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**Analysis of Transport North Bound Interface Use Case 1**  
**draft-tnbidt-ccamp-transport-nbi-analysis-uc1-01**

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Abstract

This document analyses how YANG models being defined by IETF (TEAS and CCAMP WGs in particular) can be used to support Use Case 1 (single-domain with single-layer) scenarios, as referenced later in this document.

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**1. Introduction**

This document analyses how YANG models being developed by IETF (TEAS and CCAMP WGs) can be used to support Use Case 1 (single-domain with single-layer) scenarios, as described in [[TNBI-UseCases](#)].



### **1.1. Assumptions**

This document analyses how existing models developed by the IETF can be used at the MPI between the Transport PNC and the MDSC to support the use case 1 scenarios, as defined in section 3 of [[TNBI-UseCases](#)].

This document assumes the applicability of the YANG models to the ACTN interfaces as defined in [[ACTN-YANG](#)] and therefore considers the TE Topology YANG model defined in [[TE-TOPO](#)], with the OTN Topology augmentation defined in [[OTN-TOPO](#)] and the TE Tunnel YANG model defined in [[TE-TUNNEL](#)], with the OTN Tunnel augmentation defined in [[OTN-TUNNEL](#)].

The analysis of how to use the attributes in the I2RS Topology YANG model, defined in [[I2RS-TOPO](#)], is for further study.

Moreover, this document is making the following assumptions, still to be validated with TEAS WG:

1. The MDSC can request, at the MPI, the Transport PNC to setup a Transit Tunnel Segment using the TE Tunnel YANG model: in this case, since the endpoints of the E2E Tunnel are outside the domain controlled by the Transport PNC, the MDSC would not specify any source or destination TTP (i.e., it would leave the source, destination, src-tp-id and dst-tp-id attributes empty) and it would use the explicit-route-object list to specify the ingress and egress links of the Transit Tunnel Segment.
2. The Transport PNC provides to the MDSC, at the MPI, the list of available timeslots on the access links using the TE Topology YANG model and OTN Topology augmentation. The TE Topology YANG model in [[TE-TOPO](#)] is being updated to report the label set information.

### **1.2. Feedbacks provided to the IETF Working Groups**

The analysis done in this version of this document has triggered the following feedbacks to CCAMP WG:

- o A set of YANG models have been submitted in [draft-zheng-ccamp-client-topo-yang](#) and [draft-zheng-ccamp-otn-client-signal-yang](#), providing an initial proposal, to be reviewed and discussed by the DT and the CCAMP WG, to resolve the open issues for EPL, other OTN client Private Line and EVPL services described in this version of the document.



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

This document provides some detailed JSON code examples to describe how the YANG models being developed by IETF (TEAS and CCAMP WG in particular) can be used.

The examples are provided using JSON because JSON code is easier for humans to read and write.

Different objects need to have an identifier. The convention used to create mnemonic identifiers is to use the object name (e.g., S3 for node S3), followed by its type (e.g., NODE), separated by an "-", followed by "-ID". For example the mnemonic identifier for node S3 would be S3-NODE-ID.

JSON language does not support the insertion of comments that have been instead found to be useful when writing the examples. This document inserts comments into the JSON code as JSON name/value pair with the JSON name string starting with the "//" characters. For example, when describing the example of a TE Topology instance representing the ODU Abstract Topology exposed by the Transport PNC, the following comment has been added to the JSON code:

```
"// comment": "ODU Abstract Topology @ MPI",
```

The JSON code examples provided in this document have been validated against the YANG models following the validation process described in [Appendix A](#), which would not consider the comments.

In order to have successful validation of the examples, some numbering scheme has been defined to assign identifiers to the different entities which would pass the syntax checks. In that case, to simplify the reading, another JSON name/value pair, formatted as a comment and using the mnemonic identifiers is also provided. For example, the identifier of node S3 (S3-NODE-ID) has been assumed to be "10.0.0.3" and would be shown in the JSON code example using the two JSON name/value pair:

```
"// te-node-id": "S3-NODE-ID",
```

```
"te-node-id": "10.0.0.3",
```

The first JSON name/value pair will be automatically removed in the first step of the validation process while the second JSON name/value pair will be validate against the YANG model definitions.



### **3. High-level Overview**

Use Case 1 is described in [[TNBI-UseCases](#)] as a single-domain with single layer network scenario supporting different types of services. This section provides a high-level overview of how IETF YANG models can be used to support these uses cases at the MPI between the Transport PNC and the MDSC.

