IPPM reporting MIB

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Abstract

This memo defines a portion of the Management Information Base (MIB) designed for use with network management protocols in TCP/IP-based internets.

In particular, this MIB specifies the objects used for managing the results of the IPPM metrics measures, for pushing alarms, and for reporting the measures results.
1. Introduction
This memo defines a MIB for managing network measurements based upon
the IP performance metrics specified by the IPPM Working Group.

The definition of objects in the IPPM MIB are built on notions
introduced and discussed in the IPPM Framework document, RFC 2330
[ii].

This memo defines a Management Information Base (MIB), and as such it
is intended to be respectful of the "Boilerplate for IETF MIBs"

There are companion documents to the IPPM-REPORTING-MIB both in the
Transport Area (See section 2), and in the Operations and Management
Area (See section 3). The reader should be familiar with these
documents.

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2. The IPPM Framework

The IPPM Framework consists of 3 major components:

A general framework for defining performance metrics, as described in the Framework for IP Performance Metrics, RFC 2330 [2];

A set of standardized metrics which conform to this framework: The IPPM Metrics for Measuring Connectivity, RFC 2678 [iii]; The One-way Delay Metric for IPPM, RFC 2679 [iv]; The One-way Packet Loss Metric for IPPM, RFC 2680 [v]; The Round-trip Delay Metric for IPPM, RFC 2681 [vi].

Emerging metrics that are being specified in respect of this framework.

3. The SNMP Management Framework

The SNMP Management Framework consists of five major components:

An overall architecture, described in RFC 2571 [2].

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 [3], STD 16, RFC 1212 [4] and RFC 1215 [5]. The second version, called SMIv2, is described in STD 58, RFC 2578 [6], STD 58, RFC 2579 [7] and STD 58, RFC 2580 [8].

Message protocols for transferring management information. The first version of the SNMP message protocol is called SNMPv1 and described in STD 15, RFC 1157 [9]. A second version of the SNMP message protocol, which is not an Internet standards track protocol, is called SNMPv2c and described in RFC 1901 [10] and RFC 1906 [11]. The third version of the message protocol is called SNMPv3 and described in RFC 1906 [11], RFC 2572 [12] and RFC 2574 [13].

Protocol operations for accessing management information. The first set of protocol operations and associated PDU formats is described in STD 15, RFC 1157 [9]. A second set of protocol operations and associated PDU formats is described in RFC 1905 [14].

A set of fundamental applications described in RFC 2573 [15] and the view-based access control mechanism described in RFC 2575 [16].

A more detailed introduction to the current SNMP Management Framework can be found in RFC 2570 [17].
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.

Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. Objects in the MIB are defined using the subset of Abstract Syntax Notation One (ASN.1) defined in the SMI. In particular, each object type is named by an OBJECT IDENTIFIER, an administratively assigned name.

The object type together with an object instance serves to uniquely identify a specific instantiation of the object. For human convenience, we often use a textual string, termed the descriptor, to refer to the object type.
4. Overview

Although the number of measurement devices that implement IPPM metrics is growing, there is not currently any standardized management interface to manage remotely the measurement of these metrics. This memo defines a Management Information Base for managing the measurement of IPPM metrics.

To permit metrics to be referenced by other MIBs and other protocols, the IPPM WG has defined a registry of the current metrics and a framework for the integration of future metrics in the [IPPM metrics registry].

As the specification of new metrics is a continuous process, this memo defines a framework for the integration of the future standardized metrics.

The MIB architecture is inspired by the RMON model [xxiii],[xxiv] which specifies the MIB for the monitoring of a single point of measure. The IPPM-REPORTING-MIB differs from this model in that IPPM metrics measurement involves several points of measure and requires common references for time and for measure identification.

The IPPM-REPORTING-MIB introduces a framework where each application identifies its measures in an owner namespace. The administrator may grant access to a measure, or set of measures to another owner via view based access control. As a result, one owner may compute aggregated metrics on another owner’s network measures.

Different architectures may be used to perform metric measurements, using a control protocol and a test protocol. Different control frameworks are suitable for performing measurements. The memo lists them, while also looking for a way to integrate them with the IPPM-REPORTING-MIB. This section is for informational purposes only, and is intended to help to specify the relationship among the test protocol, the control protocol and the IPPM-REPORTING-MIB.

Special care has been taken to provide a reporting mode suitable for control protocols and test protocols. It addresses the need to provide access to results for the applications. Moreover, it may be used to reduce the number of control frameworks.

This MIB is intended to handle multiple concurrent sessions by SNMP applications. However, the SNMP requests are not necessarily to be handled explicitly by the measurement devices, but can be sent to middleware performing an aggregation function. This allows for continuous collection of measurements and statistics computation.
4.1. Textual Conventions

Seven types of data are introduced as textual conventions in this document: IppmOwnerString, TimeUnit, TypeP, TypePaddress, GMTTimeStamp, IppmStandardMetrics and IppmReportDefinition.

4.1.1 IppmOwnerString

This octet string is used to represent the owners of the various measures and reports in the measurement system.

4.1.2 TimeUnit

This textual convention is used to indicate a unit of time, ranging from nanosecond, microsecond, millisecond, second, hour, day, week, month, and year.

4.1.3 TypeP and TypePaddress

Section 13 of the IPPM framework [2] introduces the generic notion of a "packet of type P" because in some contexts the metric's value depends on the type of the packets involved in the metric. In the definition of a metric, the type P will be explicitly defined, partially defined, or left generic. Measurement of metrics defined with generic type P are made specific when performing actual measurements. It is important that one be conscious of the exact type of traffic being measured.

The standardization of the management of the IPPM measures relies on the capability to finely and unambiguously configure the type P of the packets, and the parameters of the protocol suites of the type P.

RMON2 introduced the concept of protocol identifiers. RFC2895 [xxv] specifies a macro for the definition of protocol identifier. The RFC2896 [xxvi] defines the protocol identifiers for different protocol encapsulation trees.

The type P implementation relies on the MACRO PROTOCOL-IDENTIFIER defined for identifying protocol suites in RMON2. It is achieved by defining the TypeP and the TypePaddress as new syntax in SMIv2 TEXTUAL-CONVENTION.

4.1.3.1 Internet addresses

The section 14 of the IPPM framework defines (for the usual case of a unidirectional path through the Internet) the term "Src" and "Dst". "Src" denotes the IP address of the beginning of the path, and "Dst" denotes the IP address of the end.

The section 3 of the RMON PI Reference specifies the Protocol Identifier Encoding rules, which consists briefly in a recursive
length value format. "Src" and "Dst" are protocol identifier parameters. Their values are encoded in separated fields using the encoding rules of the protocol identifier, but without trailing parameters.

The packet encapsulation defined in an instance of TypeP embeds the format of "Src" and "Dst" and their values. The type and value of these addresses depend on the type P of the packet, IP version 4, IPV6, IP in IP... Both participate in the completion of the packet encoding.

Examples:

RFC2896 defines the protocol identifiers ip and ipip4. Should there be an Internet tunnel end-point of the IP address 192.168.1.1 in the tunnel 128.2.6.7. the TypeP of the source address of the tunnel, Src, is ‘ip.ipip4’. The encoding of ‘ip.ipip4’ using the RFC2895 rules adds a trailer 2.0.0. It means that an instance of this protocol identifier has 2 parameters, which values will be set only when implemented. In the IPPM TypeP context these 2 parameters are provided in Src (or Dst). In the current example the value of Src is "192.168.1.1 128.2.6.7".

4.1.4 GMTTimeStamp

This textual convention defines the time at which an event occurred. It is very similar to the NTP timestamp format except that it represents the time elapsed since January 1st, 2000 instead of January 1st, 1900.

4.1.5 IppmStandardMetrics

Each standard metric is identified in the IPPM-METRICS-REGISTRY under the node rfc in a chronological order. This textual convention defines an octet string to permit several metrics to be performed in a single measure.

4.1.6 Report definition

A report consists of sending, or logging, a subset of results of measurements that have been taken over a period of time. The report consists of actions that are taken on the measurement results. An action is performed either:

+ For each result
+ On the results corresponding to a measurement cycle
+ On the results available at the measurement completion.

To preserve the scalability of the whole measurement system, it limits:
+ The amount of data sent to the applications
+ The bandwidth consumption for uploading the result
+ The number of alarms sent to the applications
+ The amount of data saved in the point of measure

The comparison of the measures results in a metric threshold that identifies particular measure values and times that directly impact service availability.

The comparison of the duration of repeated events with a duration threshold identifies particular measure values and times that directly affect an SLA.

The combination of IPPM metric results, threshold events, and event filtering provides a very efficient mechanism to report results, events, and alarms.

A report is described using the TEXTUAL-CONVENTION IppmReportDefinition. The report setup must not dramatically increase the amount of data needed by the control protocol to setup a measure:

+ A basic report is defined in the object ippmReportSetupDefinition;
  + More elaborate reports are described using a metric threshold to generate alarms and events.
  + Pushing of alarms and reports requires a management station address to which the data will be sent.
  + SLA alarms are described using an events duration threshold.

The TEXTUAL-CONVENTION IppmReportDefinition specifies the list of events and actions that are used to create a report.

4.2 Structure of the MIB

The MIB is arranged as follow:

- ippmSystem
- ippmOwners
- ippmHistory
- ippmNetMeasure
- ippmAggrMeasure
- ippmReport
- ippmNotifications
4.2.1 The ippmSystem Group

This group consists of a set of parameters describing the clock synchronization at a particular point of measure over time, as well as the system clock where the IPPM-REPORTING-MIB agent resides.

This group is critical to the implementation of the IPPM MIB.

Section 6.3. of the IPPM Framework states that
"Those who develop such measurement methodologies should strive to:
+ Minimize their uncertainties/ errors, 
+ Understand and document the sources of uncertainty/ error, and 
+ Quantify the amounts of uncertainty/ error."

The aim of this group is to have these values available to compute reliable statistics. The implementation of this group is mandatory, whether the time synchronization is automatic or not.

4.2.2 The ippmOwners Group

This group identifies an owner, or group of owners that have access to measurements on a probe.

4.2.3 The ippmMeasure Group

This group contains all the IPPM metrics that are registered and available for use by the agent.

The measurement entity describes in the ippmMetricsTable of the SNMP agent the local implementation of the standardized metrics. All standardized metrics should be displayed in this table, with the ippmMetricCapabilities object defining whether the metric is implemented or not.

4.2.4 The ippmHistory Group

The results of any given measure are stored in the ippmHistoryTable. The indexing is such that there is an entry in this table for each result of a given measure for a given metric.

4.2.5 The ippmNetMeasure Group

The control protocol registers a description of the existing network measures in the ippmNetMeasureTable.

This group displays the network measures defined by the control protocol. The results are saved in the ippmHistoryTable.
ippmNetMeasureTable is a reflection of the configuration of the network measure.

4.2.6 The ippmAggrMeasure Group

ippmAggrMeasureTable is responsible for the consolidation, or aggregation, of results previously measured and saved in the ippmHistoryTable. The aggregated results are saved in the ippmHistoryTable and may be used for higher aggregated measures.

4.2.7 The Report Group

This group displays the existing reports of the measures collected. The ippmReportSetupTable is responsible for the configuration of the reports. The reports are saved in the ippmReportTable, or sent directly to the applications.

4.2.8 The Notification Group

The Notification group specifies a list of valid notifications. They are used to generate alarms, or reports, to the applications.

4.3 Row identification in an application namespace

The control protocol, or the test protocol, adds rows in the namespace of the corresponding measure.

An object instance identifier in an owner namespace is defined as a list of objects in the clause INDEX where the first object type is IppmOwnerString.

As the OBJECT IDENTIFIER, which identifies the instance, begins with the owner value, the remaining values of the index fields may be chosen independently from one namespace to another.

This allows the user to choose arbitrary values for the remaining fields of the INDEX clause without checking that the values of these fields exist in the MIB tables. This allows the owner to use the same values across MIB implementations.

Thus, it avoids polling to determine the next free index. Also, as a consequence, two applications will never find the same free index value.

The usage of owner namespace increases the speed of the management operations while reducing bandwidth consumption and CPU load in the agents and applications.
Measurements are requested by management applications. An instance of an object managed by a management station is identified by the management station IppmOwnerString and the private index provided by the MS.

As the MS manages its private range of indices, it simply chooses one when it wishes to create a new control entry. For the same reason, the setup of a measure on several points of measures consists of simply sending the same copy of the measure setup to the different points of measures involved.

4.4 Relationship of IPPM REPORTING MIB tables

There is inherently a relationship between various tables in the IPPM REPORTING MIB, and as such, the data integrity must be assured. This relationship is depicted in the following examples.

4.4.1 Relationship between the Owners Table and the aggregated measure table

The owners table contains the list of "owners" that can create and activate remotely aggregated measures in an IPPM agent or read the existing network measures.

