ABNO: a feasible SDN approach for multi-vendor IP and optical networks

Telefónica

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Telefónica I+D

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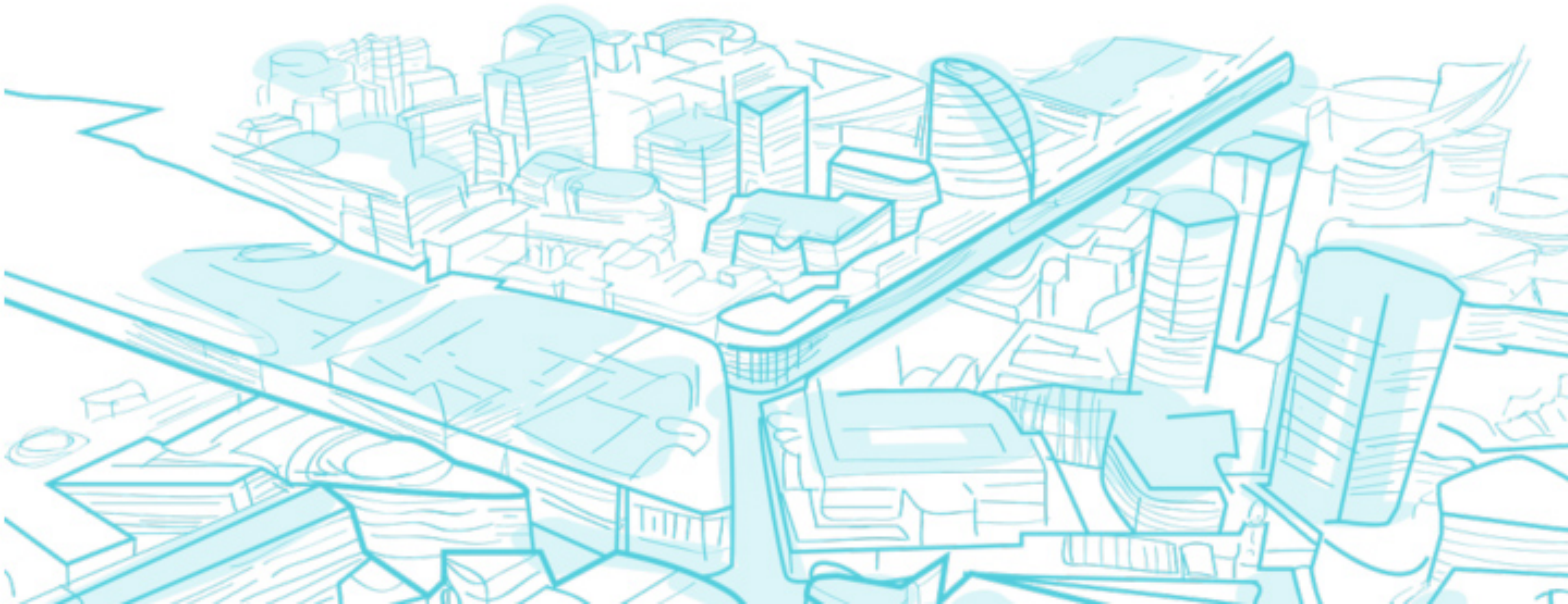
Introduction



Rationale

Changes in Traditional Networks

- Traditional carriers' networks operation is very complex and is neither readily adaptable nor programmable to traffic changes.
- Multiple manual configuration actions are needed in metro and core network nodes.
- Network solutions from different vendors typically use vendor-specific Network Management System (NMS) implementations.
- Software Defined Networking (SDN) and network programmability offer the ability to direct application service requests towards the IP/MPLS and optical network, but the proposed SDN controllers in the market are based on monolithic software, which are not adapted to current heterogeneous network environments.

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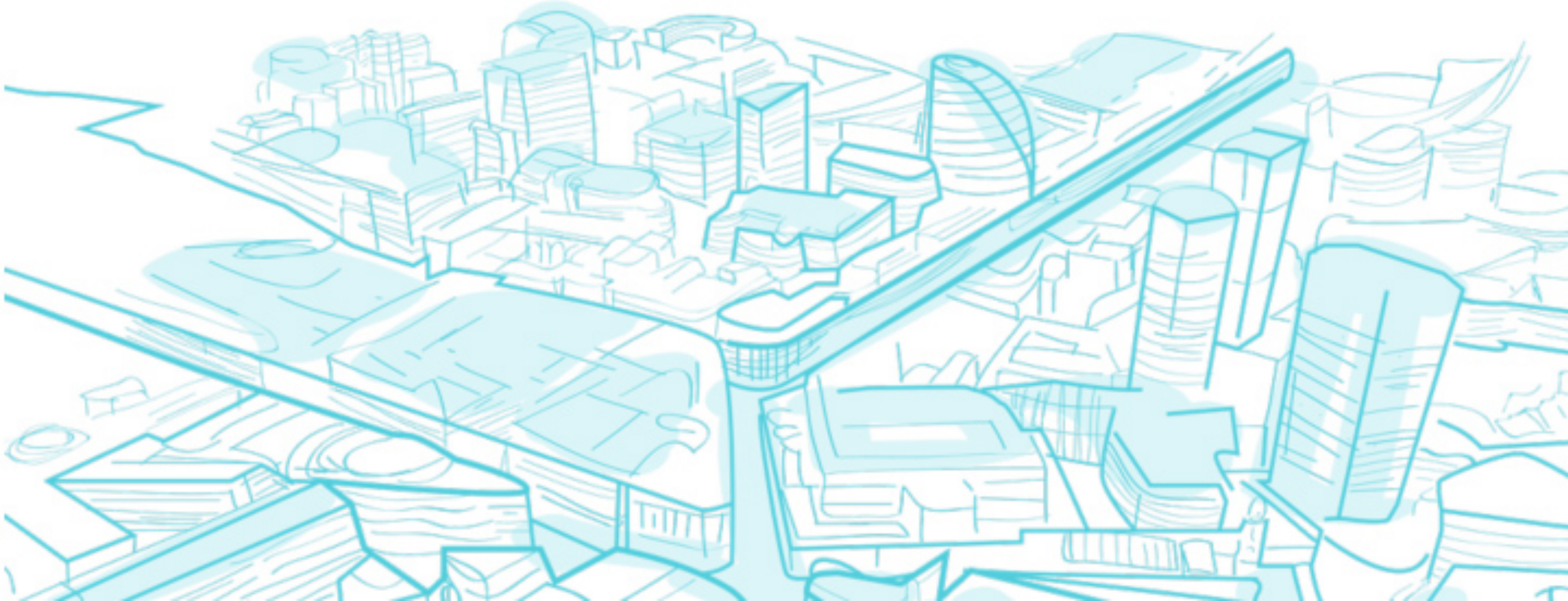
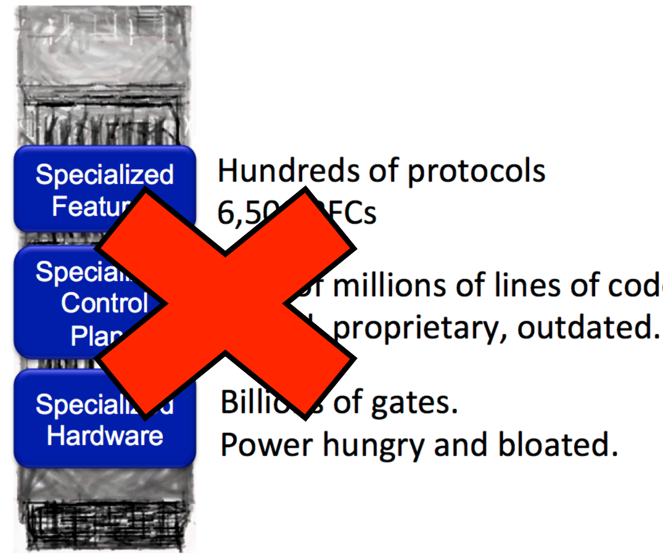
Carrier SDN architecture



