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. 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) MOs. Semantically, the AgMO will be equivalent to the concatenation of the values of the specified MOs. With the definitions done, the user can, as and when the necessity arises, do a get on instances of the AgMO to fetch the value of instances of the constituent MOs. There is substantial savings on bandwidth as the 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 response. This is the basic concept of Aggregate Managed Objects.

The concepts are explained in Fig. 2. An aggregate managed object
AgMOx has been defined for 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 |
+--------+--------+-------+... -+--------+-------+
```

![Fig. 1 Polling for MO instances](image1)

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 |
+--------+--------+------------------------+
```

![Fig. 2 MO aggregation](image2)
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.

The manager application is expected to configure 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".

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 agrrCtlTable controls the aggregation process. Each row in this table defines the attributes of aggregate object defined in the agrrMOTable.
- The agrrMOTable defines the primary MO-based aggregation i.e. the MOs that will be aggregated.
- The agrrDataTable 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, experimental, Integer32,
    OBJECT-TYPE, Opaque
    FROM SNMPv2-SMI
OwnerString
    FROM RMON-MIB
RowStatus, TEXTUAL-CONVENTION
    FROM SNMPv2-TC
MODULE-COMPLIANCE, OBJECT-GROUP
    FROM SNMPv2-CONF
SnmpAdminString
    FROM SNMP-FRAMEWORK-MIB;

aggrMIB MODULE-IDENTITY
    LAST-UPDATED "200207140000Z"        -- 14th July 2002
    ORGANIZATION "Cyber Solutions NetMan Working Group"
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        Support Group E-mail: mibsupport@cysols.com"
    DESCRIPTION
        " The MIB for servicing aggregate objects."
    ::= { experimental nnn } -- will be assigned by IANA
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  Integer32
}
AggrMOErrorStatus ::= SEQUENCE OF {
  ErrorStatus
}
Note: the command responder will supply values for all constituent MO instances and in the same order in which AggrMO is defined. If there has been an error encountered for an MO instance then the corresponding value will have an ASN.1 value NULL and, an error flagged in the corresponding AggrMOErrorStatus object. Only MOs for which errors have been encountered will have the corresponding moIndex and moError values set.
Note: the command generator will need to know the 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
               }
               -- I would have preferred to have have an object as follows. But this
               -- is probably not allowed. Is it binding for textual conventions too?
               --
               -- AggrMO ::= SEQUENCE {
               --   aggrMOValue        AggrMOValue,
               --   aggrMOErrorStatus  AggrMOErrorStatus
               --
               -- }
               Note: the command generator will need to know the
               the constituent MO instances and their order to
               correctly interpret AggrMOValue."
  SYNTAX      Opaque (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 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."
INDEX {aggrEntryID }
::= {aggrCtlTable 1 }

AggrCtlEntry ::= SEQUENCE {
  aggrEntryID
    SnmpAdminString,
  aggrAgMOIndex
    Integer32,
  aggrAgMOSnmpDescr
    SnmpAdminString,
  aggrCompressionAlgorithm
    Integer32,
  aggrEntryOwner
    OwnerString,
  aggrEntryStatus
    RowStatus
}

aggrEntryID OBJECT-TYPE
SYNTAX SnmpAdminString (SIZE(1..32))
MAX-ACCESS read-only
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 }

aggrAgMOIndex OBJECT-TYPE
SYNTAX Integer32
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 }
aggrAgMODesct 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}

aggrCompressionAlgorithm 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."
::= {aggrCtlEntry 4}

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

aggrEntryStatus OBJECT-TYPE
SYNTAX RowStatus
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"The row status variable, used according to row
installation and removal conventions."
::= {aggrCtlEntry 6}
-- The Table of primary managed MOs
-- Each row in this table represents a 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
        Integer32,
    aggrMOEntryMOID
        Integer32,
    aggrMOInstance
        OBJECT IDENTIFIER,
    aggrMODescr
        SnmpAdminString,
    aggrMOEntryStatus
        RowStatus
}

aggrMOEntryID OBJECT-TYPE
SYNTAX  Integer32 (0..65535)
MAX-ACCESS read-only
STATUS current
DESCRIPTION
" An Index uniquely indentifying a group of MOs
 that will be aggregated."
 ::= { aggrMOEntry 1 }
aggrMOEntryMOID OBJECT-TYPE
SYNTAX Integer32 (0..65535)
MAX-ACCESS read-create
STATUS current
DESCRIPTION
"An Index uniquely identifying the MOs in the
group of MOs 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
being 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}

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 5}
aggrDataTable: The Table of Data. Each row represents a Data set.
-- aggrEntryID is the key to the table.
-- of instances of the aggregated MO that will be 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 aggregate MO indexed by aggrEntryID."
::= {aggrMIB 3}

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

AggrDataEntry ::= SEQUENCE {
  aggrDataRec
    {AggrMOValue,
     aggrDataRecC
      {CompressedAggrMOValue,
       aggrErrorRec
         {AggrMOErrorStatus

aggrDataRec OBJECT-TYPE
SYNTAX  AggrMOValue
MAX-ACCESS read-only
STATUS  current
DESCRIPTION
"The snapshot value of the aggregated MO."
::= {aggrDataEntry 1}
aggrDataRecC OBJECT-TYPE
   SYNTAX CompressedAggrMOValue
   MAX-ACCESS read-only
   STATUS current
   DESCRIPTION
      " The compressed value of the aggregated MO."
   ::= { aggrDataEntry 2}

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

-- Conformance information
aggrConformance OBJECT IDENTIFIER ::= { aggrMIB 4 }
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 {
    aggrEntryID,
    aggrAgMOIndex,
    aggrAgMODescr,
    aggrCompressionAlgorithm,
    aggrEntryOwner,
    aggrEntryStatus,
    aggrMOEntryID,
    aggrMOEntryMOID,
    aggrMOInstance,
    aggrMODescr,
    aggrMOEntryStatus,
    aggrDataRec,
    aggrDataRecC,
    aggrErrorRec
  }
  STATUS current
  DESCRIPTION
    " A collection of objects for aggregation of MOs."
  ::= { aggrGroups 1 }
END
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7. Acknowledgements

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References


Protocol (SNMPv3)\end{quote}, RFC 2574, April 1999


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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