

CCAMP Working Group  
Internet-Draft  
Intended status: Informational  
Expires: 28 April 2022

J.E. Lopez de Vergara  
Naudit HPCN  
D. Perdices Burrero  
Universidad Autonoma de Madrid  
D. King  
Old Dog Consulting  
V. Lopez  
Nokia  
I. Busi  
Huawei Technologies  
O. Gonzalez de Dios  
Telefonica I+D/GCTO  
Y. Lee  
Samsung  
G. Galimberti  
Cisco  
25 October 2021

A YANG Data Model for Flexi-Grid Tunnels  
draft-ietf-ccamp-flexigrid-tunnel-yang-00

## Abstract

This document defines a YANG model for managing flexi-grid optical tunnels (media-channels), complementing the information provided by the flexi-grid topology model.

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

## Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of [BCP 78](#) and [BCP 79](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <https://datatracker.ietf.org/drafts/current/>.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on 28 April 2022.

Internet-Draft

Flexi-Grid YANG

October 2021

## Copyright Notice

Copyright (c) 2021 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to [BCP 78](#) and the IETF Trust's Legal Provisions Relating to IETF Documents (<https://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the [Trust Legal Provisions](#) and are provided without warranty as described in the Simplified BSD License.

## Table of Contents

|                       |  |                    |
|-----------------------|--|--------------------|
| <a href="#">1.</a>    | Introduction . . . . .                     | <a href="#">2</a>  |
| <a href="#">2.</a>    | Terminology . . . . .                      | <a href="#">3</a>  |
| <a href="#">3.</a>    | Flexi-Grid Tunnel Overview . . . . .       | <a href="#">3</a>  |
| <a href="#">4.</a>    | Example of Use . . . . .                   | <a href="#">4</a>  |
| <a href="#">5.</a>    | YANG Model for Flexi-Grid Tunnel . . . . . | <a href="#">6</a>  |
| <a href="#">5.1.</a>  | YANG Tree . . . . .                        | <a href="#">6</a>  |
| <a href="#">5.2.</a>  | YANG Code . . . . .                        | <a href="#">19</a> |
| <a href="#">6.</a>    | Security Considerations . . . . .          | <a href="#">38</a> |
| <a href="#">7.</a>    | IANA Considerations . . . . .              | <a href="#">39</a> |
| <a href="#">8.</a>    | Contributors . . . . .                     | <a href="#">39</a> |
| <a href="#">9.</a>    | Acknowledgments . . . . .                  | <a href="#">39</a> |
| <a href="#">10.</a>   | References . . . . .                       | <a href="#">39</a> |
| <a href="#">10.1.</a> | Normative References . . . . .             | <a href="#">39</a> |
| <a href="#">10.2.</a> | Informative References . . . . .           | <a href="#">40</a> |
|                       | Authors' Addresses . . . . .               | <a href="#">40</a> |

[1.](#) Introduction

Transport networks are evolving from current DWDM systems towards elastic optical networks, based on flexi-grid transmission and switching technologies [[RFC7698](#)]. Such technology aims at increasing both transport network scalability and flexibility, allowing the optimization of bandwidth usage.

While [[I-D.ietf-ccamp-flexigrid-yang](#)] focuses on flexi-grid objects such as nodes, transponders and links, this document presents a YANG [[RFC7950](#)] model for the flexi-grid tunnel (media-channel). This YANG

module defines the whole path from a source transponder or node to the destination through a number of intermediate nodes in the flexi-grid network.

This document identifies the flexi-grid tunne components, parameters and their values, characterizes the features and the performances of the flexi-grid elements. An application example is provided towards the end of the document to better understand their utility.

## 2. Terminology

Refer to [[RFC7446](#)] and [[RFC7699](#)] 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](#)].

## 3. Flexi-Grid Tunnel Overview

The present model defines a flexi-grid tunnel mainly composed of:

- \* source address
- \* source flexi-grid port
- \* source flexi-grid transponder
- \* destination address
- \* destination flexi-grid port
- \* destination flexi-grid transponder

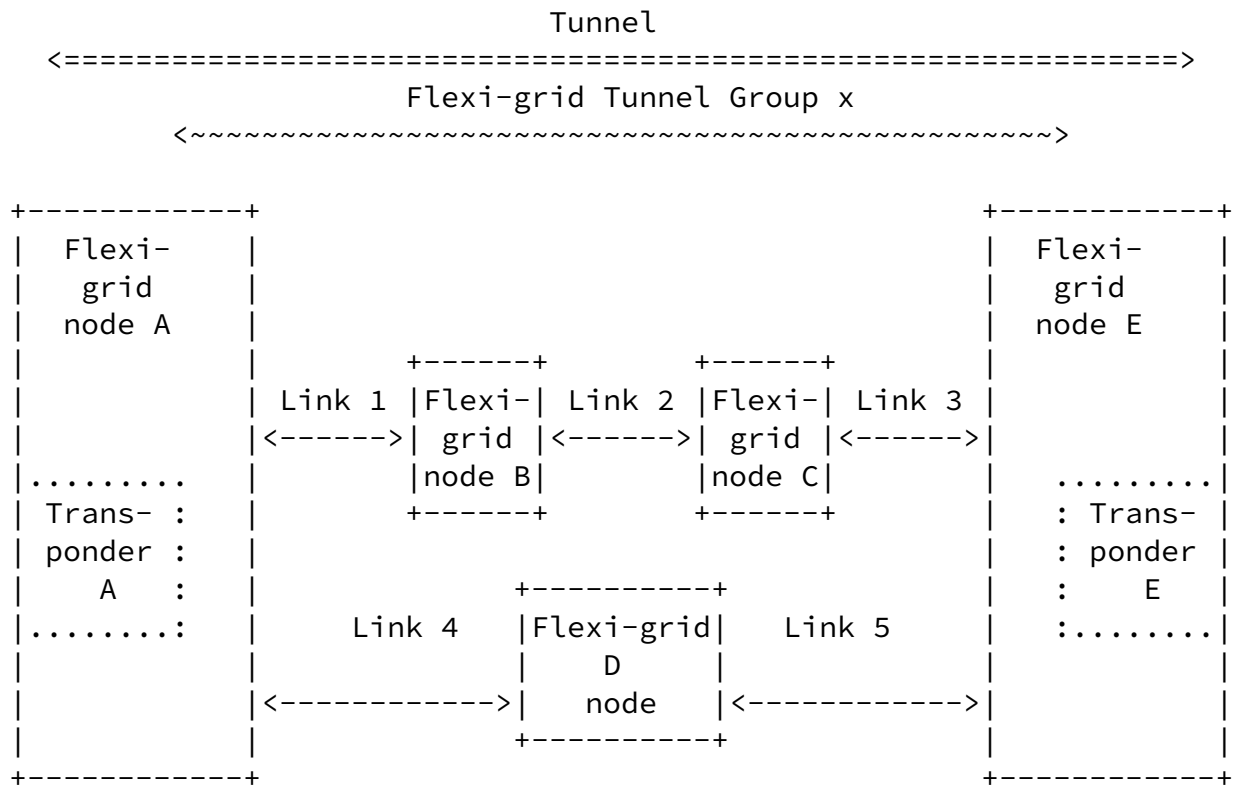
- \* list of links that defines the path
- \* other optical attributes

Each path can be a tunnel (only defined by source and destination node) or a network tunnel (additionally needs source and destination transponders). Therefore, all the attributes are optional to support both situations.

