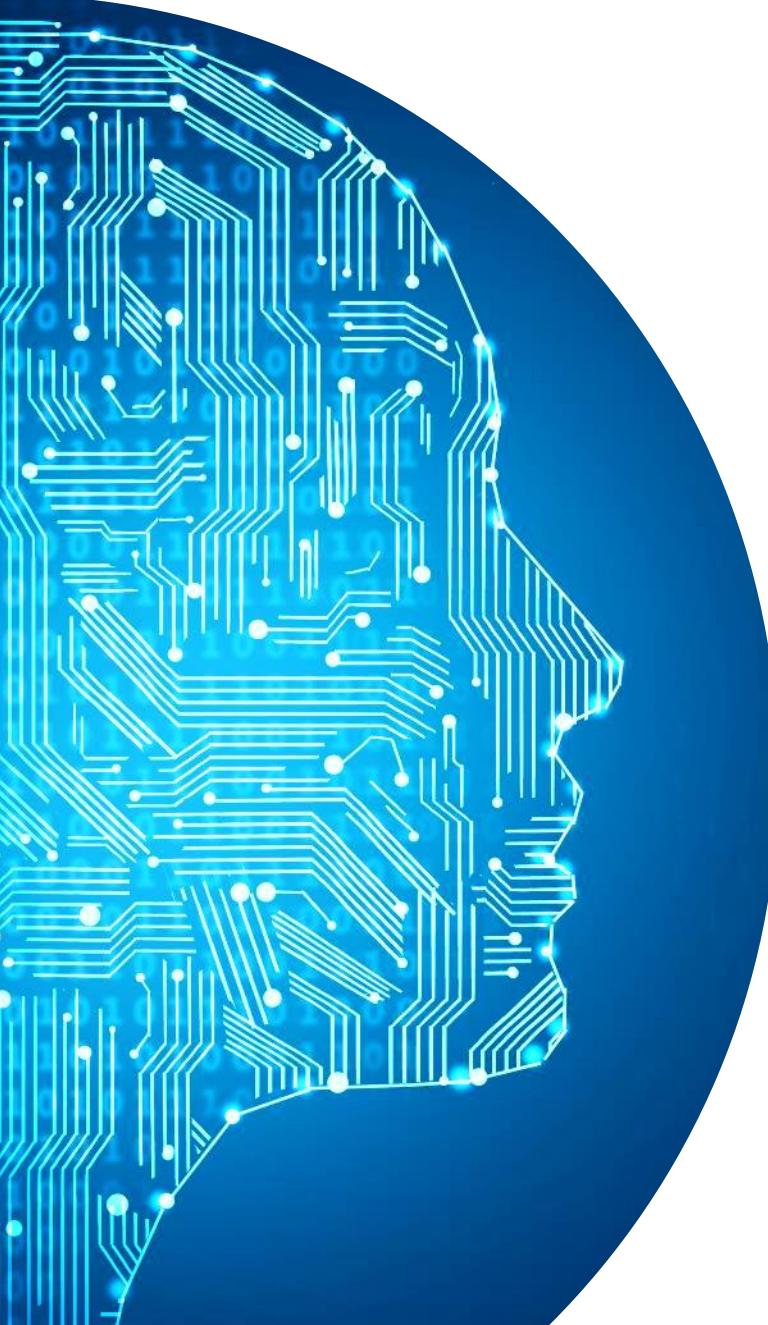


# Int5Gent+ALLEGRO+SEASON Multi-layer slice controller architecture

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Telefónica I+D

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# Agenda

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- General Architecture
- Main modules
- Request process
- Functional Architecture

