SMART GRID INTEROPERABILITY:

Prompts for State Regulators to Engage Utilities

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Glossary

Backward Compatibility – The ability of new technology operating under a new version of a program to work with an older version of the program without loss of data or communication.

Certification – When a technology has been tested against a set of requirements and certified as successfully meeting the requirements.

Closed Environment – Where there are no or limited interactions with systems other than the immediate system being tested.

Compliance – A technology is judged to meet the requirements of a standard, rule, or order.

Future-proofing – When systems or technologies are designed to include future advancements in a standard or technology that minimizes the need for modifications to the installed system.

Integration Testing – Occurs when new technologies and devices are tested to ensure successful coupling and communications with existing technologies or devices.

Interoperability – The capability of two or more networks, systems, devices, applications, or components to work together, and to exchange and readily use information—securely, effectively, and with little or no inconvenience to the user. The smart grid will be a system of interoperable systems; that is, different systems will be able to exchange meaningful, actionable information in support of the safe, secure, efficient, and reliable operations of electric systems. The systems will share a common meaning of the exchanged information, and this information will elicit agreed-upon types of response. The reliability, fidelity, and security of information exchanges between and among smart grid systems must achieve requisite performance levels.

Pilot Testing – When new technologies or systems are allowed to work with a small part of the existing system to ensure successful interaction with the exposed system that limits potential negative impacts on the broader system.

Profile – A well-defined subset of the standard for implementation that has been agreed upon by a user community, testing authority, or standards body. A profile facilitates interoperability by limiting the variety of vendor solutions under a potential standard and can serve to clarify standards-based implementation requirements for all stakeholders. An example of a profile is California's Rule 21, which determined the specific information model (IEC 61850) and communication model (IEEE 2030.5) under a standard (IEEE 1547-2018).

Testing and Certification – Programs can be offered by recognized entities to test a product against a standard to determine whether the technology successfully abides by the standard. An example of a testing and certification entity is Underwriters Laboratories (UL), which tests technology against a specific set of requirements to ensure the technology meets those requirements.

Single Point of Failure – If one part of a system fails, it causes the entirety of that system to fail. For example, if a customer has a router in the house with multiple devices connected to it to access the Internet and the router fails, then all of the devices will no longer be connected to the internet.

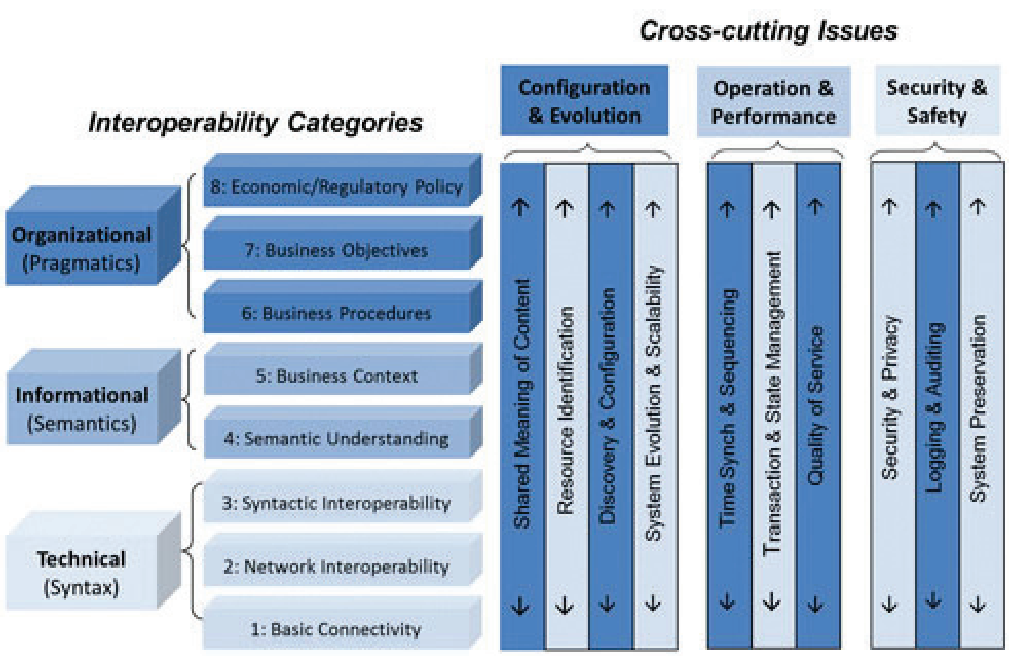
Introduction

As technologies proliferate across the electricity network, interoperability is increasing in importance to enable communication, coordination, and integration of more components essential to the network—some of which may not be owned by the utility. Interoperability is a means to ensure that operational network components work collaboratively and efficiently with each other. Investments that emphasize interoperability can improve reliability and security, reduce design and installation costs, and enable new services by preserving competitive innovation.[1] The U.S. Department of Commerce's National Institute of Standards and Technology (NIST) defines interoperability, in the context of the smart grid, as:

> The capability of two or more networks, systems, devices, applications, or components to work together, and to exchange and readily use information—securely, effectively, and with little or no inconvenience to the user. The smart grid will be a system of interoperable systems; that is, different systems will be able to exchange meaningful, actionable information in support of the safe, secure, efficient, and reliable operations of electric systems. The systems will share a common meaning of the exchanged information, and this information will elicit agreed-upon types of response. The reliability, fidelity, and security of information exchanges between and among smart grid systems must achieve requisite performance levels.[2]

This paper uses a framework developed by the GridWise Architecture Council (GWAC) that identifies the categories of interoperability and the interfaces between the categories, as shown in **Figure 1**.

Figure 1. GridWise Architecture Council (GWAC) Interoperability Context-Setting Framework



1 "Financial Benefits of Interoperability: How Interoperability in the Electric Power Industry Will Benefit Stakeholders Financially," GridWise Architecture Council (September 2009), https://www.gridwiseac.org/pdfs/financial_interoperability.pdf.

2 "Framework and Roadmap for Smart Grid Interoperability Standards, Release 3.0," National Institute of Standards and Technology, Special Publication 1108r3, (September 2014), pp. 20-21.

The GWAC framework identifies three categories of interoperability: Organizational, Informational, and Technical.[3] The categories represent the levels of interoperability across the utility, starting at a high level (regulatory and policy) down to the granular capability of two devices communicating. It also identifies 10 items that cross each category, implicating the interconnectedness of certain topics across interoperability.

This paper outlines roles, responsibilities, and actions that a state regulator may consider in its review of utility proposals for investments in smart grid technologies to ensure these investments align with good interoperability practice. It identifies a series of questions that a regulator can ask the utility (and their equipment vendors and installers) about interoperability in a variety of arenas and as opportunities arise.

Purpose

The questions provided in this document are intended to assist the regulator in reviewing utility proposals and investments of new and emerging technologies, including the cost impacts and risks of differing proposals or options. With the increasingly dynamic nature of advanced electrical systems—including the use of new technologies, two-way power flow, and customer adoption of behind-the-meter equipment—more components and systems need to work together than ever before, both internal to the utility and between the utility and external systems.

To evaluate the prudence of utilities' technology investment proposals, regulators need to ensure that they are aware of the potential impacts from technology changes. Regulators can remain vigilant by asking the right questions at the right time in the decision-making process to ensure maximum value is being sought and achieved for ratepayers. To enable interoperability, a utility might need to incur foundational costs or procure and implement new systems prior to unlocking benefits. Thus, to evaluate utilities' technology investments, it is necessary for the regulator to gather data on all investment and system-related costs.

Use

An important part of a regulator's tasks is to gather relevant information prior to issuing decisions about utility investments. Enhancing a regulator's own capabilities to ask the right questions, at the right time, and understand the answers will lead to better-informed decisions. The following four steps and related sets of questions can be used by a regulator to understand the potential impacts of interoperability on utilities' technology investments, which supports a better understanding of likely ratepayer value.

- **Step 1** starts with an understanding of the context of how and where interoperability may be evaluated (whether it is in policy development, a utility petition or application, or during a rate case, as examples) to define and determine the costs and benefits of achieving interoperability.
- **Step 2** considers the ability of new utility or customer technologies to integrate with existing technologies, people, and processes.
- **Step 3** asks questions related to the ability of the new proposed technology to work with potential future technologies, people, and processes (i.e., future-proofing).
- **Step 4** considers solutions in cases where interoperability is not immediately present, but the regulator can influence and streamline future applications of interoperability and decisions. One such approach is requiring the utility to develop a "profile" that attempts to extract a set of common requirements from several standards to facilitate technology adoption and lower costs.

We have also included a precursor **"Step 0"** that facilitates an internal commission review to allow the regulator the opportunity to review its own capabilities prior to asking the utility the key questions within the four steps.

3 "Smart Grid Interoperability Maturity Model Beta Version," GridWise Architecture Council (December 2011), pp. 3, 17, https://www.gridwiseac.org/pdfs/imm/sg_imm_beta_final_12_01_2011.pdf.

