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Catalog and registry for YANG models
draft-openconfig-netmod-model-catalog-00

Abstract

This document presents an approach for a YANG model catalog and registry that allows users to find models relevant to their use cases from the large and growing number of YANG modules being published. The model catalog may also be used to define bundles of YANG modules required to realize a particular service or function.

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[1.](#) Introduction

As YANG [[RFC6020](#)] adoption and usage grows, the number of YANG models (and corresponding module and submodule files) published is increasing rapidly. This growing collection of modules potentially enables a large set of management use cases, but from a user perspective, it is a daunting task to navigate the largely ad-hoc landscape of models to determine their functionality, availability, and implementations. For example, the IETF Routing Area Coordination page [[RTG-AD-YANG](#)] currently tracks nearly 150 YANG models related to layer 2 and layer 3 technologies.

YANG models are also being developed and published beyond the IETF, for example by open source projects, other standards organizations, and industry forums. These efforts are generally independent from each other and often result in overlapping models. While we recognize that models may come from multiple sources, the current approach of having a flat online listing of models is not sufficient to help users find the models they need, along with the information to retrieve and utilize the models in actual operational systems. There is a need for a wider registry and catalog of available models that provides a central reference for model consumers and developers.

The idea of a model catalog is inspired by service catalogs in traditional IT environments. Service catalogs serve as software-based registries of available services with information needed to discover and invoke them.

In earlier proposals [[I-D.openconfig-netmod-model-structure](#)] we motivated the need for a common structure that allows a set of models to be used together coherently in order to manage, for example, a complete network device. Other efforts have subsequently proposed further options for modeling the complete device structure [[I-D.rtgyangdt-rtgwg-device-model](#)]. We also briefly described the notion of a model catalog to provide a structured view of all of the models available from different organizations. In this document, we further elaborate on some of the details and use cases for a model catalog and registry.

There are recent proposals that address related issues in terms of understanding the set of YANG models available on a device [[I-D.ietf-netconf-yang-library](#)], and how to classify models based on their role in describing a multi-layer service [[I-D.bogdanovic-netmod-yang-model-classification](#)]. The latter, in particular, describes a taxonomy for classifying YANG models that could also be used in the model catalog, though it does not address the problem of classifying model functionality, which is a key requirement.

2. Model catalog and registry requirements

At a high level, the model catalog must provide enough information for users to determine which models are available to describe a specific service or technology, and attributes of those models that would help the user select the best model for their scenario. While this draft does not specifically address selection criteria -- they would be specific to each user -- some examples include:

- o model maturity, including availability of server implementations (e.g., native device support)
- o available of co-requisite models, and complexity of the model dependencies
- o identity and reputation of the entity or organization publishing the model

The model catalog should, therefore, include key information about YANG modules, including:

- o organization responsible for publishing and maintaining the module with contact information; organizations may include standards bodies (SDOs), industry forums, open source projects, individuals, etc.

- o classification of the module or model, which could be along several axes, e.g., functional category, service vs. element models, commercial vs. free-to-use, etc.
- o for open models, the license under which the model is distributed; this is important if there are limitations on how the model may be modified or redistributed
- o module dependencies, e.g., a list of all of the YANG modules that are required
- o pointer to the YANG module, e.g., a URI that can be machine-processed
- o implementation information, for example, a list of available server implementations that support the module
- o authentication information to allow users to verify that the model they retrieve is authentic and unaltered

Establishing a globally applicable classification scheme for models is not straightforward -- each organization developing models likely has its own taxonomy or organization strategy for YANG modules. This is an area of the catalog that is likely to require extensibility and customization, e.g., by letting each organization augment the schema with its own categories. Similarly, users may want to define their own classifications for use by internal systems.

The proposed catalog schema should be useful as a local database, deployed by a single user, and also as a global registry that can be used to discover available models. For example, the local catalog could be used to define the approved set of models for use within an organization, while the registry serves as a channel for all model developers to make information about their models available. The IETF XML Registry [[RFC3688](#)], maintained by IANA serves a similar purpose for XML documents used in IETF protocols, but it is limited to IETF-defined YANG models, is tied to XML encoded data, and has a very limited schema.

The registry implementation could be as simple as a metadata database that reflects the proposed catalog schema, along with means for online access and viewing. A key requirement for the online registry would be a robust query capability that allows users to search for modules meeting a variety of selection criteria, along with an easy way to retrieve modules (where applicable).

