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IPPM reporting MIB

Status of this Memo

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.

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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" defined in http://www.ops.ietf.org/mib-boilerplate.html.

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.

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 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, and week.

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 IPPM measures relies on the capability to 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 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 defines 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

Metric thresholds (low, high, inband, outband...) may be defined that indicate when measure values should be reported. These values and their associated time may directly impact service availability.

One may also want to report when particular values (i.e. constantly over a threshold) repeatedly occur over a period of time. For example, if one-way-day is constantly over a specified acceptable threshold value for 10 minutes, then the values should be reported.

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

- ippmMeasure

- 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 management 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 management 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 exists 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.

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 a 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 must be defined in the owners table. It may be either

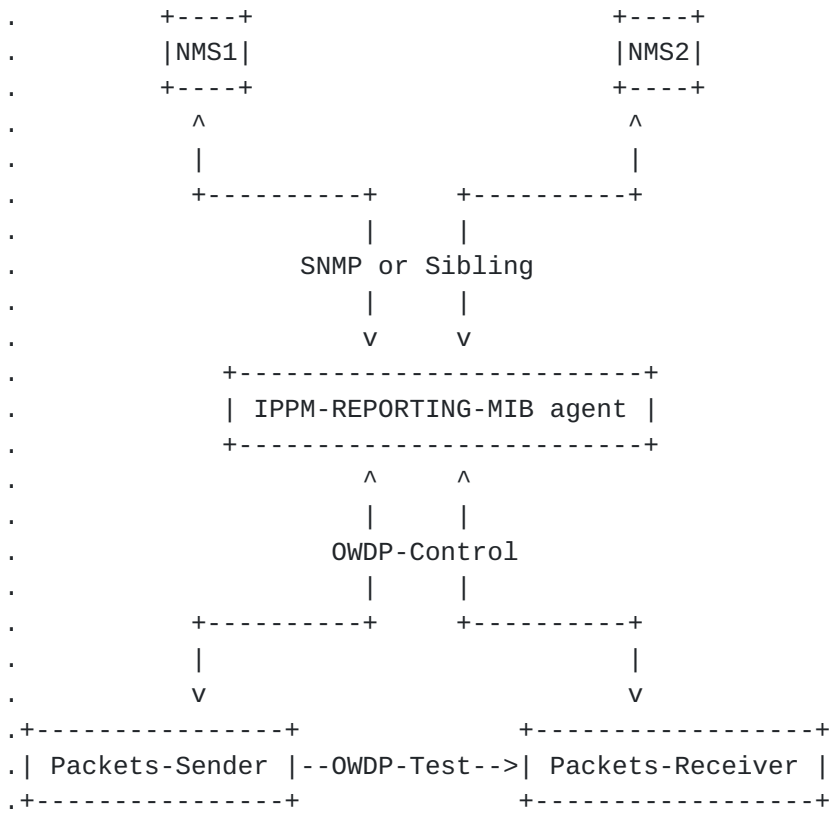
configured directly, or exported to the agent by the external measurement tool.

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 other owners in the system.

5 Measurement architectures

There are three main measurement architectures.

5.1 Proxy architecture



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

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

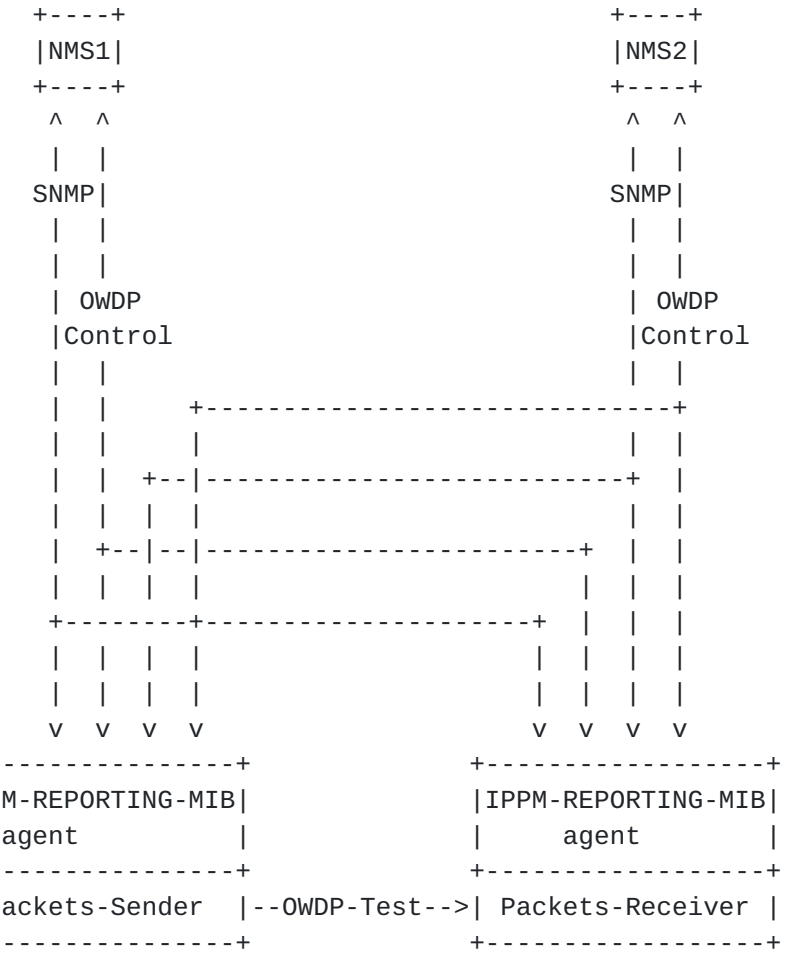
In this mode the NMS does not depend on the control protocol nor on the test protocol. The entities involved in the measurement do not

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 NMS s and event handling.