This is achieved by a combination of the traffic engineering tunnel attributes explained in [[I-D.ietf-teas-yang-te](#)] and augments when necessary. For instance, source address, source flexi-grid transponder, destination address and destination flexi-grid transponder attributes are directly taken from tunnel, whereas other attributes such as source flexi-grid port, destination flexi-grid port are defined, as they are specific for flexi-grid.

#### [4.](#) Example of Use

In order to explain how this model is used, the following example is provided. An optical network usually has multiple transponders, switches (nodes) and links. Figure 1 shows a simple topology, where two physical paths interconnect two optical transponders.



<~~~~~>

## Flexi-grid Tunnel Group y

Figure 1: Topology Example

To configure a network tunnel to interconnect transponders A and E, first of all we have to populate the flexi-grid topology YANG model with all elements in the network:

- \* We define the transponders within nodes A and E as tunnel termination points (TTPs) and provide their internal local link connectivity towards the node interfaces. We also provide nodes A and B identifiers, addresses and interfaces.
- \* We do the same for the nodes B, C and D, providing their identifiers, addresses and interfaces, as well as the internal connectivity matrix between interfaces.
- \* Then, we also define the links 1 to 5 that interconnect nodes, indicating which flexi-grid labels are available.
- \* Other information, such as the slot frequency and granularity are also provided.

After the nodes, links and transponders have been defined using [[I-D.ietf-ccamp-flexigrid-yang](#)] we can configure the tunnel from the information we have stored in the flexi-grid topology, by querying which elements are available, and planning the resources that have to be provided on each situation. Note that every element in the flexi-grid topology has a reference, and this is the way in which they are called in the tunnel.

- \* Depending on the case, it is possible to define either the source and destination node ports, or the source and destination node and transponder. In our case, we would define a network tunnel, with source transponder A and source node B, and destination transponder E and destination node C. Thus, we are going to follow path x.

- \* Then, for each link in the path x, we indicate which channel we are going to use, providing information about the slots, and what nodes are connected.
- \* Finally, the flexi-grid topology has to be updated with each element usage status each time a tunnel is created or torn down.

## 5. YANG Model for Flexi-Grid Tunnel

### 5.1. YANG Tree

```

module: ietf-flexi-grid-tunnel

augment /te:te/te:tunnels/te:tunnel:
  +--rw fec-type?          identityref
  +--rw termination-type?  identityref
  +--rw bit-stuffing?      boolean
augment /te:te/te:globals/te:named-path-constraints
  /te:named-path-constraint/te:path-in-segment
  /te:label-restrictions/te:label-restriction:
  +--rw grid-type?        identityref
  +--rw priority?         uint8
  +--rw flexi-grid
    +--rw slot-width-granularity?  identityref
    +--rw min-slot-width-factor?    uint16
    +--rw max-slot-width-factor?    uint16
augment /te:te/te:globals/te:named-path-constraints
  /te:named-path-constraint/te:path-out-segment
  /te:label-restrictions/te:label-restriction:
  +--rw grid-type?        identityref
  +--rw priority?         uint8
  +--rw flexi-grid
    +--rw slot-width-granularity?  identityref

```

```

  +--rw min-slot-width-factor?    uint16
  +--rw max-slot-width-factor?    uint16
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
  /te:primary-path/te:path-in-segment/te:label-restrictions
  /te:label-restriction:
  +--rw grid-type?        identityref
  +--rw priority?         uint8
  +--rw flexi-grid

```

```

    +--rw slot-width-granularity?  identityref
    +--rw min-slot-width-factor?    uint16
    +--rw max-slot-width-factor?    uint16
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
    /te:primary-path/te:path-out-segment
    /te:label-restrictions/te:label-restriction:
+--rw grid-type?      identityref
+--rw priority?       uint8
+--rw flexi-grid
    +--rw slot-width-granularity?  identityref
    +--rw min-slot-width-factor?    uint16
    +--rw max-slot-width-factor?    uint16
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
    /te:primary-path/te:primary-reverse-path
    /te:path-in-segment/te:label-restrictions
    /te:label-restriction:
+--rw grid-type?      identityref
+--rw priority?       uint8
+--rw flexi-grid
    +--rw slot-width-granularity?  identityref
    +--rw min-slot-width-factor?    uint16
    +--rw max-slot-width-factor?    uint16
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
    /te:primary-path/te:primary-reverse-path
    /te:path-out-segment/te:label-restrictions
    /te:label-restriction:
+--rw grid-type?      identityref
+--rw priority?       uint8
+--rw flexi-grid
    +--rw slot-width-granularity?  identityref
    +--rw min-slot-width-factor?    uint16
    +--rw max-slot-width-factor?    uint16
augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
    /te:secondary-path/te:path-in-segment
    /te:label-restrictions/te:label-restriction:
+--rw grid-type?      identityref
+--rw priority?       uint8
+--rw flexi-grid
    +--rw slot-width-granularity?  identityref
    +--rw min-slot-width-factor?    uint16

```



```

augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
    /te:secondary-path/te:path-out-segment
    /te:label-restrictions/te:label-restriction:
+--rw grid-type?      identityref
+--rw priority?       uint8
+--rw flexi-grid
    +--rw slot-width-granularity?  identityref
    +--rw min-slot-width-factor?    uint16
    +--rw max-slot-width-factor?    uint16
augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
    /te:secondary-reverse-path/te:path-in-segment
    /te:label-restrictions/te:label-restriction:
+--rw grid-type?      identityref
+--rw priority?       uint8
+--rw flexi-grid
    +--rw slot-width-granularity?  identityref
    +--rw min-slot-width-factor?    uint16
    +--rw max-slot-width-factor?    uint16
augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
    /te:secondary-reverse-path/te:path-out-segment
    /te:label-restrictions/te:label-restriction:
+--rw grid-type?      identityref
+--rw priority?       uint8
+--rw flexi-grid
    +--rw slot-width-granularity?  identityref
    +--rw min-slot-width-factor?    uint16
    +--rw max-slot-width-factor?    uint16
augment /te:te/te:globals/te:named-path-constraints
    /te:named-path-constraint
    /te:explicit-route-objects-always
    /te:route-object-exclude-always/te:type/te:label
    /te:label-hop/te:te-label/te:technology:
+--:(flexi-grid)
    +--rw (single-or-super-channel)?
        +--:(single)
        |   +--rw flexi-n?           l0-types:flexi-n
        |   +--rw flexi-m?           l0-types:flexi-m
        +--:(super)
            +--rw subcarrier-flexi-n* [flexi-n]
                +--rw flexi-n      l0-types:flexi-n
                +--rw flexi-m?     l0-types:flexi-m
augment /te:te/te:globals/te:named-path-constraints
    /te:named-path-constraint
    /te:explicit-route-objects-always
    /te:route-object-include-exclude/te:type/te:label
    /te:label-hop/te:te-label/te:technology:
+--:(flexi-grid)

