TELECOM INFRA PROJECT

TIP MANTRA Use Cases Definition Document

IPoDWDM-capable routers' coherent pluggable integration and management

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Introduction

This Use Cases Definition document extends the current MANTRA Whitepaper: IPoWDM convergent SDN architecture - Motivation, technical definition & challenges [1] with an extended description of the target applicability scenarios and use cases targeted by the TIP OOPT MANTRA operators subgroup.

1. Introduction

This Use Cases Definition document extends the current MANTRA Whitepaper: IPoWDM convergent SDN architecture - Motivation, technical definition & challenges [1] with an extended description of the target applicability scenarios and use cases targeted by the TIP OOPT MANTRA operators subgroup.

The Open Optical & Packet Transport Project Group (OOPT) within the Telecom Infra Project (TIP) works on the definition of open technologies, architectures, and interfaces in optical and IP networking. The MANTRA (Metaverse ready Architectures for Open Transport) former CANDI TIP OOPT subgroup aims to define a common set of use cases for IPoDWDM transport network scenarios to approach a common open standard definition of the SDN management for transport networks based on this architecture.

It is worth clarifying that the term IP over Dense Wavelength Division Multiplexing (IPoDWDM) refers to a network architecture where the colored optical coherent transceivers are 'plugged' directly into the routers replacing the traditional setup where the coherent DWDM transmission was performed by 'standalone' transponder/muxponder devices.

This integration imposes new challenges and operational requirements for the end-to-end management of the network. An initial approach to the problem statement, current identified challenges and potential solutions were addressed in the referred TIP MANTRA Whitepaper. Now the ambition of this new document is to come up with a further definition of the use cases and applicability scenarios which will infer the requirements of the management layer of IPoDWDM-capable routers as a first step.

1.1 Motivation and objectives

The MANTRA subgroup defined, in 2022, their objectives in a positioning whitepaper [1] describing the target to evaluate the impact of introducing the IPoDWDM transport architecture in the overall Transport SDN architecture [2].

The objective of this document is to identify the set of target use cases of interest for telecom operators, to outline the scope of the upcoming testing and proof-of-concept (PoC) activities, and to pave the way for the definition of a standard-based open management solution for IPoDWDM use cases.

In this document, as a first step, the focus will be the definition of the technical requirements for IP routers hosting coherent pluggable ZR+ transceivers. The outcomes and findings after the completion of this assessment would apply to both proposed

MANTRA SDN Architectures' solutions I and II, leaving the definition of the integration of the IPoDWDM routers into the management SDN architecture and the definition of the technical requirements of SDN controllers, for later phases.

The overall goal is to achieve a plug-and-play scenario where multiple coherent transceiver solutions, addressing the same standard definition (e.g., ZR+), can be seamlessly interoperable with the hosting IP routing platforms. Coherent pluggable shall be integrated through a standard interface such as OIF-IA-CMIS-5.x[1] [3] or newer versions of this standard, to expose in a standard way their control and monitoring capabilities.

Likewise, IP routers should expose the management and control capabilities for pluggable Optical Coherent Transceivers through a standard and open interface and data model, defined through a reference implementation agreement such as the one defined already by the TIP MUST optical subgroup [4].

The results of these efforts should allow managing different pluggable, from different manufacturers, hosted in the same router in a vendor-agnostic way. Furthermore, this approach will allow SDN Controllers and Network Management Systems to integrate different equivalent routers, supporting the same target standard interface, in a seamless manner, allowing the same use cases to be implemented over multi-vendor IP networks by the SDN Controllers.

[1] OIF-IA-CMIS-5.2 is the target release to be supported by Routers which manage coherent ZR+ pluggable since it is backward compatible with 5.0 and 5.1 versions of the standard.

