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YANG Data Models for requesting Path Computation in Optical Networks

Abstract

This document describes YANG data models for Remote Procedure Calls (RPCs) to request Path Computation in Optical Networks (OTN, WSON and Flexi-grid).

The YANG data models defined in this document conforms to the Network Management Datastore Architecture (NMDA).

Status of This Memo

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1. Introduction

[I-D.ietf-teas-yang-path-computation] describes key use cases, where a client needs to request underlying SDN controllers for path computation. In some of these use cases, the underlying SDN controller can control a single-layer optical technologies, including Optical Transport Network (OTN), Wavelength Switched Optical Networks (WSON), Flexi-grid, and multi-layer Optical network.

This document defines YANG data models, which augment the generic Path Computation RPC defined in [I-D.ietf-teas-yang-path-computation], with technology-specific augmentations required to request path computation to an underlying Optical SDN controller. These models allow a client to delegate path computation tasks to

the underlying Optical SDN controller without having to obtain optical-layer information from the controller and performing feasible path computation itself. This is especially helpful in cases where computing optically-feasible paths require knowledge of physical-layer states, such as optical impairments, which are visible only to the Optical controller.

The YANG data model defined in this document conforms to the Network Management Datastore Architecture [RFC8342].

1.1. Terminology and Notations

Refer to [RFC7446] and [RFC7581] for the key terms used in this document. The following terms are defined in [RFC7950] and are not redefined here:

- *client
- *server
- *augment
- *data model
- *data node

The following terms are defined in [RFC6241] and are not redefined here:

- *configuration data
- *state data

The terminology for describing YANG data models is found in [RFC7950].

1.2. Tree Diagram

A simplified graphical representation of the data model is used in Section 3 of this document. The meaning of the symbols in these diagrams is defined in [RFC8340].

1.3. 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, as shown in Table 1.

Prefix	YANG module	Reference
l0-types	ietf-layer0-types	[RFC9093]
l0-types-ext	ietf-layer0-types-ext	[RFCYYYY]
l0-types	ietf-layer0-types	[RFC8776]
l1-types	ietf-layer1-types	[RFCZZZZ]
te	ietf-te	[RFCKKKK]
tep	ietf-te-path-computation	[RFCJJJJ]
flexg-pc	ietf-flexi-grid-path-computation	RFCXXXX
wson-pc	ietf-wson-path-computation	RFCXXXX
otn-pc	ietf-otn-path-computation	RFCXXXX

Table 1: Prefixes and corresponding YANG modules

RFC Editor Note: Please replace XXXX with the RFC number assigned to this document. Please replace YYYY with the RFC number assigned to [I-D.ietf-ccamp-layer0-types-ext]. Please replace ZZZZ with the RFC number assigned to [I-D.ietf-ccamp-layer1-types]. Please replace KKKK with the RFC number assigned to [I-D.ietf-teas-yang-te]. Please replace JJJJ with the RFC number assigned to [I-D.ietf-teas-yang-path-computation]. Please remove this note.

2. YANG Data Models for Optical Path Computation

2.1. YANG Models Overview

The YANG data models for requesting WSON, Flexi-grid and OTN path computation are defined as augmentations of the generic Path Computation RPC defined in [I-D.ietf-teas-yang-path-computation], as shown in Figure 1.

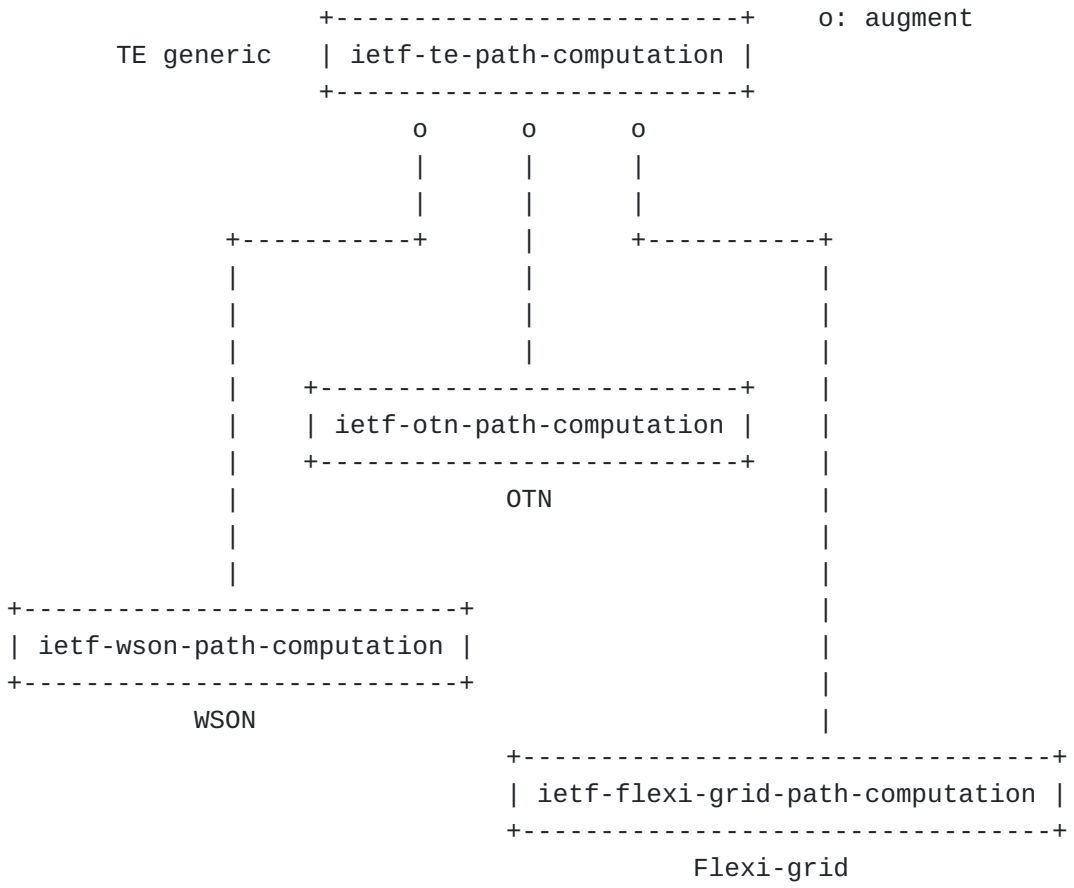

Figure 1: Relationship between WSON, Flexi-grid, OTN and TE path computation models

The entities and Traffic Engineering (TE) attributes, such as requested path and tunnel attributes, defined in [I-D.ietf-teas-yang-path-computation], are still applicable when requesting WSON, Flexi-grid and OTN path computation and the models defined in this document only specifies the additional technology-specific attributes/information, using the attributes defined in [RFC9093], [I-D.ietf-ccamp-layer0-types-ext] and [I-D.ietf-ccamp-layer1-types].

The YANG modules ietf-wson-path-computation, ietf-flexi-grid-path-computation and ietf-otn-path-computation defined in this document conforms to the Network Management Datastore Architecture (NMDA) defined in [RFC8342].

2.2. Attributes Augmentation

The common characteristics for layer 0 (WSON and Flexi-grid) tunnels are under definition in [I-D.ietf-ccamp-layer0-types-ext] and re-used in the ietf-wson-path-computation and ietf-flexi-grid-path-computation YANG models

2.3. Bandwidth Augmentation

As described in Section 4.2 of [RFC7699], there is some overlap between bandwidth and label in layer0.

