NOKIA

Mid-term extension of T-API module & integration of OpenConfig device models in ODL/TransportPCE

Javier Errea & Huy Tran & Dominique Verchere
NOKIA Bell Labs Core Research – Network Automation
12th January 2022

Animated

Agenda

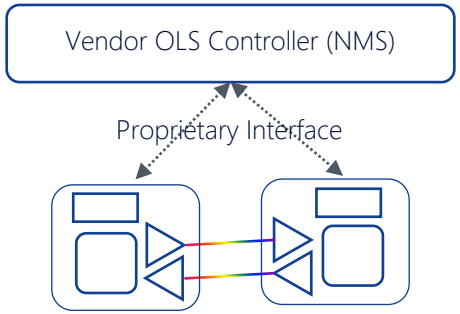
- CONTEXT
  - Challenges
  - Current status
  - Proposed solution
- IMPLEMENTATION
  - TAPI with Optical Impairment Extension module
  - TAPI-based ML-aided Path Computation And Optical Parameters Selection
  - OpenConfig Renderer
- RECAP

NOKIA

CONTEXT

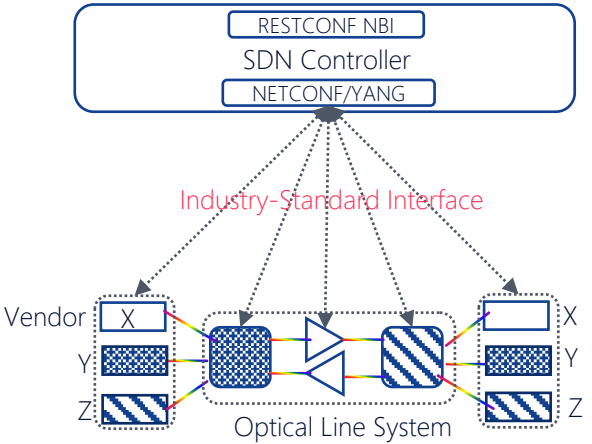
Towards Open Disaggregated Optical Transport Networks

Challenges



a) Traditional Optical Transport

- The lack of standardization
- The complexity of optical transmission due to the presence of physical impairments.
- Vendors have their best configuration for the system
- The lack of interoperability testing, and validation between vendors challenges to be overcome
- Vendor differentiating features
- Open SDN Controller for disaggregated networks to become a more robust framework
- Root cause analysis, Correlation in failure
- Common models of Service, Topology and device
- Open Planning, PCE, Auto Topology Discovery
- Power and Optical Parameters Optimization for Multi-vendor



