                     Sub-interface VLAN YANG Data Models
                   draft-ietf-netmod-sub-intf-vlan-model-00

Abstract

   This document defines YANG modules to add support for classifying
   traffic received on interfaces as Ethernet/VLAN framed packets to
   sub-interfaces based on the fields available in the Ethernet/VLAN
   frame headers. These modules allow IETF forwarding protocols (such
   as IPv6 and VPLS) to interoperate with VLAN tagged traffic orginated
   from an IEEE 802.1Q compliant bridge. Primarily the classification
   is based on VLAN identifiers in the 802.1Q VLAN tags, but the model
   also has support for matching on some other layer 2 frame header
   fields and is designed to be extensible to match on other arbitrary
   header fields.

   The model differs from an IEEE 802.1Q bridge model in that the
   configuration is interface/sub-interface based as opposed to being
   based on membership of an 802.1Q VLAN bridge.

Status of This Memo

   This Internet-Draft is submitted in full conformance with the
   provisions of BCP 78 and BCP 79.

   Internet-Drafts are working documents of the Internet Engineering
   Task Force (IETF). Note that other groups may also distribute
   working documents as Internet-Drafts. The list of current Internet-
   Drafts is at http://datatracker.ietf.org/drafts/current/.

   Internet-Drafts are draft documents valid for a maximum of six months
   and may be updated, replaced, or obsoleted by other documents at any
   time. It is inappropriate to use Internet-Drafts as reference
   material or to cite them other than as "work in progress."

   This Internet-Draft will expire on July 24, 2017.

Copyright Notice

Table of Contents

1. Introduction

   This document defines two YANG [RFC6020] modules that augment the
   encapsulation choice YANG element defined in Interface Extensions
   YANG [I-D.ietf-netmod-intf-ext-yang] and the generic interfaces data
   model defined in [RFC7223]. The two modules provide configuration
   nodes to support classification of Ethernet/VLAN traffic to sub-
   interfaces, that can have interface based feature and service
   configuration applied to them.

   The purpose of these models is to allow IETF defined forwarding
   protocols, such as IPv6 [RFC2460], Ethernet Pseudo Wires [RFC4448]
   and VPLS [RFC4761] [RFC4762] to be configurable via YANG when
   interoperating with VLAN tagged traffic received from an IEEE 802.1Q
   compliant bridge.

   In the case of layer 2 Ethernet services, the flexible encapsulation
   module also supports flexible rewriting of the VLAN tags contained
   the in frame header.

   For reference, a comparison between the sub-interface based YANG
   model documented in this draft and an IEEE 802.1Q bridge model is
   described in Appendix A.

   In summary, the YANG modules defined in this internet draft are:

      if-l3-vlan.yang - Defines the model for basic classification of
      VLAN tagged traffic to L3 transport services

      flexible-encapsulation.yang - Defines the model for flexible
      classification of Ethernet/VLAN traffic to L2 transport services

1.1. Terminology

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
   document are to be interpreted as described in RFC 2119 [RFC2119].

   Sub-interface: A sub-interface is a small augmentation of a regular
   interface in the standard YANG module for Interface Management that
   represents a subset of the traffic handled by its parent interface.
   As such, it supports both configuration and operational data using
   any other YANG models that augment or reference interfaces in the
   normal way. It is defined in Interface Extensions YANG
   [I-D.ietf-netmod-intf-ext-yang].

1.2. **Tree Diagrams**

   A simplified graphical representation of the data model is used in
   this document. The meaning of the symbols in these diagrams is as
   follows:

   o Brackets "[" and "]" enclose list keys.

   o Abbreviations before data node names: "rw" means configuration
      (read-write), and "ro" means state data (read-only).

   o Symbols after data node names: "?" means an optional node, "!"
      means a presence container, and "*" denotes a list or leaf-list.

   o Parentheses enclose choice and case nodes, and case nodes are also
      marked with a colon (":").

   o Ellipsis ("...") stands for contents of subtrees that are not
      shown.

2. **Objectives**

   The primary aim of the YANG modules contained in this draft is to
   provide the core model that is required to implement VLAN transport
   services on router based devices that is fully compatible with IEEE
   802.1Q complaint bridges.

   A secondary aim is for the modules to be structured in such a way
   that they can be cleanly extended in future.

2.1. **Interoperability with IEEE 802.1Q compliant bridges**

   The modules defined in this document are designed to fully
   interoperate with IEEE 802.1Q compliant bridges. In particular, the
   models are restricted to only matching, adding, or rewriting the
   802.1Q VLAN tags in frames in ways that are compatible with IEEE
   802.1Q compliant bridges.

2.2. **Extensibility**

   The modules are structured in such a way that they can be sensibly
   extended. In particular:

      The tag stack is represented as a list to allow a tag stack of
      more than two tags to be supported if necessary in future.

