Field Trial of a Management Architecture for Advanced Smart Pluggable Transceivers in Diverse Hosts

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Abstract *Smart pluggable transceivers are rapidly evolving, continuously introducing advanced capabilities not yet supported in deployed hosts systems. Here, we introduce and experimentally demonstrate a management paradigm simplifying integration into hosts by enabling an independent management channel to a transport management system.*

Introduction

Smart pluggable transceivers are deployed in host systems such as routers and switches to enable high-speed data transmission over fiber optic networks and soon into diverse host types. They are designed to be interoperable, compact, power-efficient, and adaptable to different network conditions and use cases. They can also relay monitoring data back to the network management system for optimization and control.

One of the main challenges of managing smart pluggable transceivers is the great variety of host systems in a disaggregated environment. While DWDM transceivers are controlled by the line system in a centralized fashion, smart pluggable transceivers are controlled by the hosts they are deployed in.

Several industry standards and initiatives have developed to address the management of smart pluggable transceivers in host systems [1]-[3]. For example, the Open ROADM MSA (Multi-Source Agreement) [1] defines a set of open specifications for interoperability and control of DWDM transceivers using a common data model and API. The OpenConfig project [2] provides a vendor-neutral data model and API for configuring and managing network devices, including pluggable transceivers. The Open Optical & Packet Transport group within the Telecom Infra Project (TIP) aims to create open and disaggregated solutions for optical transport networks, leveraging pluggable transceivers and software-defined networking (SDN) controllers [3].

In summary, smart pluggable transceivers are emerging as a key technology for enabling high-capacity, high-density, and flexible optical networks. However, they also pose significant challenges for network management and integration with existing systems. To overcome these challenges, network operators need to adopt industry standards and open solutions that ensure interoperability, compatibility, and control of smart

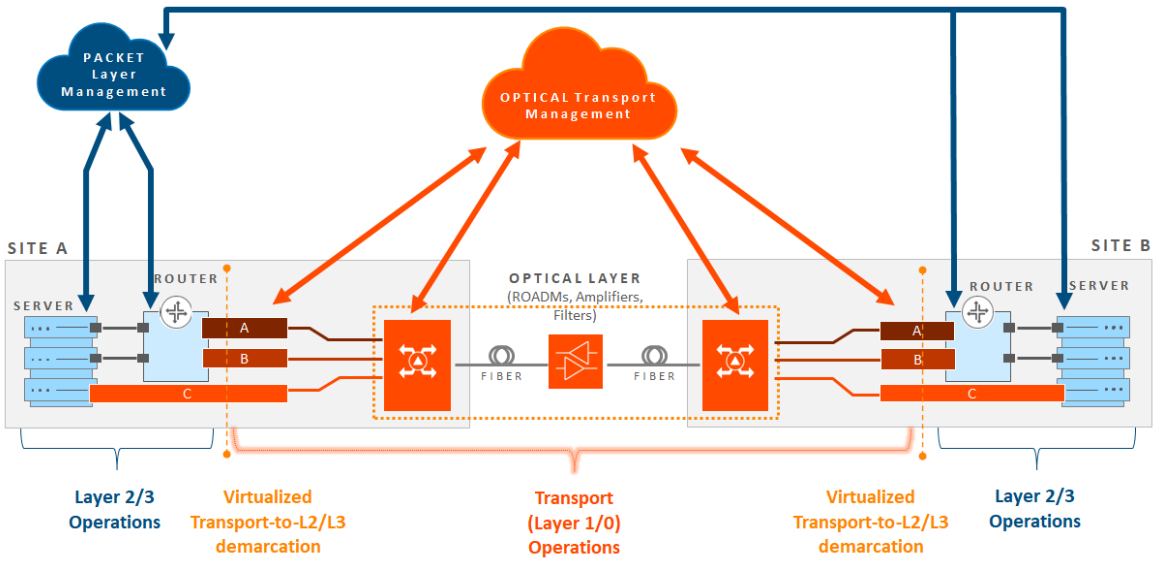

Figure 1: Proposed management architecture where a virtualized transport demarcation in smart pluggable transceivers (A, B, and C) enables separate management of packet and optical transport layers. In different sites (Site A and Site B), servers and routers with smart pluggable transceivers are managed by the packet layer management, while the virtualized transport functions within the pluggable transceivers are managed by the optical transport layer management.

pluggable transceivers in host systems.

In this paper, we report on a management architecture introduced by the Open XR forum [4] that separates the management of transceivers from host devices, enabling management of any advanced coherent module to support IP over DWDM and point-to-multipoint coherent networks. To show the capabilities, we perform a field trial of smart pluggable transceiver deployment in diverse hosts in the liberty global labs.