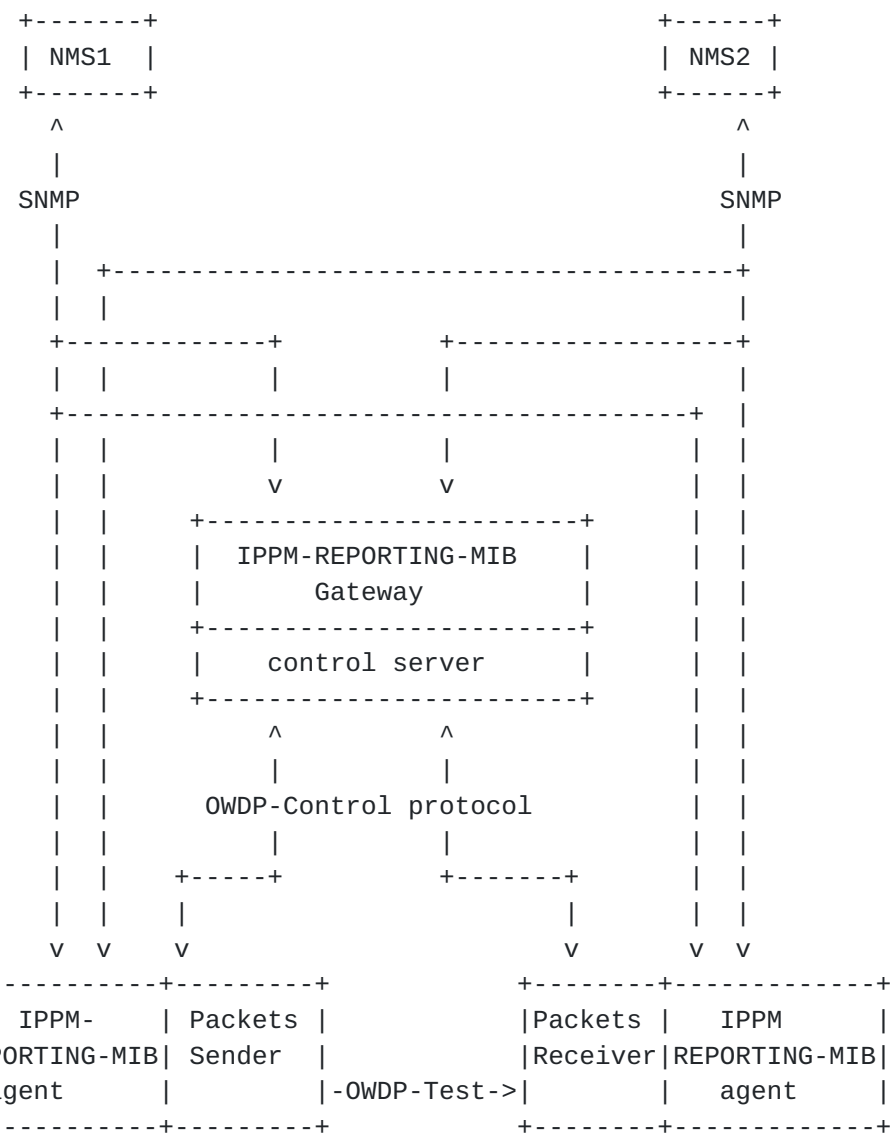
On completion, the measurement results are managed according to the measure setup:

+ 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 setup 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 metric measures;
+ Define the format of the results of the measure;
+ Define the report of the IPPM metric measure 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 exported to an NMS using an SNMP trap, SNMP Inform PDU, an email, or an 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 sent 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, or another mechanism.

6.5 Report download and upload

A report is read in the ippmReportTable using SNMP, or generated 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, zeroDotZero, Counter64, Unsigned32
    FROM SNMPv2-SMI
--
```

```
-- ippm
--      FROM IPPM-REGISTRY
```

```
--
   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 "200310141200Z" --  14 October  2003
   ORGANIZATION "France Telecom - R&D"
   CONTACT-INFO
       "Emile Stephan
       France Telecom - R&D
       2, Avenue Pierre Marzin
       Technopole Anticipa
       22307 Lannion Cedex
       FRANCE
       Tel: + 33 2 96 05 36 10
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       Jessie Jewitt
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       801 Gateway Blvd. Suit 500
       South San Francisco, CA 94080
       Tel : 1 650 875-1524
       E-mail : jessie.jewitt@rd.francetelecom.com"

   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"
```

```
   REVISION "200306291200Z" --  29 June 2003
   DESCRIPTION
       "Adaptation to VACM, preparation of the final version"

   REVISION "200310241200Z" --  24 October 2003
   DESCRIPTION
       "Modifications based upon feedback from experimental
       implementation."

