GRID MODERNIZATION LABORATORY CONSORTIUM
U.S. Department of Energy

GMLC 1.2.2 Interoperability Technical Review Meeting – Notes

May 10-11, 2017 Meeting
Hosted by American Electric Power Ohio
Gahanna, Ohio

Publish Date: July 14, 2017

PNNL-26595

Acronyms and Abbreviations

AEP – American Electric Power

ASHRAE – America Society of Heating Refrigerating and Air Conditioning Engineers

BLM – Bureau of Land Management

CSIRO – Commonwealth Scientific and Industrial Research Organization

DER – Distributed Energy Resource

DERMS – Distributed Energy Resources Management System

DSO – Distribution Systems Operator

EA – Enterprise Architecture

EPRI – Electric Power Research Institute

EPS – Energy Savings Platform

ESA - Energy Storage Association

ESB – Enterprise Service Bus

ESI – Energy Service Interface

ESIC - Energy Storage Integration Council

ESP – Energy Service Provider

GWAC – GridWise Architecture Council

IP – Intellectual Property

ISO – Independent Systems Operator

M&V – Measurement and Verification

MESA – Open Standards for Energy Storage (also Manufacturing Enterprise Solutions Assoc)

NASPI - North American SynchroPhaser Initiative

OAGi - Open Applications Group

PEV – Plugin Electric Vehicle

PUD – Public Utility Districts

PV – Photovoltaics

RTO – Regional Transmission Operator

SCADA – Supervisory Control and Data Acquisition

SDO – Standards Development Organization

SEPA – Smart Electric Power Alliance

Contents

1.0 Introduction

This report contains the meeting notes from the GMLC Interoperability Technical Review Meeting held on May 10-11, 2017 at the American Electric Power Ohio facilities in Gahanna, OH. The meeting was attended by experienced industry experts and thought leaders who shared their perspectives on the state of grid interoperability and recommendations for improving interoperability in the industry.

Under its Grid Modernization Initiative, the U.S. Department of Energy, in collaboration with energy industry stakeholders has developed a multi-year plan to modernize the electric grid. One of the foundational topics for accelerating modernization efforts is interoperability. To address this topic, four national laboratories (Pacific Northwest National Laboratory, National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, and Argonne National Laboratory) have begun a three-year project to advance the adoption of interoperable products and services in the energy sector. Key preliminary objectives are to align stakeholders on a strategic vision and to develop measures and tools to assess interoperability challenges and promote action. Accordingly, stakeholders convened at a meeting on the 27th and 28th of September 2016, in Chicago to develop and refine a shared understanding of interoperability for this project and DOE's efforts broadly. Stakeholder input from the meeting was incorporated into updated documents and a subsequent technical review meeting was held on the 10th and 11th of May 2017, at the American Electric Power Ohio headquarters, Building 700, 700 Morrison Road, Gahanna, OH 43230.

The meeting attendees generally agreed that the project's proposal to use a stakeholder developed interoperability vision with a proven roadmap methodology based upon an interoperability maturity model (IMM) with tangible metrics was an appropriate approach. The meeting and breakout sessions, revealed that defining and calibrating measurable interoperability metrics based on maturity criteria that can be applied across a wide range of ecosystems and scenarios is a challenge. This will require further refinement and trial applications of the road mapping methodology with the use of the IMM was encouraged. Several potential ecosystems were identified that could leverage the roadmap methodology for improving interoperability as a mechanism to increase participation and advance interoperability.

The valuable input from this meeting is being incorporated into the next phase of work items. The project team expresses their sincere gratitude for the ideas, diverse perspectives, and support for the effort that the attendees offered at the meeting.

We wish to give special recognition to Ron Cunningham of AEP Service Corporation and our AEP Ohio hosts for providing exceptional facilities and support for the meeting.

2.0 Agenda

May 10 - Day 1

TIME	TOPIC
8:00 – 8:45 a.m.	Security Check-in, Registration, Continental Breakfast
8:45 – 9:30 a.m.	Welcome and Opening Remarks Ron Cunningham, IT Enterprise Architect, AEP Chris Irwin, GMLC Program Manager, DOE John Sterling, Sr. Director, Research and Advisory Services, SEPA
9:30 – 10:30 a.m.	Interoperability Strategic Vision Overview – Steve Widergren
10:30 – 12:00 p.m.	Ecosystems Integration Panel Industry Segment Experts Explore Challenges of Integration Solar - Susanna Huang, Ginlong Solis Electric Vehicles – Rich Scholer, FCA Group (Fiat Chrysler) Buildings – Raymond Kaiser, Amzur Technologies Utilities – Howard Self, ABB
12:00 – 1:00 p.m.	Working Lunch Presentation – Ron Cunningham, AEP Quantification of Integration Effort
1:00 – 2:15 p.m.	Breakout Session 1 – Ecosystems Landscape Explore Technology Integration and Business Opportunities
2:15 - 2:30 p.m.	Breakout Session 1 - Report Out
2:30 – 3:30 p.m.	Measuring Interoperability and the IMM – Mark Knight, PNNL
3:30 – 4:45 p.m.	Breakout Session 2 – Usage of Interoperability Criteria Explore value and Procurement Language
4:45 – 5:00 p.m.	Breakout Session 2 - Report Out