It is recommended to make use of "view based access control" in order to restrict access to this table. For example, the master user "administrator" may be given "write" privileges on the ippmOwnersTable, whereas all others are restricted to "read" access. The user "administrator" can then setup the list of other users that have access to measures.

There must be at least 1 owner in the owners’ table. This owner may be either setup by default by the IPPM agent, or configured as stated above.

An owner may have multiple corresponding entries in the network and aggregated measure tables. Each entry in the measure table is associated with one, and only one, entry in the owners’ table. That is to say, that a defined measure may NOT have multiple owners.

Thus, we have a 1:N relationship between the owners’ table and a measure table.

4.4.2 Relationship between the Network Measure Table and the Aggregated Measure Table

The network measure table is read-only, thus entries in this table must be populated by the agent upon startup. The agent could potentially read a database that contains network measures configured by a 3rd party proprietary management system that
directly interacts with the points of measure. However, the "owner" of the measure be defined in the owners table.

The aggregated measure table allows for an "owner" to create aggregated measures (such as average, minimum, maximum) on existing measures. An owner may even create aggregated measures on network measures that are owned by other owners. However, it is recommended to use view based access control to grant access of network measures to owners in the system.

5 Measurement architectures

There are three main measurement architectures.

5.1 Proxy architecture

In this architecture, the different NMSs query the IPPM-REPORTING-MIB agent for measurements. The agent controls whether the NMS is granted access to perform the measure requested. Each NMS accesses the results of its measurements in the IPPM-REPORTING-MIB statistics table.

The measurement setup/teardown and the data collection are done using the control protocol and the test protocol.

In this mode the NMS does not depend on the control protocol nor on the test protocol. The entities involved in the measurement do not
need to implement the IPPM-REPORTING-MIB nor SNMP. This mode allows for lightweight implementation in the point of measure, and also for heterogeneous control protocols to coexist. Finally, the proxy is a checkpoint where measurement activity may be logged, and where access to measurement setups may be tightly controlled. Thus, it provides a reliable architecture to manage the security of a measurement system.

5.2 Reporting architecture

In this architecture the SNMP protocol is only used to read the results of the measurements in the IPPM-REPORTING-MIB History Table, and also to inform the NMS that an event has occurred.

The activation of a measure by the control protocol or the test protocol creates a measure in the IPPM-REPORTING-MIB Network Measure table. The table in question may be not accessible by SNMP. In this case, a list of the measure identifiers (owner, index) is handled by the measurement software.
Each timestamped result of the measure is logged in the IPPM-REPORTING-MIB History table in order to allow read access to the NMSs and event handling.

On completion, the measurement results are managed according to the measure setup:

+ The results may be sent to an NMS;
+ They may be dropped from the IPPM-REPORTING-MIB History table.

In this mode, it is recommended to use an SNMPv2 Inform PDU to send reporting events because it ensures that the entire block of the result is received. There is no control using SNMP Trap PDU.
5.3 Gateway architecture

The gateway architecture combines the proxy mode and the reporting mode.

The NMS measurement queries are registered in the IPPM-REPORTING-MIB gateway and performed by the control and the test protocol. The NMS directly consults the result in the corresponding IPPM REPORTING MIB agent of the points of measure.

5.4 Security

The proxy mode provides flexibility and control of the access to the points of measure, while allowing lightweight control protocol and test protocol implementations in the points of measure. Different security rules may be applied to the NMS domain and to measurement system domains.
The reporting mode has 2 security domains:

+ The control of the measurement setups relies on the control and the test protocol security mechanisms;
+ The control of access to the results depends on the SNMP security mechanisms such as community strings, but may also be restricted using VACM for customized access.

The gateway mode security relies on the security of the proxy mode and of the reporting mode.

6 Reporting mode integration

The IPPM-REPORTING-MIB standardizes the parameters that:

+ Define the configuration of the IPPM metrics measures;
+ Define the format of the results of the measure;
+ Define the report of the IPPM metric measures results.

It introduces the concept of owner namespace to allow for fast configuration and reporting across multiple points of measurement.

A measure is a distributed object describing a task to be performed by the control and the test protocols. A measure is identified by its owner and its owner index. This identifier is the same in all the points of measure. As the owner chooses the index, there is no need for negotiation between the NMS and the points of measure before activating the measure.

A measure is primarily defined by its identifier, the metrics to measure, the description of the end point addresses and the description of the scheduling of the measure.

The description of the measure is distributed to the points of measure involved. The distribution may not be synchronized.

6.1 Integration

The integration of the IPPM-REPORTING-MIB, and the test and control protocols consists in pushing the network measure setup/teardown parameters and the result values from the measurement software to the IPPM-REPORTING-MIB agent.

6.2 Setup of the measure network

The measurement system updates the MIB on creation of a network measure.

6.3 Setup of a measurement report
A measurement report setup describes events and data to include in the report. A report is read by an NMS in the ippmReportTable, or pushed to a NMS using an SNMP Inform PDU, an email, or a SMS.

Different types of reports may be combined:

+ A trivial report defines the results to be saved in the ippmReportTable;
+ A basic report defines the host to which the results are pushed on completion of the measure;
+ An alarm report defines a threshold on the results of the measure. A message is sent to a host when the result rises above, or falls below the threshold;
+ An SLA report defines a threshold on the results of the measure. The report consists of the results of the measure (time and value) of the filtered events. The reports are sent at each measurement cycle, or when the measure completes.

6.4 Updating the history of the MIB

Results have to be written by the measurement task in the agent implementing the IPPM REPORTING MIB.

Adding the results of a measurement consists in the transfer of the result from the measurement software to the SNMP agent. The protocol that provides the result may be the control protocol, or the test protocol.

6.5 Report download and upload

A report is read in the ippmReportTable using SNMP, or pushed by the IPPM_MIB agent using a SNMP Inform PDU, an email or a SMS.

6.6 Default value

The default values correspond to IP version 4.

7 Definition

IPPM-REPORTING-MIB DEFINITIONS ::= BEGIN

IMPORTS
    MODULE-IDENTITY,
    NOTIFICATION-TYPE,
    OBJECT-TYPE,
    experimental, Integer32
    FROM SNMPv2-SMI

--
-- ippm
-- FROM IPPM-REGISTRY

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InetAddressType,
InetAddress
FROM INET-ADDRESS-MIB
SnmpAdminString
FROM SNMP-FRAMEWORK-MIB
RowStatus,
StorageType,
TEXTUAL-CONVENTION
FROM SNMPv2-TC
MODULE-COMPLIANCE,
OBJECT-GROUP,
NOTIFICATION-GROUP
FROM SNMPv2-CONF;

ippmReportingMib MODULE-IDENTITY
LAST-UPDATED "200306291200Z" -- June, 2003
ORGANIZATION "France Telecom - R&D"
CONTACT-INFO
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France Telecom - R&D
2, Avenue Pierre Marzin
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DESCRIPTION
" This memo defines a portion of the Management Information Base
(MIB) for use with network management protocols in TCP/IP-based
internets. In particular, it specifies the objects used for
managing the results of the IPPM metrics measurements, alarms and
reporting of measurement results."

REVISION "200210181200Z" -- 18 October 2002
DESCRIPTION
"General cleanup
Change 5 tables to read write"

REVISION "200302141200Z" -- 14 February 2003
DESCRIPTION
"Modifications based upon feedback from IETF-55"
ippm OBJECT IDENTIFIER ::= { experimental 10000 }

--

IppmOwnerString ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION
"An OwnerString, which length is limited to 32."

SYNTAX OCTET STRING (SIZE (0..32))

TimeUnit ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION
"A enumerated list of time units."

SYNTAX INTEGER {
  year(1),
  month(2),
  week(3),
  day(4),
  hour(5),
  second(6),
  millisecond(7),
  microsecond(8),
  nanosecond(9)
}

--

IppmStandardMetrics ::= TEXTUAL-CONVENTION

STATUS current

DESCRIPTION
"Each standard metric is identified in the IPPM-METRICS-REGISTRY under the node rfc in chronological order. In order to allow for several metrics to be calculated in a single measure, there is a need to describe in a bit string the metrics to be measured. This textual convention defines an octet string that gathers in a bit string a sequence of bits. The bit order corresponds to the order
of the metric identifiers in the registry. The first bit of the string has the index 0. The index 1 corresponds to the first metric of the registry (instantaneousUnidirectionalConnectivity).

Example:
One-way-Delay(6) is identified as the leaf number 6 of the node rfc of the registry. One-way-Packet-Loss(12) is identified as the leaf number 12 of the node rfc of the registry. A network measure performing both One-way-Delay(6) and One-way-Packet-Loss(12) will be described as ‘0001000001000000’b, ‘1040’B.

SYNTAX OCTET STRING

GMTTimeStamp ::= TEXTUAL-CONVENTION
STATUS       current
DESCRIPTION
"The value at which a specific occurrence happened. The specific occurrence must be defined in the description of any object defined using this type.

<table>
<thead>
<tr>
<th>field</th>
<th>octets</th>
<th>contents</th>
<th>range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1-4</td>
<td>second since 1 Jan 2000 0H00*</td>
<td>0..2^31 - 1</td>
</tr>
<tr>
<td>2</td>
<td>5-8</td>
<td>fractional part of the second*</td>
<td>0..2^32 - 1</td>
</tr>
</tbody>
</table>
* the value is in network-byte order

The timestamp format is directly inspired from the NTP timestamp format. It differs because it counts the second since 1 Jan 2000 0H00 instead of 1 Jan 1900 0H00. The most significant bit of the part that represents the second is reserved. It will wrap in year 2068 (The NTP timestamp will wrap in year 2036).

This bit is set to indicate if the fractional part of the second contains a precision field and a synchronization field as initially proposed in the OWAMP draft.

When this bit is not set the resolution is maximal.

The maximal resolution is close to 250 picoseconds.

The precision of the timestamp must be provided in another field.

"SYNTAX OCTET STRING (SIZE (8))
TypeP  ::= TEXTUAL-CONVENTION
   STATUS       current
   DESCRIPTION
   "This textual convention is a display string used to describe the
   protocol encapsulation list of a packet, and is used as the value
   of the SYNTAX clause for the type of the Src and Dst of an IPPM
   measure. The RFC2895 specifies a macro named PROTOCOL-IDENTIFIER
   for the definition of protocol identifiers, while its companion
document, the RFC2896 defines a set of protocol identifiers.

   TypeP is defined as a display string. It consists of a list of
dot separated protocol names. Each protocol name has been
previously defined using the macro PROTOCOL-IDENTIFIER of the RFC
2895.

   Examples:
The RFC2896 defines the protocol identifiers 'ether2', 'ip',
'ipip4', 'udp', 'tcp', 'telnet'...

   The TypeP of the source address corresponding to telnet is the
   string 'ip.tcp.telnet'.

   The TypeP of the source address corresponding to UDP packets sent
   in an IP tunnel is the string 'ip.ipip4.udp'.

   Note:
   An IPPM measure is active, so generally a TypeP value does not
   describe the link layer (i.e. ether2...). Valid Internet packets
   are sent from Src to Dst. Then the choice of the link layer
   relies on the Internet stack."

SYNTAX       OCTET STRING (SIZE (0..512))

TypePaddress ::= TEXTUAL-CONVENTION
   DISPLAY-HINT "255a"
   STATUS       current
   DESCRIPTION
   "This textual convention is a Display string used to describe the
   parameters of the protocol encapsulation list of a packet,
   basically the address.

   TypePaddress is defined as a display string. It consists in a
   list of space separated parameter list. Each parameter in the
   list corresponds to a parameter of a PROTOCOL-IDENTIFIER of the
   TypeP.
   Example:
The TypeP 'ip.ipip4' has 2 parameters. A valid TypePaddress value
   is '192.168.1.1 128.2.6.7'."

SYNTAX       OCTET STRING (SIZE (0..512))
IppmReportDefinition ::= TEXTUAL-CONVENTION
STATUS current
DESCRIPTION
"A report definition is a list of statements describing a report. A
statement is part of this process if its bit in the definition is set
to '1'. For all bit values that are set to one, a report will be
generated.

The report process uses results saved in the history table. Threshold
values are provided by the report setup.

Given that not all results from a metric measurement are
pertinent to a particular report, and that the size of the report
must be limited whenever possible, the guidelines for the definition
of a report are as follows:

+ Select the events for consideration (1);
+ Configure filters to select pertinent values (2);
+ Describe the way the report is delivered (3);
+ Describe clean up actions to perform on report completion (4);

-1- events

Events determine when a report is processed. Events are
exclusive. The possible values are:

onSingleton:
The report is processed each time a new result of the measurement
occurs.

onMeasureCycle:
The report is processed each time a cycle of measure is
completed.

onMeasureCompletion:
The report is processed at the end of the measurement.

-2- filters

Filters determine if a result belongs to a report. ReportInBandResults and ReportOutBandResults are exclusive. The
usage of ReportInBandResults and ReportOutBandResults exclude the
usage of ReportAboveResults and ReportBelowResults.
Possible values are:

reportUpAndDownResults:
Report contiguous results that are on opposite sides of
the up and down metric threshold.

