Building Energy Management Open-Source Software (BEMOSS)

2014 Building Technologies Office Peer Review

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

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Project Summary

Timeline:

Start date: November 1, 2013

Planned end date: October 31, 2014

Key Partners:

Arlington County, VA
Danfoss Corporation
Virginia Tech Foundation

Key Milestones

1. First cut of the BEMOSS software – 10/31/2014
2. User interface app – 10/31/2014
3. Functioning plug & play compatible controllers – 10/31/2014

Budget:

Total DOE $ spent to date: $163,454

Total future DOE $: $336,491

Target Market/Audience:

Small- and medium-sized commercial buildings

Project Goal:

To develop the **Building Energy Management Open Source Software (BEMOSS)** platform, along with the user interface for three plug-and-play compatible controllers – one each for HVAC, lighting and plug load control. The BEMOSS platform is expected to improve energy efficiency in buildings and facilitate demand response implementation.

Purpose and Objectives

- Buildings consume over 40% of the total energy consumption in the U.S. Over 90% of the buildings in the U.S. are either small-sized (<5,000 square feet) or medium-sized (between 5,000 sf and 50,000 sf). These buildings typically do not use Building Automation Systems (BAS) to monitor and control their building systems from a central location.

- **BEMOSS platform** will facilitate load management capability through a very simple and scalable BAS, and therefore offer energy savings on a day-to-day basis. It can also facilitate Demand Response (DR) when needed.

Solution Approaches

Local solution: Develop low-level code to directly communicate with local controllers.

- Extra hardware needed to provide communication capability.
- End-user is tied to the hardware for which the low level code was developed.

More generic solution: Volttron was used. It is open-source and not hardware specific. It can easily be scaled to sense and control a large number of devices.

Linux

ubuntu

Volttron Features:

- Open-source platform
- Built-in security module
- Built-in resource management capability
- Distributed and decentralized control based on a multi-agent system
- Can be installed in a low-cost, low-power embedded system

