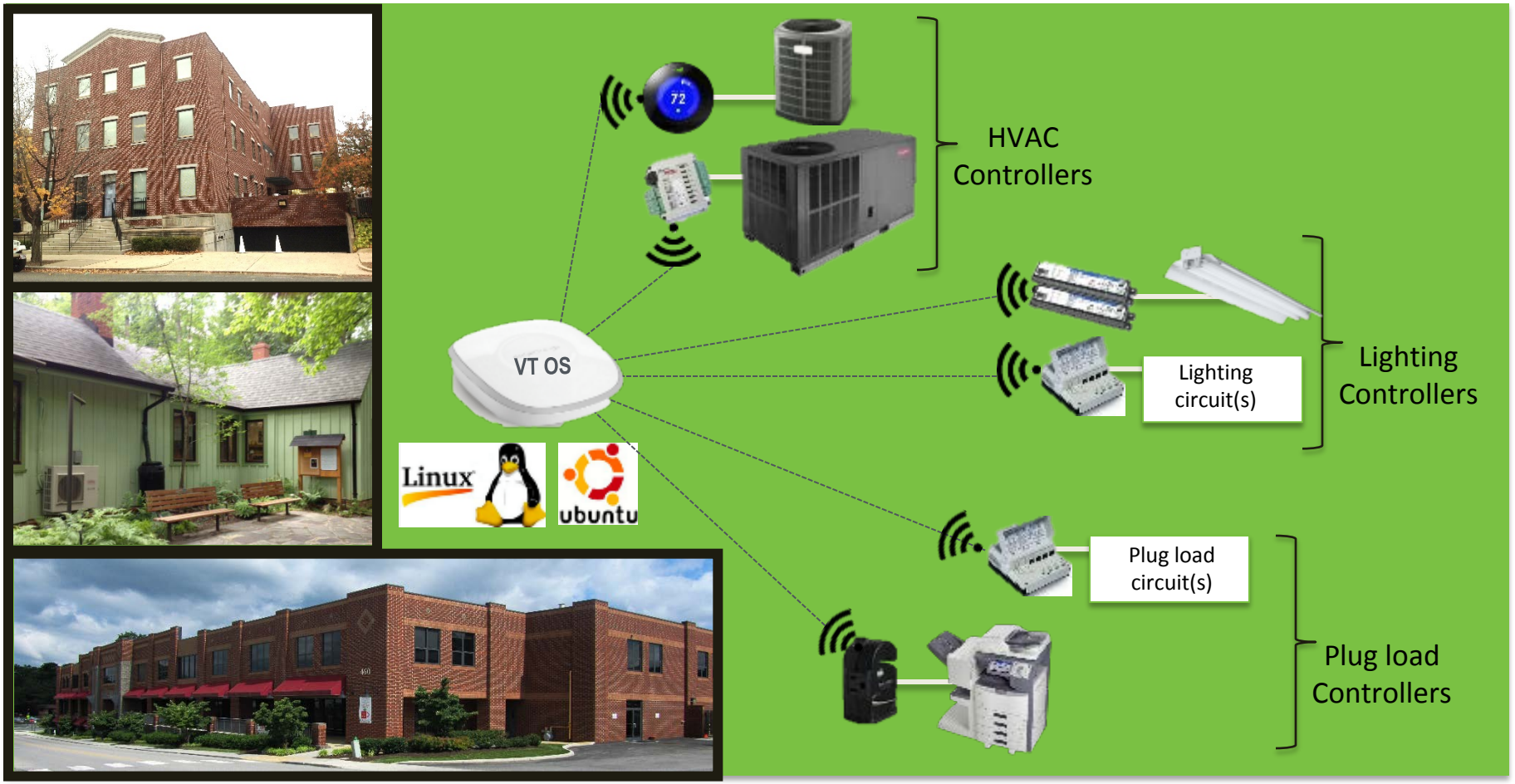
VOLTTRON™ as an Open Source Platform for Energy Management Applications



July 23, 2014

Software Framework for Transactive Energy
Case Western Reserve University
Cleveland, OH

Saifur Rahman
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Virginia Tech

History

May 2013 — Attended AAMAS conference 2013 in MN, which had a VOLTTRON™ demonstration

July 2013 — Visited PNNL and was formally introduced to VOLTTRON™

Aug 2013 — Started VOLTTRON™ installation for home energy management research

Sept 2013 — Started discussion with PNNL regarding VOLTTRON™ issues and applications