The WSON and flexi-grid label resource information described in Section 2.4, is sufficient to describe also the spectrum resources within WSON and flexi-grid networks. Therefore, the model does not define any augmentation for the te-bandwidth containers defined in [I-D.ietf-teas-yang-path-computation].

The OTN path computation model augments all the occurrences of the te-bandwidth container with the OTN technology-specific attributes using the otn-link-bandwidth and otn-path-bandwidth groupings defined in [I-D.ietf-ccamp-layer1-types].

2.4. Label Augmentations

The models augment all the occurrences of the label-restriction list with WSON, Flexi-grid and OTN technology-specific attributes using the l0-label-range-info and flexi-grid-label-range-info groupings defined in [RFC9093] and the otn-label-range-info grouping defined in [I-D.ietf-ccamp-layer1-types].

Moreover, the models augment all the occurrences of the te-label container with the WSON, Flexi-grid and OTN technology-specific attributes using the wson-label-start-end, wson-label-hop, wson-label-step, flexi-grid-label-start-end, flexi-grid-label-hop and flexi-grid-label-step defined in [RFC9093] and the otn-label-start-end, otn-label-hop and otn-label-step groupings defined in [I-D.ietf-ccamp-layer1-types].

3. Optical Path Computation Tree Diagrams

3.1. WSON Path Computation Tree Diagrams

Figure 2 below shows the tree diagram of the YANG data model defined in module ietf-wson-path-computation.yang.

```
module: ietf-wson-path-computation

  augment /te:tunnels-path-compute/te:input/te:path-compute-info
            /tepc:path-request:
    +-- fec-type?                identityref
    +-- termination-type?        identityref
    +-- bit-stuffing?            boolean
    +-- wavelength-assignment?   identityref
    +-- gsnr-margin?             snr
  augment /te:tunnels-path-compute/te:output/te:path-compute-result
            /tepc:response/tepc:computed-paths-properties
            /tepc:computed-path-properties/tepc:path-properties:
    +--ro estimated-gsnr?   snr
  augment /te:tunnels-path-compute/te:input/te:path-compute-info
            /tepc:path-request/tepc:optimizations/tepc:algorithm
            /tepc:metric/tepc:optimization-metric
            /tepc:explicit-route-exclude-objects
            /tepc:route-object-exclude-object/tepc:type:
    +--:(oms-element)
       +-- oms-element-uid?   string
  augment /te:tunnels-path-compute/te:input/te:path-compute-info
            /tepc:path-request/tepc:optimizations/tepc:algorithm
            /tepc:metric/tepc:optimization-metric
            /tepc:explicit-route-include-objects
            /tepc:route-object-include-object/tepc:type:
    +--:(oms-element)
       +-- oms-element-uid?   string
  augment /te:tunnels-path-compute/te:input/te:path-compute-info
            /tepc:path-request/tepc:explicit-route-objects-always
            /tepc:route-object-exclude-always/tepc:type:
    +--:(oms-element)
       +-- oms-element-uid?   string
  augment /te:tunnels-path-compute/te:input/te:path-compute-info
            /tepc:path-request/tepc:explicit-route-objects-always
            /tepc:route-object-include-exclude/tepc:type:
    +--:(oms-element)
       +-- oms-element-uid?   string
  augment /te:tunnels-path-compute/te:input/te:path-compute-info
            /tepc:synchronization/tepc:exclude-objects/tepc:excludes
            /tepc:type:
    +--:(oms-element)
       +-- oms-element-uid?   string
  augment /te:tunnels-path-compute/te:output/te:path-compute-result
            /tepc:response/tepc:computed-paths-properties
            /tepc:computed-path-properties/tepc:path-properties
            /tepc:path-route-objects/tepc:path-route-object
            /tepc:type:
    +--:(oms-element)
       +--ro oms-element-uid?   string
```

```
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-in-segment
          /tepc:label-restrictions/tepc:label-restriction:
  +-- grid-type?   identityref
  +-- priority?    uint8
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-out-segment
          /tepc:label-restrictions/tepc:label-restriction:
  +-- grid-type?   identityref
  +-- priority?    uint8
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:optimizations/tepc:algorithm
          /tepc:metric/tepc:optimization-metric
          /tepc:explicit-route-exclude-objects
          /tepc:route-object-exclude-object/tepc:type/tepc:label
          /tepc:label-hop/tepc:te-label/tepc:technology:
  +--:(wson)
     +-- (grid-type)?
        +--:(dwdm)
        |  +-- (single-or-super-channel)?
        |     +--:(single)
        |     |  +-- dwdm-n?              l0-types:dwdm-n
        |     +--:(super)
        |        +-- subcarrier-dwdm-n*   l0-types:dwdm-n
        +--:(cwdm)
           +-- cwdm-n?                    l0-types:cwdm-n
