A Smart Grid Interoperability Maturity Model Rating System

Predicting "Plug and Play" Integration Probability

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Abstract

This paper evaluates proposed models for assessing Smart Grid interoperability and other models referenced as instructive for this effort. This paper suggests dividing the GWAC IMM into a Smart Grid Interoperability Maturity Model (SGIMM) and a Smart Grid Interoperability CAPABILITY Maturity Model (SGICMM). We propose a specific Smart Grid Interoperability Assessment model and rating system framework for actually rating organizations using the proposed SGIMM model as to their actual interoperability with other stakeholders in their electrical grid.

The Capability Maturity Model Integrated (CMMI) developed by Carnegie Mellon's Software Engineering Institute (SEI)[1] is the de facto standard for models of software development capability maturity. However, it does not directly translate to the problem of assessing the maturity of interoperability of technologies.

Both Carnegie Mellon's SEI[2] and the GridWise Architectural Council (GWAC)[3] have proposed models for Smart Grid Maturity models. However, one is not directly applicable to assessing interoperability and a rating process has not been adopted for either model by which to measure an organizations' Smart Grid Interoperability Maturity.

1. INTRODUCTION

The Department of Energy funding opportunity announcement for Regional Smart Grid Demonstration projects[4] included Section D.4.2:

"Open architecture/standards: Interoperability Maturity Level - the weighted average maturity level of interoperability realized between electricity system stakeholders."

The July, 2009, DOE Report to Congress, the "Smart Grid System Report" includes an Annex discussion of "Open Architecture/Standards" (Section 19) that discussed interoperability maturity and concludes that "As this work has yet to be undertaken, the remaining discussion provides a qualitative view of progress of open architecture and standards."

[1] Software Engineering Institute, Carnegie Mellon University, CMMI, http://www.sei.cmu.edu/cmmi/.

[2] Software Engineering Institute, Carnegie Mellon University, SEI Smart Grid Maturity Model Overview, V1.0, July 2009, http://www.sei.cmu.edu/smartgrid/

[3] GridWise Interoperability Context-Setting Framework,, GridWise Architecture Council, March 2008, http://www.gridwiseac.org/pdfs/interopframework_v1_1.pdf.

[4] US Department of Energy, National Energy Technology Laboratory," Smart Grid Demonstrations – Recovery Act, Financial Assistance Funding Opportunity Announcement, CFDA Number 81.1222 Electricity Delivery and Energy Reliability Research, Development and Analysis", dated June 25, 2009.

Maturity models serve multiple purposes, once of which is to provide a prediction of the likelihood that an organization can achieve a specified outcome.

The CMMI is the de facto standard for models in the software space and it focuses on the software development process maturity of an organization. Its aim is to help assess the likelihood that a software development organization will deliver good quality product on time and within budget, repeatedly. Further, it can be used by software development organizations to do self-assessments in order to plan their process improvement roadmap. However, it does not directly translate to the problem of assessing the maturity of interoperability of technologies in the Smart Grid domain.

One of the critical success factors in achieving the vision of the Smart Grid is the standardization of technology so that implementing Smart Grid systems can be done cheaper, faster and better than the traditional custom engineering usually used. This means adopting standards for how Smart Grid components communicate with one another and interoperate. The easier such interoperation becomes, the lower the overall cost in time and dollars to implement effective Smart Grid systems.

As a step towards moving the industry in the direction of interoperability, a standardized method for assessing and rating an organization on the "likelihood" of achieving very easy systems interoperability (can be thought of as "plug and play" ease of interfacing) can be very useful both in predicting the outcome of projects that require interoperability and assisting the organizations in mapping out their own path to achieve a viable interoperability capability.

In our simplistic view of the world, it seems that a maturity model for "interoperability" in a technology domain should focus on the interoperability outcomes. This becomes a simple way of assessing whether technology interoperability is more or less mature. The goal of an interoperability maturity model for the Smart Grid (or utility industry) can be as simple as "to provide a method for measuring the improvement in interoperability in the domain." Or, it can be used as a method for measuring the current interoperability between specific Smart Grid stakeholders or predicting the likelihood of smooth interoperation between two different systems or organizations.

A companion maturity model could be something like a "capability" maturity model that focuses more on the behaviors, processes and characteristics of implementing organizations' capabilities to implement interoperable technologies. This could be a Smart Grid Interoperability Capability Maturity Model (SGICMM) that we outline at the end of the paper.

