TeraFlow SDN by ETSI

Int5Gent+ALLEGRO+SEASON Multi-layer slice controller architecture

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Telefónica I+D

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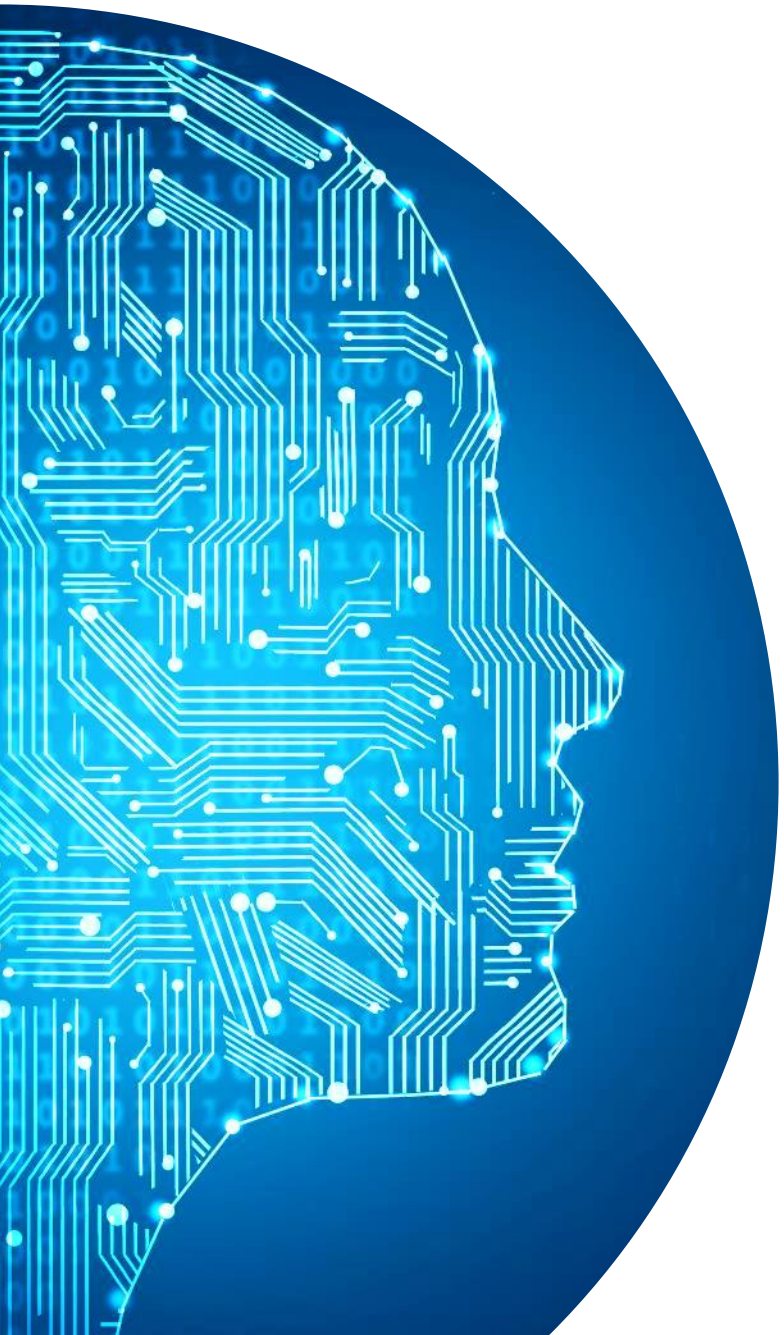


Agenda

- General Architecture
- Main modules
- Request proccess
- Functional Architecture