      The tag stack list elements allow other models, or vendors, to
      include additional forms of tag matching and rewriting. The

intention, however, is that it should not be necessary to have any
vendor specific extensions to any of the YANG models defined in
this document to implement standard Ethernet and VLAN services.

3. **L3 Interface VLAN Model**

The L3 Interface VLAN model provides appropriate leaves for
termination of an 802.1Q VLAN tagged segment to a sub-interface based
L3 service. It allows for termination of traffic with up to two
802.1Q VLAN tags.

The "if-l3-vlan" YANG module has the following structure:

```
augment /if:interfaces/if:interface/if-cmn:encapsulation/
  if-cmn:encaps-type:
   +--:(vlan)
      +--rw vlan
         +--rw tags
            +--rw tag* [index]
               +--rw index        uint8
               +--rw dot1q-tag
                  +--rw tag-type    dot1q-tag-type
                  +--rw vlan-id     dot1q-vlan-id
```

4. **Flexible Encapsulation Model**

The Flexible Encapsulation model is designed to allow for the
flexible provisioning of layer 2 services. It provides the
capability to classify Ethernet/VLAN frames received on an Ethernet
trunk interface to sub-interfaces based on the fields available in
the layer 2 headers. Once classified to sub-interfaces, it provides
the capability to selectively modify fields within the layer 2
headers before the frame is handed off to the appropriate forwarding
code for further handling.

The model supports a common core set of layer 2 header matches based
on the 802.1Q tag type and VLAN Ids contained within the header up to
a tag stack depth of two tags.

The model supports flexible rewrites of the layer 2 frame header for
data frames as they are processed on the interface. It defines a set
of standard tag manipulations that allow for the insertion, removal,
or rewrite of one or two 802.1Q VLAN tags. The expectation is that
manipulations are generally implemented in a symmetrical fashion,
i.e. if a manipulation is performed on ingress traffic on an
interface then the reverse manipulation is always performed on egress

traffic out of the same interface. However, the model also allows
for asymmetrical rewrites, which may be required to implement some
forwarding models (such as E-Tree).

The structure of the model is currently limited to matching or
rewriting a maximum of two 802.1Q tags in the frame header but has
been designed to be easily extensible to matching/rewriting three or
more VLAN tags in future, if required.

The final aim for the model design is for it to be cleanly extensible
to add in additional match and rewrite criteria of the layer 2
header, such as matching on the source or destination MAC address,
PCP or DEI fields in the 802.1Q tags, or the EtherType of the frame
payload. Rewrites can also be extended to allow for modification of
other fields within the layer 2 frame header.

The "flexible-encapsulation" YANG module has the following structure:

```
augment /if:interfaces/if:interface/if-cmn:encapsulation/
  if-cmn:encaps-type:
   +--:(flexible) {flexible-encapsulation-rewrites}?
      +--rw flexible
         +--rw match
         |  +--rw (match-type)
         |     +--:(default)
         |     |  +--rw default?          empty
         |     +--:(untagged)
         |     |  +--rw untagged?         empty
         |     +--:(priority-tagged)
         |     |  +--rw priority-tagged
         |     |     +--rw tag-type?    dot1q:dot1q-tag-type
         |     +--:(vlan-tagged)
         |        +--rw vlan-tagged
         |           +--rw tag* [index]
         |           |  +--rw index          uint8
         |           |  +--rw dot1q-tag
         |           |     +--rw tag-type    dot1q-tag-type
         |           |     +--rw vlan-id     union
         |           +--rw match-exact-tags?   empty
         +--rw rewrite {flexible-rewrites}?
            +--rw (direction)?
               +--:(symmetrical)
               |  +--rw symmetrical
               |     +--rw tag-rewrite {tag-rewrites}?
               |        +--rw pop-tags?     uint8
               |        +--rw push-tags* [index]
               |           +--rw index          uint8
```

```
                   |            +--rw dot1q-tag
                   |                +--rw tag-type    dot1q-tag-type
                   |                +--rw vlan-id     dot1q-vlan-id
                   +--:(asymmetrical) {asymmetric-rewrites}?
                      +--rw ingress
                      |  +--rw tag-rewrite {tag-rewrites}?
                      |     +--rw pop-tags?    uint8
                      |     +--rw push-tags* [index]
                      |         +--rw index        uint8
                      |         +--rw dot1q-tag
                      |             +--rw tag-type    dot1q-tag-type
                      |             +--rw vlan-id     dot1q-vlan-id
                      +--rw egress
                         +--rw tag-rewrite {tag-rewrites}?
                            +--rw pop-tags?    uint8
                            +--rw push-tags* [index]
                                +--rw index        uint8
                                +--rw dot1q-tag
                                    +--rw tag-type    dot1q-tag-type
                                    +--rw vlan-id     dot1q-vlan-id
   augment /if:interfaces/if:interface:
     +--rw flexible-encapsulation
        +--rw local-traffic-default-encaps
           +--rw tag* [index]
              +--rw index        uint8
              +--rw dot1q-tag
                 +--rw tag-type    dot1q-tag-type
                 +--rw vlan-id     dot1q-vlan-id
```

