SMART GRID COMMUNICATIONS PROGRAM MEETING

September 22-23, 2015

Meeting Summary & Next Steps

The Smart Grid Communications Program Meeting validated the need for enhanced focus on smart grid communications research and development, and the natural alignment of such a program with the Department of Energy's Office of Electricity Delivery and Energy Reliability (DOE-OE). A subsequent roadmapping exercise will be conducted to assist DOE-OE in defining R&D initiatives aimed at addressing the specific and unique needs of electric infrastructure with respect to communications capacity, networks and technology.

The smart grid is rapidly transitioning from networks with hundreds of sensors to networks with millions of sensors. This requires new thinking on network reliability, communications bandwidths, more efficient utilization of existing spectrum, and reactive architectures to ensure infrastructure resilience.

The Smart Grid Communications Program Meeting, sponsored by DOE-OE, identified technology and innovation challenges associated with pervasive smart grid communications, and the current and future innovations that may play a role in the integration of that technology. DOE-OE gauged the interest level of key utility and smart grid communication stakeholders in standing up a formal Smart Grid Communications Research and Development (R&D) program.

Participants representing utilities, vendors, professional associations, and regulatory agencies overwhelmingly responded that there is a role for a robust, active, federally-sponsored Smart Grid Communications R&D program, and that DOE-OE is uniquely positioned in government and industry to responsibly accelerate grid modernization with targeted actions in this domain.

Based on the expressed interest of those in attendance of supporting the development and implementation of a Smart Grid Communications R&D program, DOE-OE intends to enhance its national leadership role in modernizing the nation's electricity delivery system through a roadmapping exercise with key stakeholders. A roadmapping exercise would include multiple opportunities for public and private stakeholders to refine a strategic framework, shape research objectives and develop measurable goals and milestones, to accelerate the nation's adoption of a smarter grid.

The purpose of this report is to provide a summary of the participant-identified key challenges, suggested areas of innovation and R&D, and concepts which may be used as foundational information to enable a successful roadmapping exercise. For additional information, please email SmartGridComms@INL.gov.

Context

DOE-OE's Smart Grid Communications Program Meeting was hosted by Idaho National Laboratory (INL) on September 22-23, 2015. Through a series of facilitated large and small group conversations, participants engaged in establishing the status of smart grid communications implementation; identifying the challenges and barriers encountered in modernizing the grid, the domains for innovation; roles of private and public partnerships; and smart grid R&D areas in which the government could lead. Additionally, the participants were introduced to the Smart Grid Communications Planning and Modeling Tool being developed by DOE-OE and INL and toured INL facilities in order to gain an understanding of existing, relevant capabilities in the DOE national laboratory complex. To conclude the meeting, participants provided insight into a roadmapping exercise in terms of foundational materials and activities needed prior to such an exercise, key stakeholders that should be involved, and how standards and interoperability could play a role. (The meeting agenda and breakout session questions are provided at the end of this document.)

Thirty-nine strategic key stakeholders representing utilities, vendors, professional associations, regulatory agencies, the federal government, and national laboratories participated in this influential meeting.

Many utility stakeholders indicated that they were building their own smart grid communications systems that they will own and operate. Most indicated that their operations required 5-10 distinct communication networks. Participants reported the reasons for implementing smart grid communications were to support advanced metering infrastructure (AMI), safety, reliability, distributed energy resources, expand capacity, and maximize flexibility in architecture to accommodate future needs. Many voiced a lack of trust and

misalignment of business and operational objectives with commercial communication carriers. The misalignment extends to brief product lifecycle length, focus on consumer coverage, lack of common terminology, sensitivity to performance metrics, and action based primarily on regulatory accountability.

Challenges

Challenges and barriers to implementing and maintaining smart grid communications are complex and intertwined. Many of these challenges were perceived as unique to the energy sector, and not likely to be satisfied by solutions created for other industries. The complexity and interrelation aspects of these challenges require multi-level solutions that address interoperability, limited spectrum, security, reliability and resiliency. One key metric utilities use to measure the success of these solutions is by the ease and timeliness of infrastructure recovery following a disaster.

In small groups, participants identified 16 smart grid communications challenges, and then were asked to individually prioritize these items. As seen in Table 1, the top challenges related to the cost, regulations, and availability of spectrum associated with smart grid technologies.