[Section 3.1](#) describes the topology abstraction provided to the MDSC by the Transport PNC at the MPI.

[Section 3.2](#) describes how the difference services, defined in [section 4.3](#) of [[TNBI-UseCases](#)], can be requested to the Transport PNC by the MDSC at the MPI.

#### **3.1. Topology Abstraction**

##### **3.1.1. ODU White Topology Abstraction**

In case the Transport PNC exports to the MDSC a white topology, at the MPI there will be one TE Topology instance for the ODU layer (called "ODU Topology") containing one TE Node (called "ODU Node") for each physical node, as shown in Figure 1 below.



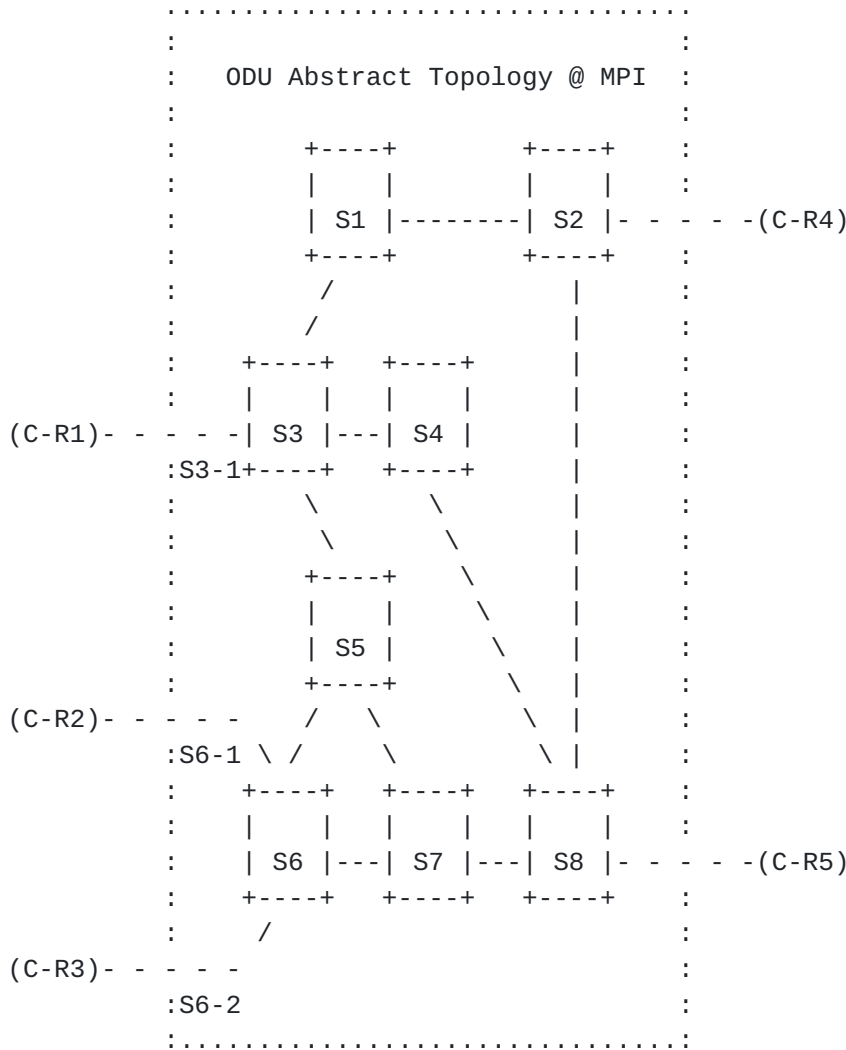


Figure 1 White Topology Abstraction (ODU Topology)

The ODU Nodes in Figure 1 are using with the same names as the physical nodes to simplify the description of the mapping between the ODU Nodes exposed by the Transport PNCs at the MPI and the physical nodes in the data plane. This does not correspond to the reality of the usage of the topology model, as described in [section 4.3](#) of [TE-TOPO], in which renaming by the client it is necessary.

As described in section 3.2 of [TNBI-UseCases], it is assumed that the physical links between the physical nodes are pre-configured up to the OTU4 trail using mechanisms which are outside the scope of this document. The Transport PNC exports to the MDSC via the MPI, one TE Link (called "ODU Link") for each of these physical links.



Access links in Figure 1 are shown as ODU Links: the modeling of the access links for other access technologies is currently an open issue.