Our observation is that GWAC has been trying to do too much with its efforts to develop an interoperability maturity model and it has mushroomed to be a complex and difficult model to penetrate and use. We propose dividing the GWAC IMM into an SGIMM as described above plus an SGICMM. The former provides a snapshot and only a predictor of interoperability efficacy while the latter provides a roadmap for achieving efficient interoperability between systems and organizations.
This last point bears repeating: the proposed interoperability maturity model is aimed at measuring the "accomplishment" of useful interoperability in an efficient fashion while the capability maturity model is focused on the processes and methodologies for getting to the desired outcomes.
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2. A SMART GRID INTEROPERABILITY MATURITY MODEL (SGIMM)

The proposed Smart Grid Interoperability Maturity Model (SGIMM) is intended very specifically to provide an objective, standardized method for evaluating (rating) the actual performance of one or more communicating organizations on their "interoperability maturity". This provides a "snapshot" of the current state of interoperability capabilities.

While focused on a specific organization in the Smart Grid, the measured interoperability maturity among multiple communicating organizations provides an insight into the likelihood of smooth interoperability among them (inter-system interoperability). Further, the assessment of interoperability maturity can be applied to internal divisions or organizations of an enterprise of other Smart Grid entities to predict the likelihood of smooth intra-system interoperation.

The goals and measures applied to evaluating interoperability can also be converted to evaluate actual outcomes of interoperability between systems and provide a rating for interoperability effectiveness and efficiency.

2.1. Interoperability Goals

The maturity of interoperability can best be accomplished by rating an organization's actual fulfillment of interoperability goals. These have been outlined by the GridWise Architecture Council in its Interoperability Framework and Decision-Maker's Interoperability Checklist shown in Figure 1.

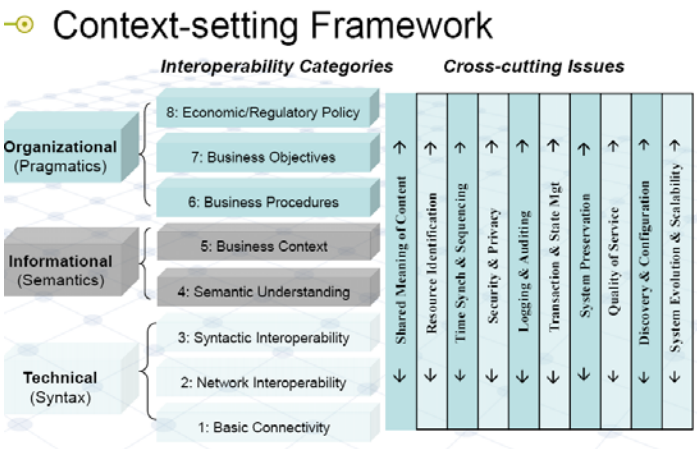

Figure 1: GWAC Interoperability Context-setting Framework

Based on the work done in the Context-Setting Framework V1.0 plus concepts included in the NEHTA Interoperability Maturity Model for eHealth systems, the key interoperability goals for Smart Grid entities are proposed to be:

1. Improvement in economics, efficiency and performance of the delivery of electrical service to customers. This is the most critical measure of the results of the interoperability maturity efforts of an organization..
2. Demonstrated maturity in each of the 8 levels of the GWAC Interoperability Categories in the GWAC Interoperability Framework.
3. Technical system architecture and design that supports the technical goals of the Interoperability Framework. This applies to all aspects of information technology used in the monitoring, management and delivery of electrical service.
4. Business system architecture and design that supports the business goals of the Interoperability Framework. This applies primarily to the information systems that support the business goals and processes of the Smart Grid organization.
5. Organizational support for interoperability behavior – i.e., disciplined adherence to adopted/emerging open industry standards for technical and business systems communications interfaces whenever system components are required to communicate information and commands to other system components. And further, the insistence on multiple, interchangeable solutions for each component in the system based on such standards.
6. Security as an integral and demonstrated feature of every system interface to other systems or any aspect of the system that can be accessed for monitoring, modification or updating.
7. Inherent evolutionary capabilities, including on-going support for legacy systems and prior versions, as an integral feature of architecture and design of all system interfaces to other Smart Grid components. This may also include flexibility for successful interoperation of two systems using different versions of the same standards or protocols.
8. Inherent design and implementation separation of key functions for most efficient interoperability – i.e., communications protocols from business policy and logic; data syntax from information semantics; ownership and rights and meta-data from explicit data.

