

# the EXTENSION

A Technical Supplement to Control Network

© 2007 Contemporary Control Systems, Inc.

## Achieving BACnet® Compliance

By George Thomas

This is a two-part series. Part 1 was entitled *Object Modeling a Physical BACnet Device* while Part 2 is entitled *Achieving BACnet Compliance*. Together they explain how BACnet devices are constructed—with emphasis on the latest BACnet/IP standard.

### Introduction

Modern control networks such as EtherNet/IP, Modbus/TCP and BACnet/IP® use Ethernet for communications due to its high speed, lowering cost and in some instances, the necessity to operate over structured wiring. Although the study of Ethernet does not require an understanding of application protocols, knowledge of application protocols has become increasingly important as modern networks are deployed. The latest protocols are all based upon Object Modeling which can be quite confusing to someone who has not been exposed to this abstract concept. The first paper introduced object modeling, object properties, and services as they pertain to a physical BACnet/IP device. This paper continues the discussion by addressing the requirements for achieving BACnet compliance.

### BACnet Interoperable Building Blocks (BIBBs)

A primary goal of the BACnet standard is interoperability among vendors of BACnet equipment. Users also need to make sense of the vast range of BACnet products from simple sensors, workstations and building controllers. Not all devices need to provide the same services so how do we classify devices? The BIBB concept was introduced later in the standards development process as a way of classifying the numerous available services into more manageable processes as would be needed in a building automation application. The resulting 67 BIBBs can be found in Annex K and are classified into five groups:

- Data Sharing (16)
- Alarm and Event Management (13)
- Scheduling (3)
- Trending (5)
- Device and Network Management (30)

At first glance it would appear that things are getting more complicated than less. How could we get 67 BIBBs from only 38 possible services?

One answer is to understand who the requesting device is and who the executing device is.

In the jargon of BIBBs, an “A” device is one who uses the data (client) while the “B” device is the one who provides the data (server). Study Tables 1 and 2 which show two Data Sharing BIBBs.

| BACnet Service | Initiate | Execute |
|----------------|----------|---------|
| ReadProperty   | X        |         |

Table 1—BIBB-Data Sharing-ReadProperty-A (DS-RP-A)

| BACnet Service | Initiate | Execute |
|----------------|----------|---------|
| ReadProperty   |          | X       |

Table 2 –BIBB-Data Sharing-ReadProperty-B (DS-RP-B)

Notice that both BIBBs use the same ReadProperty but in one operation Client A is initiating the request while in the second operation Server B is executing the operation. Devices are not required to both initiate and execute services, but some do.

BIBBs are indeed “building blocks” to interoperability. They are used to classify the capability of the device and for creating standard device profiles. The number of required BIBBs increases with the complexity of the device. To fully understand the workings of each BIBB you need to consult Annex K. Table 3 provides a listing of required BIBBs for each device profile.

