



Cisco TechClub

Programovatelnost Cisco zařízení prakticky

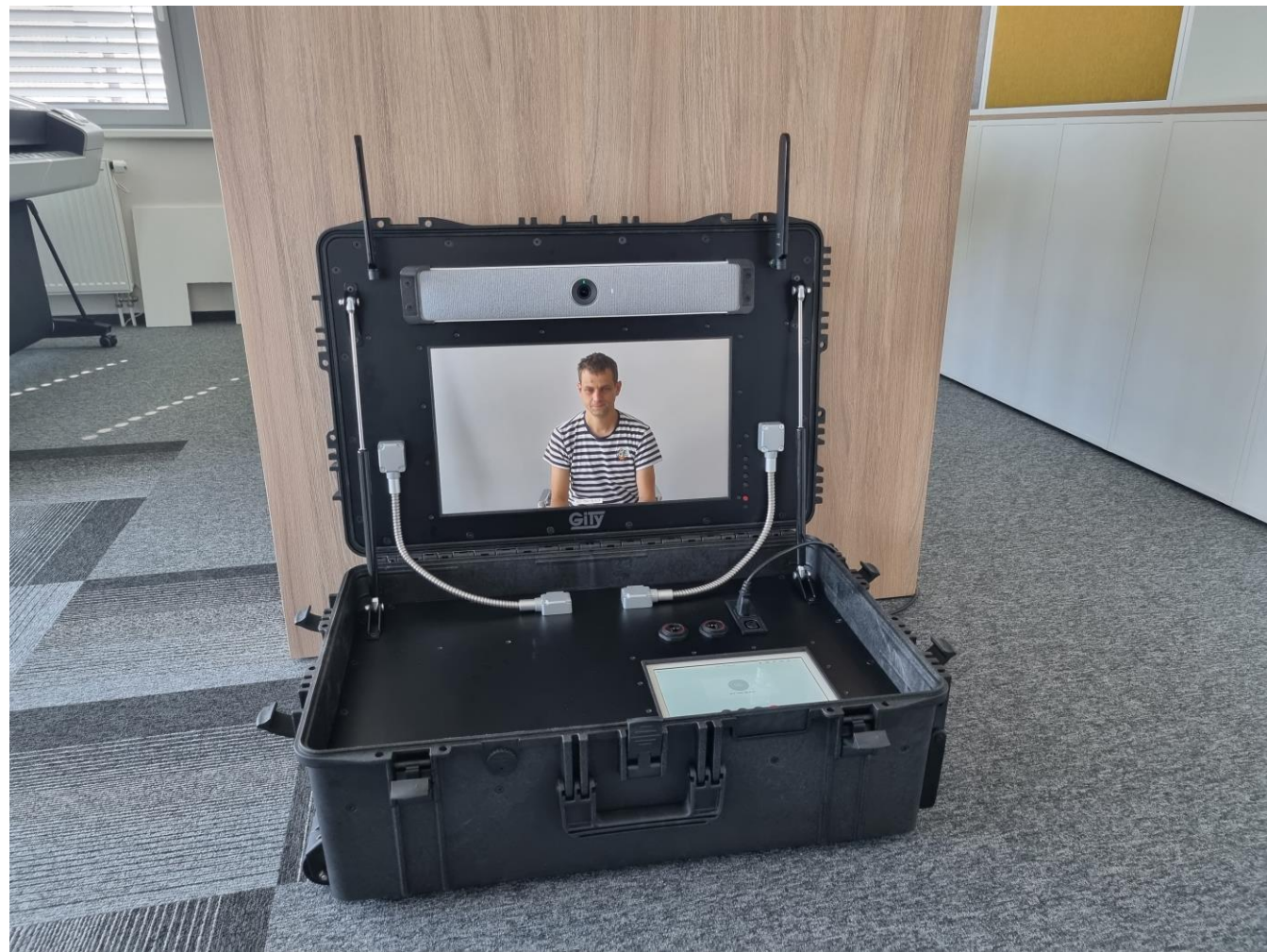
Jaroslav Martan, jmartan@cisco.com

Agenda

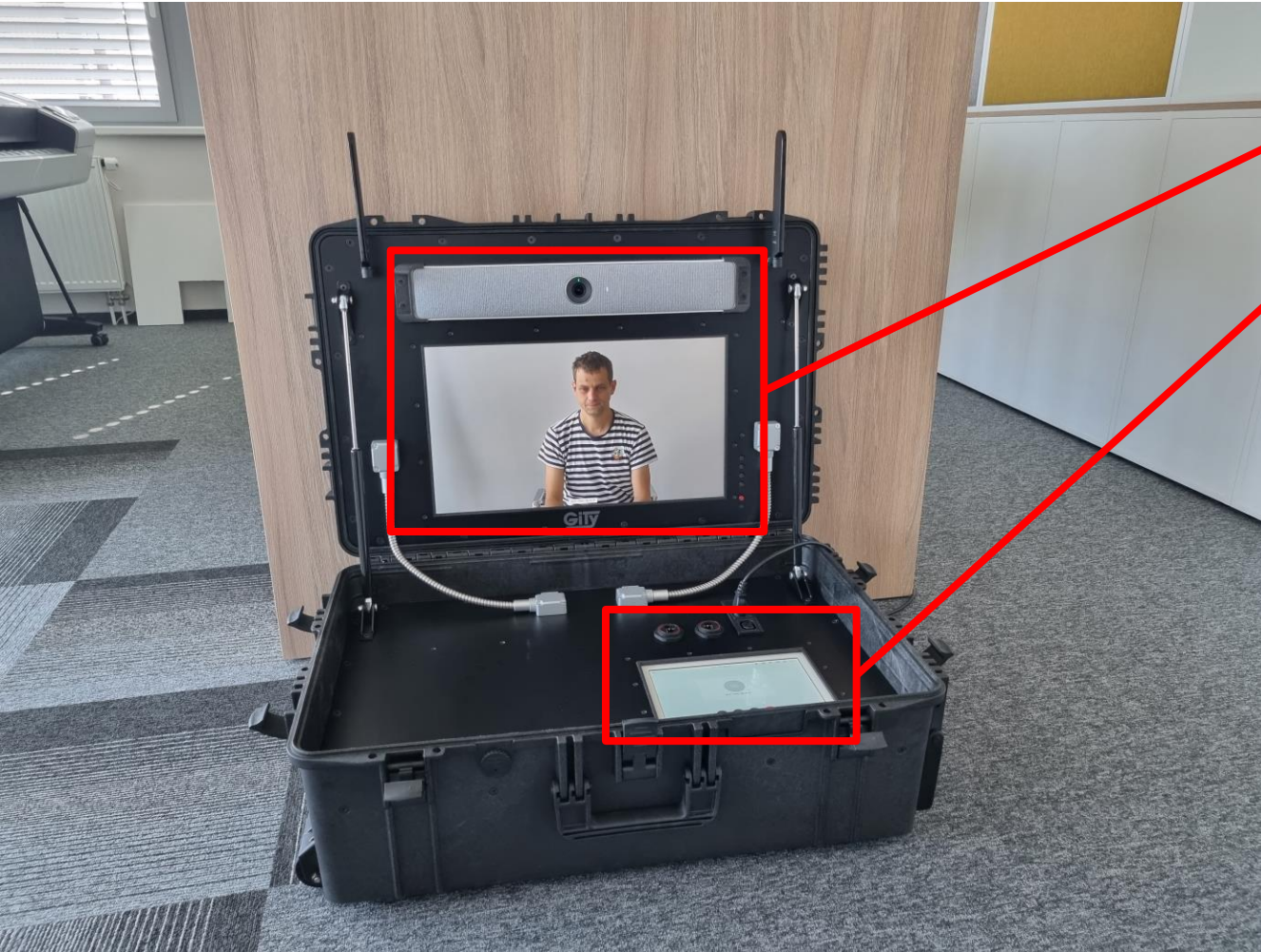
- Mobile Box description – purpose, diagrams
- IOx docker hosting on IOS-XE
- Configuration - RESTCONF
- Telemetry – gRPC, gNMI

