A YANG Data Model for Layer 0 Types

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.

Status of This Memo
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Acknowledgements
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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 the Network Configuration Protocol (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 aspects) for Layer 0 optical networks in model(s) defined outside of this document. The applicability of Layer 0 types specified in this document includes Wavelength Switched Optical Networks (WSONs) [RFC6163] [ITU-Tg6982] and flexi-grid Dense Wavelength Division Multiplexing (DWDM) networks [RFC7698] [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.

<table>
<thead>
<tr>
<th>Prefix</th>
<th>YANG module</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>l0-types</td>
<td>ietf-layer0-types</td>
<td>RFC 9093</td>
</tr>
</tbody>
</table>

*Table 1: Data Node Names*

The YANG module "ietf-layer0-types" (defined in Section 3) references [RFC4203], [RFC6163], [RFC6205], [RFC7698], [RFC7699], [RFC8363], [ITU-Tg6941], and [ITU-Tg6942].

2. Layer 0 Types Module Contents
This document defines a 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 Coarse Wavelength Division Multiplexing (CWDM) channel-spacing type as defined in [RFC6205].

wson-label-start-end:
The 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:
The 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 WSON 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:
   The 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:
   The 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 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 Module for Layer 0 Types
<CODE BEGINS> file "ietf-layer0-types@2021-08-13.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: <https://datatracker.ietf.org/wg/ccamp/>
            WG List: <mailto:ccamp@ietf.org>
            Editor: Haomian Zheng
            <mailto:zhenghaomian@huawei.com>
            Editor: Young Lee
            <mailto:younglee.tx@gmail.com>
            Editor: Aihua Guo
            <mailto:aihuaguo.ietf@gmail.com>
            Editor: Victor Lopez
            <mailto: victor.lopez@nokia.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.

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        BSD License set forth in Section 4.c of the IETF Trust's
        Legal Provisions Relating to IETF Documents

        This version of this YANG module is part of RFC 9093; see
        the RFC itself for full legal notices.";

    revision 2021-08-13 {
        description "Initial version";
        reference "RFC 9093: A YANG Data Model for Layer 0 Types";
    }

typedef dwdm-n {
    type int16;

<CODE ENDS>
"The given value 'N' is used to determine the nominal central frequency.

The nominal central frequency, 'f', is defined by:
\[ f = 193100.000 \text{ GHz} + N \times \text{channel spacing (measured in GHz)}, \]

where 193100.000 GHz (193.100000 THz) is the ITU-T 'anchor frequency' for transmission over the DWDM grid, and where 'channel spacing' is defined by the dwdm-ch-spc-type.

reference
"RFC6205: Generalized Labels for Lambda-Switch-Capable (LSC) Label Switching Routers,

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:
  \[ \text{Wavelength} = 1471 \text{ nm} + N \times \text{channel spacing (measured in nm)} \]

  where 1471 nm is the conventional 'anchor wavelength' for transmission over the CWDM grid, and where 'channel spacing' is defined by the cwdm-ch-spc-type.

  reference
  "RFC 6205: Generalized Labels for Lambda-Switch-Capable (LSC) Label Switching Routers,
}

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:
  \[ f = 193100.000 \text{ GHz} + N \times \text{channel spacing (measured in GHz)}, \]

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

  Note that the term 'channel spacing' can be substituted by the term 'nominal central frequency granularity' defined in clause 8 of ITU-T G.694.1.

