                Partial Lock Remote Procedure Call (RPC) for NETCONF

Abstract

   The Network Configuration protocol (NETCONF) defines the lock and
   unlock Remote Procedure Calls (RPCs), used to lock entire
   configuration datastores. In some situations, a way to lock only
   parts of a configuration datastore is required. This document
   defines a capability-based extension to the NETCONF protocol for
   locking portions of a configuration datastore.

Status of This Memo

   This document specifies an Internet standards track protocol for the
   Internet community, and requests discussion and suggestions for
   improvements. Please refer to the current edition of the "Internet
   Official Protocol Standards" (STD 1) for the standardization state
   and status of this protocol. Distribution of this memo is unlimited.

   outside the IETF Standards Process, and derivative works of it may
   not be created outside the IETF Standards Process, except to format
   it for publication as an RFC or to translate it into languages other
   than English.

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1. Introduction

The [[NETCONF](#)] protocol describes the lock and unlock operations that
operate on entire configuration datastores. Often, multiple
management sessions need to be able to modify the configuration of a
managed device in parallel. In these cases, locking only parts of a
configuration datastore is needed. This document defines a
capability-based extension to the NETCONF protocol to support partial
locking of the NETCONF running datastore using a mechanism based on
the existing XPath filtering mechanisms.

1.1. Definition of Terms

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
"SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and
"OPTIONAL" in this document are to be interpreted as described in [BCP
14](#), [[RFC2119](#)].

Additionally, the following terms are defined:

o Instance Identifier: an XPath expression identifying a specific
   node in the conceptual XML datastore. It contains an absolute
   path expression in abbreviated syntax, where predicates are used
   only to specify values for nodes defined as keys to distinguish
   multiple instances.

o Scope of the lock: initially, the set of nodes returned by the
   XPath expressions in a successful partial-lock operation. The set
   might be modified if some of the nodes are deleted by the session
   owning the lock.

o Protected area: the set of nodes that are protected from
   modification by the lock. This set consists of nodes in the scope
   of the lock and nodes in subtrees under them.

2. Partial Locking Capability

2.1. Overview

The :partial-lock capability indicates that the device supports the
locking of its configuration with a more limited scope than a
complete configuration datastore. The scope to be locked is
specified by using restricted or full XPath expressions. Partial
locking only affects configuration data and only the running
datastore. The candidate or the start-up datastore are not affected.

The system MUST ensure that configuration resources covered by the
lock are not modified by other NETCONF or non-NETCONF management
operations such as Simple Network Management Protocol (SNMP) and the
Command Line Interface (CLI).

The duration of the partial lock begins when the partial lock is
granted and lasts until (1) either the corresponding <partial-unlock>
operation succeeds or (2) the NETCONF session terminates.

A NETCONF session MAY have multiple parts of the running datastore
locked using partial lock operations.

The <partial-lock> operation returns a lock-id to identify each
successfully acquired lock. The lock-id is unique at any given time
for a NETCONF server for all partial-locks granted to any NETCONF or
non-NETCONF sessions.

2.1.1. Usage Scenarios

In the following, we describe a few scenarios for partial locking.
Besides the two described here, there are many other usage scenarios
possible.

2.1.1.1. Multiple Managers Handling the Writable Running Datastore with Overlapping Sections

Multiple managers are handling the same NETCONF agent simultaneously.
The agent is handled via the writable running datastore. Each
manager has his or her own task, which might involve the modification
of overlapping sections of the datastore.

After collecting and analyzing input and preparing the NETCONF
operations off-line, the manager locks the areas that are important
for his task using one single <partial-lock> operation. The manager
executes a number of <edit-config> operations to modify the
configuration, then releases the partial-lock. The lock should be
held for the shortest possible time (e.g., seconds rather than
minutes). The manager should collect all human input before locking
anything. As each manager locks only a part of the data model,
usually multiple operators can execute the <edit-config> operations
simultaneously.

2.1.1.2. **Multiple Managers Handling the Writable Running Datastore,
          Distinct Management Areas**

   Multiple managers are handling the same NETCONF agent simultaneously.
   The agent is handled via the writable running datastore. The agent's
   data model contains a number of well-defined separate areas that can
   be configured without impacting other areas. An example can be a
   server with multiple applications running on it, or a number of
   network elements with a common NETCONF agent for management.

