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A Service YANG Model for Connection-oriented Transport Networks

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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 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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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).

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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.

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................................................

: IP domain :

: .............................. :

: : ........................ : :

: : : : : :

: : : S1 -------- S2 ------ C-R4 :

: : : / | : : :

: : : / | : : :

: C-R1 ------ S3 ----- S4 | : : :

: : : \ \ | : : :

: : : \ \ | : : :

: : : S5 \ | : : :

: C-R2 -----+ / \ \ | : : :

: : : \ / \ \ | : : :

: : : S6 ---- S7 ---- S8 ------ C-R5 :

: : : / : : :

: C-R3 -----+ : : :

: : : Transport domain : : :

: : : : : :

:........: :......................: :........:

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.

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+-----+

| CNC |

+-----+

|

|CMI I/F

|

+-----------------------+

| MDSC |

+-----------------------+

|

|MPI I/F

|

+-------+

| PNC |

+-------+

|

-----

( )

( OTN )

( Physical )

( 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

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Network MPI is out of its scope and considerations about the CMI

are for further study.

3.2. Topology Abstractions

<**Young/Victor**: Describe the network topology abstraction assumed at the MPI: reference the VN abstraction I-D for the definitions of white, grey and black topologies>

There could be different ways to abstract a network topology. This document assumes the abstraction 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-Topology] 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:

* 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.
* 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.
* Grey topology: This abstraction level is between black topology and white topology from a granularity point of view. This is basically 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.

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 in order to verify the feasibility of the estimated path before making the final provisioning request to the PNC.

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:

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

C-R3 (ODU2 -> PKT)

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The MDSC should be capable via MPI i/f 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 S9&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)

The MDSC should be capable via MPI i/f to request the setup of an

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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.

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ONFOpenTransport

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