Which architecture fits in a Network Service Provider?

Big black box controlling the network



Centralize functionalities to enable automation

Define simple standard interfaces

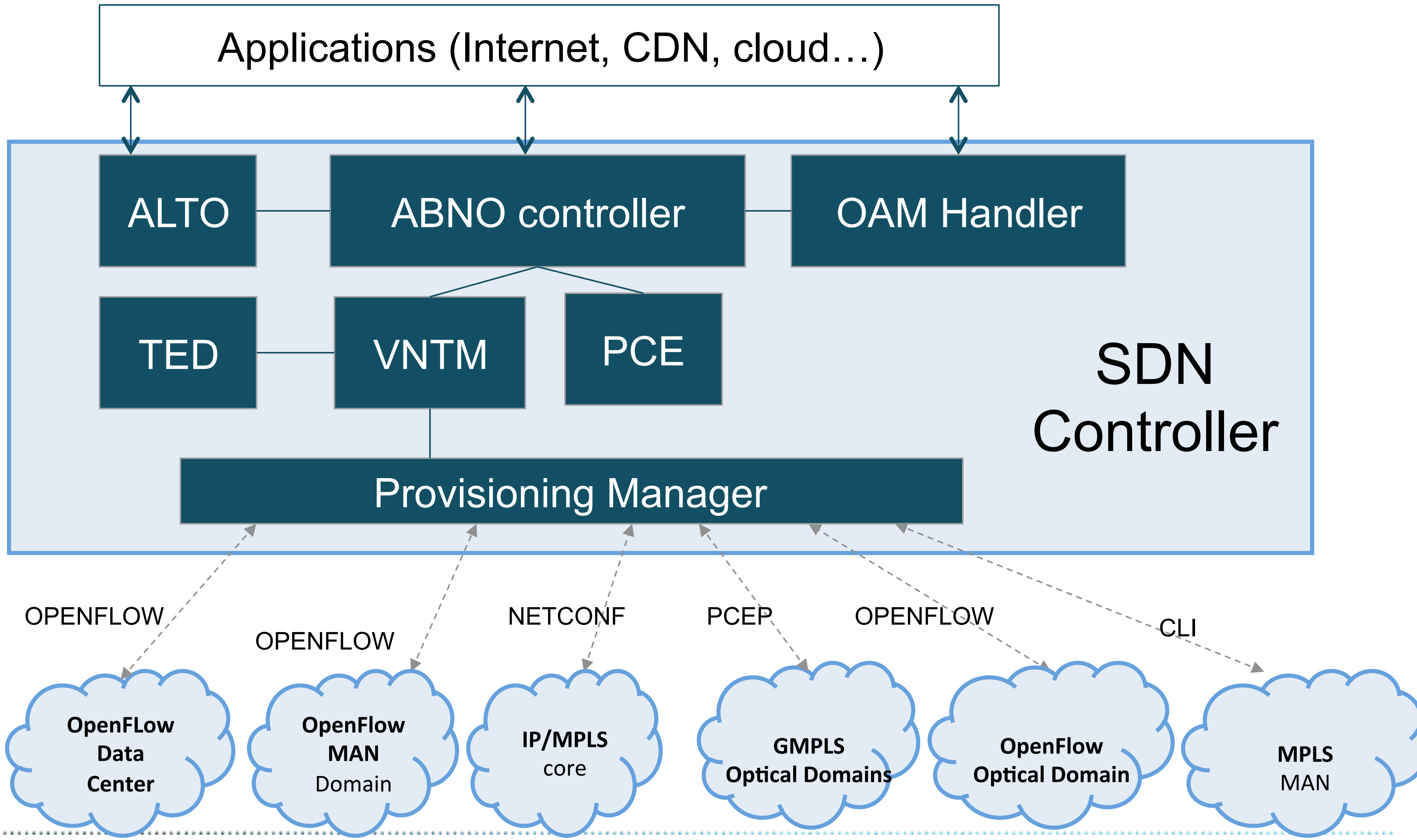
ABNO architecture

- To design and prototype a new control architecture to enable **automated and simplified layer network service provisioning** through different network segments (metro, core, data center…) and technologies (IP/MPLS, optical, OpenFlow…)

- Network **configuration points minimization** by transferring multidomain and multilayer provisioning functionalities **from Network Management Systems** (NMS) to **distributed signaling mechanisms** (control plane).

- Unified network configuration and orchestration mechanisms
  - From proprietary CLI to **standard configuration interfaces** (e.g NetConf, OpenFlow…).
  - SDN architecture **enabling end to end network orchestration** according to service and network optimization criteria.