Step 0: Internal Questions for Regulators

What follows are questions regulators may want to consider to assess their own capabilities and interest in guiding utilities' interoperability practices and policies.

- Does the regulator understand what the utilities are planning for their future grid?
- How can a regulator obtain foresight into the utility's planned investments?
- What expertise and knowledge will commission staff need to understand proposals and technologies that have not historically come before a commission?
- How can staff prepare for these developments?
- What internal expertise exists?
- What regulatory processes are available to the regulator to convene workshops, working groups, or other meetings to inform and educate stakeholders and the regulator?
- Does the regulator have the ability to use consultants to assist in the review and analysis of utility proposals? What options are available to regulators to hire consultants, and what lead work is necessary to access funds or approvals to do so?
- How and where will the review and considerations of interoperability of a specific utility proposal (or more broad modernization plan) fit within a regulator's purview? Within the cost-benefit assessment of a proposal? Through a generic proceeding? Or elsewhere?
- How can the regulator take lessons learned from one utility/project and improve future utility proposals? Are there reports or studies available from NARUC, the Department of Energy, national labs, expert consultants, or universities?
- What resources exist at trade and national organizations to help facilitate technological, process, and personnel interoperability?
- Are there national standards, guides, or recommended practices that should be adopted or developed?
- Does the commission have access to the relevant standards and materials associated with those standards? Are they engaged or need to become engaged with applicable standards development organizations (e.g., IEEE, IEC, ANSI, NAESB). How does a regulator incorporate the applicable standard(s) into rules, process, or policy?
- What role should the regulator play regarding interoperability? Does the regulator want to take a proactive position in developing interoperability policies? Does the regulator want to react? Should a regulator provide general guidance, best practices, or principles for interoperability? Does the regulator outline roles and responsibilities for interoperability?

Step 1: Identify Business Case and Benefits of Interoperability

These situations and questions can be useful for a regulator asking a utility about its business case for investing in interoperability. For example, to implement a solution that facilitates the interoperability of a utility system, the utility may request additional funding for particular equipment. In some cases, the costs of interoperable equipment may be more than a business-as-usual proposal that is not deliberately interoperable. The longer-term benefits of interoperability could be greater than the short-term incremental cost, but will need to be described to demonstrate any positive tradeoffs. These questions can apply whenever opportunities arise, including in response to a utility application or when developing commission policy or guidance.

Demonstrating a Benefit

- How does the utility define interoperability?
- How and where does the utility show benefits of interoperability?
- How does the vendor(s) demonstrate to the utility that they are interoperable, such as a certification from an independent, third-party certification authority?
- Does the utility have an example or experience where interoperability has affected (positively or negatively) the integration costs, benefits, or implementation of a technology or standards?

Integration Costs & Benefits

- Is there a benefit to accelerating the replacement of legacy systems?

Avoiding Vendor Lock-In (last single point of failure[4])

- Does diversity in vendors provide a measurable benefit?
- Do the available equipment suppliers operate on an open standard that avoids single-source systems, equipment, and service?
- What role does the commission have, if any, regarding the choice of the vendor(s)?

4 A single point of failure is where if one part of a system fails, it causes the entirety of that system to fail. For example, if a customer has a router in the house with multiple devices connected to it to access the Internet and the router fails, then all of the devices will no longer be connected to the Internet.

Step 2: Ensure New Equipment/Investments Work with Legacy Equipment/Investments

These questions are designed to be used when considering a utility investment application. They can also be helpful when developing guidance for a utility on preparation of an application or rate case, which should address the ability of new investments to work with existing or legacy utility investments.

Request for Proposal (RFP) Development

- Do the utility's RFPs have a requirement that vendors be interoperable with a standard or a profile?
- Does the utility have a map that defines which systems need to be interoperable and what data/operations will be linked?
- Does the utility require reliance on open standards?

Transition Path

- Can the utility describe its transition path from the old to the new technology? Is there a period where both legacy and new technology and equipment will be used concurrently?
- How will the utility determine that the transition is successful? Are there industry (or vendor) metrics that the utility will use to validate if the transition is successful? Why are those metrics appropriate?
- Is there a plan to address interoperability failures with legacy equipment? How does the utility plan to minimize exposure to failures?
- What organizational changes are planned to support this transition?
- What institutional knowledge about the legacy systems needs to be transferred to the new system?
- Who will ensure interoperability: the vendor or utility?
- How will the proposed investment or plan be integrated with existing utility systems? Will there be a detailed plan to track the integration steps?
- What other system components, processes, or divisions will be affected, and how will the integration approach be coordinated?
- Does the proposed investment or plan integrate into the utility systems off-the-shelf, or will specialized testing, engineering, or integration work be needed? If so, what and how is that managed?

