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Traffic Flow Measurement: Meter 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.

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Abstract

The RTFM Traffic Measurement Architecture provides a general framework for describing and measuring network traffic flows. Flows are defined in terms of their Address Attribute values and measured by a 'Traffic Meter'.

This document defines a Management Information Base (MIB) for use in controlling an RTFM Traffic Meter, in particular for specifying the flows to be measured. It also provides an efficient mechanism for retrieving flow data from the meter using SNMP. Security issues concerning the operation of traffic meters are summarised.

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1 Introduction

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes objects for managing and collecting data from network Realtime Traffic Flow Meters, as described in [RTFM-ARC].

The MIB is 'basic' in the sense that it provides more than enough information for everyday traffic measurement. Furthermore, it can be easily extended by adding new attributes as required. The RTFM Working group is actively pursuing the development of the meter in this way.

2 The SNMP Management Framework

The SNMP Management Framework presently consists of five major components:

- An overall architecture, described in RFC 2571 [RFC2571].
- Mechanisms for describing and naming objects and events for the purpose of management. The first version of this Structure of Management Information (SMI) is called SMIV1 and described in STD 16, RFC 1155 [RFC1155], STD 16, RFC 1212 [RFC1212] and RFC 1215 [RFC1215]. The second version, called SMIV2, is described in STD 58, RFC 2578 [RFC2578], RFC 2579 [RFC2579] and RFC 2580 [RFC2580].
- Message protocols for transferring management information. The first version of the SNMP message protocol is called SNMPv1 and described in STD 15, RFC 1157 [RFC1157]. A second version of the SNMP message protocol, which is not an Internet standards track protocol, is called SNMPv2c and described in RFC 1901 [RFC1901] and RFC 1906 [RFC1906]. The third version of the message protocol is called SNMPv3 and described in RFC 1906 [RFC1906], RFC 2572 [RFC2572] and RFC 2574 [RFC2574].
- Protocol operations for accessing management information. The first set of protocol operations and associated PDU formats is described in STD 15, RFC 1157 [RFC1157]. A second set of protocol operations and associated PDU formats is described in RFC 1905 [RFC1905].

- A set of fundamental applications described in RFC 2573 [RFC2573] and the view-based access control mechanism described in RFC 2575 [RFC2575].

A more detailed introduction to the current SNMP Management Framework can be found in [RFC2570].

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. Objects in the MIB are defined using the mechanisms defined in the SMI.

This memo specifies a MIB module that is compliant to the SMIV2. A MIB conforming to the SMIV1 can be produced through the appropriate translations. The resulting translated MIB must be semantically equivalent, except where objects or events are omitted because no translation is possible (use of Counter64). Some machine readable information in SMIV2 will be converted into textual descriptions in SMIV1 during the translation process. However, this loss of machine readable information is not considered to change the semantics of the MIB.

3 Overview

Traffic Flow Measurement seeks to provide a well-defined method for gathering traffic flow information from networks and internetworks. The background for this is given in "Internet Accounting Background" [ACT-BKG]. The Realtime Traffic Flow Measurement (rtfm) Working Group has produced a measurement architecture to achieve this goal; this is documented in "Traffic Flow Measurement: Architecture" [RTFM-ARC]. The architecture defines three entities:

- METERS, which observe network traffic flows and build up a table of flow data records for them,
- METER READERS, which collect traffic flow data from meters, and
- MANAGERS, which oversee the operation of meters and meter readers.

This memo defines the SNMP management information for a Traffic Flow Meter (TFM). Work in this field was begun by the Internet Accounting Working Group. It has been further developed and expanded by the Realtime Traffic Flow Measurement Working Group.

3.1 Scope of Definitions, Textual Conventions

All objects defined in this memo are registered in a single subtree within the mib-2 namespace [MIB-II, RFC2578], and are for use in network devices which may perform a PDU forwarding or monitoring function. For these devices, this MIB defines a group of objects with an SMI Network Management MGMT Code [ASG-NBR] of 40, i.e.

flowMIB OBJECT IDENTIFIER ::= mib-2 40

as defined below.

The RTFM Meter MIB was first produced and tested using SNMPv1. It was converted into SNMPv2 following the guidelines in [RFC1908].

3.2 Usage of the MIB variables

The MIB is organised in four parts - control, data, rules and conformance statements.

The rules implement the set of packet-matching actions, as described in the "Traffic Flow Measurement: Architecture" document [RTFM-ARC]. In addition they provide for BASIC-style subroutines, allowing a network manager to dramatically reduce the number of rules required to monitor a large network.

Traffic flows are identified by a set of attributes for each of their end-points. Attributes include network addresses for each layer of the network protocol stack, and 'subscriber ids', which may be used to identify an accountable entity for the flow.

The conformance statements are set out as defined in [RFC2580]. They explain what must be implemented in a meter which claims to conform to this MIB.

To retrieve flow data one could simply do a linear scan of the flow table. This would certainly work, but would require a lot of protocol exchanges. To reduce the overhead in retrieving flow data the flow table uses a TimeFilter variable, defined as a Textual Convention in the RMON2 MIB [RMON2-MIB].

As an alternative method of reading flow data, the MIB provides a view of the flow table called the flowDataPackageTable. This is (logically) a four-dimensional array, subscripted by package selector, RuleSet, activity time and starting flow number. The package selector is a sequence of bytes which specifies a list of flow attributes.

A data package (as returned by the meter) is a sequence of values for the attributes specified in its selector, encoded using the Basic Encoding Rules [ASN-BER]. It allows a meter reader to retrieve all the attribute values it requires in a single MIB object. This, when used together with SNMPv2's GetBulk request, allows a meter reader to scan the flow table and upload a specified set of attribute values for flows which have changed since the last reading, and which were created by a specified rule set.

One aspect of data collection which needs emphasis is that all the MIB variables are set up to allow multiple independent meter readers to work properly, i.e. the flow table indexes are stateless. An alternative approach would have been to 'snapshot' the flow table, which would mean that the meter readers would have to be synchronized. The stateless approach does mean that two meter readers will never return exactly the same set of traffic counts, but over long periods (e.g. 15-minute collections over a day) the discrepancies are acceptable. If one really needs a snapshot, this can be achieved by switching to an identical rule set with a different RuleSet number, hence asynchronous collections may be regarded as a useful generalisation of synchronised ones.

The control variables are the minimum set required for a meter reader. Their number has been whittled down as experience has been gained with the MIB implementation. A few of them are 'general', i.e. they control the overall behaviour of the meter. These are set by a single 'master' manager, and no other manager should attempt to change their values. The decision as to which manager is the 'master' must be made by the network operations personnel responsible; this MIB does not attempt to define any interaction between managers.

There are three other groups of control variables, arranged into tables in the same way as in the RMON2 MIB [RMON2-MIB]. They are used as follows:

- RULE SET INFO: Before attempting to download a RuleSet, a manager must create a row in the flowRuleSetInfoTable and set its flowRuleInfoSize to a value large enough to hold the RuleSet. When the rule set is ready the manager must set flowRuleInfoRulesReady to 'true', indicating that the rule set is ready for use (but not yet 'running').
- METER READER INFO: Any meter reader wishing to collect data reliably for all flows from a RuleSet should first create a row in the flowReaderInfoTable with flowReaderRuleSet set to that RuleSet's index in the flowRuleSetInfoTable. It should write that row's flowReaderLastTime object each time it starts a collection

pass through the flow table. The meter will not recover a flow's memory until every meter reader holding a row for that flow's RuleSet has collected the flow's data.

- MANAGER INFO: Any manager wishing to run a RuleSet in the meter must create a row in the flowManagerInfo table, specifying the desired RuleSet to run and its corresponding 'standby' RuleSet (if one is desired). A current RuleSet is 'running' if its flowManagerRunningStandby value is false(2), similarly a standby RuleSet is 'running' if flowManagerRunningStandby is true(1).

Times within the meter are in terms of its Uptime, i.e. centiseconds since the meter started. For meters implemented as self-contained SNMP agents this will be the same as sysUptime, but this may not be true for meters implemented as subagents. Managers can read the meter's Uptime when necessary (e.g. to set a TimeFilter value) by setting flowReaderLastTime, then reading its new value.

4 Definitions

FLOW-METER-MIB DEFINITIONS ::= BEGIN

IMPORTS

MODULE-IDENTITY, OBJECT-TYPE,
Counter32, Counter64, Integer32, mib-2
FROM SNMPv2-SMI
TEXTUAL-CONVENTION, RowStatus, TimeStamp, TruthValue
FROM SNMPv2-TC
OBJECT-GROUP, MODULE-COMPLIANCE
FROM SNMPv2-CONF
ifIndex
FROM IF-MIB
TimeFilter
FROM RMON2-MIB;

flowMIB MODULE-IDENTITY

LAST-UPDATED "9910250000Z" -- October 25, 1999
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DESCRIPTION

"MIB for the RTFM Traffic Flow Meter."

REVISION "9910250000Z"

DESCRIPTION

"Initial Version, published as RFC 2720."

