EPRI | ELECTRIC POWER RESEARCH INSTITUTE

IntelliGrid R&D Roadmap

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Elements of the R&D Roadmap

- Defines the areas in which the IntelliGrid Program will conduct R&D
  - Defines the future state for the area
  - Identifies the gaps in reaching the future state
  - Identifies other organizations working in this area
  - Defines EPRI's role and strategy in working in this area
  - Identifies the EPRI R&D projects in the area

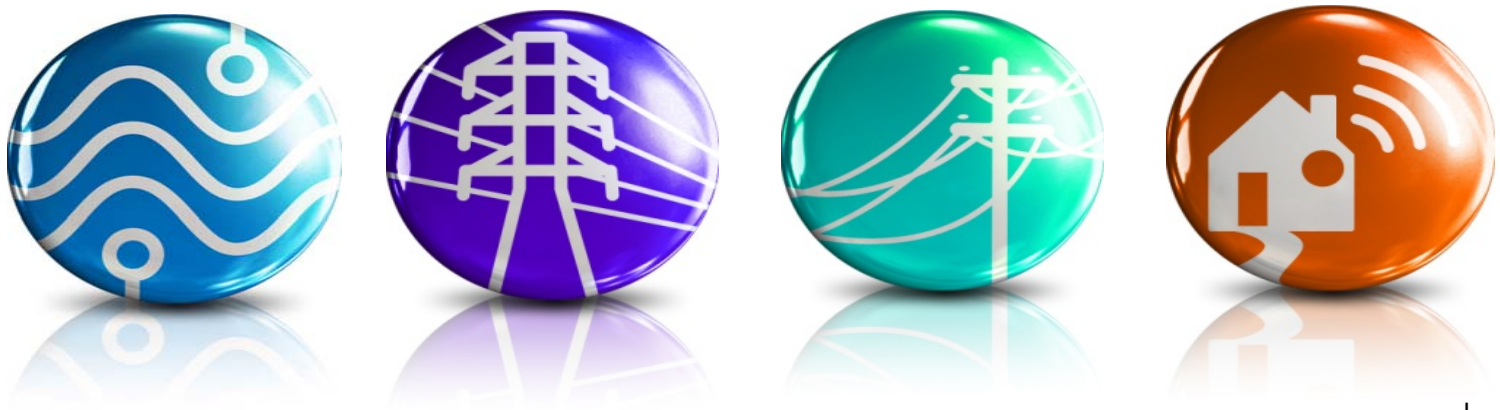
IntelliGrid Program

Vision:

A utility's meters, sensors, control devices, and software applications will be able to exchange information, and to do so with sufficient timing and data volume to enable a wide range of Smart Grid applications.

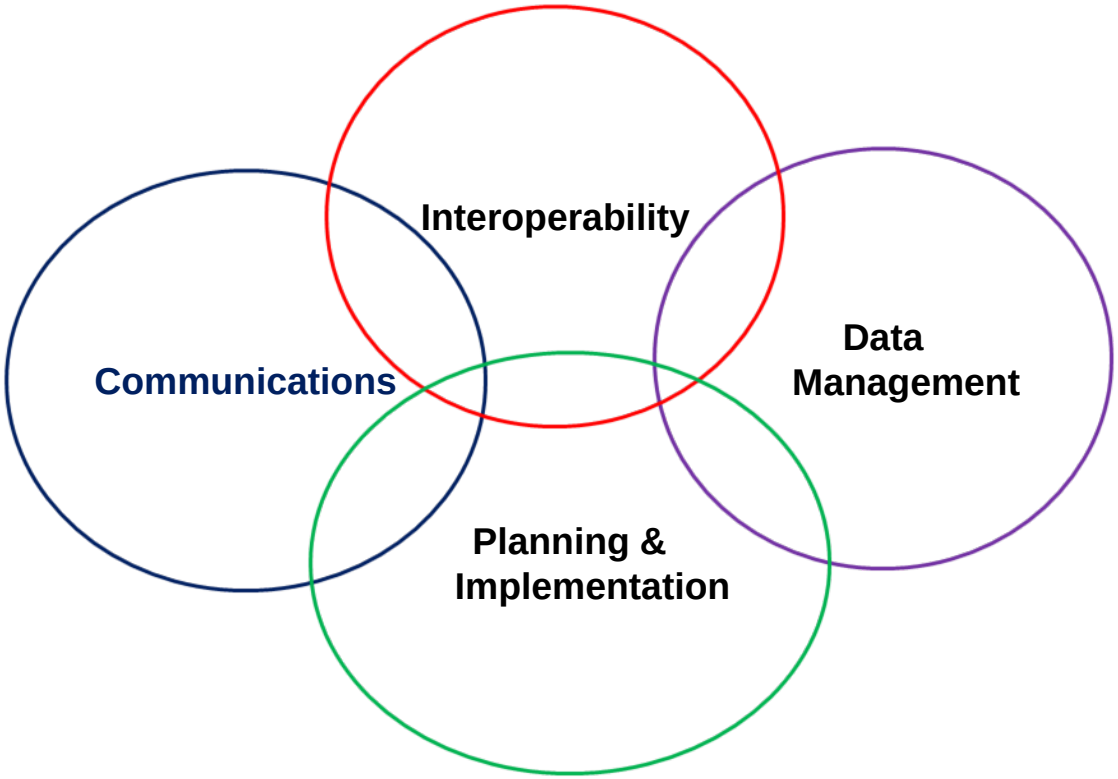
Mission:

The IntelliGrid Program conducts research, development and demonstrations on the information and communications technologies that enable Smart Grid applications



IntelliGrid R&D Areas

- Interoperability
- Communications
- Data Management
- Smart Grid Planning and Implementation



Interoperability
Technical Gaps

- Existing standards for smart grid applications are incomplete and have not been broadly adopted by utilities, vendors, and third party device manufacturers.
- Key smart grid standards need to be harmonized.
- Reference architectures and associated interface standards that will enable interoperability between equipment from different vendors do not exist.
- The tools and techniques to enable standard certification have not been fully developed.
- End to end interoperability test procedures do not exist
- Cyber security is not uniformly addressed by standards

Interoperability
Implementation Gaps

- Utilities often don't understand the risks and benefits of adopting a key standard
- It is often difficult and costly for utilities to implement a standard
- There is a lack of reference and training material for standards implementation.
- Lack of staff adequately skilled to conduct training on a broad scale.

Other Organizations Working in this Area

- The Smart Grid Interoperability Panel (SGIP)
- Standards Development Organizations
- User's Groups

EPRI's Strategy for Interoperability

- Provide organizational leadership through participation in the SGIP (at all levels) and in key standards working groups and user's groups.
- Provide technical contributions to the SGIP (PAPs, architecture and compliance and testing committee activities), key standards development and user's group activities.
- Provide leadership to key standards during the development process to ensure that the utility industry requirements are properly addressed.
- Provide information, education and training to utilities on key standards. This includes education on what the standard is and does; strategies for migrating from existing systems to the new standard, and the value, cost and risk of implementing a standard.

EPRI's Strategy for Interoperability

- Conduct implementations of emerging standards in the lab and contribute feedback to the SDO working groups and/or user's groups
- Conduct interoperability tests – either of a single standards or of multiple standards
- Work directly with utilities on demonstrations of standards implementations
- Develop applications that make use of key standards

IntelliGrid Activities Associated with Key Smart Grid Standards

	Standards Development	Harmonization	Demo	Testing	Training	Applications Development
IEC 61850						
IEC 61968 (CIM – distribution)						
IEC 61970 (CIM – transmission)						
IEEE 802.11 (Wi-Fi)						
IEEE 802.15.4 (ZigBee)						
IEEE 802.16 (WiMAX)						
IEEE 1547						
IEEE 1815 (DNP3)						
SAE Hybrid J2836/J2847/J2931/J2953 Task Force – EV comms						
Open ADR						
Smart Energy Profile 2.0						

