DIRECT DIGITAL CONTROL:
HOW I LEARNED TO STOP WORRYING AND LOVE THE BMS

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TODAY'S GOALS.

- What is a Building Management System (BMS)?
- Do I already have one and misplaced it?
- How does a BMS aid in our energy goals?
- Before we answer those and other burning questions:

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TODAY'S AGENDA

- Quick Summary of Housing Vermont's Portfolio
- Clearing the Air of Acronyms
- The Case for BMS/BEMS
- Challenges
- How We are Doing It

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A QUICK INTRODUCTION:

Trevor Parsons – Housing Vermont

Manages the energy efficiency and renewable energy effort for Housing Vermont's Portfolio

AJ Rossman – Smart Resource Institute

Builds web applications for understanding and effectively managing energy generation, distribution and efficiency

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HOUSING VERMONT PORTFOLIO

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HOUSING VERMONT'S CHALLENGE

- How do track and keep 300 plus buildings operating at peak performance?
- Who's defining peak performance?
- How do you steer capital towards the best investments in terms dollars and resources like water, fuel and power?
- How do you deploy new technology with dozens of regional property managers and contractors?
- How do we afford it?
- How do I get any sleep?

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LETS DEFINE A FEW THINGS:

As defined by Wikipedia:

- Building Management System (BMS): A Building Management System is a computer-based control system installed in buildings that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems.
- Direct digital control (DDC): is the automated control of a condition or process by a digital device (computer).

OUR DEFINITION: BEMS
BUILDING ENERGY MANAGEMENT SYSTEM

- Uses existing DDC data
- Adds context with metadata and additional energy sub-metering data
- Processes information using baselines and benchmarks
- Gives capital planners actionable information

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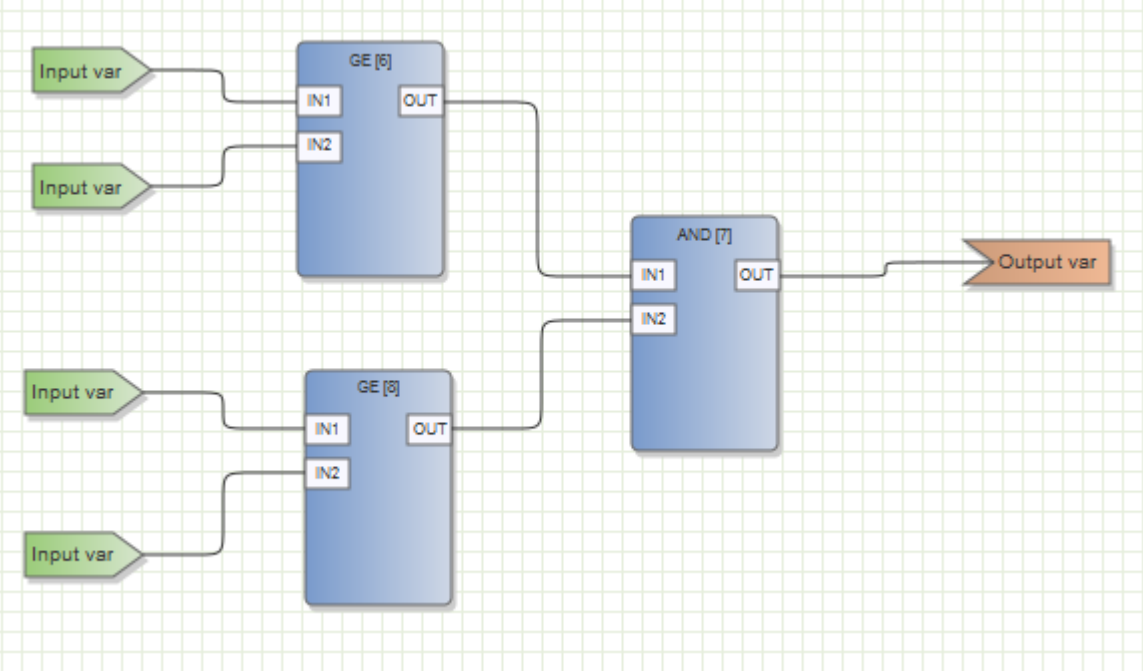
DDC'S ROLE: KEEP THE LIGHTS ON!



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QUICK DEFINITION

If you are Neo...

Understanding of Building Energy Performance Matrix

If you are like the rest of us...

