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#CiscoLiveAPJC

Programmability on Catalyst 9000 enabling Sustainability

Telemetry Dashboards

Story DeWeese, Technical Marketing
@StoryDeWeese

BRKAPP-2245

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https://ciscolive.ciscoevents.com/ciscolivebot/#BRKAPP-2245

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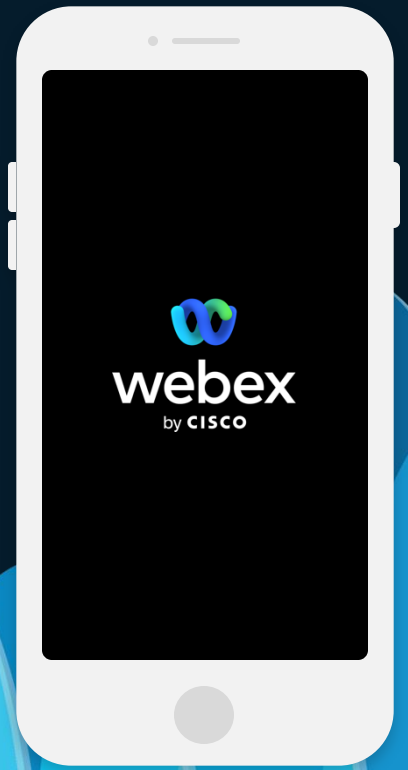

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Agenda

- **Current Situation**
  - Sustainability in Today's complex networks
- **Challenges & Impacts**
- **Demo**
- **Solutions**
  - Programmability with IOS XE
  - Model Driven Telemetry (MDT)
  - TIG Stack
  - Demo + YANG Suite
- **Benefits**
- **Next Steps**
- **Tooling**
- **Resources**

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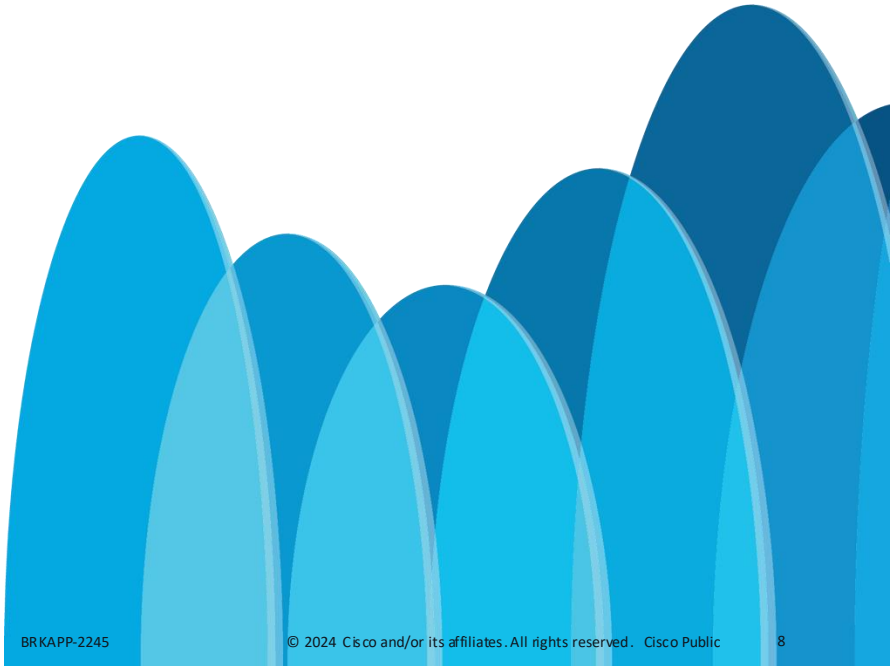
Current Situation

Sustainability in today's complex networks

Current Situation

- Complex Networks
- Limited Network Visibility
- Limited Device Tracking over time



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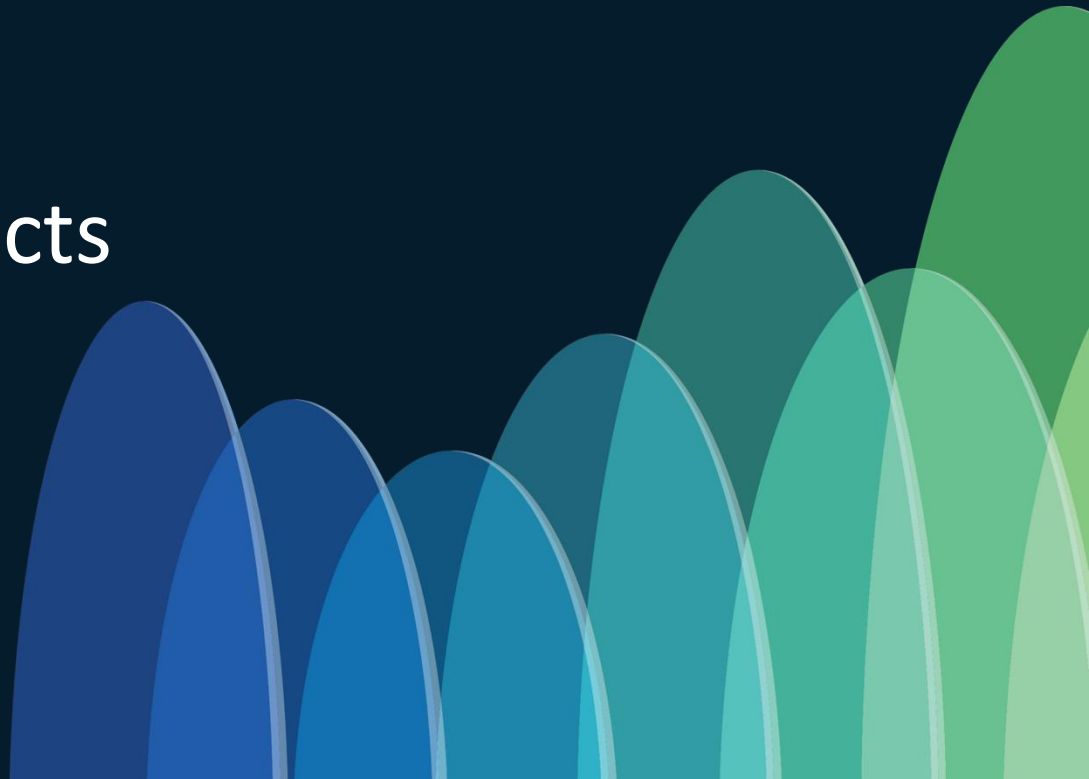
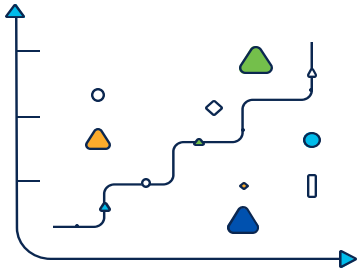
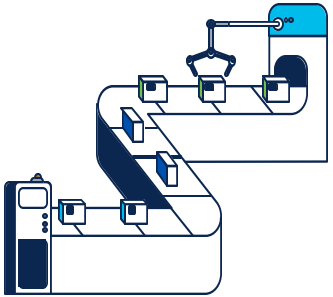
Challenges & Impacts



Challenges & Impacts





↑ Energy Consumption

↑ Operational Costs

↓ Sustainability

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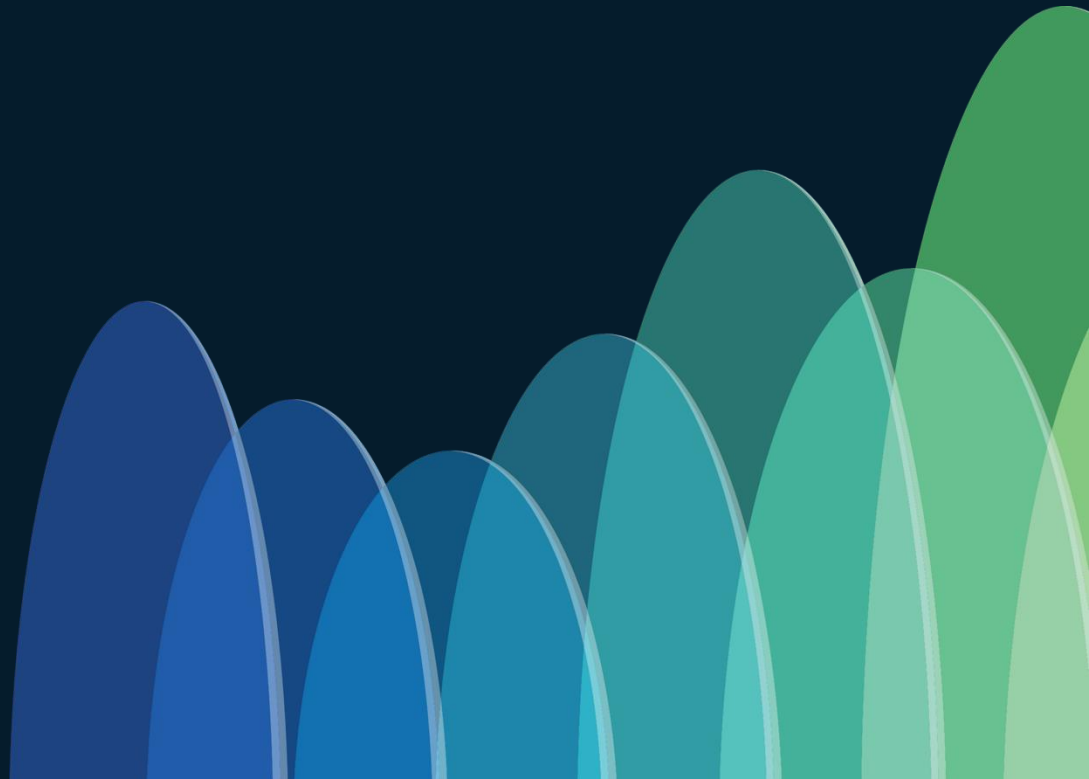
In an Ideal World…

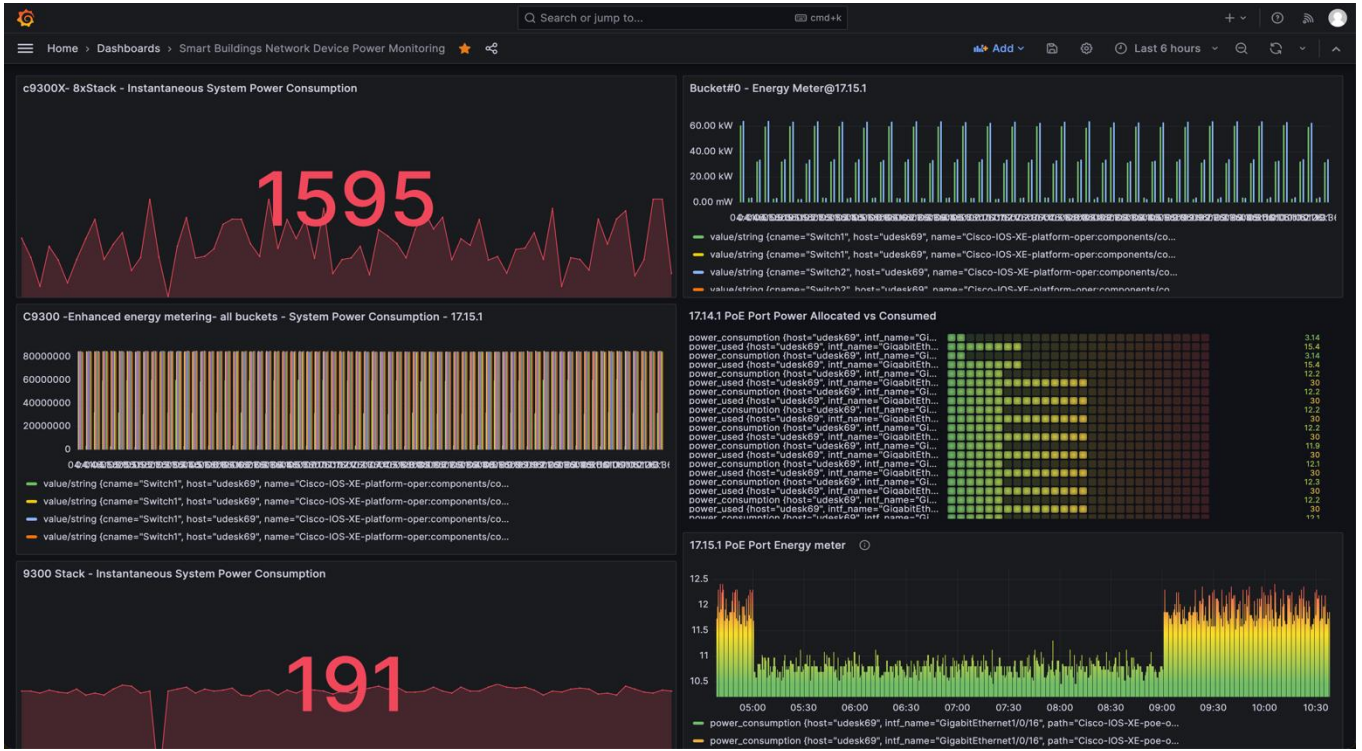


How can we save energy and cost?

How can we maintain more sustainable networks?

In our ideal world

Visibility into the amount of energy we are consuming



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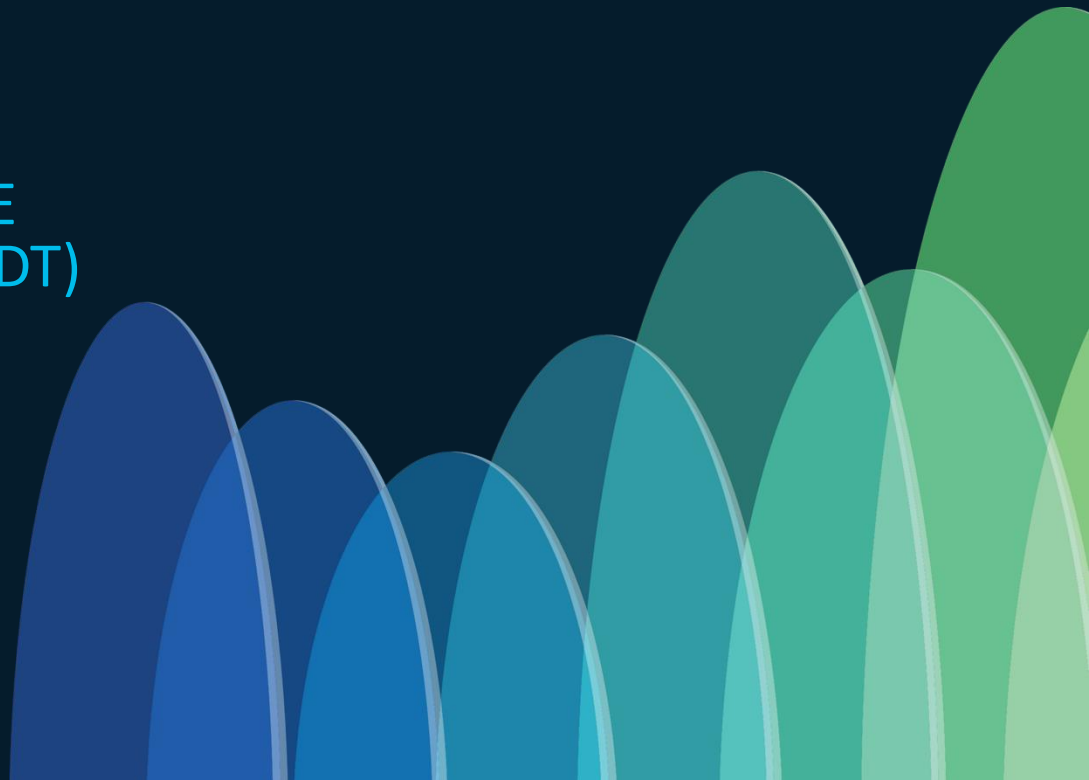
Solutions

Programmability with IOS XE
Model Driven Telemetry (MDT)



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Why do we use programmability?

Programmability solutions for complex networks

Efficient	Consistent	Scalable	Secure	Seamless	Smart
Managing infrastructure as code while lowering OPEX	Repeatable and precise intent-based outcomes	Reduce time and effort with large network automation requirements	Secure APIs and integrations	Create value integrating with 3rd party platforms	Real time event notifications, AI/ML capabilities, and streaming telemetry

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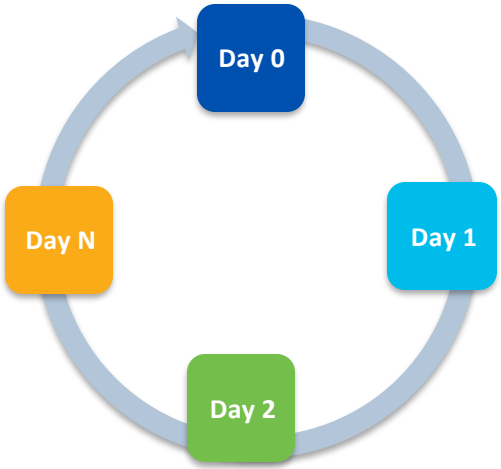
Cisco IOS XE Programmability & Automation Lifecycle



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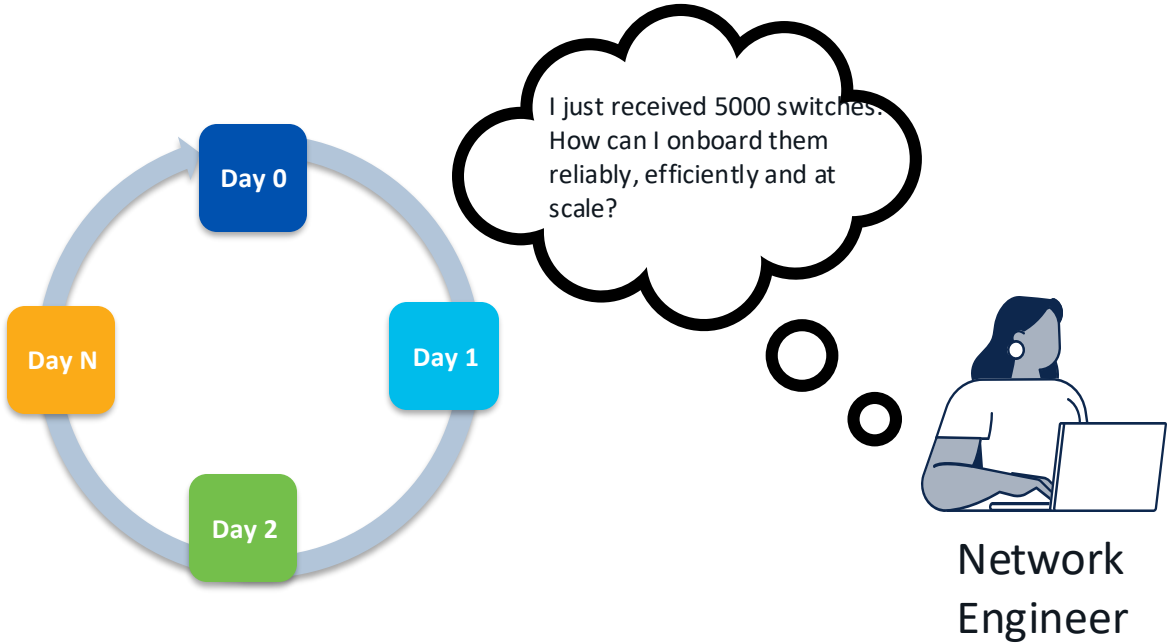
Cisco IOS XE Programmability & Automation Lifecycle



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Cisco IOS XE Programmability & Automation Lifecycle

Pre-boot Execution Environment (iPXE)

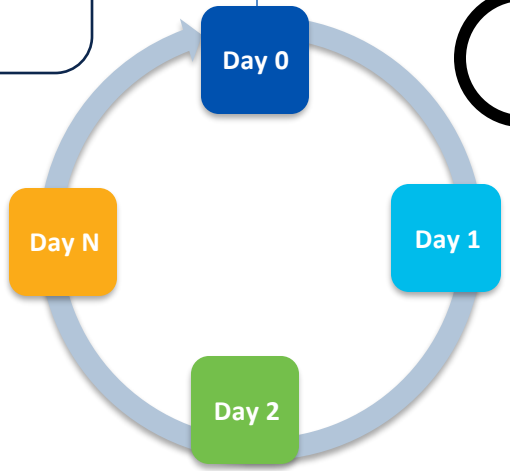
RFC8572 Secure Zero Touch Provisioning ZTP

VM Automation

Provisioning Automation

python™

Device Onboarding



Nice! All 5000 switches are onboarded using Secure Zero Touch Provisioning

Network Engineer

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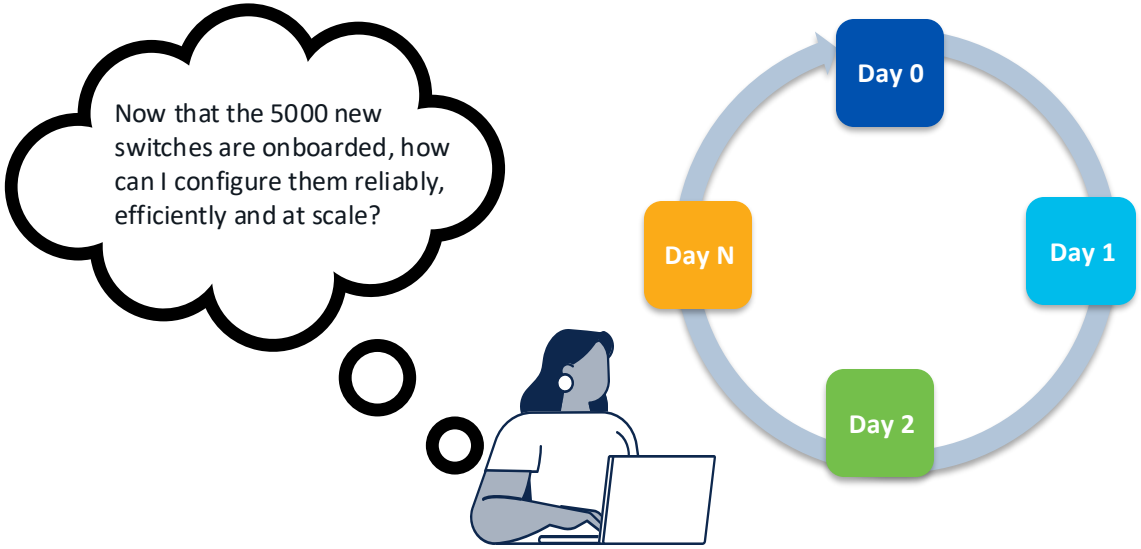
Cisco IOS XE Programmability & Automation Lifecycle



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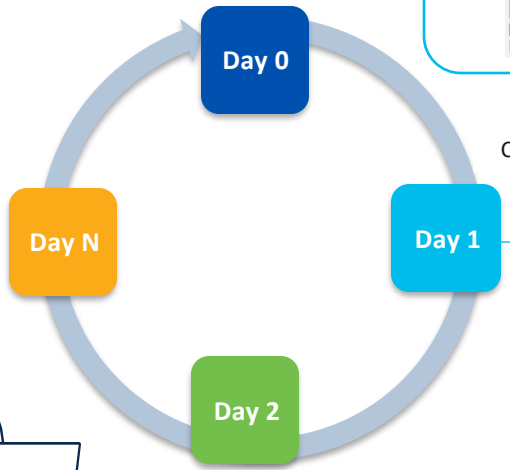
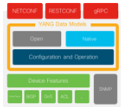
Cisco IOS XE Programmability & Automation Lifecycle

I can use a tooling such as Ansible or Terraform to configure my 5000 switches at once

