CCAMP Working Group
Internet-Draft
Intended status: Standards Track

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Expires: April 16, 2016

October 19, 2015

A YANG Data Model for Layer 1 Network Topology

draft-zhang-ccamp-l1-topo-yang-00.txt

Abstract

This draft describes a YANG data model to manipulate the topologies of a layer 1 Optical Transport Network (OTN). It is independent of control plane protocols and captures topology related information pertaining to OTN and also enables manipulation of an OTN network via the I2RS interface.

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1. Introduction

This document defines a data model of a layer one network topology, using YANG [RFC6020]. The model can be used by an application exposing to a management system. Moreover, it can also be used by an application via the I2RS interface [draft-ietf-i2rs-architecture], in the following ways (but not limited to):

o to obtain a whole view of the network topology information of its interest e.g., via a network element or maybe a Path Computation Element (PCE) or a network management system within the network ;

o to receive notifications with regard to the information of the change of the network topology of its interest;

o to enforce the establishment/update of a network topology with the characteristic specified in the data model, e.g., by a network controller or a client controller to manipulate the network provided by the provider for flexible control and management;

The YANG model defined in this draft is independent of control plane protocols and captures topology related information pertaining to an Optical Transport Networks (OTN) and also enables manipulation of an OTN network via the I2RS interface. Other network layers, such as fixed Dense Wavelength Switched Optical Network (WSON) and flexible optical networks (a.k.a., flexi-grid networks) are covered in [WSON-YANG] and [Flexi-YANG], respectively.

2. Conventions used in this document

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

3. Terminology and Notations

A simplified graphical representation of the data model is used in this document. The meaning of the symbols in the YANG data tree presented later in this draft is defined in [ietf-netmod-rfc6087bis]. They are provided below for reference.

o Brackets "[" and "]" enclose list keys.

o Abbreviations before data node names: "rw" means configuration (read-write) and "ro" state data (read-only).

o Symbols after data node names: "?" means an optional node, "!" means a presence container, and "*" denotes a list and leaf-list.

o Parentheses enclose choice and case nodes, and case nodes are also marked with a colon (":").

o Ellipsis ("...") stands for contents of subtrees that are not shown.

4. YANG Data Model for Layer 1 Topology

[Editor's note: It was agreed that the model presented in this draft will be augmenting from TE topology YANG, which is not available

during the time of writing due to its revision to augment from the generic topology YANG produced in I2RS WG. So, this issue will be addressed in the further versions of this draft.]

4.1. YANG Tree

```
module: ietf-layer1topology
augment /nt:network/nt:network-types:
   +--rw l1-network!
augment /nt:network:
   +--rw l1-network-attributes
      +--rw name?   string
augment /nt:network/nt:node:
   +--rw l1-node-attributes
      +--rw name?                  string
      +--rw connectivity-matrix* [id]
      |  +--rw id        uint32
      |  +--rw type?     enumeration
      |  +--rw in-tp* [tp-ref]
      |  |  +--rw tp-ref    leafref
      |  +--rw out-tp* [tp-ref]
      |  |  +--rw tp-ref    leafref
      |  +--rw dir       enumeration
      +--ro oper-status?           enumeration
augment /nt:network/nt:node/nttopo:termination-point:
   +--rw physical-info
      +--rw shelf-id?     uint32
      +--rw board-id?     uint32
      +--rw subcard-id?   uint32
      +--rw port-id?      uint32
augment /nt:network/nttopo:link:
   +--rw l1-link-attributes!
      +--rw source-tp-type          enumeration
      +--rw admin-status?           enumeration
      +--rw link-protection-type?   enumeration
      +--rw switching-capability?   identityref
      +--rw encoding?               identityref
      +--rw srlg
      |  +--rw srlg-values*   uint32
      +--rw (link-attributes)?
      |  +--:(ODU)
      |  |  +--rw ODU-type?               uint32
      |  |  +--rw availabe-resources
      |  |  |  +--rw granularity            enumeration
      |  |  |  +--rw num?                   uint32
      |  |  |  +--rw availability-bitmap*   boolean
      |  |  +--rw mapping-info
```

```
      |  |     +--rw mapping-list*   string
      |  +--:(client)
      |     +--rw max-bandwidth?          uint32
      |     +--rw unreserved-bandwidth?   uint32
      |     +--rw local-ip?               inet:ip-address
      |     +--rw remote-ip?              inet:ip-address
      +--ro oper-status?            enumeration
notifications:
   +---n link-failure
   |  +--ro topology-ref    leafref
   |  +--ro link-ref        leafref
   |  +--ro admin_status?   leafref
   |  +--ro oper-status?    leafref
   +---n node-failure
      +--ro topology-ref    leafref
      +--ro node-ref        leafref
      +--ro oper-status?    leafref
```

4.1.1. Augmentation

As can be seen in the YANG module presented augments from a more generic network topology model, i.e., the ietf-network-topology YANG module as specified in [draft-ietf-i2rs-yang-network-topo]. This is to follow the network model structure suggested in [draft-ietf-i2rs-yang-network-topo] figure 1.

