Review of Day 1

- BEST Center Mission Goals

- Overview of the ALC System

- ALC WebCTRL 6.1 with Simulator

- ALC System Architecture

- MCC DACUM & BAS IT Skills

- GPTC BAS Program Course Sequencing

- Introduction to BACnet

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Preview of Day 2

- More on BACnet
- ALC System Software / Tools
- WebCTRL 6.1 Introduction
- WebCTRL 6.1 Hands On
- Advisory Boards Discussion
- Process for Developing New Curriculum from JTAs / DACUMs
- Recruiting Students Discussion
- Recruiting Instructors Discussion
- Triatek Corporation

BEST CTR BAS Workshop III–BACnet Basics 2

June 18, 2015

BACnet Basics 2

BACnet Review

- Object-oriented protocol

- Think of it as a language like English

- ASHRAE, ANSI, ISO standard

- Industry-leading communication protocol

- Means of standardizing certain objects and services

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BACnet Review

- NOT a 'Plug and Play' standard
- NOT uniformly applied and/or embraced across different manufacturers
- NOT intended for full and indiscriminate interchangeability between manufacturers
- NOT dictate configuration and commissioning tools
- NOT dictate programming languages or tools
- NOT dictate the interoperation criteria for any single BACnet node (this is left to the manufacturers to determine)

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BACnet Review

- Original ASHRAE committee formed in 1987 – Standard 135: BACnet: *A Data Communication Protocol for Building Automation and Control Networks*

- ASHRAE / ANSI / ISO Standard

- Standing Standard Project Committee (SSPC) 135 – subdivided into many working groups

- Responsibilities
  - Interpretations / Clarifications
 - On-going revisions to the standard
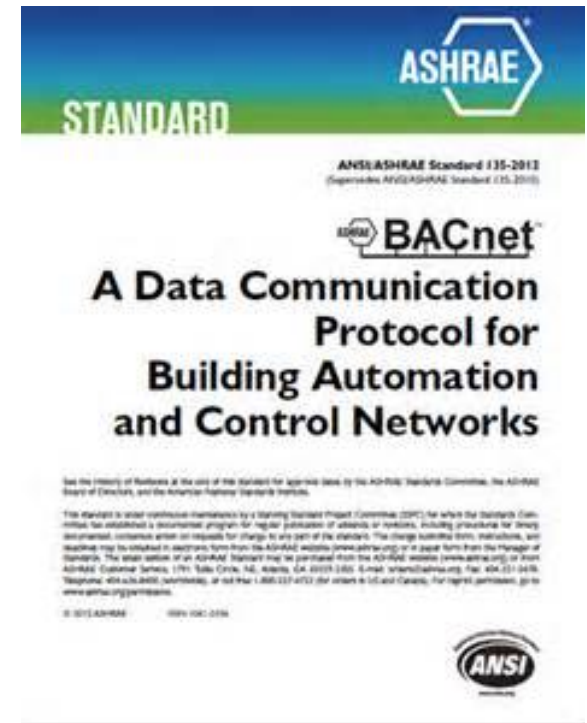
# BACnet Review

Why teach BACnet in BAS programs?

- Industry-leading communication protocol

- BACnet standard objects and services are common to any BACnet product – Student knowledge becomes transportable

- BACnet builds well upon object-oriented programming, networking, and control theory courses

