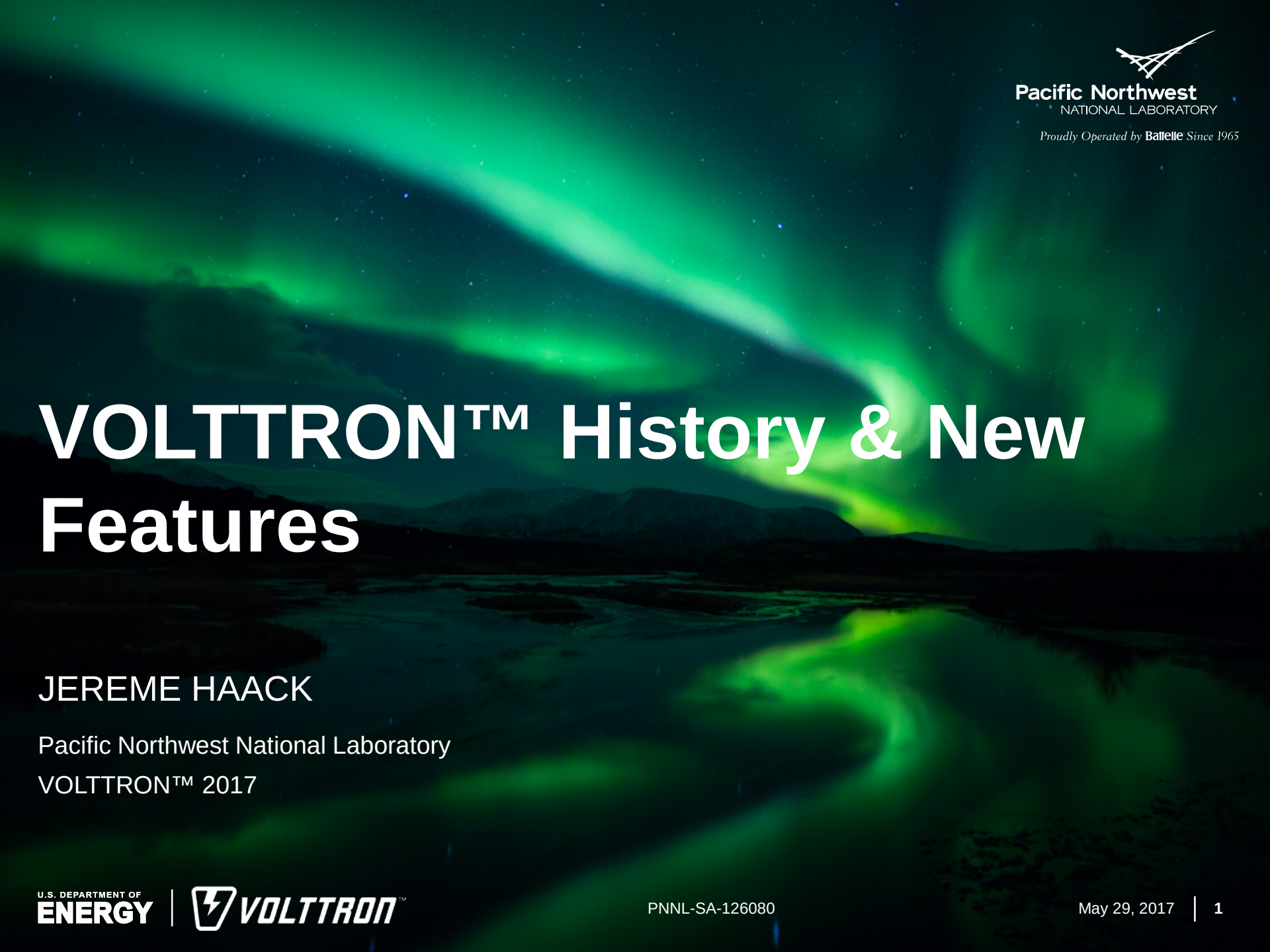

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VOLTTRON™ History & New Features