The goals for the GWAC Interoperability Framework add a further set of sub-goals and characteristics including:

- The key interoperability characteristics between two entities such as:
  - Exchange of meaningful, actionable information
  - A shared understanding of the exchanged information
  - An agreed expectation for the response to the information exchange
  - A requisite quality of service, reliability and security in the exchange and the responses.
- Scalability of the interoperable system both within a Smart Grid organization and between them.
- Distributed, de-centralized decision-making rather than hierarchical decision-making based on identified interoperability characteristics.
- Separation of data exchanged from the communications networks employed to insure multiple networks can communicate the same information.
- Adoption of common information models to insure both syntactic and semantic agreement on exchanged information.
- Adoption of common Smart Grid business context definitions and rules for interpreting the exchanged information between entities.
- Alignment of strategic and tactical objectives and operational business processes and procedures between Smart Grid entities required to make interdependent decisions.
- Operation of an entity in the context of aligned and consistent societal, political and regulatory policies and regulation. The economic and regulatory

environment is critical to interoperability between different regulatory and political jurisdictions.

As a final note on achieving the goals of interoperability as specified above, ultimately it comes down to having industry standards that are enforced through constant and rigorous validation testing and certification.

2.2. SGIMM Levels of Maturity

Based on the interoperability goals outlined above, the basic interoperability levels of the SGIMM are proposed as follows:

Level 5: Plug and Play. The technologies in a system (utility, regional IPO, national, in-domain such as HAN, BAN, etc) do not require specialized engineering efforts or expertise in order to implement different components and competing technologies. A robust maintenance and update process are planned as part of the project including a feedback process to SDOs to improve the standards.

Goal	Level 5 Status
1. Improve economics	Consistent, measurable results. Goals attained
2. GWAC Levels 1-8	All levels fully implemented
3. Technical system architecture	Consistently implemented
4. Business system architecture	Consistently implemented
5. Organizational support	Documented in consistent supporting policies
6. Security	Documented in consistent supporting policies
7. Evolution	Documented in consistent supporting policies
8. Functional separation	Evident in system architectures and design

Level 4: Certified, Minor but Planned Integration Efforts. Project plans anticipate a low level of known integration activities. Projects are implemented in plan with requisite interoperability quality. A robust maintenance lifecycle and update process is planned as part of the project. All components of a system or project conform to adopted or de facto standards and are certified as both conformant and interoperable. However, some standards testing may not be robust or the vendors may not have all achieved the desired conformance and interoperability.

Goal	Level 4 Status
1. Improve economics	Generally consistent, measurable results. Goals mostly attained
2. GWAC Levels 1-8	Levels 1-7 mostly implemented
3. Technical system architecture	Implemented most of the time
4. Business system architecture	Implemented most of the time
5. Organizational support	Documented in consistent supporting policies mostly implemented
6. Security	Documented in consistent supporting policies mostly implemented
7. Evolution	Most implementations include adequate evolutionary design and execution
8. Functional separation	Evident in system architectures and design and mostly implemented

Level 3: Emerging Interoperability. A moderate amount of integration effort is anticipated and some interoperability negative surprises occur in implementation. Moderate maintenance and update processes are planned as part of the project but challenges are expected. Most projects adopt standards that are approved or in approval stage but only some (at least 50%) have well-developed interoperability verification regimes by the organization. Vendors are able to claim standards compliance and in some cases demonstrate certifications or rigorous test results that the organization can validate some of the time.

Goal	Level 3 Status
1. Improve economics	Generally inconsistent, measurable results. Goals sometimes attained
2. GWAC Levels 1-8	Levels 1-5 being implemented
3. Technical system architecture	Implemented some of the time
4. Business system architecture	Implemented some of the time
5. Organizational support	Supporting policies in process of being developed and implemented
6. Security	Supporting policies in process of being developed and implemented
7. Evolution	Supporting policies in process of being developed and implemented
8. Functional separation	Sometimes evident in system architectures and design

Level 2: Initial Interoperability. A large amount of integration effort is anticipated on projects and numerous interoperability surprises occur in implementation causing budget and schedule overruns. Resulting systems are rarely plug compatible with other systems not specifically integrated in the project. Little, if any, maintenance and update processes are planned as part of the project. Some standards are internally adopted or in approval stage (less than 50%). Some (not even 50%) have well-developed internal interoperability verification regimes while others do not exist. Vendors are rarely able to claim standards compliance and in rare cases demonstrate certifications or rigorous test results. However, rarely are there easily interchangeable multiple applications or systems for a specific component.