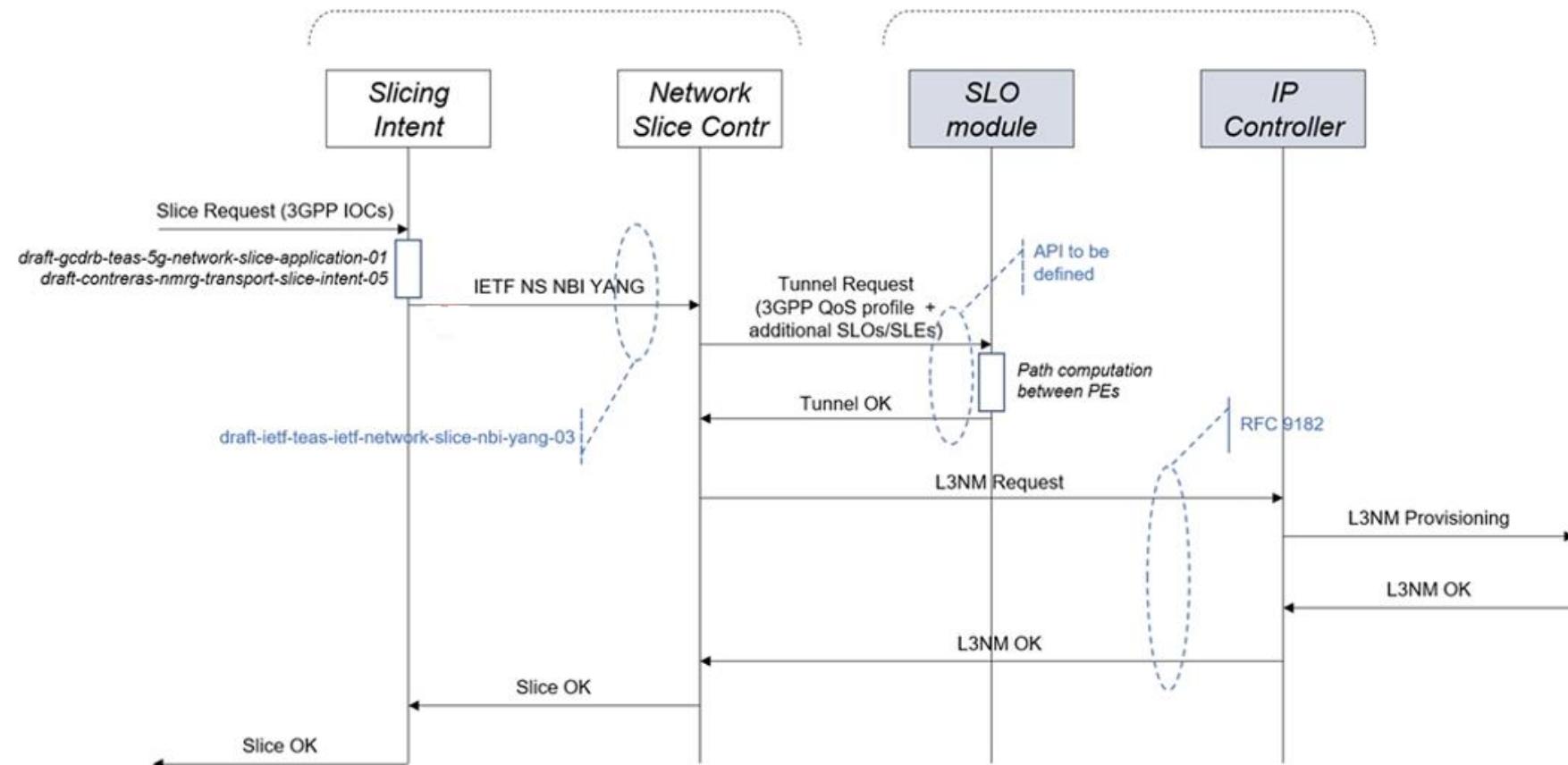
# General Architecture

# Introduction

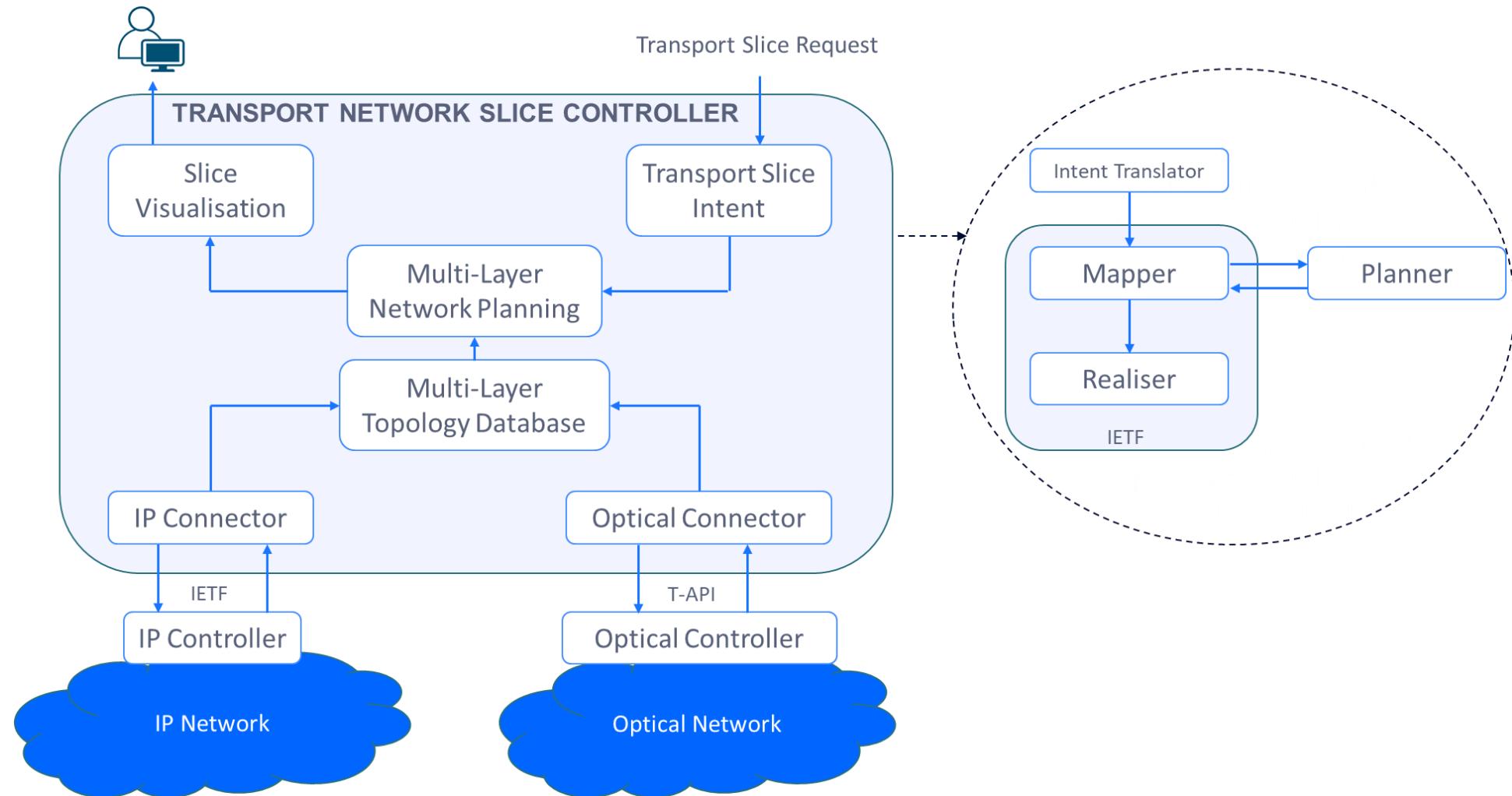
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- 3GPP does not specify slicing capabilities in the Transport Network.
- IETF is working on the definition of what is called IETF Network Slices, that essentially describes how to request and realize network slices requested by 3GPP systems with IETF-based 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 demonstrating this architecture in the ETSI TeraFlow SDN framework

