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VOLTTRON™: Introduction and History

JEREME HAACK, SRINIVAS KATIPAMULA, BRANDON CARPENTER, BORA AKYOL

Pacific Northwest National Laboratory

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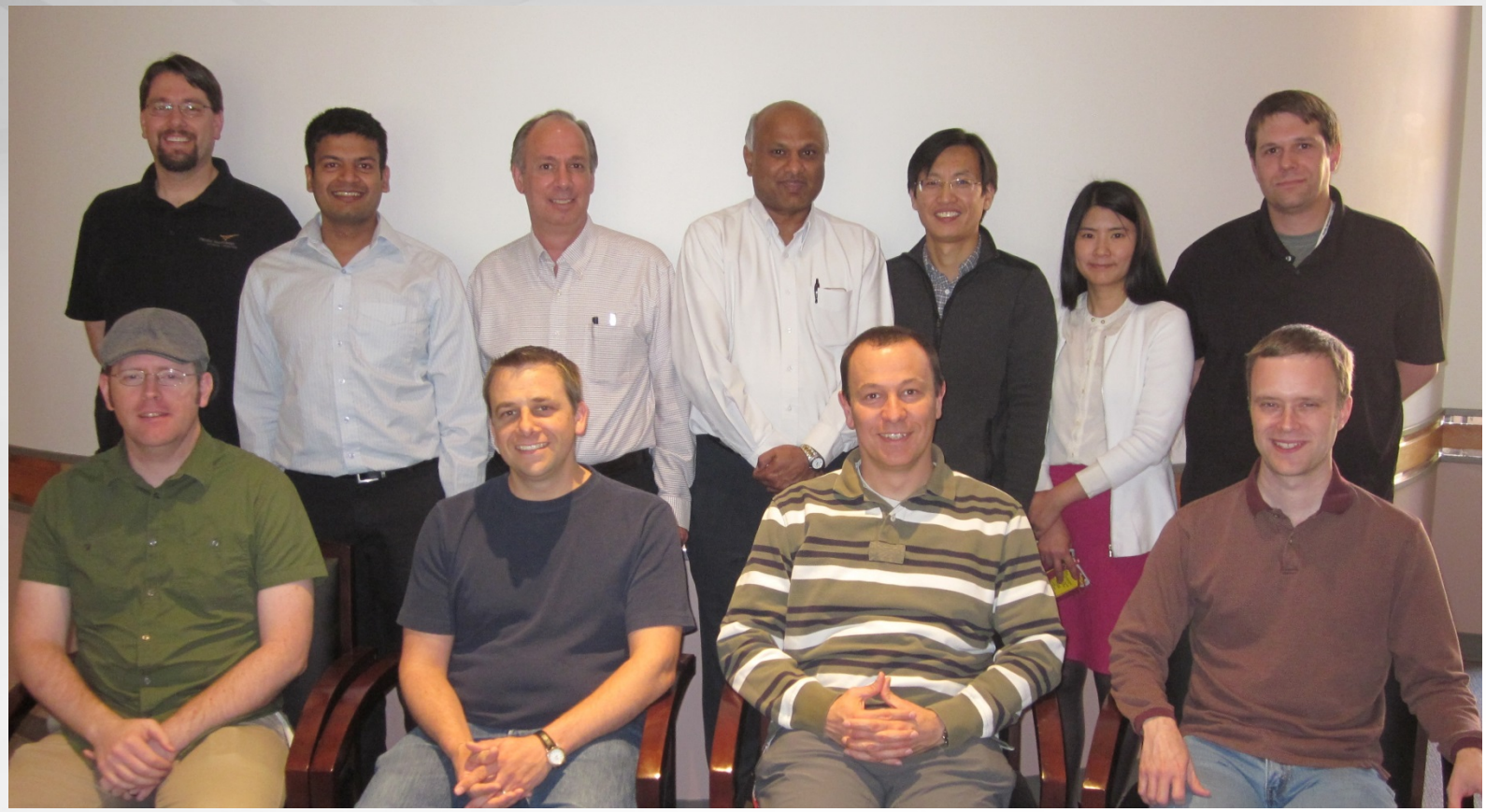
VOLTTRON Team



Presentation Outline

Background and Motivation

What is VOLTTRON?

