



## building automation systems in 2015

PIE approved presentation by Johnson Controls

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# Building Automation Systems in 2015



Presented by:

**Joe Klotz** – Systems Products Manager  
Johnson Controls

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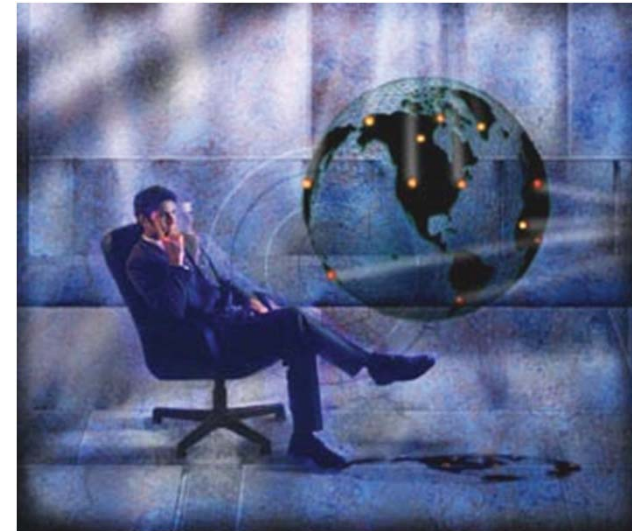
Radical adaptation to rapidly shifting customer demand is the first law of business survival today, but how can you learn what you need to know in order to anticipate those shifts?

Robert Rodin

# Building Automation Systems in 2015

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- Introduction
- Building Automation System Architectures
- Field Controllers
- Wireless
- Network Controllers
- Servers
- the User Experience
- I.T. Matters and The Cloud
- Commissioning and Building Automation Systems



## *Where is the industry going?*

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- 📱 in Jeremy Rifkin's 1987 book "Time Wars", he wrote about his theory of the "weightless economy".
- 📱 In this new world of digital networks and de-industrialization, more than the weighty physical assets such as factories and warehouses, new resources – *and **sources of wealth and profit*** – are found in knowledge creation, information and ideas.



# What are Building Owners saying?

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- ❑ **Reduce my energy consumption**  
Electricity, heating, cooling, and water usage
- ❑ **Lower my operating costs**  
Optimize staff to operate and maintain building efficiently
- ❑ **Improve tenant comfort, security and productivity**  
Temperature, airflow, lighting, and access
- ❑ **Allow me to control the building anywhere**  
Remotely, onsite, web; using any browser, mobile devices
- ❑ **Help me comply with ever-changing regulations**  
Track historical data and actions
- ❑ **Reduce maintenance and life cycle costs**  
Detect premature building equipment failures and take corrective action
- ❑ **Work together to limit my risk and exposure**  
Consultants, contractors and suppliers
- ❑ **Guide me on this journey**  
Provide consultative services to assist in decision making



# Modern BAS provide critical value to building owners

## Manage Occupant Comfort

- Automating controls & equipment (e.g. HVAC, lighting, chillers, roof tops, air handlers, vav boxes, etc.)
- Integration & control of other systems

## Energy Management

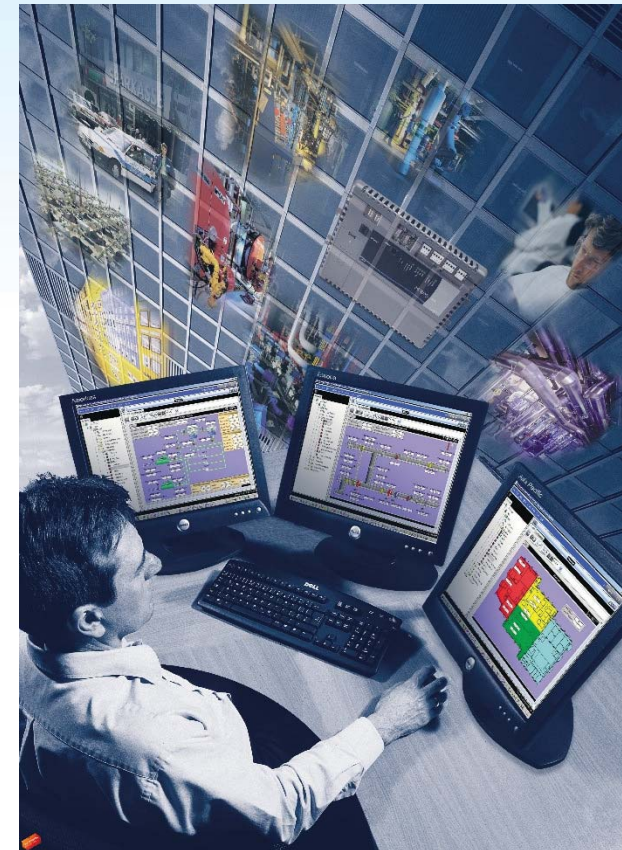
- Intelligent sequences and routines to manage building and system energy consumption

## Alert operators of facility problems

- Detect problems prior to becoming an issue.
- Alarm notification and management

## Protect facility assets

- Chiller plants, HVAC and mechanical equipment, people, Fire & Security systems
- **Increase facility value!**



## Benefits

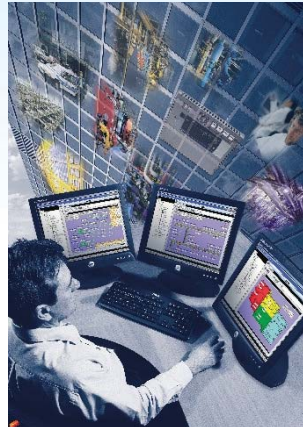
- Automate tasks for facility managers & staff
- Optimize resources; increase effectiveness
- Lower energy and operational costs

# Control Core Mechanical Systems

## Command Central



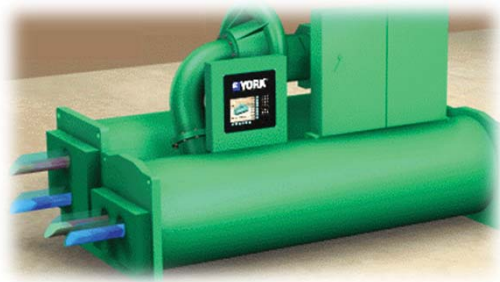
Air Handlers



Rooftop Equipment



Fan Coils  
Unit Ventilators  
VAV Boxes



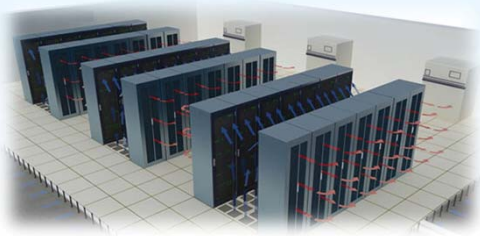
Chillers  
Cooling Towers



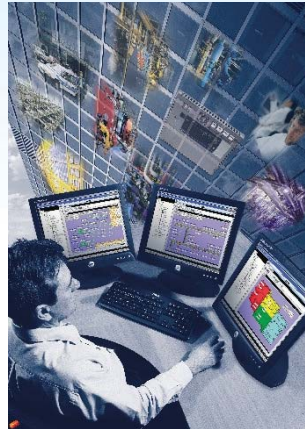
Boilers

# Key Sub-Systems Integrations

## Command Central



Data Centers



Fire



Security / Access Control



UPS / Generators



Lighting / Blinds

# Non-traditional BMS Integrations

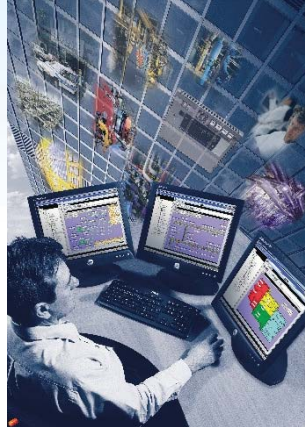
Pulse Counters/Other  
*Pumps, Flow, Temp*



Cooling Ponds



Command Central



Pulse Counters/Other  
*Pumps, Flow, Temp*



Gray Water Reclaim



N2/BACnet/Other  
*Power Meters*



N2  
*Veris - Power Meters*



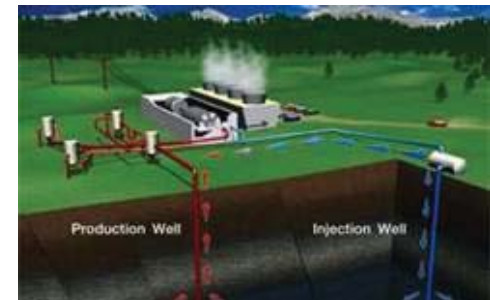
BACnet  
*Onicon - Flow/BTU*



Wind Energy



Solar Energy



Geo Thermal



Thick "Client" Workstations

Enterprise IP Network



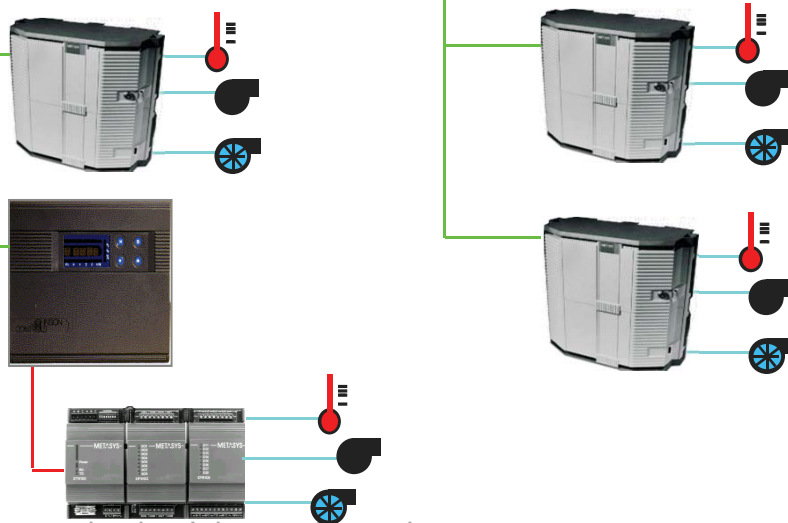
Server software

N1 Ethernet Network

N1 protocol

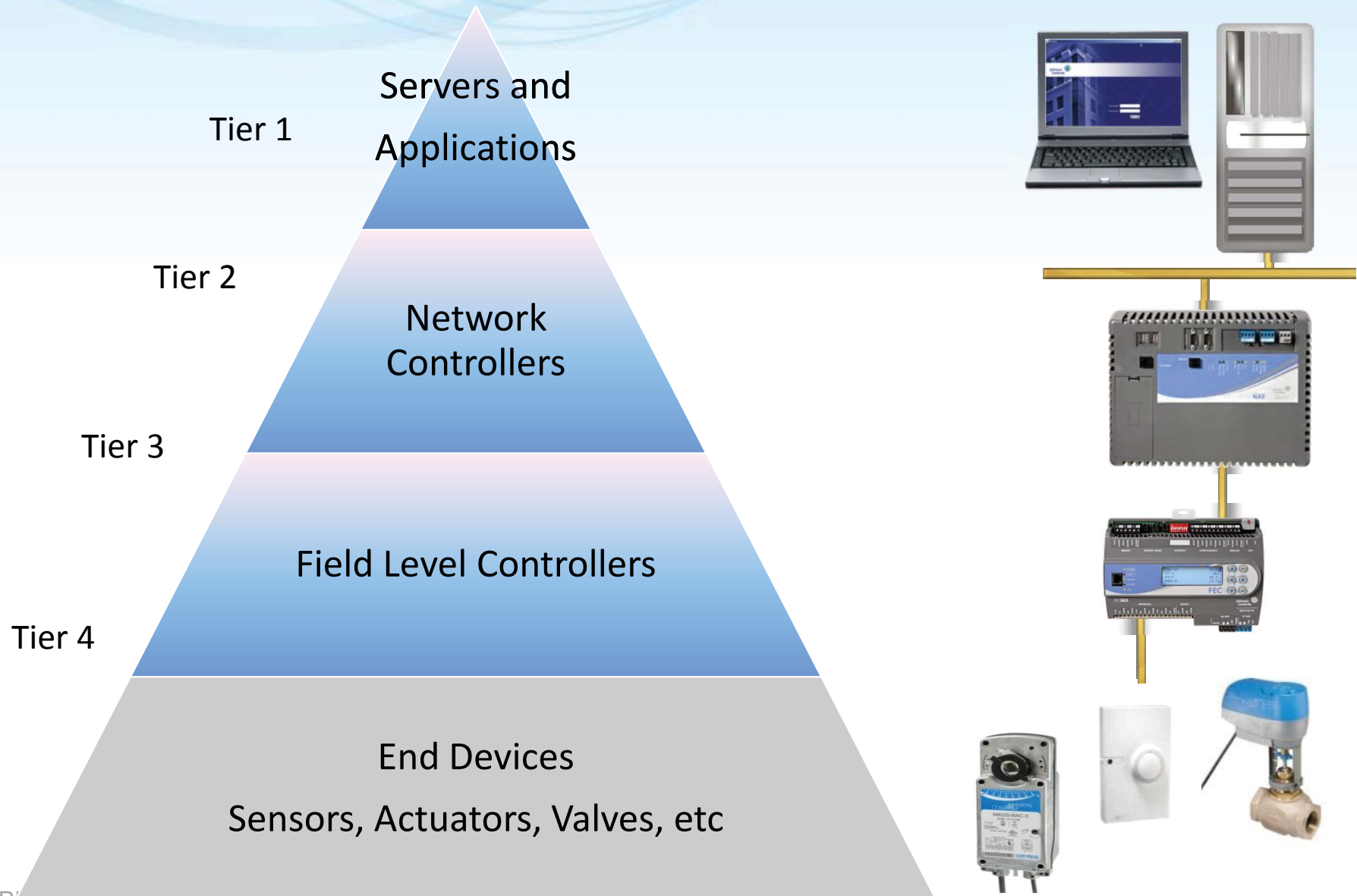


N2 Bus

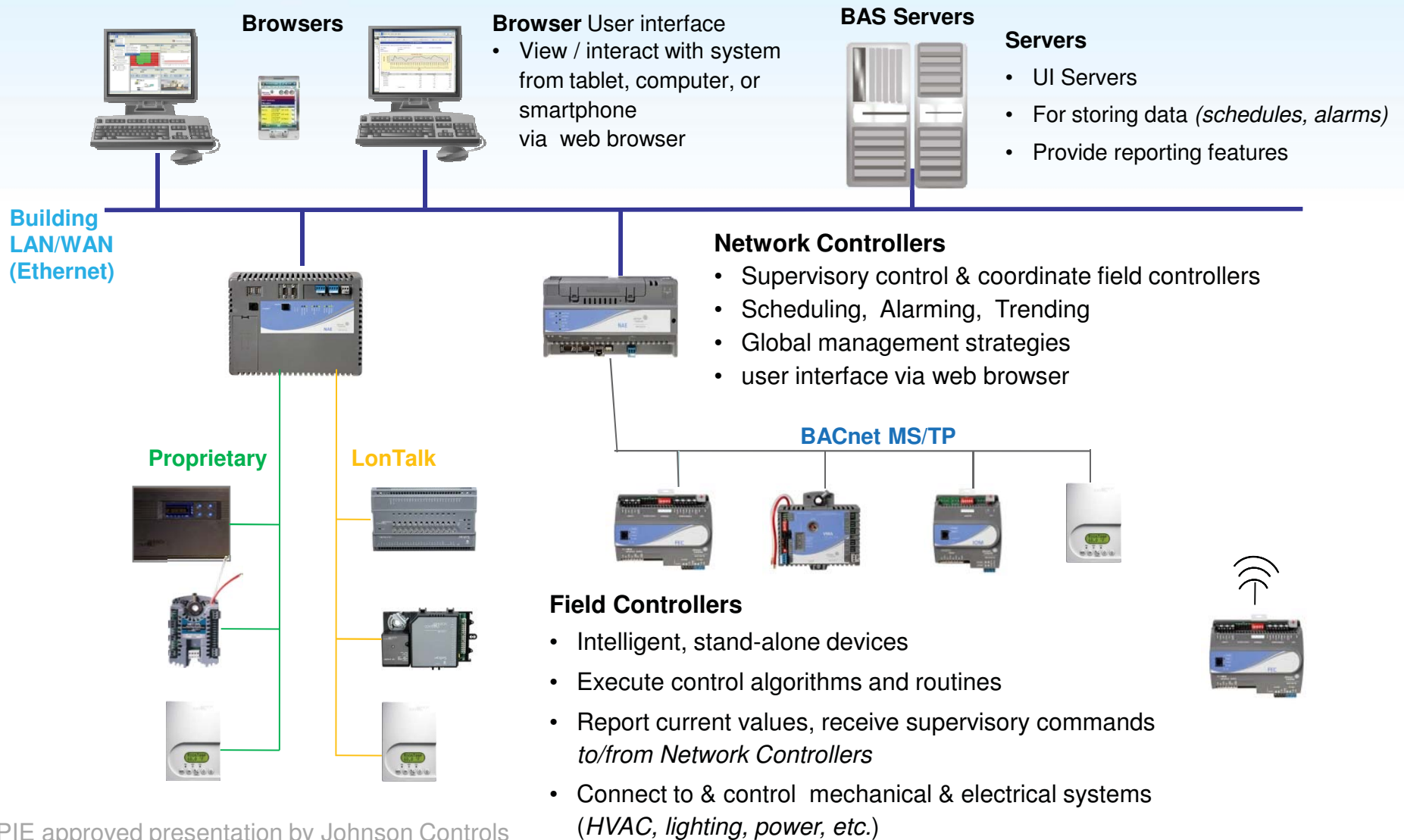


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# BAS Components



# System Architecture



# BAS Technology: 20 years later

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## Protocols used in Building Automation Systems

- BACnet
- LonTalk
- Modbus
- OPC
- IP / Web Services / SOAP
- Profibus
- BatiBUS
- EIB
- KNX
- DALI

# BAS Technology: 20 years later

## Protocols used in Building Automation Systems

- BACnet
- LonTalk

■ Modbus

■ OPC

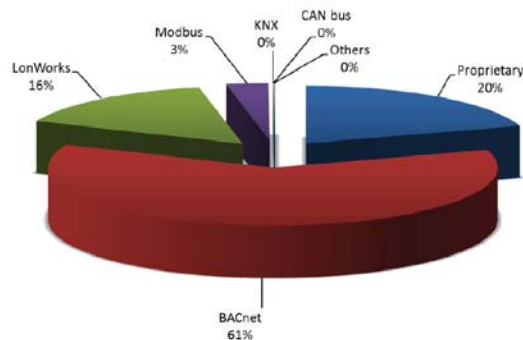
■ IP / Web Services / SOAP

Popularity of communication protocol used in BACS, 2013

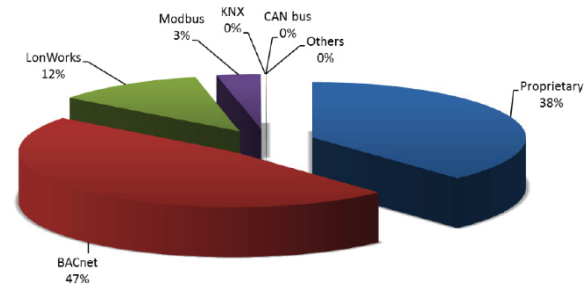
|                              | Proprietary | BACnet | LonWorks | Modbus | Total |
|------------------------------|-------------|--------|----------|--------|-------|
| Automation level controllers | 20.1%       | 61.4%  | 15.4%    | 3.0%   | 100%  |
| Field level controllers      | 38.1%       | 47.2%  | 11.3%    | 3.3%   | 100%  |

