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# Profiles for Traffic Engineering (TE) Topology Data Model
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Abstract

This document describes how profiles of the Traffic Engineering (TE) Topology Model, defined in RFC8795, can be used to address applications beyond "Traffic Engineering".

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## 1. Introduction

There are many network scenarios being discussed in various IETF Working Groups (WGs) that are not classified as "Traffic Engineering" but can be addressed by a sub-set (profile) of the Traffic Engineering (TE) Topology YANG data model, defined in [RFC8795].

Traffic Engineering (TE) is defined in [RFC3272bis] as aspects of Internet network engineering that deal with the issues of performance evaluation and performance optimization of operational IP networks.

TE encompasses the application of technology and scientific principles to the measurement, characterization, modeling, and control of Internet traffic.

The TE Topology Model is augmenting the Network Topology Model defined in [RFC8345] with generic and technology-agnostic features that some are strictly applicable to TE networks, while others applicable to both TE and non-TE networks.

Examples of such features that are applicable to both TE and non-TE networks are: inter-domain link discovery (plug-id), geo-localization, and admin/operational status.

It is also worth noting that the TE Topology Model is quite an extensive and comprehensive model in which most features are optional. Therefore, even though the full model appears to be complex, at the first glance, a sub-set of the model (profile) can be used to address specific scenarios, e.g. suitable also to non-TE use cases.

The implementation of such TE Topology profiles can simplify and expedite adoption of the full TE topology YANG data model, and allow for its reuse even for non-TE use case. The key question being whether all or some of the attributes defined in the TE Topology Model are needed to address a given network scenario.

Section 2 provides examples where profiles of the TE Topology Model can be used to address some generic use cases applicable to both TE and non-TE technologies.

## 2. Examples of non-TE scenarios

### 2.1. UNI Topology Discovery

UNI Topology Discovery is independent from whether the network is TE or non-TE.

The TE Topology Model supports inter-domain link discovery (including but not being limited to UNI link discovery) using the plug-id attribute. This solution is quite generic and does not require the network to be a TE network.

The following profile of the TE Topology model can be used for the UNI Topology Discovery:

```
module: ietf-te-topology

  augment /nw:networks/nw:network/nw:network-types:
    +--rw te-topology!

  augment /nw:networks/nw:network/nw:node/nt:termination-point:
    +--rw te-tp-id?   te-types:te-tp-id
    +--rw te!
       +--rw admin-status?
       |       te-types:te-admin-status
       +--rw inter-domain-plug-id?             binary
       +--ro oper-status?
               te-types:te-oper-status
```

Figure 1 - UNI Topology

The profile data model shown in Figure 1 can be used to discover TE and non TE UNIs as well as to discover UNIs for TE or non TE networks.

Such a UNI TE Topology profile model can also be used with technology-specific UNI augmentations, as described in section 3.

For example, in [CLIENT-TOPO], the eth-svc container is defined to represent the capabilities of the Termination Point (TP) to be configured as an Ethernet client UNI, together with the Ethernet classification and VLAN operations supported by that TP.

The [OTN-TOPO] provides another example, where:

- the client-svc container is defined to represent the capabilities of the TP to be configured as an transparent client UNI (e.g., STM-N, Fiber Channel or transparent Ethernet);

- the OTN technology-specific Link Termination Point (LTP) augmentations are defined to represent the capabilities of the TP to be configured as an OTN UNI, together with the information about OTN label and bandwidth availability at the OTN UNI.

For example, the UNI TE Topology profile can be used to model features defined in [UNI-TOPO]:

- The inter-domain-plug-id attribute would provide the same information as the attachment-id attribute defined in [UNI-TOPO];

- The admin-status and oper-status that exists in this TE topology profile can provide the same information as the admin-status and oper-status attributes defined in [UNI-TOPO].

Following the same approach in [CLIENT-TOPO] and [OTN-TOPO], the type and encapsulation-type attributes can be defined by technology-specific UNI augmentations to represent the capability of a TP to be configured as a L2VPN/L3VPN UNI Service Attachment Point (SAP).

The advantages of using a TE Topology customized profile would be having common solutions for:

- discovering UNIs as well as inter-domain NNI links, which is applicable to any technology (TE or non TE) used at the UNI or within the network;

- modelling non TE UNIs such as Ethernet, and TE UNIs such as OTN, as well as UNIs which can configured as TE or non-TE (e.g., being configured as either Ethernet or OTN UNI).

