

Network Working Group
Request for Comments: 2982
Category: Standards Track

R. Kavasseri
(Editor of this version)
B. Stewart
(Author of previous version)
Cisco Systems, Inc.
October 2000

Distributed Management Expression MIB

Status of this Memo

This document specifies an Internet standards track protocol for the Internet community, and requests discussion and suggestions for improvements. Please refer to the current edition of the "Internet Official Protocol Standards" (STD 1) for the standardization state and status of this protocol. Distribution of this memo is unlimited.

Copyright Notice

Copyright (C) The Internet Society (2000). All Rights Reserved.

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 describes managed objects used for managing expressions of MIB objects. The results of these expressions become MIB objects usable like any other MIB object, such as for the test condition for declaring an event.

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 RFC 2119.

Table of Contents

1 The SNMP Management Framework	2
2 Overview	3
2.1 Usage	4
2.2 Persistence	4
2.3 Operation	4
2.3.1 Sampling	5
2.3.2 Wildcards	5
2.3.3 Evaluation	5
2.3.4 Value Identification	6
2.4 Subsets	6
2.4.1 No Wildcards	6

2.4.2 No Deltas	7
2.5 Structure	7
2.5.1 Resource	7
2.5.2 Definition	7
2.5.3 Value	8
2.6 Examples	8
2.6.1 Wildcarding	8
2.6.2 Calculation and Conditional	10
3 Definitions	12
4 Intellectual Property	36
5 Acknowledgements	37
6 References	37
7 Security Considerations	38
8 Author's Address	40
9 Editor's Address	40
10 Full Copyright Statement	41

1. The SNMP Management Framework

The SNMP Management Framework presently consists of five major components:

- o An overall architecture, described in RFC 2571 [RFC2571].
- o 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], STD 58, RFC 2579 [RFC2579] and STD 58, RFC 2580 [RFC2580].
- o 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].
- o 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].

- o 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.

2. Overview

Users of MIBs often desire MIB objects that MIB designers have not provided. Furthermore, such needs vary from one management philosophy to another. Rather than fill more and more MIBs with standardized objects, the Expression MIB supports externally defined expressions of existing MIB objects.

In the Expression MIB the results of an evaluated expression are MIB objects that may be used like any other MIB objects. These custom-defined objects are thus usable anywhere any other MIB object can be used. For example, they can be used by a management application directly or referenced from another MIB, such as the Event MIB [MIBEventMIB]. They can even be used by the Expression MIB itself, forming expressions of expressions.

The Expression MIB is instrumentation for a relatively powerful, complex, high-level application, considerably different from simple instrumentation for a communication driver or a protocol. The MIB is appropriate in a relatively powerful, resource-rich managed system and not necessarily in a severely limited environment.

Nevertheless, due to dependencies from the Event MIB [RFC2981] and the need to support as low-end a system as possible, the Expression MIB can be somewhat stripped down for lower-power, lower-resource implementations, as described in the Subsets section, below.

Implementation of the Expression MIB in a managed system led to the addition of objects that may not have been necessary in an application environment with complete knowledge of compiled MIB definitions. This is appropriate since implementation must be possible within typical managed systems with some constraints on system resources.

2.1. Usage

On managed systems that can afford the overhead, the Expression MIB is a way to create new, customized MIB objects for monitoring. Although these can save some network traffic and overhead on management systems, that is often not a good tradeoff for objects that are simply to be recorded or displayed.

An example of a use of the Expression MIB would be to provide custom objects for the Event MIB [RFC2981]. A complex expression can evaluate to a rate of flow or a boolean and thus be subject to testing as an event trigger, resulting in an SNMP notification. Without these capabilities such monitoring would be limited to the objects in predefined MIBs. The Expression MIB thus supports powerful tools for the network manager faced with the monitoring of large, complex systems that can support a significant level of self management.

2.2. Persistence

Although like most MIBs this one has no explicit controls for the persistence of the values set in configuring an expression, a robust, polite implementation would certainly not force its managing applications to reconfigure it whenever it resets.

Again, as with most MIBs, it is implementation specific how a system provides and manages such persistence. To speculate, one could imagine, for example, that persistence depended on the context in which the expression was configured, or perhaps system-specific characteristics of the expression's owner. Or perhaps everything in a MIB such as this one, which is clearly aimed at persistent configuration, is automatically part of a system's other persistent configuration.

2.3. Operation

Most of the operation of the MIB is described or implied in the object definitions but a few highlights bear mentioning here.

2.3.1. Sampling

The MIB supports three types of object sampling for the MIB objects that make up the expression: absolute, delta, and changed.

Absolute samples are simply the value of the MIB object at the time it is sampled.

Absolute samples are not sufficient for expressions of counters, as counters have meaning only as a delta (difference) from one sample to the next. Thus objects may be sampled as deltas. Delta sampling requires the application to maintain state for the value at the last sample, and to do continuous sampling whether or not anyone is looking at the results. It thus creates constant overhead.

Changed sampling is a simple fallout of delta sampling where rather than a difference the result is a boolean indicating whether or not the object changed value since the last sample.

2.3.2. Wildcards

Wildcards allow the application of a single expression to multiple instances of the same MIB object. The definer of the expression indicates this choice and provides a partial object identifier, with some or all of the instance portion left off. The application then does the equivalent of GetNext to obtain the object values, thus discovering the instances.

All wildcarded objects in an expression must have the same semantics for the missing portion of their object identifiers. Otherwise, any successful evaluation of the wildcarded expression would be the result of the accidental matching of the wildcarded portion of the object identifiers in the expression. Such an evaluation will likely produce results which are not meaningful.

The expression can be evaluated only for those instances where all the objects in the expression are available with the same value for the wildcarded portion of the instance.

2.3.3. Evaluation

There are two important aspects of evaluation that may not be obvious: what objects and when.

What objects get used in the evaluation depends on the type of request and whether or not the expression contains wildcarded objects. If the request was a Get, that locks down the instances to

be used. If the request was a GetNext or GetBulk, the application must work its way up to the next full set of objects for the expression.

Evaluation of expressions happens at two possible times, depending on the sampling method (delta or absolute) used to evaluate the expression.

If there are no delta or change values in an expression, the evaluation occurs on demand, i.e. when a requester attempts to read the value of the expression. In this case all requesters get a freshly calculated value.

For expressions with delta or change values, evaluation goes on continuously, every sample period. In this case requesters get the value as of the last sample period. For any given sample period of a given expression, only those instances exist that provided a full set of object values. It may be possible that a delta expression which was evaluated successfully for one sample period may not be successfully evaluated in the next sample period. This may, for example, be due to missing instances for some or all of the objects in the expression. In such cases, the value from the previous sample period (with the successful evaluation) must not be carried forward to the next sample period (with the failed evaluation).

2.3.4. Value Identification

Values resulting from expression evaluation are identified with a combination of the object identifier (OID) for the data type from expValueTable (such as expValueCounter32Val), the expression owner, the expression name, and an OID fragment.

The OID fragment is not an entire OID beginning with iso.dod.org (1.3.6). Rather it begins with 0.0. The remainder is either another 0 when there is no wildcarding or the instance that satisfied the wildcard if there is wildcarding.

2.4. Subsets

To pare down the Expression MIBs complexity and use of resources an implementor can leave out various parts.

2.4.1. No Wildcards

Leaving out wildcarding significantly reduces the complexity of retrieving values to evaluate expressions and the processing required to do so. Such an implementation would allow expressions made up of

individual MIB objects but would not be suitable for expressions applied across large tables as each instance in the table would require a separate expression definition.