|                             | B-OWS       | B-BC                | B-AAC               | B-ASC    | B-SA                  | B-SS                  |
|-----------------------------|-------------|---------------------|---------------------|----------|-----------------------|-----------------------|
| Data Sharing                | DS-RP-A,B   | DS-RP-A,B           | DS-RP-B             | DS-RP-B  | DS-RP-B               | DS-RP-B               |
|                             | DS-RPM-A    | DS-RPM-A,B          | DS-RPM-B            | DS-WP-B  | DS-WP-B               |                       |
|                             | DS-WP-A     | DS-WP-A,B           | DS-WP-B             |          |                       |                       |
|                             | DS-WPM-A    | DS-WPM-B            | DS-WPM-B            |          |                       |                       |
|                             | DS-COVU-A,B |                     |                     |          |                       |                       |
| Alarm, Event Management     | AE-N-A      | AE-N-B              | AE-N-B              |          |                       |                       |
|                             | AE-ACK-A    | AE-ACK-B            | AE-ACK-B            |          |                       |                       |
|                             | AE-INFO-A   | AE-INFO-B           | AE-INFO-B           |          |                       |                       |
|                             | AE-ESUM-A   | AE-ESUM-B           |                     |          |                       |                       |
| Scheduling Trending         | SCHED-A     | SCHED-E_B           | SCHED-I-B           |          |                       |                       |
|                             | T-VMT-A     | T-VMT-I-B           |                     |          |                       |                       |
|                             | T-ATR-A     | T-ATR-B             |                     |          |                       |                       |
| Device & Network Management | DM-DDB-A,B  | DM-DDB-A,B          | DM-DDB-B            | DM-DDB-B | DM-DDB-B <sup>1</sup> | DM-DDB-B <sup>1</sup> |
|                             | DM-DDB-B    | DM-DDB-B            | DM-DOB-B            | DM-DOB-B | DM-DOB-B <sup>1</sup> | DM-DOB-B <sup>1</sup> |
|                             | DM-DCC-A    | DM-DCC-B            | DM-DCC-B            | DM-DCC-B |                       |                       |
|                             | DM-TS-A     | DM-TS-B or DM-UTC-B | DM-TS-B or DM-UTC-B |          |                       |                       |
|                             | DM-UTC-A    |                     |                     |          |                       |                       |
|                             | DM-RD-A     | DM-RD-B             | DM-RD-B             |          |                       |                       |
|                             | DM-BR-A     | DM-BR-B             |                     |          |                       |                       |
|                             | NM-CE-A     | NM-CE-A             |                     |          |                       |                       |

<sup>1</sup> Not required if the device is a BACnet MS/TP Slave.

Table 3—BIBBs required for various standard BACnet device profiles.

## BACnet Standard Device Profiles

To ease the process in determining BACnet compliance, the standard classifies devices into six categories:

- Operator Workstation (B-OWS)
- Building Controller (B-BC)
- Advanced Application Controller (B-AAC)
- Application Specific Controller (B-ASC)
- Smart Actuator (B-SA)
- Smart Sensor (B-SS)

In order for a device to be classified as a standard BACnet device, it must comply with a set of defined BIBBs. The listing of required BIBBs for each device classification is called a Device Profile. The simplest device is the Smart Sensor and, as shown in Table 3, it is only required to support the DS-RP-B BIBB. It only needs to execute the request for data since it is a sensor. The BAS Remote is more complex, being classified as a B-ASC requiring the BIBBs listed in Table 4.

| BIBB     | Description                               |
|----------|---|
| DS-RP-B  | Executes a ReadProperty request           |
| DS-WP-B  | Executes a WriteProperty request          |
| DM-DDB-B | Executes a Who-Is request                 |
| DM-DOB-B | Initiates an I-Am response                |
| DM-DCC-B | Executes a communications control request |

Table 4—B-ASC Device Profile

The Read Property and Write Property BIBBs are straightforward since they involve data sharing, but in both cases the device only responds to a request to read or write. The Device & Network Management BIBBs are also limited in that the device only responds to requests. It basically functions as a server and not a client. It should be noted that the number of BIBBs listed in Table 3 only represent minimum requirements. A vendor can choose to support more, so the device profile for his device would include more BIBBs. In order to fully understand what a device is capable of doing, you need to study the device's Protocol Implementation Conformance Statement (PICS).

## BACnet Protocol Implementation Conformance Statement

To help the customer in determining the compliance level of a device, a vendor must supply a PICS statement of compliance. The basic format of the statement is provided in the standard and this was the format used for the BAS Remote. For the BAS Remote, its PICS indicates that it complies with the B-ASC standard device profile with no additional BIBBs supported. The actual BIBBs are listed. The data link layer supported is also listed as BACnet/IP Annex J. A vendor is not required to use the identical

format, but the relevant information must be provided. Table 5 shows the PICS statement for the BAS Remote. Although the vendor has stated his product's compliance with a PICS statement, how does a user know that the product actually complies? The ideal approach is for the vendor to submit the product to the BTL Laboratories for compliance testing. These labs were formed by BACnet International, a trade association devoted to advancing the BACnet standard around the world.

