EstiNet™ Develpement Manual of Protocol Module

Release Date: May 2, 2018

Produced and maintained by EstiNet Technologies Inc.

Some requirements for reading this manual:

Experience of ESTINET GUI manipulation and simulation
Source code is already acquired
Familiar with C++
Basic knowledge of network

Who want to read this manual?

- To develop your own module on ESTINET
- To modify existed modules

Content of this manual

This manual is divided into 9 chapters: the former two chapters focus on the development interface of GUI, and the latter seven chapters focus on common API of internal modules as well as the data structure.

TABLE OF CONTENTS

Chapter 1 MDF and Protocol Stack

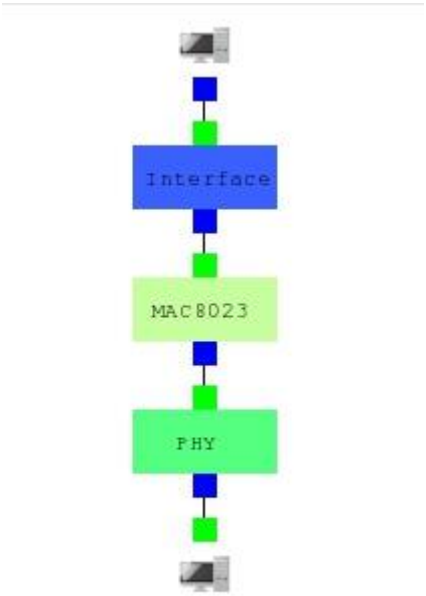
Highlights:
1. What is MDF? What is protocol stack?
2. How to modify MDF and protocol stack?
3. How to use APIs (VBind and get_nid()) in EstiNet simulation engine?
4. How to compiler the source code?

Download Exercises：

Chapter1.tar.bz2

EstiNet simulation engine provides a simulator platform with several modules, each module has different mechanism, for example, the modules simulate wired IEEE 802.3, the modules simulate wireless IEEE 802.11 series, and so on.

Tandem modules is a Protocol Stack of one network device, the following figure shows the Ptotocol Stack of Host 1. (Hint: each protocol stack of network devices is not identical.)



Each module has its own default, which is open for user's additional setting. A file of module describing and platform are needed for open GUI interface for users, this file is so-called 'MDF' file.

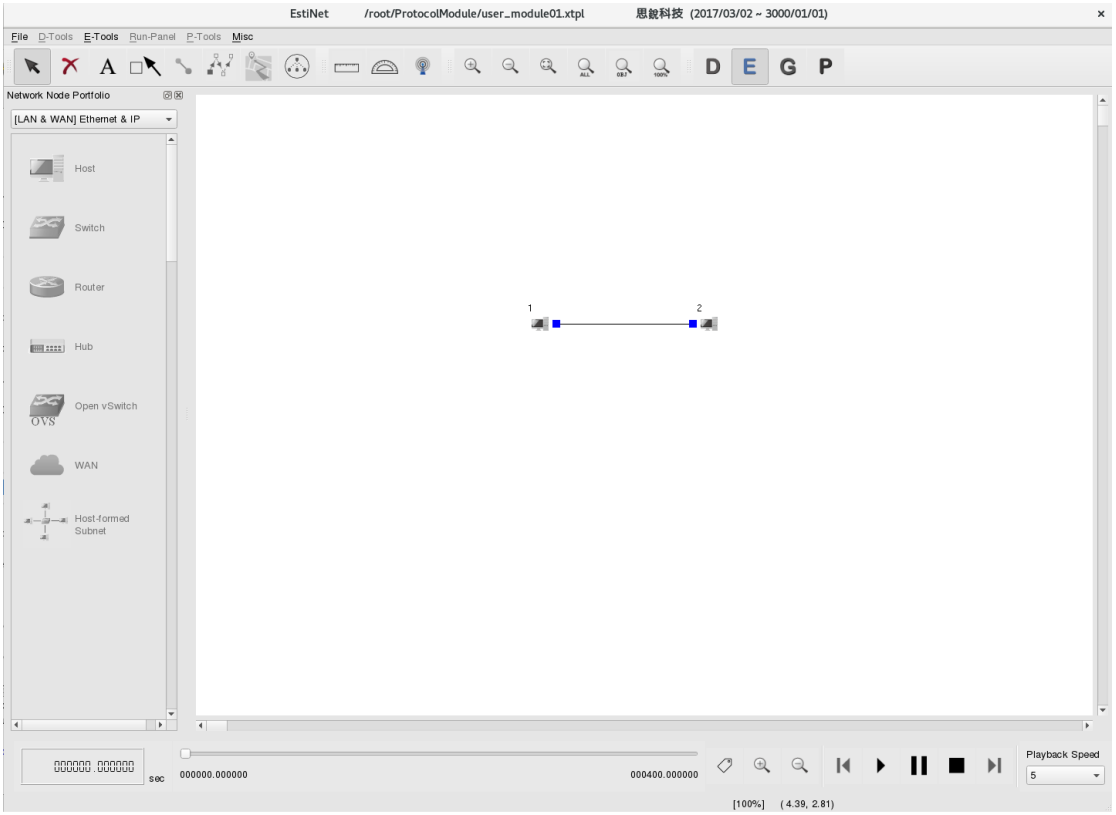
MDF is abbreviation of Module Description File, which could be used to set the factors of module via screen of GUI layout. After setting the factors by user, GUI will be switched to G mode by the user, and write the setting into the if_and_medium_conf file in the directory of sim/interface_and_medium_setting/general/.

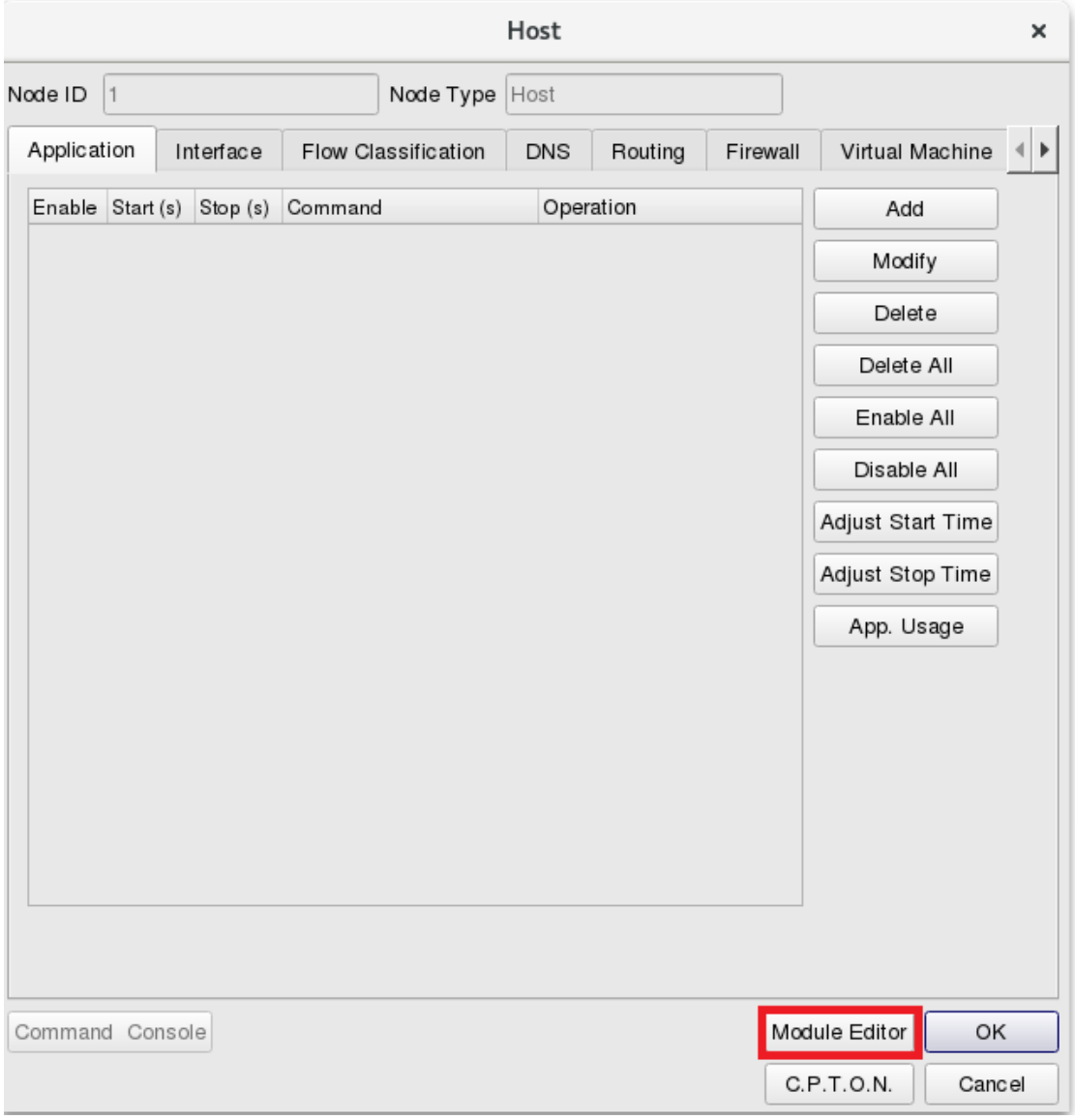
Therefore, MDF is very important for module developer. It is easy to set user's own layouts and factors with MDF assistence. There are some common events for layout such as RADIOBOX, TEXTLINE, CHECKBOX, and LABLE, etc..

Exercise 1-1. Modify MDF and Modify Protocol Stack with GUI

- Build a demo topoloy

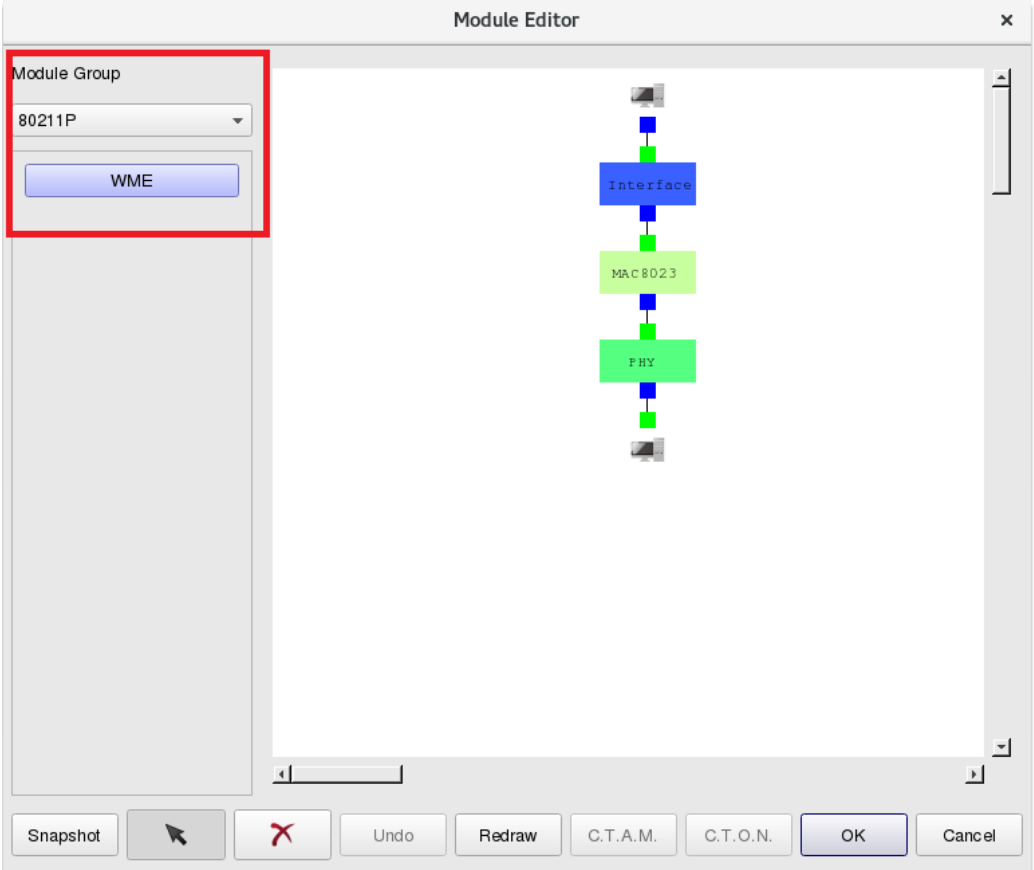
  Build a topology as the following figure in the D Mode of GUI, this example topology is the conection of Host 1 and Host 2, then transfer to the E Mode of GUI and save the file as user_defined01.



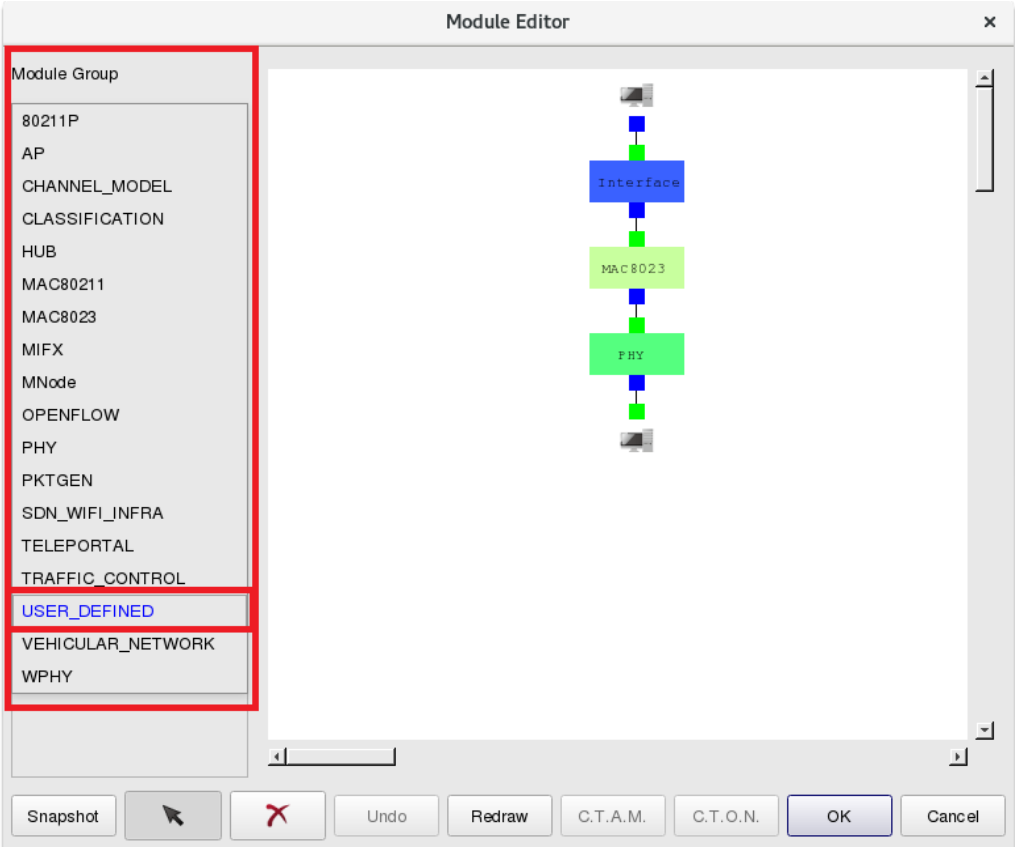


Double clicks on Host 1 in the E Mode, and select “Module Editor,” you will see the Protocol Stack of this node.

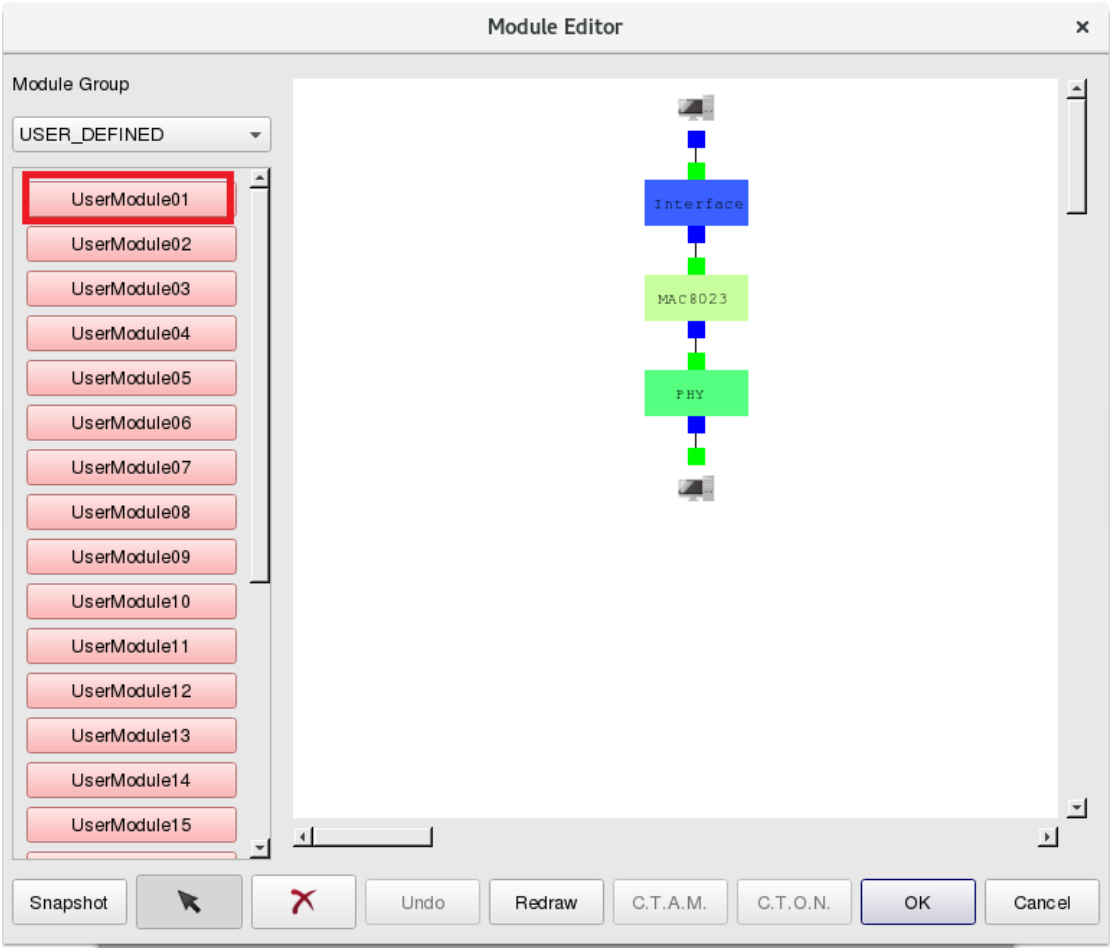
First, add a customized module in which user’ code could be added, and add this module into Protocol Stack. On the left, there is a drop-down menu, “Module Group.” GUI is responsible for management and categorization of these modules, for example, in the first option of 80211P, there is a module of WME.



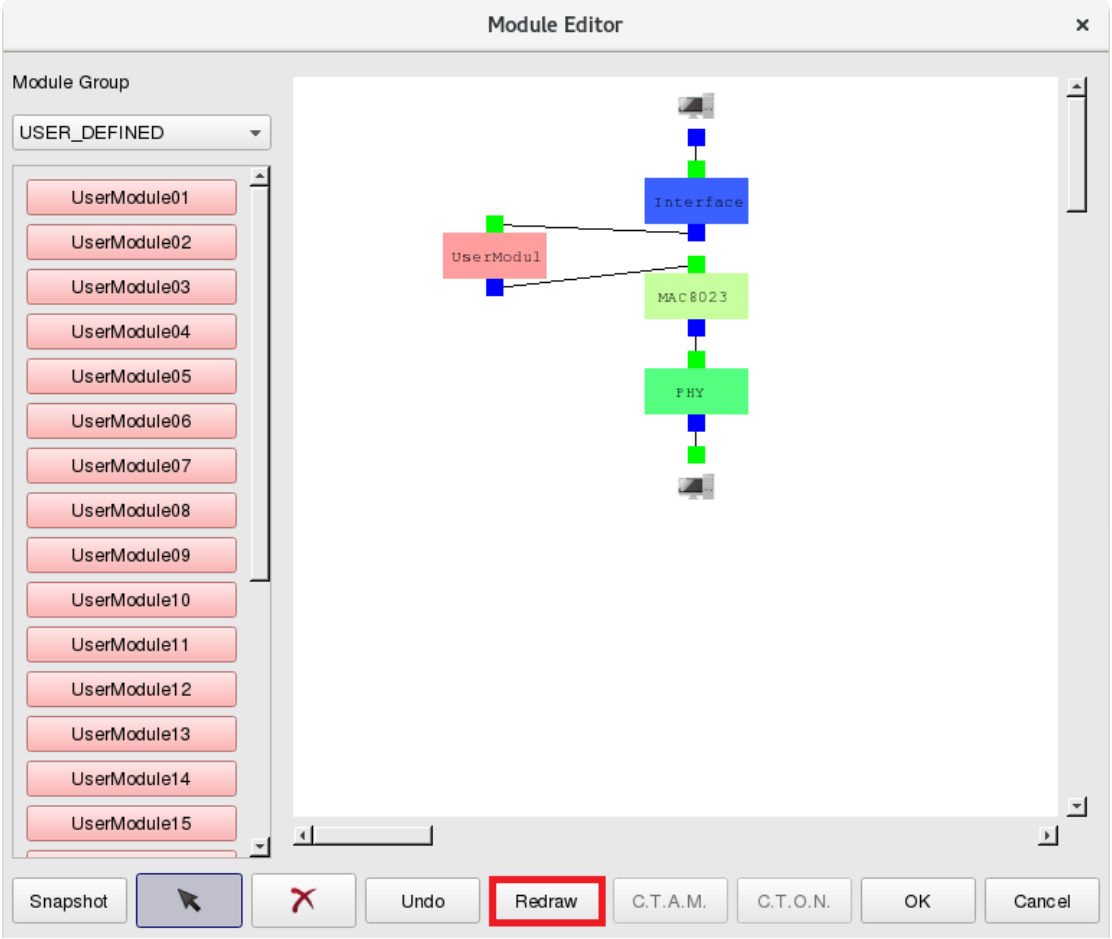
Please choose the module group, "USER_DEFINED."



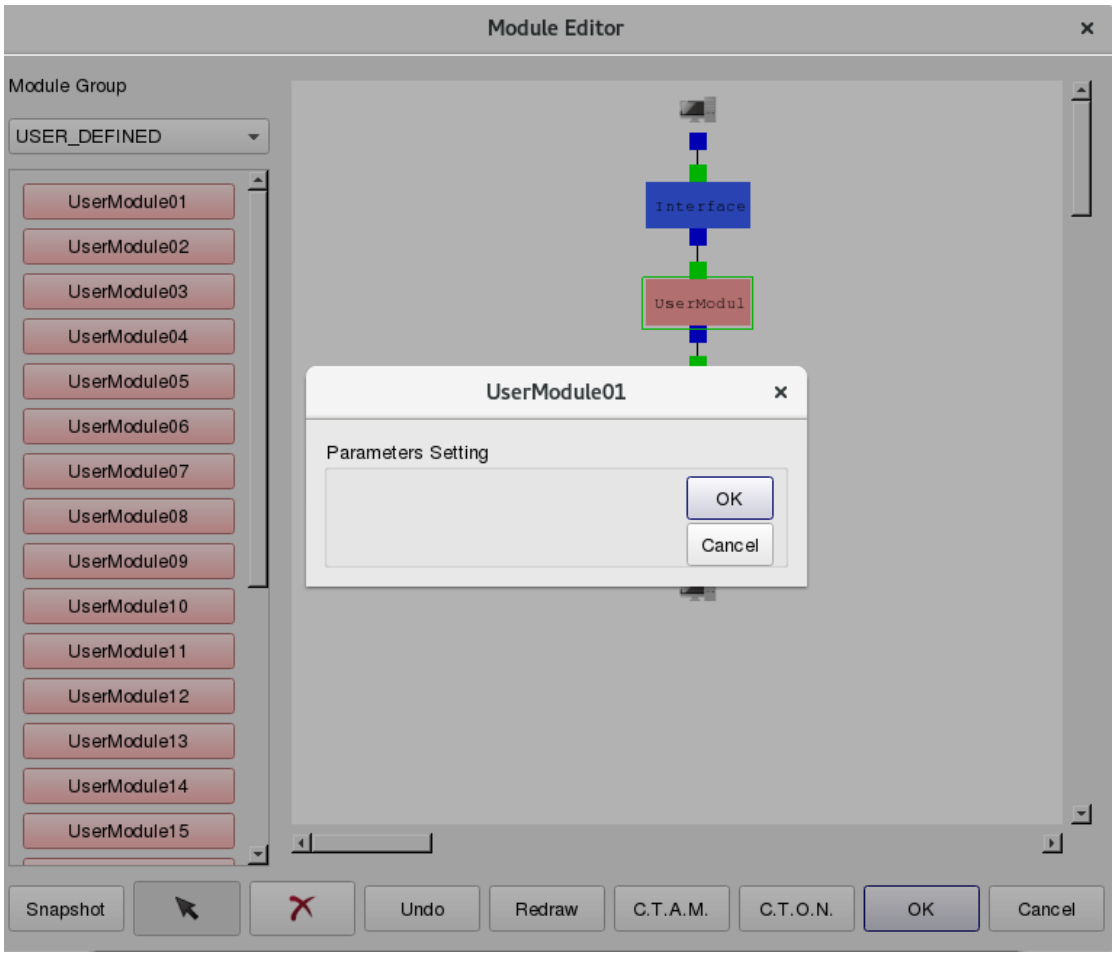
After choosing module group “USER_DEFINED,” you will see 25 UserModules, which are waiting for user’s definition. The 25 modules are **free** of charge. Now, select the first free module, "UserModule01."



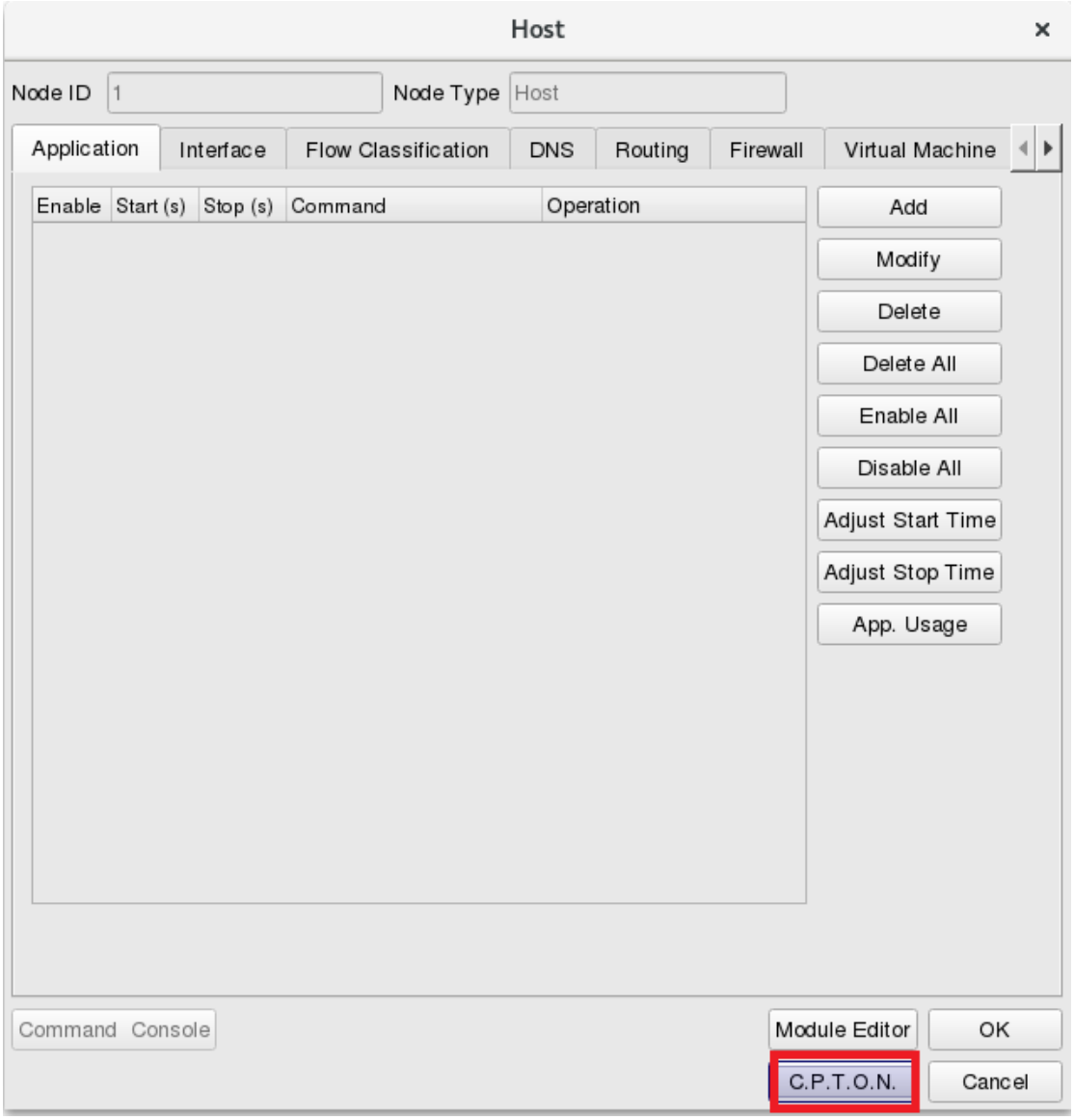
Click the icon of "UserModule01," drag it to the central white space, and insert it between Interface and MAC8023. Click the “X” button below to delete the link between Interface and MAC8023, and click the arrow botton below to connect the green end of "UserModule01" to the blue end of Interface, also, connect the blue end of "UserModule01" to the green end of MAC8023. Now, you have just finished adding UserModule01 into the Protocol Stack of Host 1. (After the insertion, you could refresh the Protocol Stack by clicking “ReDraw.”)



