



Pacific Northwest  
NATIONAL LABORATORY

*Proudly Operated by **Battelle** Since 1965*

# VOLTRON™ Deployment and Scalability

JEREME HAACK

Pacific Northwest National Laboratory

VOLTRON™ 2016



# Motivation

- ▶ Scalability is a key feature of VOLTTRON™
- ▶ Flexibility of the platform allows for numerous deployment options
  - Determine best options for given set of services running on a given set of hardware
- ▶ Discover and learn from real world deployments



# Components of a Deployment

- ▶ Hardware
- ▶ VOLTTRON™
- ▶ Historian (MySQL, MongoDB, Forwarder, etc.)
- ▶ Drivers
- ▶ Applications



# Potential Bottlenecks

- ▶ Message Bus/Router
- ▶ BaseHistorian Cache
- ▶ Database
- ▶ ForwardHistorian
- ▶ I/O
- ▶ Network
- ▶ Connections

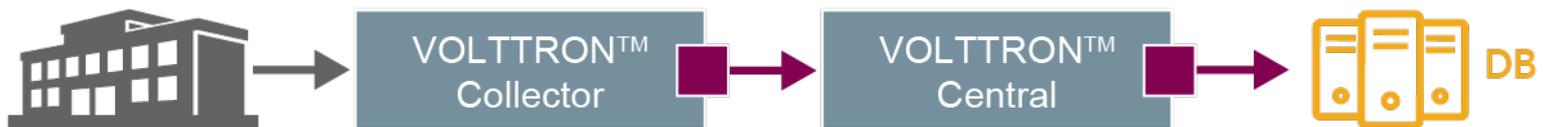


# Considerations for Deployment

- ▶ Hardware capabilities
- ▶ Number and rate of data points being collected
- ▶ Local vs. Centralized Data storage
- ▶ Interaction with the “Cloud”
- ▶ Deployment management needs
- ▶ Network
  - Throughput
  - Latency
  - Packet Drops
- ▶ Security of the network
  - OpenVPN
  - Unsecured network
  - Separate networks



# Simple Deployment Examples





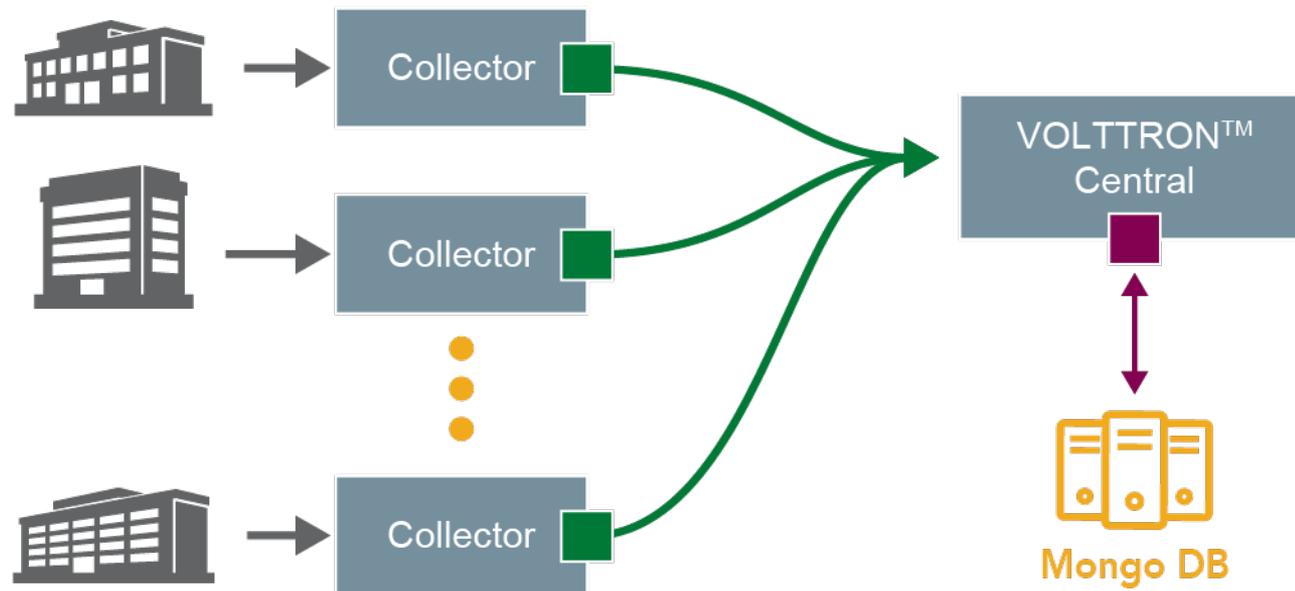


# PNNL Campus Deployment

- ▶ Data Collection from 8+ buildings
  - Collector platforms running on a range of hardware: BeagleBone, Raspberry Pi (and clones), NUC, etc.
- ▶ VOLTTRON™ Central Management
- ▶ MongoDB Historian
  - 800 million records and growing
- ▶ VOLTTRON™ instances on PNNL facilities network collect data, forward to instances on PNNL Network
- ▶ PNNL Network instances forward to an instance in the DMZ
- ▶ DMZ Instance forwards to instances at external partners' labs