Building Energy Management System

Understanding of Building Energy Performance Matrix

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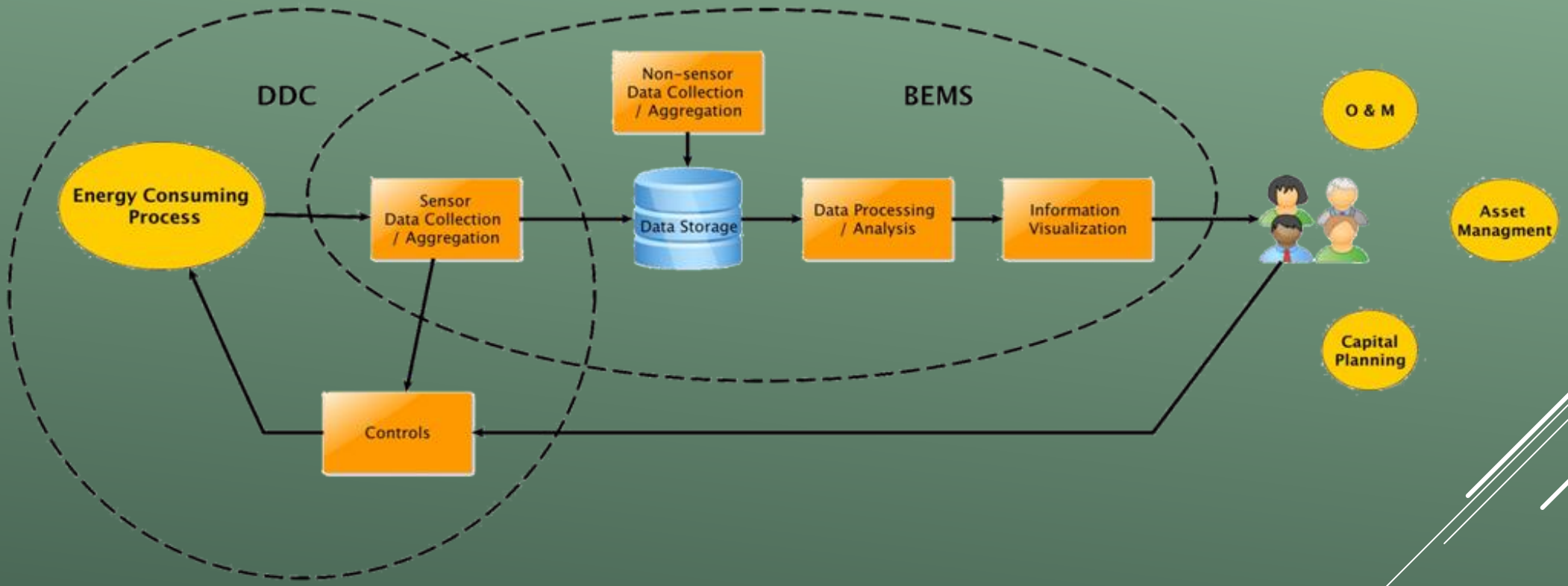
FUNCTIONAL COMPONENTS OF BEMS



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ONE BOX, MANY BOXES?

Is it best to buy one complete system or a composite?

- Controls
- IT Security
- Building Energy Data Storage and processing
- Analytics
- Measure tracking
- Data sharing

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ARE THESE BMS / DDC DEVICES?

Occ. Sensor

Boiler Controller

Prog. Thermostat

Time Clock

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HOW ABOUT THESE ?

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OR EVEN THESE?

- The Internet of Things (IoT) has arrived, (sort of).
- Lots of questions to be answered, how will devices communicate? 6lowpan, ZigBee, Wi-Fi?
- What kind of interoperability can we expect?
- We now have light bulbs that need occasional rebooting.

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DOES A BMS NEED TO BE THIS?

I think this one operates the fresh air damper

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ITS COMPLICATED…

- Much of core functionality of traditional DDC is available through stand alone, purpose built products.
- Available doesn't mean compatible or easy.
- The challenge is how to "glue" together these various products into a cohesive system.

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THE FUNDAMENTAL QUESTION: WHY BOTHER?

- How does a BMS deliver value to a building owner?
- Is it worth the hassle? At what size building?
- Does a BMS yield real energy, staff or resource savings in all buildings?

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THE CASE FOR BMS: LETS START WITH SETTINGS / COMMISSIONING.

- Stand alone controls suffer from what I call "Late night repair drift". After 3 to 5 years, we find stand alone controllers setting drastically different than design or day one.
- Its expensive to physically inspect / retro commission 300 plus buildings every three years.
- In field staff (Maintenance or contract HVAC) have widely varying degrees of interest and time.

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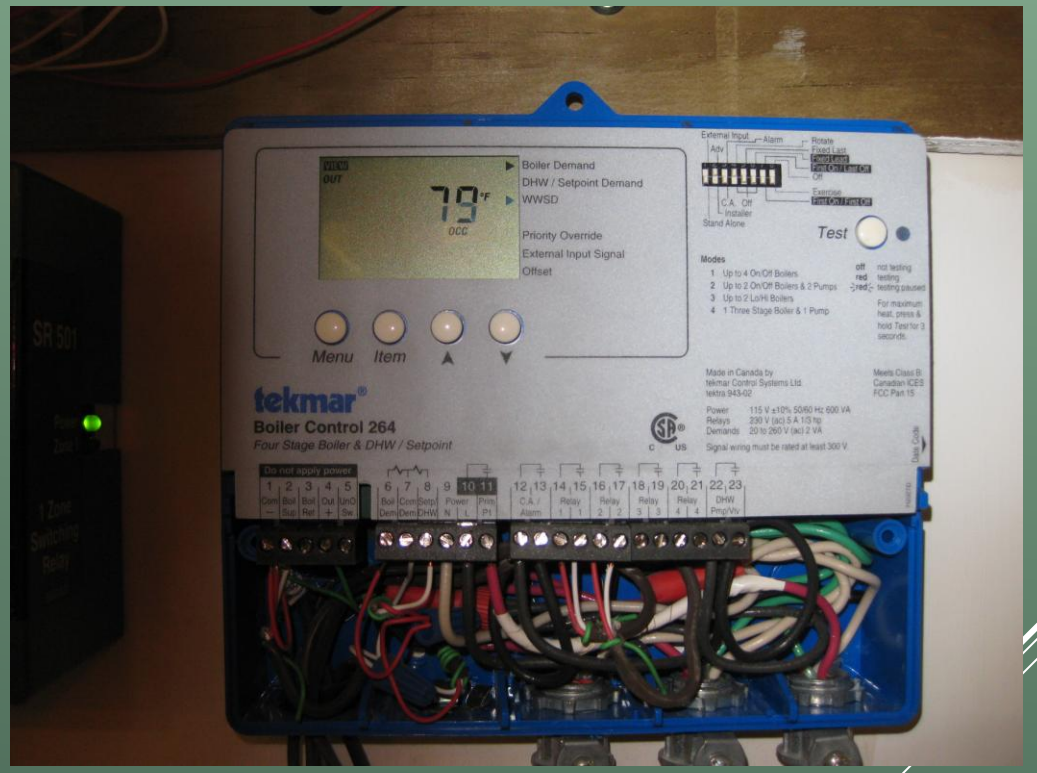
WRONG FROM THE START?



