



# Priority Testing and Certification Needs for Smart Grid Interoperability

September 2013

## Introduction

The SGIP Testing and Certification Committee (SGTCC) has launched an initiative to gather viewpoints on testing needs that require priority attention in supporting interoperability of Smart Grid systems and devices. Input from utilities, as the purchasers and decision makers for these products, is a primary focus of this initiative.

The SGTCC formed a working group to analyze the information that is submitted by project participants and to develop a “Top 10” list of testing needs and gaps that are recommended for SGIP action. It is envisioned that new Priority Action Plans (PAPs) will be formed to address these needs as appropriate.

## Background

***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<sup>1</sup> (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.

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<sup>1</sup> [http://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/IKBFramework/NIST\\_Framework\\_Release\\_2-0\\_corr.pdf](http://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/IKBFramework/NIST_Framework_Release_2-0_corr.pdf)

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.

The SGTCC working group for test program prioritization was launched with a focus on engaging utilities to better understand their views on available industry test programs, gaps in existing programs, and issues where the development of new test programs can provide value in their product assessment, selection and deployment activities. A survey form was developed by the working group to facilitate a consistent format for responses received by participants. The participants were asked to provide 3-5 testing priority needs from their own company perspective. For each cited priority, the participants were asked a series of questions such as standards associated with the issue, views on level of industry demand for a test program associated with the priority, challenges to establishing a program, etc. In addition, participants were asked questions on their own internal testing practices and viewpoints on testing to specific standards cited in the NIST Smart Grid Framework document.

Subsequent sections of this report provide summary findings from the contributed viewpoints and set the stage for planning new SGIP and SGTCC work activities that address the identified priority issues. It is important to note that this analysis is the beginning of longer and more extensive projects. The next step proposed in this process is broader outreach to SGIP stakeholders to build upon and refine the list of priority testing needs. Resources need to be identified to address these needs. With many issues and standards, and limitations on available resources to develop solutions, the prioritization of these identified issues will be used to aid in the efficient execution of work that addresses the most critical needs first, while continuing to maintain a pipeline of new test program projects over time.

The development of test programs that achieve stakeholder needs can take 1-2 years to develop, depending on the technical complexity of the program and the level of engagement of industry. This report is intended to guide the SGIP and SGTCC in developing a roadmap of action plans for 2014 and beyond. While the SGTCC is taking a lead role in coordinating work on these topics, it is envisioned that collaboration with other SGIP working groups such as DEWGs and other standing committees will be essential in providing comprehensive solutions for the identified priorities.

## Identified Priorities

Input from survey participants led to the high level list below of priority testing/certification topical areas. This list can be further distilled into an abbreviated set of focus areas --- topics cited by multiple respondents that are based on the same or related standards. These focus areas are:

- Distribution Automation testing – standards cited multiple times include IEC 61850, DNP 3.0/IEEE 1815 and CIM
- HAN related testing – standards cited multiple times include ZigBee, Smart Energy Profile, WiFi
- Security testing issues

A summary of the more complete list of priority areas cited, with accompanying ranks are shown in the table below (a rank of 1 indicates highest priority):

Priority Topic	Rank	Associated Standards
HAN-AMI-Internet Gateway Integration	1	SEP, IEC,IETF, WIFI, etc
Distribution Automation	1	IEC 61850
IEC 61850 and DNP 3.0 (IEEE 1815)	1	IEC 61850, DNP 3.0, IEEE 1815
Smart Grid Systems & Metering	1	CIM, 61850
AMI Network Wireless Intrusion Detection	1	
AMI-DMS-TMS Security Integration	2	IETF, IAM, SIEM, NERC, NIST IR 7628, ISO
AMI-IT	2	MultiSpeak 4.1
IEC 62351	2	IEC 62351
Network Architecture & Interoperability	2	IPv6, IPv4, PLC, 900 MHz
ZigBee Environmental Endurance Stress Testing	2	
AMS-OMS Integration	3	IEC, ISO
HAN Technology Demonstration and Test	3	ZigBee 1.x
ANSI C12.19	3	ANSI C12.19
Network Protocols	3	802.11, DNP3, Modbus, 802.15.4
ZigBee state management testing – connection failure/recovery	3	
ANSI C12.22	4	ANSI C12.22
Home Area Networking	4	Zigbee, Smart Energy, WiFi
HAN Penetration through the meter ESI to AMI head end	4	
ANSI/AEIC Meter C12.19 Guidelines	5	ANSI/AEIC Meter C12.19 guidelines
IEEE 802.15.4g	6	IEEE 802.15.4g

Additional anecdotal input provided via discussions with some utilities (those that have not yet provided a formal response via the survey document) include:

- Meter Security
- Smart Inverter testing (interconnect of distributed generation)
- Synchrophasor/PMU testing

These topics will be discussed and refined by the working group, along with additional utility responses as they are received. The working group will be tasked to form work activities that begin to address these topics and outreach to stakeholder groups that have an interest in these topics and provide an important voice in crafting solutions towards the development of new test programs to support these needs.

