IEC/IEEE 60802
Subscribed Notifications / YANG Push

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Overview
Subscribed Notifications
YANG Push
Suggested Usage for 60802
Questions

Relevant RFCs for Event Notifications

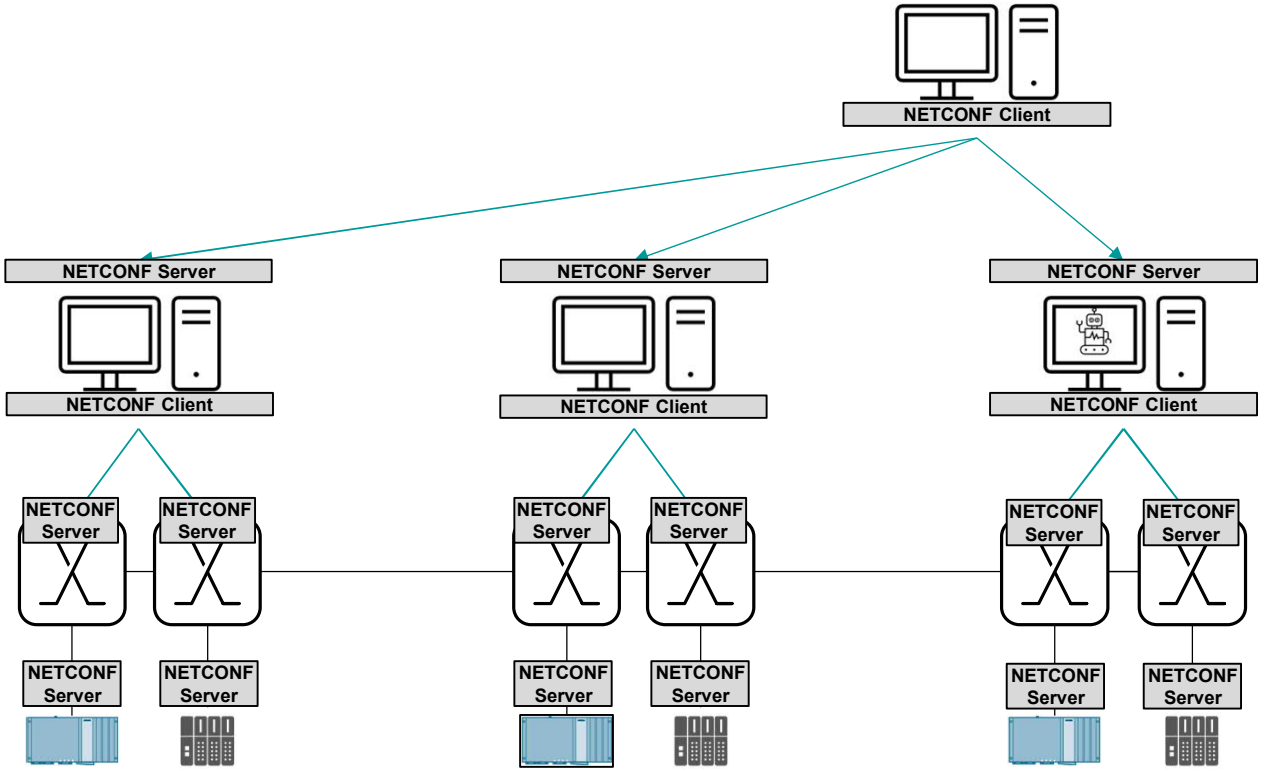
“Old” RFCs

- RFC 5277 “NETCONF Event Notifications”
  - First specification for event notifications
  - Polling required for data store update information
  - Only NETCONF supported
- RFC 7923 “Requirements for Subscriptions to YANG Datastores”
  - New pub/sub service for YANG datastore updates
  - Refinements of RFC 5277