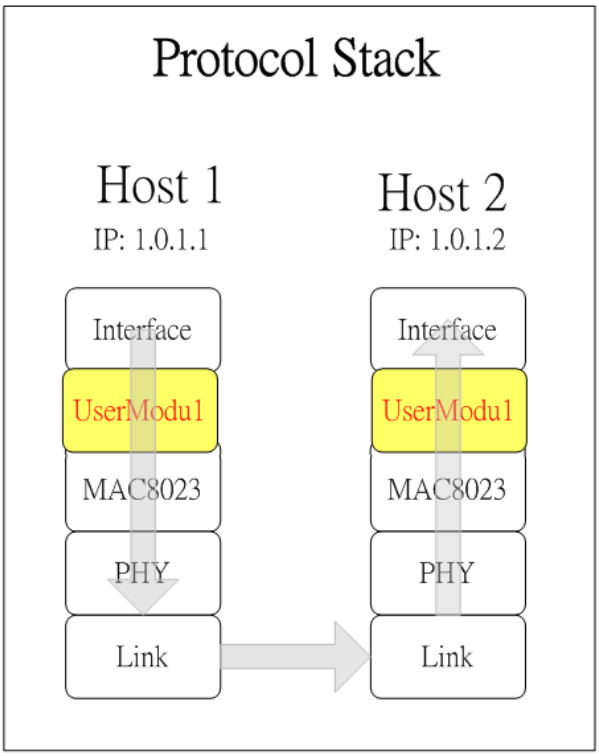
Double click “UserModule01,” this module is empty at first, later we will introduce how to add layout objects (i.e., TEXTLINE, CHECKBOX) into module by modifying MDF.



Similarly, if you want Host 2 with same Protocol Stack, just push “OK” button below, turn back to setting screen of Host 1, then push the button “C.P. T.O.N.” (Copy the Node's Protocol Stack to Other Nodes with the Same Type) to copy Protocol Stack of Host 1 to another Host, in this topology, Host 2.

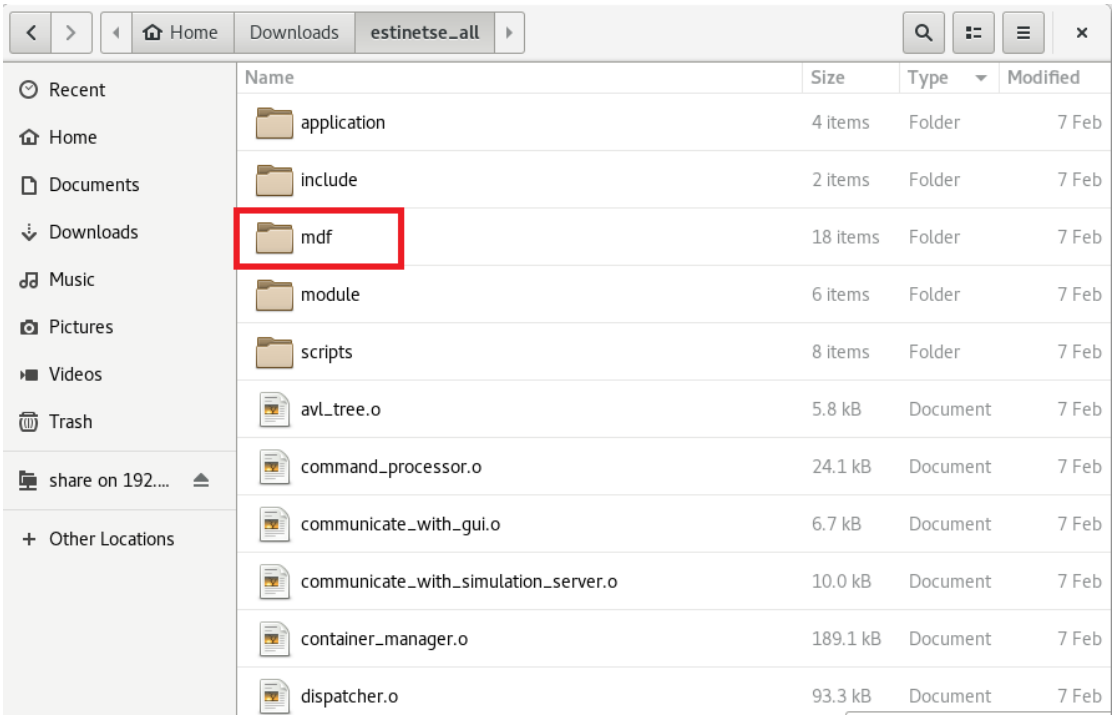


Topology setting is finished. Following topology in this manual are also based on this setting just mentioned above. Whole Protocol Stack is shown as follows:

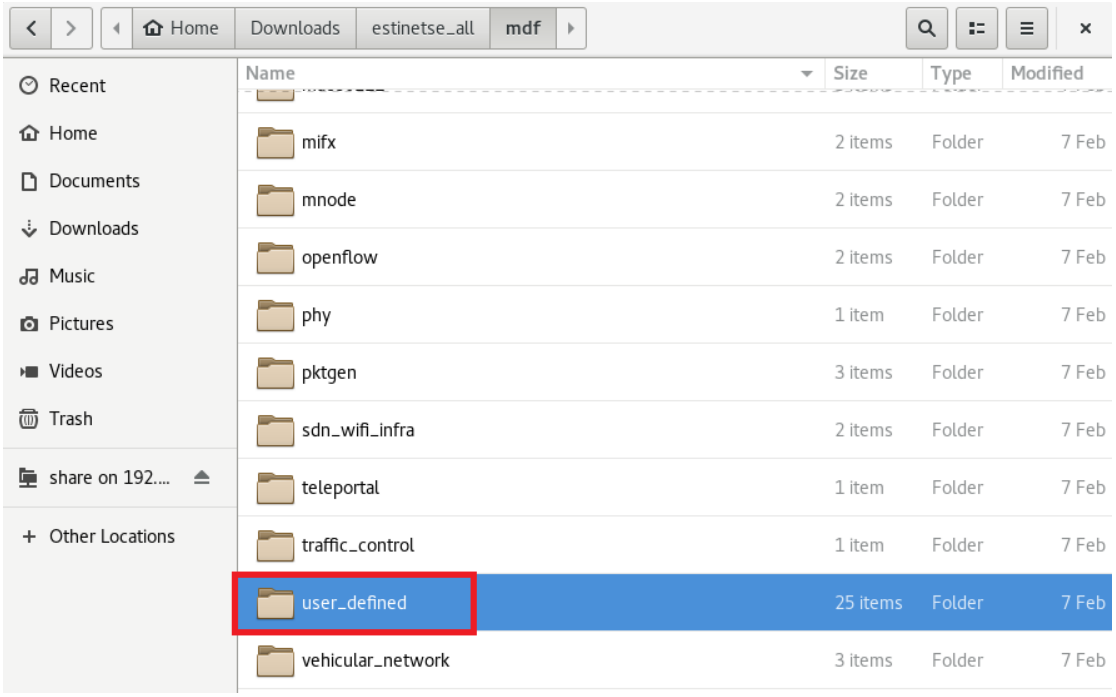


- Where is MDF?

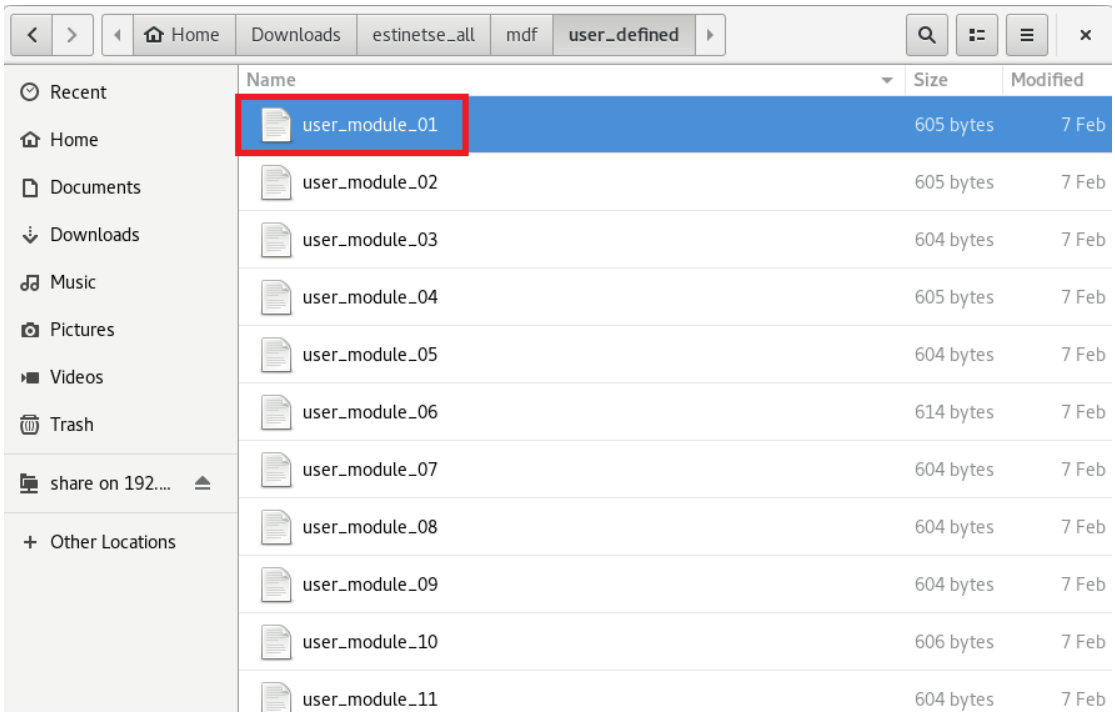
  Next, we want to write the MDF file of UserModule01 by adding TEXTLINE to fill two parameters, one is "My Number" and the other is "My String." As such, we have to modify MDF file. First, open the directory of source code (check the position of your own source code to ensure the file path is correct), there is a directory of mdf shown as the following figure.



In the directory of mdf, you can see a directory of UserDefined, as the following figure shows:



There are total 25 MDF files of UserModule in UserDefined directory. In topology, we use the module of UserModule01, so we open this file to modify.



After opening MDF file, as the following figure shows, displayed programming language has different grammer as common ones, because MDF is designed for GUI's configuration. When opening the Module Edoitor, GUI reads and categorizes all the MDF files in the order of Group Name (in a column of MDF file) in the left side; meanwhile, when one module is opened, GUI follows the grammer of MDF file in this module to execute the order.

Basic Framework of MDF:

A module description block starts with the "**ModuleSection**" keyword and ends with the "**EndModuleSection**" keyword. A module description block is divided into three parts – the **HeaderSection**, **InitVariableSection**, and **ExportSection**, respectively. Similarly, these sections start with the "**HeaderSection**," "**InitVariableSection**," and the "**ExportSection**" keywords, respectively, and end with the "**EndHeaderSection**," "**EndInitVariableSection**," and the "**EndExportSection**" keywords, respectively.

HeaderSection block are the name of defined module, the group of module (for GUI sorting), class of network, the declaration of parameter, and so on.

InitVariableSection block is display of defined GUI object, for exemple, button, TEXTLINE, RADIOBOX, CHECKBOX, and GROUP objects, etc..

ExportSection block is that, when simulation is running, GUI gets and sets data from simulated engine via IPC (inter-process communication) by two defined objects. In next chapter, we will tell you the usage of this block.

user_module_01

```
ModuleSection
    HeaderSection
        ModuleName      UserModule01

        GroupName       USER_DEFINED
        Introduction        "Empty module for development"

    EndHeaderSection

    InitVariableSection
        Caption         "Parameters Setting"
        FrameSize       320 90

        Begin BUTTON        b_ok
            Caption     "OK"
            Scale       250 17 60 30
            ActiveOn    ALL_MODE
            Action      ok
            Comment     "OK Button"
        End

        Begin BUTTON        b_cancel
            Caption     "Cancel"
            Scale       250 49 60 30
            ActiveOn    ALL_MODE
            Action      cancel
            Comment     "Cancel Button"
        End
    EndInitVariableSection

    ExportSection
        Caption         ""
        FrameSize       0 0
    EndExportSection
EndModuleSection
```

In this example, we hope to add two parameters. So, declare two parameters in **HeaderSection**, one is "MyNumber", and the other is "MyString," as shown as the red words in the following figure:

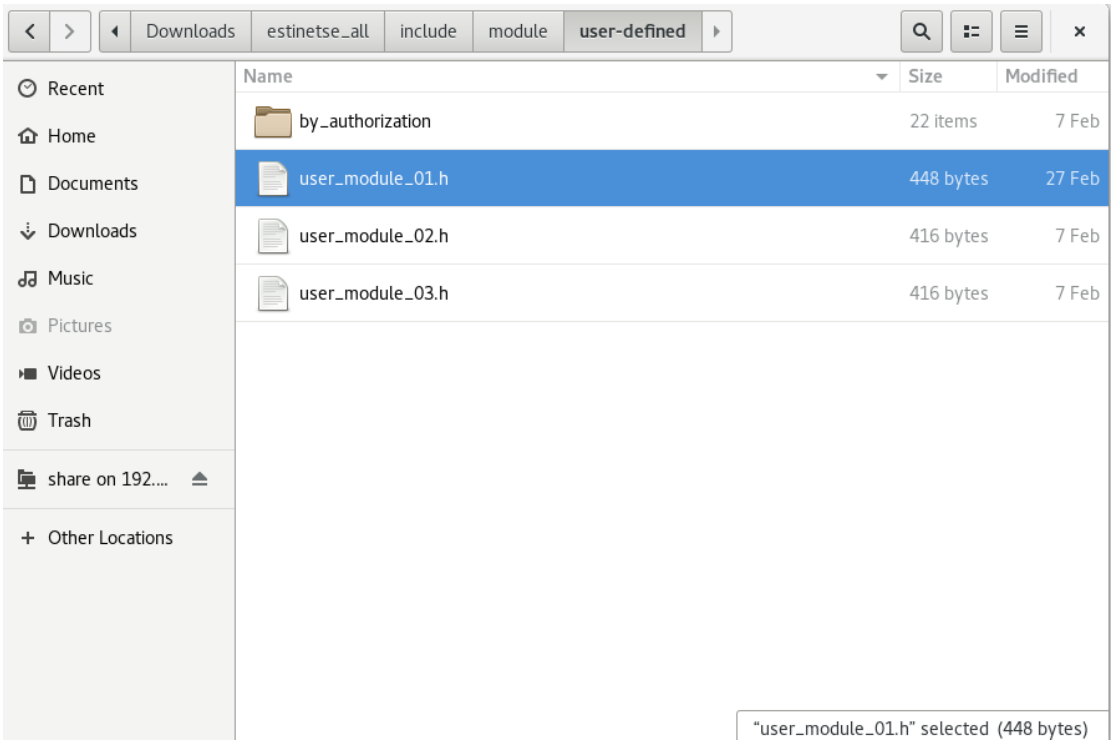
```
ModuleSection
    HeaderSection
        ModuleName      UserModule01
        GroupName       User_Defined
```

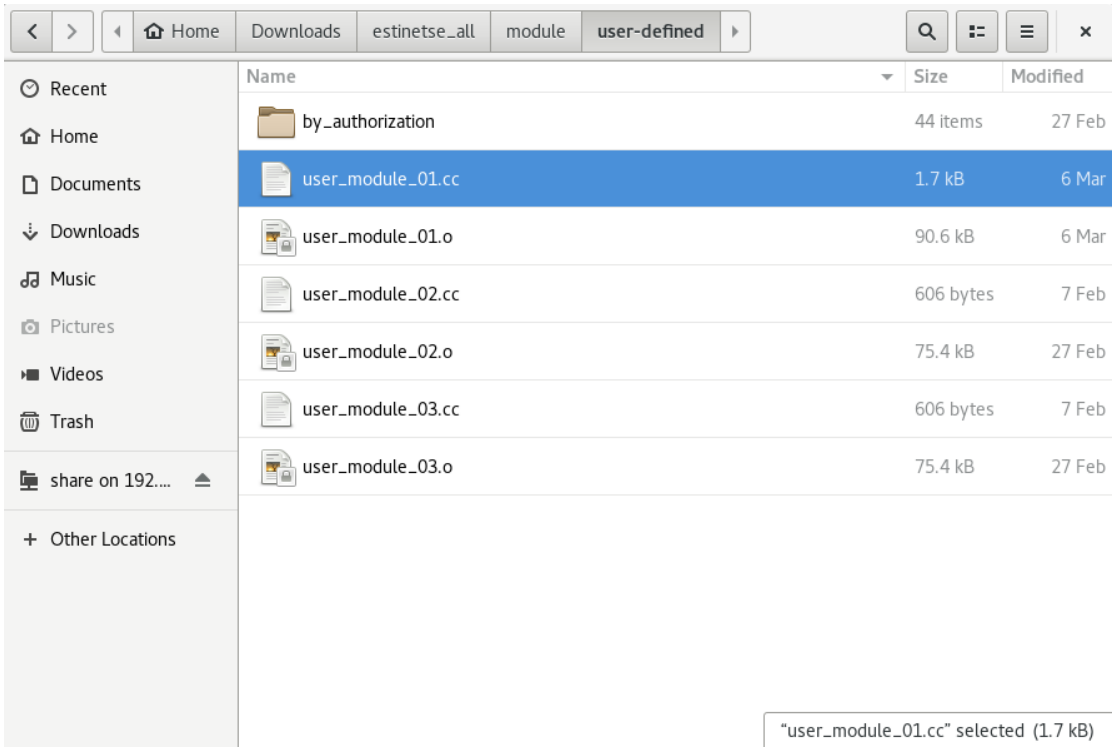
```
            Introduction            "This is a user-defined module."
            Parameter               myNumber 300 local
            Parameter               myString 111.111.111.111 local
        EndHeaderSection

        InitVariableSection
            Caption                 "Parameters Setting"
            FrameSize               320 90

            Begin BUTTON            b_ok
                Caption             "OK"
                Scale               250 17 60 30
                ActiveOn            ALL_MODE
                Action              ok
                Comment             "OK Button"
            End

            Begin BUTTON            b_cancel
                Caption             "Cancel"
                Scale               250 49 60 30
                ActiveOn            ALL_MODE
                Action              cancel
                Comment             "Cancel Button"
            End
        EndInitVariableSection

        ExportSection
            Caption                 ""
            FrameSize           0 0
        EndExportSection
EndModuleSection
```

Identifier of new parameter is shown as “parameter,” with a space behind and name of parameter; then enter the defalt value of parameter, the last identifier is “local.” By the way, the last identifier is for GUI only, you can get more details from appendex A.

You have just finished new parameters setting of MDF file.

Then we are about to set the defult of reading MDF manipulation by USER MODULE01 in the simulated engine. Every module has its own head file and cc file. The location of “user_module_01.h” is under the directory of sorce code: include/module/user-defined/user_module_01.h. That is to say, the location of “user_module_01.cc” is under the directoty of “module/user-defined/user_module_01.cc” shown in the following two figures:





Declare two parameters in the file, user_module_01.h, and read two parameters of MDF with if_and_medium_conf file. Then declare an integer(Number) and a char pointer(String), as the following red words:

```
#ifndef __user_module_01_h__
#define __user_module_01_h__

#include <event.h>
#include <object.h>

class UserModule01 : public NslObject {

 private:
        int                     Number;
        char                    *String;

 public:

        UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char *name);
        ~UserModule01();

        int             init();
        int             command(int argc, const char *argv[]);
        int             recv(ePacket_ *pkt);
        int             send(ePacket_ *pkt);

};

#endif    /* __user_module_01_h__ */
```

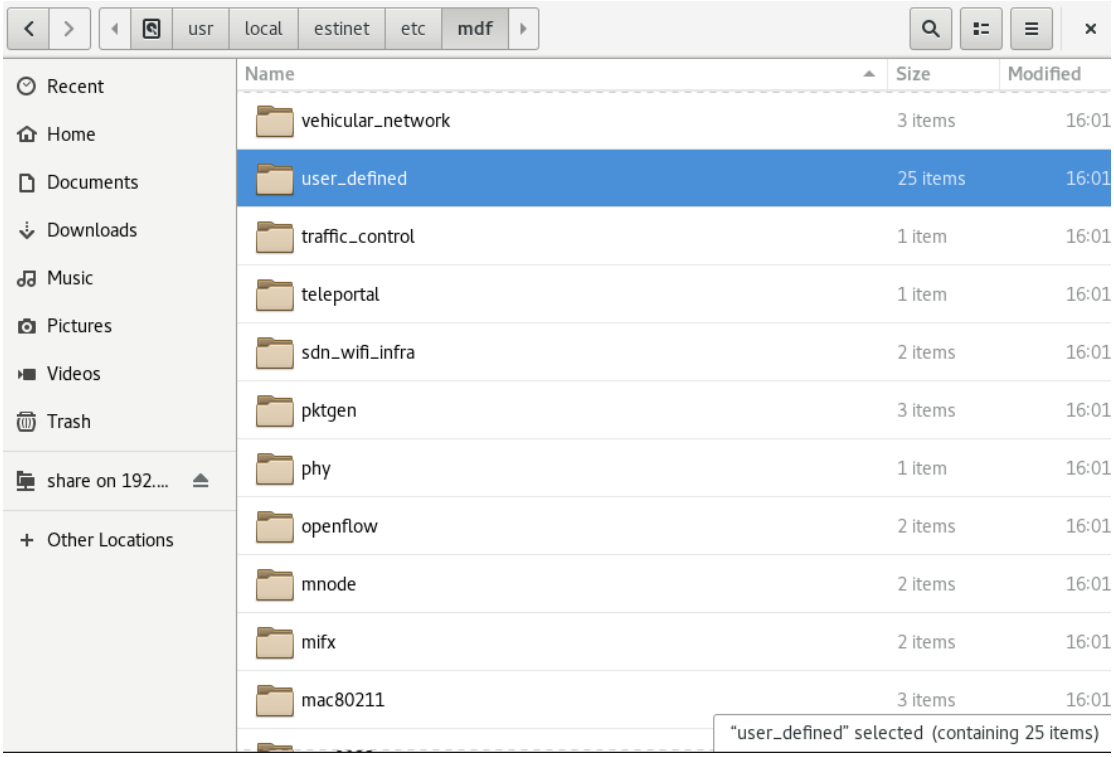
In the constructor of UserModule01, we are about to connect the variable of module to the variable of MDF via "vBind_int" and "vBind_char_str", two APIs that EstiNet offered. The first parameter is the name of defined parameter in MDF, the second is C++ variable used to connect MDF variable in the module. The method is shown as red words in the following figure. And in the function of init, print out these two variables (add ANSI

escape codes to control the word to bold and red, and set the background to black).

```
#include <stdlib.h>
#include <estinet_api.h>
#include <module/user-defined/user_module_01.h>

MODULE_GENERATOR(UserModule01);

UserModule01::UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char
*name): NslObject(type, id, pl, name) {
        vBind_int("myNumber", &Number);
        vBind_char_str("myString", &String);
}

UserModule01::~UserModule01(){}

int UserModule01::init() {


/* exercise 1 */
  printf("\e[1;31;40m\nExercise 1: myNumber = %d, myString = %s\e[m\n",
     Number, String);

        return(NslObject::init());
}

int UserModule01::command(int argc, const char *argv[]) {
        return(NslObject::command(argc, argv));
}

int UserModule01::recv(ePacket_ *pkt) {
        return(NslObject::recv(pkt));
}

int UserModule01::send(ePacket_ *pkt) {
        return(NslObject::send(pkt));
}
```

Open the terminal to the directory of the sorce code, execute **make** to compile all the sorce code.

Then execute **make install**, this will copy the binary file of simulated engine (estinetse) and just finished mdf file to the GUI designated path (bin file will copy to the directory, /usr/local/estinet/bin; mdf file will copy to the directory, /usr/local/estinet/etc/mdf) as shown in the following figure:



Attention: Before executing **make install**, GUI have to be closed. Because GUI will read all the MDF parameters while GUI is initiating. If you add parameter under activating GUI, you have to close GUI and restart it; however, if you just want to set the width and height of layout and add objects, GUI dosen't need to be restart, just click module in GUI again, you can see the result of width and height change.

After completing the steps mentioned above, compiling and install are finished.

Then open three terminals.

First terminal executes **estinetjd**, as shown in the following figure:

```
root@localhost:~
File  Edit  View  Search  Terminal  Tabs  Help
root@localhost:~   root@localhost:~...   root@localhost:~
[root@localhost ~]# estinetjd
ServerSocket listen to port:9810
ServerSocket listen to port:9800
(Active:0| fd:3)   (Active:1| fd:4)
```

Second terminal executes "**estinetss**" command.

```
root@localhost:~
File  Edit  View  Search  Terminal  Tabs  Help
root@local...   root@local...   root@local...   root@local...
[root@localhost ~]# estinetss
/usr/local/estinet/bin/
ServerSocket listen to port:9830        FD:3
ServerSocket listen to port:9840        FD:4
ServerSocket listen to port:9880        FD:5
UnixDomainSocket Bind Path:/tmp/estinet FD:6
1514197808 /root/.estinet/estinetss/workdir/1514197813-job/ 0 1
[To estinetjd...]       register|127.0.0.1|9830|9840|IDLE
[From estinetjd...]     OK
set_background_job_status|127.0.0.1|9830|9840|1514197808|FINISHED|
```

Third terminal executes "**estinetgui**" command.

First, save GUI with Protocol Stack just set, and close it.
reopen GUI, enter estinetgui at terminal, open the topology, "user_defined01.tpl," switch to mode **G** to execute simulation.

Pay attention to the result shown in the window of terminal.