The following sections of this report provide detail extracted from the participant responses. This information is organized in three sections:

1. Detailed Responses for Identified Priorities – this section provides rationale and viewpoints provided by participants relative to the priority issues that they identified
2. General Testing Questions – this section provides participant input on their internal testing practices and requirements
3. Appendix on Domain specific testing interests and Standard specific testing viewpoints

## Detailed Responses for Identified Priorities

This section provides detailed information provided by respondents to the survey prepared by the working group.

- HAN-AMI-Internet Gateway Integration (1)
  - Associated Standards: SEP, IEC, IETF, WIFI, etc.
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - Yes, we believe that a more correct technology alignment is through the use of a multi-protocol gateway capable of interfacing with the meter, in-home devices and the internet.
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - Yes, we have a few that are trying to move into this area, but lack focus as to how it should be leveraged in the industry.
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
    - YES
  - What are your recommendations for next steps to drive development of these test programs
    - Will need to identify product vendors who are trying to deploy this concept in a utility market and establish a collaborative effort to document use cases and establish an end-to-end test program
  - What impediments do you foresee in pursuing these priority programs
- AMI-DMS-TMS Security Integration (2)
  - Associated Standards: IETF, IAM, SIEM, NERC, NIST IR 7628, ISO
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?

- Yes, many of the products being implemented today lack the complete design capable of conforming with many of the security elements.
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - Yes, this is a environment in its infancy requiring utility to provide direction for interoperable solutions.
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
    - YES
  - What are your recommendations for next steps to drive development of these test programs
    - This was is more difficult due to lack of product maturity. This may need to start with vendor educational programs, development of use cases, establishing testing programs for conformity of complete standard versus partial standard, establishing common events to be used in developing incident and event models.
- AMS-OMS Integration (3)
  - Associated Standards: IEC, ISO
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - Yes, this is a new area that lacks common integration protocols to effectively leverage the AMI and OMS solutions in a combined format.
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - Yes, this is in its infancy and will continue to grow from a distribution automation perspective.
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
    - YES

- What are your recommendations for next steps to drive development of these test programs
  - This may begin with establishing common use cases based on initial implementations within the utility industry, and then establish testing models for the vendors.
- Distribution Automation (1)
  - Associated Standards: IEC 61850
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - Yes. Certification only addresses part of the spec
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - Newer in US than Europe and limited Level 1 certification labs
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
    - Don't know
  - What are your recommendations for next steps to drive development of these test programs
    - *[No response provided]*
- AMI-IT (2)
  - Associated Standards: MultiSpeak 4.1
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - *[No response provided]*
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - Maybe. Issues with 3.1 vs. 4.1

- Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
  - Don't know
- What are your recommendations for next steps to drive development of these test programs
  - *[No response provided]*
- HAN Technology Demonstration and Test (3)
  - Associated Standards: ZigBee 1.x
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - Yes. Spec and existing certification are incomplete
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - Yes
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
    - Yes
  - What are your recommendations for next steps to drive development of these test programs
    - Solicit support from utilities and ZigBee Alliance to expand certification
  - What impediments do you foresee in pursuing these priority programs
    - Utilities are slow to react and get involved
- IEC 61850 and DNP 3.0 (IEEE 1815) (1)
  - Associated Standards: IEC 61850, DNP 3.0, IEEE 1815
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?



- Yes
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - Yes
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
    - Yes
  - What are your recommendations for next steps to drive development of these test programs
    - Vendors, Integrators, Research Institutes Test Laboratories and Utilities have to collaborate with Standard bodies Working Groups to develop testable requirements for conformance, registration and interoperability of each IED.
  - What impediments do you foresee in pursuing these priority programs
    - xx
- IEC 62351 (2)
  - Associated Standards: IEC 62351
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - Yes
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - Yes
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
    - Yes
  - What are your recommendations for next steps to drive development of these test programs

- Vendors, Integrators, Research Institutes Test Laboratories and Utilities have to collaborate with Standard bodies Working Groups to develop testable requirements for conformance, registration and interoperability of each IED.
    - What impediments do you foresee in pursuing these priority programs
      - *[No response provided]*
- ANSI C12.19 (3)
  - Associated Standards: ANSI C12.19
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - Yes
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - Yes
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
    - Yes
  - What are your recommendations for next steps to drive development of these test programs
    - Vendors, Integrators, Research Institutes Test Laboratories and Utilities have to collaborate with Standard bodies Working Groups to develop testable requirements for conformance, registration and interoperability of each IED.
  - What impediments do you foresee in pursuing these priority programs
    - *[No response provided]*
- ANSI C12.22 (4)
  - Associated Standards: ANSI C12.22

- Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
  - Yes
- Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
  - Yes
- Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
  - Yes
- What are your recommendations for next steps to drive development of these test programs
  - Vendors, Integrators, Research Institutes Test Laboratories and Utilities have to collaborate with Standard bodies Working Groups to develop testable requirements for conformance, registration and interoperability of each IED.
- What impediments do you foresee in pursuing these priority programs
  - *[No response provided]*
- ANSI/AEIC Meter C12.19 Guidelines(5)
  - Associated Standards: ANSI/AEIC C12.19 Guidelines
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - Yes
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - Yes
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
    - Yes

- What are your recommendations for next steps to drive development of these test programs
  - Vendors, Integrators, Research Institutes Test Laboratories and Utilities have to collaborate with Standard bodies Working Groups to develop testable requirements for conformance, registration and interoperability of each IED.
- What impediments do you foresee in pursuing these priority programs
  - *[No response provided]*
- IEEE 802.15.4g (6)
  - Associated Standards: IEEE 802.15.4g
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - Yes
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - Yes
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
    - Yes
  - What are your recommendations for next steps to drive development of these test programs
    - Vendors, Integrators, Research Institutes Test Laboratories and Utilities have to collaborate with Standard bodies Working Groups to develop testable requirements for conformance, registration and interoperability of each IED.
  - What impediments do you foresee in pursuing these priority programs
    - *[No response provided]*
- Smart Grid System & Metering(1)

- Associated Standards: CIM, 61850
- Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
  - Utilities have many SmartGrid systems that do not interact with each other, but now need to. There is a need in the next 5 years and going forward to make these systems interoperable.
- Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
  - These projects are happening now. However, the need, protocols and technology is in no way new. If an industry test program could be established, it would be very useful. However, if that takes 3 – 5 years, the projects may be over for the large players
- Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
  - This one may be challenging, since the standards will go across different networks and systems. Perhaps a test program could be targeted to specific areas
- What are your recommendations for next steps to drive development of these test programs
  - Research the current utility project, and find examples where this type of test program could be applied (Volt/VAR, Wireless Sensors, DA, Fault Detection, PV inverters)
- What impediments do you foresee in pursuing these priority programs
  - Cost and Timing. Regulated projects have specific budgets, which often do not include support for third party test programs
- Network Architecture & Interoperability (2)
  - Associated Standards: IPv6, IPv4, PLC, 900 MHz
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?

- Utilities have many different types of networks that now need to interoperate due to Grid modernization projects. Testing programs would be very useful here.
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - These projects are happening now. However, the need, protocols and technology is in no way new. If an industry test program could be established, it would be very useful. However, if that takes 3 – 5 years, the projects may be over for the large players
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
    - Test programs in this area would be valuable, because vendors could make their products interoperable and robust before getting to the utility.
  - What are your recommendations for next steps to drive development of these test programs
    - Research the current utility project, and find examples where this type of test program could be applied (Volt/VAR, Wireless Sensors, DA, Fault Detection, PV inverters)
  - What impediments do you foresee in pursuing these priority programs
    - Cost and Timing. Regulated projects have specific budgets, which often do not include support for third party test programs.
- Network Protocols (3)
  - Associated Standards: 802.11, DNP3, Modbus, 802.15.4
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - Utilities have many different types of networks that now need to interoperate due to Grid modernization projects. Testing programs would be very useful here.
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?

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    - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
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    - What are your recommendations for next steps to drive development of these test programs
      - Research the current utility project, and find examples where this type of test program could be applied (Volt/VAR, Wireless Sensors, DA, Fault Detection, PV inverters)
    - What impediments do you foresee in pursuing these priority programs
      - Cost and Timing. Regulated projects have specific budgets, which often do not include support for third party test programs
- Home Area Networking (4)
  - Associated Standards: Zigbee, Smart Energy, WiFi
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - The energy industry has an immediate need to implement Demand Response programs, but the technology and standards do not support rollouts at scale.
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - The industry is struggling to make use of this technology due to its early stage development and associated poor reliability and interoperability. The answer is yes.
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)

- A better test program could lead to more reliable and interoperable products, which might then find better acceptance with consumers, and more support from industry.
    - What are your recommendations for next steps to drive development of these test programs
      - Compare the experience of the utilities and the certification testing from the ZigBee Alliance test houses. There are gaps that need to be addressed.
    - What impediments do you foresee in pursuing these priority programs
      - Cost and Timing. Regulated projects have specific budgets, which often do not include support for third party test programs.
- AMI Network Wireless Intrusion Detection (1)
  - Associated Standards:
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - Yes, this presents the highest risk to the Utility and yet is currently dependent on each AMI vendor's network implementation.
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - Yes, all Utilities with smart meters and AMI networks would benefit.
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
    - No, due to the lack of cyber security standards governing AMI communications across various vendor's proprietary network implementations.
  - What are your recommendations for next steps to drive development of these test programs
    - Focus on the development of cyber security standards to monitor, track & prevent intrusion of the AMI mesh network.
  - What impediments do you foresee in pursuing these priority programs
    - Each vendor's AMI network comm. is proprietary, but must encapsulate standards-based functionality