```

```

    +--rw (single-or-super-channel)?
      +--:(single)
        | +--rw flexi-n?          l0-types:flexi-n
        | +--rw flexi-m?          l0-types:flexi-m
      +--:(super)
        +--rw subcarrier-flexi-n* [flexi-n]
          +--rw flexi-n          l0-types:flexi-n
          +--rw flexi-m?         l0-types:flexi-m
augment /te:te/te:globals/te:named-path-constraints
  /te:named-path-constraint/te:path-in-segment
  /te:label-restrictions/te:label-restriction
  /te:label-start/te:te-label/te:technology:
+--:(flexi-grid)
  +--rw flexi-n?          l0-types:flexi-n
augment /te:te/te:globals/te:named-path-constraints
  /te:named-path-constraint/te:path-in-segment
  /te:label-restrictions/te:label-restriction/te:label-end
  /te:te-label/te:technology:
+--:(flexi-grid)
  +--rw flexi-n?          l0-types:flexi-n
augment /te:te/te:globals/te:named-path-constraints
  /te:named-path-constraint/te:path-in-segment
  /te:label-restrictions/te:label-restriction/te:label-step
  /te:technology:
+--:(flexi-grid)
  +--rw flexi-grid-channel-spacing?  identityref
  +--rw flexi-n-step?                 uint8
augment /te:te/te:globals/te:named-path-constraints
  /te:named-path-constraint/te:path-out-segment
  /te:label-restrictions/te:label-restriction
  /te:label-start/te:te-label/te:technology:
+--:(flexi-grid)
  +--rw flexi-n?          l0-types:flexi-n
augment /te:te/te:globals/te:named-path-constraints
  /te:named-path-constraint/te:path-out-segment
  /te:label-restrictions/te:label-restriction/te:label-end
  /te:te-label/te:technology:
+--:(flexi-grid)
  +--rw flexi-n?          l0-types:flexi-n
augment /te:te/te:globals/te:named-path-constraints
  /te:named-path-constraint/te:path-out-segment
  /te:label-restrictions/te:label-restriction/te:label-step
  /te:technology:
+--:(flexi-grid)
  +--rw flexi-grid-channel-spacing?  identityref
  +--rw flexi-n-step?                 uint8

```

```
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
        /te:primary-path/te:optimizations/te:algorithm/te:metric
```

```
        /te:optimization-metric/te:explicit-route-exclude-objects
        /te:route-object-exclude-object/te:type/te:label
        /te:label-hop/te:te-label/te:technology:
+---:(flexi-grid)
  +--rw (single-or-super-channel)?
    +---:(single)
      | +--rw flexi-n?          l0-types:flexi-n
      | +--rw flexi-m?          l0-types:flexi-m
    +---:(super)
      +--rw subcarrier-flexi-n* [flexi-n]
        +--rw flexi-n          l0-types:flexi-n
        +--rw flexi-m?         l0-types:flexi-m
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
        /te:primary-path/te:optimizations/te:algorithm/te:metric
        /te:optimization-metric/te:explicit-route-include-objects
        /te:route-object-include-object/te:type/te:label
        /te:label-hop/te:te-label/te:technology:
+---:(flexi-grid)
  +--rw (single-or-super-channel)?
    +---:(single)
      | +--rw flexi-n?          l0-types:flexi-n
      | +--rw flexi-m?          l0-types:flexi-m
    +---:(super)
      +--rw subcarrier-flexi-n* [flexi-n]
        +--rw flexi-n          l0-types:flexi-n
        +--rw flexi-m?         l0-types:flexi-m
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
        /te:primary-path/te:explicit-route-objects-always
        /te:route-object-exclude-always/te:type/te:label
        /te:label-hop/te:te-label/te:technology:
+---:(flexi-grid)
  +--rw (single-or-super-channel)?
    +---:(single)
      | +--rw flexi-n?          l0-types:flexi-n
      | +--rw flexi-m?          l0-types:flexi-m
    +---:(super)
      +--rw subcarrier-flexi-n* [flexi-n]
        +--rw flexi-n          l0-types:flexi-n
        +--rw flexi-m?         l0-types:flexi-m
```

```

augment /te:te/te:tunnels/te:tunnel/te:primary-paths
  /te:primary-path/te:explicit-route-objects-always
  /te:route-object-include-exclude/te:type/te:label
  /te:label-hop/te:te-label/te:technology:
+--:(flexi-grid)
  +--rw (single-or-super-channel)?
    +--:(single)
    |   +--rw flexi-n?           l0-types:flexi-n
    |   +--rw flexi-m?           l0-types:flexi-m

```

```

+--:(super)
  +--rw subcarrier-flexi-n* [flexi-n]
    +--rw flexi-n           l0-types:flexi-n
    +--rw flexi-m?         l0-types:flexi-m
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
  /te:primary-path/te:path-in-segment/te:label-restrictions
  /te:label-restriction/te:label-start/te:te-label
  /te:technology:
+--:(flexi-grid)
  +--rw flexi-n?           l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
  /te:primary-path/te:path-in-segment/te:label-restrictions
  /te:label-restriction/te:label-end/te:te-label
  /te:technology:
+--:(flexi-grid)
  +--rw flexi-n?           l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
  /te:primary-path/te:path-in-segment/te:label-restrictions
  /te:label-restriction/te:label-step/te:technology:
+--:(flexi-grid)
  +--rw flexi-grid-channel-spacing?  identityref
  +--rw flexi-n-step?                 uint8
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
  /te:primary-path/te:path-out-segment
  /te:label-restrictions/te:label-restriction
  /te:label-start/te:te-label/te:technology:
+--:(flexi-grid)
  +--rw flexi-n?           l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
  /te:primary-path/te:path-out-segment
  /te:label-restrictions/te:label-restriction/te:label-end
  /te:te-label/te:technology:

```

```

+---:(flexi-grid)
  +---rw flexi-n?    l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
        /te:primary-path/te:path-out-segment
        /te:label-restrictions/te:label-restriction/te:label-step
        /te:technology:
+---:(flexi-grid)
  +---rw flexi-grid-channel-spacing?  identityref
  +---rw flexi-n-step?                uint8
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
        /te:primary-path/te:computed-paths-properties
        /te:computed-path-properties/te:path-properties
        /te:path-route-objects/te:path-route-object/te:type
        /te:label/te:label-hop/te:te-label/te: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
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
        /te:primary-path/te:primary-reverse-path/te:optimizations
        /te:algorithm/te:metric/te:optimization-metric
        /te:explicit-route-exclude-objects
        /te:route-object-exclude-object/te:type/te:label
        /te:label-hop/te:te-label/te:technology:
+---:(flexi-grid)
  +---rw (single-or-super-channel)?
  +---:(single)
  | +---rw flexi-n?          l0-types:flexi-n
  | +---rw flexi-m?          l0-types:flexi-m
  +---:(super)
  +---rw subcarrier-flexi-n* [flexi-n]
  +---rw flexi-n    l0-types:flexi-n
  +---rw flexi-m?  l0-types:flexi-m
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
        /te:primary-path/te:primary-reverse-path/te:optimizations
        /te:algorithm/te:metric/te:optimization-metric

