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A YANG Data Model for Layer 0 Types - Revision 2

Abstract

This document defines a collection of common data types and groupings in the YANG data modeling language, which are used in several YANG modules for wavelength Division multiplexing (WDM) transport networks. The YANG module ietf-layer0-types-ext updates ietf-layer0-types defined in draft-ietf-ccamp-layer0-types, which has been reduced in scope prior to publication to only cover spectrum management related aspects required for the YANG module ietf-wson-topology defined in draft-ietf-ccamp-wson-yang.

To be completed

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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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.

1.1. Requirements Language

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](#)].

1.2. Terminology

2. Extensions for the Layer 0 Types Module

This document defines YANG module extensions for common Layer 0 types. named ietf-layer0-types-ext. This module can be used for both WSON and Flexi-grid DWDM networks but in particular is adding common types used in the context of optical impairment aware topology model in WSON and SSONs. The ietf-layer0-types-ext module contains the following YANG identities, types and groupings that can be reused in other YANG modules:

transceiver-capabilities:

a YANG grouping to define the transceiver capabilities (also called "modes") needed to determine optical signal compatibility.

standard-mode:

a YANG grouping for ITU-T G.698.2 standard mode that guarantees interoperability.

organizational-mode:

a YANG grouping to define transponder operational mode supported by organizations or vendors.

common-explicit-mode:

a YANG grouping to define the list of attributes related to optical impairments limits in case of transceiver explicit mode. This grouping should be the same used in [[I-D.ietf-ccamp-dwdm-if-param-yang](#)].

common-organizational-explicit-mode:

a YANG grouping to define the common capabilities attributes limit range in case of operational mode and explicit mode. Also this grouping should be used in [[I-D.ietf-ccamp-dwdm-if-param-yang](#)].

cd-pmd-penalty:

a YANG grouping to define the triplet used as entries in the list optional penalty associated with a given accumulated CD and PMD. This list of triplet cd, pmd, penalty can be used to sample the function $\text{penalty} = f(\text{CD}, \text{PMD})$.

[Editor's note: There is still stuff from the xml template that needs to be removed]

3. Layer0 Types Revision 2 YANG CODE

The YANG code is developed on GitHub and can also be found in the following CCAMP repository:

<https://github.com/ietf-ccamp-wg/ietf-ccamp-layer0-types-ext>

[Editor's note: YANG code below has to be updated before submitting a new revision!]

```

<CODE BEGINS>
module ietf-layer0-types-ext {
  namespace "urn:ietf:params:xml:ns:yang:ietf-layer0-types-ext";
  prefix "l0-types-ext";

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

    Editor: Dieter Beller
      <mailto:Dieter.Beller@nokia.com>

    Editor: Sergio Belotti
      <mailto:Sergio.Belotti@nokia.com>

    Editor: Italo Busi
      <mailto:Italo.Busi@huawei.com>

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

  // Additional contacts TBA (contributors)

  description
    "Description to be added!!!

    Copyright (c) 2021 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 "2021-02-12" {
    description
      "Initial Version";
    reference
      "RFC XXXX: A YANG Data Model for Layer 0 Types - Revision 2";
  }

/*
* Identities

```

```
*/
```

```
identity modulation {  
    description "base identity for modulation type";  
}
```

```
identity QPSK {  
    base modulation;  
    description  
        "QPSK (Quadrature Phase Shift Keying) modulation";  
}
```

```
identity DP-QPSK {  
    base modulation;  
    description  
        "DP-QPSK (Dual Polarization Quadrature  
        Phase Shift Keying) modulation";  
}
```

```
identity QAM8 {  
    base modulation;  
    description  
        "8QAM (8-State Quadrature Amplitude Modulation) modulation";  
}
```

```
identity QAM16 {  
    base modulation;  
    description  
        "QAM16 (Quadrature Amplitude Modulation)";  
}
```

```
identity DP-QAM8 {  
    base modulation;  
    description  
        "DP-QAM8 (Dual Polarization Quadrature Amplitude Modulation)";  
}
```

```
identity DC-DP-QAM8 {  
    base modulation;  
    description  
        "DC DP-QAM8 (Dual Carrier Dual Polarization Quadrature  
        Amplitude Modulation)";  
}
```

```
identity DP-QAM16 {  
    base modulation;  
    description  
        "DP-QAM16 (Dual Polarization Quadrature Amplitude  
        Modulation)";  
}
```

```

identity DC-DP-QAM16 {
    base modulation;
    description
        "DC DP-QAM16 (Dual Carrier Dual Polarization Quadrature
        Amplitude Modulation)";
}

identity fec-type {
    description
        "Base identity from which specific FEC
        (Forward Error Correction) type identities are derived.";
}

identity g-fec {
    base fec-type;
    description
        "G-FEC (Generic-FEC)";
}

identity e-fec {
    base fec-type;
    description
        "E-FEC (Enhanced-FEC)";
}

identity no-fec {
    base fec-type;
    description
        "No FEC";
}

identity reed-solomon {
    base fec-type;
    description
        "Reed-Solomon error correction";
}

identity hamming-code {
    base fec-type;
    description
        "Hamming Code error correction";
}

identity golay {
    base fec-type;
    description "Golay error correction";
}

identity line-coding {
    description

