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A YANG Data Model for Layer 0 Types
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Abstract

This document defines a collection of common data types and groupings in the YANG data modeling language. These derived common types and groupings are intended to be imported by modules that model Layer 0 optical Traffic Engineering (TE) configuration and state capabilities such as Wavelength Switched Optical Networks (WSONs) and Flexi-grid Dense Wavelength Division Multiplexing (DWDM) Networks.

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1. Introduction

YANG [RFC7950] is a data modeling language used to model configuration data, state data, Remote Procedure Calls, and notifications for network management protocols such as NETCONF [RFC6241]. The YANG language supports a small set of built-in data types and provides mechanisms to derive other types from the built-in types.

This document introduces a collection of common data types derived from the built-in YANG data types. The derived types and groupings

are designed to be the common types applicable for modeling Traffic Engineering (TE) features as well as non-TE features (e.g., physical network configuration aspect) for Layer 0 optical networks in model(s) defined outside of this document. The applicability of Layer 0 types specified in this document include Wavelength Switched Optical Networks (WSONs) [RFC6163] and [ITU-Tg6982], and Flexi-grid Dense Wavelength Division Multiplexing (DWDM) Networks [RFC7698] and [ITU-Tg6941] .

1.1. Terminology and Notations

Refer to [RFC7446] and [RFC7581] for the key terms used in this document, and the terminology for describing YANG data models can be found in [RFC7950].

The YANG data model in this document conforms to the Network Management Datastore Architecture defined in [RFC8342].

1.2. Prefix in Data Node Names

In this document, names of data nodes and other data model objects are prefixed using the standard prefix associated with the corresponding YANG imported modules.

Prefix	YANG module	Reference
l0-types	ietf-layer0-types	[RFCXXXX]

Note: The RFC Editor will replace XXXX with the number assigned to the RFC once this document becomes an RFC.

YANG module ietf-layer0-types (defined in Section 3) references [RFC6163], [RFC6205], and [RFC7698].

2. Layer 0 Types Module Contents

This document defines YANG module for common Layer 0 types, ietf-layer0-types. This module is used for WSON and Flexi-grid DWDM networks. The ietf-layer0-types module contains the following YANG reusable types and groupings:

l0-grid-type:

A base YANG identity for the grid type as defined in [RFC6163] and [RFC7698].

dwdm-ch-spc-type:

A base YANG identity for the DWDM channel spacing type as defined in [RFC6205].

cwdm-ch-spc-type:

A base YANG identity for the CWDM channel spacing type as defined in [RFC6205].

wson-label-start-end:

WSON label range was defined in [RFC6205], and the generic topology model defines the label-start/label-end in [RFC8795]. This grouping shows the WSON-specific label-start and label-end information.

wson-label-hop:

WSON label range was defined in [RFC6205], and the generic topology model defines the label-hop in [RFC8795]. This grouping shows the WSON-specific label-hop information.

l0-label-range-info:

A YANG grouping that defines the layer 0 label range information applicable for both WSON per priority level as defined in [RFC6205]. This grouping is used in the flexi-grid DWDM by adding more flexi-grid-specific parameters.

wson-label-step:

A YANG grouping that defines label steps for WSON as defined in [RFC8776].

flexi-grid-label-start-end:

Flexi-grid label range was defined in [RFC7698], and the generic topology model defines the label-start/label-end in [RFC8795]. This grouping shows the flexi-grid-specific label-start and label-end information.

flexi-grid-label-hop:

Flexi-grid label range was defined in [RFC7698], and the generic topology model defines the label-hop in [RFC8795]. This grouping shows the WSON-specific label-hop information.

flexi-grid-label-range-info:

A YANG grouping that defines flexi-grid label range information and per priority level as defined in [RFC7698] and [RFC8363].

flexi-grid-label-step:

A YANG grouping that defines flexi-grid label steps as defined in [RFC8776].