The modeling of the access link in case of non-ODU access technology, has also an impact on the need to model ODU TTPs and layer transition capabilities on the edge nodes (e.g., nodes S2, S3, S6 and S8 in Figure 1).

If, for example, the physical NE S6, is implemented in a "pizza box", the data plane would have only set of ODU termination resources (where up to 2xODU4, 4xODU3, 20xODU2, 80xODU1, 160xODU0 and 160xODUflex can be terminated). The traffic coming from each of the 10GE access links can be mapped into any of these ODU terminations.

Instead if, for example, the physical NE S6 can be implemented as a multi-board system where access links reside on different/dedicated access cards with separated set of ODU termination resources (where up to 1xODU4, 2xODU3, 10xODU2, 40xODU1, 80xODU0 and 80xODUflex for each resource can be terminated). The traffic coming from one 10GE access links can be mapped only into the ODU terminations which reside on the same access card.

The more generic implementation option for a physical NE (e.g., S6) would be case is of a multi-board system with multiple access cards with separated sets of access links and ODU termination resources (where up to 1xODU4, 2xODU3, 10xODU2, 40xODU1, 80xODU0 and 80xODUflex for each resource can be terminated). The traffic coming from each of the 10GE access links on one access card can be mapped only into any of the ODU terminations which reside on the same access card.

In the last two cases, only the ODUs terminated on the same access card where the access links resides can carry the traffic coming from that 10GE access link. Terminated ODUs can instead be sent to any of the OTU4 interfaces

In all these cases, terminated ODUs can be sent to any of the OTU4 interfaces assuming the implementation is based on a non-blocking ODU cross-connect.

If the access links are reported via MPI in some, still to be defined, client topology, it is possible to report each set of ODU termination resources as an ODU TTP within the ODU Topology of Figure 1 and to use either the inter-layer lock-id or the transitional link, as described in sections [3.4](#) and [3.10](#) of [\[TE-TOPO\]](#), to correlate the access links, in the client topology, with the ODU TTPs, in the ODU topology, to which access link are connected to.



The "external-domain" container allows the MDSC to glue together the ODU Topology provided by the Transport PNC with the information provided by the IP PNC to know which access link is connected with each link/router in the IP domain (e.g., that C-R1 is connected with the access link terminating on S3-1 LTP in the ODU Topology).

Further details about how the MDSC can glue together the access link information will be added in a future version of this document.

## **3.2. Service Configuration**

### **3.2.1. ODU Transit Service**

In this case, the access links are configured as ODU Link, as described in [section 3.1.1](#) above.

As described in section 4.3.1 of [\[TNBI-UseCases\]](#), the MDSC needs to setup an ODU2 trail, supporting an IP link, between C-R1 and C-R3.

From the topology information described in [section 3.1.1](#) above, the MDSC can know that C-R1 is attached to the access link terminating on S3-1 LTP in the ODU Topology and that C-R3 is attached to the access link terminating on S6-2 LTP in the ODU Topology.

Based on the assumption 1) in [section 1.1](#), MDSC would then request the Transport PNC to setup an ODU2 (Transit Segment) Tunnel between S3-1 and S6-2 LTPs:

- o Source and Destination TTPs are not specified (since it is a Transit Tunnel)
- o Ingress and egress points are indicated in the explicit-route-objects of the primary path:
  - o The first element of the explicit-route-objects references the access link terminating on S3-1 LTP
  - o Last element of the explicit-route-objects references the access link terminating on S6-2 LTP

The configuration of the timeslots used by the ODU2 connection within the transport network domain (i.e., on the internal links) is a matter of the Transport PNC and its interactions with the physical network elements and therefore is outside the scope of this document.

However, the configuration of the timeslots used by the ODU2 connection at the edge of the transport network domain (i.e., on the



access links) needs to take into account not only the timeslots available on the physical nodes at the edge of the transport network domain (e.g., S3 and S6) but also on the devices, outside of the transport network domain, connected through these access links (e.g., C-R1 and C-R3).

Based on the assumption 2) in [section 1.1](#), the MDSC, when requesting the Transport PNC to setup the (Transit Segment) ODU2 Tunnel, it would also configure the timeslots to be used on the access links. The MDSC can know the timeslots which are available on the edge OTN Node (e.g., S3 and S6) from the OTN Topology information exposed by the Transport PNC at the MPI as well as the timeslots which are available on the devices outside of the transport network domain (e.g., C-R1 and C-R3), by means which are outside the scope of this document.

