BACnet® Information Guide

SIEMENS

BACnet® Basics

An acronym for "Building Automation Control Network," BACnet is the standard protocol designed to enable various manufacturers' devices to share data and commands—in other words, to interoperate.

BACnet makes it possible to integrate a facility's various control systems to a single workstation application for ease of operation. It also allows users to expand and upgrade controls using technology from multiple vendors. This is possible due to common communication infrastructure and front-end building automation systems.

BACnet originated and is supported by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) and approved as the ANSI/ASHRAE/ISO Standard 135-2008.

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 the following terms: transport network types, devices, objects, services, and properties. These terms are further defined in the following sections.

BACnet® Basics

Network Types

The 2008 BACnet Standard defines 6 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 6 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.

In order to join multiple network types, a BACnet router is used. 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.

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.

Objects

All information in a BACnet system is represented in terms of 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, and 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 30 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.
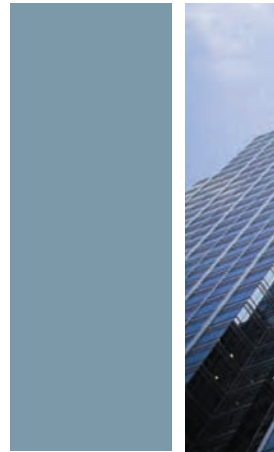
Objects will always be associated with object identifiers. Object Identifiers are a 32 bit binary number containing a code for the object type and the object instance number.

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

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 properties. 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 166 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.

Services

BACnet services are actions that a BACnet device takes to read or write to another BACnet device. Services are grouped into 5 categories of functionality – object access (read, write, create, delete, add, remove), 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).

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.

Interoperability Areas

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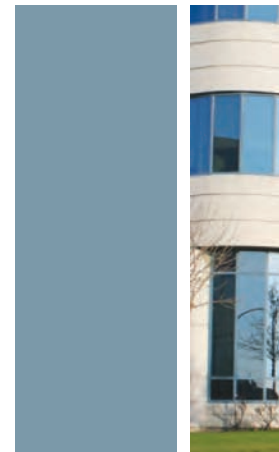
Interoperability areas are composed of the following: Data Sharing, Trending, Scheduling, Alarm & Event Management, and Device & Network Management. These "Interoperability Areas" are aligned with the BIBBs discussed in the BACnet Specification section.

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. 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.

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.

Example:

Write requests are sent with an accompanying priority if they are commands. 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 then #16.

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

BACnet® Specifications

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 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 PICS (Protocol Implementation and Conformance Statement) was therefore 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. 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 – BIBBs (BACnet Interoperability Building Blocks) as defined in Addendum D of the BACnet standard. BIBBs define sets and groupings of functionality that can be rather easily mapped from device to device, in order to determine the functionality that is likely interoperable between devices.

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), and therefore 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 therefore determine functionality that 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-AWS (BACnet Advanced Workstation)
  – 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)
- **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 are creatable and deletable by a third party BACnet system/ device**
  – Analog Input, Output, Value
  – Averaging
  – Binary Input, Output, Value
  – Calendar
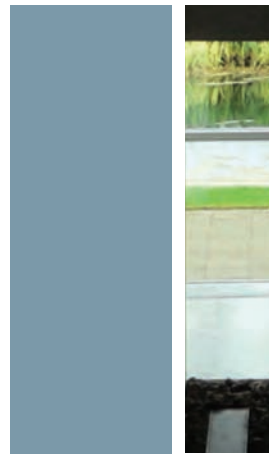
- Command
- Device
- Event Enrollment
- File
- Group
- Life Safety Point, Zone
- Loop
- Multi-State Input, Output, Value
- Notification Class
- Program
- Schedule
- Trend Log
- Proprietary
• **Datalink and physical network layers supported**
  - BACnet/IP (Annex J)
  - BACnet Ethernet (10Base 2, 10Base 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 supported**
  - Router
  - BACnet Tunneling (Annex H)
  - BACnet/IP BBMD (BACnet Broadcast Management Device)
  - BACnet/IP Foreign Device
• **Character sets supported**
  - ANSI X3.4
  - ISO 10646 (ICS-4)
  - IBM/Microsoft DBCS
  - ISO 10646 (UCS2)
  - JIS C 6226
  - ISO 8859-1

BIBBs

With the adoption of Addendum D in the BACnet standard, which superceded the conformance classes in the 1995 standard, BIBBs (Annex K) became 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 6 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
• **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
  - Object creation and deletion
  - Virtual terminal

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

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

To have interoperability between two or more BACnet devices, there must be 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.

BACnet® Certification

BACnet® International is an organization that encourages the successful use of BACnet® in building automation and control systems through interoperability testing, educational programs, and promotional activities.

BACnet International (formerly known as BACnet Manufacturers Association) encourages the successful use of BACnet® in building automation and control systems through interoperability testing and certification

services for manufacturers of BACnet devices. Through their conformance certification and listing program, they award a BTL or BACnet Testing Laboratories certification mark to BACnet® International compliant products based on ASHRAE testing.

For more information go to:
www.bacnetinternational.org

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