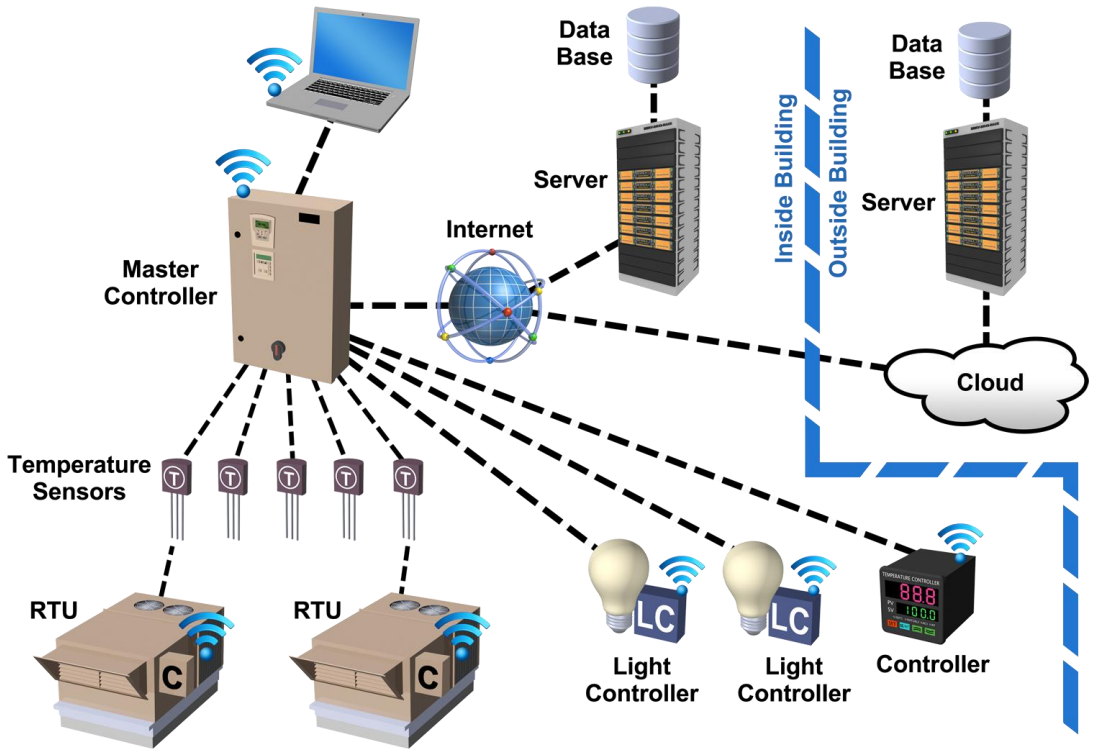

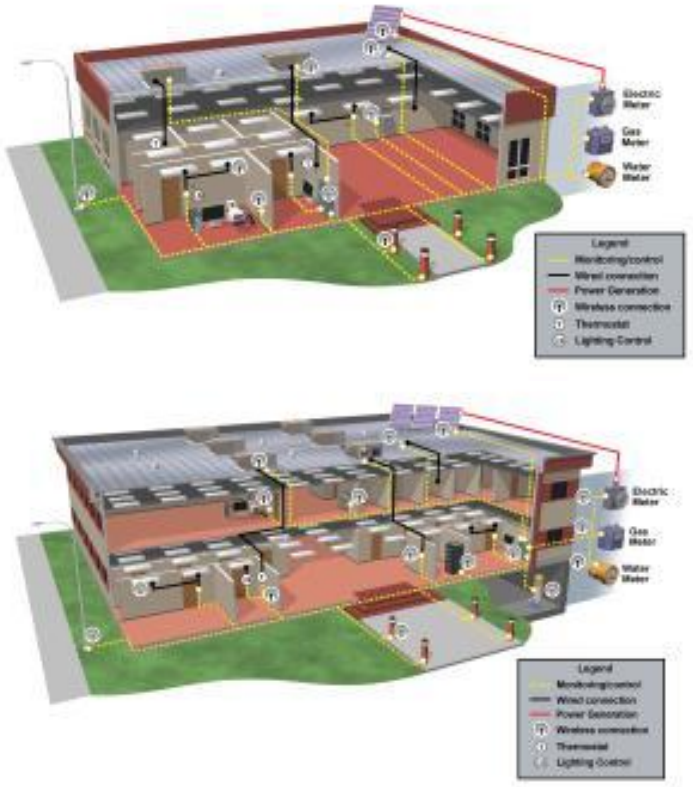

Small- and Medium-Size Building Automation and Control System Needs: Scoping Study

Michael Brambley, Ph.D.

