Network Working Group
Request for Comments: 4323
Category: Standards Track

M. Patrick
W. Murwin
Motorola BCS

January 2006

Data Over Cable System Interface Specification Quality of Service Management Information Base (DOCSIS-QoS MIB)

Status of This Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

Copyright Notice

Copyright (C) The Internet Society (2006).

Abstract

This document defines a basic set of managed objects for SNMP-based management of extended QoS features of Cable Modems (CMs) and Cable Modem Termination Systems (CMTSs) conforming to the Data over Cable System (DOCSIS) specifications versions 1.1 and 2.0.

Table of Contents

1. Introduction 2
1.1. The Internet-Standard Management Framework 2
1.2. Glossary 3
2. Overview 5
2.1. Textual Conventions 5
2.2. MIB Organization 5
2.2.1. docsIetfQosPktClassTable 9
2.2.2. docsIetfQosParamSetTable 10
2.2.2.1. Interoperation with DOCSIS 1.0 11
2.2.3. docsIetfQosServiceFlowTable 12
2.2.4. docsIetfQosServiceFlowStatsTable 13
2.2.5. docsIetfQosUpstreamStatsTable 14
2.2.6. docsIetfQosDynamicServiceStatsTable 14
2.2.7. docsIetfQosServiceFlowLogTable 14
2.2.8. docsIetfQosServiceClassTable 15
2.2.9. docsIetfQosServiceClassPolicyTable 15
2.2.10. docsIetfQosPHSTable 16
2.2.11. docsIetfQosCmtsMacToSrvFlowTable 16
3. Externally Administered Classification 16
4. DOCSIS and IPv4 Type-of-Service (ToS) Field 19
5. Definitions 20
6. Security Considerations 84
7. IANA Considerations 86
8. Acknowledgements 86
9. Normative References 86
10. Informative References 87

1. Introduction

This memo is a product of the IP over Cable Data Network (IPCDN) working group within the Internet Engineering Task Force (IETF).

1.1. The Internet-Standard Management Framework

For a detailed overview of the documents that describe the current Internet-Standard Management Framework, please refer to section 7 of RFC 3410 [15].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This memo specifies a MIB module that is compliant to the SMIv2, which is described in STD 58, RFC 2578 [1], STD 58, RFC 2579 [2] and STD 58, RFC 2580 [3].

1.2. Glossary

Active QPS	Active QoS Parameter Set (QPS). The set of QoS parameters that describe the current level of service provided to a Service Flow (SF).
Active SF	Active Service Flow. An SF with a non-empty Active QPS.
Admitted QPS	Admitted QoS Parameter Set. The set of QoS parameters that describe a level of service that the Service Flow is not currently using, but that it is guaranteed to receive upon the SF's request to make the set Active.
Admitted SF	A Service Flow with a non-empty Admitted QPS.
CATV	Cable Television.
CM	Cable Modem. A modem connecting a subscriber's LAN to the Cable Television (CATV) Radio Frequency (RF) network. DOCSIS CMs operate as a MAC layer bridge between the home LAN and the Cable Television (CATV) Radio Frequency (RF) network.
CMTS	Cable Modem Termination System. The "head-end" device providing connectivity between the RF network and the Internet.
Downstream	The direction from the head-end towards the subscriber.
DSA	Dynamic Service Addition. A DOCSIS MAC management message requesting the dynamic creation of a new Service Flow. New SFs are created with a three-message exchange of a DSA-REQ, DSA-RSP, and DSA-ACK.
DSC	Dynamic Service Change. A DOCSIS MAC management message requesting a change to the attributes of a Service Flow. SFs are changed with a three-message exchange of a DSC-REQ, DSC-RSP, and DSC-ACK.
DSD	Dynamic Service Delete. A DOCSIS MAC management message requesting the deletion of a Service Flow. SFs are deleted with a two-message exchange of a DSD-REQ and DSD-ACK.

Head-end	The origination point in most cable systems of the subscriber video signals. It is generally also the location of the CMTS.
PHS	Payload Header Suppression. A feature of DOCSIS 1.1 and 2.0 in which header bytes that are common in a sequence of packets of a Service Flow are replaced by a one-byte PHSI Index (PHSI) when transmitting the packet on the RF network.
primary SF	Primary Service Flow. All CMs have a Primary Upstream Service Flow and a Primary Downstream Service Flow. They provide a default path for forwarded packets that are not classified to any other Service Flow.
Provisioned QPS	A QoS Parameter Set describing an envelope of service within which a Service Flow is authorized to request admission. All existing Service Flows must have a non-empty Provisioned QPS; thus, all SFs are considered to be "Provisioned".
RF	Radio Frequency. In particular, this abbreviation refers to the radio frequencies for Cable Television (CATV).
SCN	Service Class Name. A named set of QoS parameters. A Service Flow may or may not be associated with a single named Service Class. A Service Class has as an attribute a QoS Parameter Set that is used as the default set of values for all Service Flows belonging to the Service Class.
SID	Service ID. A 16-bit unsigned integer assigned by the CMTS for an Upstream Service Flow with a non-empty Active QoS Parameter Set.
SF	Service Flow. A unidirectional stream of packets between the CM and CMTS. SFs are characterized as upstream or downstream. The SF is the fundamental unit of service provided on a DOCSIS CATV network.
SFID	Service Flow ID. A 32-bit unsigned integer assigned by the CMTS to each Service Flow.
Upstream	The direction from a subscriber CM to the head-end CMTS.

2. Overview

This MIB module provides a set of objects required for the management of DOCSIS 1.1 and 2.0 compliant Cable Modems (CM) and Cable Modem Termination Systems (CMTS). The specification is derived from the DOCSIS 2.0 Radio Frequency Interface specification [4]. Please note that the referenced DOCSIS specifications only requires Cable Modems to process IPv4 customer traffic. Design choices in this MIB module reflect those requirements. Future versions of the DOCSIS standard are expected to require support for IPv6 as well.

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [5].

2.1. Textual Conventions

The textual convention "DocsIetfQosRfMacIfDirection" is defined to indicate the direction of a packet classifier relative to an interface. It takes the values of either downstream(1) or upstream(2).

The textual convention "DocsIetfQosBitRate" corresponds to the bits per second as defined for QoS Parameter Sets in DOCSIS 1.1 and 2.0. This definition includes all bits of the Ethernet MAC frame as transmitted on the RF network, starting with the Destination Address and ending with the Ethernet Frame Check Sequence (FCS). It does NOT includes bits in the DOCSIS MAC header.

2.2. MIB Organization

The structure of the IPCDN QoS MIB module (DOCS-IETF-QOS-MIB) is summarized below:

```
docsIetfQosMIB
  docsIetfQosMIBObjects
    docsIetfQosPktClassTable
      docsIetfQosPktClassEntry
        docsIetfQosPktClassId
        docsIetfQosPktClassDirection
        docsIetfQosPktClassPriority
        docsIetfQosPktClassIpTosLow
        docsIetfQosPktClassIpTosHigh
        docsIetfQosPktClassIpTosMask
        docsIetfQosPktClassIpProtocol
        docsIetfQosPktClassInetAddressType
        docsIetfQosPktClassInetSourceAddr
        docsIetfQosPktClassInetSourceMask
```

```
            docsIetfQosPktClassInetDestAddr
            docsIetfQosPktClassInetDestMask
            docsIetfQosPktClassSourcePortStart
            docsIetfQosPktClassSourcePortEnd
            docsIetfQosPktClassDestPortStart
            docsIetfQosPktClassDestPortEnd
            docsIetfQosPktClassDestMacAddr
            docsIetfQosPktClassDestMacMask
            docsIetfQosPktClassSourceMacAddr
            docsIetfQosPktClassEnetProtocolType
            docsIetfQosPktClassEnetProtocol
            docsIetfQosPktClassUserPriLow
            docsIetfQosPktClassUserPriHigh
            docsIetfQosPktClassVlanId
            docsIetfQosPktClassStateActive
            docsIetfQosPktClassPkts
            docsIetfQosPktClassBitMap
        docsIetfQosParamSetTable
          docsIetfQosParamSetEntry
            docsIetfQosParamSetServiceClassName
            docsIetfQosParamSetPriority
            docsIetfQosParamSetMaxTrafficRate
            docsIetfQosParamSetMaxTrafficBurst
            docsIetfQosParamSetMinReservedRate
            docsIetfQosParamSetMinReservedPkt
            docsIetfQosParamSetActiveTimeout
            docsIetfQosParamSetAdmittedTimeout
            docsIetfQosParamSetMaxConcatBurst
            docsIetfQosParamSetSchedulingType
            docsIetfQosParamSetNomPollInterval
            docsIetfQosParamSetTolPollJitter
            docsIetfQosParamSetUnsolicitGrantSize
            docsIetfQosParamSetNomGrantInterval
            docsIetfQosParamSetTolGrantJitter
            docsIetfQosParamSetGrantsPerInterval
            docsIetfQosParamSetTosAndMask
            docsIetfQosParamSetTosOrMask
            docsIetfQosParamSetMaxLatency
            docsIetfQosParamSetType
            docsIetfQosParamSetRequestPolicyOct
            docsIetfQosParamSetBitMap
        docsIetfQosServiceFlowTable
          docsIetfQosServiceFlowEntry
            docsIetfQosServiceFlowId
            docsIetfQosServiceFlowSID
            docsIetfQosServiceFlowDirection
            docsIetfQosServiceFlowPrimary
        docsIetfQosServiceFlowStatsTable
```

```
      docsIetfQosServiceFlowStatsEntry
        docsIetfQosServiceFlowPkts
        docsIetfQosServiceFlowOctets
        docsIetfQosServiceFlowTimeCreated
        docsIetfQosServiceFlowTimeActive
        docsIetfQosServiceFlowPHSUnknowns
        docsIetfQosServiceFlowPolicedDropPkts
        docsIetfQosServiceFlowPolicedDelayPkts
    docsIetfQosUpstreamStatsTable
      docsIetfQosUpstreamStatsEntry
        docsIetfQosSID
        docsIetfQosUpstreamFragments
        docsIetfQosUpstreamFragDiscards
        docsIetfQosUpstreamConcatBursts
    docsIetfQosDynamicServiceStatsTable
      docsIetfQosDynamicServiceStatsEntry
        docsIetfQosIfDirection
        docsIetfQosDSAReqs
        docsIetfQosDSARsps
        docsIetfQosDSAAcks
        docsIetfQosDSCReqs
        docsIetfQosDSCRsps
        docsIetfQosDSCAcks
        docsIetfQosDSDReqs
        docsIetfQosDSDRsps
        docsIetfQosDynamicAdds
        docsIetfQosDynamicAddFails
        docsIetfQosDynamicChanges
        docsIetfQosDynamicChangeFails
        docsIetfQosDynamicDeletes
        docsIetfQosDynamicDeleteFails
        docsIetfQosDCCReqs
        docsIetfQosDCCRsps
        docsIetfQosDCCAcks
        docsIetfQosDCCs
        docsIetfQosDCCFails
    docsIetfQosServiceFlowLogTable
      docsIetfQosServiceFlowLogEntry
        docsIetfQosServiceFlowLogIndex
        docsIetfQosServiceFlowLogIfIndex
        docsIetfQosServiceFlowLogSFID
        docsIetfQosServiceFlowLogCmMac
        docsIetfQosServiceFlowLogPkts
        docsIetfQosServiceFlowLogOctets
        docsIetfQosServiceFlowLogTimeDeleted
        docsIetfQosServiceFlowLogTimeCreated
        docsIetfQosServiceFlowLogTimeActive
        docsIetfQosServiceFlowLogDirection
```

```
        docsIetfQosServiceFlowLogPrimary
        docsIetfQosServiceFlowLogServiceClassName
        docsIetfQosServiceFlowLogPolicedDropPkts
        docsIetfQosServiceFlowLogPolicedDelayPkts
        docsIetfQosServiceFlowLogControl
    docsIetfQosServiceClassTable
      docsIetfQosServiceClassEntry
        docsIetfQosServiceClassName
        docsIetfQosServiceClassStatus
        docsIetfQosServiceClassMaxTrafficRate
        docsIetfQosServiceClassMaxTrafficBurst
        docsIetfQosServiceClassMinReservedRate
        docsIetfQosServiceClassMinReservedPkt
        docsIetfQosServiceClassMaxConcatBurst
        docsIetfQosServiceClassNomPollInterval
        docsIetfQosServiceClassTolPollJitter
        docsIetfQosServiceClassUnsolicitGrantSize
        docsIetfQosServiceClassNomGrantInterval
        docsIetfQosServiceClassTolGrantJitter
        docsIetfQosServiceClassGrantsPerInterval
        docsIetfQosServiceClassMaxLatency
        docsIetfQosServiceClassActiveTimeout
        docsIetfQosServiceClassAdmittedTimeout
        docsIetfQosServiceClassSchedulingType
        docsIetfQosServiceClassRequestPolicy
        docsIetfQosServiceClassTosAndMask
        docsIetfQosServiceClassTosOrMask
        docsIetfQosServiceClassDirection
        docsIetfQosServiceClassStorageType
        docsIetfQosServiceClassDSCPOverwrite
    docsIetfQosServiceClassPolicyTable
      docsIetfQosServiceClassPolicyEntry
        docsIetfQosServiceClassPolicyIndex
        docsIetfQosServiceClassPolicyName
        docsIetfQosServiceClassPolicyRulePriority
        docsIetfQosServiceClassPolicyStatus
        docsIetfQosServiceClassPolicyStorageType
    docsIetfQosPHSTable
      docsIetfQosPHSEntry
        docsIetfQosPHSField
        docsIetfQosPHSMask
        docsIetfQosPHSSize
        docsIetfQosPHSVerify
        docsIetfQosPHSIndex
    docsIetfQosCmtsMacToSrvFlowTable
      docsIetfQosCmtsMacToSrvFlowEntry
```

```
            docsIetfQosCmtsCmMac
            docsIetfQosCmtsServiceFlowId
            docsIetfQosCmtsIfIndex
```

This MIB module is organized as 11 tables. Most tables are implemented in both the CM and CMTS; the docsIetfQosUpstreamStatsTable and docsIetfQosServiceFlowLogTable are implemented on the CMTS only.

2.2.1. docsIetfQosPktClassTable

The docsIetfQosPktClassTable reports the Service Flow Classifiers implemented by the managed device. The table is indexed by the tuple { ifIndex, docsIetfQosServiceFlowId, docsIetfQosPktClassId }. The ifIndex corresponds to a CATV MAC interface. Each CATV MAC interface has a set of Service Flows identified with a docsIetfQosServiceFlowId value that is unique for that interface. Each Service Flow may have a number of packet classifiers that map packets to the flow. The ClassifierId for the classifier is unique only within a particular Service Flow.

The semantics of packet classification are provided in [4]. Briefly, the DOCSIS MAC interface calls for matching packets based on values within the 802.2 (LLC), 802.3, IP, and/or UDP/TCP headers. Packets that map more than one classifier are prioritized according to their docsIetfQosPktClassPriority values. The docsIetfQosServiceFlowId (an index object) indicates to which Service Flow the packet is classified.

The docsIetfQosPktClassTable is distinct from the docsDevIpFilterTable of [6] in that docsIetfQosPktClassTable is intended only to reflect the state of the Service Flow Classifiers. Service Flow Classifiers may be created only via a CM configuration file or from the Dynamic Service Addition (DSA) messages. For this reason, docsIetfQosPktClassTable is read-only.

The docsDevIpFilterTable is intended for external policy-based administration of packet classifiers. See the section "Externally Administered Classification", below.

2.2.2. docsIetfQosParamSetTable

The docsIetfQosParamSetTable reports the values of QoS Parameter Set as defined in Section C.2.2 of [4].

In general, a Service Flow is associated with three different QoS Parameter Sets (QPSs): an "active" QPS, an "admitted" QPS, and a "provisioned" or "authorized" QPS. The relationship of these three sets is represented below:

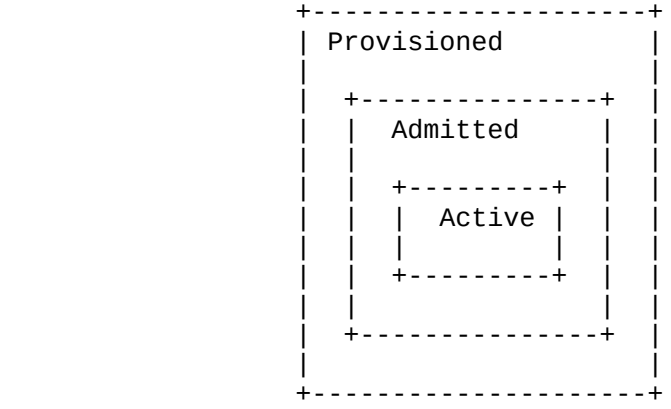


Figure 1: QoS Parameter Sets

The Provisioned QPS describes the maximum service envelope for which the SF is authorized. The Admitted QPS is the set of services for which a Service Flow has requested admission to the DOCSIS RF network, but which is not yet active. The Admitted QPS is used during the two-phase process of IP Telephony/PacketCable Service Flow admission to admit the bandwidth for a bidirectional voice call when the far end is ringing. Because ringing may occur for up to four minutes, this permits the bandwidth to be reserved but not actually consumed during this interval. The Active QPS is the set of services actually being used by the Service Flow. The DOCSIS v1.1 specification [4] defines what it means for a QPS envelope to be "within" another. In general, an inner QPS is considered "within" an outer QPS when all QoS parameters represent demands of equal or fewer resources of the network.

In addition to its use as an attribute of a Service Flow, a QPS is also an attribute of a Service Class. A DOCSIS CM configuration file or DSA message may request the creation of a new SF and give only the Service Class Name. The CMTS "expands the macro" of a Service Class Name creation by populating the Provisioned, Admitted, and/or Active QPSs of the Service Flow with the QPS of the Service Class Name. All

the QPSs of a Service Flow must be expansions of the same Service Class, and in this case the SF is said to "belong" to the Service Class. Changing the contents of a Service Class' QPS does not affect the QPS of any Service Flow earlier expanded from that Service Class name. Only the CMTS implements docsIetfQosServiceClassTable.

