

IETF YANG-Push Implementations and Next Steps

Where it started...

Starting at IETF 115, In context of a seamless Data Mesh message broker integration described in [draft-ietf-nmop-yang-message-broker-integration](#), **a group of network operators, network vendors and academia have been reviewing currently deployed non-standard YANG notification implementations of major vendors and compared to IETF YANG-Push defined in [RFC 8639](#) and [RFC 8641](#).**

Out of this comparison and the requirements for seamless Data Mesh message broker integration, **several notification, subscription and capability discovery enhancements have been proposed** and discussed at IETF NETCONF and NMOP working groups.

Address YANG Specification and Integration Gaps

Aiming for an automated data processing pipeline

YANG Specifications Gaps:

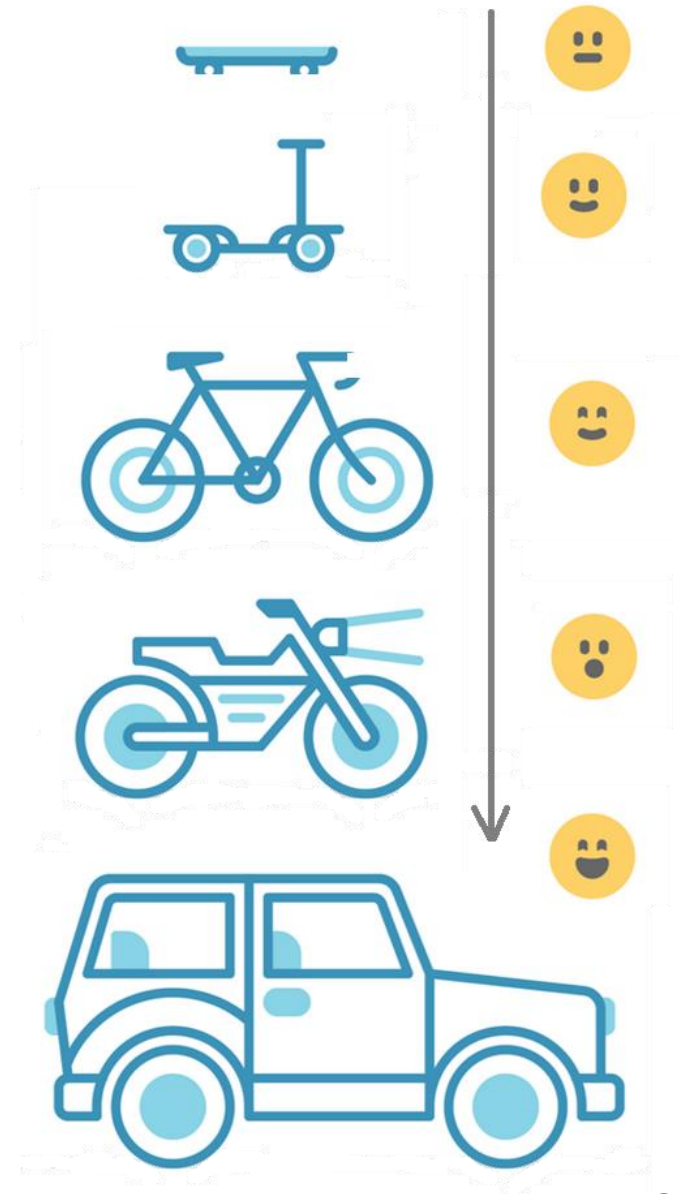
- Extensible YANG model for YANG-Push Notifications
[draft-netana-netconf-notif-envelope](#)
- YANG Notification Transport Capabilities
[draft-netana-netconf-yp-transport-capabilities](#)
- Validating anydata in YANG Library context
[draft-aelhassany-anydata-validation](#)

YANG Integration Gaps:

- Support of Network Observation Timestamping in YANG Notifications
[draft-tgraf-netconf-yang-push-observation-time](#)
- Support of Versioning in YANG Notifications Subscription
[draft-ietf-netconf-yang-notifications-versioning](#)
- Augmented-by Addition into the IETF-YANG-Library
[draft-ietf-netconf-yang-library-augmentation](#)

YANG Simplification:

- YANG-Push Operational Data Observability Enhancements
[draft-wilton-netconf-yp-observability](#)



IETF YANG-Push Implementations and Next Steps

What we discussed...

