

Eclipse VOLTTRON[™] Proves Its Versatility and Value in Real-World IoT Deployments





Bringing VOLTTRON Technology to the Broadest Possible Community

hen the team at the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL) contributed the VOLTTRON software to the Eclipse Foundation in 2018, they created the ideal conditions to sustain the strong growth and adoption the platform was experiencing.

The Eclipse VOLTTRON project began in 2012 as an internal PNNL project in the Laboratory Directed Research and Development (LDRD) program. The distributed control and sensing software platform was made available as open source in 2014 and was being used in an increasingly wide variety of IoT applications, including:

- Automated fault detection, diagnostics, and continuous commissioning for air-handling units
- Autonomous control of rooftop units

- Dynamic electricity pricing based on demand
- Supermarket refrigeration
- Renewable energy integration
- Measurement and verification
- Intelligent load control
- Gateways for smart homes and buildings

As the breadth of the software's potential applications became apparent, the decision was made to move the software to a vendor-neutral open source community.



Eclipse Foundation Gives VOLTTRON Life Beyond the Lab

"PNNL had been building up the VOLTTRON platform over the years with funding from the U.S. Department of Energy's Building Technologies Office (BTO)," explains George Hernandez, the Eclipse VOLTTRON project lead. "The BTO wanted to ensure the platform would have a life outside of PNNL. We felt it should have its own community, and its own users that could drive the direction of the platform, find the right use cases for the technology, and contribute back to the software."

After evaluating other open source options, Hernandez chose the Eclipse Foundation to host the project. "We chose the Eclipse Foundation because it provided exactly what we were looking for — the governance and supporting infrastructure to build a vendor-neutral, open source ecosystem that gives all stakeholders the opportunity to participate in a more meaningful way," he says.

ACE IoT Solutions Specializes in Eclipse VOLTTRON Technology

ACE IPT

ACE IoT Solutions is a software development company based in Chattanooga, Tennessee. The company leverages open source technologies, including the Eclipse VOLTTRON platform, to provide its customers with low-cost approaches to acquire, access, and manage data from distributed control systems and sensors. ACE IoT Solutions has incorporated Eclipse VOLTTRON technology into customized solutions for manufacturers, municipalities, renewable energy companies, and others.



An Open, Flexible Platform for Data Collection, Management, and Analysis

clipse VOLTTRON is a software platform for distributed sensing and control. It provides a cost-effective, scalable, and secure foundation for any application that needs to collect, manage, and analyze data streams from almost any system or subsystem (Figure 1).



Figure 1: Eclipse VOLTTRON Platform Overview

"VOLTTRON is an enabling technology that allows people to do whatever they need to do without tying them to specific hardware or proprietary code." —Jereme Haack

The freedom and flexibility VOLTTRON software enables is one of the main reasons the platform is used in such a wide range of IoT applications. "VOLTTRON is an enabling technology that allows people to do whatever they need to do without tying them to specific hardware or proprietary code," explains Jereme Haack, a senior research scientist at PNNL and an active member of the Eclipse VOLTTRON project.

In some cases, organizations that adopt the VOLTTRON platform develop the higher level application on their own.

"Because the software is written in Python and includes a number of tools that simplify tasks, such as moving data, organizations with in-house Python expertise can easily build on the Eclipse VOLTTRON platform," says Haack. "For example, one of our adopters is using the VOLTTRON platform to develop a plug-and-play control system for thermostats."

Other organizations partner with companies, such as ACE IoT Solutions and Intellimation, to develop applications based on VOLTTRON and, in some cases, manage the application on their behalf.



With the many different ways the Eclipse VOLTTRON platform can be used, it has proved its value as a:

- Reliable, cost-effective, and convenient data acquisition solution
- Protocol-agnostic platform to effectively manage building automation, building operations, and energy usage data
- Platform to develop and deploy applications that control distributed energy resources



Washington, DC, Uses Eclipse VOLTTRON to Increase Energy Efficiency

he city of Washington DC's Department of General Services (DGS) is using Eclipse VOLTTRON as part of its efforts to re-commission building systems to improve their efficiency. To support the initiative, the DGS evaluated several approaches that would allow the agency to:

- Acquire granular energy data from building systems
- Create time-series trending of that data in the cloud
- Enable access to the data gathered from multiple buildings across its portfolio using a single system

The solution had to:

- Bring together the data from multiple buildings and a variety of heating, ventilation, and air conditioning (HVAC) and controls systems into a standard data format and common operations management interface.
- Enable DGS to own and control its data and to select analytics applications and other solutions that would meet the city's current and future objectives without being locked into a specific vendor.

