                    The Managed Object Aggregation MIB

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   for more information.

Abstract

   This memo defines a portion of the Management Information Base (MIB),
   the Aggregation MIB modules, for use with network management
   protocols in the Internet community. In particular, the Aggregation
   MIB modules will be used to configure a network management agent to
   aggregate the values of a user-specified set of Managed Object
   instances and to service queries related to the aggregated Managed
   Object instances.

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1. The Internet-Standard Management Framework

   For a detailed overview of the documents that describe the current
   Internet-Standard Management Framework, please refer to section 7 of
   RFC 3410 [RFC3410].

   Managed objects are accessed via a virtual information store, termed
   the Management Information Base or MIB. MIB objects are generally
   accessed through the Simple Network Management Protocol (SNMP).

   Objects in the MIB are defined using the mechanisms defined in the
   Structure of Management Information (SMI). This memo specifies a MIB
   module that is compliant to the SMIv2, which is described in STD 58,
   RFC 2578 [RFC2578], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580
   [RFC2580].

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
   document are to be interpreted as described in BCP 14, RFC 2119
   [RFC2119].

2. Background

   For the purpose of management, it is necessary to access Managed
   Objects (MOs). The SNMP framework provides a mechanism for naming
   and describing managed objects. These objects are accessed via a
   virtual information store termed a Management Information Base (MIB).
   MIBs have been defined by equipment, protocol, and application
   developers to provide management access to the managed entities. We
   will call the MOs defined in these MIBs simple MOs (SMO). Management
   applications will access one or more instances of these SMOs, one or
   more times, to monitor the target entity.

There is a cost associated with accessing MOs. The cost is the
network bandwidth and the packet header processing overhead at the
command generator (manager) and the command responder (agent). This
cost constrains the number of MO instances that can be polled and the
interval at which polling can be carried out.

The overhead reduction can be carried out by reducing the number of
query-response packets. This will reduce the packet processing
overhead, and to some extent, the bandwidth.

The payloads in a typical SNMP "get" packet and the corresponding
response are as shown in Figure 1. In this example, polling is
carried out for 'n' Managed Object instances OID1, OID2, ..., OIDn.
It is obvious that a substantial amount of the payload in an SNMP
packet consists of the OIDs.

3. MO Aggregation: The Concept

In this document, a mechanism of MO aggregation for payload
compression is defined. The idea is simple: we introduce the concept
of an Aggregate MO (AgMO). An AgMO is just another MO as far as the
SNMP protocol is concerned. No new protocol operations will be
required to handle these MOs. As in the case of any other MO, it
requires additional instrumentation at the command responder (agent)
and at the (command generator) manager. In this mechanism, the user
defines an Aggregate MO (AgMO) corresponding to one or more
(predefined) MO instances. Semantically, the value of an AgMO
instance will be equivalent to the concatenation of the values of the
corresponding MO instances. The order of the concatenation will be
determined by the order in which the MO instances are specified in
the AgMO definition. With the definitions done, the user can, as and
when the necessity arises, do an SNMP 'get' on instances of the AgMO
to fetch the value of the constituent MO instances. There is
substantial savings on bandwidth, as only one instance object
identifier is carried in the request and the response. In the normal
case, instance object identifiers for each of the constituent MO
instances would be carried in the requests and the responses. This
is the basic concept of Aggregate Managed Objects. For every AgMO,
an ErrorStatus Managed Object is defined. This MO indicates errors,
if any, that have been encountered while fetching the values of the
constituent MO instances. The error indication is comprised of the
index of the MO instance and the corresponding error. If there are
no errors, the ErrorStatus Managed Object instance will have a null
value. This is the basic concept of Aggregate Managed Objects.

The concepts are explained in Figure 2. An aggregate managed object,
AgMOx, has been defined for the MO instances MOI1, ... MOIn. The
value of an instance of AgMOx will be a concatenation of the values
of MOI1, ... MOIn, in that order.

   Polling for MO Instances [MOI1, MOI2, ... MOIn]:

```
            +--------+------+-------+... -+------+------+
     Query: |Get req | MOI1 | NULL  |     | MOIn | NULL |
            +--------+------+-------+... -+------+------+


            +--------+------+-------+... -+------+------+
  Response: |Get resp| MOI1 | Val1  |     | MOIn | Valn |
            +--------+------+-------+... -+------+------+
```

                 Figure 1. Polling for MO instances

   Polling for an instance (AgMOIx) of an aggregate MO (AgMOx):

   AgMOx = aggr{AgMOI1, AgMOI2, ...AgMOIn}

```
            +--------+--------+-------+
     Query: |Get req | AgMOIx | NULL  |
            +--------+--------+-------+


            +--------+--------+------------------------+
  Response: |Get resp| AgMOIx |     Val1,Val2,...,Valn |
            +--------+--------+------------------------+
```

                      Figure 2. MO aggregation

As a further refinement of the AgMO, we introduce the Time-Based
Aggregated Managed Object (TAgMO). The TAgMO is an MO that
represents the values of a user-specified MO instance sampled at
user-specified intervals for a user-specified number of times. In
this case, the user defines a TAgMO by specifying the MO instance
that needs to be sampled, the sampling interval, and the desired
number of samples that will be included in one TAgMO. The value of a
TAgMO instance will include the timestamp (sysUpTime) at which the
first sample was taken. The start time is not specified when the
TAgMO is defined. Implementations may choose to align the start time
with the appropriate time boundaries (e.g., seconds, minutes, hours).
With the definitions, the user can do an SNMP "get" on an instance of
the TAgMO to fetch the values of the constituent MO instance sampled
at the specified intervals. This is the concept of Time-Based
aggregation.

