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B5G-OPEN: Towards packet-optical multi-band networks

B5G-Open consortium

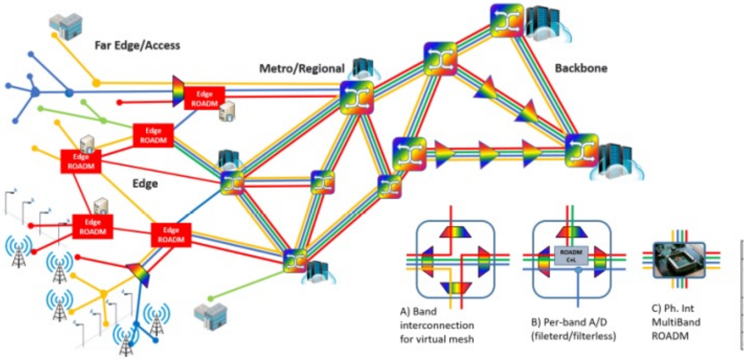
The 5G Infrastructure Public Private Partnership

B5G-OPEN Project

- Beyond 5G – OPtical nEtwork continuum
- Grant Agreement Number: 101016663
- Start Date: 01 Nov 2021
- Duration: 36 months
- Budget: €5.465.068,75
- Call ID:H2020 ICT-52-2020 (RIA)

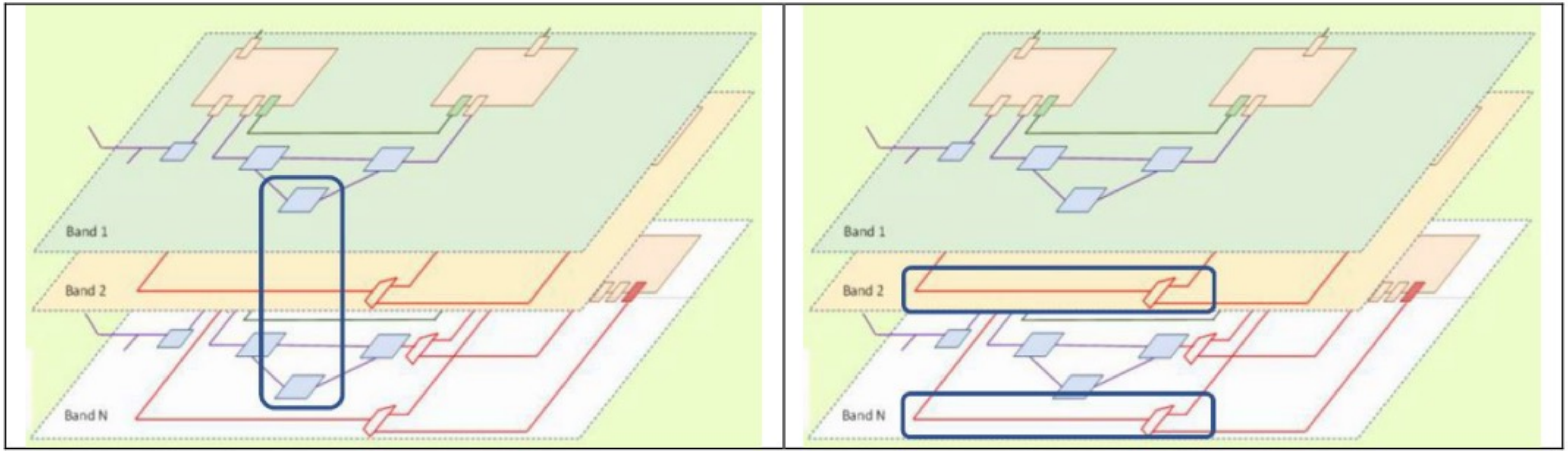
B5G-Open Pillars

Band	O	E	S	C	L
Wavelength (nm)	1260-1360	1360-1460	1460-1530	1530 - 1565	1565-1625
C-band				35 nm	
C+L-band				95 nm	
All band	365 nm				

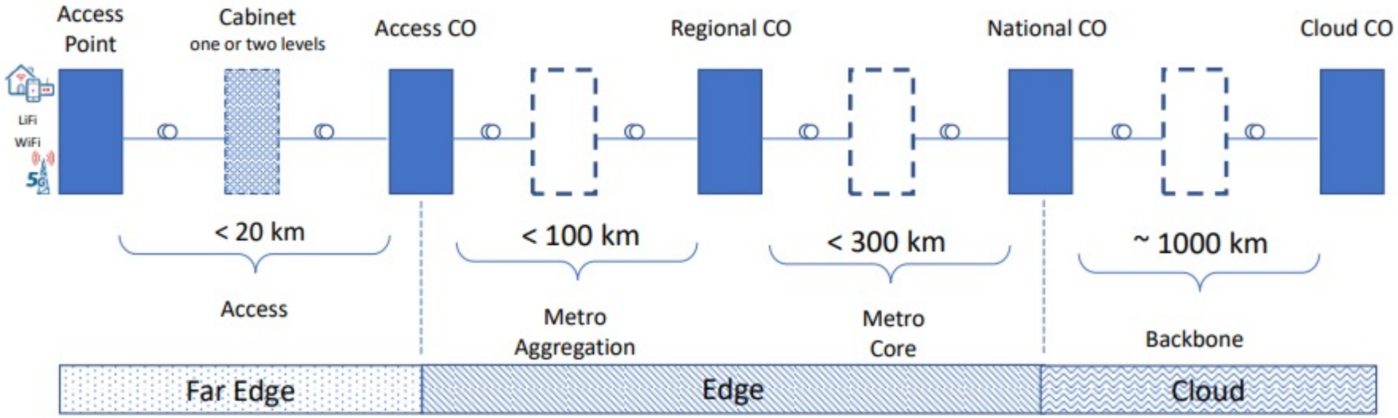


Key Feature	Description
Multi-Band operation	Availability of bands O, E, S, C, L to provision: a) the required capacity, and b) service based on requirements
Optical continuum	Operate connectivity extending the principles of optical bypassing of nodes in the Multi-Band B5G-OPEN network, allowing optical slicing based on service requirements and crossing network segments (i.e. access, metro, core, etc.)
Integrated access	Operate and control service regardless of the access technology (Mobile, Fixed, WiFi, LiFi)
E2E network orchestration	Operate service and network operations from the Access Point to the Cloud node, which may include monitoring and AI/ML
Autonomous operation	Based on Intent-based and zero-touch networking paradigms, autonomous operation is built using closed-control loops at various levels, from device to network. Empowered by a distributed AI/ML-based engine providing data collection and intelligent aggregation, analysis, and acting on the network devices, autonomous operation enables coordinated decision-making across domains

