Moving Forward With BACnet™

"It is safe to say that consulting engineers remain puzzled by the standard. ASHRAE is addressing this problem by focusing on redefining how to specify BACnet."

ASHRAE's Building Automation and Controls Network (BACnet) Standard holds great promise for the hvac industry. Most control manufacturers have announced support for the standard, and many are providing BACnet products today.

Several key real-world projects have been completed with BACnet, helping to prove that the technology is solid and practical. Yet despite these successes, many consulting engineers remain puzzled by the standard and how to apply it to their projects.

One reason for this confusion has to do with the BACnet standard itself. Many consulting engineers have purchased the standard, only to find that it is filled with detailed information on how to implement the protocol and little on how to specify its use. In fact, only one clause (Clause 22) is dedicated to the specification of BACnet systems. This clause describes the concept of BACnet "Conformance Classes" and "Functional Groups." Unfortunately, experience on projects has shown that these concepts are badly flawed.

Here are some particular areas of difficulty:

- Conformance classes range from 1 to 6. While the standard states that they are not hierarchical, many specifiers have assumed that if Class 1 is good, then Class 6 must be better. This is not the case.
- The assumption of the clause was that the specifying engineer would evaluate the Product Implementation Conformance Statements (PICS) from a number of vendors and determine which could be used together. However, in the real world, projects need to be specified and competitively bid, with an assurance that any two selected vendors' systems will work together.
- Clause 22 assumed that the consulting engineer would have an intimate knowledge of BACnet objects and services. In reality, most consultants are unlikely to take the time to become communication protocol experts.
- Manufacturers are looking for ways to build standard products that can interoperate. Without a definition of what is required in each device, it was impossible to determine if two BACnet products would be able to communicate.

It's good to know that help is on the way.

In Search of Clarity

In order to alleviate this problem, the committee charged with the maintenance of the BACnet standard (ASHRAE SSPC-135) has been focusing on redefining how to specify BACnet. The committee may approve the modified clause at ASHRAE's Summer Meeting in Toronto this month. Next in the process would be a public review.

The committee is looking to provide a series of interoperable functions that manufacturers can incorporate into their products. A separate document is expected to detail which of these functions is required in a device. For example, this document will provide a description of all of the interoperable functions that a BACnet workstation will provide.

Real-World Customer Needs

Why should an engineer specify an interoperable system? What functions will it provide for the client? These are basic questions that an engineer will need to answer before writing any sort of specification.

Interoperable systems should have the ability to do the following:

- Provide single-seat operation (see Figure A).
  This means an operator sitting at a PC should be able to accomplish his/her daily tasks, even though the controllers may be furnished from several different suppliers. For example, a school district may have a central PC that operates buildings with control systems furnished by two or more suppliers.

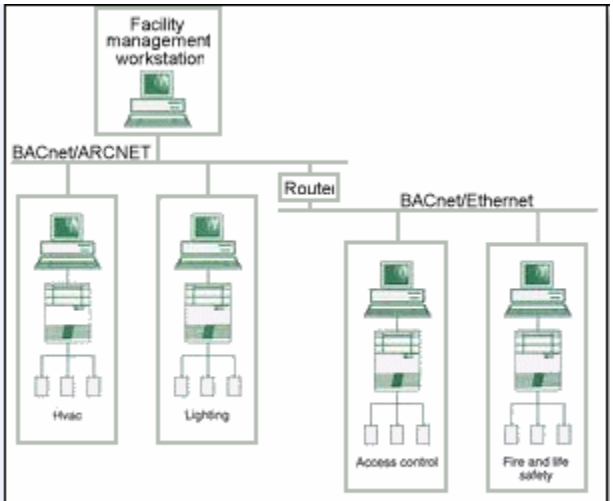

FIGURE A: BACnet protocol can link multiple standalone building systems into a cohesive facility-wide system for day-to-day operation, including supervisory control, monitoring, and data management.

- Provide equipment integration.
  Interoperability will offer a simple and economical way to connect the controls provided in building systems. For example, you can integrate chillers, rooftop units, fire alarm, and lighting control systems. (See Figure B.)

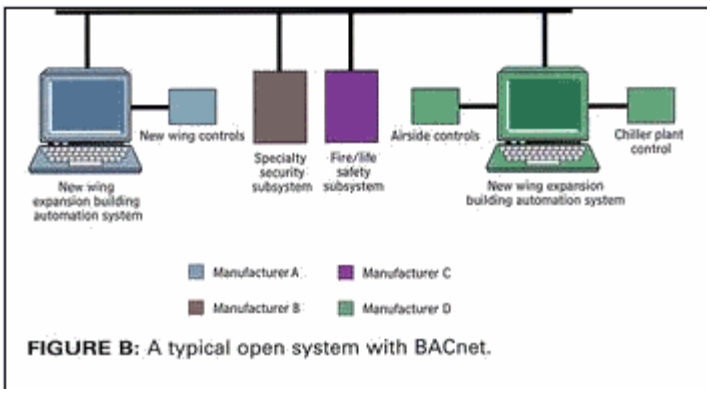

FIGURE B: A typical open system with BACnet.