SDN controller based on IETF building blocks



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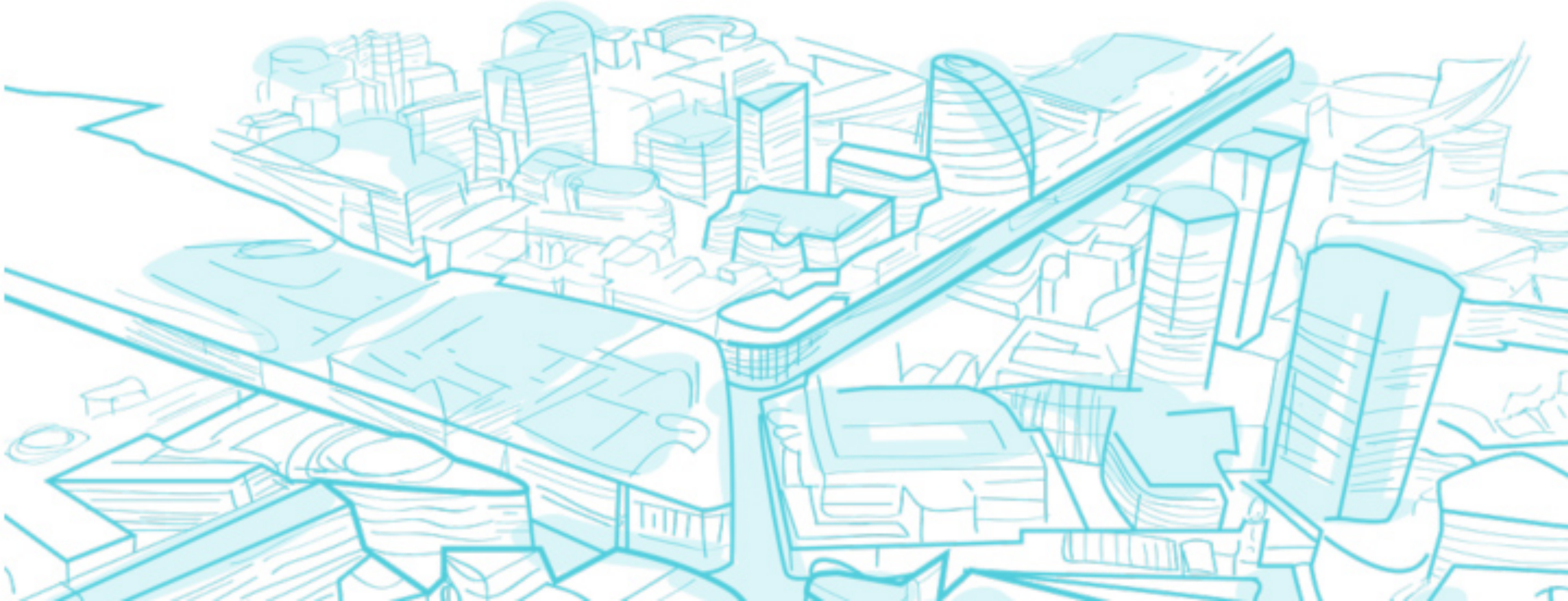
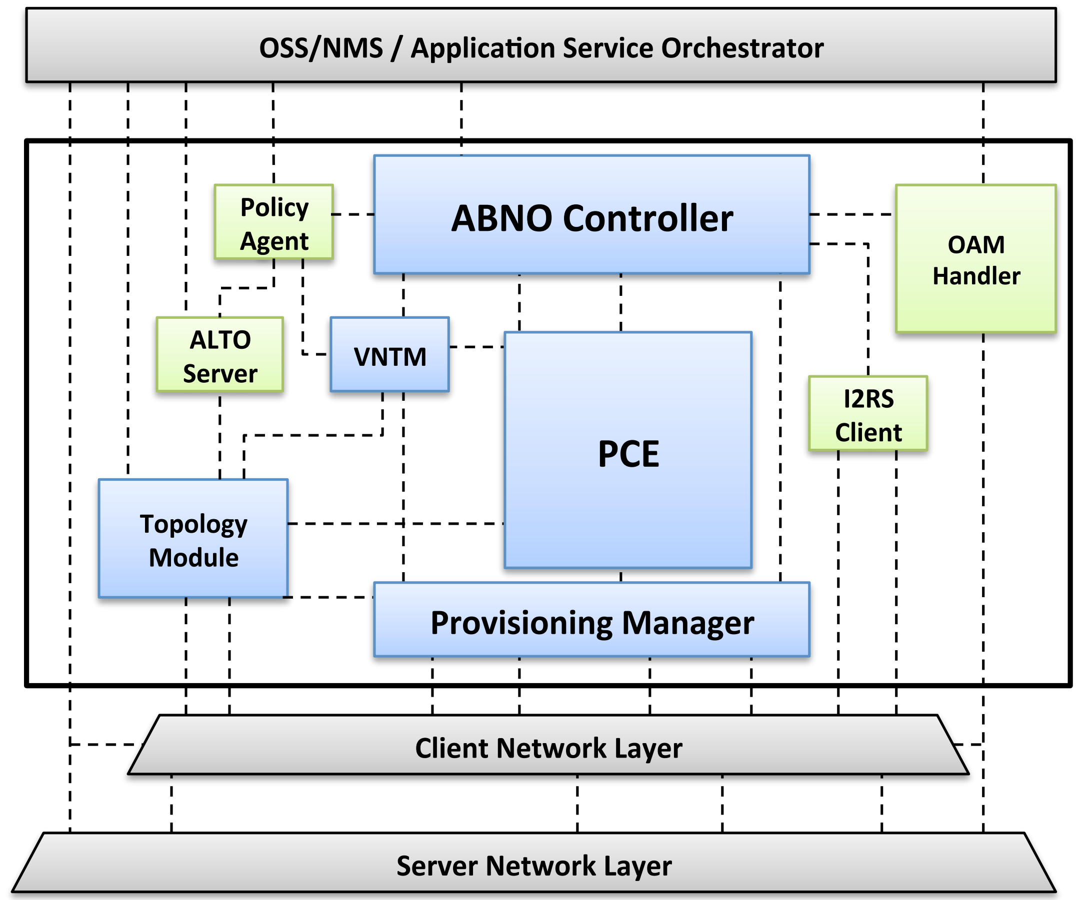
Overview of the architecture



