Building Energy Management Open-Source Software (BEMOSS)

VOLTTRON Meeting

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U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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What is BEMOSS?

BEMOSS is a Building Energy Management Open Source Software (BEMOSS) solution that is engineered to improve sensing and control of equipment in small- and medium-sized commercial buildings.

BEMOSS monitoring and control:

Three major loads in buildings
- HVAC
- Lighting loads
- Plug loads

BEMOSS value:

Improves energy efficiency and facilitates demand response implementation in buildings.

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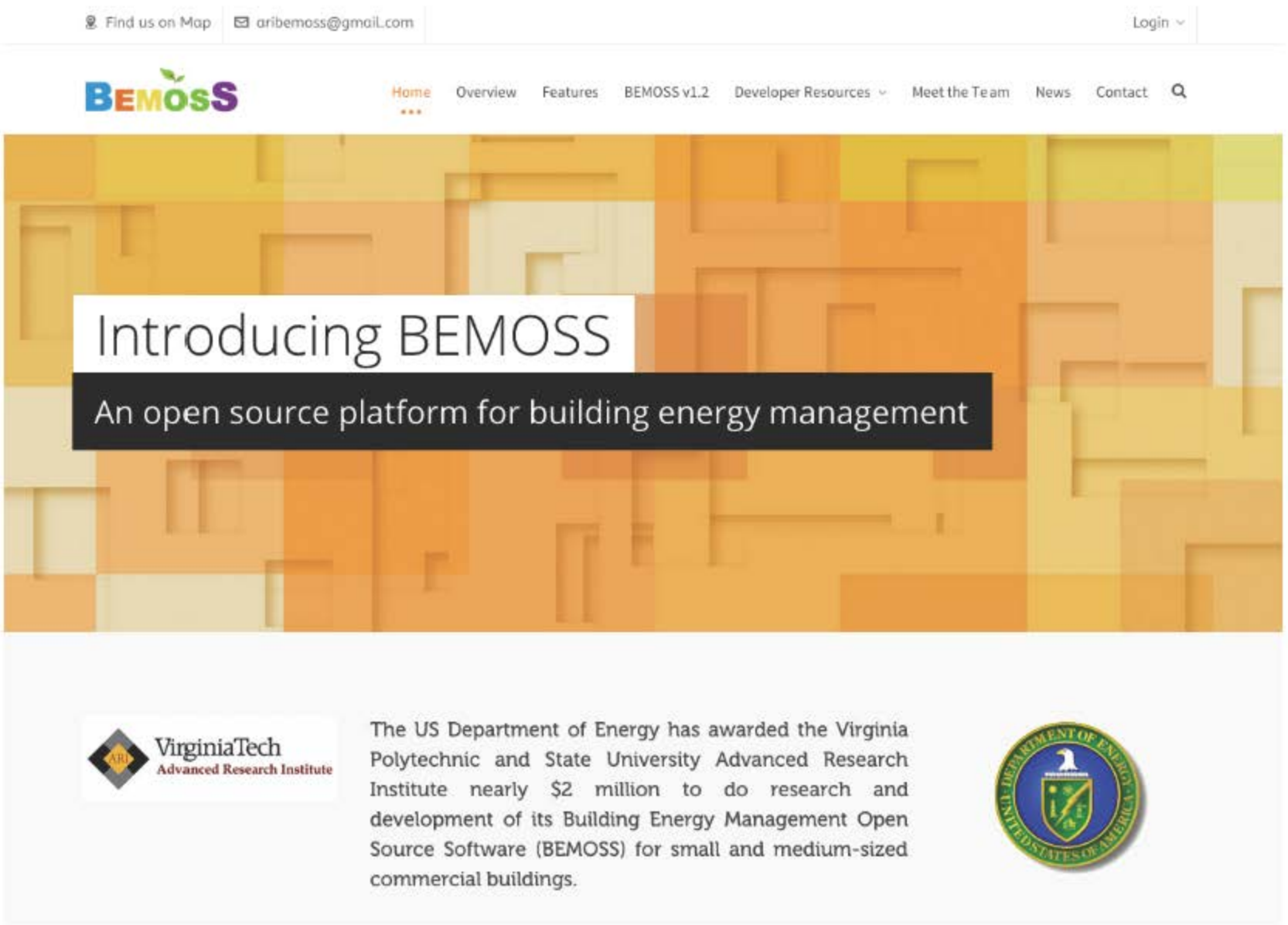
www.BEMOSS.org



BEMOSS Advisory Committee

BEMOSS is developed in consultation with industry

BEMOSS advisory committee has representatives from 21 organizations:

BEMOSS is Built upon Open-Source Software

VOLTTRON™ was used as a platform to host our BEMOSS solution. It is open-source and not hardware specific.

Linux

ubuntu

Other software used:

python

C++

jQuery
write less, do more.

JavaScript

PostgreSQL

django

Bootstrap

ZeroMQ

Cassandra

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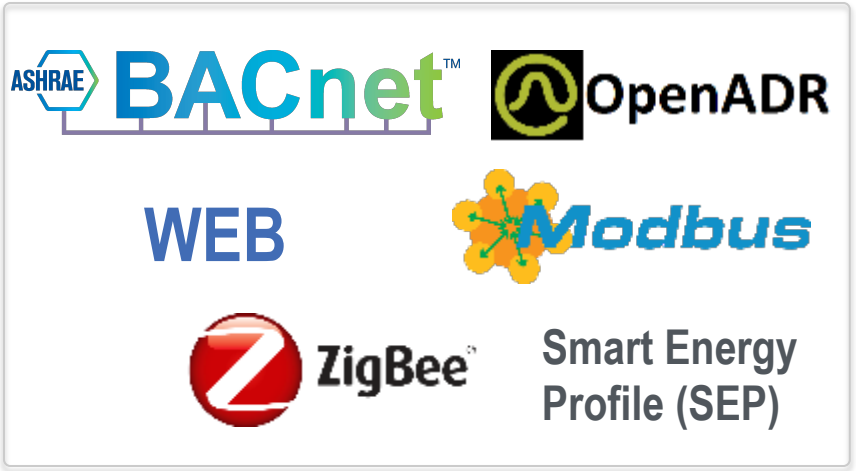
BEMOSS Interoperability

Communication Technologies

- ❑ Ethernet (IEEE 802.3)
- ❑ Serial Interface (RS-485)
- ❑ ZigBee (IEEE 802.15.4)
- ❑ WiFi (IEEE 802.11)

Data Exchange Protocols

- ❑ BACnet (IP and MS/TP)
- ❑ Modbus (RTU and TCP)
- ❑ Web (e.g., XML, JSON, RSS/Atom)
- ❑ ZigBee API
- ❑ Smart Energy (SE)
- ❑ OpenADR (Open Automated Demand Response)