5. L3 Interface VLAN YANG Module

This YANG module augments the encapsultion container defined in
Interface Extensions YANG [I-D.ietf-netmod-intf-ext-yang].


```
<CODE BEGINS> file "ietf-if-l3-vlan@2016-10-21.yang"
module ietf-if-l3-vlan {
  namespace "urn:ietf:params:xml:ns:yang:ietf-if-l3-vlan";
  prefix if-l3-vlan;

  import ietf-interfaces {
    prefix if;
  }

  import iana-if-type {
    prefix ianaift;
  }
```

```
import ieee802-dot1q-types {
  prefix dot1q-types;
}

import ietf-interfaces-common {
  prefix if-cmn;
}

organization
  "IETF NETMOD (NETCONF Data Modeling Language) Working Group";

contact
  "WG Web:   <http://tools.ietf.org/wg/netmod/>
   WG List:  <mailto:netmod@ietf.org>

   WG Chair: Lou Berger
             <mailto:lberger@labn.net>

   WG Chair: Kent Watsen
             <mailto:kwatsen@juniper.net>

   Editor:   Robert Wilton
             <mailto:rwilton@cisco.com>";

description
  "This YANG module models L3 VLAN sub-interfaces";

revision 2016-10-21 {
  description "Latest draft revision";

  reference "Internet-Draft draft-wilton-netmod-intf-vlan-yang-04";
}

feature l3-vlan-sub-interfaces {
  description
    "This feature indicates that the device supports L3 VLAN
     sub-interfaces";
}

/*
 * Add support for the 802.1Q VLAN encapsulation syntax on layer 3
 * terminated VLAN sub-interfaces.
 */
augment "/if:interfaces/if:interface/if-cmn:encapsulation/" +
        "if-cmn:encaps-type" {
  when "../if:type = 'ianaift:l2vlan' and
        ../if-cmn:transport-layer = 'layer-3'" {
    description "Applies only to VLAN sub-interfaces that are
```

```
                        operating at layer 3";
      }
      if-feature l3-vlan-sub-interfaces;
      description "Augment the generic interface encapsulation with an
                    encapsulation for layer 3 VLAN sub-interfaces";

      /*
       * Matches a VLAN, or pair of VLAN Ids to classify traffic
       * into an L3 service.
       */
      case vlan {
        container vlan {
          description
          "Match VLAN tagged frames with specific VLAN Ids";
          container tags {
            description "Matches frames tagged with specific VLAN Ids";
            list tag {
              must 'index != 0 or ' +
                   'count(../tag/index) != 2 or ' +
                   'dot1q-tag/tag-type = "s-vlan"' {
                error-message
                  "When matching two tags, the outer tag must be of
                   S-VLAN tag type";
                description
                  "For IEEE 802.1Q interoperability, when matching two
                   tags, it is required that the outer tag is an
                   S-VLAN, and the inner tag is a C-VLAN";
              }

              must 'index != 1 or ' +
                   'count(../tag/index) != 2 or ' +
                   'dot1q-tag/tag-type = "c-vlan"' {
                error-message
                  "When matching two tags, the inner tag must be of
                   C-VLAN tag type";
                description
                  "For IEEE 802.1Q interoperability, when matching two
                   tags, it is required that the outer tag is an
                   S-VLAN, and the inner tag is a C-VLAN";
              }

              key "index";
              min-elements 1;
              max-elements 2;

              description "The tags to match, with the outermost tag to
                          match with index 0";
              leaf index {
```

```
                 type uint8 {
                   range "0..1";
                 }

                 /*
                  * Only allow matching on an inner tag (at index 1), if
                  * also matching on the outer tag at the same time.
                  */
                 must ". = 0 or
                       count(../../tag[index = 0]/index) > 0" {
                   error-message
                     "An inner tag can only be matched on when also
                      matching on an outer tag";
                   description
                     "Only allow matching on an inner tag, if also
                      matching on the outer tag at the same time";
                 }

                 description
                   "The index into the tag stack, outermost tag first";
               }

               uses dot1q-types:dot1q-tag-classifier;
             }
           }
         }
       }
     }
     <CODE ENDS>
```

6. Flexible Encapsulation YANG Module

This YANG module augments the encapsultion container defined in
Interface Extensions YANG [I-D.ietf-netmod-intf-ext-yang].

