

The background is a vibrant, abstract graphic. It features a central bright white light source from which numerous colorful rays emanate, creating a sunburst or starburst effect. The rays transition through a spectrum of colors: yellow, orange, red, pink, purple, blue, and green. Overlaid on this are large, soft, wavy shapes in shades of orange, red, and yellow, giving the impression of clouds or flowing liquid. The overall composition is dynamic and energetic.

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The bridge to possible

Model-Driven Programmability

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BRKDCN-2604

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Agenda

- Model-driven programmability overview
- The building blocks of programmability on NX-OS
- Live demo

Why Model-Driven Programmability?



Why Model-Driven Programmability?

I can't remotely access some configuration elements...

I want to compare data with other devices...

My data transport is not secure...



It's difficult to structure the data I have...

My data transport is not efficient...

The configuration tools I have don't scale well...

Why Model-Driven Programmability?

Model-driven methods save the day!



What Is Model-Driven Programmability?



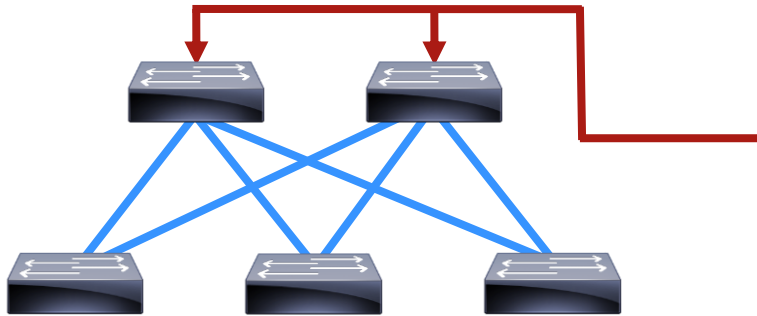
What is Model-Driven Programmability?



Real-time data collection or configuration of network devices using common models and protocols



Example: For every spine switch, set the CDP hold time to 90 seconds



Model-Driven Programmability Advantages



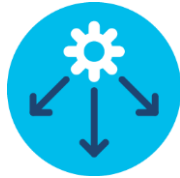
Model-Driven Programmability Advantages



Scalability



Performance



Zero-Touch
Provisioning



Detailed
Information

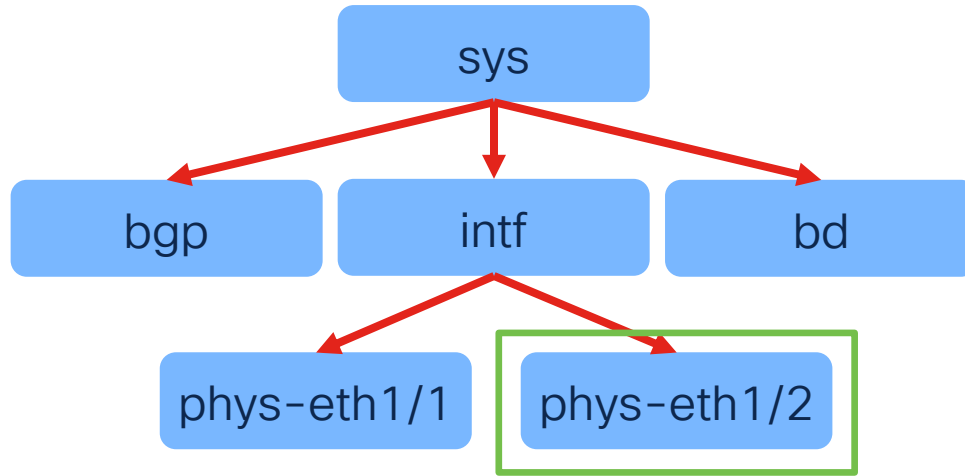


Building Blocks of NX-OS Programmability

• **Data Storage**

- Data Models
- Data Transport
- Zero-Touch Provisioning

Data Storage



- Configuration and operational data is stored in DME
- Tree structure
- .../.../.../... formatting

