TE Topology and Tunnel Modeling for Transport Networks

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Igor Bryskin (Huawei Technologies)
Xufeng Liu (Jabil)
Vishnu Pavan Beeram (Juniper Networks)
Tarek Saad (Cisco)
Includes:

- TE topology modeling constructs and attributes
- TE Tunnel modeling constructs and attributes
- Use cases explaining use of TE topology and tunnel models
Changes from IETF99 presentation

• Aligned with the latest TE Topology and TE Tunnel models

• Introduced new concepts/features:
  - dependency TE tunnels
  - protection/restoration configuration
  - protection commands/actions

• Examples of JSON encoding are added to the use cases
TE topology - traffic engineering representation of a network domain resources
TE Topology Elements

- **TE node** (vertex on TE topology graph)
  - represents network's flexibility (switching capabilities and limitations)

- **TE link** (edge on TE topology graph)
  - represents network’s forwarding capability (bandwidth)

- **TE link termination point**
  - represents a point of connection of a TE node to one of TE links it terminates

- **TE tunnel termination point**
  - represents network’s client-server layer adaptation capability
TE Topology Elements

[Diagram showing TE node, LTP termination points, TE links, and TE tunnel termination points (TTP)]
TE Node Connectivity Matrix

TE node basic connectivity matrix:

LTP_5/label_x ⇔ LTP_1/label_y
LTP_6/label_x ⇔ LTP_2/label_y
LTP_6/label_x ⇔ LTP_3/label_y
LTP_4/label_x ⇔ LTP_1/label_y
LTP_4/label_x ⇔ LTP_2/label_y
...

TE node detailed connectivity matrix:

LTP_5/label_x ⇔ LTP_1/label_y
(Cost c, Delay d, SRLGs s, ...)
LTP_6/label_x ⇔ LTP_2/label_y
(Cost c, Delay d, SRLGs s, ...)
LTP_6/label_x ⇔ LTP_3/label_y
(Cost c, Delay d, SRLGs s, ...)
LTP_4/label_x ⇔ LTP_1/label_y
(Cost c, Delay d, SRLGs s, ...)
LTP_4/label_x ⇔ LTP_2/label_y
(Cost c, Delay d, SRLGs s, ...)
...

Describes a TE node’s switching capabilities/limitations
Intra-domain (close-ended) TE links

Open-ended TE links:
- access TE links
- inter-domain TE links
TE Link Termination Point, Bi-directional TE link group

- TE links are uni-directional
- Bi-directional TE link group is a pair of parallel oppositely directed TE links connected to TE nodes over common TE link termination points
TE Tunnel Termination Point

Describes a TE node’s tunnel termination and general client-server layer adaptation capabilities.
Inter-layer Locks

Describes a TE node’s detailed client-server layer adaptation capabilities
**TE Path**

- **TE path** - an ordered list of TE node/link IDs (each possibly augmented with labels) that interconnects over a TE topology a pair of TTPs and could be used by an e2e connection
TE Topology Types: native/abstract, underlay/overlay
TE Topology Negotiation, Customization, (Re-)configuration
TE Tunnel Modeling
TE Tunnel Modeling

- **TE tunnel** - a connection-oriented service provided by a layer network of delivery of a client’s data between source and destination tunnel termination points

- **Tunnel termination point (TTP)** – a physical device inside a given node/switch realizing a TE tunnel termination function in a given layer network, as well as the TE tunnel’s adaptation function provided for client layer network(s)

- **TE tunnel hand-off point** – an access link or inter-domain link by which a multi-domain TE tunnel enters or exits a given network domain

- **TE tunnel segment** – a part of a multi-domain TE tunnel that spans a given network domain and is directly and fully controlled by the domain’s controller

- **Hierarchy TE tunnel** - a server layer TE tunnel that supports a dynamically created TE link in the client layer network topology

- **Potential TE tunnel/segment** – a TE tunnel/segment configured in COMPUTE_ONLY mode.
TE Tunnel Components
TE Tunnel Connections/LSPs

- **Connection/LSP** - a layer network path supporting a TE tunnel by realizing its implied forwarding function; provisioned in a given layer network’s data plane over a chain of links and cross-connected over switches terminating the links.

- **Working connection** – the primary connection of the supported TE tunnel

- **End-to-end protection connection** – a secondary end-to-end connection of the supported TE tunnel (e.g. end-to-end 1+1 protection connection)

- **Segment protection connection** – a secondary connection of the supported TE tunnel’s segment protecting the segment in a given network domain (e.g. 1+1 segment protection connection)
TE Tunnel Paths

• **Inclusion path** – a TE path over a TE topology describing a layer network/domain that specifies (loosely or strictly) the client’s requirements with respect to an ordered list of network nodes, links and resources on the nodes/links a given TE tunnel connection should go through

• **Exclusion path** – a TE path over a TE topology describing a layer network/domain that specifies the client’s requirements with respect to an unordered list of network nodes, links or resources on the nodes/links that are to be avoided by a given TE tunnel connection

• **Computed path** – a TE path over a TE topology describing a layer network/domain as computed (subject to all configured constraints and optimization criteria) for a given TE tunnel connection to take

• **Actual path** – a TE tunnel active connection’s path as provisioned in the layer network’s data plane in the form of a TE path over a TE topology describing the layer network/domain
Use Cases

• **Use Case 1.** Access link to access link TE tunnel control on a single layer multi-domain transport network

• **Use Case 2.** End-to-end TE tunnel control on a single layer multi-domain transport network

• **Use Case 3.** TE Tunnel control on a ODUk/Och multi-domain transport network with Ethernet access links

• **Use Case 4.** TE Tunnel control on a ODUk/Och multi-domain transport network with multi-function access links

• **Use Case 5.** Real time updates of IP/MPLS layer TE link attributes that depend on supporting transport TE tunnel (e.g. transport SRLGs, propagation delay, etc.)

• **Use Case 6.** Virtual Network Service support
Next steps

- Adding definitions and use cases involving transitional links
- Soliciting more feedback from WG
- Asking for WG adoption