

# BACnet: Its Origins and Evolution



# BACnet: 1964 – ????

- 1964 – 1981 The Pre-Pre-History
  - 1981 – 1987 The Pre-History
  - 1987 – 1995 The Development
  - 1995 – 2015 The Evolution
  - 2016 – ????
- Future Directions

# The Pre-Pre-History – 1964 - 1981

- 1964 - Honeywell Selectrographic 6 installed
- 1975 – Diskless IBM System/7 arrives
- 1977 – The first System/7 with a hard disk and software from the IBM Palo Alto Research Center





# The Pre-History – 1981-1987

- DDC arrives at Cornell in the form of JCI DSC-8500s
- Everyone wanted to sell us DDC – but none of it could interoperate!
- The ASHRAE struggle begins and I attend my first meeting...

# The Development – 1987-1995

- An "SPC" is formed and meets in Nashville
- Who is in? Who is out?
- We finally publish ANSI/ASHRAE Standard 135 in 1995!

Are we done yet? No! We're just starting.

# Twenty Years of Evolution – 1995-2015

- What the BACnet standard was –  
and is...



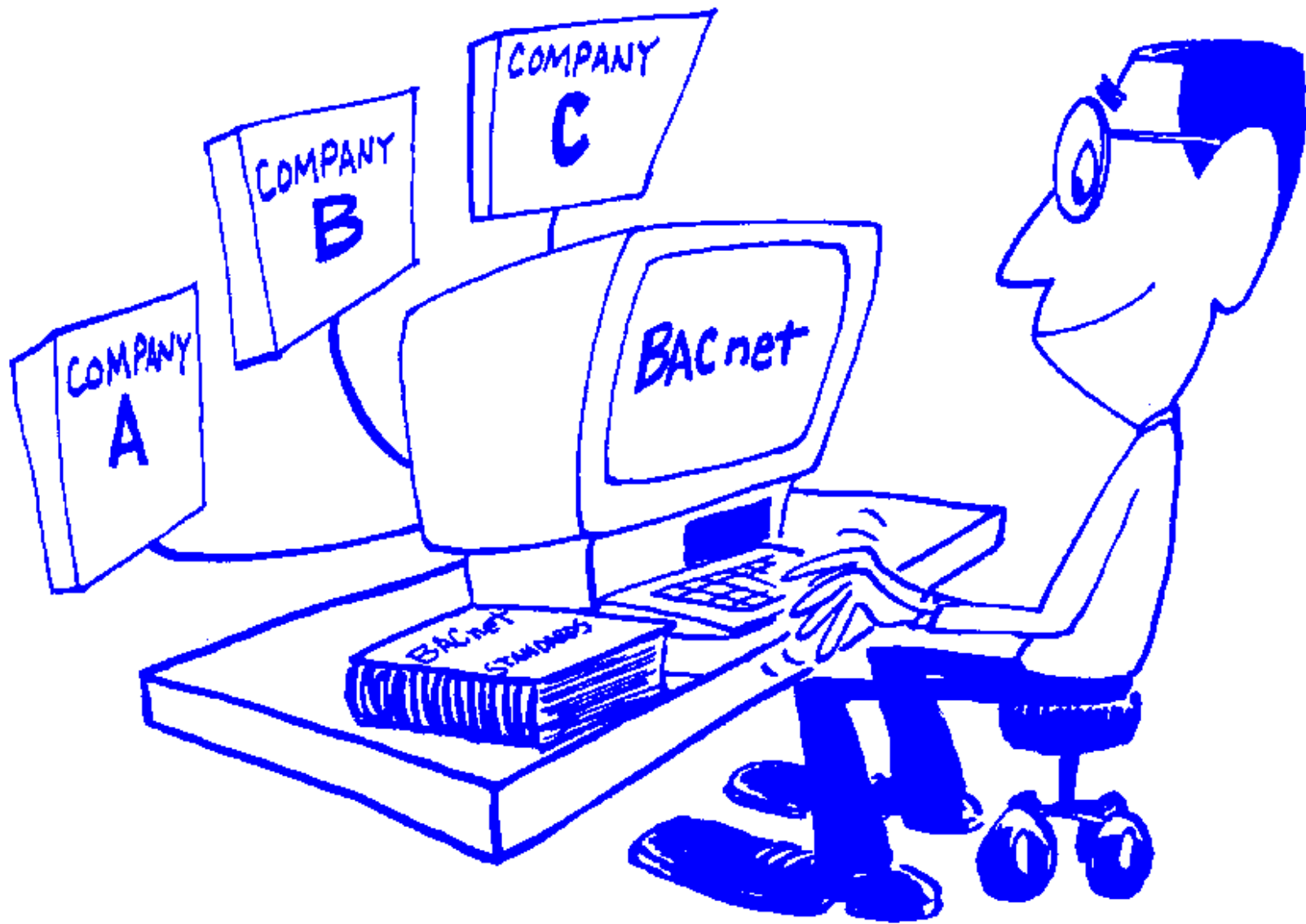
A Data Communication Protocol  
for **B**uilding **A**utomation and  
**C**ontrol **net**works

Only standard protocol  
specifically for buildings.





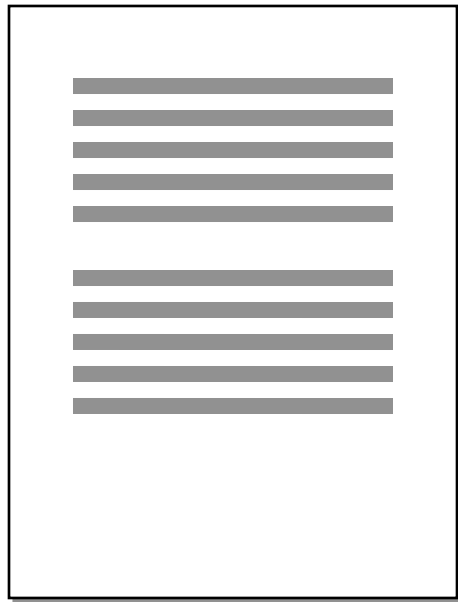




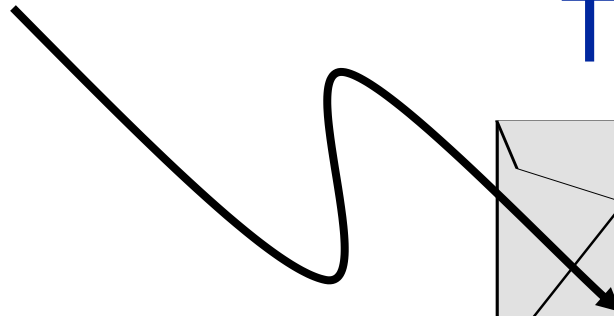
# **Protocol rules apply to:**

- **Messages and their format**
- **Networking options  
(LANs, WANs, Dial-up, etc.)**
- **Joining networks together  
to form "internetworks"**

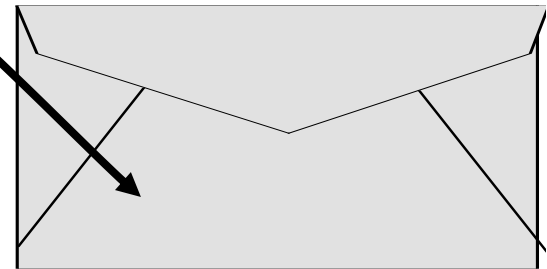
# A Protocol's Two Main Parts



Application  
Message



Transport

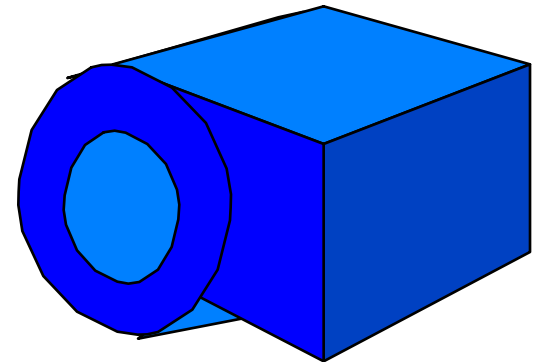
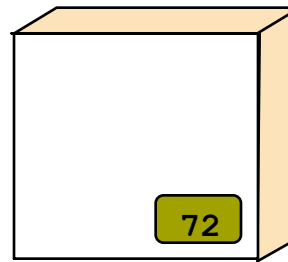
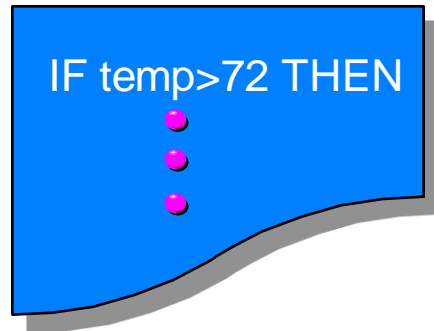


**BACnet provides the capability to communicate about the "*application*" of "*building automation*" in all its diversity: HVAC, lighting, security, access control, fire detection, utility interaction, etc., by means of **Objects, Messages, and Transport Options.****



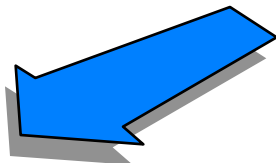
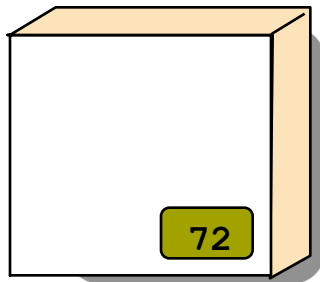
# Objects

