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Self Describing Data Object Tags
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Abstract

This document defines a method to tag data objects associated with operation and management data in YANG modules. This YANG data object tagging method can be used to classify data objects from different YANG modules and identify their characteristics data. It can also provide input, instruction, indication to selection filter, and filter queries of operational state on a server during a "pub/sub" service for YANG datastore updates. When the subscriptions of a particular subscriber to be fetched is very large, the amount of data to be streamed out to the destination can be reduced and only targeted to the characteristics data. These data object tags may be registered as well as assigned during the module definition, assigned by implementations, or dynamically defined and set by users.

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Table of Contents

1. Introduction

As described in [RFC8819], the use of tags for classification and organization is fairly ubiquitous not only within IETF protocols, but in the Internet itself (e.g., "#hashtags"). As a reminder, a module tag defined in [I.D-ietf-netmod-module-tags] is a string associated only with a module name at the module level.

At the time of writing this document (2020), there are many data models that have been specified or are being specified by various SDOs and the Open Source community. These models cover many of the networking protocols and techniques. However, data objects defined by these technology-specific data models might represent a portion of fault, configuration, accounting, performance, and security management categories information at different locations in various different ways. Let alone the lack consistent classification criteria and representation for a specific service, feature, or data source.

This document defines self-describing data object tags and associates them with data objects within a YANG module, which:

- Provide dictionary meaning for specific targeted data objects.
- Indicate relationship between data objects within the same YANG module or from different YANG modules.
- Identify key performance metric data objects and the absolute XPath expression identifying the element path to the node.

The self describing data object tags can be used by the NETCONF/ RESTCONF client to classify data objects from different YANG modules and identify characteristics data. In addition, it can provide input, instruction, indication to selection filter and filter queries of configuration or operational state on a server based on these data object tags, e.g., return specific object type of operational state

related to system-management. NETCONF clients can discover data objects with self describing data object tags supported by a NETCONF server by means of <get-schema> operation. The self describing data object tag capability can also be advertised using the capability notification model [I-D.netconf-notification-capabilities] by the NETCONF server or some place where offline document are kept. These

data object tags may be registered or assigned during the module definition, assigned by implementations, or dynamically defined and set by users.

This document defines a YANG module [RFC7950] which augments the module tag model and provides a list of data object entries to allow for adding or removing of self describing tags as well as viewing the set of self describing tags associated with specific data objects within YANG modules.

This document defines an extension statement to be used to indicate self describing tags that should be added by the module implementation automatically (i.e., outside of configuration).

This document also defines an IANA registry for tag prefixes as well as a set of globally assigned tags (Section 9).

Section 8 provides guidelines for authors of YANG data models.

The YANG data model in this document conforms to the Network Management Datastore Architecture defined in [RFC8342].

The meaning of the symbols can be found in [RFC8340].

2. Terminology

2.1. Requirements Notation

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119][RFC8174] when, and only when, they appear in all capitals, as shown here.

2.2. Glossary

OPM Object Property Metric

3. Self Describing Data Object Tags: Massive Data Object Collection Use Case

Among data object tags, the 'opm' (object, property, metric) tags can be used to tackle massive data objects collection and only capture YANG data objects associated with performance metrics data modelled with YANG (Figure 1).