- ZigBee Environmental endurance/stress testing (2)
  - Associated Standards:
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - Yes, the current SEP certification testing focuses on pass or fail of discrete transactions. What is needed is the addition of more testing over time under environmental stresses.
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - Yes, ZigBee has emerged as the HAN comm. standard for Utilities yet is missing this key 'real world' area of standards & certification.
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
    - Yes, with the release of SEP2 and separation of transport and app layers it is even more important to add environment testing over time to harden the impacts of these stresses on the phys layer.
  - What are your recommendations for next steps to drive development of these test programs
    - Create repository of use cases for testing of this type
  - What impediments do you foresee in pursuing these priority programs
    - None
  
- ZigBee State Management Testing – Connection Failure/Recovery (3)
  - Associated Standards:
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - Yes, the biggest problem for all Utilities with HAN programs is maintaining device connectivity (join state) over time. Standards & testing are needed to prescribe how devices manage state & recover from state changes.

- Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
  - Yes, many Utilities are early in their deployment of large-scale HAN programs (most are still in pilot stage), and this remains the single biggest issue for ZigBee HAN communications.
- Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)
  - Yes, as stated above this is the single biggest issue for ZigBee HAN deployments and has to be remediated regardless of cost.
- What are your recommendations for next steps to drive development of these test programs
  - Improve and enforce, as mandatory, the provisioning / joining / authentication ZigBee SEP clusters.
- What impediments do you foresee in pursuing these priority programs
  - Ratification of any changes to SEP will require more time than an approach of thoroughly testing various HAN manufacturer's implementation of this functionality and letting the market apply the necessary pressure to improve performance. Testing would still benefit HAN mfrs.
- HAN Penetration through the meter ESI to AMI head end (4)
  - Associated Standards:
  - Do you feel that there is widespread industry interest for each identified priority such that a test program will be financially viable?
    - No, most Utilities have adequately secured the ESI in their smart meters to prevent penetration, but attack through the HAN (ZigBee & broadband) has received very little formal attention.
  - Is the technology/deployment associated with the testing priority sufficiently early in its life cycle that the future volume of testing needed would support an industry test program?
    - Yes, but probably too early for an industry-scale test program.
  - Do you feel a test program for this issue has an acceptable and credible business case for adoption (e.g. based on cost efficiency, timeliness in information availability)

- No, not until the first Utility's AMI is penetrated through a HAN.
- What are your recommendations for next steps to drive development of these test programs
  - Review of current ZigBee and broadband standards with this risk in mind.
- What impediments do you foresee in pursuing these priority programs
  - Cost/benefit of the exercise.

## General Testing Questions

A number of general testing questions were posed to participants to gauge their views on topics related to the recommended testing best practices described in the Interoperability Process Reference Manual (IPRM). Topics included the performance of in-house testing versus the use of 3<sup>rd</sup> party test organizations, views on available industry test program sufficiency and gaps, procurement requirements relative to certifications, interest/demand for support of new test programs, and requirements/criteria approaches for new test programs.

### **Question 1 - Is all testing performed in-house?**

- Yes. In most cases, we are engaging the product vendors in establishing the business requirements, testing / validation programs that will be used to implement the desired result. Since our initial deployment of the AMI program, there have been very few entities capable of providing these services based on common standards, business cases, and historical knowledge.
- Meter firmware updates are tested in house. Meter shop is just now getting up to speed on testing ZigBee firmware to the extent that it may impact metrology and communications firmware; IEC 61850 and ANSI C12 tests are performed by labs selected by product vendors; HAN device testing is done in house for now because ZigBee is not plug-and-play, but would like to eventually outsource; AMI IT end-to-end testing is done in house
- We are currently performing limited IEC 61850 IED conformance testing in-house. Most of the AMI testing is based on regression testing fulfilling contractual requirements ( Acceptance Testing).

- Home Area Network Testing (Zigbee Smart Energy; Usage/Demand Response/Load Control) – Zigbee certification is done by third party; Interoperability done in house
- AMI System Upgrades (Metering/Network/Meter Firmware) – all testing performed in house
- Smart Grid Projects (Volt/Var; Wireless Sensors; Fault Detection) – testing has not begun yet, but it will be in-house
- No. We outsource ZigBee SEP certification and SSN compatibility testing to NTS. Our in-house HAN lab performs Utility and program-specific functional end-to-end testing over our AMI as well as usability testing with focus groups.