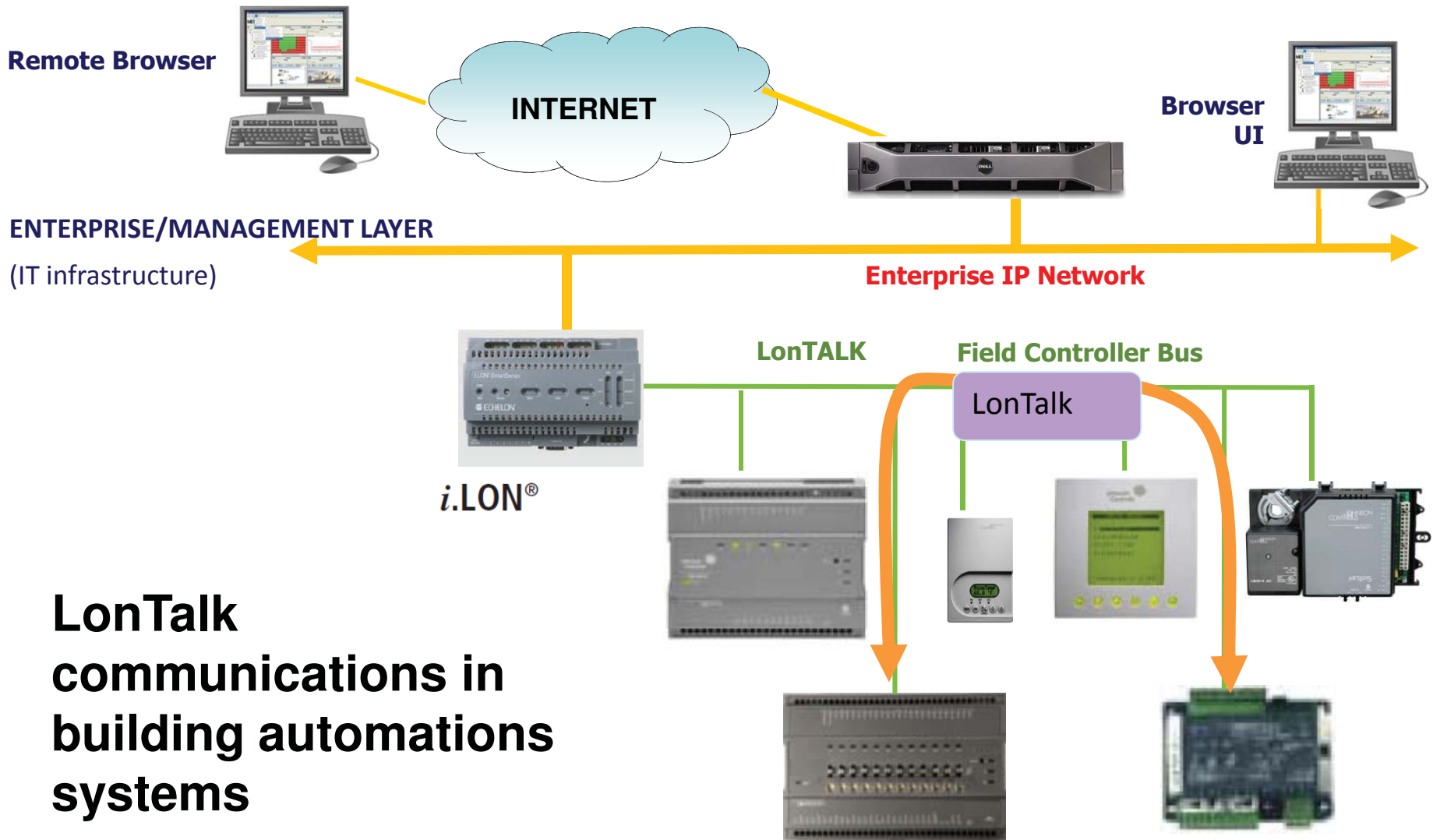
Source: BSRIA

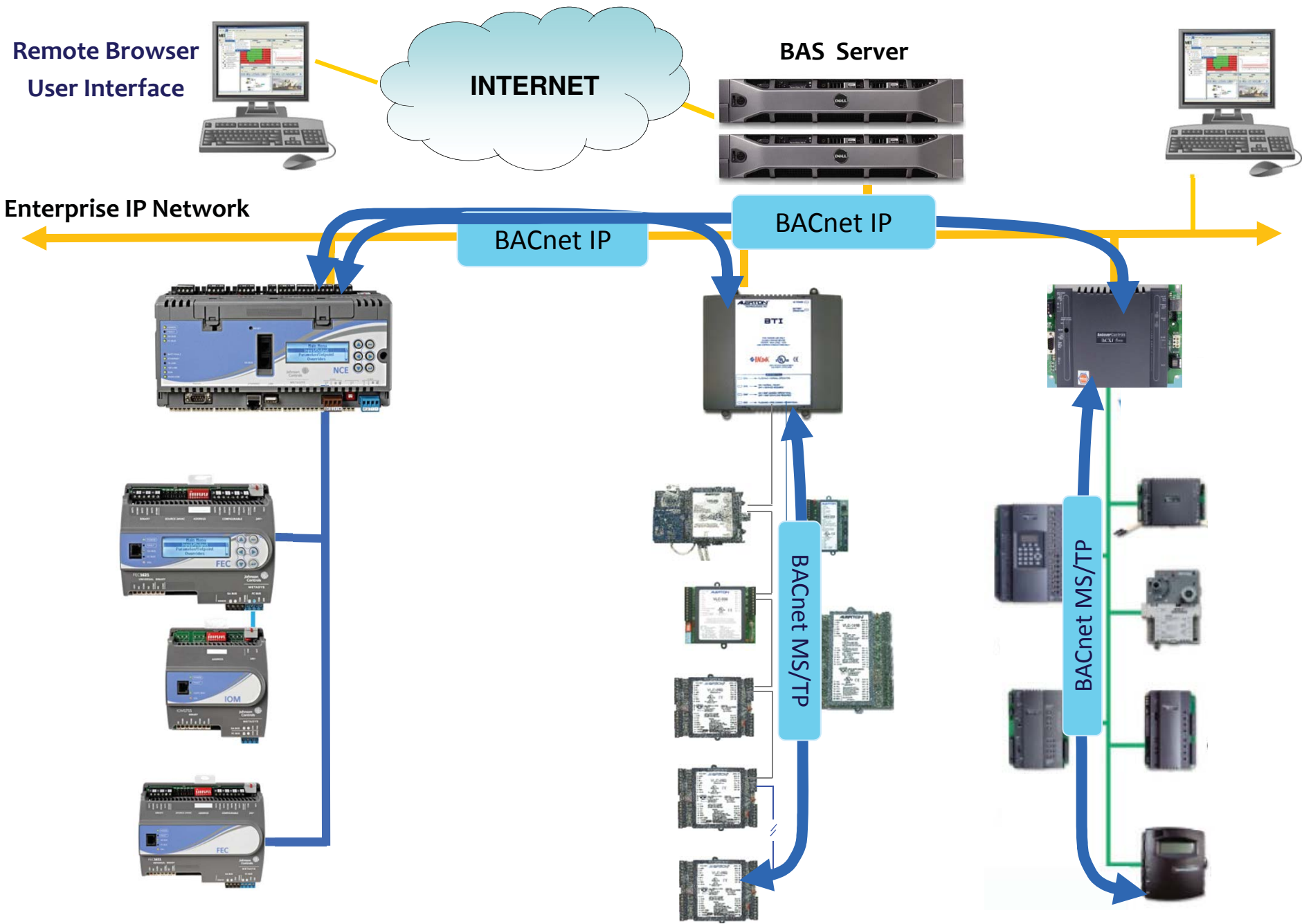
### Network Controller Protocols

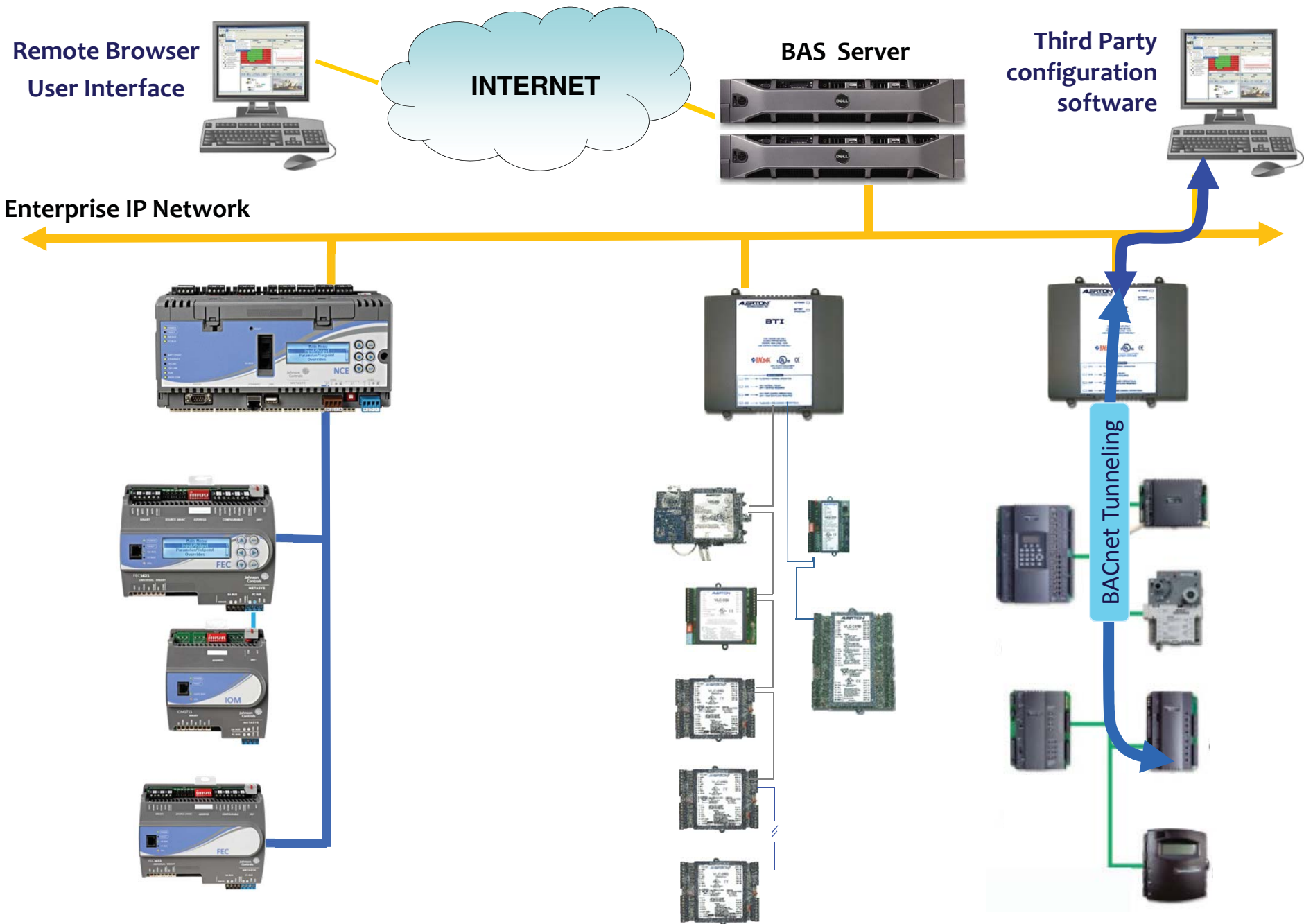


### Field Controller Protocols

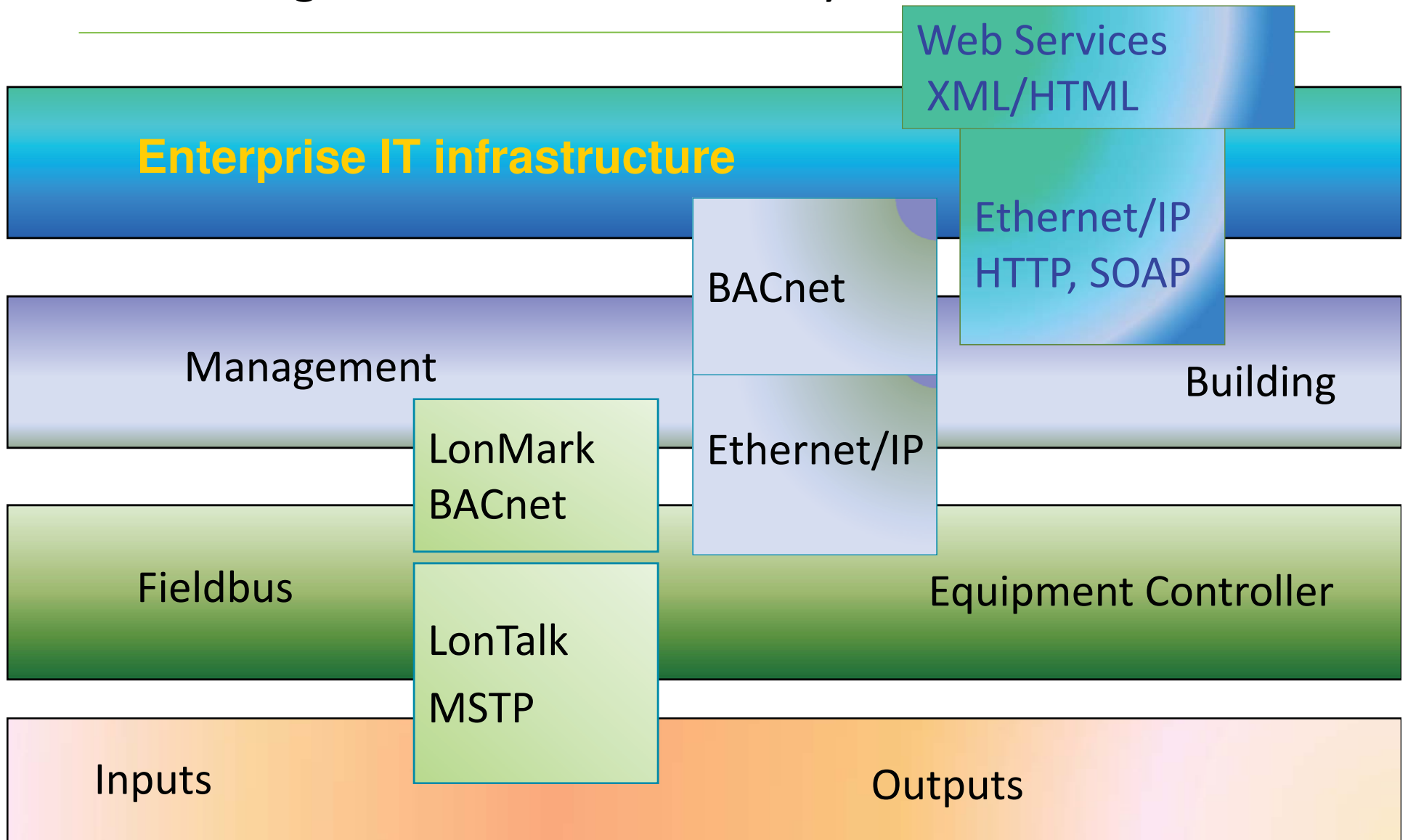








# Data Integration Levels - summary



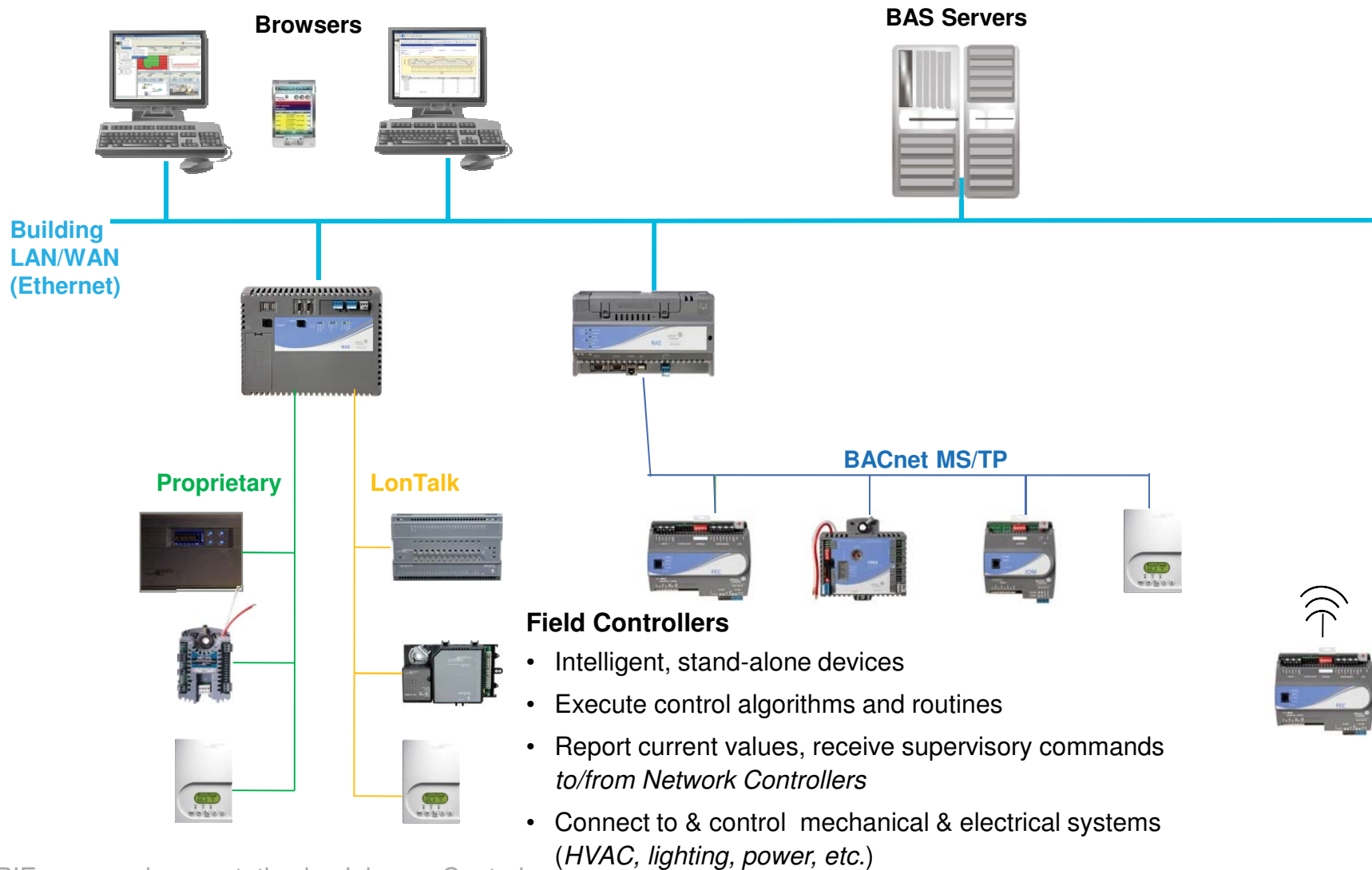
# BACnet Testing Laboratories – controller listings

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## **BTL defined and tested compatibility**

- B-SA – BACnet Smart Actuator
- B-SS - BACnet Smart Sensor
- B-ASC - BACnet Application Specific Controller
- B-AAC - BACnet Advanced Applications Controller
- B-BC - BACnet Building Controller

# System Architecture



# Field controllers

Fully programmable field controllers

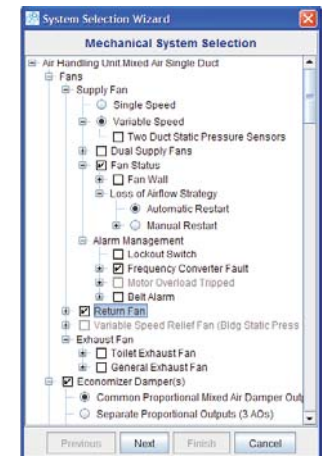
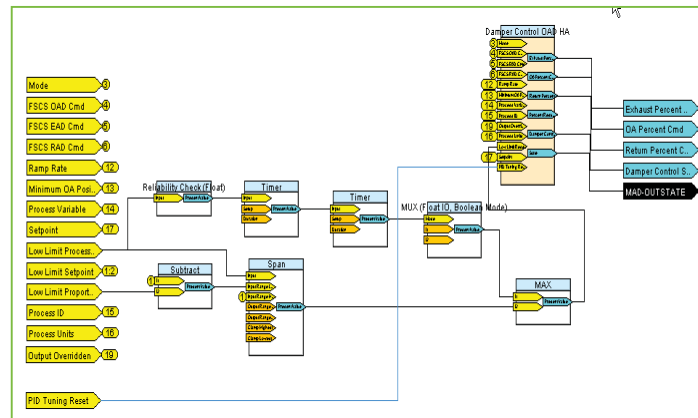
Continuous auto-tuning

State-based & adaptive control

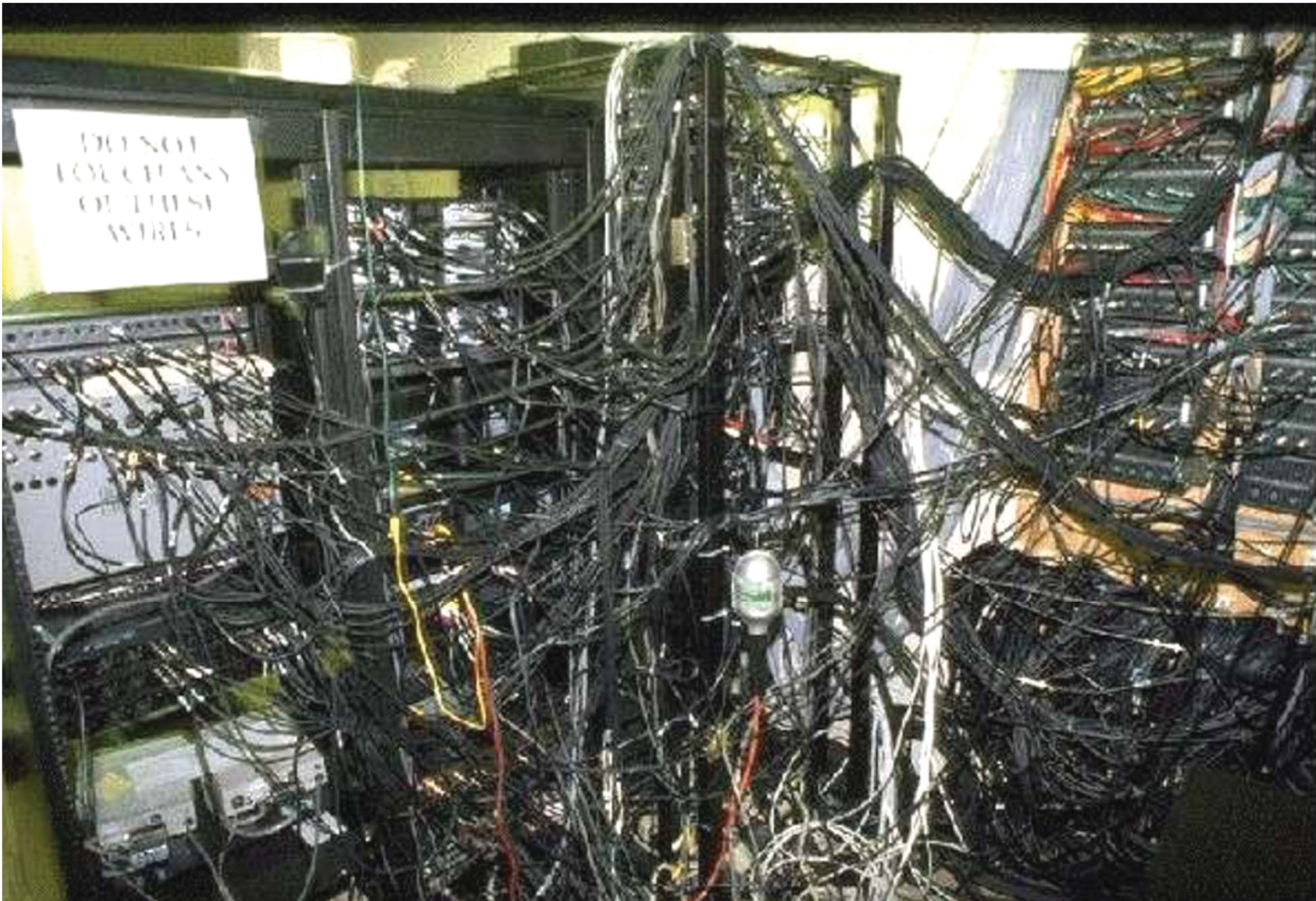
Fully programmable & Q/A based

## Benefits

- Minimize manual tuning at installation, & eliminates need to retuning.
- Provides comfort, & energy efficiency
- Easy & versatile configuration & programming
- Proven, tested & documented applications
- Customizable programming where needed.



So, what is the attraction to wireless in our industry?

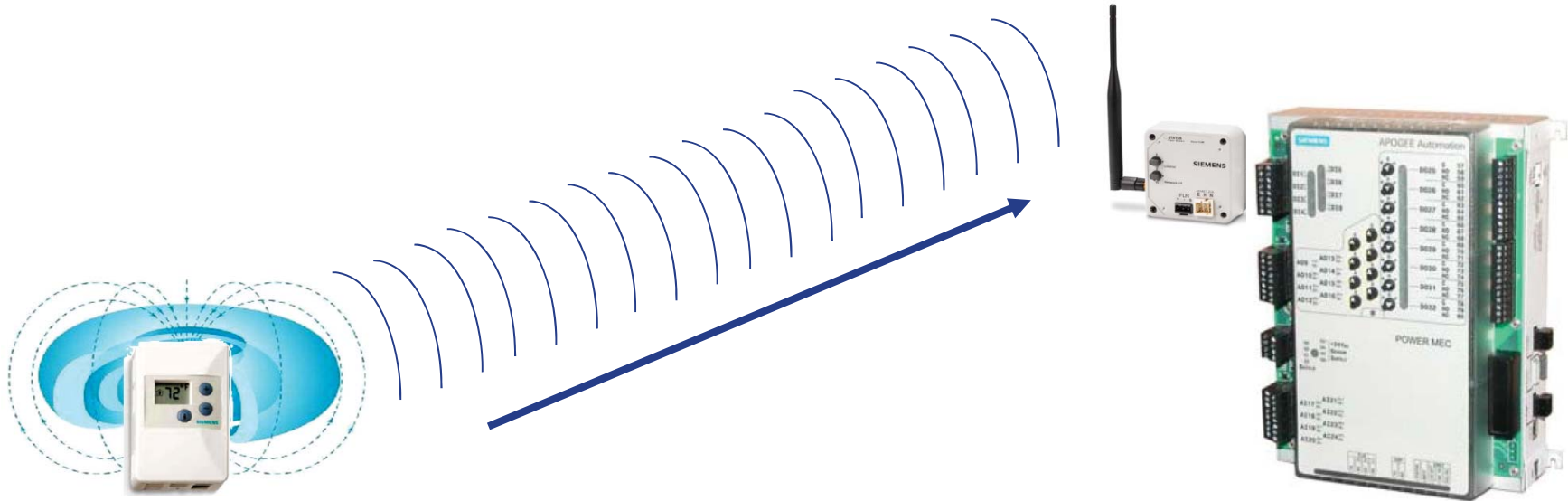




# “One to One”

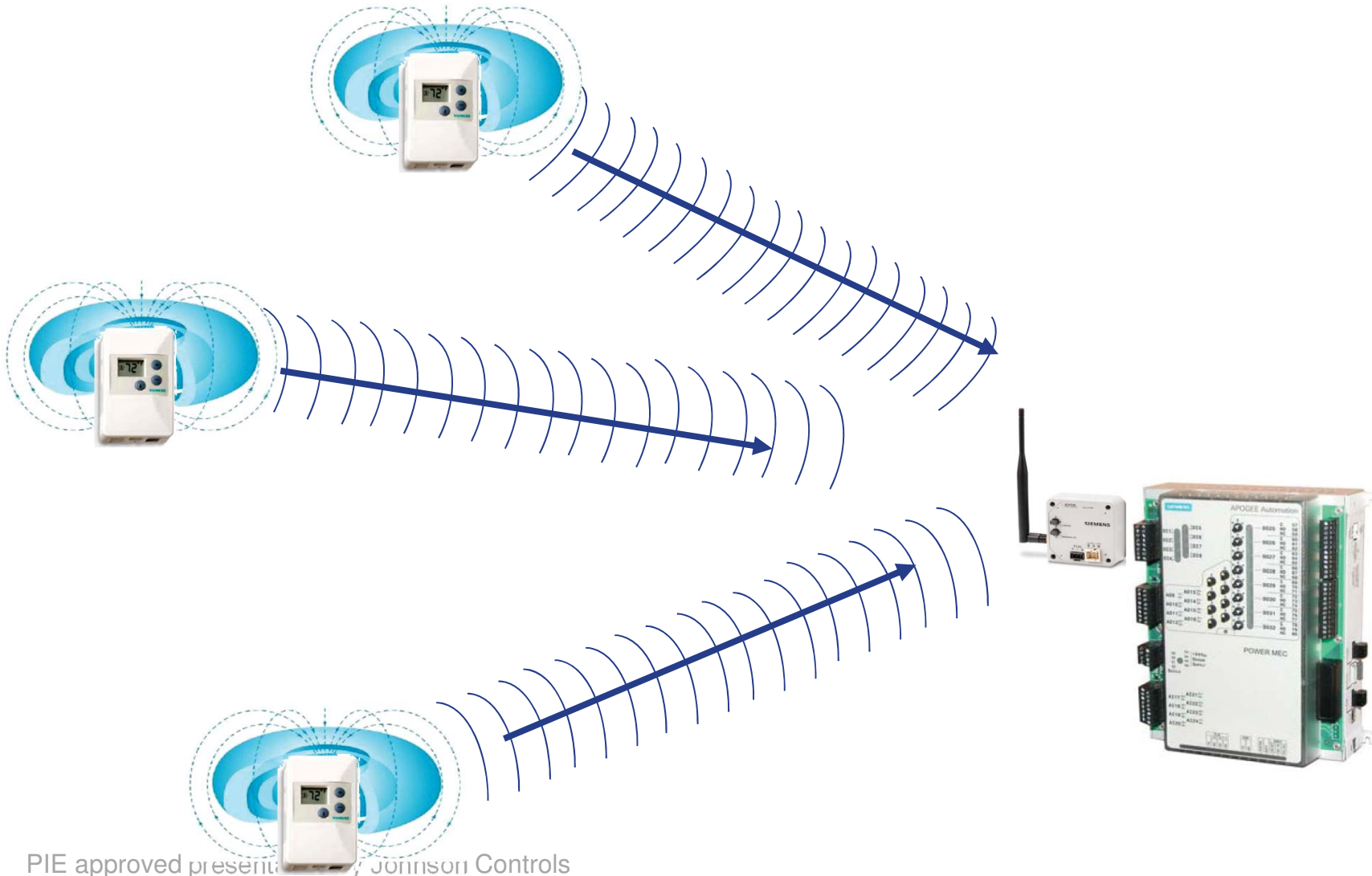
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- one sensor communicating with one controller
- one-way broadcast communication
- no message acknowledgement



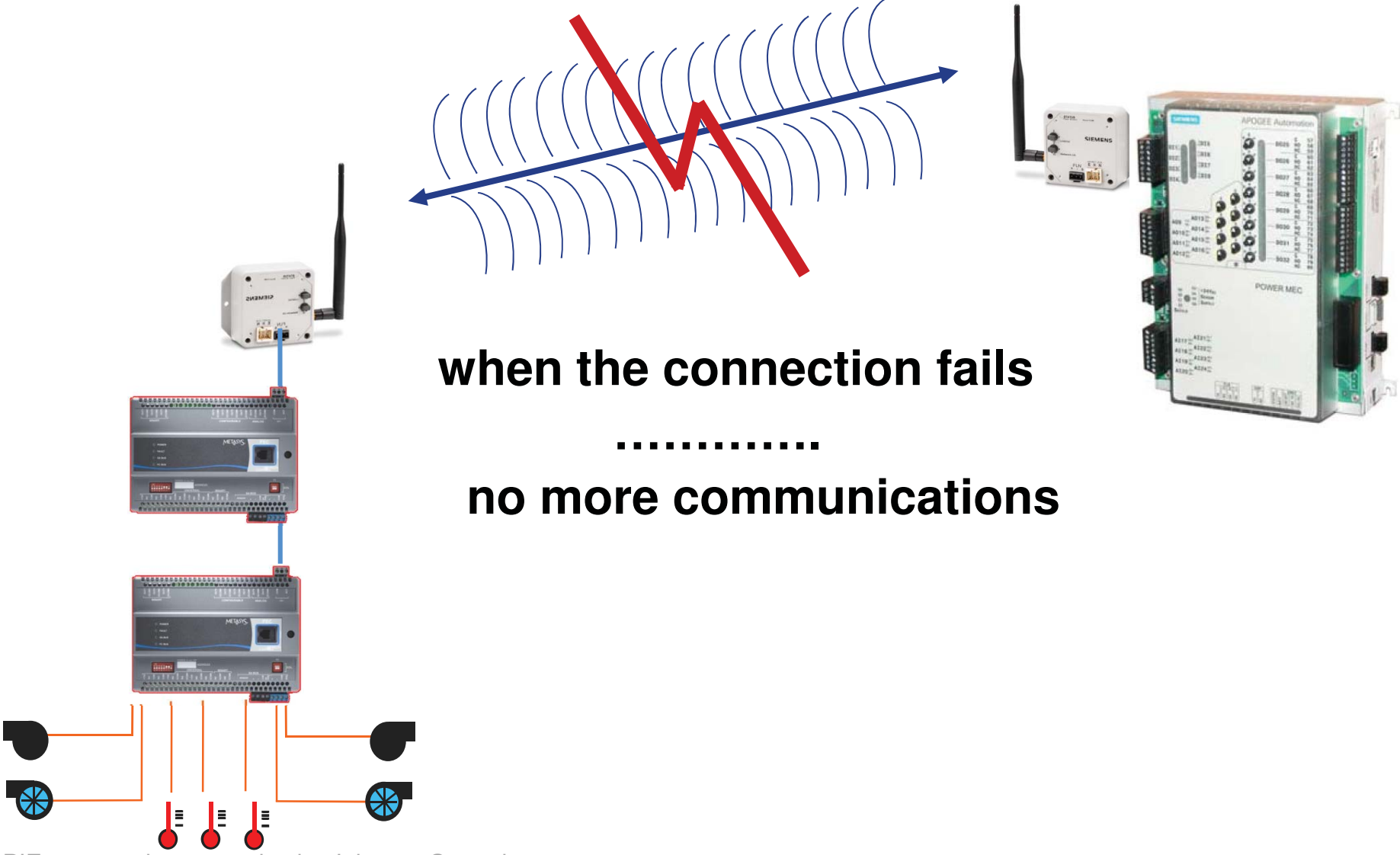
# Many to One format

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# The biggest drawback with wireless ... previously



# ZigBee Technology Overview

- **ZigBee: A High Level Communication Protocol**
  - ▶ Uses small, ultra low-power digital radios based on the IEEE 802.15.4 standard for wireless networks
- **Targeted at RF Applications Requiring:**
  - ▶ Low data rate
  - ▶ Long battery life
  - ▶ Secure networking
- **IEEE 802.15.4**
  - ▶ Serves as the standard upon which ZigBee is built

## ZigBee Technology Facts

| Attribute               | ZigBee  |
|-------------------------|---|
| Number of Channels      | 27  |
| Radio Frequency Band[s] | <ul style="list-style-type: none"><li>• 2.4 GHz with 16 channels for global use</li><li>• 915 MHz with 10 channels for N. America, Australia and a few additional countries</li><li>• 868 MHz with 1 channel for EU countries</li></ul> |
| Network Capabilities    | Self-organizing and self-healing dynamic mesh network based on ZigBee public standard   |
| Network Size            | Thousands of devices per network  |

# Open Technology Standards

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ZigBee Alliance and ASHRAE worked together to create a wireless BAS standard.