- BACnet instruction should be an integral part of any BAS program
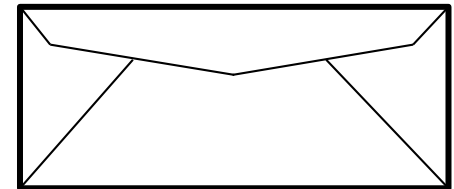
BACnet Review
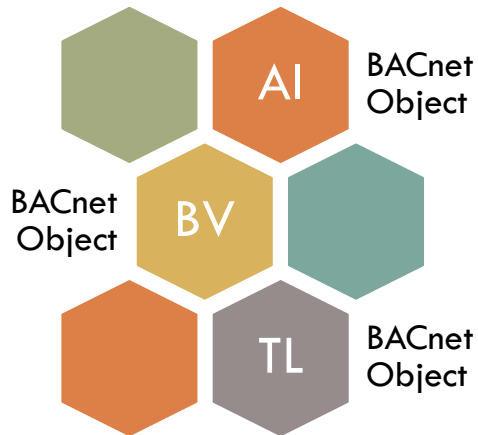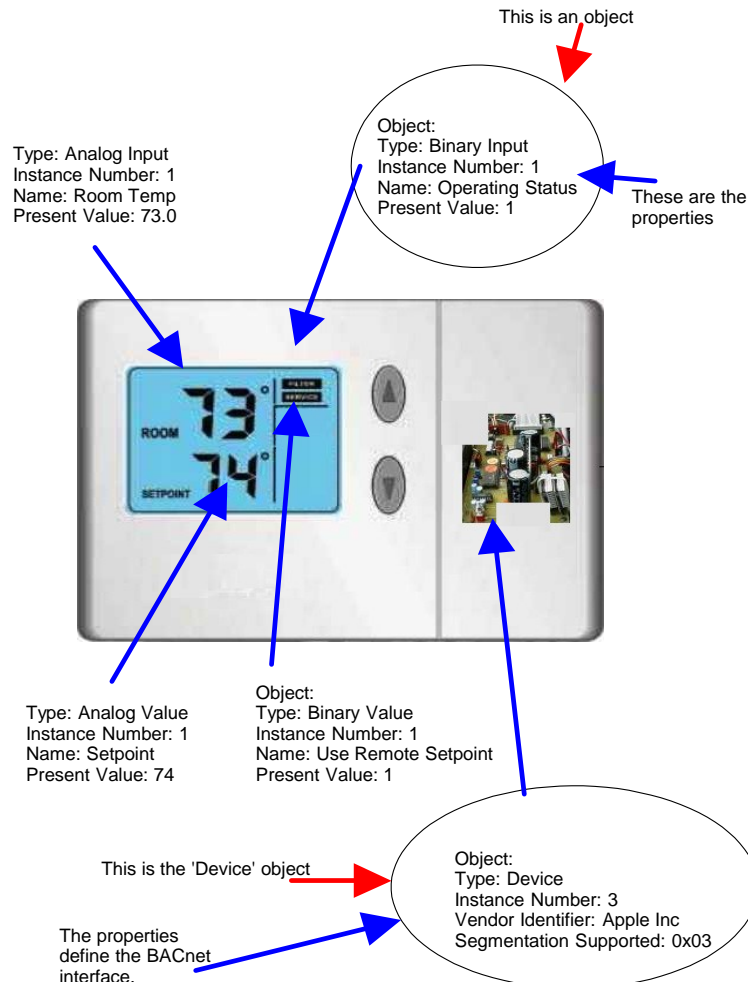
Data Representation
Objects
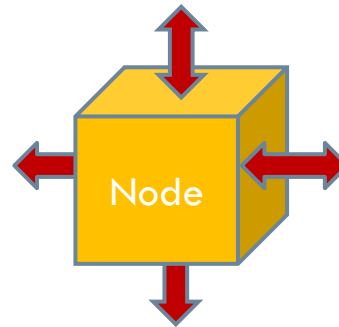
Data Requests
Services

Messages across
Comm. standards
Transport

A bit more on objects courtesy of Paul Flor

This is an object

Object:
Type: Binary Input
Instance Number: 1
Name: Operating Status
Present Value: 1

These are the properties

Type: Analog Input
Instance Number: 1
Name: Room Temp
Present Value: 73.0

Type: Analog Value
Instance Number: 1
Name: Setpoint
Present Value: 74

Object:
Type: Binary Value
Instance Number: 1
Name: Use Remote Setpoint
Present Value: 1

This is the 'Device' object

The properties define the BACnet interface.

Object:
Type: Device
Instance Number: 3
Vendor Identifier: Apple Inc
Segmentation Supported: 0x03

Chipkin
Automation Systems

BACnet Objects and Properties cont'd

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.

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.

Useful Tip

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

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BACnet Review

- Controller, gateway, user interface which uses and understands BACnet protocol

- Every BACnet device must have a **device object**

- The device object must have a unique number across the entire BACnet network where it resides: the unique number is known as the *device instance*

BACnet Review

- All information in BACnet systems is organized in the structure of objects

- Objects can have a physical component physical like analog, digital inputs / also can be completely virtual like trend logs, schedules

- 54 standard objects types

- Non-standard object types allowable

BACnet Review

Analog Input

Analog Output

Analog Value

Binary Input

Binary Output

Binary Value

Calendar

Command

Device

BACnet Review

10-bit object type

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
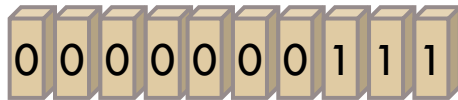
Object Type
7 – Command Object

