REPORT TO NIST PROVIDES INSIGHT ON SMART GRID INTEROPERABILITY STANDARDS DEVELOPMENT

By Christopher B. Kelly

Chris Kelly is an intellectual property lawyer in the Atlanta office of Alston & Bird, LLP and a registered patent attorney. The views expressed in the article are his own and not necessarily those of Alston & Bird or its clients.

The Report

On June 17, 2009, the National Institute of Standards and Technology (NIST) released the *Report to NIST on the Smart Grid Interoperability Standards Roadmap* (the Report), an extensive interim report on the development of Smart Grid interoperability standards.[1] The Report details major steps made toward achieving a Smart Grid Interoperability Framework, identifies applicable Smart Grid interoperability standards, discusses the gaps present in currently available standards, and lays out priorities for near-term development of Smart Grid standards. The Report's analysis of various interoperability issues will aid NIST as it selects standards for various aspects of the Smart Grid. The eventually adopted standards will have a significant impact on clients' businesses, the value of their intellectual property (IP), and the landscape of important IP owned by their competitors. As an illustration of Smart Grid IP activity, a table of U.S. patents and patent applications related to various Smart Grid functional priorities is provided at the end of this article.

Since 2007, NIST has been assigned primary responsibility for developing a framework of standards and protocols designed to achieve interoperability among Smart Grid technologies (the Interoperability Framework). The Report, produced by the Electric Power Research Institute (EPRI), was commissioned by NIST to evaluate the current status, issues, and priorities for Smart Grid interoperability standards development and harmonization. NIST has issued a request for public comment on the Report via the *Federal Register*[2] and will use the Report and subsequent public comments as input in drafting its own interim "roadmap" for the development of Smart Grid interoperability standards.[3] For additional guidance, NIST will look to the Federal Energy Regulatory Commission's (FERC) recent Smart Grid policy statement, which contains

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[1] *Report to NIST on the Smart Grid Interoperability Standards Roadmap* (June 17, 2009), *available at* http://www.nist.gov/smartgrid/InterimSmartGridRoadmapNISTRestructure.pdf (prepared by the Electric Power Research Institute).

[2] Request for Comments on "Report to NIST on the Smart Grid Interoperability Standards Roadmap," 74 Fed. Reg. 124, 31524 (June 30, 2009).

[3] Development of the interim "roadmap" is required of NIST under The Energy Independence and Security Act (EISA) of 2007. The NIST "roadmap" is targeted for delivery in mid to late September will also be made available for public comment via the *Federal Register*.

FERC's thoughts on current Smart Grid standards development.[4] NIST's upcoming roadmap will be the next major step toward arriving at a consensus on Smart Grid standards sufficient for FERC to institute a formal rulemaking proceeding to adopt the standards.[5]

Opportunities for Smart Grid Stakeholders

Although NIST intends to use the Report as one piece of input in developing its own roadmap, the Report does provide Smart Grid stakeholders with a clear look at the direction of the Interoperability Framework development and the issues likely to be at the top of NIST's list of priorities in its upcoming roadmap. In addition, Smart Grid stakeholders have an opportunity to influence the development of the Interoperability Framework through the following avenues:

- Public Comment via *Federal Register* on the "Report to NIST on the Smart Grid Interoperability Standards Roadmap." (Comments due July 30, 2009)[6]
- Public Workshop on Smart Grid Interoperability Standards. (Washington D.C., Aug. 3rd & 4th, 2009)[7]
- Public Comment via *Federal Register* on NIST's upcoming interim roadmap for Smart Grid interoperability standards. (Expected September 2009).

Smart Grid stakeholders would be well advised to review this Advisory and pertinent sections of the Report to identify issues worth advocating via the forums listed above. The opportunities to comment on the contents of the Report and NIST's upcoming roadmap, as well as to attend the public workshop, are valuable tools for influencing the standards selected for the Interoperability Framework. As the Report itself recognizes, most participants thus far in the development of Smart Grid standards have detailed knowledge of a small set of standards. As a result, it is critical for entities with specialized knowledge in various areas of Smart Grid technology to come forward and provide input for development of the Interoperability Framework.

