Interoperability Strategic Vision
Overview
GMLC 1.2.2 Interoperability

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Project Summary

**Project Description**
Align stakeholders on a strategic vision for devices and systems integration and develop measures and tools to support interoperability

**Value Proposition**
- Reduction of cost and effort for system integration
- Improve grid performance, efficiency and security
- Increase in customer choice and participation
- Establishment of industry-wide best practices
- Catalyst of innovation

**Expected Outcomes**
- Establish an interoperability strategic vision
- Describe the state, challenges, and path forward to advance interoperability
- Offer tools to facilitate gap analysis, develop roadmaps, and demonstrate vision concepts

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The ability of two or more systems or components to exchange information and to use the information that has been exchanged.

ISO/IEC/IEEE 24765
Quadrennial Energy Review (QER) 6th recommendation: Improve grid communication through standards and interoperability

Multi-year Plan: Frames interoperability as a fundamental quality that needs attention for grid modernization. The chart shows some of the main activities with linkages.
Topics

► Project approach
► Progress to date
► Interoperability strategic vision
  □ Discussion framework
    • Concepts and models for interoperability
    • Business drivers – grid services
    • Actors, stakeholders, and ecosystems
  □ State of interoperability
  □ Desired integration experience
  □ Criteria for measuring interoperability
  □ DER interoperability path forward
► Agenda review
**Approach**

- **Strategic vision**
  - State of interoperability and desired integration experience
  - Document with stakeholder buy-in, socialization

- **Gaps & roadmaps**
  - Tools to measure interoperability/ease of integration
  - A roadmap methodology for technology communities to set goals and a path to achieve them

- **Industry engagement incentives**
  - Tools to encourage interoperable product/service procurements

- **Demonstrate visionary interop capability**
  - Industry directed contest to exhibit advance interop concepts
  - Identify priority gaps and potential “leapfrog” capabilities
  - Conduct project/contest(s) and promote results for follow-on efforts

**Tools to facilitate detailed gap identification, develop roadmaps, and demonstrate vision concepts**

**High level view of the state, challenges, and path forward**

**Interoperability Strategic Vision**

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We, the participants in the GMLC Interoperability program, based upon our collective resolve and industry experience, set forth these principles, enumerated below, aligned with the Department of Energy’s congressionally mandated charter to convene, adopt, and deploy tools and techniques to enable interoperability to create a more reliable, secure, affordable, flexible, sustainable, and resilient electric power system. We believe this industry-led approach can, by following these principles, develop the needed solutions to achieve these goals.

We recognize that a lack of cost-effective interoperability creates onerous and ongoing problems for system integration and operation.

> It wastes energy. > It wastes money. > It wastes time. > It impedes goals of renewable generation and grid performance.

Our future electric power system must easily integrate great numbers of an evolving mix of intelligent, interacting systems and components. Achieving this state requires the advancement of interoperability and the principles that support it; this is a shared challenge requiring alignment across all electric system stakeholders. It is therefore necessary to articulate interoperability goals and requirements and establish a strategic vision for interoperability.

Interoperability is “The ability of two or more systems or components to exchange information and to use the information that has been exchanged”. Interoperability also refers to the steps required to achieve this state, which directly relates to the level of effort to successfully integrate systems or components. With this understanding, we recognize the following principles:

- Systems or components need to interact according to agreements at their interface boundaries.
- A system architecture description needs to clearly identify the interface points where systems or components may interact.
- Interoperability concerns need to pervade across a heterogeneous mix of technologies, business practices, and deployment approaches.
- Stakeholders need to participate in the process to develop, use, and maintain interoperability standards, conventions, and supporting capabilities such as certification programs, registries, and security policies.

The principles above require changes in today’s technologies, business practices, and deployment approaches, to promote interoperability and simplify the integration experiences.