3. YANG Code for Layer 0 Types

```
<CODE BEGINS>file "ietf-layer0-types@2020-12-29.yang"
module ietf-layer0-types {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-layer0-types";

  prefix "l0-types";

  organization
    "IETF CCAMP Working Group";
  contact
    "WG Web: <http://tools.ietf.org/wg/ccamp/>
     WG List: <mailto:ccamp@ietf.org>

     Editor: Haomian Zheng
       <mailto:zhenghaomian@huawei.com>

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     Editor: Victor Lopez
       <mailto:victor.lopezalvarez@telefonica.com>

     Editor: Daniel King
       <mailto:d.king@lancaster.ac.uk>";

  description
    "This module defines Optical Layer 0 types. This module
     provides groupings that can be applicable to Layer 0
     Fixed Optical Networks (e.g., CWDM (Coarse Wavelength
     Division Multiplexing) and DWDM (Dense Wavelength Division
     Multiplexing)) and Flexi-grid Optical Networks.

     Copyright (c) 2020 IETF Trust and the persons identified
     as authors of the code.  All rights reserved.

     Redistribution and use in source and binary forms, with
     or without modification, is permitted pursuant to, and
     subject to the license terms contained in, the Simplified
     BSD License set forth in Section 4.c of the IETF Trust's
```

```
        Legal Provisions Relating to IETF Documents
        (http://trustee.ietf.org/license-info).

        This version of this YANG module is part of RFC XXXX; see
        the RFC itself for full legal notices.";

    revision "2020-12-29" {
      description
        "Initial Version";
      reference
        "RFC XXXX: A YANG Data Model for Layer 0 Types";
    }

    typedef dwdm-n {
      type int16;
      description
        "The given value 'N' is used to determine the nominal central
         frequency.

         The nominal central frequency, 'f' is defined by:
           f = 193100.000 GHz + N x channel-spacing (measured in GHz),

         where 193100.000 GHz (193.100000 THz) is the ITU-T 'anchor
         frequency' for transmission over the C band; and where
         'channel-spacing' is defined by the dwdm-ch-spc-type.";
      reference
        "RFC6205: Generalized Labels for Lambda-Switch-Capable (LSC)
         Label Switching Routers,
         ITU-T G.694.1 (02/2012): Spectral grids for WDM applications:
         DWDM frequency grid";
    }

    typedef cwdm-n {
      type int16;
      description
        "The given value 'N' is used to determine the nominal central
         wavelength.

         The nominal central wavelength is defined by:
           Wavelength = 1471 nm + N x channel-spacing (measured in nm)

         where 1471 nm is the ITU-T 'anchor wavelength' for
         transmission over the C band; and where 'channel-spacing' is
         defined by the cwdm-ch-spc-type.";
      reference
        "RFC6205: Generalized Labels for Lambda-Switch-Capable (LSC)
         Label Switching Routers,
         ITU-T G.694.2 (12/2003): Spectral grids for WDM applications:
```

```
        CWDM wavelength grid";
    }

    typedef flexi-n {
      type int16;
      description
        "The given value 'N' is used to determine the nominal central
         frequency.

         The nominal central frequency, 'f' is defined by,
           f = 193100.000 GHz + N x channel-spacing (measured in GHz),

         where 193100.000 GHz (193.100000 THz) is the ITU-T 'anchor
         frequency' for transmission over the C band; and where
         'channel-spacing' is defined by the flexi-ch-spc-type.

         Note that the term 'channel-spacing' can be alternated by the
         term 'nominal central frequency granularity' defined in
         clause 7 of ITU-T G.694.1.";
      reference
        "RFC7698: Framework and Requirements for GMPLS-Based Control
         of Flexi-Grid Dense Wavelength Division Multiplexing (DWDM)
         Networks.
         ITU-T G.694.1 (02/2012): Spectral grids for WDM applications:
         DWDM frequency grid";
    }

    typedef flexi-m {
      type uint16;
      description
        "The given value 'M' is used to determine the slot width.

         A slot width is defined by:
           slot width = M x SWG (measured in GHz),

         where SWG is defined by the flexi-slot-width-granularity.";
      reference
        "RFC7698: Framework and Requirements for GMPLS-Based Control
         of Flexi-Grid Dense Wavelength Division Multiplexing (DWDM)
         Networks.
         ITU-T G.694.1 (02/2012): Spectral grids for WDM applications:
         DWDM frequency grid";
    }

    identity l0-grid-type {
      description
        "Layer 0 grid type";
      reference
```

```
          "RFC6163:Framework for GMPLS and Path Computation Element
           (PCE) Control of Wavelength Switched Optical Networks
(WSONs),
           ITU-T G.694.1 (02/2012): Spectral grids for WDM applications:
           DWDM frequency grid,
           ITU-T G.694.2 (12/2003): Spectral grids for WDM applications:
           CWDM wavelength grid";
      }

      identity flexi-grid-dwdm {
        base l0-grid-type;
        description
          "Flexi-grid";
        reference
          "RFC7698: Framework and Requirements for GMPLS-Based Control
           of Flexi-Grid Dense Wavelength Division Multiplexing (DWDM)
           Networks,
           ITU-T G.694.1 (02/2012): Spectral grids for WDM applications:
           DWDM frequency grid";
      }

      identity wson-grid-dwdm {
        base l0-grid-type;
        description
          "DWDM grid";
        reference
          "RFC6163:Framework for GMPLS and Path Computation Element
           (PCE) Control of Wavelength Switched Optical Networks
(WSONs),
           ITU-T G.694.1 (02/2012): Spectral grids for WDM applications:
           DWDM frequency grid";
      }

      identity wson-grid-cwdm {
        base l0-grid-type;
        description
          "CWDM grid";
        reference
          "RFC6205: Generalized Labels for Lambda-Switch-Capable (LSC)
           Label Switching Routers,
           ITU-T G.694.2 (12/2003): Spectral grids for WDM applications:
           CWDM wavelength grid";
      }

      identity dwdm-ch-spc-type {
        description
          "DWDM channel spacing type";
        reference
          "RFC6205: Generalized Labels for Lambda-Switch-Capable (LSC)
