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Telecommunications and exchange between information technology systems — Requirements for local and metropolitan area networks

Part 3-2: Standard for Ethernet YANG data model definitions

National foreword

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metropolitan area networks —**

**Part 3-2:
Standard for Ethernet YANG data
model definitions**

*Télécommunications et échange entre systèmes de technologies
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métropolitains —*

*Partie 3-2: Norme pour les définitions des modèles de données YANG
Ethernet*



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Abstract: YANG models for IEEE Std 802.3 are defined in this standard. This standard also publishes these models in a machine-readable format.

Keywords: 802.3, 802.3.2, Ethernet, YANG

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Introduction

This introduction is not part of IEEE Std 802.3.2-2019, IEEE Standard for Ethernet YANG Data Model Definitions.

The YANG modules included in this standard provide YANG versions of attributes defined in IEEE Std 802.3TM-2018, Clause 30, as well as derivative attributes defined in other management information bases (e.g., SNMP attributes included in IEEE Std 802.3.1, YANG versions of IETF Etherlike MIB attributes, etc.). The YANG modules defined in this standard accommodate IEEE Std 802.3-2018, excluding any currently published or future amendments. As IEEE Std 802.3 continues to evolve, new revisions of this standard may be published in the future to address new technologies and features.

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IEEE Standard for Ethernet YANG Data Model Definitions

1. Overview

This standard defines YANG modules for various Ethernet devices specified in IEEE Std 802.3. This includes half-duplex and full-duplex data terminal equipment (DTE) using either Carrier Sense Multiple Access/Collision Detection (CSMA/CD) or Multipoint Control Protocol (MPCP), and Power Sourcing Equipment (PSE).

1.1 Scope

This standard defines YANG data models for IEEE Std 802.3 Ethernet.

1.2 Purpose

The purpose of the standard is to define YANG modules for IEEE Std 802.3 and publish these modules in a machine-readable format.

1.3 Machine-readable YANG modules

The machine-readable files are available for download at the following URL: <https://github.com/YangModels/yang/tree/master/standard/ieee/published/802.3> as text files with a *.yang* extension, e.g., *ieee802-ether-net-interface.yang*. The use of specialized tools to view YANG modules may be useful to create tree, UML image, and HTML outputs from the YANG modules.

Like other languages, YANG (see IETF RFC 7950) has an accepted style for machine-readable files, which was followed during the development of this standard. This formatting may not be preserved when importing the machine-readable YANG modules into the PDF. In case of any formatting discrepancies, the published machine-readable files should be consulted.

1.4 Summary of YANG-based management framework

The structure of YANG-based management framework closely resembles the structure of the Internet-Standard Management Framework, described in detail in section 7 of IETF RFC 3410.

Managed objects defined using YANG modeling language are hosted on the managed device and accessed through NETCONF (see IETF RFC 7803) or RESTCONF (see IETF RFC 8040). This standard specifies YANG modules that are compliant to YANG 1.1 (see IETF RFC 7950).

1.5 Security considerations

The YANG modules defined in this standard are designed to be accessed via network management protocols, including NETCONF (see IETF RFC 7803) or RESTCONF (see IETF RFC 8040). The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) (see IETF RFC 6242) or TLS (see IETF RFC 8446). The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS (see IETF RFC 8446).

The NETCONF access control model (see IETF RFC 8341) provides the means to restrict access for particular NETCONF or RESTCONF users to a pre-configured subset of all available NETCONF or RESTCONF protocol operations and content.

There are a number of data nodes defined in these YANG modules that are writable/creatable/deletable, i.e., have the config property set to true, which is the default setting. 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.

Some of the readable data nodes in these YANG modules may be considered sensitive or vulnerable in some network environments. It is thus important to control read access (e.g., via get, get-config, or notification) to these data nodes.

Some of the RPC operations in these YANG modules may be considered sensitive or vulnerable in some network environments. Therefore, it is important to control access to these operations.

1.6 YANG module syntax validation

All YANG modules included in this standard are YANG 1.1 (see IETF RFC 7950) compliant and pass automated checks using tools available at the time of publication.

The following open source and/or free versions of YANG validation tools may be used: Pyang (see <https://github.com/mbj4668/pyang>), ConfD (see <http://www.tail-f.com/confd-basic>), as well as other YANG model validation tools listed at <http://www.yangvalidator.com>.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEEE Std 802®-2014, IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture.^{1, 2}

IEEE Std 802d™-2017, IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture Amendment 1: Allocation of Uniform Resource Name (URN) Values in IEEE 802 Standards.

IEEE Std 802.1Q™-2014, IEEE Standard for Local and metropolitan area networks—Bridges and Bridged Networks.

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IETF RFC 8040, *RESTCONF Protocol*, Bierman A., Bjorklund M., and Watsen K., January 2017.

IETF RFC 8342, *Network Management Datastore Architecture (NMDA)*, M. Bjorklund, J. Schoenwaelder, P. Shafer, K. Watsen, and R. Wilton, March 2018.

IETF RFC 8341, *Network Configuration Access Control Model*, A. Bierman and M. Bjorklund, March 2018.

¹The IEEE standards or products referred to in this clause are trademarks owned by the Institute of Electrical and Electronics Engineers, Incorporated.

²IEEE publications are available from the Institute of Electrical and Electronics Engineers (<http://standards.ieee.org/>).

³Internet Requests for Comments (RFCs) are available on the World Wide Web at the following ftp site: venera.isi.edu; login: anonymous; password: user's e-mail address; directory: in-inotes.

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IETF RFC 8343, *A YANG Data Model for Interface Management*, Bjorklund, M., March 2018.

IETF RFC 8407, *Guidelines for Authors and Reviewers of YANG Data Model Documents*, Bierman A., October 2018.

IETF RFC 8446, *The Transport Layer Security (TLS) Protocol Version 1.3*, E. Rescorla, August 2018.

