Prioritization Methodology White Paper

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Introduction and Background

Purpose

This white paper has been developed to provide a roadmap and guidance to assist in developing methods to identify critical testing needs for the Smart Grid, and will assist in the development of methods to focus the resources necessary to incubate and accelerate new test programs that address gaps in test program availability. ***Accelerating the availability of test programs in support of Smart Grid standards is a primary objective for NIST and the Smart Grid Interoperability Panel (SGIP).***

Over one hundred standards have been identified in the NIST Framework and Roadmap for Smart Grid Interoperability Standards, Version 2 [1] (NIST Framework 2.0) as supporting Smart Grid implementation. It is a NIST and SGIP goal that test programs are available for all key standards as a means to assess whether Smart Grid systems successfully implement the standard, thereby driving interoperability. The SGIP Testing and Certification Committee (SGTCC) is tasked with addressing this goal. Resources necessary to realize this broad goal are limited, thus prioritization is necessary to identify those test program needs that are most critical and focus resources effectively to address these challenges.

The recommendations in this white paper can be used by industry stakeholders, particularly the SGIP in generating a prioritization of required test programs, identifying gaps in test programs and opportunities to accelerate the establishment of needed test programs.

Why is Testing Important

The Smart Grid is often described as a "system of systems" spanning multiple technology domains, involving thousands of organizations, and numerous standards. Smart Grid products, systems and applications require an extensive exchange of information necessitating well defined interfaces to securely transfer and translate this information from point to point across the grid. Interoperability is more imperative than ever before to provide the seamless functional performance that enables the many benefits of the Smart Grid.

Interoperability testing programs provide the verification that the standards have been implemented appropriately and consistently. Testing and certification is taking on increased urgency as industry reaches consensus on the underlying standards for the Smart Grid. This urgency is driven by the fact that *while there are many standards, there remains a large gap in the availability of test programs corresponding to these standards*.

Testing and certification programs for Smart Grid systems and devices have been recognized as a key element in the NIST Framework and Roadmap for Smart Grid Interoperability Standards. The SGTCC has

[1] http://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/IKBFramework/NIST_Framework_Release_2-0_corr.pdf

developed and issued several deliverables providing best practices for testing programs, guidance on end to end interoperability testing, and assessment of the availability of testing programs aligned with key standards cited in the NIST Framework. All of this work has contributed greatly to setting a baseline understanding and expectation of test program needs that will help accelerate the deployment of Smart Grid products.

Gaps in Test Program Availability

As noted above, only a small percentage of Smart Grid standards are supported by associated test programs. The NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 2.0 cites over one hundred key Smart Grid standards. Ideally, Interoperability Testing and Certification Authorities (ITCAs) and test programs should be in place to address each of these standards. Additionally, these test programs should adopt the recommendations and best practices developed by the SGTCC in its Interoperability Process Reference Manual (IPRM) to assure rigorous and high quality programs.

The figure below provides a visual representation of the state of Smart Grid industry test programs. Of the over one hundred standards cited in the NIST Framework 2.0, only 13 have associated test programs, with less than half of those having committed to implementing the IPRM recommendations of the SGTCC. The nascent availability of test programs is further compounded in that some of the key standards cited in the NIST Framework are comprised of multiple parts (e.g. IEC 61850, IEEE 1547) where available test programs may address only selected parts of the overall standard. Additionally, there are about a dozen additional standards for which varying ad hoc laboratory services may be commercially available. However, these are stand-alone services, and not part of any formal industry test/certification program.

