
cisco Live!
ALL IN

The bridge to possible

Streaming Telemetry on Cisco NX-OS

Shangxin Du
Technical Marketing Engineer, Cloud Networking
BRKDCN-2991

Cisco Webex App

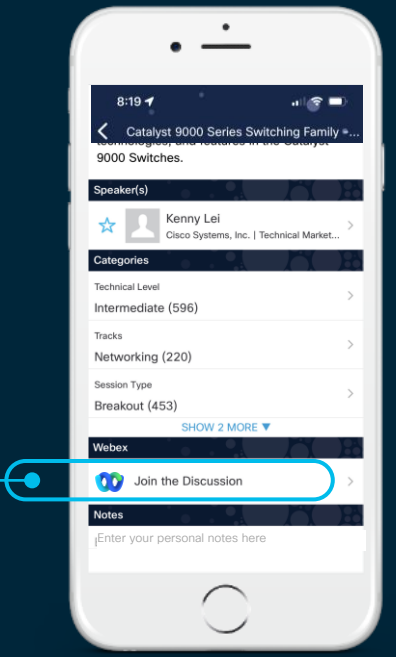
Questions?

Use Cisco Webex App to chat
with the speaker after the session

How

1. Find this session in the Cisco Live Mobile App
2. Click “Join the Discussion”
3. Install the Webex App or go directly to the Webex space
4. Enter messages/questions in the Webex space

Webex spaces will be moderated by the speaker until June 17, 2022.



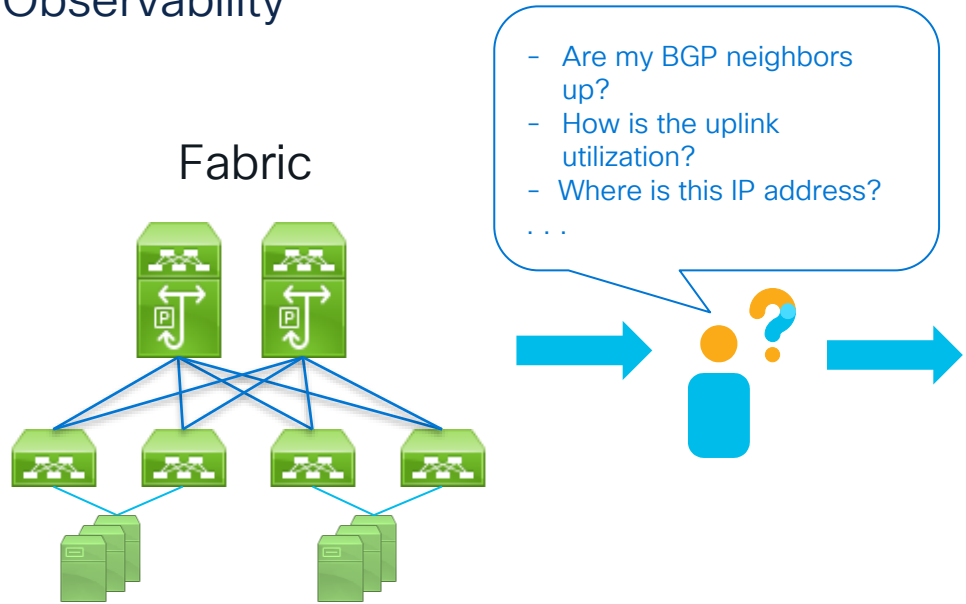
https://ciscolive.ciscoevents.com/ciscolivebot/#BRKDCN-2991

Agenda

- Why do we need streaming telemetry?
- Telemetry data sources, subscription modes, and encodings
- Transport options and design consideration
- How to build telemetry system with opensource tools

Why do we need streaming telemetry

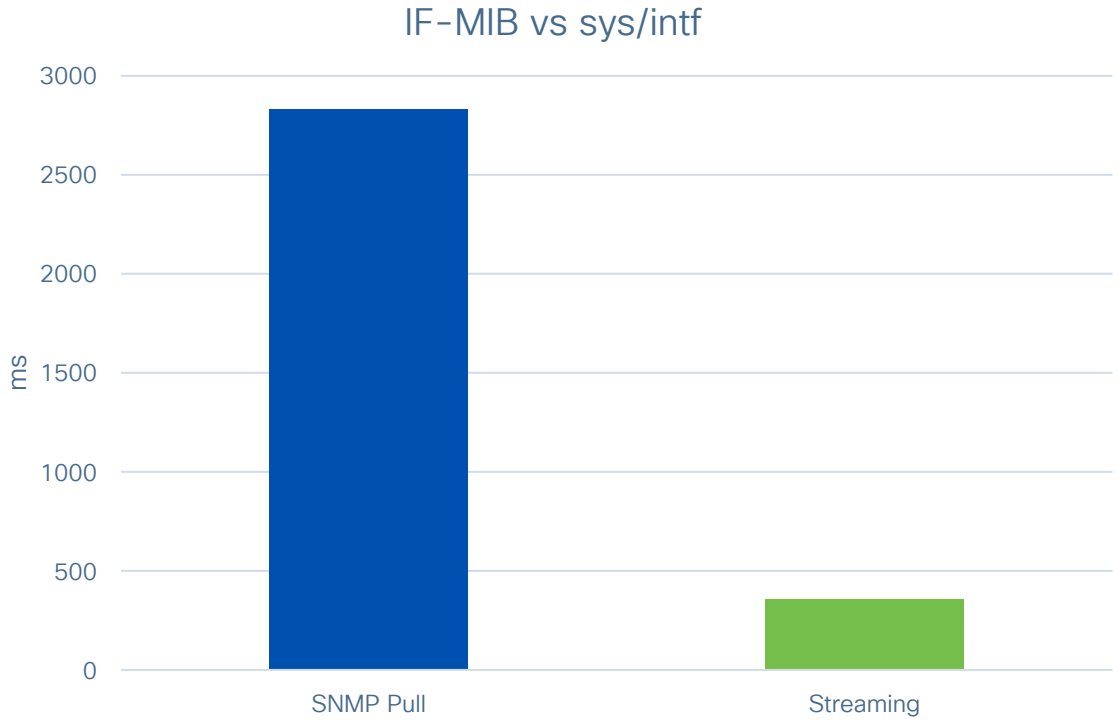
Observability



- What information shall I collect?
- How do I collect those metrics?
- What can I do with those data?