## Standards Based

- IEEE 802.15.4
- ZigBee<sup>®</sup> technology
- ASHRAE BACnet

# Wireless Field Bus Reliability / Security

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- Wireless field bus system uses an IEEE 802.15.4 transmitter on the 2.4G Hz operating frequency band
- No common frequencies between **cell phone** bands and 2.4G Hz band where the wireless field bus system operates
- Does not use WiFi technology, so is not part of the IT network. It does use the same frequency band as IEEE 802.11 **WiFi**, but channel spacing; system automatically selects non-overlapping, “quiet” channels (e.g. 25, 15, 20).
- Uses the ZigBee technology, and leverages a secure application profile and messaging within the ZigBee standard; Prevents wireless field bus data transmissions from being interpreted by other wireless devices
- Uses BACnet MS/TP messaging

# Channel Spacing

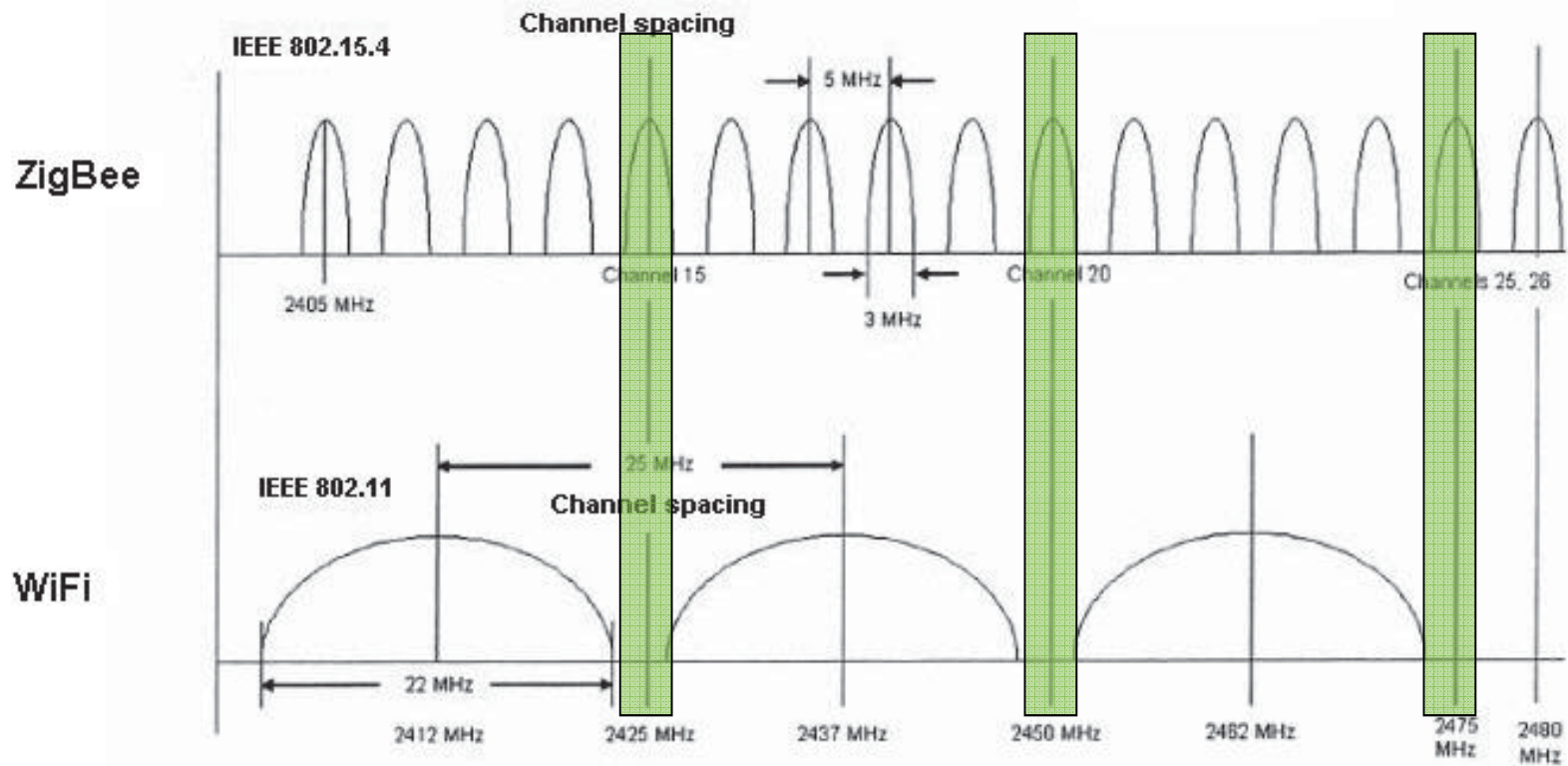
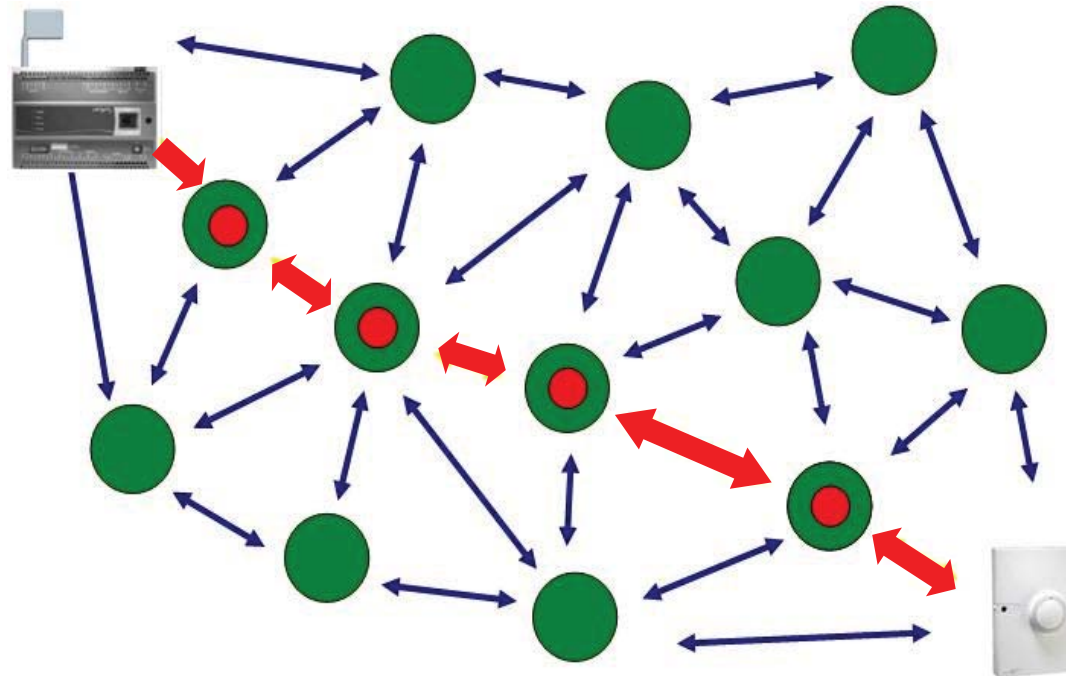


Figure 1: IEEE802.15.4 and IEEE802.11 Channels

# Mesh System Reliability

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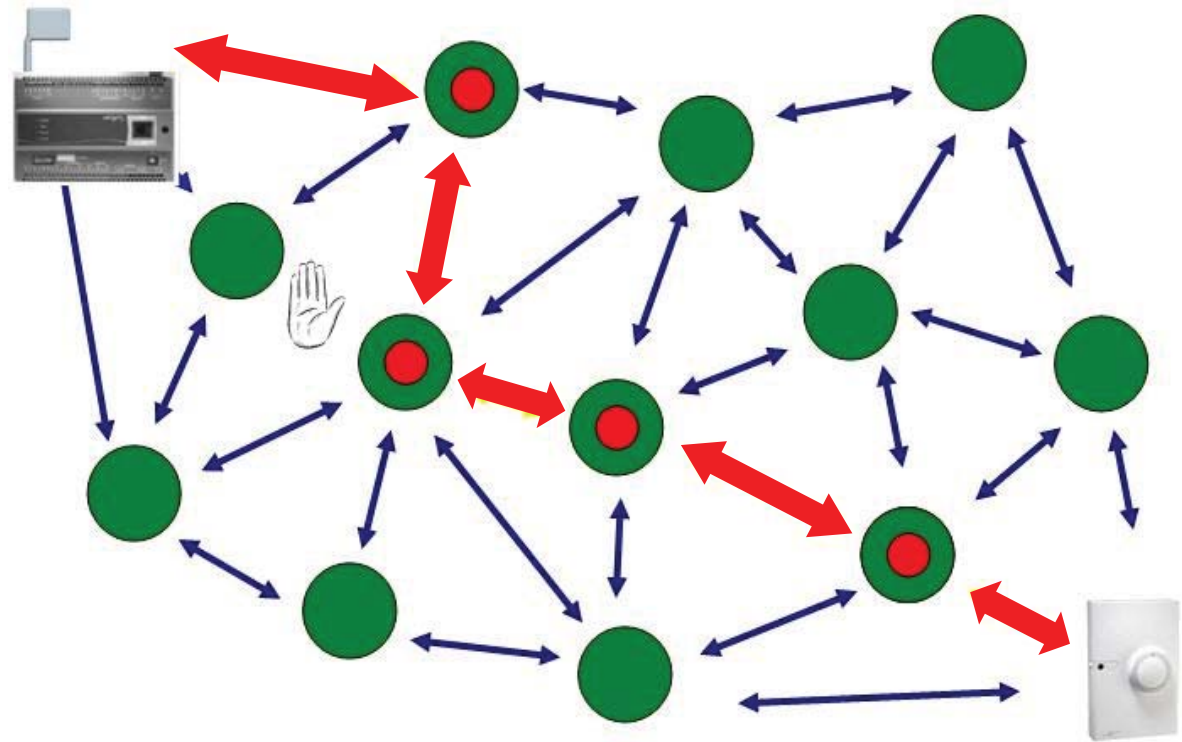
Wireless mesh network provides multiple wireless transmission paths that enhance wireless reliability, automatically forming a resilient, self-healing, multi-hop wireless network.



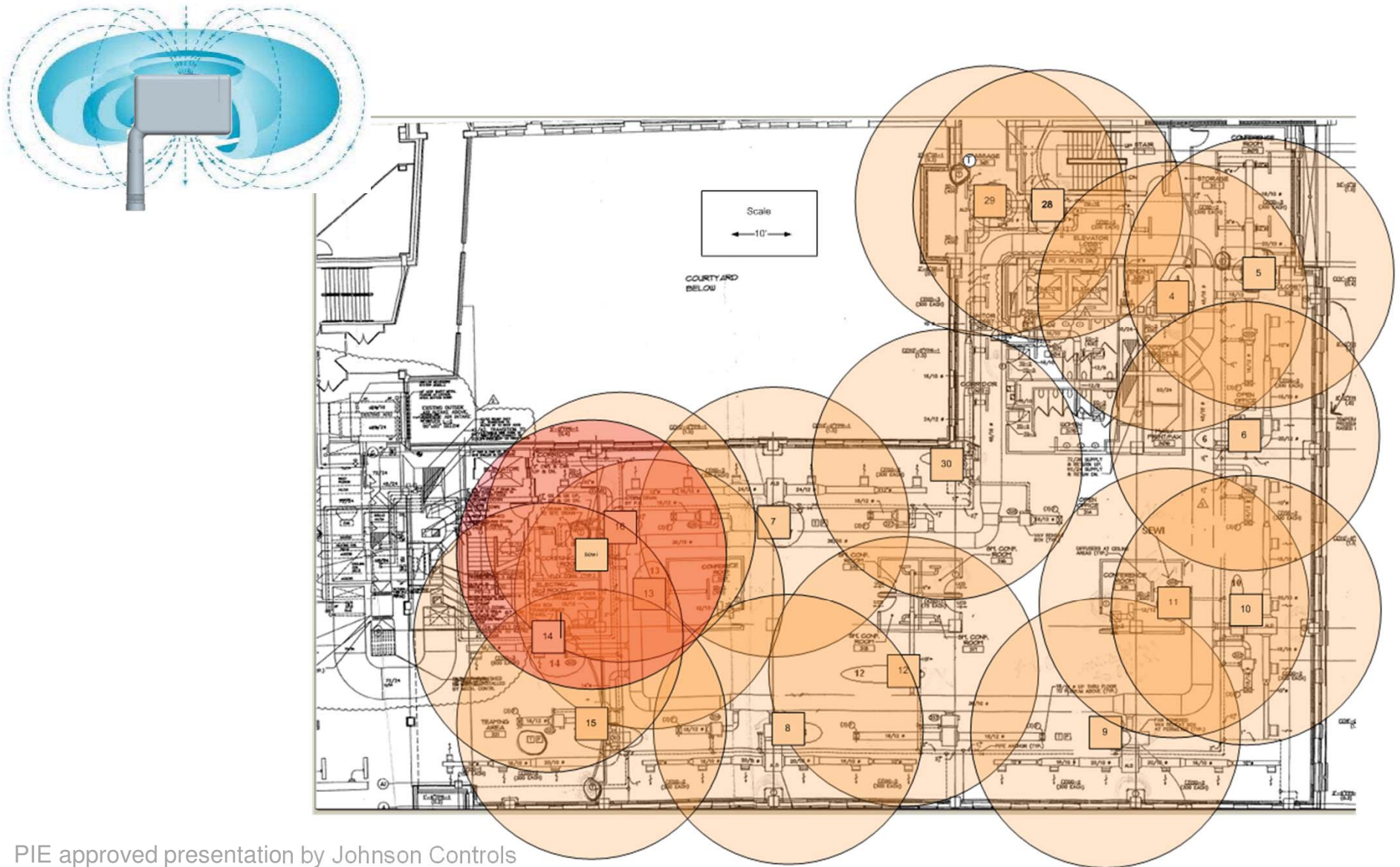
# Mesh System Reliability

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If a device experiences interference or drops out, the wireless data communicates over alternative, automatically-forming paths to get to target destination device.



# Installation Planning Discussion



# EnOcean Technology



- Sensor to receiver (LON, BACnet)
- “energy harvesting” uses light, kinetic energy; backup battery
- Uses 868MHz frequency range; (10mW) transmitting power
- Transmitting range up to 30m in buildings; 300m in open areas
- Wireless output receivers
- Proprietary message format



# What is driving Wireless acceptance?

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- Structures with excessive brick or concrete walls
- Buildings with decorative surfaces; marble, granite, glass
- Locations with large, open spaces
- Buildings with frequent tenant turnover or changes in use
- Historic buildings
- Retrofits, converting pneumatic HVAC controls to digital
- Regions with high labor costs

Initially, wireless controls focused on Niche Applications

Today, ***the Application of Wireless Controls Is Practically Limitless***



# What is driving ZigBee acceptance?

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## ASHRAE adoption as data link layer

### Faster Installations and Commissioning

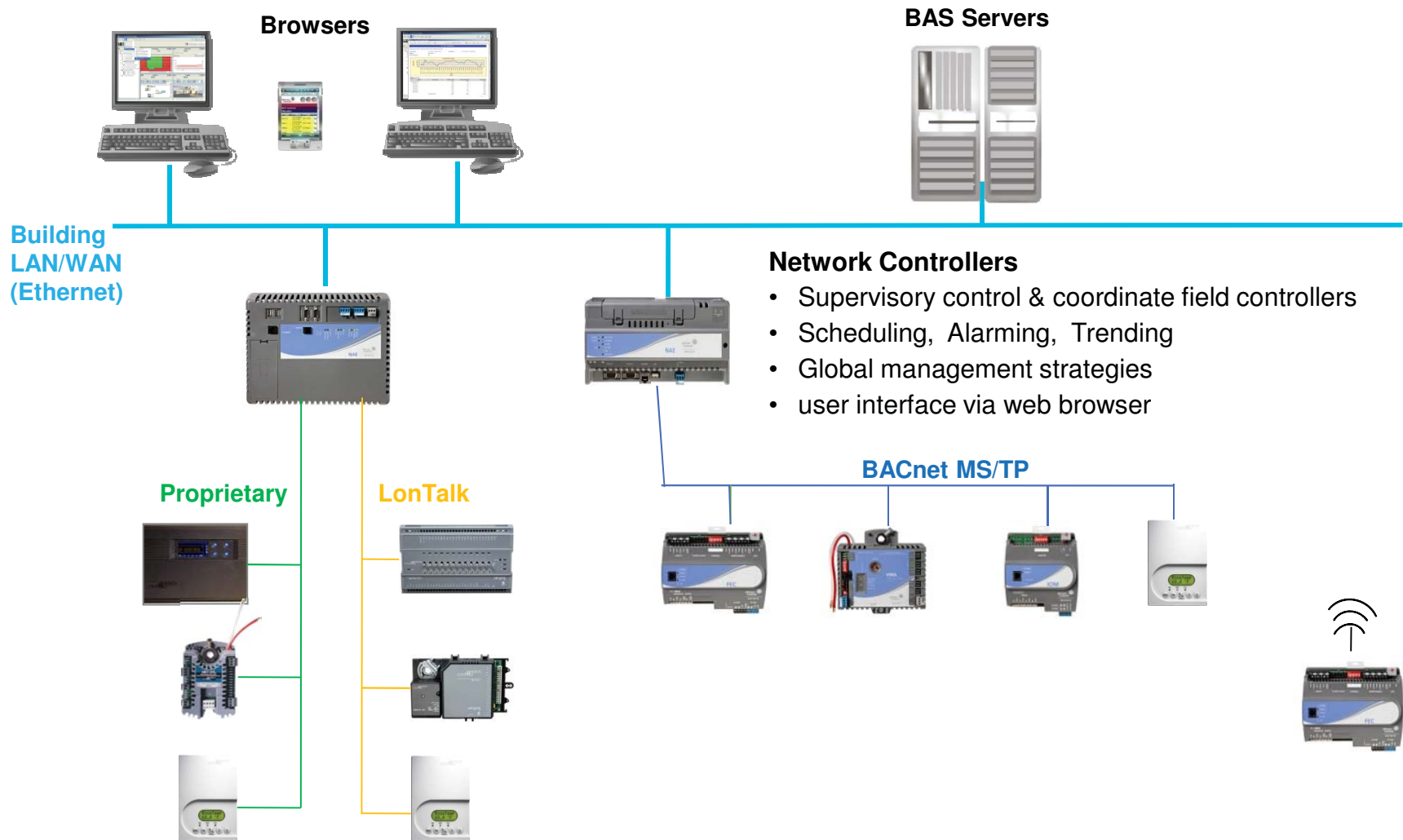
- Reduces time/costs for wiring installation
- Factory-packaged wireless control options
- Wireless scanning tools for commissioning
- Troubleshooting and installation validation

### Sustainability

- Less raw materials consumed (copper)
- Fewer labor resources consumed (installation)
- Need less resources for adds, moves, and changes



# System Architecture



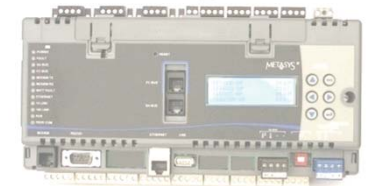
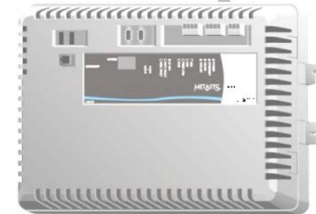
# Network Controllers. Living in two worlds: BAS and IT

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## AUTOMATION LAYER

## IP Network and Infrastructure

Network Controllers



### IP Level Integration

- BACnet IP
- Modbus TCP
- Proprietary
- XML / SOAP
- Browser UI

### Fieldbus Level Integration

- ❖ BACnet MS/TP
- ❖ LON
- ❖ Proprietary
- ❖ ZFR Wireless
- ❖ Modbus RTU

# Network Controllers

## Supervisory Functions

- Integrate field controllers
- Alarm detection
- Scheduling
- Trends (short-term storage)
- Global control strategies
- Optimal stop/start
- BACnet IP integration
- BACnet MS/TP integration
- Modbus integration

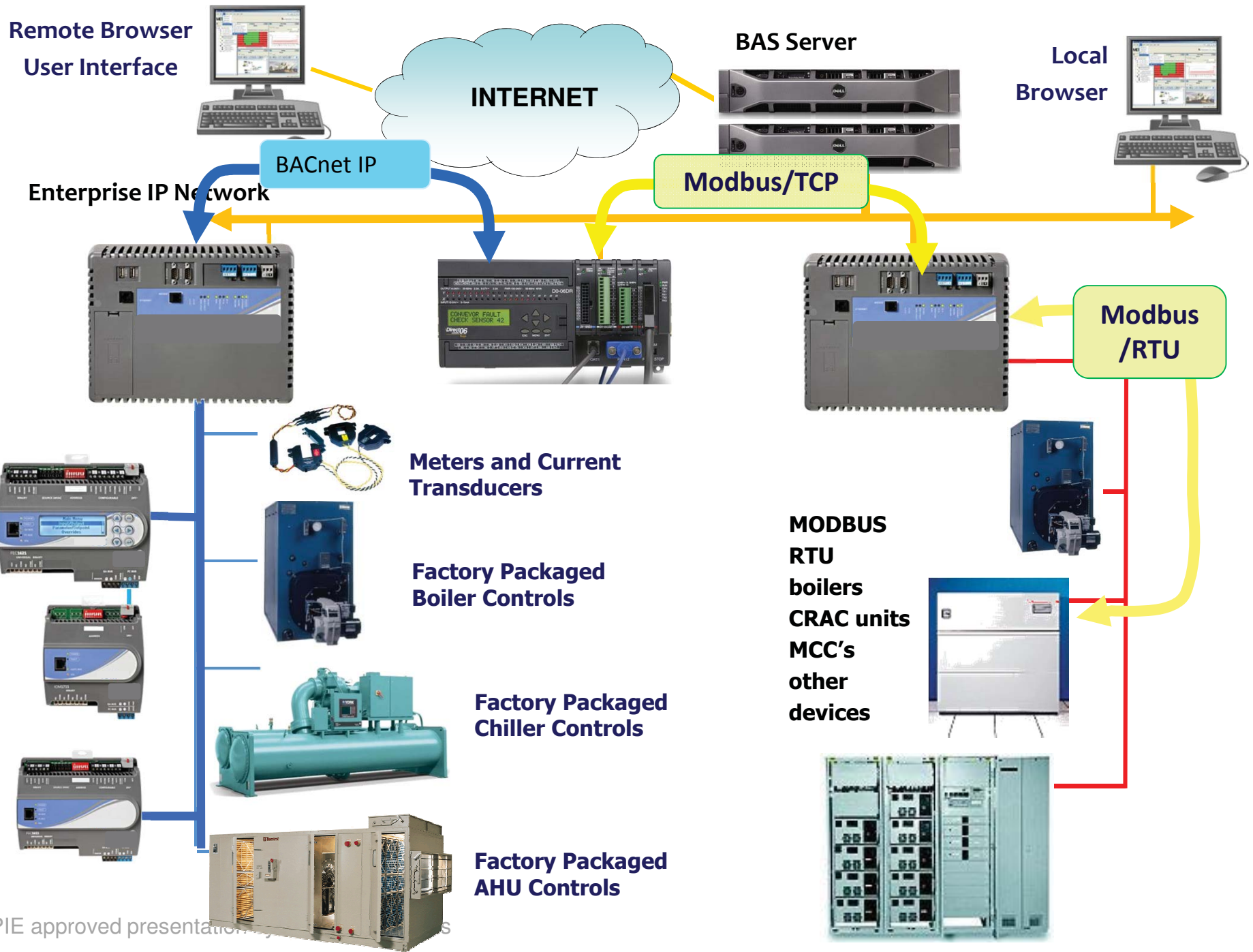
On Board User Interface

On Board Tools

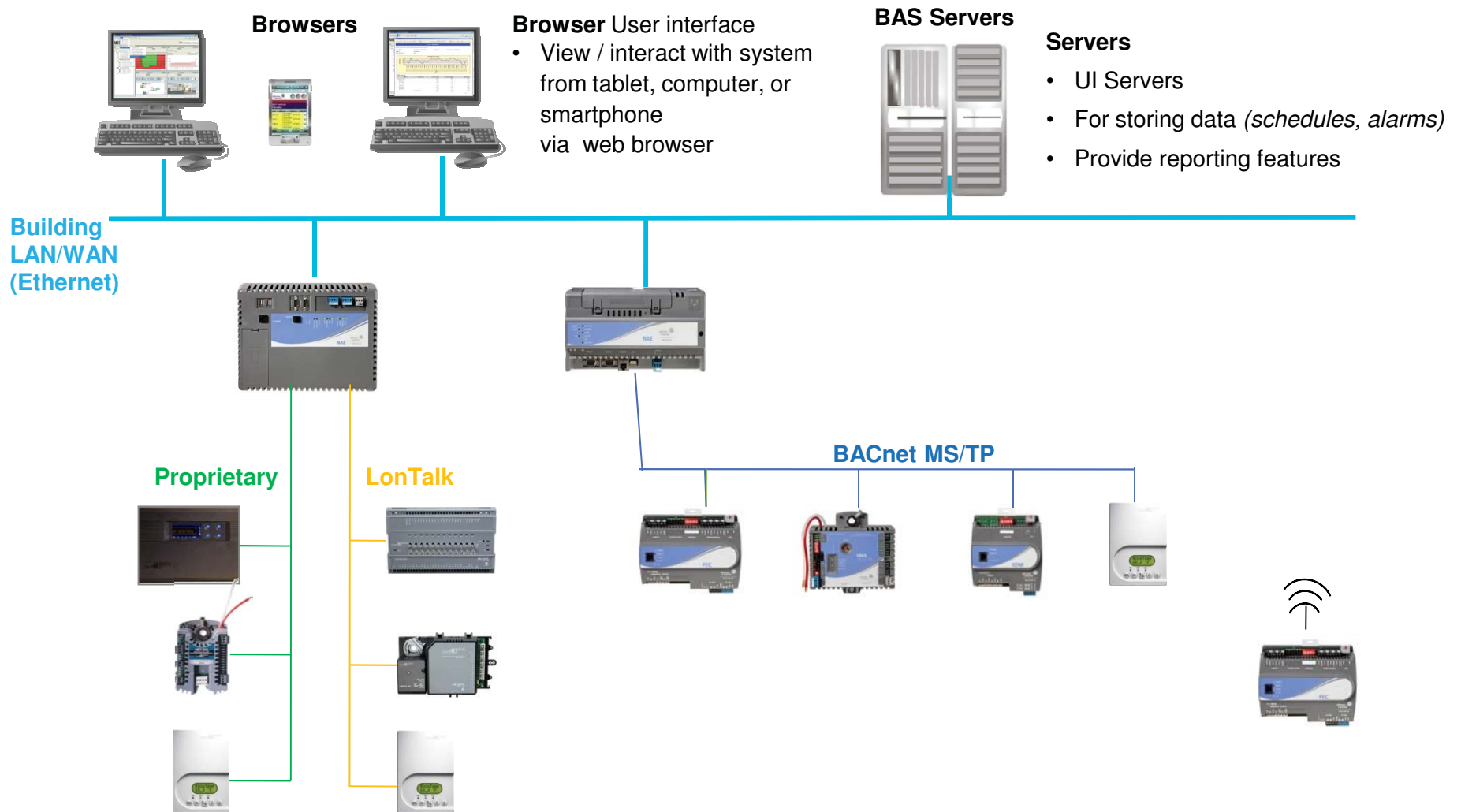
*Provide supervisory control and monitoring of field controllers, and bring information to BAS server*

