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NETCONF Event Notifications
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Abstract

This document defines mechanisms which provide an asynchronous message notification delivery service for the NETCONF protocol. This is an optional capability built on top of the base NETCONF definition. This document defines the capabilities and operations necessary to support this service.

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1. Introduction

[NETCONF] can be conceptually partitioned into four layers:

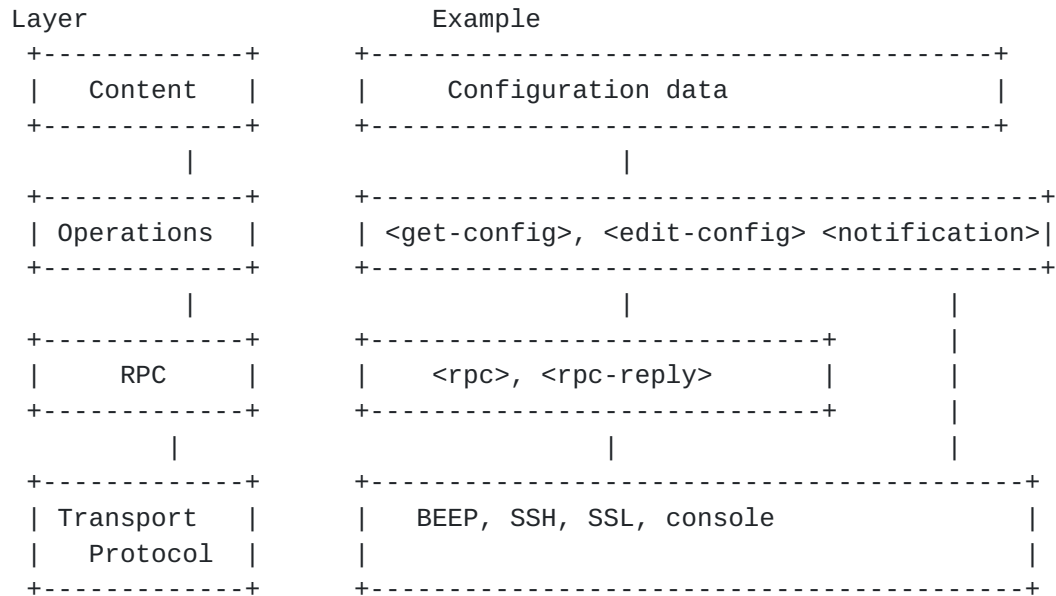


Figure 1

This document defines mechanisms which provide an asynchronous message notification delivery service for the [NETCONF] protocol. This is an optional capability built on top of the base NETCONF definition. This memo defines the capabilities and operations necessary to support this service.

1.1. Definition of Terms

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 [RFC2119].

Element: An [XML] Element.

Subscription: An agreement and method to receive event notifications over a NETCONF session. A concept related to the delivery of notifications (if any to send) involving destination and selection of notifications. It is bound to the lifetime of a session.

Operation: This term is used to refer to NETCONF protocol operations [NETCONF]. Specifically within this document, operation refers to NETCONF protocol operations defined in support of NETCONF notifications.

Event: An event is something that happens which may be of interest - a configuration change, a fault, a change in status, crossing a threshold, or an external input to the system, for example. Often this results in an asynchronous message, sometimes referred to as a notification or event notification, being sent to interested parties to notify them that this event has occurred.

Replay: The ability to send/re-send previously logged notifications upon request. These notifications are sent asynchronously. This feature is implemented by the NETCONF server and invoked by the NETCONF client.

Stream: An event stream is a set of event notifications matching some forwarding criteria and it is available to NETCONF clients for subscription.

Filter: A parameter that indicates which subset of all possible events are of interest.

1.2. Motivation

The motivation for this work is to enable the sending of asynchronous messages that are consistent with the data model (content) and security model used within a NETCONF implementation.

1.3. Event Notifications in NETCONF

This memo defines a mechanism whereby the NETCONF client indicates interest in receiving event notifications from a NETCONF server by creating a subscription to receive event notifications. The NETCONF server replies to indicate whether the subscription request was successful and, if it was successful, begins sending the event notifications to the NETCONF client as the events occur within the system. These event notifications will continue to be sent until either the NETCONF session is terminated or the subscription terminates for some other reason. The event notification subscription allows a number of options to enable the NETCONF client to specify which events are of interest. These are specified when the subscription is created.

A NETCONF server is will not read RPC requests, by default, on the session associated with the subscription until the notification subscription is done. A capability may be advertised to announce that a server is able to process RPCs while a notification stream is active on a session. The behaviour of such a capability is outside the scope of this document.