Current RFC

- RFC 8639 “Subscription to YANG Notifications”
  - Describes a transport-agnostic mechanism for subscribing to and receiving content from an event stream in a publisher via a subscription
- RFC 8641 “Subscription to YANG Notifications for Datastore Updates”
  - expands RFC 8639 by a subscription service for datastore updates (YANG-Push)
- RFC 8640 “Dynamic Subscription to YANG Events and Datastores over NETCONF”

Hierarchical Architecture for Configuration
NETCONF Client / Server Relations



Orchestrator

API based on
Network YANG modules

Controller

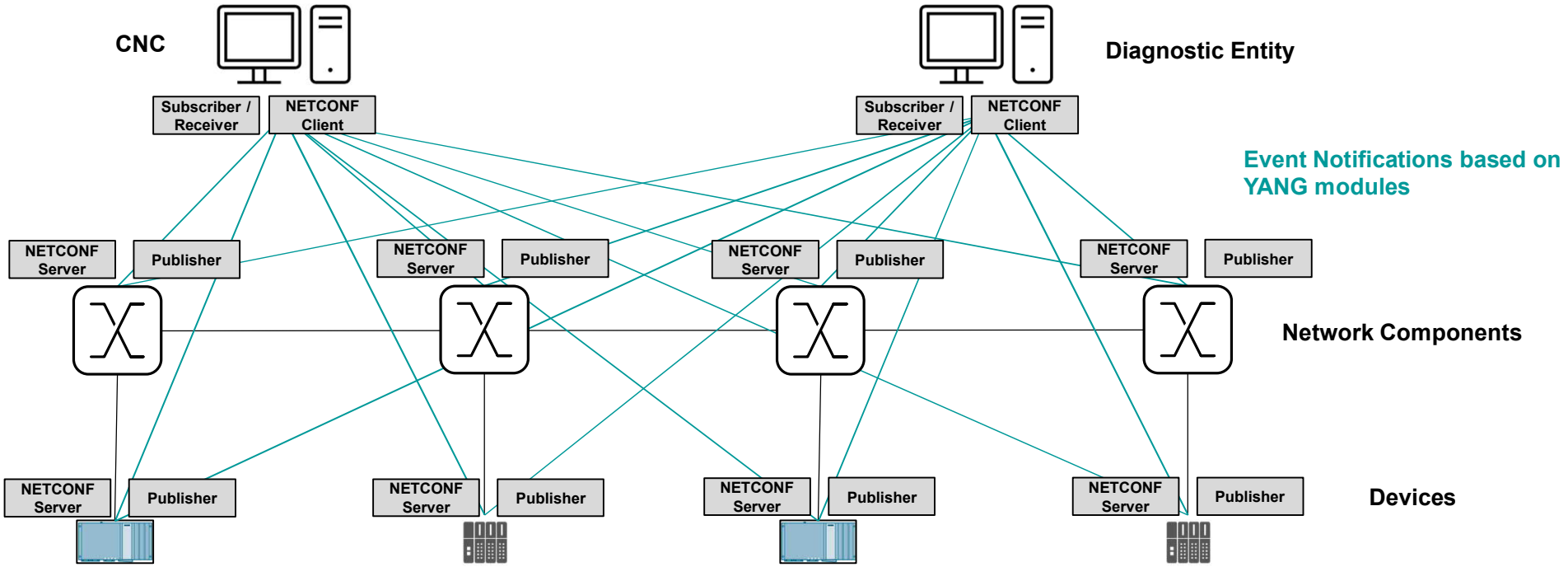
API based on
Network Element YANG modules

Network Components

Devices

Multiple API locations – all deduced from YANG modules

Hierarchical Architecture for Event Notifications
Publisher / Subscriber Relations



The Event Notification Architecture is similar to the configuration architecture but uses subscriptions

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Subscribed Notifications (RFC 8639)
NETCONF Protocol Layers

