



Technical Report

TR-454 **YANG Modules for Network Map & Equipment** **Inventory**

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Executive Summary

In a CloudCO architecture, the management of physical nodes requires interfaces to maintain and expose Network Map and Equipment Inventory information within the CloudCO, providing the CloudCO owner the ability to perform activities like Network Operation and Maintenance. For the support of multiple tenants, it's also useful to expose to Tenants only relevant Network Map and Equipment Inventory information across the CloudCO's Northbound API.

1 Purpose and Scope

1.1 Purpose

The purpose of this Technical Report is to define YANG data models for maintaining and reporting Network Map and Equipment Inventory information that is applicable to the BAA layer and SDN Management and Control functions. These YANG data models are able to be reported through the CloudCO's Northbound API.

1.2 Scope

The data models defined by this Technical Report are related to the following network resources:

- **Network Map:** An ensemble of network nodes that represent Physical Network Functions (PNF) with information that provides location, contact and site information where the PNF is deployed and location and contact information that can be associated with termination points. Additionally, the model provides linkage to network connectivity models identified in TR-411 [5] and the Equipment Inventory devices.
- **Equipment Inventory:** Provides a representation of devices either as a network or end user devices. The model provides information related to the device, it's hardware components, software/firmware information for the device and management information relevant for the device and/or it's hardware and software/firmware elements. Additionally, when the device is a managed physical Access Node (pAN), the management information related to the pAN is provided.

Note: This Technical Report defines a superset of the Network Map and Equipment Inventory information elements with the understanding that deployments can use only a subset of the information elements.

The expectation is that the information model is used as a basis for reporting Network Maps and Equipment Inventories to Tenants and as such, the data provided by the models in this Technical Report can be exposed to management systems through the CloudCO's Northbound API as is; as a reduced set of instance data or data elements; abstracted into a different Network Map or Equipment inventory model representation.

2 References and Terminology

2.1 Conventions

In this Technical Report, several words are used to signify the requirements of the specification. These words are always capitalized. More information can be found in RFC 2119 [1].

MUST	This word, or the term “REQUIRED”, means that the definition is an absolute requirement of the specification.
MUST NOT	This phrase means that the definition is an absolute prohibition of the specification.
SHOULD	This word, or the term “RECOMMENDED”, means that there could exist valid reasons in particular circumstances to ignore this item, but the full implications need to be understood and carefully weighed before choosing a different course.
SHOULD NOT	This phrase, or the phrase "NOT RECOMMENDED" means that there could exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications need to be understood and the case carefully weighed before implementing any behavior described with this label.
MAY	This word, or the term “OPTIONAL”, means that this item is one of an allowed set of alternatives. An implementation that does not include this option MUST be prepared to inter-operate with another implementation that does include the option.

2.2 References

The following references are of relevance to this Technical Report. At the time of publication, the editions indicated were valid. All references are subject to revision; users of this Technical Report are therefore encouraged to investigate the possibility of applying the most recent edition of the references listed below.

A list of currently valid Broadband Forum Technical Reports is published at www.broadband-forum.org.

Document	Title	Source	Year
[1] RFC 2119	<i>Key words for use in RFCs to Indicate Requirement Levels</i>	IETF	1997
[2] RFC 7950	<i>The YANG 1.1 Data Modeling Language</i>	IETF	2016
[3] RFC 6991	<i>Common YANG Data Types</i>	IETF	2013
[4] RFC 8345	<i>A YANG Data Model for Network Topologies</i>	IETF	2018
[5] TR-411	<i>Definition of interfaces between CloudCO Functional Modules</i>	BBF	2021
[6] TR-383a4	<i>Common YANG Modules for Access Networks</i>	BBF	2021

2.3 Definitions

The following terminology is used throughout this Technical Report.

