

# Addressing Network Operator Challenges in YANG push Data Mesh Integration

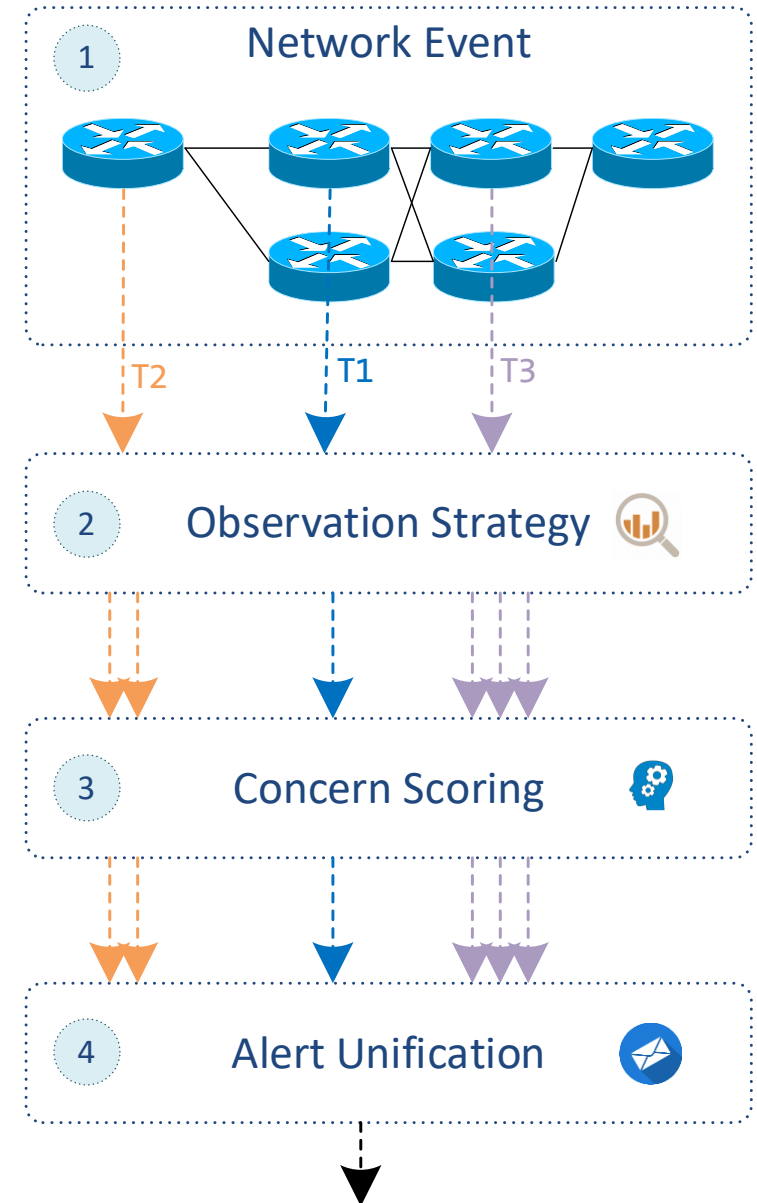
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18. March 2023