Pacific Northwest National Laboratory
Michael.Brambley@pnnl.gov (509) 375-6875

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Problem Statement

- Less than 10% of the buildings have building automation systems (BAS)
- Over 90% of buildings stock either:
  - small (<5,000 sf) or
  - medium-sized (between 5,000 sf and 50,000 sf)
- HVAC, lighting, plug loads in many of these buildings not properly controlled
  - Most of these buildings do not have a cost-effective way to monitor and control their building systems from central location (no BAS)
  - Equipment operates when building not occupied
- Consequence: Uncontrolled building operations lead to unnecessary energy waste of 10% to 25%
- Solution: Scoping study that lays out approach/criteria for realizing better controls in small/medium buildings

Project Objective and Team

- Characterize the monitoring and controls needs for the various end-uses, identify the requirements to develop control packages and the target cost of doing so
  - for both efficiency improvement and enabling grid integration
- Study conducted by three national laboratories
  - Pacific Northwest
  - Oak Ridge
  - Lawrence Berkeley

Potential Project Impact

- Many small buildings have inadequate controls, wasting as much as 10% to 25% of the energy consumption
- These buildings consume approximately 3 Quads of source energy annually
- By deploying cost-effective controls systems significant portion of the energy that is currently wasted can be avoided
  - Up to 750 trillion Btus annually

Link to BTO Strategic Goals

- This project contributes to the BTO goal to reduce the energy required to operate existing commercial buildings by 40 percent, at less than the cost of the energy saved
- Bring needed technologies and practices to market delivering:
  - Annual savings of 1,600 trillion BTUs by 2020
  - Annual savings of 6,000 trillion BTUs by 2030

Approach for the Scoping Study

- Building Characterization
- Communication Architectures
- Building Automation Systems (BASs)
- Requirements of the Devices Used to Monitor and Control
- Installed Cost of the Control Systems
- Control Retrofit of a Medium-Sized Commercial Building: Case Study
- Discussion and Recommendations

Definition of Small- and Medium-Sized Commercial Building

- For this study we used following definitions
  - Small: A building less than 5,000 sf
  - Medium: A building between 5,000 sf and 50,000 sf
- CBECS 2003 classifies buildings into 20 different types
  - HVAC, lighting and plug loads dominates most energy use in following building types: office, education, retail (including strip and enclosed mall), outpatient, religious worship and services
  - Similar control solutions for these buildings
- Based on CBECS, energy end use distributions for small- and medium-sized buildings not significantly different