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VOLTTRON™ 2017

PNNL Internal Development

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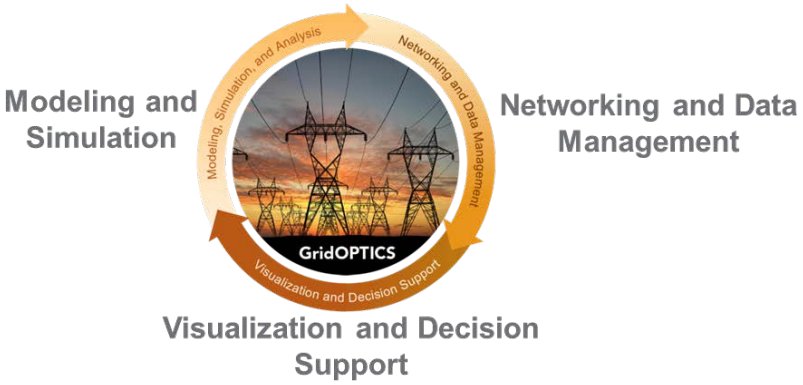
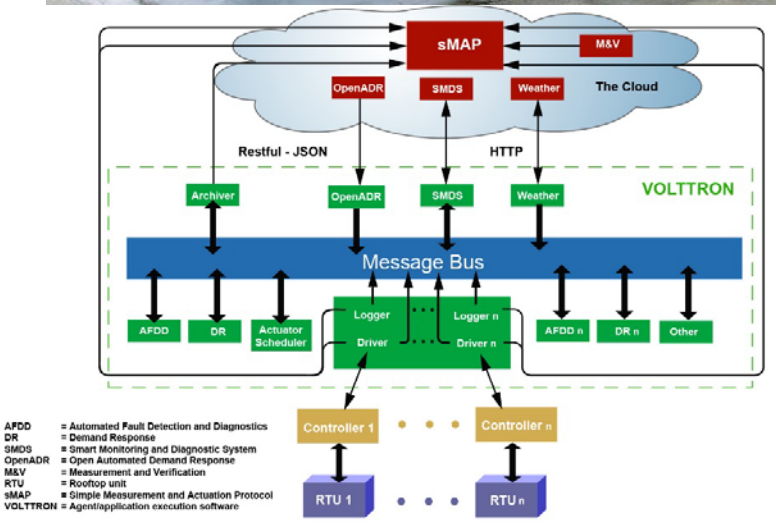
- 2010 Future Power Grid Initiative
- Proposed to deploy intelligence into the Smart Grid using an agent platform
- No existing platforms met the needs
  - Security
  - Resource management
- Create a design document laying out platform and use cases
- Developed proof-of-concept simulations
- Develop prototype platform
- Deploy in instrumented home



RTU Network Project

- Re-implemented as Open Source
- Integrating platform for RTU Network Project
  - Coordinate behavior of rooftop HVAC units
  - Deploy researcher control algorithms
  - Provide single point of contact for
    - Appliances
    - Data historian
    - External resources
- Platform supported applications developed by
  - ORNL
  - LBNL
  - PNNL



VOLTTRON™ Timeline Highlights

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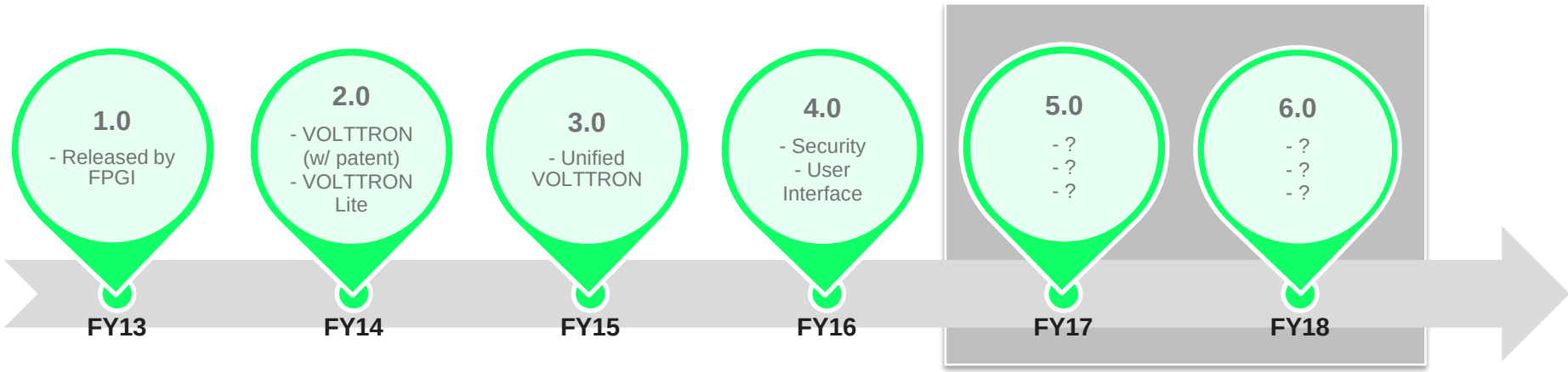
VOLTTRON™ Timeline



