Emulating Adversary Actions in the Operational Environment with Caldera™ for OT

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MITRE | SOLVING PROBLEMS FOR A SAFER WORLD®

Remote System Discovery (T0846)

Ability: BACnet Who-Is

- I-Am
  - pduSource: <**Misha Belisle**>
  - iAmDeviceIdentifier: **Senior Applied Cybersecurity Engineer**
  - vendorID: **MITRE**
- Adversary emulation and cyber R&D
- Interest in natural languages; Spanish, Russian, ASL

- I-Am
  - pduSource: <**Blaine Jeffries**>
  - iAmDeviceIdentifier: **Operational Technology Security Engineer**
  - vendorID: **MITRE**
- Testbeds, Reverse Engineering
- Strategy card game fanatic: MTG, Dominion, Ascension

Outline

- **What is Caldera?**
  - What can Caldera do?
- **What is Caldera for OT?**
  - What problem did we make Caldera for OT to solve?
  - What kinds of ICS protocols can we support?
  - How can you use Caldera for OT?
- **What's next?**
- **Where can I get Caldera for OT?**

What is CALDERA?

Open-Source Adversary Emulation Platform

- Automatable, repeatable emulation of realistic adversary attacks
- **Freely available on GitHub**

Portable

- Python3 app deployable to Mac/Linux server
- Frontend web interface
- Easily containerized

Accessible

- **Can run on a laptop!**
- Server Min Requirements: 8GM RAM, 2 CPU Cores
- Client: any device with a web browser

Flexible

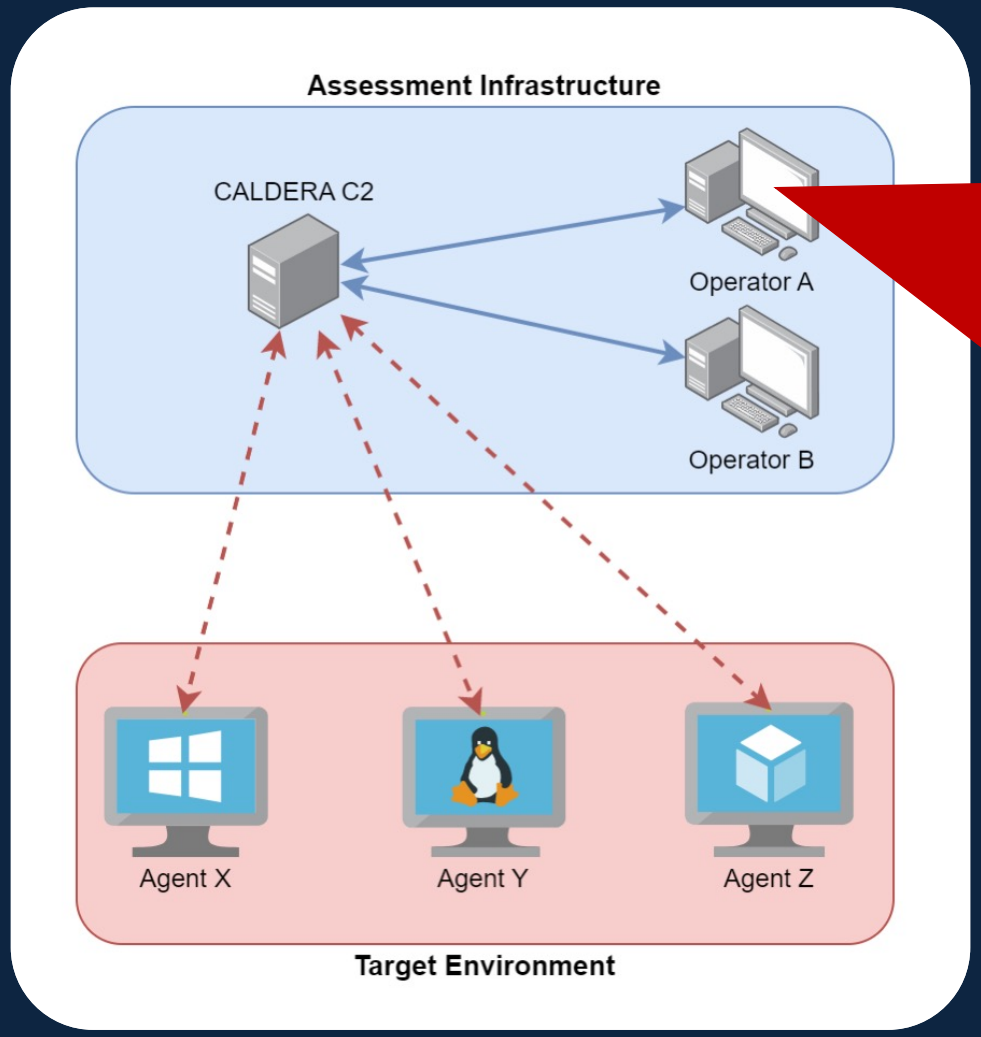
- Agent support for: Windows, Linux, MacOS
- A dozen+ built-in plugins
- Supports custom plugin development

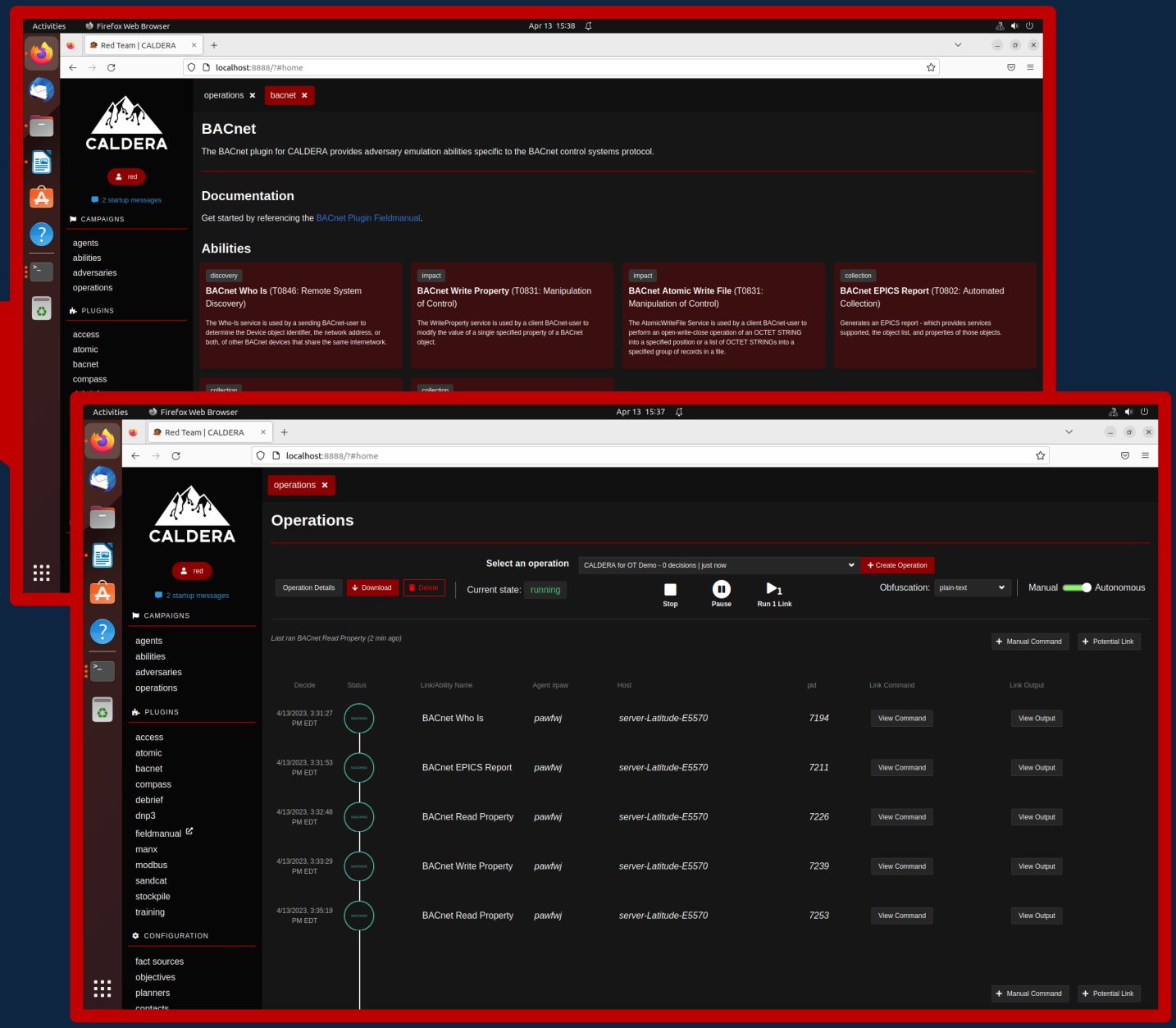
MITRE

A Quick Note about Caldera-isms

- **Agent** – Software program that connects back to Caldera server
- **Ability** – Specific ATT&CK tactic/technique implementation; execute on an agent
- **Adversary** – Group of abilities representing the TTPs available to a threat actor
- **Operation** – Context in which abilities can be run on agent groups, based on adversary profiles. Also has the option to manually run abilities.
- **Fact** – Identifiable piece of information that may be required to execute an ability, e.g., an IP address, a hostname

Example Deployment





Why does Caldera Exist? Adversary Emulation is Hard

Exercises **cost** a lot to run

They require a significant **time** investment

Results are dependent on the capabilities of involved **personnel**

Exercises can be difficult to **repeat** unless extensively documented

Design (e.g., TTPs, scope, adversary profile, etc.) can be challenging

https://ttpe/learningnets

Caldera Makes Testing **Easier!**

Lowers the **cost** to run exercises

Less **time** intensive – can run and plan exercises faster

Dependent now on **attacker model**, not on personnel

Can **repeat** tests at the push of a button

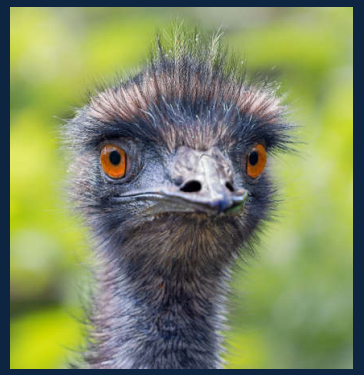
Designs can be saved, re-used, and designed with easy interfaces

https://me/learningnets

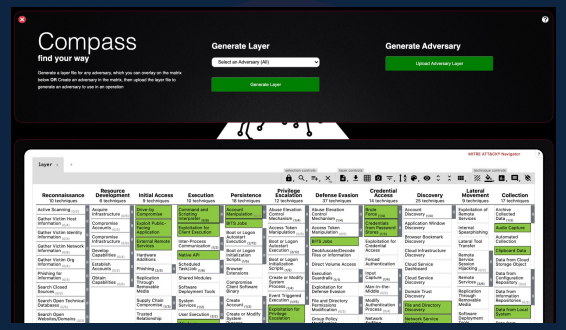
Caldera Plugins

- **Core system with modular plugin architecture**

ATOMIC
Converts Atomic Red Team tests to CALDERA format



EMU
Converts Adversary Emulation Plans to CALDERA format



COMPASS
Generates Adversaries from the ATT&CK Matrix

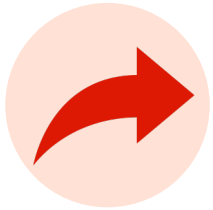
CALDERA™ for OT
Purpose: Extend core to the OT environment

Why Caldera for OT?