This YANG module also augments the interface container defined in
[RFC7223].

```
<CODE BEGINS> file "ietf-flexible-encapsulation@2016-10-21.yang"
module ietf-flexible-encapsulation {
  namespace
    "urn:ietf:params:xml:ns:yang:ietf-flexible-encapsulation";

  prefix flex;
```

```
  import ietf-interfaces {
    prefix if;
  }

  import ietf-interfaces-common {
    prefix if-cmn;
  }

  import ieee802-dot1q-types {
    prefix dot1q-types;
  }

  organization
    "IETF NETMOD (NETCONF Data Modeling Language) Working Group";

  contact
    "WG Web:   <http://tools.ietf.org/wg/netmod/>
     WG List:  <mailto:netmod@ietf.org>

     WG Chair: Lou Berger
               <mailto:lberger@labn.net>

     WG Chair: Kent Watsen
               <mailto:kwatsen@juniper.net>

     Editor:   Robert Wilton
               <mailto:rwilton@cisco.com>";

  description
    "This YANG module describes interface configuration for flexible
     VLAN matches and rewrites.";

  revision 2016-10-21 {
    description "Latest draft revision";

    reference
      "Internet-Draft draft-wilton-netmod-intf-vlan-yang-04";
  }

  feature flexible-encapsulation-rewrites {
    description
      "This feature indicates whether the network element supports
       flexible Ethernet encapsulation that allows for matching VLAN
       ranges and performing independent tag manipulations";
  }

  feature flexible-rewrites {
    description
```

```
      "This feature indicates whether the network element supports
        specifying flexible rewrite operations";
    }

    feature asymmetric-rewrites {
      description
        "This feature indicates whether the network element supports
         specifying different rewrite operations for the ingress
         rewrite operation and egress rewrite operation.";
    }

    feature tag-rewrites {
      description
        "This feature indicates whether the network element supports
         the flexible rewrite functionality specifying flexible tag
         rewrites";
    }

    /*
     * flexible-match grouping.
     *
     * This grouping represents a flexible match.
     *
     * The rules for a flexible match are:
     *     1. default, untagged, priority tag, or a stack of tags.
     *    - Each tag in the stack of tags matches:
     *        1. tag type (802.1Q or 802.1ad) +
     *        2. tag value:
     *           i. single tag
     *           ii. set of tag ranges/values.
     *           iii. "any" keyword
     */
    grouping flexible-match {
      description "Flexible match";
      choice match-type {
        mandatory true;
        description "Provides a choice of how the frames may be
                     matched";

        case default {
          description "Default match";
          leaf default {
            type empty;
            description
              "Default match.  Matches all traffic not matched to any
               other peer sub-interface by a more specific
               encapsulation.";
          } // leaf default
```

```
            } // case default

            case untagged {
              description "Match untagged Ethernet frames only";
              leaf untagged {
                type empty;
                description
                  "Untagged match.  Matches all untagged traffic.";
              } // leaf untagged
            } // case untagged

            case priority-tagged {
              description "Match priority tagged Ethernet frames only";

              container priority-tagged {
                description "Priority tag match";
                leaf tag-type {
                  type dot1q-types:dot1q-tag-type;
                  description "The 802.1Q tag type of matched priority
                               tagged packets";
                }
              }
            }

            case vlan-tagged {
              container vlan-tagged {
                description "Matches VLAN tagged frames";
                list tag {
                  must 'index != 0 or ' +
                       'count(../tag/index) != 2 or ' +
                       'dot1q-tag/tag-type = "s-vlan"' {
                    error-message
                      "When matching two tags, the outer tag must be of
                       S-VLAN tag type";
                    description
                      "For IEEE 802.1Q interoperability, when matching two
                       tags, it is required that the outer tag is an
                       S-VLAN, and the inner tag is a C-VLAN";
                  }

                  must 'index != 1 or ' +
                       'count(../tag/index) != 2 or ' +
                       'dot1q-tag/tag-type = "c-vlan"' {
                    error-message
                      "When matching two tags, the inner tag must be of
                       C-VLAN tag type";
                    description
                      "For IEEE 802.1Q interoperability, when matching two
```

```
                    tags, it is required that the outer tag is an
                    S-VLAN, and the inner tag is a C-VLAN";
              }

              key "index";
              min-elements 1;
              max-elements 2;
              description "The tags to match, with the outermost tag to
                         match assigned index 0";
              leaf index {
                type uint8 {
                  range "0..1";
                }

                must ". = 0 or
                      count(../../tag[index = 0]/index) > 0" {
                  error-message "An inner tag can only be matched on
                                  when also matching on an outer tag";
                  description "Only allow matching on an inner tag, if
                              also matching on the outer tags at the
                              same time";
                }
                description
                  "The index into the tag stack, outermost tag first";
              }

              uses dot1q-types:dot1q-tag-ranges-or-any-classifier;
            }

          leaf match-exact-tags {
            type empty;
            description
              "If set, indicates that all 802.1Q VLAN tags in the
               Ethernet frame header must be explicitly matched, i.e.
               the EtherType following the matched tags must not be a
               802.1Q tag EtherType.  If unset then extra 802.1Q VLAN
               tags are allowed.";
          }
        }
      }
    } // encaps-type
  }

  /*
   * Grouping for tag-rewrite that can be expressed either
   * symmetrically, or in the ingress and/or egress directions
   * independently.
   */
```

```
  grouping tag-rewrite {
    description "Flexible rewrite";
    leaf pop-tags {
      type uint8 {
        range 1..2;
      }
      description "The number of tags to pop (or translate if used in
                   conjunction with push-tags)";
    }

    list push-tags {
      must 'index != 0 or ' +
           'count(../push-tags/index) != 2 or ' +
           'dot1q-tag/tag-type = "s-vlan"' {
        error-message