   Each manager has his or her own task, which does not involve the
   modification of overlapping sections of the datastore.

   The manager locks his area with a <partial-lock> operation, uses a
   number of <edit-config> commands to modify it, and later releases the
   lock. As each manager has his functional area assigned to him, and
   he locks only that area, multiple managers can edit the configuration
   simultaneously. Locks can be held for extended periods (e.g.,
   minutes, hours), as this will not hinder other managers.

   This scenario assumes that the global lock operation from [NETCONF]
   is not used.

2.2. **Dependencies**

   The device MUST support restricted XPath expressions in the select
   element, as described in Section 2.4.1. Optionally, if the :xpath
   capability is also supported (as defined in [NETCONF], Section 8.9.
   "XPath Capability"), the device MUST also support using any XPath 1.0
   expression in the select element.

2.3. **Capability Identifier**

   urn:ietf:params:netconf:capability:partial-lock:1.0

2.4. **New Operations**

2.4.1. **<partial-lock>**

   The <partial-lock> operation allows the client to lock a portion of
   the running datastore. The portion to lock is specified with XPath
   expressions in the "select" elements in the <partial-lock> operation.
   Each XPath expression MUST return a node set.

   When a NETCONF session holds a lock on a node, no other session or
   non-NETCONF mechanism of the system can change that node or any node
   in the hierarchy of nodes beneath it.

Locking a node protects the node itself and the complete subtree
under the node from modification by others. The set of locked nodes
is called the scope of the lock, while all the locked nodes and the
nodes in the subtrees under them make up the protected area.

The XPath expressions are evaluated only once: at lock time.
Thereafter, the scope of the lock is maintained as a set of nodes,
i.e., the returned nodeset, and not by the XPath expression. If the
configuration data is later altered in a way that would make the
original XPath expressions evaluate to a different set of nodes, this
does not affect the scope of the partial lock.

Let's say the agent's data model includes a list of interface nodes.
If the XPath expression in the partial-lock operation covers all
interface nodes at locking, the scope of the lock will be maintained
as the list of interface nodes at the time when the lock was granted.
If someone later creates a new interface, this new interface will not
be included in the locked-nodes list created previously so the new
interface will not be locked.

A <partial-lock> operation MUST be handled atomically by the NETCONF
server. The server either locks all requested parts of the datastore
or none. If during the <partial-lock> operation one of the requested
parts cannot be locked, the server MUST unlock all parts that have
already been locked during that operation.

If a node in the scope of the lock is deleted by the session owning
the lock, it is removed from the scope of the lock, so any other
session or non-NETCONF mechanism can recreate it. If all nodes in
the scope of the lock are deleted, the lock will still be present.
However, its scope will become empty (since the lock will not cover
any nodes).

A NETCONF server that supports partial locking MUST be able to grant
multiple simultaneous partial locks to a single NETCONF session. If
the protected area of the individual locks overlap, nodes in the
common area MUST be protected until all of the overlapping locks are
released.

A <partial-lock> operation MUST fail if:

o Any NETCONF session (including the current session) owns the
   global lock on the running datastore.

o Any part of the area to be protected is already locked (or
   protected by partial locking) by another management session,
   including other NETCONF sessions using <partial-lock> or any other
   non-NETCONF management method.

o The requesting user is not successfully authenticated.

o The NETCONF server implements access control and the locking user
   does not have sufficient access rights. The exact handling of
   access rights is outside the scope of this document, but it is
   assumed that there is an access control system that MAY deny or
   allow the <partial-lock> operation.

The <partial-lock> operation is designed for simplicity, so when a
partial lock is executed, you get what you asked for: a set of nodes
that are locked for writing.

As a consequence, users must observe the following:

o Locking does not affect read operations.

o If part of the running datastore is locked, this has no effect on
   any unlocked parts of the datastore. If this is a problem (e.g.,
   changes depend on data values or nodes outside the protected part
   of the datastore), these nodes SHOULD be included in the protected
   area of the lock.

o Configuration data can be edited both inside and outside the
   protected area of a lock. It is the responsibility of the NETCONF
   client application to lock all relevant parts of the datastore
   that are crucial for a specific management action.