Lower the **barrier** to ICS skills

Efficient and **reliable** to repeat tests

Enable **testing** and tailoring of detections for known procedures



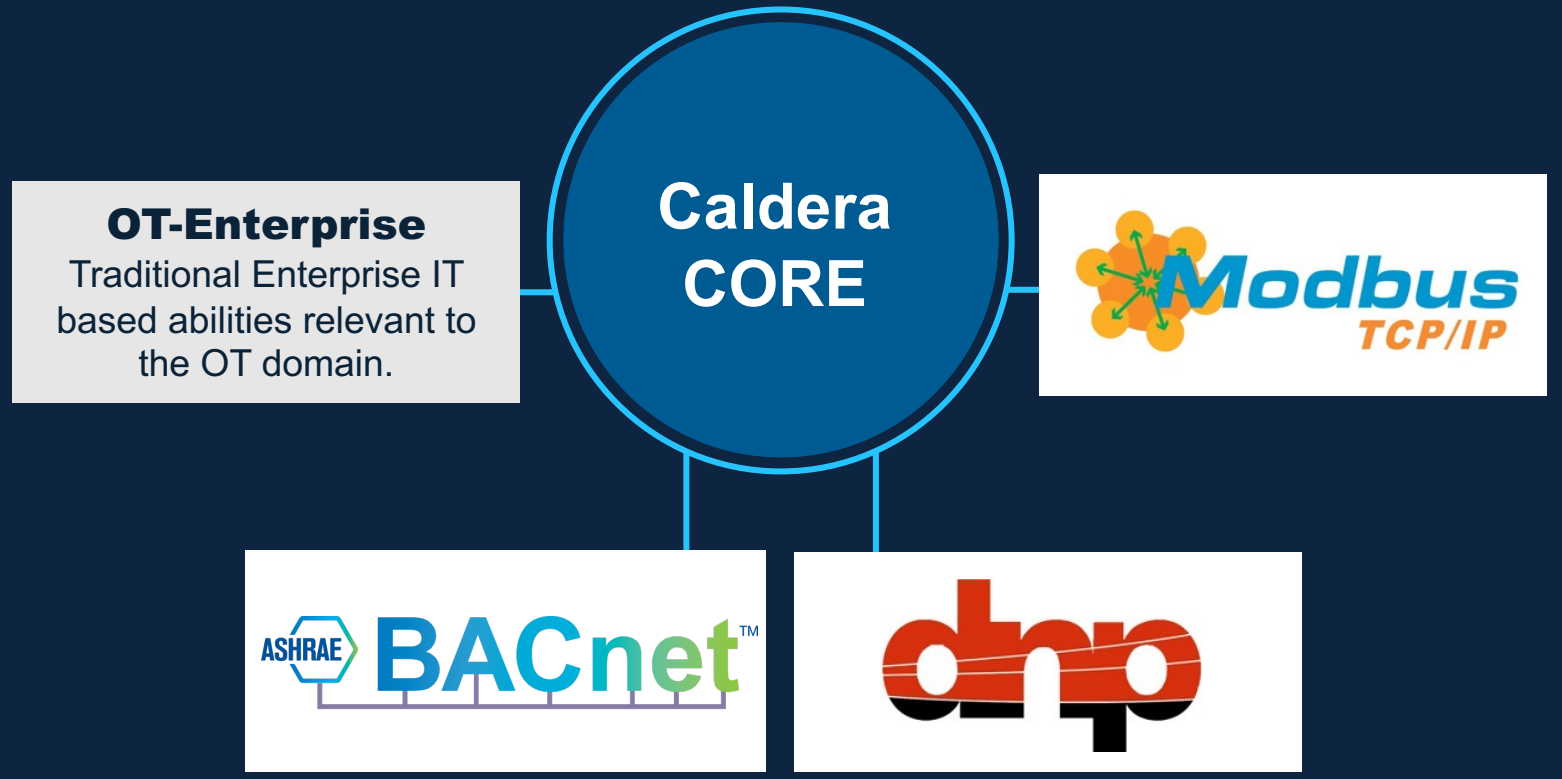
Simplify modification to execute iterative attacks to circumvent detections

Support threat emulation scenario integrators and operators **in the OT domain**

https://me/learningnets

Caldera for OT Plugins

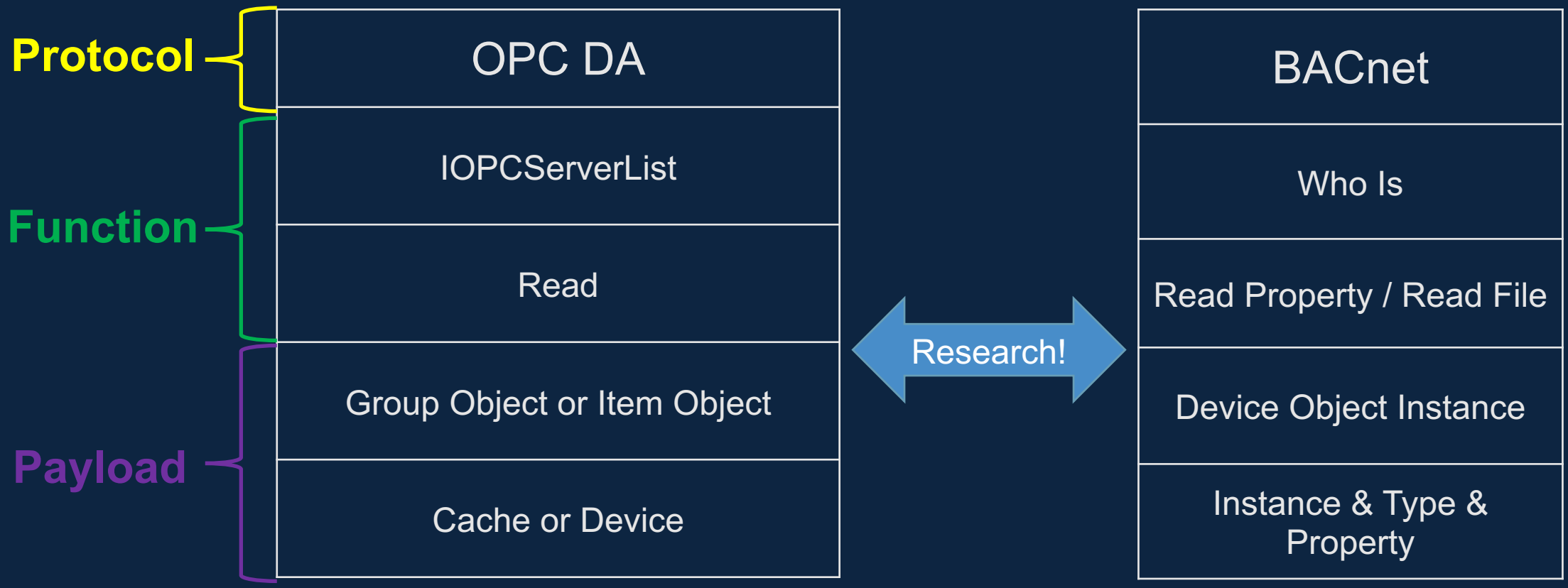
Expand operator toolkit with ATT&CK for ICS mapped OT abilities