**Objects represent physical inputs, outputs and software processes**



# Objects

**Each object is characterized by a set of “properties” that describe its behavior or govern its operation**



Object_Name	SPACE TEMP
Object_Type	ANALOG INPUT
Present_Value	72.3
Status_Flags	Normal, Out-of-Service
High_Limit	78.0
Low_Limit	68.0

# Objects

BACnet 2012 defines a collection of 54 standard objects

Access Door

Accumulator

Analog Input

Analog Output

Analog Value

Averaging

Binary Input

Binary Output

Binary Value

Calendar

Command

Device

Event Enrollment

Event Log

File

Group

Life Safety Point

Life Safety Zone

Load Control

Loop

Multi-state Input

Multi-state Output

Multi-state Value

Notification Class

Program

Pulse Convertor

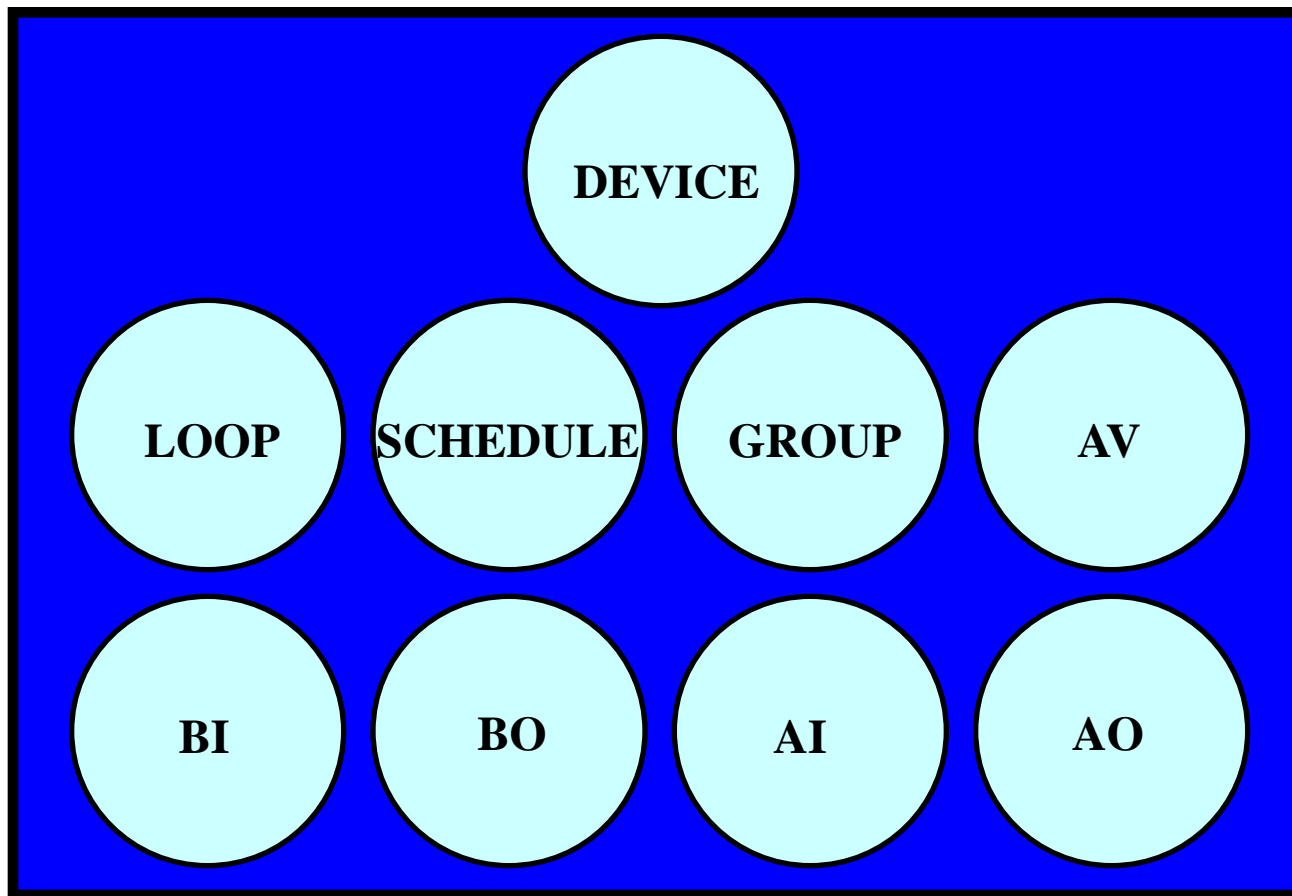
Schedule

Structured View

Trend Log

Trend Log Multiple

# BACnet Device



# Messages

- **Object Access Services**
- **Alarm and Event Services**
- **File Access Services**
- **Remote Device Management Services**
- **Miscellaneous**

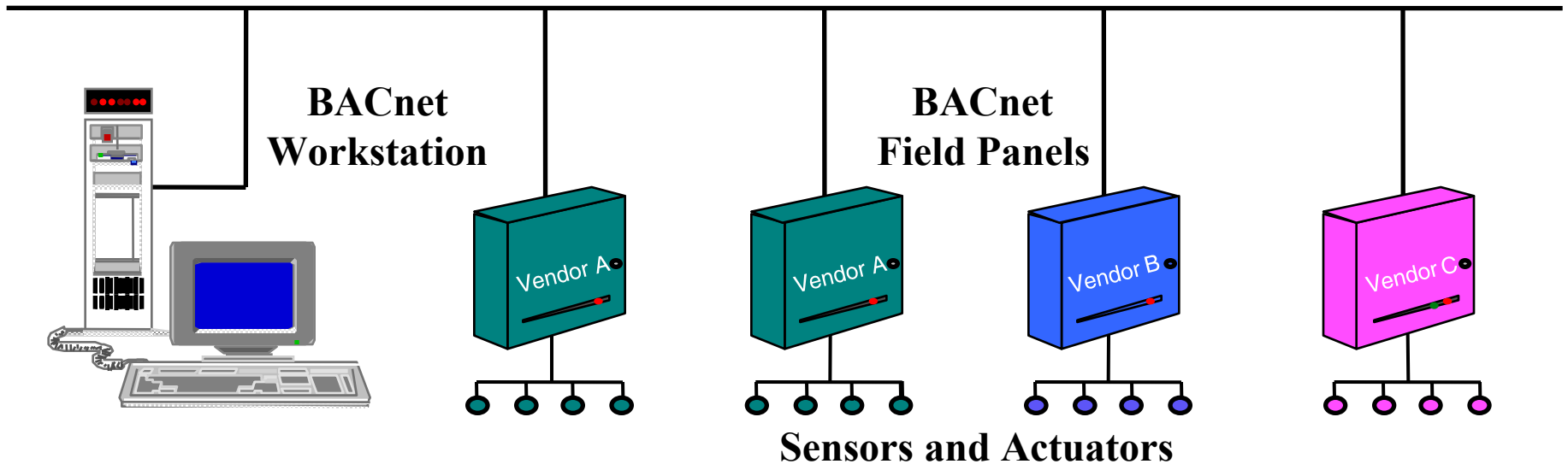


# Transport Options

- **Ethernet**
- **ARCNET**
- **Master-Slave/Token-Passing (MS/TP)**
- **Point-to-Point (PTP)**
- **Echelon's LonTalk**
- **BACnet/IP (Internet Protocol)**
- **BACnet/WS (Web Services)**
- **ZigBee**

# "Native" BACnet

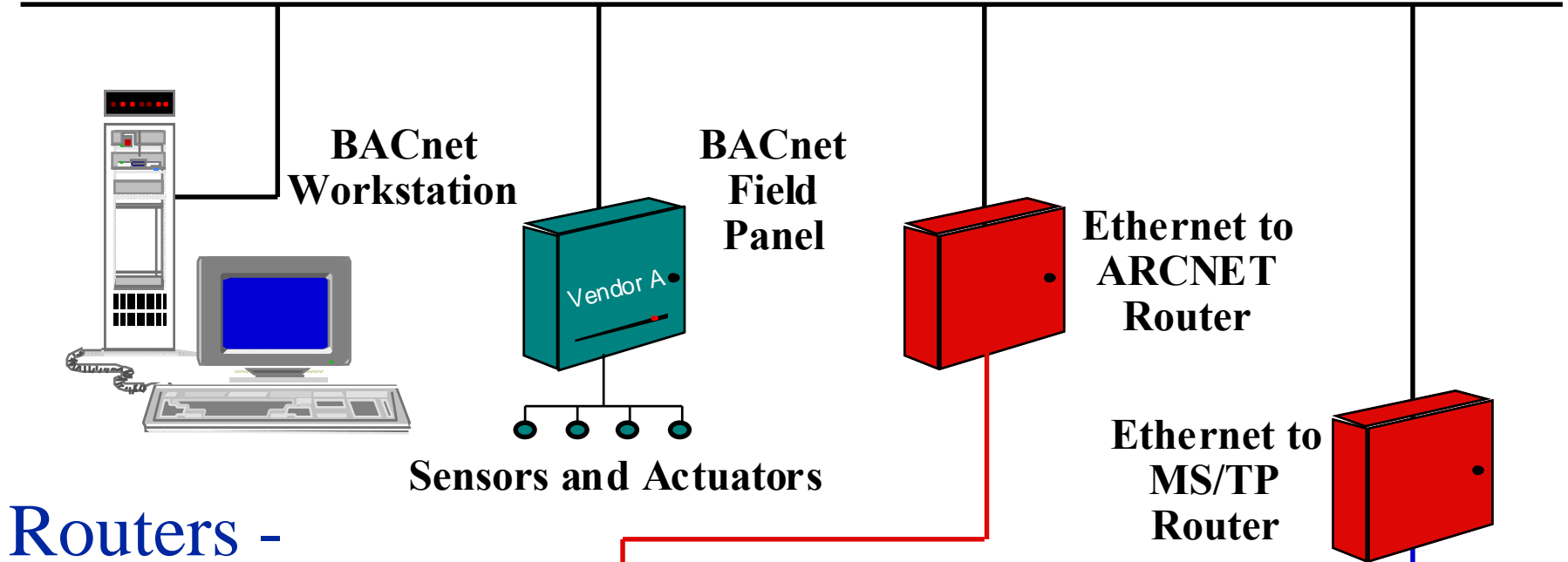
BACnet LAN - Ethernet, ARCNET, MS/TP, LonTalk, BACnet/IP or ZigBee