REVISION "9908301250Z"

DESCRIPTION

"UTF8OwnerString Textual Convention added, and used to replace OwnerString. Conceptually the same as OwnerString, but facilitating internationalisation by using UTF-8 encoding for its characters rather than US-ASCII."

REVISION "9908191010Z"

DESCRIPTION

"Changes to SIZE specification for two variables:
- flowRuleInfoName SIZE specified as (0..127)
- flowRuleIndex SIZE increased to (1..2147483647)"

REVISION "9712230937Z"

DESCRIPTION

"Two further variables deprecated:
- flowRuleInfoRulesReady (use flowRuleInfoStatus instead)
- flowDataStatus (contains no useful information)"

REVISION "9707071715Z"

DESCRIPTION

"Significant changes since RFC 2064 include:
- flowDataPackageTable added
- flowColumnActivityTable deprecated
- flowManagerCounterWrap deprecated"

REVISION "9603080208Z"

DESCRIPTION

"Initial version of this MIB (RFC 2064)"
::= { mib-2 40 }

flowControl OBJECT IDENTIFIER ::= { flowMIB 1 }

flowData OBJECT IDENTIFIER ::= { flowMIB 2 }

flowRules OBJECT IDENTIFIER ::= { flowMIB 3 }

flowMIBConformance OBJECT IDENTIFIER ::= { flowMIB 4 }

-- Textual Conventions

UTF8OwnerString ::= TEXTUAL-CONVENTION

DISPLAY-HINT "127t"

STATUS current

DESCRIPTION

"An administratively assigned name for the owner of a resource, conceptually the same as OwnerString in the RMON MIB [RMON-MIB].

To facilitate internationalisation, this name information is represented using the ISO/IEC IS 10646-1 character set, encoded as an octet string using the UTF-8 transformation format described in the UTF-8 standard [UTF-8]."

SYNTAX OCTET STRING (SIZE (0..127))

PeerType ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"Indicates the type of a PeerAddress (see below). The values used are from the 'Address Family Numbers' section of the Assigned Numbers RFC [ASG-NBR]. Peer types from other address families may also be used, provided only that they are identified by their assigned Address Family numbers."

SYNTAX INTEGER {
 ipv4(1),
 ipv6(2),
 nsap(3),
 ipx(11),
 appletalk(12),
 decnet(13) }

PeerAddress ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"Specifies the value of a peer address for various network protocols. Address format depends on the actual protocol, as indicated below:

IPv4: ipv4(1)
 4-octet IpAddress (defined in the SNMPv2 SMI [RFC2578])

IPv6: ipv6(2)
 16-octet IpAddress (defined in the
 IPv6 Addressing RFC [V6-ADDR])

CLNS: nsap(3)
 NsapAddress (defined in the SNMPv2 SMI [RFC2578])

Novell: ipx(11)

4-octet Network number,
6-octet Host number (MAC address)

AppleTalk: appletalk(12)
2-octet Network number (sixteen bits),
1-octet Host number (eight bits)

DECnet: decnet(13)
1-octet Area number (in low-order six bits),
2-octet Host number (in low-order ten bits)

"

SYNTAX OCTET STRING (SIZE (3..20))

AdjacentType ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"Indicates the type of an adjacent address. May be a medium type or (if metering is taking place inside a tunnel) a PeerType (see above).

The values used for IEEE 802 medium types are from the 'Network Management Parameters (ifType definitions)' section of the Assigned Numbers RFC [ASG-NBR]. Other medium types may also be used, provided only that they are identified by their assigned ifType numbers."

SYNTAX INTEGER {
ip(1),
nsap(3),
ethernet(7), -- ethernet-like [ENET-OBJ],
-- includes ethernet-csmacd(6)
tokenring(9),
ipx(11),
appletalk(12),
decnet(13),
fddi(15) }

AdjacentAddress ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"Specifies the value of an adjacent address. May be a Medium Access Control (MAC) address or (if metering is taking place inside a tunnel) a PeerAddress (see above).

MAC Address format depends on the actual medium, as follows:

Ethernet: ethernet(7)
6-octet 802.3 MAC address in 'canonical' order

Token Ring: tokenring(9)
6-octet 802.5 MAC address in 'canonical' order

FDDI: fddi(15)
FddiMACLongAddress, i.e. a 6-octet MAC address
in 'canonical' order (defined in [FDDI-MIB])

"

SYNTAX OCTET STRING (SIZE (3..20))

TransportType ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"Indicates the type of a TransportAddress (see below). Values will depend on the actual protocol; for IP they will be those given in the 'Protocol Numbers' section of the Assigned Numbers RFC [ASG-NBR], including icmp(1), tcp(6) and udp(17)."

SYNTAX Integer32 (1..255)

TransportAddress ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"Specifies the value of a transport address for various network protocols. Format as follows:

IP:

2-octet UDP or TCP port number

Other protocols:

2-octet port number

"

SYNTAX OCTET STRING (SIZE (2))

RuleAddress ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"Specifies the value of an address. Is a superset of MediumAddress, PeerAddress and TransportAddress."

SYNTAX OCTET STRING (SIZE (2..20))

FlowAttributeNumber ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"Uniquely identifies an attribute within a flow data record."

SYNTAX INTEGER {
flowIndex(1),
flowStatus(2),
flowTimeMark(3),

```
sourceInterface(4),
sourceAdjacentType(5),
sourceAdjacentAddress(6),
sourceAdjacentMask(7),
sourcePeerType(8),
sourcePeerAddress(9),
sourcePeerMask(10),
sourceTransType(11),
sourceTransAddress(12),
sourceTransMask(13),

destInterface(14),
destAdjacentType(15),
destAdjacentAddress(16),
destAdjacentMask(17),
destPeerType(18),
destPeerAddress(19),
destPeerMask(20),
destTransType(21),
destTransAddress(22),
destTransMask(23),

pduScale(24),
octetScale(25),

ruleSet(26),
toOctets(27),           -- Source-to-Dest
toPDUs(28),
fromOctets(29),         -- Dest-to-Source
fromPDUs(30),
firstTime(31),          -- Activity times
lastActiveTime(32),

sourceSubscriberID(33), -- Subscriber ID
destSubscriberID(34),
sessionID(35),

sourceClass(36),        -- Computed attributes
destClass(37),
flowClass(38),
sourceKind(39),
destKind(40),
flowKind(41) }
```

RuleAttributeName ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"Uniquely identifies an attribute which may be tested in

a rule. These include attributes whose values come directly from (or are computed from) the flow's packets, and the five 'meter' variables used to hold an Attribute Number."

```
SYNTAX INTEGER {
    null(0),
    sourceInterface(4),          -- Source Address
    sourceAdjacentType(5),
    sourceAdjacentAddress(6),
    sourcePeerType(8),
    sourcePeerAddress(9),
    sourceTransType(11),
    sourceTransAddress(12),

    destInterface(14),          -- Dest Address
    destAdjacentType(15),
    destAdjacentAddress(16),
    destPeerType(18),
    destPeerAddress(19),
    destTransType(21),
    destTransAddress(22),

    sourceSubscriberID(33),     -- Subscriber ID
    destSubscriberID(34),
    sessionID(35),

    sourceClass(36),            -- Computed attributes
    destClass(37),
    flowClass(38),
    sourceKind(39),
    destKind(40),
    flowKind(41),

    matchingStoD(50),          -- Packet matching

    v1(51),                    -- Meter variables
    v2(52),
    v3(53),
    v4(54),
    v5(55) }
```

ActionNumber ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION

"Uniquely identifies the action of a rule, i.e. the Pattern Matching Engine's opcode number. Details of the opcodes are given in the 'Traffic Flow Measurement: Architecture' document [RTFM-ARC]."

SYNTAX INTEGER {

```
ignore(1),
noMatch(2),
count(3),
countPkt(4),
return(5),
gosub(6),
gosubAct(7),
assign(8),
assignAct(9),
goto(10),
gotoAct(11),
pushRuleTo(12),
pushRuleToAct(13),
pushPktTo(14),
pushPktToAct(15),
popTo(16),
popToAct(17) }
```

```
--
-- Control Group: RuleSet Info Table
--
```

flowRuleSetInfoTable OBJECT-TYPE

SYNTAX SEQUENCE OF FlowRuleSetInfoEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An array of information about the RuleSets held in the meter.

Any manager may configure a new RuleSet for the meter by creating a row in this table with status active(1), and setting values for all the objects in its rules. At this stage the new RuleSet is available but not 'running', i.e. it is not being used by the meter to produce entries in the flow table.

To actually 'run' a RuleSet a manager must create a row in the flowManagerInfoTable, set its flowManagerStatus to active(1), and set either its CurrentRuleSet or StandbyRuleSet to point to the RuleSet to be run.

Once a RuleSet is running a manager may not change any of the objects within the RuleSet itself. Any attempt to do so should result in a notWritable(17) SNMP error-status for such objects.

A manager may stop a RuleSet running by removing all references to it in the flowManagerInfoTable (i.e. by setting CurrentRuleSet and StandbyRuleSet values to 0). This provides

a way to stop RuleSets left running if a manager fails. For example, when a manager is started, it could search the meter's flowManager table and stop all RuleSets having a specified value of flowRuleInfoOwner.