# From Network to Alert Event

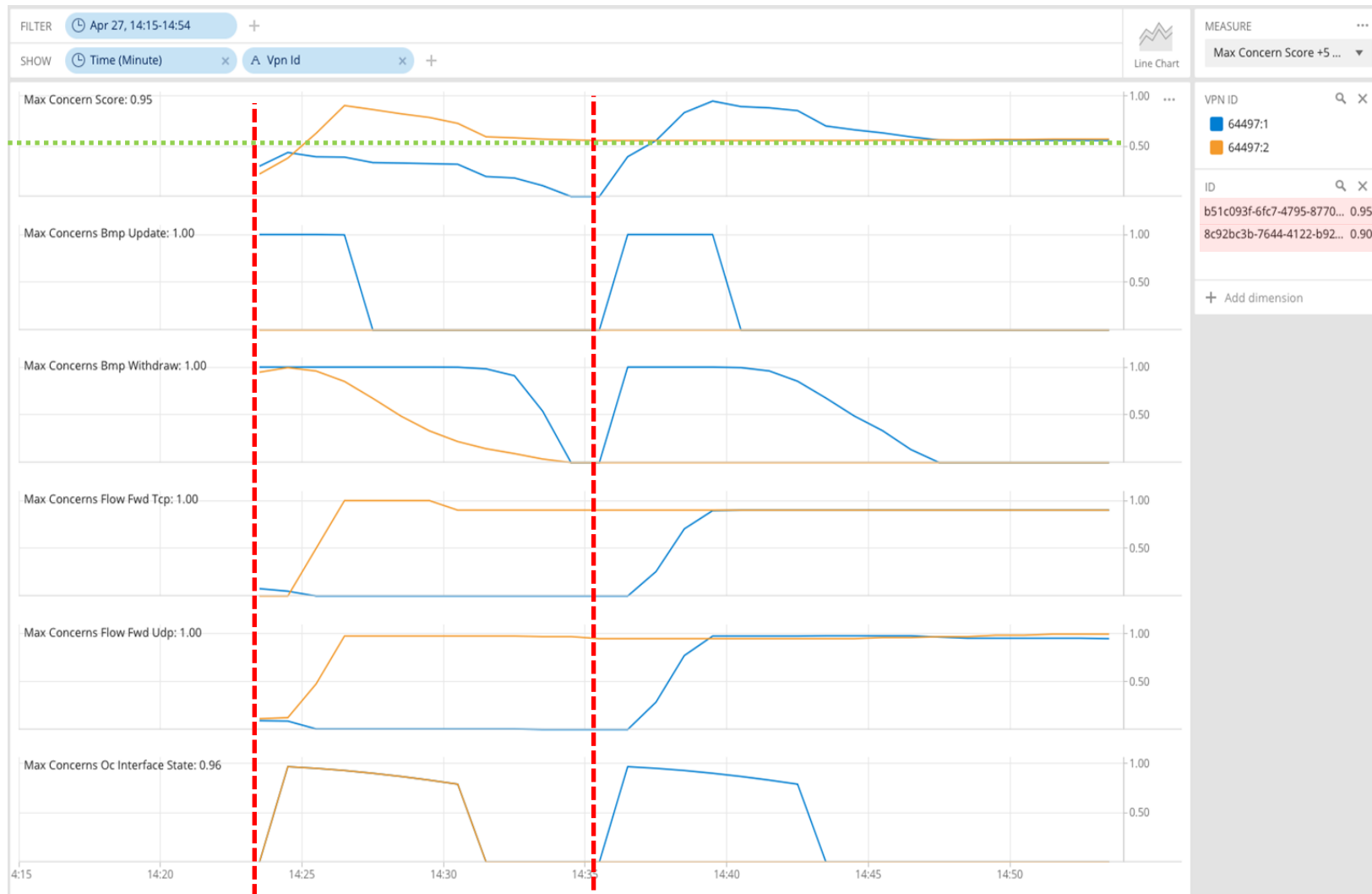
Observe multiple perspectives at different times

1. **A single link down** results in multiple device topology, control-plane and forwarding-plane events being exposed at different times.
2. **Determine** which interfaces and BGP peerings are being used first and then observe state. **Observe** BGP withdrawals and updates, traffic drop spikes and missing traffic. Generate multiple concerns.
3. **Calculate** for each observation a concern score between 0 and 1. **The higher, the more probable** the changes impacted forwarding.
4. **Unify** several concerns for one VPN connectivity service to one alert identifier.



# L3 VPN Network Anomaly Detection

Verify operational changes automatically



## Analytical Perspectives

Monitors the network service and wherever it is congested or not.

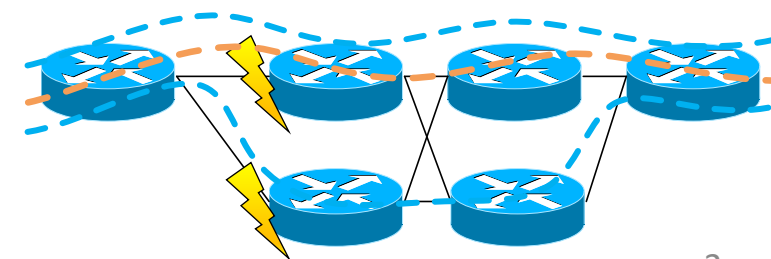
- BGP updates and withdrawals.
- UDP vs. TCP missing traffic.
- Interface state changes.