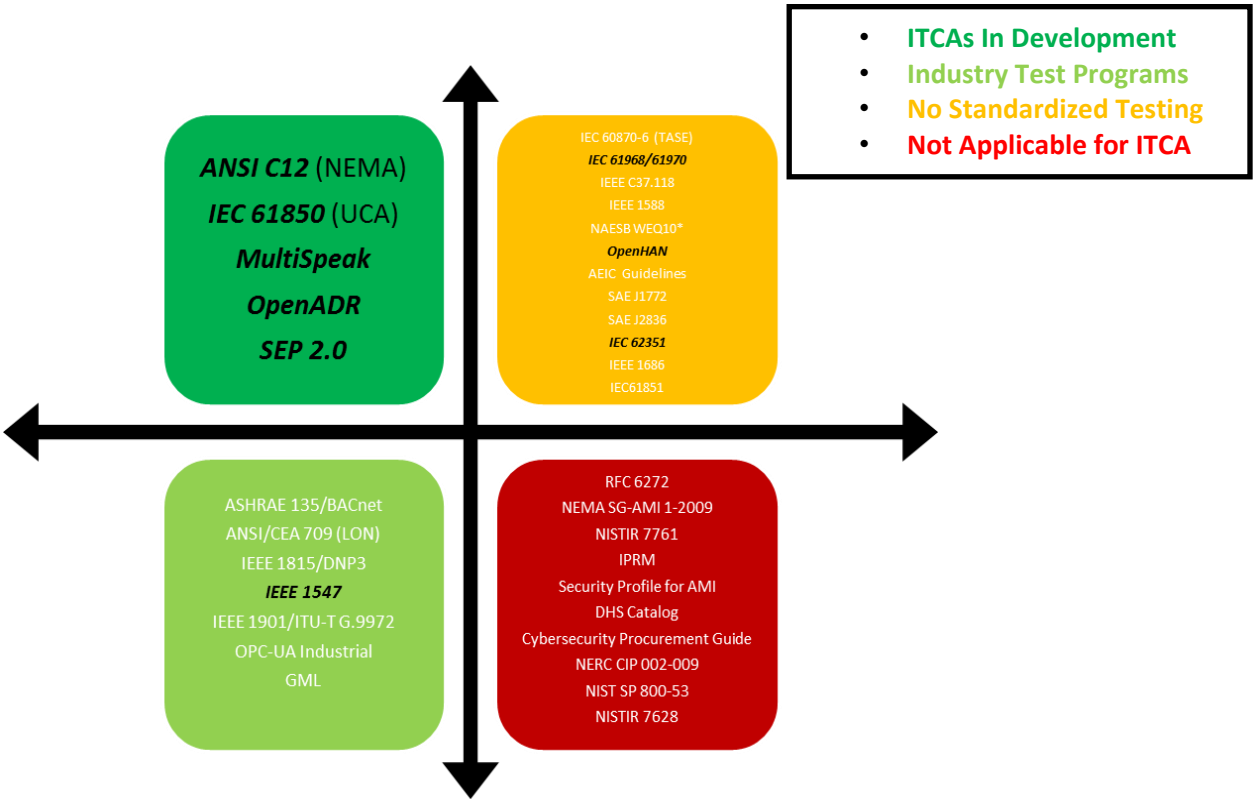

Figure 1 – State of Industry Test Programs

ANSI C12.22-24
Packet Cable SMA
GPS Signal Specification
IEC 61400-25
ITU G.9960/9961 (G.hn)*
IEEE P1901*
1901.2/G.hnem
ISO/IEC 8824
ISO/IEC 12139
IEEE 802
TIA TR-45/3GPP
3GPP Stds. Family
ETSI GMR-1 3G
ISA SP100
NMS Stds.
ASHRAE 201P
NIST SP 500-267
Z-wave
IEEE 2030
IEC 60929
IEC/TR61000 (EMC)
IEC 62056
IEC PAS 62559
IEC 60870
IEC 60255-22
IEC CISPR 22/24
IEEE C62.022
IEC 61326x
IEEE 1560
IEEE 1613
IEEE P1642

IEEE 473
IEEE P1775
IEEE C63.16
IEEE C37.90
IEEE C37.2
IEEE C37.111
IEEE C37.232
IEEE 1159.3
IEEE 1379
ISO/IEC 15045
ISO/IEC 15067-3
ISO/IEC 18012
NAESB OASIS
NAESB WEQ015
OASIS EI
FIXML
OASIS oBIX
SAE J2847/2-3
WC3 SOAP
W3C WSDL
W3C XML
W3C XSD
W3C EXI
DOT NTCIP 1213
OpenADE
UL-1741
ISA SP99
ISO27000
NIST FIPS 140-2
OASIS WS-Security

Figure 2 Additional Framework 2.0 Standards

Over 70% of the standards cited in the NIST Framework have NO associated test programs or services.

Acceleration of Test Programs

Accelerating the availability of test programs in support of Smart Grid standards is a primary objective for NIST and the SGIP. The development of new testing programs requires significant engagement with a broad range of stakeholders to assure that the programs are technically sound and complete, well executed, and meet industry needs. There needs to be strong engagement with the end users to build the demand drivers that lead to successful programs.