Polling for 'n' samples of an MO Instance [MOI] at an interval 'i':

```
                Query                Time          Response
                =====                ====          ========
    +--------+-----+-----------+
    |Get req | MOI |    NULL    | t
    +--------+-----+-----------+  :     +--------+-----+--------------+
                                  :     |Get resp| MOI |    Val(t)    |
                                  :     +--------+-----+--------------+
    +--------+-----+-----------+  t+i
    |Get req | MOI |    NULL    |  :
    +--------+-----+-----------+  :     +--------+-----+--------------+
                                  :     |Get resp| MOI |    Val(t+i)  |
                                  X     +--------+-----+--------------+
                                  X
                                  :
    +--------+-----+-----------+  t+(n-1)i
    |Get req | MOI |    NULL    |  :
    +--------+-----+-----------+  :     +--------+-----+--------------+
                                  :     |Get resp| MOI | Val(t+(n-1)i)|
                                        +--------+-----+--------------+
```

       Figure 3. Periodic polling for samples of an MO instance

Polling for an instance (TAgMOIx) of a Time-Based aggregate MO
(TAgMOx):

TAgMOx = aggr{'n' polled samples of an instance (MOI) of MO
            at intervals   = 'i' microseconds}

```
          +--------+---------+-------+
   Query: |Get req | TAgMOIx | NULL  |
          +--------+---------+-------+


          +--------+---------+------------------------------------+
Response: |Get resp| TAgMOIx | t,Val(t),Val(t+i),.,Val(t + (n-1)*i) |
          +--------+---------+------------------------------------+
```

              Figure 4. Time-Based aggregation

The TAgMO instance is a "bucket" of data representing the value of
the corresponding MO instance sampled at 'i' microsecond intervals,
'n' times (i.e., over a 'n' X 'i' microsecond window). The TAgMO
instance value gets updated at 'n' X 'i' microsecond intervals.

4. The Requirements for Managed Object Aggregation

   The general requirements of managed object aggregation are as
   follows:

      o It should lead to fewer packets.
      o It should lead to less bandwidth consumption.
      o It should not lead to loss of information.

   In the case of Time-Based aggregation, there will be a delay involved
   in getting the actual data. The minimum delay in this case will be
   the duration of the aggregation.

   The manager application is expected to configure AgMOs (Aggregate
   MOs) and TAgMOs (Time-Based Aggregate MOs) with care so that the
   response size is not too large. In case the resultant response size
   is larger than the maximum acceptable message size of the originator
   or larger than the local maximum message size, then the error-status
   field will be set to "tooBig".

   Note that an aggregate MO can be defined only when all the
   constituent MO instances of interest are known. This scheme cannot
   be employed if a manager/application does not know the specific MO
   instances (of interest) that are serviced by the management target.
   In such cases, the application may "discover" the MO instances of
   interest by some means, e.g., by "walking" through the MIB tree on
   the agent. According to the results of the "walk", the application
   can define an appropriate aggregate MO that will serve the purpose.
   Considering the cost involved in this exercise, this method is
   recommended only if the aggregate MO will be used repeatedly, so that
   the benefits of aggregation outweigh the costs of configuration.

5. MIB Design

   The basic principle has been to keep the MIB as simple as possible
   and at the same time to make it flexible enough that a large number
   of users and applications can use the MIB to configure aggregate MOs
   conveniently.

   Two separate MIB modules have been defined. The AggrMIB supports the
   aggregation of independent MO instances, while TAggrMIB supports the
   aggregation of several samples of the same MO instance. Both of
   these MIB modules use the textual conventions defined in RMON-MIB
   [RFC2819] and SNMP-FRAMEWORK-MIB [RFC3411].

The AggrMIB is comprised of three tables, described below.

- The aggrCtlTable controls the aggregation process. Each row in
  this table defines the attributes of the aggregate object defined
  in the aggrMOTable.

- The aggrMOTable defines the primary MO-based aggregation, i.e.,
  the MOs that will be aggregated.

- The aggrDataTable contains the details of the aggregated object.

The TAggrMIB is comprised of two tables described below.

- The tAggrCtlTable controls the aggregation process. Each row in
  this table defines the attributes of the aggregate object defined
  in the aggrMOTable.

- The tAggrDataTable contains the details of the aggregated object.

6. The Aggregation MIB Modules

```
    AGGREGATE-MIB DEFINITIONS ::= BEGIN
     IMPORTS
       MODULE-IDENTITY,  experimental, Unsigned32,
       OBJECT-TYPE, Opaque
                 FROM SNMPv2-SMI
       OwnerString
                 FROM RMON-MIB
       RowStatus, StorageType, TEXTUAL-CONVENTION
                 FROM SNMPv2-TC
       MODULE-COMPLIANCE, OBJECT-GROUP
                 FROM SNMPv2-CONF
       SnmpAdminString
                 FROM SNMP-FRAMEWORK-MIB;

    aggrMIB MODULE-IDENTITY
        LAST-UPDATED "200604270000Z"         --  27th April, 2006
        ORGANIZATION "Cyber Solutions Inc. NetMan Working Group"
        CONTACT-INFO
        "                       Glenn Mansfield Keeni
                       Postal: Cyber Solutions Inc.
                               6-6-3, Minami Yoshinari
                               Aoba-ku, Sendai, Japan 989-3204.
                          Tel: +81-22-303-4012
                          Fax: +81-22-303-4015
                       E-mail: glenn@cysols.com

           Support Group E-mail: mibsupport@cysols.com"
```

           DESCRIPTION
                   "The MIB for servicing aggregate objects.

