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I2RS Protocol

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Abstract

This document provides a proposal for the I2RS protocol covering the

ephemeral data store. It provides Yang ephemeral statement, netconf

protocol extensions for the ephemeral data store, and RESTCONF

protocol extensions for the protocol data store.

This proposal is not complete, but a start toward the I2RS work.

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1. Introduction

This documents is a strawman/strawperson for the I2RS Protocol from

early I2RS design team discussions. It focuses on the protocol

extensions for ephemeral data store.

This draft provides suggests the following additions to support the

I2RS ephemeral state:

o Yang ephemeral statement,

o NETCONF ([RFC6241]) protocol extensions for the ephemeral data

store,

o RESTCONF ([I-D.ietf-netconf-restconf]) protocol extensions for the

ephemeral data store

draft-hares-i2rs-protocol-strawman-examples provides provides

examples of this strawman protocol use for I2RS. This draft uses a

simple thermostat model to illustrate commands.

This draft is input to a NETCONF review and design team.

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2. Definitions Related to Ephemeral Configuration

Currently the configuration systems managed by NETCONF ([RFC6241]) or

RESTCONF ([I-D.ietf-netconf-restconf]) has three types of

configuration: candidate, running, and startup under the

config=true flag.

o The candidate receives configuration changes from NETCONF

(RESTCONF uses an abstract "unified datatstore" API.)

o The running configuration is the configuration currently operating

on a devices

o The start-up configuration is the configuration that survives a

reboot.

The config=false flag has operational data which exists alongside the

config=true data. Currently, there is no datastore defined for

configuration false.

........... ........... ...........

:Candidate : --> : running : --> :start-up :

........... ........... ...........

config true

---------------------------------------------

config false

===============

| operational |

| data |

================

Figure 1

In reality, the running configuration becomes the intended

configuration that is intended to be loaded into a device. The

loading process of the intended configuration into a devices compares

it against the actual devices and creates the actual configuration

loaded into a box.

Some people denote the actual configuration as applied configuration.

The [I-D.openconfig-netmod-opstate] denotes the actual configuration

as derived state. This document will use the term actual

configuration.

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........... ........... ...........

:Candidate : --> : running : --> :start-up :

........... ........... ...........

=============

| Intended |

| config |

=============

config true

---------------------------------------------

config false

=============

| Actual |

| config |

=============

\_\_\_\_\_\_\_\_\_\_\_\_\_\_

| operational |

| data |

|\_\_\_\_\_\_\_\_\_\_\_\_\_\_|

Figure 2

Recently the [I-D.openconfig-netmod-opstate] has proposed that

intended configuration, actual configuration, and the traditional

type of operational data be included as operational state.

Operational data may include:

o derived state (e.g. negotiated bgp hold timer)

o operational state for counters or statistics (interface counters)

Again, this document will use the definitions above to discuss

ephemeral state until the NETCONF WG agrees upon the changes to the

state diagrams.

3. Definition of ephemeral datastore for NETCONF/RESTCONF

This section describes the properties of the ephemeral datastore.

The ephemeral datastore is not unique to I2RS. This approach to the

ephemeral datastore is a panes-of-glass model. This definition of

I2RS does not support caching in the I2RS Agents. Future I2RS work

may reconsider supporting caching.

The ephemeral data store has the following qualities:

1. Ephemeral state is not unique to I2RS work.

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2. The ephemeral datastore is a datastore that holds ephemeral

configuration information that is intended to not survive a

reboot. Configuration information is defined as "config=true""

nodes.

3. Since Ephemeral is just about data not persisting over a reboot,

so in theory every configuration data node in a YANG data model

could be ephemeral. The importance of tagging an "ephemeral

node" is for conformance checking. Therefore, ephemeral nodes

need to be signaled in the conformance portions of the NETCONF

and RESTCONF work. Conformance is signaled in the following

ways:

\* The conformance portion of NETCONF ([RFC6241]) is currently

signaled in the <hello>.

\* Yang 1.1 and RESTCONF uses the module library

([I-D.ietf-netconf-yang-library])

\* NETCONF may use the module library in the future.

4. The ephemeral datastore is never locked.

5. The ephemeral datastore is one pane of glass that overrides the

running data store.

