NETCONF Support for Event Notifications
draft-ietf-netconf-netconf-event-notifications-06

Abstract

This document provides a NETCONF binding for [I-D. draft-ietf-netconf-subscribed-notifications]. Included are:

- Transport mappings for subscription RPCs, state change notifications, and notification messages
- Functionality which must be supported with NETCONF
- Examples in appendices

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on May 3, 2018.
1. Introduction
This document defines a binding for notification message delivery for [I-D.ietf-netconf-subscribed-notifications] transported over the NETCONF protocol [RFC6241]. In addition, as [I-D.ietf-netconf-yang-push] is itself built upon [I-D.ietf-netconf-subscribed-notifications], this document enables a NETCONF client to maintain a subset/extract of an actively changing YANG datastore located on a NETCONF server.

This document is broken into two main parts. The first contains normative requirements which are incremental to [I-D.ietf-netconf-subscribed-notifications] when NETCONF transport is used. The second are examples and are included as appendices.

2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

The following terms are defined in [I-D.ietf-netconf-subscribed-notifications]: notification message, stream, publisher, receiver, subscriber, subscription, configured subscription.

3. Interleave Capability

To support multiple subscriptions on a single session, a NETCONF publisher MUST support the :interleave capability as defined in [RFC5277]. Such support MUST be indicated by the following capability: "urn:ietf:params:netconf:capability:interleave:1.0". Advertisement of this capability along with support [I-D.ietf-netconf-subscribed-notifications] will indicate that a NETCONF publisher is able to receive, process, and respond to NETCONF requests and [I-D.ietf-netconf-subscribed-notifications] subscription operations on a session with active subscriptions.

4. Mandatory stream and datastore support
A NETCONF publisher supporting [I-D.draft-ietf-netconf-subscribed-notifications] MUST support the "NETCONF" event stream identified in that draft.

A NETCONF publisher supporting [I-D.ietf-netconf-yang-push] MUST support the "running" datastore as defined by [I.D.draft-ietf-netmod-revised-datastores].

5. Transport connectivity

5.1. Dynamic Subscriptions

For dynamic subscriptions, if the NETCONF session involved with the "establish-subscription" terminates, the subscription MUST be deleted.

5.2. Configured Subscriptions

For a configured subscription, there is no guarantee a transport session is currently in place with associated receiver(s). So where a configured subscription has a receiver in the connecting state, but no NETCONF transport exists to that receiver, the publisher MUST be able to initiate a NETCONF transport session via NETCONF call home [RFC8071], section 4.1 to that receiver. Until NETCONF connectivity is established and a subscription-started state change notification is successfully sent, that receiver MUST remain in its status of a "connecting".

If the call home fails because the publisher receives receiver credentials which are subsequently declined as part [RFC8071], Section 4.1, step S5 authentication, then that receiver MUST be assigned a "suspended" status.

If the call home fails to establish for any other reason, the publisher MAY leave the receiver in a "connecting" status, and retry the call home at a future time. Alternatively, the publisher MAY place the receiver into a "suspended" status after a predetermined
number of call home attempts.

NETCONF Transport session connectivity SHOULD be verified via Section 4.1, step S7.

Failure of an active NETCONF session MUST reset the call home process, and return the receiver to "connecting".

6. Notification Messages

Notification messages transported over NETCONF will be identical in format and content to those encoded using one-way operations defined within [RFC5277], section 4.

7. Security Considerations

Notification messages (including state change notifications) are never sent before the NETCONF capabilities exchange has completed.

If a malicious or buggy NETCONF subscriber sends a number of "establish-subscription" requests, then these subscriptions accumulate and may use up system resources. In such a situation, subscriptions MAY be terminated by terminating the suspect underlying NETCONF sessions. The publisher MAY also suspend or terminate a subset of the active subscriptions on the NETCONF session.

The NETCONF Authorization Control Model [RFC6536] SHOULD be used to control and restrict authorization of subscription configuration.

8. Acknowledgments

We wish to acknowledge the helpful contributions, comments, and suggestions that were received from: Andy Bierman, Yan Gang, Sharon Chisholm, Hector Trevino, Peipei Guo, Susan Hares, Tim Jenkins, Balazs Lengyel, Kent Watsen, and Guangying Zheng.

