Michael Ries (Michael.Ries@belden.com)

Andreas Walden (Andreas.Walden@belden.com)

Inhalt

Abstract 1

Related standards..... 2

Related patents 2

Appendix..... 2

Abstract

The Management Information Base (MIB) is a data model often associated with the ubiquitous Simple Network Management Protocol (SNMP), a standard protocol for managing devices on IP networks. The invention relates to a method for transferring said MIB data in a manner which does not underlay restrictions from current implementations, namely SNMP version 1-3.

The proposed MIB-oriented protocol (MOP) is a stateless protocol based on HTTP. The content of the HTTP message is XML or JSON, as seen in figure 1.

Goals of the protocol:

Reduce influence of network latency, Minimize network traffic compared to SNMP

Support common existing use cases of HTTP

Low-effort transition from MIB-based SNMP implementations

Support extended error handling

The protocol offers significant performance improvements: SNMP response packets are limited to the maximum transmission unit (MTU), the largest frame size allowed for a single frame on your network. Therefore requesting large chunks of data results in a series of requests/responses, which is critical in networks with high latency or high packet loss. MOP does not underlie such size restrictions and therefore the complete request is transferred before being processed by the server. Having complete requests allows the server to optimize data processing, such as setting locks on a database, pipelining operations, etc. When requesting table data, MOP allows to set a filter to reduce the network bandwidth and optimize data processing even further which is not possible in an equivalent SNMP bulk request. The SNMP bulk request is not capable to get a desired table in a single request-response message exchange, since the protocol defines no end-Object Identifier for the request, only a start identifier and the number of repetitions is supported (see figure SNMP Table Request). Compared to this, MOP forms the MIB tree to a map with keys and values, where the keys are the

accessible nodes and the values the accessible leafs of these nodes. These nodes can be accessed in one request via MOP. *N* nodes are allowed in one request of the protocol (see figure MOP Table Request).

While standard SNMP uses UDP as a transport protocol and a binary data format, MOP allows lightweight client frameworks built around HTTP to access MIB information. The data is represented in a textual data format: XML or JSON. This choice allows modern web browsers and web APIs to implement a MOP client. While the basic protocol operation is built on top of the NETCONF remote procedure call (RPC) definition, MOP defines its own data model and data representation layer to present the MIB data.

MOP is designed to allow an easy transition from MIB based SNMP implementations. Since the MIB access layer is commonly decoupled from the SNMP layer, implementers can access the MIB data directly to build the MOP response. The MOP server may run as a HTTP service and use existing security and load balancing mechanisms from the HTTP server. The data format was chosen in a way that a 1:1 mapping from the hierarchical MIB structure to the MOP data is possible.

The SNMP response messages only allow a restricted set of error status codes. Therefore efforts were done to work around that limitation: See extended error handling. MOP allows to freely assign error codes to either protocol operations or MIB data objects. A 1:1 mapping from SNMP error codes to MOP error codes is possible and recommended for implementers. In order to support extended error handling, the element containing a MIB object's data may be extended.

Related standards

RFC 2616: Hypertext Transfer Protocol -- HTTP/1.1

RFC 3416: Version 2 of the Protocol Operations for the Simple Network Management Protocol (SNMP)

RFC 3418: Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)

RFC 6241: Network Configuration Protocol (NETCONF)

Related patents

(1) Extension for the simple network management protocol (SNMP) in order to ascertain information on the status of SET-PDUS, Walden, Patent No. US 9,191,268 B2, Nov. 17, 2015

Appendix

```
Application          SNMP       SNMP                 Tunneling SNMP   Tunneling SNMP      MOPS
        |            rfc1157    over TCP (rfc3440)   over SSH         over HTTP
                       |          |                     |                |                |
                       |          |                     |                |                |
Presentation           ASN.1      ASN.1                  ASN.1            ASN.1          XML/JSON
                       |          |                     |                |                |
                       |          |                     |                |                |
Session                |          |                     SSH              HTTP             HTTP
                       |          |                     |                |                |
                       |          |                     |                |                |
Transport              UDP        TCP                    TCP              TCP              TCP
                       |          |                     |                |                |
                       |          |                     |                |                |
Network                                   Internet Protocol (IPv4/IPv6)

Data Link

Physical
```