3. Definitions

For the purposes of this document, the following terms and definitions apply. Some terms used in this document are defined in IEEE Std 802.3, and where alternative definitions occur in the IEEE Standards Dictionary, the IEEE Std 802.3 definition should be used. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.⁴

3.1 data model: A data model describes how data is represented and accessed.

3.2 YANG module: A YANG module defines a hierarchy of nodes that can be used for NETCONF-based (see IETF RFC 7803) and RESTCONF-based (see IETF RFC 8040) operations. With its definitions and the definitions it imports or includes from elsewhere, a module is self-contained and can be compiled.

⁴*IEEE Standards Dictionary Online* is available at: <http://dictionary.ieee.org/>.

4. Abbreviations

This standard contains the following abbreviations:

CO	Central Office
CPE	Customer Premise Equipment
CSMA/CD	carrier sense multiple access with collision detection
DTE	data terminal equipment
EFM	Ethernet in the First Mile
ELO	Ethernet Link OAM
EPON	Ethernet passive optical networks
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
NETCONF	Network Configuration Protocol
OAM	Operations, Administration, and Maintenance
PoE	Power over Ethernet
RESTCONF	RESTful Configuration Protocol
YANG	Yet Another Next Generation

5. Ethernet YANG Module

5.1 YANG module structure

Two modules defined in this clause are focused on the configuration and monitoring of IEEE Std 802.3 Ethernet interfaces. The *ieee802-ethernet-interface* YANG module contains definitions of current attributes used widely in the industry in current products, while the *ieee802-ethernet-interface-half-duplex* YANG module contains definitions of half-duplex attributes.

This standard does not have a normative requirement for data nodes of the base ietf-interfaces YANG module, but the following data nodes are supported: name, description, type, enabled, admin-status, oper-status, if-index, and phys-address.

5.2 Mapping of IEEE Std 802.3, Clause 30 managed objects

This subclause contains the mapping between YANG data nodes included in *ieee802-ethernet-interface* (see Table 5–1) and *ieee802-ethernet-interface-half-duplex* (see Table 5–4) YANG modules, managed objects, and attributes defined in IEEE Std 802.3, Clause 30.

Table 5–1—Mapping between IEEE Std 802.3, Clause 30 managed objects and *ieee802-ethernet-interface* YANG data nodes

IEEE Std 802.3, Clause 30		Corresponding <i>ieee802-ethernet-interface</i> YANG data nodes		
Managed object(s)	Attribute(s)	Reference	Container(s)	Data node(s) R/W
oAutoNegotiation	acAutoNegAdminControl	30.6.1.2.2	interfaces/interface/ethernet/	auto-negotiation/enable R/W
	aAutoNegAutoConfig	30.6.1.1.4		negotiation-status R
	N/A			flow-control/pause/direction R/W
oMACControl-FunctionEntity	aPAUSEMACCtrlFramesReceived	30.3.4.3		flow-control/pause/statistics/in-frames-pause R
	aPAUSEMACCtrlFramesTransmitted	30.3.4.2		flow-control/pause/statistics/out-frames-pause R
N/A	dot3HCOOutPFCFrames			
N/A	N/A			flow-control/force-flow-control R/W
N/A	N/A			speed R/W
oMACEntity	aDuplexStatus	30.3.1.1.32		duplex R/W
	aMaxFrameLength	30.3.1.1.37		max-frame-length R
	aSlowProtocolFrameLimit	30.3.1.1.38		frame-limit-slow-protocol R
oEXTENSION	aEXTENSIONMACCtrlStatus	30.3.8.3		mac-control-extension-control R
	N/A			capabilities/auto-negotiation R

Table 5–1—Mapping between IEEE Std 802.3, Clause 30 managed objects and *ieee802-ethernet-interface* YANG data nodes (continued)

IEEE Std 802.3, Clause 30		Corresponding <i>ieee802-ethernet-interface</i> YANG data nodes		
Managed object(s)	Attribute(s)	Reference	Container(s)	Data node(s)
oMACEntity	aFramesReceivedOK	30.3.1.1.5	interfaces/interface/ethernet/statistics/frame	in-frames
	aMulticastFramesReceivedOK	30.3.1.1.21		in-multicast-frames
	aBroadcastFramesReceivedOK	30.3.1.1.22		in-broadcast-frames
	aFrameCheckSequenceErrors + aAlignmentErrors	30.4.3.1.6, 30.4.3.1.7		in-error-fcs-frames
	aFrameTooLongErrors	30.3.1.1.25		in-error-oversize-frames
oMACEntity	aFramesLostDueToIntMACRcvError	30.3.1.1.15		in-error-mac-internal-frames
	aFramesTransmittedOK	30.3.1.1.2		out-frames
	aMulticastFramesXmittedOK	30.3.1.1.18		out-multicast-frames
	aBroadcastFramesXmittedOK	30.3.1.1.19		out-broadcast-frames
	aFramesLostDueToIntMACXmitError	30.3.1.1.12		out-error-mac-internal-frames
oPHYEntity	aSymbolErrorDuringCarrier	30.3.2.1.5	interfaces/interface/ethernet/statistics/phy	in-error-symbol
	aReceiveLPITransitions	30.3.2.1.11	interfaces/interface/ethernet/statistics/phy/lpi	in-lpi-transitions
	aReceiveLPIMicroseconds	30.3.2.1.9		in-lpi-time
	aTransmitLPITransitions	30.3.2.1.10		out-lpi-transitions
	aTransmitLPIMicroseconds	30.3.2.1.8		out-lpi-time

Table 5-1—Mapping between IEEE Std 802.3, Clause 30 managed objects and *ieee802-ethernet-interface* YANG data nodes (continued)

