OpenFlow start up

Let's take a look! SDN

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1-1 OpenSource SDN Projects

Name	Language	Platform(s)	License	Original Author	Notes
OpenFlow Reference	C	Linux	OpenFlow License	Stanford/Nicira	not designed for extensibility
NOX	Python, C++	Linux	GPL	Nicira	actively developed
POX	Python	Any			
Beacon	Java	Win, Mac, Linux, Android	GPL (core), FOSS Licenses for your code	David Erickson (Stanford)	web UI framework, regression test framework
Floodlight	Java	Any	Apache	BigSwitch, based on Beacon	
RouteFlow	C++, Python	Linux	Apache	CPqD (Brazil)	virtual IP routing as a service
Maestro	Java	Win, Mac, Linux	LGPL	Zheng Cai (Rice)	
FlowVisor				On.lab	
Trema	Ruby, C	Linux	GPL	NEC	regression test Framework

1-2 OpenSource SDN Controllers

- The first SDN controller
- Linux
- C++ and Python
- OpenFlow Interface
- Event-based programming model
- Packet construction/dissection libraries
- Applications:
- Forwarding (reactive), topology discovery, host tracking,…
- Download from http://www.noxrepo.org

- Python only
- Build a new platform in pure Python
- Target Linux, Mac OS, and Windows
- Good for research & education
- Download from http://www.noxrepo.org

Nox classic	"New" nox
✓ C++ and Python	✓ Remove Python from nox
✓ branch	✓ C++ Only
– Destiny (active) 0.9.1	✓ branch
– Zaku (release) 0.9.0	– 0..9.2

- A Java-based OpenFlow Controller(forked from Beacon)
- Apache Licensed
- REST API
- Pure java(no OSGI know how required)
- Dead simple to build and run
- Tested and hardened in real environmets
- Physical OpenFlow switches and real networks
- Code included in commercial product from Big Switch Networks
- Download from http://floodlight.openflowhub.org

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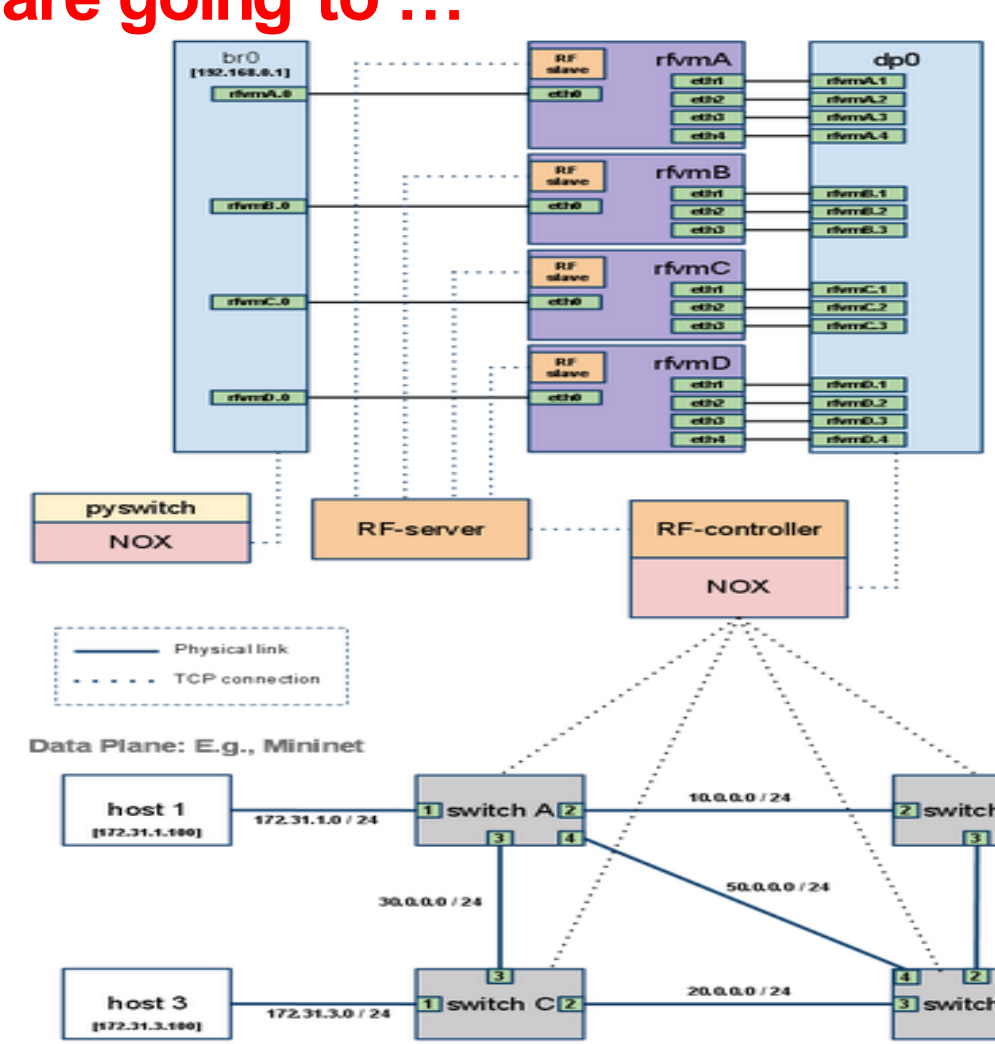
2-1 We are going to …



rfvmA:
eth0 - 192.169.1.101/24
eth1 - 172.31.1.1/24
eth2 - 10.0.0.1/24
eth3 - 30.0.0.1/24
eth4 - 50.0.0.1/24