Multi-band architectures



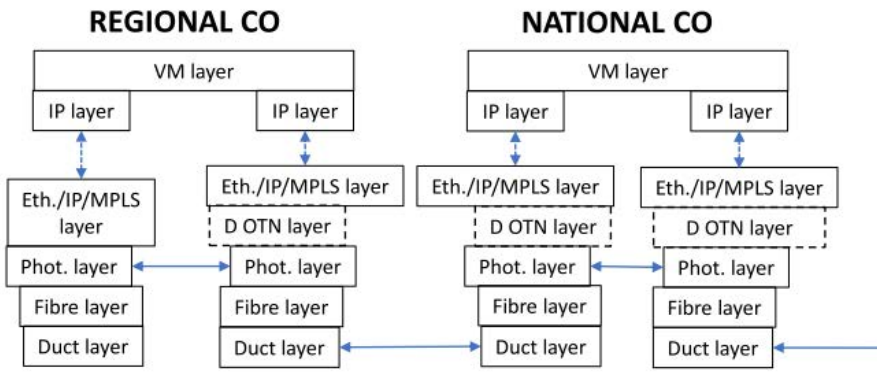
Optical continuum

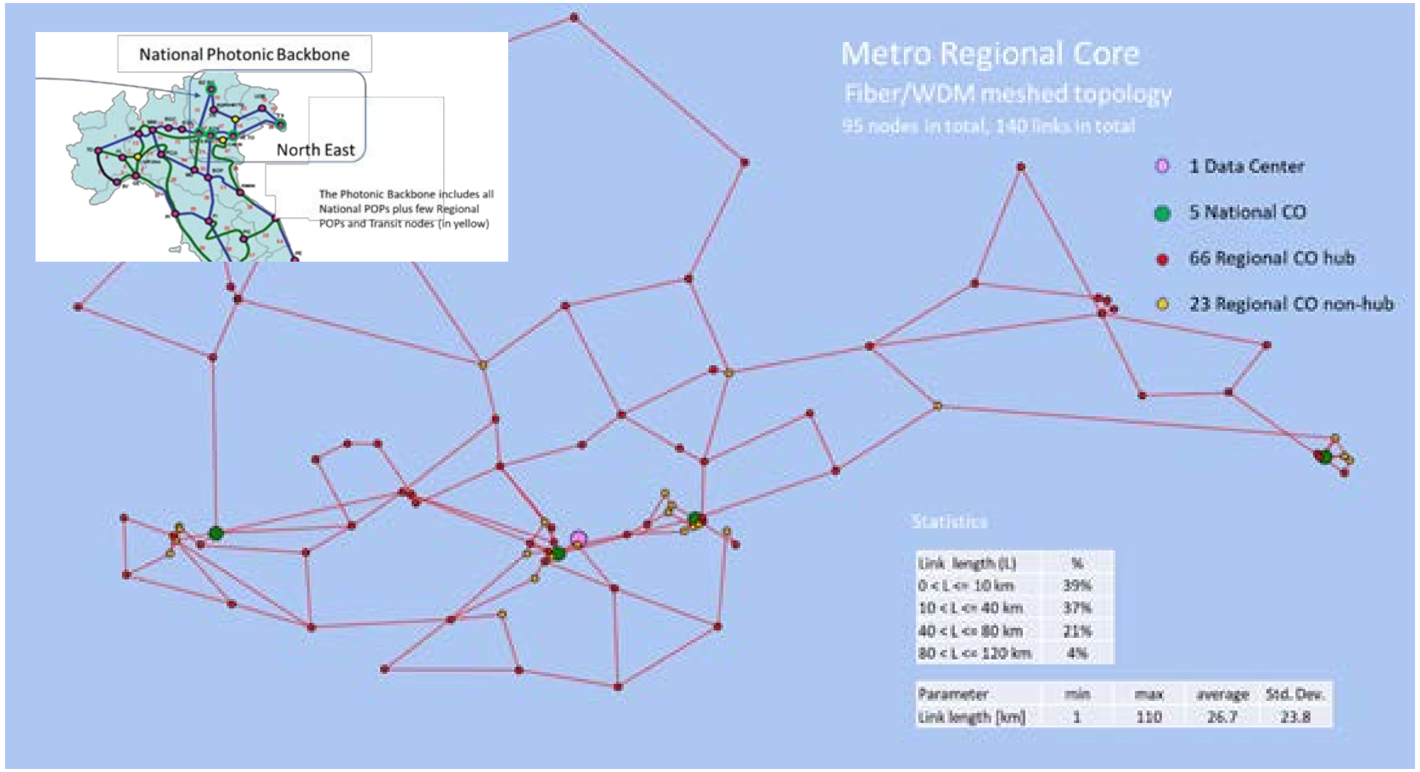


- Optical continuum
  - Transparent multi-domain
  - Access CO bypass
  - Regional CO bypass
- Multi-band
- Packet-optical nodes (IPoWDM)
  - Coherent pluggable modules (no transponders)
  - Coherent Point-to-MultiPoint (P2MP)

Metro-core interconnection

- Currently, regional networks are terminated electronically at the IP/MPLS layer
- To enable regional to core optical bypass
  → multi-domain, disaggregated, impairment-aware transparent networking