PNNL EV Demo

BEMOSS
RTU Network
First User Forum

NREL ESIF
2nd User Forum

NREL ESIF
3nd User Forum
Transactive Campus
BIRD-IP
GMLC Usage
Buildings Challenge

NW Tech Meeting
4th User Forum

Pillars of VOLTTRON™

- 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.

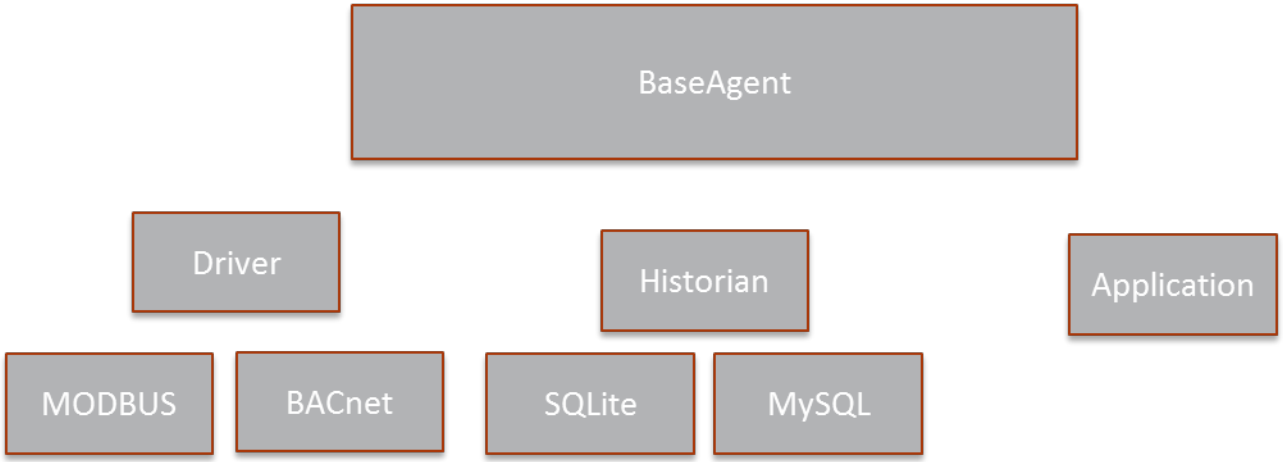
Pillars of VOLTTRON™ Contd.

- 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 extending 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 an application themselves
  - Historians
  - Drivers
- Driver – A VAgent which wraps communication with a device or devices. Drivers handle the specific protocols required and allow Applications to interact with devices via the message bus
- Historian – A VAgent which subscribes to the message bus and stores messages for later retrieval. Historians 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



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

Overview of Improvements for 5.0

- Driver Improvements
- Toward Commercial Use
- General Performance Improvements
- Ease of Use
- Monitoring
- Scalable Deployment

Driver Improvements

- Device Configuration UI
  - Updated based on user responses
  - Allows for remote configuration of drivers through central server UI
  - Actively being used by external collaborators
- Updated BACnet libraries
- Better interaction with low power devices
- BACnet Scan improvement for large scale deployments