rfvmB:
eth0 - 192.169.1.102/24
eth1 - 172.31.2.1/24
eth2 - 10.0.0.2/24
eth3 - 40.0.0.2/24

rfvmC:
eth0 - 192.169.1.103/24
eth1 - 172.31.3.1/24
eth2 - 20.0.0.3/24
eth3 - 30.0.0.3/24

rfvmD:
eth0 - 192.169.1.104/24
eth1 - 172.31.4.1/24
eth2 - 40.0.0.4/24
eth3 - 20.0.0.4/24
eth4 - 50.0.0.4/24

host1:
eth0 - 172.31.1.100/24
gw - 172.31.1.1

host2:
eth0 - 172.31.2.100/24
gw - 172.31.2.1

host3:
eth0 - 172.31.3.100/24
gw - 172.31.3.1

host4:
eth0 - 172.31.4.100/24
gw - 172.31.4.1

환경구성 | Openflow tutorial | Emulate Network (MININET) | Controller (NOX) | routeflow

2-2 Let's start SDN (step 1)

1. **Download & Install Virtual Box**
   VirtualBox 4.2.6 for Windows hosts
   https://www/virtualbox.org/wiki/Downloads

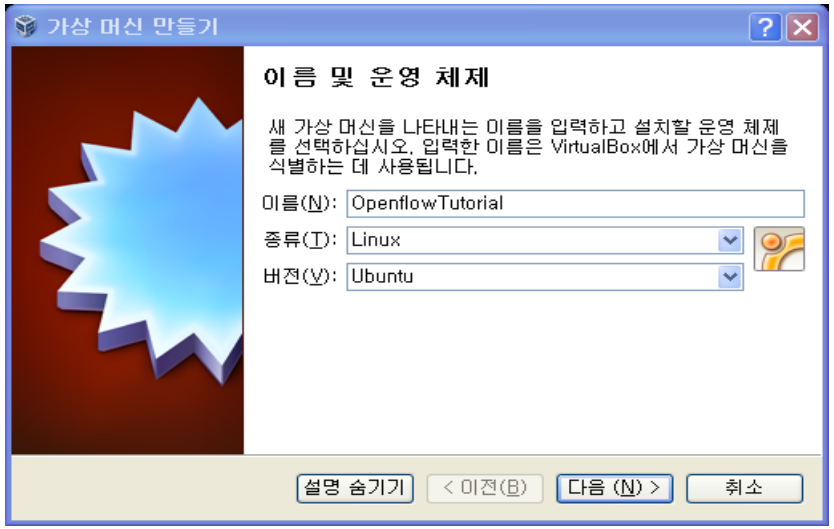
2. **Donwload a compressed VM image**
   : OpenFlowTutorial-101311.zip
   http://www.openflow.org/wk/index.php/OpenFlow_Tutorial#Start_Network

Windows Users

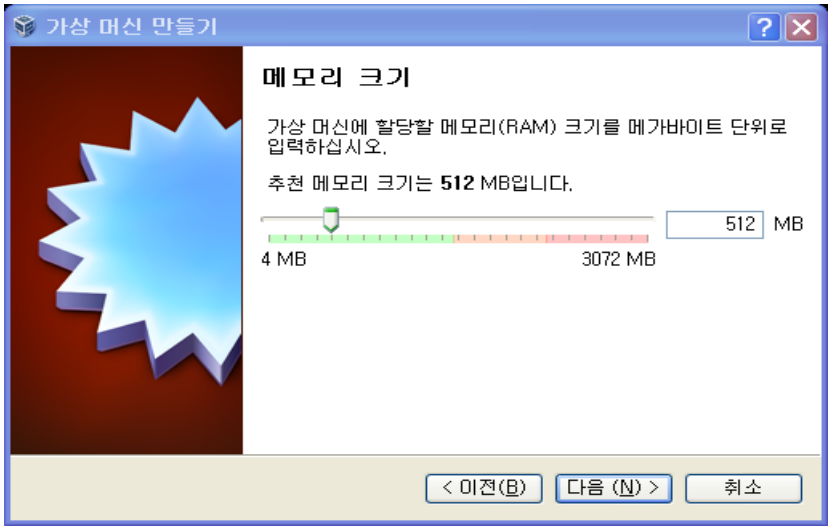
3. **Unzip the image in Windows Explorer**
   Linux Users : unzip OpenFlowTutorial-101311.zip

2-3 Let's start SDN (step2)