See [4], section 8, for a full description and the theory of operation of DOCSIS 1.1 QoS operation.

The docsIetfQosParamSetTable sets are indexed by { ifIndex, docsIetfQosServiceFlowId, docsIetfQosParamSetType}. ifIndex indicates a particular "DOCSIS MAC Domain". docsIetfQosServiceFlowId uniquely identifies a Service Flow on that MAC domain. The docsIetfQosParamSetType indicates whether the row describes an active, admitted, or provisioned QoS Parameter Set.

The docsIetfQosParamSetTable is read-only because it indicates the QoS Parameter Set contents as defined by DOCSIS signaling. The docsIetfQosServiceClassTable is read-create to permit managers to define a template of QoS Parameters that can be referenced by DOCSIS modems when creating their QoS Parameter Sets.

2.2.2.1. Interoperation with DOCSIS 1.0

The DOCS-IF-MIB [7] specifies a docsIfQosProfileTable to describe the set of Class Of Service (COS) parameters associated with a COS "profile". The docsIfCmServiceTable, which contains one entry per SID, references this table with a docsIfCmServiceQosProfile number.

The DOCSIS 1.1 and 2.0 CM registration process allows a modem to register as operating with DOCSIS 1.0, DOCSIS 1.1, or DOCSIS 2.0 functionality. For ease of expression, we call a modem registering with DOCSIS 1.0 functionality a "DOCSIS 1.0 modem", regardless of the modem's capabilities.

A CMTS or CM supporting DOCSIS 1.0, as well as DOCSIS 1.1, and/or DOCSIS 2.0 implements both the tables of [7] and the tables of this MIB module. The interoperation goal is that before modem registration, the DOCSIS 1.0 MIB [7] applies. After registration, either the DOCSIS 1.0 or DOCSIS 1.1/2.0 MIB applies, depending on the mode with which the modem registered. The specific interoperation rules are:

1. When a CM initially ranges, the CM implements a row in the DOCS-IF-MIB docsIfCmServiceTable, and the CMTS implements a row in the DOCS-IF-MIB docsIfCmtsServiceTable corresponding to the default upstream Service ID (SID) used for pre-registration

upstream traffic. For historical compatibility, a row may be created for the docsIfQosProfileTable with default values, which may be referenced by the docsIfCmServiceTable entries.

2. Both a CMTS and CM implementing this MIB MUST NOT implement docsIetfQosParamSetTable or docsIetfQosServiceFlowTable rows until after the CM registers with DOCSIS 1.1 or 2.0 modem operation.

3. When a modem registers with the CMTS as a "DOCSIS 1.1" or "DOCSIS 2.0" modem, any exclusively-referenced row in DOCS-IF-MIB docsIfQosProfileTable representing the modem's upstream QoS profile for pre-registration traffic MUST be removed. Multiply-referenced rows may remain. The docsIfCmServiceQosProfile object in the CM's row of

   docsIfCmServiceTable MUST be set to zero. The docsIfCmServiceTable row for the DOCSIS 1.1 or DOCSIS 2.0 modem continues to exist, and the various statistic objects in that row are incremented. The CMTS should retain a docsIfCmtsServiceTable entry for the DOCSIS 1.1 or DOCSIS 2.0 CM.

4. When a DOCSIS 1.1 or DOCSIS 2.0 modem registers, both the CMTS and CM represent all Service Flows described in the modem configuration file in docsIetfQosParamSetTable and docsIetfQosServiceFlowTable.

5. DOCSIS 1.0 modems do not have entries in the DOCS-IETF-QOS-MIB.

2.2.3. docsIetfQosServiceFlowTable

The docsIetfQosServiceFlowTable provides read-only information about all the Service Flows known by the device. It is indexed by the combination of { ifIndex, dosQosServiceFlowId }, where ifIndex corresponds to a CATV MAC interface and docsIetfQosServiceFlowId is the 32-bit integer assigned by the CMTS controlling the MAC domain. A CM typically has only a single CATV MAC interface, whereas a CMTS may have several. See [7] for a description of the ifIndex numbering for DOCSIS devices.

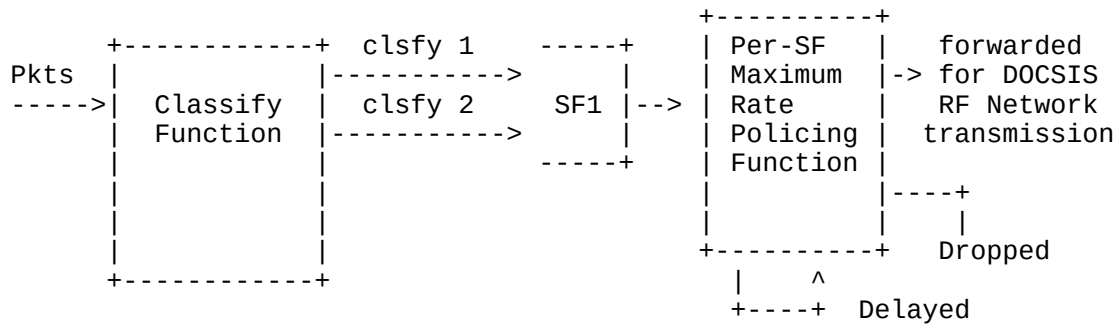
The table indicates whether a given SF is in the upstream or downstream direction, and whether it is the "primary" SF in that direction. The primary SF carries traffic that is not otherwise classified to any other SF in that direction.

2.2.4. docsIetfQosServiceFlowStatsTable

The docsIetfQosServiceFlowStatsTable provides statistics for all currently existing SFs known by the managed device. It provides basic packet and octet counters, as well as certain other SF-specific stats such as the time at which the flow was created and how many seconds it has been active.

The table also provides objects that can be used to fine-tune admission control decisions; namely, the number of packets dropped or delayed due to QoS policing decisions enforced by the managed device.

The model of the Service Flows stats table is that there exists a Service Flow Classification function followed by a Service Flow maximum rate Policing function for packets transmitted onto the DOCSIS RF network, as depicted below.



Packets intended for transmission onto the DOCSIS RF network (upstream or downstream) are first classified to a Service Flow by matching one of several possible classifiers associated with that Service Flow. The docsIetfQosPktClassPkts count includes the number of packets that match the classifier, regardless of the eventual disposition of the packet.

DOCSIS requires that each Service Flow be policed to maintain a maximum rate of transmission. This is performed by either dropping or delaying a packet on that Service Flow. The docsIetfQosServiceFlowPolicedDropPkts object counts the number of Service Flow packets dropped by the policing function. The docsIetfQosServiceFlowPolicedDelayPkts counts the number of packets delayed but still forwarded. The docsIetfQosServiceFlowPkts object counts the total number of packets forwarded beyond the policing function intended for eventual transmission onto the DOCSIS RF network. Although packets may later be dropped by other functions (e.g., a transmit queue overflow on a DOCSIS hardware transmitter), the docsIetfQos MIB per service-flow counters are not affected.

2.2.5. docsIetfQosUpstreamStatsTable

This table provides statistics that are measured only at the CMTS in the upstream direction. These include counts of fragmentation headers received, fragments discarded, and concatenation headers received.

2.2.6. docsIetfQosDynamicServiceStatsTable

This table provides read-only stats on the operation of the Dynamic Service state machines as specified in section 9.4 of [4]. It provides a set of 14 counters in each direction for a DOCSIS MAC layer interface. That is, each DOCSIS MAC layer interface has one row for downstream stats and a second row for upstream stats.

Eight of the counters are DSx packet type counts, one counter for each of the eight DSx packet types. For example, the docsIetfQosDSAReqs object in the upstream row at the CMTS counts the number of DSA-REQ messages received by the CMTS from that interface. The docsIetfQosDSAReqs object in the downstream row at the CMTS counts the number of DSA-REQ messages transmitted by the CMTS on that interface.

The remaining six counters per (interface, direction) combination count the number of successful and unsuccessful transactions that were initiated on the interface and direction. For example, the upstream docsIetfQosDynamicAdds on a CMTS is the number of successfully completed CM-initiated dynamic additions, because at the CMTS a CM-initiated DSA starts in the upstream direction. The downstream docsIetfQosDynamicAdds at a CMTS is the number of successful CMTS-initiated DSA transactions.

Dynamic service transactions can fail for a number of reasons, as listed in the state machines of section 9.4. Rather than include still more counters for each different failure reason, they are grouped into a single count, e.g., docsIetfQosDynamicAddFails. Again, this object exists in both directions, so that locally originated and remotely originated transaction failures are counted separately. Further troubleshooting of transaction failures will require vendor-specific queries and operation.

2.2.7. docsIetfQosServiceFlowLogTable

This table contains a log of the Service Flows that no longer exist in the docsIetfQosServiceFlowTable. It is intended to be periodically polled by traffic monitoring and billing agents. It is implemented only at the CMTS.

It contains a chronological log of SF session statistics, including a total count of packets and octets transferred on the SF. It includes time stamps of the SF creation and deletion time, and of its number of active seconds. The active second count is the count of seconds that the SF had a non-empty Active QoS Parameter Set, i.e., it was eligible to pass data. For unicast SFs, it includes the CM MAC address associated with the flow for billing reference purposes.

The maximum number of log records kept by a CMTS and the duration that a log record is maintained in the table are vendor-specific. An explicit control object is provided so that the monitoring application can explicitly delete records it has read.

2.2.8. docsIetfQosServiceClassTable

This table defines the Service Class Name and references a QoS Parameter Set for each Service Class defined in a CMTS. It is indexed by the Service Class Name string itself. The table is read-create on a CMTS, and is not implemented in a CM. Each entry of the docsIetfQosServiceClassTable should define a template for flows in a given direction (upstream or downstream). Some parameters of the docsIetfQosServiceClassTable are specific to a particular direction, and so their values are not applicable when used as a template for flows in the other direction.

2.2.9. docsIetfQosServiceClassPolicyTable

The docsIetfQosServiceClassPolicyTable can be referenced by the docsDevFilterPolicyTable of [6] in order to have a "policy" that classifies packets to a named Service Class. This is one mechanism by which "external" entities (such as an SNMP manager) may control the classification of a packet for QoS purposes. Entries are indexed by a small-integer docsIetfQosServiceClassPolicyIndex. They provide a Service Class Name and a Rule Priority. A policy referencing a row of this table intends the packet to be forwarded on a Service Flow "belonging" to the named Service Class. See section 3, "Externally Administered Classification", below.

This table is implemented on both the CM and CMTS, and is read-create on both.

2.2.10. docsIetfQosPHSTable

The Payload Header Suppression (PHS) feature of DOCSIS 1.1 and 2.0 permits packets to replace the unchanging bytes of the Ethernet, IP, and UDP headers with a one-byte index when transmitting on the cable network. This is especially useful for IP Telephony packets, where such suppression can result in almost twice the number of calls supported within the same upstream channel.

Each entry of the table corresponds to a PHS Rule as described in section 8.4 of [4]. The rules are identified by their corresponding Service Flow ID and docsIetfQosPktClassId. A PHS rule is associated with exactly one classifier. The table is therefore indexed by the tuple { ifIndex, docsIetfQosServiceFlowId, docsIetfQosPktClassId}.

This table is read-only, and MUST be implemented on both the CM and CMTS when PHS is supported.

2.2.11 docsIetfQosCmtsMacToSrvFlowTable

The docsIetfQosCmtsMacToSrvFlowTable describes the mapping of CM MAC addresses to the Service Flow IDs that are uniquely identified with that CM. External applications may collect statistics on all packets flowing through a CM by determining the SFID of all of its flows, and then collecting the statistics of packets and bytes for each flow.

Downstream multicast Service Flows are not indicated in the docsIetfQosCmtsMacToSrvFlowTable because they are not associated with only one CM.

3. Externally Administered Classification

DOCSIS 1.1 and 2.0 provide rich semantics for the classification of packets to Service Flows with the Service Flow Classifier table. Service Flow Classifiers may be created statically in the DOCSIS CM configuration file, or may be created dynamically with Dynamic Service Addition (DSA) and Dynamic Service Change (DSC) DOCSIS MAC messages.

Several major issues arose with the concept of externally administered classification; e.g., should an external SNMP manager be permitted to create classification rows? One problem was the coordination of classifier IDs because such an approach would require either separate classifier ID number spaces or objects to coordinate both internal and external classifier ID assignments. A more serious problem, however, was that external creation of SF Classifiers would require "knowledge" of the individual Service Flow ID for Service Flows by external applications. It was strongly felt by the

committee that SFIDs should remain internal DOCSIS objects, and not be transmitted as part of protocol flows, e.g., for IP packet telephony signaling. DOCSIS 1.1 introduced the concept of named Service Classes for ease of administration within a domain of CMs and CMTSs. What was desired was to permit external classification of packets to a Service Class, not to a particular Service Flow.

The DOCSIS committee therefore decided to use the already-defined IP Packet Filter Table [6] for the external classification of packets for QoS purposes. The docsDevIpPacketFilterTable defines similar packet matching criteria as does docsIetfQosPktClassTable, but it matches a packet to an arbitrary "policy set" instead of a particular Service Flow. One of the policies in the policy set then selects the Service Class of the SF on which to forward the packet. The docsIetfQosServiceClassPolicyTable of this MIB module defines the Service Class Name to which a packet is classified.

The interaction of external and internal packet classification is depicted below.

Figure 2: DOCSIS Packet Classification

The processing of an outgoing packet proceeds as follows:

1. The packet is first checked for matches with rows of the docsDevIpFilterTable. If it matches, the matching row provides a docsDevFilterPolicyId integer.

2. The docsDevFilterPolicyId indexes into one (or more) rows of docsDevFilterPolicyTable. Each row provides an arbitrary RowPointer (docsDevFilterPolicyPtr), corresponding to a policy to be applied to the packet.

3. This MIB module defines a docsIetfQosServiceClassPolicyTable whose entries may be pointed to by docsDevFilterPolicyPtr in order to classify packets administratively to a named DOCSIS Service Class. The docsIetfQosServiceClassPolicyEntry provides a Service Class Name (SCN) as docsIetfQosServiceClassPolicyName and a classification rule priority as docsIetfQosServiceClassPolicyRulePriority. These are submitted to the device's DOCSIS MAC Layer entity as a special form of the MAC_DATA.request primitive, as described in Section E.2.1 of [4].

4. The MAC Layer selects an SFID ("Y") of an active Service Flow belonging to the named class, choosing an SF arbitrarily if there is more than one.

5. The packet is then classified according to the docsIetfQosPktClassTable, which may classify the packet to a different SFID "X". Associated with the classifier is a docsIetfQosPktClassPriority.

6. In the event of a conflict between the SCN-determined SFID and the classified SFID, the greater of docsIetfQosPktClassPriority and docsIetfQosServiceClassPolicyRulePriority determines which SFID is selected to forward the packet.

A packet that does not match a docsIetfQosServiceClassPolicyEntry is directly submitted to the DOCSIS MAC layer, where the docsIetfQosPktClassTable selects the SID on which it is to be forwarded.

By convention (in [4]), the "internal" docsIetfQosPktClassPriority values should be in the range 64-191, while the "external" priorities may be either in the range 192-255 to override the internal classification or in the range 0-63 to be overridden by internal classification.

This classification mechanism applies both upstream from the CM and downstream from the CMTS.

4. DOCSIS and IPv4 Type-of-Service (ToS) Field

The DOCSIS-IETF-QOS-MIB MIB module relies on the DOCSIS MAC layer protocols and uses objects that reflect the IPv4 Type-of-Service (ToS) octet as defined in [14]. The applicability of these objects is limited to the DOCSIS access network. The past and current versions of the DOCSIS specifications for which this MIB module is defined do not reflect Differentiated Services [9] on the DOCSIS access network. However, with proper selection of values for these

objects, the network operator can enforce Differentiated Services Per-hop Behaviors (PHBs) on the DOCSIS Access Network, and can configure the modification of the DSCP for certain packet flows as they enter the metro network from the access network. Essentially this makes the DOCSIS access network TOS marking compatible with the wider use of DSCP outside DOCSIS networks. Note that because the entire IPv4 TOS octet may be available for modification via the latter mechanism (due to the current MAC level DOCSIS protocols and CLI interface configuration), it is possible that the DOCSIS network could be configured to modify the Explicit Congestion Notification (ECN) bits [10] of certain packets. This modification of the ECN bits is prevented by the MIB module's design. The MIB module prohibits the modification of the TOS octet (read-only objects: docsIetfQosPktClassIpTosLow, docsIetfQosPktClassIpTosHigh docsIetfQosPktClassIpTosMask, docsIetfQosParamSetTosAndMask, docsIetfQosParamSetTosOrMask) and allows the DSCP field to be modified (read-create object: docsIetfQosServiceClassDSCPOverwrite).

