

Network Working Group
Internet-Draft
Obsoletes: [rfc7223](#) (if approved)
Intended status: Standards Track
Expires: February 22, 2018

M. Bjorklund
Tail-f Systems
August 21, 2017

A YANG Data Model for Interface Management
draft-bjorklund-netmod-rfc7223bis-00

Abstract

This document defines a YANG data model for the management of network interfaces. It is expected that interface-type-specific data models augment the generic interfaces data model defined in this document. The data model includes definitions for configuration and system state (status information and counters for the collection of statistics). This document obsoletes [RFC 7223](#).

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 February 22, 2018.

Copyright Notice

Copyright (c) 2017 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to [BCP 78](#) and the IETF Trust's Legal Provisions Relating to IETF Documents (<http://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in [Section 4.e](#) of

the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

Table of Contents

1.	Introduction	2
1.1.	Summary of Changes from RFC 7223	3
1.2.	Terminology	3
1.3.	Tree Diagrams	4
2.	Objectives	4
3.	Interfaces Data Model	5
3.1.	The Interface List	6
3.2.	Interface References	8
3.3.	Interface Layering	8
4.	Relationship to the IF-MIB	9
5.	Interfaces YANG Module	10
6.	IANA Considerations	34
7.	Security Considerations	35
8.	Acknowledgments	35
9.	References	35
9.1.	Normative References	35
9.2.	Informative References	36
Appendix A.	Example: Ethernet Interface Module	36
Appendix B.	Example: Ethernet Bonding Interface Module	38
Appendix C.	Example: VLAN Interface Module	39
Appendix D.	Example: NETCONF <get-config> Reply	40
Appendix E.	Example: NETCONF <get-data> Reply	41
Appendix F.	Examples: Interface Naming Schemes	43
F.1.	Router with Restricted Interface Names	43
F.2.	Router with Arbitrary Interface Names	44
F.3.	Ethernet Switch with Restricted Interface Names	45
F.4.	Generic Host with Restricted Interface Names	45
F.5.	Generic Host with Arbitrary Interface Names	46
	Author's Address	47

[1.](#) Introduction

This document defines a YANG [[RFC7950](#)] data model for the management of network interfaces. It is expected that interface-type-specific data models augment the generic interfaces data model defined in this document.

Network interfaces are central to the management of many Internet

protocols. Thus, it is important to establish a common data model for how interfaces are identified, configured, and monitored.

The data model includes configuration data and state data (status information and counters for the collection of statistics).

This version of the interfaces data model supports the Network Management Datastore Architecture (NMDA) [[I-D.ietf-netmod-revised-datastores](#)].

[1.1.](#) Summary of Changes from [RFC 7223](#)

The `"/interfaces-state"` subtree with `"config false"` data nodes is deprecated. All `"config false"` data nodes are now present in the `"/interfaces"` subtree.

Servers that do not implement NMDA, or that wish to support clients that do not implement NMDA, MAY implement the deprecated `"/interfaces-state"` tree.

[1.2.](#) Terminology

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](#)].

The following terms are used within this document:

- o **system-controlled interface:** An interface is said to be system-controlled if the system creates and deletes the interface independently of what has been explicitly configured. Examples are interfaces representing physical hardware that appear and disappear when hardware (e.g., a line card or hot-pluggable wireless interface) is added or removed. System-controlled interfaces may also appear if a certain functionality is enabled (e.g., a loopback interface might appear if the IP protocol stack is enabled).
- o **user-controlled interface:** An interface is said to be user-controlled if the creation of the interface is controlled by adding explicit interface configuration to the running

configuration datastore and the removal of the interface is controlled by removing explicit interface configuration from the running configuration datastore. Examples are VLAN interfaces configured on a system-controlled Ethernet interface.

The following terms are defined in [[I-D.ietf-netmod-revised-datastores](#)] and are not redefined here:

- o client
- o server

- o configuration
- o system state
- o operational state datastore
- o running configuration datastore
- o startup configuration datastore

The following terms are defined in [[RFC7950](#)] and are not redefined here:

- o augment
- o data model
- o data node
- o presence container

[1.3.](#) 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 either a list or a 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

This section describes some of the design objectives for the model presented in [Section 5](#).

- o It is recognized that existing implementations will have to map the interface data model defined in this memo to their proprietary native data model. To facilitate such mappings, the data model should be simple.
- o The data model should be suitable for new implementations to use as is, without requiring a mapping to a different native model.
- o References to interfaces should be as simple as possible, preferably by using a single leafref.
- o The mapping to ifIndex [[RFC2863](#)] used by the Simple Network Management Protocol (SNMP) to identify interfaces must be clear.
- o The model must support interface layering: both (1) simple layering, where one interface is layered on top of exactly one other interface, and (2) more complex scenarios, where one interface results from the aggregation of N other interfaces or when N interfaces are multiplexed over one other interface.
- o The data model should support the pre-provisioning of interface configuration, i.e., it should be possible to configure an

interface whose physical interface hardware is not present on the device. It is recommended that devices that support dynamic addition and removal of physical interfaces also support pre-provisioning.

- o The data model should support physical interfaces as well as logical interfaces.
- o The data model should include read-only counters in order to gather statistics for sent and received octets and packets, received packets with errors, and packets that could not be sent due to errors.

[3.](#) Interfaces Data Model

This document defines the YANG module "ietf-interfaces", which has the following structure, excluding the deprecated "/interfaces-state" subtree:

```
module: ietf-interfaces
  +--rw interfaces
    +--rw interface* [name]
      +--rw name                string
      +--rw description?       string
      +--rw type                identityref
      +--rw enabled?           boolean
      +--rw link-up-down-trap-enable? enumeration {if-mib}?
      +--ro admin-status       enumeration {if-mib}?
      +--ro oper-status        enumeration
      +--ro last-change?       yang:date-and-time
      +--ro if-index           int32 {if-mib}?
      +--ro phys-address?      yang:phys-address
      +--ro higher-layer-if*   interface-ref
      +--ro lower-layer-if*   interface-ref
```

```

+--ro speed?                               yang:gauge64
+--ro statistics
  +--ro discontinuity-time                 yang:date-and-time
  +--ro in-octets?                         yang:counter64
  +--ro in-unicast-pkts?                   yang:counter64
  +--ro in-broadcast-pkts?                 yang:counter64
  +--ro in-multicast-pkts?                 yang:counter64
  +--ro in-discards?                       yang:counter32
  +--ro in-errors?                         yang:counter32
  +--ro in-unknown-protos?                 yang:counter32
  +--ro out-octets?                         yang:counter64
  +--ro out-unicast-pkts?                   yang:counter64
  +--ro out-broadcast-pkts?                 yang:counter64
  +--ro out-multicast-pkts?                 yang:counter64
  +--ro out-discards?                       yang:counter32
  +--ro out-errors?                         yang:counter32

```

[3.1.](#) The Interface List

The data model for interfaces presented in this document uses a flat list of interfaces ("/interfaces/interface"). Each interface in the list is identified by its name. Furthermore, each interface has a mandatory "type" leaf.

The "iana-if-type" module [[RFC7224](#)] defines YANG identities for the interface types in the IANA-maintained "ifType definitions" registry.