Note: The <partial-lock> operation does not modify the global <lock>
operation defined in the base NETCONF protocol [NETCONF]. If part of
the running datastore is already locked by <partial-lock>, then a
global lock for the running datastore MUST fail even if the global
lock is requested by the NETCONF session that owns the partial lock.

2.4.1.1. Parameters, Results, Examples

   Parameters:

   select: One or more 'select' elements, each containing an XPath
            expression. The XPath expression is evaluated in a context
            where the context node is the root of the server's
            conceptual data model, and the set of namespace declarations
            are those in scope on the select element.

   The nodes returned from the select expressions are reported in the
      rpc-reply message.

   Each select expression MUST return a node set, and at least one of
      the node sets MUST be non-empty.

   If the device supports the :xpath capability, any valid XPath 1.0
      expression can be used. If the device does not support the
      :xpath capability, the XPath expression MUST be limited to an
      Instance Identifier expression. An Instance Identifier is an
      absolute path expression in abbreviated syntax, where predicates
      are used only to specify values for nodes defined as keys to
      distinguish multiple instances.

   Example: Lock virtual router 1 and interface eth1

```
    <nc:rpc
       xmlns="urn:ietf:params:xml:ns:netconf:partial-lock:1.0"
       xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0"
       message-id="135">
         <partial-lock>
             <select xmlns:rte="http://example.com/ns/route">
                 /rte:routing/rte:virtualRouter[rte:routerName='router1']
             </select>
             <select xmlns:if="http://example.com/ns/interface">
                 /if:interfaces/if:interface[if:id='eth1']
             </select>
         </partial-lock>
    </nc:rpc>

    <nc:rpc-reply
       xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0"
       xmlns="urn:ietf:params:xml:ns:netconf:partial-lock:1.0"
       message-id="135">
         <lock-id>127</lock-id>
         <locked-node xmlns:rte="http://example.com/ns/route">
             /rte:routing/rte:virtualRouter[rte:routerName='router1']
         </locked-node>
         <locked-node xmlns:if="http://example.com/ns/interface">
             /if:interfaces/if:interface[if:id='eth1']
         </locked-node>
    </nc:rpc-reply>
```

   Note: The XML Schema in [NETCONF] has a known bug that requires the
   <data> XML element in a <rpc-reply>. This means that the above
   examples will not validate using the XML Schema found in [NETCONF].

   Positive Response:

   If the device was able to satisfy the request, an <rpc-reply> is sent
   with a <lock-id> element (lock identifier) in the <rpc-reply>
   element. A list of locked nodes is also returned in Instance
   Identifier format.

Negative Response:

If any select expression is an invalid XPath expression, the <error-
tag> is 'invalid-value'.

If any select expression returns something other than a node set, the
<error-tag> is 'invalid-value', and the <error-app-tag> is 'not-a-
node-set'.

If all the select expressions return an empty node set, the <error-
tag> is 'operation-failed', and the <error-app-tag> is 'no-matches'.

If the :xpath capability is not supported and the XPath expression is
not an Instance Identifier, the <error-tag> is 'invalid-value', the
<error-app-tag> is 'invalid-lock-specification'.

If access control denies the partial lock, the <error-tag> is
'access-denied'. Access control SHOULD be checked before checking
for conflicting locks to avoid giving out information about other
sessions to an unauthorized client.

If a lock is already held by another session on any node within the
subtrees to be locked, the <error-tag> element is 'lock-denied' and
the <error-info> element includes the <session-id> of the lock owner.
If the lock is held by a non-NETCONF session, a <session-id> of 0
(zero) SHOULD be included. The same error response is returned if
the requesting session already holds the (global) lock for the
running datastore.

If needed, the returned session-id may be used to <kill-session> the
NETCONF session holding the lock.

[2.4.1.2](#). Deadlock Avoidance

As with most locking systems, it is possible that two management
sessions trying to lock different parts of the configuration could
become deadlocked. To avoid this situation, clients SHOULD lock
everything they need in one operation. If locking fails, the client
MUST back-off, release any previously acquired locks, and SHOULD
retry the procedure after waiting some randomized time interval.

