DRAFT Interoperability Profile Description

Information exchanges and coordinated actions across devices, actors and systems are required to maximize the operational and economic value of the smart grid.[1] The interoperability required to enable this optimization is best achieved through the use of open standards to define interface performance requirements.[2] Testing and certification programs provide a mechanism to ensure that equipment function conforms to standards and will operate as intended when deployed. NIST research reveals a limited availability of testing and certification programs for smart gird interoperability standards,[3] and this paper proposes an approach to developing interoperability profiles to help accelerate the development of testing and certification programs.

Testing and Certification—Context

Testing and certification programs provide common and acceptable processes that are used to demonstrate conformance with a standard and support interoperability between devices and systems.[4] Completing the program allows vendors to offer products certified to that standard, and affords customers a level of trust that products will work as intended when deployed. Standardized interface performance requirements are required for modernizing the grid as new technology integrates with legacy grid systems,[5] and the value of certification programs increases as the number of devices, range of technologies, and operational paradigms on the grid continues to grow.

The testing and certification value proposition benefits all grid stakeholders. Customers benefit by ensuring that standards and performance requirements are implemented appropriately and consistently across procured equipment, which eases integration of new products and services with existing infrastructure and operations.[6] Testing and certification also reduces vendor and manufacturer implementation costs for new standards by establishing clear performance requirements and ensuring product certifications occur in a neutral environment, which can facilitate market access.[7] State legislators and regulators have also recognized the importance of interoperability testing and certification as a means to maximize the benefits of new grid technology investments.[5,7]

Testing and certification programs help achieve interoperability across smart grid devices and systems,[8] an important component of NIST's mandate in this space.[9] Yet despite the substantial

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[1] NIST Special Publication 1108r3, NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 3.0 (2014), https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1108r3.pdf

[2] European Commission Smart Grids Task Force, *Interoperability, Standards and Functionalities applied in the large scale roll out of smart metering* (2015). Available here.

[3] See companion document: *DRAFT Evaluation of Testing & Certification Landscape for Smart Grid Standards*. Available here.

[4] ANSI/NEMA Smart Grid Interoperability Process Reference Manual (ANSI/NEMA SG-IPRM 1-2016). Available here.

[5] Illinois Statute 220 ILCS 5/16-108.6. Available here; California Code - PUC § 8360. Available here.

[6] Ahmadi, M. *The Need for Security Testing and Conformance Standards in the Smart Grid*. Grid-Interop Forum, 2011. Available here.

[7] Public Utilities Commission of the State of California, RESOLUTION E-4527 (2012). Available here.

[8] SEPA. *Interoperability Process Reference Manual—User's Guide* (2017). Available here.

[9] Energy Independence and Security Act of 2007 (Public Law 110-140, available here).

benefits brought by testing and certification programs, evaluation of more than two hundred smart grid standards reveals that industry testing programs are available for only about one out of every four interoperability standards.[3] This gap in the availability of testing and certification programs for interoperability standards often leads to challenges when deploying assets.

Testing and Certification—Challenges

Many standards still do not have associated testing and certification programs, including several important ones such as the IEC Common Information Model (CIM), Facility Smart Grid Information Model (FSGIM), and the IEEE 2030.5 Smart Energy Profile 2.0 (SEP 2.0) application protocol standard. Among the numerous challenges which limit the development of testing and certification programs for interoperability standards, two stand out:

> **Diversifying universe of standards**: The universe of standards and associated applications continues to diversify, increasing the need for approaches that simplify implementation and testing, and enable industry to coalesce around a subset of the options.
>
> **Parallel pathways to interoperability:** Even as new and updated standards incorporate a greater focus on information exchange, allowances for multiple communications protocols and information models within the same standard often provide multiple mechanisms through which this information exchange can occur.[10] Parallel pathways to interoperability could result in two devices certified to the same standard but still being unable to communicate.

