Why do operators need multi-layer coordination?

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Network Architecture Geeks (NAG)
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Index

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01

Towards Cloud-Ready Transport Networks

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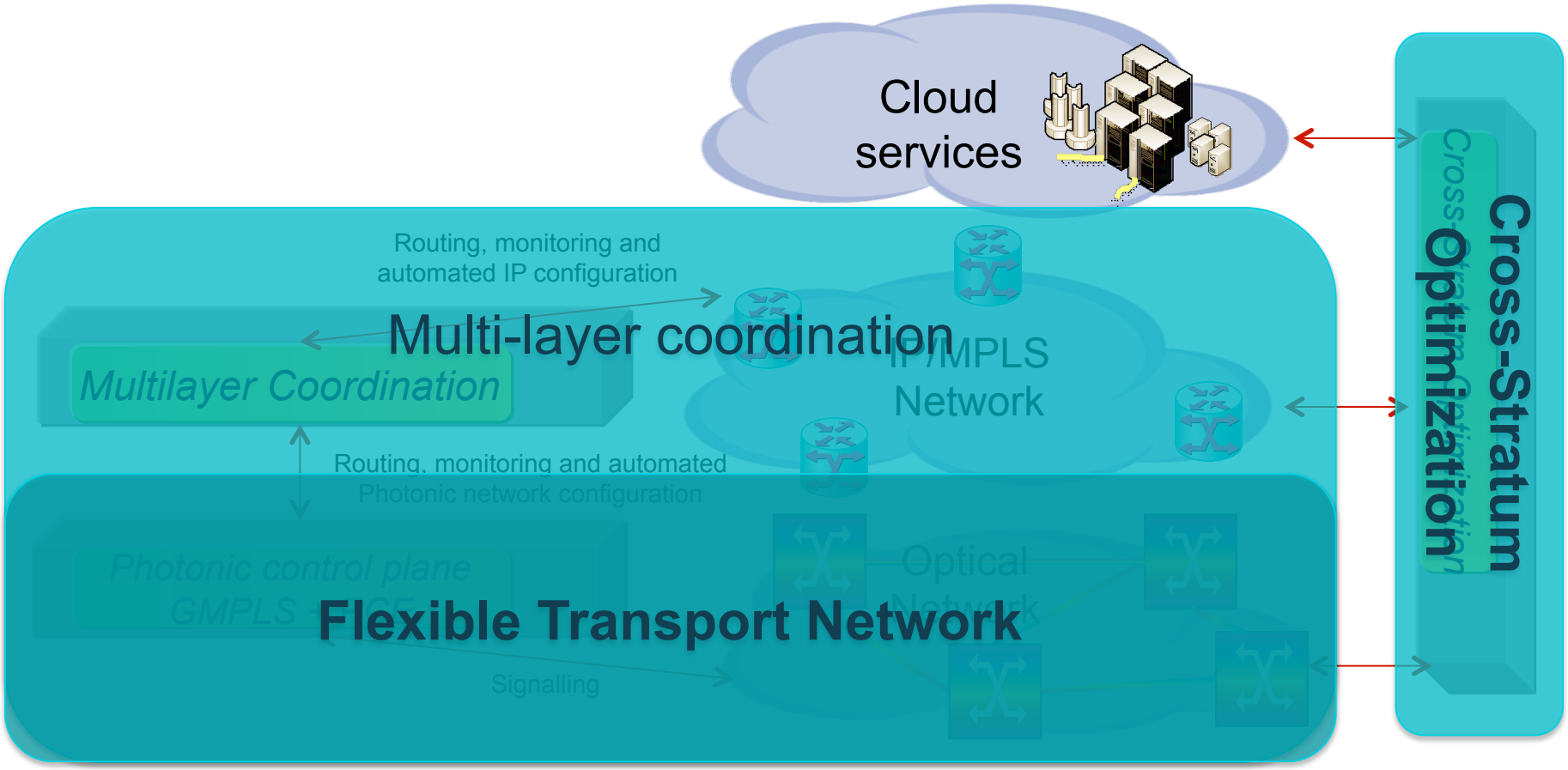


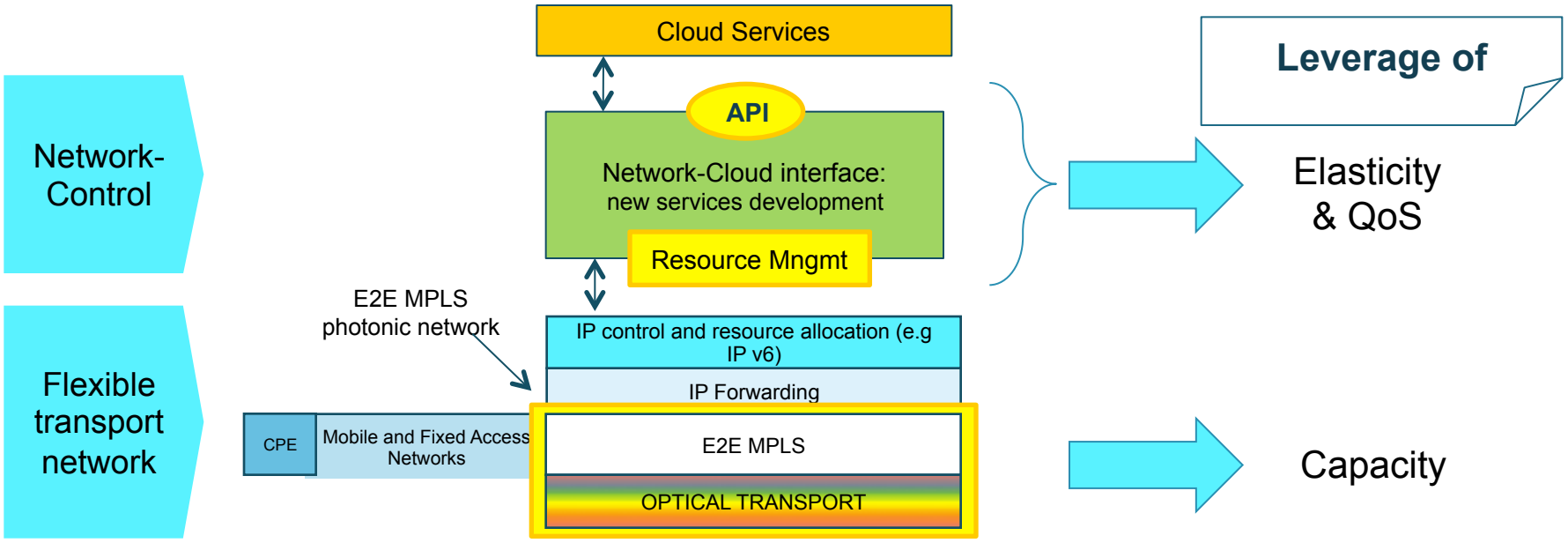
L. M. Contreras, V. López, O. González de Dios, A. Tovar, F. Muñoz, A. Azañón, J.P. Fernández-Palacios, J. Folgueira: Towards Cloud-Ready Transport Networks, in IEEE Communications Magazine, September 2012, Vol. 50, Issue. 9, Pages. 48 - 55.