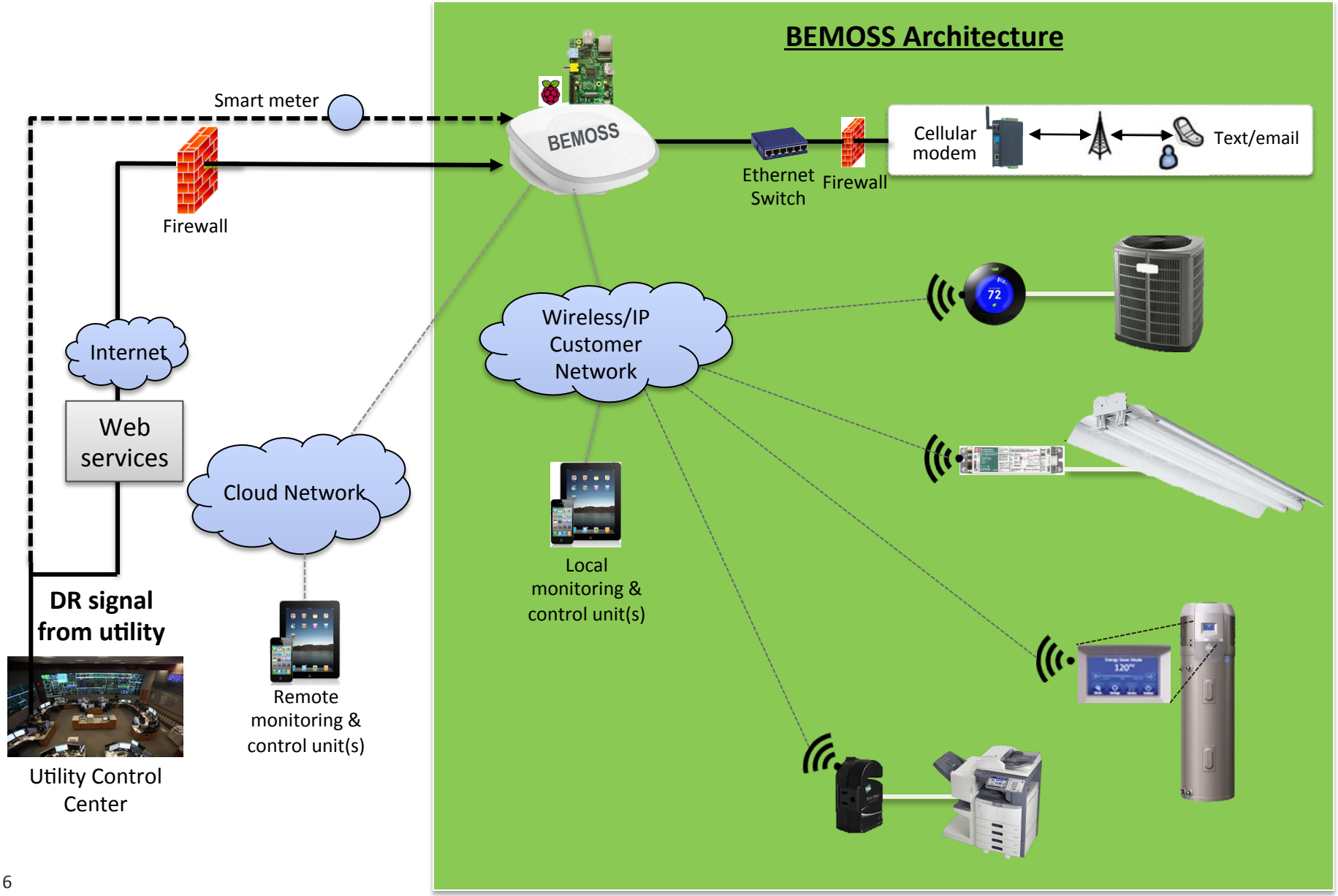
Approach

- **Task 1:** BEMOSS open source software development in consultation with Industry
