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A Perspective on Software-Defined Networking for Optical Transport Networks

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SDN stands for Software-Defined Networking

What is SDN?

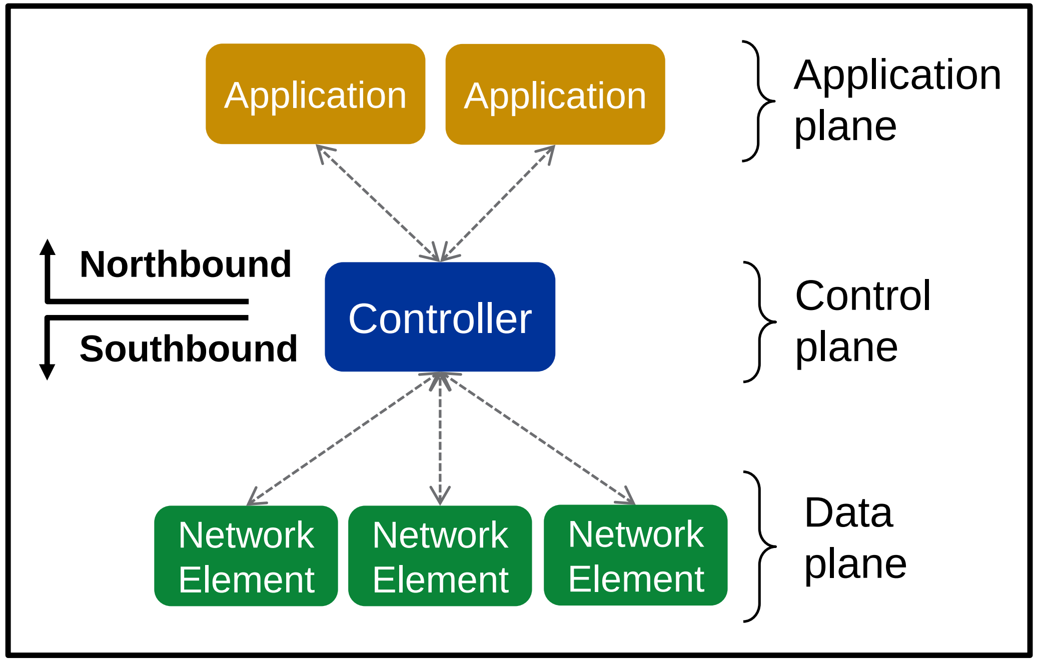
Centralized control architecture based on the separation of data and control planes

Advantages

- Global view of the network, leading to optimized decision making
- Scalable computation capabilities
- Commoditized hardware
- Oriented for automated (M2M) operations

Disadvantages

- Control and data plane interaction latency
- Hardware loses autonomy



What is the reference today?

Vertically-integrated solutions are the norm for optical transport

- All hardware and software is acquired from one vendor
- This also includes planning tools and network management system (NMS)

Advantages

- Turnkey solutions complying with carrier requirements
- Optical transmission performance is optimized
- Support and troubleshooting is provided by the vendor
- Accountability is easy to derive

Disadvantages

- Dependency from a single vendor for network upgrades (for both line system and transponders)
- Introduction of novel technologies may be difficult if not aligned with vendor roadmap
- Interconnection with other vendor equipment can only be done on the transponder client side
- May be difficult to mix equipment from different generations

The control plane

At first sight, the SDN architecture is not much different from a traditional NMS, however:

- NMS is inherently used for manual operations
- Covers fault, configuration, accounting, performance, and security (FCAPS) functions
- Uses proprietary northbound (NB) and southbound (SB) interfaces
- Supports legacy equipment
- Based on monolithic design

Unlike NMS, SDN can provide modularity and programmability

- The network provider management solution can interact with function-specific controllers that handle only a set of vendors/technologies (e.g., IP/MPLS or OTN/DWDM)
- Automated functions can be programmed on both orchestrator and controllers
- Open/standard interfaces are used between orchestrator and controllers
- Simple design and easy code upgrade
- Enable third-party software development