- sys/intf/phys-eth1/2 represents interface 2
- Stores interface configuration and state

Data Storage

<u>11PhysIf</u>	
FECMode	auto
accessVlan	vlan-1
adminSt	up
autoNeg	on
beacon	off
bw	default
childAction	
controllerId	
delay	1
descr	
dfeAdaptiveTuning	enable
dfeTuningDelay	100
dn	sys/intf/phys-[eth1/33] < > III ! H
dot1qEtherType	0x8100
duplex	auto

- Browse through DME with Visore
- e.g. <https://<SwitchIP>/visore.html>



Building Blocks of NX-OS Programmability

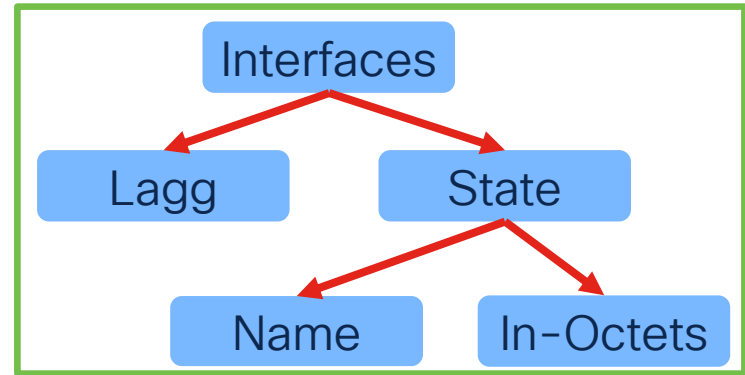
- Data Storage
- **Data Models**
- Data Transport
- Zero-Touch Provisioning

Data Models

- YANG (Yet Another Next Generation) is a data modeling language
- Defines the data structure and data type for the model we use



Data Structure

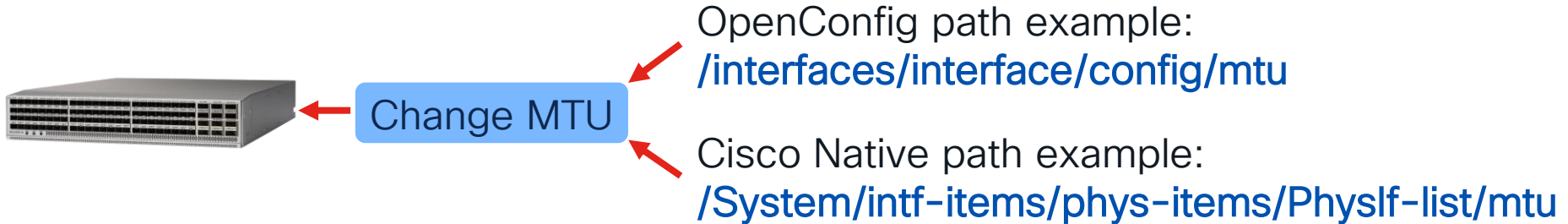


Data Type



Data Models

- NX-OS supports two YANG models for programmability
 - OpenConfig model (open-source model)
 - Cisco Native model
- Configuration elements can be accessed with a YANG model path



Data Models



Cisco Native Model

- Vendor specific
- Created by Cisco
- Supports almost every feature on NX-OS



OpenConfig Model

- Vendor agnostic
- Created by many networking companies (open-source)
- Does not support every feature on NX-OS