- **Task 2:** BEMOSS user interface and software tool design
- **Task 3:** Plug & play device integration

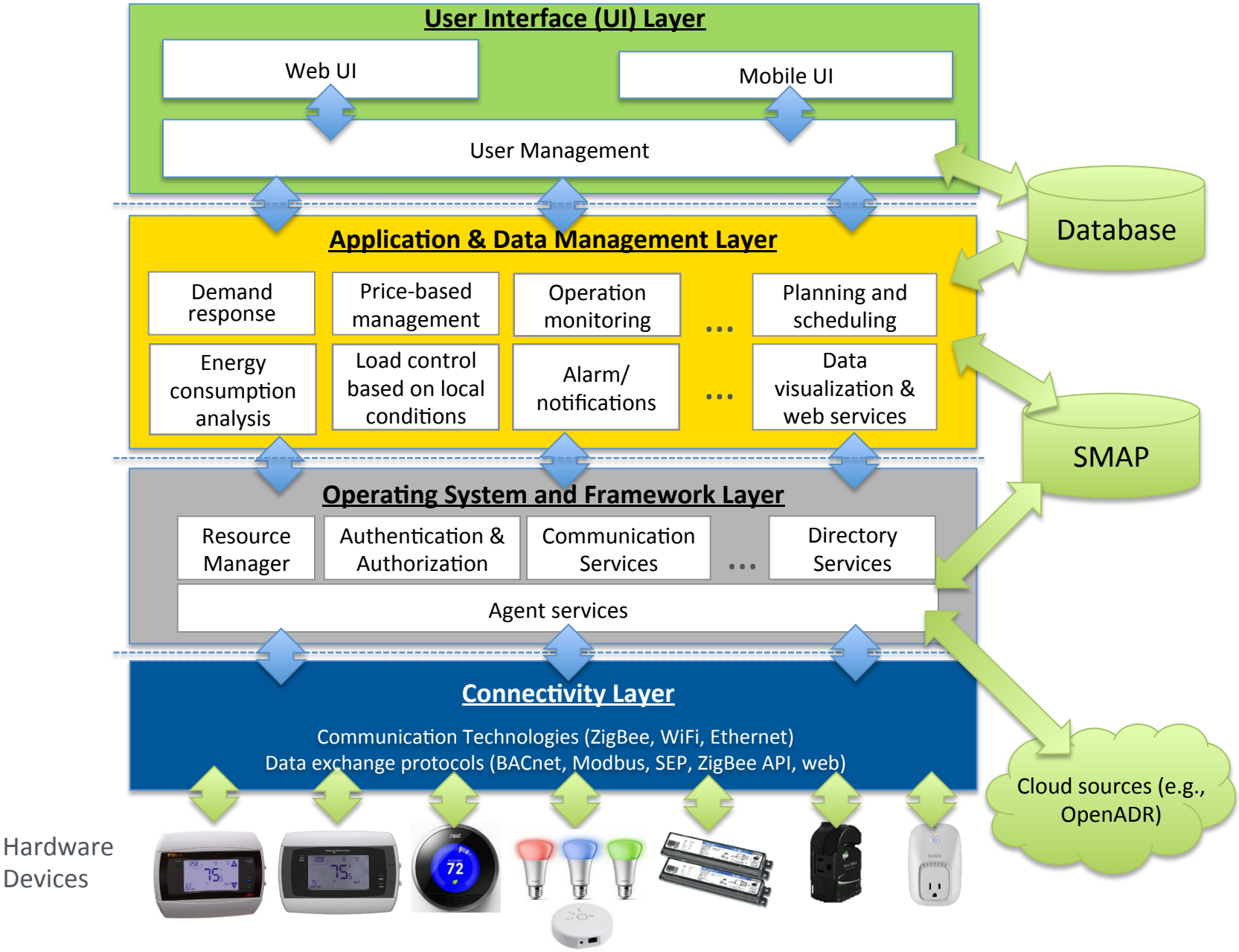
Distinctive Characteristics:

- Discovering and controlling device controllers without any user inputs

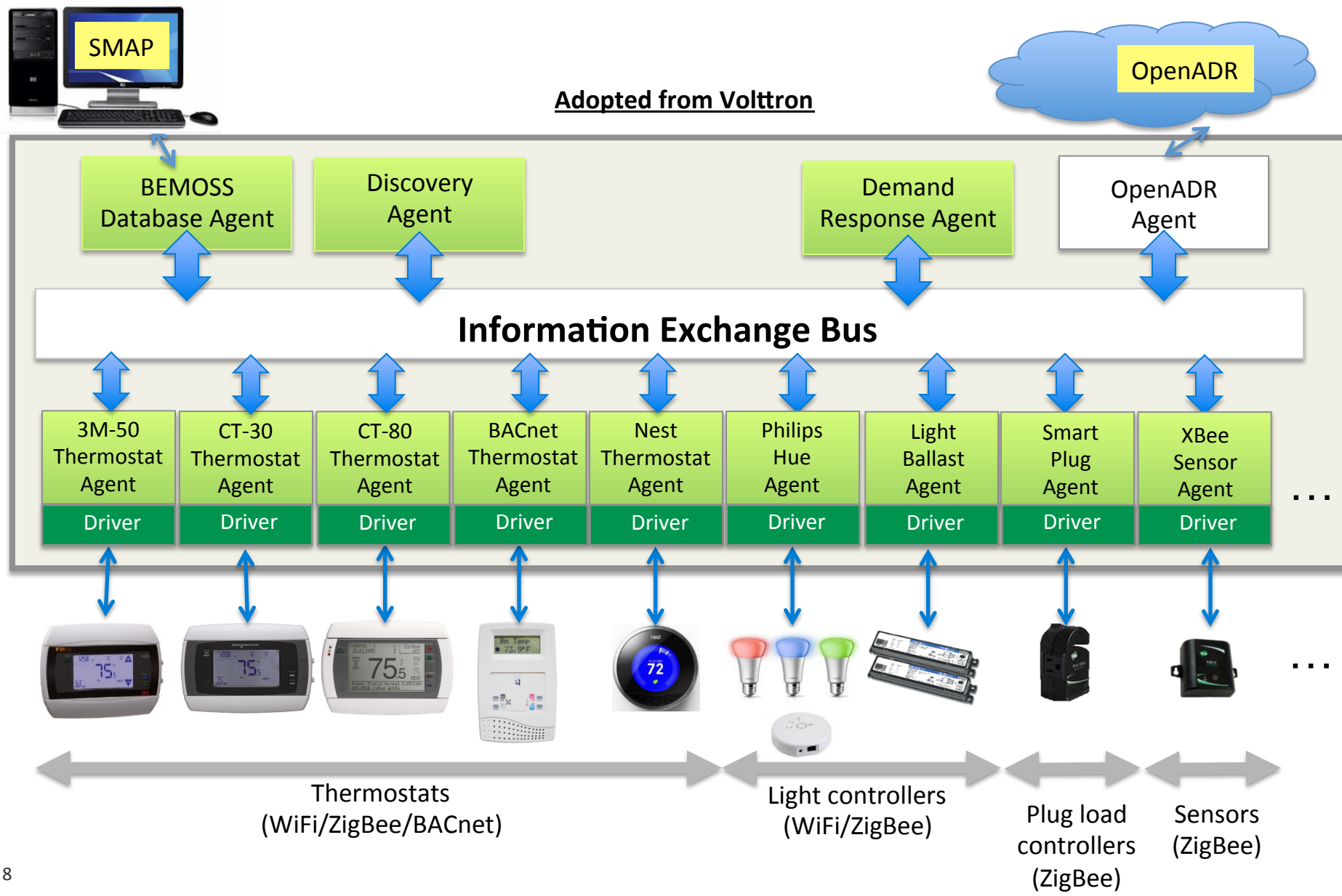
BEMOSS: Fundamental Building Block



BEMOSS Software Architecture



BEMOSS Agent



BEMOSS Security

Existing Security Features in Volttron:

- ❑ Agent authentication
- ❑ Agent authorization
- ❑ Protection of data carried or produced by agents

Additional Security Features to be Developed:

- ❑ Information exchange platform security
- ❑ Database security
- ❑ User interface/web application security