The Management Architecture

The architecture, first proposed in [4], is illustrated in Figure 1. Here, the management of packet layer and optical transport layer can be treated separately. This is enabled by virtualized transport to L2/L3 demarcation in the smart pluggable transceivers. Consequently, the development and deployment of new functionalities of transport and packet layer is simplified, lowering the burden of having to implement all new features on the diverse hosts from multiple vendors.

To enable such a novel management approach, connectivity between the centralized optical network management system and the pluggable transceivers needs to be established once transceivers have been initialized by the host system [5]. Here, we need to differentiate between two different types of host systems and capabilities.

Optical transport related host systems like optical line terminations (OLTs) in passive optical networks (PONs), optical line systems, or other optical transport systems typically offer advanced management functions and capabilities, advanced telemetry, and network awareness. These systems often provide access through dedicated low and high bandwidth management interfaces to control smart pluggable transceivers, as illustrated in Figure 2 A.

IP network elements like routers and servers on the other hand often provide only limited management capabilities for advanced pluggable transceivers, and in case of high-port-count systems often refrain from implementing high speed management interfaces like Serial Gigabit Media Independent Interface (SGMII) due to the additional cost and system complexity. Here, management can be implemented by communication over a management virtualized local area network (VLAN) within the regular data path, either through integrated routing functionalities of the host or through other data network elements, see Figure 2 B and C.

In a diverse environment, the management system must be able to deal with a large variety of these host systems from core routers to edge compute at radio tower sites and anything in between. While administration through dedicated management ports is the norm, virtualized management access through the data path is usually not possible. As such we focus on the second case in our experimental validation.

Experimental Setup and Results

The experimental setup is described in Figure 3. Two smart optical pluggable transceivers in two host systems, here MPLS Routers, are automatically provisioned through a dedicated management VLAN in the IP/MPLS network.

At the start up, the smart pluggable transceivers establishes contact to the DHCP server to be assigned an IP address and retrieve the Device Provisioning Service (DPS) IP address. The transceivers then initiate contact to DPS to retrieve the Open XR Controller's address and then connect to the Open XR Controller, completing the onboarding process.

Figure 4 A shows a Wireshark screenshot of the DHCP transaction and TLS connection initialization to the DPS with IP address 10.101.71.2 of

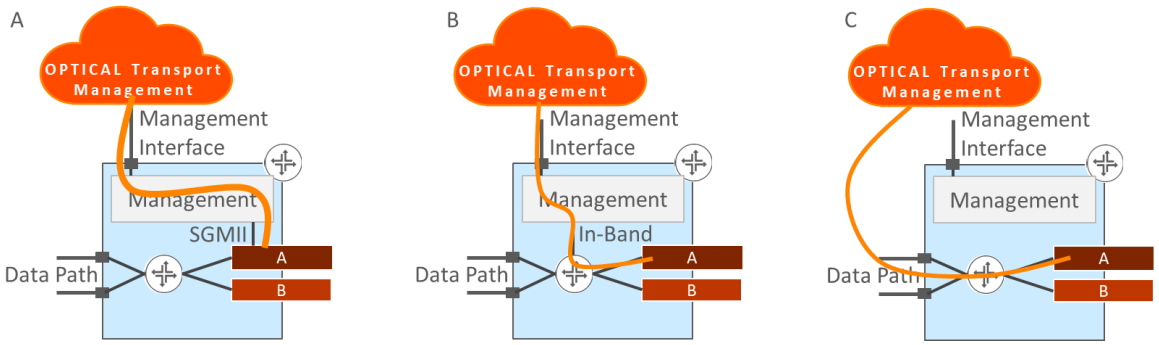

Figure 2: Paths for the optical transport management system to access advanced capabilities of the smart pluggable transceivers. A: The management system accesses the pluggable through a transparent connection provided by the management system of the host device to the pluggable SGMII port. B: The management system accesses the pluggable through a transparent connection provided by the management system of the host device to an in-band channel provided by the host device. C: The transport management system connects to the pluggable transceiver through an in-band communication channel in the data path.