May 11 - Day 2

TIME	TOPIC
7:30 – 8:00 a.m.	Continental Breakfast
8:00 – 8:15 a.m.	Welcome and Recap – Steve Widergren, PNNL
8:15 – 9:00 a.m.	Roadmap Methodology Overview – Dave Narang, NREL
9:00 – 11:00 a.m.	Mini Roadmap Demo – Dave Narang, NREL Demonstration of Roadmap Methodology
11:00 – 11:30 a.m.	Roadmap Methodology Discussion – Dave Narang, NREL
11:30 – 12:00 p.m.	Next Steps – Steve Widergren, PNNL
12:00 p.m.	Adjourn
12:00 – 12:30 p.m.	Lunch *(AEP Hosted)*
12:30 – 1:00 p.m.	Drive to AEP Dolan Technology Center *(Optional)*
1:00 – 4:00 p.m.	Tour AEP Dolan Technology Center℠

3.0 Attendee List

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4.0 Meeting Input

Wednesday, 10 May 2017

4.1 Opening Remarks

Presenters:

- Ron Cunningham: AEP Welcome
- Chris Irwin: DOE Welcome
- John Sterling: SEPA Welcome

Participant feedback/questions:

- AEP's Grid of the Future: Decentralized, Digitized and Decarbonized. Customer relations is an area undergoing significant change for the future of the system.
- The SEPA 51st State Initiative visioning and roadmap framework is aligned in concept and structure to the GMLC Interoperability visioning and road mapping methodology.
- Question: GMLC Interoperability represents a set of tools but are there benefits in submitting a GMLC Interoperability report to the 51st State and how best could that be accomplished?

4.2 Interoperability Strategic Vision Overview

Presenter: Steve Widergren

Participant feedback/questions:

- Emphasis on level of effort for "integration" is a good approach because it is very relevant to, and understood by, practitioners.
- DER Facility Conceptual Model makes sense but the ESI and Facility Management System needs to integrate multiple DER ecosystems such as PV, storage and smart buildings. It is difficult for ecosystems to converge on common intra-ecosystem integration approaches and even harder for separate ecosystems to converge on inter-ecosystem integration approaches. There must be sufficient business drivers to overcome competitive forces. The value of inter-ecosystem integration could leverage concepts like Smart Communities.
- DER will probably require participation in more than one grid service to offset installation and operational costs.
- Interoperability is by its nature an "ugly" product for generating interest, much like infrastructure. Learn from John Oliver's infrastructure video analogy: https://www.youtube.com/watch?v=Wpzvaqypav8 .
- Municipalities can be considered an ecosystem.
- Interoperability reduces the cost of entry, which reduces a barrier to innovation.
- Address issues at point of common coupling, the interface.

4.3 Ecosystems Integration Panel

Presenters:

- Bruce Nordman (Moderator)
- Susanna Huang (Solar)
- Rich Scholer (EV)
- Raymond Kaiser (Buildings)
- Howard Self (Utilities)

Participant feedback/questions:

- Solar: SunSpec Alliance has a vision for an end-to-end open architecture covering the life cycle of solar assets including solar panels, inverters and storage. SunSpec Orange Button taxonomy and API are a component of this architecture framework. SunSpec Cybersecurity workgroup will start in second half of 2017 and provide digital certificate infrastructure for industry.
- Solar: California Energy Commission is driving smart inverters through CA Rule 21. Rule 21 requires phase 1 autonomous functions (9/8/2017) and phase 2 data communications, with IEEE 2030.5 as default protocol. Utility may communicate with DER, plant management system or aggregator. Phase 3 additional functions to use revised IEEE 1547 to specify requirements.
- Buildings: DER integration should leverage IoT models and platforms, and focus on interoperable services that integrate smart devices using COTS (commercial off the shelf) solutions, shared services, and multiple communication pathways. Solutions should ideally be open source, vendor-neutral and protocol agnostic.
- Buildings: Existing COTS ecosystems that have technologies relevant for DER include the OSGi Alliance for device integration which is used in many industries and OAGi (Open Applications Group).
- Buildings: Existing standards relevant to DER include the ASHRAE Facility Smart Grid Information Model (ASHRAE 201) along with industry data models (e.g. SunSpec Orange Button, OASIS, OpenADR, IEEE 2030.5).
- Buildings: The ASHRAE Facility Smart Grid Information Model can be leveraged beyond smart buildings to include DER facilities of all types.
- Buildings: Effort should focus on the design and development of interoperable micro-services that cover user interface, economic dispatch, device monitoring and control, and external systems integration and should include life-cycle supply chain services.
- EV: Electric vehicle standards are being driven by SAE and include IEEE/ISO/DIN standards. The SAE suite includes J2836 use cases, J2847 messages/signals, and J2931/J3072 requirements. There are 22 standards being integrated in the SAE working groups.
- EV: IEEE 2030.5 is a key standard for PEV as a DER in J2847/3 for AC optimized charging/discharging. It combines price and demand response with energy planning.
- EV: Older neighborhoods may have limits on distribution circuits and transformers. Most 25 kVA transformers feed 5-10 homes. These transformers can be overloaded 150-200% for hours but need to cool at night. This will not occur if vehicles start charging at night, providing further stress and reducing reliability.
- EV: Home energy management is required since PEV charging will not be predictable. Charging will be at different times and amounts each day.
- EV: Although many different configurations will be used, home energy management will leverage WIFI technology to integrate and manage SEP2 smart meters, thermostats, stationary storage, hot water heaters, solar inverters, pool pumps and EV supply equipment.
- Utilities: DNP3 is a widely used SCADA protocol and ANSI C12/IEC 61850/IEC 61968/61970 are the global standards for meters, control centers and substation automation.
- Utilities: The standards were created to cover a wide range of implementations and therefore contain many optional choices that make specification and configuration difficult.
- Utilities: Utilities typically rely upon single-vendor implementations which results in difficult and expensive equipment interchangeability between vendors due to the lack of certification testing or differences in philosophy between vendor implementations at the semantic understanding, business context and business procedure levels (GWAC Stack).
- Create an “information fabric” for energy that covers geospatial and temporal dimensions.
- Focus on turning energy information into insights (CSIRO).
- Ecosystems must have consensus on requirements and priorities.

