

## Learning BACnet Concept for Home Automation

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**Abstract**— Home Automation system requires real time monitoring, control system and real time communication between various devices. BACnet(Building Automation and Control networks) is a standard data communication protocol designed specifically for building/home automation and control systems. BACnet adopts Master-Slave/Token-Passing (MS/TP) protocol as one of its field level communication networks. This paper describes Basics of BACnet protocol and their services, object & properties of BACnet devices. And how the local BACnet unable devices and foreign devices are communicate in a network through BBMD.

**Keywords**- BACnet, BBMD, BDT.

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### I. INTRODUCTION

Building automation systems require real-time monitoring and control of building facilities. In order to efficiently manage building systems, building-related information needs to be collected, stored, and analyzed.[2]. Intelligent control devices of different manufacturers have poor cooperation because most manufacturers use their specific method of data communication. The purpose of BACnet is to provide a way of communication between different building automation control systems so that different devices can be integrated into a whole automation control system.[6] And it is used to provide interoperability between various types of vendor's devices.

BACnet was designed specifically to meet the communication needs of building automation and control systems. Larry in 1997 stated that, BACnet provides the method by which computer-based controls systems equipment from different manufacture can work together, or “interoperate.” It is designed to handle many types of building controls including HVAC, lighting, fire and other systems[1].

This paper contains what exactly the BACnet is, how the BACnet is useful to control Home Automation System.

### II. BRIEF DESCRIPTION OF BACNET

#### A. What is BACnet

BACnet is a Data Communication Protocol for Building Automation and Control Networks. It was developed by American Society of Heating Refrigeration and Air-conditioning Engineers (ASHRAE). BACnet was designed

specifically to meet the communication needs of building automation and control systems.

BACnet adopts Master-Slave/Token-Passing (MS/TP) protocol as one of its local area networks (LANs). MS/TP protocol is mainly used as a field level network that performs various control activities and application specific operations[7].

#### B. Architectural Comparison of BACnet with OSI Layer

BACnet is based on a four-layer architecture that corresponds to the physical, data link, network, and application layers of the OSI model as shown in Figure 1.[4]

BACnet Layers				OSI Layers
BACnet Application Layer				Application
BACnet Network Layer				Network
ISO 8802-2 (IEEE 802.2) Type 1	MS/TP	PTP	LonTalk	Data Link
ISO 8802-3 (IEEE 802.3)	ARCNET	EIA-485 EIA-232		Physical

**Figure1** Architectural Comparison of BACnet with OSI Layer

#### C. BACnet Objects and Properties

Data inside a BACnet device is organized as a series of objects. Each object has a type and a set of properties. There is always at least one object in a device – it is used to represent the device itself. The other objects represent the device's data.

The following figure represents the BACnet objects:

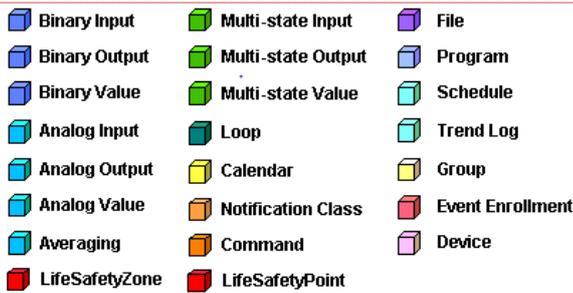


Figure2 BACnet Objects

In practical terms think of a simple thermostat. Our example is a simple device that has a temperature sensor, allows the set point to be changed locally or remotely, has a local remote selection and reports there is an internal fault by reporting its status as normal/abnormal.

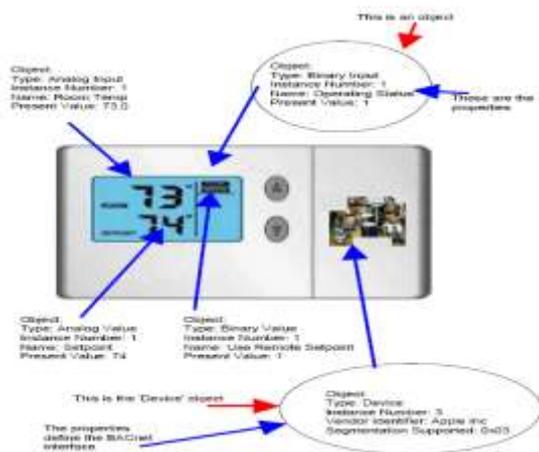


Figure3 BACnet Device with their object and properties [3].

