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Framework and Data Model for OTN Network Slicing
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Abstract

The requirement of slicing network resource with desired quality of service is emerging at every network technology, including the Optical Transport Networks (OTN). As a part of the transport network, the OTN has the capability to provide hard pipes with guaranteed data isolation and deterministic low latency, which are highly demanded in the Service Level Agreement (SLA).

This document describes a framework for OTN network slicing. A YANG data model augmentation will be defined in a future version of this draft.

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1. Introduction

The requirement of slicing network resource with desired quality of service is emerging at every network technology, including the Optical Transport Networks (OTN). As a part of the transport network, the OTN has the capability to provide hard pipes with guaranteed data

isolation and deterministic low latency, which are highly demanded in the Service Level Agreement (SLA).

This document describes a framework for OTN network slicing. A YANG data model augmentation will be defined in a future version of this draft.

2. Use Cases for OTN Network Slicing

2.1. Leased Line Services with OTN

For large OTT enterprises, leased lines have the advantage of providing high-speed connections with low costs. On the other hand, the traffic control of leased lines is very challenging due to rapid changes of service demands. Carriers are recommended to provide network-level slicing capabilities to meet this demand. Based on such capabilities, private network users have full control over the sliced resources which have allocated to them and which could be used to support their leased lines, when needed. Users may formulate policies based on the demand on services and time to flexibly schedule the network from the perspective of the entire network. For example, the bandwidth between any two points may be established or released based on the time or monitored traffic characteristics, the routing and bandwidth may be adjusted at specific time interval to maximize network resource utilization efficiency.

2.2. Co-construction and Sharing

Co-construction and sharing of a network is becoming a popular mean amongst service providers with the goal of reducing networking building capex. For Co-construction and sharing case, there are typically multiple co-founders for the same network. For example, one founder may provide optical fibres and another founder may provide OTN equipment, while each of them occupies a certain percentage of the usage rights of the network resources. In this scenario, the network O&M is performed by certain founder in each region, where an independent management and control system is usually deployed by the same founder. The other founders of the network use each other's management and control system to provision services remotely. In this scenario, network resources used by different founders need to be automatically (associated) divided, isolated, and visualized. In addition, all founders have independent O&M capabilities, and should be able to perform service-level provisioning in their respective slices.

2.3. Wholesale of optical resources

In the optical resource wholesale market, smaller, local carriers and wireless carriers may rent resources from larger carriers, or infrastructure carriers, instead of building their own networks. Likewise, international carriers may rent resources from respective local carriers and local carriers may lease their owned networks to each other to achieve better network utilization efficiency.

From the perspective of a resource provider, it is crucial that a network slice is timely configured to meet traffic matrix requirements requested by its tenants. The support for multi-tenancy within the resource provider's network demands that the network slices are qualitatively isolated from each other to meet the requirements for transparency, non-interference, and security.

Typically, a resource purchaser expects to flexibly use the leased network resources just like they are self-constructed. Therefore, the purchaser is not only provided with a network slice, but also the full set of functionalities for operating and maintaining the network slice. The purchaser also expects to, in a flexible and independent manner, schedule and maintain physical resources to support their own end-to-end automation using both leased and self-constructed network resources.

2.4. Vertical dedicated network with OTN

Vertical industry slicing is an emerging category of network slicing due to the high demand of private high-speed network interconnects for industrial applications.

In this scenario, the biggest challenge is to implement differentiated optical network slices based on the requirements from different industries. For example, in the financial industry, to support high-frequency transactions, the slice must ensure to provide the minimum latency along with the mechanism for latency management. For the healthcare industry, online diagnosis network and software capabilities to ensure the delivery of HD video without frame loss. For bulk data migration in data centers, network needs to support on-demand, large-bandwidth allocation. In each of the aforementioned vertical industry scenarios, the bandwidth shall be adjusted as required to ensure flexible and efficient network resource usage.

3. Framework for OTN slicing

An OTN slice is a collection of OTN network resources that is used to establish a logically dedicated OTN virtual network over one or more OTN networks. For example, the bandwidth of an OTN slice is described in terms of the number/type of OTN time slots; the labels may be specified as OTN tributary slots and/or tributary ports to allow slice users to interconnect devices with matching specifications.

The relationship between an OTN slice and an IETF network slice [I-D. teas-transport-network-slice-yang] is for further discussions.

To support the configuration of OTN slices, an OTN slice controller (OTN-SC) can be deployed either outside or within the SDN controller.

In the former case, the OTN-SC translates an OTN slice configuration request into a TE topology configuration or a set of TE tunnel configurations, and instantiate it by using the TE topology [RFC8795] or TE tunnel [I-D.ietf-teas-yang-te] interfaces at the MPI, as defined in the ACTN framework [RFC8453].

In the latter case, an Orchestrator or an end-to-end slice controller may request OTN slices directly through the OTN slicing interface provided by the OTN-SC. A higher-level OTN-SC may also designate the creation of OTN slices to a lower-level OTN-SC in a recursive manner.

Figure 1 illustrates the OTN slicing control hierarchy and the positioning of the OTN slicing interfaces.

