

Charting a Course to Energy Independence

**Providence, RI
August 9-12, 2009**

**Redefining the Edges of the Enterprise
Vision – Technology - Execution**

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Director, Vykon Automation, Energy, Security
Tridium, Inc.





Agenda

- BOA Intelligent Command & Control Center
 - ☐ Vision
 - ☐ Execution
 - ☐ Technology
 - ☐ Applications
- The Edge of the Enterprise is Expanding
 - ☐ Hostware – Middleware – Deviceware
 - ☐ Technology Enablers



Bank of America's Intelligent Command and Control Center



Building a world class Energy and Maintenance Management Solution to optimize two of the largest facility operating expenses and reduce Global Greenhouse Gas Emissions





- One of the world's largest financial institutions with Multi Sites, Multiple Locations
- 11,000 facilities and 120 million square feet of commercial office space worldwide
- Operates over 6,100 banking centers in 34 states



Goals

- Reduce energy use, reduce utility cost
- Control maintenance expenses within their entire portfolio of buildings at the enterprise level
- Centralize facility management; work with their existing infrastructure and the variety of systems within their facilities
- Address the different sizes and types of buildings with in the portfolio
- Impact the company's bottom line with significant savings
- Reduce greenhouse gas (GHG) emissions
- Improve occupant comfort levels
- Total Cost of Operations



Solution

- A **combination** of proven technologies and innovation delivers a solution that balances functionality with ROI
- Automation Framework, Analytical & Fault Diagnostic Applications, Remote Wired & Wireless Controllers, Energy & Maintenance Strategies
- **Intelligent Command & Control Center (iC3)**, created as a centralized energy and intelligent facilities management center

High Level Architecture



Data Servers

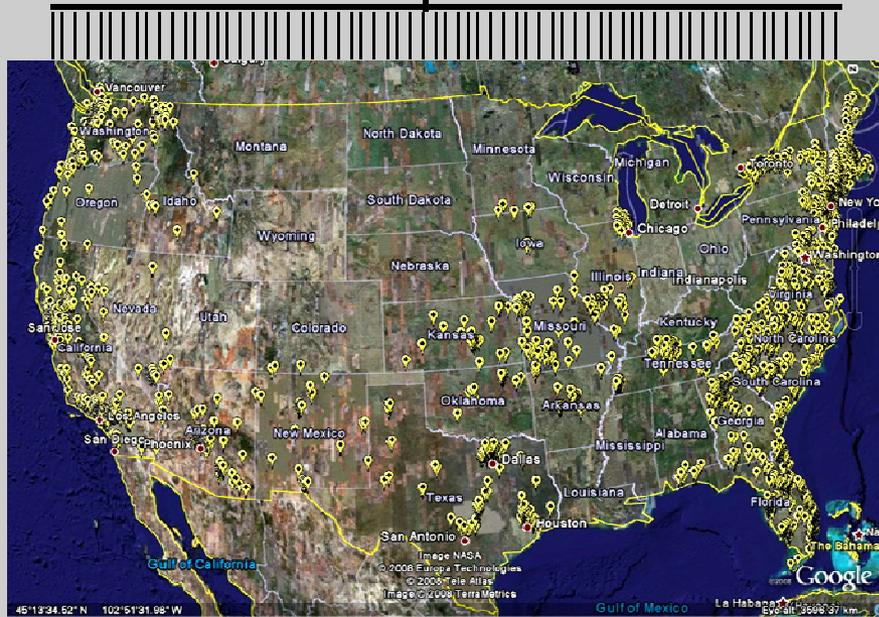


Analytics Engine



iC3 Center – Charlotte, NC

Bank Secure Intranet





Business Challenges

- Controlling maintenance and utility expense within this portfolio is extremely challenging while working to sustain a comfortable environment.
- Delivering on this balancing act was left up to local mobile maintenance staff; B of A relied on adherence to preventative maintenance schedules and prompt response to system failures. The only insight into success or failure of their efforts was from associate feedback out in the field.
- Conventional wisdom was that monitoring and controlling a variety of locations at the enterprise level was not cost effective.



Business Challenges

- Identified a significant opportunity to reduce operational expense and save energy, but only if they could cost effectively deploy a system that would work well within their existing infrastructure.
- Collect and process diverse types of data and deliver the analytics capacity and capability to deliver operational intelligence for thousands of facilities and their associated equipment.



Technical Challenges & Opportunities

How do you develop a repeatable, cost effective solution for a variety of facilities varying widely in age, construction and geography?

- Developed a standard set of “building blocks” that is used within each facility that optimized what data and control points for a given piece of equipment and device
- Implemented a survey and pre-commissioning process for the environmental equipment at each facility prior to installation and deployment
- Equipment is tuned up and optimized, increasing the energy savings realized by the program immediately



Technical Challenges & Opportunities

- Baseline equipment specifications and performance are captured electronically for storage in an asset management database
- Rebate data is captured and processed with participating utilities and a bill of materials for the installation is created automatically
- Unique databases and control schemes for the systems and devices in a specific location can be **created in a manner of minutes instead of hours**
- **Wireless technology** to all remote controllers is leveraged where practical to reduce disruptions during the deployment phase and to keep deployment cost down



Technical Challenges & Opportunities

How do you efficiently and reliably collect and store large amounts of data for analytic purposes?

- Tridium's Niagara Framework was leveraged to provide fault tolerant infrastructure between the geographically diverse sites and Bank of America's servers
- A Tridium JACE controller was installed in each banking center
- This JACE serves as the local managing and controlling device as well as the data buffer and provides fault tolerance and stand alone capability for each site



Technical Challenges & Opportunities

How do you efficiently and reliably collect and store large amounts of data for analytic purposes?

- Analytic automation within the JACE and at the Server level transforms the data into operational intelligence that assesses the “health” of the facilities and associated equipment
- Using this intelligence, B of A knows where to focus their time and expertise to get the greatest return on their investment.
- Intelligent Command and Control Center (iC3), a central network operations center
- Technicians monitor the performance of the portfolio, troubleshoot and make adjustments as indicated by calls from the field, alarms and the performance analytics engine



Technical Challenges & Opportunities

How do you insure a quality installation and sustainable solution for such a geographically diverse and large deployment?

- Baseline equipment performance data and facility data is gathered electronically and uploaded into a database, where it is QC'd to make sure that the technician performed the right work while on site
- A remote commissioning process leveraging the Niagara Framework, where technicians in Charlotte virtually walk the facility down with the installation contractor to validate that all components are installed and working as designed
- All installation data is captured in an electronic project management tool



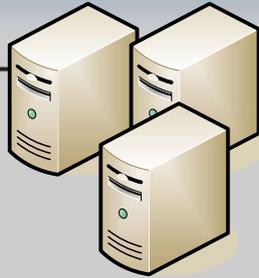
Technical Challenges & Opportunities

How do you insure a quality installation and sustainable solution for such a geographically diverse and large deployment?