          "When pushing two tags, the outer tag must be of
           S-VLAN tag type";
        description
          "For IEEE 802.1Q interoperability, when pushing two
           tags, it is required that the outer tag is an
           S-VLAN, and the inner tag is a C-VLAN";
      }

      must 'index != 1 or ' +
           'count(../push-tags/index) != 2 or ' +
           'dot1q-tag/tag-type = "c-vlan"' {
        error-message
          "When pushing two tags, the inner tag must be of
           C-VLAN tag type";
        description
          "For IEEE 802.1Q interoperability, when pushing two
           tags, it is required that the outer tag is an
           S-VLAN, and the inner tag is a C-VLAN";
      }

      key "index";
      max-elements 2;
      description "The number of tags to push (or translate if used
                   in conjunction with pop-tags)";
      /*
       * Server should order by increasing index.
       */
      leaf index {
        type uint8 {
          range 0..1;
        }

        /*
```

```
               * Only allow a push of an inner tag if an outer tag is also
               * being pushed.
               */
              must ". != 0 or
                    count(../../push-tags[index = 0]/index) > 0" {
                error-message "An inner tag can only be pushed if an outer
                              tag is also specified";
                description "Only allow a push of an inner tag if an outer
                            tag is also being pushed";
              }

              description "The index into the tag stack";
            }

            uses dot1q-types:dot1q-tag-classifier;
          }
        }

      /*
       * Grouping for all flexible rewrites of fields in the L2 header.
       *
       * This currently only includes flexible tag rewrites, but is
       * designed to be extensible to cover rewrites of other fields in
       * the L2 header if required.
       */
      grouping flexible-rewrite {
        description "Flexible rewrite";

        /*
         * Tag rewrite.
         *
         * All tag rewrites are formed using a combination of pop-tags
         * and push-tags operations.
         */
        container tag-rewrite {
          if-feature tag-rewrites;
          description "Tag rewrite.  Translate operations are expressed
                      as a combination of tag push and pop operations.";
          uses tag-rewrite;
        }
      }
      augment "/if:interfaces/if:interface/if-cmn:encapsulation/" +
            "if-cmn:encaps-type" {
        when "../if:type = 'if-cmn:ethSubInterface' and
              ../if-cmn:transport-layer = 'layer-2'" {
          description "Applies only to Ethernet sub-interfaces that are
                      operating at transport layer 2";
        }
```

```
          description
            "Add flexible match and rewrite for VLAN sub-interfaces";

          /*
           * A flexible encapsulation allows for the matching of ranges and
           * sets of VLAN Ids.  The structure is also designed to be
           * extended to allow for matching/rewriting other fields within
           * the L2 frame header if required.
           */
          case flexible {
            if-feature flexible-encapsulation-rewrites;
            description "Flexible encapsulation and rewrite";
            container flexible {
              description "Flexible encapsulation and rewrite";

              container match {
                description
                  "The match used to classify frames to this interface";
                uses flexible-match;
              }

              container rewrite {
                if-feature flexible-rewrites;
                description "L2 frame rewrite operations";
                choice direction {
                  description "Whether the rewrite policy is symmetrical or
                               asymmetrical";
                  case symmetrical {
                    container symmetrical {
                      uses flexible-rewrite;
                      description
                        "Symmetrical rewrite.  Expressed in the ingress
                         direction, but the reverse operation is applied
                         to egress traffic";
                    }
                  }

                  /*
                   * Allow asymmetrical rewrites to be specified.
                   */
                  case asymmetrical {
                    if-feature asymmetric-rewrites;
                    description "Asymmetrical rewrite";
                    container ingress {
                      uses flexible-rewrite;
                      description "Ingress rewrite";
                    }
                    container egress {
```

```
                uses flexible-rewrite;
                description "Egress rewrite";
              }
            }
          }
        }
      }
    }
  }

augment "/if:interfaces/if:interface" {
  when "if:type = 'if-cmn:ethSubInterface' and
        if-cmn:transport-layer = 'layer-2'" {
    description "Any L2 Ethernet sub-interfaces";
  }
  description "Add flexible encapsulation configuration for VLAN
              sub-interfaces";

  /*
   * All flexible encapsulation specific interface configuration
   * (except for the actual encapsulation and rewrite) is contained
   * by a flexible-encapsulation container on the interface.
   */
  container flexible-encapsulation {
    description
      "All per interface flexible encapsulation related fields";

    /*
     * For encapsulations that match a range of VLANs (or Any),
     * allow configuration to specify the default VLAN tag values
     * to use for any traffic that is locally sourced from an
     * interface on the device.
     */
    container local-traffic-default-encaps {
      description "The VLAN tags to use by default for locally
                   sourced traffic";
      list tag {
        key "index";
        max-elements 2;

        description
          "The VLAN tags to use by locally sourced traffic";

        leaf index {
          type uint8 {
            range "0..1";
          }
```

```
                    /*
                     * Only allow an inner tag to be specified if an outer
                     * tag has also been specified.
                     */
                    must ". = 0 or
                          count(../../tag[index = 0]/index) > 0" {
                      error-message "An inner tag can only be specified if an
                                       outer tag has also been specified";
                      description "Ensure that an inner tag cannot be
                                     specified without an outer tag'";
                    }

                    description "The index into the tag stack, outermost tag
                                  assigned index 0";
                  }

                  uses dot1q-types:dot1q-tag-classifier;
                }
              }
            }
          }
        }
        <CODE ENDS>
```