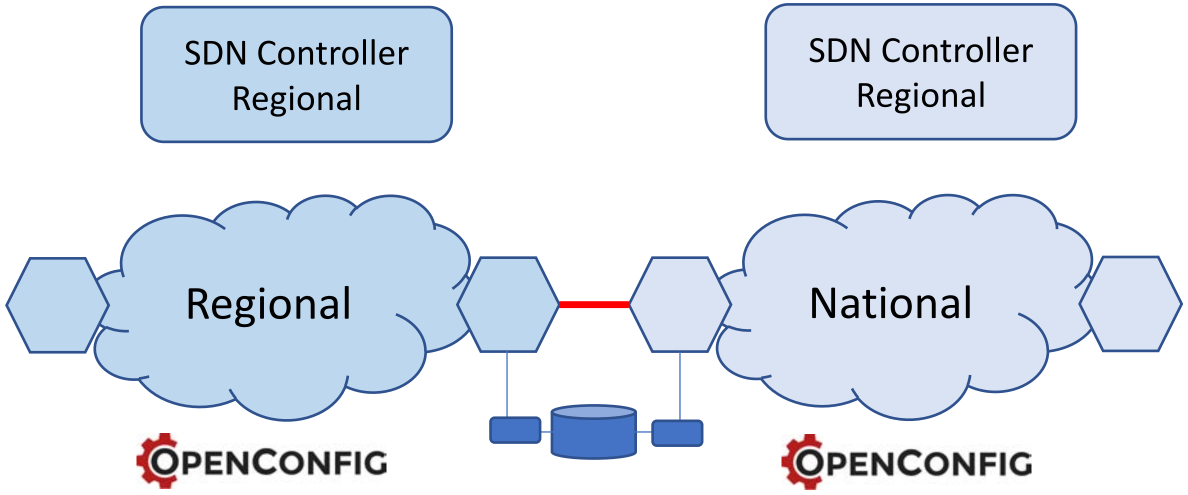


Example of regional and national optical networks (TIM)

Metro-core transparent interconnection

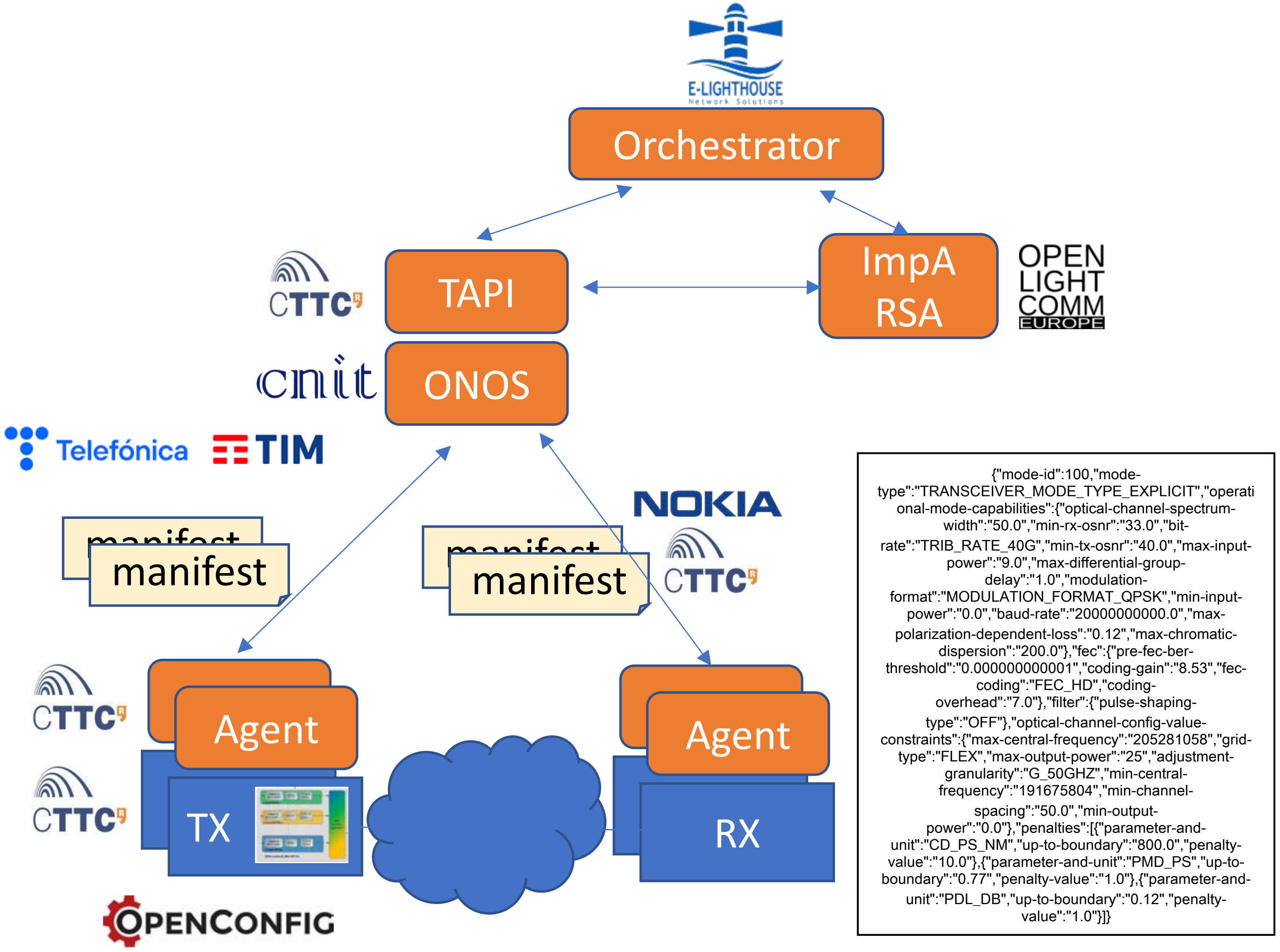
- Regional and National optical networks are typically provided by different vendors
- Impairment-aware path computation across domains considering multiple bands
- Standardized way to handle impairments and expose (manifest) capabilities

IETF explicit mode	GNPY	OpenConfig	OLC-E tool
supported modes	mode		operational mode
bit rate	bit rate		data rate
baud rate	baud rate	baud rate	symbol rate
min OSNR	required OSNR in 0.1nm		can be extracted by 'Additional parameters'
roll off	Tx roll-off	filter roll off	can be extracted by 'Additional parameters'
central frequency step	grid spacing	adjustment granularity	slot spacing
min central frequency	min frequency		min frequency
max central frequency	max frequency		max frequency
rx-channel-power-min	min Rx power		min Rx power
rx-channel-power-max	max Rx power		max Rx power
max CD	CD max		-
max PMD	PMD max		-
chromatic and dispersion penalty	CD penalty		-
	PMD penalty		-
max diff group delay	DGD penalty		-
Additional parameters: min Q-factor, min carrier spacing, rx-total-power-max, tx-channel-power-min, tx-channel-power-max, max PDL penalty, FEC type, FEC code rate, FEC threshold, modulation type	Additional parameters: Tx OSNR	Additional parameters: grid type, otsi media channel, effective media channel, SOP, filter shape, filter order, modulation format	Additional parameters: transmitted power range, emission frequency range, received power range, receiver frequency range, FEC type, FEC code rate, FEC threshold, DSP type, bandwidth, modulation format