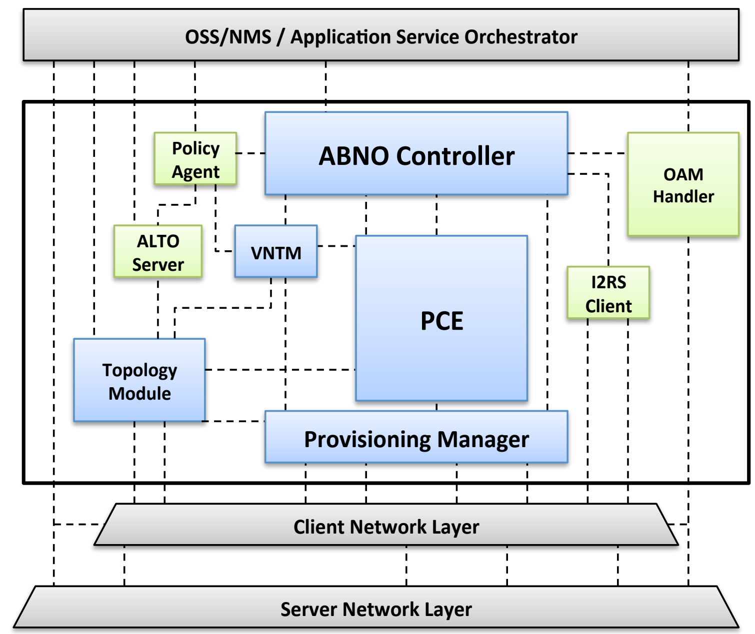
ABNO architecture

- NBI Interface to interface applications
- SBI with three main functionalities:
  - Discover network resources
    - Example: IGP, BGP-LS, etc.
  - Provision the request
    - Ej: OF, PCEP, NetConf, etc.
  - Monitor the network.
    - Not included in the project



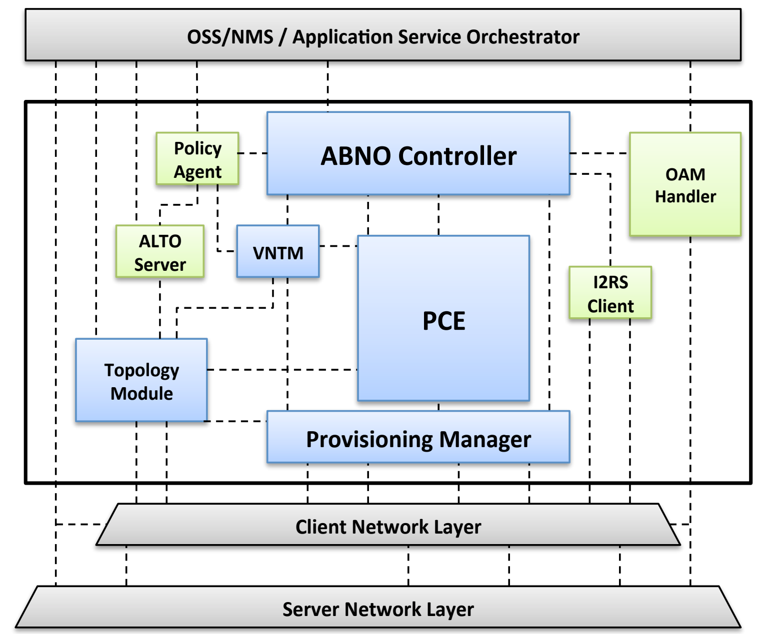
ABNO building blocks

- **ABNO Controller**
  - Main component of the architecture
  - Responsible of orchestrating
  - Request from the NMS/OSS and selects the appropriate workflow to follow in order to satisfy each request.
- **Policy Agent**
  - Stores the restrictions and policies
  - Responsible for propagating those
- **Path Computation Element**
  - Path computation across the network graph.
  - Coordination between multiple PCEs for multi-domain (for example, inter-AS) or multi-layer networks.
  - Instantiation capabilities.



ABNO building blocks

- **Virtual Network Topology Manager (VNTM)**
  - Maintaining the topology of the upper layer by connections in the lower layer.
  - Simplifies the upper-layer routing and traffic engineering decisions.
- **Topology Module.**
  - Retrieve and provide network topology information, both per-layer topologies as well as inter-layer topology.
- **Provisioning Manager.**
  - In charge of configuring the network elements so the LSP can be established.
  - There are several protocols that allow the configuration of specific network resources such as Openflow, Netconf, CLI and PCEP.



