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A YANG Data Model for Multipath Traffic Engineering Directed Acyclic Graph (MPTED) Tunnels and Junctions
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Abstract

This document defines a YANG data model for representing, retrieving, and manipulating Multipath Traffic Engineering Directed Acyclic Graph (MPTED) Tunnels and Junctions. The model includes two YANG modules, one for managing MPTED Tunnels on an MPTED tunnel originator node and the other for managing MPTED Junctions on an MPTED junction node.

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1. Introduction

The notions of a Multipath Traffic Engineering Directed Acyclic Graph (MPTED) tunnel and an MPTED junction are introduced in [I-D.draft-kompella-teas-mpte]. An MPTED tunnel is a Traffic Engineering (TE) construct that contains a constrained set of paths representing an optimized Directed Acyclic Graph (DAG) from one or more ingresses to one or more egresses. The paths that make up an MPTED tunnel traverse a set of junction nodes. An MPTED junction refers to the construct associated with the MPTED tunnel at each junction node and constitutes a set of previous-hops and a set of next-hops over which traffic is load-balanced in a weighted fashion. Provisioning an MPTED tunnel in a TE network involves provisioning MPTED junction state at each junction node.

An MPTED tunnel is instantiated and managed on a tunnel originator node, while an MPTED junction is instantiated and managed on a junction node. A tunnel originator node MAY also be a junction node.

This document defines a YANG data model for representing, retrieving, and manipulating Multipath Traffic Engineering Directed Acyclic Graph (MPTED) Tunnels and Junctions. The model includes two YANG modules, one for managing MPTED Tunnels on a tunnel originator node and the other for managing MPTED Junctions on a junction node.

The YANG modules discussed in this version of the document are scoped to MPLS MPTED tunnels and junctions with signaled label switching. The coverage for other types of MPTED tunnels and junctions will be added in later versions.

1.1. Requirements Language

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

1.2. Terminology

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

The reader is expected to be familiar with the terminology used in [I-D.draft-kompella-teas-mpte].

1.3. Tree Diagram

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

2. MPTED YANG Module

2.1. Model Structure

The high-level model structure for MPTED tunnels defined by this document is as shown below:

```
module: ietf-mpted

  augment /te:te:
    +--rw mpted-tunnels
       +--rw tunnel* [originator identifier]
          +--rw originator                        inet:ip-address
          +--rw identifier                        uint32
          +  ..
          +--ro junctions
             +--ro junction* [node-id]
                +--ro node-id                     inet:ip-address
                +  ..
                +--ro phops
                |  +--ro phop* [hop-address hop-index]
                |     +--ro hop-address    inet:ip-address
                |     +--ro hop-index      uint32
                |     +  ..
                +--ro nhops
                |  +--ro nhop* [hop-address hop-index]
                |     +--ro hop-address           inet:ip-address
                |     +--ro hop-index             uint32
                |     +  ..
                +--ro phops-pending-deletion
                |  +--ro phop* [hop-address hop-index]
                |     +--ro hop-address    inet:ip-address
                |     +--ro hop-index      uint32
                |     +  ..
                +--ro nhops-pending-deletion
                   +--ro nhop* [hop-address hop-index]
                      +--ro hop-address    inet:ip-address
                      +--ro hop-index      uint32
                      +  ..
```

Figure 1: MPTED YANG Structure

The top-level 'te' container is [I-D.draft-ietf-teas-yang-te] is augmented with a set of MPTED tunnels. The 'mpted-tunnels' container carries a list of tunnel entries. Each tunnel entry includes the set of parameters required to produce a list of junctions that need to programmed in the network. The state for each junction entry consists of the set of previous-hops ('phops' container) and next-hops ('nhops' container) associated with the current version, as well as those that are pending deletion ('phops-pending-deletion' and 'nhops-pending-deletion' containers).