Furthermore it would not be suitable for tables with arbitrary, dynamic instances, as expressions definitions could not predict what instance values to use.

An implementation without wildcards might be useful for a self-managing system with small tables or few dynamic instances, or one that can do calculations only for a few key objects.

2.4.2. No Deltas

Leaving out delta processing significantly reduces state that must be kept and the burden of ongoing processing even when no one is looking at the results. Unfortunately it also makes expressions on counters unusable, as counters have meaning only as deltas.

An implementation without deltas might be useful for a severely limited, self-managing system that has no need for expressions or events on counters. Although conceivable, such systems would be rare.

2.5. Structure

The MIB has the following sections:

- o Resource -- management of the MIB's use of system resources.
- o Definition -- definition of expressions.
- o Value -- values of evaluated expressions.

2.5.1. Resource

The resource section has objects to manage resource usage by wildcarded delta expressions, a potential major consumer of CPU and memory.

2.5.2. Definition

The definition section contains the tables that define expressions.

The expression table, indexed by expression owner and expression name, contains those parameters that apply to the entire expression, such as the expression itself, the data type of the result, and the sampling interval if it contains delta or change values.

The object table, indexed by expression owner, expression name and object index within each expression, contains the parameters that apply to the individual objects that go into the expression, including the object identifier, sample type, discontinuity indicator, and such.

2.5.3. Value

The value section contains the values of evaluated expressions.

The value table, indexed by expression owner, expression name and instance fragment contains a "discriminated union" of evaluated expression results. For a given expression only one of the columns is instantiated, depending on the result data type for the expression. The instance fragment is a constant or the final section of the object identifier that filled in a wildcard.

2.6. Examples

The examples refer to tables and objects defined below in the MIB itself. They may well make more sense after reading those definitions.

2.6.1. Wildcarding

An expression may use wildcarded MIB objects that result in multiple values for the expression. To specify a wildcarded MIB object a management application leaves off part or all of the instance portion of the object identifier, and sets `expObjectWildcard` to `true(1)` for that object. For our example we'll use a counter of total blessings from a table of people. Another table, indexed by town and person has blessings just from that town.

So the index clauses are:

```
personEntry OBJECT-TYPE
...
INDEX { personIndex }
```

And:

```
townPersonEntry OBJECT-TYPE
...
INDEX { townIndex, personIndex }
```


In our friendly application we may have entered our expression as:

```
100 * townPersonBlessings.976.* / personBlessings.*
```

What goes in expExpression is:

```
100*$1/$2
```

For example purposes we'll use some slightly far-fetched OIDs. The People MIB is 1.3.6.1.99.7 and the Town MIB is 1.3.6.1.99.11, so for our two counters the OIDs are:

```
personBlessings      1.3.6.1.99.7.1.3.1.4
townPersonBlessings  1.3.6.1.99.11.1.2.1.9
```

The rule for wildcards is that all the wildcarded parts have to match exactly. In this case that means we have to hardwire the town and only the personIndex can be wildcarded. So our values for expObjectID are:

```
1.3.6.1.99.7.1.3.1.4
1.3.6.1.99.11.1.2.1.9.976
```

We're hardwired to townIndex 976 and personIndex is allowed to vary.

The value of expExpressionPrefix can be either of those two counter OIDs (including the instance fragment in the second case), since either of them takes you to a MIB definition where you can look at the INDEX clause and figure out what's been left off. What's been left off doesn't have to work out to be the same object, but it does have to work out to be the same values (semantics) for the result to make sense. Note that the managed system can not typically check such semantics and if given nonsense will return nonsense.

If we have people numbered 6, 19, and 42 in town number 976, the successive values of expValueInstance will be:

```
0.0.6
0.0.19
0.0.42
```

So there will be three values in expValueTable, with those OIDs as the expValueInstance part of their indexing.

2.6.2. Calculation and Conditional

The following formula for line utilization of a half-duplex link is adapted from [PracPersp].

$$\text{utilization} = (\text{ifInOctets} + \text{ifOutOctets}) * 800 / \text{seconds} / \text{ifSpeed}$$

The expression results in the percentage line utilization per second. The total octets are multiplied by 8 to get bits and 100 to scale up the percentage as an integer.

The following Expression MIB object values implement this as an expression for all ifIndexes that directly represent actual hardware. Since the octet counters are Counter32 values, they must be delta sampled to be meaningful. The sample period is 6 seconds but for accuracy and independence is calculated as a delta of sysUpTime.

The expObjectTable entry for ifInOctets has an expObjectConditional that checks for being a hardware interface. Only one object in the expression needs that check associated, since it applies to the whole expression. Since ifConnectorPresent is a TruthValue with values of 1 or 2 rather than 0 and non-zero, it must also be in an expression rather than used directly for the conditional.

The interface-specific discontinuity indicator is supplied only for ifInOctets since invalidating that sample will invalidate an attempt at evaluation, effectively invalidating ifOutOctets as well (correctly, because it has the same indicator).

For notational clarity, in the rest of this document, a string in quotes as part of the object instance indicates the value that would actually be one subidentifier per byte. The objects all belong to owner "me".

Also for clarity OIDs are expressed as the object descriptor and instance. In fact they must be supplied numerically, with all subidentifiers in place before the part for the particular object and instance.

What the user would set in expExpressionTable:

```
expExpression.2."me".4."hard"      = "$1==1"
expExpressionValueType.2."me".4."hard" = unsigned32
expExpressionRowStatus.2."me"4."hard" = 'active'
```

```

expExpression.2."me".4."util"      = "($1+$2)*800/$4/$3"
expExpressionValueType.2."me".4."util" = integer32
expExpressionDeltaInterval.2."me".4."util" = 6
expExpressionRowStatus.2."me".4."util" = 'active'

```

What the user would set in expObjectTable:

```

expObjectID.2."me".4."hard".1      = ifConnectorPresent
expObjectWildcard.2."me".4."hard".1 = 'true'
expObjectSampleType.2."me".4."hard".1 = 'absoluteValue'
expObjectRowStatus.2."me".4."hard".1 = 'active'

expObjectID.2."me".4."util".1      = ifInOctets
expObjectWildcard.2."me".4."util".1 = 'true'
expObjectSampleType.2."me".4."util".1 = 'deltaValue'
expObjectConditional.2."me".4."util".1 =
expValueUnsigned32Val.4."hard".0.0
expObjectConditionalWildcard.2."me".4."util".1 = 'true'
expObjectDiscontinuityID.2."me".4."util".1 =
ifCounterDiscontinuityTime
expObjectDiscontinuityIDWildcard.2."me".4."util".1 = 'true'
expObjectRowStatus.2."me".4."util".1 = 'active'

expObjectID.2."me".4."util".2      = ifOutOctets
expObjectWildcard.2."me".4."util".2 = 'true'
expObjectSampleType.2."me".4."util".2 = 'deltaValue'
expObjectRowStatus.2."me".4."util".2 = 'active'

expObjectID.2."me".4."util".3      = ifSpeed
expObjectWildcard.2."me".4."util".3 = 'true'
expObjectSampleType.2."me".4."util".3 = 'absoluteValue'
expObjectRowStatus.2."me".4."util".3 = 'active'

expObjectID.2."me".4."util".4      = sysUpTime.0
expObjectWildcard.2."me".4."util".4 = 'false'
expObjectSampleType.2."me".4."util".4 = 'deltaValue'
expObjectRowStatus.2."me".4."util".4 = 'active'

```

These settings will result in populating one column of expValueTable:

```
expValueInteger32Val.2."me".4."util".0.0.?
```

The subidentifier represented by "?" above represents one subidentifier that takes on a value of ifIndex and identifies a row for each ifIndex value where ifConnectorPresent is 'true' and the interface was present for two samples to provide a delta.