```

```

        /te:explicit-route-include-objects
        /te:route-object-include-object/te:type/te:label
        /te:label-hop/te:te-label/te:technology:
+---:(flexi-grid)
  +---rw (single-or-super-channel)?
  +---:(single)
  |   +---rw flexi-n?           l0-types:flexi-n
  |   +---rw flexi-m?           l0-types:flexi-m
  +---:(super)
  +---rw subcarrier-flexi-n* [flexi-n]
  +---rw flexi-n      l0-types:flexi-n
  +---rw flexi-m?    l0-types:flexi-m
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
        /te:primary-path/te:primary-reverse-path
        /te:explicit-route-objects-always
        /te:route-object-exclude-always/te:type/te:label
        /te:label-hop/te:te-label/te:technology:
+---:(flexi-grid)
  +---rw (single-or-super-channel)?
  +---:(single)
  |   +---rw flexi-n?           l0-types:flexi-n
  |   +---rw flexi-m?           l0-types:flexi-m
  +---:(super)

```

```

  +---rw subcarrier-flexi-n* [flexi-n]
  +---rw flexi-n      l0-types:flexi-n
  +---rw flexi-m?    l0-types:flexi-m
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
        /te:primary-path/te:primary-reverse-path
        /te:explicit-route-objects-always
        /te:route-object-include-exclude/te:type/te:label
        /te:label-hop/te:te-label/te:technology:
+---:(flexi-grid)
  +---rw (single-or-super-channel)?
  +---:(single)
  |   +---rw flexi-n?           l0-types:flexi-n
  |   +---rw flexi-m?           l0-types:flexi-m
  +---:(super)
  +---rw subcarrier-flexi-n* [flexi-n]
  +---rw flexi-n      l0-types:flexi-n
  +---rw flexi-m?    l0-types:flexi-m
augment /te:te/te:tunnels/te:tunnel/te:primary-paths

```

```

        /te:primary-path/te:primary-reverse-path
        /te:path-in-segment/te:label-restrictions
        /te:label-restriction/te:label-start/te:te-label
        /te:technology:
+---:(flexi-grid)
    +--rw flexi-n?    l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
        /te:primary-path/te:primary-reverse-path
        /te:path-in-segment/te:label-restrictions
        /te:label-restriction/te:label-end/te:te-label
        /te:technology:
+---:(flexi-grid)
    +--rw flexi-n?    l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
        /te:primary-path/te:primary-reverse-path
        /te:path-in-segment/te:label-restrictions
        /te:label-restriction/te:label-step/te:technology:
+---:(flexi-grid)
    +--rw flexi-grid-channel-spacing?  identityref
    +--rw flexi-n-step?                uint8
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
        /te:primary-path/te:primary-reverse-path
        /te:path-out-segment/te:label-restrictions
        /te:label-restriction/te:label-start/te:te-label
        /te:technology:
+---:(flexi-grid)
    +--rw flexi-n?    l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
        /te:primary-path/te:primary-reverse-path
        /te:path-out-segment/te:label-restrictions

```

```

        /te:label-restriction/te:label-end/te:te-label
        /te:technology:
+---:(flexi-grid)
    +--rw flexi-n?    l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:primary-paths
        /te:primary-path/te:primary-reverse-path
        /te:path-out-segment/te:label-restrictions
        /te:label-restriction/te:label-step/te:technology:
+---:(flexi-grid)
    +--rw flexi-grid-channel-spacing?  identityref
    +--rw flexi-n-step?                uint8

```

```

augment /te:te/te:tunnels/te:tunnel/te:primary-paths
    /te:primary-path/te:primary-reverse-path
    /te:computed-paths-properties/te:computed-path-properties
    /te:path-properties/te:path-route-objects
    /te:path-route-object/te:type/te:label/te:label-hop
    /te:te-label/te: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
augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
    /te:secondary-path/te:optimizations/te:algorithm
    /te:metric/te:optimization-metric
    /te:explicit-route-exclude-objects
    /te:route-object-exclude-object/te:type/te:label
    /te:label-hop/te:te-label/te:technology:
+---:(flexi-grid)
    +---rw (single-or-super-channel)?
        +---:(single)
            | +---rw flexi-n?          l0-types:flexi-n
            | +---rw flexi-m?          l0-types:flexi-m
        +---:(super)
            +---rw subcarrier-flexi-n* [flexi-n]
                +---rw flexi-n      l0-types:flexi-n
                +---rw flexi-m?     l0-types:flexi-m
augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
    /te:secondary-path/te:optimizations/te:algorithm
    /te:metric/te:optimization-metric
    /te:explicit-route-include-objects
    /te:route-object-include-object/te:type/te:label
    /te:label-hop/te:te-label/te:technology:
+---:(flexi-grid)

```

```

+---rw (single-or-super-channel)?
    +---:(single)
        | +---rw flexi-n?          l0-types:flexi-n
        | +---rw flexi-m?          l0-types:flexi-m

```



```

    +---:(super)
        +---rw subcarrier-flexi-n* [flexi-n]
            +---rw flexi-n      l0-types:flexi-n
            +---rw flexi-m?    l0-types:flexi-m
augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
        /te:secondary-path/te:explicit-route-objects-always
        /te:route-object-exclude-always/te:type/te:label
        /te:label-hop/te:te-label/te:technology:
+---:(flexi-grid)
    +---rw (single-or-super-channel)?
        +---:(single)
            | +---rw flexi-n?          l0-types:flexi-n
            | +---rw flexi-m?          l0-types:flexi-m
        +---:(super)
            +---rw subcarrier-flexi-n* [flexi-n]
                +---rw flexi-n      l0-types:flexi-n
                +---rw flexi-m?    l0-types:flexi-m
augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
        /te:secondary-path/te:explicit-route-objects-always
        /te:route-object-include-exclude/te:type/te:label
        /te:label-hop/te:te-label/te:technology:
+---:(flexi-grid)
    +---rw (single-or-super-channel)?
        +---:(single)
            | +---rw flexi-n?          l0-types:flexi-n
            | +---rw flexi-m?          l0-types:flexi-m
        +---:(super)
            +---rw subcarrier-flexi-n* [flexi-n]
                +---rw flexi-n      l0-types:flexi-n
                +---rw flexi-m?    l0-types:flexi-m
augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
        /te:secondary-path/te:path-in-segment
        /te:label-restrictions/te:label-restriction
        /te:label-start/te:te-label/te:technology:
+---:(flexi-grid)
    +---rw flexi-n?    l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
        /te:secondary-path/te:path-in-segment
        /te:label-restrictions/te:label-restriction/te:label-end
        /te:te-label/te:technology:
+---:(flexi-grid)
    +---rw flexi-n?    l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
        /te:secondary-path/te:path-in-segment

```

```

        /te:label-restrictions/te:label-restriction/te:label-step
        /te:technology:
+---:(flexi-grid)
    +---rw flexi-grid-channel-spacing?  identityref
    +---rw flexi-n-step?                 uint8
augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
        /te:secondary-path/te:path-out-segment
        /te:label-restrictions/te:label-restriction
        /te:label-start/te:te-label/te:technology:
+---:(flexi-grid)
    +---rw flexi-n?    l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
        /te:secondary-path/te:path-out-segment
        /te:label-restrictions/te:label-restriction/te:label-end
        /te:te-label/te:technology:
+---:(flexi-grid)
    +---rw flexi-n?    l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
        /te:secondary-path/te:path-out-segment
        /te:label-restrictions/te:label-restriction/te:label-step
        /te:technology:
+---:(flexi-grid)
    +---rw flexi-grid-channel-spacing?  identityref
    +---rw flexi-n-step?                 uint8
augment /te:te/te:tunnels/te:tunnel/te:secondary-paths
        /te:secondary-path/te:computed-paths-properties
        /te:computed-path-properties/te:path-properties
        /te:path-route-objects/te:path-route-object/te:type
        /te:label/te:label-hop/te:te-label/te: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
augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
        /te:secondary-reverse-path/te:optimizations/te:algorithm
        /te:metric/te:optimization-metric
        /te:explicit-route-exclude-objects
        /te:route-object-exclude-object/te:type/te:label
        /te:label-hop/te:te-label/te:technology:
+---:(flexi-grid)
    +---rw (single-or-super-channel)?
        +---:(single)