22-bit object instance

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
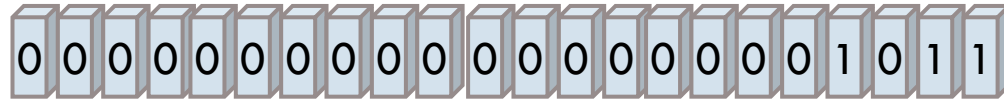
Object Instance

- 32-bit number BACnet object identifier
- 0-127 reserved for standard objects / 128-1023 reserved for non-standard
- BACnet limit of 4,194,303 devices per network
- Each individual object is an "instance" of the object type

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BACnet Review

Property Identifier	Value
Object_Identifier	(Device, Instance 2749)
Object_Name	"RE1 Penthouse"
Object_Type	DEVICE
System_Status	(OPERATIONAL)
Vendor_Name	"Contemporary Controls"
Vendor_Identifier	245
Model_Name	"BASR-8M"
Firmware_Revision	"1.0"
Application_Software_Version	"1.0"
Protocol_Version	2
Protocol_Revision	
Protocol_Services_Supported	(List of services)
Protocol_Object_Types_Supported	(List of object types)
Object_List	(List of all the objects)
Max_APDU_Length_Accepted	1476
Segmentation_Supported	(NO SEGMENT)
APDU_Timeout	(3000 MSEC)
Number_Of_APDU_Retries	0
Device_Address_Binding	
Database_Revision	1

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BACnet Review

- BACnet services fall into one of five categories
  - Object Access
  - Device Management
  - Alarm & Event
  - File Transfer
  - Virtual Terminal

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BACnet Object Services

- Object Access Services
  - Read / write properties
  - Create / delete objects
  - Search for objects & properties
  - Manipulate lists of data
- Device Management Services
  - Remote control of nodes
  - Discovery / Initialization
  - Backup / Restore

BACnet Review
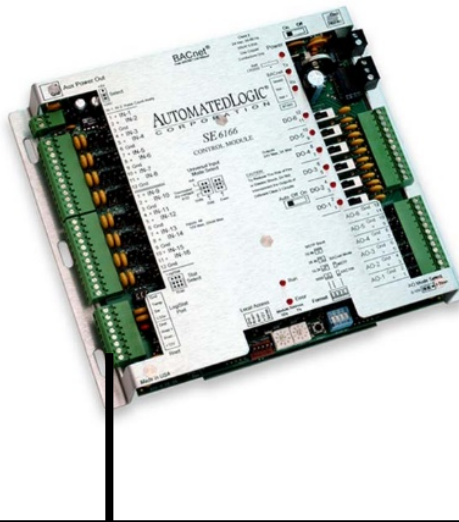
Client: Requester of info

Server: Provider of info

ReadProperty {obj. identifier = AI2,
prop identifier = Present value}

Reply {obj. identifier = AI2,

prop identifier = Present value, value = **72.5**}
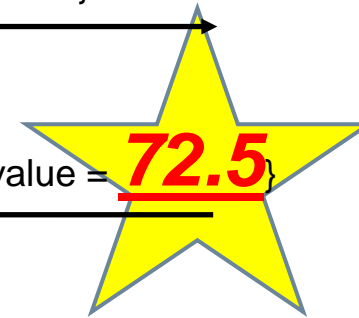
ReadProperty is a commonly used Object Access service
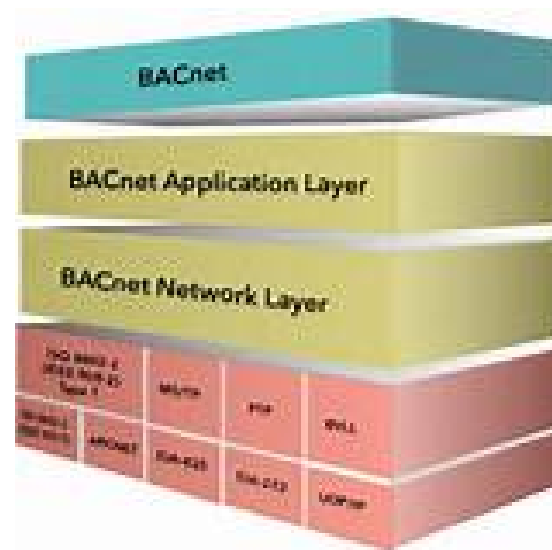
BACnet Review

