GridWise™ Architecture Council
Interoperability Path Forward
Whitepaper

1 Introduction

The Gridwise Architecture Council (GWAC) exists to enable automation among the many entities that interact with the electric power infrastructure. Though we do not prejudge what this automation will be used for, once it is enabled, we presume that, given opportunity, many possibilities will be explored and much economic and social good will result. The GWAC mission is merely to enable. The goal is something called "interoperability". To consider interoperability in terms of what it accomplishes, you achieve interoperability between computers of different parties if valuable ideas are not scrapped because of the difficulty to make these computers cooperate in the proposed process. Such a definition, though, does not help in understanding how to achieve interoperability. Without getting too technical, this paper will talk more about the nature of interoperability and what path we can take to achieve it.

The interoperability concepts come from work relevant to distributed process integration and interoperation across the economic spectrum. By framing the debate and setting a path forward, we endeavor to align thought and vision around the best ideas that exist in this field today, with an eye toward the emergence of new concepts that may better address interoperation issues and expand the community of adopters in the future. With a shared meaning of interoperability and an appreciation of the related complex issues, we look to a path that prioritizes areas where policy agreements and/or standardization can ease integration and interoperability.

Abstract

The North American electric system is composed of many businesses cooperating to deliver electricity to the end customer. Today's technology offers the ability to exchange information to enhance operational and financial effectiveness beyond the automation in present use. The incentive to exchange information electronically is a result of system and business processes that span organizations such as scheduling and coordinating electric supply and demand, detecting and correcting system problems, or providing settlement and billing information to market participants. The drivers for automating these information processes are evolving as industry policies, market rules, and technical capabilities mature. To facilitate information exchange, the GridWise™ Architecture Council (GWAC) promotes a collaborative path forward to advance interoperability so that organizations can connect their inter-business processes as they see fit now and over the next thirty years. Following these high-level steps, the GWAC aims to frame the debate on interoperability to advance an overriding strategic perspective. This whitepaper introduces an initial, working definition of interoperability, and a path forward to advance information system interoperability between partners in the electric system.

2 What do we mean by Interoperability?

All definitions of interoperability related to distributed systems have common factors:

- exchange of meaningful, actionable information between two or more systems across organizational boundaries,

- a shared meaning of the exchanged information,

- an agreed expectation for the response to the information exchange,

- requisite quality of service in information exchange: reliability, fidelity, security.

The result of such interaction enables a larger system capability that transcends the local perspective of each participating subsystem.

While full interoperability may have a "plug and play" flavor (connect it and it works), interoperation can be thought about in terms of different levels of technical and conceptual agreement, such as agreements at syntactic, protocol levels, or conceptual and semantic modeling levels, or overall process level. Even though agreement at conceptual levels may not provide "plug and play", it can greatly facilitate the configuration of information systems to make components work together.

In addition, honoring communication protocol and syntactic agreements can fall short of interoperation if information meaning or process sequence rules are ambiguous. Note that, successful interoperation between systems is not the same as open systems interfaces. Open systems interface specifications rarely assure complete interoperability, but when they are widely deployed and understood by different implementers, they can greatly advance interoperation.

> **Process Level Interoperability**
> Consider the process "accounts receivables." Organization A sends an invoice to organization B expecting "accounts payable" to process it in a well understood accounting-manner and return a check to organization A's "accounts receivable" process. This interoperable exchange may be conducted via paper or information exchanges via electronic data interchange (EDI) networks or the internet. Whether the exchange is appropriate in paper or electronically depends on the volume and efficiencies required on the communication loop supporting the processes. Complete interoperability is a requirement for a new or existing process to be successful.

3 Our Situation Today

Interoperability assumes that two or more entities agree to cooperate toward a shared set of expectations, meanings, and responses to information exchanges. Inter-organizational or inter-functional processes drive the need for interoperability. The advancement of information technology is changing what has been process interoperation that involved a high level of human interaction with processes that make use of greater levels of automation between organizations and devices. All working automation interfaces between these entities interoperate today; however, the complexity, frailty, and/or expense to configure and maintain these interfaces are hindering the pace of expansion of automation to integrate cross-business processes. The result is that new values and new capabilities remain untapped.

Those attempting to unlock the potential benefits to the electric system enabled through the interoperation of automated systems typically face a number of issues, for example:

- *The electric infrastructure and its associated information systems are becoming more and more complex*. Systems that started as islands of automation are now being integrated into larger automation frameworks. Often these systems are stretched in unanticipated ways, they integrate multiple legacy technologies, and their styles of integration vary.