IEEE Std 802.3, Clause 30		Corresponding <i>ieee802-ethernet-interface</i> YANG data nodes		
Managed object(s)	Attribute(s)	Reference	Container(s)	Data node(s) R/W
oMACControlEntity oEXTENSION	aUnsupportedOpCodesReceived	30.3.3.5	interfaces/interface/ethernet/statistics/mac-control	in-frames-mac-control-unknown R
	aEXTENSIONMACCtrlFramesReceived	30.3.8.2		in-frames-mac-control-extension R
	aEXTENSIONMACCtrlFramesTransmitted	30.3.8.1		out-frames-mac-control-extension R

Table 5-2—Mapping between IETF RFC 2819 managed objects and *ieee802-ethernet-interface* YANG data nodes

Corresponding <i>ieee802-ethernet-interface</i> YANG data nodes			
IETF RFC 2819 Attribute(s)		Container(s)	Data node(s) R/W
no direct object ^a etherStatsOctets etherStatsUndersizePkts + etherStatsFragments		interfaces/interface/ethernet/statistics/frame	in-total-frames R
			in-total-octets R
			in-error-undersize-frames R

^a Can be calculated as: aFramesReceivedOK + aFrameCheckSequenceErrors + aAlignmentErrors + aFrameTooLongErrors + aFramesLostDuplicateToIntMACRevError.

Table 5-3—Mapping between IETF RFC 3635 managed objects and *ieee802-ethernet-interface* YANG data nodes

ETHERLIKE MIB Attribute(s)	Corresponding <i>ieee802-ethernet-interface</i> YANG data nodes		
	Container(s)	Data node(s)	R/W
dot3HCInPFCFrames	interfaces/interface/ethernet/	flow-control/pfc {ethernet-pfc} / statistics/in-frames-pfc	R
dot3HCOuPFCFrames		flow-control/pfc {ethernet-pfc} / statistics/out-frames-pfc	R

Table 5-4—Mapping between IEEE Std 802.3, Clause 30 managed objects and *ieee802-ethernet-interface-half-duplex* YANG data nodes

IEEE Std 802.3, Clause 30		Corresponding <i>ieee802-ethernet-interface-half-duplex</i> YANG data nodes		
Managed object(s)	Attribute(s)	Reference	Container(s)	Data node(s) R/W
oMACEntity	aRateControlAbility	30.3.1.1.33	interfaces/interface/ethernet	dynamic-rate-control R/W
	aSQETestErrors	30.3.2.1.4	interfaces/interface/ethernet/capability interfaces/interface/ethernet/statistics/frame/ csmacd {csma-cd}	dynamic-rate-control-supported R
	aSingleCollisionFrames	30.3.1.1.3		in-errors-sqe-test R
	aMultipleCollisionFrames	30.3.1.1.4		out-frames-collision-single R
	aFramesWithDeferredXmissions	30.3.1.1.9		out-frames-collision-multiple R
	aFramesAbortedDueToXSColls	30.3.1.1.11		out-frames-deferred R
	aLateCollisions	30.3.1.1.10		out-frames-collisions-excessive R
	aCarrierSenseErrors	30.3.1.1.13		out-collisions-late R
	aCollisionFrames	30.3.1.1.30		out-errors-carrier-sense R
				collision-histogram/collision-count R
				collision-histogram/collision-count-frames R

5.3 YANG module definition⁵

The YANG module tree hierarchy uses terms defined in IETF RFC 8407.

5.3.1 Tree hierarchy

```

module: ieee802-ethernet-interface
  augment /if:interfaces/if:interface:
    +---w ethernet
      +---w auto-negotiation!
      | +---w enable?                               boolean
      | +---ro negotiation-status?                 enumeration
      | +---w duplex?                               duplex-type
      | +---w speed?                               eth-if-speed-type
      +---w flow-control
      | +---rw pause {ethernet-pause}?
      | | +---rw direction?                       pause-fc-direction-type
      | | +---ro statistics
      | | | +---ro in-frames-pause?                yang:counter64
      | | | +---ro out-frames-pause?               yang:counter64
      | | +---rw pfc {ethernet-pfc}?
      | | | +---rw enable?                         boolean
      | | | +---ro statistics
      | | | +---ro in-frames-pfc?                  yang:counter64
      | | | +---ro out-frames-pfc?                  yang:counter64
      | | +---rw force-flow-control?               boolean
      | +---ro max-frame-length?                   uint16
      +---ro mac-control-extension-control?         boolean
      +---ro frame-limit-slow-protocol?             uint64
      +---ro capabilities
      | +---ro auto-negotiation?                   boolean
      +---ro statistics
      | +---ro frame
      | | +---ro in-total-frames?                  yang:counter64

```

⁵ Copyright release for YANG modules: Users of this standard may freely reproduce the YANG module contained in this subclause so that it can be used for its intended purpose.

```

| +--ro in-total-octets?          yang:counter64
| +--ro in-frames?               yang:counter64
| +--ro in-multicast-frames?     yang:counter64
| +--ro in-broadcast-frames?     yang:counter64
| +--ro in-error-fcs-frames?     yang:counter64
| +--ro in-error-undersize-frames? yang:counter64
| +--ro in-error-oversize-frames? yang:counter64
| +--ro in-error-mac-internal-frames? yang:counter64
| +--ro out-frames?              yang:counter64
| +--ro out-multicast-frames?    yang:counter64
| +--ro out-broadcast-frames?    yang:counter64
| +--ro out-error-mac-internal-frames? yang:counter64
+--ro phy
| +--ro in-error-symbol?        yang:counter64
| +--ro lpi
| | +--ro in-lpi-transitions?    yang:counter64
| | +--ro in-lpi-time?          decimal64
| | +--ro out-lpi-transitions?   yang:counter64
| | +--ro out-lpi-time?         decimal64
+--ro mac-control
| +--ro in-frames-mac-control-unknown? yang:counter64
| +--ro in-frames-mac-control-extension? yang:counter64
| +--ro out-frames-mac-control-extension? yang:counter64

module: ieee802-ethernet-interface-half-duplex
augment /if:interfaces/if:interface/ieee802-eth-if:ethernet:
+--rw dynamic-rate-control? dynamic-rate-control-type {dynamic-rate-control}?
augment /if:interfaces/if:interface/ieee802-eth-if:ethernet/ieee802-eth-if:capabilities:
+--ro dynamic-rate-control-supported? boolean {dynamic-rate-control}?
augment /if:interfaces/if:interface/ieee802-eth-if:ethernet/ieee802-eth-if:statistics/ieee802-eth-
if:frame:
+--ro csma-cd {csma-cd}?
| +--ro in-errors-sqe-test?          yang:counter64
| +--ro out-frames-collision-single? yang:counter64
| +--ro out-frames-collision-multiple? yang:counter64
| +--ro out-frames-deferred?         yang:counter64