1.4. Requirements

The following requirements have been addressed by the solution:

- o Initial release should ensure it supports notification in support of configuration operations
- o Data content must not preclude the use of the same data model as used in configuration
- o Solution should support a reasonable message size limit (ie, not too short)
- o Solution should provide reliable delivery of notifications
- o Solution should provide a subscription mechanism (A NETCONF server does not send notifications before being asked to do so and the NETCONF client initiates the flow of notifications)
- o Solution should provide a filtering mechanism within the NETCONF server
- o Solution should send sufficient information in a notification so that it can be analyzed independent of the transport mechanism (data content fully describes a notification; protocol information is not needed to understand a notification)
- o Solution should support replay of locally logged notifications

2. Notification-Related Operations

2.1. Subscribing to Receive Event Notifications

The event notification subscription is initiated by the NETCONF client and responded to by the NETCONF server. When the event notification subscription is created, the events of interest are specified.

Content for an event notification subscription can be selected by applying user-specified filters.

2.1.1. <create-subscription>

Description:

This operation initiates an event notification subscription which will send asynchronous event notifications to the initiator of the command until the subscription terminates.

Parameters:

Stream:

An optional parameter that indicates which stream of events is of interest. If not present, then events in the default NETCONF stream will be sent.

Filter:

An optional parameter that indicates which subset of all possible events are of interest. The format of this parameter is the same as that of the filter parameter in the NETCONF protocol operations. If not present, all events not precluded by other parameters will be sent. See [section 3.6](#) for more information on filters.

Start Time:

A parameter used to trigger the replay feature and indicate that the replay should start at the time specified. If `startTime` is not present, this is not a replay subscription. It is valid to specify start times that are later than the current time. If the `startTime` specified is earlier than the log can support, the replay will begin with the earliest available notification. This parameter is of type `dateTime`.

Stop Time:

An optional parameter used with the optional replay feature to indicate the newest notifications of interest. If stop time is not present, the notifications will continue until the subscription is terminated. Must be used with and be later than 'startTime'. It is valid to specify stop times that are later than the current time. This parameter is of type dateTime.

Positive Response:

If the NETCONF server can satisfy the request, the server sends an <ok> element.

Negative Response:

An <rpc-error> element is included within the <rpc-reply> if the request cannot be completed for any reason. Subscription requests will fail if a filter with invalid syntax is provided or if the name of a non-existent profile or stream is provided.

If a stopTime is specified in a request without having specified a startTime the following error is returned:

Tag: missing-element

Error-type: protocol

Severity: error

Error-info: <badElement>: startTime

Description: An expected element is missing.

If the optional replay feature is requested but it is not supported by the NETCONF server, the following error is returned:

Tag: operation-failed

Error-type: protocol

Severity: error

Error-info: none

Description: Request could not be completed because the requested operation failed for some reason not covered by any other error condition

2.1.1.1. Usage Example

```
<netconf:rpc message-id="101"
  xmlns:netconf="urn:ietf:params:xml:ns:netconf:base:1.0">
  <create-subscription
    xmlns="urn:ietf:params:netconf:capability:notification:1.0">
    </create-subscription>
  </netconf:rpc>
```

Figure 2

2.2. Sending Event Notifications

Once the subscription has been set up, the NETCONF server sends the event notifications asynchronously over the connection.

2.2.1. <notification>

Description:

An event notification is sent to the client who initiated a <create-subscription> command asynchronously when an event of interest (i.e., meeting the specified filtering criteria) to them has occurred. An event notification is a complete and well-formed XML document. Note that <notification> is not an RPC method but rather the top level element identifying the one way message as a notification.

Parameters:

Contains notification-specific tagged content. The content of the data tag is beyond the scope of this document.

Response:

No response. Not applicable.

2.3. Terminating the Subscription

Closing of the event notification subscription can be done by terminating the NETCONF session (`<kill-session>`) or the underlying transport session. If a stop time is provided when the subscription is created, then the subscription will terminate after the stop time is reached. In this case, the NETCONF session will still be an active session.

3. Supporting Concepts

3.1. Capabilities Exchange

The ability to process and send event notifications is advertised during the capability exchange between the NETCONF client and server.

3.1.1. Capability Identifier

"urn:ietf:params:netconf:capability:notification:1.0"

3.1.2. Capability Example

```
<hello xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <capabilities>
    <capability>
      urn:ietf:params:xml:ns:netconf:base:1.0
    </capability>
    <capability>
      urn:ietf:params:netconf:capability:startup:1.0
    </capability>
    <capability>
      urn:ietf:params:netconf:capability:notification:1.0
    </capability>
  </capabilities>
  <session-id>4</session-id>
</hello>
```

Figure 3

3.2. Event Streams

An event stream is defined as a set of event notifications matching some forwarding criteria.

The diagram depicted in Figure 2 illustrates the notification flow and concepts identified in this document. The following is observed from the diagram below: System components (c1..cn) generate event notifications which are passed to a central component for classification and distribution. The central component inspects each event notification and matches the event notification against the set of stream definitions. When a match occurs, the event notification is considered to be a member of that event stream (stream 1..stream n). An event notification may be part of multiple event streams.