[Editor's note: how TE topo YANG fits in this figure has been discussed and yet to be updated in that draft.]

4.1.2. The node and link list

The module presented in this draft contains all the nodes and links information pertaining to a layer one network. As specified in the ietf-network YANG module, a node is identified by the node-id, which is unique within the network. Within the nodes, all the interfaces pertaining to this node and their potential capabilities/constraints SHOULD be present. Besides this, the constraints associated with a node as a whole SHOULD also be present, such as the connectivity constraints introduced due to abstraction or due to the hardware limitations.

Similarly, a link is identified by the link-id, which is unique within a node. It includes the association with nodes as well as interfaces. Moreover, it includes information that is of interest to the management and I2RS client, for purposes, such as path computation, monitoring etc. For termination points, physical information is provided as an optional feature and it provides

additional information to allow management/I2RS client to be better informed of this attribute and can help visualize and simply the operation of termination points selection.

[editor's note]: for next update: any specific information related to an OTN interface has to be described in the context of technologic specific extension of OTN-TDM ISCD''.

Since for an optical transport network, its client interface attributes may be different with that of the links within the network. For full control purpose, this attributes and information are also captured and listed in this YANG module.

4.1.3. Notification

Two types of notifications are introduced: node failure and link failure.

4.2. YANG Code

<CODE BEGINS> file "ietf-layer1topology@2015-10-19.yang''

```
module ietf-layer1topology {
  yang-version 1;

  namespace "urn:ietf:params:xml:ns:yang:ietf-layer1topology";
  prefix "l1topo";

  import ietf-inet-types {
    prefix "inet";
  }
  import ietf-network {
    prefix "nt";
  }

  import ietf-network-topology {
    prefix "nttopo";
  }

  import ietf-te-types {
    prefix "ietf-te-types";
  }

  organization
    "Internet Engineering Task Force (IETF) CCAMP WG";
  contact
    "ID-draft editor: zhang.xian@huawei.com";
```

```
  description
    "This module defines a protocol independent Layer One/OTN
    topology data model.";

  revision 2015-10-16 {
    description
      "Initial version.";
    reference
      "draft-zhang-ccamp-l1-topo-yang-00.txt";
  }

  /*
  Groupings
  */

  grouping srlg-attributes {
    description
      "Shared Risk Link Group Attributes";
    reference
      "RFC 4203: OSPF Extensions in Support of Generalized
      Multi-Protocol Label Switching (GMPLS)";
    leaf-list srlg-values {
      type uint32;
      description "SRLG value list";
    }
  }

  grouping l1-network-type {
    container l1-network {
      presence "indicates a L1 network, i.e., Optical
      Transport Network (OTN).";
      description "l1 network type";
    }
    description "l1-network-type";
  }

  grouping l1-network-attributes {
    container l1-network-attributes {
      leaf name {
        type string;
        description "the network name";
      }
      description "name attribute for l1 network";
    }
    description "l1-network-attributes";
  }
```

```
  grouping l1-node-attributes {
    description "l1-node-attributes";
    container l1-node-attributes {
      description "l1-node-attributes";
      leaf name {
        type string;
        description "a name for this node.";
      }

      list connectivity-matrix {
        key "id";

        description
          "This describes the connectivity constraints within
          a node in the network. It can be one matrix or a set
          of matrixes. Further details, read the reference
          provided below.";
        reference
          "https://tools.ietf.org/html/draft-ietf-ccamp-general
          -constraint-encode-16 Section 2.1";

        leaf id {
          type uint32;
          description "matrix id";
        }
        leaf type {
          type enumeration {
            enum fixed {
              value 0;
              description "Fixed";
            }
            enum dynamic {
              value 1;
              description "Dynamic/changeable";
            }
          }
          description
            "This field describes the attribute of a
            connectivity matrix, i.e., whether it is
            fixed or switched.";
        }
        list in-tp {
          key "tp-ref";

          description
            "This list describes a (sub)-set of ingoing
```

```
        interfaces within a node that may have
        connectivity constraints.
        Note: directionality may not be relevant
         and it is decided by the dir parameter.";

      leaf tp-ref {
        type leafref {
          path "../../../../nttopo:termination-point/"+
          "nttopo:tp-id";
        }
        description "reference to an incoming interface,
        must be within the same node";
      }
    }
    list out-tp {
      key "tp-ref";

      description
        "This list describes a (sub)-set of outgoing
        interfaces within a node that may have
        connectivity constraints.
        Note: directionality may not be relevant and