```

| +--rw flexi-n? l0-types:flexi-n

Internet-Draft

Flexi-Grid YANG

October 2021

```

    | +--rw flexi-m?          l0-types:flexi-m
  +--:(super)
    +--rw subcarrier-flexi-n* [flexi-n]
      +--rw flexi-n          l0-types:flexi-n
      +--rw flexi-m?        l0-types:flexi-m
augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
  /te:secondary-reverse-path/te:optimizations/te:algorithm
  /te:metric/te:optimization-metric
  /te:explicit-route-include-objects
  /te:route-object-include-object/te:type/te:label
  /te:label-hop/te:te-label/te:technology:
+--:(flexi-grid)
  +--rw (single-or-super-channel)?
    +--:(single)
      | +--rw flexi-n?          l0-types:flexi-n
      | +--rw flexi-m?          l0-types:flexi-m
    +--:(super)
      +--rw subcarrier-flexi-n* [flexi-n]
        +--rw flexi-n          l0-types:flexi-n
        +--rw flexi-m?        l0-types:flexi-m
augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
  /te:secondary-reverse-path
  /te:explicit-route-objects-always
  /te:route-object-exclude-always/te:type/te:label
  /te:label-hop/te:te-label/te:technology:
+--:(flexi-grid)
  +--rw (single-or-super-channel)?
    +--:(single)
      | +--rw flexi-n?          l0-types:flexi-n
      | +--rw flexi-m?          l0-types:flexi-m
    +--:(super)
      +--rw subcarrier-flexi-n* [flexi-n]
        +--rw flexi-n          l0-types:flexi-n
        +--rw flexi-m?        l0-types:flexi-m
augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
  /te:secondary-reverse-path
  /te:explicit-route-objects-always
  /te:route-object-include-exclude/te:type/te:label
  /te:label-hop/te:te-label/te:technology:
+--:(flexi-grid)
```

```

+--rw (single-or-super-channel)?
  +--:(single)
  | +--rw flexi-n?          l0-types:flexi-n
  | +--rw flexi-m?          l0-types:flexi-m
  +--:(super)
    +--rw subcarrier-flexi-n* [flexi-n]
      +--rw flexi-n          l0-types:flexi-n
      +--rw flexi-m?         l0-types:flexi-m

```

```

augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
  /te:secondary-reverse-path/te:path-in-segment
  /te:label-restrictions/te:label-restriction
  /te:label-start/te:te-label/te:technology:
+--:(flexi-grid)
  +--rw flexi-n?          l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
  /te:secondary-reverse-path/te:path-in-segment
  /te:label-restrictions/te:label-restriction/te:label-end
  /te:te-label/te:technology:
+--:(flexi-grid)
  +--rw flexi-n?          l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
  /te:secondary-reverse-path/te:path-in-segment
  /te:label-restrictions/te:label-restriction/te:label-step
  /te:technology:
+--:(flexi-grid)
  +--rw flexi-grid-channel-spacing?  identityref
  +--rw flexi-n-step?                 uint8
augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
  /te:secondary-reverse-path/te:path-out-segment
  /te:label-restrictions/te:label-restriction
  /te:label-start/te:te-label/te:technology:
+--:(flexi-grid)
  +--rw flexi-n?          l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
  /te:secondary-reverse-path/te:path-out-segment
  /te:label-restrictions/te:label-restriction/te:label-end
  /te:te-label/te:technology:
+--:(flexi-grid)
  +--rw flexi-n?          l0-types:flexi-n
augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
  /te:secondary-reverse-path/te:path-out-segment

```

```

        /te:label-restrictions/te:label-restriction/te:label-step
        /te:technology:
+---:(flexi-grid)
    +--rw flexi-grid-channel-spacing?  identityref
    +--rw flexi-n-step?                 uint8
augment /te:te/te:tunnels/te:tunnel/te:secondary-reverse-paths
        /te:secondary-reverse-path/te:computed-paths-properties
        /te:computed-path-properties/te:path-properties
        /te:path-route-objects/te:path-route-object/te:type
        /te:label/te:label-hop/te:te-label/te: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
augment /te:te/te:lsp/te:lsp/te:lsp-record-route-information
        /te:lsp-record-route-information/te:type/te:label
        /te:label-hop/te:te-label/te: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

```

## 5.2. YANG Code

```

<CODE BEGINS> file "ietf-flexi-grid-tunnel@2021-10-25.yang"
module ietf-flexi-grid-tunnel {
  yang-version 1.1;
  namespace
    "urn:ietf:params:xml:ns:yang:ietf-flexi-grid-tunnel";

```

```

prefix "flexg-tnl";

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";
}

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

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

```

```

WG List:  <mailto:ccamp@ietf.org>
Editor:   Jorge E. Lopez de Vergara
          <jorge.lopez_vergara@uam.es>
Editor:   Daniel Perdices
          <daniel.perdices@naudit.es>
Editor:   Victor Lopez
          <victor.lopez@nokia.com>
Editor:   Young Lee
          <leeyoung@huawei.com>";

```

description

"This module defines a model for Flex-grid Tunnel Services.  
The model fully conforms to the Network Management Datastore Architecture (NMDA).

Copyright (c) 2021 IETF Trust and the persons identified as authors of the code. All rights reserved. Redistribution and use in source and binary forms, with or

without modification, is permitted pursuant to, and subject to the license terms contained in, the Simplified BSD License set forth in [Section 4.c](#) of the IETF Trust's Legal Provisions Relating to IETF Documents (<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 "2021-10-20" {
  description
    "Initial Revision";
  reference
    "RFC XXXX: YANG data model for Flexi-Grid tunnels";
  // RFC Ed.: replace XXXX with actual RFC number, update date
  // information and remove this note
}

/*
 * Data nodes
 */

augment "/te:te/te:tunnels/te:tunnel" {
  description
    "Augment with additional parameters required for flexi-grid
    tunnels.";
  uses l0-types-ext:l0-tunnel-attributes;
}

/*
```

```
 * Augment TE label range information
 */

augment "/te:te/te:globals/te:named-path-constraints/"
  + "te:named-path-constraint/te:path-in-segment/"
  + "te:label-restrictions/te:label-restriction" {
  description
    "Augment TE label range information for the ingress segment
    of the named path constraint.";
  uses l0-types:flexi-grid-label-range-info;
}
```