**Native BACnet devices provide BACnet communications directly, device to device**

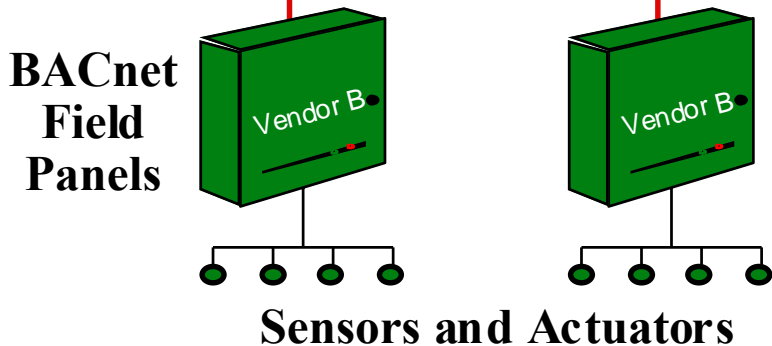
# BACnet LAN - Ethernet

Net 1

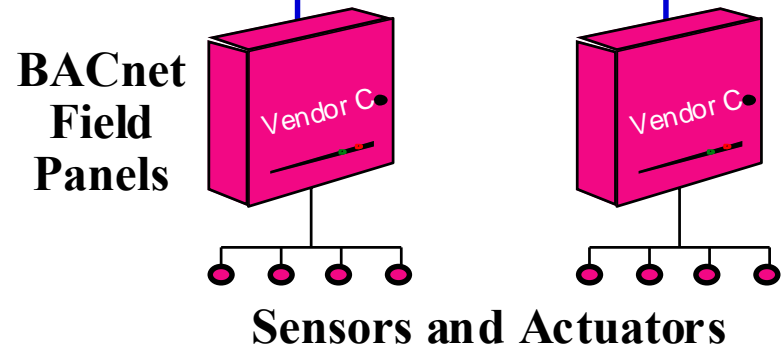


Routers -

## BACnet LAN - ARCNET Net 2

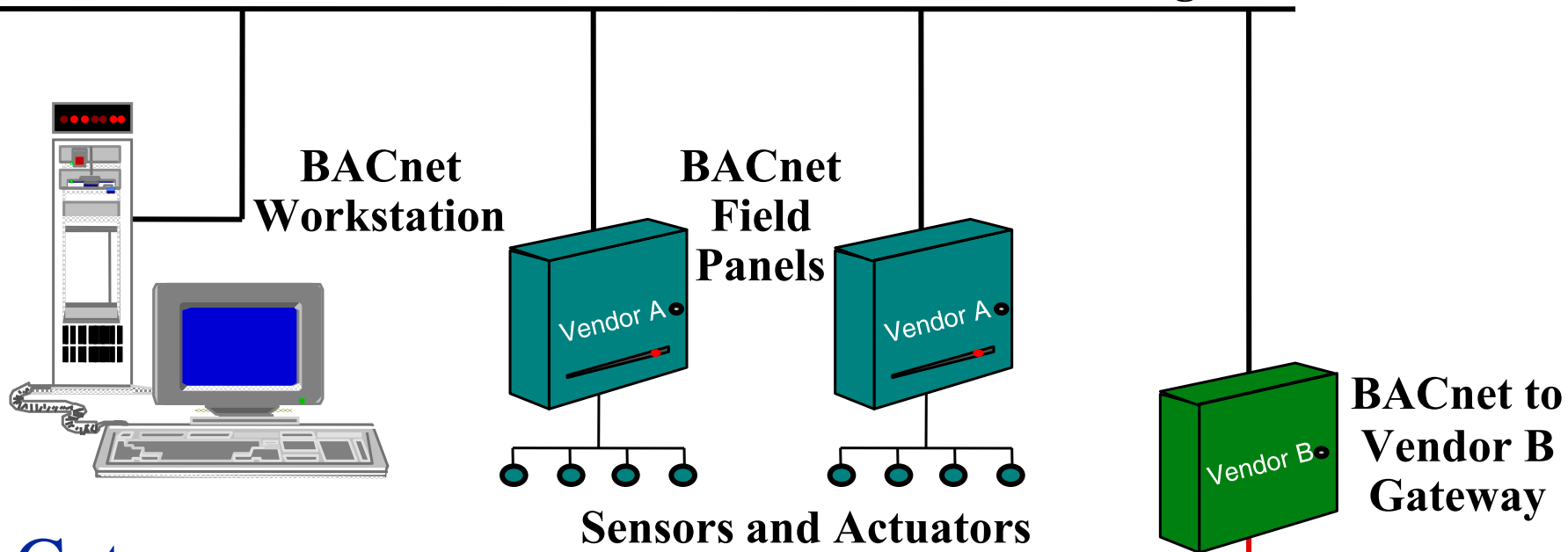


## BACnet LAN - MS/TP Net 3

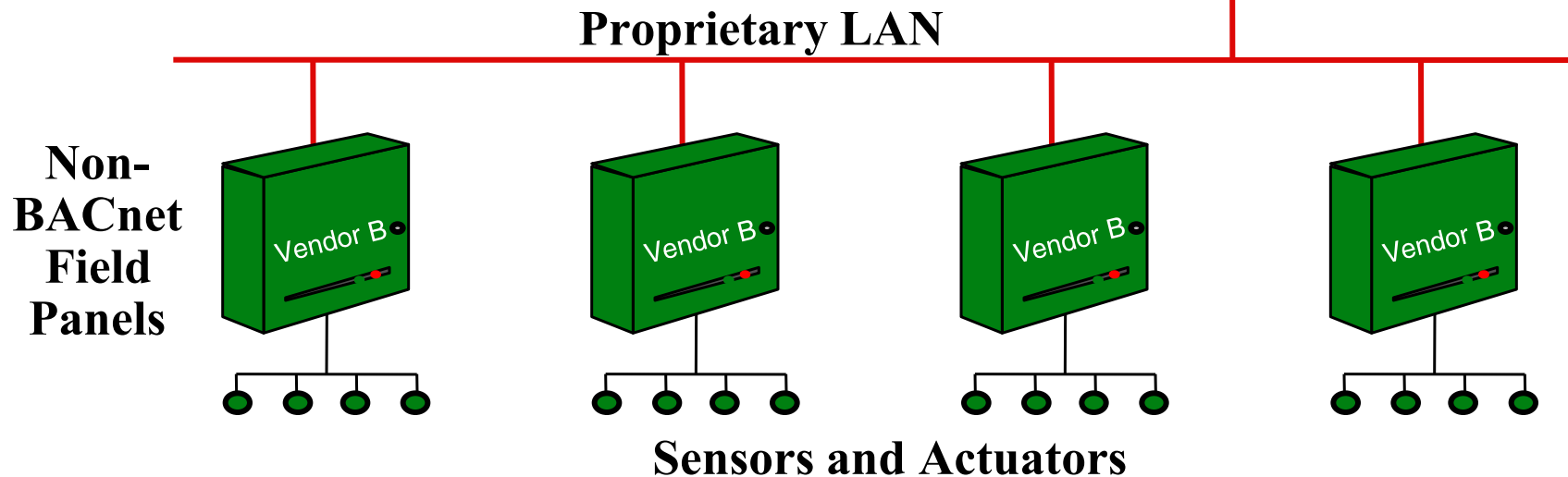