```

```

+--ro out-frames-collisions-excessive?  yang:counter64
+--ro out-collisions-late?              yang:counter64
+--ro out-errors-carrier-sense?         yang:counter64
+--ro collision-histogram* [collision-count]
    +--ro collision-count                yang:counter64
    +--ro collision-count-frames?       yang:counter64

```

5.3.2 YANG module

In the following YANG module definitions, should any discrepancy between the text of the description for individual YANG nodes and the corresponding definition in 5.2 through 5.3 of this clause occur, the definitions and mappings in 5.3 shall take precedence.

An ASCII text version of the Ethernet YANG module can be found at the following URL:⁶
<https://github.com/YangModels/yang/tree/master/standard/ieee/published/802.3>.

5.3.2.1 Ethernet interface module

```
module ieee802-ethernet-interface {
  yang-version 1.1;

  namespace
    "urn:ieee:std:802.3:yang:ieee802-ethernet-interface";

  prefix ieee802-eth-if;

  revision 2019-06-21 {
    description "Initial revision.";
  }

  import ietf-yang-types {
    prefix yang;
    reference "IETF RFC 6991";
  }

  import ietf-interfaces {
    prefix if;
    reference "IETF RFC 8343";
  }

  import iana-if-type {
    prefix ianaift;
    reference "http://www.iana.org/assignments/yang-parameters/iana-if-type@2018-07-03.yang";
  }

  organization
    "IEEE Std 802.3 Ethernet Working Group
    Web URL: http://www.ieee802.org/3/";

  contact
    "Web URL: http://www.ieee802.org/3/";

  description
    "This module contains YANG definitions for configuring IEEE Std
    802.3 Ethernet Interfaces.
    In this YANG module, 'Ethernet interface' can be interpreted
    as referring to 'IEEE Std 802.3 compliant Ethernet
```

⁶Copyright release for YANG modules: Users of this standard may freely reproduce the YANG module contained in this subclause so that it can be used for its intended purpose.

```

    interfaces'.";

reference "IEEE Std 802.3-2018, unless dated explicitly";

typedef eth-if-speed-type {
    type decimal64 {
        fraction-digits 3;
    }
    units "Gb/s";
    description
        "Used to represent the configured, negotiated, or actual speed
        of an Ethernet interface in Gigabits per second (Gb/s),
        accurate to 3 decimal places (i.e., accurate to 1 Mb/s).";
}

typedef duplex-type {
    type enumeration {
        enum full {
            description
                "Full duplex.";
        }
        enum half {
            description
                "Half duplex.";
        }
        enum unknown {
            description
                "Link is currently disconnected or initializing.";
        }
    }
    default full;
    description
        "Used to represent the configured, negotiated, or actual
        duplex mode of an Ethernet interface.";
    reference "IEEE Std 802.3, 30.3.1.1.32, aDuplexStatus";
}

typedef pause-fc-direction-type {
    type enumeration {
        enum "disabled" {
            description
                "Flow-control disabled in both ingress and egress
                directions, i.e., PAUSE frames are not transmitted and
                PAUSE frames received in the ingress direction are
                discarded without processing.";
        }
        enum "ingress-only" {
            description
                "PAUSE frame based flow control is enabled in the ingress
                direction only, i.e., PAUSE frames may be transmitted to
                reduce the ingress traffic flow, but PAUSE frames received
                in the ingress direction are discarded without reducing
                the egress traffic rate.";
        }
    }
}

```

```

enum "egress-only" {
  description
    "PAUSE frame based flow control is enabled in the egress
    direction only, i.e., PAUSE frames are not transmitted,
    but PAUSE frames received in the ingress direction are
    processed to reduce the egress traffic rate.";
}
enum "bi-directional" {
  description
    "PAUSE frame based flow control is enabled in both ingress
    and egress directions, i.e., PAUSE frames may be
    transmitted to reduce the ingress traffic flow, and
    PAUSE frames received on ingress are processed to reduce
    the egress traffic rate.";
}
enum "undefined" {
  description
    "Link is currently disconnected or initializing.";
}
}
description
  "Used to represent the configured, negotiated, or actual
  PAUSE frame-based flow control setting.";

reference
  "IEEE Std 802.3.1, dot3PauseAdminMode and dot3PauseOperMode";
}

feature ethernet-pfc {
  description
    "This device supports Ethernet priority flow-control.";
}

feature ethernet-pause {
  description
    "This device supports Ethernet PAUSE.";
}

augment "/if:interfaces/if:interface" {
  when "derived-from-or-self(if:type, 'ianaift:ethernetCsmacd')" {
    description
      "Applies to all P2P Ethernet interfaces.";
  }
  description
    "Augment interface model with Ethernet interface
    specific configuration nodes.";

  container ethernet {
    description
      "Contains all Ethernet interface related configuration.";

    container auto-negotiation {
      presence
        "The presence of this container indicates that

```

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```

    auto-negotiation is supported on this Ethernet
    interface.";
description
    "Contains auto-negotiation transmission parameters

    This container contains a data node that allows the
    advertised duplex value in the negotiation to be
    restricted.

    If not specified then the default behavior for the duplex
    data node is to negotiate all available values for the
    particular type of Ethernet PHY associated with the
    interface.