```

augment "/te:te/te:globals/te:named-path-constraints/"
  + "te:named-path-constraint/te:path-out-segment/"
  + "te:label-restrictions/"
  + "te:label-restriction" {
  description
    "Augment TE label range information for the egress segment
    of the named path constraint.";
  uses l0-types:flexi-grid-label-range-info;
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:path-in-segment/te:label-restrictions/"
  + "te:label-restriction" {
  description
    "Augment TE label range information for the ingress segment
    of the primay path.";
  uses l0-types:flexi-grid-label-range-info;
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:path-out-segment/te:label-restrictions/"
  + "te:label-restriction" {
  description
    "Augment TE label range information for the egress segment
    of the primay path.";
  uses l0-types:flexi-grid-label-range-info;
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:primary-reverse-path/"
  + "te:path-in-segment/te:label-restrictions/"
  + "te:label-restriction" {
  description

```

```

    "Augment TE label range information for the ingress segment
    of the primay reverse path.";
  uses l0-types:flexi-grid-label-range-info;
}

```



```

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:primary-reverse-path/"
  + "te:path-out-segment/te:label-restrictions/"
  + "te:label-restriction" {
  description
    "Augment TE label range information for the egress segment
    of the primay reverse path.";
  uses l0-types:flexi-grid-label-range-info;
}

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

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

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-reverse-paths/te:secondary-reverse-path/"
  + "te:path-in-segment/te:label-restrictions/"
  + "te:label-restriction" {
  description
    "Augment TE label range information for the ingress segment
    of the secondary reverse path.";
  uses l0-types:flexi-grid-label-range-info;
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-reverse-paths/te:secondary-reverse-path/"

```

```

    + "te:path-out-segment/te:label-restrictions/"
    + "te:label-restriction" {
description
    "Augment TE label range information for the egress segment
    of the secondary reverse path.";
uses l0-types:flexi-grid-label-range-info;
}

/*
 * Augment TE label.
 */

augment "/te:te/te:globals/te:named-path-constraints/"
    + "te:named-path-constraint/"
    + "te:explicit-route-objects-always/"
    + "te:route-object-exclude-always/te:type/te:label/"
    + "te:label-hop/te:te-label/te:technology" {
description
    "Augment TE label hop for the explicit route objects always
    excluded by the path computation with the named path
    constraint.";
case flexi-grid {
    uses l0-types:flexi-grid-label-hop;
}
}

augment "/te:te/te:globals/te:named-path-constraints/"
    + "te:named-path-constraint/"
    + "te:explicit-route-objects-always/"
    + "te:route-object-include-exclude/te:type/te:label/"
    + "te:label-hop/te:te-label/te:technology" {
description
    "Augment TE label hop for the explicit route objects included
    or excluded by the path computation with the named path
    constraint.";
case flexi-grid {
    uses l0-types:flexi-grid-label-hop;
}
}

augment "/te:te/te:globals/te:named-path-constraints/"
    + "te:named-path-constraint/te:path-in-segment/"
    + "te:label-restrictions/"
    + "te:label-restriction/te:label-start/"
    + "te:te-label/te:technology" {
description
    "Augment TE label range start for the ingress segment
    of the named path constraint.";
}

```

Internet-Draft

Flexi-Grid YANG

October 2021

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

augment "/te:te/te:globals/te:named-path-constraints/"
  + "te:named-path-constraint/te:path-in-segment/"
  + "te:label-restrictions/"
  + "te:label-restriction/te:label-end/"
  + "te:te-label/te:technology" {
  description
    "Augment TE label range end for the ingress segment
    of the named path constraint.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-start-end;
  }
}

augment "/te:te/te:globals/te:named-path-constraints/"
  + "te:named-path-constraint/te:path-in-segment/"
  + "te:label-restrictions/te:label-restriction/"
  + "te:label-step/te:technology" {
  description
    "Augment TE label range step for the ingress segment
    of the named path constraint.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-step;
  }
}

augment "/te:te/te:globals/te:named-path-constraints/"
  + "te:named-path-constraint/te:path-out-segment/"
  + "te:label-restrictions/"
  + "te:label-restriction/te:label-start/"
  + "te:te-label/te:technology" {
  description
    "Augment TE label range start for the egress segment
    of the named path constraint.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-start-end;
  }
}
```

```
augment "/te:te/te:globals/te:named-path-constraints/"
  + "te:named-path-constraint/te:path-out-segment/"
  + "te:label-restrictions/"
  + "te:label-restriction/te:label-end/"
  + "te:te-label/te:technology" {
```

```
  description
    "Augment TE label range end for the egress segment
    of the named path constraint.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-start-end;
  }
}

augment "/te:te/te:globals/te:named-path-constraints/"
  + "te:named-path-constraint/te:path-out-segment/"
  + "te:label-restrictions/te:label-restriction/"
  + "te:label-step/te:technology" {
  description
    "Augment TE label range step for the egress segment
    of the named path constraint.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-step;
  }
}

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

```

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

```

```

}

```

```

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

```

```

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

```

```

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:path-in-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-start/"
  + "te:te-label/te:technology" {
description
  "Augment TE label range start for the ingress segment
  of the primay path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-start-end;
}
}

```

```

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:path-in-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-end/"
  + "te:te-label/te:technology" {
description
  "Augment TE label range end for the ingress segment

```

```

  of the primay path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-start-end;
}
}

```

```

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:path-in-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-step/te:technology" {
description
  "Augment TE label range step for the ingress segment
  of the primay path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-step;
}
}

```

```

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:path-out-segment/te:label-restrictions/"

```

```

    + "te:label-restriction/te:label-start/"
    + "te:te-label/te:technology" {
description
  "Augment TE label range start for the egress segment
  of the primay path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-start-end;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:path-out-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-end/"
  + "te:te-label/te:technology" {
description
  "Augment TE label range end for the egress segment
  of the primay path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-start-end;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:path-out-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-step/te:technology" {

```

```

description
  "Augment TE label range end for the egress segment
  of the primay path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-step;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:computed-paths-properties/"
  + "te:computed-path-properties/te:path-properties/"
  + "te:path-route-objects/te:path-route-object/"
  + "te:type/te:label/"

```

```

    + "te:label-hop/te:te-label/te:technology" {
description
  "Augment TE label hop for the route object of the computed
  primary path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-hop;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:primary-reverse-path/"
  + "te:optimizations/te:algorithm/te:metric/"
  + "te:optimization-metric/te:explicit-route-exclude-objects/"
  + "te:route-object-exclude-object/te:type/te:label/"
  + "te:label-hop/te:te-label/te:technology" {
description
  "Augment TE label hop for the optimization of the explicit
  route objects excluded by the path computation of the primary
  reverse path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-hop;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:primary-reverse-path/"
  + "te:optimizations/te:algorithm/te:metric/"
  + "te:optimization-metric/te:explicit-route-include-objects/"
  + "te:route-object-include-object/te:type/te:label/"
  + "te:label-hop/te:te-label/te:technology" {
description
  "Augment TE label hop for the optimization of the explicit

```

```

  route objects included by the path computation of the primary
  reverse path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-hop;
}
}

```



```

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:primary-reverse-path/"
  + "te:explicit-route-objects-always/"
  + "te:route-object-exclude-always/"
  + "te:type/te:label/"
  + "te:label-hop/te:te-label/te:technology" {
description
  "Augment TE label hop for the explicit route objects always
  excluded by the path computation of the primary reverse
  path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-hop;
}
}

