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A YANG data model to manage configurable DWDM optical interfaces
draft-ietf-ccamp-dwdm-if-param-yang-13

Abstract

This memo defines a Yang model related to the Optical Transceiver parameters characterising coherent 100G and above interfaces. 100G and above Transceivers support coherent modulation, multiple modulation formats, multiple FEC codes including some not yet specified (or in phase of specification by) [ITU-T_G.698.2] or any other ITU-T recommendation. Use cases are described in [RFC7698].

The Yang model defined in this memo can be used for Optical Parameters monitoring and/or configuration of DWDM interfaces. The use of this model does not guarantee interworking of DWDM transceivers. Optical path feasibility and interoperability has to be determined by tools and algorithms 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.

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

This memo defines a Yang model for managing single channel optical interface parameters of coherent interfaces supporting DWDM applications, using the approach specified in G.698.2. This model supports parameters to characterize coherent transceivers found in current implementations to specify the mode of operation. As application identifiers like those specified in [ITU-T_G.874], [ITU-T_G.874.1], [ITU-T_G.698.2] and [ITU-T_G.959.1] may not always be available, mode templates are used. A mode template describes transceiver characteristics in detail and can be identified by a mode-id.

This draft refers to [RFC7698] use cases and is aligned to the definition of [RFC9093] and its update in I-D [I-D.ietf-ccamp-rfc9093-bis]. Finally, the models described in this draft are compliant with the models described in [I-D.ietf-ccamp-optical-impairment-topology-yang] and [I-D.ietf-ccamp-wdm-tunnel-yang].

The key concept introduced by this YANG model in accordance with I-D [I-D.ietf-ccamp-optical-impairment-topology-yang] and [I-D.ietf-ccamp-rfc9093-bis] is the notion of a mode. A mode is a combination of parameters and parameter ranges that is supported by a transceiver. As an example, operating a device in QPSK modulation may use a different FEC and requires less OSNR than the same transceiver operating in QAM16 modulation. Given the number of parameters and their possible combinations it is important for vendors to be able to qualify a set of combinations which is the basis to define a mode. As described in [I-D.ietf-ccamp-optical-impairment-topology-yang] and modeled in [I-D.ietf-ccamp-rfc9093-bis], the list of transceiver modes (properly classified in standard, organizational and explicit modes) provide information about the transmission capabilities of an optical DWDM interface. The same approach is used in this RFC to allow the device netconf agent to export such capabilities to the client controllers.

To advertise the capability supported by an interface, a list of transceiver modes is provided by the device for each dwdm coherent module (supported-modes).

The YANG model provides a configuration attribute named "configured-mode" as a mean to provision the working mode of the interface from the supported-modes listed as capabilities. Once provisioned, current-wdm-if-parameters provide the means to configure specific parameters at run time and retrieve configuration, performance and operational state information from the module [ITU-T_G.7710]. For example, the frequency is a parameter that can be set within min/max

boundaries defined in the current mode. Laser Temperature, RX/TX optical power, RX OSNR, etc. however are read-only parameters available at run-time that can be checked against the mode boundaries and may trigger events.

