What is BACnet?

BACnet® Defined

BACnet is a "data communication protocol for Building Automation and Control networks". BACnet is an "open" protocol standard that was developed and is governed by ASHRAE (American Society of Heating Refrigerating and Air-Conditioning Engineering).

BACnet was developed to standardize the method of communications between building automation devices from different manufacturers.

Brief History

The official origins of BACnet date back to 1987 when the ASHRAE Standard Project Committee SPC 135P was founded. This committee was challenged with the task of "*defining a communication protocol for building control and energy management"*. In August of 1991, the protocol was first released for public review. After two more public review processes, the BACnet protocol standard was finally published in September of 1995 as ASHRAE Standard 135-1995. In December of that year, ANSI (American National Standards Institute) adopted the BACnet standard.

Basics of BACnet

BACnet departs from traditional Building Automations System (BAS) industry conventions with its object-oriented nomenclature. The industry has long used the term *points*, which could refer to sensor inputs, control outputs or control values, with different characteristics depending on the manufacturer. BACnet instead defines a standard set of *Objects*, each of which has a standard set of *Properties*, which describe the Object and its current status to other devices on the BACnet network. It is through these Properties that other BACnet devices may control the Object.

As an example, one of the standard BACnet Objects is the Analog Input Object. This Object type can represent an analog sensor input such as a thermistor. Figure 1 shows a diagram of an Analog Input Object as it might be seen on a BACnet network through five of its properties. Some of the properties, such as Description, Device_Type and Units, are set during installation. Other properties, including Present_Value and Out_Of_Service, provide status about the sensor input when the device is active. The remaining properties (an Analog Input Object can have up to twenty-five properties – some of which are required, others are optional) may be set by the equipment manufacturer. All properties may be read. In this example of a thermistor, a query about the Present_Value Property of the Analog Input Object would result in the reply "71.0".

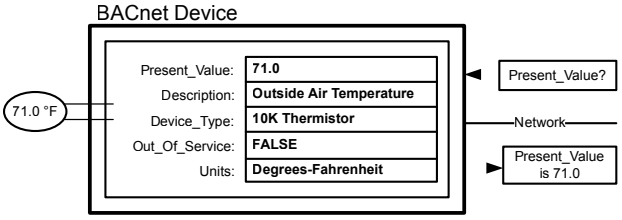

Figure 1. Analog Input Object

BACnet defines twenty-five standard types of Objects (refer to Table 1). One or more of the Objects represents each element of a complete building control system, whether Analog Input for a sensor, a Schedule for scheduling, or Notification Class for alarms.

The Objects that are present in a BACnet device are determined by the device's function and capabilities. The BACnet standard does not require all Objects in all BACnet devices. For example, a device that controls a VAV box is likely to have several Analog Input and Analog Output Objects while an operator workstation typically does not have either.

Every BACnet device must have a Device Object, the Properties of which fully describe the BACnet device to the network and how it interacts with other BACnet devices. For example, the Object_List Property of the Device Object provides a list of every Object contained within the BACnet device. The Vendor_Name, Vendor_Identifier and Model_Name Properties provide the manufacturer name and model of the device.

Table 1. Standard BACnet Objects

OBJECT	EXAMPLE OF USE	OBJECT	EXAMPLE OF USE
Accumulator	Defines a standardized object whose properties represent the externally visible characteristics of a device that indicates measurements made by counting pulses.	Group	Provides access to multiple properties of multiple objects in a read single operation.
Analog Input	Sensor input	Life Safety Point	Defines a standardized object whose properties represent the externally visible characteristics associated with initiating and indicating devices in fire, life safety and security applications.
Analog Output	Control output	Life Safety Zone	Defines a standardized object whose properties represent the externally visible characteristics associated with an arbitrary group of BACnet Life Safety Point and Life Safety Zone objects in fire, life safety and security applications.
Analog Value	Setpoint or other analog control system parameter	Loop	Provides standardized access to a “control loop.”
Averaging	Defines a standardized object whose properties represent the externally visible characteristics of a value that is sampled periodically over a specified time interval.	Multi-state Input	Represents the status of a multiple-state process, such as a refrigerator’s On, Off, and Defrost cycles.
Binary Input	Switch input	Multi-state Output	Represents the desired state of a multiple-state process (such as It’s Time to Cool, It’s Cold Enough and it’s Time to Defrost).
Binary Output	Relay output	Multi-state Value	Represents the value of the multi-state
Binary Value	Binary (digital) control system parameter	Notification Class	Contains a list of devices to be informed if an Event Enrollment object determines that a warning or alarm message needs to be sent.
Calendar	Defines a list of dates, such as holidays or special events, for scheduling.	Program	Allows a program running in the device to be started, stopped, loaded and unloaded, and reports the present status of the program.
Command	Writes multiple values to multiple objects in multiple devices to accomplish a specific purpose, such as day-mode to night-mode, or emergency mode.	Pulse Converter	Defines a standardized object that represents a process whereby ongoing measurements made of some quantity, such as electric power or water or natural gas usage, and represented by pulses or counts, might be monitored over some time interval for applications such as peak load management.
Device	Properties tell what objects and services the device supports, and other device-specific information such as vendor, firmware revision, etc.	Schedule	Defines a weekly schedule of operations (performed by writing to specified list of objects) with exceptions such as holidays. Can use a Calendar object for the exceptions.
Event Enrollment	Describes an event that might be an error condition (e.g., “Input out of range”) or an alarm that other devices to know about. It can directly tell one device or use a Notification Class object to tell multiple devices.	Trend Log	Logging of properties for a set criteria
File	Allows read and write access to data files supported by the device.		