Goal	**Level 2 Status**
1. Improve economics	Inconsistent. Goals sometimes attained
2. GWAC Levels 1-8	Levels 1-3 being implemented
3. Technical system architecture	Initial work in process
4. Business system architecture	Initial work in process
5. Organizational support	Supporting policies identified and under consideration
6. Security	Supporting policies identified and under consideration
7. Evolution	Supporting policies identified and under consideration
8. Functional separation	Initial work in process

Level 1: Non-Interoperable. Most components are unique, custom-developed systems or products that require significant custom engineering to integrate with other components. There are few if any internally adopted standards used in projects and inconsistent adherence to such standards. Interoperability is difficult to achieve and very expensive to maintain.

Goal	**Level 2 Status**
1. Improve economics	Inconsistent. Goals sometimes attained through great heroic effort and expense
2. GWAC Levels 1-8	No awareness of effort underway
3. Technical system architecture	No awareness of effort underway
4. Business system architecture	No awareness of effort underway
5. Organizational support	No awareness of effort underway
6. Security	Security achieved through isolation of systems and implementing current regulatory mandates
7. Evolution	No awareness of effort underway
8. Functional separation	No awareness of effort underway

3. ASSESSING INTEROPERABILITY LEVELS

The assessment (or rating) of an organization's interoperability is a matter of evaluating it achieving the 8 goals listed above. There are four potential sources to look at for developing measuring tools of interoperability in the Smart Grid arena:

1. The GWAC Interoperability Stack (Context-setting Framework) provides a hierarchical set of levels that indicate increasing interoperability as an organization matures in implementing them. How the cumulative ratings of an organization and its relevant divisions or departments measure up on the GWAC Stack is a strong indicator of the Interoperability Maturity Level. The GWAC Interoperability Framework document contains a number of specific examples and potential indicators or maturity at each stack level.
2. The GWAC Decisions-Maker's Checklist[5], along with proposed additions provides a starting point for the actual information collection that will support specific ratings of interoperability maturity. The specific questions can be aligned with the 8 goals of the SGIMM.
3. The Interoperability framework in NEHTA's IMM can also be useful in assessing the maturity of an organization's interoperability. NEHTA starts with the concept of interoperability goals and identifies characteristics that need to be present in order to meet the goals. This is not that different from the GWAC Stack but approaches the goals in four general classifications: Common across all organizations; Organizational; Informational and Technical. These actually correlate to the GWAC's Organizational, Informational and Technical maturity levels.

[5] GridWise Architecture Council Policy Team, "Introduction to Interoperability and Decision-Maker's Interoperability Checklist, Version 1.0", April 2007, http://www.gridwiseac.org/pdfs/gwac_decisionmakerchecklist.pdf.

4. The work of the SEI at Carnegie Mellon on the SEI-SGMM Assessment Survey is helpful and contains a number of questions that deal with interoperability indicators as defined above.

The following outlines the process for developing the SGIMM Rating System using these resources and provides an example of using each one.

3.1. GWAC Stack and SGIMM Rating System

Each GWAC Stack level contains explicit and implicit goals and measures of maturity. Rating an organization's maturity on each level helps evaluate the likelihood of interoperability maturity – e.g., an organization that meets/exceeds all of the implementation goals and characteristics of all 8 GWAC Stack levels is most likely to be able to "plug and play" with other organizations meeting the same maturity on each of the 8 GWAC levels.

For instance, the following model illustrates the goals, characteristics and metrics associated with Level 4 of the GWAC Stack: Semantic Understanding.

Goal: Level 4: Semantic	Characteristics	Metrics	Rating
Interpretation of message information for action	Common definitions used by each partner	Conformance to industry accepted definitions	Lowest where all semantic definitions proprietary
Coordinated updates and changes to definitions	Industry repository or other mechanism for coordination of changes	Lag in adopting updates	Lowest where no update process exists
Interpretation of multiple standard semantic definitions	Support for any relevant industry standard	Comparison of relevant adopted standards to supported ones	Lowest where no standards adhered to
Support for development of specific industry standards	Active in named standards SDO relevant to organization	Support activity	Lowest where no active support exhibited

3.2. GWAC Decision-Maker's Checklist and the SGIMM Rating System

The GWAC Decision-Makers Interoperability Checklist conveniently organizes itself into key rating areas of:

- Architecture and Design
- Interconnectivity and Security
- Evolutionary capability and service life
- Collaborator independence

There is a proposed addendum[6] to the Decision-Maker's Checklist that has additional questions which probe further the issues of interoperability. Between the two sets of questions, part of the evaluation of an organization's interoperability level can be facilitated.

