Yang Data Model for TE Topologies
draft-ietf-teas-yang-te-topo-05


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Summary of Changes

- Draft re-organization.
- Added support for multi-layer topology.
- Added support for protection on tunnel termination point.
- Added support for label restrictions on connectivity matrix.
- Added support for topology optimization options.
- Enhanced support for inter-domain topology.
Draft Re-organization

- Moved shared type definitions to ietf-te-types.yang in draft-ietf-teas-yang-te.
  - To share type definitions by multiple models.
  - Kept draft-ietf-teas-yang-te-topo-05 technology agnostic.
- Extended ietf-teas-yang-te-topo to cover SR topology and SR TE topology
  - Submitted draft-liu-teas-yang-sr-te-topo.
  - Will describe more at end of this presentation.
Added Support for Multi-layer Topology

- **Transitional link**
  - Connects link termination points at different layers.

- **Modeling abstraction**
  - Added switch-layer attributes to TE Link Termination Point.
  - Added a flag to TE Link to indicate transitional.

```text
augment /nw:networks/nw:network/nw:node:
  +--rw te!
    +--rw tunnel-termination-point* [tunnel-tp-id]
      +--rw tunnel-tp-id    binary
      +--rw config
        |  +--rw switching-capability?     identityref
        |  +--rw encoding?                 identityref
      +--ro state
        +--ro switching-capability?     identityref
        +--ro encoding?                 identityref

augment /nw:networks/nw:network/nt:link:
  +--rw te!
    +--rw config
      |  +--rw te-link-attributes
      |  |  +--rw interface-switching-capability* [switching-capability]
      |  |  |  +--rw switching-capability               identityref
      |  |  |  +--rw encoding?                          identityref
      |  |  +--ro state
      |  |    +--ro switching-capability?     identityref
      |  |    +--ro encoding?                 identityref
      |  |  +--ro max-lsp-bandwidth* [priority]
    +--ro state
      +--ro is-transitional?        empty
```

"Layer 1" at one end, "Layer 2" at other end.
Transitional Link

- Tunnel Termination Point (TTP)
- Server Link Termination Point (S-LTP)
- Client Link Termination Point (C-LTP)

Transformation

Logical Sub-node

Layer 1

Layer 2

Layer 3
Added Support for Multi-layer Topology

- Inter layer lock
  - Describes client-server layer adaptation relationships
- Modeling abstraction
  - Added inter-layer-lock-id to TE Tunnel Termination Point.

```
augment /nw:networks/nw:network/nw:node:
  +--rw te!
    +--rw te-node-id      te-node-id
    +--rw tunnel-termination-point* [tunnel-tp-id]
      +--rw tunnel-tp-id    binary
    +--rw config
      |  +--rw inter-layer-lock-id?   uint32
      |  +--rw termination-capability* [link-tp]
      |    +--rw link-tp    leafref
    +--ro state
      +--ro inter-layer-lock-id?   uint32
      +--ro termination-capability* [link-tp]
      |    +--ro link-tp    leafref

augment /nw:networks/nw:network/nw:node/nt:termination-point:
  +--rw te!
    +--rw te-tp-id    te-tp-id
    +--rw config
      |  +--rw schedules
      |    +--rw schedule* [schedule-id]
      |    +--rw interface-switching-capability* [switching-capability]
      |    +--rw inter-layer-lock-id   uint32
    +--ro state
      +--ro schedules
      |    +--ro schedule* [schedule-id]
      |    +--ro inter-layer-lock-id?   uint32
```
Inter-layer Lock

- Describes client-server layer adaptation relationship.
- It is an association of M client layer LTPs and N server layer TTPs.
- Each association is uniquely identified by an inter-layer lock ID.