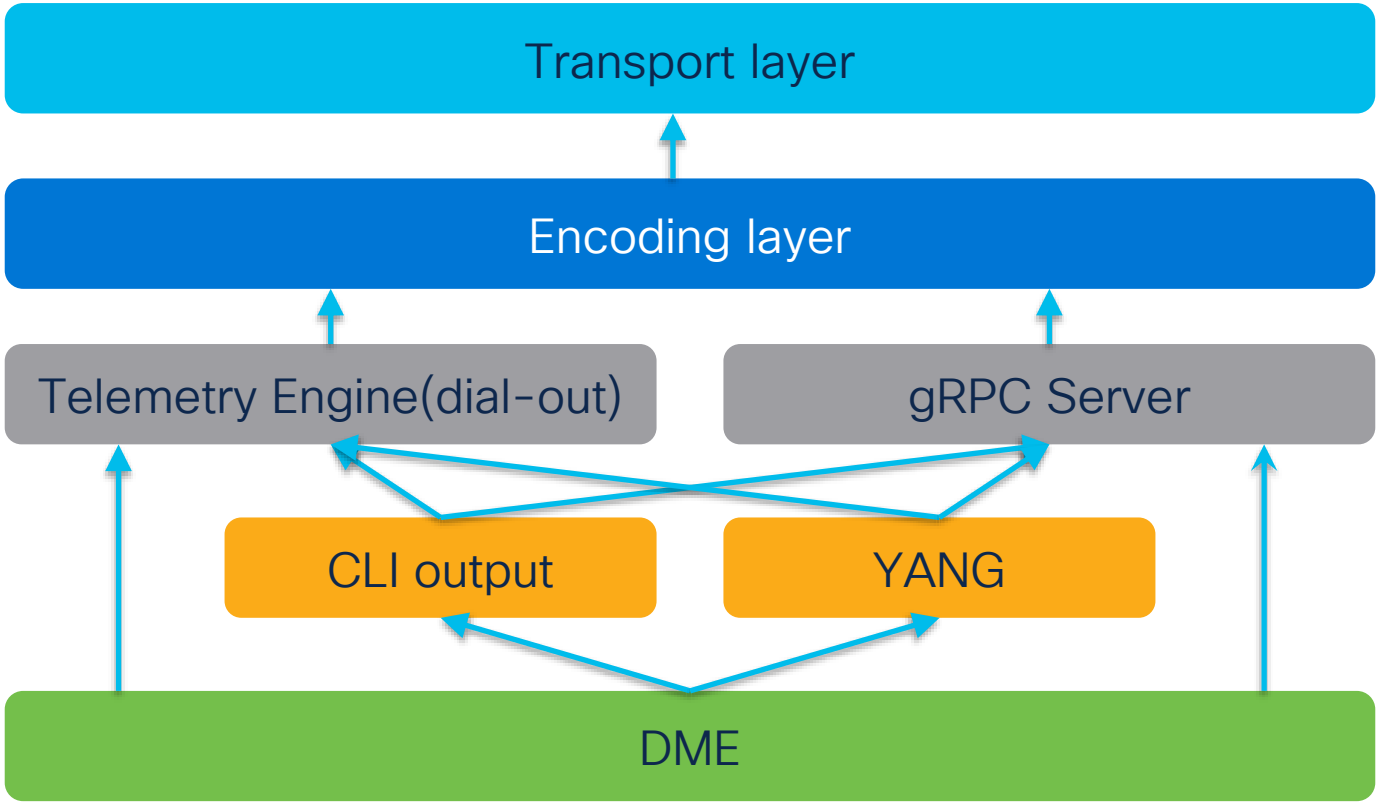
Why do we need streaming telemetry

Performance

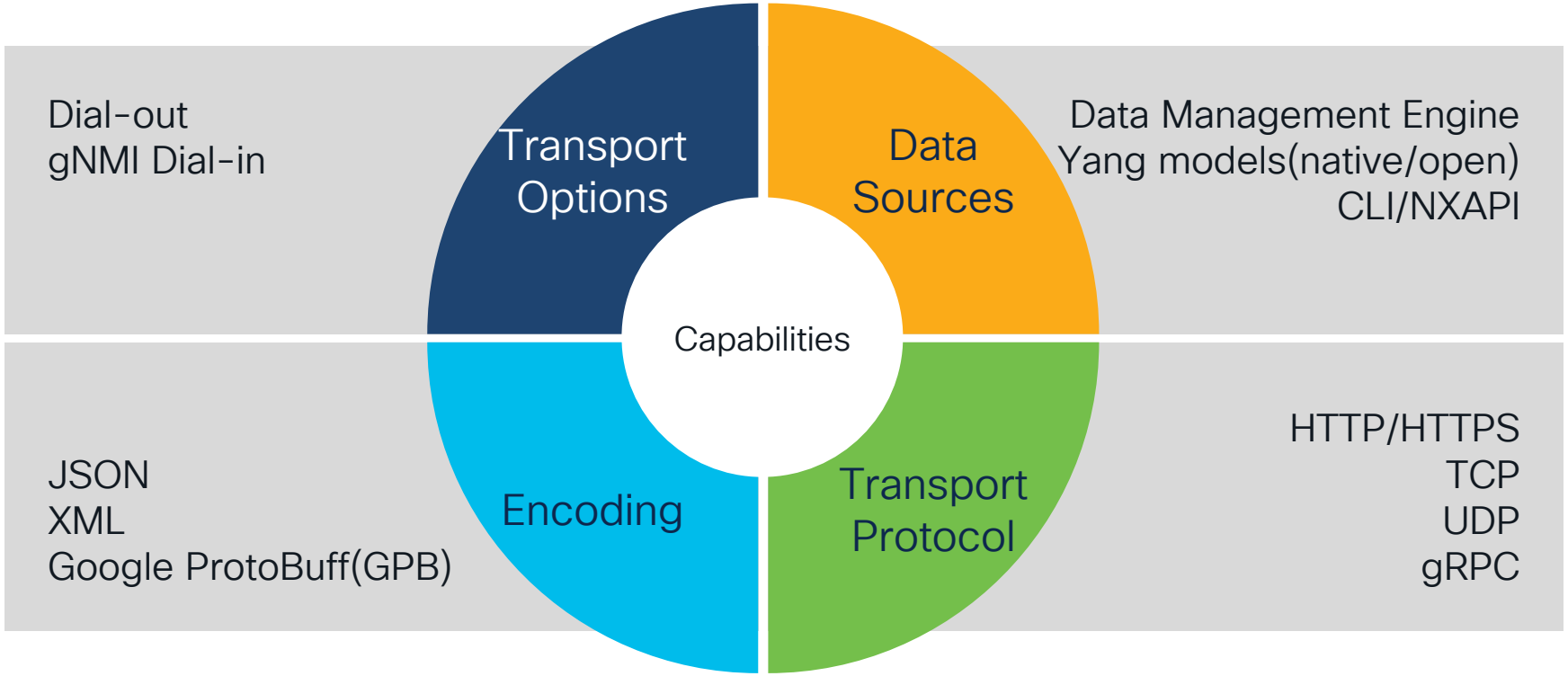


- SNMP bulk-get `IF-MIB`
- Streaming DME sensor path `sys/intf`

NX-OS telemetry architecture



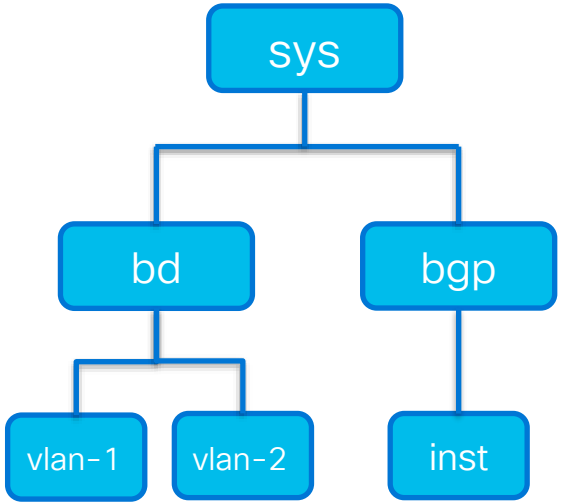
NX-OS telemetry architecture -Capabilities