Table 1: Prioritized Challenges of Smart Grid Network Planning

Challenges	Voting Tally
Cost	13
Regulatory*	9
Inadequate Spectrum	7
Regulatory Inconsistencies**	7
Needs from Business Req Gathering	6
Legacy Infrastructure	6
Silos	6
Reliability	6
Uncertainty	6
Internet of Things (IOT) Explosion	6
Spectrum/Network Sharing	5
Security	5
Patching Systems Smart Grid Component vs Legacy Components (IT/OT)	4
Ownership, Right of Way	1
Knowledge from other industries	1
Variations in life cycle	1

*Difficulty in developing comprehensive comms solutions in the current regulatory environment
**Evolving regulatory standards and short notifications create unpredictability for future decisions

It is interesting to note that while cost was cited as one of the most common challenges above, earlier discussion at the meeting indicated that actual discrete costs of communications technologies (beyond one-time project costs) at the organizational level are not well understood. Additionally, perspectives on cost were related to business models, in that organizations that profit by capital expenditures (capex) were more sensitive to operational expenditures (opex).

"Smart grid" generally refers to a class of technology people are using to bring utility electricity delivery systems into the 21st century, using remote control and automation. These systems are made possible by two-way communication technology and computation that has been used for decades in other industries. They are beginning to be used on electricity networks, from generation all the way to the consumers of electricity in homes and businesses. They offer many benefits to utilities and consumers -- mostly seen in big improvements in energy efficiency on the electricity grid and in the energy users' homes and offices.

OE has a vision of a smart grid that uses digital technology to improve reliability, resiliency, flexibility, and efficiency (both economic and energy) of the electric delivery system. The strategy to achieve this vision hinges upon activities that directly address the technical, business, and institutional challenges to realizing a smarter grid.

For more information on the smart grid and DOE-OE's national leadership role in this space, visit energy.gov/oe/services/technology-

Other challenges related to smart grid communications that were articulated by participants throughout the meeting were:

- Utilities' dependence on vendors for solutions advice; and the value of independent third-party resources to assess or validate potential solutions
- Specific types of communications skills shortages; resulting in the need to employ large engineering firm expertise for smart grid communications planning and implementation
- Related to the two challenges above, utilities don't always clearly articulate system performance and system qualities in a language understood by vendors
- Large-scale validation of technology prior to comprehensive deployment
- Necessity of involving trades and front line employees in change management associated with communications modernization and formal training
- Inability to articulate value of flexibility in architecture and design in business and regulatory settings
- Lack of coordination on communications issues between FCC, DOE, NERC and FERC
- Need for input on architecture and interoperability from the SGIP, and standards organizations

At different points during the discussions, utility participants made an appeal for "long-term certainty" or "long-term stability" which developed into a broader topic than expected. In aggregate, the phrase was used to describe technology development, spectrum availability, planning, system design and implementation, finance, and training and recruitment. Neither long-term nor short-term approaches solve all problems, but a thoughtful consideration of the foundations of both approaches might yield new and better hybrids in addressing in tandem communications and modernization challenges.

Areas for Innovation and R&D

Several areas for innovation and R&D that could be facilitated by DOE-OE were identified during the meeting. Participants indicated that these areas would provide significant benefits for the electric sector. These areas are listed below in random order (not prioritized by frequency or impact):

- Advanced spectrum-sharing options
- Convene utility and communications industry stakeholders to solidify common terminology and performance metrics
- Customer-owned communications reliability/resiliency (communications and information assurance beyond the meter)
- Cybersecurity around diverse communications technologies (scalable, decentralized security)
- Density of communications support to microgrid, distributed energy resources, new apps
- Extreme environment communications
- Follow-on to early R&D, grants for restorative services and documentation (resiliency)
- Grants to pilot new technology, fiber optic options, use cases
- Interdependencies between communication priorities, data, and applications
- Interoperability (survey of legacy systems)
- Mixed media (multiple PHY) communications, differing connectivity options, dynamic path selection
- Networks for distributed controls
- Peer to peer networks for distribution and transmissions systems
- Responsible WiFi implementation guidance
- Software defined networking
- Standards conformance
- System architecture (validation, regulatory, control, communications)
- Tools for costing in opex-biased and capex-biased business models

Participants were strongly interested about the potential of collaborating with DOE and national laboratories in research, development, demonstration and deployment activities for smart grid communications technologies. They indicated that national lab capabilities, such as those shown during the INL tour, are unique and that labs could provide an independent, knowledgeable resource utilities need to help determine the best solutions to their complex smart grid challenges. Utility and vendor partnerships with these institutions would greatly enable the successful transformation of the grid.