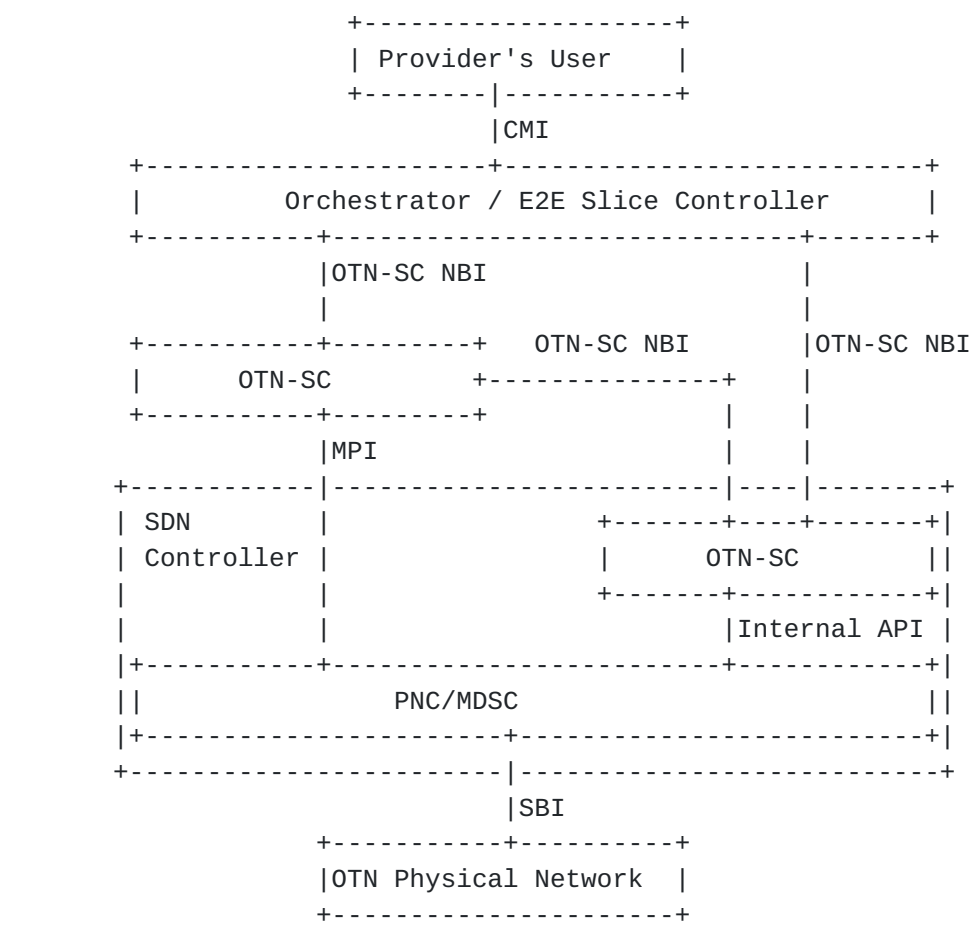

Figure 1 - Positioning of OTN Slicing Interfaces

A particular OTN network resource, such as a port or link, may be sliced in two modes:

- Link-based slicing, where a link and its associated link termination points (LTPs) are dedicatedly allocated to a particular OTN network slice.

- Tributary-slot based slicing, where multiple OTN network slices share the same link by allocating different OTN tributary slots in different granularities.

Additionally, since OTN tributary slots are usually switched unconstrained at every node within an OTN network, it is unimportant to which exact tributary slot(s) an OTN slice is allocated, but rather mattered is the number and type of the tributary slots.

4. YANG Model

TBD. The OTN slice YANG model may augment the IETF network slice YANG models, developed in [I-D. teas-transport-network-slice-yang], and/or the TE topology defined in [RFC8795].

5. YANG Tree

TBD.

6. Manageability Considerations

To ensure the security and controllability of physical resource isolation, slice-based independent operation and management are required to achieve management isolation.

Each optical slice typically requires dedicated accounts, permissions, and resources for independent access and O&M. This mechanism is to guarantee the information isolation among slice tenants and to avoid resource conflicts. The access to slice management functions will only be permitted after successful security checks.

7. Security Considerations

<Add any security considerations>

8. IANA Considerations

<Add any IANA considerations>

9. References

9.1. Normative References

[RFC8453] Ceccarelli, D., Ed. and Y. Lee, Ed., "Framework for Abstraction and Control of TE Networks (ACTN)", RFC 8453, DOI 10.17487/RFC8453, August 2018 <https://www.rfc-editor.org/info/rfc8453>.

[RFC8795] Liu, X., Bryskin, I., Beeram, V., Saad, T., Shah, H., and O. Gonzalez de Dios, "YANG Data Model for Traffic Engineering (TE) Topologies", RFC 8795, DOI 10.17487/RFC8795, August 2020, <https://www.rfc-editor.org/info/rfc8795>.

[I-D. teas-transport-network-slice-yang] Liu, X., Tantsura J., Bryskin I., Contreras L., Wu Q., Belotti S., and Rokui R., "Transport Network Slice YANG Data Model", draft-liu-teas-transport-network-slice-yang-01 (work in progress), July 2020.

[I-D.ietf-teas-yang-te] Saad, T., Gandhi, R., Liu, X., Beeram, V., and I. Bryskin, "A YANG Data Model for Traffic Engineering Tunnels and Interfaces", draft-ietf-teas-yang-te-22 (work in progress), November 2019.

9.2. Informative References

TBD

Acknowledgments

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