```

```

        "base line-coding class";
    reference
        "ITU-T G.698.2-201811 section 7";
}

identity line-coding-NRZ-2p5G {
    base line-coding;
    description
        "ITU-T G.698.2-201811 section 7 table 8-1";
}

identity line-coding-NRZ-OTU1 {
    base line-coding;
    description
        "ITU-T G.698.2-201811 section 7 table 8-2";
}

identity line-coding-NRZ-10G {
    base line-coding;
    description
        "ITU-T G.698.2-201811 section 7 table 8-3/8-5";
}

identity line-coding-NRZ-OTU2 {
    base line-coding;
    description
        "ITU-T G.698.2-201811 section 7 table 8-4/8-6";
}

identity wavelength-assignment {
    description
        "Wavelength selection base";
    reference
        "RFC6163:Framework for GMPLS and Path Computation Element
        (PCE) Control of Wavelength Switched Optical Networks (WSOs)";
}

identity unspecified-wavelength-assignment {
    base wavelength-assignment;
    description
        "No method specified";
}

identity first-fit-wavelength-assignment {
    base wavelength-assignment;
    description
        "All the available wavelengths are numbered,
        and this WA (Wavelength Assignment) method chooses
        the available wavelength with the lowest index";
}

```



```

}

identity random-wavelength-assignment {
    base wavelength-assignment;
    description
        "This WA method chooses an available
        wavelength randomly";
}

identity least-loaded-wavelength-assignment {
    base wavelength-assignment;
    description
        "This WA method selects the wavelength that
        has the largest residual capacity on the most loaded
        link along the route (in multi-fiber networks)";
}

identity term-type {
    description
        "Termination type";
    reference
        "ITU-T G.709: Interfaces for the Optical Transport Network";
}

identity term-phys {
    base term-type;
    description
        "Physical layer termination";
}

identity term-otu {
    base term-type;
    description
        "OTU (Optical Transport Unit) termination";
}

identity term-odu {
    base term-type;
    description
        "ODU (Optical Data Unit) termination";
}

identity term-opu {
    base term-type;
    description
        "OPU (Optical Payload Unit) termination";
}

identity otu-type {
    description

```

```
        "Base identity from which specific OTU identities are derived";
    reference
        "ITU-T G.709: Interfaces for the Optical Transport Network";
}

identity OTU1 {
    base otu-type;
    description
        "OTU1 (2.66 Gb/s)";
}

identity OTU1e {
    base otu-type;
    description
        "OTU1e (11.04 Gb/s)";
}

identity OTU1f {
    base otu-type;
    description
        "OTU1f (11.27 Gb/s)";
}

identity OTU2 {
    base otu-type;
    description
        "OTU2 (10.70 Gb/s)";
}

identity OTU2e {
    base otu-type;
    description
        "OTU2e (11.09 Gb/s)";
}

identity OTU2f {
    base otu-type;
    description
        "OTU2f (11.31G)";
}

identity OTU3 {
    base otu-type;
    description
        "OTU3 (43.01 Gb/s)";
}

identity OTU3e1 {
    base otu-type;
    description
```

```

        "OTU3e1 (44.57 Gb/s)";
    }

    identity OTU3e2 {
        base otu-type;
        description
            "OTU3e2 (44.58 Gb/s)";
    }

    identity OTU4 {
        base otu-type;
        description
            "OTU4 (111.80 Gb/s)";
    }

    identity OTUCn {
        base otu-type;
        description
            "OTUCn (n x 105.25 Gb/s)";
    }

/*
 * Typedefs
 */

typedef operational-mode {
    type string;
    description
        "Organization/vendor specific mode that guarantees
        interoperability.";
    reference "ITU-T G.698.2 (11/2018)";
}

typedef standard-mode {
    type string;
    description
        "ITU-T G.698.2 standard mode that guarantees
        interoperability.
        It must be an string with the following format:
        B-DScW-ytz(v) where all these attributes
        are conformant
        to the ITU-T recomendation";
    reference "ITU-T G.698.2 (11/2018)";
}

typedef organization-identifier {
    type string;
    description
        "vendor/organization identifier that uses a private mode