## BACnet International

According to its website at <http://www.bacnetassociation.org>, BACnet International (BI) is an organization that encourages the successful use of BACnet in building automation and control systems through interoperability testing, educational programs, and promotional activities. Membership is open to both companies and individuals interested in the BACnet standard. There are two key activities BI sponsors in its mission to encourage successful installations. BI organizes annual Plugfests where vendors can bring their products to an event in order to verify that their devices interoperate. The other initiative is the creation of the BACnet Testing Laboratories (BTL) where products can bear the BTL mark upon successful completion of conformance testing.

## Plugfests

Plugfests are a convenient way for vendors to test-drive their products before actually incurring the expense and effort of a formal conformance test. Usually run once a year, the Plugfest is open to any BACnet device manufacturer, but BI members can attend for free. The trade press is not invited, and results are not tabulated. It is an opportunity for vendors to freely discuss the intricacies of the BACnet protocol and to verify that their products can communicate among compliant equipment as required by the standard. It is expected that there could be some glitches occurring during testing and experts are at hand to clarify the requirements of the standard. This is all being done to improve the interoperability between competing products.

One BI member offers to be the host for the annual event and assumes responsibility for securing space for the event. To make it quick and easy to setup, communication among vendors should be BACnet/Ethernet although other data links can be tested. This requires that routers be used to support the various data links. To avoid conflicting BACnet Device IDs, each vendor is assigned a range of 1000 IDs based upon their ASHRAE-assigned vendor ID. Each vendor needs to provide a printed document listing a product's BACnet objects that the vendor intends to test. For each object, the object ID, object name and any optional properties must be listed.

continued on page 4

## BACnet Protocol Implementation Conformance Statement (Annex A)

**Date:** July 30, 2007

**Vendor Name:** Contemporary Controls

**Product Name:** BAS Remote

**Product Model Number:** BASR-8M

**Applications Software Version:**

**Firmware Revision:**

**BACnet Protocol Revision:**

**Product Description:** BACnet/IP compliant 8-point remote input/output device that allows a direct connection to Ethernet without the need of a BACnet router.

### BACnet Standardized Device Profile (Annex L):

- BACnet Operator Workstation (B-OWS)
  BACnet Application Specific Controller (B-ASC)
- BACnet Building Controller (B-BC)
  BACnet Smart Sensor (B-SS)
- BACnet Advanced Application Controller (B-AAC)
  BACnet Smart Actuator (B-SA)

### List all BACnet Interoperability Building Block Supported (Annex K):

DS-RP-B Data Sharing—ReadProperty-B

DS-WP-B Data Sharing—WriteProperty-B

DM-DDB-B Device Management—Dynamic Device Binding-B

DM-DOB-B Device Management—Dynamic Object Binding-B

DM-DCC-B Device Management—Dynamic Communication Control-B

### Segmentation Capability:

- Able to transmit segmented messages Window Size:
  Able to receive segmented messages Window Size:

### Standard Object Types Supported:

| Object Type Supported | Can Be Created Dynamically | Can Be Deleted Dynamically |
|-----------------------|----------------------------|----------------------------|
| Analog Input          | No                         | No                         |
| Analog Output         | No                         | No                         |
| Binary Input          | No                         | No                         |
| Binary Output         | No                         | No                         |
| Device                | No                         | No                         |

No optional properties are supported.

### Data Link Layer Options:

- BACnet IP, (Annex J)
  Point-to-Point, EIA 232 (Clause 10), baud rate(s):
- BACnet IP, (Annex J), Foreign Device
  Point-to-Point, modem, (Clause 10), baud rate(s):
- ANSI/ATA 878.1, EIA-485 ARCNET (Clause 8), baud rate(s):
  LonTalk, (Clause 11), medium
- MS/TP master (Clause 9), baud rate(s):
  Other:
- MS/TP slave (Clause 9), baud rate(s):

### Device Address Binding:

Is static device binding supported? (This is currently necessary for two-way communication with MS/TP slaves and certain other devices.)