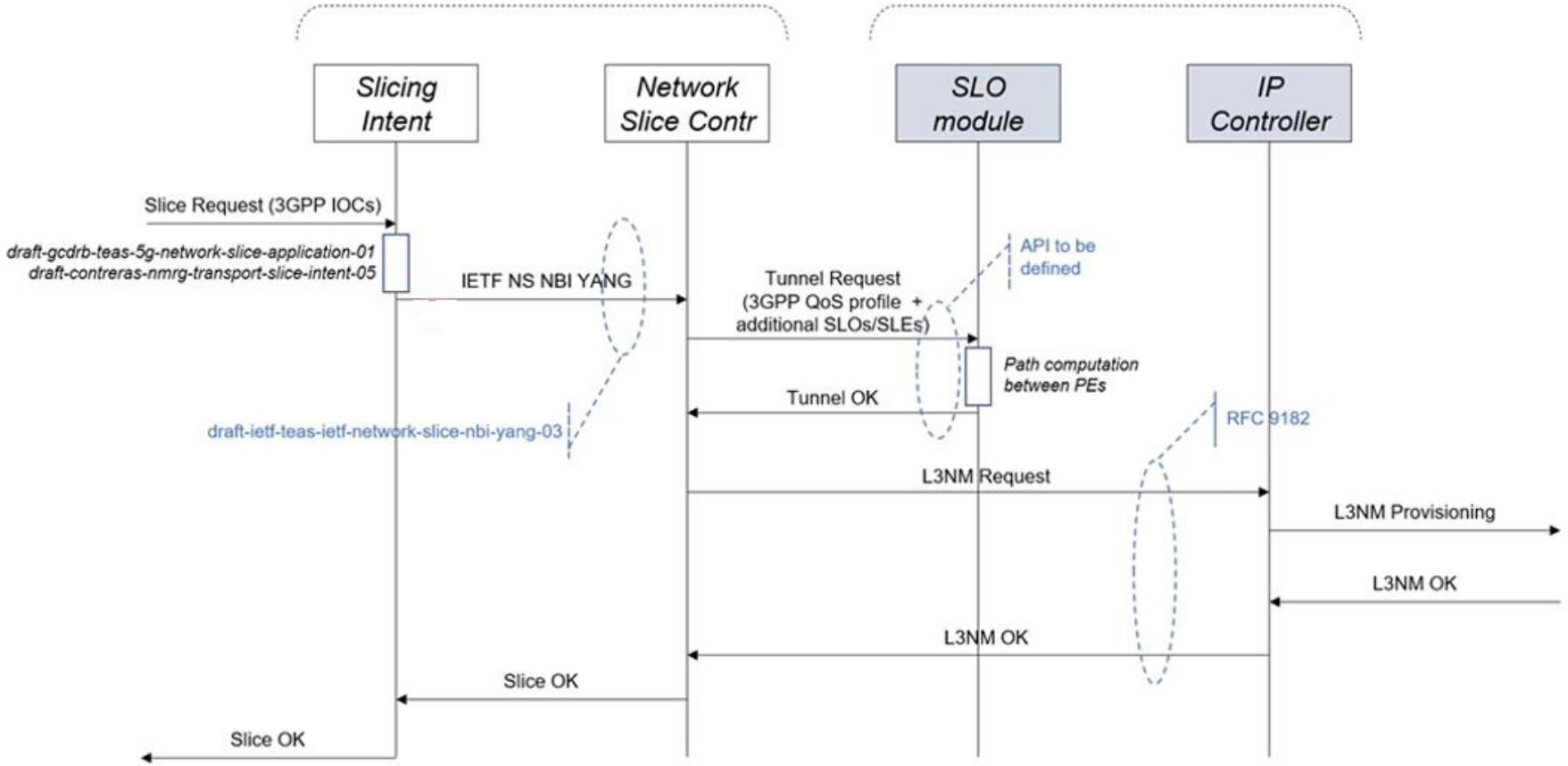
General Architecture

Introduction

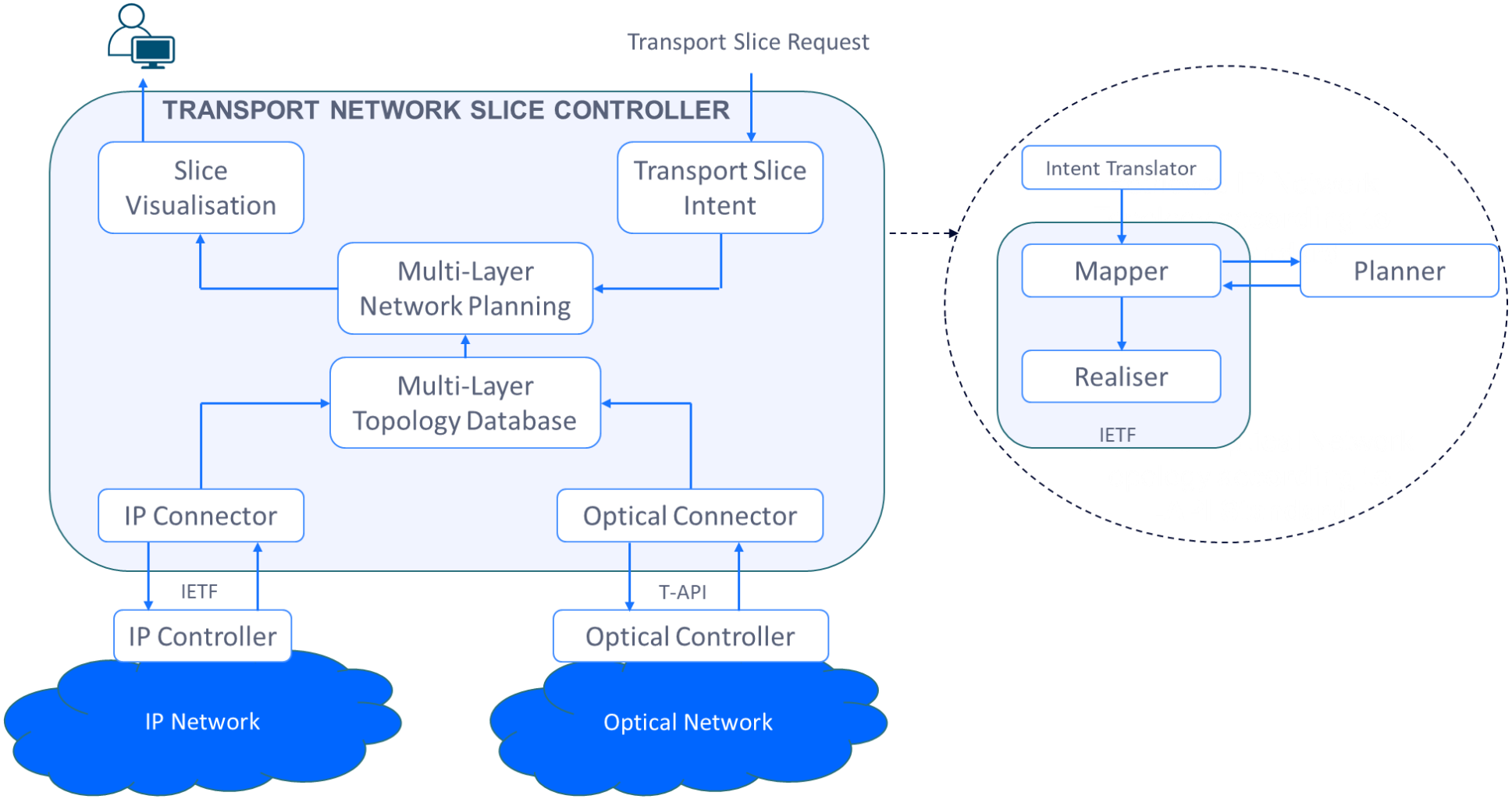
- 3GPP does not specify slicing capabilities in the Transport Network.
- IETF is working on the definition of what is called IETF Network Slices, that essentially describes how to request and realized network slices requested by 3GPP systems with IETF-based technologies.
- What do you need to fulfil the gap in transport networks?
  - Connecting 3GPP slices through IETF Network Slice services.
  - Mapping process between 3GPP and IETF network slices.
  - Multilayer Path Computation enabling transport resources allocation for each transport slice
  - Vendor agnostic Multilayer Topology and Inventory database

- Telefonica is prototyping and demostrating this architecture in the ETSI TeraFlow SDN framework