Development on first major vendor implementations started at IETF 118. Throughout IETF 119 and 120, vendor implementation and network operator testing scope and interest from other vendors and operators steadily grew. **In this process questions on various feature specifications were brought forward.** To channelize these discussions, 4 workshops have been organized throughout the last 3 months. **In the workshops we clarified:**

- What do you like about IETF YANG-Push?
- What in IETF YANG-Push could have been defined differently and why?
- What prevents IETF YANG-Push for being integrated/used efficiently?
- What in IETF YANG-Push is missing and for which purpose?
- What xpaths do you subscribe to for which Network Analytics use case?
- Which features should be available in which MVP release?
- How to make IETF YANG-Push available to a wider audience?

IETF YANG-Push Implementations and Next Steps

Who we are and what we like...

The group consisting of: **34 colleagues** from Bell Canada, Deutsche Telekom, NTT International, Swisscom, Huawei, Cisco, 6Wind, Ciena Blueplanet, Juniper, Nokia, and INSA Lyon.

The group decided to make the outcome of these workshops **available to the IETF community at NMOP and NEMOPS and continue there these discussions.**



What do you like about IETF YANG-Push?

- Interoperable
- Unified with Netconf and Restconf
- Transport independent
- Push based

What will you never implement nor use in IETF YANG-Push?

- Replay
- Message Bundling
- Dampening

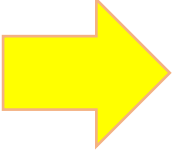
IETF YANG-Push Implementations and Next Steps

Challenges and how to solve...

What in IETF YANG-Push could have been defined differently and why?

What prevents IETF YANG-Push for being integrated/used efficiently?

What in IETF YANG-Push is missing and for which purpose?

- On-change notification schema different then periodical
 - Patch-id in On-Change complex to implement.
 - Reduce YANG complexity (example: augmentations, deviations, xpath, lists)
 - Each subscribed xpath needs normalization. High effort with many vendor specific YANG modules
 - Missing end to end open-source implementations
- 
- Extensible YANG-Push header combing notification and subscription. Separation of header and subscribed content is needed to allow partial parsing of message in binary encoding for data processing chain.
 - On-change and periodical notification schema should have identical schema and contain the entire schema tree below subscription and represent current state.
 - Common alignment on what should be supported in xpath and what not.
 - Agile incremental driven development. Deployment guide describing implementers and operators what is/should be supported at which MVP stage.

IETF YANG-Push Subscriptions

What Deutsche Telekom subscribes to...

Cisco

Cisco-IOS-XR-fib-common-oper:mpls-forwarding/nodes/node[node-name=0/RP0/CPU0]/label-fib/forwarding-details/forwarding-detail

Cisco-IOS-XR-sysadmin-asr9k-envmon-ui:environment/oper/power/location/pem_attributes

Cisco-IOS-XR-envmon-oper:power-management/rack/producers

Cisco-IOS-XR-nto-misc-oper:memory-summary/nodes/node/summary

Cisco-IOS-XR-qos-ma-oper:qos/interface-table/interface/output

openconfig-interfaces:interfaces/interface/state

Cisco-IOS-XR-wdsysmon-fd-oper:system-monitoring/cpu-utilization/total-cpu-one-minute

Cisco-IOS-XR-wdsysmon-fd-oper:system-monitoring/cpu-utilization/total-cpu-five-minute

Cisco-IOS-XR-wdsysmon-fd-oper:system-monitoring/cpu-utilization/total-cpu-fifteen-minute

Cisco-IOS-XR-qos-ma-oper:qos/interface-table/interface/

Juniper

/components/component[name=Routing Engine0]/properties/property

/components/component[name=Routing Engine1]/properties/property

/interfaces/interface/state

/junos/services/segment-routing/sid/usage

IETF YANG-Push Subscriptions

What Bell Canada subscribes to...

