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A YANG model to manage the optical parameters for in a WDM network
draft-galimbe-ccamp-iv-yang-12

Abstract

This memo defines a Yang model that translate the information model to support Impairment-Aware (IA) Routing and Wavelength Assignment (RWA) functionality. The information model is defined in draft-ietf-ccamp-wson-iv-info and draft-martinelli-ccamp-wson-iv-encode. This document defines proper encoding and extend to the models defined in draft-lee-ccamp-wson-yang to support Impairment-Aware (IA) Routing and Wavelength Assignment (RWA) functions

The Yang model defined in this memo can be used for Optical Parameters monitoring and/or configuration of the multivendor Endpoints and ROADMs. The use of this model does not guarantee interworking of transceivers over a DWDM. Optical path feasibility and interoperability has to be determined by means outside the scope of this document. The purpose of this model is to program interface parameters to consistently configure the mode of operation of transceivers.

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Table of Contents

1. Introduction	3
2. The Internet-Standard Management Framework	3
3. Conventions	4
4. Definition	4
5. Applicability	4
6. Properties	4
7. Overview	4
7.1. Optical Parameters Description	5
7.1.1. Optical path from point Ss to Rs	6
7.1.2. Rs and Ss Configuration	7
7.1.3. Table of Application Codes	7
7.2. Use Cases	7
7.3. Optical Parameters for impairment validation in a WDM network	7
8. Structure of the Yang Module	8
9. Yang Module	9
10. Security Considerations	20
11. IANA Considerations	20
12. Acknowledgements	21
13. Contributors	21
14. References	22
14.1. Normative References	22
14.2. Informative References	24
Appendix A. Change Log	24

Appendix B. Open Issues	24
Authors' Addresses	24

1. Introduction

This memo defines a Yang model that translates the existing mib module defined in draft-ietf-ccamp-wson-iv-info and draft-martinelli-ccamp-wson-iv-encode to provide the network impairment information to an SDN controller. One of the key SDN controller features is to support multivendor network and support the service calculation and deployment in multilayer topologies, for the DWDM layer it is fundamental that the SDN controller is aware of the optical impairments to verify the feasibility of new circuits before their provisioning. Although SDN controller will not apply exhaustive and accurate algorithms and the optical channel feasibility verification may have a degree of unreliability this function can work on a multivendor common set of parameter and algorithms to ensure the operator the best change to set a circuit. This document follows the same impairment definition and applicability of draft-ietf-ccamp-wson-iv-info.

The optical impairments related to the DWDM Transceiver are described by draft draft-dharini-ccamp-if-param-yang. Applications are defined in G.698.2 [ITU.G698.2] using optical interface parameters at the single-channel connection points between optical transmitters and the optical multiplexer, as well as between optical receivers and the optical demultiplexer in the DWDM system. This Recommendation uses a methodology which explicitly specify the details of the optical network between reference point Ss and Rs, e.g., the passive and active elements or details of the design.

The building of a yang model describing the optical parameters allows the different vendors and operator to retrieve, provision and exchange information across multi-vendor domains in a standardized way. In addition to the parameters specified in ITU recommendations the Yang models support also the "vendor specific parameters".

2. The Internet-Standard Management Framework

For a detailed overview of the documents that describe the current Internet-Standard Management Framework, please refer to section 7 of RFC 3410 [RFC3410].

This memo specifies a Yang model for optical interfaces.

3. Conventions

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]. In the description of OIDs the convention: Set (S) Get (G) and Trap (T) conventions will describe the action allowed by the parameter.

4. Definition

For a detailed definition this draft refers to draft-ietf-ccamp-wson-iv-info.

