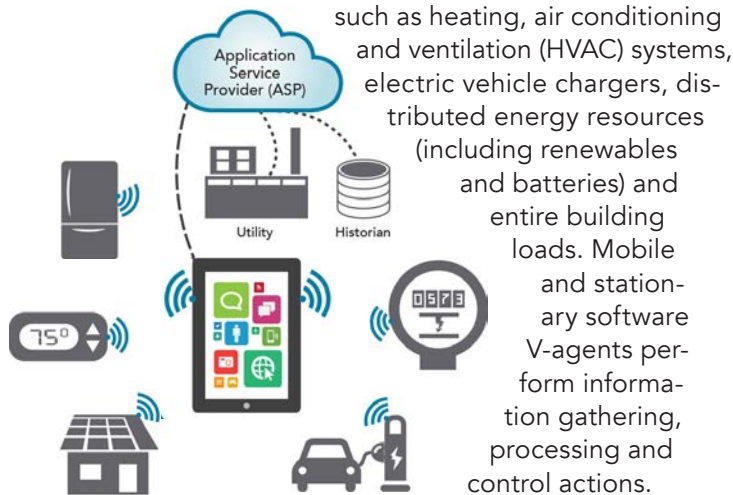


A Technology for Efficient Buildings and Integration of Distributed Energy Resources with the Grid

VOLTTTRON™, developed at Pacific Northwest National Laboratory, is a distributed control and sensing software platform. Used in concert with special applications known as V-agents, VOLTTTRON™ analyzes and converts growing data streams from today's buildings to actionable information that improves building operations, manages energy consumption and enables true integration of buildings with the electric grid. VOLTTTRON™ independently and securely manages a wide range of devices,



VOLTTTRON™'s Key Benefits:

Cost-effective – Open source software (free to users) and can be hosted on inexpensive computing resources

Scalable – Can be used in one building or a fleet of buildings

Interoperable – Enables interaction/connection with various systems and subsystems, in and out of the energy sector

Secure – Underpinned with a robust security foundation to combat today's cyber vulnerabilities and attacks

VOLTTTRON™'s Primary Use Areas:

Building Efficiency – To help control building energy system performance

Building-Grid Integration – To support "beyond demand response" approach and integration of distributed energy resources into the grid

Transactive Control – To support a scalable, distributed control mechanism for transacting information about systems, loads, and constraints to deliver user specified services

VOLTTTRON™ TIMELINE

» VOLTTTRON™ developed (September 2012)

2014

» Deployed in DOE Transactive Network Project (March)

» Released as open source software (April)

» First DOE-sponsored user forum (July)

» Release of Version 2.0 (September)

2015

» Second DOE-sponsored user forum (July)

» Release of Version 3.0 (September)

2016

» Deployed by Transformative Wave in Northwest buildings (Spring)

» Implemented in DOE Clean Energy and Transactive Campus Project (Spring)

» Deployed by Intellimation in D.C. buildings (Spring)

» Applied in DOE grid modernization projects (Summer)

» Third DOE-sponsored user forum (August)

» Release of Version 4.0 (September)

2017

» Fourth DOE-sponsored user forum (May)

» Incorporated in connected homes project in southeast U.S. (Fall)

» Release of Version 5.0 (September)

2018

» Planned transition to Eclipse Foundation

VOLTRON™: MORE THAN A DOZEN USABILITY ADVANTAGES

- » Open, flexible and modular software platform
- » Easy application development
- » Object-oriented, modern software development environment
- » Language agnostic
- » Low CPU, memory and storage requirements
- » Built-in weather service that retrieves info from any location
- » Cybersecurity features

Supports:

- » ZeroMQ distributed messaging
- » MODBUS and BACnet protocols
- » Both Intel and non-Intel CPUs
- » Collection of non-energy-related data (comfort, financial, etc.)
- » Platform services such as messaging, mobility and application support
- » Flexible Historian framework (enables use of preferred storage solution)
- » Many other protocols

COUNTING ON SECURITY

VOLTRON™ was designed with cybersecurity in mind, including features such as memory protection, resource constraints and guarantees, authentication, authorization, and trust. For applications that require software to “move” between platforms, VOLTRON™ supports secure application transport, including code, configuration and collected data.



VOLTRON™ + APPLICATIONS = SOLUTIONS

Key applications developed by PNNL and others to date:

- » Automated Fault Detection and Diagnostic V-Agent (for air-handling units or rooftop units)
- » Autonomous Control of Rooftop Units
- » Demand Response V-Agent (dynamic electric pricing)
- » Supermarket Refrigeration
- » Renewable Energy Integration
- » Automated Continuous Commissioning V-Agents for Air-Handling Units
- » Measurement and Verification
- » Intelligent Load Control V-Agent
- » Home Gateway



COAST-TO-COAST USE AND DEVELOPMENT

VOLTRON™ developers have built a nationwide community of more than 30 public and private sector users to apply the technology and help drive improvements. Two national laboratories—NREL and Oak Ridge—are among those that have provided key development contributions.

VOLTRON™ IN THE MARKETPLACE

Developers and services:

- » **Transformative Wave**—Small buildings
- » **Intellimation**—Commercial office buildings
- » **New City Energy**—Commercial and municipal buildings
- » **SkyCentrics**—Connected buildings



VOLTRON™ is available to the public for download. Visit <https://github.com/VOLTRON/voltrion> to learn more. Redistribution and use of VOLTRON™ in source and binary forms are permitted in accordance with VOLTRON™ Terms listed on GitHub.

An “Office Hours” users group has been formed to periodically discuss the technology and new developments. For general information about VOLTRON™ and/or the users group schedule, contact voltrion@pnnl.gov.

Web page: Voltrion.org