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:optimizations/tepc:algorithm
          /tepc:metric/tepc:optimization-metric
          /tepc:explicit-route-include-objects
          /tepc:route-object-include-object/tepc:type/tepc:label
          /tepc:label-hop/tepc:te-label/tepc:technology:
  +--:(wson)
     +-- (grid-type)?
        +--:(dwdm)
        |  +-- (single-or-super-channel)?
        |     +--:(single)
        |     |  +-- dwdm-n?              l0-types:dwdm-n
        |     +--:(super)
        |        +-- subcarrier-dwdm-n*   l0-types:dwdm-n
        +--:(cwdm)
           +-- cwdm-n?                    l0-types:cwdm-n
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:explicit-route-objects-always
          /tepc:route-object-exclude-always/tepc:type/tepc:label
          /tepc:label-hop/tepc:te-label/tepc:technology:
  +--:(wson)
     +-- (grid-type)?
        +--:(dwdm)
```

```
        |  +-- (single-or-super-channel)?
        |     +--:(single)
        |     |  +-- dwdm-n?              l0-types:dwdm-n
        |     +--:(super)
        |        +-- subcarrier-dwdm-n*   l0-types:dwdm-n
        +--:(cwdm)
           +-- cwdm-n?                    l0-types:cwdm-n
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:explicit-route-objects-always
          /tepc:route-object-include-exclude/tepc:type/tepc:label
          /tepc:label-hop/tepc:te-label/tepc:technology:
  +--:(wson)
     +-- (grid-type)?
        +--:(dwdm)
        |  +-- (single-or-super-channel)?
        |     +--:(single)
        |     |  +-- dwdm-n?              l0-types:dwdm-n
        |     +--:(super)
        |        +-- subcarrier-dwdm-n*   l0-types:dwdm-n
        +--:(cwdm)
           +-- cwdm-n?                    l0-types:cwdm-n
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-in-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-start/tepc:te-label/tepc:technology:
  +--:(wson)
     +-- (grid-type)?
        +--:(dwdm)
        |  +-- dwdm-n?   l0-types:dwdm-n
        +--:(cwdm)
           +-- cwdm-n?   l0-types:cwdm-n
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-in-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-end/tepc:te-label/tepc:technology:
  +--:(wson)
     +-- (grid-type)?
        +--:(dwdm)
        |  +-- dwdm-n?   l0-types:dwdm-n
        +--:(cwdm)
           +-- cwdm-n?   l0-types:cwdm-n
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-in-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-step/tepc:technology:
  +--:(wson)
     +-- (l0-grid-type)?
        +--:(dwdm)
        |  +-- wson-dwdm-channel-spacing?   identityref
```

```
        +--:(cwdm)
           +-- wson-cwdm-channel-spacing?   identityref
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-out-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-start/tepc:te-label/tepc:technology:
  +--:(wson)
     +-- (grid-type)?
        +--:(dwdm)
        |  +-- dwdm-n?   l0-types:dwdm-n
        +--:(cwdm)
           +-- cwdm-n?   l0-types:cwdm-n
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-out-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-end/tepc:te-label/tepc:technology:
  +--:(wson)
     +-- (grid-type)?
        +--:(dwdm)
        |  +-- dwdm-n?   l0-types:dwdm-n
        +--:(cwdm)
           +-- cwdm-n?   l0-types:cwdm-n
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-out-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-step/tepc:technology:
  +--:(wson)
     +-- (l0-grid-type)?
        +--:(dwdm)
        |  +-- wson-dwdm-channel-spacing?   identityref
        +--:(cwdm)
           +-- wson-cwdm-channel-spacing?   identityref
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:synchronization/tepc:exclude-objects/tepc:excludes
          /tepc:type/tepc:label/tepc:label-hop/tepc:te-label
          /tepc:technology:
  +--:(wson)
     +-- (grid-type)?
        +--:(dwdm)
        |  +-- (single-or-super-channel)?
        |     +--:(single)
        |     |  +-- dwdm-n?              l0-types:dwdm-n
        |     +--:(super)
        |        +-- subcarrier-dwdm-n*   l0-types:dwdm-n
        +--:(cwdm)
           +-- cwdm-n?                    l0-types:cwdm-n
augment /te:tunnels-path-compute/te:output/te:path-compute-result
          /tepc:response/tepc:computed-paths-properties
          /tepc:computed-path-properties/tepc:path-properties
```

```
        /tepc:path-route-objects/tepc:path-route-object/tepc:type
        /tepc:label/tepc:label-hop/tepc:te-label/tepc:technology:
+--:(wson)
   +--ro (grid-type)?
      +--:(dwdm)
      |  +--ro (single-or-super-channel)?
      |     +--:(single)
      |     |  +--ro dwdm-n?              l0-types:dwdm-n
      |     +--:(super)
      |        +--ro subcarrier-dwdm-n*   l0-types:dwdm-n
      +--:(cwdm)
         +--ro cwdm-n?                    l0-types:cwdm-n
```