Toward Commercial Use

- Database Improvements
  - MongoDB updates including better indexing and time based binning
  - New Crate Historian which provides better time series handling and integrates with existing user technology stacks
  - Stress tested backup cache with 10+ GB of data collected during an outage
- New Forward Historian which ensures there is a receiving agent to store data
- Web interface for tying together services
  - Enables development of web applications that tie into the platform
  - Kisensum planning to use for SEP2.0 driver

Performance Improvements

- Stress tests of components
- Historian improvements
  - More efficient backup cache
- Message Bus performance improvement
  - Improved performance 4 – 10x without sacrificing security improvements
  - Closer to base ZMQ performance
- VOLTTRON™ Management UI
  - Replaced charting library with better performing and more stable library
  - Better responsiveness

Ease of Use

- Multi-platform publish/subscribe
  - Ability to pub/sub to topics on other platforms without specifying IP address
- Tagging Service
  - Associate Haystack based tags to topics to simplify lookup and enable dynamic topic actions
- Improvements to VOLTTRON™ Configure
- Additional scripts including script for installing agents without needing to package first
- Configuration Store
  - Ability for agent configuration to be stored in the platform instead of needing a config file
  - Allows for dynamic updating of agents

Monitoring

- AgentWatcher to notify of Agent death
- Threshold Agent to monitor points for out of bounds
- System monitor agent which can send logs back to VOLTTRON™ Central
- Alert Subsystem that agents can use to notify VOLTTRON™ Central of off normal conditions
- Emailer Agent will notify administrators when an alert is sent (with time delay to prevent spam)
  - Actively being used in CETC to notify of potential data loss and agent health

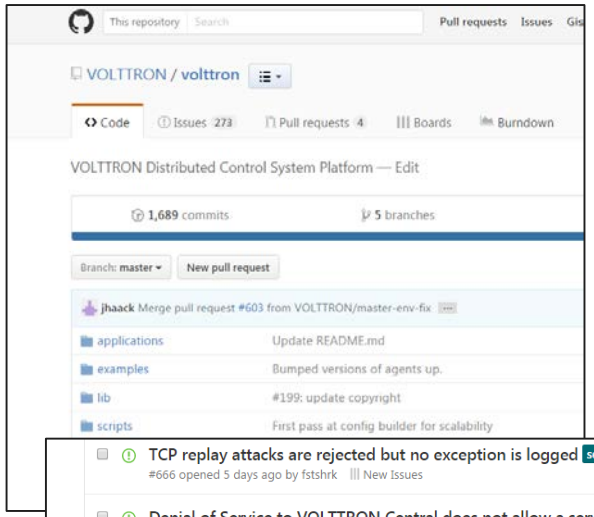
Scalable Deployment

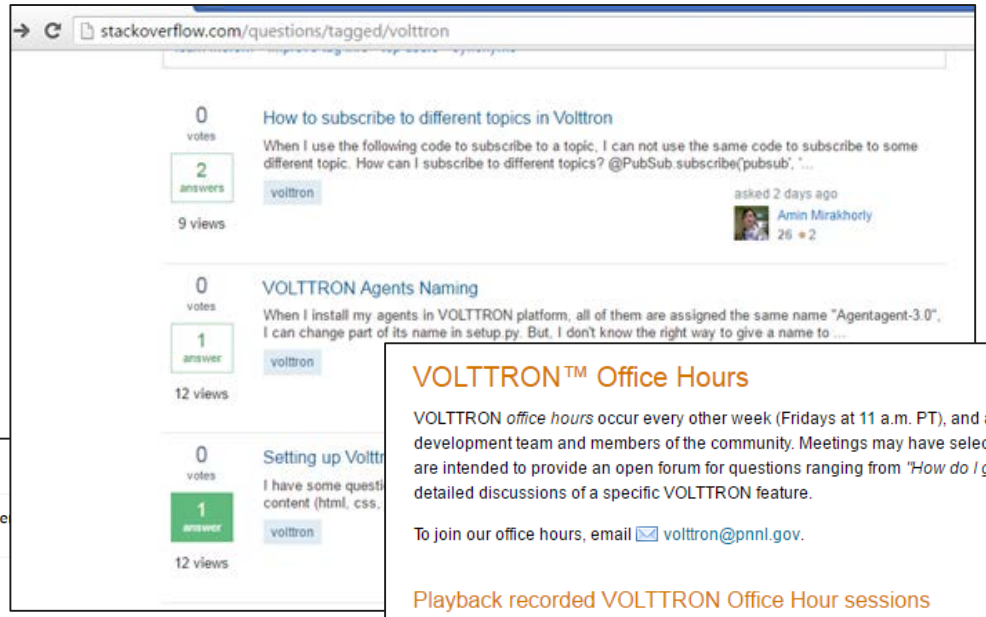
- New Install agent script that simplifies automated deployment
- Ansible script for configuring and managing secured VOLTTRON™ deployments