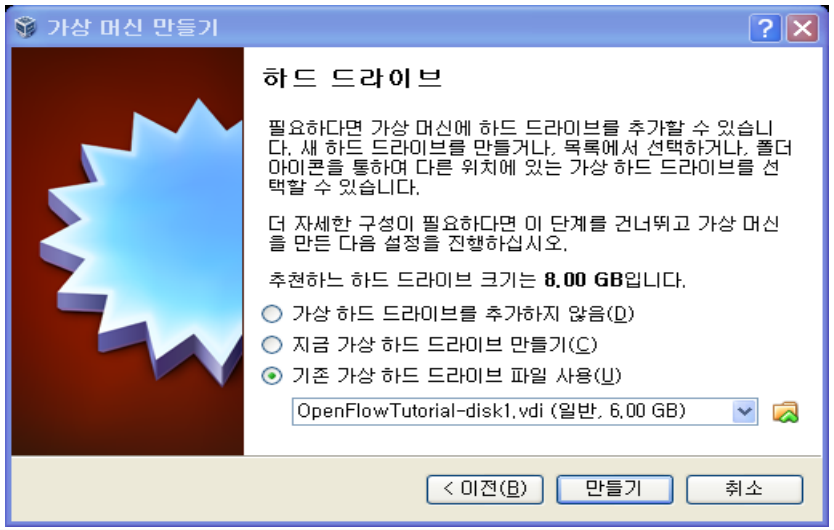
1



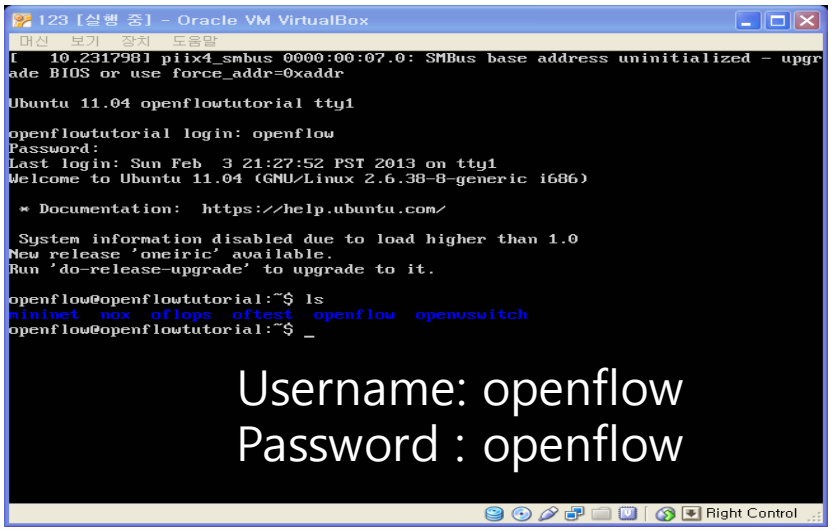
2



3

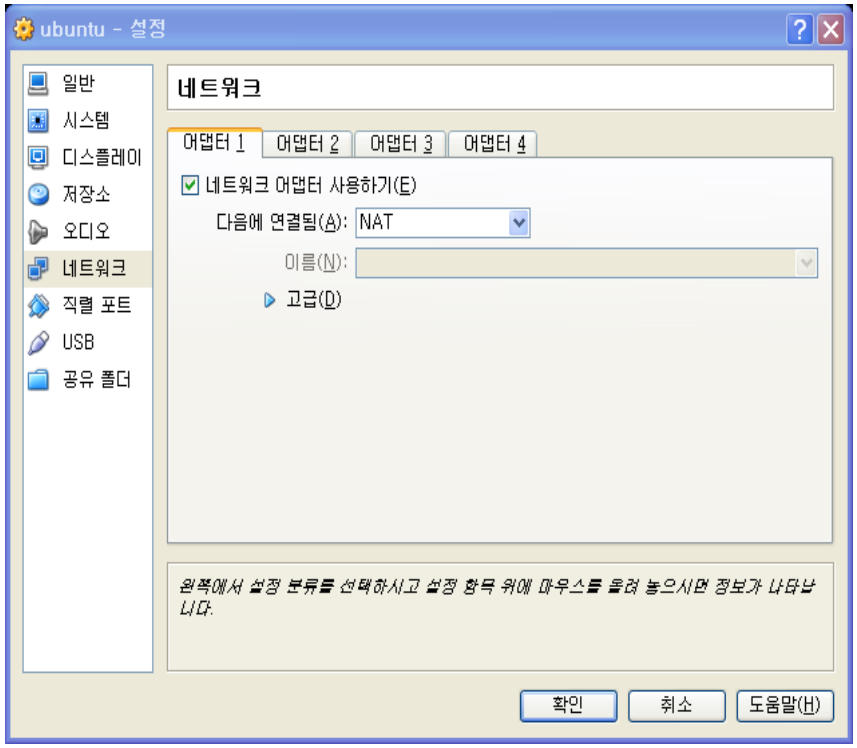


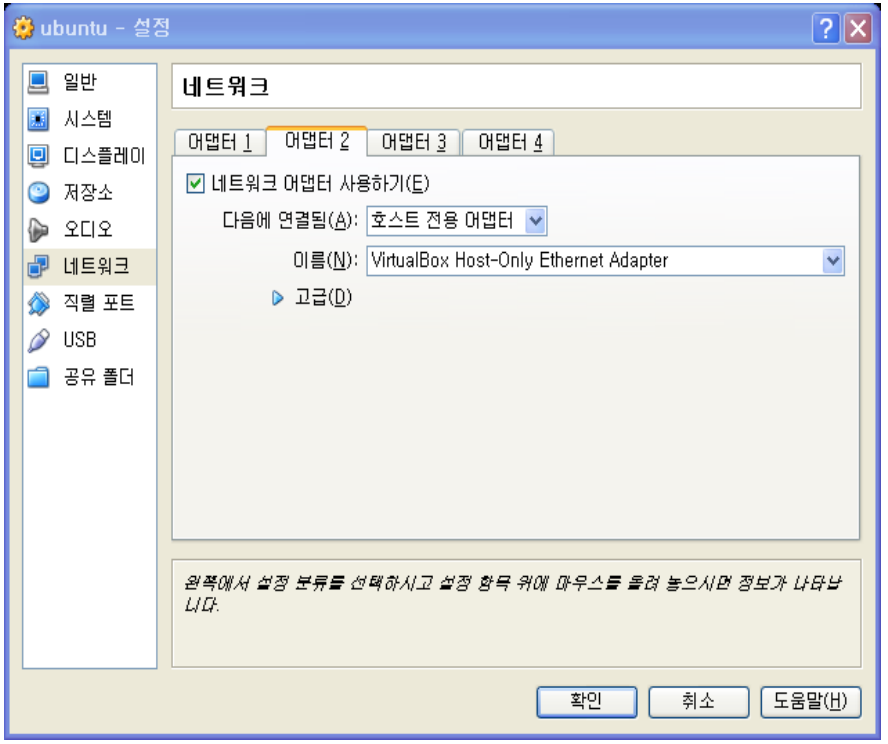
4



2-4 Let's start SDN (step3)

Virtualbox settings





Note: if you are running VirtualBox, you should make sure your VM has **two network interfaces**. One should be a **NAT interface** that it can use to access the Internet, and the other should be a **host-only interface** to enable it to communicate with the host machine.