The summary of the Report provided below is intended to be a user-friendly guide for understanding the contents of the Report and identifying issues ripe for discussion via public comment or the public workshop. EPRI's Report is divided into six sections and covers, generally, the following:

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[4] Smart Grid Policy Statement, 74 Fed. Reg. 142, 37098 (July 27, 2009).

[5] *See* Energy Independence and Security Act of 2007, H.R. 6, 110th Cong. § 1305(d) (requiring FERC to institute a rulemaking to adopt Smart Grid standards upon sufficient consensus).

[6] 74 Fed. Reg. 124, 31524 (June 30, 2009). Although comments on the Report are officially due to NIST on or before July 30, 2009, it is unlikely comments submitted soon after that date will be ignored.

[7] Third Smart Grid Interoperability Standards Roadmap Public Workshop, 74 Fed. Reg. 141, 36672 (July 24, 2009).

I. Purpose & Scope of the Report
II. Smart Grid Vision and Summary of On-Going Governance Process
III. Smart Grid Conceptual Model
IV. Priority Smart Grid Applications and Requirements
V. Cyber-Security Considerations for the Smart Grid
VI. Near-Term Actions for Developing Interoperability Framework

I. Purpose & Scope of the Report[8]

In the Energy Independence and Security Act (EISA) of 2007, Congress assigned primary responsibility for developing a framework of standards and protocols for Smart Grid technologies to NIST. Since 2008, NIST has been working with the Department of Energy and Smart Grid stakeholders to establish an Interoperability Framework. In light of the American Reinvestment and Recovery Act of 2009, NIST has recently sought to expedite development of the Interoperability Framework.

In April of 2009, NIST announced a 3-phase plan for reaching a consensus on an initial set of Smart Grid standards and establishing a framework for development of future standards.

- Phase 1: Publish a report describing stakeholder consensus on the following:
    - The Smart Grid Architecture
    - Standardization Priorities
    - An Initial Set of Standards ("Smart Grid Release 1")
    - A Roadmap for Addressing Remaining Standards Needs
- Phase 2: Launch a public-private partnership to develop additionally needed standards.
- Phase 3: Develop a plan for testing and certification to ensure Smart Grid devices and systems conform to interoperability and cyber-security standards.

The Report will be used as input into Phase 1 of NIST's plan. The Report's high-level overview of the Smart Grid's architecture, principles, and interface design, as well as its summary of the current status, issues, and priorities for Smart Grid interoperability standards development and harmonization, is likely to be integrated into NIST's upcoming roadmap.

II. Smart Grid Vision[9]

Defining the Smart Grid

The Report describes the Smart Grid as the "modernization of the electricity delivery system [such that] it monitors, protects, and automatically optimizes the operation of its interconnected

[8] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at 1-5.

[9] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at 6-18.

elements."[10] By delivering real-time information over a distributed computing and communications infrastructure, the Smart Grid seeks to provide a near-instantaneous balance of electricity supply (from the power grid) and electricity demand (from electrically powered devices). The benefits of implementing the Smart Grid include improved power reliability and quality, enhanced safety and cyber-security, optimized energy efficiency, reduction in greenhouse gases and other pollutants, and financial benefits for suppliers and consumers.

Specifically, the Report lists seven characteristics that distinguish a "Smart" Grid:

1. Enables active participation by consumers by providing choices and incentives to modify electricity purchasing patterns and behavior.
2. Accommodates all generation and storage options, including wind and solar power.
3. Enables new products, services, and markets through a flexible market providing cost-benefit tradeoffs to consumers and market participants.
4. Provides reliable power that is relatively interruption-free.
5. Optimizes asset utilization and maximizes operational efficiency.
6. Has the ability to "self-heal" by anticipating and responding to system disturbances.
7. Resists attacks on physical infrastructure by natural disasters and attacks on cyber-structure by malware and hackers.