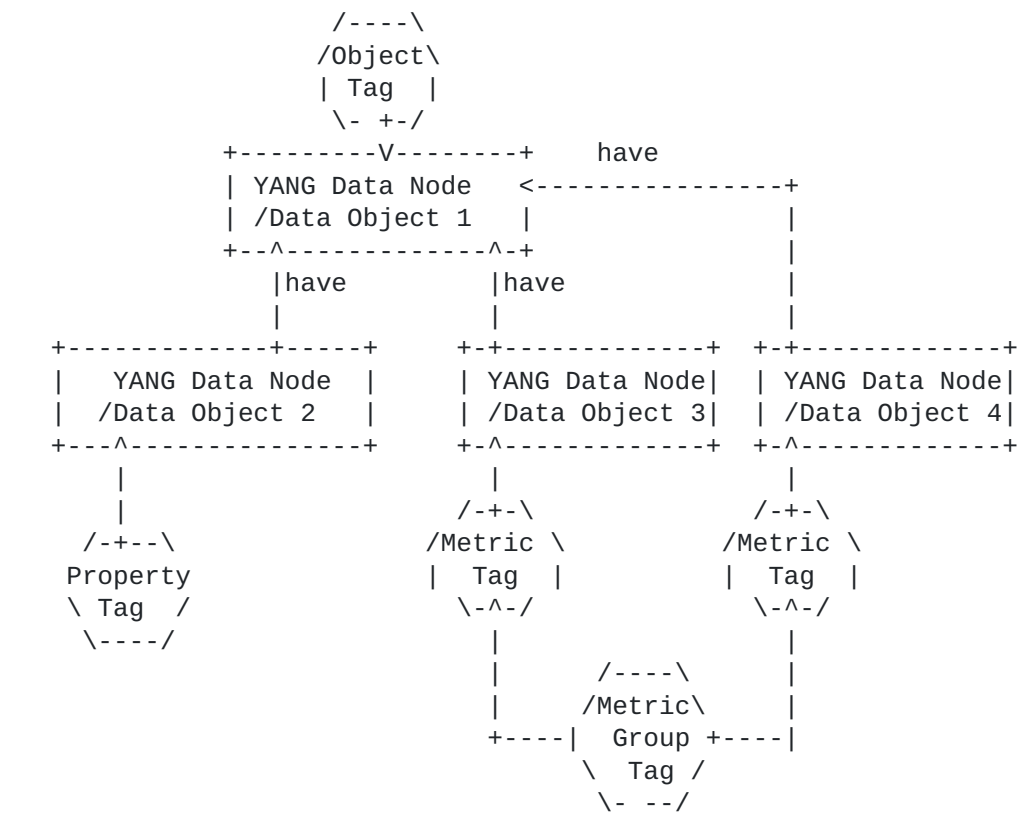

Figure 1: The Relation between Object, Property and Metric

In Figure 1, data objects can contain other data objects called subobjects. Both object and subobjects can be modeled as YANG data nodes [RFC7950]. Data objects that contain other data objects can be one of 'container', 'leaf-list', and 'list' and are tagged with object tag. A subobject tagged with the property tag is a 'leaf' node. Subobjects tagged with the metric tag can be one of 'container', 'leaf-list', 'list', or 'leaf' data node.

A data object contains one single object tag, one single property tag, or one single metric tag. A data object tagged with metric tag also can have one or multiple Metric Type tags and/or one single multi-source tag.

The use of 'opm' tags is meant to help filter discrete categories of YANG data objects scattered across the same or different YANG modules supported by a device and capture all network performance data or all property data in the single view of the data. In Figure 2, 'tunnel-svc' data object is a container node defined in the 'tunnel-pm' module and can be seen as the root object for property tagged subobjects (e.g., 'tunnel-svc'/'create-time') and metric tagged

subobjects (e.g., 'tunnel-svc'/'avg-latency'). The 'name', 'create-time', and 'modified-time' are property tagged subobjects under 'tunnel-svc' container. The 'avg-latency' and 'packet-loss' metrics are tagged subobjects under 'tunnel-svc' container node. Consider 'tunnel-svc' data object and tunnel-svc/name data object as an example, 'tunnel-svc' data object has one single object tag (i.e., 'ietf:object') while tunnel-svc/name data object has one property subobject tag (i.e., 'ietf:property'). In addition, not all metric subobjects need to be tagged, e.g., only specific category such as loss-related metric subobjects need to be tagged with metric-type tag which can further reduce amount data to be fetched.

Data Object	Object Tag	Property Tag	Metric Tag	Module Name
	ietf: object			
tunnel-svc				tunnel-pm
		ietf: property		
tunnel-svc/name				tunnel-pm
		ietf: property		
tunnel-svc/create-time				tunnel-pm
		ietf: property		
tunnel-svc/modified-time				tunnel-pm
tunnel-svc/avg-latency			ietf: metric	tunnel-pm
tunnel-svc/packet-loss			ietf: metric	tunnel-pm
tunnel-svc/min-latency			ietf: metric	tunnel-pm
tunnel-svc/ max-latency			ietf:	tunnel-

```
pm|
 |                       |                       metric
|
 +-----------------------+-------------------------------------------
+
```

Figure 2: Example of OPM Tags Used in the YANG Module

If data objects in YANG modules are suitably tagged and learnt by the client from a live server, the client can retrieve paths to all targeted data objects and then use an XPath query defined [RFC8639][RFC8641] to list all tagged data objects which reflect network characteristics.

4. Data Object Tag Values

All data object tags SHOULD begin with a prefix indicating who owns their definition. To that aim, an IANA registry (Section 9.1) is

used to support registering data object tag prefixes. Three prefixes are defined in the following subsections.

No further structure is imposed by this specification on the value following the registered prefix other than the value can contain any YANG type 'string' characters except carriage-returns, newlines, and tabs. Therefore, designers, implementers, and users are free to add or not any structure they may require to their own tag values.

4.1. IETF Tags Prefix

An IETF tag is a data object tag that has the prefix "ietf:".

All IETF data object tags are registered with IANA in a registry defined Section 9.2.

4.2. Vendor Tags Prefix

A vendor tag is a tag that has the prefix "vendor:".

These tags are defined by the vendor that implements the module, and are not registered. However, it is RECOMMENDED that the vendor includes extra identification in the tag to avoid collisions such as using the enterprise or organization name following the "vendor:" prefix (e.g., vendor:vendor-defined-classifier).

4.3. User Tags Prefix

A user tag is any tag that has the prefix "user:".

These tags are defined by the user/administrator and are not meant to be registered. Users are not required to use the "user:" prefix; however, doing so is RECOMMENDED as it helps avoid prefix collisions.

