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**Transport Northbound Interface Use Cases**  
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**Abstract**

Transport network domains, including Optical Transport Network (OTN) and Wavelength Division Multiplexing (WDM) networks, are typically deployed based on a single vendor or technology platforms. They are often managed using proprietary interfaces to dedicated Element Management Systems (EMS), Network Management Systems (NMS) and increasingly Software Defined Network (SDN) controllers.

A well-defined open interface to each domain management system or controller is required for network operators to facilitate control automation and orchestrate end-to-end services across multi-domain networks. These functions may be enabled using standardized data models (e.g. YANG), and appropriate protocol (e.g., RESTCONF).

This document describes the key use cases and requirements for transport network control and management. It reviews proposed and existing IETF transport network data models, their applicability, and highlights gaps and requirements.

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## Table of Contents

<a href="#">1.</a>	<a href="#">Introduction.....</a>	<a href="#">1</a>
<a href="#">2.</a>	<a href="#">Conventions used in this document.....</a>	<a href="#">3</a>
<a href="#">3.</a>	<a href="#">Use Case 1: Single-domain with single-layer.....</a>	<a href="#">3</a>
<a href="#">3.1.</a>	<a href="#">Reference Network.....</a>	<a href="#">3</a>
<a href="#">3.1.1.</a>	<a href="#">Single Transport Domain - OTN Network.....</a>	<a href="#">6</a>
<a href="#">3.1.2.</a>	<a href="#">Single Domain - ROADM Network.....</a>	<a href="#">6</a>
<a href="#">3.2.</a>	<a href="#">Topology Abstractions.....</a>	<a href="#">6</a>
<a href="#">3.3.</a>	<a href="#">Service Configuration.....</a>	<a href="#">7</a>
<a href="#">3.3.1.</a>	<a href="#">ODU Transit.....</a>	<a href="#">7</a>
<a href="#">3.3.2.</a>	<a href="#">EPL over ODU.....</a>	<a href="#">8</a>
<a href="#">3.3.3.</a>	<a href="#">Other OTN Client Services.....</a>	<a href="#">8</a>
<a href="#">3.3.4.</a>	<a href="#">EVPL over ODU.....</a>	<a href="#">9</a>
<a href="#">3.3.5.</a>	<a href="#">EVPLAN and EVPTree Services.....</a>	<a href="#">9</a>
<a href="#">3.3.6.</a>	<a href="#">Virtual Network Services.....</a>	<a href="#">9</a>
<a href="#">3.4.</a>	<a href="#">Multi-functional Access Links.....</a>	<a href="#">9</a>
<a href="#">4.</a>	<a href="#">Use Case 2: Single-domain with multi-layer.....</a>	<a href="#">9</a>
<a href="#">5.</a>	<a href="#">Use Case 3: Multi-domain with single-layer.....</a>	<a href="#">9</a>
<a href="#">6.</a>	<a href="#">Use Case 4: Multi-domain and multi-layer.....</a>	<a href="#">9</a>
<a href="#">7.</a>	<a href="#">Security Considerations.....</a>	<a href="#">9</a>
<a href="#">8.</a>	<a href="#">IANA Considerations.....</a>	<a href="#">9</a>
<a href="#">9.</a>	<a href="#">References.....</a>	<a href="#">10</a>
<a href="#">9.1.</a>	<a href="#">Normative References.....</a>	<a href="#">10</a>
<a href="#">9.2.</a>	<a href="#">Informative References.....</a>	<a href="#">10</a>
<a href="#">10.</a>	<a href="#">Acknowledgments.....</a>	<a href="#">10</a>
	<a href="#">Authors' Addresses.....</a>	<a href="#">11</a>

## [1. Introduction](#)

A common open interface to each domain controller/management system is pre-requisite for network operators to control multi-vendor and multi-domain networks and enable also service provisioning coordination/automation. This can be achieved by using standardized YANG models, used together with an appropriate protocol (e.g., RESTCONF).



This document assumes a reference architecture, including interfaces, based on the Abstraction and Control of Traffic-Engineered Networks (ACTN), defined in [[ACTN-Frame](#)].

The focus of the current version is on the MPI (interface between the Multi Domain Service Coordinator (MDSC) and a Physical Network Controller (PNC), controlling a transport network domain).

The relationship between the current IETF YANG models and the type of ACTN interfaces can be found in [[ACTN-YANG](#)].

The ONF Technical Recommendations for Functional Requirements for the transport API, may be found in [ONF TR-527]. Furthermore, ONF transport API multi-layer examples may be found in [ONF GitHub].

