

The image features a complex background with a grid pattern, a large white circle, and a green-tinted photograph of skyscrapers. The Siemens logo is prominently displayed in the top left corner.

SIEMENS

Building Technologies

BACnet[®]

Information Guide

A reference guide on
"Building Automation Control Network"
protocol standards.

Table of Contents

BACnet Basics	4
Network Types	5
Devices	6
Objects	7
Properties	8
Services	9
Interoperability Areas	11
Data Sharing	11
Trending	13
Scheduling	13
Alarm & Event Management	13
Device & Network Management	13
BACnet Specifications	15
Protocol Implementation and Conformance Statement (PICS)	17
BACnet Interoperability Building Blocks (BIBBs)	21
BACnet Certification	25
BACnet Terminology	27

SIEMENS

Building Technologies



BACnet Basics

- Network Types
- Devices
- Objects
- Properties
- Services

BACnet Basics

TIP!

Think of BACnet protocol terms in HVAC terms:

Device = *Controller or PC*

Network type = *Physical communication method (i.e., Ethernet)*

Object = *Information point (i.e., temperature reading, flow setpoint or equipment schedule)*

Service = *Request for information or fulfill change to information (read a temperature, change a flow setpoint, edit an equipment schedule, send an alarm)*

BACnet®, short for “Building Automation Control Network,” is a protocol standard approved as the ANSI/ASHRAE/ISO Standard 135-2004. The protocol defines a model for building automation systems, describing the interaction between devices and systems. The protocol model specifically defines:

- Data and control functions structured in an object-oriented fashion
- Services that describe data requests and responses
- Network datalink types
- A scalable and flexible internetwork and network architecture

The functionality defined in the BACnet protocol may be summarized as these terms: transport network types, devices, objects, services, and properties. These terms are defined in the following sections.

BACnet Basics

TIP!

Think of the network types as different transportation methods for the same message, like delivering a letter via airplane, train, or automobile.

Network Types

The 2004 BACnet Standard defines six network types, which serve as the transport for BACnet messages. The network types encompass the physical and datalink layers of the protocol. A BACnet message itself is independent of the physical and datalink layer used to transport the message. Therefore, messages in BACnet to command or monitor information are the same, no matter the physical or datalink layer used for transport. The six supported network types are:

- BACnet ARCnet
- BACnet ISO 8802-3 (Ethernet)
- BACnet LonTalk
- BACnet MS/TP (Master-Slave/Token Passing)
- BACnet Point-to-Point (EIA-232)
- BACnet/IP

A BACnet router is used to join multiple network types. A BACnet router is a protocol message routing device that links dissimilar network types (i.e., Ethernet to EIA-485, or EIA-485 to EIA-232) and passes BACnet messages among the dissimilar network types without changing or disturbing the message contents.

BACnet Basics

Devices

A BACnet device is a microprocessor-based unit that is designed to understand and use the BACnet protocol. A BACnet device is typically a controller, gateway, or user interface. A BACnet device contains a collection of information about the device called objects and properties.

A BACnet device will contain a device object that defines certain device information, including the device object identifier or instance number. A BACnet device object instance number must be unique across the entire BACnet network.

BACnet Basics

TIP!

Objects and Properties are similar in concept to folders and documents in a PC. Think of an object as a folder containing documents describing the information in the folder. The folder is the object, and the documents describing the folder are the properties.

Objects

A BACnet object is a collection of information within a device. Objects represent either physical or virtual information, such as analog and digital inputs and outputs, control algorithms, specific applications, and calculations. Objects also may represent single pieces of information, or a collection of multiple pieces of information such as a logical grouping.

The current BACnet standard defines 25 standard object types for which a vendor device may be able to provide interoperability, if implemented correctly. The BACnet standard also allows for the creation of non-standard or proprietary objects for which interoperability with other vendors will typically not be available.

Objects will always be associated with object identifiers. Object identifiers are a 32-bit binary number containing a code for the object type and the object instance number.

Every object, no matter its purpose or function, has a collection of properties that define the object.