4.4. Reserved Tags Prefix

Any tag not starting with the prefix "ietf:", "vendor:" or "user:" is reserved for future use. These tag values are not invalid, but simply reserved in the context of specifications (e.g., RFCs).

5. Data Object Tag Management

Tags may be associated with a data object within a YANG module in a number of ways. Typically, tags may be defined and associated at the module design time, at implementation time without the need of live server, or via user administrative control. As the main consumer of data object tags are users, users may also remove any tag from a

live

server, no matter how the tag became associated with a data object within a YANG module.

5.1. Module Design Tagging

A data object definition MAY indicate a set of data object tags to be added by a module's implementer. These design time tags are indicated using a set of extension statements which include:

opm-tag extension statement: Classifies management and operation data into object, property subobject, and metric subobject categories. Both object and subobjects can be modeled as YANG data nodes [RFC7950]. Data objects that contain other data objects can be one of 'container', 'leaf-list', and 'list' and are tagged with object tag. A subobject tagged with the property tag is a 'leaf' node. Subobjects tagged with the metric tag can be one of 'container', 'leaf-list', 'list', or 'leaf' data node. A data object contains one single object tag, one single property tag, or one single metric tag. A data object tagged with metric tag also can have one or multiple Metric type tag and/or one single multi-source tag. See the examples depicted in Figure 2 and Figure 3.

metric-type extension statement: Provides metric data objects classification (e.g., loss, jitter, delay, counter, gauge, histogram, summary, unknown) within the YANG module.

multi-source-tag extension statement: Identifies multi-source aggregation type (e.g., aggregated, non-aggregated) related to metric subobject. 'aggregated' multi-source aggregation type allows a large number of measurements on metric subobjects from different sources of the same type (e.g., line card, each subinterface of aggregated Ethernet interface) being combined into aggregated statistics and report as one metric subobject. 'non-aggregated' multi-source aggregation type allows measurement from each source of the same type (e.g., line card, each subinterface of aggregated Ethernet interface) be reported separately.

Among these extension statements, the metric-type and multi-source-tag extension statements are context information that can be used to correlate data object from the different modules.

If the data node is defined in an IETF standards track document, the data object tags MUST be IETF Tags (Section 4.1). Thus, new data object can drive the addition of new IETF tags to the IANA registry defined in Section 9, and the IANA registry can serve as a check against duplication.

5.2. Implementation Tagging

An implementation MAY include additional tags associated with data object within a YANG module. These tags SHOULD be IETF Tags (i.e., registered) or vendor specific tags.

5.3. User Tagging

Data object tags of any kind, with or without a prefix, can be assigned and removed by the user from a live server using normal configuration mechanisms. In order to remove a data object tag from the operational datastore, the user adds a matching "masked-tag" entry for a given data object within the 'ietf-data-object-tags' module.

6. Data Object Tags Module Structure

6.1. Data Object Tags Module Tree

The tree associated with the "ietf-data-object-tags" module is as follows:

```
module: ietf-data-object-tags
  augment /tags:module-tags/tags:module:
    +--rw data-object-tags
       +--rw data-object* [object-name]
          +--rw object-name    nacm:node-instance-identifier
          +--rw tag*           tags:tag
          +--rw masked-tag*    tags:tag
```