BACnet Review

BACnet Review

BACnet 2012 standard – 7 types of networks

- BACnet / IP
- BACnet MS/TP
- BACnet ISO 8802-3
- BACnet on ARCNET
- BACnet PTP
- BACnet over LonTalk
- BACnet over Zigbee

BACnet Review

- BACnet doesn't address configuration tools / troubleshooting methods

- Vendors have own solutions

- Some work only on proprietary systems, others work more generally

- Discovery of nodes, provide info on node, pull down list of objects & properties

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ALC System Architecture
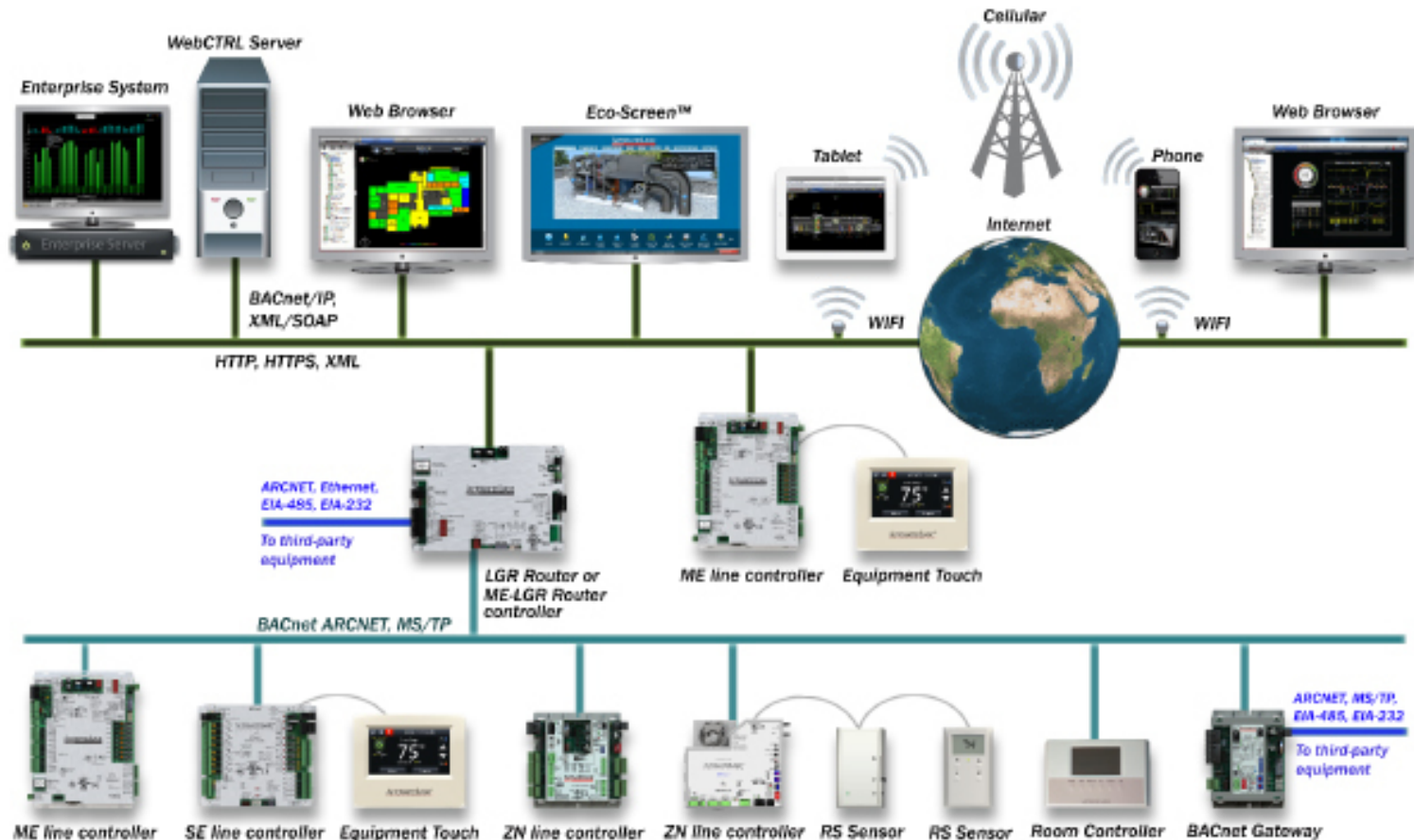
BACnet Testing