Cloud-ready Network Approach

Cloud Ready Networks rely on two main technological pillars

- **Network Control**
- **Flexible Transport Network**

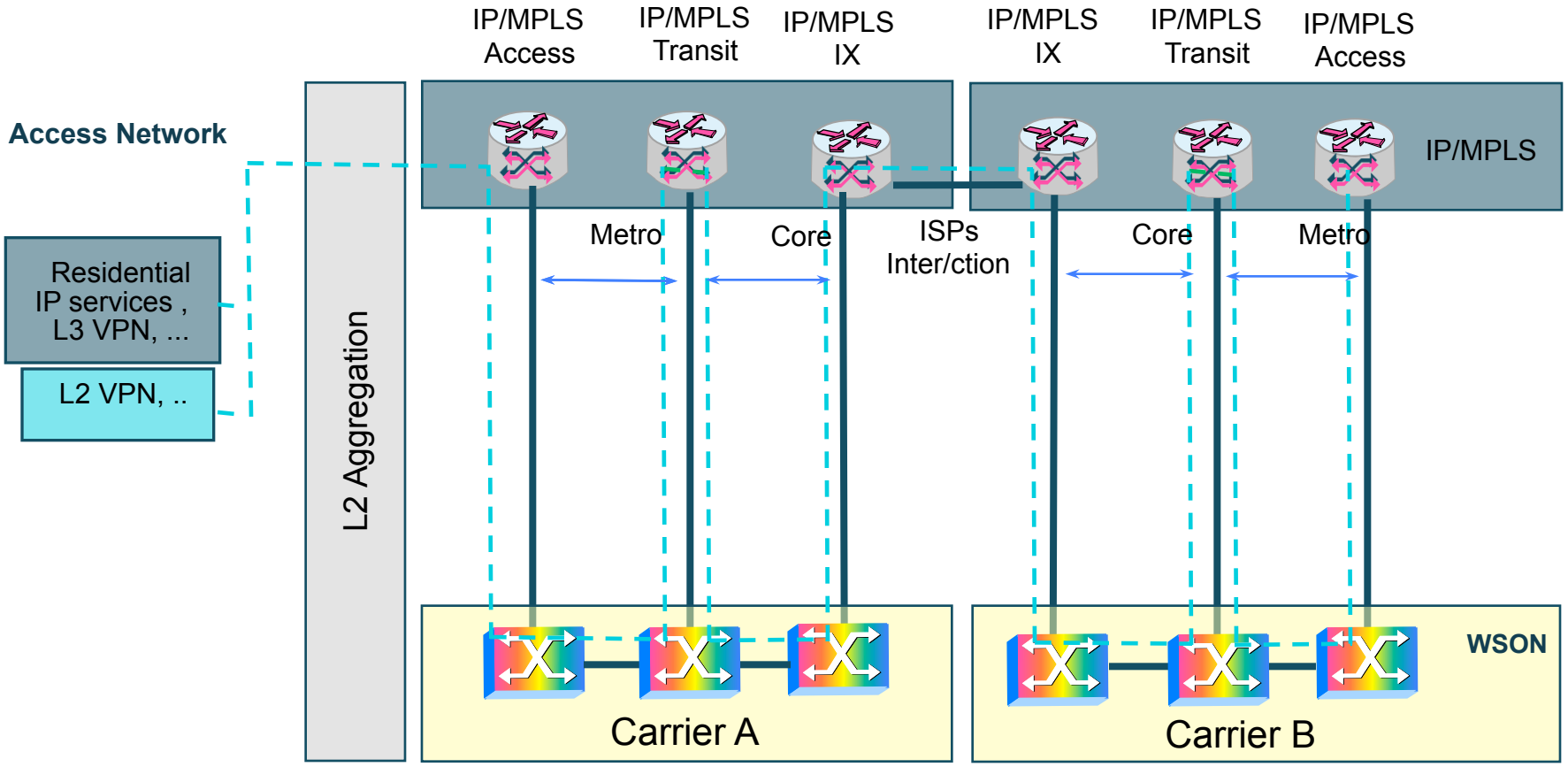
- The target is an E2E network able to perform automated connectivity control between end users and cloud data centers
- This innovative network model aims to:
  - ✓ Accelerate service provisioning and performance monitoring
  - ✓ Enable on-demand connectivity configurations (e.g bandwidth) by end users
  - ✓ Optimize both cloud costs and power consumption
  - ✓ Guarantee the required QoS/QoE (…) for real time and video services