Oct 2013 — Started participating in VOLTTRON™ twice-monthly calls

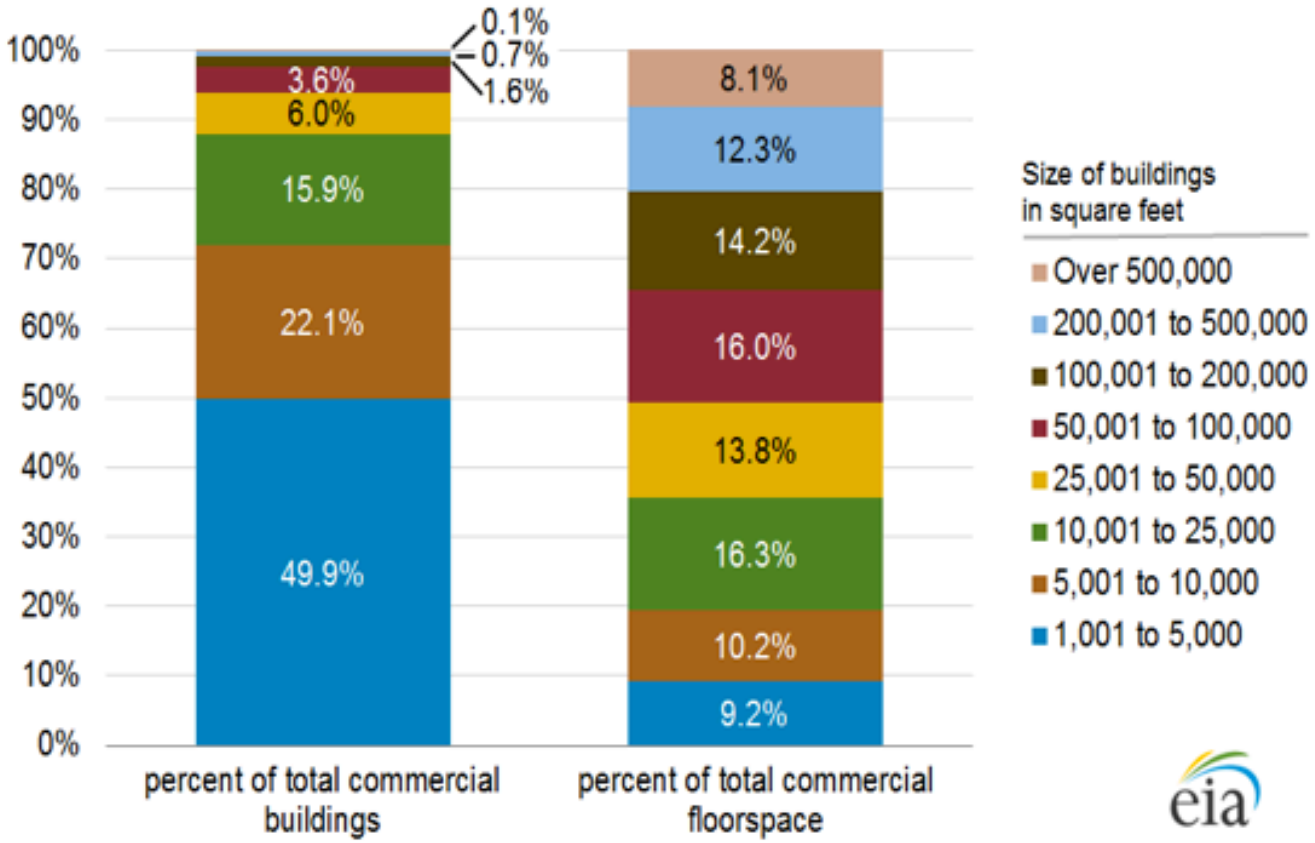
In-house agent development

May 2014 — Submitted a conference paper using VOLTTRON™ as an energy management platform for buildings (ISGT 2014 Turkey)