   ::= { experimental 10001 } -- XXX to be assigned by IANA

ippm           OBJECT IDENTIFIER   ::= { experimental 10000 }

--
-- TEXTUAL-CONVENTION
--

IppmOwnerString ::= TEXTUAL-CONVENTION
   STATUS       current
   DESCRIPTION
       "An OwnerString. The length is limited to 32 bytes."
   SYNTAX OCTET STRING (SIZE (0..32))


TimeUnit ::= TEXTUAL-CONVENTION
   STATUS       current
   DESCRIPTION
       "A enumerated list of time units."
   SYNTAX       INTEGER {
       week(1),
       day(2),
       hour(3),
       minute(4),
       second(5),
       millisecond(6),
       microsecond(7),
       nanosecond(8)
   }
--
--

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
       '0000001000001000'b, '1040'B.
       "
   SYNTAX OCTET STRING (SIZE (1..64))



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

       field  octets  contents                  range
       -----  ------  --------                  -----
       1       1-4    second since 1 Jan 2000 0H00*    0..2^31 - 1
       2       5-8    fractional part of the second*   0..2^32 - 1
       * the value is in network-byte order

       The timestamp format is directly inspired from the NTP timestamp
       format.
       It differs in that it counts the seconds 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 blank separated addresses that reflect the encapsulation
       of the TypeP. 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 a corresponding 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 or 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.

-3- deliver

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.

