Smart Grid Standards Information

Version 1.6
Monday, April 5, 2010

Section I: Use and Application of the Standard

A. Identification and Affiliation

1.	Number of the standard	ANSI/ASHRAE 135-2008/ISO 16484-5
2.	Title of the standard	BACnet - A Data Communication Protocol for Building Automation and Control Networks
3.	Name of owner organization	ASHRAE
4.	Latest versions, stages, dates	This standard is in a continuous maintenance process that results in a series of addenda being published and then periodically consolidated into a new version. Latest consolidated version: 2008 Most recent addendum: January 2010
5.	URL(s) for the standard	http://www.ashrae.org/technology/page/548 http://www.bacnet.org/ http://bacnetassociation.org/
6.	Working group / committee	ASHRAE SSPC 135, ISO TC 205
7.	Original source of the content (if applicable)	
8.	Brief description of scope	This standard defines a data communication protocol for building automation and control networks. It applies to a comprehensive set of building system operations including HVAC control, lighting control, physical access control, and energy management. It defines an object-oriented information model and application services that are transmitted over a variety of local and wide area networking technologies.

B. Level of Standardization

1.	Names of standards development organizations that recognize this standard and/or accredit the owner organization	ANSI, ISO, CEN, and over thirty individual countries around the world.
2.	Has this standard been adopted in regulation or legislation, or is it under consideration for adoption?	☐ Yes ☒ No

Section I: Use and Application of the Standard

3.	Has it been endorsed or recommended by any level of government? If "Yes", please describe	☒ Yes ☐ No Various municipalities and school districts have adopted it for use in all of their building. Individual federal civil and military agencies have adopted it for their facilities.
4.	Level of Standard (check all that apply)	☒International ☒National ☒Industry ☐de Facto ☐ Single Company
5.	Type of document	☒Standard ☐ Report ☐ Guide ☐ Technical Specification
6.	Level of Release	☒ Released ☐ In Development ☐ Proposed

C. Areas of Use

1.	Currently used in which domains? (check all that apply)	☐ Markets ☐ Operations ☐ Service Providers ☐ Generation ☐ Transmission ☐ Distribution ☒ Customer
2.	Planned for use in which domains? (check all that apply)	☐ Markets ☐ Operations ☐Service Providers ☐ Generation ☐ Transmission ☐ Distribution ☒ Customer
3.	Please describe the Smart Grid systems and equipment to which this standard is applied	Applies broadly to the control and energy efficiency of building equipment operations. It is also applicable to control of on-site generation equipment. The technology is suited to buildings of all sizes and for residential applications. Commercial products are widely available today for commercial, industrial, and institutional buildings but not for single family residences.

D. Relationship to Other Standards or Specifications

1.	Which standards or specifications are referenced by this standard?	A number of national and international local and wide area networking standards FIPS data encryption and security standards
2.	Which standards or specifications are related to this standard?	ANSI/ASHRAE 135.1 (ISO-16484-6) Method of Test for Conformance to BACnet ASHRAE Guideline 13 Specifying Direct Digital Control Systems Various guidelines related to ISO-certified conformance testing of BACnet products
3.	Which standards or specifications cover similar areas (may overlap)?	Lonmark International profile guidelines for building applications Various home automation networking standards in development

Section I: Use and Application of the Standard

4.	What activities are building on this work?	#####

E. Dept of Energy Smart Grid Characteristics

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

1.	Enables informed participation by customers	☒ Yes ☐ No #####
2.	Accommodates all generation and storage options	☒ Yes ☐ No #####
3.	Enables new products, services and markets	☒ Yes ☐ No #####
4.	Provides the power quality for a range of needs	☐ Yes ☒ No #####
5.	Optimizes asset utilization and operating efficiency	☒ Yes ☐ No Optimizes energy efficiency of customer operations, not utility operations
6.	Operates resiliently to disturbances, attacks, and natural disasters	☒ Yes ☐ No In multi-building systems loss of connectivity between buildings does not prevent each building from continuing to operating independently. Within a building control is distributed and individual controllers can operate with degraded performance if connectivity is lost.

