SNMP

Protocol SNMP

Supported device types and versions

Protocol **SNMP** (Simple Network Management Protocol) is used for monitoring and administration of network components. It allows to detect the status of network devices and change their settings. In an application it is possible to monitor functionality of e.g. routers, switches, computers, etc.

To create a station equipped with SNMP protocol it is necessary to have a UDP line (link type TCP-UDP). Its is worth mentioning here that a UDP link in perception of D2000 system is actually a UDP socket which is a logical device to support communication of individual stations. As the use of these sockets differs from each other in various D2000 system implementations, it is not possible to use multiple D2000 UDP protocols on one line!

Communication line configuration

- Communication line category: **TCP-IP/UDP**.
- UDP parameters:
  - Host: There are three ways:
    1. IP address of the particular network interface – datagrams will be transmitted and received only via this interface.
       Example: *192.168.1.10*
    2. Symbolic name of particular network interface.
       Example: *D2SRV_PRIMARY*
    3. *ANY* or *ALL* -the configured UDP port is opened on all available network interfaces. Optimal network interface should be used for communication based on routing tables. All network interfaces will receive the messages.
  - Port: UDP port number (0 through 65535) from which the D2000 KOM process sends calls and receives the replies. If the value is 0, the port number is determined automatically by OS.
    Note: Ports 161 and 162 are the standard UDP ports used in SNMP but they are often reserved for SNMP agent - that is why it is recommended to choose different ports. There can occur problems with value 0 (zero) if the network uses firewalls and other security. Then the particular port needs to be configured on firewalls so that the packets from this port are passed via firewalls.

***** The value ALL in station configuration can be used for either Primary or Backup server only in case of SNMP protocol. As for the other protocols, this can be done solely for Backup server.

Note:
If SNMP protocol needs to run in a redundant system, where two instances of KOM process are running concurrently on two different computers and the IP address cannot be positively determined in line configuration, it is suitable to choose „ANY“ or „ALL“ configuration option or to name the network addresses identically as e.g. SNMP_LAN and assign them a correct IP address in the host file of each computer. See example:

on PC1:	192.168.0.1	PC1, SNMP_LAN
on PC2:	192.168.0.11	PC2, SNMP_LAN

Protocol parameters on the line

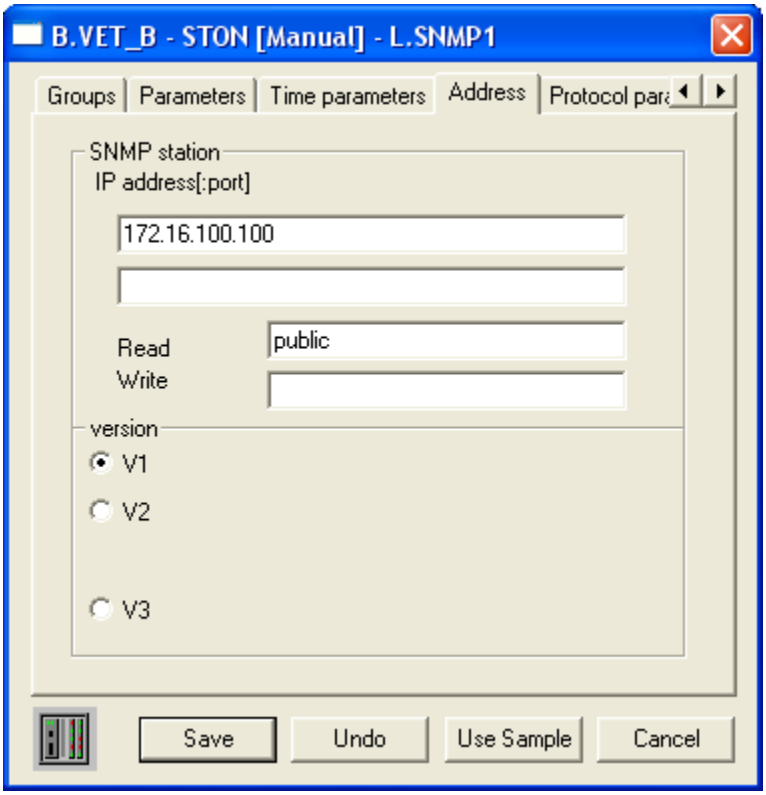
Following parameters of protocol can be set on the line:

Key word	Full name	Description	Unit	Default value

<table>
<tr><td>TRACE</td><td>Trace Level</td><td>
<table>
<tr><td>Trace level = 0</td><td>- no debugging information output, the same as turning it off in Line parameters</td></tr>
<tr><td>Trace level = 1</td><td>- only information on receiving and sending UDP packet and IP address</td></tr>
<tr><td>Trace level = 2</td><td>- adds information on request preparation</td></tr>
<tr><td>Trace level = 3</td><td>- adds packet's HEX dump</td></tr>
<tr><td>Trace level = 4</td><td>- the same as value of 3</td></tr>
<tr><td>Trace level = 5</td><td>- adds:
• detailed analysis of packet structure in ASN1 coding
• order of data in packet
• detailed information</td></tr>
<tr><td>Trace level = 9999</td><td>- adds information on preparation and decision making of packet distribution and that concerning searching</td></tr>
</table>
The values 5 and 9999 are intended for debugging and their permanent use is not recommended. In case, that the information is needed from a monitored station(s) only, the setting of the Trace level can be performed for a particular station in its configuration dialog box.

The value of 1 is recommended for ordinary operation.</td><td>-</td><td>1</td></tr>
<tr><td>TE</td><td>Trap Enable</td><td>Enables to receive the messages of Trap type.</td><td>Boolean</td><td>False</td></tr>
<tr><td>TTI</td><td>Trap IP Address</td><td>IP address for receiving the Trap messages.</td><td>-</td><td>ANY</td></tr>
<tr><td>TTP</td><td>Trap Port</td><td>UDP port for receiving the Trap messages.</td><td>-</td><td>162</td></tr>
</table>

Communication station configuration



- Communication protocol: **SNMP Manager**.
- Station's address: it is defined in format IP_address1[:port1], IP_address2[:port2].

IP_address may be set in decimal dotted notation (e.g. 192.168.0.1) or as a name, which assumes address translation by means of DNS or HOST. Address1 and Address2 concern the existence of primary and backup line / route. Address 2 is usable for example for server containing two network interface cards, which is connected to two different network segments available from two different lines.

Port is a number in range 1..65535 on which an SNMP agent expects communication to take place. As the default (if not stated, or set to 0) port the standard port 161 will be used.

Note:

- IF the line has only primary IP address configured (numerical or symbolic), UDP packets are sent from this socket to both IP addresses of the station. One numerical primary IP address of line + two IP addresses of the station are valid for network topology where the local network is non redundant but the remote network (where the station is located) is accessible via two redundant communication paths.
- If the line has both IP addresses configured, UDP packets to IP_address1 leave from the primary IP address of the line and UDP packets to IP_address2 leave from the backup IP address of the line.

The situation when e.g. IP_address1 is not configured conforms to the topology when the station is connected to backup communication path only.

Protocol
Employed version of SNMP protocol – one of options can be selected:

- SNMP_V1 – the oldest version – does not support any secured access to SNMP agent. It distinguishes only object that are freely accessible (public) and those belonging to a restricted group (private).
- SNMP_V2 – a version that supports authentication to access individual data types - an agent might (not) provide a particular set of data for an anonymous user (a manager,...) and different data for a user whose identity has been verified by entering correct name and password.
- SNMP_V2C – the same as SNMP_V2 – the D2000 system does not distinguish these variants.
- SNMP_V3 – so far the latest protocol version – besides functions provided by SNMP_V2C, supports functions for authentication and encryption. It requires entering the name of an authentication server and authentication keys, to authenticate prior to communication with an agent, and keys for encrypting communication.

SNMP_V2, SNMP_V2C and SNMP_V3 are not supported yet. Neither the writing into SNMP agent nor reading MIB branches as a table (structured I/O tags or directly entered structure entries) are supported.