Contents

Mininet is a tool that emulates an arbitrary openflow network on your machine.

3-1 MININET Download and Get Started

Mininet is a tool that emulates an arbitrary openflow network on your machine.

- **How download MININET**

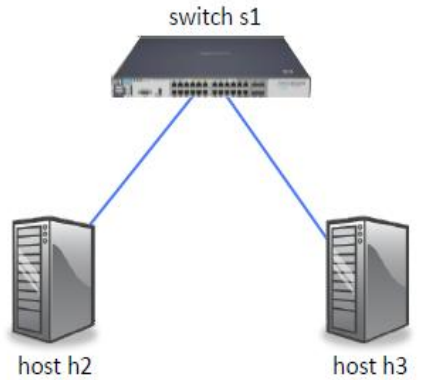
  Openflow tutorial을 설치하면 기본으로 구성되어있음.

  http://yuba.stanford.edu/foswiki/bin/view/OpenFlow/Mininet

  1. git clone git://github.com/mininet/mininet
  2. mininet/util/install.sh –a

- **How to run mininet**:

  1. Open a new terminal (try ssh'ing to your VM).
  2. Run: sudo mn
     : Note: The default topology is a line with two hosts (h2 and h3) and a switch
  3. You should see the mininet terminal: mininet>
  4. Now, ping h3 from h2: mininet> h2 ping h3