Network Engineer



Model Driven Programmability



Device Configuration

Network Configuration Protocol (NETCONF), RESTCONF, gNMI

YANG “native” Data Models, OpenConfig,

YANG Suite, Terraform, Ansible, pyATS tooling

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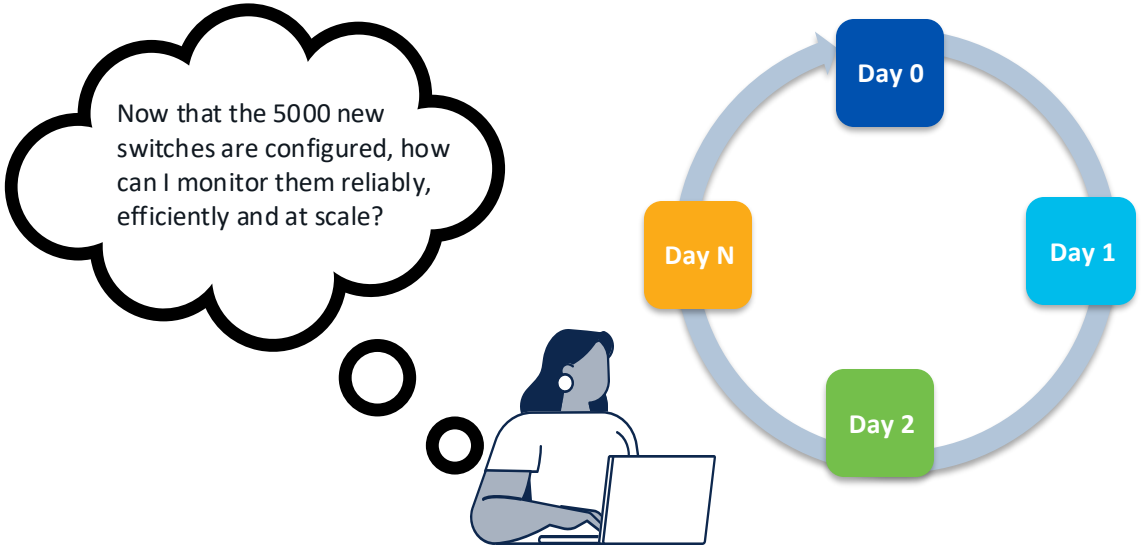
Cisco IOS XE Programmability & Automation Lifecycle



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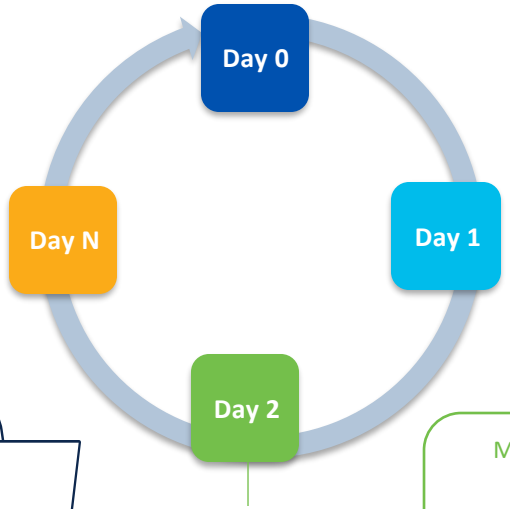
Cisco IOS XE Programmability & Automation Lifecycle

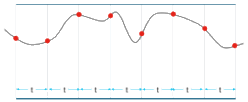
I'll use gRPC for Model Driven Telemetry to monitor changes on my device and quickly find any anomalies

Network Engineer



Device Monitoring

Model Driven Telemetry



TIG_MDT container + guide

YANG On-Change support

gRPC Dial-Out + DNS + mTLS

gNMI/NETCONF Dial-In

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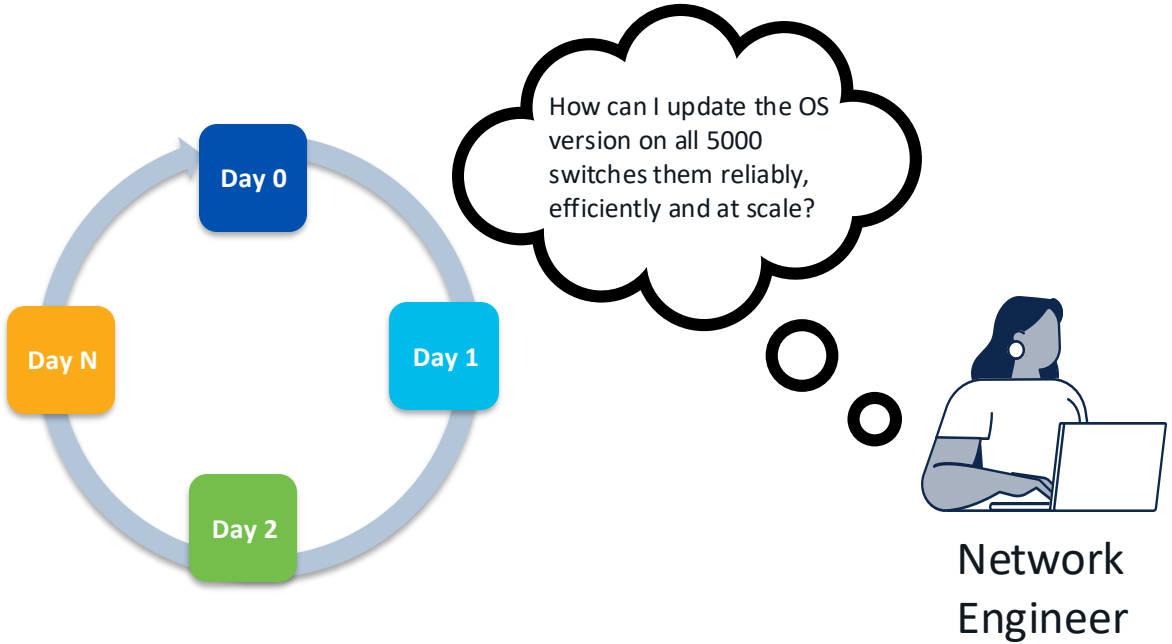
Cisco IOS XE Programmability & Automation Lifecycle



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Cisco IOS XE Programmability & Automation Lifecycle

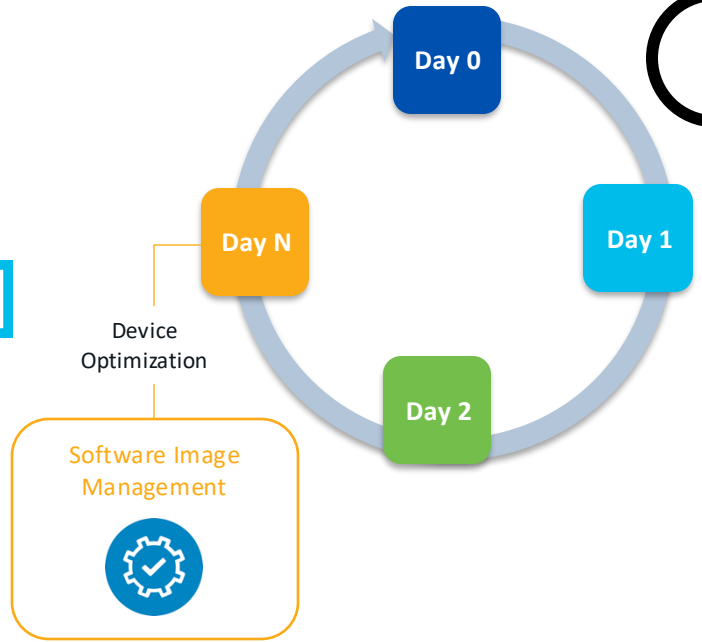
gNOI cert/os/reset proto

Guest Shell + Python/NETCONF

CentOS 8 Python 3

Application Hosting with Docker

“show run” CLI to YANG



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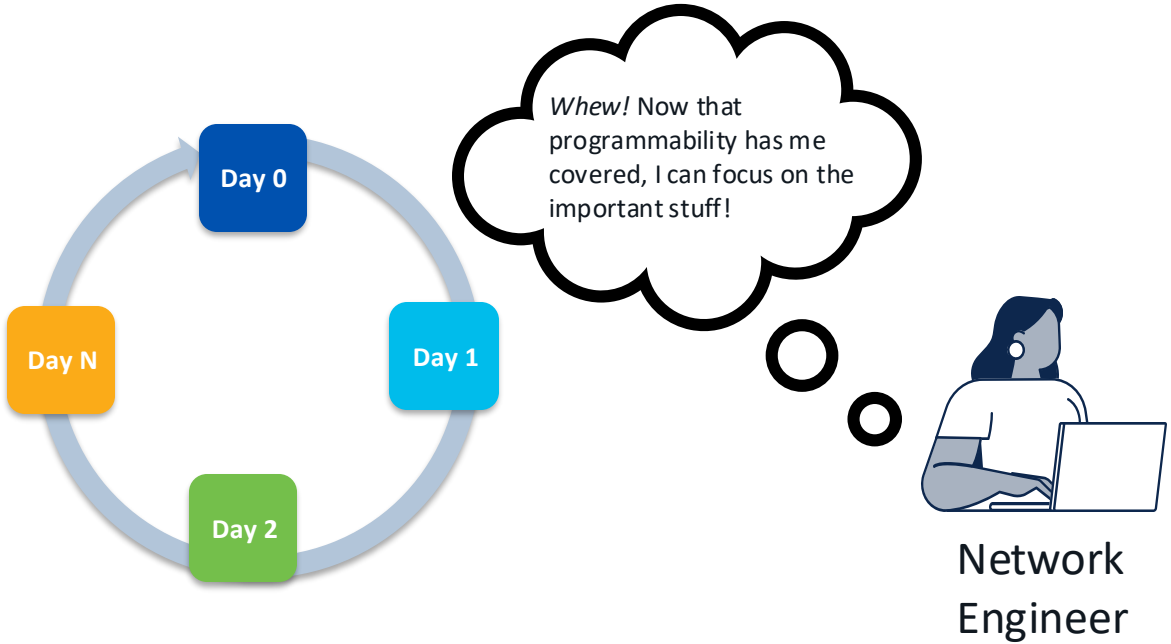
Cisco IOS XE Programmability & Automation Lifecycle



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Cisco IOS XE Programmability & Automation Lifecycle

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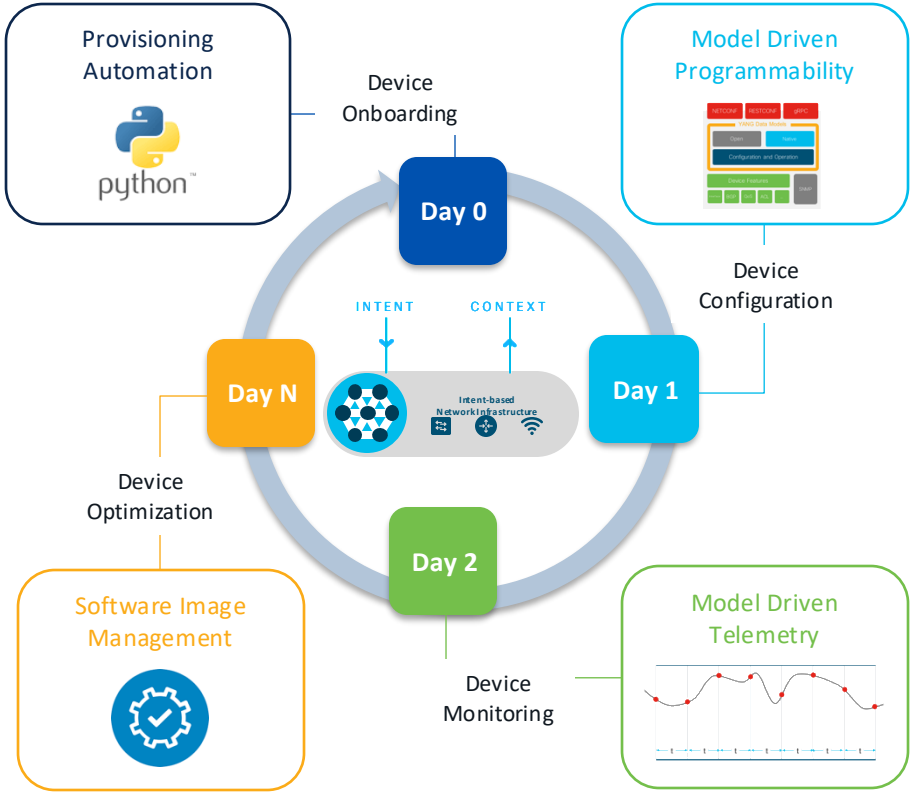
RFC8572 Secure Zero Touch Provisioning ZTP

VM Automation



Network Configuration Protocol (NETCONF), RESTCONF, gNMI

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TIG_MDT container + guide

YANG On-Change support

gRPC Dial-Out + DNS + mTLS

gNMI/NETCONF Dial-In

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IOS XE programmability and Telemetry “Stack”

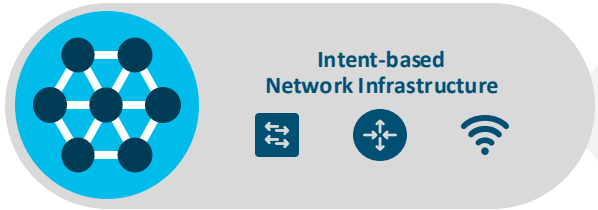
CLI

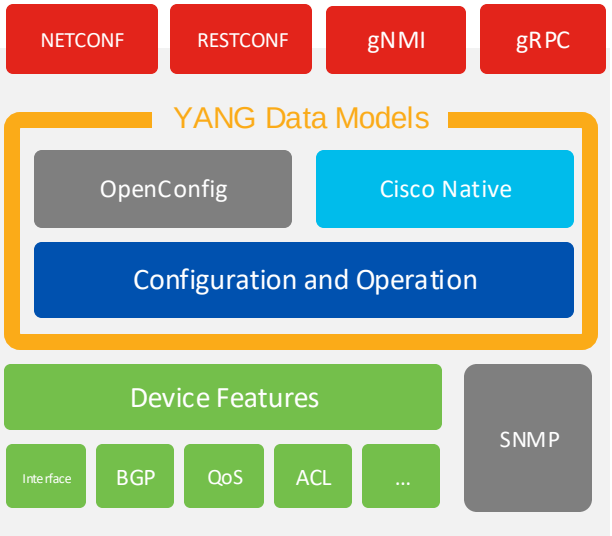
SNMP

WebUI

The NETCONF, RETCONF, gNMI and gRPC are programmatic interfaces that provide **additional** methods for interfacing with the IOS XE device – Just like the CLI, SNMP, and WebUI is used for configuration changes and operational metrics so can the programmatic interfaces of NETCONF, RESTCONF, gNMI, and gRPC.

YANG data models define the data that is available for configuration and streaming telemetry





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Reference

Model Driven Programmability Interface Comparison

Network architecture, security posture and policy, YANG data modules, tools and language preferences are some considerations when leveraging the various MDP interfaces

	NETCONF	RESTCONF	gNMI
Minimum IOS XE Version	16.6	16.7	16.8
Recommended Version	17.6	17.6	17.7
Default Port	830	443	9339
Operations	<get>,<get-config>,<edit-config>,<establish-subscription>	GET, POST, PUT, PATCH, DELETE	GET, SET, SUBSCRIBE
Encoding	XML	XML or JSON	RFC7951 JSON_IETF
Security	SSH + PKI certificate or password	HTTPS user/pass	TLS certificate with user authentication
Transport Protocol	SSH	HTTPS	HTTP/2
Tooling	YANG Suite, ncclient, Netconf-console	YANG Suite*, Postman, python	YANG Suite*, gnmic, gnmi_cli
Content	YANG	YANG	YANG + Protobuf

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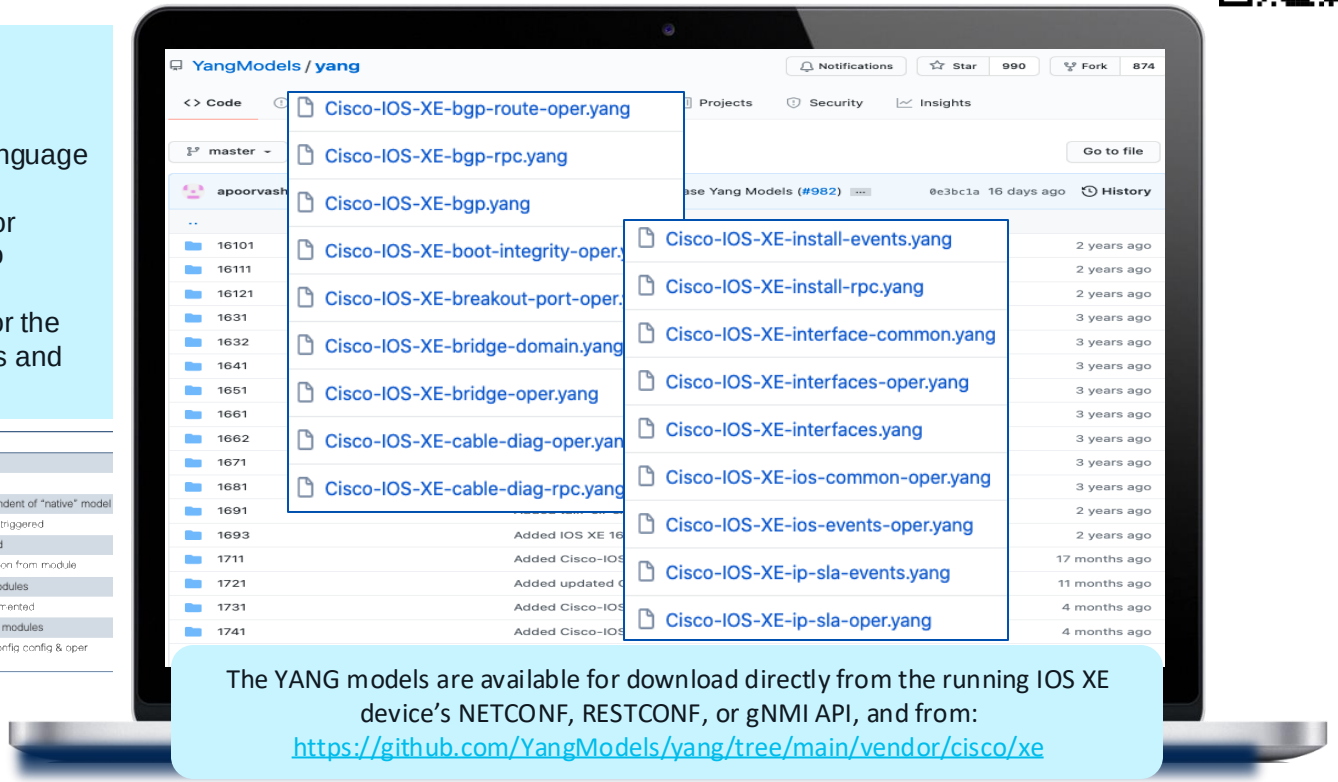
Cisco IOS XE - YANG model API documentation

- There are 10 types of data models including config, oper, actions, and deviations
- RFC 7950 YANG data modelling language are the API definitions for IOS XE
- The YANG modules are available for download from the API and are also published on Github.com
- Notable modules are listed below for the running-config, feature oper, actions and event notifications

	TYPE	YANG module name.yang	Description
1	Native configuration model	Cisco-IOS-XE-native	running-config
2	Operation	Cisco-IOS-XE-{feature}-oper	Feature operational data
3	Configuration	Cisco-IOS-XE-{feature}-cfg	Feature configuration, independent of "native" model
4	Events	Cisco-IOS-XE-{feature}-events	Telemetry Events that can be triggered
5	RPC	Cisco-IOS-XE-{feature}-rpc	Actions that can be performed
6	Deviation	Cisco-IOS-XE-{feature}-deviation	Device implementation deviation from module
7	Types	Cisco-IOS-XE-{feature}-types	Types – Imported by other modules
8	Obsolete	Cisco-IOS-XE-{feature}-obsolete	Obsolete should not be implemented
9	Common	Cisco-IOS-XE-{feature}-common	Common – Imported by other modules
10	Abstractions	OpenConfig-{feature} & Cisco-evpn-service	abstraction for EVPN, OpenConfig config & oper



The YANG models are available for download directly from the running IOS XE device's NETCONF, RESTCONF, or gNMI API, and from: https://github.com/YangModels/yang/tree/main/vendor/cisco/xe

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Day 2: Device Monitoring

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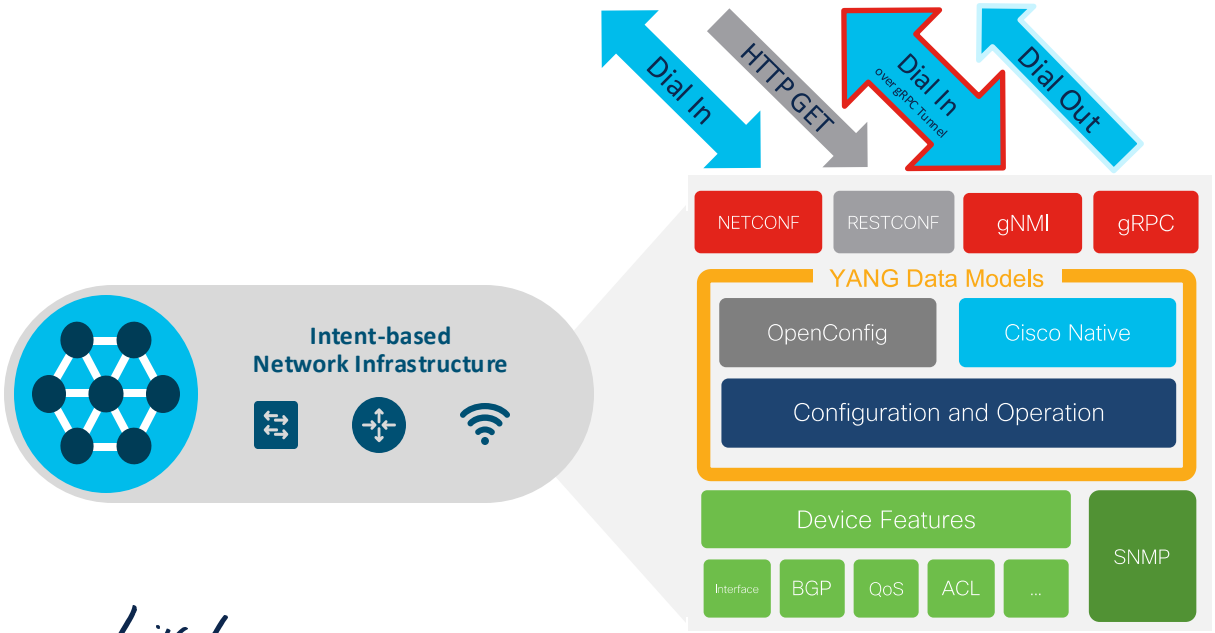
Model Driven Telemetry Interfaces

Dial In: Collector establishes a connection to the device then subscribes to telemetry (pub/sub)

Dial Out: Telemetry is pushed from the device to the collector based off configuration (push)

Publication / Subscription



XML, JSON, proto and kvGPB encoding

Consistent YANG data models between interfaces

On-change event and time-based publication options

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How do we get telemetry data from our Catalyst devices?

Telemetry Data Flow

Cisco IOS XE Devices

Collector/Receiver
Decodes to text

telegraf™

Storage
Time Series Database

InfluxDB

Monitoring and Visualisations

Grafana

https://hub.docker.com/r/jeremycohoe/tig_mdt https://github.com/jeremycohoe/cisco-ios-xe-mdt
https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/prog/configuration/179/b_179_programmability_cg/m_179_prog_ietf_telemetry.html

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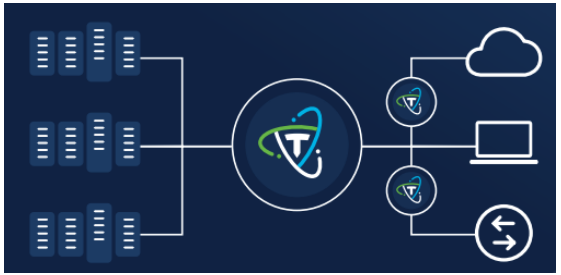
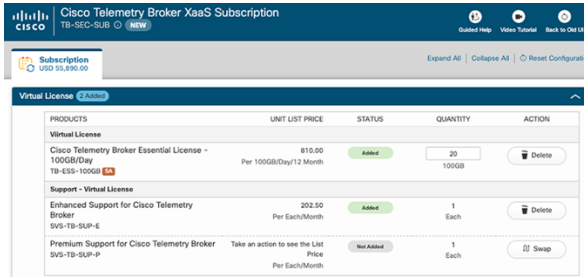
Cisco Telemetry Data Broker (Telegraf)

Cisco Telemetry Broker provides many benefits include brokering, filtering, and transforming data. It provides the ability to replicate telemetry data.





- **Brokering Data:**
  The ability to route and replicate telemetry data from a source location to multiple destination consumers.

  Quickly onboard new telemetry-based tools!

- **Filtering Data:**
  The ability to filter data that is being replicated to consumers for fine grain control over what consumers are able to see and analyze.