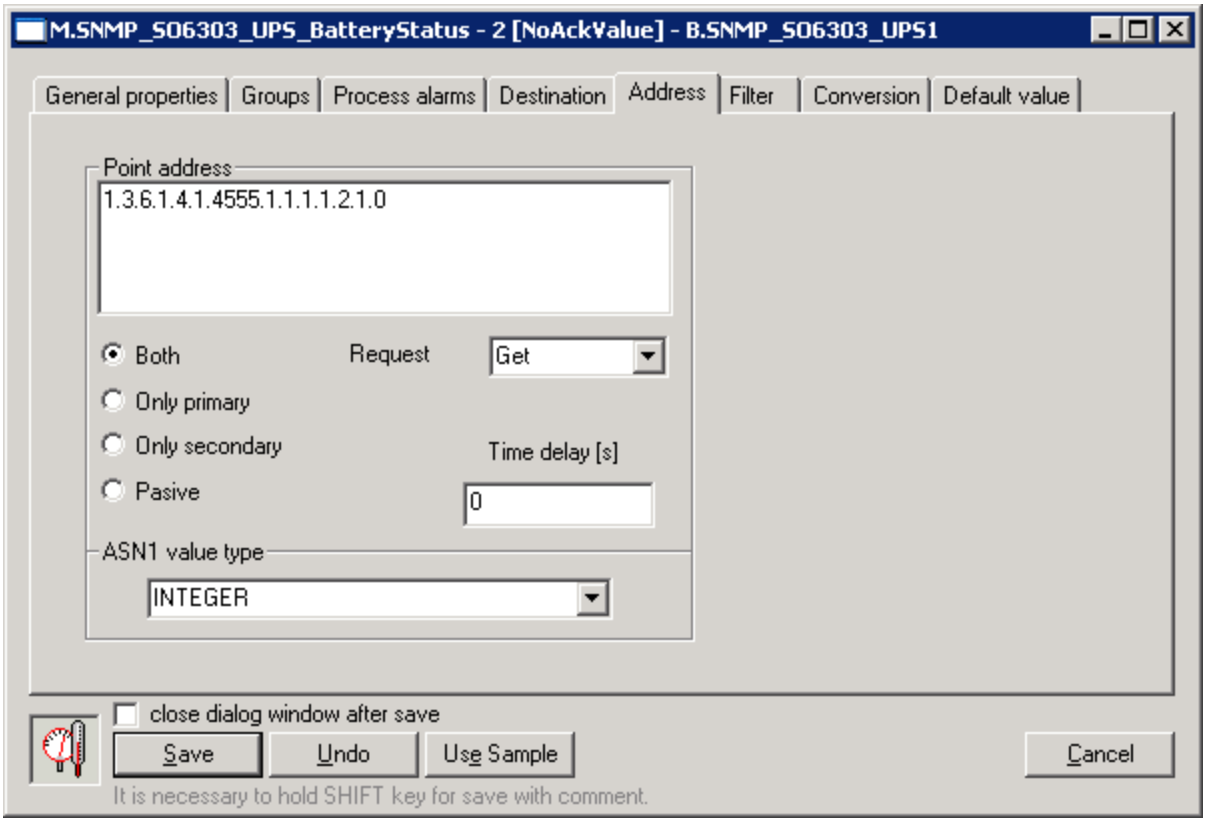
Station protocol parameters

The following station protocol parameters can be set:

Table no. 2

Key word	Full name	Description	Unit	Default value
WT	Wait Timeout	Timeout period for the response to the read request.	ms	
RC	Retry Count	Number of re-sent read requests before the read is considered to be unsuccessful and another I/O tag will be queried.	-	
EC	Max Error Count	Maximum count of unsuccessful read requests, until the station changes value to StCOMERR state. A successful value delivery nullifies all counters and puts the station back into StON state.	-	
TL	Trace Level	The same meaning as parameter Trace Level on a line, but this setting is valid for the particular station. However, the higher value of a line parameter Trace level takes precedence. Note: Debugging of incoming packets is influenced by the line parameter Trace Level because at the time of reception it is still unknown which station the packet belongs to.	-	

I/O tags configuration



Address1: Address of I/O tag. Address is displayed in number format e.g.: 1.3.6.1.2.1.1.1.0 An I/O tag with an address defined like that will all be read on a line, that is just operational (a primary or a backup line is determined according to the result of reply to previous request or possibly could be switched manually).