For instance, Goal 3 is:

"Technical system architecture and design that supports the technical goals of the Interoperability Framework."

A number of the questions from the Decision-Maker's Checklist and proposed Addendum can be used to evaluate achievement of this goal:

Technical system architecture

From the Decision-Maker's Checklist (with slight modifications):

1. Does a typical project design specify the points of interface and the protocols to be used at such interfaces between systems? By examining project designs and standard guidelines (if any exist) the answer to this question could be yes, no or sometimes. To the extent that there is a clear organizational mandate to adhere to good project design and clear guidelines or model designs to be used for future project designs, an organization could receive a YES rating even though current projects may not adhere to such guidelines (due to being designed before they were in place).
2. Do projects typically specify an "open" architecture such that any vendor can have access to the architectural requirements? Again, this could be yes, no or sometimes and the rating can take into account recently implemented policies and practices.
3. Do project specifications clearly specify open, published standards? Examination of policies and practices can determine if an organization's answer is yes, no or sometimes. To the extent that an organization has adopted a mandate for and specific standards in their projects, a yes answer may be warranted.

From the proposed Addendum, several additional questions focus on architecture and design to support interoperability goals:

[6] "GWAC Decision Makers Checklist – Proposed Additions", June 2009, by James Mater, QualityLogic, Inc. Presented to GWAC at the August 2009 meeting for incorporation into the Decision-Maker's Checklist.

1. **Has the utility adopted requirements for meeting specific open interoperability standards?** Does the utility require vendors to conform to these standards in their proposed products? Asking for specific evidence of such requirements – e.g., RFP mandated requirements or general RFP guidelines used for acquiring grid assets – will quickly reveal whether the organization is following through on its commitment to interoperability.
2. **Where national standards are not yet adopted – e.g., ADR – how does the utility support adoption of a standard?** Do they belong to the standards working group? Are they active in it? Which ones? The level and internal reputation of those assigned to further the standards efforts tells a lot about the organizations' commitment to implementing the Smart Grid.
3. **When specifying standards, how does the utility deal with optional and proprietary extensions that could render a product non-operable with other products?** Most adopted standards allow for optional features that can render otherwise interoperable components non-operable. How well an organization deals with this issue is indicative of the level of sophistication they bring to the challenge of interoperability.
4. **When requesting proposals for grid components does the utility look for at least two competing and comparable solutions that claim to meet the same standards?** Further, do they have an efficient method for validating the claimed interchangeability of the products? Until Smart Grid products can be easily substituted for one another the promise of lower costs through competition among vendors will not be realized.
5. **What do they do when only one such vendor exists?** If possible, does the utility re-design the project so that each component can be supplied by multiple vendors? Do they actively cultivate competition when a re-design is not feasible? Simply accepting that only one vendor can supply a critical project component furthers the status quo of expensive, non-interoperable one-of-a-kind solutions. The benefits that Smart Grid interoperability can achieve won't be realized if utilities continue to accept unique, non-standard solutions.
6. **How does a utility validate claims of conformance to specified open standards?** Do they require evidence from vendors such as a recognized independent certification? Do they perform internal validation testing? Do they contract with a third party to do validation testing? How they do the validation is not nearly as important as the insistence that conformance and interoperability claims are validated.
7. **What do they do if the testing shows a lack of conformance to the claimed standard?** Setting clear conformance and interoperability standards is critical. Just as critical is holding vendors accountable for meeting those standards. This might be done through withholding partial payments until a conformance or certification test is passed or the product meets internal testing criteria. Alternatively, products can be rejected from a bid outright until they meet the specified standards and interoperability requirements.

While the Decision-Maker's Checklist and proposed Addendum do not address all of the interoperability goals in the SGIMM, they do provide a starting point for evaluation questions on a number of the goals in the SGIMM and in the GWAC Stack.