Zach Wilson, managing partner at New City Energy, led the DGS project and is very familiar with the VOLTTRON technology.

"There are so many things you can do with data access and granular visibility into HVAC systems performance," Wilson says. "Eclipse VOLTTRON is the only platform that provides the performance data and visibility in a vendor-neutral cloud where many advanced applications can access it. With other solutions that provide these kinds of capabilities, you're typically locked in to a specific vendor, their applications, and the fees they charge to access the data and run the applications. In contrast, with Eclipse VOLTTRON, a customer can self-administer data flows or choose any vendor to support the data flows."

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DGS deployed the Eclipse VOLTTRON platform as a secure, integrative layer that collects and manages data from controllers, switches, meters, submeters, and other building devices. The VOLTTRON appliance can be installed by a DGS facilities team member or an HVAC vendor in an hour or two and, in most cases, data is streaming to the cloud the same day.

As of September 2019, data from more than 60 buildings is being sent to Washington DC's cloudbased building performance data hub. The DGS and its partner organizations have used the data to:

- Implement re-commissioning initiatives
- Monitor results from building re-tuning
- Leverage energy data analytics software
- Make data-driven decisions about how to most effectively and efficiently achieve its energy efficiency and carbon reduction goals

Wilson says it's difficult to quantify the exact energy savings these steps enable due to fluctuating energy prices, concurrent energy-saving measures, and other factors. The most accurate estimates available indicate the initiatives have saved the city approximately \$1.5 million per year in energy costs.



Penn State University Enables Data-Driven Facilities Management

enn State University (PSU) has partnered with ACE IoT Solutions and Onboard Data to use Eclipse VOLTTRON in a pilot project to reduce the cost and time required to manually tag and map data so it can be used in advanced building analytics applications. The goal was to evaluate new approaches that help drive widespread adoption of data-driven facilities management technologies.

To fully realize the promise of data-driven facilities optimization and algorithmic automated fault detection, the PSU facilities professionals needed:

- Data acquisition tools
- Data tagging
- Algorithms and machine learning applications

PSU and its project partners use Eclipse VOLTTRON as part of a convenient, low-cost, and secure solution to obtain data from PSU building automation systems, elevators, and other building systems. They can then leverage advanced data science techniques to automate data tagging and data mapping.

Based on the results of a 10-building pilot project, PSU has successfully automated point mapping with a level of accuracy that significantly reduces the level of manual labor required to prepare a building for data-driven facilities management.



Energy-Provider, Southern Company, Creates Smart Neighborhoods That Optimize Energy Use

he potential for Eclipse VOLTTRON goes well beyond smart building applications," notes Bill Maguire of ACE IoT Solutions. "For example, Southern Company is using VOLTTRON in Smart Neighborhood projects that encompass solar and battery power."

The projects in suburban Birmingham, Alabama, and the Upper West Side of Atlanta, Georgia, received funding from the BTO and encompass a total of 108 homes. Both projects include the use of photovoltaic (PV) and battery energy storage systems (BESS) to optimize energy usage and delivery. They also illustrate the increasing promise of grid-interactive efficient buildings (GEB).

Each Smart Neighborhood home has a dedicated Eclipse VOLTTRON instance that connects the home to a network that uses VOLTTRON agents to interact with the home's HVAC and water heating systems. Based on data inputs including weather, solar irradiance, load forecasts, and time-of-use pricing, the network can optimize battery storage and power generation to minimize overall system cost.

The Smart Neighborhood homes are 50 to 60 percent more energy efficient than a conventional home, and feature a home energy rating system (HERS) score that is 40 points lower than a typical single-family home built in 2017.



University of Toledo Uses Eclipse VOLTTRON to Manage Connected Energy Assets

t the Scott Park Campus of Energy and Innovation at the University of Toledo, the University's Facilities and Engineering departments are using Eclipse VOLTTRON to connect the campus' photovoltaic (PV) panels, building automation systems, and battery energy storage systems (BESS) in a demonstration project.