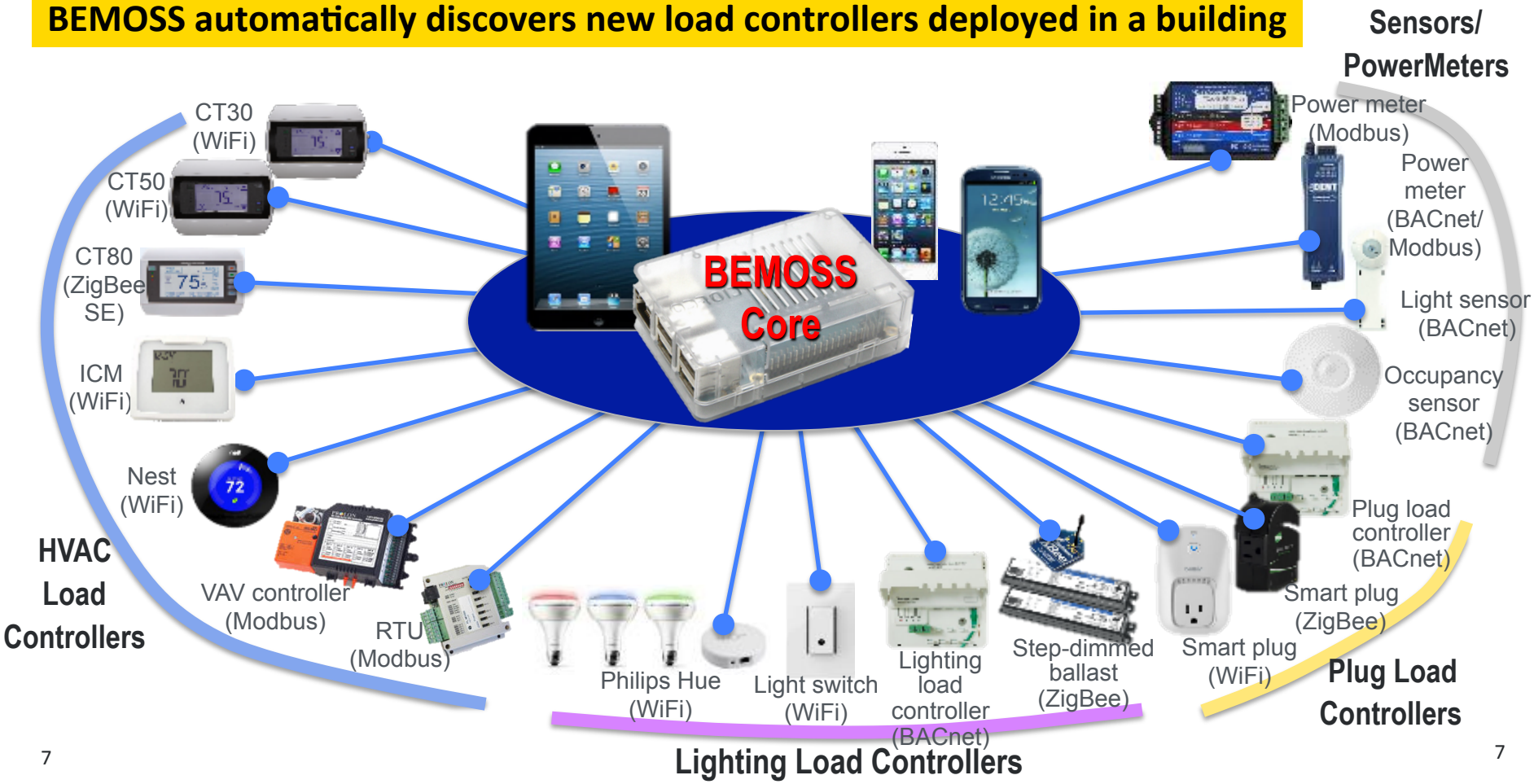


BEMOSS Plug & Play

With BEMOSS discovery agent, we know:

- The device is present in the building.
- Device model number, e.g., 3M-50.
- What the device can do, e.g., monitor temperature and adjust set point.

BEMOSS automatically discovers new load controllers deployed in a building



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BEMOSS on Various Embedded Devices

beagleboard

CPU:	**1GHz ARM**
RAM:	**512MB SD**
Ethernet:	10/100 RJ45
USB 2.0:	Available
Price:	**$55**
Size:	3.4”x2.1”

Raspberry Pi 2
Model B | 1GB RAM

CPU:	**900Mhz A7**
RAM:	**1 GB**
Ethernet:	10/100 RJ45
USB 2.0:	4 ports
Price:	**$35**
Size:	3.3”x2.2”

ODROID Hardkernel
U3

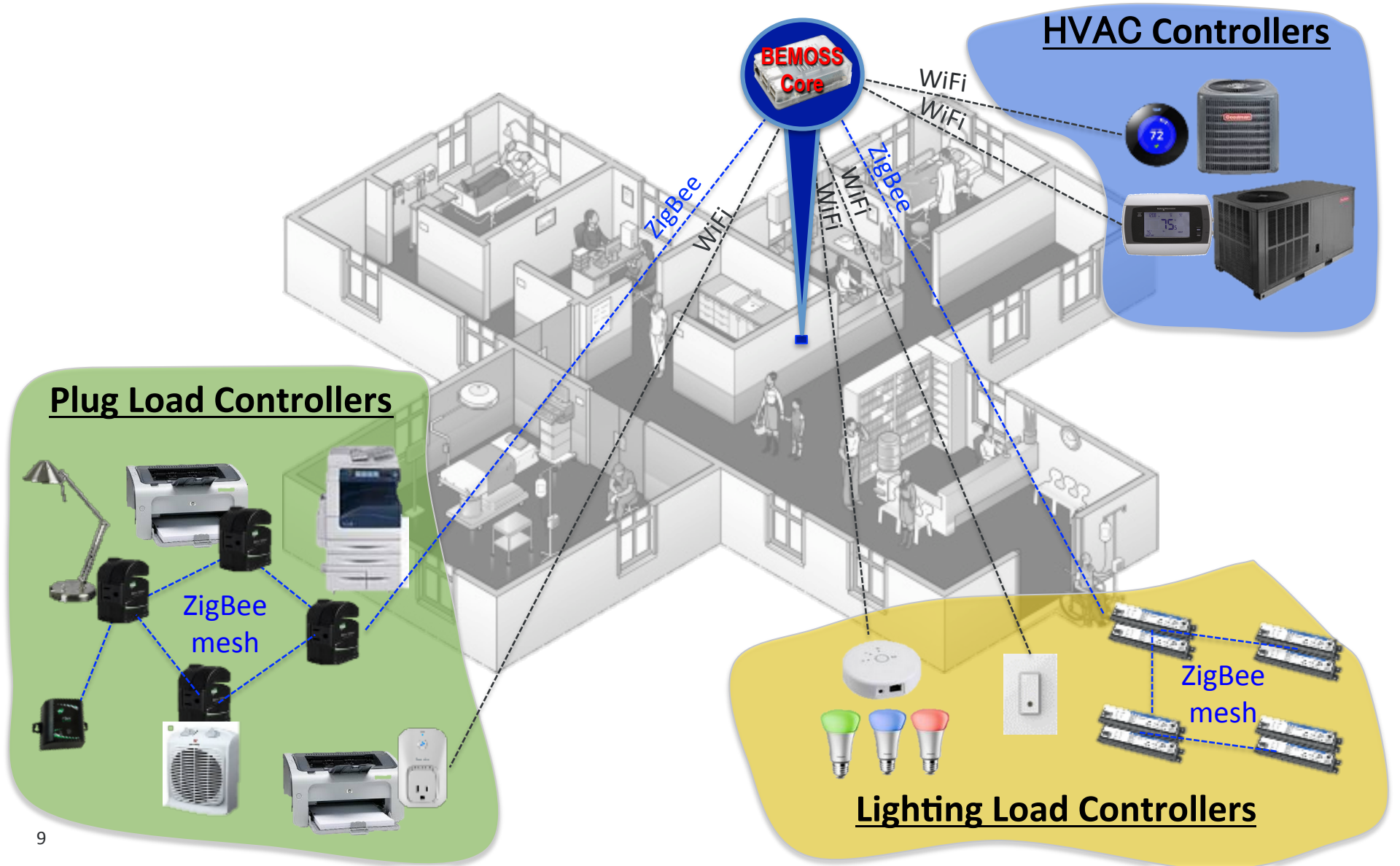
CPU:	**1.7 GHz**
RAM:	**2 GB**
Ethernet:	10/100 RJ45
USB 2.0:	3 ports
Price:	**$69**
Size:	3.3”x1.8”