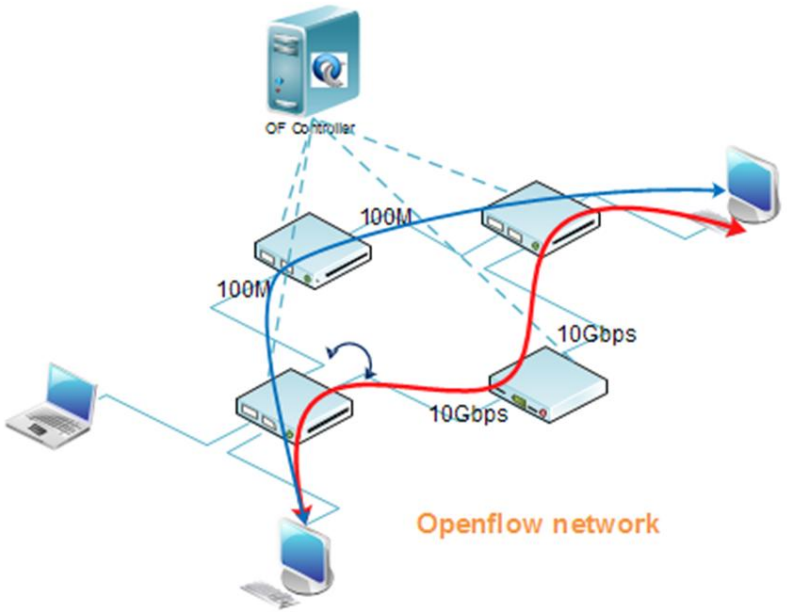


topo-2host-1switch

3-2 MININET edit by code

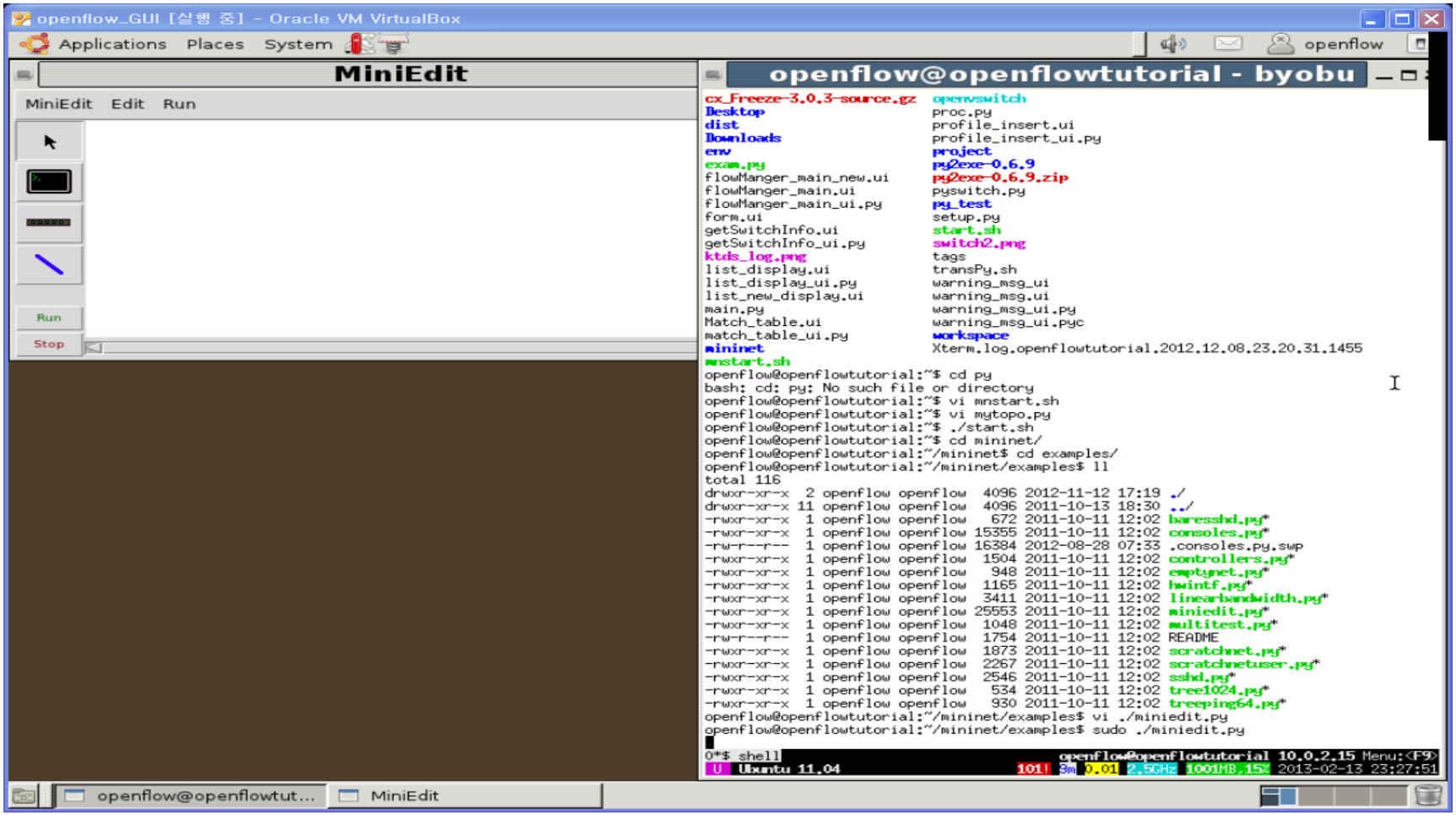
mytopo.py

```
from mininet.topo import Topo, Node

class MyTopo( Topo ):
    "Simple topology example."

    def __init__( self, enable_all = True ):
        "Create custom topo."

        # Add default members to class.
        super( MyTopo, self ).__init__()

        # Set Node IDs for hosts and switches
        leftHost = 1
        leftSwitch = 2
        rightSwitch = 3
        rightHost = 4

        # Add nodes
        self.add_node( leftSwitch, Node( is_switch=True ) )
        self.add_node( rightSwitch, Node( is_switch=True ) )
        self.add_node( leftHost, Node( is_switch=False ) )
        self.add_node( rightHost, Node( is_switch=False ) )

        # Add edges
        self.add_edge( leftHost, leftSwitch )
        self.add_edge( leftSwitch, rightSwitch )
        self.add_edge( rightSwitch, rightHost )

        # Consider all switches and hosts 'on'
        self.enable_all()


topos = { 'mytopo': ( lambda: MyTopo() ) }
```