b) Open Disaggregated Optical Transport

Toward Open Disaggregated Optical Transport Networks

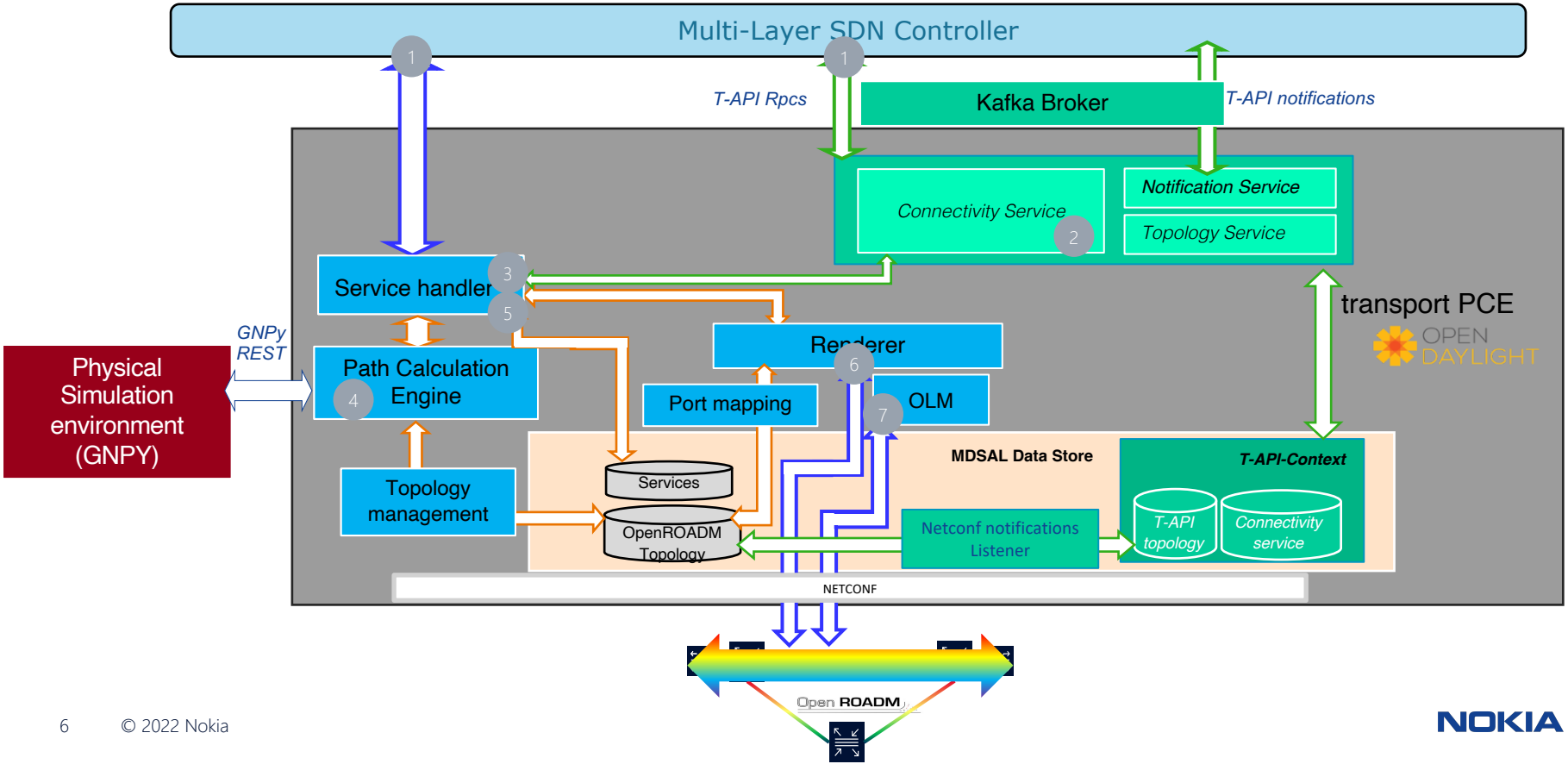
Current status: Open & Automated Optical Networks

- Optical network disaggregation → drive down costs while increasing network flexibility
- Open standards, APIs & platforms are keys for vendor interoperability and automated control of optical networks
- Multiple industry organizations:
  - OpenROADM MSA
  - OpenConfig
  - Telecom Infra Project (TIP)
  - Open Networking Foundation (ONF)
  - OpenDayLight (ODL)

- Problem:
  - Implementation overlapping
  - Varying level of maturity: model definition, commercially available implementation