7. YANG Module

```
<CODE BEGINS> file "ietf-data-object-tags@2021-05-03.yang"
module ietf-data-object-tags {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-data-object-tags";
  prefix ntags;

  import ietf-netconf-acm {
    prefix nacm;
  }
  import ietf-module-tags {
    prefix tags;
  }

  organization
    "IETF NetMod Working Group (NetMod)";
  contact
```

```
    "WG Web:  <https://tools.ietf.org/wg/netmod/>
     WG List: <mailto:netmod@ietf.org>
     Editor:  Qin Wu <mailto:bill.wu@huawei.com>
     Editor:  Benoit Claise <mailto:bclaise@cisco.com>
     Editor:  Peng Liu <mailto:liupengyjy@chinamobile.com>
     Editor:  Zongpeng Du <mailto:duzongpeng@chinamobile.com>
     Editor:  Mohamed Boucadair <mailto:mohamed.boucadair@orange.com>";
  description
    "This module describes a mechanism associating self-describing
     tags with YANG data object within YANG modules. Tags may be IANA
     assigned or privately defined.

     Copyright (c) 2021 IETF Trust and the persons identified as
     authors of the code. All rights reserved.

     Redistribution and use in source and binary forms, with or
     without modification, is permitted pursuant to, and subject to
     the license terms contained in, the Simplified BSD License set
     forth in Section 4.c of the IETF Trust's Legal Provisions
     Relating to IETF Documents
     (https://trustee.ietf.org/license-info).

     This version of this YANG module is part of RFC XXXX
     (https://tools.ietf.org/html/rfcXXXX); see the RFC itself for
     full legal notices.";

  revision 2021-05-03 {
    description
      "Initial revision.";
    reference
      "RFC XXXX: Self Describing Data Object Tags";
  }

  extension opm-tag {
    argument tag;
    description
      "The argument 'tag' is of type 'tag'. This extension statement
       is used by module authors to indicate the opm tags that should
       be added automatically by the system. Opm Tag is used to
       classify operation and management data object into object,
       property, and metric three categories. Data Object can contain
       other data objects called subobjects. Both object and subobjects
       can be modeled as data nodes. The Data Object tagged with object
       tag can be one of container, leaf-list and list. Data Object
       tagged with the Property tag is a leaf node. Data Object tagged
with
       the Metric tag can be one of container, leaf-list, list, leaf.
       Data objects tagged with either property tag or metric tag are
       subobjects belonging to specific root data object.  Data Object
```

```
       contains One object tag or one property tag, or one metric tag.
As
       such the origin of the value for the pre-defined tags should be
set
       to 'system'.";
  }

  extension metric-type {
    argument tag;
    description
      "The argument 'tag' is of type 'tag'. The metric type can be
       used to provide metric data object classification
       (e.g., loss, jitter, packet loss,counter, gauge, histogram,
       summary, unknown) within the YANG module.";
  }

  extension multi-source-tag {
    argument tag;
    description
      "The argument 'tag' is of type 'tag'. The multi-source-tag can be
       used to identify  multi-source aggregation type (e.g.,
aggregated,
       non-aggregated) related to metric subobject.

      'aggregated' multi-source aggregation type allows a large number
of
      measurements on metric subobjects from different sources of the
same
      type (e.g., line card, each subinterface of aggregated Ethernet
interface)
      being combined into aggregated statistics and report as one
metric subobject
      value. 'non-aggregated' multi-source aggregation type allows
measurement from
      each source of the same type (e.g., line card, each subinterface
of aggregated
      Ethernet interface) be reported separately.";
   }

  augment "/tags:module-tags/tags:module" {
    description
      "Augment the Module Tags module with data object tag attributes";
    container data-object-tags {
      description
        "Contains the list of data objects and their associated data
object tags";
      list data-object {
        key "object-name";
        description
          "A list of data objects and their associated data object
tags";
        leaf object-name {
```

```
          type nacm:node-instance-identifier;
          mandatory true;
          description
            "The YANG data object name.";
        }
        leaf-list tag {
          type tags:tag;
```

```
          description
            "Tags associated with the data object within the YANG
module. See
             the IANA 'YANG Data Object Tag Prefixes' registry for
reserved
             prefixes and the IANA 'IETF YANG Data Object Tags'
registry for
             IETF tags.

             The 'operational' state view of this list is
             constructed using the following steps:

             1) System tags (i.e., tags of 'system' origin) are added.
             2) User configured tags (i.e., tags of 'intended' origin)
             are added.
             3) Any tag that is equal to a masked-tag is removed.";
        }
        leaf-list masked-tag {
          type tags:tag;
          description
            "The list of tags that should not be associated with the
data
             object within the YANG module. The user can remove (mask)
tags from the
             operational state datastore by adding them to
             this list. It is not an error to add tags to this list
             that are not associated with the data object within YANG
module,
             but they have no operational effect.";
        }
      }
    }
  }
}
<CODE ENDS>
```

8. Guidelines to Model Writers

This section updates [RFC8407].

8.1. Define Standard Tags

A module MAY indicate, using data object tag extension statements, a set of data object tags that are to be automatically associated with data object within the module (i.e., not added through configuration).

```
    module example-module-A {
           //...
           import ietf-data-node-tags { prefix ntags; }
           container top {
             ntags:opm-tag "ietf:object";
            list X {
              leaf foo {
              ntags:opm-tag "ietf:property";
               }
             }
           container Y {
             leaf bar {
             ntags:opm-tag "ietf:metric";
             }
         }
       }
     // ...
    }
```

Figure 3: Data object tag example

The module writer can use existing standard data object tags, or use new data object tags defined in the data object definition, as appropriate. For IETF standardized modules, new data object tags MUST be assigned in the IANA registry defined below, see Section Section 9.2.

9. IANA Considerations

9.1. YANG Data Object Tag Prefixes Registry

This document requests IANA to create a new registry entitled "YANG Data Object Tag Prefixes" grouped under a new "Protocol" category named "YANG Data Object Tag Prefixes".

This registry allocates tag prefixes. All YANG Data Object Tags should begin with one of the prefixes in this registry.

Prefix entries in this registry should be short strings consisting of lowercase ASCII alpha-numeric characters and a final ":" character.

The allocation policy for this registry is Specification Required [RFC8126]. The Reference and Assignee values should be sufficient to identify and contact the organization that has been allocated the prefix.

The initial values for this registry are as follows:

Prefix	Description	Reference	Assignee
ietf:	IETF Tags allocated in the IANA IETF YANG Data Object Tags registry	[This document]	IETF
vendor:	Non-registered tags allocated by the module's implementer.	[This document]	IETF
user:	Non-registered tags allocated by and for the user.	[This document]	IETF

Other standards organizations (SDOs) wishing to allocate their own set of tags should allocate a prefix from this registry.