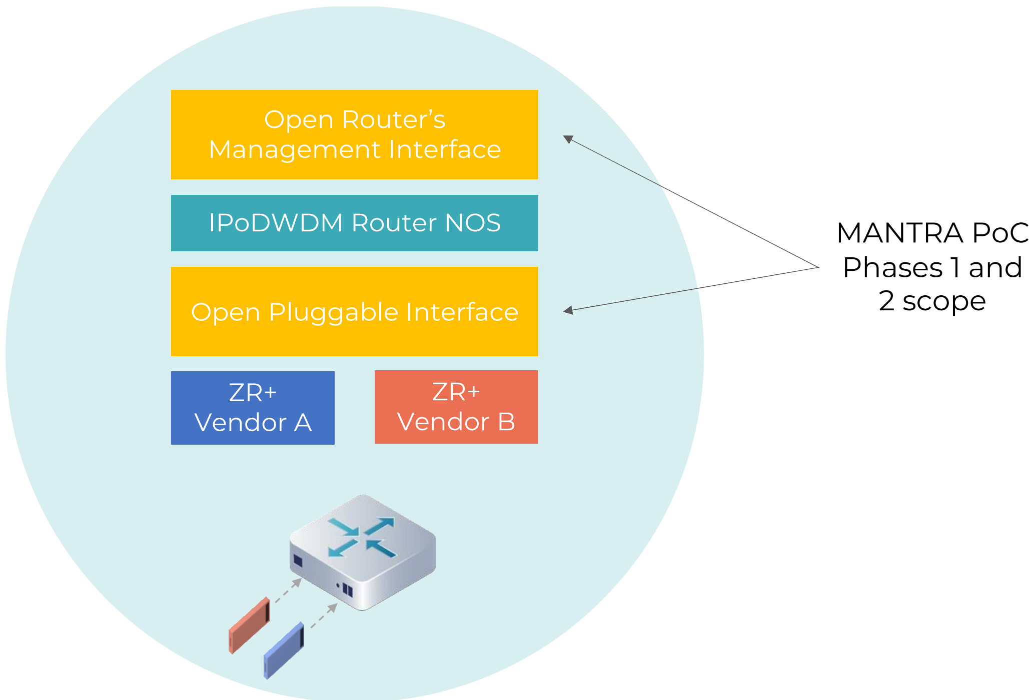

Figure 1. MANTRA IPoDWDM Proof-of-concept phases.

1.2 Challenges

The problem statement described in the previous section highlights two major technology drivers to achieve the desired open and standard architecture:

- **Open Pluggable Interface** – Based on Common Management Interface Specification (CMIS) Implementation Agreement (IA) [3] and the Coherent OIF C-CMIS version 1.3 [5]. This interface shall permit the seamless integration of coherent ZR+ transceiver pluggable modules in the routers and it shall be based on a standard definition. This integration shall cover the optical coherent pluggable modules management functions such as:
    - (1) the optical channel's basic feature's configuration such as the optical central frequency and the output power, and the client encapsulation settings;
    - (2) the selection of the transmission mode (aka operational-mode), defining the modulation format, FEC coding, and baud-rate;
    - (3) the diagnosis monitoring functions of the tunable laser and the optical channel's key performance indicators such as received power, OSNR, Chromatic Dispersion, PMD, PDL;
    - (4) monitoring of Error Performance Statistics such as the Bit Error Rates;

- (5) basic discovery of the hardware inventory details such as firmware version, serial number, part numbers etc;
- (6) monitoring of fault management features such as control flags (e.g. operational-status etc.) and warnings.

- **Open Router's Control/Management Interface** - NETCONF/gNMI OpenConfig interface covering control, management and telemetry functions. The definition of a reference implementation agreement for this interface has been pursued by TIP MUST subgroup as a solution for Open Optical Terminals in Open Optical Networks [6]. The MANTRA subgroup believes that the current MUST SDN Technical Requirements for Open Terminals [4] reference implementation is valid for IPoDWDM scenarios as well, with the extra advantage that it natively integrates with the rest of OpenConfig IP data models [7].

However, the maturity of the definition of the previous two standard interfaces is not yet at the desired level to guarantee full interoperability.

On the one hand, the OIF-IA-CMIS-5.x [3] allows a high degree of flexibility for optical coherent pluggable vendors to expose their management capabilities in a customizable way. The MANTRA subgroup is keen to understand how the proposed Implementation Agreement is utilized/implemented by the vendors nowadays, as well as the interface limitations for the set of target use cases operators want to achieve. This information will be used to fill the gaps that will guarantee the full interoperability objectives in the future.

On the Open Router's Management Interface side, the target implementation agreement based on OpenConfig data models and NETCONF/gNMI interface is quite mature for traditional transponder/muxponder devices. Certainly, this definition can be applied to the IPoDWDM scenario. However, integrating the management of the optical transport interface into a router requires an additional correlation between the management of the optical layer and the management of the IP layer. For instance, the support of the optical coherent channels' performance indicators such as OSNR, Q-Value, PRE and POST FEC BER, the fault management alarms and the correlation with the status of the L2 and L3 logical interfaces, in the routers is yet pending to be evaluated.

1.3 Terminology

In this document, the following terms are employed with the definitions specified below:

- **IPoDWDM**: IP-over-Dense Wavelength Division Multiplexing. This concept refers to a network architecture where independent transponder/muxponder network elements are suppressed in favor of routers equipped with integrated coherent transceiver modules (either as pluggable modules or fixed modules).