5. Definitions

This MIB module refers to the SNMPv2-SMI [1] MIB module, SNMPv2-TC [2] MIB module, SNMPv2-CONF [3] MIB Module, DOCSIS RFI Specification SP-RFIv2.0-I06-040804 [4], INET-ADDRESS-MIB [8] MIB module, IF-MIB [11] MIB module, SNMP-FRAMEWORK-MIB [12] MIB module, and DIFFSERV-DSCP-TC [13] MIB module.

```
DOCS-IETF-QOS-MIB DEFINITIONS ::= BEGIN

IMPORTS
    MODULE-IDENTITY,
    OBJECT-TYPE,
    Integer32,
    Counter32,
    Unsigned32,
    Counter64,
    mib-2
      FROM SNMPv2-SMI

    TEXTUAL-CONVENTION,
    MacAddress,
    RowStatus,
    TruthValue,
    TimeStamp,
    StorageType
      FROM SNMPv2-TC

    OBJECT-GROUP,
    MODULE-COMPLIANCE
```

```
      FROM SNMPv2-CONF

    ifIndex,
    InterfaceIndex
      FROM IF-MIB

    InetAddressType,
    InetAddress,
    InetPortNumber
      FROM INET-ADDRESS-MIB

    DscpOrAny
      FROM DIFFSERV-DSCP-TC

    SnmpAdminString
        FROM SNMP-FRAMEWORK-MIB;

docsIetfQosMIB   MODULE-IDENTITY
    LAST-UPDATED    "200601230000Z" -- January 23, 2006
    ORGANIZATION    "IETF IP over Cable Data Network (IPCDN)
                     Working Group"
    CONTACT-INFO
        "
         Co-Author: Michael Patrick
         Postal:    Motorola BCS
                    111 Locke Drive
                    Marlborough, MA 01752-7214
                    U.S.A.
         Phone:     +1 508 786 7563
         E-mail:    michael.patrick@motorola.com

         Co-Author: William Murwin
         Postal:    Motorola BCS
                    111 Locke Drive
                    Marlborough, MA 01752-7214
                    U.S.A.
         Phone:     +1 508 786 7594
         E-mail:    w.murwin@motorola.com

         IETF IPCDN Working Group
         General Discussion: ipcdn@ietf.org
         Subscribe: http://www.ietf.org/mailman/listinfo/ipcdn
         Archive: ftp://ftp.ietf.org/ietf-mail-archive/ipcdn
         Co-chairs: Richard Woundy, Richard_Woundy@cable.comcast.com
                    Jean-Francois Mule, jfm@cablelabs.com"
    DESCRIPTION
        "This is the management information for
         Quality Of Service (QOS) for DOCSIS 1.1 and 2.0.
```