3. Model catalog schema

We propose a schema for the model catalog defined using YANG (see the modules in [Section 7](#)). The YANG modules in the catalog are organized at the top level by the publishing organization and its associated contact information. The catalog structure is shown below.

```
+--rw organizations
  +--rw organization* [name]
    +--rw name          string
    +--rw type?         identityref
    +--rw contact?      string
    +--rw modules
      +--rw module* [name]
        +--rw name          string
        +--rw namespace?    string
        +--rw prefix?       string
        +--rw revision?     string
        +--rw summary?      string
        +--rw module-version? string
        +--rw module-hierarchy
          | ...
        +--rw classification
          | ...
        +--rw dependencies
          | ...
        +--rw module-usage
          | ...
        +--rw implementations
          | ...
          | ...
```

In this model, each organization publishes a list of available modules, each module having associated data describing its classification, dependencies, usage information, and implementation information. In addition, some of the basic module metadata is included in the catalog, e.g., namespace, prefix, and revision.

3.1. Module information

Each module has several types of information associated with it. These are described below.

The basic information includes module metadata as mentioned above and also the location of module in its own dependency chain. The module-hierarchy container indicates whether the module is a submodule of another module, and has a reference to its parent module.

The classification data is meant to capture some base information but leave the taxonomy largely to model publishers. The category and subcategory leaves are identities that are expected to be augmented with additional values. The classification also includes a status to indicate the development or deployment status of the module, e.g., whether it is purely experimental, or mature enough for production use. The classification data is shown below:

```
+--rw module* [name]
  +--rw classification
    +--rw status?      identityref
    +--rw category?    identityref
    +--rw subcategory? identityref
```

In this initial version of the catalog schema, the module dependencies are represented as a simple list of references to co-requisite modules. The model assumes that required modules are also represented in the catalog, and that only the first-level dependencies are included in the list. That is, each of the listed modules can be examined to determine its dependencies.

The usage data contains information required to retrieve and validate the module. Specifically, it includes authentication and validation data to ensure the origin and integrity of the module, respectively. The authentication information will be further developed in future revisions of the document; in the current version, these can be considered placeholders. This section also includes a URI for modules that can be downloaded directly. This part of the schema is shown below:

```
+--rw module* [name]
  +--rw module-usage
    +--rw authentication? string
    +--rw md5-hash?       string
    +--rw access-uri?     inet:uri
```

The implementation container provides information about known implementations of the module, for example by network devices or other servers. This data is structured as a list to account for multiple implementations of a module, e.g., by different vendors. It includes some basic information about the platform on which the module is supported, and the status of the implementation, but it is expected that details and limitations of the implementation will require consulting the implementor. The implementation information in the catalog is shown below:


```
+--rw module* [name]
  +--rw implementations
    +--rw implementation* [implementation-id]
      +--rw implementation-id      string
      +--rw description?          string
      +--rw reference?            union
      +--rw implementor-name?     string
      +--rw platform?            string
      +--rw platform-version?    string
      +--rw implementation-status? identityref
```

4. Module composition with bundles

From an operational perspective, the utility of a single module is quite limited. Most, if not all, use cases require multiple modules that work together coherently. Managing a network device typically requires configuration and operational state models for device-wide services, network protocols, virtual instances, etc. Network services, such as those delivered by many service providers, require not only infrastructure-level management models, such as devices and protocols, but also service-level models that describe service parameters.

The model catalog and registry provides a common way to define service bundles, or recipes, that describe the set of modules required for realizing the feature or service. For example, a Layer 3 VPN bundle would list its required configuration and state models, including VRFs, interfaces, BGP, policy, ACLs, and QoS. Similar bundles can be defined for other services or use cases, for example, basic Internet operations such as adding new peers or customers, or setting up Layer 2 VPNs. Note these bundle definitions complement actual configuration models for such services, which may focus on providing an abstracted set of configuration or operational state variables. These variables would then be mapped onto device level variables. We leave discussion of such mapping mechanisms to future revisions.

Bundle definitions are particularly useful for organizations that identify and validate a set of models that are used to build a service, and then define an approved bundle based on that set. Users within the organization can be assured that the corresponding bundles are known to work together to support the desired service. Another use case for bundle definitions is for third-party testing or certification organizations to provide services to validate a set of modules and maintain the bundle.

