The Managed Object Aggregation MIB

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Abstract

this memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it is used to configure an agent to aggregate MOs and to service queries related to the aggregated MOs.
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1. Introduction.

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 of these MOs one or more times to monitor the target entity.

There is a cost associated with polling. 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 objects 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 Fig. 1. In the example shown in the figure polling is carried out for 'n' Managed Objects (MOs) OID1, OID2, .., OIDn. It is obvious that a substantial amount of the payload in an SNMP packet consists of the OIDs. In [ODC-Dft] OID compression has been proposed by using the OID Delta Compression mechanism.

In this draft a mechanism of MO aggregation for payload compression is defined. In this mechanism the user defines a new MO - an aggregate MO corresponding to one or more predefined MOs. Semantically, the aggregate MO will be equivalent to the concatenation of the ascii text value of the (user) specified MOs separated by a (user) specified separator. We will call this MO-based aggregation.

In another mode of usage the aggregate MOs may be defined so that they represent the ascii values of a (user) specified MO polled at (user) specified intervals for a (user) specified number of times, each value separated by a (user) specified separator. We will call this time-based aggregation.

The concept is explained in Fig. 2. An aggregate managed object OIDx has been defined. The value of OIDx will be a concatenation of the values of OID1, ... OIDn each separated by the specified separator, in that order.
Polling for primary MOs [OID1, OID2, … OIDn] :

Query: | Get req | OID1 | NULL | | OIDn | NULL |
+--------+-------+-------+... -+-------+-------|

Response: | Get resp | OID1 | Val1 | | OIDn | Valn |
+--------+-------+-------+... -+-------+-------|

Fig. 1 Polling for primary MOs

Polling for an aggregate MO [OIDx]:
OIDx = aggr{OID1, OID2, ……OIDn,
separator = ‘,’}

Query: | Get req | OIDx | NULL |
+--------+-------+-------|

Response: | Get resp | OIDx | Val1,Val2,…,Valn |
+--------+-------+------------------------|

Fig. 2 MO-based aggregation

Polling for an aggregate MO [OIDx]:
OIDx = aggr{‘n’ polled samples of OID
at intervals = ‘t’,
separator = ‘,’}

Query: | Get req | OIDx | NULL |
+--------+-------+-------|

Response: | Get resp | OIDx | t,Val(t),Val(t+i),…,Val(t + n-1)*i |
+--------+-------+---------------------------------------|

Fig. 3 Time-based aggregation
Fig. 3 shows the concept of time-based aggregation. The aggregate MO OIDx aggregates the ‘n’ consecutive samples of OID at intervals indicating the start time at which the first sampling was done.

An aggregate object will generally have a large size and may be optionally compressed to achieve further compression, albeit at the cost of a few more cpu cycles.

This mechanism does not require any change to the SNMP framework. It will require additional instrumentation at the command generator and command responder.
2. The SNMP Management Framework

The SNMP Management Framework presently consists of five major components:

- An overall architecture, described in RFC 2571 [RFC2571].
- Mechanisms for describing and naming objects and events for the purpose of management. The first version of this Structure of Management Information (SMI) is called SMIv1 and described in STD 16, RFC 1155 [RFC1155], STD 16, RFC 1212 [RFC1212] and RFC 1215 [RFC1215]. The second version, called SMIv2, is described in STD 58, RFC 2578 [RFC2578], RFC 2579 [RFC2579] and RFC 2580 [RFC2580].
- Message protocols for transferring management information. The first version of the SNMP message protocol is called SNMPv1 and described in STD 15, RFC 1157 [RFC1157]. A second version of the SNMP message protocol, which is not an Internet standards track protocol, is called SNMPv2c and described in RFC 1901 [RFC1901] and RFC 1906 [RFC1906]. The third version of the message protocol is called SNMPv3 and described in RFC 1906 [RFC1906], RFC 2572 [RFC2572] and RFC 2574 [RFC2574].
- Protocol operations for accessing management information. The first set of protocol operations and associated PDU formats is described in STD 15, RFC 1157 [RFC1157]. A second set of protocol operations and associated PDU formats is described in RFC 1905 [RFC1905].
- A set of fundamental applications described in RFC 2573 [RFC2573] and the view-based access control mechanism described in RFC 2575 [RFC2575].

A more detailed introduction to the current SNMP Management Framework can be found in RFC 2570 [RFC2570].