- *Many subsystems are reaching their operational limits*, thus risking reliable operation for themselves with the potential for wide-area system implications.
- *Legacy solutions must continue to operate* as businesses increasingly integrate their processes across organizational boundaries with continually evolving approaches and tools.
- *Automation in other industries is enabling non-traditional players in electric system operations to become active participants*; however, technical and conceptual mismatches exacerbate interoperation. E.g., the consumer side has greater capability to control local electrical resources automatically to benefit local or system level operations. Interestingly, the consumer automation communities also face similar interoperability challenges.
- *New investment is limited*. Contributing to this issue is the risk on return of investment when embarking on large, complex integration projects. In addition, the business and regulatory environment may not offer an affordable path to reward investment for the risk taken.

4 Our Desired Destiny

Information technology advances are moving us toward a "wired" world of increasingly interconnected, automated processes that pervades our work and our lives. What does this mean for our electric system and the nature of interoperability we desire?

The characteristics of our desired destiny regarding interoperability are reflected in the Constitution Statements of Principle. They include the following aspects:

- *Respect organizational boundaries and security across the electric system supply chain.* Electric system business processes are automated across the value chain. Process integration is enabled across organizational boundaries with due respect for privacy and the right for each business to determine their internal processes and technical solutions. The interactions are done securely to mitigate cyber attacks, support privacy requirements, and localize issues.
- *Embrace the evolutionary dynamics of business processes, technologies, and interfaces.* Over time, organizations come and go, their boundaries of responsibility shift, and their service offerings and requests change While new value chains emerge. Business processes evolve and the information system interfaces with other organizations that support them are smoothly modified. Similarly, technology offerings change, new solutions are deployed, and the resulting mixtures of information system technologies successfully co-exist. Through it all, regional electric system operation is not compromised.
- *Enable the discovery and creation of new value chains and participants.* New players now become active participants by accessing and delivering services through information system interfaces with other organizations. For example, electricity consumers become active participants with the capability to choose from a variety of electric service plans from providers that can offer incentives to customers who can shape their consumption as a service in return.

- *Enhance the resilience of the system to natural or deliberate attacks.* Automation with independent, distributed decision-making schemes promotes self-organization responses to reconfigure aspects of the electric grid to protect regional system operations, localize problems, and support responses at the local level to mitigate impacts.

In short, integration and interoperation becomes simple, economic from a technical perspective, and scalable from a system integration perspective. As the internet unlocked unimagined capabilities, innovative solutions and business opportunities will emerge from such an environment.

5 The Path Forward

No one group has the authority to dictate or drive deployment solutions across multiple organizations. Those responsible for the inter-company interactions are closest to the issues and motivated to prioritize and resolve the problems reliably and economically. Still, the choices these people make can benefit from the knowledge and perspective of the tools and methods offered by the information technology community, as well as the shared experience of their colleagues facing similar issues within related industries. The Architecture Council strives to bridge these communities, make connections across disciplines, and nurture mindshare for a path to simplify interoperation.

The path forward has several expected steps; some of these have already begun via the Constitution interview process. They are presented here to spur discussion and involve the voices of the greater electric system community to bring them into sharper focus.

1. Identify and engage the organizations, associations and regulatory spheres with stake in the future of the electric system.

2. Develop a common understanding of interoperability and the various levels of interoperability.

3. Classify the information exchange needs, the collaboration required at organizational boundaries, as well as the issues impeding the advancement of interoperation.

4. Establish liaisons and working groups with influential organizations to debate interoperability issues in an open manner that disseminates important points for all to monitor, comment, and prioritize action (standards, policy, etc.)..

5. Measure progress along this path and refine directions accordingly.

An expansion of each step appears below.

5.1 Identify and Engage Stakeholders

The Interoperability Constitution is an initial list of statements of principle that unites as many stakeholders as possible in concepts that can be used to measure or debate proposals offered

in the name of enhancing interoperability. The Architecture Council drafted a set of statements to engage a larger audience of representative parties in an interview process. This resulted in a revised list that supports the "Constitutional Convention", a meeting to increase the number of stakeholders represented and solicit their thoughts and buy-in.

An important outcome of this meeting will be the directions proposed for further refinement of these principles and champions to manage renewal and relevance in a sustainable manner into the future. The cross-industry representation embodied in the structure and composition of a governance organization as well as their rules of engagement will be important aspects to establish as a part of this process.

5.2 Develop a Common Understanding

The concepts and issues surrounding interoperability between partners in the electric system are multi-faceted and complex. A variety of insights and opinions exist on the matter with a definitive voice unlikely to emerge. Rather than end the discussion about interoperability, the Architecture Council intends to "frame the debate" about important concepts and issues by helping to develop an arena for discourse, a place where people and communities can share their views and foster understanding. This means settling on a language with common meaning to key terms and building on these terms to communicate a shared understanding of relevant concepts. With better tools for understanding, people can debate interoperability issues, challenges, and resolutions more effectively.