Data Sources

Data Source

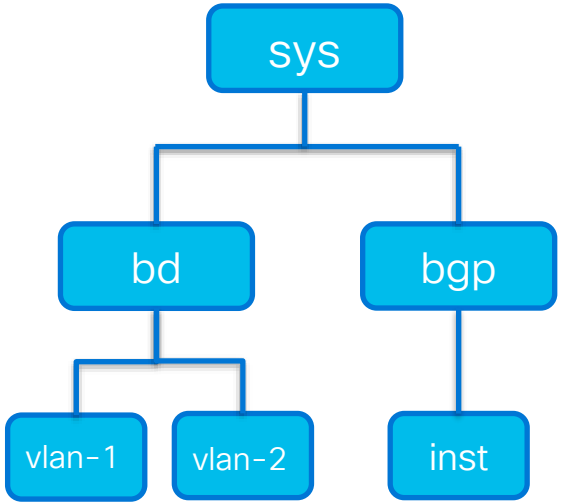
DME



- Tree data structure
- The root of the tree is `sys`
- DN(Distinguished Name) is in ../../.. Format
  - Ex, sys/bgp/inst is representing the bgp instance on switch, it contains all config and state of bgp process
- When streaming telemetry, use DN as a sensor path

Data Source

What is available in DME?



- Almost everything
  - As 10.2(2)F, 90% of command is DMElized
  - Configuration data and Operational data
- Support event-based and sample-based telemetry
- The extra filter is supported to minimize the data size

Data Source

How to get sensor path of DME

Visore is built-in DME browser of NX-OS, navigate to https://[ip_of_swtich]/visore.html

rmonIfIn	?
broadcastPkts	199779
clearTs	never
discards	0
dn	sys/intf/phys-[eth1/27]/dbgIfIn
errors	0
modTs	2022-03-28T16:45:11.658+00:00
multicastPkts	345290
nUcastPkts	545069
noBuffer	0
octetRate	3657496
octets	11346525403646
packetRate	3438
rateInterval	300
ucastPkts	3777158007
unknownEtype	0
unknownProtos	0

API reference is also available: https://developer.cisco.com/site/nxapi-dme-model-reference-api/?version=10.2(2)

rmon:IfHCIn

The interface high capacity input statistics.

Telemetry Sensor Path(s)

- sys/mgmt-[id]/dbgIfHCIn
- sys/intf/phys-[id]/dbgIfHCIn
- sys/intf/aggr-[id]/dbgIfHCIn

Operational Properties

PROPERTY NAME	DATA TYPE	DESCRIPTION	POSSIBLE VALUES
broadcastPkts	scalar:Uint64	Broadcast Packets	RANGE: [0, 18446744073709551615]
multicastPkts	scalar:Uint64	Multicast Packets	RANGE: [0, 18446744073709551615]
octets	scalar:Uint64	Octets	RANGE: [0, 18446744073709551615]
ucastPkts	scalar:Uint64	Unicast Packets	RANGE: [0, 18446744073709551615]

Data Source

Yang

- Yang(Yet Another Next Generation) is a data modeling language used to describe the data sent over the network
- NX-OS supports two different types of yang model
  - Openconfig yang model is vendor agnostic
  - Native/Device yang is the vendor-specific yang model

Example of xpath:

```
openconfig-interfaces:interfaces/interface/state/oper-status
```

model name
container
list
leaf

Data Source

Supported OC Yang model

model	Revision in 10.2(2)F
openconfig-aaa.yang	2019-10-28
openconfig-acl.yang	2019-11-27
openconfig-bfd.yang	2020-05-08
openconfig-bgp.yang	2019-07-10
openconfig-igmp.yang	2019-07-09
openconfig-interfaces.yang	2019-11-19
openconfig-isis.yang	2020-03-24
openconfig-lacp.yang	2018-11-21
openconfig-lldp.yang	2018-11-21
openconfig-mpls.yang	2019-03-26
openconfig-network-instance.yang	2020-06-20
openconfig-ospfv2.yang	2019-11-28
openconfig-pim.yang	2019-07-09
openconfig-platform.yang	2019-04-16
openconfig-qos.yang	2019-11-28
openconfig-routing-policy.yang	2018-11-21
openconfig-system.yang	2020-03-25

- To support OC yang
  - Before 10.2(2)F, `mtx-openconfig-all` rpm needs to be installed on the streaming switch, refer to the programmability guide to install the package
  - After 10.2(2)F, use `feature opeconfig` to enable
- Beware of deviation, the model is supported doesn't mean all the paths are supported
  - Like all other vendors, the deviation is created when a certain path is not following the definition in OC models, or the path is not supported
- A full list of supported models and deviations is listed on GitHub: https://github.com/YangModels/yang/tree/master/vendor/cisco/nx

Openconfig VXLAN EVPN model

- Cisco co-authors with Google and Telefónica
- Phase one will focus on operational data of EVPN address family
- Committed in 10.3(1)F

Phase one components
L2rib
L3fib
Adjacency(ARP/ND)
BGP Type2 Routes
BGP Type5 Routes
VXLAN NVE state