    If auto-negotiation is enabled, and PAUSE frame based flow
    control has not been explicitly configured, then the
    default PAUSE frame based flow control capabilities that
    are negotiated allow for bi-directional or egress-only
    PAUSE frame based flow control.

    If auto-negotiation is enabled, and PAUSE frame based flow
    control has been explicitly configured, then the
    configuration settings restrict the values that may be
    negotiated. However, it should be noted that the protocol
    does not allow only egress PAUSE frame based flow control
    to be negotiated without also allowing bi-directional
    PAUSE frame based flow control.";
reference
    "IEEE Std 802.3, Clause 28 and Annexes 28A-D";

leaf enable {
    type boolean;
    default true;

    description
        "Controls whether auto-negotiation is enabled or
        disabled.
        For interface types that support auto-negotiation then
        it defaults to being enabled.

        For interface types that do not support auto-negotiation,
        the related configuration data is ignored.";
}
leaf negotiation-status {
    when "../enable = 'true'";
    type enumeration {
        enum in-progress {
            description
                "The auto-negotiation protocol is running and
                negotiation is currently in-progress.";
        }
        enum complete {
            description
                "The auto-negotiation protocol has completed

```

```

        successfully.";
    }
    enum failed {
        description
            "The auto-negotiation protocol has failed.";
    }
    enum unknown {
        description
            "The auto-negotiation status is not currently known,
            this could be because it is still negotiating or the
            protocol cannot run (e.g., if no medium is present).";
    }
    enum no-negotiation {
        description
            "No auto-negotiation is executed.
            The auto-negotiation function is either not supported
            on this interface or has not been enabled.";
    }
    }
    config false;
    description
        "The status of the auto-negotiation protocol.";
    reference
        "IEEE 802.3, 30.6.1.1.4, aAutoNegAutoConfig";
    }
}

leaf duplex {
    type duplex-type;
    description
        "Operational duplex mode of the Ethernet interface.";
    reference
        "IEEE Std 802.3, 30.3.1.1.32 aDuplexStatus";
}

leaf speed {
    type eth-if-speed-type;
    units "Gb/s";
    description
        "Operational speed (data rate) of the Ethernet interface.
        The default value is implementation-dependent.";
}

container flow-control {
    description
        "Holds the different types of Ethernet PAUSE frame based
        flow control that can be enabled.";
    container pause {
        if-feature "ethernet-pause";
        description
            "IEEE Std 802.3 PAUSE frame based PAUSE frame based flow
            control.";
        reference

```

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```

    "IEEE Std 802.3, Annex 31B";
  leaf direction {
    type pause-fc-direction-type;
    description
      "Indicates which direction PAUSE frame based flow
       control is enabled in, or whether it is disabled.
       The default flow-control settings are vendor specific.
       If auto-negotiation is enabled, then PAUSE based
       flow-control is negotiated by default.
       The default value is implementation-dependent.";
  }

  container statistics {
    config false;
    description
      "Contains the number of PAUSE frames received or
       transmitted.";
    leaf in-frames-pause {
      type yang:counter64;
      units frames;
      description
        "A count of PAUSE MAC Control frames transmitted on
         this Ethernet interface.

         Discontinuities in the values of counters in
         this container can occur at re-initialization of the
         management system, and at other times as indicated
         by the value of the 'discontinuity-time' leaf
         defined in the ietf-interfaces YANG module
         (IETF RFC 8343).";
      reference
        "IEEE Std 802.3, 30.3.4.3 aPAUSEMACCtrlFramesReceived";
    }
    leaf out-frames-pause {
      type yang:counter64;
      units frames;
      description
        "A count of PAUSE MAC Control frames transmitted on
         this Ethernet interface.

         Discontinuities in the values of counters in
         this container can occur at re-initialization of the
         management system, and at other times as indicated
         by the value of the 'discontinuity-time' leaf
         defined in the ietf-interfaces YANG module
         (IETF RFC 8343).";
      reference
        "IEEE Std 802.3, 30.3.4.2
         aPAUSEMACCtrlFramesTransmitted";
    }
  }
}

container pfc {

```

```
if-feature "ethernet-pfc";
description
  "IEEE Std 802.3 Priority-based flow control.";
reference
  "IEEE Std 802.3, Annex 31D";

leaf enable {
  type boolean;

  description
    "True indicates that IEEE Std 802.3 priority-based
    flow control is enabled, false indicates that
    IEEE Std 802.3 priority-based flow control is disabled.
    For interfaces that have auto-negotiation,
    the priority-based flow control is enabled by default.";
}

container statistics {
  config false;
  description
    "This container collects all statistics for
    Ethernet interfaces.";

  leaf in-frames-pfc {
    type yang:counter64;
    units frames;
    description
      "A count of PFC MAC Control frames received on this
      Ethernet interface.

      Discontinuities in the values of counters in
      this container can occur at re-initialization of the
      management system, and at other times as indicated
      by the value of the 'discontinuity-time' leaf
      defined in the ietf-interfaces YANG module
      (IETF RFC 8343).";
    reference
      "IEEE Std 802.3.1, dot3HCInPFCFrames";
  }

  leaf out-frames-pfc {
    type yang:counter64;
    units frames;
    description
      "A count of PFC MAC Control frames transmitted on
      this interface.

      Discontinuities in the values of counters in
      this container can occur at re-initialization of the
      management system, and at other times as indicated
      by the value of the 'discontinuity-time' leaf
      defined in the ietf-interfaces YANG module
      (IETF RFC 8343).";
    reference
```

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```

        "IEEE Std 802.3.1, dot3HCInPFCFrames";
    }
}

leaf force-flow-control {
    type boolean;
    default false;
    description
        "Explicitly forces the local PAUSE frame based flow control
        settings regardless of what has been negotiated.

