



Smart Grid Standards Information

Version 1.6.1 – Thomas.Basso@NREL.gov

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Section I: Use and Application of the Standard

A. Identification and Affiliation

1.	Number of the standard	1547, 1547.1, 1547.2, 1547.3, 1547.4, 1547.5, 1547.6, 1547.7, 1547.8
2.	Title of the standard	<ul style="list-style-type: none"> • IEEE 1547 <i>Standard for Interconnecting Distributed Resources with the Electric Power Systems</i> • IEEE P1547.1 <i>Standard For Conformance Test Procedures for Equipment Interconnecting Distributed Resources With Electric Power Systems</i>; • IEEE P1547.2 <i>Application Guide for IEEE Std. 1547 Standard for Interconnecting Distributed Resources With Electric Power Systems</i>; • IEEE P1547.3 <i>Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected With Electric Power Systems</i>; • IEEE P1547.4 <i>Draft Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems</i> • IEEE P1547.5 <i>Draft Technical Guidelines for Interconnection of Electric Power Sources Greater than 10 MVA To The Power Transmission Grid.</i> • IEEE P1547.6 <i>Draft Recommended Practice For Interconnecting Distributed Resources With Electric Power Systems Distribution Secondary Networks</i> • IEEE P1547.7 <i>Draft Guide to Conducting Distribution Impact Studies for Distributed Resource Interconnection</i> • IEEE P1547.8 <i>TBD (e.g., expanded use of Std 1547)</i>
3.	Name of owner organization	IEEE SA
4.	Latest versions, stages, dates	1547, 1547.1, 1547.2, 1547.3 are Published Standards, 1547.4 is in Ballot , 1547.6 will Ballot this Spring, 1547.5 and 1547.7 are under development, and 1547.8 is in PAR development.
5.	URL(s) for the standard	http://grouper.ieee.org/groups/scc21/1547/1547_index.html
6.	Working group / committee	IEEE SCC21
7.	Original source of the content (if applicable)	

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8.	Brief description of scope	1547 provides a basis for Electrical Interconnection and Net Metering rules for Distributed Generation including Storage. This includes all types of synchronous, induction, and inverter based generators.
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B. Level of Standardization

1.	Names of standards development organizations that recognize this standard and/or accredit the owner organization	IEC, UL, NFPA/NEC, ANSI
2.	Has this standard been adopted in regulation or legislation, or is it under consideration for adoption?	x Yes <input type="checkbox"/> No The majority of State Public Utility Commissions in the US have adopted 1547 for interconnection and 1547.1 for conformance testing and certification. The FERC approved PJM Standard for Interconnection of Small Generators 0-10 MW and 10-20 MW (including synchronous, induction, and inverter based) specifies use of IEEE 1547.
3.	Has it been endorsed or recommended by any level of government? If "Yes", please describe	x Yes <input type="checkbox"/> No The Energy Policy Act of 2005 states that <i>"Interconnection services shall be offered based upon the standards developed by the IEEE Standard 1547 for Interconnecting Distributed Resources with Electric Power Systems."</i>
4.	Level of Standard (check all that apply)	x International x National <input type="checkbox"/> Industry <input type="checkbox"/> de Facto <input type="checkbox"/> Single Company IEEE Std 1547 was approved by the IEEE Standards Board and shortly thereafter approved as an American National Standard (ANSI/IEEE) in October 2003. IEC TC8 has also considered dual logo. Differences in regulatory approach between countries complicates the adoption of a common international interconnection standard. However, the technical requirements aspects of 1547 (excluding regulatory considerations) is used as the basis for many other non-US National interconnection standards.
5.	Type of document	<input checked="" type="checkbox"/> Standard <input type="checkbox"/> Report <input checked="" type="checkbox"/> Guide <input type="checkbox"/> Technical Specification
6.	Level of Release	<input checked="" type="checkbox"/> Released <input checked="" type="checkbox"/> In Development <input type="checkbox"/> Proposed – IEEE Std 1547 is released, along with 1547.1, 1547.2, and 1547.3. Others, 1547.4, 1547.5, 1547.6 and 1547.7 are under development and available in draft form. Standard 1547.8 is proposed and in the process of development.