## Network Events

1. VPN orange lost connectivity.  
VPN blue lost redundancy.
2. VPN blue lost connectivity.

## Key Point

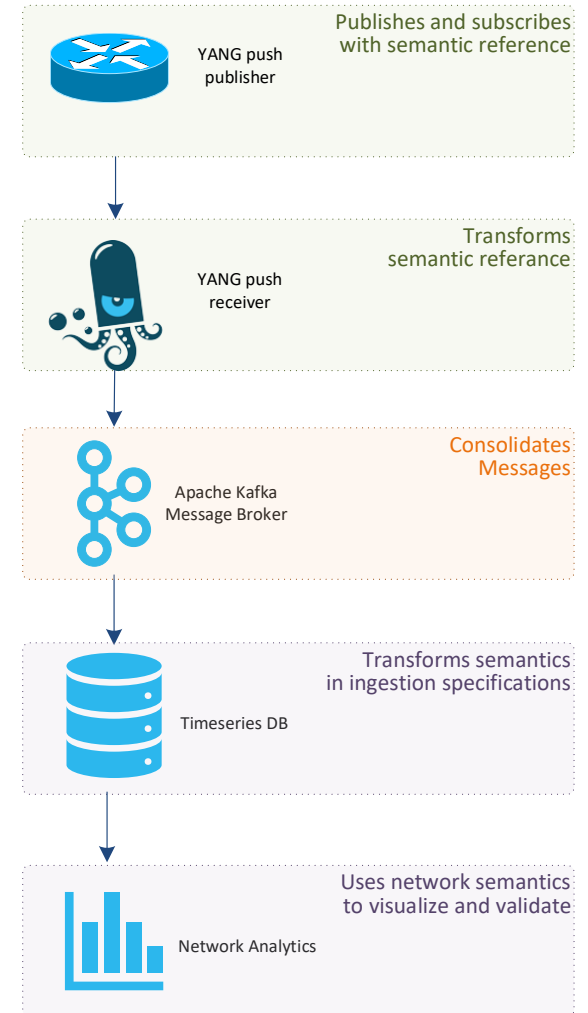
- AI/ML **requires** network intent and network modelled data to deliver dependable results.



# From YANG push to Analytics

Aiming for an automated processing pipeline

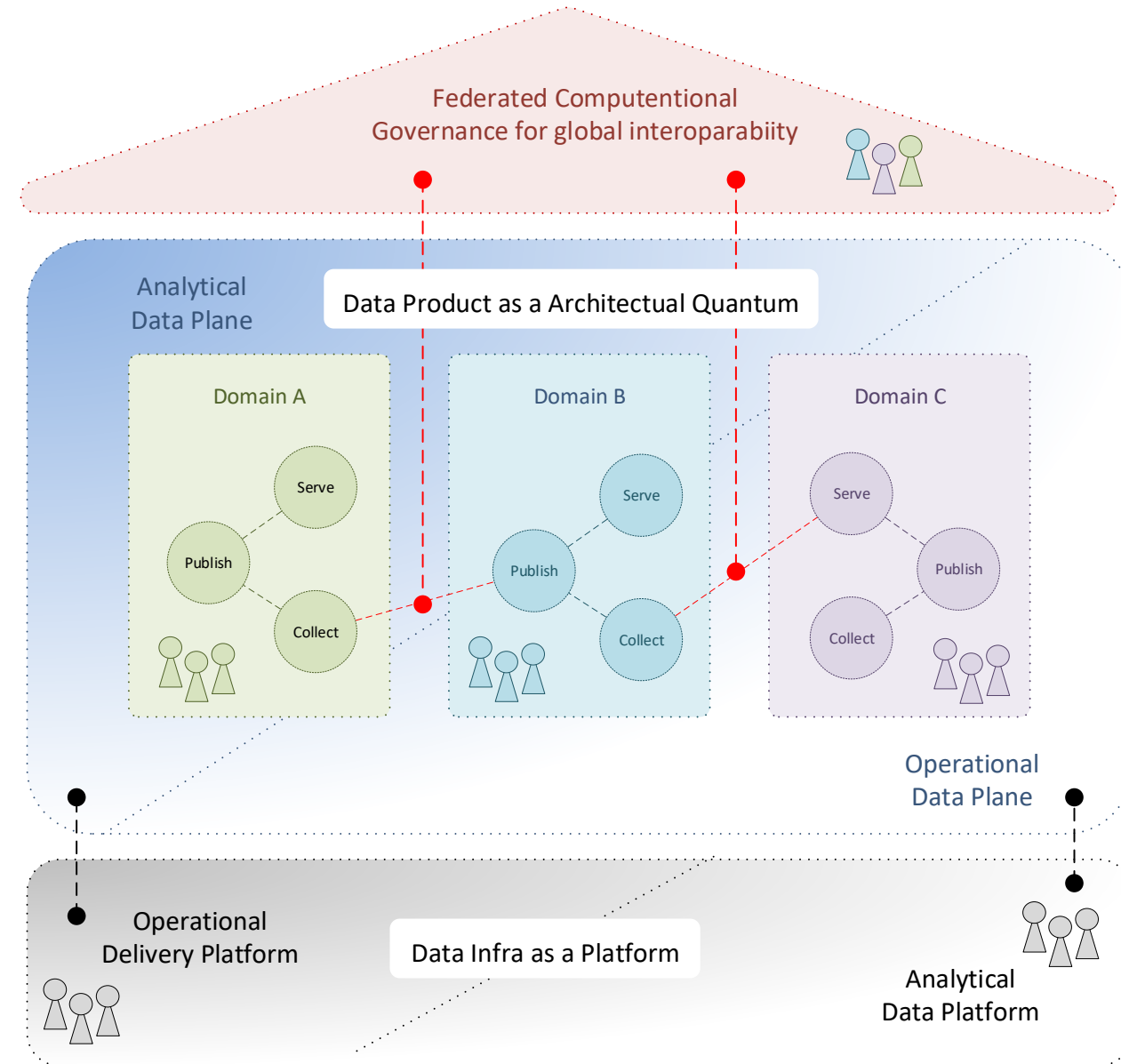
- **A network operator aims for:**
  - An **automated data processing pipeline** which starts with YANG push, consolidates at Data Mesh and ends at Network Analytics.
  - Operational metrics where **IETF defines the semantics.**
  - Analytical metrics where **network operators gain actionable insights.**
- **We achieve this by integrating YANG push into Data Mesh to:**
  - Produce metrics from networks **with timestamps when network events were observed.**
  - Hostname, publisher ID and sequence numbers help us to understand **from where metrics were exported and measure its delay and loss.**
  - Forward **metrics unchanged** from networks
  - **Learn semantics** from networks and validate messages.
  - **Control semantic** changes end to end.