Because there are **two** nodes of the topology, which are both put in the module, "User module01," the init function of this module prints out parameters with **two** resultes as shown in the following figure:

```
In CmdProcessor::cmdEndCreate(), Node 2's protocol stack construction ends.
The maximum node ID in this simulation is 2.
The maximum socket non-blocking read count for a traffic generator process is 10.
In Node::command(), node 1 calls Node::MobilityEvent() to set up each mobile node's initi
add_interface: add interface, node:1 port_no:1 dev:tun1 rename:eth0
[FlowClassifier] Warning: No flow rule setting file /root/.estinet/estinetss/workdir/1524

Exercise 1: myNumber = 300, myString = 111.111.111.111
In Node::init(), the initialization of node 1's all modules succeeds.
add_interface: add interface, node:2 port_no:1 dev:tun2 rename:eth0
[FlowClassifier] Warning: No flow rule setting file /root/.estinet/estinetss/workdir/1524

Exercise 1: myNumber = 300, myString = 111.111.111.111
In Node::init(), the initialization of node 2's all modules succeeds.
RanSeed=181296
=======================================================
=============== Start executing events ===============
=======================================================
current ticks= 0, run "2 sh init.sh"
net.ipv4.conf.all.forwarding = 1
net.ipv4.conf.all.rp_filter = 0
net.ipv4.conf.eth0.forwarding = 1
net.ipv4.conf.eth0.rp_filter = 0
```

- Modify Layout

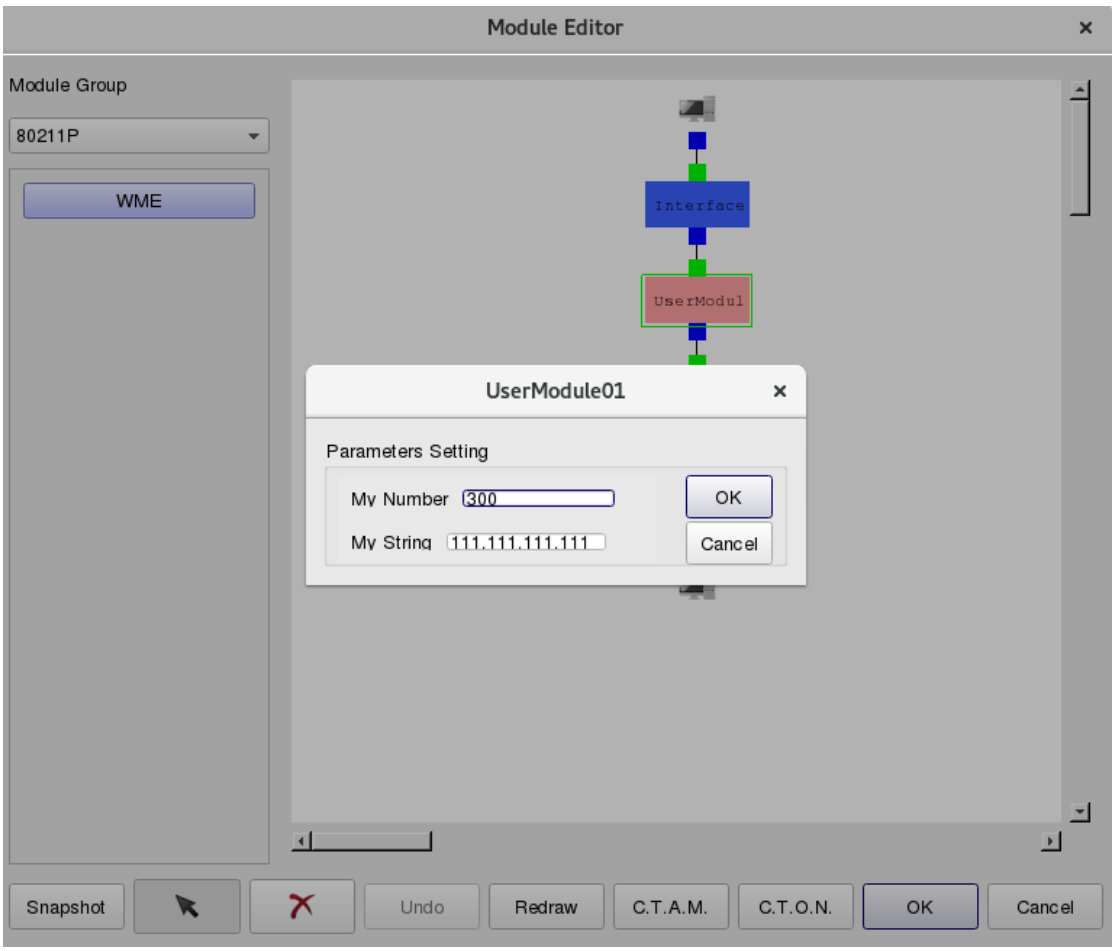
  The above result on estinetss displays default value of declared parameters in MDF. While you want to input parameter value via GUI objects, you have to use GUI objects like TEXTLINE and LABEL in MDF.

```
ModuleSection
    HeaderSection
        ModuleName          UserModule01
        GroupName           User_Defined
        Introduction        "This is a user-defined module."
        Parameter           myNumber 300 local
        Parameter           myString 111.111.111.111 local
    EndHeaderSection

    InitVariableSection
        Caption             "Parameters Setting"
        FrameSize           320 90

        Begin TEXTLINE      myNumber
            Caption         "My Number "
```

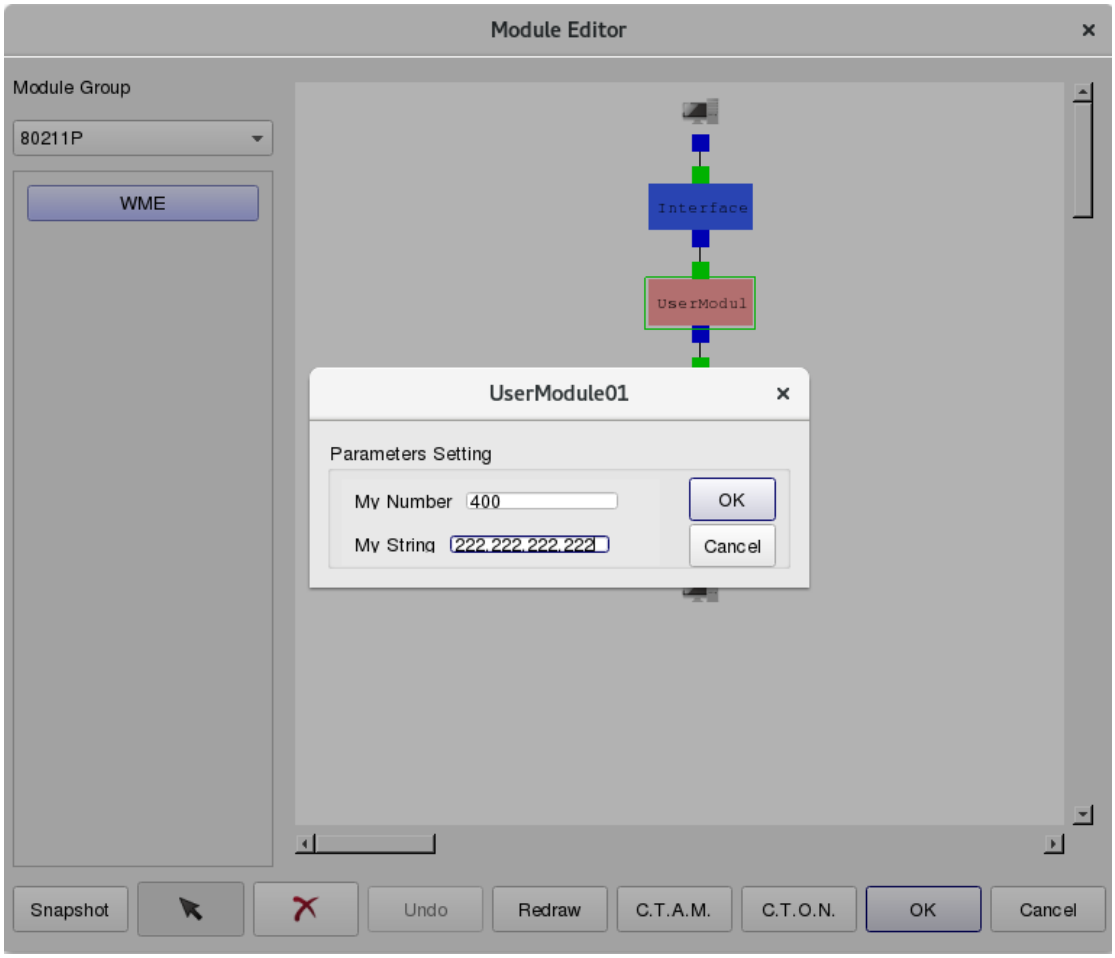
```
                Scale           10 18 220 30
                ActiveOn        MODE_EDIT
                Enabled         TRUE
                Type            INT
                Comment         "An Integer"
            End

            Begin TEXTLINE      myString
                Caption         "My String "
                Scale           10 48 220 30
                ActiveOn        MODE_EDIT
                Enabled         TRUE
                Type            IP
                Comment         "An IP string"
            End

            Begin BUTTON        b_ok
                Caption         "OK"
                Scale           250 17 60 30
                ActiveOn        ALL_MODE
                Action          ok
                Comment         "OK Button"
            End

            Begin BUTTON        b_cancel
                Caption         "Cancel"
                Scale           250 49 60 30
                ActiveOn        ALL_MODE
                Action          cancel
                Comment         "Cancel Button"
            End
        EndInitVariableSection

        ExportSection
            Caption         ""
            FrameSize       0 0
        EndExportSection
EndModuleSection
```

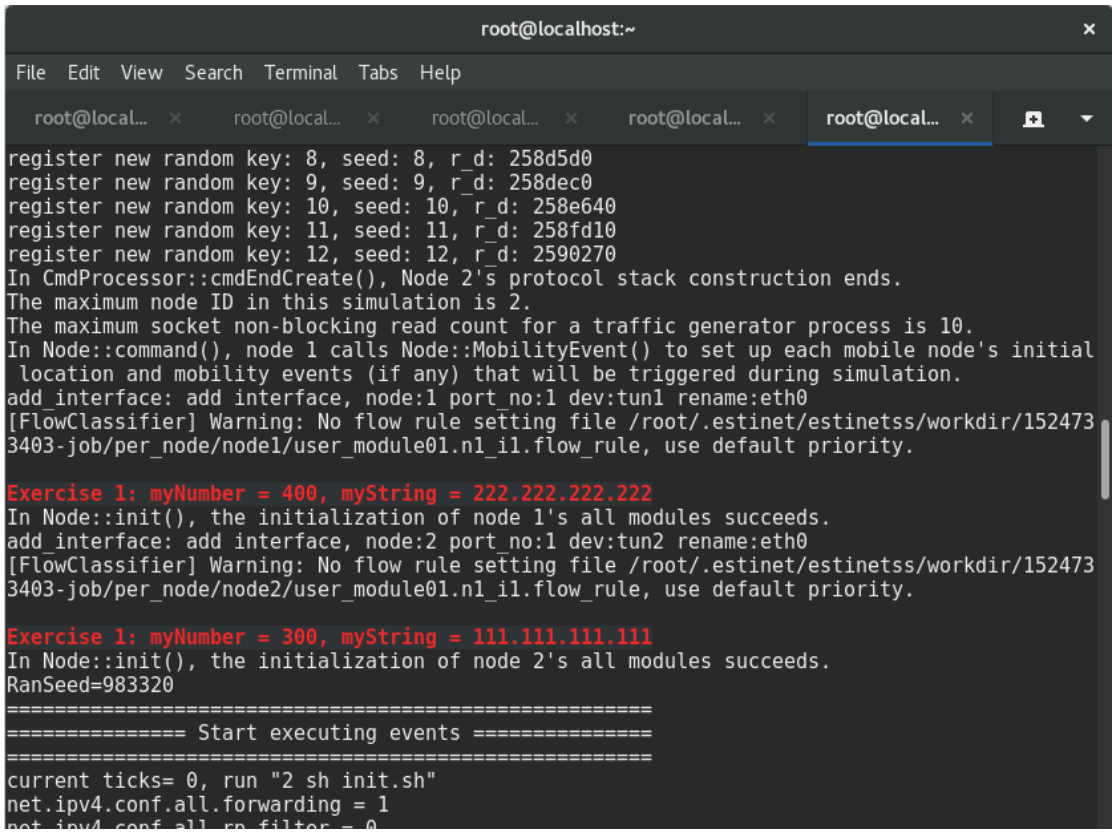
Add two TEXTLINE objects to MDF, execute **make install** in the directory of estinetse_all, and transfer modified MDF file to the position for GUI to read. Because there is no additional parameter to MDF, don't have to reopen GUI, just turn to Module Editor to check adding status of "USER MODELE 01."

It is shown as the following figure:



And then Input 400 to **My Number** of Host 1, input 222.222.222.222 to **My String of Host 1**, and execute simulation again. Remind the window of estinetss, you will see the printed value of Host 1 has been changed, as the following figure shows.


Module Editor
Module Group
80211P
WME
Interface
UserModul
UserModule01
Parameters Setting
My Number 400
My String 222.222.222.222
OK
Cancel
Snapshot
Undo
Redraw
C.T.A.M.
C.T.O.N.
OK
Cancel


root@localhost:~
File Edit View Search Terminal Tabs Help
root@local... root@local... root@local... root@local... root@local...
register new random key: 8, seed: 8, r_d: 258d5d0
register new random key: 9, seed: 9, r_d: 258dec0
register new random key: 10, seed: 10, r_d: 258e640
register new random key: 11, seed: 11, r_d: 258fd10
register new random key: 12, seed: 12, r_d: 2590270
In CmdProcessor::cmdEndCreate(), Node 2's protocol stack construction ends.
The maximum node ID in this simulation is 2.
The maximum socket non-blocking read count for a traffic generator process is 10.
In Node::command(), node 1 calls Node::MobilityEvent() to set up each mobile node's initial location and mobility events (if any) that will be triggered during simulation.
add_interface: add interface, node:1 port_no:1 dev:tun1 rename:eth0
[FlowClassifier] Warning: No flow rule setting file /root/.estinet/estinetss/workdir/1524733403-job/per_node/node1/user_module01.n1_i1.flow_rule, use default priority.
Exercise 1: myNumber = 400, myString = 222.222.222.222
In Node::init(), the initialization of node 1's all modules succeeds.
add_interface: add interface, node:2 port_no:1 dev:tun2 rename:eth0
[FlowClassifier] Warning: No flow rule setting file /root/.estinet/estinetss/workdir/1524733403-job/per_node/node2/user_module01.n1_i1.flow_rule, use default priority.
Exercise 1: myNumber = 300, myString = 111.111.111.111
In Node::init(), the initialization of node 2's all modules succeeds.
RanSeed=983320
==========
========== Start executing events ==========
==========
current ticks= 0, run "2 sh init.sh"
net.ipv4.conf.all.forwarding = 1

So the developer could arrange GUI with MDF to set parameters for simulated engine.

- Use get_nid()

  From print result, we cannot recognize which node has printed this result. At this moment, we can use the API, “get_nid(),” to arrange print.

```
printf("\e[1;31;40m\nExercise 1: Node ID = %d, myNumber = %d, myString = %s\e[m\n", get_nid(), Number, String);
```

The print-out result is shown as follow:

```
root@localhost:~
File  Edit  View  Search  Terminal  Tabs  Help
root@local...  root@local...  root@local...  root@local...  root@local...
In Node::command(), node 1 calls Node::MobilityEvent() to set up each mobile node'
 location and mobility events (if any) that will be triggered during simulation.
add_interface: add interface, node:1 port_no:1 dev:tun1 rename:eth0
[FlowClassifier] Warning: No flow rule setting file /root/.estinet/estinetss/workd
3750-job/per_node/node1/user_module01.n1_i1.flow_rule, use default priority.

Exercise 1: Node ID = 1, myNumber = 400, myString = 222.222.222.222
In Node::init(), the initialization of node 1's all modules succeeds.
add_interface: add interface, node:2 port_no:1 dev:tun2 rename:eth0
[FlowClassifier] Warning: No flow rule setting file /root/.estinet/estinetss/workd
3750-job/per_node/node2/user_module01.n1_i1.flow_rule, use default priority.

Exercise 1: Node ID = 2, myNumber = 300, myString = 111.111.111.111
In Node::init(), the initialization of node 2's all modules succeeds.
RanSeed=162916
=======================================================
=============== Start executing events ================
=======================================================
current ticks= 0, run "2 sh init.sh"
net.ipv4.conf.all.forwarding = 1
net.ipv4.conf.all.rp_filter = 0
net.ipv4.conf.eth0.forwarding = 1
```

- Detail of TEXTLINE

  TEXTLINE has a lot of parameters for additional setting; please turn to appendix B for all introductions of parameters. Here, we introduce common part of them in brief.

Caption：

Title of the TEXTLINE

Scale

Here is an example as mentioned above, in"Scale 10 48 220 30," four figures represent X, Y, width, and hight respectively. X, Y on the upper left corner are 0, 0.

ActiveOn

The setting has three values: MODE_EDIT, MODE_SIMULATION, and ALL_MODE. These values are mainly used to set user-designated TEXTLINE to active state in GUI mode. When the setting is MODE_EDIT, the TEXTLINE is enabled in Edit mode; when the setting is MODE_SIMULATION, the TEXTLINE is enabled in G mode; when the setting is ALL_MODE, the TEXTLINE is enabled in every mode

Enabled

If this parameter is OFF, this TEXTLINE is not enabled (greyscale), user could not use it. If this parameter is “ON” or the TEXTLINE is actived in other modes, the TEXTLINE is enabled for user to use.

- Supplement: vBind() API

In above-mentioned exercises, simulated engine uses function of vBind(), and turns GUI-produced if_and_medium_conf module variable into MODULE of simulated engine. In exercise 1-1, after finishing MDF setting, we run simulation in GUI, if_and_medium_conf file will be transferred to simulated engine. The parameter values of UserModule01 in if_and_medium_conf are shown bellow:

user_module_01 | user_module_01.h | user_module_01.cc | interface | node.cc | user_module01....and_medium_conf

```
Set RandomNumberSeed = 0
Set WireLogFlag = on
Set WirelessLogFlag = on
Set WiFiEnableBitError11a = off
Set WiFiChannelCoding11a = on
Set WiFiEnableBitError11n = off
Set WiFiChannelCoding11n = on
Set WAVEEnableBitError = off
Set WAVEChannelCoding = on
Set RunTimeFrameAnimationAndNodeMovement = off
Set RunTimeSDNGroupingStatus = off

Create Node 1 as HOST with name = HOST1
    Define InterfaceID 1
        Module Interface : Node1_Interface_InterfaceID_1
            Set Node1_Interface_InterfaceID_1.tunnel_type = tap
            Set Node1_Interface_InterfaceID_1.nat_id = 0
            Set Node1_Interface_InterfaceID_1.if_name = eth0
            Set Node1_Interface_InterfaceID_1.max_qlen = 50
            Set Node1_Interface_InterfaceID_1.log_qlen = off
            Set Node1_Interface_InterfaceID_1.log_option = FullLog
            Set Node1_Interface_InterfaceID_1.samplerate = 1
            Set Node1_Interface_InterfaceID_1.logFileName = user_module01.interface_n1_i1_qlen.log
            Set Node1_Interface_InterfaceID_1.log_drop = off
            Set Node1_Interface_InterfaceID_1.drop_samplerate = 1
            Set Node1_Interface_InterfaceID_1.droplogFileName = user_module01.interface_n1_i1_drop.log
            Set Node1_Interface_InterfaceID_1.EnableClassify = on
            Set Node1_Interface_InterfaceID_1.ClassifyFileName = user_module01.n1_i1.flow_rule

        Module UserModule01 : Node1_UserModule01_InterfaceID_1
            Set Node1_UserModule01_InterfaceID_1.myNumber = 400
            Set Node1_UserModule01_InterfaceID_1.myString = 222.222.222.222

        Module MAC8023 : Node1_MAC8023_InterfaceID_1
            Set Node1_MAC8023_InterfaceID_1.mac = 0:1:0:0:0:1
            Set Node1_MAC8023_InterfaceID_1.lock_mac = off
            Set Node1_MAC8023_InterfaceID_1.PromisOpt = off
            Set Node1_MAC8023_InterfaceID_1.mode = full
            Set Node1_MAC8023_InterfaceID_1.log = off
            Set Node1_MAC8023_InterfaceID_1.logInterval = 1
            Set Node1_MAC8023_InterfaceID_1.NumCollision = off
            Set Node1_MAC8023_InterfaceID_1.NumUniInPkt = off
            Set Node1_MAC8023_InterfaceID_1.NumUniOutPkt = off
            Set Node1_MAC8023_InterfaceID_1.NumUniInOutPkt = off
            Set Node1_MAC8023_InterfaceID_1.NumBroInPkt = off
            Set Node1_MAC8023_InterfaceID_1.NumBroOutPkt = off
            Set Node1_MAC8023_InterfaceID_1.NumBroInOutPkt = off
```

As such, the module read if_and_medium_conf parameter via vBind() c++ function. In order to use vBind(), we need to know the data type of the mdf parameter. Current estinetse support ten data type for vBind (int, uint8, uint16, bool, float, double, char_str, ip, ipv6, mac). The first parameter of vBind() is parameter of MDF, and the second parameter is c++ varible of module in simulation. Here is the following example for vBind_int, an API:

vBind_int("myNumber", &Number);

- Exercise 1-2
  - RADIOBOX & GROUP

    Here is the exercise of Layout with the object, RADIOBOX.

    Attention! While using RADIOBOX, outer layer has to cooperate with GROUP object, because the length, width and height of RADIOBOX must coordinate with GROUP object.

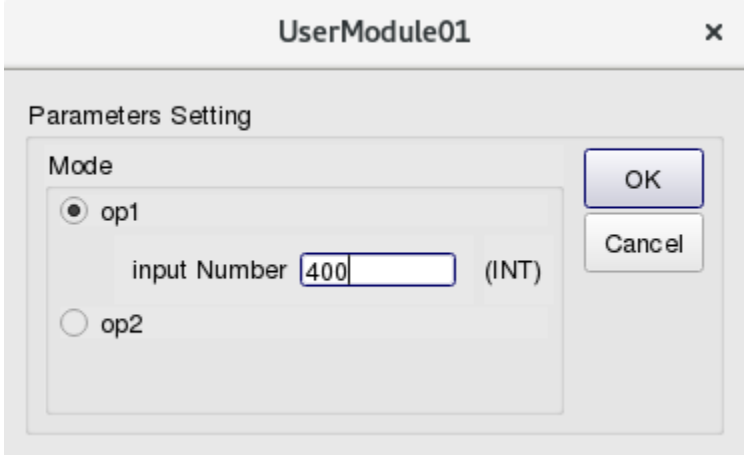
    MDF design is shown below:

```
ModuleSection
    HeaderSection
```

```
        ModuleName          UserModule01
        GroupName           User_Defined
        Introduction        "This is a user-defined module."
        Parameter           myNumber 300 local
        Parameter           myString string1 local
EndHeaderSection

InitVariableSection
        Caption             "Parameters Setting"
        FrameSize           350 170

        Begin Group         g_radio
            Caption         "Mode"
            Scale           10 15 260 135
            ActiveOn        MODE_EDIT
            Enabled         TRUE

            Begin RADIOBOX      myString
                Option          "op1"
                Enable          myNumber
                Enable          lable1
                OptValue        "string1"
                VSpace          5
                EndOption

                Option          "op2"
                Disable         myNumber
                Disable         lable1
                OptValue        "string2"
                VSpace          40
                EndOption

                Type            STRING
                Comment         "radiobox test"
            End

          Begin TEXTLINE        myNumber
                Caption         "input Number"
```

```
                    Scale           35 35 180 35
                    ActiveOn        MODE_EDIT
                    Enabled         FALSE
                    Type            INT
                    Comment         "for test"
                End

                Begin LABEL         lable1
                    Caption         "(INT)"
                    Scale           220 35 35 35
                    ActiveOn        MODE_EDIT
                    Enabled         FALSE
                End
            End

            Begin BUTTON        b_ok
                Caption         "OK"
                Scale           280 17 60 30
                ActiveOn        ALL_MODE
                Action          ok
                Comment         "OK Button"
            End

            Begin BUTTON        b_cancel
                Caption         "Cancel"
                Scale           280 49 60 30
                ActiveOn        ALL_MODE
                Action          cancel
                Comment         "Cancel Button"
            End
        EndInitVariableSection

        ExportSection
            Caption         ""
            FrameSize       0 0
        EndExportSection
EndModuleSection
```

Then install the MDF file, and open GUI, executive screen is shown below:



You can find more details about the parameters of RADIOBOX and GROUP in appendix B.

■ Exercise 1-3

◆ CHECKBOX

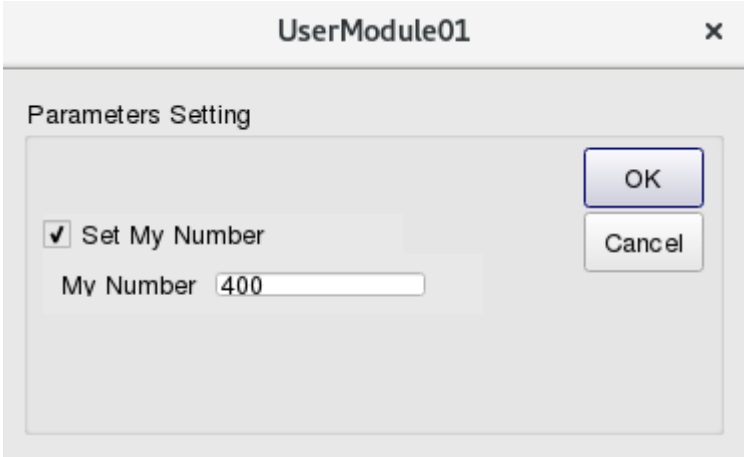
Here, try to use CHECKBOX with the following example.

```
ModuleSection
    HeaderSection
        ModuleName          UserModule01
        GroupName           User_Defined
        Introduction        "This is a user-defined module."
        Parameter           myNumber 300 local
        Parameter           myString 111.111.111.111 local
    EndHeaderSection

    InitVariableSection
        Caption             "Parameters Setting"
        FrameSize           350 170

        Begin CHECKBOX      check1
            Caption         "Set My Number"
            Scale           10 50 180 20
            ActiveOn        MODE_EDIT
```

```
        Enabled         TRUE

        Option          "TRUE"
        OptValue        "on"
        Enable          myNumber
        EndOption

        Option          "FALSE"
        OptValue        "off"
        Disable         myNumber
        EndOption
        Comment         ""
End

Begin TEXTLINE          myNumber
        Caption         "My Number "
        Scale           10 70 220 30
        ActiveOn        MODE_EDIT
        Enabled         FALSE

        Type            INT
        Comment         "An Integer"
End

Begin BUTTON            b_ok
        Caption         "OK"
        Scale           280 17 60 30
        ActiveOn        ALL_MODE
        Action          ok
        Comment         "OK Button"
End

Begin BUTTON            b_cancel
        Caption         "Cancel"
        Scale           280 49 60 30
        ActiveOn        ALL_MODE
        Action          cancel
        Comment         "Cancel Button"
```

```
            End
        EndInitVariableSection


        ExportSection
            Caption             ""
            FrameSize           0 0
        EndExportSection
EndModuleSection
```

Then install the MDF file, and then open GUI, executive screen is shown below:



You can find more details about the parameters of CHECKBOX in appendix **B**.

Chapter 2 MDF and Run Time Query

Highlights:
1. How to use “Run Time Query”?
2. The first kind object of EXPORT SECTION --**ACCESSBUTTON**
3. The second kind object of EXPORT SECTION --**INTERACTIONVIEW**
4. Introduction of APIs -- EXPORT() and COMMAND().

Download Exercises：

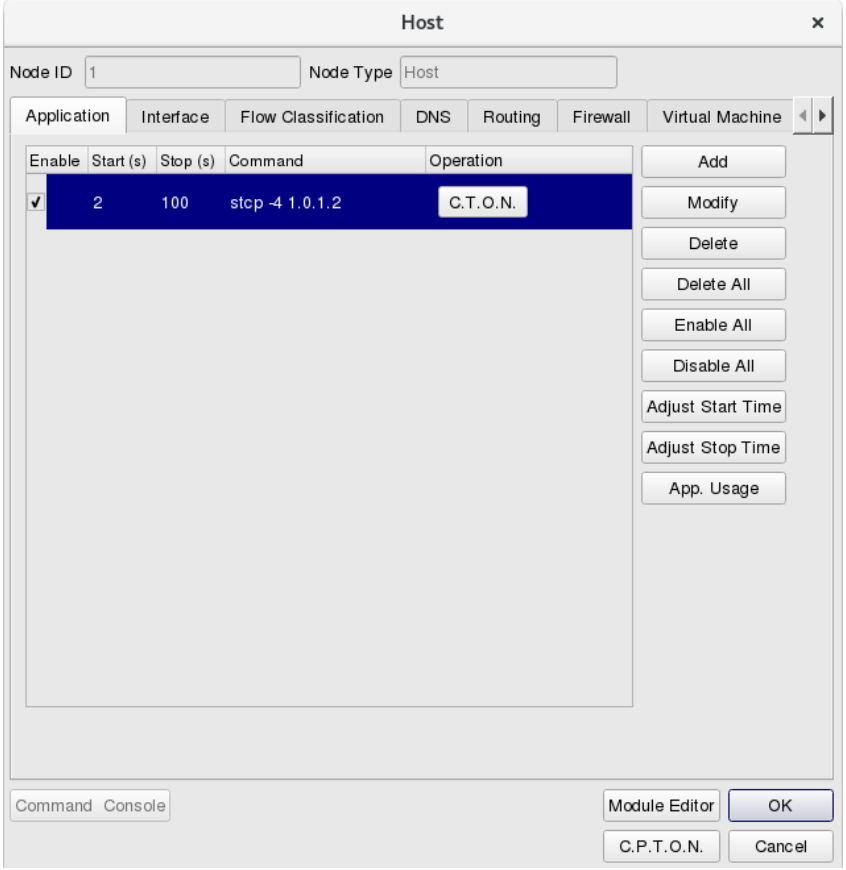
Chapter2.tar.bz2

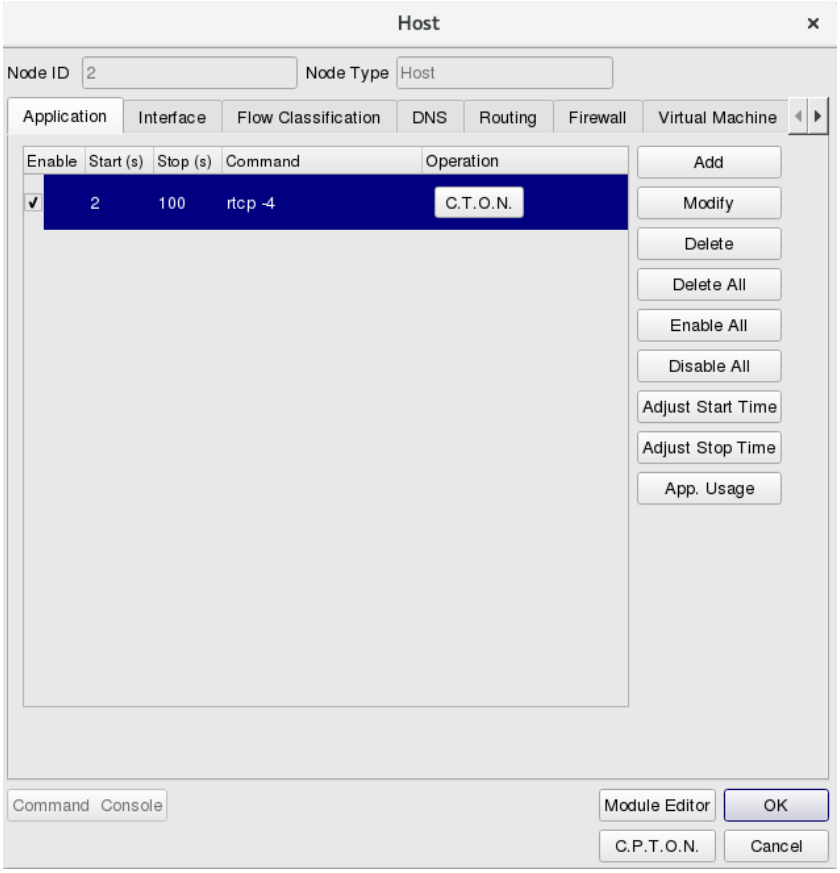
In MDF, there are two objects for variable inquiry during simulation, one is **ACCESSBUTTON**, and the other is **INTERACTIONVIEW**. Both objects have to collaborate with function **COMMAND()** and **EXPORT().**

- Topology Setting

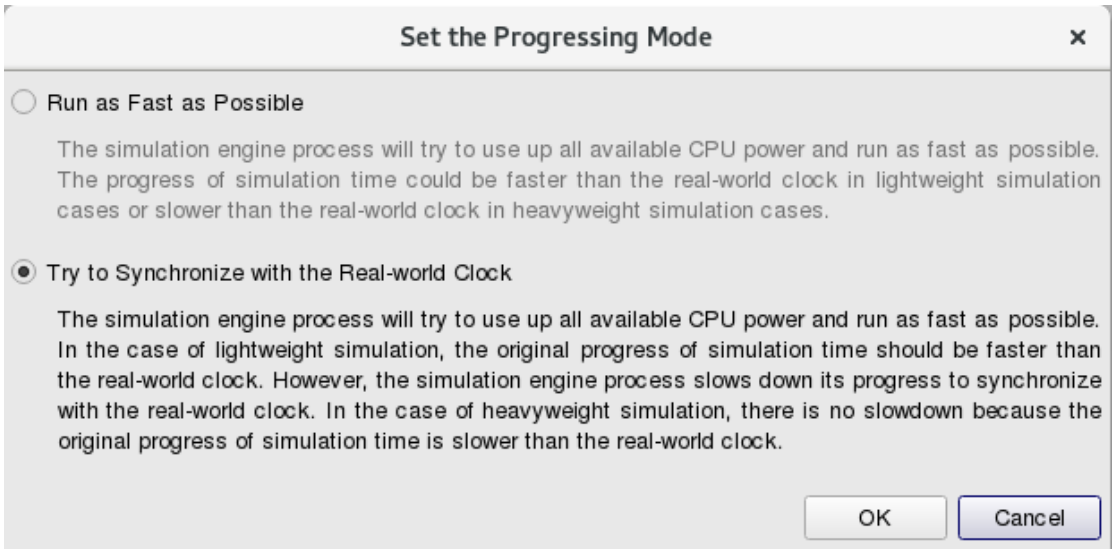
In this chapter, we will use the same topology (user_module01.xtpl) model as in chapter 1, and collaborate with user_module_01 module. Also, we will introduce the function of reading and setting variables of module during simulating in this chapter.