5. Applicability

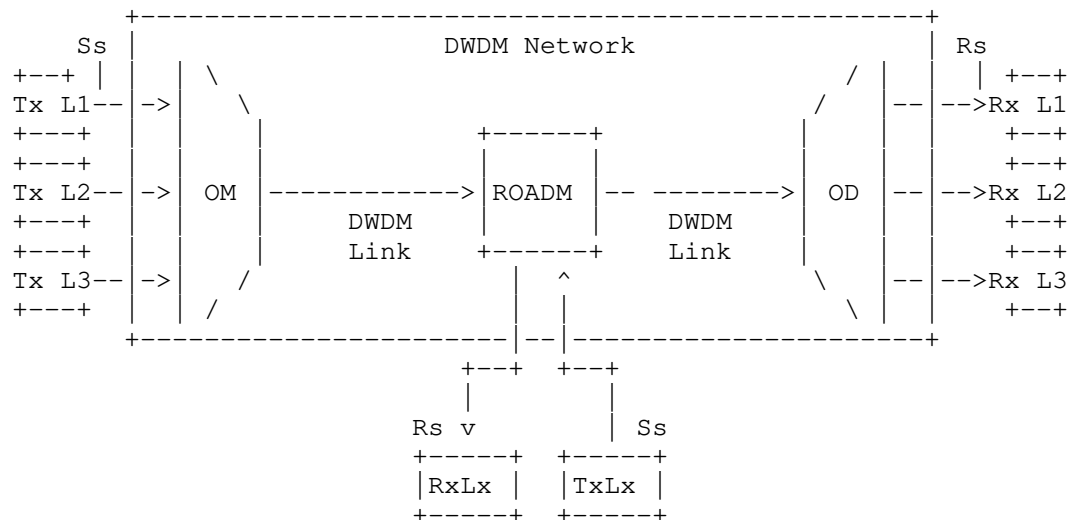
This document targets at Scenario C defined in [RFC6566] section 4.1.1. as approximate impairment estimation. The Approximate concept refers to the fact that this Information Model covers information mainly provided by [ITU.G680] Computational Model. Although the [RFC6566] provides no or little approximation the parameters described in this draft can be applied to the algorithms verifying the circuit feasibility in the new coherent non compensated DWDM networks. In this case the impairments verification can reach a good reliability and accuracy. This draft does not address computational matters but provides all the information suitable to cover most of the full coherent network algorithms, not being exhaustive the information can give an acceptable or even good approximation in terms of connection feasibility. This may not be true for legacy compensated networks.

6. Properties

For the signal properties this draft refers to draft-ietf-ccamp-wson-iv-info Ch.2.3 with some extension of the parameters.

7. Overview

Figure 1 shows a set of reference points, for single-channel connection between transmitters (Tx) and receivers (Rx). Here the DWDM network elements include an OM and an OD (which are used as a pair with the opposing element), one or more optical amplifiers and may also include one or more OADMs.



Ss = reference point at the DWDM network element tributary output
Rs = reference point at the DWDM network element tributary input
Lx = Lambda x
OM = Optical Mux
OD = Optical Demux
ROADM = Reconfigurable Optical Add Drop Mux

from Fig. 5.1/G.698.2

Figure 1: External transponder in WDM networks

7.1. Optical Parameters Description

The link between the external transponders through a WDM network media channels are managed at the edges, i.e. at the transmitters (Tx) and receivers (Rx) attached to the S and R reference points respectively. The set of parameters that could be managed are defined by the "application code" notation

The definitions of the optical parameters are provided below to increase the readability of the document, where the definition is

ended by (R) the parameter can be retrieve with a read, when (W) it can be provisioned by a write, (R,W) can be either read or written.

7.1.1. Optical path from point Ss to Rs

The following parameters for the optical path from point S and R are defined in G.698.2 [ITU.G698.2].

Maximum and minimum (residual) chromatic dispersion:

These parameters define the maximum and minimum value of the optical path "end to end chromatic dispersion" (in ps/nm) that the system shall be able to tolerate. (R)

Minimum optical return loss at Ss:

These parameter defines minimum optical return loss (in dB) of the cable plant at the source reference point (Ss), including any connectors (R)

Maximum discrete reflectance between Ss and Rs:

Optical reflectance is defined to be the ratio of the reflected optical power present at a point, to the optical power incident to that point. Control of reflections is discussed extensively in ITU-T Rec. G.957 (R)

Maximum differential group delay:

Differential group delay (DGD) is the time difference between the fractions of a pulse that are transmitted in the two principal states of polarization of an optical signal. For distances greater than several kilometers, and assuming random (strong) polarization mode coupling, DGD in a fiber can be statistically modelled as having a Maxwellian distribution. (R)

Maximum polarization dependent loss:

The polarization dependent loss (PDL) is the difference (in dB) between the maximum and minimum values of the channel insertion loss (or gain) of the black link from point SS to RS due to a variation of the state of polarization (SOP) over all SOPs. (R)

Maximum inter-channel crosstalk:

Inter-channel crosstalk is defined as the ratio of total power in all of the disturbing channels to that in the wanted channel, where the wanted and disturbing channels are at different wavelengths. The parameter specifies the isolation of a link conforming to the "black link" approach such that under the worst-case operating conditions the inter-channel crosstalk at any reference point RS is less than the maximum inter-channel crosstalk value (R)

Maximum interferometric crosstalk:

This parameter places a requirement on the isolation of a link conforming to the "black link" approach such that under the worst case operating conditions the interferometric crosstalk at any reference point RS is less than the maximum interferometric crosstalk value. (R)

Maximum optical path OSNR penalty:

The optical path OSNR penalty is defined as the difference between the Lowest OSNR at Rs and Lowest OSNR at Ss that meets the BER requirement (R)

Maximum ripple:

Although is defined in G.698.2 (R).

7.1.2. Rs and Ss Configuration

For the Rs and Ss configuration this draft refers the draft-dharini-ccamp-dwdm-if-param-yang while for the Rs-Ss extended parameters for coherent transmission interfaces refer to draft-dharini-ccamp-dwdm-if-param-yang

7.1.3. Table of Application Codes

For Application Codes configuration this draft refers the draft-dharini-ccamp-dwdm-if-param-yang

7.2. Use Cases

The use cases are described in draft-ietf-ccamp-dwdm-if-mng-ctrl-fwk

7.3. Optical Parameters for impairment validation in a WDM network

The ietf-opt-parameters-wdm is an augment to the ?????. It allows the user to get and set the application Optical Parameters of a DWDM network.

```
module: ietf-opt-parameters-wdm
  augment /if:interfaces/if:interface:
    +--rw optical-transport
    |   +--rw attenuator-value?      attenuator-t
    |   +--rw offset?                decimal64
    |   +--rw channel-power-ref?    decimal64
    |   +--rw tilt-calibration?     tilt-t
    +--rw opwr-threshold-warning
    |   +--rw opwr-min?              dbm-t
    |   +--rw opwr-min-clear?       dbm-t
```

```

|   +---rw opwr-max?           dbm-t
+---rw gain-degrade-alarm
|   +---rw gain-degrade-low?   dbm-t
|   +---rw gain-degrade-high?  dbm-t
+---rw power-degrade-high-alarm
|   +---rw gain-degrade-high?  dbm-t
+---rw power-degrade-low-alarm
|   +---ro power-degrade-low?  dbm-t
+---rw noise
|   +---rw noise?              decimal64
+---rw
|   +---rw noise?              decimal64
+---rw chromatic-dispersion
|   +---rw noise-sigma?        decimal64
+---rw chromatic-dispersion-slope
|   +---rw chromatic-dispersion-slope?  decimal64
+---rw pmd
|   +---rw pmd?                decimal64
+---rw pdl
|   +---rw pdl?                decimal64
+---rw drop-power
|   +---rw drop-power?         decimal64
+---rw drop-power-sigma
|   +---rw noise?              decimal64
+---rw ripple
|   +---rw drop-power-sigma?    decimal64
+---ro ch-noise-figure
|   +---ro ch-noise-figure* [ch-noise-fig]
|       +---ro ch-noise-fig      ch-noise-figure-point
|       +---ro input-to-output?  decimal64
|       +---ro input-to-drop?    decimal64
|       +---ro add-to-output?    decimal64
+---rw dgd
|   +---rw dgd?                decimal64
+---ro ch-isolation
|   +---ro ch-isolation* [ch-isolat]
|       +---ro ch-isolat         ch-isolation-cross
|       +---ro ad-ch-isol?       decimal64
|       +---ro no-ad-ch-iso?     decimal64
+---rw ch-extinction
|   +---rw cer?                decimal64

```

8. Structure of the Yang Module

ietf-opt-parameters-wdm is a top level model for the support of this feature.

9. Yang Module

The ietf-opt-parameters-wdm is defined as an extension to ietf interfaces ????.

