How to implement SNMP

(w5200 Application Notes)

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1. Introduction

Simple Network Management Protocol (SNMP) is an "Internet-standard protocol for managing devices on IP networks. Devices that typically support SNMP include routers, switches, servers, workstations, printers, modem racks, and more."

SNMP is extremely easy for any programmer to understand. A gross over simplification can explain the system simply. A network device runs an SNMP agent as a daemon process which answers requests from the network. The agent provides a large number of Object Identifiers (OIDs). An OID is a unique key-value pair. The agent populates these values and makes them available. An SNMP manager (client) can then query the agents key-value pairs for specific information. From a programming standpoint it's not much different than importing a ton of global variables. SNMP OIDs can be read or written. While writing information to an SNMP device is fairly rare, it is a method used by several management applications to control devices (such as an administrative GUI for your switches). A basic authentication scheme exists in SNMP, allowing the manager to send a community name (think clear text password) to authorize reading or writing of OIDs. Most devices use the insecure community name "public". SNMP communication is preformed via UDP on ports 161 and 162.
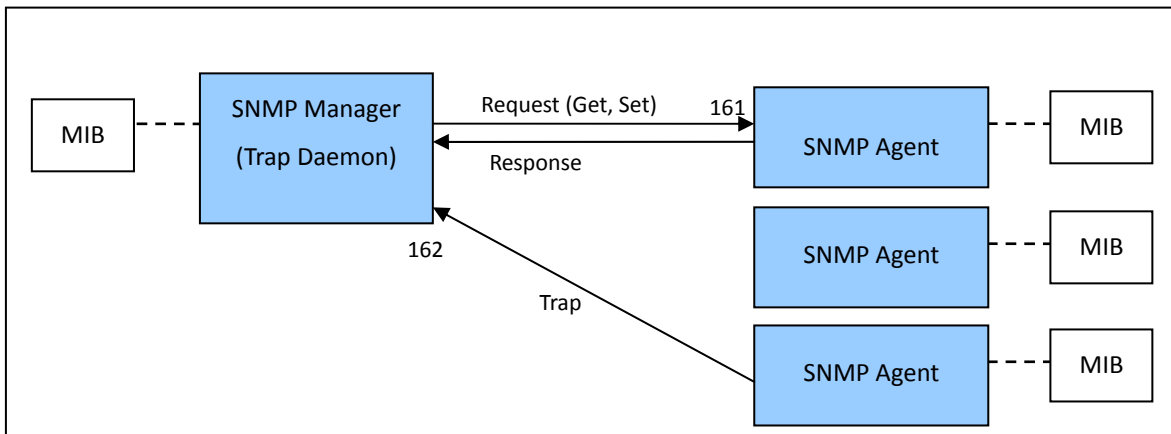

This application note show that how communicate between <SNMP agent> in w5200E01-M3 and <SNMP manager> in computer.

All codes and files mentioned in this document are available for download from http://www.wiznet.co.kr/w5200/download.

2. SNMP Protocol

The SNMP message format specifies which fields to include in the message and in what order. Ultimately, the message is made of several layers of nested fields. At the outer-most layer, the SNMP message is a single field, of the Sequence type. The entire message is a Sequence of three smaller fields: the SNMP Version (Integer), the SNMP Community String (Octet String), and the SNMP PDU (GetRequest, or SetRequest).