        Since the auto-negotiation of flow-control settings
        does not allow all sane combinations to be negotiated
        (e.g., consider a device that is only capable of sending
        PAUSE frames connected to a peer device that is only
        capable of receiving and acting on PAUSE frames) and
        failing to agree on the flow-control settings does not
        cause the auto-negotiation to fail completely, then it is
        sometimes useful to be able to explicitly enable
        particular PAUSE frame based flow control settings on
        the local device regardless of what is being advertised
        or negotiated.";
    reference
        "IEEE Std 802.3, Table 28B-3";
}

leaf max-frame-length {
    type uint16;
    units octets;
    config false;
    description
        "This indicates the MAC frame length (including FCS bytes)
        at which frames are dropped for being too long.";
    reference
        "IEEE Std 802.3, 30.3.1.1.37 aMaxFrameLength";
}

leaf mac-control-extension-control {
    type boolean;
    config false;
    description
        "A value that identifies the current EXTENSION MAC Control
        function, as specified in IEEE Std 802.3, Annex 31C.";
    reference
        "IEEE Std 802.3, 30.3.8.3 aEXTENSIONMACCtrlStatus
        IEEE Std 802.3.1, dot3ExtensionMacCtrlStatus ";
}

leaf frame-limit-slow-protocol {
    type uint64;
    units f/s;
    default 10;

```

```

    config false;
    description
        "The maximum number of Slow Protocol frames of a given
        subtype that can be transmitted in a one second interval.
        The default value is 10.";
    reference
        "IEEE Std 802.3, 30.3.1.1.38 aSlowProtocolFrameLimit";
}

container capabilities {
    config false;
    description
        "Container all Ethernet interface specific capabilities.";

    leaf auto-negotiation {
        type boolean;
        description
            "Indicates whether auto-negotiation may be configured on
            this interface.";
    }
}

container statistics {
    config false;
    description
        "Contains statistics specific to Ethernet interfaces.

        Discontinuities in the values of counters in the
        container can occur at re-initialization of the management
        system, and at other times as indicated by the value of
        the 'discontinuity-time' leaf defined in the
        ietf-interfaces YANG module (IETF RFC 8343).";

    container frame {
        description
            "Contains frame statistics specific to Ethernet
            interfaces.

            All octet frame lengths include the 4 byte FCS.

            Error counters are only reported once ... The count
            represented by an instance of this object is incremented
            when the frameCheckError status is returned by the MAC
            service to the LLC (or other MAC user). Received frames
            for which multiple error conditions pertain are,
            according to the conventions of IEEE Std 802.3 Layer
            Management, counted exclusively according to the error
            status presented to the LLC.

            A frame that is counted by an instance of this object is
            also counted by the corresponding instance of 'in-errors'
            leaf defined in the ietf-interfaces YANG module
            (IETF RFC 8343).";
    }
}

```

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Discontinuities in the values of counters in the container can occur at re-initialization of the management system, and at other times as indicated by the value of the 'discontinuity-time' leaf defined in the ietf-interfaces YANG module (IETF RFC 8343).";

```
leaf in-total-frames {
  type yang:counter64;
  units frames;
  description
    "The total number of frames (including bad frames)
    received on the Ethernet interface.

    This counter is calculated by summing the following
    IEEE Std 802.3, Clause 30 counters:
    aFramesReceivedOK +
    aFrameCheckSequenceErrors +
    aAlignmentErrors +
    aFrameTooLongErrors +
    aFramesLostDueToIntMACRcvError

    Also see the 'description' statement associated with
    the parent 'statistics' container for additional
    common semantics related to this counter.";

  reference
    "IEEE Std 802.3, Clause 30 counters, as specified
    in the description above.";
}

leaf in-total-octets {
  type yang:counter64;
  units octets;
  description
    "The total number of octets of data (including those in
    bad frames) received on the Ethernet interface.

    Includes the 4-octet FCS.

    Also see the 'description' statement associated with
    the parent 'statistics' container for additional
    common semantics related to this counter.";

  reference
    "IETF RFC 2819, etherStatsOctets";
}

leaf in-frames {
  type yang:counter64;
  units frames;
  description
    "A count of frames (including unicast, multicast and
    broadcast) that have been successfully received on the
```

Ethernet interface.

This count does not include frames received with frame-too-long, FCS, length or alignment errors, or frames lost due to internal MAC sublayer error.

Also see the 'description' statement associated with the parent 'statistics' container for additional common semantics related to this counter.";

```
reference
  "IEEE Std 802.3, 30.3.1.1.5 aFramesReceivedOK";
}

leaf in-multicast-frames {
  type yang:counter64;
  units frames;
  description
    "A count of multicast frames that have been
    successfully received on the Ethernet interface.

    This counter represents a subset of the frames counted
    by in-frames.

    This count does not include frames received with
    frame-too-long, FCS, length or alignment errors, or
    frames lost due to internal MAC sublayer error.

    Also see the 'description' statement associated with
    the parent 'statistics' container for additional
    common semantics related to this counter.";

  reference
    "IEEE Std 802.3, 30.3.1.1.21 aMulticastFramesReceivedOK";
}

leaf in-broadcast-frames {
  type yang:counter64;
  units frames;
  description
    "A count of broadcast frames that have been
    successfully received on the Ethernet interface.

    This counter represents a subset of the frames counted
    by in-frames.

    This count does not include frames received with
    frame-too-long, FCS, length or alignment errors, or
    frames lost due to internal MAC sublayer error.

