Automating Cisco IOS XR Configuration with Unified Data Models

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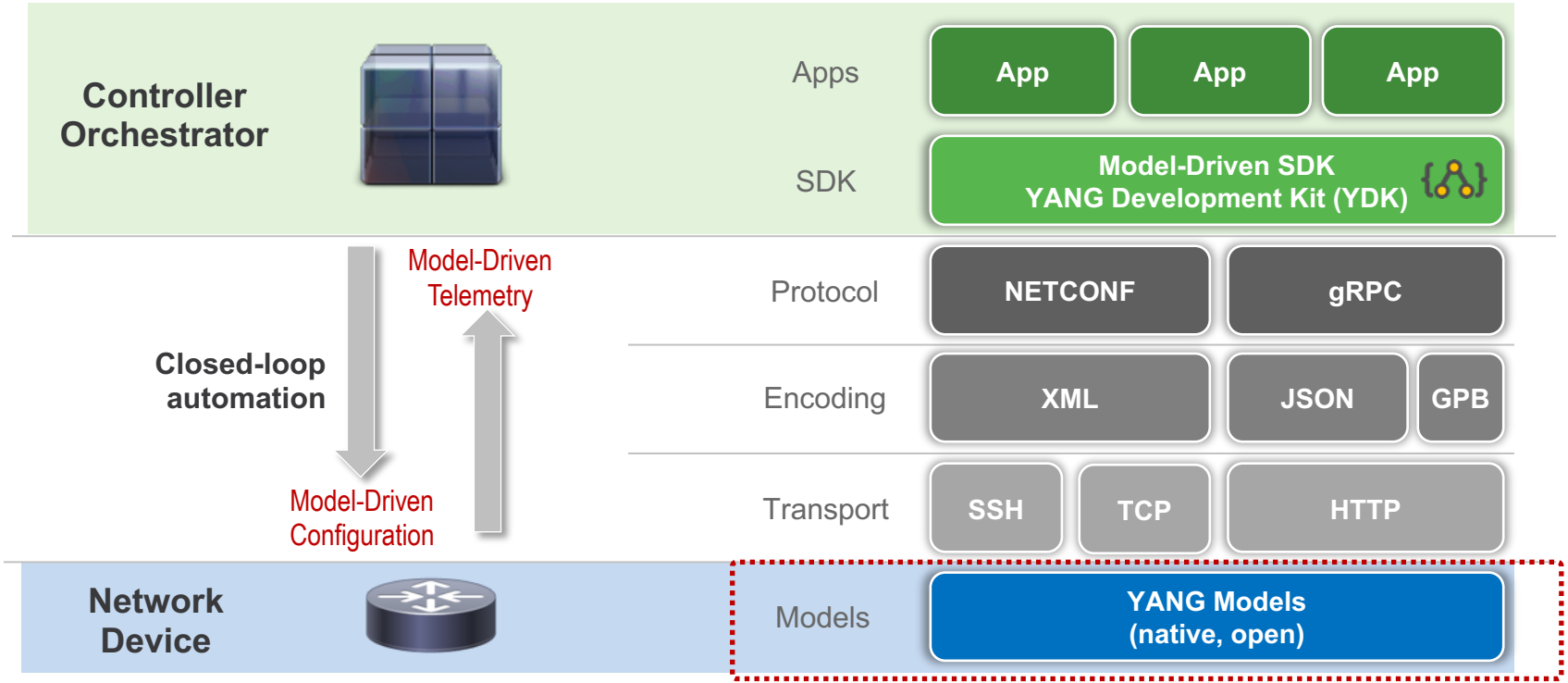
Model-Driven Manageability



Alternatives for Configuration Data Models in IOS XR

XR Native

Unified

- XR or platform specific
- Full coverage of device functionality
- Single abstraction for YANG and CLI
- Full parity and deterministic coverage
- Same help/doc strings
- Expected to be current

Non-Unified

- XR or platform specific
- Full coverage of device functionality
- Different abstractions for YANG and CLI
- Independent testing of parity and coverage
- Expected to be obsoleted