This value could in turn be used as an event threshold [RFC2981] to watch for overutilization of all hardware network connections.

3. Definitions

DISMAN-EXPRESSION-MIB DEFINITIONS ::= BEGIN

IMPORTS

```

MODULE-IDENTITY, OBJECT-TYPE,
Integer32, Gauge32, Unsigned32,
Counter32, Counter64, IpAddress,
TimeTicks, mib-2, zeroDotZero FROM SNMPv2-SMI
RowStatus, TruthValue, TimeStamp FROM SNMPv2-TC
sysUpTime FROM SNMPv2-MIB
SnmpAdminString FROM SNMP-FRAMEWORK-MIB
MODULE-COMPLIANCE, OBJECT-GROUP FROM SNMPv2-CONF;

```

dismanExpressionMIB MODULE-IDENTITY

```

LAST-UPDATED "200010160000Z" -- 16 October 2000
ORGANIZATION "IETF Distributed Management Working Group"
CONTACT-INFO "Ramanathan Kavasseri
Cisco Systems, Inc.
170 West Tasman Drive,
San Jose CA 95134-1706.
Phone: +1 408 527 2446
Email: ramk@cisco.com"

```

DESCRIPTION

"The MIB module for defining expressions of MIB objects for management purposes."

-- Revision History

```

REVISION "200010160000Z" -- 16 October 2000
DESCRIPTION "This is the initial version of this MIB.
Published as RFC 2982"

```

```

::= { mib-2 90 }

```

```

dismanExpressionMIBObjects OBJECT IDENTIFIER ::=
{ dismanExpressionMIB 1 }

```

```

expResource OBJECT IDENTIFIER ::= { dismanExpressionMIBObjects 1 }
expDefine OBJECT IDENTIFIER ::= { dismanExpressionMIBObjects 2 }
expValue OBJECT IDENTIFIER ::= { dismanExpressionMIBObjects 3 }

```

```

--
-- Resource Control
--

```

expResourceDeltaMinimum OBJECT-TYPE

SYNTAX Integer32 (-1 | 1..600)

UNITS "seconds"

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"The minimum expExpressionDeltaInterval this system will accept. A system may use the larger values of this minimum to lessen the impact of constantly computing deltas. For larger delta sampling intervals the system samples less often and suffers less overhead. This object provides a way to enforce such lower overhead for all expressions created after it is set.

The value -1 indicates that expResourceDeltaMinimum is irrelevant as the system will not accept 'deltaValue' as a value for expObjectSampleType.

Unless explicitly resource limited, a system's value for this object should be 1, allowing as small as a 1 second interval for ongoing delta sampling.

Changing this value will not invalidate an existing setting of expObjectSampleType."

```
::= { expResource 1 }
```

expResourceDeltaWildcardInstanceMaximum OBJECT-TYPE

SYNTAX Unsigned32

UNITS "instances"

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"For every instance of a deltaValue object, one dynamic instance entry is needed for holding the instance value from the previous sample, i.e. to maintain state.

This object limits maximum number of dynamic instance entries this system will support for wildcarded delta objects in expressions. For a given delta expression, the number of dynamic instances is the number of values that meet all criteria to exist times the number of delta values in the expression.

A value of 0 indicates no preset limit, that is, the limit is dynamic based on system operation and resources.

Unless explicitly resource limited, a system's value for this object should be 0.

Changing this value will not eliminate or inhibit existing delta wildcard instance objects but will prevent the creation of more such objects.

An attempt to allocate beyond the limit results in `expErrorCode` being `tooManyWildcardValues` for that evaluation attempt."
`::= { expResource 2 }`

`expResourceDeltaWildcardInstances` OBJECT-TYPE

```
SYNTAX      Gauge32
UNITS       "instances"
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
  "The number of currently active instance entries as
  defined for expResourceDeltaWildcardInstanceMaximum."
 ::= { expResource 3 }
```

`expResourceDeltaWildcardInstancesHigh` OBJECT-TYPE

```
SYNTAX      Gauge32
UNITS       "instances"
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
  "The highest value of expResourceDeltaWildcardInstances
  that has occurred since initialization of the managed
  system."
 ::= { expResource 4 }
```

`expResourceDeltaWildcardInstanceResourceLacks` OBJECT-TYPE

```
SYNTAX      Counter32
UNITS       "instances"
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
  "The number of times this system could not evaluate an
  expression because that would have created a value instance in
  excess of expResourceDeltaWildcardInstanceMaximum."
 ::= { expResource 5 }
```

--

-- Definition

--

-- Expression Definition Table

--

`expExpressionTable` OBJECT-TYPE

```

SYNTAX      SEQUENCE OF ExpExpressionEntry
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
  "A table of expression definitions."
 ::= { expDefine 1 }

```

expExpressionEntry OBJECT-TYPE

```

SYNTAX      ExpExpressionEntry
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
  "Information about a single expression.  New expressions
  can be created using expExpressionRowStatus.

```

To create an expression first create the named entry in this table. Then use expExpressionName to populate expObjectTable. For expression evaluation to succeed all related entries in expExpressionTable and expObjectTable must be 'active'. If these conditions are not met the corresponding values in expValue simply are not instantiated.

Deleting an entry deletes all related entries in expObjectTable and expErrorTable.

Because of the relationships among the multiple tables for an expression (expExpressionTable, expObjectTable, and expValueTable) and the SNMP rules for independence in setting object values, it is necessary to do final error checking when an expression is evaluated, that is, when one of its instances in expValueTable is read or a delta interval expires. Earlier checking need not be done and an implementation may not impose any ordering on the creation of objects related to an expression.

To maintain security of MIB information, when creating a new row in this table, the managed system must record the security credentials of the requester. These security credentials are the parameters necessary as inputs to isAccessAllowed from the Architecture for

Describing SNMP Management Frameworks. When obtaining the objects that make up the expression, the system must (conceptually) use isAccessAllowed to ensure that it does not violate security.

The evaluation of the expression takes place under the security credentials of the creator of its expExpressionEntry.

Values of read-write objects in this table may be changed

at any time."

```
INDEX      { expExpressionOwner, expExpressionName }
 ::= { expExpressionTable 1 }
```

```
ExpExpressionEntry ::= SEQUENCE {
  expExpressionOwner      SnmpAdminString,
  expExpressionName      SnmpAdminString,
  expExpression          OCTET STRING,
  expExpressionValueType INTEGER,
  expExpressionComment   SnmpAdminString,
  expExpressionDeltaInterval Integer32,
  expExpressionPrefix    OBJECT IDENTIFIER,
  expExpressionErrors    Counter32,
  expExpressionEntryStatus RowStatus
}
```

```
expExpressionOwner OBJECT-TYPE
  SYNTAX      SnmpAdminString (SIZE(0..32))
  MAX-ACCESS  not-accessible
  STATUS      current
  DESCRIPTION
    "The owner of this entry. The exact semantics of this
    string are subject to the security policy defined by the
    security administrator."
  ::= { expExpressionEntry 1 }
```

```
expExpressionName OBJECT-TYPE
  SYNTAX      SnmpAdminString (SIZE (1..32))
  MAX-ACCESS  not-accessible
  STATUS      current
  DESCRIPTION
    "The name of the expression. This is locally unique, within
    the scope of an expExpressionOwner."
  ::= { expExpressionEntry 2 }
```

```
expExpression OBJECT-TYPE
  SYNTAX      OCTET STRING (SIZE (1..1024))
  MAX-ACCESS  read-create
  STATUS      current
  DESCRIPTION
    "The expression to be evaluated. This object is the same
    as a DisplayString (RFC 1903) except for its maximum length.
```

Except for the variable names the expression is in ANSI C syntax. Only the subset of ANSI C operators and functions listed here is allowed.