Figure 2: WSON path computation tree diagram

3.2. Flexi-grid Path Computation Tree Diagrams

Figure 3 below shows the tree diagram of the YANG data model defined in module ietf-flexi-grid-path-computation.yang.

```
module: ietf-flexi-grid-path-computation

  augment /te:tunnels-path-compute/te:input/te:path-compute-info
            /tepc:path-request:
    +-- fec-type?                identityref
    +-- termination-type?        identityref
    +-- bit-stuffing?            boolean
    +-- wavelength-assignment?   identityref
    +-- gsnr-margin?             snr
  augment /te:tunnels-path-compute/te:output/te:path-compute-result
            /tepc:response/tepc:computed-paths-properties
            /tepc:computed-path-properties/tepc:path-properties:
    +--ro estimated-gsnr?   snr
  augment /te:tunnels-path-compute/te:input/te:path-compute-info
            /tepc:path-request/tepc:optimizations/tepc:algorithm
            /tepc:metric/tepc:optimization-metric
            /tepc:explicit-route-exclude-objects
            /tepc:route-object-exclude-object/tepc:type:
    +--:(oms-element)
       +-- oms-element-uid?   string
  augment /te:tunnels-path-compute/te:input/te:path-compute-info
            /tepc:path-request/tepc:optimizations/tepc:algorithm
            /tepc:metric/tepc:optimization-metric
            /tepc:explicit-route-include-objects
            /tepc:route-object-include-object/tepc:type:
    +--:(oms-element)
       +-- oms-element-uid?   string
  augment /te:tunnels-path-compute/te:input/te:path-compute-info
            /tepc:path-request/tepc:explicit-route-objects-always
            /tepc:route-object-exclude-always/tepc:type:
    +--:(oms-element)
       +-- oms-element-uid?   string
  augment /te:tunnels-path-compute/te:input/te:path-compute-info
            /tepc:path-request/tepc:explicit-route-objects-always
            /tepc:route-object-include-exclude/tepc:type:
    +--:(oms-element)
       +-- oms-element-uid?   string
  augment /te:tunnels-path-compute/te:input/te:path-compute-info
            /tepc:synchronization/tepc:exclude-objects/tepc:excludes
            /tepc:type:
    +--:(oms-element)
       +-- oms-element-uid?   string
  augment /te:tunnels-path-compute/te:output/te:path-compute-result
            /tepc:response/tepc:computed-paths-properties
            /tepc:computed-path-properties/tepc:path-properties
            /tepc:path-route-objects/tepc:path-route-object
            /tepc:type:
    +--:(oms-element)
       +--ro oms-element-uid?   string
```

```
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-in-segment
          /tepc:label-restrictions/tepc:label-restriction:
  +-- grid-type?    identityref
  +-- priority?     uint8
  +-- flexi-grid
     +-- slot-width-granularity?   identityref
     +-- min-slot-width-factor?    uint16
     +-- max-slot-width-factor?    uint16
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-out-segment
          /tepc:label-restrictions/tepc:label-restriction:
  +-- grid-type?    identityref
  +-- priority?     uint8
  +-- flexi-grid
     +-- slot-width-granularity?   identityref
     +-- min-slot-width-factor?    uint16
     +-- max-slot-width-factor?    uint16
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:optimizations/tepc:algorithm
          /tepc:metric/tepc:optimization-metric
          /tepc:explicit-route-exclude-objects
          /tepc:route-object-exclude-object/tepc:type/tepc:label
          /tepc:label-hop/tepc:te-label/tepc:technology:
  +--:(flexi-grid)
     +-- (single-or-super-channel)?
        +--:(single)
        |  +-- flexi-n?             l0-types:flexi-n
        |  +-- flexi-m?             l0-types:flexi-m
        +--:(super)
           +-- subcarrier-flexi-n* [flexi-n]
              +-- flexi-n    l0-types:flexi-n
              +-- flexi-m?   l0-types:flexi-m
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:optimizations/tepc:algorithm
          /tepc:metric/tepc:optimization-metric
          /tepc:explicit-route-include-objects
          /tepc:route-object-include-object/tepc:type/tepc:label
          /tepc:label-hop/tepc:te-label/tepc:technology:
  +--:(flexi-grid)
     +-- (single-or-super-channel)?
        +--:(single)
        |  +-- flexi-n?             l0-types:flexi-n
        |  +-- flexi-m?             l0-types:flexi-m
        +--:(super)
           +-- subcarrier-flexi-n* [flexi-n]
              +-- flexi-n    l0-types:flexi-n
              +-- flexi-m?   l0-types:flexi-m
augment /te:tunnels-path-compute/te:input/te:path-compute-info
```

```
          /tepc:path-request/tepc:explicit-route-objects-always
          /tepc:route-object-exclude-always/tepc:type/tepc:label
          /tepc:label-hop/tepc:te-label/tepc:technology:
  +--:(flexi-grid)
     +-- (single-or-super-channel)?
        +--:(single)
        |  +-- flexi-n?             l0-types:flexi-n
        |  +-- flexi-m?             l0-types:flexi-m
        +--:(super)
           +-- subcarrier-flexi-n* [flexi-n]
              +-- flexi-n    l0-types:flexi-n
              +-- flexi-m?   l0-types:flexi-m
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:explicit-route-objects-always
          /tepc:route-object-include-exclude/tepc:type/tepc:label
          /tepc:label-hop/tepc:te-label/tepc:technology:
  +--:(flexi-grid)
     +-- (single-or-super-channel)?
        +--:(single)
        |  +-- flexi-n?             l0-types:flexi-n
        |  +-- flexi-m?             l0-types:flexi-m
        +--:(super)
           +-- subcarrier-flexi-n* [flexi-n]
              +-- flexi-n    l0-types:flexi-n
              +-- flexi-m?   l0-types:flexi-m
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-in-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-start/tepc:te-label/tepc:technology:
  +--:(flexi-grid)
     +-- flexi-n?   l0-types:flexi-n
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-in-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-end/tepc:te-label/tepc:technology:
  +--:(flexi-grid)
     +-- flexi-n?   l0-types:flexi-n
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-in-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-step/tepc:technology:
  +--:(flexi-grid)
     +-- flexi-grid-channel-spacing?   identityref
     +-- flexi-n-step?                 uint8
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-out-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-start/tepc:te-label/tepc:technology:
  +--:(flexi-grid)
```

```
     +-- flexi-n?   l0-types:flexi-n
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-out-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-end/tepc:te-label/tepc:technology:
  +--:(flexi-grid)
     +-- flexi-n?   l0-types:flexi-n
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-out-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-step/tepc:technology:
  +--:(flexi-grid)
     +-- flexi-grid-channel-spacing?   identityref
     +-- flexi-n-step?                 uint8
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:synchronization/tepc:exclude-objects/tepc:excludes
          /tepc:type/tepc:label/tepc:label-hop/tepc:te-label
          /tepc:technology:
  +--:(flexi-grid)
     +-- (single-or-super-channel)?
        +--:(single)
        |  +-- flexi-n?             l0-types:flexi-n
        |  +-- flexi-m?             l0-types:flexi-m
        +--:(super)
           +-- subcarrier-flexi-n* [flexi-n]
              +-- flexi-n    l0-types:flexi-n
              +-- flexi-m?   l0-types:flexi-m
augment /te:tunnels-path-compute/te:output/te:path-compute-result
          /tepc:response/tepc:computed-paths-properties
          /tepc:computed-path-properties/tepc:path-properties
          /tepc:path-route-objects/tepc:path-route-object/tepc:type
          /tepc:label/tepc:label-hop/tepc:te-label/tepc:technology:
  +--:(flexi-grid)
     +--ro (single-or-super-channel)?
        +--:(single)
        |  +--ro flexi-n?             l0-types:flexi-n
        |  +--ro flexi-m?             l0-types:flexi-m
        +--:(super)
           +--ro subcarrier-flexi-n* [flexi-n]
              +--ro flexi-n    l0-types:flexi-n
              +--ro flexi-m?   l0-types:flexi-m
```

