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Back to Basics

BACnet

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Back to Basics - Questions to Ponder

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- What is a High Level Interface (HLI)
- What is a Communication Protocol
- What is defined by a Communication Protocol
- What is **NOT** defined by a Communication Protocol
- What is the difference between an Open and Proprietary Communication Protocol
- What is BACnet
- Why is BACnet used for Building Management Systems

Simple Communication Experiment

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- Set up communication between two people to allow the transfer of room temperature information
- First Step is to define the communications media
 - Direct for close communication
 - Phone for longer distances
 - Two Way Radio
 - SMS

Simple Communication Experiment

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- Next Steps
 - Decide what information needs to be exchanged
 - Decide on the language to be used
 - Decide on an addressing method
 - Decide on the question and answer formats
 - Decide on the words to be used
 - Test the communication

Simple Communication Experiment

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- **What has just been created is a Communication Protocol**
- The Protocol Defines a set of rules for specific information exchange between two people
- The Protocol only includes the rules for information exchange

Simple Communication Experiment

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- **The protocol does not define - At the remote end:**
 - How the temperature is measured
 - How often the temperature is measured
 - What the remote person does with the measured values
- **The protocol does not define - At the local end:**
 - How often the information is requested
 - If the information is recorded or how it is recorded
 - If the information is displayed in any way

Simple Communication Experiment

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- **The Protocol is an Open Protocol if:**
 - The details are freely shared
 - Anyone can use the Protocol
 - Changes to Protocol take into consideration backwards compatibility for all vendors
- **The Protocol could be a Proprietary Protocol if:**
 - The details are not freely shared
 - Could be covered by a Patent
 - Use of the Protocol is restricted by the owner
 - Changes to the Protocol can be made by the owner without consideration for other vendors

What about Building Management Systems

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- **How does this apply to Building Management Systems?**
- **A High Level Interface (HLI) details a requirement for equipment to communicate using a data communication protocol**
- **A data communication protocol is a set of rules governing the exchange of data over a computer network**
- **The Data communication protocol could be an open or proprietary protocol**
- **Open or Proprietary does not change the functionality available – only the ability for vendors other than the owner to use it**

What is BACnet

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- BACnet is a Data Communication Protocol for Building Automation and Control Networks
- The protocol was developed and is supported and maintained by ASHRAE Standing Standard Project Committee 135
- BACnet was first published in 1995
- BACnet® was published in Jan 2003 as an international standard by the International Organization for Standardization as ISO 16484-5
- BACnet is an Open Communication Protocol. There is NO charge for it's use – Anyone may develop products that use BACnet for communications

Why does BACnet work

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- The BACnet rules relate specifically to the requirements of Building Automation and Control equipment
- BACnet is a set of Hardware and Software rules that defines the interoperability between equipment
- The standard is supported by many Manufacturers via ASHRAE and BACnet International
- Manufacturers who submit products to BACnet Testing Labs (BTL) for compliance with the Standard can use the BTL Mark
- BTL maintains a list of compliant products with links to product details
- Manufacturers must publish their compliance with the BACnet standard in Protocol Implementation Conformance Statements (PICS)

What is defined by BACnet's Rules

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- BACnet covers everything from what kind of cable to use to how to form a particular request for data or command a point in a standard way.
- BACnet's rules relate specifically to the needs of building automation and control equipment, i.e., they cover things like
 - How to ask for the value of a temperature
 - How to define a fan operating schedule
 - How to send a pump status alarm to a work station
 - How to share a trend of a point value
 - Etc.
- This distinguishes BACnet from other protocols used for BMS like LON, Modbus etc. These are simply data sharing protocols

What Systems does BACnet apply to

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- Is BACnet limited to only HVAC equipment?
- No! BACnet can also be used for
 - Fire Detection and Alarm Systems
 - Lighting Systems
 - Security Systems
 - "Smart" Elevators
 - Utility Company Interface (Smart Grid)

BACnet Advantages

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- **Provides easy and reliable interoperability between equipment from:**
 - Different vendors
 - Different system types (life safety / DDC etc)
- **Provides a seamless integration between systems and vendors to operator work stations**

What BACnet does not cover

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- **BACnet does not detail:**
 - Whether equipment is configurable or programmable
 - Performance of field devices (execution times I/O update rates etc)
 - Programming / Configuration tool functionality for field controllers
 - Operational functionality / User interface for workstations
 - Graphic and database configuration tools for workstations
 - Free availability of vendor configuration tools
 - Interoperability of configuration tools between vendors
 - Direct Inter-changeability between equipment from different vendors
 - Communications between field controllers and associated Input/Output modules
 - Naming rules for Devices (Controllers) or Objects (Points/Schedules/Trends)
 - Initiation and processing of events like eg. fan status alarms

BACnet in Detail

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- To understand the flexibility built into BACnet and the need to manage BMS integration we need to take a quick deep dive into the BACnet standard

