PCM2.2. SDN programming and simulation of SDN composing, configuring and scaling

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Laboratory work 1

WORKING IN MINIEDIT GRAPHICAL ENVIRONMENT

Goal: obtain the skills of MiniEdit graphical environment of Mininet emulator usage. Get familiar with Software defined network topology graphical constructor, network hosts configuring, network topology testing.

Training participants: lecturers, scientists, technical staff, students and post-graduate students of the department (faculty, institute) of the university; developers, engineers, trainees.

1.1. Theoretical information

To foster the convenience of Mininet environment usage, the MiniEdit graphical interface is taking place.

To get started with it, the following toolset is required:

– *VirtualBox software* – the 4.3.10-93012-Win.exe built;

– the deployed *Mininet* virtual machine – the content of 2.2.1-150420-ubuntu-14.04-server-i386.zip archive should be used as a hard drive of virtual machine;

– *PuTTY utility* – the putty.exe executable – openly accessible client software with different protocols support, Telnet and SSH (Secure Shell) in particular. SSH – application layer network protocol that allows to perform remote control of operating system. In contrast with Telnet, all the transmitted data is encrypted;

– *Xming Server* – the xming-x-server-6.9.0.38.exe built – the implementation of X Window System to provide standard instruments and protocols to build graphical interface for user. This server will be used in our work in order to compensate the absence of graphical interface in virtual machine the Mininet environment is installed in. It will provide the opportunity to visualize MiniEdit interface of Mininet that is implemented in Linux-environment of virtual machine within

Windows-environment [1].

First and second tools mentioned have already been covered in previous work.

Current work is all about the following steps:

– Xming Server installation – to work with MiniEdit graphical interface of Mininet in Windows-environment;

– Mininet environment launching and configuration;

– PuTTY SSH-client set-up – to connect to virtual machine's Mininet Linux-environment in encrypted manner;

– connect to virtual machine's Mininet Linux-environment via PuTTY interface.

1.2. Example of work execution

Step 1. Install Xming Server.

Perform the installation of Xming Server on E logical drive.

During this, the "*Full installation*" option should be chosen, the checkbox in front of "*Normal PuTTY Link SSH client*" position should also be set up.

As a result of successful installation, Xming Server will be launched automatically (Fig. 1).

Fig. 1 – An icon indicating that Xming Server has been launched

To launch Xming Server manually, the *XLaunch.exe* utility has to be used. The utility is located in Xming installation directory.

Step 2. Configure Mininet virtual environment.

Launch Mininet emulator via VirtualBox. Enter login and password (mininet, mininet) – as it was for previous work.

Then the following substeps should be performed:

– (1-st substep) – try to launch MiniEdit interface directly in Mininet virtual environment by executing the following console command:

```
> sudo python ./mininet/examples/miniedit.py
```

As a result, the error message will appear: “no display name and no $DISPLAY environment variable”. To get rid of it, the succeeding steps should be done;

– (2-nd substep) – check the configuration of network interfaces:

```
> ifconfig -a
```

As a result of command execution, the IP-address of eth1 interface should be remembered – it should be like *192.168.56.101*. This address will be used further to externally connect to Mininet virtual Linux-environment from Windows-enfvironment by way of PuTTY client usage.

– (3-rd step) – manually configure eth1 network interface as DHCP-client:

```
> sudo dhclient eth1
```

Step 3. Configure PuTTY SSH-client.

To make it possible for PuTTY SSH-client to get access to Xming Server launched, the following steps should be accomplished:

– mark with a checkbox the “*Enable X11 forwarding*” option in “*Connection -> SSH -> X11*” category of PuTTY settings (Fig. 2);

– connect to Mininet virtual Linux-environment in “*Session*” category, entering previously remembered *192.168.56.101* IP-address. Then press “*Open*” to open the session.

Notice: connection port number should be left by default (22). As a connection type, the “*SSH*” option should be marked.

