

# TE Topology and Tunnel Modeling for Transport Networks

draft-bryskin-teas-te-topo-and-tunnel-modeling-00

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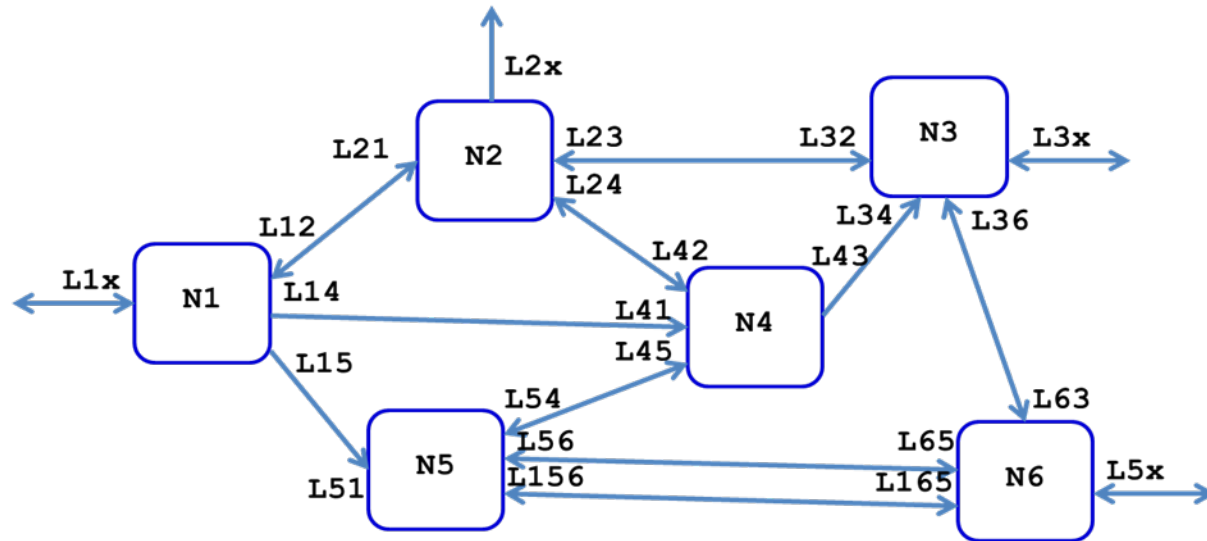
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# Includes:

- TE topology modeling constructs and attributes
- TE Tunnel modeling constructs and attributes
- Use cases explaining use of TE topology and tunnel models