Since the SNMP Version and SNMP Community String are primitive data types they are not built from smaller fields (no more layers). However, the PDU is a complex data type made up of several smaller fields (more layers). The PDU is composed of a Request ID (Integer), Error (Integer), Error Index (Integer), and a Varbind List. A Varbind or Variable Binding is a Sequence of two specific fields. The first field is an OID, which addresses a specific parameter. The second field contains the Value of the specified parameter. In a SetRequest, Value must be the same data type specified in the MIB for the parameter being set. In a GetRequest, Value is a Null with length 0x00. This null data is a placeholder for the Value data that the SNMP agent returns using the GetResponse PDU. Furthermore, as the name suggests, a Varbind List is a Sequence of Varbinds. Finally, when a message is setting or getting a single parameter, the Varbind List holds only one Varbind. For an explanation of each field in the SNMP message see below table.
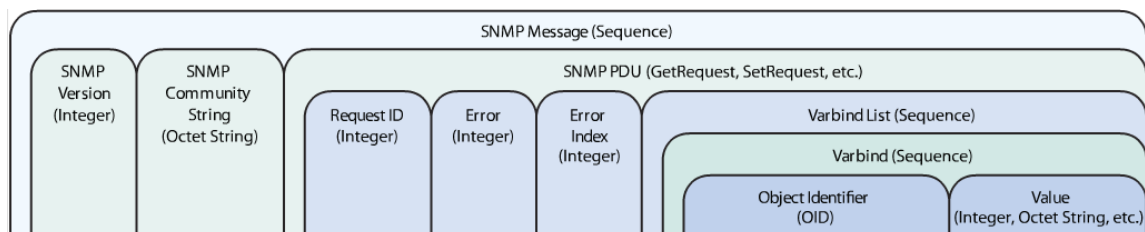

Field	Description
SNMP message	A Sequence representing the entire SNMP message consisting of the SNMP version, Community String, and SNMP PDU.
SNMP Version	An Integer that identifies the version of SNMP. SNMPv1 = 0
SNMP Community String	An Octet String that may contain a string used to add security to SNMP devices.
SNMP PDU	An SNMP PDU contains the body of the SNMP message. There are several types of PDUs. Three common PDUs are GetRequest, GetResponse, SetRequest.

Request ID	An Integer that identifies a particular SNMP request. This index is echoed back in the response from the SNMP agent, allowing the SNMP manager to match an incoming response to the appropriate request.
Error	An Integer set to 0x00 in the request sent by the SNMP manager. The SNMP agent places an error code in this field in the response message if an error occurred processing the request. Some error codes include: 0x00 -- No error occurred 0x01 -- Response message too large to transport 0x02 -- The name of the requested object was not found 0x03 -- A data type in the request did not match the data type in the SNMP agent 0x04 -- The SNMP manager attempted to set a read-only parameter 0x05 -- General Error (some error other than the ones listed above)
Error Index	If an Error occurs, the Error Index holds a pointer to the Object that caused the error, otherwise the Error Index is 0x00.
Varbind List	A Sequence of Varbinds.
Varbind	A Sequence of two fields, an Object ID and the value for/from that Object ID.
Object Identifier	An Object Identifier that points to a particular parameter in the SNMP agent.
Value	SetRequest PDU -- Value is applied to the specified OID of the SNMP agent.
	GetRequest PDU -- Value is a Null that acts as a placeholder for the return data.
	GetResponse PDU -- The returned Value from the specified OID of the SNMP agent.

The SNMP-related branches of the MIB tree are located in the internet branch, which contains two main types of branches:

■ Public branches (mgmt=2), which are defined by the Internet Engineering Task Force (IETF) RFCs, are the same for all SNMP-managed devices.

■ Private branches (private=4), which are assigned by the Internet Assigned Numbers Authority (IANA), are defined by the companies and organizations to which these branches are assigned.

