



# VOLTRON™: A Software Framework for Connecting Buildings and Grid

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# 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

**Residential**

**Commercial**

**Industrial**

## ▶ 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



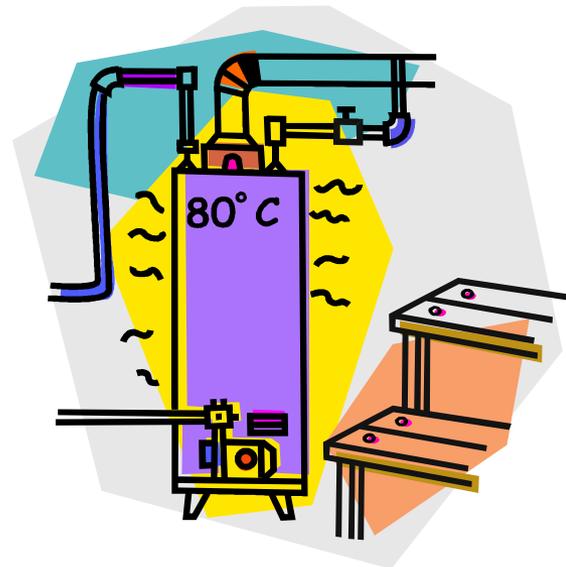
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# Distributed Systems Call for Distributed Solutions

- ▶ 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



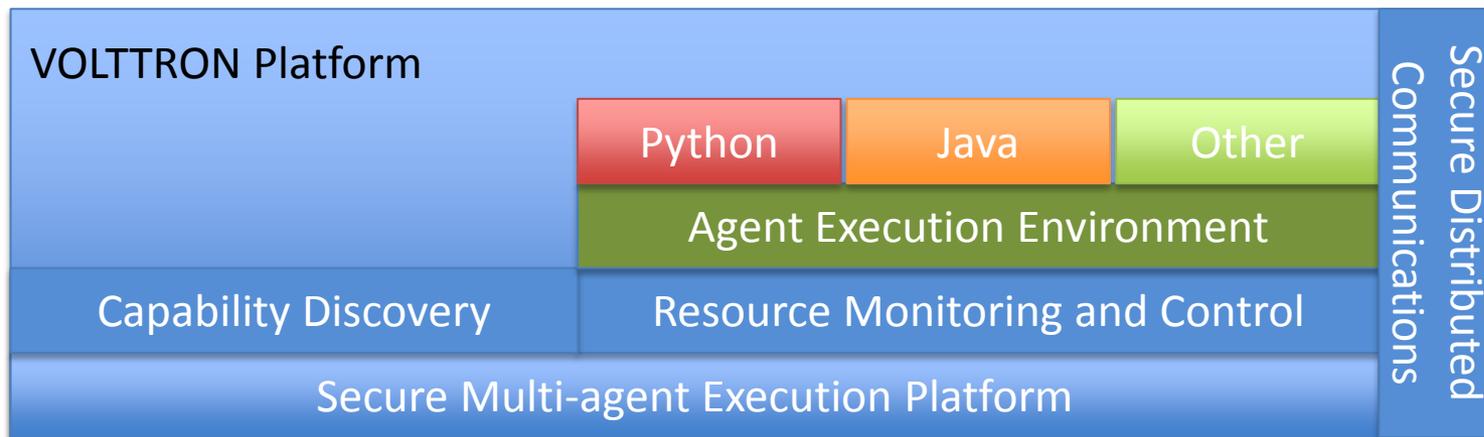


# Technology Solution Attributes

- ▶ 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: VOLTRON™ Platform

- ▶ VOLTRON 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



# VOLTRON 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

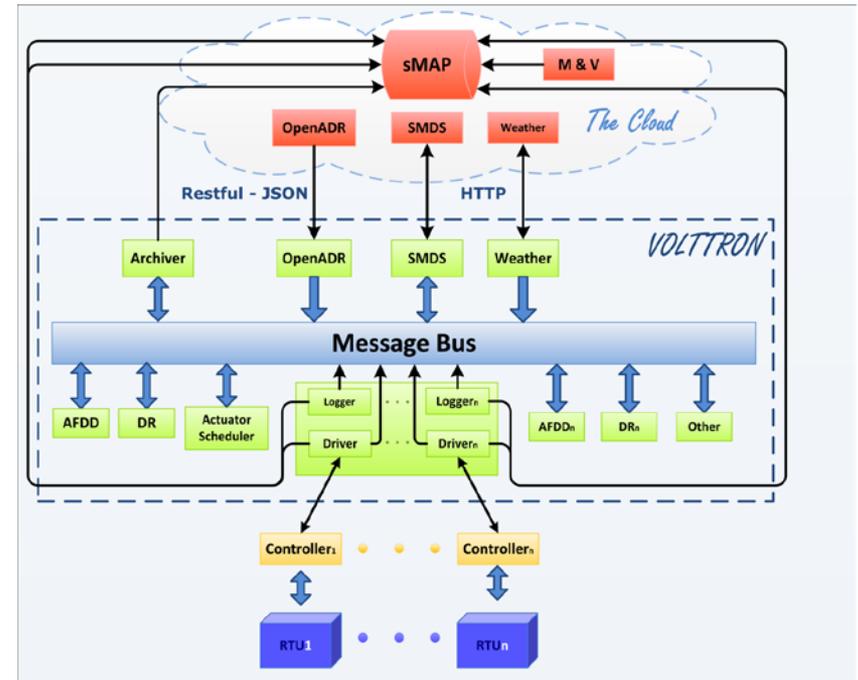
# Transactional Network Example

## ▶ 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
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- ▶ VOLTTRON Resources
    - Wiki: <https://github.com/VOLTTRON/volttron/wiki>
    - Email: [volttron@pnnl.gov](mailto:volttron@pnnl.gov)
    - Developer mailing list
    - Bi-monthly office hours