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                    version of this MIB module is part of RFC 4498;
                    see the RFC itself for full legal notices.
                   "
           REVISION   "200604270000Z"   -- 27th April, 2006
           DESCRIPTION "Initial version, published as RFC 4498."
                ::= { experimental 123 }

      AggrMOErrorStatus ::= TEXTUAL-CONVENTION
        STATUS   current
        DESCRIPTION
          "This data type is used to model the error status of the
          constituent MO instances. The error status for a
          constituent MO instance is given in terms of two elements:
              o The moIndex, which indicates the position of the MO
                instance (starting at 1) in the value of the aggregated
                MO instance.
              o The moError, which indicates the error that was
                encountered in fetching that MO instance.
          The syntax in ASN.1 Notation will be
          ErrorStatus :: = SEQUENCE {
             moIndex Integer32,
             moError SnmpPduErrorStatus
          }
          AggrMOErrorStatus ::= SEQUENCE OF {
             ErrorStatus
          }
          Note1: The command responder will supply values for all
                  constituent MO instances, in the same order in
                  which the MO instances are specified for the AgMO.
                  If an error is encountered for an MO instance, then
                  the corresponding value will have an ASN.1 value NULL,
                  and an error will be flagged in the corresponding
                  AggrMOErrorStatus object.
                  Only MOs for which errors have been encountered will
                  have their corresponding moIndex and moError values
                  set.
          Note2: The error code for the component MO instances will be
                  in accordance with the SnmpPduErrorStatus TC defined
                  in the DISMAN-SCHEDULE-MIB [RFC3231].
          Note3: The command generator will need to know
                  constituent MO instances and their order to correctly
                  interpret AggrMOErrorStatus.
          "
        SYNTAX   Opaque (SIZE (0..1024))

```
    AggrMOValue ::= TEXTUAL-CONVENTION
      STATUS        current
      DESCRIPTION
        "This data type is used to model the aggregate
        MOs.  It will have a format dependent on the constituent
        MOs, a sequence of values.  The syntax in ASN.1 Notation will
        be
        MOValue :: = SEQUENCE {
             value ObjectSyntax
        }
        where 'value' is the value of a constituent MO instance.
        AggrMOValue :: = SEQUENCE OF {
            MOValue
        }

        Note: The command generator will need to know the
        constituent MO instances and their order to
        correctly interpret AggrMOValue."
      SYNTAX        Opaque (SIZE (0..1024))

    AggrMOCompressedValue ::= TEXTUAL-CONVENTION
      STATUS        current
      DESCRIPTION
        "This data type is used to model the compressed
        aggregate MOs."
      SYNTAX        OCTET STRING (SIZE (0..1024))

  --
  -- The aggregation control table
  -- There will be a row for each aggregate MO
  --
    aggrCtlTable OBJECT-TYPE
        SYNTAX   SEQUENCE OF AggrCtlEntry
        MAX-ACCESS  not-accessible
        STATUS current
        DESCRIPTION
          "A table that controls the aggregation of the MOs."
        ::= {aggrMIB 1}

     aggrCtlEntry OBJECT-TYPE
        SYNTAX  AggrCtlEntry
        MAX-ACCESS  not-accessible
        STATUS  current
        DESCRIPTION
          "A row of the control table that defines one aggregated
           MO.
```

             Entries in this table are required to survive a reboot
             of the managed entity depending on the value of the
             corresponding aggrCtlEntryStorageType instance.
            "
         INDEX {aggrCtlEntryID }
         ::= {aggrCtlTable 1 }

      AggrCtlEntry ::= SEQUENCE {
         aggrCtlEntryID
                     SnmpAdminString,
         aggrCtlMOIndex
                     Unsigned32,
         aggrCtlMODescr
                     SnmpAdminString,
         aggrCtlCompressionAlgorithm
                     INTEGER,
         aggrCtlEntryOwner
                     OwnerString,
         aggrCtlEntryStorageType
                     StorageType,
         aggrCtlEntryStatus
                     RowStatus
      }

     aggrCtlEntryID OBJECT-TYPE
         SYNTAX SnmpAdminString (SIZE(1..32))
         MAX-ACCESS not-accessible
         STATUS current
         DESCRIPTION
           "A locally unique, administratively assigned name
            for this aggregated MO. It is used as an index to
            uniquely identify this row in the table."
         ::= { aggrCtlEntry 1 }

     aggrCtlMOIndex OBJECT-TYPE
         SYNTAX Unsigned32 (1..2147483647)
         MAX-ACCESS read-create
         STATUS current
         DESCRIPTION
           "A pointer to a group of MOs identified by aggrMOEntryID
            in the aggrMOTable. This is the group of MOs that will
            be aggregated."
         ::= { aggrCtlEntry 2 }