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

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:primary-reverse-path/"
  + "te:path-in-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-start/"
  + "te:te-label/te:technology" {
description
  "Augment TE label range start for the ingress segment
  of the primay reverse path.";
}

```

```

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

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:primary-reverse-path/"
  + "te:path-in-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-end/"
  + "te:te-label/te:technology" {
  description
    "Augment TE label range end for the ingress segment
    of the primay reverse path.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-start-end;
  }
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:primary-reverse-path/"
  + "te:path-in-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-step/te:technology" {
  description
    "Augment TE label range step for the ingress segment
    of the primay reverse path.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-step;
  }
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:primary-reverse-path/"
  + "te:path-out-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-start/"
  + "te:te-label/te:technology" {
  description
    "Augment TE label range start for the egress segment
    of the primay reverse path.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-start-end;
  }
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"

```

Internet-Draft

Flexi-Grid YANG

October 2021

```
    + "te:primary-reverse-path/"
    + "te:path-out-segment/te:label-restrictions/"
    + "te:label-restriction/te:label-end/"
    + "te:te-label/te:technology" {
description
  "Augment TE label range end for the egress segment
  of the primay reverse path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-start-end;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:primary-paths/te:primary-path/"
  + "te:primary-reverse-path/"
  + "te:path-out-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-step/te:technology" {
description
  "Augment TE label range step for the egress segment
  of the primay reverse path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-step;
}
}

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

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-paths/te:secondary-path/"
  + "te:optimizations/te:algorithm/te:metric/"
```

```
    + "te:optimization-metric/te:explicit-route-exclude-objects/"
    + "te:route-object-exclude-object/te:type/te:label/"
    + "te:label-hop/te:te-label/te:technology" {
description
    "Augment TE label hop for the optimization of the explicit
```

```
    route objects excluded by the path computation of the
    secondary path.";
case flexi-grid {
    uses l0-types:flexi-grid-label-hop;
}
}

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

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

augment "/te:te/te:tunnels/te:tunnel/"
```

```

    + "te:secondary-paths/te:secondary-path/"
    + "te:explicit-route-objects-always/"
    + "te:route-object-include-exclude/te:type/te:label/"
    + "te:label-hop/te:te-label/te:technology" {
description
    "Augment TE label hop for the explicit route objects included
    or excluded by the path computation of the secondary path.";
case flexi-grid {
    uses l0-types:flexi-grid-label-hop;
}
}

```

```

augment "/te:te/te:tunnels/te:tunnel/"
    + "te:secondary-paths/te:secondary-path/"
    + "te:path-in-segment/te:label-restrictions/"
    + "te:label-restriction/te:label-start/"
    + "te:te-label/te:technology" {
description
    "Augment TE label range start for the ingress segment
    of the secondary path.";
case flexi-grid {
    uses l0-types:flexi-grid-label-start-end;
}
}

```

```

augment "/te:te/te:tunnels/te:tunnel/"
    + "te:secondary-paths/te:secondary-path/"
    + "te:path-in-segment/te:label-restrictions/"
    + "te:label-restriction/te:label-end/"
    + "te:te-label/te:technology" {
description
    "Augment TE label range end for the ingress segment
    of the secondary path.";
case flexi-grid {
    uses l0-types:flexi-grid-label-start-end;
}
}

```

```

augment "/te:te/te:tunnels/te:tunnel/"
    + "te:secondary-paths/te:secondary-path/"
    + "te:path-in-segment/te:label-restrictions/"
    + "te:label-restriction/te:label-step/te:technology" {

```

```

description
  "Augment TE label range step for the ingress segment
  of the secondary path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-step;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-paths/te:secondary-path/"
  + "te:path-out-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-start/"
  + "te:te-label/te:technology" {
description
  "Augment TE label range start for the egress segment
  of the secondary path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-start-end;
}
}

```

```

}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-paths/te:secondary-path/"
  + "te:path-out-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-end/"
  + "te:te-label/te:technology" {
description
  "Augment TE label range end for the egress segment
  of the secondary path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-start-end;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-paths/te:secondary-path/"
  + "te:path-out-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-step/te:technology" {
description
  "Augment TE label range step for the egress segment
  of the secondary path.";
}
}

```

```

    case flexi-grid {
      uses l0-types:flexi-grid-label-step;
    }
  }

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

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-reverse-paths/te:secondary-reverse-path/"
  + "te:optimizations/te:algorithm/te:metric/"
  + "te:optimization-metric/te:explicit-route-exclude-objects/"
  + "te:route-object-exclude-object/te:type/te:label/"
  + "te:label-hop/te:te-label/te:technology" {

```

```

description
  "Augment TE label hop for the optimization of the explicit
  route objects excluded by the path computation of the
  secondary reverse path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-hop;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-reverse-paths/te:secondary-reverse-path/"
  + "te:optimizations/te:algorithm/te:metric/"
  + "te:optimization-metric/te:explicit-route-include-objects/"
  + "te:route-object-include-object/te:type/te:label/"
  + "te:label-hop/te:te-label/te:technology" {

```

```

description
  "Augment TE label hop for the optimization of the explicit
  route objects included by the path computation of the
  secondary reverse path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-hop;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-reverse-paths/te:secondary-reverse-path/"
  + "te:explicit-route-objects-always/"
  + "te:route-object-exclude-always/te:type/te:label/"
  + "te:label-hop/te:te-label/te:technology" {
description
  "Augment TE label hop for the explicit route objects always
  excluded by the path computation of the secondary reverse
  path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-hop;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-reverse-paths/te:secondary-reverse-path/"
  + "te:explicit-route-objects-always/"
  + "te:route-object-include-exclude/te:type/te:label/"
  + "te:label-hop/te:te-label/te:technology" {
description
  "Augment TE label hop for the explicit route objects included
  or excluded by the path computation of the secondary reverse
  path.";
case flexi-grid {

```

```

  uses l0-types:flexi-grid-label-hop;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-reverse-paths/te:secondary-reverse-path/"
  + "te:path-in-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-start/"

```



```

    + "te:te-label/te:technology" {
description
  "Augment TE label range start for the ingress segment
  of the secondary reverse path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-start-end;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-reverse-paths/te:secondary-reverse-path/"
  + "te:path-in-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-end/"
  + "te:te-label/te:technology" {
description
  "Augment TE label range end for the ingress segment
  of the secondary reverse path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-start-end;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-reverse-paths/te:secondary-reverse-path/"
  + "te:path-in-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-step/te:technology" {
description
  "Augment TE label range step for the ingress segment
  of the secondary reverse path.";
case flexi-grid {
  uses l0-types:flexi-grid-label-step;
}
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-reverse-paths/te:secondary-reverse-path/"
  + "te:path-out-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-start/"
  + "te:te-label/te:technology" {
description

```

"Augment TE label range start for the egress segment

```

    of the secondary reverse path.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-start-end;
  }
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-reverse-paths/te:secondary-reverse-path/"
  + "te:path-out-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-end/"
  + "te:te-label/te:technology" {
  description
    "Augment TE label range end for the egress segment
    of the secondary reverse path.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-start-end;
  }
}

augment "/te:te/te:tunnels/te:tunnel/"
  + "te:secondary-reverse-paths/te:secondary-reverse-path/"
  + "te:path-out-segment/te:label-restrictions/"
  + "te:label-restriction/te:label-step/te:technology" {
  description
    "Augment TE label range step for the egress segment
    of the secondary reverse path.";
  case flexi-grid {
    uses l0-types:flexi-grid-label-step;
  }
}