6. Ephemeral data can be exposed in three ways:

\* protocol YANG module with nodes that can be either non-

ephemeral and ephemeral,

\* protocol YANG modules with added nodes which can only be

ephemeral, OR

\* protocol independent YANG module which designed to be only

ephemeral such as I2RS RIB, I2RS Topology models, and I2RS FB-

RIB.

However, ephemeral data nodes cannot have non-ephemeral data

nodes within the subtree. Ephemeral sub-modules cannot have non-

ephemeral data nodes within the module. Ephemeral modules cannot

have non-ephemeral sub-modules or nodes within the module.

7. Ephemeral nodes will be denoted by an "ephemeral config statement

in the YANG protocol at the node level and at the module level.

8. Ephemeral provides two additional error handling features:

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1. Ephemeral data store allows for reduced error handling that may

remove the requirements for leafref checking, MUST clauses,

and instance identifier.

2. Ephemeral data store allows for priority preemption of the

write operation. Priority preemption means each I2RS client

of the ephemeral I2RS agent (netconf server) is associated

with a priority. Priority preemption occurs when a I2RS

client with a higher priority writes a node which has been

written by an I2RS client (with the lower priority). At this

point, the I2RS agent (netconf server) allows the write and may

provide a notification indication to entities monitoring that node.

4. Error handling

Error handling is an I2RS protocol feature. Normal error handling of

I2RS Agent for an I2RS client's information examines the following:

o syntax validation for nodes of data model,

o referential validation for nodes of data model,

o grouping of data within a data models or across data models to

accomplish tasks,

o permission to write nodes of data model,

o grouping,

o priority to write nodes of data model being higher than existing

priority

This section describes the ephemeral datastore's handling of each of

these error functions.

4.1. syntax validation

Syntax validation of the message should be done according to the

NETCONF or RESTCONF protocol features. New features for ephemeral

datastore should provide the error handling with the feature.

Syntax validation of the data model included in the ephemeral data

store should be done by the I2RS Agent (NETCONF/RESTCONF server).

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4.2. Referential validation

The ephemeral data store normal processing may? not do the following

referential checks: leafref, MUST, instance identifier. The removal

of this validations allows for intelligence I2RS clients to rapidly

write data, and handle error conditions at a higher level.

4.3. Grouping and Error handling

Yang 1.0 and Yang 1.1 provide the ability to group data in groupings,

leafref lists, lists, and containers. Data models group data in

order to group data that is logically associated with one another.

Data models may logical group data across groupings. One example of

such an association is the association of a static route with an

interface. The concepts of groupings apply to both ephemeral and

non-ephemeral nodes within a data model.

Error handling on writes of the ephemeral datastore is different for

nodes that are grouped versus orthogonal. Group nodes may need to be

all changed or all removed (all-or-nothing). In contrast, writing

orthogonal data nodes in the same data module or between data models

need to be added or deleted in sync.

The [I-D.ietf-i2rs-architecture] specifies three types of error

handling for a partial write operation: "all-or-nothing", "stop-on-

error", or "continue-on-error". Partial write operations of "stop-

on-error" or "continue-on-error" are allowed only for data writes

which are not a part of a grouping within a data model. The

definition of the I2RS error conditions are:

o stop-on-error - means that the configuration process stops when a

write to the configuration detects an error due to write conflict.

o continue-on-error - means the configuration process continues when

a write to the configuration detects an error due to write

process, and error reports are transmitted back to the client

writing the error.

o all-or-nothing - means that all of the configuration process is

correctly applied or no configuration process is applied.

(Inherent in all-or-nothing is the concept of checking all changes

before applying.)

4.3.1. NETCONF Support of Partial Writes

NETCONF does not support a mandated sequencing of edit functions or

write functions. Without this mandated sequences, NETCONF cannot

support partial edits.

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4.3.2. RESTCONF Support of Partial Writes

RESTCONF has a complete set of operations per message. The RESTCONF

patch can support accessing multiple data messages.

4.3.3. Initial Support of Partial Writes

The initial releases of I2RS will only require "all-or-nothing" in

the I2RS Agent.