The Transport PNC performs path computation and sets up the ODU2 cross-connections within the physical nodes S3, S5 and S6, as shown in section 4.3.1 of [\[TNBI-UseCases\]](#).

The Transport PNC reports the status of the created ODU2 (Transit Segment) Tunnel and its path within the ODU Topology as shown in Figure 2 below:

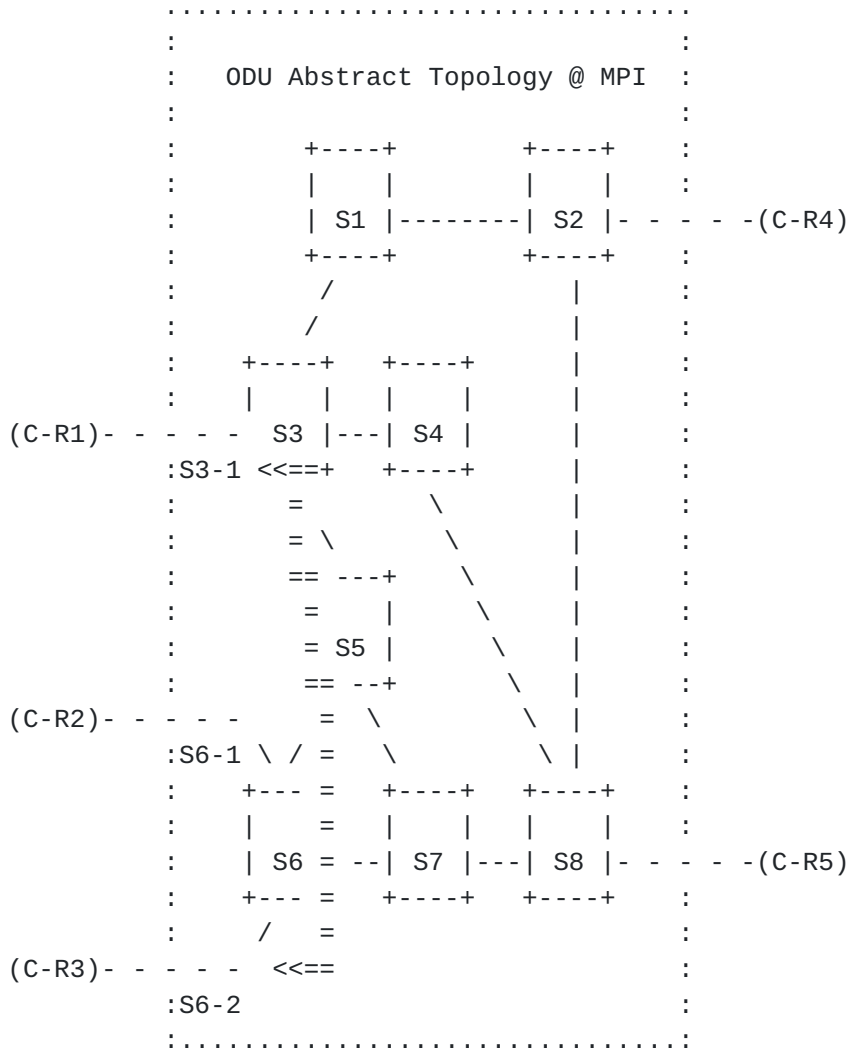


Figure 2 ODU2 Transit Tunnel

**3.2.2. EPL over ODU Service**

As described in section 4.3.2 of [TNBI-UseCases], the MDSC needs to setup an EPL service between C-R1 and C-R3 supported by an ODU2 end-to-end connection between S3 and S6.

As described in section 3.1.1 above, it is not clear in this case how the Ethernet access links between the transport network and the IP router, are reported by the PNC to the MDSC.

If the 10GE physical links are not reported as ODU links within the ODU topology information, described in section 3.1.1 above, than the MDSC will not have sufficient information to know that C-R1 and C-R3 are attached to nodes S3 and S6.





Assuming that the MDSC knows how C-R1 and C-R3 are attached to the transport network, the MDSC would request the Transport PNC to setup an ODU2 end-to-end Tunnel between S3 and S6.

This ODU Tunnel is setup between two TTPs of nodes S3 and S6. In case nodes S3 and S6 support more than one TTP, the MDSC should decide which TTP to use.