Data Source

Native Yang

DME

```
/sys/bgp/inst
```

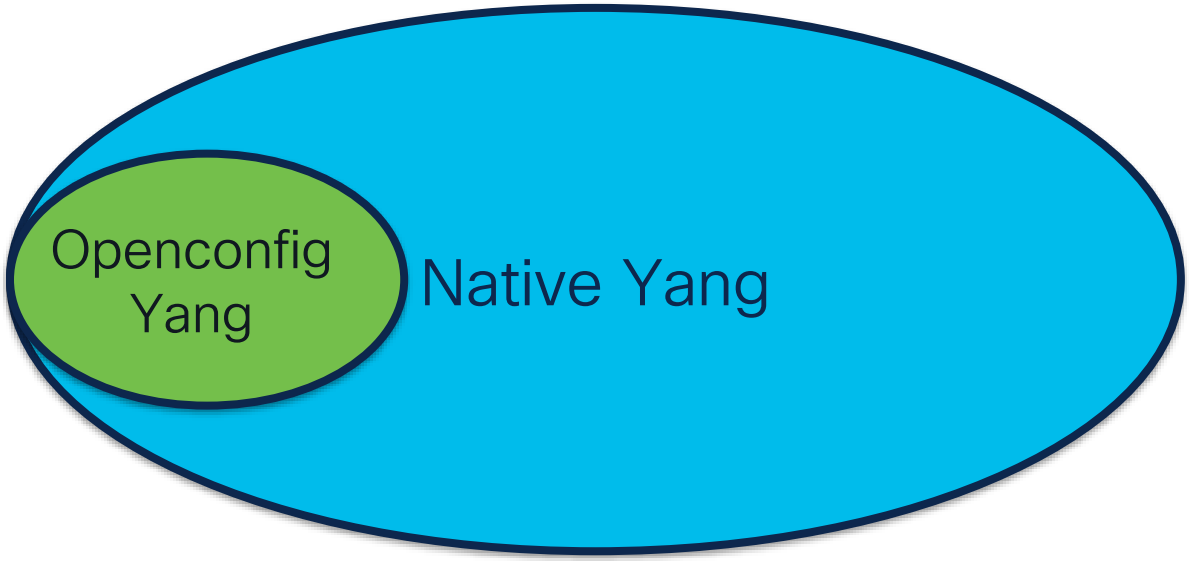
=

Native Yang

```
/System/bgp-items/inst-items
```

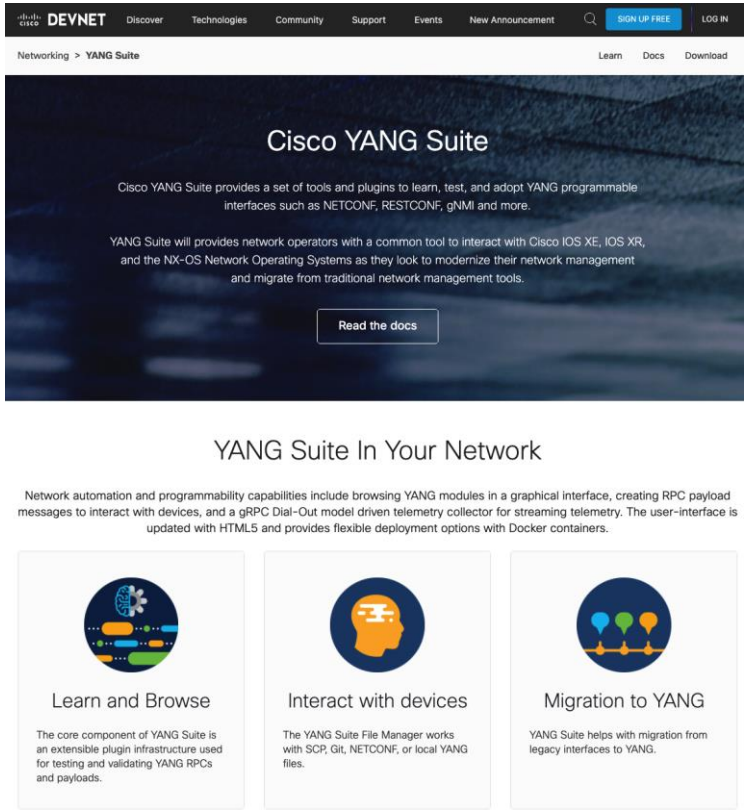
- The Native Yang model is a vendor-specific model but is still described in Yang, aka Device Yang.
- NX-OS Native Yang is defined in *Cisco-NX-OS-device.yang*
- It is1:1 mapping from DME objects to Native Yang

Openconfig Yang and Native Yang



Yangsuite

Swiss knife of Yang



- One-stop tool for automating network devices using the Yang model
- Construct and test Yang base API interface over NETCONF, RESTCONF and gNMI
- Yang model browser built-in

https://developer.cisco.com/yangsuite

Data Source

CLI/NX-API

```
93240YC-FX2-L02-S4# show nve vni  | json-pretty
{
    "TABLE_nve_vni": {
        "ROW_nve_vni": [
            {
                "if-name": "nve1",
                "vni": "30000",
                "mcast": "239.1.1.1",
                "vni-state": "Up",
                "mode": "CP",
                "type": "L2 [2300]",
                "flags": null,
                "dci-mcast": "Unconfigured"
            },
```

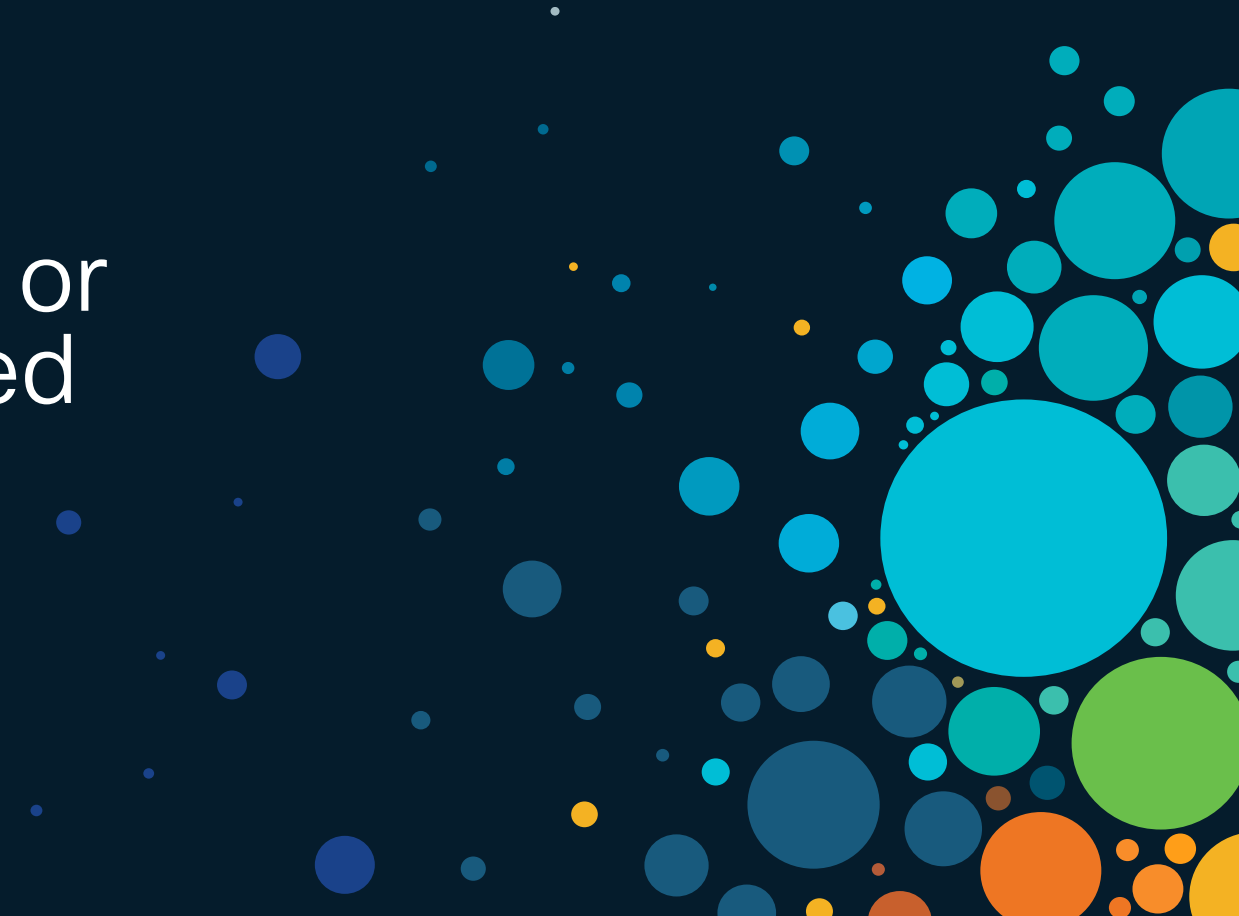
- NX-API is CLI program interface NX-OS, the query result will be returned as structured data encoded in JSON
- Starting from 9.3.6, almost 100% of show command of NX-OS has structured output except for some platform-specific command
- CLI/NX-API only supports cadence-based telemetry
- CLI doesn‘t have a native data type, all the value is a string type, the collector need to parse the result to “guess” the value of the data