```

```

        out of already defined in G.698.2 ITU-T application-code";
reference
    "RFC7581: Routing and Wavelength Assignment Information
        Encoding for Wavelength Switched Optical Networks";
}

typedef frequency-thz {
    type decimal64 {
        fraction-digits 6;
    }
    units THz;
    description
        "The DWDM frequency in THz, e.g., 193.112500";
    reference
        "RFC6205: Generalized Labels for
            Lambda-Switch-Capable (LSC) Label Switching Routers";
}

typedef frequency-ghz {
    type decimal64 {
        fraction-digits 3;
    }
    units GHz;
    description
        "The DWDM frequency in GHz, e.g., 193112.500";
    reference
        "RFC6205: Generalized Labels for
            Lambda-Switch-Capable (LSC) Label Switching Routers";
}

typedef dbm-t {
    type int32;
    units ".01dbm";
    description
        "Amplifiers and Transceivers Power in dBm.";
}

typedef snr {
    type decimal64 {
        fraction-digits 2;
    }
    units "dB@0.1nm";
    description
        "(Optical) Signal to Noise Ratio measured over 0.1 nm
            resolution bandwidth";
}

/*
 * Groupings

```

```

*/

/* supported inverse multiplexing capabilities such as
   max. OTSiG:OTSi cardinality
   It is a transponder attribute not transceiver
*/

/*    leaf multiplexing-cap {
        type uint32;
        config false;
        description "supported inverse multiplexing capabilities
            such as max. OTSiG:OTSi cardinality";
    }
*/

grouping transceiver-capabilities {
    description
        "This grouping is intended to be use for reporting the
        capabilities of a transceiver.";

    container supported-modes {
        description
            "Transceiver's supported modes.";
        list supported-mode {
            key "mode-id";
            config false;
            description "list of supported transceiver's modes.";
            leaf mode-id {
                type string {
                    length "1..255";
                }
                description "ID for the supported transceiver's mode.";
            }
        }
        choice mode {
            mandatory true;
            description
                "Indicates whether the transceiver's mode is a standard
                mode, an organizational mode or an explicit mode.";
            case G.698.2 {
                uses standard-mode;
            }
            case organizational-mode {
                container organizational-mode {
                    description
                        "The set of attributes for an organizational mode";
                    uses organizational-mode;
                    uses common-organizational-explicit-mode;
                } // container organizational-mode
            }
        }
    }
}

```

```

case explicit-mode {
  container explicit-mode {
    description
      "The set of attributes for an explicit mode";
    container supported-modes {
      description
        "Container for all the standard and organizational
        modes supported by the transceiver's explicit
        mode.";
      leaf-list supported-application-codes {
        type leafref {
          path "../.../.../mode-id";
        }
        must "../.../.../"
          + "supported-mode[mode-id=current()]/"
          + "standard-mode" {
          description
            "The pointer is only for application codes
            supported by transceiver.";
        }
        description
          "List of pointers to the application codes
          supported by the transceiver's explicit mode.";
      }
      leaf-list supported-organizational-modes {
        type leafref {
          path "../.../.../mode-id";
        }
        must "../.../.../"
          + "supported-mode[mode-id=current()]/"
          + "organizational-mode" {
          description
            "The pointer is only for organizational modes
            supported by transceiver.";
        }
        description
          "List of pointers to the organizational modes
          supported by the transceiver's explicit mode.";
      }
    } // container supported-modes
    uses common-explicit-mode;
    uses common-organizational-explicit-mode;
  } // container explicit-mode
} // end of case explicit-mode
} // end of choice
} // list supported-modes
} // container supported-modes
} // grouping transceiver-capabilities