Backward Compatibility[5]

- How does the utility and vendor test for backward compatibility?
- Did the utility require backward compatibility for its vendor, either for the prior investment or new investment?
- Who is responsible for backward compatibility challenges that might arise: the utility or the vendor?

5 Backward compatibility is the ability of new technology operating under a new version of a program to work with an older version of the program without loss of data or communication.

Integration Testing[6] (closed environment,[7] piloting[8])

- What is the utility's plan for a testing program for the integration of new technologies with the remaining legacy system? Are there examples from prior installations that can be used as a roadmap?
- How will the utility determine that the integration of technologies is successful? How does the utility/regulator define success?
- How can the utility and their vendor design the testing and integration to insulate the utility customer from financial risk?
- Does the utility rely on self-certification or third-party certification for proof of ability to integrate?

Third-party and Customer System Integration

- Are there requirements or standards for customer devices to connect to utility systems?

6 Integration testing occurs when new technologies and devices are tested to ensure successful coupling and communications with existing technologies or devices.

7 A closed environment is where there are no or limited interactions with systems other than the immediate system being tested.

8 Pilot testing occurs when new technologies or systems are allowed to work with a small part of the existing system to ensure successful interaction with the exposed system that limits potential negative impacts on the broader system.

Step 3: Ensuring Investments Today Support Investments Tomorrow

These questions can be used by a regulator when reviewing utility applications or when developing guidance or requirements for future utility filings. These questions can be used to address the ability of new investments to work with future investments.

Future Proofing[9]

- How can the utility incorporate future-proofing and/or planned obsolescence as a means to manage technology replacement? What methodology is used or information relied on that informs the utility decisions on future-proofing?
- How does the utility incorporate interoperability into its procurement, investment, and installation practices?
- How does the utility internalize business practices, technology evolution, and information exchanges within and across utility business units (technical, informational, and organizational)? What have been the results thus far?

Open Standards

- Is the utility relying on open standards (compared with proprietary standards)? What percentage of standards being relied upon is built on proprietary versus open?
- Are there examples of utilities that have successfully deployed the standard and associated technologies?
- Does the utility rely on third-party certification for conformance to an identified standard?

Investment Strategy

- Is there a plan for obsolescence and a replacement strategy? Which business units are responsible for and contributing to that plan? Are new business units anticipated?
- How does interoperability impact investment/implementation strategies for new technologies?
- How is interoperability reflected in investment/implementation strategies for new technologies?
- How is that investment strategy reflected in organizational, informational, and technical investments, planning, or implementation?
- Is there a long-term investment strategy for organizational, administrative interoperability?

9 Future-proofing occurs when systems or technologies are designed to include future advancements in a standard or technology that minimizes the need for modifications to the installed system.

Step 4: Profile Development

Questions that follow can be used to identify if there is a need for the development of an interoperability profile and what a profile could encompass. For example, if a standard includes many options to make hardware or software compliant, developing a profile that consists of a common set of those options may assist in supporting interoperability.

Need for a Profile

- Is there a set of standards that work together to facilitate compliance[10]?
- Do the standards have multiple choices for compliance?
- Would a profile (a subset of multiple standards) facilitate interoperability?
- Who is contributing to developing the profile? (e.g., the utility, the commission, the state, the vendor)
- Where were the standards published and how widespread is the use of that standard?

Identify Components of Multiple Standards to Create a Profile

- What are the standards that would be used to create a profile?
- If there is a use case for the profile, what are the standards that will be used for that purpose?
- What are the specific functions in the standards that would make up the profile?

Time, Money, and People to Work on the Creation of a Profile

- How will the utility work with the vendor to develop a profile?
- Does the utility currently have the resources to develop a profile? If not, what steps will be taken to develop a profile?

Testing and Certifying a Profile

- Who develops the testing and certification program?[11,12]
- Presuming third-party certification, who conducts the testing and certification? Is there an existing third-party certifying entity? Is there a need to create a third party certification entity? How is the certifying entity 'certified'?

10 Compliance is achieved when a technology is judged to meet the requirements of a standard, rule, or order.

11 Certification occurs when a technology has been tested against a set of requirements and certified as successfully meeting the requirements.

12 Testing and certification programs can be offered by recognized entities to test a product against a standard to determine whether or not the technology successfully abides by the standard. An example of a testing and certification entity is Underwriters Laboratories, which tests technology against a specific set of requirements to ensure the technology meets those requirements.