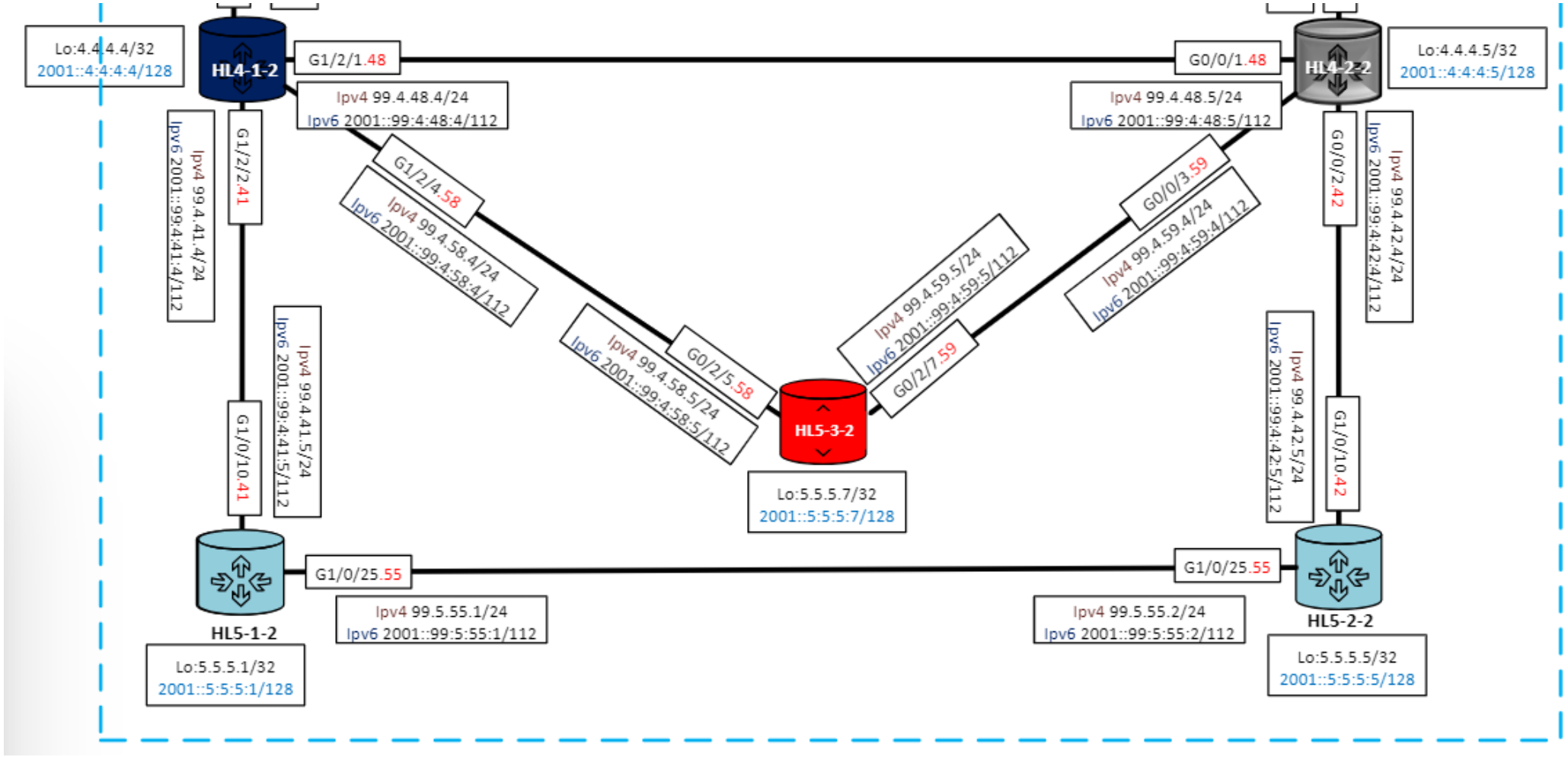
Transport Slice Workflow



General Architecture



Test bed



Main modules

Transport Slice Intents

Needs a Translation
3GPP → IETF

Mapper:

1. Receives the IETF Network Slice request
2. Does it fit?
3. Performance Notification (if needed)

Realizer:

1. Receives provisioning requests.
2. Determines how to realize it.
3. Requests it to the required Controller.

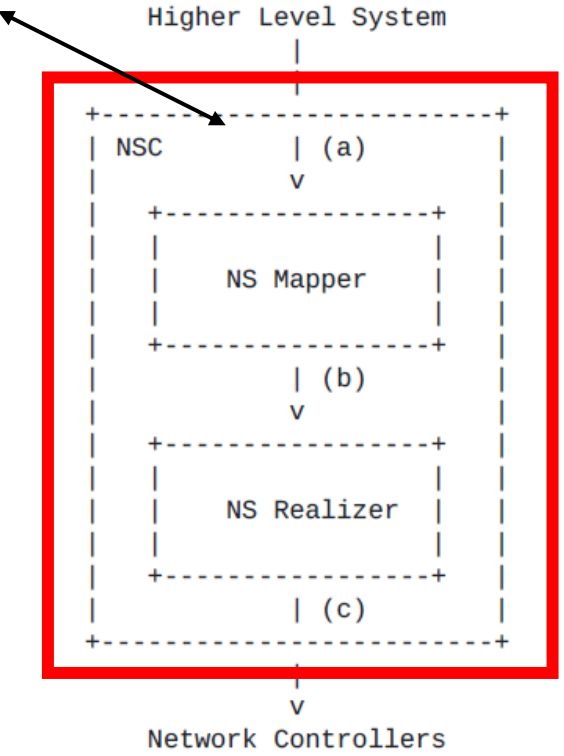
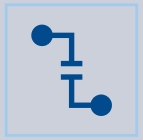


Figure 2: IETF Network Slice Controller structure and asspociated data models

draft-contreras-teas-slice-controller-models-05

Multilayer Network Planning (Planner)

Focus on multi-layer path computation using Segment Routing (SR) technology.



SR enables efficient Traffic Engineering (TE) and path calculation through predefined segments or labels.

Exploration of AI techniques in segment routing for optimized path computation.

Teraflow SDN Controller

TeraFlow SDN

Multilayer topology DB

- Stores Topology information and shares it with the Planner.
- Updated with network modifications.

Slice Creation

- Zero-touch automatation paradigm.
- Transforms SLA intents into L3VPN connections.
- Interacts with both IP and Optical controllers to enable the multilayer capability.