Software Telemetry Platform Support

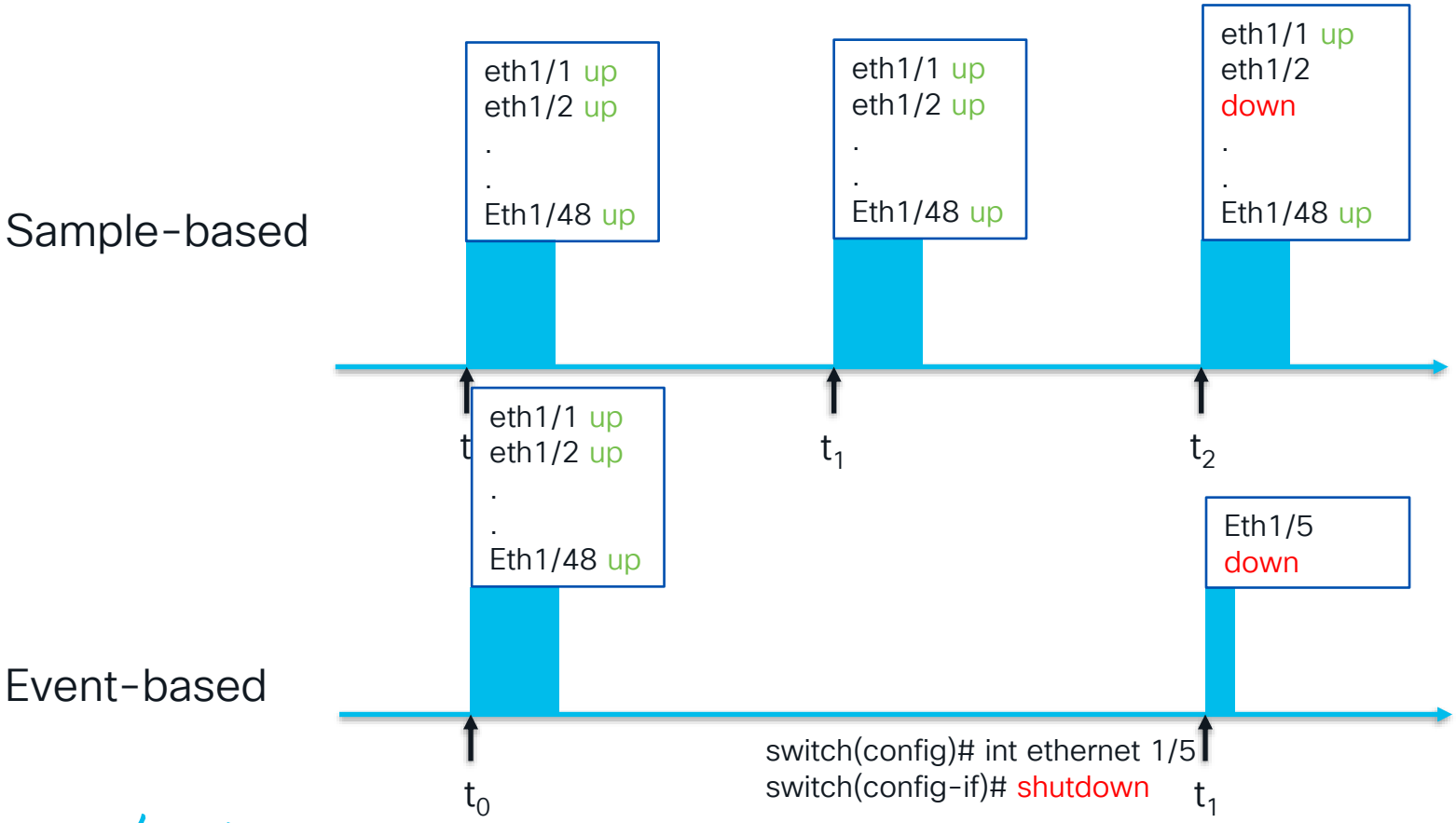
Nexus Platform	DME	CLI/NX-API	Yang	Release
3000 with 8G+ RAM	✓	✓	✓ *	7.0(3)I7(1)
9200/9300	✓	✓	✓ *	7.0(3)I5(1)
9500	✓	✓	✓ *	7.0(3)I7(1)
5000/5500/6000	✗	✗	✗	N/A
7000/7700	✗	✓	✗	8.3(1)

* Streaming Yang models start from 9.2(1)

Event-based or Sample-based telemetry



Sample-based vs Event-based



Encoding

How does GPB work

```
<interface>
  <name>eth1/49</name>
  <state>
    <counters>
      <in-broadcast-pkts>2</in-broadcast-pkts>
      <in-discards>0</in-discards>
      <in-errors>0</in-errors>
      <in-fcs-errors>0</in-fcs-errors>
      <in-multicast-pkts>30543</in-multicast-pkts>
      <in-octets>13320913920</in-octets>
      <in-unicast-pkts>5406026</in-unicast-pkts>
      <in-unknown-protos>0</in-unknown-protos>
      <out-broadcast-pkts>3</out-broadcast-pkts>
      <out-discards>0</out-discards>
      <out-errors>0</out-errors>
      <out-multicast-pkts>26070</out-multicast-pkts>
      <out-octets>143144868</out-octets>
      <out-unicast-pkts>1424051</out-unicast-pkts>
    </counters>
  </state>
</interface>
```


```
1:"eth1/49"
2:{
  1:{
    1:2
    2:0
    3:0
    4:0
    5:30543
    613320913920
    7:5406026
    8:0
    9:3
    10:0
    11:0
    12:26070
    13:143144868
    14:1424051
  }
}
```