## 2.2. Administrative and Operational status management

The TE Topology Model supports the management of administrative and operational state, including also the possibility to associate some administrative names, for nodes, termination points and links. This solution is generic and also does not require the network to be a TE network.

The following profile of the TE Topology Model can be used for administrative and operational state management:

```
module: ietf-te-topology

  augment /nw:networks/nw:network/nw:network-types:
    +--rw te-topology!

     augment /nw:networks/nw:network:
       +--rw te-topology-identifier
       |  +--rw provider-id?   te-global-id
       |  +--rw client-id?     te-global-id
       |  +--rw topology-id?   te-topology-id
       +--rw te!
          +--rw name?                    string

     augment /nw:networks/nw:network/nw:node:
       +--rw te-node-id?   te-types:te-node-id
       +--rw te!
          +--rw te-node-attributes
          |  +--rw admin-status?            te-types:te-admin-status
          |  +--rw name?                    string
          +--ro oper-status?                   te-types:te-oper-
status

     augment /nw:networks/nw:network/nt:link:
       +--rw te!
          +--rw te-link-attributes
          |  +--rw name?                              string
          |  +--rw admin-status?
          |  |       te-types:te-admin-status
          +--ro oper-status?                   te-types:te-oper-
status

     augment /nw:networks/nw:network/nw:node/nt:termination-point:
       +--rw te-tp-id?   te-types:te-tp-id
       +--rw te!
          +--rw admin-status?
          |       te-types:te-admin-status
          +--rw name?                              string
          +--ro oper-status?
                  te-types:te-oper-status
```

Figure 2 - Generic Topology with admin and operational state

The TE topology data model profile shown in Figure 2 is applicable to any technology (TE or non-TE) that requires management of the administrative and operational state and administrative names for nodes, termination points and links.

## 2.3. Geolocation

The TE Topology model supports the management of geolocation coordinates for nodes and termination points. This solution is generic and does not necessarily require the network to be a TE network.

The TE topology data model profile shown in Figure 3can be used to model geolocation data for networks.

```
module: ietf-te-topology

  augment /nw:networks/nw:network/nw:network-types:
    +--rw te-topology!

     augment /nw:networks/nw:network:
       +--rw te-topology-identifier
       |  +--rw provider-id?   te-global-id
       |  +--rw client-id?     te-global-id
       |  +--rw topology-id?   te-topology-id
       +--rw te!
          +--ro geolocation
             +--ro altitude?    int64
             +--ro latitude?    geographic-coordinate-degree
             +--ro longitude?   geographic-coordinate-degree

     augment /nw:networks/nw:network/nw:node:
       +--rw te-node-id?   te-types:te-node-id
       +--rw te!
          +--ro geolocation
          |  +--ro altitude?    int64
          |  +--ro latitude?    geographic-coordinate-degree
          |  +--ro longitude?   geographic-coordinate-degree

     augment /nw:networks/nw:network/nw:node/nt:termination-point:
       +--rw te-tp-id?   te-types:te-tp-id
       +--rw te!
          +--ro geolocation
             +--ro altitude?    int64
             +--ro latitude?    geographic-coordinate-degree
             +--ro longitude?   geographic-coordinate-degree
```

Figure 3 - Generic Topology with geolocation information

This profile is applicable to any network technology (TE or non-TE) that requires management of the geolocation information for its nodes and termination points.

### 2.4. Overlay and Underlay non-TE Topologies

The TE Topology model supports the management of overlay/underlay relationship for nodes and links, as described in section 5.8 of [RFC8795]. This solution is generic and does not require the network to be a TE network.