pandaboard

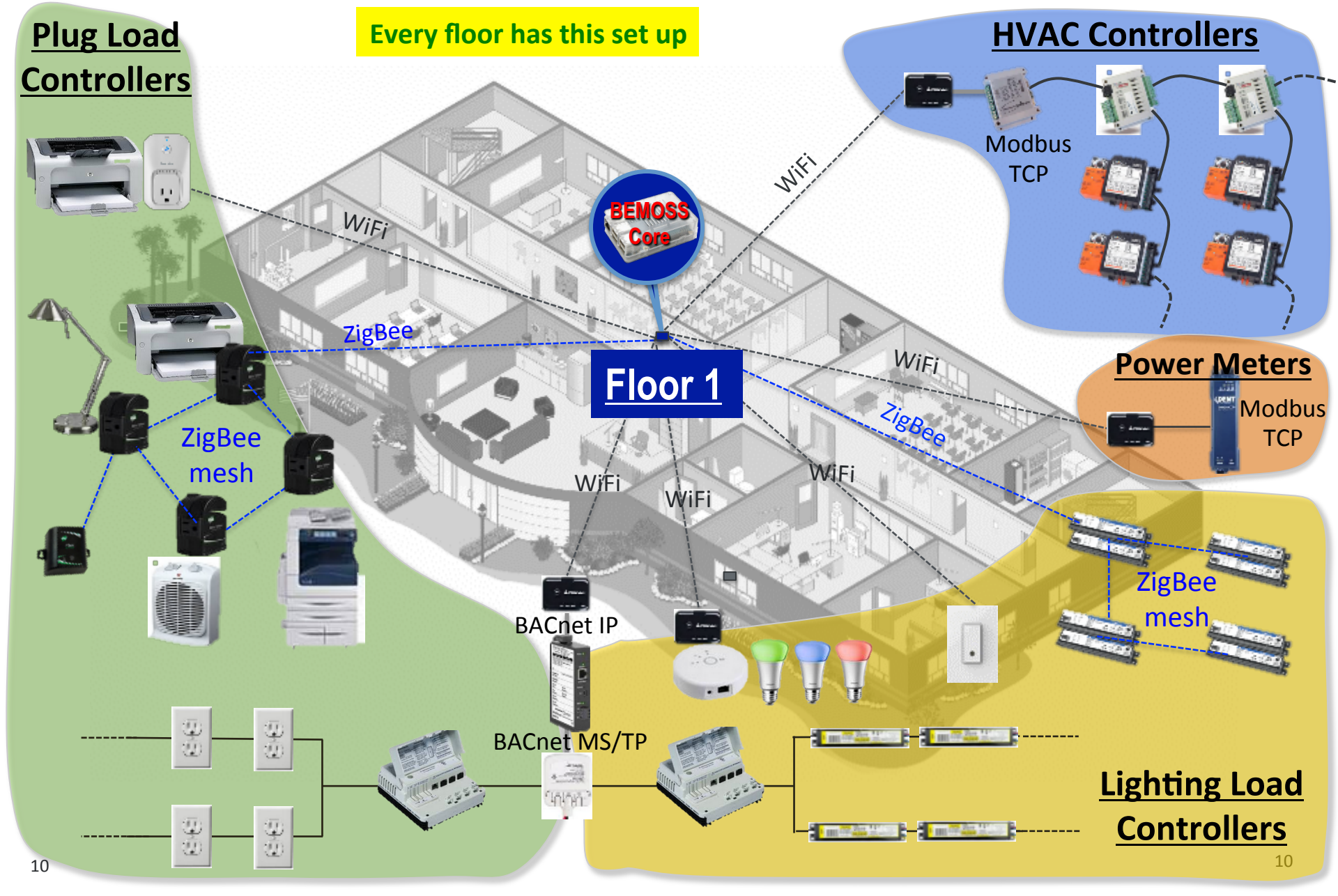
CPU:	**1.2 GHz**
RAM:	**1 GB**
Ethernet:	10/100 RJ45
USB 2.0:	2 ports
Price:	**$220**
Size:	4.5”x4.0”

This enables low-cost deployment, and expandability.