4.1. Schema for module bundles

We propose an initial YANG-defined schema for describing a service bundle for building composite services and functions (shown below).

```
+--rw bundle
  +--rw name?          string
  +--rw version?       string
  +--rw description?   string
  +--rw category?      string
  +--rw subcategory?   string
  +--rw modules
    +--rw module* [module-type]
      +--rw module-type          string
      +--rw catalog-reference? -> /cat:organizations/.../module/name
      +--rw application-sequence? uint8
```

Each bundle includes basic information such as the name of the feature or service, the bundle version, and its category and subcategory. The modules comprising the bundle are contained in the modules list with a reference to the module in the catalog. The application sequence number can be used to indicate an ordering of the modules in realizing the service, for example, device or element configuration modules followed by service configuration models. The application sequence is a high level indication; a complete realization of the service would require a detailed definition of the mapping between module variables at different levels as discussed in [Section 4](#).

5. Security Considerations

The model catalog and registry described in this document do not define actual configuration and state data, hence are not directly responsible for security risks.

However, since the model catalog is intended to be an authoritative and authenticated database of published modules, there are security considerations in securing the catalog (both contents and access), and also in authenticating organizations that deposit data into the catalog.

6. IANA Considerations

The YANG model catalog is intended to complement the IANA XML Registry. YANG modules defined in this document may be entered in the XML registry if they are placed or redirected for the standards track, with an appropriate namespace URI.