Technologies and Protocols Supported by BEMOSS

Communication Technologies

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

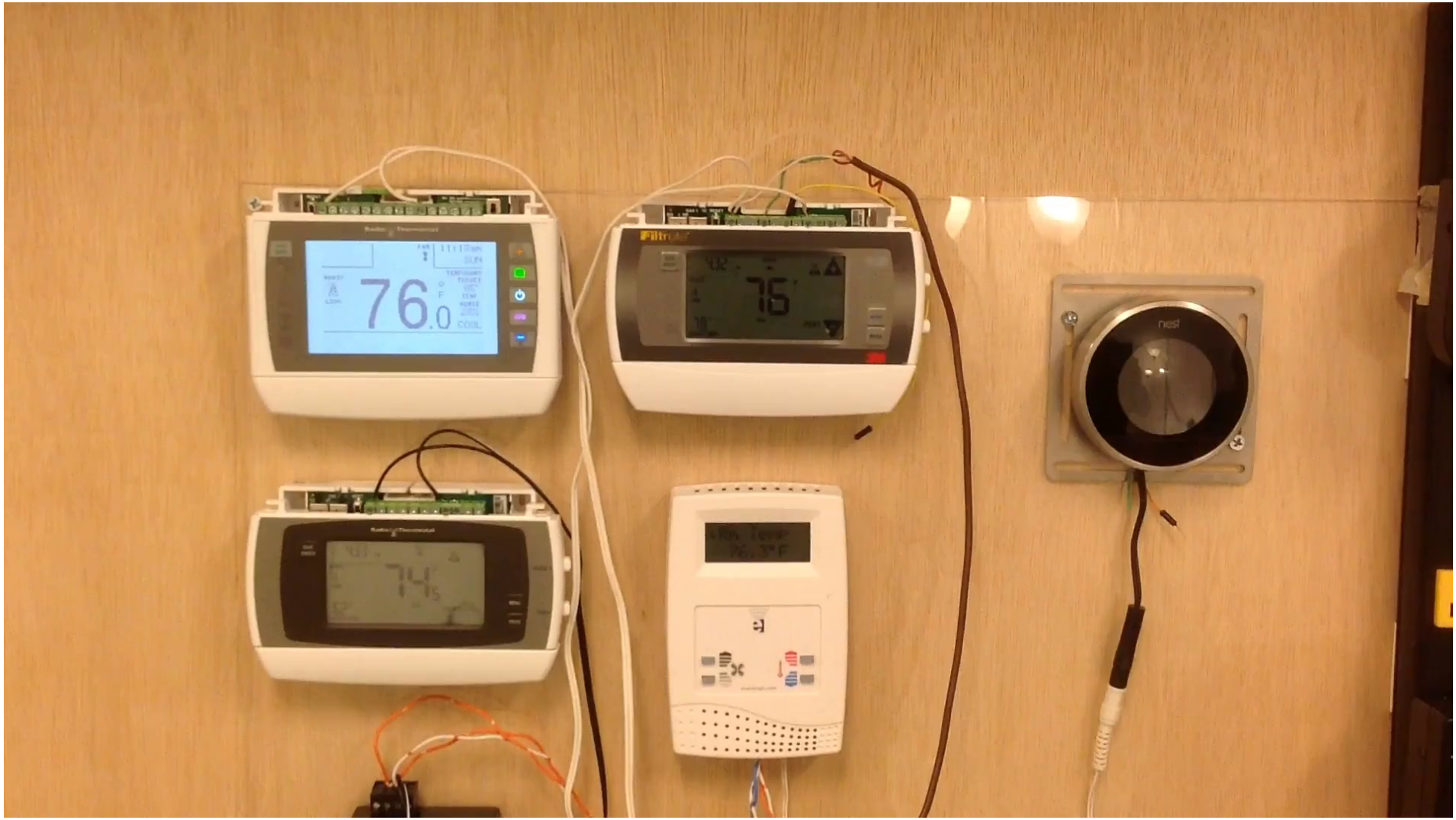
Data Exchange Protocols

- ❑ BACnet (IP and MS/TP)
- ❑ Modbus (RTU and TCP)
- ❑ Web (e.g., XML, JSON, RSS/Atom)
- ❑ ZigBee API
- ❑ Smart Energy Profile (SEP)
- ❑ OpenADR

Key BEMOSS Features

- **Open source** – Volttron, Linux Ubuntu, contribution by developers
- **Plug & play** – Automatically discovers commercially available smart thermostats, lighting controllers and plug load controllers in commercial buildings
- **Interoperability** – Support popular communication technologies and data exchange protocols
- **Scalability** – Distributed architecture with agent technologies
- **User interface** – Web UI and mobile UI
- **Security** – Incorporate security features
- **Industry involvement** – BEMOSS advisory committee

Device Discovery and Control



Project Integration and Collaboration

Project Integration:

The BEMOSS advisory committee with 15 individuals from government and Industry has been established. The advisory committee members meet face-to-face on a quarterly basis with additional email exchanges based on work at hand.

Partners, Subcontractors, and Collaborators:

Partner	Role
Arlington County	Offers access to Long Branch Nature Center for energy consumption data
Danfoss Corp.	Supports in modeling the performance of HVAC units under different operating conditions
VT Foundation	Offers access to buildings in Alexandria and Blacksburg, VA for BEMOSS demonstration

Communications:

- ❑ "Conceptual architecture of Building Energy Management Open Source Platform (BEMOSS)," submitted to ISGT Europe 2014.
- ❑ "Open-source approaches to building energy management," seminar by Prof. Saifur Rahman at the Rutgers University Center for Green Buildings, NJ, Feb 10, 2014.

Progress and Accomplishments

Lessons Learned:

- ❑ As many smart devices, together with associated APIs, are becoming available in the market, our BEMOSS platform will provide the space for application developers and device manufacturers to integrate building load controllers with smart devices for remote and automated monitoring and control.

Accomplishments: From the start of the project in Nov 2013, the following tasks have been carried out:

- ❑ Establish BEMOSS advisory board
- ❑ Design preliminary BEMOSS software architecture
- ❑ Develop BEMOSS open source software (on-going)
- ❑ Design user interface (on-going)
- ❑ Perform hardware selection/evaluation (on-going)
- ❑ Interface selected load controllers with BEMOSS (on-going)

Market Impact:

- ❑ Software/hardware under development

Project Impact

Improve energy efficiency and help **implement load management** in small- and medium-sized commercial buildings.

- **Project endpoint:** Open-source software platform that allows automatic discovery and control of HVAC, lighting and plug load devices

- **Expected achievements after Year 1:**
  - ❑ Successful operation of HVAC, lighting and plug load devices in a simulated environment
  - ❑ Successful integration of all three hardware controller interfaces with BEMOSS
  - ❑ Software apps that display sufficient maturity to allow testing BEMOSS functionality
  - ❑ Plug & play capable hardware controller interface

Next Steps and Future Plans

- ❑ Continue the development of BEMOSS open source software
- ❑ Continue user interface design
- ❑ Interface selected load controllers with BEMOSS
- ❑ Perform user acceptance and software tool evaluation
- ❑ Deploy BEMOSS in a living laboratory
- ❑ Online repository for software developers