Procedural and Technical Issues

The advanced Smart Grid capabilities described above bring with them a number of technical and procedural challenges. On the technical side, for example, computer or microprocessor based equipment must be robust enough to handle a variety of future applications. In addition, communications systems, which are in various stages of maturity, must be capable of handling new media technologies as they emerge. Finally, and perhaps most significant, new Smart Grid technologies must be capable of interoperability with legacy systems currently in use, as these legacy systems will be replaced gradually for many years to come.

On the procedural side, efforts to establish the Interoperability Framework must consider a broad set of Smart Grid stakeholders. Conceivably, every person and every business in the United States will be affected by the Smart Grid. In addition, as mentioned above, the transition to the Smart Grid will be a lengthy process due to the large number of existing systems and equipment that will be replaced over time. This gradual process necessitates a well defined plan for integrating the Smart Gird into current legacy systems in various phases.

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[10] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at 6.

III. Smart Grid Conceptual Model[11]

The Report also sets forth a Smart Grid Conceptual Model to be used as a tool for describing, discussing, and developing the final architecture of the Smart Grid. This Conceptual Model will provide a common language allowing Smart Grid stakeholders to discuss the Smart Grid at varying levels of focus. The Report recognizes that it is particularly critical to establish this Conceptual Model in the infancy of the Smart Grid Interoperability Framework.

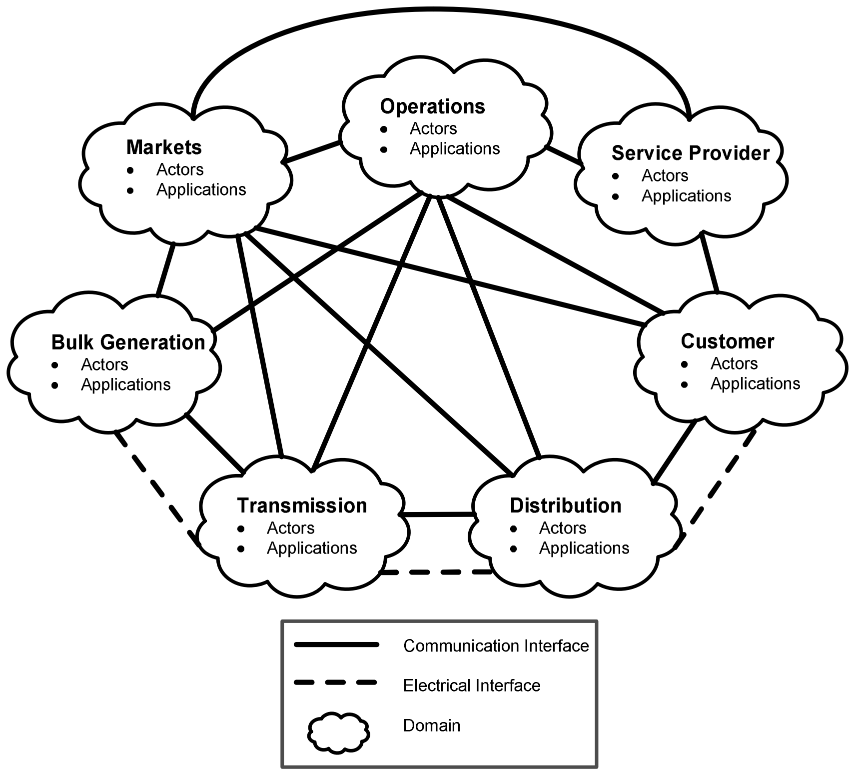

Figure 1

As illustrated in Figure 1,[12] at the highest level of the conceptual model, the Smart Grid is divided into several "domains:"

- *Markets*: operators and participants in electricity markets
- *Operations*: managers of the movement of electricity
- *Service Providers*: organizations providing service to electrical customers and utilities
- *Bulk Generation*: generators of electricity in bulk quantities
- *Transmission*: carriers of bulk electricity over long distances
- *Distribution*: distributors of electricity to and from customers
- *Customers*: end users of electricity

[11] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at 19-44.

[12] *See Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at 21 (Figure 3).