     aggrCtlMODescr OBJECT-TYPE
         SYNTAX SnmpAdminString (SIZE(0..64))
         MAX-ACCESS read-create
         STATUS current

```
       DESCRIPTION
         "A textual description of the object that is
          being aggregated."
       ::= {aggrCtlEntry 3}

   -- only one compression algorithm is defined as of now.
   aggrCtlCompressionAlgorithm OBJECT-TYPE
       SYNTAX INTEGER {
               none      (1),
               deflate   (2)
       }
       MAX-ACCESS read-create
       STATUS current
       DESCRIPTION
         "The compression algorithm that will be used by
          the agent to compress the value of the aggregated
          object.
          The deflate algorithm and corresponding data format
          specification is described in RFC 1951.  It is
          compatible with the widely used gzip utility.
          "
       REFERENCE
         "RFC1951 : DEFLATE Compressed Data Format Specification
          version 1.3
          "
       DEFVAL { none }
       ::= {aggrCtlEntry 4}

   aggrCtlEntryOwner OBJECT-TYPE
       SYNTAX OwnerString
       MAX-ACCESS read-create
       STATUS current
       DESCRIPTION
         "The entity that created this entry."
       ::= {aggrCtlEntry 5}

   aggrCtlEntryStorageType OBJECT-TYPE
       SYNTAX StorageType
       MAX-ACCESS read-create
       STATUS current
       DESCRIPTION
          "This object defines whether the parameters defined in
           this row are kept in volatile storage and lost upon
           reboot or backed up by non-volatile (permanent)
           storage.

           Conceptual rows having the value 'permanent' need not
           allow write-access to any columnar objects in the row.
```

```
                     "
                 ::= {aggrCtlEntry 6}

         aggrCtlEntryStatus OBJECT-TYPE
             SYNTAX RowStatus
             MAX-ACCESS read-create
             STATUS current
             DESCRIPTION
                 "The row status variable, used according to row
                  installation and removal conventions.
                  Objects in a row can be modified only when the value of
                  this object in the corresponding conceptual row is not
                  'active'.
                  Thus, to modify one or more of the objects in this
                  conceptual row,
                     a. change the row status to 'notInService',
                     b. change the values of the row, and
                     c. change the row status to 'active'.
                  The aggrCtlEntryStatus may be changed to 'active' if
                  all the MOs in the conceptual row have been assigned
                  valid values.
                 "
             ::= {aggrCtlEntry 7}

   --
   -- The Table of primary(simple) MOs
   --
       aggrMOTable OBJECT-TYPE
             SYNTAX   SEQUENCE OF AggrMOEntry
             MAX-ACCESS  not-accessible
             STATUS current
             DESCRIPTION
                 "The table of primary(simple) MOs that will be aggregated.
                  Each row in this table represents a MO that will be
                  aggregated.  The aggrMOEntryID index is used to identify
                  the group of MOs that will be aggregated.  The
                  aggrMOIndex instance in the corresponding row of the
                  aggrCtlTable will have a value equal to the value of
                  aggrMOEntryID.  The aggrMOEntryMOID index is used to
                  identify an MO in the group.
                 "
             ::= {aggrMIB 2}

        aggrMOEntry OBJECT-TYPE
             SYNTAX  AggrMOEntry
             MAX-ACCESS  not-accessible
             STATUS  current
             DESCRIPTION
```

```
             "A row of the table that specifies one MO.
              Entries in this table are required to survive a reboot
              of the managed entity depending on the value of the
              corresponding aggrMOEntryStorageType instance.
              "
          INDEX { aggrMOEntryID, aggrMOEntryMOID }
          ::= {aggrMOTable 1 }

     AggrMOEntry ::= SEQUENCE {
        aggrMOEntryID
                        Unsigned32,
        aggrMOEntryMOID
                        Unsigned32,
        aggrMOInstance
                        OBJECT IDENTIFIER,
        aggrMODescr
                        SnmpAdminString,
        aggrMOEntryStorageType
                        StorageType,
        aggrMOEntryStatus
                        RowStatus
     }

     aggrMOEntryID OBJECT-TYPE
         SYNTAX Unsigned32 (1..2147483647)
         MAX-ACCESS not-accessible
         STATUS current
         DESCRIPTION
           "An index uniquely identifying a group of MOs
            that will be aggregated."
         ::= { aggrMOEntry 1 }

     aggrMOEntryMOID OBJECT-TYPE
         SYNTAX Unsigned32 (1..65535)
         MAX-ACCESS not-accessible
         STATUS current
         DESCRIPTION
           "An index to uniquely identify an MO instance in the
            group of MO instances that will be aggregated."
         ::= { aggrMOEntry 2 }

     aggrMOInstance OBJECT-TYPE
         SYNTAX OBJECT IDENTIFIER
         MAX-ACCESS read-create
         STATUS current
         DESCRIPTION
           "The OID of the MO instance, the value of which will
            be sampled by the agent."
```

```
              ::= { aggrMOEntry 3 }

      aggrMODescr OBJECT-TYPE
           SYNTAX SnmpAdminString (SIZE(0..64))
           MAX-ACCESS read-create
           STATUS current
           DESCRIPTION
              "A textual description of the object that will
               be aggregated."
           ::= {aggrMOEntry 4}

      aggrMOEntryStorageType OBJECT-TYPE
           SYNTAX StorageType
           MAX-ACCESS read-create
           STATUS current
           DESCRIPTION
              "This object defines whether the parameters defined in
               this row are kept in volatile storage and lost upon
               reboot or backed up by non-volatile (permanent)
               storage.
               Conceptual rows having the value 'permanent' need not
               allow write-access to any columnar objects in the row.
               "
           ::= {aggrMOEntry 5}

      aggrMOEntryStatus OBJECT-TYPE
           SYNTAX RowStatus
           MAX-ACCESS read-create
           STATUS current
           DESCRIPTION
              "The row status variable, used according to row