"re-package" BACnet messages and re-transmit them unchanged

# BACnet LAN - Ethernet, ARCNET, MS/TP, LonTalk or ZigBee



## Gateways -



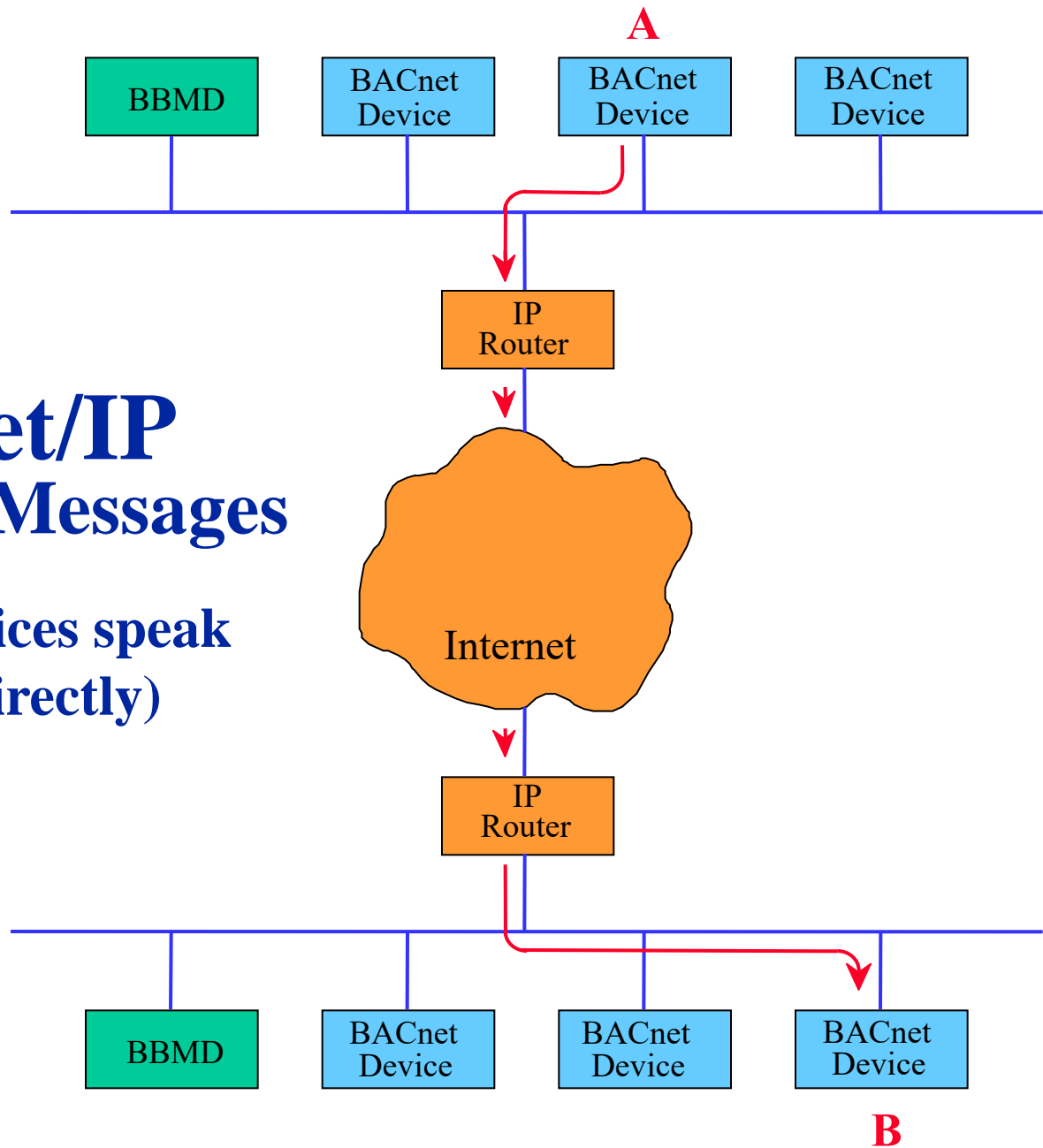
must "translate" messages before retransmission

**BACnet, of course, also  
works with the  
Internet...**

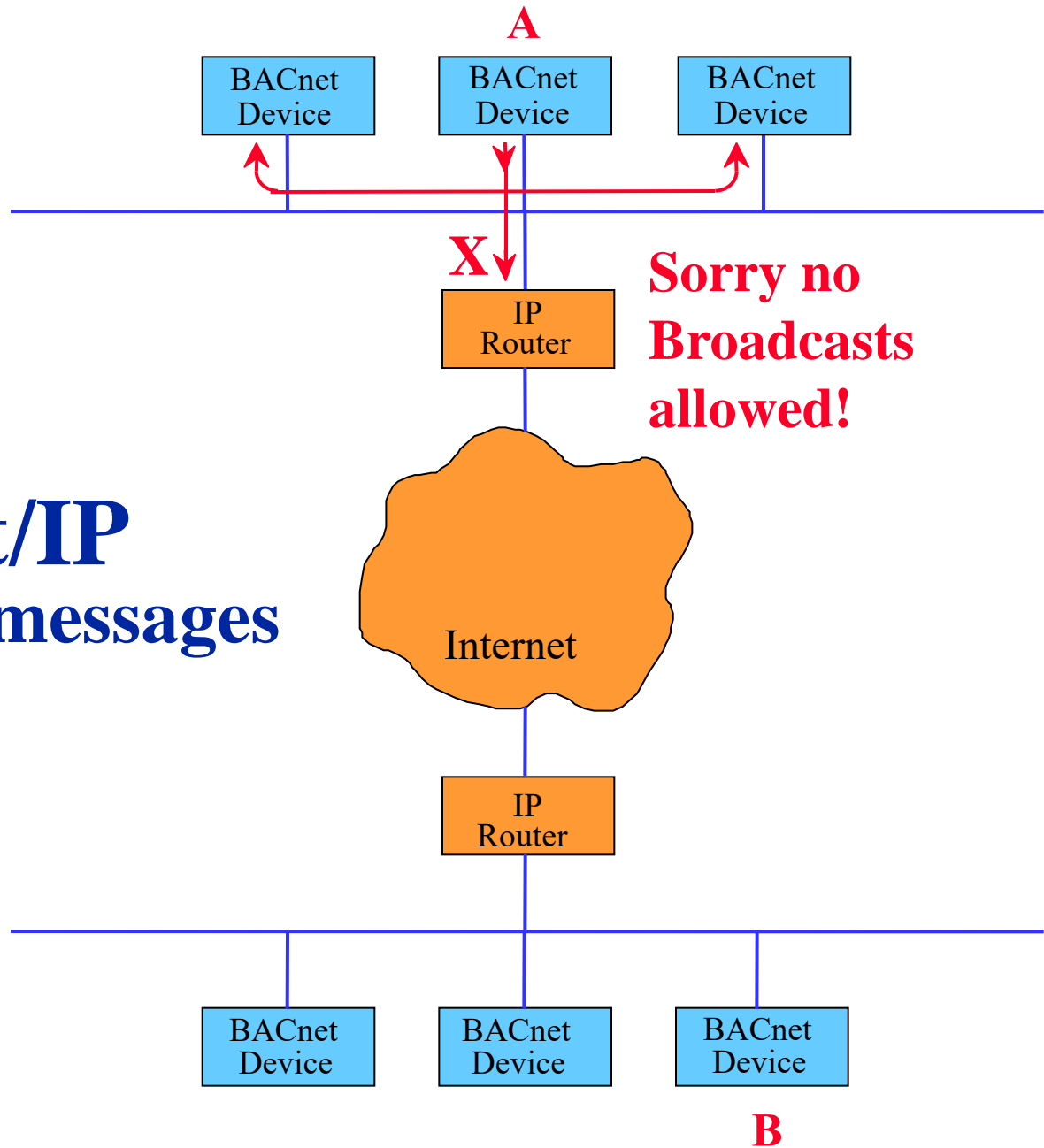


# BACnet/IP "Unicast" Messages

(BACnet devices speak  
using IP directly)