**Question 2 - Are there external industry test programs that you require vendors to participate in (e.g. 3<sup>rd</sup> party certifications, results, etc.)**

- At this point, we establish base standards as part of the contract process for both product vendors and integration service providers to align our environments with the industry standards. We encourage those entities which lack the technical knowledge to seek 3<sup>rd</sup> party certification programs to validate their solutions before providing them to us. At present, we do not have or maintain a list of 3<sup>rd</sup> party certification entities that can be provided to a prospective vendor to support their efforts.
- HAN devices require ZigBee 1.1 certification plus Certicom certification (“Production Certs); DA components require 61850 certification; Meters must comply with applicable ANSI C12.XX specs
- Unfortunately, there are no certified laboratories that can test end to end conformance and interoperability IED compliance.
- HAN – ZigBee Alliance Certification, Vendor test harness; AMI System – FCC, ANSI; Smart Grid – TBD
- Yes, as gating requirements for our in-house testing, or for Production deployment, all HAN devices must pass the above ZigBee SEP certification and SSN compatibility testing for each firmware version submitted at their own expense.

**Question 3 - Do these industry test programs meet your needs?**

- Based on where we are with respect to the overall maturity of the programs, they currently do not meet our needs.
- Partially. ZigBee certification is necessary, but not sufficient. Certification only confirms compliance with the communications protocol, not functionality. Utilities must test HAN devices with specific meters to ensure interoperability.
- No
- These programs partially meet our needs. We still find significant interoperability issues, so we must conduct our own testing. However, without any certification or third party testing, the product quality would be much worse than it is now.
- Yes, based on the use cases we have cooperatively developed with NTS.

**Question 4 - Are there gaps in current test programs that require new or modified industry test programs? Please explain.**

- Some test programs are very mature, but the product vendors lack the knowledge or insight to engage these programs due to the overall maturity of their development programs. Some test programs appear to not be as complete / thorough with the conformance testing resulting in additional work by the utilities. Some challenges are with the industry trying to catch up with the utility requirements.
- Not all ZigBee-certified HAN devices are equal. Devices may work with some meters, but not all. Ideally, all ZigBee-certified meters should be able to pair up with any ZigBee-certified HAN device, but they don't. NDAs between utilities and manufacturers prevent sharing test results.
- This was the purpose of the SGIP-TCC program: To identify gaps and promote an open architecture for interoperability and certification.. We have long ways to go yet!

- HAN – certification testing should include tests with actual meters, as well as outage and negative testing. Gaps in the standard allow too much variation in implementations.
- AMI – No industry programs
- SmartGrid – No industry programs
- Yes, as noted in the matrix above (ZigBee environmental endurance/stress testing and ZigBee state management testing).

**Question 5 - If an industry group formed to develop a test program aligned with one of your identified needs, would your company be likely to require/demand vendors participate in the program as a condition of purchase/deployment?**

- Yes.
- Yes. We would welcome the opportunity to force manufacturers of meters and HAN devices to meet more stringent certification/interoperability requirements
- Yes!
- Yes, ZigBee certification requires third party testing
- Yes, in fact we already do

**Question 6 - For test programs of specific interest to your company, what would you view as required to launch the initiative and drive others to participate?**

- A clear set of objectives that can be completed in a defined time-frame with a full commitment by all parties.
- For starters, an industry forum involving utilities, meter manufacturers, HAN device manufacturers and certification labs. Maybe this could be combined with an Interop conference of plugfest.
- Building products on Open protocols will promote innovation, increase power system and network reliability and reduce rate payer cost of energy. It is a win-win situation for all parties involved.
- Test programs would require budget, industry support and regulatory support. When utilities and some industry elements attempt to change standards, they fail, or it takes too long to be useful.
- Member participation in the development of the use cases and test cases would increase likelihood of our stakeholders embracing the effort. Additional incentives would include shared costs of the initiative where there are shared purposes & goals with federal funding.

**Question 7 - Do you require specific certifications that vendors must contractually meet?**

- Not at this time. It is more specifically designed to ensure that the vendors are conforming to industry standards and that we would validate the conformity.
- ANSI C12, IEC 61850, ZigBee SEP 1.1, Certicom
- Not all the time. We recognize the fact that most Vendors cannot certify their products since standard requirements are interpreted differently.
- Yes we do (e.g. ANSI, FCC, etc.)
- Yes, ZigBee SEP to a specific version, and cyber security review to our in-house standards for any head-end systems or hosted systems.

**Question 8 - Are there opportunities that you see where a common set of criteria and common test program could be established to meet the needs of multiple utilities? (e.g. a baseline set of tests**

**independent of utility specific applications/use cases such that the cost of running redundant tests can be reduced for both utilities and their vendors)**

- Yes. While there may be variances associated with their respective service territories, we believe there are sufficient common criteria which would benefit everyone.
- Yes. A collaborative effort between utilities and the ZigBee Alliance could expand the definition of “ZigBee Certified”
- Each published Standard shall be accompanied by a testable specification that clearly identifies the requirements for conformance and certification.
- Yes, very much so. The communication and network technology are common between utilities, just the implementation is different. A parallel example would be the telecom industry. They use the same phone type, same network type, just different implementations.
- Yes. The ZigBee Alliance seems to be heavily influenced by manufacturers & vendors for standards development while not embracing input from the Utilities – users of the standards. However, ZigBee is in need of test cases for use in certifying to their standards. This is an area where Utilities might have their greatest influence which would be felt across all Utilities.