As discussed in [section 3.1.1](#), depending on the different hardware implementations of the physical nodes S3 and S6, not all the access links can be connected to all the TTPs. The MDSC should therefore not only select the optimal TTP but also a TTP that would allow the Tunnel to be used by the service.

It is assumed that in case node S3 or node S6 supports only one TTP, this TTP can be accessed by all the access links.

Once the ODU2 Tunnel setup has been requested, unless there is a one-to-one relationship between the S3 and S6 TTPs and the Ethernet access links toward C-R1 and C-R3 (as in the case, described in [section 3.1.1](#), where the Ethernet access links reside on different/dedicated access card such that the ODU2 tunnel can only carry the Ethernet traffic from the only Ethernet access link on the same access card where the ODU2 tunnel is terminated), the MDSC also needs to request the setup of an EPL service from the access links on S3 and S6, attached to C-R1 and C-R3, and this ODU2 Tunnel.

### **[3.2.3. OTN Client Private Line Service](#)**

As described in [section 3.1.1](#) above, it is not clear in this case how the access links (e.g., the STM-N access links) between the transport network and the IP router, are reported by the PNC to the MDSC.

As described in section 4.3.3 of [[TNBI-UseCases](#)], the MDSC needs to setup an STM-64 Private Link service between C-R1 and C-R3 supported by an ODU2 end-to-end connection between S3 and S6.

The same issues, as described in [section 3.2.2](#), apply here:

- o the MDSC needs to understand that C-R1 and C-R3 are connected, through STM-64 access links, with S3 and S6
- o the MDSC needs to understand which TTPs in S3 and S6 can be accessed by these access links
- o the MDSC needs to configure the private line service from these access links through the ODU2 tunnel



### **3.2.4. EVPL over ODU Service**

As described in [section 3.1.1](#) above, it is not clear in this case how the Ethernet access links between the transport network and the IP router, are reported by the PNC to the MDSC.

As described in section 4.3.3 of [[TNBI-UseCases](#)], the MDSC needs to setup EVPL services between C-R1 and C-R3, as well as between C-R1 and C-R4, supported by ODU0 end-to-end connections between S3 and S6 as well as between S3 and S2.

The same issues, as described in [section 3.2.2](#), apply here:

- o the MDSC needs to understand that C-R1, C-R3 and C-R4 are connected, through the Ethernet access links, with S3, S6 and S2
- o the MDSC needs to understand which TTPs in S3, S6 and S2 can be accessed by these access links
- o the MDSC needs to configure the EVPL services from these access links through the ODU0 tunnels

In addition, the MDSC needs to get the information that the access links on S3, S6 and S2 are capable to support EVPL (rather than just EPL) as well as to coordinate the VLAN configuration, for each EVPL service, on these access links (this is a similar issue as the timeslot configuration on access links discussed in [section 3.2.1](#) below).

## **4. Topology Abstraction: detailed JSON examples**

### **4.1. ODU White Topology Abstraction**

[Section 3.1.1](#) describes how the Transport PNC can provide a white topology abstraction to the MDSC via the MPI. Figure 1 is an example of such ODU Topology.

This section provides the detailed JSON code describing how this ODU Topology is reported by the PNC, using the [[TE-TOPO](#)] and [[OTN-TOPO](#)] YANG models at the MPI.

JSON code "use-case-1-topology-01.json" has been provided at in the appendix of this document.



## **5. Service Configuration: detailed JSON examples**

### **5.1. ODU Transit Service**

[Section 3.2.1](#) describes how the MDSC can request a Transport PNC, via the MPI, to setup an ODU2 transit service over an ODU Topology described in [section 3.1.1](#).

This section provides the detailed JSON code describing how the setup of this ODU2 transit service can be requested by the MDSC, using the [\[TE-TUNNEL\]](#) and [\[OTN-TUNNEL\]](#) YANG models at the MPI.

JSON code "use-case-1-odu2-service-01.json" has been provided at in the appendix of this document.

## **6. Security Considerations**

This section is for further study

## **7. IANA Considerations**

This document requires no IANA actions.