It is expected that interface-type-specific data models augment the interface list and possibly use the "type" leaf to make the augmentation conditional.

As an example of such an interface-type-specific augmentation, consider this YANG snippet. For a more complete example, see [Appendix A](#).

```

import interfaces {
  prefix "if";
}
import iana-if-type {

```

```

    prefix ianaift;
  }

  augment "/if:interfaces/if:interface" {
    when "if:type = 'ianaift:ethernetCsmacd'";

    container ethernet {
      leaf duplex {
        ...
      }
    }
  }
}

```

For system-controlled interfaces, the "name" is the device-specific name of the interface.

If the device supports arbitrarily named user-controlled interfaces, then the server will advertise the "arbitrary-names" feature. If the server does not advertise this feature, the names of user-controlled interfaces MUST match the device's naming scheme. How a client can learn the naming scheme of such devices is outside the scope of this document. See [Appendix F.1](#) and [Appendix F.2](#) for examples.

When a system-controlled interface is created in the operational state datastore by the system, the system tries to apply the interface configuration in the intended configuration datastore with the same name as the new interface. If no such interface configuration is found, or if the configured type does not match the real interface type, the system creates the interface without applying explicit configuration.

When a user-controlled interface is created, the configuration determines the name of the interface.

Depending on the operating system and the physical attachment point to which a network interface may be attached or removed, it may be impossible for an implementation to provide predictable and consistent names for system-controlled interfaces across insertion/removal cycles as well as in anticipation of initial insertion. The

ability to provide configurations for such interfaces is therefore

dependent on the implementation and cannot be assumed in all cases.

[3.2.](#) Interface References

An interface is identified by its name, which is unique within the server. This property is captured in the "interface-ref" and typedef, which other YANG modules SHOULD use when they need to reference an interface.

[3.3.](#) Interface Layering

There is no generic mechanism for how an interface is configured to be layered on top of some other interface. It is expected that interface-type-specific models define their own data nodes for interface layering by using "interface-ref" types to reference lower layers.

Below is an example of a model with such nodes. For a more complete example, see [Appendix B](#).

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

augment "/if:interfaces/if:interface" {
    when "if:type = 'ianaift:ieee8023adLag'";

    leaf-list slave-if {
        type if:interface-ref;
        must "/if:interfaces/if:interface[if:name = current()]"
            + "/if:type = 'ianaift:ethernetCsmacd'" {
            description
                "The type of a slave interface must be
                'ethernetCsmacd'.";
        }
    }
    // other bonding config params, failover times, etc.
}
```

While the interface layering is configured in interface-type-specific models, two generic state data leaf-lists, "higher-layer-if" and "lower-layer-if", represent a read-only view of the interface layering hierarchy.

4. Relationship to the IF-MIB

If the device implements the IF-MIB [[RFC2863](#)], each entry in the `/interfaces/interface` list in the operational state datastore is typically mapped to one `ifEntry`. The `if-index` leaf MUST contain the value of the corresponding `ifEntry`'s `ifIndex`.

In most cases, the `name` of an `/interfaces/interface` entry is mapped to `ifName`. The IF-MIB allows two different `ifEntries` to have the same `ifName`. Devices that support this feature and also support the data model defined in this document cannot have a 1-1 mapping between the `name` leaf and `ifName`.

The configured `description` of an `interface` has traditionally been mapped to `ifAlias` in some implementations. This document allows this mapping, but implementers should be aware of the differences in the value space and persistence for these objects. See the YANG module definition of the leaf `description` in [Section 5](#) for details.

The IF-MIB also defines the writable object `ifPromiscuousMode`. Since this object typically is not implemented as a configuration object by SNMP agents, it is not mapped to the `ietf-interfaces` module.

The `ifMtu` object from the IF-MIB is not mapped to the `ietf-interfaces` module. It is expected that interface-type-specific YANG modules provide interface-type-specific MTU leafs by augmenting the `ietf-interfaces` model.

There are a number of counters in the IF-MIB that exist in two versions: one with 32 bits and one with 64 bits. The 64-bit versions were added to support high-speed interfaces with a data rate greater than 20,000,000 bits/second. Today's implementations generally support such high-speed interfaces, and hence only 64-bit counters are provided in this data model. Note that NETCONF and SNMP may differ in the time granularity in which they provide access to the counters. For example, it is common that SNMP implementations cache counter values for some time.

The objects `ifDescr` and `ifConnectorPresent` from the IF-MIB are not mapped to the `ietf-interfaces` module.

The following tables list the YANG data nodes with corresponding objects in the IF-MIB.

YANG data node in /interfaces/interface	IF-MIB object
name	ifName
type	ifType
description	ifAlias
admin-status	ifAdminStatus
oper-status	ifOperStatus
last-change	ifLastChange
if-index	ifIndex
link-up-down-trap-enable	ifLinkUpDownTrapEnable
phys-address	ifPhysAddress
higher-layer-if and lower-layer-if	ifStackTable
speed	ifSpeed and ifHighSpeed
discontinuity-time	ifCounterDiscontinuityTime
in-octets	ifHCInOctets
in-unicast-pkts	ifHCInUcastPkts
in-broadcast-pkts	ifHCInBroadcastPkts
in-multicast-pkts	ifHCInMulticastPkts
in-discards	ifInDiscards
in-errors	ifInErrors
in-unknown-protos	ifInUnknownProtos
out-octets	ifHCOutOctets
out-unicast-pkts	ifHCOutUcastPkts
out-broadcast-pkts	ifHCOutBroadcastPkts
out-multicast-pkts	ifHCOutMulticastPkts
out-discards	ifOutDiscards
out-errors	ifOutErrors

YANG Data Nodes and Related IF-MIB Objects

5. Interfaces YANG Module

This YANG module imports typedefs from [\[RFC6991\]](#).

```
<CODE BEGINS> file "ietf-interfaces@2017-08-14.yang"
```

```
module ietf-interfaces {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-interfaces";
  prefix if;

  import ietf-yang-types {
    prefix yang;
  }
}
```

Bjorklund

Expires February 22, 2018

[Page 10]

Internet-Draft

YANG Interface Management

August 2017

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

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

  Editor:   Martin Bjorklund
            <mailto:mbj@tail-f.com>";
```

```
description
  "This module contains a collection of YANG definitions for
  managing network interfaces.
```

Copyright (c) 2017 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 (<http://trustee.ietf.org/license-info>).