-4- Cleanup
onReportDeliveryClearReport(12):

```
                Remove all the results corresponding to this measure
                from the ippmReportTable when the report has been
                delivered. This must be set in conjunction with
                inIppmReportTable, and onMeasureCompletion.

   "
   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 Object 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 GMTTimeStamp
   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, it is 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 ippmSystemSynchonizationDescription.

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

       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."
    ::= { ippmSystem 3 }
```

```
ippmSystemClockResolution OBJECT-TYPE
   SYNTAX     Unsigned32
   UNITS "Nanoseconds"
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
       "ippmSystemClockResolution provides the precision of the clock
       used for the measures . The unit is the nanosecond. 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
       10000000 nanoseconds and the value of ippmSystemClockResolution
       is 10000000."
   ::= { 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 point measurement
   status.
       unknown(0)
       up(1) means service is operational and available for general use.
       down(2) means the agent 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              Unsigned32,
       ippmSynchronizationTime               GMTTimeStamp,
       ippmSynchronizationStratum            Unsigned32,
       ippmSynchronizationResolution         Unsigned32
   }

ippmSynchronizationIndex     OBJECT-TYPE
   SYNTAX     Unsigned32 (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     Unsigned32
   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     Unsigned32
   UNITS      "Nanoseconds"
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
       "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 agent 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 some 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               Unsigned32,
   ippmPointOfMeasureMgmtAddrType        InetAddressType,
   ippmPointOfMeasureMgmtAddress         InetAddress,
   ippmPointOfMeasureTestAddrTypeP       TypeP,
   ippmPointOfMeasureTestAddr            TypePaddress,
   ippmPointOfMeasureMetrics             IppmStandardMetrics
}



ippmPointOfMeasureIndex OBJECT-TYPE
   SYNTAX Unsigned32 (1 .. 65535)
   MAX-ACCESS not-accessible
```

```
    STATUS     current
    DESCRIPTION
```

```
        "A local index that identifies an entry in the point of measure
        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 }


ippmPointOfMeasureTestAddrTypeP OBJECT-TYPE
    SYNTAX TypeP
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "Defines the address type of the measurement interface of the
        point of measure."
    ::= { ippmPointOfMeasureEntry 4 }

ippmPointOfMeasureTestAddr OBJECT-TYPE
    SYNTAX TypePaddress
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "Specifies the address of the measurement interface for the point
        of measure."
    ::= { 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           Unsigned32,
   ippmMetricCapabilities    INTEGER,
   ippmMetricType            INTEGER,
   ippmMetricUnit            INTEGER,
   ippmMetricDescription     SnmpAdminString
}

ippmMetricIndex OBJECT-TYPE
   SYNTAX Unsigned32 (1.. 65535)
   MAX-ACCESS not-accessible
   STATUS     current
   DESCRIPTION
       "ippmMetricIndex defines an unambiguous index for each
       standardized metric. It identifies a metric, and as such 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, onewayPacketLossAverage is
       registered as the node 14 of ippmMetricsRegistry.metrics.rfc.
       Consequently the index of the metric onewayPacketLossAverage in
       the IppmMetricTable will always be '14'"
   ::= { ippmMetricEntry 1 }


ippmMetricCapabilities OBJECT-TYPE
```

```
   SYNTAX INTEGER {
   notImplemented(0),
   implemented(1)
```

```
   }
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
       "A value of notImplemented implies the metric is not implemented.
       A value of implemented implies the metric is implemented either
       in the proxy or the point of measure itself.
       Example: if the aggregated metric is not implemented in the point
       of measure it may be implemented in the proxy."
   ::= { ippmMetricEntry 2 }

ippmMetricType OBJECT-TYPE
   SYNTAX INTEGER {
   network(0),
   aggregated(1)
   }
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
       "Indicates the metric type, whether it is network or aggregated"
   ::= { ippmMetricEntry 3 }


ippmMetricUnit OBJECT-TYPE
   SYNTAX INTEGER {
        noUnit(0),
        second(1),
        millisecond(2),
        microsecond(3),
        nanosecond(4),
        percentage(5),
        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: OWD Metric ."
    ::= { 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 access or aggregate remote Ippm
measurements in an agent must previously be registered in the
ippmOwnersTable. This table is read-create and contains at least  the
owner 'monitor'."
   ::= { 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              Unsigned32,
   ippmOwnersOwner              IppmOwnerString,
   ippmOwnersGrantedMetrics     IppmStandardMetrics,
   ippmOwnersQuota              Unsigned32,
   ippmOwnersIpAddressType      InetAddressType,
   ippmOwnersIpAddress          InetAddress,
   ippmOwnersEmail              SnmpAdminString,
   ippmOwnersSMS                SnmpAdminString,
```

```
   ippmOwnersStatus             RowStatus
}
```

```
ippmOwnersIndex OBJECT-TYPE
   SYNTAX Unsigned32 (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 }

ippmOwnersQuota OBJECT-TYPE
   SYNTAX     Unsigned32
   MAX-ACCESS read-create
   STATUS     current
   DESCRIPTION
       " The maximum number of records that this owner may have in the
       history table and in the report table."
   ::= { ippmOwnersEntry 4 }

ippmOwnersIpAddressType OBJECT-TYPE
   SYNTAX     InetAddressType
   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. For example, the IP address of the management console used
       to send SNMP requests."
   ::= { 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. Once this status is set to
       active, the corresponding entry in the table may not be
       modified."
   ::= { 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 ippmHistorySequence.

       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  ippmMetricTable;

       + ippmHistorySeqence is the sequence number of the measurement
       result for an entry in the history table."
   INDEX { ippmHistoryMeasureOwner, ippmHistoryMeasureIndex,
   ippmHistoryMetricIndex, ippmHistorySequence }
   ::= { ippmHistoryTable 1 }

IppmHistoryEntry ::=
   SEQUENCE {
       ippmHistoryMeasureOwner      IppmOwnerString,
       ippmHistoryMeasureIndex      Unsigned32,
       ippmHistoryMetricIndex       Unsigned32,
       ippmHistorySequence          Unsigned32,
       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 Unsigned32 (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 Unsigned32 (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 }



ippmHistorySequence OBJECT-TYPE
       SYNTAX Unsigned32 (0..4294967295)
       MAX-ACCESS not-accessible
       STATUS     current
       DESCRIPTION
       "ippmHistorySequence is the sequence number of the measurement
       results for a metric.

       Network metrics:
       It's the sequence number of a measurement packet. Typically, it
       identifies the order of the packet in the stream of packets sent
       by the source.

       Aggregated metrics:
       It is the sequence number of the computed aggregated metric
       result."
   ::= { ippmHistoryEntry 4 }



ippmHistoryTimestamp OBJECT-TYPE
   SYNTAX GMTTimeStamp
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
       "The timestamp when the measurement occurred."
   ::= { ippmHistoryEntry 5 }

ippmHistoryValue OBJECT-TYPE
   SYNTAX Integer32
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
       "The observed value of the measurement."
   ::= { ippmHistoryEntry 6 }
```

```
--
-- ippmMeasure Group
--

--
--
-- ippmNetMeasureTable
--
--

ippmNetMeasureTable OBJECT-TYPE
   SYNTAX     SEQUENCE OF IppmNetMeasureEntry
   MAX-ACCESS not-accessible
   STATUS     current
   DESCRIPTION
       "An 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
       " The IppmNetMeasureTable is mandatory, and its 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. As an example, OWAP provides a
       setup protocol to setup and tear down 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.

       One may create aggregated measures by using the results of
       network measures. They may be referenced by their table index
       values. "

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

IppmNetMeasureEntry ::= SEQUENCE {
   ippmNetMeasureOwner              IppmOwnerString,
```

```
   ippmNetMeasureIndex              Unsigned32,
   ippmNetMeasureName               SnmpAdminString,
   ippmNetMeasureMetrics            IppmStandardMetrics,
   ippmNetMeasureBeginTime          GMTTimeStamp,
```

```
   ippmNetMeasureCollectionRateUnit  TimeUnit,
   ippmNetMeasureCollectionRate      Unsigned32,
   ippmNetMeasureDurationUnit        TimeUnit,
   ippmNetMeasureDuration            Unsigned32,
   ippmNetMeasureHistorySize         Unsigned32,
   ippmNetMeasureFailureMgmtMode     INTEGER,
   ippmNetMeasureResultsMgmt         INTEGER,
   ippmNetMeasureSrcTypeP            TypeP,
   ippmNetMeasureSrc                 TypePaddress,
   ippmNetMeasureDstTypeP            TypeP,
   ippmNetMeasureDst                 TypePaddress,
   ippmNetMeasureTxMode              INTEGER,
   ippmNetMeasureTxPacketRateUnit    TimeUnit,
   ippmNetMeasureTxPacketRate        Unsigned32,
   ippmNetMeasureMedOrBurstSize      Unsigned32,
   ippmNetMeasureDevOrIntBurstSize   Unsigned32,
   ippmNetMeasureLossTimeout         Unsigned32,
   ippmNetMeasureL3PacketSize        Unsigned32,
   ippmNetMeasureDataPattern         OCTET STRING,
   ippmNetMeasureMap                 SnmpAdminString,
   ippmNetMeasureTotalPktsRecv       Counter64,
   ippmNetMeasureLastUpdate          GMTTimeStamp,
   ippmNetMeasureOperState           INTEGER
}


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

ippmNetMeasureIndex OBJECT-TYPE
   SYNTAX Unsigned32 (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(s)as defined in
```

ippmNetMeasureMetrics. It illustrates the specificity of the metric(s) and includes the metric(s) 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.