- **Open**: Generally, when this term is prefixed to a target (e.g., an Open Line System, O-OLS), it implies that the target (system, piece of equipment, software (SW), network function, etc.) exposes interfaces, often Application Programming Interfaces (API), with a well-known and standard protocol, data model and rules for use for the integration by the Operators in their networks and OSS/BSS systems. These interfaces are specified by MUST. The specific meaning of this attribute, as applied to an architectural component, is clarified, and extended in the relevant specific chapters within this document.
- **Open-Optical Line System (O-OLS**): A complete and autonomously managed optical transport network also supporting (together with digital clients), or exclusively supporting optical analogical DWDM channels as clients. In the context of this document, the term "open" refers to the fact that an O-OLS allows, as analogical clients, any signal which follows a given behavior, specified by the O-OLI definition in this document. It exposes an open and standard-based programmable NBI (such as per the implementation proposed by TIP MUST [7]).
- **Optical Terminal (OT):** In the context of this document, the term designates a category of NEs in an Optical Transport Network, including the network functions of Transponders (1:1 mapping of clients to line side interfaces); Muxponders (N:1 mapping and multiplexing); Switchponders (N: M mapping, digital switching, and multiplexing). Their role is to adapt digital clients of the Optical Transport Network over DWDM channels.
- **Open-Optical Terminal (O-OT):** This term as defined in this paper, extends the definition of Optical Terminal to all the categories of devices housing Open Optical Line Interfaces (O-OLIs), which fulfills the set of requirements, also included in this document. In summary, these are the support of Open and Standard management interfaces; the standalone deployment and management, independently from the Open Optical Line System (O-OLS). An O-OT adapts digital clients and generates one or more "alien wavelength" optical DWDM channels to be transparently transported by one, or a chain of O-OLS.
- **Open-Optical Line Interface (O-OLI**): In the context of "partial disaggregation", an O-OLI specifies the physical and logical single optical DWDM channel interface between O-OTs or IP routers, and the O-OLS. An O-OLI is therefore the functional and administrative demarcation point between an O-OLS and the set of O-OTs generating the analogical "alien wavelength" channels. O-OLI provides all the required physical, control, and management information to allow and adapt "alien wavelengths" and possible OTN capabilities over the O-OLS for the aggregated optical transport network.
- **Open-Planning and Impairment Validation (O-PaIV):** An open planning functionality that provides: (1) OLS network design and (2) verification of EoL margins for connections (wavelengths) between optical line interfaces. This definition implies that any third party can perform (1) and (2) since necessary data is shared by the O-OLS and the O-OLI vendors.

- **Small Form-factor Pluggable (SFP):** Compact, hot-pluggable network interface module that can be plugged into network devices/servers.
- **Common Management Interface Specification (CMIS)**: Interface, initially defined by the QSFP-DD Multi-Source Agreement and currently as a work item of OIF, to communicate between a QSFP-DD pluggable and a network device.

2

IPoDWDM target scope and SDN architecture

The technical scope to be considered as part of the evaluation of MANTRA IPoDWDM activity is summarized in this section.

2. IPoDWDM target scope and SDN architecture

The technical scope to be considered as part of the evaluation of MANTRA IPoDWDM activity is summarized in this section.

2.1 Target Scenarios

The IPoDWDM scenarios considered shall accommodate the following requirements:

- The IPoDWDM router must provide an open and standard SDN interface for control, management, and monitoring functions.
- The IPoDWDM router must assure interoperability with multiple manufacturers' coherent transceivers to avoid vendor lock-in.
- The focus is on disaggregated O-OLS-based scenarios (Metro, Long Haul) where coordination between the IP and the Optical transport domain is needed.
- Coherent pluggables in the routers are considered as a new deployment option in addition to the traditional optical transponders option and, depending on the specific scenario targeted by the operator (Metro/Core, LH/ULH etc.), one option may be preferred and selected over the other based on the outcome of the optical planning and validation phase.
- The applicable network scenarios are not constrained here, the objective is to evaluate this technology over any possible scenario such as P2P or ROADM based, and any feasible distances allowed by the transmission capabilities of the coherent transceiver modules. However, two main scenarios are presented in following sub-sections, with highest priority for operators.

2.1.1 High capacity point-to-point WDM links over dedicated DWDM infrastructure

Low power ZR (typically -9/-10dBm), due to its shorter reach and optical characteristics, fits better high capacity (nx400G) point-to-point connections in Metro area scenarios over dedicated DWDM infrastructure and dedicated fibre. Typically, we are referring to average distances below 100km. An example could be between a Core router and an Internet GW router. Operationally, being a set of point-to-point DWDM connections through a dedicated fibre, with no ROADMs nor amplifiers in between, it is a simpler case which can be managed only with an IP SDN controller.

Figure 2 shows a point-to-point dedicated DWDM infrastructure that is optimized for metropolitan areas, using low-power, pluggable ZR (or alternatively ZR+ transceivers) that have a typical range of less than 100 km and are suitable for nx400G links. The diagram includes optical line amplifiers to ensure optimum performance, but in practical metropolitan scenarios, the capabilities of ZR pluggables sometimes do not even require them. This makes operational management more efficient and allows seamless control with an SDN IP controller.