Open

OpenConfig

- Vendor neutral
- Partial coverage of device functionality
- Different abstraction from native model and CLI

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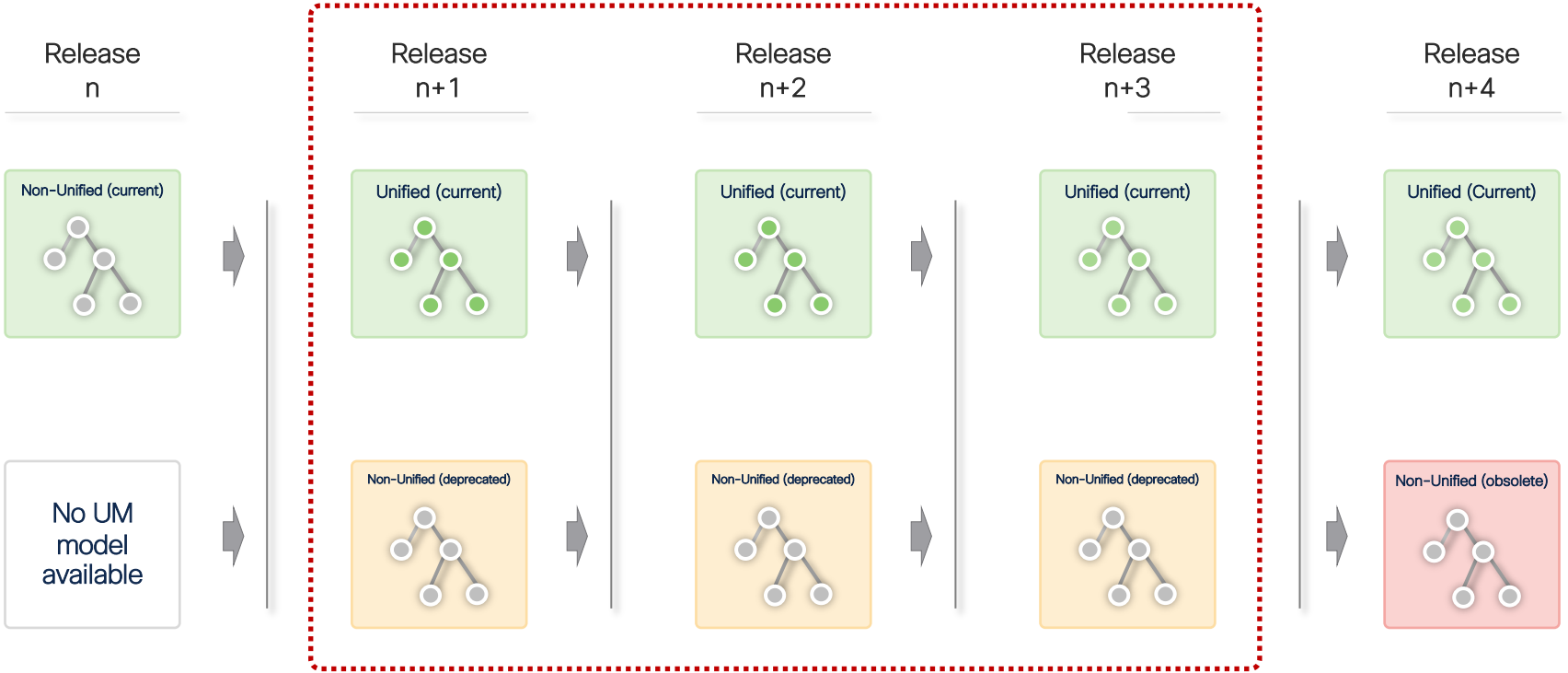
Unified Configuration Models

7.0.1	7.1.1	7.2.1
Interfaces Bundles ARP LACP VRF Static routing RIB MPLS (LDP, LSD, L3VPN) Telemetry NETCONF gRPC SNMP	BGP ISIS OSPF (v2/v3) MPLS (TE) RSVP	QoS ACL (IPv4, IPv6, Ethernet, prefix list, object group) Multicast (AMT, IGMP, MLD, MSDP, PIM)