In addition, BACnet allows manufacturers to provide proprietary Objects, which are not necessarily accessible or understood by equipment from other manufacturers. These proprietary Objects do not interfere with standard BACnet Objects.

What is an Open Protocol Standard?

An open protocol is defined as "any protocol that a company or an individual chooses to publish." Such protocols are typically not monitored and can therefore be changed at any time and for any reason. In contrast, an open protocol *standard* is published by an established governing body and adopted by a national (or international) standards body. Any changes to the protocol standard are first submitted for public review. After a sufficient time for review and revision, the governing body must then approve any changes before they are implemented. Such a process ensures long-term stability of the protocol standard without the hindrance of undue influences from companies or individuals.

Why Choose an Open Protocol Standard?

The implementation of an open protocol standard results in a much easier process of enabling controls manufactured by one company to communicate with controls made by another company. This greatly simplifies the integration of all building systems (HVAC, Power, Fire and Life Safety, Security, Lighting, Access Control, etc.) and allows the use of a common operator interface. Implementation of an open protocol standard also ensures that the network infrastructure, normally the highest cost component of the BAS, is suitable for integration of future system enhancements.

An open protocol standard allows for greater flexibility during future expansion and/or retrofit projects. While many of the proprietary communication protocols used by most manufacturers handle communications adequately within their own proprietary network, customers of such systems are forced to make future purchases of equipment from the same vendor. This presents a real problem if a customer wants to do business with a different manufacturer when it's time to expand an existing system.

A choice to implement yet another proprietary protocol presents a greater problem; it is a difficult task to integrate the communications of two systems with different proprietary protocols. The cost of the custom programming requirements alone usually exceeds the resources of most building owners. Even more cost prohibitive is the prospect of replacing the existing controls with an entirely new system. Instead, the owner must choose between purchasing systems from the vendor who installed the original control system or buying and installing a stand-alone system for the new addition, complete with a separate front-end computer interface. This presents another challenge, as operators must now be trained to utilize multiple systems. Additionally, the lack of interoperability between different systems makes it impossible to implement a facility-wide approach to energy saving strategies such as electrical demand limiting and HVAC optimization. But perhaps the greatest detriment to this approach is that it further digresses from the owners' ultimate desire to have a fully integrated building management system.

Not surprisingly, it is these difficulties that are driving customer interests toward the capabilities of an open protocol. Even among building owners who are satisfied with their current vendor's service, there is a growing interest in open protocol solutions. After all, it is in their best interest to preserve their options for future expansion.

Why Choose BACnet?

The Building Owner's Perspective

Once the decision is made to adopt an open communication protocol, the next logical decision is "which protocol to choose?" BACnet and LonWorks are easily the most recognized open protocol standards in the building automation industry. However, they are not the only open protocols available.

An open protocol should be subject to the following criteria:

- Powerful and robust
- Capable of meeting all future communication needs
- Meet all present needs throughout all system levels

Any open protocol that does not meet these criteria should not be considered a viable option. The BACnet protocol does meet these stringent requirements. It does so, in part because of the wide range of com-

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munication transports that it supports. From high-speed Ethernet LANs to low cost MS/TP device networks, BACnet can be used by an automation system at all system levels.

The high-speed capabilities of BACnet provide room for future growth, while its flexibility in networking options allows it to be used in even small zone controller subnets. Ethernet capability allows connection directly to wide area networks (WANs) that link remote building sites as well as multiple campus-wide local area networks (LANs). The fact that BACnet does not impose a set hierarchy on the control system layout gives manufacturers the flexibility to match the cost and performance of the controls to the needs of the application.

