TE Topology Applicability to Digital Map

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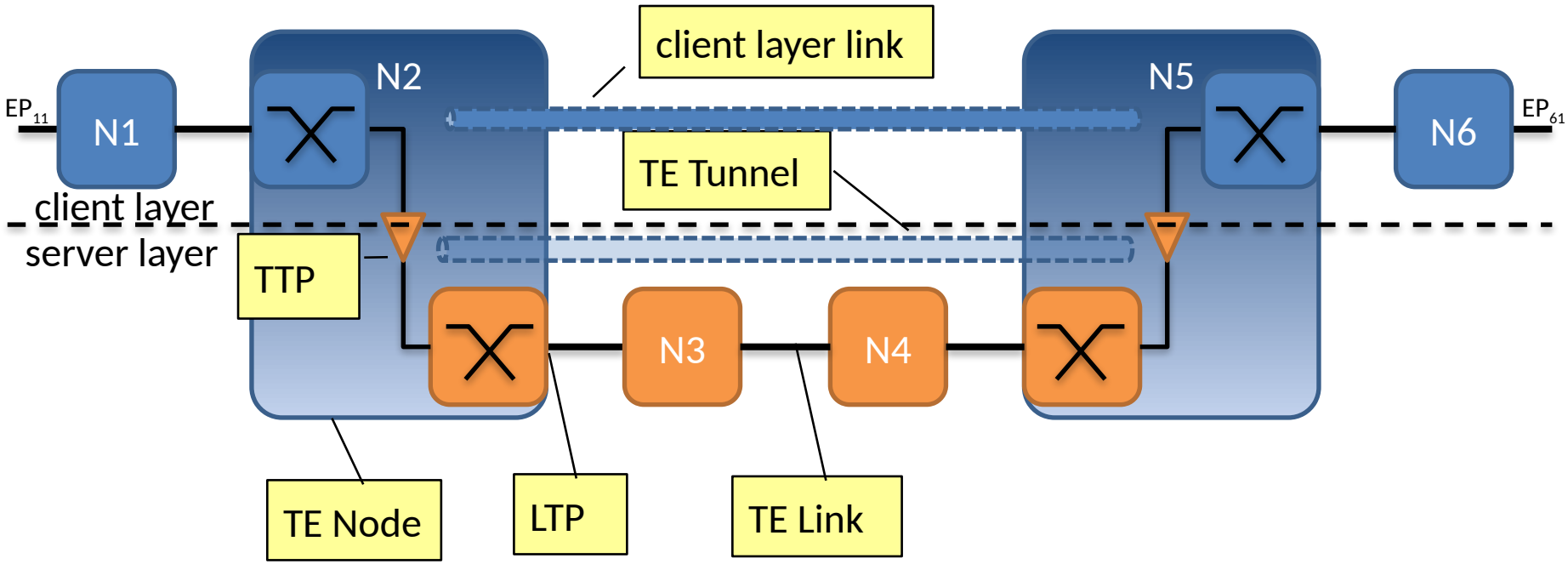
TE Topology – Overview

- Yang Data Model for representing, retrieving and manipulating TE Topologies:
  - Technology agnostic TE Topology building blocks
    - Generic Node/Link attributes
    - Can be augmented and used by other technology specific TE Topology Models
    - Information Sources
  - Features
    - Native and customized TE topologies
      - Model facilitates the notion of “TE Topology as a Service”
    - Abstract TE Topologies
    - Overlay and underlay relationship for nodes and links
      - Allows Hierarchical TE Topology views
    - Topology inter-layer modeling
    - Topology inter-domain modeling

Building Blocks

- Generic TE Topology Attributes
  - Optimization options
- Generic TE Link Attributes
  - Bandwidth, Admin groups, SRLGs, Switching Capabilities, TE metric extensions etc.
- Generic TE Node Attributes
  - Generic Connectivity Matrix, with optional label restrictions
- Information Sources
  - Each TE topological element can have multiple TE information sources (OSPF-TE, ISIS-TE, BGP-LS, User-Configured, Other)
  - Each information source is associated with a credibility preference.

Multi-layer Support



Abstraction

Network Facing Line Card

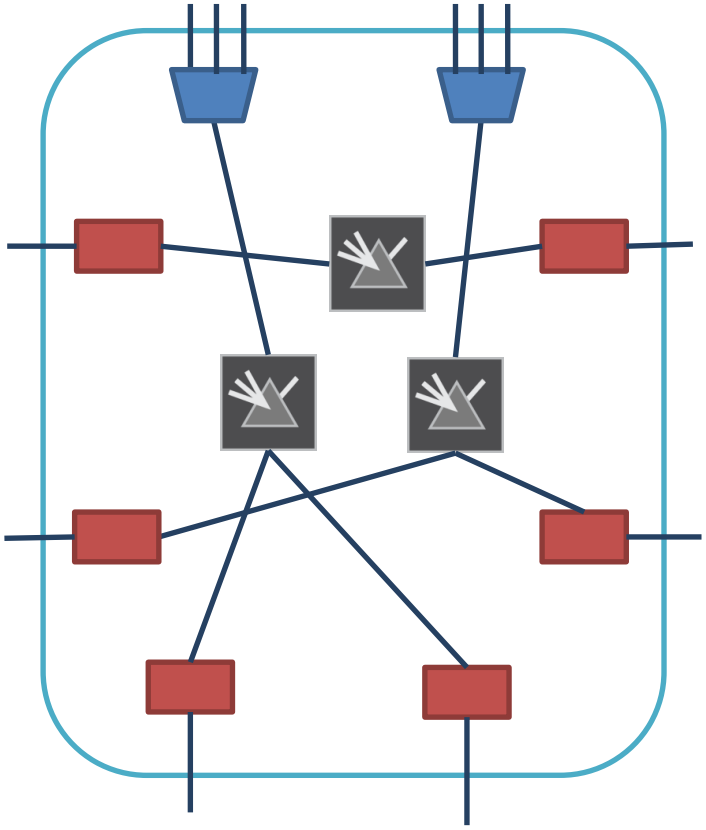
Termination Device with Client Ports

Blocking Switching component

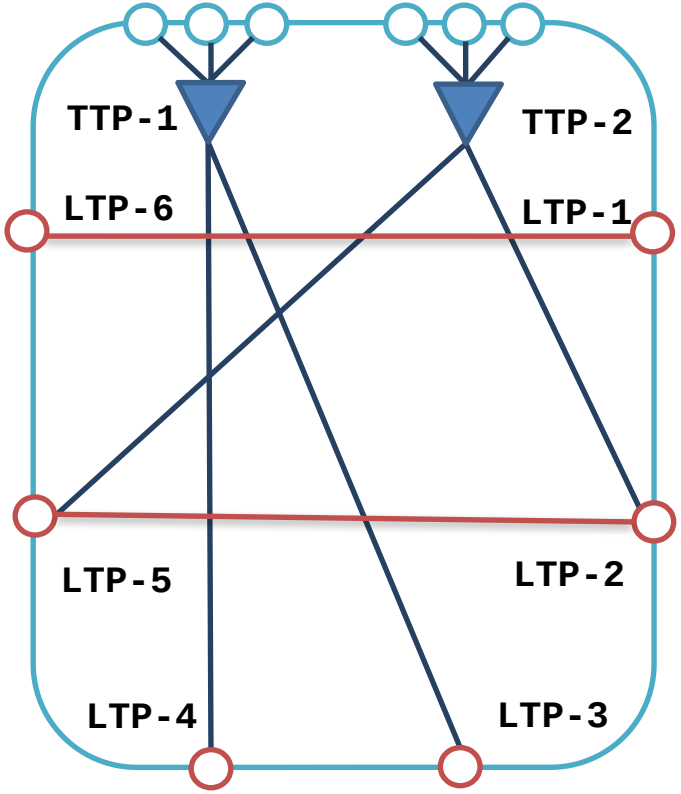
Tunnel Termination Point (TTP)

Server Link Termination Point (S-LTP)

Client Link Termination Point (C-LTP)