               installation and removal conventions.
               Objects in a row can be modified only when the value of
               this object in the corresponding conceptual row is not
               'active'.
               Thus, to modify one or more of the objects in this
               conceptual row,
                 a. change the row status to 'notInService',
                 b. change the values of the row, and
                 c. change the row status to 'active'.
               The aggrMOEntryStatus may be changed to 'active' iff
               all the MOs in the conceptual row have been assigned
               valid values.
               "
           ::= {aggrMOEntry 6}

      --
      -- aggrDataTable: The Table of Data.  Each row represents a Data
```

```
     --                  set.  aggrCtlEntryID is the key to the table.
     --                  It is used to identify instances of the
     --                  aggregated MO that are present in the table.
     --
     aggrDataTable OBJECT-TYPE
         SYNTAX   SEQUENCE OF AggrDataEntry
         MAX-ACCESS  not-accessible
         STATUS   current
         DESCRIPTION
            "Each row of this table contains information
             about an aggregateMO indexed by aggrCtlEntryID."
         ::= {aggrMIB 3}

     aggrDataEntry OBJECT-TYPE
         SYNTAX   AggrDataEntry
         MAX-ACCESS  not-accessible
         STATUS   current
         DESCRIPTION
            "Entry containing information pertaining to
             an aggregate MO."
         INDEX {aggrCtlEntryID}
         ::= {aggrDataTable 1 }

     AggrDataEntry ::= SEQUENCE {
        aggrDataRecord
                  AggrMOValue,
        aggrDataRecordCompressed
                  AggrMOCompressedValue,
        aggrDataErrorRecord
                  AggrMOErrorStatus
        }

     aggrDataRecord OBJECT-TYPE
         SYNTAX AggrMOValue
         MAX-ACCESS read-only
         STATUS current
         DESCRIPTION
           "The snapshot value of the aggregated MO.
            Note that the access privileges to this object will be
            governed by the access privileges of the component
            objects.  Thus, an entity attempting to access an
            instance of this MO MUST have access rights to all the
            component instance objects and this MO instance.
            "
         ::= { aggrDataEntry 1}

     aggrDataRecordCompressed OBJECT-TYPE
         SYNTAX AggrMOCompressedValue
```

```
            MAX-ACCESS read-only
            STATUS current
            DESCRIPTION
              "The compressed value of the aggregated MO.
               The compression algorithm will depend on the
               aggrCtlCompressionAlgorithm given in the corresponding
               aggrCtlEntry.  If the value of the corresponding
               aggrCtlCompressionAlgorithm is (1) 'none', then the value
               of all instances of this object will be a string of zero
               length.
               Note that the access privileges to this object will be
               governed by the access privileges of the component
               objects.  Thus, an entity attempting to access an instance
               of this MO MUST have access rights to all the component
               instance objects and this MO instance.
              "
            ::= { aggrDataEntry 2}

     aggrDataErrorRecord OBJECT-TYPE
            SYNTAX AggrMOErrorStatus
            MAX-ACCESS read-only
            STATUS current
            DESCRIPTION
              "The error status corresponding to the MO instances
               aggregated in aggrDataRecord (and
               aggrDataRecordCompressed)."
            ::= { aggrDataEntry 3}

      -- Conformance information
     aggrConformance OBJECT IDENTIFIER ::= { aggrMIB 4 }
     aggrGroups      OBJECT IDENTIFIER ::= { aggrConformance 1 }
     aggrCompliances OBJECT IDENTIFIER ::= { aggrConformance 2 }

      -- Compliance statements
     aggrMibCompliance MODULE-COMPLIANCE
            STATUS  current
            DESCRIPTION
                    "The compliance statement for SNMP entities
                     that implement the AGGREGATE-MIB."
            MODULE  -- this module
                MANDATORY-GROUPS { aggrMibBasicGroup }
            ::= { aggrCompliances 1 }

      -- Units of conformance
     aggrMibBasicGroup    OBJECT-GROUP
            OBJECTS {
                        aggrCtlMOIndex,
                        aggrCtlMODescr,
```

```
                    aggrCtlCompressionAlgorithm,
                    aggrCtlEntryOwner,
                    aggrCtlEntryStorageType,
                    aggrCtlEntryStatus,
                    aggrMOInstance,
                    aggrMODescr,
                    aggrMOEntryStorageType,
                    aggrMOEntryStatus,
                    aggrDataRecord,
                    aggrDataRecordCompressed,
                    aggrDataErrorRecord
          }
           STATUS  current
           DESCRIPTION
                   "A collection of objects for aggregation of MOs."
          ::= { aggrGroups 1 }
     END


     TIME-AGGREGATE-MIB DEFINITIONS ::= BEGIN
      IMPORTS
        MODULE-IDENTITY,  experimental,
        OBJECT-TYPE,      Opaque, Integer32
                   FROM SNMPv2-SMI
        OwnerString
                   FROM RMON-MIB
        RowStatus, StorageType, TEXTUAL-CONVENTION
                   FROM SNMPv2-TC
        MODULE-COMPLIANCE, OBJECT-GROUP
                   FROM SNMPv2-CONF
        SnmpAdminString
                   FROM SNMP-FRAMEWORK-MIB;

    tAggrMIB MODULE-IDENTITY
        LAST-UPDATED "200604270000Z"      --  27 April 2006
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             DESCRIPTION
```

```
                     "The MIB for servicing Time-Based aggregate
                       objects.

                       Copyright (C) The Internet Society (2006).  This
                       version of this MIB module is part of RFC 4498;
                       see the RFC itself for full legal notices.
                      "
             REVISION      "200604270000Z"      -- 27th April, 2006
             DESCRIPTION "Initial version, published as RFC 4498."
                   ::= { experimental 124 }

     TAggrMOErrorStatus ::= TEXTUAL-CONVENTION
       STATUS         current
       DESCRIPTION