Copyright (C) The Internet Society (2006). This version of this MIB module is part of RFC 4323; see the RFC itself for full legal notices."

```
    REVISION        "200601230000Z" -- January 23, 2006
    DESCRIPTION
        "Initial version, published as RFC 4323."
    ::= { mib-2 127 }

--
-- Placeholder for notifications/traps.
--
docsIetfQosNotifications OBJECT IDENTIFIER  ::= { docsIetfQosMIB 0 }

docsIetfQosMIBObjects  OBJECT IDENTIFIER ::= { docsIetfQosMIB 1 }

-- Textual Conventions
DocsIetfQosRfMacIfDirection ::= TEXTUAL-CONVENTION
    STATUS          current
    DESCRIPTION    "Indicates a direction on an RF MAC interface.

                    The value downstream(1) is from Cable Modem
                    Termination System to Cable Modem.

                    The value upstream(2) is from Cable Modem to
                    Cable Modem Termination System."
    SYNTAX          INTEGER {
                       downstream(1),
                       upstream(2)
                    }

DocsIetfQosBitRate ::= TEXTUAL-CONVENTION
    DISPLAY-HINT    "d"
    STATUS          current
    DESCRIPTION    "The rate of traffic in unit of bits per second.
                    Used to specify traffic rate for QOS."
    SYNTAX          Unsigned32

DocsIetfQosSchedulingType ::= TEXTUAL-CONVENTION
    STATUS          current
    DESCRIPTION    "The scheduling service provided by a CMTS for an
                    upstream Service Flow.  If the parameter is omitted
                    from an upstream QOS Parameter Set, this object
                    takes the value of bestEffort (2).  This parameter
                    must be reported as undefined (1) for downstream
                    QOS Parameter Sets."
    SYNTAX          INTEGER {
                      undefined (1),
```

```
                      bestEffort (2),
                      nonRealTimePollingService(3),
                      realTimePollingService(4),
                      unsolictedGrantServiceWithAD(5),
                      unsolictedGrantService(6)
                    }

--------------------------------------------------------------------------
--
-- Packet Classifier Table
--
docsIetfQosPktClassTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF DocsIetfQosPktClassEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "This table describes the packet classification
                    configured on the CM or CMTS.
                    The model is that a packet either received
                    as input from an interface or transmitted
                    for output on an interface may be compared
                    against an ordered list of rules pertaining to
                    the packet contents.  Each rule is a row of this
                    table.  A matching rule provides a Service Flow
                    ID to which the packet is classified.
                    All rules need to match for a packet to match
                    a classifier.

                    The objects in this row correspond to a set of
                    Classifier Encoding parameters in a DOCSIS
                    MAC management message.  The
                    docsIetfQosPktClassBitMap indicates which
                    particular parameters were present in the
                    classifier as signaled in the DOCSIS message.
                    If the referenced parameter was not present
                    in the signaled DOCSIS 1.1 and 2.0 Classifier, the
                    corresponding object in this row reports a
                    value as specified in the DESCRIPTION section."
    ::= { docsIetfQosMIBObjects 1 }


docsIetfQosPktClassEntry OBJECT-TYPE
    SYNTAX          DocsIetfQosPktClassEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "An entry in this table provides a single packet
                    classifier rule.  The index ifIndex is an ifType
                    of docsCableMaclayer(127)."
    INDEX {
```

```
            ifIndex,
            docsIetfQosServiceFlowId,
            docsIetfQosPktClassId
          }
    ::= { docsIetfQosPktClassTable 1 }


DocsIetfQosPktClassEntry ::= SEQUENCE {
    docsIetfQosPktClassId                   Unsigned32,
    docsIetfQosPktClassDirection            DocsIetfQosRfMacIfDirection,
    docsIetfQosPktClassPriority             Integer32,
    docsIetfQosPktClassIpTosLow             OCTET STRING,
    docsIetfQosPktClassIpTosHigh            OCTET STRING,
    docsIetfQosPktClassIpTosMask            OCTET STRING,
    docsIetfQosPktClassIpProtocol           Integer32,
    docsIetfQosPktClassInetAddressType      InetAddressType,
    docsIetfQosPktClassInetSourceAddr       InetAddress,
    docsIetfQosPktClassInetSourceMask       InetAddress,
    docsIetfQosPktClassInetDestAddr         InetAddress,
    docsIetfQosPktClassInetDestMask         InetAddress,
    docsIetfQosPktClassSourcePortStart      InetPortNumber,
    docsIetfQosPktClassSourcePortEnd        InetPortNumber,
    docsIetfQosPktClassDestPortStart        InetPortNumber,
    docsIetfQosPktClassDestPortEnd          InetPortNumber,
    docsIetfQosPktClassDestMacAddr          MacAddress,
    docsIetfQosPktClassDestMacMask          MacAddress,
    docsIetfQosPktClassSourceMacAddr        MacAddress,
    docsIetfQosPktClassEnetProtocolType     INTEGER,
    docsIetfQosPktClassEnetProtocol         Integer32,
    docsIetfQosPktClassUserPriLow           Integer32,
    docsIetfQosPktClassUserPriHigh          Integer32,
    docsIetfQosPktClassVlanId               Integer32,
    docsIetfQosPktClassStateActive          TruthValue,
    docsIetfQosPktClassPkts                 Counter64,
    docsIetfQosPktClassBitMap               BITS
  }

docsIetfQosPktClassId       OBJECT-TYPE
    SYNTAX          Unsigned32 (1..65535)
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "Index assigned to packet classifier entry by
                    the CMTS, which is unique per Service Flow."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.3.2"
    ::= { docsIetfQosPktClassEntry 1 }

docsIetfQosPktClassDirection OBJECT-TYPE
```

```
    SYNTAX          DocsIetfQosRfMacIfDirection
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Indicates the direction to which the classifier
                    is applied."
    ::= { docsIetfQosPktClassEntry 2 }

docsIetfQosPktClassPriority OBJECT-TYPE
    SYNTAX          Integer32 (0..255)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The value specifies the order of evaluation
                    of the classifiers.

                    The higher the value, the higher the priority.
                    The value of 0 is used as default in
                    provisioned Service Flows Classifiers.
                    The default value of 64 is used for dynamic
                    Service Flow Classifiers.

                    If the referenced parameter is not present
                    in a classifier, this object reports the default
                    value as defined above."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.3.5"
    ::= { docsIetfQosPktClassEntry 3 }

docsIetfQosPktClassIpTosLow OBJECT-TYPE
    SYNTAX          OCTET STRING (SIZE(1))
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The low value of a range of TOS byte values.
                    If the referenced parameter is not present
                    in a classifier, this object reports the value
                    of 0.

                    The IP TOS octet, as originally defined in RFC 791,
                    has been superseded by the 6-bit Differentiated
                    Services Field (DSField, RFC 3260) and the 2-bit
                    Explicit Congestion Notification Field (ECN field,
                    RFC 3168).  This object is defined as an 8-bit
                    octet as per the DOCSIS Specification
                    for packet classification."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.5.1"
    ::= { docsIetfQosPktClassEntry 4 }

docsIetfQosPktClassIpTosHigh OBJECT-TYPE
    SYNTAX          OCTET STRING (SIZE(1))
    MAX-ACCESS      read-only
```

```
    STATUS          current
    DESCRIPTION    "The 8-bit high value of a range of TOS byte
                    values.

                    If the referenced parameter is not present
                    in a classifier, this object reports the
                    value of 0.

                    The IP TOS octet as originally defined in RFC 791
                    has been superseded by the 6-bit Differentiated
                    Services Field (DSField, RFC 3260) and the 2-bit
                    Explicit Congestion Notification Field (ECN field,
                    RFC 3168).  This object is defined as an 8-bit
                    octet as defined by the DOCSIS Specification
                    for packet classification."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.5.1"
    ::= { docsIetfQosPktClassEntry 5 }

docsIetfQosPktClassIpTosMask OBJECT-TYPE
    SYNTAX          OCTET STRING (SIZE(1))
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The mask value is bitwise ANDed with TOS byte
                    in an IP packet, and this value is used for
                    range checking of TosLow and TosHigh.

                    If the referenced parameter is not present
                    in a classifier, this object reports the value
                    of 0.

                    The IP TOS octet as originally defined in RFC 791
                    has been superseded by the 6-bit Differentiated
                    Services Field (DSField, RFC 3260) and the 2-bit
                    Explicit Congestion Notification Field (ECN field,
                    RFC 3168).  This object is defined as an 8-bit
                    octet per the DOCSIS Specification for packet
                    classification."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.5.1"
    ::= { docsIetfQosPktClassEntry 6 }

docsIetfQosPktClassIpProtocol OBJECT-TYPE
    SYNTAX          Integer32 (0..258)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object indicates the value of the IP
                    Protocol field required for IP packets to match
                    this rule.
```

```
                    The value 256 matches traffic with any IP Protocol
                    value.  The value 257 by convention matches both TCP
                    and UDP.

                    If the referenced parameter is not present
                    in a classifier, this object reports the value
                    of 258."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.5.2"
    ::= { docsIetfQosPktClassEntry 7 }

docsIetfQosPktClassInetAddressType OBJECT-TYPE
    SYNTAX          InetAddressType
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The type of the Internet address for
                    docsIetfQosPktClassInetSourceAddr,
                    docsIetfQosPktClassInetSourceMask,
                    docsIetfQosPktClassInetDestAddr, and
                    docsIetfQosPktClassInetDestMask.

                    If the referenced parameter is not present
                    in a classifier, this object reports the value of
                    ipv4(1)."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.5.3"
    ::= { docsIetfQosPktClassEntry 8 }

docsIetfQosPktClassInetSourceAddr OBJECT-TYPE
    SYNTAX          InetAddress
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object specifies the value of the IP
                    Source Address required for packets to match
                    this rule.

                    An IP packet matches the rule when the packet
                    IP Source Address bitwise ANDed with the
                    docsIetfQosPktClassInetSourceMask value equals the
                    docsIetfQosPktClassInetSourceAddr value.

                    The address type of this object is specified by
                    docsIetfQosPktClassInetAddressType.

                    If the referenced parameter is not present
                    in a classifier, this object reports the value of
                    '00000000'H."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.5.3"
    ::= { docsIetfQosPktClassEntry 9 }
```

```
docsIetfQosPktClassInetSourceMask OBJECT-TYPE
    SYNTAX          InetAddress
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object specifies which bits of a packet's
                    IP Source Address are compared to match
                    this rule.

                    An IP packet matches the rule when the packet
                    source address bitwise ANDed with the
                    docsIetfQosPktClassInetSourceMask value equals the
                    docsIetfQosIpPktClassInetSourceAddr value.

                    The address type of this object is specified by
                    docsIetfQosPktClassInetAddressType.

                    If the referenced parameter is not present
                    in a classifier, this object reports the value of
                    'FFFFFFFF'H."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.5.4"
    ::= { docsIetfQosPktClassEntry 10 }

docsIetfQosPktClassInetDestAddr OBJECT-TYPE
    SYNTAX          InetAddress
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object specifies the value of the IP
                    Destination Address required for packets to match
                    this rule.

                    An IP packet matches the rule when the packet
                    IP Destination Address bitwise ANDed with the
                    docsIetfQosPktClassInetDestMask value
                    equals the docsIetfQosPktClassInetDestAddr value.

                    The address type of this object is specified by
                    docsIetfQosPktClassInetAddressType.

                    If the referenced parameter is not present
                    in a classifier, this object reports the value of
                    '00000000'H."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.5.5"
    ::= { docsIetfQosPktClassEntry 11 }

docsIetfQosPktClassInetDestMask OBJECT-TYPE
    SYNTAX          InetAddress
    MAX-ACCESS      read-only
    STATUS          current
```

```
    DESCRIPTION    "This object specifies which bits of a packet's
                    IP Destination Address are compared to
                    match this rule.

                    An IP packet matches the rule when the packet
                    destination address bitwise ANDed with the
                    docsIetfQosPktClassInetDestMask value equals the
                    docsIetfQosIpPktClassInetDestAddr value.

                    The address type of this object is specified by
                    docsIetfQosPktClassInetAddressType.

                    If the referenced parameter is not present
                    in a classifier, this object reports the value of
                    'FFFFFFFF'H."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.5.6"
    ::= { docsIetfQosPktClassEntry 12 }

docsIetfQosPktClassSourcePortStart OBJECT-TYPE
    SYNTAX          InetPortNumber
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object specifies the low-end inclusive
                    range of TCP/UDP source port numbers to which
                    a packet is compared.  This object is irrelevant
                    for non-TCP/UDP IP packets.

                    If the referenced parameter is not present
                    in a classifier, this object reports the value
                    of 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.5.7"
    ::= { docsIetfQosPktClassEntry 13 }

docsIetfQosPktClassSourcePortEnd OBJECT-TYPE
    SYNTAX          InetPortNumber
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object specifies the high-end inclusive
                    range of TCP/UDP source port numbers to which
                    a packet is compared.  This object is irrelevant
                    for non-TCP/UDP IP packets.

                    If the referenced parameter is not present
                    in a classifier, this object reports the value of
                    65535."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.5.8"
    ::= { docsIetfQosPktClassEntry 14 }
```

```
docsIetfQosPktClassDestPortStart OBJECT-TYPE
    SYNTAX          InetPortNumber
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION     "This object specifies the low-end inclusive
                     range of TCP/UDP destination port numbers to
                     which a packet is compared.

                     If the referenced parameter is not present
                     in a classifier, this object reports the value
                     of 0."
    REFERENCE       "SP-RFIv2.0-I06-040804, Appendix C.2.1.5.9"
    ::= { docsIetfQosPktClassEntry 15 }

docsIetfQosPktClassDestPortEnd OBJECT-TYPE
    SYNTAX          InetPortNumber
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object specifies the high-end inclusive
                    range of TCP/UDP destination port numbers to which
                    a packet is compared.

                    If the referenced parameter is not present
                    in a classifier, this object reports the value of
                    65535."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.5.10"
    ::= { docsIetfQosPktClassEntry 16 }

docsIetfQosPktClassDestMacAddr OBJECT-TYPE
    SYNTAX          MacAddress
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "An Ethernet packet matches an entry when its
                    destination MAC address bitwise ANDed with
                    docsIetfQosPktClassDestMacMask equals the value of
                    docsIetfQosPktClassDestMacAddr.


                    If the referenced parameter is not present
                    in a classifier, this object reports the value of
                    '000000000000'H."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.6.1"
    ::= { docsIetfQosPktClassEntry 17 }

docsIetfQosPktClassDestMacMask OBJECT-TYPE
    SYNTAX          MacAddress
    MAX-ACCESS      read-only
    STATUS          current
```

```
    DESCRIPTION    "An Ethernet packet matches an entry when its
                    destination MAC address bitwise ANDed with
                    docsIetfQosPktClassDestMacMask equals the value of
                    docsIetfQosPktClassDestMacAddr.

                    If the referenced parameter is not present
                    in a classifier, this object reports the value of
                    '000000000000'H."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.6.1"
    ::= { docsIetfQosPktClassEntry 18 }

docsIetfQosPktClassSourceMacAddr OBJECT-TYPE
    SYNTAX          MacAddress
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "An Ethernet packet matches this entry when its
                    source MAC address equals the value of
                    this object.

                    If the referenced parameter is not present
                    in a classifier, this object reports the value of
                    'FFFFFFFFFFFF'H."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.6.2"
    ::= { docsIetfQosPktClassEntry 19 }

docsIetfQosPktClassEnetProtocolType OBJECT-TYPE
    SYNTAX          INTEGER {
                      none(0),
                      ethertype(1),
                      dsap(2),
                      mac(3),
                      all(4)
                    }
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object indicates the format of the layer 3
                    protocol ID in the Ethernet packet.  A value of
                    none(0) means that the rule does not use the
                    layer 3 protocol type as a matching criteria.

                    A value of ethertype(1) means that the rule
                    applies only to frames that contain an
                    EtherType value.  Ethertype values are contained
                    in packets using the Dec-Intel-Xerox (DIX)
                    encapsulation or the RFC1042 Sub-Network Access
                    Protocol (SNAP) encapsulation formats.

                    A value of dsap(2) means that the rule applies
```

```
                    only to frames using the IEEE802.3
                    encapsulation format with a Destination Service
                    Access Point (DSAP) other
                    than 0xAA (which is reserved for SNAP).

                    A value of mac(3) means that the rule applies
                    only to MAC management messages for MAC management
                    messages.

                    A value of all(4) means that the rule matches
                    all Ethernet packets.

                    If the Ethernet frame contains an 802.1P/Q Tag
                    header (i.e., EtherType 0x8100), this object
                    applies to the embedded EtherType field within
                    the 802.1P/Q header.

                    If the referenced parameter is not present in a
                    classifier, this object reports the value of 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.6.3"
    ::= { docsIetfQosPktClassEntry 20 }

docsIetfQosPktClassEnetProtocol OBJECT-TYPE
    SYNTAX          Integer32 (0..65535)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "If docsIetfQosEthPktClassProtocolType is none(0),
                    this object is ignored when considering whether
                    a packet matches the current rule.

                    If dosQosPktClassEnetProtocolType is ethertype(1),
                    this object gives the 16-bit value of the
                    EtherType that the packet must match in order to
                    match the rule.

                    If docsIetfQosPktClassEnetProtocolType is dsap(2),
                    the lower 8 bits of this object's value must match
                    the DSAP byte of the packet in order to match the
                    rule.

                    If docsIetfQosPktClassEnetProtocolType is mac(3),
                    the lower 8 bits of this object's value represent a
                    lower bound (inclusive) of MAC management message
                    type codes matched, and the upper 8 bits represent
                    the upper bound (inclusive) of matched MAC message
                    type codes.  Certain message type codes are
                    excluded from matching, as specified in the
                    reference.
```

```
                    If the Ethernet frame contains an 802.1P/Q Tag
                    header (i.e., EtherType 0x8100), this object applies
                    to the embedded EtherType field within the 802.1P/Q
                    header.

                    If the referenced parameter is not present in the
                    classifier, the value of this object is reported
                    as 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.6.3"
    ::= { docsIetfQosPktClassEntry 21 }

docsIetfQosPktClassUserPriLow OBJECT-TYPE
    SYNTAX          Integer32 (0..7)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object applies only to Ethernet frames
                    using the 802.1P/Q tag header (indicated with
                    EtherType 0x8100).  Such frames include a 16-bit
                    Tag that contains a 3-bit Priority field and
                    a 12-bit VLAN number.

                    Tagged Ethernet packets must have a 3-bit
                    Priority field within the range of
                    docsIetfQosPktClassPriLow to
                    docsIetfQosPktClassPriHigh in order to match this
                    rule.

                    If the referenced parameter is not present in the
                    classifier, the value of this object is reported
                    as 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.7.1"
    ::= { docsIetfQosPktClassEntry 22 }

docsIetfQosPktClassUserPriHigh OBJECT-TYPE
    SYNTAX          Integer32 (0..7)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object applies only to Ethernet frames
                    using the 802.1P/Qtag header (indicated with
                    EtherType 0x8100).  Such frames include a 16-bit
                    Tag that contains a 3-bit Priority field and
                    a 12-bit VLAN number.

                    Tagged Ethernet packets must have a 3-bit
                    Priority field within the range of
                    docsIetfQosPktClassPriLow to
                    docsIetfQosPktClassPriHigh in order to match this
                    rule.
```

```
                    If the referenced parameter is not present in the
                    classifier, the value of this object is reported
                    as 7."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.7.1"
    ::= { docsIetfQosPktClassEntry 23 }

docsIetfQosPktClassVlanId OBJECT-TYPE
    SYNTAX          Integer32 (0 | 1..4094)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object applies only to Ethernet frames
                    using the 802.1P/Q tag header.

                    Tagged packets must have a VLAN Identifier that
                    matches the value in order to match the rule.

                    If the referenced parameter is not present in the
                    classifier, the value of this object is reported
                    as 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.7.2"
    ::= { docsIetfQosPktClassEntry 24 }

docsIetfQosPktClassStateActive OBJECT-TYPE
    SYNTAX          TruthValue
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object indicates whether or not the classifier
                    is enabled to classify packets to a Service Flow.

                    If the referenced parameter is not present in the
                    classifier, the value of this object is reported
                    as true(1)."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.3.6"
    ::= { docsIetfQosPktClassEntry 25 }

docsIetfQosPktClassPkts OBJECT-TYPE
    SYNTAX          Counter64
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object counts the number of packets that have
                    been classified using this entry.  This
                    includes all packets delivered to a Service Flow
                    maximum rate policing function, whether or not that
                    function drops the packets.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
```

```
    ::= { docsIetfQosPktClassEntry 26 }


docsIetfQosPktClassBitMap OBJECT-TYPE
    SYNTAX          BITS {          -- Reference SP-RFIv2.0-I06-040804
                        rulePriority(0),     -- Appendix C.2.1.3.4
                        activationState(1),  -- Appendix C.2.1.3.6
                        ipTos(2),            -- Appendix C.2.1.5.1
                        ipProtocol(3),       -- Appendix C.2.1.5.2
                        ipSourceAddr(4),     -- Appendix C.2.1.5.3
                        ipSourceMask(5),     -- Appendix C.2.1.5.4
                        ipDestAddr(6),       -- Appendix C.2.1.5.5
                        ipDestMask(7),       -- Appendix C.2.1.5.6
                        sourcePortStart(8),  -- Appendix C.2.1.5.7
                        sourcePortEnd(9),    -- Appendix C.2.1.5.8
                        destPortStart(10),   -- Appendix C.2.1.5.9
                        destPortEnd(11),     -- Appendix C.2.1.5.10
                        destMac(12),         -- Appendix C.2.1.6.1
                        sourceMac(13),       -- Appendix C.2.1.6.2
                        ethertype(14),       -- Appendix C.2.1.6.3
                        userPri(15),         -- Appendix C.2.1.7.1
                        vlanId(16)           -- Appendix C.2.1.7.2
                    }
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION
                    "This object indicates which parameter encodings
                    were actually present in the DOCSIS packet
                    classifier encoding signaled in the DOCSIS message
                    that created or modified the classifier.  Note that
                    Dynamic Service Change messages have replace
                    semantics, so that all non-default parameters must
                    be present whether the classifier is being created
                    or changed.

                    A bit of this object is set to 1 if the parameter
                    indicated by the comment was present in the
                    classifier encoding, and to 0 otherwise.

                    Note that BITS are encoded most significant bit
                    first, so that if, for example, bits 6 and 7 are
                    set, this object is encoded as the octet string
                    '030000'H."
    ::= { docsIetfQosPktClassEntry 27 }

--
-- QOS Parameter Set Table
--
```

```
docsIetfQosParamSetTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF DocsIetfQosParamSetEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "This table describes the set of DOCSIS 1.1 and 2.0
                    QOS parameters defined in a managed device.

                    The ifIndex index specifies a DOCSIS MAC Domain.
                    The docsIetfQosServiceFlowId index specifies a
                    particular Service Flow.
                    The docsIetfQosParamSetType index indicates whether
                    the active, admitted, or provisioned QOS Parameter
                    Set is being described by the row.

                    Only the QOS Parameter Sets of DOCSIS 1.1 and 2.0
                    Service Flows are represented in this table.