<CODE BEGINS> file "ietf-opt-parameters-wdm.yang"

```
module ietf-opt-parameters-wdm {  
  namespace "urn:ietf:params:xml:ns:yang:ietf-opt-parameters-wdm";  
  prefix iietf-opt-parameters-wdm;
```

```
  import ietf-interfaces {  
    prefix if;  
  }
```

```
  import iana-if-type {  
    prefix ianaift;  
  }
```

```
  organization  
    "IETF CCAMP  
    Working Group";
```

```
  contact  
    "WG Web:   <http://tools.ietf.org/wg/ccamp/>  
    WG List:  <mailto:ccamp@ietf.org>
```

```
    Editor:   Gabriele Galimberti  
             <mailto:ggalimbe@cisco.com>;
```

```
  description  
    "This module contains a collection of YANG definitions for  
    collecting and configuring Optical Parameters  
    in Optical Networks and calculate the circuit feasibility.
```

```
    Copyright (c) 2016 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  
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    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).";
```

```
revision "2021-06-28" {
    description
        "Revision 1.3";
    reference
        "";
}

revision "2020-03-13" {
    description
        "Revision 1.2";
    reference
        "";
}

revision "2018-10-22" {
    description
        "Revision 1.1";
    reference
        "";
}

revision "2018-03-06" {
    description
        "Revision 1.0";
    reference
        "";
}

revision "2016-10-30" {
    description
        "Initial revision.";
    reference
        "RFC XXXX: A YANG Data Model for Optical Parameters
        of DWDM Networks";
}

typedef tilt-t {
    type decimal64 {
        fraction-digits 2;
        range "-5..5";
    }
    description "Tilt Type";
}
```

```
}

typedef signal-output-power-t {
    type decimal64 {
        fraction-digits 2;
        range "-10..30";
    }
    description "
        Amplifier Power provisioning ";
}

typedef active-channel-t {
    type union {
        type uint8 {
            range "0..200";
        }
    }
    description "
        Number of channels active on a span - and on an amplifier";
}

typedef dbm-t {
    type decimal64 {
        fraction-digits 2;
        range "-50..-30 | -10..5 | 100000000";
    }
    description "
        Amplifier Power in dBm ";
}

typedef attenuator-t {
    type decimal64 {
        fraction-digits 2;
        range "-15..-5";
    }
    description "
        Attenuation value (attenuator) applied after the Amplifier";
}

typedef ch-noise-figure-point {
    type decimal64 {
        fraction-digits 2;
        range "-15..-5";
    }
    description "
        Amplifier noise figure of point power";
}
```

```
typedef ch-isolation-cross {
  type decimal64 {
    fraction-digits 2;
    range "-15..-5";
  }
  description "
cross channel isolation value";
}

grouping opwr-threshold-warning-grp {
  description "
    Minimum Optical Power threshold
    - this is used to rise Power alarm ";

  leaf opwr-min {
    type dbm-t;
    units "dBm";
    default -1;
    description "Minimum Power Value";
  }

  leaf opwr-min-clear {
    type dbm-t;
    units "dBm";
    default -1;
    description "threshold to clear Minimum Power value Alarm";
  }

  leaf opwr-max {
    type dbm-t;
    units "dBm";
    default 1;
    description "
      Maximum Optical Power threshold
      - this is used to rise Power alarm ";
  }
}

grouping gain-degrade-alarm-grp {
  description "
    Low Optical Power gain threshold
    - this is used to rise Power alarm ";

  leaf gain-degrade-low {
    type dbm-t;
    units "dBm";
    default -1;
    description "Low Gain Degrade Value";
  }
}
```

```
    }

    leaf gain-degrade-high {
      type dbm-t;
      units "dBm";
      default 1;
      description "
        High Optical Power gain threshold
        - this is used to rise Power alarm ";
    }
  }

  grouping power-degrade-high-alarm-grp {
    description "
      High Optical Power gain alarm ";

    leaf gain-degrade-high {
      type dbm-t;
      units "dBm";
      default 1;
      description "Low Gain Degrade Value";
    }
  }

  grouping power-degrade-low-alarm-grp {
    description "
      Low Optical Power gain alarm ";