When a NETCONF client subscribes to a given event stream, user-

defined filters, if applicable, are applied to the event stream and matching event notifications are forwarded to the NETCONF server for distribution to subscribed NETCONF clients. For more information on filters, see [section 3.6](#).

A notification logging service may also be available, in which case, the central component logs notifications. The NETCONF server may later retrieve logged notifications via the optional replay feature. For more information on replay, see [section 3.3](#).

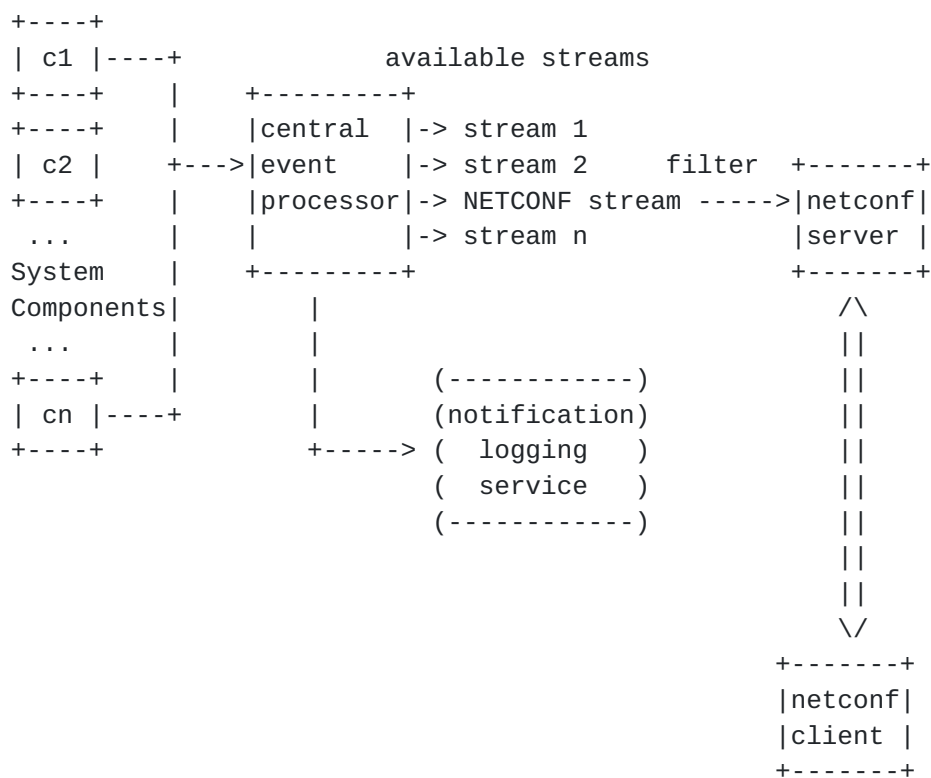


Figure 4

[3.2.1](#). Event Stream Definition

Event streams are predefined on the managed device. The configuration of event streams is outside the scope of this document. However, it is envisioned that event streams are either pre-established by the vendor (pre-configured) or user configurable (e.g., part of the device's configuration) or both. Device vendors may allow event stream configuration via NETCONF protocol (i.e., edit-config operation).

3.2.2. Event Stream Content Format

The contents of all event streams made available to a NETCONF client (i.e., the notification sent by the NETCONF server) must be encoded in XML.

3.2.3. Default Event Stream

A NETCONF server implementation supporting the notification capability must support the "NETCONF" notification event stream. This stream contains all NETCONF XML event notifications supported by the NETCONF server. The definition of the event notifications and their contents for this event stream is outside the scope of this document.

3.2.4. Event Stream Sources

With the exception of the default event stream (NETCONF notifications) specification of additional event stream sources (e.g., SNMP, syslog, etc.) is outside the scope of this document. NETCONF server implementations may leverage any desired event stream source in the creation of supported event streams.

3.2.5. Event Stream Discovery

A NETCONF client retrieves the list of supported event streams from a NETCONF server using the <get> RPC request.

3.2.5.1. Name Retrieval using <get> operation

The list of available event streams is retrieved by requesting the <eventStreams> subtree via a <get> operation. Available event streams for the requesting session are returned in the reply containing the <name> and <description> elements, where the <name> element is mandatory and its value is unique within the scope of a NETCONF server. The returned list must only include the names of those event streams for which the NETCONF session has sufficient privileges. The NETCONF session privileges are determined via access control mechanisms which are beyond the scope of this document. An empty reply is returned if there are no available event streams. The information is retrieved by requesting the <eventStreams> subtree via a <get> operation.