C. Areas of Use

1.	Currently used in which domains? (check all that apply)	<input type="checkbox"/> Markets <input type="checkbox"/> Operations <input type="checkbox"/> Service Providers <input type="checkbox"/> Generation <input type="checkbox"/> Transmission x Distribution x Customer
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2.	Planned for use in which domains? (check all that apply)	<input type="checkbox"/> Markets x Operations <input type="checkbox"/> Service Providers <input type="checkbox"/> Generation x Transmission x Distribution x Customer The 1547.4 draft was accelerated to ballot in response to the SGIP PAP 7 activity and defines the integration and operation of Islanded systems within Electric Power Systems. The 1547.8 PAR initiated in response to the SGIP PAP 7 activity proposes to enable operational control of distributed generators <u>(including energy storage)</u> and ancillary services and provide extension to sub-transmission, as well as defining object models and requirements (such as low-voltage ride through) that are consistent with those of transmission level generators.
3.	Please describe the Smart Grid systems and equipment to which this standard is applied	Electrical Interconnection of all types of generators (synchronous, induction, and inverter based) with the electric power system. The inverter based systems may be fueled by PV, Wind, Fuel Cells, Storage, and PEVs, etc., and the synchronous and induction mechanical generators are typically driven by fossil energy fueled engines.

D. Relationship to Other Standards or Specifications

1.	Which standards or specifications are referenced by this standard?	Many other equipment specific, application specific, and communication standards incorporate specifications for compatibility with 1547 requirements.
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2.	Which standards or specifications are related to this standard?	<p>When applied to utility-interactive equipment, UL 1741 Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources is "intended to supplement and be used in conjunction with the Standard for Interconnecting Distributed Resources With Electric Power Systems, IEEE 1547, and the Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems, IEEE 1547.1." The products covered by these requirements are intended to be installed in accordance with the National Electrical Code, NFPA 70.</p> <p>Many other equipment specific, application specific, and communication standards incorporate specifications for compatibility with 1547 requirements. <i>NRECA Application Guide to 1547</i> is published. Also, the FERC approved PJM Standard for Interconnection of Small Generators 0-10 MW and 10-20 MW (that incorporate 1547 and 1547.1).</p>
3.	Which standards or specifications cover similar areas (may overlap)?	#####
4.	What activities are building on this work?	#####IEEE Std P2030 guide for smart grid interoperability (under development; drafts established).

E. Dept of Energy Smart Grid Characteristics

Please describe how this standard may encourage each of the following:

1.	Enables informed participation by customers	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No #####
2.	Accommodates all generation and storage options	x Yes <input type="checkbox"/> No #####
3.	Enables new products, services and markets	X Yes <input type="checkbox"/> No #####

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4.	Provides the power quality for a range of needs	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No ##### Today 1547 defines the power quality of distributed generators. Distributed generation is required to disconnect to avoid uncontrolled islands. In the future, 1547.8 may provide advanced operational power quality support such as harmonic cancelation functions.
5.	Optimizes asset utilization and operating efficiency	<input type="checkbox"/> Yes <input type="checkbox"/> No #####
6.	Operates resiliently to disturbances, attacks, and natural disasters	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 1547.8 may provide low voltage ride through and controllable trip point specifications that will enhance resiliency of the Electric Power System particularly in a high penetration level scenario for renewable energy.

F. FERC and NIST Priority Areas

Please describe if and how this standard may be applied in each of the following areas. Note that there is space in section J to discuss any other significant areas where the standard may be applied.

1.	Demand response and consumer energy efficiency	<input type="checkbox"/> Yes <input type="checkbox"/> No #####
2.	Wide area situational awareness	<input type="checkbox"/> Yes <input type="checkbox"/> No #####
3.	Electric storage	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Electric storage under discharge mode requires should conform to 1547 specifications.
4.	Electric transportation	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Electric transportation used as storage in a distributed generation mode should conform to 1547 specifications.
5.	Advanced metering infrastructure	<input checked="" type="checkbox"/> <input type="checkbox"/> Yes <input type="checkbox"/> No ##### IEEE Std 1547.3 provides guidance (alternative approaches) for monitoring, information exchange and control of distributed energy resources (includes energy storage systems).
6.	Distribution grid management	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Utility control of the operational interface functions for distributed generators and storage is a key focus of 1547.8. The 1547.7 Draft Guide to Conducting Distribution Impact Studies for Distributed Resource Interconnection also addresses Distribution Grid Management.