To prevent a manager from interfering with variables belonging to another manager, the meter should use MIB views [RFC2575] so as to limit each manager's access to the meter's variables, effectively dividing the single meter into several virtual meters, one for each independent manager."

::= { flowControl 1 }

flowRuleSetInfoEntry OBJECT-TYPE
SYNTAX FlowRuleSetInfoEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"Information about a particular RuleSet."
INDEX { flowRuleInfoIndex }
::= { flowRuleSetInfoTable 1 }

FlowRuleSetInfoEntry ::= SEQUENCE {
flowRuleInfoIndex Integer32,
flowRuleInfoSize Integer32,
flowRuleInfoOwner UTF8OwnerString,
flowRuleInfoTimeStamp TimeStamp,
flowRuleInfoStatus RowStatus,
flowRuleInfoName OCTET STRING,
flowRuleInfoRulesReady TruthValue,
flowRuleInfoFlowRecords Integer32
}

flowRuleInfoIndex OBJECT-TYPE
SYNTAX Integer32 (1..2147483647)
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"An index which selects an entry in the flowRuleSetInfoTable. Each such entry contains control information for a particular RuleSet which the meter may run."
::= { flowRuleSetInfoEntry 1 }

flowRuleInfoSize OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"Number of rules in this RuleSet. Setting this variable will

cause the meter to allocate space for these rules."
 ::= { flowRuleSetInfoEntry 2 }

flowRuleInfoOwner OBJECT-TYPE

SYNTAX UTF8OwnerString

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Identifies the manager which 'owns' this RuleSet. A manager must set this variable when creating a row in this table."

::= { flowRuleSetInfoEntry 3 }

flowRuleInfoTimeStamp OBJECT-TYPE

SYNTAX TimeStamp

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Time this row's associated RuleSet was last changed."

::= { flowRuleSetInfoEntry 4 }

flowRuleInfoStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The status of this flowRuleSetInfoEntry. If this value is not active(1) the meter must not attempt to use the row's associated RuleSet. Once its value has been set to active(1) a manager may not change any of the other variables in the row, nor the contents of the associated RuleSet. Any attempt to do so should result in a notWritable(17) SNMP error-status for such variables or objects.

To download a RuleSet, a manager could:

- Locate an open slot in the RuleSetInfoTable.
- Create a RuleSetInfoEntry by setting the status for this open slot to createAndWait(5).
- Set flowRuleInfoSize and flowRuleInfoName as required.
- Download the rules into the row's rule table.
- Set flowRuleInfoStatus to active(1).

The RuleSet would then be ready to run. The manager is not allowed to change the value of flowRuleInfoStatus from active(1) if the associated RuleSet is being referenced by any of the entries in the flowManagerInfoTable.

Setting RuleInfoStatus to destroy(6) destroys the associated RuleSet together with any flow data collected by it."

```
::= { flowRuleSetInfoEntry 5 }
```

flowRuleInfoName OBJECT-TYPE

SYNTAX OCTET STRING (SIZE (0..127))

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"An alphanumeric identifier used by managers and readers to identify a RuleSet. For example, a manager wishing to run a RuleSet named WWW-FLOWS could search the flowRuleSetInfoTable to see whether the WWW-FLOWS RuleSet is already available on the meter.

Note that references to RuleSets in the flowManagerInfoTable use indexes for their flowRuleSetInfoTable entries. These may be different each time the RuleSet is loaded into a meter."

```
::= { flowRuleSetInfoEntry 6 }
```

flowRuleInfoRulesReady OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-create

STATUS deprecated

DESCRIPTION

"Indicates whether the rules for this row's associated RuleSet are ready for use. The meter will refuse to 'run' the RuleSet unless this variable has been set to true(1).

While RulesReady is false(2), the manager may modify the RuleSet, for example by downloading rules into it."

```
::= { flowRuleSetInfoEntry 7 }
```

flowRuleInfoFlowRecords OBJECT-TYPE

SYNTAX Integer32

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The number of entries in the flow table for this RuleSet. These may be current (waiting for collection by one or more meter readers) or idle (waiting for the meter to recover their memory)."

```
::= { flowRuleSetInfoEntry 8 }
```

--

-- Control Group: Interface Info Table

--

flowInterfaceTable OBJECT-TYPE

SYNTAX SEQUENCE OF FlowInterfaceEntry

MAX-ACCESS not-accessible


```
STATUS    current
DESCRIPTION
    "An array of information specific to each meter interface."
::= { flowControl 2 }
```

```
flowInterfaceEntry OBJECT-TYPE
    SYNTAX  FlowInterfaceEntry
    MAX-ACCESS not-accessible
    STATUS  current
    DESCRIPTION
        "Information about a particular interface."
    INDEX   { ifIndex }
    ::= { flowInterfaceTable 1 }
```

```
FlowInterfaceEntry ::= SEQUENCE {
    flowInterfaceSampleRate  Integer32,
    flowInterfaceLostPackets Counter32
}
```

```
flowInterfaceSampleRate OBJECT-TYPE
    SYNTAX  Integer32
    MAX-ACCESS read-write
    STATUS  current
    DESCRIPTION
        "The parameter N for statistical counting on this interface.
        Set to N to count 1/Nth of the packets appearing at this
        interface.  A sampling rate of 1 counts all packets.
        A sampling rate of 0 results in the interface being ignored
        by the meter.

        A meter should choose its own algorithm to introduce variance
        into the sampling so that exactly every Nth packet is counted.
        The IPPM Working Group's RFC 'Framework for IP Performance
        Metrics' [IPPM-FRM] explains why this should be done, and sets
        out an algorithm for doing it."
    DEFVAL { 1 }
    ::= { flowInterfaceEntry 1 }
```

```
flowInterfaceLostPackets OBJECT-TYPE
    SYNTAX  Counter32
    MAX-ACCESS read-only
    STATUS  current
    DESCRIPTION
        "The number of packets the meter has lost for this interface.
        Such losses may occur because the meter has been unable to
        keep up with the traffic volume."
    ::= { flowInterfaceEntry 2 }
```

```
--
-- Control Group:  Meter Reader Info Table
--

-- Any meter reader wishing to collect data reliably for flows
-- should first create a row in this table.  It should write that
-- row's flowReaderLastTime object each time it starts a collection
-- pass through the flow table.

-- If a meter reader (MR) does not create a row in this table, e.g.
-- because its MIB view [RFC2575] did not allow MR create access to
-- flowReaderStatus, collection can still proceed but the meter will
-- not be aware of meter reader MR.  This could lead the meter to
-- recover flows before they have been collected by MR.

flowReaderInfoTable OBJECT-TYPE
    SYNTAX  SEQUENCE OF FlowReaderInfoEntry
    MAX-ACCESS not-accessible
    STATUS  current
    DESCRIPTION
        "An array of information about meter readers which have
        registered their intent to collect flow data from this meter."
    ::= { flowControl 3 }

flowReaderInfoEntry OBJECT-TYPE
    SYNTAX  FlowReaderInfoEntry
    MAX-ACCESS not-accessible
    STATUS  current
    DESCRIPTION
        "Information about a particular meter reader."
    INDEX   { flowReaderIndex }
    ::= { flowReaderInfoTable 1 }

FlowReaderInfoEntry ::= SEQUENCE {
    flowReaderIndex      Integer32,
    flowReaderTimeout    Integer32,
    flowReaderOwner      UTF8OwnerString,
    flowReaderLastTime   TimeStamp,
    flowReaderPreviousTime TimeStamp,
    flowReaderStatus     RowStatus,
    flowReaderRuleSet    Integer32
}

flowReaderIndex OBJECT-TYPE
    SYNTAX  Integer32 (1..2147483647)
    MAX-ACCESS not-accessible
    STATUS  current
    DESCRIPTION
```

"An index which selects an entry in the flowReaderInfoTable."
 ::= { flowReaderInfoEntry 1 }

flowReaderTimeout OBJECT-TYPE

SYNTAX Integer32

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Specifies the maximum time (in seconds) between flow data collections for this meter reader. If this time elapses without a collection, the meter should assume that this meter reader has stopped collecting, and delete this row from the table. A value of zero indicates that this row should not be timed out."

::= { flowReaderInfoEntry 2 }

flowReaderOwner OBJECT-TYPE

SYNTAX UTF8OwnerString

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Identifies the meter reader which created this row."

::= { flowReaderInfoEntry 3 }

flowReaderLastTime OBJECT-TYPE

SYNTAX TimeStamp

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Time this meter reader began its most recent data collection."

This variable should be written by a meter reader as its first step in reading flow data. The meter will set this LastTime value to its current Uptime, and set its PreviousTime value (below) to the old LastTime. This allows the meter to recover flows which have been inactive since PreviousTime, for these have been collected at least once.

If the meter reader fails to write flowLastReadTime, collection may still proceed but the meter may not be able to recover inactive flows until the flowReaderTimeout has been reached for this entry."