NLC	Network Logical Connectivity: A network topology that depicts the logical connection/session connectivity between Nodes within the Network. Nodes can be entities that represent PNFs and VNFs or can be an abstract entity that represents a set of PNFs or VNFs. This type of topology is also known as a Layer 2/layer 3 (L2/3) topology.
NPC	Network Physical Connectivity: A network topology that depicts the physical connectivity between Nodes within the Network. Nodes can be entities that represent PNFs and VNFs or can be an abstract entity that represents a set of PNFs or VNFs. This type of topology is also known as a Layer 1 (L1) topology.

2.4 Abbreviations

This Technical Report uses the following abbreviations:

ANM	Access Network Map
CloudCO	Cloud Central Office
InP	Infrastructure Provider
Lx	Layer x – X=1,2,3
NM	Network Map
pAN	Physical Access Node
PNF	Physical Network Function
TR	Technical Report
VNF	Virtual Network Function
VNO	Virtual Network Operator
WA	Work Area
WT	Working Text

3 Technical Report Impact

3.1 Energy Efficiency

TR-454 has no impact on energy efficiency.

3.2 Security

TR-454 has no impact on security.

3.3 Privacy

Any issues regarding privacy are not affected by TR-454.

4 Objectives of the Model

In a CloudCO architecture, the management of physical nodes requires interfaces to maintain and expose Network Map and Equipment Inventory information within the CloudCO, providing the CloudCO owner to perform activities like Network Operation and Maintenance. For the support of multiple tenants, it's also useful to expose to Tenants only relevant Network Map and Equipment Inventory information across the CloudCO's Northbound API.

The figure below provides a high level view of the functionality covered by this Technical Report (BBF YANG in green):

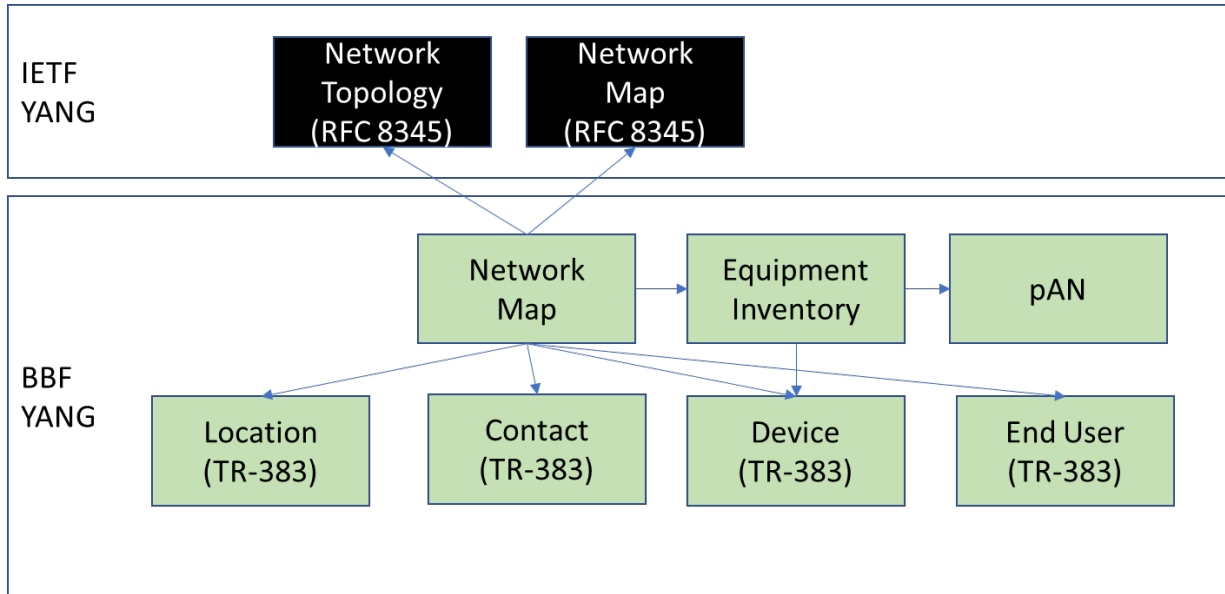


Figure 1 – YANG Data Model Relationships

5 YANG Modules

The Network Map is a list of network nodes that represent Physical Network Functions (PNF) with information that provides location, contact and site information where the PNF is deployed and location and contact information that can be associated with termination points. Additionally, the model provides linkage to network connectivity models identified in TR-411 [5] and the Equipment inventory devices.