IntelliGrid Deliverables and Supplemental Projects Relating to Interoperability

	2011 Deliverables	2012 Deliverables
Project Set A	• Smart Grid Interoperability Standards Tracking, Analysis and Contribution • White Papers on the Implementation of Smart Grid Interoperability Standards	• Smart Grid Interoperability Standards Tracking, Analysis and Contribution • White Papers on the Implementation of Smart Grid Interoperability Standards • Smart Grid Standards Tracking, Analysis and Contribution: Annual summary report
Project Set B	• Data Heap Specification • IEC 61850 Implementation / Transition • CIM Harmonization and Implementation Examples • Mapping IEEE 1815 (DNP3) to IEC 61850 Objects	• Transition from Legacy Protocols to IEC 61850 • Network Model Manager and Repository • Using Standards to Disperse Field Data Across The Enterprise (supplemental)

IntelliGrid Deliverables and Supplemental Projects Relating to Interoperability

	2011 Deliverables	2012 Deliverables
Project Set C	• CIM Primer • CIM – MultiSpeak Harmonization • CIM Conformity and Interoperability Test Procedure Development	• Update on CIM for Distribution Development and Testing Activities • Application of the CIM in Distribution Enterprise Applications • Field Force Data Visualization • Field Area Network Demo (supplemental) • CIM development (supplemental)
Project Set D	• Customer Communications Architecture Development • Demand Response Appliance Modular Interface Demonstration	• Smart Building Interfaces • Using SEP2 for DER Integration • Demand Response Appliance Modular Interface Demonstration (supplemental) • OpenADR & Ancillary Services Demonstration (supplemental)

Communications

Issues and Gaps

- Lack of accurate, unbiased information regarding the capabilities costs, benefits, and risks of different communications technologies
- Need to understand the specific communications requirements for both near and long-term applications.
- Lack of standards sufficient to enable utility systems to be constructed in an open way

Research Plan

- Research around communications standards and technologies to compile a broad spectrum of relevant data without preference to vendor or technology
- Research to synthesize trends in communications with historical trends for growth of application bandwidth and performance requirements
- Research around open hardware and open software to encourage rapid development of interoperable ecosystems.

Communications

Issues and Gaps

- Leveraging customer Internet infrastructure
- Lack of common off-the-shelf customer products capable of communicating with the grid
- Effective approaches for securing both wired and wireless communications networks





Research Plan

- Research for taking advantage of connectivity in a secure and predictable manner; filling in gaps where connectivity is missing or not functional.
- Further research beyond DR-Socket is needed - extend grid communication functionality into the core of appliances and consumer products.
- Beyond basic link encryption, research needed into key management for wireless. E.G. 802.15.9

IntelliGrid Deliverables and Supplemental Projects Relating to Communications

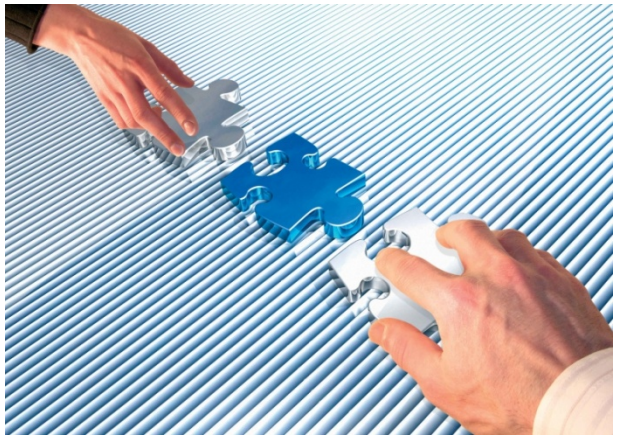
	2011 Deliverables	2012 Deliverables
Project Set A		• Smart Grid Communications Intelligencer • Communications Interest Group
Project Set B	• Synchrophasor Communications Infrastructure	• Synchrophasor Communications Infrastructure
Project Set C	• Advanced Smart Grid Communications • Smart Grid Communications Intelligencer • Communications Infrastructure for Distribution Applications and Automation	• FAN Demonstration (supplemental)
Project Set D	• HAN Performance Metrics and Monitoring • Modular Communication Interface Demo (supplemental)	• The Role of Customer Broadband

Data Management
Gaps

- Data is often held in disparate locations with no relationship between the data in those locations.
- Data can be “federated”, that is located in different applications but with a relationship to the data across the entire enterprise.
- No conventions have been determined for when data should be stored centrally and when it should be stored in a federated data structure.
- Traditional databases are optimized to overcome storage or performance limitations. Storing data in a format that is optimized for analysis needs to be investigated.