Example: Retrieving available event stream list using <get> operation:

```
<rpc message-id="101"
  xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">

  <get>
    <filter type="subtree">
      <eventStreams xmlns="urn:ietf:params:xml:ns:netmod:notification"/>
    </filter>
  </get>
</rpc>
```

Figure 5

The NETCONF server returns a list of event streams available for subscription: NETCONF, SNMP, and syslog-critical in this example.

```
<rpc-reply message-id="101"
  xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <data>
    <eventStreams xmlns="urn:ietf:params:xml:ns:netmod:notification">
      <stream>
        <name>NETCONF</name>
        <description>Default netconf event stream
        </description>
        <replaySupport>true</replaySupport>
        <replayLogStartTime>2007-07-08T00:00:00Z</replayLogStartTime>
      </stream>
      <stream>
        <name>SNMP</name>
        <description>SNMP notifications</description>
        <replaySupport>false</replaySupport>
      </stream>
      <stream>
        <name>syslog-critical</name>
        <description>Critical and higher severity
        </description>
        <replaySupport>true</replaySupport>
        <replayLogStartTime>2007-07-01T00:00:00Z</replayLogStartTime>
      </stream>
    </eventStreams>
  </data>
</rpc-reply>
```


Figure 6

3.2.5.2. Event Stream Subscription

A NETCONF client may request from the NETCONF server the list of event streams available to this session and then issue a <create-subscription> request with the desired event stream name. Omitting the event stream name from the <create-subscription> request results in subscription to the default NETCONF event stream.

3.2.5.2.1. Filtering Event Stream Contents

The set of event notifications delivered in an event stream may be further refined by applying a user-specified filter at subscription creation time (<create-subscription>). This is a transient filter associated with the event notification subscription and does not modify the event stream configuration.

XPATH support for the Notification capability is advertised as part of the normal XPATH capability advertisement. If XPATH support is advertised via the XPATH capability then XPATH is supported for notification filtering and if this capability is not advertised, then XPATH is not supported for notification filtering.

3.3. Notification Replay

3.3.1. Overview

Replay is the ability to create an event subscription that will resend recently generated notifications, or in some cases send them for the first time to a particular NETCONF client. These notifications are sent the same way as normal notifications.

A replay of notifications is specified by including an optional parameter to the subscription command that indicates the start time of the replay. The end time is specified using the optional stopTime parameter. If not present, notifications will continue to be sent until the subscription is terminated.

A notification stream that supports replay is not expected to have an unlimited supply of saved notifications available to accommodate any replay request.

The actual number of stored notifications available for retrieval at any given time is a NETCONF server implementation specific matter. Control parameters for this aspect of the feature are outside the scope of the current document.

Replay is dependent on a notification stream supporting some form of notification logging, although it puts no restrictions on the size or form of the log, nor where it resides within the device. Whether or not a stream supports replay can be discovered by doing a <get> operation on the eventStreams element of the Notification Management Schema. This schema also provides the replayLogStartTime element to indicate the earliest available logged notification.

3.3.2. Creating a Subscription with Replay

This feature uses optional parameters to the <create-subscription> command called 'startTime' and 'stopTime'. 'startTime' identifies the earliest date and time of interest for event notifications being replayed and also indicates that a subscription will be providing replay of notifications. Events generated before this time are not matched. 'stopTime' specifies the latest date and time of interest for event notifications being replayed. If it is not present, then notifications will continue to be sent until the subscription is terminated.

Note that startTime and stopTime are associated with the time an event was generated by the system.

A replayComplete notification is sent to indicate that all of the replay notifications have been sent. If this subscription has a stop time, then this session becomes a normal NETCONF session again. In the case of a subscription without a stop time, after the replayComplete notification has been sent, it can be expected that any notifications generated since the start of the subscription creation will be sent followed by notifications as they arise naturally within the system.

3.3.3. Replay Complete Notification

The replayComplete notification is the last notification sent over a replay subscription. It indicates that replay is complete. After this notification is received the subscription is terminated and the session becomes normal command-response NETCONF session.

The replayComplete can not be filtered out. It will always be sent on a relay subscription that specified a stop time.