I/O tag with the address set by this way will be red always in active line (primary line, if this line is not available, then in case of need the backup line is automatic switched).
Information on availability of the primary or backup IP address of device can be found out using by so called forced addressing - just select the option *Only primary* or *Only secondary*. Thus we ensure, that value acquisition of I/O tag is required on that line only. The option *Both* is default one, when the values of I/O tags are acquired continuously on both lines. The option *Passive* indicates, that this I/O tag is not directly called, but its value is acquired indirectly as a copy of a value of another I/O tag with the same address but in the state e.g. *Only primary*.

If I/O tag, with entered OID address, does not exit, the SNMP agent returns an error code with different OID address (because the object with required OID dos not exist) and therefore the communication will be denoted as unsuccessful. The I/O tag passes to the „Unknown value“ state. If it is necessary to indicate the line status by value change and not by the validity of object's value, the object of DI type can be created, an integer value (e.g. UpTime) can be asked for and automatic number to boolean conversion can be utilised, where 0 is converted to false and the others to True. The object properties can be then adjusted to use a substitute value and to set the default to False. Then the object may acquire only the values True or False in dependence on object's availability in SNMP agent.

Request: Default value *Get* causes the values will be read by SNMP request *Get*.
Some devices have problems to give value by *Get*, if it is the item of field. Then, you must configure the type of request GetNext and the address should be OID of previous object (to find the address, use java application MIB Browser (http://tl1.ireasoning.com/mibbrowser.shtml) that reads whole tree of values and detects the OID address of previous object).

Time delay: Offers a possibility to set a delay period for particular I/O tags – to optimize the network's load. This time is added to the current time after a successful call and next call request will processed as soon as the current time is greater than or equal to the time calculated in this way.
If the object's value is unknown, the object will be included in communication in the next call (according to the time parameters of station) regardless of the delay time.
Parameter Time delay does not influence the processing of TRAP messages if the TRAP has the same address than address of I/O tag.

After receiving the value from SNMP agent, the conversion will be done according to real type of value in SNMP protocol and required type in D2000 system. If it is not possible to carry out the conversion, the value will be in unknown state and a report about the wrong conversion will be logged into a trace file.

ASN1 value type: Specifies, the value type in SNMP agent's response. It also determines applicable conversions. The value type can be detected in MIB database (*note* MIB database browser is not a part of the solution). One of freely available browsers can be used and desired data format can be set. It is recommended to use java application MIB Browser (http://tl1.ireasoning.com/mibbrowser.shtml).

Possible value types:

Integer	input value - expected as signed integer number (up to 64bit *****)

Unsigned	input value - expected as unsigned integer number (up to 64bit *****)
Float	input value - expected as floating-point number (float, a longfloat)
Textxt	input value - text string
IP address	input sequence of bytes interpreted as sequence of numbers separated by a dot – the sequence is converted to text
Hex text	input sequence of bytes is interpreted as sequence of hexadecimal numbers separated by colon – the sequence is converted to text

The value types *IP address* and *Hex text* can be applied to an arbitrary input data type, which will be further handled with as sequence of bytes. E.g., the input value of text type with value "test@ipesoft.sk" can be interpreted in following ways:

Text: "test@ipesoft.sk"
IP address: „112.101.114.105.99.104.64.105.112.101.115.111.102.116.46.115.107“7“
Hex text: „70:65:72:69:63:56:40:69:70:65:73:6F:66:74:2E:73:6B“

These methods were introduced to support cooperation with IP and MAC addresses of network interfaces.

***** System D2000 support values of objects in maximum range of 32 bits for integer types. Therefore, if the number is bigger then the maximum value of the 32 bit range will be assigned to it. If the input object of D2000 system is of *Ai* type, the system will attempt to convert it to *Real*.