# APPENDIX

## Criteria 1: Technology Domain Priorities

The NIST conceptual model segments Smart Grid technologies by domain. Please comment on each domain based on the priority attention needed relative to testing programs that support technology adoption and facilitate interoperability. Responses should consider:

- What test programs do you view as highly important within each domain?
- Which domains do you view as most in need of testing programs and why?

**DOMAIN**

**COMMENTS**

*(Please identify specific testing program needs/gaps for those domains that you view as needing priority attention for testing; comments on your rationale for these priorities are also requested)*

<p>Customer Premises (e.g. appliances, devices)</p>	<p>For a deregulated utility, the programs associated with customer premises are limited to simply providing access to customer meter information and connectivity of in-home programs. Hence the focus on multi-protocol gateways which can integrate with the meter.</p> <p>Expanded scope of ZigBee certification to include baseline plug-and-play capabilities</p> <p>We have no current plans to provide HAN/HEM services inside the home. A gateway with SEP1.x-2.0 application layer firmware can provide many value added services to the residential customer by using a cloud service proxy.</p> <p>This domain is most in need of testing as it represents risks outside the Utility's control. Test programs should include all of the suggestions above.</p>
<p>Distribution</p>	<p>Significant focus on how to leverage and integrate AMI, Distribution Automation, Outage Management System, and Distribution SCADA to effectively manage the distribution grid. Challenges or opportunities exist around integrating these solutions using common standards/security protocols. Since many of these concepts are relatively new from a maturity perspective, a good set of business requirements are lacking to effectively integrate and automate new business processes.</p> <p>DMS, SCADA, Outage management system, AMI, Distribution Automation, FAN..., V2G/EVSE</p> <p>Security of AMI networks for Distribution Automation control signals. AMI network performance and latency for RTU / DA telemetry</p>

Transmission	<p>Transmission has been constrained by the lack of sufficient communication bandwidth to support integration of field assets with back-office solutions. PMUs and security continue to be the greatest focus areas for our utility, and challenges with establish appropriate business use cases for new technology to adherence with security standards/protocols.</p> <p>N/A</p>
Generation	<p>N/A</p> <p>Energy Optimization, Distributed Resources</p>
Operations	<p>Currently working on implementing an Integrated Operating Center (NOC/SOC) to support both IT/OT functions. Largest challenges are associated with business re-alignment and cross business integration requirements.</p> <p>DMS/SOC</p> <p>Use of HAN gateways as a Utility demarcation point to limit operations support &amp; testing requirements of HAN devices behind the gateway.</p>
Markets	<p>N/A</p> <p>Deregulated Markets do not share data</p>
Service Provider	<p>N/A</p> <p>Electric Choice</p>
Other (e.g. cross-domain)	

**Criteria 2: Device Focus**

Preliminary working group discussions have identified various product/device types and families that may need more urgent focus on test program development. Please comment on the relative priority of this initial list to your organizations **and please add other priority devices to this list if not shown.**

**Priorities should be identified at a minimum as high/medium/low; a rank order of the high priority devices is preferred.**

**Also, please note specific standards you currently specify relative to devices of key interest**

<b>DEVICES</b>	<b>COMMENTS</b>	<b>STANDARD</b>	<b>PRIORITY</b>
	<p><i>Please identify the specific types of testing of greatest priority for a given device (e.g. communications, security, all) and where applicable, the minimum core set of features/functions that you require vendors to test and comply to for acceptance)</i></p>	<p><i>Please note specific standards you currently specify relative to devices of key interest</i></p>	<p><i>5 = Highest Priority, 1 = Lowest Priority</i></p>