       "
   ::= { ippmNetMeasureEntry 4 }

ippmNetMeasureBeginTime OBJECT-TYPE
   SYNTAX GMTTimeStamp
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
       "Specifies the time at which the measurement begins."
   ::= { ippmNetMeasureEntry 5 }


ippmNetMeasureCollectionRateUnit OBJECT-TYPE
   SYNTAX TimeUnit
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
       "Specifies the unit of the measurement period."
   ::= { ippmNetMeasureEntry 6 }

ippmNetMeasureCollectionRate OBJECT-TYPE
   SYNTAX     Unsigned32
   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."
   ::= { ippmNetMeasureEntry 7 }


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

ippmNetMeasureDuration OBJECT-TYPE
   SYNTAX     Unsigned32
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
       "Specifies the measurement duration."
   ::= { ippmNetMeasureEntry 9 }

ippmNetMeasureHistorySize OBJECT-TYPE
   SYNTAX     Unsigned32
   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
       "This object defines whether this row (and the measure controlled
       by this row) is restarted automatically, manually, or discarded
       upon failure, or reboot of the measurement system.
       'auto'
          The measure is restarted automatically.
       'manual'
```

The measure has to be restarted manually.

'discarded'

The measure and it results are discarded.

```
        "
    ::= { ippmNetMeasureEntry 11 }

ippmNetMeasureResultsMgmt OBJECT-TYPE
    SYNTAX INTEGER {
        wrap(1),
        suspend(2)
    }
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "
        Action to take when the log is full. The measurement system owner
        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.
        "
    ::= { 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."
    ::= { 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 set 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."
   ::= { 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 ippmNetMeasureDevOrIntBurstSize, the deviation is
       ippmNetMeasureMedOrBurstSize.
       'multiburst'
          Packets are sent bursty at ippmNetMeasureTxPacketRate. The
       size of the burst is made of ippmNetMeasureMedOrBurstSize
       packets.
       Between 2 consecutive bursts, transmission stops during the time
       needed to send ippmNetMeasureDevOrIntBurstSize.

       "
   ::= { 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 Unsigned32
    UNITS "Packets"
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "The rate the packets are sent."
    ::= { ippmNetMeasureEntry 19 }

ippmNetMeasureMedOrBurstSize   OBJECT-TYPE
    SYNTAX     Unsigned32
    UNITS "Packets"
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "
        Multi-burst mode: This field represents the burst size in number
        of packets.
        Poisson mode: This field indicates the number of packets sent, on
        average, during each period corresponding to the median.
        The median is therefore
        MedOrBurstSize*TxPacketRateUnit/TxPacketRate.

        Example:
        If  TxPacketRateUnit/TxPacketRate is 100 packets/second, and if
        MedOrBurstSize, the number of packets sent during the period
        corresponding to the median is 50 packets, then the median equals
        50*1/100 = 1/2 seconds.
        "
    ::= { ippmNetMeasureEntry 20 }

ippmNetMeasureDevOrIntBurstSize   OBJECT-TYPE
    SYNTAX     Unsigned32
    UNITS "Packets"
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "
        Multi-burst mode: This field indicates the gap between 2
        bursts, in number of packets.
        Example:
        If TxPacketRateUnit/TxPacketRate is 100 packets/second,
        and DevOrIntBurstSize equals 50 packets, then the gap
        between 2 bursts is
        equal to 50*1/100, or 1/2 second.
```

Poisson mode:

```
       This field indicates the typical difference between the packets
       of the period corresponding to the median.

       "
   ::= { ippmNetMeasureEntry 21 }



ippmNetMeasureLossTimeout OBJECT-TYPE
   SYNTAX     Unsigned32
   UNITS      "Milliseconds"
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
        "Specifies the delay after which the packet is considered lost
   by the sink."
   ::= { ippmNetMeasureEntry 22 }



ippmNetMeasureL3PacketSize OBJECT-TYPE
   SYNTAX     Unsigned32
   UNITS      "Bytes"
   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.
       "
   ::= { 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."

   ::= { ippmNetMeasureEntry 24 }

ippmNetMeasureMap OBJECT-TYPE
   SYNTAX SnmpAdminString
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
       "An administrative name of a network management map to which the
       measure belongs."
```

```
   ::= { ippmNetMeasureEntry 25 }
```

```
ippmNetMeasureTotalPktsRecv  OBJECT-TYPE
   SYNTAX Counter64
   UNITS "Packets"
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
       "Reports the current number of packets received since the
       beginning of the measure.
       This parameters is useful to monitor the measure and it is needed
to compute statistics."
   ::= { ippmNetMeasureEntry 26 }


ippmNetMeasureLastUpdate OBJECT-TYPE
SYNTAX GMTTimeStamp
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
       "The time when the last aggregation was computed."
   ::= { ippmNetMeasureEntry 27 }


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 28 }


--
--
-- 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 are saved in the
```

ippmHistoryTable.