# BACnet/IP "Broadcast" messages



**Enter the "BACnet Broadcast Management Device" or "BBMD".**

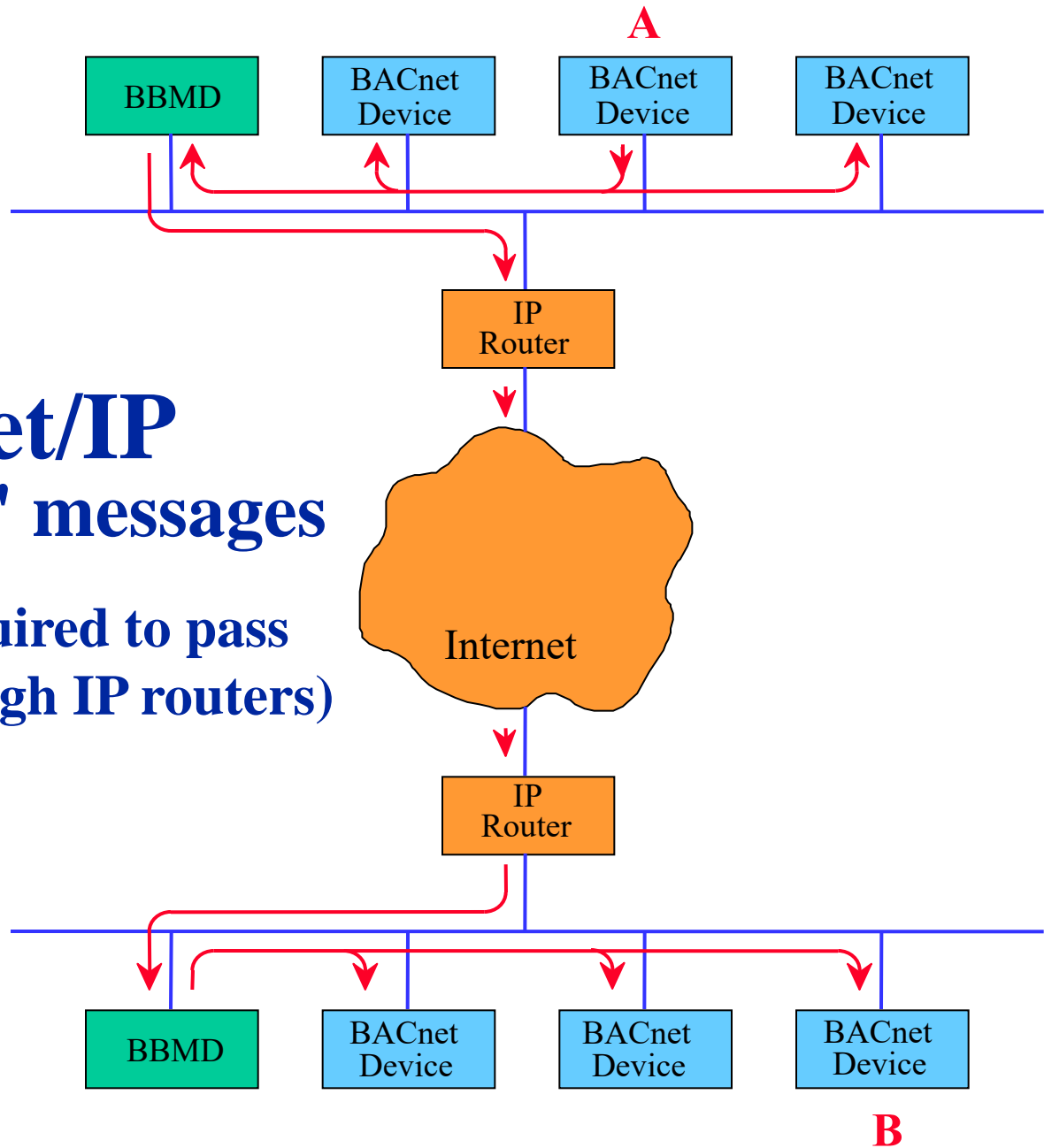
**It intercepts broadcasts and sends them as unicast messages to its peer(s).**

**These *are* accepted by the IP Gateways!**

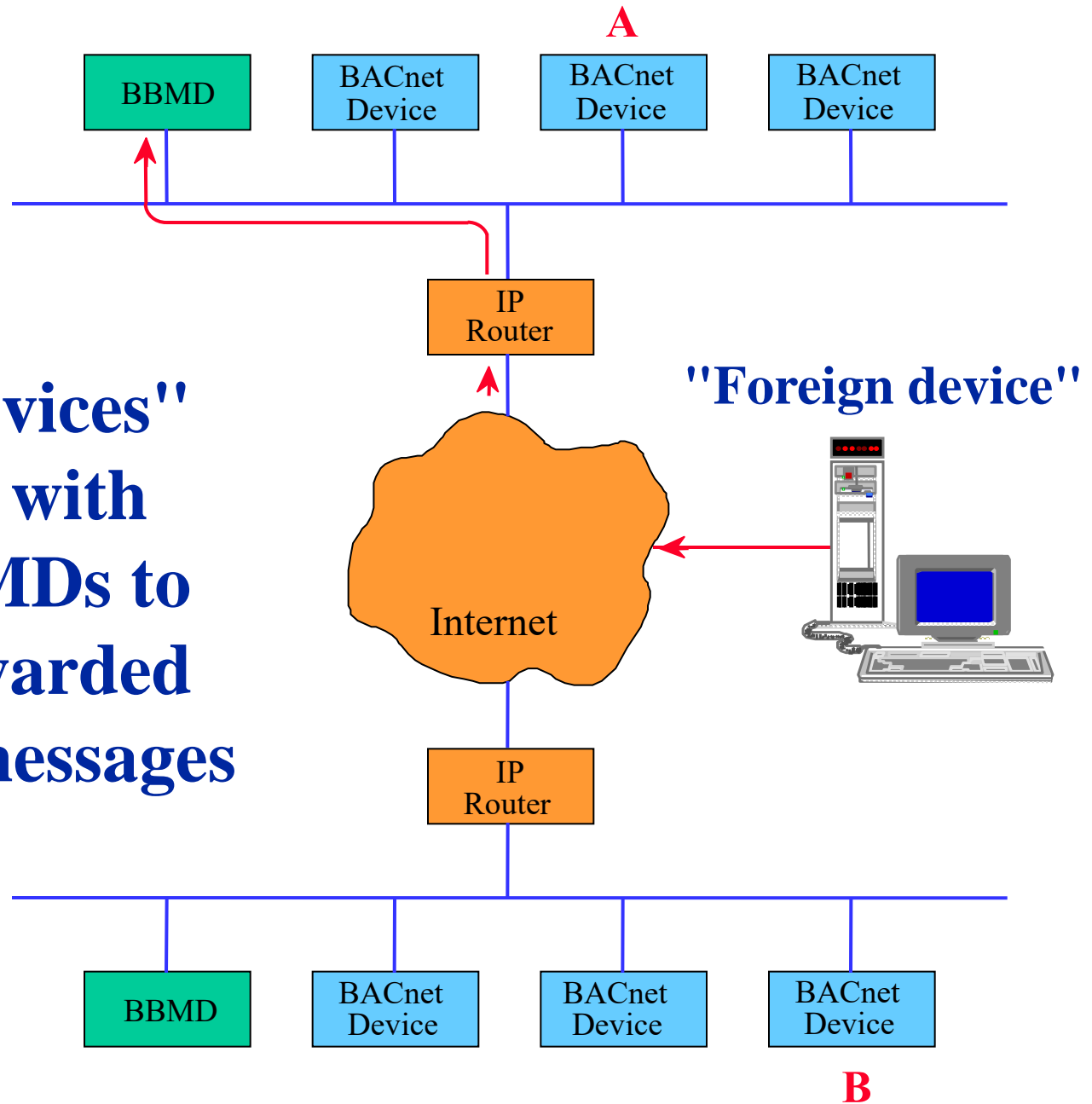
# BACnet/IP

## "Broadcast" messages

("BBMD" required to pass broadcasts through IP routers)



**"Foreign devices"  
can register with  
certain BBMDs to  
receive forwarded  
broadcast messages**





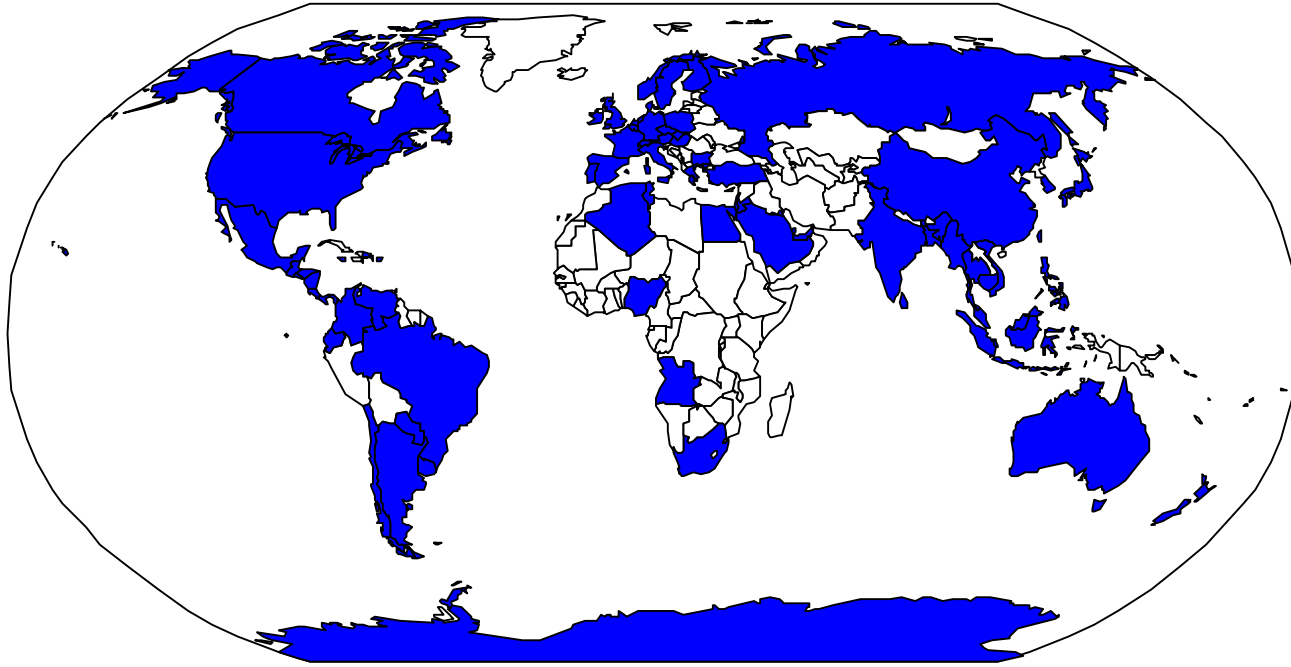
**Support for IPv6 was added in March (last month) in Addendum 135-2012aj – so things may get easier in the future?!**

