Vendor-neutral Network Representations for Transport SDN

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Abstract: We describe a model-based approach for building a transport SDN platform that uses operator-defined data models to build common APIs for managing multi-vendor optical networks consisting of terminal devices and line systems.

1. Introduction

Software-defined networking (SDN) for optical transport networks is being developed in the industry to enable programmability and flexibility in optical networks for capacity optimization, more agile management, and rapid recovery from failures. The transport SDN platform implements a closed-loop control and management system that performs a number of key functions including monitoring, provisioning, commissioning, and configuration in an automated fashion. It also is able to interface with management systems operating on other layers of the network (e.g., the layer-3 / packet layer) to provide cross-layer traffic planning and optimization. By separating control and management functions from embedded hardware, SDN provides a logically centralized platform for automation and improved operational efficiency [1].

One of the goals of the transport SDN platform is to provide a single system for managing the end-to-end network, regardless of which vendor equipment is used, whether a terminal or line system device. Traditional transport network operations are often siloed based on the device type because it is only possible to manage a particular device with the corresponding vendor's management system. This results in significant operational complexity and inefficiency since it requires different skills, processes, and tooling for each element management system (EMS).

The transport SDN system should ideally hide this complexity from operators and upstream tools by providing an abstraction layer that exposes a common API for retrieving and sending monitoring and configuration data, respectively. One promising approach for realizing such an interface is to develop vendor-neutral data models that describe a common structure, syntax, naming, and semantics for the data, regardless of the vendor. Vendor-neutral interfaces are particularly important to simplify operator's qualification processes, which generally require full end-to-end integration and testing with existing management systems, automation tools, and IT processes. The qualification process can be significantly accelerated if vendor proprietary integrations can be minimized, or avoided altogether.

In this presentation, we describe OpenConfig, a group of global-scale network operators working to develop open, vendor-neutral data models for configuration and network monitoring for both packet-switched and transport network devices. Native support for OpenConfig APIs is now being developed by major networking vendors to support programmatic configuration and telemetry. This is the first industry-wide initiative driving an open, software defined, and declarative network management plane that allows programmatic operation of physical and virtual networks across the OSI stack.

2. Transport SDN architecture

In the transport SDN architecture (shown in Figure 1), a logically centralized management system implements a network operating system (NOS) which manages communication with optical network elements through a set of optical element services (OES). The NOS interacts with a number of management and control applications which perform dynamic path optimization, physical layer validation, device configuration, telemetry data collection and analysis, and maintenance of the overall topology view. These applications leverage the NOS to collect operational state information via streaming telemetry from element management systems, or directly from devices, and also to push configuration or control updates to network elements.

The OESes in the NOS are analogous to device drivers in that they must be developed to interface with a variety of network elements from different vendors, including terminal optics devices such as transponders or muxponders and

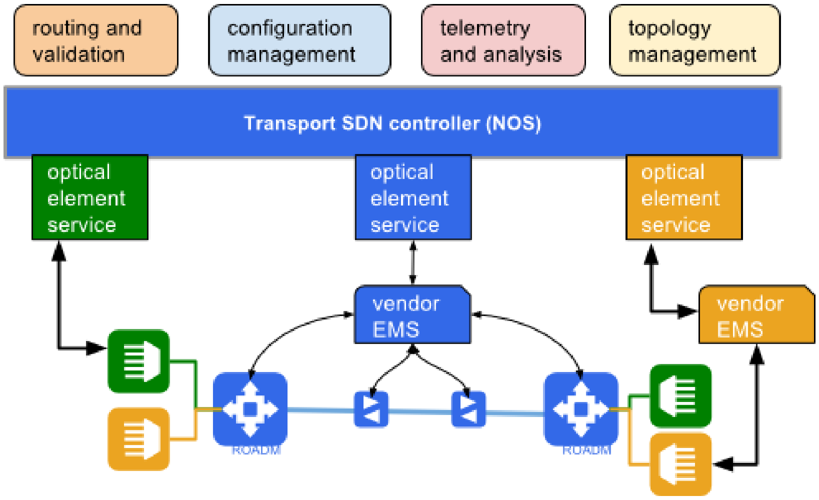

Fig. 1. Transport SDN architecture

line system devices including ROADMs and ILAs (in-line amplifiers). In some cases, the interaction is directly with the elements, but it could also be via a vendor-supplied EMS that provides programming interfaces (APIs) for client applications. The use of an EMS is particularly common for line system elements which typically are sourced from a single vendor and require end-to-end coordination.

3. Model-driven network management

In a model-driven network management system, data models are used to represent a common interface for communication with heterogeneous devices in a multi-vendor environment. The data model defines a durable API that remains stable for operators and network tools to use. It also provides an abstraction layer that insulates the management system from variations in the proprietary schemas used by each device type.

We consider three types of data models. Configuration models describe the structure and content of configuration data, as well as constraints on the data that ensure that valid configuration instances are sent to devices. Operational state, or telemetry, data models describe read-only data that consists of performance metrics (PMs), statistics, counters, etc. Topology models describe the connectivity of network elements at multiple layers, including physical and logical (e.g., OTN layers).

3.1. Model development by network operators

Our strategy for developing data models for network infrastructure, including optical elements, is based on an operator perspective, with primary emphasis on models reflecting actual operational use cases. While there is value in using a vendor-neutral data model as an abstraction layer within the management system, the goal is to have native support for the models on the elements themselves. This removes the need for proprietary integrations in the transport SDN controller via vendor-specific OESes.

In order to ensure that models are representative of a broad set of use cases, the OpenConfig working group was formed as a collaboration between a number of large-scale network operators from various segments, including traditional communication service providers and Web-scale service providers [2]. The focus of OpenConfig is to develop and publish vendor-neutral data models for configuration and operational state, and work with equipment vendors to ensure native support on their platforms. OpenConfig, along with much of the networking industry, has adopted the YANG data modeling language to define the data models [3].

3.2. Data models for optical transport

Specifically for optical networks, and in support of transport SDN, OpenConfig has initially focused on models for terminal optics, ROADMs, and amplifiers. The vendor-neutral terminal optics model provides data definitions for configuring client and line ports, including physical channels, as well as optical channels for line side transmission. It also provides flexibility to define 'logical' channels which represent multiple stages of multiplexing, demultiplexing, or signal grooming to handle a variety of use cases. The model also contains a comprehensive set of operational state parameters, such as PMs for various elements of the device. OpenConfig is also publishing data models for line system elements, focusing on ROADMs and optical amplifiers. The ROADM model is particularly important for realizing transport SDN since it allows node capacity to be allocated flexibly to different links based on changing traffic demand, or to route around failures and breakages.

4. Conclusion

For transport SDN to deliver on its promises of operational efficiency and flexibility, it must provide abstractions and durable APIs that allow management and control of optical elements from multiple providers. Vendor-neutral data models based on established operational use cases are essential to represent the interfaces needed for configuration and operational state monitoring. The OpenConfig working group is an effort to bring together network operators to develop the key data models, and work with a number of vendors to ensure native support on their devices. Initial focus in OpenConfig has been on three main models that form the basis of most large scale transport networks, including terminal optics, ROADMs, and optical amplifiers. These data models form the basis of the model-driven management architecture for optical transport networks.

References

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