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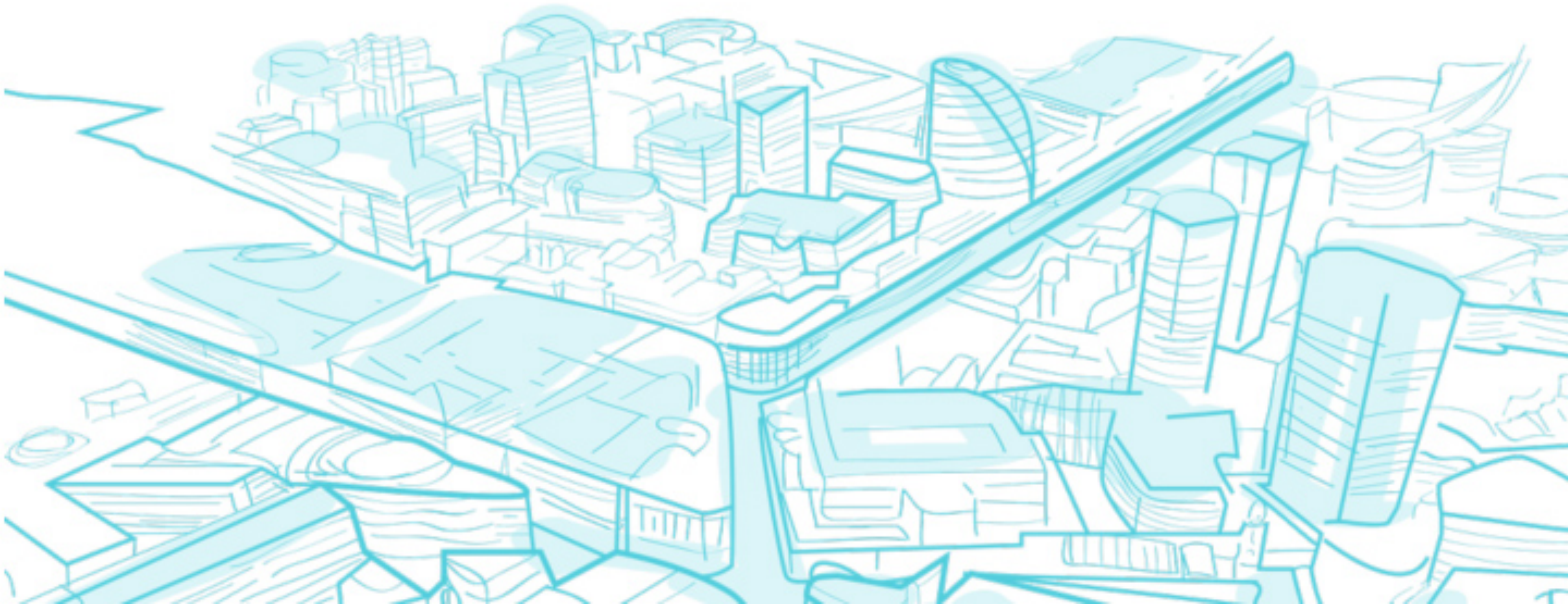
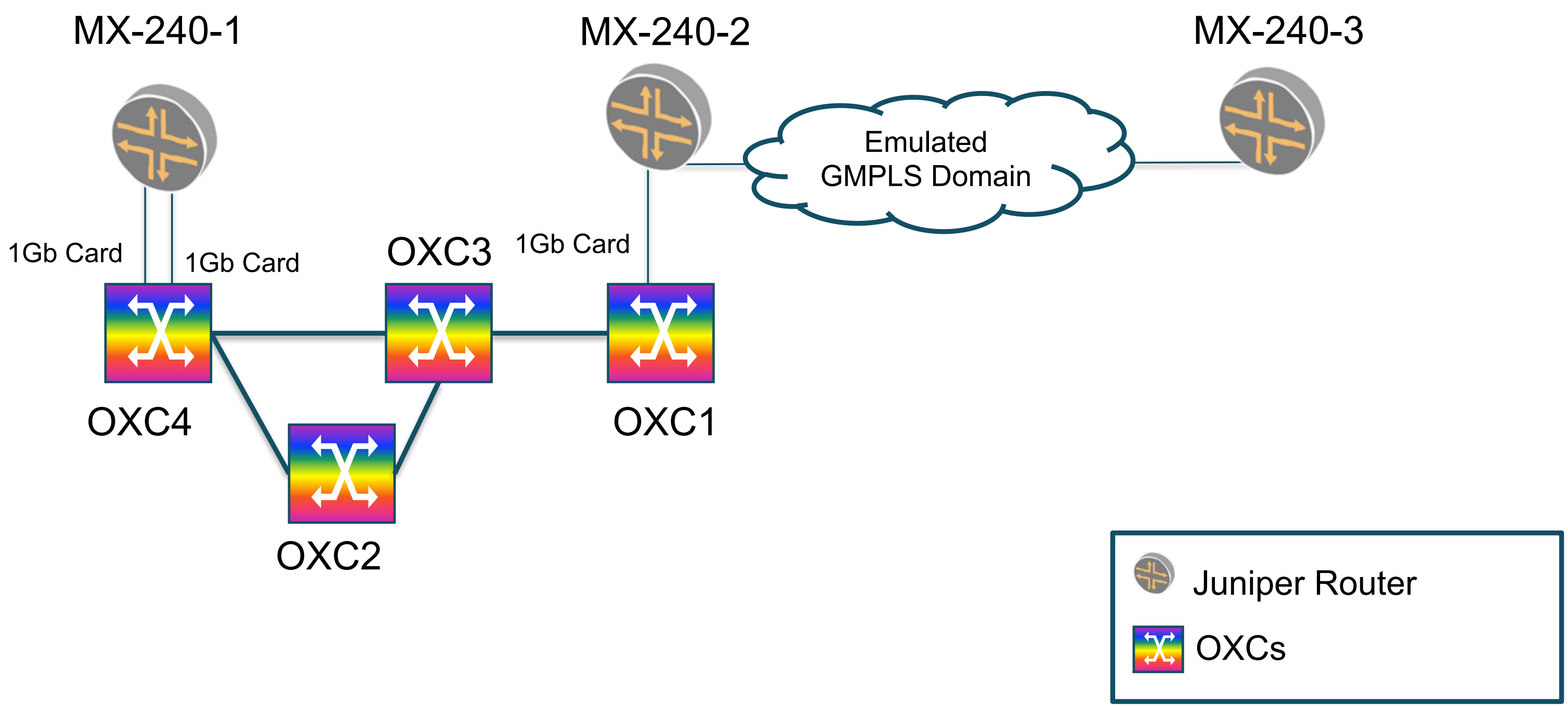
Test-bed Set-up

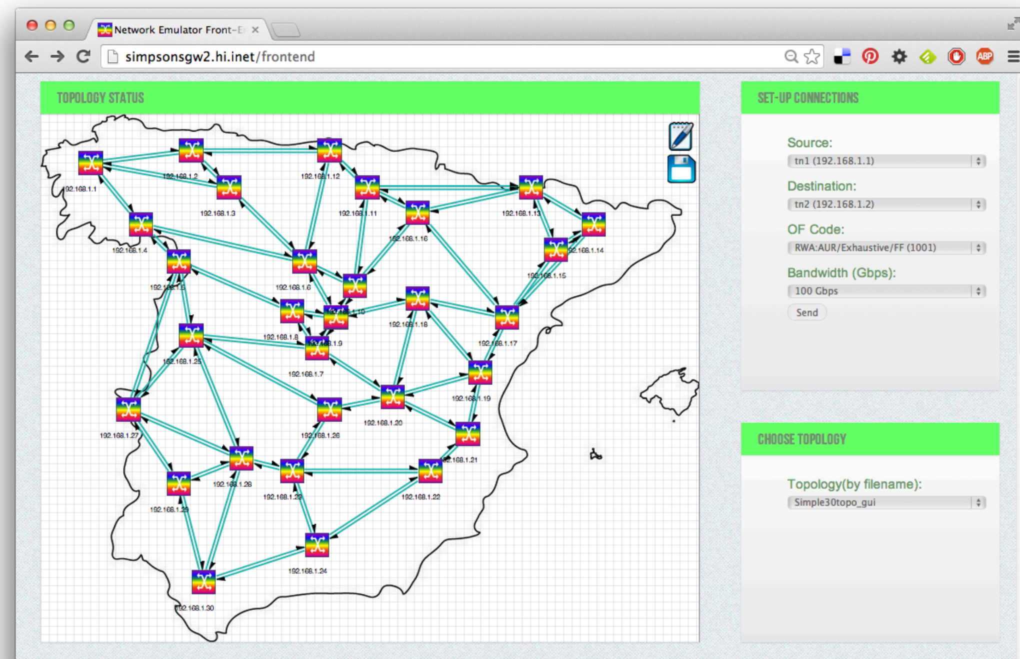


Test-bed Set-up



GMPLS emulated domain

- Telefonica I+D control plane test bed is composed by 30 GMPLS nodes.
- Each GMPLS controller is a VM and all are running is a server with two processor Intel Xeon E5-2630 2.30GHz, 6 cores each, and 192 GB RAM.
- CP running in the demo is flexgrid.