SDN for optical transport: option A

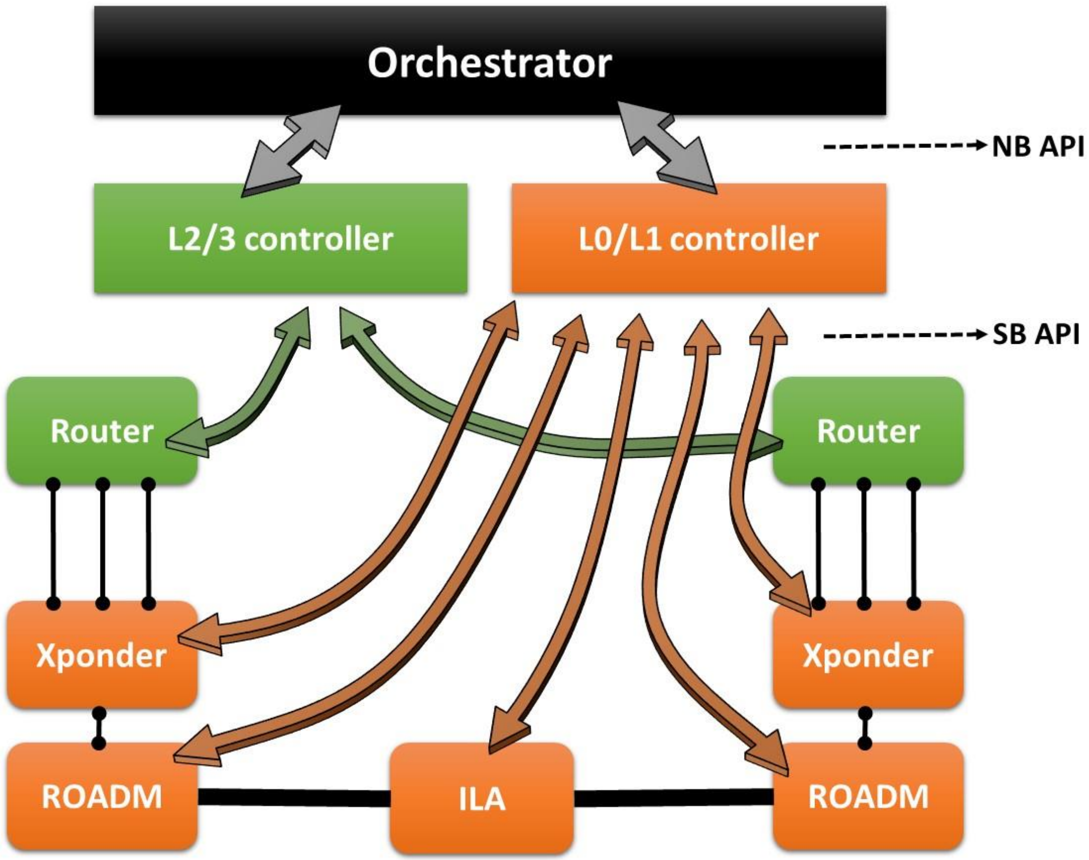
Less disruptive option. Replaces NMS with SDN for service management operations

Advantages

- Supports different vendors between IP/MPLS and OTN/WDM layers (already common nowadays)
- Advantages from vertically-integrated solutions are kept
- Replaces a great deal of manual operations (OPEX reduction)
- Opens the door for third-party development of the orchestrator
- Reduce software functions in the hardware

Disadvantages

- Disadvantages from vertically-integrated solutions are kept
- Some vendors may be inclined to just add another NB API to their current NMS solution (hence, controller = NMS)



SDN-driven automation

Fully exploit the existing flexibility in modern optical networks

- Line systems (ROADMs) can route/add/drop optical signals of variable spectrum (flexi-grid)
- Transponders can be tuned w.r.t. modulation format, baud-rate, FEC, traffic grooming, etc.

On-demand multi-layer service creation

Self-healing
- Service restoration
- Preemptive failure detection
  - Trigger repair tasks
  - Activate service rerouting

Self-optimizing
- Continuous network defragmentation
- Pre-computation of optimized routes (e.g., for restoration)

Resource segmentation/virtualization

Perform data plane adjustments (e.g., amplifier equalization)

Coriant Transcend software suite

Coriant Transcend™

Transcend Maestro
Multi-Domain Orchestrator

Transcend Symphony
Multi-Vendor SDN Controllers

- For Transport
- For Packet

Transcend Chorus
Network Management & Operation

- For Transport
- For Packet

Coriant NOS

Transport | Packet | Whitebox

Coriant feature-rich Transport Controller

Layer 0 to Layer 2 Service Provisioning & Monitoring

- SLA based provisioning: e.g., bandwidth, latency, shared risk
- Monitoring: e.g., throughput (bit errors at ODU transport container)