                    DOCSIS 1.0 QOS service profiles are not
                    represented in this table.

                    Each row corresponds to a DOCSIS QOS Parameter Set
                    as signaled via DOCSIS MAC management messages.
                    Each object in the row corresponds to one or
                    part of one DOCSIS 1.1 Service Flow Encoding.
                    The docsIetfQosParamSetBitMap object in the row
                    indicates which particular parameters were signaled
                    in the original registration or dynamic service
                    request message that created the QOS Parameter Set.

                    In many cases, even if a QOS Parameter Set parameter
                    was not signaled, the DOCSIS specification calls
                    for a default value to be used.  That default value
                    is reported as the value of the corresponding object
                    in this row.

                    Many objects are not applicable, depending on
                    the Service Flow direction or upstream scheduling
                    type.  The object value reported in this case
                    is specified in the DESCRIPTION clause."
    ::= { docsIetfQosMIBObjects 2 }

docsIetfQosParamSetEntry OBJECT-TYPE
    SYNTAX          DocsIetfQosParamSetEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "A unique set of QOS parameters."
    INDEX {
        ifIndex, docsIetfQosServiceFlowId, docsIetfQosParamSetType
```

```
        }
    ::= { docsIetfQosParamSetTable 1 }

DocsIetfQosParamSetEntry ::= SEQUENCE {
    docsIetfQosParamSetServiceClassName   SnmpAdminString,
    docsIetfQosParamSetPriority           Integer32,
    docsIetfQosParamSetMaxTrafficRate     DocsIetfQosBitRate,
    docsIetfQosParamSetMaxTrafficBurst    Unsigned32,
    docsIetfQosParamSetMinReservedRate    DocsIetfQosBitRate,
    docsIetfQosParamSetMinReservedPkt     Integer32,
    docsIetfQosParamSetActiveTimeout      Integer32,
    docsIetfQosParamSetAdmittedTimeout    Integer32,
    docsIetfQosParamSetMaxConcatBurst     Integer32,
    docsIetfQosParamSetSchedulingType     DocsIetfQosSchedulingType,
    docsIetfQosParamSetNomPollInterval    Unsigned32,
    docsIetfQosParamSetTolPollJitter      Unsigned32,
    docsIetfQosParamSetUnsolicitGrantSize Integer32,
    docsIetfQosParamSetNomGrantInterval   Unsigned32,
    docsIetfQosParamSetTolGrantJitter     Unsigned32,
    docsIetfQosParamSetGrantsPerInterval  Integer32,
    docsIetfQosParamSetTosAndMask         OCTET STRING,
    docsIetfQosParamSetTosOrMask          OCTET STRING,
    docsIetfQosParamSetMaxLatency         Unsigned32,
    docsIetfQosParamSetType               INTEGER,
    docsIetfQosParamSetRequestPolicyOct   OCTET STRING,
    docsIetfQosParamSetBitMap             BITS
    }

docsIetfQosParamSetServiceClassName OBJECT-TYPE
    SYNTAX          SnmpAdminString
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Refers to the Service Class Name from which the
                    parameter set values were derived.

                    If the referenced parameter is not present in the
                    corresponding DOCSIS QOS Parameter Set, the default
                    value of this object is a zero-length string."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.3.4"
    ::= { docsIetfQosParamSetEntry 1 }

docsIetfQosParamSetPriority OBJECT-TYPE
    SYNTAX          Integer32 (0..7)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The relative priority of a Service Flow.
                    Higher numbers indicate higher priority.
                    This priority should only be used to differentiate
```

```
                    Service Flow from identical parameter sets.

                    If the referenced parameter is not present in the
                    corresponding DOCSIS QOS Parameter Set, the default
                    value of this object is 0.  If the parameter is
                    not applicable, the reported value is 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.5.1"
    ::= { docsIetfQosParamSetEntry 2 }

docsIetfQosParamSetMaxTrafficRate OBJECT-TYPE
    SYNTAX          DocsIetfQosBitRate
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Maximum sustained traffic rate allowed for this
                    Service Flow in bits/sec.  Must count all MAC frame
                    data PDU from the bytes following the MAC header
                    HCS to the end of the CRC.  The number of bytes
                    forwarded is limited during any time interval.
                    The value 0 means no maximum traffic rate is
                    enforced.  This object applies to both upstream and
                    downstream Service Flows.

                    If the referenced parameter is not present in the
                    corresponding DOCSIS QOS Parameter Set, the default
                    value of this object is 0.  If the parameter is
                    not applicable, it is reported as 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.5.2"
    ::= { docsIetfQosParamSetEntry 3 }

docsIetfQosParamSetMaxTrafficBurst OBJECT-TYPE
    SYNTAX          Unsigned32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies the token bucket size in bytes
                    for this parameter set.  The value is calculated
                    from the byte following the MAC header HCS to
                    the end of the CRC.  This object is applied in
                    conjunction with docsIetfQosParamSetMaxTrafficRate
                    to calculate maximum sustained traffic rate.

                    If the referenced parameter is not present in the
                    corresponding DOCSIS QOS Parameter Set, the default
                    value of this object for scheduling types
                    bestEffort (2), nonRealTimePollingService(3),
                    and realTimePollingService(4) is 3044.

                    If this parameter is not applicable, it is reported
                    as 0.
```

```
                    "
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.5.3"
    ::= { docsIetfQosParamSetEntry 4 }

docsIetfQosParamSetMinReservedRate OBJECT-TYPE
    SYNTAX          DocsIetfQosBitRate
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies the guaranteed minimum rate in
                    bits/sec for this parameter set.  The value is
                    calculated from the byte following the MAC
                    header HCS to the end of the CRC.  The default
                    value of 0 means that no bandwidth is reserved.

                    If the referenced parameter is not present in the
                    corresponding DOCSIS QOS Parameter Set, the default
                    value of this object is 0.  If the parameter
                    is not applicable, it is reported as 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.5.4"
    ::= { docsIetfQosParamSetEntry 5 }

docsIetfQosParamSetMinReservedPkt OBJECT-TYPE
    SYNTAX          Integer32 (0..65535)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies an assumed minimum packet size in
                    bytes for which the
                    docsIetfQosParamSetMinReservedRate will be
                    provided.  The value is calculated from the byte
                    following the MAC header HCS to the end of the
                    CRC.

                    If the referenced parameter is omitted from a
                    DOCSIS QOS parameter set, the default value is
                    CMTS implementation dependent.  In this case, the
                    CMTS reports the default value it is using, and the
                    CM reports a value of 0.  If the referenced
                    parameter is not applicable to the direction or
                    scheduling type of the Service Flow, both CMTS and
                    CM report this object's value as 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.5.5"
    ::= { docsIetfQosParamSetEntry 6 }

docsIetfQosParamSetActiveTimeout OBJECT-TYPE
    SYNTAX          Integer32 (0..65535)
    UNITS           "seconds"
    MAX-ACCESS      read-only
    STATUS          current
```

```
    DESCRIPTION    "Specifies the maximum duration in seconds that
                    resources remain unused on an active service
                    flow before CMTS signals that both active and
                    admitted parameters set are null.  The default
                    value of 0 signifies an infinite amount of time.

                    If the referenced parameter is not present in the
                    corresponding DOCSIS QOS Parameter Set, the default
                    value of this object is 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.5.6"
    ::= { docsIetfQosParamSetEntry 7 }

docsIetfQosParamSetAdmittedTimeout OBJECT-TYPE
    SYNTAX          Integer32 (0..65535)
    UNITS           "seconds"
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies the maximum duration in seconds that
                    resources remain in admitted state before
                    resources must be released.

                    The value of 0 signifies an infinite amount
                    of time.

                    If the referenced parameter is not present in the
                    corresponding DOCSIS QOS Parameter Set, the
                    default value of this object is 200.
                   "

    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.5.7"
    DEFVAL          { 200 }
    ::= { docsIetfQosParamSetEntry 8 }

docsIetfQosParamSetMaxConcatBurst OBJECT-TYPE
    SYNTAX          Integer32 (0..65535)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies the maximum concatenated burst in
                    bytes that an upstream Service Flow is allowed.
                    The value is calculated from the FC byte of the
                    Concatenation MAC Header to the last CRC byte in
                    of the last concatenated MAC frame, inclusive.
                    The value of 0 specifies no maximum burst.

                    If the referenced parameter is not present in the
                    corresponding DOCSIS QOS Parameter Set, the default
                    value of this object for scheduling types
                    bestEffort(2), nonRealTimePollingService(3), and
```

```
                    realTimePollingService(4) is 1522.  If the parameter
                    is not applicable, this object's value is reported
                    as 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.6.1"
    ::= { docsIetfQosParamSetEntry 9 }


docsIetfQosParamSetSchedulingType OBJECT-TYPE
    SYNTAX          DocsIetfQosSchedulingType
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies the upstream scheduling service used for
                    upstream Service Flow.

                    If the referenced parameter is not present in the
                    corresponding DOCSIS QOS Parameter Set of an
                    upstream Service Flow, the default value of this
                    object is bestEffort(2).  For QOS parameter sets of
                    downstream Service Flows, this object's value is
                    reported as undefined(1)."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.6.2"
    ::= { docsIetfQosParamSetEntry 10 }

docsIetfQosParamSetNomPollInterval OBJECT-TYPE
    SYNTAX          Unsigned32
    UNITS           "microseconds"
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies the nominal interval in microseconds
                    between successive unicast request
                    opportunities on an upstream Service Flow.

                    This object applies only to upstream Service Flows
                    with DocsIetfQosSchedulingType of value
                    nonRealTimePollingService(3),
                    realTimePollingService(4), and
                    unsolictedGrantServiceWithAD(5).  The parameter is
                    mandatory for realTimePollingService(4).  If the
                    parameter is omitted with
                    nonRealTimePollingService(3), the CMTS uses an
                    implementation-dependent value.  If the parameter
                    is omitted with unsolictedGrantServiceWithAD(5),
                    the CMTS uses as a default value the value of the
                    Nominal Grant Interval parameter.  In all cases,
                    the CMTS reports the value it is using when the
                    parameter is applicable.  The CM reports the
                    signaled parameter value if it was signaled,
                    and 0 otherwise.
```

```
                    If the referenced parameter is not applicable to
                    the direction or scheduling type of the
                    corresponding DOCSIS QOS Parameter Set, both
                    CMTS and CM report this object's value as 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.6.4"
    ::= { docsIetfQosParamSetEntry 11 }

docsIetfQosParamSetTolPollJitter OBJECT-TYPE
    SYNTAX          Unsigned32
    UNITS           "microseconds"
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies the maximum amount of time in
                    microseconds that the unicast request interval
                    may be delayed from the nominal periodic
                    schedule on an upstream Service Flow.

                    This parameter is applicable only to upstream
                    Service Flows with a DocsIetfQosSchedulingType of
                    realTimePollingService(4) or
                    unsolictedGrantServiceWithAD(5).

                    If the referenced parameter is applicable but not
                    present in the corresponding DOCSIS QOS Parameter
                    Set, the CMTS uses an implementation-dependent
                    value and reports the value it is using.
                    The CM reports a value of 0 in this case.

                    If the parameter is not applicable to the
                    direction or upstream scheduling type of the
                    Service Flow, both CMTS and CM report this
                    object's value as 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.6.5"
    ::= { docsIetfQosParamSetEntry 12 }

docsIetfQosParamSetUnsolicitGrantSize OBJECT-TYPE
    SYNTAX          Integer32 (0..65535)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies the unsolicited grant size in bytes.
                    The grant size includes the entire MAC frame
                    data PDU from the Frame Control byte to the end
                    of the MAC frame.

                    The referenced parameter is applicable only
                    for upstream flows with a DocsIetfQosSchedulingType
                    of unsolicitedGrantServicewithAD(5) or
                    unsolicitedGrantService(6), and it is mandatory
```

```
                    when applicable.  Both CMTS and CM report
                    the signaled value of the parameter in this
                    case.

                    If the referenced parameter is not applicable to
                    the direction or scheduling type of the
                    corresponding DOCSIS QOS Parameter Set, both
                    CMTS and CM report this object's value as 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.6.6"
    ::= { docsIetfQosParamSetEntry 13 }

docsIetfQosParamSetNomGrantInterval OBJECT-TYPE
    SYNTAX          Unsigned32
    UNITS           "microseconds"
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies the nominal interval in microseconds
                    between successive data grant opportunities
                    on an upstream Service Flow.

                    The referenced parameter is applicable only
                    for upstream flows with a DocsIetfQosSchedulingType
                    of unsolicitedGrantServicewithAD(5) or
                    unsolicitedGrantService(6), and it is mandatory
                    when applicable.  Both CMTS and CM report the
                    signaled value of the parameter in this case.

                    If the referenced parameter is not applicable to
                    the direction or scheduling type of the
                    corresponding DOCSIS QOS Parameter Set, both
                    CMTS and CM report this object's value as 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.6.7"
    ::= { docsIetfQosParamSetEntry 14 }

docsIetfQosParamSetTolGrantJitter OBJECT-TYPE
    SYNTAX          Unsigned32
    UNITS           "microseconds"
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies the maximum amount of time in
                    microseconds that the transmission opportunities
                    may be delayed from the nominal periodic schedule.

                    The referenced parameter is applicable only
                    for upstream flows with a DocsIetfQosSchedulingType
                    of unsolicitedGrantServicewithAD(5) or
                    unsolicitedGrantService(6), and it is mandatory
                    when applicable.  Both CMTS and CM report the
```

```
                    signaled value of the parameter in this case.

                    If the referenced parameter is not applicable to
                    the direction or scheduling type of the
                    corresponding DOCSIS QOS Parameter Set, both
                    CMTS and CM report this object's value as 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.6.8"
    ::= { docsIetfQosParamSetEntry 15 }

docsIetfQosParamSetGrantsPerInterval OBJECT-TYPE
    SYNTAX          Integer32 (0..127)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies the number of data grants per Nominal
                    Grant Interval
                    (docsIetfQosParamSetNomGrantInterval).

                    The referenced parameter is applicable only
                    for upstream flows with a DocsIetfQosSchedulingType
                    of unsolicitedGrantServicewithAD(5) or
                    unsolicitedGrantService(6), and it is mandatory
                    when applicable.  Both CMTS and CM report the
                    signaled value of the parameter in this case.

                    If the referenced parameter is not applicable to
                    the direction or scheduling type of the
                    corresponding DOCSIS QOS Parameter Set, both
                    CMTS and CM report this object's value as 0."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.6.9"
    ::= { docsIetfQosParamSetEntry 16 }

docsIetfQosParamSetTosAndMask OBJECT-TYPE
    SYNTAX          OCTET STRING (SIZE(1))
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies the AND mask for the IP TOS byte for
                    overwriting IP packet's TOS value.  The IP packet
                    TOS byte is bitwise ANDed with
                    docsIetfQosParamSetTosAndMask, and the result is
                    bitwise ORed with docsIetfQosParamSetTosORMask and
                    the result is written to the IP packet TOS byte.
                    A value of 'FF'H for docsIetfQosParamSetTosAndMask
                    and a value of '00'H for
                    docsIetfQosParamSetTosOrMask means that the IP
                    Packet TOS byte is not overwritten.

                    This combination is reported if the referenced
                    parameter is not present in a QOS Parameter Set.
```

```
                    The IP TOS octet as originally defined in RFC 791
                    has been superseded by the 6-bit Differentiated
                    Services Field (DSField, RFC 3260) and the 2-bit
                    Explicit Congestion Notification Field (ECN field,
                    RFC 3168).  Network operators SHOULD avoid
                    specifying values of docsIetfQosParamSetTosAndMask
                    and docsIetfQosParamSetTosORMask that would result
                    in the modification of the ECN bits.

                    In particular, operators should not use values of
                    docsIetfQosParamSetTosAndMask that have either of
                    the least-significant two bits set to 0.  Similarly,
                    operators should not use values of
                    docsIetfQosParamSetTosORMask that have either of
                    the least-significant two bits set to 1.

                    Even though this object is only enforced by the
                    Cable Modem Termination System (CMTS),
                    Cable Modems MUST report the value as signaled in
                    the referenced parameter."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.6.10;
                    RFC 3168, The Addition of Explicit Congestion
                    Notification (ECN) to IP;
                    RFC 3260, New Terminology and Clarifications for
                    Diffserv."
    ::= { docsIetfQosParamSetEntry 17 }

docsIetfQosParamSetTosOrMask OBJECT-TYPE
    SYNTAX          OCTET STRING (SIZE(1))
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies the OR mask for the IP TOS byte.

                    See the description of docsIetfQosParamSetTosAndMask
                    for further details.

                    The IP TOS octet as originally defined in RFC 791
                    has been superseded by the 6-bit Differentiated
                    Services Field (DSField, RFC 3260) and the 2-bit
                    Explicit Congestion Notification Field (ECN field,
                    RFC 3168).  Network operators SHOULD avoid
                    specifying values of docsIetfQosParamSetTosAndMask
                    and docsIetfQosParamSetTosORMask that would result
                    in the modification of the ECN bits."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.6.10;
                    RFC 3168, The Addition of Explicit Congestion
                    Notification (ECN) to IP;
                    RFC 3260, New Terminology and Clarifications for
```

```
                    Diffserv."
    ::= { docsIetfQosParamSetEntry 18 }

docsIetfQosParamSetMaxLatency OBJECT-TYPE
    SYNTAX          Unsigned32
    UNITS           "microseconds"
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Specifies the maximum latency between the
                    reception of a packet by the CMTS on its NSI
                    and the forwarding of the packet to the RF
                    interface.  A value of 0 signifies no maximum
                    latency is enforced.  This object only applies to
                    downstream Service Flows.

                    If the referenced parameter is not present in the
                    corresponding downstream DOCSIS QOS Parameter Set,
                    the default value is 0.  This parameter is
                    not applicable to upstream DOCSIS QOS Parameter
                    Sets, and its value is reported as 0 in this case."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.7.1"
    ::= { docsIetfQosParamSetEntry 19 }


docsIetfQosParamSetType     OBJECT-TYPE
    SYNTAX          INTEGER {
                       active (1),
                       admitted (2),
                       provisioned (3)
                    }
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "Defines the type of the QOS parameter set defined
                    by this row.  active(1) indicates the Active QOS
                    parameter set, describing the service currently
                    being provided by the DOCSIS MAC domain to the
                    Service Flow.  admitted(2) indicates the Admitted
                    QOS Parameter Set, describing services reserved by
                    the DOCSIS MAC domain for use by the service
                    flow.  provisioned (3) describes the QOS Parameter
                    Set defined in the DOCSIS CM Configuration file for
                    the Service Flow."
    REFERENCE      "SP-RFIv2.0-I06-040804, 8.1.5"
    ::= { docsIetfQosParamSetEntry 20 }

docsIetfQosParamSetRequestPolicyOct OBJECT-TYPE
    SYNTAX          OCTET STRING (SIZE(4))
                    -- A 32-bit mask represented most significant byte
```

```
                    -- first.  The 32-bit integer represented in this
                    -- manner equals the binary value of the referenced
                    -- integer parameter of the DOCSIS RFI
                    -- specification.
                    -- The BITS syntax is not used in order to avoid
                    -- the confusion caused by different bit-numbering
                    -- conventions.
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION     "Specifies which transmit interval opportunities
                    the CM omits for upstream transmission requests and
                    packet transmissions.  This object takes its
                    default value for downstream Service Flows.

                    Unless otherwise indicated, a bit value of 1 means
                    that a CM must not use that opportunity for
                    upstream transmission.

                    If bit 0 is the least significant bit of the
                    least significant (4th) octet, and if bit number
                    is increased with significance, the bit definitions
                    are defined as follows:

                    broadcastReqOpp(0):
                         all CMs broadcast request opportunities

                    priorityReqMulticastReq(1):
                         priority request multicast request
                         opportunities

                    reqDataForReq(2):
                         request/data opportunities for requests

                    reqDataForData(3):
                         request/data opportunities for data

                    piggybackReqWithData(4):
                         piggyback requests with data

                    concatenateData(5):
                         concatenate data

                    fragmentData(6):
                         fragment data

                    suppresspayloadheaders(7):
                         suppress payload headers
```

```
                    dropPktsExceedUGSize(8):
                         A value of 1 means that the Service Flow must
                         drop packets that do not fit in the Unsolicited
                         Grant size.

                    If the referenced parameter is not present in
                    a QOS Parameter Set, the value of this object is
                    reported as '00000000'H."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.6.3"
    ::= { docsIetfQosParamSetEntry 21 }

docsIetfQosParamSetBitMap OBJECT-TYPE
                              -- Each bit corresponds to a parameter
                              -- from SP-RFI-v1.1-I10-037030,
                              -- Appendix C in the indicated
    SYNTAX          BITS {    -- section number.
                        trafficPriority(0),     -- C.2.2.5.1
                        maxTrafficRate(1),      -- C.2.2.5.2
                        maxTrafficBurst(2),     -- C.2.2.5.3
                        minReservedRate(3),     -- C.2.2.5.4
                        minReservedPkt(4),      -- C.2.2.5.5
                        activeTimeout(5),       -- C.2.2.5.6
                        admittedTimeout(6),     -- C.2.2.5.7
                        maxConcatBurst(7),      -- C.2.2.6.1
                        schedulingType(8),      -- C.2.2.6.2
                        requestPolicy(9),       -- C.2.2.6.3
                        nomPollInterval(10),    -- C.2.2.6.4
                        tolPollJitter(11),      -- C.2.2.6.5
                        unsolicitGrantSize(12), -- C.2.2.6.6
                        nomGrantInterval(13),   -- C.2.2.6.7
                        tolGrantJitter(14),     -- C.2.2.6.8
                        grantsPerInterval(15),  -- C.2.2.6.9
                        tosOverwrite(16),       -- C.2.2.6.10
                        maxLatency(17)          -- C.2.2.7.1
                    }
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object indicates the set of QOS Parameter
                    Set parameters actually signaled in the
                    DOCSIS registration or dynamic service request
                    message that created or modified the QOS Parameter
                    Set.  A bit is set to 1 when the parameter described
                    by the indicated reference section is present
                    in the original request.

                    Note that when Service Class names are expanded,
                    the registration or dynamic response message may
                    contain parameters as expanded by the CMTS based
```

```
                    on a stored service class.  These expanded
                    parameters are not indicated by a 1 bit in this
                    object.

                    Note that even though some QOS Parameter Set
                    parameters may not be signaled in a message
                    (so that the paramater's bit in this object is 0),
                    the DOCSIS specification requires that default
                    values be used.  These default values are reported
                    as the corresponding object's value in the row.

                    Note that BITS objects are encoded most
                    significant bit first.  For example, if bits
                    1 and 16 are set, the value of this object