Development History

DOE Funded Enhancements

Open Source

VOLTTRON Development Timeline

Future Power Grid Initiative

- Challenge

Accommodate Millions of Electric Vehicles

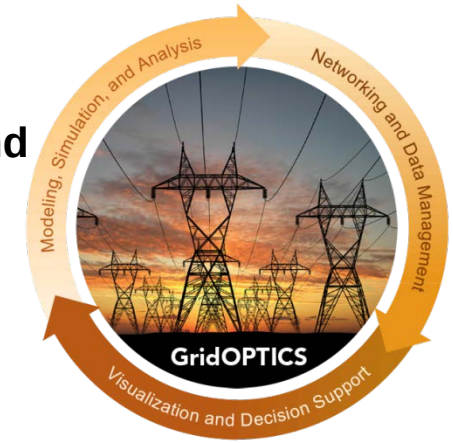
Manage Smart Loads

Integrate Renewables

Maintain Reliability

- Approach

Modeling and Simulation



Networking and Data Management

Visualization and Decision Support

- Impact
  - Bridging operation and planning to enable seamless grid management and control
  - Integrating transmission and distribution in end-to-end grid modeling and simulation
  - Managing large-scale data in real time with high reliability and security

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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- Background and Motivation
- **VOLTTRON**
- Development History
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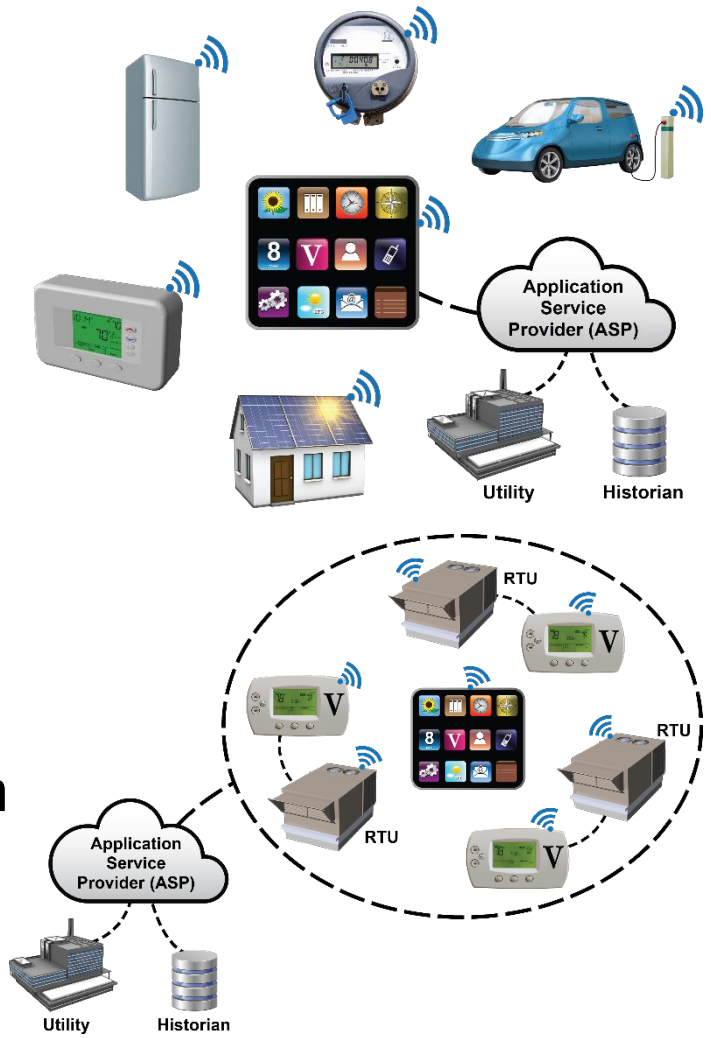
- Open Source
- VOLTTRON Development Timeline

What is VOLTTRON?

- VOLTTRON is an application platform (e.g. Android, iOS) for distributed sensing and control applications
- VOLTTRON is not a protocol
  - A protocol, such as SEP2.0. or OpenADR, are implemented as applications
- VOLTTRON is not an application such as demand response
  - Demand response can be implemented as an application on top of VOLTTRON
- VOLTTRON is open, flexible and already benefits from community support and development



VOLTTRON

- VOLTTRON is a platform that enables distributed sensing and controls
  - Flexible and extensible platform for allowing application developers to work with devices, external resources, and each other over a common interface without worrying about underlying details.
  - Drivers for Modbus and BACnet
  - Services for storing data, logging, accessing historical data, scheduling resources
  - Secure application packaging and communication
  - Open source, non-proprietary solution

- VOLTTRON is NOT a fully realized commercial grade product with a suite of applications already implemented to perform transactional actions
  - VOLTTRON enables application development. In and of itself, it is not an energy efficiency solution

VOLTTRON Attributes

- Open, flexible and modular software platform
  - Easy 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

Ruby C C# C++ Python Java Perl

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VOLTTRON Attributes (cont.)

