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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], [RFC7205], 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:

Operational-mode:

A type that represents operational mode as defined in [ITU-Tg6982].

layer0-node-type:

A base YANG identity for supported node type as defined in [RFC6163].

wavelength-assignment:

A base YANG identity for allocated wavelength assignment type as defined in [RFC6163].

layer0-grid-type:

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

term-type:

A base YANG identity for the supported termination type as defined in [ITU-Tg709].

layer0-bandwidth-type:

A base YANG identity for the layer 0 bandwidth type as defined in [ITU-Tg709].

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].

FEC-type:

A base YANG identity for the FEC type as defined in [ITU-Tg709].

wson-path-bandwidth:

A YANG grouping that defines the WSON path bandwidth attributes as defined in [RFC6163].

wson-link-bandwidth:

A YANG grouping that defines WSON link bandwidth attributes as defined in [RFC6163].

wson-label-start-end:

A YANG grouping that defines the label-start and label-end for WSON as defined in [RFC6205].

wson-label-hop:

A YANG grouping that defines the label hop for WSON as defined in [RFC6205].

layer0-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 [I-D.ietf-teas-yang-te-types].

flexi-grid-node-attributes:

A YANG grouping that defines flexi-grid node attributes as defined in [RFC7698].

flexi-grid-path-bandwidth:

A YANG grouping that defines flexi-grid path bandwidth attributes as defined in [RFC7698].

flexi-grid-link-bandwidth:

A YANG grouping that defines flexi-grid link bandwidth attributes as defined in [RFC7698].

flexi-grid-label-start-end:

A YANG grouping that defines the label-start and label-end for flexi-grid as defined in [RFC7698].

flexi-grid-channel:

A YANG grouping that defines flexi-grid channel as defined in [RFC7698].

flexi-grid-label-hop:

A YANG grouping that defines the label hop for both single channel and multiple carriers in flexi-grid DWDM, as defined in [RFC7698].

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 [I-D.ietf-teas-yang-te-types].

3. YANG Code for Layer 0 Types

```
<CODE BEGINS>file "ietf-layer0-types@2020-05-08.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
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       <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.

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```

```
       (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 "2020-05-08" {
      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 compute the channel
        wavelength as per the formula:
          Wavelength (nm) = 1471 + 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 'chanel-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 int16;
      description
        "M is used to determine the slot width. A slot width is
         constrained to be M x SWG (that is, M x 12.500 GHz),
         where M is a positive integer.";
      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 {
            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 {
            type l0-types:cwdm-n;
            description
              "Channel wavelength computing input. ";
            reference
              "RFC6205: Generalized Labels for
               ambda-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 central frequency of DWDM. ";
               }
            }
            case super {
             leaf-list subcarrier-dwdm-n {
                type l0-types:dwdm-n;
                description
                  "List of center frequencies 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
              "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 l0-label-range-info {
      description
        "Information for 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.";
      }
      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 {
            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 {
            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
        "Label-start and Label-end information for Flexi-grid.";
      leaf flexi-n {
        type l0-types:flexi-n;
        description
          "The central frequency in Flexi-grid.";
      }
      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
          "M is used to determine the slot width. A slot width is
           constrained to be M x SWG (that is, M x 12.500 GHz),
           where M is a positive integer.";
      }
      reference
        "RFC7698: Framework and Requirements for GMPLS-Based Control
        of Flexi-Grid Dense Wavelength Division Multiplexing (DWDM)
        Networks";
    }
    grouping flexi-grid-label-hop {
      description "Flexi-grid path label.";
        choice single-or-super-channel {
         description "single of 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
       "Info of Flexi-grid-specific label range";
     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
           "Slot width range: two multipliers of the slot width ,
            granularity, each indicating the minimal and maximal slot
            width supported by a port, respectively.

            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";
          }
          description
            "Slot width range: two multipliers of the slot width ,
             granularity, each indicating the minimal and maximal slot
             width supported by a port, respectively.

             Maximum slot width is calculated by:
               Maximum slot width (GHz) =
                 max-slot-width-factor * slot-width-granularity";
          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 granularity of supported values
          for the nominal central frequency as a multiplier of the
          channel-spacing.

          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
          constraints 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 YANG module in this document defines optical layer 0 type definitions (i.e., typedef, identity and grouping statements) in YANG data modeling language to be imported and used by other layer 0 specific modules. When imported and used, the resultant schema will have data nodes that can be writable, or readable. The access to such 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.

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

5. IANA Considerations

It is proposed that IANA should 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)
```

6. Acknowledgements

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8. References

8.1. Normative References

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