2.2. YANG Code

<CODE BEGINS> file "ietf-mpted@2025-07-07.yang"
(Artwork only available as YANG: see
https://www.ietf.org/archive/id/draft-beeram-teas-yang-mpted-00.html)
<CODE ENDS>

Figure 2: MPTED YANG module

3. MPTED-JCT YANG Module

3.1. Model Structure

The high-level model structure for MPTED junctions defined by this document is as shown below:

```
module: ietf-mpted-jct

  augment /te:te:
    +--rw mpted-junctions
       +--rw junction* [node-id originator identifier]
          +--rw node-id                inet:ip-address
          +--rw originator             inet:ip-address
          +--rw identifier             uint32
          +  ..
          +--rw phops
          |  +--rw phop* [hop-address hop-index]
          |     +--rw hop-address    inet:ip-address
          |     +--rw hop-index      uint32
          |     +  ..
          +--rw nhops
             +--rw nhop* [hop-address hop-index]
                +--rw hop-address           inet:ip-address
                +--rw hop-index             uint32
                +  ..
```

Figure 3: MPTED-JCT YANG Structure

The top-level 'te' container is [I-D.draft-ietf-teas-yang-te] is augmented with a set of MPTED junctions. The 'mpted-junctions' container carries a list of junction entries. Each junction entry includes information about the associated set of previous-hops ('phops' container) and next-hops ('nhops' container).

3.2. YANG Code

<CODE BEGINS> file "ietf-mpted-jct@2025-07-07.yang"
(Artwork only available as YANG: see
https://www.ietf.org/archive/id/draft-beeram-teas-yang-mpted-00.html)
<CODE ENDS>

Figure 4: MPTED JCT YANG module

4. Security Considerations

The YANG module specified in this document defines a schema for data that is designed to be accessed via network management protocols such as NETCONF [RFC6241] or RESTCONF [RFC8040]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [RFC8446].

The Network Configuration Access Control Model (NACM) [RFC8341] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

The data nodes defined in these YANG modules that are writable/creatable/deletable (i.e., config true, which is the default) 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/mpted-tunnels": Unauthorized access to this list could influence how traffic is forwarded through the network.

"/te/mpted-junctions": Unauthorized access to this list could influence how traffic is forwarded on a junction node.

The readable data nodes in these YANG module may be considered sensitive or vulnerable in some network environments. It is thus important to control read access (e.g., via get, get-config, or notification) to these data nodes. These are the subtrees and data nodes and their sensitivity/vulnerability:

"/te/mpted-tunnels/tunnel/junctions": Unauthorized read access to this list can disclose how traffic is load-balanced on each junction node.

5. IANA Considerations

This document requests IANA to register the following URIs in the "ns" subregistry within the "IETF XML Registry" [RFC3688].

```
      URI:  urn:ietf:params:xml:ns:yang:ietf-mpted
      Registrant Contact:  The IESG.
      XML: N/A; the requested URI is an XML namespace.

      URI:  urn:ietf:params:xml:ns:yang:ietf-mpted-jct
      Registrant Contact:  The IESG.
      XML: N/A; the requested URI is an XML namespace.
```

This document requests IANA to register the following YANG modules in the "YANG Module Names" subregistry [RFC6020] within the "YANG Parameters" registry.

```
      name:      ietf-mpted
      namespace: urn:ietf:params:xml:ns:yang:ietf-mpted
      prefix:    mpted
      reference: RFC XXXX

      name:      ietf-mpted-jct
      namespace: urn:ietf:params:xml:ns:yang:ietf-mpted-jct
      prefix:    mpted-jct
      reference: RFC XXXX
```

RFC Editor: Please replace XXXX with the RFC number assigned to this document.

6. References

6.1. Normative References

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Saad, T., Gandhi, R., Liu, X., Beeram, V. P., and I. Bryskin, "A YANG Data Model for Traffic Engineering Tunnels, Label Switched Paths and Interfaces", Work in Progress, Internet-Draft, draft-ietf-teas-yang-te-38, 29 May 2025, <https://datatracker.ietf.org/doc/html/draft-ietf-teas-yang-te-38>.

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[RFC8446] Rescorla, E., "The Transport Layer Security (TLS) Protocol Version 1.3", RFC 8446, DOI 10.17487/RFC8446, August 2018, <https://www.rfc-editor.org/rfc/rfc8446>.

6.2. Informative References

[RFC8340] Bjorklund, M. and L. Berger, Ed., "YANG Tree Diagrams", BCP 215, RFC 8340, DOI 10.17487/RFC8340, March 2018, <https://www.rfc-editor.org/rfc/rfc8340>.