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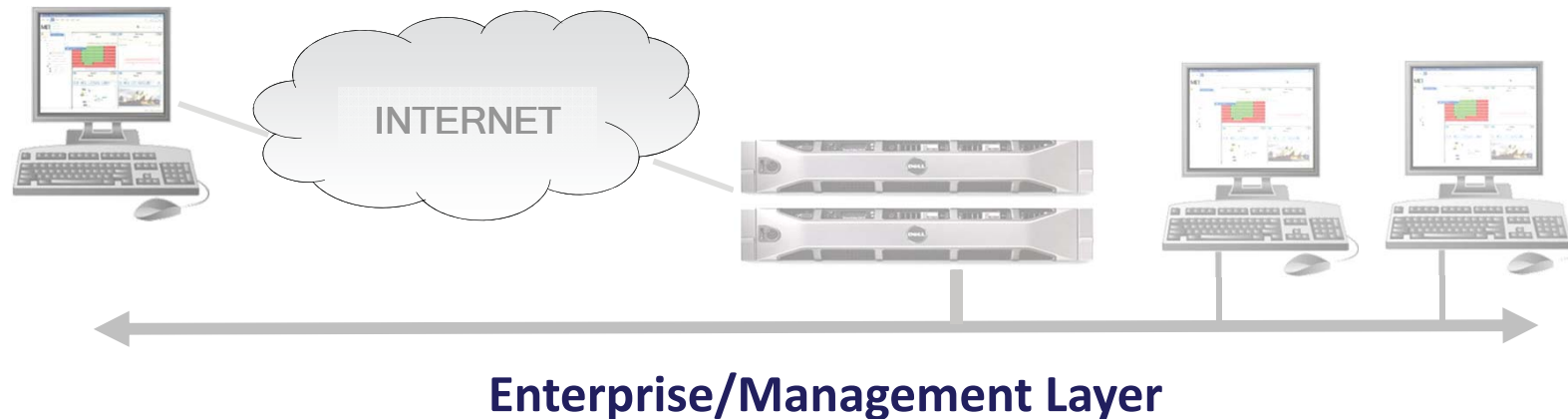


# System Architecture



# BAS Servers: part of the IT Infrastructure

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BAS Servers must integrate seamlessly with Corporate IT Infrastructure

- Hardware **IT appliance; Ethernet (100Mb/1Gb); Virtual Environment**
- Protocols **TCP/SNMP/SNTP/HTTP/SOAP/Port80**
- Enterprise Applications **XML/SOAP/SQL**
- BACnet /IP *communications*

# BAS Application and Data Servers

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*Provides data aggregation, navigation and storage in a managed IT environment*

## Needs to be Scalable

- From a simple desktop PC to high availability blade servers
- SQL-lite or full SQL Server as the primary database engine

## Server level applications

- Network-wide user management
- Network-wide data manager

Consistent UI, regardless of system size

## Virtualized Environment



# Shares IT infrastructure and “rules of the road”

Resides on existing IT infrastructures

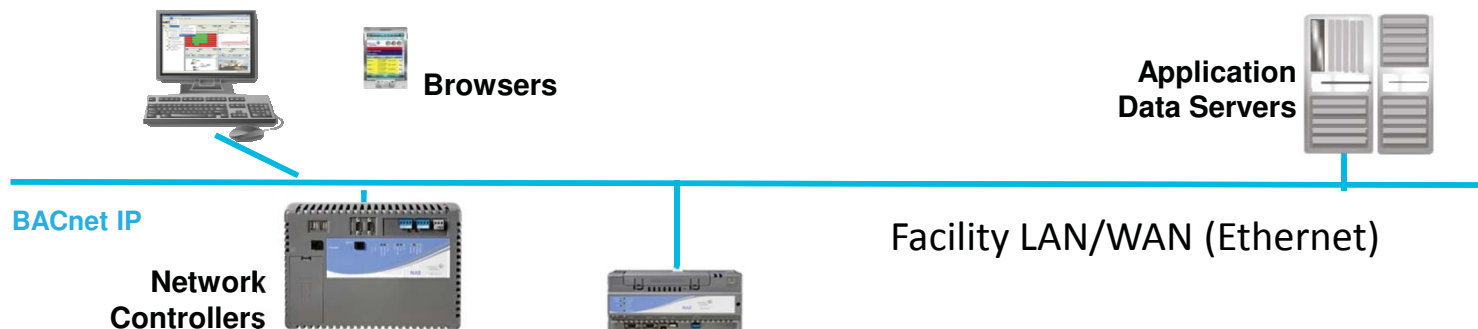
Utilizes IT device management

Web based user interfaces

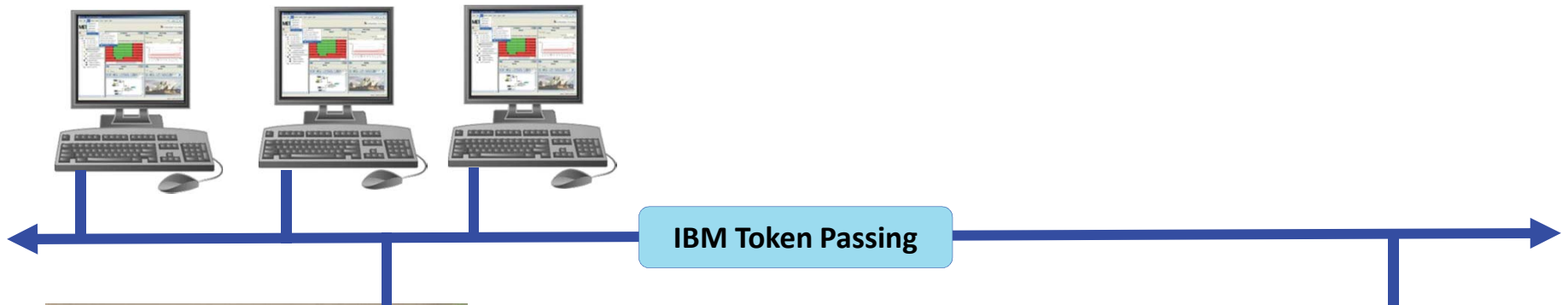
Data access via web services & http

## Benefits

- Lower costs , complexity, & maintenance of network.
- Availability of facility data to other enterprise applications using commonly accepted IT infrastructure
- Follows IT best practices



# Information Technology Evolution



**Proprietary “Dumb” Terminals**



**IBM System 34 “mini”Server**

# Information Technology Evolution



## Novell Networks – Arcnet and Ethernet

# Information Technology Evolution

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**NO STOPPING UNTIL THE  
WORLD IS CONNECTED.**

ANNOUNCING THE LAUNCH OF WiMAX IN  
BALTIMORE, MD: THE ERA OF 4G HAS BEGUN.

WiMAX - the best solution for high-speed wireless Internet - is here, and it's real. Intel is proud to be the leading force in pioneering this initiative and celebrating the beginning of the 4G era. The entire world will be watching Baltimore to witness the future of mobile connectivity.



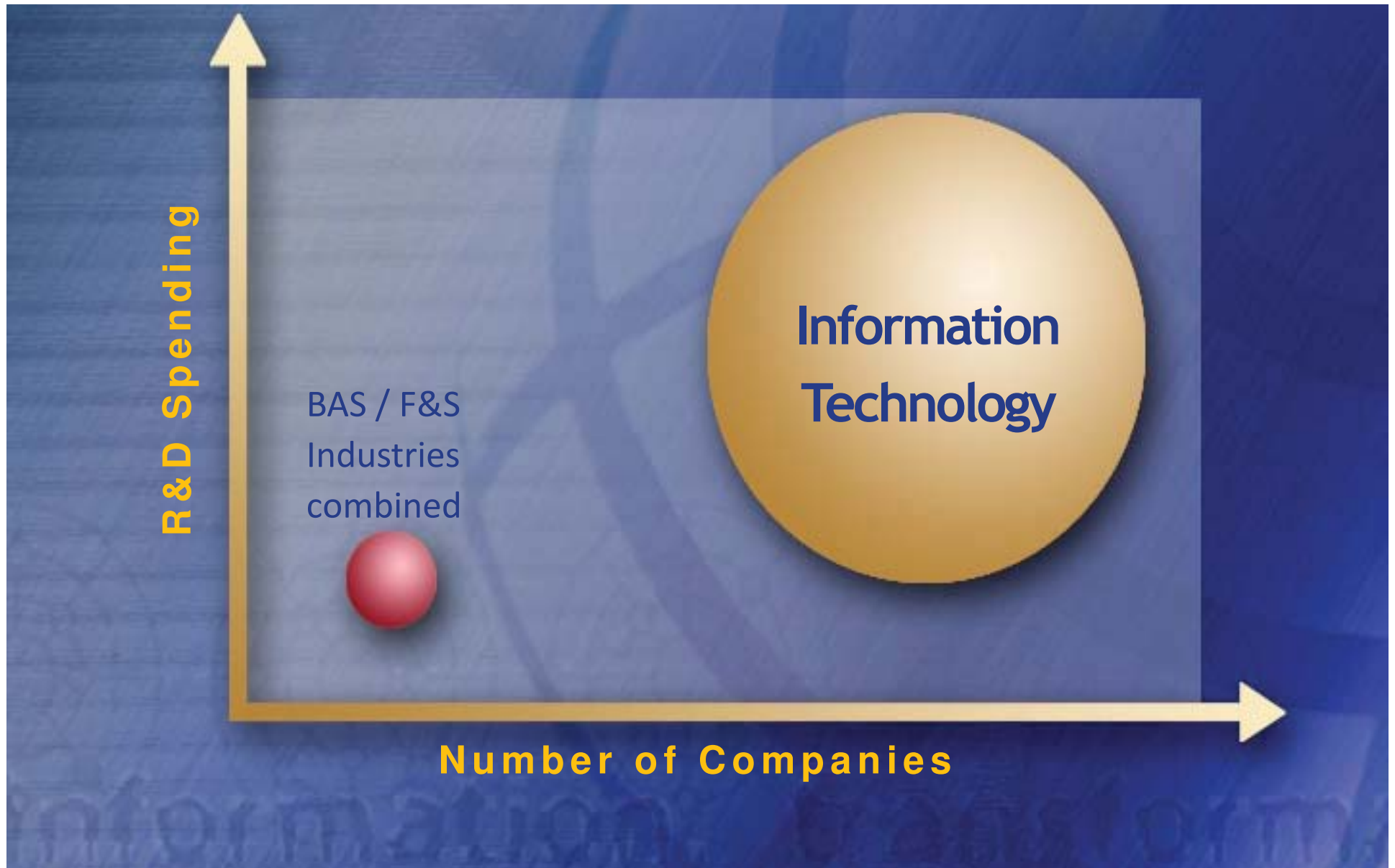
# Information Technology Evolution

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- Languages, Operating Systems, Data Exchange Protocols, and the “user experience”
- Standard PC LAN Architectures
- the Internet
- .NET
- SOAP
- XML
- Web Services



# Why is I.T. so important to the BAS world?



## Why I.T. Matters

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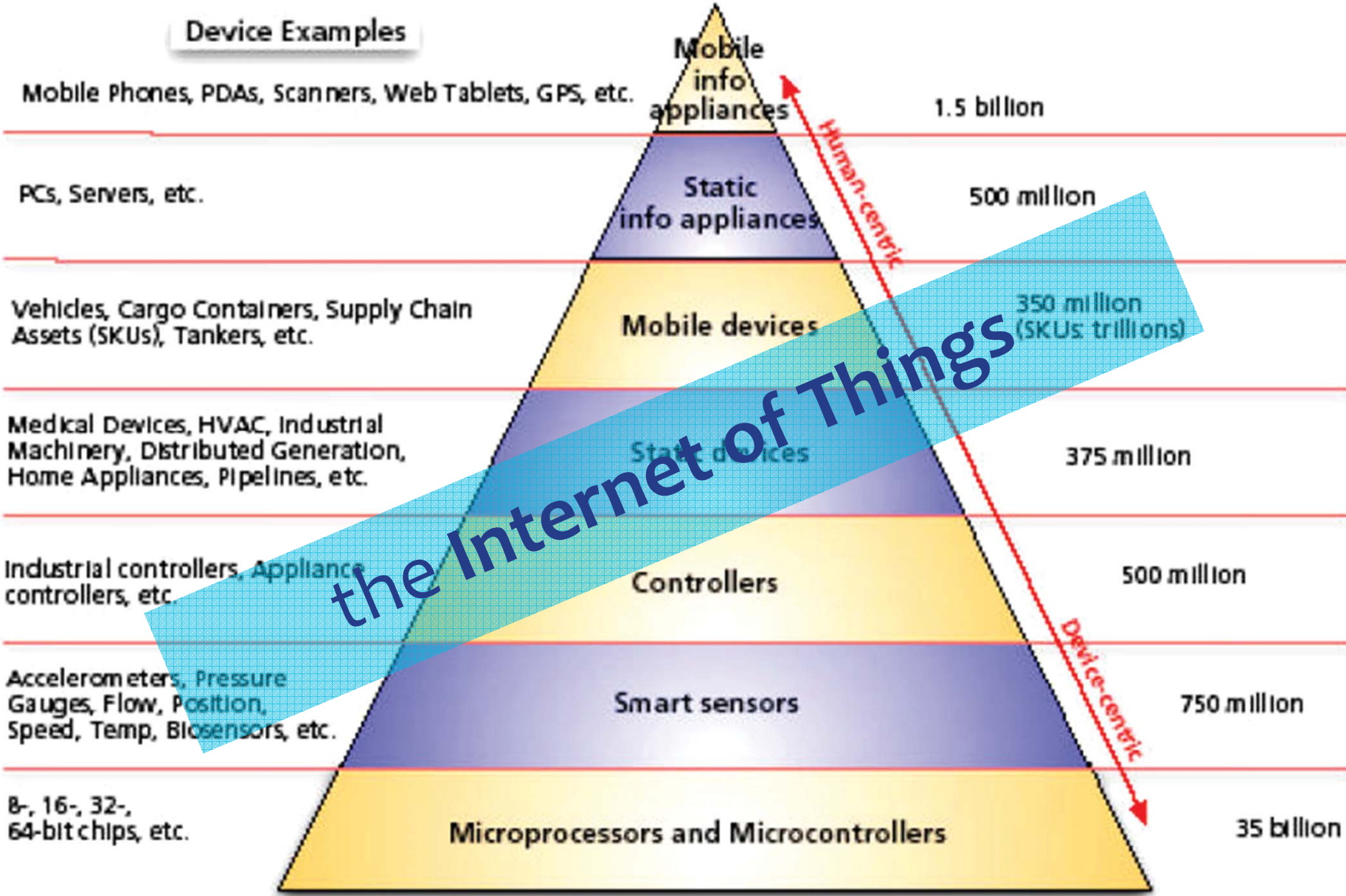
### **Harbor Research, 2001:**

“By 2010, there will be one TRILLION more internet users than today –

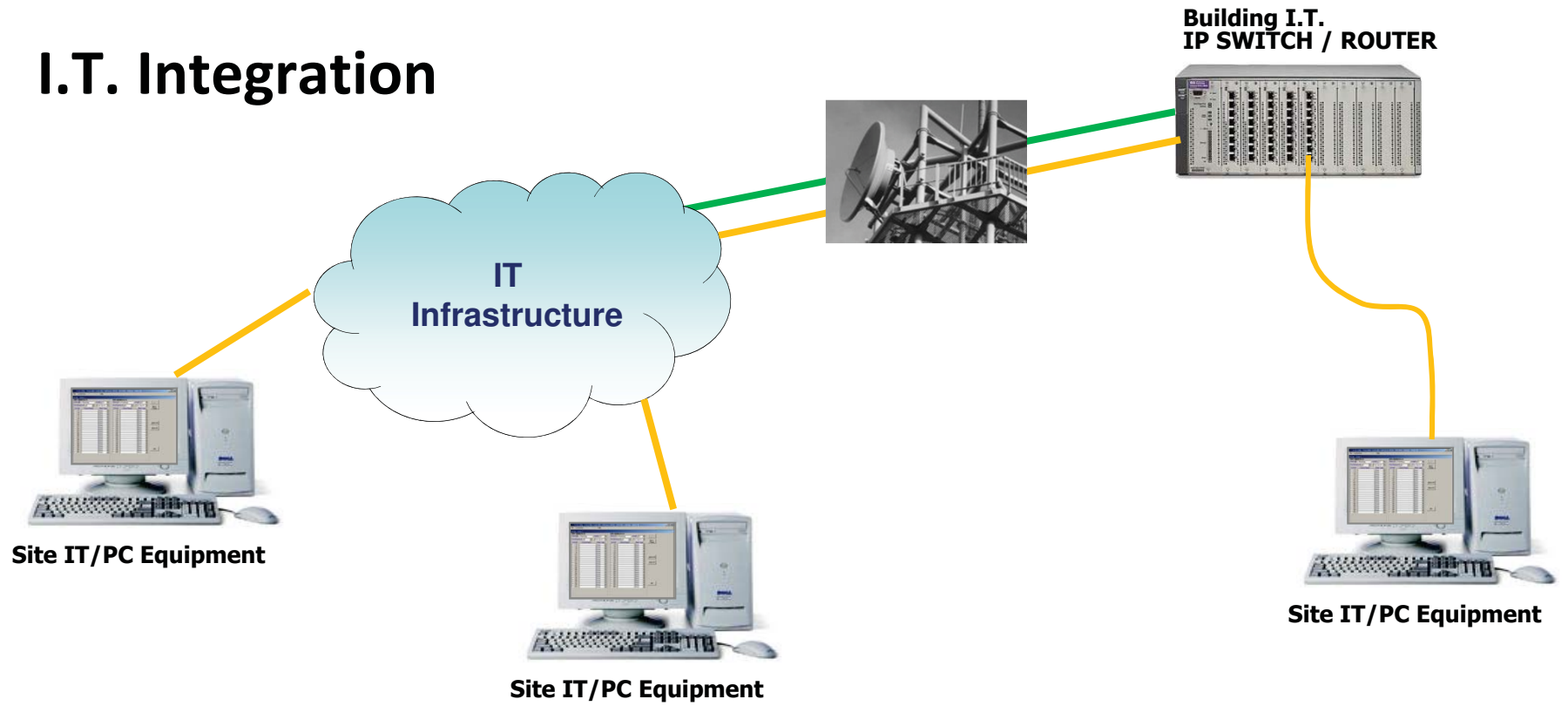
and most of them won't be humans.”