Each domain is comprised of a group of "actors" and "applications." The actors are devices, systems, or programs (or organizations that own them) that make decisions and exchange information through a variety of interfaces in order to perform applications. The applications are various tasks performed by an actor or actors within a certain domain. Accordingly, the domains comprise groups of actors with similar objectives performing a variety of applications. As shown in the Figure 1, the domains are able to communicate with one another via communications interfaces. This communication is critical to the overall interoperability of the Smart Grid, allowing it to collectively generate and distribute electricity efficiently based on input from all domains.

Each domain may be further divided into sub-domains. For example, Table 1 shows "Customer" domain applications and actors. This hierarchical structure of the Smart Grid Conceptual Model is used throughout the Report to discuss the Smart Grid at varying levels of specificity.

Domain	**Sub-Domain**	**Application**	**Actors**
Customer	Home	Home Automation	*For Temperature Control*: • Thermostat, • Automated Control Unit, • Air Conditioning Unit *For Lighting Control*: • Lighting user interface, • Automated Lighting Control, • Light Sources
		Solar Generation	• Solar Panels, • Power Storage Devices • Control Unit
		Energy Management	• Meter • Energy Management System configured to communicate with other domains
	Building/Commercial	Building Automation	*Similar to Home Automation Actors*
		Solar Generation	*Similar to Home Solar Generation Actors*
		Energy management	*Similar to Home Energy Management Actors*
	Industrial	Industrial Automation	*Similar to Home Automation Actors*
		Wind Generation	• Wind Turbines • Power Storage Devices • Control Unit
		Energy Management	*Similar to Home Energy Management Actors*

Table 1

Finally, the Smart Grid Conceptual Model also includes a series of layers developed by the GridWise Architecture Council (GWAC) to organize various issues underlying domains, actors, and applications. The layers, or "GWAC Stacks," include:[13]

- Organizational (e.g., Policy, Business Objectives, Business Procedures)
- Informational (e.g., Business Context, Semantic Understanding)
- Technical (e.g., Syntactic Interoperability, Network Interoperability, Connectivity)
- Cross-Cutting Issues (e.g., Security, Resource Identification, Time Synch)

IV. Priority Smart Grid Applications and Requirements

The Report also presents results from a study of priority Smart Grid functionalities identified by FERC in their draft "Smart Grid Policy" issued on March 19, 2009 (denoted by *) and additional priority functionalities chosen as a result of stakeholder feedback:

- Wide-Area Situational Awareness (WASA)*
- Demand Response*
- Electric Storage*
- Electric Transportation*
- Advanced Metering Infrastructure (AMI)
- Distribution Grid Management (DGM)

Each functionality describes a broad attribute of the Smart Grid. The Report discusses the selection of standards needed for each functionality in terms of "Use Cases" and "Requirements." A series of "Use Cases," or examples of how a particular functionality might be used in the Smart Grid context, are identified for each functionality. For each Use Case, the technical "Requirements" for satisfying the Use Case are derived. Finally, standards are selected that afford capabilities to satisfy the derived Requirements.

Wide-Area Situational Awareness[14]

Wide-Area Situational Awareness (WASA) refers to the Smart Grid's ability to monitor its power system across wide geographic areas. WASA includes monitoring the state of various power system components and effectively managing the power system components based on an understanding of how each component affects the system as a whole. The large number of complex components comprising the power system makes WASA a challenging, yet necessary functionality of the Smart Grid.

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[13] *See GridWise Interoperability Context-Setting Framework* (March 2008), *available at* http://www.gridwiseac.org/pdfs/interopframework_v1_1.pdf (prepared by The GridWise Architecture Council).

[14] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at 46-52.