Impact: Rapid integration & emulation in the OT environment

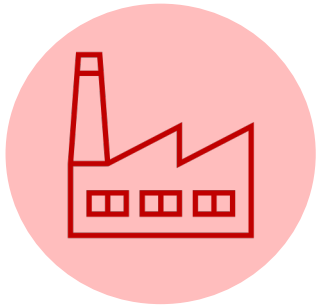
Expose native OT protocol functionality

Demonstrating a Technique Across Diverse Protocols



https://github.com/learningnets

Other Use Cases



Adversary Emulation

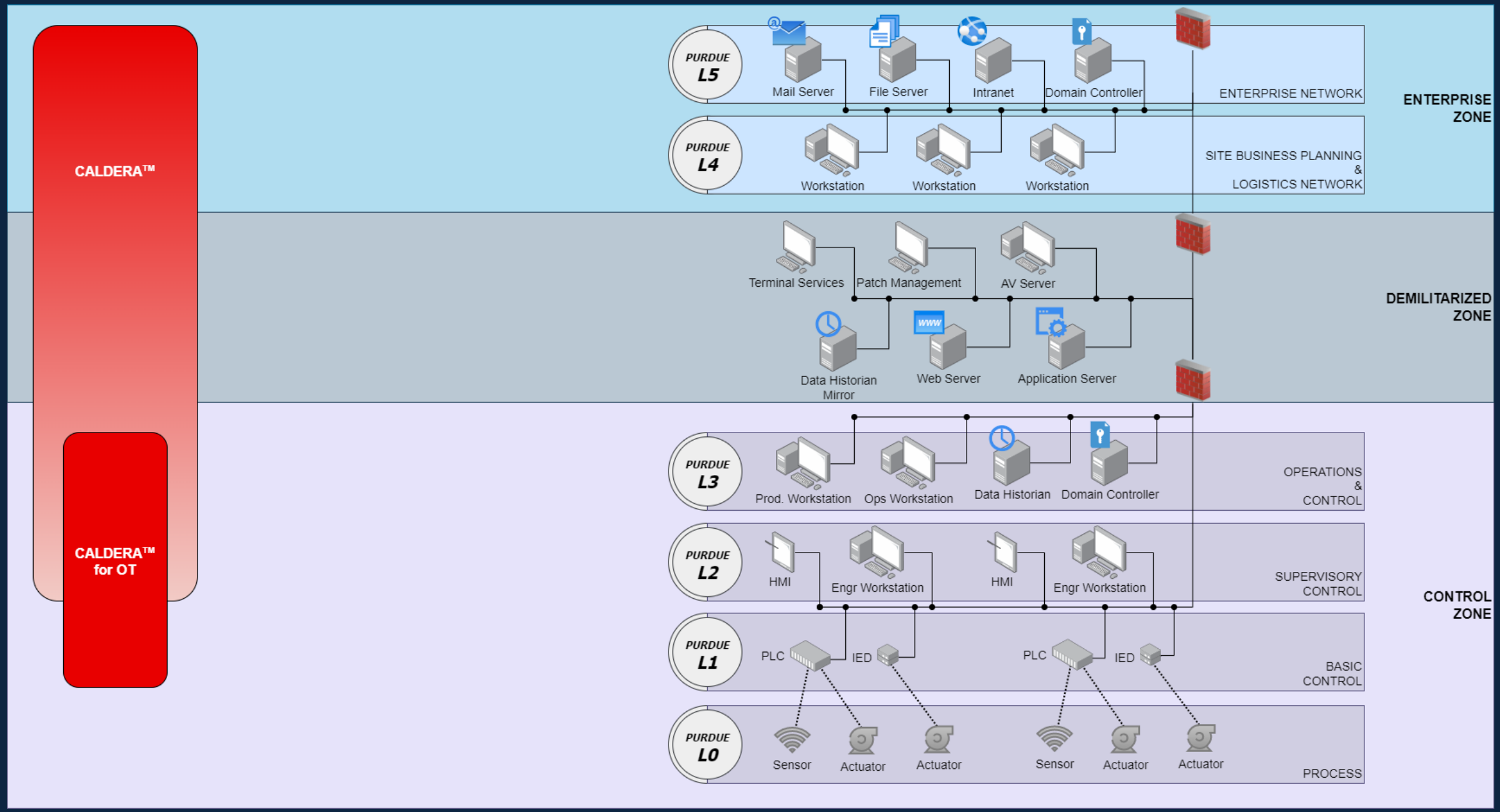
Training & Purple Teaming

FAT/SAT Testing

Caldera for OT Plugins provide extensible tooling for testing network security posture by coordinating the execution of real threat activity

https://t.me/learningnets

Scenario Walkthrough



CALDERA™

CALDERA™ for OT

INITIAL ACCESS

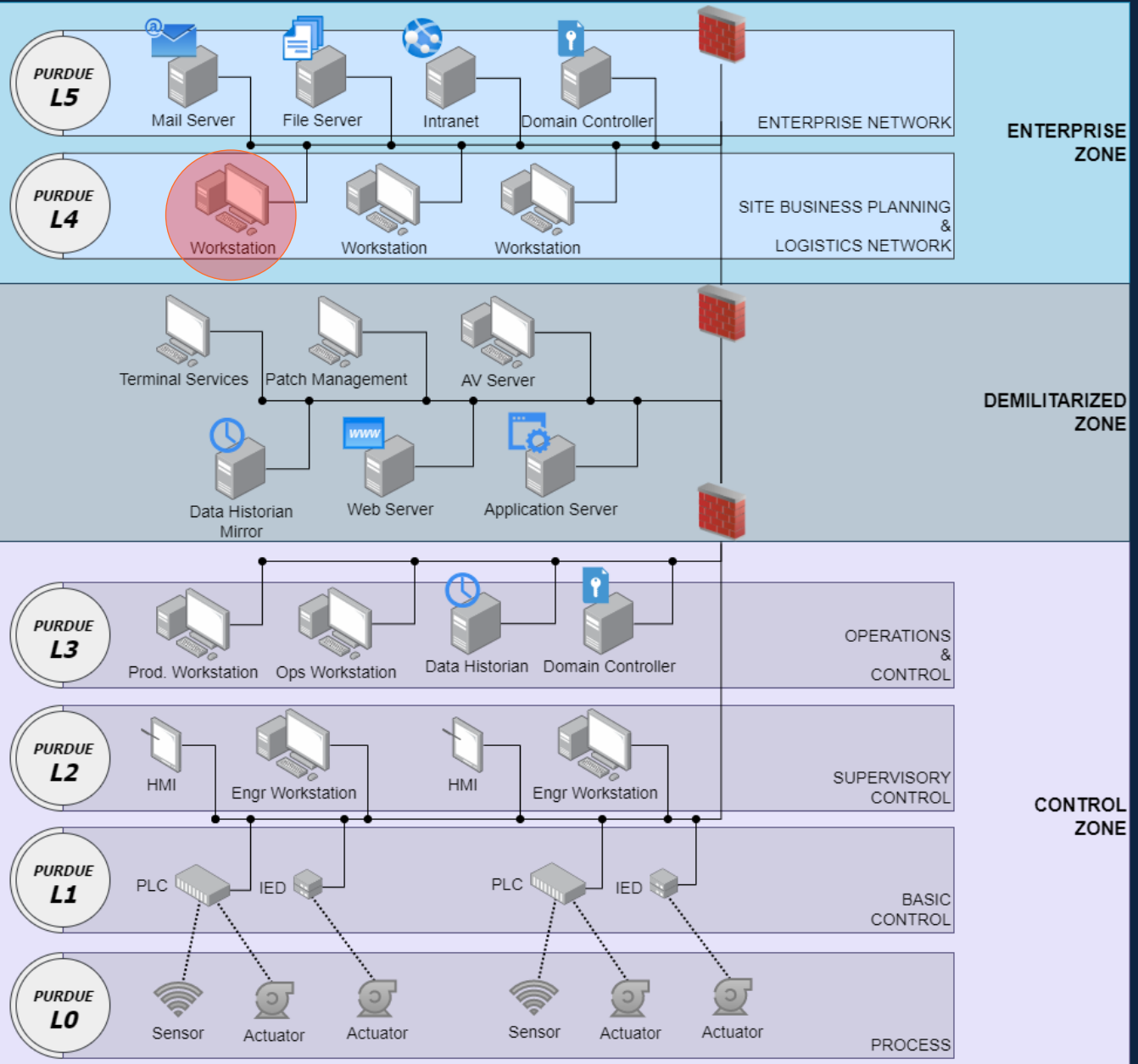
- *Phishing* T1566

User opens malicious email attachment that spawns a CALDERA agent in the Enterprise Zone.

PERSISTENCE

- *Logon / Boot Autostart Execution* T1547

Add encoded command in Windows registry to run CALDERA agent on system startup.



CALDERA™

CALDERA™ for OT

INITIAL ACCESS

PERSISTENCE

DISCOVERY

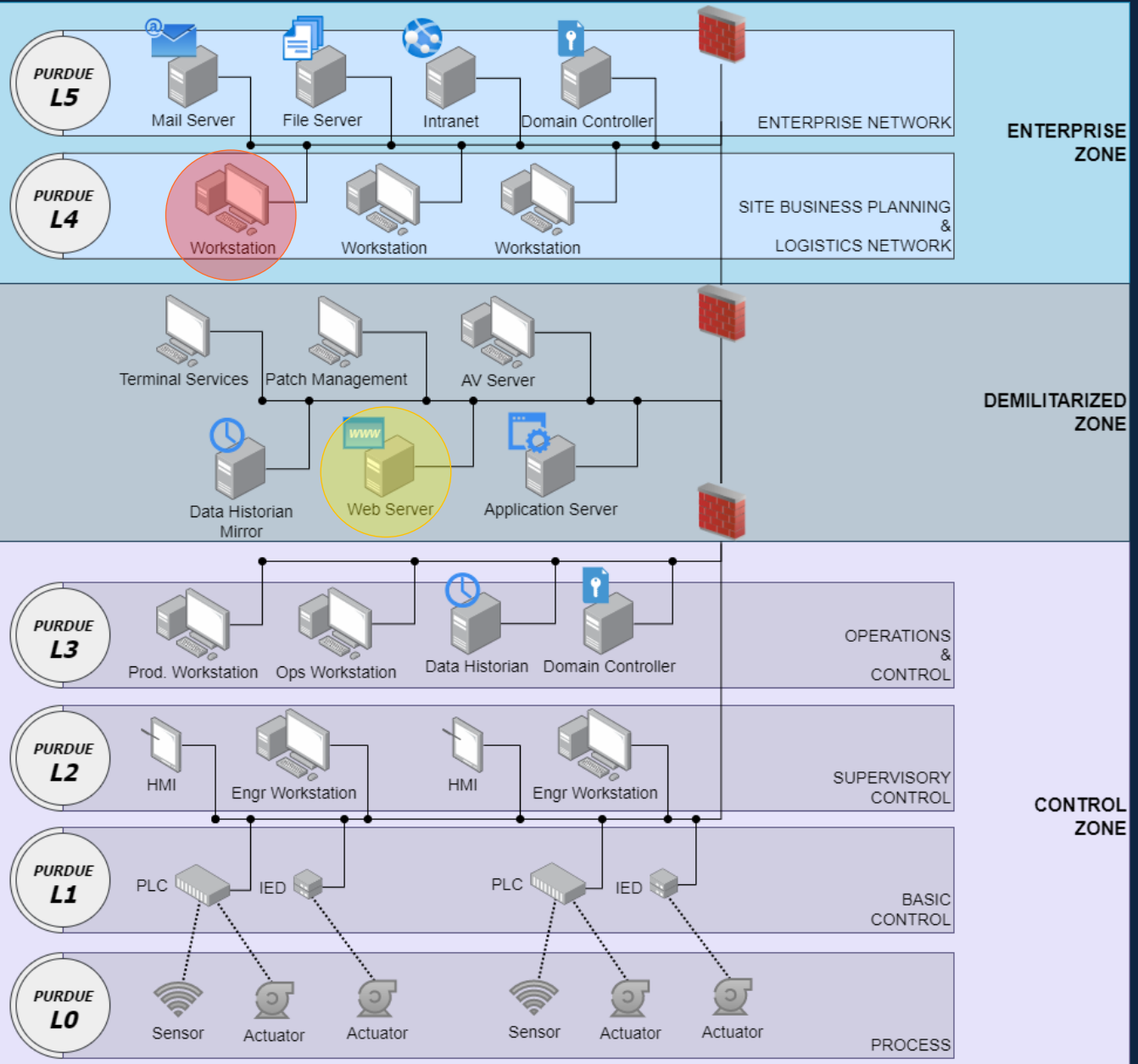
- *Account Discovery* T1087
- *Process Discovery* T1057
- *System Network Connections Discovery* T1049

Discover local accounts, processes, and network connections. An internal webserver is identified as a potential target.

CREDENTIAL ACCESS

- *OS Credential Dumping* T1003

Dump local workstation credentials using PowerSploit Invoke-Mimikatz module.