Request proccess

3GPP request


```
{
    "Nsi":"6075934279a17d12456d19ac",
    "ServiceProfile":{
        "SNSSAIList":null,
        "PLMNIdList":null,
        "MaxNumberofUEs":0,
        "CoverageArea":"",
        "Latency":0,
        "DLThptPerSlice":{
            "GuaThpt":0,
            "MaxThpt":0
        },
        "DLThptPerUE":{
            "GuaThpt":0,
            "MaxThpt":0
        },
        "ULThptPerSlice":{
            "GuaThpt":0,
            "MaxThpt":0
        },
        "ULThptPerUE":{
            "GuaThpt":0,
            "MaxThpt":0
        }
    },
    "NetworkSliceSubnet":{
        "SliceProfile":{
            "SNSSAIList":null,
            "PLMNIdList":null,
            "PerfReq":{
                "PerfReqEmbbList":{
                    "ExpDataRateDL":0,
                    "ExpDataRateUL":0,
                    "AreaTrafficCapDL":0,
                    "AreaTrafficCapUL":0,
                    "UserDensity":0,
                    "ActivityFactor":0
                },
                "PerfReqUrllcList":{
                    "CSAvailabilityTarget":0,
                    "CSReliabilityMeanTime":0,
                    "ExpDataRateDL":0,
                    "MsgSizeByte":""
                }
            },
            "CNSliceSubnetProfile":{
                "MaxNumberofUEs":0,
                "Latency":0,
                "DLThptPerSliceSubnet":{
                    "GuaThpt":0,
                    "MaxThpt":0
                },
                "DLThptPerUEPerSubnet":{
                    "GuaThpt":0,
                    "MaxThpt":0
                },
                "ULThptPerSlicePerSubnet":{
                    "GuaThpt":0,
                    "MaxThpt":0
                },
                "ULThptPerUEPerSubnet":{
                    "GuaThpt":0,
                    "MaxThpt":0
                },
                "MaxNumberofPDUSessions":0,
                "CoverageAreaTAList":{
                    "TAC":null
                }
            },
            "RANSliceSubnetProfile":{
                "CoverageAreaTAList":{
                    "TAC":null
                },
                "UEMobilityLevel":"",
                "ResourceSharingLevel":0,
                "MaxNumberofUEs":0,
                "ActivityFactor":0,
                "DLThptPerUEPerSubnet":{
                    "GuaThpt":0,
                    "MaxThpt":0
                },
                "ULThptPerUEPerSubnet":{
                    "GuaThpt":0,
                    "MaxThpt":0
                },
                "UESpeed":0
            },
            "TopSliceSubnetProfile":""
        },
        "ManagedFunction":""
    },
    "EpTransport":[
    {
        "IpAddress":"1.1.1.1/24",
        "LogicInterfaceType": "tcp-ip",
        "LogicInterfaceId":"GigabitEthernet0/0/1.56",
        "NextHopInfo": "98.4.56.1",
        "QosProfile":"6000",
        "EpApplicationRef":"EP_F1U CU-UP1"
    },
    {
        "IpAddress":"1.1.1.1/24",
        "LogicInterfaceType": "tcp-ip",
        "LogicInterfaceId":"GigabitEthernet2/2/3.43",
        "NextHopInfo": "98.5.54.2",
        "QosProfile":"",
        "EpApplicationRef":"EP_F2U CU-UP2"
    }
    ]
}
```


Transport metrics

Planner

TeraFlow SDN

NSC to planner:

```
ubuntu@tfcontroller:~/nsc$ python3 network_slice_controller.py
{'source': 'HL5-1-2', 'destination': 'HL5-3-2', 'bandwidth': 150}
{'source': 'HL5-1-2', 'destination': 'HL4-1-2', 'bandwidth': 150}
{'source': 'HL5-3-2', 'destination': 'HL5-2-2', 'bandwidth': 100}
{'source': 'HL5-2-2', 'destination': 'HL4-2-2', 'bandwidth': 50}
{'source': 'HL5-3-2', 'destination': 'HL5-1-2', 'bandwidth': 50}
```

Planner's response:


```
[
    {
        "success": "True",
        "description": "Traffic intent established successfully!",
        "SR Policy TeraFlow": {
            "0": [
                ["HL5-2-2", "eth-1/0/10.42"],
                ["HL4-2-2", "to_HL5-2-2"]
            ],
            "1": [
                ["HL4-2-2", "to_HL4-1-2"],
                ["HL4-1-2", "to_HL4-2-2"]
            ]
        },
        "SR Policy (SR-LEA)": [24006, 24004]
    }
]
```