Mobile Box

Zástavba Cisco RoomKit mini

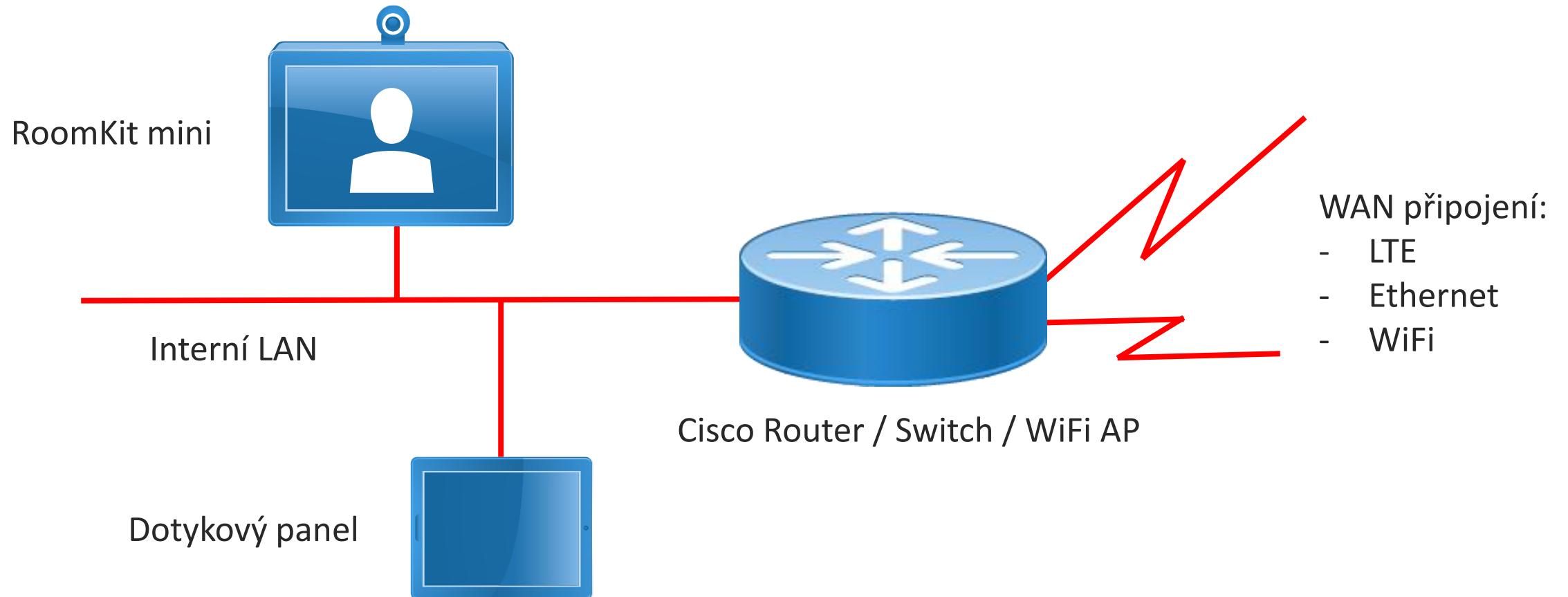


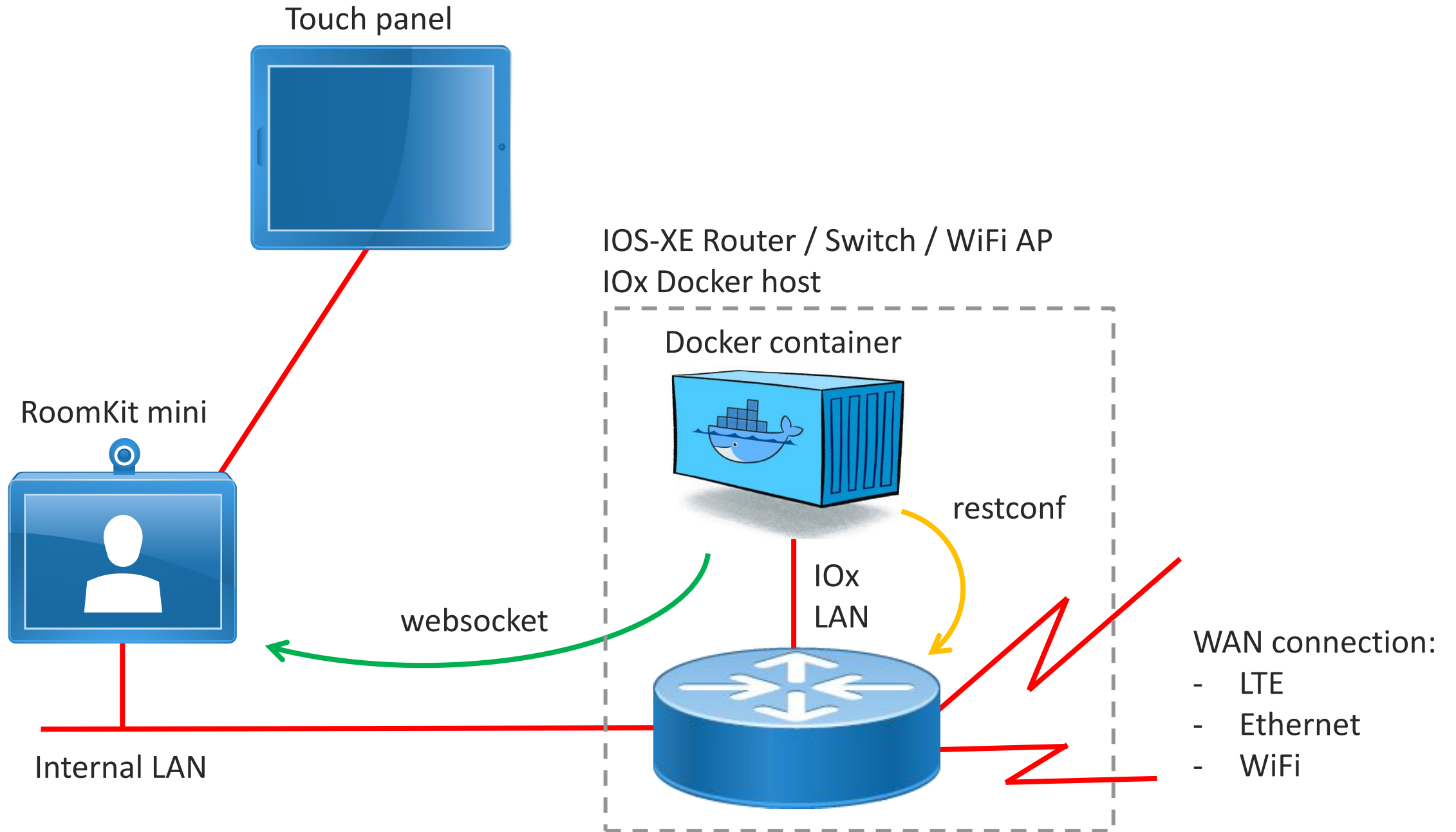
Co je uvnitř, jak to funguje?



- Cisco RoomKit mini
- Dotykové ovládání
- Cisco router
 - LTE / Ethernet / Wifi
 - Automatická nebo manuální volba připojení
- Prostor pro UPS