CALDERA™

CALDERA™ for OT

INITIAL ACCESS

PERSISTENCE

DISCOVERY

CREDENTIAL ACCESS

RECONNAISSANCE

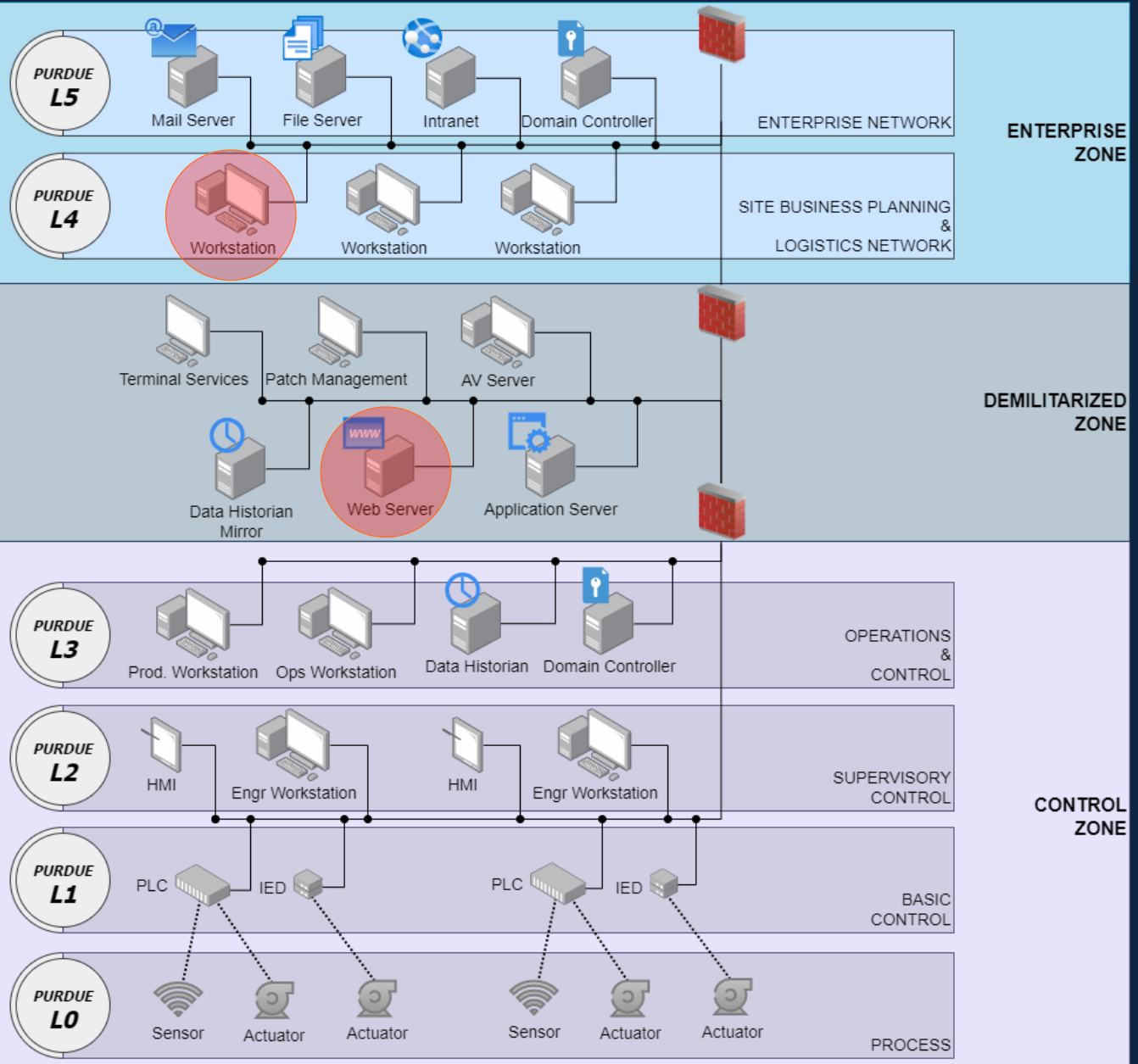
- *Active Scanning* T1595

Scan the identified web server for potential vulnerabilities.

LATERAL MOVEMENT

- *Exploitation of Remote Services* T1210

Exploit a remote-code-execution vulnerability on the web server to spawn an agent in the DMZ.



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INITIAL ACCESS

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DISCOVERY

CREDENTIAL ACCESS

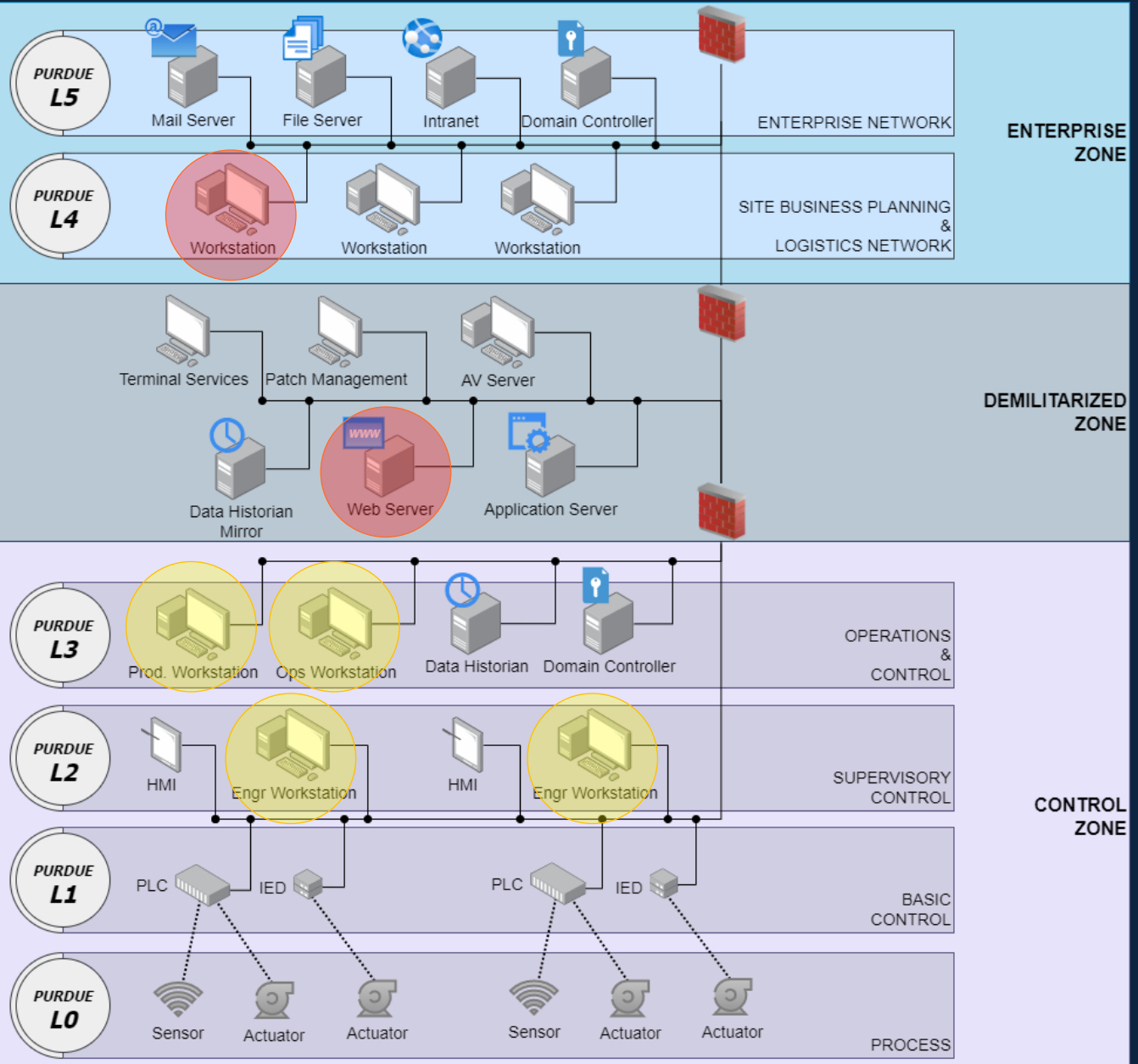
RECONNAISSANCE

LATERAL MOVEMENT

DISCOVERY

- *Account Discovery* T1087
- *Process Discovery* T1057
- *System Network Connections Discovery* T1049

Discover local accounts, processes, and network connections. Identify multiple targets in control zone with connections to DMZ web server.



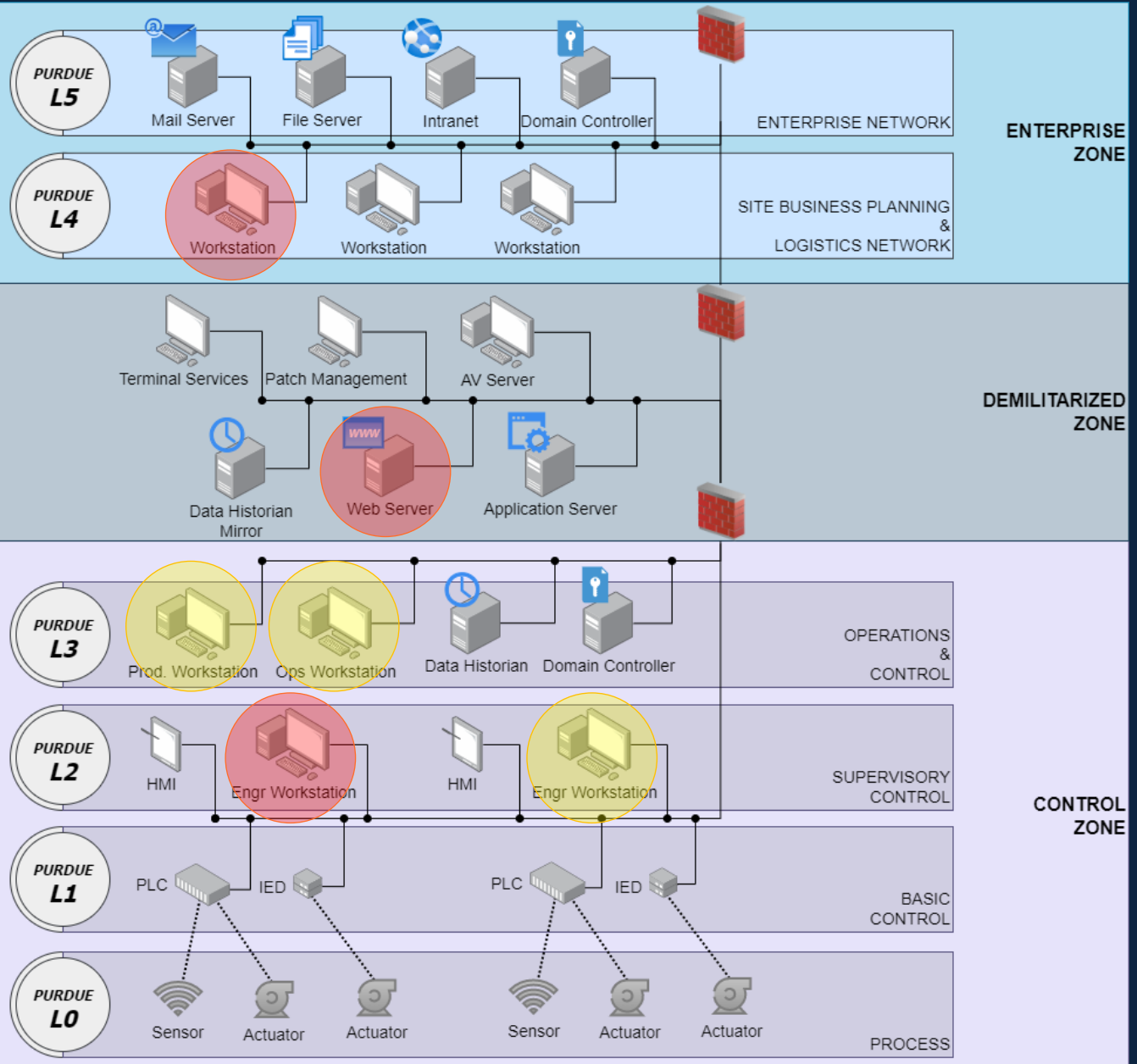
CALDERA™

CALDERA™ for OT

- INITIAL ACCESS
- PERSISTENCE
- DISCOVERY
- CREDENTIAL ACCESS
- RECONNAISSANCE
- LATERAL MOVEMENT
- DISCOVERY
- **LATERAL MOVEMENT**