Multi-Layer Path Computation Engine (PCE)

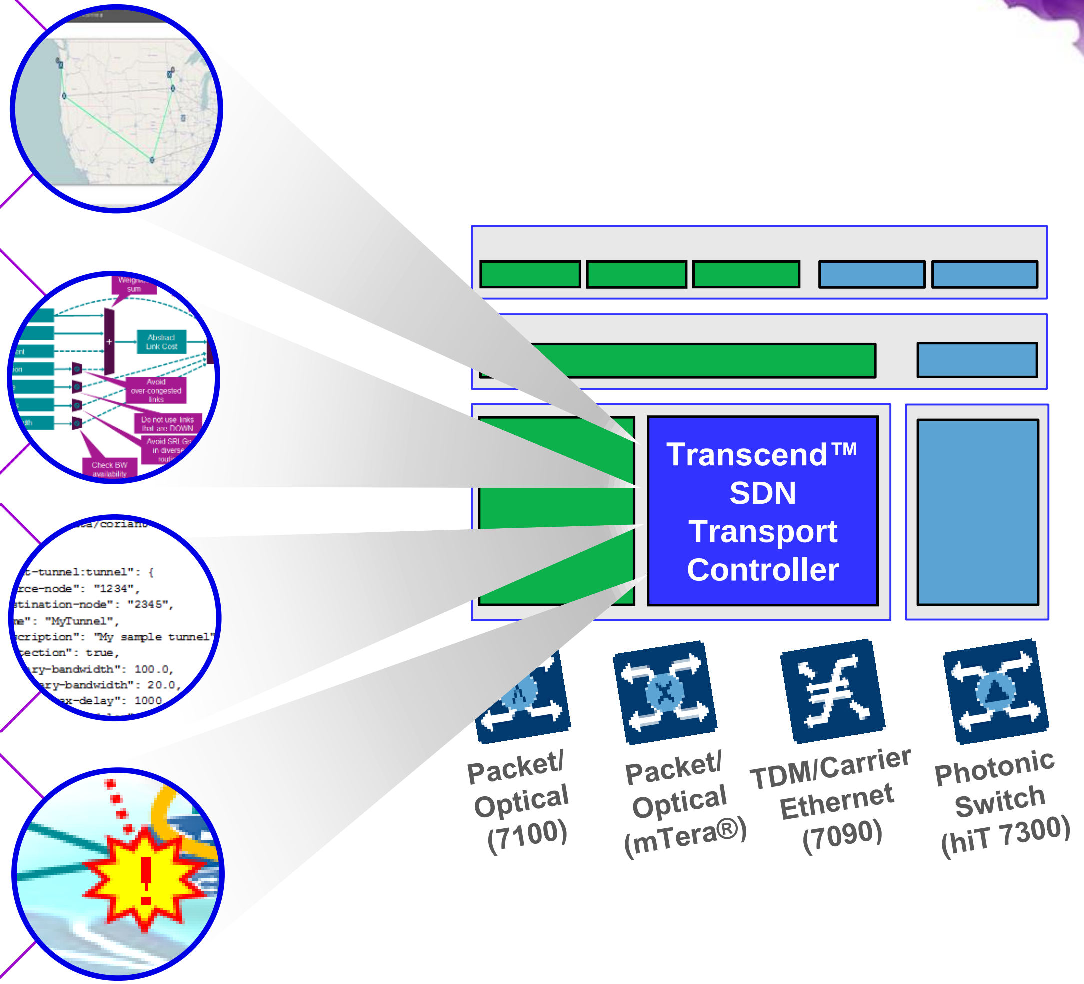
- Optimal paths based on real-time network status
- Multi-layer paths (e.g., OCh server connections)

SDN REST API

- Extendable API for integrations & programmable networks

Restoration Engine

- Service monitoring & dynamic restoration
- Autonomous & Application controlled, Sharing free capacity



The data plane

Network providers are very keen on moving beyond the vertical-integration hurdle

Interoperability between transponders or line systems is not assured between different vendors

- Transponders: Different DSP modules, different FEC codes, etc.
- Line systems: Different protocols, different link management strategies, etc.
- Proprietary interfaces (e.g., SNMP)
- Different design specifications
- Specific modelling of optical transmission impairments
- Transponders and line systems jointly optimized

The data center evolution is imposing a change of scenery in the optical transport