Architectural Needs and Technical Requirements Identified

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

Architectural Needs for BASs

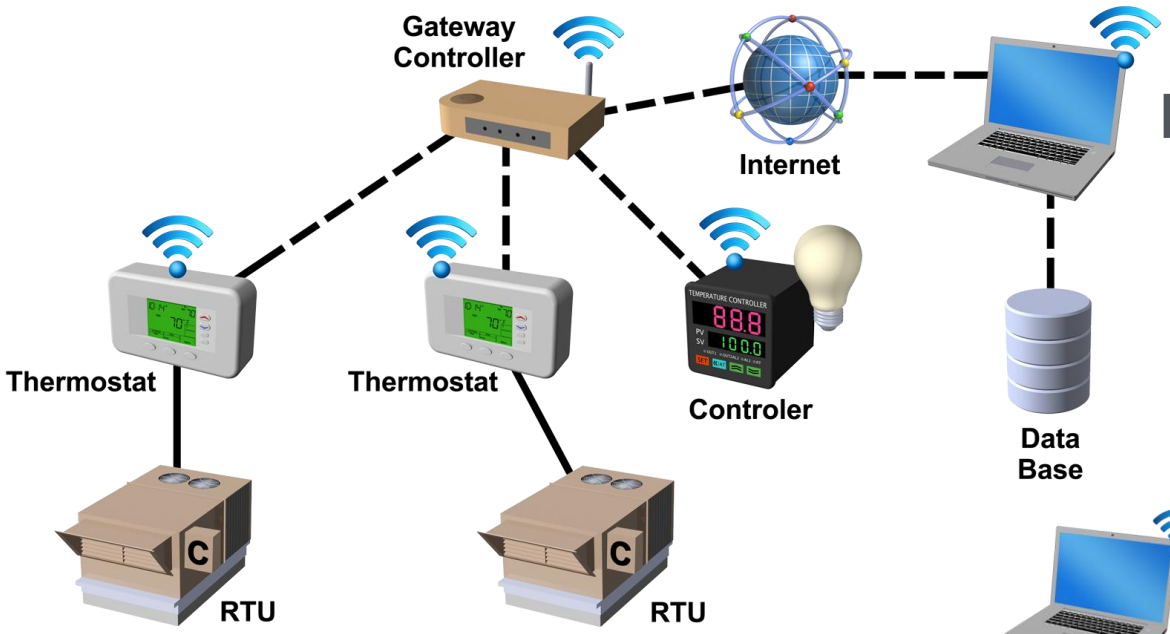
- Interoperability
- Scalability
- Deployment – new vs. retrofit
- Open
- Plug-n-play
- Enable local or remote monitoring

Technical Requirements for Various Control Devices

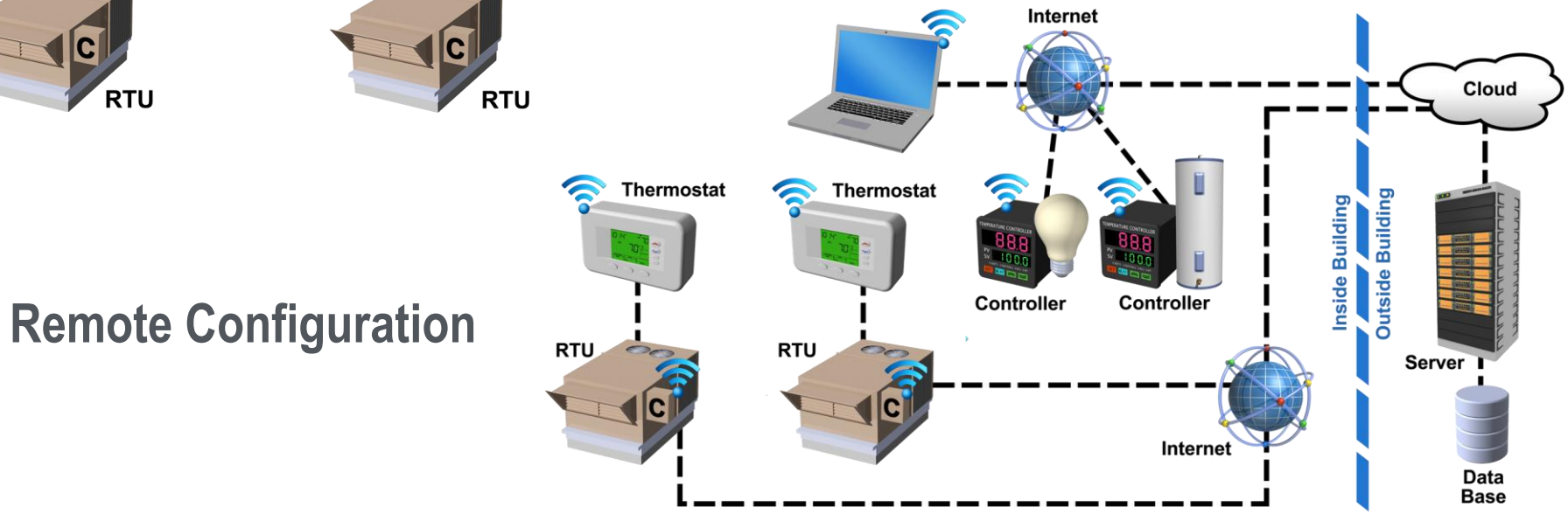
- Gateways
- Master Controller
- Communicating Thermostat
- General Purpose Controller
- Demand Response of HVAC, Lighting and other End-uses Loads