Variables are expressed as a dollar sign ('\$') and an

integer that corresponds to an expObjectIndex. An example of a valid expression is:

```
($1-$5)*100
```

Expressions must not be recursive, that is although an expression may use the results of another expression, it must not contain any variable that is directly or indirectly a result of its own evaluation. The managed system must check for recursive expressions.

The only allowed operators are:

```
( )
- (unary)
+ - * / %
& | ^ << >> ~
! && || == != > >= < <=
```

Note the parentheses are included for parenthesizing the expression, not for casting data types.

The only constant types defined are:

```
int (32-bit signed)
long (64-bit signed)
unsigned int
unsigned long
hexadecimal
character
string
oid
```

The default type for a positive integer is int unless it is too large in which case it is long.

All but oid are as defined for ANSI C. Note that a hexadecimal constant may end up as a scalar or an array of 8-bit integers. A string constant is enclosed in double quotes and may contain back-slashed individual characters as in ANSI C.

An oid constant comprises 32-bit, unsigned integers and at least one period, for example:

```
0.
.0
1.3.6.1
```

No additional leading or trailing subidentifiers are automatically added to an OID constant. The constant is taken as expressed.

Integer-typed objects are treated as 32- or 64-bit, signed or unsigned integers, as appropriate. The results of mixing them are as for ANSI C, including the type of the result. Note that a 32-bit value is thus promoted to 64 bits only in an operation with a 64-bit value. There is no provision for larger values to handle overflow.

Relative to SNMP data types, a resulting value becomes unsigned when calculating it uses any unsigned value, including a counter. To force the final value to be of data type counter the expression must explicitly use the counter32() or counter64() function (defined below).

OCTET STRINGS and OBJECT IDENTIFIERS are treated as one-dimensioned arrays of unsigned 8-bit integers and unsigned 32-bit integers, respectively.

IpAddresses are treated as 32-bit, unsigned integers in network byte order, that is, the hex version of 255.0.0.0 is 0xff000000.

Conditional expressions result in a 32-bit, unsigned integer of value 0 for false or 1 for true. When an arbitrary value is used as a boolean 0 is false and non-zero is true.

Rules for the resulting data type from an operation, based on the operator:

For << and >> the result is the same as the left hand operand.

For &&, ||, ==, !=, <, <=, >, and >= the result is always Unsigned32.

For unary - the result is always Integer32.

For +, -, *, /, %, &, |, and ^ the result is promoted according to the following rules, in order from most to least preferred:

If left hand and right hand operands are the same type, use that.

If either side is Counter64, use that.

If either side is IpAddress, use that.

If either side is TimeTicks, use that.

If either side is Counter32, use that.

Otherwise use Unsigned32.

The following rules say what operators apply with what data types. Any combination not explicitly defined does not work.

For all operators any of the following can be the left hand or right hand operand: Integer32, Counter32, Unsigned32, Counter64.

The operators +, -, *, /, %, <, <=, >, and >= work with TimeTicks.

The operators &, |, and ^ work with IpAddress.

The operators << and >> work with IpAddress but only as the left hand operand.

The + operator performs a concatenation of two OCTET STRINGS or two OBJECT IDENTIFIERS.

The operators &, | perform bitwise operations on OCTET STRINGS. If the OCTET STRING happens to be a DisplayString the results may be meaningless, but the agent system does not check this as some such systems do not have this information.

The operators << and >> perform bitwise operations on OCTET STRINGS appearing as the left hand operand.

The only functions defined are:

- counter32
- counter64
- arraySection
- stringBegins
- stringEnds
- stringContains
- oidBegins
- oidEnds
- oidContains
- average
- maximum
- minimum
- sum
- exists

The following function definitions indicate their parameters by naming the data type of the parameter in the parameter's position in the parameter list. The parameter must be of the type indicated and generally may be a constant, a MIB object, a function, or an expression.

counter32(integer) - wrapped around an integer value counter32 forces Counter32 as a data type.

counter64(integer) - similar to counter32 except that the resulting data type is 'counter64'.

arraySection(array, integer, integer) - selects a piece of an array (i.e. part of an OCTET STRING or OBJECT IDENTIFIER). The integer arguments are in the range 0 to 4,294,967,295. The first is an initial array index (one-dimensional) and the second is an ending array index. A value of 0 indicates first or last element, respectively. If the first element is larger than the array length the result is 0 length. If the second integer is less than or equal to the first, the result is 0 length. If the second is larger than the array length it indicates last element.

stringBegins/Ends/Contains(octetString, octetString) - looks for the second string (which can be a string constant) in the first and returns the one-dimensional arrayindex where the match began. A return value of 0 indicates no match (i.e. boolean false).

oidBegins/Ends/Contains(oid, oid) - looks for the second OID (which can be an OID constant) in the first and returns the one-dimensional index where the match began. A return value of 0 indicates no match (i.e. boolean false).

average/maximum/minimum(integer) - calculates the average, minimum, or maximum value of the integer valued object over multiple sample times. If the object disappears for any sample period, the accumulation and the resulting value object cease to exist until the object reappears at which point the calculation starts over.

sum(integerObject*) - sums all available values of the wildcarded integer object, resulting in an integer scalar. Must be used with caution as it wraps on overflow with no notification.

exists(anyTypeObject) - verifies the object instance exists. A return value of 0 indicates NoSuchInstance (i.e. boolean false)."

```
::= { expExpressionEntry 3 }
```

```
expExpressionValueType OBJECT-TYPE
```

```
SYNTAX      INTEGER { counter32(1), unsigned32(2), timeTicks(3),
                    integer32(4), ipAddress(5), octetString(6),
                    objectId(7), counter64(8) }
```

```
MAX-ACCESS  read-create
```

```
STATUS      current
```

```
DESCRIPTION
```

"The type of the expression value. One and only one of the value objects in expValueTable will be instantiated to match this type.

If the result of the expression can not be made into this type, an invalidOperandType error will occur."

```
DEFVAL      { counter32 }
```

```
::= { expExpressionEntry 4 }
```

```
expExpressionComment OBJECT-TYPE
```

```
SYNTAX      SnmpAdminString
```

```
MAX-ACCESS  read-create
```

```
STATUS      current
```

```
DESCRIPTION
```

"A comment to explain the use or meaning of the expression."

```
DEFVAL      { ''H }
```

```
::= { expExpressionEntry 5 }
```

```
expExpressionDeltaInterval OBJECT-TYPE
```

```
SYNTAX      Integer32 (0..86400)
```

```
UNITS      "seconds"
```

```
MAX-ACCESS  read-create
```

```
STATUS      current
```

```
DESCRIPTION
```

"Sampling interval for objects in this expression with expObjectSampleType 'deltaValue'.

This object has no effect if the the expression has no deltaValue objects.