This requests needs two slices

Slice Request

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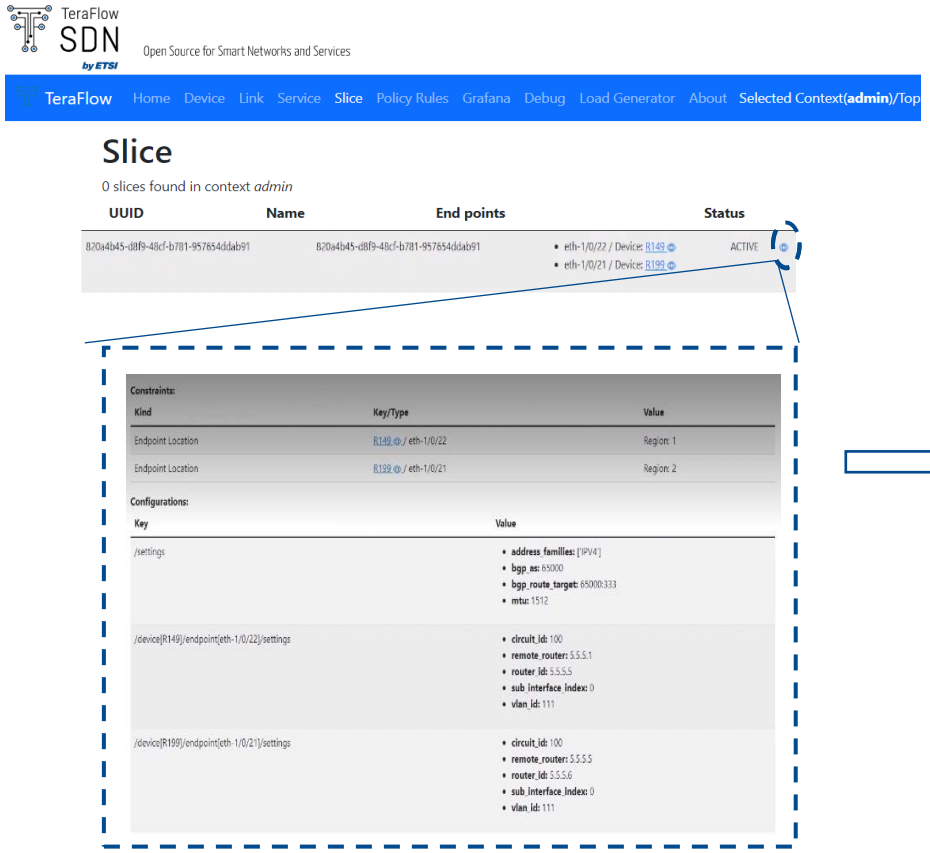
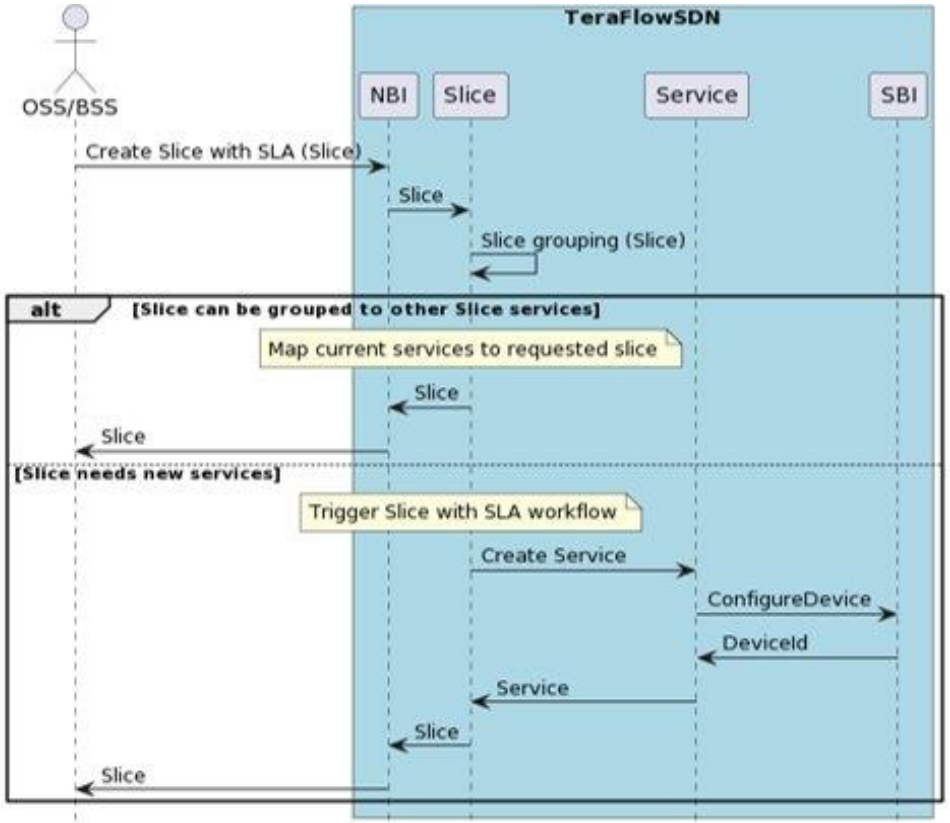
Identifiers

Endpoints

Slice requirements

Slice management in TFS





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Functional Architecture

Slice Visualization

Opening up Disaggregated IP & Optical Networks

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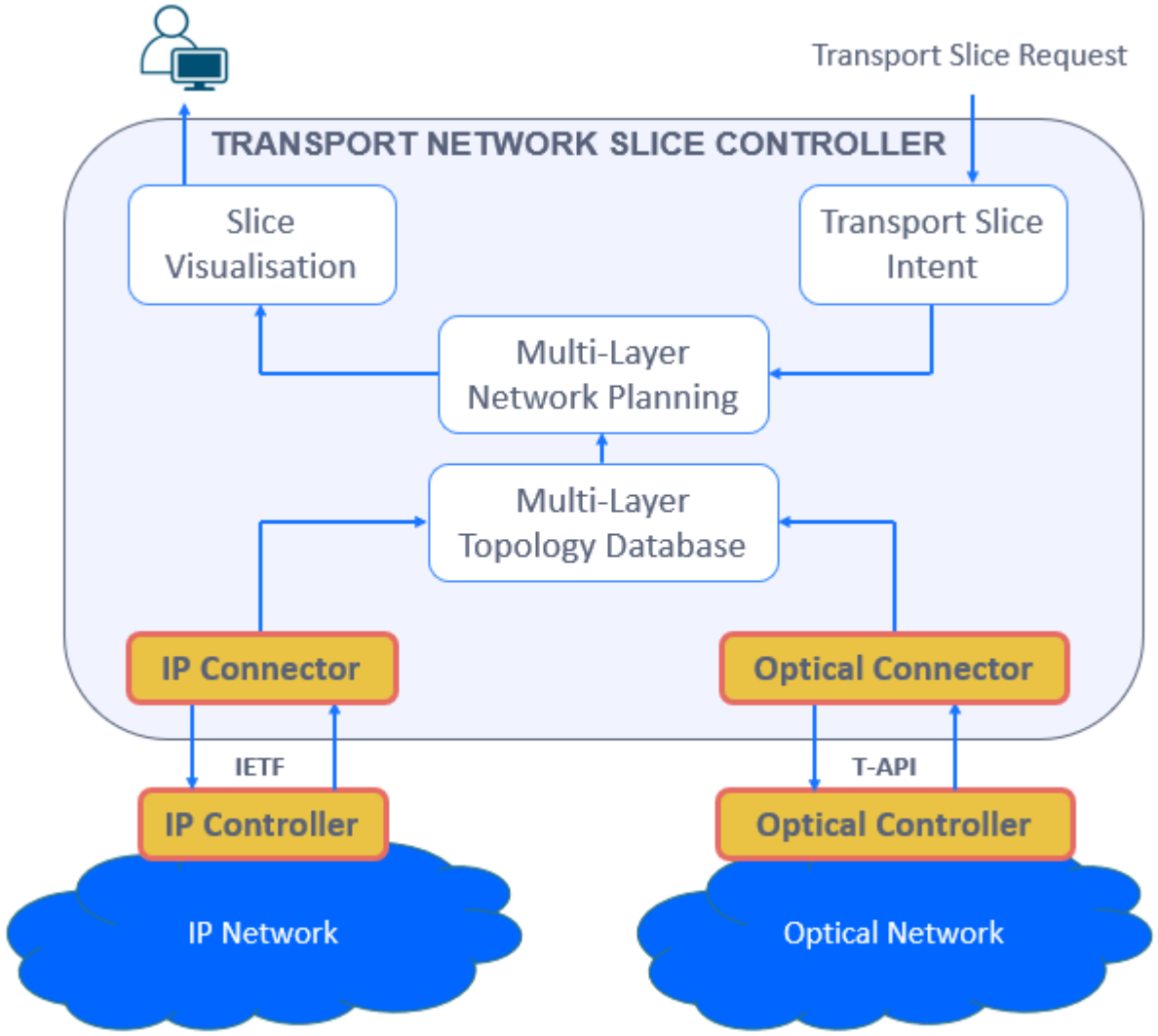
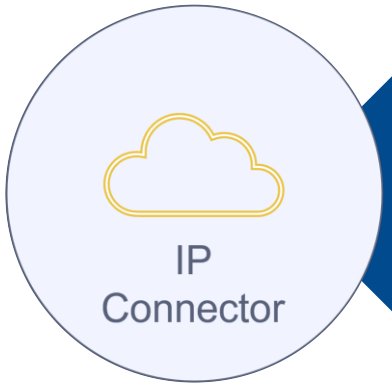
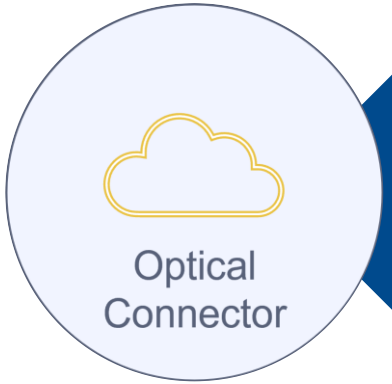