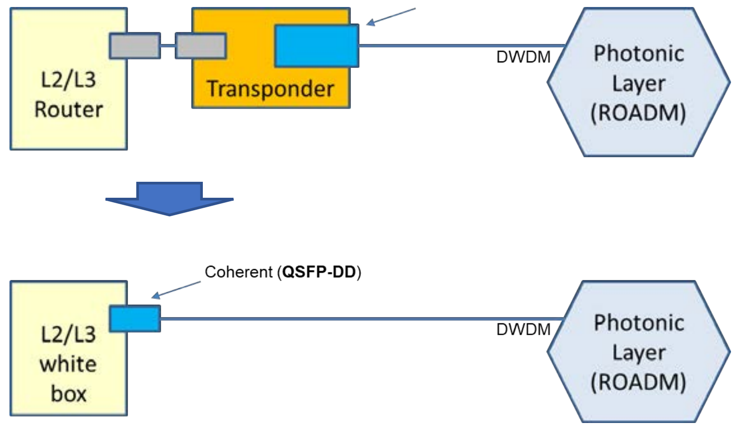
Provisioning with Manifest

- OpenConfig Agent of devices exposing detailed descritpion of supported parameters
- For example, a transpoder can include the *detailed* description of supported operational modes
- SDN Controller forwards such info through TAPI to the impairment-aware Path Computation Element
- Fiber parameters are taken from inventory
- Next step to move towards MB multi-domain
    - Connection termination to a ROADM degree (not to a receiver)
    - Updates to OpenConfig model



IPoWDM

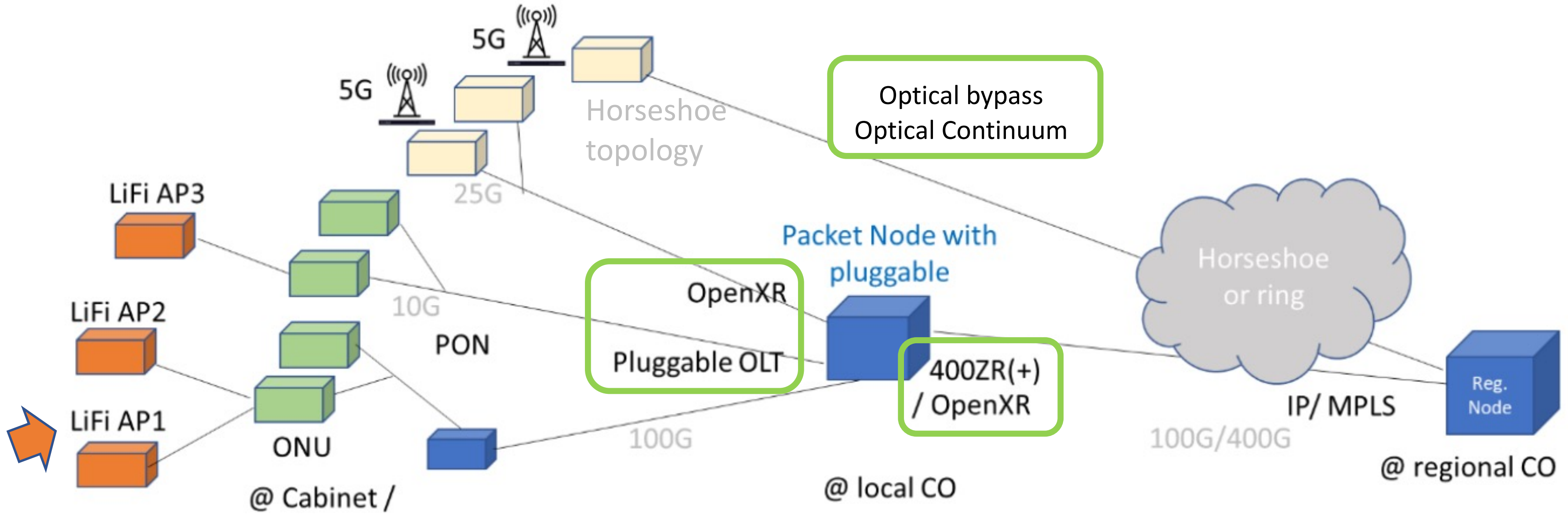
- Benefits
  - Removal of transponders as standalone network elements
  - Tight integration with IP layer
  - Savings in power consumption and space in central office
  - Savings in CAPEX, leveraging on white box for Data Centers