The Report identifies and discusses in further detail the following WASA Use Cases, for which requirements will be derived and considered in the selection of applicable standards:

- *Contingency Analysis*: Analyzing the ability of the Smart Grid to withstand outages of a critical infrastructure element and simulating the effects of various contingency events.
- *Inter-Area Oscillation Damping*: Identifying inter-area oscillations and modulating voltage to damp out those oscillations to ensure maximum power transfer and optimal power flow.
- *Wide Area Control System for Self Healing Grid Application*: Evaluating power system behavior to prepare for combinations of contingency events, prevent wide-area blackouts, and fast recovery from an emergency state.
- *Voltage Security*: Detecting low voltage conditions and initiating corrective action (e.g., load shed).
- *Monitoring Distribution Operations*: Monitoring and analyzing the behavior of distribution operations and providing transmission automated management systems and the transmission operator with results of the analysis.
- *Voltage, Var, and Watt Control*: Adjusting loads with respect to voltage tolerances, eliminating overload and voltage violations, and providing reactive power support and spinning reserve support.

Demand Response[15]

Demand Response refers to the Smart Grid's ability to vary the supply of electricity via "Distributed Energy Resources" (DERs) in response to changes in demand for electricity from "Demand Resources." DERs represent small-scale energy generation and storage sources configured to provide temporary changes in electricity supply. Demand Resources represent loads or aggregations of loads on the Smart Grid (e.g., home appliances) capable of providing temporary changes in energy consumption. By allowing communication between DERs and Demand Resources, the Smart Grid is able to control peak power conditions, limit blackout instances, maximize the use of available power, increase power system efficiency through time-of-use and dynamic pricing models, and allow customers to make market participation and electricity consumption choices.

The Report identifies and discusses in further detail the following Demand Response Use Cases, for which requirements will be derived and considered in the selection of applicable standards:

[15] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at 53-58.

- *Direct Load Control*: Managing direct load control programs and conveying direct load control information to customers.
- *Managing Demand in Response to Pricing Signals*: Managing the transmission of price signal information to demand response enabled devices.
- *Customer Reduction in Usage in Response to Pricing/Load Reduction Events*: Providing customers with timely price, event, and usage information in conjunction with national system market.
- *External Clients Use of AMI to Interact with Devices at Customer Site*: Allowing third parties (e.g., energy management companies) to control customer equipment located at a customer's premise.
- *Customer Use of Energy Management System or In-Home Display*: Connecting customers' personal control and display devices to utility grid allowing customers to make educated energy decisions.
- *Utility Procures Energy & Settles Wholesale Transactions*: Providing the retail market with information regarding availability to resources and usage data gathered by metering system.
- *Dynamic Pricing*: Facilitating dynamic bid/offer system between customers and service providers.
- *Voltage, Var, and Watt Control*: Calculating optimal settings for various control devices.

Electric Storage[16]

Electric Storage refers to new electricity storage technologies currently being developed to address energy resource and management concerns. Generally, these technologies may be deployed in a distributed manner or as bulk storage. Distributed storage is generally configured as local storage that may be aggregated (e.g., local storage for uninterrupted power supply systems), while bulk storage is generally configured as a direct interface to system energy management functions (e.g., pumped storage hydroelectric technology).

Electric Storage technology is expected to benefit all levels of the Smart Grid. At the generation level, storage technologies will aid in frequency control, spinning reserve, supply-ramping, demand-leveling, and minimum loading. At the transmission level, they will improve stability, power quality, transfer-leveling, reactive power (Var) support, and reliability. At the distribution level, they will contribute to peak shaving, voltage support, power quality, capacity investment deferral, and reliability. Finally, at the end-use level, they will enhance demand control, interruption protection, voltage support, and power quality.

[16] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at 59-62.

The Report identifies and discusses in further detail the following Electric Storage Use Cases, for which requirements will be derived and considered in the selection of applicable standards:

- *Energy Storage Owners Store Energy from the Power System*
- *Energy Storage Owners Discharge Energy into the Power system*
- *Building Energy Usage Optimization using Electric Storage*: Optimizing building energy usage in response to real-time pricing signals.
- *RTO/ISO Directly Dispatches Electric Storage to Meet Power Demand*: Using market-based energy scheduling or emergency control capabilities to dispatch stored electric energy to meet local or regional power demand.
- *Utility Dispatches Electric Storage to Support Intentional Islanding*
- *Electric Storage Used to Provided Fast Voltage Sag Correction*
- *Impact on Distribution Operations of Plug-in Electric Vehicles as Electric Storage*: Taking into account behavior of Energy Storage as loads and as sources of energy.