If it isn't enough to simply say, "All devices shall be compatible with the ASHRAE Standard 135 BACnet communication protocol" in a specification, why should an engineer go to the trouble of specifying it in the required detail?

The demands of the building automation system (BAS) customer are pushing engineers to design systems, and manufacturers to build products, that have the ability to integrate information exchange between systems of different manufacturers. Several factors have driven this need, including:

- A desire for the lowest possible lifecycle cost; while the initial purchase of a system might have been competitively bid and awarded to the lowest bidder, owners have found themselves limited to that original low-bid supplier for service and upgrades. This has often resulted in higher costs and fewer options.
- The expanded availability of intelligent devices that maybe provided by someone other than the BAS supplier; most new pieces of equipment such as chillers, boilers, and variable-speed drives (vsd's) are supplied with intelligent electronic panels or interfaces that ought to communicate with the has. Owners also want to integrate lighting, security, access, and fire alarm controls into one system, so the building can be run from a single operator interface.

ASHRAE responded to these needs in 1987 by establishing a committee to develop a common communication protocol. The society formally adopted the BACnet standard in 1995. Since then, the standard has been adopted by ANSI and is in the process of gaining acceptance as an international standard.

Realistic Expectations

BACnet is not a "plug-and-play" system. The same can be said for other interoperable options available today. For example, it is not possible to simply remove a VAV box controller and replace it with one from another supplier without performing additional setup and programming.

The use of BACnet (or any open protocol) is limited to a basic level of system performance and functionality. BACnet is designed to provide the tasks that the daily operator needs to accomplish - data exchanges, alarms and events management, scheduling, and trending. it does not address system programming, configuration, or

setup. These functions will continue to be achieved in unique manners by each supplier.

When BACnet is applied correctly, it can deliver an interoperable system. However, the owner will still need supplier-specific software packages in order to edit or reconfigure the system.

The goal of an interoperable system is to allow the following tasks to be accomplished in a common format:

- View data on a PC (on a menu, graphic, or report);
- Change setpoints;
- Share data between controllers;
- View alarms for points that are out of a defined range;
- Set up and modify schedules;
- Sample data at regular intervals and retrieve it for viewing or storage; and
- Provide the ability to manage the system.

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Of these functions, the first three are the most basic, those of "data exchange." These functions will be able to be supported by even the most basic BACnet device. The other functions are in the process of gaining further definition in SSPC- 135. For example, the committee is further clarifying scheduling and alarming, while the trending function is still in initial definition. (For more information on these system functions, see related article, "BACnet's interoperable functions.")

The addition of BACnet data exchange capability can easily be added to project specifications and can be supported by suppliers of native BACnet systems, as well as suppliers that offer BACnet gateways.

What You Need to Know

Specification of a BACnet system can be fairly basic. The following examples will allow for the specification of a PC workstation that will have the ability to perform data exchange. This means that it will be able to look at information that is contained in BACnet controllers and will also be able to change setpoints and other values on these controllers. Technically, this is accomplished with a series of BACnet functions or services called "Read Property" and "Write Property."

These are cited in the specification by the sections of the BACnet standard where they appear.

Specification of this interoperable capability will enable a workstation to perform the following types of tasks:

- Display temperature, pressures, and other values on graphics for the operator;
- Allow the operator to change setpoints; and
- Store data readings periodically for historical trending.

The specification must be prescriptive in stating the following areas:

1. Allowable network medium.
   Since BACnet supports different network methods, the specifier needs to clarify which option should be used at both the PC workstation and at the controller on the other end of the wire. Here's an example of necessary specification wording:

   Workstation information access shall use the BACnet protocol. Communication shall use the ISO 8802-3 ("Ethernet") Data Link/Physical layer protocol.

2. Necessary BACnet services (or desired functionality of the interoperable system).
   These are the functions of BACnet that must be supported. In the example below, we want the ability to read data (used for viewing on graphics) and write (used for changing setpoints). Here is the necessary wording:

   The workstation shall use the Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135-95, to communicate with BACnet objects in the internetwork.

3. Required objects (which may also be referred to as "points").
   To perform this function, it is suggested to use the project points (or, using the BACnet term "object") list to show that an object should be made accessible to the BACnet internetwork. (Refer to Figure C for an example of this object list.)

	AHU 1, Objects		Services		
Tag	Name [control point]	Type	Alarm	Graphic*	Trend**
A-1	Discharge air temp.	AI	60/	Yes	Data
A-2	Mixed air temp.	AI	/40	Yes	
A-3	Low limit	BI	Yes	—	
A-4	Fan status	BI	Yes	—	
A-5	Run time	AV	10,000	—	
A-6	Discharge air setpoint	AV	—	Yes	
A-7	Duct static	AI	0.5/4.5	Yes	
A-8	Duct static setpoint	AV	—	Yes	
A-9	CHW valve position	AO	—	—	
A-10	Economizer position	AO	—	—	
A-11	Outdoor air flow	AI	—	—	

* Graphic temp., pressure, etc., display
** Data readings stored for trending

FIGURE C: Sample ddc control system Object list.