BEMOSS: Solutions for Small Buildings



BEMOSS Scalability



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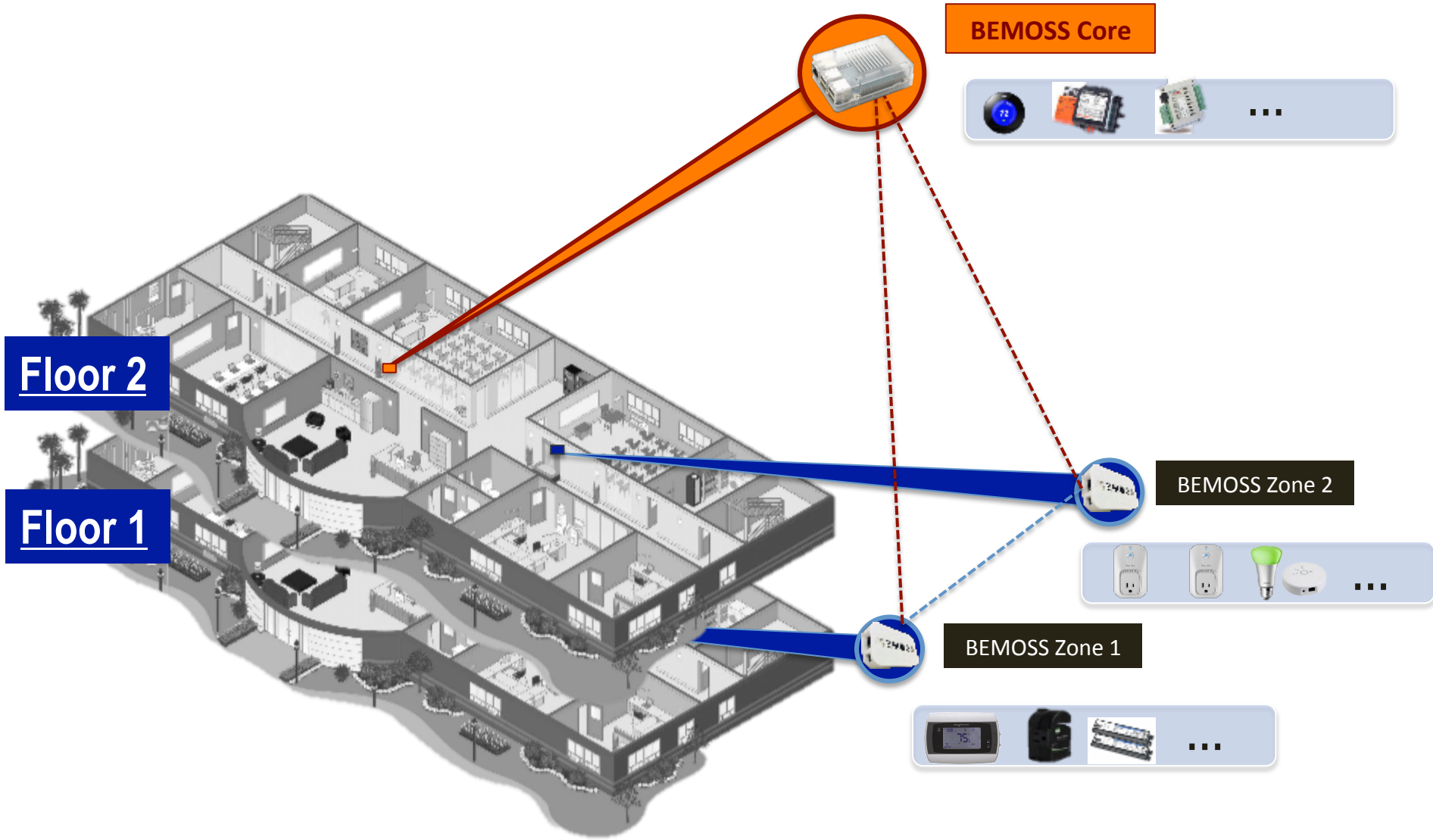
BEMOSS Scalability: Solutions for Larger Buildings



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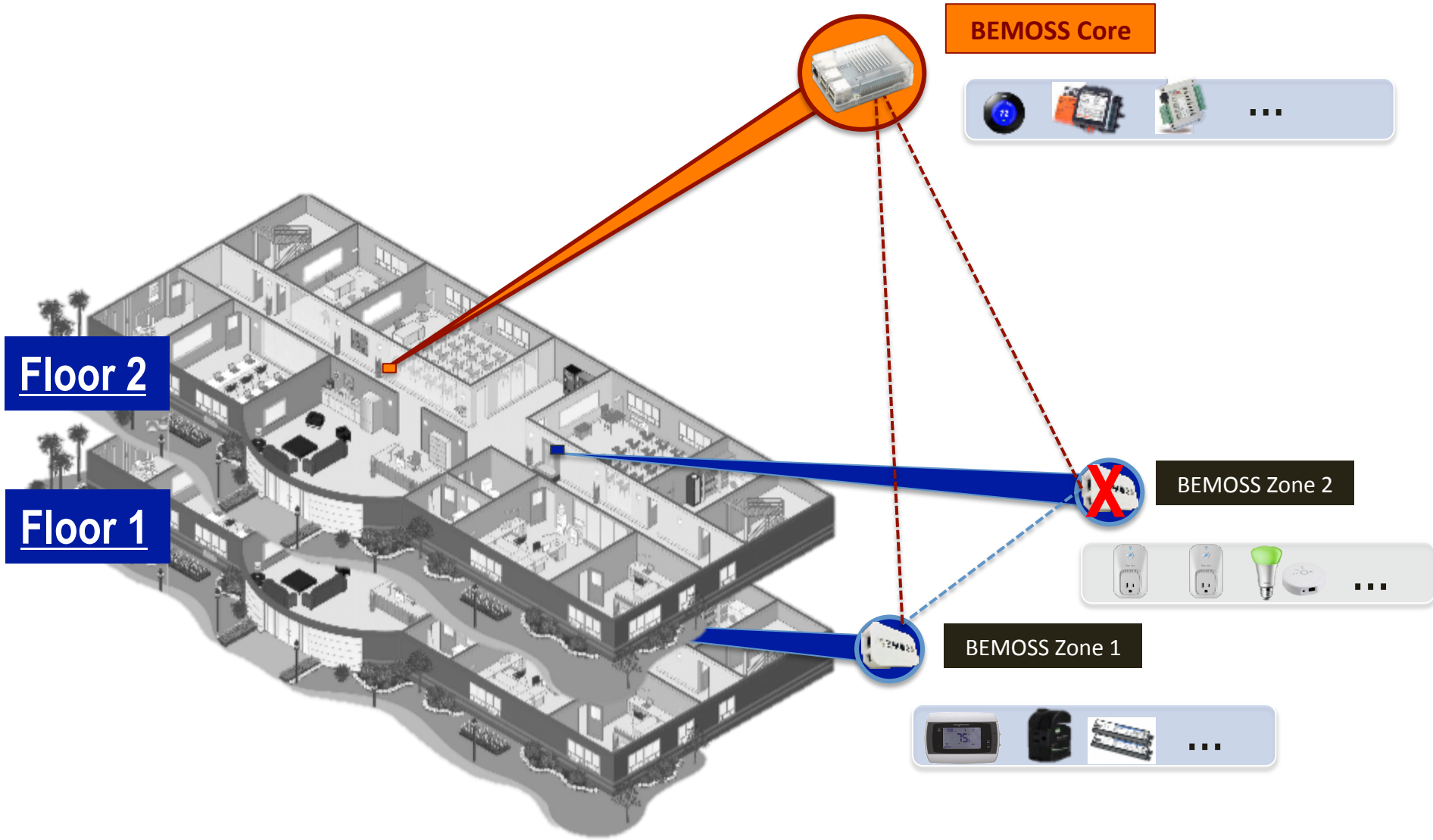
BEMOSS Scalability: Solutions for Larger Buildings