- *Remote Services* T1021
- *Lateral Tool Transfer* T1570

Using a valid account collected from the enterprise workstation, remotely download and execute the agent payload to gain access to a Control Zone workstation.



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INITIAL ACCESS
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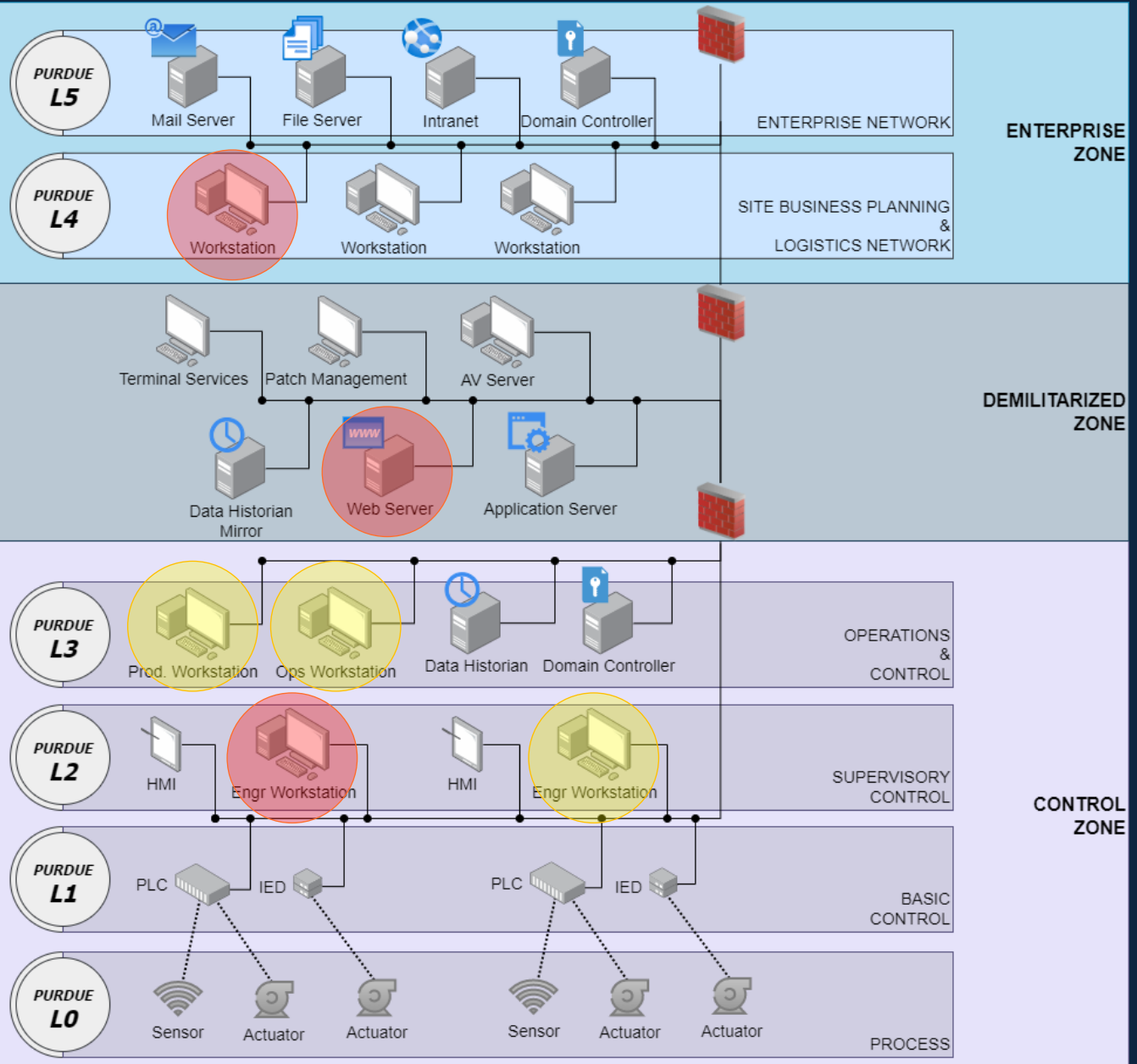
- *Logon / Boot Autostart Execution* T1547

Add encoded command in Windows registry to run CALDERA agent on system startup.



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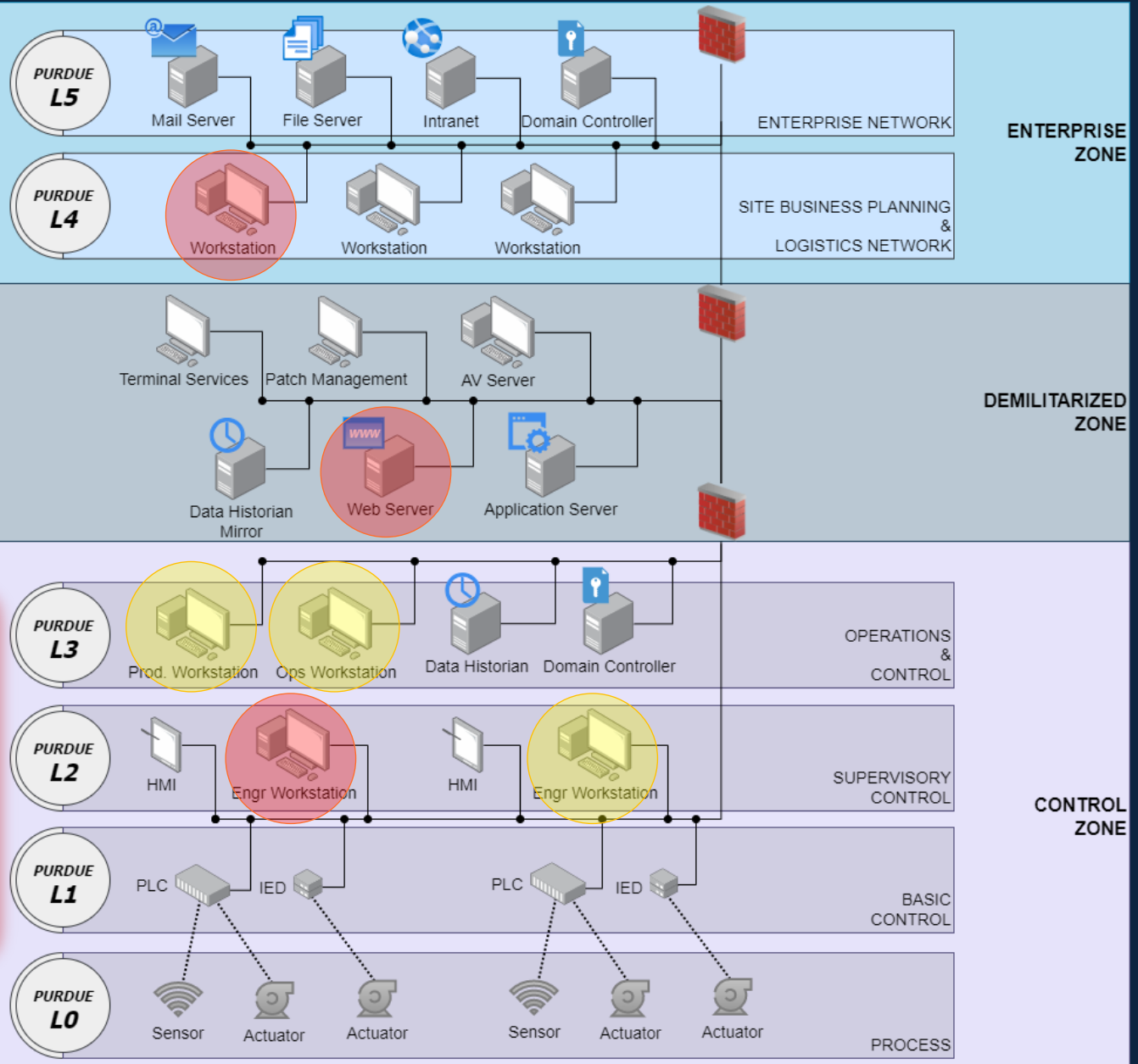
- DISCOVERY
- LATERAL MOVEMENT
- PERSISTENCE

CALDERA alone is limited in abilities applicable to Purdue L2 / L1 assets.

Enter CALDERA for OT!



BACnet Plugin Abilities

BACnet

The BACnet plugin for CALDERA provides adversary emulation abilities specific to the BACnet control systems protocol.

Documentation

Get started by referencing the BACnet Plugin Fieldmanual.