- When a facility defect is discovered post installation, the technicians can quickly evaluate whether this is a pre-existing condition, an installation error, or a new problem—all remotely
- Alarms and analytics within the system assess the health of the monitoring system



High Level Architecture



Data Servers

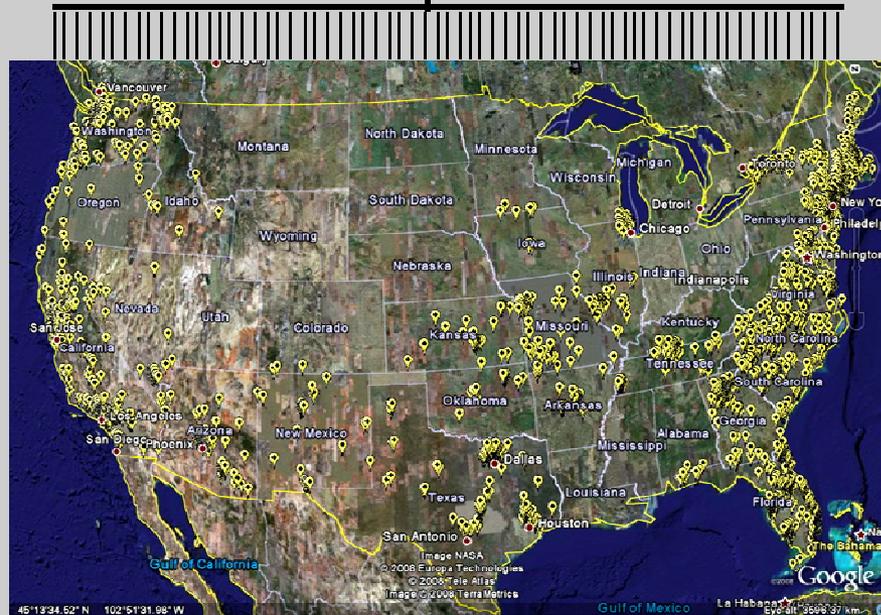


iC3 Center – Charlotte, NC

Bank Secure Intranet



Analytics Engine





Web Based Local Control System

Control Capabilities



"Vital Few" data points

Plug-n-Play devices

Standard Unitary Designs



Interior Lights On/Off



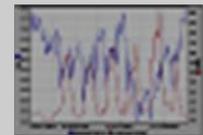
Exterior Lights On/Off, Status



Space Temperature



HVAC System Status/Condition



Building Health

...local control accessed and programmed remotely



Business Ops Model – Gen 1 Service Offerings

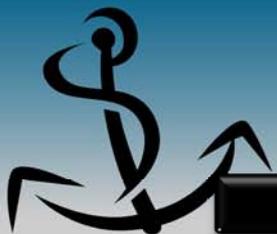
Energy and Maintenance Management Solution (EMMS) Services

EMMS
System
Deployment

EMMS
System
Operation

EMMS
Analytics and
Reporting

Portfolio
Recovery
Management



EMMS System Deployment

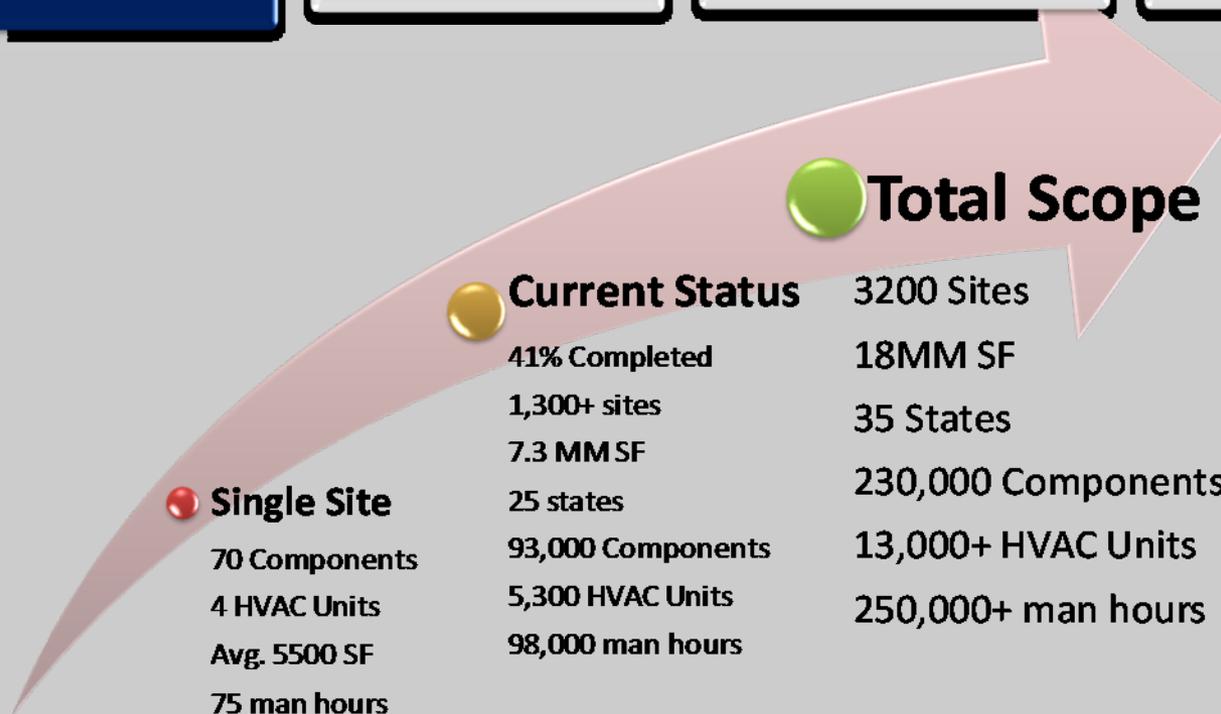
Energy and Maintenance Management Solution (EMMS) Services

EMMS System Deployment

EMMS System Operation

EMMS Analytics and Reporting

Portfolio Recovery Management



Key Stats:

- Running 14 Install Teams (24 installers) diversified across 5 contractors
- Installing at a pace of 5 sites/workday
- 6 months of consecutive 100+ installs, ramping to 150