    Also see the 'description' statement associated with
    the parent 'statistics' container for additional
    common semantics related to this counter.";
```

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```

reference
  "IEEE Std 802.3, 30.3.1.1.22 aBroadcastFramesReceivedOK";
}

leaf in-error-fcs-frames {
  type yang:counter64;
  units frames;
  description
    "A count of receive frames that are of valid length,
    but do not pass the FCS check, regardless of whether
    or not the frames are an integral number of octets in
    length.

    This count effectively comprises
    aFrameCheckSequenceErrors and aAlignmentErrors added
    together.

    Also see the 'description' statement associated with
    the parent 'statistics' container for additional
    common semantics related to this counter.";

  reference
    "IEEE Std 802.3, 30.3.1.1.6 aFrameCheckSequenceErrors;
    IEEE Std 802.3, 30.3.1.1.7 aAlignmentErrors";
}

leaf in-error-undersize-frames {
  type yang:counter64;
  units frames;
  description
    "A count of frames received on a particular Ethernet
    interface that are less than 64 bytes in length, and
    are discarded.

    This counter is incremented regardless of whether the
    frame passes the FCS check.

    Also see the 'description' statement associated with
    the parent 'statistics' container for additional
    common semantics related to this counter.";

  reference
    "IETF RFC 2819, etherStatsUndersizePkts and
    etherStatsFragments";
}

leaf in-error-oversize-frames {
  type yang:counter64;
  units frames;
  description
    "A count of frames received on a particular Ethernet
    interface that exceed the maximum permitted frame
    size, that is specified in max-frame-length, and are
    discarded."

```

This counter is incremented regardless of whether the frame passes the FCS check.

Also see the 'description' statement associated with the parent 'statistics' container for additional common semantics related to this counter.";

```
reference "IEEE Std 802.3, 30.3.1.1.25 aFrameTooLongErrors";
}
```

```
leaf in-error-mac-internal-frames {
  type yang:counter64;
  units frames;
  description
    "A count of frames for which reception on a particular
    Ethernet interface fails due to an internal MAC
    sublayer receive error.

    A frame is only counted by an instance of this object
    if it is not counted by the corresponding instance of
    either the in-error-fcs-frames, in-error-undersize-frames,
    or in-error-oversize-frames. The precise meaning of the
    count represented by an instance of this object is
    implementation-specific.
```

In particular, an instance of this object may represent a count of receive errors on a particular Ethernet interface that are not otherwise counted.

Also see the 'description' statement associated with the parent 'statistics' container for additional common semantics related to this counter.";

```
reference
  "IEEE Std 802.3, 30.3.1.1.15
  aFramesLostDueToIntMACRcvError";
}
```

```
leaf out-frames {
  type yang:counter64;
  units frames;
  description
    "A count of frames (including unicast, multicast and
    broadcast) that have been successfully transmitted on
    the Ethernet interface.
```

Also see the 'description' statement associated with the parent 'statistics' container for additional common semantics related to this counter.";

```
reference
  "IEEE Std 802.3, 30.3.1.1.2 aFramesTransmittedOK";
}
```

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```

leaf out-multicast-frames {
  type yang:counter64;
  units frames;
  description
    "A count of multicast frames that have been
    successfully transmitted on the Ethernet interface.

    This counter represents a subset of the frames counted
    by out-frames.

    Also see the 'description' statement associated with
    the parent 'statistics' container for additional
    common semantics related to this counter.";

  reference
    "IEEE Std 802.3, 30.3.1.1.18 aMulticastFramesXmittedOK";
}

leaf out-broadcast-frames {
  type yang:counter64;
  units frames;
  description
    "A count of broadcast frames that have been
    successfully transmitted on the Ethernet interface.

    This counter represents a subset of the frames counted
    by out-frames.

    Also see the 'description' statement associated with
    the parent 'statistics' container for additional
    common semantics related to this counter.";

  reference
    "IEEE Std 802.3, 30.3.1.1.19 aBroadcastFramesXmittedOK";
}

leaf out-error-mac-internal-frames {
  type yang:counter64;
  units frames;
  description
    "A count of frames for which transmission on a
    particular Ethernet interface fails due to an internal
    MAC sublayer transmit error.

    The precise meaning of the count represented by an
    instance of this object is implementation-specific. In
    particular, an instance of this object may represent a
    count of transmission errors on a particular Ethernet
    interface that are not otherwise counted.

    Also see the 'description' statement associated with
    the parent 'statistics' container for additional
    common semantics related to this counter.";
```

```

        reference
        "IEEE Std 802.3, 30.3.1.1.12
        aFramesLostDueToIntMACXmitError";
    }
}

container phy {
    description
        "Ethernet statistics related to the PHY layer.

        Discontinuities in the values of counters in the
        container can occur at re-initialization of the
        management system, and at other times as indicated by
        the value of the 'discontinuity-time' leaf defined in
        the ietf-interfaces YANG module (IETF RFC 8343).";

    leaf in-error-symbol {
        type yang:counter64;
        units errors;
        description
            "A count of the number of symbol errors that have
            occurred.

            For the precise definition of when the symbol error
            counter is incremented, please see the 'description'
            text associated with aSymbolErrorDuringCarrier,
            specified in IEEE Std 802.3, 30.3.2.1.5.

            Also see the 'description' statement associated with
            the parent 'phy-statistics' container for additional
            common semantics related to this counter.";
        reference
            "IEEE Std 802.3, 30.3.2.1.5 aSymbolErrorDuringCarrier";
    }

    container lpi {
        description
            "Physical Ethernet statistics for the energy efficiency
            related low power idle indications.";

        leaf in-lpi-transitions {
            type yang:counter64;
            units transitions;
            description
                "A count of occurrences of the transition from
                DEASSERT to ASSERT of the LPI_INDICATE
                parameter. The indication reflects the state of the
                PHY according to the requirements of the RS (see
                IEEE Std 802.3, 22.7, 35.4, and 46.4).