  Save money sending data to expensive tools!

- **Transforming Data:**
  The ability to transform data protocols from the exporter to the consumer's protocol of choice.

  Enable tools to consume multiple data formats!

https://cs.co/telemetrybroker aka https://www.cisco.com/c/en/us/products/security/telemetry-broker/index.html
https://blogs.cisco.com/security/taking-full-control-of-your-telemetry-with-the-intelligent-telemetry-plane

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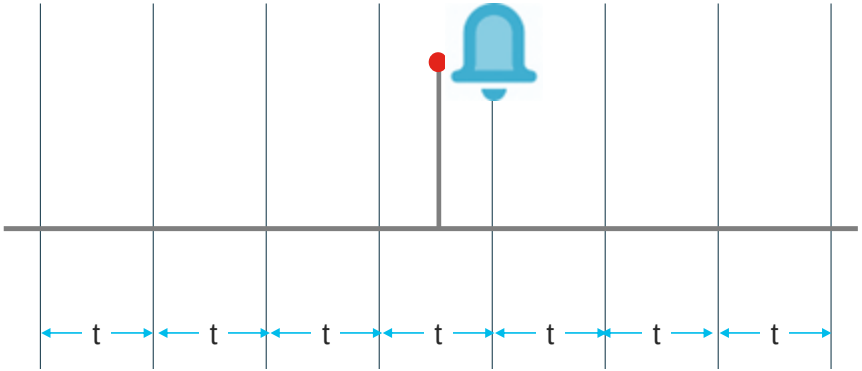
Publication options

On-Change

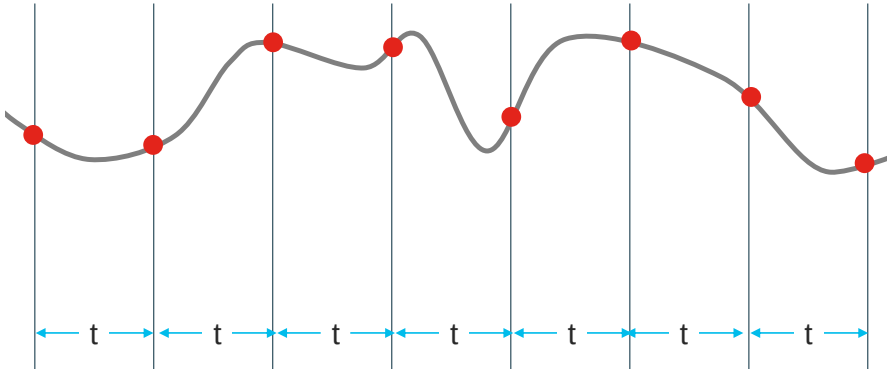


Feature Model "On-Change" Notifications

Event Notifications (failed login, optic fault, etc)

State and Configuration

Periodic



Feature Model "Periodic" Notifications

Time based publication

Minimum interval 100 centiseconds (1s)

OpenConfig YANG with GNXI, not NETCONF

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Monitoring today for each network device

CLI

```
cat9300x-pod29a#show processes cpu
CPU utilization for five seconds: 0%/0%; one minute: 0%; five minutes: 0%
 PID Runtime(ms)     Invoked      uSecs   5Sec   1Min   5Min TTY Process
   1           0          19          0  0.00%  0.00%  0.00%   0 Chunk Manager
   2      429509     2209233        194  0.00%  0.00%  0.00%   0 Load Meter
   3           0           2          0  0.00%  0.00%  0.00%   0 PKI Trustpool
   4         378          17      22235  0.00%  0.00%  0.00%   0 RF Slave Main Th
   5           0           1          0  0.00%  0.00%  0.00%   0 Retransmission o
   6           0           1          0  0.00%  0.00%  0.00%   0 IPC ISSU Dispatc
   7           0           1          0  0.00%  0.00%  0.00%   0 RO Notify Timers
   8        1920      368205          5  0.00%  0.00%  0.00%   0 VIDB BACKGD MGR
   9     4460802     1502068       2969  0.00%  0.03%  0.00%   0 Check heaps
  10       27588      184104        149  0.00%  0.00%  0.00%   0 Pool Manager
  11           0           1          0  0.00%  0.00%  0.00%   0 DiscardQ Backgro
  12           0           2          0  0.00%  0.00%  0.00%   0 Timers
  13          11        1623          6  0.00%  0.00%  0.00%   0 WATCH_AFS
  14        6955      472437         14  0.00%  0.00%  0.00%   0 DB Lock Manager
  15       69695    11046159          6  0.00%  0.00%  0.00%   0 GraphIt
  16           0           3          0  0.00%  0.00%  0.00%   0 DB Notification
```

x6 devices

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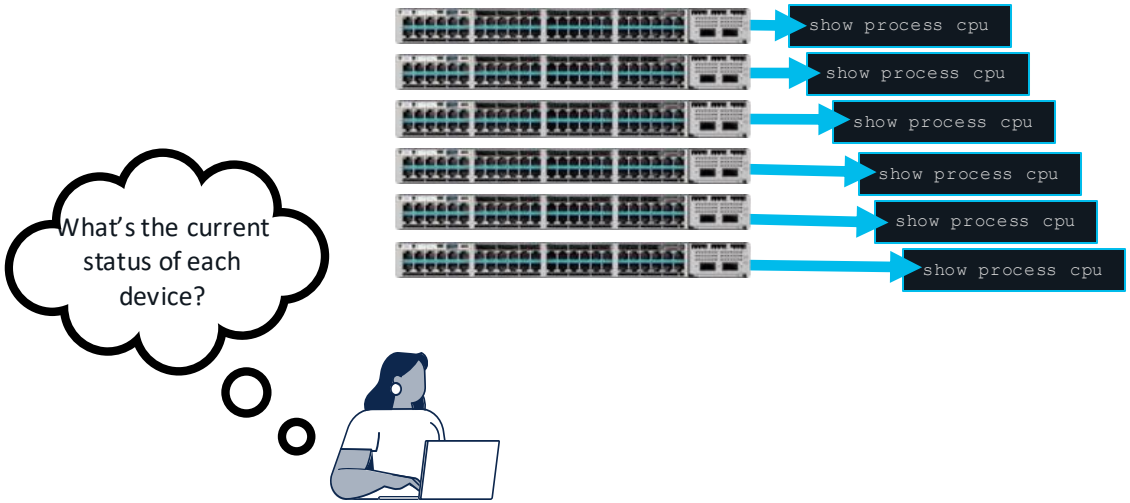
Using Telemetry to Track Devices

Show CPU on each device



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Now, let's work more efficiently

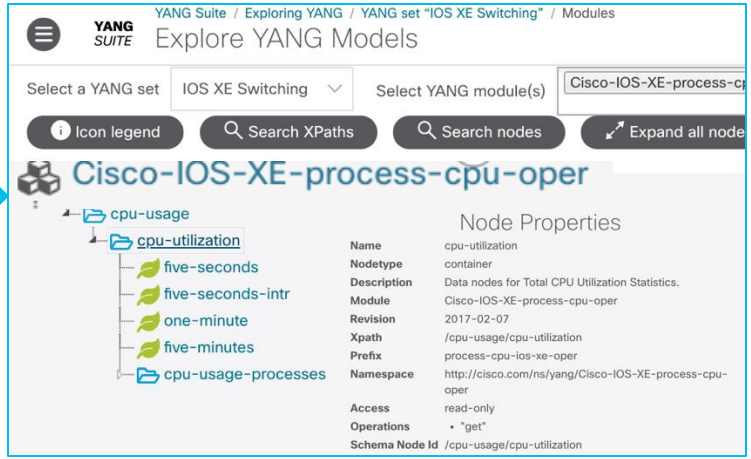
Cisco devices use structured data called YANG models

CLI

```
cat9300x-pod29a#show processes cpu
CPU utilization for five seconds: 0%/0%; one minute: 0%; five minutes: 0%
 PID Runtime(ms)     Invoked      uSecs   5Sec   1Min   5Min TTY Process
   1           0          19          0  0.00%  0.00%  0.00%   0 Chunk Manager
   2      429509     2209233        194  0.00%  0.00%  0.00%   0 Load Meter
   3           0           2          0  0.00%  0.00%  0.00%   0 PKI Trustpool
   4         378          17      22235  0.00%  0.00%  0.00%   0 RF Slave Main Th
   5           0           1          0  0.00%  0.00%  0.00%   0 Retransmission o
   6           0           1          0  0.00%  0.00%  0.00%   0 IPC ISSU Dispatc
   7           0           1          0  0.00%  0.00%  0.00%   0 RO Notify Timers
   8        1920      368205          5  0.00%  0.00%  0.00%   0 VIDB BACKGD MGR
   9     4460802     1502068       2969  0.00%  0.03%  0.00%   0 Check heaps
  10       27588      184104        149  0.00%  0.00%  0.00%   0 Pool Manager
  11           0           1          0  0.00%  0.00%  0.00%   0 DiscardQ Backgro
  12           0           2          0  0.00%  0.00%  0.00%   0 Timers
  13          11        1623          6  0.00%  0.00%  0.00%   0 WATCH_AFS
  14        6955      472437         14  0.00%  0.00%  0.00%   0 DB Lock Manager
  15       69695    11046159          6  0.00%  0.00%  0.00%   0 GraphIt
  16           0           3          0  0.00%  0.00%  0.00%   0 DB Notification
```

CPU data

YANG Model



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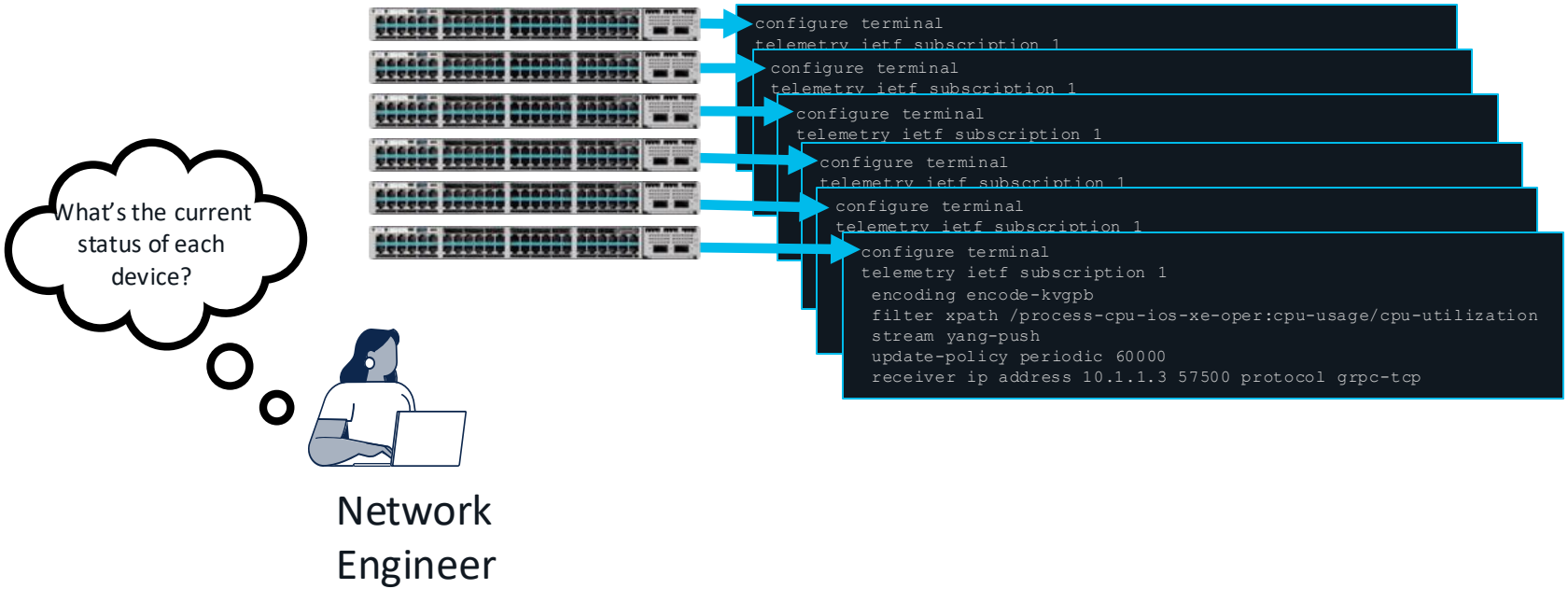
Using Telemetry to Track Devices

Configure Telemetry Subscription One Time



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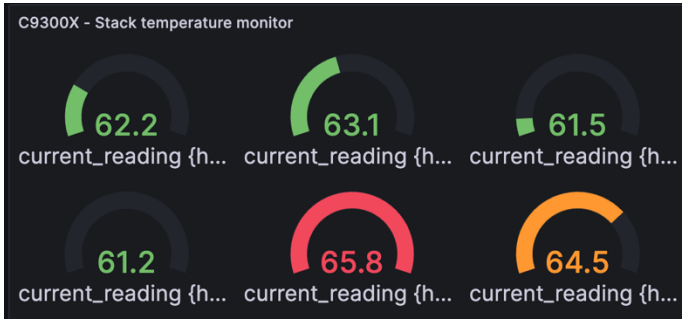
Monitor devices through a single pane of glass

We need to track the status of all these devices at scale



Telemetry from a Cisco device allows us to know its current status

We can collect this data at scale!

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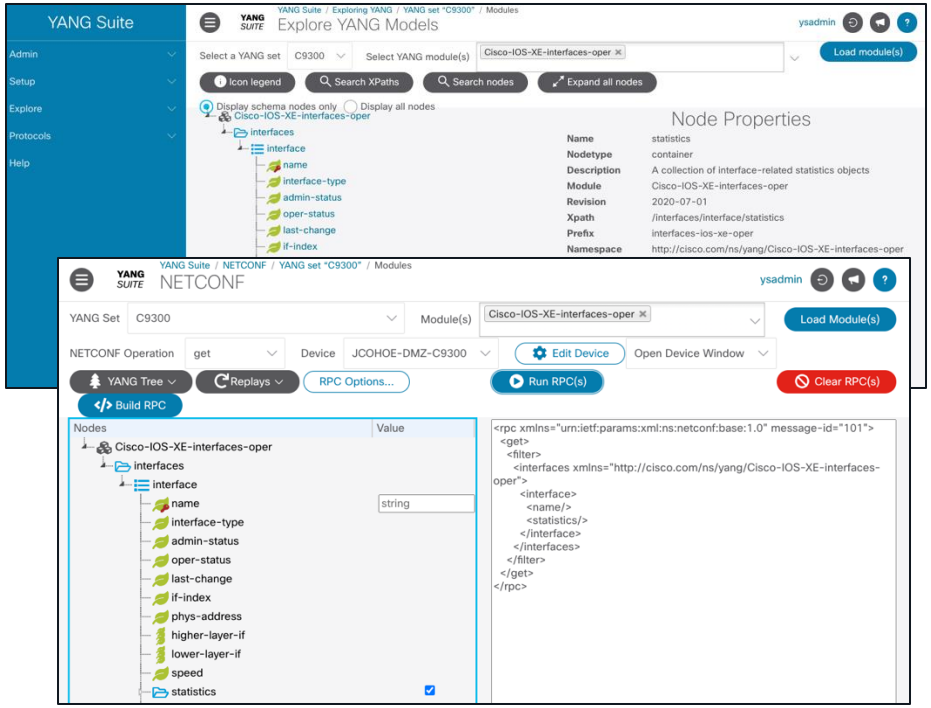
Cisco YANG Suite



YANG API Testing and Validation Environment

Construct and test YANG based APIs over NETCONF, RESTCONF, gRPC and gNMI

IOS XE / IOS XR / NX OS platforms

Get hands-on using the new learning lab!
https://developer.cisco.com/learning/labs/intro-yangsuite/

developer.cisco.com/yangsuite

github.com/CiscoDevNet/yangsuite

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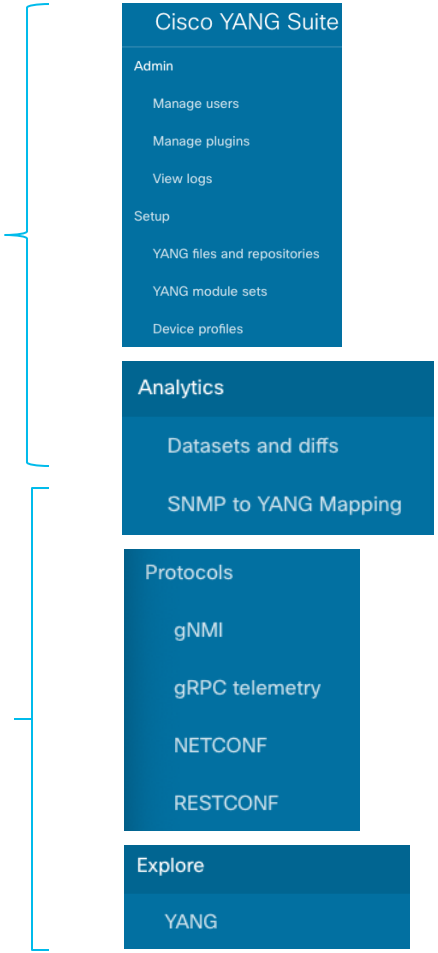
YANG Suite Capabilities

- Initial Release:
  - Plugin and YANG File Manager, Datasets and diffs
  - Device Manager
  - NETCONF (Python), gRPC Telemetry
  - Docker install support with HTTPS
- Second Release:
  - RESTCONF
  - gNMI
  - Python Integrations
- Third Release:
  - gRPC Telemetry with TLS Support
  - SNMP OID to YANG Xpath Mapping
  - Ansible Integrations
  - Pip install support

Core plugins

Additional plugins



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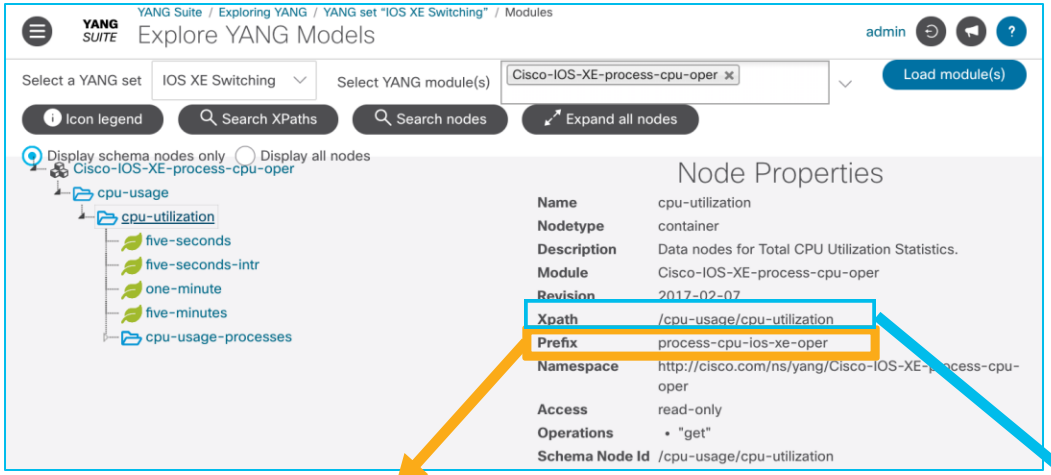
Model Metadata with YANG Suite

The CLI config to enable MDT requires the “filter xpath” which defines which YANG data to publish

Use YANG Suite to find the prefix and xpath from the YANG models to use in the configuration

Configuration Guide:
https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/prog/configuration/1610/b_1610_programmability_cg/model_driven_telemetry.html

filter xpath / PREFIX : XPATH



filter xpath /process-cpu-ios-xe-oper:cpu-usage/cpu-utilization

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Configure a gRPC Telemetry Subscription

Configuring telemetry subscriptions like the following to collect CPU data over time

On Cisco IOS XE Device:

```
configure terminal
telemetry ietf subscription 1
 encoding encode-kvgpb
 filter xpath /process-cpu-ios-xe-oper:cpu-usage/cpu-utilisation
 stream yang-push
 update-policy periodic 60000
 receiver ip address 10.1.1.3 57500 protocol grpc-tcp
```

See more examples at: https://github.com/jeremycohoe/cisco-ios-xe-mdt

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How does this relate to our sustainability efforts?

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Power Telemetry

https://github.com/YangModels/yang/blob/main/vendor/cisco/xe/17101/Cisco-IOS-XE-poe-oper.yang

telemetry configuration

```
no telemetry ietf subscription 69001
telemetry ietf subscription 69001
 filter xpath /poe-oper-data/poe-port-detail
  receiver ip address 10.85.134.66 57508 protocol grpc-tcp
source-address 10.85.134.70
  source-vrf Mgmt-vrf
  stream yang-push
  update-policy periodic 3000
   encoding encode-kvgpb

no telemetry ietf subscription 69002
telemetry ietf subscription 69002
 filter xpath /poe-oper-data/poe-switch
  receiver ip address 10.85.134.66 57508 protocol grpc-tcp
source-address 10.85.134.70
  source-vrf Mgmt-vrf
  stream yang-push
  update-policy periodic 3000
   encoding encode-kvgpb

no telemetry ietf subscription 69003
telemetry ietf subscription 69003
 filter xpath /poe-oper-data/poe-stack
  receiver ip address 10.85.134.66 57508 protocol grpc-tcp
source-address 10.85.134.70
  source-vrf Mgmt-vrf
  stream yang-push
  update-policy periodic 3000
   encoding encode-kvgpb
```

YANG data model

- poe-port-detail
  - intf-name
  - power-used
  - pd-class
  - device-detected
  - device-name
  - police
  - power-admin-max
  - power-from-pse
  - power-to-pd
- poe-switch
  - switch-num
  - power-budget
  - power-allocated
  - low-port-priority
  - high-port-priority
  - switch-priority
  - port-one-status
  - port-two-status
- poe-stack
  - power-stack-name
  - mode
  - topolgy
  - total-power
  - rsvd-power
  - alloc-power
  - unused-power
  - num-sw
  - num-ps

Name	poe-port-detail
Nodetype	list
Description	List of PoE interfaces, keyed by interface name
Module	Cisco-IOS-XE-poe-oper
Revision	2022-07-01
Xpath	/poe-oper-data/poe-port-detail
Prefix	poe-ios-xe-oper
Namespace	http://cisco.com/ns/yang/Cisco-IOS-XE-poe-oper
Schema Node Id	/poe-oper-data/poe-port-detail
Keys	• "intf-name"
Access	read-only
Operations	• "get"
Name	poe-switch
Nodetype	list
Description	List of PoE switches, keyed by switch number
Module	Cisco-IOS-XE-poe-oper
Revision	2022-07-01
Xpath	/poe-oper-data/poe-switch
Prefix	poe-ios-xe-oper
Namespace	http://cisco.com/ns/yang/Cisco-IOS-XE-poe-oper
Schema Node Id	/poe-oper-data/poe-switch
Keys	• "switch-num"
Access	read-only
Operations	• "get"
Name	poe-stack
Nodetype	list
Description	List of PoE stacks, keyed by stack name
Module	Cisco-IOS-XE-poe-oper
Revision	2022-11-01
Xpath	/poe-oper-data/poe-stack
Prefix	poe-ios-xe-oper
Namespace	http://cisco.com/ns/yang/Cisco-IOS-XE-poe-oper
Schema Node Id	/poe-oper-data/poe-stack
Keys	• "power-stack-name"
Access	read-only
Operations	• "get"

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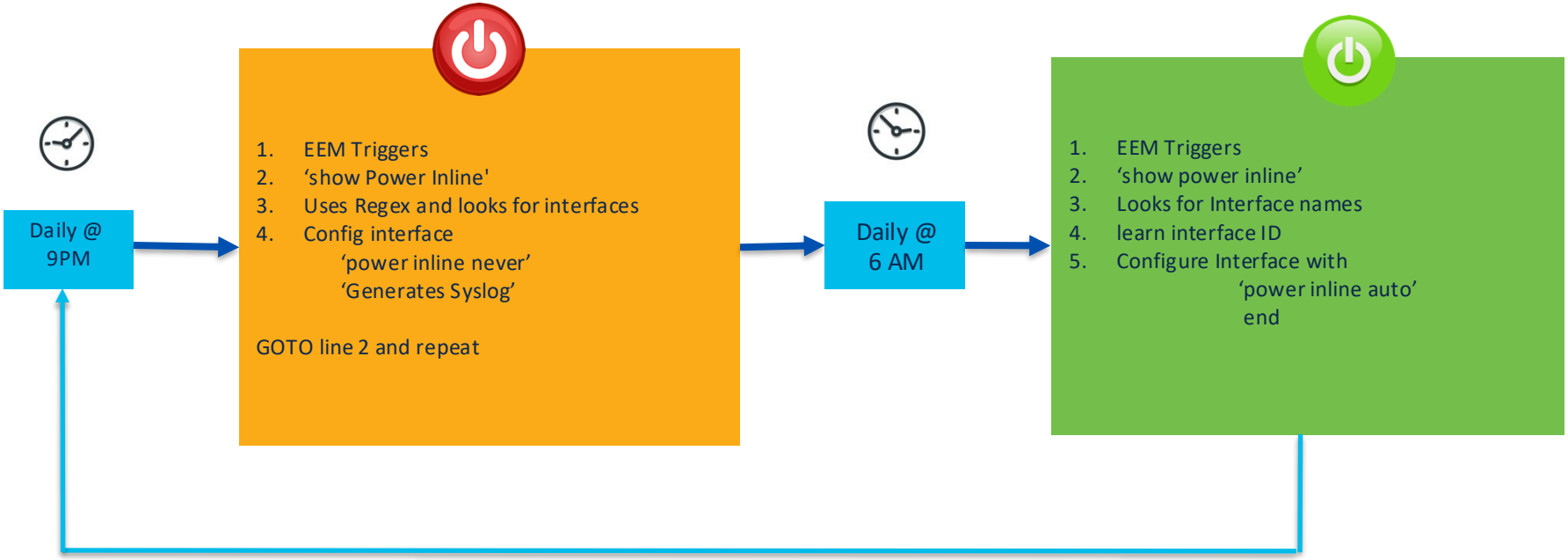
Embedded Event Manager – Applet Flow

Cisco IOS XE Embedded Event Manager (EEM) is a powerful and flexible subsystem
It provides real-time network event detection and onboard automation.
It provides the ability to adapt the behavior of the network devices to better align with business needs.