EMMS System Operation

Energy and Maintenance Management Solution (EMMS) Services

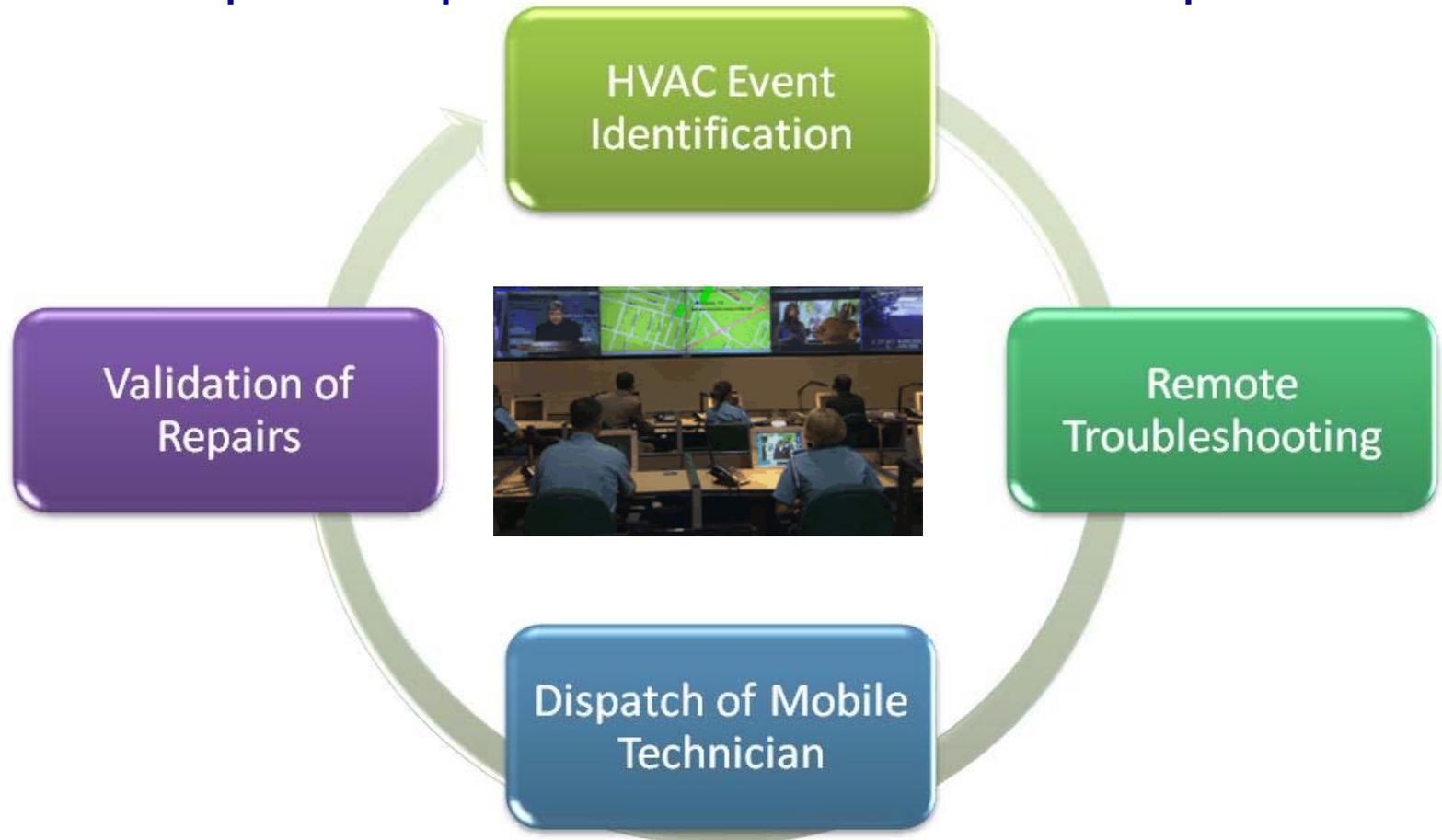
EMMS System Deployment

EMMS System Operation

EMMS Analytics and Reporting

Portfolio Recovery Management

Bank HVAC Operations Specialists in Charlotte drive end-to-end process...





EMMS System Operation

Energy and Maintenance Management Solution (EMMS) Services

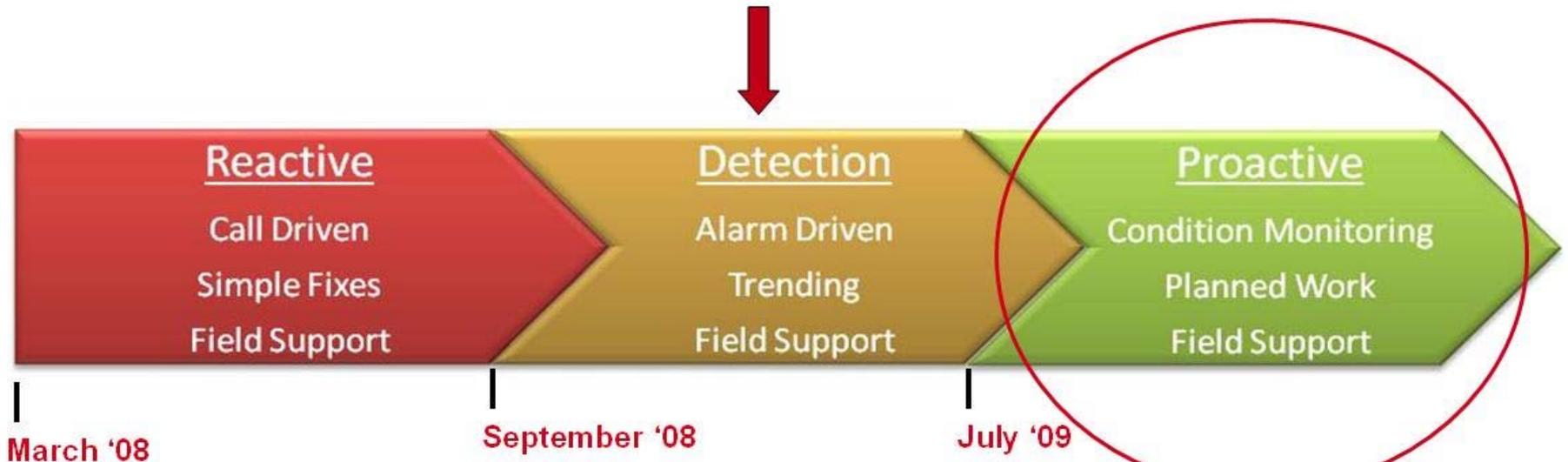
EMMS System Deployment

EMMS System Operation

EMMS Analytics and Reporting

Portfolio Recovery Management

Traditional EMS operations stop here...



GAME CHANGING!