Electric Transportation[17]

With the automotive industry focused on development plug-in electric vehicles (PEVs) for mass production, FERC has insisted that the Smart Grid be capable of handling the loads a mass deployment of PEVs would entail. A primary concern is that increased loads from PEVs on the Smart Grid could significantly increase the cost of peak power without proper regulation, coordination, and incentives. However, the Report notes that PEVs may balance on- and off-peak loads through shifting when PEVs are charged. Future developments may also utilize PEVs for their storage and discharging capacity, which could improve energy efficiency and power quality. Accordingly, the Smart Grid is being designed under the assumption that it must handle the load of large amounts of PEVs and with an optimistic view toward taking advantage of the attributes of that PEV presence.

The Report identifies and discusses in further detail the following Electric Transportation Use Cases, for which requirements will be derived and considered in the selection of applicable standards:

- *Customer Does Not Enroll in any PEV-Specific Program*: Customer plugs PEV into electrical connections lacking smart meters or other communication with grid resulting utility having no knowledge of PEV load.
- *Utility/ESP Develops Different Tariffs and Service Programs*: Utility or Energy Services Provider offers PEV-specific programs.

[17] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at 63-70.

- *PEV Charges After Customer Establishes Charging Parameters*
- *PEV Charges at Different Locations*: Roaming scenarios with customer plugging PEV into grid a location away from "home" location.
- *PEV Roaming, Assuming Unbundled Retail Electricity Reselling*: Permitting customers to store electricity during low price times and resell electricity to PEVs during high price times for profit.
- *PEV Used for On-Premise Backup Power or Other Use of Storage*
- *Utility Provides Accounting Services to PEV Customer*
- *Impact of PEV as Load on Distribution Operations*: Allowing distribution operations to assess when, where, and how fast PEVs are charging.
- *PEV Network Testing, Diagnostics, and Maintenance*

Advanced Metering Infrastructure[18]

Many of the most advantageous aspects of the Smart Grid, such as demand response and dynamic pricing, will require enhanced communication with customers in order to function. Advanced Metering Infrastructure (AMI) systems integrated into the Smart Grid will allow utilities to interact with meters at customer sites. For example, external clients may use an AMI system to interact with devices at a customer site. This allows clients to monitor the power used by particular customer equipment, make on-demand control requests of customer equipment, and detect outages to customer portions of the power grid. In addition, AMI systems may allow utilities to communicate instantaneous kWhr pricing and notification of load reduction events to customers. The integration of AMI systems into the Smart Grid will be particularly challenging, however, as the information exchanged between devices have varied complexity, ownership, and access rights.

The Report identifies and discusses in further detail the following Advanced Metering Infrastructure Use Cases, for which requirements will be derived and considered in the selection of applicable standards:

- *External Clients Use AMI System to Interact with Devices at Customer Site*: Allowing third party vendors to detect the power drawn by customer equipment and make on-demand status and control requests of said equipment.
- *Demand Response Management System Manages Demand through Direct Load Control*: Allowing utilities to communicate pricing and voluntary load reduction events to customers.

[18] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at 71-77.

- *Building Automation Software/System Optimization Using Electric Storage*: Allowing building operators to adjust how equipment responds to pricing/operational signals.
- *Outage detection and restoration using AMI*

Distribution Grid Management[19]

A significant component of the Smart Grid infrastructure will be the addition of sophisticated Distribution Management Systems (DMSs) to distribution grids, which currently operate with limited automation and intelligence. These new management systems will be capable of managing the distribution of electricity, identifying and isolating outages, and supporting various efficiency technologies. The DMSs must be configured to communicate with field intelligent electronic devices, transmission systems and distribution systems (e.g., SCADA, EMS), and customer systems (e.g., AMI, DER, DR, PEV, and Electric storage). The ability to communicate with these advanced systems will be critical to the management system's interoperability with the Smart Grid.