Small Building Controls Options

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

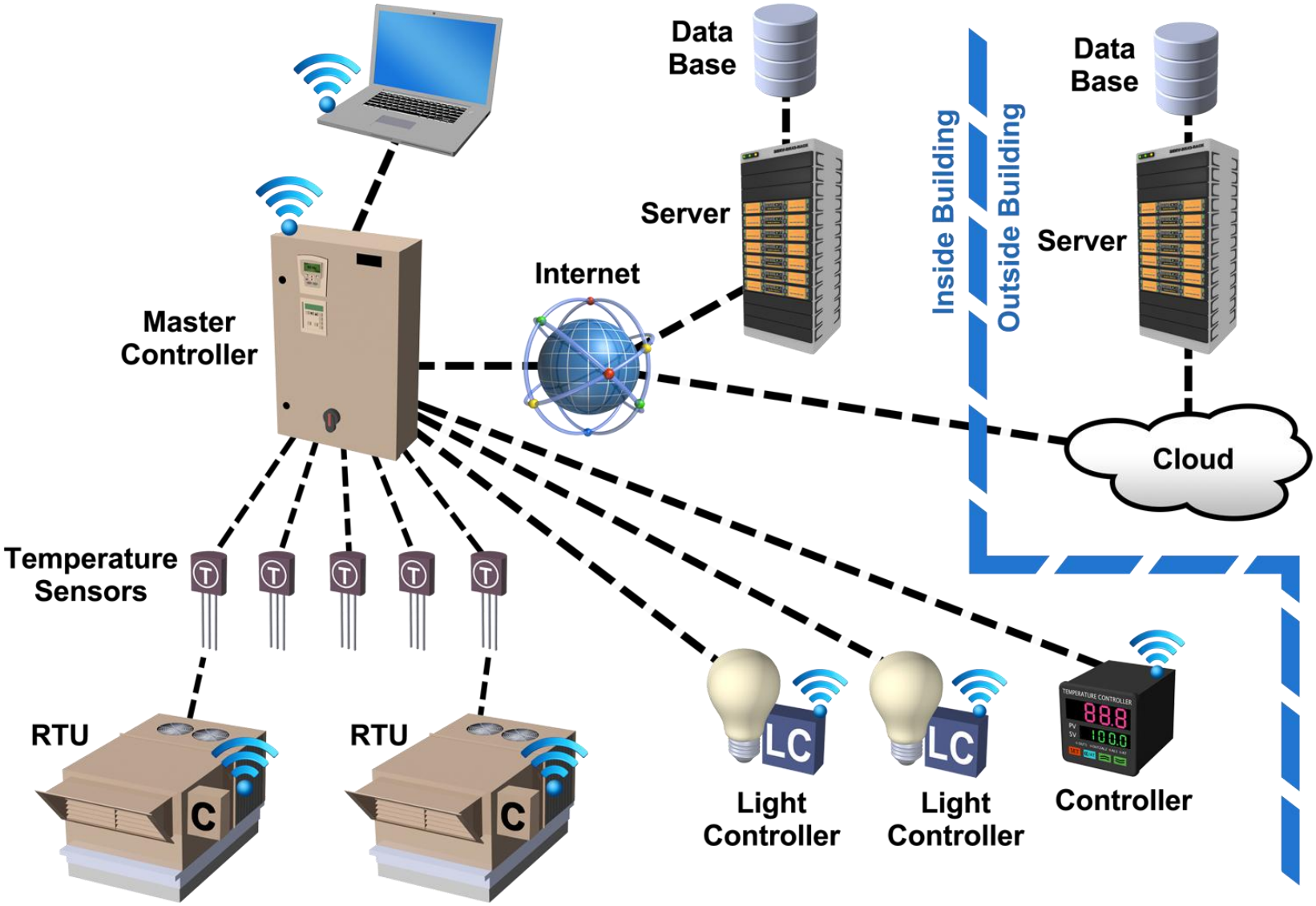


Local Configuration



Remote Configuration

BASs with Local Control and Configuration and Local or Remote Monitoring for Medium-Sized Buildings