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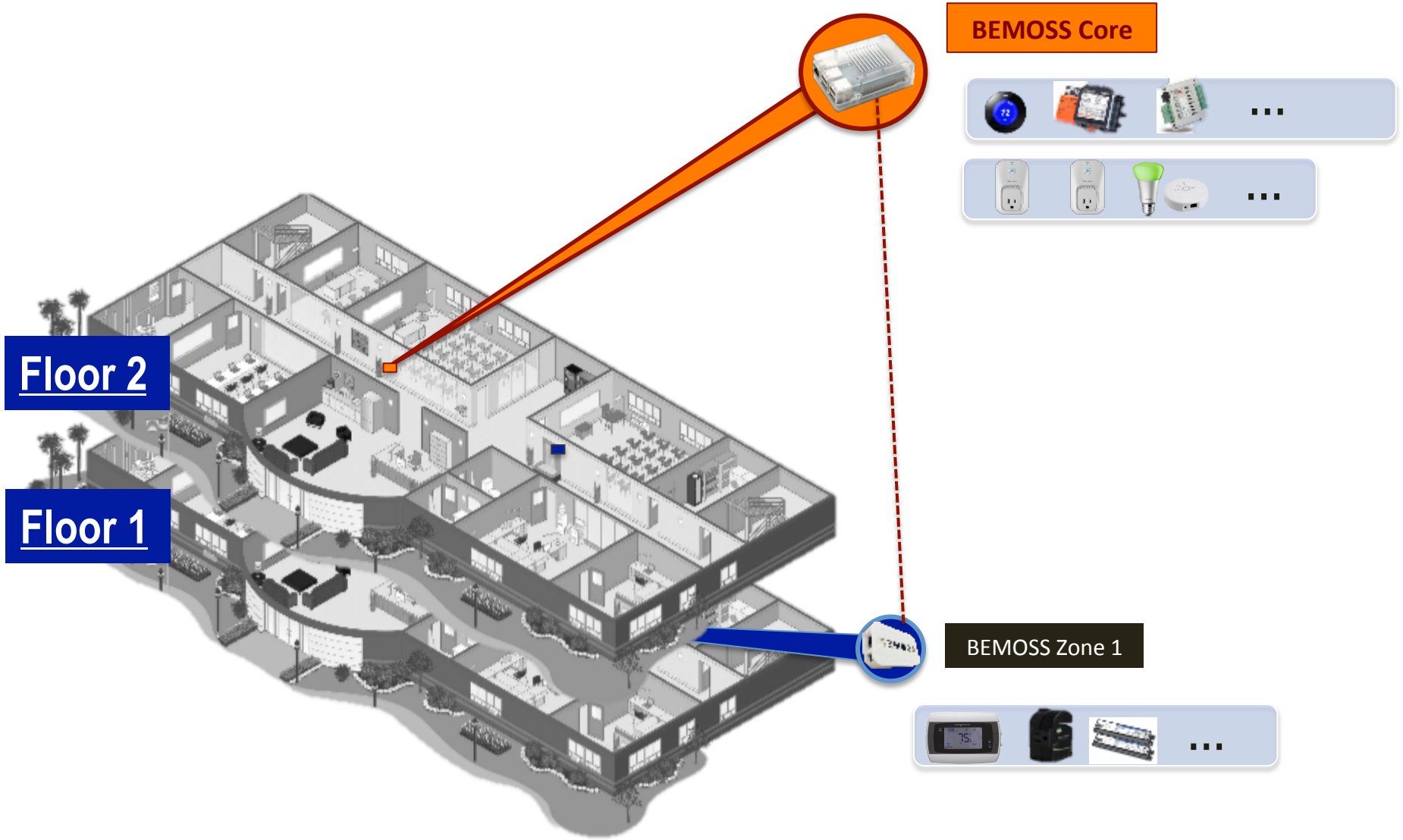
BEMOSS Scalability: Solutions for Larger Buildings



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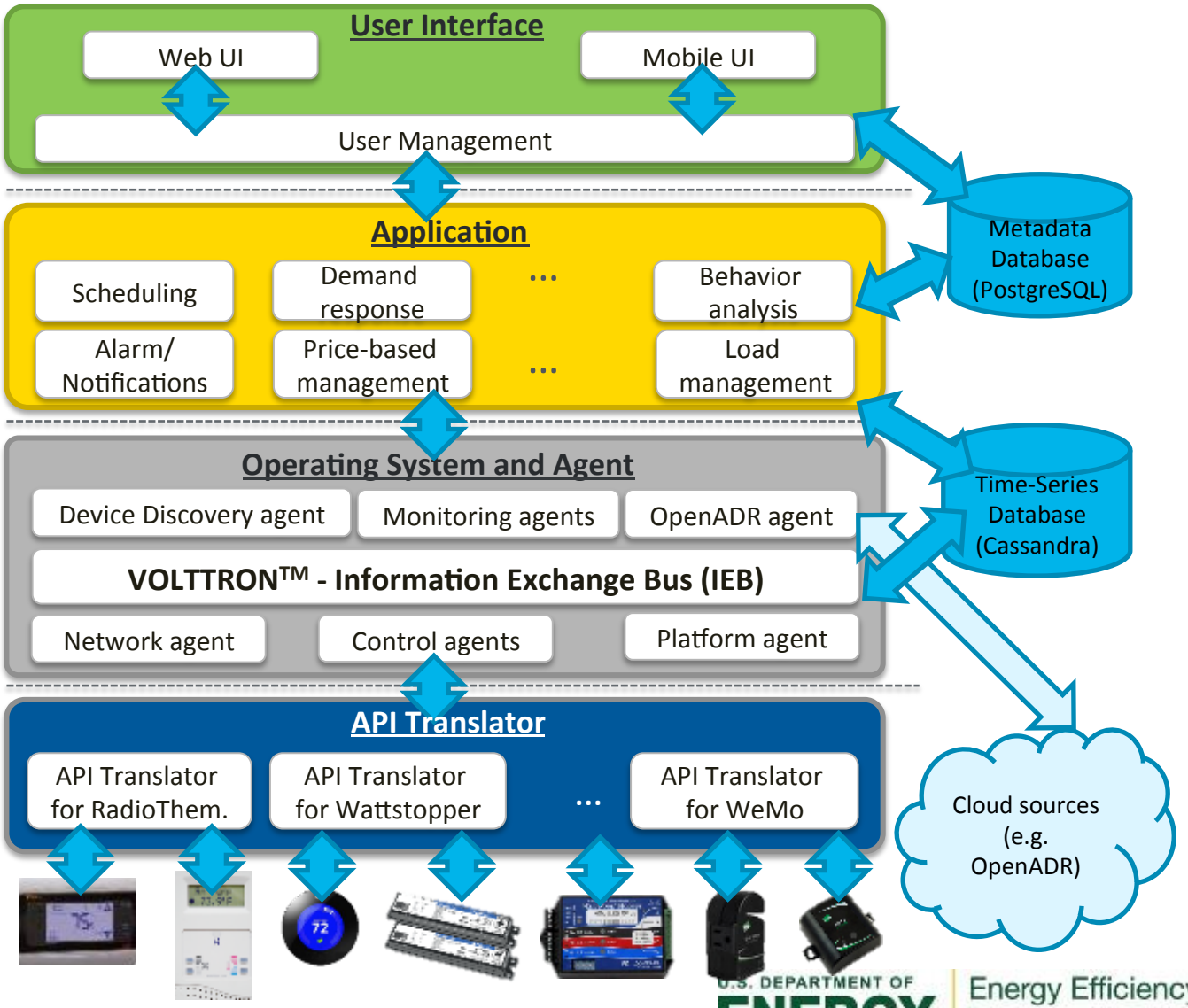
BEMOSS Software Architecture