F. Priority Areas Previously Mentioned by FERC and NIST

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.	Cybersecurity and physical security	☒ Yes ☐ No #####
2.	Communicating and coordinating across inter-system interfaces	☒ Yes ☐ No #####
3.	Wide area situational awareness	☐ Yes ☒ No #####
4.	Electric storage	☐ Yes ☒ No Has the potential to control electric storage systems in buildings but not at the utility level.
5.	Electric vehicle transportation	☒ Yes ☐ No The transportation impact would be in controlling charging stations connected to buildings and parking lots.
6.	Advanced metering infrastructure	☒ Yes ☐ No Applies to building response to advanced metering information
7.	Distribution grid management	☐ Yes ☒ No #####

Section I: Use and Application of the Standard

G. Openness

1.	Amount of fee (if any) for the documentation	Approximately $100.
2.	Amount of fee (if any) for implementing the standard	None
3.	Amount of fee (if any) to participate in updating the standard	None
4.	Is the standard documentation available online?	☒ Yes ☐ No http://www.ashrae.org/publications/page/1285 URL
5.	Are there open-source or reference implementations?	☒ Yes ☐ No
6.	Are there open-source test tools?	☒ Yes ☐ No
7.	Would open-source implementations be permitted?	☒ Yes ☐ No
8.	Approximately how many implementers are there?	420
9.	Approximately how many users are there?	Hundreds of thousands
10.	Where is the standard used outside of the USA?	The standard is used in over 80 countries and on every continent.
11.	Is the standard free of references to patented technology?	☒ Yes ☐ No
12.	If patented technology is used, does the holder provide a royalty-free license to users of the standard?	☐ Yes ☐ No ☒ Not Patented
13.	Can an implementer use the standard without signing a license agreement?	☒ Yes ☐ No
14.	Are draft documents available to the public at no cost?	☒ Yes ☐ No
15.	How does one join the working group or committee that controls the standard?	All meetings are publicly announced and open to any interested party. Applications to become a voting member are available online from ASHRAE.
16.	Is voting used to decide whether to modify the standard? If Yes, explain who is permitted to vote.	☒ Yes ☐ No A standing committee meeting ANSI balance requirements is maintained for this purpose.
17.	Is an ANSI-accredited process used to develop the standard?	☒ Yes ☐ No
18.	What countries are represented in the working group or committee that controls the standard?	Australia, Austria, Belgium, Canada, Finland, France, Germany, Japan, Korea, Norway, Russia, Sweden, Switzerland, United States,

H. Support, Conformance, Certification and Testing

1.	Is there a users group or manufacturers group to support this standard?	☒ Yes ☐ No

Section I: Use and Application of the Standard

2.	What is the name of the users group or manufacturers group (if any)?	BACnet France BACnet International BACnet Interest Group AustralAsia BACnet Interest Group China BACnet Interest Group Europe BACnet Interest Group Finland BACnet Interest Group Middle East BACnet Interest Group Poland BACnet Interest Group Russia BACnet Interest Group Sweden
3.	What type of test procedures are used to test this standard? (please check all that apply)	☐ Internal to the lab ☒ Published by standards organization ☒ Published by users group ☐ No procedures, informal testing
4.	Are there test vectors (pre-prepared data) used in testing? (please check all that apply)	☐ Internal to the lab ☒ Published by standards organization ☒ Published by users group ☐ No procedures, informal testing
5.	What types of testing programs exist? (check all that apply)	☒ Interoperability Testing ☒ Conformance Testing ☐ Security Testing ☐ No Testing
6.	What types of certificates are issued? (check all that apply)	☐ Interoperability Certificate ☒ Conformance Certificate ☐ Security Certificate (text document) ☐ No Certificates
7.	Are there rules controlling how and when to use the logo?	☒ Yes ☐ No ☐ Standard has no logo
8.	Is there a program to approve test labs?	☒ Yes ☐ No
9.	Approximately how many test labs are approved (if any)?	Two
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?	☒ Yes ☐ No
11.	Is there a published conformance checklist or table?	☒ Yes ☐ No
12.	Are there defined conformance blocks or subsets?	☒ Yes ☐ No
13.	Approximately how many vendors provide test tools?	One commercial tool and one open source tool are available.
14.	Are there tools for pre-certification prior to testing?	☒ Yes ☐ No
15.	Can vendors self-certify their implementations?	☐ Yes ☒ No
16.	Is there application testing for specific uses?	☒ Yes ☐ No ☐ Not applicable
17.	Is there a "golden" or "reference" implementation to test against?	☐ Yes ☒ No There are open source implementations that can be used to test against but they have no specially designated reference status.