         "This data type is used to model the error status of the
         sampled MO instance.  The error status for a sampled MO
         instance is given in terms of two elements:
            o The moIndex, which indicates the sample number of the MO
              instance (starting at 1) in the value of the time-
              aggregated MO instance.
            o The moError, which indicates the error that was
              encountered in sampling that MO instance.
         The syntax in ASN.1 Notation will be
         ErrorStatus :: = SEQUENCE {
            moIndex  Integer32,
            moError  SnmpPduErrorStatus
         }
         TAggrMOErrorStatus ::= SEQUENCE OF {
            ErrorStatus
         }
         Note1: The command responder will supply values for all
                 the samples of the MO instance.  If an error is
                 encountered for a sample, then the corresponding
                 value will have an ASN.1 value NULL, and an error
                 will be flagged in the corresponding
                 TAggrMOErrorStatus object.
                 Only MOs for which errors have been encountered will
                 the corresponding moIndex and moError values be set.
         Note2: The error code for the component MO instances will be
                 in accordance with the SnmpPduErrorStatus TC defined
                 in the DISMAN-SCHEDULE-MIB[RFC3231].
          "
       SYNTAX         Opaque (SIZE (0..1024))

     TimeAggrMOValue ::= TEXTUAL-CONVENTION
       STATUS         current
       DESCRIPTION
         "This data type is used to model the time-aggregated MOs.  It
```

```
        will be a sequence of values.  The syntax in ASN.1 Notation
        will be
        MOSampleValue :: = SEQUENCE {
             value ObjectSyntax
        }
        TimeAggrMOValue ::= SEQUENCE OF {
             MOSampleValue
        }
        where the first MOSampleValue, if any, will always be the
        timestamp of the first sample in the aggregated object.  The
        subsequent values are the values of the MO instance sampled
        at the specified intervals for the specified number of times.
        Note: The command generator will need to know the
              constituent MO instance and the sampling interval to
              correctly interpret TimeAggrMOValue.
         "
      SYNTAX       Opaque (SIZE (0..1024))

   CompressedTimeAggrMOValue ::= TEXTUAL-CONVENTION
     STATUS        current
     DESCRIPTION
       "This data type is used to model the compressed
       TAgMOs."
     SYNTAX       Opaque (SIZE (0..1024))

 --
 -- The Time-Based aggregation control table
 --
   tAggrCtlTable OBJECT-TYPE
       SYNTAX   SEQUENCE OF TAggrCtlEntry
       MAX-ACCESS  not-accessible
       STATUS current
       DESCRIPTION
          "The Time-Based aggregation control table.  It controls
           the aggregation of the samples of MO instances.  There
           will be a row for each TAgMO.
          "
       ::= {tAggrMIB 1}

    tAggrCtlEntry OBJECT-TYPE
       SYNTAX   TAggrCtlEntry
       MAX-ACCESS  not-accessible
       STATUS   current
       DESCRIPTION
         "A row of the control table that defines one Time-Based
          aggregate MO (TAgMO)."
       INDEX {tAggrCtlEntryID }
       ::= {tAggrCtlTable 1 }
```

```
     TAggrCtlEntry ::= SEQUENCE {
        tAggrCtlEntryID
                    SnmpAdminString,
        tAggrCtlMOInstance
                    OBJECT IDENTIFIER,
        tAggrCtlAgMODescr
                    SnmpAdminString,
        tAggrCtlInterval
                    Integer32,
        tAggrCtlSamples
                    Integer32,
        tAggrCtlCompressionAlgorithm
                    INTEGER,
        tAggrCtlEntryOwner
                    OwnerString,
        tAggrCtlEntryStorageType
                    StorageType,
        tAggrCtlEntryStatus
                    RowStatus
      }

     tAggrCtlEntryID OBJECT-TYPE
         SYNTAX SnmpAdminString (SIZE(1..32))
         MAX-ACCESS not-accessible
         STATUS current
         DESCRIPTION
           "A locally unique, administratively assigned name
            for this aggregated MO.  It is used as an index to
            uniquely identify this row in the table."
         ::= { tAggrCtlEntry 1 }

     tAggrCtlMOInstance OBJECT-TYPE
         SYNTAX OBJECT IDENTIFIER
         MAX-ACCESS read-create
         STATUS current
         DESCRIPTION
           "The sampled values of this MO instance will be
            aggregated by the TAgMO.
            "
         ::= { tAggrCtlEntry 2 }

     tAggrCtlAgMODescr OBJECT-TYPE
         SYNTAX SnmpAdminString (SIZE(0..64))
         MAX-ACCESS read-create
         STATUS current
         DESCRIPTION
           "A textual description of the aggregate object."
         ::= {tAggrCtlEntry 3}
```

```
    tAggrCtlInterval OBJECT-TYPE
        SYNTAX Integer32
        UNITS  "micro seconds"
        MAX-ACCESS read-create
        STATUS current
        DESCRIPTION
           "The interval, in microseconds, at which the MO instance
            pointed at by tAggrInstance will be sampled for
            Time-Based aggregation.
          "
        ::= {tAggrCtlEntry 4}

    tAggrCtlSamples OBJECT-TYPE
        SYNTAX Integer32
        MAX-ACCESS read-create
        STATUS current
        DESCRIPTION
           "The number of times at which the MO instance referred
            to by tAggrInstance will be sampled for Time-Based
            aggregation."
        ::= {tAggrCtlEntry 5}

    -- only one compression algorithm is defined as of now.
    tAggrCtlCompressionAlgorithm OBJECT-TYPE
        SYNTAX INTEGER {
                none      (1),
                deflate   (2)
        }
        MAX-ACCESS read-create
        STATUS current
        DESCRIPTION
           "The compression algorithm that will be used by
            the agent to compress the value of the TAgMO.
            The deflate algorithm and corresponding data format
            specification is described in RFC 1951.  It is
            compatible with the widely used gzip utility.
          "
        REFERENCE
          "RFC1951 : DEFLATE Compressed Data Format Specification
           version 1.3
          "
        DEFVAL { none }
        ::= {tAggrCtlEntry 6}

    tAggrCtlEntryOwner OBJECT-TYPE
        SYNTAX OwnerString
        MAX-ACCESS read-create
        STATUS current
```