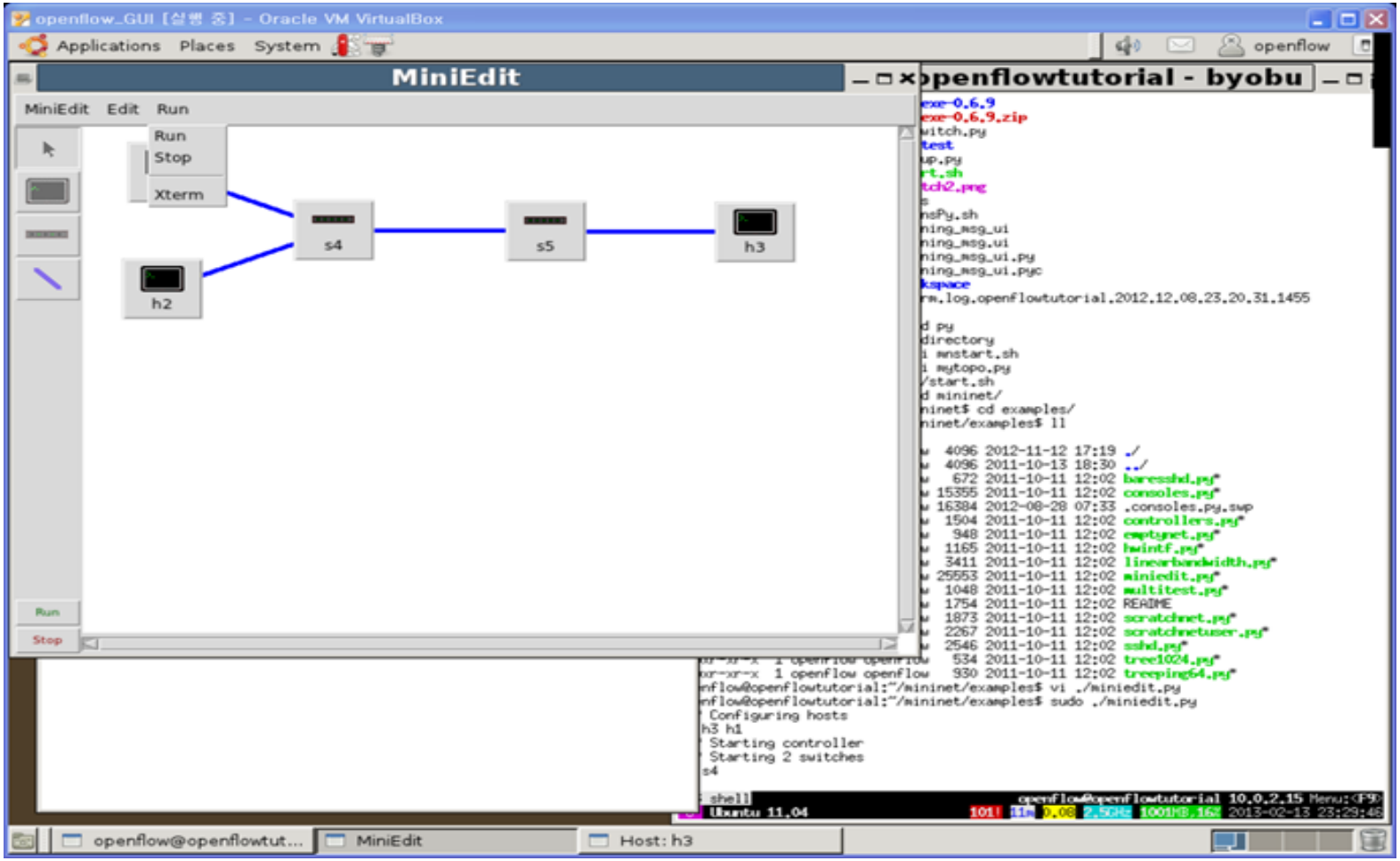
3-3 MININET edit by tools

~/mininet/examples$ sudo miniedit.py



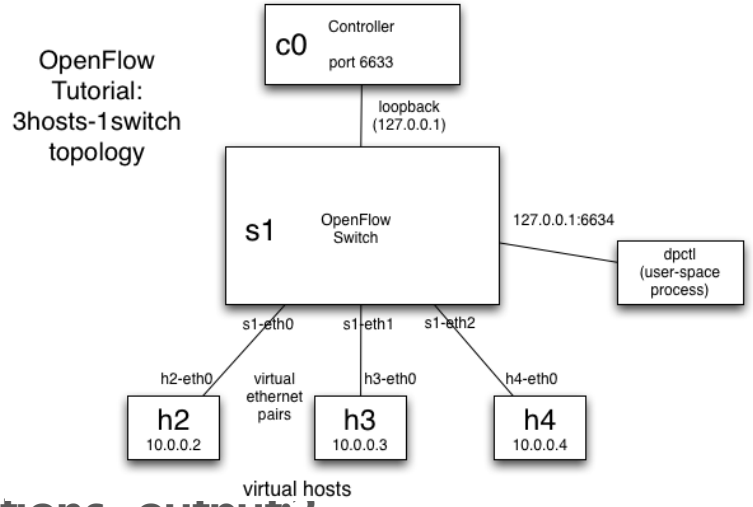
3-4 MININET edit by tools

Easy!



3-5 MININET test

- **Simulate network & ping**
  sudo mn --topo single,3 --mac --switch
  ovsk --controller remote
  mininet> h2 ping -c3 h3



- **Flow 확인**
  dpctl dump-flows tcp:127.0.0.1:6634
- **ADD Flow**
  dpctl add-flow tcp:127.0.0.1:6634 in_port=1,actions=output:2
  dpctl add-flow tcp:127.0.0.1:6634 in_port=2,actions=output:1
- **DELETE Flow**
  dpctl del-flows tcp:127.0.0.1:6634 in_port=1

add : dpctl add-flow tcp:127.0.0.1:6634 in_port=1, actions=output:2

Contents

There are a handful of controllers available:
Beacon, Floodlight, NOX, NOX Classic, POX, Ryu, Threma, ...
In this tutorial, **we use NOX Classic.**

4-1 About NOX history

The official version of NOX-Classic supports OpenFlow 1.0

NOX

	Active	Release
Branch	verity	None yet!
Release Date	2012-05-11	N/A
Snapshots	tgz zip	

NOX-Classic (Deprecated)

	Next	Active	Release
Branch	impulse	destiny	zaku
Release Date	2012-??-??	2012-07-20	2010-09-15
Snapshots		tgz zip	tgz zip

- To get the latest version of NOX, you'd do the following:
  git clone http://noxrepo.org/git/nox
- If you don't want to use the default branch
  git checkout branch-name

POX

	Active	Release
Branch	master	None yet!
Release Date	2012?	N/A
Snapshots	tgz zip	N/A

NOX-Classic has had a Qt based GUI for quite a while now, and in slightly modified form, it made it into POX as well.

4-2 About NOX version

- **Bootstraping NOX 0.9.0**

You do not need to install NOX
- it comes ready to run on the VM.

```
cd ~/nox/build/src
./nox_core -v -i ptcp: pytutorial
```

- **Check NOX Version**

openflow@openflowtutorial:~/nox/build/src$ **./nox_core -V**
NOX 0.9.0(zaku)~full~beta (nox_core), compiled Oct 13 2011 17:49:51
Compiled with OpenFlow 0x01

4-3 Bootstrapping NOX 0.9.1

- **Download and bootstrapping nox**

```
$ git clone https://github.com/noxrepo/nox-classic.git
$ ls
      mininet  nox  nox-classic  oflops  oftest  openflow  openvswitch  pox
$ cd nox-classic/
$ ./boot.sh
$ mkdir build/
$ cd build/
$ ../configure
$ make
$ cd src
$ ./nox_core –V
      NOX 0.9.1~full~beta (nox_core), compiled Feb  6 2013 23:36:29
      Compiled ith OpenFlow 0x01
```