3.4. Notification Management Schema

This Schema is used to learn about the event streams supported on the system. It also contains the definition of the replayComplete, which is sent to indicate that an event replay has sent all applicable notifications."


```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:netconf="urn:ietf:params:xml:ns:netconf:base:1.0"
  xmlns:ncEvent="urn:ietf:params:netconf:capability:notification:1.0"
  xmlns:manageEvent="urn:ietf:params:xml:ns:netmod:notification"
  targetNamespace="urn:ietf:params:xml:ns:netmod:notification"
  elementFormDefault="qualified"
  attributeFormDefault="unqualified">
  <xs:annotation>
    <xs:documentation xml:lang="en">
      A schema that can be used to learn about current
      event streams. It also
      contains the replayComplete notification.
    </xs:documentation>
  </xs:annotation>

  <xs:import namespace="http://www.w3.org/XML/1998/namespace"
    schemaLocation="http://www.w3.org/2001/xml.xsd"/>
  <xs:import namespace="urn:ietf:params:xml:ns:netconf:base:1.0"
    schemaLocation=
      "http://www.iana.org/assignments/xml-registry/schema/netconf.xsd"/>
  <xs:import namespace=
    "urn:ietf:params:netconf:capability:notification:1.0"
    schemaLocation=
      "http://www.iana.org/assignments/xml-registry/schema/notification.xsd"/>

  <xs:element name="netconf" type="manageEvent:Netconf"/>

  <xs:complexType name="Netconf">
    <xs:sequence>
      <xs:element name="eventStreams" >
        <xs:annotation>
          <xs:documentation>
            The list of event streams supported by the
            system. When a query is issued, the returned
            set of streams is determined based on user
            privileges.
          </xs:documentation>
        </xs:annotation>
        <xs:complexType>
          <xs:sequence minOccurs="0" maxOccurs="unbounded">
            <xs:element name="stream">
              <xs:annotation>
                <xs:documentation>
                  Stream name and description.
                </xs:documentation>
              </xs:annotation>
            
```



```
<xs:complexType>
  <xs:sequence>
    <xs:element name="name" type="xs:string"/>
    <xs:element name="description"
      type="xs:string"/>
    <xs:element name="replaySupport"
      type="xs:boolean"/>
    <xs:element name="replayLogStartTime"
      type="xs:dateTime" minOccurs="0">
      <xs:annotation>
        <xs:documentation>
          The start time of the log used to
          support the replay function. This
          object MUST be present if replay is
          supported.
        </xs:documentation>
      </xs:annotation>
    </xs:element>
  </xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>

<xs:complexType name="ReplayCompleteNotificationType">
  <xs:complexContent>
    <xs:extension base="ncEvent:NotificationContentType"/>
  </xs:complexContent>
</xs:complexType>

<xs:element name="replayComplete"
  type="manageEvent:ReplayCompleteNotificationType"
  substitutionGroup="ncEvent:notificationContent">
  <xs:annotation>
    <xs:documentation>
      This notification is sent to signal the end of a replay
      portion of a subscription.
    </xs:documentation>
  </xs:annotation>
</xs:element>
</xs:schema>
```

Figure 7

3.5. Subscriptions Data

While it may be possible to retrieve information about subscriptions via a get operation, subscriptions are not stored configuration. They are non-persistent state information and their lifetime is defined by their session.

3.6. Filter Mechanics

When multiple filter elements are specified, they are applied collectively, so event notifications need to pass all specified filters in order to be sent to the subscriber. If a filter element is specified to look for data of a particular value, and the data item is not present within a particular event notification for its value to be checked against, the notification will be filtered out. For example, if one were to check for 'severity=critical' in a configuration event notification where this field was not supported, then the notification would be filtered out.

The order that filter elements are applied does not matter since the resulting set of notifications is the intersection of the set of notifications that pass each filtering criteria.

3.6.1. Filtering

Filtering is explicitly stated when the event notification subscription is created. This is specified via the 'filter' parameter. Filters only exist as parameters to the subscription.

3.7. Message Flow

The following figure depicts message flow between a NETCONF client (C) and NETCONF server (S) in order create a subscription and begin the flow of notifications. It is possible that many rpc/rpc-reply sequences occur before the subscription is created or after a stopTime in a replay subscription, but this is not depicted in the figure.

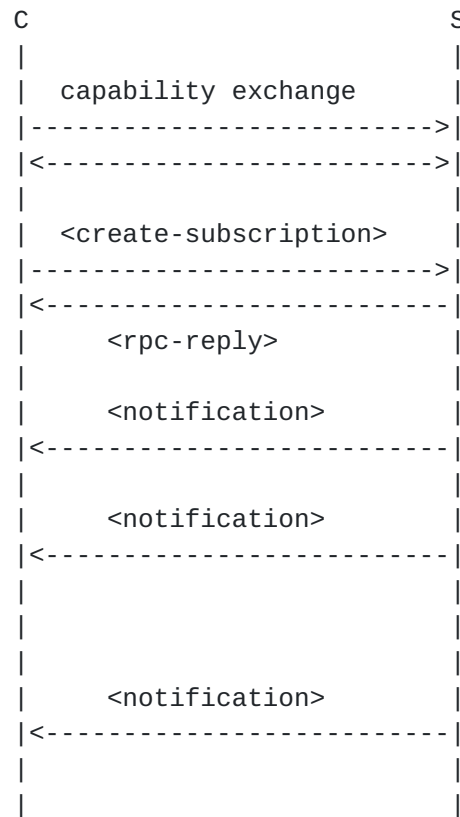


Figure 8

4. XML Schema for Event Notifications

The following [XML Schema] defines NETCONF Event Notifications.