Smart Grid Communications Planning and Modeling Tool

The Smart Grid Communications Planning and Modeling tool, currently under development by DOE and INL, will assist utility owners, operators, engineers and consultants with smart grid communications planning and engineering. This will be accomplished through the delivery of community-owned tools that assist in first pass geospatial planning, logical diagramming of components, data aggregation estimation, wireless network coverage and capacity, worst case wireless spectrum studies, economic comparisons, and design basis cyber security requirements. This tool will assist in a data first quantitative future-oriented communications strategy using planning and modeling. The term "data first" alludes to the observation that there are very few entirely new devices being installed – just existing devices producing more data, and new applications that require that data to be moved from place to place. Users will use the first order tool to help design communications networks to manage and control the smart power grid. The term "first order" is intended to indicate that the tool should be able to accommodate estimates and best available data alongside default settings, which the user can then improve over time. This tool is not intended replace higher order engineering tools and processes required for complex power grid communication problems.

Smart Grid Technologies Enabled by Communications
(listed by meeting participants)

- Asset failure reporting
- Circuit reconfiguration
- Distributed energy resources
- Distributed intelligence and machine learning
- Drones for monitoring
- Equipment/breaker status
- Fault location
- Advanced Metering Infrastructure
- Field force visibility into devices
- Mobile workforce
- Outage management
- Predictive maintenance
- Security
- Self-healing distributed networks
- Situational awareness
- Smart thermostats
- Transactive energy
- Weather damage prediction

Roadmapping Exercise

As stated above, participants were overwhelmingly supportive of DOE-OE moving forward with an exercise that would result in Smart Grid Communications R&D Roadmap. Participants identified two sets of materials that would assist stakeholders in being prepared to fully participate in a roadmapping exercise: background readings (e.g., relevant DOE funded efforts, emerging technologies, aligned roadmaps from associations,

relevant standards or gaps that require new standards) and the program's vision, mission, value and foundational principles.

Meeting participants expressed interest in their continued involvement in this initiative and recommended additional key stakeholder groups necessary for a successful roadmapping exercise: communications system manufacturers, standards forums, network management and situational awareness operators, security consultants, academia, public safety, renewable energy community and regulatory staff. Participants indicated that commercial wireless operators and broadband network providers ought to be engaged, but it was undecided at what point within the roadmapping process these participants should actively influence the roadmap.

When asked how standards and interoperability play a role in an R&D roadmapping exercise, participants responded that industry standards are foundations for interoperability which go hand-in-hand with certification and compliance testing. Ultimately, participants indicated that standards should follow an established roadmap but that interoperability should have a foundational role in roadmap development. DOE could provide a guiding role and influence the alignment of interoperability with key standards in industry; particularly, opportunities for DOE exist in developing test plans to demonstrate interoperability, partnering with the user community, and illuminating paths of differentiation to motivate suppliers. Participants also emphasized that a "clean slate" vision for communications networks is not constructive without a path between the vision and the present state of affairs.

Christopher Irwin

Department of Energy's Office of Electricity Delivery and Energy Reliability

Christopher Irwin has spent over 20 years in a diverse spectrum of high technology fields from HVAC to semiconductor manufacturing, communication networks for advanced metering, and Smart Grid infrastructure.

At the Department of Energy's Office of Electricity Delivery and Energy Reliability, he has managed over $1.5B in grid modernization projects. He has seen some of the top utilities in the country, from very large to very small, tackle technology, integration and business challenges necessary to bring about the Smart Grid.

Chris leads DOE's Smart Grid standards and interoperability efforts, working alongside NIST, FERC and others in the Smart Grid Interoperability Panel. He founded DOE's participation in the Green Button Data Access Initiative to empower customers with improved access to their own energy data, and works with the GridWise Architecture Council on Transactive Energy concept development.

Prior to joining the DOE, he served as Director of Products at an AMI communications vendor, gaining a perspective on the electric energy sector, as well as natural gas and water infrastructure. Chris holds a B.S. in Mechanical Engineering from the University of Maryland, College Park, and an M.B.A. from the W.P. Carey School of Business at Arizona State University.