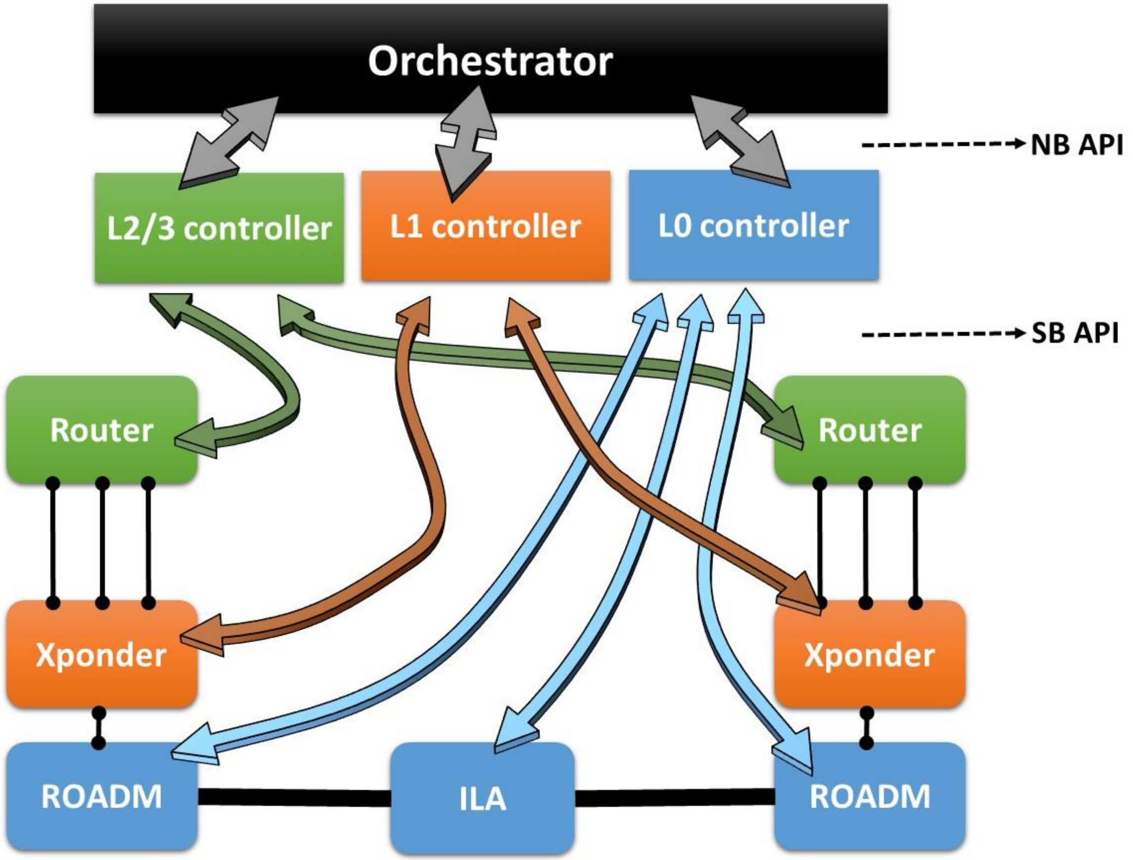
- Network disaggregation
  - Different vendors for different network functions
- White boxes
  - Multi-sourced hardware with “à la carte” software

SDN for optical transport: option B (open line system)

The open line system (OLS) disaggregates transponders from the line system. Also known as alien wavelengths.

Advantages
- Provider can source optical sources from multiple vendors (CAPEX reduction)
- Potentially faster to add novel transponder technology
  - Decouple deployment cycles between line system and transponders

Disadvantages
- Line system and transponders are not jointly optimized: optical reach could be compromised
- Vendor planning tools may not be applicable
- Troubleshooting network problems becomes harder
- Operator must perform or hire system integration
- Interoperability between optical equipment still not available



Coriant Groove™ G30 Network Disaggregation Platform – OLS Solution

Modular Approach:
Consistent with the Groove™ G30 modular approach that has delivered the industry leading 3.2G Muxponder, Groove™ G30 OLS extends the modular approach to the optical layer

Open Platform:
Groove™ G30 OLS is as an open platform based on YANG API and NETCONF/RESCONF north bound interfaces for fast integration with any OS.

Versatility:
The optical layer is configurable to support a range of different applications including Coherent (QPSK, 8QAM, 16QAM, 64QAM), Short Reach Coherent (16QAM) and Direct Detect (PAM4/DMT)

Best Density:
Groove OLS features the most dense Optical Layer for DCI and Metro deployments with 19.2T capacity in 1RU including Mux/Demux, Preamp, Booster, OCM and OSC.