7. Acknowledgements

   The authors would particularly like to thank John Messenger, Glenn
   Parsons, and Dan Romascanu for their help progressing this draft.

   The authors would also like to thank Eric Gray, Marc Holness, Neil
   Ketley, William Lupton, John Messenger, Glenn Parsons, Ludwig
   Pauwels, and members of the IEEE 802.1 WG for their helpful feedback
   on this draft.

8. ChangeLog

8.1. Version -04

   o IEEE 802.1 specific types have been removed from the draft. These
      are now referenced from the 802.1Qcp draft YANG modules.

   o Fixed errors in the xpath expressions.

8.2. **Version -03**

   o Incorporates feedback received from presenting to the IEEE 802.1
      WG.

   o Updates the modules for double tag matches/rewrites to restrict
      the outer tag type to S-VLAN and inner tag type to C-VLAN.

   o Updates the introduction to indicate primary use case is for IETF
      forwarding protocols.

   o Updates the objectives to make IEEE 802.1Q bridge interoperability
      a key objective.

9. **IANA Considerations**

   This document defines several new YANG module and the authors
   politely request that IANA assigns unique names to the YANG module
   files contained within this draft, and also appropriate URIs in the
   "IETF XML Registry".

10. **Security Considerations**

   The YANG module defined in this memo is designed to be accessed via
   the NETCONF protocol RFC 6241 [RFC6241]. The lowest NETCONF layer is
   the secure transport layer and the mandatory to implement secure
   transport is SSH RFC 6242 [RFC6242]. The NETCONF access control
   model RFC 6536 [RFC6536] provides the means to restrict access for
   particular NETCONF users to a pre-configured subset of all available
   NETCONF protocol operations and content.

   There are a number of data nodes defined in this YANG module which
   are writable/creatable/deletable (i.e. config true, which is the
   default). These data nodes may be considered sensitive or vulnerable
   in some network environments. Write operations (e.g. edit-config) to
   these data nodes without proper protection can have a negative effect
   on network operations. These are the subtrees and data nodes and
   their sensitivity/vulnerability:

10.1. **if-l3-vlan.yang**

   The nodes in the if-l3-vlan YANG module are concerned with matching
   particular frames received on the network device to connect them to a
   layer 3 forwarding instance, and as such adding/modifying/deleting
   these nodes has a high risk of causing traffic to be lost because it
   is not being classified correctly, or is being classified to a
   separate sub-interface. The nodes, all under the subtree