<table>
<thead>
<tr>
<th>TTP</th>
<th>IL</th>
<th>C-LTP</th>
<th>IL</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTP1</td>
<td>IL-1</td>
<td>C-LTP-1</td>
<td>IL-1</td>
</tr>
<tr>
<td>TTP2</td>
<td>IL-2, IL-3</td>
<td>C-LTP-2</td>
<td>IL-1</td>
</tr>
<tr>
<td>TTP3</td>
<td>IL-2</td>
<td>C-LTP-3</td>
<td>IL-1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C-LTP-4</td>
<td>IL-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C-LTP-5</td>
<td>IL-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C-LTP-6</td>
<td>IL-3</td>
</tr>
</tbody>
</table>
Added Support for Protection on Tunnel Termination Point

- Tunnel Termination Point to Support Protection
  - Added attribute `protection-type` to specify the type of protection that the TTP is capable of, as specified in RFC4872.

```yaml
augment /nw:networks/nw:network/nw:node:
  +--rw te!
    +--rw tunnel-termination-point* [tunnel-tp-id]
      +--rw tunnel-tp-id binary
      +--rw config
        | +--rw protection-type? identityref
        +--ro state
          +--ro protection-type? identityref

protection-type value range:
- lsp-prot-unprotected
- lsp-prot-reroute-extra
- lsp-prot-reroute
- lsp-prot-1-for-n
- lsp-prot-unidir-1-to-1
- lsp-prot-bidir-1-to-1
```
Added Support for Label Restrictions on Connectivity Matrix

Tunnel Termination Point (TTP)

Server Link Termination Point (S-LTP)

Client Link Termination Point (C-LTP)

TTP-1
TTP-2
TTP-3

C-LTP-1,2,3
C-LTP-4,5,6

LTP-1
LTP-2
LTP-3
LTP-4
LTP-5
LTP-6

Inclusive Labels: 101, 102, 103, 111, 112

Exclusive Labels: 100 .. 199
Added Support for Label Restrictions on Connectivity Matrix

- RFC7579 specifies label constraints on connectivity matrix.
  - Inclusion and exclusion.
  - Simple label, label range, and label set.

```plaintext
augment /nw:networks/nw:network/nw:node:
  +--rw te!
    +--rw config
      |  +--rw te-node-attributes
      |  |  +--rw connectivity-matrix* [id]
      |  |  |  +--rw id                       uint32
      |  |  |  +--rw label-restriction* [inclusive-exclusive label-start]
      |  |  |  |  +--rw inclusive-exclusive   enumeration
      |  |  |  |  +--rw label-start            te-types:generalized-label
      |  |  |  |  +--rw label-end?            te-types:generalized-label
      |  |  |  |  +--rw range-bitmap?         binary
    +--ro state
      |  +--ro te-node-attributes
      |  |  +--ro connectivity-matrix* [id]
      |  |  |  +--ro id                       uint32
      |  |  |  +--ro label-restriction* [inclusive-exclusive label-start]
      |  |  |  |  +--ro inclusive-exclusive   enumeration
      |  |  |  |  +--ro label-start            te-types:generalized-label
      |  |  |  |  +--ro label-end?            te-types:generalized-label
      |  |  |  |  +--ro range-bitmap?         binary
```
Added Support for Topology Optimization Options

- The optimization objectives may be different for different situations, and may change over time [RFC3272].
- Added attribute `optimization-criterion` to specify the optimization options.

```yang
augment /nw:networks/nw:network:
  +--rw te!
    +--rw provider-id te-types:te-global-id
    +--rw client-id te-types:te-global-id
    +--rw te-topology-id te-types:te-topology-id
    +--rw config
      |   +--rw optimization-criterion? identityref
      +--ro state
        +--ro optimization-criterion? Identityref

optimization-criterion value range:
- not-optimized
- cost
- delay
```
Enhanced Support for Inter-domain Topology

Domain TE topologies renamed and merged into client’s native TE topology

Domain 1 TE topology

Domain 2 TE topology
Topology Abstractions for Inter-domain Topology

Domain 1 abstract TE topology 1

S3 -- S5 -- S8 -- S7

S9 -- S5

Domain 2 abstract TE topology 1

S3 -- S5

S4 -- S8

S9 -- S7

Domain 1 abstract TE topology 2

AN1

Domain 2 abstract TE topology 2

AN1
Multiple Merged Native TE Topologies

Client’s merged TE topology 2

Client’s merged TE topology 3
Modeling Support for Inter-domain Topology

- Specify remote TE node ID and TE link ID.
- Specify inter-domain plug ID.

```
augment /nw:networks/nw:network/nt:link:
  +--rw te!
    +--rw config
      |  +--rw te-link-attributes
      |     +--rw schedules
      |     |  +--rw schedule* [schedule-id]
      |     +--rw external-domain
      |     |  +--rw remote-te-node-id? te-types:te-node-id
      |     |  +--rw remote-te-link-tp-id? te-types:te-tp-id
      |     |  +--rw plug-id? uint32
      |     +--rw is-abstract? empty
    +--ro state
      +--ro te-link-attributes
        |  +--ro schedules
        |   |  +--ro schedule* [schedule-id]
        |  +--ro external-domain
        |   |  +--ro remote-te-node-id? te-types:te-node-id
        |   |  +--ro remote-te-link-tp-id? te-types:te-tp-id
        |   |  +--ro plug-id? uint32
        |   +--ro is-abstract? empty
```
Topology Abstractions for Inter-domain Topology