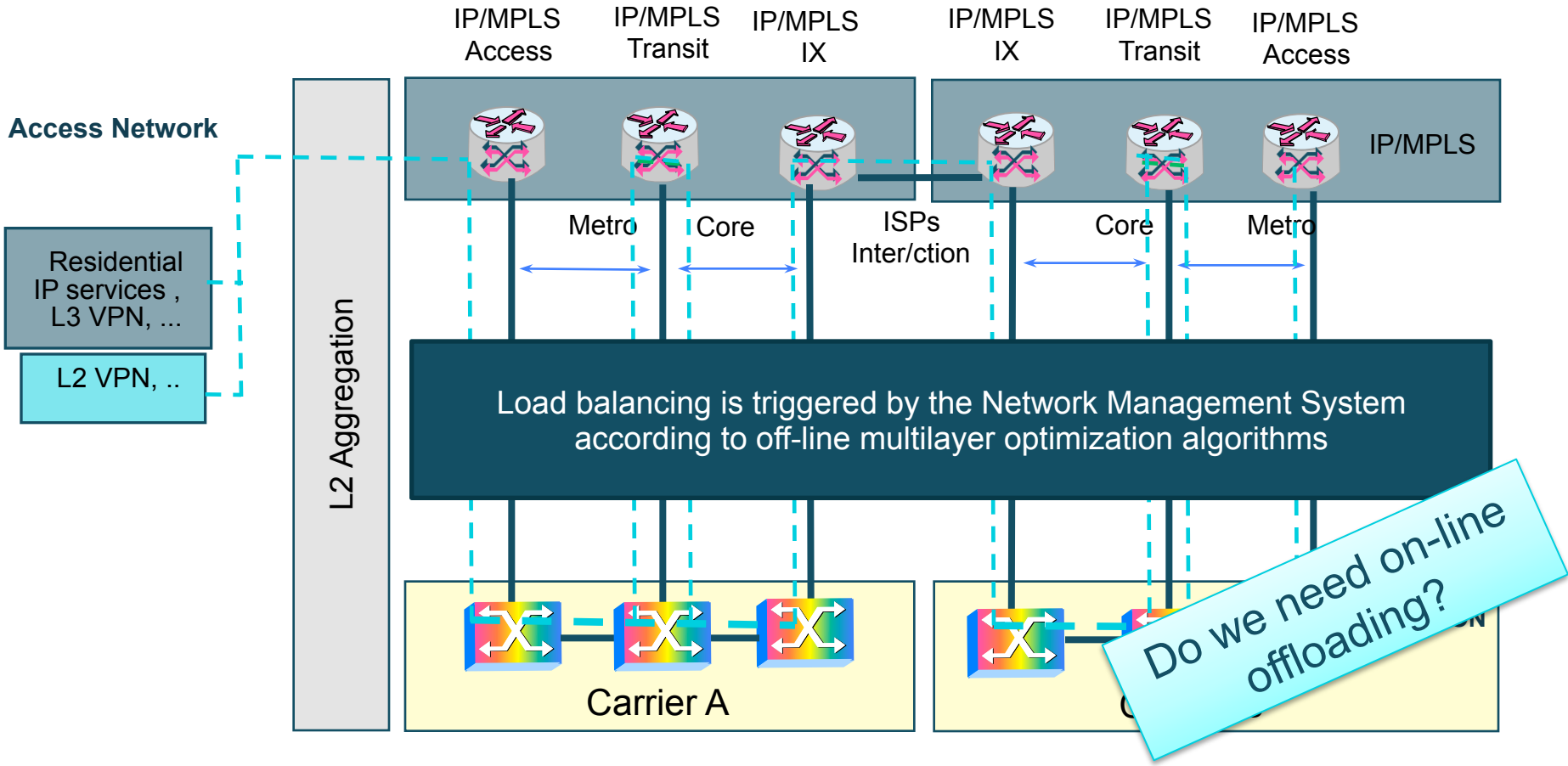
02

Multi-layer networks

Independent Layers

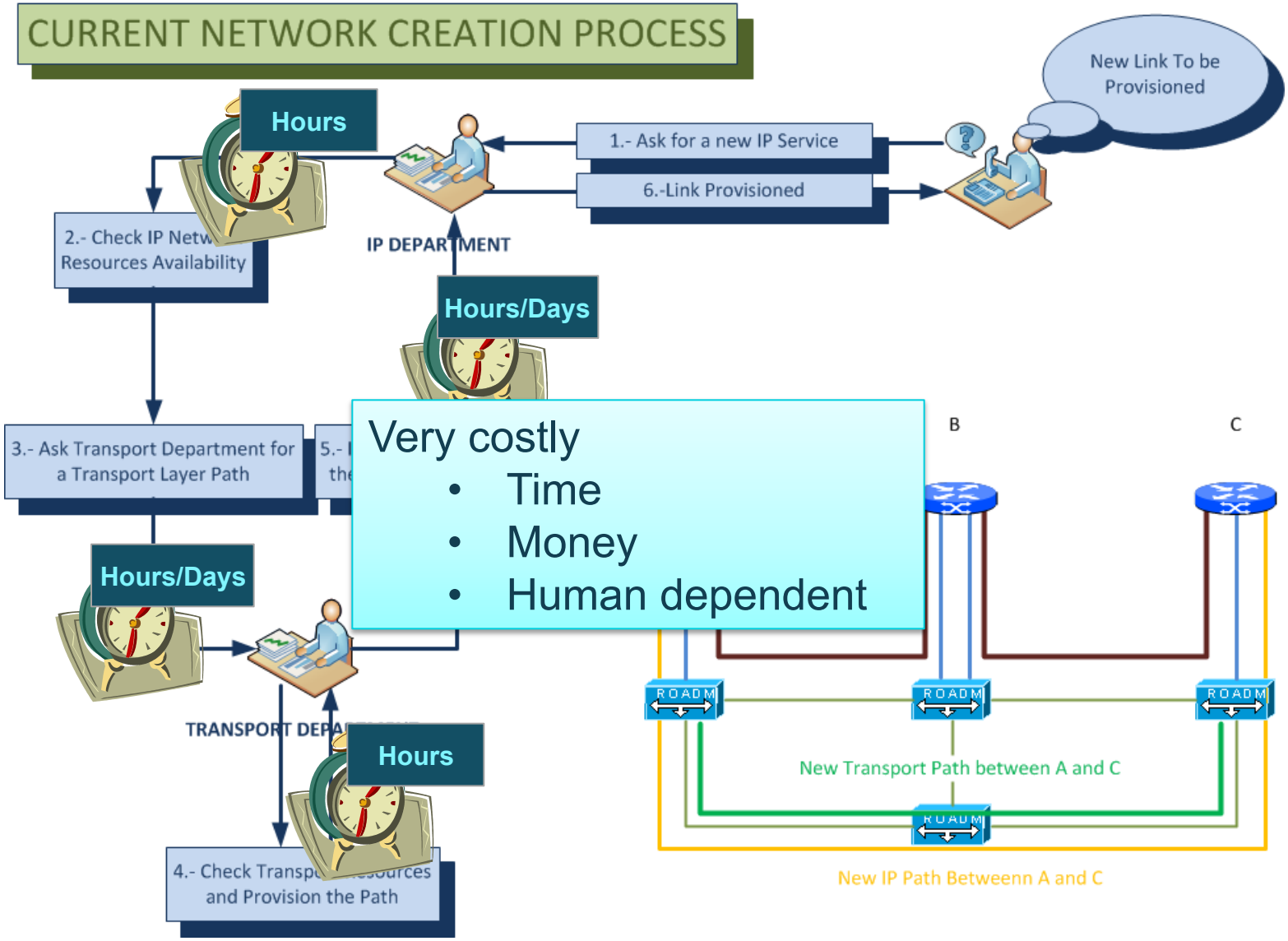


Current Multilayer Coordination

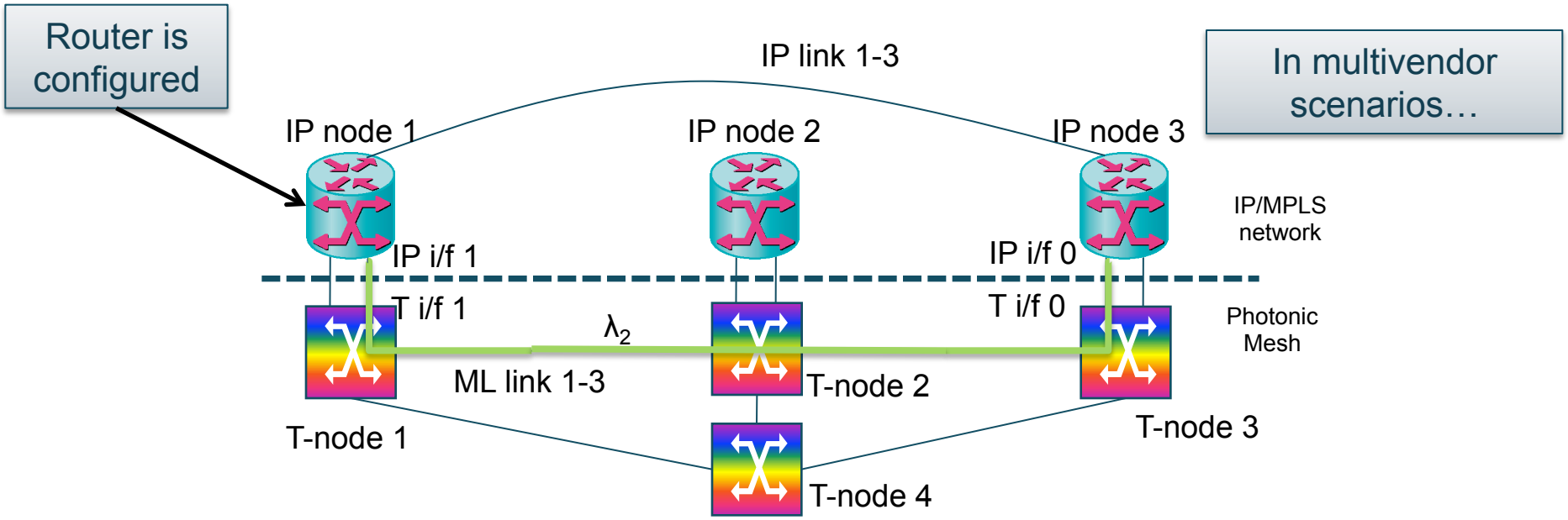


Load balancing between IP/MPLS and WSON. High capacity flows (e.g between IP access and IP interconnection) are directly transported over WSON