Permissible types: **Di**, **Ci**, **Ai**, **TxI**, **TiR**, **TiA**

The following table shows the supported conversions of value types:

	Typ hodnoty v systéme D2000					
Typ hodnoty SNMP	*Di*	*Ci*	*Ai*	*TxI*	*TiR*	*TiA*
Boolean	●	●	●	●		
Integer	●	●	●	●		
Unsigned	●	●	●	●		
Counter	●	●	●	●		
Gauge	●	●	●	●		
Float		●	●	●		
Text				●		
TimeTicks		●	●	●	●	
Time			●	●		●

- admissible conversion

Trap messages receiving and processing

Protocol SNMP also allows, except for cyclic value reading, to send messages about important events. This messages are called Traps.
SNMP agent sends the Traps to the configured IP address and port (by default 162) (elementary devices support to send Traps to one IP address and port, advance ones send Traps to more addresses).
The parameter Trap IP address must by configured to activate a task that receives the Traps on the port Trap port.
Trap receiving is supported in the version V1 and V2C of protocol SNMP. Default mode - one device send Traps to one version of protocol.
To receive Traps from particular device, I/O tags with following text addresses (there is no need all of them) must be configured on the station:

Text addresses of I/O tags for Traps in SNMP protocol, version V1:

I/O tag address	Data type	Description
TRAP_ENTERPRISE	OID	OID of the object which generate Trap (for particular device it is constant). **Note:** A producer of device can be often detected from OID.
TRAP_GENERIC_TRAP	Integer	Identifier of Trap class. Following values are defined in RFC 1157 for SNMP, version 1: • 0 - coldStart • 1 - warmStart • 2 - linkDown • 3 - linkUp • 4 - authenticationFailure • 5 - egpNeighborLoss • 6 - enterpriseSpecific
TRAP_SPECIFIC_TRAP	Integer	Specific code of message.

TRAP_TIMESTAMP	TimeTicks	Time-stamp (according to RFC 1157 it means the hundreds of second that passed between the last network reinitialization of device and trap generating. **Note:** If I/O tag is *Ai - Analog input*, its value will be in seconds, i.e. TimeTicks/100. If I/O tag is *Ci - Integer input*, its value will be in hundreds of second, i.e. TimeTicks. The maximum value for integer value in D2000 is 2^31-1 (because the integer type is implemented as 32-bit integer with sign). I/O tag of *Ci - Integer input* type cannot acquire the higher values than 2^31-1. According to RFC 1157, the Time-stamp is of TimeTicks type which is a non-negative integer. It can acquire higher values than 2^31-1 which are not allowed to be written into I/O tag of *Ci - Integer input* type. That is why it is recommended to configure I/O tag of *Ai - Analog input* type.
TRAP_OID	OID	OID of object that caused a formation of Trap or object which Trap relate to.
TRAP_VALUE	Arbitrary	Value of object that caused a formation of Trap or object which Trap relate to. **Note 1:** Because the value is arbitrary, it is recommended to configure I/O tag of *TxtI - Text input* type. Otherwise, some values will not be converted (e.g. to *Integer input*) and value TRAP_VALUE will not be changed. **Note 2:** Trap can contain several couples (OID, value) as well. In this case, the value of I/O tags with addresses TRAP_OID and TRAP_VALUE will be set for all couples step-by-step. It is possible to configure event which is initiated when the value of I/O tag with address TRAP_VALUE is changed, and to save the couples (OID, value) into database.
TRAP_CONFIRM	Boolean	I/O tag which confirm the values processing. Because several couples (TRAP_OID, TRAP_VALUE) can exist in one Trap message, the correct processing by e.g. ESL script needs so that KOM process will set next couple after the first one is processed. Also the values of other input I/O tags for Trap messages should be set after signalization that previous values have been already processed. If the output I/O tag with address *TRAP_CONFIRM* exists, KOM process will set next couple of input I/O tag values after it is written into output I/O tag with address *TRAP_CONFIRM* (ESL script will execute the record as one of the last operations). The values of another I/O tags (with addresses TRAP_ENTERPRISE, TRAP_GENERIC_TRAP, TRAP_SPECIFIC_TRAP, TRAP_TIMESTAMP and TRAP_OID) will be set if it is the processing of the first couple of values (TRAP_OID, TRAP_VALUE). In case of another couples, the values of I/O tags will be the same and they will be changed during the next Trap message processing. If the output I/O tag with address *TRAP_CONFIRM* does not exist, the values of all input I/O tags with addresses TRAP_* will be set immediately after Trap message occurred. The values can get lost, because of existence of the several value couples in Trap message or because of new message arrival, before the user script has processed the previous values.

