



**Pacific Northwest**  
NATIONAL LABORATORY

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# VOLTRON™ Technical Overview

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VOLTRON™ 2016

# Overview



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- ▶ Motivation
- ▶ Internal Development
- ▶ DOE Development
- ▶ Future



# What is the VOLTRON™ Platform?

- ▶ VOLTRON™ is an application **platform** (e.g., Android, iOS) for distributed sensing and controls
  - Open, flexible, and modular
  - Scalable
  - Built in features to streamline application development
  - Secure communication (e.g., security libraries/cryptography)
  - Platform services





# Enabling Hardware and Software

- ▶ Code is open source and available on github
  - <https://github.com/VOLTTRON/voltron/>
- ▶ Linux as target platform
- ▶ Designed to run on small form factor computers
  - PandaBoard\*
  - Beagle Bone Black
  - Intel NUC
  - Desktop computer/server
- ▶ Python 2.7
  - 0MQ: Message bus (<http://zeromq.org/>)
  - PyModbus: Used by driver to enable interaction with MODBUS devices. (<https://code.google.com/p/pymodbus/>)
  - BACPytes: Python module for BACnet communication (<http://bacpytes.sourceforge.net/>)
  - Wheel: Used for agent packaging in 2.0 (<https://pypi.python.org/pypi/wheel>)
  - Several other libraries used





# Pillars of VOLTRON™

- ▶ Flexibility - The platform should be flexible to meet requirements for a varied set of solution spaces
  - Deployment – Can be installed on a variety of hardware with differing capabilities
  - Topology – Can be arranged in differing topologies to meet the needs of specific implementations
  - Services – Components of the platform can be easily added to/replaced
  
- ▶ Usability – The platform should be both easy to use and straightforward to develop
  - Development – It should be clear how to develop agents and services for the platform. Developers should have the insight and feedback to ease development
  - End User – The platform should provide services that enable the development of high quality user interfaces to simplify deployment, installation, and management of the end solution



# Pillars of VOLTRON™ (cont'd.)

- ▶ Scalability – The platform should enable deployments at scale through proper deployment and division of resources
  - Number of platforms
  - Number of agents
  - Number of devices
- ▶ Security – The platform must be secure to protect the devices being controlled and not provide a “backdoor”
  - Platform integrity – The platform must protect itself from subversion
  - Infrastructure integrity – Recommendations for securing the underlying resources used by the platform
- ▶ Interoperability – The platform must work across vendors and protocols and provide capabilities to simplify these interactions
  - Data standard – A standard data format and naming convention would allow applications written by different organizations to easily talk with each other and the devices being controlled.
  - Interface library – A library of interfaces allowing the platform to communicate with a variety of devices through standard (Modbus, BACnet, etc.) or custom protocols.



# Terminology

- ▶ Platform – VOLTTRON™
- ▶ VAgent – A process executing within the VOLTTRON™ platform communicating on the message bus.
  - Python VAgents extend the BaseAgent class in the VOLTTRON™ code base
- ▶ Application – One or more VAgents working with each other and platform services to achieve some goal
  - Fault Detection Agent
  - Intelligent Load Control
- ▶ Service – A VAgent which provides a capability to applications and the platform. Services *enable* applications but are not applications themselves.
  - Historians
  - Drivers



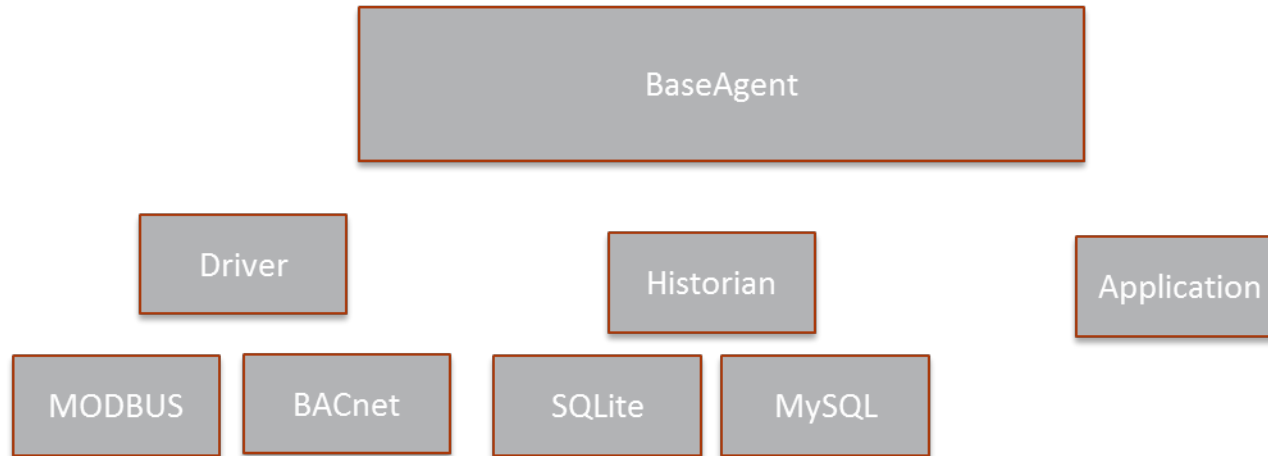
# Terminology (cont'd.)