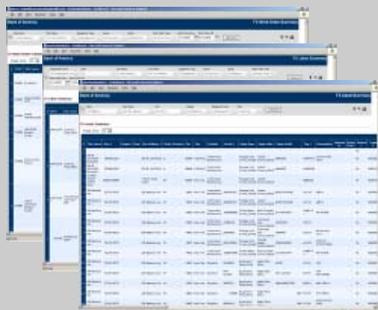


EMMS Analytics and Reporting

Energy and Maintenance Management Solution (EMMS) Services



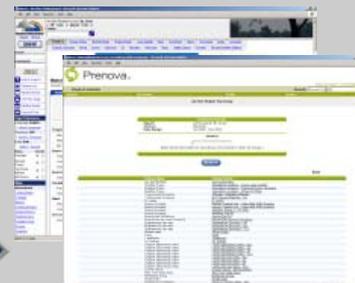
Work Order Data



Property / Financial Data



Weather / Bill Data

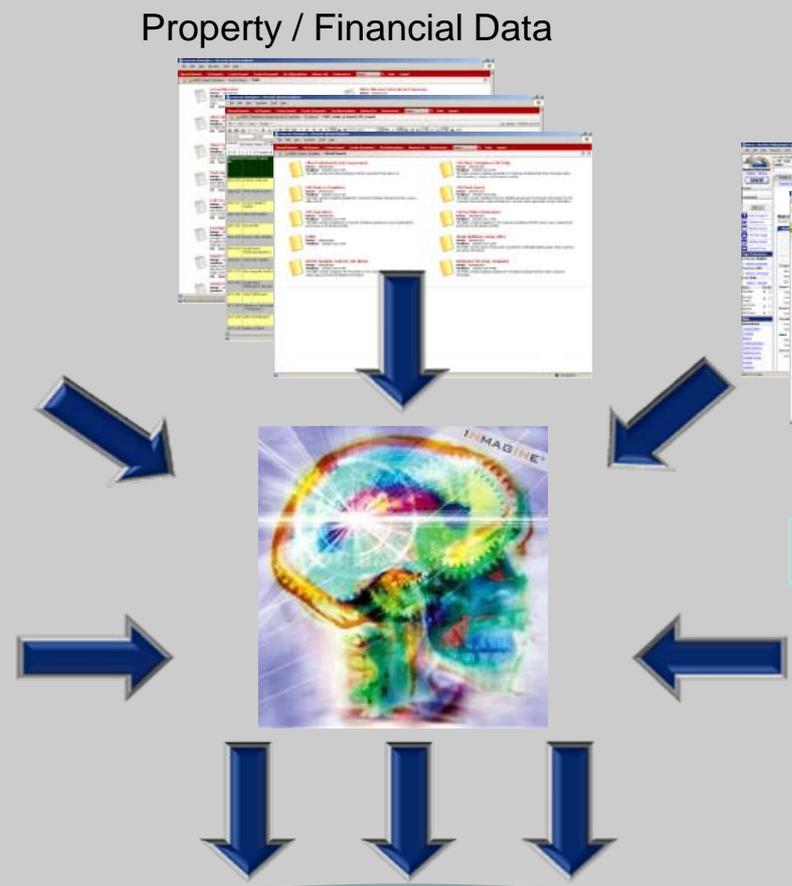


Site System Data



Intermediate / Misc Data

HVAC Equip Monitoring	Alarms & Comfort Complaints
Daily Price Data	Asset Data



Optimized Intelligent Decisioning

EMMS Analytics and Reporting

Energy and Maintenance Management Solution (EMMS) Services

EMMS System Deployment

EMMS System Operation

EMMS Analytics and Reporting

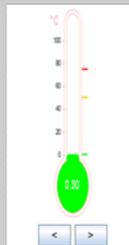
Portfolio Recovery Management

These update as change filter, start at portfolio view



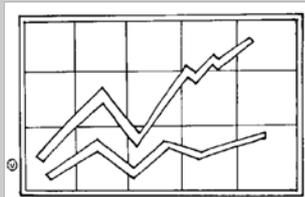
Alarms

Dial indicates quantity, severity across portfolio



System Health

Indicates operational performance of equipment



Cost of Operations

Indicates month over month energy consumption, # truck rolls, # IC3 cases

# Facilities	xxx
Total Sqft	xxx
Ave Sqft	xxx
Ave Age	xxx
# Pkg Units	xxx
# Splits	xxx
# Boilers	

Facility Stats

facilities, square footage, # of units, average age

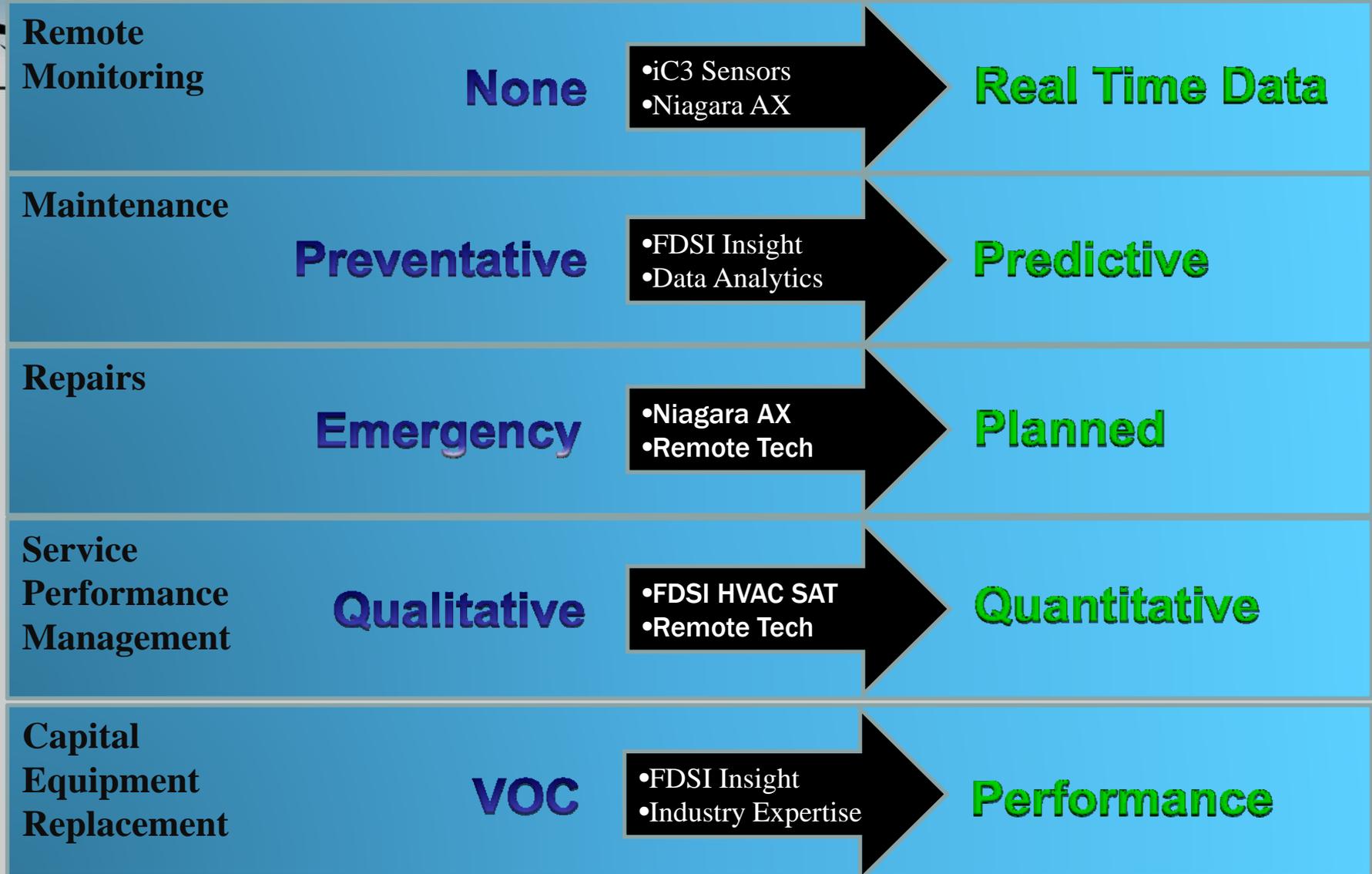
Filter Options

List of sites/units with:

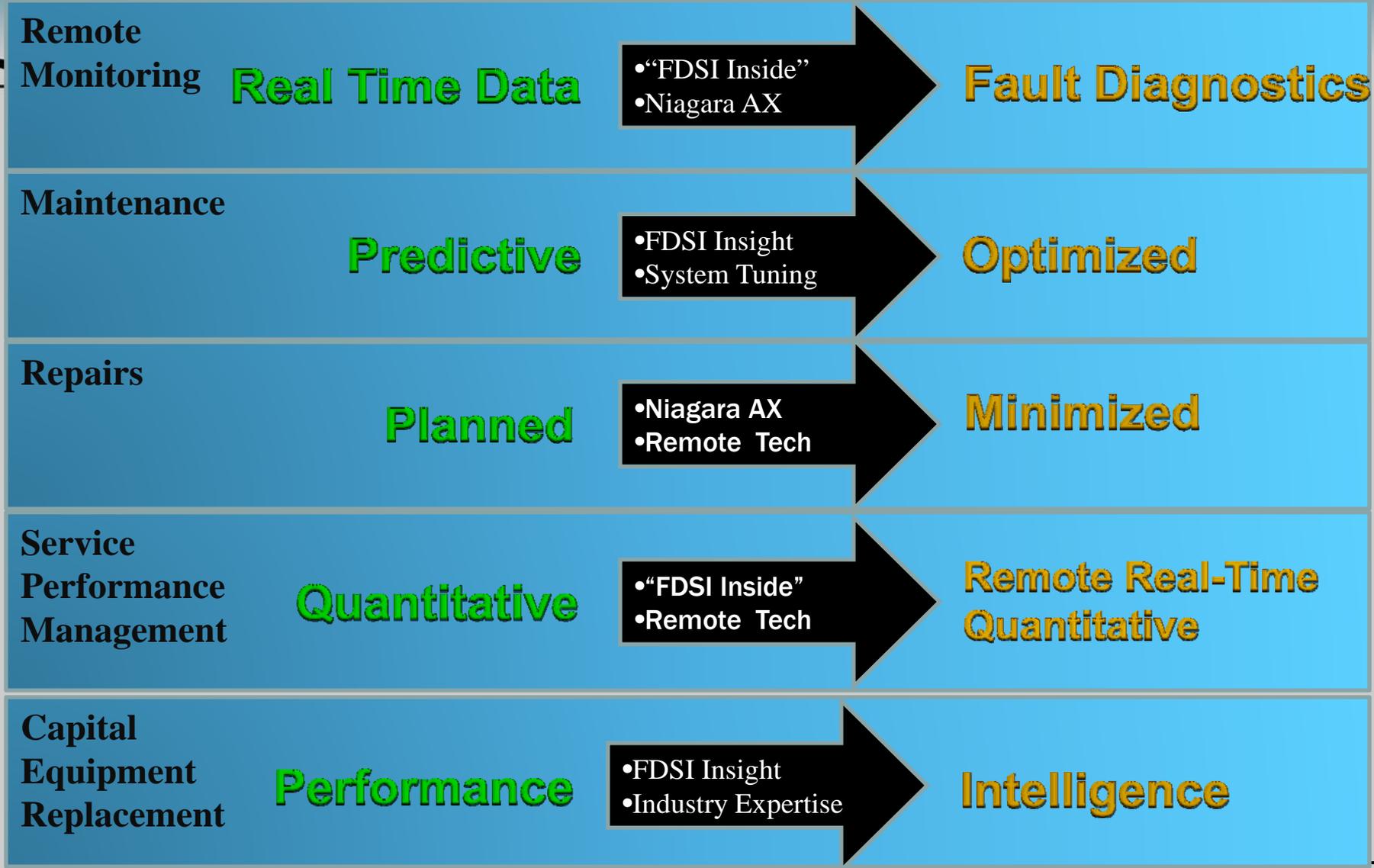
- performance indicator (i.e. bar, color)
- alarm status (i.e. flashing light bulb if an active alarm)
- Work Trakker case indicator, show # and status of active cases,
- links to detailed site information, niagara front end, etc when clicked
- can sort by alphabetical, worst performer, number of alarms

List of Standard Reports to Run

Maintenance Vision – Generation 1



Maintenance Vision – Generation 2





Energy

Bank of America is able to answer several important questions that is leading to further energy-savings:

- How can the bank “buy” or “shed” electricity at optimal hours and rates, while preserving our standards for comfort?
- When should facilities start and stop equipment to meet comfort service-level agreements but eliminate the use excessive energy?
- What type of equipment runs most efficiently, has the cleanest emissions and lasts the longest in different geographies and in different facility types?
- How should maintenance routines be adjusted to change filters and clean coils when they need it versus just scheduling routines with fixed calendar-driven intervals?



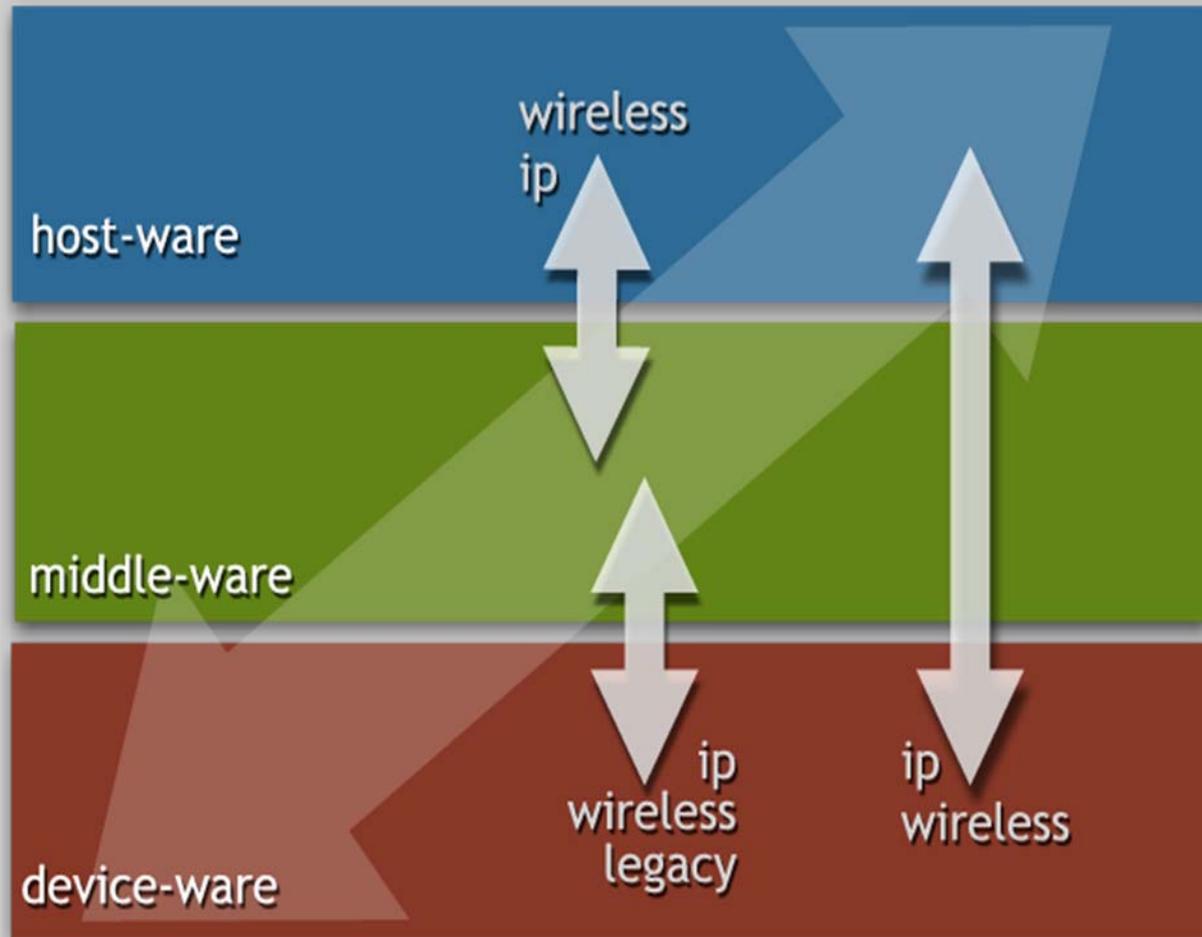
Results and ROI

Bank of America is forecasting up to a 50 percent greater cost savings when compared to a deployment of standard building control technologies.