This version of this YANG module is part of RFC XXXX; see the RFC itself for full legal notices.";

```
revision 2017-08-17 {
  description
    "Updated to support NMDA.";
  reference
    "RFC XXXX: A YANG Data Model for Interface Management";
```

```

}

revision 2014-05-08 {
  description
    "Initial revision.";
  reference
    "RFC 7223: A YANG Data Model for Interface Management";
}

/*
 * Typedefs
 */

typedef interface-ref {
  type leafref {
    path "/if:interfaces/if:interface/if:name";
  }
}

```

```

}
description
  "This type is used by data models that need to reference
  interfaces.";
}

/*
 * Identities
 */

identity interface-type {
  description
    "Base identity from which specific interface types are
    derived.";
}

/*
 * Features
 */

feature arbitrary-names {
  description
    "This feature indicates that the device allows user-controlled
    interfaces to be named arbitrarily.";
}

```

```

feature pre-provisioning {
  description
    "This feature indicates that the device supports
    pre-provisioning of interface configuration, i.e., it is
    possible to configure an interface whose physical interface
    hardware is not present on the device.";
}
feature if-mib {
  description
    "This feature indicates that the device implements
    the IF-MIB.";
  reference
    "RFC 2863: The Interfaces Group MIB";
}

/*
 * Data nodes
 */

container interfaces {
  description
    "Interface parameters.";
}

```

```

list interface {
  key "name";

  description
    "The list of interfaces on the device.

    The operational state of an interface is available in this
    list in the operational state datastore. If the
    configuration of a system-controlled interface cannot be
    used by the system (e.g., the interface hardware present
    does not match the interface type), then the configuration
    is not applied to the system-controlled interface shown in
    the operational state datastore. If the configuration of a
    user-controlled interface cannot be used by the system, the
    configured interface is not instantiated in the operational
    state datastore.

    System-controlled interfaces created by the system are

```

always present in this list in the operational state datastore, whether they are configured or not.";

```
leaf name {  
  type string;  
  description  
    "The name of the interface.
```

A device MAY restrict the allowed values for this leaf, possibly depending on the type of the interface. For system-controlled interfaces, this leaf is the device-specific name of the interface.

If a client tries to create configuration for a system-controlled interface that is not present in the operational state datastore, the server MAY reject the request if the implementation does not support pre-provisioning of interfaces or if the name refers to an interface that can never exist in the system. A NETCONF server MUST reply with an rpc-error with the error-tag 'invalid-value' in this case.

If the device supports pre-provisioning of interface configuration, the 'pre-provisioning' feature is advertised.

If the device allows arbitrarily named user-controlled interfaces, the 'arbitrary-names' feature is advertised.

When a configured user-controlled interface is created by

the system, it is instantiated with the same name in the operational state datastore.

A server implementation MAY map this leaf to the ifName MIB object. Such an implementation needs to use some mechanism to handle the differences in size and characters allowed between this leaf and ifName. The definition of such a mechanism is outside the scope of this document.";

reference

"[RFC 2863](#): The Interfaces Group MIB - ifName";

```
}
```

```
leaf description {
  type string;
  description
    "A textual description of the interface.
```

A server implementation MAY map this leaf to the ifAlias MIB object. Such an implementation needs to use some mechanism to handle the differences in size and characters allowed between this leaf and ifAlias. The definition of such a mechanism is outside the scope of this document.

Since ifAlias is defined to be stored in non-volatile storage, the MIB implementation MUST map ifAlias to the value of 'description' in the persistently stored datastore.

Specifically, if the device supports the startup configuration datastore, when ifAlias is read the device MUST return the value of 'description' in the startup configuration datastore, and when it is written, it MUST be written to the running and startup configuration datastores. Note that it is up to the implementation to decide whether to modify this single leaf in the startup configuration datastore or perform an implicit copy from the running configuration datastore to the startup configuration datastore.

If the device does not support the startup configuration datastore, ifAlias MUST be mapped to the 'description' leaf in the running configuration datastore.";

```
reference
  "RFC 2863: The Interfaces Group MIB - ifAlias";
}
```

```
leaf type {
  type identityref {
```

```
    base interface-type;
  }
  mandatory true;
  description
```


"The type of the interface.

When an interface entry is created, a server MAY initialize the type leaf with a valid value, e.g., if it is possible to derive the type from the name of the interface.

If a client tries to set the type of an interface to a value that can never be used by the system, e.g., if the type is not supported or if the type does not match the name of the interface, the server MUST reject the request. A NETCONF server MUST reply with an rpc-error with the error-tag 'invalid-value' in this case.";

reference

"[RFC 2863](#): The Interfaces Group MIB - ifType";

}

leaf enabled {

type boolean;

default "true";

description

"This leaf contains the configured, desired state of the interface.

Systems that implement the IF-MIB use the value of this leaf in the running configuration datastore to set IF-MIB.ifAdminStatus to 'up' or 'down' after an ifEntry has been initialized, as described in [RFC 2863](#).

Changes in this leaf in the running configuration datastore are reflected in ifAdminStatus, but if ifAdminStatus is changed over SNMP, this leaf is not affected.";

reference

"[RFC 2863](#): The Interfaces Group MIB - ifAdminStatus";

}

leaf link-up-down-trap-enable {

if-feature if-mib;

type enumeration {

enum enabled {

value 1;

description

"The device will generate linkUp/linkDown SNMP

```
        notifications for this interface.";
    }
    enum disabled {
        value 2;
        description
            "The device will not generate linkUp/linkDown SNMP
            notifications for this interface.";
    }
}
description
    "Controls whether linkUp/linkDown SNMP notifications
    should be generated for this interface.

    If this node is not configured, the value 'enabled' is
    operationally used by the server for interfaces that do
    not operate on top of any other interface (i.e., there are
    no 'lower-layer-if' entries), and 'disabled' otherwise.";
reference
    "RFC 2863: The Interfaces Group MIB -
    ifLinkUpDownTrapEnable";
}

leaf admin-status {
    if-feature if-mib;
    type enumeration {
        enum up {
            value 1;
            description
                "Ready to pass packets.";
        }
        enum down {
            value 2;
            description
                "Not ready to pass packets and not in some test mode.";
        }
        enum testing {
            value 3;
            description
                "In some test mode.";
        }
    }
}
config false;
mandatory true;
description
    "The desired state of the interface.

    This leaf has the same read semantics as ifAdminStatus.";
```

```
    "RFC 2863: The Interfaces Group MIB - ifAdminStatus";
}

leaf oper-status {
  type enumeration {
    enum up {
      value 1;
      description
        "Ready to pass packets.";
    }
    enum down {
      value 2;
      description
        "The interface does not pass any packets.";
    }
    enum testing {
      value 3;
      description
        "In some test mode.  No operational packets can
        be passed.";
    }
    enum unknown {
      value 4;
      description
        "Status cannot be determined for some reason.";
    }
    enum dormant {
      value 5;
      description
        "Waiting for some external event.";
    }
    enum not-present {
      value 6;
      description
        "Some component (typically hardware) is missing.";
    }
    enum lower-layer-down {
      value 7;
      description
        "Down due to state of lower-layer interface(s).";
    }
  }
}
```

```
    }
  }
  config false;
  mandatory true;
  description
    "The current operational state of the interface.

    This leaf has the same semantics as ifOperStatus.";
```

```
    reference
      "RFC 2863: The Interfaces Group MIB - ifOperStatus";
  }

  leaf last-change {
    type yang:date-and-time;
    config false;
    description
      "The time the interface entered its current operational
      state. If the current state was entered prior to the
      last re-initialization of the local network management
      subsystem, then this node is not present.";
    reference
      "RFC 2863: The Interfaces Group MIB - ifLastChange";
  }

  leaf if-index {
    if-feature if-mib;
    type int32 {
      range "1..2147483647";
    }
    config false;
    mandatory true;
    description
      "The ifIndex value for the ifEntry represented by this
      interface.";
    reference
      "RFC 2863: The Interfaces Group MIB - ifIndex";
  }

  leaf phys-address {
    type yang:phys-address;
    config false;
```

```
description
  "The interface's address at its protocol sub-layer. For
  example, for an 802.x interface, this object normally
  contains a Media Access Control (MAC) address. The
  interface's media-specific modules must define the bit
  and byte ordering and the format of the value of this
  object. For interfaces that do not have such an address
  (e.g., a serial line), this node is not present.";
reference
  "RFC 2863: The Interfaces Group MIB - ifPhysAddress";
}
```

```
leaf-list higher-layer-if {
  type interface-ref;
  config false;
```

```
description
  "A list of references to interfaces layered on top of this
  interface.";
reference
  "RFC 2863: The Interfaces Group MIB - ifStackTable";
}
```

```
leaf-list lower-layer-if {
  type interface-ref;
  config false;
  description
    "A list of references to interfaces layered underneath this
    interface.";
  reference
    "RFC 2863: The Interfaces Group MIB - ifStackTable";
}
```

```
leaf speed {
  type yang:gauge64;
  units "bits/second";
  config false;
  description
    "An estimate of the interface's current bandwidth in bits
    per second. For interfaces that do not vary in
    bandwidth or for those where no accurate estimation can
    be made, this node should contain the nominal bandwidth.
```

```

        For interfaces that have no concept of bandwidth, this
        node is not present.";
reference
    "RFC 2863: The Interfaces Group MIB -
        ifSpeed, ifHighSpeed";
}

container statistics {
    config false;
    description
        "A collection of interface-related statistics objects.";

    leaf discontinuity-time {
        type yang:date-and-time;
        mandatory true;
        description
            "The time on the most recent occasion at which any one or
            more of this interface's counters suffered a
            discontinuity.  If no such discontinuities have occurred
            since the last re-initialization of the local management
            subsystem, then this node contains the time the local
            management subsystem re-initialized itself.";
    }
}