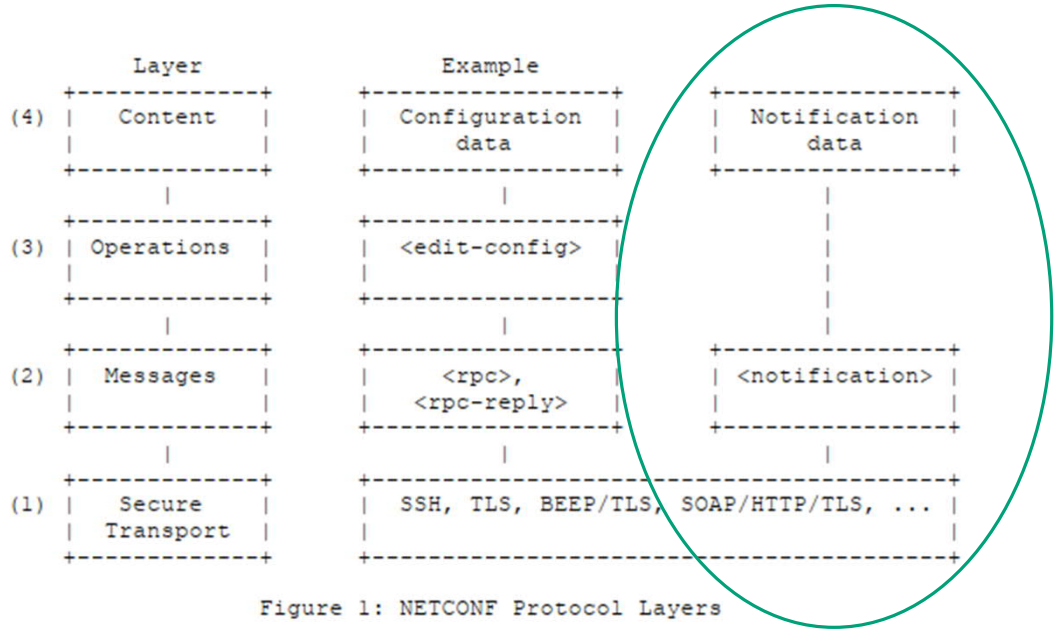


Figure 1: NETCONF Protocol Layers

- Client -> Server communication is RPC
- Server -> Client communication is notification

Source: RFC 6241 - NETCONF

Subscribed Notifications (RFC 8639)
Example: Subscribed Notification Message

```
<notification
       xmlns="urn:ietf:params:xml:ns:netconf:notification:1.0">
    <eventTime>2007-09-01T10:00:00Z</eventTime>
    <link-failure xmlns="https://acme.example.com/system">
        <if-name>so-1/2/3.0</if-name>
        <if-admin-status>up</if-admin-status>
        <if-oper-status>down</if-oper-status>
    </link-failure>
</notification>
```

Figure 10: Subscribed Notification Message

- Notification Message for a link-failure
- Parameters:
  - if-name
  - if-admin-status
  - if-oper-status
- Complete XML document

Source: RFC 8639 – Subscription to YANG Notifications

Subscribed Notifications (RFC 8639)
Dynamic Subscriptions vs. Configured Subscriptions

Dynamic Subscriptions

- The subscriber initiates a subscription via a NETCONF RPC mechanism
- If the publisher is able to serve the request, notification messages are sent from the publisher to the subscriber
- The lifetime of the subscription is bound by the transport session – the loss of the transport session will result in the immediate termination of any associated dynamic subscription if NETCONF is used
- Modifications can only be done through an RPC by the original subscriber
- This feature is mandatory in RFC 8639

Configured Subscriptions

- The subscriptions are configured based on options provided by YANG modules
- The notification messages are sent from the publisher to one or more (!) receivers
- The lifetime of the subscription is driven by configuration being present and persists across reboots and also if the publisher is disconnected from any network
- Modifications can be done by any configuration client with write permission
- This feature is optional in RFC 8639 and is advertised via the “configured” YANG feature

There is no mixing of dynamic and configured operations on a single subscription!