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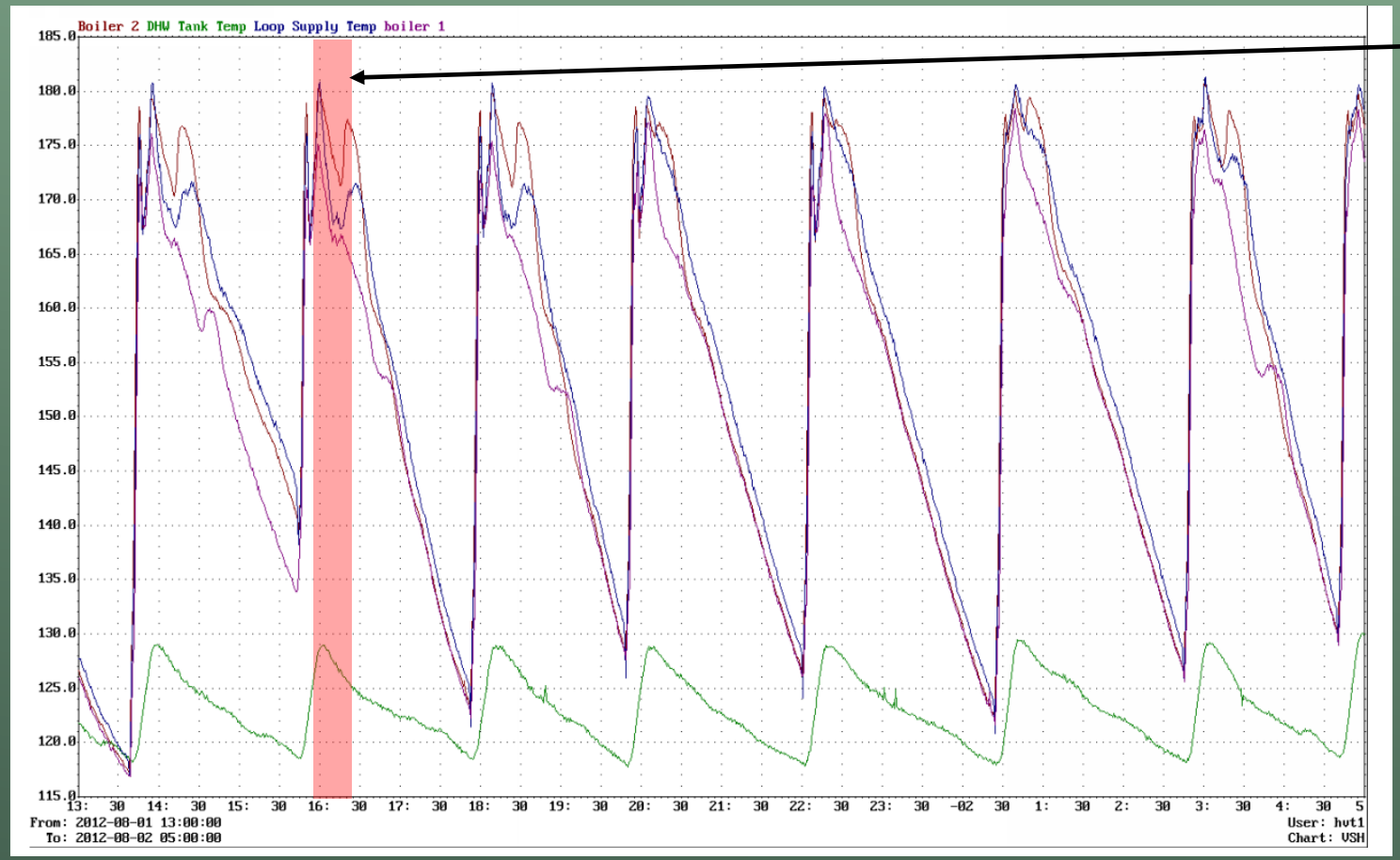
MORE FUN FINDS.

- Fresh Air Dampers, open, closed, fixed, broken (who knows).
- Domestic Hot Water systems: mechanical aquastats are horseshoes and hand grenades accurate.
- Failed sensors, causing heat to operate all summer.
- Equipment turned on manually, and left on.
- Time clocks set to the wrong continent.
- Simultaneous heating and cooling, happens more than you think.

TIME! IT GOES BY SO FAST (OR SLOW)



Time in mechanical room

The time period for discovering faults / mistakes is often much longer than Humans like to spend in mechanical rooms.

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FAULT DETECTION:

- When something fails, its often easy to identify (with sensors) and alarm.
- Self testing and notification can be built into most standard DDC logic