We hereby recognize that improving stakeholder agreement on clear interface definitions and mechanisms to simply and cost-effectively integrate systems and components will catalyze the realization of a more efficient and secure electric system sensitive to our operational, economic, and ecologic needs. And in response, we join in the efforts to advance interoperability of the future electric system and commit to changing technologies and business processes to accomplish this mission.

### Progress to Date

- **Drafted foundational documents**
  - Declaration of Interoperability
  - Interoperability Strategic Vision
  - Interoperability Maturity Model (IMM)
  - Interoperability Roadmap Methodology

- **Stakeholder engagement – critical!**
  - 16 partner organizations, regular 7 web meetings
  - Sep 2016 stakeholder technical meeting
    - Consensus voiced through unanimous vote in favor of the project’s objectives and plan
  - Interoperability goals/requirements statements tested
  - Nov 2016 outreach at SGIP annual meeting reviewed Declaration, interop criteria, and roadmap methodology plan
  - Apr 2017 Public Utilities Fortnightly article
  - Several presentations: AHR Expo, ISGT…
Layered decomposition coordination framework

Defined interface points for integration

Taft, JD. 2016. *Architectural Basis for Highly Distributed Transactive Power Grids: Frameworks, Networks, and Grid Codes*. PNNL-25480
Example: Components for DER to Grid Integration

Purpose

- Preserve layered decomposition coordination framework pattern
- Separate concerns on networking, cybersecurity, and privacy
- Acknowledge separate “ecosystems” of business propositions internal and external
- Encourage common business processes to reduce the number of specialized interfaces
  - E.g., eliminate/reduce dependence of external interface on equipment type

Places for focusing interoperability activities

External integration

Internal integration

DER Facility

Energy Service Interface

Facility Management System

DER Equipment

Interacting Party

Places for focusing interoperability activities

- External integration
- Internal integration
The sets of arrows and dotted lines represent areas of focus for discussing interoperability issues.
Grid Services – Drivers for DER Integration

- Peak capacity management
- Energy market price response
- Capacity market dispatch
- Frequency regulation
- Spinning reserve
- Ramping (a new type of service)
- Artificial inertia (a new type of service)
- Distribution voltage management (a new type of service)

* Preliminary from GMLC 1.4.2 input to GMLC 1.2.1 common grid services list
Actors, Stakeholders, and Ecosystems

**Actors**
- **DER Operations**
  - Responsible for DER operation
- **DER Communities**
  - Collection of DER that work together
- **DER Service Provider**
  - Equipment monitoring, diagnostics, and troubleshooting
- **Market Service Provider**
  - Aggregator of DER
- **Distribution System Operations**
  - Responsible for the reliable operation of the distribution system

**Stakeholders**
- **DER operators (managers, owners, and users)**
- **DER communities**
- **DER service providers**
- **Market service providers**
- **Distribution system operators**
- **DER equipment suppliers (hardware manufacturers)**
- **DER energy management system suppliers (s/w automation suppliers)**
- **Communications infrastructure and service providers**
- **Regulators and government agencies**
- **Trade associations, industry consortia, and standards development organizations**
- **Testing and certification organizations**

**Integration Ecosystems**
- Communities of organizations with business alignment to drive standards, testing, branding, policy in one or more “technology integration areas”
- Example technology integration areas
  - Electric vehicles
  - Photovoltaics, smart inverters
  - Commercial building loads
  - Residential loads
  - Metering
- Need help to identify and describe these integration ecosystems
- More on this later…
DER Connectivity Framework

Interoperability Categories (GWAC Stack)

- Technical
- Informational
- Organizational

Devices (I/O, local control)

Control (application specific control)

Supervisory (facility coordination, operations)

Management (business, enterprise)

DER Automation Zones (ASHRAE-Purdue model)

DER Actor Domains (Conceptual Model)

Transmission services work through market and distribution
Using the GWAC Interop Context-Setting Framework categories…