Today — Have a working energy management platform developed on VOLTTRON™

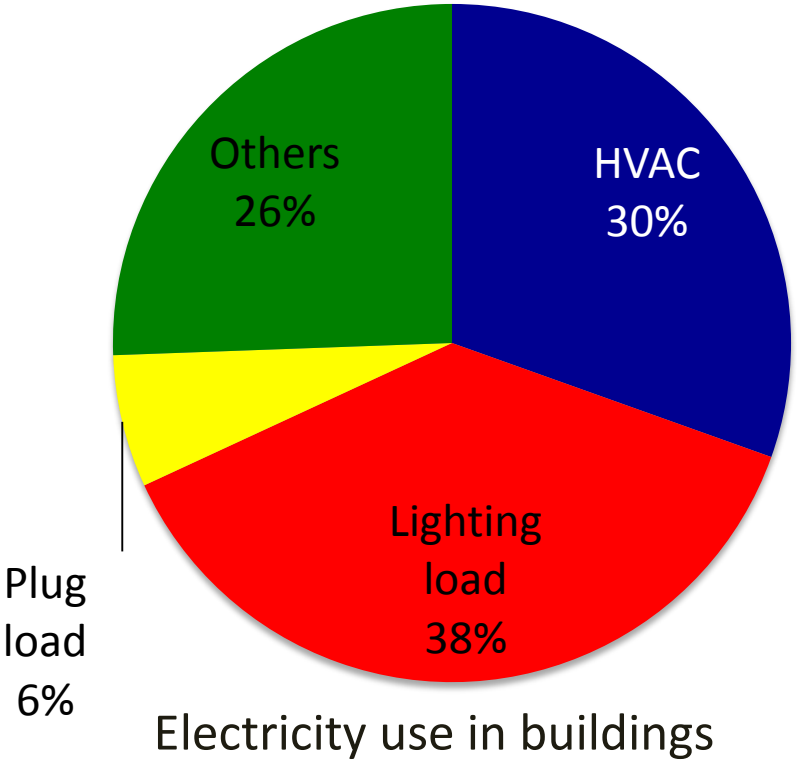
Problem Statement

- 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.



Virginia Tech Focus

Develop an open source, low cost, low power consumption platform that can monitor and control majority of loads in buildings to **improve energy efficiency** and **facilitate demand response** implementation.



Electricity use in buildings

Three major loads in buildings:

- HVAC
- Lighting loads
- Plug loads

Source: EIA - Commercial Building Energy Consumption Survey (CBECS)
http://www.eia.gov/consumption/commercial/data/2003/index.cfm?view=consumption#e1a