::= { flowReaderInfoEntry 4 }

flowReaderPreviousTime OBJECT-TYPE

SYNTAX TimeStamp

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Time this meter reader began the collection before last."
::= { flowReaderInfoEntry 5 }

flowReaderStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The status of this FlowReaderInfoEntry. A value of active(1) implies that the associated reader should be collecting data from the meter. Once this variable has been set to active(1) a manager may only change this row's flowReaderLastTime and flowReaderTimeout variables."
::= { flowReaderInfoEntry 6 }

flowReaderRuleSet OBJECT-TYPE

SYNTAX Integer32 (1..2147483647)

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"An index to the array of RuleSets. Specifies a set of rules of interest to this meter reader. The reader will attempt to collect any data generated by the meter for this RuleSet, and the meter will not recover the memory of any of the RuleSet's flows until this collection has taken place. Note that a reader may have entries in this table for several RuleSets."
::= { flowReaderInfoEntry 7 }

--

-- Control Group: Manager Info Table

--

-- Any manager wishing to run a RuleSet must create a row in this
-- table. Once it has a table row, the manager may set the control
-- variables in its row so as to cause the meter to run any valid
-- RuleSet held by the meter.

-- A single manager may run several RuleSets; it must create a row
-- in this table for each of them. In short, each row of this table
-- describes (and controls) a 'task' which the meter is executing.

flowManagerInfoTable OBJECT-TYPE

SYNTAX SEQUENCE OF FlowManagerInfoEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An array of information about managers which have

registered their intent to run RuleSets on this meter."
 ::= { flowControl 4 }

flowManagerInfoEntry OBJECT-TYPE

SYNTAX FlowManagerInfoEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"Information about a particular meter 'task.' By creating an entry in this table and activating it, a manager requests that the meter 'run' the indicated RuleSet.

The entry also specifies a HighWaterMark and a StandbyRuleSet. If the meter's flow table usage exceeds this task's HighWaterMark the meter will stop running the task's CurrentRuleSet and switch to its StandbyRuleSet.

If the value of the task's StandbyRuleSet is 0 when its HighWaterMark is exceeded, the meter simply stops running the task's CurrentRuleSet. By careful selection of HighWaterMarks for the various tasks a manager can ensure that the most critical RuleSets are the last to stop running as the number of flows increases.

When a manager has determined that the demand for flow table space has abated, it may cause the task to switch back to its CurrentRuleSet by setting its flowManagerRunningStandby variable to false(2)."

INDEX { flowManagerIndex }

::= { flowManagerInfoTable 1 }

FlowManagerInfoEntry ::= SEQUENCE {

flowManagerIndex	Integer32,
flowManagerCurrentRuleSet	Integer32,
flowManagerStandbyRuleSet	Integer32,
flowManagerHighWaterMark	Integer32,
flowManagerCounterWrap	INTEGER,
flowManagerOwner	UTF8OwnerString,
flowManagerTimeStamp	TimeStamp,
flowManagerStatus	RowStatus,
flowManagerRunningStandby	TruthValue

}

flowManagerIndex OBJECT-TYPE

SYNTAX Integer32 (1..2147483647)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"An index which selects an entry in the flowManagerInfoTable."
::= { flowManagerInfoEntry 1 }

flowManagerCurrentRuleSet OBJECT-TYPE

SYNTAX Integer32

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Index to the array of RuleSets. Specifies which set of rules is the 'current' one for this task. The meter will be 'running' the current RuleSet if this row's flowManagerRunningStandby value is false(2).

When the manager sets this variable the meter will stop using the task's old current RuleSet and start using the new one. Specifying RuleSet 0 (the empty set) stops flow measurement for this task."

::= { flowManagerInfoEntry 2 }

flowManagerStandbyRuleSet OBJECT-TYPE

SYNTAX Integer32

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"Index to the array of RuleSets. After reaching HighWaterMark (see below) the manager will switch to using the task's StandbyRuleSet in place of its CurrentRuleSet. For this to be effective the designated StandbyRuleSet should have a coarser reporting granularity than the CurrentRuleSet. The manager may also need to decrease the meter reading interval so that the meter can recover flows measured by this task's CurrentRuleSet."

DEFVAL { 0 } -- No standby

::= { flowManagerInfoEntry 3 }

flowManagerHighWaterMark OBJECT-TYPE

SYNTAX Integer32 (0..100)

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"A value expressed as a percentage, interpreted by the meter as an indication of how full the flow table should be before it should switch to the standby RuleSet (if one has been specified) for this task. Values of 0% or 100% disable the checking represented by this variable."

::= { flowManagerInfoEntry 4 }

flowManagerCounterWrap OBJECT-TYPE

SYNTAX INTEGER { wrap(1), scale(2) }

MAX-ACCESS read-create
STATUS deprecated
DESCRIPTION
 "Specifies whether PDU and octet counters should wrap when they reach the top of their range (normal behaviour for Counter64 objects), or whether their scale factors should be used instead. The combination of counter and scale factor allows counts to be returned as non-negative binary floating point numbers, with 64-bit mantissas and 8-bit exponents."

DEFVAL { wrap }
::= { flowManagerInfoEntry 5 }

flowManagerOwner OBJECT-TYPE
 SYNTAX UTF8OwnerString
 MAX-ACCESS read-create
 STATUS current
 DESCRIPTION
 "Identifies the manager which created this row."
 ::= { flowManagerInfoEntry 6 }

flowManagerTimeStamp OBJECT-TYPE
 SYNTAX TimeStamp
 MAX-ACCESS read-only
 STATUS current
 DESCRIPTION
 "Time this row was last changed by its manager."
 ::= { flowManagerInfoEntry 7 }

flowManagerStatus OBJECT-TYPE
 SYNTAX RowStatus
 MAX-ACCESS read-create
 STATUS current
 DESCRIPTION
 "The status of this row in the flowManagerInfoTable. A value of active(1) implies that this task may be activated, by setting its CurrentRuleSet and StandbyRuleSet variables. Its HighWaterMark and RunningStandby variables may also be changed."
 ::= { flowManagerInfoEntry 8 }

flowManagerRunningStandby OBJECT-TYPE
 SYNTAX TruthValue
 MAX-ACCESS read-create
 STATUS current
 DESCRIPTION
 "Set to true(1) by the meter to indicate that it has switched to running this task's StandbyRuleSet in place of its

```
CurrentRuleSet. To switch back to the CurrentRuleSet, the
manager may simply set this variable to false(2)."
```

```
DEFVAL { false }
::= { flowManagerInfoEntry 9 }
```

```
--
-- Control Group: General Meter Control Variables
--
```

```
flowFloodMark OBJECT-TYPE
    SYNTAX Integer32 (0..100)
    MAX-ACCESS read-write
    STATUS current
    DESCRIPTION
        "A value expressed as a percentage, interpreted by the meter
        as an indication of how full the flow table should be before
        it should take some action to avoid running out of resources
        to handle new flows, as discussed in section 4.6 (Handling
        Increasing Traffic Levels) of the RTFM Architecture RFC
        [RTFM-ARC].

        Values of 0% or 100% disable the checking represented by
        this variable."
    DEFVAL { 95 } -- Enabled by default.
    ::= { flowControl 5 }
```

```
flowInactivityTimeout OBJECT-TYPE
    SYNTAX Integer32
    MAX-ACCESS read-write
    STATUS current
    DESCRIPTION
        "The time in seconds since the last packet seen, after which
        a flow becomes 'idle.' Note that although a flow may be
        idle, it will not be discarded (and its memory recovered)
        until after its data has been collected by all the meter
        readers registered for its RuleSet."
    DEFVAL { 600 } -- 10 minutes
    ::= { flowControl 6 }
```

```
flowActiveFlows OBJECT-TYPE
    SYNTAX Integer32
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "The number of flows which are currently in use."
    ::= { flowControl 7 }
```

```
flowMaxFlows OBJECT-TYPE
```



```
SYNTAX Integer32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
    "The maximum number of flows allowed in the meter's
    flow table. At present this is determined when the meter
    is first started up."
 ::= { flowControl 8 }
```

```
flowFloodMode OBJECT-TYPE
```

```
SYNTAX TruthValue
MAX-ACCESS read-write
STATUS current
DESCRIPTION
    "Indicates that the meter has passed its FloodMark and is
    not running in its normal mode.

    When the manager notices this it should take action to remedy
    the problem which caused the flooding. It should then monitor
    flowActiveFlows so as to determine when the flood has receded.
    At that point the manager may set flowFloodMode to false(2) to
    resume normal operation."
 ::= { flowControl 9 }
```

```
--
```

```
-- The Flow Table
```

```
--
```

```
-- This is a table kept by a meter, with one flow data entry for every
-- flow being measured. Each flow data entry stores the attribute
-- values for a traffic flow. Details of flows and their attributes
-- are given in the 'Traffic Flow Measurement: Architecture'
-- document [RTFM-ARC].
```

```
-- From time to time a meter reader may sweep the flow table so as
-- to read counts. This is most effectively achieved by using the
-- TimeMark variable together with successive GetBulk requests to
-- retrieve the values of the desired flow attribute variables.
```

```
-- This scheme allows multiple meter readers to independently use the
-- same meter; the meter readers do not have to be synchronised and
-- they may use different collection intervals.
```

```
-- If identical sets of counts are required from a meter, a manager
-- could achieve this using two identical copies of a RuleSet in that
-- meter and switching back and forth between them. This is discussed
-- further in the RTFM Architecture document [RTFM-ARC].
```

flowDataTable OBJECT-TYPE

SYNTAX SEQUENCE OF FlowDataEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The list of all flows being measured."