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

This memo specifies a MIB module that is compliant to the SMIv2. A MIB conforming to the SMIv1 can be produced through the appropriate translations. The resulting translated MIB must be semantically equivalent, except where objects or events are omitted because no translation is possible (use of Counter64). Some machine readable information in SMIv2 will be converted into textual descriptions in SMIv1 during the translation process. However, this loss of machine
readable information is not considered to change the semantics of the MIB.

3. The Requirements for Managed Object aggregation

The general requirements of managed object aggregation are as follows:

- It should lead to lesser number of packets
- It should lead to lesser bandwidth consumption

It should not

- lead to loss of information

In case of time-based aggregation there may be a delay involved in getting the actual data. The minimum delay in this case will be the duration of the aggregation.

4. 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 so that a large number of users and applications can use the MIB to configure aggregate MOs conveniently.

The MIB comprises of three tables described below.
- The aggrMOTable defines the primary MO-based aggregation i.e. the MOs that will be aggregated.
- The aggrTSAttrTable controls the aggregation process. Each row in this table defines the attributes of aggregate object defined in the aggrMOTable.
- The aggrTSDataTable contains the details of the aggregated object

The size of the table may be decided by implementations.
5. The Managed Object Aggregation MIB.

AGGREGATE-MIB DEFINITIONS ::= BEGIN
IMPORTS
MODULE-IDENTITY, Counter32, Gauge32, OBJECT-TYPE,
OBJECT-IDENTITY FROM SNMPv2-SMI
RowStatus
FROM SNMPv2-TC
MODULE-COMPLIANCE, OBJECT-GROUP
FROM SNMPv2-CONF
SnmpAdminString
FROM SNMP-FRAMEWORK-MIB;

aggrMIB MODULE-IDENTITY
LAST-UPDATED "200111160000Z" -- 14th November 2001
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DESCRIPTION
"The MIB for servicing aggregate objects."
::= { experimental nnn } -- will be assigned by IANA

AggrMOValue ::= TEXTUAL-CONVENTION
STATUS current
DESCRIPTION
"This data type is used to model the aggregate MOs. It will have a format dependent on the
type of aggregation that is being carried out.
for MO-based aggregation the format will be
<separator><value><separator>....<value><separator>
for time-based aggregation
<timestamp><space><value><separator>....<value><separator>
Note:
- The command generator is expected to know
  - the MO(s) that are being aggregated and,
  - the length of the aggregation"
to be able to correctly interpret the constants of this data
type.

- The values are ordered according
to increasing order of aggrMOEntryID of the corresponding MOs
  in the aggrMOTable
- That the TimeStamp is not present for MO-based aggregation
  [aggrTSLength <= 1].

SYNTAX OCTET STRING (SIZE (0..1024))
CompressedAggrMOValue ::= 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 a row for each agregate MO defined in the
-- aggrMOTable. It drives the time-based aggregation.
-- The attributes in a row pertain to the aggregation
-- time samples of the corresponding MOs defined in the
-- aggrMOTable.

aggrTSAttrsTable OBJECT-TYPE
SYNTAX SEQUENCE OF AggrAttrsEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
" A table that controls the aggregation of the MOs."
::= {aggrMIB 1}

aggrTSAttrsEntry OBJECT-TYPE
SYNTAX AggrAttrsEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
" A row of the control table that defines one aggregated
MO."
INDEX {aggrTSEntryID }
::= {aggrTSAttrsTable 1}

AggrAttrsEntry ::= SEQUENCE {
  aggrTSEntryID
    INTEGER,
  aggrTSMOIndex
    INTEGER,
  aggrTSObjectDescr
    OCTET STRING (SIZE (0..1024))
}
SnmpAdminString,
aggrTSLength  
  Gauge32,
aggrTSInterval  
  Gauge32,
aggrTSSeparator  
  INTEGER,
aggrTSCompressionAlgorithm  
  INTEGER,
aggrTSEntryStatus  
  RowStatus
}

aggrTSEntryID OBJECT-TYPE
SYNTAX INTEGER
MAX-ACCESS read-create
STATUS current
DESCRIPTION
  " An Index uniquely identifying the attributes in this row."
::= { aggrTSAttrsEntry 1 }

aggrTSMOIndex OBJECT-TYPE
SYNTAX INTEGER
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."
::= { aggrTSAttrsEntry 2 }