4.4. Priority Preemption

I2RS protocol uses priority to resolve two I2RS clients having

permissions to write the same pieces of data in an I2RS agent

(NETCONF server). If two (or more) I2RS clients attempt to write the

same data, the one with the highest priority is enabled to write the

data. In the case of two clients with the sample priority attempting

to write data, the first one to request write wins.

Each client has a unique priority. Client identities and priorities

are assigned outside of I2RS by exterior mechanisms such as AAA or

adminstrative interfaces. A valid I2RS client must have both an

identity and a priority.

A sample container for I2RS client information is shown below.

container i2rs-clients {

leaf max-clients {

config false;

mandatory true;

type uint32 {

range "1 .. max";

}

}

list i2rs-client {

key name;

unique priority;

leaf name { ... }

leaf priority { ... }

}

}

Figure 3

5. Yang Library Use by Ephemeral

The data modules supporting the Ephemeral datastore can use the Yang

module to describe their datastore. Figure 4 shows the module

library data structure. One part of the features of a module is the

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type of ephemeral support (module level, submodule level, or node

level with a list of nodes). A feature list gives the reference to

the identifier for the ephemeral support. The feature references

may allow for vendor extensions to ephemeral support for a specific

model. Similarly, the deviation may point to a deviation for a

ephemeral state model.

+--ro modules

+--ro module\*[name revision]

+--ro name yang: yang-identifier

+--ro revision union;

+--ro schema? inet:uri

+--ro namespace inet:uri

+--ro feature\* yang:yang-identifier

+--ro deviation\* [name revision]

| +-- ro name yang:yang-identifier

| +-- ro revision union

+--ro conformance enumeration

+--ro submodules

+--ro submodule\*[name revision]

+--ro name yang:yang-identifier

+--ro revision union

+--ro schema? inet:uri

Figure 4

6. transport protocol

6.1. Secure Protocols

NETCONF's XML-based protocol ([RFC6241]) can operate over the

following secure and encrypted transport layer protocols:

SSH as defined in [RFC6242],

TLS with X.509 authentication [RFC7589]

RESTCONF's XML-based or JSON [RFC7158] data encodings of Yang

functions are passed over http with (GET, POST, PUT, PATCH, DELETE,

OPTIONS, and HEAD).

6.2. Insecure Protocol

The ephemeral database may support insecure protocols for information

which is ephemeral state which does not engage configuration. The

insecure protocol must be defined in conjunction with a data model or

a subdata model.

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7. Simple Thermostat Model

In this discussion of ephemeral configuration, this draft utilizes a

simple thermostat model with the YANG configuration found in figure

4.

module thermostat {

..

leaf desired-temp {

type int32;

units "degrees Celsius";

description "The desired temperature";

}

leaf actual-temp {

type int32;

config false;

units "degrees Celsius";

description "The measured temperature

(operational state).";

}

}

Figure 4 - Simple thermostat model yabng

Figure 5 shows the diagram of the configuration state with the Simple

thermostat model being attached to by an I2RS scheduler client

receiving query information regarding intended configuration and

actual configuration. Scheduler has a schedule set of temperatures

to put in the thermostat. Actual temperature is operational state.

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........... ............... ...........

:Candidate : --> : Desired temp:-->:start-up :

........... ............... ...........

|

V

============ ===========

| Intended |----| I2RS |

| config | |scheduler|

| | | client |

============ ===========

config true ^

------------------------------- |

config false |

============= |

| Actual |--------|

| config |

=============

\_\_\_\_\_\_\_\_\_\_\_\_\_\_

| actual temp |

|(operational |

| state |

| (op-state) |

---------------

Figure 5 - Scheduler client only

Figure 6 shows two I2RS clients talking to this model: scheduler and

hold-temp. Scheduler has a schedule set of temperatures to put in

the thermostat. Hold-temp holds the temperature at the same value.

The hold-temp I2RS client has a higher priority than the scheduler

client.

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........... ............... ...........