- Yielding savings of 10%-15%
- Energy Consumption and Greenhouse Gas Emissions have decreased by 11%
- Maintenance costs have been cut—reduced service calls, fewer truck rolls
- A substantial increase in HVAC, Lighting System performance



The Enterprise – Device to the Cloud





Middleware

Enterprise Servers



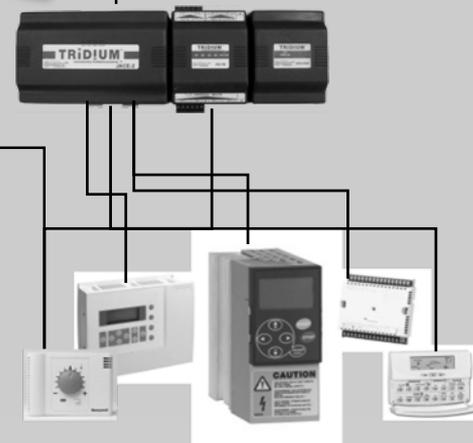
Browser



- presentation layer**
web-server, programming, graphics, dynamic data, e-mail, alarming
- internet connectivity layer**
TCP/IP, HTTP, SNMP, oBIX (XML)
- control layer**
real-time control loops, schedules, alarming, data logging, archiving
- object modeling layer**
Java component object model, indirect modeling
- communications layer**
LON, OPC, Z-Wave, BACnet, SNMP



Browser





Middleware Enablers

- Integration Capabilities
 - ☐ Open and Legacy Integration
- Programming/Integration Tools
 - ☐ Easily integrate multiple vendors and protocols
 - ☐ Building Block Approach to creating local site Control database
 - Cut & Paste
 - Automated Design
 - Provisioning and Robots for upgrade and reprogramming of 1000's of sites
- Open Protocols and DB
 - ☐ OpenADR
 - ☐ OBIX
 - ☐ Database Connectivity
- User Interface
 - ☐ Flash/Flex
 - ☐ Silverlight
 - ☐ Graphics no longer specific to a vendor



Flash Based Dashboard with Google Gadget

Waibel Energy Systems - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://energy.buildinglogix.net/blxecorate/Waibel\$20Energy\$20Systems

BuildingLogix EcoRate Waibel Energy Systems

DashBoards

Enter Historical Data

Waibel Energy Systems

eco rate

Last Update: Monday August 3, 2009 5:31:18

iGoogle WAIBEL ENERGY SYSTEMS

Transferring data from energy.buildinglogix.net...

start 2 Microsoft ... RE: smart gir... Waibel Energ... 5:31 PM



Flash Based Analytical Application using XML interface

Screenshot of a Mozilla Firefox browser displaying a web application titled "Prophet Energy". The browser address bar shows the URL: <http://dev.prophetsuite.com/ord?station:|slot:/ProphetTree/ProphetApplication#>.

The application interface includes a navigation menu on the left with a tree view under "ACME Corporation" and "San Francisco Campus". The main dashboard contains several data visualization components:

- Guage:** A semi-circular gauge showing a value of 41.4 on a scale from 0 to 100.
- Building Data Table:** A table with columns: Name, Electrical Power (kW), Gas Energy (therm), Gas Power (BTU/hr), Square Footage (ft), Temperature/Outside Air Temperature (°F), and Water Flow (gal/min).

Name	Electrical Power (kW)	Gas Energy (therm)	Gas Power (BTU/hr)	Square Footage (ft)	Temperature/Outside Air Temperature (°F)	Water Flow (gal/min)
Building 1	1009.54 kW	29481.76 therm	13.30 BTU/hr	100000.00 ft	74.0 °F	41.40 gal/min
Building 3	809.11 kW	29481.76 therm	16.21 BTU/hr	100000.00 ft	77.1 °F	34.33 gal/min
- Pie Chart 11:** A 3D pie chart with three segments in green, blue, and pink.
- Water Volume:** A digital display showing "3643443.52 GAL".
- OAT:** A digital display showing "74.0 °F".
- ACME Corporation Bar Chart:** A bar chart with two y-axes (left: kW, right: kWh/ft) and three categories: Los Angeles Campus, San Francisco Campus, and ACME Corporation. The bars are colored green and yellow.
- San Francisco Campus Horizontal Bar Chart:** A horizontal bar chart with a y-axis labeled "Category" and an x-axis labeled "BTU/hr" (0 to 20). It shows data for Building 1, Building 2, and Building 3 with multiple colored bars for each.

The status bar at the bottom indicates "Transferring data from dev.prophetsuite.com...". The Windows taskbar shows the Start button, system tray, and active applications including Mozilla Firefox.



Hostware – Dealing With The New IT Infrastructure

- Larger Systems
 - ☐ Millions of data points
- Remote Computing and Data Centers
 - ☐ Servers are scattered
 - ☐ Applications and data across multiple locations and servers
- Virtual Computing
 - ☐ Many applications on a single server
- Cloud Computing
 - ☐ Leasing Processor Time and Memory
- Third Party Application Servers
 - ☐ Remote Servers Manipulating & Analyzing Data
 - ☐ Open APIs



Hostware – Auto Sizing Systems



Application Server

Application Server

Browser

Auto Sizing Algorithm
Notify stakeholders, provide links to application servers.

Auto Sizing Algorithm
Find a server and load required software for monitoring, control, archiving.

Auto Sizing Algorithm
I just added many remote sites.