ReportInBandResults:
Report results lower than the high metric threshold field of the report setup and greater than the low metric threshold field of the report setup.

ReportOutBandResults:
Report results greater than the high metric threshold field of the report setup and lower than the low metric threshold field of the report setup.

ReportAboveResults:
Report results greater than the high metric threshold field of the report setup.

ReportBelowResults:
Report results lower than the low metric threshold field of the report setup.

reportExceededEventsDuration:
Save the results of the metric only if the current filter triggers repeatedly for a series of contiguous results during more than ippmReportSetupDurationThreshold seconds.

Even though report delivery statements are not exclusive, care should be taken to limit the number of report methods to 2. The delivery methods are:

inIppmReportTable:
Store the report in the local ippmReportTable.
NOTE WELL: Results are not stored in the report table if this flag is not set.

inSNMPv2TrapPDU:
Send the report using a SNMPv2-Trap-PDU.

inInformRequestPDU:
Send the report using a SNMP InformRequest-PDU.

inEmail:
Send the report using an email.

inSMS:
Send the report using a SMS.

Cleanup
onReportDeliveryClearReport(12):
Remove all the results corresponding to this measure from the ippmReportTable when the report has been delivered.

```
SYNTAX BITS {
    none(0), -- reserved
    onSingleton(1),
    onMeasureCycle(2),
    onMeasureCompletion(3),
    reportUpAndDownResults(4),
    reportInBandResults(5),
    reportOutBandResults(6),
    reportAboveResults(7),
    reportBelowResults(8),
    reportExceededEventsDuration(9),
    inIppmReportTable(10),
    inSNMPv2TrapPDU(11),
    inInformRequestPDU(12),
    inEmail(13),
    inSMS(14),
    onReportDeliveryClearReport(15)
}
```

--
-- IPPM Notifications
--
ippmNotifications OBJECT IDENTIFIER ::= { ippm 0 }

--
-- IPPM Conformance
--
ippmConformance OBJECT IDENTIFIER ::= { ippm 1 }

--
-- IPPM Mib objects definitions
--
ippmSystem OBJECT IDENTIFIER ::= { ippmReportingMib 1 }
ippmOwners OBJECT IDENTIFIER ::= { ippmReportingMib 2 }
ippmHistory OBJECT IDENTIFIER ::= { ippmReportingMib 3 }
ippmMeasure OBJECT IDENTIFIER ::= { ippmReportingMib 4 }
ippmReport OBJECT IDENTIFIER ::= { ippmReportingMib 5 }

--
-- ippmSystem Group
--
ippmSystemTime OBJECT-TYPE
SYNTAX GMTTimeStmp
MAX-ACCESS read-only
STATUS current
DESCRIPTION "The current time of the system running the IPPM REPORTING MIB
SNMP agent.
When the agent is running in proxy mode is it the current time of the
proxy agent.
When the agent is located in the probe, it is the current time
of the probe agent."
::= { ippmSystem 1 }

ippmSystemSynchronizationType OBJECT-TYPE
SYNTAX INTEGER
{ other(0),
  ntp(1),
  gps(2),
  cdma(3)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION "ippmSystemSynchronizationType describes the mechanism
used to synchronize the system running the IPPM REPORTING MIB
SNMP agent.

Other(0)
The synchronization process must be defined
in the ippmSystemSynchronizationDescription.

Ntp(1)
The system is synchronized using the network
time protocol. The NTP synchronization must be described
in the ippmSystemSynchronizationDescription.

Gps(2)
The system is synchronized using the GPS clocks.

Cdma(3)
The system is synchronized using the CDMA clocks."
::= { ippmSystem 2 }

ippmSystemSynchronizationDesc OBJECT-TYPE
SYNTAX SnmpAdminString
MAX-ACCESS read-only
STATUS current
DESCRIPTION "The description of the synchronization process of the system
running the IPPM REPORTING MIB SNMP agent."

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::= { ippmSystem 3 }

ippmSystemClockResolution OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-only
-- UNITS "picoseconds"
STATUS current
DESCRIPTION
"ippmSystemClockResolution provides the precision of the clock 
used for the measures. The unit is the picosecond. For example, 
the clock on an old Unix host might advance only once every 10 
msec, and thus have a resolution of 10 msec. So its resolution is 
100000 picosecond and the value of ippmSystemClockResolution is 
100000."
::= { ippmSystem 4 }

ippmSystemOperationalStatus OBJECT-TYPE
SYNTAX INTEGER { unknown(0),
                   up(1),
                   down(2) }
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This object describes the status of the system running the IPPM 
REPORTING MIB SNMP agent. It does not describe end points measurement 
status. 
unknown(0)
up(1) means service is operational and available for general use. 
down(2) means the proxy is not available for use."
::= { ippmSystem 5 }

ippmSynchronizationTable OBJECT-TYPE
SYNTAX SEQUENCE OF IppmSynchronizationEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"This table registers the event related to the synchronization of 
the points of measure. Each event is described in an 
ippmSynchronizationEntry. 
ippmSynchronizationTable is mandatory. 
ippmSynchronizationTable content is read only."
::= { ippmSystem 6 }

ippmSynchronizationEntry OBJECT-TYPE
SYNTAX IppmSynchronizationEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"An entry describes a modification of the synchronization status.
"
INDEX { ippmPointOfMeasureIndex, ippmSynchronizationIndex }
::= { ippmSynchronizationTable 1 }

IppmSynchronizationEntry ::= SEQUENCE {
    ippmSynchronizationIndex               Integer32,
    ippmSynchronizationTime                GMTTimeStamp,
    ippmSynchronizationStratum             Integer32,
    ippmSynchronizationResolution          Integer32
}

ippmSynchronizationIndex OBJECT-TYPE
SYNTAX    Integer32 (1 .. 65535)
MAX-ACCESS not-accessible
STATUS     current
DESCRIPTION
"An index that identifies the synchronization events in chronological order."
::= { ippmSynchronizationEntry 1 }

ippmSynchronizationTime OBJECT-TYPE
SYNTAX    GMTTimeStamp
MAX-ACCESS read-only
STATUS     current
DESCRIPTION
"The time when the synchronization event occurs."
::= { ippmSynchronizationEntry 2 }

ippmSynchronizationStratum OBJECT-TYPE
SYNTAX    Integer32
MAX-ACCESS read-only
STATUS     current
DESCRIPTION
"The stratum level of the clock computed when the synchronization event occurs."
::= { ippmSynchronizationEntry 3 }

ippmSynchronizationResolution OBJECT-TYPE
SYNTAX    Integer32
UNITS      "NanoSeconds"
MAX-ACCESS read-only
STATUS     current
DESCRIPTION
"The synchronization resolution of the clock computed when the synchronization event occurs."
::= { ippmSynchronizationEntry 4 }

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"The new time resolution computed after the synchronization event occurred."
::= { ippmSynchronizationEntry 4 }

ippmPointOfMeasureTable OBJECT-TYPE
SYNTAX     SEQUENCE OF IppmPointOfMeasureEntry
MAX-ACCESS not-accessible
STATUS     current
DESCRIPTION
" This table is the list of measurement end points available in the measurement system.

Proxy mode:
It is the list of the measurement end points of the set of probes for which the IPPM proxy provides an SNMP interface.

IPPM MIB implemented in a probe:
It is the list of the measurement end points of the probe.

The ippmPointOfMeasureTable content is read only. This implies that the measurement software handles the table internally

ippmPointOfMeasureTable is mandatory."
::= { ippmSystem 7 }

ippmPointOfMeasureEntry OBJECT-TYPE
SYNTAX,     IppmPointOfMeasureEntry
MAX-ACCESS not-accessible
STATUS     current
DESCRIPTION
" An entry may be the management address of a middleware in charge of the management of a set of probes. It may the management address of a probe that contains several line cards.

An entry describes the capability of a point of measure. The description may make the use of wildcards to define multiple capabilities."
INDEX { ippmPointOfMeasureIndex }
::= { ippmPointOfMeasureTable 1 }

IppmPointOfMeasureEntry ::= SEQUENCE {
  ippmPointOfMeasureIndex                  Integer32,
  ippmPointOfMeasureMgmtAddrType           InetAddressType,
  ippmPointOfMeasureMgmtAddress            InetAddress,
  ippmPointOfMeasureTypePAddress           TypeP,
  ippmPointOfMeasureAddress                InetAddress,
  ippmPointOfMeasureMetrics                IppmStandardMetrics
}
ippmPointOfMeasureIndex OBJECT-TYPE
   SYNTAX Integer32 (1 .. 65535)
   MAX-ACCESS not-accessible
   STATUS current
   DESCRIPTION
      "A local index that identifies an entry of the points of measures
table."
   ::= { ippmPointOfMeasureEntry 1 }

ippmPointOfMeasureMgmtAddrType OBJECT-TYPE
   SYNTAX InetAddressType
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "The address type associated with the management address."
   ::= { ippmPointOfMeasureEntry 2 }

ippmPointOfMeasureMgmtAddress OBJECT-TYPE
   SYNTAX InetAddress (SIZE (1..128))
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "The management address on the point of measure"
   ::= { ippmPointOfMeasureEntry 3 }

ippmPointOfMeasureTypePAddress OBJECT-TYPE
   SYNTAX TypeP
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "Defines the type P address of the point of measure."
   DEFVAL { "ip" }
   ::= { ippmPointOfMeasureEntry 4 }

ippmPointOfMeasureAddress OBJECT-TYPE
   SYNTAX InetAddress
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "Specifies the address of the point of measure.

      It is represented as an octet string with specific semantics and
      length as identified by the ippmPointOfMeasureTypePAddress.

      For example, if the ippmPointOfMeasureTypePAddress indicates an
      encapsulation of ‘ip’, this object length is 4, followed by the 4
      octets of the IP address, in network byte order."
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::= {ippmPointOfMeasureEntry 5}

ippmPointOfMeasureMetrics OBJECT-TYPE
SYNTAX IppmStandardMetrics
MAX-ACCESS read-only
STATUS current
DESCRIPTION
   "Metrics supported by this point of measure."
 ::= {ippmPointOfMeasureEntry 6}

ippmMetricTable OBJECT-TYPE
SYNTAX SEQUENCE OF IppmMetricEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
   "This table is mandatory. It describes the current
   implementation. Each IPPM standardized metric must be described
   in the table.
   ippmMetricTable content is read only."
 ::= {ippmSystem 8}

ippmMetricEntry OBJECT-TYPE
SYNTAX IppmMetricEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
   "An entry describes the static capabilities of a metric
   implementation."
INDEX {ippmMetricIndex}
 ::= {ippmMetricTable 1}

IppmMetricEntry ::= SEQUENCE {
   ippmMetricIndex           Integer32,
   ippmMetricCapabilities    INTEGER,
   ippmMetricType            INTEGER,
   ippmMetricUnit            INTEGER,
   ippmMetricDescription     SnmpAdminString
}

ippmMetricIndex OBJECT-TYPE
SYNTAX Integer32 (1..65535)
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"ippmMetricIndex defines an unambiguous index for each standardized metric. It identifies a metric. Its value is the value of the node of the metric in an IPPM registry. This value is the same in any implementation of the IPPM REPORTING MIB.

Example:
In the IPPM-METRICS-REGISTRY, one way Packet Loss Average is registered as the node 14 of ippmMetricsRegistry.metrics.rfc. Consequently the index of the metric one way Packet Loss Average in the Ippm Metric Table will always be ‘14’

::= { ippmMetricEntry 1 }
packet(6),
byte(7),
kilobyte(8),
megabyte(9)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The unit used in the current entity for the results of the
measurement of this metric."
::= { ippmMetricEntry 4 }

ippmMetricDescription OBJECT-TYPE
SYNTAX SnmpAdminString
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"A textual description of the metric implementation following the exact
name of this metric in the registry. For example:
oneWayDelay: text ."
::= { ippmMetricEntry 5 }

--
-- ippmOwners Group
--
-- The ippmOwners objects are responsible for managing
-- the owners access to the measurements.
--
--
ippmOwnersTable OBJECT-TYPE
SYNTAX SEQUENCE OF IppmOwnersEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"A management entity wishing to create and activate remote Ippm
measurements in an agent must previously be registered in the
ippmOwnersTable.
ippmOwnersTable content is read-create. It contains at least the
owner 'monitor'. Ä|Ä|
::= { ippmOwners 1 }

ippmOwnersEntry OBJECT-TYPE
SYNTAX IppmOwnersEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"The description of the resources granted to an SNMP application."
For example, an instance of ippmOwnersOwner with an ippmOwnerString 'acme', which represents the 14th owner created in ippmOwnersTable would be named ippmOwnersEntryOwner.14.

Notes:

The ippmOwnersIndex value is a local index managed directly by the agent. The management application must poll to get the next available index value. It is not used in anyway in other IPPM tables."