# TE Topology Modeling

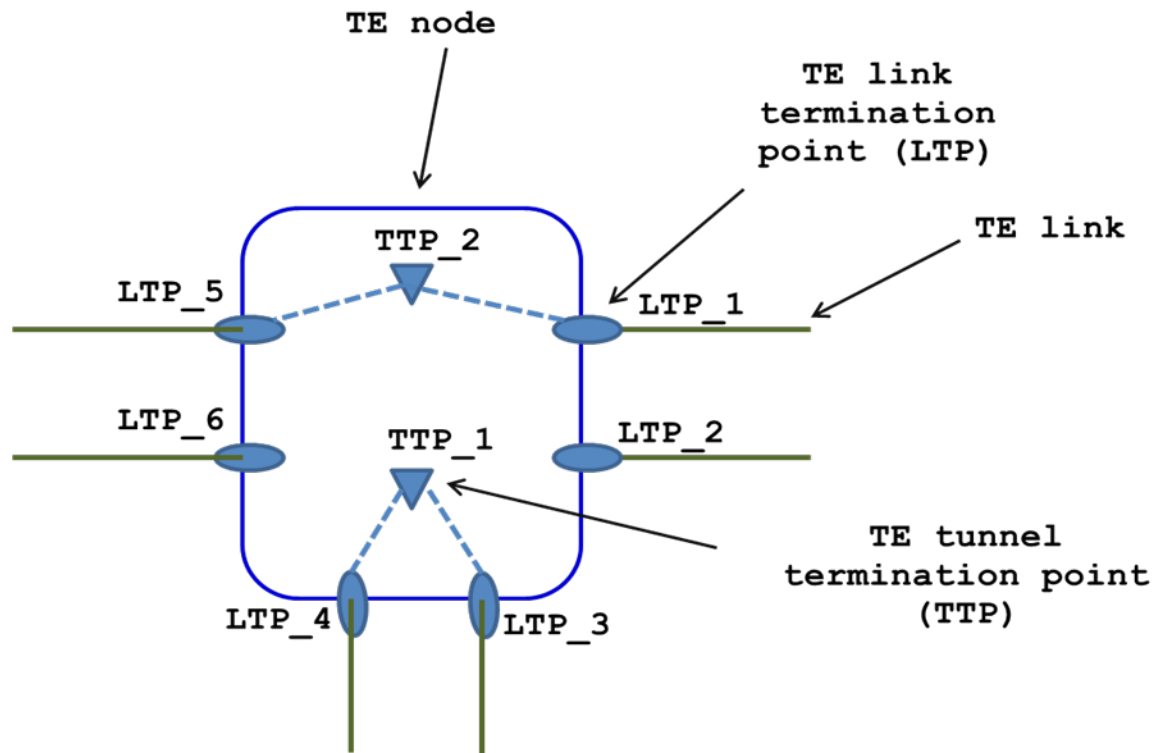


**TE topology** – traffic engineering representation of a network domain resources

# 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

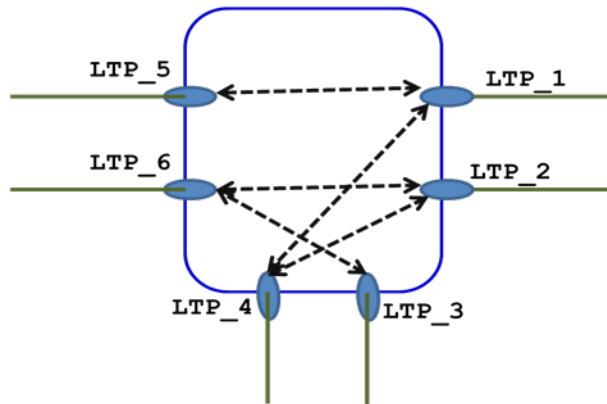
# TE Topology Elements



# 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
...
```

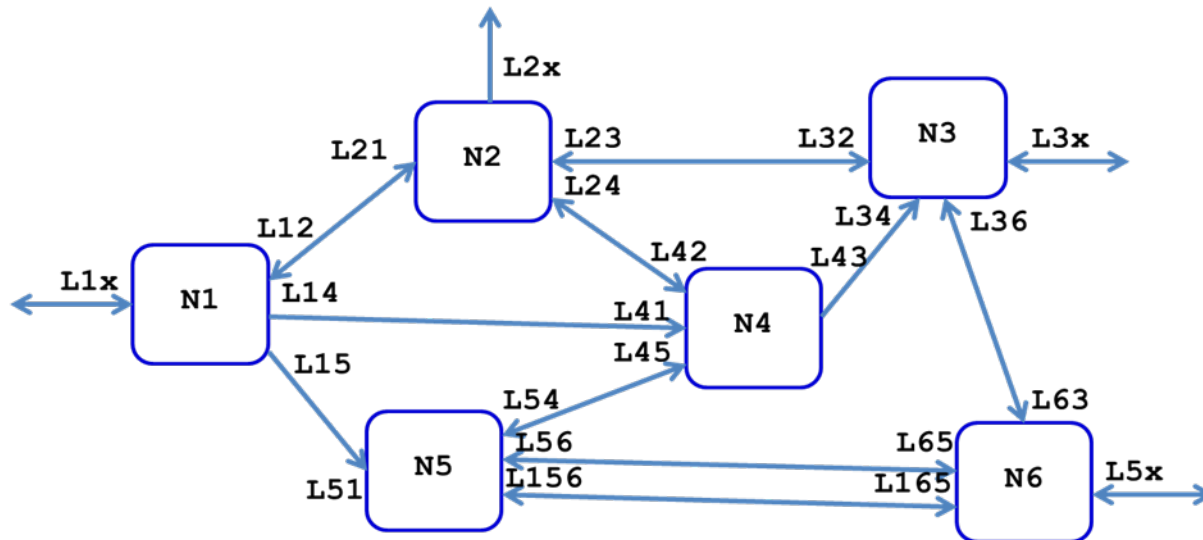


TE node detailed connectivity matrix:

```
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

# TE Link



- 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



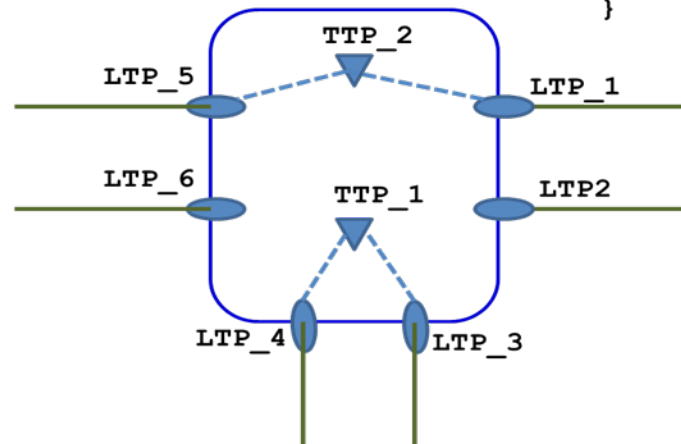
- TE links are uni-directional
- Bi-directional TE link group is a pair of parallel oppositely directed TE links connected to TE nodes over common TE link termination points



# TE Tunnel Termination Point

TTP\_2 Basic LLCL:  
TTP\_2  $\Leftrightarrow$  {LTP\_5/label\_x,  
LTP\_1/label\_y}

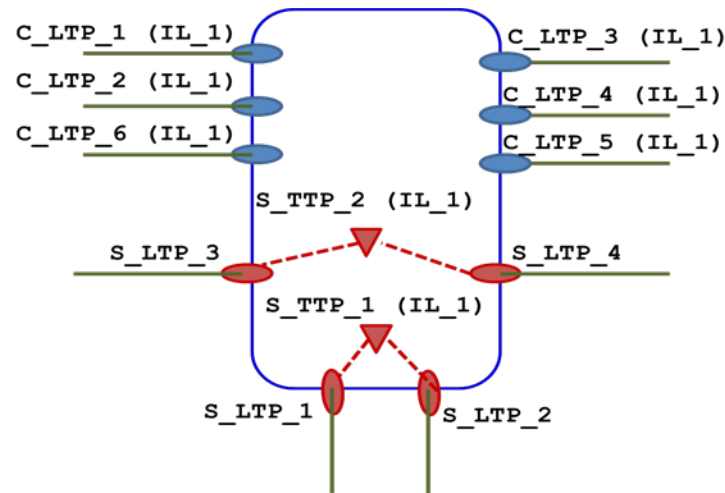
TTP\_2 Detailed LLCL:  
TTP\_2  $\Leftrightarrow$  {  
LTP\_5/label\_x,  
(Cost c, Delay d,  
SRLGs s, ...),  
LTP\_1/label\_y,  
(Cost c, delay d,  
SRLGs s, ...)  
}



Describes a TE node's tunnel termination and general client-server layer adaptation capabilities

