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Northwest Connected Buildings Challenge

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VOLTTRON™ 2017

Event Summary

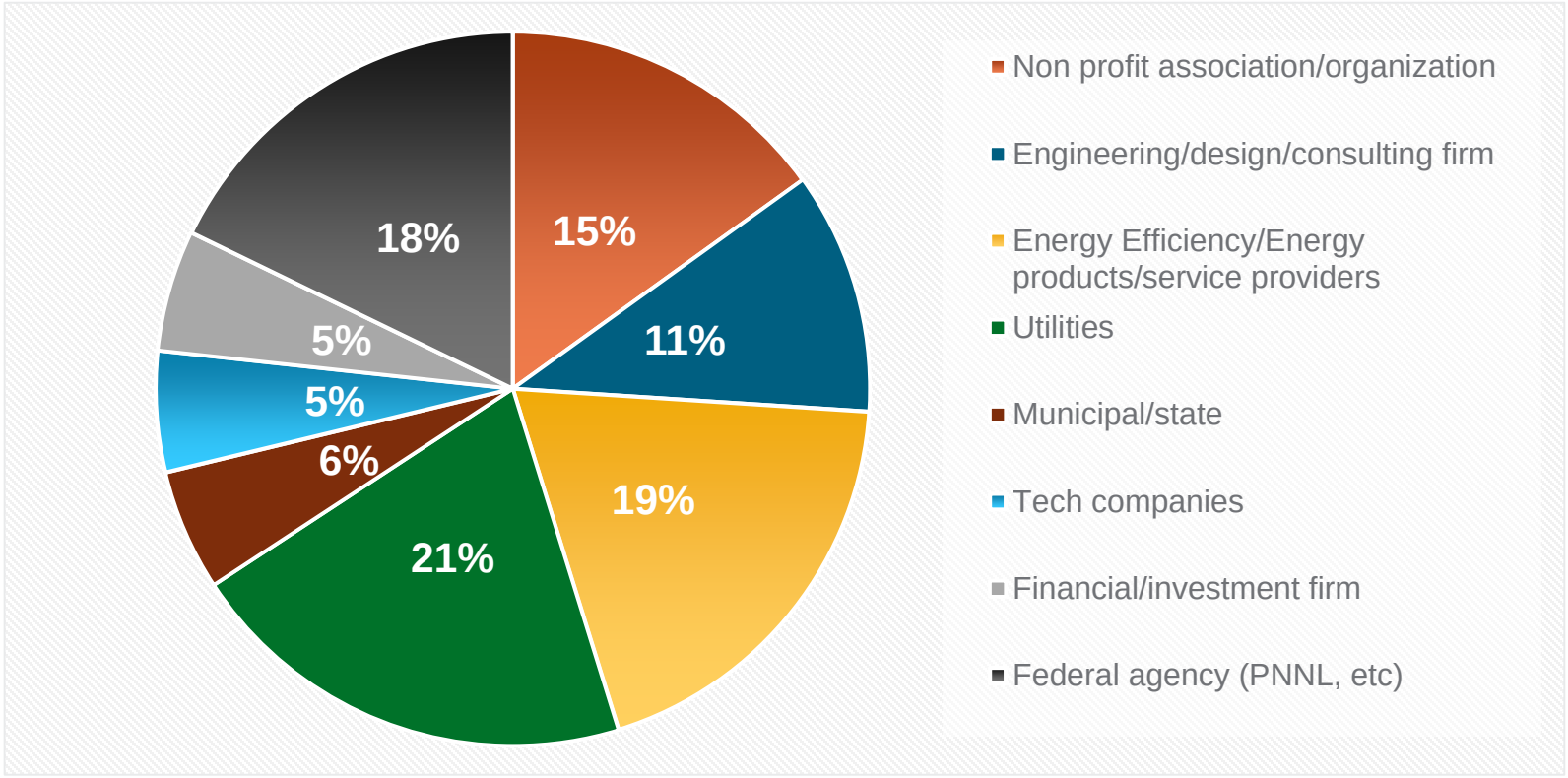
- PNNL organized the Connected Buildings Challenge Demonstration in Seattle (CBC Seattle Demo) on 08/03/2016 at the Smart Buildings Center.
- Five Challenge teams presented solutions of remarkable sophistication despite the relatively short time frame (3 months).
- The demo served as a networking event for the sponsors, PNNL, CBC partners and other key players in the connected buildings space, particularly in the Pacific Northwest region.
- Subsequent to the demonstration, the PNNL project team also set up five follow-up calls with the participating teams to gather their feedback and discuss their future plans.