Schéma zapojení









Call



Share screen



Share screen



Room Calendar



Router



Router



Share screen



Join Webex



Router

Router Control

Router Info

show version

show ip route

ir1101, hw: IR1101-K9, sw: 17.8

Router Control

Router Info

show version

show ip route

0.0.0.0/0.0.0.0 -> 192.168.21.1

Router Control

Router Info

CPU Usage

5s: 0%, 1m: 0%, 5m: 1%

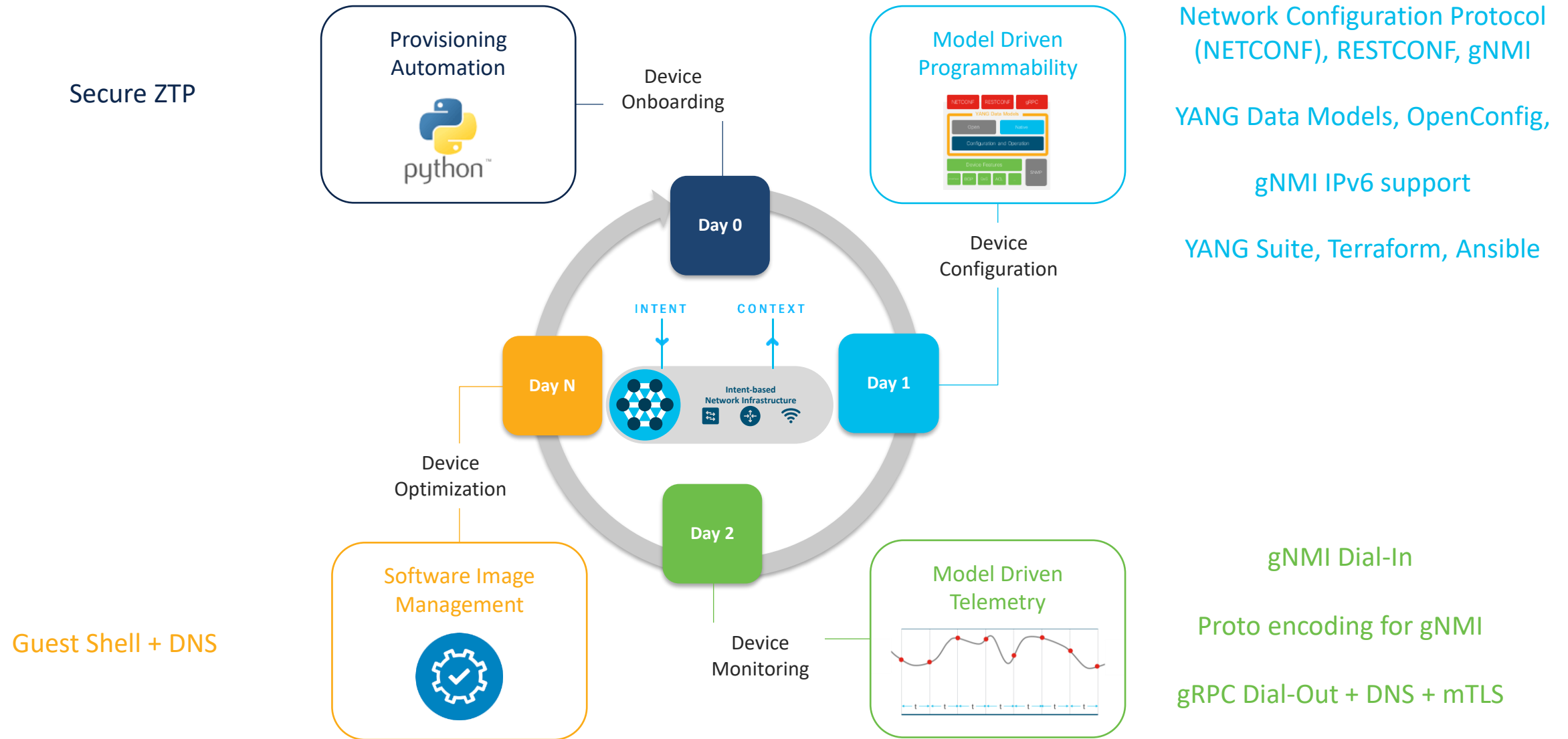
Memory Usage

used: 279628488, free: 1078701952

Last Update

2022-06-24T15:48:12

IOS XE Programmable Device Lifecycle

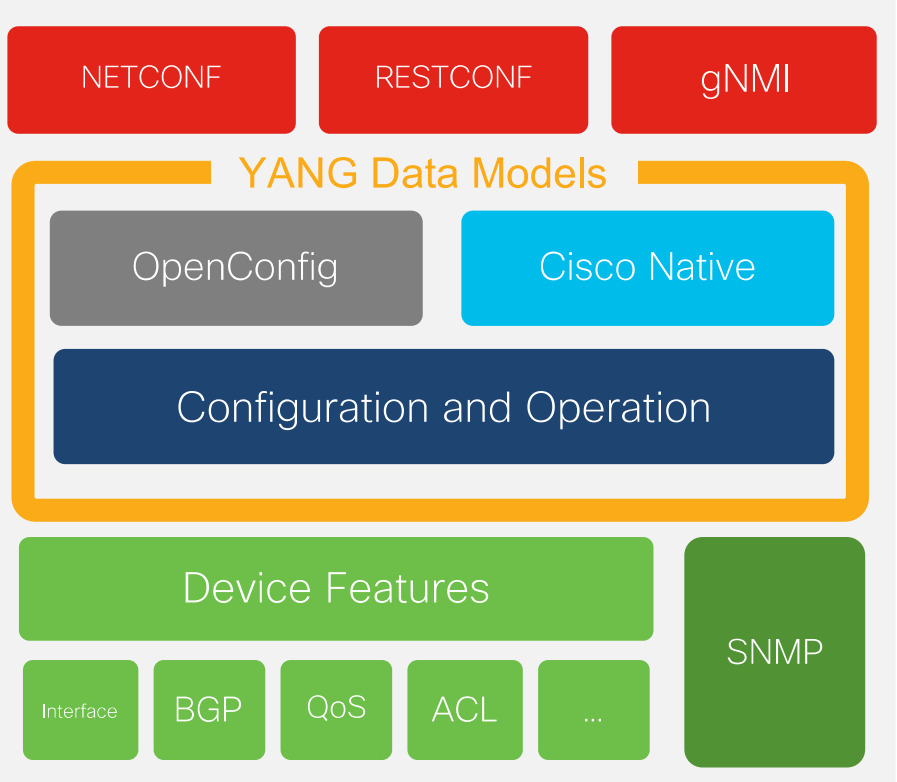
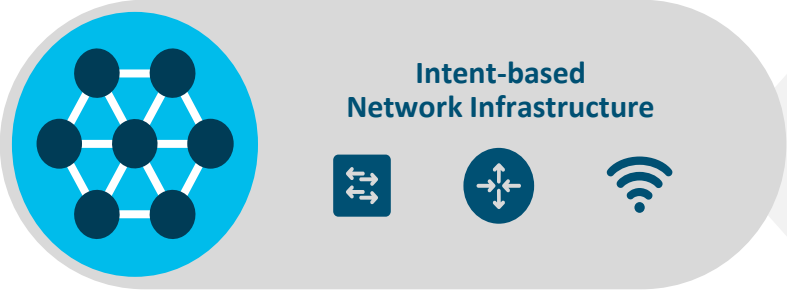


Programmable Interfaces

- CLI
- SNMP
- WebUI