                    is the octet string '400080'H."
    ::= { docsIetfQosParamSetEntry 22 }

--
--  Service Flow Table
--
docsIetfQosServiceFlowTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF DocsIetfQosServiceFlowEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "This table describes the set of DOCSIS-QOS
                    Service Flows in a managed device."
    ::= { docsIetfQosMIBObjects 3 }

docsIetfQosServiceFlowEntry OBJECT-TYPE
    SYNTAX          DocsIetfQosServiceFlowEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "Describes a Service Flow.
                    An entry in the table exists for each
                    Service Flow ID.  The ifIndex is an
                    ifType of docsCableMaclayer(127)."
    INDEX {
            ifIndex,
            docsIetfQosServiceFlowId
          }
    ::= { docsIetfQosServiceFlowTable 1 }

DocsIetfQosServiceFlowEntry ::= SEQUENCE {
    docsIetfQosServiceFlowId               Unsigned32,
    docsIetfQosServiceFlowSID              Unsigned32,
    docsIetfQosServiceFlowDirection        DocsIetfQosRfMacIfDirection,
    docsIetfQosServiceFlowPrimary          TruthValue
    }
```

```
docsIetfQosServiceFlowId    OBJECT-TYPE
    SYNTAX          Unsigned32 (1..4294967295)
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "An index assigned to a Service Flow by CMTS."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.3.2"
    ::= { docsIetfQosServiceFlowEntry 1 }

docsIetfQosServiceFlowSID  OBJECT-TYPE
    SYNTAX          Unsigned32 (0..16383)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Service Identifier (SID) assigned to an
                    admitted or active Service Flow.  This object
                    reports a value of 0 if a Service ID is not
                    associated with the Service Flow.  Only active
                    or admitted upstream Service Flows will have a
                    Service ID (SID)."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.3.3"
    ::= { docsIetfQosServiceFlowEntry 2 }

docsIetfQosServiceFlowDirection OBJECT-TYPE
    SYNTAX          DocsIetfQosRfMacIfDirection
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The direction of the Service Flow."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.1/2"
    ::= { docsIetfQosServiceFlowEntry 3 }

docsIetfQosServiceFlowPrimary OBJECT-TYPE
    SYNTAX          TruthValue
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Object reflects whether Service Flow is the primary
                    or a secondary Service Flow.

                    A primary Service Flow is the default Service Flow
                    for otherwise unclassified traffic and all MAC
                    messages."
    REFERENCE      "SP-RFIv2.0-I06-040804, Section 8.1 "
    ::= { docsIetfQosServiceFlowEntry 4 }

--
--  Service Flow Stats Table
--
docsIetfQosServiceFlowStatsTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF DocsIetfQosServiceFlowStatsEntry
    MAX-ACCESS      not-accessible
```

```
    STATUS          current
    DESCRIPTION     "This table describes statistics associated with the
                     Service Flows in a managed device."
    ::= { docsIetfQosMIBObjects 4 }

docsIetfQosServiceFlowStatsEntry OBJECT-TYPE
    SYNTAX          DocsIetfQosServiceFlowStatsEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "Describes a set of Service Flow statistics.
                    An entry in the table exists for each
                    Service Flow ID.  The ifIndex is an
                    ifType of docsCableMaclayer(127)."
    INDEX {
            ifIndex,
            docsIetfQosServiceFlowId
          }
    ::= { docsIetfQosServiceFlowStatsTable 1 }

DocsIetfQosServiceFlowStatsEntry ::= SEQUENCE {
    docsIetfQosServiceFlowPkts                      Counter64,
    docsIetfQosServiceFlowOctets                    Counter64,
    docsIetfQosServiceFlowTimeCreated               TimeStamp,
    docsIetfQosServiceFlowTimeActive                Counter32,
    docsIetfQosServiceFlowPHSUnknowns               Counter32,
    docsIetfQosServiceFlowPolicedDropPkts           Counter32,
    docsIetfQosServiceFlowPolicedDelayPkts          Counter32
    }

docsIetfQosServiceFlowPkts OBJECT-TYPE
    SYNTAX          Counter64
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "For outgoing Service Flows, this object counts the
                    number of Packet Data PDUs forwarded to this
                    Service Flow.  For incoming upstream CMTS service
                    flows, this object counts the number of Packet
                    Data PDUs actually received on the Service Flow
                    identified by the SID for which the packet was
                    scheduled.  CMs not classifying downstream packets
                    may report this object's value as 0 for downstream
                    Service Flows.  This object does not count
                    MAC-specific management messages.

                    Particularly for UGS flows, packets sent on the
                    primary Service Flow in violation of the UGS grant
                    size should be counted only by the instance of this
                    object that is associated with the primary service
```

```
                    flow.

                    Unclassified upstream user data packets (i.e., non-
                    MAC-management) forwarded to the primary upstream
                    Service Flow should be counted by the instance of
                    this object that is associated with the primary
                    service flow.

                    This object does include packets counted by
                    docsIetfQosServiceFlowPolicedDelayPkts, but does not
                    include packets counted by
                    docsIetfQosServiceFlowPolicedDropPkts
                    and docsIetfQosServiceFlowPHSUnknowns.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosServiceFlowStatsEntry 1 }

docsIetfQosServiceFlowOctets OBJECT-TYPE
    SYNTAX          Counter64
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of octets from the byte after the MAC
                    header HCS to the end of the CRC for all packets
                    counted in the docsIetfQosServiceFlowPkts object for
                    this row.  Note that this counts the octets after
                    payload header suppression and before payload
                    header expansion have been applied.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosServiceFlowStatsEntry 2 }

docsIetfQosServiceFlowTimeCreated OBJECT-TYPE
    SYNTAX          TimeStamp
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The value of sysUpTime when the service flow
                    was created."
    ::= { docsIetfQosServiceFlowStatsEntry 3 }

docsIetfQosServiceFlowTimeActive OBJECT-TYPE
    SYNTAX          Counter32
    UNITS           "seconds"
    MAX-ACCESS      read-only
    STATUS          current
```

```
    DESCRIPTION    "The number of seconds that the service flow
                    has been active.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosServiceFlowStatsEntry 4 }

docsIetfQosServiceFlowPHSUnknowns OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "For incoming upstream CMTS service flows, this
                    object counts the number of packets received
                    with an unknown payload header suppression index.
                    The service flow is identified by the SID for which
                    the packet was scheduled.

                    On a CM, only this object's instance for the primary
                    downstream service flow counts packets received with
                    an unknown payload header suppression index.  All
                    other downstream service flows on CM report this
                    objects value as 0.

                    All outgoing service flows report this object's
                    value as 0.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosServiceFlowStatsEntry 5 }

docsIetfQosServiceFlowPolicedDropPkts OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "For outgoing service flows, this object counts the
                    number of Packet Data PDUs classified to this
                    service flow dropped due to:
                       (1) implementation-dependent excessive delay
                           while enforcing the Maximum Sustained
                           Traffic Rate; or
                       (2) UGS packets dropped due to exceeding the
                           Unsolicited Grant Size with a
                           Request/Transmission policy that requires
                           such packets to be dropped.

                    Classified packets dropped due to other reasons
```

```
                    must be counted in ifOutDiscards for the interface
                    of this service flow.  This object reports 0 for
                    incoming service flows.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosServiceFlowStatsEntry 6 }

docsIetfQosServiceFlowPolicedDelayPkts OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "This object counts only outgoing packets delayed in
                    order to maintain the Maximum Sustained Traffic
                    Rate.  This object will always report a value of 0
                    for UGS flows because the Maximum Sustained Traffic
                    Rate does not apply.  This object is 0 for incoming
                    service flows.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosServiceFlowStatsEntry 7 }

--
--  Upstream Service Flow Stats Table (CMTS ONLY)
--
docsIetfQosUpstreamStatsTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF DocsIetfQosUpstreamStatsEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "This table describes statistics associated with
                    upstream service flows.  All counted frames must
                    be received without a Frame Check Sequence (FCS)
                    error."
    ::= { docsIetfQosMIBObjects 5 }

docsIetfQosUpstreamStatsEntry OBJECT-TYPE
    SYNTAX          DocsIetfQosUpstreamStatsEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "Describes a set of upstream service flow
                    statistics.  An entry in the table exists for each
                    upstream Service Flow in a managed device.
                    The ifIndex is an ifType of
                    docsCableMaclayer(127)."
    INDEX {
```

```
            ifIndex,
            docsIetfQosSID
          }
    ::= { docsIetfQosUpstreamStatsTable 1 }

DocsIetfQosUpstreamStatsEntry ::= SEQUENCE {
    docsIetfQosSID                          Unsigned32,
    docsIetfQosUpstreamFragments            Counter32,
    docsIetfQosUpstreamFragDiscards         Counter32,
    docsIetfQosUpstreamConcatBursts         Counter32
    }

docsIetfQosSID OBJECT-TYPE
    SYNTAX          Unsigned32 (1..16383)
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "Identifies a service ID for an admitted or active
                    upstream service flow."
    ::= { docsIetfQosUpstreamStatsEntry 1 }

docsIetfQosUpstreamFragments OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of fragmentation headers received on an
                    upstream service flow, regardless of whether
                    the fragment was correctly reassembled into a
                    valid packet.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosUpstreamStatsEntry 2 }

docsIetfQosUpstreamFragDiscards OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of upstream fragments discarded and not
                    assembled into a valid upstream packet.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosUpstreamStatsEntry 3 }

docsIetfQosUpstreamConcatBursts OBJECT-TYPE
    SYNTAX          Counter32
```

```
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of concatenation headers received on an
                    upstream service flow.
                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosUpstreamStatsEntry 4 }


--
--  Dynamic Service Stats Table
--
docsIetfQosDynamicServiceStatsTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF DocsIetfQosDynamicServiceStatsEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "This table describes statistics associated with the
                    Dynamic Service Flows in a managed device."
    ::= { docsIetfQosMIBObjects 6 }

docsIetfQosDynamicServiceStatsEntry OBJECT-TYPE
    SYNTAX          DocsIetfQosDynamicServiceStatsEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "Describes a set of dynamic service flow statistics.
                    Two entries exist for each DOCSIS MAC layer
                    interface for the upstream and downstream
                    direction.  On the CMTS, the downstream direction
                    row indicates messages transmitted or transactions
                    originated by the CMTS.  The upstream direction row
                    indicates messages received or transaction
                    originated by the CM.  On the CM, the downstream
                    direction row indicates messages received or
                    transactions originated by the CMTS.  The upstream
                    direction row indicates messages transmitted by
                    the CM or transactions originated by the CM.
                    The ifIndex is an ifType of
                    docsCableMaclayer(127)."
    INDEX {
            ifIndex,
            docsIetfQosIfDirection
          }
    ::= { docsIetfQosDynamicServiceStatsTable 1 }

DocsIetfQosDynamicServiceStatsEntry ::= SEQUENCE {
    docsIetfQosIfDirection                DocsIetfQosRfMacIfDirection,
    docsIetfQosDSAReqs                    Counter32,
```

```
    docsIetfQosDSARsps                  Counter32,
    docsIetfQosDSAAcks                  Counter32,
    docsIetfQosDSCReqs                  Counter32,
    docsIetfQosDSCRsps                  Counter32,
    docsIetfQosDSCAcks                  Counter32,
    docsIetfQosDSDReqs                  Counter32,
    docsIetfQosDSDRsps                  Counter32,
    docsIetfQosDynamicAdds              Counter32,
    docsIetfQosDynamicAddFails          Counter32,
    docsIetfQosDynamicChanges           Counter32,
    docsIetfQosDynamicChangeFails       Counter32,
    docsIetfQosDynamicDeletes           Counter32,
    docsIetfQosDynamicDeleteFails       Counter32,
    docsIetfQosDCCReqs                  Counter32,
    docsIetfQosDCCRsps                  Counter32,
    docsIetfQosDCCAcks                  Counter32,
    docsIetfQosDCCs                     Counter32,
    docsIetfQosDCCFails                 Counter32
   }

docsIetfQosIfDirection OBJECT-TYPE
    SYNTAX          DocsIetfQosRfMacIfDirection
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "The direction of interface."
    ::= { docsIetfQosDynamicServiceStatsEntry 1 }

docsIetfQosDSAReqs OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of Dynamic Service Addition Requests,
                    including retries.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 2 }

docsIetfQosDSARsps OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of Dynamic Service Addition Responses,
                    including retries.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
```

```
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 3 }

docsIetfQosDSAAcks OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of Dynamic Service Addition
                    Acknowledgements, including retries.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 4 }

docsIetfQosDSCReqs OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of Dynamic Service Change Requests,
                    including retries.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 5 }

docsIetfQosDSCRsps OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of Dynamic Service Change Responses,
                    including retries.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 6 }

docsIetfQosDSCAcks OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of Dynamic Service Change
                    Acknowledgements, including retries.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
```

```
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 7 }

docsIetfQosDSDReqs OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of Dynamic Service Delete Requests,
                    including retries.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 8 }

docsIetfQosDSDRsps OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of Dynamic Service Delete Responses,
                    including retries.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 9 }

docsIetfQosDynamicAdds OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of successful Dynamic Service Addition
                    transactions.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 10 }

docsIetfQosDynamicAddFails OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of failed Dynamic Service Addition
                    transactions.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
```

```
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 11 }

docsIetfQosDynamicChanges OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of successful Dynamic Service Change
                    transactions.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 12 }

docsIetfQosDynamicChangeFails OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of failed Dynamic Service Change
                    transactions.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 13 }

docsIetfQosDynamicDeletes OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of successful Dynamic Service Delete
                    transactions.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 14 }

docsIetfQosDynamicDeleteFails OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of failed Dynamic Service Delete
                    transactions.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
```

```
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 15 }


docsIetfQosDCCReqs OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of Dynamic Channel Change Request
                    messages traversing an interface.  This count
                    is nonzero only on downstream direction rows.
                    This count should include the number of retries.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex
                    that indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 16 }

docsIetfQosDCCRsps OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of Dynamic Channel Change Response
                    messages traversing an interface.  This count is
                    nonzero only on upstream direction rows.  This count
                    should include the number of retries.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 17 }

docsIetfQosDCCAcks OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of Dynamic Channel Change Acknowledgement
                    messages traversing an interface.  This count
                    is nonzero only on downstream direction rows.
                    This count should include the number of retries.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 18 }

docsIetfQosDCCs OBJECT-TYPE
    SYNTAX          Counter32
```

```
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of successful Dynamic Channel Change
                    transactions.  This count is nonzero only on
                    downstream direction rows.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 19 }

docsIetfQosDCCFails OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of failed Dynamic Channel Change
                    transactions.  This count is nonzero only on
                    downstream direction rows.

                    This counter's last discontinuity is the
                    ifCounterDiscontinuityTime for the same ifIndex that
                    indexes this object."
    ::= { docsIetfQosDynamicServiceStatsEntry 20 }


--
--  Service Flow Log Table (CMTS ONLY)
--
docsIetfQosServiceFlowLogTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF DocsIetfQosServiceFlowLogEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "This table contains a log of the disconnected
                    Service Flows in a managed device."
    ::= { docsIetfQosMIBObjects 7 }

docsIetfQosServiceFlowLogEntry OBJECT-TYPE
    SYNTAX          DocsIetfQosServiceFlowLogEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "The information regarding a single disconnected
                    service flow."
    INDEX {
            docsIetfQosServiceFlowLogIndex
          }
    ::= { docsIetfQosServiceFlowLogTable 1 }

DocsIetfQosServiceFlowLogEntry ::= SEQUENCE {
```

```
    docsIetfQosServiceFlowLogIndex                Unsigned32,
    docsIetfQosServiceFlowLogIfIndex              InterfaceIndex,
    docsIetfQosServiceFlowLogSFID                 Unsigned32,
    docsIetfQosServiceFlowLogCmMac                MacAddress,
    docsIetfQosServiceFlowLogPkts                 Counter64,
    docsIetfQosServiceFlowLogOctets               Counter64,
    docsIetfQosServiceFlowLogTimeDeleted          TimeStamp,
    docsIetfQosServiceFlowLogTimeCreated          TimeStamp,
    docsIetfQosServiceFlowLogTimeActive           Counter32,
    docsIetfQosServiceFlowLogDirection    DocsIetfQosRfMacIfDirection,
    docsIetfQosServiceFlowLogPrimary              TruthValue,
    docsIetfQosServiceFlowLogServiceClassName     SnmpAdminString,
    docsIetfQosServiceFlowLogPolicedDropPkts      Counter32,
    docsIetfQosServiceFlowLogPolicedDelayPkts     Counter32,
    docsIetfQosServiceFlowLogControl              INTEGER
    }

docsIetfQosServiceFlowLogIndex OBJECT-TYPE
    SYNTAX          Unsigned32 (1..4294967295)
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "Unique index for a logged service flow."
    ::= { docsIetfQosServiceFlowLogEntry 1 }

docsIetfQosServiceFlowLogIfIndex OBJECT-TYPE
    SYNTAX          InterfaceIndex
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The ifIndex of ifType docsCableMaclayer(127)
                    on the CMTS where the service flow was present."
    ::= {  docsIetfQosServiceFlowLogEntry 2 }

docsIetfQosServiceFlowLogSFID    OBJECT-TYPE
    SYNTAX          Unsigned32 (1..4294967295)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The index assigned to the service flow by the CMTS."
    ::= {  docsIetfQosServiceFlowLogEntry 3 }

docsIetfQosServiceFlowLogCmMac OBJECT-TYPE
    SYNTAX          MacAddress
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The MAC address for the cable modem associated with
                    the service flow."
    ::= { docsIetfQosServiceFlowLogEntry 4 }

docsIetfQosServiceFlowLogPkts OBJECT-TYPE
```

```
    SYNTAX          Counter64
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of packets counted on this service flow
                    after payload header suppression."
    ::= { docsIetfQosServiceFlowLogEntry 5 }

docsIetfQosServiceFlowLogOctets OBJECT-TYPE
    SYNTAX          Counter64
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The number of octets counted on this service flow
                    after payload header suppression."
    ::= { docsIetfQosServiceFlowLogEntry 6 }

docsIetfQosServiceFlowLogTimeDeleted OBJECT-TYPE
    SYNTAX          TimeStamp
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The value of sysUpTime when the service flow
                    was deleted."
    ::= { docsIetfQosServiceFlowLogEntry 7 }

docsIetfQosServiceFlowLogTimeCreated OBJECT-TYPE
    SYNTAX          TimeStamp
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The value of sysUpTime when the service flow
                    was created."
    ::= { docsIetfQosServiceFlowLogEntry 8 }

docsIetfQosServiceFlowLogTimeActive OBJECT-TYPE
    SYNTAX          Counter32
    UNITS           "seconds"
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The total time that the service flow was active."
    ::= { docsIetfQosServiceFlowLogEntry 9 }

docsIetfQosServiceFlowLogDirection OBJECT-TYPE
    SYNTAX          DocsIetfQosRfMacIfDirection
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The value of docsIetfQosServiceFlowDirection
                    for the service flow."
    ::= { docsIetfQosServiceFlowLogEntry  10 }

docsIetfQosServiceFlowLogPrimary OBJECT-TYPE
```

```
    SYNTAX          TruthValue
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The value of docsIetfQosServiceFlowPrimary for the
                    service flow."
    ::= { docsIetfQosServiceFlowLogEntry 11 }

docsIetfQosServiceFlowLogServiceClassName OBJECT-TYPE
    SYNTAX          SnmpAdminString
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The value of docsIetfQosParamSetServiceClassName for
                    the provisioned QOS Parameter Set of the
                    service flow."
    ::= { docsIetfQosServiceFlowLogEntry  12 }

docsIetfQosServiceFlowLogPolicedDropPkts OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The final value of
                    docsIetfQosServiceFlowPolicedDropPkts for the
                    service flow."
    ::= { docsIetfQosServiceFlowLogEntry  13 }

docsIetfQosServiceFlowLogPolicedDelayPkts OBJECT-TYPE
    SYNTAX          Counter32
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The final value of
                    docsIetfQosServiceFlowPolicedDelayPkts for the
                    service flow."
    ::= { docsIetfQosServiceFlowLogEntry  14 }

docsIetfQosServiceFlowLogControl OBJECT-TYPE
    SYNTAX          INTEGER {
                     active(1),
                     destroy(6)
                    }

    MAX-ACCESS      read-write
    STATUS          current
    DESCRIPTION    "Setting this object to the value destroy(6) removes
                    this entry from the table.

                    Reading this object returns the value active(1)."
    ::= { docsIetfQosServiceFlowLogEntry 15 }
```

```
--
-- Service Class Table (CMTS ONLY)
--
docsIetfQosServiceClassTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF DocsIetfQosServiceClassEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "This table describes the set of DOCSIS-QOS
                    Service Classes in a CMTS."
    ::= { docsIetfQosMIBObjects 8 }

docsIetfQosServiceClassEntry OBJECT-TYPE
    SYNTAX          DocsIetfQosServiceClassEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "A provisioned service class on a CMTS.
                    Each entry defines a template for certain
                    DOCSIS QOS Parameter Set values.  When a CM
                    creates or modifies an Admitted QOS Parameter Set
                    for a Service Flow, it may reference a Service Class
                    Name instead of providing explicit QOS Parameter
                    Set values.  In this case, the CMTS populates
                    the QOS Parameter Set with the applicable
                    corresponding values from the named Service Class.
                    Subsequent changes to a Service Class row do not
                    affect the QOS Parameter Set values of any service
                    flows already admitted.

                    A service class template applies to only
                    a single direction, as indicated in the
                    docsIetfQosServiceClassDirection object."
    INDEX {
            docsIetfQosServiceClassName
          }
    ::= { docsIetfQosServiceClassTable 1 }

DocsIetfQosServiceClassEntry ::= SEQUENCE {
    docsIetfQosServiceClassName               SnmpAdminString,
    docsIetfQosServiceClassStatus             RowStatus,
    docsIetfQosServiceClassPriority           Integer32,
    docsIetfQosServiceClassMaxTrafficRate     DocsIetfQosBitRate,
    docsIetfQosServiceClassMaxTrafficBurst    Unsigned32,
    docsIetfQosServiceClassMinReservedRate    DocsIetfQosBitRate,
    docsIetfQosServiceClassMinReservedPkt     Integer32,
    docsIetfQosServiceClassMaxConcatBurst     Integer32,
    docsIetfQosServiceClassNomPollInterval    Unsigned32,
    docsIetfQosServiceClassTolPollJitter      Unsigned32,
    docsIetfQosServiceClassUnsolicitGrantSize Integer32,
```

```
    docsIetfQosServiceClassNomGrantInterval   Unsigned32,
    docsIetfQosServiceClassTolGrantJitter     Unsigned32,
    docsIetfQosServiceClassGrantsPerInterval  Integer32,
    docsIetfQosServiceClassMaxLatency         Unsigned32,
    docsIetfQosServiceClassActiveTimeout      Integer32,
    docsIetfQosServiceClassAdmittedTimeout    Integer32,
    docsIetfQosServiceClassSchedulingType     DocsIetfQosSchedulingType,
    docsIetfQosServiceClassRequestPolicy      OCTET STRING,
    docsIetfQosServiceClassTosAndMask         OCTET STRING,
    docsIetfQosServiceClassTosOrMask          OCTET STRING,
    docsIetfQosServiceClassDirection        DocsIetfQosRfMacIfDirection,
    docsIetfQosServiceClassStorageType        StorageType,
    docsIetfQosServiceClassDSCPOverwrite      DscpOrAny
    }

docsIetfQosServiceClassName OBJECT-TYPE
    SYNTAX          SnmpAdminString (SIZE (1..15))
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "Service Class Name.  DOCSIS specifies that the
                    maximum size is 16 ASCII characters including
                    a terminating zero.  The terminating zero is not
                    represented in this SnmpAdminString syntax object."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.3.4"
    ::= { docsIetfQosServiceClassEntry 1 }

docsIetfQosServiceClassStatus OBJECT-TYPE
    SYNTAX          RowStatus
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Used to create or delete rows in this table.
