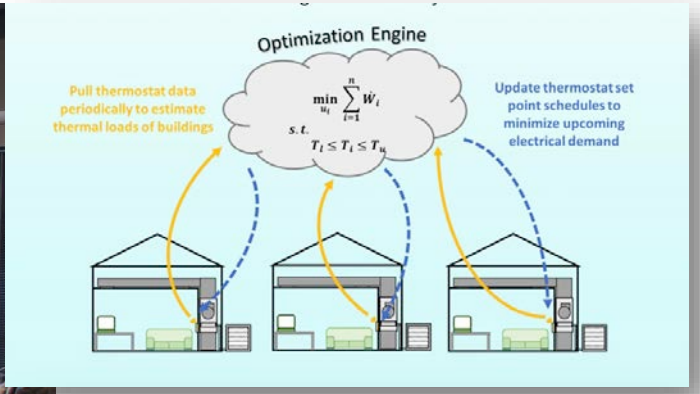
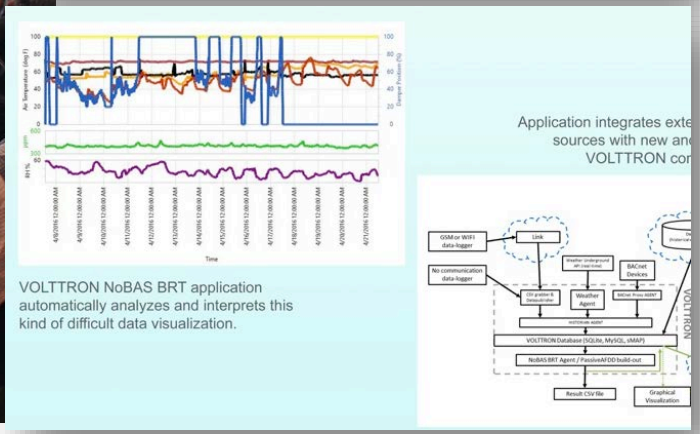
Northwest Connected Buildings Innovator

2017 Building Technologies Office Peer Review





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Project Summary

Timeline:

Start date: 01/01/2016

Planned end date: 09/30/2019

Key Milestones

1. Connected Buildings Challenge Demo; 08/03/2016
2. Focus Groups Report; 09/01/2016

Budget:

Total Project $ to Date:

- DOE: $500K
- Cost Share: $0K

Total Project $:

- DOE: $2,300K
- Cost Share: $0

Key Partners:

Amazon	City of Seattle
BNIM (architecture)	CleanTech Alliance
Emerson Climate Technologies	National Association of Realtors
Microsoft	Smart Buildings Center

Project Outcome:

- Developing transactive algorithms for connected residential energy systems
- Validating the state-of-the-art solutions through filed trials
- Forming a network and leadership group to advance Connected Buildings technologies

Purpose and Objectives

Problem Statement: Despite the projection of tremendous market growth of connected devices in the near future, the current technologies (especially for residential and small commercial buildings) have not been valued in the mainstream market due to lack of connection with fundamental consumer benefits and demonstrated grid benefits. System-level research strategies that enable a full integration of fragmentally developed connected devices is important to enable a truly transactive utility network for residential buildings (the attributes of which are also shared with small commercial buildings).

Target Market and Audience: Technology Companies, Utilities

Impact of Project:

The project is intended to:

- Guide the existing R&D in transactive buildings by integrating technologies with factors that motivate the market (near-term)
- Validate the connected buildings technologies through proof of concept and field trials (mid-term)
- Create a self-accelerating market channel to facilitate market adoption and scaling up (long-term)

Approach

Approach:

- Conducted industry status review and focus groups among realtors to gather market feedback and perceived value proposition
- Organized an open challenge to inspire innovated market solutions
- Formed a leadership network to create a joint workforce through collaborations among various sectors
- Will develop system-level technical strategies for connected homes and neighborhoods
- Will develop a prototype of a transactive-based home energy management system and demonstrate through filed trials