Challenge Partners

- Core partners for the CBC Seattle Demo include Amazon, BNIM (architectural firm), City of Seattle, CleanTech Alliance, Emerson Climate Technologies, Microsoft, the National Association of Realtors, Seattle City Light, and the Smart Buildings Center.

Attendees

- The event was well attended (75 attendees) and attracted a mixture of businesses regionally.
- The attendance well represents the project's goal of supporting the northwest and acceleration of solutions within the region.



Summary

- Key feedback from the judges and other attendees
- Main takeaways from CBC project teams, which can inform future activities under the Connected Buildings Innovator program and the NW Transactive Accelerator—part of the WA State Campus Project (co-funded by WA State Department of Commerce)

More information can be found online.

- Demo Day Video: https://www.youtube.com/watch?v=X7nYZLysOM0
- Demo Day Summary: http://bgintegration.pnnl.gov/connectedbuildings/demo.asp
- Interviews of the teams as reported by GeekWire: http://www.geekwire.com/2016/alexa-much-water-using-connected-buildings-challenge-paves-way-smarter-efficient-energy-use/?platform=hootsuite
- Participating teams: http://bgintegration.pnnl.gov/connectedbuildings/challenge1teams.asp
- Judging panel: http://bgintegration.pnnl.gov/connectedbuildings/judges.asp

Main Takeaways

- Received many useful recommendations and suggestions from the demo attendees, challenge teams, and the judge panel to accelerate the development of connected buildings
- Grouped suggestions into the following four categories:

1. PNNL should create an information clearinghouse for data sharing and solution testing for smart buildings (particularly capturing the NW solutions).
2. PNNL should establish an effective partnership network with key players of the connected buildings ecosystem within the NW.
3. PNNL should enlarge the smart buildings' network and leverage existing relevant NW programs.
4. PNNL should accelerate the market penetration of innovative connected buildings technologies through case studies, demonstration, and education within the NW.

During the Challenge, the Teams Shared their Stories and Experiences with Blog Posts

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https://connectedbuildingschallenge.wordpress.com

Ventos scheduler – demonstration

Hi everyone! I'm sure we are all working hard to explain our projects the next week. We wanted to show you what would be our demonstration . This is a testagent that modifies the operation of the VAV controller according to a generic occupancy sensor connected to a raspberry pi, which depends on a scheduler…

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Update from Smart (No)BAS BRT with VOLTTRON team

Our idea is to Building Re-Tune (BRT) buildings and their HVAC systems with VOLTTRON. The target building types are buildings with no building automation system (BAS) or buildings with not fully equipped BAS. We are a team with good ex-engineers, ex-consultants and smart interns, but we are absolute new to VOLTTRON. So, before I report…

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Update from the Enerphant team

We have been busy developing our "Enerphant" mobile application that will be the user interface of the Volttron platform running on small board computers (i.e., Raspberry Pi and Odroid XU4). We have been also experimenting of running Volttron on AWS to provide additional solution for homeowner who would like to try our cloud solution without…

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Neighborhood Coordinator Status Update

Here is a quick update about our status: We are almost finished developing a Python class that can be used to interface with ecobee's thermostat API. The class allows us to get the current status, program, and temperature in the space. It also allows us to set set points and change modes. The next step…

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Occupancy sensor driver

Update from the Ventilation Scheduler Team. We are glad to inform that the occupancy-sensor milestone has been completed. This work will help the general public to test volttron. One of the constraints of building automation is the cost of the devices, but we have built the driver using a generic occupancy sensor that costs around…

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Volttron on Campus

This past month our team has been working towards collecting HVAC data from a university campus using Volttron. At the same time, we have been coming up with ways to automatically map the data to existing applications in the Volttron platform. In coordination with the Energy Management and IT teams at Simon Fraser University, we deployed Volttron on…

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Enerphant Team

Enerphant is a mobile app that informs the user (e.g., home owner, tenant) about real-time energy saving opportunities. As a result, the app users can take action and turn off energy intensive devices during peak hour demand. Besides the mobile app, Enerphant has integrated Amazon Echo with their solution. The user can give voice control commands (such as “What was my energy usage today”) and the Amazon Echo answers what was the total energy consumption of the household.