Toward Open Disaggregated Optical Transport Networks

T-PCE current T-API connectivity service creation workflow

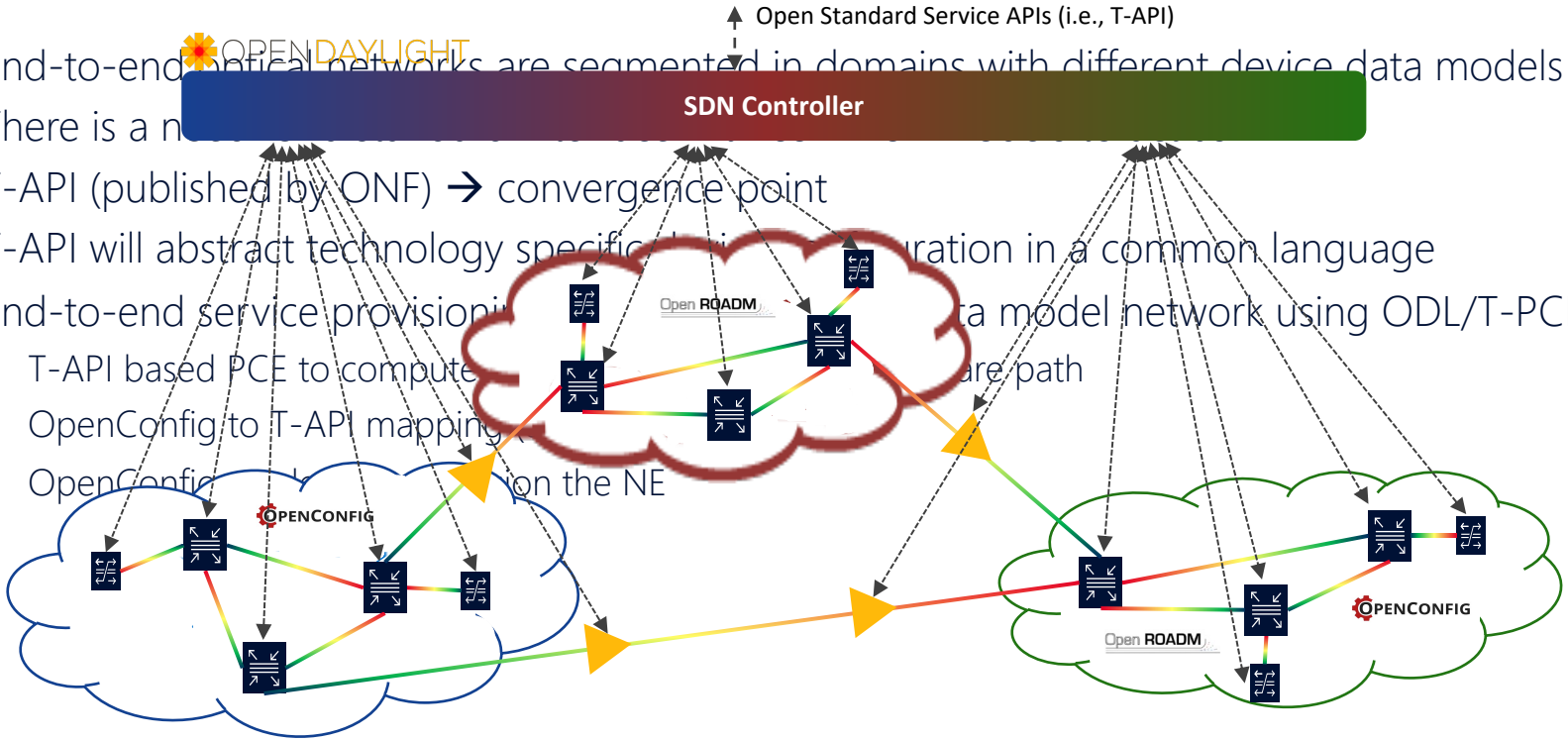


NOKIA

Toward Open Disaggregated Optical Transport Networks

Proposed solution: A different approach

- End-to-end optical networks are segmented in domains with different device data models
- There is a n
- T-API (published by ONF) → convergence point
- T-API will abstract technology specific
- End-to-end service provisioni
  - T-API based PCE to compute
  - OpenConfig to T-API mapping
  - OpenConfig



Toward Open Disaggregated Optical Transport Networks

TAPI Models Extension For Optical Impairment And OpenConfig Device Model

- Background and related work:
  - OpenConfig device model is not supported in transportPCE
  - TAPI does not support Optical Impairment parameters
  - transportPCE validates computed path with GNPy via its ad-hoc models
  - IETF *Yang Data Model for Optical Impairment-aware Topology* (draft-ietf-ccamp-optical-impairment-topology-yang-08)

Extend OpenConfig device model support
Extend TAPI with Optical Impairment parameters to unify E2E service and topology management

LAYERS	transportPCE	Bell Labs SDNC
optical impairment	GNPy ad-hoc models	TAPI + OI extension
service	OpenROADM service model + TAPI	TAPI + OI extension
topology	OpenROADM topology model + TAPI	TAPI + OI extension
device	OpenROADM device model	OpenConfig + OpenROADM device models

NOKIA

Toward Open Disaggregated Optical Transport Networks

ML-aided Path Computation And Optical Parameters Selection

Traditional approach

- Network planning with set-and-forget strategy
- Network Management System (NMS) computes, selects and provisions impairment-aware optical paths
- Vendor's proprietary solutions via their closed loop optical power control algorithms
- Vendor-specific Optical Supervisory Channel distributed between optical devices for power adjustment

Challenges in the multi-vendor scenario

- Online path computation for dynamic multi-vendor optical network service provisioning
- Centralized SDN architecture requires a new approach for multi-vendor power optimization
- Lack of optimized and exact algorithms to select the optimal transmit power, operational mode, etc. within a reasonable time