::= { flowData 1 }

flowDataEntry OBJECT-TYPE

SYNTAX FlowDataEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The flow data record for a particular flow."

INDEX { flowDataRuleSet, flowDataTimeMark, flowDataIndex }

::= { flowDataTable 1 }

FlowDataEntry ::= SEQUENCE {

flowDataIndex

Integer32,

flowDataTimeMark

TimeFilter,

flowDataStatus

INTEGER,

flowDataSourceInterface

Integer32,

flowDataSourceAdjacentType

AdjacentType,

flowDataSourceAdjacentAddress

AdjacentAddress,

flowDataSourceAdjacentMask

AdjacentAddress,

flowDataSourcePeerType

PeerType,

flowDataSourcePeerAddress

PeerAddress,

flowDataSourcePeerMask

PeerAddress,

flowDataSourceTransType

TransportType,

flowDataSourceTransAddress

TransportAddress,

flowDataSourceTransMask

TransportAddress,

flowDataDestInterface

Integer32,

flowDataDestAdjacentType

AdjacentType,

flowDataDestAdjacentAddress

AdjacentAddress,

flowDataDestAdjacentMask

AdjacentAddress,

flowDataDestPeerType

PeerType,

flowDataDestPeerAddress

PeerAddress,

flowDataDestPeerMask

PeerAddress,

flowDataDestTransType

TransportType,

flowDataDestTransAddress

TransportAddress,

flowDataDestTransMask

TransportAddress,

flowDataPDUScale

Integer32,

flowDataOctetScale

Integer32,

flowDataRuleSet

Integer32,

```
flowDataToOctets          Counter64,    -- Source->Dest
flowDataToPDUs            Counter64,
flowDataFromOctets        Counter64,    -- Dest->Source
flowDataFromPDUs          Counter64,
flowDataFirstTime         TimeStamp,    -- Activity times
flowDataLastActiveTime    TimeStamp,

flowDataSourceSubscriberID OCTET STRING,
flowDataDestSubscriberID  OCTET STRING,
flowDataSessionID         OCTET STRING,

flowDataSourceClass        Integer32,
flowDataDestClass          Integer32,
flowDataClass              Integer32,
flowDataSourceKind         Integer32,
flowDataDestKind           Integer32,
flowDataKind               Integer32
}
```

flowDataIndex OBJECT-TYPE

SYNTAX Integer32 (1..2147483647)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"Value of this flow data record's index within the meter's
flow table."

::= { flowDataEntry 1 }

flowDataTimeMark OBJECT-TYPE

SYNTAX TimeFilter

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"A TimeFilter for this entry. Allows GetNext and GetBulk
to find flow table rows which have changed since a specified
value of the meter's Uptime."

::= { flowDataEntry 2 }

flowDataStatus OBJECT-TYPE

SYNTAX INTEGER { inactive(1), current(2) }

MAX-ACCESS read-only

STATUS deprecated

DESCRIPTION

"Status of this flow data record."

::= { flowDataEntry 3 }

flowDataSourceInterface OBJECT-TYPE

SYNTAX Integer32

MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Index of the interface associated with the source address
 for this flow. It's value is one of those contained in the
 ifIndex field of the meter's interfaces table."
 ::= { flowDataEntry 4 }

flowDataSourceAdjacentType OBJECT-TYPE

SYNTAX AdjacentType
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Adjacent address type of the source for this flow.

 If metering is being performed at the network level,
 AdjacentType will indicate the medium for the interface on
 which the flow was observed and AdjacentAddress will be the
 MAC address for that interface. This is the usual case.

 If traffic is being metered inside a tunnel, AdjacentType will
 be the peer type of the host at the end of the tunnel and
 AdjacentAddress will be the peer address for that host."
 ::= { flowDataEntry 5 }

flowDataSourceAdjacentAddress OBJECT-TYPE

SYNTAX AdjacentAddress
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Address of the adjacent device on the path for the source
 for this flow."
 ::= { flowDataEntry 6 }

flowDataSourceAdjacentMask OBJECT-TYPE

SYNTAX AdjacentAddress
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "1-bits in this mask indicate which bits must match when
 comparing the adjacent source address for this flow."
 ::= { flowDataEntry 7 }

flowDataSourcePeerType OBJECT-TYPE

SYNTAX PeerType
MAX-ACCESS read-only
STATUS current
DESCRIPTION

"Peer address type of the source for this flow."
::= { flowDataEntry 8 }

flowDataSourcePeerAddress OBJECT-TYPE

SYNTAX PeerAddress
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"Address of the peer device for the source of this flow."
::= { flowDataEntry 9 }

flowDataSourcePeerMask OBJECT-TYPE

SYNTAX PeerAddress
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"1-bits in this mask indicate which bits must match when
comparing the source peer address for this flow."
::= { flowDataEntry 10 }

flowDataSourceTransType OBJECT-TYPE

SYNTAX TransportType
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"Transport address type of the source for this flow. The
value of this attribute will depend on the peer address type."
::= { flowDataEntry 11 }

flowDataSourceTransAddress OBJECT-TYPE

SYNTAX TransportAddress
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"Transport address for the source of this flow."
::= { flowDataEntry 12 }

flowDataSourceTransMask OBJECT-TYPE

SYNTAX TransportAddress
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"1-bits in this mask indicate which bits must match when
comparing the transport source address for this flow."
::= { flowDataEntry 13 }

flowDataDestInterface OBJECT-TYPE

SYNTAX Integer32

MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Index of the interface associated with the dest address for
 this flow. This value is one of the values contained in the
 ifIndex field of the interfaces table."
::= { flowDataEntry 14 }

flowDataDestAdjacentType OBJECT-TYPE
SYNTAX AdjacentType
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Adjacent address type of the destination for this flow."
::= { flowDataEntry 15 }

flowDataDestAdjacentAddress OBJECT-TYPE
SYNTAX AdjacentAddress
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Address of the adjacent device on the path for the
 destination for this flow."
::= { flowDataEntry 16 }

flowDataDestAdjacentMask OBJECT-TYPE
SYNTAX AdjacentAddress
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "1-bits in this mask indicate which bits must match when
 comparing the adjacent destination address for this flow."
::= { flowDataEntry 17 }

flowDataDestPeerType OBJECT-TYPE
SYNTAX PeerType
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Peer address type of the destination for this flow."
::= { flowDataEntry 18 }

flowDataDestPeerAddress OBJECT-TYPE
SYNTAX PeerAddress
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Address of the peer device for the destination of this flow."

```
::= { flowDataEntry 19 }
```

flowDataDestPeerMask OBJECT-TYPE

SYNTAX PeerAddress

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"1-bits in this mask indicate which bits must match when
comparing the destination peer type for this flow."

```
::= { flowDataEntry 20 }
```

flowDataDestTransType OBJECT-TYPE

SYNTAX TransportType

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Transport address type of the destination for this flow. The
value of this attribute will depend on the peer address type."

```
::= { flowDataEntry 21 }
```

flowDataDestTransAddress OBJECT-TYPE

SYNTAX TransportAddress

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"Transport address for the destination of this flow."

```
::= { flowDataEntry 22 }
```

flowDataDestTransMask OBJECT-TYPE

SYNTAX TransportAddress

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"1-bits in this mask indicate which bits must match when
comparing the transport destination address for this flow."

```
::= { flowDataEntry 23 }
```

flowDataPDUScale OBJECT-TYPE

SYNTAX Integer32 (0..255)