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns="urn:ietf:params:netconf:capability:notification:1.0"
  xmlns:netconf="urn:ietf:params:xml:ns:netconf:base:1.0"
  targetNamespace=
    "urn:ietf:params:netconf:capability:notification:1.0"
  elementFormDefault="qualified"
  attributeFormDefault="unqualified"
  xml:lang="en">

  <!-- import standard XML definitions -->

  <xs:import namespace="http://www.w3.org/XML/1998/namespace"
    schemaLocation="http://www.w3.org/2001/xml.xsd">
    <xs:annotation>
      <xs:documentation>
        This import accesses the xml: attribute groups for the
        xml:lang as declared on the error-message element.
      </xs:documentation>
    </xs:annotation>
  </xs:import>

  <!-- import base netconf definitions -->
  <xs:import namespace="urn:ietf:params:xml:ns:netconf:base:1.0"
    schemaLocation=
      "http://www.iana.org/assignments/xml-registry/schema/netconf.xsd"/>

  <!-- ***** Symmetrical Operations *****-->

  <!-- <create-subscription> operation -->

  <xs:complexType name="createSubscriptionType">
    <xs:complexContent>
      <xs:extension base="netconf:rpcOperationType">
        <xs:sequence>
          <xs:element name="stream"
            type="streamNameType" minOccurs="0">
            <xs:annotation>
              <xs:documentation>
                An optional parameter that indicates
```



```
        which stream of events is of interest. If
        not present, then events in the default
        NETCONF stream will be sent.
    </xs:documentation>
</xs:annotation>
</xs:element>
<xs:element name="filter"
    type="netconf:filterInlineType"
    minOccurs="0">
    <xs:annotation>
        <xs:documentation>
            An optional parameter that indicates
            which subset of all possible events
            are of interest. The format of this
            parameter is the same as that of the
            filter parameter in the NETCONF
            protocol operations. If not present,
            all events not precluded by other
            parameters will be sent.
        </xs:documentation>
    </xs:annotation>
</xs:element>
<xs:element name="startTime" type="xs:dateTime"
    minOccurs="0" >
    <xs:annotation>
        <xs:documentation>
            A parameter used to trigger the replay
            feature and indicates that the replay
            should start at the time specified. If
            start time is not present, this is not a
            replay subscription.
        </xs:documentation>
    </xs:annotation>
</xs:element>
<xs:element name="stopTime" type="xs:dateTime"
    minOccurs="0" >
    <xs:annotation>
        <xs:documentation>
            An optional parameter used with the
            optional replay feature to indicate the
            newest notifications of interest. If
            stop time is not present, the
            notifications will continue until the
            subscription is terminated. Must be used
            with 'startTime'.
        </xs:documentation>
    </xs:annotation>
</xs:element>
```



```
        </xs:sequence>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>
```

```
<xs:simpleType name="streamNameType">
  <xs:annotation>
    <xs:documentation>
      The name of an event stream.
    </xs:documentation>
  </xs:annotation>
  <xs:restriction base="xs:string"/>
</xs:simpleType>
```

```
<xs:element name="create-subscription"
  type="createSubscriptionType"
  substitutionGroup="netconf:rpcOperation">
  <xs:annotation>
    <xs:documentation>
      The command to create a notification subscription. It
      takes as argument the name of the notification stream
      and filter or profile information. All of those options
      limit the content of the subscription. In addition,
      there are two time-related parameters startTime and
      stopTime which can be used to select the time interval
      of interest.
    </xs:documentation>
  </xs:annotation>
</xs:element>
```

```
<!-- ***** One-way Operations *****-->
```

```
  <!-- <Notification> operation -->
  <xs:complexType name="NotificationContentType"/>

  <xs:element name="notificationContent"
    type="NotificationContentType" abstract="true"/>

  <xs:complexType name="NotificationType">
    <xs:sequence>
      <xs:element ref="notificationContent"/>
    </xs:sequence>
  </xs:complexType>

  <xs:element name="notification" type="NotificationType"/>
```


</xs:schema>

Figure 9

5. Filtering Examples

The following section provides examples to illustrate the various methods of filtering content on an event notification subscription.

5.1. Subtree Filtering

XML subtree filtering is not well suited for creating elaborate filter definitions given that it only supports equality comparisons and logical OR operations (e.g., in an event subtree give me all event notifications which have severity=critical or severity=major or severity=minor). Nevertheless, it may be used for defining simple event notification forwarding filters as shown below.

In order to illustrate the use of filter expressions it is necessary to assume some of the event notification content. The examples herein assume that the event notification schema definition has an <events> element at the top level that contains one or more child elements <eventEntry> consisting of the event class (e.g., fault, state, config, etc.) reporting entity and either severity or operational state.

Sample event list

```
<event xmlns="http://example.com/event/1.0">
  <eventClass>fault</eventClass>
  <reportingEntity>
    <card>Ethernet0</card>
  </reportingEntity>
  <severity>major</severity>
</event>

<event xmlns="http://example.com/event/1.0">
  <eventClass>fault</eventClass>
  <reportingEntity>
    <card>Ethernet2</card>
  </reportingEntity>
  <severity>critical</severity>
</event>

<event xmlns="http://example.com/event/1.0">
  <eventClass>fault</eventClass>
  <reportingEntity>
    <card>ATM1</card>
  </reportingEntity>
  <severity>minor</severity>
</event>