Pervasive Internet Device Hierarchy

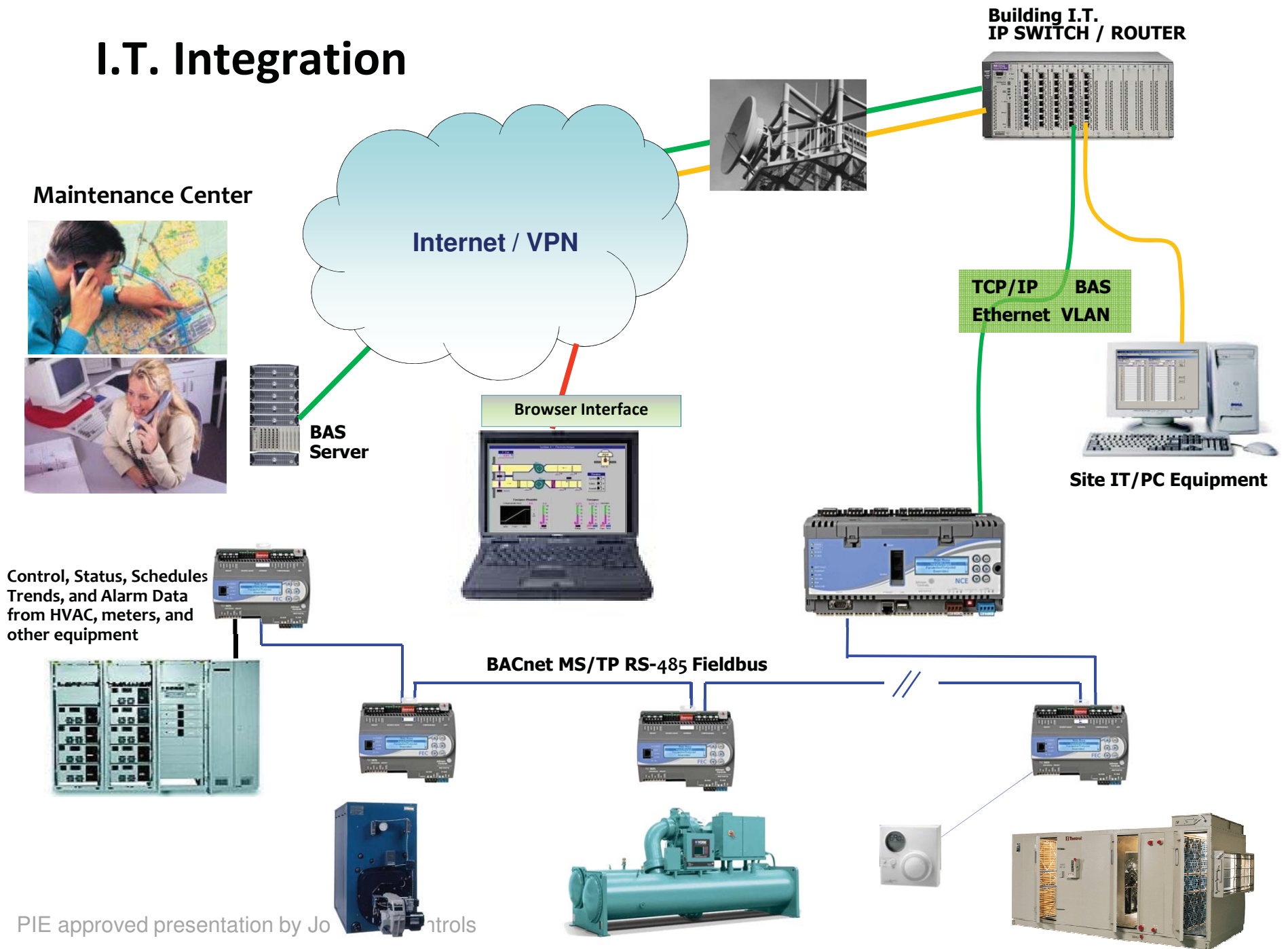
Device Examples



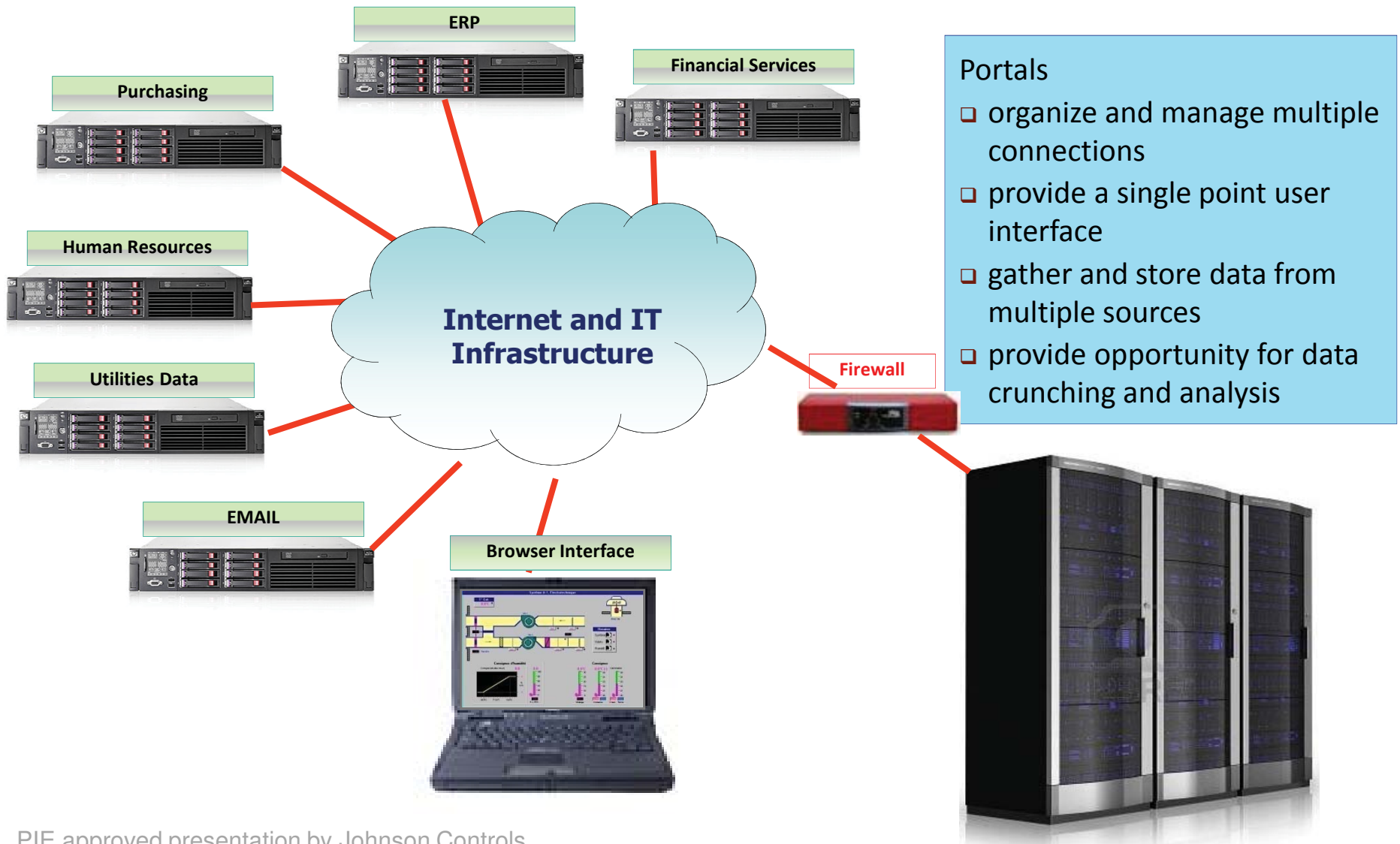
# I.T. Integration



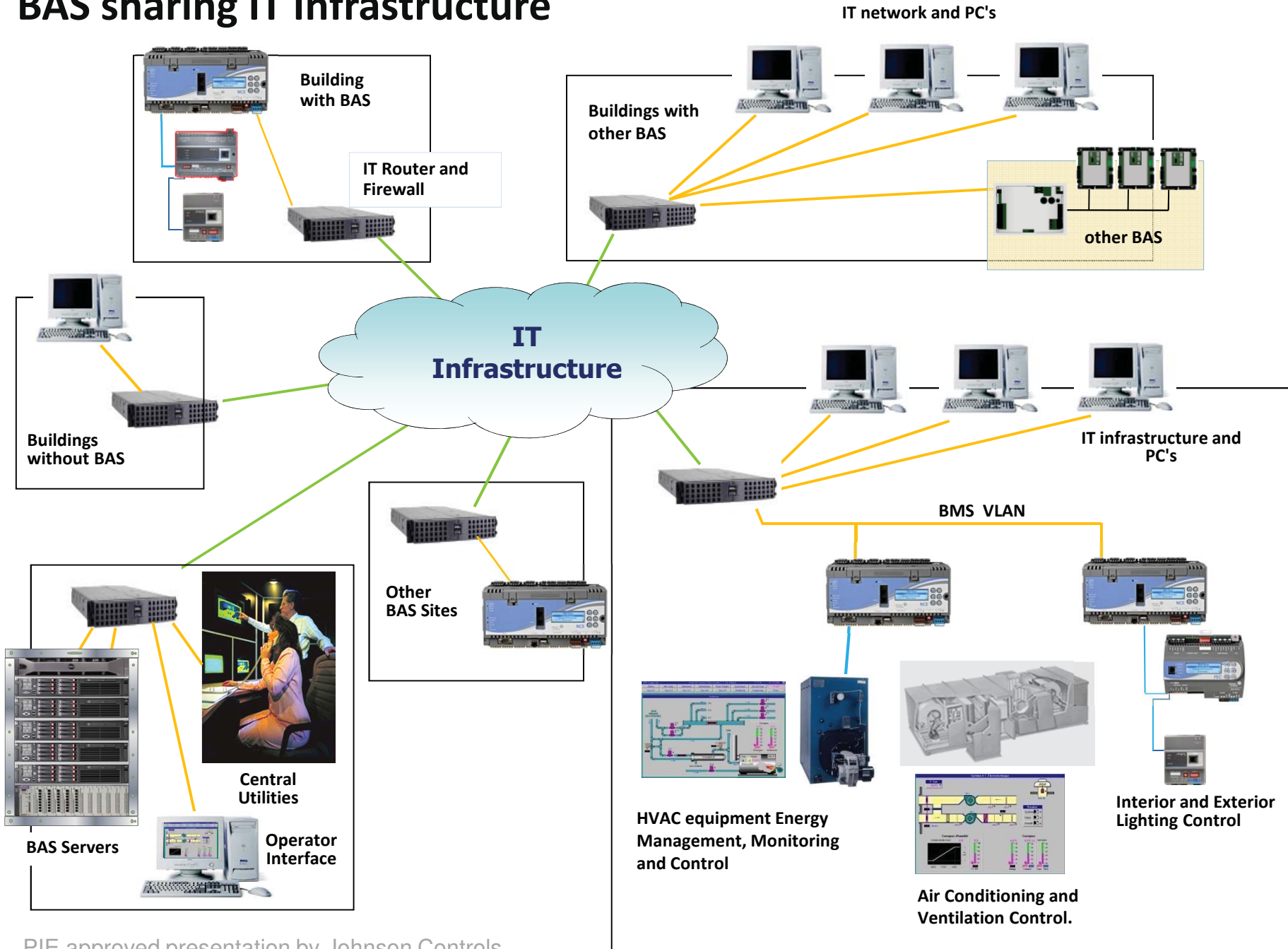
# I.T. Integration



# Information Technology: servers and portals



# BAS sharing IT Infrastructure



# User Interfaces

Web-Based & Mobile User Interfaces

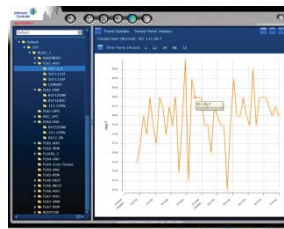
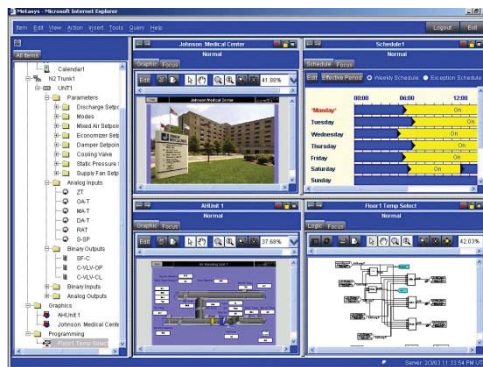
User Interfaces designed for purpose

Customizable Navigation

Dynamic Graphics

## Benefits

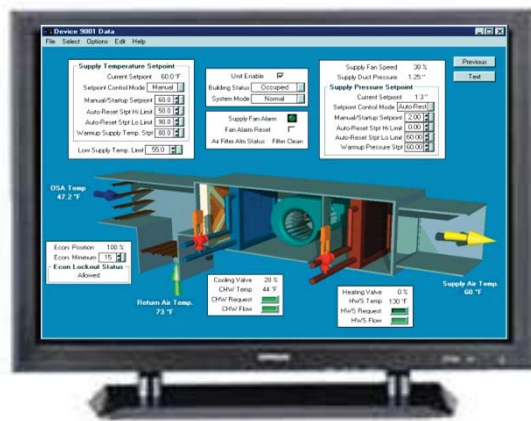
- Availability, anytime, & anywhere
- UIs feature & function to match user capabilities & tasks (Site Management Portal, and Ready Access Portal)
- Navigation that is customizable to customer needs, & can be assigned to specific users/tenants.
- Dynamic, Intuitive, and Smart Widgets



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# Evolution of BAS User Interfaces

- Dumb terminal "COMMAND Prompt"
- PC's and terminal interface text software
- Manufacturer's menu-driven graphical PC software
- WEB browser interface
- "smart phone" interface



# User interfaces to meet user roles



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Graphic Focus

# Pascack Hills High School School Dashboard



## Outside Air



Temperature

42.0 deg F

Humidity

40.0 % RH

## Energy Usage



Electrical Consumption

2357 kWh



## Building Overview

Multi-Purpose

73.9 deg F

Zone Setpoint: 68 deg F

Occupancy: Occupied

Fan Mode: Off

Lighting: Off

Humidity: 40 %

## Primary Systems



Discharge Water

50.0 deg F

Chilled Water System



Discharge Air

65.0 deg F

Air Handler



Discharge Water

120.0 deg F

Hot Water System

# Simplicity Through Graphics



## Utilities

### Outside Air



Temperature  
42.0 deg F

Humidity  
40.0 % RH

### Energy Usage



Electrical Consumption  
2357 kWh

### Gas Usage



Gas Consumption  
1000 cu feet

### Water Usage



Water Consumption  
35 GPM

## Core Systems

### Chillers



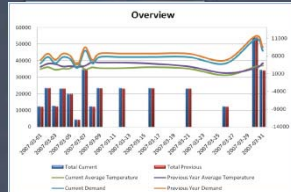
0  
1? 0  
0  
0

### Pumps/Circulation



0  
1? 0  
0  
0

### Energy Reports



### Airhandling Units



0  
1? 0  
0  
0

### Steam Plant



0  
1? 0  
0  
0

### Security / Access



0  
1? 0  
4  
0

## Tenants

### Tenant C



0  
1? 0  
2  
0

### Tenant B



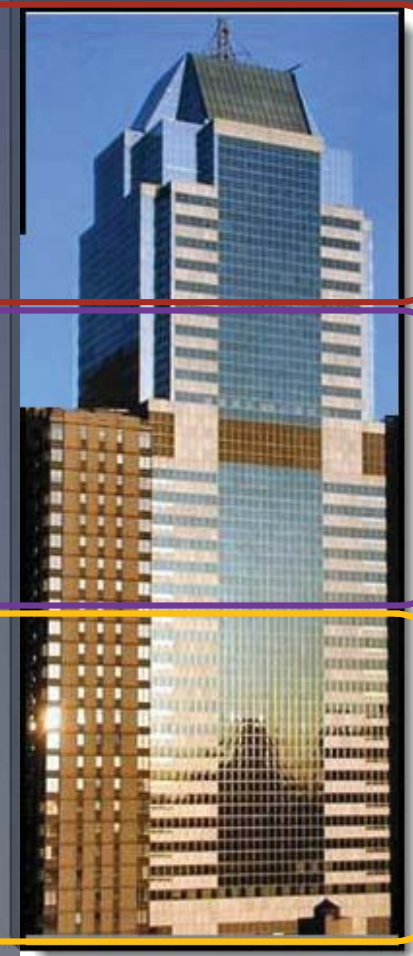
0  
1? 0  
0  
0

### Tenant A



0  
1? 0  
0  
0

## System Riser

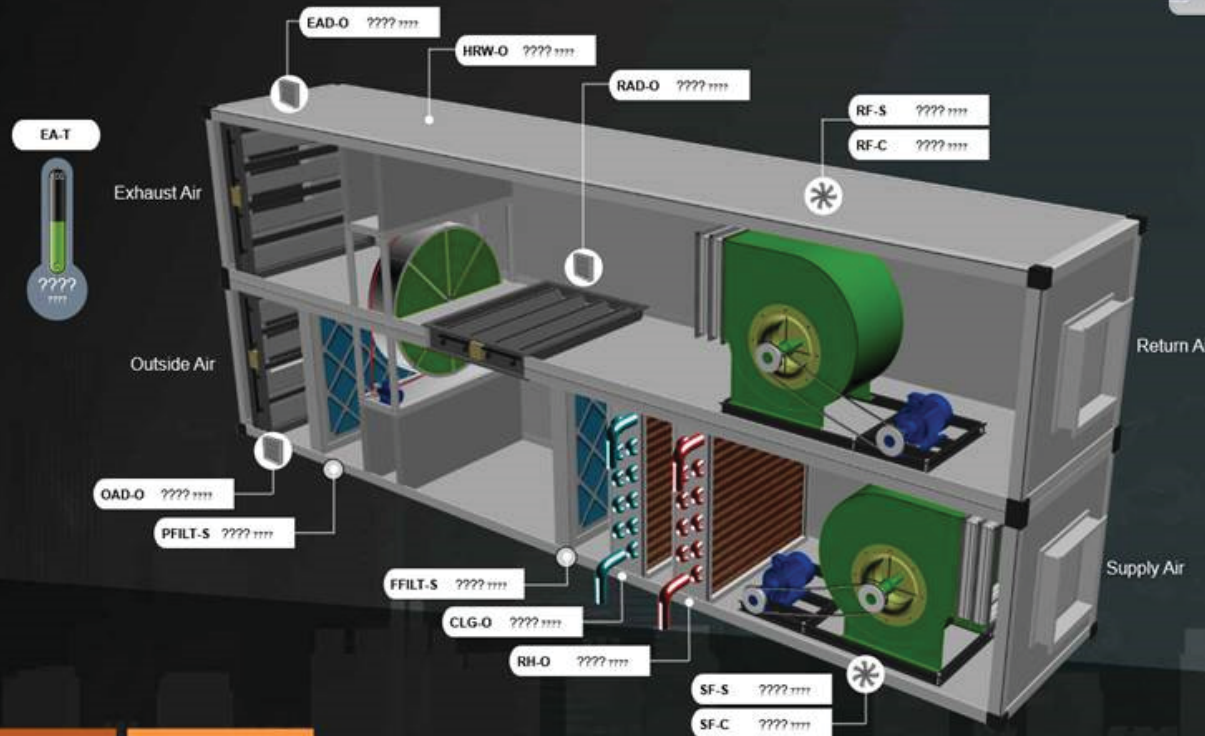


# XYZ Building AHU-01

35.25 deg c 40.25 %RH

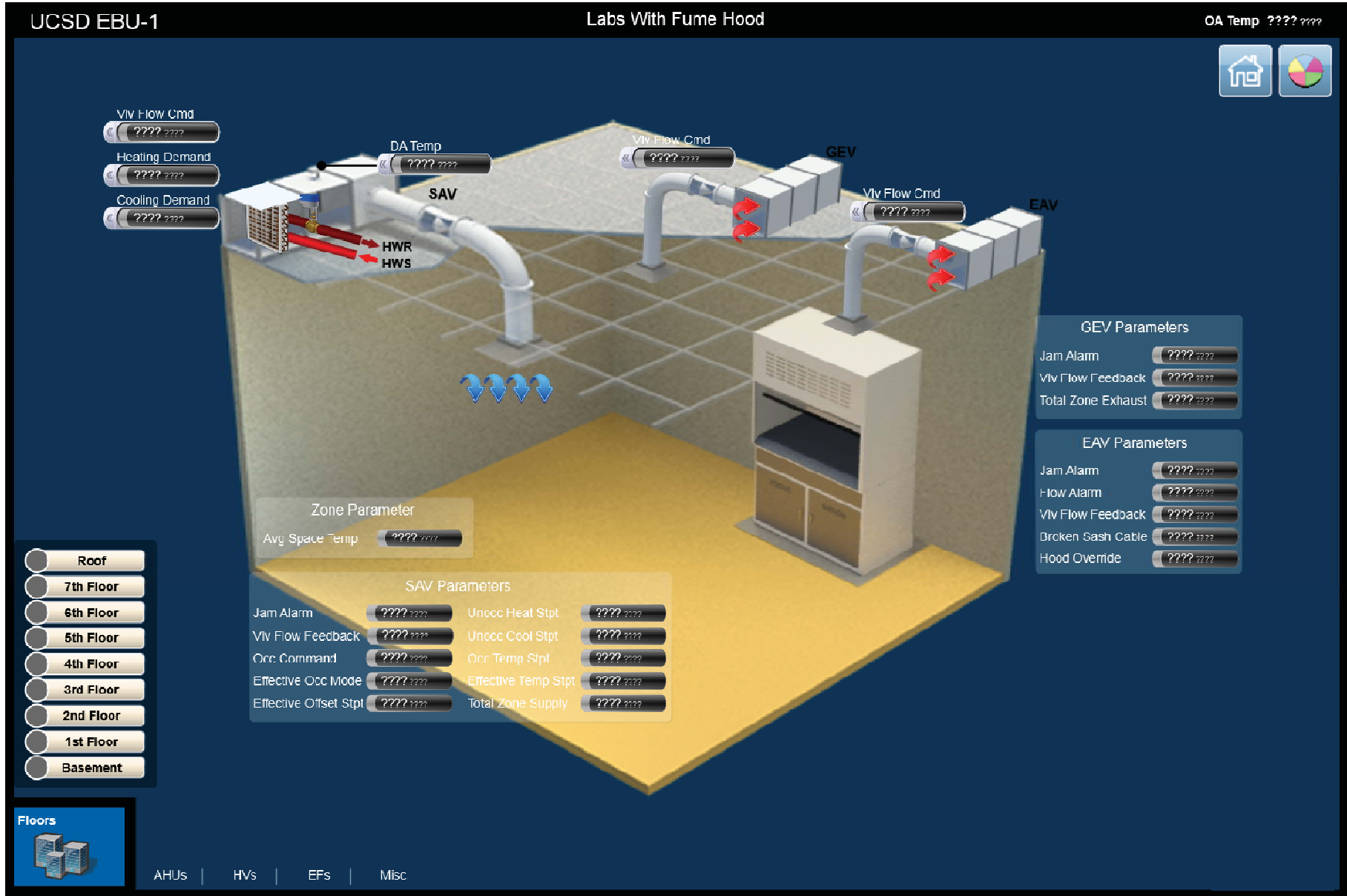


Param...



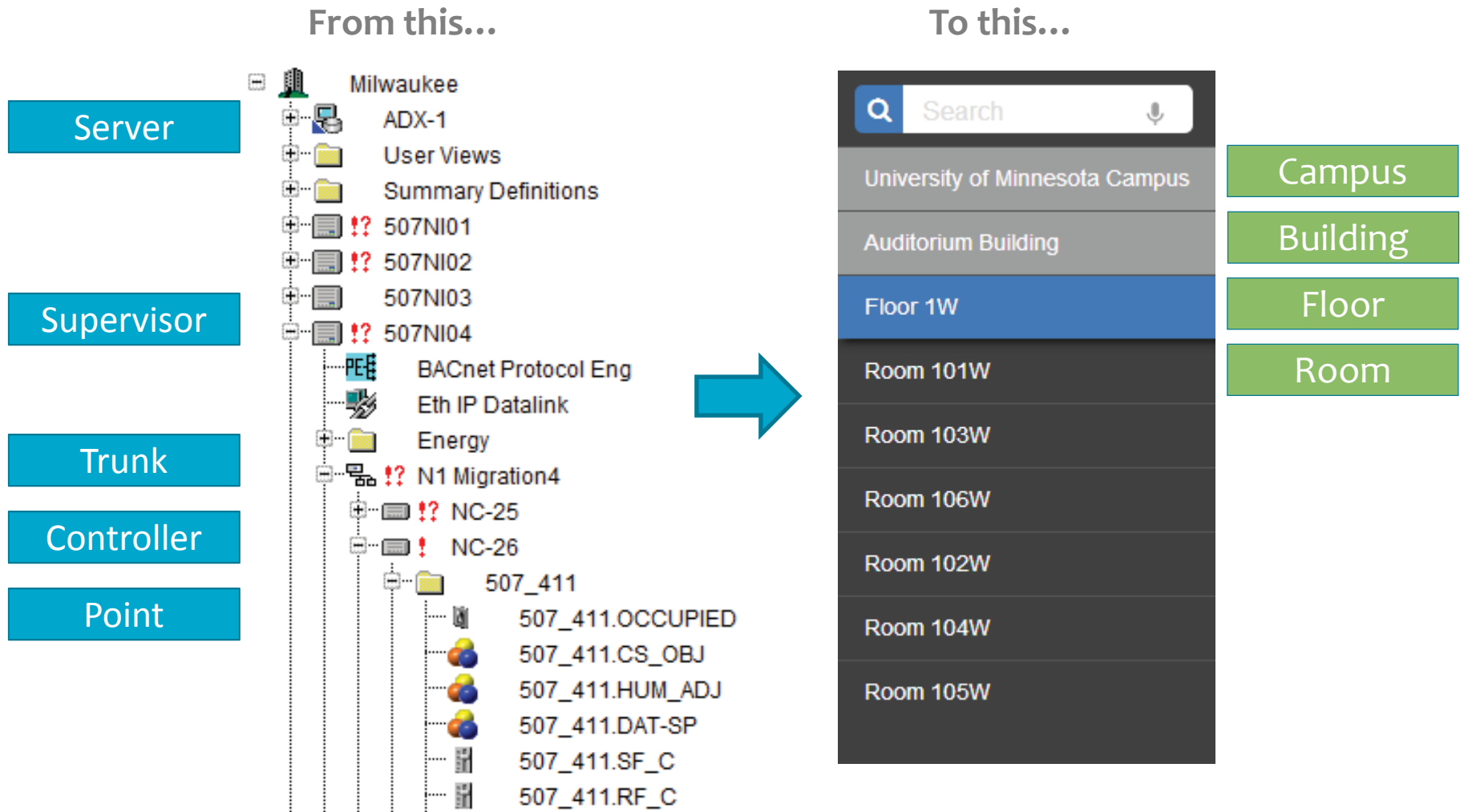
| AHU Summary | Zone Parameters        | Modes                 |
|-------------|------------------------|-----------------------|
|             | Zone Temp: '????'      | Occ Mode: '????'      |
|             | Zone Temp Stpt: '????' | Shutdown Mode: '????' |





PIE approved presentation by Johnson Controls

# Changing user interface concepts



# Focus on the user: Mobility, Spaces and Equipment

- Lighting
- Energy
- Fire
- Security
- HVAC

Space

The screenshot displays a mobile application interface for Room 101W. On the left is a navigation menu with a search bar and a list of locations: University of Minnesota Campus, Auditorium Building, Floor 1W, and Room 101W. The main content area shows 'Key Data' with a current temperature of 75° and 'Occupied' status. Below this is a slider for 'AIR TEMPERATURE SET POINT' ranging from 65 to 80, currently set at 71°. Further down are controls for VAV 3155 (73° AIR TEMP SET POINT, 45% DAMPER POSITION) and AHU 2003 (55° DISCHARGE AIR TEMP, ON SUPPLY FAN STATUS). At the bottom, the 'CHILLER SYSTEM' is ON at 43° and the 'BOILER SYSTEM' is OFF. To the right of the interface, a vertical arrow points from the HVAC category to a list of equipment: VAV, AHU, Cooling System, and Heating System.

| Equipment      | Status / Value                               |
|----------------|--|
| VAV 3155       | 73° AIR TEMP SET POINT, 45% DAMPER POSITION  |
| AHU 2003       | 55° DISCHARGE AIR TEMP, ON SUPPLY FAN STATUS |
| CHILLER SYSTEM | ON, 43°                                      |
| BOILER SYSTEM  | OFF  |

# Custom Dashboards via Smartphone or tablet



Lobby Live Video Feed

| Right Now  | Today   | Tonight  |
|--|---|--|
| <br>79°F<br>FEELS LIKE 82°<br>Light Rain<br><small>Nearby locations are also reporting rain.</small><br>Past 24-hr Precip:<br>0.12 in (est.) | <br>81°<br>HIGH<br>Isolated T-Storms<br>Chance of Rain<br>30% | <br>73°<br>LOW<br>Isolated T-Storms<br>Chance of Rain<br>30% |

Local Weather Forecast

Savings Meter

M&V Plan: 2009 Controls Retrofit  
 Baseline: Central Electric Meter

Savings for Most Recent 30 Days

Cumulative Savings since 1/1/11

Alarm Acceptable

Range: All Year to Date Past Month View by: kWh Dollars (\$)

November 22 2014

Multi-Purpose

73.9 deg F

Zone Setpoint: 68 deg F

Occupancy: Occupied

Fan Mode: Off

Lighting: Off

Humidity: 40%

ON RAISE LOWER OFF

Thermostat

Lighting

Southeast Quadrant  
 2<sup>nd</sup> Floor

Marketing Live Video Feed



Multi-Purpose

73.9 deg F

Zone Setpoint: 68 deg F

Occupancy: Occupied

Fan Mode: Off

Lighting: Off

Humidity: 40%

ON RAISE LOWER OFF

Thermostat

Lighting

Northwest Quadrant  
 1<sup>st</sup> Floor

Customer Service Live Video Feed



# Access via Mobile Device

Use Browser-enabled portable mobile devices to securely:

- Monitor facility equipment operation
- Troubleshoot systems
- View / Acknowledge Alarms
- Change setpoints
- Turn on/off Outputs
- View/change Schedules

on your smart phone...  
anywhere, anytime

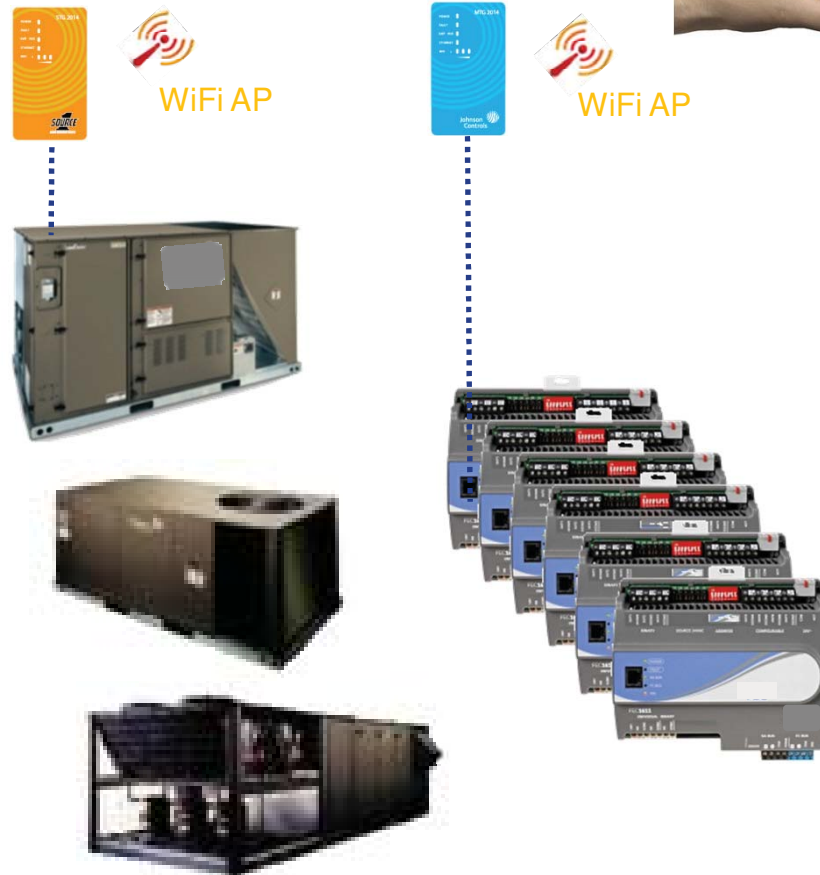


# Mobile Access Portals

One to One  
"Local Only"



Many to One  
"MAP"