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Living Laboratory

1021 Prince St.,
Alexandria, VA 22314

Area: 25,000 SF
Energy: 14-25 MWh/mo.
Peak load: 61 kW

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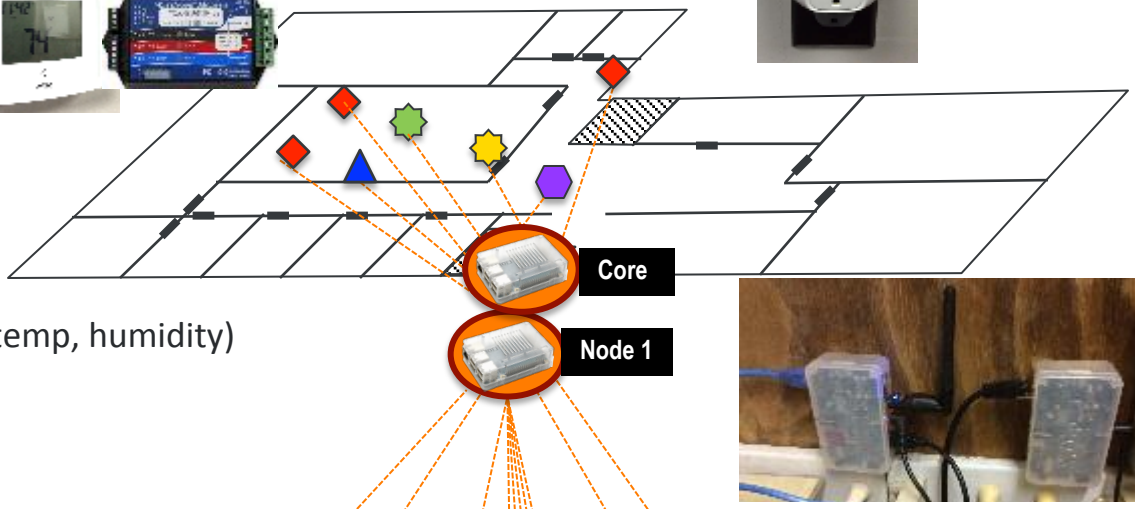
Living Laboratory Setup

- Thermostats (WiFi)
- Plug load controllers (WiFi)
- Motion sensor (WiFi)
- Environment sensor (WiFi)
- Power meter (Modbus)

Floor 3 – Classroom

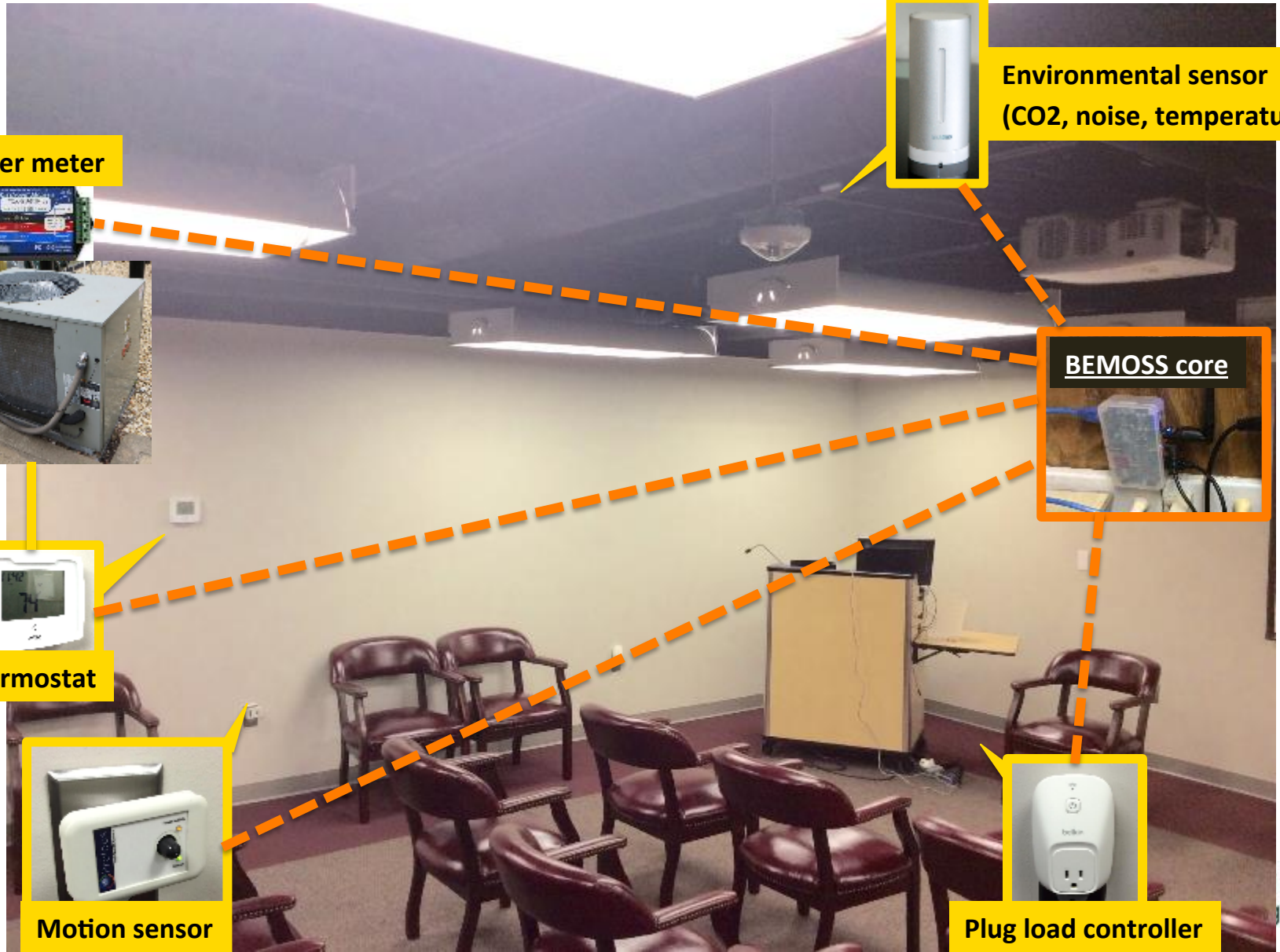
- 1 thermostat
- 3 plug load controllers
- 1 motion sensor
- 1 environment sensor (CO_2, temp, humidity)
- 1 power meter
- BEMOSS core
- BEMOSS node