Subscribed Notifications (RFC 8639) Operations for Dynamic Subscriptions

Following RPC operations are defined for dynamic subscriptions in the “ietf-subscribed-notifications” YANG module

- establish-subscription
- modify-subscription
- delete-subscription
- kill-subscription

Subscribed Notifications (RFC 8639)
Subscription State Change Notifications

Following state change notifications are defined in the “ietf-subscribed-notifications” YANG module

- subscription-started
- subscription-modified
- subscription-terminated
- subscription-suspended
- subscription-resumed
- subscription-completed
- replay-completed

Subscribed Notifications (RFC 8639)
Publisher's State Machine for a Dynamic Subscription

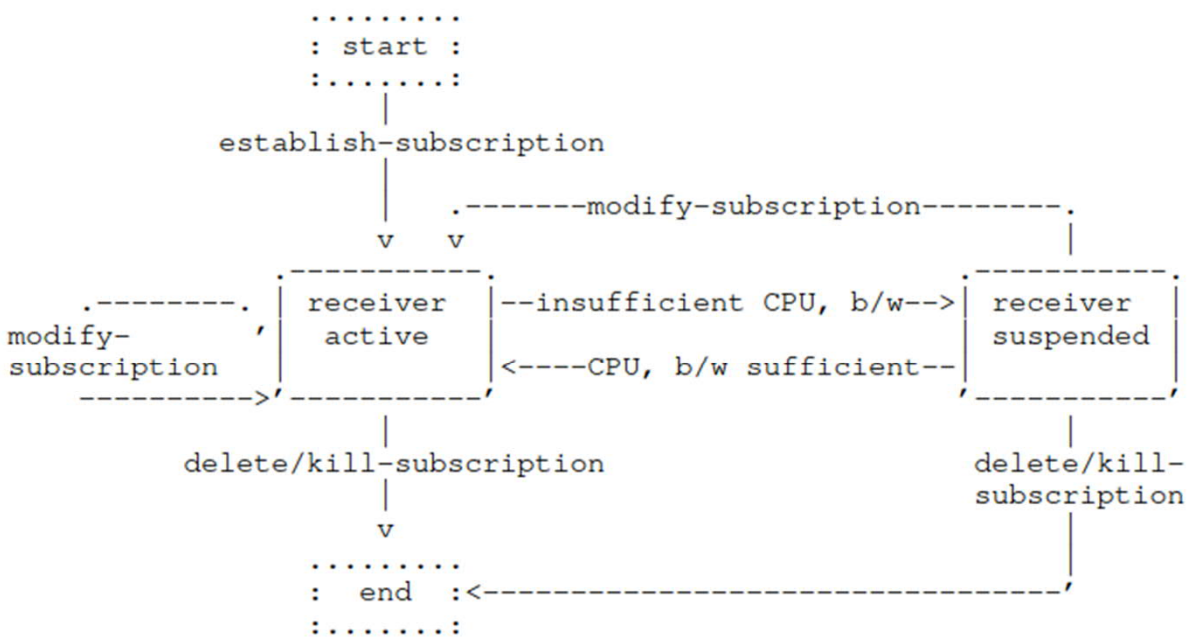
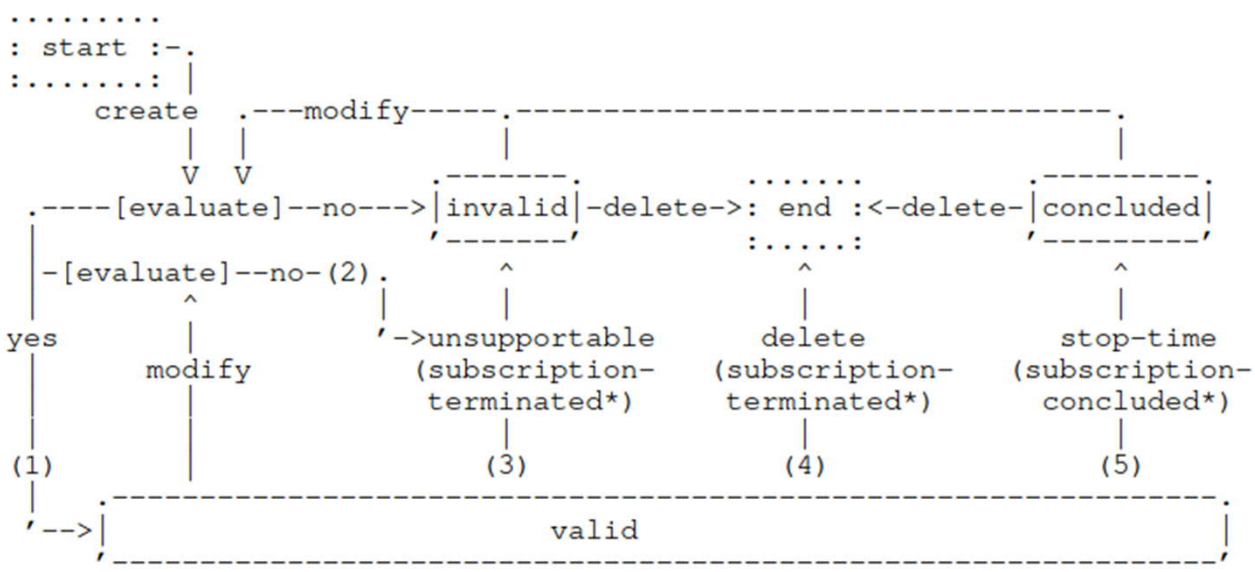