- Ecosystems play a key role in conformance testing and certification.

4.4 Quantification of Integration Effort

Presenter: Ron Cunningham

Participant feedback/questions:

- Identified as GRID 3.0 Interoperability Roadmap work item by EPRI P161E and EA Collaboration Workgroup
- Deliverable: EPRI white paper with slide deck
- Status: White paper in process of being drafted
- Hypothesis: System integrations using interoperable industry standards and enterprise service buses become more cost effective after X additional integrations than basic point-to-point integrations
- Define and compare integration work effort/costs using work breakdown structure

4.5 Breakout Session 1: Ecosystems Landscape

Participant feedback/questions:

<u>Metering Ecosystem – Red Team</u>

- Lots of discussion concerning "Competition vs Cooperation" within an ecosystem.
- Participants within an emerging ecosystem each want to control as much of the ecosystem market as they can and do not encourage standards.
- Increasing interoperability may threaten individual intellectual property.
- "Extend and Extinguish" strategy often used by key market players that want to fight ecosystem/industry efforts to standardize. This involves accepting the base functionality of the standard but adding proprietary extensions and functionality which makes the standard appear inadequate in the market and provides justification for proprietary solutions.
- Ecosystems tend to form organically after enough competitors realize that there is a business opportunity to support a common integration approach and standard.
- Potential convening organizations for measuring interoperability and strategic road mapping:
  - NIST
  - DOE
  - Big Dogs, e.g. Texas, California, New York
  - NASPI (North American Synchro-Phasor Initiative)
  - Project Haystack
  - Manufacturers
- Look at Amazon how interactive devices such as Amazon Alexa are quickly changing the human experience with technology using IoT interfaces that are becoming common.

<u>Commercial Buildings and Responsive Load Ecosystem – Yellow Team</u>

- Selection matrix

III	**Smart Communities**	• *Smart City* • *Smart Home* • *Smart Community* • *Smart Campus*
I		• *Energy storage Systems*

I		• *EV Integration*
I		• *PV & Inverters*
III		• *Comm. Buildings & responsive load*
I		• *Metering*

- Stakeholders / Actors
  - Owners
  - Vendors /Suppliers of equipment
  - Integrators of vendor products
  - Municipal authority (taxing authorization)
  - Occupants / residents
  - Users
  - Aggregators
  - Utility / ESP
  - 3rd party service providers

- Business Drivers

	Suppliers	***Users***
Operational Efficiency		
Reliability / Safety		
Cost Control		
System Reliability		
Investment Deferral		

- Convening Organizations

	Convener	***Roadmap***
ASHRAE		
CTA		
NEMA		
UL		
NFPA		
IEEE		
NIBS		
LONMARK		
ANSI		
IBEW		
ISA		
IES		
HAYSTACK		

<u>Storage Ecosystem – Orange Team</u>

- Two Roles

        - Load
        - Supply (e.g. spinning result inertia)
    - Types:
        - Transmission
        - Distribution
        - Bulk Power
        - Premise
            - Resident
            - Commercial
            - Industrial
    - Devices:
        - Water/pumped hydro
        - Air
        - Ice
        - Battery
        - Thermal Mass
        - Fly Wheel
        - Other
            - Inverter
            - One way (Non-reversible energy converted to electrons)
    - Business Drivers / Opportunities
        - Provide auxiliary services
        - Support for local reliability
        - Support for utility services
    - Major Organizations Active in Ecosystem
        - Training
        - Utilities
        - Technical vendors
        - Building, industrial, state, BLM, EPS, PUDs, ISO, RTO, DSO, ESA (energy storage association), MESA, ASHRAE
    - Interoperability Challenges
        - Policies / Regulations
        - Setting storage priority for whom? What are the value streams?
        - Market availability for storage: where? when? contracted terms? how much?
        - Data – what is needed (to / from), age of data, ownership, cybersecurity, volatility, semantics/context
    - Best Convening Organizations
        - National Labs (Argonne)
        - GMLC
        - SEPA
        - EPRI
        - Energy Storage Integration Council
        - MESA

<u>Deep Sub-metering Ecosystem - Orange Team</u>

- Business Drivers (+/- load management)
    - Bidirectional services revenue
    - Status
    - Power quality

    - Diagnostics
    - Rev-time energy management
    - Measurement and Verification
    - Profiling and Forecasting
    - Enterprise energy management
    - Docking & Un-docking
  - Interoperability Challenges
    - Utility or owner/user
    - Integration costs
    - Vendor-level variation
    - Transfer protocols
    - Communications knowledge and background
    - Cybersecurity

4.6 Measuring Interoperability and the IMM

Presenter: Mark Knight

Participant feedback/questions:

- Criteria are difficult to measure and grade using an absolute scale and are not externally calibrated.
- Criteria can only be measured relative to each other but can be easily interpreted differently by different people.
- What documents would be examples of good evidence for each criterion?
- Can we quantify the risk of not being at a specific level?
- An ecosystem governance model is important.
- Different standards, systems, protocols, working groups, ecosystems, consortia, regulators. How to create criteria that work for everyone?
- Boundaries concept caused a lot of confusion.
- Simple criteria can be interpreted in multiple ways.
- Level descriptions remove some subjectivity but are still subject to subjectivity themselves.
- Some levels are vague and need less ambiguity.