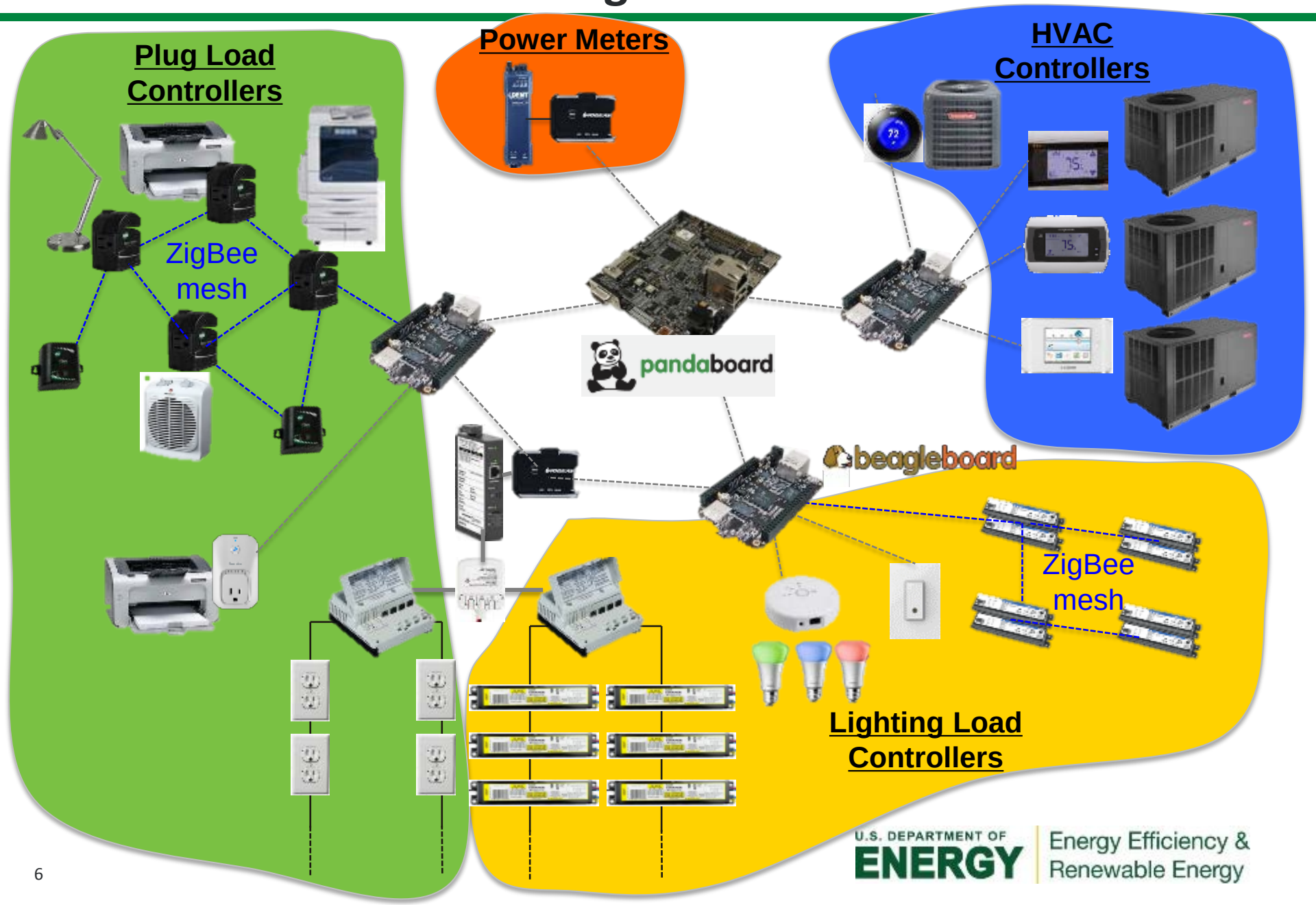
Solution Approach

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

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
- Sensitive to CA Title 24 requirements

Solutions for Small Buildings



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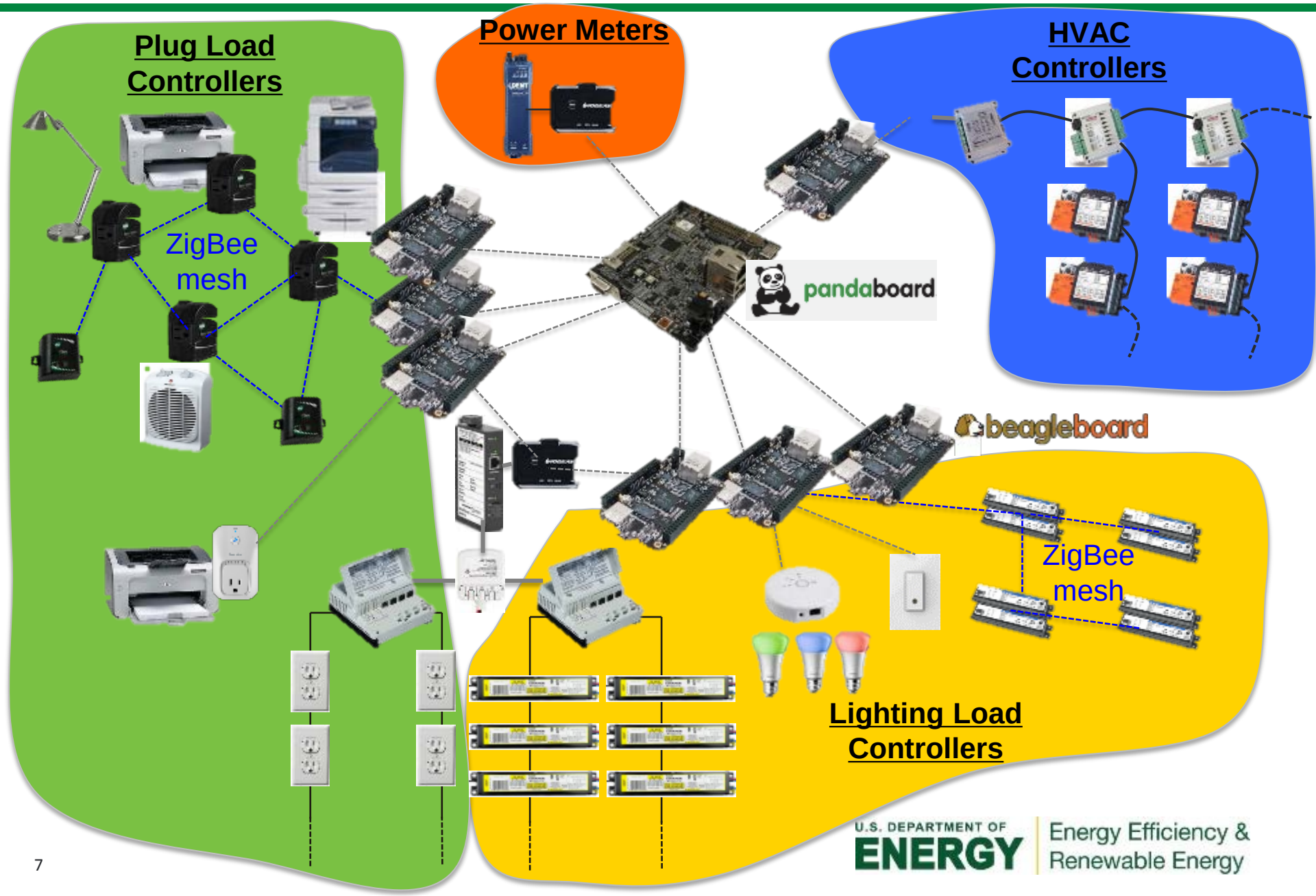
Solutions for Larger Buildings