- 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

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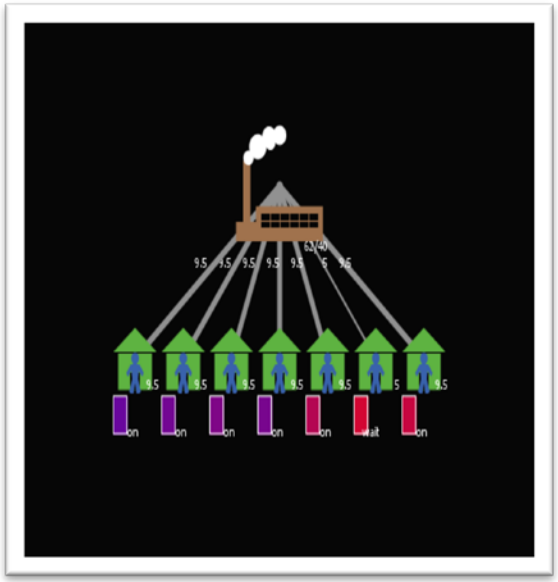
VOLTTRON LDRD

- Requirements gathering
- Initial simulations
- Build and deploy platform on demonstration testbed
- Deploy into instrumented home



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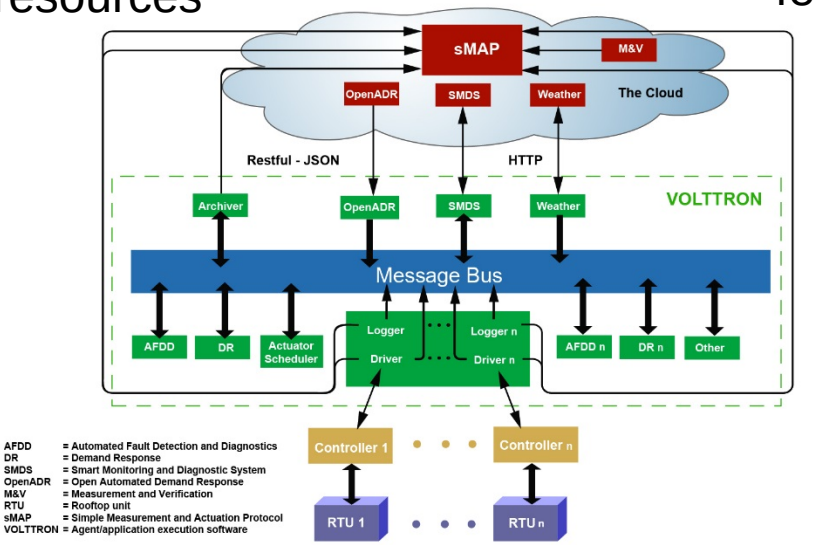
VOLTTRON Development Timeline

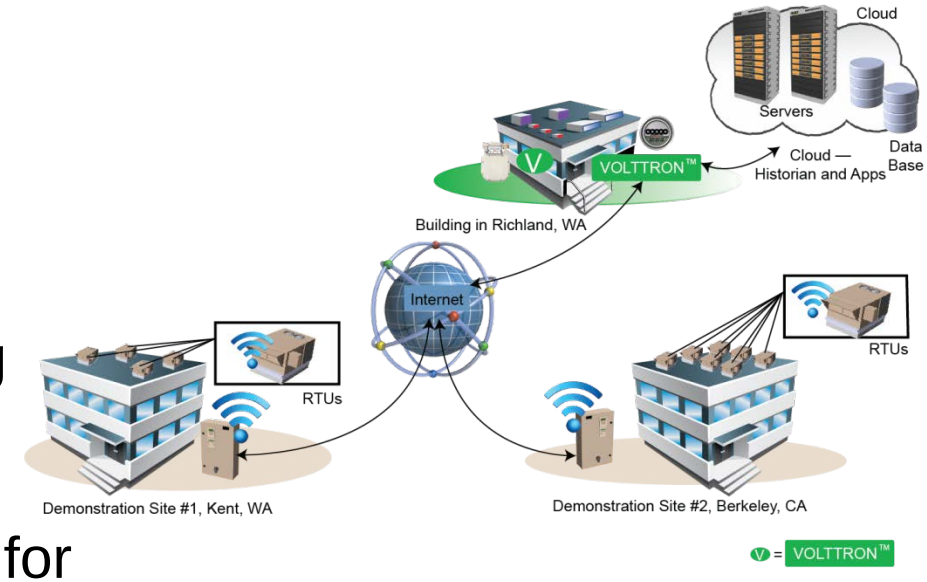
Transactional Network

- Integrating platform for DOE funded demonstration
  - Coordinate behavior of rooftop 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
- Open Source Requirement
  - Re-implementation of platform omitting patented features