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POE power management with EEM

EEM is used to toggle the power inline auto / never at 9 PM and 6 AM

Power on/off POE ports on a once daily time schedule

Trigger manually by setting event to none and sending CLI:
C9300-SB# event manager run SelectivePowerOn
C9300-SB# event manager run SelectivePowerOff

```
! EEM POE example SelectivePowerOff
no event manager applet SelectivePowerOff
event manager applet SelectivePowerOff
! Turn *OFF* POE power to the ports daily at 9PM: 0 21 * * *
event timer cron name SelectivePowerOff cron-entry "0 21 * * *"
! or
! event none
!
 action 0.0 cli command "enable"
 action 0.1 cli command "show power inline"
 action 0.2 foreach line "$_cli_result" "\n"
 action 1.1  regexp "^([^[:space:]]*)[[:space:]]*[^[:space:]]*[[:space:]]*on.*$" "$line" temp interface
 action 1.2  if $_regexp_result eq 1
 action 1.3   cli command "conf t"
 action 1.4   cli command "interface $interface"
 action 1.5   cli command "power inline never"
 action 1.6   syslog msg "Turned off PoE on $interface"
 action 1.7  end
 action 2.1 end
```

Examples @ https://github.com/jeremycohoe/cisco-catalyst-eem-examples
NETCONF/RSTCONF/gNMI YANG API: https://github.com/YangModels/yang/blob/main/vendor/cisco/xe/17101/Cisco-IOS-XE-eem.yang
Example source: https://glennmatthys.wordpress.com/2014/08/24/intermediary-eem-scripting-more-fun-with-power-over-ethernet/
EEM https://www.cisco.com/c/en/us/support/docs/ios-nx-os-software/ios-xe-16/216091-best-practices-and-useful-scripts-for-ee.html
https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/eem/command/eem-cr-book/eem-cr-e2.html

Set power on daily

```
! EEM POE example SelectivePowerOn
no event manager applet SelectivePowerOn
event manager applet SelectivePowerOn
! Turn **ON** POE power to the ports daily at 6AM: 0 6 * * *
event timer cron name SelectivePowerOn cron-entry "0 6 * * *"
!
! or
! event none
!
 action 0.0 cli command "enable"
 action 0.1 cli command "show power inline"
 action 0.2 foreach line "$_cli_result" "\n"
 action 1.1  regexp "^([^[:space:]]*)[[:space:]]*off.*$" "$line" temp interface
 action 1.2  if $_regexp_result eq 1
 action 1.3   cli command "conf t"
 action 1.4   cli command "interface $interface"
 action 1.5   cli command "power inline auto"
 action 1.6   syslog msg "Turned on PoE on $interface"
 action 1.7  end
 action 2.1 end
```


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Benefits

Up to 25% energy usage reduction on POE switchports with IOT endpoints turned off at TOD (Time of a Day)

How is this applicable to Cisco controller-based solutions for Wireless Access Points?

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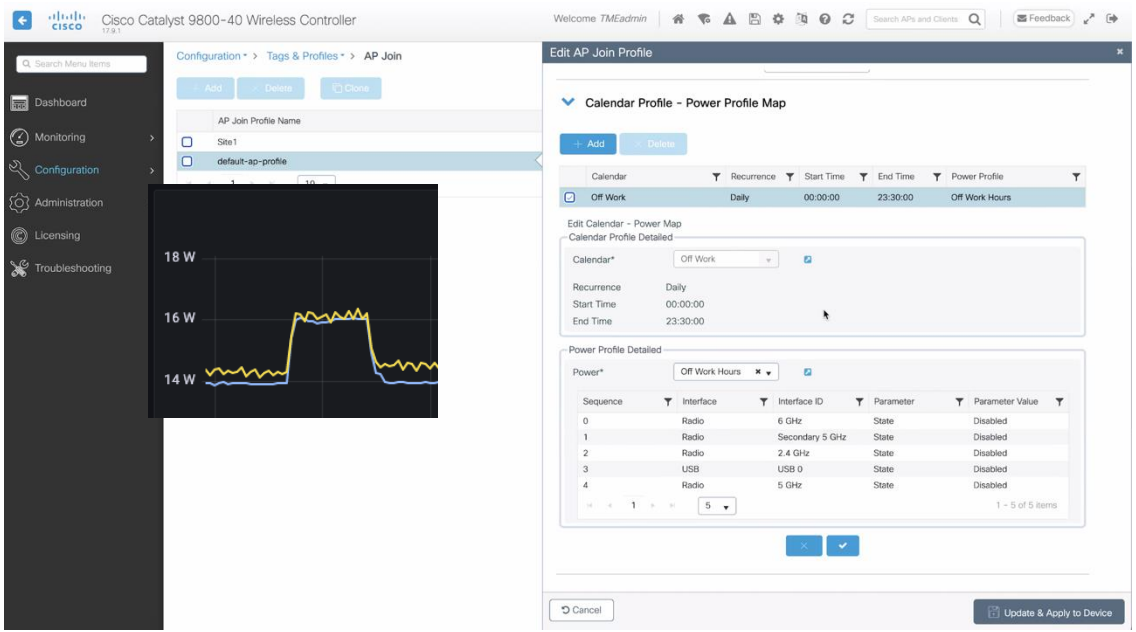
Catalyst 9800 WLC Calendar Template scheduling

To enable **power save mode** on Cisco Catalyst Access Points
https://github.com/jeremycohoe/c9800-ap-power-save/




```
wireless profile power "Off Work Hours"
 0 radio 6ghz state shutdown
 1 radio secondary-5ghz state shutdown
 2 usb 0 state disable
 3 radio 5ghz state shutdown

wireless profile calender-profile name "Off Work 5PM to
Midnight"
 day monday
 day tuesday
 day wednesday
 day thursday
 day friday
 recurrance weekly
 start 17:00:00 end 23:59:59

wireless profile calender-profile name "Off Work
Midnight to 8AM"
 day monday
 day tuesday
 day wednesday
 day thursday
 day friday
 recurrance weekly
 start 00:00:00 end 08:00:00

ap profile default-ap-profile
 calendar-profile "Workday 5pm to Midnight"
  action power-saving-mode power-profile "Off Work
Hours"
 calendar-profile "Workday Midnight to 8am"
  action power-saving-mode power-profile "Off Work
Hours"
```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POE Interface

device	intf_name	power_admin_max	max_power_drawn	power_consumption	power_to_pd
C9130AXE-B	TenGigabitEthernet1/0/47	60	13.3	11.6	33.3
CW9164I-B	TwoGigabitEthernet1/0/1	60	15.6	11.9	31.4
C9136I-B	TwoGigabitEthernet1/0/13	60	21.3	17.0	41.9
C9136I-B	TwoGigabitEthernet1/0/16	60	6.25	0.950	41.9
CW9164I-B	TwoGigabitEthernet1/0/2	60	13.3	12.5	31.4
CW9166I-B	TwoGigabitEthernet1/0/3	60	15.7	12.6	34.1

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Monitoring & Automation Impact

Up to 25% ↓ Energy usage reduction on POE switchports with IOT endpoints turned off ~ 9hrs/Day

Minimum of 12% ↓ Energy usage reduction for controller-based Cisco Catalyst Access Points

100 % ↑ Visibility on POE Power Consumption

*based on use case and data presented in demos

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Enhanced Energy Metering

What it is

Enables energy meter for Switch System Power and PoE switchport power consumption
Platforms: C9200, C9300, C9400

What it does

System Energy is power consumed by the system for a specific duration, measured in unit of Watt Second. Macro-metered window size of 3-hours with 12 x 15-minute micro-meters

Gives the visibility within the windows of consumption that can be further analysed and considered for carbon intensity reporting, density-based usage analysis and so on.

What it receives

Ledger on Energy consumption for System Power and PoE Port with a bucketised data of 15 minutes each.

System Meter

```
Meter start time 2024-10-22 10:36:34 PST
Energy Data For Last 180 Minute

                          System Energy   System Meter Update
Mod  Model No             (MilliWattSec)  Time
---  -------------------- --------------- ------------------------

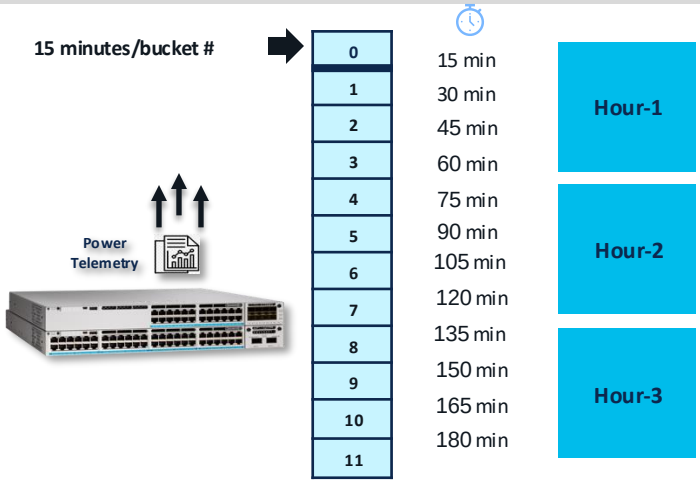
1    C9300-24H            234894600       2024-10-22 11:32:39 PST

---  -------------------- --------------- ------------------------
```

PoE Port Meter

```
SB-Salone1-C9324H#sho power inline meter
Module  Available    Used     Remaining
        (Watts)     (Watts)  (Watts)
------  ---------    -------  ---------
1       860.0        120.0    740.0

Interface   Meter Update Time      Hourly Metered Value (MilliWattSec)   Metered Energy in MilliWattSec (15 min Buckets)
----------  ------------------------  ------------------------  ----------------------------------------------------------------------------------------------------
Gi1/0/1     2024-10-22 11:21:09 PST   0                         0-0-0-0-0-0-0-0-0-0-0-0
Gi1/0/2     2024-10-22 11:21:09 PST   10507380                  14653668-35532424-35583220-19304668-0-0-0-0-0-0-0-0
```



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What’s changed with power in the 17.15 release?

Previously

- Instantaneous power only

Today

- Instantaneous power
- Power over time
  - Smart Buildings use case:
    - 48 PoE ports create too much data, now we can use buckets & can collect data at less frequent intervals

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Enhanced Energy Metering

CLI with micro-metering

Energy Metering System Power

```
Meter start time 2024-10-22 10:36:34 PST
Energy Data For Last 180 Minute

                                System Energy   System Meter Update
Mod  Model No                   (MilliWattSec)  Time
---  ---------------------      --------------  -------------------------
1    C9300-24H                  234894600        2024-10-22 11:32:39 PST
---  ---------------------      --------------  -------------------------
```

Energy Metering PoE Port Power

```
SB-Salone1-C9324H#sho power inline meter

Module   Available     Used     Remaining
          (Watts)    (Watts)    (Watts)
------   ---------   --------   ---------
1          860.0      120.0      740.0
Interface    Meter Update              Hourly Metered        Metered Energy in MilliWattSec (15min Buckets)
              Time                     Value (MilliWattSec)
----------   ----------------------    --------------------  ----------------------------------------------
Gi1/0/1      2024-10-22 11:21:09 PST                      0   0-0-0-0-0-0-0-0-0-0-0-0
Gi1/0/2      2024-10-22 11:21:09 PST               10507380   1465368-3553224-3558320-1930468-0-0-0-0-0-0-0-0
Gi1/0/3      2024-10-22 11:21:09 PST                      0   0-0-0-0-0-0-0-0-0-0-0-0
Gi1/0/4      2024-10-22 11:21:09 PST                      0   0-0-0-0-0-0-0-0-0-0-0-0
Gi1/0/5      2024-10-22 11:21:09 PST                      0   0-0-0-0-0-0-0-0-0-0-0-0
Gi1/0/6      2024-10-22 11:21:09 PST                      0   0-0-0-0-0-0-0-0-0-0-0-0

SB-Salone1-C9324H#sho ver | i time
SB-Salone1-C9324H uptime is 45 minutes
Uptime for this control processor is 46 minutes
```


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Enhanced Energy Metering

Data models updated for Power Telemetry

Energy Metering - System Power

Name	cname
Nodetype	leaf
Datatype	string
Description	References component name
Module	Cisco-IOS-XE-platform-oper
Revision	2023-03-01
Xpath	/components/component/cname
Prefix	platform-ios-xe-oper
Namespace	http://cisco.com/ns/yang/Cisco-IOS-XE-platform-oper
Schema Node Id	/components/component/cname
Key	true
Access	read-only
Operations	• "get"

Energy Metering – PoE Port Power

Name	power-consumption
Nodetype	leaf
Datatype	decimal64
Description	Actual Power consumed by power device
Module	Cisco-IOS-XE-poe-oper
Revision	2024-03-01
Xpath	/poe-oper-data/poe-port-detail/power-consumption
Prefix	poe-ios-xe-oper
Namespace	http://cisco.com/ns/yang/Cisco-IOS-XE-poe-oper
Schema Node Id	/poe-oper-data/poe-port-detail/power-consumption
Units	Watts
Min	-92233720368547758.08
Max	92233720368547758.07
Fraction Digits	2
Access	read-only
Operations	• "get"

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Energy Metering using the API

Show same 2 things as CLI

Get system energy + time

NETCONF GET operation

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="101">
 <get>
  <filter>
   <components xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-platform-oper">
    <component>
     <platform-properties>
      <platform-property>
       <name>meter-update-time</name>
      </platform-property>
     </platform-properties>
    </component>
   </components>
  </filter>
 </get>
</rpc>
```

Response

```
<rpc-reply xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0"
message-id="urn:uuid:820e9cb4-fc8d-4f3d-bad9-4b09bab635e2">
 <data>
  <components xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-platform-oper">
   <component>
    <platform-properties>
     <platform-property>
      <name>meter-update-time</name>
      <value>
       <string>1730240928747</string>
      </value>
      <configurable>false</configurable>
     </platform-property>
    </platform-properties>
   </component>
  </components>
 </data>
</rpc-reply>
```

Epoch time

= Wednesday October 30, 2024
Melbourne, Australia

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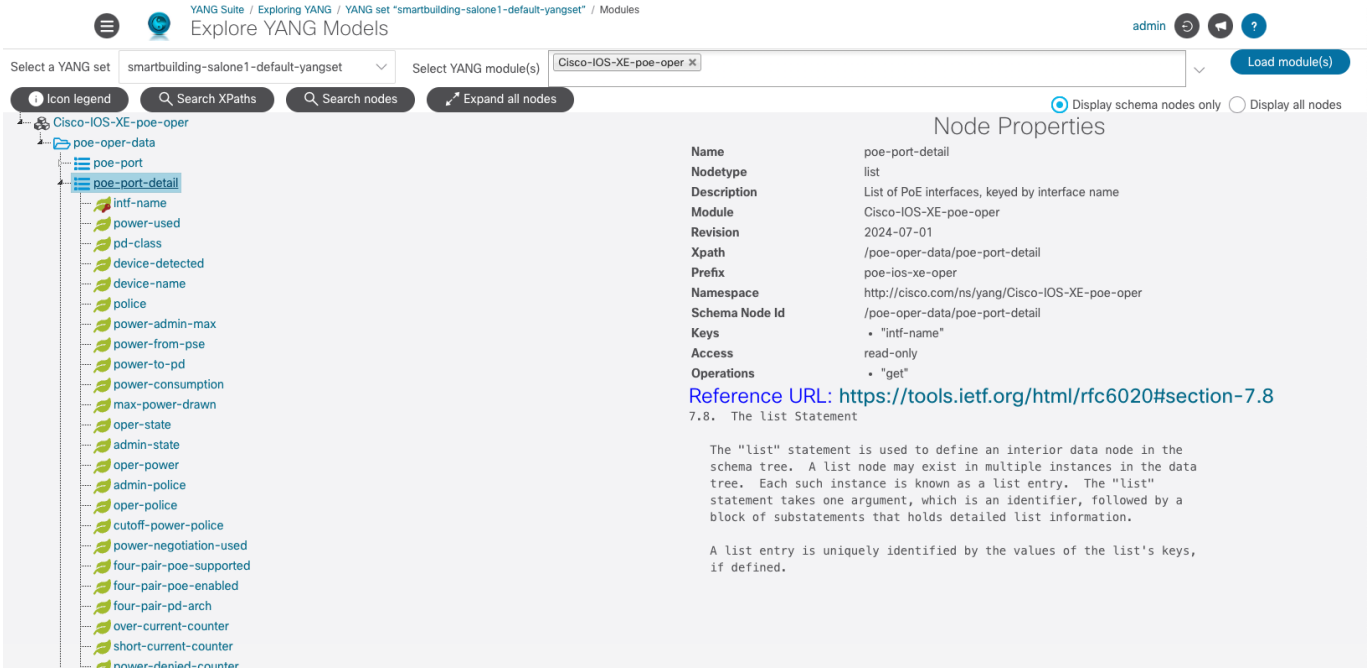
PoE API



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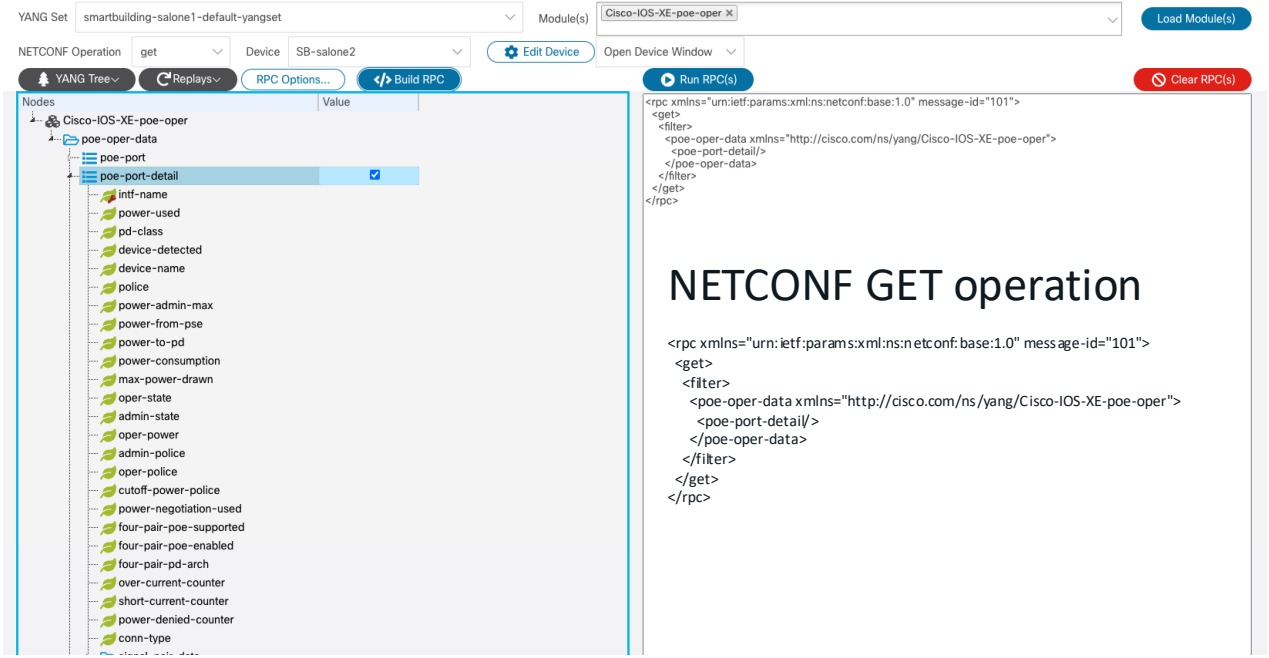
PoE API (cont.) NETCONF GET



NETCONF GET operation

```
<rpc xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" message-id="101">
 <get>
  <filter>
   <poe-oper-data xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-poe-oper">
    <poe-port-detail/>
   </poe-oper-data>
  </filter>
 </get>
</rpc>
```

Response

```
<rpc-reply xmlns="urn:ietf:params:xml:ns:netconf:base:1.0" xmlns:nc="urn:ietf:params:xml:ns:netconf:
 <data>
  <poe-oper-data xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-poe-oper">
   <poe-port-detail>
    <intf-name>GigabitEthernet1/0/2</intf-name>
    <power-used>30.0</power-used>
    <pd-class>pd-ieee4</pd-class>
    <device-detected>true</device-detected>
    <device-name>Ieee PD</device-name>
    <police>false</police>
    <power-admin-max>90.0</power-admin-max>
    <power-from-pse>30.0</power-from-pse>
    <power-to-pd>30.0</power-to-pd>
    <power-consumption>3.91</power-consumption>
    <max-power-drawn>5.08</max-power-drawn>
<snip>
  <number-of-buckets>12</number-of-buckets>
    <poe-bucket>166584</poe-bucket>
    <poe-bucket>291216</poe-bucket>
    <poe-bucket>291434</poe-bucket>
    <poe-bucket>291356</poe-bucket>
    <poe-bucket>291188</poe-bucket>
    <poe-bucket>291132</poe-bucket>
    <poe-bucket>291132</poe-bucket>
    <poe-bucket>291096</poe-bucket>
    <poe-bucket>291324</poe-bucket>
    <poe-bucket>291692</poe-bucket>
    <poe-bucket>291972</poe-bucket>
    <poe-bucket>291468</poe-bucket>
   </poe-port-detail>
  </poe-oper-data>
 </data>
</rpc-reply>
```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Subscription to the new platform data

```
telemetry ietf subscription 79007
 encoding encode-kvgpb
 filter xpath /platform-ios-xe-oper:components/component/platform-properties/platform-property
 source-address 172.26.202.111
 stream yang-push
 update-policy periodic 300000
 receiver ip address 172.26.202.69 57000 protocol grpc-tcp

telemetry ietf subscription 79008
 encoding encode-kvgpb
 filter xpath /poe-ios-xe-oper:poe-oper-data/poe-port-detail
 source-address 172.26.202.111
 stream yang-push
 update-policy periodic 30000
 receiver ip address 172.26.202.69 57000 protocol grpc-tcp
```


```
telemetry ietf subscription 79007
 encoding encode-kvgpb
 filter xpath /platform-ios-xe-oper:components/component/platform-properties/platform-property
 source-address 172.26.202.111
 stream yang-push
 update-policy periodic 300000
 receiver ip address 172.26.202.69 57000 protocol grpc-tcp
```