Study Summary

- Significant savings are possible if the buildings are retrofitted with controls that can be centrally managed
- These retrofits can be cost-effective, even in regions with low utility rates (<$0.06/kWh)
- However, there are a number of hurdles to overcome
  - Some of the hurdles are technology and others policy
- Policy issues
  - Lack of trained personnel
  - Lack of easy financing
  - Split incentives
  - Lack of awareness of benefits and how to realize them
  - Current building codes do not require building controls
- Fundamental building blocks necessary to develop a cost-effective controls solution for small- and medium-sized commercial building exist
- These building blocks need to be packaged into open, standard and truly “plug-n-play” solutions

Recommendations: Technology

- Develop performance-based specification for controls architecture that is truly open, based on a standard and plug-n-play and issue a “Controls Challenge” to industry to meet it
  - Solutions should scale, so they can be deployed in all building sizes
- Solution may have to be tailored by building size (type), for example, for buildings
  - less than 1,000 sf will need an easily programmable thermostat and occupancy-based lighting controls
  - between 1,000 sf and 5,000 sf, a networked programmable thermostat so central monitoring is possible and occupancy-based lighting controls
  - between 5,000 sf and 20,000 sf, a networked programmable thermostat, a good replacement advanced RTU controller and occupancy-based lighting controls
  - greater than 20,000 sf, a true central BAS

Recommendations: Policy

- Consider “mandating” certain minimum controls infrastructure for all commercial buildings, including small- and medium-sized buildings
  - ASHRAE 90.1 is “mandating” certain controls sequences
- Create pathways for easy financing of building controls retrofit
- Encourage utilities to provide incentives to create a market for these solutions
- Develop user guides/applications providing step by step instructions on how to implement controls sequences, control architectures with today‘s technology
- Educate building owners about controls benefits
- Provide solutions to deal with the split incentives

Project Plan & Schedule

Project plan:

Initiated in the second half of FY12 and completed as planned in the first quarter of FY13

Summary
ET-SENCON-PNNL-FY12-02
19471 (FY12)/25406 (FY13)

Legend
Work completed
Active Task
Milestones & Deliverables (Original Plan)
Milestones & Deliverables (Actual)

Task / Event	FY2012 Q1 (Oct-Dec)	FY2012 Q2 (Jan-Mar)	FY2012 Q3 (Apr-Jun)	FY2012 Q4 (Jul-Sep)	FY2013 Q1 (Oct-Dec)	FY2013 Q2 (Jan-Mar)	FY2013 Q3 (Apr-Jun)	FY2013 Q4 (Jul-Sep)	FY2014 Q1 (Oct-Dec)	FY2014 Q2 (Jan-Mar)	FY2014 Q3 (Apr-Jun)	FY2014 Q4 (Jul-Sep)
Small-building control systems												
Task 1 Milestone: Identification of building automation system needs completed				◆								
Task 2 Milestone: Identification of control capabilities completed				◆								
Task 3 Milestone: Development of case-study completed				◇	◆							
Task 4 Milestone: Identification of monitoring needs completed				◇	◆							
Deliverable: Draft-final case-study building controls small/med bldgs cost-effective					◆							
Deliverable: Final report						◆						
Current work and future research												

Project Budget

Project Budget: $155K received in FY12; this budget is for all three labs

Cost to Date*: $140K

Additional Funding: None

*as of 3/1/2013

Budget History					
FY2010		FY2011		FY2012	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$0K	$0K	$0K	$0K	$155K	$0K

Next Steps and Future Plans

Next Steps and Future Plans: Emerging Technologies is planning the next steps beyond the scoping study by issuing a Federal Opportunity Announcement for organizations to develop and demonstrate an open, scalable, plug-n-play control system that is suitable for small- and medium-sized commercial buildings