Domain 1 abstract TE topology 1
- Remote TE Node: S3
- Remote TE Link: 301
- Link ID: 301

Domain 2 abstract TE topology 1
- Link ID: 301

Domain 1 abstract TE topology 2
- Remote TE Node: S3
- Remote TE Link: 301
- Link ID: 101

Domain 2 abstract TE topology 2
- Link ID: 101
Topology Abstractions for Inter-domain Topology

Domain 1 abstract TE topology 1

Domain 2 abstract TE topology 1

Plug ID: 11

Domain 1 abstract TE topology 2

Domain 2 abstract TE topology 2

Plug ID: 11
ID Type Debate

- It is being debated on the YANG data types for the IDs. Need WG consensus.
  1. The type for plug ID:
     - uint32
     - URI
     - String
  2. More generally, the types for other IDs, including TE Node ID and TE Link ID:
     - More specific types: dotted-quad, uint32
     - URI
ID Type Debate

- Arguments for number type (uint32 or dotted-quad):
  - Compatible to current implementations and RFCs.
  - More efficient to implement (e.g. searching, sorting, and indexing).
  - Easier to advertise.
  - Easier to do automation (e.g. getting the next available value).
  - The model is mostly for machine-to-machine interface. Client software can do the mapping if user friendly formats are needed.
  - No need for parsing and conversion, and no ambiguity for interpretation.

- Arguments for URI:
  - Forward thinking.
  - More human readable.
  - Flexible for conversion to other formats.
Next Steps

- Address review comments.
  - To Do List:
- Request further review.
Yang Data Model for Layer 3 TE Topologies

draft-liu-teas-yang-l3-te-topo-01

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Augmentation Hierarchy

- L3 TE Topology augments L3 Topology and references TE Topology.
- Packet extension module augments ietf-te-topology.
  - Asking feedback on the module name. Options can be:
    - ietf-te-topology-pcs
    - ietf-te-topology-packet
    - ietf-te-topology-mpls
Augmenting L3 Network Topology Model

- Add references to TE topology instances.

```yaml
module: ietf-l3-te-topology
augment /nw:networks/nw:network/nw:network-types/l3t:l3-unicast-igp-topology:
    +--rw l3-te!
augment /nw:networks/nw:network/l3t:igp-topology-attributes:
    +--rw l3-te-topology-attributes
        +--rw network-ref?         leafref
augment /nw:networks/nw:network/nw:node/l3t:igp-node-attributes:
    +--rw l3-te-node-attributes
        +--rw node-ref?           leafref
        +--rw network-ref?        leafref
augment /nw:networks/nw:network/nw:node/nt:termination-point/l3t:igp-termination-point-attributes:
    +--rw l3-te-tp-attributes
        +--rw tp-ref?            leafref
        +--rw node-ref?          leafref
        +--rw network-ref?       leafref
augment /nw:networks/nw:network/nt:link/l3t:igp-link-attributes:
    +--rw l3-te-link-attributes
        +--rw link-ref?         leafref
        +--rw network-ref?      leafref
```
Augmenting Base TE Topology Model

- Add attributes that are specific to packet switching technology.

```plaintext
module: ietf-te-topology-psc
    +-rw packet-switch-capable
       +-rw minimum-lsp-bandwidth?  decimal64
       +-rw interface-mtu?           Uint16

    +-ro packet-switch-capable
       +-ro minimum-lsp-bandwidth?  decimal64
       +-ro interface-mtu?           Uint16

    +-ro packet-switch-capable
       +-ro minimum-lsp-bandwidth?  decimal64
       +-ro interface-mtu?           Uint16

augment /tet:te-link-event/tet:te-link-attributes/tet:interface-switching-capability:
    +---- packet-switch-capable
       +---- minimum-lsp-bandwidth?  decimal64
       +---- interface-mtu?           uint16

augment /tet:te-link-event/tet:information-source-entry/tet:interface-switching-capability:
    +---- packet-switch-capable
       +---- minimum-lsp-bandwidth?  decimal64
       +---- interface-mtu?           uint16
```
Next Steps