The following figure shows the structure of the SNMP MIB tree. There are no limits on the width and depth of the MIB tree.
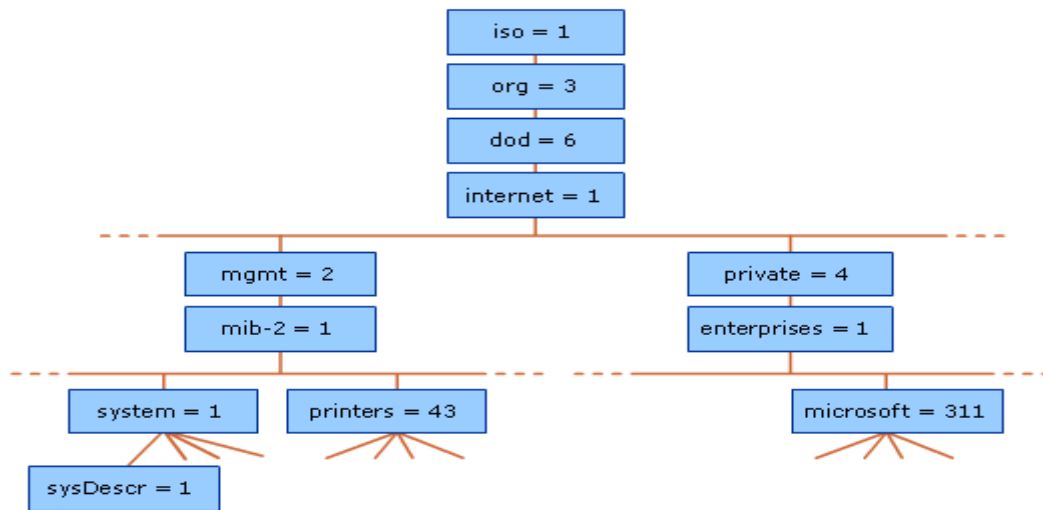
Immediately beneath the root of the MIB tree, International Organization for Standardization (iso), is the Organization (org) branch, followed by Department of Defense (dod), and then Internet (internet). Management (mgmt), the main public branch, defines network management parameters common to devices from all vendors. Underneath the Management branch is MIB-II (mib-2), and beneath this are branches for common management functions such as system management, printers, host resources, and interfaces.

The private branch of the MIB tree contains branches for large organizations, organized under the enterprises branch. Each organization has a root branch node under this object. Each organization creates its own subset of MIB branches and objects, which must comply with a common definition of SNMP information known as Structure of Management Information (SMI). SMI defines the allowed data types for MIB objects.

3. SNMP Get/Set/Trap Demo

[net-snmp version 5.7 package for windows] is used for this demo. You can download this source code at http://www.net-snmp.org/.