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BEMOSS on Various Embedded Devices

Raspberry Pi

CPU:	700 MHz ARM processor
RAM:	512MB SD
Ethernet:	10/100 RJ45
USB 2.0:	Available
Price:	$35
Size:	3.4”x2.2”

beagleboard

CPU:	1GHz ARM Cortex-A8
RAM:	512MB SD
Ethernet:	10/100 RJ45
USB 2.0:	Available
Price:	$55
Size:	3.4”x2.1”

pandaboard

CPU:	Dual core 1.2GHz ARM Cortex-A9
RAM:	1GB SD
Ethernet:	10/100 RJ45
USB 2.0:	Available
Price:	$220
Size:	4.5”x4.0”

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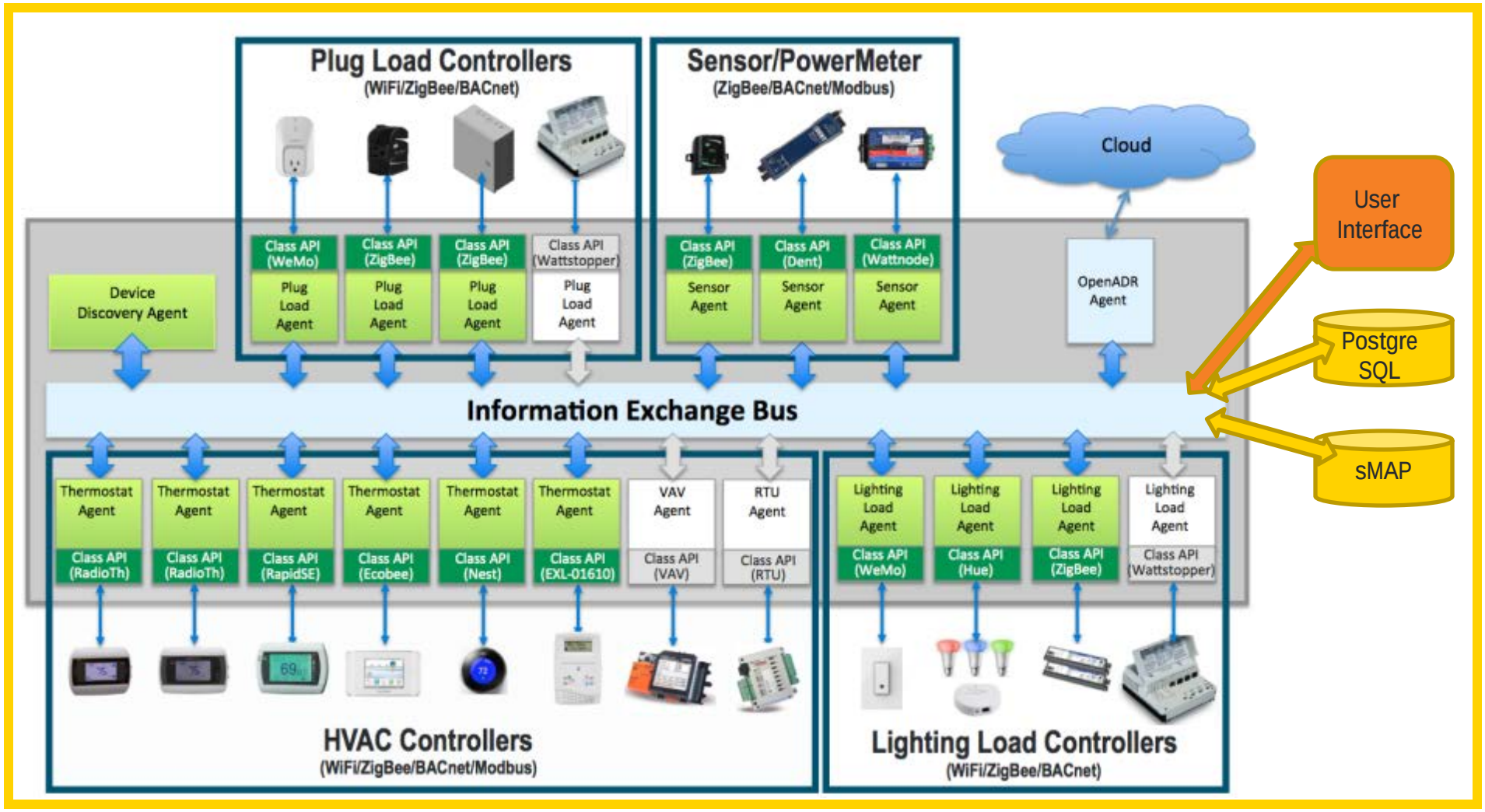
Virginia Tech's Agent Development on VOLTTRON™