INDEX { ippmOwnersIndex }
 ::= { ippmOwnersTable 1 }

IppmOwnersEntry ::= SEQUENCE {
  ippmOwnersIndex              Integer32,
  ippmOwnersOwner              IppmOwnerString,
  ippmOwnersGrantedMetrics     IppmStandardMetrics,
  ippmOwnersQuota              Integer32,
  ippmOwnersIpAddressType      InetAddressType,
  ippmOwnersIpAddress          InetAddress,
  ippmOwnersEmail              SnmpAdminString,
  ippmOwnersSMS                SnmpAdminString,
  ippmOwnersStatus             RowStatus
}

ippmOwnersIndex OBJECT-TYPE
 SYNTAX Integer32 (1.. 65535)
 MAX-ACCESS not-accessible
 STATUS     current
 DESCRIPTION
   "An arbitrary index that identifies an entry in the owners table."
 ::= { ippmOwnersEntry 1 }

ippmOwnersOwner OBJECT-TYPE
 SYNTAX     IppmOwnerString
 MAX-ACCESS read-create
 STATUS     current
 DESCRIPTION
   "The owner described by this entry."
 ::= { ippmOwnersEntry 2 }

ippmOwnersGrantedMetrics OBJECT-TYPE
 SYNTAX     IppmStandardMetrics
 MAX-ACCESS read-create
 STATUS     current
 DESCRIPTION
   " Defines the metrics granted to an owner for which measurements can be performed."
 ::= { ippmOwnersEntry 3 }

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ippmOwnersQuota OBJECT-TYPE
SYNTAX     Integer32
MAX-ACCESS read-create
STATUS     current
DESCRIPTION
"The maximum number of records that this owner may have in the history
table and/or in the report table."
 ::= { ippmOwnersEntry 4 }

ippmOwnersIpAddressType OBJECT-TYPE
SYNTAX     InetAddressType {
    ipv4(1),
    ipv6(2),
    dns(16)
}
MAX-ACCESS read-create
STATUS     current
DESCRIPTION
"The IP address type of the management entity corresponding to
this owner.
InetAddressType is restricted to ipv4(1),ipv6(2) and dns(16)."
 ::= { ippmOwnersEntry 5 }

ippmOwnersIpAddress OBJECT-TYPE
SYNTAX     InetAddress  (SIZE  (1..128))
MAX-ACCESS read-create
STATUS     current
DESCRIPTION
"The IP address of the management entity corresponding to this
owner."
 ::= { ippmOwnersEntry 6 }

ippmOwnersEmail OBJECT-TYPE
SYNTAX     SnmpAdminString
MAX-ACCESS read-create
STATUS     current
DESCRIPTION
"The email address of the management entity corresponding to this
owner."
 ::= { ippmOwnersEntry 7 }

ippmOwnersSMS OBJECT-TYPE
SYNTAX     SnmpAdminString
MAX-ACCESS read-create
STATUS     current
DESCRIPTION
"The SMS phone number of the management entity corresponding to
this owner."
 ::= { ippmOwnersEntry 8 }
ippmOwnersStatus OBJECT-TYPE
   SYNTAX     RowStatus
   MAX-ACCESS read-create
   STATUS     current
   DESCRIPTION
      "The status of this table entry."
   ::= { ippmOwnersEntry 9 }

-- ippmHistory  Group
--
--

-- ippmHistoryTable
--

ippmHistoryTable OBJECT-TYPE
   SYNTAX     SEQUENCE OF IppmHistoryEntry
   MAX-ACCESS not-accessible
   STATUS     current
   DESCRIPTION
      "The table containing the measurement results."
   ::= { ippmHistory 1 }

ippmHistoryEntry OBJECT-TYPE
   SYNTAX     IppmHistoryEntry
   MAX-ACCESS not-accessible
   STATUS     current
   DESCRIPTION
   "An ippmHistoryEntry entry is one of the results of a measure
   identified by ippmHistoryMeasureOwner, ippmHistoryMeasureIndex,
   ippmHistoryMetricIndex and ippmHistoryIndex. In the index :
   + ippmHistoryMeasureOwner identifies the owner of the measure;
   + ippmHistoryMeasureIndex identifies the measure in the owner
     namespace;
   + ippmHistoryMetricIndex identifies the metric measured by the
     measure. The metric is described in the corresponding entry of
     the n ippmMetricTable;
   + ippmHistoryIndex is the local index of the result on the
     history table."
INDEX { ippmHistoryMeasureOwner, ippmHistoryMeasureIndex, 
         ippmHistoryMetricIndex, ippmHistoryIndex } 
::= { ippmHistoryTable 1 }

IppmHistoryEntry ::= SEQUENCE {
   ippmHistoryMeasureOwner      IppmOwnerString,
   ippmHistoryMeasureIndex      Integer32,
   ippmHistoryMetricIndex       Integer32,
   ippmHistoryIndex             Integer32,
   ippmHistorySequence          Integer32,
   ippmHistoryTimestamp         GMTTimeStamp,
   ippmHistoryValue             Integer32
}

ippmHistoryMeasureOwner OBJECT-TYPE
SYNTAX     IppmOwnerString
MAX-ACCESS not-accessible
STATUS     current
DESCRIPTION "The owner of the measure that produced this result."
::= { ippmHistoryEntry 1 }

ippmHistoryMeasureIndex OBJECT-TYPE
SYNTAX Integer32 (1.. 65535)
MAX-ACCESS not-accessible
STATUS     current
DESCRIPTION " The owner index of the measure that produced this result."
::= { ippmHistoryEntry 2 }

ippmHistoryMetricIndex OBJECT-TYPE
SYNTAX Integer32 (1.. 65535)
MAX-ACCESS not-accessible
STATUS     current
DESCRIPTION " ippmHistoryMetricIndex identifies the metric measured by the
measure. The metric is described in the corresponding entry of
the ippmMetricTable."
::= { ippmHistoryEntry 3 }

ippmHistoryIndex OBJECT-TYPE
SYNTAX Integer32 (1.. 65535)
MAX-ACCESS not-accessible
STATUS     current
DESCRIPTION " A local index that identifies a result in the history table."
::= { ippmHistoryEntry 4 }
ippmHistorySequence OBJECT-TYPE
   SYNTAX Integer32 (0.. 65535)
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
   "ippmHistorySequence is the sequence index of the measurement
   results for a metric.

   Network metrics:
   It’s the sequence index of a measurement packet. Typically, it
   identifies the order of the packet in the stream of packets sends
   by the source.

   Aggregated metrics:
   It is the sequence index of the computed aggregated metric
   result."
 ::= { ippmHistoryEntry 5 }

ippmHistoryTimestamp OBJECT-TYPE
   SYNTAX GMTTimeStamp
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
   "The timestamp when the measurement occurred."
 ::= { ippmHistoryEntry 6 }

ippmHistoryValue OBJECT-TYPE
   SYNTAX Integer32
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
   "The observed value of the measurement."
 ::= { ippmHistoryEntry 7 }

--
-- ippmMeasure Group
--

--
--
-- ippmNetMeasureTable
--

ippmNetMeasureTable OBJECT-TYPE
   SYNTAX     SEQUENCE OF IppmNetMeasureEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"A entry is a measurement that performs network measures and provides results.
It performs several metric measurements per packet exchange. Each step of a measure produces a singleton result per metric. The time of the measurement and the value of the metric are saved in the ippmHistoryTable."
::= { ippmMeasure 1 }

ippmNetMeasureEntry OBJECT-TYPE
SYNTAX IppmNetMeasureEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
" Typically the configuration operation sets both the values of the new IppmNetMeasureEntry.
The IppmNetMeasureTable is mandatory.

The IppmNetMeasureTable content is read only. It means that the measurement software handles the table internally. The setup of the network measure is not permitted through the IPPM REPORTING MIB. OWAP provides a setup protocol to enable and teardown networks measures.

The ippmNetMeasureMetrics is set to a list of metrics to be computed from the same raw packet exchange. Each step of measurement delivers a singleton per chosen metric. Results are timestamped and saved in the ippmHistoryTable.

The ippmNetMeasureTable typical usage consists in providing network measure indices in order to allow aggregated measures to perform aggregation on the results of network measures.

INDEX { ippmNetMeasureOwner, ippmNetMeasureIndex }
::= { ippmNetMeasureTable 1 }

IppmNetMeasureEntry ::= SEQUENCE {
ippmNetMeasureOwner IppmOwnerString,
ippmNetMeasureIndex Integer32,
ippmNetMeasureName SnmpAdminString,
ippmNetMeasureMetrics IppmStandardMetrics,
ippmNetMeasureBeginTime GMTTimeStamp,
ippmNetMeasureCollectionRateUnit TimeUnit,
ippmNetMeasureCollectionRate Integer32,
ippmNetMeasureDurationUnit TimeUnit,
ippmNetMeasureDuration Integer32,
ippmNetMeasureHistorySize Integer32,
ippmNetMeasureFailureMgmtMode INTEGER,
ippmNetMeasureResultsMgmt Integer32,
ippmNetMeasureSrcTypeP TypeP,
ippmNetMeasureSrc TypePaddress,
ippmNetMeasureDstTypeP TypeP,
ippmNetMeasureDst TypePaddress,
ippmNetMeasureTxMode Integer32,
ippmNetMeasureTxPacketRateUnit Integer32,
ippmNetMeasureTxPacketRate INTEGER,
ippmNetMeasureDevtnOrBurstSize Integer32,
ippmNetMeasureMedOrIntBurstSize Integer32,
ippmNetMeasureLossTimeout Integer32,
ippmNetMeasureL3PacketSize Integer32,
ippmNetMeasureDataPattern OCTET STRING,
ippmNetMeasureMap SnmpAdminString,
ippmNetMeasureSingletons INTEGER,
ippmNetMeasureOperState INTEGER
}

ippmNetMeasureOwner OBJECT-TYPE
SYNTAX IppmOwnerString
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"The owner of the network measurement."
::= { ippmNetMeasureEntry 1 }

ippmNetMeasureIndex OBJECT-TYPE
SYNTAX Integer32 (1.. 65535)
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"The owner index of the network measure."
::= { ippmNetMeasureEntry 2 }

ippmNetMeasureName OBJECT-TYPE
SYNTAX SnmpAdminString
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The name of the metric instance. It illustrates the specificity of the metric and includes the metric and the TypeP.

Example:
IP-TCP-HTTP-One-way-Delay: free text"
::= { ippmNetMeasureEntry 3 }
ippmNetMeasureMetrics OBJECT-TYPE
SYNTAX IppmStandardMetrics
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"Defines the metrics to compute within this measure. ONLY network metrics of the same type are allowed in this field.
A measure may be configured for the result of different metric singletons to be archived in the ippmHistoryTable. The ippmMetricIndex of the created result has the value of the bit index of the corresponding ippmMeasureMetrics as explained above in the ippmMetricIndex definition.

Example:
A measure asking for One-way-Delay(6) and One-way-Packet-Loss(12) generated a flow of singletons which are logged in the ippmHistoryTable. The singletons created for the One-way-Delay measure have a value of ippmMetricIndex of 6 while the created singletons for the One-way-Packet-Loss measure have a value of ippmMetricIndex of 12.

One measure may perform simultaneously
    either several network metrics
    either several aggregated metrics
"

-- { one-way-Delay, one-way-Packet-Loss }
DEFVAL { \x80000000000010\x80000010 }::= { ippmNetMeasureEntry 4 }
SYNTAX   Integer32
MAX-ACCESS read-only
STATUS   current
DESCRIPTION
    "Gives the period used to collect singletons from the point of
    measures.
    This value is used as the cycle period in the report."
DEFVAL { 60 }
 ::= { ippmNetMeasureEntry 7 }

ippmNetMeasureDurationUnit OBJECT-TYPE
SYNTAX   TimeUnit
MAX-ACCESS read-only
STATUS   current
DESCRIPTION
    "Specifies the measurement duration unit."
DEFVAL { second }
 ::= { ippmNetMeasureEntry 8 }

ippmNetMeasureDuration OBJECT-TYPE
SYNTAX   Integer32
MAX-ACCESS read-only
STATUS   current
DESCRIPTION
    "Specifies the measurement duration."
DEFVAL { 120 }
 ::= { ippmNetMeasureEntry 9 }

ippmNetMeasureHistorySize OBJECT-TYPE
SYNTAX   Integer32
MAX-ACCESS read-only
STATUS   current
DESCRIPTION
    "Specifies the maximum number of results saved for each metric of
    this measure.
    Overflow condition will be managed by the object
    ippmNetMeasureResultsMgmt."

 ::= { ippmNetMeasureEntry 10 }

ippmNetMeasureFailureMgmtMode OBJECT-TYPE
SYNTAX   INTEGER {
    auto(1),
    manual(2),
    discarded(3)
 }
MAX-ACCESS read-only
STATUS   current
DESCRIPTION

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"This object defines whether this row and the measure controlled by this row are kept in volatile storage and lost upon reboot or if this row is backed up by non-volatile or permanent storage.