- Yes
  No

### Networking Options:

- Router, Clause 6—List all routing configurations, e.g., ARCNET-Ethernet-MS/TP,
- Annex H, BACnet Tunneling Router over IP
- BACnet/IP Broadcast Management Device (BBMD)
- Does the BBMD support registrations by Foreign Devices?
  Yes
  No

### Character Sets Supported:

Indicating support for multiple character sets does not imply that they can all be supported simultaneously.

- ANSI X3.4
  IBM™ /Microsoft™
  ISO 8859-1
- ISO 10646 (UCS-2)
  ISO 10646 (UCS-4)
  JIS C 6226

**Table 5—PICS Statement for BAS Remote**

Each vendor has to provide an Ethernet 10BASE-T connection along with an Ethernet repeating hub and some sort of protocol analyzer for observing the data being sent and received. Repeating hubs facilitate the use of protocol analyzers since all traffic can be observed on all hub ports. Software changes could be made during breaks if the vendor brings along a full development system. This is the one chance during the year to do some real interoperability testing, so it is best to come prepared.

The Plugfest occupies two to three days of organized testing. On the first day are speed sessions requiring ten minutes of setup and fifty minutes of testing. Vendors are assigned to teams with one team meeting with another team for the full session. One of the teams must have equipment that can read another vendor's device. For example, not much would occur if the two teams only had sensor devices. Little testing would occur. For any one session there could be 24 tables each occupied by two teams. Upon completion of the session, another session immediately starts with different teams occupying the same tables. These sessions go on all day.

On the second day there are mini-roundtables consisting of four or more participants communicating to one host participant. There are only four of these sessions lasting for two hours each. Also on this day are panel discussions from the experts on how to design for interoperability. With easy access to the experts, this is the time to ask questions and to take advantage of this excellent training opportunity.

The third day creates functional round tables for participants particularly interested in functions such as alarming, trending, life safety, scheduling, backup and restoring. With the completion of the third day, the Plugfest ends. The vendor can now return with added confidence of a successful submission to the BTL Labs.

### **BTL Mark**

The BACnet Testing Laboratories was created by BI to support compliance testing and interoperability testing. BTL published Implementation Guidelines which provides excellent information on achieving compliance. This document can be downloaded from the BI website. Another source of information on compliance can be gained by joining the BACnet mail list by visiting:

<http://www.bacnet.org/contact/bacnet-L.htm>.

Compliance testing and listing is overseen by the BACnet Working Group. A vendor can receive a set of testing procedures from the labs to do some pre-testing before actual submission to the labs. Although you do not need to be a BI member to submit a product for testing, BI members receive preference and a discount on testing. Once the product has been successfully tested by the labs, it can be listed and bear the BTL Mark as shown in Figure 1 below. This mark gives the user assurance that the product complies with the BACnet device profile to which it was tested. An added benefit to the vendor is that some bid specifications require only BTL listed products.



### **Summary**

Although object modeling appears complex, it is the modern method of making devices "network visible." Through the use of objects, properties and services, the BACnet standard defines BACnet compliance through defined BIBBs that lead to standard device profiles. Using a PICs statement, a user can determine the capability of a device and its compliance level. Users can be assured that a product is BACnet compliant if it completed conformance testing. Vendors also use compliance before submitting the product to the BACnet Testing Laboratories.

### **References**

**ANSI/ASHRAE Standard 135-2004 BACnet—A Data Communication Protocol for Building Automation and Control Networks**, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

**Direct Digital Control of Building Systems Theory and Practice**, H. Michael Newman, John Wiley and Sons, Inc. 1994.

<http://www.polarsoft.biz/langbac.html>, The Language of BACnet—Objects, Properties and Services, Bill Swan, Allerton Technologies, Inc.

<http://www.ccontrols.com/pdf/TD0403000D.pdf>, Building Automation System Remote, Contemporary Controls.

<http://www.bacnetassociation.org>, BACnet International.