Cisco

openconfig-interfaces:interfaces

Cisco-IOS-XR-envmon-oper:power-management

Cisco-IOS-XR-envmon-oper:environmental-monitoring

Cisco-IOS-XR-nto-misc-oper:memory-summary/nodes/node/summary

Cisco-IOS-XR-procmem-oper:processes-memory/nodes/node/process-ids/process-id

Cisco-IOS-XR-wdsysmon-fd-oper:system-monitoring/cpu-utilization/total-cpu-one-minute

Cisco-IOS-XR-qos-ma-oper:qos/interface-table/interface/input/service-policy-names/service-policy-instance/statistics

Cisco-IOS-XR-qos-ma-oper:qos/interface-table/interface/output/service-policy-names/service-policy-instance/statistics

Cisco-IOS-XR-platforms-ofa-oper:ofa/stats/nodes/node/Cisco-IOS-XR-8000-platforms-npu-resources-oper:hw-resources-datas/hw-resources-data

Cisco-IOS-XR-mpls-lsd-oper:mpls-lsd-nodes/mpls-lsd-node/label-summary

Cisco-IOS-XR-controller-optics-oper:optics-oper/optics-ports/optics-port/optics-info

Cisco-IOS-XR-controller-optics-oper:optics-oper/optics-ports/optics-port/optics-lanes

Cisco-IOS-XR-invmgr-oper:inventory/entities/entity/attributes/inv-basic-bag

Cisco-IOS-XR-mediasvr-linux-oper:media-svr/nodes/node/partition

IETF YANG-Push Subscriptions

What Swisscom subscribes to...

Cisco

openconfig-interfaces:interfaces

Cisco-IOS-XR-nto-misc-oper:memory-summary/nodes/node/summary

Cisco-IOS-XR-procmem-oper:processes-memory/nodes/node/process-ids/process-id

Cisco-IOS-XR-qos-ma-oper:qos/interface-table/interface/input/service-policy-names/service-policy-instance/statistics

Cisco-IOS-XR-qos-ma-oper:qos/interface-table/interface/output/service-policy-names/service-policy-instance/statistics

Cisco-IOS-XR-wdsysmon-fd-oper:system-monitoring/cpu-utilization

Cisco-IOS-XR-sysadmin-fretta-envmon-ui:environment/oper

Cisco-IOS-XR-envmon-oper:environmental-monitoring

Cisco-IOS-XR-sysadmin-asr9k-envmon-ui:environment/oper

Cisco-IOS-XR-asr9k-lpts-oper:platform-lptsp-ifib-static/node-statics

Cisco-IOS-XR-asr9k-np-oper:hardware-module-np/nodes/node/nps/np/counters/np-counter

Cisco-IOS-XR-platforms-ofa-oper:ofa/stats/nodes/node/Cisco-IOS-XR-NCS-BDplatforms-npu-resources-oper:hw-resources-datas

Cisco-IOS-XR-platforms-ofa-oper:ofa/stats/nodes/node/Cisco-IOS-XR-8000-platforms-npu-resources-oper:hw-resources-datas/hw-resources-data

IETF YANG-Push Subscriptions

What Swisscom subscribes to...