aggrTSObjectDescr OBJECT-TYPE
SYNTAX SnmpAdminString (SIZE(0..64))
MAX-ACCESS read-create
STATUS current
DESCRIPTION
  " A textual description of the object that is being aggregated."
::= {aggrTSAttrsEntry 3}

aggrTSLength OBJECT-TYPE
SYNTAX Gauge32
MAX-ACCESS read-create
STATUS current
DESCRIPTION
  " The number of times the group of MO(s) pointed at by the aggrTSObject will be sampled and aggregated."
 ::= {aggrTSAattrsEntry 4}

aggrTSInterval OBJECT-TYPE
SYNTAX Gauge32
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"The interval at which the group of MO(s) pointed at by
aggrTSSObject, will be sampled for time-based
aggregation. If the aggrTSLength = 1 then this
field is irrelevant."
 ::= {aggrTSAattrsEntry 5}

aggrTSSeparator OBJECT-TYPE
SYNTAX INTEGER {
  none   (1),
  comma  (2),
  period (3),
  slash  (4),
  space  (5),
  colon  (6),
  semicolon (7),
  dash   (8),
  underbar  (9)
}
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"The separator that will be used to separate
the sampled values of the group of MO(s) pointed at by
aggrTSSObject."
 ::= {aggrTSAattrsEntry 6}

aggrTSCompressionAlgorithm OBJECT-TYPE
SYNTAX INTEGER {
  none   (1)
}
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"The Compression algorithm that will be used by
the agent to compress the aggregated object."
 ::= {aggrTSAattrsEntry 7}

aggrTSEntryStatus OBJECT-TYPE
SYNTAX RowStatus
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"The row status variable, used according to row
installation and removal conventions."
 ::= {aggrISAttrsEntry 8}

-- The Table of primary managed MOs
-- Each row in this table represents a primary MO which will be
-- aggregated. The aggrMOEntryID index is used to identify the
-- group of MOs that will be aggregated. The aggrMOEntryMOID
-- index is used to identify an MO in the group.
--
aggrMOTable OBJECT-TYPE
SYNTAX  SEQUENCE OF AggrMOEntry
MAX-ACCESS not-accessible
STATUS  current
DESCRIPTION
"A table of the MOs that will be aggregated."
 ::= {aggrMIB 2}

aggrMOEntry OBJECT-TYPE
SYNTAX  AggrMOEntry
MAX-ACCESS not-accessible
STATUS  current
DESCRIPTION
"A row of the table that specifies one MO."
INDEX { aggrMOEntryID, aggrMOEntryMOID }
 ::= {aggrMOTable 1 }

AggrMOEntry ::= SEQUENCE {
  aggrMOEntryID
    INTEGER,
  aggrMOEntryMOID
    INTEGER,
  aggrMOObject
    INTEGER,
  aggrMOObjectDescr
    SnmpAdminString,
  aggrMOErrorIndicator
    INTEGER,
  aggrMOSeparator
    INTEGER,
  aggrMOEntryStatus
    RowStatus
}

aggrMOEntryID OBJECT-TYPE
SYNTAX INTEGER

Expires: May 13, 2002
MAX-ACCESS read-create  
STATUS current  
DESCRIPTION  
"An Index uniquely identifying a group of MOs that will be aggregated."  
::= {aggrMOEntry 1}

aggrMOEntryMOID OBJECT-TYPE  
SYNTAX INTEGER  
MAX-ACCESS read-create  
STATUS current  
DESCRIPTION  
"An Index uniquely the MOs in the group of MOs that will be aggregated."  
::= {aggrMOEntry 2}

aggrMOObject OBJECT-TYPE  
SYNTAX OBJECT IDENTIFIER  
MAX-ACCESS read-create  
STATUS current  
DESCRIPTION  
"The OID of the MO - the value of which will be being sampled by the agent. Note. this must be a leaf OID."  
::= {aggrMOEntry 3}

aggrMOObjectDescr 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}

aggrMOErrorIndicator OBJECT-TYPE  
SYNTAX INTEGER {  
  null (1),  
  space (2),  
  minusOne (3),  
  hyphen (4),  
  underbar (5)  
}  
MAX-ACCESS read-create  
STATUS current  
DESCRIPTION  
"An indicator that there was a problem in getting
the value of this MO.