The Report identifies and discusses in further detail the following Distribution Grid Management Use Cases, for which requirements will be derived and considered in the selection of applicable standards:

- *Monitoring Distribution Operations with Demand Response, DER, PEV, and Electric Storage*
- *Service Restoration*: Utilizing Electric Storage for improvement of power reliability and contingency analysis.
- *Voltage, Var, and Watt Control with Demand Response, DER, PEV and Electric Storage*
- *Coordination of Emergency and Restorative Actions in Distribution*
- *Impact of PEV and Load and Electric Storage on Distribution Operations*: Allowing distribution monitoring functions to assess PEV loads as electric storage and provide look-ahead monitoring.

V. Cyber Security Considerations for the Smart Grid[20]

Although the Smart Grid will provide dramatic improvements in the reliability, quality, and efficiency of power delivery, its advanced capabilities are much more dependent on information and telecommunications infrastructures. As such, cyber security will be a primary concern in developing all aspects of the Smart Grid. To further development of cyber security standards, the Report identifies a significant number of use cases that are architecturally significant for

[19] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at 78-83.

[20] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at 88-89.

cyber security requirements. For each use case, the Report identifies cyber security objectives, requirements, and potential stakeholder issues.[21] These use cases are divided into the following categories:

- Advanced Metering Infrastructure
- Demand Response
- Customer Interfaces
- Electricity Market
- Distribution Automation
- Plug-In Hybrid Electric Vehicles
- Distributed Resources
- Transmission Operations
- RTO/ISO Operations
- Asset Management

The Report also identifies three Vulnerability Classes that represent categories of weakness that could adversely impact the operation of the electric grid. The Vulnerability Classes include (1) People, Policy, & Procedure Vulnerabilities, (2) Platform Vulnerabilities, and (3) Network Vulnerabilities. Each Vulnerability Class is comprised of identified vulnerabilities that can be leveraged to cause disruption or negative influence over the Smart Grid and are noted in the appendix to the Report. The vulnerabilities identified in the Report are intended to provide a starting point for development of cyber security requirements.

VI. Near-Term Actions for Developing Interoperability Framework[22]

Although NIST will finalize its priorities in its upcoming roadmap, the Report provides a look at the near-term actions likely to be given priority by NIST. The Report identifies a list "Cross-Cutting and Overarching Issues" and "Priority Functionality Issues" that are limiting wide-spread deployment of the Smart Grid and suggests actions NIST may take to address these issues. In addition, steps needed to complete the roadmap for the Smart Grid Interoperability Framework are highlighted.

The Report provides a detailed analysis of the following priorities:

- Cross-Cutting & Overarching Issues:
  - Common Pricing Model Standard
  - Common Time Synchronization and Management
  - Common Semantic Model
  - Application of Internet-Based Networking Technology
  - Communications Interference in Unlicensed Radio Spectrums

[21] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at Appendix D.

[22] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at 90-103.

- Priority Functionality Issues:
    - Demand Response & Consumer Energy Efficiency
    - Wide Area Situational Awareness
    - Electric Storage
    - Electric Transportation
    - Advanced Metering Infrastructure
    - Distribution Grid Management Initiatives
    - Cyber Security Strategy
- Further 2009 Roadmap Activities:
    - Completion of NIST Standards Evaluation Process
    - Architecture Framework Development and NIST IKB
    - Policy and Regulatory

The Report also provides a table of requirements, standards gaps, and discussion issues for the actions items listed above.[23] The table provides detailed actions NIST should promote, as well as issues that will need further discussion before definite actions on standards are appropriate.

VII. Additional Information

Identified Standards[24]

The Report provides a profile of currently identified standards organized by Domain in a table. The standards identified were selected based on the following criteria:

1. Standard was supported by an Standards Developing Organization (SDO) or via an emergent SDO process
2. Standard is also supported by a users community
3. Standard is directly relevant to the Use Cases analyzed for the Smart Grid
4. Consideration was given to those standards with a viable installed base and vendor community

As the included standards are analyzed further, standards gaps will be filled and, with certain standards being valued over others, an increase in harmonization across standards should be realized. This harmonization is significant in light of the need for adaptor devices (e.g., bridges, routers, gateways) at all interfaces having mismatched standards. Although adaptors will be necessary for remaining legacy technologies, the harmonization of standards and construction of non-duplicative profiles should minimize the need for interface adaptors

[23] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at Appendix C.