Huawei

```
/huawei-ifm:ifm/interfaces/interface  
/huawei-ifm:ifm/interfaces/interface/dynamic  
/huawei-ifm:ifm/interfaces/interface/mib-statistics  
/huawei-ifm:ifm/interfaces/interface/mib-statistics/huawei-pic:eth-port-err-sts  
/huawei-bras-user-manage:bras-user-manage/access-tables/access-table  
/huawei-bras-user-manage:bras-user-manage/access-tables/access-table/access-user-aaa-info  
/huawei-bras-user-manage:bras-user-manage/access-tables/access-table/access-user-basic-info  
/huawei-bras-user-manage:bras-user-manage/access-tables/access-table/access-user-edsg-infos/access-user-edsg-info  
/huawei-bras-user-manage:bras-user-manage/online-fail-or-offline-records/online-fail-or-offline-record  
/huawei-bras-dhcp-access:bras-dhcp-access/dhcp-access-statistics  
/huawei-bras-dhcp-server:bras-dhcp-server/dhcp-servers/dhcp-server/statistics  
/huawei-bras-dhcpv6-access:bras-dhcpv6-access/dhcpv6-packets-statistics  
/huawei-bras-l2tp-access:bras-l2tp-access/lac-tunnels/lac-tunnel  
/huawei-bras-l2tp-access:bras-l2tp-access/lac-tunnels/lac-tunnel/redundant  
/huawei-bras-l2tp-access:bras-l2tp-access/lac-tunnels/lac-tunnel/statistics  
/huawei-bras-user-manage:bras-user-manage/domain-statistics/domain-statistic  
/huawei-bras-user-statistic:bras-user-statistic/access-user/summary/by-user-types/by-user-type  
/huawei-bras-user-statistic:bras-user-statistic/access-user/summary/by-vpn-instances/by-vpn-instance  
/huawei-ifm:ifm/interfaces/interface/huawei-bras-basic-access:bas/bas-interface/information  
/huawei-radius:radius/account-packet-statistics/account-packet-statistic  
/huawei-radius:radius/authentication-packet-statistics/authentication-packet-statistic  
/huawei-radius:radius/author-packet-statistics/author-packet-statistic
```

IETF YANG-Push Use Cases

Operator consolidated...

66% Common among 3 Operators

- Environment Metrics (Power, Fan Speed, Temperature) -> RFC 8348 ietf-hardware
- Memory Usage (summary and per process) ->
- CPU Usage (summary and per process) -> RFC 8348 ietf-hardware
- Network Processor Usage (per type) -> RFC 8348 ietf-hardware
- MPLS label (summary) -> RFC 8960 ietf-mpls
- SRv6 SID usage (summary) -> draft-ietf-spring-srv6-yang ietf-srv6-base
- QOS Interface Statistics (ingress and egress) -> draft-ietf-rtgwg-qos-model ietf-traffic-policy
- Interface Statistics (ingress and egress) -> RFC 8343 ietf-interfaces

33% Specific to 1 Operator

- RIB/FIB entries for Traffic Engineering -> RFC 8349 ietf-routing, RFC 9403 ietf-rib-extension
- Optical interface statistics ->
- Link Layer Discovery -> RFC 8449 ietf-l2-topology
- Hardware Inventory -> RFC 8348 ietf-hardware

IETF YANG-Push Use Cases

high level and how frequent...

66% Common among 3 Operators

- **Capacity Management**

Frequency: Between 1 min and 1 hour periodical for metrics.

Use Case: Learn from the past, trend the future and alert x weeks before reaching limit.

- **Interface Statistics**

Frequency: On-change sync on start for state and between 1- and 5-minutes periodical for metrics.

Use Case: Monitor and verify current state.

33% Specific to 1 Operator

- **Traffic Engineering**

Frequency: On-change sync on start for state and 15 minutes periodical for metrics.

Use Case: Monitor and Verify current state.

- **Visualize L1 Topology and Hardware Inventory**

Frequency: On-Change sync on start for state.

Use Case: Visualize Dependencies.

IETF YANG-Push Implementations and Next Steps

Incremental development...