BACnet Basics

Properties

A BACnet property conveys information about a BACnet object. A typical object has an extensive collection of properties, based on the function and purpose of the object. Each property contains two pieces of information—a property name or identifier and the property's value.

Properties may be defined as read-only or read/write. A property's purpose is to allow other BACnet devices to read information about the object containing the property, and potentially command a different value to the property. Depending on the type of object that the property resides in, particular object properties may be optional or required for implementation per the BACnet standard. Objects may also contain properties that are non-standard or proprietary.

Properties are identified using property identifiers. These property identifiers are enumeration codes that represent a given property. The BACnet standard defines 192 property identifiers.

A BACnet object will have required and optional properties, as well as properties that are read-only or read/write, depending on the type of object and its function. In order for actions to be taken on objects and properties, such as read or write, services are defined within BACnet.

BACnet Basics

TIP!

Services act like the action verb in the BACnet protocol. Services ask for an action to take place, like a read temperature request or a write to setpoint request.

Services

BACnet services are actions that a BACnet device takes to read or write to another BACnet device. Services are grouped into five categories of functionality – object access (read, write, create, delete); device management (discover, time synchronization, initialize, backup and restore database); alarm and event (alarms and changes of state); file transfer (trend data, program transfer); and virtual terminal (human machine interface via prompts and menus).

SIEMENS

Building Technologies



Interoperability Areas

- Data Sharing
- Trending
- Scheduling
- Alarm & Event Management
- Device & Network Management

Interoperability Areas

Q&A

Q:

Can vendor "X" BACnet device talk directly to vendor "Y" BACnet device?

A:

It depends on the network type supported by both devices, and the functionality supported by both devices. Refer to and compare the PICS and the BIBBs of both devices. Only those areas in common are areas of possible interoperability.

Using the concepts of devices, objects, properties, and services, BACnet provides functional capabilities referred to as "Interoperability Areas." Interoperability Areas are composed of the following: Data Sharing, Trending, Scheduling, Alarm & Event Management, and Device & Network Management. These Interoperability Areas are aligned with the BACnet Interoperability Building Blocks (BIBBs), which are discussed later in the BACnet Specification section.

Data Sharing

Data Sharing is the exchange of data between BACnet devices for the purpose of data collection and monitoring, as well as commanding. In Data Sharing, a client device requests a server device for data, and may also send commands to the server. Typical Data Sharing requests that a client will make to a server are *read property request* and *write property request*.

A *write property request* will allow a client device to write to the property of a server device. In situations where there is a command priority array, a write property request will be a command accompanied by a command priority. Otherwise, a write property request without a command priority array is simply a write to a property. Commands are sent in one of 16 command priorities defined in the BACnet standard.

Interoperability Areas

When a command is sent, it takes effect only if it is the highest command priority (lowest number) currently in the command priority array for that property. If the command has a lower priority than a current command, it takes its place in the command priority array and will take effect only when higher command priorities are relinquished. The command priorities are illustrated in the table below.

Example: Write requests are sent with an accompanying priority if they are commands.

12

A command priority will determine whether the command takes effect right away, or is stored in the command priority queue until the higher priority command is no longer in effect. For example, an operator commands a temperature setpoint at "Manual Operator" priority #8. The command is sent to the object, and the command priority sent is compared with its current command priorities in effect and in queue. If a command priority of "Critical Equipment" priority #5 is currently in effect, then the priority #8 must wait until the current priority is no longer in effect. By contrast, if an object under "Default" priority #16 receives the "Manual Operator" priority, then the new command takes effect, since #8 is a higher priority than #16.

Priority	BACnet Priority
1	Manual Life-Safety
2	Automatic Life-Safety
3	Available
4	Available
5	Critical Equipment Control
6	Minimum On/Off
7	Available
8	Manual Operator
9	Available
10	Available
11	Available
12	Available
13	Available
14	Available
15	Available
16	Available (Default)

Interoperability Areas

Trending

Trending allows BACnet devices to enable trend collection and request trend data from other BACnet devices.