    leaf power-degrade-low {
      type dbm-t;
      units "dBm";
      default -1;
      config false;
      description "High Gain Degrade Value";
    }
  }

  grouping noise-grp {
    description "Noise feasibility";
    leaf noise {
      type decimal64 {
        fraction-digits 2;
      }
      units "dB";
      description "Noise feasibility - reference ITU-T G.680
        OSNR added to the signal by the OMS. The noise is intended
        per channel and is independent of the number of active
```

```
        channels in OMS";
    }
}

grouping noise-sigma-grp {
    description "Noise sigma feasibility";
    leaf noise-sigma {
        type decimal64 {
            fraction-digits 2;
        }
        units "dB";
        description "Noise Sigma feasibility - accuracy of the
            OSNR added to
            the signal by the OMS";
    }
}

grouping chromatic-dispersion-grp {
    description "Chromatic Dispersion";
    leaf chromatic-dispersion {
        type decimal64 {
            fraction-digits 2;
        }
        units "ps/nm";
        description "Chromatic Dispersion (CD) related to the OMS";
    }
}

grouping chromatic-dispersion-slope-grp {
    description "Chromatic Dispersion slope";
    leaf chromatic-dispersion-slope {
        type decimal64 {
            fraction-digits 2;
        }
        units "ps/nm^2";
        description "Chromatic Dispersion (CD) Slope related to
            the OMS";
    }
}

grouping pmd-grp {
    description "Polarization Mode Dispersion";
    leaf pmd {
        type decimal64 {
            fraction-digits 2;
        }
        units "ps";
    }
}
```

```
        description "Polarization Mode Dispersion (PMD) related
            to OMS";
    }
}

grouping pdl-grp {
    description "Polarization Dependent Loss";
    leaf pdl {
        type decimal64 {
            fraction-digits 2;
        }
        units "dB";
        description "Polarization Dependent Loss (PDL) related to
            the OMS";
    }
}

grouping drop-power-grp {
    description "Drop power at DWDM if RX feasibility";
    leaf drop-power {
        type decimal64 {
            fraction-digits 2;
        }
        units "dBm";
        description "Drop Power value at the DWDM Transceiver RX
            side";
    }
}

grouping drop-power-sigma-grp {
    description "Drop power sigma at DWDM if RX feasibility ";
    leaf drop-power-sigma {
        type decimal64 {
            fraction-digits 2;
        }
        units "db";
        description "Drop Power Sigma value at the DWDM Transceiver
            RX side";
    }
}

grouping ripple-grp {
    description "Channel Ripple";
    leaf ripple {
        type decimal64 {
            fraction-digits 2;
        }
        units "db";
    }
}
```

```
        description "Channel Ripple";
    }
}

grouping ch-noise-figure-grp {
    list ch-noise-figure {
        key "ch-noise-fig";
        description "Channel signal-spontaneous noise figure";

        leaf ch-noise-fig {
            type ch-noise-figure-point;
            description "Channel signal-spontaneous noise
            figure point";
        }

        leaf input-to-output {
            type decimal64 {
                fraction-digits 2;
            }
            units "dB";
            description "from input port to output port";
        }

        leaf input-to-drop {
            type decimal64 {
                fraction-digits 2;
            }
            units "dB";
            description "from input port to drop port";
        }

        leaf add-to-output {
            type decimal64 {
                fraction-digits 2;
            }
            units "dB";
            description "from add port to output port";
        }
    }
    description "Channel signal-spontaneous noise figure";
}

grouping dgd-grp {
    description "Differential Group Delay";
    leaf dgd {
        type decimal64 {
            fraction-digits 2;
        }
    }
}
```



```
        units "db";
        description "differential group delay";
    }
}

grouping ch-isolation-grp {
    list ch-isolation {