          DESCRIPTION
             "A textual description of the entity that created
              this entry.
             "
          ::= {tAggrCtlEntry 7}

      tAggrCtlEntryStorageType OBJECT-TYPE
          SYNTAX StorageType
          MAX-ACCESS read-create
          STATUS current
          DESCRIPTION
             "This object defines whether the parameters defined in
              this row are kept in volatile storage and lost upon
              reboot or backed up by non-volatile (permanent)
              storage.
              Conceptual rows having the value 'permanent' need not
              allow write-access to any columnar objects in the row.
             "
          ::= {tAggrCtlEntry 8}

      tAggrCtlEntryStatus OBJECT-TYPE
          SYNTAX RowStatus
          MAX-ACCESS read-create
          STATUS current
          DESCRIPTION
             "The row status variable, used according to row
              installation and removal conventions.
              Objects in a row can be modified only when the value of
              this object in the corresponding conceptual row is not
              'active'.
              Thus, to modify one or more of the objects in this
              conceptual row,
                a. change the row status to 'notInService',
                b. change the values of the row, and
                c. change the row status to 'active'.
              The tAggrCtlEntryStatus may be changed to 'active' iff
              all the MOs in the conceptual row have been assigned
              valid values.
             "
          ::= {tAggrCtlEntry 9}

      --
      -- tAggrDataTable: The data table.
      --
      tAggrDataTable OBJECT-TYPE
          SYNTAX   SEQUENCE OF TAggrDataEntry

```
            MAX-ACCESS  not-accessible
            STATUS  current
            DESCRIPTION
              "This is the data table.  Each row of this table contains
               information about a TAgMO indexed by tAggrCtlEntryID.
               tAggrCtlEntryID is the key to the table.  It is used to
               identify instances of the TAgMO that are present in the
               table.
             "
            ::= {tAggrMIB 2}

       tAggrDataEntry OBJECT-TYPE
            SYNTAX  TAggrDataEntry
            MAX-ACCESS  not-accessible
            STATUS  current
            DESCRIPTION
              "Entry containing information pertaining
               to a TAgMO."
            INDEX {tAggrCtlEntryID}
            ::= {tAggrDataTable 1 }

       TAggrDataEntry ::= SEQUENCE {
          tAggrDataRecord
                    TimeAggrMOValue,
          tAggrDataRecordCompressed
                    CompressedTimeAggrMOValue,
          tAggrDataErrorRecord
                    TAggrMOErrorStatus
          }

       tAggrDataRecord OBJECT-TYPE
            SYNTAX TimeAggrMOValue
            MAX-ACCESS read-only
            STATUS current
            DESCRIPTION
              "The snapshot value of the TAgMO."
            ::= { tAggrDataEntry 1}

       tAggrDataRecordCompressed OBJECT-TYPE
            SYNTAX CompressedTimeAggrMOValue
            MAX-ACCESS read-only
            STATUS current
            DESCRIPTION
              "The compressed value of the TAgMO.
               The compression algorithm will depend on the
               tAggrCtlCompressionAlgorithm given in the corresponding
               tAggrCtlEntry.  If the value of the corresponding
               tAggrCtlCompressionAlgorithm is (1) 'none', then the
```

             value of all instances of this object will be a string
             of zero length.
             Note that the access privileges to this object will be
             governed by the access privileges of the corresponding MO
             instance. Thus, an entity attempting to access an
             instance of this MO MUST have access rights to the
             instance object pointed at by tAggrCtlMOInstance and this
             MO instance.
            "
         ::= { tAggrDataEntry 2}

     tAggrDataErrorRecord OBJECT-TYPE
         SYNTAX TAggrMOErrorStatus
         MAX-ACCESS read-only
         STATUS current
         DESCRIPTION
            "The error status corresponding to the MO instance
             samples aggregated in tAggrDataRecord (and
             tAggrDataRecordCompressed)."
         ::= { tAggrDataEntry 3}

      -- Conformance information
     tAggrConformance OBJECT IDENTIFIER ::= { tAggrMIB 3 }
     tAggrGroups   OBJECT IDENTIFIER ::= { tAggrConformance 1 }
     tAggrCompliances OBJECT IDENTIFIER ::= { tAggrConformance 2 }

      -- Compliance statements
     tAggrMibCompliance MODULE-COMPLIANCE
         STATUS   current
         DESCRIPTION
                 "The compliance statement for SNMP entities
                  that implement the TIME-AGGREGATE-MIB."
         MODULE   -- this module
             MANDATORY-GROUPS { tAggrMibBasicGroup }
         ::= { tAggrCompliances 1 }

       -- Units of conformance
     tAggrMibBasicGroup   OBJECT-GROUP
         OBJECTS {
                   tAggrCtlMOInstance,
                   tAggrCtlAgMODescr,
                   tAggrCtlInterval,
                   tAggrCtlSamples,
                   tAggrCtlCompressionAlgorithm,
                   tAggrCtlEntryOwner,
                   tAggrCtlEntryStorageType,
                   tAggrCtlEntryStatus,

```
                            tAggrDataRecord,
                            tAggrDataRecordCompressed,
                            tAggrDataErrorRecord
            }
              STATUS   current
              DESCRIPTION
                        "A collection of objects for Time-Based aggregation
                         of MOs."
              ::= { tAggrGroups 1 }
        END
```

7. Security Considerations

There are management objects in the MIB modules defined in this
document that have a MAX-ACCESS clause of read-create. Such objects
may be considered sensitive or vulnerable in some network
environments. The support for SET operations in a non-secure
environment without proper protection can have a negative effect on
network operations. The objects and corresponding vulnerabilities
are discussed below.