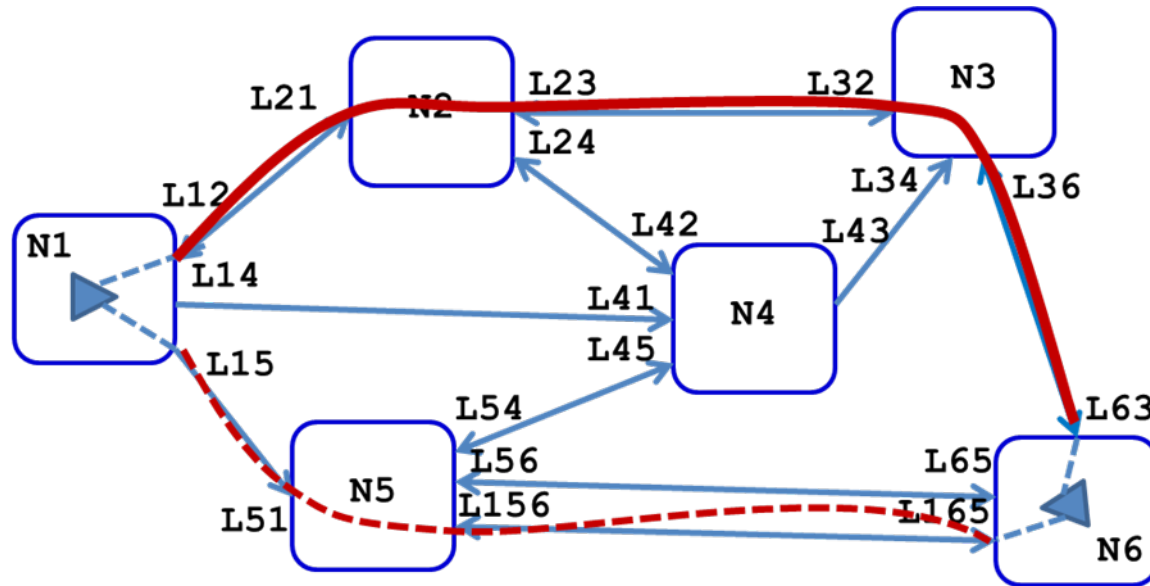
# Inter-layer Locks

TE inter-layer lock IL\_1  
Associates 6 client  
layer LTPs with 2 server  
layer TTPs to model  
capability of each of  
the two S\_TTPs to adopt  
data coming of any of  
the 6 C\_LTPs