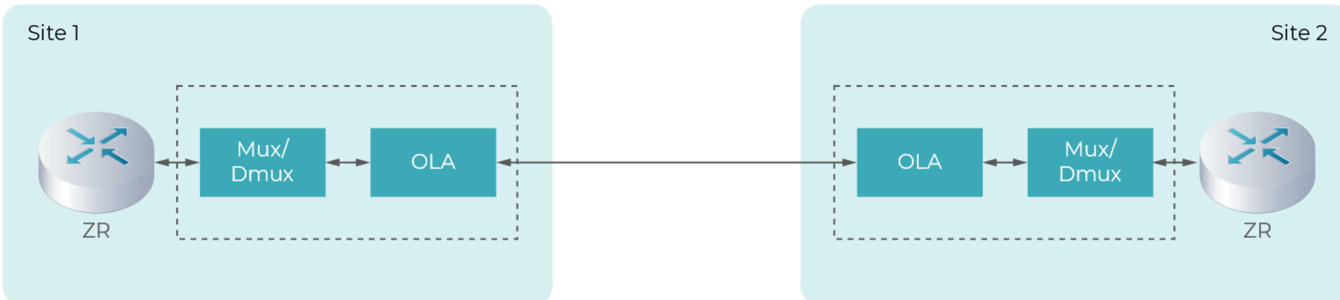

Figure 2: High capacity point-to-point link over dedicated DWDM infrastructure with low power ZR/ZR+

2.1.2 High capacity ROADM based WDM links over shared DWDM infrastructure

High power ZR+ pluggables versions (0 or few more dBm) represent an attractive option, not only because of the cost and energy savings benefits, but also because of their output power and their optical characteristics that make them very similar to native transponders used today in operators' DWDM networks. As a consequence, high power ZR+ pluggables can be connected to the same type of add/drop filters of existing ROADMs (C-F or CDC-F) in the same way as native transponders. This enables reaches above 100km for scenarios with a reduced number of ROADMs and/or a certain number of line amplifiers. This kind of scenarios works well for a number of Core links in metro/regional areas where distances are not too high.

Figure 3 shows an optical communication system using high-power ZR+ pluggable transceivers at both ends to achieve longer distances than 100km where low power ZR/ZR+ pluggables cannot meet the operators' requirements. Due to its multi-layered nature and shared infrastructure, this scenario can be more complex operationally than a simple point-to-point connection.

This scenario requires a robust SDN management system that is able to handle the multi-layer complexity, including the discovery of pluggable capabilities and the visualization of the multi-layer topology. For troubleshooting and maintenance of the supported services, performance monitoring and event/alarm correlation between the pluggable and the optical line system, the SDN control/management system is essential. This integrated approach enables operators to maximize the utilization of their existing DWDM networks, while at the same time introducing new high-capacity transceivers that can support the growing demand for bandwidth in metropolitan and regional areas.

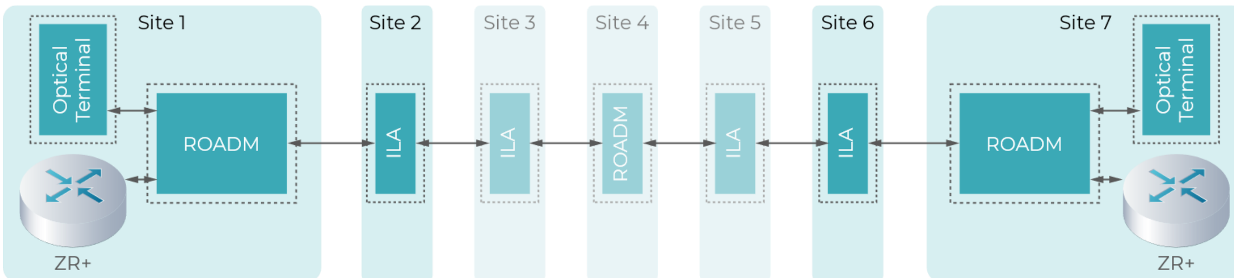

Figure 3: High capacity ZR+ link over ROADM based shared DWDM network

2.2 Target SDN Architecture

The target SDN Architecture was already defined in the first TIP MANTRA Whitepaper [MANTRA-WHITEPAPER] and it is covered by two possible alternatives.

2.2.1 Proposal 1 – Dual SBI management of IPoDWDM routers

The main characteristic is that the management of the IPoDWDM routers is shared among the IP and the Optical SDN Controllers.