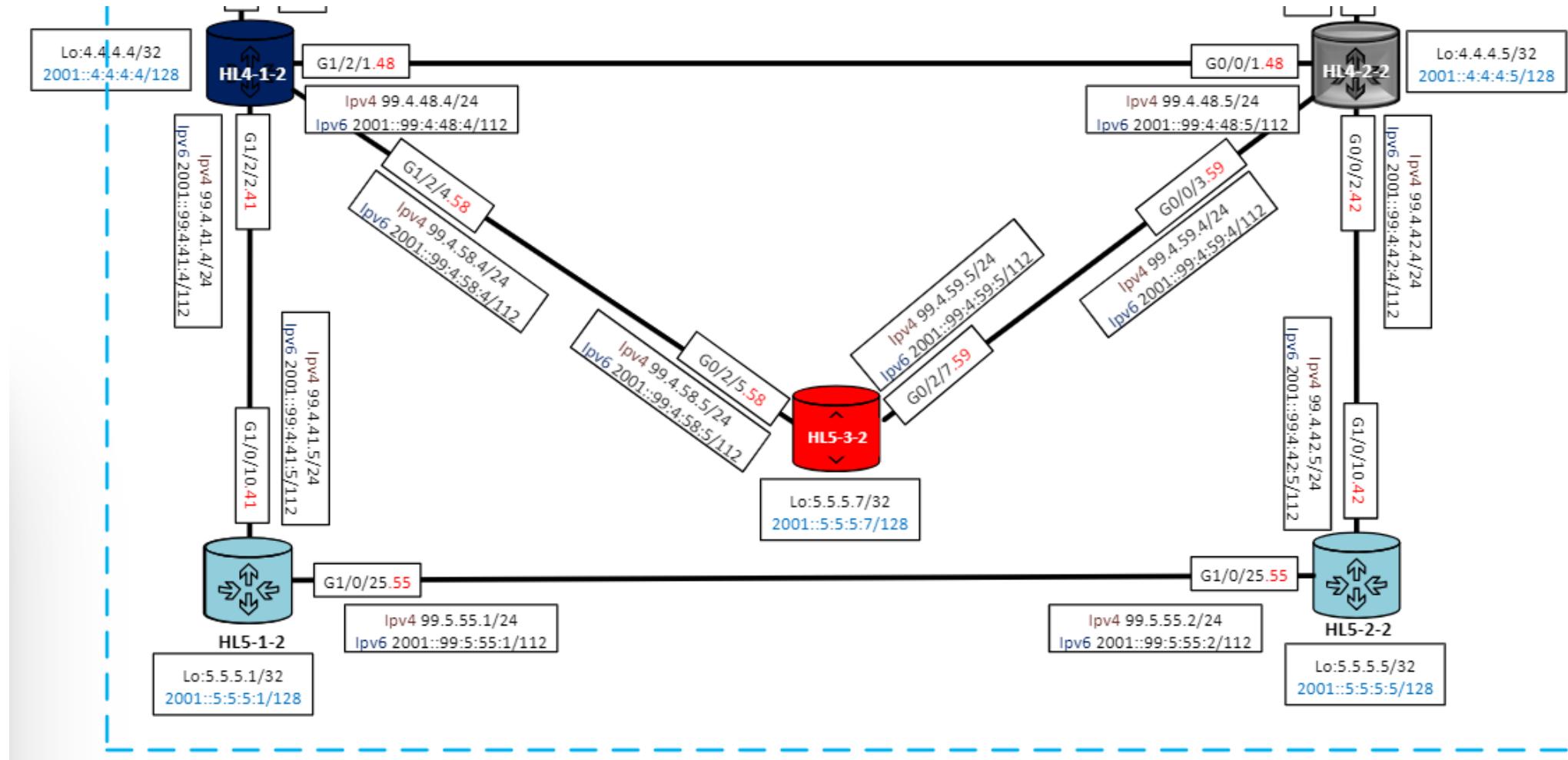
# Transport Slice Workflow



# General Architecture



# Test bed



# Main modules

# Transport Slice Intents

**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.

Needs a Translation  
3GPP → IETF

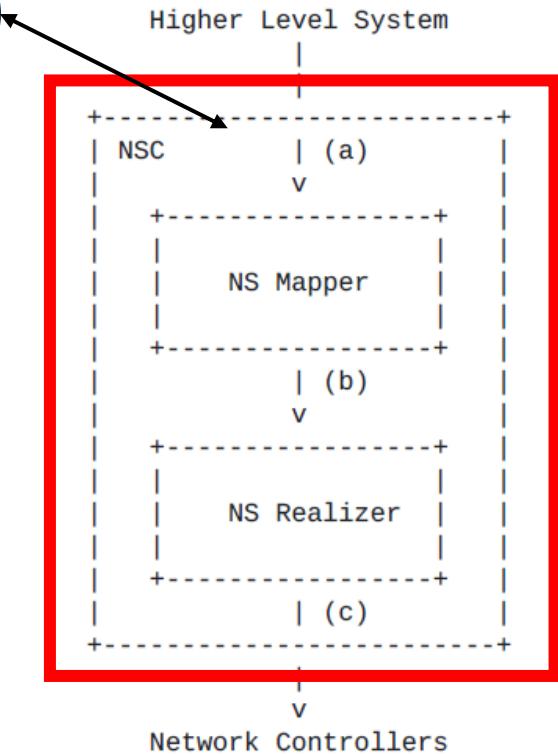


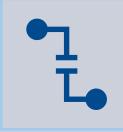
Figure 2: IETF Network Slice Controller structure and associated data models

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

## Multilayer topology DB

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

## Slice Creation

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

# Request process

# 3GPP request

```

1  {
2    "NsI":"6075934279a17d12456d19ac",
3    "ServiceProfile":{
4      "SNSSAIlList":null,
5      "PLMNIIdList":null,
6      "MaxNumberofUEs":0,
7      "CoverageArea":"",
8      "Latency":0,
9      "DLThptPerSlice":{
10        "GuaThpt":0,
11        "MaxThpt":0
12      },
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14        "GuaThpt":0,
15        "MaxThpt":0
16      },
17      "ULThptPerSlice":{
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19        "MaxThpt":0
20      },
21      "ULThptPerUE":{
22        "GuaThpt":0,
23        "MaxThpt":0
24      }
25    },
26    "NetworkSliceSubnet":{
27      "SliceProfile":{
28        "SNSSAIlList":null,
29        "PLMNIIdList":null,
30        "PerfReq":{
31          "PerfReqEmbbList":{
32            "ExpDataRateDL":0,
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34            "AreaTrafficCapDL":0,
35            "AreaTrafficCapUL":0,
36            "UserDensity":0,
37            "ActivityFactor":0
38          }
39        }
40      }
41    }
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44 }
45 },
46 "CNSliceSubnetProfile":{
47   "MaxNumberofUEs":0,
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65   "MaxNumberofPDUSessions":0,
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67     "TAC":null
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71     "CoverageAreaTAList":{
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75     "ResourceSharingLevel":0,
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82 }
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88   "GuaThpt":0,
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98     "IpAddress": "1.1.1.1/24",
99     "LogicInterfaceType": "tcp-ip",
100    "LogicInterfaceId": "GigabitEthernet0/0/1.56",
101    "NextHopInfo": "98.4.56.1",
102    "QosProfile": "6000",
103    "EpApplicationRef": "EP_FIU CU-UP1"
104  },
105  {
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```

# Planner

---

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:

```
1  [
2    {
3      "success": "True",
4      "description": "Traffic intent established successfully!",
5      "SR Policy TeraFlow": [
6        "0": [
7          ["HL5-2-2", "eth-1/0/10.42"],
8          ["HL4-2-2", "to_HL5-2-2"]
9        ],
10       "1": [
11          ["HL4-2-2", "to_HL4-1-2"],
12          ["HL4-1-2", "to_HL4-2-2"]
13        ]
14      },
15      "SR Policy (SR-LEA)": [24006, 24004]
16    }
17 ]
```

This request needs  
two slices

# Slice Request

```

1  {
2    "slices": [
3      {
4        "slice_id": {
5          "context_id": {
6            "context_uuid": {"uuid": "admin"}
7          },
8          "slice_uuid": {
9            "uid": "test-iron-16968341484863460"
10         }
11       },
12       "name": "test-iron-",
13       "slice_config": {
14         "config_rules": [
15           {
16             "action": 1,
17             "custom": {
18               "resource_key": "/settings",
19               "resource_value": {
20                 "address_families": ["IPV4"],
21                 "bgp_as": "",
22                 "bgp_route_target": "",
23                 "mtu": ""
24               }
25             }
26           },
27           {
28             "action": 1,
29             "custom": {
30               "resource_key": "/device[HL5-2-2]/endpoint[eth-1/0/25]/settings",
31               "resource_value": {"router_id": "HL5-2-2"}
32             }
33           },
34           {
35             "action": 1,
36             "custom": {
37               "resource_key": "/device[HL5-1-2]/endpoint[eth-1/0/25]/settings",
38               "resource_value": {"router_id": "HL5-1-2"}
39             }
40           }
41         ],
42         "slice_constraints": [
43           {
44             "endpoint_location": {
45               "endpoint_id": {
46                 "device_id": {
47                   "device_uuid": {"uuid": "R1"}
48                 },
49                 "endpoint_uuid": {"uuid": "1/2"}
50               },
51               "location": {"region": ""}
52             }
53           }
54         ]
55       }
56     ]
57   }
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```

Identifiers

Endpoints

```

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```

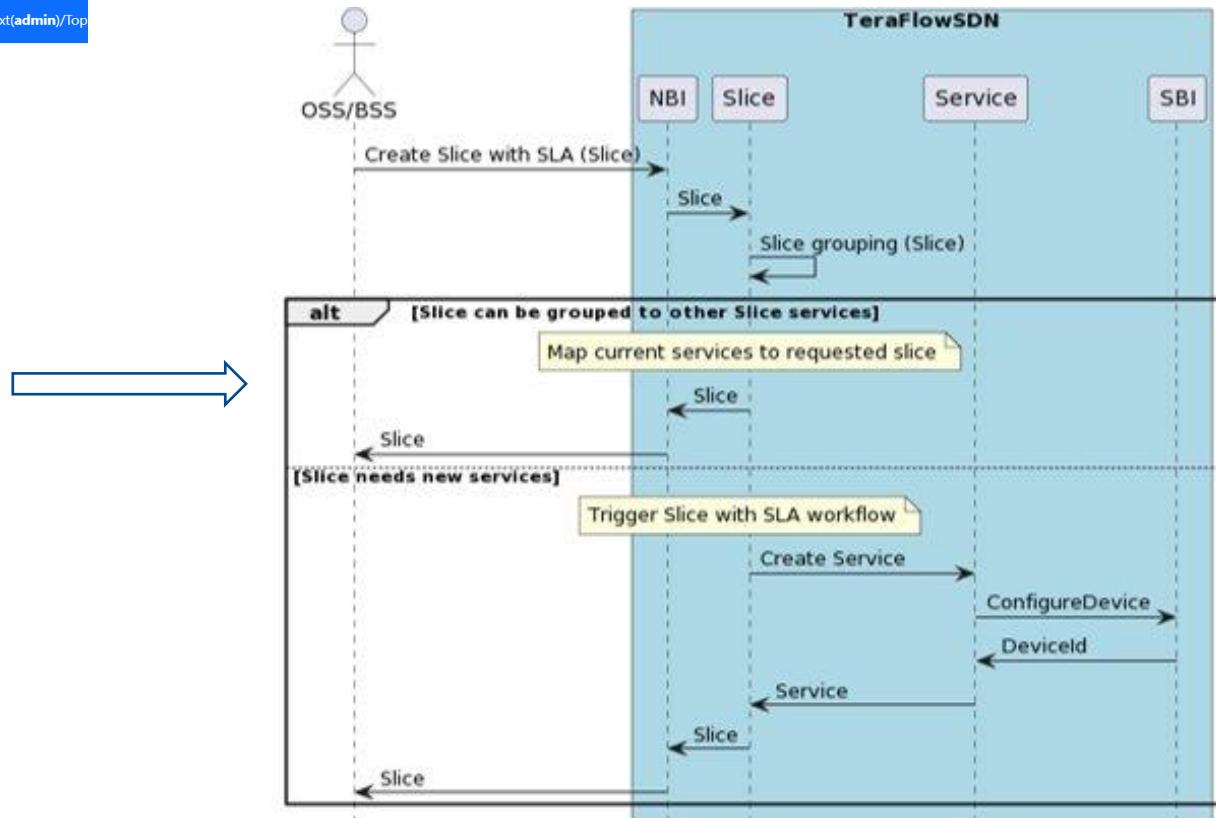
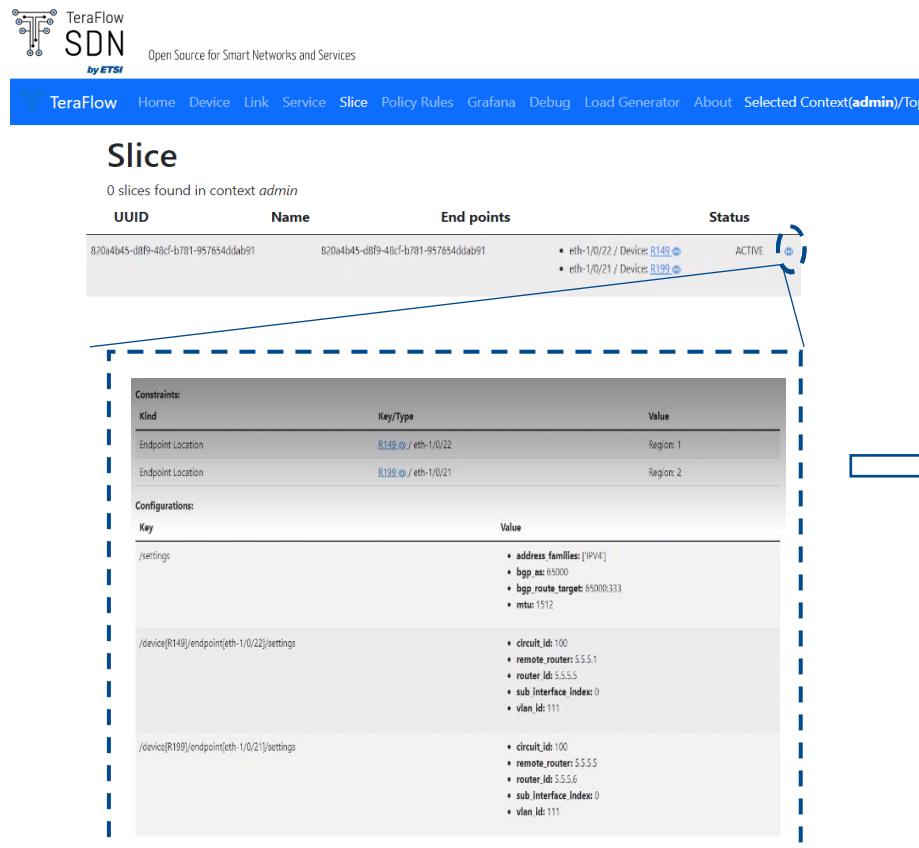
Slice requirements