This document describes use cases that could be used for analyzing the applicability of the existing models defined by the IETF for transport networks

Considerations about the CMI (interface between the Customer Network Controller (CNC) and the MDSC) are for further study.

## **2. Conventions used in this document**

For discussion in future revisions of this document.

## **3. Use Case 1: Single-domain with single-layer**

### **3.1. Reference Network**

The current considerations discussed in this document are based on the following reference networks:

- single transport domain: OTN network

It is expected that future revisions of the document will include additional reference networks.

#### **3.1.1. Single Transport Domain - OTN Network**

Figure 1 shows the network physical topology composed of a single-domain transport network providing transport services to an IP network through five access links.



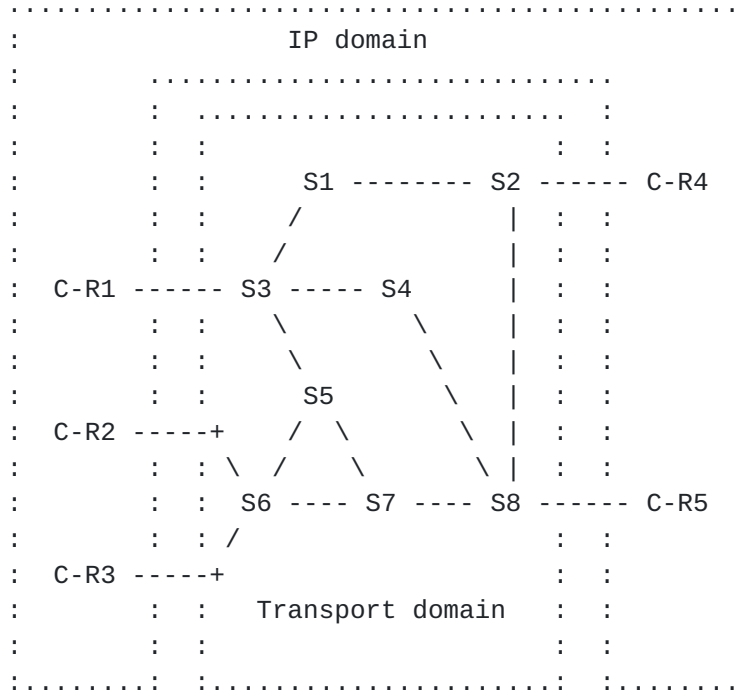


Figure 1 Reference network for Use Case 1

The IP and transport (OTN) domains are respectively composed by five routers C-R1 to C-R5 and by eight ODU switches S1 to S8. The transport domain acts as a transit domain providing connectivity to the IP layer.

The behavior of the transport domain is the same whether the ingress/egress nodes in the IP domain, supporting an IP service, are directly attached to the transport domain or there are other routers in between the ingress/egress nodes of the IP domain and the routers directly attached to the transport network.





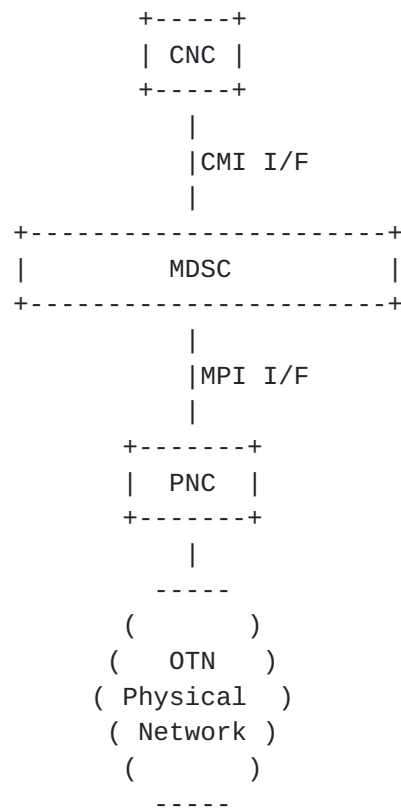


Figure 2 Controlling Hierarchy for Use Case 1

The mapping of the client IP traffic on the physical link between the routers and the transport network is made in the IP routers only and is not controlled by the transport PNC and is transparent to the transport nodes.

The control plane architecture follows the ACTN architecture and framework document [[ACTN-Frame](#)]. The Client Controller act as a client with respect to the Multi-Domain Service Coordinator (MDSC) via the Controller-MDSC Interface (CMI). The MDSC is connected to a plurality of Physical Network Controllers (PNCs), one for each domain, via a MDSC-PNC Interface (MPI). Each PNC is responsible only for the control of its domain and the MDSC is the only entity capable of multi-domain functionalities as well as of managing the inter-domain links. The key point of the whole ACTN framework is detaching the network and service control from the underlying technology and help the customer express the network as desired by business needs. Therefore, care must be taken to keep minimal dependency on the CMI (or no dependency at all) with respect to the network domain technologies. The MPI instead requires some specialization according to the domain technology.