Abilities

discovery

BACnet Who Is (T0846: Remote System Discovery)

The Who-Is service is used by a sending BACnet-user to determine the Device object identifier, the network address, or both, of other BACnet devices that share the same internetwork.

impact

BACnet Write Property (T0831: Manipulation of Control)

The WriteProperty service is used by a client BACnet-user to modify the value of a single specified property of a BACnet object.

impact

BACnet Atomic Write File (T0831: Manipulation of Control)

The AtomicWriteFile Service is used by a client BACnet-user to perform an open-write-close operation of an OCTET STRING into a specified position or a list of OCTET STRINGs into a specified group of records in a file.

collection

BACnet EPICS Report (T0802: Automated Collection)

Generates an EPICS report - which provides services supported, the object list, and properties of those objects.

collection

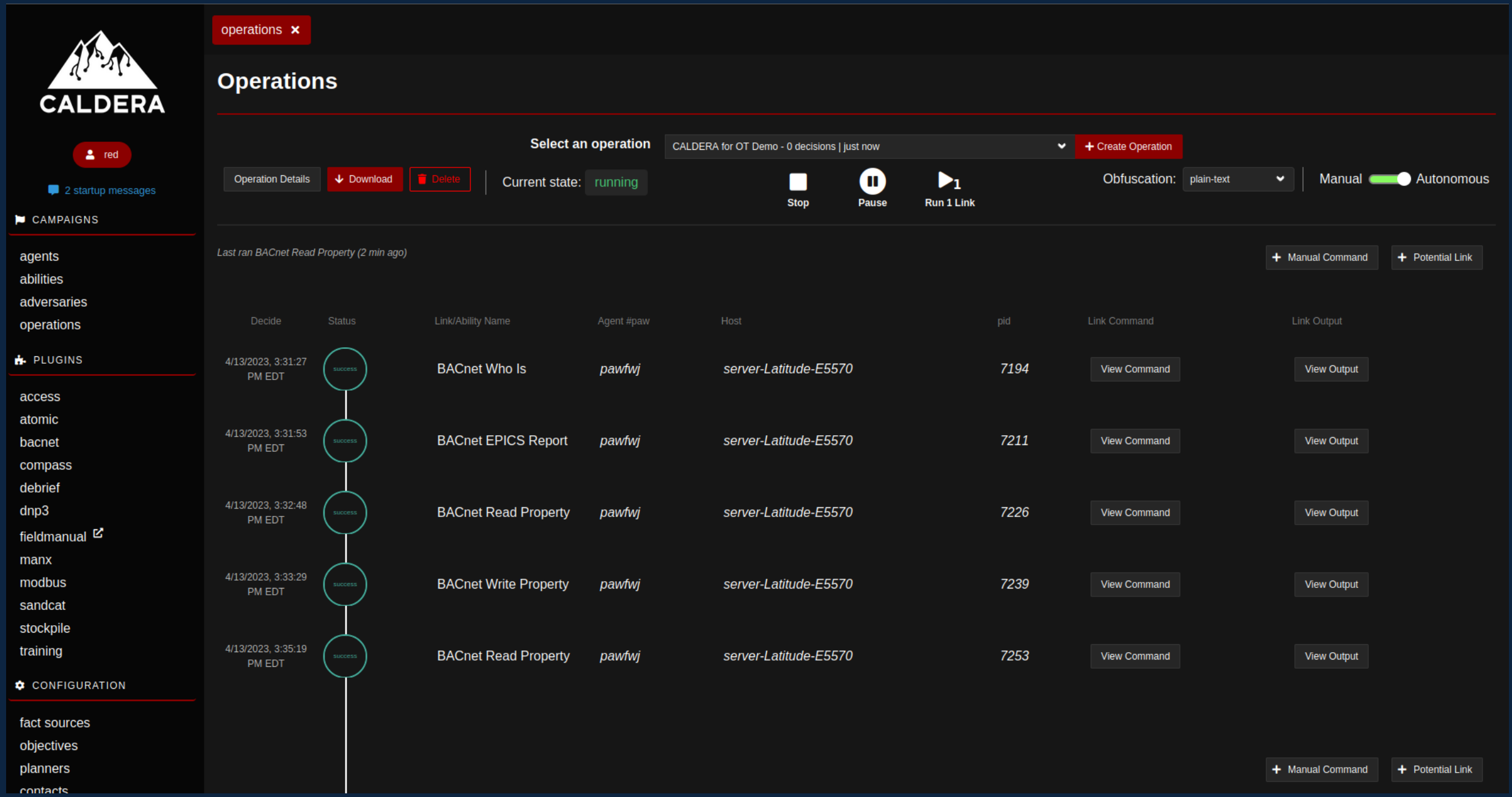
BACnet Read Property (T0861: Point & Tag Identification)

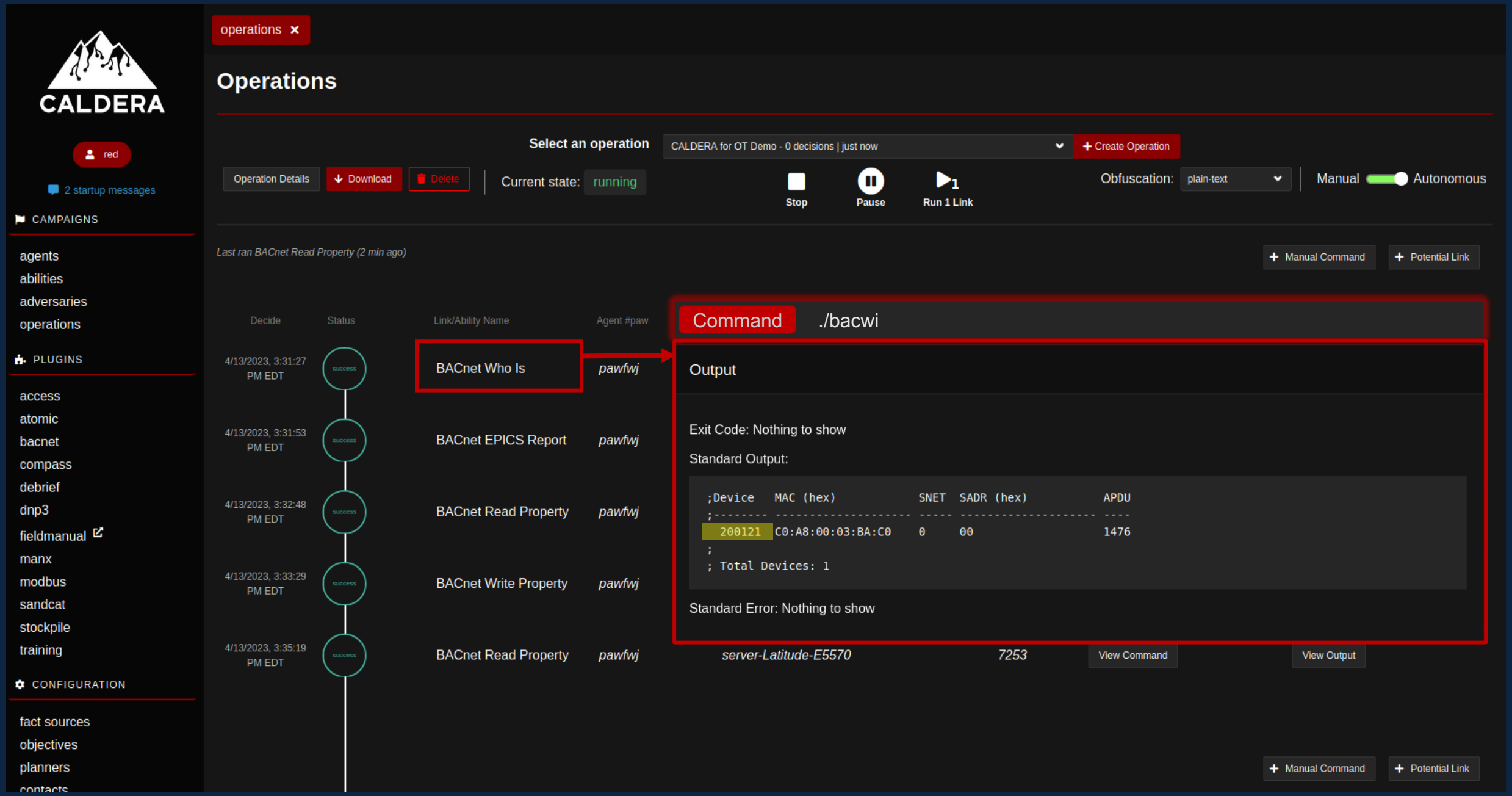
The ReadProperty service is used by a client BACnet-user to request the value of one property of one BACnet Object.