# Evolving Big Data Architecture

Domain oriented, like **networks**

- 1st Generation**  
**Proprietary**  
Enterprise Data Warehouse
- 2nd Generation**  
**Data lake**  
Big data ecosystem
- 3rd Generation**  
**current**  
**Kappa**  
Adds streaming for real-time data
- 4th Generation**  
**next-step**  
**Data Mesh**  
Distributed and organized in domains.

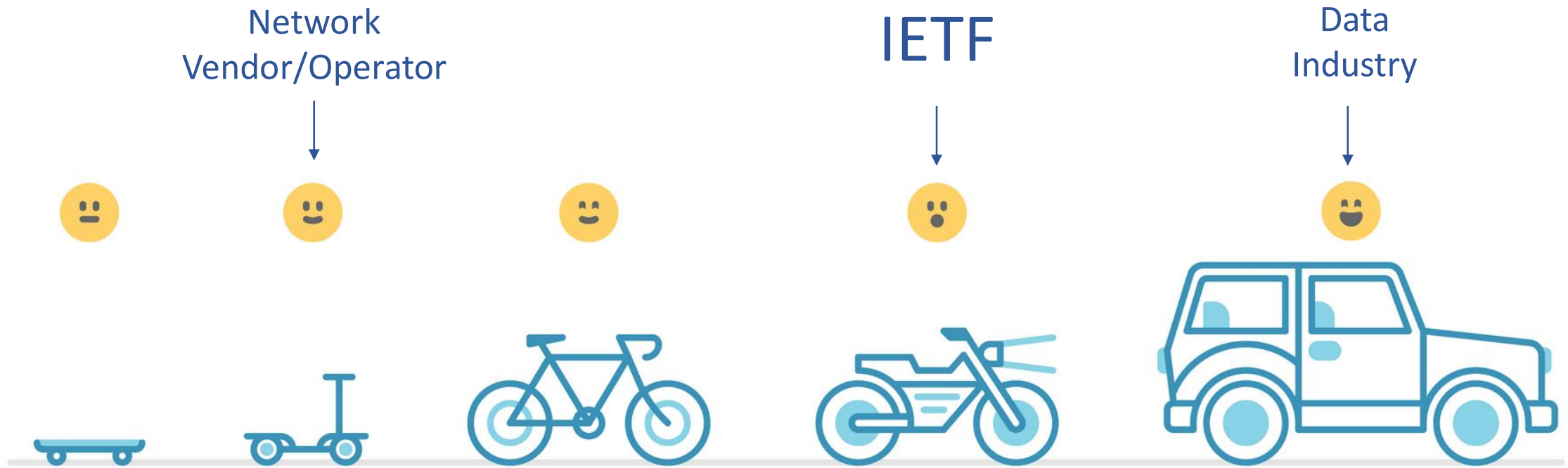


From Principles to Logical Architecture

# Evolving YANG Push

## Missing puzzle pieces

YANG Push	Today at Network Operators	Today at IETF
Transport Protocol	Many and non-standard	netconf-https-notif and netconf-udp-notif
Encoding	JSON widely adopted. Propriety protobuf in various variants. CBOR not implemented yet.	XML in RFC7950, JSON in RFC7951, CBOR in RFC9254
Subscription	Non-standard, periodical widely adopted. On-change sparse.	RFC8639 and RFC8641
Metadata	Non-standard. Partially among message content.	netconf-yang-notifications-versioning, draft-tgraf-netconf-notif-sequencing, draft-tgraf-yang-push-observation-time, draft-claise-opsawg-collected-data-manifest, draft-claise-netconf-metadata-for-collection
Versioning	Neither covered in subscription nor in publishing.	netmod-yang-module-versioning
YANG module	Non-standard widely adopted. IETF coverage non-existent.	Many RFC's defined

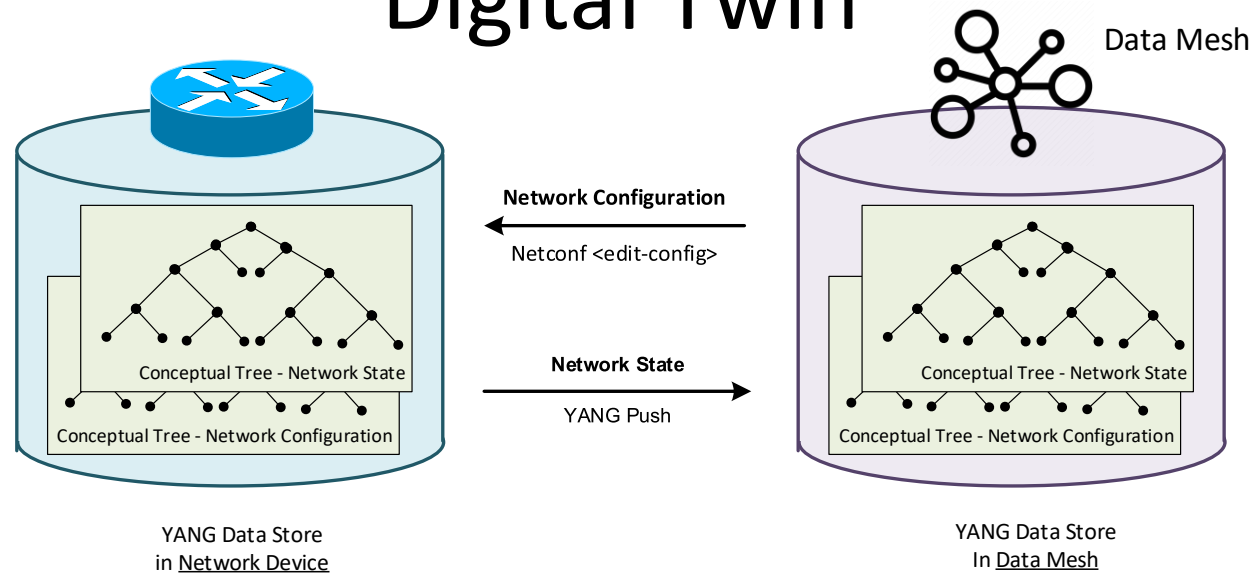


State of the Union  
From data **mess** to data **mesh**

# YANG datastores enabling Closed Loop Operation

**Automated** data onboarding with bounded context

## Digital Twin



YANG is a data modelling language which will not only transform how we managed our networks; it will transform also how we manage our services.

**News: 17 industry leading colleagues** from 4 network operators, 2 network and 3 analytics providers, and 3 universities **commit on a project to integrate YANG and CBOR into data mesh. IETF 116 public side meeting on Wednesday March 29<sup>th</sup> 12:00 – 12:45.**