First, add traffic command to topology model: add into “stcp -4 1.0.1.2” under APPLICATION tag of HOST 1, and add into “rtcp -4” under APPLICATION tag of HOST 2, as shown in the following figure:

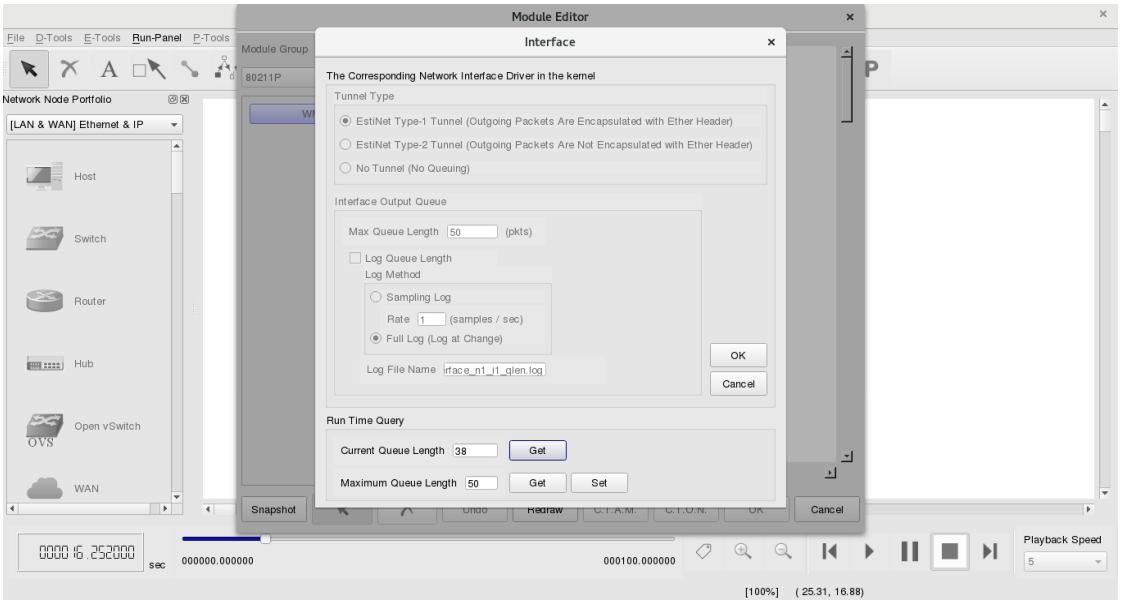

Host
Node ID
1
Node Type
Host
Application
Interface
Flow Classification
DNS
Routing
Firewall
Virtual Machine
Enable
Start (s)
Stop (s)
Command
Operation
2
100
stcp -4 1.0.1.2
C.T.O.N.
Add
Modify
Delete
Delete All
Enable All
Disable All
Adjust Start Time
Adjust Stop Time
App. Usage
Command Console
Module Editor
OK
C.P.T.O.N.
Cancel


Host
Node ID
2
Node Type
Host
Application
Interface
Flow Classification
DNS
Routing
Firewall
Virtual Machine
Enable
Start (s)
Stop (s)
Command
Operation
2
100
rtcp -4
C.T.O.N.
Add
Modify
Delete
Delete All
Enable All
Disable All
Adjust Start Time
Adjust Stop Time
App. Usage
Command Console
Module Editor
OK
C.P.T.O.N.
Cancel

In order to avoid the simulation finishing too fast to observe the change of values, click “E-Tools→Configure Simulation Processes→Simulation→Set the Progressing→ Try to Synchronize the Real-World Clock”. The option makes virtual time in consistent with real time.



Then switch to G mode to execute simulation. During simulating, select Host 1 with right click, choose Module Editor, and double clicks at Interface module. You will see Export section at the bottom, which can get and set some queue parameters. After clicking, you will get current simulated data from module, as shown in following figure:



So, in exercise 2-1, we need to add the function of Run Time Query in User module01.

- Exercise 2-1：modify mdf

  First open mdf in “usermodule01” (procedures of opening this module is described in Chapter 1), then modify the bottom Export Section as red words in the following figure:

```
ModuleSection
    HeaderSection
        ModuleName          UserModule01
        GroupName           User_Defined
        Introduction        "This is a user-defined module."
        Parameter           myNumber 300 local
        Parameter           myString 111.111.111.111 local
    EndHeaderSection

    InitVariableSection
        Caption             "Parameters Setting"
        FrameSize           380 100

        Begin TEXTLINE      myNumber
            Caption         "My Number "
```

```
            Scale           10 18 220 30
            ActiveOn        MODE_EDIT
            Enabled         TRUE
            Type            INT
            Comment         "An Integer"
        End

        Begin TEXTLINE      myString
            Caption         "My String "
            Scale           10 48 220 30
            ActiveOn        MODE_EDIT
            Enabled         TRUE
            Type            IP
            Comment         "An IP string"
        End

        Begin BUTTON        b_ok
            Caption         "OK"
            Scale           250 17 60 30
            ActiveOn        ALL_MODE
            Action          ok
            Comment         "OK Button"
        End

        Begin BUTTON        b_cancel
            Caption         "Cancel"
            Scale           250 49 60 30
            ActiveOn        ALL_MODE
            Action          cancel
            Comment         "Cancel Button"
        End
    EndInitVariableSection

    ExportSection
        Caption             ""
        FrameSize           380 120

        Begin TEXTLINE      text_query_mynum
```

```
        Caption         "My Number "
        Scale           10 15 200 35
        ActiveOn        MODE_SIMULATION
        Enabled         TRUE
        Type            INT
        Comment         ""
End

Begin TEXTLINE          text_query_mystr
        Caption         "My String "
        Scale           10 55 200 35
        ActiveOn        MODE_SIMULATION
        Enabled         TRUE

        Type            INT
        Comment         ""
End

Begin ACCESSBUTTON      ab_get_mynum
        Caption         "Get"
        Scale           215 20 70 25
        ActiveOn        MODE_SIMULATION
        Enabled         TRUE

        Action          GET
        ActionObj       "export-my-number"

        Reference       text_query_mynum
        Comment         "get"
End

Begin ACCESSBUTTON      ab_get_mystr
        Caption         "Get"
        Scale           215 55 70 25
        ActiveOn        MODE_SIMULATION
        Enabled         TRUE

        Action          GET
```

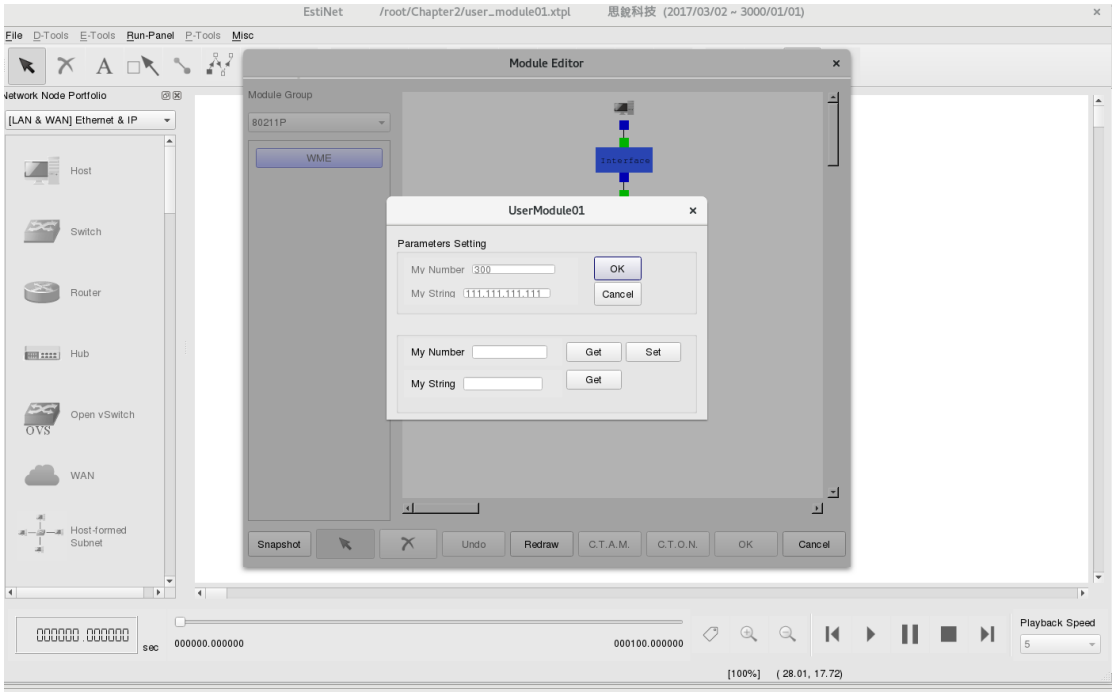
```
                ActionObj        "export-my-string"

                Reference        text_query_mystr
                Comment          "get"
            End

            Begin ACCESSBUTTON   ab_set_mynum
                Caption          "Set"
                Scale            290 20 70 25
                ActiveOn         MODE_SIMULATION
                Enabled          TRUE

                Action            SET
                ActionObj        "export-my-number"

                Reference        text_query_mynum
                Comment          "set"
            End
        EndExportSection
EndModuleSection
```

In the bottom of EXPORT SECTION, alter CAPTION into “RUN TIME QUERY,” alter FRAMSIZE from 0 0 into 380 120 (width height), and add three objects of ACCESSBUTTON. Two of objects are “ab_get_mynum,” “ab_get_mystr,” and the other is “ab_set_mystr.”

After altering, use “make install” in the directory of source code, install mdf for GUI, and open GUI to see modified Layout.

User could check appendix C for the details of parameters in Export section.

Modified objects can be enabled in G MODE after opening GUI, as shown in the following figure:



- Modify user_module01.cc file:

Return to directory of source code to modify “user_module01.cc” with APIs, like VBIND mentioned in the exercise 1-1, with EXPORT API and add codes into the function command() to parsing the command form GUI.

The first parameter of EXPORT API is user-defined string from “ActionObj” of MDF of GUI. The second parameter is permission mode. The permission has E_RONLY(readonly) 、E_WONLY(writeonly) and E_RONLY|E_E_WONLY(can read/write). For example, string “export-my-number” like as below:

EXPORT("export-my-number", E_RONLY|E_WONLY);

Here, try to modify function of **command()**. This function is available in every module, which could read some orders from GUI during run time. When receiving an orede form GUI, the first is checking the order belongs to GET or SET type of command. Then the second is get value to or set value from “ActionObj” according to the kind type of receiving order as red words in the following figure:

```
#include <stdlib.h>
#include <estinet_api.h>
#include <module/user-defined/user_module_01.h>
```

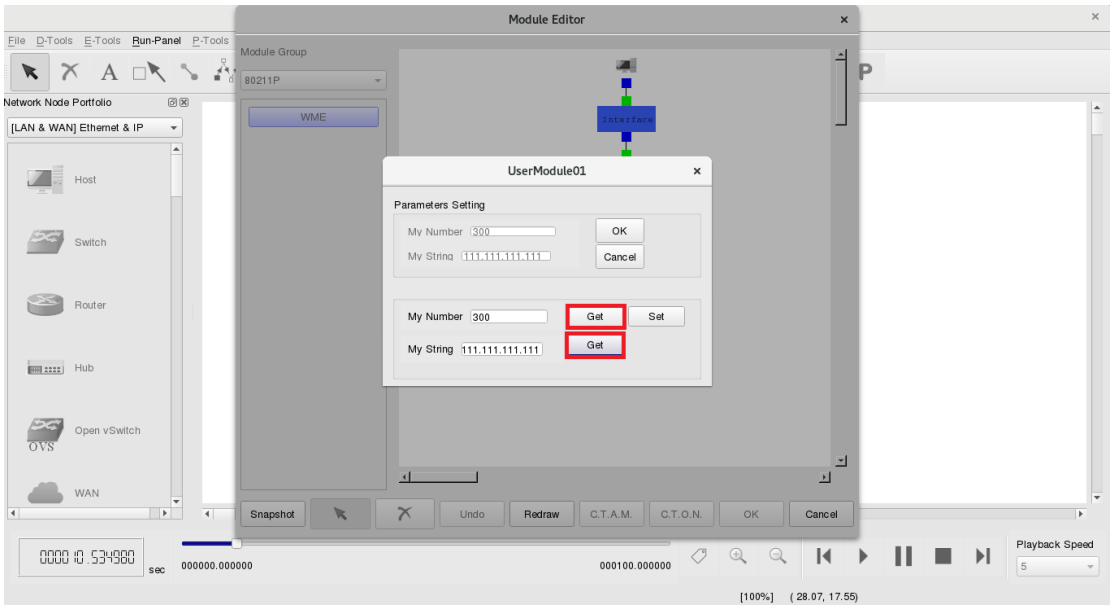
```
MODULE_GENERATOR(UserModule01);

UserModule01::UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char *name)
        : NslObject(type, id, pl, name) {
        vBind_int("myNumber", &Number);
        vBind_char_str("myString", &String);
}

UserModule01::~UserModule01(){}

int UserModule01::init() {
        EXPORT("export-my-number", E_RONLY|E_WONLY);
        EXPORT("export-my-string", E_RONLY|E_WONLY);
        /* exercise 1 */
        printf("\e[1;31;40m\nExercise 1: Node ID = %d, myNumber = %d, myString = %s\e[m\n",
                        get_nid(), Number, String);
        return(NslObject::init());
}

int UserModule01::command(int argc, const char *argv[]) {

        char                    tmpBuf[10];
        struct ExportStr        *ExpStr;
        u_int32_t               row,column;

        /* The Get implementation of Exported Variable "export-my-number" */
            if (!strcmp(argv[0], "Get")&&(argc==2)) {
                        if (!strcmp(argv[1], "export-my-number")) {
                        ExpStr = new ExportStr(1);
                        row = ExpStr->Add_row();
                        column = 1;

                        bzero(tmpBuf, sizeof(tmpBuf));
                                        sprintf(tmpBuf, "%d", Number);
                        ExpStr->Insert_cell(row, column, tmpBuf, "\n");
                        EXPORT_GET_SUCCESS(ExpStr);
                                        return 1;
```

```
                }
        }

    /* The Get implementation of Exported Variable "export-my-string" */
        if (!strcmp(argv[0], "Get")&&(argc==2)) {
                if (!strcmp(argv[1], "export-my-string")) {
            ExpStr = new ExportStr(1);
            row = ExpStr->Add_row();
            column = 1;

            bzero(tmpBuf, sizeof(tmpBuf));
                    sprintf(tmpBuf, "%s", String);
            ExpStr->Insert_cell(row, column, tmpBuf, "\n");
            EXPORT_GET_SUCCESS(ExpStr);
                    return 1;
                }
        }

    /* The Set implementation of Exported Variable "export-my-number" */
       if (!strcmp(argv[0], "Set")&&(argc==3)) {
                if (!strcmp(argv[1], "export-my-number")) {
                    Number = atoi(argv[2]);
            EXPORT_SET_SUCCESS();
                    return 1 ;
                }
        }
    return(NslObject::command(argc, argv));
}

int UserModule01::recv(ePacket_ *pkt) {
    return(NslObject::recv(pkt));
}

int UserModule01::send(ePacket_ *pkt) {
    return(NslObject::send(pkt));
}
```

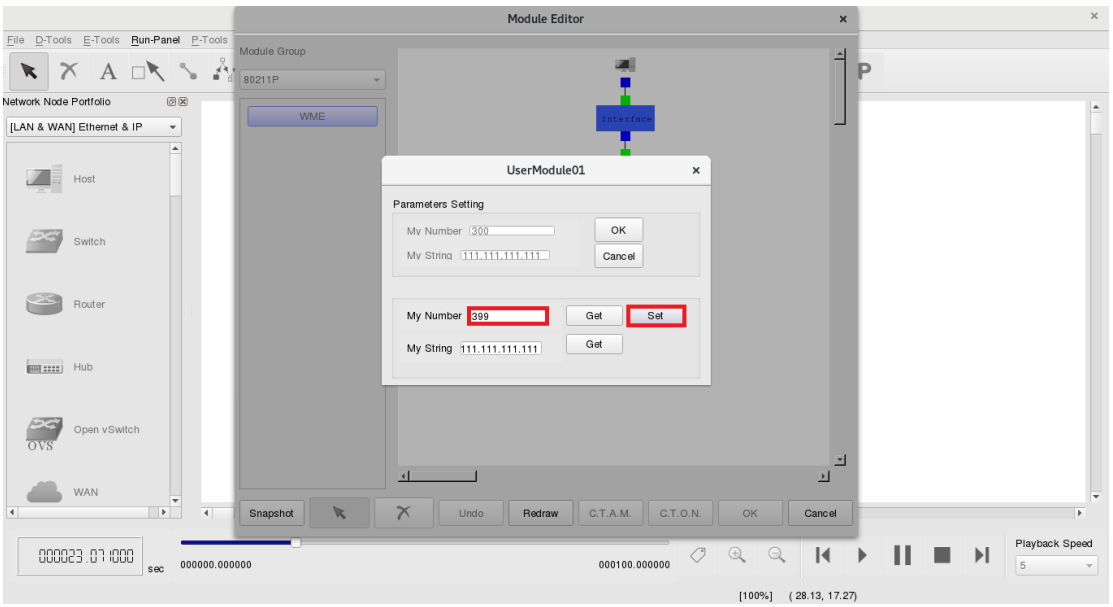
NOTE: Difference between function VBIND and EXPORT
VBIND reads MDF parameter value from if_and_medium_conf file at beginning of simulation. EXPORT reads and writes MDF parameter value in COMMAND function of the module via IPC. Every module has function of COMMAND().

After finishing, execute “make” and “make install” in the directory of source code.

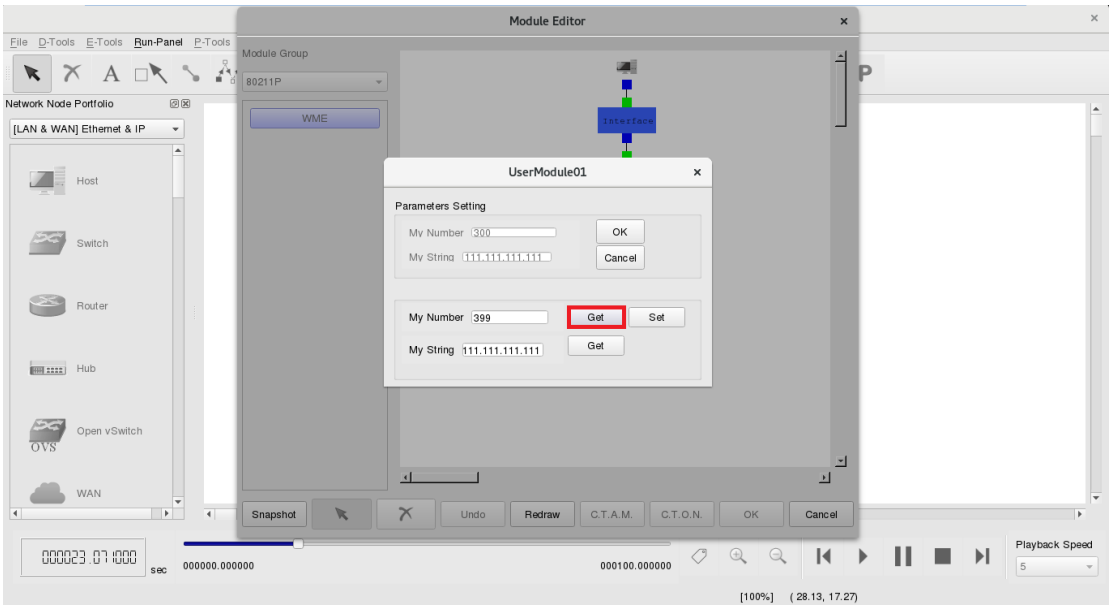
Then execute simulation, right click on “Module Editor” in HOST 1, and double click on user module01. You can get the “Number” values of current simulating engine and values of “String” in module by click “Get” button, as shown in the following figure:



Change “My number” from 300 to 399, and click “Set” button, as the following figure shows:



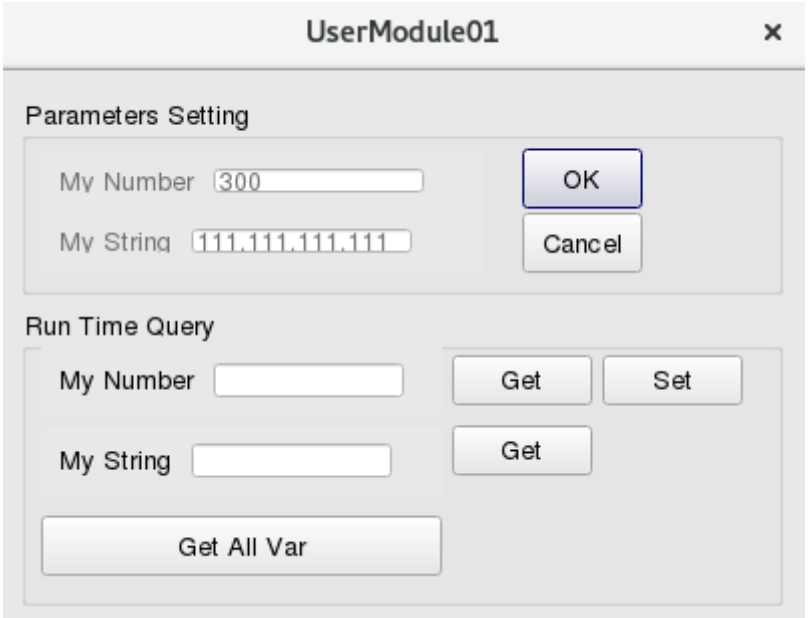
Once again, click “Get” button of “My Number”, you will find out that the value of “My number” is successfully modified as shown in the following figure:



- Another object of Export in MDF
  RUN TIME QUERY could be presented as table.

- Exercise 2-2

Display with **INTERACTIONVIEW** in GUI. Modify MDF of USERMODULE01 as the following figure:



Rewrite the block of EXPORT SECTION as follows:

```
ModuleSection
    HeaderSection
        ModuleName          UserModule01
        GroupName           User_Defined
        Introduction        "This is a user-defined module."
        Parameter           myNumber 300 local
        Parameter           myString 111.111.111.111 local
    EndHeaderSection

    InitVariableSection
        Caption             "Parameters Setting"
        FrameSize           380 100

        Begin TEXTLINE          myNumber
            Caption         "My Number "
            Scale           10 18 220 30
            ActiveOn        MODE_EDIT
            Enabled         TRUE
            Type            INT
            Comment         "An Integer"
        End

        Begin TEXTLINE          myString
            Caption         "My String "
            Scale           10 48 220 30
            ActiveOn        MODE_EDIT
            Enabled         TRUE
            Type            IP
            Comment         "An IP string"
        End

        Begin BUTTON        b_ok
            Caption         "OK"
            Scale           250 17 60 30
            ActiveOn        ALL_MODE
            Action          ok
            Comment         "OK Button"
        End
```

```
        Begin BUTTON        b_cancel
            Caption         "Cancel"
            Scale           250 49 60 30
            ActiveOn        ALL_MODE
            Action          cancel
            Comment         "Cancel Button"
        End
    EndInitVariableSection

    ExportSection
        Caption         "Run Time Query"
        FrameSize       380 150

        Begin TEXTLINE          text_query_mynum
            Caption         "My Number "
            Scale           10 10 200 35
            ActiveOn        MODE_SIMULATION
            Enabled         TRUE

            Type        INT
            Comment         ""
        End

        Begin TEXTLINE          text_query_mystr
            Caption         "My String "
            Scale           10 50 200 35
            ActiveOn        MODE_SIMULATION
            Enabled         TRUE

            Type        INT
            Comment         ""
        End

        Begin ACCESSBUTTON      ab_get_mynum
            Caption         "Get"
            Scale           215 15 70 25
            ActiveOn        MODE_SIMULATION
```

```
        Enabled         TRUE

        Action          GET
        ActionObj       "export-my-number"

        Reference       text_query_mynum
        Comment         "get"
End

Begin ACCESSBUTTON      ab_get_mystr
        Caption         "Get"
        Scale           215 50 70 25
        ActiveOn        MODE_SIMULATION
        Enabled         TRUE

        Action          GET
        ActionObj       "export-my-string"

        Reference       text_query_mystr
        Comment         "get"
End

Begin ACCESSBUTTON      ab_set_mynum
        Caption         "Set"
        Scale           290 15 70 25
        ActiveOn        MODE_SIMULATION
        Enabled         TRUE

        Action            SET
        ActionObj       "export-my-number"

        Reference       text_query_mynum
        Comment         "set"
End

Begin INTERACTIONVIEW  iv_get_all
        Caption         "Get All Var"
        Scale           10 100 200 30
```

```
                ActiveOn        MODE_SIMULATION
                Enabled         TRUE

                Action          GET
                ActionObj       "export-all-data"

                Fields          "My String" "My Number"
                Comment         "All Data"
            End
        EndExportSection
EndModuleSection
```

Modify user_module01.cc:

```
#include <stdlib.h>
#include <estinet_api.h>
#include <module/user-defined/user_module_01.h>

MODULE_GENERATOR(UserModule01);

UserModule01::UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char *name)
        : NslObject(type, id, pl, name) {
        vBind_int("myNumber", &Number);
        vBind_char_str("myString", &String);
}

UserModule01::~UserModule01(){}

int UserModule01::init() {
        EXPORT("export-my-number", E_RONLY|E_WONLY);
        EXPORT("export-my-string", E_RONLY|E_WONLY);
        EXPORT("export-all-data", E_RONLY|E_WONLY);
        /* exercise 1 */
        printf("\e[1;31;40m\nExercise 1: Node ID = %d, myNumber = %d, myString = %s\e[m\n",
                get_nid(), Number, String);
        return(NslObject::init());
}
```

```
int UserModule01::command(int argc, const char *argv[]) {

        char                    tmpBuf[10];
        struct ExportStr   *ExpStr;
        u_int32_t           row,column;
        u_long *mytunidp;

        /* The Get implementation of Exported Variable "export-my-number" */
            if (!strcmp(argv[0], "Get")&&(argc==2)) {
                        if (!strcmp(argv[1], "export-my-number")) {
                    ExpStr = new ExportStr(1);
                    row = ExpStr->Add_row();
                    column = 1;

                    bzero(tmpBuf, sizeof(tmpBuf));
                                sprintf(tmpBuf, "%d", Number);
                    ExpStr->Insert_cell(row, column, tmpBuf, "\n");
                    EXPORT_GET_SUCCESS(ExpStr);
                                return 1;
                        }
            }

        /* The Get implementation of Exported Variable "export-my-string" */
            if (!strcmp(argv[0], "Get")&&(argc==2)) {
                        if (!strcmp(argv[1], "export-my-string")) {
                    ExpStr = new ExportStr(1);
                    row = ExpStr->Add_row();
                    column = 1;

                    bzero(tmpBuf, sizeof(tmpBuf));
                                sprintf(tmpBuf, "%s", String);
                    ExpStr->Insert_cell(row, column, tmpBuf, "\n");
                    EXPORT_GET_SUCCESS(ExpStr);
                                return 1;
                        }
            }

        /* The Set implementation of Exported Variable "export-my-number" */
```

```
        if (!strcmp(argv[0], "Set")&&(argc==3)) {
                if (!strcmp(argv[1], "export-my-number")) {
                        Number = atoi(argv[2]);
            EXPORT_SET_SUCCESS();
                        return 1 ;
                }
        }

        /* The Set implementation of Exported Variable "export-all-data" */
        if (!strcmp(argv[0], "Get")&&(argc==2)) {
                if (!strcmp(argv[1], "export-all-data")) {

            ExpStr = new ExportStr(2);

            bzero(tmpBuf, sizeof(tmpBuf));
            sprintf(tmpBuf, "String\t\tNumber\n");
            ExpStr->Insert_comment(tmpBuf);

            row = ExpStr->Add_row();
            column = 1;

            bzero(tmpBuf, sizeof(tmpBuf));
                sprintf(tmpBuf, "%s", String);
            ExpStr->Insert_cell(row, column++, tmpBuf, "\t\t");

            bzero(tmpBuf, sizeof(tmpBuf));
            sprintf(tmpBuf, "%d", Number);
            ExpStr->Insert_cell(row, column, tmpBuf, "\n");

            EXPORT_GET_SUCCESS(ExpStr);
                        return 1 ;
                }
        }

    return(NslObject::command(argc, argv));
}

int UserModule01::recv(ePacket_ *pkt) {
    return(NslObject::recv(pkt));
```

```
}

int UserModule01::send(ePacket_ *pkt) {
        return(NslObject::send(pkt));
}
```

After modifying, execute “make,” “make install,” and run simulation, you will see the result shown in the figure above.