```

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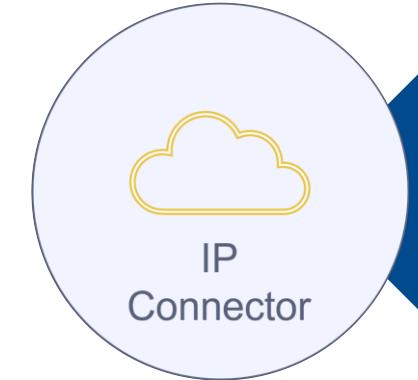
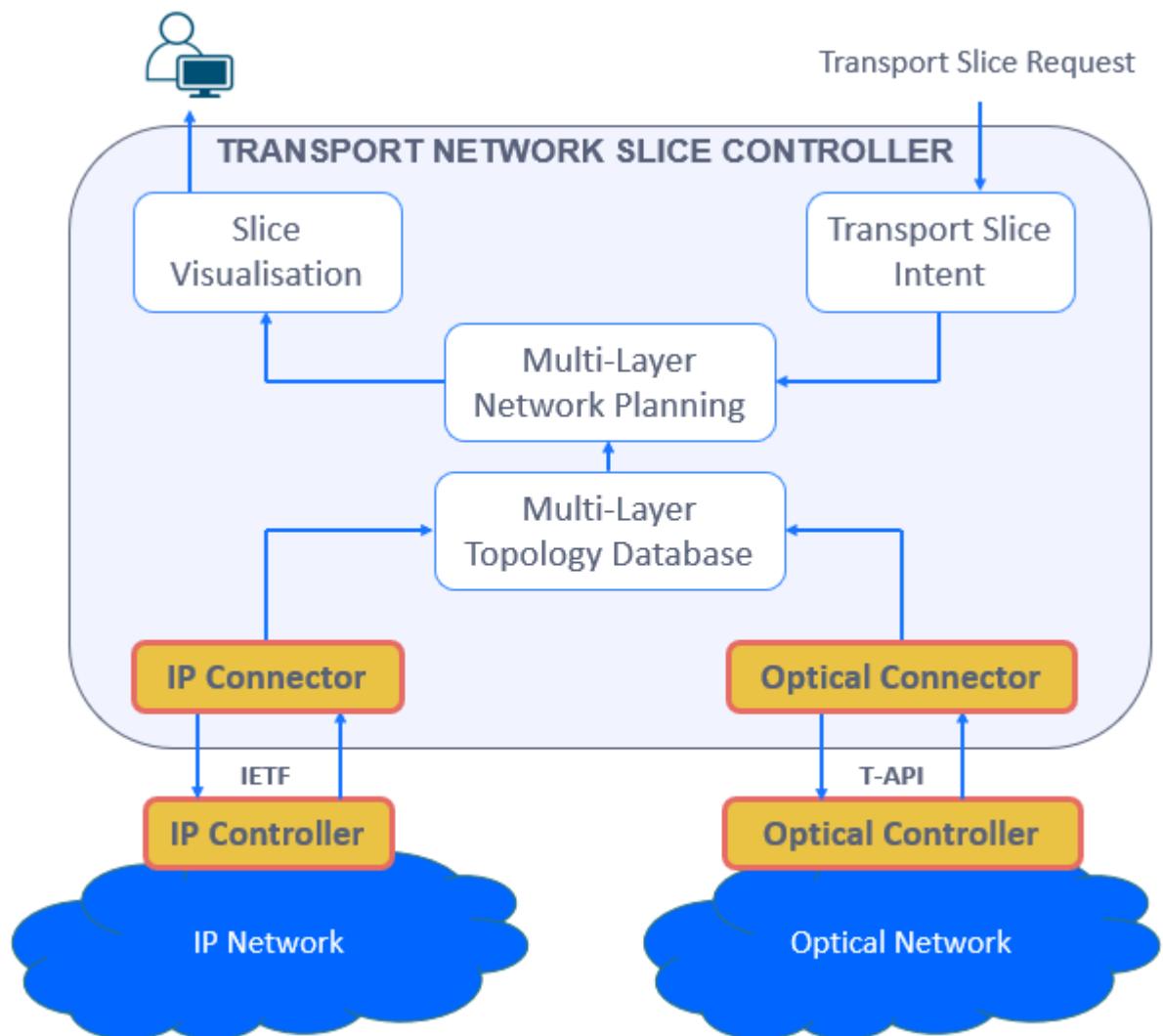
# Slice management in TFS



