YANG Module Classification
draft-ietf-netmod-yang-model-classification-03

Abstract

   The YANG [RFC6020] data modeling language is currently being
   considered for a wide variety of applications throughout the
   networking industry at large. Many standards-defining organizations
   (SDOs), open source software projects, vendors and users are using
   YANG to develop and publish YANG modules for a wide variety of
   applications. At the same time, there is currently no well-known
   terminology to categorize various types of YANG modules.

   A consistent terminology would help with the categorization of YANG
   modules, assist in the analysis of the YANG data modeling efforts in
   the IETF and other organizations, and bring clarity to the YANG-
   related discussions between the different groups.

   This document describes a set of concepts and associated terms to
   support consistent classification of YANG modules.

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[1](#). Introduction

   The Internet Engineering Steering Group (IESG) has been actively
   encouraging IETF working groups to use the YANG modeling language
   [RFC6020], [RFC7950] and NETCONF protocol [RFC6241] for configuration
   management purposes, especially in new working group charters
   [Writable-MIB-Module-IESG-Statement].

   YANG is also gaining wide acceptance as the de-facto standard
   modeling language in the broader industry. This extends beyond the
   IETF, including many standards development organizations, industry

consortia, ad hoc groups, open source projects, vendors, and end-
users.

There are currently no clear guidelines on how to classify the
layering of YANG modules according to abstraction, or how to classify
modules along the continuum spanning formal standards publications,
vendor-specific modules and modules provided by end-users.

This document presents a set of concepts and terms to form a useful
taxonomy for consistent classification of YANG modules in two
dimensions:

o The layering of modules based on their abstraction levels

o The type of module based on the nature and intent of the content

The intent of this document is to provide a taxonomy to simplify
human communication around YANG modules. The authors acknowledge
that the classification boundaries are at times blurry, but believe
that this document should provide a robust starting point as the YANG
community gains further experience with designing and deploying
modules. To be more explicit, the authors believe that the
classification criteria will change over time.

A number of module types have created substantial discussion during
the development of this document including those concerned with
topologies. Topology modules are useful both on the Network Element
level (e.g. link-state database content) as well as on the Network
Service level (e.g. network-wide, configured topologies). In the
end, it is the module developer that classifies the module according
to the initial intent of the module content.

This document should provide benefits to multiple audiences:

o First, a common taxonomy helps with the different standards
   development organizations and industry consortia discussions,
   whose goals are determined in their respective areas of work.

o Second, operators might look at the YANG module classification
   type to understand which Network Service YANG modules and Network
   Element YANG modules are available for their service composition.
   It is difficult to determine the module type without inspecting
   the YANG module itself. The YANG module name might provide some
   useful information but is not a definite answer. For example, an
   L2VPN YANG module might be a Network Service YANG module, ready to
   be used by the operators. Alternatively, it might be a Network
   Element YANG module that contains the L2VPN data definitions
   required to be configured on a single device.

o And thirdly, this taxonomy would help equipment vendors (whether
   physical or virtual), controller vendors, orchestrator vendors to
   explain to their customers the relationship between the different
   YANG modules they propose in their products. See Figure 1.

1.1. Terminology

   [RFC7950] specifies:

o data model: A data model describes how data is represented and
   accessed.

o module: A YANG module defines a hierarchy of nodes that can be
   used for NETCONF-based operations. With its definitions and the
   definitions it imports or includes from elsewhere, a module is
   self-contained and "compilable".

2. First Dimension: YANG Module Abstraction Layers

   Module developers have taken two approaches to developing YANG
   modules: top-down and bottom-up. The top-down approach starts with
   high level abstractions modeling business or customer requirements
   and maps them to specific networking technologies. The bottom-up
   approach starts with fundamental networking technologies and maps
   them into more abstract constructs.

   There are currently no specific requirements on, or well-defined best
   practices around the development of YANG modules. For the purpose of
   this document we assume that both approaches (bottom-up and top-down)
   will be used as they both provide benefits that appeal to different
   groups.

   For layering purposes, this document suggests the classification of
   YANG modules into two distinct abstraction layers:

o Network Element YANG Modules describe the configuration, state
   data, operations and notifications of specific device-centric
   technologies or features