Current multi-layer provisioning



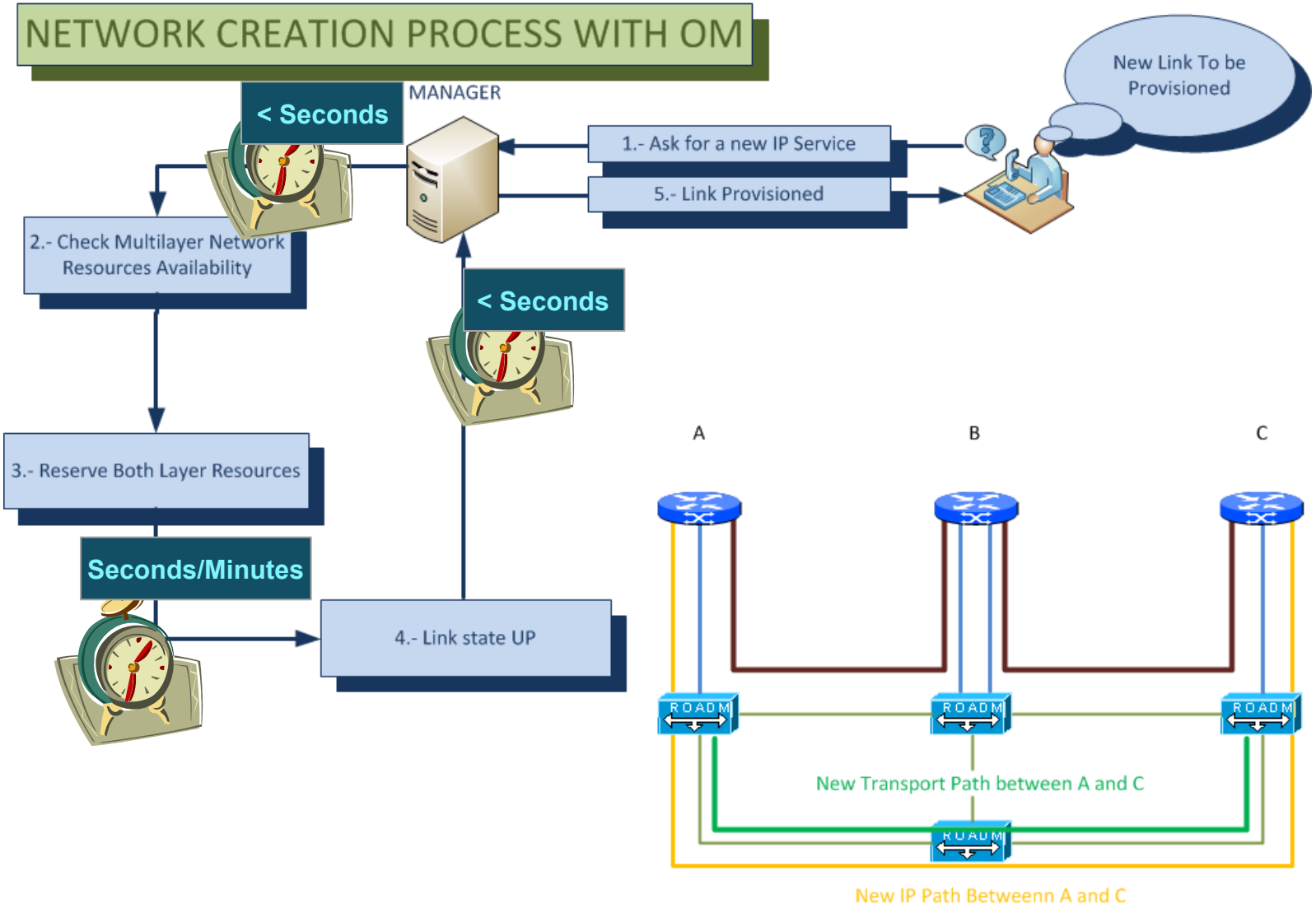
What do we want of a multi-layer network?



Pending standardization work NOW!!

- Standard interface to configure the routers.
  - NETCONF is standard (RFC 6241), but data models are vendor dependent.
  - Openflow enables standard configuration of flow tables. Is it enough?
- Interaction between the PCE and the VNTM for multi-layer networks.
  - An element is required to configure VNT to the upper layer through a standard interface.
  - Functional validation of the cooperation between Virtual Network Topology Manager (VNTM) and Path Computation Element (PCE), IPOP 2012.

Automated Multi-layer Provisioning

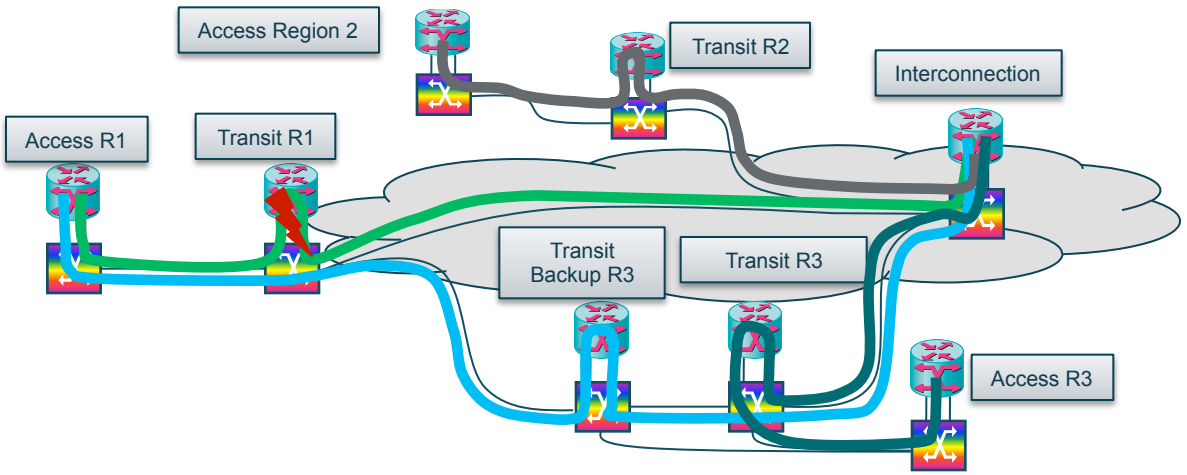


03

Multi-layer restoration

Multi-layer Restoration

- Multi-layer restoration consist on using the increased DWDM layer connectivity and dynamicity to recover both layer failures.
- Multi-layer restoration allows to increase availability due to the higher number of resources to drive traffic available.