Status Evolution For Non-Unified Models



Status defined in RFC 6020, section-7.19.2

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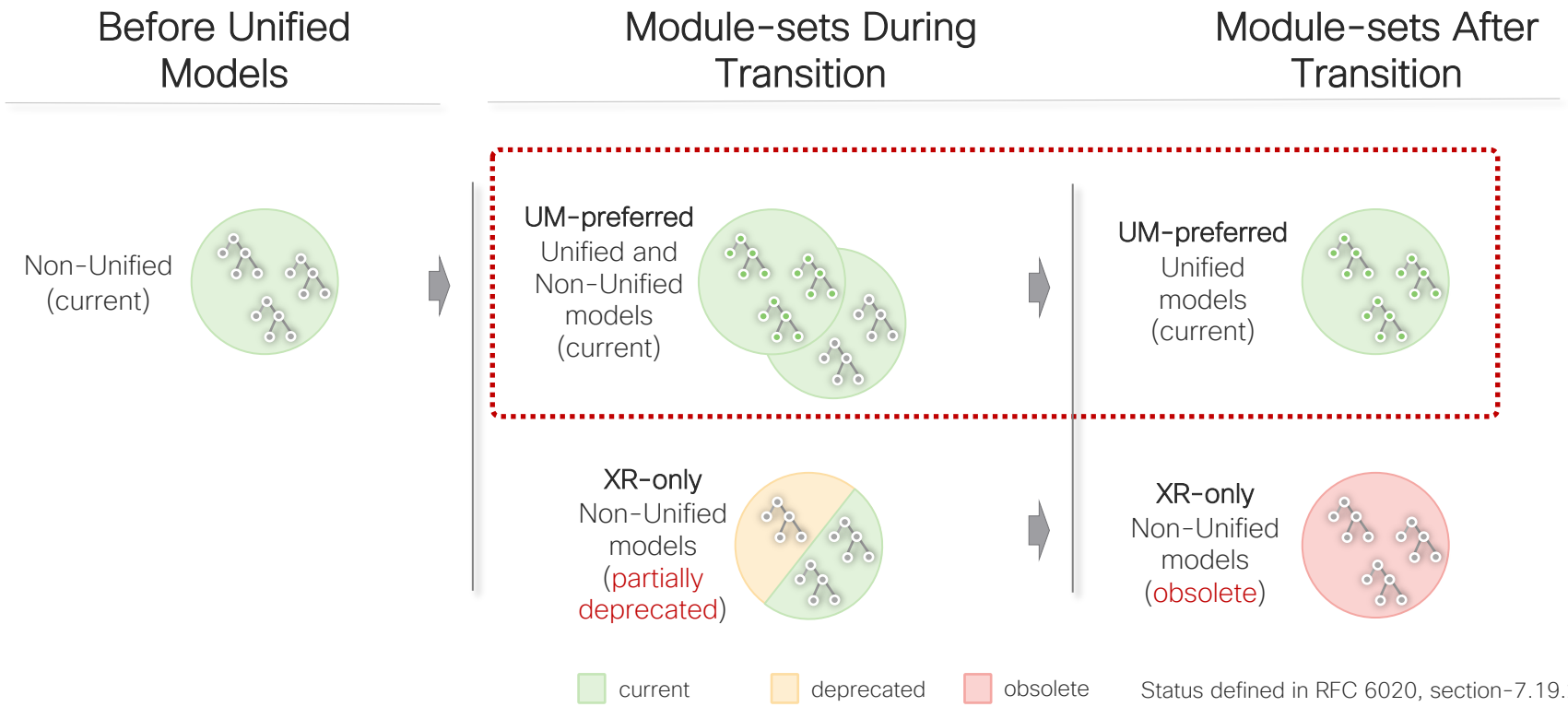
Client Development Guidelines For Configuration Models

- Unified model should always be considered preferred for new development if model available
- No new development should take place against obsoleted models
- Deprecated models advertised in device capabilities
- Obsoleted models NOT advertised in device capabilities
- Best practice: Manage an XR device with a single set of consistent models (module-set) as specified in IETF YANG library model

What Models Should Be Used to Configure Device?