In summary,



Object Model +  
Messages +  
LANs and WANS

# Where is BACnet being used?



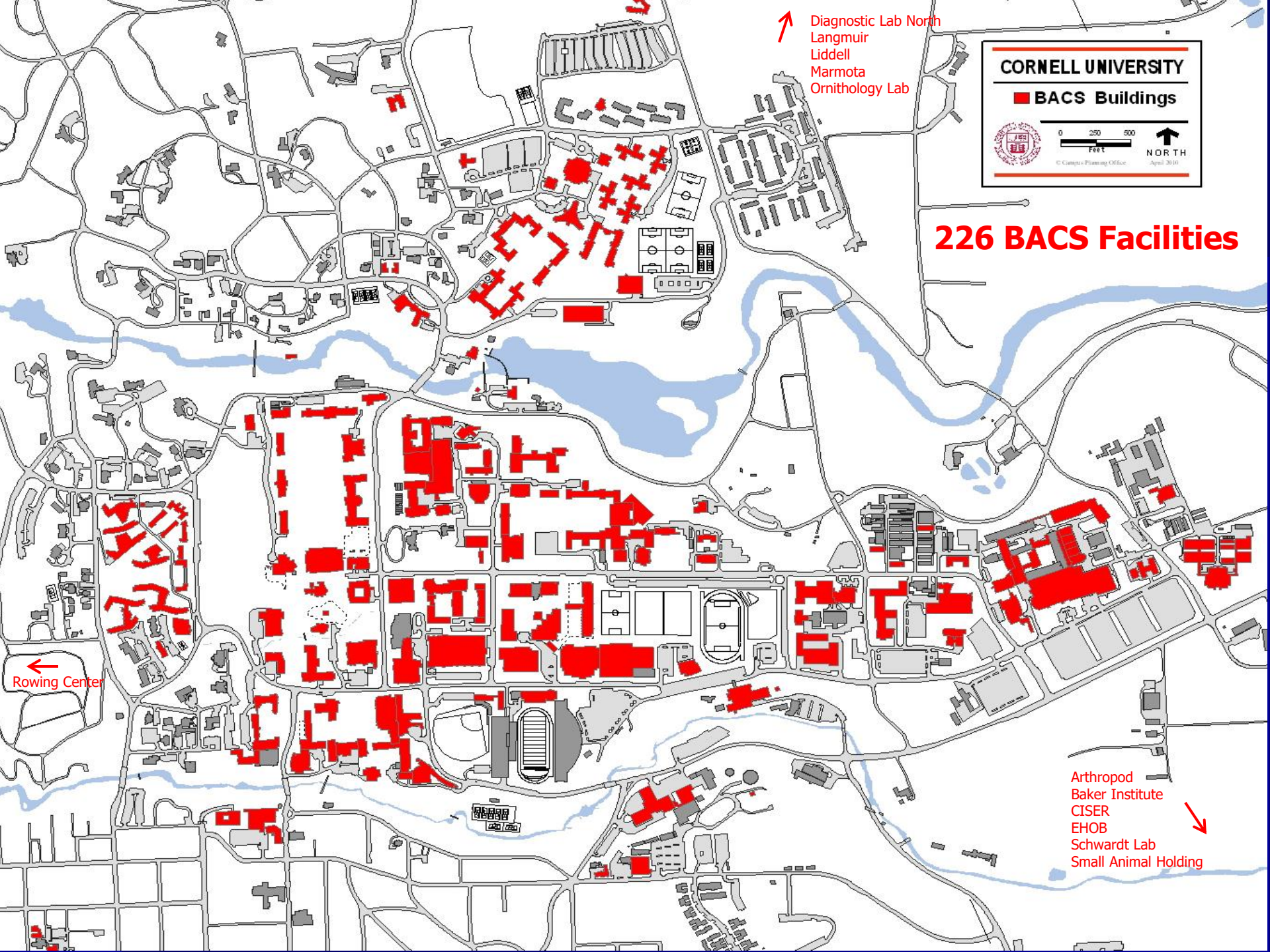
**More than 100,000 systems are installed today world-wide in 82 countries and on all continents. About 10,000 involve multiple vendors.**