- Request further review.
- Ask for WG adoption.
Yang Data Model for SR and SR TE Topologies

draft-liu-teas-yang-sr-te-topo-00

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SR (Segment Routing) Topology

- Augment layer 3 network topology model.
SR Topology Structure

- Define a new network-type “sr”.
- Add network-wide SRGB.

```yaml
module: ietf-l3-unicast-igp-topology
augment /nw:networks/nw:network/nw:network-types:
    +--rw l3-unicast-igp-topology!
        +--rw srt:sr!

augment /nw:networks/nw:network:
    +--rw igp-topology-attributes
        +--rw name?     string
        +--rw flag*     flag-type
    +--rw srt:sr
        +--rw srt:config
            +--rw srt:srgb* [lower-bound upper-bound]
                +--rw srt:lower-bound    uint32
                +--rw srt:upper-bound    uint32
```
Augment node to add per-node attributes.

```yaml
augment /nw:networks/nw:network/nw:node:
  +--rw igmp-node-attributes
  |    +--rw name?      inet:domain-name
  |    +--rw flag*     flag-type
  |    +--rw router-id* inet:ip-address
  |    +--rw prefix* [prefix]
  |    |    +--rw prefix    inet:ip-prefix
  |    |    +--rw metric?   uint32
  |    |    +--rw flag*     flag-type
  |    |    +--ro srt:start-sid        uint32
  |    |    +--ro srt:range?           uint32
  |    |    +--ro srt:last-hop-behavior? enumeration {sid-last-hop-behavior}?
  |    |    +--ro srt:is-local?        boolean
  |    |    +--ro srt:algorithm?      sr-algorithm
  |    +--ro srt:config
  |    |    +--ro srt:srgb* [lower-bound upper-bound]
  |    |    |    +--ro srt:lower-bound   uint32
  |    |    |    +--ro srt:upper-bound    uint32
  |    |    +--ro srt:capabilities
  |    |    |    +--ro srt:transport-planes* [transport-plane]
  |    |    |    |    +--ro srt:transport-plane    identityref
  |    |    |    +--ro srt:segment-stack-push-limit?     uint8
  |    |    |    +--ro srt:readable-label-stack-depth?   uint8
  +--ro srt:state
  |    +--ro srt:information-source?    enumeration
  |    +--ro srt:information-source-state
  |    |    +--ro srt:credibility-preference?    uint16
  +--ro srt:capabilities
  |    +--ro srt:transport-planes* [transport-plane]
  |    |    +--ro srt:transport-plane    identityref
  |    +--ro srt:segment-stack-push-limit?     uint8
  +--ro srt:readable-label-stack-depth?   uint8
```
SR Topology Structure

- Augment link to add per-link attributes.

```
augment /nw:networks/nw:network/nt:link:
    |--rw igp-link-attributes
    |   |--rw name? string
    |   |--rw flag* flag-type
    |   |--rw metric? uint32
    |--rw srt:sr
    |   |--rw srt:config
    |   |   |--rw srt:sid? uint32
    |   |   |--rw srt:value-type? enumeration
    |   |   |--rw srt:is-local? boolean
    |   |   |--ro srt:is-part-of-set? boolean
    |   |   |--ro srt:is-on-lan? boolean
    |   |--ro srt:state
    |   |   |--ro srt:information-source? enumeration
    |   |   |--ro srt:information-source-state
    |   |   |   |--ro srt:credibility-preference? uint16
```
SR (Segment Routing) TE Topology

- Multiple inheritance:
  - Is both SR topology and layer 3 TE topology model.
  - Uses multiple network types: "l3-te" and "sr".

```
+----------------+              +----------------+              +----------------+
| SR Topology   |              | Layer 3 TE Topology |              | SR TE Topology |
| ietf-sr-topology |              | ietf-l3-te-topology |              |
```

```
Next Steps

- Work with authors of draft-ietf-spring-sr-yang to share YANG types.
- Add support for protection on link.
- Add support for link bundle.