o Network Service YANG Modules describe the configuration, state
   data, operations and notifications of abstract representations of
   services implemented on one or multiple network elements

```
                    +--------------------------+
                    |  Operations and Business |
                    |      Support Systems     |
                    |        (OSS/BSS)         |
                    +--------------------------+


     - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        Network Service YANG Modules


          +------------+      +-------------+     +-------------+
          |            |      |             |     |             |
          |  - L2VPN   |      |  - L2VPN    |     |    L3VPN    |
          |  - VPWS    |      |  - VPLS     |     |             |
          |            |      |             |     |             |
          +------------+      +-------------+     +-------------+


     - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        Network Element YANG Modules


       +------------+  +------------+  +-------------+  +------------+
       |            |  |            |  |             |  |            |
       |   MPLS     |  |    BGP     |  | IPv4 / IPv6 |  |  Ethernet  |
       |            |  |            |  |             |  |            |
       +------------+  +------------+  +-------------+  +------------+


        L2VPN: Layer 2 Virtual Private Network
        L3VPN: Layer 3 Virtual Private Network
        VPWS: Virtual Private Wire Service
        VPLS: Virtual Private LAN Service
```
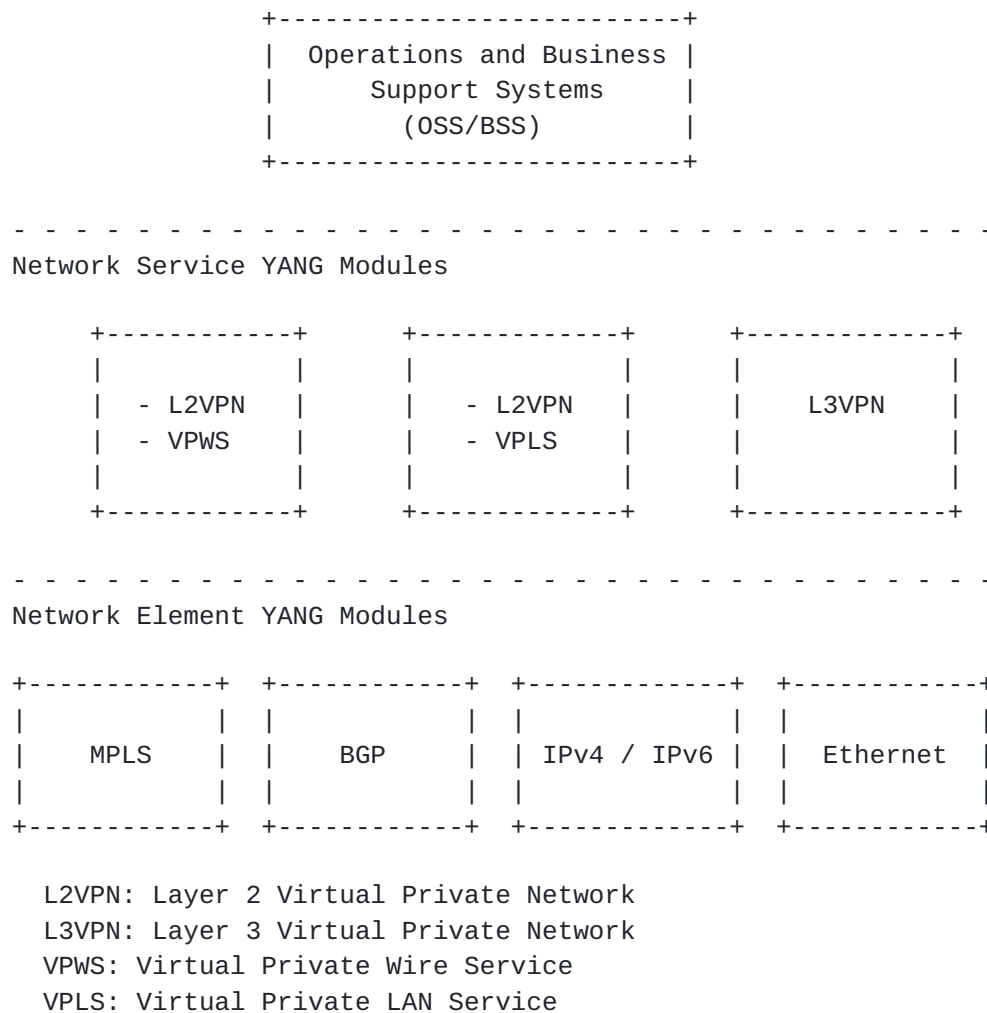
                     Figure 1: YANG Module Layers

   Figure 1 illustrates the application of YANG modules at different
   layers of abstraction. Layering of modules allows for reusability of
   existing lower layer modules by higher level modules while limiting
   duplication of features across layers.

   For module developers, per-layer modeling allows for separation of
   concern across editing teams focusing on specific areas.

   As an example, experience from the IETF shows that creating useful
   network element YANG modules for e.g. routing or switching protocols
   requires teams that include developers with experience of
   implementing those protocols.

   On the other hand, network service YANG modules are best developed by
   network operators experienced in defining network services for

consumption by programmers developing e.g. flow-through provisioning
systems or self-service portals.