```

```

}

leaf in-octets {
    type yang:counter64;
    description
        "The total number of octets received on the interface,
        including framing characters.

        Discontinuities in the value of this counter can occur
        at re-initialization of the management system, and at
        other times as indicated by the value of
        'discontinuity-time'.";
    reference
        "RFC 2863: The Interfaces Group MIB - ifHCInOctets";
}

leaf in-unicast-pkts {
    type yang:counter64;
    description

```

"The number of packets, delivered by this sub-layer to a higher (sub-)layer, that were not addressed to a multicast or broadcast address at this sub-layer.

Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of 'discontinuity-time'.";

reference

"[RFC 2863](#): The Interfaces Group MIB - ifHCInUcastPkts";

}

leaf in-broadcast-pkts {

type yang:counter64;

description

"The number of packets, delivered by this sub-layer to a higher (sub-)layer, that were addressed to a broadcast address at this sub-layer.

Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of 'discontinuity-time'.";

reference

"[RFC 2863](#): The Interfaces Group MIB - ifHCInBroadcastPkts";

}

leaf in-multicast-pkts {

type yang:counter64;

description

"The number of packets, delivered by this sub-layer to a higher (sub-)layer, that were addressed to a multicast address at this sub-layer. For a MAC-layer protocol, this includes both Group and Functional addresses.

Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of 'discontinuity-time'.";

reference

```

        "RFC 2863: The Interfaces Group MIB -
            ifHCInMulticastPkts";
    }

leaf in-discards {
    type yang:counter32;
    description
        "The number of inbound packets that were chosen to be
        discarded even though no errors had been detected to
        prevent their being deliverable to a higher-layer
        protocol. One possible reason for discarding such a
        packet could be to free up buffer space.

        Discontinuities in the value of this counter can occur
        at re-initialization of the management system, and at
        other times as indicated by the value of
        'discontinuity-time'.";
    reference
        "RFC 2863: The Interfaces Group MIB - ifInDiscards";
}

leaf in-errors {
    type yang:counter32;
    description
        "For packet-oriented interfaces, the number of inbound
        packets that contained errors preventing them from being
        deliverable to a higher-layer protocol. For character-
        oriented or fixed-length interfaces, the number of
        inbound transmission units that contained errors
        preventing them from being deliverable to a higher-layer
        protocol.

        Discontinuities in the value of this counter can occur
        at re-initialization of the management system, and at
        other times as indicated by the value of
        'discontinuity-time'.";
}

reference
    "RFC 2863: The Interfaces Group MIB - ifInErrors";
}

leaf in-unknown-protos {

```



```
type yang:counter32;
description
  "For packet-oriented interfaces, the number of packets
  received via the interface that were discarded because
  of an unknown or unsupported protocol. For
  character-oriented or fixed-length interfaces that
  support protocol multiplexing, the number of
  transmission units received via the interface that were
  discarded because of an unknown or unsupported protocol.
  For any interface that does not support protocol
  multiplexing, this counter is not present.

  Discontinuities in the value of this counter can occur
  at re-initialization of the management system, and at
  other times as indicated by the value of
  'discontinuity-time'.";
reference
  "RFC 2863: The Interfaces Group MIB - ifInUnknownProtos";
}
```

```
leaf out-octets {
  type yang:counter64;
  description
    "The total number of octets transmitted out of the
    interface, including framing characters.

    Discontinuities in the value of this counter can occur
    at re-initialization of the management system, and at
    other times as indicated by the value of
    'discontinuity-time'.";
  reference
    "RFC 2863: The Interfaces Group MIB - ifHCOutOctets";
}
```

```
leaf out-unicast-pkts {
  type yang:counter64;
  description
    "The total number of packets that higher-level protocols
    requested be transmitted, and that were not addressed
    to a multicast or broadcast address at this sub-layer,
    including those that were discarded or not sent.
```

```

        Discontinuities in the value of this counter can occur
        at re-initialization of the management system, and at
        other times as indicated by the value of
        'discontinuity-time.';
    reference
        "RFC 2863: The Interfaces Group MIB - ifHCOutUcastPkts";
}

leaf out-broadcast-pkts {
    type yang:counter64;
    description
        "The total number of packets that higher-level protocols
        requested be transmitted, and that were addressed to a
        broadcast address at this sub-layer, including those
        that were discarded or not sent.

        Discontinuities in the value of this counter can occur
        at re-initialization of the management system, and at
        other times as indicated by the value of
        'discontinuity-time.';
    reference
        "RFC 2863: The Interfaces Group MIB -
        ifHCOutBroadcastPkts";
}

leaf out-multicast-pkts {
    type yang:counter64;
    description
        "The total number of packets that higher-level protocols
        requested be transmitted, and that were addressed to a
        multicast address at this sub-layer, including those
        that were discarded or not sent. For a MAC-layer
        protocol, this includes both Group and Functional
        addresses.

        Discontinuities in the value of this counter can occur
        at re-initialization of the management system, and at
        other times as indicated by the value of
        'discontinuity-time.';
    reference
        "RFC 2863: The Interfaces Group MIB -
        ifHCOutMulticastPkts";
}

leaf out-discards {
    type yang:counter32;
    description
        "The number of outbound packets that were chosen to be

```

discarded even though no errors had been detected to prevent their being transmitted. One possible reason for discarding such a packet could be to free up buffer space.

Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of 'discontinuity-time'.";

reference

[RFC 2863](#): The Interfaces Group MIB - ifOutDiscards";

}

leaf out-errors {

type yang:counter32;

description

"For packet-oriented interfaces, the number of outbound packets that could not be transmitted because of errors. For character-oriented or fixed-length interfaces, the number of outbound transmission units that could not be transmitted because of errors.

Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of 'discontinuity-time'.";

reference

[RFC 2863](#): The Interfaces Group MIB - ifOutErrors";

}

}

}

}

/*

* Legacy typedefs

*/

typedef interface-state-ref {

type leafref {

path "/if:interfaces-state/if:interface/if:name";

}

```
status deprecated;
description
  "This type is used by data models that need to reference
  the operationally present interfaces.";
}
```

```
/*
 * Legacy operational state data nodes
 */

container interfaces-state {
  config false;
  status deprecated;
  description
    "Data nodes for the operational state of interfaces.";

  list interface {
    key "name";
    status deprecated;

    description
      "The list of interfaces on the device.

      System-controlled interfaces created by the system are
      always present in this list, whether they are configured or
      not.";

    leaf name {
      type string;
      status deprecated;
      description
        "The name of the interface.

        A server implementation MAY map this leaf to the ifName
        MIB object. Such an implementation needs to use some
        mechanism to handle the differences in size and characters
        allowed between this leaf and ifName. The definition of
        such a mechanism is outside the scope of this document.";
      reference
        "RFC 2863: The Interfaces Group MIB - ifName";
    }
  }
}
```

```
leaf type {
  type identityref {
    base interface-type;
  }
  mandatory true;
  status deprecated;
  description
    "The type of the interface.";
  reference
    "RFC 2863: The Interfaces Group MIB - ifType";
}
```

```
leaf admin-status {
  if-feature if-mib;
  type enumeration {
    enum up {
      value 1;
      description
        "Ready to pass packets.";
    }
    enum down {
      value 2;
      description
        "Not ready to pass packets and not in some test mode.";
    }
    enum testing {
      value 3;
      description
        "In some test mode.";
    }
  }
  mandatory true;
  status deprecated;
  description
    "The desired state of the interface.

    This leaf has the same read semantics as ifAdminStatus.";
  reference
    "RFC 2863: The Interfaces Group MIB - ifAdminStatus";
}
```

```

leaf oper-status {
  type enumeration {
    enum up {
      value 1;
      description
        "Ready to pass packets.";
    }
    enum down {
      value 2;
      description
        "The interface does not pass any packets.";
    }
    enum testing {
      value 3;
      description
        "In some test mode. No operational packets can
        be passed.";
    }
    enum unknown {

```

```

      value 4;
      description
        "Status cannot be determined for some reason.";
    }
    enum dormant {
      value 5;
      description
        "Waiting for some external event.";
    }
    enum not-present {
      value 6;
      description
        "Some component (typically hardware) is missing.";
    }
    enum lower-layer-down {
      value 7;
      description
        "Down due to state of lower-layer interface(s).";
    }
  }
}
mandatory true;

```

```

status deprecated;
description
    "The current operational state of the interface.

    This leaf has the same semantics as ifOperStatus.";
reference
    "RFC 2863: The Interfaces Group MIB - ifOperStatus";
}

leaf last-change {
    type yang:date-and-time;
    status deprecated;
    description
        "The time the interface entered its current operational
        state. If the current state was entered prior to the
        last re-initialization of the local network management
        subsystem, then this node is not present.";
    reference
        "RFC 2863: The Interfaces Group MIB - ifLastChange";
}

leaf if-index {
    if-feature if-mib;
    type int32 {
        range "1..2147483647";
    }
    mandatory true;
}

```

```

status deprecated;
description
    "The ifIndex value for the ifEntry represented by this
    interface.";
reference
    "RFC 2863: The Interfaces Group MIB - ifIndex";
}

leaf phys-address {
    type yang:phys-address;
    status deprecated;
    description
        "The interface's address at its protocol sub-layer. For
        example, for an 802.x interface, this object normally

```

```

        contains a Media Access Control (MAC) address. The
        interface's media-specific modules must define the bit
        and byte ordering and the format of the value of this
        object. For interfaces that do not have such an address
        (e.g., a serial line), this node is not present.";
    reference
        "RFC 2863: The Interfaces Group MIB - ifPhysAddress";
}

leaf-list higher-layer-if {
    type interface-state-ref;
    status deprecated;
    description
        "A list of references to interfaces layered on top of this
        interface.";
    reference
        "RFC 2863: The Interfaces Group MIB - ifStackTable";
}

leaf-list lower-layer-if {
    type interface-state-ref;
    status deprecated;
    description
        "A list of references to interfaces layered underneath this
        interface.";
    reference
        "RFC 2863: The Interfaces Group MIB - ifStackTable";
}

leaf speed {
    type yang:gauge64;
    units "bits/second";
    status deprecated;
    description

```

```

        "An estimate of the interface's current bandwidth in bits
        per second. For interfaces that do not vary in
        bandwidth or for those where no accurate estimation can
        be made, this node should contain the nominal bandwidth.
        For interfaces that have no concept of bandwidth, this
        node is not present.";
    reference

```



```

        "RFC 2863: The Interfaces Group MIB -
           ifSpeed, ifHighSpeed";
    }

    container statistics {
        status deprecated;
        description
            "A collection of interface-related statistics objects.";

        leaf discontinuity-time {
            type yang:date-and-time;
            mandatory true;
            status deprecated;
            description
                "The time on the most recent occasion at which any one or
                 more of this interface's counters suffered a
                 discontinuity.  If no such discontinuities have occurred
                 since the last re-initialization of the local management
                 subsystem, then this node contains the time the local
                 management subsystem re-initialized itself.";
        }

        leaf in-octets {
            type yang:counter64;
            status deprecated;
            description
                "The total number of octets received on the interface,
                 including framing characters.

                 Discontinuities in the value of this counter can occur
                 at re-initialization of the management system, and at
                 other times as indicated by the value of
                 'discontinuity-time'.";
            reference
                "RFC 2863: The Interfaces Group MIB - ifHCInOctets";
        }

        leaf in-unicast-pkts {
            type yang:counter64;
            status deprecated;
            description

```

"The number of packets, delivered by this sub-layer to a higher (sub-)layer, that were not addressed to a multicast or broadcast address at this sub-layer.

Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of 'discontinuity-time'.";

reference

"[RFC 2863](#): The Interfaces Group MIB - ifHCInUcastPkts";

}

leaf in-broadcast-pkts {

type yang:counter64;

status deprecated;

description

"The number of packets, delivered by this sub-layer to a higher (sub-)layer, that were addressed to a broadcast address at this sub-layer.

Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of 'discontinuity-time'.";

reference

"[RFC 2863](#): The Interfaces Group MIB - ifHCInBroadcastPkts";

}

leaf in-multicast-pkts {

type yang:counter64;

status deprecated;

description

"The number of packets, delivered by this sub-layer to a higher (sub-)layer, that were addressed to a multicast address at this sub-layer. For a MAC-layer protocol, this includes both Group and Functional addresses.

Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of 'discontinuity-time'.";

reference

"[RFC 2863](#): The Interfaces Group MIB - ifHCInMulticastPkts";

}

leaf in-discards {

```
type yang:counter32;
status deprecated;
description
  "The number of inbound packets that were chosen to be
  discarded even though no errors had been detected to
  prevent their being deliverable to a higher-layer
  protocol. One possible reason for discarding such a
  packet could be to free up buffer space.

  Discontinuities in the value of this counter can occur
  at re-initialization of the management system, and at
  other times as indicated by the value of
  'discontinuity-time'.";
reference
  "RFC 2863: The Interfaces Group MIB - ifInDiscards";
}

leaf in-errors {
  type yang:counter32;
  status deprecated;
  description
    "For packet-oriented interfaces, the number of inbound
    packets that contained errors preventing them from being
    deliverable to a higher-layer protocol. For character-
    oriented or fixed-length interfaces, the number of
    inbound transmission units that contained errors
    preventing them from being deliverable to a higher-layer
    protocol.

    Discontinuities in the value of this counter can occur
    at re-initialization of the management system, and at
    other times as indicated by the value of
    'discontinuity-time'.";
  reference
    "RFC 2863: The Interfaces Group MIB - ifInErrors";
}

leaf in-unknown-protos {
  type yang:counter32;
  status deprecated;
  description
    "For packet-oriented interfaces, the number of packets
    received via the interface that were discarded because
```

of an unknown or unsupported protocol. For character-oriented or fixed-length interfaces that support protocol multiplexing, the number of transmission units received via the interface that were discarded because of an unknown or unsupported protocol.

For any interface that does not support protocol multiplexing, this counter is not present.

Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of 'discontinuity-time'.";

reference

"[RFC 2863](#): The Interfaces Group MIB - ifInUnknownProtos";

}

leaf out-octets {

type yang:counter64;

status deprecated;

description

"The total number of octets transmitted out of the interface, including framing characters.

Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of 'discontinuity-time'.";

reference

"[RFC 2863](#): The Interfaces Group MIB - ifHCOutOctets";

}

leaf out-unicast-pkts {

type yang:counter64;

status deprecated;

description

"The total number of packets that higher-level protocols requested be transmitted, and that were not addressed to a multicast or broadcast address at this sub-layer, including those that were discarded or not sent.

Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of 'discontinuity-time'.";

```
reference
  "RFC 2863: The Interfaces Group MIB - ifHCOutUcastPkts";
}

leaf out-broadcast-pkts {
  type yang:counter64;
  status deprecated;
  description
```

```
"The total number of packets that higher-level protocols
requested be transmitted, and that were addressed to a
broadcast address at this sub-layer, including those
that were discarded or not sent.

Discontinuities in the value of this counter can occur
at re-initialization of the management system, and at
other times as indicated by the value of
'discontinuity-time'.";
reference
  "RFC 2863: The Interfaces Group MIB -
    ifHCOutBroadcastPkts";
}

leaf out-multicast-pkts {
  type yang:counter64;
  status deprecated;
  description
    "The total number of packets that higher-level protocols
    requested be transmitted, and that were addressed to a
    multicast address at this sub-layer, including those
    that were discarded or not sent. For a MAC-layer
    protocol, this includes both Group and Functional
    addresses.

    Discontinuities in the value of this counter can occur
    at re-initialization of the management system, and at
    other times as indicated by the value of
    'discontinuity-time'.";
```

```
reference
  "RFC 2863: The Interfaces Group MIB -
    ifHCOutMulticastPkts";
}

leaf out-discards {
  type yang:counter32;
  status deprecated;
  description
    "The number of outbound packets that were chosen to be
    discarded even though no errors had been detected to
    prevent their being transmitted. One possible reason
    for discarding such a packet could be to free up buffer
    space.

    Discontinuities in the value of this counter can occur
    at re-initialization of the management system, and at
    other times as indicated by the value of
    'discontinuity-time'.";
}
```

Bjorklund

Expires February 22, 2018

[Page 33]

Internet-Draft

YANG Interface Management

August 2017

```
reference
  "RFC 2863: The Interfaces Group MIB - ifOutDiscards";
}

leaf out-errors {
  type yang:counter32;
  status deprecated;
  description
    "For packet-oriented interfaces, the number of outbound
    packets that could not be transmitted because of errors.
    For character-oriented or fixed-length interfaces, the
    number of outbound transmission units that could not be
    transmitted because of errors.

    Discontinuities in the value of this counter can occur
    at re-initialization of the management system, and at
    other times as indicated by the value of
    'discontinuity-time'.";
  reference
    "RFC 2863: The Interfaces Group MIB - ifOutErrors";
}
}
```

```
}  
}  
}
```

<CODE ENDS>

6. IANA Considerations

This document registers a URI in the "IETF XML Registry" [[RFC3688](#)]. Following the format in [RFC 3688](#), the following registration has been made.

URI: urn:ietf:params:xml:ns:yang:ietf-interfaces

Registrant Contact: The IESG.

XML: N/A, the requested URI is an XML namespace.

This document registers a YANG module in the "YANG Module Names" registry [[RFC6020](#)].

```
name:          ietf-interfaces  
namespace:    urn:ietf:params:xml:ns:yang:ietf-interfaces  
prefix:      if  
reference:    RFC XXXX
```

7. Security Considerations

The YANG module defined in this memo is designed to be accessed via the NETCONF protocol [[RFC6241](#)]. The lowest NETCONF layer is the secure transport layer and the mandatory-to-implement secure transport is SSH [[RFC6242](#)]. The NETCONF access control model [[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 the 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:

/interfaces/interface: This list specifies the configured interfaces on a device. Unauthorized access to this list could cause the device to ignore packets it should receive and process.

/interfaces/interface/enabled: This leaf controls whether an interface is enabled or not. Unauthorized access to this leaf could cause the device to ignore packets it should receive and process.

8. Acknowledgments

The author wishes to thank Alexander Clemm, Per Hedeland, Ladislav Lhotka, and Juergen Schoenwaelder for their helpful comments.

9. References

9.1. Normative References

- [I-D.ietf-netmod-revised-datastores]
Bjorklund, M., Schoenwaelder, J., Shafer, P., Watsen, K., and R. Wilton, "Network Management Datastore Architecture", [draft-ietf-netmod-revised-datastores-03](#) (work in progress), July 2017.
- [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>>.

- [RFC2863] McCloghrie, K. and F. Kastenholz, "The Interfaces Group MIB", [RFC 2863](#), DOI 10.17487/RFC2863, June 2000, <<https://www.rfc-editor.org/info/rfc2863>>.
- [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>>.
- [RFC6991] Schoenwaelder, J., Ed., "Common YANG Data Types", [RFC 6991](#), DOI 10.17487/RFC6991, July 2013, <<https://www.rfc-editor.org/info/rfc6991>>.
- [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>>.

9.2. 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>>.
- [RFC6536] Bierman, A. and M. Bjorklund, "Network Configuration Protocol (NETCONF) Access Control Model", [RFC 6536](#), DOI 10.17487/RFC6536, March 2012, <<https://www.rfc-editor.org/info/rfc6536>>.
- [RFC7224] Bjorklund, M., "IANA Interface Type YANG Module", [RFC 7224](#), DOI 10.17487/RFC7224, May 2014, <<https://www.rfc-editor.org/info/rfc7224>>.