Figure 3: Flexi-grid path computation tree diagram

3.3. OTN Path Computation Tree Diagrams

Figure 4 below shows the tree diagram of the YANG data model defined in module ietf-otn-path-computation.yang.

```
module: ietf-otn-path-computation

  augment /te:tunnels-path-compute/te:input/te:path-compute-info
            /tepc:path-request/tepc:te-bandwidth/tepc:technology:
    +--:(otn)
       +-- otn
          +-- odu-type?                     identityref
          +-- (oduflex-type)?
             +--:(generic)
             |  +-- nominal-bit-rate        uint64
             +--:(cbr)
             |  +-- client-type             identityref
             +--:(gfp-n-k)
             |  +-- gfp-n                   uint8
             |  +-- gfp-k?                  gfp-k
             +--:(flexe-client)
             |  +-- flexe-client            flexe-client-rate
             +--:(flexe-aware)
             |  +-- flexe-aware-n           uint16
             +--:(packet)
                +-- opuflex-payload-rate    uint64
  augment /te:tunnels-path-compute/te:input/te:path-compute-info
            /tepc:tunnel-attributes/tepc:te-bandwidth
            /tepc:technology:
    +--:(otn)
       +-- otn
          +-- odu-type?                     identityref
          +-- (oduflex-type)?
             +--:(generic)
             |  +-- nominal-bit-rate        uint64
             +--:(cbr)
             |  +-- client-type             identityref
             +--:(gfp-n-k)
             |  +-- gfp-n                   uint8
             |  +-- gfp-k?                  gfp-k
             +--:(flexe-client)
             |  +-- flexe-client            flexe-client-rate
             +--:(flexe-aware)
             |  +-- flexe-aware-n           uint16
             +--:(packet)
                +-- opuflex-payload-rate    uint64
  augment /te:tunnels-path-compute/te:output/te:path-compute-result
            /tepc:response/tepc:computed-paths-properties
            /tepc:computed-path-properties/tepc:path-properties
            /tepc:te-bandwidth/tepc:technology:
    +--:(otn)
       +--ro otn
          +--ro odu-type?                     identityref
          +--ro (oduflex-type)?
```

```
           +--:(generic)
           |  +--ro nominal-bit-rate        uint64
           +--:(cbr)
           |  +--ro client-type             identityref
           +--:(gfp-n-k)
           |  +--ro gfp-n                   uint8
           |  +--ro gfp-k?                  gfp-k
           +--:(flexe-client)
           |  +--ro flexe-client            flexe-client-rate
           +--:(flexe-aware)
           |  +--ro flexe-aware-n           uint16
           +--:(packet)
              +--ro opuflex-payload-rate    uint64
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-in-segment
          /tepc:label-restrictions/tepc:label-restriction:
  +-- range-type?      otn-label-range-type
  +-- tsg?             identityref
  +-- odu-type-list*   identityref
  +-- priority?        uint8
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-out-segment
          /tepc:label-restrictions/tepc:label-restriction:
  +-- range-type?      otn-label-range-type
  +-- tsg?             identityref
  +-- odu-type-list*   identityref
  +-- priority?        uint8
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:optimizations/tepc:algorithm
          /tepc:metric/tepc:optimization-metric
          /tepc:explicit-route-exclude-objects
          /tepc:route-object-exclude-object/tepc:type/tepc:label
          /tepc:label-hop/tepc:te-label/tepc:technology:
  +--:(otn)
     +-- otn-tpn?   otn-tpn
     +-- tsg?       identityref
     +-- ts-list?   string
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:optimizations/tepc:algorithm
          /tepc:metric/tepc:optimization-metric
          /tepc:explicit-route-include-objects
          /tepc:route-object-include-object/tepc:type/tepc:label
          /tepc:label-hop/tepc:te-label/tepc:technology:
  +--:(otn)
     +-- otn-tpn?   otn-tpn
     +-- tsg?       identityref
     +-- ts-list?   string
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:explicit-route-objects-always
```

```
          /tepc:route-object-exclude-always/tepc:type/tepc:label
          /tepc:label-hop/tepc:te-label/tepc:technology:
  +--:(otn)
     +-- otn-tpn?   otn-tpn
     +-- tsg?       identityref
     +-- ts-list?   string
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:explicit-route-objects-always
          /tepc:route-object-include-exclude/tepc:type/tepc:label
          /tepc:label-hop/tepc:te-label/tepc:technology:
  +--:(otn)
     +-- otn-tpn?   otn-tpn
     +-- tsg?       identityref
     +-- ts-list?   string
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-in-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-start/tepc:te-label/tepc:technology:
  +--:(otn)
     +-- (range-type)?
        +--:(trib-port)
        |  +-- otn-tpn?   otn-tpn
        +--:(trib-slot)
           +-- otn-ts?    otn-ts
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-in-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-end/tepc:te-label/tepc:technology:
  +--:(otn)
     +-- (range-type)?
        +--:(trib-port)
        |  +-- otn-tpn?   otn-tpn
        +--:(trib-slot)
           +-- otn-ts?    otn-ts
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-in-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-step/tepc:technology:
  +--:(otn)
     +-- (range-type)?
        +--:(trib-port)
        |  +-- otn-tpn?   otn-tpn
        +--:(trib-slot)
           +-- otn-ts?    otn-ts
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-out-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-start/tepc:te-label/tepc:technology:
  +--:(otn)
```

```
     +-- (range-type)?
        +--:(trib-port)
        |  +-- otn-tpn?   otn-tpn
        +--:(trib-slot)
           +-- otn-ts?    otn-ts
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-out-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-end/tepc:te-label/tepc:technology:
  +--:(otn)
     +-- (range-type)?
        +--:(trib-port)
        |  +-- otn-tpn?   otn-tpn
        +--:(trib-slot)
           +-- otn-ts?    otn-ts
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:path-request/tepc:path-out-segment
          /tepc:label-restrictions/tepc:label-restriction
          /tepc:label-step/tepc:technology:
  +--:(otn)
     +-- (range-type)?
        +--:(trib-port)
        |  +-- otn-tpn?   otn-tpn
        +--:(trib-slot)
           +-- otn-ts?    otn-ts
augment /te:tunnels-path-compute/te:input/te:path-compute-info
          /tepc:synchronization/tepc:exclude-objects/tepc:excludes
          /tepc:type/tepc:label/tepc:label-hop/tepc:te-label
          /tepc:technology:
  +--:(otn)
     +-- otn-tpn?   otn-tpn
     +-- tsg?       identityref
     +-- ts-list?   string
augment /te:tunnels-path-compute/te:output/te:path-compute-result
          /tepc:response/tepc:computed-paths-properties
          /tepc:computed-path-properties/tepc:path-properties
          /tepc:path-route-objects/tepc:path-route-object/tepc:type
          /tepc:label/tepc:label-hop/tepc:te-label/tepc:technology:
  +--:(otn)
     +--ro otn-tpn?   otn-tpn
     +--ro tsg?       identityref
     +--ro ts-list?   string
```