► Technical state
- Mature set of communications networking standards and protocols
  - Many to choose from, wired and wireless
- Integration ecosystems pick their own set of standards-based profiles
- Cybersecurity is getting attention, but legacy standard vulnerabilities an issue

► Informational state
- Informational models generic, SCADA-oriented, but richer standards emerging
- Modeling approaches tend to support read/write, direct control approaches rather than service-oriented techniques
- Modeling methods and tools differ in technology integration areas
- Harmonization of information models hampered by legacy modeling approaches that challenge transformation
Organizational state

- Grid service programs for using grid-edge resources
  - Many different programs offered by utilities depending on facility size
  - Grid services defined differently for each utility
    - load-shedding, peak capacity management, spinning reserve, time of use, critical peak pricing
  - The concept of an ESI is not embraced and often equipment-type dependent and not coordinated at the facility level
  - Usually direct control-oriented design
  - Where markets exist, aggregators use proprietary system interfaces to DER

- Regulatory and legislative policy
  - Regulatory compact encourages regulated return on capital investments, not least cost supplier
  - Policies encourage technology-specific investments such as PV or wind with no communications for operations coordination (e.g., net metering)
  - Where communications are used, policies tend to be technology-specific
Desired Integration Experience

NOTES:
1. Platforms provide hosting services for apps
2. System Integrators: Install and configure system hardware and software
3. DER Operator: Download, monitor and support DER apps
4. DER Operator may assume role of System Integrator
Market Service Provider Story

- MSP works with wholesale energy providers to create buy/sell forward products
- MSP runs a forward contracts market for energy that exposes an interface
- Buildings Operator (BO) connects to this interface using apps provided by the MSP or third parties
- BO configures his app and devices to select contracts automatically
- As agent for BO, the app buys/sells contracts according to anticipated and historical consumption
- In monthly billing period, BO and MSP reconcile contract performance. BO’s app uses this information to improve future contract selection

Interop Challenge: What needs to be established *behind the scenes* to support the integration of the components in this story in a scalable, evolvable, secure manner across a changing set of actors and technology solutions providers?
Challenge: How can we measure interoperability characteristics to simplify integration?

Approach: an interoperability maturity model (IMM)
- Identify criteria whose existence contributes to achieving interoperability
  - E.g., unambiguous resource identification, information models, security policy defined
- Define levels of maturity
- Create a maturity model with testable statements for each criteria
- Propose a scoring system

Application: describe state of interoperability and identify gaps in an integration area
Roadmap Methodology

- Emphasizes stakeholder engagement
- Incorporates interoperability maturity model (IMM) for state and gaps
- Desired outcome
  - Identify gaps and barriers
  - Resolve benefits and priorities
  - Milestones, precedence, and timelines

Phase 1: Qualification & scoping
Phase 2: Planning and preparation
Phase 3: Visioning
Phase 4: Roadmap development
Phase 5: Roadmap implementation and adjustment
Phase 6: Application to other domains
Business drivers

- EV owner/operators: affordable and convenient energy provision to assets
- Auto manufactures and charging suppliers: serve all EVs and complete transactions effectively
- Market service providers (aggregators): use flexibility for grid services
- Distribution operators: ensure operations are reliable and use flexibility for distribution operations grid services (voltage and distribution capacity management)

Major organizations

- International car companies, charge station suppliers, distribution utilities, governments, standards organizations
- Conveners:
  - DOE and EC’s Joint Research Center’s EV smart grid interoperability centers
  - SAE, IEEE, ISO standards organizations
  - CHAdeMO, Charin, Global InterOP, Open Charge Alliance (OPCC) consortia
Integration Ecosystem Example: Photovoltaics, Smart Inverter

► Business drivers
  - PV system host: least cost and/or environment sensitive energy provision
  - State policies in CA, HI, NY… to encourage PV deployment
  - Market service providers: integrate turnkey PV systems and consider flexibility for grid services
  - Distribution operators: ensure operations are reliable and use flexibility for distribution operations grid services (voltage and distribution capacity management)