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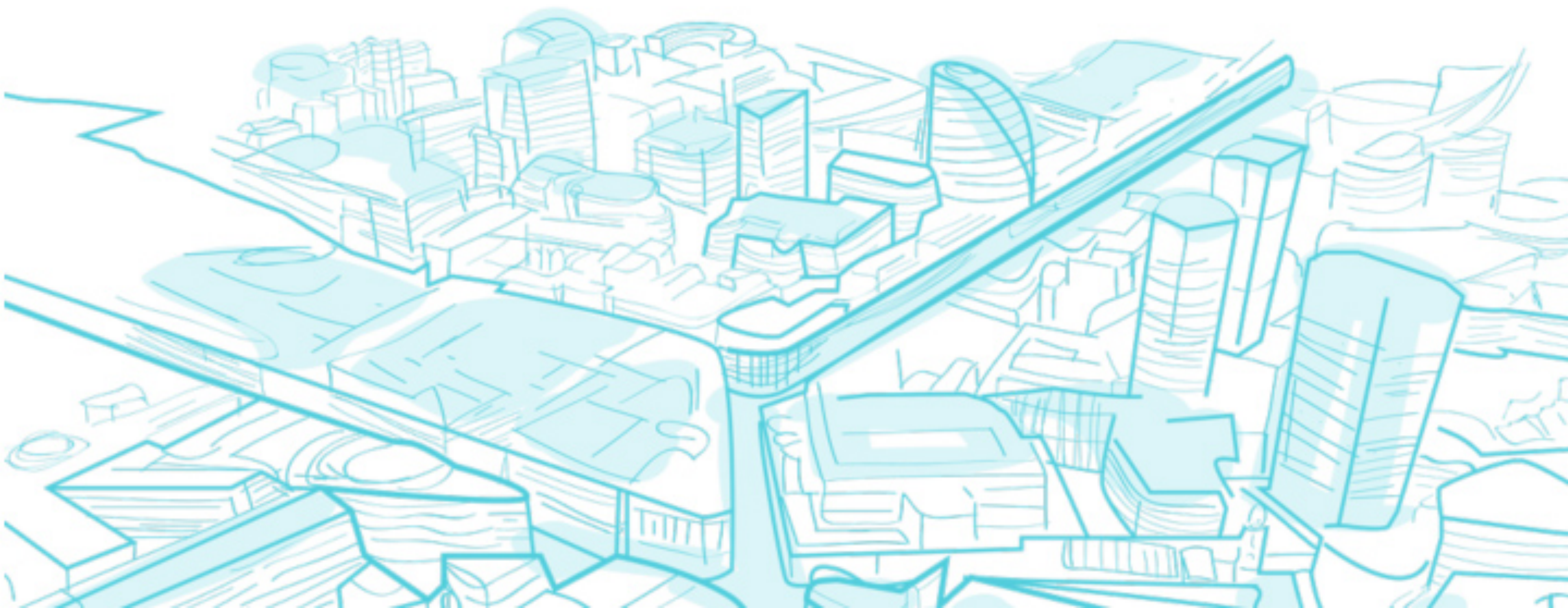
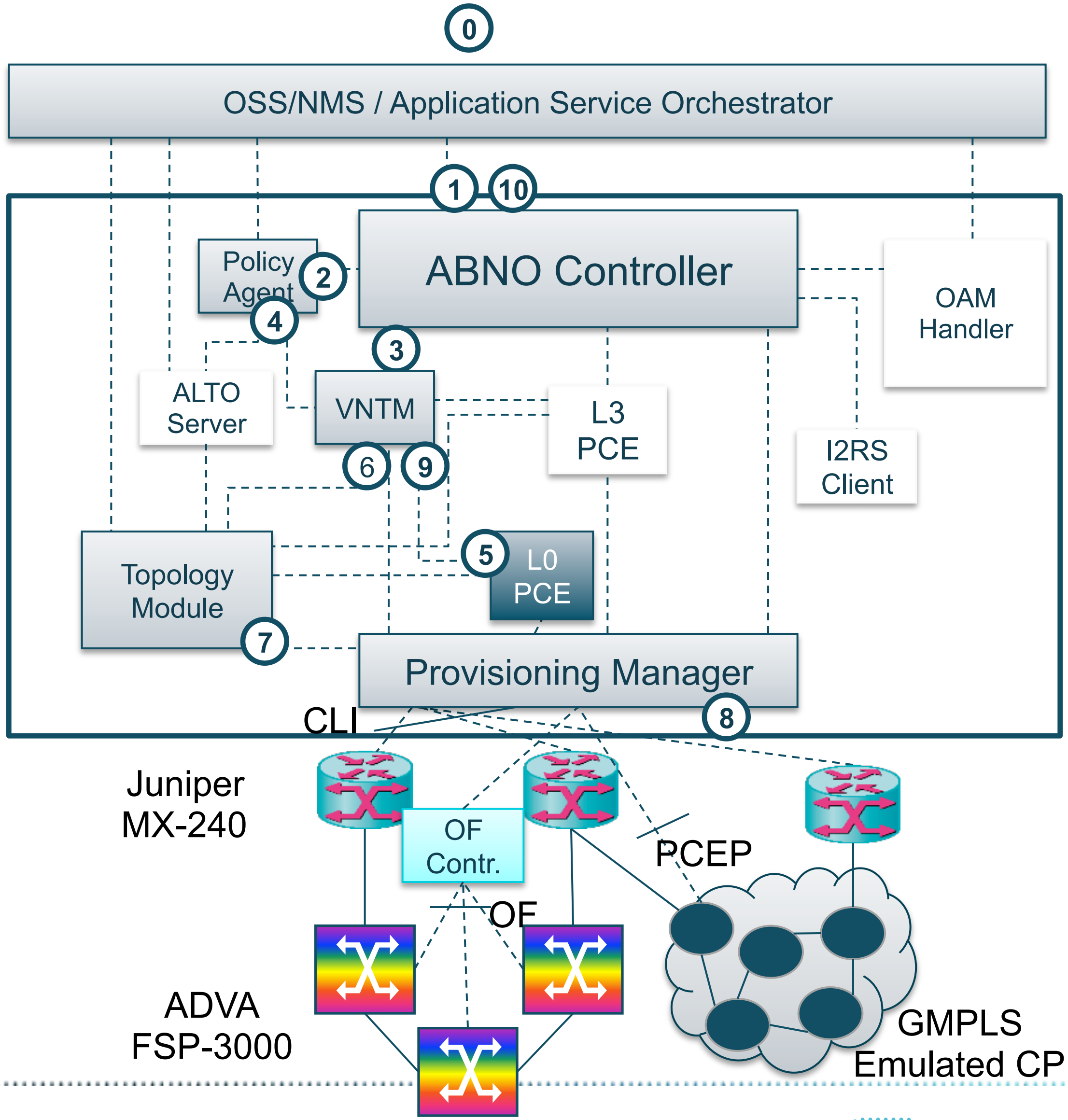
Results