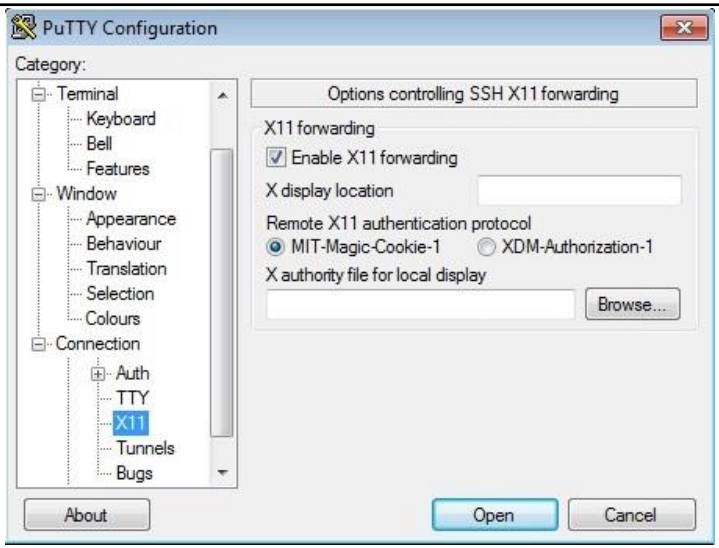

Fig. 2 – SSH-client configuration

Step 4. Connect to Mininet-console via PuTTY-client.

The following steps should be done:

– in opened PuTTY-console the login and password for Mininet (mininet, mininet) need to be entered;

– set up SSH-connection by assigning eth1 interface IP-address:

```
> ssh -Y mininet@192.168.56.101
```

– enter the password upon request – mininet;

– perform 1-st substep of step 2 again by entering the appropriate command via PuTTY-console.

As a result of rightly accomplished steps, the graphical MiniEdit environment should appear in a separate window (Fig. 3). It's possible due to Xming Server functioning.

The main advantage from Xming Server usage is that there is no need to utilize the additional libraries, comparing to Cygwin server [2], when working in Windows-environment.

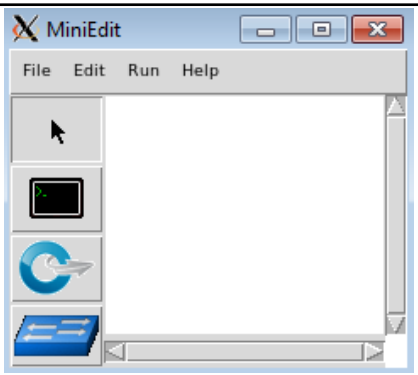

Fig. 3 – MiniEdit workspace

Step 5. Create SDN-network with minimal topology in MiniEdit graphical environment.

The network to be created is depicted in Fig. 4.

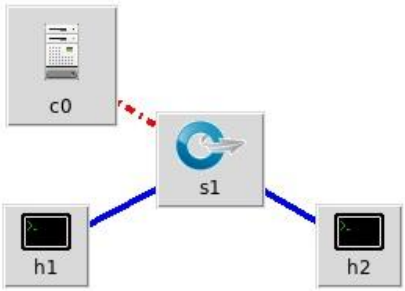

Fig. 4 – Network representation in MiniEdit workspace

Each of the nodes can be configured appropriately (by changing the name, setting IP-address, etc.) by pressing with right mouse button on Properties option. For instance, in case of *c0* node, the properties set will be as given in Fig. 5.

In Fig. 21.5, port 6633 is set by default.

In case of many controllers, their port numbers should be different. For instance, if we have a pair of controllers, port numbers can be set as 6633 and 6634.

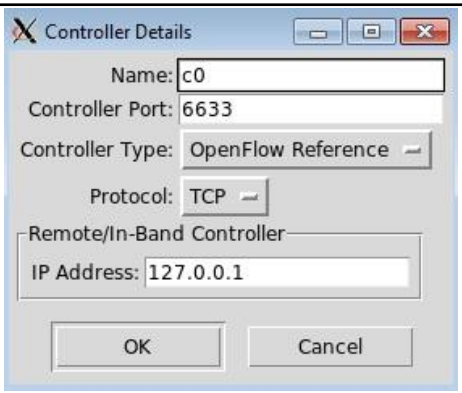

Fig. 5 – Controller configuration

To check and set up network preferences in MiniEdit environment, the option "*Edit -> Preferences*" can be used (Fig. 6) [3].

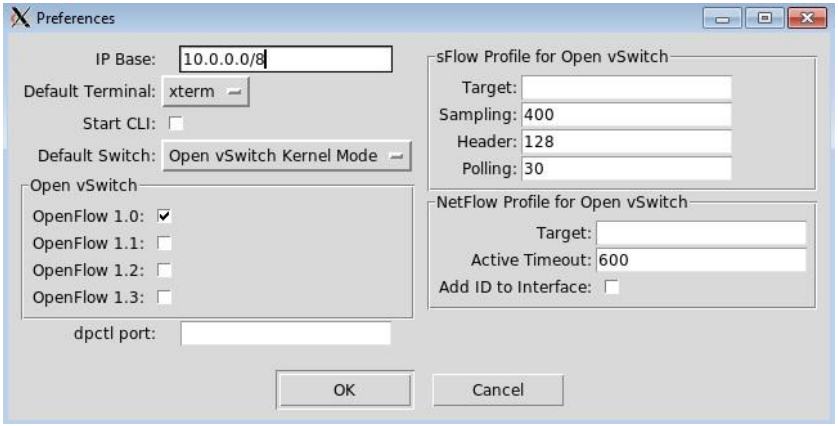

Fig. 6 – Network preferences

In Fig. 6, it can be seen that 1.0 version of OpenFlow protocol is being used by default. It's a typical picture for current level of SDN networks implementation. These preferences are legit only for created topology (Fig. 4).