```
       Each step of the calculation for the measure produces a singleton
result per metric."
   ::= { ippmMeasure 2 }

ippmAggrMeasureEntry OBJECT-TYPE
   SYNTAX     IppmAggrMeasureEntry
   MAX-ACCESS not-accessible
   STATUS     current
   DESCRIPTION
       "Typically, the configuration operation sets the value of
       theIppmAggrMeasureEntry.

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

       The aggregated task starts at ippmAggrMeasureBeginTime and ends
       after ippmAggrMeasureDuration. An aggregated result is performed
       and saved in the ippmHistoryTable for each
       ippmMeasureCollectionRate tick. "
   INDEX { ippmAggrMeasureOwner, ippmAggrMeasureIndex }
   ::= { ippmAggrMeasureTable 1 }


IppmAggrMeasureEntry ::= SEQUENCE {
   ippmAggrMeasureOwner                  IppmOwnerString,
   ippmAggrMeasureIndex                  Unsigned32,
   ippmAggrMeasureName                   SnmpAdminString,
   ippmAggrMeasureMetrics                IppmStandardMetrics,
   ippmAggrMeasureBeginTime              GMTTimeStamp,
   ippmAggrMeasureAggrPeriodUnit         TimeUnit,
   ippmAggrMeasureAggrPeriod             Unsigned32,
   ippmAggrMeasureDurationUnit           TimeUnit,
   ippmAggrMeasureDuration               Unsigned32,
   ippmAggrMeasureHistorySize            Unsigned32,
   ippmAggrMeasureStorageType            StorageType,
   ippmAggrMeasureHistoryOwner           IppmOwnerString,
   ippmAggrMeasureHistoryOwnerIndex      Unsigned32,
   ippmAggrMeasureHistoryMetric          Unsigned32,
   ippmAggrMeasureAdminState             INTEGER,
   ippmAggrMeasureFastReport             OBJECT IDENTIFIER,
   ippmAggrMeasureMap                    SnmpAdminString,
   ippmAggrMeasureResultsMgmt            INTEGER,
   ippmAggrMeasureLastUpdate             GMTTimeStamp,
   ippmAggrMeasureOperState              INTEGER,
   ippmAggrMeasureNbPktsTreated          Counter64,
   ippmAggrMeasureStatus                 RowStatus
```

```
}

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 Unsigned32 (1.. 65535)
   MAX-ACCESS not-accessible
   STATUS     current
   DESCRIPTION
       "The index of the aggregated 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 typeP.

       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 network 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.The aggregated
```

measure definition(s) might be One-Way-Delay-Percentile(8),One-
way-Delay-Median(9), or One-way-Delay-Minimum(10 .
"

```
   ::= { 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     Unsigned32
   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, and as the sending timestamp is part of the
       measurement packet, the sink has 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 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     Unsigned32
   MAX-ACCESS read-create
   STATUS     current
   DESCRIPTION
       "Specifies the duration of the measure."
   DEFVAL { 120 }
   ::= { ippmAggrMeasureEntry 9 }

ippmAggrMeasureHistorySize OBJECT-TYPE
   SYNTAX     Unsigned32
   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. "
   DEFVAL { 2 }
   ::= { 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), nonVolatile(3),
       permanent(4), readOnly(5)."
   DEFVAL { nonVolatile }
   ::= { ippmAggrMeasureEntry 11 }

ippmAggrMeasureResultsMgmt OBJECT-TYPE
   SYNTAX INTEGER {
```

```
        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 }
   ::= { ippmAggrMeasureEntry 12 }


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

ippmAggrMeasureHistoryOwnerIndex OBJECT-TYPE
   SYNTAX Unsigned32 (1.. 65535)
   MAX-ACCESS read-create
   STATUS     current
   DESCRIPTION
       "The owner index of the measure to summarize. "
   ::= { ippmAggrMeasureEntry 14 }

ippmAggrMeasureHistoryMetric OBJECT-TYPE
   SYNTAX Unsigned32 (1.. 65535)
   MAX-ACCESS read-create
   STATUS     current
   DESCRIPTION
       "The metric of the measure to summarize. "
   ::= { ippmAggrMeasureEntry 15 }


ippmAggrMeasureAdminState 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."
    DEFVAL { start }

    ::= { 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 { zeroDotZero }
    ::= { 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 }

ippmAggrMeasureLastUpdate OBJECT-TYPE
SYNTAX GMTTimeStamp
    MAX-ACCESS read-only
```

```
    STATUS     current
    DESCRIPTION
```

```
        "The time when the last aggregated measure was computed."
    ::= { ippmAggrMeasureEntry 19 }


ippmAggrMeasureOperState OBJECT-TYPE
    SYNTAX INTEGER {
        unknown(0),
        running(1),
        stopped(2)
    }
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "Reports the operational status of the aggregated measure."
    ::= { ippmAggrMeasureEntry 20 }


ippmAggrMeasureNbPktsTreated  OBJECT-TYPE
    SYNTAX Counter64
    UNITS  "Packets"
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
        "Reports the current number of packets used to calculate the
        aggregation since the start of the measure.
        This parameters is useful to monitor the measure and it is needed
        to compute statistics."
    ::= { ippmAggrMeasureEntry 21 }