2.4.2. <partial-unlock>

   The operation unlocks the parts of the running datastore that were
   previously locked using <partial-lock> during the same session. The
   operation unlocks the parts that are covered by the lock identified
   by the lock-id parameter. In case of multiple potentially
   overlapping locks, only the lock identified by the lock-id is
   removed.

   Parameters:

   lock-id: Identity of the lock to be unlocked. This lock-id MUST
             have been received as a response to a lock request by the
             manager during the current session, and MUST NOT have been
             sent in a previous unlock request.

   Example: Unlock a previously created lock

      <nc:rpc xmlns="urn:ietf:params:xml:ns:netconf:partial-lock:1.0"
        xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0"
        message-id="136">
          <partial-unlock>
            <lock-id>127</lock-id>
          </partial-unlock>
      </nc:rpc>

   Positive Response:

   If the device was able to satisfy the request, an <rpc-reply> is sent
   that contains an <ok> element. A positive response MUST be sent even
   if all of the locked parts of the datastore have already been
   deleted.

   Negative Response:

   If the <lock-id> parameter does not identify a lock that is owned by
   the session, an 'invalid-value' error is returned.

2.5. Modifications to Existing Operations

   A successful partial lock will cause a subsequent operation to fail
   if that operation attempts to modify nodes in the protected area of
   the lock and is executed in a NETCONF session other than the session
   that has been granted the lock. The <error-tag> 'in-use' and the
   <error-app-tag> 'locked' is returned. All operations that modify the

running datastore are affected, including: <edit-config>, <copy-
config>, <delete-config>, <commit>, and <discard-changes>. If
partial lock prevents <edit-config> from modifying some data, but the
operation includes the continue-on-error option, modification of
other parts of the datastore, which are not protected by partial
locking, might still succeed.

If the datastore contains nodes locked by partial lock, this will
cause the (global) <lock> operation to fail. The <error-tag> element
'lock-denied' and an <error-info> element including the <session-id>
of the lock owner will be returned. If the lock is held by a non-
NETCONF session, a <session-id> of 0 (zero) is returned.

All of these operations are affected only if they are targeting the
running datastore.

2.6. Interactions with Other Capabilities

2.6.1. Candidate Configuration Capability

The candidate datastore cannot be locked using the <partial-lock>
operation.

2.6.2. Confirmed Commit Capability

If:

o a partial lock is requested for the running datastore, and

o the NETCONF server implements the :confirmed-commit capability,
   and

o there was a recent confirmed <commit> operation where the
   confirming <commit> operation has not been received

then the lock MUST be denied, because if the confirmation does not
arrive, the running datastore MUST be rolled back to its state before
the commit. The NETCONF server might therefore need to modify the
configuration.

In this case, the <error-tag> 'in-use' and the <error-app-tag>
'outstanding-confirmed-commit' is returned.

2.6.3. Distinct Startup Capability

The startup datastore cannot be locked using the <partial-lock>
operation.

3. Security Considerations

The same considerations are relevant as for the base NETCONF protocol
[NETCONF]. <partial-lock> and <partial-unlock> RPCs MUST only be
allowed for an authenticated user. <partial-lock> and <partial-
unlock> RPCs SHOULD only be allowed for an authorized user. However,
as NETCONF access control is not standardized and not a mandatory
part of a NETCONF implementation, it is strongly recommended, but
OPTIONAL (although nearly all implementations include some kind of
access control).

A lock (either a partial lock or a global lock) might prevent other
users from configuring the system. The following mechanisms are in
place to prevent the misuse of this possibility:

   A user, that is not successfully authenticated, MUST NOT be
   granted a partial lock.

   Only an authorized user SHOULD be able to request a partial lock.

   The partial lock is automatically released when a session is
   terminated regardless of how the session ends.

   The <kill-session> operation makes it possible to terminate other
   users' sessions.

   The NETCONF server MAY log partial lock requests in an audit
   trail.

A lock that is hung for some reason (e.g., a broken TCP connection
that the server has not yet recognized) can be released using another
NETCONF session by explicitly killing the session owning that lock
using the <kill-session> operation.