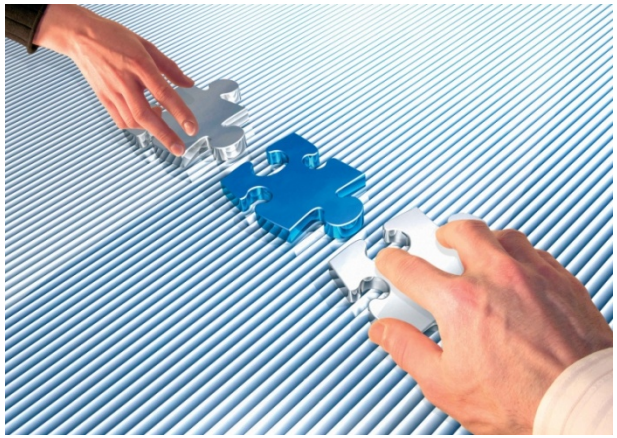
EPRI's Strategy for Data Management

- Provide thought leadership and industry perspective to key standards working groups
- Perform basic research into the nature and structure of utility data, where data is required and how data is turned in to actionable information.
- Develop models for the cost of poor data quality to the utility
- Develop methods of identifying and correcting poor or missing data, particularly in GIS data.



EPRI's Strategy for Data Management

- Perform research into data visualization which includes dashboards, operational displays, reports, and mobile data platforms.
- Apply techniques such as complex event analysis, data fusion, pattern recognition and neural networks to utility data.
- Perform basic research into how to structure data using object oriented databases to facilitate data analysis.



IntelliGrid Deliverables and Supplemental Projects Relating to Data Management

	2011 Deliverables	2012 Deliverables
Project Set A		
Project Set B	• Data Heap Specification • CIM Harmonization and Implementation Examples • Mapping IEEE 1815 (DNP3) to IEC 61850 Objects • CIM Harmonization and Implementation Examples	• Transition from Legacy Protocols to IEC 61850 • Network Model Manager and Repository • Using Standards to Disperse Field Data Across the Enterprise (supplemental)

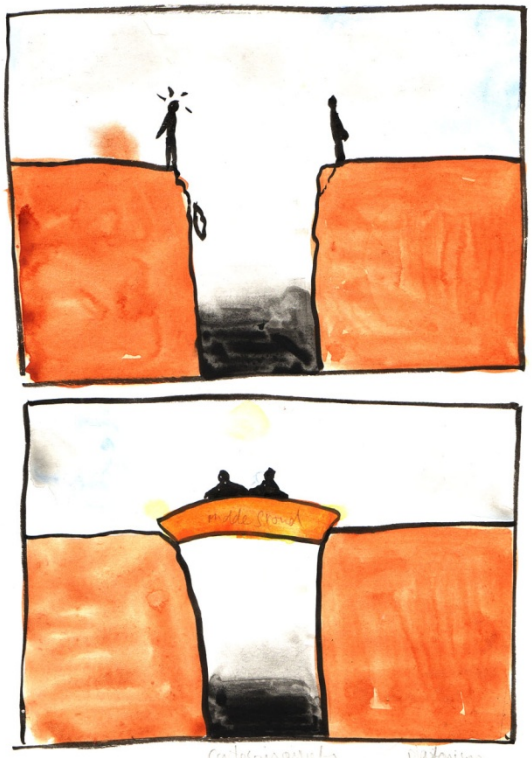
IntelliGrid Deliverables and Supplemental Projects Relating to Data Management

	2011 Deliverables	2012 Deliverables
Project Set C	• CIM – MultiSpeak Harmonization • CIM Conformity and Interoperability Test Procedure Development	• Geospatial Information System (GIS) Data Improvement: Processes, strategies, tactics and tools • Update on CIM for Distribution Development and Testing Activities • Application of the CIM in Distribution Enterprise Applications • Field Force Data Visualization • CIM Development (supplemental)
Project Set D	• Customer Communications Architecture Development	• AMI Data for DR Verification • Using SEP 2.0 for DER Integration