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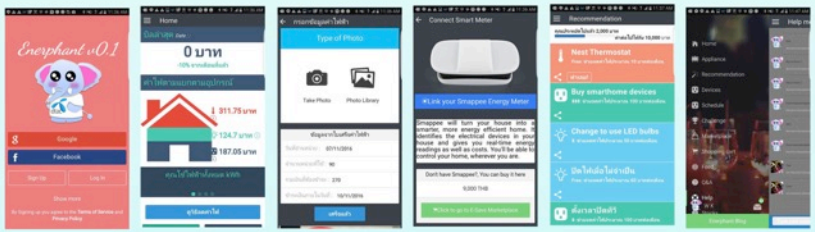
Enerphant

Demand response not widely known in residential sector

Team Members: Warodom Khamphanchai, Thamrongpan Chaiyamas, and Tony Chotibhongs

- Electric utilities are struggling to engage residential customers to participate in demand response (DR) programs due to implementation cost as well as users’ understanding.
- Homeowners do not know what to do to participate in DR program as well as how to change appliances (e.g. thermostat) settings to save energy. Most of the time people forget to turn off appliances or lazy to do so due to savings benefit is not quickly realized.
- Many of existing demand response and energy saving



CUNY Team

Many small commercial buildings in the US are equipped with Air Handler Units (AHUs), which are not coupled with a Building Automation System (BAS). A BAS allows to continuously monitor the AHU operation and the outside air temperature. As a result, the BAS controls can allow an AHU to use outdoor air to reduce the need for mechanical cooling. However, the BAS are usually very expensive and small commercial buildings cannot afford such a capital investment. The NoBAS team proposed a solution to use VOLTTRON™ as a very low cost BAS. VOLTTRON™ agents were used to monitor and store operation data from the AHU. The data were then charted in trend logs that a building engineer can easily access and take an educated decision on how to efficiently operate the mechanical equipment in the building according to economizing opportunities.

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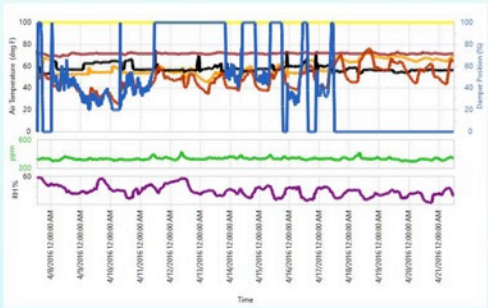
Smart Building Re-Tuning with VOLTTRON

Re-tuning for buildings without automation systems, NoBAS BRT

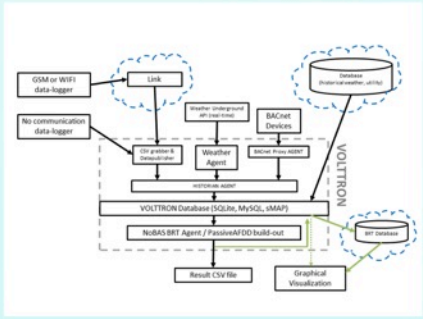
Team Members: Da-Wei Huang, Kirk Tryone Shillingford, and Marco Ascazubi

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



Purdue Team

Purdue's project builds upon a previously developed and validated RTUs (Roof Top Units) coordinator. The coordinator software assigns operation priority to several RTUs that serve a single open space zone (e.g., Walmart supermarket). The implementation of the RTU coordination algorithm led to energy savings. Similarly, an analogous concept with the RTU coordinator was applied to the neighborhood level by coordinating residential Air Conditioning Units. More specifically, VOLTTRON™ was used to access the web-enabled thermostats in the residential houses and communicate household temperature data to a central coordination algorithm hosted at the University's server. Purdue's simulations show that when residential Air Conditioning Units operate in a coordinated manner and not altogether there are significant energy savings of 15% at peak electricity demand periods.