                    There is no restriction on the ability to change
                    values in this row while the row is active.
                    Inactive rows need not be timed out."
    ::= { docsIetfQosServiceClassEntry 2 }

docsIetfQosServiceClassPriority OBJECT-TYPE
    SYNTAX          Integer32 (0..7)
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Template for docsIetfQosParamSetPriority."
    DEFVAL          { 0 }
    ::= { docsIetfQosServiceClassEntry 3 }

docsIetfQosServiceClassMaxTrafficRate OBJECT-TYPE
    SYNTAX          DocsIetfQosBitRate
    MAX-ACCESS      read-create
    STATUS          current
```

```
    DESCRIPTION    "Template for docsIetfQosParamSetMaxTrafficRate."
    DEFVAL         { 0 }
    ::= { docsIetfQosServiceClassEntry 4 }

docsIetfQosServiceClassMaxTrafficBurst OBJECT-TYPE
    SYNTAX         Unsigned32
    MAX-ACCESS     read-create
    STATUS         current
    DESCRIPTION    "Template for docsIetfQosParamSetMaxTrafficBurst."
    DEFVAL         { 3044 }
    ::= { docsIetfQosServiceClassEntry 5 }

docsIetfQosServiceClassMinReservedRate OBJECT-TYPE
    SYNTAX         DocsIetfQosBitRate
    MAX-ACCESS     read-create
    STATUS         current
    DESCRIPTION    "Template for docsIetfQosParamSEtMinReservedRate."
    DEFVAL         { 0 }
    ::= { docsIetfQosServiceClassEntry 6 }

docsIetfQosServiceClassMinReservedPkt OBJECT-TYPE
    SYNTAX         Integer32 (0..65535)
    MAX-ACCESS     read-create
    STATUS         current
    DESCRIPTION    "Template for docsIetfQosParamSetMinReservedPkt."
    ::= { docsIetfQosServiceClassEntry 7 }

docsIetfQosServiceClassMaxConcatBurst OBJECT-TYPE
    SYNTAX         Integer32 (0..65535)
    MAX-ACCESS     read-create
    STATUS         current
    DESCRIPTION    "Template for docsIetfQosParamSetMaxConcatBurst."
    DEFVAL         { 1522 }
    ::= { docsIetfQosServiceClassEntry 8 }

docsIetfQosServiceClassNomPollInterval OBJECT-TYPE
    SYNTAX         Unsigned32
    UNITS          "microseconds"
    MAX-ACCESS     read-create
    STATUS         current
    DESCRIPTION    "Template for docsIetfQosParamSetNomPollInterval."
    DEFVAL         { 0 }
    ::= { docsIetfQosServiceClassEntry 9 }

docsIetfQosServiceClassTolPollJitter OBJECT-TYPE
    SYNTAX         Unsigned32
    UNITS          "microseconds"
    MAX-ACCESS     read-create
```

```
    STATUS          current
    DESCRIPTION    "Template for docsIetfQosParamSetTolPollJitter."
    DEFVAL          { 0 }
    ::= { docsIetfQosServiceClassEntry 10 }

docsIetfQosServiceClassUnsolicitGrantSize OBJECT-TYPE
    SYNTAX          Integer32 (0..65535)
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Template for docsIetfQosParamSetUnsolicitGrantSize."
    DEFVAL          { 0 }
    ::= { docsIetfQosServiceClassEntry 11 }

docsIetfQosServiceClassNomGrantInterval OBJECT-TYPE
    SYNTAX          Unsigned32
    UNITS           "microseconds"
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Template for docsIetfQosParamSetNomGrantInterval."
    DEFVAL          { 0 }
    ::= { docsIetfQosServiceClassEntry 12 }

docsIetfQosServiceClassTolGrantJitter OBJECT-TYPE
    SYNTAX          Unsigned32
    UNITS           "microseconds"
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Template for docsIetfQosParamSetTolGrantJitter."
    DEFVAL          { 0 }
    ::= { docsIetfQosServiceClassEntry 13 }

docsIetfQosServiceClassGrantsPerInterval OBJECT-TYPE
    SYNTAX          Integer32 (0..127)
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Template for docsIetfQosParamSetGrantsPerInterval."
    DEFVAL          { 0 }
    ::= { docsIetfQosServiceClassEntry 14 }

docsIetfQosServiceClassMaxLatency OBJECT-TYPE
    SYNTAX          Unsigned32
    UNITS           "microseconds"
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Template for docsIetfQosParamSetClassMaxLatency."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.7.1"
    DEFVAL          { 0 }
    ::= { docsIetfQosServiceClassEntry 15 }
```

```
docsIetfQosServiceClassActiveTimeout OBJECT-TYPE
    SYNTAX          Integer32 (0..65535)
    UNITS           "seconds"
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Template for docsIetfQosParamSetActiveTimeout."
    DEFVAL          { 0 }
    ::= { docsIetfQosServiceClassEntry 16 }

docsIetfQosServiceClassAdmittedTimeout OBJECT-TYPE
    SYNTAX          Integer32 (0..65535)
    UNITS           "seconds"
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Template for docsIetfQosParamSetAdmittedTimeout."
    DEFVAL          { 200 }
    ::= { docsIetfQosServiceClassEntry 17 }

docsIetfQosServiceClassSchedulingType OBJECT-TYPE
    SYNTAX          DocsIetfQosSchedulingType
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Template for docsIetfQosParamSetSchedulingType."
    DEFVAL          { bestEffort }
    ::= { docsIetfQosServiceClassEntry 18 }

docsIetfQosServiceClassRequestPolicy OBJECT-TYPE
    SYNTAX          OCTET STRING (SIZE(4))
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Template for docsIetfQosParamSetRequestPolicyOct."
    DEFVAL          { '00000000'H } -- no bits are set
    ::= { docsIetfQosServiceClassEntry 19 }

docsIetfQosServiceClassTosAndMask OBJECT-TYPE
    SYNTAX          OCTET STRING (SIZE(1))
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Template for docsIetfQosParamSetTosAndMask.
                    The IP TOS octet as originally defined in RFC 791
                    has been superseded by the 6-bit Differentiated
                    Services Field (DSField, RFC 3260) and the 2-bit
                    Explicit Congestion Notification Field (ECN field,
                    RFC 3168).  Network operators SHOULD avoid
                    specifying values of
                    docsIetfQosServiceClassTosAndMask and
                    docsIetfQosServiceClassTosOrMask that would result
                    in the modification of the ECN bits.
```

```
                    In particular, operators should not use values of
                    docsIetfQosServiceClassTosAndMask that have either
                    of the least-significant two bits set to 0.
                    Similarly,operators should not use values of
                    docsIetfQosServiceClassTosOrMask that have either
                    of the least-significant two bits set to 1."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.6.10;
                    RFC 3168, The Addition of Explicit Congestion
                    Notification (ECN) to IP;
                    RFC 3260, New Terminology and Clarifications for
                    Diffserv."
    ::= { docsIetfQosServiceClassEntry 20 }

docsIetfQosServiceClassTosOrMask OBJECT-TYPE
    SYNTAX          OCTET STRING (SIZE(1))
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Template for docsIetfQosParamSetTosOrMask.
                    The IP TOS octet as originally defined in RFC 791
                    has been superseded by the 6-bit Differentiated
                    Services Field (DSField, RFC 3260) and the 2-bit
                    Explicit Congestion Notification Field (ECN field,
                    RFC 3168).  Network operators SHOULD avoid
                    specifying values of
                    docsIetfQosServiceClassTosAndMask and
                    docsIetfQosServiceClassTosOrMask that would result
                    in the modification of the ECN bits.

                    In particular, operators should not use values of
                    docsIetfQosServiceClassTosAndMask that have either
                    of the least-significant two bits set to 0.
                    Similarly, operators should not use values of
                    docsIetfQosServiceClassTosOrMask that have either
                    of the least-significant two bits set to 1."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.2.6.10;
                    RFC 3168, The Addition of Explicit Congestion
                    Notification (ECN) to IP;
                    RFC 3260, New Terminology and Clarifications for
                    Diffserv."
    ::= { docsIetfQosServiceClassEntry 21 }

docsIetfQosServiceClassDirection OBJECT-TYPE
    SYNTAX          DocsIetfQosRfMacIfDirection
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Specifies whether the service class template
                    applies to upstream or downstream service flows."
    DEFVAL          { upstream }
```

```
    ::= { docsIetfQosServiceClassEntry 22 }

docsIetfQosServiceClassStorageType OBJECT-TYPE
    SYNTAX          StorageType
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "This object defines whether this row is kept in
                    volatile storage and lost upon reboot or whether
                    it is backed up by non-volatile or permanent
                    storage.  'permanent' entries need not allow
                    writable access to any object."
    DEFVAL { nonVolatile }
    ::= { docsIetfQosServiceClassEntry 23 }

docsIetfQosServiceClassDSCPOverwrite OBJECT-TYPE
    SYNTAX          DscpOrAny
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "This object allows the overwrite of the DSCP
                    field per RFC 3260.

                    If this object is -1, then the corresponding entry's
                    docsIetfQosServiceClassTosAndMask value MUST be
                    'FF'H and docsIetfQosServiceClassTosOrMask MUST be
                    '00'H.  Otherwise, this object is in the range of
                    0..63, and the corresponding entry's
                    docsIetfQosServiceClassTosAndMask value MUST be
                    '03'H and the docsIetfQosServiceClassTosOrMask MUST
                    be this object's value shifted left by two bit
                    positions."
    REFERENCE      "RFC 3168, The Addition of Explicit Congestion
                    Notification (ECN) to IP;
                    RFC 3260, New Terminology and Clarifications for
                    Diffserv."
    DEFVAL          { -1 }
    ::= { docsIetfQosServiceClassEntry 24 }

--
-- Service Class PolicyTable
--
docsIetfQosServiceClassPolicyTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF DocsIetfQosServiceClassPolicyEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "This table describes the set of DOCSIS-QOS
                    Service Class Policies.

                    This table is an adjunct to the
```

```
                    docsDevFilterPolicy table.   Entries in the
                    docsDevFilterPolicy table can point to
                    specific rows in this table.

                    This table permits mapping a packet to a service
                    class name of an active service flow so long as
                    a classifier does not exist at a higher
                    priority."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix E.2.1"
    ::= { docsIetfQosMIBObjects 9 }

docsIetfQosServiceClassPolicyEntry OBJECT-TYPE
    SYNTAX          DocsIetfQosServiceClassPolicyEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "A service class name policy entry."
    INDEX {
            docsIetfQosServiceClassPolicyIndex
          }
    ::= { docsIetfQosServiceClassPolicyTable 1 }

DocsIetfQosServiceClassPolicyEntry ::= SEQUENCE {
    docsIetfQosServiceClassPolicyIndex        Unsigned32,
    docsIetfQosServiceClassPolicyName         SnmpAdminString,
    docsIetfQosServiceClassPolicyRulePriority Integer32,
    docsIetfQosServiceClassPolicyStatus       RowStatus,
    docsIetfQosServiceClassPolicyStorageType  StorageType
    }

docsIetfQosServiceClassPolicyIndex OBJECT-TYPE
    SYNTAX          Unsigned32 (1..2147483647)
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "Index value to identify an entry in
                    this table uniquely."
    ::= { docsIetfQosServiceClassPolicyEntry 1 }

docsIetfQosServiceClassPolicyName OBJECT-TYPE
    SYNTAX          SnmpAdminString
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Service Class Name to identify the name of the
                    service class flow to which the packet should be
                    directed."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix E.2.1"
    ::= { docsIetfQosServiceClassPolicyEntry 2 }

docsIetfQosServiceClassPolicyRulePriority OBJECT-TYPE
```

```
    SYNTAX          Integer32 (0..255)
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Service Class Policy rule priority for the
                    entry."
    REFERENCE      "SP-RFIv2.0-I06-040804, Appendix C.2.1.3.5"
    ::= { docsIetfQosServiceClassPolicyEntry 3 }

docsIetfQosServiceClassPolicyStatus OBJECT-TYPE
    SYNTAX          RowStatus
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "Used to create or delete rows in this table.
                    This object should not be deleted if it is
                    referenced by an entry in docsDevFilterPolicy.
                    The reference should be deleted first.
                    There is no restriction on the ability
                    to change values in this row while the row is
                    active.  Inactive rows need not be timed out."
    ::= { docsIetfQosServiceClassPolicyEntry 4 }

docsIetfQosServiceClassPolicyStorageType OBJECT-TYPE
    SYNTAX          StorageType
    MAX-ACCESS      read-create
    STATUS          current
    DESCRIPTION    "This object defines whether this row is kept in
                    volatile storage and lost upon reboot or whether
                    it is backed up by non-volatile or permanent
                    storage.  'permanent' entries need not allow
                    writable access to any object."
    DEFVAL { nonVolatile }
    ::= { docsIetfQosServiceClassPolicyEntry 5 }

--
-- Payload Header Suppression(PHS) Table
--
docsIetfQosPHSTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF DocsIetfQosPHSEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "This table describes the set of payload header
                    suppression entries."
    ::= { docsIetfQosMIBObjects 10 }

docsIetfQosPHSEntry OBJECT-TYPE
    SYNTAX          DocsIetfQosPHSEntry
    MAX-ACCESS      not-accessible
    STATUS          current
```

```
    DESCRIPTION    "A payload header suppression entry.

                    The ifIndex is an ifType of docsCableMaclayer(127).
                    The index docsIetfQosServiceFlowId selects one
                    service flow from the cable MAC layer interface.
                    The docsIetfQosPktClassId index matches an
                    index of the docsIetfQosPktClassTable."
    INDEX {
            ifIndex,
            docsIetfQosServiceFlowId,
            docsIetfQosPktClassId
          }
    ::= { docsIetfQosPHSTable 1 }

DocsIetfQosPHSEntry ::= SEQUENCE {
    docsIetfQosPHSField            OCTET STRING,
    docsIetfQosPHSMask             OCTET STRING,
    docsIetfQosPHSSize             Integer32,
    docsIetfQosPHSVerify           TruthValue,
    docsIetfQosPHSIndex            Integer32
    }

docsIetfQosPHSField         OBJECT-TYPE
    SYNTAX          OCTET STRING (SIZE(0..255))
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Payload header suppression field defines the
                    bytes of the header that must be
                    suppressed/restored by the sending/receiving
                    device.

                    The number of octets in this object should be
                    the same as the value of docsIetfQosPHSSize."
    REFERENCE       "SP-RFIv2.0-I06-040804, Appendix C.2.2.10.1"
    ::= { docsIetfQosPHSEntry 1 }

docsIetfQosPHSMask          OBJECT-TYPE
    SYNTAX          OCTET STRING(SIZE(0..32))
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Payload header suppression mask defines the
                    bit mask that is used in combination with the
                    docsIetfQosPHSField.  It defines which bytes in
                    the header must be suppressed/restored by the
                    sending or receiving device.

                    Each bit of this bit mask corresponds to a byte
                    in the docsIetfQosPHSField, with the least
```

```
                    significant bit corresponding to the first byte
                    of the docsIetfQosPHSField.

                    Each bit of the bit mask specifies whether
                    the corresponding byte should be suppressed
                    in the packet.  A bit value of '1' indicates that
                    the byte should be suppressed by the sending
                    device and restored by the receiving device.
                    A bit value of '0' indicates that
                    the byte should not be suppressed by the sending
                    device or restored by the receiving device.

                    If the bit mask does not contain a bit for each
                    byte in the docsIetfQosPHSField, then the bit mask
                    is extended with bit values of '1' to be the
                    necessary length."
    REFERENCE       "SP-RFIv2.0-I06-040804, Appendix C.2.2.10.3"
    ::= { docsIetfQosPHSEntry 2 }

docsIetfQosPHSSize          OBJECT-TYPE
    SYNTAX          Integer32 (0..255)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Payload header suppression size specifies the
                    number of bytes in the header to be suppressed
                    and restored.

                    The value of this object must match the number
                    of bytes in the docsIetfQosPHSField."
    REFERENCE       "SP-RFIv2.0-I06-040804, Appendix C.2.2.10.4"
    ::= { docsIetfQosPHSEntry 3 }

docsIetfQosPHSVerify       OBJECT-TYPE
    SYNTAX          TruthValue
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Payload header suppression verification value.  If
                    'true', the sender must verify docsIetfQosPHSField
                    is the same as what is contained in the packet
                    to be suppressed."
    REFERENCE       "SP-RFIv2.0-I06-040804, Appendix C.2.2.10.5"
    ::= { docsIetfQosPHSEntry 4 }

docsIetfQosPHSIndex         OBJECT-TYPE
    SYNTAX          Integer32 (1..255)
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "Payload header suppression index uniquely
```

```
                    references the PHS rule for a given service flow."
    REFERENCE       "SP-RFIv2.0-I06-040804, Appendix C.2.2.10.2"
    ::= { docsIetfQosPHSEntry 5 }


--
-- docsIetfQosCmtsMacToSrvFlowTable (CMTS Only)
--
docsIetfQosCmtsMacToSrvFlowTable OBJECT-TYPE
    SYNTAX          SEQUENCE OF DocsIetfQosCmtsMacToSrvFlowEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "This table provides for referencing the service
                    flows associated with a particular cable modem.
                    This allows indexing into other docsIetfQos
                    tables that are indexed by docsIetfQosServiceFlowId
                    and ifIndex."
    ::= { docsIetfQosMIBObjects 11 }

docsIetfQosCmtsMacToSrvFlowEntry OBJECT-TYPE
    SYNTAX          DocsIetfQosCmtsMacToSrvFlowEntry
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "An entry is created by CMTS for each service flow
                    connected to this CMTS."
    INDEX {
            docsIetfQosCmtsCmMac,
            docsIetfQosCmtsServiceFlowId
          }
    ::= { docsIetfQosCmtsMacToSrvFlowTable 1 }

DocsIetfQosCmtsMacToSrvFlowEntry ::= SEQUENCE {
    docsIetfQosCmtsCmMac                MacAddress,
    docsIetfQosCmtsServiceFlowId        Unsigned32,
    docsIetfQosCmtsIfIndex              InterfaceIndex
    }

docsIetfQosCmtsCmMac OBJECT-TYPE
    SYNTAX          MacAddress
    MAX-ACCESS      not-accessible
    STATUS          current
    DESCRIPTION    "The MAC address for the referenced CM."
    ::= { docsIetfQosCmtsMacToSrvFlowEntry 1 }

docsIetfQosCmtsServiceFlowId OBJECT-TYPE
    SYNTAX          Unsigned32 (1..4294967295)
    MAX-ACCESS      not-accessible
    STATUS          current
```

```
    DESCRIPTION    "An index assigned to a service flow by CMTS."
    ::= { docsIetfQosCmtsMacToSrvFlowEntry 2 }

docsIetfQosCmtsIfIndex OBJECT-TYPE
    SYNTAX          InterfaceIndex
    MAX-ACCESS      read-only
    STATUS          current
    DESCRIPTION    "The ifIndex of ifType docsCableMacLayer(127)
                    on the CMTS that is connected to the Cable Modem."
    ::= { docsIetfQosCmtsMacToSrvFlowEntry 3 }

--
-- Conformance definitions
--
docsIetfQosConformance  OBJECT IDENTIFIER
        ::= { docsIetfQosMIB 2 }

docsIetfQosGroups       OBJECT IDENTIFIER
        ::= { docsIetfQosConformance 1 }

docsIetfQosCompliances  OBJECT IDENTIFIER
        ::= { docsIetfQosConformance 2 }

docsIetfQosCompliance MODULE-COMPLIANCE
    STATUS  current
    DESCRIPTION
        "The compliance statement for MCNS Cable Modems and
         Cable Modem Termination Systems that implement DOCSIS
         Service Flows."

    MODULE  -- docsIetfQosMIB
        MANDATORY-GROUPS { docsIetfQosBaseGroup }

        GROUP docsIetfQosCmtsGroup
        DESCRIPTION
            "This group is mandatory for Cable Modem Termination
             Systems (CMTS) and is not implemented for Cable Modems
             (CM)."

        GROUP docsIetfQosParamSetGroup
        DESCRIPTION
            "This group is mandatory for Cable Modem Termination
             Systems (CMTS) and Cable Modems.  Cable modems only
             implement objects in this group as read-only."

        GROUP docsIetfQosSrvClassPolicyGroup
        DESCRIPTION
            "This group is optional for Cable Modem Termination
```

```
             Systems (CMTS) and Cable Modems.  This group is relevant
             if policy-based service flow classification
             is implemented.  See docsDevPolicyTable in
             DOCS-CABLE-DEVICE-MIB for more details."

        GROUP docsIetfQosServiceClassGroup
        DESCRIPTION
            "This group is mandatory for a Cable Modem Termination
             System (CMTS) that implements expansion of Service Class
             Names in a QOS Parameter Set.  This group is
             not implemented on the Cable Modems."

        OBJECT  docsIetfQosPktClassPkts
        DESCRIPTION
            "This object only needs to be implemented in entries
             that are classifying packets and not policing packets."

        OBJECT  docsIetfQosPktClassInetAddressType
        SYNTAX InetAddressType { ipv4(1) }
        DESCRIPTION
            "An implementation is only required to support IPv4
             address."

        OBJECT  docsIetfQosPktClassInetSourceAddr
        SYNTAX InetAddress (SIZE(4))
        DESCRIPTION
            "An implementation is only required to support IPv4
             address."

        OBJECT  docsIetfQosPktClassInetSourceMask
        SYNTAX InetAddress (SIZE(4))
        DESCRIPTION
            "An implementation is only required to support IPv4
             address."

        OBJECT  docsIetfQosPktClassInetDestAddr
        SYNTAX InetAddress (SIZE(4))
        DESCRIPTION
            "An implementation is only required to support IPv4
             address."

        OBJECT  docsIetfQosPktClassInetDestMask
        SYNTAX InetAddress (SIZE(4))
        DESCRIPTION
            "An implementation is only required to support IPv4
             address."

        OBJECT  docsIetfQosServiceClassStorageType
```

```
        SYNTAX StorageType { nonVolatile(3) }
        DESCRIPTION
            "An implementation is only required to support nonvolatile
             storage."

        OBJECT  docsIetfQosServiceClassPolicyStorageType
        SYNTAX StorageType { nonVolatile(3) }
        DESCRIPTION
            "An implementation is only required to support nonvolatile
             storage."

    ::= { docsIetfQosCompliances 1 }

docsIetfQosBaseGroup OBJECT-GROUP
    OBJECTS {
    docsIetfQosPktClassDirection,
    docsIetfQosPktClassPriority,
    docsIetfQosPktClassIpTosLow,
    docsIetfQosPktClassIpTosHigh,
    docsIetfQosPktClassIpTosMask,
    docsIetfQosPktClassIpProtocol,
    docsIetfQosPktClassSourcePortStart,
    docsIetfQosPktClassSourcePortEnd,
    docsIetfQosPktClassDestPortStart,
    docsIetfQosPktClassDestPortEnd,
    docsIetfQosPktClassDestMacAddr,
    docsIetfQosPktClassDestMacMask,
    docsIetfQosPktClassSourceMacAddr,
    docsIetfQosPktClassEnetProtocolType,
    docsIetfQosPktClassEnetProtocol,
    docsIetfQosPktClassUserPriLow,
    docsIetfQosPktClassUserPriHigh,
    docsIetfQosPktClassVlanId,
    docsIetfQosPktClassStateActive,
    docsIetfQosPktClassPkts,
    docsIetfQosPktClassBitMap,
    docsIetfQosPktClassInetAddressType,
    docsIetfQosPktClassInetSourceAddr,
    docsIetfQosPktClassInetSourceMask,
    docsIetfQosPktClassInetDestAddr,
    docsIetfQosPktClassInetDestMask,

    docsIetfQosServiceFlowSID,
    docsIetfQosServiceFlowDirection,
    docsIetfQosServiceFlowPrimary,

    docsIetfQosServiceFlowPkts,
    docsIetfQosServiceFlowOctets,
```

```
    docsIetfQosServiceFlowTimeCreated,
    docsIetfQosServiceFlowTimeActive,
    docsIetfQosServiceFlowPHSUnknowns,
    docsIetfQosServiceFlowPolicedDropPkts,
    docsIetfQosServiceFlowPolicedDelayPkts,

    docsIetfQosDSAReqs,
    docsIetfQosDSARsps,
    docsIetfQosDSAAcks,
    docsIetfQosDSCReqs,
    docsIetfQosDSCRsps,
    docsIetfQosDSCAcks,
    docsIetfQosDSDReqs,
    docsIetfQosDSDRsps,
    docsIetfQosDynamicAdds,
    docsIetfQosDynamicAddFails,
    docsIetfQosDynamicChanges,
    docsIetfQosDynamicChangeFails,
    docsIetfQosDynamicDeletes,
    docsIetfQosDynamicDeleteFails,
    docsIetfQosDCCReqs,
    docsIetfQosDCCRsps,
    docsIetfQosDCCAcks,
    docsIetfQosDCCs,
    docsIetfQosDCCFails,

    docsIetfQosPHSField,
    docsIetfQosPHSMask,
    docsIetfQosPHSSize,
    docsIetfQosPHSVerify,
    docsIetfQosPHSIndex
    }
    STATUS  current
    DESCRIPTION
        "Group of objects implemented in both Cable Modems and
         Cable Modem Termination Systems."
    ::= { docsIetfQosGroups 1 }

docsIetfQosParamSetGroup OBJECT-GROUP
    OBJECTS {
    docsIetfQosParamSetServiceClassName,
    docsIetfQosParamSetPriority,
    docsIetfQosParamSetMaxTrafficRate,
    docsIetfQosParamSetMaxTrafficBurst,
    docsIetfQosParamSetMinReservedRate,
    docsIetfQosParamSetMinReservedPkt,
    docsIetfQosParamSetActiveTimeout,
    docsIetfQosParamSetAdmittedTimeout,
```

```
    docsIetfQosParamSetMaxConcatBurst,
    docsIetfQosParamSetSchedulingType,
    docsIetfQosParamSetNomPollInterval,
    docsIetfQosParamSetTolPollJitter,
    docsIetfQosParamSetUnsolicitGrantSize,
    docsIetfQosParamSetNomGrantInterval,
    docsIetfQosParamSetTolGrantJitter,
    docsIetfQosParamSetGrantsPerInterval,
    docsIetfQosParamSetTosAndMask,
    docsIetfQosParamSetTosOrMask,
    docsIetfQosParamSetMaxLatency,
    docsIetfQosParamSetRequestPolicyOct,
    docsIetfQosParamSetBitMap
    }
    STATUS  current
    DESCRIPTION
        "Group of objects implemented in both Cable Modems and
         Cable Modem Termination Systems for QOS Parameter Sets."
    ::= { docsIetfQosGroups 2 }


docsIetfQosCmtsGroup OBJECT-GROUP
    OBJECTS {

    docsIetfQosUpstreamFragments,
    docsIetfQosUpstreamFragDiscards,
    docsIetfQosUpstreamConcatBursts,

    docsIetfQosServiceFlowLogIfIndex,
    docsIetfQosServiceFlowLogSFID,
    docsIetfQosServiceFlowLogCmMac,
    docsIetfQosServiceFlowLogPkts,
    docsIetfQosServiceFlowLogOctets,
    docsIetfQosServiceFlowLogTimeDeleted,
    docsIetfQosServiceFlowLogTimeCreated,
    docsIetfQosServiceFlowLogTimeActive,
    docsIetfQosServiceFlowLogDirection,
    docsIetfQosServiceFlowLogPrimary,
    docsIetfQosServiceFlowLogServiceClassName,
    docsIetfQosServiceFlowLogPolicedDropPkts,
    docsIetfQosServiceFlowLogPolicedDelayPkts,
    docsIetfQosServiceFlowLogControl,

    docsIetfQosCmtsIfIndex -- docsIetfQosCmtsMacToSrvFlowTable required

    }
    STATUS  current
    DESCRIPTION
```

```
        "Group of objects implemented only in the CMTS."
    ::= { docsIetfQosGroups 3 }

docsIetfQosSrvClassPolicyGroup OBJECT-GROUP
    OBJECTS {
    docsIetfQosServiceClassPolicyName,
    docsIetfQosServiceClassPolicyRulePriority,
    docsIetfQosServiceClassPolicyStatus,
    docsIetfQosServiceClassPolicyStorageType
    }
    STATUS  current
    DESCRIPTION
        "Group of objects implemented in both Cable Modems and
         Cable Modem Termination Systems when supporting policy-based
         service flows."
    ::= { docsIetfQosGroups 4 }

docsIetfQosServiceClassGroup OBJECT-GROUP
    OBJECTS {
    docsIetfQosServiceClassStatus,
    docsIetfQosServiceClassPriority,
    docsIetfQosServiceClassMaxTrafficRate,
    docsIetfQosServiceClassMaxTrafficBurst,
    docsIetfQosServiceClassMinReservedRate,
    docsIetfQosServiceClassMinReservedPkt,
    docsIetfQosServiceClassMaxConcatBurst,
    docsIetfQosServiceClassNomPollInterval,
    docsIetfQosServiceClassTolPollJitter,
    docsIetfQosServiceClassUnsolicitGrantSize,
    docsIetfQosServiceClassNomGrantInterval,
    docsIetfQosServiceClassTolGrantJitter,
    docsIetfQosServiceClassGrantsPerInterval,
    docsIetfQosServiceClassMaxLatency,
    docsIetfQosServiceClassActiveTimeout,
    docsIetfQosServiceClassAdmittedTimeout,
    docsIetfQosServiceClassSchedulingType,
    docsIetfQosServiceClassRequestPolicy,
    docsIetfQosServiceClassTosAndMask,
    docsIetfQosServiceClassTosOrMask,
    docsIetfQosServiceClassDirection,
    docsIetfQosServiceClassStorageType,
    docsIetfQosServiceClassDSCPOverwrite
    }
    STATUS  current
    DESCRIPTION
        "Group of objects implemented only in Cable Modem
         Termination Systems when supporting expansion of Service
         Class Names in a QOS Parameter Set"
```

```
    ::= { docsIetfQosGroups 5 }

END
```

