Open-Source Approaches to Building Energy Management

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Why is Open Source BEMS Important

Many companies in the US offer Building Energy Management Systems

But there are two problems – Cost and Closed Architecture

Large buildings (>75,000 sq ft) can afford to install BEMS upfront because the incremental cost is relatively small and the opportunity for energy savings is large

Smaller buildings (<50,000 sq ft) do not benefit from the above

Vendors do not find the market big enough or profitable enough

Need an alternate approach

Open source source software platform using commercially available hardware can provide that option

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BEMOSS Development in Consultation with Industry

As of January 2014, the BEMOSS advisory committee includes representatives from the following organizations:

Objectives

◆ **We propose** to develop a web-based BEMOSS software platform for monitoring and managing electrical energy demands in small and medium-sized buildings.

◆ **Our foci:**

❑ **Applications** – Open architecture and scalability for accelerated deployment

❑ **Usability** – Interoperability and plug & play feature for flexible integration with different equipment and device controllers

❑ **Advanced monitoring** – Web-service interface allowing access from virtually anywhere

❑ **Cost-effectiveness** – Low deployment cost and advanced algorithms for energy saving improvement and demand response

BEMOSS Goals

BEMOSS Key Features:
- Scalability
- Robustness
- Plug and play
- Open protocol
- Interoperability
- Cost-effectiveness
- Local and remote monitoring

Open communication protocols,
e.g.,
- BACNet
- MODBus
- OpenADR

Communication technologies,
e.g.,
- WiFi
- ZigBee
- Ethernet

Loads,
e.g.,
- Lighting loads
- Plug loads
- HVAC

- Various sensors, e.g., ambient light/ temperature, occupancy, photocells
- Multiple-zone control
- Alarm management
- Weekday/weekend schedules

Communications with external sources via web services,
e.g.,
- Utilities
- DR aggregators

Overall Concept

◆ Select commercially available hardware devices, including HVAC, lighting and plug load controllers

◆ Design & develop BEMOSS operating system environment based on LINUX (or iOS, or Windows)

◆ Develop open source software to interact with the controllers of selected commercial products so that they function as plug-and-play devices in the BEMOSS operating system environment

◆ Design BEMOSS user interface

◆ Demonstrate the preliminary BEMOSS operating system in a simulated environment

BEMOSS Hardware Devices

HVAC load controller
- Smart thermostat
- VAV controller

Lighting load controller
- Dimable ballast
- Step dim ballast

Plug load controller
- Smart plug

Sensor
- Occupancy sensor
- Ambient light sensor
- Temperature

Meter
- Power/energy meter

Smart Appliances
- Electric water heater

Select Commercially Available Hardware Devices

HVAC load controllers

Wi-Fi Thermostat   ZigBee Thermostat   BACnet Thermostat

Lighting controllers

- Circuit-level lighting controller
  - VT smart circuit (with ZigBee comm)

- Individual lighting controller
  - Dimmable electronic ballast

Load controllers

- Smart plugs
  - XBee smart plug (120V 8A)
  - Entek load controller (240V 30A)

- Smart appliances

BEMOSS Hardware Devices – Smart Appliances

Smart appliance:

- GE Hybrid Water Heater (GeoSpring GEH50DEEDSR) (Heat pump + Electric elements)
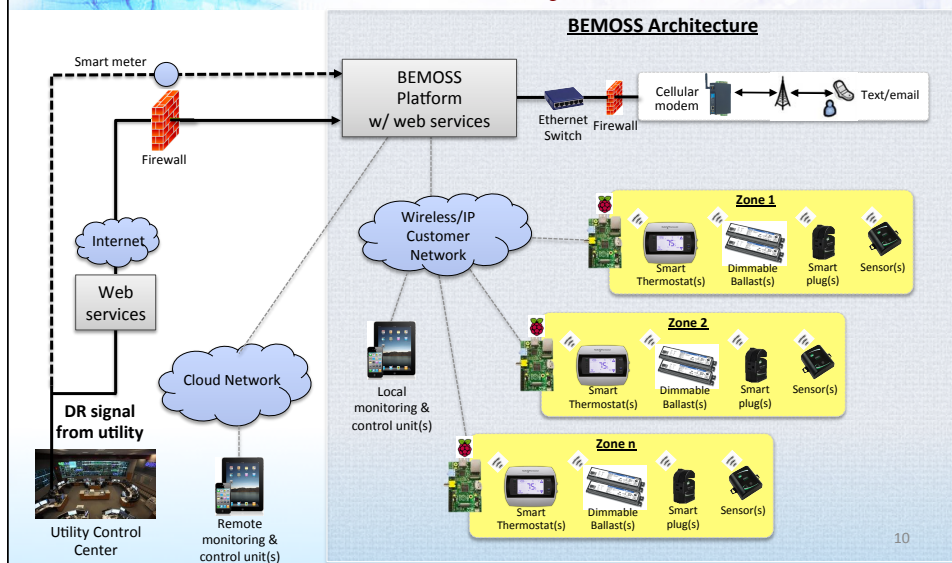
Reasons for selection:

- Smart appliance – allowing remote control of temperature setpoint and operational modes
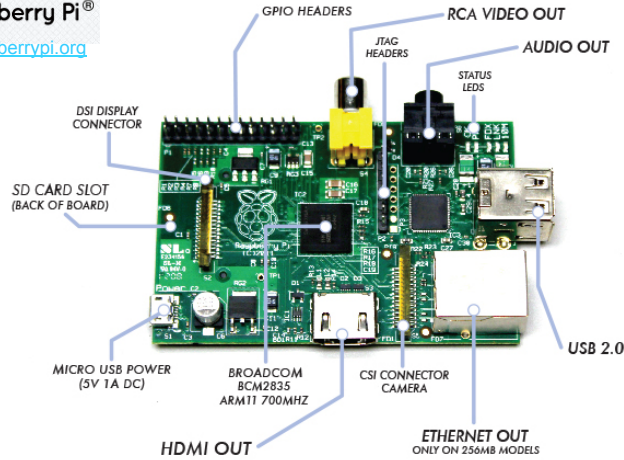- Showcase that BEMOSS works with smart appliances
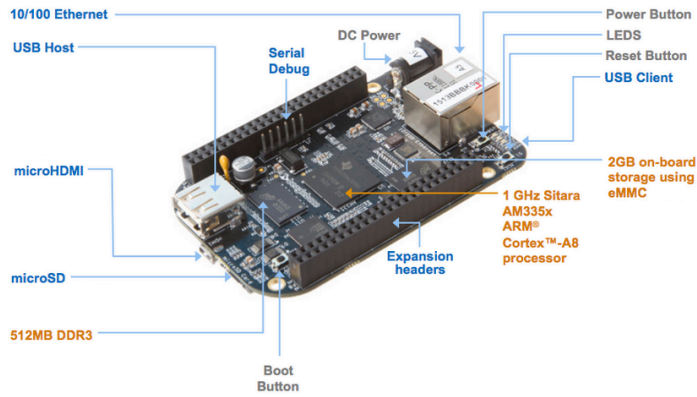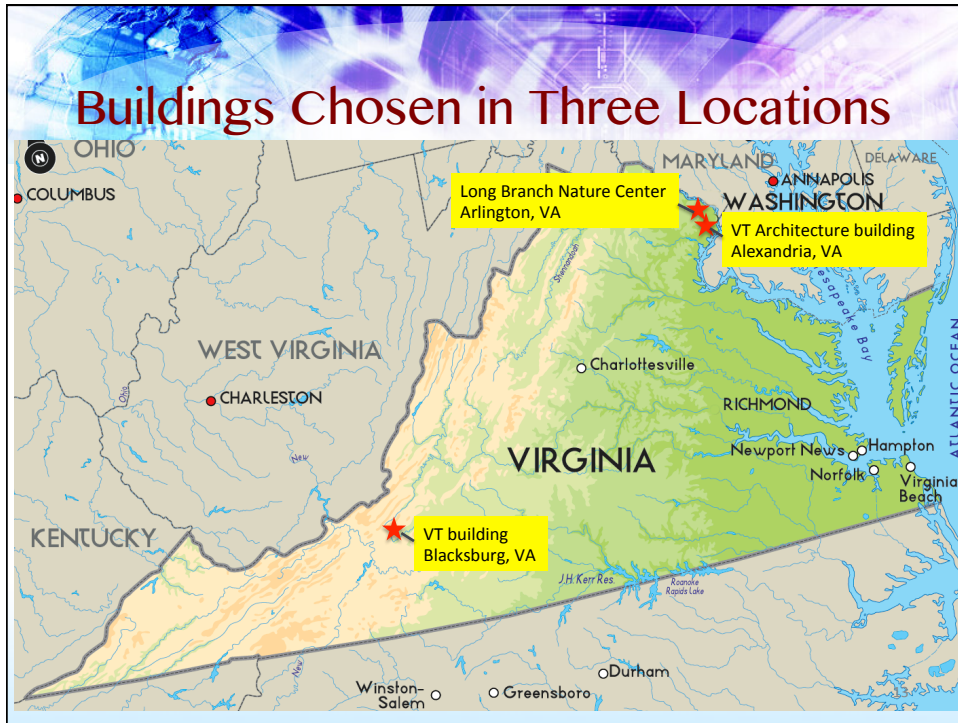
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BEMOSS Architecture (As of January 2014)