'auto'
continue the measurement and erase the older entries in the history.

'manual'
continue the measurement and erase the older entries in the history.

'discarded'
continue the measurement and erase the older entries in the history.

Possible values are: other(1), volatile(2), nonVolatile(3), permanent(4)

Network: "
DEFVAL { auto }
::= { ippmNetMeasureEntry 11 }

ippmNetMeasureResultsMgmt OBJECT-TYPE
SYNTAX INTEGER {
  wrap(1),
  suspend(2),
  delete(3)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION "
Action to take when the log is full. The user may choose to either wrap, in which case the agent writes over existing records. The user may choose to suspend writing to the log in the event that he wishes to archive the data. The resume action causes the agent to begin to write in the log, and assumes the data has been cleared.

This object indicates the way the measurement results are managed when the owner quota has been exceeded:

'wrap'
continue the measurement and erase the older entries in the history.

'suspend'
stop the measure and keep the results in the history.

'delete'
remove the results from the history.

":= { ippmNetMeasureEntry 12 }

ippmNetMeasureSrcTypeP OBJECT-TYPE
SYNTAX TypeP
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"Defines the type P of the source address of the packets sent by
the measure."
DEFVAL { "ip" }
::= { ippmNetMeasureEntry 13 }

ippmNetMeasureSrc OBJECT-TYPE
SYNTAX TypePaddress
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"Specifies the address of the source of the measure.
It is represented as a list of parameters corresponding to those
of the PROTOCOL IDENTIFIER sets in ippmNetMeasureSrcTypeP."
::= { ippmNetMeasureEntry 14 }

ippmNetMeasureDstTypeP OBJECT-TYPE
SYNTAX TypeP
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"Defines the type P of the destination address of the packets
sent by the measure."
DEFVAL { "ip" }
::= { ippmNetMeasureEntry 15 }

ippmNetMeasureDst OBJECT-TYPE
SYNTAX TypePaddress
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"Specifies the address of the destination of the measure.
It is represented as a list of parameters corresponding to those
of the PROTOCOL IDENTIFIER set in ippmNetMeasureDstTypeP."
::= { ippmNetMeasureEntry 16 }

ippmNetMeasureTxMode OBJECT-TYPE
SYNTAX INTEGER {
  other(0),
  periodic(1),
  poisson(2),
  multiburst(3)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The transmit mode used to send the packets:
'other'
   The rule used to send the packets is unknown.
'periodic'
   Packets are sent periodically at ippmNetMeasureTxPacketRate rate.
'poisson'
   Packets are sent using a Poisson law, the median is the value of ippmNetMeasureMedOrIntBurstSize, the deviation is ippmNetMeasureDevtnOrBurstSize.
'multiburst'
   Packets are sent bursty at ippmNetMeasureTxPacketRate. The size of the burst is made of ippmNetMeasureDevtnOrBurstSize packets.
   Between 2 consecutive bursts, transmission stops during the time needed to send ippmNetMeasureInterBurstPacketsNb.

::= { ippmNetMeasureEntry 17 }

ippmNetMeasureTxPacketRateUnit OBJECT-TYPE
SYNTAX   TimeUnit
MAX-ACCESS read-only
STATUS    current
DESCRIPTION
   "The packet rate unit used to send the packets."
::= { ippmNetMeasureEntry 18 }

ippmNetMeasureTxPacketRate OBJECT-TYPE
SYNTAX   Integer32
MAX-ACCESS read-only
STATUS    current
DESCRIPTION
   "The rate the packets are sent."
::= { ippmNetMeasureEntry 19 }

ippmNetMeasureDevtnOrBurstSize OBJECT-TYPE
SYNTAX   Integer32
MAX-ACCESS read-only
STATUS    current
DESCRIPTION
   "Indicates the average number of packets per seconds sent using a poisson law.

ippmNetMeasurePoissonRate can not be used conjointly with ippmNetMeasureClockPattern."
DEFVAL { 30 }
::= { ippmNetMeasureEntry 20 }

ippmNetMeasureMedOrIntBurstSize OBJECT-TYPE

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SYNTAX    Integer32
MAX-ACCESS read-only
STATUS     current
DESCRIPTION  
"According to the transmit mode, this value indicates the average number of packets per seconds sent using a poisson law, or the number of packets to wait between consecutive bursts."
DEFVAL { 30 }
 ::= { ippmNetMeasureEntry 21 }

ippmNetMeasureLossTimeout OBJECT-TYPE
SYNTAX    Integer32
MAX-ACCESS read-only
STATUS     current
-- UNITS     "Milliseconds"
DESCRIPTION  
"Specifies the delay after which the packet is considered lost by the sink."
DEFVAL { 10 }
 ::= { ippmNetMeasureEntry 22 }

ippmNetMeasureL3PacketSize OBJECT-TYPE
SYNTAX    Integer32
MAX-ACCESS read-only
STATUS     current
DESCRIPTION  
"Specifies the size of the packets counted at the IP network layer in regards to the TypeP definition.

Example: For a TypeP 'ip ipip4' the L3 size will be the size of the packet at ipip4 level.
"
DEFVAL { 64 }
 ::= { ippmNetMeasureEntry 23 }

ippmNetMeasureDataPattern OBJECT-TYPE
SYNTAX    OCTET STRING
MAX-ACCESS read-only
STATUS     current
DESCRIPTION  
"The pattern used to fill the payload of the packet."
DEFVAL { 'FF'H }
 ::= { ippmNetMeasureEntry 24 }

ippmNetMeasureMap OBJECT-TYPE
SYNTAX    SnmpAdminString
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"A administrative name of a network management map to which the measure
belongs."
DEFVAL { "" }
::= { ippmNetMeasureEntry 25 }

ippmNetMeasureSingletons OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"Reports the number of singletons performed per metric by the
measure since the beginning of the measure. This parameters is
required for aggregation."
::= { ippmNetMeasureEntry 26 }

ippmNetMeasureOperState OBJECT-TYPE
SYNTAX INTEGER {
    unknown(0),
    running(1),
    stopped(2)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"Reports the operational status of the network measure."
::= { ippmNetMeasureEntry 27 }

--
--
-- ippmAggrMeasureTable
--
--

ippmAggrMeasureTable OBJECT-TYPE
SYNTAX SEQUENCE OF IppmAggrMeasureEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"An aggregated measure summarizes the results of previous
network or aggregated measures. The results may be saved in the
ippmHistoryTable."
Each step of the calculation for the measure produces a singleton result per metric.

```plaintext
::= { ippmMeasure 2 }
```

**ippmAggrMeasureEntry OBJECT-TYPE**

SYNTAX  IppmAggrMeasureEntry

MAX-ACCESS not-accessible

STATUS     current

DESCRIPTION

"Typically the configuration operation sets the value of the IppmAggrMeasureEntry.

The ippmAggrMeasureTable is mandatory.

The ippmAggrMeasureMetrics defines the metric to compute. The results of the measure to summarize are identified by:

+ ippmAggrMeasureHistoryOwner,
+ ippmAggrMeasureHistoryOwnerIndex and
+ ippmAggrMeasureHistoryMetric

The aggregated task starts at ippmMeasureBeginTime and ends after ippmMeasureDuration. An aggregated result is performed and saved in the ippmHistoryTable for each ippmMeasureCollectionRate tick.

```
INDEX { ippmAggrMeasureOwner, ippmAggrMeasureIndex }
::= { ippmAggrMeasureTable 1 }
```

**IppmAggrMeasureEntry ::= SEQUENCE {**

<table>
<thead>
<tr>
<th>Field</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>ippmAggrMeasureOwner</td>
<td>IppmOwnerString,</td>
</tr>
<tr>
<td>ippmAggrMeasureIndex</td>
<td>Integer32,</td>
</tr>
<tr>
<td>ippmAggrMeasureName</td>
<td>SnmpAdminString,</td>
</tr>
<tr>
<td>ippmAggrMeasureMetrics</td>
<td>IppmStandardMetrics,</td>
</tr>
<tr>
<td>ippmAggrMeasureBeginTime</td>
<td>GMTTimeStamp,</td>
</tr>
<tr>
<td>ippmAggrMeasureAggrPeriodUnit</td>
<td>TimeUnit,</td>
</tr>
<tr>
<td>ippmAggrMeasureAggrPeriod</td>
<td>Integer32,</td>
</tr>
<tr>
<td>ippmAggrMeasureDurationUnit</td>
<td>TimeUnit,</td>
</tr>
<tr>
<td>ippmAggrMeasureDuration</td>
<td>Integer32,</td>
</tr>
<tr>
<td>ippmAggrMeasureHistorySize</td>
<td>Integer32,</td>
</tr>
<tr>
<td>ippmAggrMeasureStorageType</td>
<td>StorageType,</td>
</tr>
<tr>
<td>ippmAggrMeasureHistoryOwner</td>
<td>IppmOwnerString,</td>
</tr>
<tr>
<td>ippmAggrMeasureHistoryOwnerIndex</td>
<td>Integer32,</td>
</tr>
<tr>
<td>ippmAggrMeasureHistoryMetric</td>
<td>Integer32,</td>
</tr>
<tr>
<td>ippmAggrMeasureAdminState</td>
<td>Integer32,</td>
</tr>
<tr>
<td>ippmAggrMeasureFastReport</td>
<td>OBJECT IDENTIFIER,</td>
</tr>
<tr>
<td>ippmAggrMeasureMap</td>
<td>SnmpAdminString,</td>
</tr>
<tr>
<td>ippmAggrMeasureResultsMgmt</td>
<td>Integer32,</td>
</tr>
<tr>
<td>ippmAggrMeasureStatus</td>
<td>RowStatus</td>
</tr>
</tbody>
</table>

**}**
ippmAggrMeasureOwner OBJECT-TYPE
SYNTAX IppmOwnerString
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"The owner who has configured this entry."
 ::= { ippmAggrMeasureEntry 1 }

ippmAggrMeasureIndex OBJECT-TYPE
SYNTAX Integer32 (1..65535)
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"The owner index of the measure. The value is managed by the owner."
 ::= { ippmAggrMeasureEntry 2 }

ippmAggrMeasureName OBJECT-TYPE
SYNTAX SnmpAdminString
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"The name of the instance of the metric. It illustrates the specificity of the metric and includes the metric and the type.
example: IP-port-HTTP-connectivity"
 ::= { ippmAggrMeasureEntry 3 }

ippmAggrMeasureMetrics OBJECT-TYPE
SYNTAX IppmStandardMetrics
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"Defines the metrics to compute within this aggregated measure.
ONLY aggregated metrics of the same type are allowed in this field.
A measure may be configured for the result of different metric singletons to be archived in the ippmHistoryTable. The ippmMetricIndex of the created result has the value of the bit index of the corresponding ippmAggrMeasureMetrics as explained above in the ippmMetricIndex definition.
Example:
A measure asking for One-way-Delay(6) and One-way-Packet-Loss(12) generated a flow of singletons which are logged in the ippmHistoryTable. The singletons created for the One-way-Delay measure have a value of ippmMetricIndex of 6 while the created..."
singletons for the One-way-Packet-Loss measure have a value of ippmMetricIndex of 12.

::= { ippmAggrMeasureEntry 4 }

ippmAggrMeasureBeginTime OBJECT-TYPE
SYNTAX GMTTimeStamp
MAX-ACCESS read-create
STATUS current
DESCRIPTION "Specifies the time at which the aggregated measure starts."
::= { ippmAggrMeasureEntry 5 }

ippmAggrMeasureAggrPeriodUnit OBJECT-TYPE
SYNTAX TimeUnit
MAX-ACCESS read-create
STATUS current
DESCRIPTION "Specifies the unit of the aggregated measure period."
DEFVAL { second }
::= { ippmAggrMeasureEntry 6 }

ippmAggrMeasureAggrPeriod OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-create
STATUS current
DESCRIPTION "Specifies the amount of time between 2 measurement action intervals. The action is specific to the semantic of the measure."

Network metrics:

The ippmNetMeasureClockPattern transforms the flow of periodical instants as a flow of unpredictable instants of measurement packet emission.

As the source and the sink share the definition of the clock of the measure, as the sending timestamp is part of the measurement packet, the sink have the information to verify that the stream of packets generated by the source respects the clock law.