The NETCONF, RESTCONF and gNMI 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 and gNMI

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



IOx Docker hosting on IOS-XE

IOx Network Infrastructure

IR 809



IR 829



IE 4000



CGR 1120/1240



ISR 44xx,43xx



C819

ASR 1001/2X,/HX



Broad Connectivity

- Ethernet
- Cellular 3G, 4G LTE
- Wi-Fi
- Industrial protocols
- Zero touch deployment

Proven Security

- HW-accelerated encryption
- IPSec VPN
- 802.1x
- Firewall
- Identity services

Industrial Grade

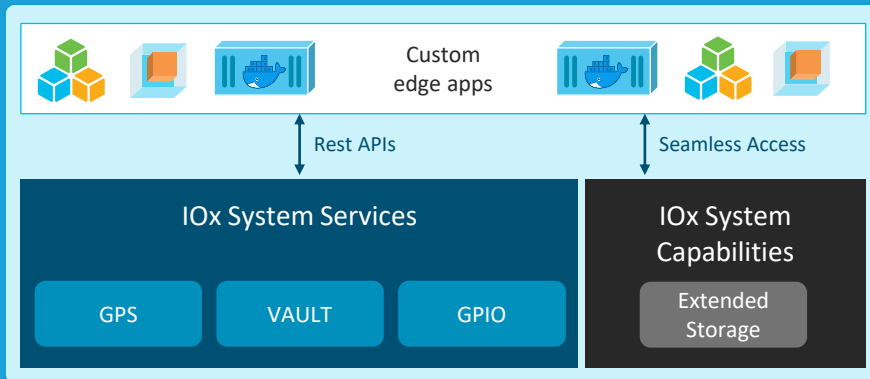
- Ruggedized for shock/vibration, humidity, temperature, dust
- DC power supplies
- High reliability
- Certifications