Smart Grid Planning and Implementation

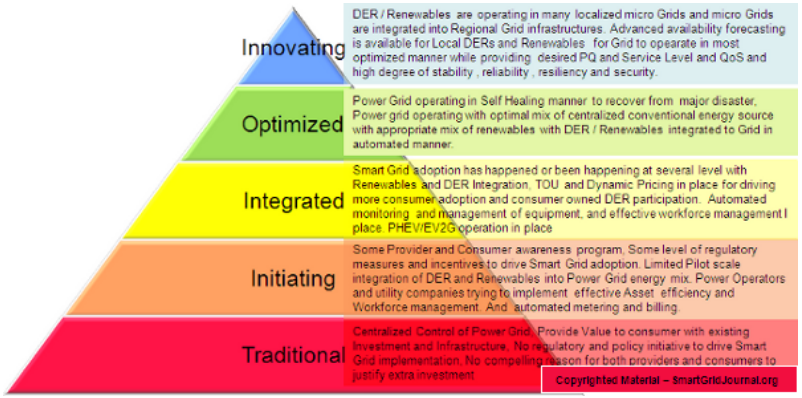
Gaps

- Strategies and best practices for building out the smart grid
- Accurate cost / benefit / risk information from actual smart grid implementations
- Change management processes for both utilities and their customers
- Workforce training



Other Organizations Working in this Area

U.S. DEPARTMENT OF ENERGY



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EPRI's Strategy for Smart Grid Implementation and Planning

- **Demonstration Projects**
  - Using Standards to Disperse Field Data Across the Enterprise
  - Field Area Network Demo
  - Open ADR & Ancillary Services Demo

EPRI's Strategy for Smart Grid Implementation and Planning

- **Lessons Learned from Implementations**
  - White Papers on the Implementation of Smart Grid Interoperability Standards
  - CIM Harmonization and Implementation Examples
  - Transition from Legacy Protocols to IEC 61850

EPRI's Strategy for Smart Grid Implementation and Planning

- **Smart Grid Roadmaps:**
  - Envisions the future state
  - Defines the current state
  - Provides the implementation strategy for creating the IT and communications infrastructure to support the future vision
- Identify change management issues and experiences
- Identify workforce training issues and experiences

EPRI's Strategy for Smart Grid Implementation and Planning

- **Cost / Benefit Analysis**
  - EPRI and DOE have jointly developed a cost / benefit methodology for smart grid demo projects
  - AMI Costs & Benefits White Paper

IntelliGrid Deliverables & Supplemental Projects Relating to Smart Grid Planning / Implementation

	2011 Deliverables	2012 Deliverables
Project Set A	• California Utility Vision and Roadmap for the Smart Grid of 2020 • Smart Grid Roadmap Interest Group • White Papers on the Implementation of Smart Grid Interoperability Standards	• Smart Grid Roadmap Synthesis Report • Smart Grid Roadmap Interest Group • Smart grid roadmap workshop • White Papers on the Implementation of Smart Grid Interoperability Standards • Analytical Studies on Topics that Impact the Deployment of the Smart Grid
Project Set B	• IEC 61850 Implementation and Transition • CIM Harmonization and Implementation Examples	• Transition from Legacy Protocols to IEC 61850 • Using Standards to Disperse Field Data Across the Enterprise (supplemental)

IntelliGrid Deliverables & Supplemental Projects Relating to Smart Grid Planning / Implementation

	2011 Deliverables	2012 Deliverables
Project Set C		• Field Force Data Visualization • Field Area Network Demo (supplemental)
Project Set D	• Metering, Network, in the field Operations, and Information Systems (MENOFIS)	• Options for Effective Sub-Metering • AMI Data for DR Verification • Using SEP 2.0 for DER Integration • Open ADR & Ancillary Services Demo (supplemental)

Together…Shaping the Future of Electricity