## Metric #19: Open Architecture/Standards

### M.19.1.0 Introduction and Background

The vision for the smart grid hinges on the ease of integration of intelligent equipment and systems to enable their collaboration and coordination to achieve local, regional, and national energy objectives. Given the abundance of such components, the information-technology integration approach must be scalable and the connectivity agreements in an area, such as integrating building resources with the electric system, must converge to a few commonly supported practices. Though such practices will change as technology solutions advance, commercially viable approaches will consider a measured level of stability for interface definitions that support legacy systems and the introduction of new technology. The term "open" is intended to mean that the specification, approach, or resource that facilitates system integration is accessible to all interested parties without unreasonable barriers to entry.

The Smart Grid Implementation Workshop identified related concepts in this area, including the percentage of the electric system that is networked to standards, the number of products with end-to-end interoperability certification, and the level of deployment of common communications infrastructure. Although the proposed metrics are relevant, obtaining measurements for these concepts is difficult.

While direct measures of openness or standards adoption are difficult obtain, the conjecture that any of these metrics would accurately indicate progress toward enabling a smart grid is dubious. One promising approach is to use concepts derived from the Carnegie Mellon Software Engineering Institute and the software capability maturity model (CMM).

Widespread adoption of openly available standards and architectural approaches is an indication of maturity in technology and business practices. A smart grid, with its diverse stakeholders, represents a relatively immature movement composed of many parties, each with its own heritage in business practices and standards. A convergence of approaches may come from the large penetration of Internet-based technology and methodology, but it will take time to develop and materialize. The development of software in general experienced a similar situation; there were many methods, languages, and processes for developing software in different communities, with different levels of success. Rather than pick a "winner," the Software Engineering Institute (SEI) at Carnegie Mellon took the approach of encouraging a culture of continuous process improvement. The result is the SEI Capability Maturity Model for Software (CMM), and subsequently, the CMM Integration (CMMI).[1]

Rather than specifying a set of standards or particular development methodology, the CMM asks organizations to specify how software is developed and managed, and then provides a ruler for gauging a level of maturity in the discipline of software development. The National E-Health Transition Authority of Australia (NEHTA) has taken these notions a step further and closer to the situation we face with system integration and interoperability in a smart grid. As with electricity, the health industry has numerous stakeholders, including government agencies, hospitals, public and private practices, insurance companies, medical products and service providers, and most of all, patients. As a step to address the interoperation of automation systems that link the complex web of business processes associated with

---

[1]Software Engineering Institute. Carnegie Mellon University. 2008. [CMM] *The Capability Maturity Model for Software.* Accessed October 14, 2008, at:http://www.sei.cmu.edu/cmm/

health, NEHTA augmented CMMI to create the e-health interoperability maturity model (IMM).[2] The IMM is, "… a reference model for expressing levels of e-health organization capability on their path toward delivering better interoperability outcomes. Each capability level represents a process improvement, referred to as an organizational maturity level. Consequently, each maturity level requires attaining the previous maturity levels, while incrementally adding new capability and bringing new benefits. There are five maturity levels identified, namely Initial, Managed, Defined, Measured and Optimized." Figure M.19.1 explains these levels.

**Figure M.19.1**. Interoperability Maturity Levels[3]

Note, the interviews with electric service providers used to help characterize the status of smart grid deployment in this report was augmented from a similar approach used to measure intelligence in a utility enterprise and called the Intelligent Utility Network Maturity Model (IUN/MM) [Annex B].

## M.19.2.0 Description of Metric and Measurable Elements

*(Metric 19) Interoperability Maturity Level – the weighted average maturity level of interoperability realized among electricity system stakeholders.*

The method to measure progress in open architecture and standards is to develop a smart-grid Interoperability Maturity Model (IMM) and then survey interactions between stakeholders to measure the interoperability maturity level in specific smart-grid areas that emphasize the interfaces between organizational boundaries. Examples of these boundaries include the residential, commercial building, and industrial plant interfaces with the electricity service provider. Another is the balancing-authority to reliability-coordinator interface.

As this work has yet to be undertaken, the remaining discussion provides a qualitative view of progress of open architecture and standards.

[2]National E-Health Transition Authority (NEHTA). 2007. *Interoperability Maturity Model, Version 1.0*. NEHTA, Sydney, Australia. Accessed October 14, 2008, at www.nehta.gov.au/index.php?option=com_docman&task=doc_download&gid=220&Itemid=139
[3]NEHTA 2007.

## M.19.3.0 Deployment Trends and Projections

The scope of the smart grid includes the connectivity that occurs in the transmission and distribution areas (such as substation automation), the control centers (such as SCADA information sharing with other applications and between operating organizations), and the consumer-side resources (such as commercial equipment and distributed generation and storage). Efforts have been underway for some time to integrate equipment and systems in substation automation, control centers, enterprise systems, and within industrial, commercial-building, and residential energy management systems. The level of integration is increasing in each of these areas, and the amount of integration between these areas is also increasing.

Standards and openness are also advancing in terms of the layers of agreement that must align. The GridWise® Architecture Council (GWAC)[4] proposes three major categories that need to be aligned to achieve interoperability: technical, informational, and organizational (see Figure 2). The bottom levels focus on information technology (I), while the top levels focus on electric energy (E). The status of these layers as they pertain to the smart grid follows.