"The Economics of Next-Gen ROADM Networks", Heavy Reading September 2012.

Multilayer restoration: Alternatives comparison

	1+1 Protection and Multilayer Restoration	1+1 Protection, multilayer restoration (additional router)	Multilayer restoration only
OPEX	Reduction	Highest reduction	No change
CAPEX	No change	Increase	Reduction
Failure recovery time	1st failure: 50 ms 2nd failure: 1 minute (approx) without FRR	1st failure: 50 ms 2nd failure: 50 ms	1st failure: 1 minute (approx) without FRR 2nd failure: 1 minute (approx) without FRR

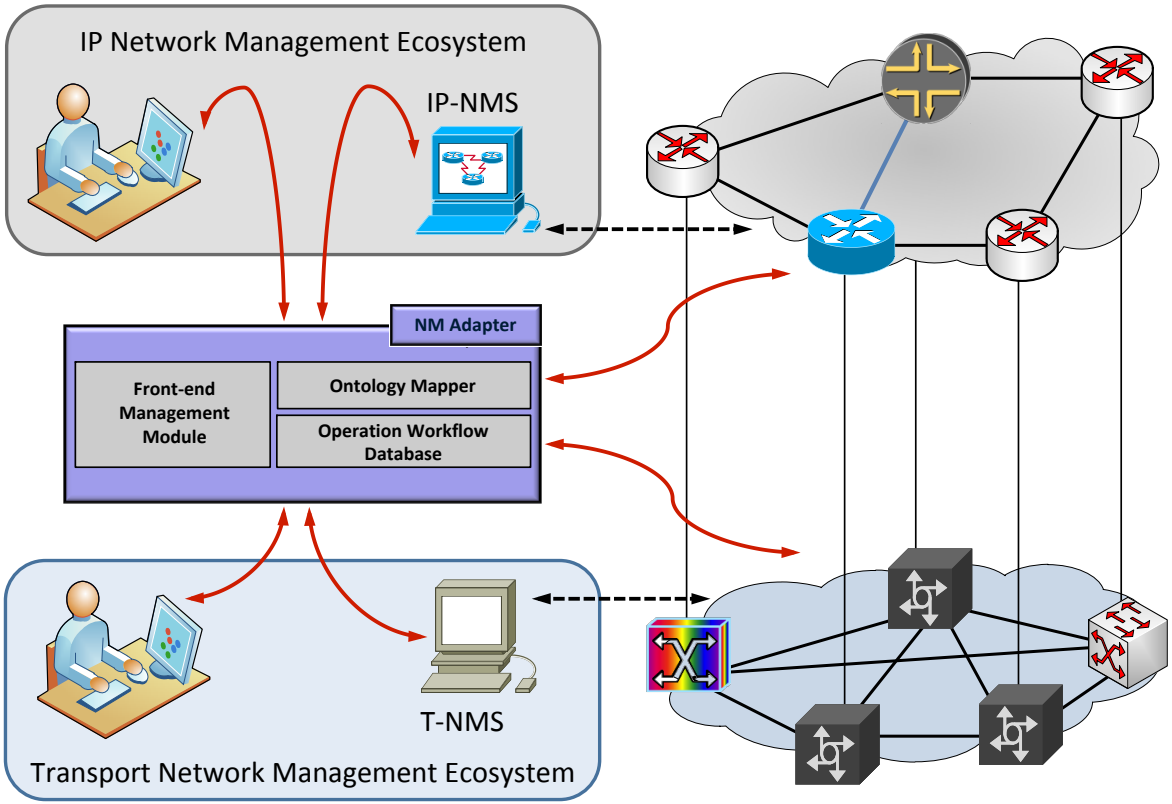
04

Demonstrations

FP7 STREP ONE
Project

ONE project

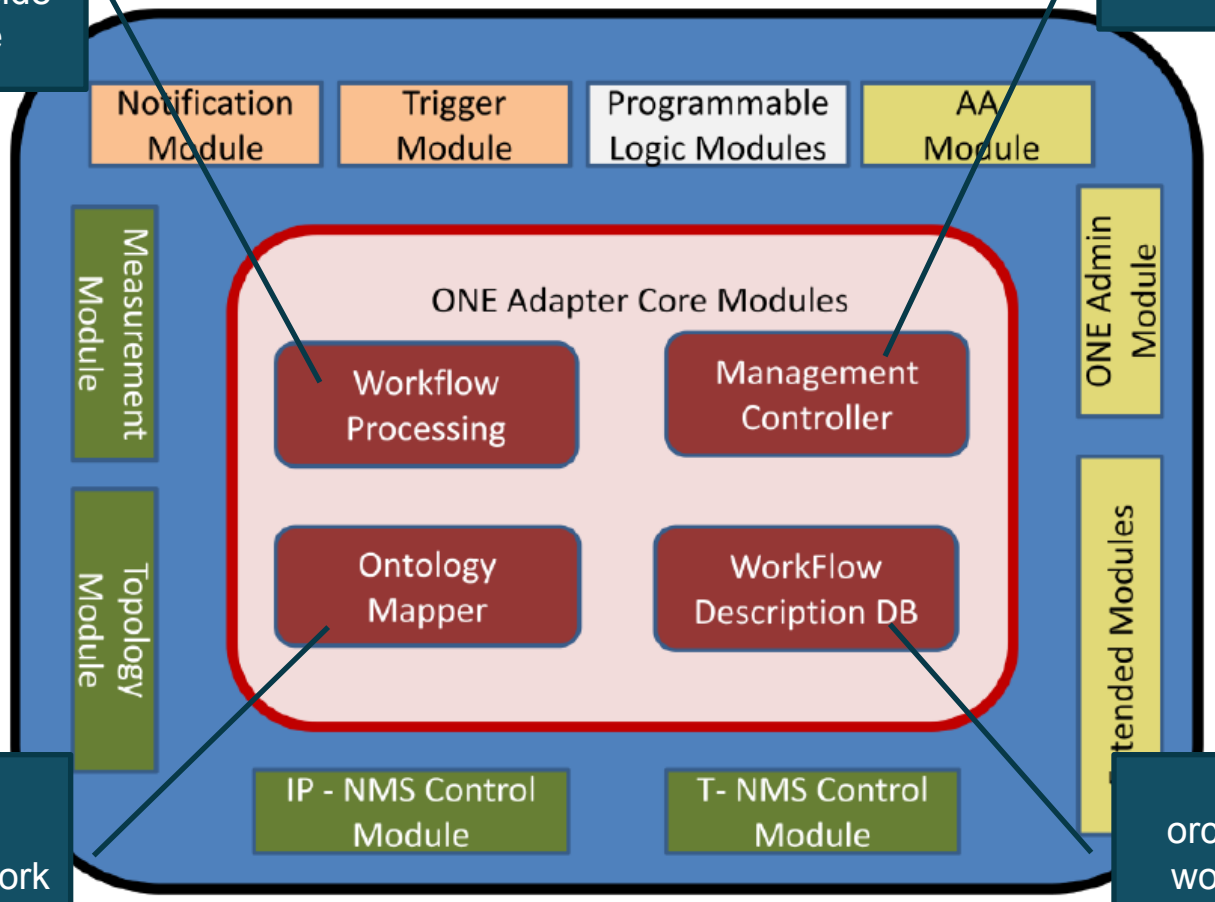
- The project has three main contributions:
  - A Network Management Adapter
  - Semantic Adaptation
  - A Programmable Management Framework
- ONE adapter enables:
  - Dynamic IP service provisioning.
  - Automatic IP Offloading.
  - Multi-layer Restoration.