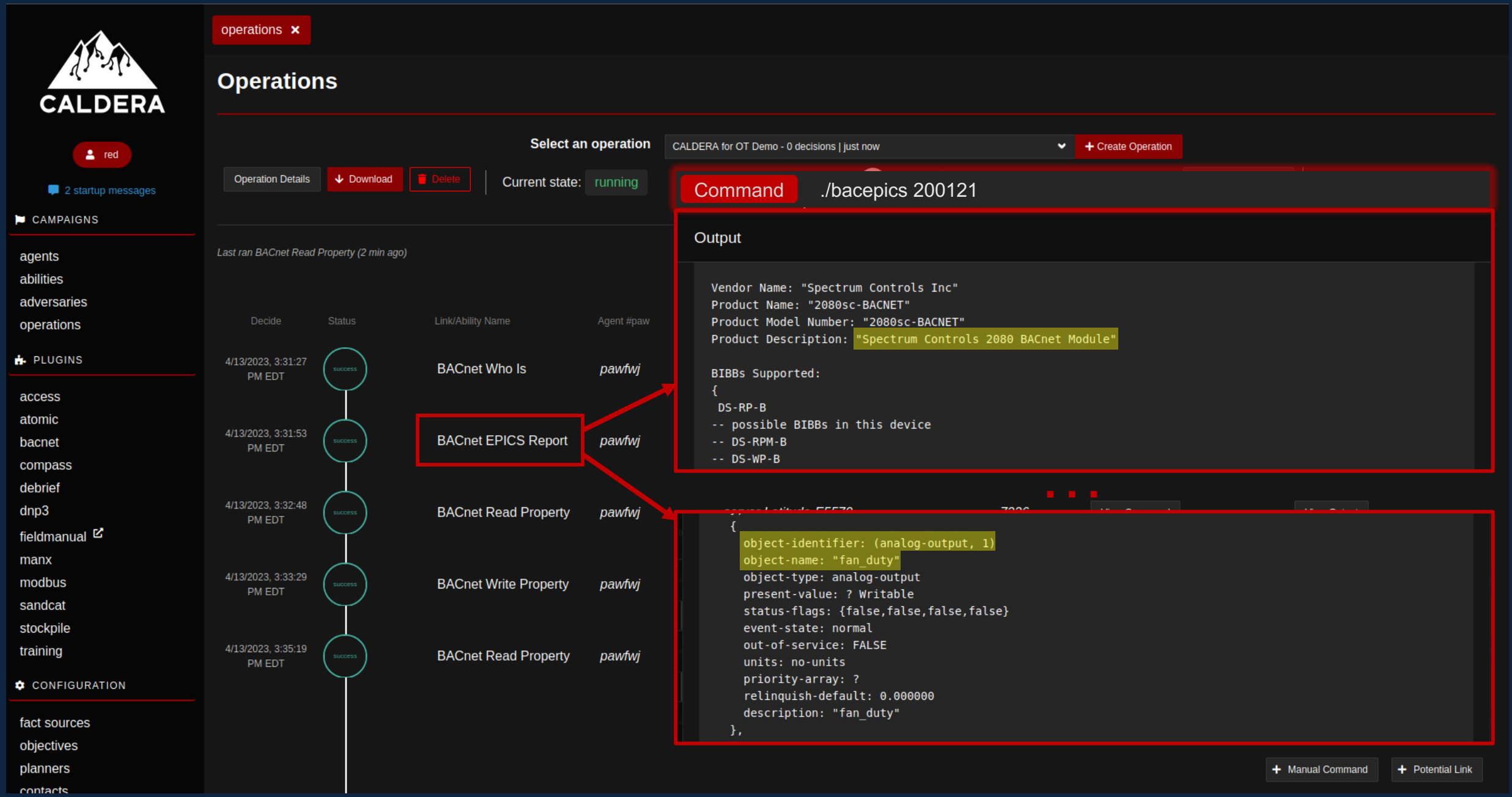
collection

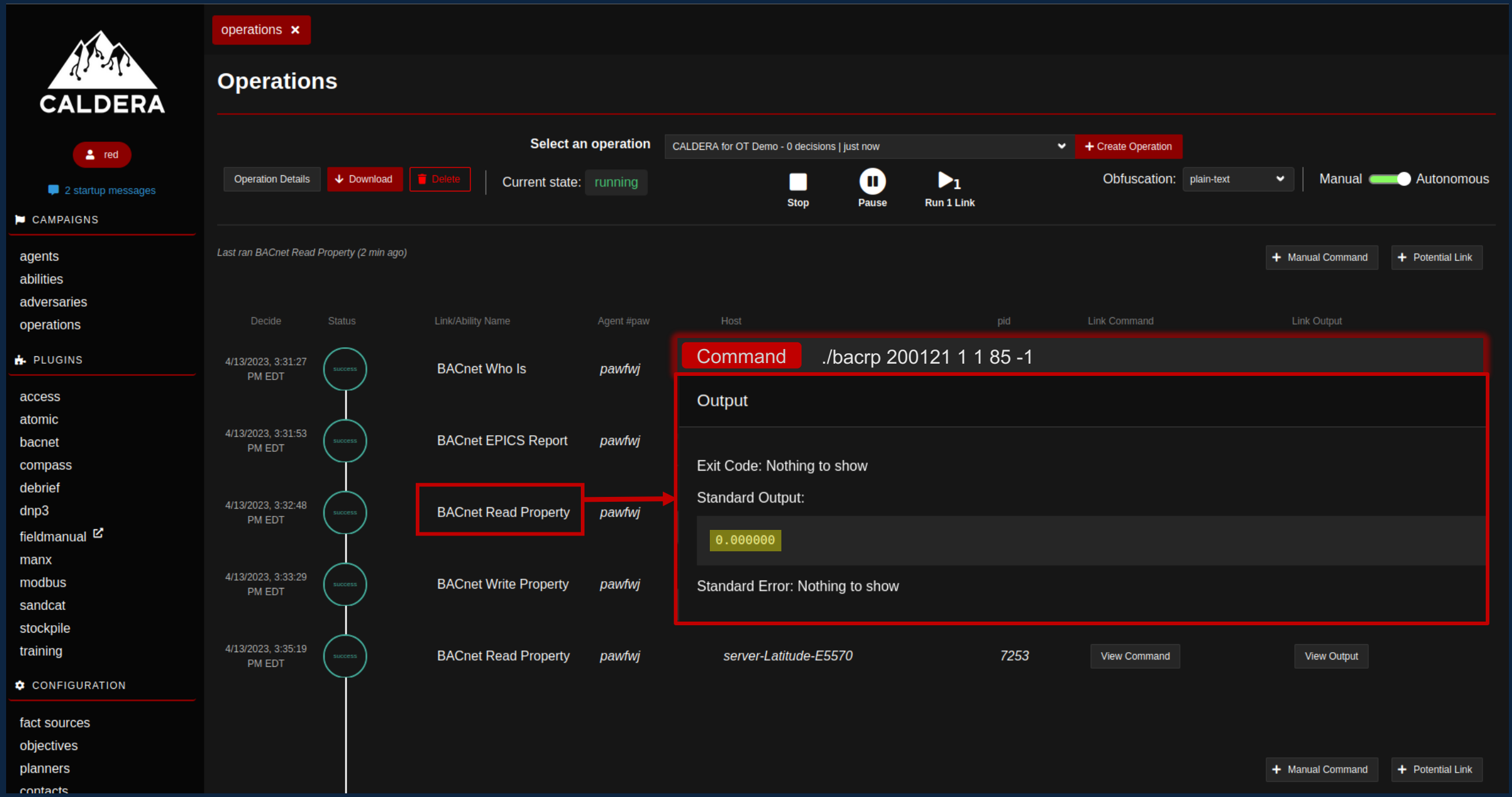
BACnet Atomic Read File (T0801: Monitor Process State)

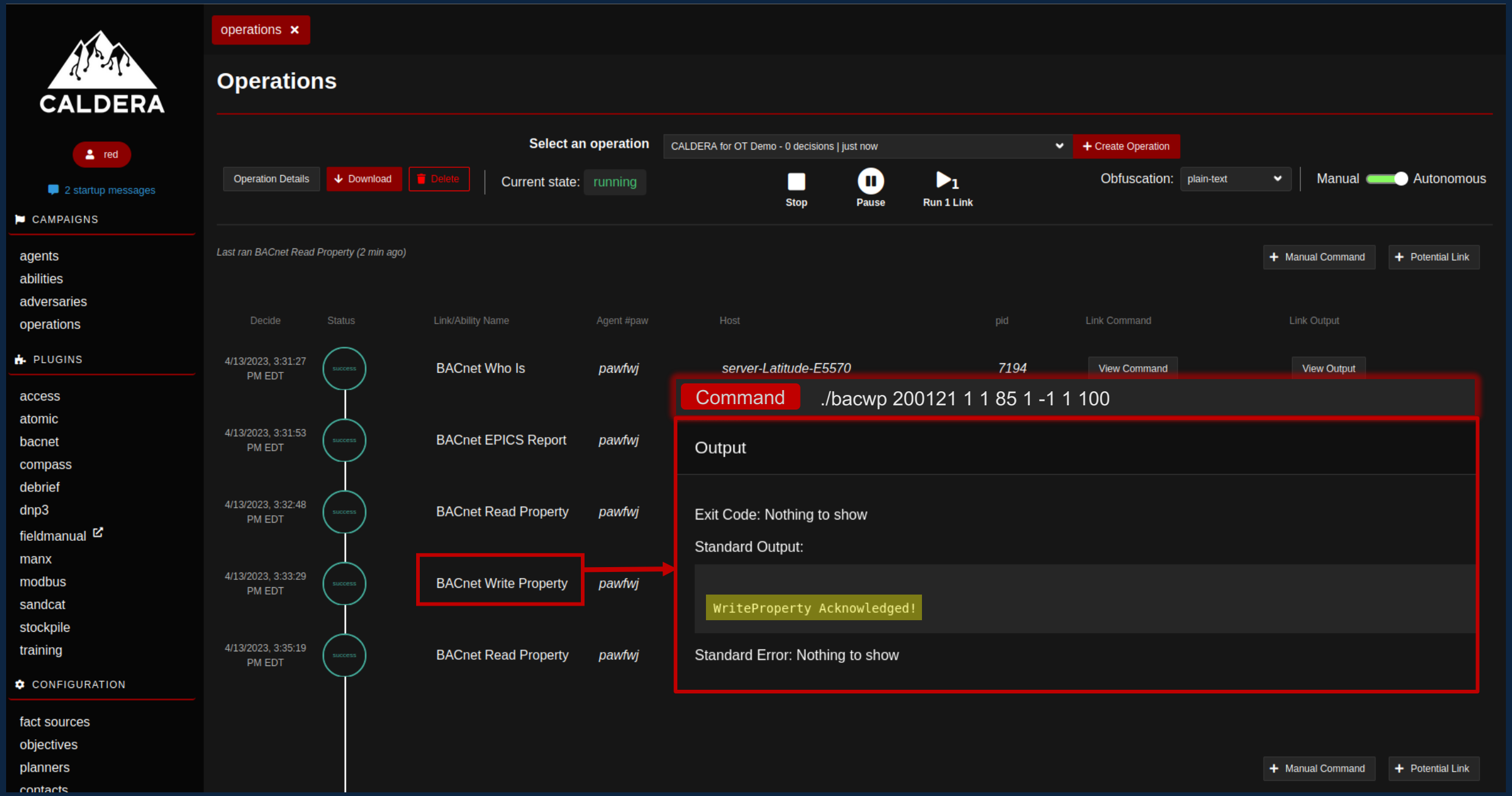
The AtomicReadFile Service is used by a client BACnet-user to perform an open-read-close operation on the contents of the specified file. The file is saved locally.