7. YANG modules

The model catalog and associated types modules are listed below.

```
<CODE BEGINS> file openconfig-module-catalog.yang
module openconfig-module-catalog {

    yang-version "1";

    // namespace
    namespace "http://openconfig.net/yang/module-catalog";

    prefix "cat";

    // import some basic types
    import ietf-inet-types { prefix inet; }
    import openconfig-catalog-types { prefix cat-types; }

    // meta
    organization "OpenConfig working group";

    contact
        "OpenConfig working group
        www.openconfig.net";

    description
        "This module provides a schema for cataloging and descrbing
        YANG models published across various organizations.";

    revision "2015-10-18" {
        description
            "Initial revision";
        reference "TBD";
    }

    // extension statements

    // feature statements

    // identity statements

    // typedef statements

    // grouping statements

    grouping module-implementation-information {
        description
```



```
"Data describing any available implementations";

container implementations {
  description
    "Container for module implementation information";

  list implementation {
    key implementation-id;
    description
      "List of available implementations, keyed by an identifier
      provided by either the implementor or the module
      maintainer. Such a key avoids needing a complex composite
      key to uniquely identify an implementation.";

    leaf implementation-id {
      type string;
      description
        "An identifier for the implementation, provided by the
        implementor or the module maintainer. This id should
        uniquely identify a specific implementation of the
        module, e.g., based on the vendor, platform, and platform
        version.";
    }

    leaf description {
      type string;
      description
        "A text summary of important information about the
        implementation";
    }

    leaf reference {
      type union {
        type string;
        type inet:uri;
      }
      description
        "A URI or text reference to more detailed information
        about the implementation.";
    }

    leaf implementor-name {
      type string;
      description
        "Name of the vendor or entity providing the module
        implementation";
    }
  }
}
```



```
    leaf platform {
      type string;
      description
        "Name of the server platform on which the implementation
        is available -- this could be the model name of a network
        device, a server OS, etc.";
    }

    leaf platform-version {
      type string;
      description
        "Implementor-defined version name or number for the
        module implementation, corresponding to the platform.
        This could be the firmware version of a network device
        such as a router, OS version, or other server platform
        version.";
    }

    leaf implementation-status {
      type identityref {
        base cat-types:implementation-status-type;
      }
      description
        "Indicates the status of the implementation, e.g.,
        complete, partial, in-progress, etc. Implementors
        may define additional values for the base identity";
    }
  }
}

grouping module-dependency-information {
  description
    "Information about module dependencies";

  container dependencies {
    description
      "Container for information about module dependencies";

    leaf-list required-module {
      type leafref {
        path "../..../name";
      }
      description
        //TODO: should this list be complete, or only the first-
        //level dependencies?
        "A simple list of modules that are prerequisites for the
        current module. It is expected that each of the required
```



```
        modules would in turn list their dependencies.  The list
        values should be references to other modules in the
        catalog.";
    }
}

grouping module-classification-information {
  description
    "Data describing the module's classification(s)";

  container classification {
    description
      "Container for data describing the module's classification";

    leaf status {
      type identityref {
        base cat-types:module-status-type;
      }
      description
        "Status of the module -- experimental, standards-track,
        production, etc.";
    }

    leaf category {
      type identityref {
        base cat-types:module-category-base;
      }
      description
        "Categorization of the module based on identities defined
        by the publishing organizations.";
    }

    leaf subcategory {
      type identityref {
        base cat-types:module-subcategory-base;
      }
      description
        "Sub-categorization of the module based on identities
        defined by the publishing organizations.";
    }
  }
}

grouping module-usage-information {
  description
    "Data pertaining to retrieval and usage of the module";
```



```
container module-usage {
  description
    "Container for data pertaining to retrieval and usage of the
    module";

  leaf authentication {
    //TODO: requires more detailed model for different types
    //of authentication / validation schemes
    type string;
    description
      "Authentication information to allow
      users to verify that the model originates from
      stated organization, e.g., X.509 certificate";
  }

  leaf md5-hash {
    type string;
    description
      "MD5 hash of the module file, used by users to validate
      data integrity";
  }

  leaf access-uri {
    type inet:uri;
    description
      "URI where module can be downloaded. Modules may be
      made available from the catalog maintainer, or directly
      from the publisher";
  }
}

grouping module-base-information {
  description
    "Basic information describing the module, e.g., the
    YANG metadata in the module preface.";

  leaf name {
    type string;
    description
      "The module name, as defined in the YANG module file.";
  }

  leaf namespace {
    //type inet:uri;
    type string;
    description
      "Published namespace of module";
  }
}
```



```
}

leaf prefix {
  type string;
  description "Published prefix of module";
}

leaf revision {
  type string;
  description
    "Date in the revision statement of the module";
}

leaf summary {
  type string;
  description
    "Brief summary of the module description";
}

leaf module-version {
  type string;
  description
    "Optional version number for the module, in addition to the
    YANG revision statement";
}

container module-hierarchy {

  description
    "YANG module hierarchy specification";

  leaf module-hierarchy-level {
    type uint8 {
      range 1..5;
    }
    default 1;
    description
      "Module hierarchy level. If this is a sub-module,
      it is set to > 1, depending
      on the hierarchy level of the sub-module";
  }

  leaf module-parent {
    when "../module-hierarchy-level > '1'" {
      description "Only applicable to sub-modules";
    }
    type leafref {
      path "../../name";
    }
  }
}
```



```
        }
        description
            "Parent module, if this is a sub-module";
    }
}
} //module-base-information

grouping organization-information {
    description
        "Data describing the publisher of the module";

    leaf name {
        type string;
        description
            "Name of Organization defining YANG Module:"
            + "Standards Body examples:"
            + "    ietf, ieee, opendaylight, etc."
            + "Commercial entity examples:"
            + "    AT&T"
            + "Name of industry forum examples:"
            + "    openconfig, other";
    }

    leaf type {
        type identityref {
            base cat-types:organization-type;
        }
        description
            "YANG modules publication authority";
    }

    leaf contact {
        type string;
        description
            "Contact information for the publishing organization";
    }
}

grouping module-catalog-top {
    description
        "Top level structure of the module catalog";

    container organizations {

        description
            "List of organizations owning modules";
```



```
list organization {
    key "name";

    description
        "List of organizations defining the YANG Modules";

    uses organization-information;

    container modules {
        description
            "Modules published by this organization";

        list module {
            key name;
            description
                "List of published modules from the organization";

            uses module-base-information;
            uses module-classification-information;
            uses module-dependency-information;
            uses module-usage-information;
            uses module-implementation-information;
        }
    }
}

// data definition statements

uses module-catalog-top;

// augment statements

// rpc statements

// notification statements

}
<CODE ENDS>

<CODE BEGINS> file openconfig-catalog-types.yang
module openconfig-catalog-types {

    yang-version "1";
```



```
// namespace
namespace "http://openconfig.net/yang/catalog-types";

prefix "cat-types";

// import some basic types

// meta
organization "OpenConfig working group";

contact
  "OpenConfig working group
  www.openconfig.net";

description
  "This module defines types and identities used by the OpenConfig
  YANG module catalog model.";

revision "2015-10-18" {
  description
    "Initial revision";
  reference "TBD";
}

// extension statements

// feature statements

// identity statements

identity implementation-status-type {
  description
    "Indications of the status of a module's implementation on a
    device or server";
}

identity in-progress {
  base implementation-status-type;
  description
    "Implementation is in progress";
}

identity planned {
  base implementation-status-type;
  description
    "Implementation is planned";
}
```



```
identity complete {
  base implementation-status-type;
  description
    "Implementation is complete and fully supports the model";
}

identity partial {
  base implementation-status-type;
  description
    "Implementation is complete, but only supports the model
    partially";
}

identity module-status-type {
  description
    "Indicates the deployment status of the module";
}

identity experimental {
  base module-status-type;
  description
    "Module should be considered experimental, not deployed in
    production settings";
}

identity production {
  base module-status-type;
  description
    "Module is suitable for use in production, or has been
    deployed in production";
}

identity module-category-base {
  description
    "Base identity for the module category. It is expected that
    publishing organizations will define additional derived
    identities to describe their categorization scheme.";
}

identity module-subcategory-base {
  description
    "Base identity for the module subcategory. It is expected that
    publishing organizations will define additional derived
    identities to describe their categorization scheme.";
}

identity organization-type {
  description
```



```
    "Publishing organization type for the set of modules";
}

identity standards {
    base organization-type;
    description
        "Standards development organization (SDO) publisher type";
}

identity industry {
    base organization-type;
    description
        "Industry forum or other industry group";
}

identity commercial {
    base organization-type;
    description
        "Commercial entity, company, etc.";
}

identity individual {
    base organization-type;
    description
        "For modules published by an individual";
}

// typedef statements

typedef yang-model-publisher
{
    type enumeration {
        enum "standards";
        enum "commercial";
        enum "forum";
    }
}

// grouping statements

// data definition statements

// augment statements

// rpc statements

// notification statements
```



```
}  
<CODE ENDS>
```