4.7 Breakout Session 2: Usage of Interoperability Criteria Exercise

Participant feedback/questions:

<u>Criteria #7 - Unambiguous Resource ID & its management shall be described – Red Team</u>

- *Score: level 2*
  - No Interoperability between device and controller
  - Management ad hoc / poor communication
  - No records to a central information system
  - Internal failure in procurement
  - External – Auto-discovery not standard
- Benefits
  - Capability
    - Resource visible
    - Potential revenue lost
    - Controllable asset
  - Ecosystem – maintain vendor competition (or procurement)

- Additional Issues by Layer
  - Nonregistered / logged asset goes offline, no tracking of asset, paying for service not getting
    - Rogue asset, can cause grid damage or impact operating state
    - Lots of labor for diagnosing and resolving problem
  - Lesser frequency of level 1 occurrence
    - Not documenting process communication
  - Lesser frequency of level 2 occurrence
  - Lesser frequency of level 3 occurrence
  - What are the influence factors and costs at each level?
  - What is level 2 – level 4 objective?
    - Prioritize . . .Fix Process (e.g., procurement)
    - NOTE: Example (v. real issue) impacts evaluation process
      - Requires data governance
- Recommendations
  - Create a feedback loop in the process flow
    - Feasibility looping mechanism less of an incremental-step process and more circular
  - Identify barriers – IP, security, etc.
  - Swim lanes needed
    - Identified in an agreement document. Those that can't agree leave effort
  - Plug fests important part of the process
  - Spiral outward to grow interoperability
  - Iterative Process. (updated from breakout session)
    - Vision
    - Objectives
    - Scope/Requirements (boundaries)
    - Plan
    - Adoption
    - Enforcement
    - Validation – plug fests
  - New IP is often generated during process

<u>Criteria #17 - Compatible business processes and procedures shall exist across interface boundaries – Yellow Team</u>

- Score: level 1: business process has some alignment, but it is not implement well.
- Additional Issues
  1. Process functionality fails (Internal)
  2. Firmware upgrade (External/Internal)
  3. System additions / extensions (Internal)
  4. Commissioning process not complete (Internal)
  5. Cybersecurity changes (Internal/External)
  6. Communications failure (Internal)
- Benefits associated with Above Issues
  1. Improved management process
     - Improved operational process
  2. Improved procurement process
     - Improved capability to validate
     - Could be an ecosystem benefit with improved independent test times
  3. Ditto #2 - Improved procurement process
  4. Ditto #1 - Improved management process
  5. Ecosystem benefit if internal other benefits too

6. Improve design
    - Capability benefits
    - Process benefits
    - Integrity benefits

- Where are the boundaries?
  - Technology questions? "Roundtable"
  - Technical & business processes in parallel
  - More discussion required
- Business side considerations
  - Planning
  - Standards
  - Procurement
  - Gaming
  - Placement
  - Domain
  - Apply external expertise
  - Business equation involves Cost – Standards – Regulations

<u>Criterion #9 – the requirements and mechanisms for auditing and logging exchanges of information shall be described – Orange Team</u>

- *Score: level 1*
  - Logging needs to be configured and verified as an upfront activity.
  - Sufficient logging would have helped identify that there was a problem with registeration and where that problem existed.
  - Interoperability criteria can be interrelated. In this case, a resource ID was needed to properly log messages.
  - Adequate logging needs to include a variety of time-stamped notifications that cover a range of conditions such as hard errors, soft errors, and warnings in addition to just information.
  - Boundaries need to be clearly defined.
- Baseline
  - Storage Alliance
  - Develop project centric requirements for level 2
- Boundaries
  - Storage
  - Site Controller
  - Procurement Process
  - Time Frame 1-2 Years
- Technology Domains
  - Site Components
  - Controller
  - Communications
  - DERMS
- Visions
  - Level 5 – Aim High
    - Requirements defined, documented and reviewed
    - Auditing

- Objectives
    - Training
    - Community requirements
        - Utiltities
        - Manufacturing
        - Owners
        - Integrators
        - SDO’s
        - Example- Devices not to function until configured
    - Governance
    - Procurement Language
    - Technical requirements
    - Business requirements
    - Parallel efforts
        - Standards
        - Reference designs

Wednesday, 10 May 2017

4.8 Roadmap Methodology Overview and Mini Roadmap Demonstration

Presenter: Dave Narang

Participant feedback/questions:

- Similar roadmap methodologies have been successfully applied in many diverse road mapping exercises including the International Energy Agency (IEA) and Denmark.
- Quantifying the return-on-investment benefits for improving interoperability using a roadmap will continue to be a challenge.
- Without roadmaps, work becomes pilots which ultimately die.
- Roadmaps should contain multiple outlooks [optimistic, pessimistic etc.]. Phase 1 should capture multiple future scenarios as part of its scope.
- How does an organization, such as a utility, know when it should become involved in developing an interoperability roadmap? Depends how many ecosystems it participates in, how complex they are, how long it wants to defer the benefits.
- What is the role of government versus industry? The role of government should support interoperability, but not compete with private sector effort. A few participants felt that the scope of government initiatives sometimes overlapped with industry initiatives.
- Distinction should be made between business vs technology and between system and economics.
- The combination of IOT and DER is becoming a global vision.
- Long term strategies and alignment of business value streams are very important for road mapping.
- Consider that 100 years is about 2 asset cycles in the utility industry.
- The roadmap methodology and/or IMM should have interoperability tests called out.
- Defining the boundaries of an ecosystem is very difficult. Organizations can adopt offensive or defensive business strategies as they struggle to monitor and defend market position.
- Exclusivity is a brand. Initial position is typically to control and monopolize industry.
- Barriers can be soft or hard. Intellectual property is a hard barrier.
- Incentive structures must be clearly identified.
- The methodology should consider stage gates that ensure and recognized the committed “travelers”.
- OpenFMB is using a “coalition of the willing” concept to engage members.
- Is OpenFMB at a point where ecosystem expansion and growth needs to be boosted to reach maturity? Does a road mapping approach make sense to expand the OpenFMB ecosystem?
- Simple is better.
- Integration is becoming a social engineering issue and needs to be visible at the C-level.
- Maybe the fear motive and pain approach makes sense by focusing on failed integration attempts.