9. References

9.1. Normative References

[I-D.draft-ietf-netconf-subscribed-notifications]


9.2.  Informative References
Appendix A. Examples

A.1. Event Stream Discovery

As defined in [I-D. draft-ietf-netconf-subscribed-notifications] an event stream exposes a continuous set of events available for subscription. A NETCONF client can retrieve the list of available event streams from a NETCONF publisher using the "get" operation against the top-level container "/streams" defined in [I-D. draft-ietf-netconf-subscribed-notifications]. Any reply will include the stream identities supported on the NETCONF publisher which may be available to that client.

The following example illustrates the retrieval of the list of available event streams using the "get" operation.

```xml
<rpc message-id="101"
     xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <get>
    <filter type="subtree">
      <streams
    </filter>
  </get>
</rpc>
```
After such a request, the NETCONF publisher returns a list of event streams available. In the example reply below, the list contains just the NETCONF stream.

```
<rpc-reply message-id="101"
   xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
   <data>
     <streams
       xmlns="urn:ietf:params:xml:ns:yang:ietf-subscribed-notifications">
       <name>NETCONF</name>
     </streams>
   </data>
</rpc-reply>
```

Figure 2: Get streams response

A.2. Dynamic Subscriptions

The dynamic subscription RPCs and interactions operation are defined in [I-D.draft-ietf-netconf-subscribed-notifications] and enhanced in [I-D.ietf-netconf-yang-push].

A.2.1. Establishing Dynamic Subscriptions

An example of establish-subscription interactions over NETCONF transport for a sample subscription is described below:
If the NETCONF publisher can satisfy the request, the publisher sends a positive "subscription-result" element, and the subscription-id of the accepted subscription.

```xml
<rpc-reply message-id="102"
  xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <subscription-result
    xmlns="urn:ietf:params:xml:ns:yang:ietf-subscribed-notifications">
    ok
  </subscription-result>
  <identifier
    xmlns="urn:ietf:params:xml:ns:yang:ietf-subscribed-notifications">
    22
  </identifier>
</rpc-reply>
```

Figure 4: Successful establish-subscription

If the NETCONF publisher cannot satisfy the request, or subscriber has no authorization to establish the subscription, the publisher will send a negative "subscription-result" element. For instance:

```xml
<rpc-reply message-id="101"
  xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <subscription-result
    xmlns="urn:ietf:params:xml:ns:yang:ietf-subscribed-notifications">
    stream-unavailable
  </subscription-result>
</rpc-reply>
```

Figure 5: Unsuccessful establish subscription
To get an idea of the interaction model, the following figure shows two separate establish subscriptions RPC being made. The first is given subscription id 22, the second, id 23.

```
+------------+                 +-----------+
| Subscriber |                 | Publisher |
+------------+                 +-----------+
|                              |
|    Capability Exchange       |
|<---------------------------->|
|                              |
|    Establish Subscription    |
|----------------------------->|
| RPC Reply: OK, id = 22       |
|<-----------------------------|
|                              |
| notification message (for 22)|
|<-----------------------------|
|                              |
|    Establish Subscription    |
|----------------------------->|
| RPC Reply: OK, id = 23       |
|<-----------------------------|
|                              |
| notification message (for 22)|
|<-----------------------------|
| notification message (for 23)|
|<-----------------------------|
|                              |
```

Figure 6: Multiple subscription establishments over a single NETCONF session

In the example above, it is important to note that the subscription ids of 22 and 23 are not included in the notification messages of [I-D.ietf-netconf-yang-push]. However because [I-D.ietf-netconf-notification-messages] has defined its own notifications, subscription identifiers are available within those notification messages. With the availability of [I.D.ietf-netconf-notification-messages], all notification messages will be able to transport a subscription identifier.
A.2.2. Modifying Dynamic Subscriptions

The following demonstrates modifying a dynamic subscription. Consider a subscription from [I-D.ietf-netconf-yang-push]. An established may have a new filter applied. The desired modification is the application of a new filter.

```xml
<rpc message-id="102"
     xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <modify-subscription
      xmlns="urn:ietf:params:xml:ns:yang:ietf-subscribed-notifications"
    <yp:datastore>
      <yp:xpath-filter xmlns="http://example.com/datastore">
        /interfaces-state/interface/oper-status
      </yp:xpath-filter>
    </yp:datastore>
    <identifier>22</identifier>
  </modify-subscription>
</rpc>
```

Figure 7: Subscription modification

If the NETCONF publisher can satisfy the request, the publisher sends a positive "subscription-result". This response is like that to an establish-subscription request, but without the subscription identifier.

```xml
<rpc-reply message-id="102"
            xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <subscription-result
      xmlns="urn:ietf:params:xml:ns:yang:ietf-subscribed-notifications">
    ok
  </subscription-result>
</rpc-reply>
```

Figure 8: Successful modify-subscription
If the NETCONF publisher cannot satisfy the request, the publisher sends a negative "subscription-result" element. Its contents and semantics match those from an establish-subscription request.

