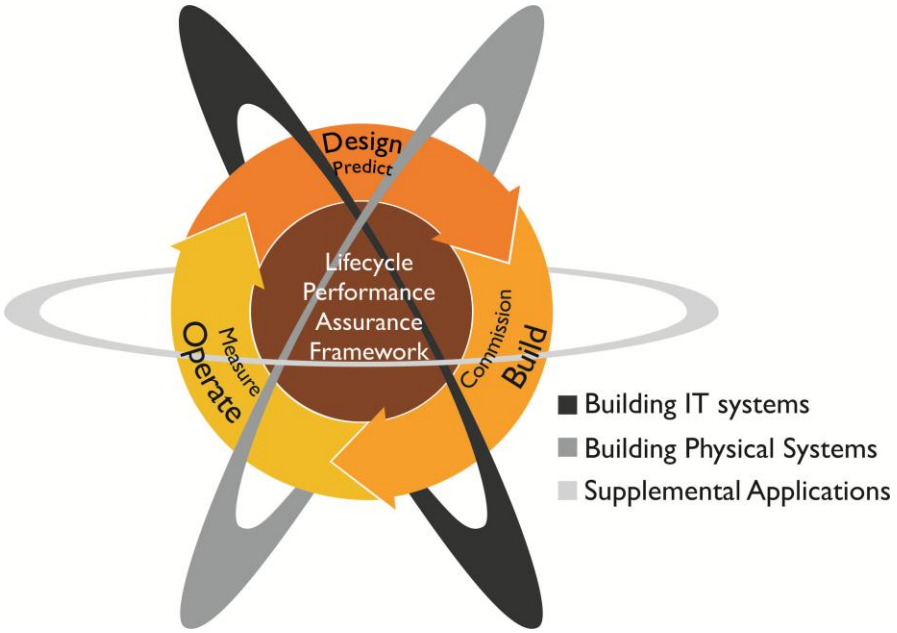
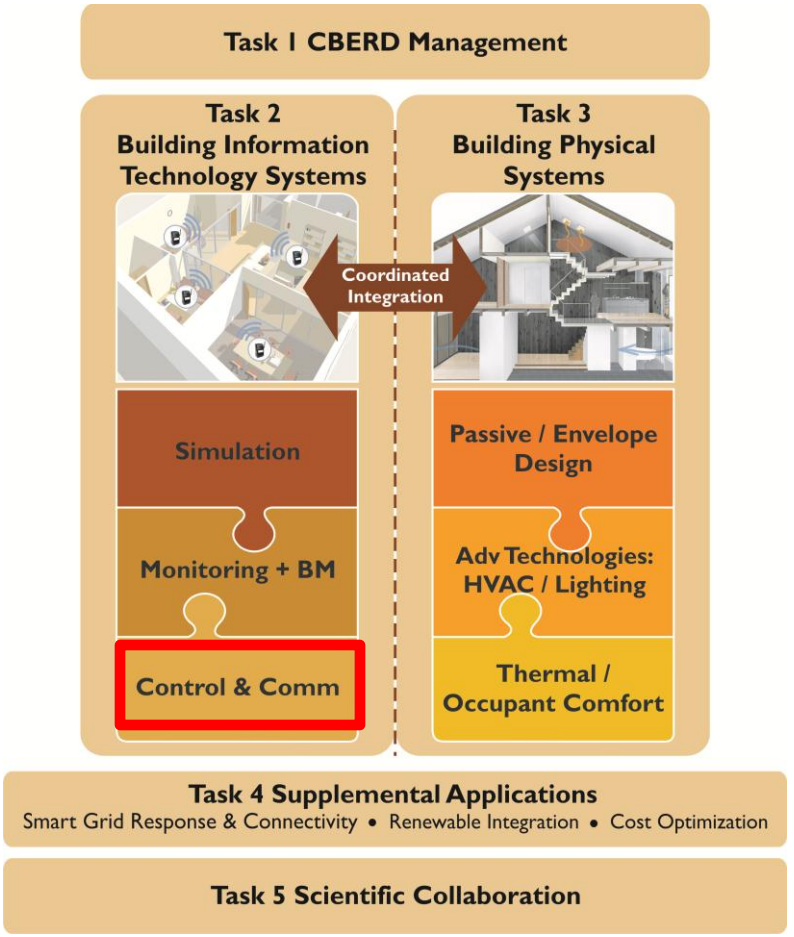
US India Joint Center for Building Energy Research and Development (CBERD) : Controls and Communications Integration

2014 Building Technologies Office Peer Review

CBERD promotes innovation in energy efficiency through collaborative research, contributing to significant reduction in energy use in both nations.