More efficient  
User Experience



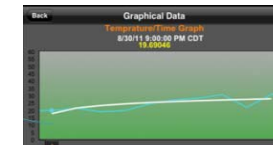
Configure



Schedule



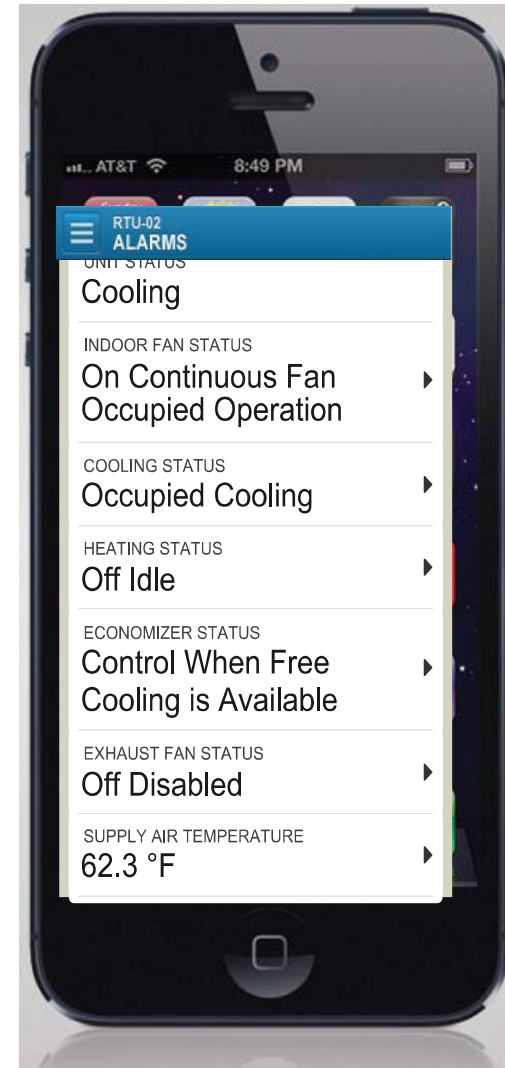
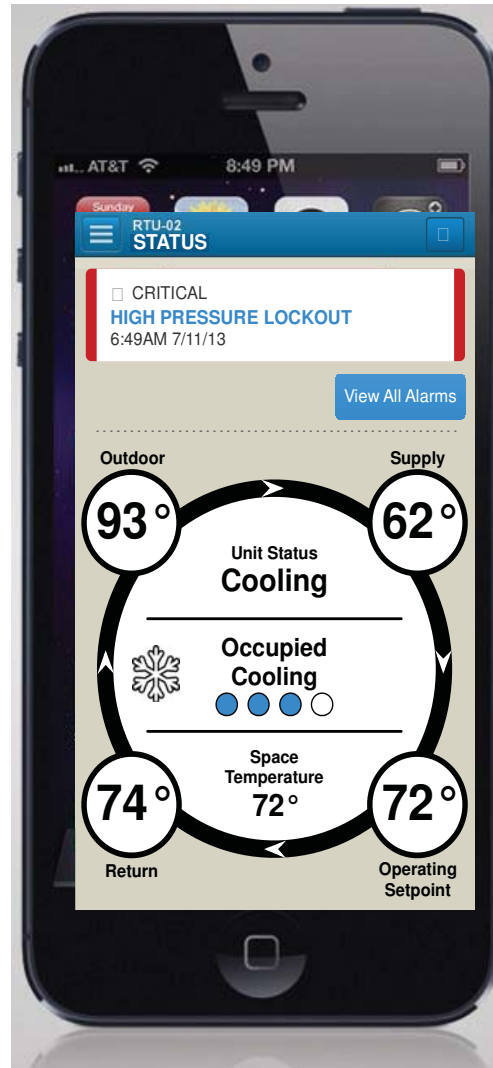
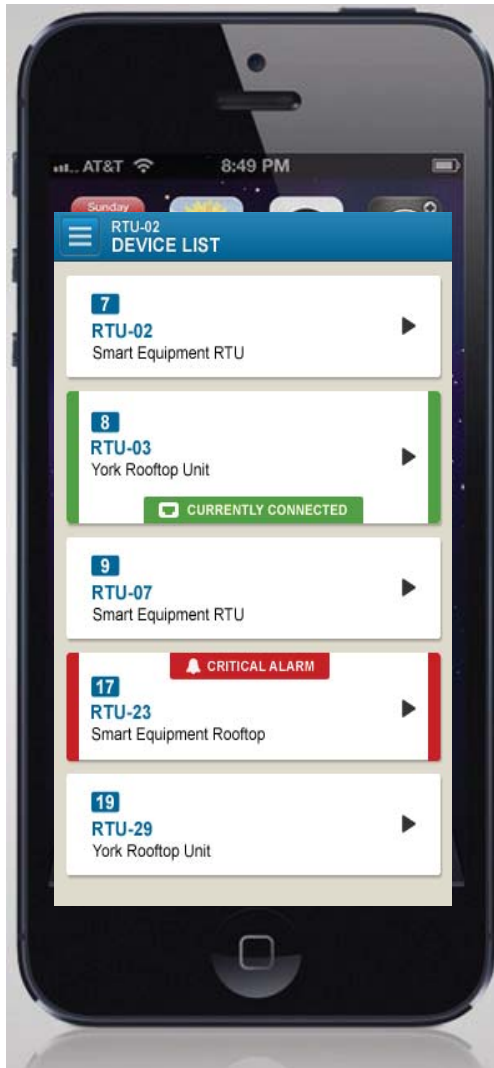
View



Override



# Mobile Access Portals



# Wireless Operator Interfaces for Service

---



## Supporting technologies

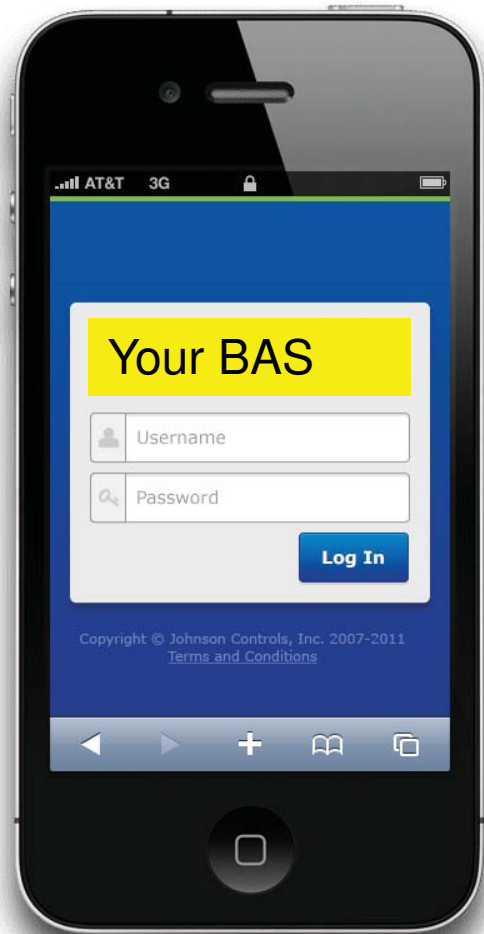
- increased use of WiFi
- smart phones
- tablets
- Fault detection and diagnostics (FDD)
- BMS / work order software integration
- IT / Internet / BMS integration
- smart equipment and “hot spots”
- “Cloud” applications and services



# User Experience

Carried forward with advances in IT and browser technology

---



**Apple Phone**



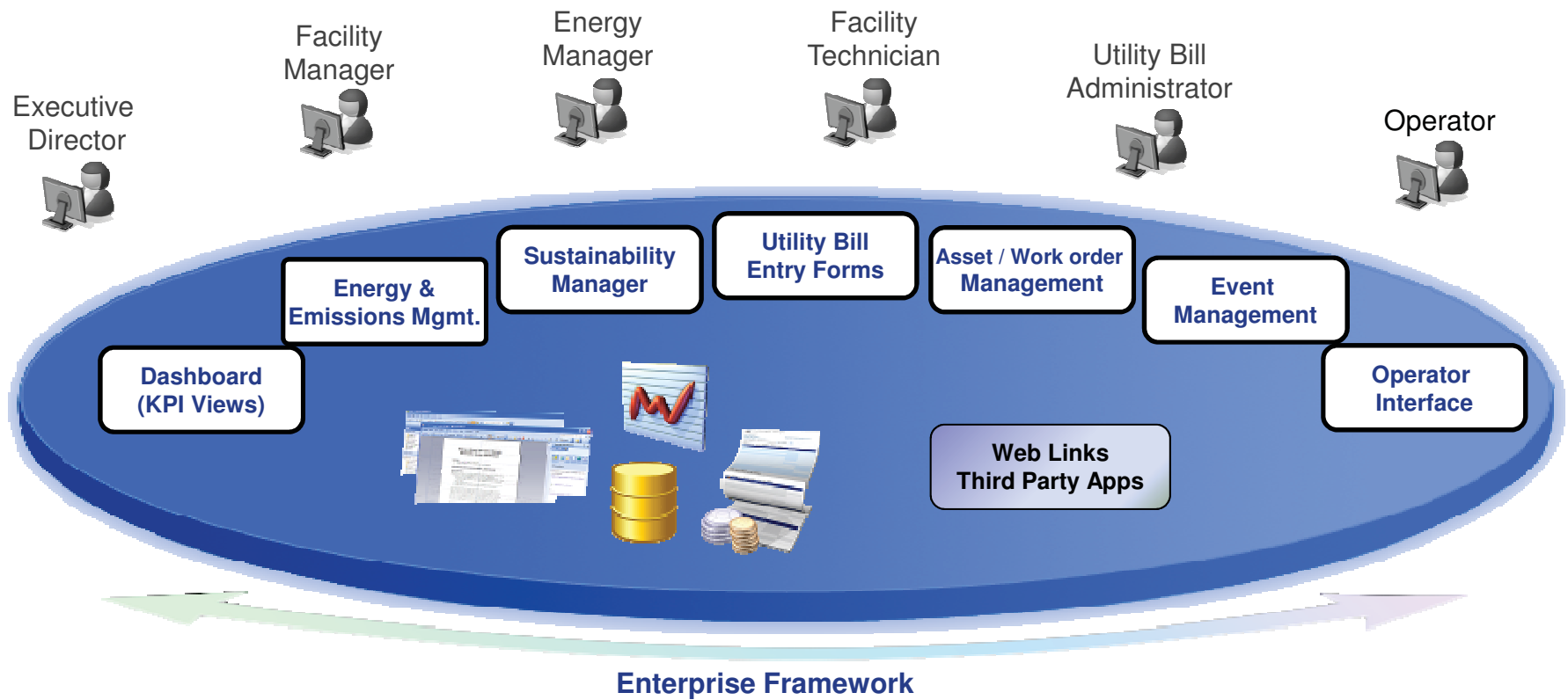
**Samsung Galaxy**

# User Experience and “wearable technology”

Carried forward with advances in IT and browser technology



# Role Based Enterprise Portfolio Management



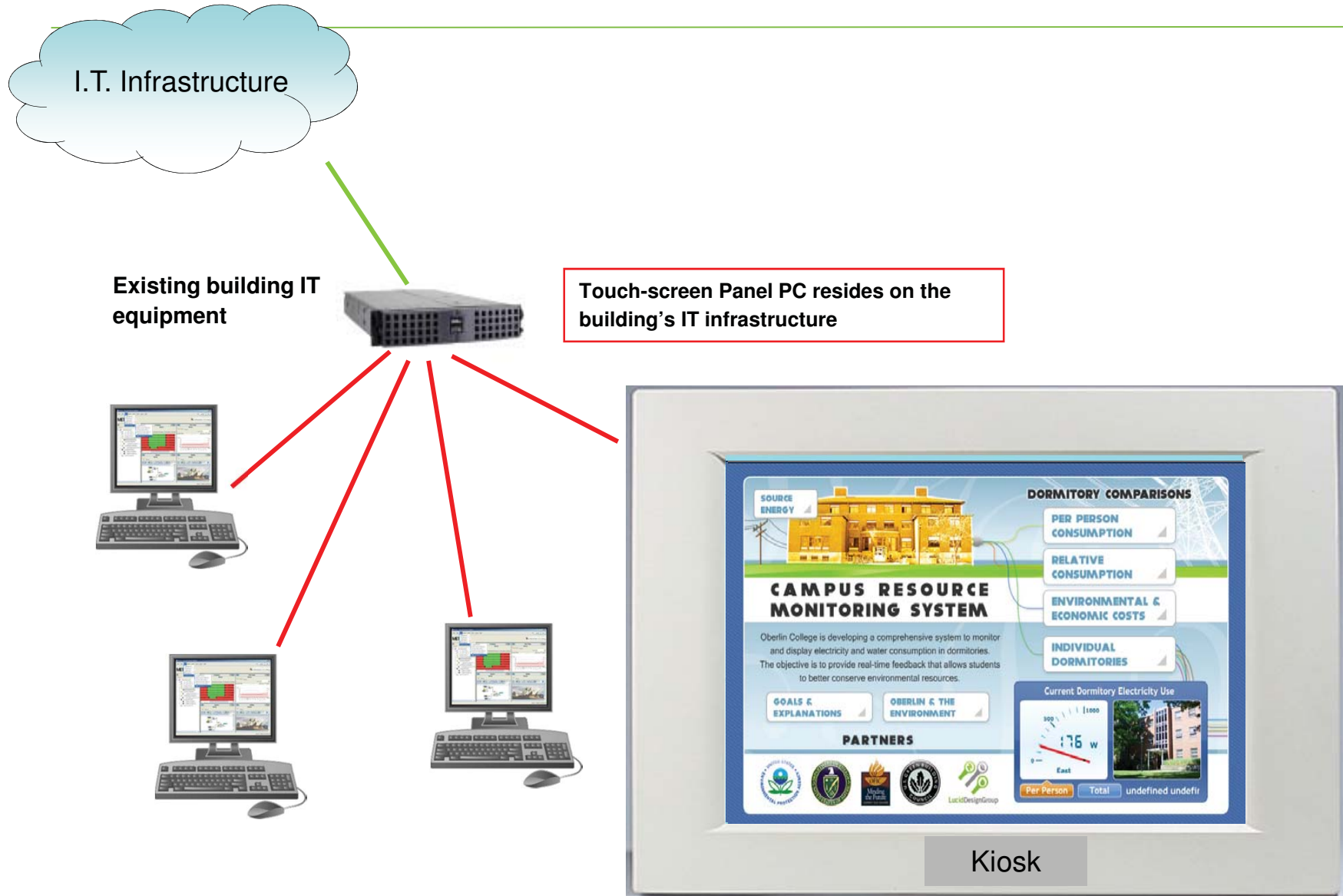
# Data, Delivery, and Applications to match User Roles and the Customer needs

---



PIE approved presentation by Johnson Controls

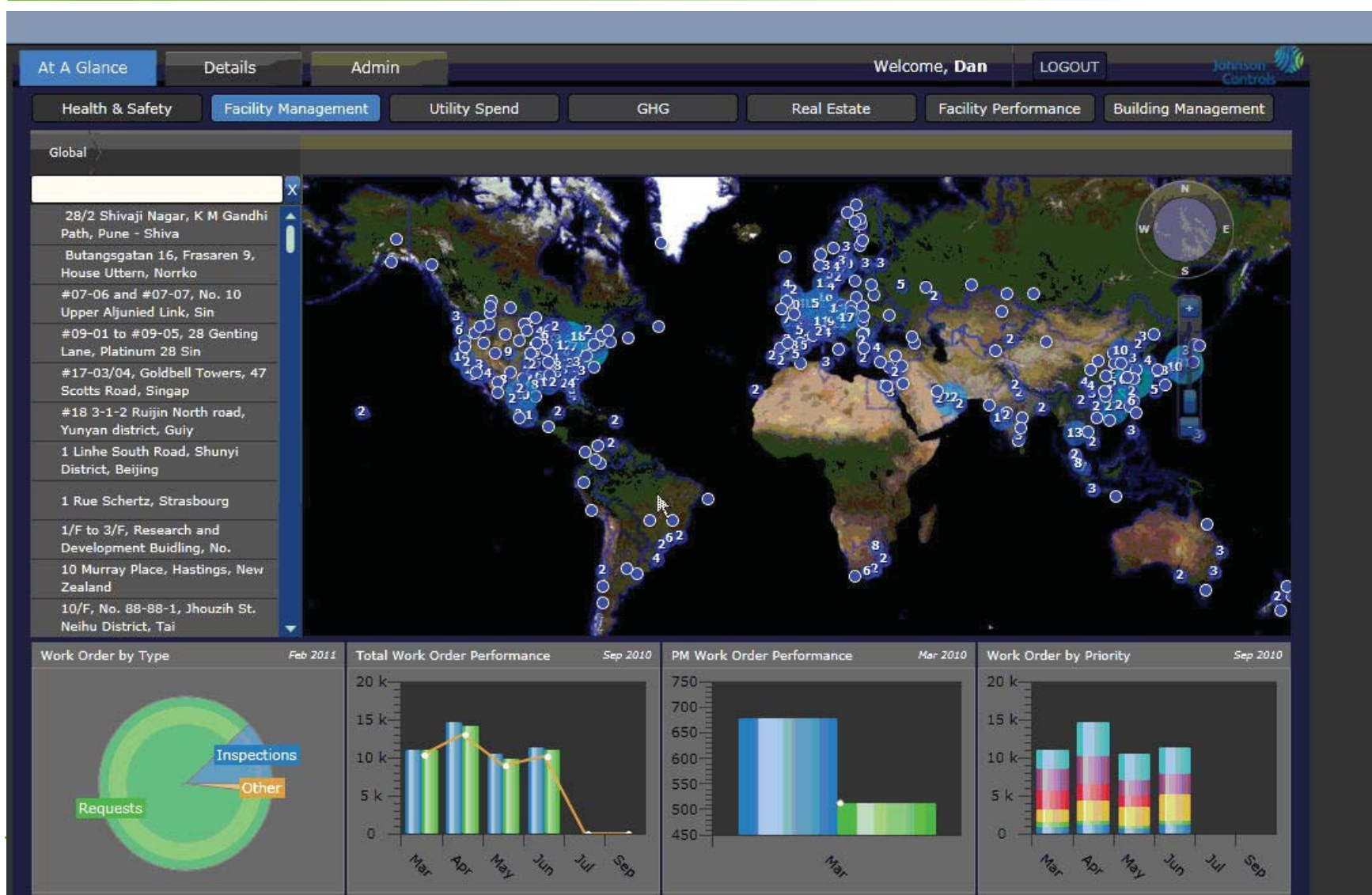
# Energy Performance Kiosks





PIE approved presentation by Johnson Controls

# “Composite” Dashboards

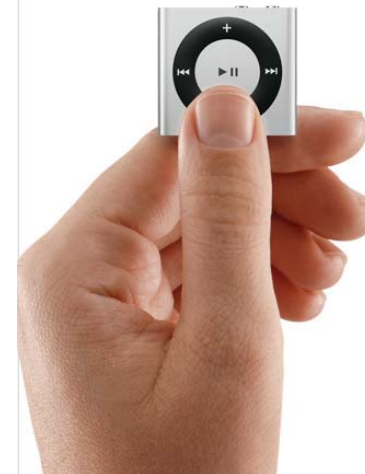


PIE approved presentation by Johnson Controls

# the USER EXPERIENCE

---

- It's all about the **HARDWARE**



# the USER EXPERIENCE

---

■ It's all about the **HARDWARE**

■ It's all about **CONTENT!**



## Apps for whatever you're up for.

A new game or a new photo collage maker. Something to help you track down your favorite food truck or help you keep track of your soccer training. For all the incredible things your iPod touch already does, there are thousands more waiting for you at the App Store.



### Action Games

Conduct secret missions, fight your way to the finish line, or take to the skies for intense aerial combat.

[View action games in the App Store](#) ▶



### Casual Games

Outwordsmith your friend, slice through fruit, fly over hills, and rule your own island with games designed for everyday fun.

[View casual games in the App Store](#) ▶



### Education

Keep up with your studies using intelligent education apps like King of Math and NatureTap.

[View education apps in the App Store](#) ▶



### Entertainment

Kick back and enjoy the show. Or find countless other ways to entertain yourself. These apps offer hours of viewing pleasure.

[View entertainment apps in the App Store](#) ▶



### Games for Gamers

Explore fantasy worlds, battle fierce competition, or take your team to the championship game.

[View games for gamers in the App Store](#) ▶



### Kids

Turn every night into family night with interactive apps that are fun for the whole house.

[View kids apps in the App Store](#) ▶



### Lifestyle

Find the perfect recipe for Friday night. Or see what the surf conditions are like on Saturday. Whatever your passion, there's an app for you.

[View lifestyle apps in the App Store](#) ▶



### Music

Discover new music or make some of your own with apps like Shazam and dJaz 2 for iPod touch.

[View music apps in the App Store](#) ▶



### Social Networking

Stay connected to the rest of the world with apps like Pinterest, Twitter, and more. You'll be in the know, no matter what.

[View social networking apps in the App Store](#) ▶

# the USER EXPERIENCE – Social Media

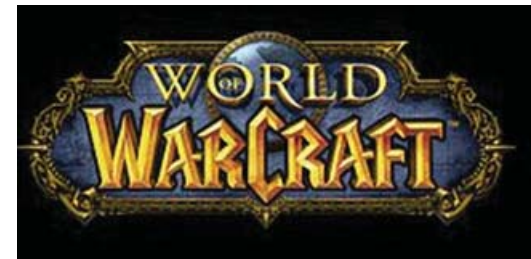
The screenshot displays a Facebook news feed interface. At the top, there is a search bar with the text "Search for people, places and things" and a search icon. To the right of the search bar are navigation icons for Home and a profile picture. Below the search bar, the left sidebar contains a "My FB page" link, a "FAVORITES" section with links to News Feed, Messages, Events, Photos, and Browse, and a "GROUPS" section listing various groups like BMW MOA, YOU'RE PROBABLY..., Official Johnson Controls E..., Alaska Nanook Hock..., La Famiglia Lucchetti, and You know you attended th... with member counts. Below the groups is a "FRIENDS" section listing Close Friends, Family, Johnson Controls Inc., and Dover, New Hampshire Area.

The main content area shows a post by Greg Fritze, who shared a photo from TheSadlersLady. The photo depicts a white Yeti-like creature in a snowy forest, holding a blue fork and a bottle of beer. A small figure of a person in a red outfit is visible in the background. The post includes a caption: "No elves were harmed in the making of this photo.... ;D". Below the photo, there are interaction options: "Like · Comment · Share · 3 hours ago · [privacy icon]". It shows "2 people like this." and a comment from Melanie Hill: "This is my coworkers pic 😊 about an hour ago via mobile · Like".

On the right side of the news feed, there are sponsored advertisements. The first is for "The Sportman's Guide" (sportsmansguide.com) featuring "Guide Ge Cargo Pa" pants. The second is for "Desert Warrior Products" with the text "We are a wants to outfit you weapon" and an image of a handgun. Below the ads is a "Ticker" section showing recent activity: "John Lentine likes A M Garden B&B.", "Francois Wilberz likes I photo.", and "Marc N Davida Hess a". At the bottom right, there is a "Chat (Off)" button.

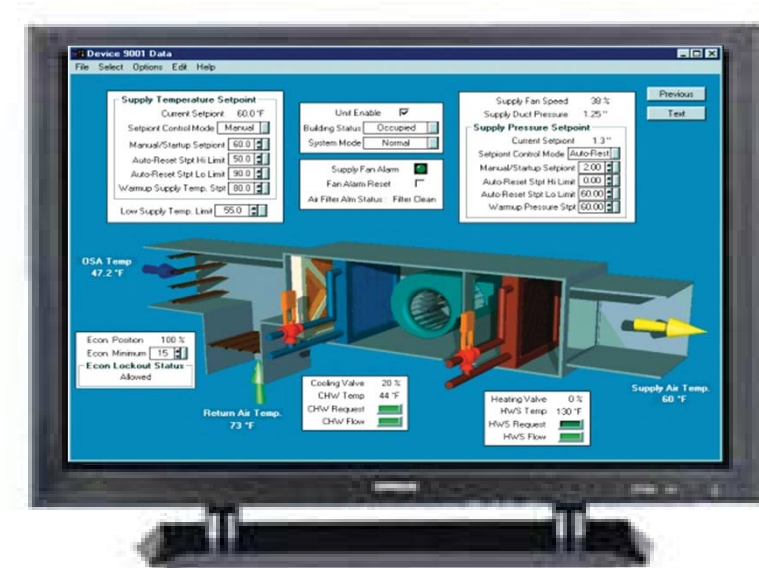
# the USER EXPERIENCE – Social Media

---



# the USER EXPERIENCE – the Delivery

- It's all about the **HARDWARE**
- It's all about **CONTENT!**
- It's all about **DELIVERY!**



# It's about Delivery !

---



# It's about Delivery !



# the USER EXPERIENCE

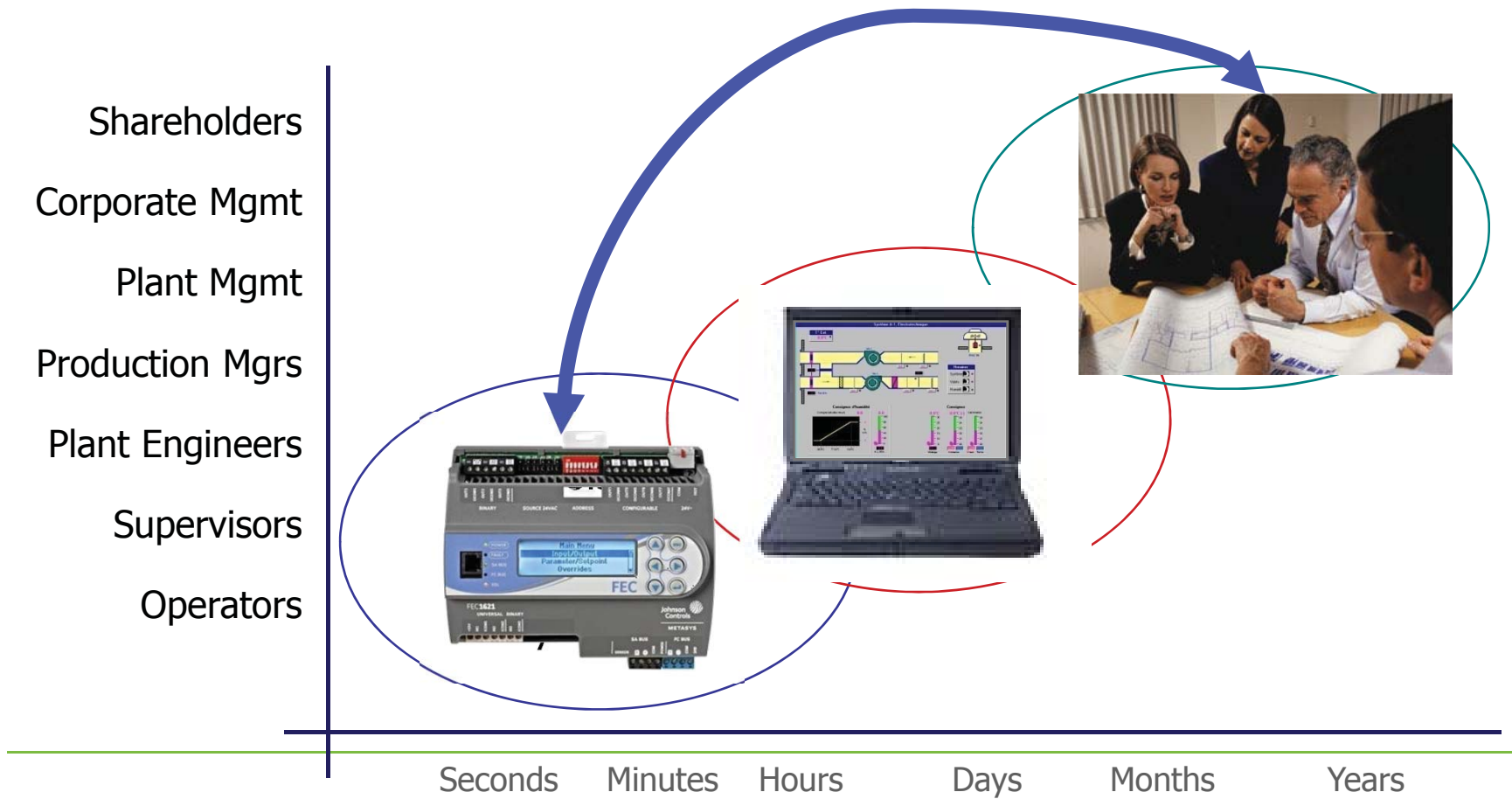
---

- It's all about the **HARDWARE**
- It's all about **CONTENT!**
- It's all about **DELIVERY!**
- **It's a changing landscape**
  