Figure 1: Publisher's State Machine for a Dynamic Subscription

Note: If the connection is terminated, the subscription also will implicitly be killed

Subscribed Notifications (RFC 8639)
Publisher's State Machine for a Configured Subscription



Legend:
  Dotted boxes: subscription added or removed via configuration
  Dashed boxes: states for a subscription
  [evaluate]: decision point on whether the subscription
              is supportable
  (*): resulting subscription state change notification

Figure 8: Publisher's State Machine for a Configured Subscription

Note: Configured subscriptions are independent from any active connection

Subscribed Notifications (RFC 8639)
Example “notification” Statement in YANG (Tree Diagram)

```
+---n subscription-started {configured}?
   +--ro id
   |       subscription-id
   +--ro (target)
   |  +--:(stream)
   |     +--ro (stream-filter)?
   |     |  +--:(by-reference)
   |     |  |  +--ro stream-filter-name
   |     |  |           stream-filter-ref
   |     |  +--:(within-subscription)
   |     |     +--ro (filter-spec)?
   |     |        +--:(stream-subtree-filter)
   |     |        |  +--ro stream-subtree-filter?   <anydata>
   |     |        |           {subtree}?
   |     |        +--:(stream-xpath-filter)
   |     |           +--ro stream-xpath-filter?     yang:xpath1.0
   |     |                    {xpath}?
   |     +--ro stream                               stream-ref
   |     +--ro replay-start-time?
   |     |       yang:date-and-time {replay}?
   |     +--ro replay-previous-event-time?
   |             yang:date-and-time {replay}?
   +--ro stop-time?
   |       yang:date-and-time
   +--ro dscp?                                      inet:dscp
   |       {dscp}?
   +--ro weighting?                                 uint8 {qos}?
   +--ro dependency?
   |       subscription-id {qos}?
   +--ro transport?                                 transport
   |       {configured}?
   +--ro encoding?                                  encoding
   +--ro purpose?                                   string
           {configured}?
```

Figure 11: "subscription-started" Notification Tree Diagram

- Notifications have to be defined in YANG models via “notification” statements
- There is no possibility to define new notifications dynamically