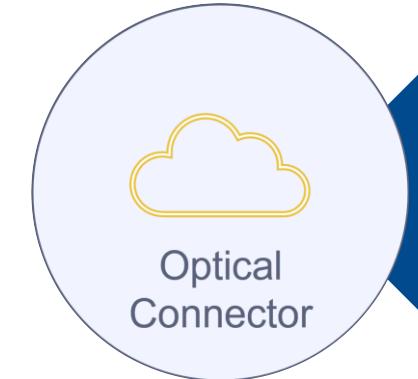
# Functional Architecture

# Slice Visualization

## Opening up Disaggregated IP & Optical Networks



Retrieves **IP Network Topology according to IETF Standard**



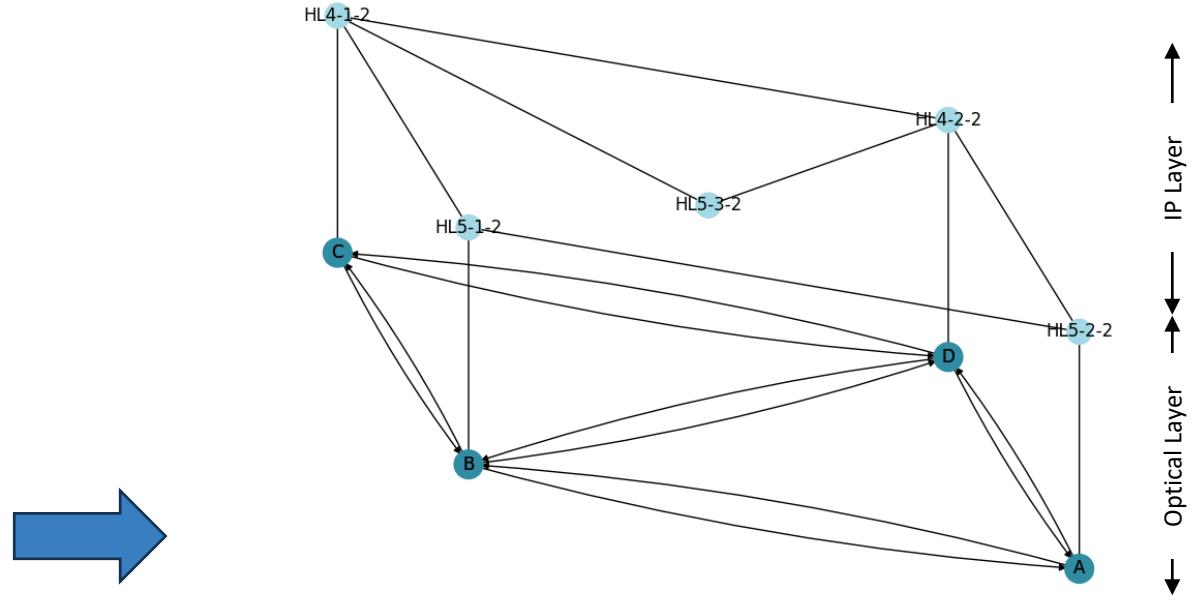
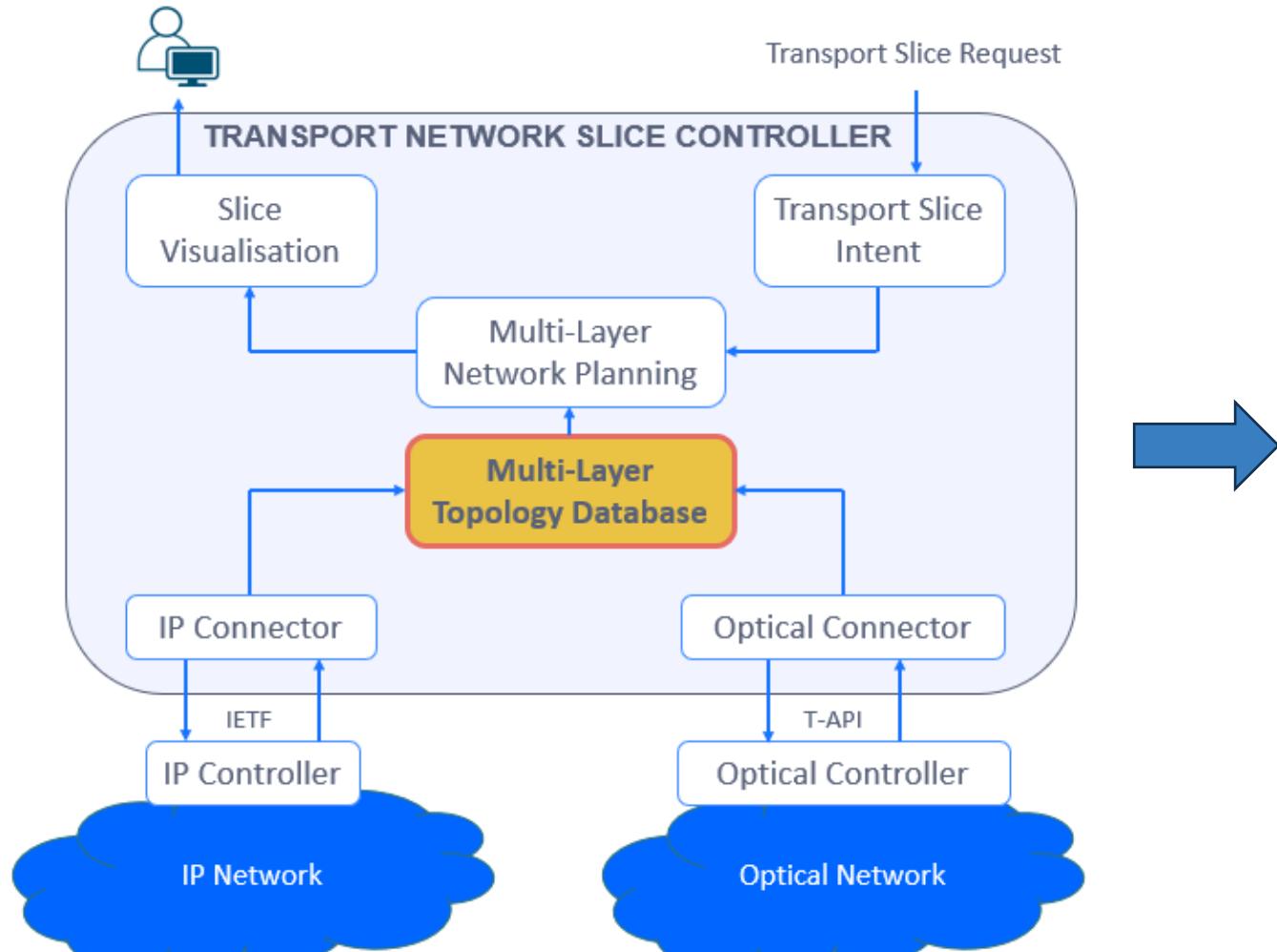
Retrieves **Optical Network Topology according to T-API Standard**