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G. Openness

1.	Amount of fee (if any) for the documentation	#####Visit http://standards.ieee.org/Shop
2.	Amount of fee (if any) for implementing the standard	#####
3.	Amount of fee (if any) to participate in updating the standard	#####none
4.	Is the standard documentation available online?	<input type="checkbox"/> Yes <input type="checkbox"/> No http://standards.ieee.org/Shop ##### URL
5.	Are there open-source or reference implementations?	<input type="checkbox"/> Yes <input type="checkbox"/> No
6.	Are there open-source test tools?	<input type="checkbox"/> Yes <input type="checkbox"/> No
7.	Would open-source implementations be permitted?	<input type="checkbox"/> Yes <input type="checkbox"/> No
8.	Approximately how many implementers are there?	#####
9.	Approximately how many users are there?	#####
10.	Where is the standard used outside of the USA?	#####
11.	Is the standard free of references to patented technology?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
12.	If patented technology is used, does the holder provide a royalty-free license to users of the standard?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Patented
13.	Can an implementer use the standard without signing a license agreement?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
14.	Are draft documents available to the public at no cost?	<input type="checkbox"/> Yes <input type="checkbox"/> No
15.	How does one join the working group or committee that controls the standard?	#####visit http://grouper.ieee.org/groups/scc21/index.html
16.	Is voting used to decide whether to modify the standard? If Yes, explain who is permitted to vote.	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No ##### IEEE SA members or anyone who pays a one-time fee as per ANSI-accredited procedures.
17.	Is an ANSI-accredited process used to develop the standard?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
18.	What countries are represented in the working group or committee that controls the standard?	#####Membership is open to all individuals (not representatives).

H. Support, Conformance, Certification and Testing

1.	Is there a users group or manufacturers group to support this standard?	x Yes <input type="checkbox"/> No
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2.	What is the name of the users group or manufacturers group (if any)?	When applied to utility-interactive equipment, UL 1741 Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources is "intended to supplement and be used in conjunction with the Standard for Interconnecting Distributed Resources With Electric Power Systems, IEEE 1547, and the Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems, IEEE 1547.1." The products covered by these requirements are intended to be installed in accordance with the National Electrical Code, NFPA 70.
3.	What type of test procedures are used to test this standard? (please check all that apply)	<input type="checkbox"/> Internal to the lab <input checked="" type="checkbox"/> Published by standards organization <input type="checkbox"/> Published by users group <input type="checkbox"/> No procedures, informal testing
4.	Are there test vectors (pre-prepared data) used in testing? (please check all that apply)	<input type="checkbox"/> Internal to the lab <input type="checkbox"/> Published by standards organization <input type="checkbox"/> Published by users group <input type="checkbox"/> No procedures, informal testing
5.	What types of testing programs exist? (check all that apply)	<input type="checkbox"/> Interoperability Testing <input checked="" type="checkbox"/> Conformance Testing <input type="checkbox"/> Security Testing <input type="checkbox"/> No Testing
6.	What types of certificates are issued? (check all that apply)	<input type="checkbox"/> Interoperability Certificate <input checked="" type="checkbox"/> Conformance Certificate <input type="checkbox"/> Security Certificate (text document) <input type="checkbox"/> No Certificates
7.	Are there rules controlling how and when to use the logo?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Standard has no logo
8.	Is there a program to approve test labs?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
9.	Approximately how many test labs are approved (if any)?	NERTL accredited laboratories as defined by OSHA (such as UL) that are certified accredited for UL 1741 ² /IEEE 1547.1 conformance testing.
10.	Is there a defined process for users to make technical comments on the standard or propose changes to the standard and have these issues resolved?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
11.	Is there a published conformance checklist or table?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No (IEEE Std 1547.1)
12.	Are there defined conformance blocks or subsets?	<input type="checkbox"/> Yes <input type="checkbox"/> No
13.	Approximately how many vendors provide test tools?	#####
14.	Are there tools for pre-certification prior to testing?	<input type="checkbox"/> Yes <input type="checkbox"/> No