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

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Project Summary

Timeline:

Start date: Oct 2012; Planned end date: Sep 2017

Key Milestones

1. Pilot lighting system deployment with open control interface (Fall 2014)
2. Demonstration of plug-load identification based control (Summer 2015)
3. Multi-system control pilot in India using open, web-based interfaces (Summer 2017)

Budget:

Total DOE $ to date: $250K (FY13 and FY14)

Total future DOE $: $375 K (FY15-FY17)

Target Market/Audience:

Commercial building owners and system innovators

Key Partners:

Institutional	Industry
UC Berkeley	enLighted, Honeywell, Infosys, Neosilica, Philips, Schneider Electric, Synapsense, Wipro EcoEnergy
International Institute of Information Technology Hyderabad (IIIT-H)	

Project Goals:

Demonstrate open-source tools that allow building control systems to interact, to achieve whole building energy optimization

Purpose and Objectives

Problem Statement: Building systems do not interact. This prevents whole building energy optimization and stifles innovation.

Without open interfaces and software:

- New, innovative players find market entry difficult
- Building owners find new sensor and control technologies cost prohibitive to install and integrate into building management systems.

Target Market and Audience:

- Commercial building owners and system innovators.
- Commercial buildings use 18 Quads annually in the US.

Impact of Project: This project will:

- Demo proof-of-concept unified HVAC, lighting, and plug load control
- Release open source software tools enabling unified control
- Work directly with industrial partners in the U.S. and India on this system

Impacts:

- Near-term: open source tools enabling optimization with current partners
- Intermediate-term: Provide foundation for expansion with more players
- Longer-term: Invigorate industry players for open software architectures

Approach

Approach:

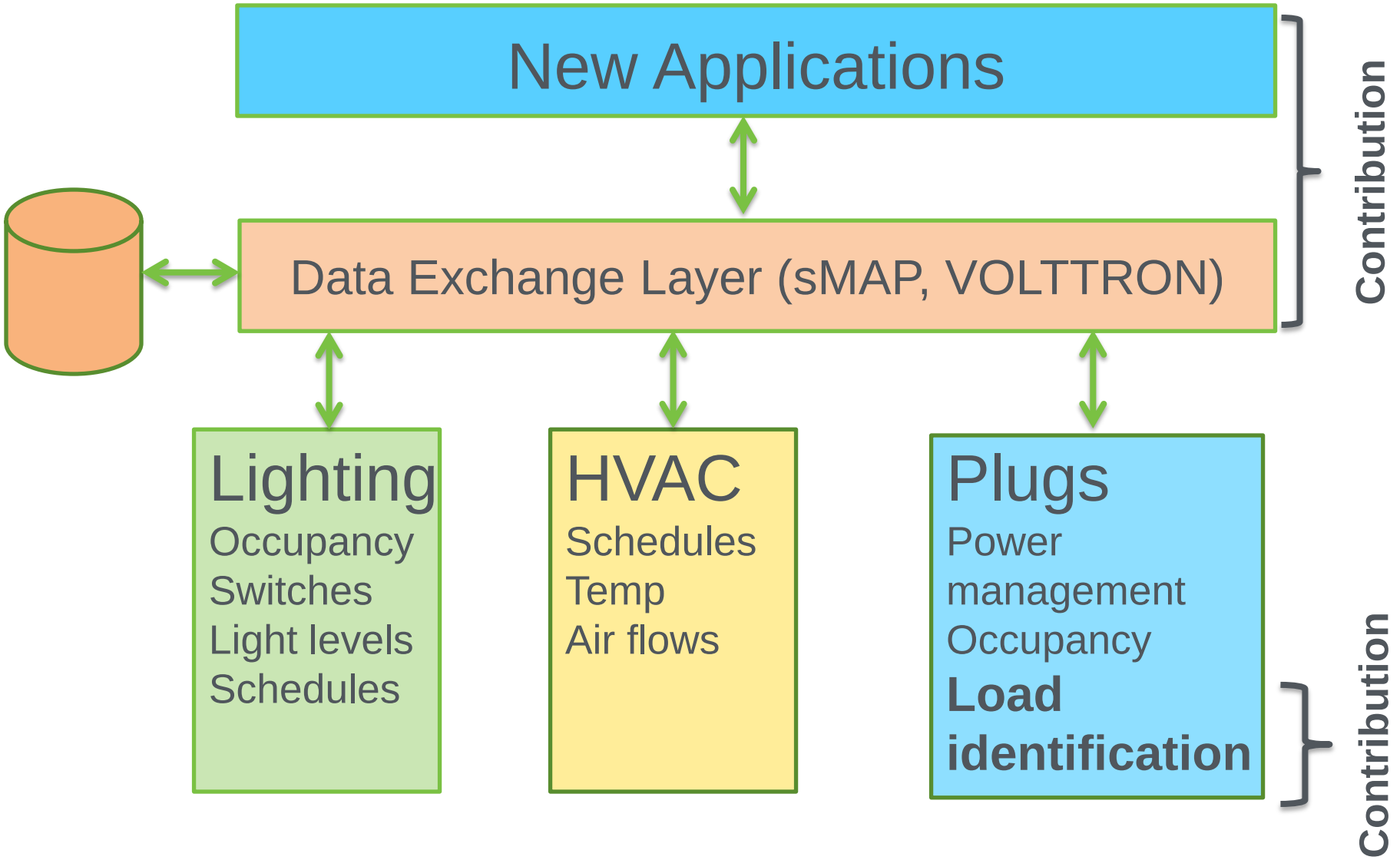
- Build on existing, open-source building system interface, control, and management systems (e.g., sMAP*, Volttron)
- Work directly with industry to integrate open-source tools with next-generation buildings systems
- Show proof-of-concept control of multiple building systems using a single, open-source, easy to use, data management and control interface
- Demonstrate advanced plug-load management capabilities integrated with the platform (demonstrate with Indian partners)

Key Issues: Developing open interfaces to commercial systems, developing plug-load control logic that eliminates user frustration