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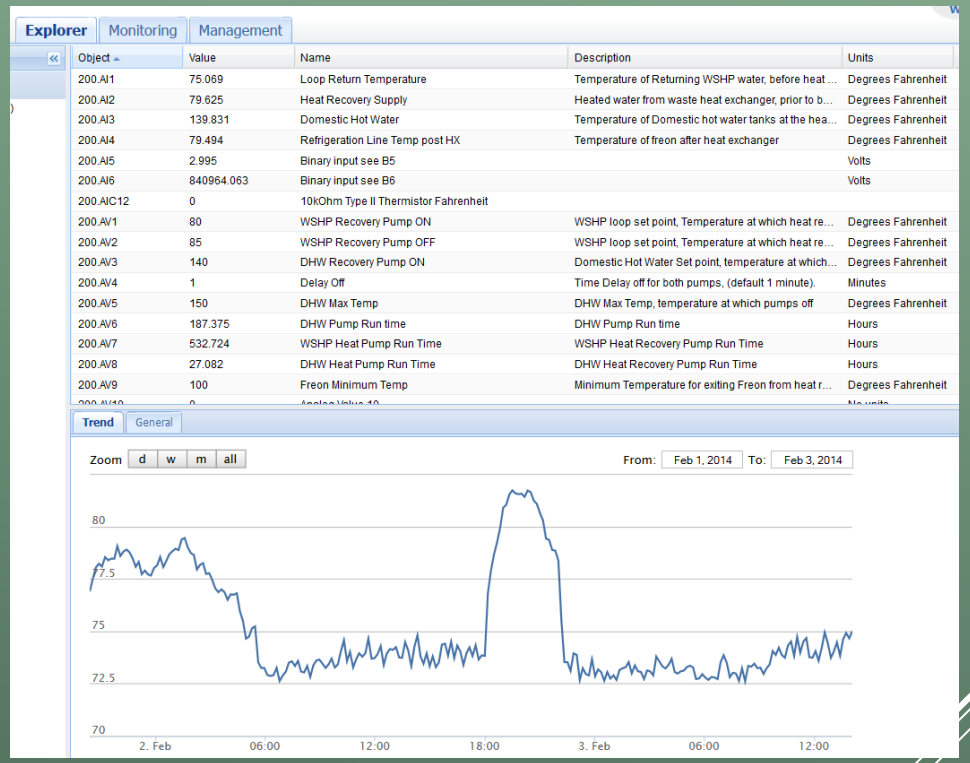
OFFSITE SUPPORT:

- The ability to "dial in" has greatly improved my ability to support HVAC systems.
- Offsite support offers us the ability to have specialist, focused, to aid folks in the field.



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CHALLENGES

- Interoperability
  - Multiple vendors
  - Multiple standards
  - Multiple communication protocols
- Processing role-specific information
- Benchmarking
- Establishing and interpreting baselines

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CHALLENGES

- Naming conventions
- Data management
- Security
- Commitment
- Cost

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DISRUPTIVE TECHNOLOGY: GOOD FOR OWNERS (EVENTUALLY)

- Wireless options for sensors, controls and actuators.
- Open protocols allow for mixing and matching.
- Computing power is cheap!

ZigBee Alliance

ASHRAE BACnet™

oBIX™ Open Building Information Xchange

openADR ALLIANCE

Modbus

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PROCESSING DATA

- Need to figure out appropriate data for different stakeholder groups
- How granular data do you collect?
- How granular of data do you store?
- How do you structure the data?
- What statistics do you keep?
- How do I best visualize the data?
- Where does the processing happen?

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DATA, ANALYTICS, CLOUD SERVICES: THE REVOLUTION WILL NOT BE TELEVISED

- Cloud services and analytics still require a large time investment, a deep understanding of HVAC systems.
- Once deployed, any energy management system needs to be used.
- Consider what *questions* any piece of software *answers*, and how those answers will be integrated into asset management.

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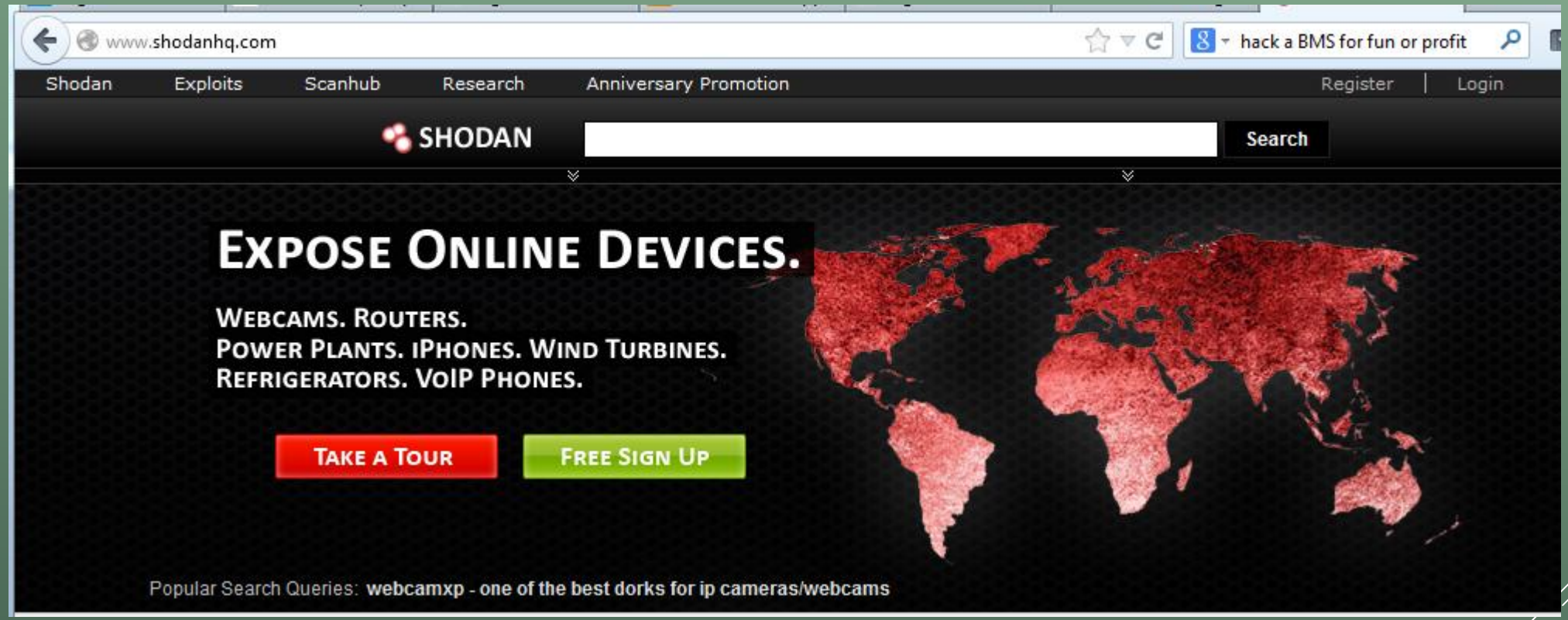
IT SECURITY AND INTEGRATION:

- IT Security and interoperability are often at odds.
- In the past, IT departments were unaware of BMS systems, which often utilized its own parallel LAN architecture.
- More and more are we seeing "sharing" of existing IT resources.
- It is now essential that BMS equipment be treated no differently than a workstation, server or router by IT.

FIRST LETS SCARE THE PANTS OFF YOU!



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IF GOOGLE CAN BE HACKED…

Researchers Hack Building Control System at Google Australia Office

BY KIM ZETTER 05.06.13 6:30 AM

Follow @KimZetter

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IT SECURITY BASICS:

LEGAL DISCLAIMER: AJ AND TREVOR CAN BARELY DRESS THEMSELVES AND YOU SHOULD GET REAL IT SECURITY FROM EXPERTS.

- Do not expose BMS equipment to the internet, use firewalls!
- Use strong passwords, do not let vendors add users / passwords that look like this **bobscontrols / bobscontrols123**, you know damn well that's the password at the 200 sites they deployed.
- Do not share subnets with any non-BMS equipment

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FIREWALLS ARE LIKE ZOMBIE APOCALYPSE

- A firewall can act like a gate, allowing only designated packets from entering the secure LAN side of a given router.
- Firewalls can also be configured to be very porous, port forwards are form of unlocking the backdoor…
- The only way to beat zombies is a circle of trust and a solid plan, the same is true for IT security.

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HOUSING VERMONT'S REQUIREMENTS

- Affordable at smaller sites (4 – 8 unit buildings).
- Easily scalable and modular (not monolithic).
- Non-proprietary mode of communication, ie, BACnet or oBix.
- The ability to configure and program the device. In particular, the ability to audit the logic and make changes.

Other owners will have different requirements, our choices were arrived at for our specific portfolio needs. A 200,000 sq/ft hospital may reach a different set of requirements.

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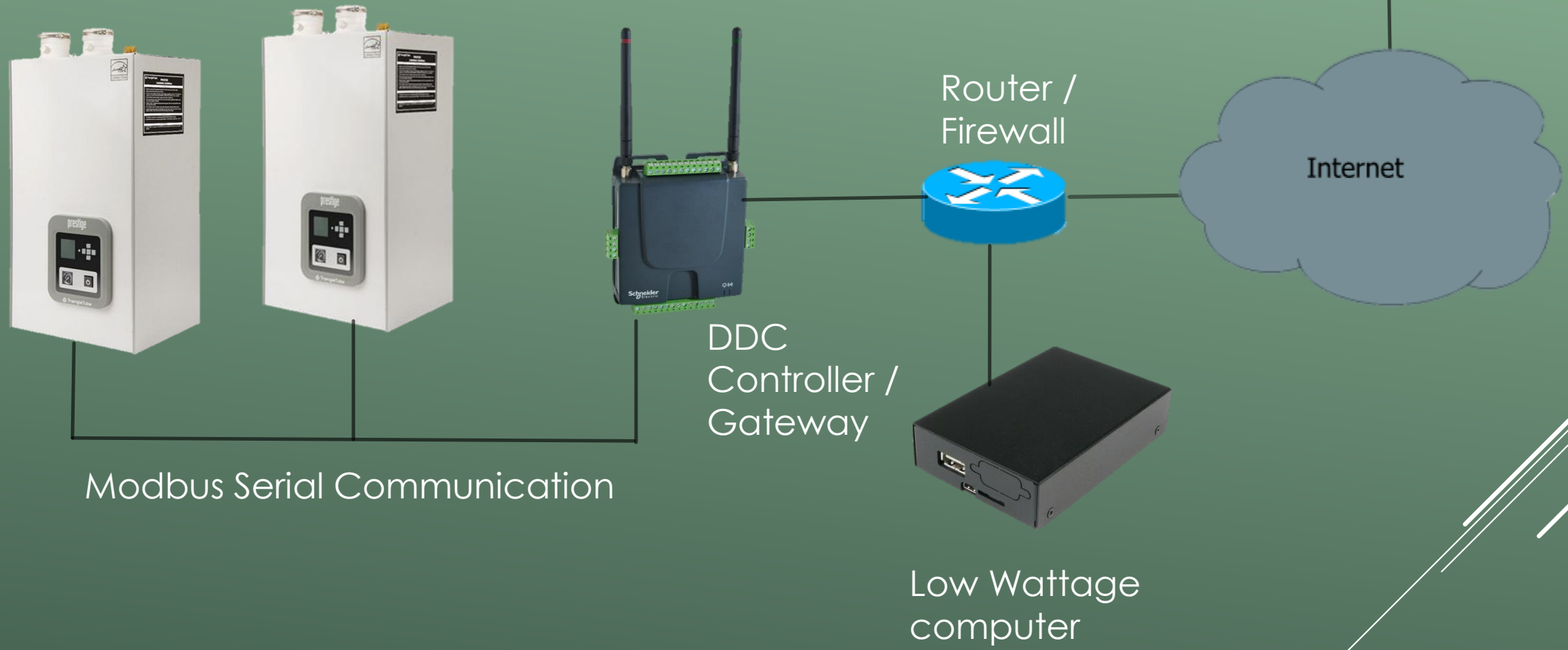
HOW WE ARE DOING IT: SITE INFRASTRUCTURE

- DDC controllers that can map low level serial bus communication (Modbus Mostly) to a Standard IP protocol (BACnet IP or oBix).
- A single hop to IP enables us to create modular control designs. A set of boilers gets a controller and reusable logic. This approach doesn't require (but doesn't prevent either) a central controller or gateway.
- We poll controllers using a low wattage Linux computer for data and fault detection, first pass on data processing and secure upload of data.