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.
        "
    ::= { ippmAggrMeasureEntry 22 }


--
-- ippmReport  Group
--

ippmReportPathToResults   OBJECT-TYPE
    SYNTAX SnmpAdminString
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
```

" It is typically a 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 and/or aggregated measures that
       are to be reported. A report is saved in the ippmReportTable, or
       sent to an application using an SNMP Trap, an 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 }

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
       ippmAggrMeasureAdminStatus 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 and its period."
```

```
   INDEX { ippmReportSetupOwner, ippmReportSetupIndex }
   ::= { ippmReportSetupTable 1 }
```

```
IppmReportSetupEntry ::=
   SEQUENCE {
       ippmReportSetupOwner                IppmOwnerString,
       ippmReportSetupIndex                Unsigned32,
       ippmReportSetupMeasureOwner         IppmOwnerString,
       ippmReportSetupMeasureIndex         Unsigned32,
       ippmReportSetupMeasureMetric        Unsigned32,
       ippmReportSetupDefinition           IppmReportDefinition,
       ippmReportSetupUpDownThreshold      Unsigned32,
       ippmReportSetupLowThreshold         Unsigned32,
       ippmReportSetupHighThreshold        Unsigned32,
       ippmReportSetupDurationThresUnit    TimeUnit,
       ippmReportSetupDurationThreshold    Unsigned32,
       ippmReportSetupReportSize           Unsigned32,
       ippmReportSetupResultsMgmt          INTEGER,
       ippmReportSetupNMS                  IppmOwnerString,
       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 Unsigned32 (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 Unsigned32 (1.. 65535)
   MAX-ACCESS read-create
   STATUS     current
```

```
   DESCRIPTION
       "The index of the measure to report."
   ::= { ippmReportSetupEntry 4 }

ippmReportSetupMeasureMetric OBJECT-TYPE
   SYNTAX Unsigned32 (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
       determine the notification:
       + 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 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 result 5.1 corresponding to a down to up event;
+ The second one carries the result 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
}
```

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 5.1 and 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 Unsigned32
   MAX-ACCESS read-create
   STATUS     current
   DESCRIPTION
       "An event is generated when the result of the measure exceeds the
       value of ippmReportSetupMetricThreshold, and then goes below the
       threshold or vice versa. In the case of being over the threshold,
       and then being below it, the measure value that is immediately
       below the threshold, after previously being above it, is
       reported. In the case of being below the threshold and then being
```

above it, the measure value that is above the threshold is reported.

```
       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 Unsigned32
   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 Unsigned32
   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."
   DEFVAL  { second }
   ::= { ippmReportSetupEntry 10 }


ippmReportSetupDurationThreshold OBJECT-TYPE
SYNTAX Unsigned32
   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 measures,
       or with the period of aggregation of an aggregated measure."

   DEFVAL { 15 }
   ::= { ippmReportSetupEntry 11 }

ippmReportSetupReportSize OBJECT-TYPE
   SYNTAX     Unsigned32
   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)
   }
   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"
   DEFVAL { wrap }

   ::= { ippmReportSetupEntry 13 }
```

```
ippmReportSetupNMS OBJECT-TYPE
   SYNTAX IppmOwnerString
```

```
   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.
       "
   DEFVAL { "" }
   ::= { 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 { zeroDotZero }
   ::= { 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:

       + ippmReportSetupOwner identifies the owner of the measure

       + ippmReportSetupIndex identifies the measure in the owner
       namespace;

       + ippmReportSequence identifies the sequence number of the
       measure result"

   INDEX { ippmReportSetupOwner, ippmReportSetupIndex,
   ippmReportSequence }
   ::= { ippmReportTable 1 }


IppmReportEntry ::=
   SEQUENCE {
       ippmReportSequence          Unsigned32,
       ippmReportTimestamp         GMTTimeStamp,
       ippmReportValue             Integer32
```

```
}
```

```
ippmReportSequence OBJECT-TYPE
   SYNTAX Unsigned32 (0..4294967295)
   MAX-ACCESS not-accessible
   STATUS     current
   DESCRIPTION

       "ippmReportSequence is the sequence number of the measurement
       results to report.

       Network metrics:

       It's the sequence number 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 number of the aggregated metric results
       computed."
   ::= { ippmReportEntry 1 }



ippmReportTimestamp OBJECT-TYPE
   SYNTAX GMTTimeStamp
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
       "The timestamp of the measurement result."
   ::= { ippmReportEntry 2 }

ippmReportValue OBJECT-TYPE
   SYNTAX Integer32
   MAX-ACCESS read-only
   STATUS     current
   DESCRIPTION
       "The value."
   ::= { ippmReportEntry 3 }


--
-- IPPM  Notifications
--

ippmUpAndDownReport    NOTIFICATION-TYPE
   OBJECTS      {
       ippmReportSetupDefinition,
       ippmReportSetupUpDownThreshold,
```