Optical Access Segment

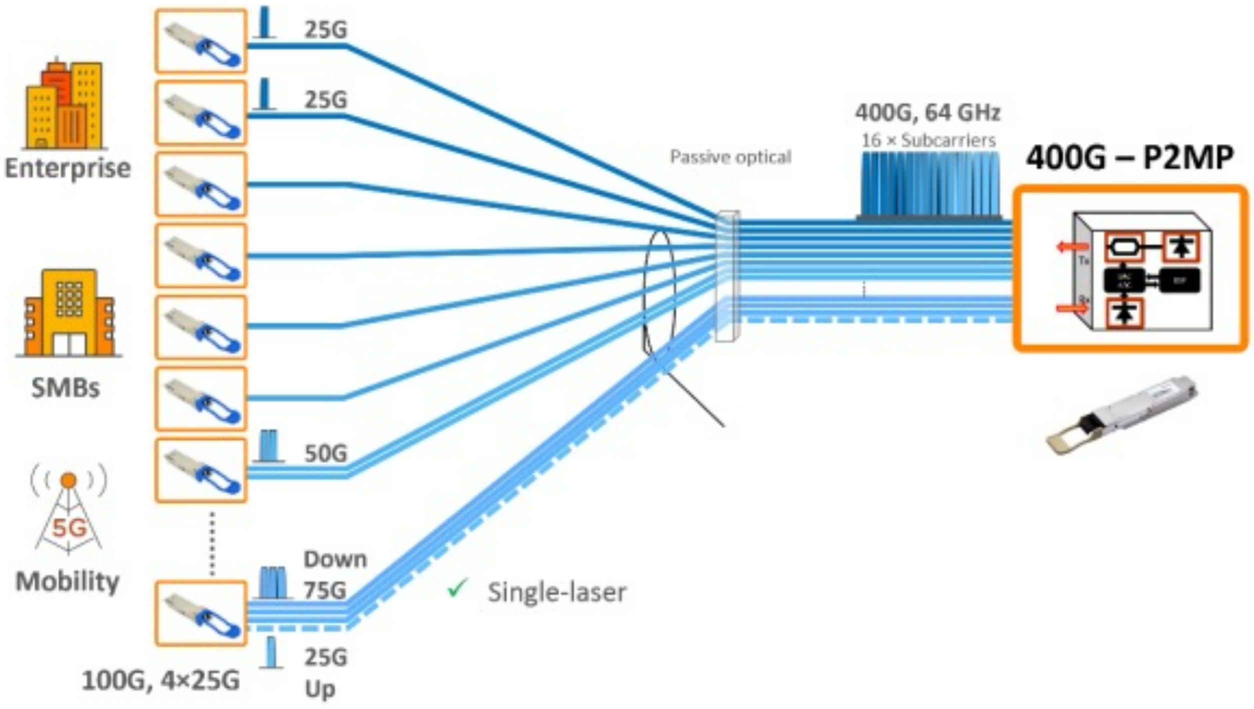
In BG5-ERA we envision the diverse landscape in the access/aggregation segment

- WDM in access networks to allow mobile network functional splits and save fiber
- TDM PONs
- Placing of computing resources close to the end-user
- Optical bypass of the local/access CO (optical continuum)



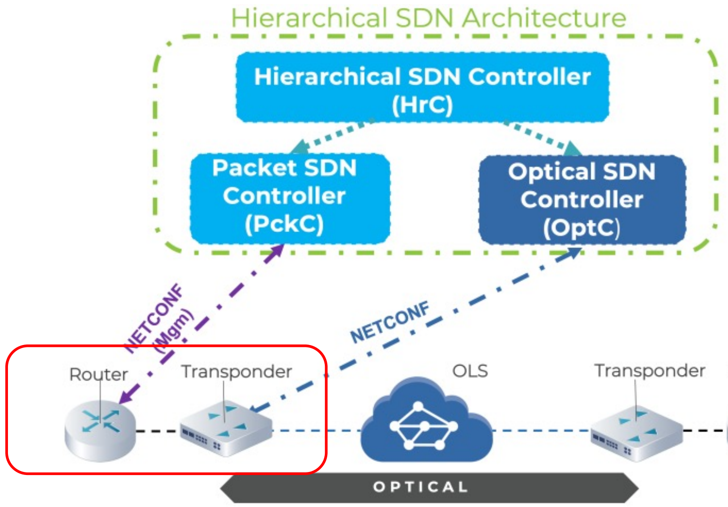
Point-to-MultiPoint pluggable interfaces

Aggregation performed at the interface level, avoiding intermediate aggregation switches/routers

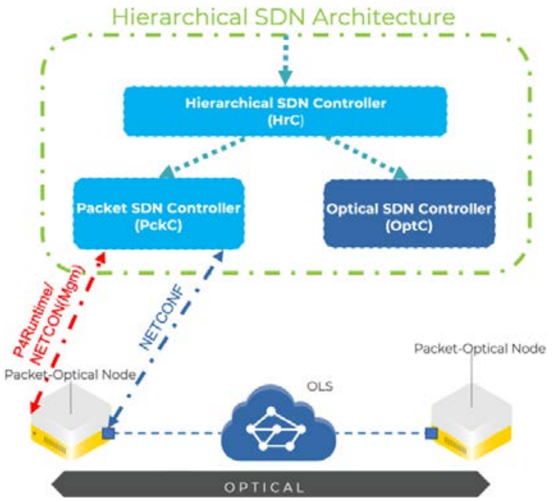


IPoWDM

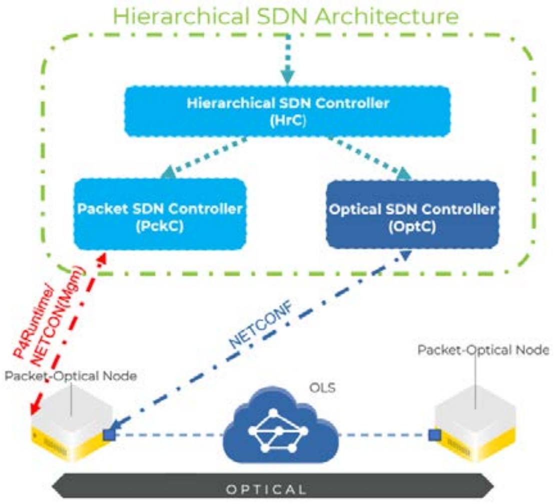
- Traditionally,
  - the SDN Optical Controller controls the transport network
  - only the SDN Packet controller has the capability to configure resources within the packet node, including its pluggables
- How to control pluggable modules?