WHAT IT LOOKS LIKE.



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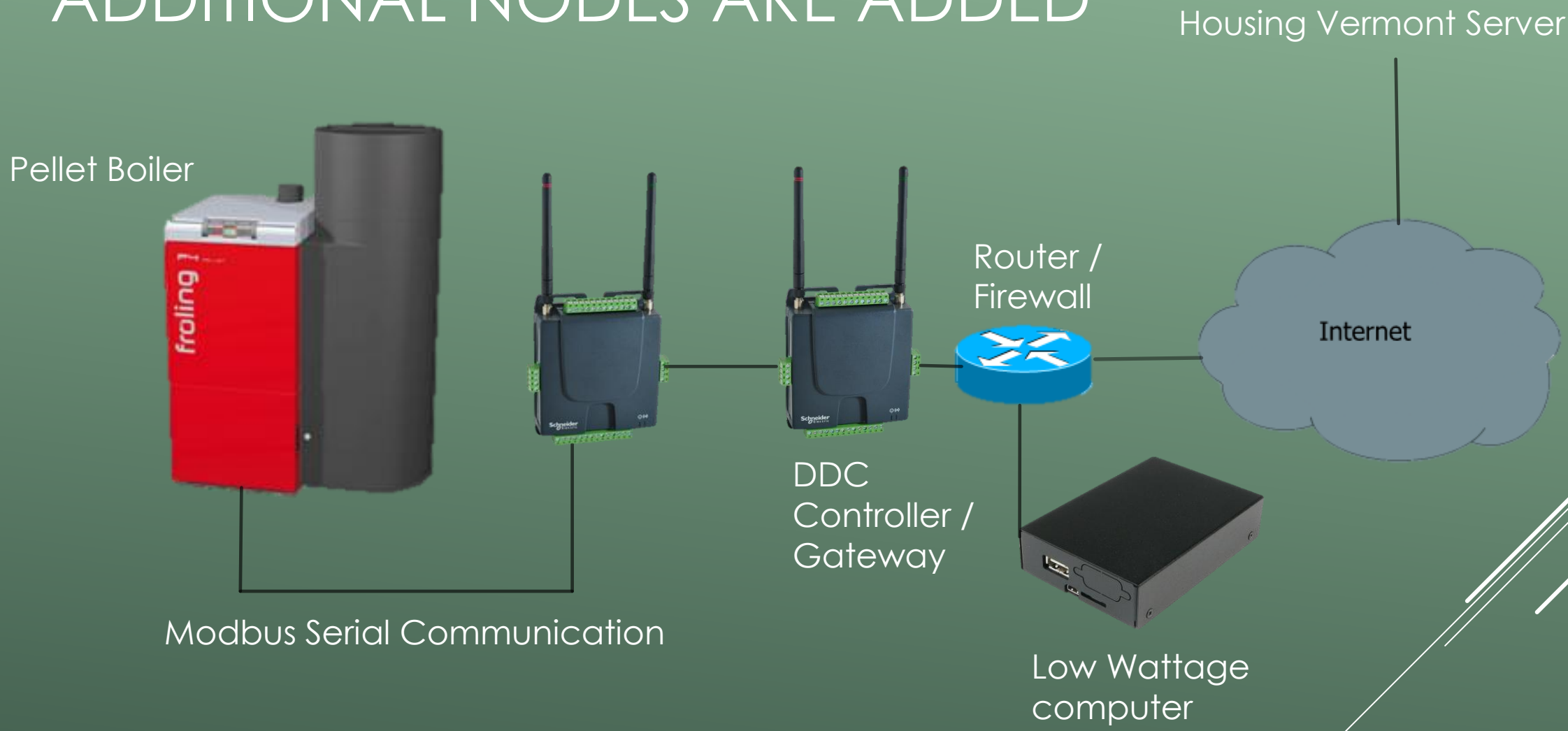
ADDITIONAL NODES ARE ADDED



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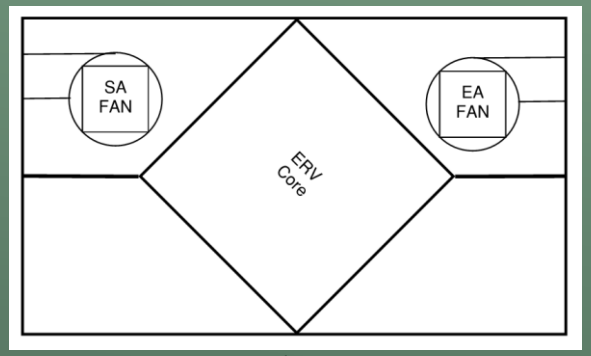
ADDITIONAL NODES ARE ADDED

Housing Vermont Server

HRV / ERV



Router /
Firewall

Internet

DDC
Controller /
Gateway

Analog and Binary points
(sensors, relays, etc.)