EMCS Servers



Remote Site

Remote Site

Remote Site

Remote Site

Remote Site

Remote Site



Deviceware

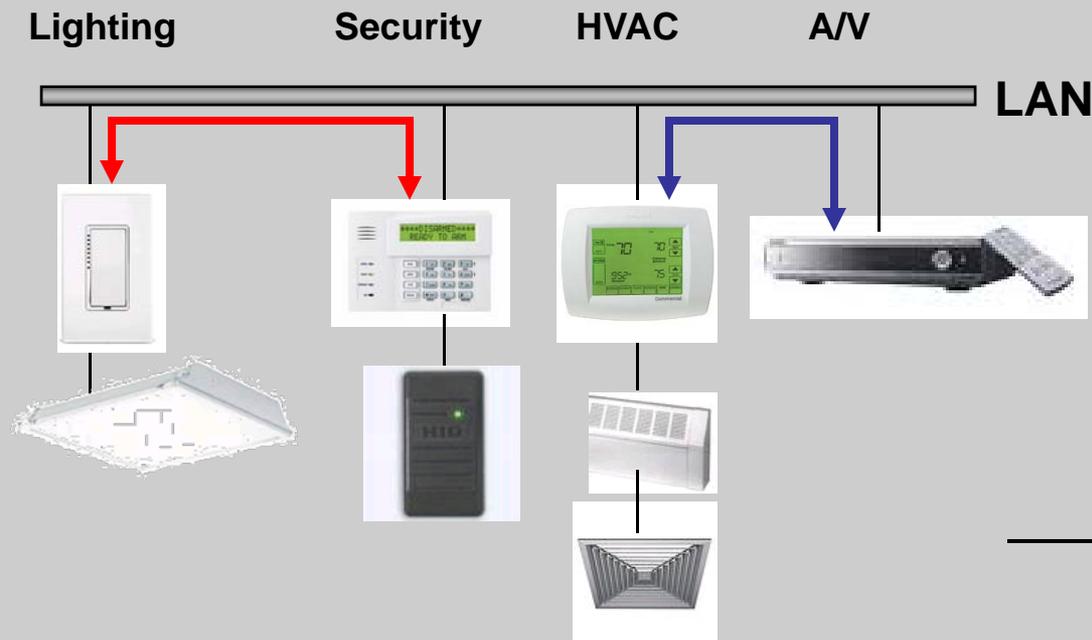
- Must move down to device based technology solutions that can be continuously monitored and optimized.
- All systems and **devices** in a building must contribute to the Green Intelligent Building cause.
- Occupants generally interact with devices and are not as aware of systems.
 - ☐ Thermostat
 - ☐ Light Switch & Fixtures
 - ☐ Diffusers
 - ☐ Card Reader
 - ☐ Set Top Box





Green Building Technology Evolution

- Devices need to communicate, control, alarm, and serve data
- Devices are usually connected in vertical system silos
- Integration is generally across a wired network

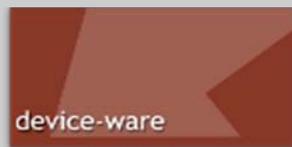




Personal Area Network

- Emerging technology allows communication in groups of PANs
 - ☐ **Personal Area Network**
 - ☐ Add more processing power
 - ☐ Local energy management and optimization
 - ☐ Card swipe
 - Opens door
 - Turns on lights
 - Resets temperature
 - Resets ventilation
 - ☐ A/V On
 - Resets lights