(Net-SNMP is a suite of software for using and deploying the SNMP protocol. It contains a generic client library, a suite of command line applications, a highly extensible SNMP agent, perl modules and python modules.)
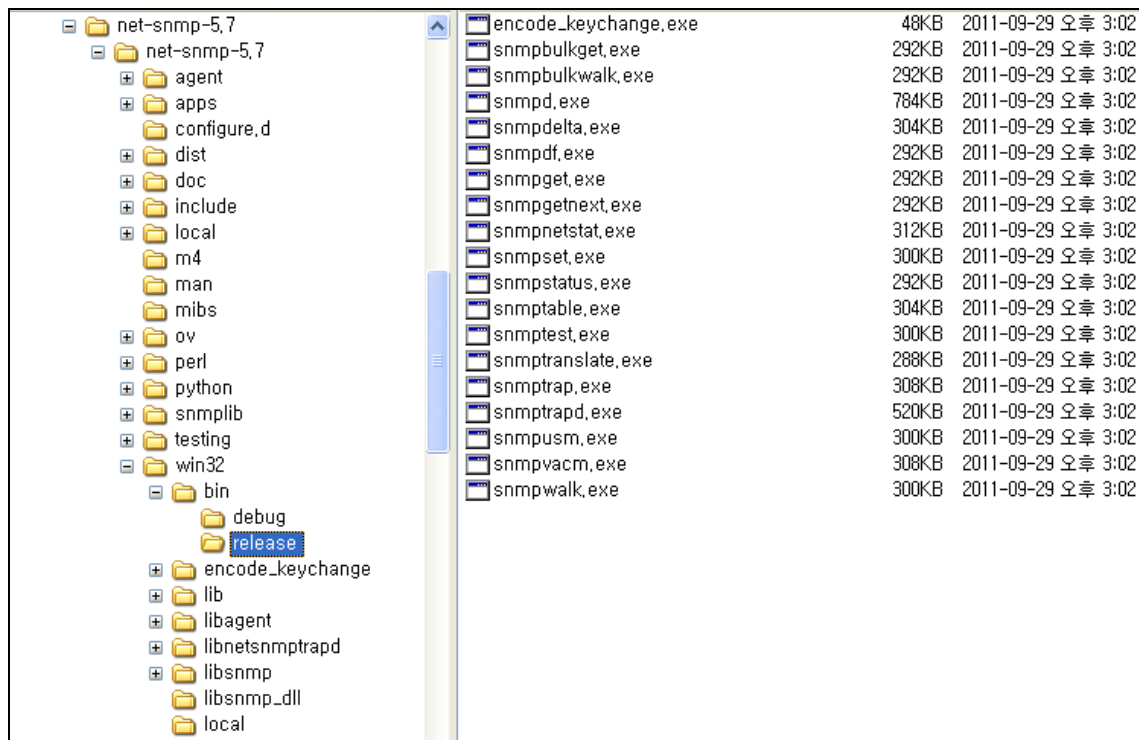
You can get the all net-snmp sample executable files, after building the project with Microsoft Visual Studio. Of all net-snmp sample executable files, snmpget.exe, snmpset.exe, snmpwalk.exe and snmptrapd.exe are used.
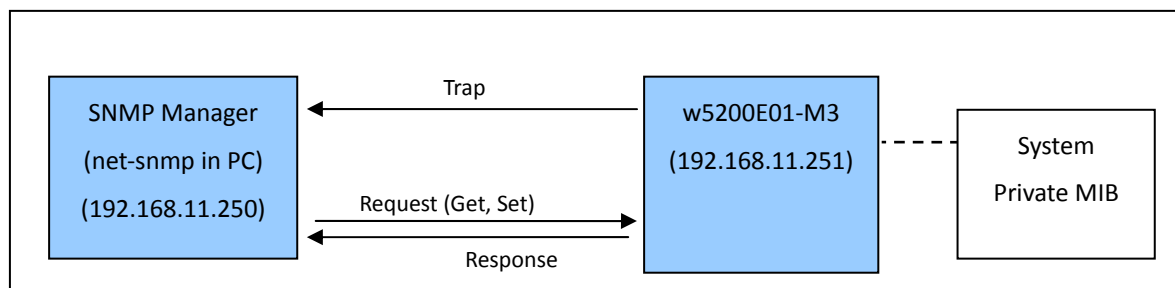
3.1 Trap Demo

First, launch the <snmptrapd.exe> in net-snmp package as below.

```
>snmptrapd -f -L o -d -c ./snmptrapd.conf
MIB search path: C:\usr\mibs
Cannot find module (IP-MIB;IF-MIB;TCP-MIB;UDP-MIB;HOST-RESOURCES-MIB;SNMPv2-MIB;
RFC1213-MIB;NOTIFICATION-LOG-MIB;UCD-SNMP-MIB;UCD-DEMO-MIB;SNMP-TARGET-MIB;NET-S
NMP-AGENT-MIB;DISMAN-EVENT-MIB;SNMP-VIEW-BASED-ACM-MIB;SNMP-COMMUNITY-MIB;UCD-DL
MOD-MIB;SNMP-FRAMEWORK-MIB;SNMP-MPD-MIB;SNMP-USER-BASED-SM-MIB;SNMP-NOTIFICATION
-MIB;SNMPv2-TM): At line 0 in (none)
NET-SNMP version unknown
```

Reset the [w5200E01-M3] module.

```
-----------------------------------------
W5200E01-M3
Network Configuration Information
-----------------------------------------
MAC : 00.08.DC.01.02.03
IP : 192.168.11.251
SN : 255.255.255.0
GW : 192.168.11.1

Start UserSnmpDemo
Start SNMP Daemon(Agent)
```