- ANSI / ASHRAE 135.1: *Method of Test for Conformance to BACnet*

- BACnet Testing Laboratory (BTL) set up by the BACnet Manufacturers Association to test to the standard

- Began testing products in 2001 for conformance

- BTL now part of BACnet International

BACnet Interoperability

- Interoperation requires at least two disparate elements working together in some fashion

- To test for interoperation, testing criteria are required

- In BACnet, the applied criteria are *BACnet Interoperability Building Blocks* (BIBBs)

- BIBBs always come in pairs (1 for the requester / 1 for the responder)

- BIBBs are associated with some specific BACnet feature of interoperability

BACnet Interoperability

- BACnet defines six areas of interoperability
    - Data Sharing (DS-)
    - Alarm & Event Management (AE-)
    - Scheduling (SCHED-)
    - Trending (T-)
    - Device & Network Management (DM-)
    - Network Management (NM-)
- BIBBs act as the line-by-line interoperability features under each interoperability area as the next table shows…

# BACnet Interoperability

Simple examples of BIBBs

Area of Interoperability	Client (requester) -A	Server (responder) -B
Data Sharing	ReadProperty-A (DS-RP-A)	ReadProperty-B (DS-RP-B)
Alarm & Event Mgmt	ACK-A (AE-ACK-A)	ACK-B (AE-ACK-B)
Scheduling	Scheduling-A (SCHED-A)	Scheduling-B (SCHED-B)
Trending	Automated Trend Retrieval-A (T-ATR-A)	Automated Trend Retrieval-B (T-ATR-B)
Device & Network Mgmt	Restart-A (DM-R-A)	Restart-B (DM-R-B)

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BACnet Interoperability

Client: Requester of info   Server: Provider of info
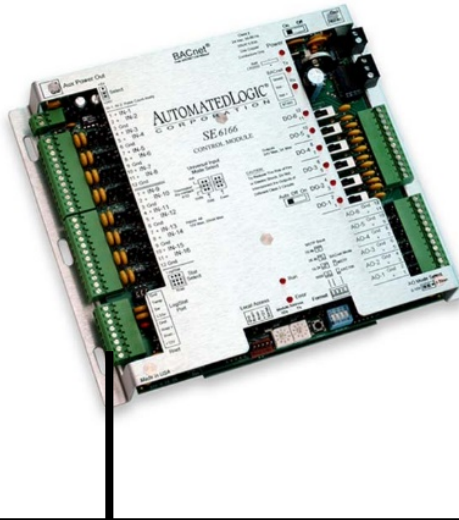
ReadProperty {obj. identifier = AI2,
      prop identifier = Present value}

Reply {obj. identifier = AI2,
prop identifier = Present value, value = 73.5}

For this operation to work, the client must be
DS-RP-A and the server must be DS-RP-B
This would represent one BIBB

Specifying BACnet Interoperability

- Engineers can use BIBBs to meticulously specify interoperability line-by-line, but… who wants to do all that work

- The BACnet standard suggest a number of *device profiles* for interoperability in the most commonly used nodes

- *Device profiles* only deal with interoperability of the nodes

BACnet Device Profiles (partial example)

OWS (B-OWS)	Bldg. Ctrllr (B-BC)	Appl. Ctrllr (B-AAC)	ASC (B-ASC)	Smart Act (B-SA)	Smart Sens (B-SS)
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-A	DS-WP-A,B	DS-WP-B	DS-WP-B	DS-WP-B	
AE-N-A	AE-N-I-B	AE-N-I-B			
AE-ACK-A	AE-ACK-B	AE-ACK-B			
T-VMT-A	T-VMT-I-B				
SCHED-A	SCHED-E-B	SCHED-I-B			

BACnet Protocol Implementation & Conformance Statements (PICS)

- BACnet defines a standardized datasheet for disclosing BACnet features in a given device

- These datasheets are known as PICS

- BIBBs form an important element of the PICS

- Important tool for consulting engineers, customers, vendors and others

Free Learning Resources

www.bacnet.org

www.bacnetinternational.org

www.automatedbuildings.com

www.chipkin.com

www.kele.com

www.wireshark.org

www.atpgroupinc.com

References

National Joint Apprenticeship & Training Committee, 2009. *Building Automation: System Integration with Open Protocols*. American Technical Publishers: Orlando Park, IL.

BACnet International, 2014. *Introduction to BACnet For Building Owners and Engineers*. BACnet International: Marietta, GA.

End of Introduction