- XR devices arrange models in module-sets which provide complete device coverage and include all dependencies
- Three module-sets introduced in IOS XR:
  - **UM-preferred** - All unified and current non-unified models
  - **XR-only** - Current and deprecated non-unified models
  - **All** - All models supported by device
- One model may be present in multiple module-sets
- No separate module-set for OpenConfig
- OpenConfig models easily identified by namespace in “All” module-set
- Module-sets stored in IETF YANG library model (module-set list at yanglib:yang-library/module-set)

Module-Set Evolution



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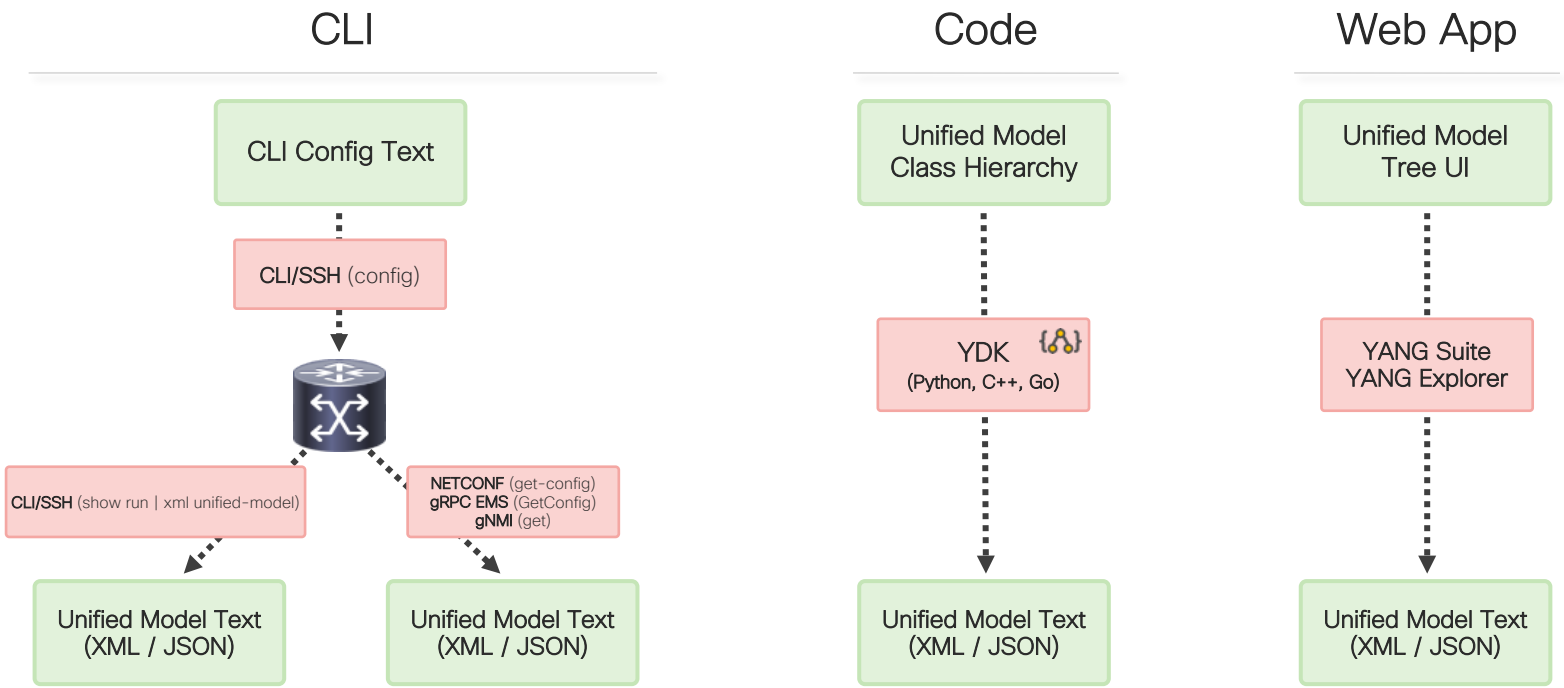
How to Create a Unified Model Configuration