To get an idea of the interaction model, the following figure shows a successful RPC modification request to subscription with an identifier of 22.

![Figure 9: Interaction model for successful subscription modification]

### A.2.3. Deleting Dynamic Subscriptions

The following demonstrates deleting a subscription.

```xml
<rpc message-id="103"
     xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <delete-subscription
       xmlns="urn:ietf:params:xml:ns:yang:ietf-subscribed-notifications">
    <identifier>22</identifier>
  </delete-subscription>
</rpc>
```

![Figure 10: Delete subscription]
If the NETCONF publisher can satisfy the request, the publisher sends an OK element. For example:

```xml
<rpc-reply message-id="103"
    xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <ok/>
</rpc-reply>
```

Figure 11: Successful delete subscription

If the NETCONF publisher cannot satisfy the request, the publisher sends an error-rpc element indicating the modification didn't work. One way this could happen is if an existing valid subscription identifier was given, but that subscription was created on a different NETCONF transport session:

```xml
<rpc-reply message-id="103"
    xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <rpc-error>
    <error-type>application</error-type>
    <error-tag>invalid-value</error-tag>
    <error-severity>error</error-severity>
      sn:identifier
    </error-path>
    <error-message xml:lang="en">
      no-such-subscription
    </error-message>
  </rpc-error>
</rpc-reply>
```

Figure 12: Unsuccessful delete subscription

### A.3 Configured Subscriptions

Configured subscriptions may be established, modified, and deleted using configuration operations against the top-level subtree of [I-D.draft-ietf-netconf-subscribed-notifications] or [I-D.ietf-netconf-yang-push].
In this section, we present examples of how to manage the configuration subscriptions using a NETCONF client. Key differences from dynamic subscriptions over NETCONF is that subscription lifetimes are decoupled from NETCONF sessions.

A.3.1. Creating Configured Subscriptions

For subscription creation, a NETCONF client may send:

```xml
<rpc message-id="201"
     xmlns="urn:ietf:params:xml:ns:netconf:base:1.0"
     xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0">
  <edit-config>
    <target>
      <running/>
    </target>
    <subscription-config
      xmlns="urn:ietf:params:xml:ns:yang:ietf-subscribed-notifications">
      <subscription>
        <identifier>22</identifier>
        <encoding>encode-xml</encoding>
        <stream>
          <name>NETCONF</name>
          <receiver>
            <address>1.2.3.4</address>
            <port>1234</port>
          </receiver>
        </stream>
      </subscription>
    </subscription-config>
  </edit-config>
</rpc>
```
Figure 13: Create a configured subscription

If the request is accepted, the publisher would reply:

```xml
<rpc-reply message-id="201"
    xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
    <ok/>
</rpc-reply>
```

Figure 14: Response to a successful configuration subscription establishment

If the request is not accepted because the publisher cannot serve it, no configuration is changed. In this case the publisher may reply:

```xml
<rpc-reply message-id="201"
    xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
    <rpc-error>
        <error-type>application</error-type>
        <error-tag>resource-denied</error-tag>
        <error-severity>error</error-severity>
        <error-message xml:lang="en">
            Temporarily the publisher cannot serve this subscription due to the current workload.
        </error-message>
    </rpc-error>
</rpc-reply>
```
Figure 15: Response to a failed configured subscription establishment

After a subscription has been created, NETCONF connectivity to each receiver's IP address and port will be established if it does not already exist. This will be accomplished via [RFC8071].

To get an idea of the interaction model, the following figure shows a successful configuration based creation of a subscription.

```
+----------+                 +-----------+     +---------+
|Config Ops|                 | Publisher |     | 1.2.3.4 |
+----------+                 +-----------+     +---------+
      |                            |                |
      |    Capability Exchange     |                |
      |<-------------------------->|                |
      |                            |                |
      |                            |                |
      |        Edit-config         |                |
      |--------------------------->|                |
      |       RPC Reply: OK        |                |
      |<---------------------------|                |
      |                            |   Call Home    |
      |                            |<-------------->|
      |                            |                |
      |                            |  Subscription  |
      |                            |  Started       |
      |                            |--------------->|
      |                            |                |
      |                            |  notification  |
      |                            |  message       |
      |                            |--------------->|
      |                            |                |
```