Data Link / Physical Standards

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- BACnet devices must use one of the defined Data Link /Physical standards
- ISO 8802-3 ("Ethernet")
- ARCNET
 - Coaxial Token Ring – Largely Superseded
- PTP
 - Point-To-Point – EIA 232 Single point connection
 - Intended for modem type devices
- LonTalk
 - Twisted Pair, Power line, Fibre and RF

Data Link / Physical Standards

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- **MS/TP**
 - Master Slave Token Passing – EIA 485
 - Used for Multidrop connection to multiple devices

- **BACnet/IP**

- **The Data Link /Physical Layers supported must be listed in the Protocol Implementation Conformance Statement (PICS) for the device**

BACnet Device Profiles

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- **BACnet devices must conform to one of the standard Device Profiles**
- **Device profiles define the minimum interoperability functionality to be provided by a device**
- **Device profiles are:**
 - BACnet Advanced Workstation (B-AWS)
 - BACnet Operator Workstation (B-OWS)
 - BACnet Operator Display (B-OD)
 - BACnet Building Controller (B-BC)
 - BACnet Advanced Application Controller (B-AAC)
 - BACnet Application Specific Controller (B-ASC)
 - BACnet Smart Actuator (B-SA)
 - BACnet Smart Sensor (B-SS)

BACnet Services

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- All communication between BACnet devices is performed by applications called Services
- The Services are grouped into the following categories
 - Alarm and Event Services
 - File Access Services
 - Object Access Services
 - Remote Device Access Services
 - Virtual Terminal Services

BIBBs

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- BACnet Interoperability Building Blocks (BIBBs) are collections of one or more BACnet services
- BIBBs are grouped according to the type of function
- Data Sharing
 - Reading / Writing Properties
 - Reading / Writing Multiple Properties
 - COV Reporting – Automatic reporting on Change Of Value
- Alarm and Event Management
 - Alarm and Event Notification
 - Alarm and Event Acknowledgement
 - Alarm and Event Summary
- Scheduling
 - Creation and Modification of Schedules and Calendars

BIBBs

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- **Trending**
 - Creating / Deleting and viewing Trends
 - Automatic Upload of Trend Data to Workstation
- **Device and Network Management**
 - Who Is / I Am – Device Discovery
 - Who Has / I Have – Object Discovery
 - Time Synchronization
 - Device Reinitialisation / Restart
 - Device Backup and Restore
 - Connection to Network
 - Network Router Configuration

Why are BIBBs Important

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- **Devices must conform to one of the BACnet Standard Device Profiles**
- **The Device Profile details the Minimum interoperability the device must support**
- **The interoperability is defined by the BIBBs**
- **Devices may provide more than the minimum interoperability**
- **The BIBBs supported must be listed in the Protocol Implementation Conformance Statement (PICS) for the device**

An Example of a Device Profile

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- **Application Specific Controller (B-ASC)**
 - Limited Resources
 - Specific Application
 - Limited Programmability
- **Data Sharing**
 - Share values for any of it's objects
 - Allow modification of some of it's objects
- **Alarm and Event Management**
 - No Requirement
- **Scheduling**
 - No Requirement
- **Trending**
 - No Requirement
- **Device and Network Management**
 - Ability to respond to information about it's status only

MODELLING CONTROL DEVICES

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- **Control Devices in BACnet are Modelled as a collection of Objects**
- **An Object is used to provide a standardized network-visible representation of data.**
- **Data represented as Objects include:**
 - **Controllers, Workstations**
 - **Points**
 - ◆ Analog Input, Analog Output, and Analog Value
 - ◆ Binary Input, Analog Output, and Analog Value
 - ◆ Multistate Input, Multistate Output and Multistate Value
 - ◆ Life Safety
 - **Schedules and Calendars**
 - **Trends**
 - **Notification Classes (Alarming and Event Notification)**

Object Properties

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- There is no requirement for any particular object type to be supported for a Device Profile – Unless required by a specified Service
 - Eg. A B-BC (Building Controller) must support Trend BIBBs and so must also support Trend Objects
- The number of instances of any Object that a Device can support is not defined
- Each Object consists of a number of properties
- The properties fall into one of three categories
 - R – Required and Readable
 - W – Required and Writable
 - O - Optional

Example Analog Value Object Properties

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- | | | | |
|----------------------|-----|----------------------|---|
| • Object_Identifier | R | • Time_Delay | ○ |
| • Object_Name | R | • Notification_Class | ○ |
| • Object_Type | R | • High_Limit | ○ |
| • Present_Value | R/W | • Low_Limit | ○ |
| • Description | ○ | • Deadband | ○ |
| • Status_Flags | R | • Limit_Enable | ○ |
| • Event_State | R | • Event_Enable | ○ |
| • Reliability | ○ | • Acked_Transitions | ○ |
| • Out_Of_Service | R | • Notify_Type | ○ |
| • Units | R | • Event_Time_Stamps | ○ |
| • Priority_Array | ○ | • Profile_Name | ○ |
| • Relinquish_Default | ○ | | |
| • COV_Increment | ○ | | |
- The Object Types supported and the Object Properties supported must be listed in the Protocol Implementation Conformance Statement (PICS) for each device