<event xmlns="http://example.com/event/1.0">
  <eventClass>state</eventClass>
  <reportingEntity>
    <card>Ethernet0</card>
  </reportingEntity>
  <operState>enabled</operState>
</event>
```

Figure 10

The following example illustrates selecting events which have severities of critical, major, or minor (presumably fault events). The filtering criteria evaluation is as follows:

```
((severity=critical) | (severity=major) | (severity=minor))
```



```
<netconf:rpc netconf:message-id="101"
  xmlns:netconf="urn:ietf:params:xml:ns:netconf:base:1.0">
  <create-subscription
    xmlns="urn:ietf:params:netconf:capability:notification:1.0">
    <filter netconf:type="subtree">
      <event xmlns="http://example.com/event/1.0">
        <eventClass>fault</eventClass>
        <severity>critical</severity>
      </event>
      <event xmlns="http://example.com/event/1.0">
        <eventClass>fault</eventClass>
        <severity>major</severity>
      </event>
      <event xmlns="http://example.com/event/1.0">
        <eventClass>fault</eventClass>
        <severity>minor</severity>
      </event>
    </filter>
  </create-subscription>
</netconf:rpc>
```

Figure 11

The following example illustrates selecting state or config EventClasses or fault events that are related to card Ethernet0. The filtering criteria evaluation is as follows:

```
( state | config | fault & card=Ethernet0)
```



```
<netconf:rpc netconf:message-id="101"
  xmlns:netconf="urn:ietf:params:xml:ns:netconf:base:1.0">
  <create-subscription
    xmlns="urn:ietf:params:netconf:capability:notification:1.0">
    <filter netconf:type="subtree">
      <event xmlns="http://example.com/event/1.0">
        <eventClass>fault</eventClass>
      </event>
      <event xmlns="http://example.com/event/1.0">
        <eventClass>state</eventClass>
      </event>
      <event xmlns="http://example.com/event/1.0">
        <eventClass>config</eventClass>
      </event>
      <event xmlns="http://example.com/event/1.0">
        <eventClass>fault</eventClass>
        <reportingElement>
          <card>Ethernet0</card>
        </reportingElement>
      </event>
    </filter>
  </create-subscription>
</netconf:rpc>
```

5.2. XPATH filters

The following [XPATH] example illustrates selecting fault EventClass notifications that have severities of critical, major, or minor. The filtering criteria evaluation is as follows:

```
((fault) & ((severity=critical) | (severity=major) | (severity =
minor)))
```

```
<netconf:rpc netconf:message-id="101"
  xmlns:netconf="urn:ietf:params:xml:ns:netconf:base:1.0">
  <create-subscription
    xmlns="urn:ietf:params:netconf:capability:notification:1.0">
    <filter netconf:type="xpath"
      xmlns:ex="http://example.com/event/1.0"
      select="/ex:event[ex:eventClass='fault' and
        (ex:severity='minor' or ex:severity='major'
          or ex:severity='critical')]">
    </create-subscription>
  </netconf:rpc>
```


Figure 13

The following example illustrates selecting state and config EventClasses or fault events that have severities of critical, major, or minor or come from card Ethernet0. The filtering criteria evaluation is as follows:

```
(( state | config) & ((fault & severity=critical) | (fault &
severity=major) | (fault & severity = minor) | (fault &
card=Ethernet0)))
```