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15.	Can vendors self-certify their implementations?	<input type="checkbox"/> Yes <input type="checkbox"/> No Yes if they are an accredited laboratory (e.g., a NRTL)
16.	Is there application testing for specific uses?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
17.	Is there a “golden” or “reference” implementation to test against?	<input type="checkbox"/> Yes <input type="checkbox"/> No
18.	Who typically funds the testing? (check all that apply)	<input type="checkbox"/> User <input type="checkbox"/> Users Group <input checked="" type="checkbox"/> Vendor <input type="checkbox"/> Confidential
19.	Is there a method for users and implementers to ask questions about the standard and have them answered? (check all that apply)	<input checked="" type="checkbox"/> Yes, official interpretations <input checked="" type="checkbox"/> Yes, informal opinions <input type="checkbox"/> No
20.	Does the users’ group (or some other group) fund specific tasks in the evolution of the standard?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
21.	Is the users’ group working on integration, harmonization or unification with other similar standards?	<input type="checkbox"/> Yes <input type="checkbox"/> No via individuals who work on multiple standards development
22.	What other standards is this standard being integrated, harmonized, or unified with (if any)?	#####various IEEE stds; NEC; UL1741; IEC
23.	Are there application notes, implementation agreements, or guidelines available describing specific uses of the standard?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable E.g., via 1547.2, 1547.3; NRECA guide to 1547.

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J. Notes

Please present here any additional information about the standard that might be useful:

1. IEEE 1547 series of standards are primarily written in terms of functional technical requirements and specifications: 1547 standards are primarily technology neutral being cognizant of certain differing technology functional attributes, e.g., synchronous, induction and inverter-based machines. IEEE P2030 series addresses multiple topics in Section II of this form.

Section II: Functional Description of the Standard

K. GridWise Architecture: Layers

Please identify which layers this standard specifies, as described in

http://www.gridwiseac.org/pdfs/interopframework_v1_1.pdf, and the applicable section of the standard. Note the mapping to the Open Systems Interconnect (OSI) model is approximate.

1.	Layer 8: Policy	<input type="checkbox"/> Yes <input type="checkbox"/> No #####
2.	Layer 7: Business Objectives	<input type="checkbox"/> Yes <input type="checkbox"/> No #####
3.	Layer 6: Business Procedures	<input type="checkbox"/> Yes <input type="checkbox"/> No #####
4.	Layer 5: Business Context	<input type="checkbox"/> Yes <input type="checkbox"/> No #####
5.	Layer 4: Semantic Understanding (object model)	<input type="checkbox"/> Yes <input type="checkbox"/> No #####
6.	Layer 3: Syntactic Interoperability (OSI layers 5-7)	<input type="checkbox"/> Yes <input type="checkbox"/> No #####
7.	Layer 2: Network Interoperability (OSI layers 3-4)	<input type="checkbox"/> Yes <input type="checkbox"/> No #####
8.	Layer 1: Basic Connectivity (OSI layers 1-2)	<input type="checkbox"/> Yes <input type="checkbox"/> No #####

L. GridWise Architecture: Cross-Cutting Issues

Please provide an explanation in the box beside the heading for any questions answered "Not applicable". If the question is not applicable because the function is provided in another layer or standard, please suggest any likely candidates. Note that "the standard" refers to the technology specified by the standard, not the documents themselves.

	Shared Meaning of Content	#####
1.	Do all implementations share a common information model?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
2.	Can data be arranged and accessed in groups or structures?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
3.	Can implementers extend the information model?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
4.	Can implementers use a subset of the information model?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
	Resource Identification	#####
5.	Can data be located using human-readable names?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
6.	Can names and addresses be centrally managed without human intervention?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
	Time Synchronization and Sequencing	#####
7.	Can the standard remotely synchronize time?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Provided in another layer
8.	Can the standard indicate the quality of timestamps?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Provided in another layer
	Security and Privacy	#####
9.	Where is security provided for this standard?	<input type="checkbox"/> Within this standard <input type="checkbox"/> By other standards
10.	Does the standard provide authentication?	<input type="checkbox"/> Yes <input type="checkbox"/> No
11.	Does the standard permit role-based access control?	<input type="checkbox"/> Yes <input type="checkbox"/> No