Abbildung 1: Network Transport Layer

Abbildung 2: SNMP Table Request

Abbildung 3: MOP Table Request

ASN.1 type	ASN.1 Object	ASN.1 String
OCTET STRING	{ 0x41, 0x5A}	"41 5A"
BITS(same conversion as OCTET STRING)	{ 0x7, 0xA}	"07 0A"
OBJECT IDENTIFIER	{ 3, 5 }	"3.5"
IP ADDRESS	{ 0xff, 0xff, 0x00, 0x00}	"255.255.0.0"
INTEGER	-3	"-3"
TimeTicks	3	"3"
Gauge	3	"3"
Counter	3	"3"

Abbildung 4: MOP MIB Data Represenation

MOP Data Model (XSD Schema)

```
                "1.0"            "UTF-8"
                      "http://www.w3.org/2001/XMLSchema"
                "urn:ietf:params:xml:ns:netconf:base:1.0"        "urn:x-
mops:1.0"                  "urn:x-mops:1.0"                      "qualified"
                         "unqualified"          "en"          "1.1"
                              "netconf.xsd"
           "urn:ietf:params:xml:ns:netconf:base:1.0"

                        "SNMPErrorStatus"
                           "xs:string"
                              "noError"
                              "tooBig"
                              "noSuchName"
                              "badValue"
                              "readOnly"
                              "genError"
                              "wrongValue"
                              "wrongEncodomg"
                              "wrongType"
                              "wrongLength"
                              "inconsistentValue"
                              "noAccess"
                              "notWriable"
                              "noCreation"
                              "inconsistentName"
```

"resourceUnavailable"
"commitFailed"
"undoFailed"
"authoizationError"

"mibOperation" "netconf:rpcOperation"

"netconf:rpcOperationType"

"get-config" "0"

Request configuration data.

"source"

Source of the data.

Source types.

"running-config"
"default-config"

"MIBData"

Filter for the requested data.

"unbounded" "0"
"MIB"

"unbounded" "0"
"Node"

Contain a set of attributes with the same path (except subId) in the MIB tree.

"unbounded" "0"
"Get"
"unbounded"

Represents one MIB attribute.

"name"
"required"

Name of the attribute according to the MIB without namespace.

"name"

"name" "required"

"edit-config" "0"

Modify configuration data.

"1" "1"
"MIBData"

Filter for the requested data.

"unbounded" "0"
"MIB"

"unbounded"
"0"
"Node"

Contain a set of attributes with the same path (except subId) in the MIB tree.

"unbounded"
"0"
"0" "Index"

"unbounded"
"1"
"Attribute"
"true"
"name"

"Set"
"unbounded"

Represents one MIB attribute. Content is the new value for the attribute.

"true"
"name"
"required"

Name of the attribute according to the MIB without namespace.

"name"

"name" "required"

"mibResponse" "netconf:rpcResponse"

"netconf:rpcResponseType"

"MIBData"

"unbounded" "0"
"MIB"

Represents one single MIB definition

"0" "unbounded"
"Node"

Used for table definitions (parent name ends with "Entry") and 0 or more instances can exists (except instance "0").

"unbounded"
"0"
"Entry"

Represents a single instance of the table definition.

"0"
"unbounded"
"Attribute"

Represents one MIB attribute. The value of MIB attribute is the text content of the XML attribute as a an ASN.1 value (until not required with the convert attribute).

"true"
"0"

"extendedErrorHandling"

"name"
"required"

Name of the attribute according to the MIB without namespace.

"error"
"xs:string"

"name" "required"
"xs:string"
"error" "xs:string"

"name" "required"
"xs:string"

Name of the MIB, for ex. "SNMPv2-MIB".

"error" "xs:string"

"error"

"0"
"snmp-error-status"

"SNMPErrorStatus"

"extendedErrorHandling"

Element to support the extended error MIB.

"0" "unbounded"
"parameter" "xs:string"

"path" "required"

Path to the Object Identity (OID-Path, for ex. 1.3.6.xx) which reflects the error.

"Filter"

"rpn"