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Sub-interface VLAN YANG Data Models
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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 configuration of Layer 3 and Layer 2 sub-interfaces (e.g. attachment circuits) that can interoperate with IETF based forwarding protocols; such as IP and L3VPN services; or L2VPN services like VPWS, VPLS, and EVPN. The sub-interfaces also interoperate with VLAN tagged traffic orginating 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.

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This Internet-Draft will expire on September 14, 2017.

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1. Introduction

This document defines two YANG [RFC7950] 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:

- Brackets "[" and "]" enclose list keys.
- Abbreviations before data node names: "rw" means configuration (read-write), and "ro" means state data (read-only).
- Symbols after data node names: "?" means an optional node, "!" means a presence container, and "*" denotes a list or leaf-list.
- Parentheses enclose choice and case nodes, and case nodes are also marked with a colon (":").
- 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:

```
module: ietf-if-l3-vlan
  augment /if:interfaces/if:interface/if-cmn:encapsulation/
                                                  if-cmn:encaps-type:
    +--:(vlan)
       +--rw vlan
          +--rw tag* [index]
             +--rw index        uint8
             +--rw dot1q-tag
                +--rw tag-type    dot1q-tag-type
                +--rw vlan-id     ieee:vlanid
```

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:

```
module: ietf-flexible-encapsulation
  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-types: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-tag* [index]
```

```
                  |           +--rw index        uint8
                  |           +--rw dot1q-tag
                  |              +--rw tag-type    dot1q-tag-type
                  |              +--rw vlan-id     ieee:vlanid
                  +--:(asymmetrical) {asymmetric-rewrites}?
                     +--rw ingress
                     |  +--rw tag-rewrite {tag-rewrites}?
                     |     +--rw pop-tags?   uint8
                     |     +--rw push-tag* [index]
                     |        +--rw index        uint8
                     |        +--rw dot1q-tag
                     |           +--rw tag-type    dot1q-tag-type
                     |           +--rw vlan-id     ieee:vlanid
                     +--rw egress
                        +--rw tag-rewrite {tag-rewrites}?
                           +--rw pop-tags?   uint8
                           +--rw push-tag* [index]
                              +--rw index        uint8
                              +--rw dot1q-tag
                                 +--rw tag-type    dot1q-tag-type
                                 +--rw vlan-id     ieee:vlanid
  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     ieee:vlanid
```

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@2017-03-13.yang"
module ietf-if-l3-vlan {
  yang-version 1.1;

  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 2017-03-13 {
       description "Latest draft revision";

       reference
         "Internet-Draft draft-ietf-netmod-sub-intf-vlan-model-01";
     }

     /*
      * 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
             derived-from-or-self(../if-cmn:forwarding-mode,
                                  'if-cmn:network-layer')" {
         description
```

```
          "Applies only to VLAN sub-interfaces that are operating at
           layer 3";
        }
        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";
            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-grouping;
          }
        }
      }
    }
  }
  <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@2017-03-13.yang"
module ietf-flexible-encapsulation {
  yang-version 1.1;

  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 2017-03-13 {
    description "Latest draft revision";

    reference
      "Internet-Draft draft-ietf-netmod-sub-intf-vlan-model-01";
  }

  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-grouping';
              }

              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-tag {
          must 'index != 0 or ' +
               'count(../push-tag/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-tag/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-tag[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;
      }
    }

    /*
     * 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
            derived-from-or-self(../if-cmn:forwarding-mode,
                                 'if-cmn:layer-2-forwarding')" {
        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
              derived-from-or-self(if-cmn:forwarding-mode,
                                   'if-cmn:layer-2-forwarding')" {
          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-grouping;
          }
        }
      }
    }
  }
  <CODE ENDS>
```

7. Acknowledgements

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8. ChangeLog

8.1. WG version -01

- Tweaked the abstract.
- Removed unnecessary feature for the L3 sub-interface module.
- Update the 802.1Qcp type references.

- Remove extra tag container for L3 sub-interfaces YANG.

8.2. Version -04

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

- Fixed errors in the xpath expressions.

8.3. Version -03

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

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

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

- 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:

- tag
- tag/index
- tag/index/tag-type
- tag/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:

- default
- untagged
- priority-tagged
- priority-tagged/tag-type
- vlan-tagged
- vlan-tagged/index
- vlan-tagged/index/dot1q-tag/vlan-type
- vlan-tagged/index/dot1q-tag/vlan-id
- 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:

- symmetrical/tag-rewrite/pop-tags
- symmetrical/tag-rewrite/push-tag
- symmetrical/tag-rewrite/push-tag/index
- symmetrical/tag-rewrite/push-tag/dot1q-tag/tag-type
- symmetrical/tag-rewrite/push-tag/dot1q-tag/vlan-id
- asymmetrical/ingress/tag-rewrite/pop-tags
- asymmetrical/ingress/tag-rewrite/push-tag
- asymmetrical/ingress/tag-rewrite/push-tag/index
- asymmetrical/ingress/tag-rewrite/push-tag/dot1q-tag/tag-type
- asymmetrical/ingress/tag-rewrite/push-tag/dot1q-tag/vlan-id
- asymmetrical/egress/tag-rewrite/pop-tags
- asymmetrical/egress/tag-rewrite/push-tag
- asymmetrical/egress/tag-rewrite/push-tag/index
- asymmetrical/egress/tag-rewrite/push-tag/dot1q-tag/tag-type
- asymmetrical/egress/tag-rewrite/push-tag/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:

- tag

- tag/index
- tag/dot1q-tag/tag-type
- tag/dot1q-tag/vlan-id

11. References

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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:

- 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.

- 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.

- 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.

- 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.

- 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:

- 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.

- 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.

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

- 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.

- 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.

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