Then, you can see the snmp trap packets as below in your PC.

```
Received 42 byte packet from UDP: [192.168.11.251]:162->[0.0.0.0]:0
0000: 30 28 02 01   00 04 06 70   75 62 6C 69   63 A4 1B 06    0(.....public...
0016: 08 2B 06 01   04 01 00 10   00 40 04 C0   A8 0B FB 02    .+.......@......
0032: 01 01 02 01   00 43 01 00   30 00                        .....C..0.

2011-10-31 14:49:53 192.168.11.251(via UDP: [192.168.11.251]:162->[0.0.0.0]:0> T
RAP, SNMP v1, community public
        iso.3.6.1.4.1.0.16.0 Warm Start Trap (0) Uptime: 0:00:00.00


Received 82 byte packet from UDP: [192.168.11.251]:162->[0.0.0.0]:0
0000: 30 50 02 01   00 04 06 70   75 62 6C 69   63 A4 43 06    0P.....public.C.
0016: 08 2B 06 01   04 01 00 10   00 40 04 7F   00 00 00 02    .+.......@......
0032: 01 06 02 01   00 43 01 00   30 28 30 14   06 08 2B 06    .....C..0(0...+.
0048: 01 04 01 00   0B 00 04 08   41 6C 65 72   74 21 21 21    ........Alert!!!
0064: 30 10 06 08   2B 06 01 04   01 00 0C 00   02 04 00 01    0...+...........
0080: E2 40                                                    .@

2011-10-31 14:49:53 127.0.0.0(via UDP: [192.168.11.251]:162->[0.0.0.0]:0) TRAP,
SNMP v1, community public
        iso.3.6.1.4.1.0.16.0 Enterprise Specific Trap (0) Uptime: 0:00:00.00
        iso.3.6.1.4.1.0.11.0 = STRING: "Alert!!!"        iso.3.6.1.4.1.0.12.0 =
NTEGER: 123456
```