```
<netconf:rpc netconf:message-id="101"
  xmlns:netconf="urn:ietf:params:xml:ns:netconf:base:1.0">
  <create-subscription
    xmlns="urn:ietf:params:netconf:capability:notification:1.0">
    <filter netconf:type="xpath"
      xmlns:ex="http://example.com/event/1.0"
      select="/ex:event[
        ex:eventClass='fault' and ex:severity='minor') or
        (ex:eventClass='fault' and ex:severity='major') or
        ex:eventClass='fault' and ex:severity='critical') or
        (ex:eventClass='fault' and
        ex:reportingElement/ex:card='Ethernet0') or
        ex:eventClass='state' or
        ex:eventClass='config']"/>
    </create-subscription>
  </netconf:rpc>
```

Figure 14

6. Security Considerations

The security considerations from the base [[NETCONF](#)] document apply also to the Notification capability.

The access control framework and the choice of transport will have a major impact on the security of the solution.

The <notification> elements are never sent before the transport layer and the netconf layer (capabilities exchange) have been established, and the manager has been identified and authenticated.

It is recommended that care be taken to ensure the secure operation of the following commands:

- o <create-subscription> invocation
- o read-only data models
- o read-write data models
- o notification content

One issue related to the notifications draft is the transport of data from non-netconf streams, such as syslog and SNMP. This data may be more vulnerable (or is not more vulnerable) when being transported over netconf than when being transported using the protocol normally used for transporting it, depending on the security credentials of the two subsystems. The NETCONF server is responsible for providing access control to stream content.

If a user does not have permission to view content via other NETCONF operations it does not have permission to access that content via Notifications. If a user is not permitted to view one element in the content of the notification, the notification is not sent to that user.

If a subscription is created with a stopTime, the NETCONF session will return to being a normal command-response NETCONF session when the replay is completed. It is the responsibility of the NETCONF client to close off this session when it is no longer of use.

7. IANA Considerations

This document registers two URIs for the NETCONF XML namespace in the IETF XML registry [[RFC3688](#)].

Following the format in [RFC 3688](#), IANA has made the following registration.

URI: urn:ietf:params:netconf:capability:notification:1.0

URI: urn:ietf:params:xml:ns:netmod:notification

Registrant Contact: The IESG.

XML: N/A, the requested URI is an XML namespace.

8. Acknowledgements

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9. Normative References

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- [XML Schema] Fallside, D. and P. Walmsley, "XML Schema Part 0: Primer Second Edition", W3C XML Schema, October 2004.
- [XPath] Clark, J. and S. DeRose, "XML Path Language (XPath) Version 1.0", W3C <http://www.w3.org/TR/1999/REC-xpath-19991116>, November 1999.

[Appendix A](#). Change Log

[A.1](#). Version -08

1. Removed named profiles
2. Removed eventClass that was accidentally included in the definition of the replayComplete notification
3. Deleted data wrapper from notification
4. Changed replayLogStartTime to have a minOccurs of 0. It will only be there when replay is supported. Verify examples in [section 3.2.5.1](#) are correct with respect to this element.
5. Error codes in [section 2.1.1](#), fixed formatting issue
6. Moved replayComplete to not be under <netconf>
7. [Section 2.1](#), fixed capitalization
8. In figure 4, the line was pushed out by 'system components', fixed this.
9. On page 8, replaced "If the startTime specified is earlier than the" with 'If the startTime specified is earlier than the'
10. Updated some name spaces and schemaLocations as per Andy's June 3rd email.
11. Added discussion of replayLogStartTime to draft in [section 3.3.1](#) as follows "Whether or not a stream supports replay can be discovered by doing a <get> operation on the eventStreams elements of the Notification Management Schema. This schema also provides the replayLogStartTime element to indicate the earliest available logged notification."
12. Removed most of the uses of the phrase 'Note that'. I kept two uses that prevent sentences from starting with either a lower case letter or an angle bracket.
13. In [section 3.6](#) replaced "it will be filtered out" with "the notification will be filtered out"
14. In [section 3.4](#), replaced "and the query" with "and to query"
15. Replaced 3 instances of "replay complete notification" with "replayComplete notification"

16. In [section 3.3.2](#), replaced "normal NETCONF session" with "normal command-response NETCONF session"
17. In [section 3.3.1](#), replaced "create an event subscription that will resend recently generated notification" with "create an event subscription that will resend recently generated notification, or in some cases send them for the first time to a particular NETCONF client."
18. In [section 3.2.5.2](#), s/available event streams to/event streams available to/
19. In one spot, changed snmp to SNMP (the other gets deleted)
20. In [section 3.2.5.1](#) s/where <name> element is/where the <name> element is/
21. In [section 3.2.5.1](#), clarified that "value is unique" - within the scope of a NETCONF server.
22. In [section 2.1.1](#), clarified that stopTime cannot precede start time.
23. In [section 2.1.1](#), in Start Time s/indicates/indicate/
24. In [section 2.1.1](#), in Filter: s/This is mutually exclusive/The filter parameter is mutually exclusive/ ("this" could refer to the behavior described in the previous sentence.)
25. In [section 1.4](#), third bullet, replaced "syslog and SNMP are rather constrained in terms of message sizes)" with (ie, not too short)
26. In [section 1.4](#), made all bullets start with capital letters.
27. Added definition of Filter to [section 1.1](#)
28. In [section 1.1](#), improved the definition of subscription with "An agreement and method to receive event notifications over a NETCONF session."
29. In [section 1.1](#), in the definition of operation, added a reference to [[NETCONF](#)].
30. Created a change log [section](#)
- [31](#). Fixed reference to IETF XML Registry in IANA Considerations section.

32. In [section 3.3.3](#), deleted "This notification will only be sent if a 'stopTime' was specified when the replay subscription was created."
33. Added text to the security considerations section that says "If a subscription is created with a stopTime, the NETCONF session will return to being a normal command-response NETCONF session when the replay is completed. It is the responsibility of the NETCONF client to close off this session when it is no longer of use".
34. Update examples in [section 5](#) to get rid of extra wrapper tag.
35. In [section 2.1](#), replace "A NETCONF server is not required to process RPC requests on the session associated with the subscription until the notification subscription is done and may silently discard these requests." with "A NETCONF server is will not read RPC requests, by default, on the session associated with the subscription until the notification subscription is done."
36. Updated the notification definition and the replyComplete notification definition to use a substitution group.

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