MAX-ACCESS read-only

STATUS current

DESCRIPTION

"The scale factor applied to this particular flow. Indicates
the number of bits the PDU counter values should be moved left
to obtain the actual values."

```
::= { flowDataEntry 24 }
```

flowDataOctetScale OBJECT-TYPE

SYNTAX Integer32 (0..255)
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "The scale factor applied to this particular flow. Indicates
 the number of bits the octet counter values should be moved
 left to obtain the actual values."
 ::= { flowDataEntry 25 }

flowDataRuleSet OBJECT-TYPE
 SYNTAX Integer32 (1..255)
 MAX-ACCESS not-accessible
 STATUS current
 DESCRIPTION
 "The RuleSet number of the RuleSet which created this flow.
 Allows a manager to use GetNext or GetBulk requests to find
 flows belonging to a particular RuleSet."
 ::= { flowDataEntry 26 }

flowDataToOctets OBJECT-TYPE
 SYNTAX Counter64
 MAX-ACCESS read-only
 STATUS current
 DESCRIPTION
 "The count of octets flowing from source to destination
 for this flow."
 ::= { flowDataEntry 27 }

flowDataToPDUs OBJECT-TYPE
 SYNTAX Counter64
 MAX-ACCESS read-only
 STATUS current
 DESCRIPTION
 "The count of packets flowing from source to destination
 for this flow."
 ::= { flowDataEntry 28 }

flowDataFromOctets OBJECT-TYPE
 SYNTAX Counter64
 MAX-ACCESS read-only
 STATUS current
 DESCRIPTION
 "The count of octets flowing from destination to source
 for this flow."
 ::= { flowDataEntry 29 }

flowDataFromPDUs OBJECT-TYPE
 SYNTAX Counter64

MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "The count of packets flowing from destination to source
 for this flow."
 ::= { flowDataEntry 30 }

flowDataFirstTime OBJECT-TYPE
SYNTAX TimeStamp
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "The time at which this flow was first entered in the table"
 ::= { flowDataEntry 31 }

flowDataLastActiveTime OBJECT-TYPE
SYNTAX TimeStamp
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "The last time this flow had activity, i.e. the time of
 arrival of the most recent PDU belonging to this flow."
 ::= { flowDataEntry 32 }

flowDataSourceSubscriberID OBJECT-TYPE
SYNTAX OCTET STRING (SIZE (4..20))
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Subscriber ID associated with the source address for this
 flow. A Subscriber ID is an unspecified text string, used
 to ascribe traffic flows to individual users. At this time
 the means by which a Subscriber ID may be associated with a
 flow is unspecified."
 ::= { flowDataEntry 33 }

flowDataDestSubscriberID OBJECT-TYPE
SYNTAX OCTET STRING (SIZE (4..20))
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Subscriber ID associated with the destination address for
 this flow. A Subscriber ID is an unspecified text string,
 used to ascribe traffic flows to individual users. At this
 time the means by which a Subscriber ID may be associated
 with a flow is unspecified."
 ::= { flowDataEntry 34 }

flowDataSessionID OBJECT-TYPE
SYNTAX OCTET STRING (SIZE (4..10))
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Session ID for this flow. Such an ID might be allocated
 by a network access server to distinguish a series of sessions
 between the same pair of addresses, which would otherwise
 appear to be parts of the same accounting flow."
 ::= { flowDataEntry 35 }

flowDataSourceClass OBJECT-TYPE
SYNTAX Integer32 (1..255)
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Source class for this flow. Determined by the rules, set by
 a PushRule action when this flow was entered in the table."
 ::= { flowDataEntry 36 }

flowDataDestClass OBJECT-TYPE
SYNTAX Integer32 (1..255)
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Destination class for this flow. Determined by the rules, set
 by a PushRule action when this flow was entered in the table."
 ::= { flowDataEntry 37 }

flowDataClass OBJECT-TYPE
SYNTAX Integer32 (1..255)
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Class for this flow. Determined by the rules, set by a
 PushRule action when this flow was entered in the table."
 ::= { flowDataEntry 38 }

flowDataSourceKind OBJECT-TYPE
SYNTAX Integer32 (1..255)
MAX-ACCESS read-only
STATUS current
DESCRIPTION
 "Source kind for this flow. Determined by the rules, set by
 a PushRule action when this flow was entered in the table."
 ::= { flowDataEntry 39 }

flowDataDestKind OBJECT-TYPE

```
SYNTAX Integer32 (1..255)
MAX-ACCESS read-only
STATUS current
DESCRIPTION
    "Destination kind for this flow.  Determined by the rules, set
    by a PushRule action when this flow was entered in the table."
 ::= { flowDataEntry 40 }
```

```
flowDataKind OBJECT-TYPE
    SYNTAX Integer32 (1..255)
    MAX-ACCESS read-only
    STATUS current
    DESCRIPTION
        "Class for this flow.  Determined by the rules, set by a
        PushRule action when this flow was entered in the table."
    ::= { flowDataEntry 41 }
```

```
--
-- The Activity Column Table
--
```

```
flowColumnActivityTable OBJECT-TYPE
    SYNTAX SEQUENCE OF FlowColumnActivityEntry
    MAX-ACCESS not-accessible
    STATUS deprecated
    DESCRIPTION
        "Index into the Flow Table.  Allows a meter reader to retrieve
        a list containing the flow table indexes of flows which were
        last active at or after a given time, together with the values
        of a specified attribute for each such flow."
    ::= { flowData 2 }
```

```
flowColumnActivityEntry OBJECT-TYPE
    SYNTAX FlowColumnActivityEntry
    MAX-ACCESS not-accessible
    STATUS deprecated
    DESCRIPTION
        "The Column Activity Entry for a particular attribute,
        activity time and flow."
    INDEX { flowColumnActivityAttribute, flowColumnActivityTime,
            flowColumnActivityIndex }
    ::= { flowColumnActivityTable 1 }
```

```
FlowColumnActivityEntry ::= SEQUENCE {
    flowColumnActivityAttribute  FlowAttributeNumber,
    flowColumnActivityTime      TimeFilter,
    flowColumnActivityIndex     Integer32,
    flowColumnActivityData      OCTET STRING
```

}

flowColumnActivityAttribute OBJECT-TYPE

SYNTAX FlowAttributeNumber

MAX-ACCESS read-only

STATUS deprecated

DESCRIPTION

"Specifies the attribute for which values are required from active flows."

::= { flowColumnActivityEntry 1 }

flowColumnActivityTime OBJECT-TYPE

SYNTAX TimeFilter

MAX-ACCESS read-only

STATUS deprecated

DESCRIPTION

"This variable is a copy of flowDataLastActiveTime in the flow data record identified by the flowColumnActivityIndex value of this flowColumnActivityTable entry."

::= { flowColumnActivityEntry 2 }

flowColumnActivityIndex OBJECT-TYPE

SYNTAX Integer32 (1..2147483647)

MAX-ACCESS read-only

STATUS deprecated

DESCRIPTION

"Index of a flow table entry which was active at or after a specified flowColumnActivityTime."

::= { flowColumnActivityEntry 3 }

flowColumnActivityData OBJECT-TYPE

SYNTAX OCTET STRING (SIZE (3..1000))

MAX-ACCESS read-only

STATUS deprecated

DESCRIPTION

"Collection of attribute data for flows active after flowColumnActivityTime. Within the OCTET STRING is a sequence of { flow index, attribute value } pairs, one for each active flow. The end of the sequence is marked by a flow index value of 0, indicating that there are no more rows in this column."

The format of objects inside flowColumnFlowData is as follows. All numbers are unsigned. Numbers and strings appear with their high-order bytes leading. Numbers are fixed size, as specified by their SYNTAX in the flow table (above), i.e. one octet for flowAddressType and small constants, and four octets for Counter and TimeStamp. Strings are variable-length, with

the length given in a single leading octet.

The following is an attempt at an ASN.1 definition of flowColumnActivityData:

```
flowColumnActivityData ::= SEQUENCE flowRowItemEntry
flowRowItemEntry ::= SEQUENCE {
    flowRowNumber      Integer32 (1..65535),
                        -- 0 indicates the end of this column
    flowDataValue      flowDataType -- Choice depends on attribute
}
flowDataType ::= CHOICE {
    flowByteValue      Integer32 (1..255),
    flowShortValue     Integer32 (1..65535),
    flowLongValue      Integer32,
    flowStringValue    OCTET STRING -- Length (n) in first byte,
                        -- n+1 bytes total length, trailing zeroes truncated
}
 ::= { flowColumnActivityEntry 4 }
```

--

-- The Data Package Table

--

```
flowDataPackageTable OBJECT-TYPE
    SYNTAX SEQUENCE OF FlowDataPackageEntry
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "Index into the Flow Table. Allows a meter reader to retrieve
        a sequence containing the values of a specified set of
        attributes for a flow which came from a specified RuleSet and
        which was last active at or after a given time."
    ::= { flowData 3 }
```

```
flowDataPackageEntry OBJECT-TYPE
    SYNTAX FlowDataPackageEntry
    MAX-ACCESS not-accessible
    STATUS current
    DESCRIPTION
        "The data package containing selected variables from
        active rows in the flow table."
    INDEX { flowPackageSelector,
            flowPackageRuleSet, flowPackageTime, flowPackageIndex }
    ::= { flowDataPackageTable 1 }
```

```
FlowDataPackageEntry ::= SEQUENCE {
    flowPackageSelector OCTET STRING,
```

```
flowPackageRuleSet      Integer32,  
flowPackageTime         TimeFilter,  
flowPackageIndex        Integer32,  
flowPackageData         OCTET STRING  
}
```

flowPackageSelector OBJECT-TYPE

SYNTAX OCTET STRING

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"Specifies the attributes for which values are required from an active flow. These are encoded as a sequence of octets each containing a FlowAttribute number, preceded by an octet giving the length of the sequence (not including the length octet). For a flowPackageSelector to be valid, it must contain at least one attribute."

::= { flowDataPackageEntry 1 }

flowPackageRuleSet OBJECT-TYPE

SYNTAX Integer32 (1..255)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"Specifies the index (in the flowRuleSetInfoTable) of the rule set which produced the required flow."