Chapter 3 Inter-Module Communication

Highlights:
1. APIs and related demo cases: REG_VAR() and GET_REG_VAR()
2. API and related demo case: InstanceLookup()

Download Exercises：

Chapter3.tar.bz2

This chapter describes how to share variables and functions to the other module, for example, a module need to get data from phy module (i.e. bandwidth etc.). In module-based platform of simulator, each node has its own protocol stack, hence, many module operate in one node. And simulated engine provide a global structrue, “var-register-table,” in node structure. Each module can register its own variables to this public structure, and other module can get these registered variables.

- Register Varibles
  REG_VAR() registers a variable of module to a common structure of every node, “var-register-table.” It can be accessed by protocol stack of all modules in this node.

  For example, in this exercise, we will get a registed variable from phy module.

  Usage: REG_VAR(vname, var)
  The first parameter is a variable name to be registered, and the second parameter is pointer to a variable to be registered.

- Get registered varibles from other modules
  GET_REG_VAR() accesses a variable which has been registered from other modules.

Usage: GET_REG_VAR(interface id, vname, type)

The first parameter is interface id, which indicates interface id of the protocol stack. We can use get_ifid() API to get the interface id, so the parameter points to the shared variable of specified module more precisely.

- Usage of get_ifid()
  get_ifid() will return interface id which is connected to.

- Exercise 3-1: REG_VAR() and GET_REG_VAR()
  First step, use the same topology model as in chapter 1, and collaborate with USERMODULE01 module. Modify the user_module01.cc file. Like the red words in the following figure, register the "Number" variable to other modules in constructor.

Modify user_module01.cc:

```
#include <stdlib.h>
#include <estinet_api.h>
#include <module/user-defined/user_module_01.h>
MODULE_GENERATOR(UserModule01);

UserModule01::UserModule01(u_int32_t type, u_int32_t id, struct iflist* ifl, const char
*name): NslObject(type, id, ifl, name) {
        vBind_int("myNumber", &Number);
        vBind_char_str("myString", &String);
        REG_VAR("shared-number", &Number);
}
UserModule01::~UserModule01(){}
int UserModule01::init() {
        return(NslObject::init());
}

int UserModule01::command(int argc, const char *argv[]) {
        return(NslObject::command(argc, argv));
}

int UserModule01::recv(ePacket_ *pkt) {
        return(NslObject::recv(pkt));
```

```
}

int UserModule01::send(ePacket_ *pkt) {
        return(NslObject::send(pkt));
}
```

Next, in phy module of protocol stack, get the shared variable in UserModule01 module. Modify init() in "**module/8023/phy/phy.cc**" in source code's directory. Print the shared variable value of UserModule01 as the red words shown in the following table.

```
int phy::init() {
        NslObject::init();
        int *get_share_data = GET_REG_VAR(get_ifid(), "shared-number", int *);
        if (get_share_data)
        {
                printf("\e[1;36;46m\nExercise3-1: Get Shared Number in UserModule01=
%d\e[m\n", *get_share_data);
        }
 }
```

Execution result is shown as the following figure:

In phy module, you can get registered variable from UserModule01 module via **GET_REG_VAR()** API.

```
e's initial location and mobility events (if any) that will be triggered during
simulation.
add_interface: add interface, node:1 port_no:1 dev:tun1 rename:eth0
[FlowClassifier] Warning: No flow rule setting file /root/.estinet/estinetss/wor
kdir/1525186664-job/per_node/node1/user_module01.n1_i1.flow_rule, use default pr
iority.

Exercise3-1: Get Shared Number in UserModule01= 300
In Node::init(), the initialization of node 1's all modules succeeds.
add_interface: add interface, node:2 port_no:1 dev:tun2 rename:eth0
[FlowClassifier] Warning: No flow rule setting file /root/.estinet/estinetss/wor
kdir/1525186664-job/per_node/node2/user_module01.n1_i1.flow_rule, use default pr
iority.

Exercise3-1: Get Shared Number in UserModule01= 300
In Node::init(), the initialization of node 2's all modules succeeds.
RanSeed=485297
=========================================================
=============== Start executing events ===============
=========================================================
current ticks= 0, run "2 sh init.sh"
```

■ Exercise 3-2：REG_VAR() and GET_REG_VAR()

In phy module, there are some register variables shared with other module, for example:

REG_VAR("DataRate", &bw_);

This shared variable is data of bandwidth. Try to get the “DataRate” from phy module in UserModule01 module.

Reference Answers:

```
int UserModule01::send(ePacket_ *pkt) {

printf("\e[1;33;43m\nExercise 3-2: Get Shared BW in Phy Module = %f\e[m\n",
*(GET_REG_VAR(get_ifid(), "DataRate", double *)));
    return(NslObject::send(pkt));
}
```

```
net.ipv6.conf.eth0.autoconf = 0
Current Time:    0.00 sec   Event#: <Insert:22, Dequeue:5, Rest:17>
current ticks= 100100000, run "1 sh init_daemon.sh"
current ticks= 100200000, run "2 sh init_daemon.sh"

Exercise 3-2: Get Shared DataRate in Phy Module = 10000000.000000

Exercise 3-2: Get Shared DataRate in Phy Module = 10000000.000000

Exercise 3-2: Get Shared DataRate in Phy Module = 10000000.000000

Exercise 3-2: Get Shared DataRate in Phy Module = 10000000.000000

Exercise 3-2: Get Shared DataRate in Phy Module = 10000000.000000

Exercise 3-2: Get Shared DataRate in Phy Module = 10000000.000000

Exercise 3-2: Get Shared DataRate in Phy Module = 10000000.000000

Exercise 3-2: Get Shared DataRate in Phy Module = 10000000.000000
Current Time:    1.00 sec   Event#: <Insert:54, Dequeue:54, Rest:17>
```

Hint: if you execute the above red words with the init() of UserModule01, the data you get is zero, because the init() of phy module executes later than init() of UserModule01. So select the case print message in send() of UserModule01 module; remember there must be a traffic, like ipv6 broadcast packet, or

stcp/rtcp, for successfully executing send().

Moreover, there is a way for a module to use another module's function: using the API, InstanceLookup().

- Usage of InstanceLookup:
  The first parameter is Node ID, you can use get_nid() API to get current Node ID. The second parameter is current interface id in the protocol stack, you can use the get_ifid() to get the interface id. And the third parameter places phy module name registered in whole simulated engine, so we can point to the object via the name, and we can follow c++ grammer to use the object's member and member function. For example:

  ((phy *)InstanceLookup(get_nid(), get_ifid(), "Phy"))->Debugger();

- Exercise 3-3：InstanceLookup()
  First, we modify the code of user_module01.cc, add source code as the red words in the following figure. It includes phy.h, because the Debugger() will be used latter.
  Next, in the function send() of UserModule01, use the API, InstanceLookup, to call Debugger() of phy module.

```
#include <stdlib.h>
#include <estinet_api.h>
#include <module/user-defined/user_module_01.h>
#include <module/8023/phy/phy.h>

MODULE_GENERATOR(UserModule01);

UserModule01::UserModule01(u_int32_t type, u_int32_t id, struct iflist* ifl, const char
*name): NslObject(type, id, ifl, name) {
        vBind_int("myNumber", &Number);
        vBind_char_str("myString", &String);
        REG_VAR("shared-number", &Number);
}

UserModule01::~UserModule01(){}
```

```
int UserModule01::init() {
        return(NslObject::init());
}

int UserModule01::command(int argc, const char *argv[]) {
        return(NslObject::command(argc, argv));
}

int UserModule01::recv(ePacket_ *pkt) {
        return(NslObject::recv(pkt));
}

int UserModule01::send(ePacket_ *pkt) {
        ((phy *)InstanceLookup(get_nid(), get_ifid(), "PHY"))->Debugger();
        return(NslObject::send(pkt));
}
```

Next, add ascii color display effect (green background and yellow word) in Debugger() of phy module, it is much more obvious for print message on the screen.

```
int phy::Debugger() {
        printf("\e[1;33;42mExercise 2 Start:\n");
        NslObject::Debugger();
        printf("      Data Rate: %13.3lf\n", bw_);
        printf("Exercise 2 End\e[m\n\n");
        return(1);
}
```

Execute “make” and “make install” in the directory of the source code, and then run the simulation, we can see as the following green block.

```
net.ipv6.conf.eth0.autoconf = 0
Current Time:    0.00 sec   Event#: <Insert:22, Dequeue:5, Rest:17>
current ticks= 100100000, run "1 sh init_daemon.sh"
current ticks= 100200000, run "2 sh init_daemon.sh"
Exercise 3-3 Start:
Instance name: Node2_PHY_InterfaceID_1
Node ID: 2,  Node type: HOST
variables:
   Data Rate:  10000000.000
Exercise 3-3 End

Exercise 3-3 Start:
Instance name: Node1_PHY_InterfaceID_1
Node ID: 1,  Node type: HOST
variables:
   Data Rate:  10000000.000
Exercise 3-3 End
```

Therefore, through this API, perform the functions of other modules.

Chapter 4 RUN TIME MESSAGE

Highlights:
1. Exercise for RUN TIME MESSAGE -- WARNING
2. Exercise for RUN TIME MESSAGE -- INFOMATION
3. Exercise for RUN TIME MESSAGE – FATAL ERROR
4. send() and recv() architecture in EstiNet module

Download Exercises：

Chapter4.tar.bz2

Run Time Message can be arranged with some error tips, warning tips or some information tips in the form of sourece code. During simulating, execute these source codes will send the message to GUI via IPC, GUI will pop the interactive window.

Run Time Message could be divided into three types in simulation engine.

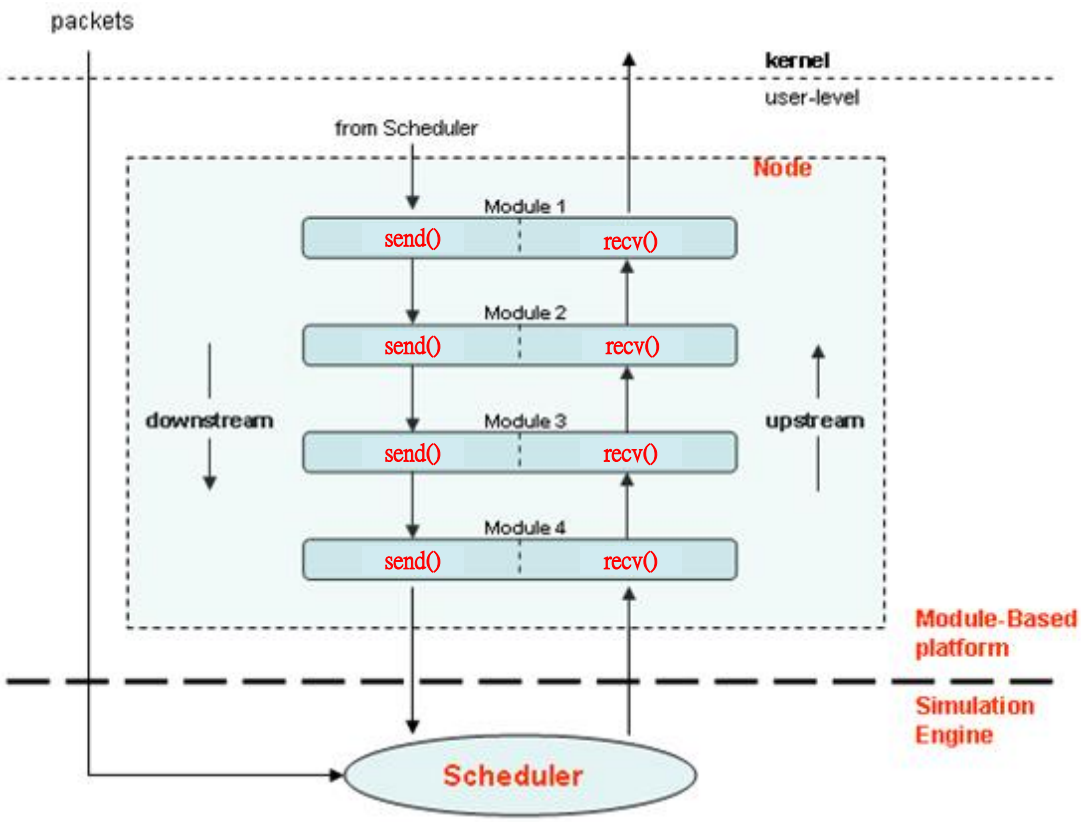
- INFORMATION
- WARNING
- FATAL ERROR

Use three sample codes to show.

We use the demo topology (user_module01.xtpl).

Then, as scheduled, add one line code in "send()" function of user_module01.cc.

Hint: The packet enter the module via send(). When the packet process is finished, the packet is then transfered to send() of next module, so on and so forth, the packet is sent to the lowest module, and switch to other nodes. When module receives other node's packet, it will trigger the recv() function to handle the packet from the bottom module to upper modules gradually. Finally, the packet will be sent to kernel via interface module. As the following figure:



Hence, we use traffic flow to trigger "send()" function of USERMODULE01 module. Here, we take three types of run time messages for demostration:

- Exercise 4-1：INFORMATION

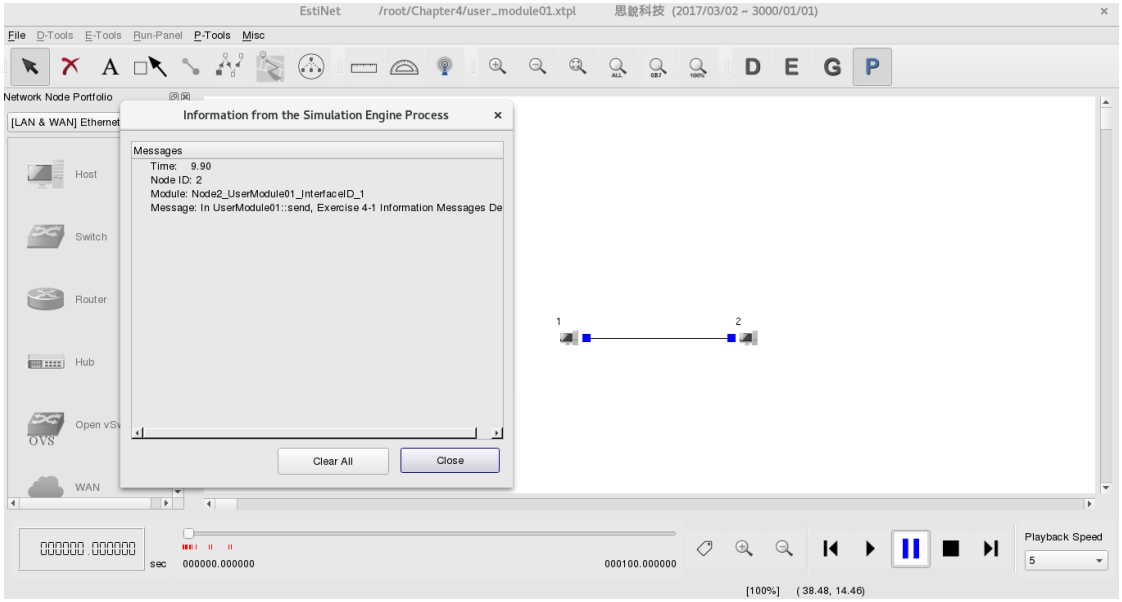
  The API, sendRuntimeMsg, is used to demo RUN TIME MESSAGE in simulation engine. The first parameter is type of RUN TIME MESSAGE. For example, in exercise 4-1, we use "**RTMSG_INFORMATION**" type.

  The second parameter is node id, and the third parameter is module name. We can use get_name () to get module name. And the fourth parameter is a string that we want to display on GUI, as shown in the following red words.

```
int UserModule01::send(ePacket_ *pkt) {
        sendRuntimeMsg(RTMSG_INFORMATION, get_nid(), get_name(), "In UserModule01::send,
Exercise 4-1 Information Messages Demo");
        return(NslObject::send(pkt));
}
```

After modifying code, we need to **make** and **make install** to compiler and install. Then we run the simulation, a window will pop out continously with print message,

as the traffic always send packt constantly. Each packet enters send(), which will trigger this kind of function again. GUI will gather all the information into the same window.



■ Exercise 4-2：WARNING

Next, modify the send() function in user_module01.cc. Modify the first paramerer of sendRuntimeMsg in exercise 4-1 to “**RTMSG_WARNING**”, and change the fourth parameter as red words in he following figure:

```
int UserModule01::send(ePacket_ *pkt) {
        sendRuntimeMsg(RTMSG_WARNING, get_nid(), get_name(), "In UserModule01::send,
Exercise 4-2 Warning Messages Demo");
        return(NslObject::send(pkt));
}
```

After modifying code, execute "**make**" and "**make install**" to finish compilation and installation. Then run the simulation, an interactive window will pop out, and ask user to“Continue” or “Stop”. If you press “Stop”, it will stop the simulation; however, if you press “Continue”, it will continue the simulation, but next packet arrived will also trigger the WARNING message soon. User can decide this type message in what timing to appear.

■ Exercise 4-3：FATAL ERROR

Next, modify the send() function in user_module01.cc. The first parameter of the sendRuntimeMsg is “**RTMSG_FATAL_ERROR**”, change the message sting in the fourth parameter as the red words shown in the following figure.

```
int UserModule01::send(ePacket_ *pkt) {
        sendRuntimeMsg(RTMSG_FATAL_ERROR, get_nid(), get_name(), "In UserModule01::send,
Exercise 4-3 Error Messages Demo");
        return(NslObject::send(pkt));
}
```

After modifying code, execute "**make**" and "**make install**" to finish compilation and installation. Then run the simulation, an interactive window will pop out, and ask user to“Stop”. If press “Stop”, it will stop the simulation. This type of message is used when some error happen. Developer can use this message to stop the simulation.

These three types of run time message can be used in different situation. This would let user to know interactive information of simulation engine by GUI. The application of these three types of message are different different from each other. Developers can decide which time to use which type of message.

Chapter 5 Run a Simulation Case without the Use of the GUI

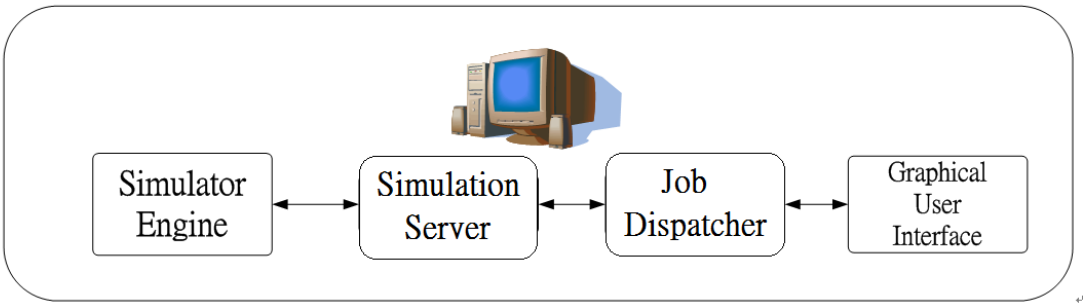
Highlights:
1. Simulation Architecture
2. How to turn off IPC
3. How to check Frame Trace File

Download Exercises：

Chapter5.tar.bz2

In some developing situations, developer wants a simpler enviroment to execute simulation without using the GUI via IPC. And this chapter will introduce how to simulate without GUI.

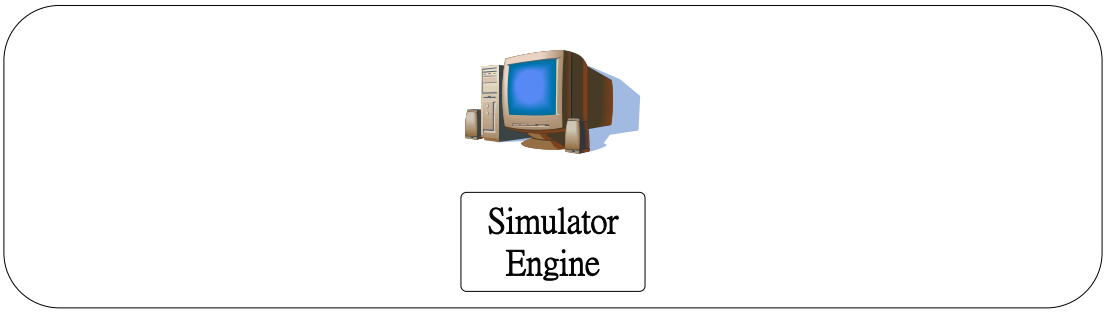
Normal single computer architecture for simulation is shown in the following figure: (EstiNet simulation is also a distruibuted architechure, see appendix D)



It is same as chapter 1, to execute "**estinetjd**", "**estinetss**", and "**estinetgui**" in the same computer before simulation. GUI responses to export the simulated setting files and send them to estinetjd, which assigns job. The estinetjd finds idle simulation engine with estinetss to read those files to execute the simulation.

In such developing process, GUI cannot support all types of new node developing. Developer wants a more simple simulation environment, he or she can choose to turn off the IPC with remaining active simulated engine (estinetse).

If turn off IPC, the architecture is shown as the following figure:



Developer designs new protocol module or debugs in this architechure. It is more convenient to develop a new protocol module.
Take the demo topology (user_module01.xtpl) for example.

Generally, three directories and one file will be generated after simulation with GUI. The file(user_module01.xtpl) and gui_data folder(user_module01.gui_data) are only for GUI, , they store up GUI's object information, for GUI use.
Directory, user_module01.sim, will send files such as if_and_medium_conf setting file to simulation engine for simulation. Finally, the simulation engine will return the result of directory, user_module01.result.

The key step is to send setting files of the directory **sim** to simulated engine.
The procedures of executing simulation without GUI are described as follows:
First, set the environment variable, "ESTINET_WORKDIR," to the directory **sim**, as shown in the following figure:

```
[root@localhost Chapter5]# ls user_module01.sim/.for_se_direct_access/
per_node                                                                    user_module01.obstacle
runtime_fatal_error_message_log    user_module01.if_and_medium_conf         user_module01.run
user_module01.application                                                   user_module01.traffic_light_log
user_module01.car_moving_path_log  user_module01.node_type_and_virtualization
[root@localhost Chapter5]# export ESTINET_WORKDIR=/root/Chapter5/user_module01.sim/
[root@localhost Chapter5]# estinetse -d $ESTINET_WORKDIR/.for_se_direct_access/user_module01.if_and_medium_conf
docker daemon is running.
docker images: estinet10/fedora24:v1
turn off docker seccomp setting
clean old container
The maximum number of kernel-supported tunnel interfaces is 40960.
The maximum queue length of kernel-supported data tunnel interfaces is 1000.
The maximum queue length of kernel-supported event tunnel interfaces is 50000.
The limited maximum number of file descriptors is 1048576.
The limited maximum number of forked processes is unlimited.
The limited maximum size of a core dump file is unlimited.
In HeapObject::HeapObject(), the event heap's capacity is 5000000.
Trying to connect to license server 1, please wait
LogID : 36998
Get capablilty v2 command
```

Next, execute “estinetse -d"; in addition, the “-d” denotes estinetse disable the GUI via the IPC. Then add “$ESTINET_WORKDIR/.for_se_direct_access/” and if_and_medium_conf file name.

```
estinetse -d $ESTINET_WORKDIR/.for_se_direct_access/user_module01.if_and_medium_conf
```

Press “enter”, initiate the simulation.

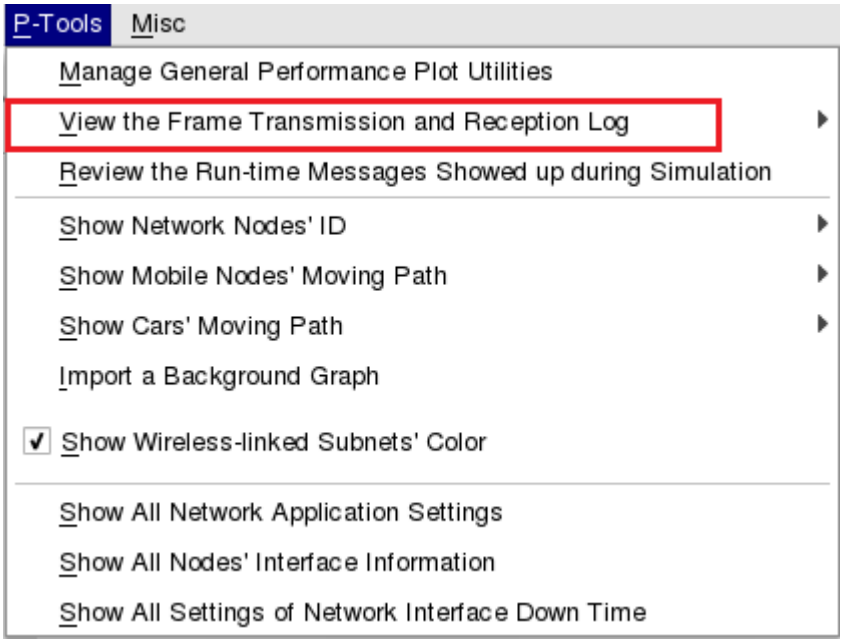
```
Current Time:    3.00 sec   Event#: <Insert:2318, Dequeue:2317, Rest:21>
6664     3          1182 Kbyte/sec ==>  9.460160 Mbit/sec
Current Time:    4.00 sec   Event#: <Insert:2299, Dequeue:2299, Rest:21>
6664     4          1183 Kbyte/sec ==>  9.464128 Mbit/sec
Current Time:    5.00 sec   Event#: <Insert:2299, Dequeue:2299, Rest:21>
6664     5          1183 Kbyte/sec ==>  9.464128 Mbit/sec
Current Time:    6.00 sec   Event#: <Insert:2301, Dequeue:2301, Rest:21>
6664     6          1183 Kbyte/sec ==>  9.464128 Mbit/sec
Current Time:    7.00 sec   Event#: <Insert:2300, Dequeue:2300, Rest:21>
6664     7          1183 Kbyte/sec ==>  9.464128 Mbit/sec
Current Time:    8.00 sec   Event#: <Insert:2299, Dequeue:2299, Rest:21>
6664     8          1183 Kbyte/sec ==>  9.464128 Mbit/sec
Current Time:    9.00 sec   Event#: <Insert:2299, Dequeue:2299, Rest:21>
6664     9          1183 Kbyte/sec ==>  9.464128 Mbit/sec
Current Time:   10.00 sec   Event#: <Insert:2300, Dequeue:2300, Rest:21>
6664     10          1183 Kbyte/sec ==>  9.464128 Mbit/sec
Current Time:   11.00 sec   Event#: <Insert:2300, Dequeue:2300, Rest:21>
6664     11          1183 Kbyte/sec ==>  9.464128 Mbit/sec
Current Time:   12.00 sec   Event#: <Insert:2298, Dequeue:2298, Rest:21>
6664     12          1183 Kbyte/sec ==>  9.464128 Mbit/sec
```

After simulation without IPC, we can see the frame trace file in $ESTINET_WORKDIR shown in the following figure. Because $ESTINET_WORKDIR is in sim folder, so the frame_trace_file file is stored sim/.for_se_direct_access forder. (Normal GUI will store in result folder, but store in $ESTINET_WORKDIR without IPC.)