4.9 Roadmap Methodology Breakout Discussion

Facilitator: Dave Narang

Participant feedback/questions:

- Phase 1: Qualification and Scoping
  - Community requirements defined and validated

        - Identify parallel efforts
        - Embrace standards
        - Develop reference designs
        - Technical requirements
        - Business requirements
    - Training: generally need more information technology expertise applied to the power and DER integration industries.
- Phase 2: Planning and Preparation
    - Most felt that efforts should aim high Level 5 – aim high
    - Requirements must be defined, documented and reviewed
    - Defining boundaries for the scope of the roadmap can be difficult to do up front.
    - Setting up the governance of the process is important to manage the effort.
- Phase 3: Visioning
    - The vision should capture the future scenarios that improved interoperability will support. The team should consider moving at least some aspect of this to Phase 1 for the overview.
- Phase 4: Roadmap Development
    - The methodology should consider interoperability "tests". This might be part of the IMM assessment.
- Phase 5: Implementation, Monitoring, and Revision
    - Auditing is important.
    - Consider adding a cyclical aspect to the process that looks a compliance to the roadmap and refreshing the roadmap with implementation experience.

General Comments

- The breakout is hard to do without considering a real-world problem and having the requisite expertise. More context would have been helpful.
- The concept of "swim lanes" which allows the phases of the process to overlap and perhaps interact with each other was suggested.
- A challenge for the roadmap to capture and address are intellectual property issues.
- At the completion of each phase, consider a "stage gate" that checks the commitment of each party to the process going forward. The number of "travelers" may thin through the process, but explicitly understanding the commitment of those moving forward will ensure their engagement.
- Time Frame: target 1 -2 years to complete a full roadmap.

4.10 Next Steps and General Feedback

Presenter: Steve Widergren

Participant feedback/questions:

- Application of the work
    - Consider a trial of the Roadmap/IMM on the OpenFMB project
    - Consider applying the Roadmap/IMM to the GMLC projects
    - Have one state lead the way and have the remaining states follow the lead.
    - Roadmap breakouts need strong facilitation in the future.
    - Interoperability engagement means involving upper layers of GWAC stack [focus on benefits not raw connectivity]
    - Insert interoperability language in contract procurements.
- Interoperability Maturity Model
    - Keep it simple and as short as possible.

    - Nice proposition to uncover the gaps in integration and standards.
    - Some maturity levels (such as few, many, most) seem vague.
    - Consider what an integration ecosystem can say after going through an assessment. Make it a selling point.
    - What would be the result of an assessment to make it effective? Consider examples where maturity models have been applied.
- Stakeholder Engagement
    - Share and explain catastrophes where failure of interoperability concerns had bad results
        - Create participation with such stories and audience sensitivities.
    - Prepare a strategy to engage high levels of desired organizations to enable resources of expert staff to participate.

5.0 Breakout Session Handout Material

5.1 Ecosystems Landscape Breakout Session Handout

Theme: Explore areas of technology integration and the business opportunities driving deployments and prospects for interoperability advancement

Desired Outcomes:

- List of DER integration ecosystems in place or emerging
  - Technology area
  - Business drivers/opportunities
  - Biggest interoperability challenges
  - Bonus: common interoperability challenges across ecosystems
- Best ecosystem candidates for measuring interoperability and strategic roadmap

Logistics:

- 3 groups ~11 people/group
- Group membership indicated by color coded dots on badge
- 1 hour discussion
- 15-minute prep for report out – flip chart bullet points

5.1.1 Breakout Plan

- 5 min – instructions and assemble groups
- 35 min – Task 1: characterize one or more technology integration ecosystems, for each…
  - Name technology area: Pick one of the examples (EV, solar, buildings, meters…)
  - List 1-3 main business drivers/opportunities for participants
  - List major organizations active in the ecosystem and type of stakeholder
  - List 1-3 biggest interoperability challenges
    - Organizational: is there commonality in business drivers, regulatory issues, business processes?
    - Informational: is there a formal information model? Does it use state of the art tools?
    - Technical: does it support the same information exchange across different communications technologies?
- 20 min – Task 2: identify best convening organization candidates for measuring interoperability and strategic roadmap
  - Use list from Task 1
    - Does the ecosystem have a planning roadmap process?
    - Is there an opportunity to review directions?
    - Which people or organizations would be best to contact?
- 15 min – prepare flipchart for report out
- 15 Min – report out