Retrieves **IP** Network Topology ac**cording to IETF Standard**



Retrieves **Optical** Network Topology ac**cording to T-API Standard**

In Progress: **Real-Time** Extraction of Topological Data

Now: Static topology info stored under ./json

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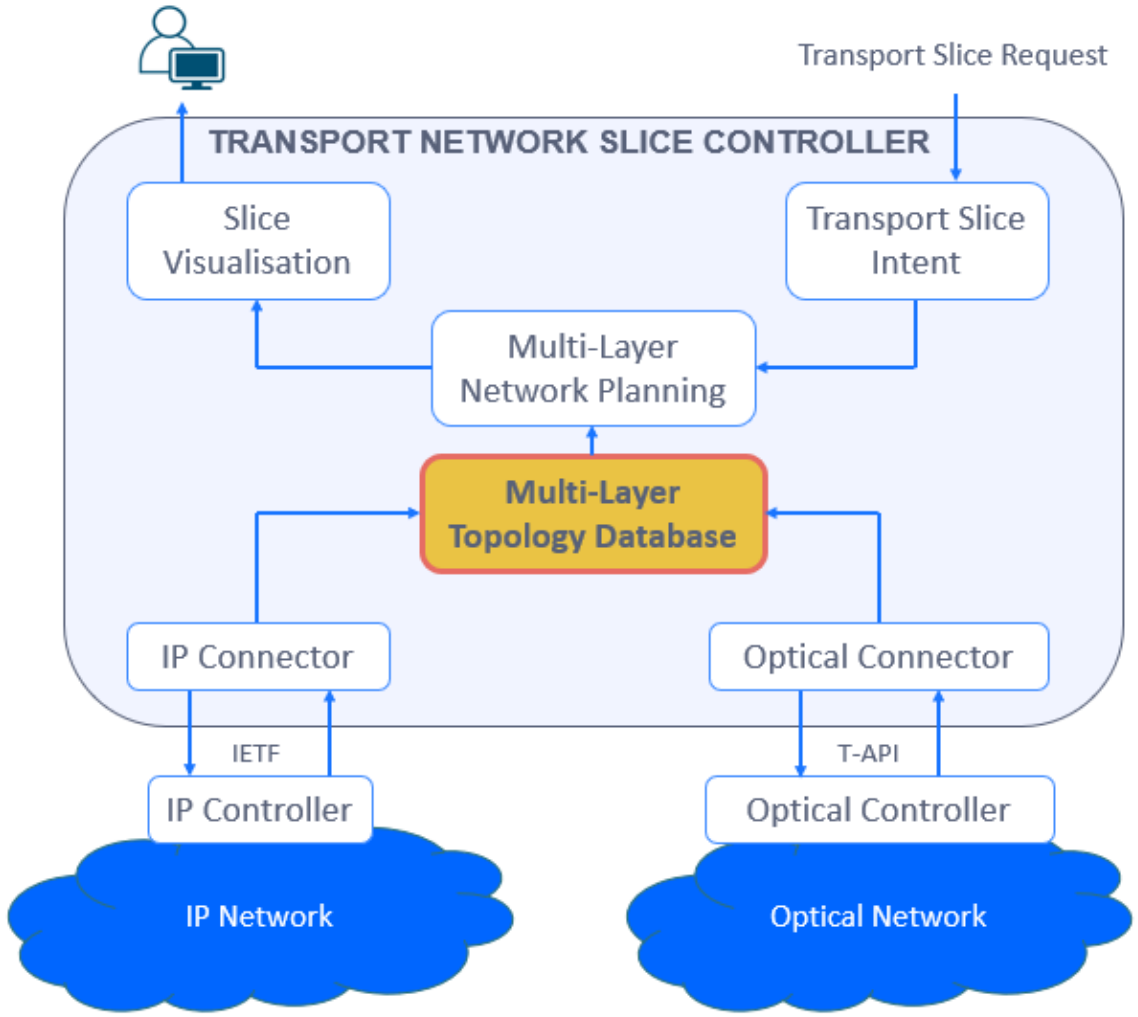
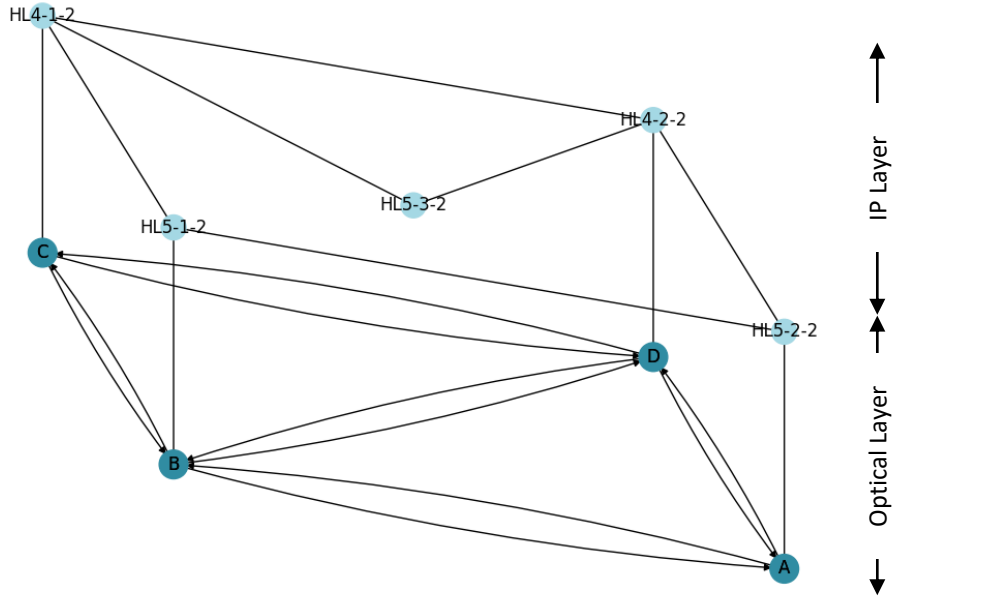
Slice Visualization

