VOLTTRON™: A Software Framework for Connecting Buildings and Grid

BORA AKYOL, JEREME HAACK, BRANDON CARPENTER

Fundamental and Computational Sciences Directorate
Richland, WA
Technology Challenges

- Too much data, not enough information
  - Rapid deployment of networked, affordable sensors and controllers
- Scalable and fault tolerant control and diagnostics
- Secure and reliable communication
- Tight, vertical integration of single vendor products
- Lack of a cross-vendor “App Store” for Energy Applications for best of breed solutions
- Evolving standards landscape for transactive energy
- Lack of a reference platform for R&D use
Application Challenges

- Managing end-use loads
- Increasing end-use efficiencies
- Integrating variable distributed generation
  - Solar
  - Wind
- Integrating storage at multiple layers
- Integrating electric vehicles (EV)
- Enabling energy coordination and trading between buildings and trading between buildings and grid
Distributed Systems Call for Distributed Solutions

- What happens in a neighborhood where everyone owns an EV and everyone comes home at the same time on a hot day?
- What if appliances in your house could communicate with each other to coordinate energy usage and shift load to off-peak times?
  - Customer sees lower bills
  - Utilities get more predictable and even load
  - Quicker response to variable power generation
Technology Solution Attributes

- Open, flexible and modular software platform
  - Ease of application development
  - Interoperable across vendors and applications
  - Hides power and control system complexities from developers
  - Object oriented, modern software development environment
  - Language agnostic. Does not tie the applications to a specific language such as Java

- Broad device and control systems protocols support built-in
  - ModBUS, BACNet, and others
  - Multiple types of controllers and sensors
  - Low CPU, memory and storage footprint requirements
  - Supports non-Intel CPUs

- Secure
  - Security libraries and cryptography built-in
  - Manage applications to prevent resource exhaustion (CPU, memory, storage)
  - Robust against denial-of-service (e.g. does not crash when scanned via NMAP)
  - Supports modern application development environments
Approach: VOLTTRON™ Platform

- VOLTTRON is a software platform for next generation distributed control applications for integrating buildings and power grid
  - Proven through simulation, prototypes and field deployments
  - Flexible, Modular and Language-agnostic
  - Open-source, easy to extend, already being used by external collaborators
  - Maintain security and manage platform resources
  - Services for applications to find each other
VOLTTRON Success Stories

► Ideal platform for Department of Energy to use for transactive energy research and demonstrations
► Enables decentralized, distributed or hierarchical control applications with fast, and easy code development
► Demonstrated with real hardware
  ■ Hardware testbed
  ■ EV Charging coordination at PNNL SmartHomes
  ■ Transactional Network Program
► Downloaded and used by:
  ■ Virginia Tech
  ■ LBNL
  ■ ORNL
► Funded by PNNL’s Future Power Grid Initiative
Transactional Network Example

- Cornerstone of DOE funded demonstration
  - Coordinate behavior of roof top HVAC units
  - Deploy researcher control algorithms
  - Provide single point of contact for
    - Appliances
    - Data historian
    - External resources

- Components
  - Researcher control algorithms
  - Cloud applications and resources
  - HVAC and other appliances
Conclusion

- VOLTTRON is the ideal platform for supporting DOE missions in buildings and grid
- Hardware and software to support this platform already exists and is affordable
- Proven through field deployments

VOLTTRON Resources
- Wiki: https://github.com/VOLTTRON/volttron/wiki
- Email: volttron@pnnl.gov
- Developer mailing list
- Bi-monthly office hours