Scheduling

Scheduling allows BACnet devices to establish and edit schedules in BACnet devices so that control can be coordinated based on dates and times.

Alarm & Event Management

Alarm & Event Management defines the exchange of data based on pre-defined alarm limits or event triggers. The event or alarm may require human intervention and acknowledgement. Alarms and events may also be logged and summaries generated.

Device & Network Management

Device & Network Management consists of the establishment and exchange of operational characteristics. It allows BACnet devices to discover other BACnet devices, discover objects within devices, establish and re-establish communications, synchronize time, and re-initialize a device's program.

SIEMENS

Building Technologies



BACnet Specifications

- Protocol Implementation and Conformance Statement (PICS)
- BACnet Interoperability Building Blocks (BIBBs)

BACnet Specifications

TIP!

You will often see specification language saying, "Device shall comply with ANSI/ASHRAE Standard 135-2004 [or the outdated 135-1995 or 135-2001] BACnet standard."

This request is difficult to interpret or prove because the BACnet standard is purposely designed to be very broad in scope. More appropriate language could be "Device shall use the ANSI/ASHRAE Standard 135-2004 BACnet standard for communications and has passed BTL certification as available."

Specifying BACnet is challenging because the protocol purposely defines more functionality than any particular device will likely implement, and devices can vary greatly in their implementation of BACnet and BACnet functionality. Therefore, a format was devised to disclose BACnet information such that vendors, customers and consulting engineers could understand the functionality implemented in a given device and determine realistic expectations for interoperability between any given BACnet devices.

The Protocol Implementation and Conformance Statement (PICS) was derived and incorporated into the 1995 BACnet standard. The PICS provides a format for disclosing key BACnet information regarding devices.

Originally, in the 1995 BACnet standard, conformance classes were defined in the PICS with the thought that these classes could simplify the understanding of device conformance to the BACnet standard and assist in specifications development.

BACnet Specifications

However, it was quickly realized that the conformance classes fell short of their intended purpose and, in fact, caused confusion among consulting engineers and customers. Thus, the conformance classes were dropped in the 2001 BACnet standard in favor of the currently accepted approach — BACnet Interoperability Building Blocks (BIBBs) as defined in Addendum D of the BACnet standard. BIBBs define sets and groupings of functionality that can be easily mapped from device to device, to determine the functionality that is likely interoperable between devices.

BACnet Specifications

Protocol Implementation and Conformance Statement (PICS)

The PICS is the most effective and useful tool for consulting engineers, vendors and customers to determine the BACnet implementation of a given device. The PICS is generally provided in a format that is common among vendors (format is specified in Annex A of the ASHRAE standard). It is a useful tool when comparing BACnet devices among various vendors to determine functionality and interoperability. The PICS may be used to determine what functionality devices are capable of supporting and what functionality is interoperable with other devices.

The PICS discloses the following areas of information about a BACnet device:

- Product name, version, and description
- Device profile (Annex L) to which the device conforms
 - *B-OWS (BACnet Operator Workstation)*
 - *B-BC (BACnet Building Controller)*
 - *B-AAC (BACnet Advanced Application Controller)*
 - *B-ASC (BACnet Application Specific Controller)*
 - *B-SS (BACnet Smart Sensor)*
 - *B-SA (BACnet Smart Actuator)*

BACnet Specifications

- BIBBs supported by the device
 - *Data Sharing*
 - *Scheduling*
 - *Trending*
 - *Network Management*
 - *Alarm and Event*
 - *Device Management*
- Segmentation support and window size
- Standard object types supported, plus an indication of objects that can be created and deleted by a third-party BACnet system/device
 - *Analog Input, Output, Value*
 - *Averaging*
 - *Binary Input, Output, Value*
 - *Calendar*
 - *Command*
 - *Device*
 - *Event Enrollment*
 - *File*
 - *Group*
 - *Life Safety Point, Zone*
 - *Loop*
 - *Multi-State Input, Output, Value*