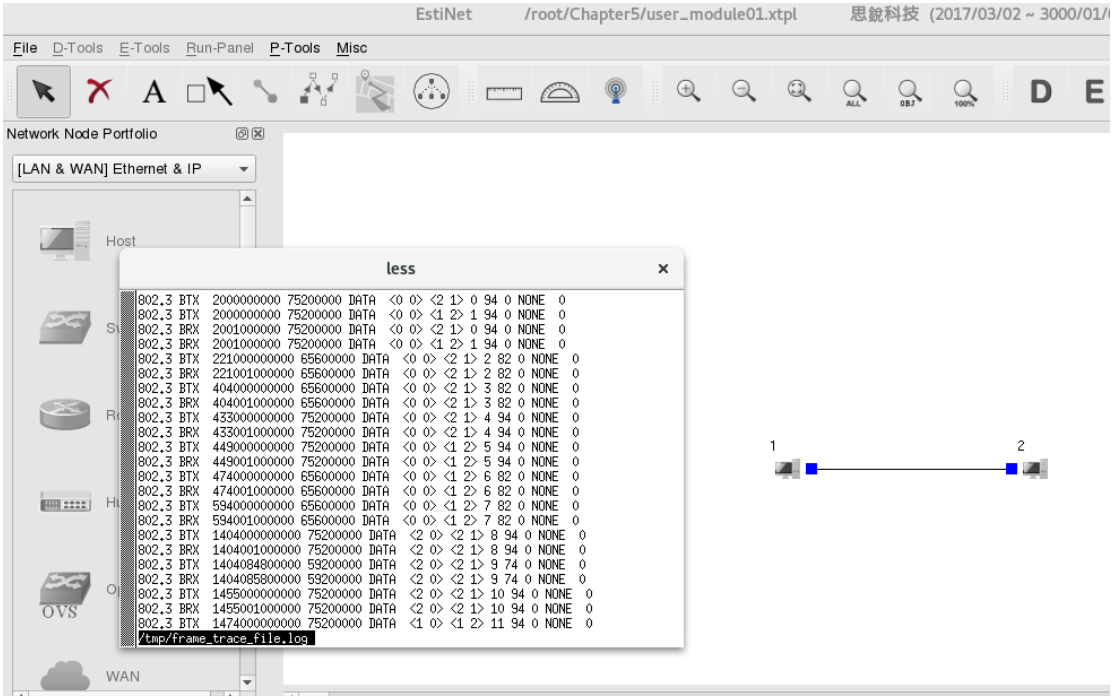
The frame trace file in siumulation engine mainly logs packet record in mac layer.

```
[root@localhost user_module01.sim]# ls
application_setting          networking_setting  user_module01.node_type_and_virtualization
interface_and_medium_setting  particular_field    user_module01.run
[root@localhost user_module01.sim]# cd .for_se_direct_access/
[root@localhost .for_se_direct_access]# ls
per_node                          user_module01.frame_trace_file          user_module01.obstacle
runtime_fatal_error_message_log   user_module01.if_and_medium_conf        user_module01.run
user_module01.application         user_module01.moving_path               user_module01.traffic_light_log
user_module01.car_moving_path_log user_module01.node_type_and_virtualization
```

View the frame trace file via GUI, press the command “P_Tools→View the Frame Transmission and Reception Log→Open the Frame Trace File” as shown in the following figure.

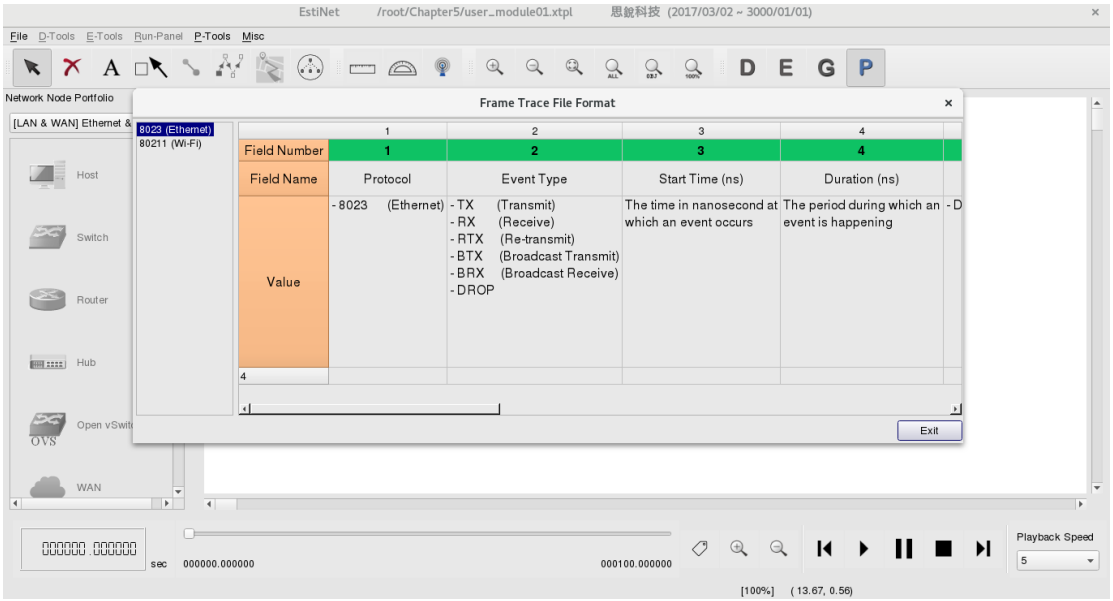


After pressing, you can see the frame_trace_file content.



Press “P_Tools→View the Frame Transmission and Reception Log→Show the Frame Trace File’s Format” to view the meaning in each field of each line in frame_trace_file.

Press the option, you can see the meaning of each field.



If you don't want to view frame_trace_file file via GUI, you can execute "estinet_printftr" in console to view and export, as shown in the following two figures.

estinet_printftr /root/Chapter5/user_module01.sim/.for_se_direct_access/user_module01.frame_trace_file

```
[root@localhost Chapter5]# estinet_printftr /root/Chapter5/user_module01.sim/.for_se_direct_access/user_module01.frame_trac
e_file
```

```
802.3 TX  99991082400000 1214400000 DATA  <1 2> <1 2> 120132 1518 0 NONE  0
802.3 RX  99991083400000 1214400000 DATA  <1 2> <1 2> 120132 1518 0 NONE  0
802.3 TX  99992306400000 1214400000 DATA  <1 2> <1 2> 120133 1518 0 NONE  0
802.3 RX  99992307400000 1214400000 DATA  <1 2> <1 2> 120133 1518 0 NONE  0
802.3 TX  99993521800000 56000000 DATA  <2 1> <2 1> 120191 70 0 NONE  0
802.3 RX  99993522800000 56000000 DATA  <2 1> <2 1> 120191 70 0 NONE  0
802.3 TX  99993530400000 1214400000 DATA  <1 2> <1 2> 120134 1518 0 NONE  0
802.3 RX  99993531400000 1214400000 DATA  <1 2> <1 2> 120134 1518 0 NONE  0
802.3 TX  99994754400000 1214400000 DATA  <1 2> <1 2> 120135 1518 0 NONE  0
802.3 RX  99994755400000 1214400000 DATA  <1 2> <1 2> 120135 1518 0 NONE  0
802.3 TX  99995969800000 56000000 DATA  <2 1> <2 1> 120192 70 0 NONE  0
802.3 RX  99995970800000 56000000 DATA  <2 1> <2 1> 120192 70 0 NONE  0
802.3 TX  99995978400000 1214400000 DATA  <1 2> <1 2> 120136 1518 0 NONE  0
802.3 RX  99995979400000 1214400000 DATA  <1 2> <1 2> 120136 1518 0 NONE  0
802.3 TX  99997202400000 1214400000 DATA  <1 2> <1 2> 120137 1518 0 NONE  0
802.3 RX  99997203400000 1214400000 DATA  <1 2> <1 2> 120137 1518 0 NONE  0
802.3 TX  99998417800000 56000000 DATA  <2 1> <2 1> 120193 70 0 NONE  0
802.3 RX  99998418800000 56000000 DATA  <2 1> <2 1> 120193 70 0 NONE  0
802.3 TX  99998426400000 1214400000 DATA  <1 2> <1 2> 120138 1518 0 NONE  0
802.3 RX  99998427400000 1214400000 DATA  <1 2> <1 2> 120138 1518 0 NONE  0
[root@localhost Chapter5]#
```

Chapter 6 TIMER

Highlights:
1. Introduction to Timer
2. Exercises of TIMER
3. Introduce APIs: GETCURRENTTIME, GETNODETIME, SEC_TO_TICK, MILLI_TO_TICK, BASE_OBJTYPE, POINTER_TO_MEMBER etc..

Download Exercises：

Chapter6.tar.bz2

Timer is an important object in simulation, to tigger or initiates some special function in desired time. Timer object offers functions to control, like **init()**, **start()**, **cancel()**, **expire()** and so on. Here is a simple example:

■ Exercise 6-1

We use the demo topology (user_module01.xtpl) similarly.

Next, Declare a “myTimer” timer object in “user_module01.h,” just make sure “include timer.h” is included. And declare a “timeout” function in public block in UserModule01 Class, this function is called expectedly when the “myTimer” expires.

The modified part of "user_module01.h" is shown as following red word.

```
#ifndef __user_module_01_h__
#define __user_module_01_h__

#include <event.h>
#include <object.h>
#include <timer.h>

class UserModule01 : public NslObject {

  private:
```

```
        int                 Number;
        char                *String;
        timerObj            myTimer;

  public:

        UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char *name);
        ~UserModule01();

        int         init();
        int         command(int argc, const char *argv[]);
        int         recv(ePacket_ *pkt);
        int         send(ePacket_ *pkt);
        void        timeout();
};

#endif    /* __user_module_01_h__ */
```

In file “user_module01.cc,” during executing the function of timeout, we can print some information of current virtual time as well as virtual time of every node. **GetCurrentTime** is used for getting global virtual time of every node in simulator. Time Unit here is 1 tick for 1 picoosecond(10^{-12}). Yet in simulator, every node has its own time, you can get individual time by using API, **GetNodeCurrentTime**().

Meanwhile in the function, init(), add definition of myTimer timer object.
First, declare two variables: one is “first_timeout_in_tick,” which is time point of first execution; the other is “subsequent_timeout_in_tick,” which is interval between execution and timeout.

The modified part of "user_module01.cc" is shown as following red word.

```
#include <stdlib.h>
#include <estinet_api.h>
#include <module/user-defined/user_module_01.h>

MODULE_GENERATOR(UserModule01);

UserModule01::UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char *name)
        : NslObject(type, id, pl, name) {
```

```
        vBind_int("myNumber", &Number);
        vBind_char_str("myString", &String);
        REG_VAR("shared-number", &Number);
}

UserModule01::~UserModule01(){}

int UserModule01::init() {
        u_int64_t   first_timeout_in_tick;
        u_int64_t   subsequent_timeout_in_tick;
        BASE_OBJTYPE(mem_func);

        SEC_TO_TICK(first_timeout_in_tick, 3);
        MILLI_TO_TICK(subsequent_timeout_in_tick, 500);

        mem_func = POINTER_TO_MEMBER(UserModule01, timeout);
        myTimer.setCallOutObj(this, mem_func);
        myTimer.start(first_timeout_in_tick, subsequent_timeout_in_tick);

        return(NslObject::init());
}

int UserModule01::command(int argc, const char *argv[]) {
        return(NslObject::command(argc, argv));
}

int UserModule01::recv(ePacket_ *pkt) {
        return(NslObject::recv(pkt));
}

int UserModule01::send(ePacket_ *pkt) {
        return(NslObject::send(pkt));
}

void UserModule01::timeout() {

        printf("\e[1;33;40mExercise 6-1: Timeout (%llu) (%llu)\e[m\n",
                        GetCurrentTime(), GetNodeCurrentTime(get_nid()));
```

```
        return;
}
```

BASE_OBJTYPE(mem_func);

This line declares a pointer to a basic object, which is used to point some function of module later.

SEC_TO_TICK(first_timeout_in_tick, 3);

SEC_TO_TICK() converts second to tick as time unit, in this example, 3 seconds was converted to 3000000000000 tick, and braught the value to the variable, first_timeout_in_tick.

MILLI_TO_TICK(subsequent_timeout_in_tick, 500);

MILLI_TO_TICK is similar to SEC_TO_TICK, but converts millisecond to tick as time unit. In this example, 500 millisecond (0.5 second) is converted to 500000000000 tick, and braught the value to the variable, subsequent_timeout_in_tick.

mem_func = POINTER_TO_MEMBER(UserModule01, timeout);

Let the object variable, mem_func, use the API, POINTER_TO_MEMBER, to point the timeout() address of UserModule01.

myTimer.setCallOutObj(this, mem_func);

Define myTimer the object to call the pointed function, mem_func, at desired time.

myTimer.start(first_timeout_in_tick, subsequent_timeout_in_tick);

Set initiation time of myTimer and interval of restart. First parameter is first initiated time point, and the second parameter is repeat duration in time unit.

So we can kown that this timer will initiate at 3rd second, and repeat every 0.5 second, as shown in the following figure.

Execution result is shown as the following figure:

```
net.ipv6.conf.eth0.disable_ipv6 = 0
net.ipv6.conf.eth0.autoconf = 0
Current Time:    0.00 sec   Event#: <Insert:23, Dequeue:5, Rest:18>
current ticks= 100100000, run "1 sh init_daemon.sh"
current ticks= 100200000, run "2 sh init_daemon.sh"
Current Time:    1.00 sec   Event#: <Insert:1048, Dequeue:1048, Rest:18>
Current Time:    2.00 sec   Event#: <Insert:1053, Dequeue:1053, Rest:18>
Current Time:    3.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Exercise 6-1: Timeout (3000000000000) (3000000004383)
Exercise 6-1: Timeout (3000000000000) (3000000003677)
Exercise 6-1: Timeout (3500000000000) (3500000004383)
Exercise 6-1: Timeout (3500000000000) (3500000003677)
Current Time:    4.00 sec   Event#: <Insert:1043, Dequeue:1043, Rest:18>
Exercise 6-1: Timeout (4000000000000) (4000000004383)
Exercise 6-1: Timeout (4000000000000) (4000000003677)
Exercise 6-1: Timeout (4500000000000) (4500000004383)
Exercise 6-1: Timeout (4500000000000) (4500000003677)
Current Time:    5.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Exercise 6-1: Timeout (5000000000000) (5000000004383)
Exercise 6-1: Timeout (5000000000000) (5000000003677)
Exercise 6-1: Timeout (5500000000000) (5500000004383)
Exercise 6-1: Timeout (5500000000000) (5500000003677)
Current Time:    6.00 sec   Event#: <Insert:1045, Dequeue:1045, Rest:18>
Exercise 6-1: Timeout (6000000000000) (6000000004383)
Exercise 6-1: Timeout (6000000000000) (6000000003677)
Exercise 6-1: Timeout (6500000000000) (6500000004383)
Exercise 6-1: Timeout (6500000000000) (6500000003677)
Current Time:    7.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Exercise 6-1: Timeout (7000000000000) (7000000004383)
Exercise 6-1: Timeout (7000000000000) (7000000003677)
Exercise 6-1: Timeout (7500000000000) (7500000004383)
```

- Exercise 6-2：

  Try to call function “timeout” in “mytimer,” intiate at 3rd second, repeat in every 2 second.

  The modified part of "user_module01.cc" is shown as following red word.

```
#include <stdlib.h>
#include <estinet_api.h>
#include <module/user-defined/user_module_01.h>

MODULE_GENERATOR(UserModule01);

UserModule01::UserModule01(u_int32_t type, u_int32_t id, struct iflist* ifl, const char
*name): NslObject(type, id, ifl, name) {
        vBind_int("myNumber", &Number);
        vBind_char_str("myString", &String);
        REG_VAR("shared-number", &Number);
}
```

```
UserModule01::~UserModule01(){}

int UserModule01::init() {
        u_int64_t   first_timeout_in_tick;
        u_int64_t   subsequent_timeout_in_tick;
        BASE_OBJTYPE(mem_func);

        SEC_TO_TICK(first_timeout_in_tick, 5);
        SEC_TO_TICK(subsequent_timeout_in_tick, 2);

        mem_func = POINTER_TO_MEMBER(UserModule01, timeout);
        myTimer.setCallOutObj(this, mem_func);
        myTimer.start(first_timeout_in_tick, subsequent_timeout_in_tick);

        return(NslObject::init());
}

int UserModule01::command(int argc, const char *argv[]) {
        return(NslObject::command(argc, argv));
}

int UserModule01::recv(ePacket_ *pkt) {
        return(NslObject::recv(pkt));
}

int UserModule01::send(ePacket_ *pkt) {
        return(NslObject::send(pkt));
}

void UserModule01::timeout() {

        printf("\e[1;33;40mExercise 6-2: Timeout (%llu) (%llu)\e[m\n",
                        GetCurrentTime(), GetNodeCurrentTime(get_nid()));
        return;
}
```

```
current ticks= 100200000, run "2 sh init_daemon.sh"
Current Time:    1.00 sec   Event#: <Insert:1048, Dequeue:1048, Rest:18>
Current Time:    2.00 sec   Event#: <Insert:1052, Dequeue:1052, Rest:18>
Current Time:    3.00 sec   Event#: <Insert:1042, Dequeue:1042, Rest:18>
Current Time:    4.00 sec   Event#: <Insert:1043, Dequeue:1043, Rest:18>
Current Time:    5.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Exercise 6-2: Timeout (5000000000000) (5000000004383)
Exercise 6-2: Timeout (5000000000000) (5000000003677)
Current Time:    6.00 sec   Event#: <Insert:1045, Dequeue:1045, Rest:18>
Current Time:    7.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Exercise 6-2: Timeout (7000000000000) (7000000004383)
Exercise 6-2: Timeout (7000000000000) (7000000003677)
Current Time:    8.00 sec   Event#: <Insert:1043, Dequeue:1043, Rest:18>
Current Time:    9.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Exercise 6-2: Timeout (9000000000000) (9000000004383)
Exercise 6-2: Timeout (9000000000000) (9000000003677)
Current Time:   10.00 sec   Event#: <Insert:1045, Dequeue:1045, Rest:18>
Current Time:   11.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Exercise 6-2: Timeout (11000000000000) (11000000004383)
Exercise 6-2: Timeout (11000000000000) (11000000003677)
Current Time:   12.00 sec   Event#: <Insert:1043, Dequeue:1043, Rest:18>
Current Time:   13.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Exercise 6-2: Timeout (13000000000000) (13000000004383)
Exercise 6-2: Timeout (13000000000000) (13000000003677)
Current Time:   14.00 sec   Event#: <Insert:1043, Dequeue:1043, Rest:18>
Current Time:   15.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Exercise 6-2: Timeout (15000000000000) (15000000004383)
Exercise 6-2: Timeout (15000000000000) (15000000003677)
```

- Exercise 6-3:

Try to call function “timeout” in “mytimer,” intiate at 3rd second, repeat in every 0.5 second, pause at 5th second, resume at 7th second, and cancel at 9th second. You will use some member functions in timer: **cancel**(), **pause**(), and **resume().**

Declare another timer and function in user_module01.h file. First, let timer be paused, and make the other timer help resume, as shown as the blue words in the following figure.

```
#ifndef __user_module_01_h__
#define __user_module_01_h__

#include <event.h>
#include <object.h>
#include <timer.h>

class UserModule01 : public NslObject {
```

```
        private:
            int             Number;
            char            *String;
            timerObj        myTimer, resumeTimer;

        public:

            UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char *name);
            ~UserModule01();

            int         init();
            int         command(int argc, const char *argv[]);
            int         recv(ePacket_ *pkt);
            int         send(ePacket_ *pkt);
            void        timeout();
            void        resumetimer();
        };

#endif    /* __user_module_01_h__ */
```

The modified part of "user_module01.cc" is shown as following red word.

```
#include <stdlib.h>
#include <estinet_api.h>
#include <module/user-defined/user_module_01.h>

MODULE_GENERATOR(UserModule01);

UserModule01::UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char
*name)
        : NslObject(type, id, pl, name) {}

UserModule01::~UserModule01(){}



int UserModule01::init() {
        u_int64_t   first_timeout_in_tick;
        u_int64_t   subsequent_timeout_in_tick;
```

```
        BASE_OBJTYPE(mem_func);

        SEC_TO_TICK(first_timeout_in_tick, 3);
        MILLI_TO_TICK(subsequent_timeout_in_tick, 500);

        mem_func = POINTER_TO_MEMBER(UserModule01, timeout);
        myTimer.setCallOutObj(this, mem_func);
        myTimer.start(first_timeout_in_tick, subsequent_timeout_in_tick);

        u_int64_t   resume_timeout_in_tick;
        BASE_OBJTYPE(mem_func2);
        mem_func2 = POINTER_TO_MEMBER(UserModule01, resumetimer);
        SEC_TO_TICK(resume_timeout_in_tick, 7);
        resumeTimer.setCallOutObj(this, mem_func2);
        resumeTimer.start(resume_timeout_in_tick, 0);

        return(NslObject::init());
}

int UserModule01::command(int argc, const char *argv[]) {
        return(NslObject::command(argc, argv));
}

int UserModule01::recv(ePacket_ *pkt) {
        return(NslObject::recv(pkt));
}

int UserModule01::send(ePacket_ *pkt) {
        return(NslObject::send(pkt));
}

void UserModule01::timeout() {

        printf("\e[1;33;40mExercise 6-3: Timeout (%llu) (%llu) Get time timer expired time:
%llu \e[m\n", GetCurrentTime(), GetNodeCurrentTime(get_nid()), myTimer.expire());

        if(GetCurrentTime() == 9000000000000)
        {
```

```
            myTimer.cancel();
        }
        else if(GetCurrentTime() == 5000000000000)
        {
            myTimer.pause();
        }

        return;
}

void UserModule01::resumetimer() {

        myTimer.resume();
        return;
}
```

Modify function timeout(), pause mytimer while acquired virtual time is 5th second, and cancel mytimer while simulator time is 9th second.

Add function **expire**() into myTimer(), you can see next expired time of myTimer.

Define the function resumetimer() to resume mytimer.
Add blue section in init(), and define resumeTimer to initiate the function resumetimer() to resume myTimer() at 7th second.

It is noteworthy that zero behind resumeTimer indicates this Timer executes only once.

From the result down under, you can see: at 5th second, timeout and execute print time, and then myTimer is paused; at 7th second, resumeTimer resume myTimer object, and call timeout() function to print again; at 9th second, timeout() function print and cancel myTimer directly.

```
current ticks= 100200000, run "2 sh init_daemon.sh"
Current Time:    1.00 sec   Event#: <Insert:1048, Dequeue:1048, Rest:18>
Current Time:    2.00 sec   Event#: <Insert:1052, Dequeue:1052, Rest:18>
Current Time:    3.00 sec   Event#: <Insert:1042, Dequeue:1042, Rest:18>
Exercise 6-3: Timeout (3000000000000) (3000000004383) Get time timer expired time: 3500000000000
Exercise 6-3: Timeout (3000000000000) (3000000003677) Get time timer expired time: 3500000000000
Exercise 6-3: Timeout (3500000000000) (3500000004383) Get time timer expired time: 4000000000000
Exercise 6-3: Timeout (3500000000000) (3500000003677) Get time timer expired time: 4000000000000
Current Time:    4.00 sec   Event#: <Insert:1043, Dequeue:1043, Rest:18>
Exercise 6-3: Timeout (4000000000000) (4000000004383) Get time timer expired time: 4500000000000
Exercise 6-3: Timeout (4000000000000) (4000000003677) Get time timer expired time: 4500000000000
Exercise 6-3: Timeout (4500000000000) (4500000004383) Get time timer expired time: 5000000000000
Exercise 6-3: Timeout (4500000000000) (4500000003677) Get time timer expired time: 5000000000000
Current Time:    5.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Exercise 6-3: Timeout (5000000000000) (5000000004383) Get time timer expired time: 5500000000000
Exercise 6-3: Timeout (5000000000000) (5000000003677) Get time timer expired time: 5500000000000
Current Time:    6.00 sec   Event#: <Insert:1045, Dequeue:1045, Rest:18>
Current Time:    7.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Exercise 6-3: Timeout (7500000000000) (7500000004383) Get time timer expired time: 8000000000000
Exercise 6-3: Timeout (7500000000000) (7500000003677) Get time timer expired time: 8000000000000
Current Time:    8.00 sec   Event#: <Insert:1043, Dequeue:1043, Rest:18>
Exercise 6-3: Timeout (8000000000000) (8000000004383) Get time timer expired time: 8500000000000
Exercise 6-3: Timeout (8000000000000) (8000000003677) Get time timer expired time: 8500000000000
Exercise 6-3: Timeout (8500000000000) (8500000004383) Get time timer expired time: 9000000000000
Exercise 6-3: Timeout (8500000000000) (8500000003677) Get time timer expired time: 9000000000000
Current Time:    9.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Exercise 6-3: Timeout (9000000000000) (9000000004383) Get time timer expired time: 9500000000000
Exercise 6-3: Timeout (9000000000000) (9000000003677) Get time timer expired time: 9500000000000
Current Time:   10.00 sec   Event#: <Insert:1045, Dequeue:1045, Rest:18>
Current Time:   11.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Current Time:   12.00 sec   Event#: <Insert:1043, Dequeue:1043, Rest:18>
Current Time:   13.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Current Time:   14.00 sec   Event#: <Insert:1043, Dequeue:1043, Rest:18>
Current Time:   15.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Current Time:   16.00 sec   Event#: <Insert:1043, Dequeue:1043, Rest:18>
Current Time:   17.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
Current Time:   18.00 sec   Event#: <Insert:1043, Dequeue:1043, Rest:18>
Current Time:   19.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:18>
```

Chapter 7 EVENT

Highlights:
1. Introduction to EVENT
2. Exercises of EVENT

Download Exercises：

Chapter7.tar.bz2

We can use an event structure to trigger a function in simulatior. Essentially, many components in simulator are event, like ePacket. A packet is encapsulated by event structure as an ePacket. And timer also is an extension event, but it has lots of designed functions for it.

In this chapter, we introduce how to create an event instance and use it to trigger a function to execute. And then, we use an event API to release the event.

Here is an exercise to explain the event usage. We create an event and declare a print_event() function, and then set the event in the first second to trigger the print_event() function.

- Exercise 7-1

  We use the demo topology (user_module01.xtpl) as same as chapter one does.

  The modified part of "user_module01.h" is shown as following red word.

```
#ifndef __user_module_01_h__
#define __user_module_01_h__

#include <event.h>
#include <object.h>

class UserModule01 : public NslObject {

  private:
```

```
        int                     Number;
        char                    *String;

  public:

        UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char *name);
        ~UserModule01();

        int             init();
        int             command(int argc, const char *argv[]);
        int             recv(ePacket_ *pkt);
        int             send(ePacket_ *pkt);
        void            print_event(Event_ *ep);
};

#endif    /* __user_module_01_h__ */
```

The modified part of "user_module01.cc" is shown as following red word.

```
#include <stdlib.h>
#include <estinet_api.h>
#include <module/user-defined/user_module_01.h>

MODULE_GENERATOR(UserModule01);

UserModule01::UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char
*name): NslObject(type, id, pl, name) {
        vBind_int("myNumber", &Number);
        vBind_char_str("myString", &String);
        REG_VAR("shared-number", &Number);
}

UserModule01::~UserModule01(){}

int UserModule01::init() {

        Event_ *ep;
        ep = createEvent();
```

```
        u_int64_t expire;
        BASE_OBJTYPE(mem_func3);

        SEC_TO_TICK(expire, 1);
        mem_func3 = POINTER_TO_MEMBER(UserModule01, print_event);

        setObjEvent(ep,
                    expire,
                    0,
                    this,
                    mem_func3,
                    (void *)0
                  );

        return(NslObject::init());

}

int UserModule01::command(int argc, const char *argv[]) {
        return(NslObject::command(argc, argv));
}

int UserModule01::recv(ePacket_ *pkt) {
        return(NslObject::recv(pkt));
}

int UserModule01::send(ePacket_ *pkt) {
        return(NslObject::send(pkt));
}

void UserModule01::print_event(Event_ *ep) {
        printf("\e[1;33;40mExercise 7-1: Timeout (%llu) (%llu)\e[m\n",
                    GetCurrentTime(), GetNodeCurrentTime(get_nid()));
        freeEvent(ep);
        return;
}
```

createEvent() is used to create a new event structue.

freeEvent() is be used to release memory of a event structure.

setObjEvent () is used to set detail of an event. The first parameter is a pointer to the event. The second parameter is execution timestamp of the event. The third parameter is periodical execution interval time, if it is zero indicated that this event executes only once. The fourth is object to execute the event. And the fifth is a function that is a trigger by the event. The sixth is additional data of event, like packet.