2.1. Network Service YANG Modules

Network Service YANG Modules describe the characteristics of a
service, as agreed upon with consumers of that service. That is, a
service module does not expose the detailed configuration parameters
of all participating network elements and features, but describes an
abstract model that allows instances of the service to be decomposed
into instance data according to the Network Element YANG Modules of
the participating network elements. The service-to-element
decomposition is a separate process with details depending on how the
network operator chooses to realize the service. For the purpose of
this document we will use the term "orchestrator" to describe a
system implementing such a process.

As an example, the Network Service YANG Module defined in
[YANG-Data-Model-for-L3VPN-service-delivery] provides an abstract
model for Layer 3 IP VPN service configuration. This module includes
e.g. the concept of a 'site-network-access' to represent bearer and
connection parameters. An orchestrator receives operations on
service instances according to the service module and decomposes the
data into specific Network Element YANG Modules to configure the
participating network elements to perform the intent of the service.
In the case of the L3VPN module, this would include translating the
'site-network-access' parameters to the appropriate parameters in the
Network Element YANG Module implemented on the constituent elements.

Network Service YANG Modules define service models to be consumed by
external systems. These modules are commonly designed, developed and
deployed by network infrastructure teams.

YANG allows for different design patterns to describe network
services, ranging from monolithic to component-based approaches.

The monolithic approach captures the entire service in a single
module and does not put focus on reusability of internal data
definitions and groupings. The monolithic approach has the
advantages of single-purpose development including speed at the
expense of reusability.

The component-based approach captures device-centric features (e.g.
the definition of a VRF, routing protocols, or packet filtering) in a
vendor-independent manner. The components are designed for reuse
across many service modules. The set of components required for a
specific service is then composed into the higher-level service. The
component-based approach has the advantages of modular development

including a higher degree of reusability at the expense of initial
speed.

As an example, an L2VPN service can be built on many different types
of transport network technologies, including e.g. MPLS or carrier
ethernet. A component-based approach would allow for reuse of e.g.
UNI-interface definitions independent of the underlying transport
network (e.g. MEF UNI interface or MPLS interface). The monolithic
approach would assume a specific set of transport technologies and
interface definitions.

2.2. Network Element YANG Modules

Network Element YANG Modules describe the characteristics of a
network device as defined by the vendor of that device. The modules
are commonly structured around features of the device, e.g. interface
configuration [RFC7223], OSPF configuration [I-D.ietf-ospf-yang], and
firewall rules definitions [I-D.ietf-netmod-acl-model].

The module provides a coherent data model representation of the
software environment consisting of the operating system and
applications running on the device. The decomposition, ordering, and
execution of changes to the operating system and application
configuration is the task of the agent that implements the module.

3. Second Dimension: Module Types

This document suggests classifying YANG module types as standard YANG
modules, vendor-specific YANG modules and extensions, or user-
specific YANG modules and extensions

The suggested classification applies to both Network Element YANG
Modules and Network Service YANG Modules.

It is to be expected that real-world implementations of both Network
Service YANG Modules and Network Element YANG Modules will include a
mix of all three types of modules.

Figure 2 illustrates the relationship between the three types of
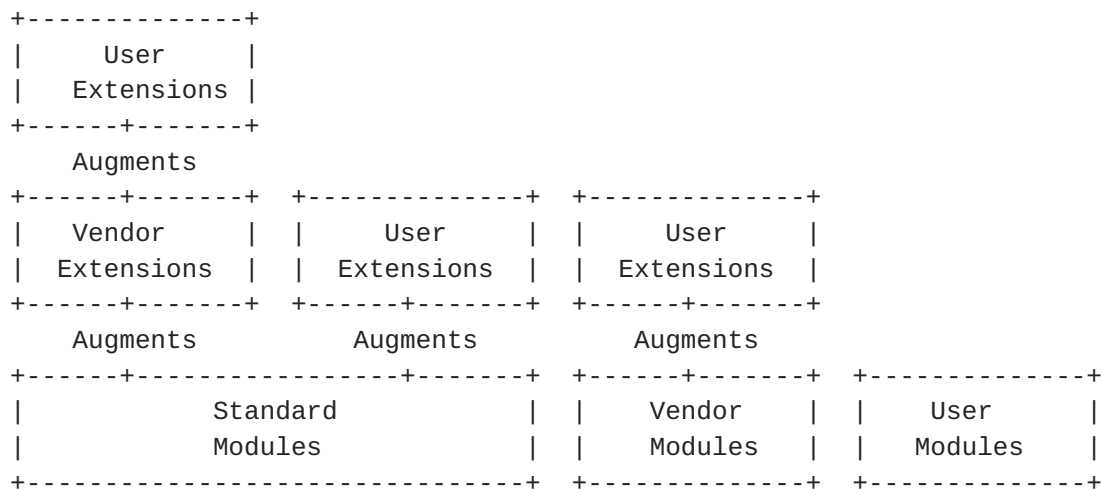modules.

```
 +--------------+
 |     User     |
 |  Extensions  |
 +------+-------+
     Augments
 +------+-------+  +--------------+  +--------------+
 |    Vendor    |  |     User     |  |     User     |
 |  Extensions  |  |  Extensions  |  |  Extensions  |
 +------+-------+  +------+-------+  +------+-------+
     Augments        Augments         Augments
 +------+-----------------+-------+  +------+-------+  +--------------+
 |           Standard             |  |    Vendor    |  |     User     |
 |           Modules              |  |    Modules   |  |    Modules   |
 +--------------------------------+  +--------------+  +--------------+
```