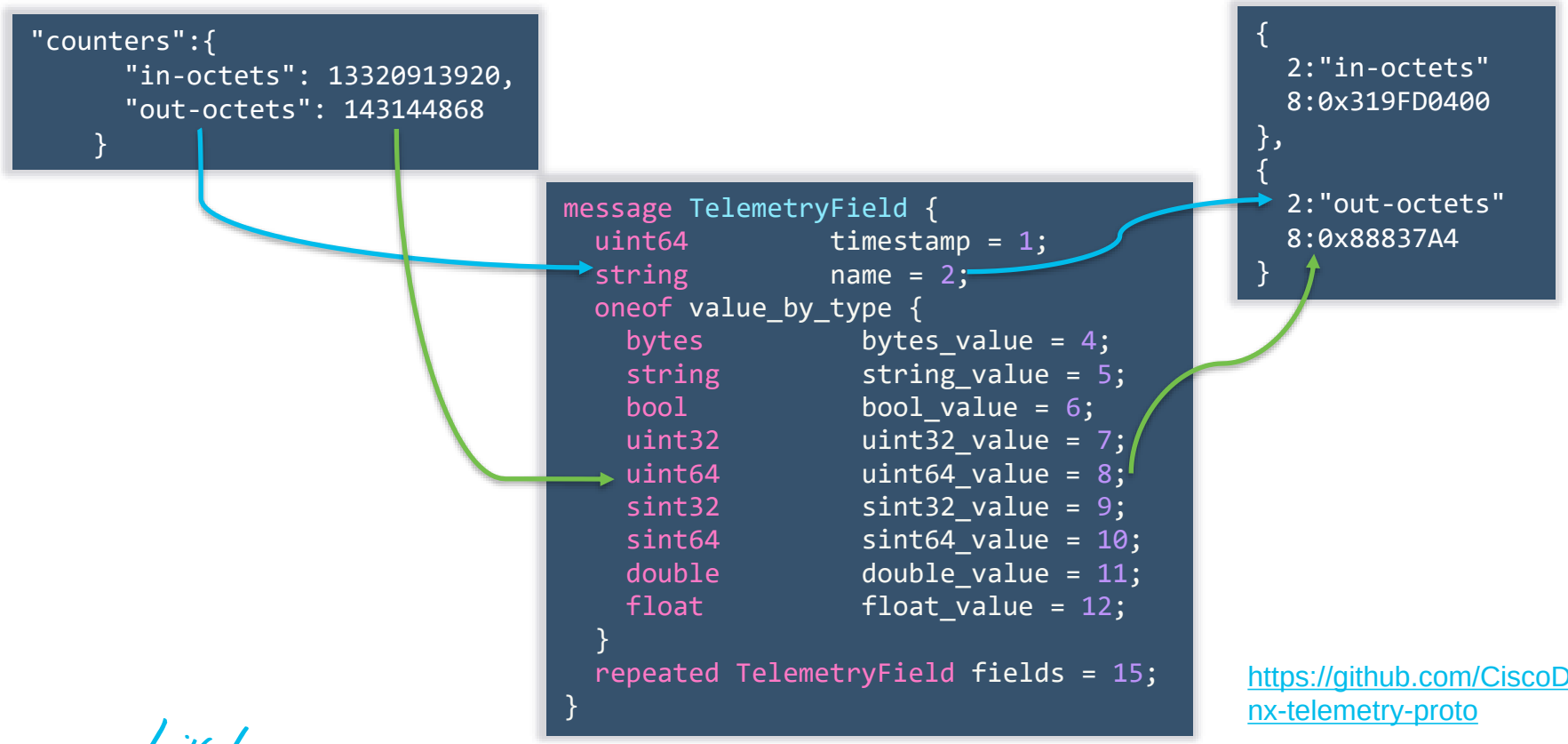
How does GPB work

```
<interface>
  <name>eth1/49</name>
  <state>
    <counters>
      <in-broadcast-pkts>2</in-broadcast-pkts>
      <in-discards>0</in-discards>
      <in-errors>0</in-errors>
      <in-fcs-errors>0</in-fcs-errors>
      <in-multicast-pkts>30543</in-multicast-pkts>
      <in-octets>13320913920</in-octets>
      <in-unicast-pkts>5406026</in-unicast-pkts>
      <in-unknown-protos>0</in-unknown-protos>
      <out-broadcast-pkts>3</out-broadcast-pkts>
      <out-discards>0</out-discards>
      <out-errors>0</out-errors>
      <out-multicast-pkts>26070</out-multicast-pkts>
      <out-octets>143144868</out-octets>
      <out-unicast-pkts>1424051</out-uni
    </counters>
  </state>
</interface>
```


```
1:"eth1/49"
2:{
  1:{
    1:2
    2:0
    3:0
    4:0
    5:30543
    613320913920
    7:5406026
    8:0
    9:3
    10:0
    11:0
    12:26070
    143144868
    424051
```

High wire efficiency
But hard to develop encoder and decoder

How does GPB-KV work



https://github.com/CiscoDevNet/nx-telemetry-proto

Encoding Comparison – kv-GPB vs JSON

encoding = json

```
"updates": [
  {
    "Path": "openconfig:interfaces",
    "values": {
      "interfaces": {
        "interface": [
          {
            "config": {
              "description": "connected-to-9316D-GX-SP1-S4-Ethernet1/12",
              "enabled": true,
              "mtu": 9216,
              "name": "eth1/49",
              "tpid": "TPID_0X8100",
              "type": "ethernetCsmacd"
            },
            "ethernet": {
              "config": {
                "auto-negotiate": true,
                "enable-flow-control": false,
                "mac-address": "00:00:00:00:00:00"
              },
```

```
mtu := values['interface']['config']['mtu']
```