4-4 NOX, Let's Take a look

- src / nox / coreapps / examples / pyswitch.py

```
# --
# Given a packet, learn the source and peg to a switch/inport
# --
def do_l2_learning(dpid, inport, packet):
    global inst

    # Learn MAC on incoming port
    srcaddr = packet.src.tostring()
    if ord(srcaddr[0]) & 1:
        return
    if inst.st[dpid].has_key(srcaddr):
        dst = inst.st[dpid][srcaddr]
        if dst[0] != inport:
            log.msg('MAC has moved from '+str(dst)+'to'+str(inport), system='pyswitch')
        else:
            return
    else:
        log.msg('learned MAC '+mac_to_str(packet.src)+' on %d %d'% (dpid,inport), system

    # Learn or update timestamp of entry
    inst.st[dpid][srcaddr] = (inport, time(), packet)

    # Replace any old entry for (switch,mac).
    mac = mac_to_int(packet.src)
```

```
# --
# If we've learned the destination MAC set up a flow and
# send only out of its inport.  Else, flood.
# --
def forward_l2_packet(dpid, inport, packet, buf, bufid):
    dstaddr = packet.dst.tostring()
    if not ord(dstaddr[0]) & 1 and inst.st[dpid].has_key(dstaddr):
        prt = inst.st[dpid][dstaddr]
        if  prt[0] == inport:
            log.err('**warning** learned port = inport', system="pyswitch")
            inst.send_openflow(dpid, bufid, buf, openflow.OFPP_FLOOD, inport)
        else:
            # We know the outport, set up a flow
            log.msg('installing flow for ' + str(packet), system="pyswitch")
            flow = extract_flow(packet)
            flow[core.IN_PORT] = inport
            actions = [[openflow.OFPAT_OUTPUT, [0, prt[0]]]]
            inst.install_datapath_flow(dpid, flow, CACHE_TIMEOUT,
                                       openflow.OFP_FLOW_PERMANENT, actions,
                                       bufid, openflow.OFP_DEFAULT_PRIORITY,
                                       inport, buf)
    else:
        # haven't learned destination MAC. Flood
        inst.send_openflow(dpid, bufid, buf, openflow.OFPP_FLOOD, inport)
```

4-5 Bootstrapping NOX GUI

- **Nox GUI를 실행하기 위해서 Monitoring 실행**

  ~/nox-classic/build/src$ ./nox_core -v -v -i ptcp:6633 monitoring switch routing trackhost_pktin

- **nox-gui.py scripts 위치 확인.**

  ~/nox-classic/src$ ls

  builtin etc gui include lib Makefile.am Makefile.in Make.vars nox nox-gui.py nox_main.cc scripts tests utilities

- **NOX GUI 실행, error 확인.**

  openflow@openflowtutorial:~/nox-classic/src$ **./nox-gui.py**

  Traceback (most recent call last):

  File "./nox-gui.py", line 18, in <module>

  from PyQt4 import QtGui, QtCore

  ImportError: No module named PyQt4

- **fix errors.**

  sudo apt-get update

  sudo apt-get install pyqt4-dev-tools

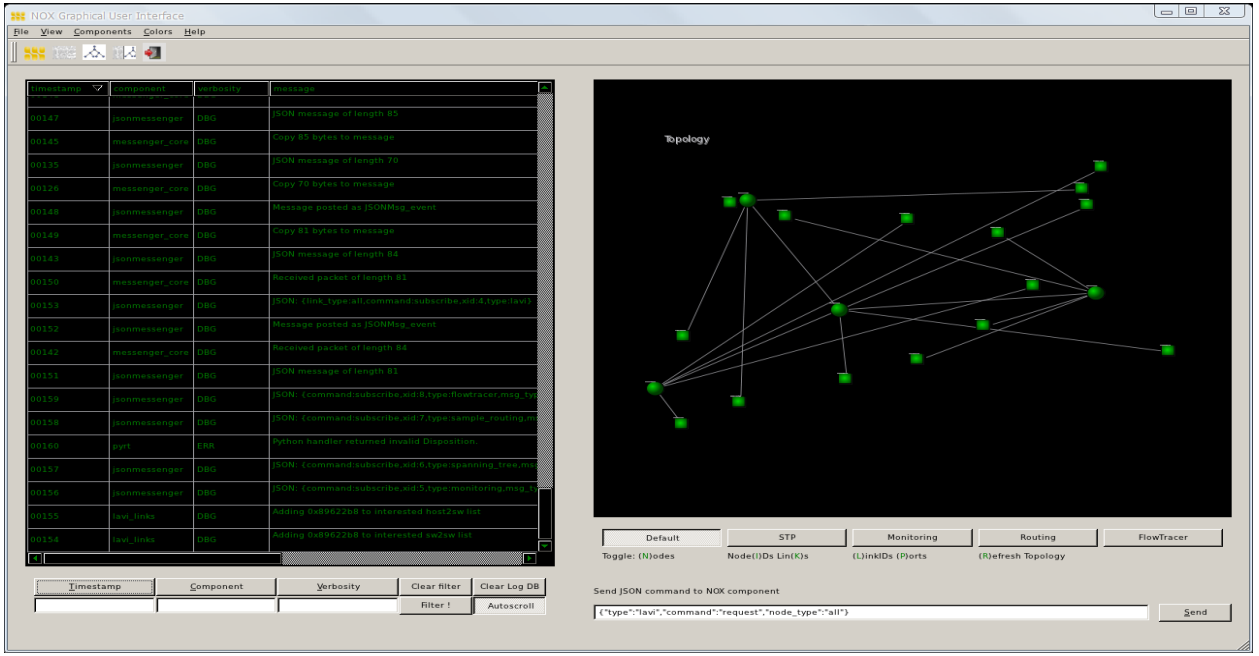
  python-qt4, python-simplejson python-qt4-sql libqt4-sql-sqlite