Appendix A. Example: Ethernet Interface Module

This section gives a simple example of how an Ethernet interface module could be defined. It demonstrates how media-specific configuration parameters can be conditionally augmented to the generic interface list. It also shows how operational state parameters can be conditionally augmented to the operational

interface list. The example is not intended as a complete module for

Ethernet configuration.

```
module ex-ethernet {
  namespace "http://example.com/ethernet";
  prefix "eth";

  import ietf-interfaces {
    prefix if;
  }
  import iana-if-type {
    prefix ianaift;
  }

  // configuration and state parameters for Ethernet interfaces
  augment "/if:interfaces/if:interface" {
    when "if:type = 'ianaift:ethernetCsmacd'";

    container ethernet {
      choice transmission-params {
        case auto {
          leaf auto-negotiate {
            type empty;
          }
        }
        case manual {
          leaf duplex {
            type enumeration {
              enum "half";
              enum "full";
            }
          }
        }

        leaf speed {
          type enumeration {
            enum "10Mb";
            enum "100Mb";
            enum "1Gb";
            enum "10Gb";
          }
        }
      }
    }
  }
  leaf duplexx {
    type enumeration {
      enum "half";
      enum "full";
    }
  }
}
```

```
        config false;
    }
    // other Ethernet-specific params...
}
}
```

[Appendix B](#). Example: Ethernet Bonding Interface Module

This section gives an example of how interface layering can be defined. An Ethernet bonding interface that bonds several Ethernet interfaces into one logical interface is defined.

```
module ex-ethernet-bonding {
    namespace "http://example.com/ethernet-bonding";
    prefix "bond";

    import ietf-interfaces {
        prefix if;
    }
    import iana-if-type {
        prefix ianaift;
    }

    augment "/if:interfaces/if:interface" {
        when "if:type = 'ianaift:ieee8023adLag'";

        leaf-list slave-if {
            type if:interface-ref;
            must "/if:interfaces/if:interface[if:name = current()]"
                + "/if:type = 'ianaift:ethernetCsmacd'" {
                description
                    "The type of a slave interface must be 'ethernetCsmacd.'";
            }
        }
    }
    leaf bonding-mode {
        type enumeration {
            enum round-robin;
            enum active-backup;
            enum broadcast;
        }
    }
    // other bonding config params, failover times, etc.
}
```

}

[Appendix C](#). Example: VLAN Interface Module

This section gives an example of how a VLAN interface module can be defined.

```
module ex-vlan {
  namespace "http://example.com/vlan";
  prefix "vlan";

  import ietf-interfaces {
    prefix if;
  }
  import iana-if-type {
    prefix ianaift;
  }

  augment "/if:interfaces/if:interface" {
    when "if:type = 'ianaift:ethernetCsmacd' or
          if:type = 'ianaift:ieee8023adLag'";
    leaf vlan-tagging {
      type boolean;
      default false;
    }
  }

  augment "/if:interfaces/if:interface" {
    when "if:type = 'ianaift:l2vlan'";

    leaf base-interface {
      type if:interface-ref;
      must "/if:interfaces/if:interface[if:name = current()]"
        + "/vlan:vlan-tagging = 'true'" {
        description
          "The base interface must have VLAN tagging enabled.";
      }
    }
  }
  leaf vlan-id {
    type uint16 {
      range "1..4094";
    }
  }
}
```

```

    }
    must "../base-interface" {
        description
            "If a vlan-id is defined, a base-interface must
            be specified.";
    }
}
}
}
}

```

[Appendix D](#). Example: NETCONF <get-config> Reply

This section gives an example of a reply to the NETCONF <get-config> request for <running> for a device that implements the example data models above.

```

<rpc-reply
  xmlns="urn:ietf:params:xml:ns:netconf:base:1.0"
  message-id="101">
  <data>
    <interfaces
      xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces"
      xmlns:ianaift="urn:ietf:params:xml:ns:yang:iana-if-type"
      xmlns:vlan="http://example.com/vlan">

      <interface>
        <name>eth0</name>
        <type>ianaift:ethernetCsmacd</type>
        <enabled>>false</enabled>
      </interface>

      <interface>
        <name>eth1</name>
        <type>ianaift:ethernetCsmacd</type>
        <enabled>>true</enabled>
        <vlan:vlan-tagging>>true</vlan:vlan-tagging>
      </interface>

      <interface>
        <name>eth1.10</name>
        <type>ianaift:l2vlan</type>
        <enabled>>true</enabled>
    </interfaces>
  </data>
</rpc-reply>

```

```

    <vlan:base-interface>eth1</vlan:base-interface>
    <vlan:vlan-id>10</vlan:vlan-id>
</interface>

<interface>
  <name>lo1</name>
  <type>ianaift:softwareLoopback</type>
  <enabled>true</enabled>
</interface>

</interfaces>
</data>
</rpc-reply>

```

[Appendix E](#). Example: NETCONF <get-data> Reply

This section gives an example of a reply to the NETCONF <get-data> request for <operational> for a device that implements the example data models above.

```

<rpc-reply
  xmlns="urn:ietf:params:xml:ns:netconf:base:1.0"
  message-id="101">
  <data>
    <interfaces
      xmlns="urn:ietf:params:xml:ns:yang:ietf-interfaces"
      xmlns:ianaift="urn:ietf:params:xml:ns:yang:iana-if-type"
      xmlns:vlan="http://example.com/vlan"
      xmlns:or="urn:ietf:params:xml:ns:yang:ietf-origin">

      <interface or:origin="or:intended">
        <name>eth0</name>
        <type>ianaift:ethernetCsmacd</type>
        <enabled>>false</enabled>
        <admin-status>down</admin-status>
        <oper-status>down</oper-status>
        <if-index>2</if-index>
        <phys-address>00:01:02:03:04:05</phys-address>
        <statistics>

```

```

    <discontinuity-time>
      2013-04-01T03:00:00+00:00
    </discontinuity-time>
    <!-- counters now shown here -->
  </statistics>
</interface>

<interface or:origin="or:intended">
  <name>eth1</name>
  <type>ianaift:ethernetCsmacd</type>
  <enabled>true</enabled>
  <admin-status>up</admin-status>
  <oper-status>up</oper-status>
  <if-index>7</if-index>
  <phys-address>00:01:02:03:04:06</phys-address>
  <higher-layer-if>eth1.10</higher-layer-if>
  <statistics>
    <discontinuity-time>
      2013-04-01T03:00:00+00:00
    </discontinuity-time>
    <!-- counters now shown here -->
  </statistics>
  <vlan:vlan-tagging>true</vlan:vlan-tagging>

```

```

</interface>

<interface or:origin="or:intended">
  <name>eth1.10</name>
  <type>ianaift:l2vlan</type>
  <enabled>true</enabled>
  <admin-status>up</admin-status>
  <oper-status>up</oper-status>
  <if-index>9</if-index>
  <lower-layer-if>eth1</lower-layer-if>
  <statistics>
    <discontinuity-time>
      2013-04-01T03:00:00+00:00
    </discontinuity-time>
    <!-- counters now shown here -->
  </statistics>
  <vlan:base-interface>eth1</vlan:base-interface>
  <vlan:vlan-id>10</vlan:vlan-id>

```

```

</interface>

<!-- This interface is not configured -->
<interface or:origin="or:system">
  <name>eth2</name>
  <type>ianaift:ethernetCsmacd</type>
  <admin-status>down</admin-status>
  <oper-status>down</oper-status>
  <if-index>8</if-index>
  <phys-address>00:01:02:03:04:07</phys-address>
  <statistics>
    <discontinuity-time>
      2013-04-01T03:00:00+00:00
    </discontinuity-time>
    <!-- counters now shown here -->
  </statistics>
</interface>

<interface or:origin="or:intended">
  <name>lo1</name>
  <type>ianaift:softwareLoopback</type>
  <enabled>true</enabled>
  <admin-status>up</admin-status>
  <oper-status>up</oper-status>
  <if-index>1</if-index>
  <statistics>
    <discontinuity-time>
      2013-04-01T03:00:00+00:00
    </discontinuity-time>
    <!-- counters now shown here -->
  </statistics>
</interface>

```

```

    </statistics>
  </interface>

</interfaces>
</data>
</rpc-reply>

```

[Appendix F](#). Examples: Interface Naming Schemes

This section gives examples of some implementation strategies.