A value of 0 indicates no automated sampling. In this case the delta is the difference from the last time the expression was evaluated. Note that this is subject to unpredictable delta times in the face of retries or multiple managers.

A value greater than zero is the number of seconds between automated samples.

Until the delta interval has expired once the delta for the

object is effectively not instantiated and evaluating the expression has results as if the object itself were not instantiated.

Note that delta values potentially consume large amounts of system CPU and memory. Delta state and processing must continue constantly even if the expression is not being used. That is, the expression is being evaluated every delta interval, even if no application is reading those values. For wildcarded objects this can be substantial overhead.

Note that delta intervals, external expression value sampling intervals and delta intervals for expressions within other expressions can have unusual interactions as they are impossible to synchronize accurately. In general one interval embedded below another must be enough shorter that the higher sample sees relatively smooth, predictable behavior. So, for example, to avoid the higher level getting the same sample twice, the lower level should sample at least twice as fast as the higher level does."

```
DEFVAL      { 0 }
 ::= { expExpressionEntry 6 }
```

expExpressionPrefix OBJECT-TYPE

```
SYNTAX      OBJECT IDENTIFIER
```

```
MAX-ACCESS  read-only
```

```
STATUS      current
```

```
DESCRIPTION
```

"An object prefix to assist an application in determining the instance indexing to use in expValueTable, relieving the application of the need to scan the expObjectTable to determine such a prefix.

See expObjectTable for information on wildcarded objects.

If the expValueInstance portion of the value OID may be treated as a scalar (that is, normally, 0) the value of expExpressionPrefix is zero length, that is, no OID at all. Note that zero length implies a null OID, not the OID 0.0.

Otherwise, the value of expExpressionPrefix is the expObjectID value of any one of the wildcarded objects for the expression. This is sufficient, as the remainder, that is, the instance fragment relevant to instancing the values, must be the same for all wildcarded objects in the expression."

```
::= { expExpressionEntry 7 }
```

expExpressionErrors OBJECT-TYPE

```

SYNTAX      Counter32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
  "The number of errors encountered while evaluating this
  expression."

```

Note that an object in the expression not being accessible, is not considered an error. An example of an inaccessible object is when the object is excluded from the view of the user whose security credentials are used in the expression evaluation. In such cases, it is a legitimate condition that causes the corresponding expression value not to be instantiated."

```
 ::= { expExpressionEntry 8 }
```

```
expExpressionEntryStatus OBJECT-TYPE
```

```

SYNTAX      RowStatus
MAX-ACCESS  read-create
STATUS      current
DESCRIPTION
  "The control that allows creation and deletion of entries."
 ::= { expExpressionEntry 9 }

```

```

--
-- Expression Error Table
--

```

```
expErrorTable OBJECT-TYPE
```

```

SYNTAX      SEQUENCE OF ExpErrorEntry
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
  "A table of expression errors."
 ::= { expDefine 2 }

```

```
expErrorEntry OBJECT-TYPE
```

```

SYNTAX      ExpErrorEntry
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
  "Information about errors in processing an expression."

```

Entries appear in this table only when there is a matching expExpressionEntry and then only when there has been an error for that expression as reflected by the error codes defined for expErrorCode."

```
INDEX      { expExpressionOwner, expExpressionName }
```

```
 ::= { expErrorTable 1 }
```

```
ExpErrorEntry ::= SEQUENCE {
    expErrorTime      TimeStamp,
    expErrorIndex     Integer32,
    expErrorCode      INTEGER,
    expErrorInstance  OBJECT IDENTIFIER
}
```

```
expErrorTime OBJECT-TYPE
    SYNTAX      TimeStamp
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The value of sysUpTime the last time an error caused a
        failure to evaluate this expression."
    ::= { expErrorEntry 1 }
```

```
expErrorIndex OBJECT-TYPE
    SYNTAX      Integer32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The one-dimensioned character array index into
        expExpression for where the error occurred. The value
        zero indicates irrelevance."
    ::= { expErrorEntry 2 }
```

```
expErrorCode OBJECT-TYPE
    SYNTAX      INTEGER {
        invalidSyntax(1),
        undefinedObjectIndex(2),
        unrecognizedOperator(3),
        unrecognizedFunction(4),
        invalidOperandType(5),
        unmatchedParenthesis(6),
        tooManyWildcardValues(7),
        recursion(8),
        deltaTooShort(9),
        resourceUnavailable(10),
        divideByZero(11)
    }
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
        "The error that occurred. In the following explanations the
        expected timing of the error is in parentheses. 'S' means
        the error occurs on a Set request. 'E' means the error
```


occurs on the attempt to evaluate the expression either due to Get from expValueTable or in ongoing delta processing.

invalidSyntax the value sent for expExpression is not
 valid Expression MIB expression syntax
 (S)

undefinedObjectIndex an object reference (\$n) in
 expExpression does not have a matching
 instance in expObjectTable (E)

unrecognizedOperator the value sent for expExpression held an
 unrecognized operator (S)

unrecognizedFunction the value sent for expExpression held an
 unrecognized function name (S)

invalidOperandType an operand in expExpression is not the
 right type for the associated operator
 or result (SE)

unmatchedParenthesis the value sent for expExpression is not
 correctly parenthesized (S)

tooManyWildcardValues evaluating the expression exceeded the
 limit set by
 expResourceDeltaWildcardInstanceMaximum
 (E)

recursion through some chain of embedded
 expressions the expression invokes itself
 (E)

deltaTooShort the delta for the next evaluation passed
 before the system could evaluate the
 present sample (E)

resourceUnavailable some resource, typically dynamic memory,
 was unavailable (SE)

divideByZero an attempt to divide by zero occurred
 (E)

For the errors that occur when the attempt is made to set expExpression Set request fails with the SNMP error code 'wrongValue'. Such failures refer to the most recent failure to Set expExpression, not to the present value of expExpression which must be either unset or syntactically correct.

Errors that occur during evaluation for a Get* operation return the SNMP error code 'genErr' except for 'tooManyWildcardValues' and 'resourceUnavailable' which return the SNMP error code 'resourceUnavailable'."

```
::= { expErrorEntry 3 }
```

```
expErrorInstance OBJECT-TYPE
SYNTAX            OBJECT IDENTIFIER
MAX-ACCESS        read-only
```

```

STATUS      current
DESCRIPTION
  "The expValueInstance being evaluated when the error
  occurred.  A zero-length indicates irrelevance."
 ::= { expErrorEntry 4 }

```

```

--
-- Object Table
--

```

```

expObjectTable OBJECT-TYPE
SYNTAX      SEQUENCE OF ExpObjectEntry
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
  "A table of object definitions for each expExpression.