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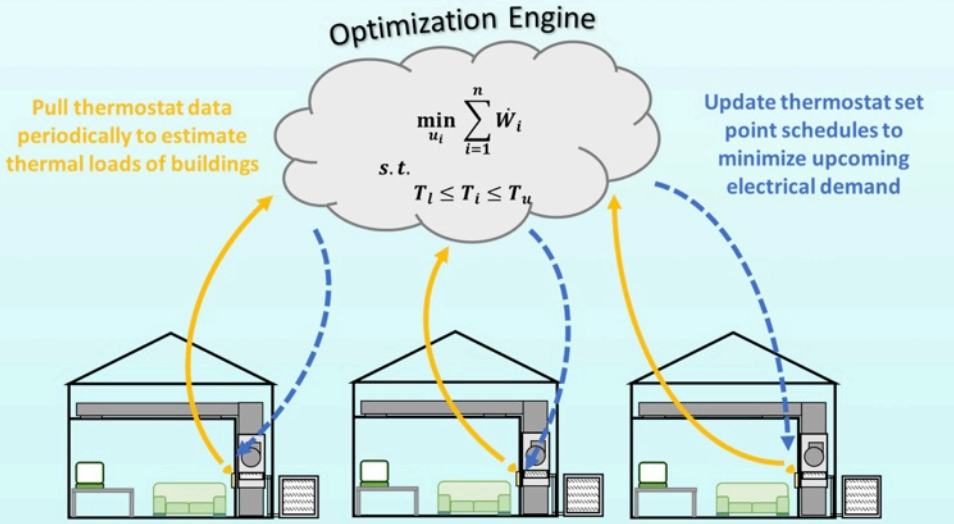
Neighborhood Air-Conditioning Coordinator

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.



VENTOS Team

VENTOS created a “Ventilation Scheduler” software module for VOLTTRON™ to be implemented in a University classroom setup. The software pulls data from an excel sheet containing the number of students that are registered for the class. Based on student registration data, which is the number of expected occupants in a class, VENTOS varies the airflow delivered in the room by controlling the air through the VAV (Variable Air Volume) box. The delivered air volume is proportional to the registered occupants. The occupancy-based controller yields energy savings when compared to the standard occupancy sensor. Current occupancy sensors detect whether the space is occupied or not without providing any information about the amount of occupants. The solution will be further developed to derive scheduling/occupancy data from personal calendars, such as google calendar, and/or scheduling services, such as doodle.

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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

OPAS Team

OPAS team focused on identifying energy opportunities in commercial buildings. Currently, there is no affordable, integrated benchmarking and data analysis platform that can be leveraged by consulting engineers in order to audit a building. In contrary, engineers spent hours collecting data points from Building Automation Systems, plotting them, and looking for energy saving opportunities or irregular mechanical equipment operation. This is inefficient for the engineers and expensive for the building owners. OPAS team solved this problem by creating a common auditing and continuous commissioning software tool. More specifically, VOLTTRON™ is deployed at the BACnet devices of commercial buildings and data points are collected and organized based on machine learning classification algorithms. As a result, the collection and trend logging is automated and the commissioning procedure is faster and more efficient.

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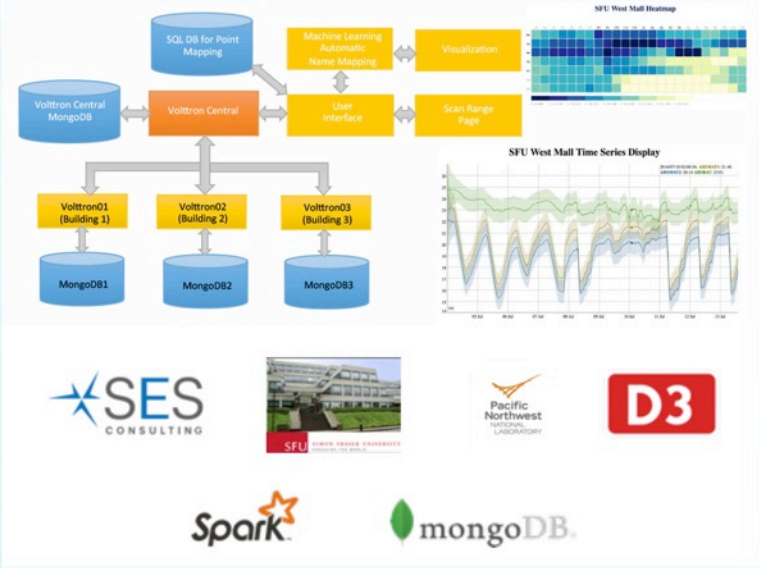
OPAS