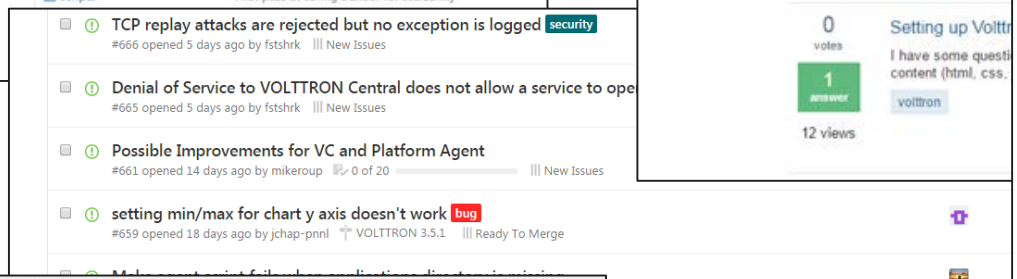
Next Steps

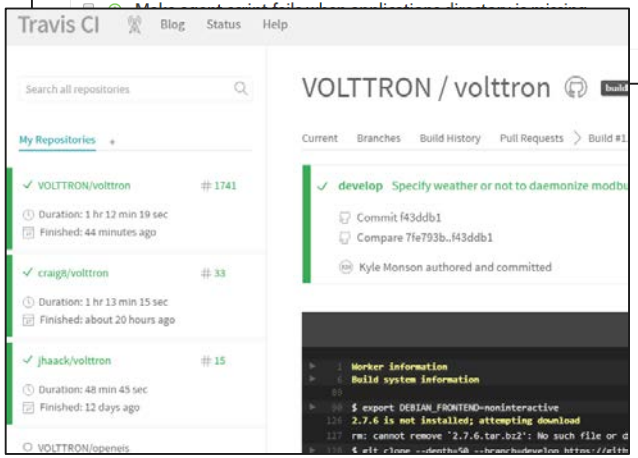
- Decouple the message bus from ZMQ
  - MQTT identified as potential first alternative bus
- Site Reliability Engineering – Next step in scalable deployment
- RESTful interface
- Suggestions?

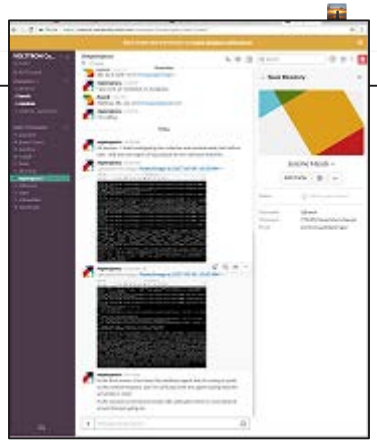
Support Mechanisms











VOLTTRON™ Office Hours

VOLTTRON *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 VOLTTRON feature.

To join our office hours, email volttron@pnnl.gov.

Playback recorded VOLTTRON Office Hour sessions

VOLTTRON Office Hours - June 24, 2016

Chad Corbin of PNNL presented the Transactive Control of Commercial Building HVAC multi-agent VOLTTRON application (recording is audio-only, download PDF of presentation here).

PNNL-SA-119047

VOLTTRON Office Hours - June 10, 2016

Discussion of creating a data model for adding context to VOLTTRON data, presentations on integrating VOLTTRON 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
- Slack: https://volttron-community.slack.com
- Email: volttron@pnnl.gov
- Bi-weekly office hours, email to be added
  - Recordings: https://volttron.org/office-hours