[24] *Report to NIST on the Smart Grid Interoperability Standards Roadmap*, *supra* note 1, at Appendix A.

Smart Grid Patent Activity

Table 2 provides a sample of U.S. Patents and Patent Applications directed to a variety of the priority functionalities identified in the Report.

FUNCTIONALITY	*PATENT OR APPLICATION NO.*	*TITLE*	*OWNER*
Electric Storage	6,614,132	Multiple Flywheel Energy Storage System	Beacon Power Corporation
Distribution Grid Management	7,184,903	System and Method for a Self-Healing Grid using Demand Side Management Techniques and Energy Storage	VRB Power Systems, Inc.
Wide Area Situational Awareness	7,233,843	Real-Time Performance Monitoring and Management System	Electric Power Group, LLC
Distribution Grid Management Demand Response	7,274,975	Optimized Energy Management System	GridPoint, inc.
Electric Storage	7,299,633	Solar Dish Concentrator with a Molten Salt Receiver Incorporating Thermal Energy Storage	Pratt & Whitney Rocketdyne, Inc.
Distribution Grid Management	7,305,281	Management of a Bulk Electric Power Market	ISO New England, Inc.
Distribution Grid Management Demand Response	7,337,153	Resolving Energy Imbalance Requirements in Real-Time	Siemens Power Transmission & Distribution, Inc.
Distribution Grid Management Demand Response	2008/0005044	Method and Apparatus for Using Power-Line Phase-Cut Signaling to Change Energy Usage	Filed by University of California Davis.
Electric Storage	2008/0044725	High-Amperage Energy Storage Device and Method	No assignment of record
Electric Storage Electric Transportation	2008/0052145	Power Aggregation System for Distributed Electric Resources	V2 Green, Inc.
Distribution Grid Management Wide Area Situational Awareness	2008/0088183	Integrated Closed Loop Control Method and Apparatus for Combined Uninterruptible Power Supply and Generation System	Electric Power Research Institute, Inc.
Advanced Metering Infrastructure Demand Response	2008/0177678	Method of Communicating Between a Utility and its Customer Locations	Southern California Edison
Consumer Energy Efficiency	2008/0009979	Device for the Controlled Power Consumption of Electric Drives in Machinery . . .	Heldelberger Druckmaschinen AG
Application of Internet-Based Networking Technology	2009/0034419	Method and system of routing in a utility smart-grid network	No assignment of record
Advanced Metering Infrastructure	2009/0088907	Modular Electrical Grid Interface Device	GridPoint, Inc.

Table 2

Links to Related Content:

The full *Report to NIST on the Smart Grid Interoperability Standards Roadmap* is available at http://www.nist.gov/smartgrid/InterimSmartGridRoadmapNISTRestructure.pdf.

Smart Grid Public Workshop, Aug. 3 and 4, 2009 at
http://www.nist.gov/public_affairs/releases/smartgrid_wkshp_072409.html

Request for Public Comment on *Report to NIST on the Smart Grid Interoperability Standards Roadmap* at http://edocket.access.gpo.gov/2009/E9-15467.htm

FERC's Recent Policy Statement at
http://www.ferc.gov/whats-new/comm-meet/2009/071609/E-3.pdf

The Impact of Patents on Smart Grid Objectives, by Jeff Young, Smart Grid News, April 24, 2009 at
http://www.smartgridnews.com/artman/uploads/1/The_Impact_of_Patents_on_Smart_Grid_Objectives.pdf

Additional Smart Grid Information at
http://www.nist.gov/smartgrid/
http://www.ferc.gov/industries/electric/indus-act/smart-grid.asp
http://www.smartgridnews.com