- ▶ Driver – A VAgent which wraps communication with a device or devices.
  - Handles specific protocols required
  - Allows applications to interact with devices via the message bus
- ▶ Historian – A VAgent which subscribes to the message bus and stores messages for later retrieval.
  - Can be implemented to work with any storage solution
- ▶ Message Bus – The integrating service which allows the actors in the platform to communicate with each other
- ▶ VIP – A protocol built on top of ZeroMQ which allows for secure communication between platforms





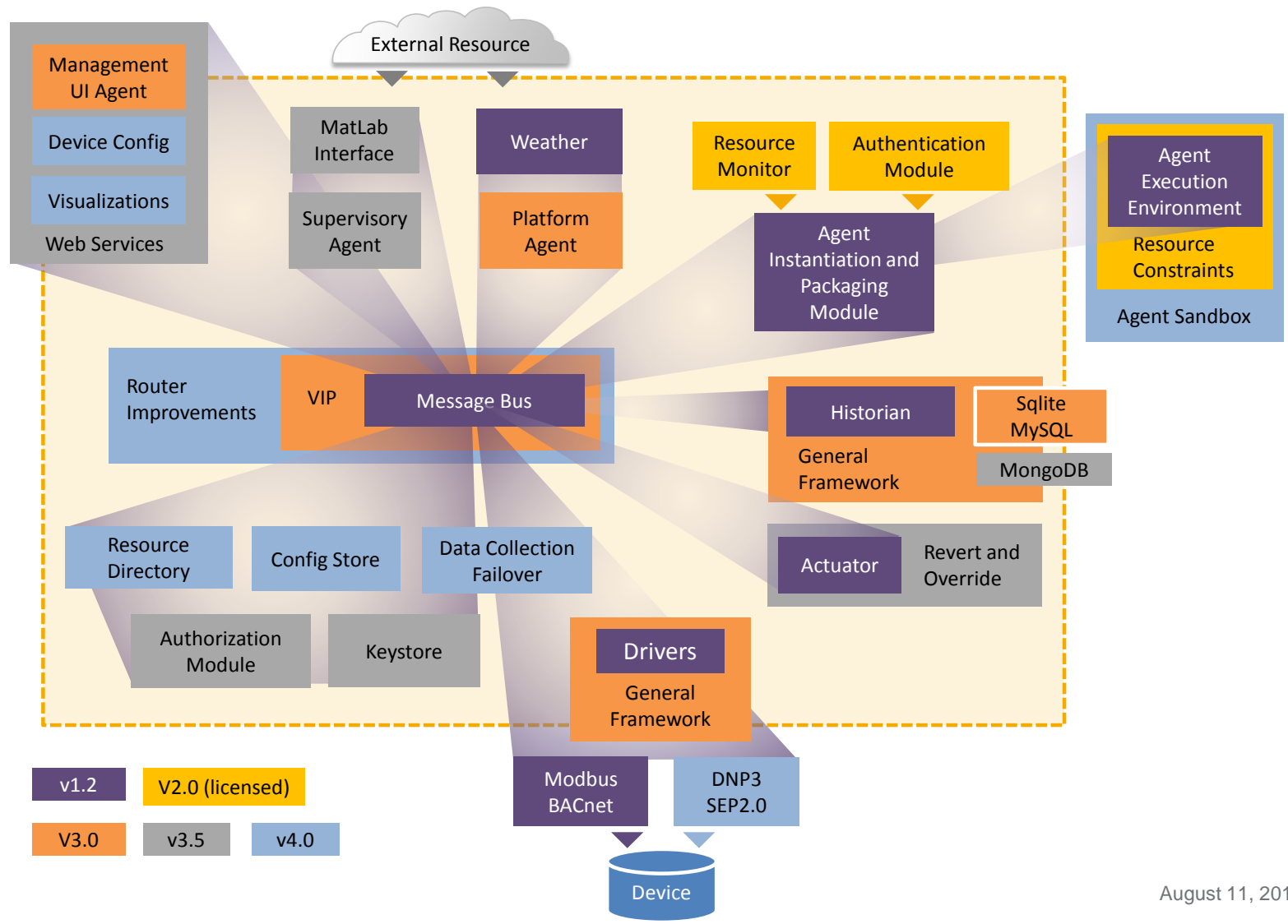