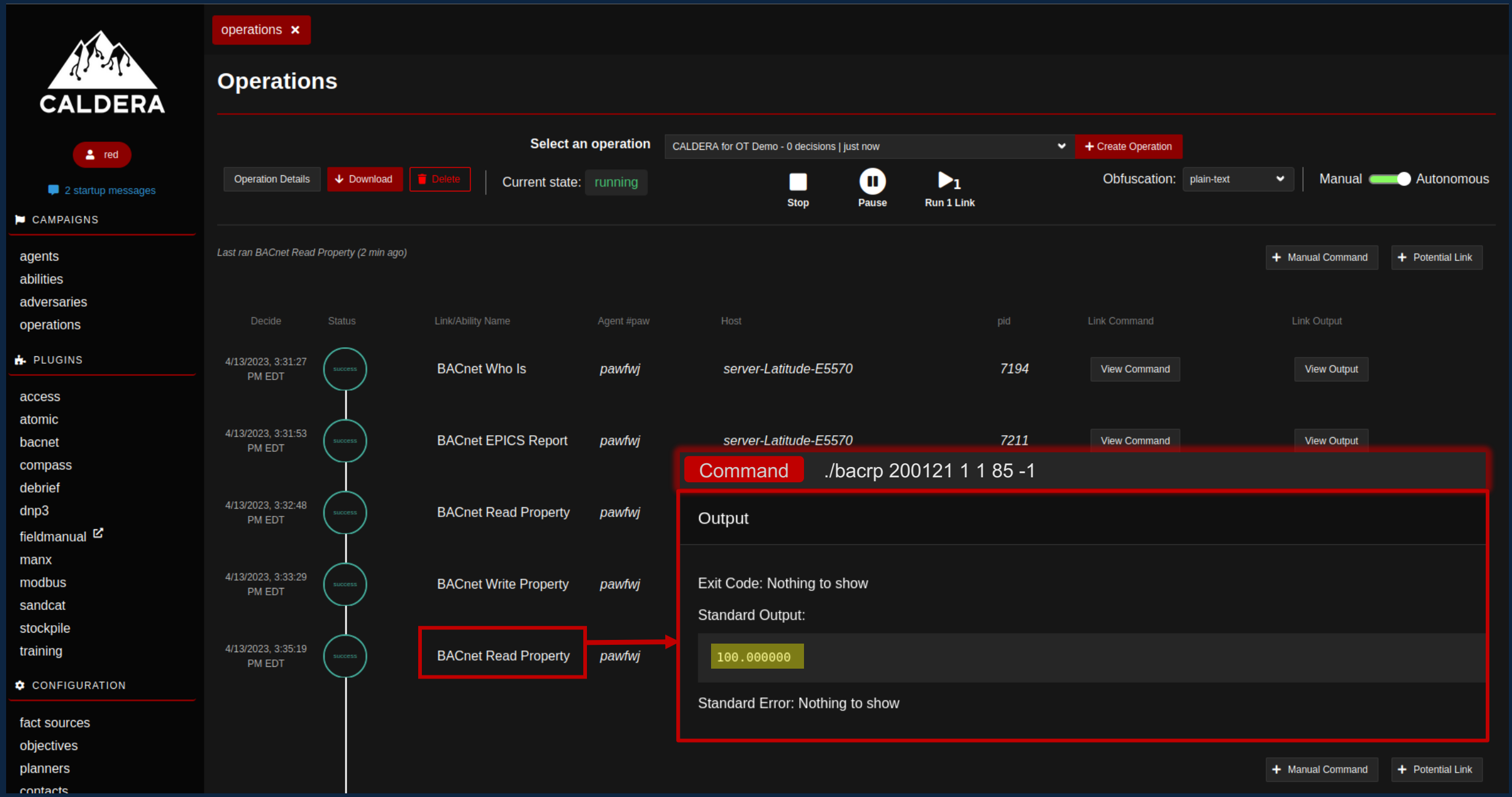












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PERSISTENCE

DISCOVERY
- *Rem. System Discovery* T0846

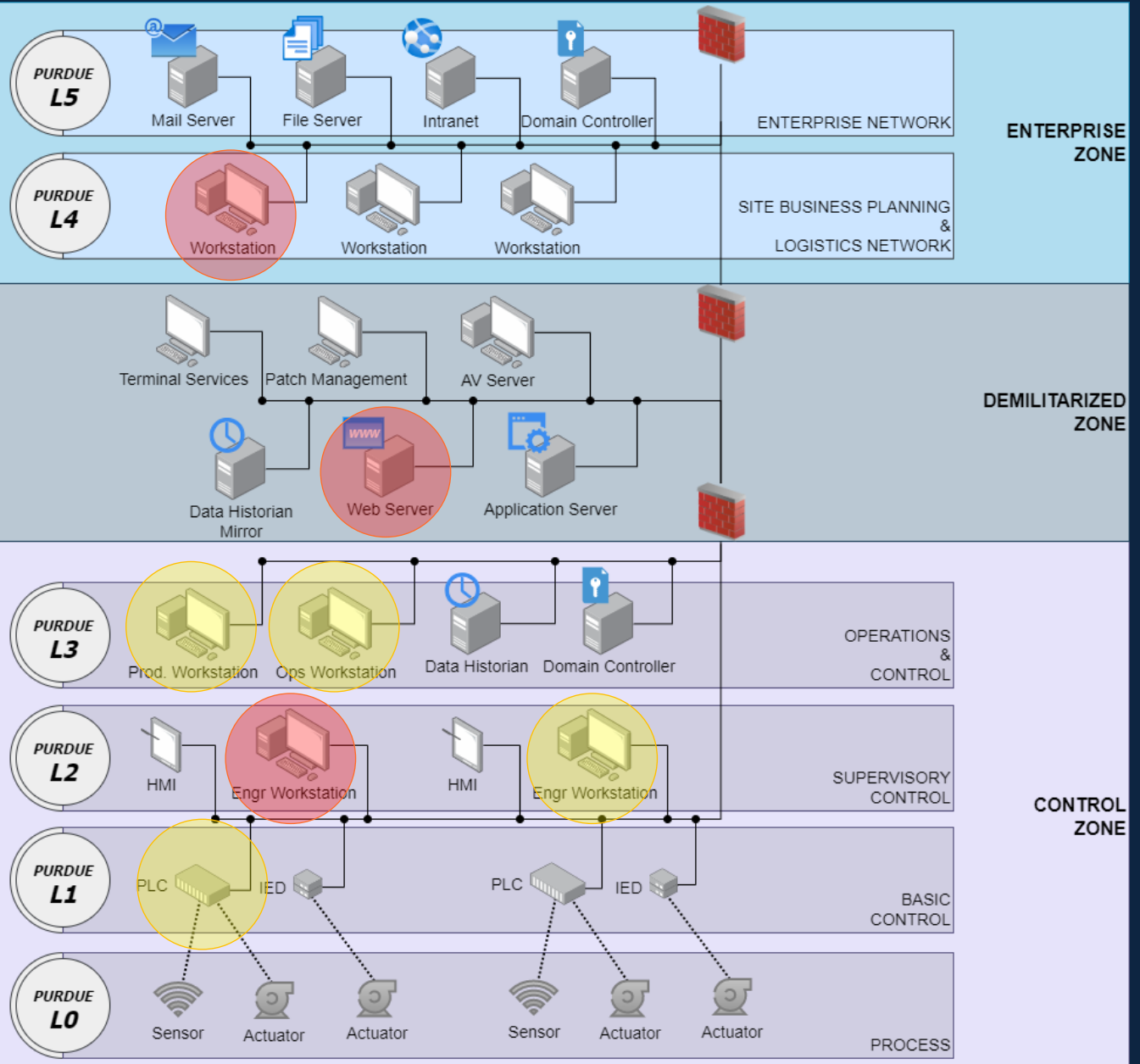
BACnet Who Is

COLLECTION
- *Automated Collection* T0802
- *Point & Tag Identification* T0861

BACnet EPICS Report
BACnet Read Property

IMPACT
- *Manipulation of Control* T0831

BACnet Write Property



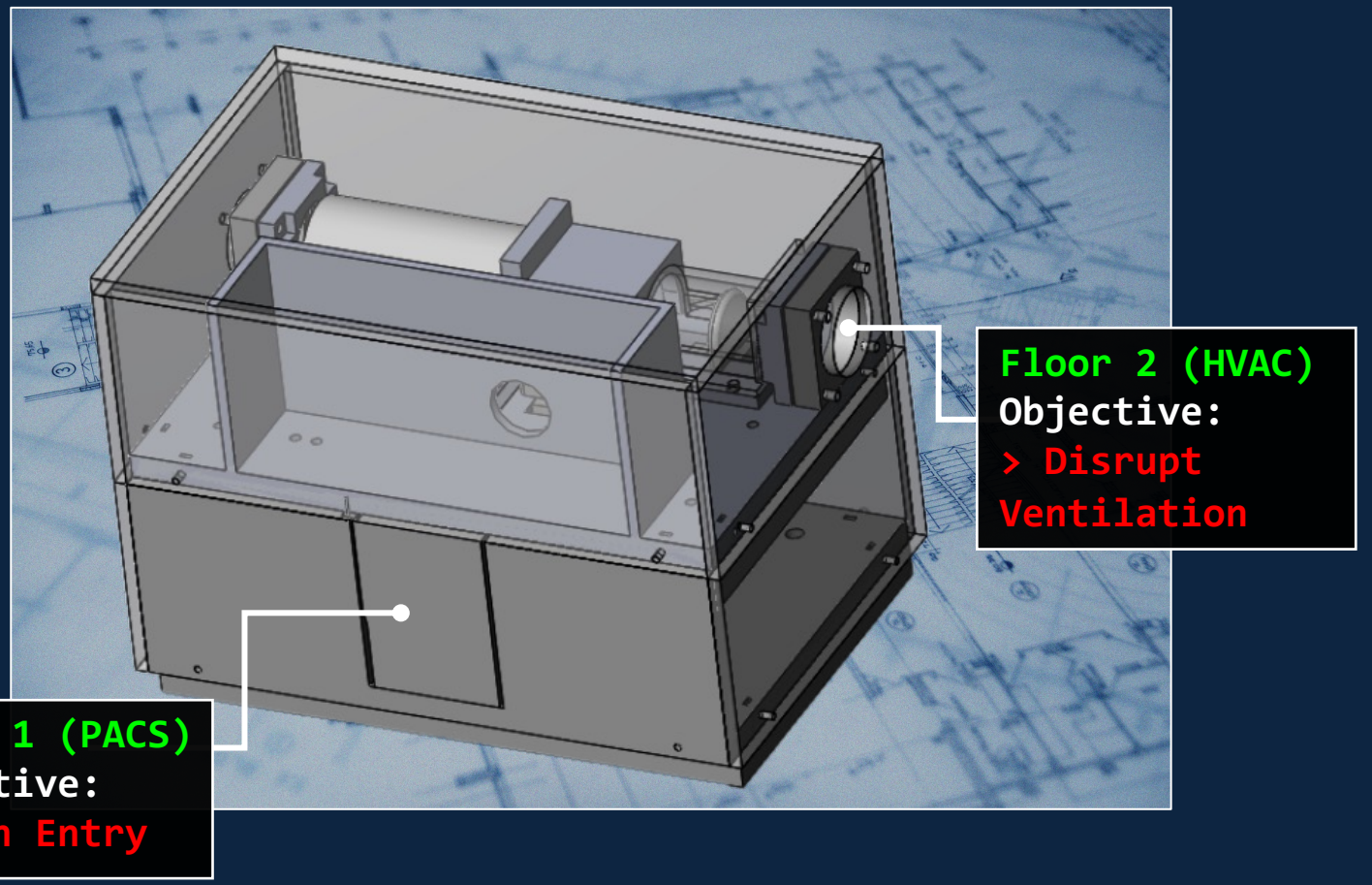
Try it yourself! (visit us at Booth #8!)

Hands-on Demo!:

- Portable “building in a box”
- Interact with Caldera for OT plugins

The Mission:

- Challenge 1: PACS
- Challenge 2: HVAC



Future Direction (and how *you* can contribute!)

Future Releases:

- Expand ICS protocol coverage and capabilities
- Caldera for OT blog posts and learning materials

Community Engagement:

- Actively seeking feedback and collaboration opportunities
- Contribute to the open-source on GitHub!

Coming Soon:

https://github.com/mitre/caldera-ot

Explore Caldera:

https://github.com/mitre/caldera

Reach us at:
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Caldera™ for OT

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