- **“Digital Natives”**  
Young people are the early adopters

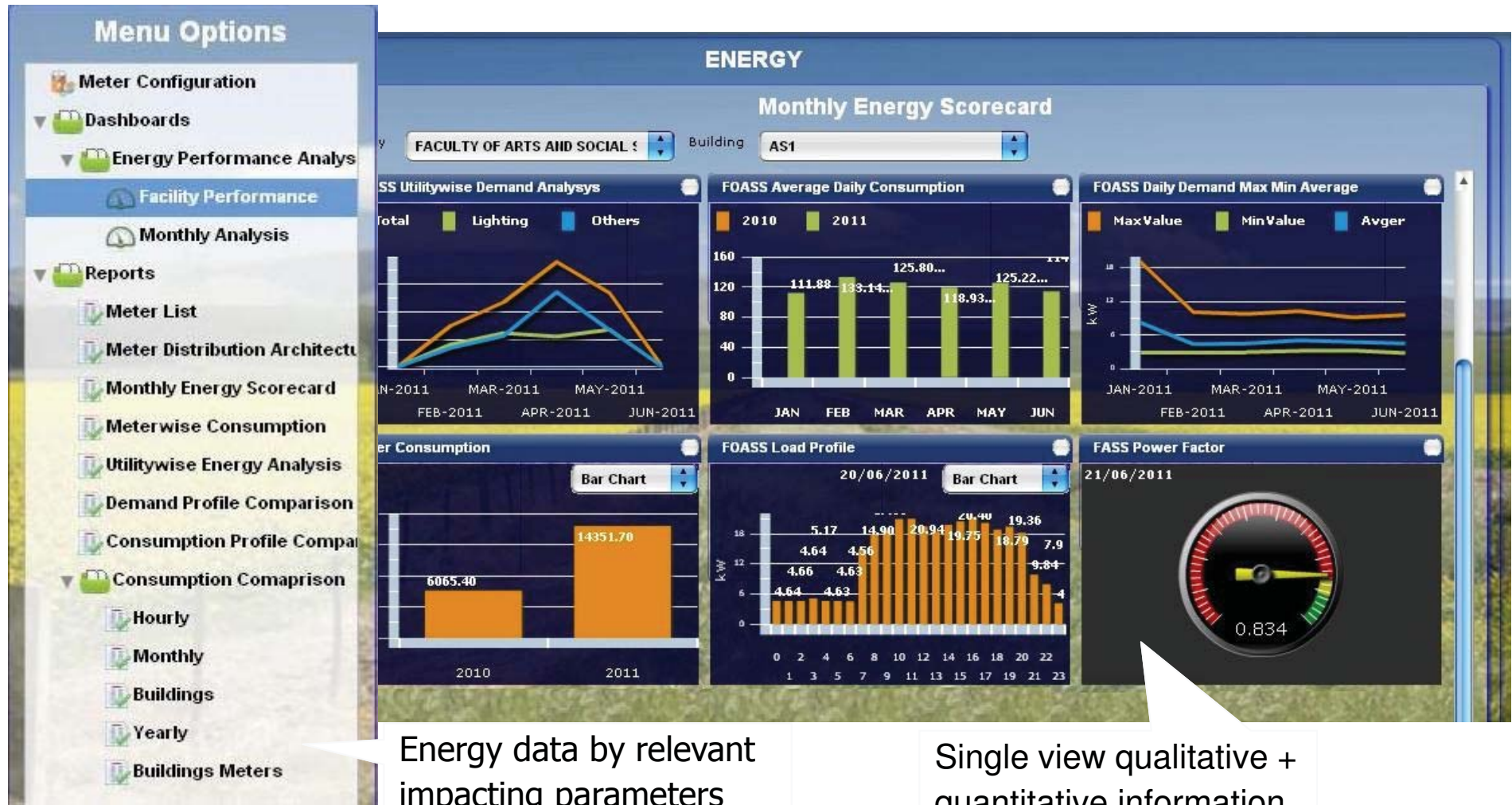


# Management information

Enterprise Applications present a **bridge** between the data available in energy management and control systems and corporate management objectives



# Consolidated Dashboards with wide range of KPIs



# the power of big data

---

“Everyone thinks Walmart’s success is because of economies of scale. The real reason is that **we replaced inventory with information.**”

Walmart tracks over 800 million transactions per day, with detail down to the store level and item level.

Walmart computers “learned” which products are in the highest demand before intense weather. Today, Walmart tracks weather and shifts their inventory ahead of bad weather, to help shoppers can ‘stock up’.



Sam Walton  
founder of Walmart

Shop All Departments

Search Industrial & Scientific

GO

Cart

Wish List

Industrial & Scientific

Lab & Scientific

Materials

Industrial Tools

Metalworking

Fasteners

Tube, Pipe & Hose

Electronic Components

Power Transmission

Safety

Deals

Tube Fitting Finder Tube Fitting Type: Brand: 6,478 results

All All Find now



Parker 8MSC8N-316 316 Stainless Steel A-LOK Male Connector 1/2" Compression Fitting 1/2" Male NPT

by Parker

Be the first to review this item | Like (0)

Price: \$18.38 & eligible for FREE Super Saver Shipping on orders over \$25. Details

In Stock.

Ships from and sold by Amazon.com.

Want it delivered Monday, June 6? Order it in the next 0 hours and 10 minutes, and choose One-Day Shipping at checkout. Details

Share your own related images

Quantity: 1

Add to Cart

or

Sign in to turn on 1-Click ordering.

or

Add to Cart with FREE Two-Day Shipping

Amazon Prime Free Trial required. Sign up when you check out. Learn More

Add to Wish List

More Buying Choices

Have one to sell? Sell yours here

Share

Customers Who Bought This Item Also Bought



Stainless Steel 321 Seamless Round Tubing, 1 / 2" by Small Parts  
★★★★☆ (3)  
\$19.33



White Silicone Tubing, 1 / 4" ID, 3 / 8" OD, 1 / 16" by Small Parts  
★★★★★ (5)  
\$15.49



Greenlee 730BB-13 / 16 Standard Round Knockout Punch... by Greenlee  
\$43.46



Parker 6MSC8N-316 316 Stainless Steel A-LOK Male Connec... by Parker  
\$14.82



Parker A-Lok 8FSC8N-316 316 Stainless Steel Compression... by Parker  
\$24.27

# Star Trek

Novelties

Brand:

6,478 results

All ↓

All ↓ cheapest

Find now



## Klingon Disruptor Star Trek the Next Generation

by Playmates

Be the first to review this item

Price: **\$19.98** & FREE Shipping on orders over \$35. Details

Only 1 left in stock.

Sold by Startrekgeeks and Fulfilled by Amazon. Gift-wrap available.

Want it tomorrow, Feb. 28? Order within **7 hrs 11 mins** and choose One-Day Shipping at checkout. Details

- Includes original price stickers from store purchase
- Exclusive Min Star Trek Generations Movie Poster included
- Technical Blueprint included
- Sound still works
- Unsure about light-up beam emitter as can't view that feature with box unopened

11 new from **\$14.99**

Quantity:

**Add to Cart**

OR

[Sign in](#) to turn on 1-Click ordering.

OR

**Add to Cart with FREE Two-Day Shipping**

Amazon Prime Free Trial required. Sign up when you check out. [Learn More](#)

**Add to Wish List**

**More Buying Choices**

Have one to sell? [Sell yours here](#)

[Share](#)

[Share your own related images](#)

## Customers Who Bought This Item Also Bought



Star Trek The Next Generation Deluxe Shirt Costume

★★★★☆ (201)

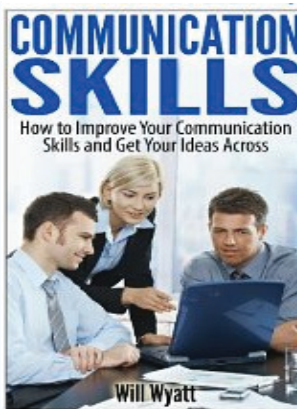
\$29.25 - \$50.00



Rubie's Costume Co - Star Trek Next Generation Phaser Gun

★★★★☆ (48)

\$9.99



**COMMUNICATION SKILLS**

How to Improve Your Communication Skills and Get Your Ideas Across

Will Wyatt

kindle edition

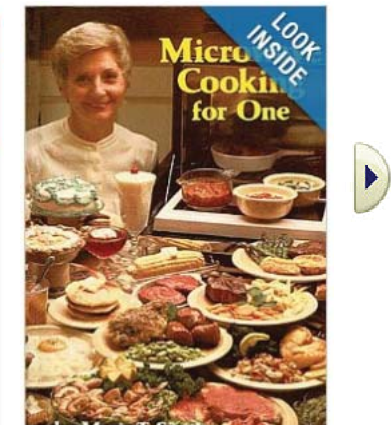


**Remodeling Your Parent's Basement**

LOOK INSIDE

FRAMING • PLUMBING • WIRING • INSULATING • FINISHING

Roger German



**Micro Cooking for One**

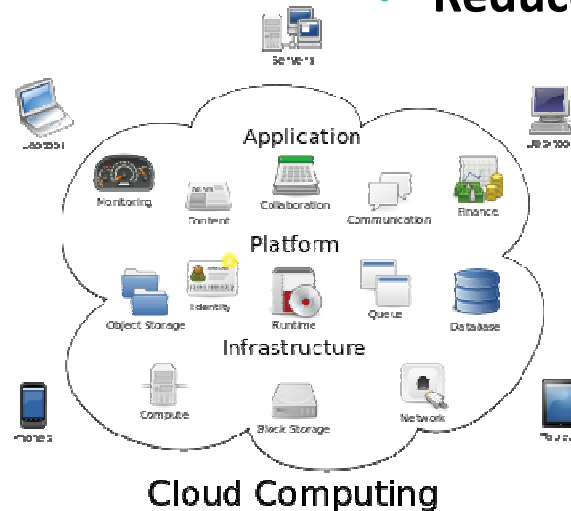
LOOK INSIDE

by Marie T. Smith

# “Cloud Computing”

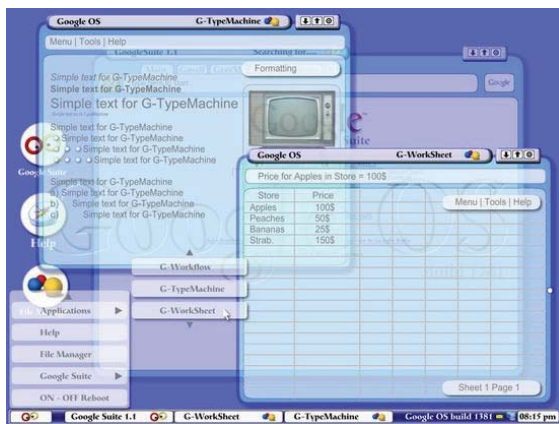
---

- **Allow the organization to be more flexible and react quickly to market conditions**
- **Allows an organization to focus on its core business**
- **Accessibility**
- **Security and reliability**
- **Collaboration**
- **Remote Computational Resources**
- **Access / delivery via Browser**
- **Collaborative functionality**
- **Lower cost of ownership**
- **Accelerated feature delivery**
- **Reduces up-front costs**



# Cloud Apps you might recognize

- iTunes
- VMware
- Funambol
- Gmail
- Amazon's EC2
- Google Apps
- Zoho Office Suite
- Microsoft Azure
- MS Business Online Services
- Salesforce



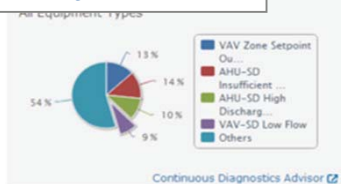
# Converting Data to Insights

## Enterprise Dashboard Application

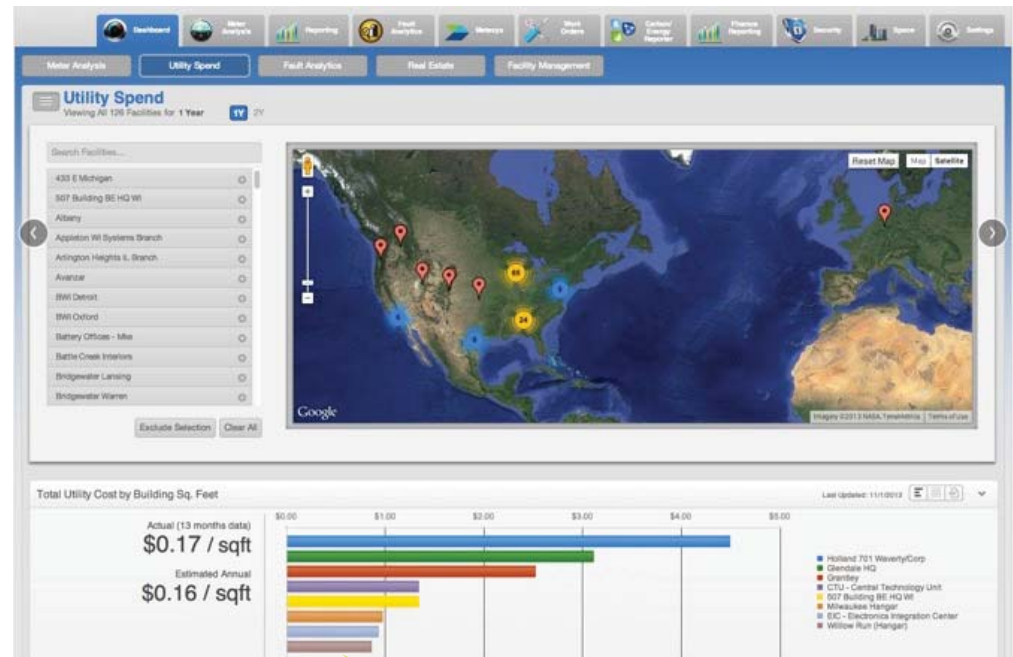
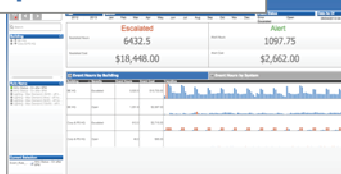
### Reporting



### Analysis



### Optimization



Utility spend – roll up by meter, building, tenant, and portfolio.

“What are my energy costs and how do they compare?”

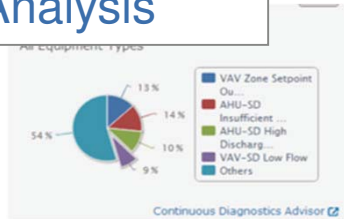
# Converting Data in to Action

## Enterprise Dashboard Application

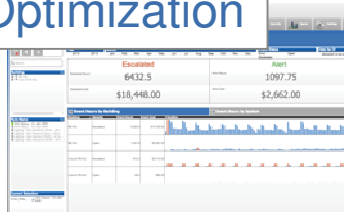
### Reporting



### Analysis



### Optimization



“How well are we responding to, and following up with, tenant needs?”

Work order metrics by type, priority, state of completion, and rolled up by building, tenant space, or portfolio.

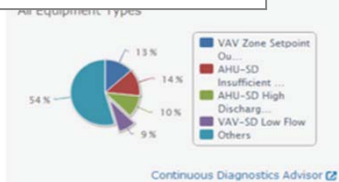
# Converting Data to Insights

## Enterprise Dashboard Application

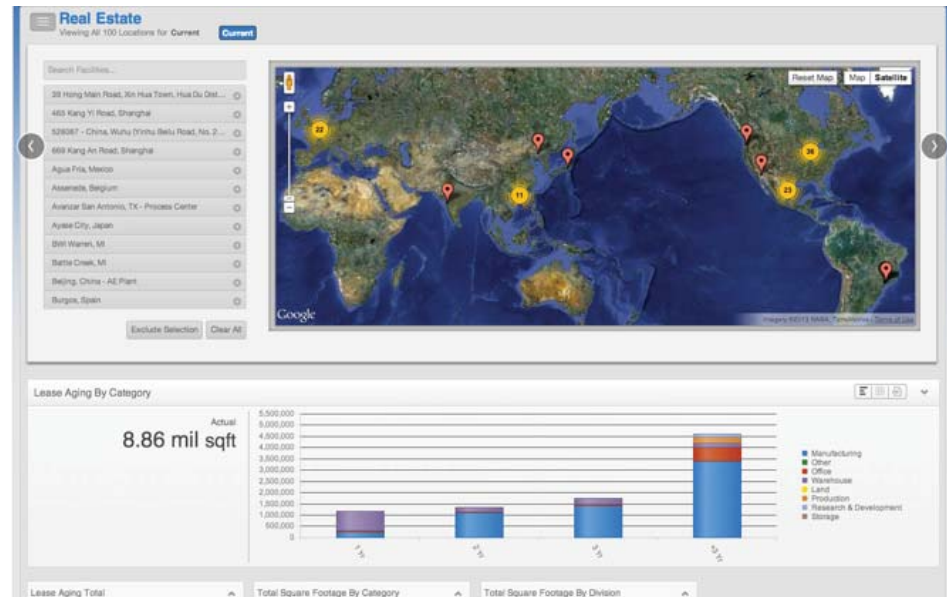
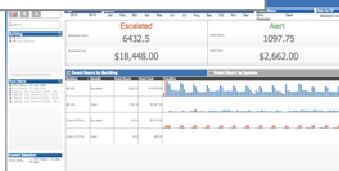
### Reporting



### Analysis



### Optimization



Lease aging and space metrics by category, and rolled up by facility, country, region, portfolio and by division or business.

"Can I roll up all my lease schedules into one geo-referenced map?"

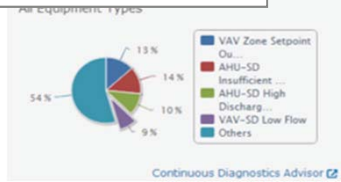
# Converting Data to Insights

## Facility Performance Dashboard

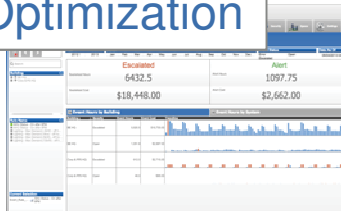
### Reporting



### Analysis



### Optimization



“How are my HVAC systems performing in the central plant and in individual buildings?”

HVAC Systems Performance  
Performance tracking of HVAC equipment and systems with generated alerts for persistent issues.

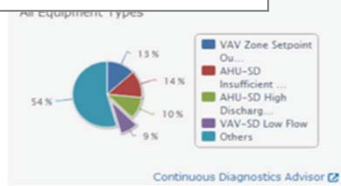
# Converting Data to Action

## Operations Dashboard

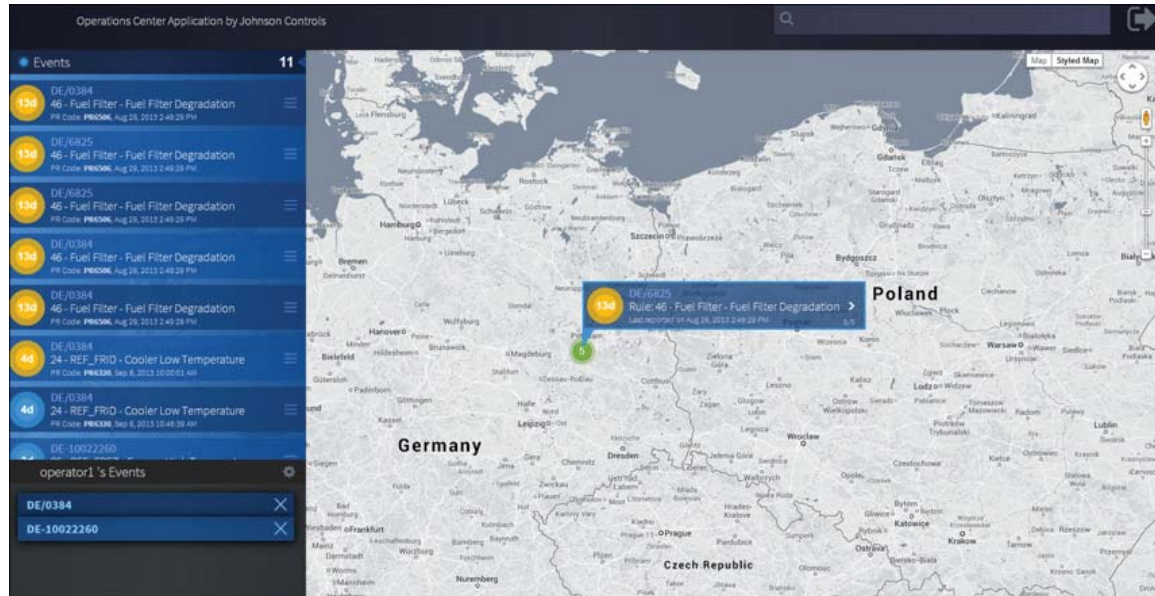
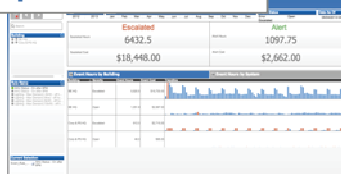
### Reporting



### Analysis



### Optimization



Operations workflow  
Prioritized real time event list  
with work order automation –  
available via browser or iPhone.

“How can my staff be efficient with such overwhelming amounts of information?”

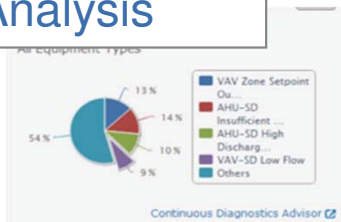
# Converting Data to Behaviors

## Green Kiosk Dashboard

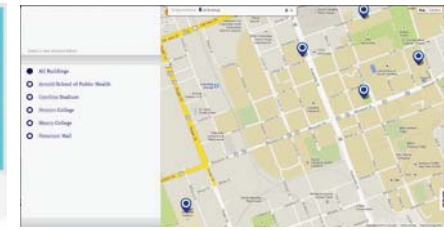
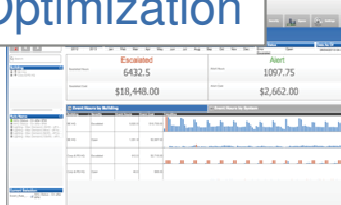
### Reporting



### Analysis



### Optimization



Public view of facility energy and carbon performance  
Awareness, education, and behavioral cues for building occupant involvement.

“How can I educate my occupants to participate in our energy savings programs?”

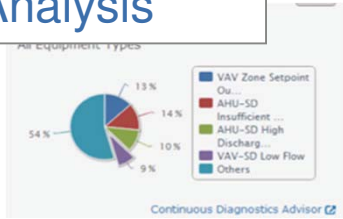
# Converting Data to Action

## Equipment Analytics and smart Phone Applications

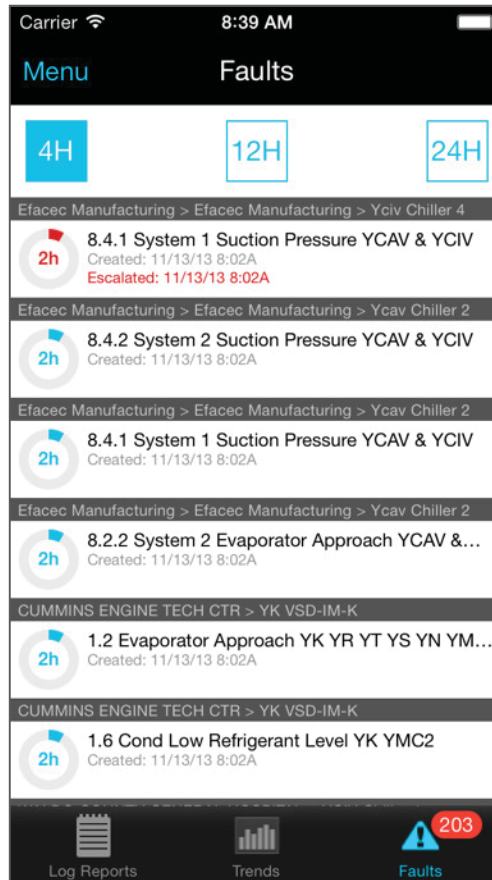
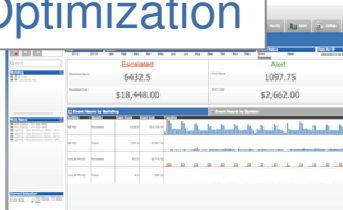
### Reporting



### Analysis



### Optimization



Equipment analytics  
Analysis and reporting of  
equipment faults with data  
supporting root cause  
investigations.

“Can I get real time  
fault and event  
tracking to my  
phone?”

86° F / 72% H

53° F / 89% H

21° F / 46% H

ADMINISTRATION OPEN LOCATION

Global Operations

507 E. Michigan

MKE Glendale

Madison Campus

Dashboard

Projects

Applications

Equipment

Feeds

# Global Operations: Dashboard

MANAGE WIDGETS

### Savings Meter

**M&V Plan:** 2009 Controls Retrofit  
**Baseline:** Central Electric Meter

Savings for Most Recent 30 Days

Cumulative Savings since 1/1/11

Alarm Acceptable

Range: All Year to Date Past Month View by: kWh Dollars (\$)

### Fault Activity by Type

Milwaukee Campus, Building 1, Floor 1  
All Vav Boxes  
April 9, 2011 - May 9, 2011

Zone Temp Control Error

Other Faults

Box Heating Control Effort

Box Flow Control Error

Zone Temp Control Effort

Date: Today Past Week Past Month Past Year Custom Date

### Current Faults by Location

Criteria: Fault Severity Financial Impact Display: All Faults Severe Faults Only

| Severe Faults     | Count      |
|-------------------|------------|
| Milwaukee Campus  | 30 Faults  |
| Glendale Campus   | 22 Faults  |
| Medium Faults     | Count      |
| Pewaukee Campus   | 40 Faults  |
| Eau Claire Campus | 27 Faults  |
| Other Faults      | Count      |
| Waukesha Campus   | 400 Faults |
| Delafield Campus  | 200 Faults |

### Building Snapshot

**Milwaukee Campus: Performing Arts Building**

Facilities: George Stephanopoulos  
Security: Anderson Cooper  
IT: Mike Wallace

Current Occupancy: 1,082

Average Interior Temperature: 73°

Weather Summary: 86° F / 72% H

Jump to building details >

### Energy Usage

Site: Pewaukee Campus - Civil Eng. Bldg.