/interfaces/interface/encapsulation/vlan, that are sensitive to this
are:

o tags

o tags/index

o tags/index/tag-type

o tags/index/vlan-id

10.2. flexible-encapsulation.yang

There are many nodes in the flexible-encapsulation YANG module that
are concerned with matching particular frames received on the network
device, and as such adding/modifying/deleting these nodes has a high
risk of causing traffic to be lost because it is not being classified
correctly, or is being classified to a separate sub-interface. The
nodes, all under the subtree
/interfaces/interface/encapsulation/flexible/match, that are
sensitive to this are:

o default

o untagged

o priority-tagged

o priority-tagged/tag-type

o vlan-tagged

o vlan-tagged/index

o vlan-tagged/index/dot1q-tag/vlan-type

o vlan-tagged/index/dot1q-tag/vlan-id

o vlan-tagged/match-exact-tags

There are also many modes in the flexible-encapsulation YANG module
that are concerned with rewriting the fields in the L2 header for
particular frames received on the network device, and as such
adding/modifying/deleting these nodes has a high risk of causing
traffic to be dropped or incorrectly processed on peer network
devices, or it could cause layer 2 tunnels to go down due to a
mismatch in negotiated MTU. The nodes, all under the subtree

/interfaces/interface/encapsulation/flexible/rewrite, that are
sensitive to this are:

o symmetrical/tag-rewrite/pop-tags

o symmetrical/tag-rewrite/push-tags

o symmetrical/tag-rewrite/push-tags/index

o symmetrical/tag-rewrite/push-tags/dot1q-tag/tag-type

o symmetrical/tag-rewrite/push-tags/dot1q-tag/vlan-id

o asymmetrical/ingress/tag-rewrite/pop-tags

o asymmetrical/ingress/tag-rewrite/push-tags

o asymmetrical/ingress/tag-rewrite/push-tags/index

o asymmetrical/ingress/tag-rewrite/push-tags/dot1q-tag/tag-type

o asymmetrical/ingress/tag-rewrite/push-tags/dot1q-tag/vlan-id

o asymmetrical/egress/tag-rewrite/pop-tags

o asymmetrical/egress/tag-rewrite/push-tags

o asymmetrical/egress/tag-rewrite/push-tags/index

o asymmetrical/egress/tag-rewrite/push-tags/dot1q-tag/tag-type

o asymmetrical/egress/tag-rewrite/push-tags/dot1q-tag/vlan-id

Nodes in the flexible-encapsulation YANG module that are concerned
with the VLAN tags to use for traffic sourced from the network
element could cause protocol sessions (such as CFM) to fail if they
are added, modified or deleted. The nodes, all under the subtree
/interfaces/interface/flexible-encapsulation/local-traffic-default-
encaps that are sensitive to this are:

o tag

o tag/index

o tag/dot1q-tag/tag-type

o tag/dot1q-tag/vlan-id

11. References

11.1. Normative References

[I-D.ietf-netmod-intf-ext-yang]
          Wilton, R., Ball, D., tsingh@juniper.net, t., and S.
          Sivaraj, "Common Interface Extension YANG Data Models",
          draft-ietf-netmod-intf-ext-yang-03 (work in progress),
          October 2016.

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

[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>.

[RFC7223] Bjorklund, M., "A YANG Data Model for Interface
          Management", RFC 7223, DOI 10.17487/RFC7223, May 2014,
          <http://www.rfc-editor.org/info/rfc7223>.

[RFC7224] Bjorklund, M., "IANA Interface Type YANG Module",
          RFC 7224, DOI 10.17487/RFC7224, May 2014,
          <http://www.rfc-editor.org/info/rfc7224>.

11.2. Informative References

[dot1Qcp] Holness, M., "802.1Qcp Bridges and Bridged Networks -
          Amendment: YANG Data Model", 2016.

[RFC2460] Deering, S. and R. Hinden, "Internet Protocol, Version 6
          (IPv6) Specification", RFC 2460, DOI 10.17487/RFC2460,
          December 1998, <http://www.rfc-editor.org/info/rfc2460>.

[RFC4448] Martini, L., Ed., Rosen, E., El-Aawar, N., and G. Heron,
          "Encapsulation Methods for Transport of Ethernet over MPLS
          Networks", RFC 4448, DOI 10.17487/RFC4448, April 2006,
          <http://www.rfc-editor.org/info/rfc4448>.

[RFC4761] Kompella, K., Ed. and Y. Rekhter, Ed., "Virtual Private
          LAN Service (VPLS) Using BGP for Auto-Discovery and
          Signaling", RFC 4761, DOI 10.17487/RFC4761, January 2007,
          <http://www.rfc-editor.org/info/rfc4761>.

   [RFC4762] Lasserre, M., Ed. and V. Kompella, Ed., "Virtual Private
              LAN Service (VPLS) Using Label Distribution Protocol (LDP)
              Signaling", RFC 4762, DOI 10.17487/RFC4762, January 2007,
              <http://www.rfc-editor.org/info/rfc4762>.

   [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,
              <http://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,
              <http://www.rfc-editor.org/info/rfc6242>.

   [RFC6536] Bierman, A. and M. Bjorklund, "Network Configuration
              Protocol (NETCONF) Access Control Model", RFC 6536,
              DOI 10.17487/RFC6536, March 2012,
              <http://www.rfc-editor.org/info/rfc6536>.