9.2. IETF YANG Data Object Tags Registry

This document requests IANA to create three new registries "IETF OPM Tags","IETF Metric Type Tags","IETF Multiple Source Tags" grouped under a new "Protocol" category. These 3 registries should be included below "YANG Data Object Tag Prefixes" when listed on the same page.

Three registries are used to allocate tags that have the registered prefix "ietf:". New values should be well considered and not achievable through a combination of already existing IETF tags.

The allocation policy for these three registries is IETF Review [RFC8126].

The initial values for these three registries are as follows:

OPM Tag	Description	Reference

ietf:object	Represents Root object containing other data objects (e.g., interfaces)	[This document]
ietf:property	Represents a property data object(e.g., ifindex) associated with a specific root object (e.g., interfaces)	[This document]

ietf:metric	Represent metric data object(e.g., ifstatistics) associated with specific root object(e.g., interfaces)	[This document]

Metric Type Tag	Description	Reference
ietf:delay	Represents the delay metric group to which the metric data objects belong to.	[This document]
ietf:jitter	Represents the jitter metric group to which the metric data objects belong to.	[This document]
ietf:loss	Represents the loss metric group to which the metric data objects belong to.	[This document]
ietf:counter	Represents any metric value associated with a metric data object that monotonically increases over time, starting from zero.	[This document]

	ietf:gauge	Represents current measurements associated with a metric data object that may increase, decrease or stay constant.	[This document]
	ietf:histogram	Represents the frequency of value observations associated with a metric data object that falls into specific predefined range.	[This document]
	ietf:histogram	Represents the metric value associated with a metric data object that measures distributions of discrete events without knowing predefined range.	[This document]
	ietf:unknown	Represents the metric value associated with metric	[This document]

| | |data object that can not | |
| | |determine the type of metric. | |

Multiple Source Tag	Description	Reference
ietf:agg	Relates to multiple sources [This aggregation type (i.e., aggregated statistics)	document]
ietf:non-agg	Relates to multiple sources [This aggregation type (i.e., non-aggregated statistics)	document]

Each YANG data object can have one 'opm' tag, zero or one metric-type tag, zero or one multi-source tag.

9.3. Updates to the IETF XML Registry

This document requests IANA to register a new URI in the "IETF XML Registry" [RFC3688]. Following the format in [RFC3688], the following registration has been made:

URI: urn:ietf:params:xml:ns:yang:ietf-data-object-tags
Registrant Contact: The IESG.
XML: N/A; the requested URI is an XML namespace.

9.4. Updates to the YANG Module Names Registry

This document requests IANA to register one YANG module in the "YANG Module Names" registry [RFC6020]. Following the format in [RFC6020], the following registration has been made:

name: ietf-data-object-tags

```
      namespace: urn:ietf:params:xml:ns:yang:ietf-data-object-tags
      prefix: ntags
      reference: RFC XXXX
      maintained by IANA: N
```

10. Security Considerations

The YANG module specified in this document defines schema for data that is designed to be accessed via network management protocols such as NETCONF [RFC6241] or RESTCONF [RFC8040]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer

is HTTPS, and the mandatory-to-implement secure transport is TLS [RFC8446].

The Network Configuration Access Control Model (NACM) [RFC8341] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

This document adds the ability to associate data object tag meta-data with data object within the YANG modules. This document does not define any actions based on these associations, and none are yet defined, and therefore it does not by itself introduce any new security considerations.

Users of the data object tag meta-data may define various actions to be taken based on the data object tag meta-data. These actions and their definitions are outside the scope of this document. Users will need to consider the security implications of any actions they choose to define.

11. Acknowledgements

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13. References

13.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

[RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688, DOI 10.17487/RFC3688, January 2004, <https://www.rfc-editor.org/info/rfc3688>.

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

[RFC7950] Bjorklund, M., Ed., "The YANG 1.1 Data Modeling Language", RFC 7950, DOI 10.17487/RFC7950, August 2016, <https://www.rfc-editor.org/info/rfc7950>.

[RFC8040] Bierman, A., Bjorklund, M., and K. Watsen, "RESTCONF Protocol", RFC 8040, DOI 10.17487/RFC8040, January 2017, <https://www.rfc-editor.org/info/rfc8040>.

[RFC8126] Cotton, M., Leiba, B., and T. Narten, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 8126, DOI 10.17487/RFC8126, June 2017, <https://www.rfc-editor.org/info/rfc8126>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <https://www.rfc-editor.org/info/rfc8174>.

[RFC8341] Bierman, A. and M. Bjorklund, "Network Configuration Access Control Model", STD 91, RFC 8341, DOI 10.17487/RFC8341, March 2018, <https://www.rfc-editor.org/info/rfc8341>.

[RFC8407] Bierman, A., "Guidelines for Authors and Reviewers of Documents Containing YANG Data Models", BCP 216, RFC 8407, DOI 10.17487/RFC8407, October 2018, <https://www.rfc-editor.org/info/rfc8407>.