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12.	Does the standard provide encryption?	<input type="checkbox"/> Yes <input type="checkbox"/> No
13.	Does the standard detect intrusions or attacks?	<input type="checkbox"/> Yes <input type="checkbox"/> No
14.	Does the standard facilitate logging and auditing of security events?	<input type="checkbox"/> Yes <input type="checkbox"/> No
15.	Can the security credentials be upgraded remotely?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> No Credentials
16.	Can the security credentials be managed centrally?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> No Credentials
17.	Please list any security algorithms and standards used	#####
18.	Please provide additional information on how the standard addresses any "Yes" answers above	#####
19.	Please provide additional information about why any of the questions listed above do not apply to this standard	#####
Logging and Auditing		#####
20.	Does the standard facilitate logging and auditing of critical operations and events?	<input type="checkbox"/> Yes <input type="checkbox"/> No
21.	Can the standard gather statistics on its operation?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
22.	Can the standard report alerts and warnings?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
Transaction State Management		#####
23.	Can the standard remotely enable or disable devices or functions?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
System Preservation		#####
24.	Can the standard automatically recover from failed devices or links?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable <input type="checkbox"/> Provided in another layer
25.	Can the standard automatically re-route messages?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable <input type="checkbox"/> Provided in another layer
26.	Can the standard remotely determine the health (as opposed to just connectivity) of devices or software?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
Other Management Capabilities		
27.	Please describe any other system or network management capabilities the standard provides.	#####
Quality of Service		#####
28.	Is data transfer bi-directional?	<input type="checkbox"/> Yes <input type="checkbox"/> No
29.	Can data be prioritized?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
30.	What types of reliability are provided?	<input type="checkbox"/> Reliable <input type="checkbox"/> Non-guaranteed <input type="checkbox"/> Both <input type="checkbox"/> Either <input type="checkbox"/> Provided in another layer
31.	Can information be broadcast to many locations with a single transmission?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
32.	Please describe any other methods the standard uses to manage quality of service.	#####
Discovery and Configuration		#####
33.	Can the software or firmware be upgraded remotely?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable

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34.	Can configuration or settings be upgraded remotely?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
35.	Can implementations announce when they have joined the system?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
36.	Can implementations electronically describe the data they provide?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not applicable
System Evolution and Scalability		#####
37.	What factors could limit the number of places the standard could be applied?	It is generally recognized that a major obstacle that precludes high penetration of distributed renewable energy resources is the lack low voltage ride through and controllable trip point specifications in interconnection standards.
38.	What steps are required to increase the size of a system deploying this standard?	The 1547.8 Standard may provided enhance resiliency of the Electric Power System particularly in a high penetration level scenario for renewable energy by providing low voltage ride through and controllable trip point specifications as well as other grid support functions which enhance the EPS operational support value of the DER devices.
39.	Is the information model separate from the transport method?	<input type="checkbox"/> Yes <input type="checkbox"/> No
40.	Does the standard support alternate choices in the layers(s) below it?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> No layers below
41.	List the most common technology choices for layers implemented below this standard	#####
42.	Does the standard support multiple technology choices in the layers above it?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> No layers above
43.	List the technologies or entities that would most commonly use this standard in the layer above	#####
44.	Please describe any mechanism or plan to ensure the standard is as backward-compatible as possible with previous versions	#####
45.	Please describe how the design of this standard permits it to be used together with older or legacy technologies	#####
46.	Please describe how the design of this standard permits it to co-exist on the same network or in the same geographic area with similar technologies, and give examples	#####
47.	Electromechanical	#####
M. Architectural Principles		
Please describe how this standard may apply any of these principles:		
1.	Symmetry – facilitates bi-directional flow of energy and information	#####

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2.	Transparency – supports a transparent and auditable chain of transactions	#####
3.	Composition – facilitates the building of complex interfaces from simpler ones	#####
4.	Loose coupling – can support bilateral and multilateral transactions without elaborate pre-arrangement	#####
5.	Shallow integration – does not require detailed mutual information to interact with other components	#####
6.	Please list any other architectural models, reference architectures or frameworks this standard was designed to be compliant with, e.g. W3C, IEC TC57, OSI and how it fits those models	#####