2. Conventions

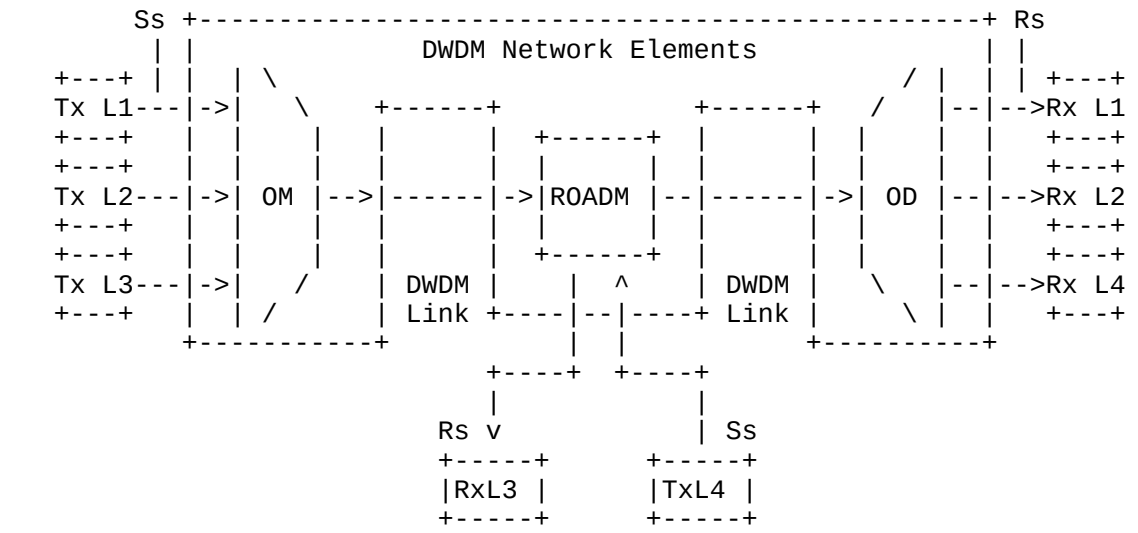
The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

This document is structured following the guidelines for documents containing YANG Data defined in [RFC8407] and its update in [I-D.ietf-netmod-rfc8407bis]

3. Module Description

3.1. 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 (Optical Multiplexer) and an OD (Optical Demultiplexer) which are used as a pair with the opposing element, one or more optical amplifiers and may also include one or more ROADMs. Is to be noted that the TX L1 and RX L1 may be located outside the DWDM network and fitted in the packet layer network elements as pluggable modules.



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 Multiplexer

Figure 1: External transponder in WDM netwoks

from Fig. 5.1/G.698.2

This document introduce the ietf-wdm-interface model as an augment to the ietf-interface. It allows the client to set the operating mode of transceivers as well as other operational parameters. The module provides also threshold settings and notifications to supervise measured parameters and notify the client.

3.2. YANG Module Classification

The model defined in this RFC is meant to be used as Device Model as per definition in [RFC8199] and [RFC8309]

3.3. Optical Parameters Description

[Editor Note: This section need some update to describe all the relevant parameters added in the model]

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.

Definitions of the optical parameters are provided below to increase the readability of the document.

3.3.1. Parameters at Ss

output-power:
The mean launched power at Ss is the average power (in dBm) of a pseudo-random data sequence coupled into the DWDM link.

central frequency:
This parameter indicates the Central frequency value that Ss and Rs will be set to work (in THz) [ITU-T_G.694.1]

3.3.2. Interface at point Rs

input-power:
The average received power (in dBm) at point Rs.

Curr-OSNR:
Current Optical Signal to Noise Ratio (OSNR) estimated at Rx Transceiver port.

Curr-q-factor:
"Q" factor estimated at Rx Transceiver port.

3.4. Use Cases

The use cases are described in draft-ietf-ccamp-optical-impairment-topology-yang, draft-ietf-teas-actn-poi-applicability and draft-poidt-ccamp-actn-poi-pluggable-usecases-gaps.

4. WDM Interface YANG Module

ietf-wdm-interface is a top level model that allow the configuration and monitoring of DWDM interfaces optical parameters. It is defined as an extension to ietf-interfaces.

<CODE BEGINS> file "ietf-wdm-interface.yang"

```
module ietf-wdm-interface {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-wdm-interface";
  prefix wdm-if;
```

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

     import 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:   Dharini Hiremagalur <mailto:dharinih@juniper.net>
       Editor:   Gabriele Galimberti <mailto:ggalimbe56@gmail.com>
       Editor:   Gert Grammel <mailto:ggrammel@juniper.net>
       Editor:   Roberto Manzotti <mailto:rmanzott@cisco.com>";

     description
        "This module contains a collection of YANG definitions for
        configuring DWDM Optical interfaces.

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        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 Revised BSD
        License set forth in Section 4.c of the IETF Trust's Legal
        Provisions Relating to IETF Documents
        (https://trustee.ietf.org/license-info).