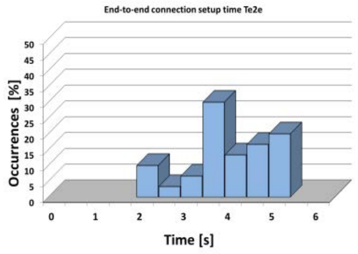


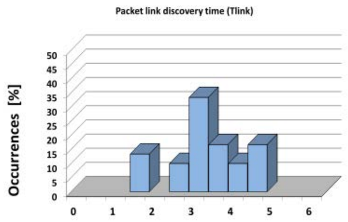
“Single” IPoWDM



“Dual” IPoWDM





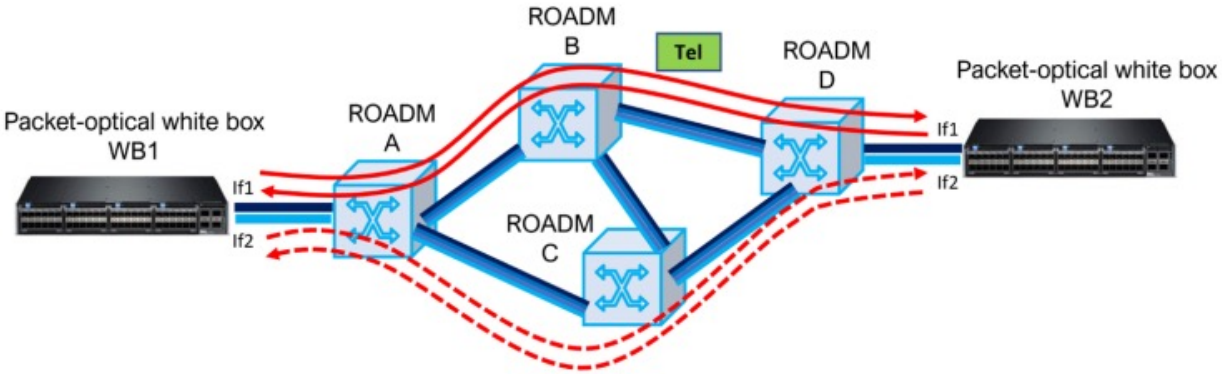


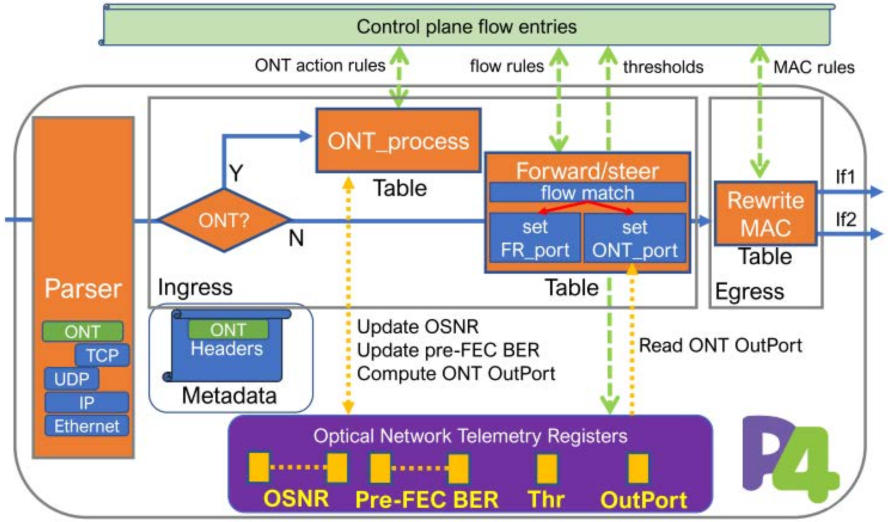
Dual is slightly faster, mainly due to a simpler coordination between the two controllers.

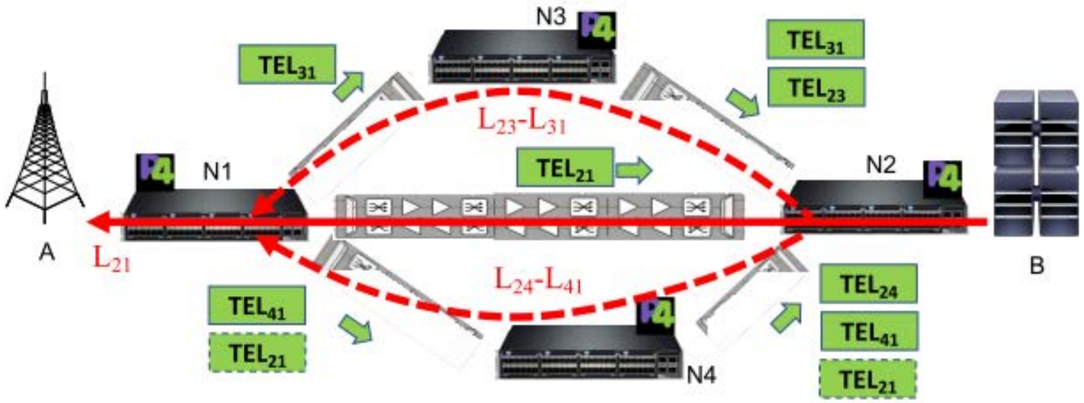
However, it poses more management challenges

IPoWDM in-band telemetry

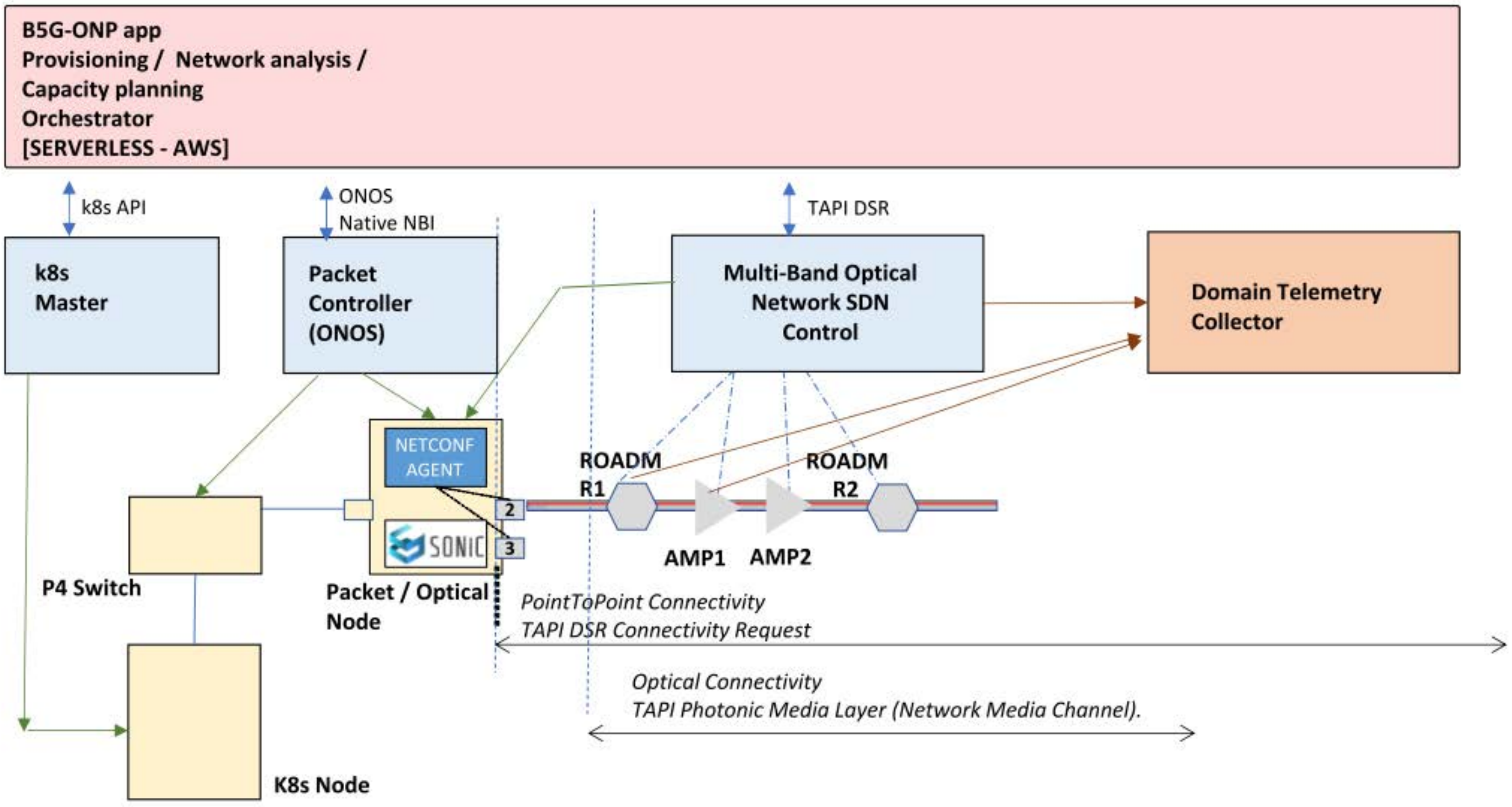
- Monitoring and processing of optical telemetry data/metadata directly in the packet forwarding plane
- Programmable ASIC (e.g. P4 technology)