BACnet's object-oriented services provide powerful tools for interconnectivity. The standard was designed from the outset to provide for interconnectivity in a large building automation system. Therefore, BACnet provides methods to share complex information such as alarms and scheduling, as well as basic input/output (I/O) point data. BACnet also supports prioritized commands, which allow critical alarms to override non-critical control systems according to a pre-ordered hierarchy e.g. a fire alarm system would override a temperature control system and an emergency control panel would override both systems.

The open structure and object-oriented commands inherent to BACnet allows developers to provide enhancements and additional features. If use of a new control feature becomes widespread and there is a need for it to be standardized among vendors, ASHRAE provides a procedure for its adoption as a standard BACnet object.

BACnet very quickly became a widely accepted, open protocol standard. Many companies began announcing their support for BACnet even before the final draft of the standard was released. The fact that ASHRAE developed and governs the BACnet standard plays a significant role in this acceptance.

The non-proprietary nature of the BACnet standard is important to building owners, because the future development of the standard is not subject to influence from any one company or individual. An open committee comprised of representatives from industry, academia and government developed the BACnet standard. The standard is in a state of "continuous maintenance", which means that changes can be proposed at any time. The BACnet committee meets semi-annually to consider any changes to the standard. These changes are then published for public review and comment before adoption. This open development process offers a level playing field to all competitors and ensures that BACnet will continue to grow and mature to meet the evolving needs of the building automation industry.

The Property Manager's Perspective

Property managers who use a competitive bid process to award contracts for control system expansion have found that specifying an open protocol is the only way to get true competition and interoperability. While it seldom makes sense to mix primary control system manufacturers within a single project, specifying an open protocol on a current project keeps the door open to competition on future projects.

The System Operator's Perspective

As mentioned previously, a mix of non-interoperable control systems presents some real challenges for the system operator. He or she must not only be proficient in the operation of each system but is further limited by the fact that these systems cannot be managed from a common interface. Without integration, each system will have its own peculiarities in their methods of handling critical alarms and service notifications. For the person(s) whose job it is to "keep things running", this only serves to complicate their job while promoting inefficiency. In contrast, a system of interoperable controls – integrated by conformance to the BACnet standard – allows for a common interface and facilitates smooth and efficient building system operation.

How Does a Building Owner Request BACnet Implementation?

The specification must clearly state the kinds of network functions that are desired. For example, if the desire is to have the controllers start and stop equipment based on date and time, network functionality is not necessarily a requirement. But, if there is a desire to manipulate the controller's schedule from a remote workstation, both the workstation and the controller must support the appropriate BACnet capabilities in terms of objects and services. A careful list of the things that are to be accomplished across the network must be constructed. Such things include: time-based functions, alarm and event requirements, points that are to be shared between devices, etc. The specification must clearly state that these functions are to be accomplished using the BACnet protocol standard.

How Has YORK Implemented the BACnet Standard?

In June of 2004, York International introduced the ISNConneXsys line of controllers. This product line conforms to the BACnet protocol standard.

York International has the unique position of being one of the only HVAC manufacturer to offer "top-to-bottom" BACnet connectivity.

Continued development of the product line allows York International to offer controls that are applicable to the ever-changing needs of the building automation industry.

How Can YORK Assist Consulting Engineers in Specifying BACnet?

As previously stated, YORK holds a unique position among HVAC equipment manufacturers. This should be leveraged in working with consulting engineers. The integration of BACnet controls with HVAC equipment offers the consulting engineer several distinct benefits:

- Single-source vendor responsibility.
- Cost advantages over HVAC equipment suppliers with add-on controls.
- Control sequences developed by a company that understands how HVAC systems should operate.
- Lower operating costs resulting from efficient control sequences and equipment matched for performance.
- BACnet open source interoperability.

All of these result in the simplification of the specification writing process, a definite plus for the consulting engineer.

Summary

"With tens of thousands of installations, and a worldwide presence, BACnet is fast becoming the only serious choice for full-scale building automation where interoperability is an issue". While there are many factors that contribute to the success of BACnet, the following are often cited:

- BACnet is an ANSI standard.
- BACnet provides a wide range of compatibility with existing network topologies.
- BACnet provides robust, scaleable networking from small, low-cost LANs like MS/TP, ARCNET, and LonTalk to high performance BACnet over Ethernet and BACnet over TCP/IP.
- BACnet has the most advanced and flexible model for data representation and standardized object framework that is safely extensible without requiring "permission".
- BACnet was developed with the cooperation of nearly every major vendor of building automation, controls, and mechanical equipment.

The bottom line – BACnet is here to stay. Its popularity in the building automation industry continues to grow everyday on a global basis.

York International is committed to being a manufacturing partner in the BACnet standard – both now and in the years ahead.

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