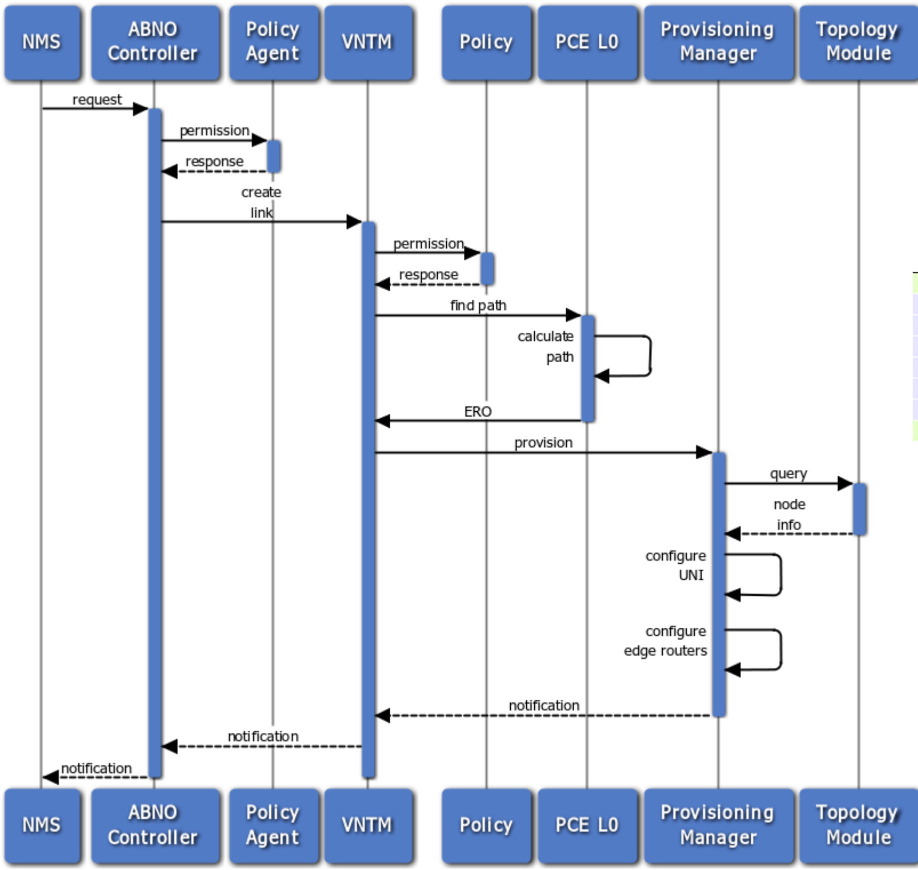
IP Link Provisioning

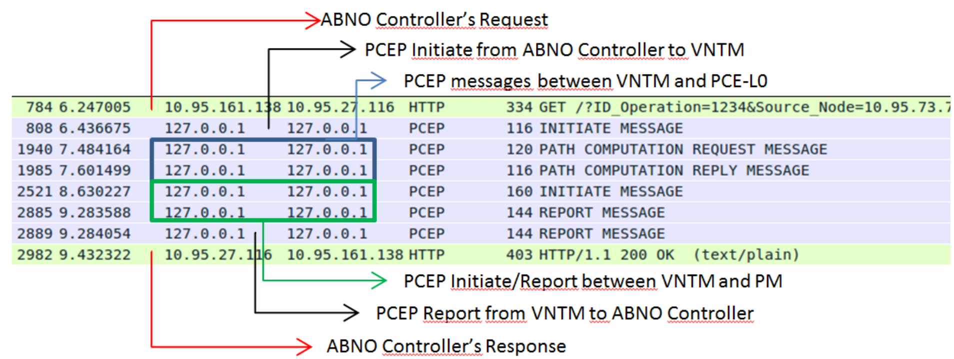


1. NMS requests for a path between two L3 nodes. This request includes the IP of R1, R2, the configuration IPs IP1 and IP2) and the IGP id (RFC6107)
2. ABNO controller verifies right asking to the Policy Manager.
3. ABNO controller asks VNTM to create a new link between the two routers.
4. VNTM checks rights for the operation.
5. VNTM requests L0 PCE to set-up a path between two locations.
6. VNTM completes ERO with the interlayer links and sends the response to the Provisioning Manager.
7. Provisioning Manager gets the topological information from the Topology Module.
8. Provisioning manager creates the path using the required interface for each node (OF, PCEP, CLI, etc.)
9. Provisioning Manager advertises that path is set-up properly.
10. NMS is notified that the connection is properly set-up.