Leading Performance:
High power amplification enabled by the latest generation EDFA and an innovative platform thermal management.

Leading Density and Power
3.2T/RU, 25W/100G

- ***Xponder***
- ***OSC***
- ***EVOA***
- ***OTDR***
- ***Amplifier***
- ***Optical mux/demux***
- ***TDCM***
- ***OPSM***

SDN for optical transport: option C (Open ROADM)

Taking disaggregation to another level. Industry consortium where several operators and vendors define interoperability specifications for line systems, transponders and interfaces.

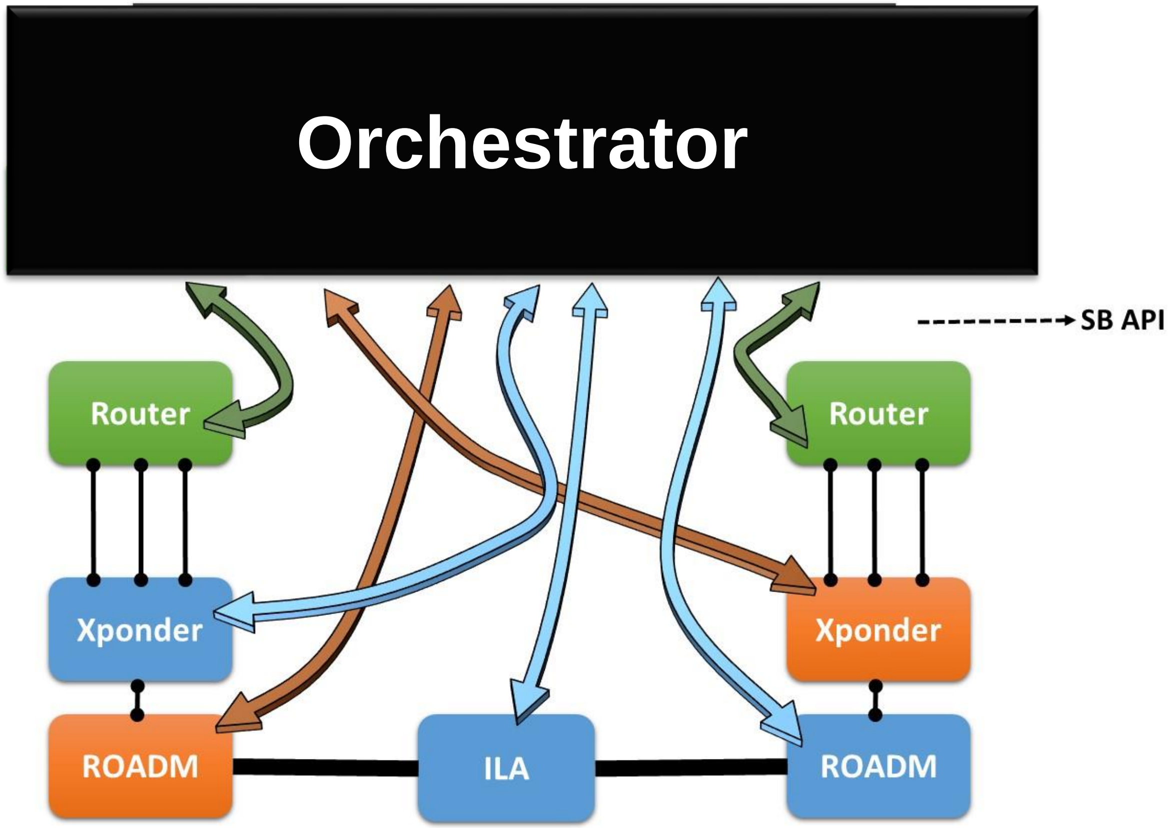
Open ROADM

Advantages

- Freely mix optical equipment vendors (interoperability)
- Orchestration can directly interact with the equipment (intermediate vendor controllers not mandatory)
- Opportunity for third-party controller development

Disadvantages

- Deployment cycles are dependent on the consortium focus (partial vendor dependency)
- Open ROADM currently focusing on line systems for metropolitan networks
- Optical equipment not optimized: optical reach could be compromised
- Vendor planning tools may not be applicable
- Troubleshooting network problems becomes harder (same for accountability)
- Operator must perform or hire system integration