Low Wattage
computer

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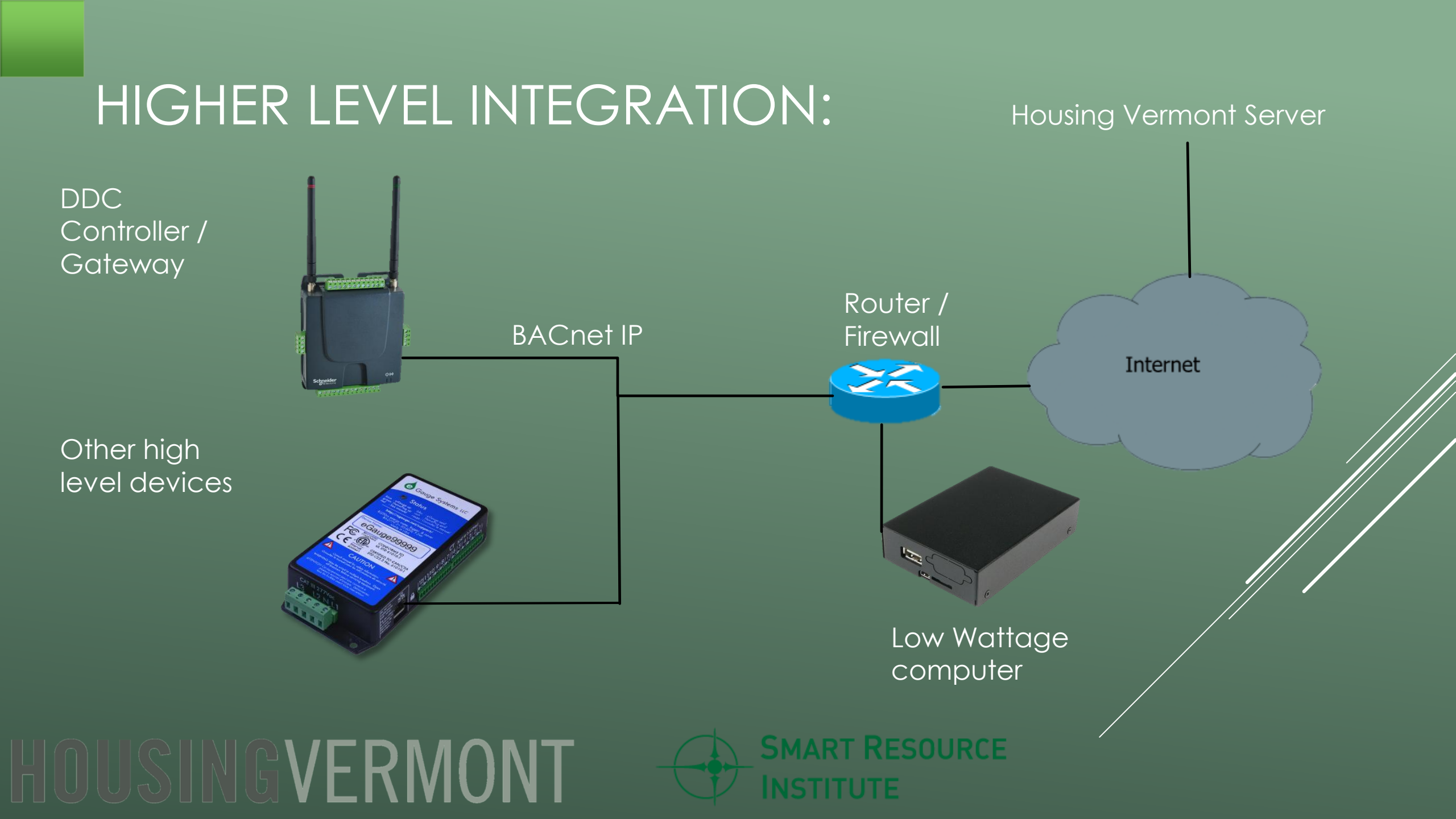
HIGHER LEVEL INTEGRATION:



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HOW WE ARE DOING IT – SERVER APPS

- Near real time site data is aggregated and entered into a relational database
- The database includes many asset management fields, such as square footage, unit count, etc.
- Drawing on the database, a web application provides users with a dashboard