Generating and Visualizing / Optical-to-IP Mapping





- Example presents a simplified and hypothetical optical-to-IP mapping
- Specific **mapping** is based on real **network designs** and **objectives**
  - Maximizing resource utilization
  - Minimizing latency
  - Ensuring resilience

Slice Visualization

Allocating and Visualizing / Transport Slice Requests

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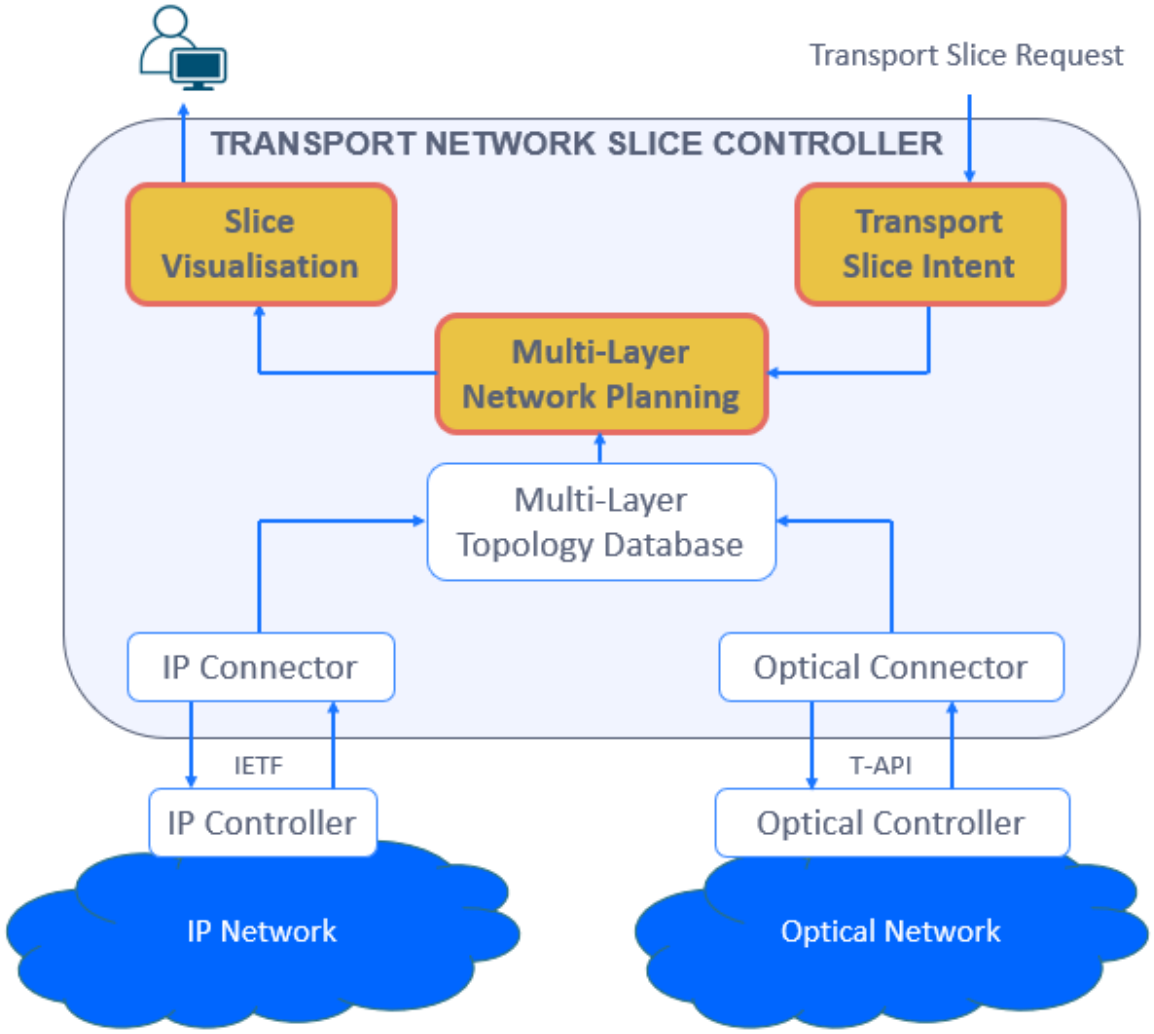