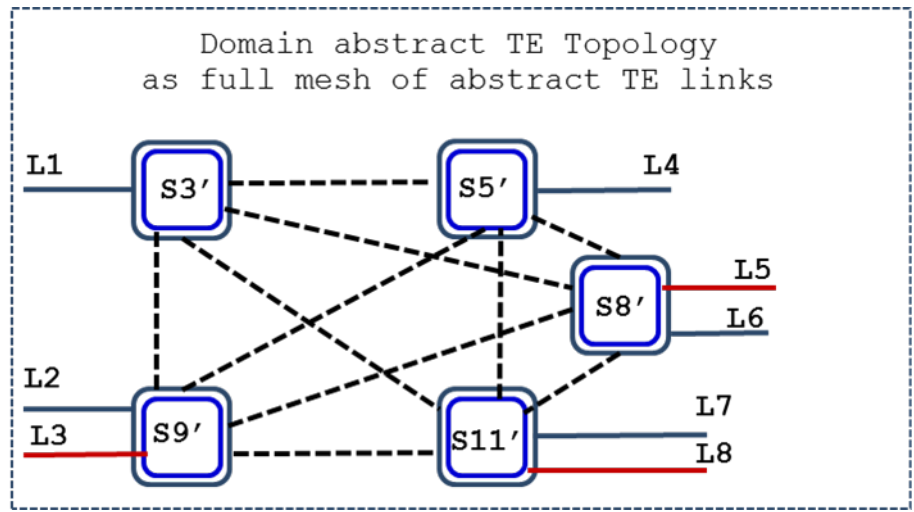
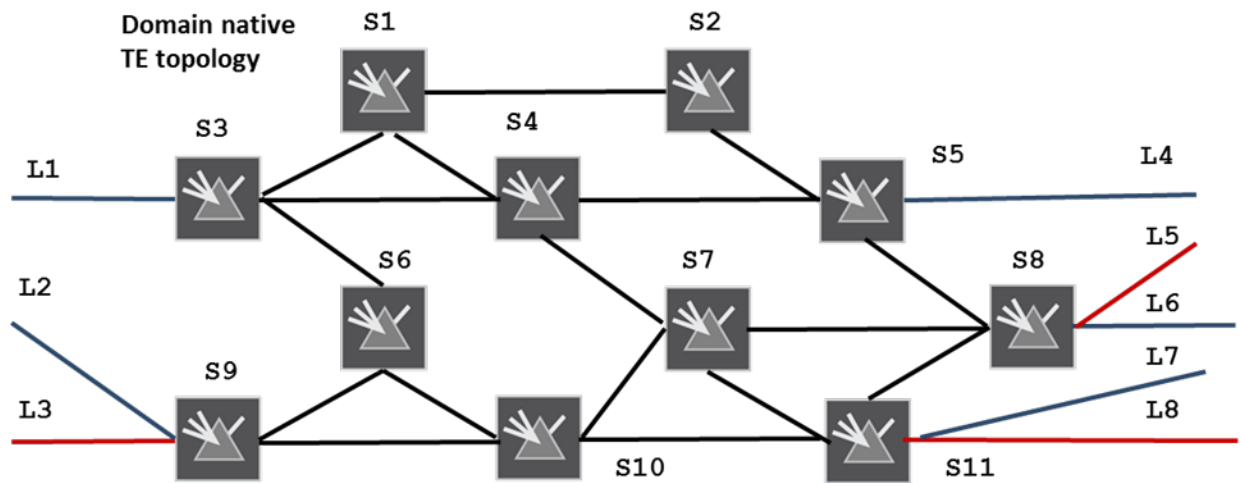
Describes a TE node's detailed client-server layer adaptation capabilities