Execution result is shown as the following figure:

The event in the first second to trigger the print_event() function. We can see execution has been done only once, because a zero is braught in the third parameter of setObjEvent.

```
current ticks= 100100000, run "1 sh init_daemon.sh"
current ticks= 100200000, run "2 sh init_daemon.sh"
Exercise 7-1: Timeout (1000000000000) (1000000004383)
Current Time:    1.00 sec   Event#: <Insert:1056, Dequeue:1055, Rest:19>
Exercise 7-1: Timeout (1000000000000) (1000000003677)
Current Time:    2.00 sec   Event#: <Insert:1046, Dequeue:1047, Rest:18>
Current Time:    3.00 sec   Event#: <Insert:1043, Dequeue:1043, Rest:18>
Current Time:    4.00 sec   Event#: <Insert:1042, Dequeue:1042, Rest:18>
Current Time:    5.00 sec   Event#: <Insert:1042, Dequeue:1042, Rest:18>
Current Time:    6.00 sec   Event#: <Insert:1044, Dequeue:1044, Rest:18>
Current Time:    7.00 sec   Event#: <Insert:1042, Dequeue:1042, Rest:18>
Current Time:    8.00 sec   Event#: <Insert:1042, Dequeue:1042, Rest:18>
Current Time:    9.00 sec   Event#: <Insert:1042, Dequeue:1042, Rest:18>
Current Time:   10.00 sec   Event#: <Insert:1044, Dequeue:1044, Rest:18>
Current Time:   11.00 sec   Event#: <Insert:1042, Dequeue:1042, Rest:18>
Current Time:   12.00 sec   Event#: <Insert:1042, Dequeue:1042, Rest:18>
Current Time:   13.00 sec   Event#: <Insert:1042, Dequeue:1042, Rest:18>
Current Time:   14.00 sec   Event#: <Insert:1042, Dequeue:1042, Rest:18>
Current Time:   15.00 sec   Event#: <Insert:1042, Dequeue:1042, Rest:18>
Current Time:   16.00 sec   Event#: <Insert:1042, Dequeue:1042, Rest:18>
Current Time:   17.00 sec   Event#: <Insert:1042, Dequeue:1042, Rest:18>
```

- Exercise 7-2:

  If we want the event can periodically exection, we can use the modified user_module01.cc as the following red words:

```
#include <stdlib.h>
#include <estinet_api.h>
#include <module/user-defined/user_module_01.h>

MODULE_GENERATOR(UserModule01);
```

```
UserModule01::UserModule01(u_int32_t type, u_int32_t id, struct iflist* ifl, const char
*name): NslObject(type, id, ifl, name) {
        vBind_int("myNumber", &Number);
        vBind_char_str("myString", &String);
        REG_VAR("shared-number", &Number);
}

UserModule01::~UserModule01(){}

int UserModule01::init() {

        Event_ *ep;
        ep = createEvent();

        u_int64_t expire;
        BASE_OBJTYPE(mem_func3);

        SEC_TO_TICK(expire, 1);
        mem_func3 = POINTER_TO_MEMBER(UserModule01, print_event);

        setObjEvent(ep,
                        expire,
                        expire,
                        this,
                        mem_func3,
                        (void *)0
                    );

        return(NslObject::init());

}

int UserModule01::command(int argc, const char *argv[]) {
        return(NslObject::command(argc, argv));
}

int UserModule01::recv(ePacket_ *pkt) {
        return(NslObject::recv(pkt));
```

```
}

int UserModule01::send(ePacket_ *pkt) {
        return(NslObject::send(pkt));
}

void UserModule01::print_event(Event_ *ep) {
        printf("\e[1;33;40mExercise 7-2: Timeout (%llu) (%llu)\e[m\n",
                        GetCurrentTime(), GetNodeCurrentTime(get_nid()));
        //freeEvent(ep);
        setEventReuse(ep);
        return;
}
```

Execution result is shown as the following figure:

```
current ticks= 100200000, run "2 sh init_daemon.sh"
Exercise 7-2: Timeout (1000000000000) (1000000004383)
Current Time:    1.00 sec   Event#: <Insert:1057, Dequeue:1055, Rest:20>
Exercise 7-2: Timeout (1000000000000) (1000000003677)
Exercise 7-2: Timeout (2000000000000) (2000000003677)
Exercise 7-2: Timeout (2000000000000) (2000000004383)
Current Time:    2.00 sec   Event#: <Insert:1054, Dequeue:1054, Rest:20>
Exercise 7-2: Timeout (3000000000000) (3000000003677)
Exercise 7-2: Timeout (3000000000000) (3000000004383)
Current Time:    3.00 sec   Event#: <Insert:1046, Dequeue:1046, Rest:20>
Current Time:    4.00 sec   Event#: <Insert:1037, Dequeue:1037, Rest:20>
Exercise 7-2: Timeout (4000000000000) (4000000003677)
Exercise 7-2: Timeout (4000000000000) (4000000004383)
Exercise 7-2: Timeout (5000000000000) (5000000004383)
Current Time:    5.00 sec   Event#: <Insert:1049, Dequeue:1049, Rest:20>
Exercise 7-2: Timeout (5000000000000) (5000000003677)
Exercise 7-2: Timeout (6000000000000) (6000000003677)
Exercise 7-2: Timeout (6000000000000) (6000000004383)
Current Time:    6.00 sec   Event#: <Insert:1047, Dequeue:1047, Rest:20>
Exercise 7-2: Timeout (7000000000000) (7000000003677)
Exercise 7-2: Timeout (7000000000000) (7000000004383)
Current Time:    7.00 sec   Event#: <Insert:1045, Dequeue:1045, Rest:20>
Current Time:    8.00 sec   Event#: <Insert:1037, Dequeue:1037, Rest:20>
Exercise 7-2: Timeout (8000000000000) (8000000003677)
Exercise 7-2: Timeout (8000000000000) (8000000004383)
Exercise 7-2: Timeout (9000000000000) (9000000004383)
Current Time:    9.00 sec   Event#: <Insert:1049, Dequeue:1049, Rest:20>
Exercise 7-2: Timeout (9000000000000) (9000000003677)
```

Except the event needs to set the third parameter, it also collaborates with an API, setEventReuse(). Hence, we suggest timer object is better for periodical execution. About the event structure of packet, we will introduce in next chapter.

Chapter 8 PACKET

Highlights:
1. Introduction to PACKET
2. Exercises of PACKET

Download Exercises：

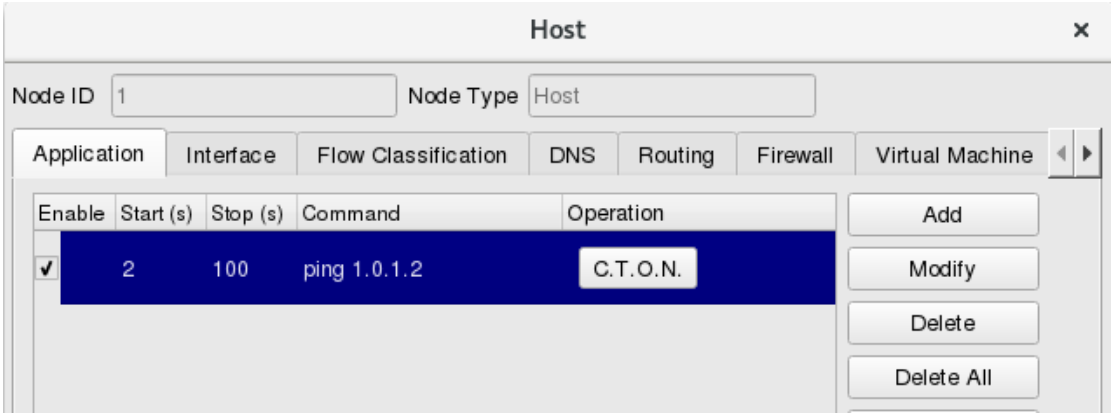
Chapter8.tar.bz2

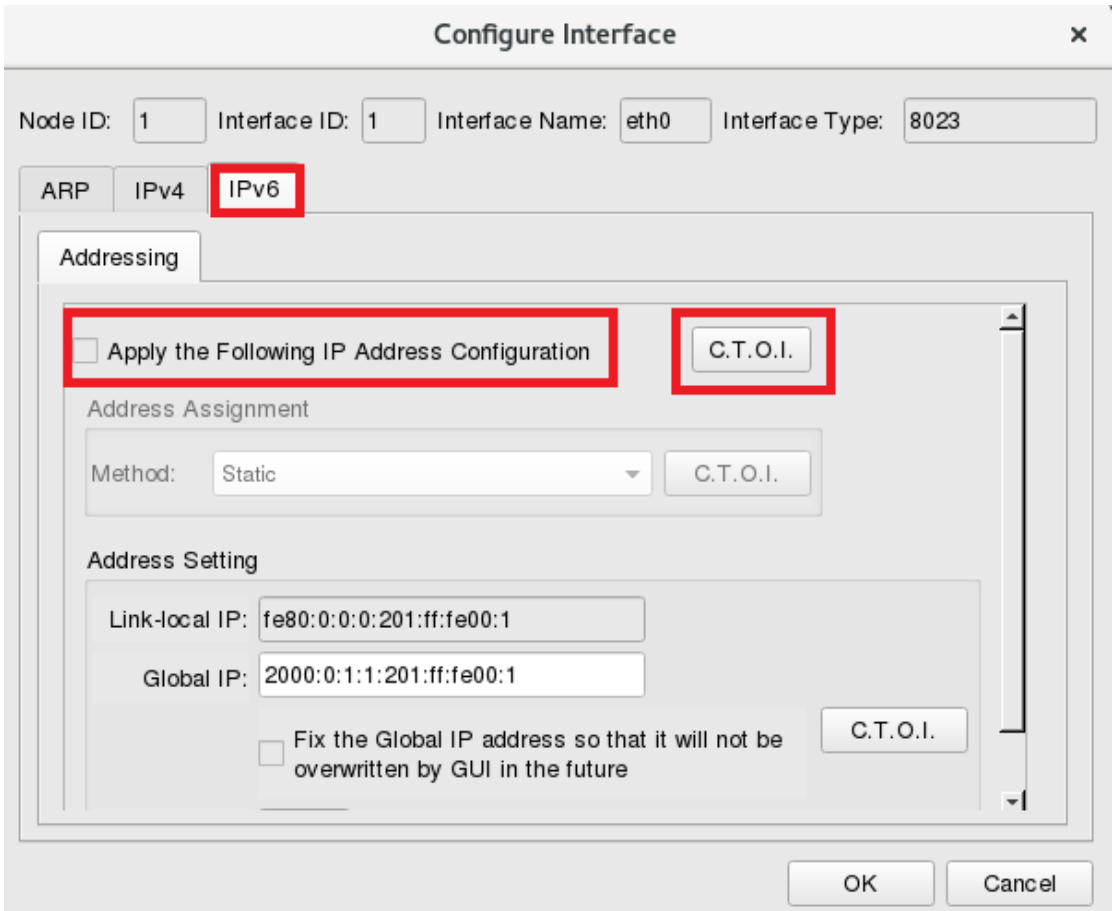
When an application sends traffic packets to simulation engine, kernel will send the traffic packets to the send() function of interface module. And interface module will encapsulate packet as an event. We name this kind of event “ePacket”. Then the ePacket will send to send() function of next module to handle the ePacket. (The architecture of module, refer to the chapter 4)

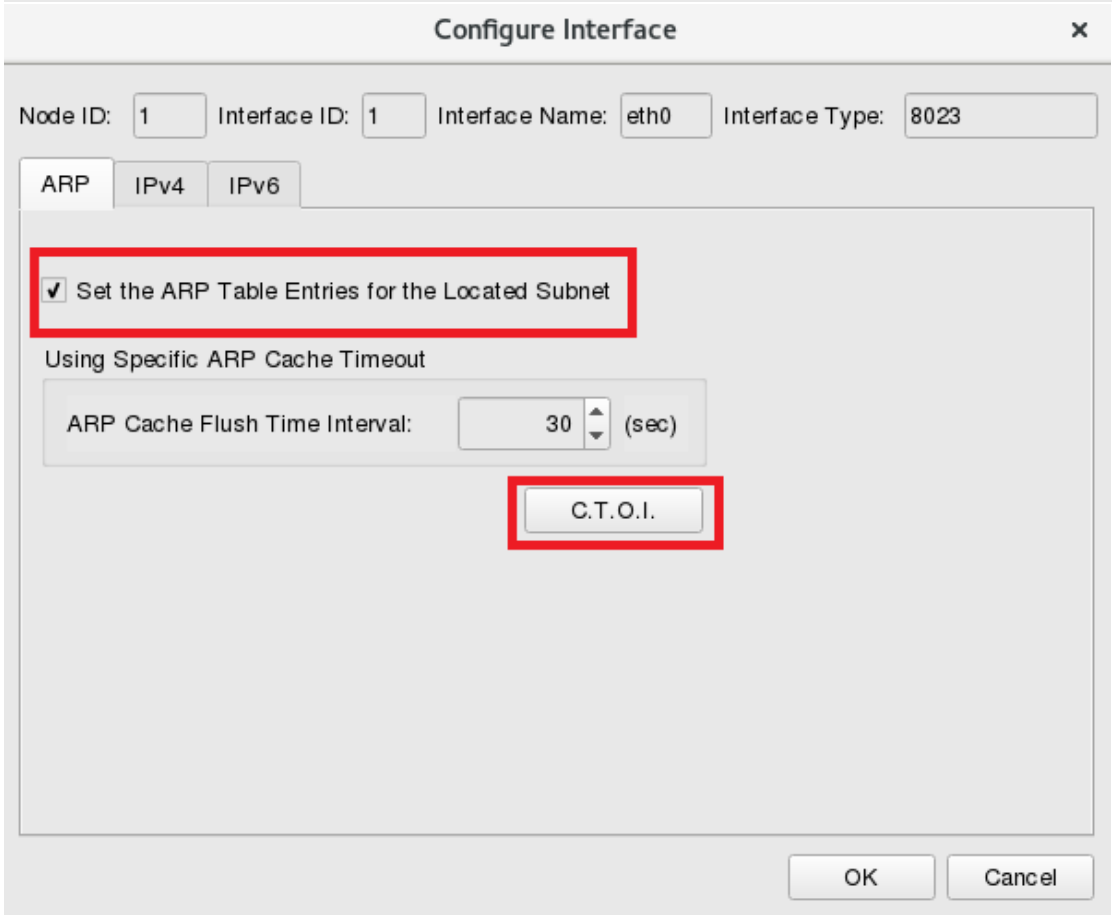
We explain the packet component by the following exercise.

■ Exercise 8-1：

We use the demo topology (user_module01.xtpl) and set traffic application. Then add “ping 1.0.1.2” in Host 1. And close ARP and IPv6 interface in Host1 and Host2.




Configure Interface
Node ID: 1
Interface ID: 1
Interface Name: eth0
Interface Type: 8023
ARP
IPv4
IPv6
Addressing
Apply the Following IP Address Configuration
C.T.O.I.
Address Assignment
Method:
Static
C.T.O.I.
Address Setting
Link-local IP:
fe80:0:0:0:201:ff:fe00:1
Global IP:
2000:0:1:1:201:ff:fe00:1
Fix the Global IP address so that it will not be overwritten by GUI in the future
C.T.O.I.
OK
Cancel


Configure Interface
Node ID: 1
Interface ID: 1
Interface Name: eth0
Interface Type: 8023
ARP
IPv4
IPv6
Set the ARP Table Entries for the Located Subnet
Using Specific ARP Cache Timeout
ARP Cache Flush Time Interval:
30
(sec)
C.T.O.I.
OK
Cancel

Next, we declare a pkt_delay() function in user_module01.h. It is shown as following red word.

```
#ifndef __user_module_01_h__
#define __user_module_01_h__

#include <event.h>
#include <object.h>

class UserModule01 : public NslObject {

 private:
        int             Number;
        char            *String;

 public:

        UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char *name);
        ~UserModule01();

        int             init();
        int             command(int argc, const char *argv[]);
        int             recv(ePacket_ *pkt);
        int             send(ePacket_ *pkt);
        void            pkt_delay(ePacket_ *pkt);
};

#endif    /* __user_module_01_h__ */
```

The modified part of "user_module01.cc" is shown as following red word.

```
#include <stdlib.h>
#include <estinet_api.h>
#include <module/user-defined/user_module_01.h>
#include <packet.h>
#include <ethernet.h>
#include <ip.h>

MODULE_GENERATOR(UserModule01);
```

```
UserModule01::UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char *name)
        : NslObject(type, id, pl, name) {
        vBind_int("myNumber", &Number);
        vBind_char_str("myString", &String);
        REG_VAR("shared-number", &Number);
}

UserModule01::~UserModule01(){}

int UserModule01::init() {
        return(NslObject::init());
}

int UserModule01::command(int argc, const char *argv[]) {
        return(NslObject::command(argc, argv));
}

int UserModule01::recv(ePacket_ *pkt) {
        return(NslObject::recv(pkt));
}

int UserModule01::send(ePacket_ *pkt) {
        u_int64_t    current_time_in_tick;
        u_int64_t    delay_time_in_tick;
        BASE_OBJTYPE(mem_func);

        current_time_in_tick = GetCurrentTime();
        SEC_TO_TICK(delay_time_in_tick, 1);
        mem_func = POINTER_TO_MEMBER(UserModule01, pkt_delay);
        setObjEvent(pkt, current_time_in_tick + delay_time_in_tick,
                0, this, mem_func, (void *)pkt->DataInfo_);
        return(1);

}

void UserModule01::pkt_delay(ePacket_ *pkt) {

        Packet                  *packet;
```

```
        struct ether_header     *eh;
        char                    src_mac_str[18];
        char                    dst_mac_str[18];

        struct ip               *iph;
        char                    src_ip_str[16];
        char                    dst_ip_str[16];

        if(pkt != NULL && pkt->DataInfo_ != NULL) {
                packet = (Packet *)pkt->DataInfo_;
                eh = (struct ether_header *)packet->pkt_get();

                macaddr_to_str(eh->ether_shost, src_mac_str);
                macaddr_to_str(eh->ether_dhost, dst_mac_str);

                printf("\e[1;36;40mExercise 8-1: Src Mac: %s, Dst Mac: %s\e[m\n",
                        src_mac_str, dst_mac_str);

                iph = (struct ip *)packet->pkt_sget();
                if(iph != NULL) {
                        ipv4addr_to_str(iph->ip_src, src_ip_str);
                        ipv4addr_to_str(iph->ip_dst, dst_ip_str);
                        printf("\e[1;36;40mExercise 8-1: Src IP: %s, Dst IP: %s\e[m\n",
                        src_ip_str, dst_ip_str);
                }
        }

        NslObject::send(pkt);
}
```

In send function, we want to apply "packet delay" effect, so we set the packet after one second to trigger the "pkt_delay()". The pkt_delay() function will put the packet to next module.

By doing so, the packet will delay one second, and you can find out that the packet in the module is actually event structure.

By the way, the traffic packet will be stored in DataInfo_ of ePacket structure.

When we use the **pkt_get()** to the packet, it can get the ether header address from the packet.

```
eh = (struct ether_header *)packet->pkt_get();
```

Next, we will transfer the source mac address of ether header to string by "**macaddr_to_str**" API.

```
macaddr_to_str(eh->ether_shost, src_mac_str);
macaddr_to_str(eh->ether_dhost, dst_mac_str);
```

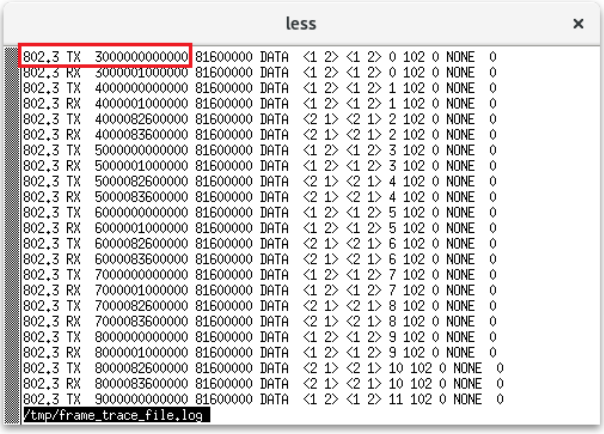
If we want to get the IP header from a packet, we can use the "**pkt_sget()**" API.

```
iph = (struct ip *)packet->pkt_sget();
```

Next, we can transfer the ip source address to string by "**ipv4addr_to_str**" API.

```
ipv4addr_to_str(iph->ip_src, src_ip_str);
ipv4addr_to_str(iph->ip_dst, dst_ip_str);
```

After modifying the source code, we execute "make" and "make install", and then run the simulation, the simulation result as shown in following figure.
We can see the packet send by the first second will be logged by second second, which is what we want, delaying the package.



Next, see the estinetss window, the printed result of using ipv4addr_to_str() and macaddr_to_str() is shown in the following figure. Developer can use this information to debug or check related information.

```
Current Time:    1.00 sec   Event#: <Insert:1046, Dequeue:1046, Rest:19>
current ticks= 2000000000000, run "1 ping 1.0.1.2"
PING 1.0.1.2 (1.0.1.2) 56(84) bytes of data.
Current Time:    2.00 sec   Event#: <Insert:1045, Dequeue:1043, Rest:21>
Current Time:    3.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:21>
Exercise 8: Src Mac: 0:1:0:0:0:1, Dst Mac: 0:1:0:0:0:2
Exercise 8: Src IP: 1.0.1.1, Dst IP: 1.0.1.2
Exercise 8: Src Mac: 0:1:0:0:0:1, Dst Mac: 0:1:0:0:0:2
Exercise 8: Src IP: 1.0.1.1, Dst IP: 1.0.1.2
Current Time:    4.00 sec   Event#: <Insert:1047, Dequeue:1046, Rest:22>
Exercise 8: Src Mac: 0:1:0:0:0:2, Dst Mac: 0:1:0:0:0:1
Exercise 8: Src IP: 1.0.1.2, Dst IP: 1.0.1.1
64 bytes from 1.0.1.2: icmp_seq=1 ttl=64 time=2000 ms
Exercise 8: Src Mac: 0:1:0:0:0:1, Dst Mac: 0:1:0:0:0:2
Exercise 8: Src IP: 1.0.1.1, Dst IP: 1.0.1.2
Current Time:    5.00 sec   Event#: <Insert:1046, Dequeue:1046, Rest:22>
Exercise 8: Src Mac: 0:1:0:0:0:2, Dst Mac: 0:1:0:0:0:1
Exercise 8: Src IP: 1.0.1.2, Dst IP: 1.0.1.1
64 bytes from 1.0.1.2: icmp_seq=2 ttl=64 time=2000 ms
Exercise 8: Src Mac: 0:1:0:0:0:1, Dst Mac: 0:1:0:0:0:2
Exercise 8: Src IP: 1.0.1.1, Dst IP: 1.0.1.2
Current Time:    6.00 sec   Event#: <Insert:1045, Dequeue:1045, Rest:22>
```

■ Exercise 8-2: pkt_addinfo, pkt_getinfo and pkt_delinfo

Sometimes, while processing packet in the modules, we hope the packet has the extra information to help us process the packet. But the packet usually has the specified format. Hence, the packet structure in simulator, every ePacket has an extra buffer to store additional information, this buffer is called PT_INFO. We can attach additional information to the packet by using **pkt_addinfo(), pkt_getinfo()** and **pkt_delinfo().**

The modified part of "user_module01.h" is shown as following red word.

```
#ifndef __user_module_01_h__
#define __user_module_01_h__

#include <event.h>
#include <object.h>

class UserModule01 : public NslObject {

  private:
        int          Number;
        char         *String;

  public:
```

```
        UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char *name);
        ~UserModule01();

        int             init();
        int             command(int argc, const char *argv[]);
        int             recv(ePacket_ *pkt);
        int             send(ePacket_ *pkt);
        void            pkt_delay(ePacket_ *pkt);
};

#endif    /* __user_module_01_h__ */
```

The following red words are same as the 8-1 case, with blue words about this case.

user_module01.cc

```
#include <stdlib.h>
#include <estinet_api.h>
#include <module/user-defined/user_module_01.h>
#include <packet.h>
#include <ethernet.h>
#include <ip.h>

MODULE_GENERATOR(UserModule01);

UserModule01::UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char *name)
        : NslObject(type, id, pl, name) {
}

UserModule01::~UserModule01(){}

int UserModule01::init() {
        return(NslObject::init());
}

int UserModule01::command(int argc, const char *argv[]) {
        return(NslObject::command(argc, argv));
}

int UserModule01::recv(ePacket_ *pkt) {
```

```
        return(NslObject::recv(pkt));
}

int UserModule01::send(ePacket_ *pkt) {
        u_int64_t    current_time_in_tick;
        u_int64_t    delay_time_in_tick;
        BASE_OBJTYPE(mem_func);

        current_time_in_tick = GetCurrentTime();
        SEC_TO_TICK(delay_time_in_tick, 1);
        mem_func = POINTER_TO_MEMBER(UserModule01, pkt_delay);
        setObjEvent(pkt, current_time_in_tick + delay_time_in_tick,
                0, this, mem_func, (void *)pkt->DataInfo_);
        return(1);

}

void UserModule01::pkt_delay(ePacket_ *pkt) {

        Packet                  *packet;
        struct ether_header     *eh;
        char                    src_mac_str[18];
        char                    dst_mac_str[18];

        struct ip               *iph;
        char                    src_ip_str[16];
        char                    dst_ip_str[16];

        if(pkt != NULL && pkt->DataInfo_ != NULL) {
                packet = (Packet *)pkt->DataInfo_;
                eh = (struct ether_header *)packet->pkt_get();

                macaddr_to_str(eh->ether_shost, src_mac_str);
                macaddr_to_str(eh->ether_dhost, dst_mac_str);

                printf("\e[1;36;40mExercise 8: Src Mac: %s, Dst Mac: %s\e[m\n",
                        src_mac_str, dst_mac_str);
```

```
            iph = (struct ip *)packet->pkt_sget();
            if(iph != NULL) {
                ipv4addr_to_str(iph->ip_src, src_ip_str);
                ipv4addr_to_str(iph->ip_dst, dst_ip_str);
                printf("\e[1;36;40mExercise 8: Src IP: %s, Dst IP: %s\e[m\n",
                src_ip_str, dst_ip_str);
            }
        }

        int NodeColor=random()%3;
        packet->pkt_addinfo("NodeColor", (char *)&NodeColor, sizeof(NodeColor));
        NslObject::send(pkt);
}
```

In the exercise, we add a packet information before the UserModule01 module put the packet to next module. The packet information is node color with three random values (color).

- Usage of the pkt_addinfo():
  The pkt_addinfo() API has three parameters. First parameter is the packet information identifier (no more than 15 characters), the second is c++ variable, and the third is the size of the c++ variable.

The modified part of "phy.cc" is shown as following blue words.

```
int phy::send(ePacket_ *pkt) {
        struct con_list             *cl;
        Packet                      *p;
        struct phyInfo              *phyinfo;

        assert(pkt&&(p=(Packet *)pkt->DataInfo_));
        if ( LinkFailFlag > 0 ) {
                freePacket(pkt);
                return(1);
        }
        int *nodecolor = (int *)p->pkt_getinfo("NodeColor");
        if(*nodecolor == 1)
                printf("\e[1;33;42mExercise 8: Node Color : %d\e[m\n", *nodecolor);
        else if(*nodecolor == 2)
                printf("\033[1;35;45mExercise 8: Node Color : %d\033[m\n", *nodecolor);
```

```
        else
                printf("\e[1;31;41mExercise 8: Node Color : %d\e[m\n", *nodecolor);
        p->pkt_delinfo("NodeColor");
```

In phy module, we use "pkt_getinfo()" to get the “NodeColor” information of the packet, and print different ascii color for different value of “NodeColor”.
After printing, we use the pkt_definfo() to delete “NodeColor” information of the packet.

- Usage of pkt_getinfo() and pkt_delinfo():
  Bring identifier of packet information into the parameter of pkt_getinfo() will return the value of identifier; however, bring identifier of packet information into the parameter of pkt_delinfo will delete the packet information.

Execution result is shown as the following figure:

```
Current Time:    1.00 sec   Event#: <Insert:1046, Dequeue:1046, Rest:19>
current ticks= 2000000000000, run "1 ping 1.0.1.2"
PING 1.0.1.2 (1.0.1.2) 56(84) bytes of data.
Current Time:    2.00 sec   Event#: <Insert:1045, Dequeue:1043, Rest:21>
Current Time:    3.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:21>
Exercise 8-2: Src Mac: 0:1:0:0:0:1, Dst Mac: 0:1:0:0:0:2
Exercise 8-2: Src IP: 1.0.1.1, Dst IP: 1.0.1.2
Exercise 8-2: Node Color : 0
Exercise 8-2: Src Mac: 0:1:0:0:0:1, Dst Mac: 0:1:0:0:0:2
Exercise 8-2: Src IP: 1.0.1.1, Dst IP: 1.0.1.2
Exercise 8-2: Node Color : 0
Current Time:    4.00 sec   Event#: <Insert:1047, Dequeue:1046, Rest:22>
Exercise 8-2: Src Mac: 0:1:0:0:0:2, Dst Mac: 0:1:0:0:0:1
Exercise 8-2: Src IP: 1.0.1.2, Dst IP: 1.0.1.1
Exercise 8-2: Node Color : 2
64 bytes from 1.0.1.2: icmp_seq=1 ttl=64 time=2000 ms
Exercise 8-2: Src Mac: 0:1:0:0:0:1, Dst Mac: 0:1:0:0:0:2
Exercise 8-2: Src IP: 1.0.1.1, Dst IP: 1.0.1.2
Exercise 8-2: Node Color : 1
Current Time:    5.00 sec   Event#: <Insert:1046, Dequeue:1046, Rest:22>
Exercise 8-2: Src Mac: 0:1:0:0:0:2, Dst Mac: 0:1:0:0:0:1
Exercise 8-2: Src IP: 1.0.1.2, Dst IP: 1.0.1.1
Exercise 8-2: Node Color : 0
64 bytes from 1.0.1.2: icmp_seq=2 ttl=64 time=2000 ms
Exercise 8-2: Src Mac: 0:1:0:0:0:1, Dst Mac: 0:1:0:0:0:2
Exercise 8-2: Src IP: 1.0.1.1, Dst IP: 1.0.1.2
Exercise 8-2: Node Color : 0
Current Time:    6.00 sec   Event#: <Insert:1045, Dequeue:1045, Rest:22>
Exercise 8-2: Src Mac: 0:1:0:0:0:2, Dst Mac: 0:1:0:0:0:1
Exercise 8-2: Src IP: 1.0.1.2, Dst IP: 1.0.1.1
Exercise 8-2: Node Color : 2
64 bytes from 1.0.1.2: icmp_seq=3 ttl=64 time=2000 ms
Exercise 8-2: Src Mac: 0:1:0:0:0:1, Dst Mac: 0:1:0:0:0:2
Exercise 8-2: Src IP: 1.0.1.1, Dst IP: 1.0.1.2
Exercise 8-2: Node Color : 2
Current Time:    7.00 sec   Event#: <Insert:1047, Dequeue:1047, Rest:22>
```

Chapter 9 Other APIs

Highlights:
1. Introduce GetNodeLoc, GetTotalNumOfNodes, GetConFilePathAndName, and getConnectNode etc.