Policy-Based Management

- Centralized control
- Network
- Security
- Fog applications

System Service To Make Smarter Apps

Optimized And Easy To Use Services At The IoT Edge



Lower TCO With Integrated Network And Edge-compute Functionalities

Vault



Stores Credentials And Certificates

GPS/Motion



Asset Tracking, Geofencing

SSD



Extended Storage At Edge

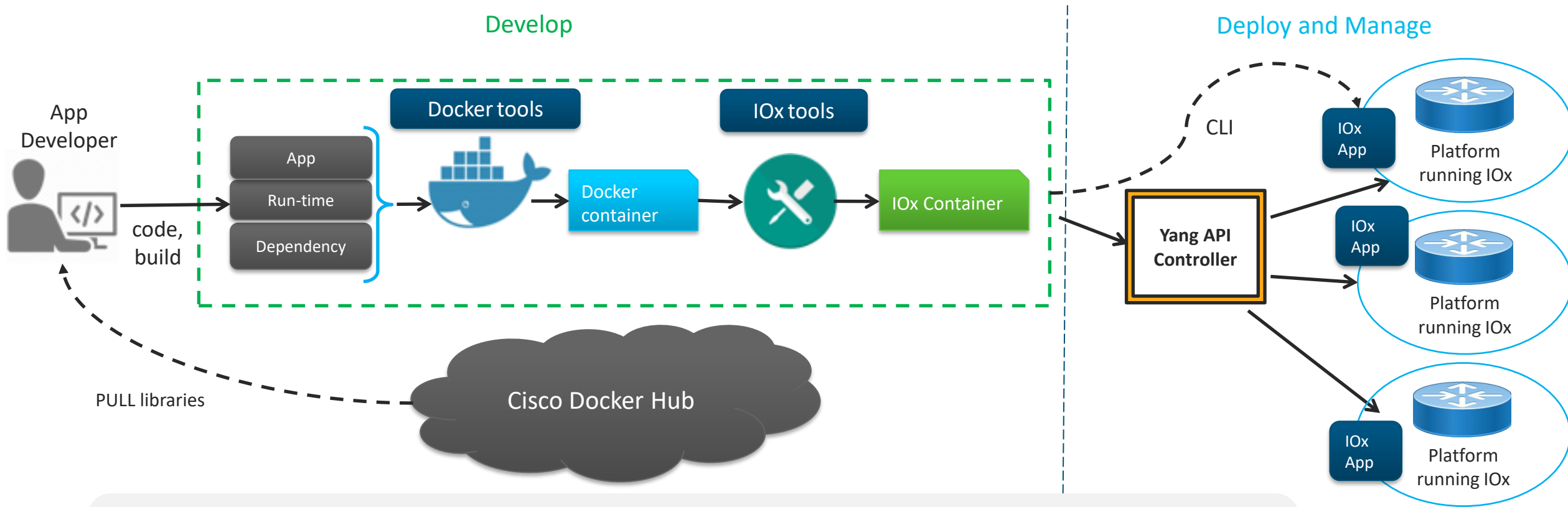
GPIO



Actuators, Relays And Contact Closure

LXC Docker Workflow

Develop using Docker tool chain; Deploy using Fog Director



Benefits:

- Leverage Developer familiarity of **Docker tool chain**
- Easy to integrate IOx deployment with **Enterprise DevOps Process**

Configuration - RESTCONF

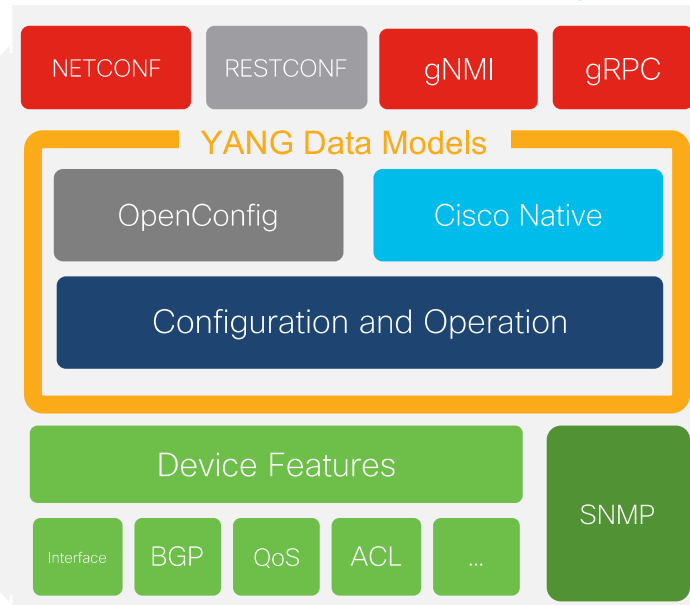
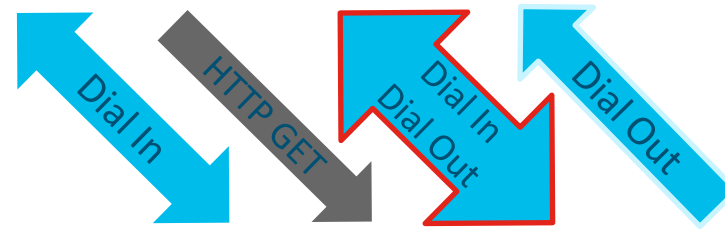
Telemetry – gRPC, gNMI

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)