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

augment "/te:te/te:lsps/"

```

```
    + "te:lsp/te:lsp-record-route-information/"
    + "te:lsp-record-route-information/te:type/te:label/"
    + "te:label-hop/te:te-label/te:technology" {
description
  "Augment TE label hop for the record route of the LSP.";
case flexi-grid {
  uses l0-types:flexi-grid-label-hop;
}
}
}
<CODE ENDS>
```

## 6. Security Considerations

The configuration, state, and action data defined in this document are designed to be accessed via a management protocol with a secure transport layer, such as NETCONF [[RFC6241](#)] or RESTCONF [[RFC8040](#)]. The NETCONF access control model [[RFC8341](#)] provides the means to restrict access for particular NETCONF users to a preconfigured subset of all available NETCONF 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). These data nodes may be considered sensitive or vulnerable in some network environments. Write operations (e.g., edit-config) to these data nodes without proper protection can have a negative effect on network operations. These are the subtrees and data nodes and their sensitivity/vulnerability:

- \* /te:te/te:tunnels/te:tunnel
- \* /te:te/.../te:te-bandwidth/te:technology
- \* /te:te/.../te:type/te:label/te:label-hop/te:te-label/te:technology
- \* /te:te/.../te:label-restrictions/te:label-restriction/te:label-start/te:te-label/te:technology
- \* /te:te/.../te:label-restrictions/te:label-restriction/te:label-end/te:te-label/te:technology
- \* /te:te/.../te:label-restrictions/te:label-restriction/

Editors note: we are using simplified description by folding similar branches to avoid repetition.

Internet-Draft

Flexi-Grid YANG

October 2021

## [7.](#) IANA Considerations

To be discussed.

## [8.](#) Contributors

This work was developed by several additional people, who due to frontpage author restrictions, are listed below:

Zafar Ali Cisco Email: [zali@cisco.com](mailto:zali@cisco.com)

Daniel Michaud Vallinoto Universidad Autonoma de Madrid Email: [daniel.michaud@estudiante.uam.es](mailto:daniel.michaud@estudiante.uam.es)

## [9.](#) Acknowledgments

This work is also partially funded by the Spanish State Research Agency under the project AgileMon (AEI PID2019-104451RB-C21) and by the Spanish Ministry of Science, Innovation and Universities under the program for the training of university lecturers (Grant number: FPU19/05678).

## [10.](#) References

### [10.1.](#) Normative References

[I-D.ietf-ccamp-flexigrid-yang]

Mendez, J. E. L. D. V., Burrero, D. P., King, D., Lee, Y., and H. Zheng, "A YANG Data Model for Flexi-Grid Optical Networks", Work in Progress, Internet-Draft, [draft-ietf-ccamp-flexigrid-yang-10](#), 12 July 2021, <<https://www.ietf.org/archive/id/draft-ietf-ccamp-flexigrid-yang-10.txt>>.

[I-D.ietf-teas-yang-te]

Saad, T., Gandhi, R., Liu, X., Beeram, V. P., Bryskin, I., and O. G. D. Dios, "A YANG Data Model for Traffic Engineering Tunnels, Label Switched Paths and Interfaces", Work in Progress, Internet-Draft, [draft-ietf-teas-yang-te](#)

27, 8 July 2021, <<https://www.ietf.org/archive/id/draft-ietf-teas-yang-te-27.txt>>.

- [RFC6241] Enns, R., Ed., Bjorklund, M., Ed., Schoenwaelder, J., Ed., and A. Bierman, Ed., "Network Configuration Protocol (NETCONF)", [RFC 6241](#), DOI 10.17487/RFC6241, June 2011, <<https://www.rfc-editor.org/info/rfc6241>>.

Lopez de Vergara, et al. Expires 28 April 2022

[Page 39]

---

Internet-Draft

Flexi-Grid YANG

October 2021

- [RFC7699] Farrel, A., King, D., Li, Y., and F. Zhang, "Generalized Labels for the Flexi-Grid in Lambda Switch Capable (LSC) Label Switching Routers", [RFC 7699](#), DOI 10.17487/RFC7699, November 2015, <<https://www.rfc-editor.org/info/rfc7699>>.
- [RFC7950] Bjorklund, M., Ed., "The YANG 1.1 Data Modeling Language", [RFC 7950](#), DOI 10.17487/RFC7950, August 2016, <<https://www.rfc-editor.org/info/rfc7950>>.
- [RFC8040] Bierman, A., Bjorklund, M., and K. Watsen, "RESTCONF Protocol", [RFC 8040](#), DOI 10.17487/RFC8040, January 2017, <<https://www.rfc-editor.org/info/rfc8040>>.
- [RFC8341] Bierman, A. and M. Bjorklund, "Network Configuration Access Control Model", STD 91, [RFC 8341](#), DOI 10.17487/RFC8341, March 2018, <<https://www.rfc-editor.org/info/rfc8341>>.

## 10.2. Informative References

- [RFC7446] Lee, Y., Ed., Bernstein, G., Ed., Li, D., and W. Imajuku, "Routing and Wavelength Assignment Information Model for Wavelength Switched Optical Networks", [RFC 7446](#), DOI 10.17487/RFC7446, February 2015, <<https://www.rfc-editor.org/info/rfc7446>>.
- [RFC7698] Gonzalez de Dios, O., Ed., Casellas, R., Ed., Zhang, F., Fu, X., Ceccarelli, D., and I. Hussain, "Framework and Requirements for GMPLS-Based Control of Flexi-Grid Dense Wavelength Division Multiplexing (DWDM) Networks", [RFC 7698](#), DOI 10.17487/RFC7698, November 2015, <<https://www.rfc-editor.org/info/rfc7698>>.

## Authors' Addresses

Jorge E. Lopez de Vergara Mendez  
Naudit HPCN

Email: [jorge.lopez\\_vergara@uam.es](mailto:jorge.lopez_vergara@uam.es)

Daniel Perdices Burrero  
Universidad Autonoma de Madrid

Email: [daniel.perdices@uam.es](mailto:daniel.perdices@uam.es)

Lopez de Vergara, et al. Expires 28 April 2022

[Page 40]

---

Internet-Draft

Flexi-Grid YANG

October 2021

Daniel King  
Old Dog Consulting

Email: [daniel@olddog.co.uk](mailto:daniel@olddog.co.uk)

Victor Lopez  
Nokia

Email: [victor.lopez@nokia.com](mailto:victor.lopez@nokia.com)

Italo Busi  
Huawei Technologies

Email: [Italo.Busi@huawei.com](mailto:Italo.Busi@huawei.com)

Oscar Gonzalez de Dios  
Telefonica I+D/GCTO

Email: [oscar.gonzalezdedios@telefonica.com](mailto:oscar.gonzalezdedios@telefonica.com)

Young Lee

Samsung

Email: [younglee.tx@gmail.co](mailto:younglee.tx@gmail.co)

G. Galimberti

Cisco

Email: [ggalimbe@cisco.com](mailto:ggalimbe@cisco.com)