Conference Room PAN



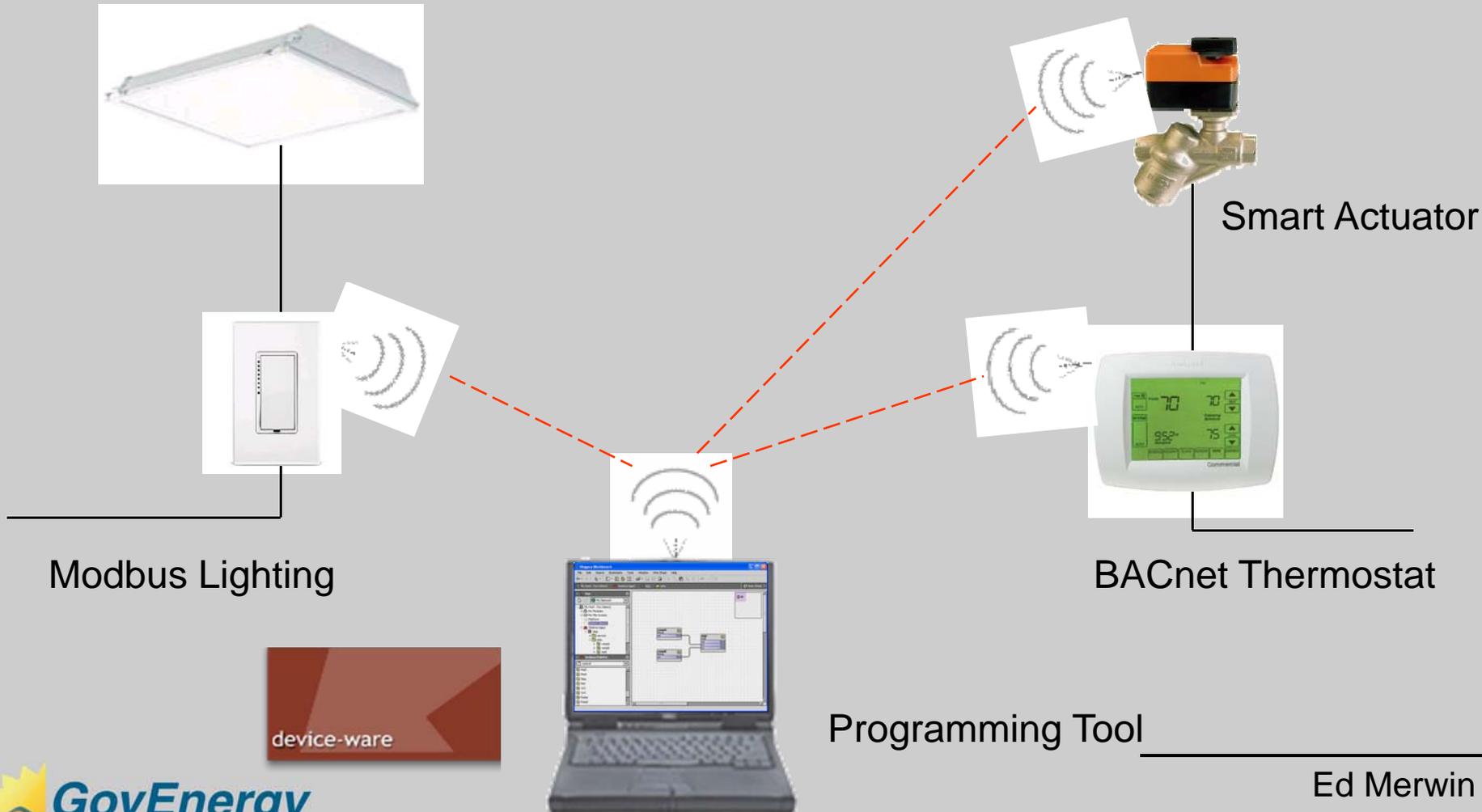


Deviceware Technology Enablers

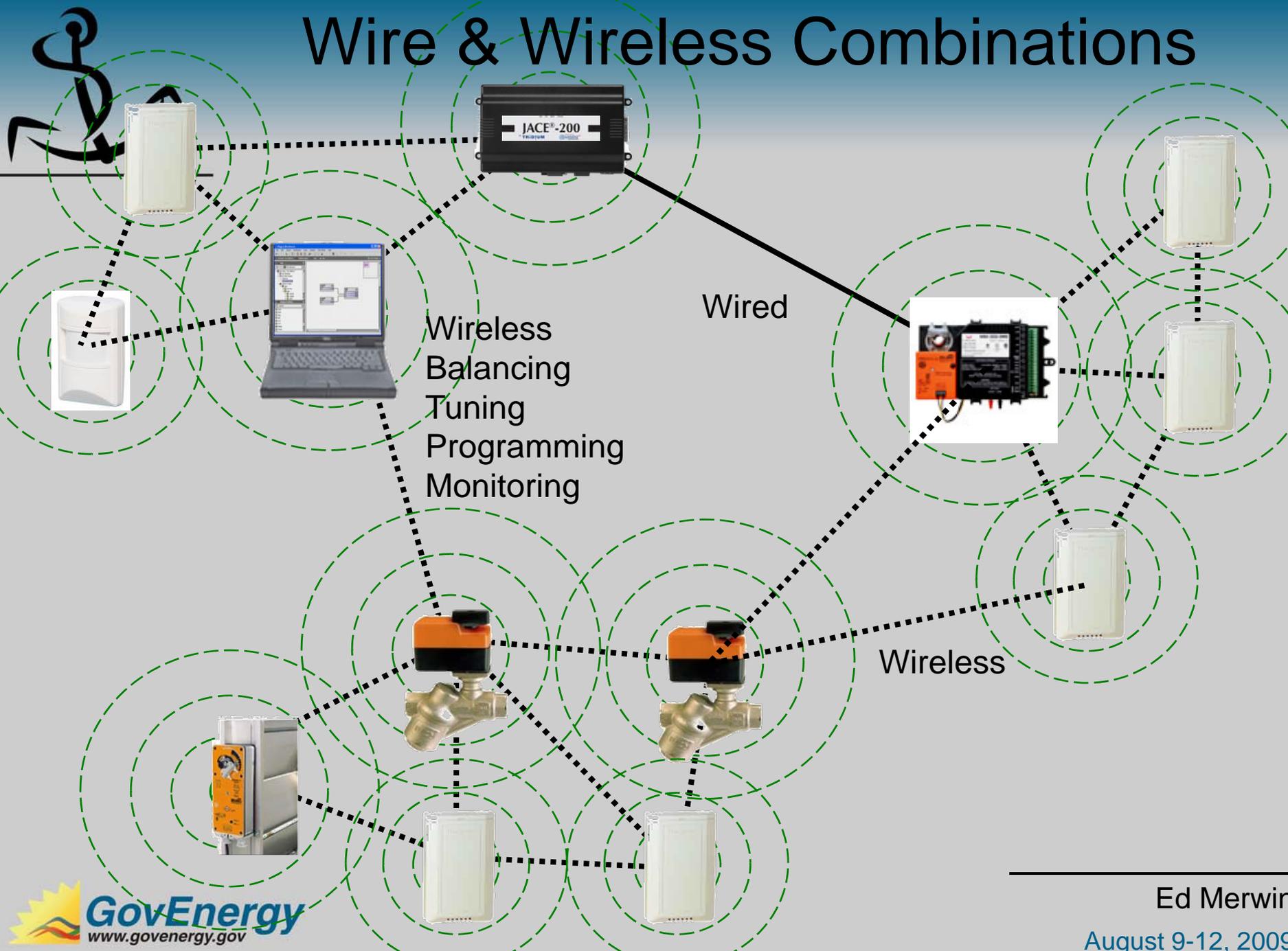
- IPV6
 - ☐ Every device in a building can have an IP address
- New Processor Technology
 - ☐ Lower Cost – Higher Power
- Wireless Networks 802.15.4
 - ☐ Zigbee
 - ☐ Wireless Hart
 - ☐ 6LoWPAN
- Device Frameworks
 - ☐ Universal Control Engines
 - Across multiple protocols
 - ☐ Sedona
 - Opensource
 - Sedonadev.org



Multiple Systems, Hardware & Protocols One Programming Tool

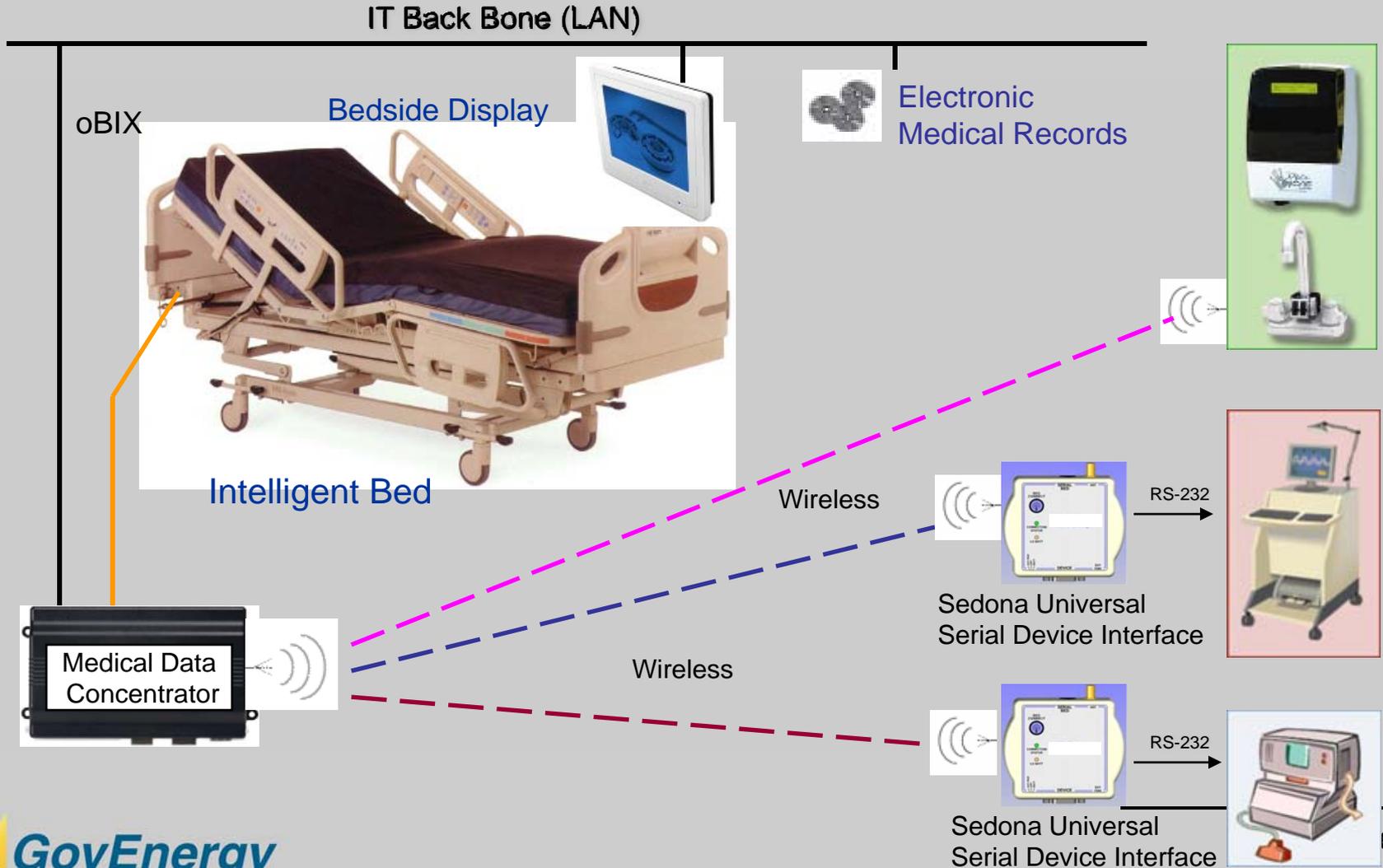


Wire & Wireless Combinations





Deviceware Healthcare Application





Thank You