Figure 4: OTN path computation tree diagram

4. YANG Models for Optical Path Computation

4.1. YANG Model for WSON Path Computation

```
<CODE BEGINS> file "ietf-wson-path-computation@2022-03-07.yang"

module ietf-wson-path-computation {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-wson-path-computation";
  prefix "wson-pc";

  import ietf-te-path-computation {
    prefix "tepc";
    revision-date "2021-09-06";
    reference
      "I-D.ietf-teas-yang-path-computation-14: Yang model
      for requesting Path Computation.";
  }

  import ietf-te {
    prefix "te";
    revision-date "2021-02-20";
    reference
      "I-D.ietf-teas-yang-te-19: A YANG Data Model for Traffic
      Engineering Tunnels and Interfaces. ";
  }

  import ietf-layer0-types {
    prefix "l0-types";
  }

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

     Editor:   Aihua Guo
               <mailto:aihuaguo.ietf@gmail.com>

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

     Editor:   Sergio Belotti
               <mailto:sergio.belotti@nokia.com>";

  description
    "This module defines a model for requesting
    WSON Path Computation.

    The model fully conforms to the Network Management
    Datastore Architecture (NMDA).

    Copyright (c) 2022 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
    (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.";

  revision "2022-03-07" {
    description
      "Initial version.";
    reference
      "RFC XXXX: YANG Model for OTN and Optical Path Computation";
    // RFC Ed.: replace XXXX with actual RFC number, update date
    // information and remove this note
  }

 /*
  * Data nodes
  */

  augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
        + "tepc:path-request" {
    description
       "Augment with additional constraints for WSON paths.";
    uses l0-types:l0-tunnel-attributes;
    uses l0-types:l0-path-constraints;
  }

  augment "/te:tunnels-path-compute/te:output/"
        + "te:path-compute-result/tepc:response/"
        + "tepc:computed-paths-properties/"
        + "tepc:computed-path-properties/tepc:path-properties" {
    description
       "Augment with additional properties for WSON paths.";
    uses l0-types:l0-path-properties;
  }

  /*
   * Augment Route Hop
   */

  augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
        + "tepc:path-request/tepc:optimizations/tepc:algorithm/"
        + "tepc:metric/tepc:optimization-metric/"
        + "tepc:explicit-route-exclude-objects/"
```

```
      + "tepc:route-object-exclude-object/tepc:type" {
  description
    "Augment the route hop for the optimization of the explicit
    route objects excluded by the path computation of the requested
    path.";
  case oms-element {
    leaf oms-element-uid {
      type string;
      description
        "The unique id of the OMS element.";
    }
    description
      "The OMS element route hop type";
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:optimizations/tepc:algorithm/"
      + "tepc:metric/tepc:optimization-metric/"
      + "tepc:explicit-route-include-objects/"
      + "tepc:route-object-include-object/tepc:type" {
  description
    "Augment the route hop for the optimization of the explicit
    route objects included by the path computation of the requested
    path.";
  case oms-element {
    leaf oms-element-uid {
      type string;
      description
        "The unique id of the OMS element.";
    }
    description
      "The OMS element route hop type";
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:explicit-route-objects-always/"
      + "tepc:route-object-exclude-always/tepc:type" {
  description
    "Augment the route hop for the explicit route objects always
    excluded by the path computation of the requested path.";
  case oms-element {
    leaf oms-element-uid {
      type string;
      description
        "The unique id of the OMS element.";
    }
    description
```

```
      "The OMS element route hop type";
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:explicit-route-objects-always/"
      + "tepc:route-object-include-exclude/tepc:type" {
  description
    "Augment the route hop for the explicit route objects included
    or excluded by the path computation of the requested path.";
  case oms-element {
    leaf oms-element-uid {
      type string;
      description
        "The unique id of the OMS element.";
    }
    description
      "The OMS element route hop type";
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:synchronization/tepc:exclude-objects/tepc:excludes/"
      + "tepc:type" {
  description
    "Augment the route hop for the explicit route objects to always
    exclude from synchronized path computation.";
  case oms-element {
    leaf oms-element-uid {
      type string;
      description
        "The unique id of the OMS element.";
    }
    description
      "The OMS element route hop type";
  }
}

augment "/te:tunnels-path-compute/te:output/"
      + "te:path-compute-result/tepc:response/"
      + "tepc:computed-paths-properties/"
      + "tepc:computed-path-properties/tepc:path-properties/"
      + "tepc:path-route-objects/tepc:path-route-object/"
      + "tepc:type" {
  description
    "Augment the route hop for the route object of the computed
    path.";
  case oms-element {
    leaf oms-element-uid {
```

```
      type string;
      description
        "The unique id of the OMS element.";
    }
    description
      "The OMS element route hop type";
  }
}

/*
 * Augment TE label range information
 */

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-in-segment/"
      + "tepc:label-restrictions/tepc:label-restriction" {
  description
    "Augment TE label range information for the ingress segment
    of the requested path.";
  uses l0-types:l0-label-range-info;
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-out-segment/"
      + "tepc:label-restrictions/tepc:label-restriction" {
  description
    "Augment TE label range information for the egress segment
    of the requested path.";
  uses l0-types:l0-label-range-info;
}

/*
 * Augment TE label.
 */

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:optimizations/tepc:algorithm/"
      + "tepc:metric/tepc:optimization-metric/"
      + "tepc:explicit-route-exclude-objects/"
      + "tepc:route-object-exclude-object/tepc:type/tepc:label/"
      + "tepc:label-hop/tepc:te-label/tepc:technology" {
  description
    "Augment TE label hop for the optimization of the explicit
    route objects excluded by the path computation of the requested
    path.";
  case wson {
    uses l0-types:wson-label-hop;
  }
}
```

```
augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:optimizations/tepc:algorithm/"
      + "tepc:metric/tepc:optimization-metric/"
      + "tepc:explicit-route-include-objects/"
      + "tepc:route-object-include-object/tepc:type/tepc:label/"
      + "tepc:label-hop/tepc:te-label/tepc:technology" {
  description
    "Augment TE label hop for the optimization of the explicit
    route objects included by the path computation of the requested
    path.";
  case wson {
    uses l0-types:wson-label-hop;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:explicit-route-objects-always/"
      + "tepc:route-object-exclude-always/tepc:type/tepc:label/"
      + "tepc:label-hop/tepc:te-label/tepc:technology" {
  description
    "Augment TE label hop for the explicit route objects always
    excluded by the path computation of the requested path.";
  case wson {
    uses l0-types:wson-label-hop;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:explicit-route-objects-always/"
      + "tepc:route-object-include-exclude/tepc:type/tepc:label/"
      + "tepc:label-hop/tepc:te-label/tepc:technology" {
  description
    "Augment TE label hop for the explicit route objects included
    or excluded by the path computation of the requested path.";
  case wson {
    uses l0-types:wson-label-hop;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-in-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-start/tepc:te-label/tepc:technology" {
  description
    "Augment TE label range start for the ingress segment
    of the requested path.";
  case wson {
    uses l0-types:wson-label-start-end;
```

```
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-in-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-end/tepc:te-label/tepc:technology" {
  description
    "Augment TE label range end for the ingress segment
    of the requested path.";
  case wson {
    uses l0-types:wson-label-start-end;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-in-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-step/tepc:technology" {
  description
    "Augment TE label range step for the ingress segment
    of the requested path.";
  case wson {
    uses l0-types:wson-label-step;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-out-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-start/tepc:te-label/tepc:technology" {
  description
    "Augment TE label range start for the egress segment
    of the requested path.";
  case wson {
    uses l0-types:wson-label-start-end;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-out-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-end/tepc:te-label/tepc:technology" {
  description
    "Augment TE label range end for the egress segment
    of the requested path.";
  case wson {
    uses l0-types:wson-label-start-end;
  }
```

```
  }

  augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
        + "tepc:path-request/tepc:path-out-segment/"
        + "tepc:label-restrictions/tepc:label-restriction/"
        + "tepc:label-step/tepc:technology" {
    description
      "Augment TE label range end for the egress segment
      of the requested path.";
    case wson {
      uses l0-types:wson-label-step;
    }
  }

  augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
        + "tepc:synchronization/tepc:exclude-objects/tepc:excludes/"
        + "tepc:type/tepc:label/tepc:label-hop/"
        + "tepc:te-label/tepc:technology" {
    description
      "Augment TE label hop for the explicit route objects to always
      exclude from synchronized path computation.";
    case wson {
      uses l0-types:wson-label-hop;
    }
  }

  augment "/te:tunnels-path-compute/te:output/"
        + "te:path-compute-result/tepc:response/"
        + "tepc:computed-paths-properties/"
        + "tepc:computed-path-properties/tepc:path-properties/"
        + "tepc:path-route-objects/tepc:path-route-object/"
        + "tepc:type/tepc:label/"
        + "tepc:label-hop/tepc:te-label/tepc:technology" {
    description
      "Augment TE label hop for the route object of the computed
      path.";
    case wson {
      uses l0-types:wson-label-hop;
    }
  }
}

<CODE ENDS>
```