           Label Switching Routers,
```

```
          ITU-T G.694.1 (02/2012): Spectral grids for WDM applications:
          DWDM frequency grid";
      }

      identity dwdm-100ghz {
        base dwdm-ch-spc-type;
        description
          "100GHz channel spacing";
      }

      identity dwdm-50ghz {
        base dwdm-ch-spc-type;
        description
          "50GHz channel spacing";
      }

      identity dwdm-25ghz {
        base dwdm-ch-spc-type;
        description
          "25GHz channel spacing";
      }

      identity dwdm-12p5ghz {
        base dwdm-ch-spc-type;
        description
          "12.5GHz channel spacing";
      }

      identity flexi-ch-spc-type {
        description
          "Flexi-grid channel spacing type";
        reference
          "RFC7698: Framework and Requirements for GMPLS-Based Control
          of Flexi-Grid Dense Wavelength Division Multiplexing (DWDM)
          Networks
          ITU-T G.694.1 (02/2012): Spectral grids for WDM applications:
          DWDM frequency grid";
      }

      identity flexi-ch-spc-6p25ghz {
        base flexi-ch-spc-type;
        description
          "6.25GHz channel spacing";
      }

      identity flexi-slot-width-granularity {
        description
          "Flexi-grid slot width granularity";
```

```
    }

    identity flexi-swg-12p5ghz {
      base flexi-slot-width-granularity;
      description
        "12.5GHz slot width granularity";
    }

    identity cwdm-ch-spc-type {
      description
        "CWDM channel spacing type";
      reference
        "RFC6205: Generalized Labels for Lambda-Switch-Capable (LSC)
            Label Switching Routers,
         ITU-T G.694.2 (12/2003): Spectral grids for WDM applications:
         CWDM wavelength grid";
    }

    identity cwdm-20nm {
      base cwdm-ch-spc-type;
      description
        "20nm channel spacing";
    }

    /* Groupings. */

    grouping wson-label-start-end {
      description
        "The WSON label-start or label-end used to specify WSON label
         range.";
      choice grid-type {
        description
          "Label for DWDM or CWDM grid";
        case dwdm {
          leaf dwdm-n {
            when 'derived-from-or-self(../../../grid-type,
            "wson-grid-dwdm")'
            {
              description
                "Valid only when grid type is DWDM.";
            }
            type l0-types:dwdm-n;
            description
             "The central frequency of DWDM.";
            reference
              "RFC6205: Generalized Labels for Lambda-Switch-Capable
               (LSC) Label Switching Routers";
          }
```

```
        }
        case cwdm {
          leaf cwdm-n {
            when 'derived-from-or-self(../../../grid-type,
            "wson-grid-cwdm")'
            {
              description
                "Valid only when grid type is CWDM.";
            }
            type l0-types:cwdm-n;
            description
              "Channel wavelength computing input.";
            reference
              "RFC6205: Generalized Labels for Lambda-Switch-Capable
               (LSC) Label Switching Routers";
          }
        }
      }
      reference
        "RFC6205: Generalized Labels for Lambda-Switch-Capable (LSC)
         Label Switching Routers";
    }

    grouping wson-label-hop {
      description
        "Generic label hop information for WSON";
      choice grid-type {
        description
          "Label for DWDM or CWDM grid";
        case dwdm {
          choice single-or-super-channel {
            description "single or super channel";
            case single {
              leaf dwdm-n {
                type l0-types:dwdm-n;
                description
                  "The given value 'N' is used to determine the
                   nominal central frequency.";
              }
            }
            case super {
              leaf-list subcarrier-dwdm-n {
                type l0-types:dwdm-n;
                description
                  "The given values 'N' are used to determine the
                   nominal central frequency for each subcarrier
                   channels.";
                reference
```

```
                  "ITU-T Recommendation G.694.1: Spectral grids for
                   WDM applications: DWDM frequency grid";
              }
            }
          }
        }
        case cwdm {
          leaf cwdm-n {
            type l0-types:cwdm-n;
            description
              "The given value 'N' is used to determine the nominal
               central wavelength.";
            reference
              "RFC6205: Generalized Labels for Lambda-Switch-Capable
               (LSC) Label Switching Routers";
          }
        }
      }
      reference
        "RFC6205: Generalized Labels for Lambda-Switch-Capable (LSC)
         Label Switching Routers";
    }

    grouping l0-label-range-info {
      description
        "Information about layer 0 label range.";
      leaf grid-type {
        type identityref {
          base l0-grid-type;
        }
        description "Grid type";
      }
      leaf priority {
        type uint8;
        description
          "Priority in Interface Switching Capability Descriptor
           (ISCD).";
        reference
          "RFC4203: OSPF Extensions in Support of Generalized
           Multi-Protocol Label Switching (GMPLS).";
      }
      reference
        "RFC6205: Generalized Labels for Lambda-Switch-Capable (LSC)
         Label Switching Routers";
    }

    grouping wson-label-step {
      description "Label step information for WSON";
```

```
      choice l0-grid-type {
        description
          "Grid type: DWDM, CWDM, etc.";
        case dwdm {
          leaf wson-dwdm-channel-spacing {
            when 'derived-from-or-self(../../grid-type,
            "wson-grid-dwdm")'
            {
              description
                "Valid only when grid type is DWDM.";
            }
            type identityref {
              base dwdm-ch-spc-type;
            }
            description
              "Label-step is the channel-spacing (GHz), e.g., 100.000,
               50.000, 25.000, or 12.500 GHz for DWDM";
            reference
              "RFC6205: Generalized Labels for Lambda-Switch-Capable
               (LSC) Label Switching Routers";
