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
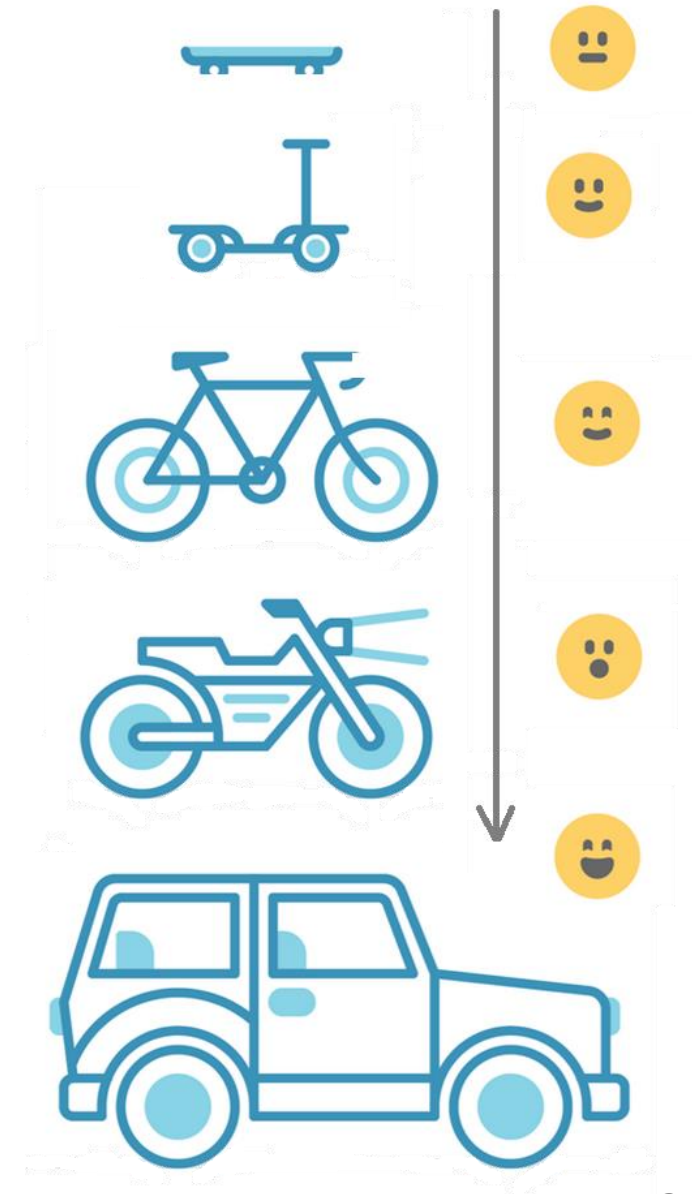
IETF YANG-Push Implementations and Next Steps
What we discussed…

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
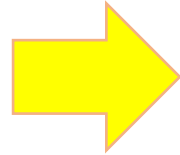
- Extensible YANG-Push header combing notification and subscription. Separation of header and subscribed content is needed to allow partial parsing of message in binary encoding for data processing chain.
- On-change and periodical notification schema should have identical schema and contain the entire 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.
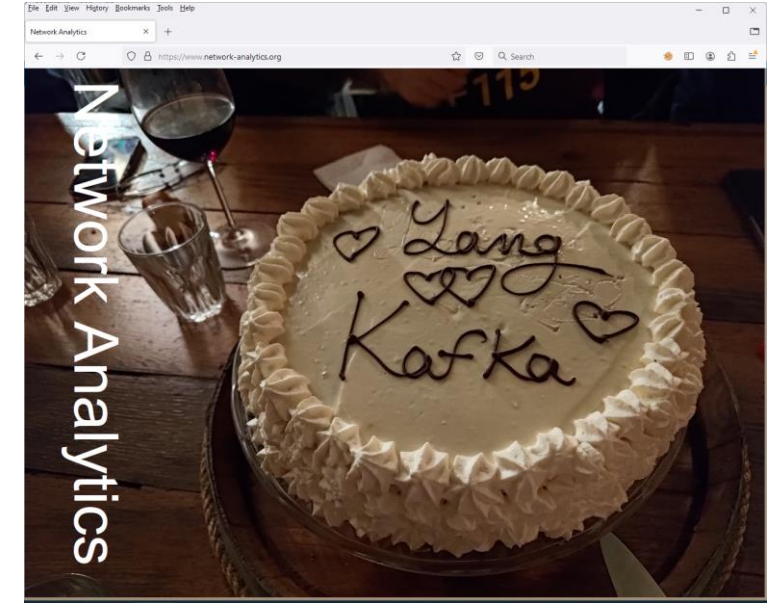
How to Deploy and Use

- 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/

Stay Up to Date

- IETF, development and collaboration news

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