The following MOs are used to configure an agent that implements the
aggregate MIB modules.

```
        aggrCtlMOIndex,
        aggrCtlMODescr,
        aggrCtlCompressionAlgorithm,
        aggrCtlEntryOwner,
        aggrCtlEntryStorageType,
        aggrCtlEntryStatus,
        aggrMOInstance,
        aggrMODescr,
        aggrMOEntryStorageType,
        aggrMOEntryStatus,
        tAggrCtlMOInstance,
        tAggrCtlAgMODescr,
        tAggrCtlInterval,
        tAggrCtlSamples,
        tAggrCtlCompressionAlgorithm,
        tAggrCtlEntryOwner,
        tAggrCtlEntryStorageType,
        tAggrCtlEntryStatus,
```

Access to these objects may be abused to affect the operation of the
data collection system. In particular,

   - by changing the value of an instance of aggrCtlEntryStatus,
      tAggrCtlEntryStatus, aggrMOEntryStatus, or tAggrMOEntryStatus
      to 'notInService' or 'destroy', the data aggregation operation
      for the corresponding entry will become unavailable to the
      management system.

   - by changing the value of an instance of aggrMOInstance or
      tAggrCtlMOInstance, the data aggregation operation may be
      subverted. This may result in wrong information being fed to
      the management system.

   - by adding several rows in the aggrMOTable corresponding to an
      aggregate MO, it is possible to make the value of the aggregate
      MOs very large. A similar effect may be achieved by
      manipulating the value of the tAggrCtlSamples instance
      corresponding to a Time-Based aggregate MO. This could result
      in very heavy management traffic and/or fragmentation of
      response packets. In some cases the responder may refuse to
      send the data and will simply respond with an error message
      indicating that the response packet size is too big.

An entity attempting to access an instance of an aggregated MO MUST
have access rights to all the component instance objects and the
aggregate MO instance. An implementation MUST follow this
requirement. Lax adherence to this requirement will breach the
security model and make the system vulnerable to illegal accesses.

SNMP versions prior to SNMPv3 did not include adequate security.
Even if the network itself is secure (for example by using IPSec),
there is no control as to who on the secure network is allowed to
access and GET/SET (read/change/create/delete) the objects in this
MIB module.

It is RECOMMENDED that implementers consider the security features as
provided by the SNMPv3 framework (see [RFC3410], section 8),
including full support for the SNMPv3 cryptographic mechanisms (for
authentication and privacy).

Further, deployment of SNMP versions prior to SNMPv3 is NOT
RECOMMENDED. Instead, it is RECOMMENDED to deploy SNMPv3 and to
enable cryptographic security. It is then a customer/operator
responsibility to ensure that the SNMP entity giving access to an
instance of this MIB module is properly configured to give access to
the objects only to those principals (users) that have legitimate
rights to indeed GET or SET (change/create/delete) them.

8. IANA Considerations

   The MIB modules in this document use the following IANA-assigned
   OBJECT IDENTIFIER values, recorded in the SMI Numbers registry:

   Descriptor   OBJECT IDENTIFIER value
   ----------   -----------------------
   aggrMIB   { experimental 123 }
   tAggrMIB   { experimental 124 }

9. References

9.1. Normative References

   [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate
             Requirement Levels", BCP 14, RFC 2119, March 1997.

   [RFC2578] McCloghrie, K., Perkins, D., and J. Schoenwaelder,
             "Structure of Management Information Version 2 (SMIv2)",
             STD 58, RFC 2578, April 1999.

   [RFC2579] McCloghrie, K., Perkins, D., and J. Schoenwaelder, "Textual
             Conventions for SMIv2", STD 58, RFC 2579, April 1999.

   [RFC2580] McCloghrie, K., Perkins, D., and J. Schoenwaelder,
             "Conformance Statements for SMIv2", STD 58, RFC 2580, April
             1999.

   [RFC2819] Waldbusser, S., "Remote Network Monitoring Management
             Information Base", STD 59, RFC 2819, May 2000.

   [RFC3411] Harrington, D., Presuhn, R., and B. Wijnen, "An
             Architecture for Describing Simple Network Management
             Protocol (SNMP) Management Frameworks", STD 62, RFC 3411,
             December 2002.

   [RFC3231] Levi, D. and J. Schoenwaelder, "Definitions of Managed
             Objects for Scheduling Management Operations", RFC 3231,
             January 2002.

   [RFC1951] Deutsch, P., "DEFLATE Compressed Data Format Specification
             version 1.3", RFC 1951, May 1996.

9.2. Informative References

   [RFC3410] Case, J., Mundy, R., Partain, D., and B. Stewart,
             "Introduction and Applicability Statements for Internet-
             Standard Management Framework", RFC 3410, December 2002.

10. Acknowledgements

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   out in the WIDE-netman group. Bert Wijnen and Glenn Waters reviewed
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