Building blocks

Execute the process orchestration inside the ONE core

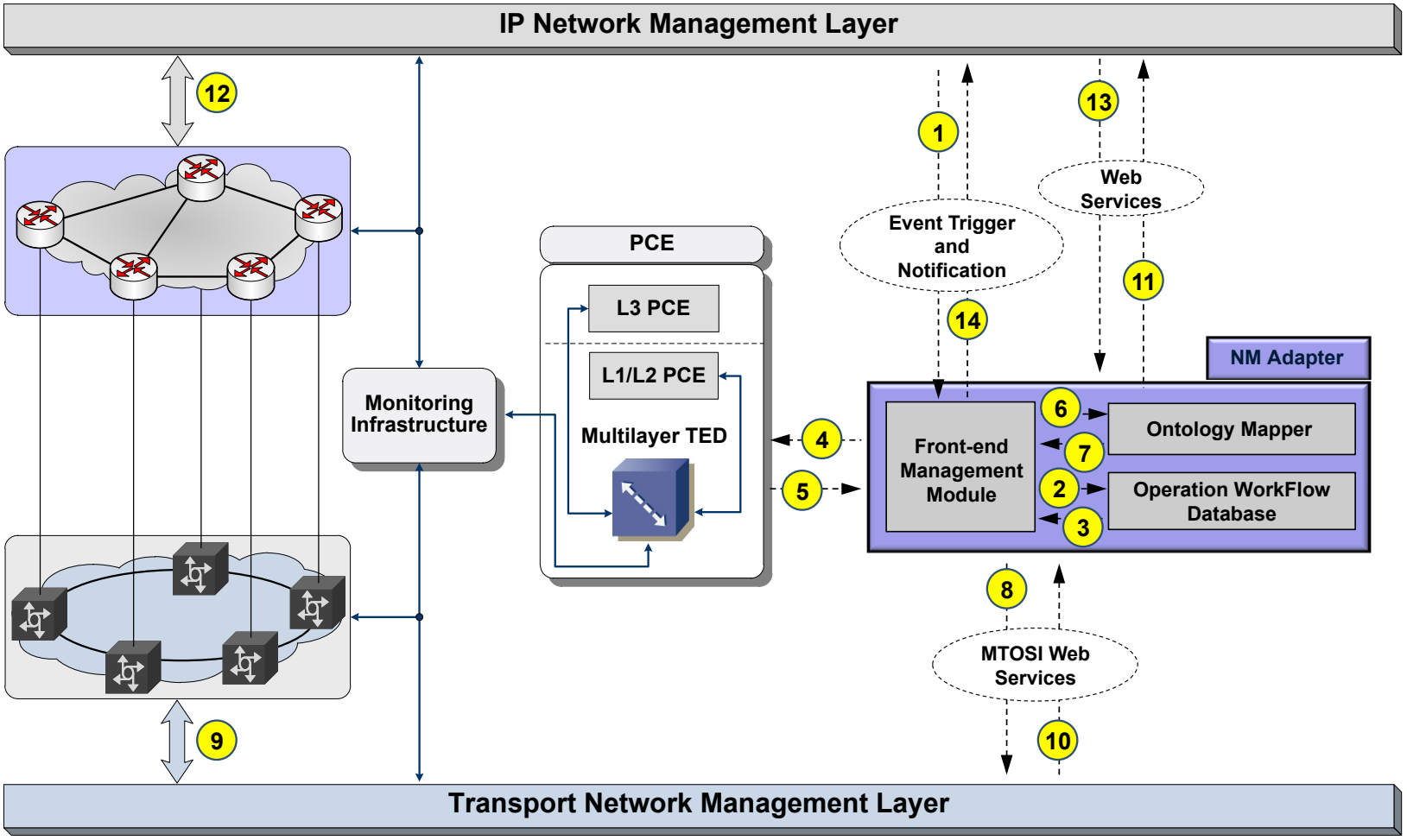
Responsible of the ONE adapter configuration



Enable interoperability between two network management layers

Store the orchestration and workflows for the processes

Example of ONE adapter operation – Automatic IP Link Provisioning

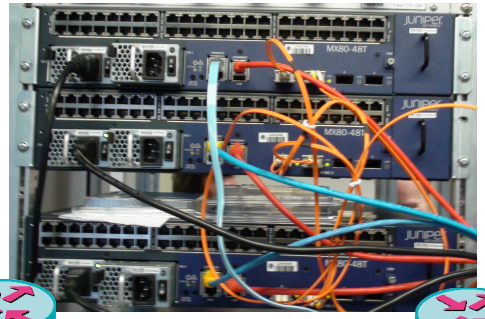


O2 Germany Field Trial

O2 Germany Field Trial

- Multi-layer operation is demonstrated in an O2 field trial with ONE adapter.
- Network scenario:
  - IP/MPLS equipment from Juniper (MX-240).
  - Optical transport equipment from ADVA.
  - UNI interface between Juniper and ADVA.
  - Multi-layer Manager
- The Multi-layer Manager is used for:
  - Supervise joint network configuration.
  - Automatic configuration based on network information.
  - Restoration under failure situation.