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YANG Push (RFC 8641) Subscription Model

Enhancements to “Subscribed Notifications”

- **Selection filters** to identify targeted YANG datastore nodes and/or subtrees for which updates are to be pushed
- Update policies
  - Periodic subscriptions
    - period interval
    - anchor-time (reference point in time)
  - on-change subscriptions
    - dampening period (optional) -> refers to update records for the same subscription
    - change-type (created, deleted, value changed)
    - sync-on-start -> sends a complete push-update of all subscribed data at the beginning of a subscription
- Encoding for the contents of push updates

YANG Push (RFC 8641)
Negotiation of Subscription Policies (for Dynamic Subscription Requests)

- The policy is submitted from the subscriber to the publisher at creation or modification of a subscription via RPC
- If the publisher cannot fulfill the required policy, the subscription should be declined by the publisher
- To avoid “random guessing of parameters” the publisher should add “hints” to the returned error-message
  - suggested periodic time intervals
  - acceptable dampening periods
  - size estimates
- There is no guarantee, that a subsequent request that considers the hints will be accepted!

YANG Push (RFC 8641)
“establish-subscription-datastore-error-info”

```
yang-data establish-subscription-datastore-error-info
  +--ro establish-subscription-datastore-error-info
     +--ro reason?                  identityref
     +--ro period-hint?             centiseconds
     +--ro filter-failure-hint?     string
     +--ro object-count-estimate?   uint32
     +--ro object-count-limit?      uint32
     +--ro kilobytes-estimate?      uint32
     +--ro kilobytes-limit?         uint32
```

Figure 3: "establish-subscription-datastore-error-info" Tree Diagram

YANG Push (RFC 8641)
On-Change Considerations

On-Change subscriptions

- Are particularly effective for data that changes infrequently and require minimal delay
- More difficult to implement than periodic subscriptions

Thus, they may not be supported by all implementations or for every object!

A publisher may accept on-change subscriptions even when it includes objects for which on-change is not supported!

- Updates are only sent for objects in the scope of the subscription that do support on-change updates, other updates are excluded from update records then
- It is the responsibility of the subscriber to cope with this fact

Alternatively, a publisher may decide to reject such an on-change subscription

YANG Push (RFC 8641)
Data Encoding

Periodic subscriptions

- Streaming through “push-update” notifications
  - An Update record is according to a regular retrieving operation

On-Change subscriptions

- Streaming through
  - “push-update” notifications at the start of a subscription or whenever the publisher chooses to resync
  - “push-change-update” notifications in case of changes
    - The encoding is according to YANG Patch operations (RFC 8072) but not limited to configuration data

YANG Push (RFC 8641)
Selection within a Datastore

There are two possible types of selection filters

- Subtree selection filter
  - It contains the possibility for Namespace Selection, Attribute Match Expressions, Containment Nodes, Selection Nodes and Content Match Nodes
  - This filter is described in detail in RFC 6241 (NETCONF Protocol)

- “XPath” selection filter
  - XPath is a query language for selecting nodes in an XML document
  - It provides powerful filtering constructs

A publisher must support at least one type of selection filter!

YANG Push (RFC 8641)
Receiver Authorization

- A publisher must ensure that no unauthorized data is included in push updates according to NACM
- It must silently remove any unauthorized data from datastore subtrees

-> same mechanism as regular retrieval operation (get)

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Suggested Usage for 60802

Usage and profiling of following RFCs

- RFC 8639 “Subscription to YANG Notifications”
- RFC 8641 “Subscription to YANG Notifications for Datastore Updates”
- RFC 8640 “Dynamic Subscription to YANG Events and Datastores over NETCONF”

Usage of On-change-Subscriptions for

- Change of link-state / MAU-type
- Change of sync-status

Usage of Periodic Time-Aligned Subscriptions for

- Statistic-counters
  - dropped frames
  - VLAN specific counters
- PoE, APL, PoDL state changes

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