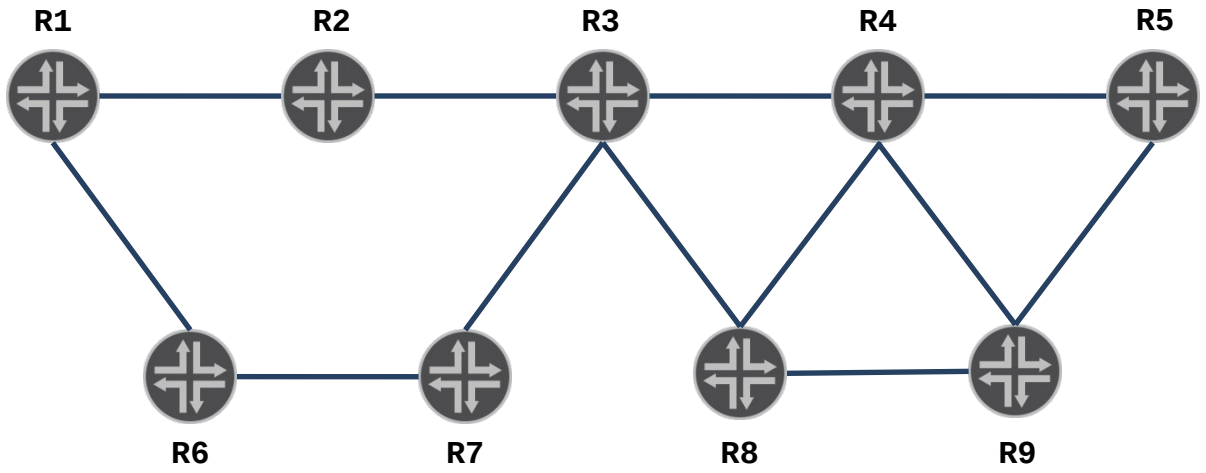


Abstraction

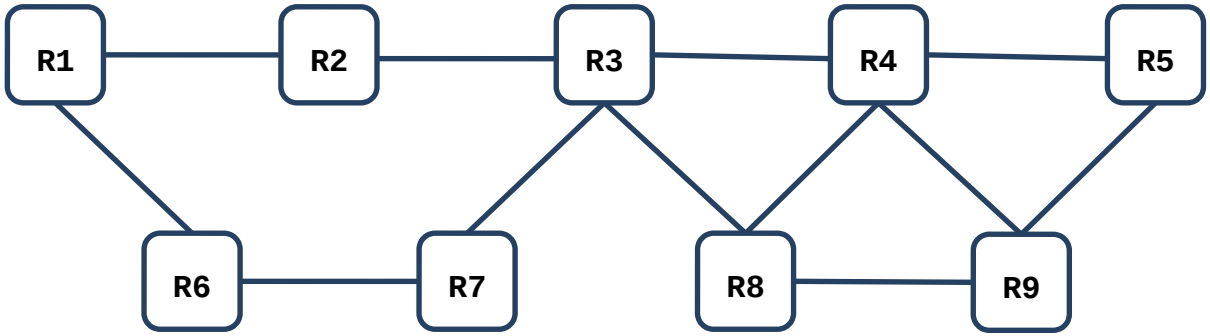


Native Topologies

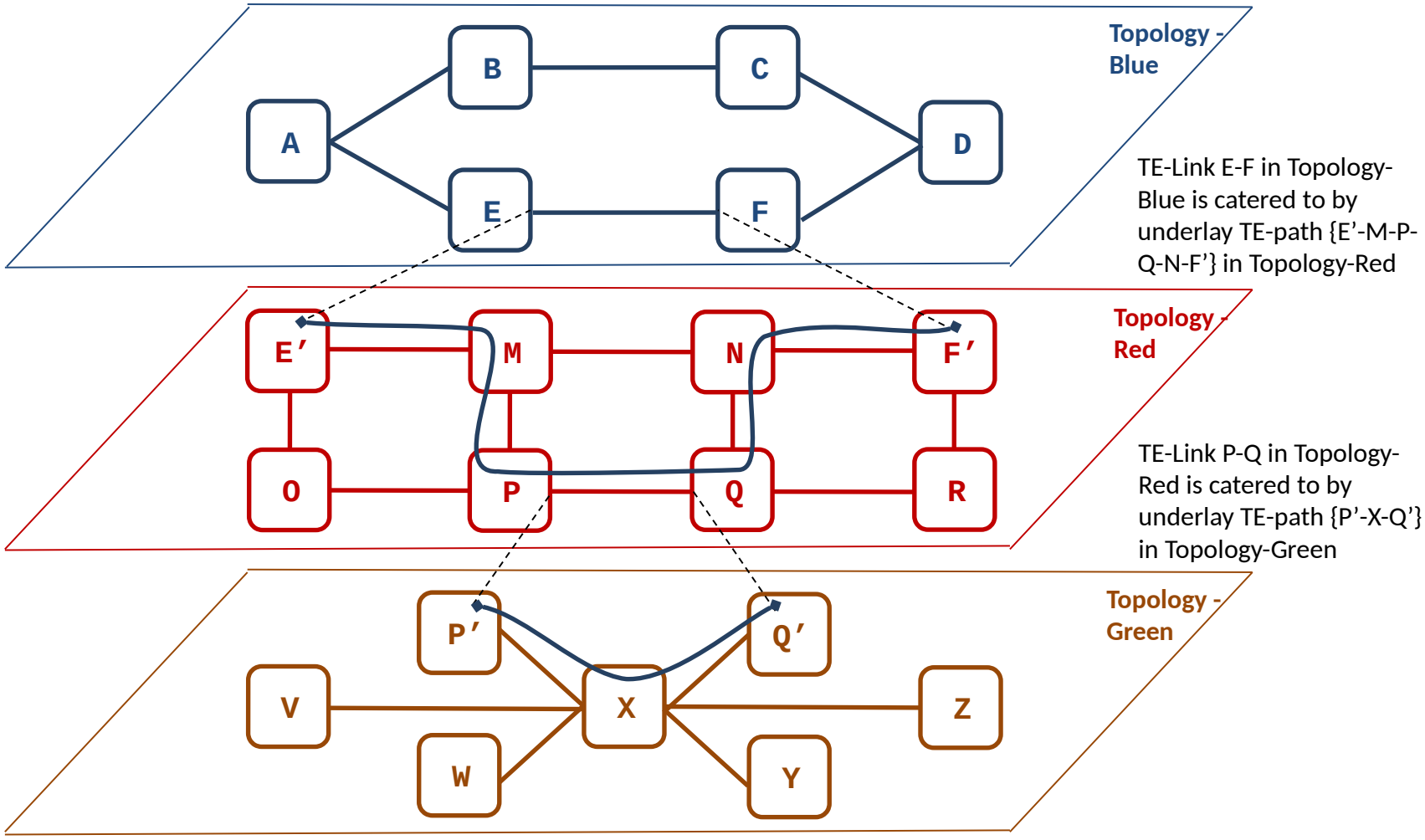
Network Topology



Native TE Topology (constructed using all nodes and links present in the given TED)

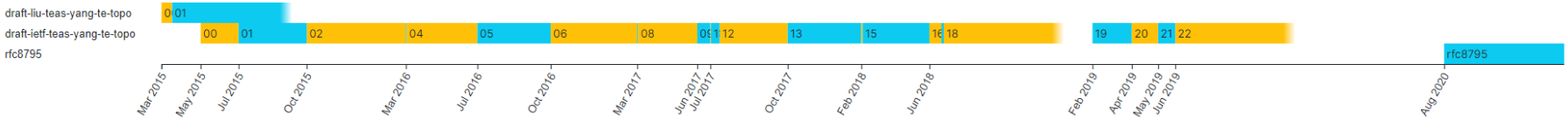


Hierarchical TE Topologies



History of RFC8795

- It has been a 5 years effort
  - Required careful analysis of requirements for both transport networks and IP networks and analysis for device and network models



- A significant number of models which augment RFC8345 are also augmenting RFC8795 and will be impacted by any change/augmentation of RFC8345 which is not compatible with RFC8795
- A detailed review of the Digital Map Analysis is still on-going
  - See: https://github.com/ietf-wg-nmop/Misc/issues/1
  - A rough estimation is that around 50% of the topology modules which augment RFC8345 are also augmenting RFC8795