# Data Forwarded to Central Instance



→  
BACnet

→  
VIP

→  
DB  
Connection

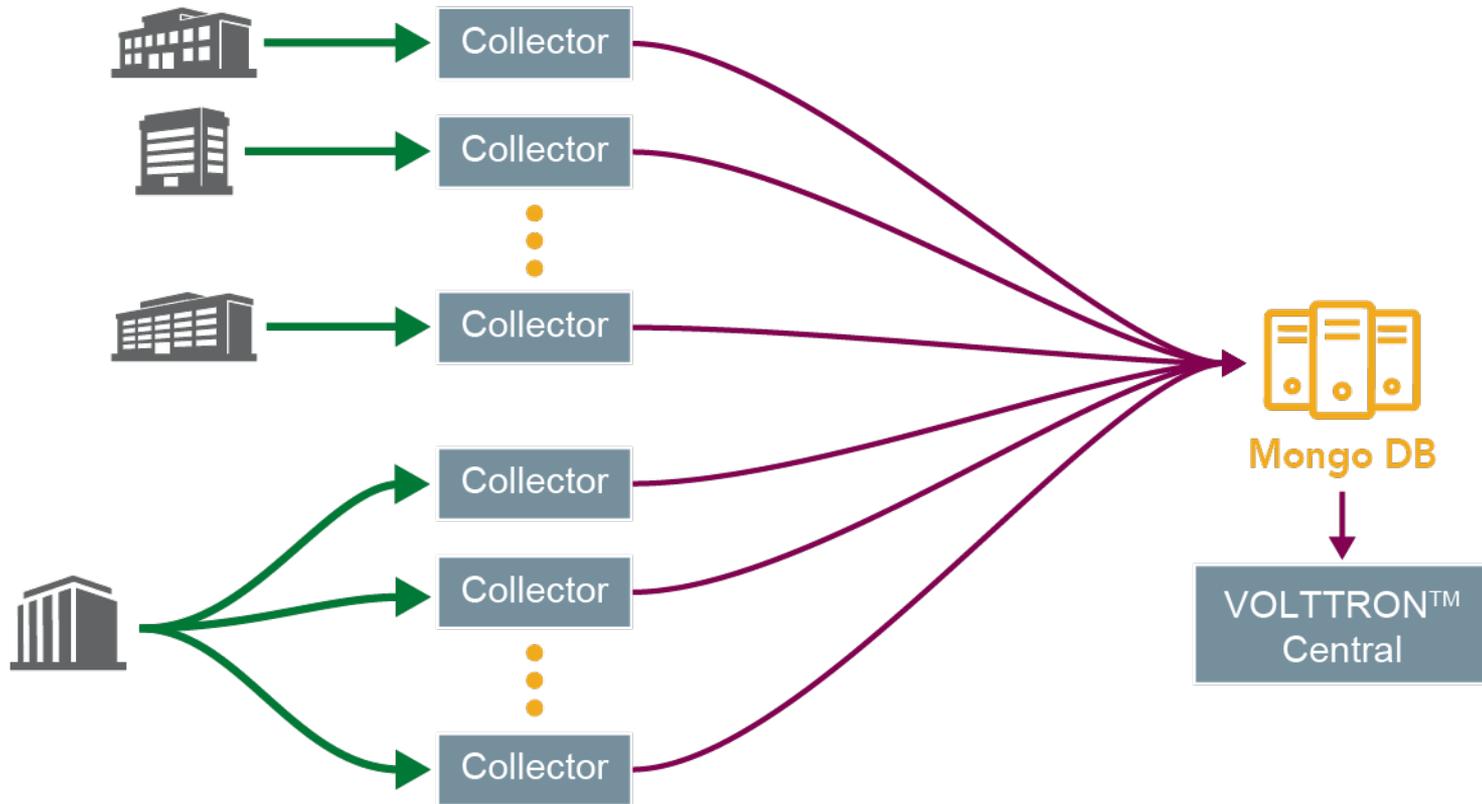
■  
MongoDB  
Historian

■  
Forward  
Historian

■  
VOLTRON™  
Instance



# Data Pushed to Networked Database



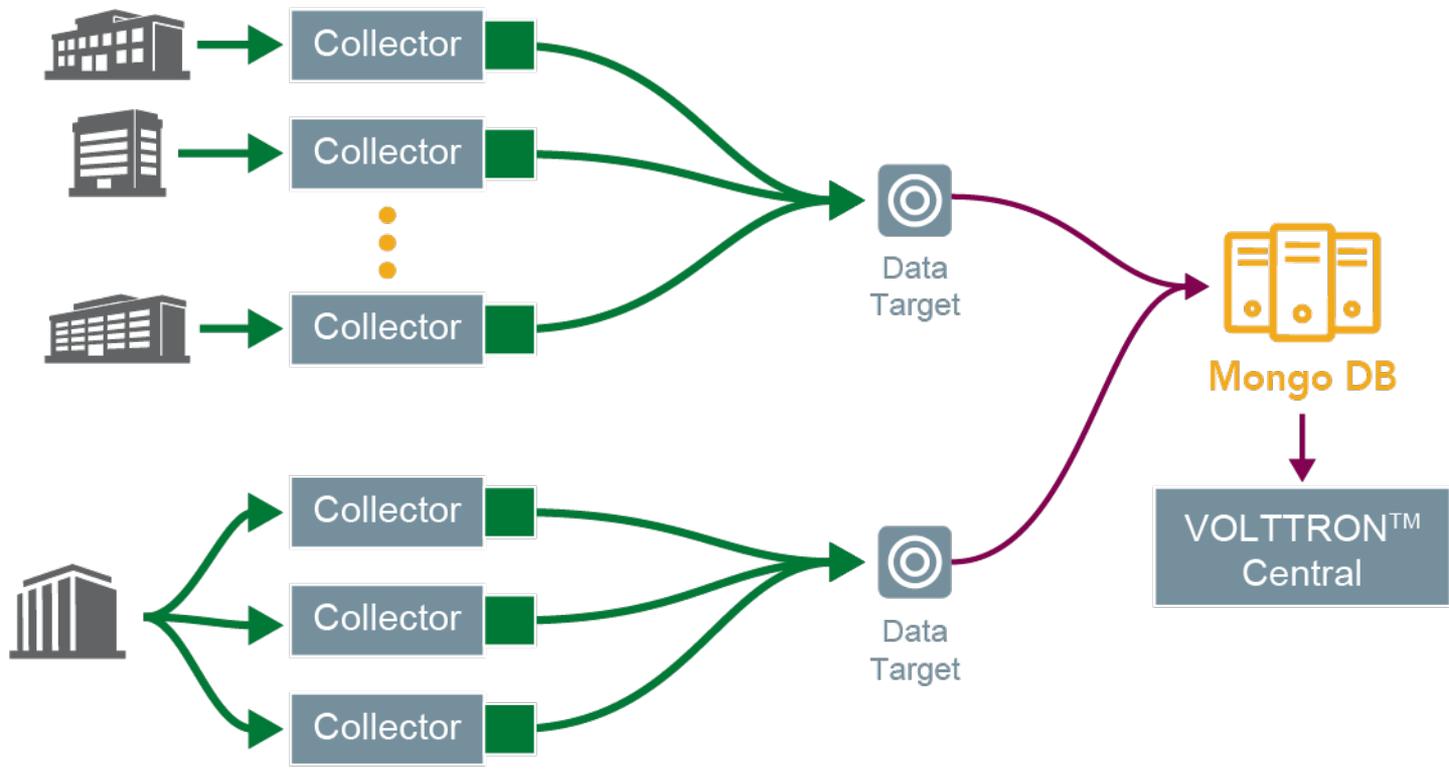
→  
MODBUS/  
BACnet

→  
DB  
Connection

■  
VOLTTRON™  
Instance



# Clustered Deployment





# Scalability Improvements

- ▶ MongoDB Historian
- ▶ Speed up BaseHistorian
- ▶ Driver performance options
  - Limit to a single “all” publish
  - Stagger collection from devices
- ▶ Router improvement investigation
  - Cython
  - Separate process for router
- ▶ ForwardHistorian
  - Short term – split forwarding topics, multithread
  - Long term – More historians to support additional use cases



# Improvements Made for 4.0

## ▶ Driver

- Cut down number of publishes to a single “all” topic. Usually all you need
- Increase number of devices you can handle
- By default driver publishes all points individually, then also two “all” publishes per device
- Number of points \* 2 faster

## ▶ Actuator

- Set Multiple points at a time allows for sending 4000 actuation commands at a time
- (Future) combine MasterDriver and Actuator since only Actuator talks to MD

## ▶ Historian

- Remove unnecessary metadata writing improved performance \*4
- Set to auto-vacuum (could remove to slightly improve performance)
- Configurable maximum size of cache

## ▶ Profiling

- Identified inefficiencies in PlatformAgent and VOLTTRON™ Central UI



# Scalability Study

- ▶ Utilize the PNNL Research Cloud for a large scale test using an ORNL agent for load management
  - Minimal image for deploying VOLTTRON™
  - Hundreds, thousands of VOLTTRON™ instances working to achieve a goal
  - Management of large scale deployment
- ▶ Analyze results
- ▶ Create GitHub issues
- ▶ Prioritize and enhance scalability
  
- ▶ More to come!