:Candidate :---: Desired temp : -- :start-up :

........... ............... ...........

|

| =============

| |I2rs Client|

| |scheduler |

V / ============

................../

ephemeral . '''''''''''''''/. ==============

datastore . 'desired-temp'---- |I2RS Client |

. '''''''''|'''' . | hold temp |

. | . ==============

. | . ============

. |---------| intended |

. . | config |

. . ======||====

config true . . ||

-------------------------------------- ||

config false ||

============= ||

| Actual |============

| config |

=============

\_\_\_\_\_\_\_\_\_\_\_\_\_\_

| actual temp |

| (op-state) |

----------------

Figure 6 - Two I2RS clients

8. Yang changes

Yang needs to add a key word ephemeral at the leaf node that signals

allowing a version of desired-temp in the ephemeral datatstore in

YANG.

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module thermostat {

..

leaf desired-temp {

type int32;

units "degrees Celsius";

ephemeral true;

description "The desired temperature";

}

leaf actual-temp {

type int32;

config false;

units "degrees Celsius";

description "The measured temperature";

}

}

Figure 7 - Simple Thermostat Yang with ephemeral

Figure 7 shows the thermostat model has ephemeral variable desired-

temp in the running configuration and the ephemeral data store. The

RESTCONF way of addressing is below:

RESTCONF running data store

PUT /restconf/data/thermostat:desired-temp

{"desired-temp":18}

RESTCONF ephemeral datastore

PUT /restconf/data/thermostat:desired-temp?datastore=ephemeral

{"desired-temp":19 }

Figure 8 - RESTCONF setting of ephemeral state

The NETCONF way of transmitting this data would be

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<rpc-message-id=101

xmlns="urn:ietf:params:xml:ns:base:1.0">

<edit-config>

<target>

<ephemeral>

</target>

<config>

<top xmlsns="http:://example.com/schema/1.0/thermostat/config>

<desired-temp> 18 </desired-temp>

</top>

</config>

</edit-config>

</rpc>

Note: config=TRUE; datastore = ephemeral

figure 8 NETCONF setting of desired-temp

9. NETCONF protocol extensions for the ephemeral datastore

capability-name: ephemeral-datastore

9.1. Overview

This capability defines the NETCONF protocol extensions for the

ephemeral state. The ephemeral state has the following features:

o the ephemeral datastore is a datastore holds configuration

information (Config=true) that is intended to not survive a

reboot.

o The ephemeral capability is signaled as a capability for a node, a

sub-module, or a module either in the conformance portion of

NETCONF (<hello>) or via netconf YANG module library

([I-D.ietf-netconf-yang-library]) used by Yang 1.1 and RESTCONF.

o ephemeral data will be doted by an "ephemeral statement at the

node, module "

o The ephemeral datastore is never locked.

o Each client has a unique priority.

o The ephemeral data store is one pane of glass that overrides the

intended config which is normally the running datastore, but can

be designated as the candidate config.

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o Ephemeral data nodes can occur as part of the following types of

data modules:

\* protocol dependent data models which mix non-ephemeral and

ephemeral configuration data (config=true),

\* protocol dependent data models which have only ephemeral data

models,

\* protocol independent data modules with only ephemeral data,

However, ephemeral data nodes cannot have non-ephemeral data nodes

within the subtree. Ephemeral sub-modules cannot have non-

ephemeral data nodes wihin the module. Ephemeral modules cannot

have non-ephemeral sub-modules or nodes within the module.

o ephemeral error checking allows for two additional options:

\* reduced error checking that remove the requirement for leafref

checking, MUST clauses, and instance identifier validation.

\* write operation with a priority preemption by a higher priority

client of the lower priority clients write where the overwrite

triggers a notification by the I2RS agent to the lower priority

client.

9.2. Dependencies

The following are the dependencies for ephemeral support:

The Yang data modules must be marked with the ephemeral flag at

the node, sub-module and model.

The Yang data modules must be flag with the ephemeral data store.

The Yang modules must support the notification of write-conflicts.

9.3. Capability identifier

The ephemeral-datastore capability is identified by the following

capability string: (capability uri)

9.4. New Operations

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9.4.1. link-ephemeral

The <link-ephemeral> allows the ephemeral datastore to be a pane of

glass that impacts either the running-config configuration pane of

glass or the candidate configuration pane of glass.

<link-ephemeral> target-config

where target config is:

writable-running or candidate config.