::= {aggrMOEntry 5}

aggrMOSeparator OBJECT-TYPE
SYNTAX INTEGER {
  none         (1),
  comma        (2),
  period       (3),
  slash        (4),
  space        (5),
  colon        (6),
  semicolon    (7),
  dash         (8),
  underbar     (9)
}
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"The separator that will be used to separate
the sampled values of the group of MOs identified by
the aggrMOEntryID.
Note that this separator should be
separate from the separator used in the time-based
aggregation of the groups specified in this table."
::= {aggrMOEntry 6}

aggrMOEntryStatus OBJECT-TYPE
SYNTAX RowStatus
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"The row status variable, used according to row
installation and removal conventions."
::= {aggrMOEntry 7}

--
-- The Aggregated MOs
--
aggrDataGroup OBJECT-IDENTITY
STATUS current
DESCRIPTION
"This is the base object for the subtree of
data objects."
::= {aggrMIB 3}

--
-- aggrDataTable: The Table of Data. Each row represents a Data set.
-- aggrTSEntryID,aggrDataID is the key to the table. The number of
-- instances of aggrDataID for each aggrTSEntryID determines the number
-- of instances of the aggregated MO that will be present in the table.  
-- The size of will be implementation dependent - some implementors may  
-- choose to keep a maximum of one message in this table (only the  
-- most recent snapshot of the aggregated MO will be serviced).

aggrDataTable OBJECT-TYPE
SYNTAX  SEQUENCE OF AggrDataEntry
MAX-ACCESS not-accessible
STATUS current
DESCRIPTION
"  Each row of this table contains information  
  about a data indexed by aggrTSDataID."
 ::= {aggrDataGroup 1 }

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

AggrDataEntry ::= SEQUENCE {
   aggrDataID
      INTEGER,
   aggrDataRec
      AggrMOValue,
   aggrDataRecC
      CompressedAggrMOValue
}

aggrDataID OBJECT-TYPE
SYNTAX INTEGER (1..65535)
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"  This along with the aggrTSEntryID uniquely  
  identifies a snapshot value of an aggregate MO."
 ::= { aggrDataEntry 1}

aggrDataRec OBJECT-TYPE
SYNTAX AggrMOValue
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"  The snapshot value of the aggregated MO."
::= { aggrDataEntry 2}

aggrDataRecC OBJECT-TYPE
SYNTAX CompressedAggrMOValue
MAX-ACCESS read-only
STATUS current
DESCRIPTION
"The compressed value of the aggregated MO."
::= { aggrDataEntry 3}

-- Conformance information
aggrConformance OBJECT IDENTIFIER ::= { aggrMIB 3 }
aggrGroups OBJECT IDENTIFIER ::= { aggrConformance 1 }
aggrCompliances OBJECT IDENTIFIER ::= { aggrConformance 2 }

-- Compliance statements
aggrDataCompliance MODULE-COMPLIANCE
STATUS current
DESCRIPTION
"The compliance statement for SNMP entities
which implement the
AGGREGATE-MIB."

MODULE -- this module
MANDATORY-GROUPS { aggrDataGroup }
::= { aggrCompliances 1 }

-- Units of conformance
aggrDataGroup OBJECT-GROUP
OBJECTS {
   aggrTSEntryID,
   aggrTSMOIndex,
   aggrTObjectDescr,
   aggrTLength,
   aggrTInterval,
   aggrTSeparator,
   aggrTCompressionAlgorithm,
   aggrTSEntryStatus,
   aggrMOEntryID,
   aggrMOEntryMOID,
   aggrMOObject,
   aggrMOObjectDescr,
   aggrMOErrorIndicator,
   aggrMOSeparator,
   aggrMOEntryStatus,
   aggrDataID,
   aggrDataRec,
   aggrDataRecC
}
STATUS current
DESCRIPTION

Expires: May 13, 2002
"A collection of objects for aggregation of MOs."

::= { aggrGroups 1 }

END
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7. Acknowledgements

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Security Considerations

There are management objects defined in this MIB that have a MAX-ACCESS clause of read-write and read-create. There is the risk that an intruder can alter or create any management objects of this MIB via direct SNMP SET operations. So, care must be taken to put in place the security provisions of SNMP for authentication and access control. Not all versions of SNMP provide features for such a secure environment.

SNMPv1 by itself is such an insecure 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 (read) and SET (write) the objects in this MIB.

It is strongly recommended that the implementors consider the security features as provided by the SNMPv3 framework. Specifically, the use of the User-based Security Model RFC 2274 [RFC2274] and the View-based Access Control Model RFC 2275 [RFC2275] 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 those objects only to those principals (users) that have legitimate rights to access them.
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