::= { flowDataPackageEntry 2 }

flowPackageTime OBJECT-TYPE

SYNTAX TimeFilter

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"This variable is a copy of flowDataLastActiveTime in the flow data record identified by the flowPackageIndex value of this flowPackageTable entry."

::= { flowDataPackageEntry 3 }

flowPackageIndex OBJECT-TYPE

SYNTAX Integer32 (1..2147483647)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"Index of a flow table entry which was active at or after a specified flowPackageTime."

::= { flowDataPackageEntry 4 }

flowPackageData OBJECT-TYPE

SYNTAX OCTET STRING
 MAX-ACCESS read-only
 STATUS current
 DESCRIPTION

"A collection of attribute values for a single flow, as specified by this row's indexes. The attribute values are contained within a BER-encoded sequence [ASN-1, ASN-BER], in the order they appear in their flowPackageSelector.

For example, to retrieve a flowPackage containing values for attributes 11, 18 and 29, for a flow in RuleSet 7, with flow index 3447, one would GET the package whose Object Identifier (OID) is

flowPackageData . 3.11.18.29 . 7. 0 . 3447

To get a package for the next such flow which had been active since time 12345 one would GETNEXT the package whose Object Identifier (OID) is

flowPackageData . 3.11.18.29 . 7. 12345 . 3447"

::= { flowDataPackageEntry 5 }

--

-- The Rule Table

--

-- This is an array of RuleSets; the 'running' ones are indicated
 -- by the entries in the meter's flowManagerInfoTable. Several
 -- RuleSets can be held in a meter so that the manager can change the
 -- running RuleSets easily, for example with time of day. Note that
 -- a manager may not change the rules in any RuleSet currently
 -- referenced within the flowManagerInfoTable (either as 'current' or
 -- 'standby')! See the 'Traffic Flow Measurement: Architecture'
 -- document [RTFM-ARC] for details of rules and how they are used.

-- Space for a RuleSet is allocated by setting the value of
 -- flowRuleInfoSize in the rule table's flowRuleSetInfoTable row.
 -- Values for each row in the RuleSet (Selector, Mask, MatchedValue,
 -- Action and Parameter) can then be set by the meter.

-- Although an individual rule within a RuleSet could be modified,
 -- it is much safer to simply download a complete new RuleSet.

flowRuleTable OBJECT-TYPE

SYNTAX SEQUENCE OF FlowRuleEntry
 MAX-ACCESS not-accessible
 STATUS current
 DESCRIPTION

"Contains all the RuleSets which may be used by the meter."

```
::= { flowRules 1 }
```

flowRuleEntry OBJECT-TYPE

SYNTAX FlowRuleEntry

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The rule record itself."

INDEX { flowRuleSet, flowRuleIndex }

```
::= { flowRuleTable 1 }
```

FlowRuleEntry ::= SEQUENCE {

flowRuleSet Integer32,

flowRuleIndex Integer32,

flowRuleSelector RuleAttributeName,

flowRuleMask RuleAddress,

flowRuleMatchedValue RuleAddress,

flowRuleAction ActionNumber,

flowRuleParameter Integer32

}

flowRuleSet OBJECT-TYPE

SYNTAX Integer32 (1..2147483647)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"Selects a RuleSet from the array of RuleSets."

```
::= { flowRuleEntry 1 }
```

flowRuleIndex OBJECT-TYPE

SYNTAX Integer32 (1..2147483647)

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The index into the Rule table. N.B: These values will normally be consecutive, given the fall-through semantics of processing the table."

```
::= { flowRuleEntry 2 }
```

flowRuleSelector OBJECT-TYPE

SYNTAX RuleAttributeName

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"Indicates the attribute to be matched."

null(0) is a special case; null rules always succeed.

matchingStoD(50) is set by the meter's Packet Matching Engine. Its value is true(1) if the PME is attempting to match the packet with its addresses in Source-to-Destination order (i.e. as they appear in the packet), and false(2) otherwise. Details of how packets are matched are given in the 'Traffic Flow Measurement: Architecture' document [RTFM-ARC]. v1(51), v2(52), v3(53), v4(54) and v5(55) select meter variables, each of which can hold the name (i.e. selector value) of an address attribute. When one of these is used as a selector, its value specifies the attribute to be tested. Variable values are set by an Assign action."

::= { flowRuleEntry 3 }

flowRuleMask OBJECT-TYPE

SYNTAX RuleAddress

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"The initial mask used to compute the desired value. If the mask is zero the rule's test will always succeed."

::= { flowRuleEntry 4 }

flowRuleMatchedValue OBJECT-TYPE

SYNTAX RuleAddress

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"The resulting value to be matched for equality. Specifically, if the attribute chosen by the flowRuleSelector logically ANDed with the mask specified by the flowRuleMask equals the value specified in the flowRuleMatchedValue, then continue processing the table entry based on the action specified by the flowRuleAction entry. Otherwise, proceed to the next entry in the rule table."

::= { flowRuleEntry 5 }

flowRuleAction OBJECT-TYPE

SYNTAX ActionNumber

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"The action to be taken if this rule's test succeeds, or if the meter's 'test' flag is off. Actions are opcodes for the meter's Packet Matching Engine; details are given in the 'Traffic Flow Measurement: Architecture' document [RTFM-ARC]."

::= { flowRuleEntry 6 }

flowRuleParameter OBJECT-TYPE

```
SYNTAX Integer32 (1..65535)
MAX-ACCESS read-write
STATUS current
DESCRIPTION
    "A parameter value providing extra information for this rule's
    action. Most of the actions use the parameter value to specify
    which rule to execute after this rule's test has failed; details
    are given in the 'Traffic Flow Measurement: Architecture'
    document [RTFM-ARC]."
 ::= { flowRuleEntry 7 }

--
-- Traffic Flow Meter conformance statement
--

flowMIBCompliances
    OBJECT IDENTIFIER ::= { flowMIBConformance 1 }

flowMIBGroups
    OBJECT IDENTIFIER ::= { flowMIBConformance 2 }

flowControlGroup OBJECT-GROUP
    OBJECTS {
        flowRuleInfoSize, flowRuleInfoOwner,
        flowRuleInfoTimeStamp, flowRuleInfoStatus,
        flowRuleInfoName,
        flowRuleInfoRulesReady,
        flowRuleInfoFlowRecords,
        flowInterfaceSampleRate,
        flowInterfaceLostPackets,
        flowReaderTimeout, flowReaderOwner,
        flowReaderLastTime, flowReaderPreviousTime,
        flowReaderStatus, flowReaderRuleSet,
        flowManagerCurrentRuleSet, flowManagerStandbyRuleSet,
        flowManagerHighWaterMark,
        flowManagerCounterWrap,
        flowManagerOwner, flowManagerTimeStamp,
        flowManagerStatus, flowManagerRunningStandby,
        flowFloodMark,
        flowInactivityTimeout, flowActiveFlows,
        flowMaxFlows, flowFloodMode }
    STATUS deprecated
    DESCRIPTION
        "The control group defines objects which are used to control
        an accounting meter."
    ::= { flowMIBGroups 1 }

flowDataTableGroup OBJECT-GROUP
```

```

OBJECTS {
--      flowDataIndex,                <- INDEX, not-accessible
      flowDataStatus,
      flowDataSourceInterface,
      flowDataSourceAdjacentType,
      flowDataSourceAdjacentAddress, flowDataSourceAdjacentMask,
      flowDataSourcePeerType,
      flowDataSourcePeerAddress, flowDataSourcePeerMask,
      flowDataSourceTransType,
      flowDataSourceTransAddress, flowDataSourceTransMask,
      flowDataDestInterface,
      flowDataDestAdjacentType,
      flowDataDestAdjacentAddress, flowDataDestAdjacentMask,
      flowDataDestPeerType,
      flowDataDestPeerAddress, flowDataDestPeerMask,
      flowDataDestTransType,
      flowDataDestTransAddress, flowDataDestTransMask,
--      flowDataRuleSet,                <- INDEX, not-accessible
      flowDataToOctets, flowDataToPDUs,
      flowDataFromOctets, flowDataFromPDUs,
      flowDataFirstTime, flowDataLastActiveTime,
      flowDataSourceClass, flowDataDestClass, flowDataClass,
      flowDataSourceKind, flowDataDestKind, flowDataKind
    }
STATUS deprecated
DESCRIPTION
    "The flow table group defines objects which provide the
    structure for the flow table, including the creation time
    and activity time indexes into it.  In addition it defines
    objects which provide a base set of flow attributes for the
    adjacent, peer and transport layers, together with a flow's
    counters and times.  Finally it defines a flow's class and
    kind attributes, which are set by rule actions."
::= {flowMIBGroups 2 }

flowDataScaleGroup OBJECT-GROUP
    OBJECTS {
        flowManagerCounterWrap,
        flowDataPDUScale, flowDataOctetScale
    }
STATUS deprecated
DESCRIPTION
    "The flow scale group defines objects which specify scale
    factors for counters."
::= {flowMIBGroups 3 }

flowDataSubscriberGroup OBJECT-GROUP
    OBJECTS {