          }
        }
        case cwdm {
          leaf wson-cwdm-channel-spacing {
            when 'derived-from-or-self(../../grid-type,
            "wson-grid-cwdm")'
            {
              description
                "Valid only when grid type is CWDM.";
            }
            type identityref {
              base cwdm-ch-spc-type;
            }
            description
              "Label-step is the channel-spacing (nm), i.e., 20 nm
               for CWDM, which is the only value defined for CWDM";
            reference
              "RFC6205: Generalized Labels for Lambda-Switch-Capable
               (LSC) Label Switching Routers";
          }
        }
      }
      reference
        "RFC6205: Generalized Labels for Lambda-Switch-Capable (LSC)
         Label Switching Routers,
         ITU-T G.694.2 (12/2003): Spectral grids for WDM applications:
         CWDM wavelength grid";
    }
```

```
    grouping flexi-grid-label-start-end {
      description
        "The Flexi-grid label-start or label-end used to specify
         Flexi-grid label range.";
      leaf flexi-n {
        type l0-types:flexi-n;
        description
          "The given value 'N' is used to determine the nominal
           central frequency.";
      }
      reference
        "RFC7698: Framework and Requirements for GMPLS-Based Control
         of Flexi-Grid Dense Wavelength Division Multiplexing (DWDM)
         Networks";
    }

    grouping flexi-grid-frequency-slot {
      description "Flexi-grid frequency slot grouping.";
      uses flexi-grid-label-start-end;
      leaf flexi-m {
        type l0-types:flexi-m;
        description
          "The given value 'M' is used to determine the slot width.";
      }
      reference
        "RFC7698: Framework and Requirements for GMPLS-Based Control
         of Flexi-Grid Dense Wavelength Division Multiplexing (DWDM)
         Networks";
    }

    grouping flexi-grid-label-hop {
      description
        "Generic label hop information for Flexi-grid";

      choice single-or-super-channel {
        description "single or super channel";
        case single {
          uses flexi-grid-frequency-slot;
        }
        case super {
          list subcarrier-flexi-n {
            key flexi-n;
            uses flexi-grid-frequency-slot;
            description
              "List of subcarrier channels for flexi-grid super
               channel.";
          }
        }
```

```
      }
      reference
        "RFC7698: Framework and Requirements for GMPLS-Based Control
         of Flexi-Grid Dense Wavelength Division Multiplexing (DWDM)
         Networks";
    }

    grouping flexi-grid-label-range-info {
      description
        "Flexi-grid-specific label range related information";
      uses l0-label-range-info;
      container flexi-grid {
        description "flexi-grid definition";
        leaf slot-width-granularity {
          type identityref {
            base flexi-slot-width-granularity;
          }
          default flexi-swg-12p5ghz;
          description
            "Minimum space between slot widths. Default is 12.500
             GHz";
          reference
            "RFC7698: Framework and Requirements for GMPLS-Based
             Control of Flexi-Grid Dense Wavelength Division
             Multiplexing (DWDM) Networks";
        }
        leaf min-slot-width-factor {
          type uint16 {
            range "1..max";
          }
          default 1;
          description
            "A multiplier of the slot width granularity, indicating
             the minimum slot width supported by an optical port.

             Minimum slot width is calculated by:
               Minimum slot width (GHz) =
                 min-slot-width-factor * slot-width-granularity.";
          reference
            "RFC8363: GMPLS OSPF-TE Extensions in Support of Flexi-
             Grid Dense Wavelength Division Multiplexing (DWDM)
             Networks";
        }

        leaf max-slot-width-factor {
          type uint16 {
            range "1..max";
          }
```

```
          must '. >= min-slot-width-factor' {
            error-message
              "Maximum slot width must be greater than or equal to
               minimum slot width.";
          }
          description
            "A multiplier of the slot width granularity, indicating
             the maximum slot width supported by an optical port.

             Maximum slot width is calculated by:
               Maximum slot width (GHz) =
                 max-slot-width-factor * slot-width-granularity

             If specified, maximum slot width must be greater than or
             equal to minimum slot width.If not specified, maximum
             slot width is equal to minimum slot width.";
          reference
            "RFC8363: GMPLS OSPF-TE Extensions in Support of Flexi-
             Grid Dense Wavelength Division Multiplexing (DWDM)
             Networks";
        }
      }
    }

    grouping flexi-grid-label-step {
      description "Label step information for flexi-grid";
      leaf flexi-grid-channel-spacing {
        type identityref {
          base flexi-ch-spc-type;
        }
        default flexi-ch-spc-6p25ghz;
        description
          "Label-step is the nominal central frequency granularity
           (GHz), e.g., 6.25 GHz";
        reference
           "RFC7699: Generalized Labels for the Flexi-Grid in Lambda
            Switch Capable (LSC) Label Switching Routers";
      }
      leaf flexi-n-step {
        type uint8;
        description
          "This attribute defines the multiplier for the supported
           values of 'N'.

           For example, given a grid with a nominal central frequency
           granularity of 6.25 GHz, the granularity of the supported
           values of the nominal central frequency could be 12.5 GHz.
           In this case, the values of flexi-n should be even and this
```

```
            constraint is reported by setting the flexi-n-step to 2.

            This attribute is also known as central frequency
            granularity in RFC8363.";
          reference
            "RFC8363: GMPLS OSPF-TE Extensions in Support of Flexi-Grid
            Dense Wavelength Division Multiplexing (DWDM) Networks";
        }
      }
    }
```