Applicability to Digital Map

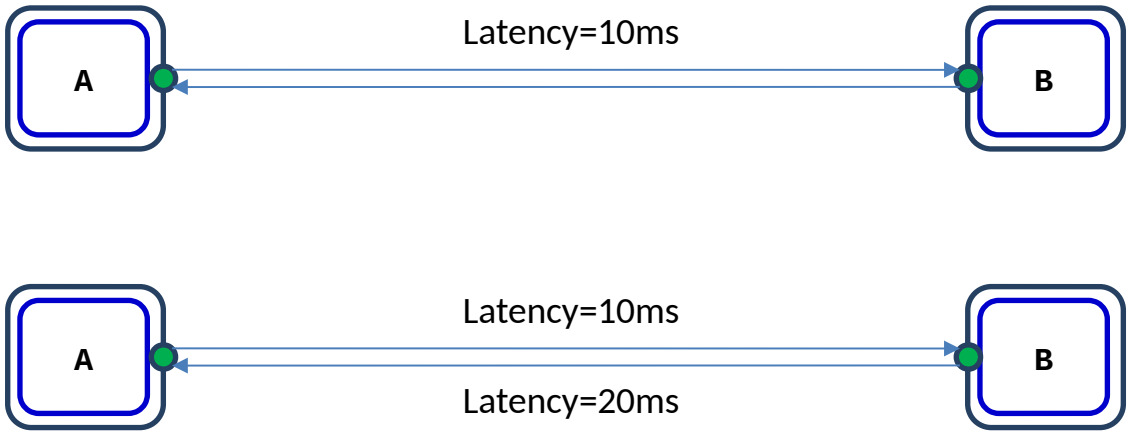
- Digital map provides the core multi-layer topology model
  - Multi-layer includes TE (e.g., WDM, OTN, MPLS-TE) and non-TE (e.g., Ethernet, IP) layers
  - TE and non-TE layers can also be interleaved in complex multi-layer networks
- Some TE attributes (e.g., SRLG, bandwidth, latency) can also be required for non-TE layers to support some Digital Map requirements such as what-if-analysis

Summary of identified RFC8345 Gaps

- Bidirectional Links
- Multi-point Connectivity
- Links between domains/networks
- Network decomposition into sub-networks
- Nodes, links and TPs belonging to different networks
- Supporting relationships
- Network topology semantic information

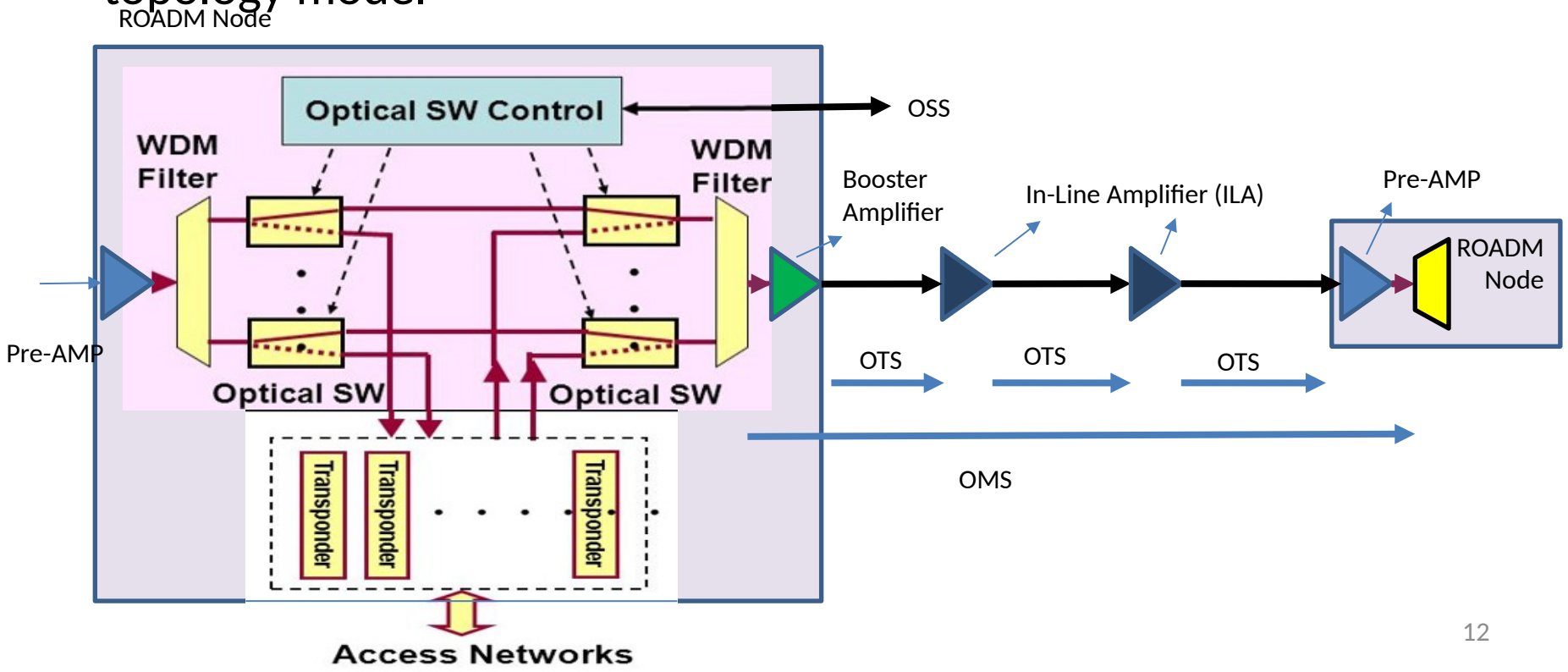
Bidirectional Links

- Modelled as two Links between the same TPs
  - See section 4.4.5 of RFC 8345
  - TE properties specified for each Link
    - Includes also information about underlay paths, SRLG, bandwidth and latency
    - Can be symmetrical or asymmetrical
      - Symmetrical properties can be specified only on one of the two Links



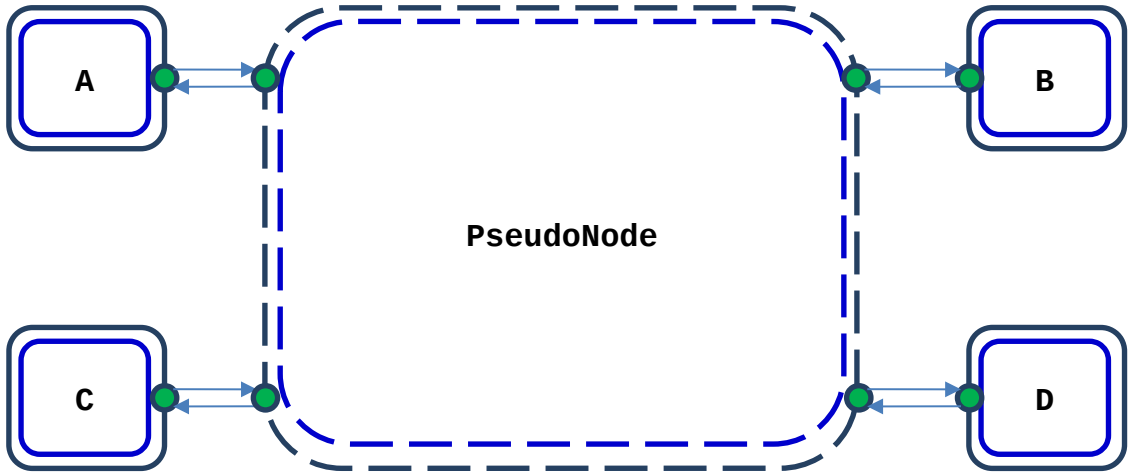
OMS Link Example

- OMS Links are bidirectional but
  - Optical impairments and OMS elements different in each direction
- RFC8345/RFC8795 approach is a perfect fit for optical impairments topology model

