VOLTTRON™ Deployment and Scalability

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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

1. Building → VOLTTRON™ Collector → DB
2. Building → VOLTTRON™ Collector → DB
3. Building → VOLTTRON™ Collector → VOLTTRON™ Central → DB
PNNL Campus Deployment

EXTERNAL INTERFACE
- Externally Accessible (DMZ)
  - Traffic Scanner
  - VOLTTRON Passthrough

DATA COLLECTION AND CONTROLS
- PNNL Facilities Network
  - VIP
- PNNL Network
  - Management Central

EVERYWHERE (Web)
- HTTPS

CENTRAL CONTROL
- VIP
- DB Port

DATABASE
- Internal Only Network
- DB

NETWORKS
- UW Facilities Network
- WSU Facilities Network
- DB
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
- VOLTTRON™ Instance
- VOLTTRON™ Central
- Mongo DB
Data Pushed to Networked Database
Clustered Deployment

- Collector
- Collector
- Collector
- Collector
- Collector
- Collector
- Data Target
- MongoDB
- VOLTTRON™ Central

VIP
DB Connection
VOLTTRON™ Instance
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!