Machine Learning is the appropriate solution to address these challenges

NOKIA

IMPLEMENTATION

Implementation

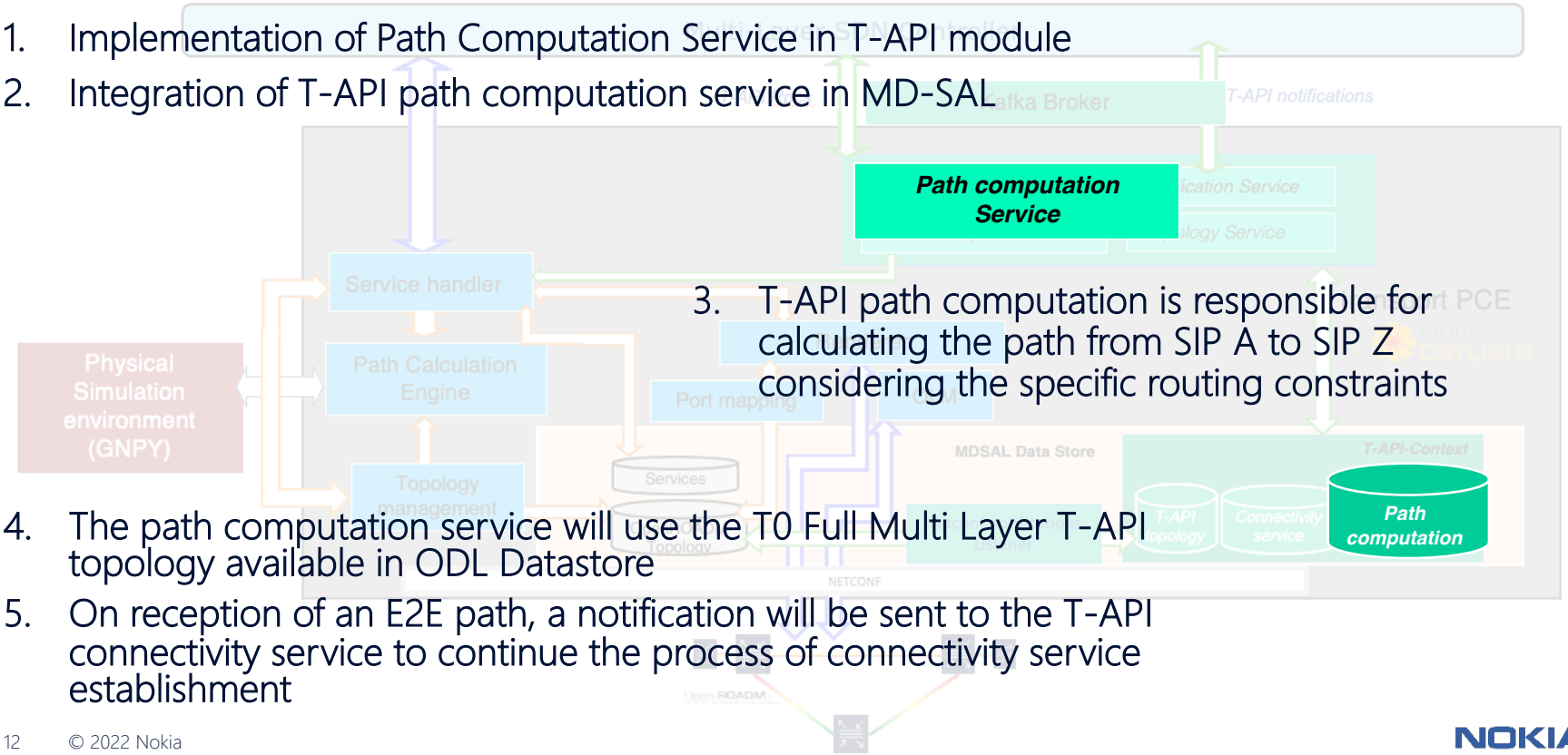
- Transport-API (TAPI) extension to express optical impairment parameters
  - TAPI Topology model
  - TAPI Connectivity model
  - TAPI Path Computation model
- Machine Learning-aided online path computation application
  - Implement a ML model to optimize power adjustment and optical parameters selection

- OpenConfig data models integration
  - OpenConfig to T-API mapping
  - T-API topology extension to include OpenConfig based devices
  - OpenConfig Renderer module
- Interface T-API module with OpenROADM Renderer