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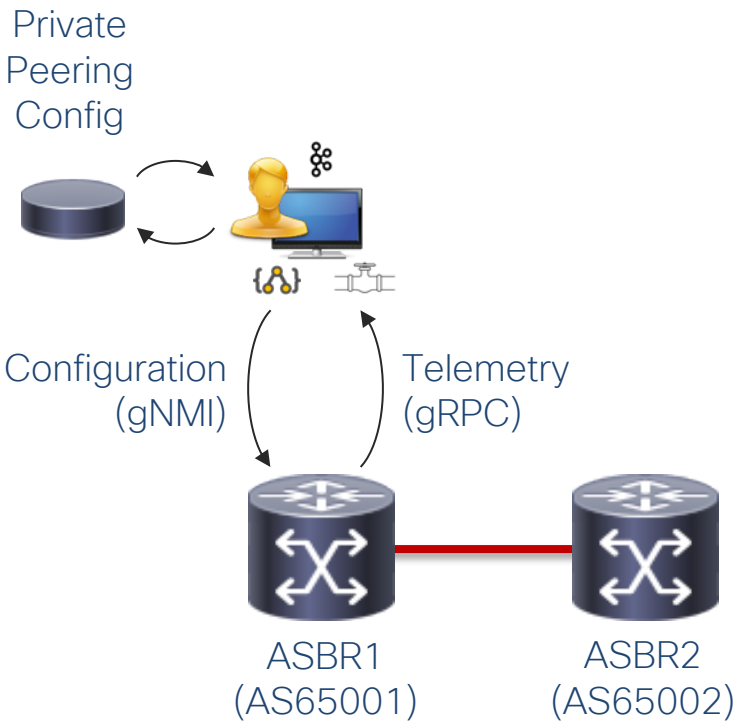
Demo

Peering Use Case
Configure and Validate Peering on ASBR1

- Load peer configuration
- Configure interface and validate operation
- Configure BGP neighbor and validate operation
- All validation against **actual operational state**



https://github.com/111pontes/xr-um

Resources

Resources

Model-driven programmability @ Cloud-Scale Networking

- Model-Driven Programmability (http://goo.gl/x3GZDB)

Programmability @ XR Docs

- Tutorials (https://xrdocs.github.io/programmability/tutorials)
- Blogs (https://xrdocs.github.io/programmability/blogs)

Configuration guide

- Cisco IOS XR programmability configuration guide for ASR 9000 series router (http://goo.gl/8dYUeK)
- Cisco IOS XR programmability configuration guide for NCS 5500 series router (http://goo.gl/cnYPw7)

Resources

YDK Portal

- YDK at DevNet (http://ydk.io)

YDK Sample Apps

- YDK-Py sample apps (https://github.com/CiscoDevNet/ydk-py-samples) - Over 700 apps!

Sandboxes

- dCloud YANG Development Kit sandbox (https://goo.gl/kaYJ3R)
- Ubuntu YDK Vagrant box (https://git.io/vaw1U)
- Docker YDK-Py (https://hub.docker.com/r/ydkdev/ydk-py)

Support

- Cisco support community (https://communities.cisco.com/community/developer/ydk)

Resources (cont.)

YDK Documentation

- YDK-Py docs (http://ydk.cisco.com/py/docs)
- YDK-Go docs (http://ydk.cisco.com/go/docs)
- YDK-Cpp docs (http://ydk.cisco.com/cpp/docs)

GitHub

- YDK Python SDK – YDK-Py (https://github.com/CiscoDevNet/ydk-py)
- YDK Go SDK – YDK-Cpp (https://github.com/CiscoDevNet/ydk-go)
- YDK C++ SDK – YDK-Cpp (https://github.com/CiscoDevNet/ydk-cpp)
- YDK-Py sample apps (https://github.com/CiscoDevNet/ydk-py-samples) - Over 700 apps!