Partial locking is not an authorization mechanism; it SHOULD NOT be
used to provide security or access control. Partial locking SHOULD
only be used as a mechanism for providing consistency when multiple
managers are trying to configure the node. It is vital that users
easily understand the exact scope of a lock. This is why the scope
is determined when granting a lock and is not modified thereafter.

4. IANA Considerations

This document registers one capability identifier URN from the
"Network Configuration Protocol (NETCONF) Capability URNs" registry,
and one URI for the NETCONF XML namespace in the "IETF XML registry"
[RFC3688]. Note that the capability URN is compliant to [NETCONF],
Section 10.3.

```
   Index          Capability Identifier
   -------------  ----------------------------------------------------
   :partial-lock  urn:ietf:params:netconf:capability:partial-lock:1.0
```

URI: urn:ietf:params:xml:ns:netconf:partial-lock:1.0

Registrant Contact: The IESG.

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

[5](#). Acknowledgements

Thanks to Andy Bierman, Sharon Chisholm, Phil Shafer, David Harrington, Mehmet Ersue, Wes Hardaker, Juergen Schoenwaelder, Washam Fan, and many other members of the NETCONF WG for providing important input to this document.

[6](#). References

[6.1](#). Normative References

[NETCONF] Enns, R., "NETCONF Configuration Protocol", [RFC 4741](#), December 2006.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.

[RFC3688] Mealling, M., "The IETF XML Registry", [BCP 81](#), [RFC 3688](#), January 2004.

[6.2](#). Informative References

[YANG]   Bjorklund, M., "YANG - A data modeling language for NETCONF", Work in Progress, December 2009.

Appendix A. XML Schema for Partial Locking (Normative)

   The following XML Schema defines the <partial-lock> and <partial-
   unlock> operations:

   <CODE BEGINS>

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

    <xs:annotation>
        <xs:documentation>
            Schema defining the partial-lock and unlock operations.
            organization "IETF NETCONF Working Group"

            contact
            Netconf Working Group
            Mailing list: netconf@ietf.org
            Web: http://www.ietf.org/html.charters/netconf-charter.html

            Balazs Lengyel
            balazs.lengyel@ericsson.com

            revision 2009-10-19
            description Initial version, published as RFC 5717.
        </xs:documentation>
    </xs:annotation>

    <xs:import namespace="urn:ietf:params:xml:ns:netconf:base:1.0"
        schemaLocation="urn:ietf:params:xml:ns:netconf:base:1.0"/>

    <xs:simpleType name="lock-id-type">
        <xs:annotation>
            <xs:documentation>
                A number identifying a specific
                partial-lock granted to a session.
                It is allocated by the system, and SHOULD
                be used in the unlock operation.
            </xs:documentation>
        </xs:annotation>
        <xs:restriction base="xs:unsignedInt"/>
    </xs:simpleType>
```

```
<xs:complexType name="partialLockType">
    <xs:annotation>
        <xs:documentation>
            A NETCONF operation that locks parts of
              the running datastore.
        </xs:documentation>
    </xs:annotation>
    <xs:complexContent>
        <xs:extension base="nc:rpcOperationType">
            <xs:sequence>
                <xs:element name="select" type="xs:string"
                    maxOccurs="unbounded">
                    <xs:annotation>
                      <xs:documentation>
                        XPath expression that specifies the scope
                        of the lock.  An Instance Identifier
                        expression must be used unless the :xpath
                        capability is supported in which case any
                        XPath 1.0 expression is allowed.
                      </xs:documentation>
                    </xs:annotation>
                </xs:element>
            </xs:sequence>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>