```
telemetry ietf subscription 79008
 encoding encode-kvgpb
 filter xpath /poe-oper-data/poe-port-detail
 source-address 172.26.202.111
 stream yang-push
 update-policy periodic 30000
 receiver ip address 172.26.202.69 57000 protocol grpc-tcp
```


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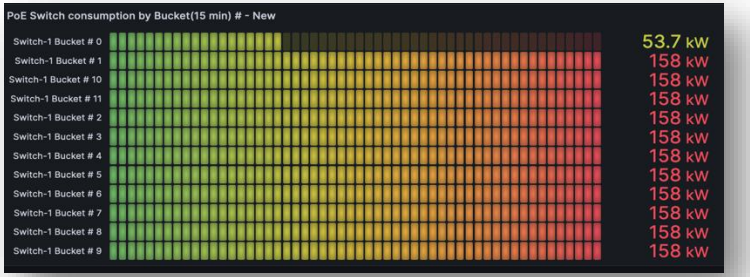
What can we do with Power Telemetry

Power Telemetry

Grafana

InfluxDB

Telegraf



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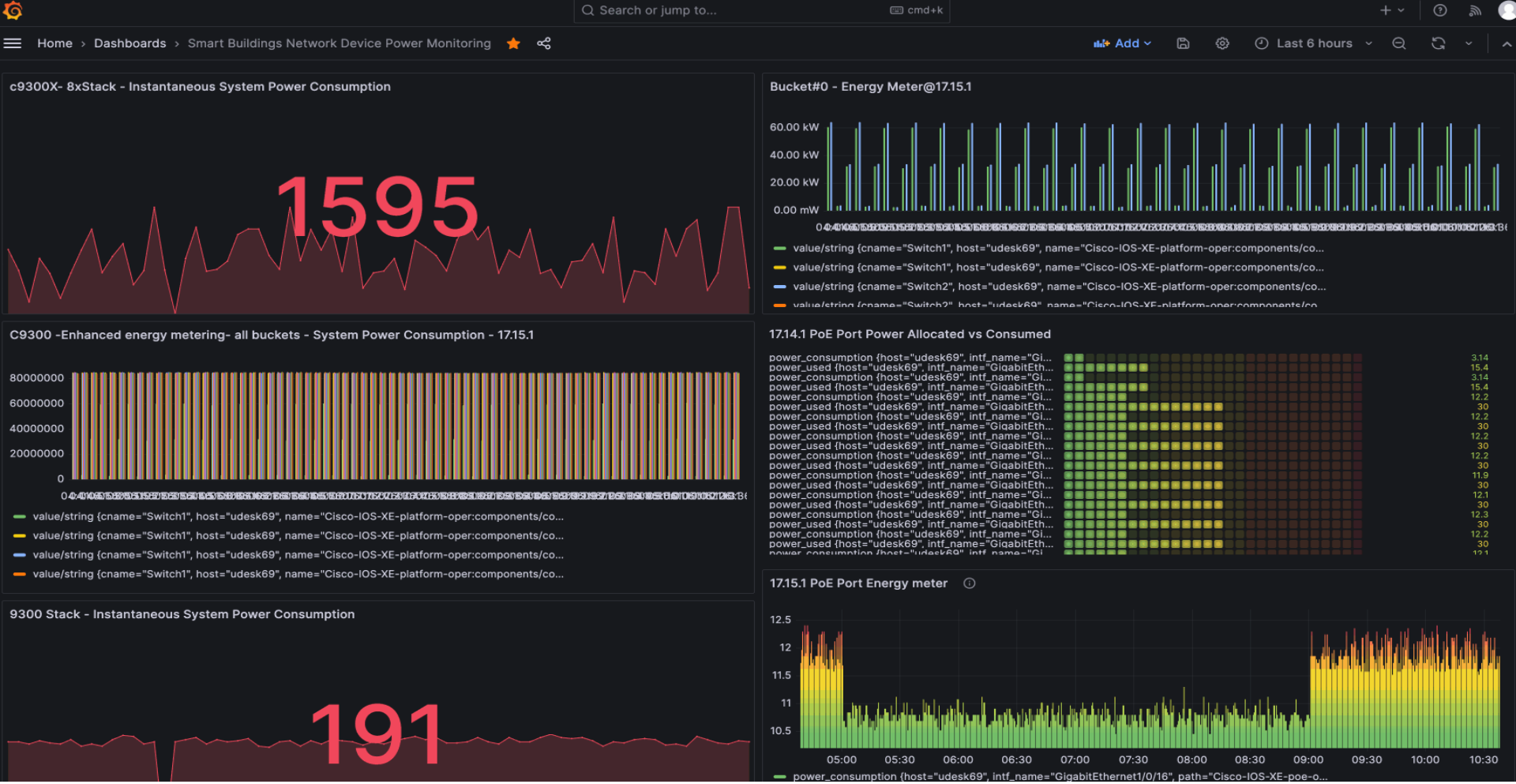

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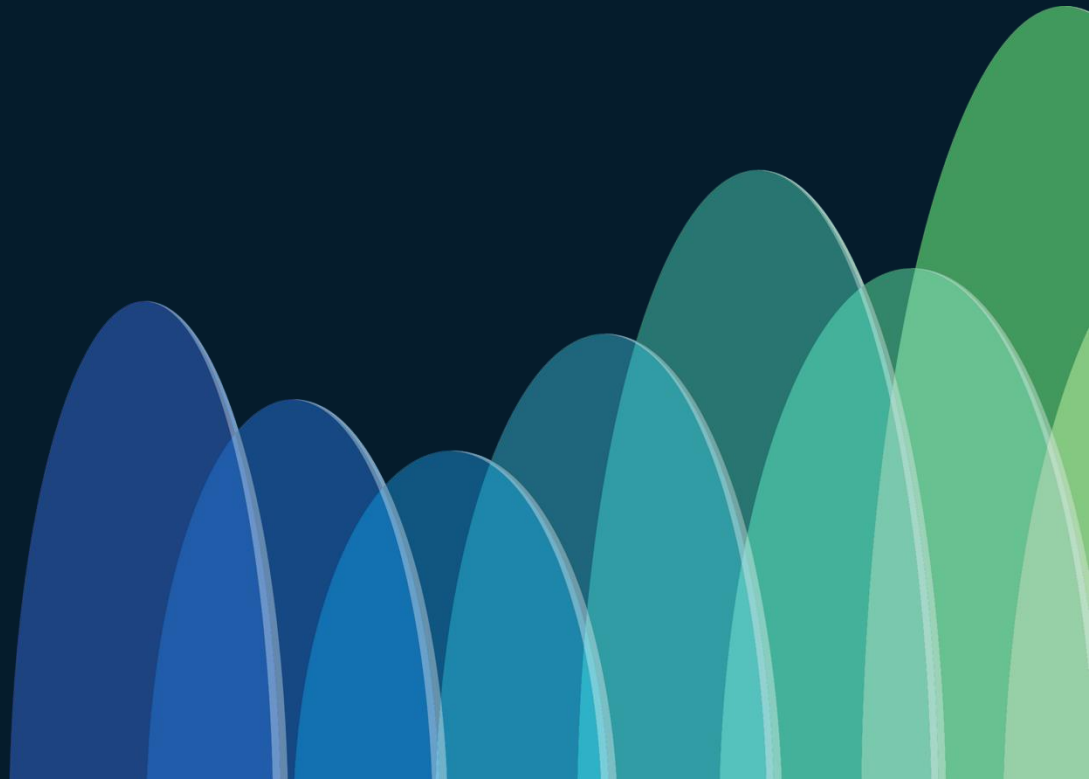
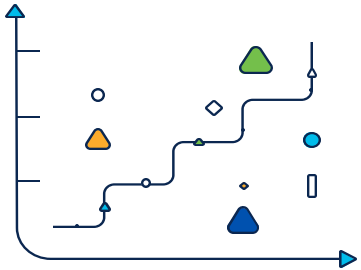
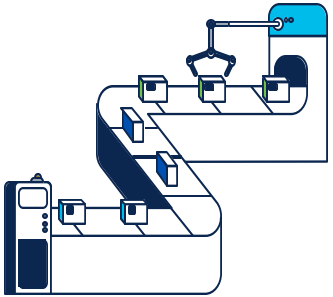
Benefits



Now using programmability for a Sustainability Use Case





Energy Consumption

Operational Costs

Sustainability

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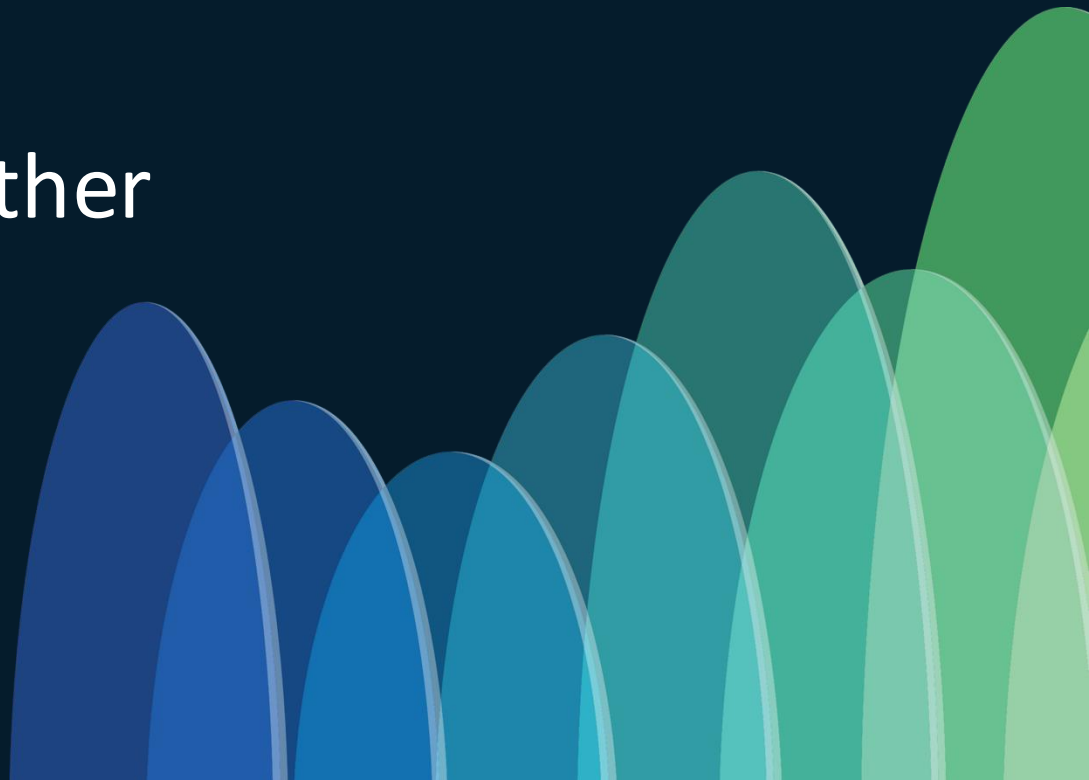
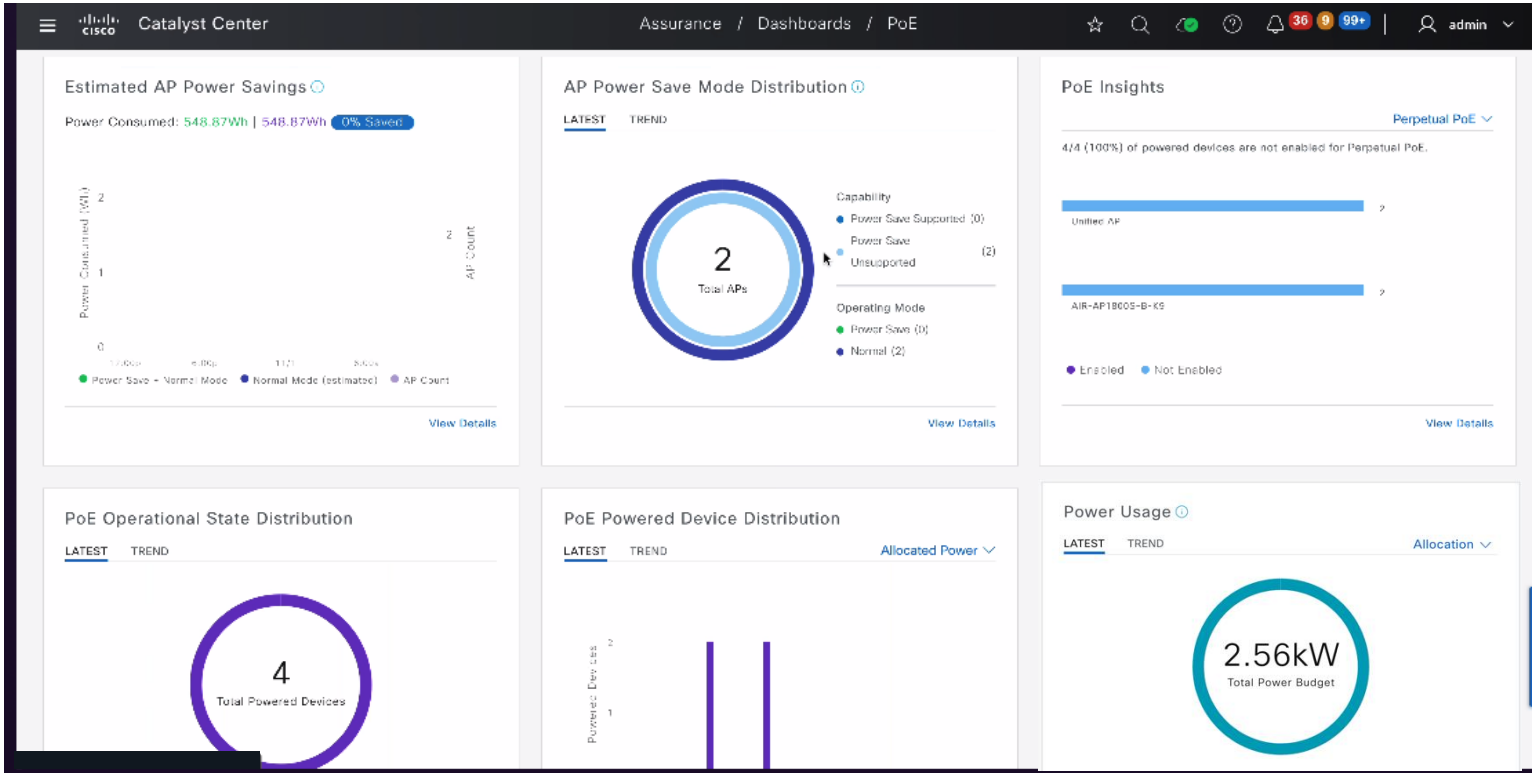
Sustainability on other Platforms



PoE Dashboard on Catalyst Center



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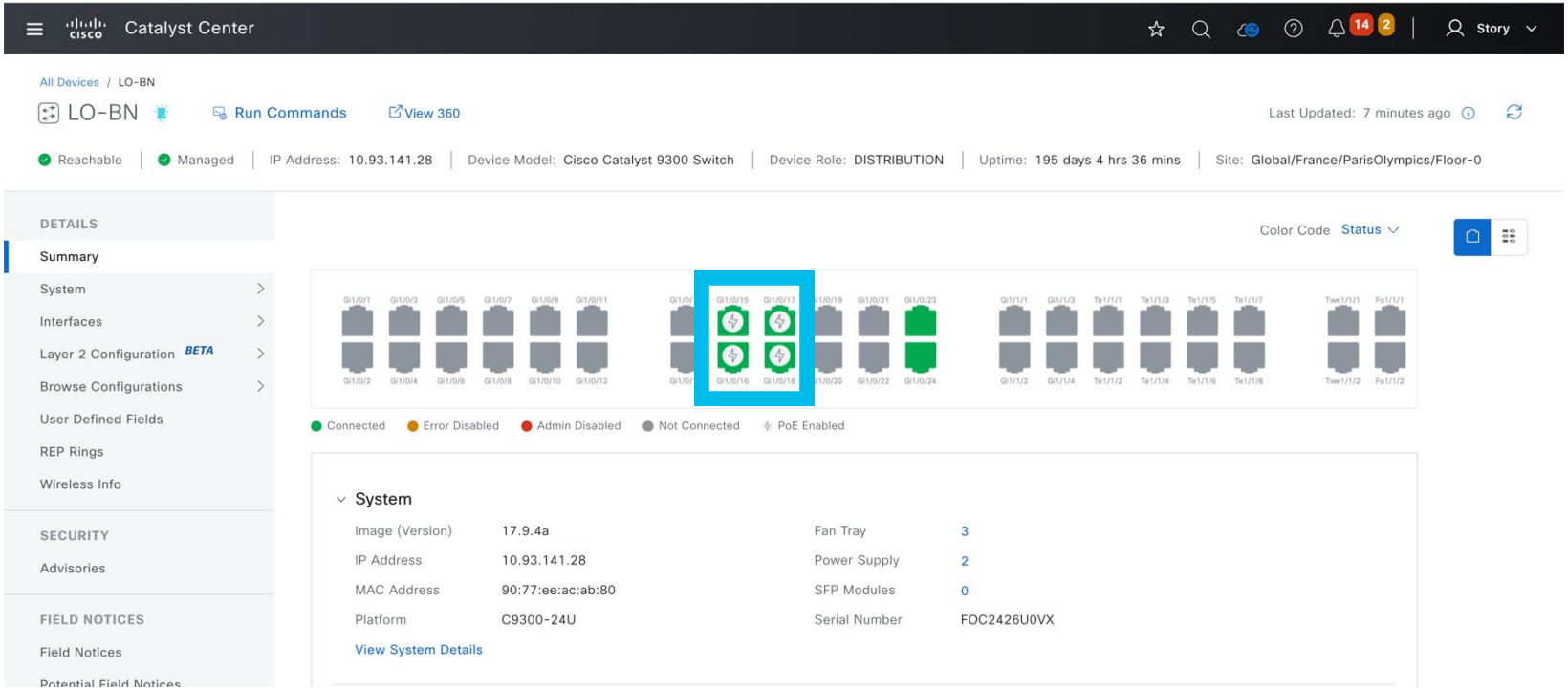
Device Inventory for PoE Devices



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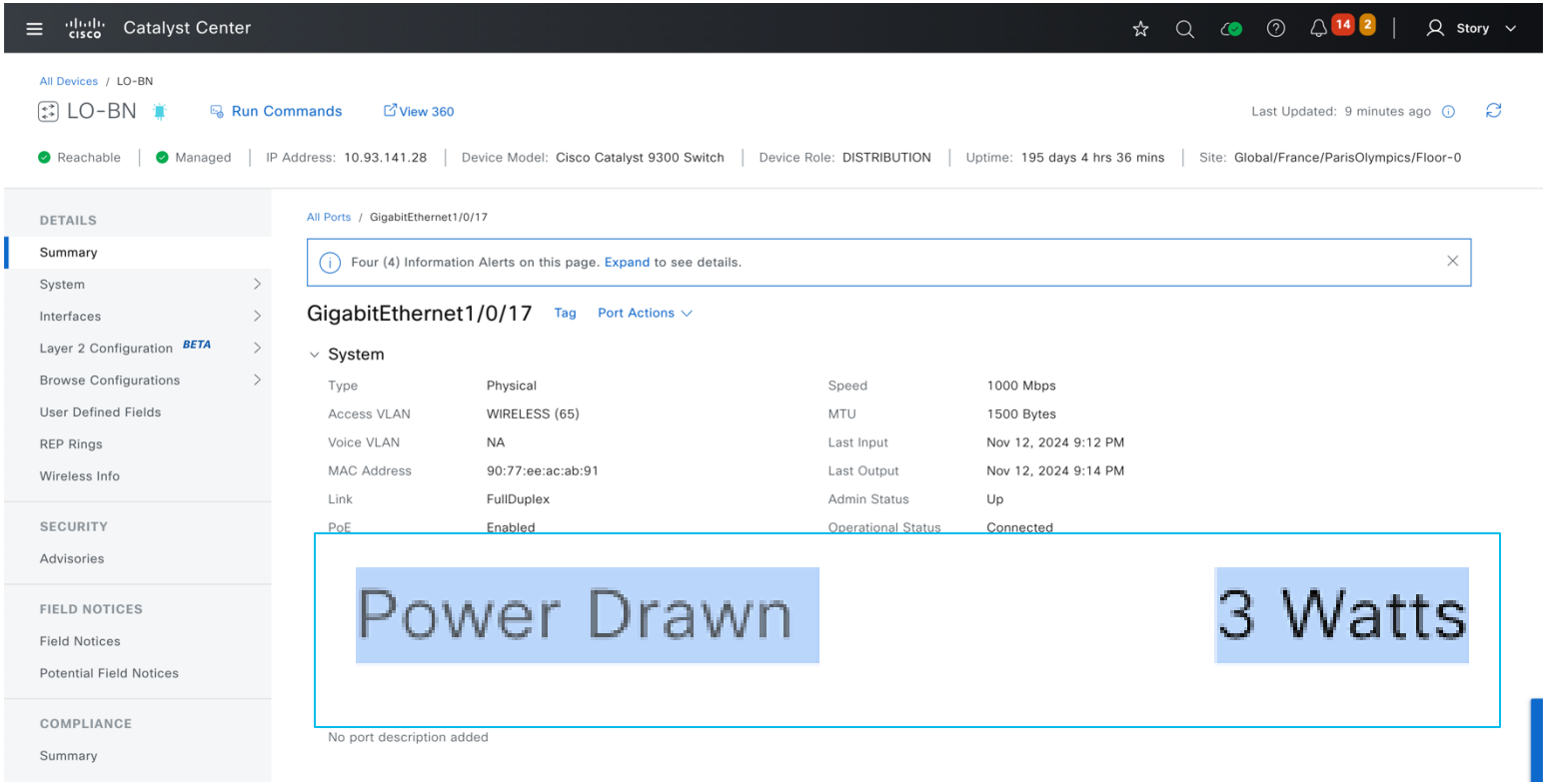
Power drawn by a device



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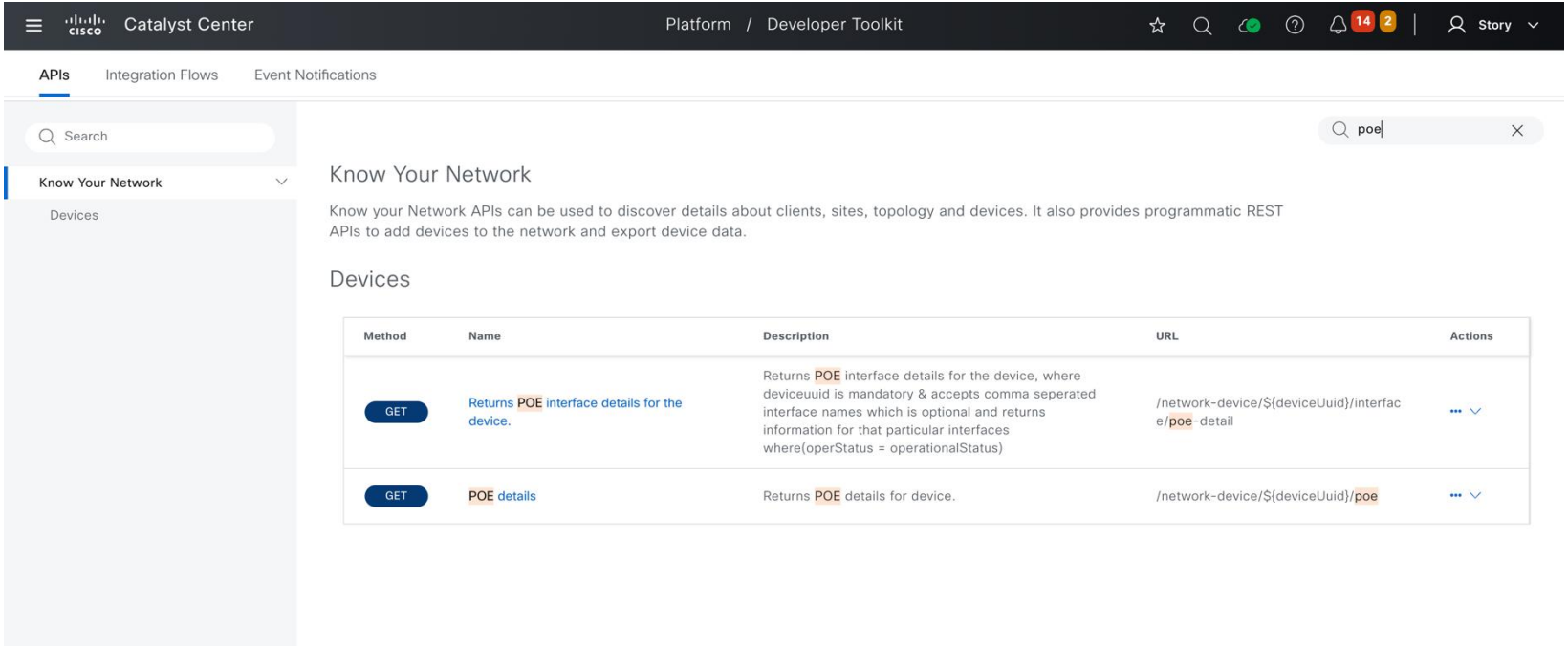
PoE APIs



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Return the PoE Interface details for the provided device

Returns POE interface details for the device.

GET https://10.93.141.45/dna/intent/api/v1/network-device/${deviceUuid}/interface/poe-detail

Returns POE interface details for the device, where deviceuuid is mandatory & accepts comma seperated interface names which is optional and returns information for that particular interfaces where(operStatus = operationalStatus)

Cisco DevNet API Guide

Parameters Responses Code Preview

Request URL Parameters

Name	Description	Da
deviceUuid	uuid of the device	str

Request Query Parameters

Name	Description	DataType
interfaceNameList	comma seperated interface names	string

Try 'Returns POE interface details for the device.'

Method: GET Public URL :https://10.93.141.45/dna/intent/api/v1/network-device/db05ad49-2c8d-4094-9df6-3a03f9b28069/interface/poe-detail

PARAMETERS

PATH PARAMETERS

deviceUuid* db05ad49-2c8d-4094-9

QUERY PARAMETERS

Select All

interfaceNameList

Reset Run

Response Headers Status Code: 200