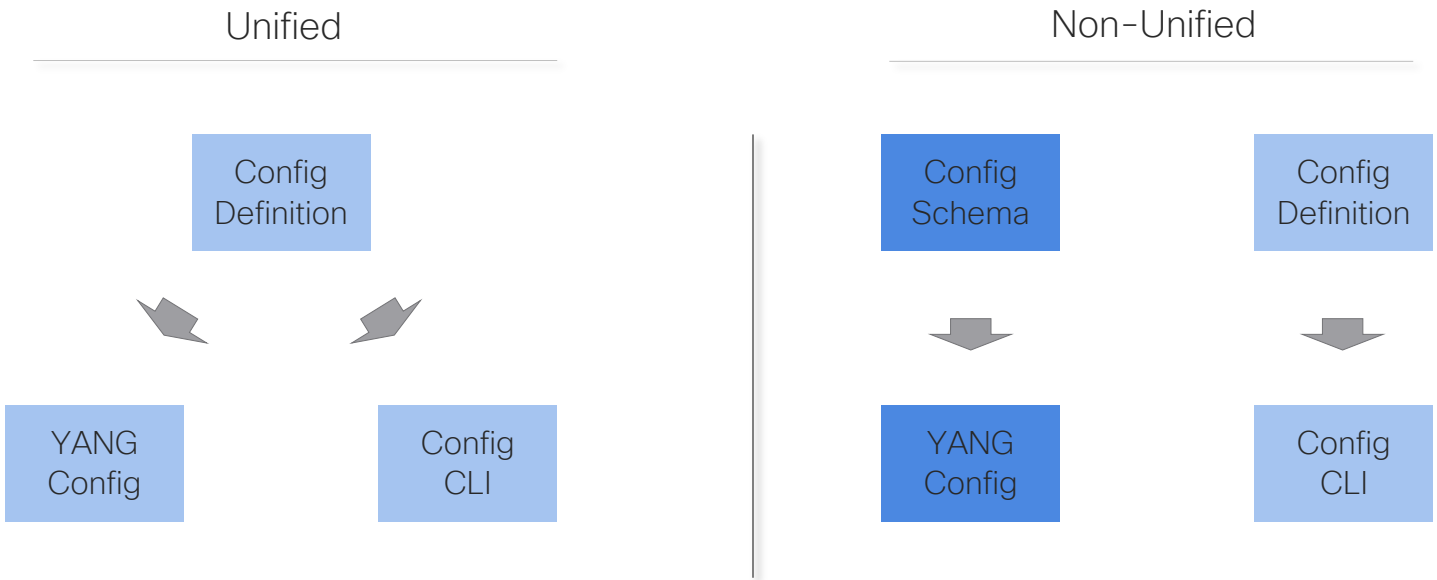
Resources (cont.)

Conferences

- MPLS+SDN+NFV World Congress 2018: Getting started with OpenConfig (http://youtu.be/B43PRZV-CD8)
- NANOG 68: Ok, We Got YANG Data Models. Now What? (http://youtu.be/2oqkiZ83vAA)
- NANOG 71: Getting started with OpenConfig (https://youtu.be/L7trUNK8NJI)
- LinuxCon NA 2016: Simplifying Network Programmability Using Model-Driven APIs (https://goo.gl/W6tH2X)
- Tech Field Day: gNMI Programmatic Configuration (http://youtu.be/8zAebRr6Pg4)