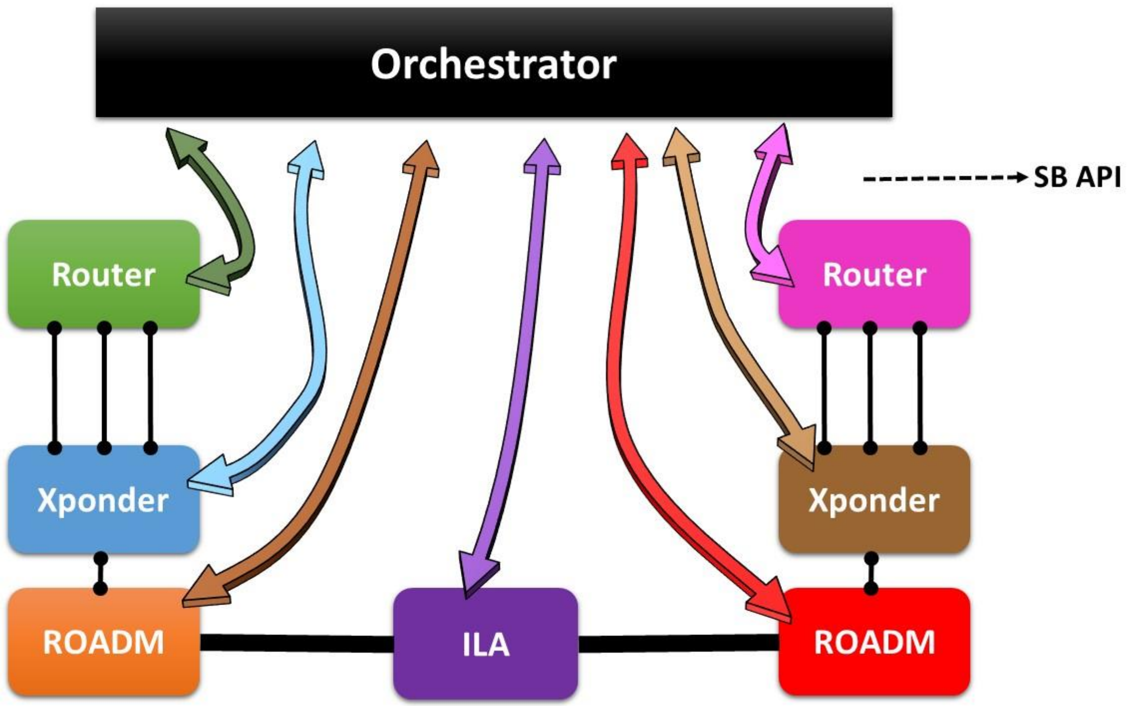
SDN for optical transport: option D (White boxes)

Optical sub-systems are based on industry standards. Hardware can be embedded with software from third-party companies.

Advantages
- Freely mix optical equipment
- Wide market availability (whole industry, not just consortium)
- Opportunity for new hardware vendors
- Use of off-the-shelf components
- Opportunity for third-party software development in the hardware
- Customization of software functions in the hardware

Disadvantages
- Dependent on standardization work (which is currently lagging)
- Specifications typically target a reference network scenario, which will certainly not satisfy all network providers
- Optical equipment not optimized: optical reach could be compromised
- Vendor planning tools may not be applicable
- Troubleshooting network problems becomes harder (same for accountability)
- Operator must perform or hire system integration

TELECOM INFRA PROJECT



The (long) road to SDN optical transport

What is the SDN network reference?

- Metro/DCI networks are more tolerable to optical transmission degradation, making it ideal for low-spec'd equipment. This would also relieve the operator from using accurate planning tools. However, regio and LH networks are much more sensitive to impairments.

Finding the (new) business case for vendors

- Bet on cutting-edge hardware, controllers, or both? System integration services?
- Move from turnkey solutions?
- New competition will surely emerge

Is it safe to let the software do (almost) everything in a network?

Are operators ready to manage system integration?

- Develop their own planning and management tools? Perform their own solution testing?

Getting standards (finally) aligned

- Interfaces (REST OIF, ONF T-API, Openflow do not fulfill all the requirements)
- Coherent receivers (not only FEC but also DSP)
- Orchestration solutions are already available (OpenDaylight, ONOS)

How to handle issues due to network migration? Coexistence of SDN with legacy systems may be difficult to manage

Thank you.
Questions?