6. Security Considerations

This MIB module relates to an agent that will provide metropolitan public Internet access. As such, improper manipulation of the objects represented by this MIB module may result in denial of service to a large number of end-users [6]. Manipulation of the docsIetfQosServiceClassTable and docsIetfQosServiceClassPolicyTable may allow an end-user to increase his or her service levels, or affect other end-users in either a positive or negative manner. In addition, manipulation of docsIetfQosServiceFlowLogControl could allow an attacker to remove logs of packet and byte counts forwarded on a Service Flow. If such logs were used for billing, the attacker would obtain free service.

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-write and/or read-create. Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations. These are the tables and objects and their sensitivity/vulnerability:

- The docsIetfQosServiceClassTable provides a template of QOS parameters such as maximum rate limits for a named service class. Changing these parameters would allow an attacker to obtain an unauthorized class of service.

- The docsIetfQosServiceClassPolicyTable applies CMTS vendor proprietary policies for packet forwarding, including dropping, scheduling, notification, or other policies. Changing this table could allow an attacker to deny service to all subscribers of the CMTS or could grant the attacker unauthorized forwarding policies.

- The docsIetfQosServiceFlowLogControl object controls the deletion of entries in the docsIetfQosServiceFlowLogTable, which acts as a historical "detail record" of DOCSIS Service Flow packets and bytes transmitted. Such records may be used for billing purposes, so the unauthorized deletion of the records can result in free service.

Some of the readable objects in this MIB module (i.e., objects with a MAX-ACCESS other than not-accessible) may be considered sensitive or vulnerable in some network environments. It is thus important to

control even GET access to these objects and possibly to even encrypt the values of these objects when sending them over the network via SNMP. These are the tables and objects and their sensitivity/vulnerability:

- Unauthorized SNMP GET access of the docsIetfQosPktClassTable or docsIetfQosPHSTable can allow an attacker to learn IP addresses permitted to have enhanced quality of service, for possible spoofing. This table typically contains the IP addresses involved in voice-over-IP sessions, for example.

- Unauthorized SNMP GET access of the docsIetfQosParamSetTable allows an attacker to learn the names of Service Classes that are permitted to have enhanced QoS service, and the values of that enhanced service. That name can be referenced in an unauthorized DOCSIS cable modem configuration file to obtain enhanced service.

- Unauthorized SNMP GET access of the docsIetfQosServiceFlowTable can tell an attacker when Service Flows are active, e.g., when a voice-over-IP call is in progress.

  Unauthorized SNMP GET access of the docsIetfQosServiceFlowLogTable can expose private information about network usage.

- Unauthorized SNMP GET access of the docsIetfQosServiceFlowStatsTable, docsIetfQosUpstreamStatsTable, docsIetfQosDynamicServiceStatsTable, docsIetfQosServiceFlowLogTable, and docsIetfQosCmtsMacToSrvFlowTable can tell an attacker the volume of traffic to and from any Service Flow in the system, resulting in loss of privacy of the amount and direction of data transfer.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPSec), even then, there is no control as to who on the secure network is allowed to access and GET/SET (read/change/create/delete) the objects in this MIB module. It is RECOMMENDED that implementers consider the security features as provided by the SNMPv3 framework (see [15], section 8), including full support for the SNMPv3 cryptographic mechanisms (for authentication and privacy). Further, deployment of SNMP versions prior to SNMPv3 is NOT RECOMMENDED. Instead, it is RECOMMENDED to deploy SNMPv3 and to enable cryptographic security. It is then a customer/operator responsibility to ensure that the SNMP

entity giving access to an instance of this MIB module, is properly configured to give access to the objects only to those principals (users) that have legitimate rights to indeed GET or SET (change/create/delete) them.

7. IANA Considerations

The MIB module in this document uses the following IANA-assigned OBJECT IDENTIFIER values recorded in the SMI Numbers registry:

Descriptor	OBJECT IDENTIFIER Value
docsIetfQosMIB	{ mib-2 127 }

8. Acknowledgements

The authors gratefully acknowledge the comments and suggestions of the IP over Cable Data Network (IPCDN) Working Group (especially the co-chairs Richard Woundy and Jean-Francois Mule) as well as the contributions of the Operation and Management Area Director, Bert Wijnen.

9. Normative References

[1] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Structure of Management Information Version 2 (SMIv2)", STD 58, RFC 2578, April 1999.

[2] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Textual Conventions for SMIv2", STD 58, RFC 2579, April 1999.

[3] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Conformance Statements for SMIv2", STD 58, RFC 2580, April 1999.

[4] "Data-Over-Cable Service Interface Specifications: Radio Frequency Interface Specification SP-RFIv2.0-I06-040804", DOCSIS, August 2004, http://www.cablelabs.com/specifications/archives/.

[5] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[6] St. Johns, M., "Cable Device Management Information Base for DOCSIS compliant Cable Modems and Cable Modem Termination Systems", RFC 2669, August 1999.

[7] St. Johns, M., "Radio Frequency (RF) Interface Management Information Base for MCNS/DOCSIS compliant RF interfaces", RFC 2670, August 1999.

[8] Daniele, M., Haberman, B., Routhier, S., and J. Schoenwaelder, "Textual Conventions for Internet Network Addresses", RFC 4001, February 2005.

[9] Grossman, D., "New Terminology and Clarifications for Diffserv", RFC 3260, April 2002.

[10] Ramakrishnan, K., Floyd, S., and D. Black, "The Addition of Explicit Congestion Notification (ECN) to IP", RFC 3168, September 2001.

[11] McCloghrie, K. and F. Kastenholz, "The Interfaces Group MIB", RFC 2863, June 2000.

[12] Harrington, D., Presuhn, R., and B. Wijnen, "An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks", STD 62, RFC 3411, December 2002.

[13] Baker, F., Chan, K., and A. Smith, "Management Information Base for the Differentiated Services Architecture", RFC 3289, May 2002.

[14] Postel, J., "Internet Protocol", STD 5, RFC 791, September 1981.

10. Informative References

[15] Case, J., Mundy, R., Partain, D., and B. Stewart, "Introduction and Applicability Statements for Internet-Standard Management Framework", RFC 3410, December 2002.

Authors' Addresses

Michael Patrick
Motorola Broadband Communications Sector
111 Locke Drive
Marlborough, MA 01752

Phone: (508) 786-7563
EMail: michael.patrick@motorola.com

William Murwin
Motorola Broadband Communications Sector
111 Locke Drive
Marlborough, MA 01752

Phone: (508) 786-7594
EMail: w.murwin@motorola.com

Full Copyright Statement

Copyright (C) The Internet Society (2006).

This document is subject to the rights, licenses and restrictions contained in BCP 78, and except as set forth therein, the authors retain all their rights.

This document and the information contained herein are provided on an "AS IS" basis and THE CONTRIBUTOR, THE ORGANIZATION HE/SHE REPRESENTS OR IS SPONSORED BY (IF ANY), THE INTERNET SOCIETY AND THE INTERNET ENGINEERING TASK FORCE DISCLAIM ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Intellectual Property

The IETF takes no position regarding the validity or scope of any Intellectual Property Rights or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; nor does it represent that it has made any independent effort to identify any such rights. Information on the procedures with respect to rights in RFC documents can be found in BCP 78 and BCP 79.

Copies of IPR disclosures made to the IETF Secretariat and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this specification can be obtained from the IETF on-line IPR repository at http://www.ietf.org/ipr.

The IETF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary rights that may cover technology that may be required to implement this standard. Please address the information to the IETF at ietf-ipr@ietf.org.

Acknowledgement

Funding for the RFC Editor function is provided by the IETF Administrative Support Activity (IASA).