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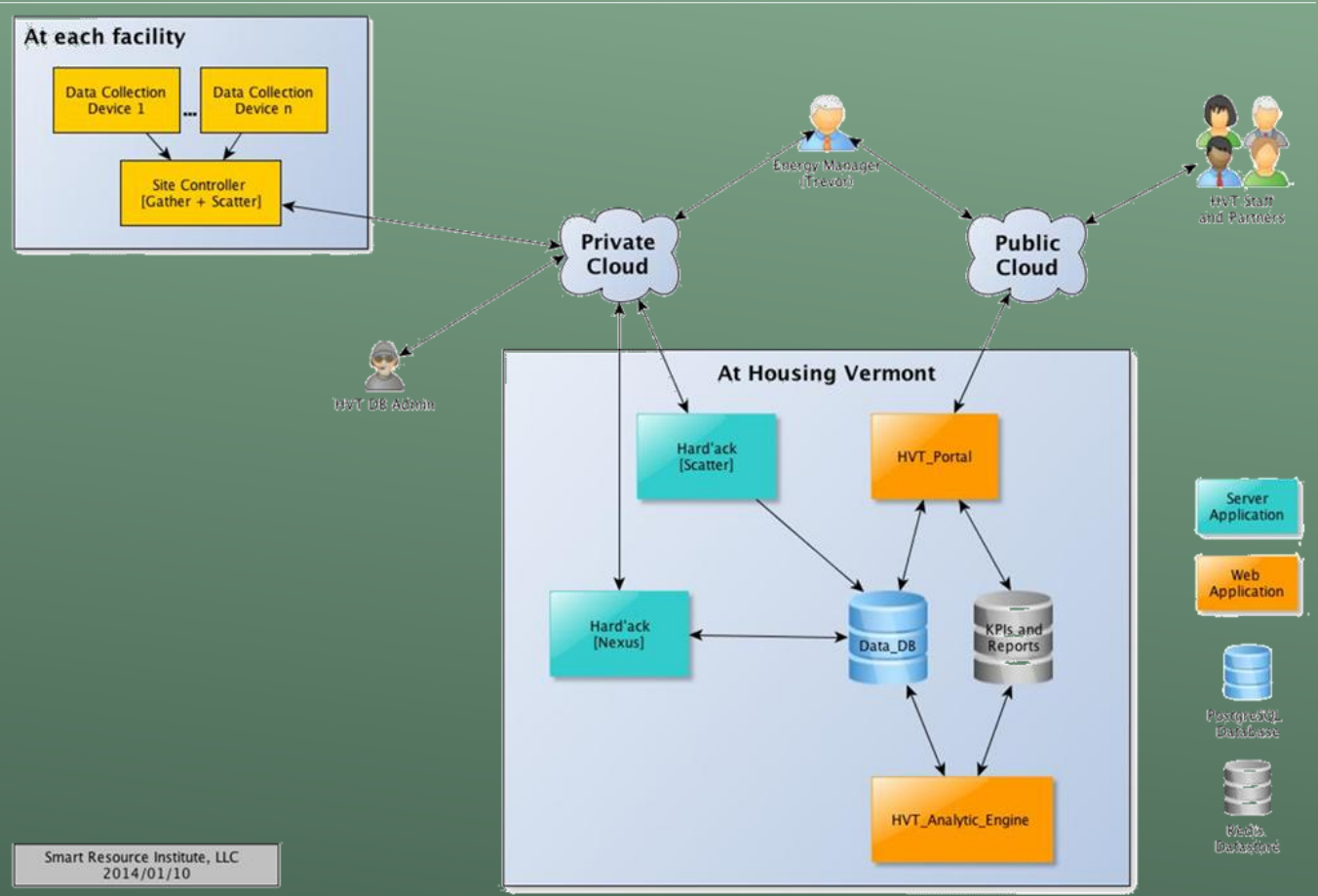
HOW WE ARE DOING IT – WEB APPS ARE GLUE



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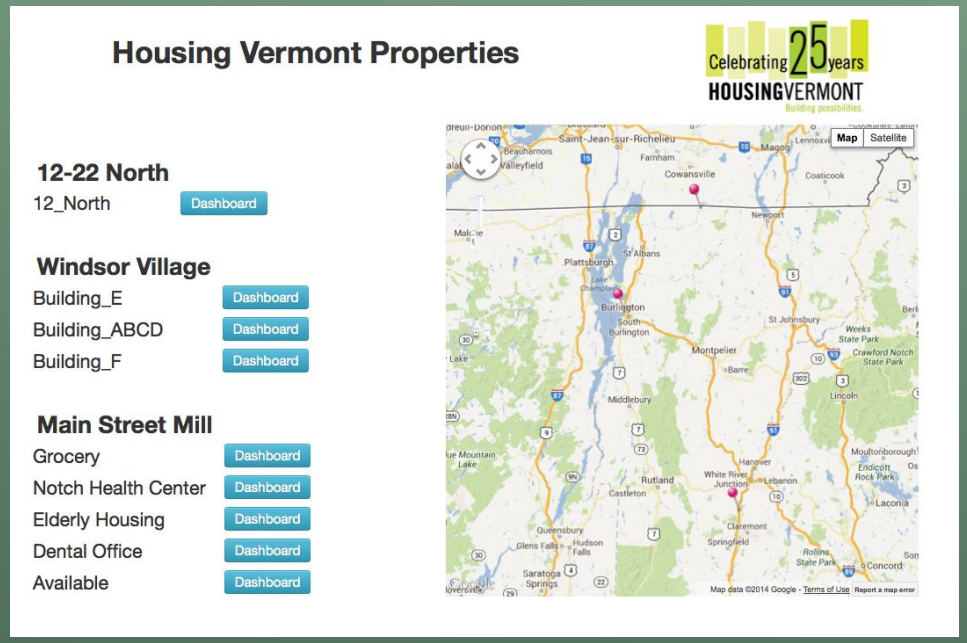
HOW WE ARE DOING IT – WEB APP PROTOTYPES



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ANALYTICS:

- What if you could list all your heat zones in order by use?
- What if you detect and be notified if you used an unusual amount of fuel, water or electricity?
- What if you could get recommendations on how to tune your control equipment?

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QUESTIONS / COMMENTS?

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ENERGY SAVING STRATEGIES:

- Optimizing equipment runtime and operating conditions:
  - Condensing Gas Boilers: Efficiency and return water temperature.
  - Staged Equipment: Boilers, chillers and cooling towers.
  - Ventilation: CO2 / VOC sensors drive the level (DCV).
  - Occupied / Unoccupied and space recovery.

NET-ZERO IN THE COMMERCIAL SETTING: HOW CAN A BMS HELP?

- Net-Zero in commercial buildings will require constant commissioning, preferably semi-automatic.
- Fault detection
- If time of use electrical purchasing becomes a reality, commercial buildings will need to be smart buyers.
- Energy generation, storage and efficiency investments will need to be gauged, monitored and evaluated.

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LOW ENERGY USE COMMERCIAL: COMPLICATED MIGHT BE AN UNDERSTATEMENT

- Refrigeration equipment, be it GSHP, ASHPs or case coolers.
- Renewable integration.
- Server rooms
- Heat recovery / free cooing
- Occupancy / Schedules

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