```

Wildcarding instance IDs:

It is legal to omit all or part of the instance portion for some or all of the objects in an expression. (See the DESCRIPTION of expObjectID for details. However, note that if more than one object in the same expression is wildcarded in this way, they all must be objects where that portion of the instance is the same. In other words, all objects may be in the same SEQUENCE or in different SEQUENCES but with the same semantic index value (e.g., a value of ifIndex) for the wildcarded portion."

```
 ::= { expDefine 3 }
```

```

expObjectEntry OBJECT-TYPE
SYNTAX      ExpObjectEntry
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
  "Information about an object.  An application uses
  expObjectEntryStatus to create entries in this table while
  in the process of defining an expression.

  Values of read-create objects in this table may be
  changed at any time."
INDEX       { expExpressionOwner, expExpressionName, expObjectIndex }
 ::= { expObjectTable 1 }

```

```

ExpObjectEntry ::= SEQUENCE {
  expObjectIndex      Unsigned32,
  expObjectID         OBJECT IDENTIFIER,
  expObjectIDWildcard TruthValue,

```

```

expObjectSampleType          INTEGER,
expObjectDeltaDiscontinuityID OBJECT IDENTIFIER,
expObjectDiscontinuityIDWildcard TruthValue,
expObjectDiscontinuityIDType  INTEGER,
expObjectConditional          OBJECT IDENTIFIER,
expObjectConditionalWildcard   TruthValue,
expObjectEntryStatus          RowStatus
}

expObjectIndex OBJECT-TYPE
SYNTAX      Unsigned32 (1..4294967295)
MAX-ACCESS  not-accessible
STATUS      current
DESCRIPTION
    "Within an expression, a unique, numeric identification for an
    object.  Prefixed with a dollar sign ('$') this is used to
    reference the object in the corresponding expExpression."
 ::= { expObjectEntry 1 }

expObjectID OBJECT-TYPE
SYNTAX      OBJECT IDENTIFIER
MAX-ACCESS  read-create
STATUS      current
DESCRIPTION
    "The OBJECT IDENTIFIER (OID) of this object.  The OID may be
    fully qualified, meaning it includes a complete instance
    identifier part (e.g., ifInOctets.1 or sysUpTime.0), or it
    may not be fully qualified, meaning it may lack all or part
    of the instance identifier.  If the expObjectID is not fully
    qualified, then expObjectWildcard must be set to true(1).
    The value of the expression will be multiple
    values, as if done for a getNext sweep of the object.

    An object here may itself be the result of an expression but
    recursion is not allowed.

    NOTE:  The simplest implementations of this MIB may not allow
    wildcards."
 ::= { expObjectEntry 2 }

expObjectIDWildcard OBJECT-TYPE
SYNTAX      TruthValue
MAX-ACCESS  read-create
STATUS      current
DESCRIPTION
    "A true value indicates the expObjectID of this row is a wildcard
    object.  False indicates that expObjectID is fully instanced.
    If all expObjectWildcard values for a given expression are FALSE,
```

expExpressionPrefix will reflect a scalar object (i.e. will be 0.0).

NOTE: The simplest implementations of this MIB may not allow wildcards."

```
DEFVAL      { false }
 ::= { expObjectEntry 3 }
```

expObjectSampleType OBJECT-TYPE

```
SYNTAX      INTEGER { absoluteValue(1), deltaValue(2),
                    changedValue(3) }
```

```
MAX-ACCESS  read-create
```

```
STATUS      current
```

```
DESCRIPTION
```

"The method of sampling the selected variable.

An 'absoluteValue' is simply the present value of the object.

A 'deltaValue' is the present value minus the previous value, which was sampled expExpressionDeltaInterval seconds ago. This is intended primarily for use with SNMP counters, which are meaningless as an 'absoluteValue', but may be used with any integer-based value.

A 'changedValue' is a boolean for whether the present value is different from the previous value. It is applicable to any data type and results in an Unsigned32 with value 1 if the object's value is changed and 0 if not. In all other respects it is as a 'deltaValue' and all statements and operation regarding delta values apply to changed values.

When an expression contains both delta and absolute values the absolute values are obtained at the end of the delta period."

```
DEFVAL      { absoluteValue }
 ::= { expObjectEntry 4 }
```

sysUpTimeInstance OBJECT IDENTIFIER ::= { sysUpTime 0 }

expObjectDeltaDiscontinuityID OBJECT-TYPE

```
SYNTAX      OBJECT IDENTIFIER
```

```
MAX-ACCESS  read-create
```

```
STATUS      current
```

```
DESCRIPTION
```

"The OBJECT IDENTIFIER (OID) of a TimeTicks, TimeStamp, or DateAndTime object that indicates a discontinuity in the value at expObjectID.

This object is instantiated only if expObjectSampleType is 'deltaValue' or 'changedValue'.

The OID may be for a leaf object (e.g. sysUpTime.0) or may be wildcarded to match expObjectID.

This object supports normal checking for a discontinuity in a counter. Note that if this object does not point to sysUpTime discontinuity checking must still check sysUpTime for an overall discontinuity.

If the object identified is not accessible no discontinuity check will be made."

```
DEFVAL      { sysUpTimeInstance }
 ::= { expObjectEntry 5 }
```

expObjectDiscontinuityIDWildcard OBJECT-TYPE

```
SYNTAX      TruthValue
MAX-ACCESS  read-create
STATUS      current
```

DESCRIPTION

"A true value indicates the expObjectDeltaDiscontinuityID of this row is a wildcard object. False indicates that expObjectDeltaDiscontinuityID is fully instanced.

This object is instantiated only if expObjectSampleType is 'deltaValue' or 'changedValue'.

NOTE: The simplest implementations of this MIB may not allow wildcards."

```
DEFVAL      { false }
 ::= { expObjectEntry 6 }
```

expObjectDiscontinuityIDType OBJECT-TYPE

```
SYNTAX      INTEGER { timeTicks(1), timeStamp(2), dateAndTime(3) }
MAX-ACCESS  read-create
STATUS      current
```

DESCRIPTION

"The value 'timeTicks' indicates the expObjectDeltaDiscontinuityID of this row is of syntax TimeTicks. The value 'timeStamp' indicates syntax TimeStamp. The value 'dateAndTime' indicates syntax DateAndTime.

This object is instantiated only if expObjectSampleType is 'deltaValue' or 'changedValue'."

```
DEFVAL      { timeTicks }
 ::= { expObjectEntry 7 }
```

expObjectConditional OBJECT-TYPE

SYNTAX OBJECT IDENTIFIER

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"The OBJECT IDENTIFIER (OID) of an object that overrides whether the instance of expObjectID is to be considered usable. If the value of the object at expObjectConditional is 0 or not instantiated, the object at expObjectID is treated as if it is not instantiated. In other words, expObjectConditional is a filter that controls whether or not to use the value at expObjectID.

The OID may be for a leaf object (e.g. sysObjectID.0) or may be wildcarded to match expObjectID. If expObject is wildcarded and expObjectID in the same row is not, the wild portion of expObjectConditional must match the wildcarding of the rest of the expression. If no object in the expression is wildcarded but expObjectConditional is, use the lexically first instance (if any) of expObjectConditional.

If the value of expObjectConditional is 0.0 operation is as if the value pointed to by expObjectConditional is a non-zero (true) value.

Note that expObjectConditional can not trivially use an object of syntax TruthValue, since the underlying value is not 0 or 1."

DEFVAL { zeroDotZero }

::= { expObjectEntry 8 }

expObjectConditionalWildcard OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-create

STATUS current

DESCRIPTION

"A true value indicates the expObjectConditional of this row is a wildcard object. False indicates that expObjectConditional is fully instanced.

NOTE: The simplest implementations of this MIB may not allow wildcards."

DEFVAL { false }

::= { expObjectEntry 9 }

expObjectEntryStatus OBJECT-TYPE

SYNTAX RowStatus

MAX-ACCESS read-create

```

STATUS      current
DESCRIPTION
  "The control that allows creation/deletion of entries.