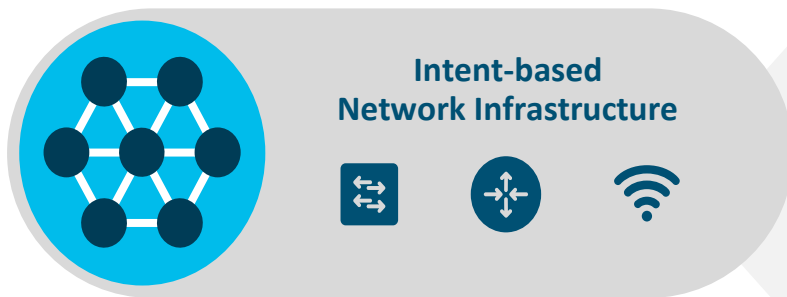
Publication / Subscription



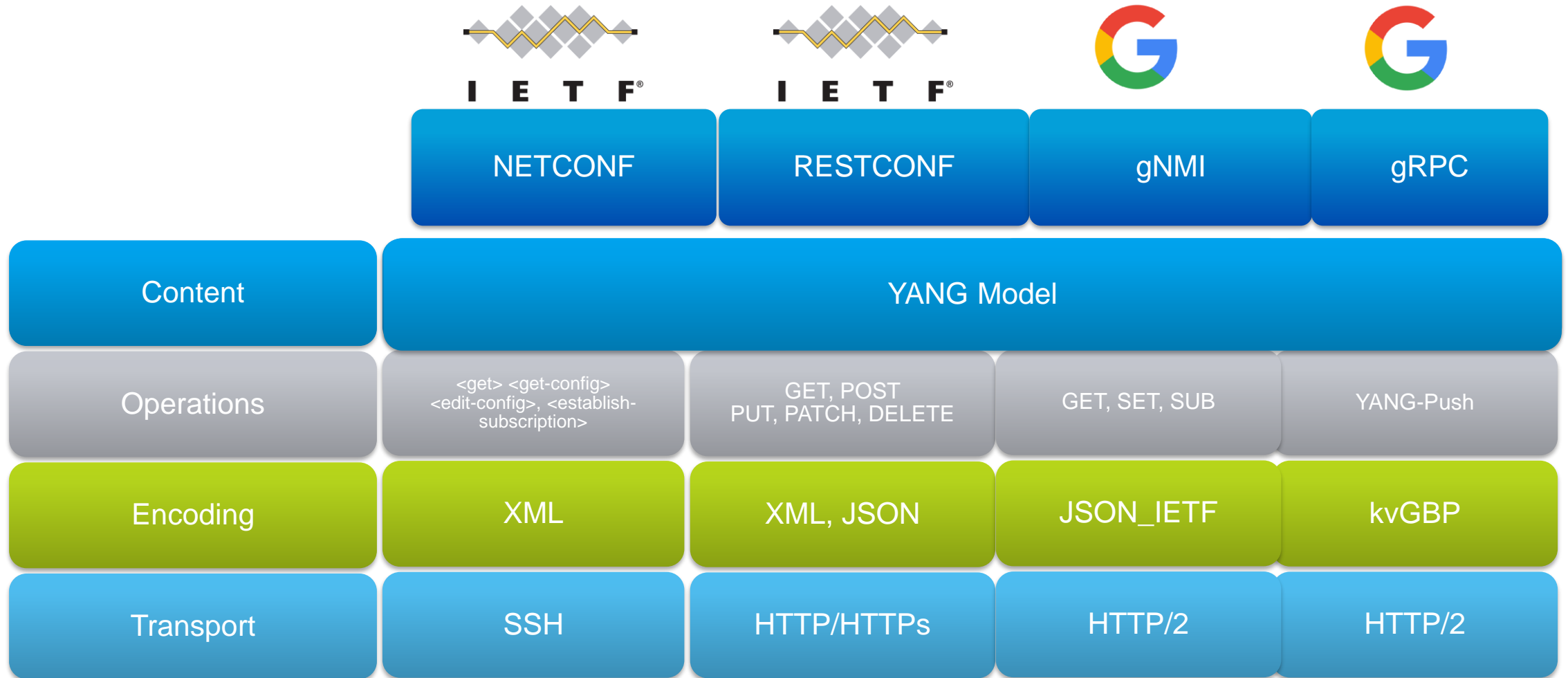
XML, JSON, proto and kvGPB encoding

Consistent YANG data models between interfaces

On-change event and time-based publication options

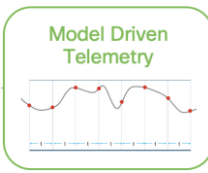


API Interfaces



API Operations

NETCONF	RESTCONF	gNMI	gRPC
<get-config>, <get>	GET	GET	
<edit-config> (operation="create")	POST	SET	
<edit-config> (operation="replace")	POST, PATCH	SET = update	
<edit-config> (operation="delete")	DELETE	SET = <null>	
<establish-subscription>		SUBSCRIBE	YANG push



Model Driven Telemetry Interface Comparison

	NETCONF	gRPC Dial-Out	gNMI Dial-In	gNMI Dial-Out
Telemetry Direction	Dial-In, IOS XE is server	Dial-Out IOS XE is client	Dial-In IOS XE is server	Dial-Out
Configuration	Dynamic per session	Static per configuration	Dynamic per session	Static
Telemetry Collector	Client	Server	Client	Server
Encoding	XML	KV GPB	JSON_IETF	PROTO + JSON_IETF
Security	SSH + PKI certificate or password	TLS or plain-text	TLS certificate with user authentication	Same
Transport Protocol	SSH	HTTP2	HTTP2	Same
Data Models	YANG	YANG	YANG	YANG

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

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

The screenshot displays two views of the Cisco YANG Suite interface. The top view, titled 'Explore YANG Models', shows a tree structure of YANG models for 'Cisco-IOS-XE-interfaces-oper' with a 'Node Properties' table on the right. The bottom view, titled 'NETCONF', shows the 'Cisco-IOS-XE-interfaces-oper' model tree with a 'Value' column and an XML RPC payload in the right pane.