The numerous standards and limited industry resources to address associated test programs creates a significant challenge in attempting to address all cited Smart Grid standards simultaneously. Some standards are more prominent than others in the view of key stakeholders, while other standards have strong and vocal champions but may not be among those that most urgently need the development of test programs. From another perspective, some standards are mature while others are still evolving. Some standards are already in the implementation stage while others remain in the early stages of emergence. Testing and certification programs take on increased urgency where products have already begun standards implementation.

How Can Acceleration be Accomplished?

A challenge in addressing the availability of test programs across so many standards is the sheer level of effort required relative to available resources. A methodology for prioritization across these standards is essential to solving the problem. Without a prioritization, efforts will lack focus and resources will be diluted across multiple efforts. Effective implementation of a prioritization requires a well thought out methodology that considers a broad range of issues, both technical and business driven.

As noted earlier in this document, there are over one hundred Smart Grid standards cited in the NIST Framework, with many of those unsupported by test programs. Thus, there are multiple testing needs requiring attention from limited resources. Much like an emergency room triage center, a methodical approach is required to assure that those issues requiring critical attention are prioritized. The approach needs to be fair and balanced in the evaluation process, and not unduly influenced by “who is screaming loudest”.

Who Would Use the Prioritization?

There are multiple stakeholders that can benefit from a prioritization of identified gaps in testing programs, as well as providing significant input to this prioritization process. These include utilities (end users), product suppliers, standards development organizations (SDOs), regulatory authorities, user groups, and test laboratories. The methodology considerations and recommendations discussed in this section are suggested for use by the SGIP as it offers the stakeholder diversity to provide a balanced development of a list of priority testing issues to address.

It is anticipated that the recommendations and considerations described in this white paper will be used by the SGIP in further refining a formal prioritization process and setting action plans to support test program development activities that align with standards priorities resulted from the prioritization process.

Methodologies for Prioritization

The prioritization of gaps in testing programs and needs can be approached from several different perspectives. This is not to say there is a single "right" way to prioritize needed test programs, but rather that a number of perspectives should be considered in driving towards a consensus set of priorities. This section discusses several approaches.

Domain Approach

One approach to support a prioritization methodology is to focus on the technology domains as defined within the NIST Framework (see Figure 3 below).

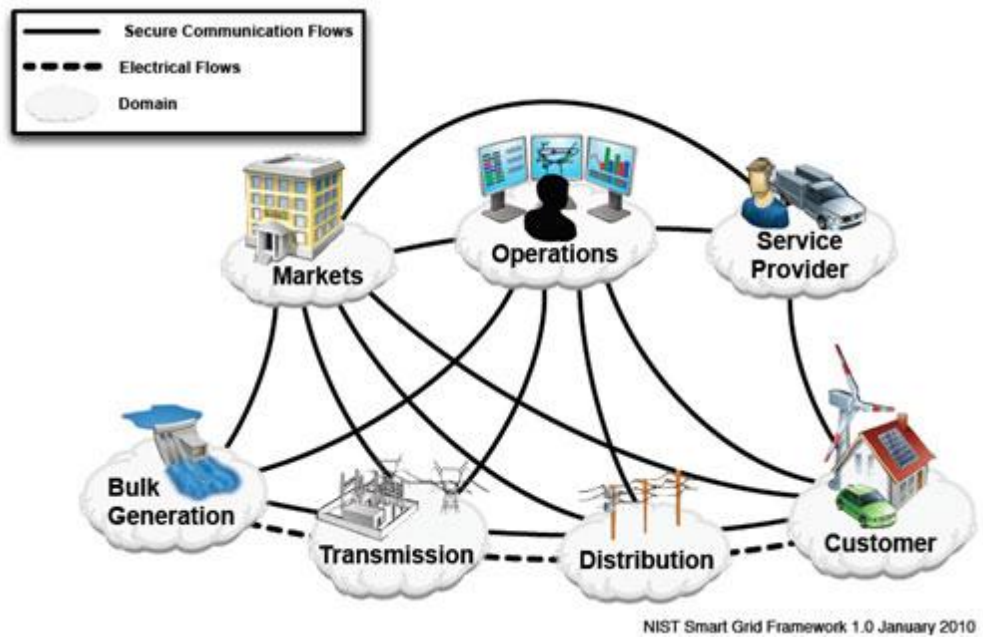

Figure 3 NIST Conceptual Model - Domains

Within a domain, another breakdown may go further by considering:

- Testing priorities within a domain – single standard focus
- Inter-domain testing priorities – single or multi-standard focus
- Interoperability between domains
- Applications/Use-Cases across multiple domains
- Security ramifications within a domain

At the highest level, one might ask themselves "which domain is most important?" The Distribution and Customer domains have received substantial attention during the emergence of smart meter deployments; however the benefits of those deployments require attention to all domains. Too much focus on an individual domain may distract attention from the other key issues that are necessary to enable the benefits of new technology deployment.