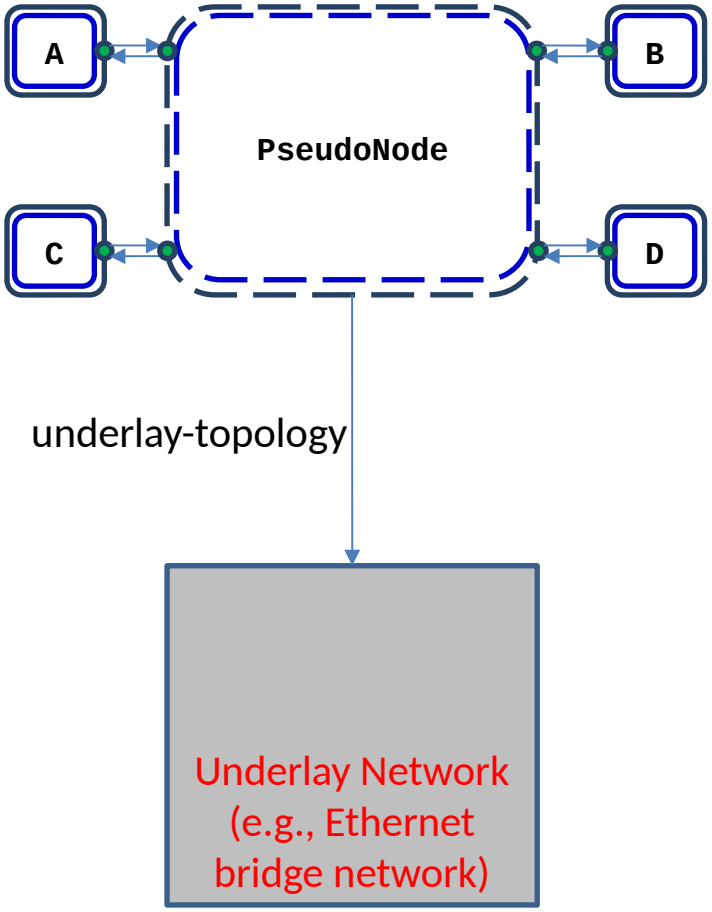


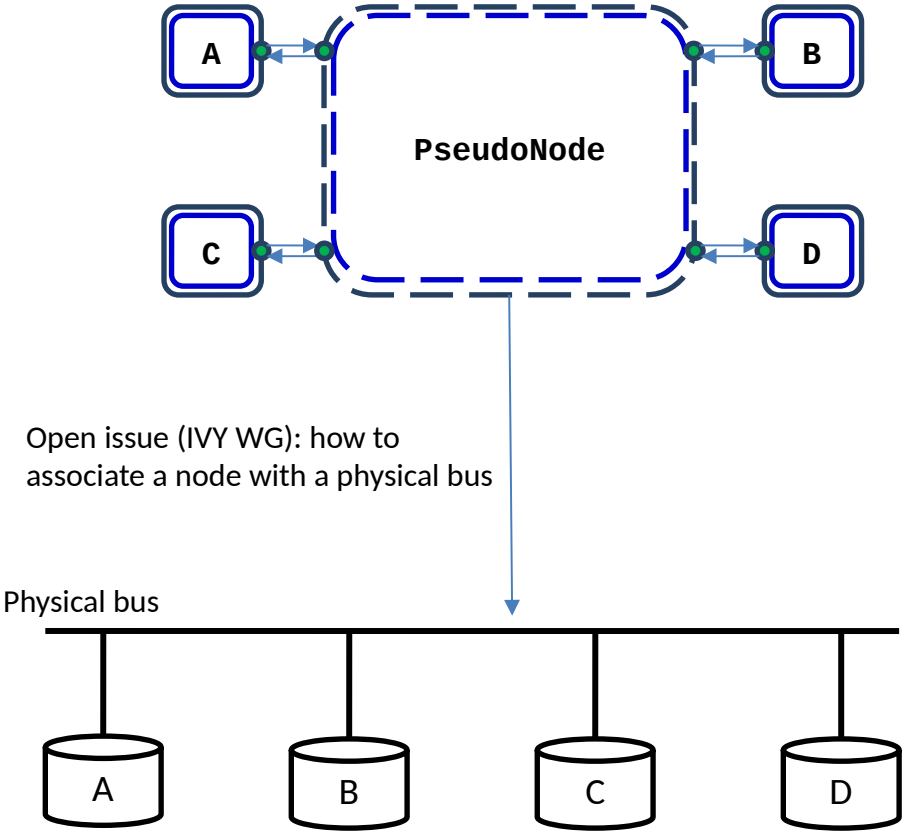
Multipoint Connectivity

- Modelled as a pseudonode
  - See section 4.4.5 of RFC 8345
  - TE properties specified using Connectivity Matrix
    - Common TE properties specified using a Default Connectivity Matrix to avoid the n^2 scalability issue
    - Differences can be specified for each source/destination TP pair