Given the multiple disciplines and communities involved, terms and language will need to be tailored according to the participating communities. For example, an information technologist attempting to resolve a messaging synchronization issue will not speak the same language as a regulator formulating rulemaking for a retail demand response market. Still, where these communities overlap consistency of terms and concepts will facilitate communication.

The starting point for framing the debate on interoperability is to define it. This whitepaper proposes a working definition for interoperability. Even though interoperation is accomplished only if complete agreement is reached on a thorough set of interoperability concerns, achieving this agreement can be simplified if the parties involved,
- have a common view of the various aspects of interoperability,
- understand each other through common use of terms,
- are able to succinctly and unambiguously specify complex areas of agreement based on standards or common codes, and
- quickly drive resolution on areas that may require customized agreements.

5.3 Classify Interoperability Needs and Issues

With a growing base of shared terms and concepts, the debate can progress further to identify important issues associated with interoperability. The Constitution statements provide a good starting point for identifying some of these issues:
- shared meaning of content,
- indisputable identification (people, places, things),
- time and sequencing,

- configuration (set up),
- security and privacy,
- performance, reliability, scalability,
- system evolution (revision deployment in a heterogeneous environment), and
- system preservation.

5.4 Debate, Prioritize, and Delegate

Advancing the strategies to enhance interoperability requires consensus building on issues and key concepts, communication and education about these issues, understanding the state and trends of related efforts, and prioritizing actions that will make a difference.

Influential experts must be brought together across the invested communities to debate these issues. Not only will the debate reveal insight and provide clarity to issues, it will encourage champions to organize efforts to address priority concerns that improve the present situation. With these priorities, efforts can be made to engage standards, trade, and policy organizations to develop applicable standards and codes.

Interest and active participation to advance interoperability concerns through standards and other codes requires a reason for engagement. Highlighting or exploring new business models and value propositions can motivate people and institutions to take concrete initiatives that make use of the power of distributed automation and provide the impetus to standards efforts, policymaking, and other codifications that enhance interoperation.

5.5 Measure Fulfillment

To determine progress as the path forward advances, measures need to be defined and samples taken. These measures can take many forms and will need to mature as directions become clear, but some examples are already apparent.

- Determine the value propositions touted because of capabilities enabled by greater degrees of interoperability. E.g., at the time of this writing, studies are underway at the federal and state levels to determine the value of demand response to system operations and electricity market stability.

- Evaluate business scenarios employed or proposed that use high levels of interoperability to create value or enhance a competitive position.

- Observe the progress of communicating shared concepts and strategies through greater consistency among targeted standards (i.e., better alignment in analogous areas).

- Measure the validity of interoperability concepts and strategies as implemented in field demonstrations or pilot programs that illustrate the application of such approaches.

6 Summary

While technically feasible, the integration of information driven processes across organizational boundaries faces several complex challenges. By identifying and addressing these challenges, interoperation between automated systems can be eased to the benefit of all stakeholders. Progress in this area must be accomplished by domain experts from the various parties involved in the inter-organizational processes of interest. The Architecture Council aims to promote interoperation between organizations within the electric system by engaging our community in framing the debate on interoperability and providing a path forward to establish common ground, identify barriers to interoperability, and prioritize near term actions whose resolution advance the cause.

References

1. GridWise™ Architecture Council, "GridWise Architecture Council Interoperability Constitution Whitepaper," October 2005. (www.gridwiseac.org)

2. Edwin Morris, Linda Levine, Craig Meyers, Dan Plakosh, "System of Systems Interoperability (SOSI): Final Report," April 2004. Technical Report, CMU/SEI-2004-TR-004, ESC-TR-2004-004

3. Healthcare Information and Management Systems Society (HIMSS) Integration and Interoperability Steering Committee, "HIMSS Interoperability Definition and Background," 6/09/2005. (http://www.himss.org/asp/topics_FocusDynamic.asp?faid=86)

4. EPRI Intelligrid Architecture, "Interoperability and Integration Issues," 2005. (http://intelligrid.info/IntelliGrid_Architecture/High_Level_Concepts/HLC_Interoperability.htm)

5. A. Tolk, "Beyond Technical Interoperability – Introducing a Reference Model for Measures of Merit for Coalition Interoperability," 8th CCRTS, National Defense University, 2003.

Revision History

Version	Date	Editor	Comment
1.0	30 Nov 05	S. Widergren	1st release.