Section I: Use and Application of the Standard

18.	Who typically funds the testing? (check all that apply)	☐ User ☐ Users Group ☒ Vendor ☐ Confidential
19.	Is there a method for users and implementers to ask questions about the standard and have them answered? (check all that apply)	☒ Yes, official interpretations ☒ Yes, informal opinions ☐ No
20.	Does the users' group (or some other group) fund specific tasks in the evolution of the standard?	☒ Yes ☐ No
21.	Is the users' group working on integration, harmonization or unification with other similar standards?	☐ Yes ☒ No
22.	What other standards is this standard being integrated, harmonized, or unified with (if any)?	#####
23.	Are there application notes, implementation agreements, or guidelines available describing specific uses of the standard?	☒ Yes ☐ No ☐ Not applicable

Section I: Use and Application of the Standard

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

1.	Every major manufacturer of building automation and control systems in the world and the overwhelming majority of smaller ones makes BACnet products. In recent years there has been explosive growth in the number of companies who offer BACnet controls packaged with specific building equipment ready for integration into a control system even though these companies do not themselves make control systems. Operating BACnet systems range in size from very small single building systems to large campuses of buildings or buildings owned by a single entity that are integrated but are geographically separated. For example, the United States General Services Administration has an integrated BACnet system that links almost all federal buildings and court houses in California, Arizona, Nevada and Hawaii in a single BACnet system.

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**	☐ Yes ☒ No #####
2.	**Layer 7: Business Objectives**	☐ Yes ☒ No #####
3.	**Layer 6: Business Procedures**	☐ Yes ☒ No #####
4.	**Layer 5: Business Context**	☒ Yes ☐ No #####
5.	**Layer 4: Semantic Understanding (object model)**	☒ Yes ☐ No #####
6.	**Layer 3: Syntactic Interoperability (OSI layers 5-7)**	☒ Yes ☐ No #####
7.	**Layer 2: Network Interoperability (OSI layers 3-4)**	☒ Yes ☐ No #####
8.	**Layer 1: Basic Connectivity (OSI layers 1-2)**	☒ Yes ☐ 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?	☒ Yes ☐ No ☐ Not applicable
2.	Can data be arranged and accessed in groups or structures?	☒ Yes ☐ No ☐ Not applicable
3.	Can implementers extend the information model?	☒ Yes ☐ No ☐ Not applicable
4.	Can implementers use a subset of the information model?	☒ Yes ☐ No ☐ Not applicable
	Resource Identification	#####
5.	Can data be located using human-readable names?	☒ Yes ☐ No ☐ Not applicable
6.	Can names and addresses be centrally managed without human intervention?	☐ Yes ☒ No ☐ Not applicable
	Time Synchronization and Sequencing	#####
7.	Can the standard remotely synchronize time?	☒ Yes ☐ No ☐ Provided in another layer
8.	Can the standard indicate the quality of timestamps?	☐ Yes ☒ No ☐ Provided in another layer
	Security and Privacy	#####
9.	Where is security provided for this standard?	☒ Within this standard ☒ By other standards
10.	Does the standard provide authentication?	☒ Yes ☐ No
11.	Does the standard permit role-based access control?	☒ Yes ☐ No
12.	Does the standard provide encryption?	☒ Yes ☐ No

Section II: Functional Description of the Standard

13.	Does the standard detect intrusions or attacks?	☒ Yes ☐ No
14.	Does the standard facilitate logging and auditing of security events?	☒ Yes ☐ No The alarm and logging features in the standard apply to physical security events but not network security events. The most common backbone network for a BACnet system is Ethernet/IP. Network security tools not defined in this standard apply in that case.
15.	Can the security credentials be upgraded remotely?	☒ Yes ☐ No ☐ No Credentials
16.	Can the security credentials be managed centrally?	☒ Yes ☐ No ☐ No Credentials
17.	Please list any security algorithms and standards used	AES, SHA256, MD5/HMAC
18.	Please provide additional information on how the standard addresses any "Yes" answers above	See Addendum g to BACnet 2008
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?	☒ Yes ☐ No
21.	Can the standard gather statistics on its operation?	☐ Yes ☒ No ☐ Not applicable Open source protocol analyzer tools with the ability to gather statistics are available but the standard has no features specifically for this purpose.
22.	Can the standard report alerts and warnings?	☒ Yes ☐ No ☐ Not applicable
	Transaction State Management	#####
23.	Can the standard remotely enable or disable devices or functions?	☒ Yes ☐ No ☐ Not applicable
	System Preservation	#####
24.	Can the standard automatically recover from failed devices or links?	☒ Yes ☐ No ☐ Not applicable ☐ Provided in another layer The ability to recover from failures is limited to portions of the system that use IP networks or special hardware that is not required by the standard and is typically only used where required by building codes (e.g. fire alarm systems)
25.	Can the standard automatically re-route messages?	☒ Yes ☐ No ☐ Not applicable ☐ Provided in another layer This re-routing ability only applies to backbone networks that use BACnet/IP. For most device level networks the standard constrains the topology to a single path.
26.	Can the standard remotely determine the health (as opposed to just connectivity) of devices or software?	☒ Yes ☐ No ☐ Not applicable
	Other Management Capabilities	