Expand Widget Remove Widget Launch App

### Annual CO2 Emissions by Region

Chart Grid

Emission CO2 - Fuels Emission CO2 - Elec

Metric Tons

| Year   | Europe  | North America | Asia    |
|--------|---------|---------------|---------|
| + 2006 | ~10,000 | ~10,000       | ~10,000 |
| + 2007 | ~10,000 | ~10,000       | ~10,000 |
| + 2008 | ~10,000 | ~10,000       | ~10,000 |
| + 2009 | ~10,000 | ~10,000       | ~10,000 |
| + 2010 | ~10,000 | ~10,000       | ~10,000 |

Expand Widget Remove Widget Launch App

George Stephanopoulos  
Facilities Manager

Watch Lists:

Alerts 4

Other Lists 4

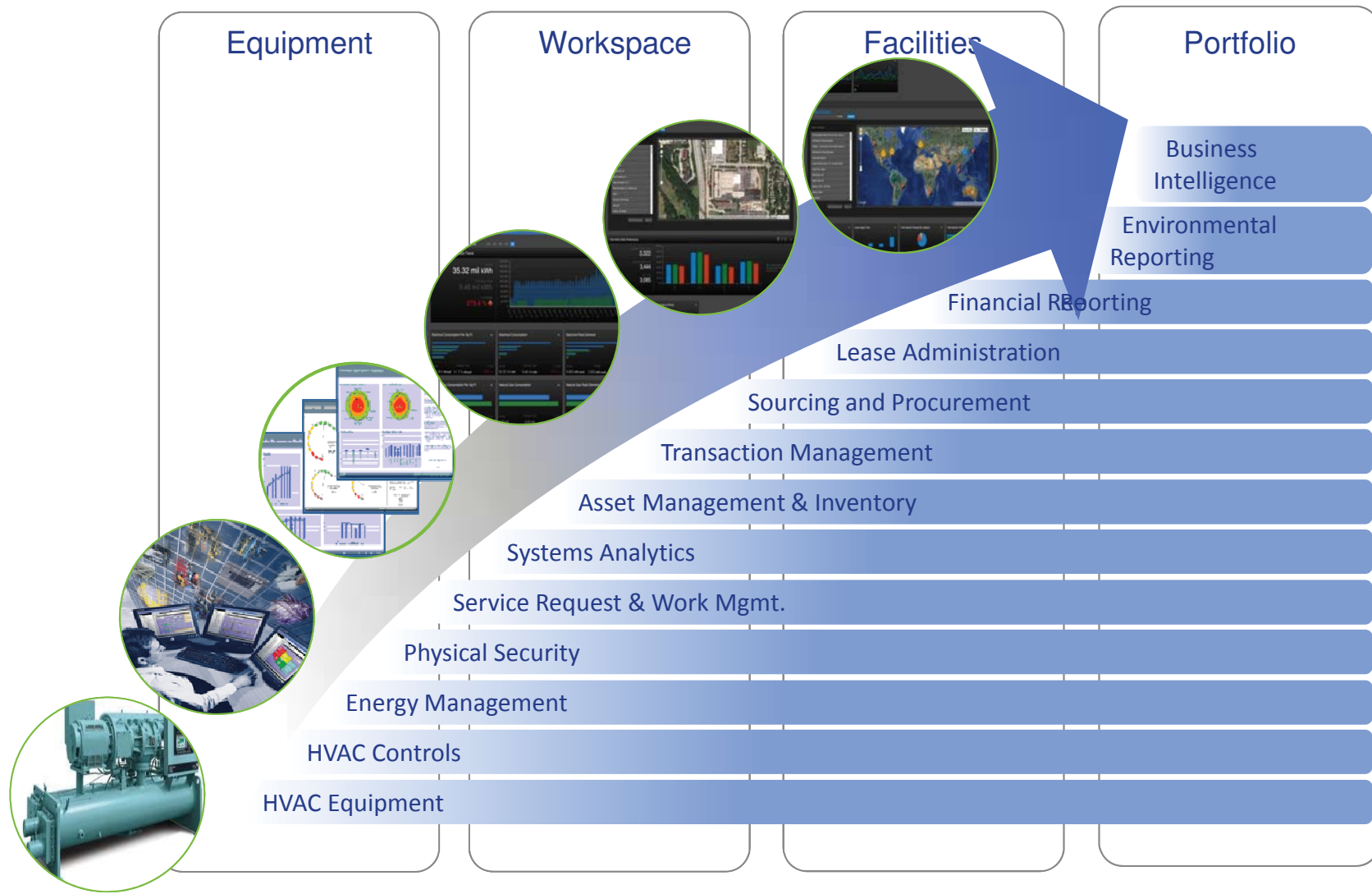


Search

Support

# Converting Data to Outcomes

Control, telemetry and Analytics from Equipment to Portfolios



# Companies positioning in this new “market space”

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# Commissioning and Building Automation Systems

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- Commissioning building automation systems
- Using BAS to commission HVAC Equipment
- Re-commissioning building automation systems
- “Continuous commissioning”
- Protocols, IP, Integration, FDD, the Cloud... and humans

# Benefits of BAS and system commissioning

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- “Real time” System visualization
- “untethered” modern UI mobility
- Simulation and Equipment commissioning
- Audit trails and documentation
- Detailed commissioning in the specification reduces risk and makes it easier for the GC, mechanical contractor and the controls contractor
- Links in equipment user interface to O&M documents
- BAS and re-commissioning

# the realities for Building Operators

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- Energy costs continue to increase
- Budgets continue to decrease
- Funding for staff and training continues to dry up
- Buildings are “value engineered” for low first cost, not ongoing operating cost
- 80% of buildings are never fully commissioned
- Too much data; not enough time to evaluate it
- Building operators often have conflicting priorities.

# Energy Costs

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*Energy costs are the most "measurable" variable expense in a facility operations budget, and therefore they receive significant attention.*

- 17% of US end use energy is consumed by HVAC equipment; \$18 billion in energy is lost to poor and inefficient operation
- Over 50% of economizers cost more in energy loss than they would if operating correctly
- As technologies become more complex in an effort to capture greater energy savings, the risk of underperformance actually increases! With modern BAS, operational errors can be implemented faster and go undetected.

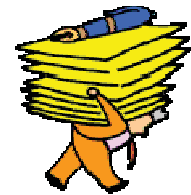


# Occupant Productivity

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*While reducing energy use is a noble goal, it cannot compromise comfort. Occupant comfort and productivity must be maintained or improved.*

- Small increases in productivity can far outweigh large reductions in building operation costs!
- 13:1 is the ratio of people costs to building costs
- 1% increase in productivity = eliminates the energy bill
- Productivity losses due to poor thermal environment or lighting issues ranges from \$20 to \$100 billion

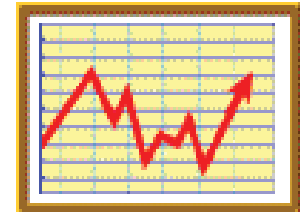


**So... why don't we just fix the BAS and HVAC systems?**

# Building Operators are under pressure!

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1. Poor building performance is costing billions of dollars in losses to American companies, in spite of proactive design trends and sophisticated building automation systems
2. Building operator productivity is negatively impacted by lack of training, tenant complaints, and reactive maintenance.
3. Cost reductions, profits and layoffs have shifted to top of the priority list while facilities repair and maintenance funding is “deferred”.
4. The majority of maintenance programs are reactive; very few of them use performance information to make decisions.



# Building Maintenance

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## Predictive maintenance

- saves 8 to 12% over preventive maintenance
- provides savings of 30 to 40% over reactive
- Lower maintenance costs: 25% to 30%
- Reduced breakdowns: 70% to 75%
- Lower downtime: 35% to 45%
- Increased productivity: 20% to 25%

*Having timely and meaningful data is the key to developing preventive and predictive maintenance programs.*

# All the Money left on the table

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*The total operating cost for a typical building can range from \$5/ft<sup>2</sup> to \$12/ft<sup>2</sup> depending on the size, hours of operation, facility usage.*

Cost reduction potentials<sup>1</sup> from a proactive and continuous Analysis and Optimization solution are not limited to energy:

- **Energy** **8 - 20%**
- **O & M** **5 - 10%**
- **Repair and Replacement** **10%**
- **Occupant Productivity** **3 - 15%**

<sup>1</sup> National Institutes of Science and Technology

**Where can you get the information to save money?**

# Continuous Commissioning <sup>SM</sup>

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- Continuous Commissioning is a comprehensive, ongoing process to identify and resolve operating problems, improve comfort, and optimize energy use
- It is a “service marked” term that was developed out of Texas A&M and adopted by FEMP
- The process focuses on improving overall system control and operations for the building **as it is currently used**, not simply to original design parameters



# Cost Saving Opportunities

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| Study / Agency   | Finding  |
|--|--|
| Federal Energy Management Program (FEMP)                       | 20% on average (based on 300 facilities [Texas A&M] study) |
| US Department of Energy (DOE)                                  | 8 – 20% (guidelines)                                       |
| California Commissioning Market Characterization Study (CCMCS) | 15% (existing facilities)<br>9% (new construction)         |
| National Institute of Standards and Technology (NIST)          | US\$0.16 per square foot (energy alone)                    |

# Overwhelming data

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*Most building operators do not have enough time to do more than operate, respond to alarms and issues, and try to resolve complaints.*

The amount of information generated by the BAS controllers in a large facility can generate alarm, audit, and point trend data equivalent to:

- All the works of Shakespeare in 20 minutes
- Two pickup trucks of text books in a week
- Enough information to kill 7000 trees a month if printed
- Fill one floor of an academic library in a week

**Even if you had the training and expertise, when would you have the time to analyze this data?**

# Ongoing Commissioning

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*Ongoing Commissioning is built on a foundation of continuous monitoring, expert analysis, and optimization.*

## **Key components include:**

- Developing monitoring and measurement methodologies
- Getting meaningful system data
- Evaluating and improving operational and control schedules, set points and optimization strategies to meet user needs
- Continuously analyzing potential performance changes and energy saving opportunities
- Performing engineering analyses of the system changes
- Reporting and tracking results

# Why I.T. Matters

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## Harbor Research, 2009:

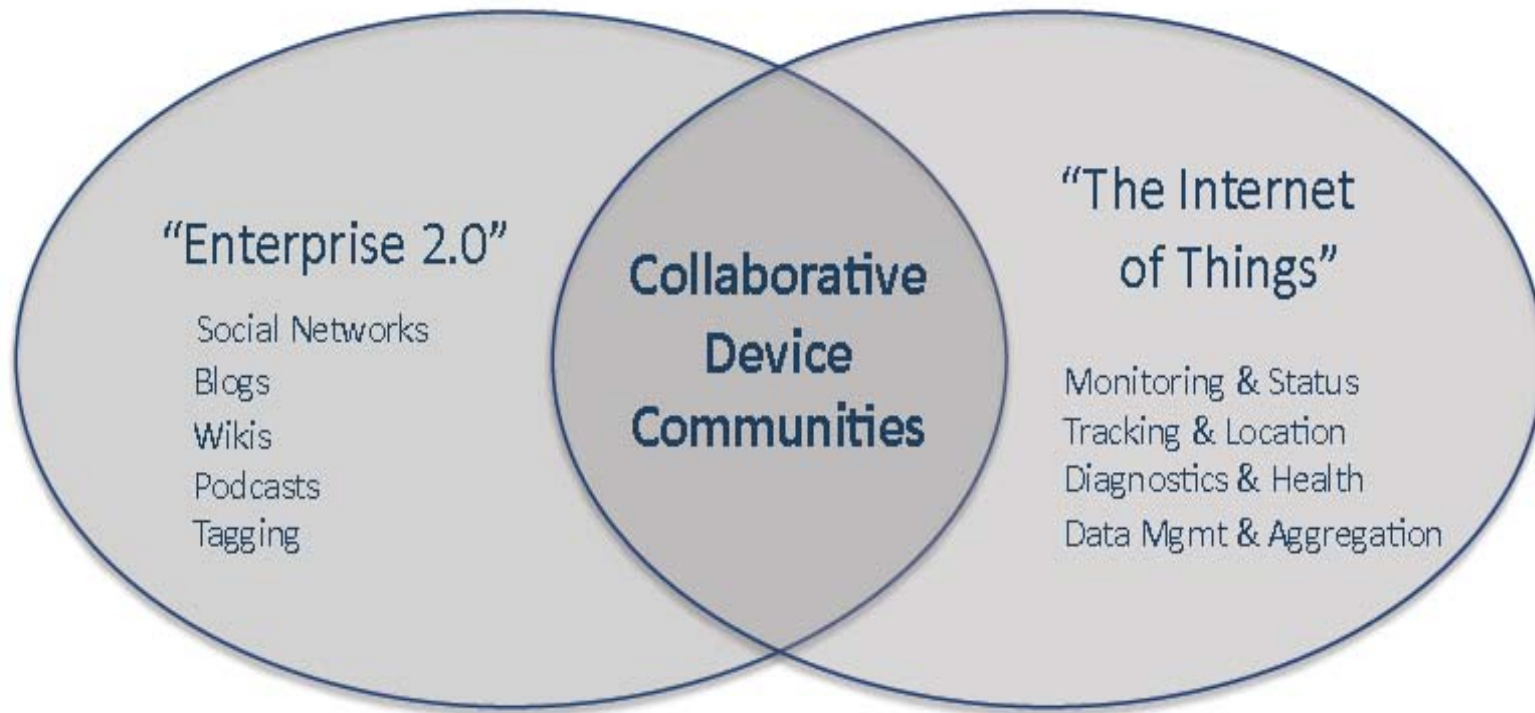
Today, enormous new value comes from two areas:

- Human Collaboration technologies: blogs, wikis, podcasts, tagging and social networks.
- Intelligent device networking, also referred to as “Pervasive Computing”

far beyond the laptops and cell phones - virtually all products that use electricity—from toys and coffee makers to cars and medical diagnostic machines—possess inherent data

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# Collaborative communities = value

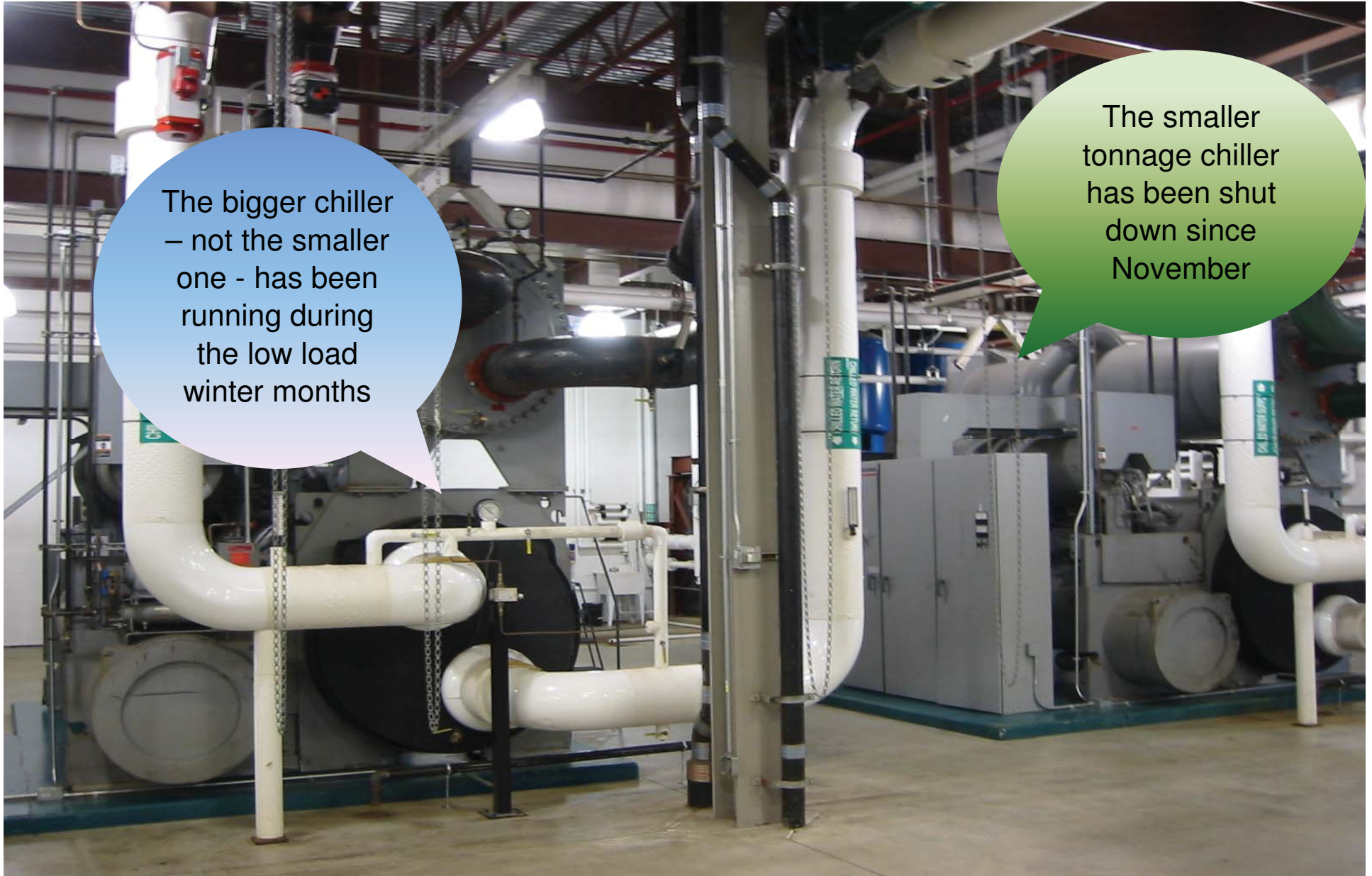


## Networking – M2M and humans

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\* Harbor Research

## if only the equipment could talk to us

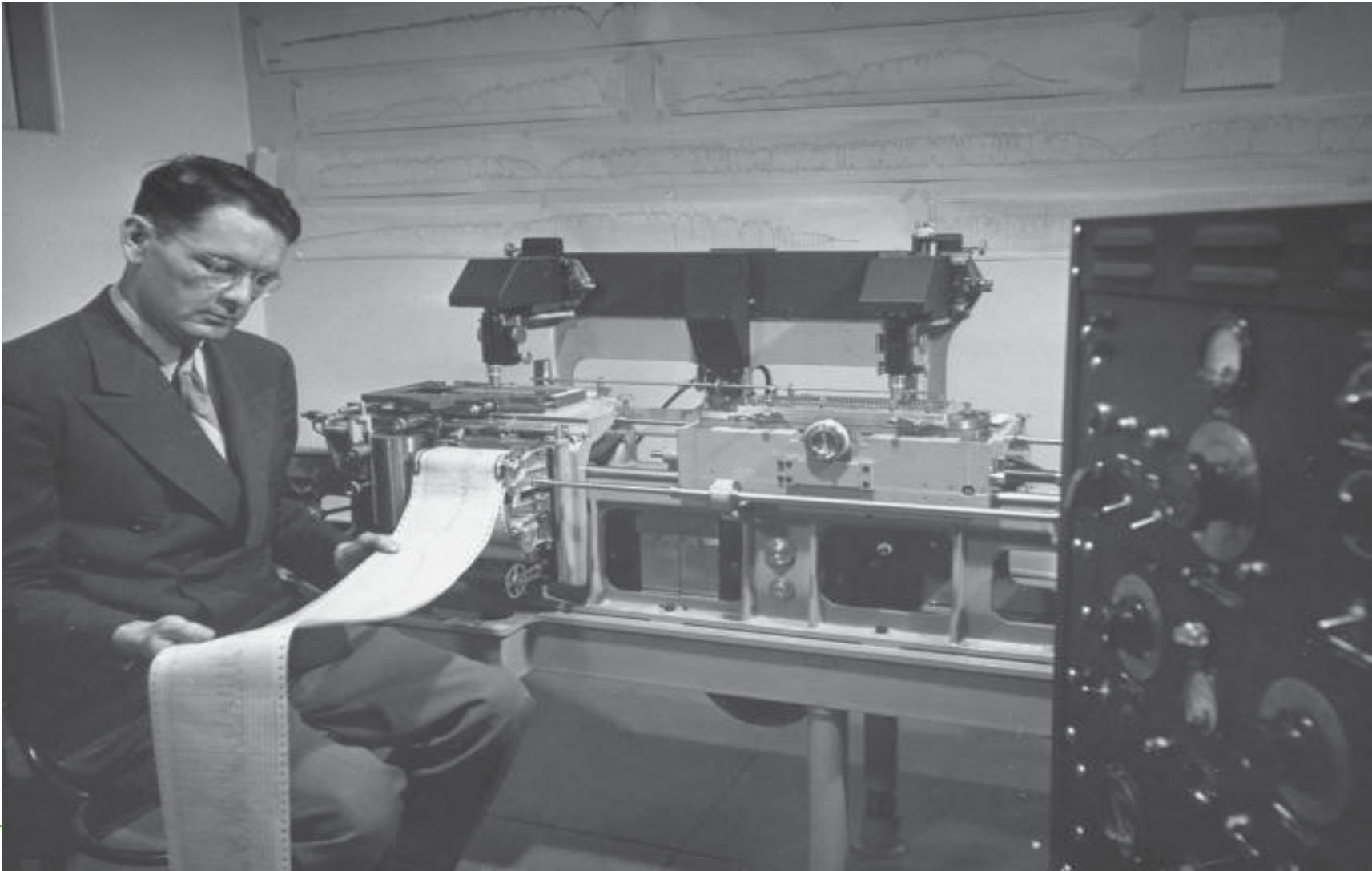


The bigger chiller – not the smaller one - has been running during the low load winter months

The smaller tonnage chiller has been shut down since November

# Continuous Diagnostics / Ongoing Commissioning

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PIE approved presentation by Johnson Controls

# FDD: Fault Detection and Diagnostics

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- miscalibrated or faulty sensors
- hunting or unstable control loops
  
- malfunctioning valves, dampers, or actuators
- manually defeated dampers and actuators
- excess or insufficient ventilation air
- simultaneous cooling and heating
- improper and/or uncoordinated setpoints
- missed or faulty free cooling opportunities (lack of economizer).

# Central Plant Examples

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- faulty sensors or outputs
- malfunctioning valves
- oscillating or un-tuned control loops
- improper or uncoordinated setpoints
- missed or faulty “free cooling” opportunities
- degrading heat exchange surfaces
- inefficient chiller or boiler sequencing
- inefficient reset schedules
- excessive on/off cycling
- unbalanced pump loops.

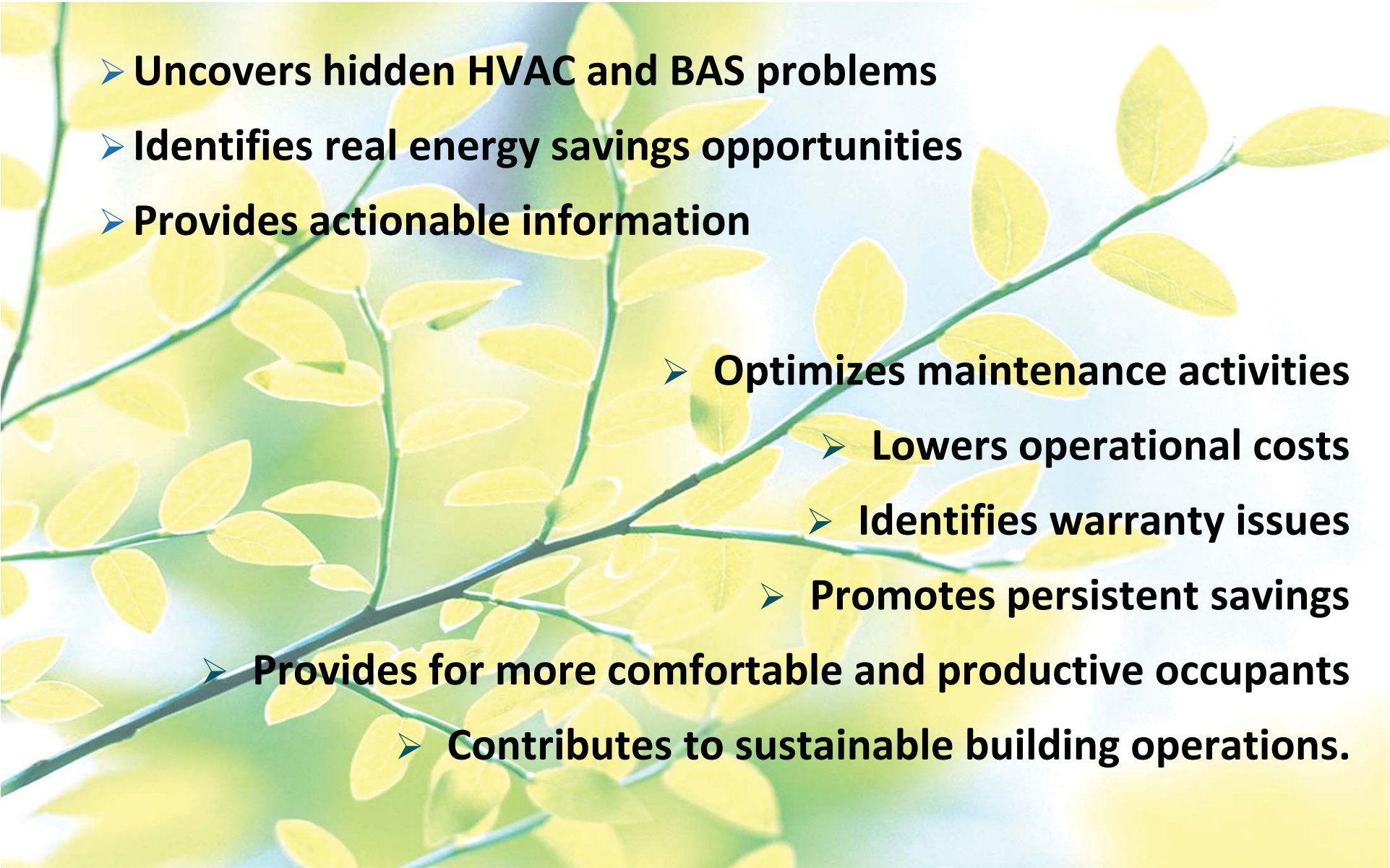
# Critical components for an effective program

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- ❑ Data sufficiency
- ❑ Documented systems, sequence of operations
- ❑ Documented understanding of the CURRENT USE of the building
- ❑ Open protocols and point naming conventions
- ❑ Cotemporal data harmonization and analysis
- ❑ Intelligent algorithms and filters
- ❑ Monetization of findings
- ❑ Experienced resources to address findings
- ❑ Verification and validation of actions .

# Benefits to building operators

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- 
- **Uncovers hidden HVAC and BAS problems**
  - **Identifies real energy savings opportunities**
  - **Provides actionable information**
    - **Optimizes maintenance activities**
    - **Lowers operational costs**
    - **Identifies warranty issues**
    - **Promotes persistent savings**
  - **Provides for more comfortable and productive occupants**
    - **Contributes to sustainable building operations.**

## The future ...

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“The future has  
already happened -  
it’s just not evenly  
distributed yet ”



William Gibson

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The problem is that, in reality, the future can be hard to recognize. It's not evenly distributed; it's hidden in corners. While there is no shortage of clues, they are buried beneath a crush of information.

Robert Rodin

A photograph of a person walking across a green field under a large, fluffy white cloud against a blue sky. The person is in silhouette, walking from right to left. The cloud is the central focus, with a smaller, crescent moon visible to its left. The horizon is flat, and the sky transitions from a deep blue at the top to a lighter blue near the horizon.

Thank You