Backup

XR Native Configuration



Unified Configuration Models (Phase 1) - 1/6

	Unified Model	CLI Root	Non-Unified Model (Deprecated)
Interfaces	Cisco-IOS-XR-um-interface-cfg	interface	Cisco-IOS-XR-ifmgr-cfg
	Cisco-IOS-XR-um-ip-address-cfg	interface ipv4 interface ipv6	Cisco-IOS-XR-ipv4-io-cfg Cisco-IOS-XR-ipv6-ma-cfg
	Cisco-IOS-XR-um-if-ethernet-cfg	interface ethernet	Cisco-IOS-XR-drivers-media-eth-cfg
	Cisco-IOS-XR-um-if-tunnel-cfg	interface tunnel	Cisco-IOS-XR-tunnel-gre-cfg
	Cisco-IOS-XR-um-if-mpls	interface mpls	Cisco-IOS-XR-mpls-io-cfg
Bundles	Cisco-IOS-XR-um-if-bundle-cfg	interface bundle	Cisco-IOS-XR-bundlemgr-cfg
	Cisco-IOS-XR-um-lacp-cfg	lacp	Cisco-IOS-XR-bundlemgr-cfg

Unified Configuration Models (Phase 1) - 2/6

	Unified Model	CLI Root	Non-Unified Model (Deprecated)
ACL	Cisco-IOS-XR-um-ipv4-access-list-cfg	ipv4 access-list	Cisco-IOS-XR-ipv4-acl-cfg Cisco-IOS-XR-ipv4-ace-cfg
	Cisco-IOS-XR-um-ipv6-access-list-cfg	ipv6 access-list	Cisco-IOS-XR-ipv6-acl-cfg Cisco-IOS-XR-ipv6-ace-cfg
	Cisco-IOS-XR-um-ethernet-services-access-list-cfg	ethernet-services access-list	Cisco-IOS-XR-es-acl-cfg Cisco-IOS-XR-es-ace-cfg
	Cisco-IOS-XR-um-if-access-group-cfg	interface access-group	Cisco-IOS-XR-ip-filter-cfg
	Cisco-IOS-XR-um-ipv4-prefix-list-cfg	ipv4 prefix-list	Cisco-IOS-XR-ipv4-acl-cfg
	Cisco-IOS-XR-um-ipv6-prefix-list-cfg	ipv6 prefix-list	Cisco-IOS-XR-ipv6-acl-cfg
	Clsco-IOS-XR-um-object-group-cfg	object-group	Cisco-IOS-XR-infra-objmgr-cfg

Unified Configuration Models (Phase 1) - 3/6

	Unified Model	CLI Root	Non-Unified Model (Deprecated)
ARP	Cisco-IOS-XR-um-arp-cfg	arp	Cisco-IOS-XR-ipv4-arp-cfg
VRF	Cisco-IOS-XR-um-vrf-cfg	vrf interface vrf	Cisco-IOS-XR-infra-rsi-cfg
Static Routing	Cisco-IOS-XR-um-router-static-cfg	router static	Cisco-IOS-XR-ip-static-cfg
IS-IS	Cisco-IOS-XR-um-router-isis-cfg	router isis	Cisco-IOS-XR-clns-isis-cfg
OSPF	Cisco-IOS-XR-um-router-ospf-cfg	router ospf	Cisco-IOS-XR-ipv4-ospf-cfg
	Cisco-IOS-XR-um-router-ospfv3-cfg	router ospfv3	Cisco-IOS-XR-ipv6-ospfv3-cfg
BGP	Cisco-IOS-XR-um-router-bgp-cfg	router bgp	Cisco-IOS-XR-ipv4-bgp-cfg

Unified Configuration Models (Phase 1) - 4/6

	Unified Model	CLI Root	Non-Unified Model (Deprecated)
RIB	Cisco-IOS-XR-um-router-rib-cfg	router rib	Cisco-IOS-XR-ip-rib-cfg
MPLS	Cisco-IOS-XR-um-mpls-te-cfg	mpls traffic-eng	Cisco-IOS-XR-mpls-te-cfg
	Cisco-IOS-XR-um-mpls-ldp-cfg	mpls ldp	Cisco-IOS-XR-mpls-ldp-cfg
	Cisco-IOS-XR-um-mpls-lsd-cfg	mpls lsd	Cisco-IOS-XR-mpls-lsd-cfg
	Cisco-IOS-XR-um-mpls-l3vpn-cfg	snmp-server traps mpls	Cisco-IOS-XR-mpls-vpn-cfg
RSVP	Cisco-IOS-XR-um-rsvp-cfg	rsvp	Cisco-IOS-XR-ip-rsvp-cfg