BACnet Specifications

- *Notification Class*
 - *Program*
 - *Schedule*
 - *Trend Log*
 - *Proprietary*
- Datalink and physical network layers support
 - *BACnet/IP (Annex J)*
 - *BACnet Ethernet (10Base 2, 10Base 5, 10Base T, Fiber)*
 - *BACnet ARCnet*
 - *BACnet MS/TP (EIA-485 Master-Slave/Token Passing)*
 - *BACnet Point-To-Point (EIA-232)*
 - *BACnet LonTalk*
- Device address binding support
- Networking datalink options support
 - *Router*
 - *BACnet Tunneling (Annex H)*
 - *BACnet/IP BBMD (BACnet Broadcast Management Device)*
 - *BACnet/IP Foreign Device*

BACnet Specifications

- Character sets support
 - ANSI X3.4
 - ISO 10646 (ICS-4)
 - IBM/Microsoft DBCS
 - ISO 10646 (UCS2)
 - JIS C 6226
 - ISO 8859-1

BACnet Specifications

BACnet Interoperability Building Blocks (BIBBs)

The adoption of Addendum D in the BACnet standard, which superseded the conformance classes in the 1995 standard, allowed BIBBs (Annex K) to become the point of functional comparison with BACnet devices. BIBBs provide a logical method for disclosure of BACnet device support for all of the BACnet interoperability areas.

Interoperability functions can be grouped into six categories or areas:

- Data Sharing
 - *Read/write property*
 - *Read/write multiple properties*
 - *Read property conditional*
 - *COV (Change of Value)*
 - *Unsolicited COV*
- Scheduling
 - *Scheduling - internal*
 - *Scheduling - external*
- Trending
 - *Viewing and modifying trends - internal*
 - *Viewing and modifying trends - external*
 - *Automated trend retrieval*

BACnet Specifications

- Network Management
 - *Device connection establishment*
 - *Router configuration*
- Alarm and Event Management
 - *Alarm and event notification - internal*
 - *Alarm and event notification - external*
 - *Alarm acknowledgement*
 - *Alarm summary*
 - *Alarm enrollment summary*
 - *Alarm information*
 - *Life safety alarm*
- Device Management
 - *Device binding - discovery and connection*
 - *Object binding - discovery and connection*
 - *Device communication control*
 - *Private transfer of message*
 - *Text message*
 - *Time synchronization*
 - *UTC time synchronization*
 - *Reinitialize device communications*
 - *Backup and restore device database*
 - *List manipulation*

BACnet Specifications

- Device Management (continued)
 - *Object creation and deletion*
 - *Virtual terminal*

Each BIBB is illustrated with an A or B in terms of prescribed functional support. Definitions of A and B support are as follows:

- *A: User of data as a client - initiate function*
- *B: Provider of data as a server -execute function*

Achieving interoperability between two or more BACnet devices requires support in the device acting as the user of data for the A type functionality, and support in the provider of the data for the B type of functionality. All devices expected to be interoperable must support the function required (BIBB) and the "Initiate" or "Execute" side of the functionality, depending on the role of the device.

SIEMENS

Building Technologies



BACnet Certification

BACnet Certification



The BACnet Manufacturers Association (BMA) created an organization to address interoperability testing and certification services for manufacturers of BACnet devices. This organization is called the BACnet Testing Laboratories, or BTL.

The organization has two main tasks:

- To sponsor the annual BACnet Interoperability Workshop
- To develop testing procedures and rules to certify BACnet devices as conforming to the BACnet standard with the goal of obtaining the BTL certification mark

SIEMENS

Building Technologies



BACnet Terminology

BACnet Terminology

Term	Definition
ANSI	<i>American National Standards Institute</i>
ASHRAE	<i>American Society of Heating, Refrigeration, and Air Conditioning Engineers</i>
Analog	A variable number used to measure a continuously varying entity, such as pressure or temperature.
BACnet	ANSI/ASHRAE Standard 135-2004. ASHRAE and ANSI standard protocol, which is a protocol designed for the HVAC and building automation industry.
BACnet Interest Group (BIG)	Associations formed by BACnet users for the benefit of BACnet users. BIGs enable individuals to exchange information and share experiences about the implementation and application of BACnet. Many BACnet Interest Groups have formed around the world to support BACnet users. There is BIG-NA, North America (www.big-na.org); BIG-EU, Europe (www.big-eu.org), and BIG-AA, AustralAsia (www.big-aa.org).