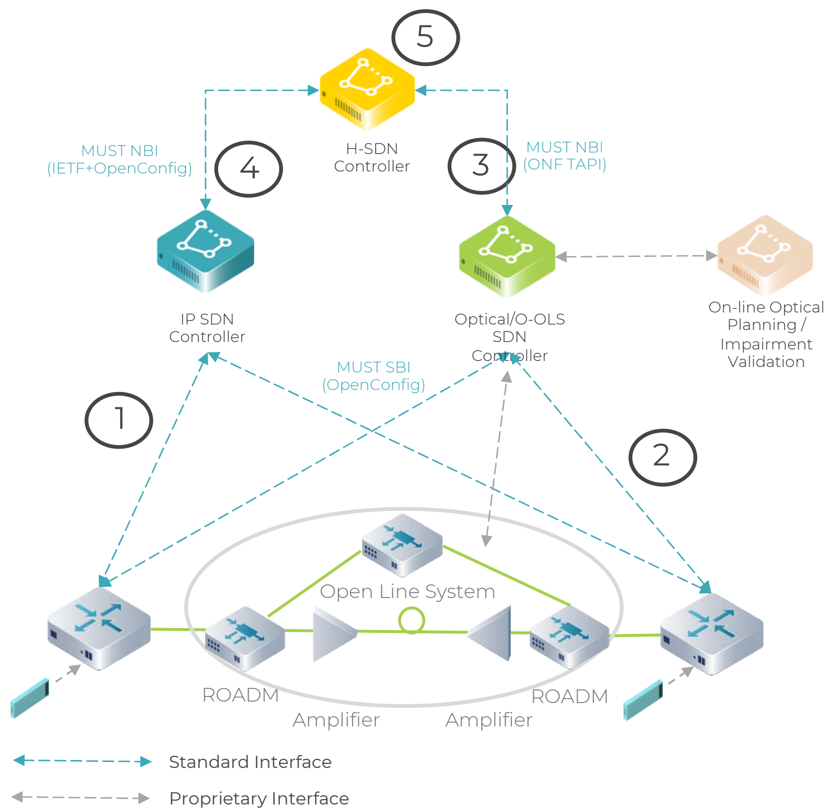

Figure 4. Dual SBI management of IPoDWDM routers.

2.2.2 Proposal 2 – Single SBI management of IPoDWDM routers

This second proposal assumes the IP SDN Controller as the only entity which directly interfaces with the IPoDWDM routers and implements all management capabilities.

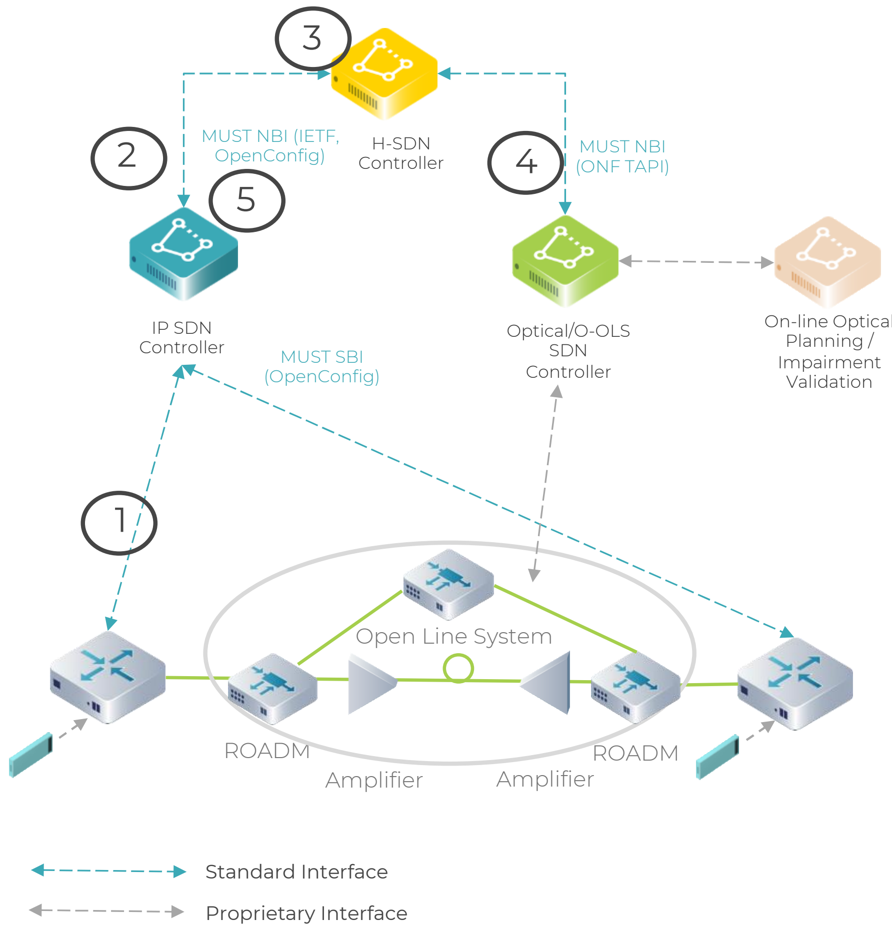

Figure 5. Single SBI management of IPoDWDM routers.

Note: for the exact meaning of the different steps described above in the workflows presented, please refer to the TIP MANTRA whitepaper [1].

2.3 Open IPoDWDM-capable router definition

In this section, the intention is to summarize the characteristics that MANTRA project was foreseeing for the IPoDWDM capable routers.

1. Open Pluggable market. Open hardware abstraction layer for coherent transceivers shall be consolidated as part of the IPoDWDM solution's development. OIF-IA-CMIS-5.x [3] seems now confirmed as the selected de facto standard. Routers shall support latest OIF-IA-CMIS-5.x release to be able to

manage different older 5.x versions of the standard supported by coherent pluggable modules.