Underlay for multipoint connectivity

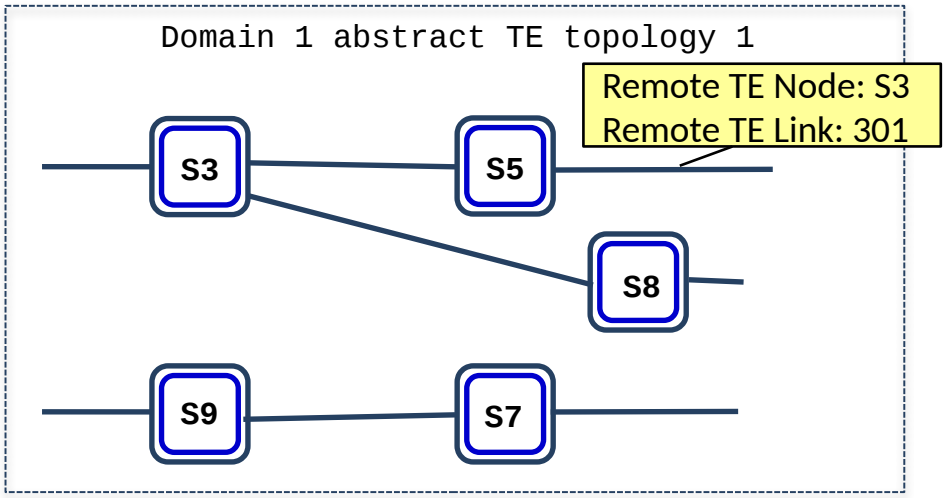


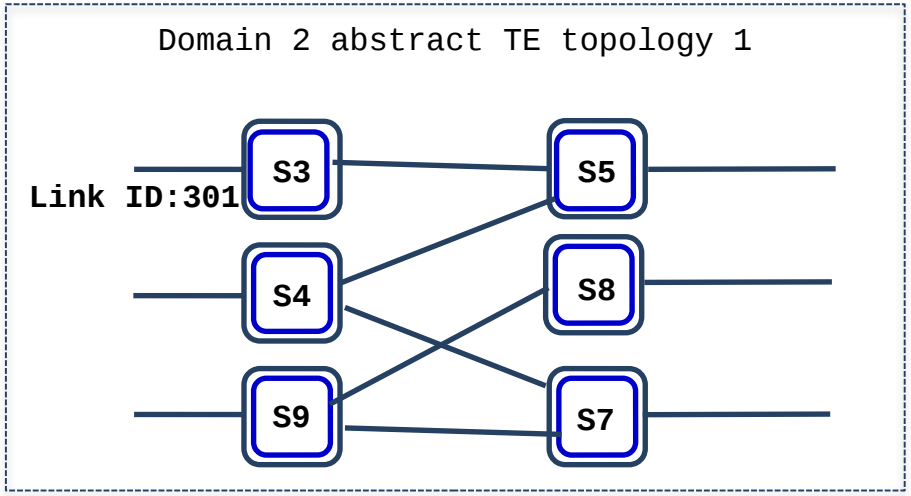


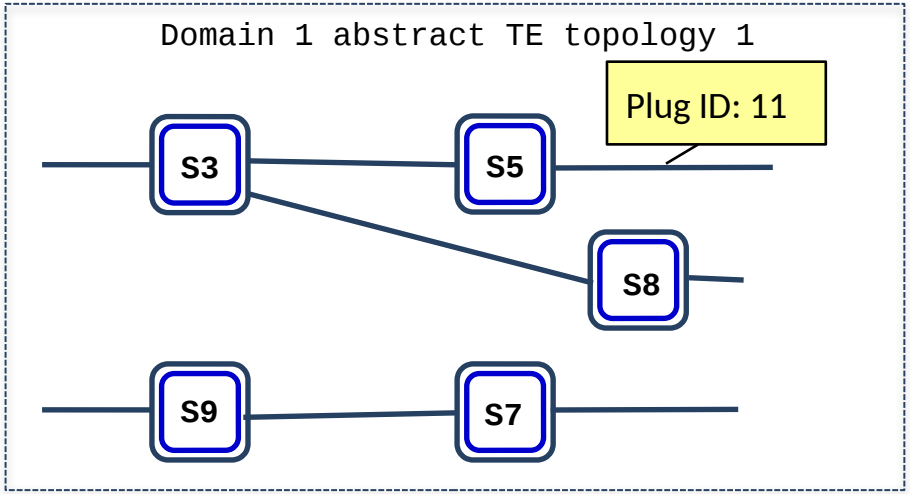
Open Issues for pseudo-node

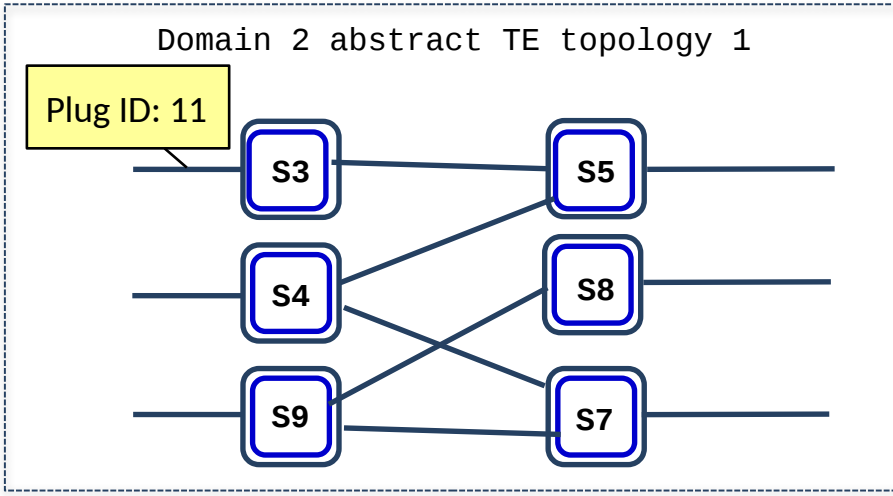
- The pseudo-node solution requires 2x data
  - Is O(2*n) instead of O(n) a scalability concern?
  - Note that encoding of text-based protocols (such as NETCONF and RESTCONF) 10x higher that the encoding of binary protocols
  - A possible work-around could be to define pseudo-TPs in the pseudo-node referencing the TPs on the attached nodes
    - Reporting the links between the pseudo-node and the attached nodes can still be required for backward-compatibility but can be avoided when BC is not required
- Improving the connectivity matrix definition (RFC8795-bis) to support different groups of common attributes
  - Option 1: instantiate multiple pseudo-nodes
  - Option 2: define a group of connectivity matrices
  - Option 3: define a group of TPs
- Note: enhancements to connectivity matrix definition are valuable for any type of node and not only for pseudo-nodes (complex link)

Links between domains/networks









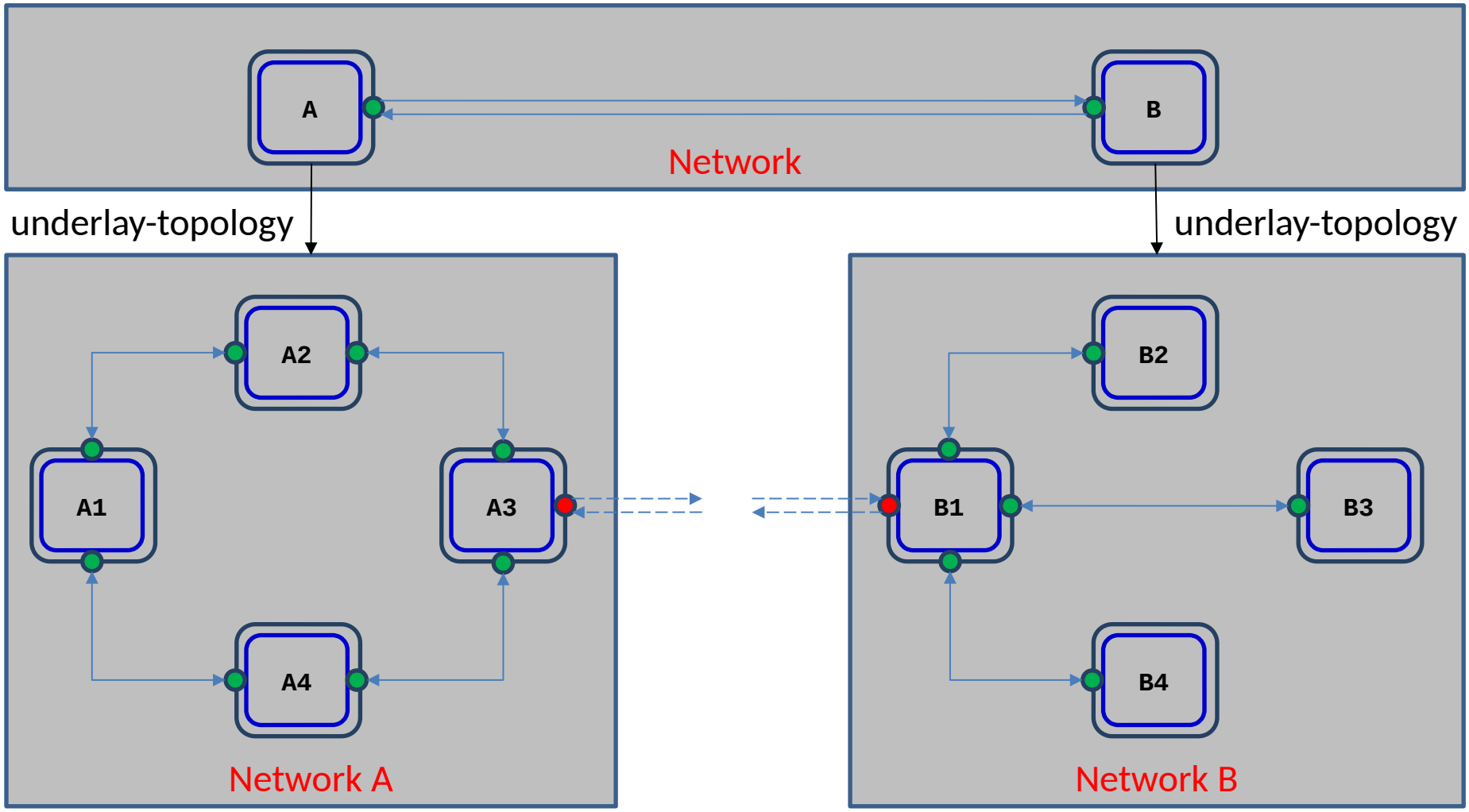
Links between domains/networks

- See section 4.3 of RFC 8795
- Use of remote node-id/tp-id has some drawbacks
- The value of the inter-domain-plug-id can be
  - assigned and managed by a central network authority
  - dynamically auto-discovered using automatic discovery protocol such as LMP and LLDP
- Reporting the open-ended Links is optional