NOKIA

T-API path computation service

1. Implementation of Path Computation Service in T-API module
2. Integration of T-API path computation service in MD-SAL

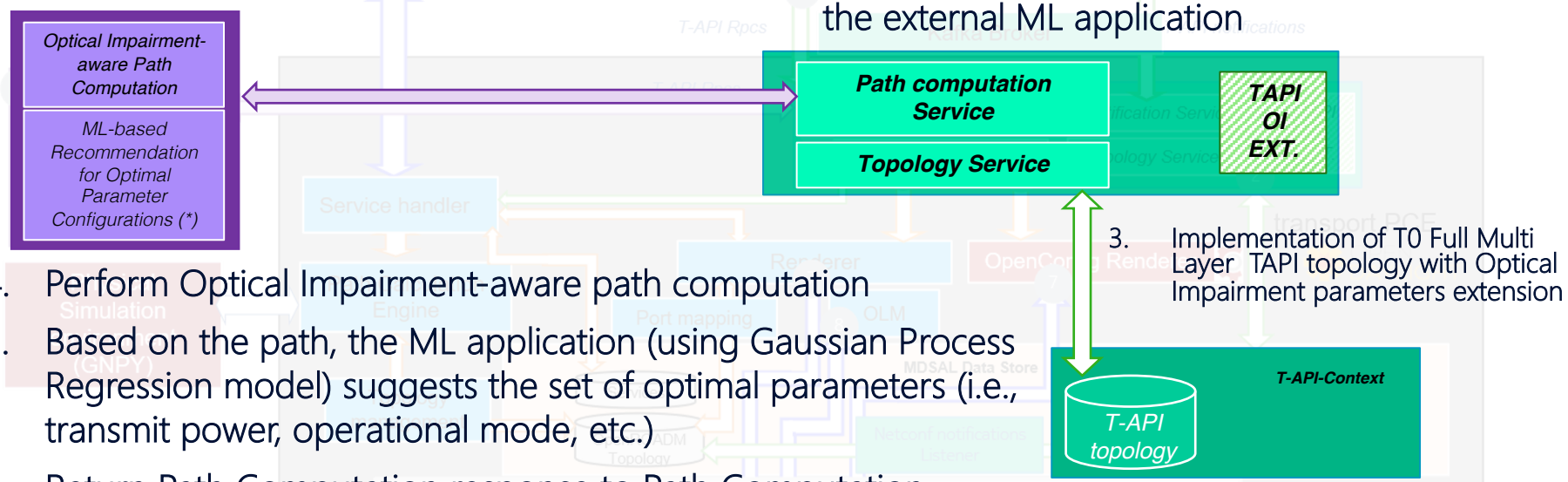


3. T-API path computation is responsible for calculating the path from SIP A to SIP Z considering the specific routing constraints
4. The path computation service will use the T0 Full Multi Layer T-API topology available in ODL Datastore
5. On reception of an E2E path, a notification will be sent to the T-API connectivity service to continue the process of connectivity service establishment

TAPI-based ML-aided Path Computation And Optical Parameters Selection

1. TAPI-based Path Computation Service sends a L0 impairment-aware path computation request to the external ML application