        it is decided by the dir parameter.";

      leaf tp-ref {
        type leafref {
          path "../../../../nttopo:termination-point"+
          "/nttopo:tp-id";
        }
        description "reference to an outgoing interface,
        must be within the same node";
      }
    }
    leaf dir{
      type enumeration{
        enum "uni-dir"{
          description
          "the matrix is unidirectional.";
        }
        enum "bi-dir"{
          description
          "this matrix is bidirectional.";
        }
      }
      mandatory true;
      description
        "the directionality attribute of a connc. matrix.";
```

```
      }
    }

    leaf oper-status {
      type enumeration {
        enum "unknown" {
          description "unknown - lost connect with control
               plane.";
        }
        enum "up" {
          description "normal";
        }
        enum "down" {
          description "not available";
        }
      }

      config false;
      description "operational status of a node";
    }
  }
}

grouping l1-link-attributes {
  description "l1-link-attributes";
  container l1-link-attributes {
    presence "L1 link attributes";
    description "l1 link attributes";
    leaf source-tp-type {
      type enumeration {
        enum "client-side" {
          description "client side";
        }
        enum "line-side" {
          description "line side";
        }
      }
      mandatory true;
      description
      "the type of a port:0-client side; 1 - line side";
    }

    leaf admin-status {
      type enumeration {
        enum "up" {
          description "up";
        }
```

```
          enum "down" {
            description "normal";
          }
       }
       description "administrative status of a link";
      }

      leaf link-protection-type {
        type enumeration {
          enum "extra-traffic" {
            description "Extra traffic";
          }
          enum "unprotected" {
            description "unprotected";
          }
          enum "shared" {
            description "Shared";
          }
          enum "1-for-1" {
            description "Dedicated one for one protection";
          }
          enum "1-plus-1" {
            description "Dedicated one plus one protection";
          }
          enum "enhanced" {
            description "a protection type that is more reliable
            than Dedicated 1+1, e.g.,4 fiber BLSR/MS-SPRING.";
          }
        }
        description
          "Link Protection Type configured for this link";
        reference
          "RFC3471: Generalized Multi-Protocol Label Switching
          (GMPLS) Signaling Functional Description.";
      }

      leaf switching-capability {
        type identityref{
          base ietf-te-types:switching-capabilities;
        }
        description
          "the switching capability supported by the link";
      }

      leaf encoding {
        type identityref{
          base ietf-te-types:lsp-encoding-types;
```

```
        }
        description
          "the encoding type supported by this link.";
      }

      container srlg {
        uses srlg-attributes;
        description " the SRLG values of a link";
      }

      choice link-attributes {
        case ODU {
          leaf ODU-type {
            type uint32;
            description "link capacity, subject to change
            to the type of enumeration";
          }

          container availabe-resources {
            leaf granularity {
              type enumeration {
                enum "1.25G" {
                  description "1.25G";
                }
                enum "2.5G" {
                  description "2.5G";
                }
              }
              mandatory true;
              description "the base unit for unreserved-bandwidth
                     description";
            }
            leaf num {
              type uint32;
             description "number * granularity = max-bandwidth";
            }
            leaf-list availability-bitmap {
              type boolean;
              description "0-avaialble, 1- unavaialbe";
            }
            description "describe what is available in the unit
                 of granularity";
          }
          container mapping-info {
            leaf-list mapping-list {
              type string;
```

```
                                              description "it can be one or
multiple mapping
                    route";
            }
            description "mapping supported by this link; subject
            to further change";
          }
        }
        case client {
          leaf max-bandwidth {
            type uint32;
            description "max bandwidth supported by this client
            facing link";
          }
          leaf unreserved-bandwidth {
            type uint32;
            description "available bandwidth on this link";
          }
          leaf local-ip {
            type inet:ip-address;
            description "the local-end ip address of a link";
          }
          leaf remote-ip {
            type inet:ip-address;
            description "the remote-end ip address of a link";
          }
        }
        description "attributes for a client interface";
      }

      leaf oper-status {
        type enumeration {