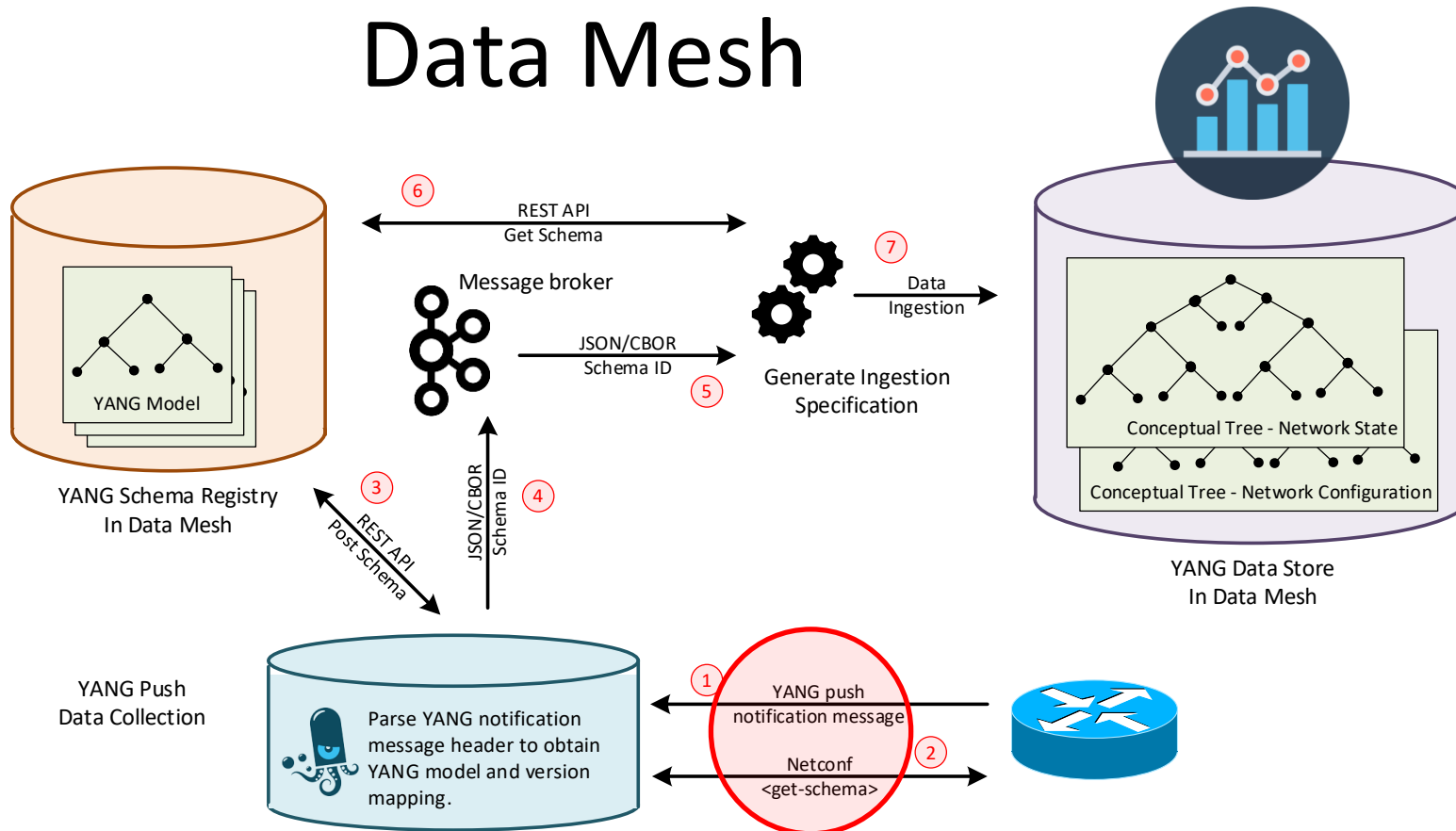
**Automated networks can only run with a common data model.** A digital twin YANG data store enables a comparison between intent and reality. Schema preservation enables closed loop operation. **Closed Loop is like an autopilot on an airplane.** We need to understand what the flight envelope is to keep the airplane within. Without, we crash.



# When Big Data and Network becomes **one**

Marrying two messaging protocols

## Data Mesh



- **Data Mesh** is a big data architecture where different domains can exchange data with a **bounded context** and **SLO's** are defined in Data Products. **Same principle as in networks.**
- **Semantics** are needed to describe the data. **A gauge32 is not the same as counter32.** Values can increase or decrease. Needs monotonic increasing counter normalization or not.
- **Versioning** is needed to not only understand that the semantic has changed, but also wherever the new semantic is backward compatible or not. **Preventing to break the data processing pipeline.**
- **Hostname, publisher ID, sequence numbers and observation timestamping** are needed to **measure loss and delay for SLO's.**
- **YANG push as defined in RFC8641 is missing hostname, sequence numbers, observation timestamping and versioning.** **draft-ahuang-netconf-notif-yang, draft-tgraf-netconf-notif-sequencing, draft-tgraf-yang-push-observation-time and draft-tgraf-netconf-yang-notifications-versioning** addresses this.