Data Models

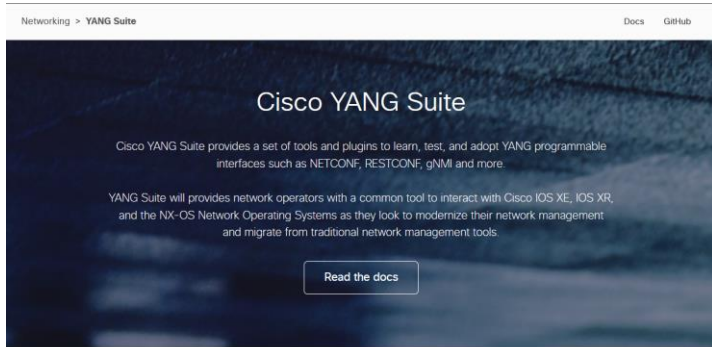


- openconfig-bgp.yang
- openconfig-evpn-types.yang
- openconfig-evpn.yang
- openconfig-extensions.yang
- openconfig-if-aggregate.yang
- openconfig-if-ethernet.yang
- openconfig-if-ip-ext.yang
- openconfig-if-ip.yang
- openconfig-if-types.yang
- openconfig-igmp-types.yang
- openconfig-igmp.yang
- openconfig-inet-types.yang
- openconfig-interfaces.yang
- openconfig-isis-lsdb-types.yang
- openconfig-isis-lsp.yang
- openconfig-isis-policy.yang

- 100+ OpenConfig modules supported
- Be aware that all paths in a module may not be supported
- These deviations happen with all vendors

Ref. - <https://github.com/YangModels/yang/tree/main/vendor/cisco/nx>

Data Models

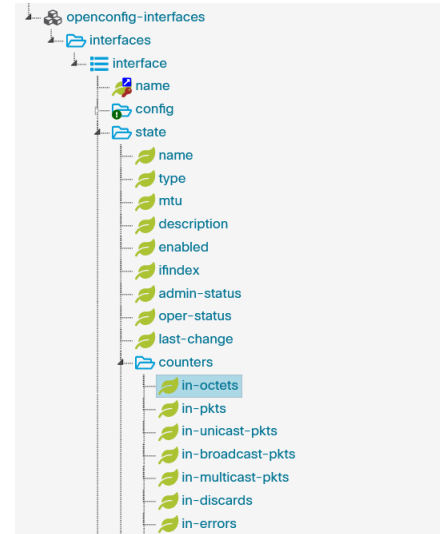


YANG Suite In Your Network

Network automation and programmability capabilities include browsing YANG modules in a graphical interface, creating RPC payload messages to interact with devices, and a gRPC Dial-Out model driven telemetry collector for streaming telemetry. The user-interface is updated with HTML5 and provides flexible deployment options with Docker containers.



- YANG Suite is a tool for programmability models
- Includes YANG browser for both models