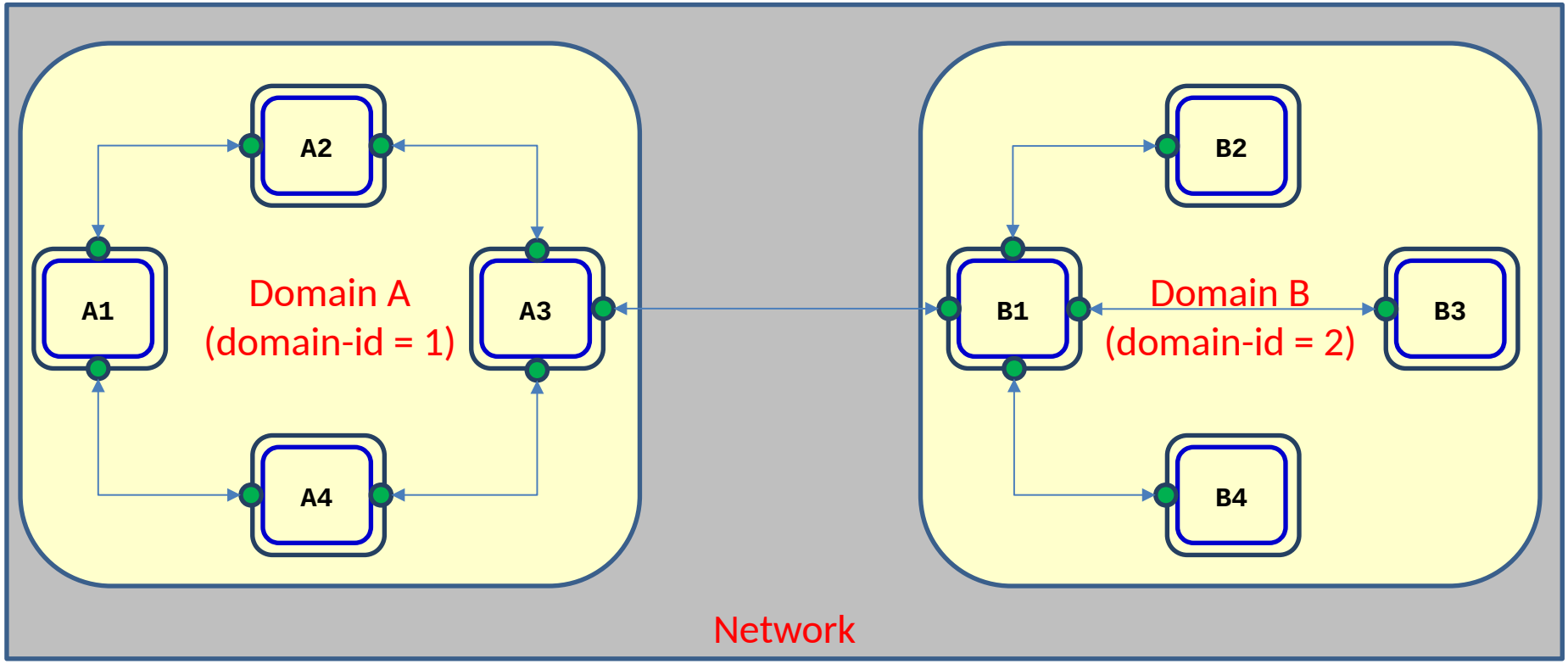
Network decomposition

- Requirements clarification is needed
  - How many domain hierarchical level are needed? 2 or more?
    - OSPF has only two hierarchical levels (AS and area)
  - Single or multiple domain hierarchy?
    - AS/IGP area domains
    - Administrative domains
    - SDN control domains
- Some solutions already exits
  - Use multi-topology hierarchy (recursive)
  - Use the domain-id attribute (only 2 levels)

Multi-topology Hierarchy



Domain Identifiers

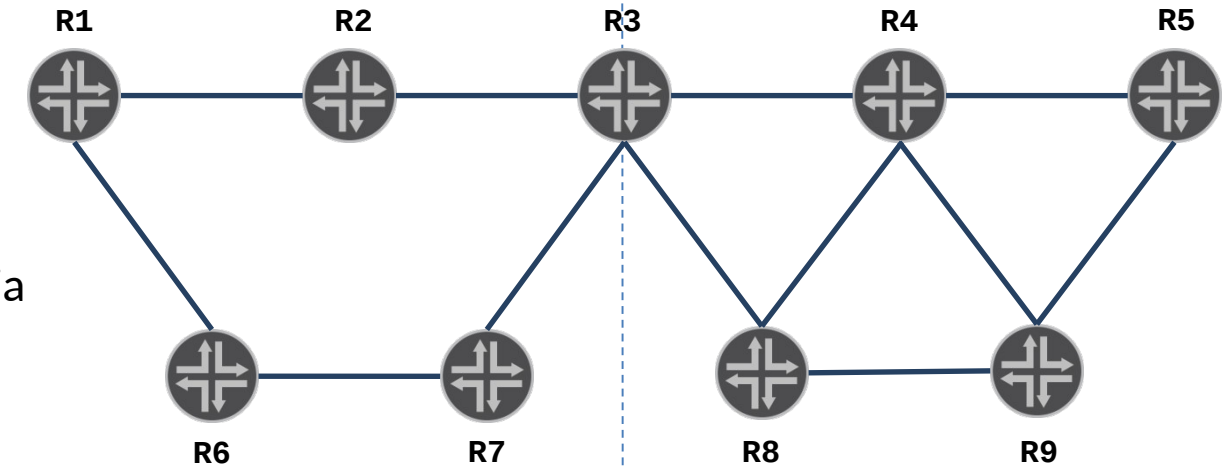


Nodes/Links/TPs in multiple networks

- Need to better understand the requirement
- RFC8345: a node/link/TP in one network instance can reference a node/link/TP on another network instance (supporting association) and inherits the properties from the supporting node/link/TP
  - Physically they are the same entity but, from a topology perspective, they are different nodes/links/TPs
- RFC8795: reports for each node/link/TP the information source and multiple information sources can be associated to the same topological element