1. The device object is the first object read after a device is discovered because it has lots of interesting information for the client. For example, the device object has properties that report whether the device supports COV, whether more than one property can be read in a single message.
2. Unique Numbers are required for BACnet Device Object Instance Numbers across the entire network.

Commonly used properties - Almost all objects you encounter will have these (and more) properties. Object Type:

- a. Popular Object Types: Analog Input, Analog Output, Binary Input, Binary Output.
- b. Instance Number: A number that must be not be repeated for any other object of the same type. The instance number and the object type must be unique for every object in a device.
- c. Name: Speaks for itself.
- d. Present Value: The current value of the object. BACnet has ways of telling you if the present value is valid – it uses a property called ‘Reliability’.

#### D. BACnet Services

BACnet is based on a "Client-Server" communication model, these messages are called "services" which are carried out by the server on behalf of the client [8]. Services are the means by which one BACnet device acquires information from another device, commands another device to perform some actions, or announces to one or more devices that some event has taken place. Each service request issued and service acknowledgment (reply) returned becomes a message packet transferred over the network from the sending to the receiving device.

BACnet defines 32 Services and classifies them into five categories[9].

1. Alarm and Event
2. File Access
3. Object Access
4. Remote Device Management
5. Virtual Terminal Services.

### III. BACNET DEVICE COMMUNICATION

#### A. Native BACnet Device Communication

"Native" BACnet implies that the devices only speak and understand BACnet. The devices may be interconnected using any of the approved LAN technologies. More and more vendors are considering replacing their legacy protocols with native BACnet implementations.

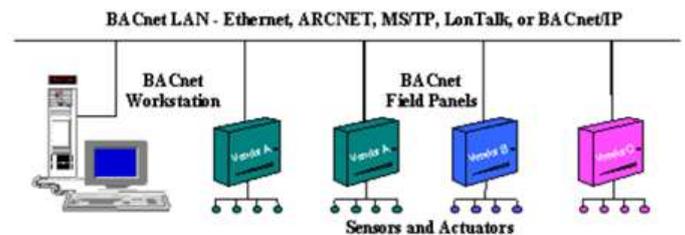


Figure4 Native BACnet devices provide BACnet communication directly, device to device.[8]

Beside using the LANs referred to previously, BACnet messages can travel over networks that use the Internet Protocol (IP) as their networking protocol.

The major distinction between the two ways that BACnet can work over an IP internet can be summarized as follows:

IP message tunneling, the BACnet devices don't know, or need to know, anything at all about IP.

BACnet/IP, each BACnet device is actually a full-fledged IP node, complete with its own IP address and IP protocol stack.

In IP tunneling, Device A on Network 1 addresses a message to Device B on Network 2 using the BACnet network layer protocol. It sends the message to the Annex H router on its local network. (The router is called an "Annex H" router because Annex H is the place in the

standard where this process is defined.) The Annex H router knows how to send IP messages over the Internet (or an "Intranet" based on IP) to its peer device on Network 2. It encapsulates the BACnet message (in a User Datagram Protocol frame) and sends it via IP to the Annex H router on Network 2. Note that both networks are connected via a standard IP router to the Internet at large.

When the Annex H router on Network 2 receives the IP message from its peer, it removes the encapsulated BACnet message and sends it on to its final destination, Device B.

The only downside to this is that each message shows up twice on each network - once as a pure BACnet message and once as an IP message.