IP Link Provisioning Use Case

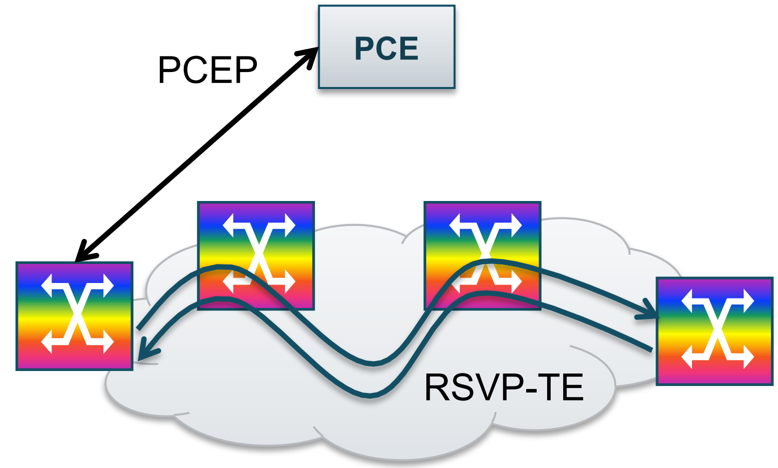
This image shows the temporal workflow for the IP Link provisioning use case





784	6.247005	10.95.161.138	10.95.27.116	HTTP	334 GET /?ID_Operation=1234&Source_Node=10.95.73.7
808	6.436675	127.0.0.1	127.0.0.1	PCEP	116 INITIATE MESSAGE
1940	7.484164	127.0.0.1	127.0.0.1	PCEP	120 PATH COMPUTATION REQUEST MESSAGE
1985	7.601499	127.0.0.1	127.0.0.1	PCEP	116 PATH COMPUTATION REPLY MESSAGE
2521	8.630227	127.0.0.1	127.0.0.1	PCEP	160 INITIATE MESSAGE
2885	9.283588	127.0.0.1	127.0.0.1	PCEP	144 REPORT MESSAGE
2889	9.284054	127.0.0.1	127.0.0.1	PCEP	144 REPORT MESSAGE
2982	9.432322	10.95.27.116	10.95.161.138	HTTP	403 HTTP/1.1 200 OK (text/plain)

PCEP to remotely initiate GMPLS LSPs



- PCInitiate message can be sent to an element to create a new path between two points.
- When the network element receives this message it can propagate it via RSVP-TE.
- This procedure allows to do remote LSP configuration.
  - ABNO → PCE → NE
- There is no support of this mechanism for Pseudowires, neither for OF nor PCEP.

PCEP Initiate from PM to the first node.

RSVP messages (PATH/RESV) between topology nodes.

59.153408	192.168.1.2	192.168.1.9	PCEP	186	INITIATE MESSAGE
59.188846	192.168.1.9	192.168.1.10	RSVP	190	PATH Message. SESSIOI
59.481235	192.168.1.10	192.168.1.9	RSVP	254	RESV Message. SESSIOI
59.537559	192.168.1.9	192.168.1.2	PCEP	214	REPORT MESSAGE

PCEP Report from the first node to PM.

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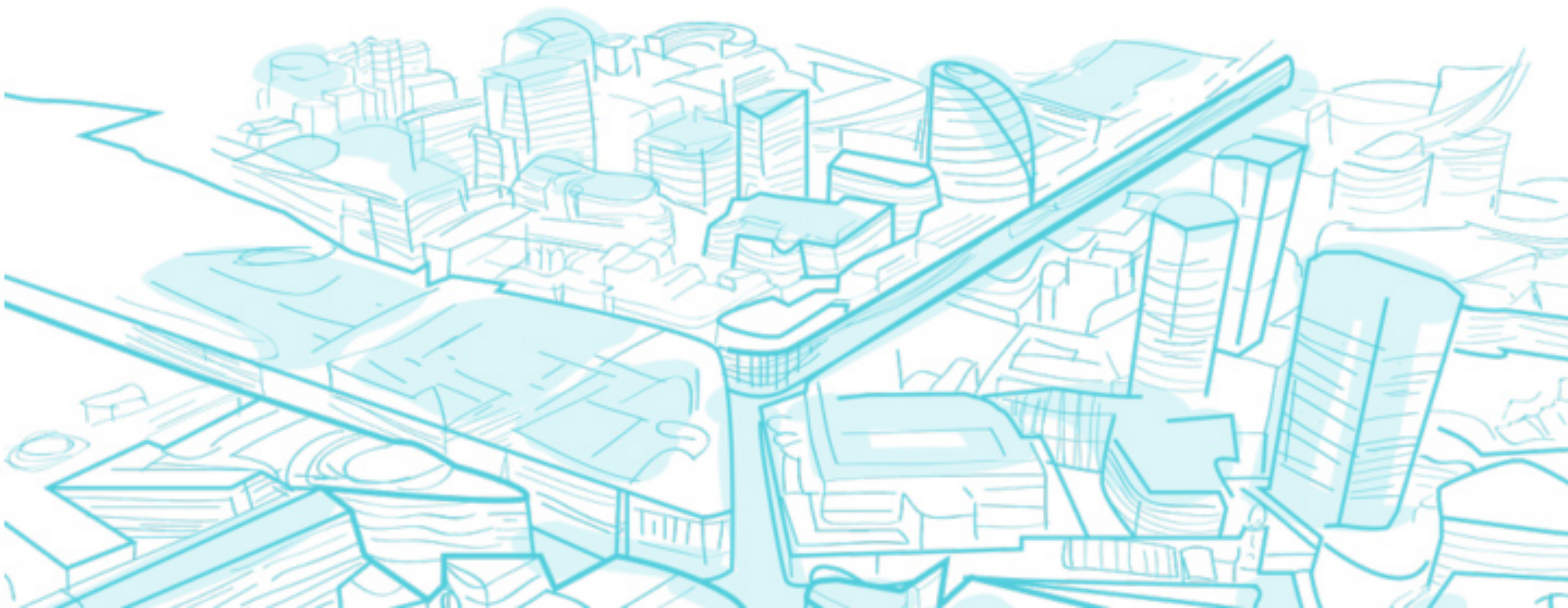
Conclusions



Conclusions and next steps

- The new control architecture proposed enables **automated** and **simplified network service provisioning** through different network **segments** (metro, core, data center…) and **technologies** (IP/MPLS, optical, OpenFlow…)
- Such automation and simplification could be achieved by applying two complementary measures:
  1. Network configuration points **minimization** by transferring multidomain and multilayer provisioning functionalities from **NMS** to the **control plane**.
  2. Unified network configuration and **orchestration** mechanisms enabling **end to end network provisioning** according to service and network optimization criteria.
- The network orchestrator proposed in this project is based on the ABNO architecture being defined in the IETF.
- Three different ABNO use cases are prototyped and demonstrated in the project (one with a field trial) and another use case with remote demos.

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