Software Used

Agent coding
- Python
- C++

Database
- sMAP
- PostgreSQL

User Interface
- Django
- jQuery
- ZeroMQ
- Java script
- Twitter Bootstrap

VOLTTRON™: Beneficial Features

- Scalability
- Open architecture
- Ease of deployment
- Built-in security module
- Interoperability (through IEB)
- Resource guarantee for agents
- Can be installed in a low-cost, low-power embedded system
- Distributed and decentralized control based on a multi-agent system
- Language-agnostic environment (supports development in Python, Java, JADE, Binary, etc.)
- Have community support

VOLTTRON™: Room for Improvement

- GUI tool may be added for agent management and debugging.
- VOLTTRON™ 1.2 does not support agent mobility and cloning service.
- VOLTTRON™ 1.2 does not follow any agent communication standards (e.g., Foundation of Intelligent Physical Agents - FIPA).
- VOLTTRON™ 1.2 does not address interaction of multi-agent systems.
- VOLTTRON™ 1.2 does not provide an easy database interface (e.g., MySQL, PostgreSQL, Oracle, etc.)
- Additional security features, may be available in VOLTTRON™ 2.0.

In-house BAS Operating System

Installation times

	PC	PandaBoard	BeagleBone
- VOLTTRON - UI - Database (PostgreSQL)	20 minutes	1 hours 20 minutes	2 hours 15 minutes

Thank You

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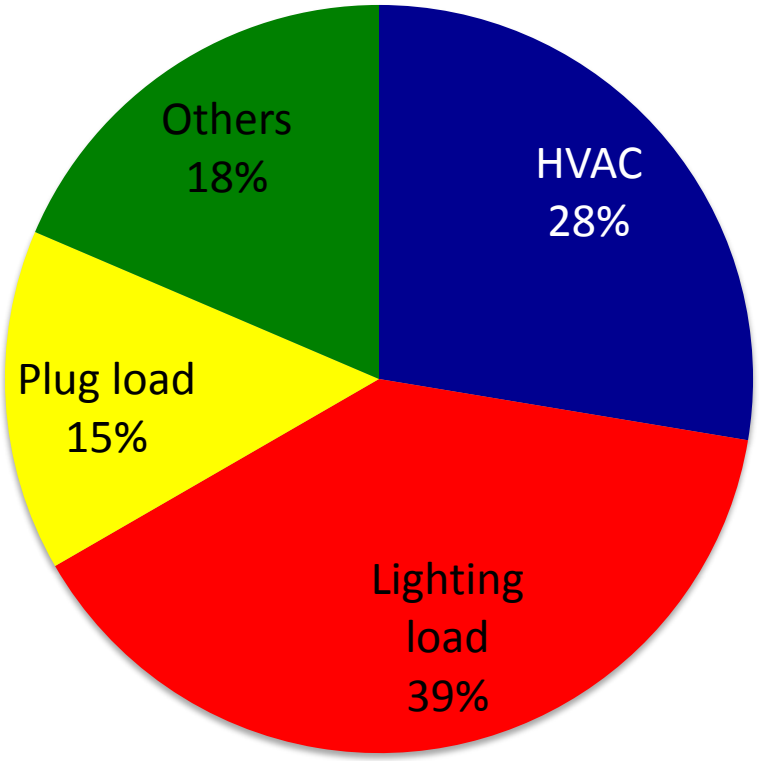
Professor and Director
Virginia Tech – Advanced Research Institute

Extra slides

Electricity Use in Office Buildings



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