Nodes in multiple networks

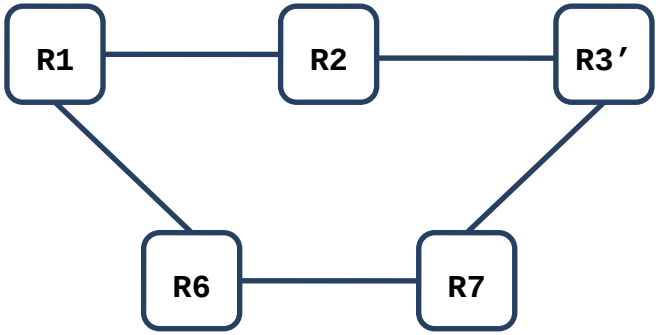
Network Topology



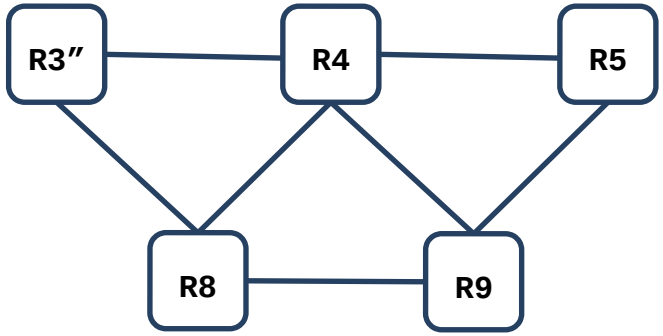
TE Info distributed via ISIS-TE

TE Info distributed via OSPF-TE

Native TE Topology 1 (as seen on R3) Info-Source: ISIS-TE



Native TE Topology 2 (as seen on R3) Info-Source: OSPF-TE

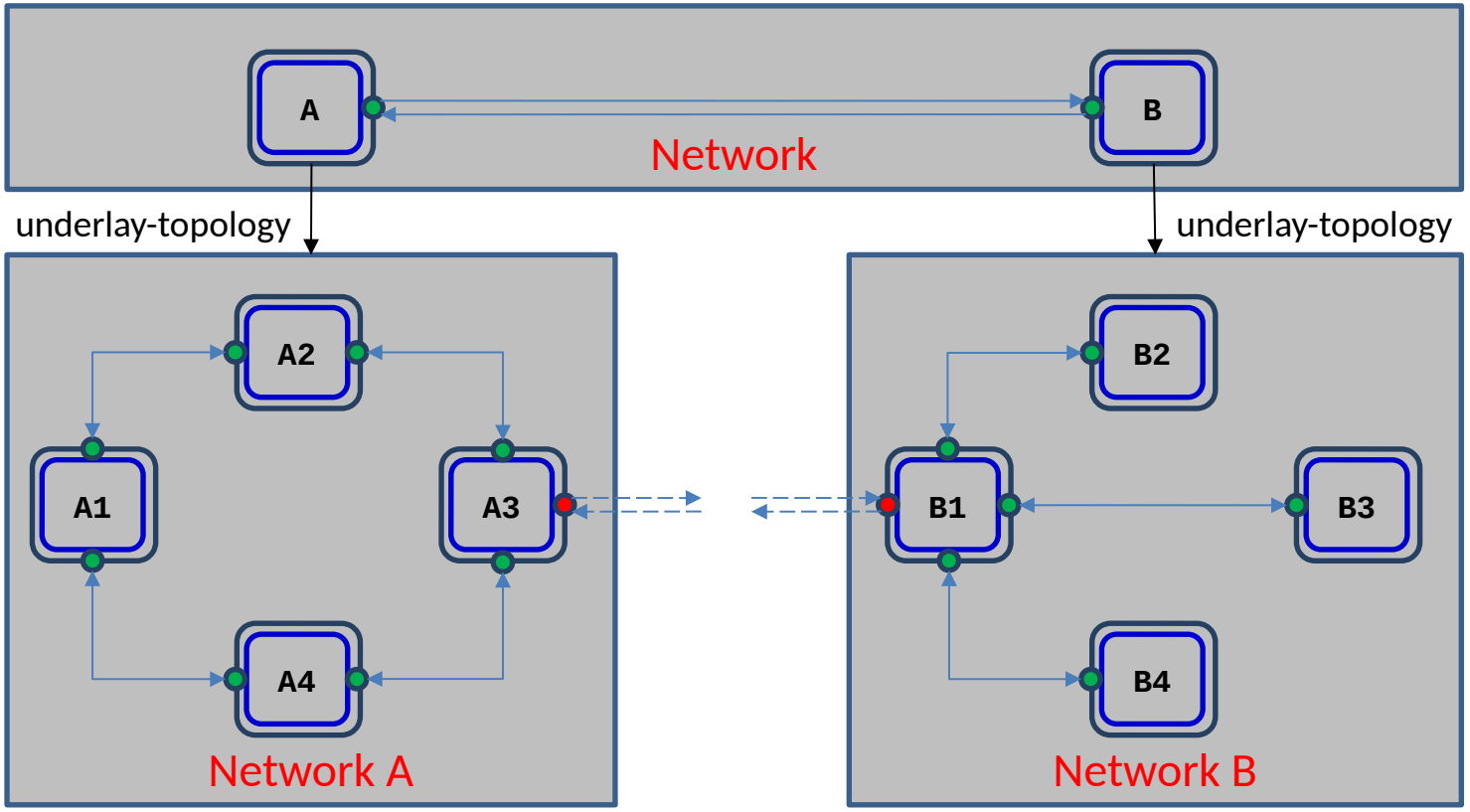


TP supported by Node

- Need to better understand the requirement
  - Discussion on-going on the mailing list
  - Need to investigate more in details the Use Case maybe something a TP should be used

Node supported by Network

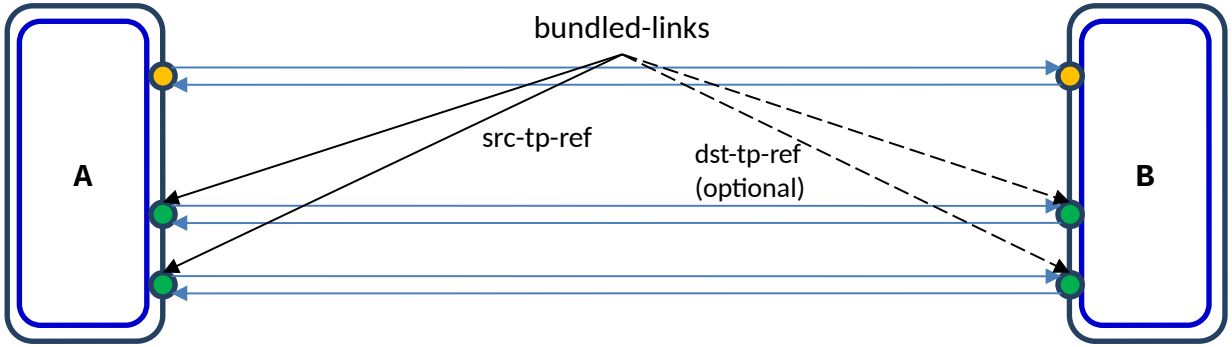
- Supported using the underlay-topology attribute



See also *previous slide (Multi-topology hierarchy)*

Link Aggregation/Bundling

- Link aggregation/bundling semantics supported using Link Bundling
  - Technology-specific augmentations can provide additional technology-specific aggregation/bundling technologies (such as in case of LAG)



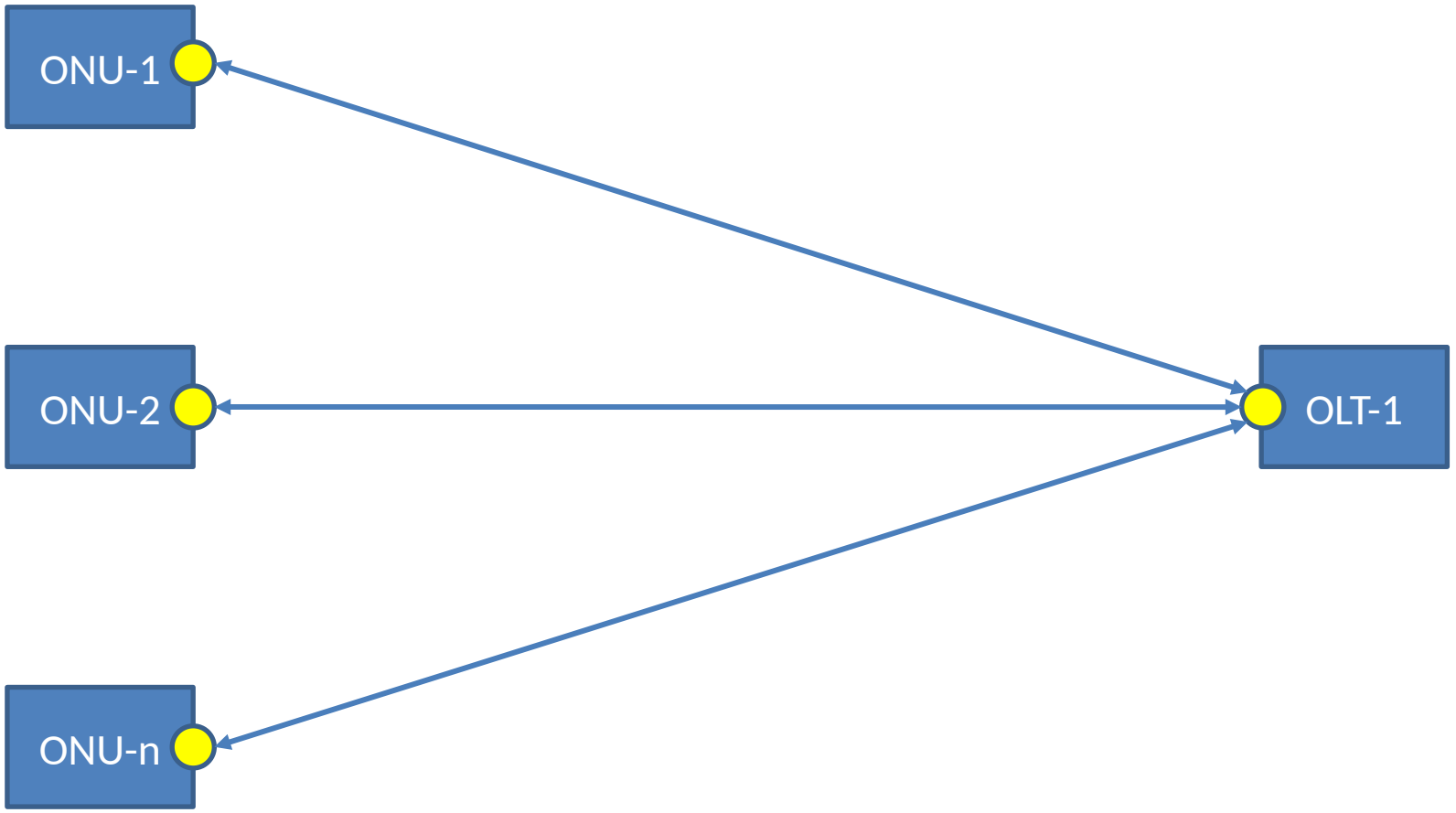
Undelay primary/backup

- Undelay with primary/backup supported by the underlay primary/secondary paths
  - See section 5.8 of RFC8795
  - The undelay paths includes hop sequence
  - Solutions to support underlay path with load balancing are under discussion
    - could be defined in a future update of RFC8795
  - Applies to links, connectivity matrix entries and local link connectivity entries