        key "ch-isolat";
        description "adjacent and not adjacent channel isolation";

        leaf ch-isolat {
            type ch-isolation-cross;
            description "channel isolation from adjacent";
        }

        leaf ad-ch-isol {
            type decimal64 {
                fraction-digits 2;
            }
            units "dB";
            description "adjacent channel isolation";
        }

        leaf no-ad-ch-iso {
            type decimal64 {
                fraction-digits 2;
            }
            units "dB";
            description "non adjacent channel isolation";
        }
    }
    description "djacent and not adjacent channel isolation";
}

grouping ch-extinction-grp {
    description "Channel Extinsion";
    leaf cer {
        type decimal64 {
            fraction-digits 2;
        }
        units "db";
        description "channel extinction";
    }
}

grouping att-coefficient-grp {
    description "Attenuation coefficient (for a fibre segment)";
    leaf att {
```

```
    type decimal64 {
      fraction-digits 2;
    }
    units "db";
    description "Attenuation coefficient (for a fibre segment)";
  }
}

augment "/if:interfaces/if:interface" {
  when "if:type = 'ianaift:opticalTransport'" {
    description "Specific optical-transport Interface Data";
  }
  description "Specific optical-transport Interface Data";
  container optical-transport {
    description "Specific optical-transport Data";

    leaf attenuator-value {
      type attenuator-t;
      description "External attenuator value ";
    }

    leaf offset {
      type decimal64 {
        fraction-digits 2;
        range "-30..30";
      }
      description "Raman and power amplifiers offset";
    }

    leaf channel-power-ref {
      type decimal64 {
        fraction-digits 2;
        range "-10..15";
      }
      description "Optical power per channel";
    }

    leaf tilt-calibration {
      type tilt-t;
      description "Amplifier Tilt tuning";
    }
  }
  container opwr-threshold-warning {
    description "Optical power threshold warning";
    uses opwr-threshold-warning-grp;
  }
  container gain-degrade-alarm {
```

```
        description "Gain degrade alarm";
        uses gain-degrade-alarm-grp;
    }
    container power-degrade-high-alarm {
        description "Power degrade high aparm";
        uses power-degrade-high-alarm-grp;
    }
    container power-degrade-low-alarm {
        description "Power degrade low alarm";
        uses power-degrade-low-alarm-grp;
    }
    container noise {
        description "Channel Noise feasibility";
        uses noise-grp;
    }
    container noise-sigma {
        description "Channel Noise sigma feasibility";
        uses noise-grp;
    }
    container chromatic-dispersion {
        description "Chromatic Dispersion";
        uses noise-sigma-grp;
    }
    container chromatic-dispersion-slope {
        description "Chromatic Dispersion slope";
        uses chromatic-dispersion-slope-grp;
    }
    container pmd {
        description "Polarization Mode Dispersion";
        uses pmd-grp;
    }
    container pdl {
        description "Polarization Dependent Loss";
        uses pdl-grp;
    }
    container drop-power {
        description "Drop power at DWDM if RX feasibility";
        uses drop-power-grp;
    }
    container drop-power-sigma {
        description "Drop power sigma at DWDM if RX feasibility";
        uses noise-grp;
    }
    container ripple {
        description "Channel Ripple";
        uses drop-power-sigma-grp;
    }
    container ch-noise-figure {
```

```
        config false;
        description "Channel signal-spontaneous noise figure";
        uses ch-noise-figure-grp;
    }
    container dgd {
        description "Differential Group Delay";
        uses dgd-grp;
    }
    container ch-isolation {
        config false;
        description "adjacent and not adjacent channel isolation";
        uses ch-isolation-grp;
    }
    container ch-extinction {
        description "Channel Extinction";
        uses ch-extinction-grp;
    }
}
}
}
```