Within a domain there will be competing priorities. In some cases, competition for attention may be divided across several standards that offer similar solutions, for example the various options available for wireless communications. Prioritization in this scenario must focus on the problem being addressed by these various standards and not prioritize in such a way as to emphasize one solution over another. The various issues that need to be addressed within a domain can however be prioritized in a consensus manner, so that the most critical needs identified by industry per domain are addressed efficiently.

Another consideration is the priorities for interoperability between domains. The interaction and interoperability between domains have unique sets of technical issues with corresponding standards that support solutions. For example, the customer to distribution domain has different issues and potential solutions than the distribution to transmission domain. It is also important to recognize the interdependencies between standards and technologies. Implementation of some standards may require the inclusion of other related standards in which case these additional standards need to be considered as a part of the prioritization evaluation. Again, the focus of test program prioritization needs to be based on the problems that are most important to solve. Once those priority problems are understood, the standards that enable those functions can be guided towards test programs that support the solutions. It is important to remember that test programs need to be designed to support solutions and deployment, and not simply address an individual standard without understanding the application of that standard when deployed in the field.

Business Function/Use Case Approach

Enabling applications and services across domains is truly the big picture issue that needs to be addressed. Business functions and/or Use Cases are often used to define these specific applications and services. Generally, a test program that addresses cross-domain interoperability will be very complex and challenging, involving many products, each of which may be based on multiple standards. Business functions and use cases will drive the criteria and metrics required in test programs that tackle these complex issues. Keys to enabling application and use case testing will be to assure that the test programs addressing individual products, product interoperability, cross-domain interoperability and other aspects are sufficiently supporting these business functions. Thus it becomes important to assure that those programs that are available to test segments supporting these business functions are providing the necessary depth and breadth of testing that will minimize the need for additional end user testing.

Standards Approach

A focus on testing programs that address the real world problems/solutions of utility deployment is a key influencer of the prioritization process. It is also valuable to take a different view that focuses on the standards. This additional viewpoint will be informative and offer a complementary set of considerations in setting priorities.

A number of issues will require analysis as a part of the prioritization methodology and process. Some of the documentation and evaluation tools developed by the SGTCC pertaining to standards maturity assessment and review processes for SGTCC Catalog of Standards candidates may provide useful input into this process. The following section detailing the proposed approach to prioritization includes recommendations relative to standards that should be addressed within the prioritization process.

Proposed Prioritization Approach

This section discusses the recommended approach for a prioritization action plan and rationale on the elements of the plan. ***It is important to keep in mind that the focus of this effort is to enable acceleration of new test programs that address Smart Grid interoperability. All of the efforts within this plan should be continually returning to that core goal.***

This white paper on the proposed prioritization methodology is only the first step in the larger process. It sets the framework for the effort and provides a starting point towards achieving an industry consensus on the priority issues to be addressed and the launch of action plans to develop solutions for these priority issues. It is the intention of NIST to provide this white paper to the SGIP as a contribution to initiate an industry driven approach that determines the priority test program needs. It is envisioned that the SGTCC and Implementation Methods Committee (IMC) will provide leadership, with support

from NIST, as required in the execution of this project. The following are the major steps in the proposed approach:

A. Launch of a SGTCC-IMC task force to lead the effort

B. Creation of a questionnaire to gather views on priority issues and development of metrics to analyze and compare the input received

C. Perform an initial round of information gathering, focusing on getting input from 5-7 utilities

D. Cross-Domain reconciliation – analyzing the input received; using the metrics to prioritize contributed issues both by domain and cross-domain

E. Share first-round findings with larger SGIP group of stakeholders; based on feedback from this larger group, refine the questionnaire as necessary and solicit a broader 2nd round of input

F. Analyze second round input to expand and refine the prioritization lists to produce a final top 10 (and top 20) list of priorities

G. Form new Priority Action Plan (PAP) groups to address the top priority items and form solutions

Each of the above steps is discussed in greater detail in subsequent sections.