```
{
  "response": [
    {
      "interfaceName": "GigabitEthernet1/0/4",
      "operStatus": "OFF",
      "adminStatus": "AUTO",
      "allocatedPower": "0.0",
      "maxPortPower": "60.0",
      "portPowerDrawn": "0"
    },
    {
      "interfaceName": "GigabitEthernet1/0/22",
      "operStatus": "OFF",
      "adminStatus": "AUTO",
      "allocatedPower": "0.0",
      "maxPortPower": "60.0",
      "portPowerDrawn": "0"
    },
    {
      "interfaceName": "GigabitEthernet1/0/11",
      "operStatus": "OFF",
      "adminStatus": "AUTO",
      "allocatedPower": "0.0",
      "maxPortPower": "60.0",
      "portPowerDrawn": "0"
    },
    {
      "interfaceName": "GigabitEthernet1/0/3",
      "operStatus": "OFF",
      "adminStatus": "AUTO",
      "allocatedPower": "0.0",
      "maxPortPower": "60.0",
      "portPowerDrawn": "0"
    },
    {
      "interfaceName": "GigabitEthernet1/0/23",
      "operStatus": "OFF",
      "adminStatus": "AUTO",
      "allocatedPower": "0.0",
```


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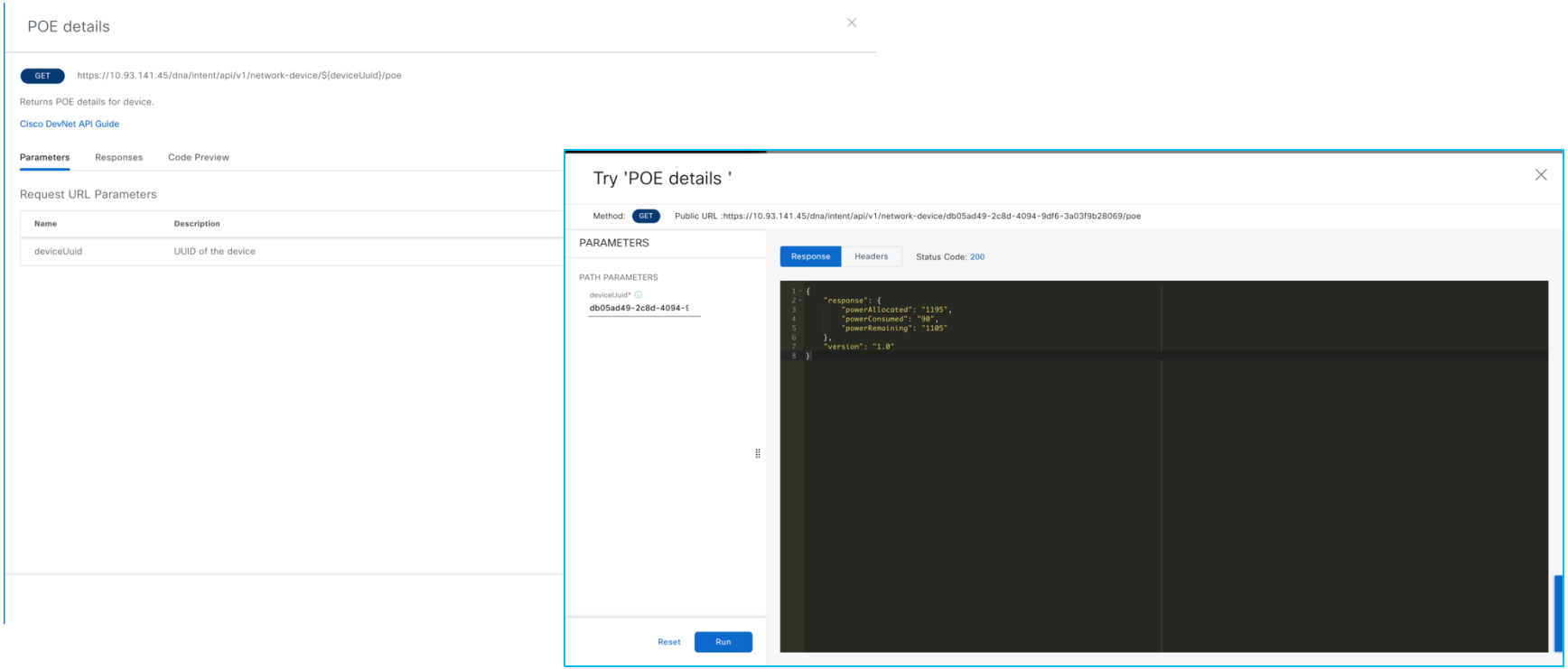
Get PoE details



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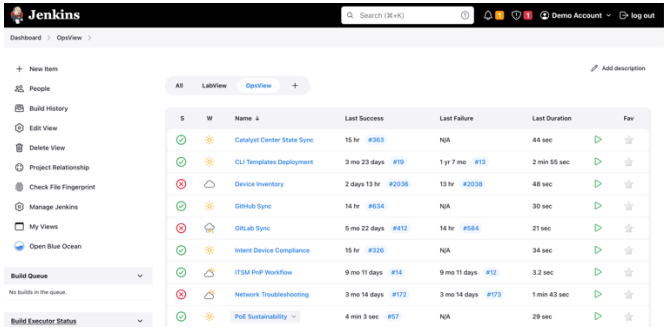
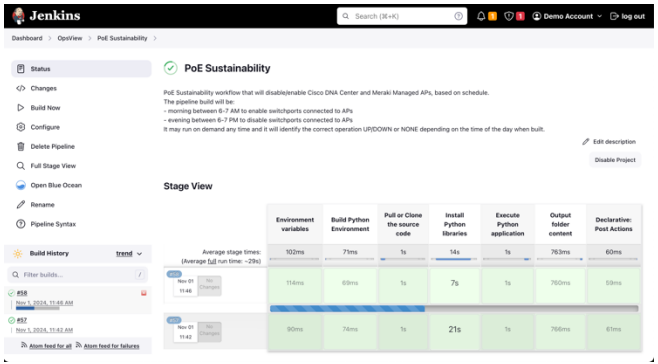
Catalyst Center + Jenkins






```
App PoE_Sustainability run:.....
[Pipeline] withEnv
[Pipeline] {
[Pipeline] echo


Verify Working Path:.....
[Pipeline] sh
+ pwd
/var/lib/jenkins/workspace/PoE Sustainability
[Pipeline] dir
Running in /var/lib/jenkins/workspace/PoE Sustainability/dnacenter_jenkins_automations
[Pipeline] {
[Pipeline] sh
+ python3 poe_sustainability.py
INFO:root:2024-11-01 11:46:57 - App "poe_sustainability.py" Start
INFO:root:2024-11-01 11:46:57 - Cisco DNA Center PoE Sustainability
INFO:root:2024-11-01 11:46:57 - Local time hour: 11
INFO:root:2024-11-01 11:46:57 - No PoE operation performed at this time, during business hours
```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What about Meraki? What can it show me?

Use Case: software updates on cash registers in retail stores: Wake On LAN use case

Did you know?

Powering off 1,000 PoE devices (10 W) for 12 hours per day can lead to 50% energy savings or ~43,800 kWh energy / ~$7,095 cost ($0.162 per kWh) / ~16.5 metric tonnes CO2 emissions* savings per year.

https://meraki.cisco.com/product-collateral/meraki-mis-sustainability-whitepaper/?file

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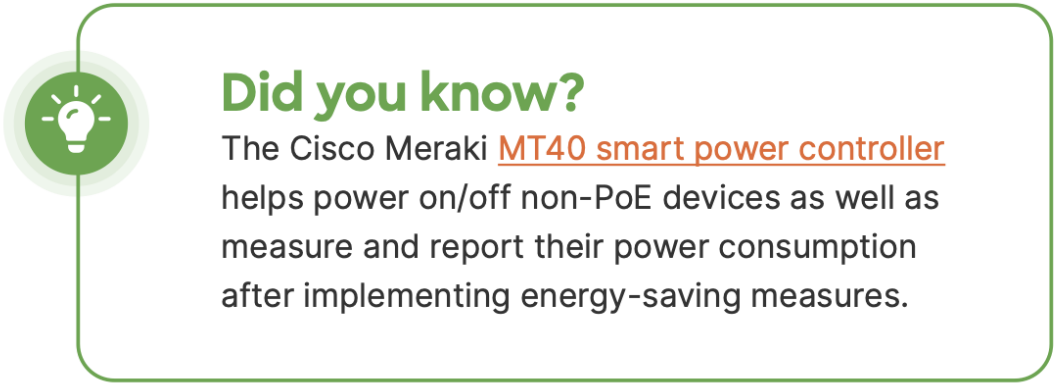
Meraki Mt40 Smart Power Controller PoE



https://meraki.cisco.com/product-collateral/meraki-ms-sustainability-whitepaper/?file

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Try out MDT in your own network!

Updated TIG_MDT container now available!

```
docker pull jeremycohoe/tig_mdt
docker run -ti -p 3000:3000 -p 57500:57500 jeremycohoe/tig_mdt
```

Upgrade coming to Telegraf, Influx, and Grafana Model Driven Telemetry (TIG_MDT) Docker container
Making it easier to consume telemetry in production

Upgraded Telegraf, InlfuxDB, and Grafana tools
Additional dashboards for
Device Health, Wireless Client, Wireless AP, RFetc
Examples for device CLI configuration for telemetry
Details of scale and data storage requirements

Cisco IOS XE Devices

Collector/Receiver
Decodes to text

telegraf™

Storage
Time Series Database

InfluxDB

Monitoring and Visualisations

Grafana

https://hub.docker.com/r/jeremycohoe/tig_mdt https://github.com/jeremycohoe/cisco-ios-xe-mdt
https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/prog/configuration/179/b_179_programmability_cg/m_179_prog_ietf_telemetry.html

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Terraform for Model Driven Telemetry

Enable gRPC Dial-Out telemetry subscriptions for the POE and Basic Device Monitoring use cases

```
auto@pod22-xelab:~/mdt_example$ terraform plan -var-file="var.tfvars"

Terraform used the selected providers to generate the following execution plan. Resource actions are indicated with the following symbols:
  + create

Terraform will perform the following actions:

  # iosxe_mdt_subscription.cpu_subs["100"] will be created
  + resource "iosxe_mdt_subscription" "cpu_subs" {
      + encoding          = "encode-kvgpb"
      + filter_xpath      = "/process-cpu-ios-xe-oper:cpu-usage/cpu-utilization/five-seconds"
      + id                = (known after apply)
      + receivers         = [
          + {
              + address  = "10.1.1.3"
              + port     = 57500
              + protocol = "grpc-tcp"
            },
        ]
      + stream            = "yang-push"
      + subscription_id   = 100
      + update_policy_periodic = 3000
    }

  # iosxe_mdt_subscription.cpu_subs["101"] will be created
  + resource "iosxe_mdt_subscription" "cpu_subs" {
      + encoding          = "encode-kvgpb"
      + filter_xpath      = "/process-cpu-ios-xe-oper:cpu-usage/cpu-utilization/one-minute"
      + id                = (known after apply)
      + receivers         = [
          + {
              + address  = "10.1.1.3"
              + port     = 57500
              + protocol = "grpc-tcp"
            },
        ]
      + stream            = "yang-push"
      + subscription_id   = 101
      + update_policy_periodic = 3000
    }
```

Lab Guide Steps:

1. Introduction
2. IOS XE CLI pre-req
3. Terraform Install & headers, device variables
4. Variables and config for MDT subscription
5. Terraform configuration for device monitoring
6. TF Workflow: init, plan, apply & destroy
7. Validation with TF and CLI
8. Conclusion

iosxe_mdt_subscription (Resource)

This resource can manage the MDT Subscription configuration.

Example Usage

```
resource "iosxe_mdt_subscription" "example" {
  subscription_id         = 101
  stream                  = "yang-notif-native"
  encoding                = "encode-kvgpb"
  source_vrf              = "Mgmt-vrf"
  source_address          = "1.2.3.4"
  update_policy_on_change = true
  filter_xpath            = "/ios-events-ios-xe-oper
  receivers = [
    {
      address  = "5.6.7.8"
      port     = 57600
      protocol = "grpc-tcp"
    }
  ]
}
```

https://registry.terraform.io/providers/CiscoDevNet/iosxe/latest/docs/resources/mdt_subscription
https://registry.terraform.io/providers/CiscoDevNet/iosxe/latest/docs/data-sources/mdt_subscription
https://github.com/jeremycohoe/cisco-ios-xe-panda-lab-terraform

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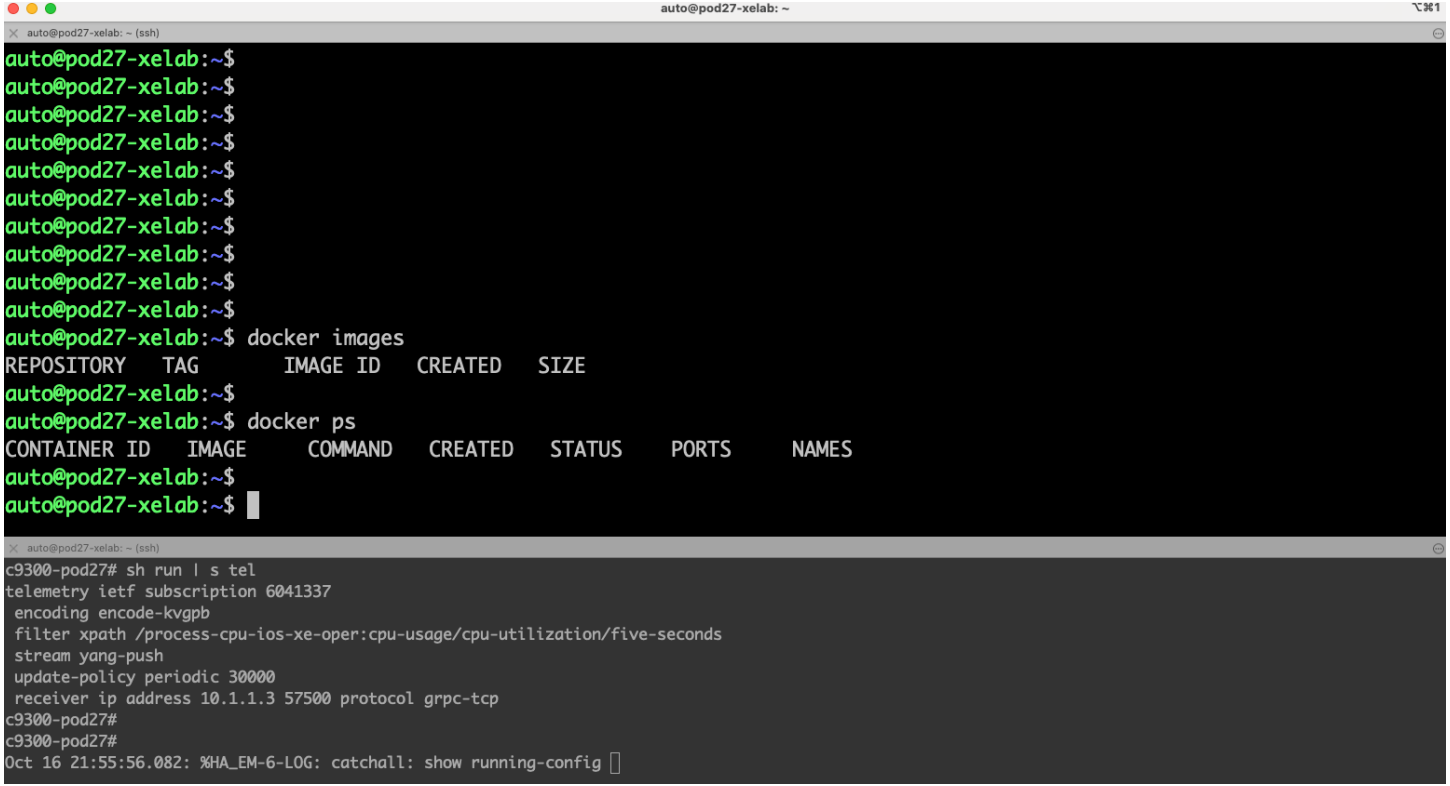
DEMO – install docker container and use Terraform files to configure telemetry subscriptions



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Github.com and Grafana.com documentation

README.md

Cisco Catalyst POE

Details about monitoring the POE and power consumption and utilization on Cisco Catalyst IOS XE.

This use case relies on the TIG_MDT Docker container which has the Telegraf, InfluxDB, and Grafana toolset available from The cisco-ios-xe-mdt repository on Github

Prerequisites

You need Cisco Catalyst 9300 POE

Some POE devices connected too

Minimum IOS XE Software release: _____ ?

POE YANG

The YANG module that has details about Power Over Etherner operational data is the Cisco-IOS-XE-poe-oper.YANG which has contains a lot of information about the feature.

There are two specific containers that have data that is relevant to POE and power monitoring: **poe-switch** which models port specific details, and the **poe-port-detail** container which models device level power information.

The **poe-switch** container has ...

poe-switch	**Name**	poe-switch
switch-num	**Nodetype**	list
power-budget	**Description**	List of PoE switches, keyed by switch number

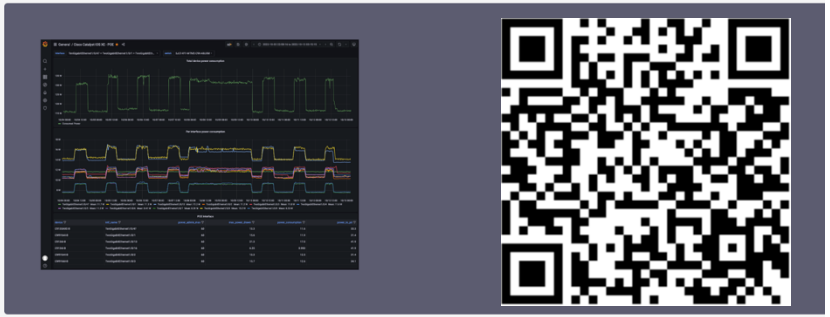
Grafana Labs Products Open source Solutions Learn Company

← All dashboards

Cisco Catalyst POE

Cisco Catalyst Model Driven Telemetry (MDT) Power Over Ethernet (POE) dashboard

Overview Revisions Reviews Edit →



See details at https://github.com/jeremycohoe/cisco-mdt-poe/

https://github.com/jeremycohoe/cisco-mdt-poe/

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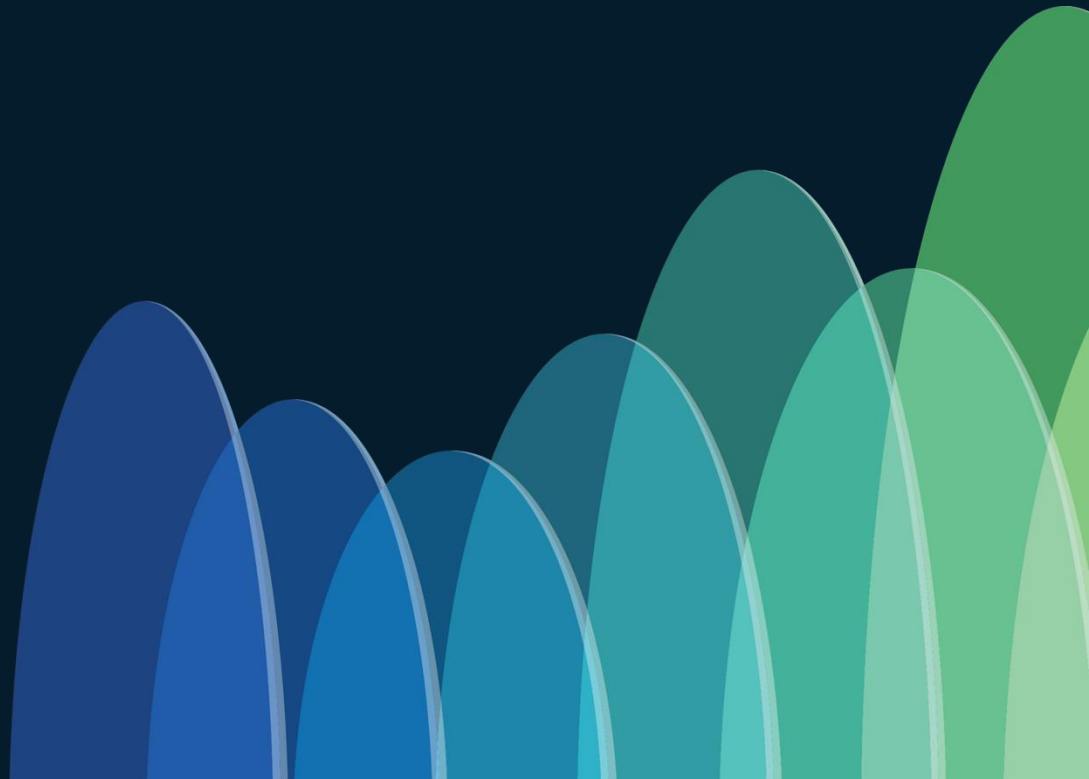
Tooling

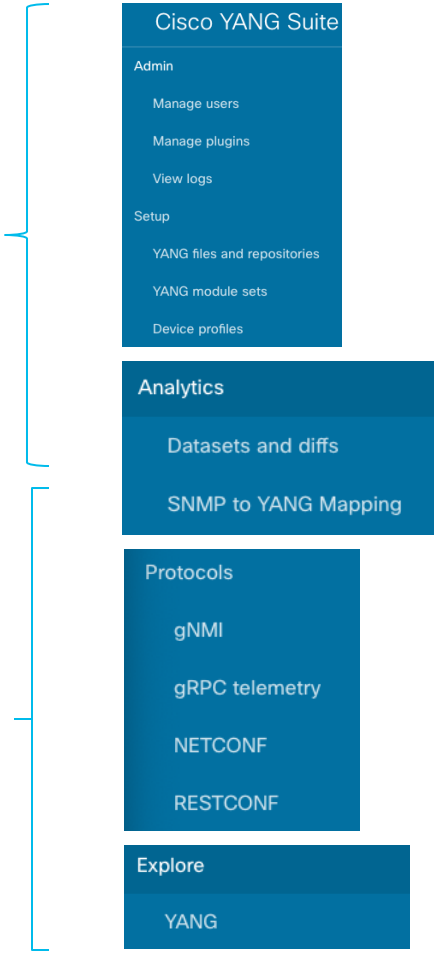


YANG Suite Capabilities

- Initial Release:
  - Plugin and YANG File Manager, Datasets and diffs
  - Device Manager
  - NETCONF (Python), gRPC Telemetry
  - Docker install support with HTTPS
- Second Release:
  - RESTCONF
  - gNMI
  - Python Integrations
- Third Release:
  - gRPC Telemetry with TLS Support
  - SNMP OID to YANG Xpath Mapping
  - Ansible Integrations
  - Pip install support

Core plugins

Additional plugins



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What is Ansible?

- Open-source configuration management tool
- Commercially supported by Red Hat
- Declarative and idempotent
- Ansible can be Imperative when needed
- Can manage a wide range of systems:
  VMs, network devices, cloud instances, etc.
- Agentless: no requirement for installation of application software to run
- Has Python server-side dependencies

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They can coexist… it's not an either/or story

- Terraform keeps state locally
- Terraform knows what is configured vs desired end-state
- Terraform can automatically destroy/recreate resources

- Ansible mutates the infrastructure
- Ansible does not keep state (mostly)
- Terraform can call Ansible to perform tasks post resource deployment (e.g., on VMs deployed)

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Create a MDT Subscription using Ansible

CLI