Unified Configuration Models (Phase 1) - 5/6

	Unified Model	CLI Root	Non-Unified Model (Deprecated)
QoS	Cisco-IOS-XR-um-policymap-classmap-cfg	class-map policy-map	Cisco-IOS-XR-infra-policymgr-cfg
	Cisco-IOS-XR-um-if-service-policy-qos-cfg	interface service-policy	Cisco-IOS-XR-qos-ma-cfg
SNMP	Cisco-IOS-XR-um-snmp-server-cfg	snmp server	Cisco-IOS-XR-snmp-agent-cfg
NETCONF	Cisco-IOS-XR-um-netconf-yang-cfg	netconf-yang agent	Cisco-IOS-XR-netconf-yang-cfg
gRPC	Cisco-IOS-XR-um-grpc-cfg	grpc	Cisco-IOS-XR-man-ems-cfg
Telemetry	Cisco-IOS-XR-um-telemetry-model-driven-cfg	telemetry model-driven	Cisco-IOS-XR-telemetry-model-driven-cfg

Unified Configuration Models (Phase 1) - 6/6

	Unified Model	CLI Root	Non-Unified Model (Deprecated)
Multicast	Cisco-IOS-XR-um-router-pim-cfg	router pim	Cisco-IOS-XR-ipv4-pim-cfg
	Cisco-IOS-XR-um-router-igmp-cfg	router igmp	Cisco-IOS-XR-ipv4-igmp-cfg
	Cisco-IOS-XR-um-router-msdp-cfg	router msdp	Cisco-IOS-XR-ipv4-msdp-cfg
	Cisco-IOS-XR-um-router-amt-cfg	router amt	N/A
	Cisco-IOS-XR-um-router-mld-cfg	router mld	N/A

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Evolution of Non-Unified Models in IOS XR

- Non-unified models published as current if no corresponding unified model exists
- Non-unified models published as deprecated if corresponding unified model exist
- Deprecated non-unified model will coexist with unified model for three major releases
- Non-unified model published as obsolete after three major releases being deprecated

Status Definitions from RFC 6020 section-7.19.2

- "current" means that the definition is current and valid
- "deprecated" indicates an obsolete definition, but it permits new/continued implementation in order to foster interoperability with older/existing implementations
- "obsolete" means the definition is obsolete and SHOULD NOT be implemented and/or can be removed from implementations

On-Box CLI-to-XML Config Conversion XML Utility

Show config as Unified Model YANG XML tree

```
RP/0/RP0/CPU0:r1#sh run | xml unified-model
```

Show configuration as YANG XML tree (Non-Unified model)

```
RP/0/RP0/CPU0:r1#sh run | xml
```

Show config as OpenConfig YANG XML tree

```
RP/0/RP0/CPU0:r1#sh run | xml openconfig
```

XML Utility
Granular Configuration Conversion

- Conversion can be invoked at any CLI top level (e.g. interface, router bgp, etc.)
- Conversion not currently supported at arbitrary granular levels (e.g. single command)

Show interface config as Unified Model YANG XML tree

```
RP/0/RP0/CPU0:r1#sh run interface | xml unified-model
```

Show BGP config as OpenConfig YANG XML tree

```
RP/0/RP0/CPU0:r1#sh run router bgp | xml openconfig
```

Open Source Tool Chain

YDK

(ydk.io)

- Python/C++/Go bindings for OpenConfig models
- Detailed client-side data validation
- Protocol / transport / encoding abstraction

Pipeline

(git.io/vdnnT)

- Collector for router streaming telemetry
- Performs basic encoding transformation
- Data producer for Kafka, InfluxDB, Prometheus, etc.

Kafka

(kafka.apache.org)

- Distributed streaming platform (message bus)
- Producer, consumer, stream and connector APIs
- Rich client support (Python, Java, etc)


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