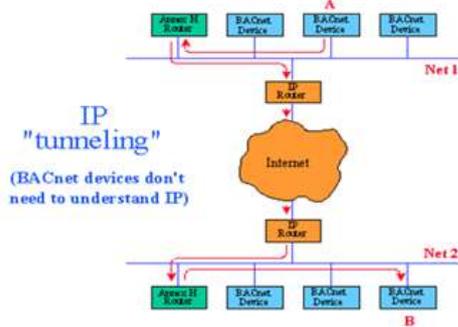


Figure5 BACnet Device Communication through IP Tunneling

**B. BACnet /IP through BBMD Communication**

The BACnet discovery uses two services - called 'Who-Is' and 'I-Am'. They rely on the use of broadcasts. Routers are used to join IP networks together so messages from one network can be sent to another. Most routers do not forward broadcast messages. Therefore we need a device which can broadcast the messages on another network.

To solve this problem BACnet provides a technology called BBMD (BACnet/IP Broadcast Management Device.) BBMD may be a device or software application on computer. We need to install a BBMD on each network.

We can configure the BBMD by specifying the IP Address and mask of the each BBMD. This makes both BBMD configs identical. When the one BBMD receives a broadcast, it forwards the messages to the other BBMD which in re-broadcasts on the other network. They are configured by BDT files and these may be modified on the fly using selected Bacnet services.

**1. BACnet/IP data communication using IP Directly**

BACnet/IP devices don't need Annex H routers and can talk with each other directly over the Internet. The only hitch is that IP routers don't normally pass along "broadcast" messages, i.e., messages intended for all devices on a BACnet internetwork. Enter the "BACnet Broadcast Management Device" (BBMD).

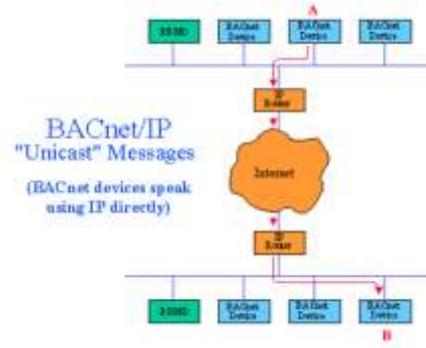


Figure6 BACnet/IP Device Communication using IP Directly.

**2. BACnet/IP data communication through BBMD**

BBMDs act similarly to the Annex H routers previously described except that they only handle the forwarding of broadcasted IP messages. Since broadcasts are generally used very infrequently in BACnet, their propagation should not cause any problems.

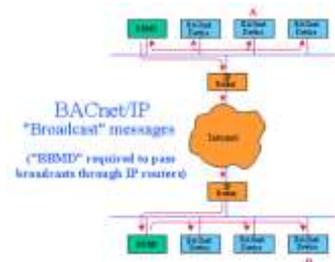


Figure7 BACnet/IP Device Communication through BBMD

**3. Foreign BACnet Device communication**

The technology also provides for foreign device registration. This allows a device on one network to communicate with a device on another network by using the BBMD to forward and route the messages.[3]

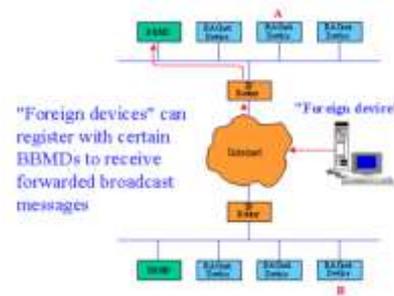


Figure8 Foreign Device Communication through BBMD

**IV. SEGMENTATION IN BACNET**

BACnet messages that don't fit in a single packet use segmentation. Why would one message need more than one packet? Well IP packets have a maximum length of 1500 bytes. So if you are sending a BACnet IP message that is longer than 1500 bytes then you need to send more than one Ethernet packet.[3]

By registering with a BBMD, the workstation above becomes a member of the BACnet/IP network and will receive

forwarded broadcast messages from the BBMD when they are available and can request that messages be broadcast by the BBMD on its behalf. The foreign device can, of course, talk with any BACnet device directly without registration but will only receive broadcasts if the registration procedure is followed.

## V. CONCLUSIONS

BACnet addresses the needs at all level in control system as well as home automation system in internet of things. It is design to be easily implemented as per our need and it is very easy to implement as it is developed in C, language. It provide a way to communicate and control the devices not only local network but also foreign devices. It uses BBMD for broadcasting the messages.

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