End-to-end provisioning assisted by AI&telemetry



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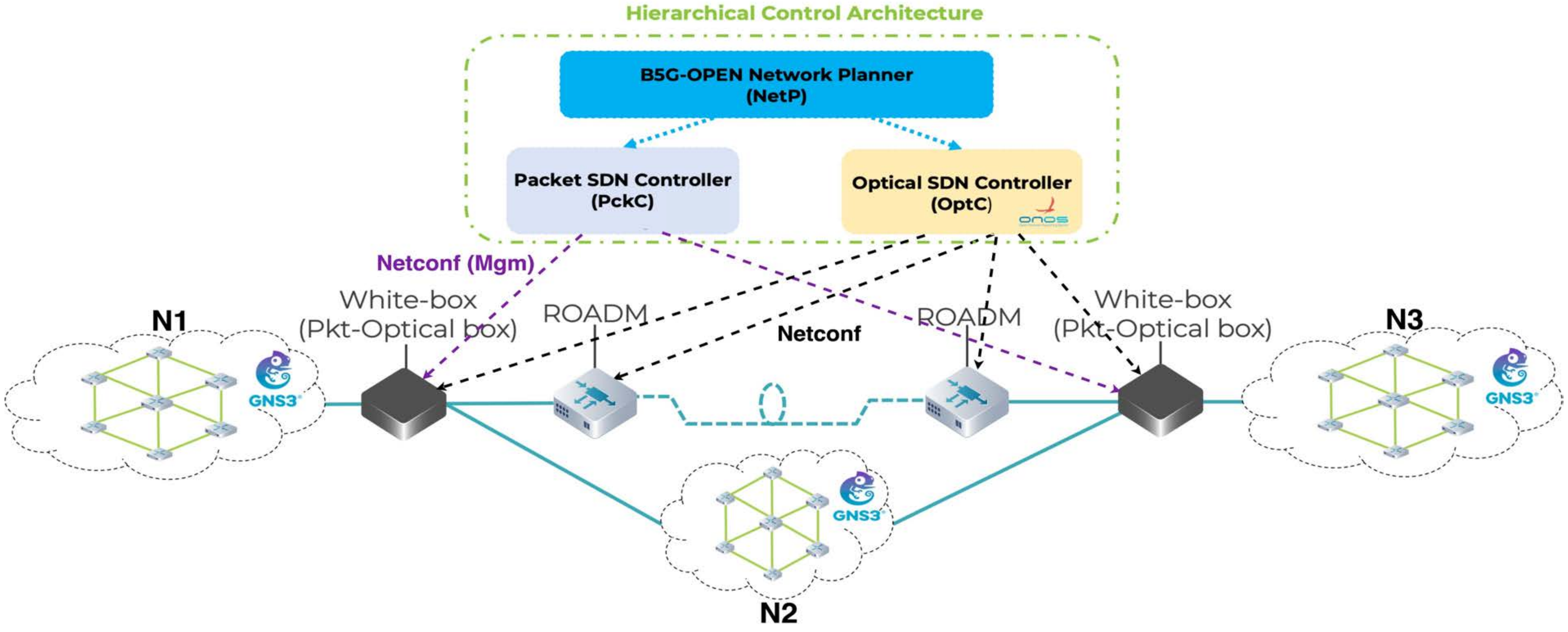