Name	statistics
Nodetype	container
Description	A collection of interface-related statistics objects
Module	Cisco-IOS-XE-interfaces-oper
Revision	2020-07-01
Xpath	/interfaces/interface/statistics
Prefix	interfaces-ios-xe-oper
Namespace	http://cisco.com/ns/yang/Cisco-IOS-XE-interfaces-oper

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

Now Generally Available !

developer.cisco.com/yangsuite

github.com/CiscoDevNet/yangsuite

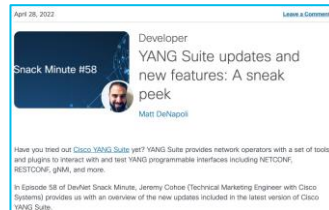
Resources

YANG Suite Resources

Blogs



<https://blogs.cisco.com/developer/363-yangsuite-01>



<https://blogs.cisco.com/developer/2022yangsuiteupdatesfeatures01>



<https://blogs.cisco.com/developer/leveragingsuite01?dtid=ossdc000283>

YouTube Videos



<https://youtu.be/smrhjL5Ayz0>



<https://www.youtube.com/watch?v=dTun33611JA>



<https://www.youtube.com/watch?v=soyWPr0fJ0s>



<https://www.youtube.com/watch?v=PkbAOzZ1vNk>



<https://www.youtube.com/watch?v=3zmNdfn8b38>

Additional Resources

<https://github.com/CiscoDevNet/yangsuite/>

<https://developer.cisco.com/yangsuite/>

<https://eurl.io/#MaW78CeIS> YANG Suite General (external)

Cisco IOS XE Programmability – Booksprint Book

<http://cs.co/programmabilitybook> OR <https://www.cisco.com/c/dam/en/us/products/collateral/enterprise-networks/nb-06-ios-xe-prog-ebook-cte-en.pdf>

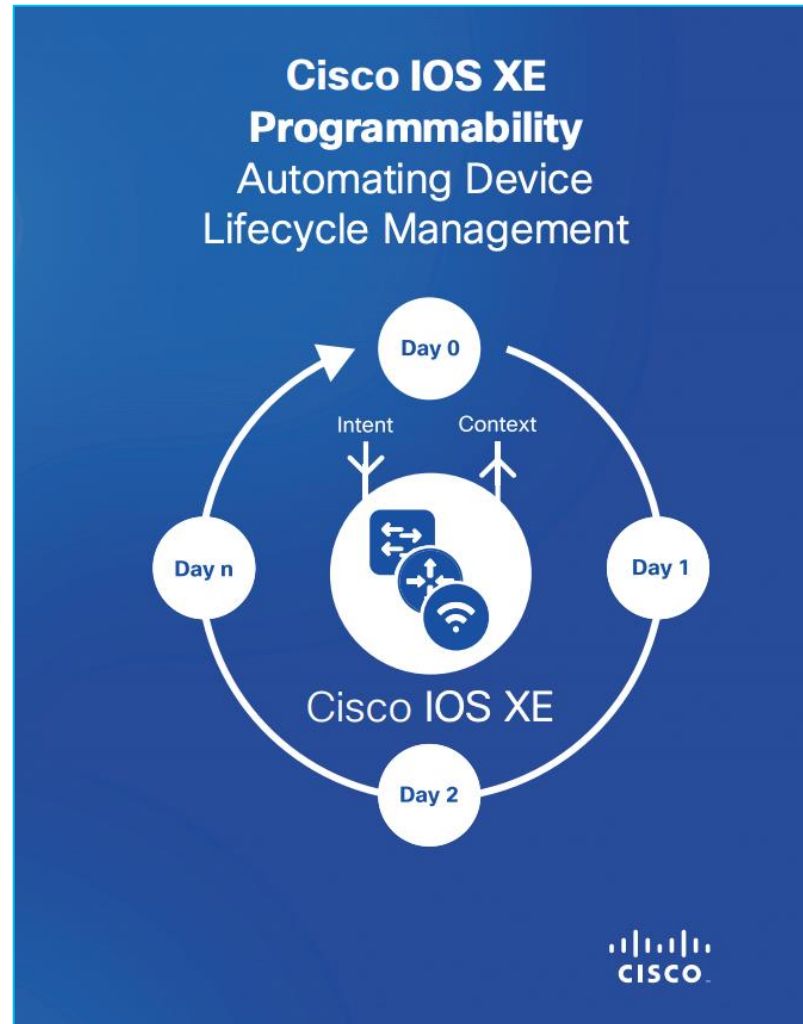


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Programmability Configuration Guide

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- ▼ Application Hosting
 - Application Hosting
- ▼ OpenFlow
 - OpenFlow
 - High Availability in OpenFlow Mode



Programmability Configuration Guide, Cisco IOS XE Cupertino 17.9.x


First Published: 2022-08-01

https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/prog/configuration/179/b_179_programmability_cg.html

Blog and Resources: Terraform

<https://github.com/CiscoDevNet/terraform-provider-iosxe/>
<https://registry.terraform.io/search/providers?namespace=CiscoDevNet>

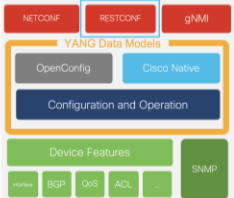
Terraform is...



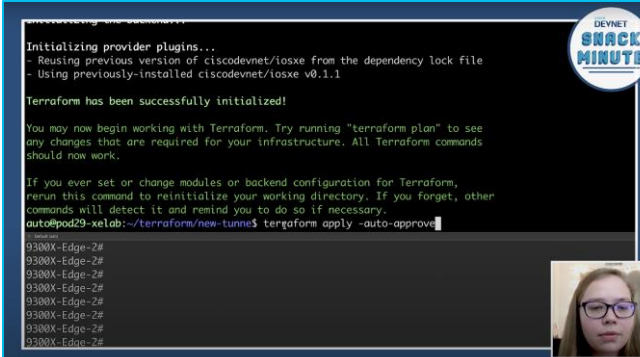
Open-source Infrastructure as Code (IaC) Software Tool providing a consistent CLI workflow to manage hundreds of cloud services. Terraform codifies cloud APIs into declarative configuration files.