```
        ippmMetricType,
        ippmMetricUnit,
```

```
        ippmMetricDescription,
        ippmHistoryTimestamp,
        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 in the case of a down to up
        change. In the case of a up to down change, the ippmHistoryValue
        object that is below the threshold immediately after being over
        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,
        ippmReportSetupLowThreshold,
        ippmReportSetupHighThreshold,
        ippmMetricType,
        ippmMetricUnit,
        ippmMetricDescription,
        ippmHistoryTimestamp,
        ippmHistoryValue,
        ippmReportPathToResults
    }
    STATUS       current
    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,
        ippmReportSetupLowThreshold,
        ippmReportSetupHighThreshold,
```

```
        ippmMetricType,
        ippmMetricUnit,
        ippmMetricDescription,
        ippmHistoryTimestamp,
        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,
        ippmReportSetupHighThreshold,
        ippmMetricType,
        ippmMetricUnit,
        ippmMetricDescription,
        ippmHistoryTimestamp,
        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 4 }

ippmBelowReport    NOTIFICATION-TYPE
    OBJECTS      {
        ippmReportSetupDefinition,
        ippmReportSetupLowThreshold,
        ippmMetricType,
        ippmMetricUnit,
        ippmMetricDescription,
        ippmHistoryTimestamp,
```

```
        ippmHistoryValue,
        ippmReportPathToResults
    }
```

```
   STATUS       current
   DESCRIPTION
       "
       The notification contains the instances of the ippmHistoryValue
       object that were below 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,
       ippmReportSetupUpDownThreshold,
       ippmReportSetupDurationThreshold,
       ippmReportSetupDurationThresUnit,
       ippmMetricType,
       ippmMetricUnit,
       ippmMetricDescription,
       ippmHistoryTimestamp,
       ippmHistoryValue,
       ippmReportPathToResults

   }
   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,
        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,
        ippmAggrMeasureHistorySize,
        ippmMetricType,
        ippmMetricUnit,
        ippmMetricDescription,
        ippmHistoryTimestamp,
        ippmHistoryValue

    }
    STATUS       current
    DESCRIPTION
        " A notification sent when the size of the history of a metric of
        a 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,
        ippmNetMeasureHistorySize,
        ippmMetricType,
        ippmMetricUnit,
        ippmMetricDescription,
        ippmHistoryTimestamp,
        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 {
       ippmReportSetupResultsMgmt,
       ippmReportSetupReportSize,
ippmReportTimestamp,
       ippmReportValue
   }
   STATUS       current
   DESCRIPTION
       "A notification sent when the size of the report of a metric of a
       measure exceeded ippmReportSetupReportSize. 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."
   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,
        ippmPointOfMeasureTestAddrTypeP,
        ippmPointOfMeasureTestAddr,
        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,
        ippmNetMeasureMedOrBurstSize,
        ippmNetMeasureDevOrIntBurstSize,
        ippmNetMeasureLossTimeout,
        ippmNetMeasureL3PacketSize,
        ippmNetMeasureDataPattern,
        ippmNetMeasureMap,
        ippmNetMeasureTotalPktsRecv,
        ippmNetMeasureLastUpdate,
        ippmNetMeasureOperState
    }
    STATUS  current
    DESCRIPTION
        "The IPPM Network Measure Group"
    ::=  { ippmGroups  3}


ippmHistoryGroup   OBJECT-GROUP
    OBJECTS  {
        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,
        ippmAggrMeasureLastUpdate,
        ippmAggrMeasureOperState,
        ippmAggrMeasureNbPktsTreated,
        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,
        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

```
group                        owner1  v2c     owner1
group                        owner2  v2c     owner2
view notif           included        ippmNotifications       ff
```

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

```
# covers PointOfMeasureTable SynchronizationTable and all scalars
view owner1read      included        ippmSystem              ff
# covers OwnersTable
view owner1read      included        ippmOwners              ff
# covers MetricsTable
view owner1read      included        ippmMeasure     ff
# covers NetworkMeasureTable
view owner1read      included
ippmNetMeasureOwner.6.111.119.110.101.114.49 ff.df.c0
# covers AggrMeasureTable
view owner1read      included
     ippmAggrMeasureOwner.6.111.119.110.101.114.49   ff.df.c0
```

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
     ippmReportSequence.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
        ippmReportSequence.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.

   access       owner1  ""      any     noauth  exact   owner1read
        owner1write     notif
   access       owner2  ""      any     noauth  exact   owner2read
        owner2write     notif
```

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 nor 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 Document management

9.1 Open issues

Usage of accessible-for-notify for an index ?

9.2 Changes done since release 03

+ SMI subtype: INTEGER vs Integer32...;
+ SMI UNITS: Clauses added;
+ cleanup of DEFVAL values;

+ Counter/index wrapping:
the index of the table wrap independently of the sequence of the results. That makes it very difficult for application to track the results. As the sequence id identify the instance of the result of a measure the index is removed both from the table and from the index clause.
ippmHistoryIndex removed from ippmHistoryEntry;

ippmHistoryIndex removed from the INDEX clause of the table ippmHistoryTable;
ippmReportIndex removed from ippmReportEntry;
ippmReportIndex removed from the clause INDEX of ippmReportEntry INDEX clause of the table ippmReportTable;

9.3 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.

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11 Acknowledgments

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