9.4.2. Bulk-write

The bulk-write goes here if we need one. So far, editor cannot find

a case.

9.4.3. Bulk-Read

The bulk-read goes here if we need one, so far the editor cannot find

a case.

9.5. Modification to existing operations

The capability for :ephemeral-datastore modifies the target for

existing operations.

9.5.1. <get-config>

The :ephemeral-datastore capability modifies the <edit-config> to

accept the <ephemeral> as a target for source, and allows the filters

focused on a particular module, submodule, or node.

<rpc message-id="101"

xmlns="urn:ietf:params:xml:ns:netconf:base:1.0">

<get-config>

<source>

<emphemeral-datastore/>

</source>

<filter type="subtree">

<top xmlns="http://example.com/schema/1.0/thermostat/config">

<desired-temp>

</top>

</filter>

</get-config>

</rpc>

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9.5.2. <edit-config>

The :ephemeral-datastore capability modifies the <edit-config> to

accept the <ephemeral> as a target for source with filters. The

operations of merge, replace, create, delete, and remove are

available, but each of these operations is modified by the priority

write as follows:

<merge> parameter is replaced by - merge-priority. The current

data is modified by the new data in a merge fashion only if

existing data either does not exist, or is owned by a lower

priority client. If any data is replaced, this event is passed to

the notification function within the pub/sub and traceability.

<replace> is replaced by replace-priority - which only replaces

data if the existing data is owned by a lower priority client. If

any data is replaced, this event is passed to the notification

function within pub/sub and traceability for notification to the

previous client. The success or failure of the event is passed to

traceabilty.

<create> - the creation of the data node works as in [RFC6241]

except that the success or failure is passed to pub/sub and

traceability functions.

<deletion> - the deletion of the data node works as in [RFC6241]

except event that the success or the error event is passed to the

notiication function withi pub/sub and traceability functions.

<remove> - the remove of the data node works as in [RFC6241]

except that all results are forwarded to traceabilty.

The existing parameters are modified as follows:

<target> - add a target of :emphemeral-datastore

<default-operation> -sllows only <merge-priority> or <replace-

priority>

<error-option> - the I2RS agent agent has "stop-on-error",

"continue-on-error", and "all-or-nothing" which follow the

validation rules listed above. This also requires I2RS agents

that support writes to have a "all-or-nothing"/"rollback-on-error"

function.

Note: The I2RS minimal function suggests that only error function

that is required is the "all-or-nothing" function.

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positive response - the <ok> is sent for a positive response

within an <rpc-reply>.

negative response - the <rpc-error> is sent for a negative

response within an <rpc-reply>.

9.5.3. <copy-config>

Copy config allows for the complete replacement of all the ephemeral

nodes within a target. The alternation is that source is the

:ephemeral datastore with the fitlering to match the datasore.

9.5.4. <delete-config>

The delete will delete all ephemeral nodes out of a datastore. The

target must be changed to be ephemeral configuration and filters.

9.5.5. <lock> and <unlock>

Lock and unlock are not supported with a target of :ephemeral-

datastore.

9.5.6. <get>

The <get> is altered to allow a target of :ephemeral-datastore and

with the filters.

9.5.7. <close-session> and <kill-session>

The close session is modified to take a taret of "ephemeral-

datastore" and to not release locks.

The kill session is modified to take a target of "ephemeral-

datastore, and to not change locks. "

9.6. Interactions with Other Capabilities

[RFC6241] defines NETCONF capabilities for writeable-running

datastore, candidate config data store, confirmed commit, rollback-

on-error, validate, distinct start-up, URL capability, and XPATH

capability.

9.6.1. writable-running and candidate datastore

The writeable-running and the candidate datastore can be used in

conjunction with the ephemeral data store. Ephemeral database

overlays an intended configuration - either the writable-running or

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the candidate configuration data store. The <link-ephemeral>

operation links the two databases.

9.6.2. confirmed commmit

Confirmed commit capability is not supported for the ephemeral

datastore.