- Cloud Native Tooling circa 2014 from HashCorp
- Agentless, single binary file
- Zero server-side dependencies

Terraform uses the RESTCONF API



<https://salesconnect.cisco.com/#/content-detail/fa072157-b099-494b-8ec5-2522c6ab2bf6>




```
Initializing provider plugins...
- Reusing previous version of cisco/devnet/iosxe from the dependency lock file
- Using previously-installed cisco/devnet/iosxe v0.1.1

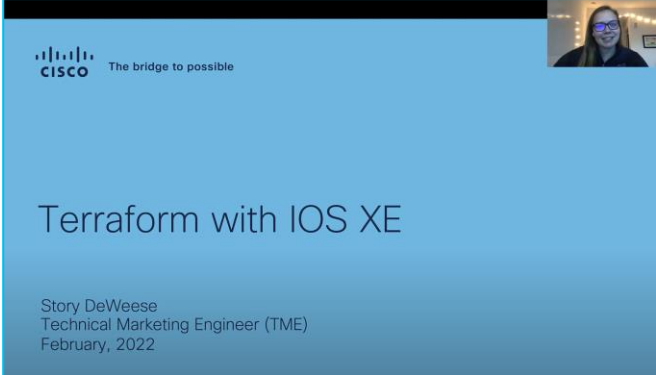
Terraform has been successfully initialized!

You may now begin working with Terraform. Try running "terraform plan" to see
any changes that are required for your infrastructure. All Terraform commands
should now work.

If you ever set or change modules or backend configuration for Terraform,
rerun this command to reinitialize your working directory. If you forget, other
commands will detect it and remind you to do so if necessary.
auto@pod29-xelab:~/terraform/new-tunnel$ terraform apply -auto-approve
```



Demo Create a Crypto Tunnel Video:
<https://www.youtube.com/watch?v=bPS0bhPacDw>




Terraform with IOS XE

Story DeWeese
Technical Marketing Engineer (TME)
February, 2022

Intro to IOS XE Terraform Provider Video:
https://www.youtube.com/watch?v=GEY_hyXimBA

Questions? Join the Ask IOS XE
Terraform Provider Webex space:
<https://eurl.io/#PtsT8eJFI>




Developer

Automation with Any Tooling on Any Interface

Story DeWeese

Terraform expands into the extensive Cisco IOS XE programmability and automation ecosystem



IOS XE's vast, programmable feature set

The Cisco IOS XE ecosystem is programmatically managed and supports a variety of tooling. This includes Ansible to YANG Suite, pyATS over NETCONF, RESTCONF, gNMI, and even with legacy CLIs. With the addition of the new Cisco IOS XE Terraform provider, we add an additional tool into the IOS XE configuration management toolbox.

<https://blogs.cisco.com/developer/terraformiosxe01>

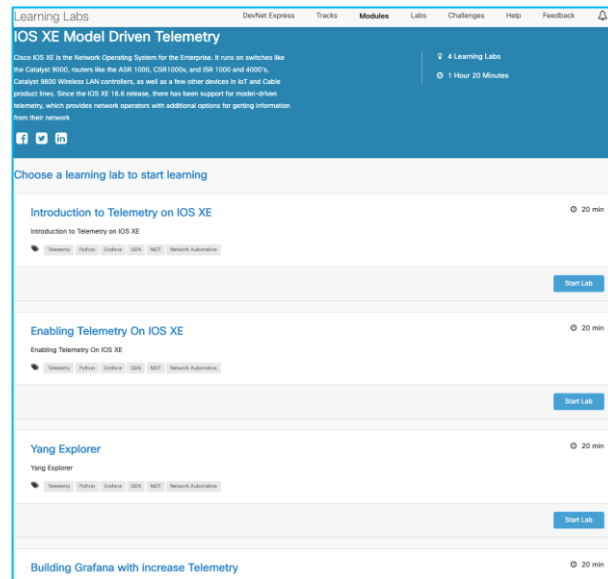
Learning Lab and Blog: Telemetry

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>



The screenshot shows the 'Learning Labs' interface for 'IOS XE Model Driven Telemetry'. It includes a navigation bar with 'DevNet Express', 'Tracks', 'Modules', 'Labs', 'Challenges', 'Help', and 'Feedback'. Below the title, there is a brief description of the lab and a '4 Learning Labs' indicator. A list of labs is provided, each with a 'Start Lab' button and a duration of 20 minutes:

- Introduction to Telemetry on IOS XE (20 min)
- Enabling Telemetry On IOS XE (20 min)
- Yang Explorer (20 min)
- Building Grafana with Increase Telemetry (20 min)



Developer

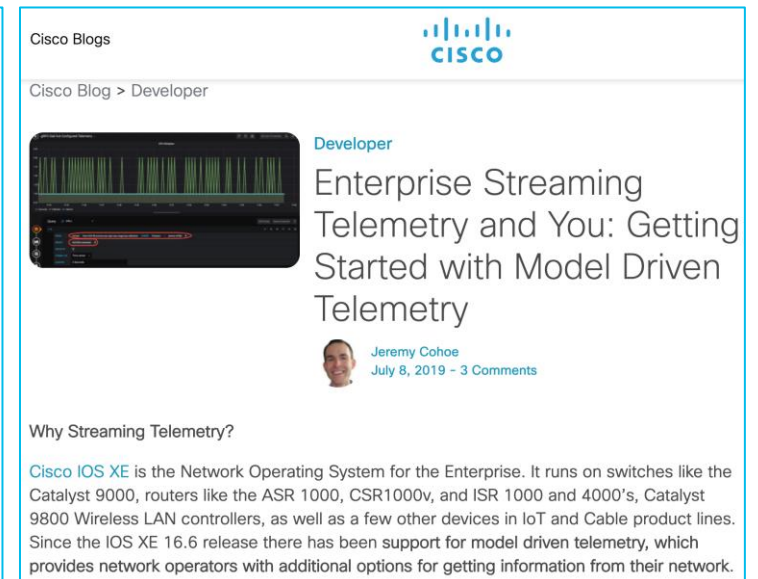
Explore Model-Driven Telemetry

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.



The screenshot shows a Cisco Blog post from the 'Developer' category. The title is 'Enterprise Streaming Telemetry and You: Getting Started with Model Driven Telemetry' by Jeremy Cohoe, dated July 8, 2019, with 3 comments. The post includes a video thumbnail showing a network monitoring interface. Below the title, there is a section titled 'Why Streaming Telemetry?' followed by a paragraph of text:

Cisco IOS XE is the Network Operating System for the Enterprise. It runs on switches like the Catalyst 9000, routers like the ASR 1000, CSR1000v, and ISR 1000 and 4000's, Catalyst 9800 Wireless LAN controllers, as well as a few other devices in IoT and Cable product lines. Since the IOS XE 16.6 release there has been support for model driven telemetry, which provides network operators with additional options for getting information from their network.

Mobile Box Code

- https://github.com/JardaMartan/mobile_box