BACnet Terminology

Term	Definition
BACnet Interoperability Building Blocks (BIBBs)	Collections of one or more BACnet services that function to define the interoperational capabilities of BACnet device. Certain BIBBs may also be predicated on the support of certain, otherwise optional, BACnet objects or properties. BIBBs may also constrain allowable values of specific properties or service parameters.
BACnet Testing Laboratories™ (BTL)	The BACnet Manufacturers Association formed the BACnet Testing Laboratories to test building automation products and certify them as BACnet compliant.
Bridge	A device that connects two LANs or two segments of the same LAN. The LANs can be alike or different. A bridge can connect an Ethernet and token-ring network, for example. Unlike routers, bridges are protocol independent. They forward messages without analyzing or rerouting them.
Client	In networked systems, an application or device acting as a requestor or consumer of data. A client requests a server device for data resident in the server.

BACnet Terminology

Term	Definition
Datalink	The datalink layer as defined in the OSI (Open Systems Interconnection) model. The datalink encompasses the data structure. In BACnet ANSI/ASHRAE Standard 135-2004, the Datalink network types are one of six types: BACnet ARCnet, BACnet Ethernet, BACnet/IP, BACnet MS/TP (master-slave/token passing), BACnet over LonTalk and BACnet PTP (point-to-point).
Digital	Discretely varying entities represented by two states, such as an on/off switch.
Ethernet	A high-speed LAN that runs on a variety of media-STP, coaxial cable, or fiber optics.
Half-router	In BACnet, a device that can participate as one partner in a point-to-point (PTP) connection. Two half-routers form an active PTP connection and act as a single router.

BACnet Terminology

Term	Definition
ID (Identifier)	BACnet defines three important IDs used to identify BACnet devices, objects, and properties. An Object ID identifies an object's type and instance number. A Vendor ID defines the vendor who manufactured a device. A Property ID identifies a property by a code.
IP	Acronym for Internet Protocol. IP handles the breaking up of data messages into packets (also called datagrams), the routing of the packets from their origin to the destination network and node, and the reassembling of the packets into the data message at the destination. IP operates at the internetwork layer of the TCP/IP model, which is equivalent to the network layer of the ISO/OSI reference model.

BACnet Terminology

Term	Definition
ISO/OSI Reference Model	Short for International Standards Organization/Open Systems Interconnection reference model. The model is the foundation of most network standards. It breaks down network communications into seven manageable, conceptual levels, each concerned with a specific aspect of network communications. The seven layers are Application, Presentation, Session, Transport, Network, Data Link and Physical.
Instance	In BACnet, a number that uniquely identifies an object within a device or a device on a BACnet internetwork.
Internetwork	A set of two or more networks interconnected by routers.
LAN	Local Area Network. A defined network providing the physical infrastructure for device communication.
Native protocol	Protocol used by device, panel or workstation for network communication without the use of a gateway or translation interface.

BACnet Terminology

Term	Definition
Media Access Control (MAC)	The part of a network that handles access to the physical network (media). In BACnet, each device has a unique MAC Address/Network Number combination that identifies it on the BACnet internetwork.
MS/TP	Master-Slave/Token Passing. It is a type of LAN implemented using the EIA-485 signaling standard. This LAN type is suitable for unitary controller and terminal control communications. To initiate communications on the network, a node will have an electronic "token" (actually a small packet), which is passed from one node to another around the network. Master devices are allowed to have the token, whereas slave devices are allowed only to respond to requests from master devices.