Aggregated metrics:

They are performed periodically on a sequence of results of other measures. The period corresponds to the interval between two successive computations of the metric. The value of ippmHistoryTimestamp result of a aggregated metric computed corresponds to the value of the ippmHistoryTimestamp of the last
metric result of the sequence used in to compute the aggregated metric."
DEFVAL { 60 }
::= { ippmAggrMeasureEntry 7 }

ippmAggrMeasureDurationUnit OBJECT-TYPE
SYNTAX TimeUnit
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"Specifies the unit of the measure duration."
DEFVAL { second }
::= { ippmAggrMeasureEntry 8 }

ippmAggrMeasureDuration OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"Specifies the duration of the measure."
DEFVAL { 120 }
::= { ippmAggrMeasureEntry 9 }

ippmAggrMeasureHistorySize OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"Specifies the maximum number of results saved for each metric of
this measure. Overflow condition will be managed by the object
ippmAggrMeasureResultsMgmt."
::= { ippmAggrMeasureEntry 10 }

ippmAggrMeasureStorageType OBJECT-TYPE
SYNTAX StorageType
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"This object defines whether this row and the measure controlled
by this row are kept in volatile storage and lost upon reboot or
if this row is backed up
by non-volatile or permanent storage.
Possible values are: other(1), volatile(2), nonVolatil(3),
permanent(4), readOnly(5)."
DEFVAL { nonVolatil }
::= { ippmAggrMeasureEntry 11 }

ippmAggrMeasureResultsMgmt OBJECT-TYPE
SYNTAX INTEGER {
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wrap(1),
suspend(2)
}
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"This object displays the way the history of the aggregated measure is managed.
'wrap'
continue the measure and erase the older entries in the history.
'suspend'
stop the measure and keep the results in the history.
"
DEFVAL { wrap }
::= { ippAggrMeasureEntry 12 }

ippAggrMeasureHistoryOwner OBJECT-TYPE
SYNTAX IppmOwnerString
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"The owner of the measure to summarize."
::= { ippAggrMeasureEntry 13 }

ippAggrMeasureHistoryOwnerIndex OBJECT-TYPE
SYNTAX Integer32 (1.. 65535)
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"The owner index of the measure to summarize."
::= { ippAggrMeasureEntry 14 }

ippAggrMeasureHistoryMetric OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"The metric of the measure to summarize."
::= { ippAggrMeasureEntry 15 }

ippAggrMeasureAdminState OBJECT-TYPE
SYNTAX INTEGER {
    start(0),
    stop(1)
}
MAX-ACCESS read-create
STATUS current
DESCRIPTION
  "This object controls the activity of the aggregated measure.
  'start'
    The aggregated measure is started.
  'stop'
    The aggregated measure is stopped.
  
  ::= { ippmAggrMeasureEntry 16 }

ippmAggrMeasureFastReport OBJECT-TYPE
SYNTAX     OBJECT IDENTIFIER
MAX-ACCESS read-create
STATUS     current
DESCRIPTION
  "A fast report is required in order to verify quickly that a
  measure is running well.
The feature 'fast report' is active if IppmAggrMeasureFastReport
is not null and points to a notification.
A fast report consists of sending by email to the owner of the
measure, a table of the results of all the metrics computed by
this aggregated measure. The owner email address is read from the
ippmOwnersTable.

  ippmAggrMeasureFastReport identifies the notification which
  defines the header of the report.

  The results part of the report is made of the a column of results
  per metrics. Results are separated using commas.

  To avoid disaster, an aggregated measure using a fast report must
  have a cycle of aggregation greater than or equal to 1 second and
  should not sent more than an email every 5 minutes and should not
  sent more than 12 emails."
-- DEFVAL { 0.0 }
 ::= { ippmAggrMeasureEntry 17 }

ippmAggrMeasureMap OBJECT-TYPE
SYNTAX     SnmpAdminString
MAX-ACCESS read-create
STATUS     current
DESCRIPTION
  "This object allows for classification of the measure. It is
  typically the name of an administrative map.
  
  DEFVAL { "" }
 ::= { ippmAggrMeasureEntry 18 }
ippmAggrMeasureStatus OBJECT-TYPE
SYNTAX RowStatus
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"The status of this table entry. Once the entry status is set to active, the associate entry cannot be modified.
The creation of an aggregated measure forced the creation of the corresponding entry in ippmMeasureTable."
 ::= { ippmAggrMeasureEntry 19 }

--
-- ippmReport  Group
--

ippmReportPathToResults OBJECT-TYPE
SYNTAX SnmpAdminString
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"It is typically an URL describing the file location where the results are logged."
 ::= { ippmReport 1 }

--
--
-- ippmReportSetupTable
--

ippmReportSetupTable OBJECT-TYPE
SYNTAX SEQUENCE OF IppmReportSetupEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"The ippmReportSetupTable is a list of definition of reports. It defines the results of network or aggregated measures that are to be reported. A report is saved in the ippmReportTable, or sent to an application using a SNMP Trap, a SNMP inform PDU, an email, or a SMS. The reporting task is not intended to be a batch action processed at the end of the measure. It is coupled with threshold detections and event filtering to deliver application level events and data, while preserving scalability.
"
 ::= { ippmReport 2 }

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ippmReportSetupEntry OBJECT-TYPE
SYNTAX  IppmReportSetupEntry
MAX-ACCESS not-accessible
STATUS   current
DESCRIPTION
"The report applies to the results of a measure as defined in
either the network measure table, or the aggregated measure
table.

The ippmReportSetupDefinition describes the data and the events
to include in the report. The definition consists of a list of
tasks to perform on the results of the measure.

A report is associated to a network measure or to an aggregated
measure.

Note 1: To associate a report to an existing measure the manager
suspends the measure by setting either the ippmNetMeasureStatus
or the ippmAggrMeasureStatus to 'notInService'. Then one sets the
report fields and activates the measure by setting the
corresponding MeasureStatus to 'active'.

Note 2: A report is tied to a measure. The period of the measure"
INDEX { ippmReportSetupOwner, ippmReportSetupIndex }
 ::= { ippmReportSetupTable 1 }

IppmReportSetupEntry ::= SEQUENCE {
   ippmReportSetupOwner                  IppmOwnerString,
   ippmReportSetupIndex                  Integer32,
   ippmReportSetupMeasureOwner           IppmOwnerString,
   ippmReportSetupMeasureIndex           Integer32,
   ippmReportSetupMeasureMetric          Integer32,
   ippmReportSetupDefinition             IppmReportDefinition,
   ippmReportSetupUpDownThreshold        Integer32,
   ippmReportSetupLowThreshold           Integer32,
   ippmReportSetupHighThreshold          Integer32,
   ippmReportSetupDurationThresUnit       TimeUnit,
   ippmReportSetupDurationThreshold      Integer32,
   ippmReportSetupReportSize             Integer32,
   ippmReportSetupResultsMgmt            Integer32,
   ippmReportSetupNMS                    SnmpAdminString,
   ippmReportSetupNotification           OBJECT IDENTIFIER,
   ippmReportSetupMap                    SnmpAdminString,
   ippmReportSetupStatus                 RowStatus
}

ippmReportSetupOwner OBJECT-TYPE
SYNTAX  IppmOwnerString
MAX-ACCESS not-accessible
STATUS          current
DESCRIPTION   "The owner who has configured this report entry."
::= { ippmReportSetupEntry 1 }

ippmReportSetupIndex OBJECT-TYPE
SYNTAX     Integer32 (1.. 65535)
MAX-ACCESS not-accessible
STATUS          current
DESCRIPTION   "The owner index of the report entry. The value is managed by the
owner."
::= { ippmReportSetupEntry 2 }

ippmReportSetupMeasureOwner OBJECT-TYPE
SYNTAX     IppmOwnerString
MAX-ACCESS read-create
STATUS          current
DESCRIPTION   "The owner of the measure to report."
::= { ippmReportSetupEntry 3 }

ippmReportSetupMeasureIndex OBJECT-TYPE
SYNTAX     Integer32 (1.. 65535)
MAX-ACCESS read-create
STATUS          current
DESCRIPTION   "The index of the measure to report."
::= { ippmReportSetupEntry 4 }

ippmReportSetupMeasureMetric OBJECT-TYPE
SYNTAX     Integer32 (1.. 65535)
MAX-ACCESS read-create
STATUS          current
DESCRIPTION   "The metric of the measure to report."
::= { ippmReportSetupEntry 5 }

ippmReportSetupDefinition OBJECT-TYPE
SYNTAX     IppmReportDefinition
MAX-ACCESS read-create
STATUS          current
DESCRIPTION   "In order to properly define a report, one must provide
information to:
   + Select the events to consider for reporting;
   + Configure filters to select pertinent values;
   + Describe the way the report is delivered;
   + Describe clean up actions to perform on report completion;"
The format of a report sent to a NMS is described in a notification defined in the ippmNotifications node.

The event and the filter selected in the report definition determines the notification to refer:
+ Up and Down filter report format is ippmUpAndDownReport;
+ Inband filter report format is ippmInBandReport;
+ Outband filter report format is ippmOutBandReport;
+ Above filter report format is ippmAboveReport;
+ Below filter report format is ippmBelowReport;
+ Any filter and reportExceededEventsDuration report format is ippmEventsDurationExceededReport;
+ Any filter and the event onMeasureCompletion report format is ippmCompletedMeasureReport;

Example 1:
Consider a report definition, which reports on the fly, up and down result events of a metric measure:

`ippmReportSetupDefinition {
  onSingleton,
  reportUpAndDownMetricResults,
  inSNMPv2TrapPDU
}

The value of the threshold is given by ippmReportSetupUpDownThreshold. It has the value '5' in this example.

Being a flow of results { 3.3 3.2 3.2 5.1 5.3 5.6 6.3 5.2 4.0 3.8 ... }, the report process will send 2 traps:
+ The first one carries the results 3.2 and 5.1 corresponding to a down to up event;
+ The second one carries the results 5.2 and 4.0 of the up to down event

Example 2:
Consider the report definition, which reports per measure cycle in a SNMP informRequestPDU, up and down results events of a metric measure:

`ippmReportSetupDefinition {
  onMeasureCycle,
  reportUpAndDownMetricResults,
  inInformRequestPDU,
  onReportDeliveryClearReport
}`
The value of the threshold is given by ippmReportSetupUpDownThreshold. It has the value ‘5’ in this example.

The cycle of measure of the measure setup is set to 10 results.

Being a flow of 10 results { 3.3 3.2 3.2 5.1 5.3 5.6 6.3 5.2 4.0 3.8 ... }, the report process will send one InformRequestPDU that carries the couples (3.2, 5.1) and (5.2 ,4.0) corresponding to the first down to up event and to the second up to down event, respectively.

::= { ippmReportSetupEntry 6 }

ippmReportSetupUpDownThreshold OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"An event is generated when the result of the measure exceeds the value of ippmReportSetupMetricThreshold. The threshold has the same unit as the metric. The metric unit is recorded in the object ippmMetricsUnit of this metric entry in the ippmMetricTable."

::= { ippmReportSetupEntry 7 }

ippmReportSetupLowThreshold OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"An event is generated when the result of the measure of the metric is lower that the value of ippmReportSetupLowThreshold. The threshold has the same unit as the metric. The metric unit is recorded in the object ippmMetricsUnit of this metric entry in the ippmMetricTable."

::= { ippmReportSetupEntry 8 }

ippmReportSetupHighThreshold OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"An event is generated when the result of the measure of the metric exceeds the value of ippmReportSetupHighThreshold."
The threshold has the same unit as the metric. The metric unit is recorded in the object ippmMetricsUnit of this metric entry in the ippmMetricTable.

::= { ippmReportSetupEntry 9 }

ippmReportSetupDurationThresUnit OBJECT-TYPE
SYNTAX TimeUnit
MAX-ACCESS read-create
STATUS current
DESCRIPTION "The unit of the duration threshold."
::= { ippmReportSetupEntry 10 }

ippmReportSetupDurationThreshold OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-create
STATUS current
DESCRIPTION "An event is generated when contiguous results of the measure are over the ippmReportSetupUpDownThreshold, during ippmReportSetupDurationThreshold seconds.

Performance:
To improve the performance of the system, the report process may be synchronized with the cycle of collection of network measure or with the period of aggregation of an aggregate measure."

DEFVAL { 15 }
::= { ippmReportSetupEntry 11 }

ippmReportSetupReportSize OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-create
STATUS current
DESCRIPTION "Specifies the maximum number of results saved for each metric of this measure. The history of each metric is managed as a circular table. The newest result overwrites the oldest one when the history granted to this metric measure is full.

The management of the results may be optimized if synchronized with the reports steps of this measure."
::= { ippmReportSetupEntry 12 }

ippmReportSetupResultsMgmt OBJECT-TYPE
SYNTAX INTEGER { wrap(1), suspend(2),

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delete(3)
}
MAX-ACCESS read-create
STATUS current
DESCRIPTION

Action to take when the report log is full. The user may choose
to either wrap, in which case the agent writes over existing
records. The user may choose to suspend writing to the log in the
event that he wishes to archive the data. The resume action
causes the agent to begin to write in the report log, and assumes
the data has been cleared
This object indicates the way the measure results are managed
when the owner quota is over:
'wrap'
    continue the measure and erase the older entries in the
    history.
'suspend'
    stop the measure and keep the results in the history.
'delete'
    remove the results from the history.