2. Send TAPI get-topology-details request to Topology Service to get the updated topology



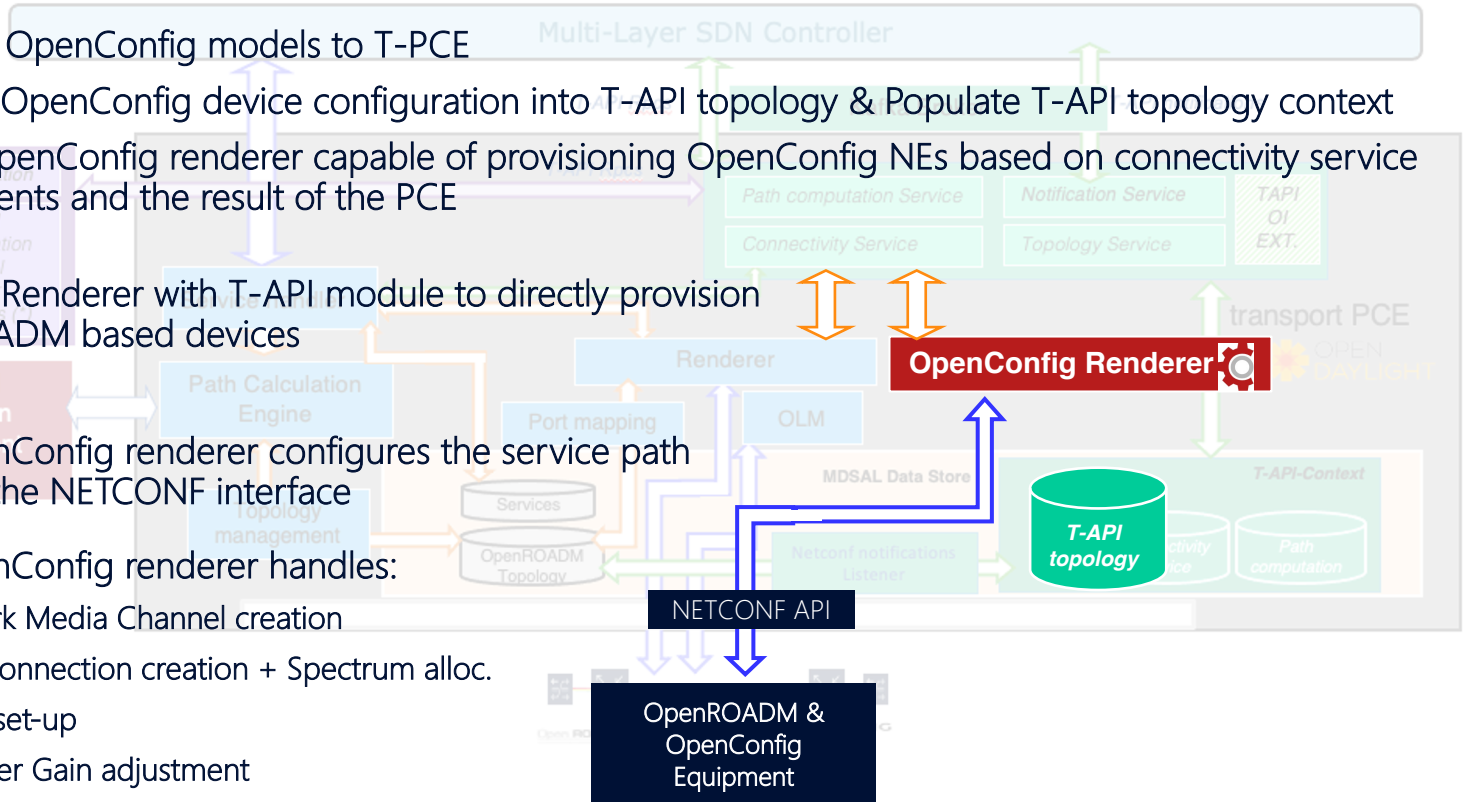
3. Implementation of T0 Full Multi Layer TAPI topology with Optical Impairment parameters extension

4. Perform Optical Impairment-aware path computation
5. Based on the path, the ML application (using Gaussian Process Regression model) suggests the set of optimal parameters (i.e., transmit power, operational mode, etc.)
6. Return Path Computation response to Path Computation Service

(*) Huy Tran et. al., *Demonstration of ML-aided Impairment-aware L0 Path Computation in Fully Disaggregated Multi-vendor Optical Transport Networks*, OFC 2021

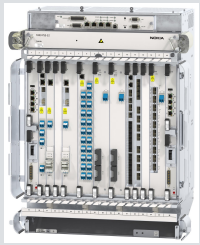
OpenConfig development

1. Integrate OpenConfig models to T-PCE
2. Translate OpenConfig device configuration into T-API topology & Populate T-API topology context
3. Create OpenConfig renderer capable of provisioning OpenConfig NEs based on connectivity service requirements and the result of the PCE
4. Interface Renderer with T-API module to directly provision OpenROADM based devices
5. The OpenConfig renderer configures the service path through the NETCONF interface
6. The OpenConfig renderer handles:
   - Network Media Channel creation
   - Cross connection creation + Spectrum alloc.
   - Power set-up
   - Amplifier Gain adjustment



OpenConfig development (cont.)