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Plan for BEMOSS Platform

Raspberry Pi®
www.raspberrypi.org

GPIO HEADERS
RCA VIDEO OUT
JTAG HEADERS
AUDIO OUT
STATUS LEDS
DSI DISPLAY CONNECTOR
SD CARD SLOT (BACK OF BOARD)
MICRO USB POWER (5V 1A DC)
BROADCOM BCM2835 ARM11 700MHZ
CSI CONNECTOR CAMERA
USB 2.0
HDMI OUT
ETHERNET OUT ONLY ON 256MB MODELS

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Plan for BEMOSS Platform (Cont'd)

BeagleBone Black 1 GHz performance — beagleboard.org

10/100 Ethernet
USB Host
Serial Debug
DC Power
Power Button
LEDS
Reset Button
USB Client
microHDMI
2GB on-board storage using eMMC
1 GHz Sitara AM335x ARM® Cortex™-A8 processor
microSD
Expansion headers
512MB DDR3
Boot Button

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Buildings Chosen in Three Locations

Long Branch Nature Center
Arlington, VA

VT Architecture building
Alexandria, VA

VT building
Blacksburg, VA

VT Architecture
Building

3 floors
25,000 sq ft

Exterior lighting

Entrance to Parking Garage

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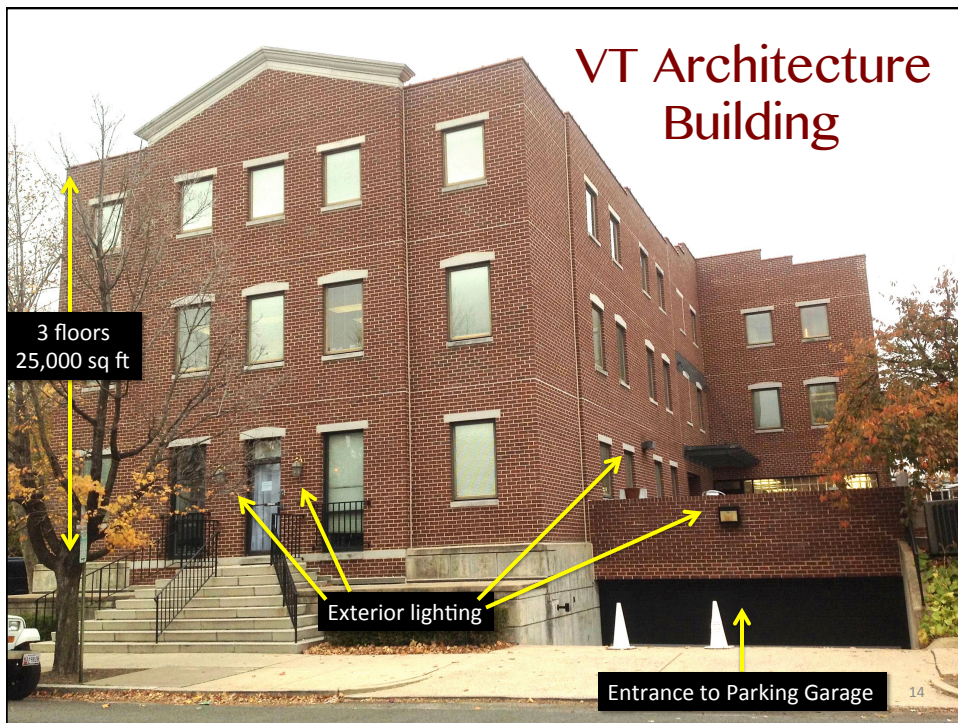
Building HVAC Loads

Compressors on the roof

Air handlers inside the building

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Building 2 – Long Branch Nature Center (625 S Carlin Springs Rd., Arlington, VA)

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Building 3 – Virginia Tech Building (460 Turner St., Blacksburg, VA)

Front

Rear

Public Domain Information Exchange

- The BEMOSS website www.bemoss.org is being populated.

- In addition, http://sourceforge.net web portal will be used as a full-scale repository to host information about the BEMOSS project, user interface tools, project progress and information about demonstration sites.

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Thank You

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