Smart Grid Communications Program Agenda

Sponsored by the Department of Energy's Office of Electricity Delivery & Energy Reliability

September 22, 2015 - Day 1

8:30-9:00	Registration at EIL Meeting Center	
9:00-9:30	Welcome	Christopher Irwin
9:30-10:00	Keynote Presentation	Michael Pesin
10:00-10:15	Break	
10:15-10:30	Introduction to Smart Grid Moderated Conversation	Moderator
10:30-11:15	Moderated Group Conversation	State of Smart Grid Comms
11:15-11:30	Conclusion from Group Conversation	Moderator
11:30-11:45	Break	
11:45-1:15	Lunch Presentation Scott McBride	INL's Full Scale Capabilities for Smart Grid R&D and Testing
1:15-2:00	DOE-OE Activities Scott Bauer & Joe Frazier	INL/DOE-OE Tool Development
2:00-2:45	Break	
2:30-2:45	Introduction to Breakout Session	Meeting Smart Grid Comms Challenges
2:45-3:30	Breakout Session	Solutions Needed to Address Smart Grid Comms Challenges
3:30-3:45	Break	
3:45-4:15	Breakout Session Report Out	Solutions Needed to Address Smart Grid Comms Challenges
4:15-4:30	Adjourn Session/Break	

Michael Pesin

Deputy Assistant Secretary, Power Systems Engineering Research and Development

Michael Pesin is Deputy Assistant Secretary for the Power Systems Engineering Research and Development Division in the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability. Mr. Pesin has 30 years of experience in the electric utility industry, much of it directing development and execution of advanced technology programs.

His most recent assignment was with Seattle City Light (SCL) where he developed the technology strategy, managed research and development projects and directed strategic programs to management demonstration projects. His subordinate strategic programs included substation automation, distributed automation, advanced metering infrastructure, enterprise OT communication networks, energy storage, microgrids, transactive energy management and distributed management systems.

Mr. Pesin has numerous professional affiliations, publications and patents. He holds a Master of Science in Electrical Engineering from St. Petersburg State Polytechnic University, St. Petersburg (Leningrad), Russia, is a Licensed Professional Electrical Engineer in the State of Washington, a Certified Project Management Professional (PMP) and a Cisco Certified Design Associate (CCDA).

Welcome to the

SMARTGRID COMMUNICATIONS PROGRAM MEETING

Smart Grid Communications Program Agenda

Sponsored by the Department of Energy's Office of Electricity Delivery & Energy Reliability

September 23, 2015 - Day 2

8:00-8:30	Tour Registration at EIL Meeting Center	
8:30	Leave for INL Site	Christopher Irwin
12:30	Return from Site tour	
12:30-1:45	Lunch at EIL - Discussion on Breakout Sessions	Christopher Irwin
1:45-2:30	Facilitated Breakout Sessions to address Roadmap for Smart Grid Comms R&D	Christopher Irwin
2:30-2:45	Break	
2:45-3:30	Breakout Sessions Conclusion for addressing Roadmap items for Smart Grid Comms R&D	Christopher Irwin
3:30-4:00	Wrap Up and Next Steps	Christopher Irwin
4:00	Adjourn	

U.S. DEPARTMENT OF ENERGY

INL Idaho National Laboratory

SEPTEMBER 22-23

Smart Grid Communications Program Meeting
Tuesday, September 22, 2015

Voting Results: 1) What are the top three SG network planning challenges, and of these, which is the highest priority?

Challenges	Tally
Cost	13
Regulatory	9
Inadequate Spectrum	7
Regulatory Inconsistencies	7
Needs from Business Rep Gathering	6
Legacy Infrastructure	6
Silos	6
Reliability	6
Uncertainty	6
IOT Explosion	6
Spectrum/Network Sharing	5
Security	5
Patching systems SG Component vs Legacy Components	4
Ownership, Right of Way	1
Knowledge from other industries	1
Variations in life cycle	1

2) **What do you consider the best domains for innovation in this space? What improvements or breakthroughs might deliver the greatest payoffs for utilities?**

3) **Utilities are sharing wireless communications capacity over non-licensed bands, the 902-928 band in particular. How can a utility assess the areas that would be appropriate for this sharing and those that would not? How can a utility assess the potential risk of using non-licensed spectrum?**

4) **Utilities are transitioning entirely away from copper loop and using Internet Protocol (IP) methodology. The U.S. government has set aside grant money to help make this happen. What are the impacts of this switch?**

5) **What roles do private infrastructure and private wireless communications technologies play in your**

6) **How are wireless communications being used in your communications networks vs. fiber, other, etc.? What communication networking technologies are you currently using: e.g., WIMAX, Cell/LTE, WiFi? What communications protocols are you using: e.g., MPLS, DNP3?**

Smart Grid Communications Program Meeting
Wednesday, September 23, 2015

1) What could the government be doing in terms of R&D in this space?

2) What information or activities should be provided/conducted prior to an R&D roadmapping exercise?

3) Who are the influencers in this space that should be involved in an R&D roadmapping exercise?

4) How do standards and interoperability play a role in an R&D roadmapping exercise?