```

```

grouping standard-mode {
  description
    "ITU-T G.698.2 standard mode that guarantees interoperability.
    It must be an string with the following format:
    B-DScW-ytz(v) where all these attributes are conformant
    to the ITU-T recomendation";

  leaf standard-mode {
    type standard-mode;
    config false;
    description
      "G.698.2 standard mode";
  }
}

grouping organizational-mode {
  description
    "Transponder operational mode supported by organizations or
    vendor";

  leaf operational-mode {
    type operational-mode;
    config false;
    description
      "configured organization- or vendor-specific
      application identifiers (AI) supported by the transponder";
  }

  leaf organization-identifier {
    type organization-identifier;
    config false;
    description
      "organization identifier that uses organizational
      mode";
  }
}

grouping cd-pmd-penalty {
  description "entries of table; triplet chromatic
  dispersion, polarization mode dispersion and
  associated penalty";

  leaf chromatic-dispersion {
    type decimal64 {
      fraction-digits 2;
      range "0..max";
    }
    units "ps/nm";
  }
}

```

```

        config false;
        mandatory true;
        description "chromatic dispersion";
    }

    leaf polarization-mode-dispersion {
        type decimal64 {
            fraction-digits 2;
            range "0..max";
        }
        units "ps";
        config false;
        mandatory true;
        description "Polarization mode dispersion";
    }

    leaf penalty {
        type decimal64 {
            fraction-digits 2;
            range "0..max";
        }
        units "dB";
        config false;
        mandatory true;
        description "Associated penalty on the receiver";
    }
}

/*
 * This grouping represent the list of attributes related to
 * optical impairment limits for explicit mode
 * (min OSNR, max PMD, max CD, max PDL, Q-factor limit, etc.)
 * In case of standard and operational mode the attributes are
 * implicit
 */

grouping common-explicit-mode {
    description "Attributes capabilities related to
    explicit mode of an optical transceiver";

    leaf line-coding-bitrate {
        type identityref {
            base line-coding;
        }
        config false;
        description "Bit rate/line coding of optical tributary signal";
        reference

```



```

        "ITU-T G.698.2 section 7.1.2";
    }
    leaf max-polarization-mode-dispersion {
        type decimal64 {
            fraction-digits 2;
            range "0..max";
        }
        units "ps";
        config false;
        description
            "Maximum acceptable accumulated polarization mode
            dispersion on the receiver";
    }
    leaf max-chromatic-dispersion {
        type decimal64 {
            fraction-digits 2;
            range "0..max";
        }
        units "ps/nm";
        config false;
        description
            "Maximum acceptable accumulated chromatic dispersion
            on the receiver";
    }
    list chromatic-and-polarization-dispersion-penalty {
        config false;
        description
            "Optional penalty associated with a given accumulated
            CD and PMD.
            This list of triplet cd, pmd, penalty can be used to
            sample the function penalty = f(CD, PMD).";
        uses cd-pmd-penalty ;
    }
    leaf max-diff-group-delay {
        type int32;
        config false;
        description "Maximum Differential group delay of this mode
            for this lane";
    }
    leaf max-polarization-dependent-loss {
        type decimal64 {
            fraction-digits 2;
        }
        units dB ;
        description
            "Maximum acceptable accumulate polarization dependent loss";
    }
    leaf available-modulation-type {
        type identityref {

```

```

    base modulation;
}
config false;
description
    "Modulation type the specific transceiver in the list
    can support";
}
leaf OTSi-carrier-bandwidth {
    type frequency-ghz;
    config false;
    description
        "Carrier bandwidth occupancy";
}
leaf min-OSNR {
    type snr;
    config false;
    description "min OSNR measured over 0.1 nm
    resolution bandwidth:
    if received OSNR at minimum Rx-power is lower than MIN-OSNR,
    an increased level of bit-errors post-FEC needs
    to be expected.";
    // change resolution BW from 12.5 GHz to 0.1 nm
}
leaf min-Q-factor {
    type int32;
    units "dB";
    config false;
    description "min Qfactor at FEC threshold";
}
leaf available-baud-rate {
    type uint32;
    units Bd;
    config false;
    description
        "Baud-rate the specific transceiver in
        the list can support.
        Baud-rate is the unit for
        symbol rate or modulation rate
        in symbols per second or
        pulses per second.
        It is the number of distinct symbol
        changes (signal events) made to the
        transmission medium
        per second in a digitally
        modulated signal or a line code";
}
leaf available-fec-type {
    type identityref {
        base fec-type;
    }
}