Alarming

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- Alarming functions in BACnet are performed by Notification Class Objects
- Notification Class Objects include a Priority Property
 - Priorities range from 0 to 255 (0 = Lowest, 255 = Highest)
- There are two Alarm mechanisms available in BACnet
- Intrinsic Alarming
 - Intrinsic alarming implies that the alarm functionality is intrinsic within the object. The object therefore must support all of the optional alarming related properties
- Algorithmic Alarming
 - Algorithmic alarming indicates that the alarm function is performed by a separate algorithm in the controller and using Event Enrolment Object type

Priority Array – Commanding Points

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- Point Objects are only commandable if the Priority Array Property is supported
 - Priority Array allows arbitration of multiple simultaneous commands
 - Priority 1 = Highest, Priority 16 = Lowest
- | | |
|--------------------------------|----------------|
| • 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 |

Plan for a Successful Integration

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- For successful integration between vendors and system types the integration must be planned
- Vendors must have a good knowledge of their products and be prepared to communicate with each other
- Systems where the installation is staged over an extended period of time provide additional challenges – particularly where different vendors may provide each stage and original vendors are not involved
- The following section details some of the things that should be considered to achieve a successful integration

Integration Critical Items

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- **Critical Items – Must be managed “Internetwork Wide” for integration to even work**
 - Devices must support the functionality required by the site (PICS)
 - Devices must support the Data link / Physical layer standards appropriate for the site
 - Device IP Addresses must be unique but consistent (Plan the network architecture)
 - Network Masks must be consistent
 - Device MAC Addresses (MSTP Devices) must be unique for each MSTP network
 - Device Instance Numbers (Object Identifier Property) must be unique
 - Network Numbers must be unique

Integration – User Experience

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- **Usability Items – Required to provide a consistent User Experience**
- **Object Naming Definitions (Object_Name Property)**
 - Device Names (Controllers)
 - Point Names
 - Trend Names
 - Schedule Names
 - Calendar Names
- **Binary Objects Active / Inactive Text**
 - State texts are optional – Are they supported in the product
 - On/Off, Start/Stop, Enable/Disable, etc.
- **Multistate Objects State Texts**
 - State texts are optional – Are they supported in the product
 - On/Off/Auto, Start/Stop/Auto, etc.

Integration – User Experience

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- **System Wide Alarm Configuration must be consistent:**
 - **Alarm Priorities (Notification Class Priority Property)**
 - ◆ Similar equipment should use similar priorities
 - **Alarming Mechanisms**
 - ◆ (Similar equipment should use similar alarming philosophy)
 - **Alarming - Analog Objects**
 - ◆ Consistent To_Off_Normal, To_Fault, Return_To Normal configuration
 - ◆ Alarm Limits
 - ◆ Alarm Delays
 - ◆ Alarm Deadbands
 - ◆ Alarm enable and disable conditions

Integration – User Experience

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- **Alarming - Binary / Multistate Objects**
 - Alarm Delays
 - Alarm Conditions
 - ◆ Eg. For a fan fail to start only or fail to start and fail to stop
 - Alarm enable and disable conditions
- **Similar equipment should be represented using similar profiles for consistent operator interface:**
 - **Plant Operating Modes**
 - Occupied/ Unoccupied/ Standby/ After hours
 - Cooling / Heating/ Humidification/ De-Humidification modes
 - Economy modes
 - Etc.
 - **Setpoints**
 - **Tuning Parameters**
 - **Etc.**

Long Term Project Integrations

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- **Understand that BACnet compliance does not mean automatic integration into the graphics and menus of existing work stations**
- **Understand that if modifications to the original Vendor's field equipment are required the original vendor's participation may also be required**
- **Plan for Workstation integration works by original vendor or similarly qualified engineer**
- **Plan for all of the Integration at the start of the project – Integration Critical and Integration User Experience data should be part of all specifications for all stages of the project**

Summary

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- BACnet is an ASHRAE and ISO Standard Open Protocol for use with Building Management Systems
- BACnet provides the necessary building blocks for successful integration and interoperability between multiple systems and multiple vendors
- Successful integration means that the system actually works as well as providing a “Consistent Operator Experience”
- Achieving a successful integration requires careful management of system configuration and usability parameters for the life of the project
- BACnet is the springboard to the future for much more complex multi-system / multi-vendor integrations in Building Management Systems

Additional Information?

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- Useful Web sites to find more information relating to the BACnet standard, BACnet compliance testing and BACnet compliant products
- ASHRAE BACnet SSPC 135
 - <http://www.bacnet.org>
- BACnet International – BACnet Testing Laboratories
 - <http://www.bacnetinternational.org>