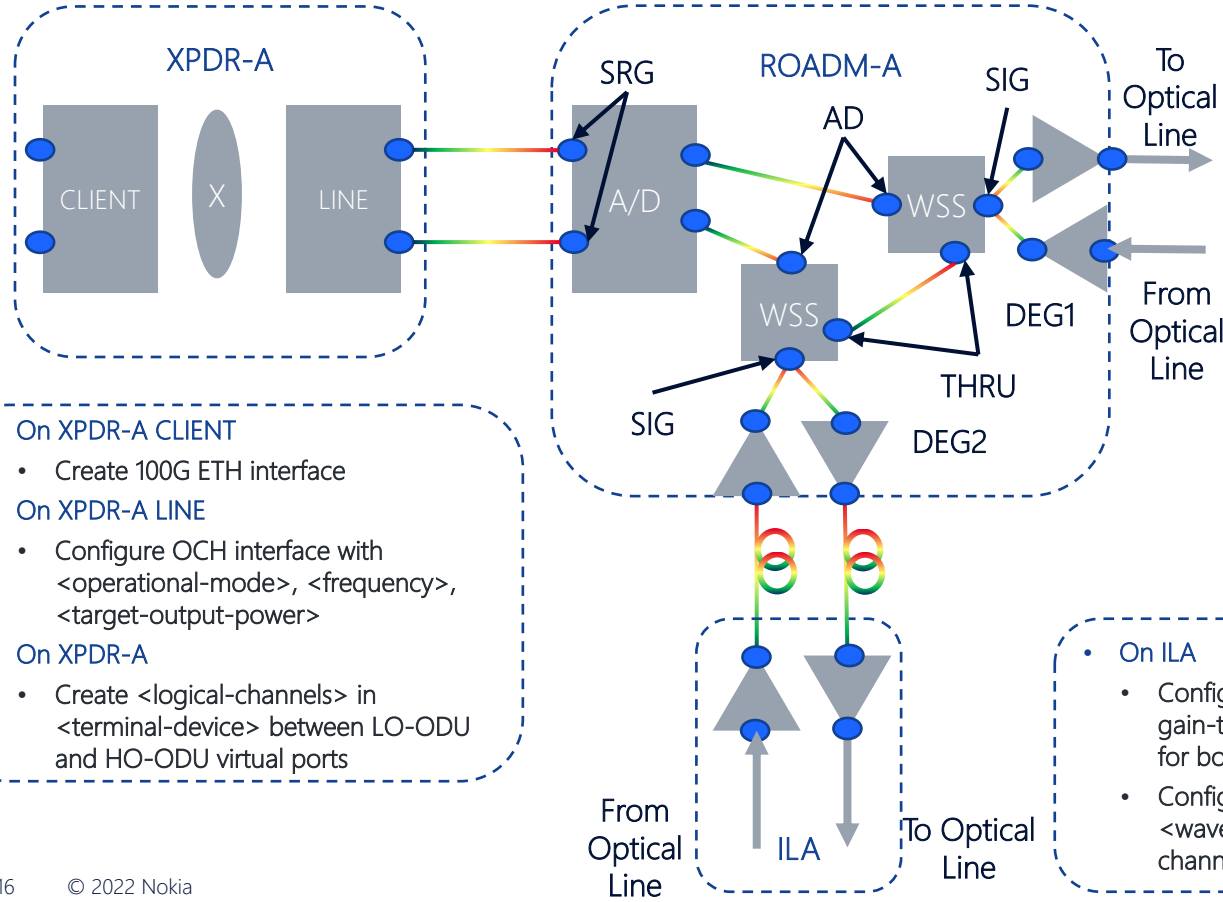
- The devices experimented with the OpenConfig renderer are:

OTs	ROADM	Amplifier
• PSI-M  • PSI-2T 	PSS-32 	PSI-8L 

Belonging to Nokia 1830 product family

OpenConfig Rendering Tasks (Simplified View)