# Agents and Services



- ▶ Base agent provides the boiler plate code for interacting with the platform
  - Provides a base for implementing applications
- ▶ Services such as drivers and historians are also built upon the base agent
  - Provide their own frameworks for implementing specific instances



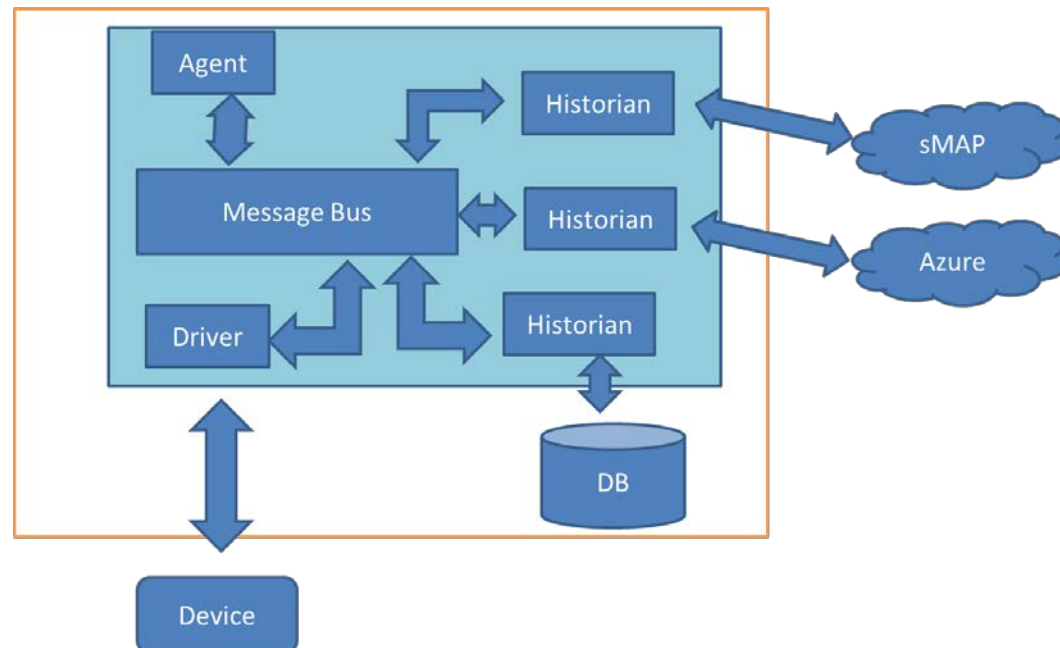
# Features Overview





# Modularized Historian

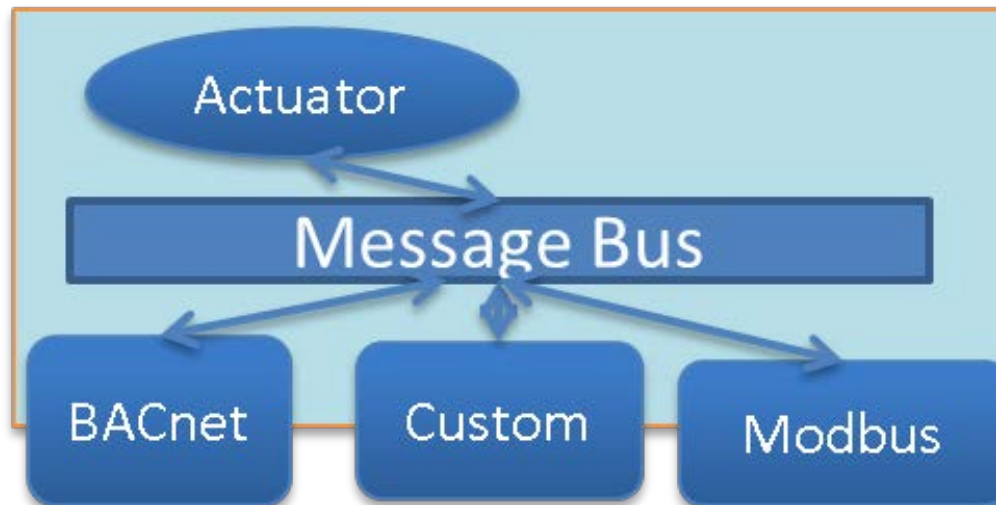
- ▶ Historians can be built for any storage solution
- ▶ Previous versions did not have option for local storage
- ▶ BaseHistorian
  - Can be extended for any solution
  - Handles subscribing to Bus
  - Local cache