```

```

  Objects in this table may be changed while
  expObjectEntryStatus is in any state."
 ::= { expObjectEntry 10 }

```

```

--
-- Expression Value Table
--

```

```

expValueTable OBJECT-TYPE
  SYNTAX      SEQUENCE OF ExpValueEntry
  MAX-ACCESS  not-accessible
  STATUS      current
  DESCRIPTION
    "A table of values from evaluated expressions."
  ::= { expValue 1 }

```

```

expValueEntry OBJECT-TYPE
  SYNTAX      ExpValueEntry
  MAX-ACCESS  not-accessible
  STATUS      current
  DESCRIPTION
    "A single value from an evaluated expression.  For a given
    instance, only one 'Val' object in the conceptual row will be
    instantiated, that is, the one with the appropriate type for
    the value.  For values that contain no objects of
    expObjectSampleType 'deltaValue' or 'changedValue', reading a
    value from the table causes the evaluation of the expression
    for that value.  For those that contain a 'deltaValue' or
    'changedValue' the value read is as of the last sampling
    interval.

```

If in the attempt to evaluate the expression one or more of the necessary objects is not available, the corresponding entry in this table is effectively not instantiated.

To maintain security of MIB information, when creating a new row in this table, the managed system must record the security credentials of the requester. These security credentials are the parameters necessary as inputs to `isAccessAllowed` from [RFC2571]. When obtaining the objects that make up the expression, the system must (conceptually) use `isAccessAllowed` to ensure that it does not violate security.

The evaluation of that expression takes place under the

security credentials of the creator of its expExpressionEntry.

To maintain security of MIB information, expression evaluation must take place using security credentials for the implied Gets of the objects in the expression as inputs (conceptually) to isAccessAllowed from the Architecture for Describing SNMP Management Frameworks. These are the security credentials of the creator of the corresponding expExpressionEntry."

```
INDEX      { expExpressionOwner, expExpressionName,
              IMPLIED expValueInstance }
 ::= { expValueTable 1 }
```

```
ExpValueEntry ::= SEQUENCE {
  expValueInstance      OBJECT IDENTIFIER,
  expValueCounter32Val  Counter32,
  expValueUnsigned32Val Unsigned32,
  expValueTimeTicksVal TimeTicks,
  expValueInteger32Val  Integer32,
  expValueIpAddressVal  IpAddress,
  expValueOctetStringVal OCTET STRING,
  expValueOidVal        OBJECT IDENTIFIER,
  expValueCounter64Val  Counter64
}
```

expValueInstance OBJECT-TYPE

SYNTAX OBJECT IDENTIFIER

MAX-ACCESS not-accessible

STATUS current

DESCRIPTION

"The final instance portion of a value's OID according to the wildcarding in instances of expObjectID for the expression. The prefix of this OID fragment is 0.0, leading to the following behavior.

If there is no wildcarding, the value is 0.0.0. In other words, there is one value which standing alone would have been a scalar with a 0 at the end of its OID.

If there is wildcarding, the value is 0.0 followed by a value that the wildcard can take, thus defining one value instance for each real, possible value of the wildcard. So, for example, if the wildcard worked out to be an ifIndex, there is an expValueInstance for each applicable ifIndex."

```
::= { expValueEntry 1 }
```

expValueCounter32Val OBJECT-TYPE

SYNTAX Counter32

MAX-ACCESS read-only


```
STATUS      current
DESCRIPTION
  "The value when expExpressionValueType is 'counter32'."
 ::= { expValueEntry 2 }
```

```
expValueUnsigned32Val OBJECT-TYPE
SYNTAX      Unsigned32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
  "The value when expExpressionValueType is 'unsigned32'."
 ::= { expValueEntry 3 }
```

```
expValueTimeTicksVal OBJECT-TYPE
SYNTAX      TimeTicks
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
  "The value when expExpressionValueType is 'timeTicks'."
 ::= { expValueEntry 4 }
```

```
expValueInteger32Val OBJECT-TYPE
SYNTAX      Integer32
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
  "The value when expExpressionValueType is 'integer32'."
 ::= { expValueEntry 5 }
```

```
expValueIpAddressVal OBJECT-TYPE
SYNTAX      IpAddress
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
  "The value when expExpressionValueType is 'ipAddress'."
 ::= { expValueEntry 6 }
```

```
expValueOctetStringVal OBJECT-TYPE
SYNTAX      OCTET STRING (SIZE (0..65536))
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
  "The value when expExpressionValueType is 'octetString'."
 ::= { expValueEntry 7 }
```

```
expValueOidVal OBJECT-TYPE
SYNTAX      OBJECT IDENTIFIER
MAX-ACCESS  read-only
```

```

STATUS      current
DESCRIPTION
  "The value when expExpressionValueType is 'objectId'."
 ::= { expValueEntry 8 }

expValueCounter64Val OBJECT-TYPE
SYNTAX      Counter64
MAX-ACCESS  read-only
STATUS      current
DESCRIPTION
  "The value when expExpressionValueType is 'counter64'."
 ::= { expValueEntry 9 }

--
-- Conformance
--

dismanExpressionMIBConformance OBJECT IDENTIFIER ::=
  { dismanExpressionMIB 3 }
dismanExpressionMIBCompliances OBJECT IDENTIFIER ::=
  { dismanExpressionMIBConformance 1 }
dismanExpressionMIBGroups      OBJECT IDENTIFIER ::=
  { dismanExpressionMIBConformance 2 }

-- Compliance

dismanExpressionMIBCompliance MODULE-COMPLIANCE
STATUS current
DESCRIPTION
  "The compliance statement for entities which implement
  the Expression MIB."
MODULE      -- this module
MANDATORY-GROUPS {
  dismanExpressionResourceGroup,
  dismanExpressionDefinitionGroup,
  dismanExpressionValueGroup
}

OBJECT      expResourceDeltaMinimum
SYNTAX      Integer32 (-1 | 60..600)
DESCRIPTION
  "Implementation need not allow deltas or it may
  implement them and restrict them to higher values."

OBJECT      expObjectSampleType
WRITE-SYNTAX  INTEGER { absoluteValue(1) }
DESCRIPTION
  "Implementation may disallow deltas calculation or

```

change detection."

```
OBJECT          expObjectIDWildcard
WRITE-SYNTAX   INTEGER { false(2) }
DESCRIPTION
    "Implementation may allow wildcards."
```

```
OBJECT          expObjectDiscontinuityIDWildcard
WRITE-SYNTAX   INTEGER { false(2) }
DESCRIPTION
    "Implementation need not allow wildcards."
```

```
OBJECT          expObjectConditionalWildcard
WRITE-SYNTAX   INTEGER { false(2) }
DESCRIPTION
    "Implementation need not allow deltas wildcards."
```

```
::= { dismanExpressionMIBCompliances 1 }
```

-- Units of Conformance

```
dismanExpressionResourceGroup OBJECT-GROUP
OBJECTS {
    expResourceDeltaMinimum,
    expResourceDeltaWildcardInstanceMaximum,
    expResourceDeltaWildcardInstances,
    expResourceDeltaWildcardInstancesHigh,
    expResourceDeltaWildcardInstanceResourceLacks
}
STATUS current
DESCRIPTION
    "Expression definition resource management."
::= { dismanExpressionMIBGroups 1 }
```

```
dismanExpressionDefinitionGroup OBJECT-GROUP
OBJECTS {
    expExpression,
    expExpressionValueType,
    expExpressionComment,
    expExpressionDeltaInterval,
    expExpressionPrefix,
    expExpressionErrors,
    expExpressionEntryStatus,

    expErrorTime,
    expErrorIndex,
    expErrorCode,
    expErrorInstance,
}
```

```

        expObjectID,
        expObjectIDWildcard,
        expObjectSampleType,
        expObjectDeltaDiscontinuityID,
        expObjectDiscontinuityIDWildcard,
        expObjectDiscontinuityIDType,
        expObjectConditional,
        expObjectConditionalWildcard,
        expObjectEntryStatus
    }
    STATUS current
    DESCRIPTION
        "Expression definition."
    ::= { dismanExpressionMIBGroups 2 }

dismanExpressionValueGroup OBJECT-GROUP
    OBJECTS {
        expValueCounter32Val,
        expValueUnsigned32Val,
        expValueTimeTicksVal,
        expValueInteger32Val,
        expValueIpAddressVal,
        expValueOctetStringVal,
        expValueOidVal,
        expValueCounter64Val
    }
    STATUS current
    DESCRIPTION
        "Expression value."
    ::= { dismanExpressionMIBGroups 3 }

END