# TE Path

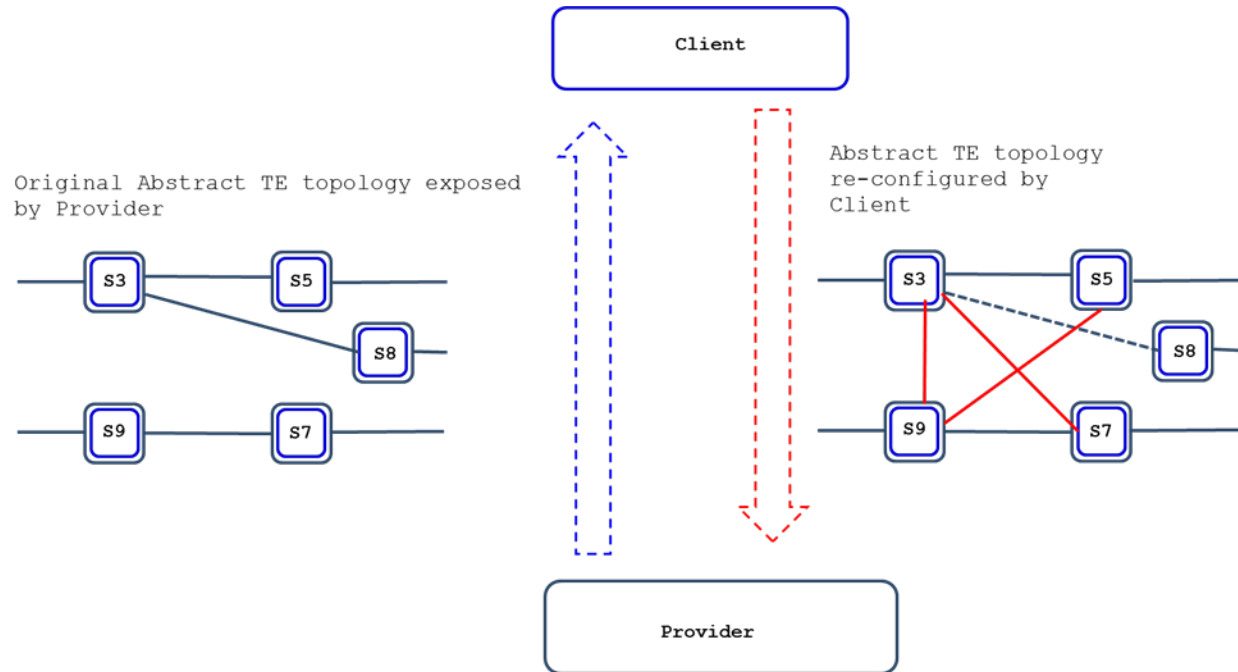


- **TE path** - an ordered list of TE node/link IDs (each possibly augmented with labels) that interconnects over a TE topology a pair of TTPs and could be used by an e2e connection

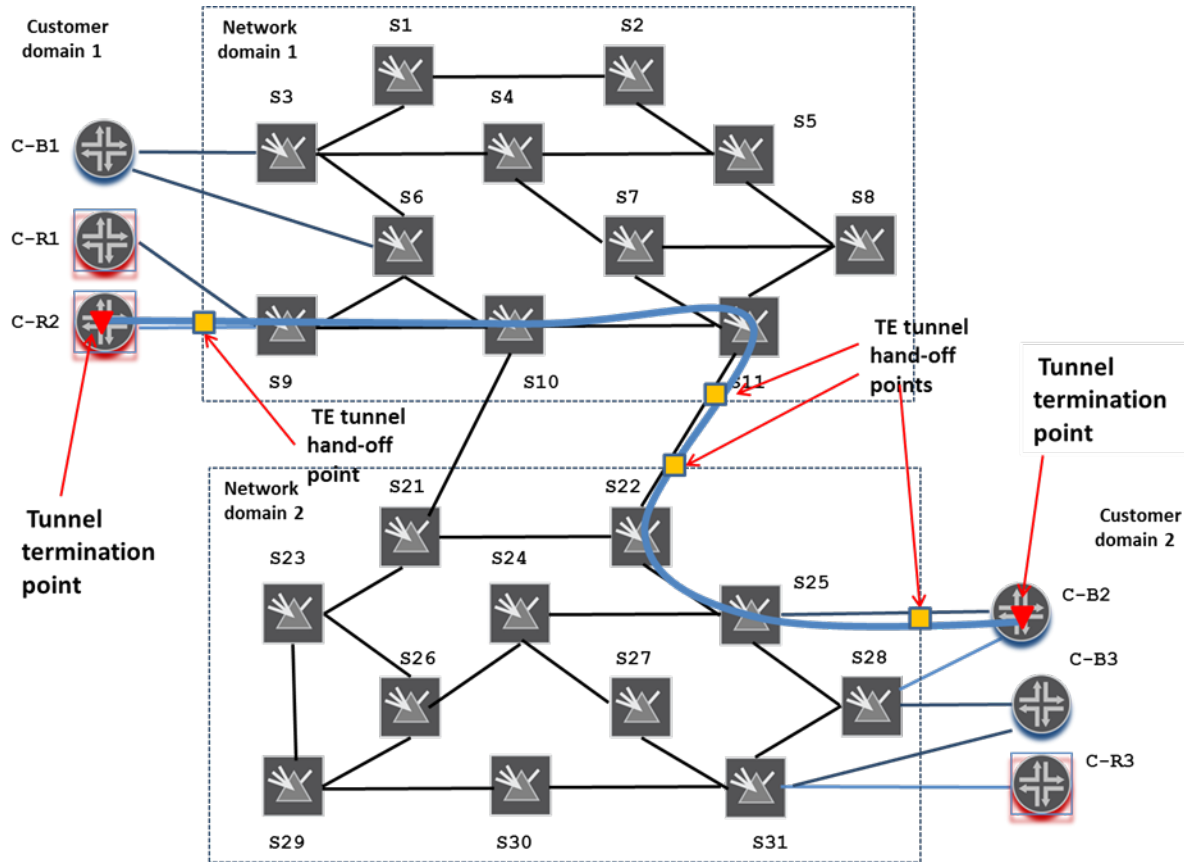
# TE Topology Types: native/abstract, underlay/overlay



