioritize and oversee the highest value tasks.

- The smart grid implementation has already started, and will be implemented as an “evolution” of successive projects over a decade or more. Standards adoption must consider the current state of deployment, development in progress and vendor product development lifecycles.

- Interoperability is generally being discussed too broadly and should be considered in two basic ways, with a focus placed on prioritization and acceleration of the adoption of “inter-system” standards.
What Does the Smart Grid Need?

For the applications of interest, can we agree on:

• What information is to be exchanged?
• What is the data to be named?
• Who is permitted to talk?
• In what format are messages transmitted?
• What frequencies and signals are used?
• What the connector looks like?

The answers are different for:

• Different physical areas of the grid
• Different functions to be performed
Utility Structure vs. Smart Grid Interfaces

- **Market / Regulatory**
  - Extranet

- **Corporate**
  - Enterprise (ESB)

- **Transmission**
  - Wide Area (WAN)

- **Distribution**
  - Field Area (FAN)

- **Load**
  - Home or Premise Area (HAN)
Smart Grid Standards Domains

- ebXML
- CIM/GID
- SOAP/Web Services
- CIM
- ICCP
- DNP3
- 61850
- WiMAX
- CDMA
- GPRS
- Microwave
- SONET
- BACNet
- DRBizNet
- OpenADR
- Field Area Network
- Proprietary
- Distributed Resources
- 61850-7-420
- 1547
- C12.22
- ZigBee
- Wi-Fi
- HomePlug
- Consumer
- SAE J?
- Bulk Wind
- PHEV
- Proprietary
- Asset Mgmt
Market / Regulatory / External

- Standards already exist for e-business
- Mostly web or “web services” based
- Not tailored for electricity markets
- Need to pass events thru to consumers
- Need agreement on the procedures first

RECOMMEND

- Implement rates that reflect true cost of energy – incentive to manage usage
- Finish developing OpenADR
- Use and coordinate with international UN/CEFACT and ebXML standards
- Standardize interfaces to 3rd parties
  - Accelerate UCAIug OpenSG ADE Effort
Utility Corporate / Control Center

- Many different computer systems
- Large amounts of data at high speeds
- Labor-intensive process to set them up
- Lots of good interfaces available
- Need to agree on an application language

RECOMMEND

- Use IEC Common Information Model (CIM)
- Already using Inter-Control Center Protocol
- Harmonize with NRECA MultiSpeak
Utility Transmission / Wide Area Networks

- Lots of wide-area networks available
- Fiber, satellite, frame relay, microwave, etc.
- Commercial-off-the-shelf (COTS) solutions for network management and security
- Utility protocols to substations and within substations are fairly mature

RECOMMEND
- Internet Protocols over COTS solutions
- Use IEC 61850 for new substations
- Continue using DNP3 for legacy subs
- Standardize wide-area protection schemes
Utility Distribution / Field Area Networks

- A variety of proprietary solutions available
  - OK as long as boundaries (well defined points of interoperability) are standards based
- Standards exist, but not always suitable
- Cable, cellular, telephone, ISPs trying to be there
- Must solve the cost/range/speed/reliability puzzle
- Difficult to deploy Internet Protocols

RECOMMEND

- Use Internet Protocols where applicable and practical
- Use DNP3 until IEC 61850 solution available
- IEEE standards for phasors and power quality
- Encourage innovation in radio technology
- Develop dynamic system protection configuration methods to support pervasive DA, DG, DR, and PEV
- Develop new planning tools
• Lots of standards in building/home automation!
• Too many to be interoperable
• Need to select some proven leaders – at least for the primary point of interoperability to the building
• Need to agree on an information model easily translated to inside the building protocols

RECOMMEND - utility
• Develop common info models based on IEC
• Use ANSI metering standards
• AMI-SEC, OpenHAN security specifications
• Coordinate with SAE on PEV integration standards development (electrical and comms – UL, NFPA 70, DR Signaling)
RECOMMEND - consumer

- ZigBee/Homeplug Smart Energy Profile for home
- BACNet and/or OpenADR (depending on successful standardization) for industrial / commercial
- Use or create Internet Protocol variants
- Support de-facto industry efforts like U-SNAP
# NIST Roadmap LHF Standards List

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<td>Cyber security standards for the bulk power system</td>
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<tr>
<td>NIST Special Publication (SP) 800-53, NIST SP 800-82</td>
<td>Cyber security standards and guidelines for federal information systems, including those for the bulk power system</td>
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<td>Open Automated Demand Response (Open ADR)</td>
<td>Price responsive and direct load control</td>
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<td>OpenHAN UtilityAMI 2008 HAN SRS</td>
<td>Home Area Network device communication, measurement, and control</td>
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<tr>
<td>ZigBee/HomePlug Smart Energy Profile</td>
<td>Home Area Network (HAN) Device Communications and Information Model</td>
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Major Challenges

- Pervasive deployment of variable generation (wind and solar) requires smart grid elements to enable it.
- Pervasive deployment of distribution connected DG and PEV affects distribution planning, upgrades, operation and protection dramatically.
- Pervasive deployment of demand response impacts control system stability.
- New standards, technologies, and best practices required to address all of these.
Conclusion

- Many of the standards we need are already there
- There are different needs in different environments
  - Define new applications and procedures
  - Agree on common information models
  - Create define new protocols
  - Develop new technologies
  - Apply systems engineering discipline
- Each of these tasks comes with a cost
- Standards provide the most benefit when implemented frequently and pervasively
- Need a cost-benefit analysis
- Which are the easiest to justify (LHF)?
- Synchronize with the NIST roadmap