3.2 Get Request Demo(system MIB)

```
>snmpget -v 1 -c public 192.168.11.251 .1.3.6.1.2.1.1.1.0
MIB search path: C:\usr\mibs
Cannot find module (IP-MIB;IF-MIB;TCP-MIB;UDP-MIB;HOST-RESOURCES-MIB;SNMPv2-MIB
RFC1213-MIB;NOTIFICATION-LOG-MIB;UCD-SNMP-MIB;UCD-DEMO-MIB;SNMP-TARGET-MIB;NET-
NMP-AGENT-MIB;DISMAN-EVENT-MIB;SNMP-VIEW-BASED-ACM-MIB;SNMP-COMMUNITY-MIB;UCD-D
MOD-MIB;SNMP-FRAMEWORK-MIB;SNMP-MPD-MIB;SNMP-USER-BASED-SM-MIB;SNMP-NOTIFICATIO
-MIB;SNMPv2-TM): At line 0 in (none)
iso.3.6.1.2.1.1.1.0 = STRING: "WIZnet Embedded SNMP Agent"

>snmpget -v 1 -c public 192.168.11.251 .1.3.6.1.2.1.1.2.0
MIB search path: C:\usr\mibs
Cannot find module (IP-MIB;IF-MIB;TCP-MIB;UDP-MIB;HOST-RESOURCES-MIB;SNMPv2-MIB
RFC1213-MIB;NOTIFICATION-LOG-MIB;UCD-SNMP-MIB;UCD-DEMO-MIB;SNMP-TARGET-MIB;NET-
NMP-AGENT-MIB;DISMAN-EVENT-MIB;SNMP-VIEW-BASED-ACM-MIB;SNMP-COMMUNITY-MIB;UCD-D
MOD-MIB;SNMP-FRAMEWORK-MIB;SNMP-MPD-MIB;SNMP-USER-BASED-SM-MIB;SNMP-NOTIFICATIO
-MIB;SNMPv2-TM): At line 0 in (none)
iso.3.6.1.2.1.1.2.0 = OID: iso.3.6.1.2.1.1.2.0

>snmpget -v 1 -c public 192.168.11.251 .1.3.6.1.2.1.1.3.0
MIB search path: C:\usr\mibs
Cannot find module (IP-MIB;IF-MIB;TCP-MIB;UDP-MIB;HOST-RESOURCES-MIB;SNMPv2-MIB
RFC1213-MIB;NOTIFICATION-LOG-MIB;UCD-SNMP-MIB;UCD-DEMO-MIB;SNMP-TARGET-MIB;NET-
NMP-AGENT-MIB;DISMAN-EVENT-MIB;SNMP-VIEW-BASED-ACM-MIB;SNMP-COMMUNITY-MIB;UCD-D
MOD-MIB;SNMP-FRAMEWORK-MIB;SNMP-MPD-MIB;SNMP-USER-BASED-SM-MIB;SNMP-NOTIFICATIO
-MIB;SNMPv2-TM): At line 0 in (none)
iso.3.6.1.2.1.1.3.0 = Timeticks: (0) 0:00:00.00

>snmpget -v 1 -c public 192.168.11.251 .1.3.6.1.2.1.1.4.0
MIB search path: C:\usr\mibs
Cannot find module (IP-MIB;IF-MIB;TCP-MIB;UDP-MIB;HOST-RESOURCES-MIB;SNMPv2-MIB
RFC1213-MIB;NOTIFICATION-LOG-MIB;UCD-SNMP-MIB;UCD-DEMO-MIB;SNMP-TARGET-MIB;NET-
NMP-AGENT-MIB;DISMAN-EVENT-MIB;SNMP-VIEW-BASED-ACM-MIB;SNMP-COMMUNITY-MIB;UCD-D
MOD-MIB;SNMP-FRAMEWORK-MIB;SNMP-MPD-MIB;SNMP-USER-BASED-SM-MIB;SNMP-NOTIFICATIO
-MIB;SNMPv2-TM): At line 0 in (none)
iso.3.6.1.2.1.1.4.0 = STRING: "support@wiznet.co.kr"

>
```

```
[Request]
0x0000 : 30 27 02 01 00 04 06 70 75 62 6c 69 63 a0 1a 02    0'.....public...
0x0010 : 02 31 3b 02 01 00 02 01 00 30 0e 30 0c 06 08 2b    .1;......0.0...+
0x0020 : 06 01 02 01 01 03 00 05 00                         .........

[Response]
0x0000 : 30 2b 02 01 00 04 06 70 75 62 6c 69 63 a2 1e 02    0+.....public...
0x0010 : 02 31 3b 02 01 00 02 01 00 30 12 30 10 06 08 2b    .1;......0.0...+
0x0020 : 06 01 02 01 01 03 00 43 04 00 00 00 00 00          .......C.....

[Request]
0x0000 : 30 27 02 01 00 04 06 70 75 62 6c 69 63 a0 1a 02    0'.....public...
0x0010 : 02 1a 1e 02 01 00 02 01 00 30 0e 30 0c 06 08 2b    .........0.0...+
0x0020 : 06 01 02 01 01 04 00 05 00                         .........

[Response]
0x0000 : 30 3b 02 01 00 04 06 70 75 62 6c 69 63 a2 2e 02    0;.....public...
0x0010 : 02 1a 1e 02 01 00 02 01 00 30 22 30 20 06 08 2b    .........0"0 ..+
0x0020 : 06 01 02 01 01 04 00 04 14 73 75 70 70 6f 72 74    .........support
0x0030 : 40 77 69 7a 6e 65 74 2e 63 6f 2e 6b 72             @wiznet.co.kr
```