Step 6. Save created topology in *topo1.mn* file by the default

address /home/mininet (the topology file should necessarily have the *.mn extension). Then created topology can be loaded again in MiniEdit environment.

To save the topology, press "*File -> Save*", to load – "*File -> Open*".

Step 7. Checking the created topology.

1. Choose "*Edit -> Preferences*" on the panel of instruments. Set the flag in front of "Start CLI". This will allow work with command line during topology checking by way of simulation.

2. Assign IP-addresses to network nodes.

The default subnetwork mask (in "*Edit -> Preferences*" section) is *10.0.0.0/8*.

3. Check the connection between hosts by launching the simulation process: "*Run -> Run*". By opening the terminal of *h1* host (press the right mouse button -> "*Terminal*"), execute the *ping* command, assigning the IP-address of node:

```
> ping 10.0.0.4
```

Notice: before closing the terminal, enter the *exit* command.

4) Acknowledge that simulation is running: "*Run -> Show OVS Summary*".

Step 8. Experiment with created network.

1. While the simulation is running, open the terminal of *h1* host and execute the following command:

```
> wireshark &
```

This will launch the *wireshark* utility (traffic analyzer) on the specified host.

2. In the main window – in *Capture* field (in the bottom left) – mark out the *h1-eth0* interface and press the *Start* control element. This will allow to associate the monitoring software with *eth0* interface of *h1* host.

3. In the terminal of *h1* host once again execute the *ping* command:

```
> ping 10.0.0.4
```

As a result of command execution, in the work area of wireshark software, the information about the packages transmitted through the *h1-eth0* interface will be shown.

1.3. Tasks for individual execution

1. Create SDN-network with tree-like topology. Choose configuration data with respect to the variant.

Notice:

– variant should be chosen with respect to the list number of the student. The odd numbers are associated with the first variant, the even ones – with the second variant.

Variant 1. The network must encompass 2 controllers, 7 switches and 8 hosts. The network should be configured with respect to the recommendations given below.

Variant 2. The network must encompass 3 controllers, 8 switches and 10 hosts. The network should be configured with respect to the recommendations given below.

Recommendations to network configuration:

– assign the unique port numbers to the controllers;

– in "*Edit -> Preferences*" section of instruments panel, set the "*Start CLI*" flag. This will allow use the command line;

– save the created network in "**.mn*" file: "*File -> Save*";

– save corresponding *Python*-script in "**.py*" file: "*File -> Export Level 2 Script*".

Notice:

– before stopping the simulation process, the *exit* command should be entered first. After that, the "*Stop*" control element on the control panel should be pressed.

2. Execute steps 7 and 8 with respect to the network created within the previous task.

1.4. Report content

The report should contain:

– title page with the name of the laboratory work;

– aim of the work; problem statement according to the task;

– work progress and the results of tasks execution;

– analysis of the results and conclusions;

– brief answers to the control questions.

1.5. Control questions:

1. Sequence of steps to get to work in graphical MiniEdit environment on Windows platform.

2. The use of PuTTY utility.

3. The use of Xming Server.

4. The advantages of Xming Server usage.

5. Describe advantages and disadvantages of command line and/or graphical MiniEdit environment usage for the purpose of SDN-network with specified topology creation.

6. Describe the use of *wireshark* utility.

7. Describe the facilities for network testing in graphical *MiniEdit* environment.

8. The use of *Show OVS Summary* command.

9. With respect to tree-like topology of SDN-network, describe the dependencies between the numbers of controllers, switches and hosts.

10. Describe the effect of subnetwork mask format on the potential number of hosts.

1.6. Recommended literature:

1. Xming X Server for Windows [Online]. Available: https://sourceforge.net/projects/xming/. [Accessed: 8 Jun. 2019].

2. Cygwin [Online]. Available: http://cygwin.com. [Accessed: 8 Jun. 2019].

3. How to use MiniEdit, Mininet's graphical user interface [Online]. Available: http://www.brianlinkletter.com/how-to-use-miniedit-mininets-graphical-user-interface/. [Accessed: 8 Jun. 2019].