# *BACnet on Capitol Hill*







**CORNELL UNIVERSITY**

**■ BACS Buildings**

0 250 500  
Feet

**NORTH**  
April 2010

© Campus Planning Office

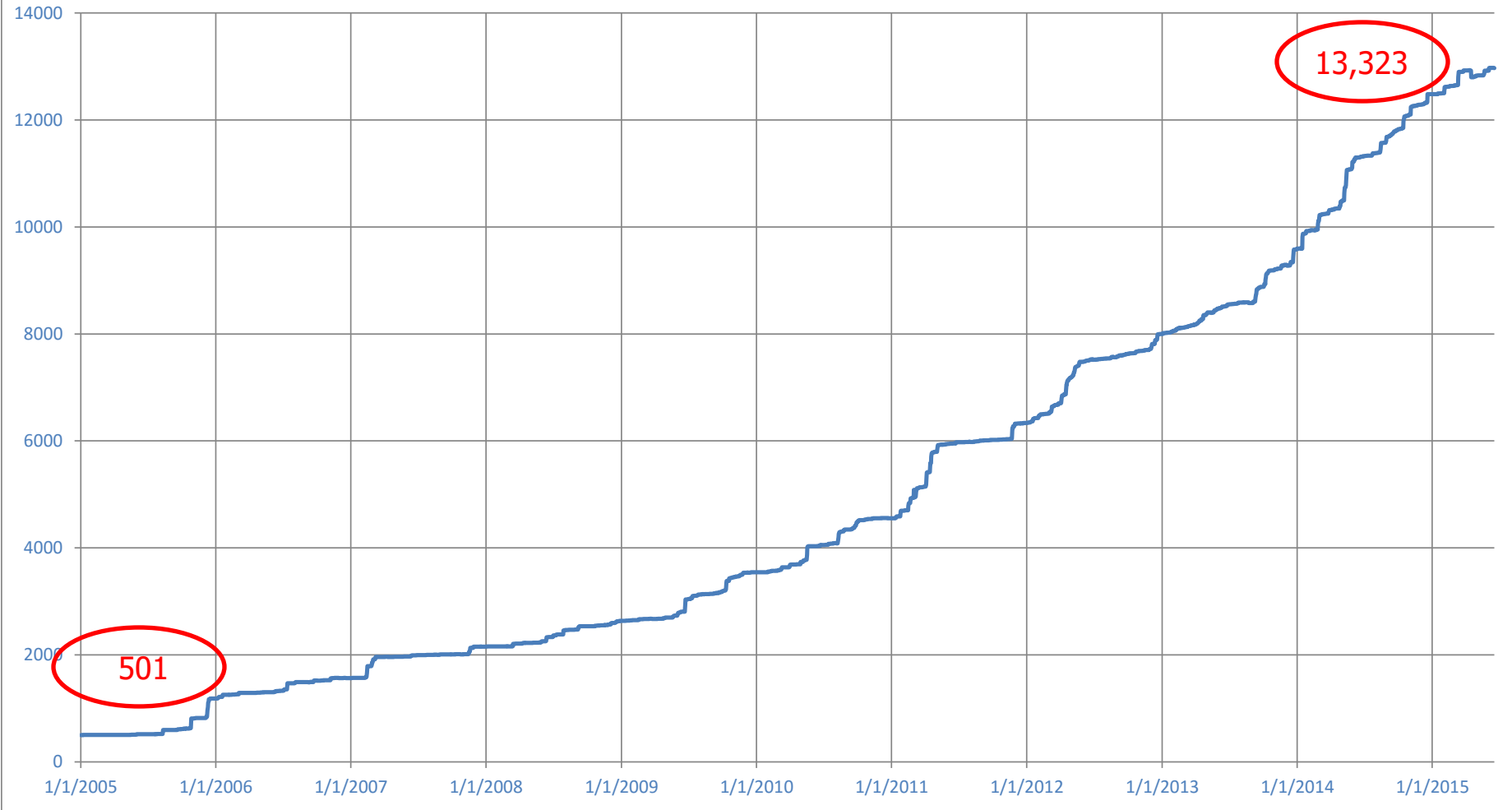
**226 BACS Facilities**

↑ Diagnostic Lab North  
Langmuir  
Liddell  
Marmota  
Ornithology Lab

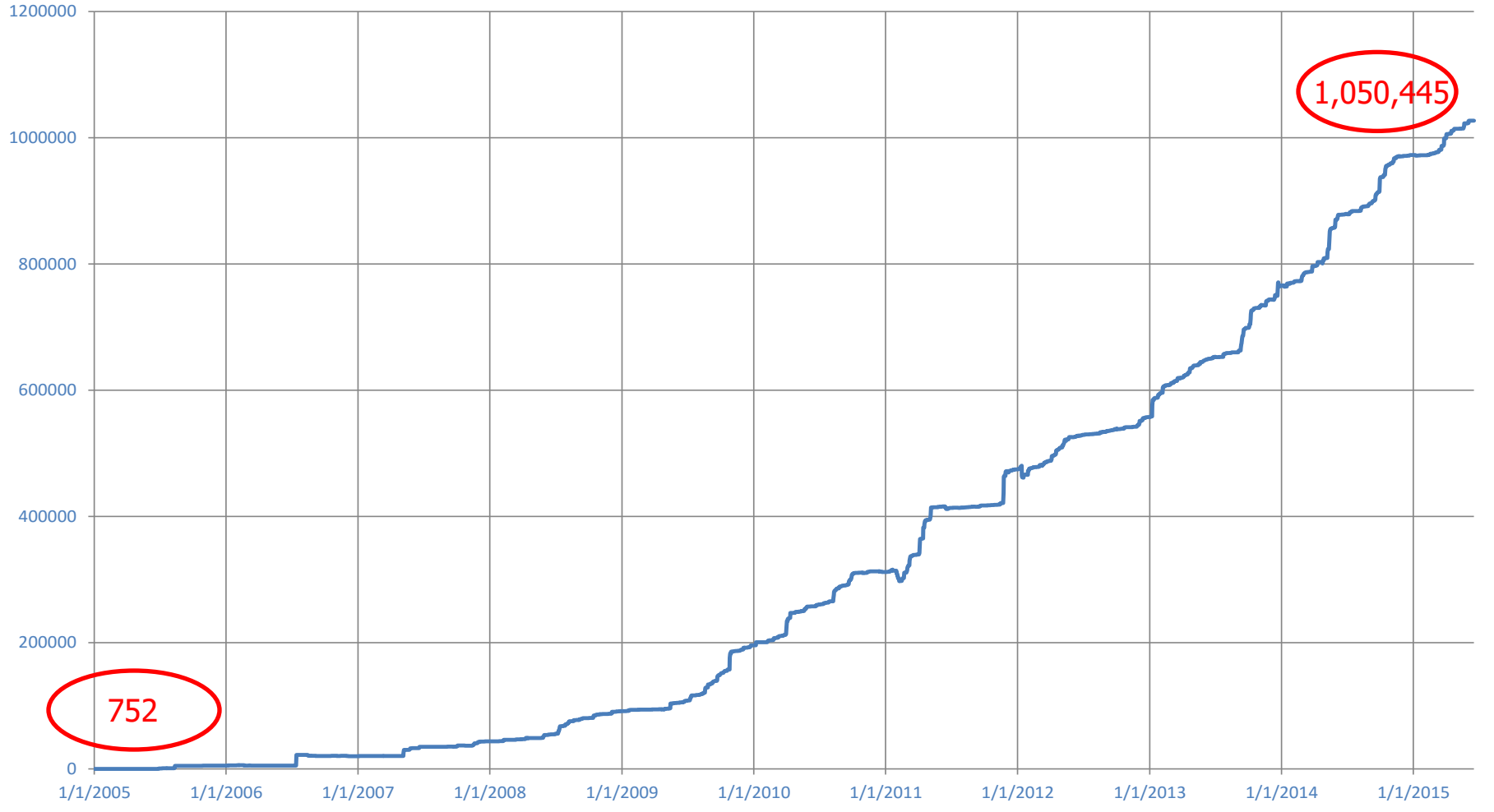
← Rowing Center

↓ Arthropod  
Baker Institute  
CISER  
EHOB  
Schwardt Lab  
Small Animal Holding

## Growth in EMCS Device Count Since 2005



Growth in EMCS **Object** Count Since 2005

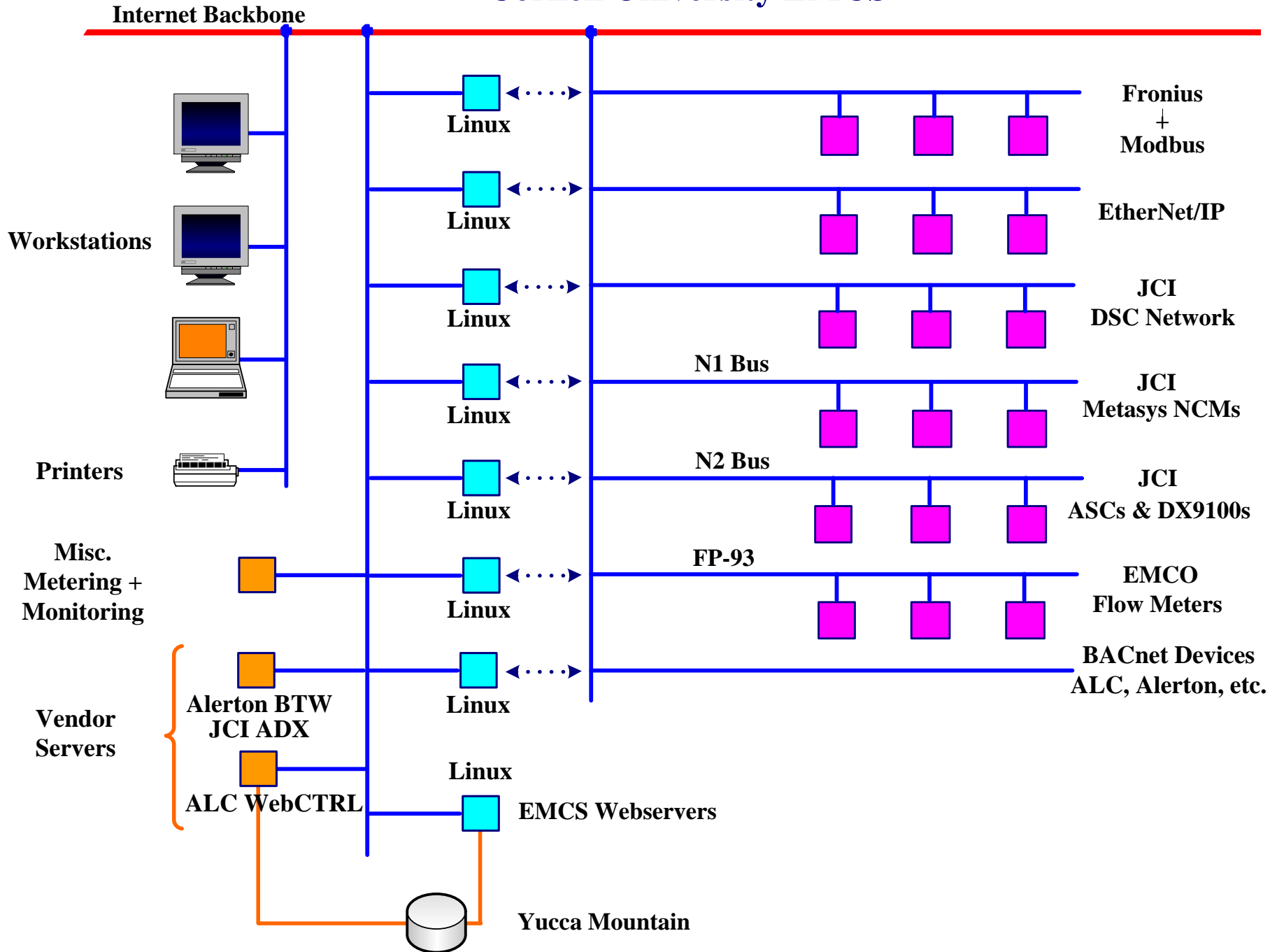




# BACS computers communicate using many protocols...

■ BACnet	12,525	(IP, ARCNET, MS/TP)
■ DSC 8500	3	(Tunneled over UDP)
■ EMCO FP-93	183	(Tunneled over UDP)
■ Ethernet/IP	10	(TCP)
■ Fronius	4	(Tunneled over UDP)
■ Metasys N1	40	(IP)
■ Metasys N2	8	(Tunneled over UDP)
■ Modbus/TCP	550	(TCP)
	-----	
	13,323	

# Cornell University EMCS



<b>Revision 18</b>	135-2012 <i>aq</i>	Elevator Monitoring and COV Multiple
Published	135-2012 <i>aj</i>	IPv6 Support
	135-2012 <i>bf</i>	Network Port Object Enhancements
	135-2012 <i>bg</i>	Miscellaneous Changes
	135-2012 <i>bh</i>	Segmentation Enhancements
<hr/>		
<b>Revision 19</b>	135-2012 <i>am</i>	BACnet Extended Data Model, RESTful Web Services
To be Published	135-2012 <i>ba</i>	CSML Device Descriptions, Semantic Tags
	135-2012 <i>bc</i>	BIBB and Device Profile Updates
<hr/>		
<b>In Process</b>	<b>135-2016</b>	<b>New consolidated version of the BACnet Standard</b> Includes 135-2012 plus all addenda through Revision 19.

# The Future – 2016-?????

Here are some things being worked on:

- Improved Integration/Convergence with IT Networks
- Semantic Tag Definition and Implementation
- Smart Grid Implementation in Buildings
- Improved BACnet Analysis and Troubleshooting
- Improved Building Intelligence



efficient.buildings.live@I+b  
Frankfurt 14. - 18.03.2016

# BACnet – Future Directions

*H. Michael Newman, Chair  
BACnet Committee  
1987-2000*



Cornell University

## Improved Integration/Convergence with IT Networks

In shared IP infrastructures, some IT departments have problems with the deployment of BACnet:

- They are unfamiliar with the BACnet standard and how it works
- Data security may be considered unsuitable
- BACnet tends to use fixed IP addresses rather than dynamic ones
- Site-wide broadcasts are considered unacceptable
- BACnet routers and BBMDs are not managed by the IT department

Education can often help to eliminate these concerns but...