3.2 Set Request Demo(Private MIB), LED On/Off Test

```
>snmpget -v 1 -c public 192.168.11.251 .1.3.6.1.4.1.0.2.0
MIB search path: C:\usr\mibs
Cannot find module (IP-MIB;IF-MIB;TCP-MIB;UDP-MIB;HOST-RESOURCES-MIB;SNMPv2-MIB
RFC1213-MIB;NOTIFICATION-LOG-MIB;UCD-SNMP-MIB;UCD-DEMO-MIB;SNMP-TARGET-MIB;NET-
NMP-AGENT-MIB;DISMAN-EVENT-MIB;SNMP-VIEW-BASED-ACM-MIB;SNMP-COMMUNITY-MIB;UCD-D
MOD-MIB;SNMP-FRAMEWORK-MIB;SNMP-MPD-MIB;SNMP-USER-BASED-SM-MIB;SNMP-NOTIFICATIO
-MIB;SNMPv2-TM): At line 0 in (none)
iso.3.6.1.4.1.0.2.0 = INTEGER: 0

>snmpset -v 1 -c public 192.168.11.251 .1.3.6.1.4.1.0.2.0 i 1
MIB search path: C:\usr\mibs
Cannot find module (IP-MIB;IF-MIB;TCP-MIB;UDP-MIB;HOST-RESOURCES-MIB;SNMPv2-MIB
RFC1213-MIB;NOTIFICATION-LOG-MIB;UCD-SNMP-MIB;UCD-DEMO-MIB;SNMP-TARGET-MIB;NET-
NMP-AGENT-MIB;DISMAN-EVENT-MIB;SNMP-VIEW-BASED-ACM-MIB;SNMP-COMMUNITY-MIB;UCD-D
MOD-MIB;SNMP-FRAMEWORK-MIB;SNMP-MPD-MIB;SNMP-USER-BASED-SM-MIB;SNMP-NOTIFICATIO
-MIB;SNMPv2-TM): At line 0 in (none)
iso.3.6.1.4.1.0.2.0 = INTEGER: 1

>snmpget -v 1 -c public 192.168.11.251 .1.3.6.1.4.1.0.2.0
MIB search path: C:\usr\mibs
Cannot find module (IP-MIB;IF-MIB;TCP-MIB;UDP-MIB;HOST-RESOURCES-MIB;SNMPv2-MIB
RFC1213-MIB;NOTIFICATION-LOG-MIB;UCD-SNMP-MIB;UCD-DEMO-MIB;SNMP-TARGET-MIB;NET-
NMP-AGENT-MIB;DISMAN-EVENT-MIB;SNMP-VIEW-BASED-ACM-MIB;SNMP-COMMUNITY-MIB;UCD-D
MOD-MIB;SNMP-FRAMEWORK-MIB;SNMP-MPD-MIB;SNMP-USER-BASED-SM-MIB;SNMP-NOTIFICATIO
-MIB;SNMPv2-TM): At line 0 in (none)
iso.3.6.1.4.1.0.2.0 = INTEGER: 1
```

If you issue the command as below, LED of [w5200E01-M3] would be off.

snmpset -v 1 -c public 192.168.11.251 .1.3.6.1.4.1.0.2.0 i 0

And if you issue the command as below, LED of [w5200E01-M3] would be on.

snmpset -v 1 -c public 192.168.11.251 .1.3.6.1.4.1.0.2.0 i 1

3.4 Walk Demo

```
>snmpwalk -v 1 -c public 192.168.11.251 .1.3.6.1.2.1.1
MIB search path: C:\usr\mibs
Cannot find module (IP-MIB;IF-MIB;TCP-MIB;UDP-MIB;HOST-RESOURCES-MIB;SNMPv2-MIB
RFC1213-MIB;NOTIFICATION-LOG-MIB;UCD-SNMP-MIB;UCD-DEMO-MIB;SNMP-TARGET-MIB;NET-
NMP-AGENT-MIB;DISMAN-EVENT-MIB;SNMP-VIEW-BASED-ACM-MIB;SNMP-COMMUNITY-MIB;UCD-D
MOD-MIB;SNMP-FRAMEWORK-MIB;SNMP-MPD-MIB;SNMP-USER-BASED-SM-MIB;SNMP-NOTIFICATIO
-MIB;SNMPv2-TM): At line 0 in (none)
iso.3.6.1.2.1.1.1.0 = STRING: "WIZnet Embedded SNMP Agent"
iso.3.6.1.2.1.1.2.0 = OID: iso.3.6.1.2.1.1.2.0
iso.3.6.1.2.1.1.3.0 = Timeticks: (0) 0:00:00.00
iso.3.6.1.2.1.1.4.0 = STRING: "support@wiznet.co.kr"
iso.3.6.1.2.1.1.5.0 = STRING: "http://www.wiznet.co.kr"
iso.3.6.1.2.1.1.6.0 = STRING: "4F Humax Village"
iso.3.6.1.2.1.1.7.0 = INTEGER: 5

>
```