► Major organizations
  - Distribution utilities in states with PV policies, PV and smart inverter suppliers, state PUCs, standards organizations
  - Conveners:
    - States: CA, HI, NY…
    - SunSpec Alliance, SEPA, EPRI, Solar Energy Industries Assoc, Utility Variable-Generation Integration Group, MESA consortia
Integration Ecosystems Example: Commercial Buildings Responsive Load

► Business drivers

☐ Buildings owner/operators: least expensive energy provision to meet building process and comfort demands
☐ Buildings automation suppliers: energy efficiency and comfort with potential payback from supplying grid services
☐ Market service providers (aggregators): use flexibility for grid services
☐ Distribution operators: ensure operations are reliable and use flexibility for distribution operations grid services (e.g., distribution capacity management)

► Major organizations

☐ States: Buildings automation and equipment suppliers and integrators, distribution utilities, governments, standards organizations
☐ Conveners:
  • States: CA, NY, MN, HI…
  • OASIS, ASHRAE standards organizations
  • ZigBee Alliance, OpenADR Alliance consortia
Integration Ecosystems Example: Metering

► Business drivers

☐ Federal and state policies to encourage advanced meter deployment to support grid services using dynamic rates

☐ Market service providers: measure flexibility for grid services and reconciliation

☐ Distribution operators: remote on/off, meter reading, monitor and compensate for operations to ensure reliable operations

► Major organizations

☐ State regulators, distribution utilities, meter suppliers, standards organizations

☐ Conveners:
  • NEMA, IEEE, ISO, IEC standards organizations
  • Association of Edison Illuminating Companies, NEMA, Utilities Telecommunications Council consortia
Integration ecosystems are communities of organizations that are motivated to work together to enable market deployments in a technology area.

The community drives standards, testing, branding, policy, and other things for the benefits that come with making interoperability easy.

It’s hard for one organization to create an ecosystem, so teaming is needed, though there will be champions and followers.

While amorphous and evolving, these communities have the reasons and critical mass to invest in interoperability improvement roadmaps.

Discussion Question: If ecosystems are not engaged, what alternatives are there to advance interoperability?
Path Forward (abridged)

- **Vision**: socialize definitions, concepts, architecture of the strategic vision
- **Ecosystems**: identify an ecosystem to trial roadmap methodology and interoperability measurement tools. Support roadmap execution
- **Culture change**: develop pro-forma interoperability performance language with, by, and for industry, applicable to technology procurement contracts
- **Characteristics**: develop plans to advance interoperability criteria across grid modernization related ecosystems (e.g., resource identification, registration and discovery, scalability, error handling, synchronization)
- **Security & privacy**: develop best practices for policy statements to incorporate into interface specifications
- **Interface contract model**: establish/adapt a framework to capture technical, informational, and organizational interface agreements in machine-readable form
- **Education**: develop introductory material on interoperability, its benefits, and how to advance it
Government Role Considerations

► Convene stakeholders for alignment on strategic vision
► Engage integration ecosystem to measure state of interoperability and apply roadmap methodology
► Sponsor demonstrations of advanced interoperability capabilities
► Adopt interoperability performance criteria in government procurement specifications (lead by example)
► Support tools to advance interoperability
  □ E.g., establish registration framework of devices/systems for unique identification and authentication
Agenda

► This morning
  ◼ Integration ecosystems panel

► This afternoon
  ◼ Ecosystems landscape breakout session
  ◼ Measuring interoperability – the IMM
  ◼ Use of Interoperability criteria breakout session

► Tomorrow morning
  ◼ Roadmap methodology
  ◼ Roadmap interactive demonstration
  ◼ Summary and next steps

► Tomorrow afternoon
  ◼ Tour of AEP Dolan Technology Center
A Hearty Thank You to

American Electric Power
To travel fast, go alone
To travel far, go together

African proverb