<p>HAN devices</p> <ul style="list-style-type: none"> <li>• Programmable Communicating Thermostats (PCTs)</li> <li>• In Home Displays</li> <li>• Gateways</li> </ul>	<p>Gateway testing is the primary focus area at this time. The gateway needs to be a multi-protocol solution capable of support communication with and management of in-home devices through the utility communication network or the Internet.</p> <p>Resp#2 -</p> <p>PCTs and IHDs to accurately display time, price and consumption info</p> <p>Gateway devices as interface between meters, HAN devices and Internet</p> <p>R3</p> <p>DOE HAN/Smart Home and EVSE projects.</p> <p>R5</p> <p>ZigBee Environmental endurance/ stress testing and ZigBee state management testing</p>	<p>SEP 1.x, IEC, IETF, ISO, NIST</p> <p>ZigBee 1.1</p> <p>SEP 1.X-SEP2.0, IEC, IETF</p> <p>SEP 1.1 and 2</p>	<p>3</p> <p>5</p> <p>5</p> <p>2</p> <p>4</p>
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<p>Meters</p> <ul style="list-style-type: none"> <li>• Bell Weather</li> <li>• Capacitor Controllers</li> <li>• Other Distribution Automation Components</li> <li>• Transformer Load Management</li> </ul>	<p>Currently working on leveraging the AMI environment to support Distribution SCADA, planning, work management, Distribution Automation programs.</p>	<p>IEC, IETF, ISO, NIST</p>	<p>4</p>
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<p><b>Criteria 3: Application/Issue Focus</b></p> <p>Preliminary working group discussions have identified various applications types that may need more urgent focus on test program development. Please comment on the relative priority of this initial list to your organizations and please add other priority applications to this list if not shown</p>			
<p><b>APPLICATION/ISSUE</b></p>	<p><b>COMMENTS</b></p>	<p><b>STANDARD</b></p> <p><i>Please note specific standards associated with your priority issues</i></p>	<p><b>PRIORITY</b></p> <p><i>5 = Highest Priority, 1 = Lowest Priority</i></p>

<p>Meter Upgrade Compatibility</p>	<p>Have a fairly comprehensive program associated with meter upgrade concepts.</p> <p>Resp#2</p> <p>Over-the-air firmware upgrades</p> <p>R3</p> <p>AMI platform, Automated process</p> <p>Referring to meter firmware or meter NIC firmware/ZigBee firmware upgradeability</p>	<p>IEC, IETF, ANSI, ISO, NIST</p> <p>ANSI/IEEE C12.19 and 22</p>	<p>2</p> <p>5</p> <p>5</p> <p>4</p>
<p>SEP 1.x</p> <p>SEP 2.0</p>	<p>Have had individuals working on the SEP 1.x standards, as well a monitoring the SEP 2.0 standard. 2.0 will require significant focus from an end-to-end perspective since it varies greatly from the SEP 1.x standard.</p> <p>R2 – No meters have 2.0 and 2.0 is not backward compatible with 1.1</p> <p>R3 – No immediate plans to enter in HEM/HAN programs</p> <p>R5 – Operational transition of devices from SEP 1.x to 2.0. We are currently planning to abandon support for all SEP 1.x devices in the field. It would make for a better customer experience if they could continue to use their HAN devices with support from the Utility ‘as-is” or with upgraded firmware.</p>	<p>IEC, IETF, ISO, NIST</p> <p>ZB-SEP</p>	<p>3</p> <p>3</p> <p>3</p> <p>2</p>



Meter Security testing	<p>Meter / meter application security testing and monitoring continue to be our focus.</p> <p>R2 – Third party outsource</p> <p>R3 – Proprietary</p> <p>R5 – Silver Spring Networks (SSN) proprietary</p>	<p>IETF, ISO, NIST</p> <p>IEC, IEEE, IETF</p> <p>SSN</p>	<p>4</p> <p>5</p> <p>5</p> <p>5</p>
RF/Building effects on wireless comm.	<p>With the recent completion of the meter deployment, all critical items associated with RF testing has been completed.</p> <p>R2 – We will be testing this fall in 100 employees' homes</p> <p>R3</p> <p>R5</p>	<p>IEC, IETF, ISO, NIST</p> <p>UL, IEC, IEEE, ANSI</p> <p>New/IEEE</p>	<p>2</p> <p>5</p> <p>4</p> <p>3</p>

<p>Core criteria/tests for HAN device compatibility</p>	<p>Significant efforts have been completed from both a device and end-to-end perspective.</p> <p>R2 – Support for Time, Metering, Price clusters</p> <p>R3</p> <p>No immediate plans to enter in HEM/HAN programs</p> <p>R5</p>	<p>IEC, SEP, IETF, ISO, NIST</p> <p>IEC, IEEE, IETF, SEP</p> <p>SEP2</p>	<p>2</p> <p>2</p> <p>2</p>
<p>Distribution Automation issues</p>	<p>Focus on establishing business requirements with the various DA projects, and implementing integration standards between AMS/DMS.</p> <p>R3</p> <p>DMS/SOC. Several projects and studies</p>	<p>IEC, IETF, ISO, NST</p> <p>IEEE/IEC</p>	<p>4</p> <p>4</p>
<p>Distributed Energy Resources issues</p>	<p>N/A</p> <p>R3</p> <p>Distributed Generators, micro-grids, PVs, EVSE/EV</p> <p>PV inverter &amp; EVSE control, and residential battery storage management</p>	<p>ICCP, DNP 3.0</p> <p>SEP2</p>	<p>5</p> <p>2</p>

#### Criteria 4: Standards Focus

Preliminary working group discussions have identified various standards that may need more urgent focus on test program development. Most test programs associated with standards tend to be conformity based, but ideally can enable interoperability. Please comment on the relative priority of this initial list to your organizations and please add other priority standards to this list if not show. (Standards listed are taken from the NIST Framework for Smart Grid Standards Interoperability; additional standards not cited in the NIST Framework may be added by respondents at their discretion).