          enum "unknown" {
                        description "unknown-lost connection with control
                plane";
          }
          enum "normal" {
            description "normal";
          }
          enum "down" {
            description "down";
          }
          enum "degraded" {
            description "degraded, temporarily unusable";
          }
        }

        config false;
```

```
        description "status of a link";
      }
    }
  }

  grouping l1-tp-attributes {
    description "l1-tp-attributes";
    container physical-info {
      description "physical info of an termination point/port";
      leaf shelf-id {
        type uint32;
        description "shelf-id of which this tp belongs to";
      }
      leaf board-id {
        type uint32;
        description "board-id of which this tp belongs to";
      }
      leaf subcard-id {
        type uint32;
        description "subcard id information, if no such info.,"+
        "fill in 0xff.";
      }
      leaf port-id {
        type uint32;
        description "port-id of which this tp belongs to";
      }
    }
  }

   /*
    * Data nodes
    */

  augment "/nt:network/nt:network-types" {
    uses l1-network-type;
    description "augment network types to include L1 newtork";
  }

  augment "/nt:network" {
    when "nt:network-types/l1-network" {
      description "Augment only for L1 network";
    }
    uses l1-network-attributes;
    description "Augment network configuration";
  }

  augment "/nt:network/nt:node" {
```

```
    when "nt:network-types/l1-network" {
      description "Augment only for L1 network";
    }
    description "Augment node configuration";

    uses l1-node-attributes;
  }

  augment "/nt:network/nt:node/nttopo:termination-point" {
    when "nt:network-types/l1-network" {
      description "Augment only for L1 network";
    }
    description "Augment tp configuration";

    uses l1-tp-attributes;
  }

  augment "/nt:network/nttopo:link" {
    when "nt:network-types/l1-network" {
      description "Augment only for L1 network.";
    }
    description "Augment link configuration";

    uses l1-link-attributes;
  }

  notification link-failure {
    leaf topology-ref {
      type leafref {
        path "/nt:network/nt:network-id";
      }
      mandatory true;
      description "the topology reference of which"
      +"this link belongs to";
    }
    leaf link-ref {
      type leafref {
        path "/nt:network[nt:network-id= current ()"+
        "/../topology-ref]/nttopo:link/nttopo:link-id";
      }
      mandatory true;
      description "";
    }
    leaf admin_status {
      type leafref {
        path
          "/nt:network/nttopo:link[nttopo:link-id ="+
```

```
          "current()/../link-ref]/l1-link-attributes/admin-status";
      }
      description "admin status of the reported link";
    }
    leaf oper-status {
      type leafref {
        path
          "/nt:network/nttopo:link[nttopo:link-id = current()"
          +"/../link-ref]/l1-link-attributes/oper-status";
      }
      description "";
    }
    description
     "link failure information";
  } //notification-link failure

  notification node-failure {
    leaf topology-ref {
      type leafref {
        path "/nt:network/nt:network-id";
      }
      mandatory true;
      description "";
    }
    leaf node-ref {
      type leafref {
        path "/nt:network[nt:network-id= current ()"+
        "/../topology-ref]/nt:node/nt:node-id";
      }
      mandatory true;
      description "";
    }
    leaf oper-status {
      type leafref {
        path
          "/nt:network/nt:node[nt:node-id = current()"
          +"/../node-ref]/l1-node-attributes/oper-status";
      }
      description "";
    }
    description
     "node failure information";
  }
}
<CODE ENDS>
```

5. Security Considerations

Since the data model defined in this draft is manipulated via the I2RS interface. The security concerns mentioned in [draft-ietf-i2rs-architecture] also applies to this draft.

The YANG module defined in this memo is designed to be accessed via the NETCONF protocol [RFC6241]. The lowest NETCONF layer is the secure transport layer and the mandatory-to-implement secure transport is SSH [RFC6242]. The NETCONF access control model [RFC6536] provides the means to restrict access for particular NETCONF users to a pre-configured subset of all available NETCONF protocol operations and content.

There are a number of data nodes defined in the YANG module which are writable/creatable/deletable (i.e., config true, which is the default). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., <edit-config>) to these data nodes without proper protection can have a negative effect on network operations.

[Editor's note: to List specific subtrees and data nodes and their sensitivity/vulnerability.]

6. Manageability Considerations

TBD.

7. IANA Considerations

TBD.

8. Acknowledgements

The initial YANG model specified in this draft is based on draft-clemm-i2rs-yang-network-topo but it is modified according to the features of the layer one networks.

We would like to thank the authors of the above mentioned draft for their helpful discussion during the creation of this draft.

9. References

9.1. Normative References

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