The YANG modules contained in Technical Report are briefly described here. These modules are published on GitHub at <https://github.com/BroadbandForum/yang/tree/master/standard>.

5.1 Network Map

The Network Map is a list of network nodes that represent Physical Network Functions (PNF) with information that provides location, contact and site information where the PNF is deployed and location and contact information that can be associated with termination points. Additionally, the model provides linkage to network connectivity models identified in TR-411 [5] and the Equipment inventory devices.

This Network Map model is defined in the `bbf-network-map.yang` module located in the `application` directory on Github.

The `bbf-network-map.yang` module imports the `bbf-end-user.yang`, `bbf-location.yang`, `bbf-device.yang` and `bbf-contact.yang` modules located in the *common* directory on Github.

5.2 Equipment Inventory

A list of devices for network and end user devices. Additionally, a list of managed pANs is provided when the device is an Access Node.

This Equipment Inventory model is defined in the `bbf-equipment-inventory.yang` module located in the *application* directory on Github.

The `bbf-equipment-inventory.yang` module imports the `bbf-baa-pan.yang` module located in the *common* directory on Github to provide information related to pANs.

The `bbf-network-map.yang` module imports the `bbf-device.yang` module located in the *common* directory on Github.

6 Documentation

There are “README.md” files; these are short text files giving brief descriptions of the contents of the directories they are in.

Documentation for each module can be found in the *docs* folder of the corresponding directory, e.g., *networking*. There are two types of documents per each top level module.

- *.tree: Provides a tree diagram of the module.
- *.xml: Provides an XML schema representation of the module

Each tree and .xml file are named according to each model's module name along with `-full` to indicate it the full tree and not just the nodes defined in a given module (in the case of submodule support), e.g., `bbf-network-map-full.tree` and `bbf-equipment-inventory-full.xml`

7 Dependencies on Related YANG Modules and Standards

TR-454 is based on YANG 1.1 (RFC 7950 [2]).

The following YANG modules are used by TR-454:

- `ietf-network` [4]
- `ietf-network-topology` [4]
- `ietf-inet-types` [3]

Appendix I. Appendix Guidelines and Examples (Informative)

This section provides general guidelines for the Network Map and Equipment Inventory YANG modules. The examples in this section are not meant to be exhaustive; they are given for informative purposes in order to further clarify the basic usage of these modules.

I.1 Instantiating a Network Map with Tenants

The Network Map provides location, site and contact information about network and end user PNFs deployed within a network. In this instance the Network Map is physical map of where devices are deployed within the service provider's network and could be, using information within the Network Map, rendered to be displayed as a street map for example. The Network Map uses the RFC 8345 concepts of networks, nodes and termination point to contain the information associated with the Network Map. The concept of a Network Map as a set of nodes is depicted in Figure 2.