```
configure terminal
telemetry ietf subscription 1
 encoding encode-kvgpb
 filter xpath /process-cpu-ios-xe-oper:cpu-usage/cpu-utilization
 stream yang-push
 update-policy periodic 60000
 receiver ip address 10.1.1.3 57500 protocol grpc-tcp
```

```
- name: add telemetry subscriptions
  hosts: c9300
  connection: netconf
  gather_facts: no

  tasks:
  - name: establish subscription
    netconf_config:
      xml: |
        <config xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
          <mdt-config-data xmlns="http://cisco.com/ns/yang/Cisco-IOS-XE-mdt-cfg">
            <mdt-subscription>
              <subscription-id>1</subscription-id>
              <base>
                <stream>yang-push</stream>
                <encoding>encode-kvgpb</encoding>
                <source-address>10.1.1.5</source-address>
                <source-vrf>Mgmt-vrf</source-vrf>
                <period>2000</period>
                <xpath>/process-cpu-ios-xe-oper:cpu-usage/cpu-utilization/five-seconds</xpath>
              </base>
              <mdt-receivers>
                <address>10.1.1.3</address>
                <port>57500</port>
                <protocol>grpc-tcp</protocol>
              </mdt-receivers>
            </mdt-subscription>
          </mdt-config-data>
        </config>
```

https://github.com/jeremycohoe/ansible-config-samples/blob/master/add_sub_17.7.yaml

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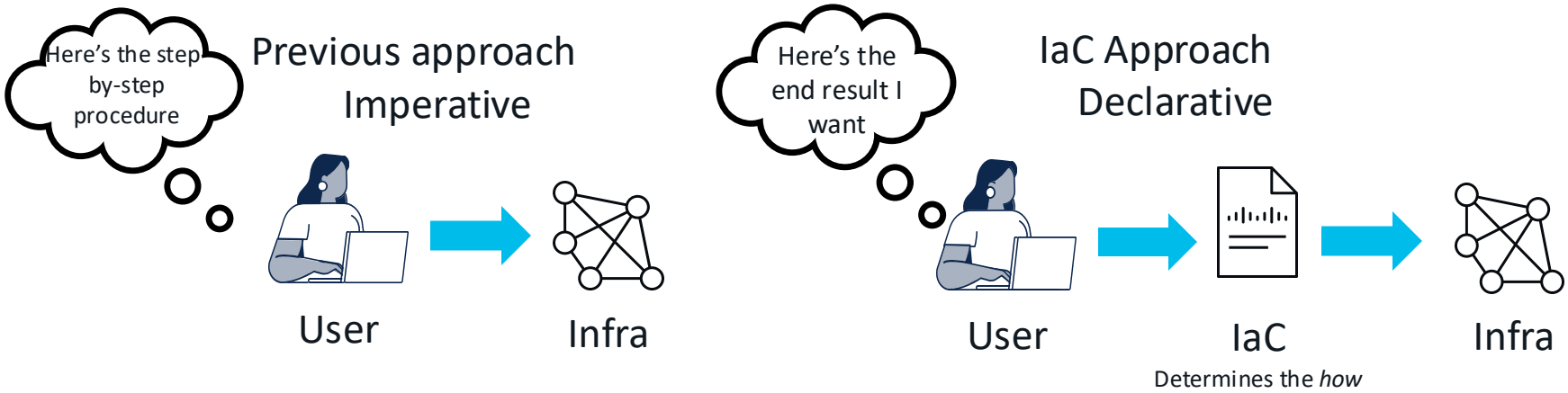
What's IaC?

Infrastructure as Code (IaC) is the process of managing changes through code, rather than a manual process



Learn more about IaC here:
https://developer.cisco.com/iac/#:~:text=Adopting%20Infrastructure%20as%20Code%20allows,data%20center%20to%20the%20edge

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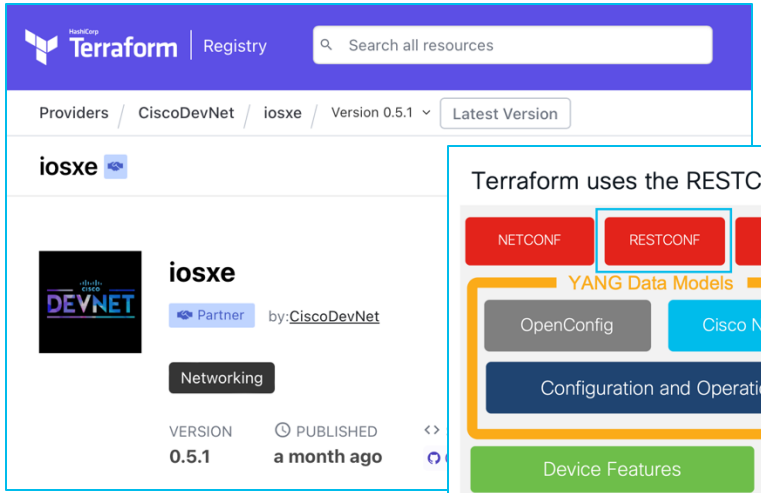
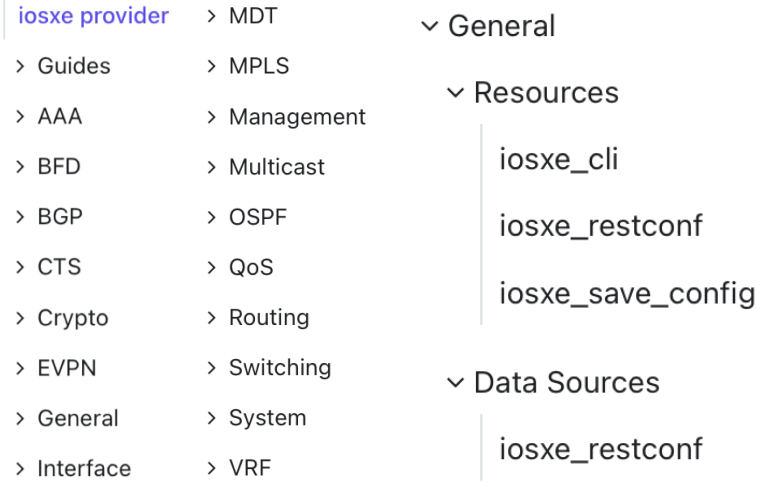
Cisco IOS XE Terraform Provider

Infrastructure as Code (IaC) Software Tool providing a consistent CLI workflow to manage hundreds of cloud services. Terraform codifies cloud APIs into declarative configuration files.

Documentation and details about the provider are available on the Hashicorp Registry
https://registry.terraform.io/providers/CiscoDevNet/iosxe/latest
Source code in GitHub Repository: https://github.com/CiscoDevNet/terraform-provider-iosxe/





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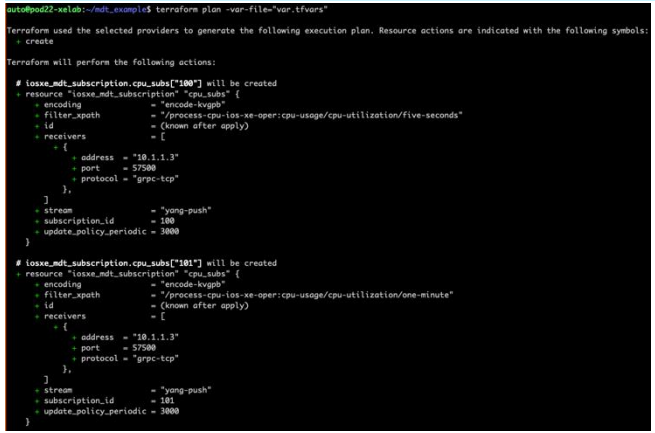
Terraform for Model Driven Telemetry

Enable gRPC Dial-Out telemetry subscriptions for the POE and Basic Device Monitoring use cases



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Terraform will perform the following actions:

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  + resource "iosxe_mdt_subscription" "cpu_subs" {
      + encoding          = "encode-kvgpb"
      + filter_xpath      = "/process-cpu-ios-xe-oper:cpu-usage/cpu-utilization/five-seconds"
      + id                = (known after apply)
      + receivers         = [
          + {
              + address  = "10.1.1.3"
              + port     = 57500
              + protocol = "grpc-tcp"
            },
        ]
      + stream            = "yang-push"
      + subscription_id   = 100
      + update_policy_periodic = 3000
    }

  # iosxe_mdt_subscription.cpu_subs["101"] will be created
  + resource "iosxe_mdt_subscription" "cpu_subs" {
      + encoding          = "encode-kvgpb"
      + filter_xpath      = "/process-cpu-ios-xe-oper:cpu-usage/cpu-utilization/one-minute"
      + id                = (known after apply)
      + receivers         = [
          + {
              + address  = "10.1.1.3"
              + port     = 57500
              + protocol = "grpc-tcp"
            },
        ]
      + stream            = "yang-push"
      + subscription_id   = 101
      + update_policy_periodic = 3000
    }
```

Lab Guide Steps:

1. Introduction
2. IOS XE CLI pre-req
3. Terraform Install & headers, device variables
4. Variables and config for MDT subscription
5. Terraform configuration for device monitoring
6. TF Workflow: init, plan, apply & destroy
7. Validation with TF and CLI
8. Conclusion

iosxe_mdt_subscription (Resource)

This resource can manage the MDT Subscription configuration.

Example Usage

```
resource "iosxe_mdt_subscription" "example" {
  subscription_id         = 101
  stream                  = "yang-notif-native"
  encoding                = "encode-kvgpb"
  source_vrf              = "Mgmt-vrf"
  source_address          = "1.2.3.4"
  update_policy_on_change = true
  filter_xpath            = "/ios-events-ios-xe-oper
  receivers = [
    {
      address  = "5.6.7.8"
      port     = 57600
      protocol = "grpc-tcp"
    }
  ]
}
```

https://registry.terraform.io/providers/CiscoDevNet/iosxe/latest/docs/resources/mdt_subscription
https://registry.terraform.io/providers/CiscoDevNet/iosxe/latest/docs/data-sources/mdt_subscription
https://github.com/jeremycohoe/cisco-ios-xe-panda-lab-terraform

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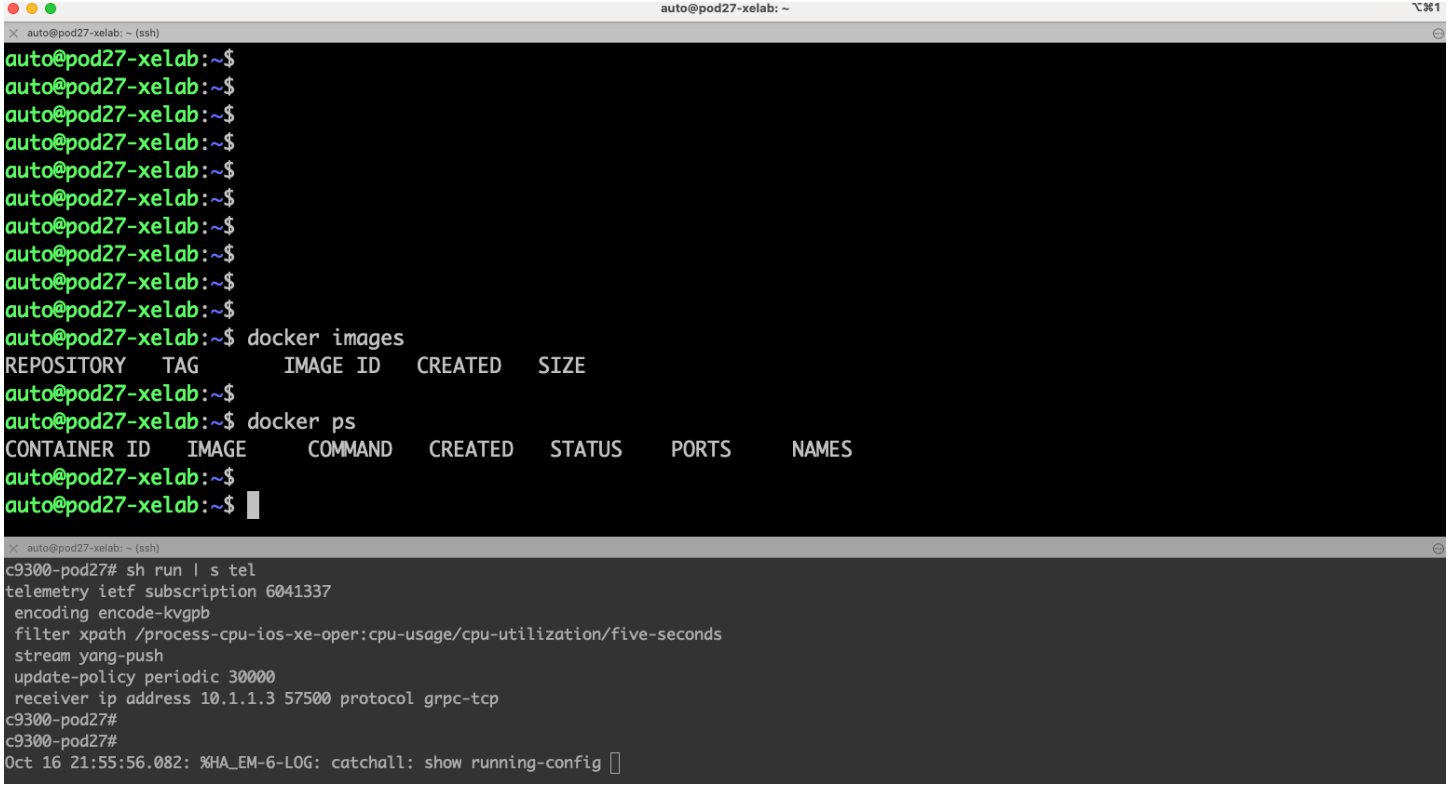
DEMO – install docker container and use Terraform files to configure telemetry subscriptions



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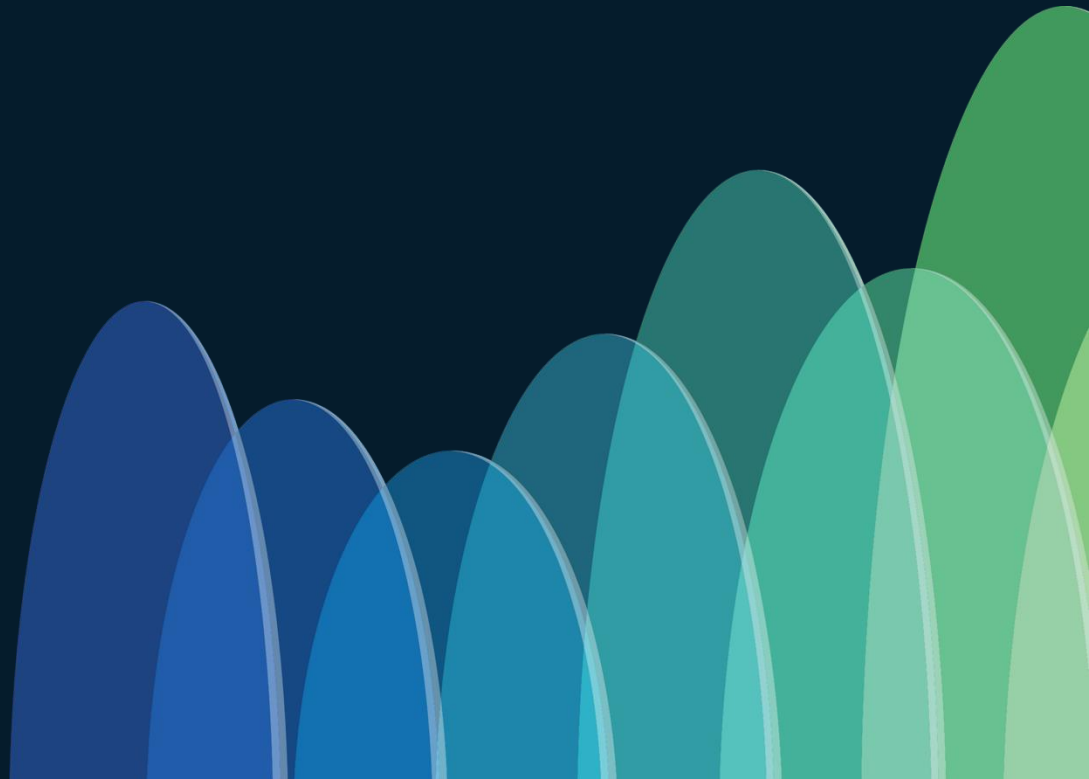
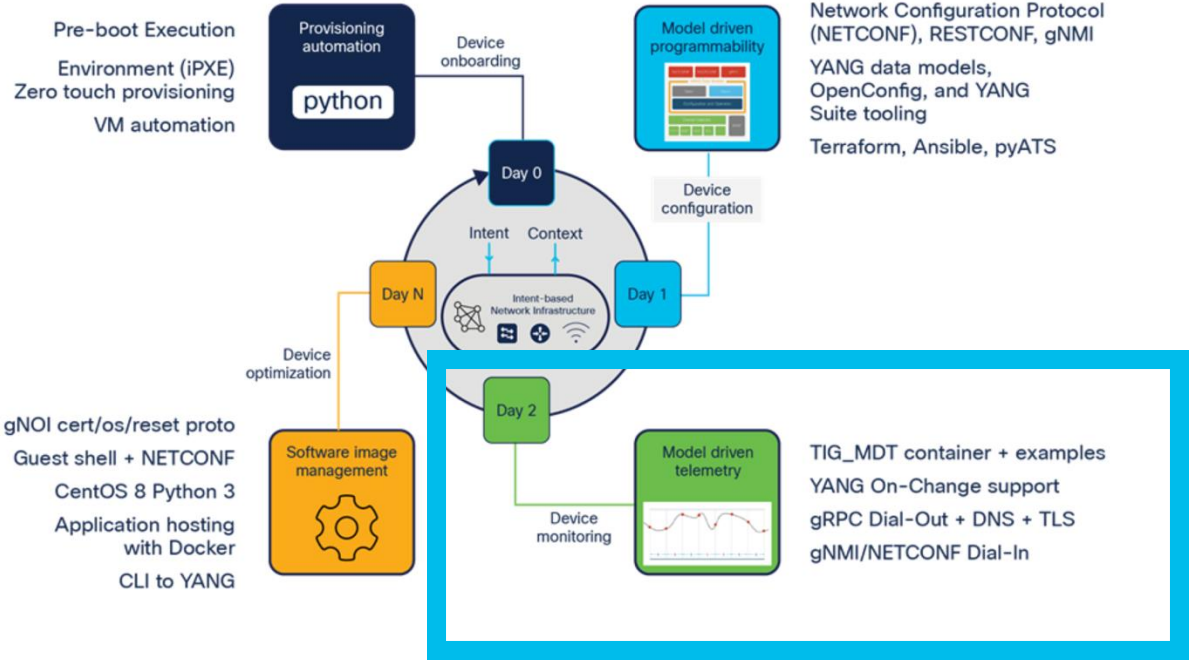
Resources



MDT White Paper

The Model Driven Telemetry White Paper includes examples, use cases and tooling related to telemetry.
This paper is now available online and in PDF form!



Website

PDF

View online: https://www.cisco.com/c/en/us/products/collateral/switches/catalyst-9300-series-switches/model-driven-telemetry-wp.html
View as PDF: https://www.cisco.com/c/en/us/products/collateral/switches/catalyst-9300-series-switches/model-driven-telemetry-wp.pdf

Introduction to Cisco IOS ...

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Programmability and Telemetry Deployment Guide

Cisco Catalyst 9800 Wireless LAN Controller

https://www.cisco.com/c/en/us/products/collateral/wireless/catalyst-9800-series-wireless-controllers/catalyst-9800-programmability-telemetry-deployment-guide.html

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Guest Shell
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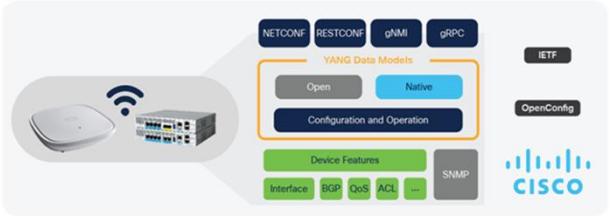
Feature overview

The world of programmability has been evolving for years, and with the latest Cisco® IOS XE releases, we've included new Yet Another Next Generation (YANG) models to bring additional automation to wireless technology. With the use of APIs, interacting with devices and retrieving data got much easier. Back in the day, we used many commands sent from a Command Line Interfaces (CLIs) to communicate with the software. In addition, the Simple Network Management Protocol (SNMP) is frequently used for network management. Fast forward to today, we use the new way to interact with the software commonly called an API. Even though CLIs and SNMP are widely used, they are not as efficient and scalable as APIs.

This document will dive into the different programmable interfaces used to communicate with the various Cisco devices and specifically target the Catalyst® 9800 Wireless LAN Controller. We will discuss the pros and cons of using Network Configuration Protocol (NETCONF), Representational State Transfer Configuration (RESTCONF), and the gRPC Network Management Interface/Google Remote Procedure Call (gNMI/gRPC) protocols, and the main differences between them.

The Catalyst 9800 IOS XE–based Wireless LAN Controller (WLC) has several options for programmatic configuration. Traditional methods for configuring the WLC include the CLI and WebUI, but that has now been expanded to include the programmatic interfaces. These programmatic interfaces include NETCONF, RESTCONF, and the gNMI/gRPC protocols. YANG data models define what data is accessible over the programmatic interfaces, and they come in several varieties. Cisco IOS XE features are defined within the Native data models, while standard and vendor agnostic features are defined within the open data models that are mapped to Native data models. Either model can be used for many tasks; however, features specific to IOS XE are available only in the Native models.

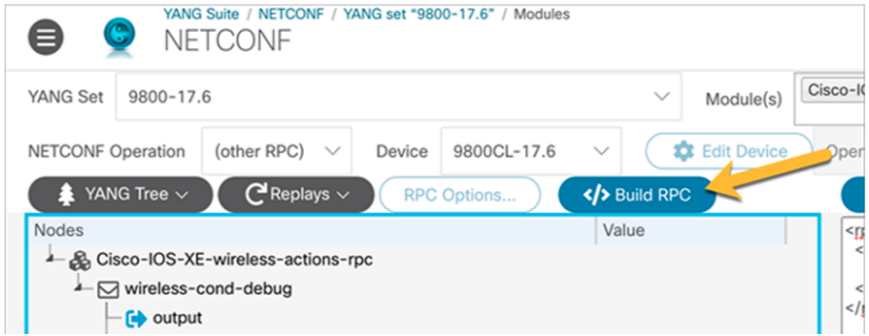
Models created by Cisco are referred to as Native data models since they are specifically created for devices and software with which they are associated. The Native data models provide most comprehensive and operational coverage for device functionality.