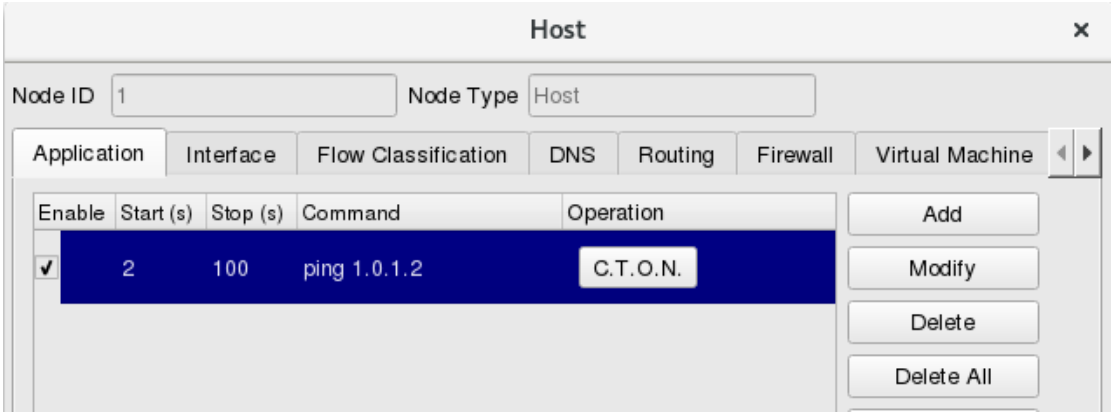
Download Exercises：

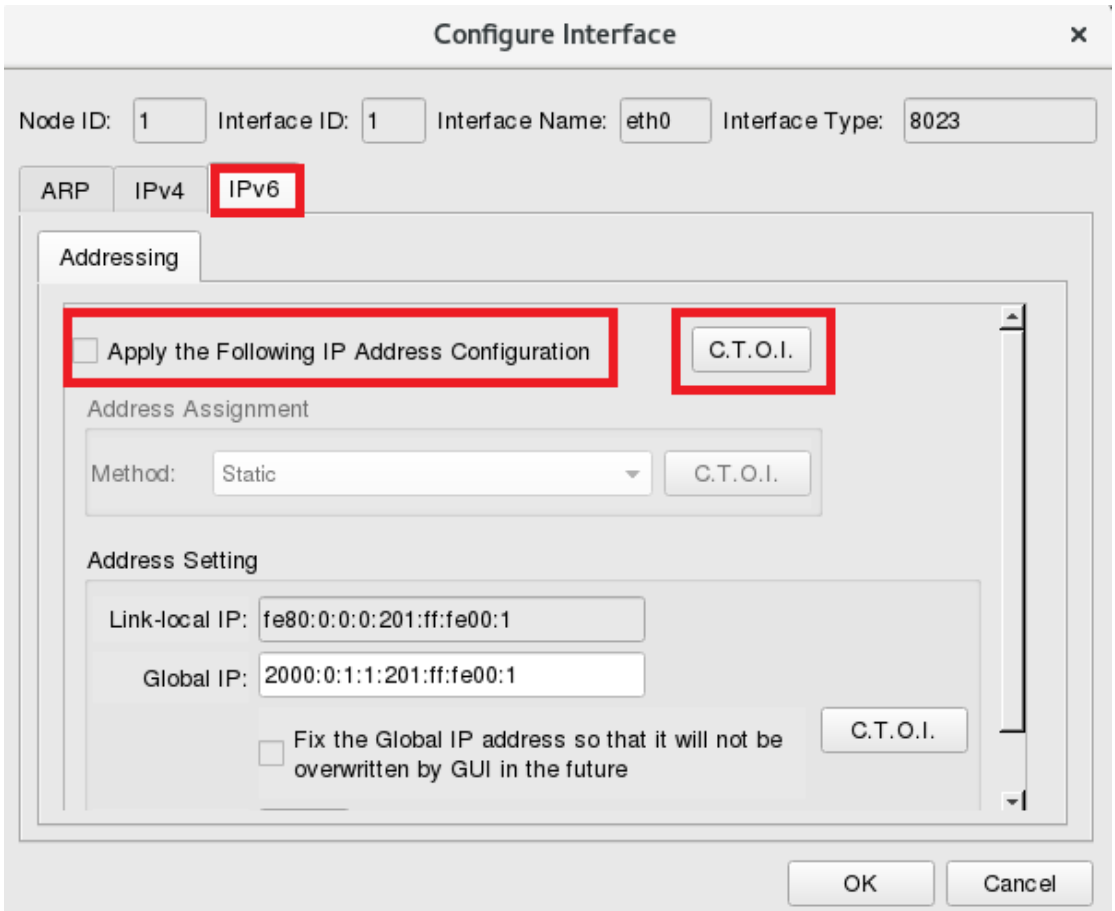
Chapter9.tar.bz2

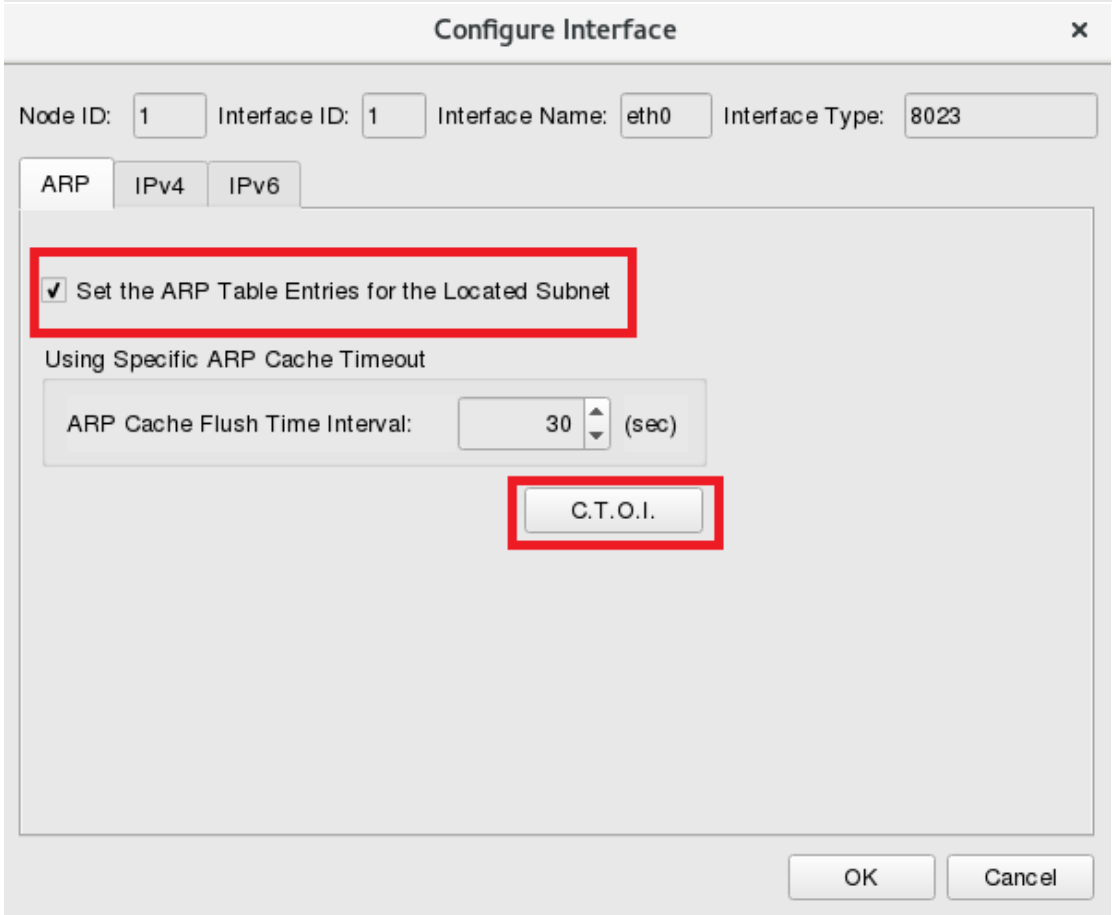
In this chapter, we introduce some common APIs.

■ Exercise 9-1

We use the demo topology (user_module01.xtpl) and set traffic application. Then add “ping 1.0.1.2” in Host 1. And close ARP and IPv6 interface in Host1 and Host2.




Configure Interface
Node ID: 1
Interface ID: 1
Interface Name: eth0
Interface Type: 8023
ARP
IPv4
IPv6
Addressing
Apply the Following IP Address Configuration
C.T.O.I.
Address Assignment
Method:
Static
C.T.O.I.
Address Setting
Link-local IP:
fe80:0:0:0:201:ff:fe00:1
Global IP:
2000:0:1:1:201:ff:fe00:1
Fix the Global IP address so that it will not be overwritten by GUI in the future
C.T.O.I.
OK
Cancel


Configure Interface
Node ID: 1
Interface ID: 1
Interface Name: eth0
Interface Type: 8023
ARP
IPv4
IPv6
Set the ARP Table Entries for the Located Subnet
Using Specific ARP Cache Timeout
ARP Cache Flush Time Interval:
30
(sec)
C.T.O.I.
OK
Cancel

The modified part of "user_module01.h" is shown as following red words.

```
#ifndef __user_module_01_h__
#define __user_module_01_h__

#include <event.h>
#include <object.h>

class UserModule01 : public NslObject {

  private:
        int             Number;
        char            *String;

  public:

        UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char *name);
        ~UserModule01();

        int             init();
        int             command(int argc, const char *argv[]);
        int             recv(ePacket_ *pkt);
        int             send(ePacket_ *pkt);
        void            pkt_delay(ePacket_ *pkt);
};

#endif    /* __user_module_01_h__ */
```

The following red words are same as the 8-1 case in chapter 8, with blue words about this chapter.

user_module01.cc

```
#include <stdlib.h>
#include <estinet_api.h>
#include <module/user-defined/user_module_01.h>
#include <packet.h>
#include <ethernet.h>
#include <ip.h>
```

```
MODULE_GENERATOR(UserModule01);

UserModule01::UserModule01(u_int32_t type, u_int32_t id, struct plist* pl, const char *name)
	: NslObject(type, id, pl, name) {
	vBind_int("myNumber", &Number);
	vBind_char_str("myString", &String);
	REG_VAR("shared-number", &Number);
}

UserModule01::~UserModule01(){}

int UserModule01::init() {
	return(NslObject::init());
}

int UserModule01::command(int argc, const char *argv[]) {
	return(NslObject::command(argc, argv));
}

int UserModule01::recv(ePacket_ *pkt) {
	return(NslObject::recv(pkt));
}

int UserModule01::send(ePacket_ *pkt) {
	u_int64_t	current_time_in_tick;
	u_int64_t	delay_time_in_tick;
	BASE_OBJTYPE(mem_func);

	current_time_in_tick = GetCurrentTime();
	SEC_TO_TICK(delay_time_in_tick, 1);
	mem_func = POINTER_TO_MEMBER(UserModule01, pkt_delay);
	setObjEvent(pkt, current_time_in_tick + delay_time_in_tick,
		0, this, mem_func, (void *)pkt->DataInfo_);
	return(1);
}

void UserModule01::pkt_delay(ePacket_ *pkt) {
```

```
	Packet		*packet;
	struct ether_header	*eh;
	char		src_mac_str[18];
	char		dst_mac_str[18];

	struct ip	*iph;
	char		src_ip_str[16];
	char		dst_ip_str[16];

	if(pkt != NULL && pkt->DataInfo_ != NULL) {
		packet = (Packet *)pkt->DataInfo_;
		eh = (struct ether_header *)packet->pkt_get();

		macaddr_to_str(eh->ether_shost, src_mac_str);
		macaddr_to_str(eh->ether_dhost, dst_mac_str);

		printf("\e[1;36;40mExercise 9-1: Src Mac: %s, Dst Mac: %s\e[m\n",
			src_mac_str, dst_mac_str);

		iph = (struct ip *)packet->pkt_sget();
		if(iph != NULL) {
			ipv4addr_to_str(iph->ip_src, src_ip_str);
			ipv4addr_to_str(iph->ip_dst, dst_ip_str);
			printf("\e[1;36;40mExercise 9-1: Src IP: %s, Dst IP: %s\e[m\n",
			src_ip_str, dst_ip_str);

		}
	}

	double x, y, z;
	GetNodeLoc(get_nid(), x, y, z);
	printf("\e[1;32;40mExercise 9-1: GetTotalNumOfNodes()=%d\e[m\n",
GetTotalNumOfNodes());
	printf("\e[1;32;40mExercise 9-1: GetConfigFilePathAndName()=%s\e[m\n",
GetConfigFilePathAndName());
	printf("\e[1;32;40mExercise 9-1: GetNodeLoc()=%f, %f, %f\e[m\n", x, y, z);
	printf("\e[1;32;40mExercise 9-1: getConnectNode()=%d\e[m\n", getConnectNode(get_nid(),
get_ifid()));
```

```
        printf("\e[1;32;40mExercise 9-1: GetPacketLength=%d\e[m\n", packet->pkt_getlen());
        NslObject::send(pkt);
}
```

The red words statement is explained by chapter 8.

And the blue words statements introduce serveral APIs, described as follows:

The **GetNodeLoc(node id, x, y, z)** function gets current position of the node. The first parameter bring it's own node id. Returned information of node position will be stored in parameters ‘x’, ‘y’ and ‘z’.

The **GetTotalNumOfNodes**() API returns the total number of nodes on a simulated network environment.

The **GetConfigFilePathAndName**() API returns the config file path and the topology file name.

The **getConnectNode()** API gets the ID of a node’s neighboring node. The first parameter is ‘***node id***’ and the second parameter is ‘***interface id***’. Interface id can use the get_ifid() API to know.

Execution result is shown as the following figure:

```
PING 1.0.1.2 (1.0.1.2) 56(84) bytes of data.
Current Time:    2.00 sec   Event#: <Insert:1045, Dequeue:1043, Rest:21>
Current Time:    3.00 sec   Event#: <Insert:1041, Dequeue:1041, Rest:21>
Exercise 9-1: Src Mac: 0:1:0:0:0:1, Dst Mac: 0:1:0:0:0:2
Exercise 9-1: Src IP: 1.0.1.1, Dst IP: 1.0.1.2
Exercise 9-1: GetTotalNumOfNodes()=2
Exercise 9-1: GetConfigFilePathAndName()=/root/.estinet/estinetss/workdir/1525235278-job/user_module01
Exercise 9-1: GetNodeLoc()=25.087500, 16.706250, 0.000000
Exercise 9-1: getConnectNode()=2
Exercise 9-1: GetPacketLength=98
Exercise 9-1: Src Mac: 0:1:0:0:0:1, Dst Mac: 0:1:0:0:0:2
Exercise 9-1: Src IP: 1.0.1.1, Dst IP: 1.0.1.2
Exercise 9-1: GetTotalNumOfNodes()=2
Exercise 9-1: GetConfigFilePathAndName()=/root/.estinet/estinetss/workdir/1525235278-job/user_module01
Exercise 9-1: GetNodeLoc()=25.087500, 16.706250, 0.000000
Exercise 9-1: getConnectNode()=2
Exercise 9-1: GetPacketLength=98
Current Time:    4.00 sec   Event#: <Insert:1047, Dequeue:1046, Rest:22>
Exercise 9-1: Src Mac: 0:1:0:0:0:2, Dst Mac: 0:1:0:0:0:1
Exercise 9-1: Src IP: 1.0.1.2, Dst IP: 1.0.1.1
Exercise 9-1: GetTotalNumOfNodes()=2
Exercise 9-1: GetConfigFilePathAndName()=/root/.estinet/estinetss/workdir/1525235278-job/user_module01
Exercise 9-1: GetNodeLoc()=37.406250, 16.706250, 0.000000
Exercise 9-1: getConnectNode()=1
Exercise 9-1: GetPacketLength=98
64 bytes from 1.0.1.2: icmp_seq=1 ttl=64 time=2000 ms
```

Appendix

Appendix A. About detail of HeaderSection in MDF

The first table collects the relevant variables and their meanings. The second table lists the set of possible values for each variable.

Field Name	Meaning
ModuleName	The name of this module
GroupName	The name of the group this module belongs to. And GUI will list GroupName in Module Editor to classify mdf file by GroupName.
Introduction	A short description or comment about this module
Parameter	A start-time parameter variable. The GUI program reads this part to know what parameters will be used at start-time. With this information, it will export these start-time parameters in the generated .if_and_medium_conf file.

TABLE THE MEANINGS OF THE VARIABLES USED IN THE HEADERSECTION

Field Name	Possible Values
ModuleName	Any user-specified string
GroupName	80211p, classification, interface, mac8023, mnode, phy, sdn_wifi_infra, traffic_control, vehicular_network, ap, hub, mac80211, mifx, openflow, pktgen, teleportal, user_defined, wphy (A user can create a new module group)
Introduction	Any user specified comment description string
Parameter	The format of a parameter statement is explained as follows: **Parameter Name Value Attribute** The possible attributes are listed below: “**local,**” “**gui_autogen,**” “**gui_autoassign,**” and “**local_only**”. “**local**” means that this parameter is used only in this module and if its value is updated, it will not be copied to other modules. Unless press "C.T.O.N." button, it can be copied to all modules on all nodes with the same node type. ”**gui_autogen**” means that the value of this parameter will be

	automatically generated by the GUI program. However, a user can **not** replace/change the auto-generated value with his (her) value. If a user press "C.T.O.N." button, the auto-generated value will be **not** copied to any module. Normally, a possible value of an **gui_autogen** parameter is a formula consisting of the three predefined variables: **$CASE$, NID, and PID.** **$CASE$** represents the main file name of a simulation case's topology file. It will be replaced by the main file name when this variable is accessed. For example, if a simulation case's topology file is saved with the filename "test.xtpl", **$CASE$** will be replaced by "test." **NID** represents the ID of the node to which this module is attached. Analogously, **PID** represents the ID of the interface to which this module is attached. "**gui_autoassign**" is similar to "**gui_autogen**" However, a user can **not** replace/change its value. No matter how a user replaces/changes the auto-generated value with his (her) desired one, the final value is still determined by a pre-defined formula. ex. ip address, mac address, interface id...etc.. "**local_only**" means that the value of this parameter can be replace/change the value with his (her) value. If a user press "C.T.O.N." button, the value will be **not** copied to any module. Because the parameter must be set respectively.

TABLE THE POSSIBLE VALUES FOR THE VARIABLES USED IN THE HEADERSECTION

Appendix B. About detail of InitVariable in MDF

Normally, a user should specify the caption and the size of the diabox. The key word "**Caption**" indicates the caption of the dialog box, and "**FrameSize width height**" indicates the size of the dialog box. For example,

```
Caption        "Parameters Setting"
FrameSize      340 80
```

These statements will generate a dialog box of 340x80 pixels with a caption of "Parameters Setting." After specifying the caption and the size of the dialog box, a user can arrange the layout inside the dialog box. A dialog box would contain a number of

GUI objects, such as an OK button, a Cancel button, a textline, etc. Each GUI object corresponds to a description block in “InitVariableSection” and always starts with “Begin” and ends with “End.” The following shows an example:

```
Begin BUTTON        b_ok
    Caption         "OK"
    Scale           270 12 60 30
    ActiveOn        MODE_EDIT
    Enabled         TRUE
    Action          ok
    Comment         "OK Button"
End
```

The description blocks for different objects share several common and basic attributes. For example, the caption and scale commands are used commonly. A “BUTTON”-like object is an example of an object consisting of only basic attributes. Let’s take the simple “BUTTON” object as an example. More specific attributes will be discussed later.

For a “BUTTON” object, the keyword “BUTTON” follows the keyword “Begin” and it is followed by the object name “b_ok”. The following table lists its attributes:

Attribute name	Possible values	Comment
Caption	User-specified	The caption of this object
Scale	User-specified	The four numbers represent (x, y, width, height).
ActiveOn	MODE_EDIT, MODE_SIMULATION, ALL_MODE	An option to specify in which mode this object should is active. The “MODE_EDIT” stand for the object is enabled at Edit Mode. The “MODE_SIMULATION” stand for the object is enabled at GUI G Mode. ALL_MODE indicates that the object will be activated whatever the Mode is.
Enabled	TRUE, FALSE	If an object is not enabled, it will be dimly displayed. That is, a user cannot operate this object.
Action	ok , cancel	An attribute used by button-like objects, such as the OK button and cancel

		buttons to indicate which action it should perform when a user presses it.
Comment	User-specified	Comment for this object

TABLE THE BASIC ATTRIBUTES USED TO DESCRIBE AN OBJECT

a. LABEL

"LABEL" is used to display some comment in a dialog box. The attributes of a LABEL object are the same as those of a "BUTTON" object. An example is following below:

```
Begin LABEL        l_ums
    Caption        "(ms)"
    Scale          220 24 35 35
    ActiveOn       MODE_EDIT
    Enabled        FALSE
End
```

b. GROUP

GROUP is used to organize related objects together. It can contain a number of objects that are related to an area. Like other objects, it has four basic attributes "**Caption**," "**Scale**," "**ActiveOn**," and "**Enabled**" to define the caption, the size of its area, the active mode, and the enabled/disabled conditions. An example is following below. The group has four objects include a Radiobox, two textline, a lable.

```
Begin Group        g_radio
    Caption        "Mode"
    Scale          10 15 260 135
    ActiveOn       MODE_EDIT
    Enabled        TRUE

    Begin RADIOBOX     myString
        Option         "op1"
        Enable         myNumber
        Enable         lable1
        OptValue       "string1"
        VSpace         5
        EndOption

        Option         "op2"
```

```
                Disable         myNumber
                Disable         lable1
                OptValue        "string2"
                VSpace          40
                EndOption

                Type            STRING
                Comment         "radiobox test"
            End

            Begin TEXTLINE      myNumber
                Caption         "input Number"
                Scale           35 35 180 35
                ActiveOn        MODE_EDIT
                Enabled         FALSE
                Type            INT
                Comment         "for test"
            End

            Begin LABEL         lable1
                Caption         "(INT)"
                Scale           220 35 35 35
                ActiveOn        MODE_EDIT
                Enabled         FALSE
            End
        End
```

c. RADIOBOX/CHECKBOX

In RADIOBOX/CHECKBOX, there are some new attributes. (Note: Outside of a **radiobox** must be a group object) Let's take the following example to explain:

```
        Begin Group         g_radio
            Caption         "Mode"
            Scale           10 15 260 135
            ActiveOn        MODE_EDIT
            Enabled         TRUE

            Begin RADIOBOX      myString
```

```
            Option          "op1"
            Enable          myNumber
            Enable          lable1
            OptValue        "string1"
            VSpace          5
            EndOption

            Option          "op2"
            Disable         myNumber
            Disable         lable1
            OptValue        "string2"
            VSpace          40
            EndOption

            Type            STRING
            Comment         "radiobox test"
        End

        Begin TEXTLINE      myNumber
            Caption         "input Number"
            Scale           35 35 180 35
            ActiveOn        MODE_EDIT
            Enabled         FALSE
            Type            INT
            Comment         "for test"
        End

        Begin LABEL         lable1
            Caption         "(INT)"
            Scale           220 35 35 35
            ActiveOn        MODE_EDIT
            Enabled         FALSE
        End
    End
```

It is a RADIOBOX block whose name is "***myString***." The two option blocks follow, each of which starts with the "**Option**" keyword and ends with the "**EndOption**" keyword. The string following the "Option" keyword specifies the string that should be shown in

the dialog box for this option. The "**OptValue**" specifies the value that will be assigned to the radiobox option variable "arpMode" if this option is selected. The "Enable" and "Disable" statements inside an "Option" block specify that, when a user selects this option, the variable objects following these statements should be enabled or disabled (When an object is enabled, its input field is enabled in the parameter dialog box, otherwise, its input field is disabled). The term "**VSpace**" is used to specify the vertical height of the area used for outside group's y location(only using for Radiobox). The term "**Comment**" is used to specify comment for this object.

```
Begin CHECKBOX      check1
    Caption         "Set My Number"
    Scale           10 50 180 20
    ActiveOn        MODE_EDIT
    Enabled         TRUE

    Option          "TRUE"
    OptValue        "on"
    Enable          myNumber
    EndOption

    Option          "FALSE"
    OptValue        "off"
    Disable         myNumber
    EndOption
    Comment         ""
End
```

The following is a checkbox block whose name is "*check1*." Like other objects, it has four basic attributes "**Caption**," "**Scale**," "**ActiveOn**," and "**Enabled**" to define the caption, the size of its area, the active mode, and the enabled/disabled conditions. And then, the two option blocks follow, each of which starts with the "**Option**" keyword and ends with the "**EndOption**" keyword. The string following the "Option" keyword specifies the string that should be shown in the dialog box for this option. The "**OptValue**" specifies the value that will be assigned to the checkbox option variable "*check1*" if this option is selected. The "Enable" and "Disable" statements inside an "Option" block specify that, when a user selects this option, the variable objects following these statements should be enabled or disabled (When an object is enabled, its input field is enabled in the parameter dialog box, otherwise, its input field is

disabled). The term "**Comment**" is used to specify comment for this object.

d. TEXTLINE

TEXTLINE provides a text field for inputting or outputting data. Like other objects, it has four basic attributes "**Caption**," "**Scale**," "**ActiveOn**," and "**Enabled**" to define the caption, the size of its area, the active mode, and the enabled/disabled conditions. A module developer can indicate the type of the data to be read from a textline. The data will be interpreted as a value of the type indicated by the "TYPE" key word. But now we only support "**STRING**" for "TYPE", other data type not yet. The term "**Comment**" is used to specify comment for this object. An example is following below.

```
Begin TEXTLINE      myNumber
    Caption         "My Number "
    Scale           10 70 220 30
    ActiveOn        MODE_EDIT
    Enabled         FALSE
    Type            INT
    Comment         "An Integer"
End
```

Appendix C. About detail of Export Section in MDF

"ExportSection" provides an area in a dialog box in which a user can get/set the current value of a variable at run-time. "**Caption**", "**FrameSize**" are the two basic attributes for this section. If a module doesn't have any variable that can be accessed during simulation, "Caption" should be set to "", a null string, and "FrameSize" should be set to 0 0. Or the ExportSection does not be added.

```
ExportSection
    Caption         ""
    FrameSize       0 0
EndExportSection
```

In addition to the objects discussed above, there are two useful objects that are new in this section. They are the "**INTERACTIONVIEW**" and "**ACCESSBUTTON.**" The formats of these two objects are shown in the following examples:

```
Begin ACCESSBUTTON  ab_get_mystr
        Caption     "Get"
        Scale       215 50 70 25
        ActiveOn    MODE_SIMULATION
        Enabled     TRUE
        Action      GET
        ActionObj   "export-my-string"
        Reference   text_query_mystr
        Comment     "get"
End

Begin ACCESSBUTTON  ab_set_mynum
        Caption     "Set"
        Scale       290 15 70 25
        ActiveOn    MODE_SIMULATION
        Enabled     TRUE
        Action       SET
        ActionObj   "export-my-number"
        Reference   text_query_mynum
        Comment     "set"
End
```

For an "**ACCESSBUTTON**" object, it is used to get or set the value of a single-value run-time variable. There are three new attributes for "**ACCESSBUTTON**." They are "**Action,**" "**ActionObj,**" and "**Reference,**" respectively. The value of "Action" can be "**GET**" or "**SET**" to indicate when a user presses this button which operation should be performed. "**ActionObj**" indicates the name of the object that the GET/SET operation should operate on in the simulation engine. Finally, "**Reference**" points to the name of the GUI object (e.g., a TEXTLINE object) in which the retrieved value should be displayed. For example, the max queue length of a FIFO module may be gotten and displayed at a TEXTLINE GUI object named "t_mq."

```
Begin INTERACTIONVIEW      iv_get_all
    Caption                "Get All Var"
    Scale                  10 100 200 30
    ActiveOn               MODE_SIMULATION
    Enabled                TRUE
    Action                 GET
    ActionObj              "export-all-data"
    Fields                 "My String" "My Number"
    Comment                "All Data"
End
```

For an "**INTERACTIONVIEW**" object, it is used to display the content of a multi-column table at run-time. Normally, it is used to get a switch table, an ARP table, or an AP's association table. Besides "**Action**" and "**ActionObj**," there is a new attribute called "**Fields**" to specify the names of the fields (columns) of the table. Several quoted strings, each of which represents the name of a field, follow the "**Fields**" attribute.

Appendix D. Distributed architecture of EstiNet

EstiNet uses a distributed architecture to support remote simulations and concurrent simulations. The estinetjd is used to do this task. It should be executed and remain alive all the time to manage multiple simulation machines. On every simulation machine, the estinetss needs to be executed and remain alive to let the estinetjd know whether currently this machine is busy running a simulation case or not. The following figure depicts the distributed architecture of EstiNet.

For example, the estinetjd in the simulation service center can accept simulation jobs from the whole world. When a user submits a simulation job to the estinetjd, the estinetjd selects an available simulation machine to service the job. If there is no available simulation machine, the job will be put into the job queue of the estinetjd. Every simulation machine always has a running estinetss to communicate with the GUI program and the estinetjd. The estinetss will notify the estinetjd whether the simulation machine managed by itself is available or not. When the estinetss receives a simulation job from the estinetjd, it forks (executes) a simulation engine process to simulate the specified network and protocols. When the simulation engine process is running, the estinetss will communicate with the estinetjd and the GUI program. For example, periodically the simulation engine process will send the current virtual time

of the simulation network to the estinetss. Then the estinetss will relay the information to the GUI program. This enables the GUI user to know the progress of the simulation. During a simulation, the user can also on-line set or get a protocol module's value (e.g. to query a switch's switch table). Message exchanges happening between the simulation engine process and the GUI program are all done via the estinetss.