Floor 2

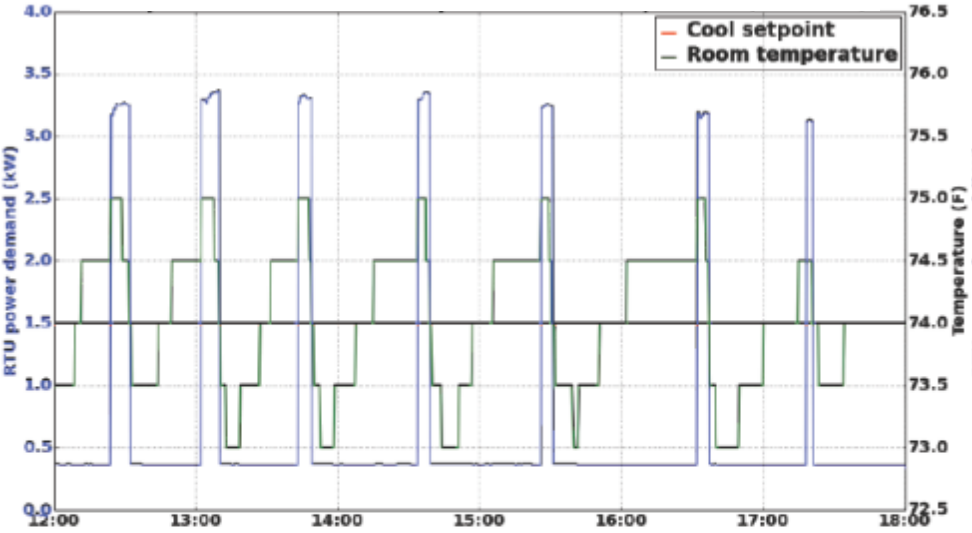
- 5 thermostats
- 5 power meters

Classroom being Monitored by BEMOSS Core

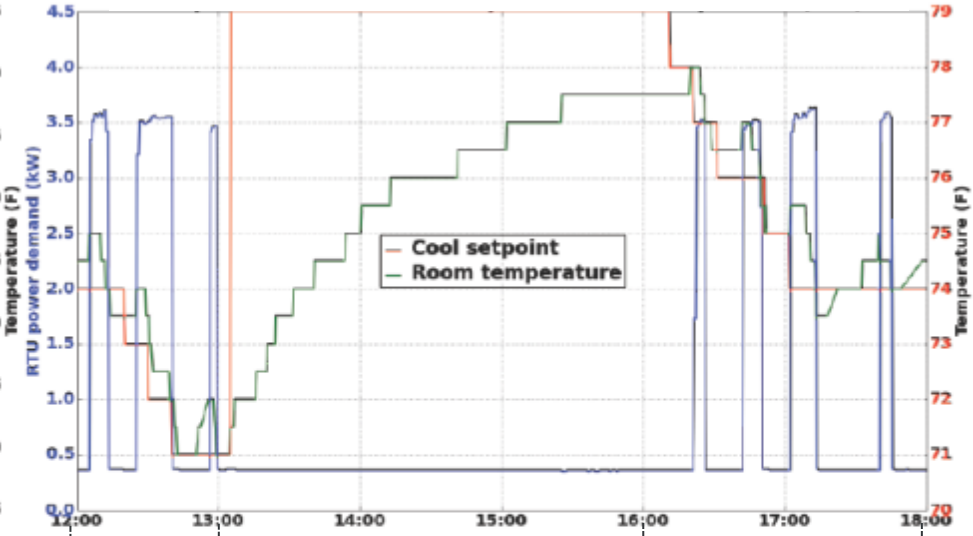


A Simulated CPP event

- RTU power demand (kW), cool set point (°F) and room temperature (°F)



Basecase
- cool set point = 74 F
- energy usage = 2.72 kWh
- max power demand = 3.98 kW



CPP
- max cool set point = 79 F
- energy usage = 1.42 kWh
- max power demand = 0.50 kW

Pre-cooling | CPP event | After CPP

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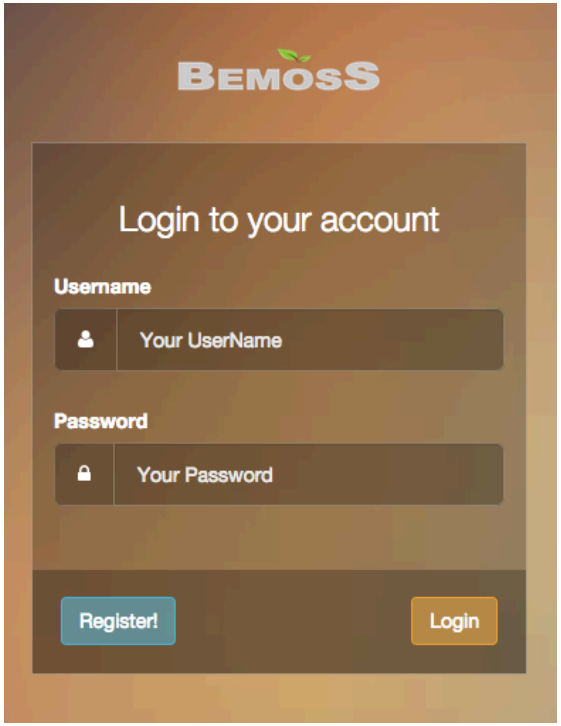
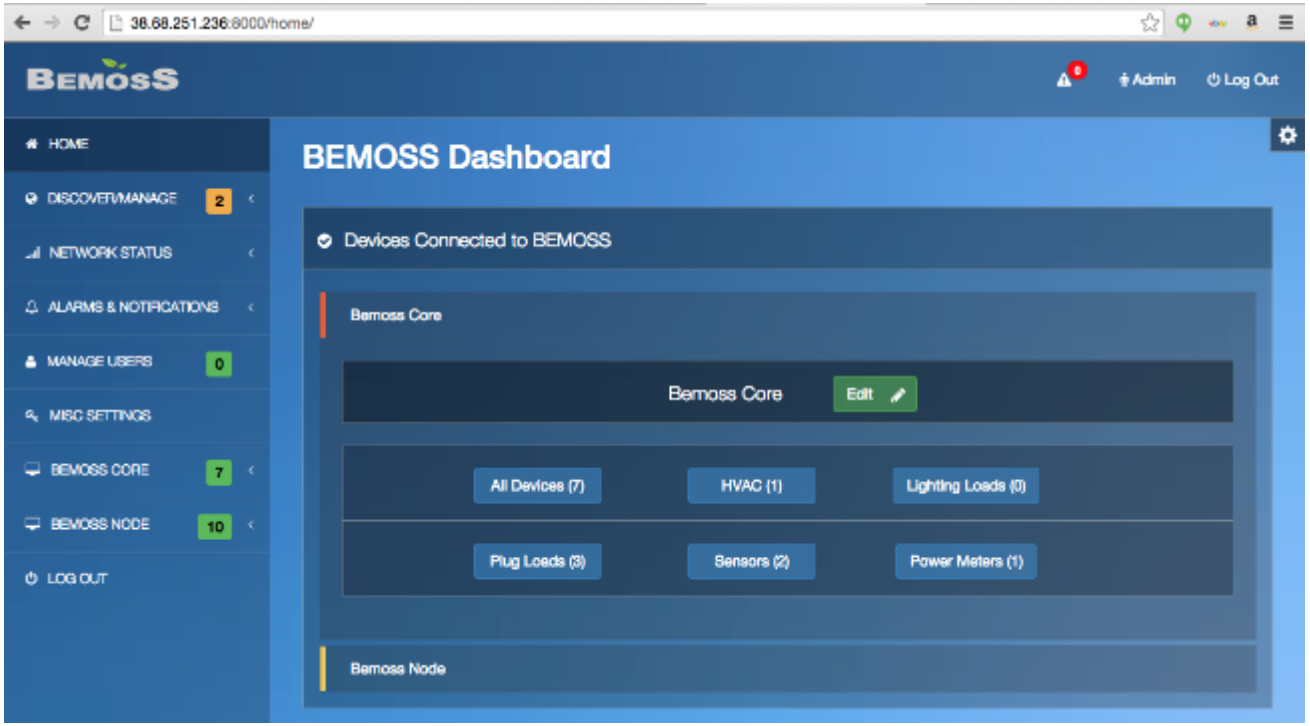
Remote Access