## Improved Integration/Convergence with IT Networks

...here is what the BACnet committee is doing to deal with them:

- Enable the use of BACnet/IP networks in a way that is suitable for highly managed IP infrastructures, not just for virtual LANs
- Enable the use of standard IP mechanisms for auto-configuration (DHCP), name resolution and device discovery (DNS), and information security (encryption)
- Enable the traversal of typical IP network hurdles, such as NATs and firewalls
- Enable the use of IP infrastructure that is built for, and shared with, office and other enterprise applications such as Smart Grid
- Enable the use of either IPv4 or IPv6, as required by the IT infrastructure

# Semantic Tag Definition and Implementation

"Tags" describe the meaning ("semantics") of data. A given object can have multiple tags. They can be a simple attribute or description

equipment

point

degrees-C

chiller

air-handler

or have values associated with them

supply-temp, 20

steam-flow, 300

static-pressure, 15



# Semantic Tag Definition and Implementation

Tags can be useful for both machine-to-machine and human-to-machine communication:

- Presentation and Visualization of data
- Reporting of status and functioning
- Grouping of related data
- Analysis and Operational Decision Making

Each of these functions is likely to have a huge impact on the building automation systems of the future, especially when the "Internet of Things" (IoT) takes off and the number of available data points grows exponentially!

## Semantic Tag Definition and Implementation

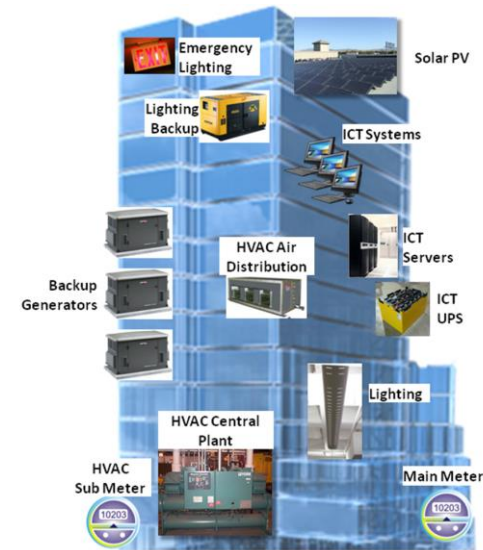
But someone still has to define the "dictionary" of tags and how they relate to each other in real systems. Many organizations are working on these problems.

The ASHRAE BACnet committee, with the help of other liaison organizations, e.g., the Project Haystack folks, is developing sets of domain-specific tags and "application interfaces", sometimes called "profiles", for different types of building equipment. Help is always wanted!

# Smart Grid Implementation in Buildings

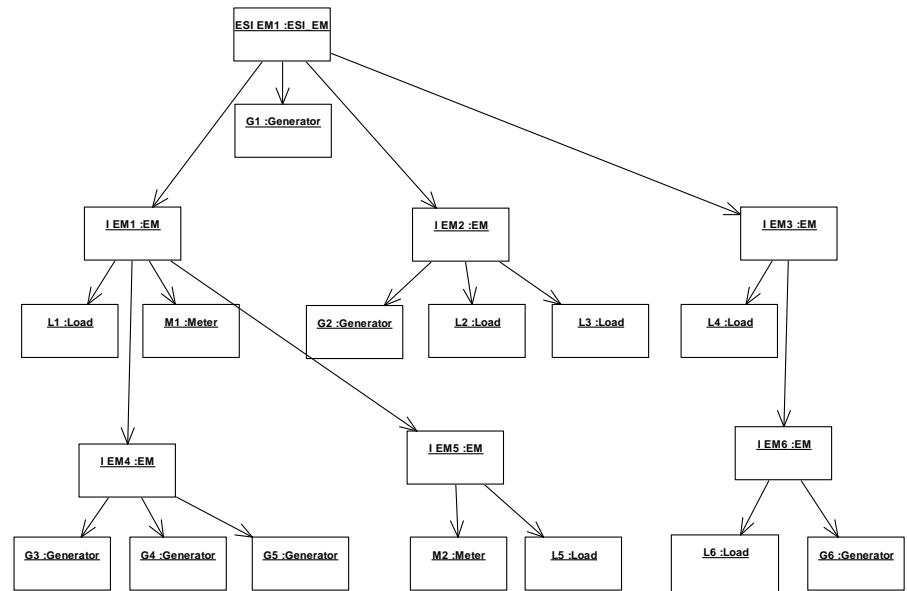
BACnet's effort is based on the ASHRAE "Facility Smart Grid Information Model" or FSGIM

The FSGIM provides a way to take all of the electricity consuming or producing devices within a facility and model how they interact with the electrical grid.



# Smart Grid Implementation in Buildings

It does this by modeling the devices in a facility as a combination of conceptual *loads*, *generators*, *meters*, and *energy managers*



BACnet's Data Modeling WG is trying to represent the components' parameters using BACnet objects and structures

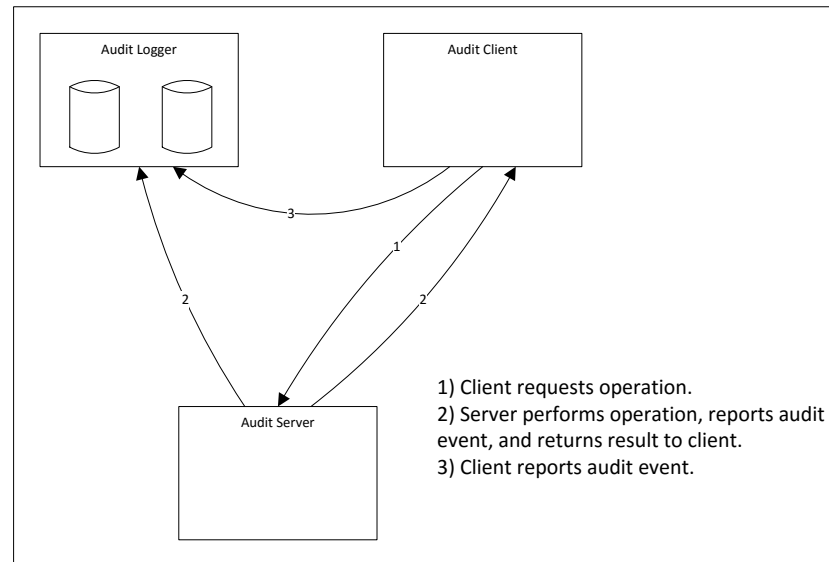
# Improved BACnet Analysis and Troubleshooting

It has long been desired to know where a particular command came from, i.e., why a BACnet device is in the state that it is in

- Addendum 135-2012*bi* adds an Audit Reporter object type and new audit notification services to report auditable actions
- An Audit Log object type and an audit query service are added to log and retrieve audit notifications
- Both clients and servers are allowed to report auditable actions. Servers report changes to local objects, clients report successful and attempted changes along with extra information such as reason for change. The consumer of the logs will be responsible for correlating the multiple entries for a single action.

# Improved BACnet Analysis and Troubleshooting

The general concept is shown here:

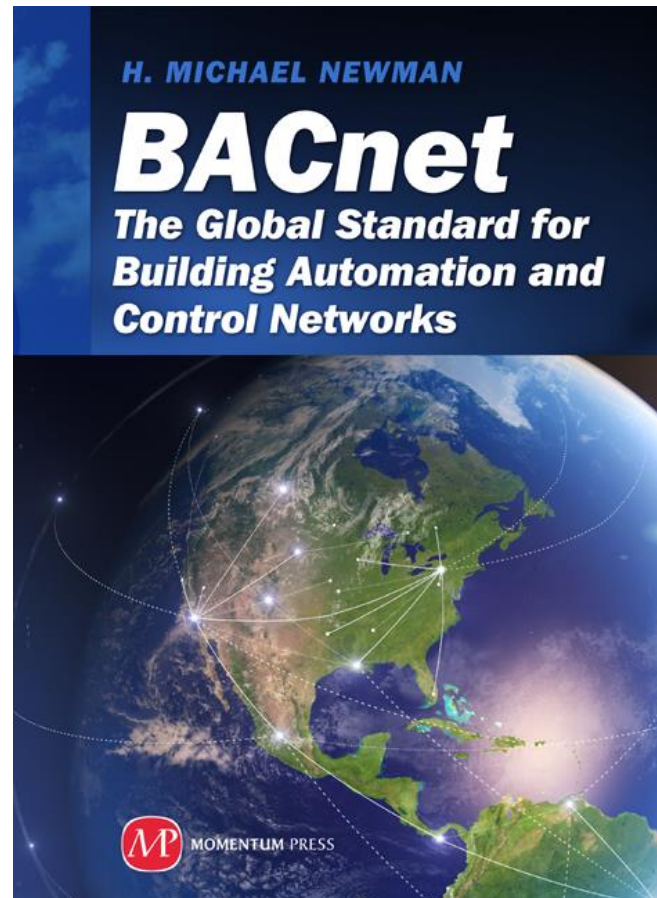


## Improved Building Intelligence

The combination of many more data points (as a result of the IoT) and the ability to more easily understand the role of each data point in specific systems (as a result of application interfaces) means that we will finally be able to:

- Operate systems more energy-efficiently
- Implement more effective Fault Detection and Diagnosis (FD&D)
- Better integrate HVAC and non-HVAC building systems
- Increase the market for building automation and control systems and BACnet!

To learn more about BACnet, please consider this book:





To stay current with BACnet developments, please visit:

[WWW.BACNET.ORG](http://WWW.BACNET.ORG)



Vielen Dank für Ihre Aufmerksamkeit!

**ou mieux**

Je vous remercie de votre attention!

# Questions?