In this section, we address the case of an IP and a Transport PNC

having respectively an IP a Transport MPI. The interface within  
the scope of this document is the Transport MPI while the IP

Network MPI is out of its scope and considerations about the CMI are for further study.

### 3.2. Topology Abstractions

There are multiple methods to abstract a network topology. This document assumes the abstraction method defined in [[RFC7926](#)]:

Abstraction is the process of applying policy to the available TE information within a domain, to produce selective information that represents the potential ability to connect across the domain. Thus, abstraction does not necessarily offer all possible connectivity options, but presents a general view of potential connectivity according to the policies that determine how the domain's administrator wants to allow the domain resources to be used.

[TE-Topo] describes a YANG base model for TE topology without any technology specific parameters. Moreover, it defines how to abstract for TE-network topologies.

[ACTN-Abstraction] provides the context of topology abstraction in the ACTN architecture and discusses a few alternatives for the abstraction methods for both packet and optical networks. This is an important consideration since the choice of the abstraction method impacts protocol design and the information it carries. According to [[ACTN-Abstraction](#)], there are three types of topology:

- o White topology: This is a case where the Physical Network Controller (PNC) provides the actual network topology to the Multi-domain Service Coordinator (MDSC) without any hiding or filtering. In this case, the MDSC has the full knowledge of the underlying network topology.
- o Black topology: The entire domain network is abstracted as a single virtual node with the access/egress links without disclosing any node internal connectivity information.
- o Grey topology: This abstraction level is between black topology and white topology from a granularity point of view. This is abstraction of TE tunnels for all pairs of border nodes. We may further differentiate from a perspective of how to abstract internal TE resources between the pairs of border nodes:
  - Grey topology type A: border nodes with a TE links between them in a full mesh fashion.
  - Grey topology type B: border nodes with some internal

abstracted nodes and abstracted links.

King & Busi, et al.

Expires September, 2017

[Page 6]

For single-domain with single-layer use-case, the white topology may be disseminated from the PNC to the MDSC in most cases. There may be some exception to this in the case where the underlay network may have complex optical parameters, which do not warrant the distribution of such details to the MDSC. In such case, the topology disseminated from the PNC to the MDSC may not have the entire TE information but a streamlined TE information. This case would for single-domain with single-layer use-case, the white topology may be disseminated from the PNC to the MDSC in most cases. There may be some exception to this in the case where the underlay network may have complex optical parameters, which do not warrant the distribution of such details to the MDSC. In such case, the topology disseminated from the PNC to the MDSC may not have the entire TE information but a streamlined TE information. This case would incur another action from the MDSC's standpoint when provisioning a path. The MDSC may make a path compute request to the PNC to verify the feasibility of the estimated path before making the final provisioning request to the PNC, as outlined in [[Path-Compute](#)].

Topology abstraction for the CMI is for further study (to be addressed in future revisions of this document).

### **[3.3. Service Configuration](#)**

In the following use cases, the Multi Domain Service Coordinator (MDSC) needs to be capable to request service connectivity from the transport Physical Network Controller (PNC) to support IP routers connectivity. The type of services could depend of the type of physical links (e.g. OTN link, ETH link or SDH link) between the routers and transport network.

As described in [section 3.1.1](#), the control of different adaptations inside IP routers, C-Ri (PKT -> foo) and C-Rj (foo -> PKT), are assumed to be performed by means that are not under the control of, and not visible to, transport PNC. Therefore, these mechanisms are outside the scope of this document.

#### **[3.3.1. ODU Transit](#)**

This use case assumes that the physical link interconnecting IP routers and transport network is an OTN link.

The physical/optical interconnection is supposed to be a pre-configured and not exposed via MPI to MDSC.

If we consider the case of a 10Gb IP link between C-R1 to C-R3, we need to instantiate an ODU2 end-to-end connection between C-R1 and C-R3, crossing transport nodes S3, S5, and S6.

The traffic flow between C-R1 and C-R3 can be summarized as:

King & Busi, et al.

Expires September, 2017

[Page 7]

C-R1 (PKT -> ODU2), S3 (ODU2), S5 (ODU2), S6 (ODU2),  
C-R3 (ODU2 -> PKT)

The MDSC should be capable via MPI interface to request the setup of ODU2 transit service with enough information that can permit transport PNC to instantiate and control the ODU2 segment through nodes S3, S5, S6.