Enable wireless conditional debugging

Based on the either the MAC or IP address of a device we can generate debug messages using the `Cisco-IOS-XE-wireless-actions-rpc.yang` model. This is equivalent to entering the following CLI command:

```
debug platform condition feature wireless <mac/ip> <MAC/IP Address>
```



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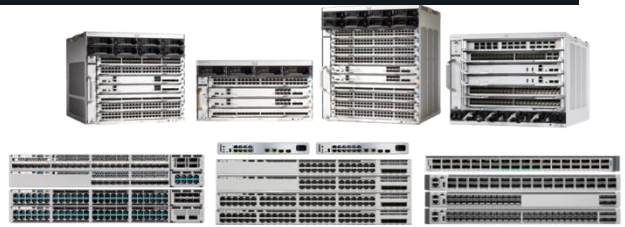
Updated TIG_MDT container now available!

```
docker pull jeremycohoe/tig_mdt
docker run -ti -p 3000:3000 -p 57500:57500 jeremycohoe/tig_mdt
```

Upgrade coming to Telegraf, Influx, and Grafana Model Driven Telemetry (TIG_MDT) Docker container
Making it easier to consume telemetry in production

Upgraded Telegraf, InlfuxDB, and Grafana tools
Additional dashboards for
Device Health, Wireless Client, Wireless AP, RF etc
Examples for device CLI configuration for telemetry
Details of scale and data storage requirements

Cisco IOS XE Devices



Collector/Receiver
Decodes to text

telegraf™

Storage
Time Series Database

InfluxDB

Monitoring and Visualisations

Grafana

https://hub.docker.com/r/jeremycohoe/tig_mdt https://github.com/jeremycohoe/cisco-ios-xe-mdt
https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/prog/configuration/179/b_179_programmability_cg/m_179_prog_ietf_telemetry.html

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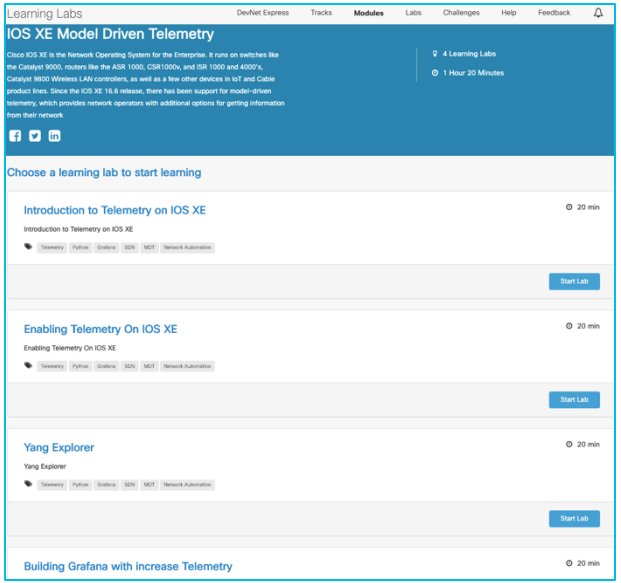
Learning Lab and Blog: IOS XE MDT

https://developer.cisco.com/learning/modules/iosxe_telemetry
https://blogs.cisco.com/developer/model-driven-telemetry-sandbox



Developer

Explore Model-Driven Telemetry

Stuart Clark

New learning labs and sandbox

As our journey through network automation grows, so does the need for our network tools. Network Engineers have always been considered the absolute escalation point for any performance difficulties and problems, irrespective whether the root cause is really the network, server, or application. Network Engineers are expected to have the knowledge and tools to isolate and identify the issue, collaborating with other teams such as SRE / AppDev to bring it to resolution and often present this in an RCA (root cause analysis).

One of these great tools which can really help is telemetry. In software, telemetry is used to gather data on the use and performance of applications and application components, e.g. how often certain features are used, measurements of start-up time and processing time, hardware, application crashes, and general usage statistics and/or user behavior.

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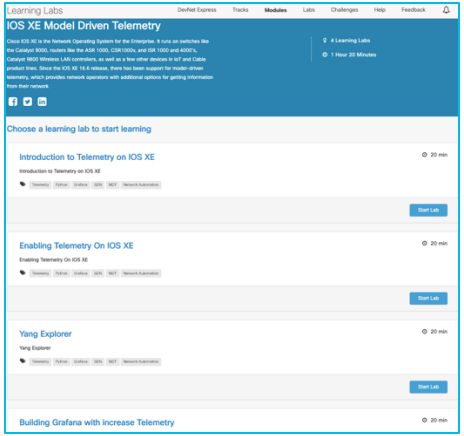
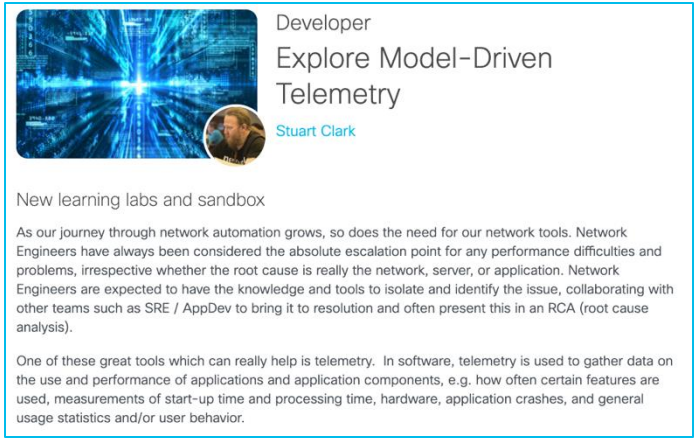
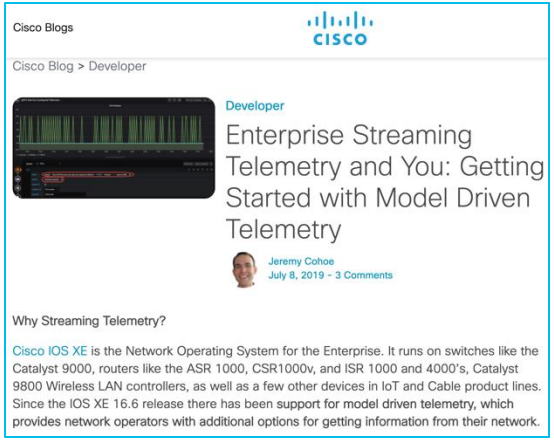
Learning Lab and Blogs: Telemetry

https://developer.cisco.com/learning/modules/iosxe_telemetry
https://blogs.cisco.com/developer/model-driven-telemetry-sandbox
https://blogs.cisco.com/developer/getting-started-with-model-driven-telemetry
https://youtu.be/QwwZakkWBng







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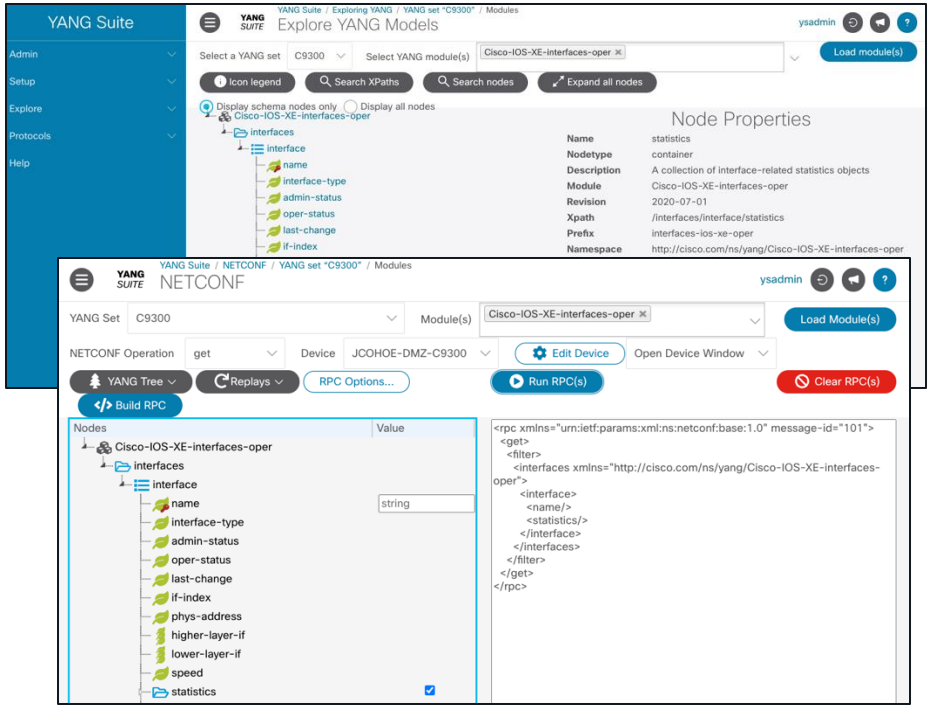
Cisco YANG Suite



YANG API Testing and Validation Environment

Construct and test YANG based APIs over NETCONF, RESTCONF, gRPC and gNMI

IOS XE / IOS XR / NX OS platforms

developer.cisco.com/yangsuite

github.com/CiscoDevNet/yangsuite

Get hands-on using the new learning lab!
https://developer.cisco.com/learning/labs/intro-yangsuite/
Docker container innovation 1 container

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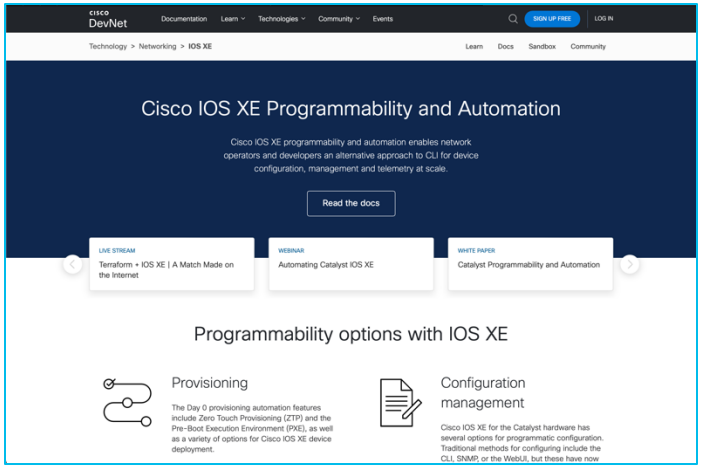
Programmability Website

The one-stop-shop for Cisco IOS XE Programmability resources including videos, white papers, labs and more!



- Community Forum
- IOS XE FAQ
- White Papers
- Code Exchange
- IOS XE Docs & Guide
- Learning Tracks and Labs
- Sandboxes
  - … and more !

https://developer.cisco.com/iosxe/

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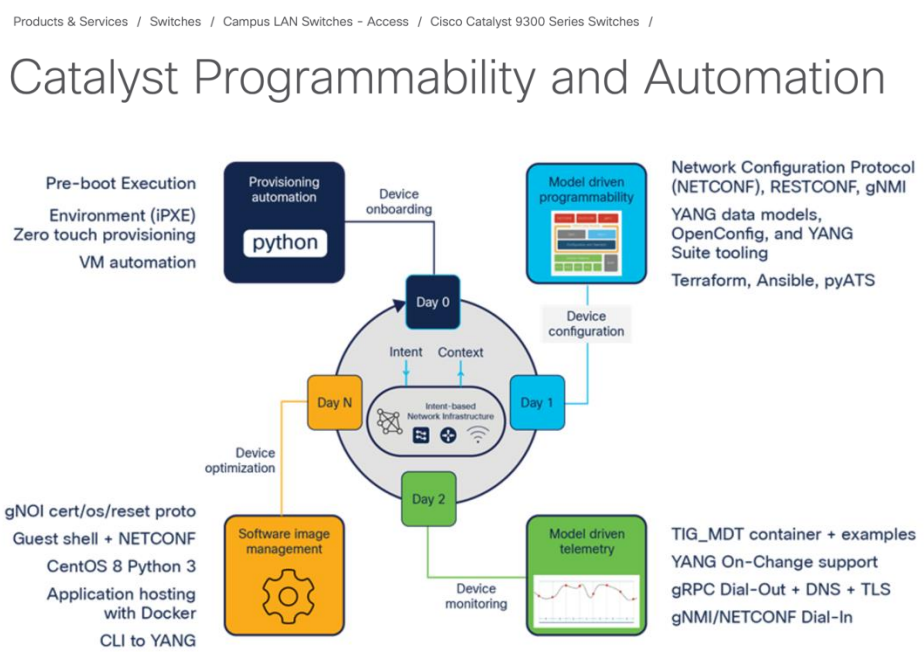
API White Paper



Website: https://www.cisco.com/c/en/us/products/collateral/switches/catalyst-9300-series-switches/nb-06-catalyst-programmability-automation-wp.html
PDF: https://www.cisco.com/c/en/us/products/collateral/switches/catalyst-9300-series-switches/nb-06-catalyst-programmability-automation-wp.pdf
Webinar with live demos & examples: https://www.youtube.com/watch?v=LdcK5PnPu2I

http://cs.co/apiwp

http://cs.co/apiwppdf

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dCloud Programmability

https://dcloud.cisco.com
"Cisco Catalyst 9000 IOS XE Programmability & Automation Lab v1"
https://dcloud2.cisco.com/demo/catalyst-9000-ios-xe-programmability-automation-lab-v1

Use Cases:

EVPN:
Ansible with CLI deployment of EVPN solutions
EVPN management over RESTCONF/YANG with Postman
Declarative EVPN fabric management with Terraform

Model Driven Telemetry
Telemetry configuration with CLI and YANG Suite
Collection with TIG_MDT container and tooling

YANG Programmability
YANG Suite tooling and integrations to YANG API's
Ansible integrations

Tooling and Integrations
YANG Suite
- NETCONF/RESTCONF/gNMI API
  - Ansible integration
- NETCONF/gNMI Dial-In Telemetry
- gRPC Dial-Out Telemetry receiver

Telemetry
- TIG stack in Docker
- Grafana dashboard for device health

Postman / RESTCONF
- EVPN fabric API calls

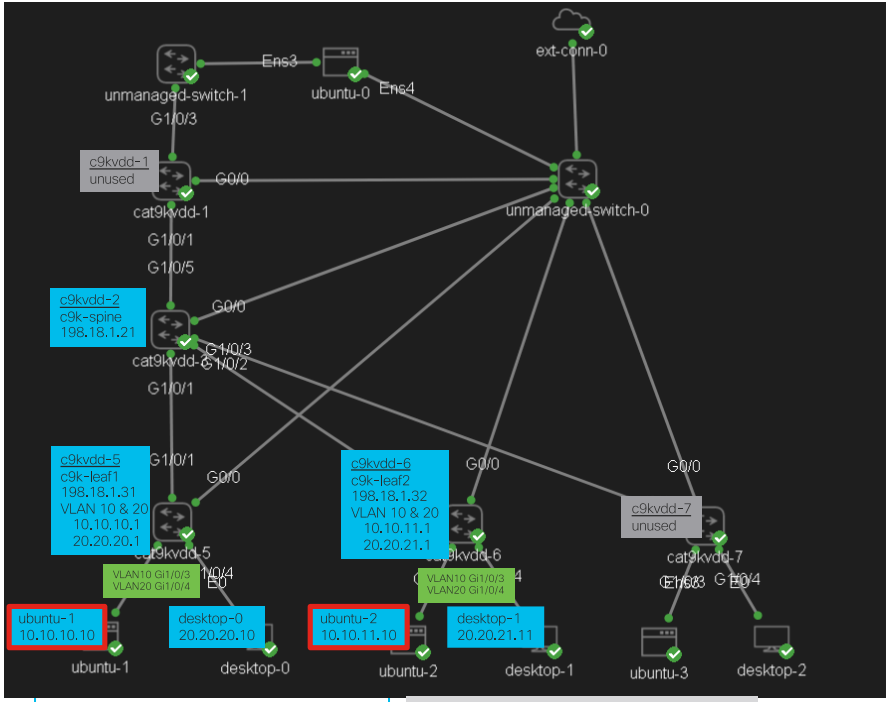
Terraform/RESTCONF
- Declarative EVPN fabric management

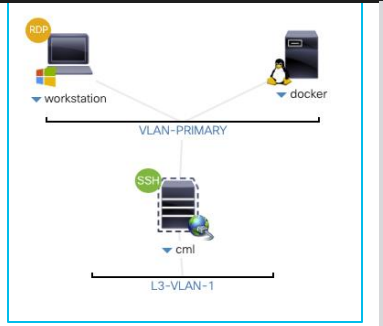
Ansible
- EVPN solution enablement using CLI

Ubuntu VM Details:
Syslog receiver from all switches
TFTP config backup
See slide

Windows VM Details
VS Code
Terraform @ folder
Ansible @ folder
Chrome browser
YANG Suite, Grafana
Bash/PS/Cmd shells
SSH into C9K or Ubuntu
Postman
Workspace for EVPN

C9K VM's





VLAN1
c9k-spine
IP: 198.18.1.21
developer / C1sco12345
c9k-leaf1
IP: 198.18.1.31
developer / C1sco12345
c9k-leaf2
IP: 198.18.1.32
developer / C1sco12345
c9kvdd-1 - unconfigured

c9kvdd-7 - unconfigured

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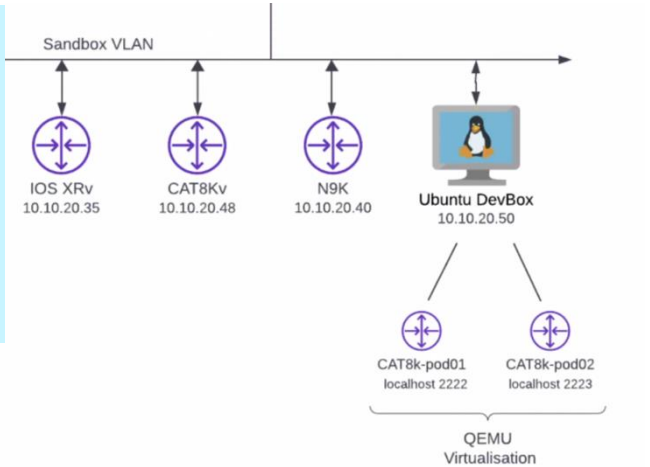
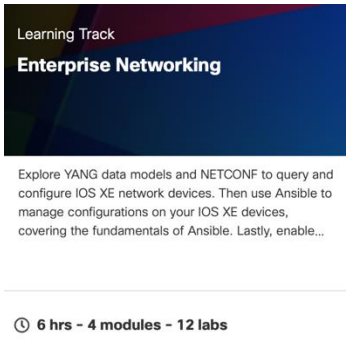
Cisco IOS XE - Reservable Virtual Sandbox

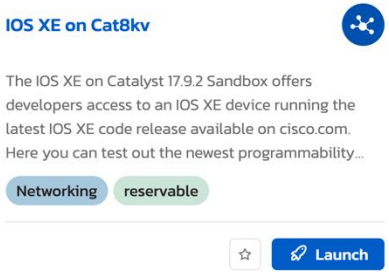
This DevNet reservable sandbox has IOS XRv + N9Kv + IOS XE
The Catalyst 8000V within the DevBox is enabled for Day 0/ZTP usecases

https://devnetsandbox.cisco.com
"IOS XE on Cat8kv"
https://devnetsandbox.cisco.com/DevNet/catalog/IOS%20XE%20on%20Cat8kv

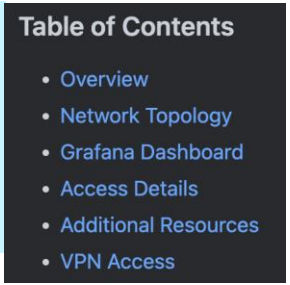
The "Enterprise Networking" Learning Labs contains guides for the supported usecases
https://developer.cisco.com/learning/

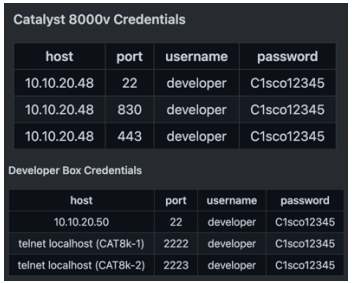






Sandbox Capabilities:
TIG_MDT Telemetry
YANG Suite API
Terraform + Ansible
ZTP & Guest Shell
... and more





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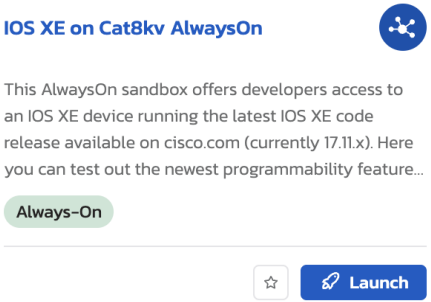
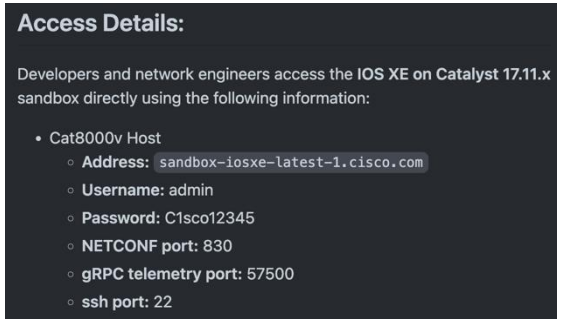
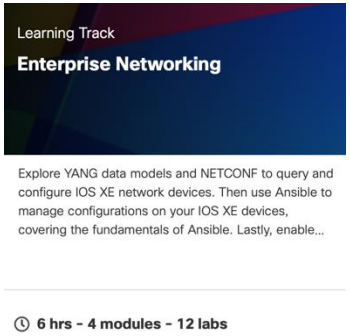
Cisco IOS XE - Always On Virtual Sandbox

The “IOS XE on Cat8kv Always On” virtual sandbox requires no reservation
The c8kv can be accessed with SSH, NETCONF, and RESTCONF
Hostname: sandbox-iosxe-latest-1.cisco.com
Username: admin Password: C1sco12345
SSH port 22, NETCONF port 830, RESTCONF HTTPS
https://devnetsandbox.cisco.com
devnetsandboxiosxe.cisco.com
https://devnetsandbox.cisco.com/DevNet/catalog/ios-xe-always-on

The “Enterprise Networking” Learning Labs contains guides for the supported usecases
https://developer.cisco.com/learning/







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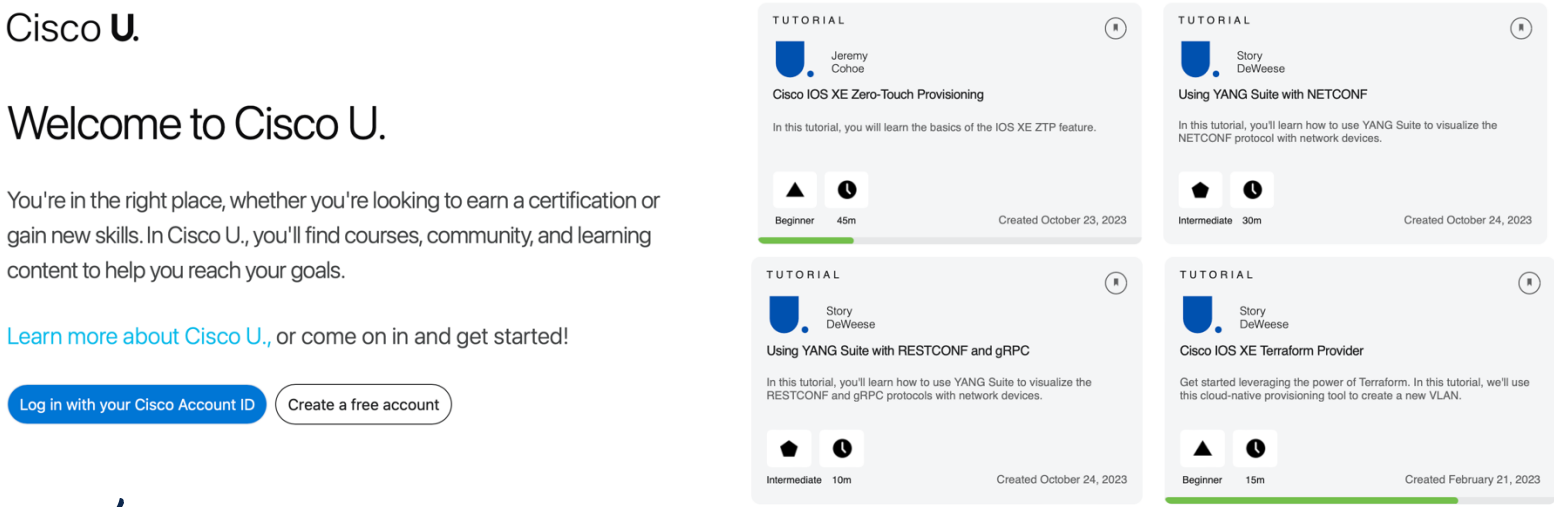
https://u.cisco.com
https://u.cisco.com/search/tutorial?query=Story%20DeWeese,%20Jeremy%20Coho,%20not%20berry

Direct link to Tutorial, requires login to u.cisco.com first:

1. https://ondemandelearning.cisco.com/apollo-alpha/tc-iosxe-ztp/pages/1
2. https://ondemandelearning.cisco.com/apollo-alpha/tc-terraform-ios-xe/pages/1
3. https://ondemandelearning.cisco.com/apollo-alpha/tc-yangsuite-netconf/pages/1
4. https://ondemandelearning.cisco.com/apollo-alpha/tc-yangsuite-restconf/pages/1



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