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

   // RFC Ed.: replace XXXX with actual RFC number and remove
   // this note
   // replace the revision date with the module publication date
   // the format is (year-month-day)

     revision "2025-02-10" {
       description
         "v1.0 Initial Version";
       reference
         "RFC XXXX: YANG model to manage the optical interface
```

```
          parameters for an external transponder in a WDM network";
        // RFC Ed.: replace XXXX with actual RFC number, update date
        // information and remove this note

      }

      // Need to verify if the enumeration is the proper approach for
      // the tca-types, since the list is not fully standardized adn
      // subject to change.
      typedef wdm-if-tca-types {
        type enumeration {
          enum laser-linewdt-tca {
            description "The laser linewidth TCA";
          }
          enum tx-power-tca {
            description "The tx power TCA";
          }
          enum rx-power-tca {
            description "The tx power TCA";
          }
          enum pol-power-diff-tca {
            description
              "The power difference between polarization TCA";
          }
          enum pol-skew-diff-tca {
            description
              "The skew between the two polarization TCA";
          }
          enum cd-tca {
            description "The chromatic dispersion TCA";
          }
          enum frequency-offset-tca {
            description "Frequency offset TCA";
          }
          enum osnr-tca {
            description "OSNR TCA";
          }
          enum laser-temperature-tca {
            description "Laser temperature TCA";
          }
          enum pre-fec-ber-tca {
            description "Pre Fec BER TCA";
          }
          enum uncorrected-words-tca {
            description "Uncorrected words TCA";
          }
          enum q-factor-tca{
            description "Q Factor TCA";
```

```
        }
      }
      description
        "The different types of TCA's for DWDM Interfaces";
    }


    grouping wdm-if-tca-thresholds {
      description "Thresholds for TCA's";
      leaf tca-type {
        type wdm-if-tca-types;
        description
          "type of the TCA that identify the
          performance measurement, eg TX Power";
      }
      leaf tca-name {
        type string;
        description
          "A name of the TCA that explain the TCA scope
          eg 'Low TX Power'";
      }
      leaf raise-threshold {
        type int32;
        description
          "A TCA is raised if the variable cross this threshold:
          - if raise-threshold is greater than clear-threshold
          (or clear threshold is not defined), the TCA
          is raised when the value exceed the threshold
          - if raise-threshold is smaller that clear-threshold, the
          TCA is raised when the value fall below the threshold";
      }
      leaf clear-threshold {
        type int32;
        description
          "A TCA cleared when the variable cross the threshold in the
          direction defined for raise-threshold";
      }
    }

    grouping wdm-if-tca-list {
      description "List of TCA's";
      leaf number-of-tcas-supported {
        type uint32;
        config false;
        description "Number of TCAs supported by this interface";
      }
      list tca-list {
        key "tca-type";
```

```
        description "List of the TCAs";
        uses wdm-if-tca-thresholds;
      }
    }

    grouping wdm-if-mode-params {
      description "OCh mode parameters";

      leaf min-osnr-margin {
        type l0-types:snr-or-null;
        units "dB";
        config false;
        description "OSNR margin to FEC threshold";
      }
      leaf q-margin {
        type int32;
        units "dB";
        config false;
        description "Q-Factor margin to FEC threshold";
      }
      leaf central-frequency {
        type l0-types:frequency-thz;
        description
          "This parameter indicates the interface Central Frequency";
      }
  //    uses wdm-if-fec-tca-thresholds;
      uses wdm-if-tca-list;
    }

    grouping wdm-if-statistics {
      description "OCh statistics";
      leaf cur-osnr {
        type l0-types:snr;
        units "dB";
        config false;
        description "OSNR margin to FEC threshold";
      }
      leaf cur-q-factor {
        type int32;
        units "dB";
        config false;
        description "Q-Factor of the interface";
      }
      leaf uncorrected-words {
        type uint64;
        config false;
        description "Post-FEC errored words";
      }
```