<xs:complexType name="partialUnLockType">
    <xs:annotation>
        <xs:documentation>
            A NETCONF operation that releases a previously acquired
            partial-lock.
        </xs:documentation>
    </xs:annotation>
    <xs:complexContent>
        <xs:extension base="nc:rpcOperationType">
            <xs:sequence>
                <xs:element name="lock-id" type="lock-id-type">
                    <xs:annotation>
                      <xs:documentation>
                        Identifies the lock to be released.  MUST
                        be the value received in the response to
                        the partial-lock operation.
                      </xs:documentation>
                    </xs:annotation>
                </xs:element>
            </xs:sequence>
        </xs:extension>
```

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

    <!-- <partial-lock> operation -->
    <xs:element name="partial-lock" type="partialLockType"
        substitutionGroup="nc:rpcOperation"/>

    <!-- <partial-unlock> operation -->
    <xs:element name="partial-unlock" type="partialUnLockType"
        substitutionGroup="nc:rpcOperation"/>

    <!-- reply to <partial-lock> -->

    <xs:complexType name="contentPartInPartialLockReplyType">
        <xs:annotation>
            <xs:documentation>
                The content of the reply to a successful
                partial-lock request MUST conform to this complex type.
            </xs:documentation>
        </xs:annotation>
        <xs:sequence>
            <xs:element name="lock-id" type="lock-id-type">
              <xs:annotation>
                <xs:documentation>
                  Identifies the lock to be released.  Must be the value
                  received in the response to a partial-lock operation.
                </xs:documentation>
              </xs:annotation>
            </xs:element>
            <xs:element name="locked-node" type="xs:string"
                maxOccurs="unbounded">
                <xs:annotation>
                    <xs:documentation>
                        List of locked nodes in the running datastore.
                    </xs:documentation>
                </xs:annotation>
            </xs:element>
        </xs:sequence>
    </xs:complexType>
</xs:schema>

    <CODE ENDS>
```

Appendix B. YANG Module for Partial Locking (Non-Normative)

   The following YANG module defines the <partial-lock> and <partial-
   unlock> operations. The YANG language is defined in [YANG].

   <CODE BEGINS>

```
module ietf-netconf-partial-lock {

  namespace urn:ietf:params:xml:ns:netconf:partial-lock:1.0;
  prefix pl;

  organization "IETF Network Configuration (netconf) Working Group";

  contact
   "Netconf Working Group
    Mailing list: netconf@ietf.org
    Web: http://www.ietf.org/html.charters/netconf-charter.html

    Balazs Lengyel
    Ericsson
    balazs.lengyel@ericsson.com";

  description
   "This YANG module defines the <partial-lock> and
    <partial-unlock> operations.";

  revision 2009-10-19 {
    description
     "Initial version, published as RFC 5717.";
  }

  typedef lock-id-type {
    type uint32;
    description
     "A number identifying a specific partial-lock granted to a session.
      It is allocated by the system, and SHOULD be used in the
      partial-unlock operation.";
  }

  rpc partial-lock {
    description
     "A NETCONF operation that locks parts of the running datastore.";
    input {
      leaf-list select {
        type string;
        min-elements 1;
        description
```

```
        "XPath expression that specifies the scope of the lock.
         An Instance Identifier expression MUST be used unless the
         :xpath capability is supported, in which case any XPath 1.0
         expression is allowed.";
    }
  }
  output {
    leaf lock-id {
      type lock-id-type;
      description
       "Identifies the lock, if granted.  The lock-id SHOULD be
        used in the partial-unlock rpc.";
    }
    leaf-list locked-node {
      type instance-identifier;
      min-elements 1;
      description
       "List of locked nodes in the running datastore";
    }
  }
}

rpc partial-unlock {
  description
   "A NETCONF operation that releases a previously acquired
    partial-lock.";
  input {
    leaf lock-id {
      type lock-id-type;
      description
       "Identifies the lock to be released.  MUST be the value
        received in the response to a partial-lock operation.";
    }
  }
}
}

  <CODE ENDS>
```

Appendix C. Usage Example - Reserving Nodes for Future Editing
            (Non-Normative)

   Partial lock cannot be used to lock non-existent nodes, which would
   effectively attempt to reserve them for future use. To guarantee
   that a node cannot be created by some other session, the parent node
   should be locked, the top-level node of the new subtree created, and
   then locked with another <partial-lock> operation. After this, the
   lock on the parent node should be removed.

   In this section, an example illustrating the above is given.

   We want to create <user> Joe under <users>, and start editing it.
   Editing might take a number of minutes. We want to immediately lock
   Joe so no one will touch it before we are finished with the editing.

   We also want to minimize locking other parts of the running datastore
   as multiple managers might be adding users near simultaneously.