Lang  
KafKa

# Define **YANG module** for Netconf Notifications

## Closing the semantic gap

```
module: ietf-notification
```

```
  structure notification:  
    +-- eventTime      yang:date-and-time
```

```
<notification  
xmlns="urn:ietf:params:xml:ns:netconf:notification:1.0">  
<eventTime>2023-02-04T16:30:11.22Z</eventTime>  
<push-update xmlns="urn:ietf:params:xml:ns:yang:ietf-yang-push">  
  <id>1011</id>  
  <datastore-contents>  
    <interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-  
interfaces">  
      <interface>  
        <name>eth0</name>  
        <oper-status>up</oper-status>  
      </interface>  
    </interfaces>  
  </datastore-contents>  
</push-update>  
</notification>
```

- With RFC 5277 the XML schema for NETCONF event notification was defined.
- With **draft-ahuang-netconf-notif-yang** updates RFC 5277 by defining the schema as a YANG module.
- **This enables YANG-push to define semantics for the entire YANG push message and use other encodings than XML such as YANG-JSON RFC 7951 or YANG-CBOR RFC 9264.**

# Extend Streaming Update Notifications with **Hostname and Sequencing**

For push-update and push-change-update

```
module: ietf-notification-sequencing

augment-structure /inotif:notification:
  +-- sysName          inet:host
  +-- publisherId      yang:gauge32
  +-- sequenceNumber   yang:counter32

<notification
  xmlns="urn:ietf:params:xml:ns:netconf:notification:1.0">
  <eventTime>2023-02-04T16:30:11.22Z</eventTime>
  <sysName xmlns="urn:ietf:params:xml:ns:yang:ietf-notification-sequencing">
    example-router
  </sysName>
  <publisherId xmlns="urn:ietf:params:xml:ns:yang:ietf-notification-sequencing">
    1
  </publisherId>
  <sequenceNumber xmlns="urn:ietf:params:xml:ns:yang:ietf-notification-sequencing">
    187653
  </sequenceNumber>
  <push-update xmlns="urn:ietf:params:xml:ns:yang:ietf-yang-push">
    <id>1011</id>
    <datastore-contents>
      <interfaces xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces">
        <interface>
          <name>eth0</name>
          <oper-status>up</oper-status>
        </interface>
      </interfaces>
    </datastore-contents>
  </push-update>
</notification>
```

- When the **NETCONF event notification message is forwarded from the YANG push receiver to another system**, such as a messaging system or a time series database where the message is stored, the **transport context is lost since it is not part of the NETCONF event notification message metadata**. Therefore, the downstream system is unable to associate the message to the publishing process (the exporting router), nor able to detect message loss or reordering.
- **draft-tgraf-netconf-notif-sequencing** extends the NETCONF notification defined in RFC5277 with:
  - **sysName**: Describes the hostname following the 'sysName' object definition in RFC1213 from where the message was published from.
  - **publisherId**: netconf-distributed-notif describes the ability to publish from network processors directly. With this identifier the publishing process from where the message was published from can be uniquely identified.
  - **sequenceNumber**: Generates a unique sequence number as described in RFC9187 for each published message.

# Extend Streaming Update Notifications with **Observation Timestamping**

For push-update and push-change-update

```
module: ietf-yang-push-netobs-timestamping

augment /yp:push-update:
  +--ro observation-time?   yang:date-and-time
augment /yp:push-change-update:
  +--ro state-changed-observation-time? yang:date-and-time

{
  "ietf-notification:notification": {
    "eventTime": "2023-02-04T16:30:11.22Z",
    "sysName": "example-router",
    "sequenceNumber": 187653,
    "ietf-yang-push:push-update": {
      "id": 1011,
      "observation-time": "2023-02-04T16:30:09.44Z",
      "datastore-xpath-filter": "ietf-interfaces:interfaces",
      "datastore-contents": {
        "ietf-interfaces:interface": {
          "name": {
            "eth0": {
              "oper-status": "up"
            }
          }
        }
      }
    }
  }
}
```

- **To correlate network data** among different Network Telemetry planes as described in Section 3.1 of RFC9232 or among different YANG push subscription types defined in Section 3.1 of RFC8641, **network observation timestamping is needed to understand the timely relationship among these different planes and YANG push subscription types.**
- **draft-tgraf-yang-push-observation-time** extends the YANG push streaming update notification defined in RFC8641 with:
  - **observation-time:** Describes the measurement observation time for the "push-update" notification in a "periodical" subscription.
  - **state-changed-observation-time:** Describes in the "push-change-update" notification in an "on-change" subscription the time when the network state change was observed after the subscription was initially established. In case of an "on-change sync on start" subscription it describes the time when the network state change was observed before the subscription was established.