Appendix A. MPTED YANG Module - Complete Tree Structure

```
   module: ietf-mpted

     augment /te:te:
       +--rw mpted-tunnels
          +--rw tunnel* [originator identifier]
             +--rw originator                        inet:ip-address
             +--rw identifier                        uint32
             +--rw name?                             string
             +--rw ingress*                          inet:ip-address
             +--rw egress*                           inet:ip-address
             +--rw version?                          uint16
             +--rw type?                             identityref
             +--rw setup-priority?                   uint8
             +--rw hold-priority?                    uint8
             +--rw optimization-metric?              identityref
             +--rw resource-affinities
             |  +--rw exclude-any*   string
             |  +--rw include-any*   string
             |  +--rw include-all*   string
             +--rw bandwidth-specification-type?   identityref
             +--rw set-bandwidth?                    uint64
             +--rw auto-bandwidth
             |  +--rw enabled?            boolean
             |  +--rw min-bw?             uint64
             |  +--rw max-bw?             uint64
             |  +--rw adjust-interval?    uint32
             |  +--rw adjust-threshold?   rt-types:percentage
             |  +--rw overflow
             |  |  +--rw enabled?               boolean
             |  |  +--rw overflow-threshold?    rt-types:percentage
             |  |  +--rw trigger-event-count?   uint16
             |  +--rw underflow
             |     +--rw enabled?               boolean
             |     +--rw underflow-threshold?   rt-types:percentage
             |     +--rw trigger-event-count?   uint16
             +--rw mpted-computer?                  inet:ip-address
             +--rw signaling-type?                  identityref
             +--rw signaling-source?                inet:ip-address
             +--ro status?                          identityref
             +--ro junctions
                +--ro junction* [node-id]
                   +--ro node-id                    inet:ip-address
                   +--ro version?                   uint16
                   +--ro bandwidth-requested?       uint64
                   +--ro mtu?                       uint16
                   +--ro status?                    identityref
                   +--ro phops
                   |  +--ro phop* [hop-address hop-index]
```

```
|     +--ro hop-address    inet:ip-address
|     +--ro hop-index      uint32
|     +--ro in-label?      rt-types:mpls-label
|     +--ro status?        identityref
+--ro nhops
|  +--ro nhop* [hop-address hop-index]
|     +--ro hop-address           inet:ip-address
|     +--ro hop-index             uint32
|     +--ro load-share?           uint16
|     +--ro bandwidth-reserved?   uint64
|     +--ro out-label?            rt-types:mpls-label
|     +--ro status?               identityref
+--ro phops-pending-deletion
|  +--ro phop* [hop-address hop-index]
|     +--ro hop-address    inet:ip-address
|     +--ro hop-index      uint32
|     +--ro version?       uint16
+--ro nhops-pending-deletion
   +--ro nhop* [hop-address hop-index]
      +--ro hop-address    inet:ip-address
      +--ro hop-index      uint32
      +--ro version?       uint16
```

Figure 5: MPTED YANG tree

Appendix B. MPTED-JCT YANG Module - Complete Tree Structure

```
   module: ietf-mpted-jct

     augment /te:te:
       +--rw mpted-junctions
          +--rw junction* [node-id originator identifier]
             +--rw node-id                inet:ip-address
             +--rw originator             inet:ip-address
             +--rw identifier             uint32
             +--rw name?                  string
             +--rw ingress*               inet:ip-address
             +--rw egress*                inet:ip-address
             +--rw version?               uint16
             +--rw type?                  identityref
             +--rw setup-priority?        uint8
             +--rw hold-priority?         uint8
             +--rw bandwidth-requested?   uint64
             +--ro mtu?                   uint16
             +--ro status?                identityref
             +--rw phops
             |  +--rw phop* [hop-address hop-index]
             |     +--rw hop-address    inet:ip-address
             |     +--rw hop-index      uint32
             |     +--ro in-label?      rt-types:mpls-label
             |     +--ro status?        identityref
             +--rw nhops
                +--rw nhop* [hop-address hop-index]
                   +--rw hop-address           inet:ip-address
                   +--rw hop-index             uint32
                   +--rw load-share?           uint16
                   +--ro bandwidth-reserved?   uint64
                   +--ro out-label?            rt-types:mpls-label
                   +--ro status?               identityref
```

Figure 6: MPTED-JCT YANG tree

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