## **8. Conclusions**

This section is for further study

## **9. References**

### **9.1. Normative References**

- [TNBI-UseCases] Busi, I., King, D. et al, "Transport Northbound Interface Applicability Statement and Use Cases", [draft-ietf-ccamp-transport-nbi-use-cases](#), work in progress.
- [TE-TOPO] Liu, X. et al., "YANG Data Model for TE Topologies", [draft-ietf-teas-yang-te-topo](#), work in progress.
- [OTN-TOPO] Zheng, H. et al., "A YANG Data Model for Optical Transport Network Topology", [draft-ietf-ccamp-otn-topo-yang](#), work in progress.
- [TE-TUNNEL] Saad, T. et al., "A YANG Data Model for Traffic Engineering Tunnels and Interfaces", [draft-ietf-teas-yang-te](#), work in progress.

[OTN-TUNNEL] Zheng, H. et al., "OTN Tunnel YANG Model", [draft-ietf-ccamp-otn-tunnel-model](#), work in progress.

## **9.2. Informative References**

[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.

[I2RS-TOPO] Clemm, A. et al., "A Data Model for Network Topologies", [draft-ietf-i2rs-yang-network-topo](#), work in progress.

## **10. Acknowledgments**

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The authors would like to thank the authors of the TE Topology and Tunnel YANG models [[TE-TOPO](#)] and [[TE-TUNNEL](#)], in particular Igor Bryskin, Vishnu Pavan Beeram, Tarek Saad and Xufeng Liu, for their support in addressing any gap identified during the analysis work.

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**Appendix A. Validating a JSON fragment against a YANG Model**

The objective is to have a tool that allows validating whether a piece of JSON code is compliant with a YANG model without using a client/server.

**A.1. DSDL-based approach**

The idea is to generate a JSON driver file (JTOX) from YANG, then use it to translate JSON to XML and validate it against the DSDL schemas, as shown in Figure 3.

Useful link: <https://github.com/mbj4668/pyang/wiki/XmlToJson>

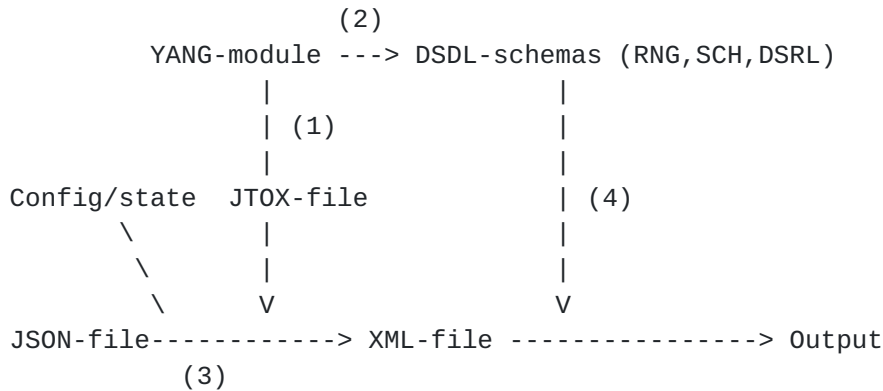


Figure 3 - DSDL-based approach for JSON code validation

In order to allow the use of comments following the convention defined in section 2 without impacting the validation process, these comments will be automatically removed from the JSON-file that will be validate.

**A.2. Why not using a XSD-based approach**

This approach has been analyzed and discarded because no longer supported by pyang.

The idea is to convert YANG to XSD, JSON to XML and validate it against the XSD, as shown in Figure 4:



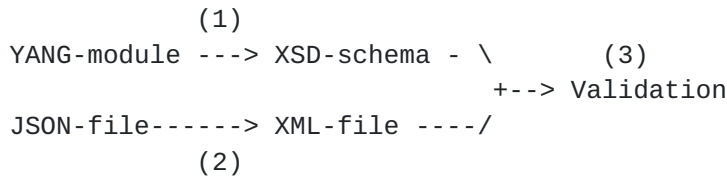


Figure 4 - XSD-based approach for JSON code validation

The pyang support for the XSD output format was deprecated in 1.5 and removed in 1.7.1. However pyang 1.7.1 is necessary to work with YANG 1.1 so the process shown in Figure 4 will stop just at step (1).

**A.3. JSON Code: use-case-1-topology-01.json**

The JSON code for this use case is currently located on GitHub at:

<https://github.com/danielkinguk/transport-nbi/blob/master/Internet-Drafts/Use-Case-1-Analysis/use-case-1-topology-01.json>

**A.4. JSON Code: use-case-1-topology-01.json**

The JSON code for this use case is currently located on GitHub at:

<https://github.com/danielkinguk/transport-nbi/blob/master/Internet-Drafts/Use-Case-1-Analysis/use-case-1-odu2-service-01.json>

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