Launch of a SGTCC-IMC task force to lead the effort

- An SGTCC and IMC task force leads the initial review of the whitepaper, refinement of the prioritization approach, implementation of the prioritization, and formation of action plans to address the top identified prioritization issues. It is anticipated that the task force will suggest analysis considerations and issues in addition to those proposed in this white paper. The task force will develop a prioritization tool and corresponding analysis metrics as needed to facilitate the prioritization process.

Creation of a questionnaire to gather views on priority issues and development of metrics to analyze and compare the input received

- A questionnaire will be developed to gather viewpoints on priority test program needs, particularly targeting utility end users, including those from the task force, for their input as product purchasers. Identification of testing gaps and test program development opportunities should also be noted by participants completing the questionnaire.

- It is recommended that the prioritization methodology address the following considerations at a minimum (and additional issues for analysis are anticipated from the SGIP):

- Priority products/applications – As has been the case for smart meters, there are certain products/applications that may take precedence for utilities and other stakeholders, particularly where such products accelerate the availability of Smart Grid benefits to customers. These shorter term priorities will need to be balance with longer term priorities that enable more widespread Smart Grid functionality.

- Reliability – federal and state authorities (e.g. regulators) value infrastructure improvements that enhance grid reliability. Regardless of domain, technologies and standards that are viewed as enhancing reliability may be prioritized higher as compared to other Smart Grid benefits, thus reliability should be a critical characteristic considered in the process of prioritization.

- Critical importance to service impact – similar to reliability, the potential impact of a technology failing to operate as intended is another critical characteristic. Whereas reliability may be viewed as a general metric across a certain area or energy service provider, this characteristic should consider factors such as economic impact (repair/replacement costs for failed devices/applications), outage to critical infrastructure, security concerns, safety to customers and utility workers, and other specific critical impacts that might foreseeably occur. This may also include environmental considerations such as electromagnetic interference and other effects.

- Critical business functions – another variant of the service impact consideration, a critical business function characteristic may be a situation where due to a product/application failure, the utility is impacted in its ability to fulfill certain business functions such as communications failure (unable to monitor status, customer remote functions, etc.), security/privacy concerns, billing functions, etc.

- Technology aptitude of user/actor – some technologies, particularly in the customer and distribution domains where consumers or other stakeholders may be able to interact directly with selected Smart Grid technologies (e.g. Green Button functions) may be impacted by usability and impacts affected by the aptitude of users that interact with devices/applications, which in some cases could lead to issues impacting business or service functions.

- Expense impact – high volume and high cost devices and applications may have a higher priority need due to either 1) failure in high volume deployed devices requiring significant operational costs in the event of performance degradation/failure or 2) failure in high cost devices that are not easily replaced and significantly impact capital expense costs.

- Cascading effects across devices/domains – a characteristic where the failure of a particular device/application at a point in the end to end use case leads to foreseeable

(or unanticipated) issues to other devices/applications somewhere upstream or downstream of the root cause of the problem, ultimately having an undesirable service or business impact.

- Integration costs for new systems/applications – integration of new technologies and services can be a significant effort and cost. Where test programs can provide a high degree of effectiveness in simplifying complexity and reducing cost in the integration stage, as a result of early and thorough pre-integration testing, the benefits to a utility may be sufficiently significant to drive such test programs as high priorities.

From a standards viewpoint, these additional considerations should be included:

- Maturity of a standard (long industry use and experience?; brand new?; existing but not broadly used?)
- Market acceptance/opportunity for the technology – widely used? Emerging technology?
- For cross-domain or inter-domain standards, do they facilitate and enable information transfer to other domains or actors
- Does the standard facilitate multi-vendor interoperability
- Does the standard have widespread impact on end user experience
- Does the standard affect products purchased via 3rd party retailers (e.g. consumer/home devices)
- What are the consequences of product functionality problems – financial; customer experience; grid reliability; end user reliability; field repairs, etc.

Perform an initial round of information gathering, focusing on getting input from 5-7 utilities

- As an initial proposal to provide a starting point to the task force, the following detailed steps are recommended for the end user outreach:
    - A set of key SGIP stakeholders is identified (utilities, both large and rural; end user interest groups, major vendors, etc.) for outreach in obtaining their views on key test program needs; this outreach will be supported via a questionnaire to facilitate the collection of consistent and comparable data to be used by the task force in developing preliminary prioritization findings and recommendations.