Text addresses of I/O tags for Traps in SNMP protocol, version V2C:

I/O tag address	Data type	Description
TRAP_REQUEST_ID	Integer	Increment number of Trap.
TRAP_ERROR_STATUS	Integer	Error code. Default value is zero (0) but it can acquire one of the following values (see RFC 1448): • noError(0) • tooBig(1) • noSuchName(2) • badValue(3) • readOnly(4) • genErr(5) • noAccess(6) • wrongType(7) • wrongLength(8) • wrongEncoding(9) • wrongValue(10) • noCreation(11) • inconsistentValue(12) • resourceUnavailable(13) • commitFailed(14) • undoFailed(15) • authorizationError(16) • notWritable(17) • inconsistentName(18)
TRAP_ERROR_INDEX	Integer	Extended error code (often it is 0).
TRAP_UPTIME_OID	OID	OID of object SysUpTime.0. This item should have the value 1.3.6.1.2.1.1.3.0 according to RFC 1448. But, if the item has not get this value in the implementation, the value can be find out by I/O tag with the address *TRAP_UPTIME_OID*.
TRAP_UPTIME_VALUE	TimeTicks	Value of object sysUpTime. The Note, mentioned in description of address TRAP_TIMESTAMP, is valid for this value.
TRAP_TRAP_OID	OID	OID of object SnmpTrap.0. This item should have the value 1.3.6.1.6.3.1.1.4.1.0 according to RFC 1448 (i.e. OID of object snmpTrapOID, see RFC 1450). But, if the item has not get this value in the implementation, the value can be find out by I/O tag with the address *TRAP_TRAP_OID*.
TRAP_TRAP_OID_VALUE	OID	Identifier of Trap category, meaning of which corresponds to item TRAP_GENERIC_TRAP in SNMP, version V1, but it is of OID type that allows to define the error codes, specific for particular producers and devices. Meaning of standard OID, which can acquire according to RFC 1450, are following: • 1.3.6.1.6.3.1.1.5.1 - coldStart • 1.3.6.1.6.3.1.1.5.2 - warmStart • 1.3.6.1.6.3.1.1.5.3 - linkDown • 1.3.6.1.6.3.1.1.5.4 - linkUp • 1.3.6.1.6.3.1.1.5.5 - authenticationFailure • 1.3.6.1.6.3.1.1.5.6 - egpNeighborLoss • 1.3.6.1.6.3.1.1.5.7 - enterpriseSpecific
TRAP_OID	OID	The same meaning as TRAP_OID in SNMP, version V1.
TRAP_VALUE	arbitrary	The same meaning as TRAP_VALUE in SNMP, version V1.

TRAP_CONFIRM	Boolean	The same meaning as TRAP_CONFIRM in SNMP, version V1.

Note 1: It will be sufficient to configure the input I/O tags with addresses TRAP_OID, TRAP_VALUE and output I/O tag with address TRAP_CONFIRM to confirm the value processing.

Note 2: If the parameter *Trap enable* has been already configured on the line, the individual task will be activated because of Trap messages processing. This task will receive the messages on the chosen UDP port, number of which specifies a link parameter *Trap port* (default 162).

If the Trap message processing is configured on the line with address *ANY* or *ALL* and on the particular port, it is not possible to configure the Trap message processing on another line and use the same port. It causes a collision. But it is possible to configure another parameter *Trap port* (e.g. 163) and set, on the devices, the sending of this messages to another port (e.g. 163).

Note 3: In a redundant system, user must take into consideration that SNMP agents usually support the sending traps to just one IP address (set in advance). Therefore, when redundancy is applied, everything will be ready for receiving traps on the side of D2000 system, but the monitored devices will send traps to the original address. A support of DDNS could be a solution but only in case that SNMP agent can use DNS services.