<CODE ENDS>

4. Security Considerations

The YANG module specified in this document defines a schema for data that is designed to be accessed via network management protocols such as NETCONF [RFC6241] or RESTCONF [RFC8040]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [RFC8446].

The NETCONF access control model [RFC8341] provides the means to restrict access for particular NETCONF users to a preconfigured subset of all available NETCONF protocol operations and content. The NETCONF Protocol over Secure Shell (SSH) [RFC6242] describes a method for invoking and running NETCONF within a Secure Shell (SSH) session as an SSH subsystem. The NETCONF access control model [RFC8341] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

The objects in this YANG module are common data types and groupings. No object in this module can be read or written to. These definitions can be imported and used by other layer 0 specific modules. It is critical to consider how imported definitions will be utilized and accessible via RPC operations, as the resultant schema will have data nodes that can be writable, or readable, and will have a significant effect on the network operations if used incorrectly or maliciously. All of this consideration belongs in the document that defines the modules that import from this YANG module. Therefore,

it
   is important to manage access to resultant data nodes that are
   considered sensitive or vulnerable in some network environments.

The security considerations spelled out in the YANG 1.1 specification
[RFC7950] apply for this document as well.

5. IANA Considerations

It is proposed to IANA to assign new URIs from the "IETF XML Registry" [RFC3688] as follows:

```
URI: urn:ietf:params:xml:ns:yang:ietf-layer0-types
Registrant Contact: The IESG
XML: N/A; the requested URI is an XML namespace.
```

This document registers following YANG modules in the YANG Module Names registry [RFC7950].

```
name:         ietf-layer0-types
namespace:    urn:ietf:params:xml:ns:yang:ietf-layer0-types
prefix:       l0-types
reference:    RFC XXXX(TBD)
```

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