BACnet Terminology

Term	Definition
National Institute of Standards & Technology (NIST)	An agency of the U.S. Department of Commerce's Technology Administration. The NIST charter is to strengthen the U.S. economy and improve the quality of life by working with industry to develop and apply technology, measurements, and standards. NIST has played an integral role in the development of BACnet.
Object	A piece of information in a BACnet system, described by its properties. An object might represent information about a physical input or output, or it may represent a logical grouping of points that perform some function, such as a setpoint. Every object has an identifier (such as AI-1) that allows the BACnet system to identify it. An object is similar to a data point, although it contains additional information other than present value. It is only through its properties that an object is monitored and controlled.
Peer-to-Peer	A type of network in which messages are passed between each node, and each node is an equal peer on the network.

BACnet Terminology

Term	Definition
Properties	The means by which objects are monitored and controlled. BACnet specifies 123 properties of objects. Three properties (Object-identifier, Object-name, and Object-type) must be present in every object. BACnet also requires that certain objects support specific additional properties. The type of object and the type of device in which that object resides determine which properties are present. Some properties can accept writes, and others can only be read.
Protocol Implementation Conformance Statement (PICS)	A document that details the particular BACnet objects, services and capabilities supported by a type of BACnet device. Every BACnet-compliant device has an associated PICS published by the manufacturer.
Router	A device that connects two LANs. Routers are similar to bridges, but provide additional functions, such as message filtering and forwarding based on various criteria.

BACnet Terminology

Term	Definition
Server	In electronic networked systems, an application or device acting as a provider of data, responding to a request from a client.
Services	How one BACnet device gets information from another device, commands a device to perform certain actions (through its objects and properties, of course), or lets other devices know that something has happened. The only service required by all devices is the Read-property service. There are a total of 32 standard services.
TCP/IP	Acronym for Transmission Control Protocol/Internet Protocol. TCP/IP is the de facto protocol standard used by the Internet. Whereas IP deals only with packet transmission, TCP enables two hosts to establish a connection and exchange streams of data. TCP handles delivery and order of data streams.

Helping your building work for you.™

Siemens Building Technologies, Inc.

1000 Deerfield Parkway
Buffalo Grove, IL 60089
USA
Tel. (847) 215-1000
Fax. (847) 215-1093

Siemens Building Technologies, Ltd.

2 Kenview Boulevard
Brampton, Ontario L6T 5E4
Canada
Tel. (905) 799-9937
Fax. (905) 799-9277

Siemens Building Technologies Ltd.

Hawthorne Road
UK-Staines, Middlesex TW 18 3AY
England
Tel: 44 1784 46 16 16
Fax: 44 1784 46 46 46

Siemens Ltd.**Siemens Building Technologies**

Building 31, Ground Floor
885 Mountain Highway
Bayswater, Victoria 3153
Australia
Tel: 61 3 9721 2000
Fax: 61 3 9720 9966

Siemens Building Technologies

(Tianjin) Ltd.
2nd Floor, Ocean Tower,
550 East Yan An Road,
Shanghai 200001, P.R. China
Tel: 86 21 6350 2277
Fax: 86 21 6350 2420

Siemens Ltd.

Unit 1006-10,
10/F China Resources Building
26 Harbour Road,
Wanchai, Hong Kong
Tel: 852 2856 3813
Fax: 852 2564 4254

Siemens Ltd. Seoul

6th Floor Asia Tower Building,
726 Yeoksam-dong, Kangnam-Gu,
Seoul 135-719, Korea
Tel: 82 2 3450 7400
Fax: 82 2 3450 7499

Siemens Pte Ltd

The Siemens Centre,
60 MacPherson Road,
Singapore 348615
Tel: 65 6490 6000
Fax: 65 6490 6001

Siemens Limited Taiwan

8F, No.3, Yuan Qu St
Nan Gang District
Taipei, 115 Taiwan, R.O.C.
Tel: 886 2 2652 8888
Fax: 886 2 2652 8824

Building Technologies

Siemens Building Technologies, Inc.

1000 Deerfield Parkway
Buffalo Grove, IL 60089
Tel. (847) 215-1000

www.sbt.siemens.com

BACnet is a registered trademark of the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE). BACnet Testing Laboratories is a trademark of the BACnet Manufacturers Association.

© Copyright 2005 Siemens Building Technologies, Inc. All rights reserved.

153-912p10 (06/05)