2. Convergence IP over Optical open control and management. The management interface shall properly integrate from the optical physical layer to the IP. Currently, OpenConfig seems the most adequate data model that consolidates this IPoDWDM network stack to model the new capabilities of routers.
3. Open data for network planning and impairment validation. Device manifest information including DWDM transmission mode such as physical performance metrics and threshold levels, shall be open and available through the standard router device management interface.
4. Non-bookended solutions through standard transmission modes are highly desirable to simplify the network architecture.

3

Use Cases

This section presents the general use cases targeted by operators regarding packet over optical multi-layer end-to-end SDN management.

They apply to any network topologies and both for traditional packet over optical networks using grey interfaces in the routers with transponders in the optical nodes, and for coherent DWDM pluggable modules in the routers over an optical DWDM network.

3. Use Cases

3.1 General packet over optical use cases

This section presents the general use cases targeted by operators regarding packet over optical multi-layer end-to-end SDN management.

They apply to any network topologies and both for traditional packet over optical networks using grey interfaces in the routers with transponders in the optical nodes and for coherent DWDM pluggable modules in the routers over an optical DWDM network. This applies for all use cases except use case 2, which is only applicable for coherent DWDM pluggable-capable routers.

Here is an attempt to present those use cases following the current operators' priorities order (first being the highest priority):

1. **End-to-end multi-layer visibility and management**
   1.1 End-to-end multi-layer network and service inventory/topology discovery
   1.2 End-to-end multi-layer event/fault management
   1.3 End-to-end multi-layer performance management

2. **Inter-domain link validation**
   Note: there is a need for operators of an automated validation phase of the required manual patch cords between pluggables and optical nodes.

3. **End-to-end L3VPN/L2VPN service multi-layer fulfilment with SLA constraints (TE constraints like SRLG avoidance, minimum latency, etc.)**

4. **End-to-end L3VPN/L2VPN service multi-layer assurance with SLA constraints**

5. **End-to-end L3VPN/L2VPN service multi-layer fulfilment with SLA constraints and optical restoration (L0 photonic GMPLS control plane)**

3.2 Specific use cases for IPoDWDM-capable routers' coherent pluggable integration and management

TIP MANTRA operators identified the following specific IPoDWDM-capable routers use cases as the minimum basis to be supported to allow then the support of the general use cases presented in the previous section:

1. **Use Case 1 - Inventory discovery and visualization of IPoDWDM routers after pluggable installation and network commissioning, without services deployed (Day 0).**
2. **Use Case 1.1 – Coherent pluggable discovery**
    a. Verify and characterize the correct detection of the pluggable by the IP Router host in different scenarios:
        i. Hot insertion, discovery of the pluggable when the IP Router host is up and running.
        ii. Cold insertion, insertion of the pluggable when the router is switched off, and verification of the correct discovery when the router is started.
    b. Once the plug-in ZR/ZR+ (hot or cold insertion) is inserted, the objective will be to verify the IP router correctly detects the new interface with its associated optical parameters (central-frequency range, operational/administrative status, Tx/Rx power range and performance counters among other parameters).
    c. The integration and discovery process shall be vendor agnostic through a common and standard implementation of the Open Pluggable Interface (potentially OIF-IA-CMIS-5.0 or newer versions).
3. **Use Case 1.2 - Physical Inventory discovery.**
    a. ZR+ coherent transceiver pluggable hardware inventory information discovery
        i. Inventory chassis/line card location, hosting port identification.
        ii. Pluggable component information part-no, serial-no, pluggable manufacturer.
        iii. HW status (admin-state, operational-state).
4. **Use Case 1.3 - ZR+ coherent transceiver pluggable discovery logical inventory.**
    a. Characterize the default configuration mode of the transceiver after the module is plugged, including the logical mapping between client and line interfaces (I.e., Ethernet Interface to Optical Channel).
5. **Use Case 2 - DWDM network planning (including physical impairment validation) for IPoDWDM-based services.**
    a. Discovery of optical-channel capabilities.
        i. Operational modes and their characteristics available (Bit rate, Baud Rate, Modulation Format, FEC coding).
        ii. Physical Rx tolerances (minOSNR, minRxPower, maxCD, maxPDL, maxDGD).

        iii. Optical channel configuration constraints (min/maxTxOutputPower, min/maxCentralFrequency, frequency grid, adjustment granularity, available modes).

6. **Use Case 3.1 - Creation/Deletion of an IP link over an Ethernet transport service over a ZR+ OTSi optical channel over WDM.**
    a. Basic provisioning of the optical channel configuration (operational modes, central frequency, output power, admin state).
    b. Correlation of operational state between Optical Channel and Ethernet interface once deployed.
7. **Use Case 3.2 - Change of the operational mode (different bit rate) and discovery of the correlation with the IP layer.**
    a. Modify the operational mode or transmission mode associated to the line interface, e.g., from 400G DP-16QAM to 300G DP-8QAM.
    b. Verify the new logical mapping between client to line interfaces.
    c. Verify client Ethernet layer correlation once the offered client bit rate changes.