  reference
  "RFC 7698: Framework and Requirements for GMPLS-Based Control of Flexi-Grid Dense Wavelength Division Multiplexing (DWDM) Networks,
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
    RFC 7698: Framework and Requirements for GMPLS-Based Control
    of Flexi-Grid Dense Wavelength Division Multiplexing (DWDM)
    Networks. 
    ITU-T G.694.1 (10/2020): Spectral grids for WDM applications: 
    DWDM frequency grid";
}

identity l0-grid-type {
  description 
    "Layer 0 grid type";
  reference 
    RFC 6163: Framework for GMPLS and Path Computation Element
    (PCE) Control of Wavelength Switched Optical Networks (WSONs),
    ITU-T G.694.1 (10/2020): 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
    RFC 7698: Framework and Requirements for GMPLS-Based Control
    of Flexi-Grid Dense Wavelength Division Multiplexing (DWDM)
    Networks, 
    ITU-T G.694.1 (10/2020): Spectral grids for WDM applications: 
    DWDM frequency grid";
}

identity wson-grid-dwdm {
  base l0-grid-type;
  description
    "DWDM grid";
  reference
    RFC 6163: Framework for GMPLS and Path Computation Element
    (PCE) Control of Wavelength Switched Optical Networks (WSONs),
    ITU-T G.694.1 (10/2020): Spectral grids for WDM applications: 
    DWDM frequency grid";
}

identity wson-grid-cwdm {
  base l0-grid-type;
  description
    "CWDM grid";
}
reference
  "RFC 6205: 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
    "RFC 6205: Generalized Labels for Lambda-Switch-Capable (LSC)
    Label Switching Routers,
    ITU-T G.694.1 (10/2020): Spectral grids for WDM applications:
    DWDM frequency grid";
}

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

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

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

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

identity flexi-ch-spc-type {
  description
    "Flexi-grid channel-spacing type";
  reference
    "RFC 7698: Framework and Requirements for GMPLS-Based Control
    of Flexi-Grid Dense Wavelength Division Multiplexing (DWDM)
    Networks,
    ITU-T G.694.1 (10/2020): Spectral grids for WDM applications:
    DWDM frequency grid";
}

identity flexi-ch-spc-6p25ghz {
  base flexi-ch-spc-type;
  description
    "6.25 GHz channel spacing";
}
identity flexi-slot-width-granularity {
  description
  "Flexi-grid slot width granularity";
}

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

identity cwdm-ch-spc-type {
  description
  "CWDM channel-spacing type";
  reference
  "RFC 6205: 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
        "RFC 6205: 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 "RFC 6205: Generalized Labels for Lambda-Switch-Capable (LSC) Label Switching Routers";
}
}
reference "RFC 6205: 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 channel.";
          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 "RFC 6205: 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 "RFC 4203: OSPF Extensions in Support of Generalized Multi-Protocol Label Switching (GMPLS)";
    }
    reference "RFC 6205: 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 "RFC 6205: 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
                    "Label-step is the channel spacing (GHz), e.g., 100.000, 50.000, 25.000, or 12.500 GHz for CWDM.”;
                }
            }
        }
    }
}

reference
"RFC 6205: Generalized Labels for Lambda-Switch-Capable (LSC) Label Switching Routers";
}
“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
  "RFC 6205: Generalized Labels for Lambda-Switch-Capable (LSC) Label Switching Routers";
}

reference
  "RFC 6205: Generalized Labels for Lambda-Switch-Capable (LSC) Label Switching Routers,

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
    "RFC 7698: 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
    "RFC 7698: 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
"RFC 7698: 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
      "RFC 7698: 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
      "RFC 8363: 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
  "RFC 8363: GMPLS OSPF-TE Extensions in Support of Flexi-Grid Dense Wavelength Division Multiplexing (DWDM) Networks";
}

}
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 Network Configuration Access Control Model (NACM) [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 NETCONF protocol over Secure Shell (SSH) specification [RFC6242] describes a method for invoking and running NETCONF within a Secure Shell (SSH) session as an SSH subsystem.

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 these considerations belong 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

IANA has assigned new URIs from the "IETF XML Registry" [RFC3688] as follows:

- Registrant Contact: The IESG
- XML: N/A; the requested URI is an XML namespace.

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

- Name: ietf-layer0-types
6. References

6.1. Normative References


6.2. Informative References


Acknowledgements

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