Figure 2: YANG Module Types

3.1. Standard YANG Modules

Standard YANG Modules are published by standards-defining
organizations (SDOs). While there is no formal definition of what
construes an SDO, a common feature is that they publish
specifications along specific processes with content that reflects
some sort of membership consensus. The specifications are developed
for wide use among the membership or for audiences beyond that.

The lifecycle of these modules is driven by the editing cycle of the
specification and not tied to a specific implementation.

Examples of SDOs in the networking industry are the IETF, the IEEE
and the MEF.

3.2. Vendor-specific YANG Modules and Extensions

Vendor-specific YANG Modules are developed by organizations with the
intent to support a specific set of implementations under control of
that organization. For example vendors of virtual or physical
equipment, industry consortia, and opensource projects. The intent
of these modules range from providing openly published YANG modules
that may eventually be contributed back to, or adopted by, an SDO, to
strictly internal YANG modules not intended for external consumption.

The lifecycle of these modules are generally aligned with the release
cycle of the product or open source software project deliverables.

It is worth noting that there is an increasing amount of interaction
between open source projects and SDOs in the networking industry.
This includes open source projects implementing published standards

as well as open source projects contributing content to SDO
processes.

Vendors also develop Vendor-specific Extensions to standard modules
using YANG constructs for extending data definitions of previously
published modules. This is done using the 'augment' statement that
allows locally defined data trees to be augmented into locations in
externally defined data trees.

Vendors use this to extend standard modules to cover the full scope
of features in implementations, which commonly is broader than that
covered by the standard module.

3.3. User-specific YANG Modules and Extensions

User-specific YANG Modules are developed by organizations that
operate YANG-based infrastructure including devices and
orchestrators. For example, network administrators in enterprises,
or at service providers. The intent of these modules is to express
the specific needs for a certain implementation, above and beyond
what is provided by vendors.

This module type obviously requires the infrastructure to support the
introduction of user-provided modules and extensions. This would
include ability to describe the service-to-network decomposition in
orchestrators and the module to configuration decomposition in
devices.

The lifecycles of these modules are generally aligned with the change
cadence of the infrastructure.

4. Adding The Classification Type to YANG Module Catalogs

The suggested classification in this document would be an useful
information in a catalog of YANG modules. Such a catalog allows for
easy lookup and reusability of YANG modules. Practically, the YANG
module classification type would be an additional leaf to a YANG
module specified in [I-D.openconfig-netmod-model-catalog]:

```
            leaf module-class{
              type enum {
                    service
                    device
                    notApplicable
              }
              description
                 "Categorization of the YANG module based on
                  draft-ietf-netmod-yang-model-classification.";
            }
```

Note: this leaf should actually be moved to
[I-D.openconfig-netmod-model-catalog]. Note2: since a YANG module
can belong to both service and device, the ENUM is not appropriate.
An extensible list of module type is more appropriate.

Indeed, without inspecting the YANG module itself, it's difficult to
determine whether its type is a network service or a network element.
The YANG module name might provide some useful information but is not
a definitive answer.

5. Security Considerations

This document doesn't have any Security Considerations.

6. IANA Considerations

This document has no IANA actions.

7. Acknowledgements

Thanks to David Ball and David Hansford for feedback and suggestions.

8. Change log [RFC Editor: Please remove]

version 00: Renamed and small fixes based on WG feedback.

version 01: Language fixes, collapsing of vendor data models and
extensions, and the introduction of user data models and extensions.

version 02: Updated the YANG Module Catalog section, terminology
alignment (YANG data model versus YANG module), explain better the
distinction between the Network Element and Service YANG data models
even if sometimes there are grey areas, editorial pass. Changed the
use of the term 'model' to 'module' to be better aligned with
RFC6020.

9. References

9.1. Normative References

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            "YANG Data Model for L3VPN service delivery",
            <https://tools.ietf.org/id/draft-l3vpn-service-yang>.

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