# Modularized Drivers

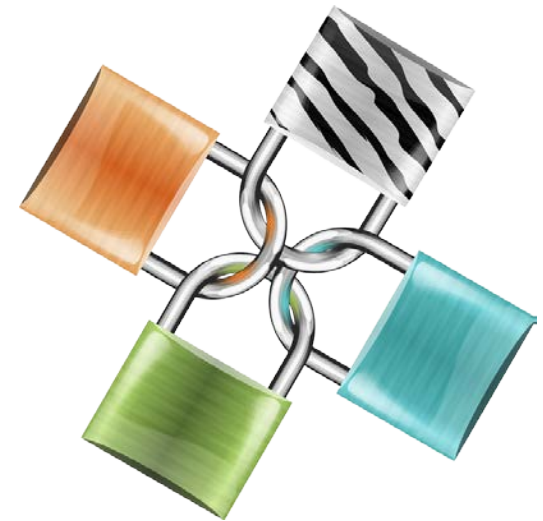
- ▶ Standardized creating custom drivers to scrape data and publish to the message bus.
- ▶ Simplify developing drivers and contributing new capabilities back to VOLTTRON™.
- ▶ Abstracted out driver interfaces allowing Actuator Agent to handle controlling devices via any protocol





# VOLTTRON™ Interconnect Protocol

- ▶ Increase security of the message bus and allow direct communication where appropriate
  - Platform – service
  - Agent – service
  - Agent – Agent large transfer
- ▶ Communication model underneath VOLTTRON™ Message Bus
  - Compatibility layer so changes are transparent to existing agents
- ▶ VOLTTRON™ now requires only a single socket
- ▶ Message Bus can be secured
  - Authenticated publishers
  - Publishers can limit subscribers





# Management Agent

- ▶ PlatformAgent acts as manager for the platform
  - Sends commands to agents
  - Enables monitoring of health of agents and platform
  - Exposes status to other platforms/web console
  - Support for applications which analyze data and issue alerts (behavior out of norm)

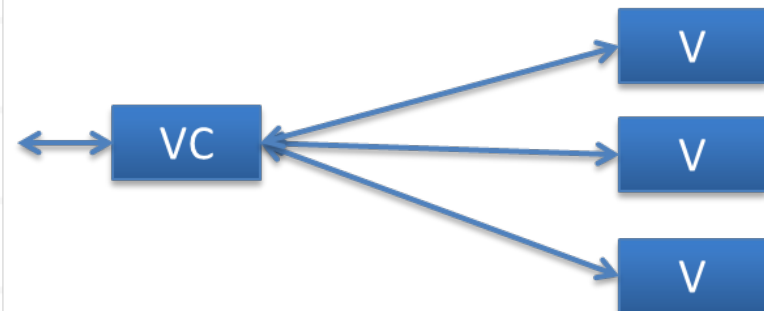




# VOLTTRON™ Management Central

- ▶ Improve visibility of deployed platforms
- ▶ Previous interface to the platform “admin centric”
- ▶ Makes use of the service exposed by the Management Agent
- ▶ VOLTTRON™ Management Dashboard
  - Allow for better insight into the state of the platform and agents
  - Does not require expert user
  - Quickly see overview of platforms being monitored

VOLTTRON™	
<b>Platforms</b>	
<b>Beagle EV2</b> ab0c25fd-3718-4222-ad25-ae44d2a5cdaa	Agents: 3 running, 0 stopped, 4 installed
<b>Panda1 WH1</b> b8eFdf20-825c-4382-900d-003eaa1d1be	Agents: 3 running, 0 stopped, 3 installed
<b>Pandas 2 EV1</b> 8785999d-e298-47b2-bb23-8a369240d220	Agents: 3 running, 0 stopped, 4 installed
<b>Rock WH2</b> c4b3282e-7517-4a8b-b76d-cfe5833ed7a6	Agents: 3 running, 0 stopped, 4 installed
<b>VC Platform</b> b5c34fd-88ed-412b-8a4c-aa4d60ec7ae5	Agents: 3 running, 0 stopped, 4 installed