3.3. NEHTA and the SGIMM Rating System

NEHTA starts with the concept of interoperability goals and identifies characteristics that need to be present in order to meet the goals. This is not that different from the GWAC Stack but approaches the goals in four general classifications: Common across all organizations; Organizational; Informational and Technical. These actually correlate to the GWAC's Organizational, Informational and Technical maturity levels.

The NEHTA IMM had a significant influence on the development of the GWAC Interoperability Framework. Further, the development of the specific goals for the SGIMM leverages some of the NEHTA concepts. Beyond this the differences between the eHealth and Smart Grid domains limit further influence on the SGIMM.

3.4. SEI-SGMM and the SGIMM Rating System

The SEI SGMM questions in V1.0 of the Assessment Survey[7] can be leveraged in some of the evaluation areas of the SGIMM. For instance, SGIMM goal area 5, Organizational Support, is addressed by specific Assessment Survey questions along with a set of potential answers:

[7] Software Engineering Institute, Carnegie Mellon University, "SEI Smart Grid Maturity Model: Assessment Survey, V1.0", June 2009.

SMR-1.1 Has a smart grid vision been defined within your organization?

1. No
2. Within a single function
3. Across multiple functions (encompasses and is communicated across functions)
4. Across the enterprise (encompasses and is communicated across the enterprise)

SMR-1.3 Has experimentation on smart grid components, tools, and techniques been given support within your organization?

1. No
2. Not specifically for smart grid vision (any amount)
3. Very little, targeted for smart grid
4. Moderate amount, targeted for smart grid

Using some of these questions can accelerate the development of the rating system for the SGIMM.

Like the proposed SGIMM, the SEI SGMM has five levels of maturity. The evaluation areas are divided into 8 general assessment areas: Strategy, Management and and Regulatory; Organization and Structure; Grid Operations; Work and Asset Management; Customer Management and Experience; Technology; Value Chain Integration and Societal and Environmental.

Because of the broad focus on overall Smart Grid maturity, much of the SGMM is not really applicable to the more narrow effort to evaluate interoperability. Never-the-less, the SGMM provides some useful tools for assessing parts of the interoperability aspects of an organization.

3.5. NIST Smart Grid Standards Roadmap and the SGIMM Rating System

Interoperability and the adoption and adherence to standard interfaces and technologies are closely related. The work of NIST to establish an interoperability standards roadmap provides an important set of evaluation tools. Simply put, does an organization adopt and enforce the relevant standards from the NIST roadmap. Further, does the organization actively support industry adoption and evolution of such standards? If the answer is yes, then the organization has achieved a higher level of interoperability (or least have a higher probability of achieving plug and play systems development).

The recent draft V1 of the NIST Roadmap[8] lists 31 standards that are applicable to Smart Grid applications and an additional 46 that may be applicable and are under further review.

The NIST Roadmap focuses on 8 priority areas for Smart Grid standardization: Wide-area Situational Awareness; Demand Response; Electric Storage; Electric Transportation; Cyber Security; Network Communications; Advanced Metering Infrastructure (AMI) and Distribution Grid Management.

By mapping the NIST adopted standards to the GWAC Interoperability Framework we can develop a very specific checklist of standards that should be adopted and enforced at different levels of the Framework. This will help assess maturity of an organization from a GWAC Interoperability Framework perspective which, in turn, maps to the SGIMM 5 levels of maturity.

For instance, OpenADR, OpenHAN and ZigBee/HomePlug Smart Energy Profile would all be considered standards at the Framework Category 4; Semantic Understanding. They may even be applicable at higher and lower Categories and it is important to map the standards accurately.

The NIST Roadmap is still in draft form and is expected to be an evolving document as standards and the industry evolves. Similarly, the mapping and use as part of the SGIMM evaluation process will need to evolve along with the Roadmap and actual adoption of standards.

4. SUMMARY OF SGIMM RATING SYSTEM

The framework proposed for a Smart Grid Interoperability Rating System includes an identified set of metrics and methodologies for incorporating other relevant work into the system. The proposed SGIMM leverages work already completed by GWAC, NEHTA, SEI and NIST.

The next tasks include:

- Developing the specific rating questions for each maturity level and goal measurement method.
- Establishing the process for gathering information to evaluate the status of an organization on each goal measurement metric.

[8] "NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0 (Draft)", Office of the National Coordinator for Smart Grid Interoperability, National Institute of Standards and Technology, US Department of Commerce, September 2009.