```
        leaf pre-fec-ber {
          type decimal64 {
            fraction-digits 18;
          }
          config false;
          description "Pre-FEC errored words";
        }
      }

      notification wdm-if-tca {
        description "A output TCA notification";

        leaf "if-name" {
          type leafref { path "/if:interfaces/if:interface/if:name"; }
          mandatory true;
          description "Interface name";
        }
        leaf tca-type {
          type wdm-if-tca-types;
          mandatory true;
          description "Type of TCA for eg min tx power TCA";
        }
        leaf tca-name {
          type string;
          description
            "A name of the TCA that explain the TCA scope
            eg 'Low TX Power'";
        }
      }

      augment "/if:interfaces" {
        description
          "Template definition for Optical Interface explicit-modes";
        container "wdm-if-templates" {
          config false;
          description "Optical Interface explicit-mode templates";
          container explicit-transceiver-modes {
            description
              "The top level container for the list of the
              transceivers' explicit modes.";
            list explicit-transceiver-mode {
              key explicit-transceiver-mode-id;
              description
                "The list of the transceivers' explicit modes.";
              leaf explicit-transceiver-mode-id {
                type string;
                description
                  "The identifier of the transceivers' explicit mode.";
```

```
            }
            uses l0-types:explicit-mode;
          } // list explicit-transceiver-mode
        } // container explicit-transceiver-modes
      }  // container dwdm-if-templates
    }  // augment interfaces

    augment "/if:interfaces/if:interface" {
      description "Parameters for an optical interface";

      container wdm-interface {
        description
          "Container for capabilities, configuration,
          current operational data for a DWDM interface";

        uses l0-types:transceiver-capabilities {
          augment "supported-modes/supported-mode/mode/"
          + "explicit-mode/explicit-mode" {
            description
              "Augment the explicit-mode container with the
              proper leafref.";
            leaf explicit-transceiver-mode-ref {
              type leafref {
                path "../../../../../../wdm-if:wdm-if-templates"
                     + "/wdm-if:explicit-transceiver-modes"
                     + "/wdm-if:explicit-transceiver-mode"
                     + "/wdm-if:explicit-transceiver-mode-id";
              }
              description
                "The reference to the explicit transceiver
                mode template.";
            }
          }
        }

        container current-wdm-if-parameters {
          leaf configured-mode {
            type union {
              type empty;
              type leafref {
                path "../../supported-modes/supported-mode/mode-id";
              }
            }
            description
              "Reference to the configured mode for transceiver
              compatibility approach.

              The empty value is used to report that no mode has
```

```
                been configured and there is no default mode.

                When not present, the configured-mode is not reported
                by the server.";
            }
            uses l0-types:common-transceiver-param;
            description "Current parameters of this interface";
            uses wdm-if-mode-params;
            uses wdm-if-statistics;
          }
        }
      }
    }
    <CODE ENDS>
```

5. Security Considerations

This section is modeled after the template described in Section 3.7 of [RFC8407] and the update in draft [I-D.ietf-netmod-rfc8407bis].

The "ietf-wdm-interface" YANG module defines a data model that is designed to be accessed via YANG-based management protocols, such as NETCONF [RFC6241] and RESTCONF [RFC8040]. These protocols have to use a secure transport layer (e.g., SSH [RFC4252], TLS [RFC8446], and QUIC [RFC9000]) and have to use mutual authentication.

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.

There are a number of data nodes defined in this YANG module that are writable/creatable/deletable (i.e., "config true", which is the default). All writable data nodes are likely to be reasonably sensitive or vulnerable in some network environments. Write operations (e.g., edit-config) and delete operations to these data nodes without proper protection or authentication can have a negative effect on network operations. The following subtrees and data nodes have particular sensitivities/vulnerabilities:

```
     augment /if:interfaces/if:interface:
       +--rw wdm-interface
          .
          .
          .
          +--rw current-wdm-if-parameters
             +--rw configured-mode?            union
             +--rw line-coding-bitrate?        identityref
             +--rw tx-channel-power?           power-dbm-or-null
             +--rw central-frequency?          l0-types:frequency-thz
```

There are no particularly sensitive readable data nodes.

6. IANA Considerations

This document registers the following namespace URIs in the IETF XML registry [RFC3688]:

```
---------------------------------------------------------------------
<!--URI: urn:ietf:params:xml:ns:yang:ietf-wdm-interface-->
URI: urn:ietf:params:xml:ns:yang:ietf-interfaces:ietf-wdm-interface
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.
---------------------------------------------------------------------
```

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

```
---------------------------------------------------------------------
name:      ietf-wdm-interface
namespace: urn:ietf:params:xml:ns:yang:ietf-wdm-interface
prefix:    wdm-if
reference: RFC XXXX (TDB)
---------------------------------------------------------------------
```

7. Acknowledgements

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Bierman, A., Boucadair, M., and Q. Wu, "Guidelines for Authors and Reviewers of Documents Containing YANG Data Models", Work in Progress, Internet-Draft, draft-ietf-netmod-rfc8407bis-28, 5 June 2025, <https://datatracker.ietf.org/doc/html/draft-ietf-netmod-rfc8407bis-28>.

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

// TEMPLATE TODO This list of issues listed in this optional section
// should be cleared and removed, and 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 C. YANG Tree

```
  module: ietf-wdm-interface

    augment /if:interfaces:
      +--ro wdm-if-templates
         +--ro explicit-transceiver-modes
            +--ro explicit-transceiver-mode*
                    [explicit-transceiver-mode-id]
               +--ro explicit-transceiver-mode-id        string
               +--ro line-coding-bitrate?                identityref
               +--ro bitrate?                            uint16
               +--ro max-diff-group-delay?               decimal-2
               +--ro max-chromatic-dispersion?           decimal-2
               +--ro cd-penalty* [cd-value]
               |  +--ro cd-value         decimal-2
               |  +--ro penalty-value    union
               +--ro max-polarization-mode-dispersion?   decimal-2
               +--ro pmd-penalty* [pmd-value]
               |  +--ro pmd-value        decimal-2
               |  +--ro penalty-value    union
               +--ro max-polarization-dependent-loss
               |       power-loss-or-null
               +--ro pdl-penalty* [pdl-value]
               |  +--ro pdl-value        power-loss
               |  +--ro penalty-value    union
               +--ro available-modulation-type?          identityref
               +--ro min-OSNR?                           snr
               +--ro rx-ref-channel-power?               power-dbm
               +--ro rx-channel-power-penalty* [rx-channel-power-value]
               |  +--ro rx-channel-power-value    power-dbm
               |  +--ro penalty-value             union
               +--ro min-Q-factor?                       decimal-2
               +--ro available-baud-rate?                decimal64
```

```
            +--ro roll-off?                              decimal64
            +--ro min-carrier-spacing?                   frequency-ghz
            +--ro available-fec-type?                    identityref
            +--ro fec-code-rate?                         decimal64
            +--ro fec-threshold?                         decimal64
            +--ro in-band-osnr?                          snr
            +--ro out-of-band-osnr?                      snr
            +--ro tx-polarization-power-difference?      power-ratio
            +--ro polarization-skew?                     decimal-2
    augment /if:interfaces/if:interface:
      +--rw wdm-interface
         +--ro supported-modes!
         |  +--ro supported-mode* [mode-id]
         |     +--ro mode-id                            string
         |     +--ro (mode)
         |        +--:(G.698.2)
         |        |  +--ro standard-mode?               standard-mode
         |        |  +--ro line-coding-bitrate*         identityref
         |        |  +--ro transceiver-tuning-range
         |        |  |  +--ro min-central-frequency?
         |        |  |  |       frequency-thz
         |        |  |  +--ro max-central-frequency?
         |        |  |  |       frequency-thz
         |        |  |  +--ro transceiver-tunability-granularity?
         |        |  |          frequency-ghz
         |        |  +--ro tx-channel-power-min?        power-dbm
         |        |  +--ro tx-channel-power-max?        power-dbm
         |        |  +--ro rx-channel-power-min?        power-dbm
         |        |  +--ro rx-channel-power-max?        power-dbm
         |        |  +--ro rx-total-power-max?          power-dbm
         |        +--:(organizational-mode)
         |        |  +--ro organizational-mode
         |        |     +--ro operational-mode?
         |        |     |       operational-mode
         |        |     +--ro organization-identifier?
         |        |     |       organization-identifier
         |        |     +--ro line-coding-bitrate*         identityref
         |        |     +--ro transceiver-tuning-range
         |        |     |  +--ro min-central-frequency?
         |        |     |  |       frequency-thz
         |        |     |  +--ro max-central-frequency?
         |        |     |  |       frequency-thz
         |        |     |  +--ro transceiver-tunability-granularity?
         |        |     |          frequency-ghz
         |        |     +--ro tx-channel-power-min?       power-dbm
         |        |     +--ro tx-channel-power-max?       power-dbm
         |        |     +--ro rx-channel-power-min?       power-dbm
         |        |     +--ro rx-channel-power-max?       power-dbm
```