O2 Germany – Data Plane Topology



ROSTOCK

SCHWERIN

Configuration via CLI

Multi-layer Manager

UNI

MX-80 R_ONE

MX-80 R_TWO

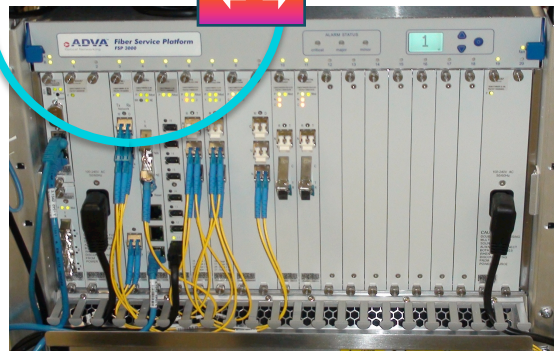
MX-80 R_THREE

ADVA ONE

ADVA TWO

ADVA THREE

HAMBURG



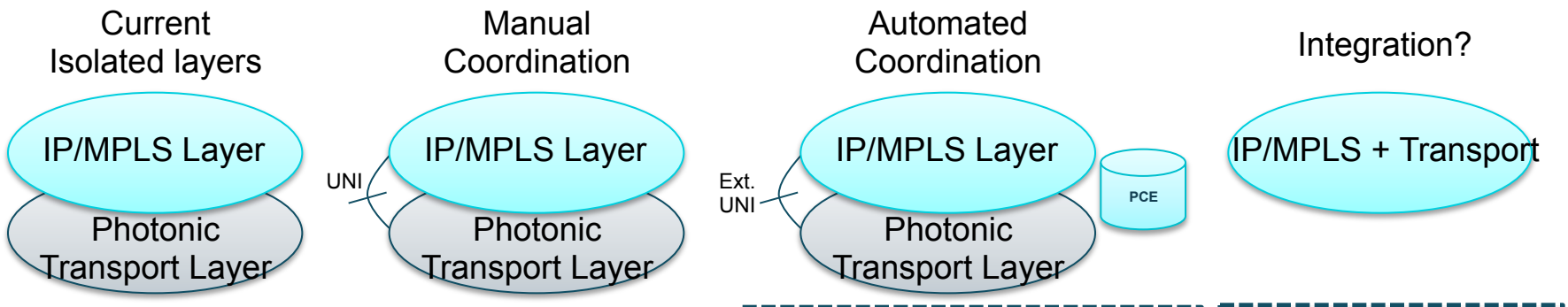
O2 Germany Field Trial - Tests

- Test Summary:
  - GMPLS path creation and deletion via UNI
  - Automatic IP Link Provisioning
  - Automatic IP Offloading
  - Multi-layer Restoration

05

Further steps

Multi-layer target architecture



Lack of Standardization

Interoperability

- Inefficient resource utilization
- Manual operation (IP and transport)
- Duplicated protection

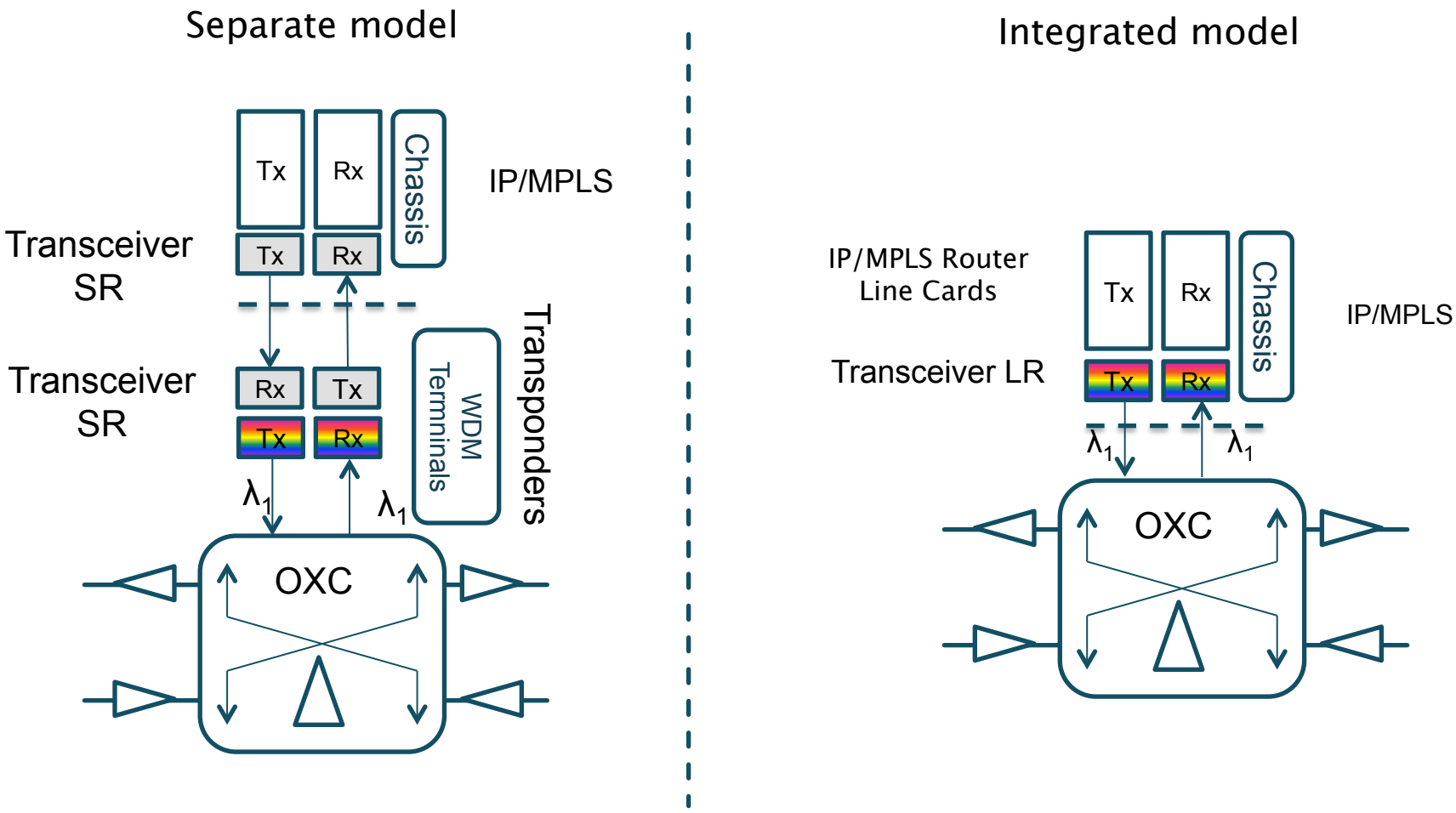
- Automated operation (only at transport level)

- Improved resource utilization
- Automated operation (MPLS and transport)
- Coordinated protection

- Optimum resource utilization

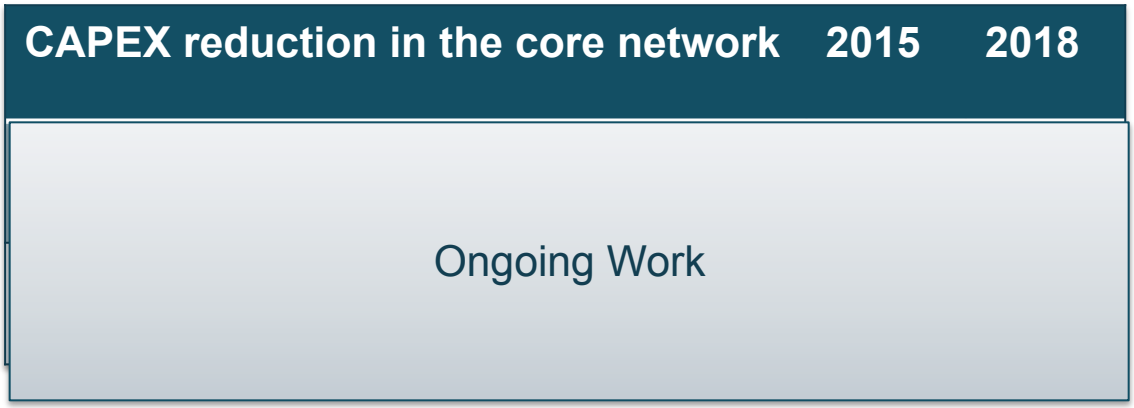
- The target multi-layer control plane to enable automatic operation and coordinated protection is based on:
  - Hierarchical LSPs and Forwarding Adjacencies → Scalability.
  - Extended UNI interface:
    - UNI enables automatic transport connection set-up.
    - Extended UNI allows multi-layer information dissemination (TE-link, SRLGs, etc.), simplifying operation and resource utilization.
  - Multi-layer PCE → Enable scalable resource optimization and interconnection.
  - Configuration mechanisms enabling automated IP routers configuration according to the new physical topology (e.g NetConf, OpenFlow). VNTM is required for this operation

Data Plane Integration



Data Plane Integration - Results

- Based on current traffic in Telefonica of Spain network, traffic is increased each year 50%.