The examples make use of the example data model "ex-vlan" (see [Appendix C](#)) to show how user-controlled interfaces can be configured.

[F.1](#). Router with Restricted Interface Names

In this example, a router has support for 4 line cards, each with 8 ports. The slots for the cards are physically numbered from 0 to 3, and the ports on each card from 0 to 7. Each card has Fast Ethernet or Gigabit Ethernet ports.

The device-specific names for these physical interfaces are "fastethernet-N/M" or "gigabitethernet-N/M".

The name of a VLAN interface is restricted to the form "<physical-interface-name>.<subinterface-number>".

It is assumed that the operator is aware of this naming scheme. The implementation auto-initializes the value for "type" based on the interface name.

The NETCONF server does not advertise the "arbitrary-names" feature in the <hello> message.

An operator can configure a physical interface by sending an <edit-config> containing:

```
<interface nc:operation="create">
  <name>fastethernet-1/0</name>
</interface>
```

When the server processes this request, it will set the leaf "type" to "ianaift:ethernetCsmacd". Thus, if the client performs a <get-config> right after the <edit-config> above, it will get:

```
<interface>
  <name>fastethernet-1/0</name>
  <type>ianaift:ethernetCsmacd</type>
</interface>
```

The client can configure a VLAN interface by sending an `<edit-config>` containing:

```
<interface nc:operation="create">
  <name>fastethernet-1/0.10005</name>
  <type>ianaift:l2vlan</type>
  <vlan:base-interface>fastethernet-1/0</vlan:base-interface>
  <vlan:vlan-id>5</vlan:vlan-id>
</interface>
```

If the client tries to change the type of the physical interface with an `<edit-config>` containing:

```
<interface nc:operation="merge">
  <name>fastethernet-1/0</name>
  <type>ianaift:tunnel</type>
</interface>
```

then the server will reply with an "invalid-value" error, since the new type does not match the name.

[F.2.](#) Router with Arbitrary Interface Names

In this example, a router has support for 4 line cards, each with 8 ports. The slots for the cards are physically numbered from 0 to 3, and the ports on each card from 0 to 7. Each card has Fast Ethernet or Gigabit Ethernet ports.

The device-specific names for these physical interfaces are "fastethernet-N/M" or "gigabitethernet-N/M".

The implementation does not restrict the user-controlled interface names. This allows an operator to more easily apply the interface configuration to a different interface. However, the additional level of indirection also makes it a bit more complex to map interface names found in other protocols to configuration entries.

The NETCONF server advertises the "arbitrary-names" feature in the `<hello>` message.

Physical interfaces are configured as in [Appendix F.1](#).

An operator can configure a VLAN interface by sending an `<edit-config>` containing:

```
<interface nc:operation="create">
  <name>acme-interface</name>
  <type>ianaift:l2vlan</type>
  <vlan:base-interface>fastethernet-1/0</vlan:base-interface>
  <vlan:vlan-id>5</vlan:vlan-id>
</interface>
```

If necessary, the operator can move the configuration named "acme-interface" over to a different physical interface with an `<edit-config>` containing:

```
<interface nc:operation="merge">
  <name>acme-interface</name>
  <vlan:base-interface>fastethernet-1/1</vlan:base-interface>
</interface>
```

[F.3.](#) Ethernet Switch with Restricted Interface Names

In this example, an Ethernet switch has a number of ports, each identified by a simple port number.

The device-specific names for the physical interfaces are numbers that match the physical port number.

An operator can configure a physical interface by sending an `<edit-config>` containing:

```
<interface nc:operation="create">
  <name>6</name>
</interface>
```

When the server processes this request, it will set the leaf "type" to "ianaift:ethernetCsmacd". Thus, if the client performs a `<get-config>` right after the `<edit-config>` above, it will get:

```
<interface>
  <name>6</name>
  <type>ianaift:ethernetCsmacd</type>
</interface>
```

[F.4.](#) Generic Host with Restricted Interface Names

In this example, a generic host has interfaces named by the kernel. The system identifies the physical interface by the name assigned by

the operating system to the interface.

The name of a VLAN interface is restricted to the form "`<physical-interface-name>:<vlan-number>`".

The NETCONF server does not advertise the "arbitrary-names" feature in the `<hello>` message.

An operator can configure an interface by sending an `<edit-config>` containing:

```
<interface nc:operation="create">
  <name>eth8</name>
</interface>
```

When the server processes this request, it will set the leaf "type" to "ianaift:ethernetCsmacd". Thus, if the client performs a `<get-config>` right after the `<edit-config>` above, it will get:

```
<interface>
  <name>eth8</name>
  <type>ianaift:ethernetCsmacd</type>
</interface>
```

The client can configure a VLAN interface by sending an `<edit-config>` containing:

```
<interface nc:operation="create">
  <name>eth8:5</name>
  <type>ianaift:l2vlan</type>
  <vlan:base-interface>eth8</vlan:base-interface>
  <vlan:vlan-id>5</vlan:vlan-id>
</interface>
```

[F.5.](#) Generic Host with Arbitrary Interface Names

In this example, a generic host has interfaces named by the kernel. The system identifies the physical interface by the name assigned by the operating system to the interface.

The implementation does not restrict the user-controlled interface names. This allows an operator to more easily apply the interface

configuration to a different interface. However, the additional level of indirection also makes it a bit more complex to map interface names found in other protocols to configuration entries.

The NETCONF server advertises the "arbitrary-names" feature in the <hello> message.

Physical interfaces are configured as in [Appendix F.4](#).

An operator can configure a VLAN interface by sending an <edit-config> containing:

```
<interface nc:operation="create">
  <name>acme-interface</name>
  <type>ianaift:l2vlan</type>
  <vlan:base-interface>eth8</vlan:base-interface>
  <vlan:vlan-id>5</vlan:vlan-id>
</interface>
```

If necessary, the operator can move the configuration named "acme-interface" over to a different physical interface with an <edit-config> containing:

```
<interface nc:operation="merge">
  <name>acme-interface</name>
  <vlan:base-interface>eth3</vlan:base-interface>
</interface>
```

Author's Address

Martin Bjorklund
Tail-f Systems

Email: mbj@tail-f.com

Bjorklund

Expires February 22, 2018

[Page 47]