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

*Now: Static topology info stored under ./json*

# Slice Visualization

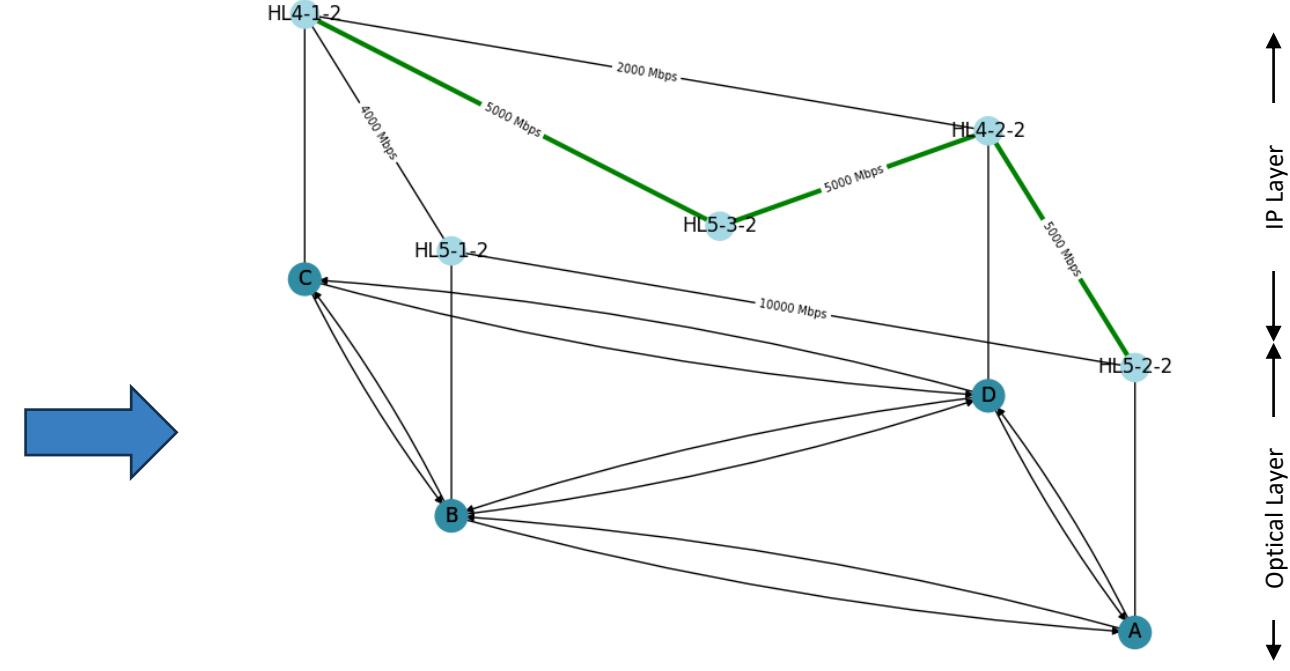
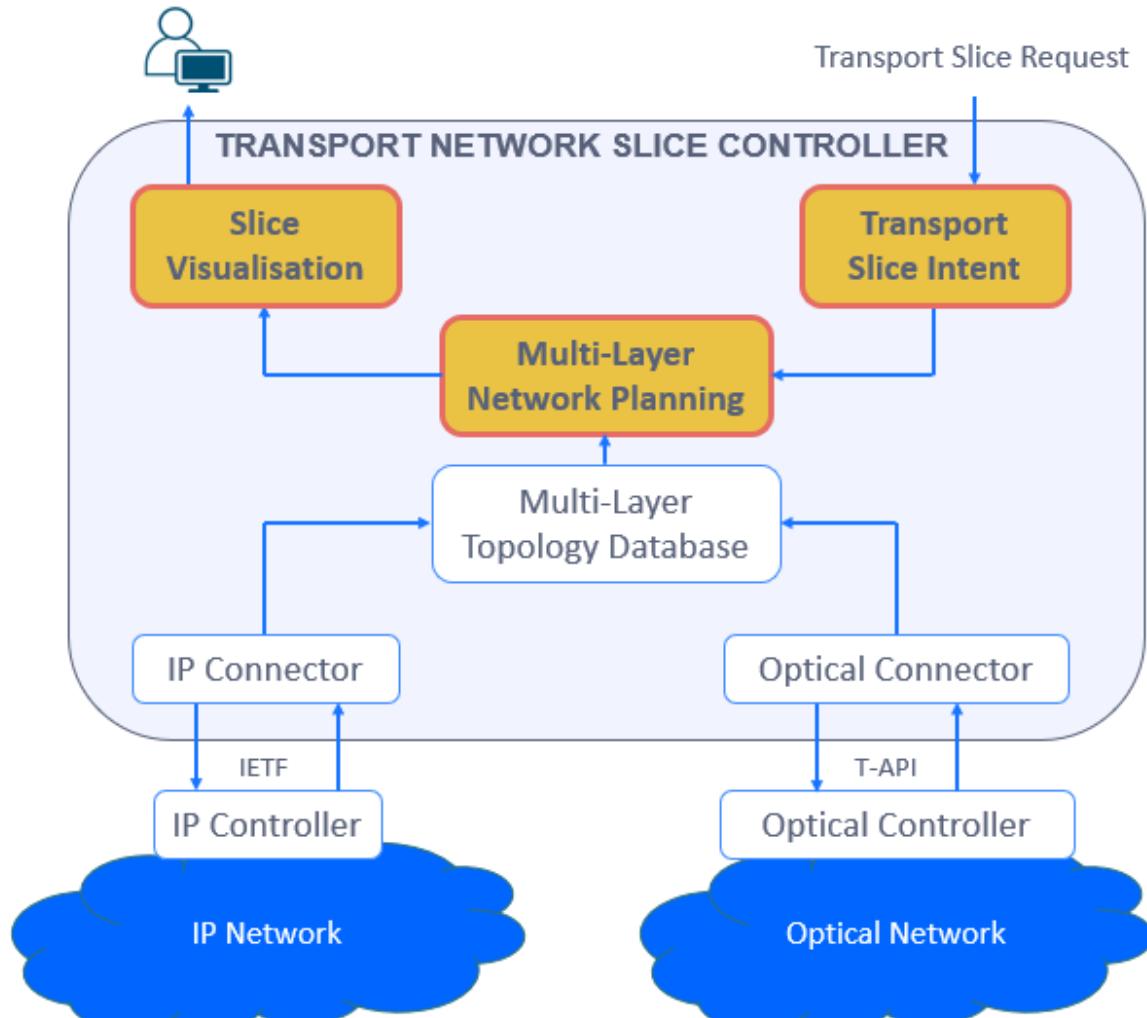
## Generating and Visualizing / Optical-to-IP Mapping