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

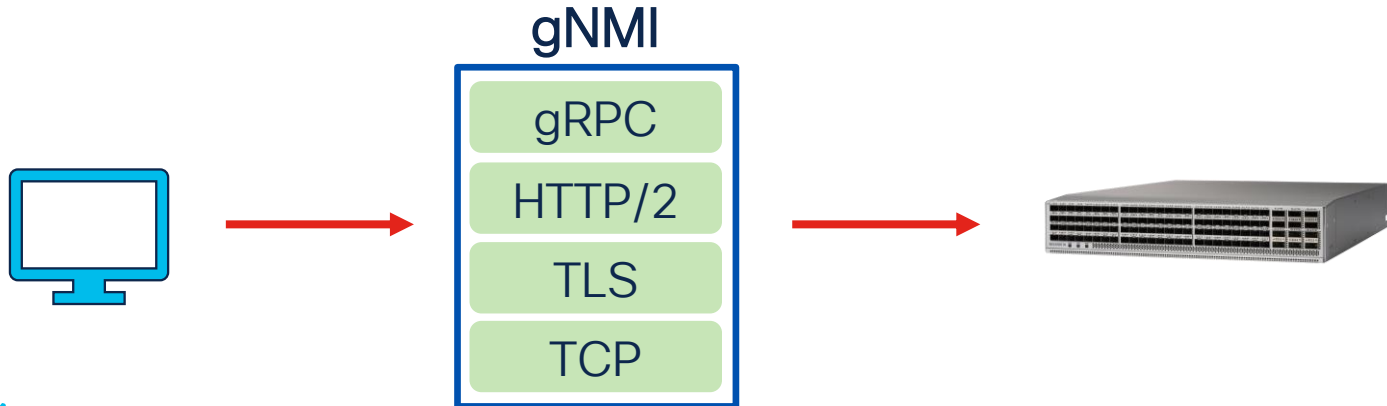


Building Blocks of NX-OS Programmability

- Data Storage
- Data Models
- **Data Transport**
- Zero-Touch Provisioning

Data Transport

- gRPC Network Management Interface (gNMI) is a protocol for managing network devices
- gNMI is an alternative to NETCONF and RESTCONF
- Enables multiplexing over a single channel



Data Transport

gNMI Features



Capabilities

Collect capabilities from device



Get

Collect current data values from device



Set

Modify data on the device



Subscribe

Subscribe to a data stream for a path in the data model

Data Transport

gNMI on NX-OS

RPC

- gNMI fully supported from NX-OS 9.3.5

Security

- gNMI leverages TLS
- Mutual TLS supported

Data Encoding

- Native and OpenConfig models supported
- Supports Google Protobuf and JSON as encoding
- Wild card supported from NX-OS 10.2.2



Building Blocks of NX-OS Programmability

- Data Storage
- Data Models
- Data Transport
- **Zero-Touch Provisioning**

Zero-Touch Provisioning

- We can combine programmability with POAP
 - Securely deploy with POAP
 - Securely manage with gNMI



Zero-Touch Provisioning - POAP

- Starting in NX-OS 10.2.3, POAP can be secured with HTTPS
- Cisco device with a SUDI (Secure Unique Device Identifier) required

①

DHCP offer with
SUDI server and
script name



②

Switch verifies
SUDI server
certificate



③

SUDI server
verifies switch
certificate



④

Setup script
downloaded
over secure
channel



Zero-Touch Provisioning - gNMI

- Programmability server will be waiting for POAP to finish
- Finish the advanced configuration with gNMI

1

Server waits for
switch to be
ready



2

Server connects
to gRPC agent
on switch



3

Server pushes
config with
YANG model





Demo

Demo Keypoints – Switch Configuration

Secure POAP

Uplink setup with OpenConfig

Uplink setup with Cisco Native

Key Takeaways



Scalability



Structured Data



Zero-Touch
Provisioning



Test YANG Suite



Detailed Telemetry

References

- POAP setup script

<https://github.com/datacenter/nexus9000/blob/master/nx-os/poap/poap.py>

- Supported OpenConfig models

<https://github.com/YangModels/yang/tree/main/vendor/cisco/nx>

- Cisco YANG Suite

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

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Thank you

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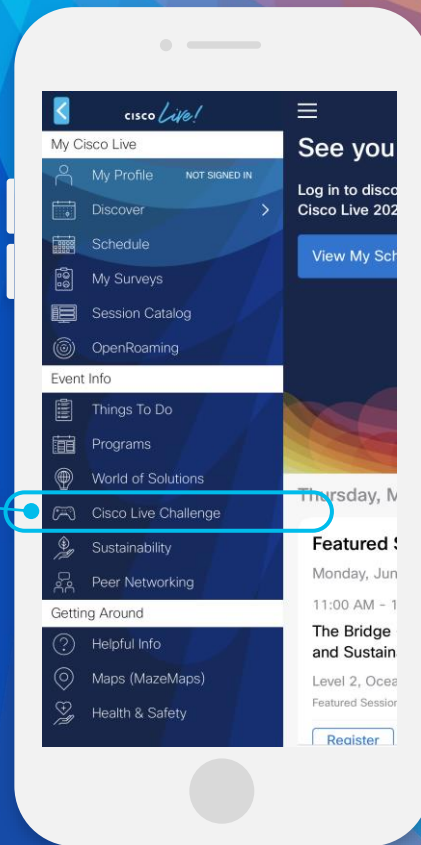
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