Section II: Functional Description of the Standard

27.	Please describe any other system or network management capabilities the standard provides.	Vendor independent backup and restore functions Automated object discovery and binding tools
	Quality of Service	#####
28.	Is data transfer bi-directional?	☒ Yes ☐ No
29.	Can data be prioritized?	☒ Yes ☐ No ☐ Not applicable Prioritization applies only to limited circumstances such as alarm and event notification processing and routers.
30.	What types of reliability are provided?	☐ Reliable ☐ Non-guaranteed ☒ Both ☐ Either ☐ Provided in another layer
31.	Can information be broadcast to many locations with a single transmission?	☒ Yes ☐ No ☐ 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?	☒ Yes ☐ No ☐ Not applicable
34.	Can configuration or settings be upgraded remotely?	☒ Yes ☐ No ☐ Not applicable
35.	Can implementations announce when they have joined the system?	☒ Yes ☐ No ☐ Not applicable
36.	Can implementations electronically describe the data they provide?	☒ Yes ☐ No ☐ Not applicable
	System Evolution and Scalability	#####
37.	What factors could limit the number of places the standard could be applied?	Cost Configuration complexity of current products requires skilled installation personnel
38.	What steps are required to increase the size of a system deploying this standard?	Prior planning for management of addresses and name space is needed. Adequate documentation of an existing system is needed in order to add new devices that interoperate.
39.	Is the information model separate from the transport method?	☒ Yes ☐ No
40.	Does the standard support alternate choices in the layers(s) below it?	☐ Yes ☐ No ☒ No layers below Alternate physical layers are supported in the standard
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?	☐ Yes ☐ No ☒ No layers above
43.	List the technologies or entities that would most commonly use this standard in the layer above	#####

Section II: Functional Description of the Standard

44.	Please describe any mechanism or plan to ensure the standard is as backward-compatible as possible with previous versions	The standard contains built-in version control mechanisms. It is common to have a systems made up of products that support different versions of the standard. The standing committee that oversees maintenance of the standard is very attentive to the need for backward compatibility. Almost all revisions to the standard since it inception have added new functionality without any adverse impact on the functionality found in prior versions.
45.	Please describe how the design of this standard permits it to be used together with older or legacy technologies	The principal application functionality is based on the use of standard objects through access to, and manipulation of, their properties. Services to discover, read, and write these properties are general and do not change when adding new functionality. The addition of new standard object types or even new services does not break the functionality of previous versions. Each device is required to contain protocol version information and detailed information about which features of the standard are implemented. This data is network visible and enables other devices to determine how to best interoperate.
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	BACnet systems are typically internetworks that are characterized by a high-speed, high-bandwidth backbone network with routers to lower performance networks that connect application or device specific controllers. Backbone networks are almost always Ethernet or BACnet/IP over Ethernet. BACnet has internationally registered protocol identifiers that make it compatible with any other protocol conveyed by either Ethernet or IP networks. The application or device specific networks are not shared with non-BACnet devices.
47.	**Electromechanical**	#####

M. Architectural Principles
Please describe how this standard may apply any of these principles:

Section II: Functional Description of the Standard

1.	Symmetry – facilitates bi-directional flow of energy and information	BACnet devices are generally peer-to-peer and without restriction on the direction of information flow. The standard does permit the use of a master-slave arrangement for on particular device level network but this option is not commonly used and would not impact communication with the electrical grid.
2.	Transparency – supports a transparent and auditable chain of transactions	There are alarm and even logging mechanisms built into the standard. These are designed to meet building operational needs and are unrelated to commercial transactions. User workstations sometimes have the ability to log configuration changes an operator actions.
3.	Composition – facilitates the building of complex interfaces from simpler ones	#####
4.	Loose coupling – can support bilateral and multilateral transactions without elaborate pre-arrangement	BACnet does not constrain who can be a communicating partner. BACnet devices can respond to any other BACnet device, even one which was unknown when the transaction began. There are mechanisms for unicast, broadcast, and limited multicast messages.
5.	Shallow integration – does not require detailed mutual information to interact with other components	BACnet has auto discovery features that enable a device to find the information it is looking for and to find and bind with a desired communication partner. Once a device is located all of its protocol capabilities become network visible.
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	BACnet is based on the OSI architecture implementing a collapsed stack made up of layers 1,2,3, and 7. It also supports web service interfaces.