```

```

    }
    config false;
    description "Available FEC";
}
leaf fec-code-rate {
    type decimal64 {
        fraction-digits 8;
        range "0..max";
    }
    config false;
    description "FEC-code-rate";
}
leaf fec-threshold {
    type decimal64 {
        fraction-digits 8;
        range "0..max";
    }
    config false;
    description
        "Threshold on the BER, for which FEC
        is able to correct errors";
}
} // grouping common-explicit-mode

grouping common-organizational-explicit-mode {
    description "Common capability attributes limit range
    in case of operational mode and explicit mode.
    These attributes are supported separately in
    case of application codes";

/* transmitter tuning range (f_tx-min, f_tx-max) */

    leaf min-central-frequency {
        type frequency-thz;
        config false;
        description
            "This parameter indicates the minimum frequency for
            this transceiver.";
    }
    leaf max-central-frequency {
        type frequency-thz;
        config false;
        description
            "This parameter indicates the maximum frequency
            for this transceiver.";
    }
}

/* transmitter-tunability-grid */

```

```

leaf minimum-channel-spacing {
    type frequency-ghz;
    config false;
    description
        "This parameter represents the minimum difference in
        frequency between two adjacent channels
        (ref. G.698.2 sec.7.1.1).
        This free value is to permit OTSi's central frequency not
        to stay on the G.694.1 grid.";
}

/* supported transmitter power range [p_tx-min, p_tx_max] */

leaf tx-channel-power-min {
    type dbm-t;
    config false;
    description "The minimum output power of this interface";
}
leaf tx-channel-power-max {
    type dbm-t;
    config false;
    description "The maximum output power of this interface";
}

/* supported receiver power range [p_rx-min, p_rx_max] */

leaf rx-channel-power-min {
    type dbm-t;
    config false;
    description "The minimum input power of this interface";
}
leaf rx-channel-power-max {
    type dbm-t;
    config false;
    description "The maximum input power of this interface";
}

leaf rx-total-power-max {
    type dbm-t;
    config false;
    description "Maximum rx optical power for
    all the channels";
}

} // grouping common-organizational-explicit-mode

/* This grouping represent the list of configured parameters */
/* values independent of operational mode */

grouping common-transceiver-configured-param {

```

```

description "Capability of an optical transceiver";

leaf OTSi-carrier-frequency {
    type frequency-thz;
    description
        "OTSi carrier frequency, equivalent to the
        actual configured transmitter frequency";
}

leaf tx-channel-power {
    type dbm-t;
    description "The current channel transmit power";
}

leaf rx-channel-power {
    type dbm-t;
    config false;
    description "The current channel received power ";
}

leaf rx-total-power {
    type dbm-t;
    config false;
    description "Current total received power";
}

} // grouping for configured attributes out of mode

grouping l0-tunnel-attributes {
    description
        "Parameters for Layer0 (WSN or Flexi-Grid) Tunnels.";
    leaf fec-type {
        type identityref {
            base fec-type;
        }
        description
            "FEC type.";
    }
    leaf termination-type {
        type identityref {
            base term-type;
        }
        description
            "Termination type.";
    }
    leaf bit-stuffing {
        type boolean;
        description

```

```
        "Bit stuffing enabled/disabled.";
    }
}

grouping l0-path-constraints {
    description
        "Global named path constraints configuration
        grouping for Layer0 (WSON or Flexi-Grid) paths.";
    leaf wavelength-assignment {
        type identityref {
            base wavelength-assignment;
        }
        description "Wavelength Allocation Method";
    }
}
}
<CODE ENDS>
```

Figure 1

4. Acknowledgements

To be added if any.

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6. IANA Considerations

This memo includes no request to IANA.

All drafts are required to have an IANA considerations section (see [Guidelines for Writing an IANA Considerations Section in RFCs](#) [RFC5226] for a guide). If the draft does not require IANA to do anything, the section contains an explicit statement that this is the case (as above). If there are no requirements for IANA, the section will be removed during conversion into an RFC by the RFC Editor.

7. Security Considerations

All drafts are required to have a security considerations section. See [RFC 3552](#) [RFC3552] for a guide.

8. References

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