5.1.2 Integration Ecosystem Examples

- Electric vehicles integration
  - Business drivers
    - EV owner/operators: affordable and convenient energy provision to assets
    - OEMs 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 OEMs, charge station suppliers, distribution utilities, governments, standards organizations
    - Conveners:
      - DOE and EC's Joint Research Center's EV smart grid interoperability centers
      - Standards organizations: SAE, IEEE, ISO
      - Consortia: CHAdeMO, Charin, Global InterOP, Open Charge Alliance
- Photovoltaics, smart inverters
  - 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…
      - Consortia: SunSpec Alliance, SEPA, EPRI, Solar Energy Industries Assoc, Utility Variable-Generation Integration Group
- 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…
      - Standards organizations: OASIS, ASHRAE
      - Consortia: ZigBee Alliance, OpenADR Alliance
- 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:
        - Standards organizations: NEMA, IEEE, ISO, IEC
        - Consortia: Association of Edison Illuminating Companies, NEMA, UTC

5.2 IMM Breakout Session Handout

5.2.1 Scenario

- Several storage startups have decided to invest in various projects to try to install significant numbers of storage devices over three years to provide services to the grid.
- They will be using different devices from different vendors and installing them at multiple sites in different utility service territories. Some sites will have one type of device, others may have multiple.
- They have plans to offer spinning reserves by using the storage in generating mode and also to participate at different times by curtailing the charging. They may also offer voltage regulation and additional services.
- The storage units are being installed on a piecemeal basis from site to site and project to project.
- One day a supervisor at one site notices that the amount of electricity stored is less than planned.
- An engineer installed a new unit which arrived early and was installed ahead of schedule.
- The device did not show up on reports or dashboard.
- Procurement had been directed to purchase this specific device but had assumed some redundant technical (self-identification/registration) language was not required and it was removed in a late review without the knowledge of the technical staff.
- On further investigation, the new unit was found to be operating as part of the site and was storing energy on a load balanced basis with the other units, creating an unaccounted for capacity.
- The new unit was not registered and should not have been having energy delivered to it. The site has a resource identification module that provides unique identifiers to devices that register with it. The controller was registered in preparation for the unit arriving and had been interacting with the other systems at the storage farm.
- The device manufacturer is building devices that can be used in different situations. The storage company is buying units from different manufacturers to get them to work together. The controller was unable to log the transactions even though they were being performed so there were no records sent to the central information system.
- The controller should have had clearly defined rules not only for raising an error for a missing storage unit identifier but also for not including the storage unit into the system without creating auditable logs of the transactions.

- The lessons learned from this experience were discussed during the weekly operating meeting so that interoperability expectations for all undelivered units from multiple vendors could be shared within the team and at the next storage conference.

5.2.2 Exercise

For the scenario above explore the following interoperability criteria from the IMM.

7	**C&E**	**S&S**	**O&P**	**O**	**I**	**T**
	Unambiguous resource identification and its management shall be described.					
Level 5	The ability to unambiguously identify resources can be demonstrated and the capabilities are regularly reviewed and improved.					
Level 4	Resources are identified unambiguously and resource management requirements for resource identification are adopted by the whole community.					
Level 3	Resources are identified unambiguously and resource management requirements exist to describe how resource identification shall be performed for the community.					
Level 2	Resources are identified unambiguously but no documentation exists to describe how unambiguous resource identification and management shall be performed.					
Level 1	Resource identification and management is ad hoc and little documentation exists to describe it.					

Related Scenario Information: A new unit which arrived early was installed but did not self-register and was therefore not identified automatically. The supervisor noticed discrepancies in performance on her reports and dashboard. The site has a resource identification module that provides unique identifiers to devices that register with it. The unit was later registered in the system and a unique ID created manually.

9	**C&E**	**S&S**	**O&P**	**O**	**I**	**T**
	The requirements and mechanisms for auditing and for logging exchanges of information shall be described.					
Level 5	Auditing and logging requirements are aligned among community members and are regularly reviewed and updated as necessary.					
Level 4	Information logging and auditing of information exchanges are described for most deployments (based on community agreements with reference examples) and examples of audits are available.					
Level 3	Information logging and auditing of information exchanges are described for many deployments (based on community agreements) with documented examples available.					
Level 2	Information logging and auditing of information exchanges are described for some deployments (mostly project-centric).					
Level 1	No documentation exists to describe auditing and logging of information used in interface(s).					

Related Scenario Information: The device manufacturer is building devices that can be used in different situations. The storage company is buying units from different manufacturers to get them to work together. The controller was unable to log transactions since there was no ID against which to record them, even though they were being performed, thus no records were sent to the information system. The controller should have had clearly defined rules not only for raising an error for a missing storage unit identifier but also for not including the storage unit into the system without creating auditable logs of the transactions.

27	C&E S&S O&P O I T
	Stakeholders shall actively identify and share lessons learned and best practices resulting from interoperability improvements.
Level 5	Interoperability lessons learned have been included in future planning for continued improvement.
Level 4	Interoperability improvements exist and lessons learned have been shared.
Level 3	Interoperability improvements exist and lessons learned have been documented.
Level 2	Interoperability improvements have been measured, but lessons learned have not been documented.
Level 1	No documented evidence of interoperability improvements can be provided.

Related Scenario Information: The lessons learned from this experience were discussed during the weekly operating meeting so that interoperability expectations for all undelivered units from multiple vendors could be shared within the team and at the next storage conference.

17	C&E S&S O&P O I T
	Compatible business processes and procedures shall exist across interface boundaries.
Level 5	Interface messages that support the business processes are specified for the community and are consistent with the business context information model and processes are reviewed and improved as required.
Level 4	Interface messages that support the business processes are specified for the community and are consistent with the business context information model.
Level 3	Interface messages that support the business processes are specified by project and are consistent with the project's business context information model.
Level 2	Interface messages that support the business processes are specified by some projects and are consistent with the project's business context information model where they exist.
Level 1	Interface messages that support the business processes are not always consistent with the project's business context information model where they exist.