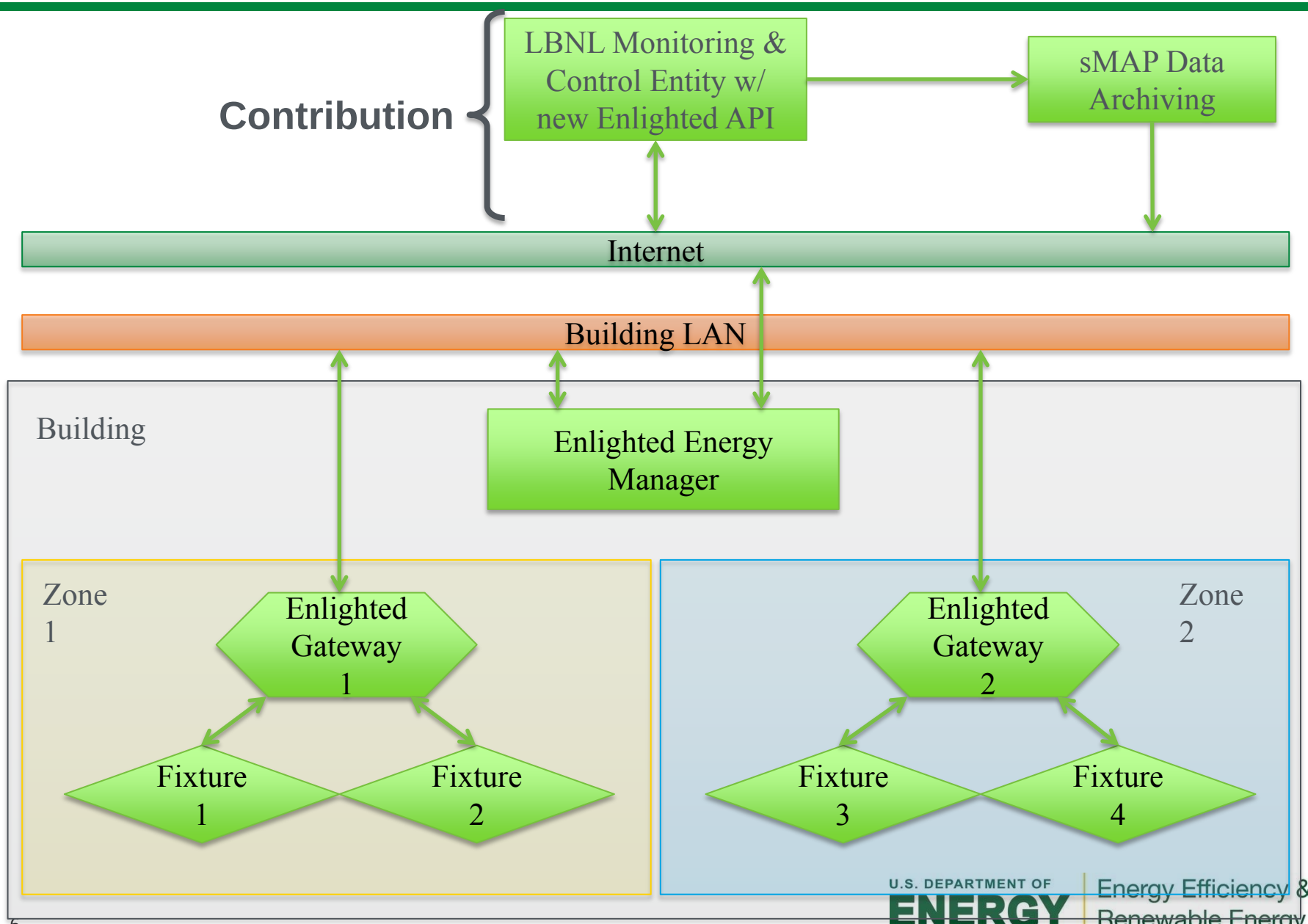
Distinctive Characteristics: Direct industry involvement in the development, use of open-source software interfaces for control. Addressing the current shortcomings of plug load controls.