The feature bundle module is listed below.

```
<CODE BEGINS> file openconfig-feature-bundle.yang  
module openconfig-feature-bundle {  
  
    // namespace  
    // TODO: change to an ietf or other more generic namespace  
    namespace "http://openconfig.net/yang/feature-bundle";  
  
    prefix bundle;  
  
    import openconfig-module-catalog { prefix cat; }  
  
    // meta  
    organization "OpenConfig working group";  
  
    contact  
        "OpenConfig working group  
        netopenconfig@googlegroups.com";  
  
    description  
        "This module can be used to build network features using  
        published YANG Models.";  
  
    revision "2015-10-18" {  
        description  
            "Initial Revision";  
        reference "TBD";  
    }  
  
    grouping bundle-information {  
  
        description  
            "Template defining the bundle";  
  
        leaf name {  
            type string;  
            description "Published name of bundle, for example:  
                l3vpn, l2vpn, internet-access";  
        }  
  
        leaf version {  
            type string;  
            description "bundle version number";  
        }  
    }  
}
```



```
    }

    leaf description {
        type string;
        description "User defined information about bundle";
    }

    leaf category {
        type string;
        description
            "Categorization of bundle such as:
             network, service, oam, experimental, other";
    }

    leaf subcategory {
        type string;
        description
            "Sub-Categorization of bundle such as:
             protocol, operational, other";
    }
} //bundle-template


grouping bundle-ingredients {

    description "Module ingredients used in bundle";

    container modules {

        description
            "Modules that comprise the bundle";

        list module {

            key "module-type";

            description
                "List of modules from yang-module-catalog comprising
                 the bundle";

            leaf module-type {
                type string;
                description
                    "A user-define type of the module";
            }

            leaf catalog-reference {
                type leafref {
```



```
        path "/cat:organizations"
          + "/cat:organization"
          + "/cat:modules"
          + "/cat:module"
          + "/cat:name";
      }
      description
        "Link to a module defined by a standards body";
    }

    leaf application-sequence {
      type uint8;
      description
        "Sequence number indicating order of application of
        module";
    }
  } //module-info
} //bundle-modules
} //bundle-ingredients

container bundle {

  description
    "Build the bundle";

  uses bundle-information;
  uses bundle-ingredients;

} //bundle
}
<CODE ENDS>
```

8. References

8.1. Normative references

- [RFC6020] Bjorklund, M., Ed., "YANG - A Data Modeling Language for the Network Configuration Protocol (NETCONF)", [RFC 6020](#), DOI 10.17487/RFC6020, October 2010, <<http://www.rfc-editor.org/info/rfc6020>>.
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8.2. Informative references

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