**Figure M.19.2**. Interoperability Categories (from GWAC Interoperability Context-Setting Framework)

The technical categories involve network connectivity and syntax. Though there are many lower-level protocols to handle communications networks (e.g., cable, twisted pair, fiber optics, wireless, broadband power line carrier), and protocols with associated syntax (e.g., Ethernet, TCP/IP, Zigbee, IEEE 802.11, Wi-Fi), the standards for these technologies are mature to the point that an assortment of communications products are now procured and integrated to support many applications. Layered on top of these communications networks are general-purpose protocols to support SCADA activities. Each

[4]GridWise Architecture Council. 2008. *Interoperability Context-Setting Framework, v1.1*. Accessed November 12, 2008 at http://www.gridwiseac.org/pdfs/interopframework_v1_1.pdf

business community has developed its own SCADA-like protocols to meet its performance and cost requirements. In each community, the trend has been to move away from proprietary communications networks, protocols, and syntax toward widely available standards supported by various product offerings.

The informational categories are less mature than those in the technical area. The SCADA information models tend to generically describe equipment, measurements, and actuators. The understanding of the equipment and how it fits within a business process is held in specification documents and the minds of the programmers and integrators. Thus, there is a high level of customization for each application. Anything approaching standardization is contained in best practices and the knowledge gained through experience. Exceptions to this exist with a few automation interface standards. However, the standards emerging to support eCommerce are making significant progress with modeling the information (semantics) for specific business contexts. The Internet-based information-modeling standards (e.g., XML Schema, Resource Description Framework (RDF), and Web Ontology Language (OWL)) dominate the new standards work, while earlier approaches to information modeling continue to progress and evolve based upon the familiarity of developers in targeted communities.

The organizational categories involve business operations and strategic decision-making. In this area, business processes are modeled using methodologies that are supported by enterprise integration and eCommerce tools and modeling techniques. These methods represent humans and machines as abstract concepts that reflect the series of actions involved in a business process. Where each human or machine application interfaces with another, the sequence, performance, information exchanged, and consequences under failure scenarios are captured in a specification. Languages continue to evolve to record these specifications and mechanically turn appropriate aspects of them into software-interface definitions and code. In particular, web services and service-oriented architecture techniques are being employed to support these higher-level concepts. Business-process modeling is virtually nonexistent in consumer-side electricity-related automation and T&D automation. It is appearing in control centers, particularly as the interface to other applications of the enterprise.

In the technical categories of network connectivity and syntax, multiple standards will continue to evolve to support the various communications media; however, bandwidth is becoming less of a problem and Internet-based approaches are likely to continue to grow as hardware and software tools make them more cost effective.

Convergence toward information modeling using UML, XML Schema, and the OWL semantic language is gaining ground. With the advent of web services and service-oriented architecture, tools and techniques for designers and implementers are making it easier to move into business-process modeling.

### M.19.3.1 Stakeholder Influences

As Figure M.19.2 suggests, nearly all stakeholders are affected by the availability and adoption of integration architectures and supporting standards. In particular, the following groups are most affected:

- Consumers: the amount and reliability of participation of demand-side resources depends on integrating automation systems cost effectively.

- Electric service retailers: aggregating demand-side resources for participation in local and area system operations depends on cost-effective automation systems to coordinate with consumer systems.
- Distribution and transmission service providers: cost-effective and reliable techniques require standards. Given the scale and long life of the equipment, approaches must be able to evolve over time and continue to integrate with legacy components.
- Balancing authorities, generators, wholesale electricity traders, market operators, and reliability coordinators: require standard enterprise-integration approaches and eCommerce standards for connectivity.
- Products and services suppliers: the maturing modularization of software systems discourages large, proprietary solutions that inhibit future competition with other suppliers. Standards are more commonly put into specifications. In addition, suppliers can be more competitive by integrating their offering with components provided by other suppliers. Less customization can allow for higher levels of productivity.
- Regulators and policy makers: Greater levels of standardization and common integration approaches can bring costs down for the consumer and foster competition.

### M.19.3.2 Regional Influences

Given the global reach of international solutions providers, open architecture and standards should be encouraged internationally. Practically speaking, national-standards bodies will likely continue to have differences with their counterparts across the globe, in particular, USA, EU, Japan, China, and India. With few exceptions, the leading IT standards in use and being developed apply uniformly to all parts of a nation.

## M.19.4.0 Challenges

### M.19.4.1 Technical Challenges

Architectures and standards are subjects of innovation through better ideas. While agreement and adoption on standards eases integration and enables cost-effective implementations, new approaches can bring greater capability and further cost reductions. Features that focus on interfaces and that support extensions, versioning, and adaption to old and newer technologies can help support the need to evolve in the quickly changing world of technology.

### M.19.4.2 Business and Financial Challenges

Flexibility is important in picking an architectural approach and associated standards. At the corporate level, a heterogeneous mixture of technologies and standards service an enterprise and its business-partner connections. A balance must be found among many factors, including the cost to move to new technology and standards, the ability to support multiple standards, the impact on productivity and competitiveness, and the risk associated with a decision. Return on investment is the classical mechanism to explore these trade-offs; however, it can be difficult to quantify the returns from moving toward solutions that manage risk and offer future alternatives.

### M.19.5.0 Metric Recommendations

Future measurements of progress in this area will depend on the development of a smart grid IMM, and later, interviews with stakeholders about smart-grid applications to investigate the interoperability maturity level in specific areas of interaction. The effort to develop a smart grid IMM should review the work of NEHTA and of other related industries. It should also review integration and interoperability tools and methodology in the smart-grid area, such as is reflected in the GWAC Interoperability Context-setting Framework,[5] the EPRI IntelliGrid Architecture,[6] and work now underway by NIST to establish an interoperability framework.

[5]GWAC 2008.

[6]EPRI-Electric Power Research Institute. *IntelliGrid*[SM] *Architecture.* Accessed November 12, 2008 at http://www.epri-intelligrid.com/intelligrid/techdev/intelligrid/intelligrid.html (undated webpage).