Related Scenario Information: The new unit was found to be storing energy on a load balanced basis with the other units thus creating an unaccounted for capacity discrepancy and it was not showing up on the supervisor's dashboard. The new unit was not registered/identified but the unit controller had been registered in preparation for the storage unit and had started interacting with the storage unit even though it did not have an ID.

5.2.2.1 Task 1 (15 minutes)

Score your chosen criteria for the scenario – what level of interoperability has been achieved

5.2.2.2 Task 2 (20 minutes)

Identify additional issues that might exist at each level (1-5)

- Internal factors (within control of the organizations and participants in the ecosystem)
- External factors (e.g. vendor goes out of business, new regulations, etc.)

5.2.2.3 Task 3 (20 minutes)

Identify common interoperability benefits from addressing these (Task 2) issues

- Capability benefits
- Ecosystem benefits
- Procurement benefits

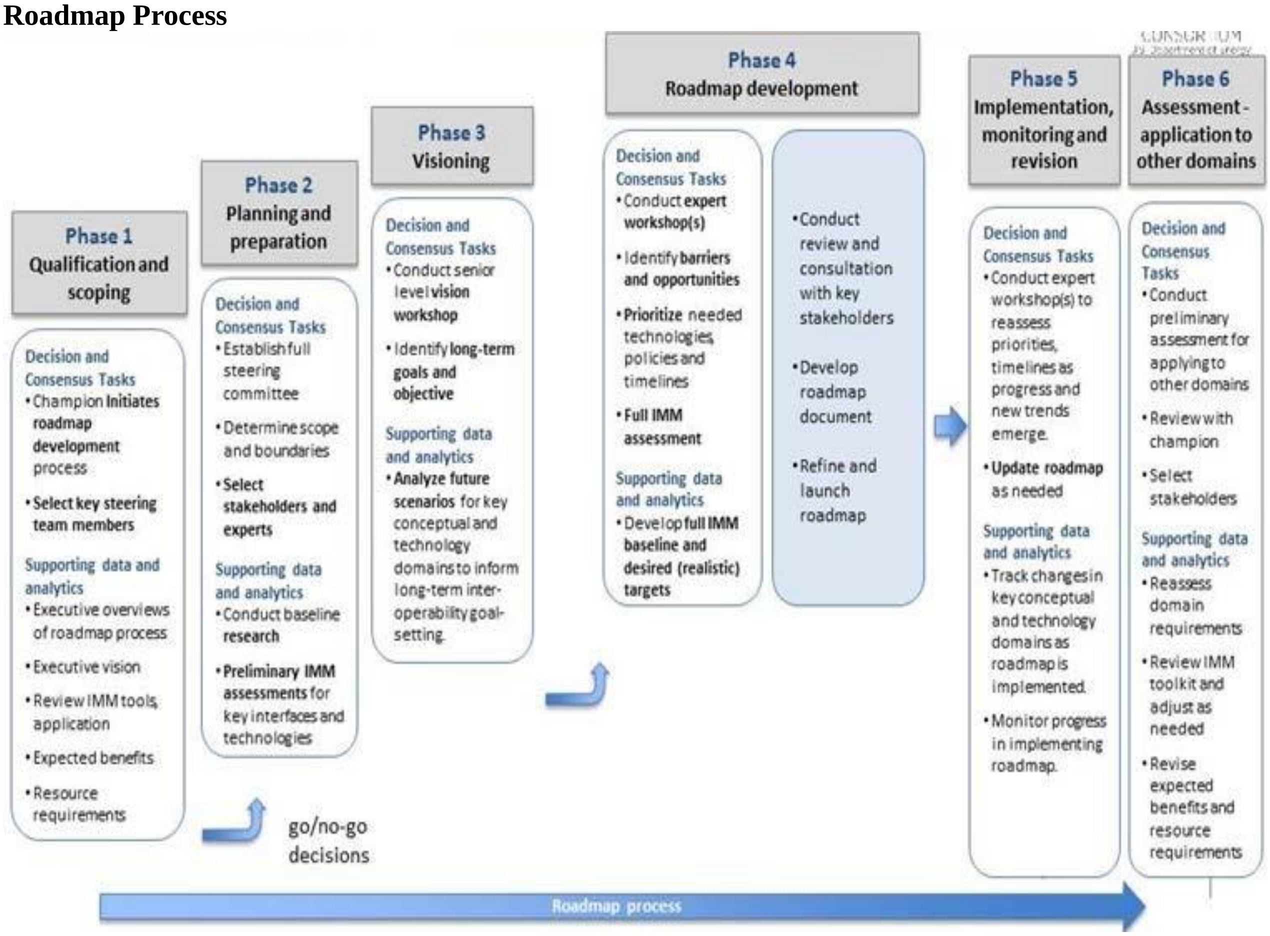
- Integration benefits
- Other

5.2.3 When you are finished (10 minutes)

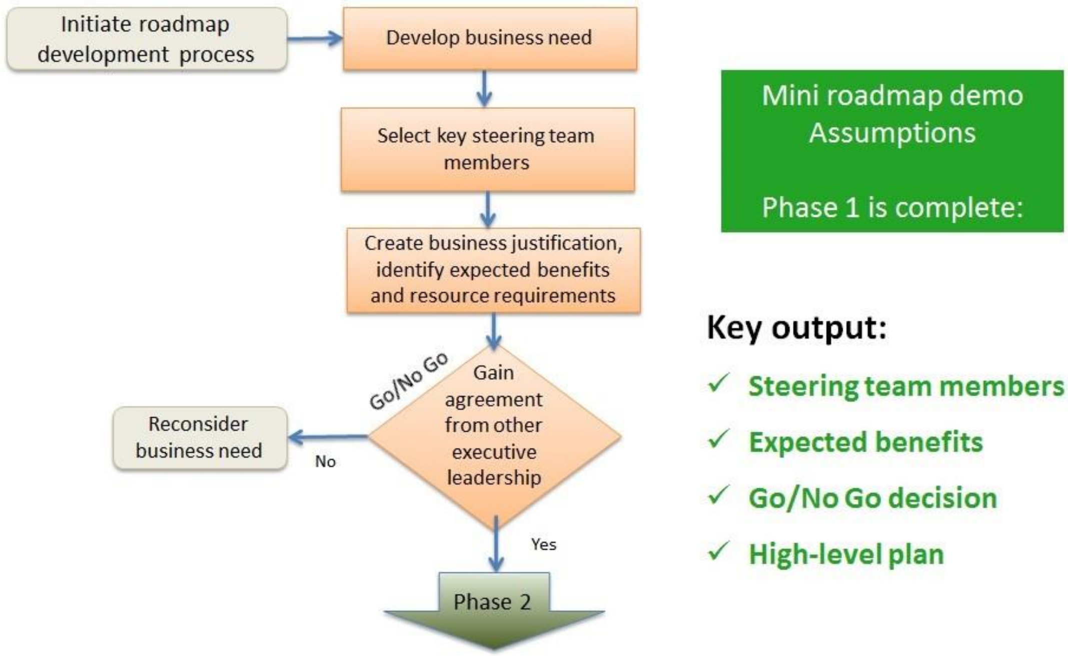
Prepare flipchart for report out

5.3 Roadmap Methodology Session Handout