Integrated port cost is varied since its price is not clear

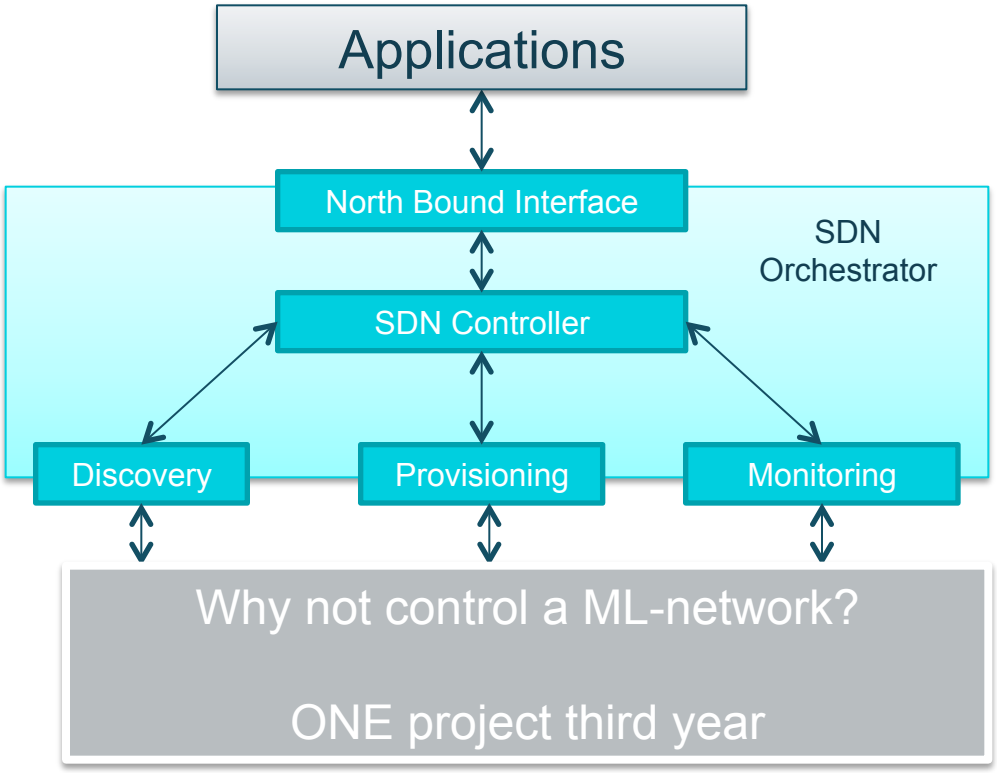
- CAPEX savings are great but… data plane integration implies:
  - Department integration.
  - Control plane interoperability between multiple optical equipment vendors.
  - And… optical compatibility of the integrated transponders so multiple vendors can use integrated transponders.

Multi-layer coordination will do this

No effort in industry so far…

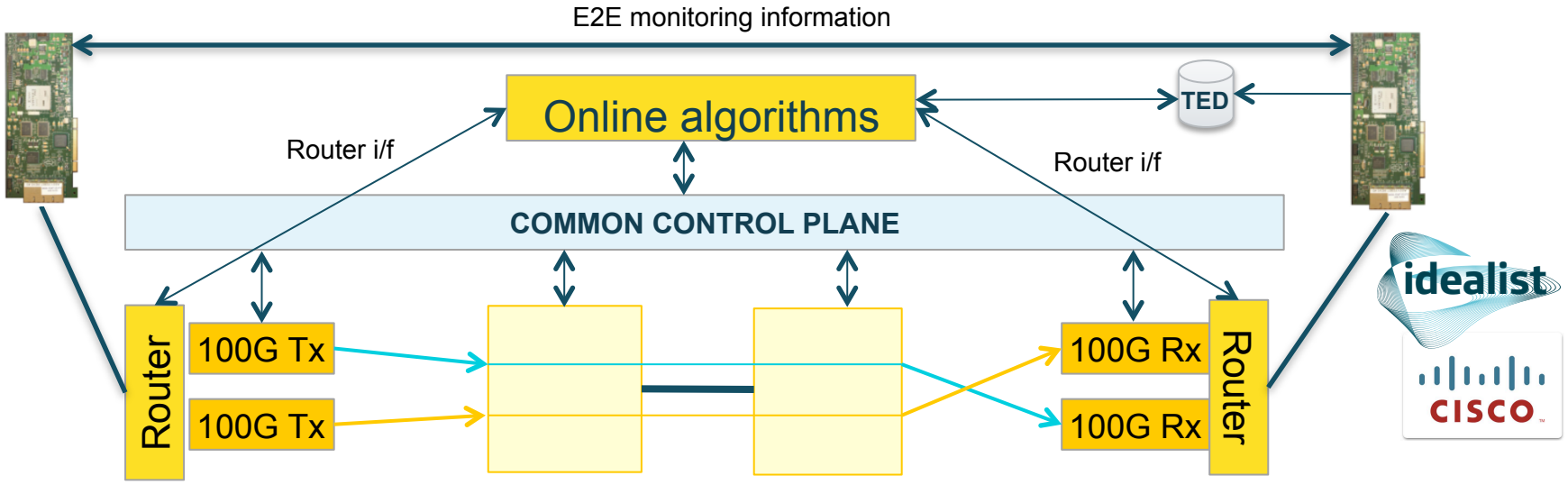
Software Define Networks for Multi-layer Architectures

- SDN appears as the old promise of real-time programmability of network functionalities.



Integration with Elastic Networks

- The elastic optical network can be configured based on:
  - Monitoring probes
  - Network status
  - Service
- Configuration can be done using:
  - Control plane
  - Management plane



06

Final Remarks

Final Remarks

1 **Savings**

- Automated multilayer coordination enables:
  - Network resources optimization (CAPEX reduction)
  - Operation simplification (OPEX reduction)

2 **ML Architecture**

- Based on based on a combination of standardized elements such as: extended UNI, multilayer PCE and VNTM enable multilayer interworking in multivendor networks

3 **Standardization**

- Some standardization is required:
  - Extended UNI
  - VNTM
  - SDN?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