<CODE ENDS>

10. Security Considerations

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

11. IANA Considerations

This document registers a URI in the IETF XML registry [RFC3688]. Following the format in [RFC3688], the following registration is requested to be made:

URI: urn:ietf:params:xml:ns:yang:ietf-interfaces:ietf-ext-xponder-wdm-if

Registrant Contact: The IESG.

XML: N/A, the requested URI is an XML namespace.

This document registers a YANG module in the YANG Module Names registry [RFC6020].

This document registers a YANG module in the YANG Module Names registry [RFC6020].

prefix: ietf-ext-xponder-wdm-if reference: RFC XXXX

12. Acknowledgements

Marco Cardani.

13. Contributors

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14. References

14.1. Normative References

- [ITU.G694.1]
International Telecommunications Union, "Spectral grids for WDM applications: DWDM frequency grid", ITU-T Recommendation G.694.1, February 2012.
- [ITU.G698.2]
International Telecommunications Union, "Amplified multichannel dense wavelength division multiplexing applications with single channel optical interfaces", ITU-T Recommendation G.698.2, November 2009.
- [ITU.G709]
International Telecommunications Union, "Interface for the Optical Transport Network (OTN)", ITU-T Recommendation G.709, June 2016.
- [ITU.G7710]
International Telecommunications Union, "Common equipment management function requirements", ITU-T Recommendation G.7710, August 2017.
- [ITU.G798]
International Telecommunications Union, "Characteristics of optical transport network hierarchy equipment functional blocks", ITU-T Recommendation G.798, December 2017.
- [ITU.G8201]
International Telecommunications Union, "Error performance parameters and objectives for multi-operator international paths within the Optical Transport Network (OTN)", ITU-T Recommendation G.8201, April 2011.
- [ITU.G826]
International Telecommunications Union, "End-to-end error performance parameters and objectives for international, constant bit-rate digital paths and connections", ITU-T Recommendation G.826, December 2002.
- [ITU.G872]
International Telecommunications Union, "Architecture of optical transport networks", ITU-T Recommendation G.872, January 2017.

- [ITU.G874] International Telecommunications Union, "Management aspects of optical transport network elements", ITU-T Recommendation G.874, August 2017.
- [ITU.G874.1] International Telecommunications Union, "Optical transport network (OTN): Protocol-neutral management information model for the network element view", ITU-T Recommendation G.874.1, November 2016.
- [ITU.G959.1] International Telecommunications Union, "Optical transport network physical layer interfaces", ITU-T Recommendation G.959.1, July 2018.
- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.
- [RFC2578] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Structure of Management Information Version 2 (SMIv2)", STD 58, RFC 2578, DOI 10.17487/RFC2578, April 1999, <<https://www.rfc-editor.org/info/rfc2578>>.
- [RFC2579] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Textual Conventions for SMIv2", STD 58, RFC 2579, DOI 10.17487/RFC2579, April 1999, <<https://www.rfc-editor.org/info/rfc2579>>.
- [RFC2580] McCloghrie, K., Ed., Perkins, D., Ed., and J. Schoenwaelder, Ed., "Conformance Statements for SMIv2", STD 58, RFC 2580, DOI 10.17487/RFC2580, April 1999, <<https://www.rfc-editor.org/info/rfc2580>>.
- [RFC2863] McCloghrie, K. and F. Kastenholtz, "The Interfaces Group MIB", RFC 2863, DOI 10.17487/RFC2863, June 2000, <<https://www.rfc-editor.org/info/rfc2863>>.
- [RFC3591] Lam, H-K., Stewart, M., and A. Huynh, "Definitions of Managed Objects for the Optical Interface Type", RFC 3591, DOI 10.17487/RFC3591, September 2003, <<https://www.rfc-editor.org/info/rfc3591>>.

- [RFC6205] Otani, T., Ed. and D. Li, Ed., "Generalized Labels for Lambda-Switch-Capable (LSC) Label Switching Routers", RFC 6205, DOI 10.17487/RFC6205, March 2011, <<https://www.rfc-editor.org/info/rfc6205>>.

14.2. Informative References

- [RFC2629] Rose, M., "Writing I-Ds and RFCs using XML", RFC 2629, DOI 10.17487/RFC2629, June 1999, <<https://www.rfc-editor.org/info/rfc2629>>.
- [RFC3410] Case, J., Mundy, R., Partain, D., and B. Stewart, "Introduction and Applicability Statements for Internet-Standard Management Framework", RFC 3410, DOI 10.17487/RFC3410, December 2002, <<https://www.rfc-editor.org/info/rfc3410>>.
- [RFC4054] Strand, J., Ed. and A. Chiu, Ed., "Impairments and Other Constraints on Optical Layer Routing", RFC 4054, DOI 10.17487/RFC4054, May 2005, <<https://www.rfc-editor.org/info/rfc4054>>.
- [RFC4181] Heard, C., Ed., "Guidelines for Authors and Reviewers of MIB Documents", BCP 111, RFC 4181, DOI 10.17487/RFC4181, September 2005, <<https://www.rfc-editor.org/info/rfc4181>>.

Appendix A. Change Log

This optional section should be removed before the internet draft is submitted to the IESG for publication as an RFC.

Note to RFC Editor: please remove this appendix before publication as an RFC.

Appendix B. Open Issues

Note to RFC Editor: please remove this appendix before publication as an RFC.

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