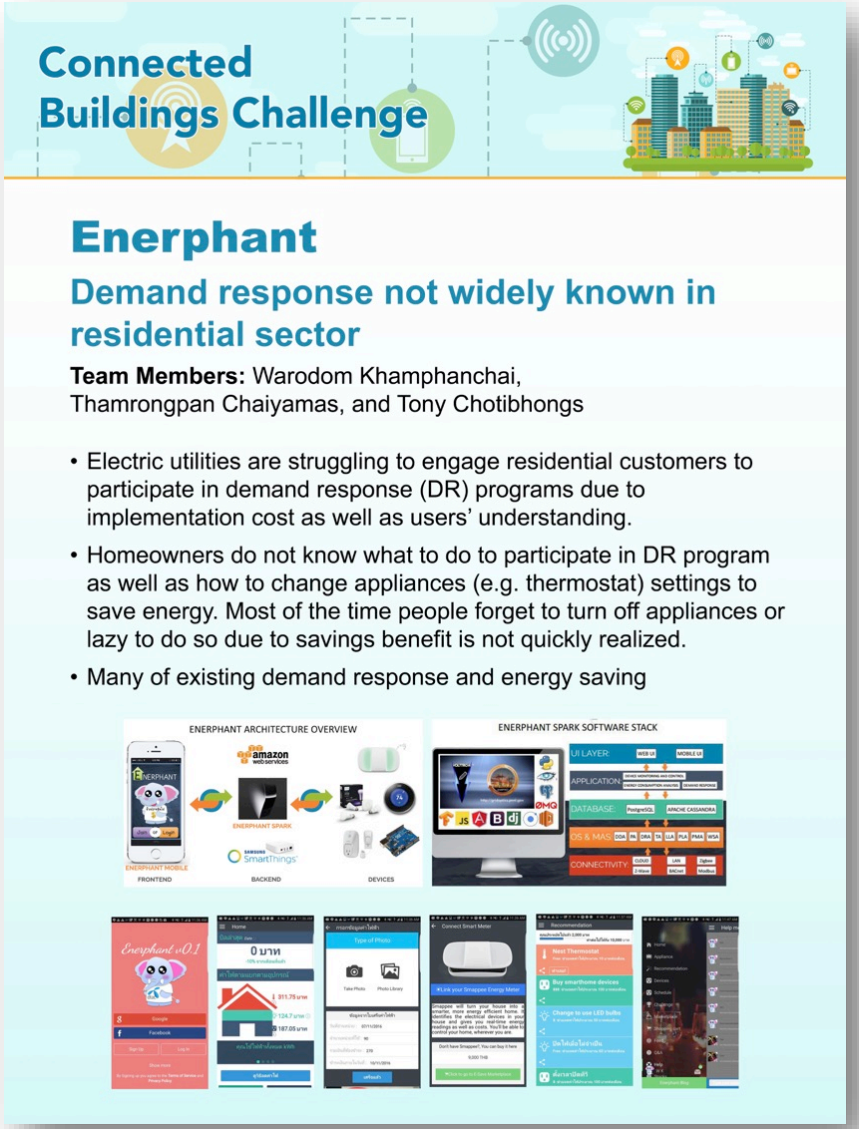
Key Issues: The fragmented technological solutions to connected devices are inadequate to revolutionize the connected buildings market

Distinctive Characteristics: Creating a strategic "hub" that attracts and connects partners who understand the magnitude of the opportunities, who can delineate clear roles and responsibilities to best support success, and who can deliver solutions without limits

Progress and Accomplishments

Accomplishments:

- Organized a Connected Buildings Challenge in Seattle on 08/03/2016 at the Smart Buildings Center
  - The event attracted a mixture of businesses regionally (75 attendees) and served as a networking event for the project partners and other key players in the connected buildings space (particularly in the Pacific Northwest region)
- Demonstrated five applications that utilize VOLTTRON to provide solutions for automatic fault detection, continuing commissioning, and demand response



Progress and Accomplishments

Connected Buildings Challenge

VENTOS – Scheduler

Adjust your HVAC and lighting operation to dynamic occupation

Team Members: Lourdes Gutierrez, Priyank Kapadia, and Saurabh Wani

Energy is wasted by overcooling/reheating buildings that assume full occupation. But occupancy can be predicted on educational buildings and office buildings with scheduled events and VAV systems. VENTOS integrates different sources of data with different building automation protocols, saving 20% of energy.

VENTOS - Scheduler

1. IMPORT EVENT SCHEDULE AND BUILDING DATA

Integrates data from EMS, Google Calendar, Mimosa, Doodle, etc.

2. CONNECT DATA TO HVAC BOX AND OCCUPANCY SENSOR

Connects data with VOLTTRON drivers (Modbus/ Bacnet) GPIO driver is enabled

3. APPROVE PROPOSED AIRFLOW

User has flexibility to adjust values from ASHRAE 62 calculations

4. SYSTEM OPERATES ACCORDING TO DYNAMIC OCCUPANCY

VENTOS could save up to 20% of energy over 5,000 million sqft in US

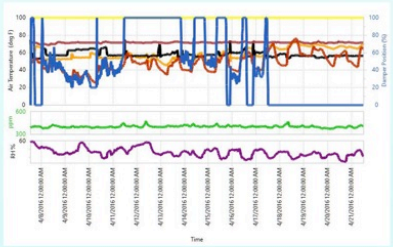
Connected Buildings Challenge

Smart Building Re-Tuning with VOLTTRON

Re-tuning for buildings without automation systems, NoBAS BRT

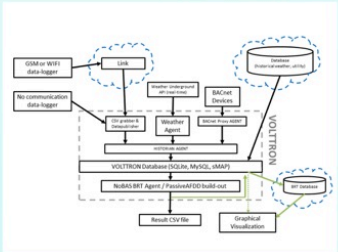
Team Members: Da-Wei Huang, Kirk Tryone Shillingford, and Marco Ascazubi