9.6.3. rollback-on-error

The rollback-on-error when included with ephemeral state allows the

error handling to be "all-or-nothing" (roll-back-on-error), "stop-on-

error", and "continue-on-error". The error handling with I2RS

ephemeral state is described above. Initial implementations of the

I2RS agent are only required to support the default "roll-back-on-

error". The use of the rollback-on-error capability allows the

optional support of more capabiity in enhanced I2RS nodes.

9.6.4. validate

The <validate> key word is expanded to support the following:

source: ephemeral-datastore

filters: reference to data node, sub-module or module.

9.6.5. Distinct Startup Capability

This NETCONF capability appears to operate to load write-able running

config, running-config, or candidate datastore. The ephemeral state

does not change the environment based on this command.

9.6.6. URL capability and XPATH capability

The URL capabilities specify a <url> in the <source> and <target>.

The initial suggestion to allow both of these features to work with

ephemeral operation.

10. RESTCONF protocol extensions for the ephemeral datastore

capability-name: ephemeral-datastore

10.1. Overview

This capability defines the RESTCONF protocol extensions for the

ephemeral state. The ephemeral state has the features described in

the previous section on NETCONF.

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10.2. Dependencies

The ephemeral capabilities have the following dependencies:

Yang data nodes, sub-modules, or modules must be flaged with the

config datastore flag;

The Yang modules must support the notification of write-conflicts.

The I2RS Yang modules must support the following:

the YANG-patch features as specified in

[I-D.ietf-netconf-yang-patch].

The YANG module library feature

[I-D.ietf-netconf-yang-library],

10.3. Capability identifier

The ephemeral-datastore capability is identified by the following

capability string: (capability uri)

10.4. New Operations

10.4.1. Bulk-write

The bulk-write goes here.

10.4.2. Bulk-Read

The bulk-read goes here.

10.5. modification to data resources

RESTCONF must be able to support the ephemeral datstore with its

rules as part of the "{+restconf}/data" subtree. The "edit

collision" features in RESTCONF must be able to provide notification

to the I2RS pub/sub facility and the traceability functions. The

"timestamp" with a last modified features must support the

traceability function.

10.6. Modification to existing operations

The current operations in RESTCONF are: OPTIONS, HEAD, GET, POST,

PUT, PATCH, and DELETE. This section describes the modification to

these exiting operations.

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10.6.1. OPTIONS changes

The options methods should be augmented by the

[I-D.ietf-netconf-yang-library] information that will provide an

indication of what ephemeral state exists in a data modules, or a

data modules sub-modules or nodes.

10.6.2. HEAD changes

The HEAD in retrieving the headers of a resources. It would be

useful to change these headers to indicate the datastore a node or

submodule or module is in.

(editor)TBD on how HEAD can be changed to do this.

10.6.3. GET changes

GET must be able to read from the URL and a particular datastore.

(editor) TBD on how to filter for datastore in read.

10.6.4. POST changes

POST must simply be able to create resources in ephemeral datastores

and invoke operations defined in ephemeral data models using the

rules of the ephemeral database.

10.6.5. PUT changes

PUT must be able to reference an ephemeral module, sub-module, and

nodes.

10.6.6. PATCH changes

Plain PATCH must be able to update or create child resources in an

ephemeral datastore. The PATCH for the ephemeral state must be

changed to provide a merge or update of the original data only if the

client is using the patch has a higher priority than an existing

datastore's client, or if PATCH requests to create a new node, sub-

module or module in the datastore.

10.6.7. DELETE changes

The phrase "?datastore=ephemeral" following an element will specify

the ephemeral data store when deleting entry.

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10.6.8. Query Parameters

The query parameters (content, depth, fields, insert, point, start-

time, stop-time, and with-defaults (report-all, trim, explicit,

report-all-tagged) must support ephemeral datastores described above.

10.7. Interactions with Other Capabilities

The ephemeral database must support subscribing to receiving

notifications as Event stream. The ephemeral database] support in

RESTCONF must also support passing error information regarding

ephemeral data access over to pub/sub client and traceability client.

11. IANA Considerations

TBD

12. Security Considerations

TBD

13. Acknowledgements

This document is an attempt to distill lengthy conversations on the

I2RS proto design team from August

Here's the list of the I2RS protocol design team members

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o Juergen Schoenwaelder

o Kent Watsen

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