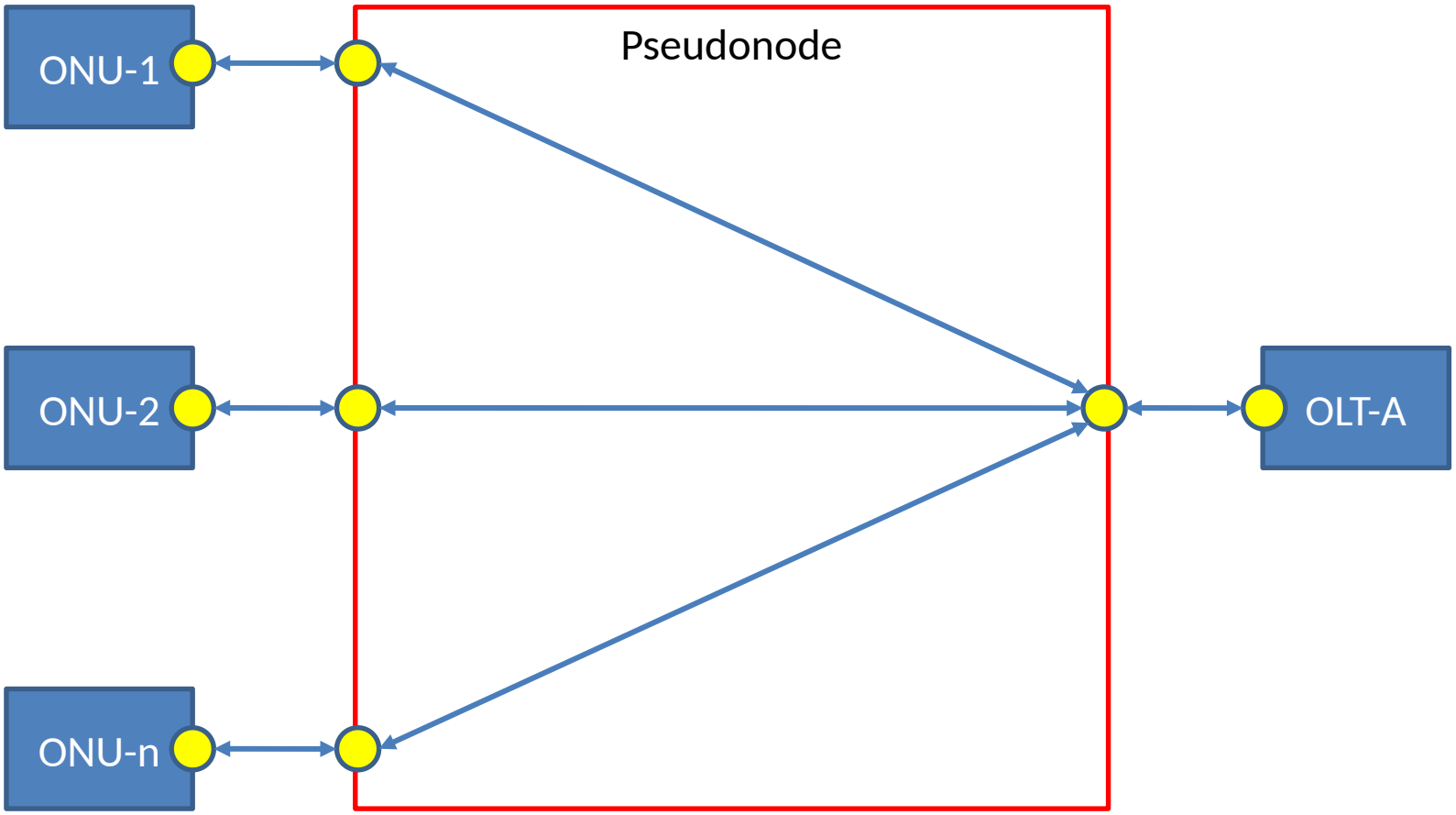
Hub&Spoke TP Roles

- Hub and spoke roles can be inferred from the Links configuration
  - More analysis is needed on the different options to manage the p2mp Links

P2MP Link – Option 1

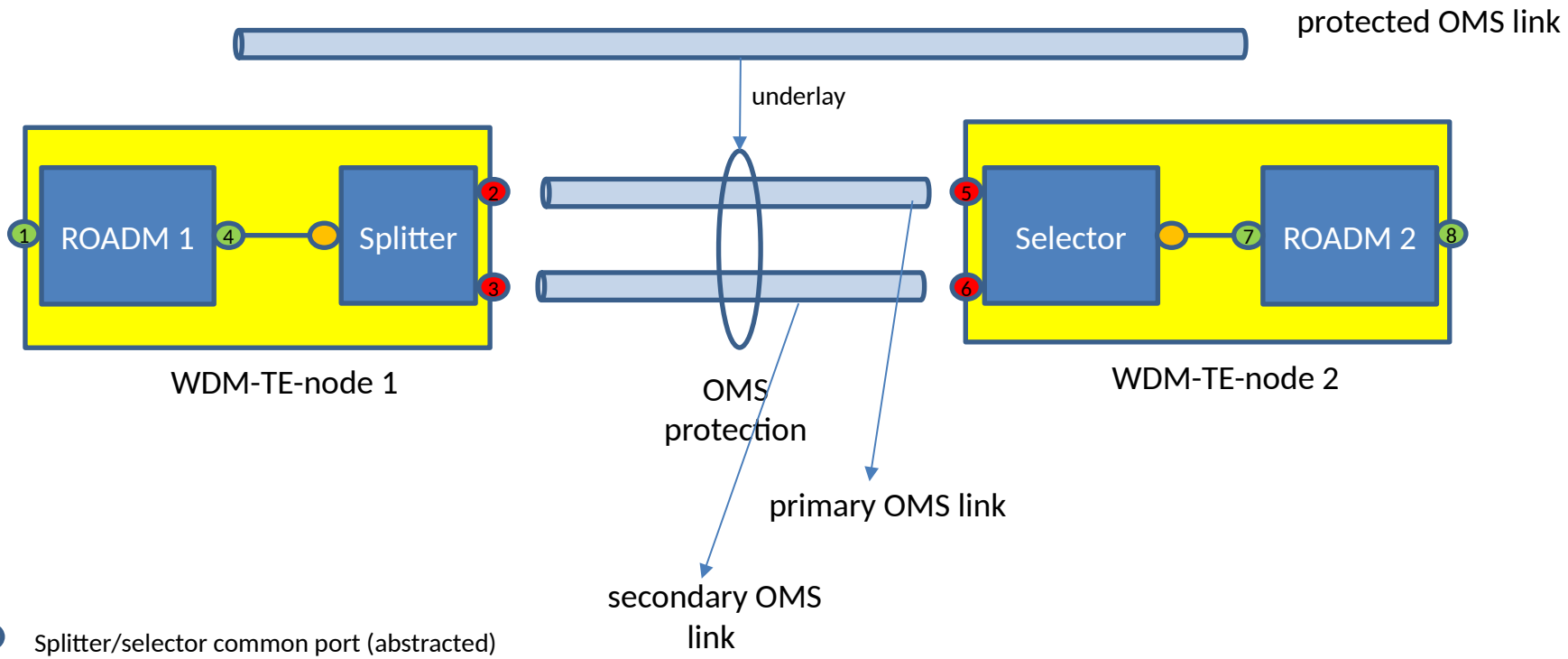


P2MP Link – Option 2



Primary/backup TP Roles

- Primary/backup TP roles can be inferred from the primary/secondary undelay paths



Conclusions

- Re-using RFC8795 for Digital Map allows smooth integration of TE and non-TE layers within the Digital Map
  - No need to discuss how to reconcile solutions based on RFC8795 and solutions based on the new RFC8345 augmentations
- TE Topology Model (RFC8795) already provides many of the augmentations to RFC8345 which are needed to address the requirements for Digital Map
  - RFC8795-bis or augmentations to RFC8795 can be considered to address gap or improvements
  - Need more discussion on the detailed gaps/enhancements design
- TE Topology Model can be profiled for non-TE applications
  - No need to implement the complete model when not needed
  - See draft-ietf-teas-te-topology-profiles for more details