```

4. Intellectual Property

The IETF takes no position regarding the validity or scope of any intellectual property or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; neither does it represent that it has made any effort to identify any such rights. Information on the IETF's procedures with respect to rights in standards-track and standards-related documentation can be found in BCP-11. Copies of claims of rights made available for publication and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementors or users of this specification can be obtained from the IETF Secretariat.

The IETF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary rights which may cover technology that may be required to practice this standard. Please address the information to the IETF Executive Director.

5. Acknowledgements

This MIB contains considerable contributions from the Distributed Management Design Team (Andy Bierman, Maria Greene, Bob Stewart, and Steve Waldbusser), and colleagues at Cisco who did the first implementation.

6. References

- [RFC2571] Harrington, D., Presuhn, R. and B. Wijnen, "An Architecture Describing SNMP Management Frameworks", RFC 2571, April 1999.
- [RFC1155] Rose, M. and K. McCloghrie, "Structure and Identification of Management Information for TCP/IP-based Internets", STD 16, RFC 1155, May 1990.
- [RFC1212] Rose, M. and K. McCloghrie, "Concise MIB Definitions", STD 16, RFC 1212, March 1991.
- [RFC1215] Rose, M., "A Convention for Defining Traps for use with the SNMP", RFC 1215, March 1991.
- [RFC2578] McCloghrie, K., Perkins, D., Schoenwaelder, J., Case, J., Rose, M. and S. Waldbusser, "Structure of Management Information Version 2 (SMIV2)", STD 58, RFC 2578, April 1999.
- [RFC2579] McCloghrie, K., Perkins, D., Schoenwaelder, J., Case, J., Rose, M. and S. Waldbusser, "Textual Conventions for SMIV2", STD 58, RFC 2579, April 1999.
- [RFC2580] McCloghrie, K., Perkins, D., Schoenwaelder, J., Case, J., Rose, M. and S. Waldbusser, "Conformance Statements for SMIV2", STD 58, RFC 2580, April 1999.
- [RFC1157] Case, J., Fedor, M., Schoffstall, M. and J. Davin, "Simple Network Management Protocol", STD 15, RFC 1157, May 1990.

- [RFC1901] Case, J., McCloghrie, K., Rose, M. and S. Waldbusser, "Introduction to Community-based SNMPv2", RFC 1901, January 1996.
- [RFC1906] Case, J., McCloghrie, K., Rose, M. and S. Waldbusser, "Transport Mappings for Version 2 of the Simple Network Management Protocol (SNMPv2)", RFC 1906, January 1996.
- [RFC2572] Case, J., Harrington D., Presuhn R. and B. Wijnen, "Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)", RFC 2572, April 1999.
- [RFC2574] Blumenthal, U. and B. Wijnen, "User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)", RFC 2574, April 1999.
- [RFC1905] Case, J., McCloghrie, K., Rose, M. and S. Waldbusser, "Protocol Operations for Version 2 of the Simple Network Management Protocol (SNMPv2)", RFC 1905, January 1996.
- [RFC2573] Levi, D., Meyer, P. and B. Stewart, "SNMPv3 Applications", RFC 2573, April 1999.
- [RFC2575] Wijnen, B., Presuhn, R. and K. McCloghrie, "View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)", RFC 2575, April 1999.
- [RFC2570] Case, J., Mundy, R., Partain, D. and B. Stewart, "Introduction to Version 3 of the Internet-standard Network Management Framework", RFC 2570, April 1999.
- [RFC1903] Case, J., McCloghrie, K., Rose, M. and S. Waldbusser, "Coexistence between Version 1 and version 2 of the Internet-standard Network Management Framework", RFC 1903, January 1996.
- [RFC2981] Stewart, B., "Event MIB", RFC 2981, October 2000.
- [PracPersp] Leinwand, A. and K. Fang, "Network Management: A Practical Perspective", Addison-Wesley Publishing Company, Inc., 1993.

7. Security Considerations

Expression MIB security involves two perspectives: protection of expressions from tampering or unauthorized use of resources, and protection of the objects used to calculate the expressions.

Security of expression definitions and results depends on the expression owner (expExpressionOwner). With view-based access control [RFC2575] a network manager can control who has what level of access to what expressions.

Access control for the objects within the expression depends on the security credentials of the expression creator. These are the security credentials used to get the objects necessary to evaluate the expression. They are the security credentials that were used to set the expExpressionRowStatus object for that expression to 'active', as recorded by the managed system.

This means that the results of an expression could potentially be made available to someone who does not have access to the raw data that went into them. This could be either legitimate or a security violation, depending on the specific situation and security policy.

To facilitate the provisioning of access control by a security administrator for this MIB itself using the View-Based Access Control Model (VACM) defined in RFC 2575 [RFC2575] for tables in which multiple users may need to independently create or modify entries, the initial index is used as an "owner index". Such an initial index has a syntax of SnmpAdminString, and can thus be trivially mapped to a securityName or groupName as defined in VACM, in accordance with a security policy.

All entries in related tables belonging to a particular user will have the same value for this initial index. For a given user's entries in a particular table, the object identifiers for the information in these entries will have the same subidentifiers (except for the "column" subidentifier) up to the end of the encoded owner index. To configure VACM to permit access to this portion of the table, one would create vacmViewTreeFamilyTable entries with the value of vacmViewTreeFamilySubtree including the owner index portion, and vacmViewTreeFamilyMask "wildcarding" the column subidentifier. More elaborate configurations are possible.

8. Author's Address

Bob Stewart
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
U.S.A.

9. Editor's Address

Ramanathan Kavasseri
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
U.S.A.

Phone: +1 408 527 2446
EMail: ramk@cisco.com

10. Full Copyright Statement

Copyright (C) The Internet Society (2000). All Rights Reserved.

This document and translations of it may be copied and furnished to others, and derivative works that comment on or otherwise explain it or assist in its implementation may be prepared, copied, published and distributed, in whole or in part, without restriction of any kind, provided that the above copyright notice and this paragraph are included on all such copies and derivative works. However, this document itself may not be modified in any way, such as by removing the copyright notice or references to the Internet Society or other Internet organizations, except as needed for the purpose of developing Internet standards in which case the procedures for copyrights defined in the Internet Standards process must be followed, or as required to translate it into languages other than English.

The limited permissions granted above are perpetual and will not be revoked by the Internet Society or its successors or assigns.

This document and the information contained herein is provided on an "AS IS" basis and THE INTERNET SOCIETY AND THE INTERNET ENGINEERING TASK FORCE DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Acknowledgement

Funding for the RFC Editor function is currently provided by the Internet Society.