# Support Mechanisms

This repository Search Pull requests Issues GIs

VOLTRON / volttron

Code Issues (273) Pull requests (4) Boards Burndown

VOLTRON Distributed Control System Platform — Edit

1,689 commits 5 branches

Branch: master New pull request

jhaack Merge pull request #603 from VOLTRON/master-env-fix

- applications Update README.md
- examples Bumped versions of agents up.
- lib #199: update copyright

- TCP replay attacks are rejected but no exception is logged **security** #666 opened 5 days ago by fsthrk ||| New Issues
- Denial of Service to VOLTRON Central does not allow a service to operate #665 opened 5 days ago by fsthrk ||| New Issues
- Possible Improvements for VC and Platform Agent #661 opened 14 days ago by mikroup ||| New Issues
- setting min/max for chart y axis doesn't work **bug** #659 opened 18 days ago by jchap-pnnl ||| Ready To Merge

Travis CI Blog Status Help

Search all repositories

My Repositories

- VOLTRON/volttron #1741
  - Duration: 1 hr 12 min 19 sec
  - Finished: 44 minutes ago
- craig8/volttron #33
  - Duration: 1 hr 13 min 15 sec
  - Finished: about 20 hours ago
- jhaack/volttron #15
  - Duration: 48 min 45 sec
  - Finished: 12 days ago

VOLTRON / volttron

Current Branches Build History Pull Requests Build #1

develop Specify weather or not to daemonize modbu

- Commit f43ddb1
- Compare 7fe793b..f43ddb1
- Kyle Monson authored and committed

```

1 Worker Information
2 Build system Information
3
4
5 $ export DEBIAN_FRONTEND=noninteractive
6 2.7.6 is not installed; attempting download
7
8 rw: cannot remove '2.7.6.tar.bz2': No such file or directory
9 $ git clone --depth=50 --recursive https://github.com/volttron/volttron.git

```

stackoverflow.com/questions/tagged/voltron

0 votes How to subscribe to different topics in Volttron

When I use the following code to subscribe to a topic, I can not use the same code to subscribe to some different topic. How can I subscribe to different topics? @PubSub.subscribe('pubsub', '...'

2 answers 9 views

asked 2 days ago Amin Mirakhorly 26 2

0 votes VOLTRON Agents Naming

When I install my agents in VOLTRON platform, all of them are assigned the same name "Agentagent-3.0". I can change part of its name in setup.py. But, I don't know the right way to give a name to ...

1 answer 12 views

0 votes Setting up Volttron

I have some question about content (html, css, js) ...

1 answer 12 views

## VOLTRON™ Office Hours

VOLTRON *office hours* occur every other week (Fridays at 11 a.m. PT), and are attended by the development team and members of the community. Meetings may have selected topics, but they are intended to provide an open forum for questions ranging from "How do I get started?" to detailed discussions of a specific VOLTRON feature.

To join our office hours, email [voltron@pnnl.gov](mailto:voltron@pnnl.gov).

## Playback recorded VOLTRON Office Hour sessions



VOLTRON Office Hours - June 24, 2016

Chad Corbin of PNNL presented the *Transactive Control of Commercial Building HVAC multi-agent VOLTRON application* (recording is audio-only, download PDF of presentation [here](#)). PNNL-SA-119047



VOLTRON Office Hours - June 10, 2016

Discussion of creating a data model for adding context to VOLTRON data, presentations on integrating VOLTRON with MATLAB and the FNCS project, and an update on data aggregation historians. PNNL-SA-118861



# VOLTTRON™ Resources

- ▶ GitHub
  - Codebase: <https://github.com/VOLTTRON/volttron.git>
  - Issues and requests: <https://github.com/VOLTTRON/volttron/issues>
  
- ▶ Documentation: <http://volttron.readthedocs.io/en/develop/>
  - Documentation is per branch
  
- ▶ StackOverflow: <http://stackoverflow.com/questions/tagged/volttron>
  
- ▶ Email: [volttron@pnnl.gov](mailto:volttron@pnnl.gov)
  
- ▶ Bi-weekly office hours, email to be added
  - Recordings: <http://bgintegration.pnnl.gov/volttronofficehours.asp>