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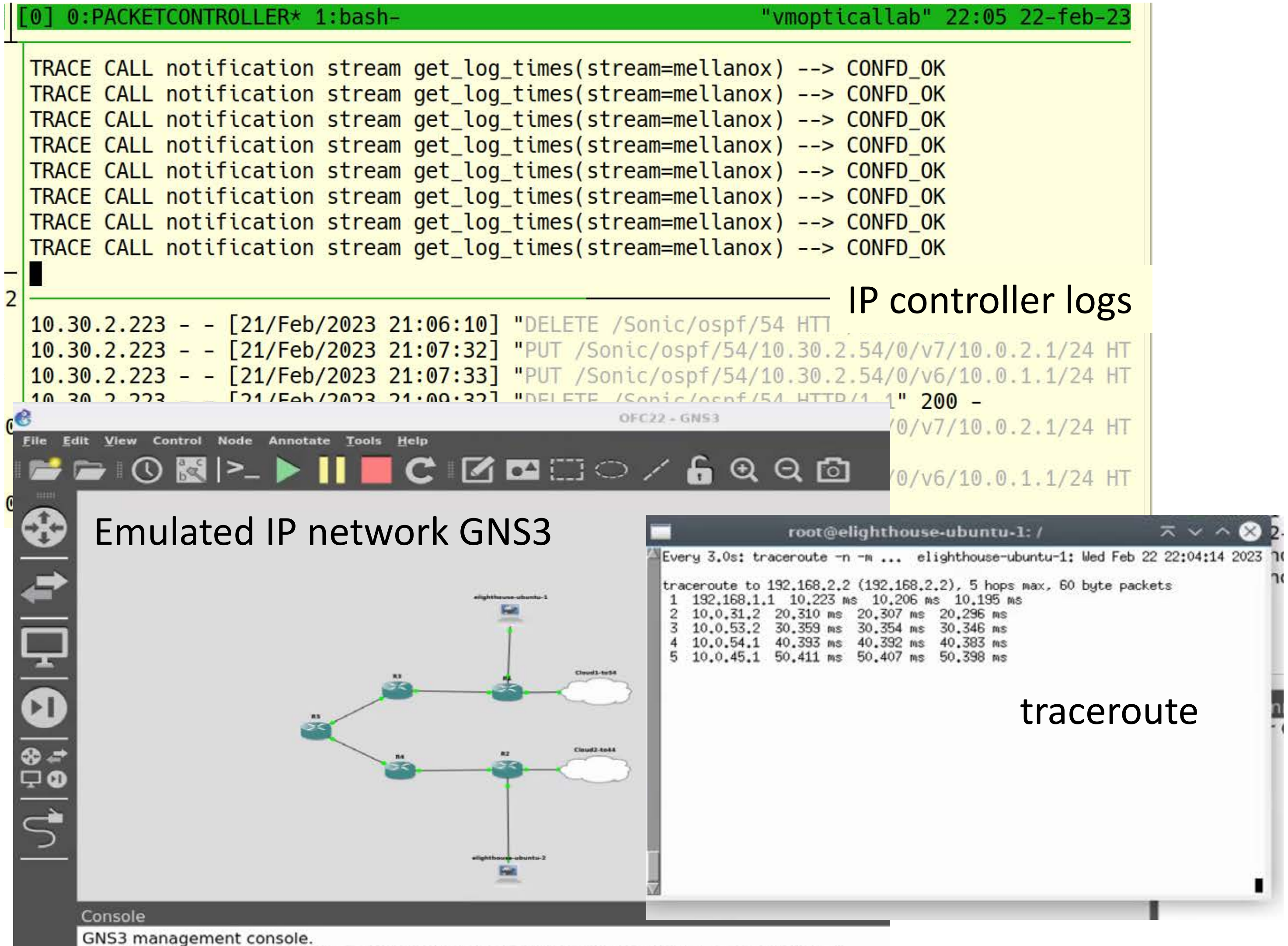

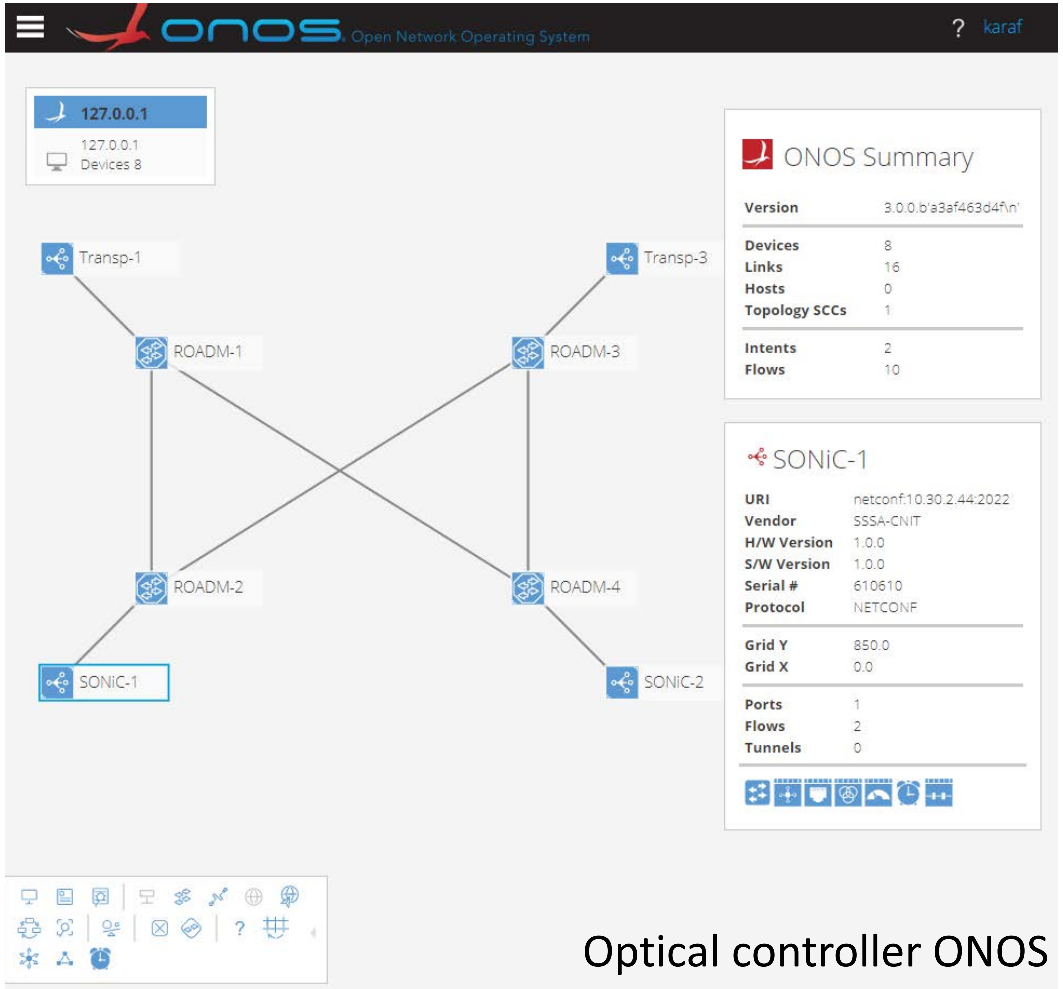

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