- Each BEMOSS node is connected to the Internet to allow remote access.





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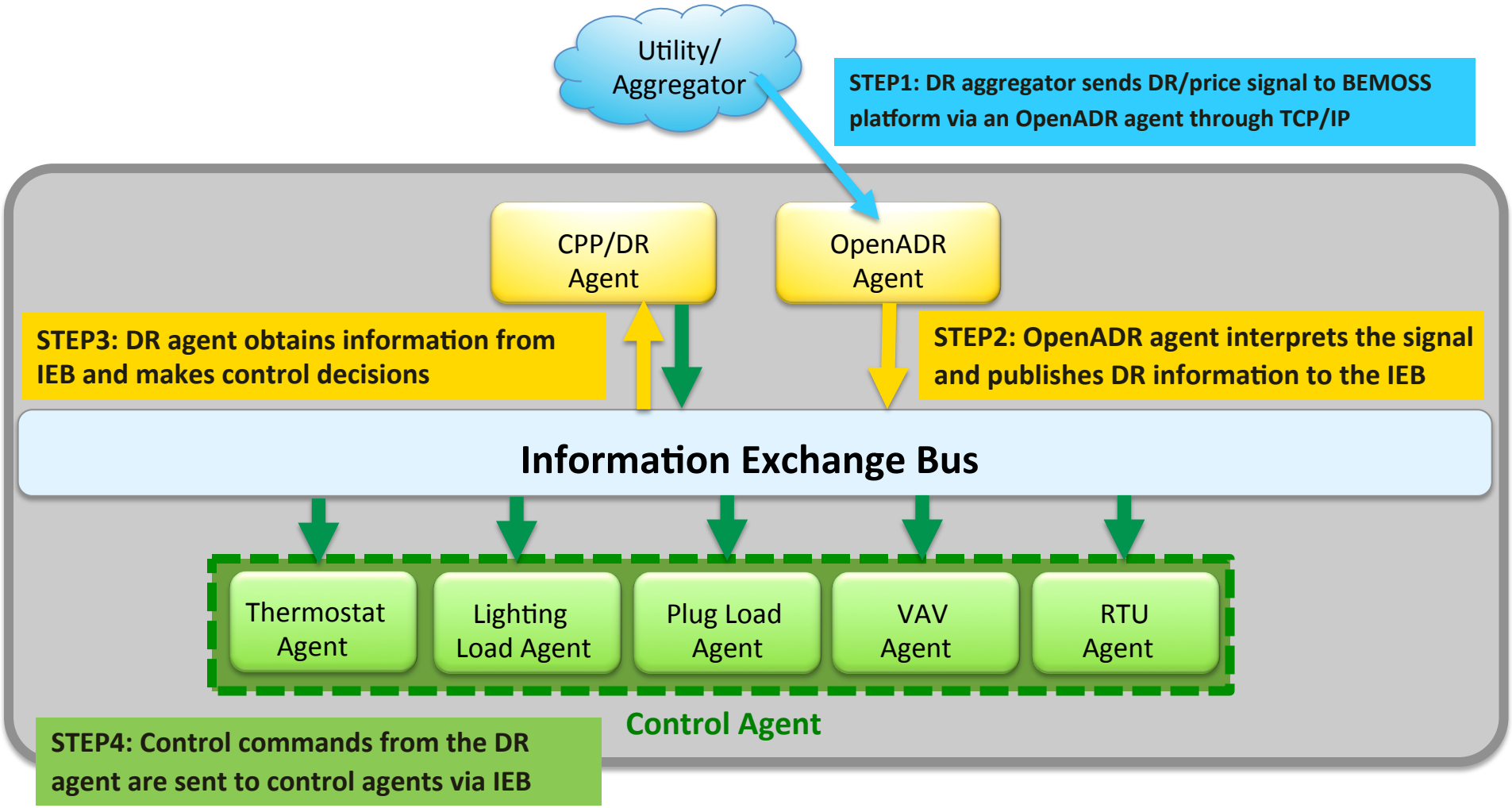
BEMOSS accepts OpenADR signals (CPP or DR)

- BEMOSS can accept simulated OpenADR signals and take actions.



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BEMOSS Security

BEMOSS utilizes built-in security features provided by VOLTTRON™, and provides enhanced security features.

Device Security	Platform Security	UI Security
◆ Rely on existing device security, e.g., SSL, TLS (if available) ◆ Add additional protection: ➢ Tampering checking ➢ Abnormal control behavior checking ➢ Device approval process	◆ Rely on VOLTTRON security: ➢ Agent validation ➢ Agent packaging ➢ Resource management ◆ Add additional protection: ➢ BEMOSS core authorization ➢ BEMOSS node authorization	◆ Role-based access control ◆ Password protected with SHA256 encryption ◆ User input validation ◆ Error handling

Thank You

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