Support operations by providing time-series visualizations and diagnostics to optimize buildings with limited or no building automation systems. Uses Building Re-Tuning (BRT) concepts, with data-loggers integrated to VOLTTRON for rule-based processing of system performance data.



VOLTTRON NoBAS BRT application automatically analyzes and interprets this kind of difficult data visualization.

Application integrates external data sources with new and existing VOLTTRON components



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Progress and Accomplishments

Connected Buildings Challenge

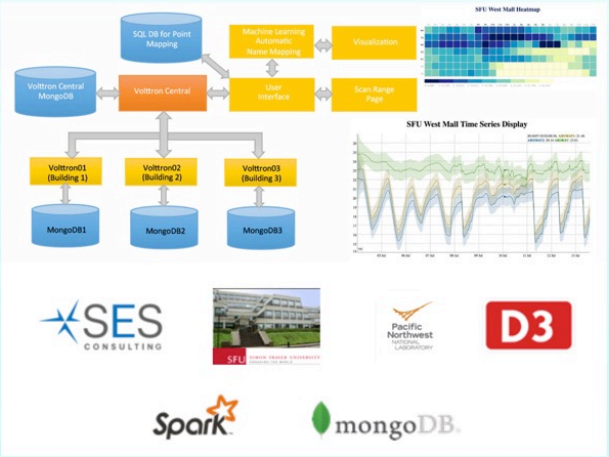
OPAS

Ongoing Performance Analysis Service

Team Members: Nigel David, Han Bao, David Putney, Rav Clair, Christopher Naismith, and Arrvindh Shriraman

SES provides engineering and occupant engagement consulting services on energy use for commercial and institutional buildings (~30/year). Our VOLTTRON web-based solution will allow

- engineers to quickly find energy conservation measures (ECM)
- owners to easily verify effectiveness of their ECM investments
- occupants to view their building's performance relative to others



Connected Buildings Challenge

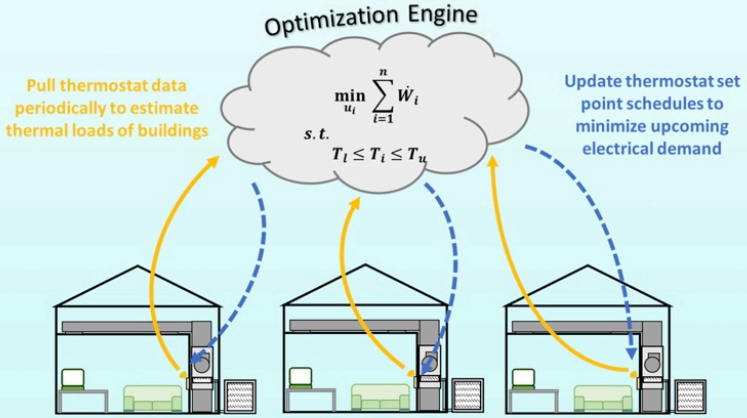
Neighborhood Air-Conditioning Coordinator

Reducing demand in homes

Team Members: Andy Hjortland, Donghun Kim, and Jim Braun

A supervisory control system for residential HVAC systems that uses web-connected thermostats to **reduce peak electrical demand** by coordinating when systems are used.

1. *Learn* a thermal model of homes to maintain comfort.
2. *Optimize* run-time of AC systems using model predictive control.
3. *Reduce* electrical demand by reducing time when many air-conditioners are running simultaneously.