8. **Use Case 3.3 - Change the client mapping mode from 4x100GE to 1X400GE and vice versa.**
    a. Discovery of the two possible client mapping mode configurations (1x400GE, 4x100GE) and the associated logical mapping between client and line interfaces.

9. **Use Case 4 - E2E Ethernet interface and OTSi service performance monitoring through streaming telemetry (gNMI subscription).**
    a. OTSi optical channel performance monitoring. Streaming telemetry of the performance of the optical channel (pre/post-fec-ber, input-power, OSNR, q-value, CD/PMD...)
    b. Ethernet interface performance monitoring.

10. **Use Case 5 - E2E Ethernet+Optical fault management troubleshooting with events/alarms correlation.**
    a. Evaluate basic optical conditions such LOS, AIS, PRE-FEC-BER degradation.
    b. Operational and Administrative status correlation between Optical Channel and Ethernet interfaces.

4

PoC Objectives and expected results

The approach decided by the MANTRA subgroup to continue with the refinement of the target technical solution and standard and open implementation of the use cases defined in this document, is to evaluate the technical solution in an incremental way through the execution of several Proof-of-Concepts in different phases of the project.

4. PoC Objectives and expected results

The approach decided by the MANTRA subgroup to continue with the refinement of the target technical solution and standard and open implementation of the use cases defined in this document, is to evaluate the technical solution in an incremental way through the execution of several Proof-of-Concepts in different phases of the project.

These Proof-of-Concepts will be carried out by different members of the TIP OOPT community in open lab environments and the results will be contributed back to the MANTRA subgroup for the elaboration of the Technical Requirements Document of the target solution.

This section of the document describes in more detail the different phases into which the PoC will be divided to adapt the scope of the PoC in each phase to the roadmap of the solutions considered. The PoC will be subdivided into 2 phases from least to highest complexity following a bottom-up model, with the clear objective, at the beginning, to simplify the execution but, in the future to verify the complete architecture solution defined as option 1 and option 2 (see Section 2.2 Target SDN Architecture) in the **MANTRA positioning whitepaper [1].**

The two phases are described below indicating the objective and the expected outcome of each phase.

1. **Phase 1: Pluggable ZR/ZR+ integration into the IP router**

   In this phase, the intention is to assess the state of the art of the integration of ZR/ZR+ pluggable modules in the Router platforms. To this aim the first PoC will evaluate available market products where the integration of the coherent pluggable is done through either standard, partially standard, or proprietary interfaces.

   The technical assessment will evaluate the whole lifecycle management of coherent pluggable through the use cases defined in section 3.

   The key findings the MANTRA team expects for this phase are:
   - Understand the current practices of ZR/ZR+ pluggable integration through standard CMIS. Required extensions, and protocol fine-tuning.
   - To understand the current limitations of latest OIF-IA-CMIS-5.2 to achieve the use cases proposed without proprietary integration between the pluggable HW and IP router software stack. Gap analysis between what is integrated through CMIS and the extra proprietary or custom integration.

- Understand the logic of the management plane of the router to further extend the definition of the use cases and their target implementation based on standard OpenConfig models. Including the current support based on the use cases proposed.
- Out of the scope
  - Integration of IP and OPTICAL SDN Controller architectures discussion is not in the scope.
  - Optical Line System management will not be part of the scope.

2. **Phase 2**: **Managed ZR/ZR+ pluggable in the IP router through open and standard interface based on OpenConfig Netconf/gNMI**

Moving forward the second phase of the proof-of-concept will focus on defining the Open Router's Management Interface based on open and standard interfaces and the evaluation of early-stage implementations of it in lab testing environments.

In this phase, the target IP router platforms will be hosting at least two different (but comparable in features) coherent pluggable modules, and the set of proposed use case implementations will be validated through the execution using both pluggable modules.

The intention is to highlight differences in the implementations or feature availability using standard and open interfaces for both the integration of the pluggable in the router (Open Pluggable Interface) and the Open Router Management Interface. The objective is to prove that the same implementation can be used indistinctly to manage both coherent pluggable solutions in a plug-and-play mode.

The key findings the MANTRA team expects for this phase are:

- Review the integration lifecycle of a new coherent pluggable module in the router through OIF-IA-CMIS-5.x.
- OIF-IA-CMIS-5.2 gap analysis evaluation completion enhancing the findings of Phase I.
- Define the target low-level use cases implementation through standard Open Router's Control/Management Interface (NETCONF/gNMI OpenConfig).
- Showcase a first implementation of the target use cases based on the defined standard-based implementation of the Open Router's Control/Management Interface (NETCONF/gNMI OpenConfig).

- Out of the scope
    - Integration of IP and OPTICAL SDN Controller architectures.
    - Optical Line System management will not be part of the scope.