Example of 100Gbps service



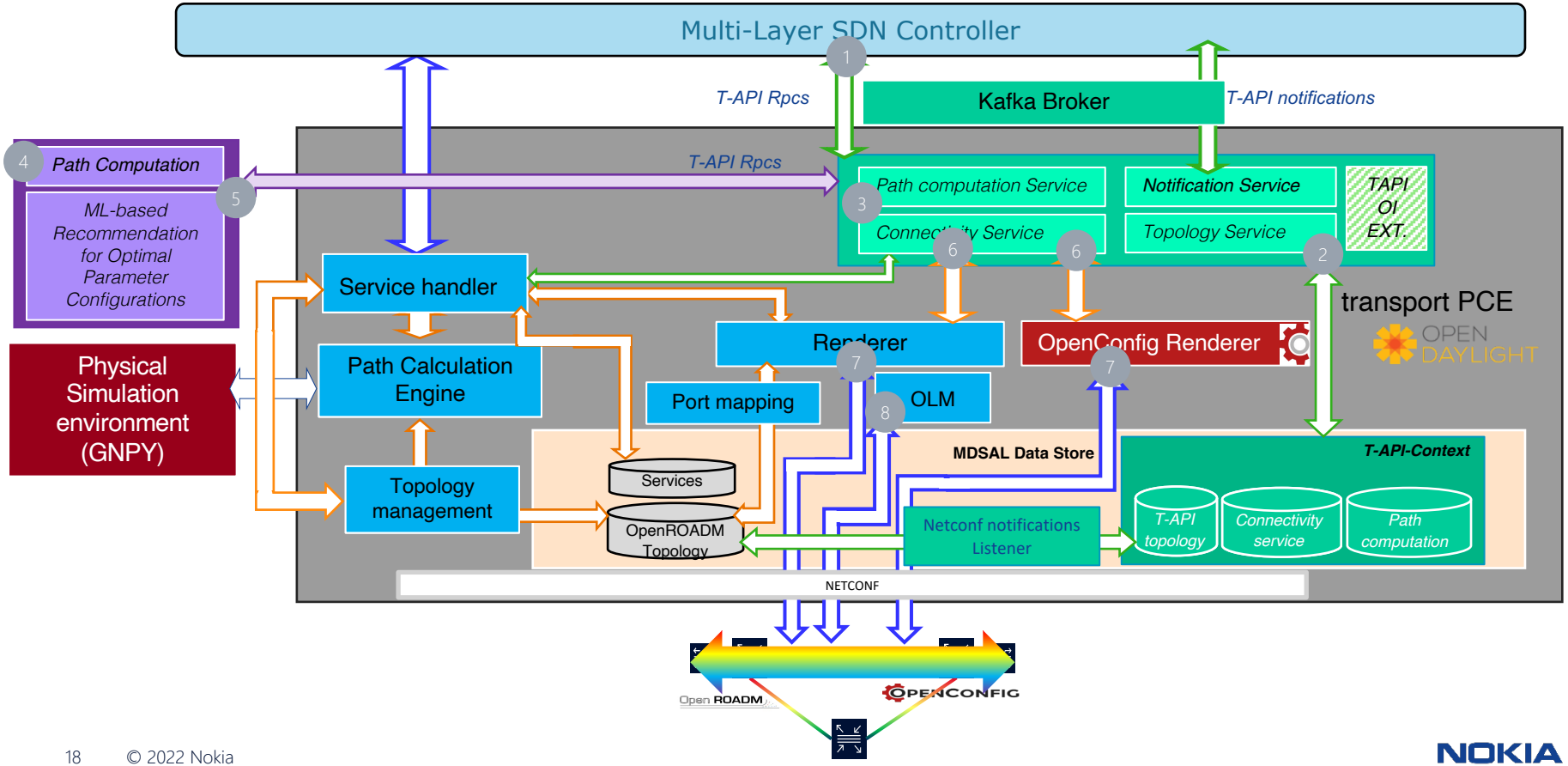
- On XPDR-A CLIENT
  - Create 100G ETH interface
- On XPDR-A LINE
  - Configure OCH interface with <operational-mode>, <frequency>, <target-output-power>
- On XPDR-A
  - Create <logical-channels> in <terminal-device> between LO-ODU and HO-ODU virtual ports

- On ROADM-A
  - Configure OCH cross connect
  - Configure <target-power> (in <wavelength-router/media-channels>) for EGRESS ports
  - Configure <target-gain> (in <optical-amplifier>) for both directions

- On ILA
  - Configure <target-gain, <target-gain-tilt> (in <optical-amplifier>) for both directions
  - Configure <target-power> (in <wavelength-router/media-channels>) for EGRESS ports

RECAP

Final T-PCE architecture



NOKIA

Recap: List of extensions and what they contribute

- OpenConfig integration
  - ✓ Support for OpenConfig in the SBI of ODL/TransportPCE
  - ✓ Integration of OpenConfig Renderer module
- Interface between T-API module and OpenROADM based Renderer
- TAPI as a NBI for Connectivity Service, Topology, Notification and Streaming
  - ✓ To abstract various SB device data model (OpenConfig and OpenROADM) and multi-vendor
- TAPI extension to support Optical Impairment PCE
  - ✓ Ensure compatibility without the need to implement a new OI model (i.e. IETF)
  - ✓ Allow external application to perform not only TAPI-based Optical Impairment-aware Path Computation but also optical parameter optimization

NOKIA

NOKIA

javier.errea_moreno@nokia.com
huy.h.tran@nokia.com

THANK YOU