### **3.3.2. EPL over ODU**

This use case assumes that the physical link interconnecting IP routers and transport network is an Ethernet link.

If we consider the case of a 10Gb IP link between C-R1 to C-R3, we need to instantiate an EPL service between C-R1 and C-R3 supported by an ODU2 end-to-end connection between S3 and S6, crossing transport node S5.

The traffic flow between C-R1 and C-R3 can be summarized as:

C-R1 (PKT -> ETH), S3 (ETH -> ODU2), S5 (ODU2),  
S6 (ODU2 -> ETH), C-R3 (ETH-> PKT)

The MDSC should be capable via MPI i/f to request the setup of EPL service with enough information that can permit transport PNC to instantiate and control the ODU2 end-to-end connection through nodes S3, S5, S6, as well as the adaptation functions inside S3 and S6: S3&S6 (ETH -> ODU2) and S5&S6 (ODU2 -> ETH).

### **3.3.3. Other OTN Client Services**

[ITU-T G.709-2016] defines mappings of different client layers into ODU. Most of them are used to provide Private Line services over an OTN transport network supporting a variety of types of physical access links (e.g., Ethernet, SDH STM-N, Fibre Channel, InfiniBand,).

This use case assumes that the physical links interconnecting IP routers and transport network are any one of these possible options.

If we consider the case of a 10Gb IP link between C-R1 to C-R3 using SDH physical links, we need to instantiate an STM-64 Private Line service between C-R1 and C-R3 supported by an ODU2 end-to-end connection between S3 and S6, crossing transport node S5.

The traffic flow between C-R1 and C-R3 can be summarized as:

C-R1 (PKT -> STM-64), S3 (STM-64 -> ODU2), S5 (ODU2),

S6 (ODU2 -> STM-64), C-R3 (STM-64 -> PKT)

King & Busi, et al.

Expires September, 2017

[Page 8]



The MDSC should be capable via MPI i/f to request the setup of an STM-64 Private Line service with enough information that can permit transport PNC to instantiate and control the ODU2 end-to-end connection through nodes S3, S5, S6, as well as the adaptation functions inside S3 and S6: S3&S6 (STM-64 -> ODU2) and S9&S3 (STM-64 -> PKT).

#### **3.3.4. EVPL over ODU**

For future revision.

#### **3.3.5. EVPLAN and EVPTree Services**

For future revision.

#### **3.3.6. Virtual Network Services**

For future revision

### **3.4. Multi-functional Access Links**

For future revision

## **4. Use Case 2: Single-domain with multi-layer**

For future revision

## **5. Use Case 3: Multi-domain with single-layer**

For future revision

## **6. Use Case 4: Multi-domain and multi-layer**

For future revision

## **7. Security Considerations**

For further study

## **8. IANA Considerations**

This document requires no IANA actions.



## **9. References**

### **9.1. Normative References**

[RFC7926] Farrel, A. et al., "Problem Statement and Architecture for Information Exchange between Interconnected Traffic-Engineered Networks", [BCP 206](#), [RFC 7926](#), July 2016.

[ITU-T G.709-2016] ITU-T Recommendation G.709 (06/16), "Interfaces for the optical transport network", June 2016.

[ACTN-Frame] Ceccarelli, D., Lee, Y. et al., "Framework for Abstraction and Control of Transport Networks", [draft-ietf-teas-actn-framework](#), work in progress.

[ACTN-Abstraction] Lee, Y. et al., " Abstraction and Control of TE Networks (ACTN) Abstraction Methods", [draft-lee-teas-actn-abstraction](#), work in progress.

### **9.2. Informative References**

[TE-Topo] Liu, X. et al., "YANG Data Model for TE Topologies", [draft-ietf-teas-yang-te-topo](#), work in progress.

[ACTN-YANG] Zhang, X. et al., "Applicability of YANG models for Abstraction and Control of Traffic Engineered Networks", [draft-zhang-teas-actn-yang](#), work in progress.

[Path-Compute] Busi, I., Belotti, S. et al., " Yang model for requesting Path Computation", [draft-busibel-teas-yang-path-computation](#), work in progress.

[ONF TR-527] ONF Technical Recommendation TR-527, "Functional Requirements for Transport API", June 2016

[ONF GitHub] ONF Open Transport (SNOWMASS)  
<https://github.com/OpenNetworkingFoundation/Snowmass-ONFOpenTransport>

## **10. Acknowledgments**

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