Figure 5: WSON path computation YANG module

4.2. YANG Model for Flexi-grid Path Computation

```
<CODE BEGINS> file "ietf-flexi-grid-path-computation@2022-03-07.yang"

module ietf-flexi-grid-path-computation {
  yang-version 1.1;
  namespace
    "urn:ietf:params:xml:ns:yang:ietf-flexi-grid-path-computation";
  prefix "flexg-pc";

  import ietf-te-path-computation {
    prefix "tepc";
    revision-date "2021-09-06";
    reference
      "I-D.ietf-teas-yang-path-computation-14: Yang model
      for requesting Path Computation.";
  }

  import ietf-te {
    prefix "te";
    revision-date "2021-02-20";
    reference
      "I-D.ietf-teas-yang-te-19: A YANG Data Model for Traffic
      Engineering Tunnels and Interfaces. ";
  }

  import ietf-layer0-types {
    prefix "l0-types";
  }

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

     Editor:   Aihua Guo
               <mailto:aihuaguo.ietf@gmail.com>

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

     Editor:   Sergio Belotti
               <mailto:sergio.belotti@nokia.com>";

  description
    "This module defines a model for requesting
    Flexi-grid Path Computation.

    The model fully conforms to the Network Management
    Datastore Architecture (NMDA).
```

```
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  (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.";

 revision "2022-03-07" {
   description
     "Initial version.";
   reference
     "RFC XXXX: YANG Model for OTN and Optical Path Computation";
   // RFC Ed.: replace XXXX with actual RFC number, update date
   // information and remove this note
 }

/*
 * Data nodes
 */

 augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
       + "tepc:path-request" {
   description
      "Augment with additional constraints flexi-grid
       media channel.";
   uses l0-types:l0-tunnel-attributes;
   uses l0-types:l0-path-constraints;
 }

 augment "/te:tunnels-path-compute/te:output/"
       + "te:path-compute-result/tepc:response/"
       + "tepc:computed-paths-properties/"
       + "tepc:computed-path-properties/tepc:path-properties" {
   description
      "Augment with additional properties for Flexi-grid paths.";
   uses l0-types:l0-path-properties;
 }

 /*
  * Augment Route Hop
  */

 augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
       + "tepc:path-request/tepc:optimizations/tepc:algorithm/"
```

```
      + "tepc:metric/tepc:optimization-metric/"
      + "tepc:explicit-route-exclude-objects/"
      + "tepc:route-object-exclude-object/tepc:type" {
  description
    "Augment the route hop for the optimization of the explicit
    route objects excluded by the path computation of the requested
    path.";
  case oms-element {
    leaf oms-element-uid {
      type string;
      description
        "The unique id of the OMS element.";
    }
    description
      "The OMS element route hop type";
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:optimizations/tepc:algorithm/"
      + "tepc:metric/tepc:optimization-metric/"
      + "tepc:explicit-route-include-objects/"
      + "tepc:route-object-include-object/tepc:type" {
  description
    "Augment the route hop for the optimization of the explicit
    route objects included by the path computation of the requested
    path.";
  case oms-element {
    leaf oms-element-uid {
      type string;
      description
        "The unique id of the OMS element.";
    }
    description
      "The OMS element route hop type";
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:explicit-route-objects-always/"
      + "tepc:route-object-exclude-always/tepc:type" {
  description
    "Augment the route hop for the explicit route objects always
    excluded by the path computation of the requested path.";
  case oms-element {
    leaf oms-element-uid {
      type string;
      description
        "The unique id of the OMS element.";
```

```
    }
    description
      "The OMS element route hop type";
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:explicit-route-objects-always/"
      + "tepc:route-object-include-exclude/tepc:type" {
  description
    "Augment the route hop for the explicit route objects included
    or excluded by the path computation of the requested path.";
  case oms-element {
    leaf oms-element-uid {
      type string;
      description
        "The unique id of the OMS element.";
    }
    description
      "The OMS element route hop type";
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:synchronization/tepc:exclude-objects/tepc:excludes/"
      + "tepc:type" {
  description
    "Augment the route hop for the explicit route objects to always
    exclude from synchronized path computation.";
  case oms-element {
    leaf oms-element-uid {
      type string;
      description
        "The unique id of the OMS element.";
    }
    description
      "The OMS element route hop type";
  }
}

augment "/te:tunnels-path-compute/te:output/"
      + "te:path-compute-result/tepc:response/"
      + "tepc:computed-paths-properties/"
      + "tepc:computed-path-properties/tepc:path-properties/"
      + "tepc:path-route-objects/tepc:path-route-object/"
      + "tepc:type" {
  description
    "Augment the route hop for the route object of the computed
    path.";
```

```
  case oms-element {
    leaf oms-element-uid {
      type string;
      description
        "The unique id of the OMS element.";
    }
    description
      "The OMS element route hop type";
  }
}

/*
 * Augment TE label range information
 */

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-in-segment/"
      + "tepc:label-restrictions/tepc:label-restriction" {
  description
    "Augment TE label range information for the ingress segment
    of the requested path.";
  uses l0-types:flexi-grid-label-range-info;
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-out-segment/"
      + "tepc:label-restrictions/tepc:label-restriction" {
  description
    "Augment TE label range information for the egress segment
    of the requested path.";
  uses l0-types:flexi-grid-label-range-info;
}

/*
 * Augment TE label.
 */

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:optimizations/tepc:algorithm/"
      + "tepc:metric/tepc:optimization-metric/"
      + "tepc:explicit-route-exclude-objects/"
      + "tepc:route-object-exclude-object/tepc:type/tepc:label/"
      + "tepc:label-hop/tepc:te-label/tepc:technology" {
  description
    "Augment TE label hop for the optimization of the explicit
    route objects excluded by the path computation of the requested
    path.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-hop;
```

```
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:optimizations/tepc:algorithm/"
      + "tepc:metric/tepc:optimization-metric/"
      + "tepc:explicit-route-include-objects/"
      + "tepc:route-object-include-object/tepc:type/tepc:label/"
      + "tepc:label-hop/tepc:te-label/tepc:technology" {
  description
    "Augment TE label hop for the optimization of the explicit
    route objects included by the path computation of the requested
    path.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-hop;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:explicit-route-objects-always/"
      + "tepc:route-object-exclude-always/tepc:type/tepc:label/"
      + "tepc:label-hop/tepc:te-label/tepc:technology" {
  description
    "Augment TE label hop for the explicit route objects always
    excluded by the path computation of the requested path.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-hop;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:explicit-route-objects-always/"
      + "tepc:route-object-include-exclude/tepc:type/tepc:label/"
      + "tepc:label-hop/tepc:te-label/tepc:technology" {
  description
    "Augment TE label hop for the explicit route objects included
    or excluded by the path computation of the requested path.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-hop;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-in-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-start/tepc:te-label/tepc:technology" {
  description
    "Augment TE label range start for the ingress segment
    of the requested path.";
```

```
  case flexi-grid {
    uses l0-types:flexi-grid-label-start-end;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-in-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-end/tepc:te-label/tepc:technology" {
  description
    "Augment TE label range end for the ingress segment
    of the requested path.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-start-end;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-in-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-step/tepc:technology" {
  description
    "Augment TE label range step for the ingress segment
    of the requested path.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-step;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-out-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-start/tepc:te-label/tepc:technology" {
  description
    "Augment TE label range start for the egress segment
    of the requested path.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-start-end;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-out-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-end/tepc:te-label/tepc:technology" {
  description
    "Augment TE label range end for the egress segment
    of the requested path.";
  case flexi-grid {
```

```
      uses l0-types:flexi-grid-label-start-end;
    }
  }

  augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
        + "tepc:path-request/tepc:path-out-segment/"
        + "tepc:label-restrictions/tepc:label-restriction/"
        + "tepc:label-step/tepc:technology" {
    description
      "Augment TE label range end for the egress segment
      of the requested path.";
    case flexi-grid {
      uses l0-types:flexi-grid-label-step;
    }
  }

  augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
        + "tepc:synchronization/tepc:exclude-objects/tepc:excludes/"
        + "tepc:type/tepc:label/tepc:label-hop/"
        + "tepc:te-label/tepc:technology" {
    description
      "Augment TE label hop for the explicit route objects to always
      exclude from synchronized path computation.";
    case flexi-grid {
      uses l0-types:flexi-grid-label-hop;
    }
  }

  augment "/te:tunnels-path-compute/te:output/"
        + "te:path-compute-result/tepc:response/"
        + "tepc:computed-paths-properties/"
        + "tepc:computed-path-properties/tepc:path-properties/"
        + "tepc:path-route-objects/tepc:path-route-object/"
        + "tepc:type/tepc:label/"
        + "tepc:label-hop/tepc:te-label/tepc:technology" {
    description
      "Augment TE label hop for the route object of the computed
      path.";
    case flexi-grid {
      uses l0-types:flexi-grid-label-hop;
    }
  }
}

<CODE ENDS>
```