```

```
        flowDataSourceSubscriberID, flowDataDestSubscriberID,
        flowDataSessionID
    }
    STATUS current
    DESCRIPTION
        "The flow subscriber group defines objects which may be used
        to identify the end point(s) of a flow."
    ::= {flowMIBGroups 4 }

flowDataColumnTableGroup OBJECT-GROUP
    OBJECTS {
        flowColumnActivityAttribute,
        flowColumnActivityIndex,
        flowColumnActivityTime,
        flowColumnActivityData
    }
    STATUS deprecated
    DESCRIPTION
        "The flow column table group defines objects which can be used
        to collect part of a column of attribute values from the flow
        table."
    ::= {flowMIBGroups 5 }

flowDataPackageGroup OBJECT-GROUP
    OBJECTS {
        flowPackageData
    }
    STATUS current
    DESCRIPTION
        "The data package group defines objects which can be used
        to collect a specified set of attribute values from a row of
        the flow table."
    ::= {flowMIBGroups 6 }

flowRuleTableGroup OBJECT-GROUP
    OBJECTS {
        flowRuleSelector,
        flowRuleMask, flowRuleMatchedValue,
        flowRuleAction, flowRuleParameter
    }
    STATUS current
    DESCRIPTION
        "The rule table group defines objects which hold the set(s)
        of rules specifying which traffic flows are to be accounted
        for."
    ::= {flowMIBGroups 7 }

flowDataScaleGroup2 OBJECT-GROUP
```

```

OBJECTS {
--   flowManagerCounterWrap,          <- Deprecated
      flowDataPDUScale, flowDataOctetScale
}
STATUS current
DESCRIPTION
    "The flow scale group defines objects which specify scale
    factors for counters.  This group replaces the earlier
    version of flowDataScaleGroup above (now deprecated)."
```

::= {flowMIBGroups 8}

```

flowControlGroup2 OBJECT-GROUP
  OBJECTS {
    flowRuleInfoSize, flowRuleInfoOwner,
      flowRuleInfoTimeStamp, flowRuleInfoStatus,
      flowRuleInfoName,
--     flowRuleInfoRulesReady,          <- Deprecated
      flowRuleInfoFlowRecords,
    flowInterfaceSampleRate,
      flowInterfaceLostPackets,
    flowReaderTimeout, flowReaderOwner,
      flowReaderLastTime, flowReaderPreviousTime,
      flowReaderStatus, flowReaderRuleSet,
    flowManagerCurrentRuleSet, flowManagerStandbyRuleSet,
      flowManagerHighWaterMark,
--     flowManagerCounterWrap,          <- Moved to DataScaleGroup
      flowManagerOwner, flowManagerTimeStamp,
      flowManagerStatus, flowManagerRunningStandby,
    flowFloodMark,
      flowInactivityTimeout, flowActiveFlows,
      flowMaxFlows, flowFloodMode }
  STATUS current
  DESCRIPTION
    "The control group defines objects which are used to control
    an accounting meter.  It replaces the earlier version of
    flowControlGroup above (now deprecated)."
```

::= {flowMIBGroups 9 }

```

flowMIBCompliance MODULE-COMPLIANCE
  STATUS current
  DESCRIPTION
    "The compliance statement for a Traffic Flow Meter."
  MODULE
    MANDATORY-GROUPS {
      flowControlGroup2,
      flowDataTableGroup,
      flowDataPackageGroup,
      flowRuleTableGroup
    }

```

```
    }  
 ::= { flowMIBCompliances 1 }
```

```
END
```

5 Security Considerations

5.1 SNMP Concerns

There are a number of management objects defined in this MIB that have 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.

There are a number of managed objects in this MIB that may contain sensitive information. These include all the objects in the Control Group (since they control access to meter resources by Managers and Meter Readers) and those in the Flow Table (since they hold the collected traffic flow data).

It is thus important to control even GET access to these objects and possibly to even encrypt the values of these object when sending them over the network via SNMP. Not all versions of SNMP provide features for such a secure environment.

SNMPv1 by itself is not a secure environment. 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.

It is recommended that the implementers consider the security features as provided by the SNMPv3 framework. Specifically, the use of the User-based Security Model [RFC2574] and the View-based Access Control Model [RFC2575] is recommended.

It is then a customer/user responsibility to ensure that the SNMP entity giving access to an instance of this MIB 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.

5.2 Traffic Meter Concerns

This MIB describes how an RTFM traffic meter is controlled, and provides a way for traffic flow data to be retrieved from it by a meter reader. This is essentially an application using SNMP as a method of communication between co-operating hosts; it does not - in itself - have any inherent security risks.

Since, however, the traffic flow data can be extremely valuable for network management purposes it is vital that sensible precautions be taken to keep the meter and its data secure. In particular, an attacker must not be permitted to write any of the meter's variables! This requires that access to the meter for control purposes (e.g. loading RuleSets and reading flow data) be restricted. Such restriction could be achieved in many ways, for example:

- Physical Separation. Meter(s) and meter reader(s) could be deployed so that control capabilities are kept within a separate network, access to which is carefully controlled.
- Application-layer Security. A minimal level of security for SNMP can be provided by using 'community' strings (which are essentially clear-text passwords) with SNMPv2C [RFC1157]. Where stronger security is needed, users should consider using the User-based Security Model [RFC2574] and the View-based Access Control Model [RFC2575].
- Lower-layer Security. Access to the meter can be protected using encryption at the network layer. For example, one could run SNMP to the meter through an encrypted TCP tunnel.

When implementing a meter it may be sensible to use separate network interfaces for control and for metering. If this is done the control network can be set up so that it doesn't carry any 'user' traffic, and the metering interfaces can ignore any user attempts to take control of the meter.

Users should also consider how they will address attempts to circumvent a meter, i.e. to prevent it from measuring flows. Such attempts are essentially denial-of-service attacks on the metering interfaces. For example

- Port Scan attacks. The attacker sends packets to each of a very large number of IP (Address : Port) pairs. Each of these packets creates a new flow in the meter; if there are enough of them the meter will recognise a 'flood' condition, and will probably stop creating new flows. As a minimum, users (and implementors) should ensure that meters can recover from flood conditions as soon as possible after they occur.
- Counter Wrap attacks: The attacker sends enough packets to cause the counters in a flow to wrap several times between meter readings, thus causing the counts to be artificially low. The change to using 64-bit counters in this MIB reduces this problem significantly.

Users can reduce the severity of both the above attacks by ensuring that their meters are read often enough to prevent them being flooded. The resulting flow data will contain a record of the attacking packets, which may well be useful in determining where any attack came from.

6 IANA Considerations

The RTFM Architecture document [RTFM-ARC], has two sets of assigned numbers: Opcodes for the PME (Pattern Matching Engine) and RTFM Attribute numbers. All the assigned numbers used in the Meter MIB appear in Textual Conventions. The numbers they use are derived as follows:

The MIB's 'Type' textual conventions use names and numbers from the Assigned Numbers RFC [ASG-NBR]:

MediumType	Uses ifType Definitions
PeerType	Uses Address Family Numbers
TransportType	Uses Protocol Numbers

The MIB's 'AttributeNumber' textual conventions use RTFM Attribute names and numbers from the RTFM Architecture document [RTFM-ARC], or other numbers allocated according to that document's IANA Considerations section:

FlowAttributeNumber	Have values stored in a flow table row
RuleAttributeNumber	May be tested in a rule

The MIB's ActionNumber textual convention uses RTFM PME Opcode names and numbers from the RTFM Architecture document [RTFM-ARC], or other numbers allocated according to that document's IANA Considerations section.

7 Appendix A: Changes Introduced Since RFC 2064

The first version of the Meter MIB was published as RFC 2064 in January 1997. The most significant changes since then are summarised below.

- TEXTUAL CONVENTIONS: Greater use is made of textual conventions to describe the various types of addresses used by the meter.
- PACKET MATCHING ATTRIBUTES: Computed attributes (e.g. FlowClass and FlowKind) may now be tested. This allows one to use these variables to store information during packet matching.

A new attribute, MatchingStoD, has been added. Its value is 1 while a packet is being matched with its addresses in 'wire' (source-to-destination) order.

- FLOOD MODE: This is now a read-write variable. Setting it to false(2) switches the meter out of flood mode and back to normal operation.
- CONTROL TABLES: Several variables have been added to the RuleSet, Reader and Manager tables to provide more effective control of the meter's activities.
- FLOW TABLE: 64-bit counters are used for octet and PDU counts. This reduces the problems caused by the wrap-around of 32-bit counters in earlier versions. flowDataRuleSet is now used as an index to the flow table. This allows a meter reader to collect only those flow table rows created by a specified RuleSet.
- DATA PACKAGES: This is a new table, allowing a meter reader to retrieve values for a list of attributes from a flow as a single object (a BER-encoded sequence [ASN-1, ASN-BER]). It provides an efficient way to recover flow data, particularly when used with SNMP GetBulk requests.

Earlier versions had a 'Column Activity Table'; using this it was difficult to collect all data for a flow efficiently in a single SNMP request.

8 Acknowledgements

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Stephen Stibler shared the development workload of producing the MIB changes summarized in chapter 5 (above).

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