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Progress and Accomplishments

Accomplishments:

- Organized a series of workshops with Microsoft, Amazon, and Smart Buildings Center after the demo to explore technical strategies and collaborations
- Conducted focus groups among realtors in Chicago and D.C. (partnering with National Association of Realtors) to inform R&D strategies

Attending Organizations:

Affiliated Engineers, Inc	LBNL
AMA	Macdonald-Miller
Amazon	FacilitySolutions
Beneficial State Foundation	McKinstry Co
BNIM	Microsoft
Bosch Research and Technology Center	National Association of Realtors
Botanic Air Corp.	Navigant
BPA	NBI
Building Envelope Engineers	New City Energy
City of Bellevue	Northwest Institute for Advanced Computing
City of Seattle Economic Dev.	ORNL
Cleantech Alliance	PNNL
Department of Commerce	Pacific Gas and Electric Company
Distributed Energy Management	Randolph M. Fritz
Dorsey & Whitney LLP	Renewable Northwest
Ecotope	Seattle City Light
EDI Provider	SES Consulting
Element 8	Snohomish County PUD
Embertec	South Seattle College
Emerald Cities Seattle	Starbucks
Emerson Environmental Technology	Trane
Fed Impact	United Technologies - Carrier
Geekwire	WA Utilities and Transportation Commission
Hitachi America Ltd.	Welsh Commissioning Group, Inc
HomeDiary	Windchange Consulting
IIIT Hyderabad	www.biomimicryindia.com
Impact Bioenergy	

Progress and Accomplishments

Focus Group Findings:

- Nearly zero market awareness
- Smart (or green, efficient) homes occasionally marketed in the high-end rental units
- Value of a smart or connected home has not been established in the market
- Market WILL evolve

Focus Group Recommendations:

- Educate the market players
- Create competition
- Make the products easier to understand, install, and use
- Offer a higher saving (>10%) and quicker payback
- Balance information sharing, privacy, and control

Progress and Accomplishments

Market Impact:

- The 2016 Challenge raised interest from a number of thought leaders from the City, utilities, energy efficiency alliance, and technological companies, who are seeking further technical collaborations
- A leadership group across sectors is being formed to carry out the missions to accelerate the transactive buildings market through advanced technologies

Lessons Learned:

- A systematic approach that integrates multiple aspects of connected buildings (such as energy, health, security, comfort) is essential to the success of market adoption.
- Proof of concept and field trials are needed to demonstrate the grid and consumer benefits and quantify energy and cost savings (including the non-monetized savings).

Project Integration and Collaboration

Project Integration: The project team closely works with our partners and align our project missions with partners' vision and business interests, such as Microsoft and Amazon's plans to provide cloud services and tools for IoT devices, Smart Buildings Center's goal to train local workforce for the evolving market of smart, efficient buildings, and utilities' interests in conducting filed trials of connected home devices

Partners, Subcontractors, and Collaborators: Microsoft, Amazon, Smart Buildings Center, National Association of Realtors, City of Seattle, and a number of utilities

Communications:

- The Seattle Demo was reported by GeekWire,[1] Rochester Institute of Technology,[2] and City University of New York[3]
- CEE Winter Meeting (2017)
- Better Buildings Summit (2017)

Links:
1. http://www.geekwire.com/2016/alexa-much-water-using-connected-buildings-challenge-paves-way-smarter-efficient-energy-use/?platform=hootsuite
2. https://www.rit.edu/research/simonecenter/ventos-scheduler
3. http://www.cunybpl.org/2016/08/bpl-one-of-5-teams-selected-for-pnnls-connected-buildings-challenge/

Next Steps and Future Plans

- Continue tracking market status to inform R&D efforts
- Maintain the leadership group to develop strategies and action plans
- Develop technical strategies to fully integrate in-home devices based on connectivity defined by home owners
- Develop technical strategies to coordinate neighbor-level energy demand and response and address perturbation outside of home owners' premises
- Develop a prototype of a transactive-based home management system by incorporating existing home platform capabilities into base VOLTTRON™ and leveraging existing open-source home energy management applications
- Conduct field trials of connected home management systems and validate the intended savings

REFERENCE SLIDES

Project Budget

Project Budget: $500K.
Variances: None.
Cost to Date: Through late February 2017, expenditures total $342K.
Additional Funding: None.

Budget History					
FY 2016 (past)		FY 2017 (current)		FY 2018 – FY2019	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$500K	$0K	$600K	$0K	$1,200K	$0K

Project Plan and Schedule

Project Schedule								
Project Start: 01/01/2016		Completed Work						
Projected End: TBD (ongoing program)		Active Task (in progress work)						
	◆	Milestone/Deliverable (Originally Planned) use for missed						
	◆	Milestone/Deliverable (Actual) use when met on time						
		FY2016				FY2017		
Task		Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)
Past Work									
Q4 Milestone: Connected Buildings Challenge Demo	N/A				◆				
Q4 Milestone: Focus Groups Report					◆				
Q1 Milestone: Connected Buildings Action Plan						◆			
Current/Future Work									
Q2 Milestone: Market outlook of connected homes and neighberhoods							◆		
Q3 Milestone: Protoype of transactive home enegy management system									◆
Q4 Milestone: Technical strategies and roadmap for transactive residential buildings									◆