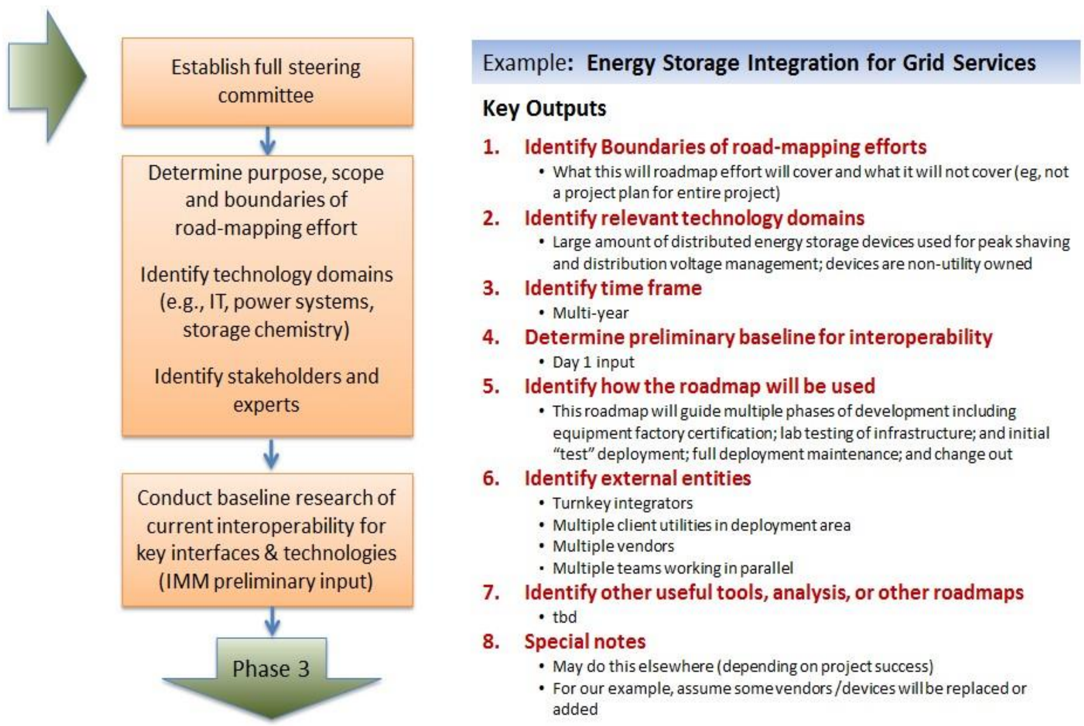
Roadmap Process



Phase 1 output summary and assumptions



Phase 2 output summary and assumptions



Phase 3 Exercise: Visioning

Key output:

1. Identification of long term vision, goals, and objectives related to interoperability
2. Analysis of future scenarios

Considerations:

- What's the overall context for this effort?
- Expected trajectory of key domains/technologies
- Status of other relevant standards, policies,
- market trends,
- Status of competing/parallel efforts

Phase 4 Exercise: Roadmap Development

Key output:

1. Development of full interoperability baseline and identification of desired maturity level
2. Identification of barriers and opportunities
3. Prioritize action plan
4. Develop roadmap document
5. Refine and launch roadmap

Considerations:

- Targets are based on what's realistic, needed, desired
- Barriers or opportunities may include technical, process, policy
- A clear action plan will identify steps for achieving the desired interoperability maturity level

Overall Feedback

1. Clarity and usability

2. Real world applicability

3. Correctness of the assumptions

4. General comments

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http://gridmodernization.labworks.org/