VOLTTRON Deployments

- Transactional Network deployment
  - VOLTTRON controlling 11 HVAC units on 2 buildings
- PNNL Deployment
  - Deployed in PNNL building operations and control center
  - Agents prioritizing devices for load reduction
- Used by VT, ORNL, LBNL, others



Complementary Platforms/Services

- VOLTTRON is an open platform and can work with other platforms and services. This is not an either/or conversation
- VOLTTRON is a very general platform. Other services may provide more structure
- OpenADR – Provides a DR signal that can be published to the platform for use by agents which then make control decisions
- Energy Service Interface (ESI) – Could work together to provide a diverse set of services and execution environments
- IBM – Prototype interaction of signals from NW SmartGrid demo data publish to VOLTTRON

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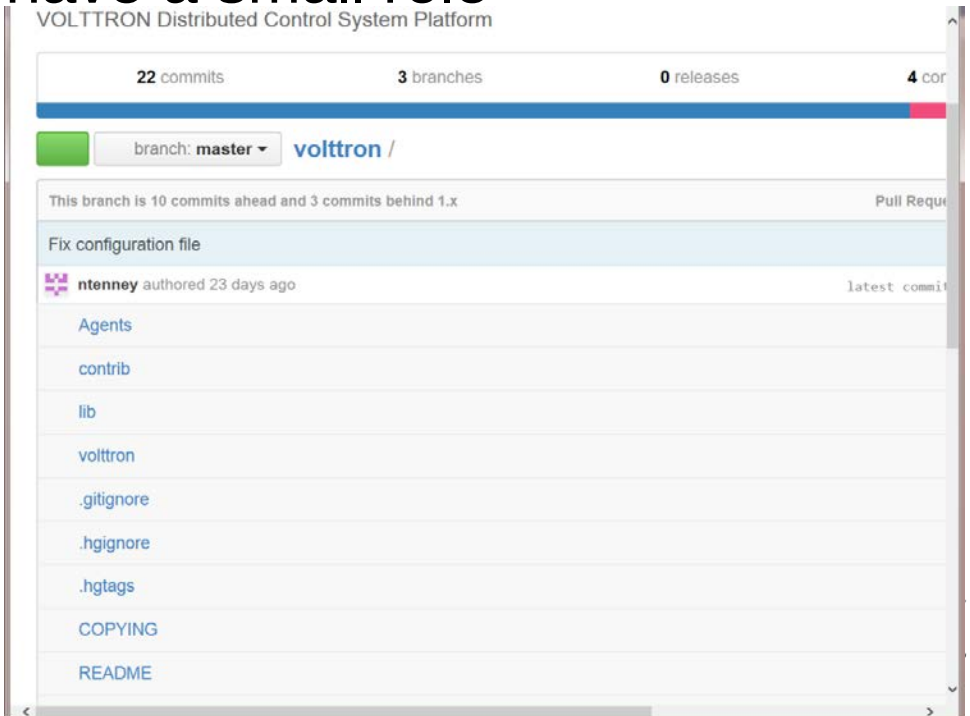
VOLTTRON Open Source

- VOLTTRON will transition to Transactional Energy Consortium
  - Further work funded by the consortium
  - Open source community
  - Members determine priorities and provide funds to support and improve the platform
  - BTO/DOE will need to have a small role to maintain the integrity of the user contributions (e.g. GridLab-D)



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Evolution of VOLTTRON FY10 – FY14

FY10 – FY13

- VOLTTRON Development - Future Power Grid LDRD
- EV Charging
- HVAC Control
- Proof of Concepts Demonstrations

FY13

- **Transactional Network Project**
- **RTU Controls, Diagnostics, Demand Response**
- **Real Time Measurement and Verification**
- **Autonomous RTU Controls**
- **MODBUS, Historian**
- **Proof of Concept with Multiple Sites**

FY14

- **Public Release of VOLTTRON 1.0, 1.1 and 1.2 and 2.0**
- **Security, Multi-Node Coordination, Robustness**
- **BACnet Support**
- **Lighting Diagnostics, on Demand Defrost, Intelligent Duty Cycling**
- **Continued Proof of Concept Demonstrations at Multiple Sites**

Evolution of VOLTTRON FY15 – FY16

FY15

- VOLTTRON 3.0 - Manageability, Scalability
- Connection to Many Energy Management Systems
- Initial Commercialization
- VOLTTRON Central
- Management & Monitoring Platform

FY16

- **Deployment by vendors**
- **VOLTTRON Consortium**
- **Transition to Community**
- **VOLTTRON Agent Development Challenge**

Questions?

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