Appendix A. Comparison with the IEEE 802.1Q Configuration Model

   In addition to the sub-interface based YANG model proposed here, the
   IEEE 802.1Q working group is also developing a YANG model for the
   configuration of 802.1Q VLANs. This raises the valid question as to
   whether the models overlap and whether it is necessary or beneficial
   to have two different models for superficially similar constructs.
   This section aims to answer that question by summarizing and
   comparing the two models.

A.1. Sub-interface based configuration model overview

   The key features of the sub-interface based configuration model can
   be summarized as:

   o The model is primarily designed to enable layer 2 and layer 3
      services on Ethernet interfaces that can be defined in a very
      flexible way to meet the varied requirements of service providers.

   o Traffic is classified from an Ethernet-like interface to sub-
      interfaces based on fields in the layer 2 header. This is often
      based on VLAN Ids contained in the frame, but the model is
      extensible to other arbitrary fields in the frame header.

   o Sub-interfaces are just a type of if:interface and hence support
      any feature configuration YANG models that can be applied
      generally to interfaces. For example, QoS or ACL models that
      reference if:interface can be applied to the sub-interfaces, or

      the sub-interface can be used as an Access Circuit in L2VPN or
      L3VPN models that reference if:interface.

   o In the sub-interface based configuration model, the classification
      of traffic arriving on an interface to a given sub-interface,
      based on fields in the layer 2 header, is completely independent
      of how the traffic is forwarded. The sub-interface can be
      referenced (via references to if:interface) by other models that
      specify how traffic is forwarded; thus sub-interfaces can support
      multiple different forwarding paradigms, including but not limited
      to: layer 3 (IPv4/IPv6), layer 2 pseudowires (over MPLS or IP),
      VPLS instances, EVPN instance.

   o The model is flexible in the scope of the VLAN Identifier space.
      I.e. by default VLAN Ids can be scoped locally to a single
      Ethernet-like trunk interface, but the scope is determined by the
      forwarding paradigm that is used.

A.2. IEEE 802.1Q Bridge Configuration Model Overview

   The key features of the IEEE 802.1Q bridge configuration model can be
   summarized as:

   o Each VLAN bridge component has a set of Ethernet interfaces that
      are members of that bridge. Sub-interfaces are not used, nor
      required in the 802.1Q bridge model.

   o Within a VLAN bridge component, the VLAN tag in the packet is
      used, along with the destination MAC address, to determine how to
      forward the packet. Other forwarding paradigms are not supported
      by the 802.1Q model.

   o Classification of traffic to a VLAN bridge component is based only
      on the Ethernet interface that it arrived on.

   o VLAN Identifiers are scoped to a VLAN bridge component. Often
      devices only support a single bridge component and hence VLANs are
      scoped globally within the device.

   o Feature configuration is specified in the context of the bridge,
      or particular VLANs on a bridge.

A.3. Possible Overlap Between the Two Models

   Both models can be used for configuring similar basic layer 2
   forwarding topologies. The 802.1Q bridge configuration model is
   optimised for configuring Virtual LANs that span across enterprises
   and data centers.

The sub-interface model can also be used for configuring equivalent
Virtual LAN networks that span across enterprises and data centers,
but often requires more configuration to be able to configure the
equivalent constructs to the 802.1Q bridge model.

The sub-interface model really excels when implementing flexible L2
and L3 services, where those services may be handled on the same
physical interface, and where the VLAN Identifier is being solely
used to identify the customer or service that is being provided
rather than a Virtual LAN. The sub-interface model provides more
flexibility as to how traffic can be classified, how features can be
applied to traffic streams, and how the traffic is to be forwarded.

Conversely, the 802.1Q bridge model can also be use to implement L2
services in some scenarios, but only if the forwarding paradigm being
used to implement the service is the native Ethernet forwarding
specified in 802.1Q - other forwarding paradigms such as pseudowires
or VPLS are not supported. The 802.1Q bridge model does not
implement L3 services at all, although this can be partly mitigated
by using a virtual L3 interface construct that is a separate logical
Ethernet-like interface which is a member of the bridge.

In conclusion, it is valid for both of these models to exist since
they have different deployment scenarios for which they are
optimized. Devices may choose which of the models (or both) to
implement depending on what functionality the device is being
designed for.

Authors' Addresses

   Robert Wilton (editor)
   Cisco Systems

   Email: rwilton@cisco.com

   David Ball
   Cisco Systems

   Email: daviball@cisco.com

   Tapraj Singh
   Cisco Systems

   Email: tapsingh@cisco.com

Selvakumar Sivaraj
Juniper Networks

Email: ssivaraj@juniper.net