# TE Topology Negotiation, Customization, (Re-)configuration



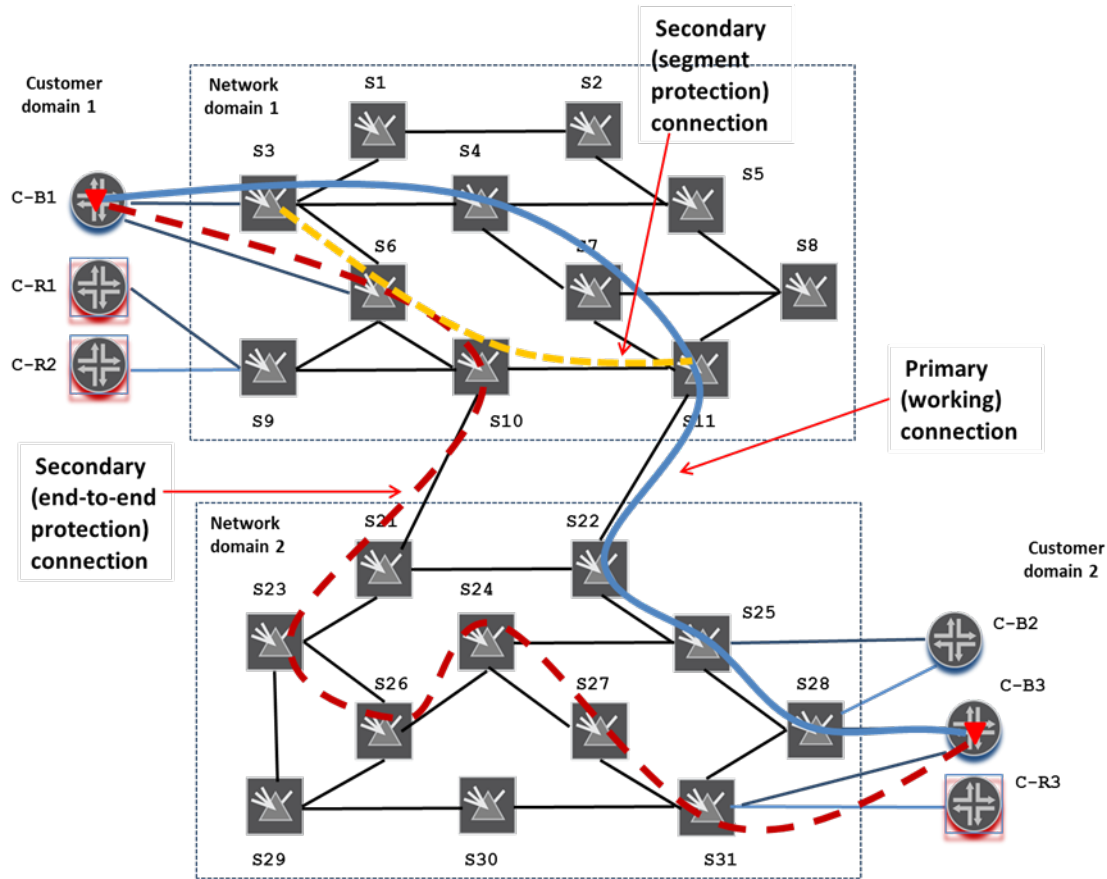
# TE Tunnel Modeling



# 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 feedback from WG