    - The IMC participants use its broader utility/end-user participant base to help gather additional utility specific input that will be used in which issue prioritization will take place.

- The initial outreach for prioritization input should target at least 5-7 utilities to assure that end purchaser/decision-maker input is well represented (segmenting priorities by domains should also be encouraged to facilitate the work of the task force).

Cross-Domain reconciliation – analyzing the input received; using the metrics to prioritize contributed issues both by domain and cross-domain

All of the metrics described in the previous sections are recommended for consideration in the prioritization process. There are likely additional key characteristics to be incorporated as well, particularly when addressing devices/applications that have already matured sufficiently to be available and/or deployed in advance of the widespread availability of test programs. The following are an initial set of suggested steps to be used in the prioritization process:

- The SGTCC-IMC task force uses input received, as well as using the SGTCC Testing Landscape[2] document and SGIP Catalog of Standards documentation to compile a list of standards/topics to be analyzed.

- The SGTCC-IMC task force facilitates the analyses by segmenting the standards/topics to be analyzed based on domain area or topic

    - This categorization approach is intended to lay the groundwork for later organization of forums where priorities will later be socialized with SGIP members in preparation for action plans addressing these issues

    - The approach may require that contributing stakeholders draw on expertise from multiple areas within their organizations to assure that the broad spectrum of Smart Grid topics are being adequately covered;

- The task force and any sub-working groups (as needed) use the analysis to develop a prioritization list in accordance with the methodology, ***for each of the agreed upon domain/topic areas.*** This will likely entail the development of agreed upon weighting of the factors above. While each of the above issues is important to consider, a consensus should be reached on how to address their relative importance. As the IMC has strong end-user

[2] https://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/SGIPDocumentsAndReferencesSGTCC/Smart_Grid_TC_Landscape_2012_-_113012.doc

representation, it may be best positioned to provide leadership on this aspect of the prioritization.

Share first-round findings with larger SGIP group of stakeholders; based on feedback from this larger group, refine the questionnaire as necessary and solicit a broader 2nd round of input

- The prioritization initiative, methodology and preliminary prioritization list are socialized at an SGIP e-meeting or via other webinars or industry forums as determined by the SGTCC-IMC joint task force. These meetings are recommended to be structured as a series with each focusing on specific groups of priority areas (e.g. by domain, by standards topic area, function such as demand response, etc.) The output from this SGIP socialization may be used at other industry forums as required.

- A second round of outreach shall target a broader set of stakeholders. The same questionnaire will be used (possibly with some refinements as needed based on feedback from the first round outreach).

- Key stakeholders for additional outreach and socialization on priorities may include an expanded set of large utilities, key utility trade groups (e.g. NRECA, EEI), and major vendor groups (e.g. NEMA)

Analyze second round input to expand and refine the prioritization lists to produce a final top 10 (and top 20) list of priorities

- The task force reconciles the additional input on individual priority lists from each of the different domain/topical areas to develop an overall "top 10, top 20" list of priorities. This step may require that the key criteria/metrics be revisited. Significant discussion may be necessary as, for example, the fourth priority in one area may be considered more critical than the top priority in another area – the top priority item in each area will not necessarily be viewed as critical from an overall perspective – thus there is a need to have a strong cross-section of domain experts contributing to this discussion in reaching a consensus

Form new Priority Action Plan (PAP) groups to address the top priority items and form solutions

- The task force proposes action plans for developing and launching priority test programs. Gaps in testing and test program opportunities relative to the priority topics should be addressed in this effort. Additionally, business considerations must be taken into account such as financial viability of establishing a test infrastructure, sufficiency of industry support and demand for specific test programs, market size, market opportunity, etc. Similar to the priority action plan

(PAP) concept for standards, task groups are recommended to be formed taking responsibility in facilitating and accelerating the development of test programs for the identified priority issues.

NIST views the development of the prioritization methodology and creation of the consensus list of priority testing needs as a six month effort to assure an open and industry driven process that considers the viewpoints across the spectrum of Smart Grid stakeholders. A March 2013 launch of this effort will enable the development of the priority list to complete by mid-year and launch of action plans addressing those priorities during the second half of 2013.

This project and the recommendations included in this white paper will require significant effort. Early engagement of SGIP volunteers, as well as targeted outreach to key stakeholders will need to take place during the formative activities for the project. This will be a critical element to drive the success of this project and drive acceleration of available test programs to address key industry needs.