Connecting to and communicating with an existing, non-BACnet system is the tricky part. Specifying BACnet to connect to existing (or legacy) systems is a challenge because the existing ddc system may not have the ability to pass information on a BACnet network. The designer will need to work closely with the existing equipment supplier to determine what degree of BACnet capability, if any, is possible with the existing system.

Legacy systems will require a gateway to connect between the BACnet and the legacy system. In specifying the gateway, the engineer needs to list alarms, trends, schedules, and point data that must be passed between BACnet and the legacy system.

Simply stating in the specification that the existing system needs to be made BACnet compatible is not enough.

BACnet's Interoperable Functions

BACnet's interoperable functions can be summarized into five categories. These are presently being proposed by ASHRAE GPC-13P "Guideline for Specification of DDC Systems" as follows:

1. **Data exchange**
   The exchange of data between two devices (e.g., PC workstations and building controllers) is the most basic of interoperable functions. This function allows for both the viewing (or reading) of data as well as making changes (or writing) to this data.

   In the BACnet standard, this can be accomplished in a number of methods. The most basic of these is a pair of services called "Read Property" and "Write Property." In BACnet, data is modeled as "objects." Each of these objects has a series of "properties" defined.

   In the same manner, we can change setpoints (write) to the values of both "Analog" and "Binary Output" and "Value" objects. These basic functions can be used to share setpoints between controllers, provide data on graphics on a PC workstation, command the lights to come on, or sample data in a trend. In fact, entire interoperable systems can be built just by using these basic functions.

   (Note: While the "data exchange" function is able to achieve a wide variety of functions, there are more efficient ways to accomplish a number of system functions. These are required for large installations and for use in remote operations of multiple buildings.)

2. **Alarms and events**
   This function allows for the exchange of alarm information in an interoperable system. A controller that has determined that an alarm has occurred is able to send an alarm message to a pre-determined location.

   BACnet defines how the alarms are generated, how they are sent, and what they should contain. This function is typically done between a building controller and a PC workstation, but could also occur in other controllers on the intranetwork. This function also might be used to trigger a control action, or to record an operator override.

3. **Schedules**
   This set of functions allows for the editing and creation of schedules on a BACnet PC workstation that will be executed in a controller. This function will typically occur between a PC workstation and a building controller, but also could occur on other controllers on the intranetwork.
4. **Trends**
   The ability to sample, store, and read trends is a valuable function. Trending is a valuable tool for collecting data on system performance and energy usage. While trends are typically stored for historical purposes on a PC workstation, there are a number of reasons to sample them in a controller.

This will minimize network traffic and also will allow for sampling of data if a PC is not continually connected to the controller.

While a trending service is not defined in ASHRAE 135-95, it is being considered in a future addition.

5. **Network management**
   The final interoperable function is the ability to manage the devices on the network. This includes tasks such as monitoring for a loss of communication and coordinating the time settings on the clocks in each controller.

What About the Other Protocols?
Of course, BACnet is not the only open protocol solution available to system designers. Other open protocols are currently used in the building automation industry, including "LonMark," "CAB," and "ModBus," as well as some manufacturer-specific proprietary protocols that have been shared between control equipment manufacturers.

Here is a quick look at some.

LonMark is a set of protocol rules and practices that has been developed and approved by a consortium of manufacturers that use the Neuron processor developed by the Echelon Corp. (Palo Alto, CA). LonMark is not subject to the same public review and comments process that BACnet uses to create and maintain its standard, depending upon agreement among its membership for maintenance of its rules and practices.

While LonMark is very efficient and prescriptive in low-speed field-device communication, many agree it does not currently support robust and high-speed exchange of data on networks (like "Ethernet"), as well as does BACnet.

For more information regarding the LonMark Interoperability Association, call 650-855-7488; 650-856-4971 (fax); director@lonmark.org (e-mail).

CAB is the set of protocol rules developed by Public Works Canada for use in the BAS systems in many government and public buildings that it owns and maintains in Canada. It is available for use by any manufacturer. However, it also does not go through a public review and comment process. It is maintained by Public Works Canada.

CAB is essentially a high-speed network protocol, best used when communicating between devices with a good deal of processor capability. It is rarely used for field-device communication.

ModBus is an Instrument Society of America (ISA) protocol that has grown out of the factory automation industry, particularly for enabling communication between different manufacturers' programmable logic controllers (PLCs) and intelligent field devices, such as transmitters and actuators.

Devices that use ModBus typically require very robust processing capabilities, and are usually much more expensive than the control devices used in a typical commercial or institutional building for environmental control.

Conclusion

Interoperable systems will provide building owners with real benefits today and greater ones tomorrow. Although this technology is still young, it is possible to properly specify it to achieve these benefits in systems installed today.

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