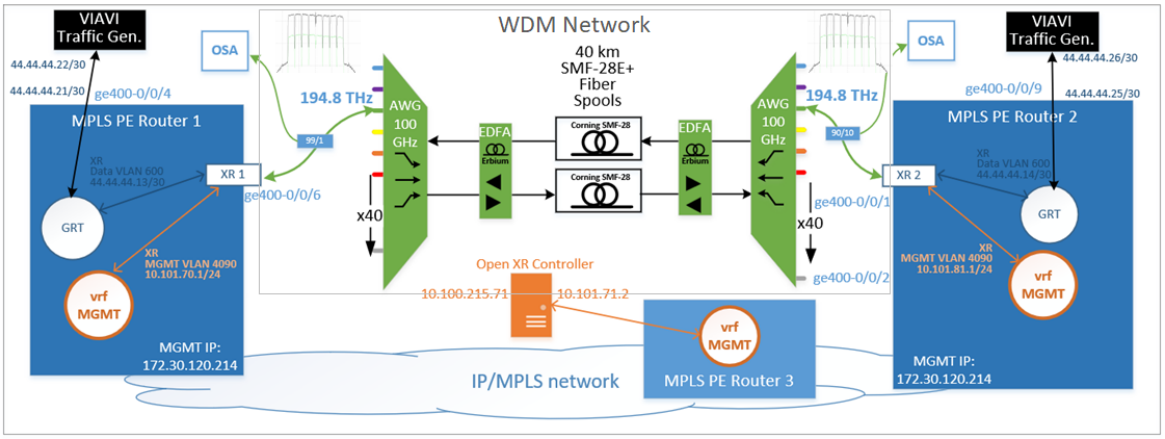

Figure 3: In the setup, two smart optical pluggable transceivers (XR 1 & 2) that are connected through a WDM network are placed in two host systems (MPLS PE router 1 & 2). The routers provide management connectivity to the optical transport management (Open XR controller) through a dedicated VLAN (vrf MGMT) over the IP/MPLS network, while also providing connectivity for traffic testing with VIAVI traffic generators.

the module:

Figure 4 B shows a Wireshark screenshot of the initialization of the TLS connection to the Open XR Controller with IP address 10.100.215.72

Finally, the module is registered in the management system as shown in the screenshot of the optical transport management system (here Open XR controller) in Figure 4 C.

The smart pluggable Open XR transceivers inside the router ports, have successfully performed an automated registration to the transport management Open XR Controller system.

Subsequently, the successful provisioning of the modules was verified through live traffic tests.

Summary and Conclusion

Emerging Edge Compute applications are driving the need for high capacity supported by coherent modules. As smart DWDM coherent modules migrate closer to the edge of the network, power and space problems can be addressed through the elimination optical transport equipment by deploying directly into an ever-increasing range of host types. However, this in turn disrupts the management paradigm that was built upon and relies on the demarcation between Packet and the DWDM transport systems. This paper addresses a key operational challenge to automate the onboarding process of a smart DWDM coherent module into the Optical Transport management system when that smart pluggable is installed into a packet host. This maintains the Packet to Optical Transport demarcation, albeit a *Virtualized* one, reflecting the team structure these organizations depend upon.

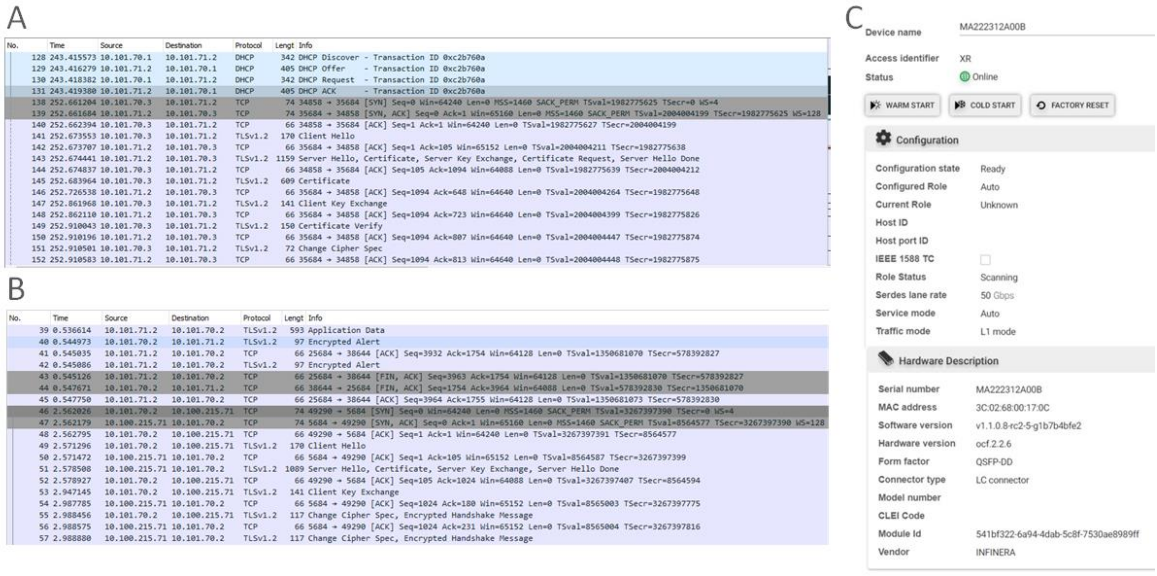

Figure 4: Experimental results, A: Wireshark screenshot of the DHCP transaction and TLS connection initialization to the DPS, B: Wireshark screenshot of the TLS connection initialization to the Open XR Controller, C: Screenshot of one of the modules registered with the management system (Open XR controller)

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