- 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

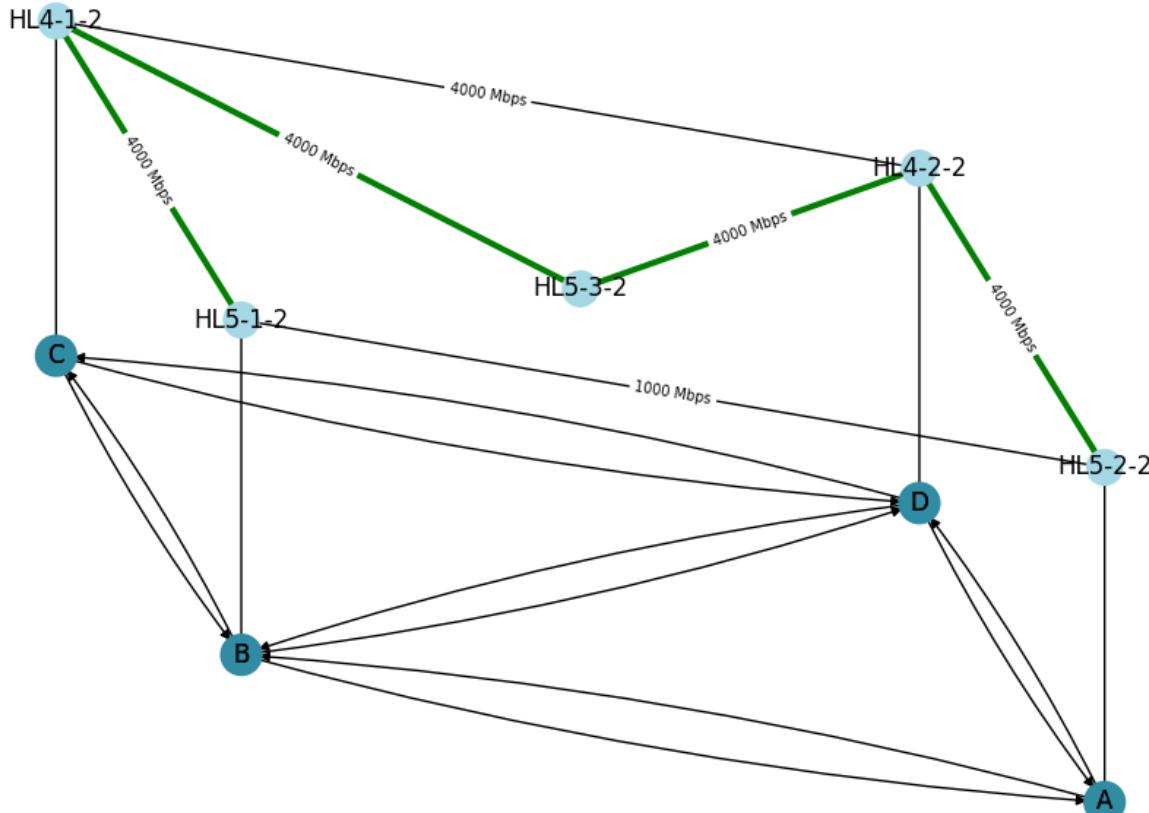
## Allocating and Visualizing / Transport Slice Requests



- 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**)

# Path Planning - Example

Best available path 6000 Mbps

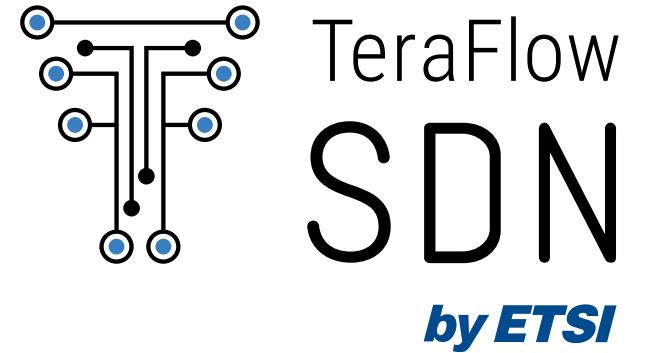


Segment routing policies provided to TeraFlow.

*Note: now printed to terminal i.o. saved, can be modified in topologyviewer.py (lines 316-317).*

Theoretical segment routing policies.  
*Note: can probably be ignored*

```
{  
    "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" ]  
        ],  
        "1": [  
            [ "HL4-1-2", "to_HL5-1-2" ]  
        ],  
        "2": [  
            [ "HL4-1-2", "to_HL5-3-2" ]  
        ],  
        "3": [  
            [ "HL5-3-2", "GigabitEthernet0/2/5" ]  
        ],  
        "4": [  
            [ "HL5-3-2", "GigabitEthernet0/2/7" ]  
        ],  
        "5": [  
            [ "HL4-2-2", "to_HL5-2-2" ]  
        ],  
        "6": [  
            [ "HL5-2-2", "eth-1/0/10.42" ]  
        ]  
    },  
    "SR Policy (SR-LEA)": [  
        16003,  
        16001  
    ]  
}
```



# Thank You!

This work has been partially funded by the 2020 Horizon Europe project Int5Gent (grant agreement No. 957403), ALLEGRO (grant agreement No. 101092766) and SEASON (grant agreement No. 101096120)