Figure 16: Interaction model for configured subscription establishment

A.3.2. Modifying Configured Subscriptions

Configured subscriptions can be modified using configuration operations against the top-level subtree subscription-config.
For example, the subscription established in the previous section could be modified as follows, here adding a second receiver:

```xml
<rpc message-id="202"
     xmlns="urn:ietf:params:xml:ns:netconf:base:1.0"
     xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0">
    <edit-config>
       <target>
          <running/>
       </target>
       <subscription-config
            xmlns="urn:ietf:params:xml:ns:yang:ietf-subscribed-notifications">
          <subscription>
             <identifier>
                1922
             </identifier>
             <receiver>
                <address>
                   1.2.3.5
                </address>
                <port>
                   1234
                </port>
             </receiver>
          </subscription>
       </subscription-config>
    </edit-config>
</rpc>
```

Figure 17: Modify configured subscription

If the request is accepted, the publisher would reply:

```xml
<rpc-reply message-id="202"
           xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
   <ok/>
</rpc-reply>
```

Figure 18: A successful configured subscription modification

And the previous interaction model would be extended as follows.
A.3.3. Deleting Configured Subscriptions

Configured subscriptions can be deleted using configuration operations against the top-level subtree subscription-config. Deleting the subscription above would result in the following flow impacting all receivers.

Note in the above that in the specific example above, modifying a configured subscription actually resulted in subscription-started notification. If the edit of the configuration had also added a filter, a separate modify-subscription would have gone to the original receiver.
A.4. Subscription State Notifications

A publisher will send subscription state notifications according to the definitions within [I-D.draft-ietf-netconf-subscribed-notifications]).

A.4.1. subscription-started and subscription-modified

A subscription-started over NETCONF encoded in XML would look like:
<notification
   xmlns="urn:ietf:params:xml:ns:netconf:notification:1.0">
   <eventTime>2007-09-01T10:00:00Z</eventTime>
   <subscription-started
      xmlns="urn:ietf:params:xml:ns:yang:ietf-subscribed-notifications">
      <identifier>39</identifier>
      <encoding>encode-xml</encoding>
      <stream>
         <name>NETCONF</name>
         <xpath-filter xmlns:ex="http://example.com/events">
            /ex:foo
         </xpath-filter>
      </stream>
   </subscription-started/>
</notification>

Figure 21: subscription-started subscription state notification

The subscription-modified is identical, with just the word "started" being replaced by "modified".

A.4.2. subscription-completed, subscription-resumed, and replay-complete

A subscription-completed would look like:

<notification
   xmlns="urn:ietf:params:xml:ns:netconf:notification:1.0">
   <eventTime>2007-09-01T10:00:00Z</eventTime>
   <subscription-completed
      xmlns="urn:ietf:params:xml:ns:yang:ietf-subscribed-notifications">
      <identifier>39</identifier>
   </subscription-completed>
</notification>
The subscription-resumed and replay-complete are virtually identical, with "subscription-completed" simply being replaced by "subscription-resumed" and "replay-complete" in both encodings.

A.4.3. subscription-terminated and subscription-suspended

A subscription-terminated would look like:

```xml
<notification
 xmlns="urn:ietf:params:xml:ns:netconf:notification:1.0">
 <eventTime>2007-09-01T10:00:00Z</eventTime>
 <subscription-terminated
 xmlns="urn:ietf:params:xml:ns:yang:ietf-subscribed-notifications">
   <identifier>39</identifier>
   <error-id>
     unsupportable-volume
   </error-id>
 </subscription-terminated>
</notification>
```

Figure 23: subscription-terminated subscription state notification

The subscription-suspended is virtually identical, with "subscription-terminated" simply being replaced by "subscription-suspended".

Appendix B. Changes between revisions

(To be removed by RFC editor prior to publication)

B.1. v05 to v06

- Moved examples to appendices
All examples rewritten based on namespace learnings

Normative text consolidated in front

Removed all mention of JSON

Call home process detailed

Note: this is a major revision attempting to cover those comments received from two week review.

### B.2. v03 to v04

- Added additional detail to "configured subscriptions"
- Added interleave capability
- Adjusted terminology to that in `draft-ietf-netconf-subscribed-notifications`
- Corrected namespaces in examples

### B.3. v01 to v03

- Text simplifications throughout
- v02 had no meaningful changes

### B.4. v00 to v01

- Added Call Home in solution for configured subscriptions.
- Clarified support for multiple subscription on a single session. No need to support multiple create-subscription.
- Added mapping between terminology in `yang-push` and [RFC6241] (the one followed in this document).
- Editorial improvements.
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