MVP 1 - Works

- [draft-ietf-netconf-udp-notif](#) transport (with segmentation option) and notifications encoded in RFC 7951 IETF-JSON.
- [RFC 8641](#) periodic subscription with anchor-time configurable in ietf-subscribed-notifications.
- YANG notifications as defined in [draft-ahuang-netconf-notif-yang](#) supporting hostname and sequence number as in [draft-tgraf-netconf-notif-sequencing](#), observation time as in [draft-tgraf-netconf-yang-push-observation-time](#), YANG module name and version as in [draft-ietf-netconf-yang-notifications-versioning](#) and notification capabilities ([RFC 9196](#)) discoverable as defined in their documents.
- YANG-Library as defined in [RFC 8525](#) and [draft-ietf-netconf-yang-library-augmentedby](#).

MVP 2 – Scales and Secures

- Distributed notifications as defined in [draft-ietf-netconf-distributed-notif](#).
- YANG notifications encoded in CBOR (named identifiers) as defined in [RFC 9254](#).
- YANG notifications DTLS (1.2 MUST [RFC 6347](#), 1.3 SHOULD [RFC 9147](#)) encrypted as defined in [draft-ietf-netconf-udp-notif](#).

MVP 3 - Optimizes

- [RFC 8641](#) on-change subscription configurable in ietf-subscribed-notifications.
- [RFC 8641](#) on-change and periodical subscription in [RFC 9196](#) defined capabilities discoverable.
- [draft-ietf-netconf-udp-notif](#) transport, encoding and encryption capabilities ([RFC 9196](#)) discoverable with [draft-netana-netconf-yp-transport-capabilities](#).

YANG-Push Implementation Status

IETF 121 – MVP 1

	6WIND VSR	Huawei VRP	Cisco IOS XR	Open- Source
RFC 8639 YANG-Push Subscription	✓	P	P	
RFC 8641 YANG-Push Notification	✓	P	✓	
draft-ietf-netconf-udp-notif	✓	✓	✓	✓
draft-ietf-netconf-yang-notifications-versioning	✓	✓	✓	
draft-tgraf-netconf-notif-sequencing	✓	✓	✓	
draft-tgraf-netconf-yang-push-observation-time	✓	✓	✓	
RFC 7895 YANG Library		✓		
RFC 8525 YANG Library (NMDA)	✓		✓	
draft-ietf-netconf-yang-library-augmentation		P		✓
RFC 9196 System and Notification Capabilities				
draft-netana-netconf-notif-envelope				



Green marked describes new capability at IETF 121. "P" to partially implemented.

YANG-Push Implementation Status

IETF 121 – MVP 2

	6WIND VSR	Huawei VRP	Cisco IOS XR	Open- Source
draft-ietf-netconf-distributed-notif	✓	✓		
RFC 9254 CBOR				
RFC 6347/RFC 9147 DTLS				



Green marked describes new capability at IETF 121. "P" to partially implemented

YANG-Push Implementation Status

IETF 121 – MVP 3

	6WIND VSR	Huawei VRP	Cisco IOS XR	Open- Source
RFC 8641 on-change subscriptions	✓	✓	P	
draft-netana-netconf-yp-transport-capabilities				



Green marked describes new capability at IETF 121. "P" to partially implemented

IETF YANG-Push Website

How do we want to advertise...

Introduction

- Overview, what does it address and solve. Example: <https://cbor.io/>

How to Implement

- Describes which features are in which MVP feature set and references to IETF documents an open-source reference implementations.

How to Deploy and Use

- List implementations and describe which MVP feature sets are available in which implementation.
- Demonstrate in video implementation examples to how to query and dashboard the collected metrics.
- Quick deployment guide on how to setup the YANG data processing chain (data collection, message broker, normalization, timeseries data base, OLAP UI).

Example: <https://imply.io/blog/an-end-to-end-streaming-analytics-stack-for-network-telemetry-data/>

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- IETF, development and collaboration news



<https://www.network-analytics.org/>