Interoperability Profiles - Description

Reducing the complexity of implementing a standard and the associated testing requirement is one approach to addressing the testing and certification challenges described above. This could be accomplished through the development and use of Interoperability Profiles, which would describe a well-defined subset of the standard for implementation that has been agreed upon by a user community, testing authority, or standards body. By defining this implementation subset—which could describe a subset of supported data types, logical nodes and elements, or services—an Interoperability Profile would narrow interoperability gaps by reducing the degrees of freedom and for implementing standards by the device supplier, implementer, and system owner.

Interoperability Profiles would not replace or be considered standards, but would instead serve to clarify standards-based implementation requirements for all stakeholders. Interoperability Profiles could therefore take many different forms based on the technology and underlying standard. For example, an Interoperability Profile based on an application would define the standard elements to be utilized in that specific application environment, thereby giving all stakeholders greater confidence in asset functionality.

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[10] For example: IEEE P1547 defines a new and extensive set of performance requirements for grid-connected inverters. The standard also introduces a communications requirement, which can be satisfied by using a number of communication protocols and information models—flexibility that creates a combinatorial complexity challenge for assuring device interoperability.

The basic set of elements for an Interoperability Profile include the asset description and associated physical performance specifications, communication protocol, and information model. The growing complexity of information models means that only a subset is likely to be necessary for any single application or piece of equipment. This can lead to interoperability failures when devices compliant to the same standard attempt to communicate different parts of the same data model, a communications failure which could be mitigated through the application of Interoperability Profiles that define implementations using a specific subset of the broader standard.

An Interoperability Profile with a narrow set of implementation requirements could be more easily tested for certification, and eventually could be listed by vendors that support it and used in procurement specifications by end users. This could facilitate the development and utilization of testing and certification programs, and advance interoperability for smart grid equipment and systems.

Interoperability Profiles – Context

The core elements of the Interoperability Profile approach have already been successfully demonstrated for smart inverters. California Rule 21 and IEEE P1547 both define the specifications for interconnection and interoperability of distributed energy resources with associated electric power systems interfaces. The standards include physical performance specifications, communication protocols, and required data elements. While the physical performance specifications are similarly prescriptive, Rule 21 and P1547 employ different approaches to communication protocol and data element requirements.

An inverter can be compliant to IEEE P1547 so long as it implements one of three defined communication protocols,[11] although the universe of communication protocol implementations could be significantly larger.[12] The standard also defines required data elements, but does not specify a particular information model. Since there are multiple allowable communication protocols and no specific information model, there are numerous permutations of possible interoperability implementations. While the inverter physical performance requirements are clear, the relatively large number of potential communication protocols and data model implementations could limit the ability to test for and certify device interoperability under the P1547 standard.

California Rule 21 also establishes rules for interconnection of inverter-based DER to the grid. While the physical specifications mirror those of IEEE P1547, Rule 21 specified IEEE P2030.5 as the required communication protocol and IEC 61850 as the required information model. This approach relied on existing standards while narrowing the degrees of freedom and complexity for implementing the required communications, and is similar to the Interoperability Profile approach described here. Rule 21 clarified inverter interoperability requirements, and an

[11] Any one of the following communications protocols could be used: IEEE P2030.5 (SEP 2.0), IEEE 1815 (DNP3), or SunSpec Modbus

[12] IEEE P1547 section 10 describes additional communications protocols and data models that could also be used

independent testing and certification program has been formed,[13] which has since been adopted as a requirement by utilities and system operators in other regions of the country.[14]

Interoperability gaps can be narrowed by reducing the degrees of freedom for implementing standards to those that are critical for operation of a specific device, or for provision of a specific service. A reduced set of requirements can also facilitate development of common testing and certification processes that verify equipment conformance, and likely will improve interoperability of deployed assets.

[13] See UL 1741 SA, available here.

[14] ISO New England and National Grid require UL 1741 SA certification for inverters installed in Massachusetts