Client need understand the json schema to decode the result

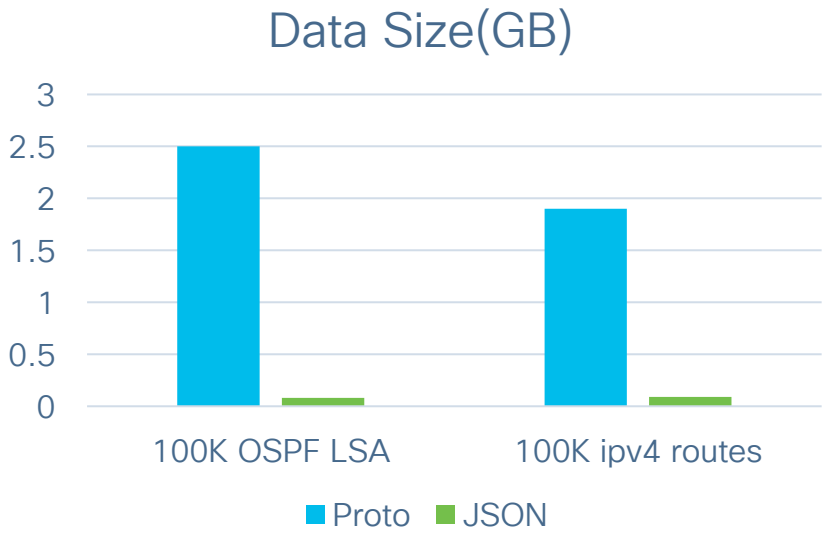
Encoding Comparison – kv-GPB vs JSON

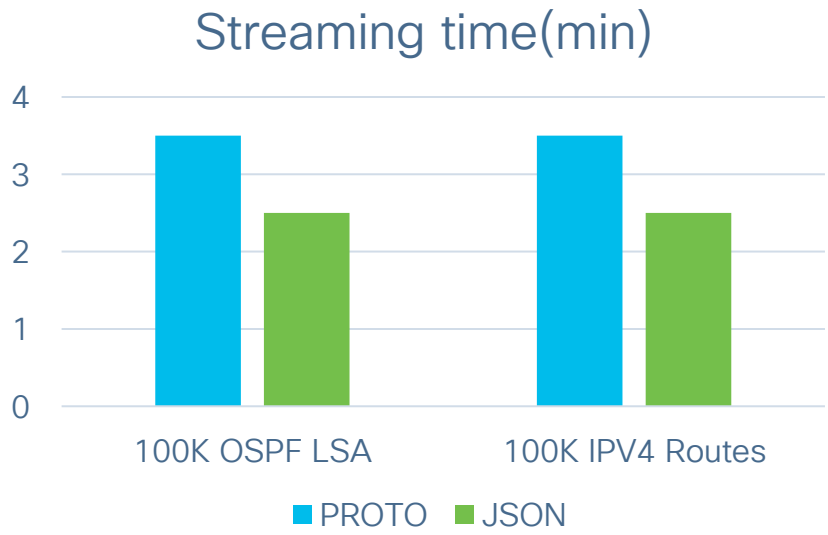
encoding = proto

```
{
  "Path": "config/enabled",
  "values": {
    "config/enabled": true
  }
},
{
  "Path": "config/mtu",
  "values": {
    "config/mtu": 9216
  }
},
{
  "Path": "config/name",
  "values": {
    "config/name": "eth1/49"
  }
},
```

Data is encoded in a flat pattern, easy write/read specific value to/from database

Encoding Comparison – kv-GPB vs JSON



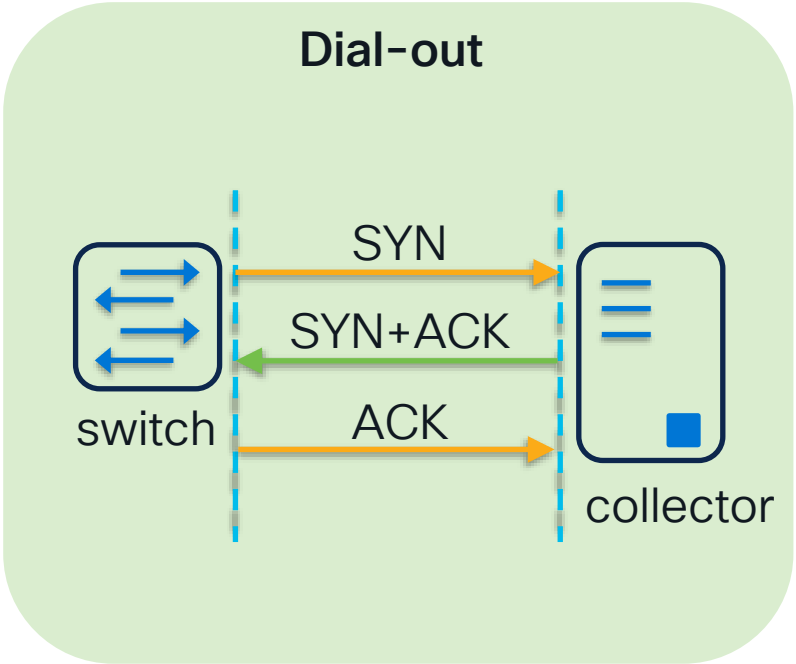


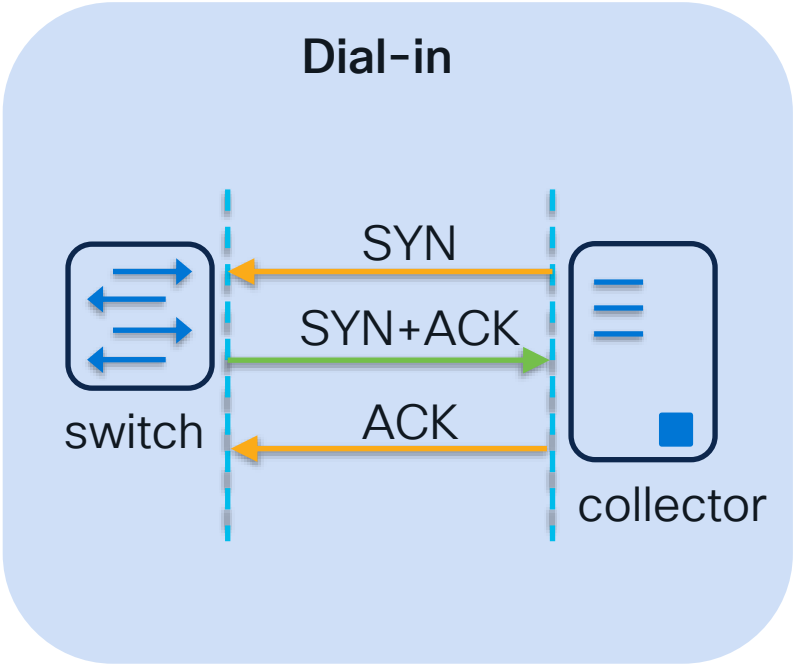
Transport options

- Dial-out vs Dial-in

Dial-out vs Dial-in

- TCP connection is always persistent in telemetry
- The difference is which part initializes the connection