- Establishing the actual rating system – what does the interoperability information actually mean in predicting ease of interoperability with the organization.
- Understanding how the model can be applied to multiple organizations – i.e., how can the ratings be used to predict ease of interoperability results between two different organizations with differing ratings?

Lastly, once an initial complete rating system is designed it needs to be piloted to demonstrate that it can be implemented and achieve desired predictive results.

5. A SMART GRID INTEROPERABILITY CAPABILITY MATURITY MODEL (SGICMM)

While the SGIMM can assess the current level of interoperability for technologies and organizations working on Smart Grid implementations it does not address how an organization and technology eco-system can improve its interoperability capabilities. This is the process assessment side of the equation and is more like the CMMI, the SEI SGMM or the NEHTA Interoperability Maturity Model as applied to e-health care systems. All of these have as a goal the assessment of the current interoperability processes and environment in order to develop an interoperability improvement roadmap.

In contrast, the goal of the SGIMM is to be able to predict and measure the actual inter and intra-system interoperability that should be or is occurring at a point in time.

A Smart Grid Interoperability Capability Maturity Model (SGCIMM) can leverage the combination of the current GWAC Interoperability Framework, the SEI-SGMM, the NIST Roadmap and the NEHTA Interoperability Maturity Model.

It is not the intent in that paper to develop a complete interoperability capability maturity model but rather suggest a starting point for developing one. The proposed starting point for a simplified SGICMM is as follows:

Level 5: Mature Interoperability Capability. Organization leadership understands, supports and funds adequate resources to implement and maintain interoperability best practices. The organization has a robust technology design and implementation process that requires components to conform to adopted standards and to be certified as both conformant and interoperable. The organization actively supports standards efforts and the implementation and evolution of robust interoperability verification and certification regimes. A robust maintenance and update process for the standards and implemented components/systems is planned as part of the project including a feedback process to SDOs to improve the standards.

Level 4: Evolving Interoperability Capability. Organization leadership is gaining understanding and provides support and funding to implement and maintain interoperability best practices, but not at the level required to be mature. The organization has a technology design and implementation process that requires components to conform to adopted standards and to be certified as both conformant and interoperable. But there are times or parts within the organization that do not or cannot (due to immature standards) implement good interoperability design all the time. The organization actively supports standards efforts and the implementation and evolution of robust interoperability verification and certification regimes. A maintenance and update process for the standards and implemented components/systems is planned as part of the project including a feedback process to SDOs to improve the standards.

Level 3: Modest Interoperability Capability. Organization leadership is gaining understanding and provides some support and funding to implement and maintain interoperability best practices, but not at the level required to be mature. The organization is developing a technology design and implementation process that requires components to conform to adopted standards and to be certified as both conformant and interoperable. But there are frequent times or parts within the organization that do not or cannot (due to immature standards) implement good interoperability design all the time. The organization is starting to support standards efforts. A maintenance and update process for the standards and implemented components/systems may be planned as part of projects.

Level 2: Nascent Interoperability Capability. Organization leadership is just starting to understand what is required to implement and maintain interoperability best practices, but support and funding are on a project-by-project basis. The organization is just starting to develop a technology design and implementation process that requires components to conform to adopted standards and to be certified as both conformant and interoperable. But more often than not the organization does not or cannot (due to immature standards) implement good interoperability design except in special cases. The organization is just starting to support standards efforts. A maintenance and update process for the standards and implemented components/systems is not planned as part of projects.

Level 1: No Interoperability Capability. Organization leadership does not understand what is required to implement and maintain interoperability best practices. The

organization is does not have a technology design and implementation process that requires components to conform to adopted standards and to be certified as both conformant and interoperable. The organization does not or cannot (due to immature standards) implement any interoperability design.

Key Conclusions from this paper:

- A good deal of work has already been done that can serve as the basis for a model and rating system for smart grid interoperability maturity.
- There is a well-developed set of interoperability goals already in place that can serve as the goal-posts against which to measure interoperability maturity of an organization.
- A five-level maturity model is proposed that would examine an organization's behaviors in pursuit of the goals of interoperability maturity.
- The method for leveraging prior work by GWAC, SEI and NIST is outlined and demonstrated.
- Additional work needs to be done to establish the details of the rating system, the methodology for developing ratings and the value of such ratings.
- Finally, an initial model for measuring interoperability "capability" is proposed. This could become the basis for evaluating an organization's interoperability processes and developing a process improvement roadmap for maturing its interoperability.