   First, we check what users are already defined.

   Step 1 - Read existing users

   <rpc message-id="101"
       xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
     <get-config>
       <source>
         <running/>
       </source>
       <filter type="subtree">
         <top xmlns="http://example.com/users">
           <users/>
         </top>
       </filter>
     </get-config>
   </rpc>

   The NETCONF server sends the following reply.

Step 2 - Receiving existing data

```
<rpc-reply message-id="101"
     xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
  <data>
    <top xmlns="http://example.com/users">
      <users>
        <user>
          <name>fred</name>
          <phone>8327</phone>
        </user>
      </users>
    </top>
  </data>
</rpc-reply>
```

We want to add the new user Joe and immediately lock him using
partial locking. The way to do this, is to first lock all <user>
nodes by locking the <users> node.

Note that if we would lock all the <user> nodes using the select
expression '/usr:top/usr:users/usr:user'; this would not lock the new
user Joe, which we will create after locking. So we rather have to
lock the <users> node.

Step 3 - Lock users

```
<nc:rpc
  xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0"
  xmlns="urn:ietf:params:xml:ns:netconf:partial-lock:1.0"
      message-id="102">
  <partial-lock>
    <select xmlns:usr="http://example.com/users">
      /usr:top/usr:users
    </select>
  </partial-lock>
</nc:rpc>
```

The NETCONF server grants the partial lock. The scope of the lock
includes only the <users> node. The lock protects the <users> node
and all <user> nodes below it from modification (by other sessions).

   Step 4 - Receive lock

   ```
   <nc:rpc-reply
     xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0"
     xmlns="urn:ietf:params:xml:ns:netconf:partial-lock:1.0"
     message-id="102">
       <lock-id>1</lock-id>
       <locked-node xmlns:usr="http://example.com/users">
           /usr:top/usr:users
       </locked-node>
   </nc:rpc-reply>
   ```

   Next we create user Joe. Joe is protected by the lock received
   above, as it is under the subtree rooted at the <users> node.

   Step 5 - Create user Joe

   ```
   <rpc message-id="103"
        xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">
     <edit-config>
       <target>
         <running/>
       </target>
       <config>
         <top xmlns:usr="http://example.com/users">
           <users>
             <user>
               <name>Joe</name>
             </user>
           </users>
         </top>
       </config>
     </edit-config>
   </rpc>
   ```

   We receive a positive reply to the <edit-config> (not shown). Next
   we request a lock, that locks only <user> Joe, and release the lock
   on the <users> node. This will allow other managers to create
   additional new users.

Step 6 - Lock user Joe

```
<nc:rpc
  xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0"
  xmlns="urn:ietf:params:xml:ns:netconf:partial-lock:1.0"
      message-id="104">
  <partial-lock>
    <select xmlns:usr="http://example.com/users">
      /usr:top/usr:users/user[usr:name="Joe"]"
    </select>
  </partial-lock>
</nc:rpc>
```

The NETCONF server grants the partial lock. The scope of this second
lock includes only the <user> node with name Joe. The lock protects
all data below this particular <user> node.

Step 7 - Receive lock

```
<nc:rpc-reply
  xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0"
  xmlns="urn:ietf:params:xml:ns:netconf:partial-lock:1.0"
  message-id="104">
    <lock-id>2</lock-id>
    <locked-node xmlns:usr="http://example.com/users">
        /usr:top/usr:users/user[usr:name="Joe"]"
    </locked-node>
</nc:rpc-reply>
```

The scope of the second lock is the <user> node Joe. It protects
this <user> node and any data below it (e.g., phone number). At this
point of time, these nodes are protected both by the first and second
lock. Next, we unlock the other <user>s and the <users> node, to
allow other managers to work on them. We still keep the second lock,
so the <user> node Joe and the subtree below is still protected.

Step 8 - Release lock on <users>

```
<nc:rpc xmlns="urn:ietf:params:xml:ns:netconf:partial-lock:1.0"
    xmlns:nc="urn:ietf:params:xml:ns:netconf:base:1.0"
    message-id="105">
  <partial-unlock>
    <lock-id>1</lock-id>
  </partial-unlock>
</nc:rpc>
```

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