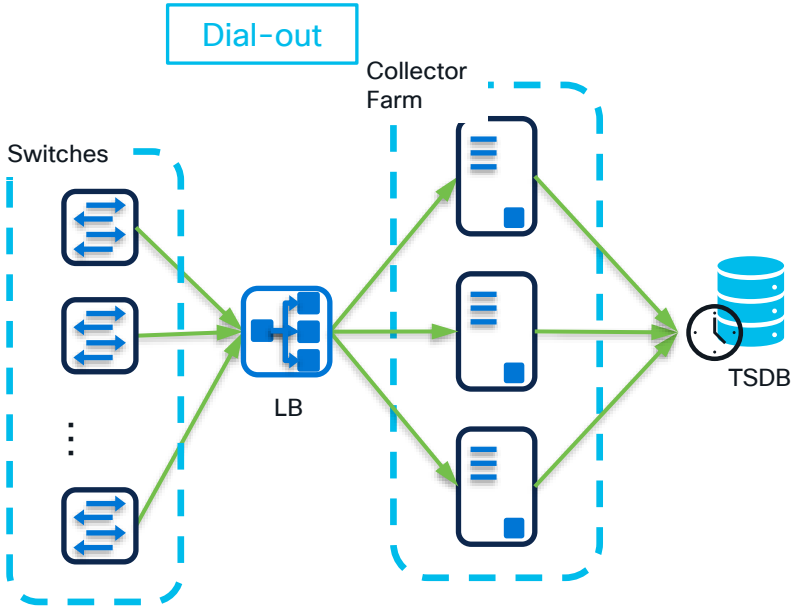


Dial-out vs Dial-in

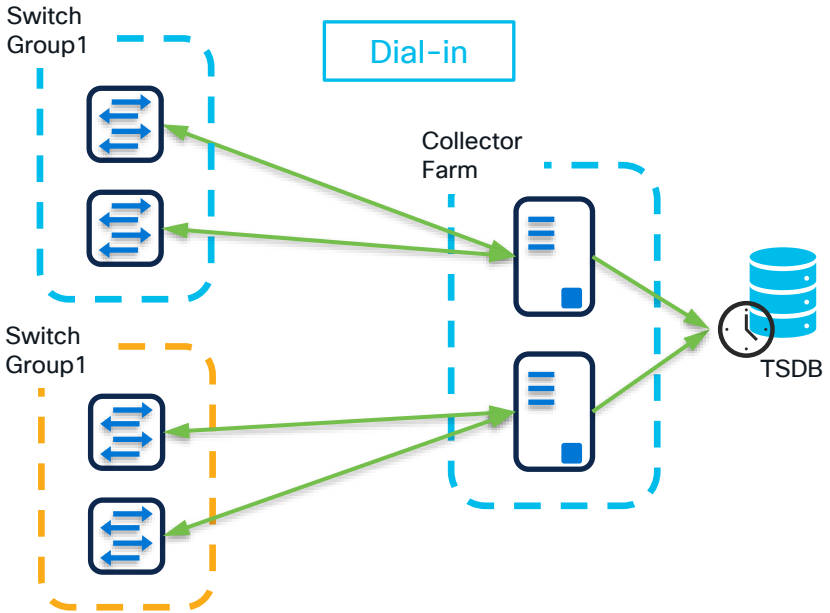
Dial-out	Dial-in
Support gRPC, HTTP, UDP as the transport protocol	Only gRPC is supported as the protocol
Configuration needs to be done from CLI or another management interface	Single-channel for subscription and data transport
No need to open a specific port to the management interface of the switch	The firewall rule needs to apply to the ingress direction to switch for gRPC
Load balancing is easy by setting up collector behind VIP	gRPC/gNMI clients need to be distributed between switches

Dial-out vs Dial-in

Design Consideration



Collectors can be set up behind load balancer, all switches stream to the same VIP of collector



To distribute the workload, the collectors need to dial into different switch groups, extra effort to keep the sensor configure synchronized across the cluster

gNMI Introduction

gRPC Nework Management Interface

- Specification of RPCs and behaviors for managing state on the network device
- Supports both configuration management and steaming telemetry
- Built on the gRPC framework
- Design to carry any tree-structured data
- Offers any alternative to NETCONF/RESTCONF

gNMI RPCs

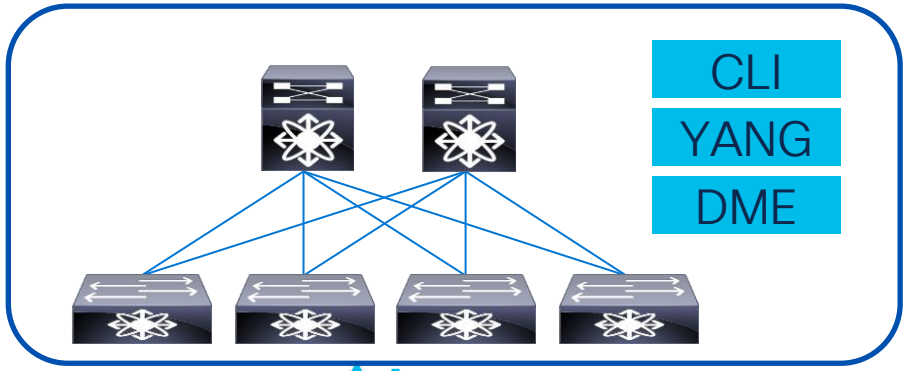
- Capabilities, Retrieve the set of capabilities supported by the target, which usually happened during initial communication
- Get, retrieve a snapshot of data from the target
- Set, Modify the state of data on the target
- Subscribe, Subscribe to a stream of values of paths within the data tree

gNMI implementation in NX-OS

Standard	gNMI in NX-OS 9.x is based on version 0.5.0
RPC Capabilities	Complete set of gNMI operation are supported since 9.3(5) Supports both ON_CHANGE and SAMPLE streaming mode `target_defined` is supported in 10.2(1)F `suppress_redundant` and `heatbeat_interval` is supported in 10.2(3)F
Security	TLS is mandatory, supports Mutual TLS
Data Model Encoding	Native and Openconfig Yang Model Supports KV-GPB and JSON as encoding Wild card is supported in 10.2(2)F

How to build a telemetry system with opensource tools

OpenSource Software Stack



gNMI Dial-in

MDT Dial-out

Write measurement

telegraf

influxdb

Prometheus

Grafana

chronograf

https://github.com/dsx1123/telemetry_collector

Takeaways

- NX-OS has a wide choice of the data model and streaming transport options, customers can choose based on business requirements
- Most of the customers are interested in gNMI dial-in but there are pros and cons between dial-out and dial-in
- To optimize the resource utilization, only stream what you need
- Use GPB-KV when possible
- Use Openconfig models first, fall back to native yang mode and DME when data is not available in OC yang

Technical Session Surveys

- Attendees who fill out a minimum of four session surveys and the overall event survey will get Cisco Live branded socks!
- Attendees will also earn 100 points in the Cisco Live Game for every survey completed.
- These points help you get on the leaderboard and increase your chances of winning daily and grand prizes.

Cisco Learning and Certifications

From technology training and team development to Cisco certifications and learning plans, let us help you empower your business and career. www.cisco.com/go/certs

Pay for Learning with Cisco Learning Credits

(CLCs) are prepaid training vouchers redeemed directly with Cisco.

Learn

Cisco U.
IT learning hub that guides teams and learners toward their goals

Cisco Digital Learning
Subscription-based product, technology, and certification training

Cisco Modeling Labs
Network simulation platform for design, testing, and troubleshooting

Cisco Learning Network
Resource community portal for certifications and learning

Train

Cisco Training Bootcamps
Intensive team & individual automation and technology training programs

Cisco Learning Partner Program
Authorized training partners supporting Cisco technology and career certifications

Cisco Instructor-led and Virtual Instructor-led training
Accelerated curriculum of product, technology, and certification courses

Certify

Cisco Certifications and Specialist Certifications
Award-winning certification program empowers students and IT Professionals to advance their technical careers

Cisco Guided Study Groups
180-day certification prep program with learning and support

Cisco Continuing Education Program
Recertification training options for Cisco certified individuals

Here at the event? Visit us at **The Learning and Certifications lounge at the World of Solutions**

Continue your education

- Visit the Cisco Showcase for related demos
- Book your one-on-one Meet the Engineer meeting
- Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs
- Visit the On-Demand Library for more sessions at www.CiscoLive.com/on-demand

Specialists

Thank you


cisco Live!
ALL IN