User must ensure so that the lines will not use the same network interface on the same UDP port. A line with IP address configuration as ANY basically causes blocking (restricting) UDP port on all network interfaces, which may collide with another TCP-UDP line.

Browsing and reading the tree of values from scrip

The version D2000 7.02.006 and higher supports the dynamic address change of I/O tag by TELL command SETPTADDR. This address together with I/O tag address GETNEXT_OID allow to browse and read the whole tree of values by SNMP request GetNext.

I/O tag address	Value type	Description
GETNEXT_OID	TxtI - Text input	OID of next object, it is in the response on request GetNext. Only requests that have been generated as the result of address change of I/O tag by tell command SETPTADDR are taken into consideration and not the requests that have been generated as a result of cyclic reading of I/O tags.

To read the tree of values, you should configure two input I/O tags of *TxtI - Text input* type. One of them has the special address *GETNEXT_OID.* Tell command SETPTADDR set the address of the second I/O tag.
After the address is set the KOM process will generate the request to read the I/O tag. If the request *GetNext* is in address (e.g. *SETPTADDR M. MySnmpVariable 1.3.6.1.2.1.1 TYPE=3;RQ=1)*, the OID (sent with reply) will be recorded into I/O tag with address *GETNEXT_OID* (e.g. 1.3.6.1.2.1.1.1.0). After that, the new tell command containing this address (*SETPTADDR M.MySnmpVariable 1.3.6.1.2.1.1.1.0 TYPE=3;RQ=1*) can be sent and so on.

Example of ESL script that shows the browsing and reading the first 100 objects from tree starting with address 1.3.6.1.2.1.1 and recording the OID addresses and values into the structure *_objlist*:

```
ENTRY query_device_OnClick
  INT _ret
  TIME _t
  TEXT _currOID  ; OID of object prior to object being read
  INT _obj_count ; number of read objects
  RECORD (SD.OID_Value) _objlist ; structure for storing OID+value of read objects

  _obj_count := 0
  _currOID := "1.3.6.1.2.1.1" ; start browsing the tree from successor of this OID

  DO_LOOP
    _t := M.SNMP_VariableAddress\TIM ; remember original time
    _ret := COMMAND "SETPTADDR M.SNMP_VariableAddress " + _currOID + " TYPE=3;RQ=1" ON SELF.KOM
    EXIT_LOOP _ret # _ERR_NO_ERROR

    DO_LOOP ; wait till the time of variable changes
      EXIT_LOOP _t # M.SNMP_VariableAddress\TIM
      DELAY 1[ms]
    END_LOOP

    EXIT_LOOP ! M.SNMP_VariableAddress\VLD ; invalid - error reading value from SNMP

    _obj_count := _obj_count + 1
    REDIM _objlist[_obj_count]
    _objlist[_obj_count]^OID := M.SNMP_GetNextOid ; OID of object
    _objlist[_obj_count]^Value := M.SNMP_VariableAddress ; value of object

    EXIT_LOOP _obj_count > 100    ; I need only first 100 values
    _currOID := M.SNMP_GetNextOid ; OID of the object which came with GetNext request
  END_LOOP
END query_device_OnClick
```

Literature

RFC
http://www.ietf.org/rfc.html
http://www.rfc-editor.org/rfcsearch.html

SNMP
http://www.snmplink.org
http://www.simpleweb.org/ietf/rfcs/rfcbymodule.html
http://publib.boulder.ibm.com/infocenter/tpfhelp/current/index.jsp?topic=/com.ibm.ztpf.doc_put.01/gtpc1/gtpc1m0a.htm
http://www.svetsiti.cz/view.asp?rubrika=Tutorialy&temaID=23&clanekID=32
http://www.microsoft.com/technet/archive/winntas/maintain/featusability/networkm.mspx?mfr=true

ASN.1
http://asn1.elibel.tm.fr/en/introduction/index.htm
http://asn1.elibel.tm.fr/en/standards

Changes and modifications

Document revisions

- 20. 3. 2006 - 1. version (testing version)
- 31. 7. 2007 - 2. version (SNMP in asynchronous mode)
- 16. 1. 2009 - GetNext support

Related pages:

Communication protocols