```
         |        |     +--ro rx-total-power-max?         power-dbm
         |        +--:(explicit-mode)
         |           +--ro explicit-mode
         |              +--ro transceiver-tuning-range
         |              |  +--ro min-central-frequency?
         |              |  |       frequency-thz
         |              |  +--ro max-central-frequency?
         |              |  |       frequency-thz
         |              |  +--ro transceiver-tunability-granularity?
         |              |          frequency-ghz
         |              +--ro tx-channel-power-min?
         |              |       power-dbm
         |              +--ro tx-channel-power-max?
         |              |       power-dbm
         |              +--ro rx-channel-power-min?
         |              |       power-dbm
         |              +--ro rx-channel-power-max?
         |              |       power-dbm
         |              +--ro rx-total-power-max?
         |              |       power-dbm
         |              +--ro compatible-modes
         |              |  +--ro supported-application-codes*
         |              |  |       -> ../../../../supported-mode/mode-id
         |              |  +--ro supported-organizational-modes*
         |              |          -> ../../../../supported-mode/mode-id
         |              +--ro explicit-transceiver-mode-ref?   leafref
         +--rw current-wdm-if-parameters
            +--rw configured-mode?            union
            +--rw line-coding-bitrate?        identityref
            +--rw tx-channel-power?           power-dbm-or-null
            +--ro rx-channel-power?           power-dbm-or-null
            +--ro rx-total-power?             power-dbm-or-null
            +--ro min-osnr-margin?            l0-types:snr-or-null
            +--ro q-margin?                   int32
            +--rw central-frequency?          l0-types:frequency-thz
            +--ro number-of-tcas-supported?   uint32
            +--rw tca-list* [tca-type]
            |  +--rw tca-type           wdm-if-tca-types
            |  +--rw tca-name?          string
            |  +--rw raise-threshold?   int32
            |  +--rw clear-threshold?   int32
            +--ro cur-osnr?                   l0-types:snr
            +--ro cur-q-factor?               int32
            +--ro uncorrected-words?          uint64
            +--ro pre-fec-ber?                decimal64

    notifications:
      +---n wdm-if-tca
```

```
         +--ro if-name     -> /if:interfaces/interface/name
         +--ro tca-type    wdm-if-tca-types
         +--ro tca-name?   string
```

Appendix D. Applicability examples

As an example here below is the way and OpenROADM compliant equipment could be managed using the Yang models described in thei draft.

[Editor Note: We may need to rephrase the following sentence, OpenROADM has now many DWDM interface mode supported]

In OpenROADM MSA there is a limited number of DWDM interfaces supported. Basically only the 100G Staircase FEC and 400G oFEC are supported and these two kind of interfaces can be easily summarized with the "mode-id" and the "application-identifier" strings.

the models below are enough to identify the interface and few working parameters:

```
module: ietf-wdm-interface
 augment /if:interfaces/if:interface:
    +--rw wdm-interface
       +--rw current-wdm-if-parameters
          +--rw configured-mode?          union
          +--rw central-frequency?        l0-types:frequency-thz
          +--rw tx-channel-power?         power-dbm-or-null
          +--ro rx-channel-power?         power-dbm-or-null
          .
          .
          .
          +--ro cur-osnr?                 layer0-types:snr
          +--ro cur-q-factor?             int32
          +--ro uncorrected-words?        uint64
          +--ro pre-fec-ber?              decimal64
```

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