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



VOLTTRON™ Integration with Cloud Services

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- PNNL interns create proof-of-concept solutions to highlight working with Microsoft Azure and Amazon AWS
- The flexibility and interoperability of VOLTTRON™ allows users to leverage the capabilities of other products without locking them into a VOLTTRON™-only approach

Azure Infrastructure

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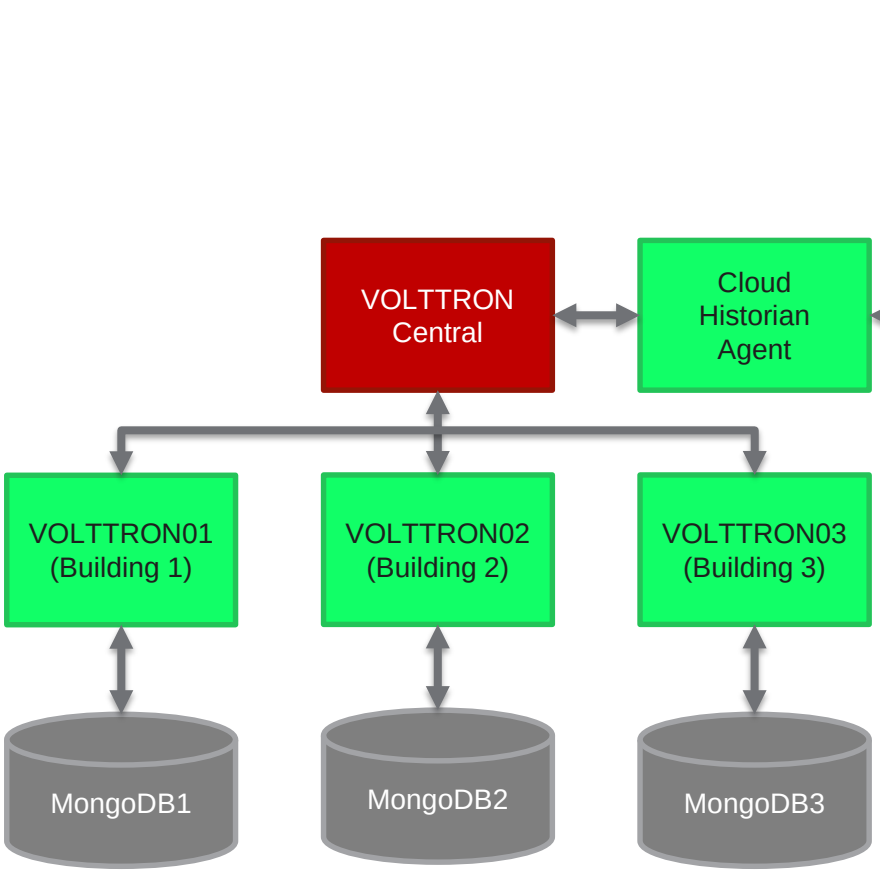
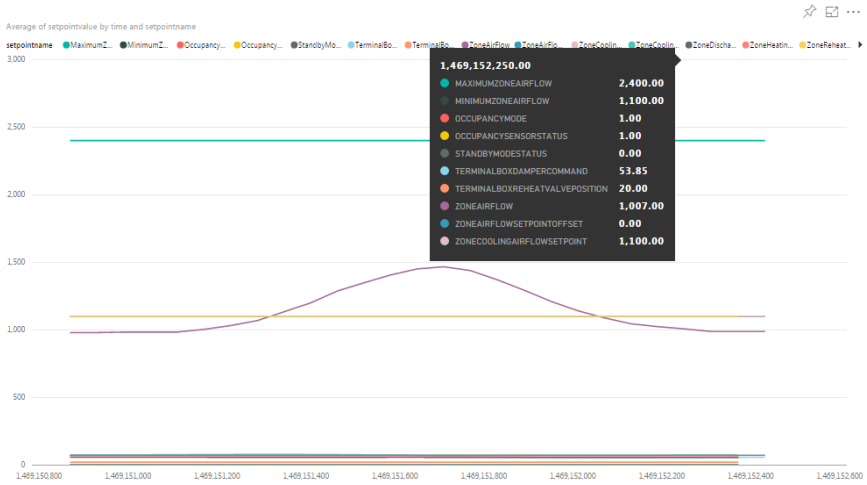
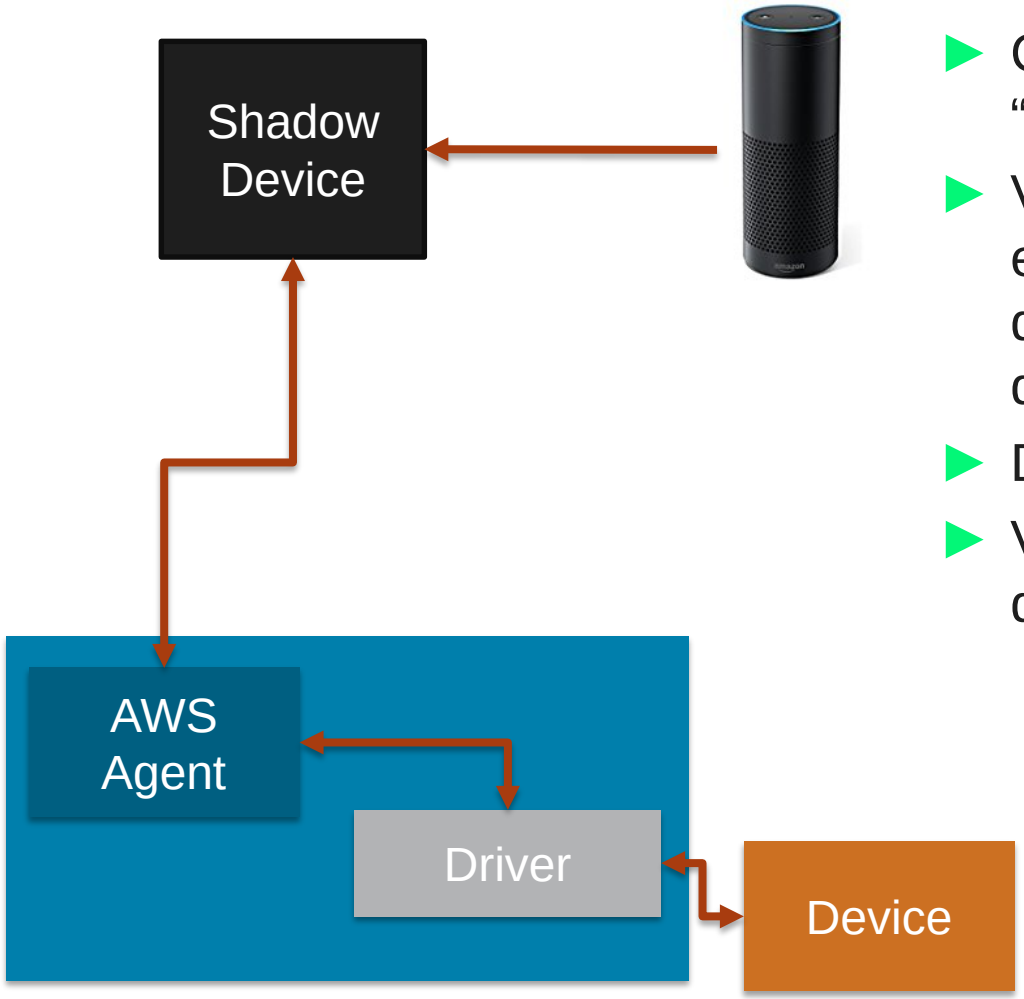




AWS Integration

"Alexa, increase set point"



- Command to Alexa modifies "shadow device" in AWS
- VOLTTRON™ agent receives event and sends a command to the driver interacting with the actual device
- Device reacts
- VOLTTRON™ agent receives new device state and sends it to AWS

VOLTTRON™ and Cloud Integration

- This project demonstrates the ease of integrating VOLTTRON™ platform's data collection capabilities with the Azure IoT and Amazon services
- The flexibility and interoperability of VOLTTRON™ allows users to leverage the capabilities of other products without locking them into a VOLTTRON™-only approach
- Once data from VOLTTRON™ is sent to cloud services, the full suite of their capabilities can be brought to bear for storage, analysis, and management
- This proof of concept allows users to interpret data through live data analytic visualization coupled with anomaly detection capabilities to automatically detect potential faults