[RFC8446] Rescorla, E., "The Transport Layer Security (TLS) Protocol Version 1.3", RFC 8446, DOI 10.17487/RFC8446, August 2018, <https://www.rfc-editor.org/info/rfc8446>.

[RFC8819] Hopps, C., Berger, L., and D. Bogdanovic, "YANG Module Tags", RFC 8819, DOI 10.17487/RFC8819, January 2021, <https://www.rfc-editor.org/info/rfc8819>.

13.2. Informative References

[RFC6241] Enns, R., Ed., Bjorklund, M., Ed., Schoenwaelder, J., Ed., and A. Bierman, Ed., "Network Configuration Protocol (NETCONF)", RFC 6241, DOI 10.17487/RFC6241, June 2011, <https://www.rfc-editor.org/info/rfc6241>.

[RFC6242] Wasserman, M., "Using the NETCONF Protocol over Secure Shell (SSH)", RFC 6242, DOI 10.17487/RFC6242, June 2011, <https://www.rfc-editor.org/info/rfc6242>.

[RFC8340] Bjorklund, M. and L. Berger, Ed., "YANG Tree Diagrams", BCP 215, RFC 8340, DOI 10.17487/RFC8340, March 2018, <https://www.rfc-editor.org/info/rfc8340>.

[RFC8342] Bjorklund, M., Schoenwaelder, J., Shafer, P., Watsen, K., and R. Wilton, "Network Management Datastore Architecture (NMDA)", RFC 8342, DOI 10.17487/RFC8342, March 2018, <https://www.rfc-editor.org/info/rfc8342>.

[RFC8639] Voit, E., Clemm, A., Gonzalez Prieto, A., Nilsen-Nygaard, E., and A. Tripathy, "Subscription to YANG Notifications", RFC 8639, DOI 10.17487/RFC8639, September 2019, <https://www.rfc-editor.org/info/rfc8639>.

[RFC8641] Clemm, A. and E. Voit, "Subscription to YANG Notifications for Datastore Updates", RFC 8641, DOI 10.17487/RFC8641, September 2019, <https://www.rfc-editor.org/info/rfc8641>.

Appendix A. NETCONF Example

The following is a NETCONF example result from a query of the data object tags list. For the sake of brevity only a few module and associated data object results are provided.

```
<ns0:data xmlns:ns0="urn:ietf:params:xml:ns:netconf:base:1.0">
  <t:module-tags xmlns:t="urn:ietf:params:xml:ns:yang:ietf-module-
tags">
    <t:module>
       <t:name>ietf-interfaces</t:name>
       <s:data-object-tags xmlns:s="urn:ietf:params:xml:ns:yang:ietf-
data-object-tags">
        <s:data-object>
         <s:object-name>/if:interfaces/if:interface</s:object-name>
         <s:tag>ietf:object</s:tag>
        </s:data-object>
       <s:data-object>
        <s:object-name>/if:interfaces/if:interface/if:last-change</
s:object-name>
        <s:tag>ietf:property</s:tag>
       </s:data-object>
        <s:data-object>
         <s:object-name>
          /if:interfaces/if:interface/if:statistics/if:in-errors
         </s:object-name>
         <s:tag>ietf:metric</s:tag>
        </s:data-object>
      </s:data-object-tags>
    </t:module>
    <t:module>
       <t:name>ietf-ip</t:name>
       <s:data-object-tags xmlns:s="urn:ietf:params:xml:ns:yang:ietf-
data-object-tags">
       <s:data-object>
         <s:object-name>/if:interfaces/if:interface/ip:ipv4</s:object-
name>
         <s:tag>ietf:object</s:tag>
       </s:data-object>
       <s:data-object>
         <s:object-name>/if:interfaces/if:interface/ip:ipv4/ip:enable</
s:object-name>
         <s:tag>ietf:property</s:tag>
       </s:data-object>
        <s:data-object>
        <s:object-name>/if:interfaces/if:interface/ip:ipv4/ip:mtu</
s:object-name>
        <s:tag>ietf:metric</s:tag>
       </s:data-object>
      </s:data-object-tags>
    </t:module>
  </t:module-tags>
</ns0:data>
```