In addition, some standards and technology areas already have test programs in progress – please comment on these where you feel that more testing specific focus and priority action plans would be beneficial to enhancing interoperability

<b>STANDARD/SPECIFICATION</b>	<b>COMMENTS</b>	<b>PRIORITY</b>  5 = Highest Priority, 1 = Lowest Priority
IEEE 1547	N/A  3 – N/A	

<p>Wireless Alternatives</p> <ul style="list-style-type: none"> <li>• Zigbee</li> <li>• ZWave</li> <li>• WiFi</li> <li>• others</li> </ul>	<p>N/A</p> <p>3 – ZB, WiFi, HP and SEP 1.X to SEP 2.0</p>	<p>3</p>
<p>Power Line Carrier communications</p> <ul style="list-style-type: none"> <li>• HomePlug</li> </ul>	<p>N/A</p> <p>2 – This may be a requirement for customer premises where ZigBee communications is not reliable due to building style or construction materials</p> <p>3- Green Phy (coexistence)</p> <p>5 – SEP over PLC, SAE</p>	<p>2</p> <p>4</p>
<p>EMC and other grid resiliency related standards</p>	<p>N/A</p> <p>3 – Vendors shall make sure that their products can withstand interference and pass all pertinent industry standards EMC/EMI requirements</p>	<p>5</p>
<p>IEC 61850</p>	<p>Continued focus on this standard, with increased utilization based on additional communication capacity.</p> <p>R3 – IEC 61850/IEC62351 implementation on a new distribution 13.2/4.8KV substation</p>	<p>3</p> <p>5</p>

SEP 2.0	<p>Zigbee has been the primary solution for our environment, and continues to require testing / conformity programs.</p> <p>R2 – Lack of backward compatibility is a problem. Replacement vs. Upgrade</p> <p>R3-Gateway ALG-translator</p> <p>R5 – Our HAN deployment model will be based on SEP2’s multi-ESI coordination through a HAN gateway</p>	<p>3</p> <p>3</p> <p>5</p>
IEC 61968/61970	<p>Significant focus on this standard based on the integration of AMI, DMS, and OMS solutions.</p> <p>R3 – CIM for DMS use cases</p> <p>R5 – As more utilities are collecting more ‘big’ data, these CIM standards will become critical to effectively gaining actionable insights from the data and to pave the way for improvements in future integration with smart grid systems</p>	<p>4</p> <p>3</p> <p>4</p>
Security standards – please identify those that you consider to be high priority	<p>NIST, ISO, IETF and NERC and the primary focus areas related to security. A focus program has been underway for more than 5 years to effectively integrate the IT/OT functions.</p> <p>R3 – IEC 62351, NERC</p> <p>R5 – AMI wireless intrusion detection, HAN intrusion detection</p>	<p>4</p> <p>5</p> <p>5</p>

OpenADE/Green Button	<p>Have deployed part of the Green Button standard as part of the Smart Meter Texas portal deployment. This is limited due to the information available at the point of interface.</p> <p>R3 – N/A</p> <p>R5</p>	<p>2</p> <p>1</p>
ANSI C12 standards	<p>Focus on this item has been significant with the complete deployment of the AMI meters.</p> <p>R3 – C12.22 and C12.19/21</p> <p>R5 – We have already implemented the use of C12.19 in our meters rather than GMI. That is why the priority is lower</p>	<p>4</p> <p>5</p> <p>1</p>
OpenADR	<p>N/A</p> <p>R3</p> <p>R5 – OpenADR 2 release b should be backward compatible with release a. We have several ADR 1.0 clients at commercial customers EMSs that would otherwise not be supported</p>	<p>3</p> <p>4</p>
MultiSpeak	<p>N/A</p> <p>N/A</p> <p>R5</p>	<p>1</p>

ASHRAE 135/BACNet	N/A  N/A	
ANSI CEA 709 (LON)	N/A  N/A	
IEEE 1815/DNP3	Continued focus on this standard, with increased utilization based on additional communication capacity.  R3 – Serial versus IP (new NERC requirements)	3  5
OPC-UA Industrial	N/A  N/A	
IEEE C37.118	Focus on this area has been limited to the original deployment of the Synchrophasors. The requirements will increase as the business requirements are established from an end-to-end perspective.  R3 - some	3  3
IEEE 1588	N/A  N/A	

OpenHAN	N/A  Superceded by SEP	2
SAE standards (J1772, J2836)	N/A  R3-Follow all SAE standards  R5 – J1772 needs to evolve to resolve conflicts between managing PEV charging from the car or the EVSE. What role/control does the utility have for demand reduction?	4  2