The following TE topology data model profile can be used to manage overlay/underlay network data:

```
   module: ietf-te-topology

     augment /nw:networks/nw:network/nw:network-types:
       +--rw te-topology!

        augment /nw:networks/nw:network/nw:node:
          +--rw te-node-id?   te-types:te-node-id
          +--rw te!
             +--rw te-node-attributes
             |  +--rw underlay-topology {te-topology-hierarchy}?
             |     +--rw network-ref?   -> /nw:networks/network/network-
   id

        augment /nw:networks/nw:network/nt:link:
          +--rw te!
             +--rw te-link-attributes
             |  +--rw underlay {te-topology-hierarchy}?
             |  |  +--rw enabled?                    boolean
             |  |  +--rw primary-path
             |  |  |  +--rw network-ref?
             |  |  |  |       -> /nw:networks/network/network-id
             |  |  |  +--rw path-element* [path-element-id]
             |  |  |     +--rw path-element-id              uint32
             |  |  |     +--rw (type)?
             |  |  |        +--:(numbered-link-hop)
             |  |  |        |  +--rw numbered-link-hop
             |  |  |        |     +--rw link-tp-id    te-tp-id
             |  |  |        |     +--rw hop-type?     te-hop-type
             |  |  |        |     +--rw direction?    te-link-direction
             |  |  |        +--:(unnumbered-link-hop)
             |  |  |        |  +--rw unnumbered-link-hop
             |  |  |        |     +--rw link-tp-id    te-tp-id
             |  |  |        |     +--rw node-id       te-node-id
             |  |  |        |     +--rw hop-type?     te-hop-type
             |  |  |        |     +--rw direction?    te-link-direction
```

Figure 4 - Generic Topology with overlay/underlay information

This profile is applicable to any technology (TE or non-TE) when it is needed to manage the overlay/underlay information. It is also allows a TE underlay network to support a non-TE overlay network and, vice versa, a non-TE underlay network to support a TE overlay network.

### 2.5. Nodes with switching limitations

A node can have some switching limitations where connectivity is not possible between all its TP pairs, for example when:

o the node represents a physical device with switching limitations;

o the node represents an abstraction of a network topology.

This scenario is generic and applies to both TE and non-TE technologies.

A connectivity TE Topology profile data model supports the management of the node connectivity matrix to represent feasible connections between termination points across the nodes. This solution is generic and does not necessarily require a TE enabled network.

The following profile of the TE Topology model can be used for nodes with connectivity constraints:

```
module: ietf-te-topology

  augment /nw:networks/nw:network/nw:network-types:
    +--rw te-topology!

     augment /nw:networks/nw:network/nw:node:
       +--rw te-node-id?   te-types:te-node-id
       +--rw te!
          +--rw te-node-attributes
          |  +--rw connectivity-matrices
          |  |  +--rw number-of-entries?     uint16
          |  |  +--rw is-allowed?            boolean
          |  |  +--rw connectivity-matrix* [id]
          |  |     +--rw id                  uint32
          |  |     +--rw from
          |  |     |  +--rw tp-ref?               leafref
          |  |     +--rw to
          |  |     |  +--rw tp-ref?               leafref
          |  |     +--rw is-allowed?         boolean
```

Figure 5 - Generic Topology with connectivity constraints

The TE topology data model profile shown in Figure 5 is applicable to any technology (TE or non-TE) networks that requires managing nodes with certain connectivity constraints. When used with TE

technologies, additional TE attributes, as defined in [RFC8795], can also be provided.

## 3. Technology-specific augmentations

There are two main options to define technology-specific Topology Models which can use the attributes defined in the TE Topology Model [RFC8795].

Both options are applicable to any possible profile such as those defined in section 2.

The first option is to define a technology-specific TE Topology Model which augments the TE Topology Model, as shown in Figure 6:

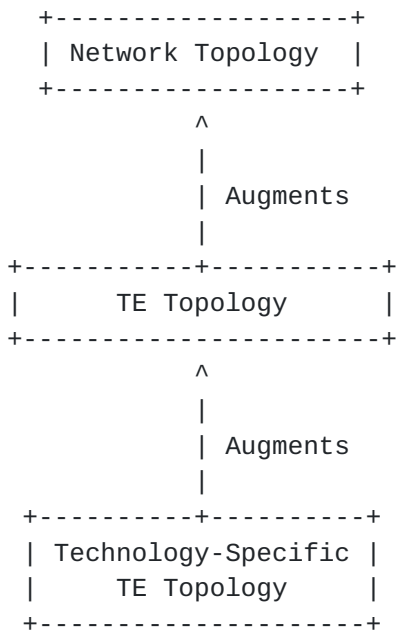


Figure 6 Augmenting the TE Topology Model

This approach is more suitable for cases when the technology-specific TE topology model provides augmentations to the TE Topology constructs, such as bandwidth information (e.g., link bandwidth), tunnel termination points (TTPs) or connectivity matrices.

This is the approach currently used in [CLIENT TOPO] and [OTN TOPO].

It is worth noting that a profile of the technology-specific TE Topology model not using any TE topology attribute or constructs can be used to address any use case that do not require these attributes.