Appendix B. Non-NMDA State Module

As per [RFC8407] the following is a non-NMDA module to support viewing the operational state for non-NMDA compliant servers.

```
<CODE BEGINS> file "ietf-data-object-tags-state@2021-05-03.yang"
module ietf-data-object-tags-state {
```

```
yang-version 1.1;
namespace "urn:ietf:params:xml:ns:yang:ietf-data-object-tags-state";
prefix ntags-s;

import ietf-netconf-acm {
  prefix nacm;
}
import ietf-module-tags {
  prefix tags;
}
organization
  "IETF NetMod Working Group (NetMod)";
contact
  "WG Web:  <https://tools.ietf.org/wg/netmod/>
   WG List: <mailto:netmod@ietf.org>
   Editor:  Qin Wu <mailto:bill.wu@huawei.com>
   Editor:  Benoit Claise <mailto:bclaise@cisco.com>
   Editor:  Peng Liu <mailto:liupengyjy@chinamobile.com>
   Editor:  Zongpeng Du <mailto:duzongpeng@chinamobile.com>
   Editor:  Mohamed Boucadair <mailto:mohamed.boucadair@orange.com>";
description
  "This module describes a mechanism associating self-describing
   tags with YANG data object within YANG modules. Tags may be IANA
   assigned or privately defined.

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   authors of the code. All rights reserved.

   Redistribution and use in source and binary forms, with or
   without modification, is permitted pursuant to, and subject to
   the license terms contained in, the Simplified BSD License set
   forth in Section 4.c of the IETF Trust's Legal Provisions
   Relating to IETF Documents
   (https://trustee.ietf.org/license-info).

   This version of this YANG module is part of RFC XXXX
   (https://tools.ietf.org/html/rfcXXXX); see the RFC itself for
   full legal notices.";

revision 2021-05-03 {
  description
    "Initial revision.";
  reference
    "RFC XXXX: Self Describing Data Object Tags";
}

extension opm-tag {
  argument tag;
```

```
    description
      "The argument 'tag' is of type 'tag'. This extension statement
       is used by module authors to indicate the opm tags that should
be
       added automatically by the system. Opm Tag is used to classify
       operation and management data into object, property subobject,
and metric
       subobject three categories. Object can contain other objects
called subobjects.
       Property and metric objects are both subobjects belonging to
specific object.
       Both object and subobjects can be modeled as data nodes. Object
can be one of
       container, leaf-list and list. Property subobject is a leaf
node. Metric subobject
       can be one of container, leaf-list, list, leaf. Object contains
zero or many
       property subobjects, zero or many metric subobjects. As such the
origin of the value
       for the pre-defined tags should be set to 'system'.";
  }
  extension metric-type {
    argument tag;
    description
      "The argument 'tag' is of type 'tag'.The metric-type can be
       used to provide metric subobject classification
       (e.g., loss, jitter, packet loss, guage, counter, histogram,
unknow, etc.)
       within the YANG module.";
  }
  extension multi-source-tag {
    argument tag;
    description
      "The argument 'tag' is of type 'tag'.The multi-source-tag can be
       used to identify  multi-source aggregation type (e.g.,
aggregated,
       non-aggregated) related to metric subobject.

      'aggregated' multi-source aggregation type allows a large number
of
      measurements on metric subobjects from different sources of the
same
      type (e.g., line card, each subinterface of aggregated Ethernet
interface)
      being combined into aggregated statistics and report as one
metric subobject
      value. 'non-aggregated' multi-source aggregation type allows
measurement from
      each source of the same type (e.g., line card, each subinterface
of aggregated
      Ethernet interface) be reported separately.";
   }
```

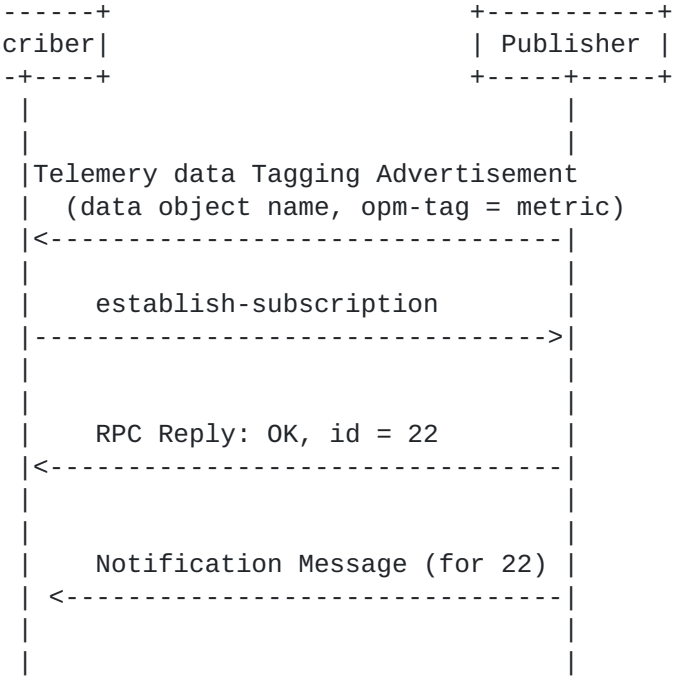
```
  augment "/tags:module-tags/tags:module" {
    description
      "Augment the Module Tags module with data object tag
attributes.";
    container data-object-tags {
      config false;
      status deprecated;
      description
        "Contains the list of data objects and their associated self
describing tags.";
      list data-object {
        key "object-name";
        status deprecated;
```

```
        description
          "A list of data objects and their associated self describing
tags.";
        leaf object-name {
          type nacm:node-instance-identifier;
          mandatory true;
          status deprecated;
          description
            "The YANG data object name.";
        }
        leaf-list tag {
          type tags:tag;
          status deprecated;
          description
            "Tags associated with the data object within the YANG
module. See
             the IANA 'YANG Data Object Tag Prefixes' registry for
reserved
             prefixes and the IANA 'IETF YANG Data Object Tags'
registry for
             IETF tags.

             The 'operational' state view of this list is
             constructed using the following steps:

             1) System tags (i.e., tags of 'system' origin) are added.
             2) User configured tags (i.e., tags of 'intended' origin)
             are added.
             3) Any tag that is equal to a masked-tag is removed.";
        }
        leaf-list masked-tag {
          type tags:tag;
          status deprecated;
          description
            "The list of tags that should not be associated with the
data
             object within the YANG module. The user can remove (mask)
tags from the
             operational state datastore by adding them to
             this list. It is not an error to add tags to this list
             that are not associated with the data object within YANG
module,
             but they have no operational effect.";
        }
      }
    }
  }
}
<CODE ENDS>
```