# Extend Datastore Selection and Subscription State Change Notifications with **revision** and **revision-label**

```
module: ietf-yang-push-revision
```

```
augment /sn:establish-subscription/sn:input/sn:target:
  +--rw revision?          rev:revision-date-or-label
  +-- revision-label?     ysver:version
augment /sn:modify-subscription/sn:input/sn:target:
  +--rw revision?          rev:revision-date-or-label
  +-- revision-label?     ysver:version
augment /sn:subscription-started/sn:target:
  +--ro revision           rev:revision-date-or-label
  +-- revision-label?     ysver:version
augment /sn:subscription-modified/sn:target:
  +--ro revision           rev:revision-date-or-label
  +-- revision-label?     ysver:version
augment /sn:subscriptions/sn:subscription/sn:target:
  +--ro revision           rev:revision-date-or-label
  +--rw revision-label?   ysver:version
```

```
{
  "ietf-restconf:notification" : {
    "eventTime": "2023-01-03T10:00:00Z",
    "ietf-subscribed-notifications:subscription-modified": {
      "id": 101,
      "revision": "2014-05-08",
      "revision-label": "1.0.0",
      "stream-xpath-filter": "/ietf-interfaces:interfaces",
      "stream": {
        "ietf-netconf-subscribed-notifications" : "NETCONF"
      }
    }
  }
}
```

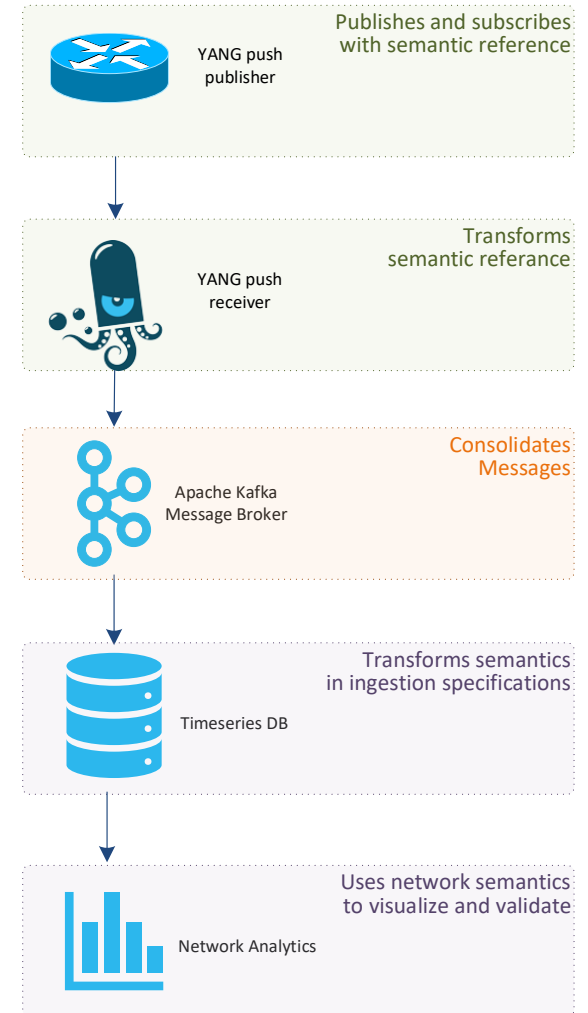
- **Network operators need to control semantics in its data processing pipeline. That includes YANG push.**
- This is today only possible during YANG push subscription but not when nodes are being upgraded or messages are being published for configured subscription.
- **draft-tgraf-netconf-yang-notifications-versioning** extends the YANG push subscription and publishing mechanism defined in RFC8641:
  - **By adding the ability to subscribe to a specific revision** or latest-compatible-semversion.
  - **By extending the YANG push Subscription State Change Notifications Message** so that the YANG push receiver learns beside the xpath and the sub-tree filter also the revision and revision-label.

# From YANG push to Analytics

## Next steps

- **Do you realize the gaps and how it could be resolved?**
  - By defining a YANG module for NETCONF notification and adding hostname, publisher ID, sequence number, observation time, revision and revision-label into YANG push-update and Subscription State Change notification messages an **automated data processing pipeline** which starts with YANG push, consolidates at Data Mesh and ends at Network Analytics would become at reach.
- **Collaborate** with different network operators, network and analytic vendors and universities on bringing YANG semantics into Apache Kafka.
- -> **What are your thoughts and comments?**
- -> **Interested to learn more? Join the IETF 116 public side meeting on Wednesday March 29<sup>th</sup> 12:00-12:45 or look at the project page:**

<https://github.com/graf3net/draft-daisy-kafka-yang-integration/blob/main/draft-daisy-kafka-yang-integration-03.md>



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