*Simple Measurement and Actuation Profile

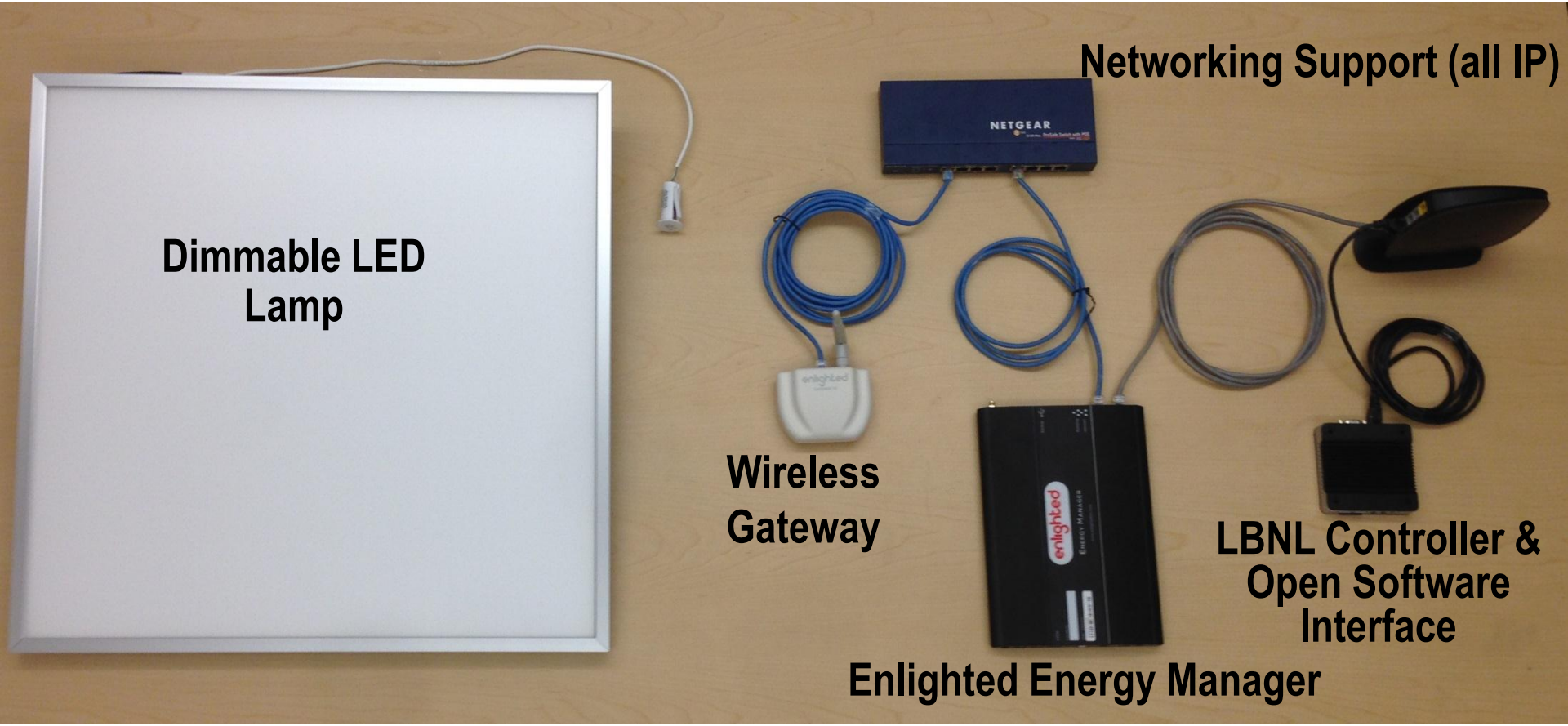
Approach: Data Exchange Platform Overview



Progress: Lighting with Enlighted



Progress: Laboratory Scale Lighting Demo



Progress: Plug Load Identification and Control with Infosys

State of the Art:

- Current plug load controls shut off power to devices based on schedule and occupancy
- Do not consider the type of device plugged in because controller does not have this information
- Computers have power removed just like lights

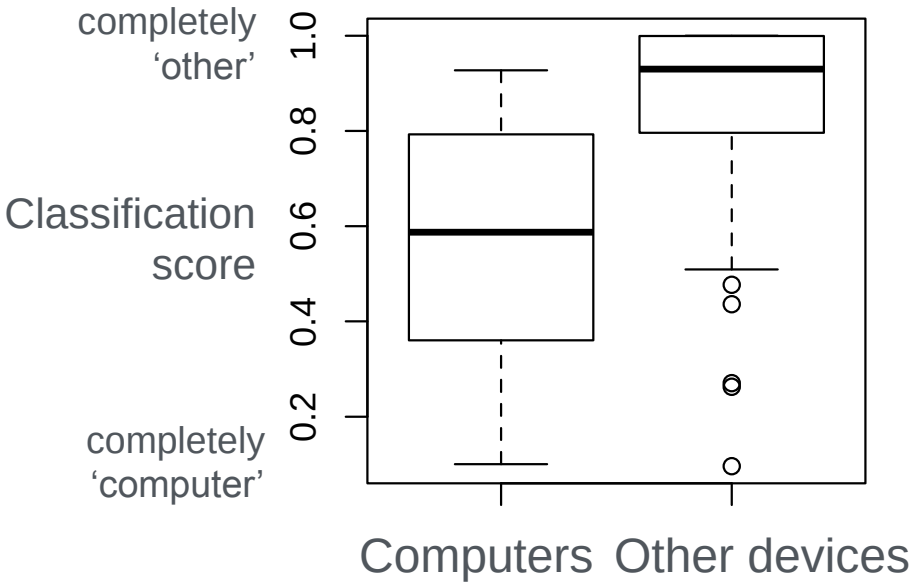
Proposed Solution:

- Use machine learning to identify type of load plugged in
- Provide control optimized for type of load along with schedule and occupancy

Progress:

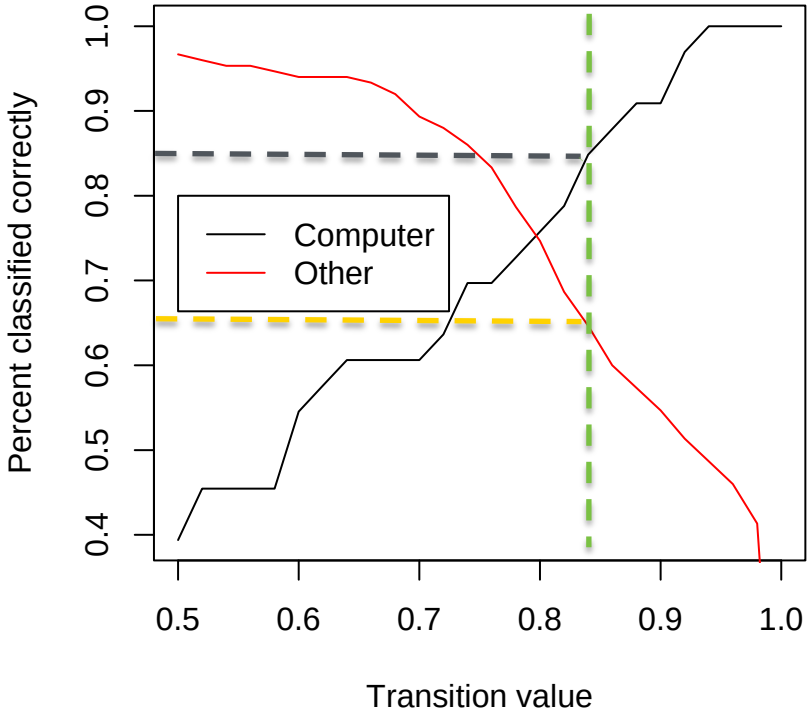
- Implemented linear regression learning system based on non-intrusive load monitoring algorithms
- Simplify algorithms to enable low-cost platforms to provide intelligence

Progress: Plug load identification



Initial results show >80% correct classification with simple algorithm using

- Standard deviation of on-mode power
- Median on-mode duration time



Plan to extend from published work to system that uses longer data records for identification and more variables

Expect >99% classification of critical loads

Progress and Accomplishments

Lessons Learned:

- Internet Protocol-based APIs simplify integration of controls across systems
- Existing building control protocols (Modbus, BACnet) pose integration challenges

Accomplishments:

- Successful industry engagement
  - Enlighted on lighting
  - Infosys on plug load control
- Produced working laboratory lighting demo
- Plug load identification algorithm development

Market Impact:

- Enlighted is working on an open, IP-based API for use in this project
- This is intended to be available to customers and third party platform providers in the future

Project Integration and Collaboration

Project Integration:

- Regular calls with Indian research partners
- Joint US-India work on data exchange platform
- Ongoing joint work with Enlighted on lighting interface

Partners, Subcontractors, and Collaborators:

- Project is a Task in the CBERD Program
- Vishal Garg, International Institute of Information Technology, Hyderabad, India
- Tanuj Mohan, Enlighted Systems, California, USA (Development Partner)
- Bob Wardell, Infosys, USA (Testing Partner)

Communications: CBERD Industry Forum

Next Steps and Future Plans

Next Steps and Future Plans:

- Deployment of prototype lighting system in a building
- Implementation of control sequences using data exchange platform
- Testing of plug-load identification algorithms with live-data
- Pilot testing of plug load control algorithms in an occupied space

REFERENCE SLIDES

Project Budget

Project Budget: $125K per year
Variances: None.
Cost to Date: $171K
Additional Funding: $300K cost share

Budget History					
Oct 2012– FY2013 (past)		FY2014 (current)		FY2015 – Sept 2017 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$125k	$0	$125k	$50k	$375k	$250k

Project Plan and Schedule