5

Conclusions and next steps

This Use Cases Definition Document has introduced the first definition of the target scenarios and use cases, the TIP OOPT MANTRA sub-group is intended to assess technically during the next phase of the project in a lab proof of concept. The main focus of this paper is to address a common and standard coherent pluggable integration and management in IPoDWDM-capable routers.

5. Conclusions and next steps

This Use Cases Definition Document has introduced the first definition of the target scenarios and use cases, the TIP OOPT MANTRA sub-group is intended to assess technically during the next phase of the project in a lab proof of concept. The main focus of this paper is to address a common and standard coherent pluggable integration and management in IPoDWDM-capable routers.

In summary, this document defines the target technical questions that shall be answered after the competition of this phase of the project:

- How optical coherent pluggable can be seamlessly integrated in IPoDWDM routers in a standard and open fashion?
- What are the current limitations on the latest OIF-IA-CMIS-5.2 (and also comparison between 5.2 and older 5.0 and 5.1) standard interface?
- What are the main challenges and extensions to current MUST Optical Open Terminals management interface definitions based on NETCONF/gNMI and OpenConfig data models, to define a common Open Router's Control/Management Interface?

The approach moving forward is to assess technically these questions through the execution of proofs-of-concept in open lab environments within the TIP OOPT community, which will help to clarify the state of the art on this open integration and management ambitions for IPoDWDM scenarios.

It is worth to highlight that both proposed SDN architectures will benefit from the achievements and conclusions of these PoC phases. In summary, the key requirement is to define a common Open Router Control and Management Interface following the path introduced by the MUST IP and Optical defined Southbound Interfaces (SBI) [6][4] respectively.

The next steps of the project would be to verify the proposed target architectures Option 1 (dual ZR/ZR+ pluggable IP/OP controller management) and Option 2 (only the IP controller manages the ZR/ZR+ pluggable in the router) including as pre-requisites the technical conclusions reached in this phase which can be summarized as the proposed Open Pluggable Interface and Open Routers Management Interface.

References

[1]. MANTRA Whitepaper IPoWDM convergent SDN architecture - Motivation, technical definition & challenges, August 2022, https://cdn.mediavalet.com/usva/telecominfraproject/tsOnpWikWkyk8AwkILoMFA/06x2yZMUaUCzphpaW3CDag/Original/TIP_OOPT_MANTRA_IP_over_DWDM_Whitepaper_-_Final_Version3.pdf

[2]. TIP OOPT MUST Open Transport SDN Architecture Whitepaper, 2020, https://cdn.mediavalet.com/usva/telecominfraproject/03V-53HVHE2_sr3_nk47_Q/WPd6tLiuS0CDkcG5S6Etug/Original/OpenTransportArchitecture-Whitepaper_TIP_Final.pdf

[3]. OIF-CMIS-05.2 - CMIS Common Management Interface Specification Revision 5.2, OIF Forum, https://www.oiforum.com/wp-content/uploads/OIF-CMIS-05.2.pdf

[4]. TIP OOPT MUST Optical SDN Controller SBI Technical Requirement for Open Terminals v1.0, June 2021, https://cdn.brandfolder.io/D8DI15S7/at/pgnh4kq5fhbj56kwnfwn3r4/TIP_OOPT_MUST-Optical-SDN-Controller-SBI-Technical-Requirements-for-Open-Terminals_V10_FINAL_GREEN_PUBLIC-ACCESS.pdf

[5]. IA OIF-C-CMIS-01.3 - Implementation Agreement for Coherent CMIS, October 12, 2023, https://www.oiforum.com/wp-content/uploads/OIF-C-CMIS-01.3.pdf

[6]. TIP OOPT MUST Optical Whitepaper – Target Architecture: Disaggregated Open Optical Networks v1.0, July 2021, https://cdn.brandfolder.io/D8DI15S7/at/k53xb6fw8f7nrjnw4fvx4c8/TIP_OOPT_MUST_Optical_Whitepaper_Target_Architecture_-_Disaggregated_Open_Optical_Networks__v10_-_GREENPUBLIC_ACCESS.pdf

[7]. TIP OOPT MUST IP – SDN Controller SBI / Router NBI Technical Requirements v1.1, December 2021, https://cdn.brandfolder.io/D8DI15S7/at/5xmjvcr3sgfrfwgmkbrhbwrs/TIP_OOPT_MUST_IP_SDN_Controller_SBI_Routers_Interface_Technical_Requiremenets_Document-FINAL_GREEN_ACCESS_v11.pdf

[8]. TIP OOPT MUST Optical SDN Controller NBI Technical Requirements Document v1.1, January 2022,

https://cdn.brandfolder.io/D8DI15S7/at/sp6tgqcpjp8rgsshf8pvmwpg/TIP_OOPT_MUST-Optical-SDN-Controller-NBI-Technical-Requirements-v11_FINAL_GREEN_ACCESS.pdf

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