::= { ippmReportSetupEntry 13 }

ippmReportSetupNMS OBJECT-TYPE
SYNTAX SnmpAdminString
MAX-ACCESS read-create
STATUS current
DESCRIPTION

"The recipient of the report may be provided in the setup. By
default the recipient of the report is the owner of the measure.
Its addresses are recorded in the ippmOwnersTable.
The type of ippmReportSetupNMS is not InetAddress because the
report may be sent using SMS or fax."

::= { ippmReportSetupEntry 14 }

ippmReportSetupNotification OBJECT-TYPE
SYNTAX OBJECT IDENTIFIER
MAX-ACCESS read-create
STATUS current
DESCRIPTION

"Even though the notification to use is defined in the report
definition, the object ippmReportSetupNotification provides
flexibility to select another notification."

-- DEFVAL { 0.0 }
::= { ippmReportSetupEntry 15 }

ippmReportSetupMap OBJECT-TYPE
SYNTAX SnmpAdminString
MAX-ACCESS read-create
STATUS current
DESCRIPTION
   "An administrative name of a map to which the report belongs."
DEFVAL { "" }
 ::= { ippmReportSetupEntry 16 }

ippmReportSetupStatus OBJECT-TYPE
SYNTAX RowStatus
MAX-ACCESS read-create
STATUS current
DESCRIPTION
   "The status of this table entry."
 ::= { ippmReportSetupEntry 17 }

--
-- ippmReportTable
--

ippmReportTable OBJECT-TYPE
SYNTAX SEQUENCE OF IppmReportEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
   "The ippmReportTable logs the results of the reports. The results
   consist of a subset of the results of a measure as described in
   the report definition. The activation of an up and down filtering
   in the report definition limits the results logged to those
   corresponding to major events. Otherwise, the ippmReportTable is
   identical to the ippmHistoryTable."
 ::= { ippmReport 3 }

ippmReportEntry OBJECT-TYPE
SYNTAX IppmReportEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
   "A report is a list of results of a measure. This sample is
   associated with the ippmReportSetupEntry which has set up the
report. An ippmReportEntry entry is one of the results of a measure to report.

An ippmReportEntry entry is one of the results of a measure identified by ippmReportMeasureOwner, ippmReportMeasureIndex, ippmReportMetricIndex and ippmReportIndex.

In the index:

+ ippmReportMeasureOwner identifies the owner of the measure;
+ ippmReportMeasureIndex identifies the measure in the owner namespace;
+ ippmReportMetricIndex identifies the metric measured in ippmMetricTable;
+ ippmReportIndex is the local index of the result on the report table."

INDEX { ippmReportMeasureOwner, ippmReportMeasureIndex, ippmReportMetricIndex, ippmReportIndex }
::= { ippmReportTable 1 }

IppmReportEntry ::= 
SEQUENCE {
  ippmReportMeasureOwner      IppmOwnerString,  
  ippmReportMeasureIndex      Integer32,  
  ippmReportMetricIndex       Integer32,  
  ippmReportIndex             Integer32,  
  ippmReportSequence          Integer32,  
  ippmReportTimestamp         GMTTimeStamp,  
  ippmReportValue             Integer32
}

ippmReportMeasureOwner OBJECT-TYPE
SYNTAX     IppmOwnerString
MAX-ACCESS not-accessible
STATUS     current
DESCRIPTION
  "The owner of the measure that produced this result."
::= { ippmReportEntry 1 }

ippmReportMeasureIndex OBJECT-TYPE
SYNTAX Integer32 (1.. 65535)
MAX-ACCESS not-accessible
STATUS     current
DESCRIPTION
  " The owner index of the measure that produced this result."
::= { ippmReportEntry 2 }

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[Page 61]
ippmReportMetricIndex OBJECT-TYPE
SYNTAX Integer32 (1.. 65535)
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
" ippmReportMetricIndex identifies the metric measured by the
measure. The metric is described in the corresponding entry of
the ippmMetricTable."
::= { ippmReportEntry 3 }

ippmReportIndex OBJECT-TYPE
SYNTAX Integer32 (1.. 65535)
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"The local index of the result of a metric measure"
::= { ippmReportEntry 4 }

ippmReportSequence OBJECT-TYPE
SYNTAX Integer32 (0.. 65535)
MAX-ACCESS read-only
STATUS current
DESCRIPTION
" ippmReportSequence is the sequence index of the measurement
results of the measure of a metric.

Network metrics:
It’s the sequence index of a measurement packet. Typically, it
identifies the order of the packet in the stream of packets sends
by the source.

Aggregated metrics:
It is the sequence index of the aggregated metric results
computed."
::= { ippmReportEntry 5 }

ippmReportTimestamp OBJECT-TYPE
SYNTAX GMTTimeStamp
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The instant of the measure of the result."
::= { ippmReportEntry 6 }

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ippmReportValue OBJECT-TYPE
   SYNTAX Integer32
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      "The value."
   ::= { ippmReportEntry 7 }

--
-- IPPM Notifications
--

ippmUpAndDownReport NOTIFICATION-TYPE
   OBJECTS
      
   ippmReportSetupDefinition,  
   ippmMetricType,  
   ippmMetricUnit,  
   ippmMetricDescription,  
   ippmHistoryTimestamp,  
   ippmHistorySequence,  
   ippmHistoryValue,  
   ippmReportPathToResults
   }  
   STATUS current  
   DESCRIPTION  
      "A notification sent because 2 contiguous results are on opposite  
      sides of the metric threshold value.  
      The notification contains the instances of the ippmHistoryValue  
      object that exceeded the threshold.  
      The notification contains the instances of the  
      ippmHistoryTimestamp identifying the time the event occurred.  
      ippmReportPathToResults is a link to the file name, which  
      contains detailed results corresponding to this event."
   ::= { ippmNotifications 1 }

ippmInBandReport NOTIFICATION-TYPE
   OBJECTS
      
   ippmReportSetupDefinition,  
   ippmMetricType,  
   ippmMetricUnit,  
   ippmMetricDescription,  
   ippmHistoryTimestamp,  
   ippmHistorySequence,  
   ippmHistoryValue,  
   ippmReportPathToResults
   }  
   STATUS current  

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DESCRIPTION
"A notification sent because the value of the measure is under the high threshold value and greater than the low threshold value.
The notification contains the instances of the ippmHistoryValue object that exceeded the threshold.
The notification contains the instances of the ippmHistoryTimestamp identifying the time the event occurred.
ippmReportPathToResults is a link to the file name, which contains detailed results corresponding to this event."
 ::= { ippmNotifications 2 }

ippmOutBandReport NOTIFICATION-TYPE
OBJECTS {
  ippmReportSetupDefinition,
  ippmMetricType,
  ippmMetricUnit,
  ippmMetricDescription,
  ippmHistoryTimestamp,
  ippmHistorySequence,
  ippmHistoryValue,
  ippmReportPathToResults
}
STATUS current

DESCRIPTION
"A notification sent because the result of the measure is either greater than the high threshold or lower than the low threshold. The notification contains the instances of the ippmHistoryValue object that exceeded the threshold.
The notification contains the instances of the ippmHistoryTimestamp identifying the time the event occurred.
ippmReportPathToResults is a link to the file name, which contains detailed results corresponding to this event."
 ::= { ippmNotifications 3 }

ippmAboveReport NOTIFICATION-TYPE
OBJECTS {
  ippmReportSetupDefinition,
  ippmMetricType,
  ippmMetricUnit,
  ippmMetricDescription,
  ippmHistoryTimestamp,
  ippmHistorySequence,
  ippmHistoryValue,
  ippmReportPathToResults
}
STATUS current

DESCRIPTION
"The notification contains the instances of the ippmHistoryValue object that exceeded the threshold."
The notification contains the instances of the ippmReportPathToResults object that exceeded the threshold. The notification contains the instances of the ippmHistoryTimestamp identifying the time the event occurred. ippmReportPathToResults is a link to the file name, which contains detailed results corresponding to this event.

::= { ippmNotifications 4 }

ippmBelowReport NOTIFICATION-TYPE
OBJECTS {
  ippmReportSetupDefinition, ippmMetricType, ippmMetricUnit, ippmMetricDescription, ippmHistoryTimestamp, ippmHistorySequence, ippmHistoryValue, ippmReportPathToResults
}
STATUS current
DESCRIPTION "The notification contains the instances of the ippmHistoryValue object that exceeded the threshold. The notification contains the instances of the ippmHistoryTimestamp identifying the time the event occurred. ippmReportPathToResults is a link to the file name, which contains detailed results corresponding to this event."

::= { ippmNotifications 5 }

ippmEventsDurationExceededReport NOTIFICATION-TYPE
OBJECTS {
  ippmReportSetupDefinition, ippmMetricType, ippmMetricUnit, ippmMetricDescription, ippmHistoryTimestamp, ippmHistorySequence, ippmHistoryValue
}
STATUS current
DESCRIPTION "A notification sent when the duration of continuously rising metric threshold exceeds the ippmReportSetupDurationThreshold value.

The notification contains the instances of the ippmReportValue object that exceeded the threshold."
The notification contains the instances of the ippmReportTimestamp identifying the time the event occurred. ippmReportPathToResults is a link to the file name, which contains detailed results corresponding to this event.

::= { ippmNotifications 6 }

ippmCompletedMeasureReport NOTIFICATION-TYPE
OBJECTS
  {
    ippmReportSetupDefinition, ippmMetricType, ippmMetricUnit, ippmMetricDescription, ippmHistoryTimestamp, ippmHistorySequence, ippmHistoryValue, ippmReportPathToResults
  }

STATUS current

DESCRIPTION
"A notification sent when a measure completes. The index of the included ippmReportSetupDefinition object identifies the ippmMeasureEntry and the ippmResultSetupEntry that specified the report.

ippmReportPathToResults is a link to the file name, which contains the results of this measure cycle."

::= { ippmNotifications 7 }

ippmAggrMeasureHistoryFull NOTIFICATION-TYPE
OBJECTS
  {
    ippmAggrMeasureName, ippmMetricType, ippmMetricUnit, ippmMetricDescription, ippmHistoryTimestamp, ippmHistorySequence, ippmHistoryValue
  }

STATUS current

DESCRIPTION
"A notification sent when the size of the history of a metric of an aggregated measure exceeds ippmAggrMeasureHistorySize. The agent will then manage the reports according to the policy described in ippmAggrMeasureResultsMgmt."

::= { ippmNotifications 8 }

ippmNetMeasureHistoryFull NOTIFICATION-TYPE
OBJECTS
ippmNetMeasureName,
ippmMetricType,
ippmMetricUnit,
ippmMetricDescription,
ippmHistoryTimestamp,
ippmHistorySequence,
ippmHistoryValue

}  
STATUS current  
DESCRIPTION "A notification sent when the size of the history of a metric of a network measure exceeded ippmNetMeasureHistorySize. Then the agent manages the records according to the policy described in ippmNetMeasureResultsMgmt."
::= { ippmNotifications 9 }

ippmReportLogFull NOTIFICATION-TYPE
OBJECTS {
   -- iIppmReportMetricIndex, 
   ippmReportSetupResultsMgmt, 
   ippmReportTimestamp, 
   ippmReportSequence, 
   ippmReportValue
}
STATUS current  
DESCRIPTION "A notification sent when the size of the report of a metric of a measure exceeded ippmReportSetupReportSize. Then the agent manages the reports according to the policy described in ippmReportSetupResultsMgmt."
::= { ippmNotifications 10 }

--  
-- IPPM MIB Conformance statements
--  
ippmCompliances OBJECT IDENTIFIER ::= { ippmConformance 1 }

ippmGroups OBJECT IDENTIFIER ::= { ippmConformance 2 }

ippmProxyInterDomainCompliances MODULE-COMPLIANCE
STATUS current  
DESCRIPTION "The compliance statement for SNMP entities which implement the IPPM MIB as a proxy in interdomain. The implementation of the VACM control is mandatory."