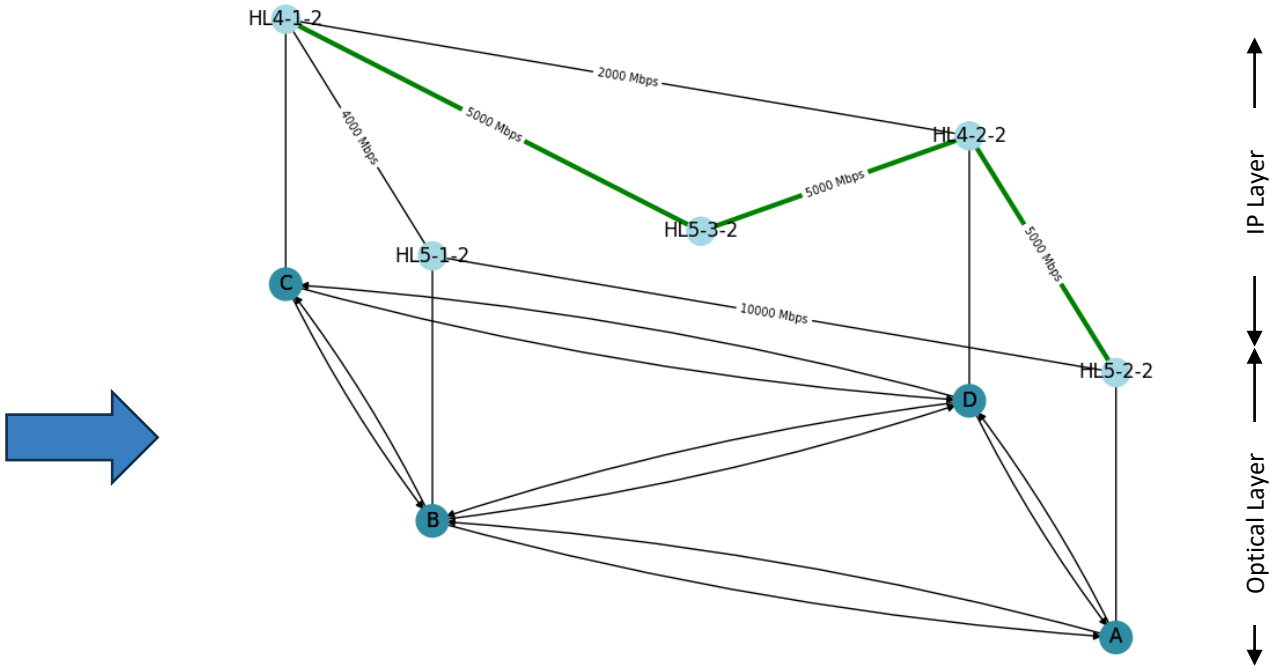

- Transport slice request: *src, dst, BW*
- Compute **optimal path**
- Define segment routing policy
- **Resource check**: If insufficient IP resources
  → Additional connectivity request in optical layer using T-API required (**in progress**)

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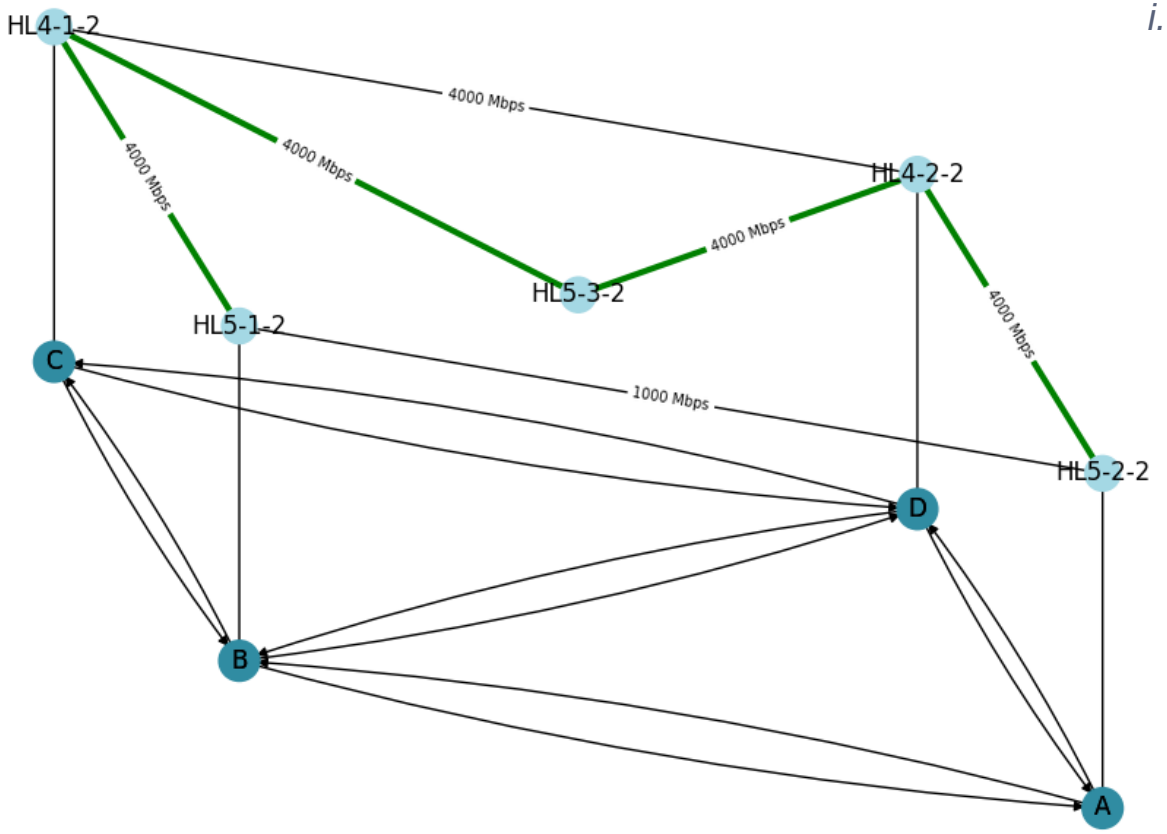
Path Planning - Example

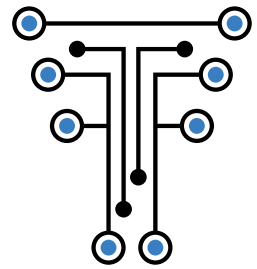
Best available path 6000 Mbps



Segment routing policies provided to TeraFlow.
Note: now printed to terminal i.o. saved, can be modified in topologyviewer.py (lines 316-317).


```
{
    "success": true,
    "description": "Traffic intent established successfully!",
    "path": [
        "HL5-1-2",
        "HL4-1-2",
        "HL5-3-2",
        "HL4-2-2",
        "HL5-2-2"
    ],
    "SR Policy TeraFlow": {
        "0": [
            [
                "HL5-1-2",
                "eth-1/0/10.41"
            ],
            [
                "HL4-1-2",
                "to_HL5-1-2"
            ]
        ],
        "1": [
            [
                "HL4-1-2",
                "to_HL5-3-2"
            ],
            [
                "HL5-3-2",
                "GigabitEthernet0/2/5"
            ]
        ],
        "2": [
            [
                "HL5-3-2",
                "GigabitEthernet0/2/7"
            ],
            [
                "HL4-2-2",
                "to_HL5-3-2"
            ]
        ],
        "3": [
            [
                "HL4-2-2",
                "to_HL5-2-2"
            ],
            [
                "HL5-2-2",
                "eth-1/0/10.42"
            ]
        ]
    },
    "SR Policy (SR-LEA)": [
        16003,
        16001
    ]
}
```


Theoretical segment routing policies.
Note: can probably be ignored



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Thank You!

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