                Also see the 'description' statement associated with
                the parent 'phy-statistics' container for additional
                common semantics related to this counter.";
        }
    }
}

```

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```

reference
  "IEEE Std 802.3, 30.3.2.1.11 aReceiveLPITransitions";
}

leaf in-lpi-time {
  type decimal64 {
    fraction-digits 6;
  }
  units seconds;
  description
    "A count reflecting the total amount of time (in
    seconds) that the LPI_REQUEST parameter has the
    value ASSERT. The request is indicated to the PHY
    according to the requirements of the RS (see IEEE Std
    802.3, 22.7, 35.4, and 46.4).

    Also see the 'description' statement associated with
    the parent 'phy-statistics' container for additional
    common semantics related to this counter.";

  reference
    "IEEE Std 802.3, 30.3.2.1.9 aReceiveLPIMicroseconds";
}

leaf out-lpi-transitions {
  type yang:counter64;
  units transitions;
  description
    "A count of occurrences of the transition from state
    LPI_DEASSERTED to state LPI_ASSERTED in the LPI
    transmit state diagram of the RS. The state
    transition corresponds to the assertion of the
    LPI_REQUEST parameter. The request is indicated to
    the PHY according to the requirements of the RS (see
    IEEE Std 802.3, 22.7, 35.4, 46.4.)

    Also see the 'description' statement associated with
    the parent 'phy-statistics' container for additional
    common semantics related to this counter.";

  reference
    "IEEE Std 802.3, 30.3.2.1.10 aTransmitLPITransitions";
}

leaf out-lpi-time {
  type decimal64 {
    fraction-digits 6;
  }
  units seconds;
  description
    "A count reflecting the total amount of time (in
    seconds) that the LPI_INDICATION parameter has the
    value ASSERT. The request is indicated to the PHY

```

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according to the requirements of the RS (see IEEE 802.3, 22.7, 35.4, and 46.4).

Also see the 'description' statement associated with the parent 'phy-statistics' container for additional common semantics related to this counter.";

```
reference
  "IEEE Std 802.3, 30.3.2.1.8 aTransmitLPIMicroseconds";
}
}
```

```
container mac-control {
  description
    "A group of statistics specific to MAC Control operation
    of selected Ethernet interfaces.
```

Discontinuities in the values of counters in the container can occur at re-initialization of the management system, and at other times as indicated by the value of the 'discontinuity-time' leaf defined in the ietf-interfaces YANG module (IETF RFC 8343).";

```
reference
  "IEEE Std 802.3.1, dot3ExtensionTable";
```

```
leaf in-frames-mac-control-unknown {
  type yang:counter64;
  units frames;
  description
    "A count of MAC Control frames with an unsupported
    opcode received on this Ethernet interface.

    Frames counted against this counter are also counted
    against in-discards defined in the ietf-interfaces
    YANG module (IETF RFC 8343).

    Also see the 'description' statement associated with
    the parent 'mac-control-statistics' container for
    additional semantics.";
  reference
    "IEEE Std 802.3, 30.3.3.5 aUnsupportedOpCodesReceived";
}
```

```
leaf in-frames-mac-control-extension {
  type yang:counter64;
  units frames;
  description
    "The count of Extension MAC Control frames received on
    this Ethernet interface.

    Also see the 'description' statement associated with
    the parent 'mac-control-statistics' container for
```

```

        additional semantics.";
    reference
        "IEEE Std 802.3, 30.3.8.2
         aEXTENSIONMACCtrlFramesReceived";
}

leaf out-frames-mac-control-extension {
    type yang:counter64;
    units frames;
    description
        "The count of Extension MAC Control frames transmitted
         on this Ethernet interface.

        Also see the 'description' statement associated with
        the parent 'mac-control-statistics' container for
        additional semantics.";
    reference
        "IEEE Std 802.3, 30.3.8.1
         aEXTENSIONMACCtrlFramesTransmitted";
}
}
}
}
}
```

5.3.2.2 Ethernet interface module (half-duplex)

```
module ieee802-ethernet-interface-half-duplex {

  yang-version 1.1;

  namespace
    "urn:ieee:std:802.3:yang:ieee802-ethernet-interface-half-duplex";

  prefix ieee802-eth-half-duplex;

  revision 2019-06-21 {
    description "Initial revision.";
  }

  import ietf-yang-types {
    prefix yang;
    reference "IETF RFC 6991";
  }

  import ietf-interfaces {
    prefix if;
    reference "IETF RFC 8343";
  }

  import iana-if-type {
    prefix ianaift;
    reference "http://www.iana.org/assignments/yang-parameters/
      iana-if-type@2018-07-03.yang";
  }

}
```

```

import ieee802-ethernet-interface {
  prefix ieee802-eth-if;
}

organization
  "IEEE Std 802.3 Ethernet Working Group
  Web URL: http://www.ieee802.org/3/";

contact
  "Web URL: http://www.ieee802.org/3/";

description
  "This module contains YANG definitions for configuring Ethernet
  interfaces that are deprecated, and are no longer
  widely used in the industry. The definitions are maintained for
  backwards compatibility purposes, but the general expectation is
  that this module is not anticipated to be widely implemented.";
reference
  "IEEE Std 802.3-2018, unless dated explicitly";

feature dynamic-rate-control {
  description
    "This feature indicates that the device supports Ethernet
    interfaces lowering the average data rate of the MAC sublayer,
    with frame granularity, by using Rate Control to dynamically
    increase the inter-packet gap for some types of Ethernet
    interface.
    Only valid for Ethernet interfaces operating at speeds (data rates)
    above 1000 Mb/s.";
  reference "IEEE Std 802.3, 30.3.1.1.33 aRateControlAbility";
}

feature csma-cd {
  description
    "This feature indicates that the device supports Ethernet
    interfaces running at half-duplex using CSMA/CD.";
}

typedef dynamic-rate-control-type {
  type enumeration {
    enum disabled {
      description
        "Dynamic rate control is disabled";
    }

    enum "sonet-oc192" {
      value 2;
      description
        "Dynamic rate control is enabled for a 10 Gb/s Ethernet
        interface to SONET/SDH OC192/STM64.";
    }
  }
}
default disabled;
description
  "Allowed values for dynamic-rate-control.";
reference
  "IEEE Std 802.3, 4.4.2 ipgStretchRatio and 30.3.1.1.34
  aRateControlStatus";

```