The second option is to define a technology-specific Topology Model which augments the Network Topology Model and to rely on the multiple inheritance capability that is defined in [RFC8345] to allow using also the attributes defined in the TE Topology model:

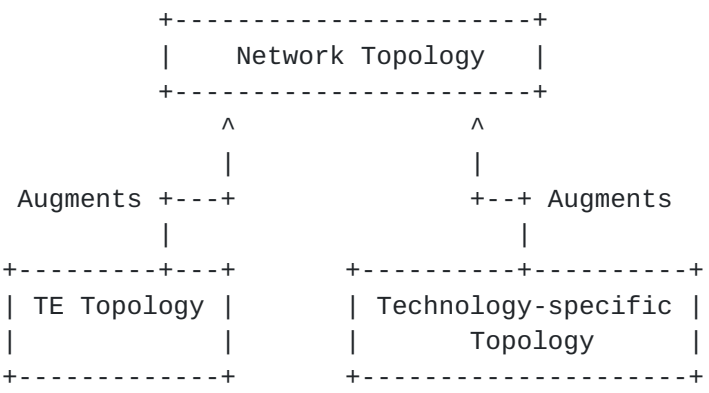


Figure 7 Augmenting the Network Topology Model with multi-inheritance

This approach is more suitable in cases where the technology-specific Topology Model provides augmentation only to the constructs defined in the Network Topology Model, such as nodes, links, and termination points (TPs). Therefore, with this approach, only the generic attributes defined in the TE Topology Model could be used.

It is also worth noting that in this case, technology-specific augmentations for the bandwidth information could not be defined.

In principle, a third option, to define both a technology specific TE Topology Model which augments the TE Topology Model, and a technology-specific Topology Model which augments the Network Topology Model and to rely on the multiple inheritance capability, as shown in Figure 8, is possible:

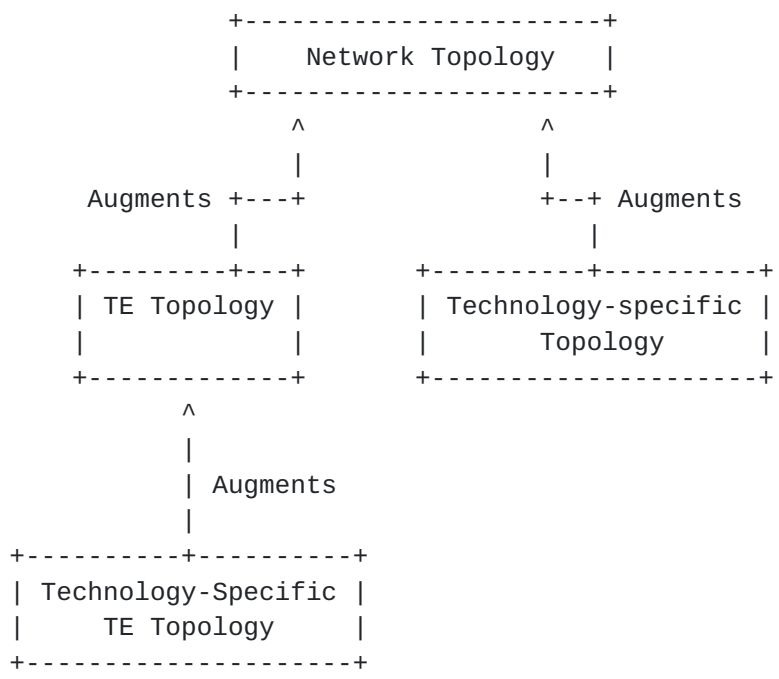


Figure 8 Augmenting both the Network and TE Topology Models

This option does not provide any technical advantage with respect to the first option, shown in Figure 6, but could be useful to add augmentations to the TE Topology constructs and re-using an already existing technology-specific Topology Model.

## 4. Security Considerations

This document provides only information about how the TE Topology Model, as defined in [RFC8795], can be profiled to address some scenarios which are not considered as TE.

As such, this document does not introduce any additional security considerations besides those already defined in [RFC8795].

## 5. IANA Considerations

This document requires no IANA actions.

# 6. References

## 6.1. Normative References

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[RFC8795] Liu, X., Bryskin, I., Beeram, V., Saad, T., Shah, H., and O. Gonzalez de Dios, "YANG Data Model for Traffic Engineering (TE) Topologies", RFC 8795, DOI 10.17487/RFC8795, August 2020, <https://www.rfc-editor.org/info/rfc8795>.

## 6.2. Informative References

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