Appendix C. Targeted data object collection example

The following provides targeted data object collection example which helps reduce amount of data to be fetched. The subscription "id"

values of 22 used below is just an example. In production, the actual values of "id" might not be small integers.



The publisher advertises telemetry data object capability to the subscriber to instruct the receiver to subscribe tagged data object (e.g., performance metric data object) using standard subscribed notification mechanism [RFC8639].

The following XML example [W3C.REC-xml-20081126] illustrates the advertisment of the list of available target objects using YANG instance file format [I-D.ietf-netmod-yang-instance-file-format]:

```
<?xml version="1.0" encoding="UTF-8"?>
<instance-data-set xmlns=\
    "urn:ietf:params:xml:ns:yang:ietf-yang-instance-data">
  <name>acme-router-notification-capabilities</name>
  <content-schema>
    <module>ietf-system-capabilities@2020-03-23</module>
    <module>ietf-notification-capabilities@2020-03-23</module>
    <module>ietf-data-export-capabilities@2020-03-23</module>
  </content-schema>
  <!-- revision date, contact, etc. -->
  <description>Defines the notification capabilities of an acme-router.
    The router only has running, and operational datastores.
    Every change can be reported on-change from running, but
    only config=true nodes and some config=false data from operational.
    Statistics are not reported based on timer based trigger and
counter
    threshold based trigger.
  </description>
  <content-data>
    <system-capabilities \
      xmlns="urn:ietf:params:xml:ns:yang:ietf-system-capabilities" \
      xmlns:inc=\
        "urn:ietf:params:xml:ns:yang:ietf-notification-capabilities" \
      xmlns:ds="urn:ietf:params:xml:ns:yang:ietf-datastores">
      <datastore-capabilities>
        <datastore>ds:operational</datastore>
        <per-node-capabilities>
          <node-selector>\
              /if:interfaces/if:interface/if:statistics/if:in-errors\
          </node-selector>
          <sec:self-describing-capabilities>
            <sec:opm-tag>metric</sec:opm-tag>
            <sec:metric-type>loss</sec:metric-type>
          </sec:self-describing-capabilities>
        </per-node-capabilities>
      </datastore-capabilities>
    </system-capabilities>
  </content-data>
</instance-data-set>
```

With telemetry data tagging information carried in the Telemetry data
Tagging Advertisement, the subscriber identifies targeted data object
and associated data path to the datastore node and sends a standard
establish-subscription RPC [RFC8639] to subscribe tagged data objects
that are interests to the client application from the publisher.

```
 <netconf:rpc message-id="101"
     xmlns:netconf="urn:ietf:params:xml:ns:netconf:base:1.0">
   <establish-subscription
       xmlns="urn:ietf:params:xml:ns:yang:ietf-subscribed-
notifications"
       xmlns:yp="urn:ietf:params:xml:ns:yang:ietf-yang-push">
     <yp:datastore
          xmlns:ds="urn:ietf:params:xml:ns:yang:ietf-datastores">
       ds:operational
     </yp:datastore>
     <yp:datastore-xpath-filter
         xmlns:ex="https://example.com/sample-data/1.0">
       /if:interfaces/if:interface/if:statistics/if:in-errors
     </yp:datastore-xpath-filter>
     <yp:periodic>
       <yp:period>500</yp:period>
     </yp:periodic>
   </establish-subscription>
 </netconf:rpc>
```

The publisher returns specific object type of operational state (e.g., in-errors statistics data) subscribed by the client.

Appendix D. Changes between Revisions

v02 - v03

- Additional Editorial changes.
- Security section enhancement.
- Nits fixed.

v01 - v02

- Clarify the relation between data object, object tag, property tag and metric tag in figure 1 and figure 2 and related description;
- Change Metric Group into Metric Type in the YANG model;
- Add 5 metric types in section 7.2;

v00 - v01

- Merge self describing data object tag use case section into introduction section as a subsection;
- Add one glossary section;

- Clarify the relation between data object, object tag, property tag and metric tag in Self Describing Data Object Tags Use Case section;

- Add update to RFC8407 in the front page.

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