4. Example of use of SNMP Library

```
dataEntryType snmpData[] ={
    // SysDescr Entry
    {8, {0x2b, 6, 1, 2, 1, 1, 1, 0},
    SNMPDTYPE_OCTET_STRING, 30, {"WIZnet Embedded SNMP Agent"},
    NULL, NULL},
    // SysObjectID Entry
    {8, {0x2b, 6, 1, 2, 1, 1, 2, 0},
    SNMPDTYPE_OBJ_ID, 8, {"\x2b\x06\x01\x02\x01\x01\x02\x00"},
    NULL, NULL},
    // SysUptime Entry
    {8, {0x2b, 6, 1, 2, 1, 1, 3, 0},
    SNMPDTYPE_TIME_TICKS, 0, {""},
    currentUptime, NULL},
    // sysContact Entry
    {8, {0x2b, 6, 1, 2, 1, 1, 4, 0},
    SNMPDTYPE_OCTET_STRING, 30, {"support@wiznet.co.kr"},
    NULL, NULL},
    // sysName Entry
    {8, {0x2b, 6, 1, 2, 1, 1, 5, 0},
    SNMPDTYPE_OCTET_STRING, 30, {"http://www.wiznet.co.kr"},
    NULL, NULL},
    // Location Entry
    {8, {0x2b, 6, 1, 2, 1, 1, 6, 0},
    SNMPDTYPE_OCTET_STRING, 30, {"4F Humax Village"},
    NULL, NULL},
    // SysServices
    {8, {0x2b, 6, 1, 2, 1, 1, 7, 0},
    SNMPDTYPE_INTEGER, 4, {""},
    NULL, NULL},
    // WIZnet LED
    {8, {0x2b, 6, 1, 4, 1, 0, 1, 0},
    SNMPDTYPE_OCTET_STRING, 30, {""},
    getWIZnetLed, NULL},
    {8, {0x2b, 6, 1, 4, 1, 0, 2, 0},
    SNMPDTYPE_INTEGER, 4, {""},
    NULL, setWIZnetLed}
};

void getWIZnetLed(void *ptr, uint8 *len)
{
    if ( wiznetLedStatus==0 )      *len = sprintf((int8 *)ptr, "LED Off");
    else                           *len = sprintf((int8 *)ptr, "LED On");
}

void setWIZnetLed(int32 val)
{
    wiznetLedStatus = val;
    if ( wiznetLedStatus==0 )    LED3_onoff(OFF); // LED in the W5200-EVB
    else                         LED3_onoff(ON);
}

void UserSnmpDemo()
{
    WDEBUG("\r\n\r\nStart UserSnmpDemo");
    SnmpXInit();

    {
        dataEntryType enterprise_oid = {8, {0x2b, 6, 1, 4, 1, 0, 0x10, 0}, SNMPDTYPE_OBJ_ID,
                               8, {"\x2b\x06\x01\x04\x01\x00\x10\x00"},     NULL, NULL};

        dataEntryType trap_oid1 = {8, {0x2b, 6, 1, 4, 1, 0, 11, 0}, SNMPDTYPE_OCTET_STRING,
                               30, {""}, NULL, NULL};
        dataEntryType trap_oid2 = {8, {0x2b, 6, 1, 4, 1, 0, 12, 0}, SNMPDTYPE_INTEGER,
                               4, {""}, NULL, NULL};

        strcpy((int8*)trap_oid1.u.octetstring, "Alert!!!");
        trap_oid2.u.intval = 123456;

        SnmpXTrapSend("192.168.11.250", "192.168.11.251", "public", enterprise_oid, 1, 0, 0);
        SnmpXTrapSend("192.168.11.250", "127.0.0.0", "public", enterprise_oid, 6, 0, 2, &trap_oid1, &trap_oid2);
    }

    SnmpXDaemon();
}
```