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MODULE -- this module
MANDATORY-GROUPS {
    ippmSystemGroup, ippmNetMeasureGroup, ippmHistoryGroup,
    ippmAggrMeasureGroup, ippmReportGroup, ippmNotificationGroup
}
::= { ippmCompliances 1 }

ippmProxyCompliances MODULE-COMPLIANCE
STATUS current
DESCRIPTION
"The compliance statement for SNMP entities which implement the
IPPM MIB as a proxy."
MODULE -- this module
MANDATORY-GROUPS {
    ippmSystemGroup, ippmNetMeasureGroup, ippmHistoryGroup,
    ippmAggrMeasureGroup, ippmReportGroup, ippmNotificationGroup
}
GROUP ippmOwnersGroup
DESCRIPTION
"The ippmOwnersGroup is needed if VACM is not implemented."
::= { ippmCompliances 2 }

ippmProbeCompliances MODULE-COMPLIANCE
STATUS current
DESCRIPTION
"The compliance statement for SNMP entities which implement the
IPPM MIB in a probe."
MODULE -- this module
MANDATORY-GROUPS {
    ippmSystemGroup, ippmNetMeasureGroup, ippmHistoryGroup
}
::= { ippmCompliances 3 }

ippmSystemGroup OBJECT-GROUP
OBJECTS {
    ippmSystemSynchronizationDesc, ippmSystemTime,
    ippmSystemSynchronizationType, ippmSystemClockResolution,
    ippmSynchronizationTime, ippmSynchronizationStratum,
    ippmSynchronizationResolution, ippmPointOfMeasureMgmtAddrType,
    ippmPointOfMeasureMgmtAddress, ippmPointOfMeasureTypePAddress,
    ippmPointOfMeasureAddress, ippmSystemOperationalStatus,
    ippmPointOfMeasureMetrics,
ippmMetricCapabilities,
ippmMetricType,
ippmMetricUnit,
ippmMetricDescription
}
STATUS current
DESCRIPTION
"The IPPM System Group"
::= { ippmGroups 1}

ippmNetMeasureGroup OBJECT-GROUP
OBJECTS {
  ippmNetMeasureName,
  ippmNetMeasureMetrics,
  ippmNetMeasureBeginTime,
  ippmNetMeasureCollectionRateUnit,
  ippmNetMeasureCollectionRate,
  ippmNetMeasureDurationUnit,
  ippmNetMeasureDuration,
  ippmNetMeasureHistorySize,
  ippmNetMeasureFailureMgmtMode,
  ippmNetMeasureResultsMgmt,
  ippmNetMeasureSrcTypeP,
  ippmNetMeasureSrc,
  ippmNetMeasureDstTypeP,
  ippmNetMeasureDst,
  ippmNetMeasureTxMode,
  ippmNetMeasureTxPacketRateUnit,
  ippmNetMeasureTxPacketRate,
  ippmNetMeasureDevtnOrBurstSize,
  ippmNetMeasureMedOrIntBurstSize,
  ippmNetMeasureLossTimeout,
  ippmNetMeasureL3PacketSize,
  ippmNetMeasureDataPattern,
  ippmNetMeasureMap,
  ippmNetMeasureSingletons,
  ippmNetMeasureOperState
}
STATUS current
DESCRIPTION
"The IPPM Network Measure Group"
::= { ippmGroups 3}

ippmHistoryGroup OBJECT-GROUP
OBJECTS {
  ippmHistorySequence,
  ippmHistoryTimestamp,
  ippmHistoryValue
} STATUS current
DESCRIPTION
"The IPPM History Group"
::= { ippmGroups 4}

ippmAggrMeasureGroup OBJECT-GROUP
OBJECTS {
  ippmAggrMeasureName,
  ippmAggrMeasureMetrics,
  ippmAggrMeasureBeginTime,
  ippmAggrMeasureAggrPeriodUnit,
  ippmAggrMeasureAggrPeriod,
  ippmAggrMeasureDurationUnit,
  ippmAggrMeasureDuration,
  ippmAggrMeasureHistorySize,
  ippmAggrMeasureStorageType,
  ippmAggrMeasureHistoryOwner,
  ippmAggrMeasureHistoryOwnerIndex,
  ippmAggrMeasureHistoryMetric,
  ippmAggrMeasureAdminState,
  ippmAggrMeasureFastReport,
  ippmAggrMeasureMap,
  ippmAggrMeasureResultsMgmt,
  ippmAggrMeasureStatus
}
STATUS current
DESCRIPTION
"The IPPM AggregatedMeasure Group"
::= { ippmGroups 5}

ippmReportGroup OBJECT-GROUP
OBJECTS {
  ippmReportSetupMeasureOwner,
  ippmReportSetupMeasureIndex,
  ippmReportSetupMeasureMetric,
  ippmReportSetupDefinition,
  ippmReportSetupUpDownThreshold,
  ippmReportSetupLowThreshold,
  ippmReportSetupHighThreshold,
  ippmReportSetupDurationThresUnit,
  ippmReportSetupDurationThreshold,
  ippmReportSetupReportSize,
  ippmReportSetupResultsMgmt,
  ippmReportSetupNMS,
  ippmReportSetupNotification,
  ippmReportSetupMap,
  ippmReportSetupStatus,
  ippmReportPathToResults,
  ippmReportSequence,
ippmReportTimestamp,
ippmReportValue
}
STATUS current
DESCRIPTION "The IPPM Report Group"
 ::= { ippmGroups 6}

ippmOwnersGroup OBJECT-GROUP
OBJECTS {
    ippmOwnersOwner,
    ippmOwnersGrantedMetrics,
    ippmOwnersQuota,
    ippmOwnersIpAddressType,
    ippmOwnersIpAddress,
    ippmOwnersEmail,
    ippmOwnersSMS,
    ippmOwnersStatus
}
STATUS current
DESCRIPTION "The IPPM Owners Group"
 ::= { ippmGroups 7}

ippmNotificationGroup NOTIFICATION-GROUP
NOTIFICATIONS {
    ippmUpAndDownReport,
    ippmInBandReport,
    ippmOutBandReport,
    ippmAboveReport,
    ippmBelowReport,
    ippmEventsDurationExceededReport,
    ippmCompletedMeasureReport,
    ippmAggrMeasureHistoryFull,
    ippmNetMeasureHistoryFull,
    ippmReportLogFull
}
STATUS current
DESCRIPTION "The IPPM Notification Group"
 ::= { ippmGroups 8}

END

8 Security Considerations

8.1 VACM Access control
View Based Access Control, or VACM may be used to restrict access to certain objects, or even object instances within tables. For example, one may:

+ Give an ‘administrator’ write access to the ippmOwnersTable, whereas all other users may only have read access
+ Give access to individual rows in the network measure, aggregated measure, history, and report table to particular owners based upon indexing on an ‘owners name’, and even upon a particular measure. This will be illustrated below.
+ Give access of one owner’s measure, and associated results, to another owner in order to create an aggregated measure based upon the results.

8.1.1 Example of implementing VACM control for the IPPM-REPORTING-MIB

The following example illustrates how one could use VACM to restrict access to particular objects within the MIB. It uses syntax specific to a particular agent development toolkit, but may be generalized using the concepts as defined in the VACM MIB.

In this example, we have two NMS users, namely user1=owner1 and user2=owner2:

1) First we define the two users and their host addresses:
com2sec owner1 owner1computer@ private
com2sec owner2 owner2computer@ private

2) We then define SNMPv2c groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Owner</th>
<th>V2c</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>owner1</td>
<td>v2c</td>
<td>owner1</td>
<td></td>
</tr>
<tr>
<td>owner2</td>
<td>v2c</td>
<td>owner2</td>
<td></td>
</tr>
</tbody>
</table>

view notif included ippmNotifications ff

3.1) For the user owner1, we now define the views for which he will have read access

<table>
<thead>
<tr>
<th>View</th>
<th>Included</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>owner1read</td>
<td>included</td>
<td>ippmSystem ff</td>
</tr>
<tr>
<td></td>
<td>included</td>
<td>ippmOwners ff</td>
</tr>
<tr>
<td></td>
<td>included</td>
<td>ippmMeasure ff</td>
</tr>
</tbody>
</table>

3.2) We will now define the views for which owner1 will have write access

view owner1write included ippmAggrMeasureOwner.6.111.119.110.101.114.49 ff.df.c0
# covers ReportSetupTable
view owner1read included
ippmReportSetupOwner.6.111.119.110.101.114.49 ff.df.c0
view owner1write included
ippmReportSetupOwner.6.111.119.110.101.114.49 ff.df.c0

# covers HistoryTable
view owner1read included
ippmHistoryMeasureOwner.6.111.119.110.101.114.49 ff.df.c0

# covers ReportTable
view owner1read included
ippmReportOwner.6.111.119.110.101.114.49 ff.df.c0

3.3) For owner2, we will define the views for which he has read access
view owner2read included ippmSystem ff
view owner2read included ippmOwners ff
view owner2read included ippmMeasure ff

# covers NetworkMeasureTable plus let’s say the owner1 network measure of index X
view owner2read included
ippmNetMeasureOwner.6.111.119.110.101.114.50 ff.df.c0
view owner2read included
ippmNetMeasureOwner.6.111.119.110.101.114.49.X ff.df.e0

# covers AggrMeasureTable plus let’s say the OWNER1 aggregated measure of index Y
view owner2read included
ippmAggrMeasureOwner.6.111.119.110.101.114.50 ff.df.c0
view owner2read included
ippmAggrMeasureOwner.6.111.119.110.101.114.49.Y ff.df.e0

3.4) For owner2, we will define the views for which he has write access
view owner2write included
ippmAggrMeasureOwner.6.111.119.110.101.114.50 ff.df.c0

# covers ReportSetupTable
view owner2read included
ippmReportSetupOwner.6.111.119.110.101.114.50 ff.df.c0
view owner2write included
ippmReportSetupOwner.6.111.119.110.101.114.50 ff.df.c0

# covers HistoryTable plus OWNER1 related X network measure results
and OWNER1 related Y aggregated measure results
view owner2read included
ippmHistoryMeasureOwner.6.111.119.110.101.114.50 ff.df.c0
view owner2read included
ippmHistoryMeasureOwner.6.111.119.110.101.114.49.X ff.df.e0
view owner2read included
ippmHistoryMeasureOwner.6.111.119.110.101.114.49.Y ff.df.e0

# covers ReportTable
view owner2read included
ippmReportOwner.6.111.119.110.101.114.50 ff.df.c0
3.5) Now we give the two users access to the views defined above. Note that owner1 and owner2 have read access to owner1read and owner2read views respectively. They have write access to owner1write and owner2write view respectively. And they both have access to all the notifications.

<table>
<thead>
<tr>
<th>access</th>
<th>owner1</th>
<th>*&quot;</th>
<th>any</th>
<th>noauth</th>
<th>exact</th>
<th>owner1read</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>owner1write</td>
<td>notif</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>access</th>
<th>owner2</th>
<th>*&quot;</th>
<th>any</th>
<th>noauth</th>
<th>exact</th>
<th>owner2read</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>owner2write</td>
<td>notif</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8.2 Privacy

The privacy concerns of network measurement are intrinsically limited by the active measurements. Unlike passive measurements, there can be no release of existing user data.

8.3 Measurement aspects

Conducting Internet measurements raises both security and privacy concerns. This memo does not specify an implementation of the metrics, so it does not directly affect the security of the Internet or of applications that run on the Internet. However, implementations of these metrics must be mindful of security and privacy concerns.

There are two types of security concerns: potential harm caused by the measurements, and potential harm to the measurements. The measurements could cause harm because they are active, and inject packets into the network. The measurement parameters MUST be carefully selected so that the measurements inject trivial amounts of additional traffic into the networks they measure. If they inject "too much" traffic, they can skew the results of the measurement, and in extreme cases cause congestion and denial of service.

The measurements themselves could be harmed by routers giving measurement traffic a different priority than "normal" traffic, or by an attacker injecting artificial measurement traffic. If routers can recognize measurement traffic and treat it separately, the measurements will not reflect actual user traffic. If an attacker injects artificial traffic that is accepted as legitimate, the loss rate will be artificially lowered. Therefore, the measurement methodologies SHOULD include appropriate techniques to reduce the probability measurement traffic can be distinguished from "normal" traffic.

Authentication techniques, such as digital signatures, may be used where appropriate to guard against injected traffic attacks.
8.4 Management aspects

There are a number of management objects defined in this MIB that have a MAX-ACCESS clause of read-write and/or read-only. 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.

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 implementors consider the security features as provided by the SNMPv3 framework. Specifically, the use of the User-based Security Model RFC 2574 [18] and the View-based Access Control Model RFC 2575 [21] 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.
9.1 Open issues

Defval 0 for an OID?
Usage of accessible-for-notify for an index?
Subtype of InetAddress?

9.2 Changes done since release 02

+ Security/VACM:
  sharing table removed;
  ippmMeasure merged with networkMeasure and AggrMeasure to have
  all networkMeasure objects in read only.
  Indexes belong to the table;
  remove all reference to SNMPv1 ...inSNMPTrapPDU

+ System:
  ippmSystemOperationalStatus added
  ippmSynchronizationTable adapted for proxy mode:
    ippmPointOfMeasureIndex added to the index of
    ippmSystemCurrentSynchronization removed from system
  capabilities:
    ippmPointOfMeasureMetrics added to
    IppmPointOfMeasureEntry;
    ippmMetricType added to ippmMetricsTable;

+ Owners
  ippmMetricMaxHistorySize replaced with quota in ippmOwnersTable;

+ ippmOnHistoryFullAction replaced with resultsMgmt in aggr and network.;

+ network measure:
  ippmNetMeasureOperState added to indicate the state of the network
  measure state;
    added burst mode;
    state of the measure: nb of singletons collected and oper status
    added;

+aggregated metric:
  fast report added to get raw results by email;

+ report setup:
  onReportDeliveryClearHistory removed from IppmReportDefinition;

+ Map field added to network, aggr and report tables to help to map
  on topology map or admin view.
References


11 Acknowledgments

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