In this case, the Eclipse VOLTTRON platform provides a common framework to dynamically control elements of the various connected systems and allow them to be abstracted into a common, protocol-agnostic platform. The university can use the common platform to develop and deploy applications that deliver maximum value from the connected energy assets.

According to project directors at the University of Toledo, the Scott Park Campus deployment has successfully demonstrated effective strategies for controlling PV and BESS energy sources in a campus environment. The project provides a roadmap for universities to use distributed solutions with no need to rely on expensive, single-vendor centralized command and control systems.

The partnership between university departments also demonstrates the value the open source Eclipse VOLTTRON software provides as a platform for faculty and students to pursue innovative research initiatives.



Monroe, Louisiana, Furthers Smart City Goals With Remote Water Level Measurement

he city of Monroe, Louisiana, is using an ACE IoT solution that includes the Eclipse VOLTTRON software to automatically collect and deliver real-time water level measurements for Lake Bartholomew and two reservoirs outside the city. "This is a great example of how utilities can use Eclipse VOLTTRON to support remote monitoring of connected devices," says ACE IoT's Maguire.

The measurements from the connected devices are provided in a dashboard to Monroe's Water Systems team and other interested parties, including the Bayou Bartholomew Homeowners Association and Tensas Basin Levee District.

The water level measurements are key inputs to the city's flood prevention efforts. The data also informs the region's water treatment plan, and can trigger authorities to issue advisories for recreational boating. Because the solution is automated, the City's Water Systems team no longer spends two to three hours a day manually collecting water measurements. With remote water meters and the Eclipse VOLTTRON-based ACE IoT platform, the City of Monroe can provide remote water level monitoring dashboards for as little as \$50.00 per month. And the city takes another step toward its goal of combining technology, information, and civic engagement to become a smart city.

Eclipse VOLTTRON Has a Bright Future

ooking ahead, several marketplace developments and trends are likely to further increase demand for Eclipse VOLTTRON:

- Growing adoption of the tagging schema developed as part of <u>Project Haystack</u>, an open source initiative to streamline working with IoT data
- Increasing numbers of utility companies that offer incentives to re-commission buildings
- Stronger regulations for municipal building data benchmarking and transparency
- Continued development of data-driven machine learning and artificial intelligence solutions for optimizing building operations

As the Eclipse VOLTTRON ecosystem grows, the vision is that it will become open source middleware that allows integration and management of the disparate systems that contribute to the performance of smart and connected buildings (Figure 2).

To learn more about Eclipse VOLTTRON, find out how to participate in the VOLTTRON community, and contribute to the VOLTTRON project and open source initiative, visit <u>volttron.org</u>.

To receive monthly updates about significant Eclipse VOLTTRON developments and engage with other members of the ecosystem, <u>subscribe</u> to the Eclipse VOLTTRON ecosystem mailing list.



Figure 2: Vision for the Eclipse VOLTTRON Ecosystem

ECLIPSE FOUNDATION

About the Eclipse Foundation

The Eclipse Foundation provides its global community of individuals and organizations with a mature, scalable, and business-friendly environment for open source software collaboration and innovation.

The Foundation is home to the Eclipse IDE, Jakarta EE, and more than 375 open source projects, including runtimes, tools, and frameworks for cloud and edge applications, IoT, AI, automotive, systems engineering, distributed ledger technologies, open processor designs, and many others.

The Eclipse Foundation is a not-for-profit organization supported by more than 300 members, including industry leaders who value open source as a key enabler for their business strategies.

The Eclipse Foundation's <u>Eclipse IoT Working Group</u> hosts more than 45 open source IoT projects, helping organizations across IoT technology domains find new ways to collaborate and build end-to-end IoT solutions that cannot be developed by a single organization on its own. In addition to Bosch, Eurotech, and Red Hat, companies such as Microsoft, Arm, Intel, Sierra Wireless, Otokar, and ADLINK also participate in Eclipse IoT projects.

To learn more about the benefits of membership in the Eclipse Foundation, visit <u>eclipse.org/membership</u>.

To stay connected with the Eclipse Foundation, follow us on Twitter <a>@EclipseFdn, <a>LinkedIn, or visit <a>eclipse.org.

To learn more about the Eclipse IoT Working Group, visit <u>iot.eclipse.org</u>.

To stay connected with the Eclipse IoT Working Group, follow us on Twitter <u>@EclipseIoT</u>.