Figure 6: Flexi-grid path computation YANG module

4.3. YANG Model for OTN Path Computation

```
<CODE BEGINS> file "ietf-otn-path-computation@2021-10-07.yang"

module ietf-otn-path-computation {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-otn-path-computation";
  prefix "otn-pc";

  import ietf-te-path-computation {
    prefix "tepc";
    revision-date "2021-09-06";
    reference
    "I-D.ietf-teas-yang-path-computation-14: Yang model
    for requesting Path Computation.";
  }

  import ietf-te {
    prefix "te";
    revision-date "2021-02-20";
    reference
      "I-D.ietf-teas-yang-te-19: A YANG Data Model for Traffic
      Engineering Tunnels and Interfaces. ";
  }

  import ietf-layer1-types {
    prefix "l1-types";
    reference
    "I-D.ietf-ccamp-layer1-types:
     A YANG Data Model for Layer 1 Types. ";
  }

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

     Editor:   Aihua Guo
               <mailto:aihuaguo.ietf@gmail.com>

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

     Editor:   Sergio Belotti
               <mailto:sergio.belotti@nokia.com>";

  description
    "This module defines a model for requesting
    OTN Path Computation.

    The model fully conforms to the Network Management
```

```
    Datastore Architecture (NMDA).

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    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.";

  revision "2021-10-07" {
    description
      "Initial version.";
    reference
      "RFC XXXX: YANG Model for OTN and Optical Path Computation";
    // RFC Ed.: replace XXXX with actual RFC number, update date
    // information and remove this note
  }

 /*
  * Data nodes
  */

  /*
   * Augment TE bandwidth
   */

  augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
        + "tepc:path-request/tepc:te-bandwidth/tepc:technology" {
    description
      "Augment TE bandwidth of the requested path.";
    case otn {
      uses l1-types:otn-path-bandwidth;
    }
  }

  augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
        + "tepc:tunnel-attributes/tepc:te-bandwidth/"
        + "tepc:technology" {
    description
      "Augment TE bandwidth of the requested tunnel attributes.";
    case otn {
      uses l1-types:otn-path-bandwidth;
    }
  }
```

```
augment "/te:tunnels-path-compute/te:output/"
      + "te:path-compute-result/tepc:response/"
      + "tepc:computed-paths-properties/"
      + "tepc:computed-path-properties/tepc:path-properties/"
      + "tepc:te-bandwidth/tepc:technology" {
  description
    "Augment TE bandwidth of the computed path properties.";
  case otn {
    uses l1-types:otn-path-bandwidth;
  }
}

/*
 * Augment TE label range information
 */

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-in-segment/"
      + "tepc:label-restrictions/tepc:label-restriction" {
  description
    "Augment TE label range information for the ingress segment
    of the requested path.";
  uses l1-types:otn-label-range-info;
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-out-segment/"
      + "tepc:label-restrictions/tepc:label-restriction" {
  description
    "Augment TE label range information for the egress segment
    of the requested path.";
  uses l1-types:otn-label-range-info;
}

/*
 * Augment TE label.
 */

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:optimizations/tepc:algorithm/"
      + "tepc:metric/tepc:optimization-metric/"
      + "tepc:explicit-route-exclude-objects/"
      + "tepc:route-object-exclude-object/tepc:type/tepc:label/"
      + "tepc:label-hop/tepc:te-label/tepc:technology" {
  description
    "Augment TE label hop for the optimization of the explicit
    route objects excluded by the path computation of the requested
    path.";
```

```
  case otn {
    uses l1-types:otn-label-hop;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:optimizations/tepc:algorithm/"
      + "tepc:metric/tepc:optimization-metric/"
      + "tepc:explicit-route-include-objects/"
      + "tepc:route-object-include-object/tepc:type/tepc:label/"
      + "tepc:label-hop/tepc:te-label/tepc:technology" {
  description
    "Augment TE label hop for the optimization of the explicit
    route objects included by the path computation of the requested
    path.";
  case otn {
    uses l1-types:otn-label-hop;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:explicit-route-objects-always/"
      + "tepc:route-object-exclude-always/tepc:type/tepc:label/"
      + "tepc:label-hop/tepc:te-label/tepc:technology" {
  description
    "Augment TE label hop for the explicit route objects always
    excluded by the path computation of the requested path.";
  case otn {
    uses l1-types:otn-label-hop;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:explicit-route-objects-always/"
      + "tepc:route-object-include-exclude/tepc:type/tepc:label/"
      + "tepc:label-hop/tepc:te-label/tepc:technology" {
  description
    "Augment TE label hop for the explicit route objects included
    or excluded by the path computation of the requested path.";
  case otn {
    uses l1-types:otn-label-hop;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-in-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-start/tepc:te-label/tepc:technology" {
  description
```

```
    "Augment TE label range start for the ingress segment
    of the requested path.";
  case otn {
    uses l1-types:otn-label-start-end;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-in-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-end/tepc:te-label/tepc:technology" {
  description
    "Augment TE label range end for the ingress segment
    of the requested path.";
  case otn {
    uses l1-types:otn-label-start-end;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-in-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-step/tepc:technology" {
  description
    "Augment TE label range step for the ingress segment
    of the requested path.";
  case otn {
    uses l1-types:otn-label-step;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-out-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-start/tepc:te-label/tepc:technology" {
  description
    "Augment TE label range start for the egress segment
    of the requested path.";
  case otn {
    uses l1-types:otn-label-start-end;
  }
}

augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
      + "tepc:path-request/tepc:path-out-segment/"
      + "tepc:label-restrictions/tepc:label-restriction/"
      + "tepc:label-end/tepc:te-label/tepc:technology" {
  description
    "Augment TE label range end for the egress segment
```

```
      of the requested path.";
    case otn {
      uses l1-types:otn-label-start-end;
    }
  }

  augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
        + "tepc:path-request/tepc:path-out-segment/"
        + "tepc:label-restrictions/tepc:label-restriction/"
        + "tepc:label-step/tepc:technology" {
    description
      "Augment TE label range end for the egress segment
      of the requested path.";
    case otn {
      uses l1-types:otn-label-step;
    }
  }

  augment "/te:tunnels-path-compute/te:input/te:path-compute-info/"
        + "tepc:synchronization/tepc:exclude-objects/tepc:excludes/"
        + "tepc:type/tepc:label/tepc:label-hop/"
        + "tepc:te-label/tepc:technology" {
    description
      "Augment TE label hop for the explicit route objects to always
      exclude from synchronized path computation.";
    case otn {
      uses l1-types:otn-label-hop;
    }
  }

  augment "/te:tunnels-path-compute/te:output/"
        + "te:path-compute-result/tepc:response/"
        + "tepc:computed-paths-properties/"
        + "tepc:computed-path-properties/tepc:path-properties/"
        + "tepc:path-route-objects/tepc:path-route-object/"
        + "tepc:type/tepc:label/"
        + "tepc:label-hop/tepc:te-label/tepc:technology" {
    description
      "Augment TE label hop for the route object of the computed
      path.";
    case otn {
      uses l1-types:otn-label-hop;
    }
  }
}

<CODE ENDS>
```

Figure 7: OTN path computation YANG module

5. Manageability Considerations

TBD.

6. Security Considerations

<Add any security considerations>

7. IANA Considerations

This document registers the following URIs in the "ns" subregistry within the "IETF XML registry" [RFC3688].

URI: urn:ietf:params:xml:ns:yang:ietf-otn-path-computation
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.

URI: urn:ietf:params:xml:ns:yang:ietf-wson-path-computation
Registrant Contact: The IESG.
XML: N/A, the requested URI is an XML namespace.

URI: urn:ietf:params:xml:ns:yang:ietf-flexi-grid-path-computation
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-otn-path-computation
namespace: urn:ietf:params:xml:ns:yang:ietf-otn-path-computation
prefix:    otn-pc
reference: this document

name:      ietf-wson-path-computation
namespace: urn:ietf:params:xml:ns:yang:ietf-wson-path-computation
prefix:    wson-pc
reference: this document

name:      ietf-flexi-grid-path-computation
namespace: ietf:params:xml:ns:yang:ietf-flexi-grid-path-computation
prefix:    flexg-pc
reference: this document
```

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