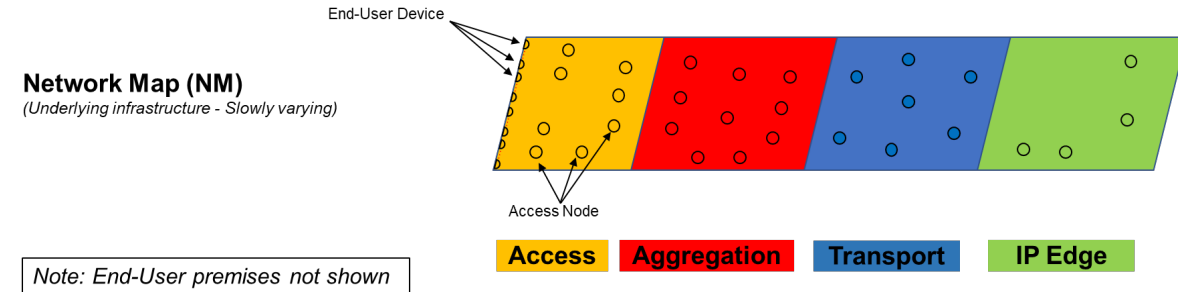


Figure 2 - Network Map

When Network Maps are defined for Tenants, the Infrastructure Network Provider and the Tenant's Network Maps are modeled as individual Network Map instances. These networks use RFC 8245's concept of a supporting-network. In the instance data model depicted above the Infrastructure Network Provider (InP) Network Map is used to as a supporting network for the Tenant's (VNO x) Network Map Instance as shown below:

```
!--Network maps-->
<network>
  <network-id>InP NM</network-id>
  <node>
    <node-id>pAN1</node-id>
    <device-ref>pAN1</device-ref>
    <termination-point>
      <tp-id>pAN1-TP1</tp-id>
    </termination-point>
    <termination-point>
      <tp-id>pAN1-TP2</tp-id>
    </termination-point>
    <!-- Other network map information (e.g., location, connected nodes)-->
  </node>
  <node>
    <node-id>pAN2</node-id>
    <device-ref>pAN2</device-ref>
    <termination-point>
      <tp-id>pAN2-TP1</tp-id>
    </termination-point>
    <termination-point>
      <tp-id>pAN2-TP2</tp-id>
    </termination-point>
    <!-- Other network map information (e.g., location, connected nodes)-->
  </node>
</network>
```

```
<node>
</network>
<network>
  <network-id>VNO x NM</network-id>
  <tenant-id>VNO x</tenant-id>
  <supporting-network>InP NM</supporting-network>
  <node>
    <node-id>vANx.1</node-id>
    <supporting-node>
      <node-ref>pAN1</node-ref>
    </supporting-node>
    <termination-point>
      <tp-id>vANx.1-TP1</tp-id>
    </termination-point>
    <device-ref>pAN1</device-ref>
    <!-- Other network map information (e.g., location, connected nodes)-->
  <node>
  <node>
    <node-id>vANx.2</node-id>
    <supporting-node>
      <node-ref>pAN2</node-ref>
    </supporting-node>
    <termination-point>
      <tp-id>vANx.2-TP1</tp-id>
    </termination-point>
    <device-ref>pAN2</device-ref>
    <!-- Other network map information (e.g., location, connected nodes)-->
  <node>
</network>
</network>
```

I.2 Using the Network Map with Network Connectivity Models

While the Network Map doesn't formally model the link relationship, which is the role of a Network Connectivity models. The nodes and termination points of the Network Map can be used by the supporting or higher layer Network Physical Connectivity models as depicted in Figure 3 below:

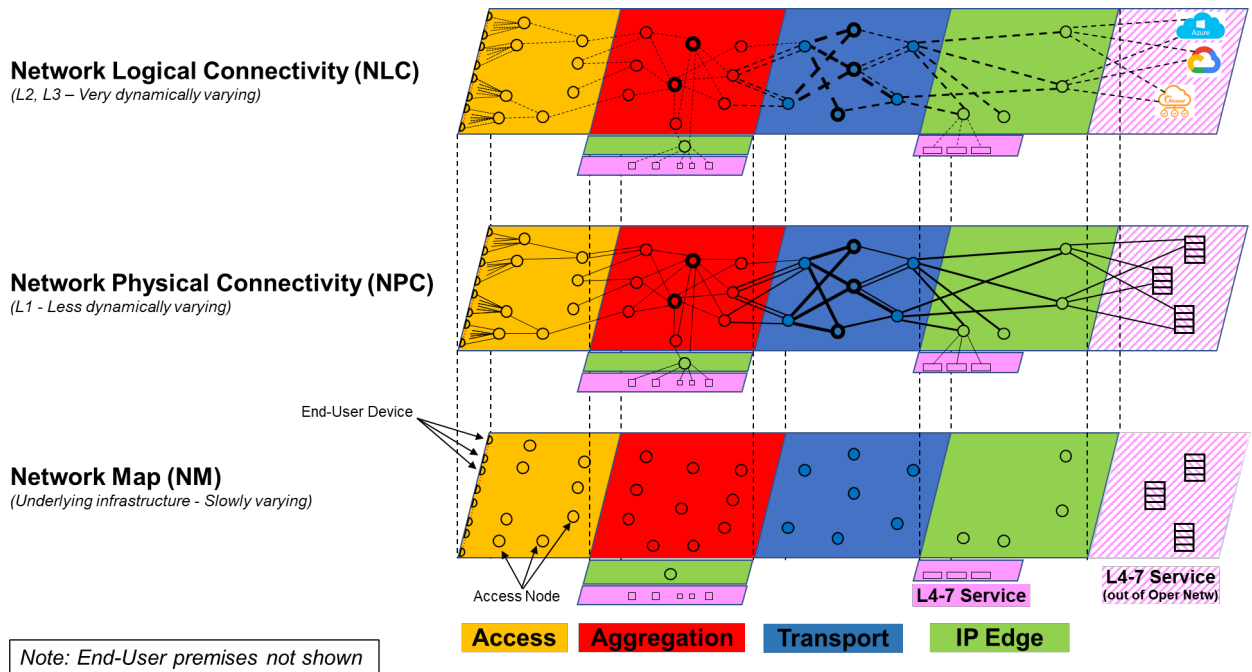


Figure 3 - Network Map relationship with Network Connectivity Models

The nodes of the Network Map are referenced by the nodes in the NPC by using networks in the NPC associating the nodes and termination points in the NPC with the corresponding nodes and termination points in the Network Map using the RFC 8345 network models concept of a supporting-node and supporting-termination-point.

The following instance model depicts the InP NPC network's node representation for "pAN1 Phy" referencing the supporting node "pAN1" from the "InP" Network Map shown in Appendix I.1. Additionally, the termination point in the InP NPC's representation for "pAN1-TP1 Phy" references the supporting termination point "pAN1-TP1".

```

<network>
  <network-id>InP Phy</network-id>
  <supporting-network>InP NM</supporting-network>
  <node>
    <node-id>pAN1 Phy</node-id>
    <supporting-node>
      <node-ref>pAN1</node-ref>
    </supporting-node>
    <termination-point>
      <tp-id>pAN1-TP1 Phy</tp-id>
      <supporting-termination-point>pAN1-TP1<supporting-termination-point>
    </termination-point>
    <termination-point>
      <tp-id>pAN1-TP2 Phy</tp-id>
      <supporting-termination-point>pAN1-TP2<supporting-termination-point>
    </termination-point>
  </node>
  <node>
    <node-id> pAN2 Phy </node-id>
    <supporting-node>
      <node-ref>pAN2</node-ref>
    </supporting-node>
  </node>

```

```
<termination-point>
  <tp-id>pAN2-TP1 Phy</tp-id>
  <supporting-termination-point>pAN2-TP1<supporting-termination-point>
</termination-point>
<termination-point>
  <tp-id>pAN2-TP2 Phy</tp-id>
  <supporting-termination-point>pAN2-TP2<supporting-termination-point>
</termination-point>
<node>
<link>
  <link-id>pAN1-pAN2 L1</link-id>
  # Source/Dest Node/TP...pAN1-TP1/pAN2-TP1
</link>
<link>
  <link-id>pAN1-pAN2 L2</link-id>
  # Source/Dest Node/TP...pAN1-TP2/pAN2-TP2
</link>
</network>
```

End of Broadband Forum Technical Report TR-454