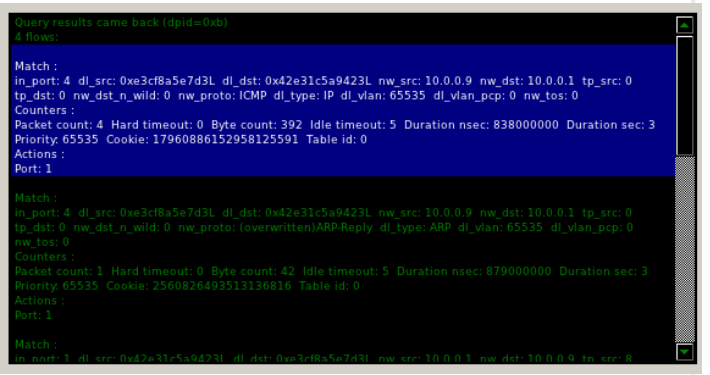
- **X server 실행 (X ming..)**
- **NOX controller 실행. NOX GUI 실행 => GUI pop-up 확인** ./nox-gui.py

4-6 NOX GUI

- **gui start**

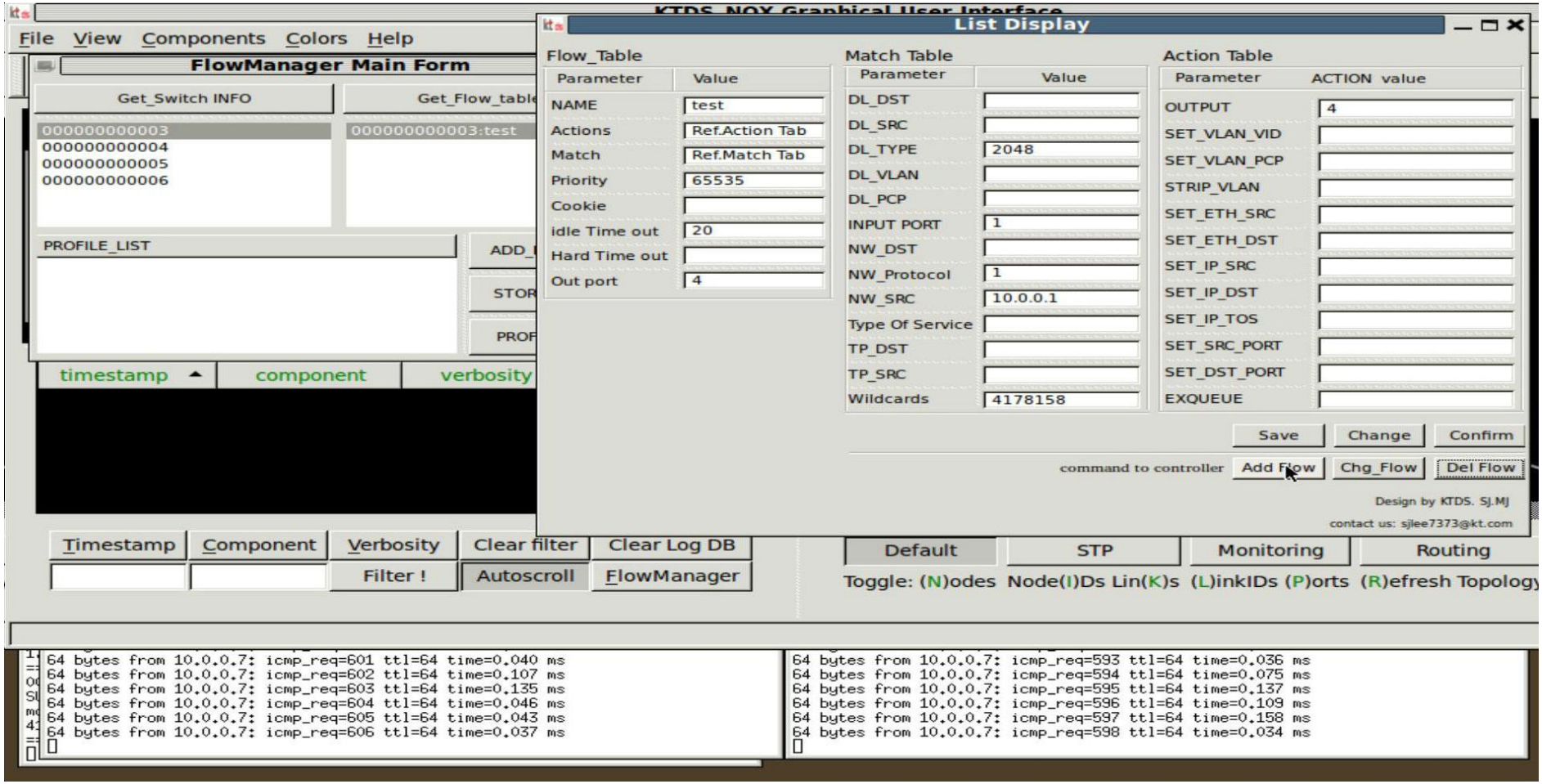
  1)~/nox-classic/build/src$ ./nox_core -v -v -i ptcp:6633 monitoring switch routing trackhost_pktin flowtracer
  2) ~/nox-classic/src$ ./nox-gui.py
  3) ~/mininet$ sudo mn --topo tree,depth=2,fanout=3





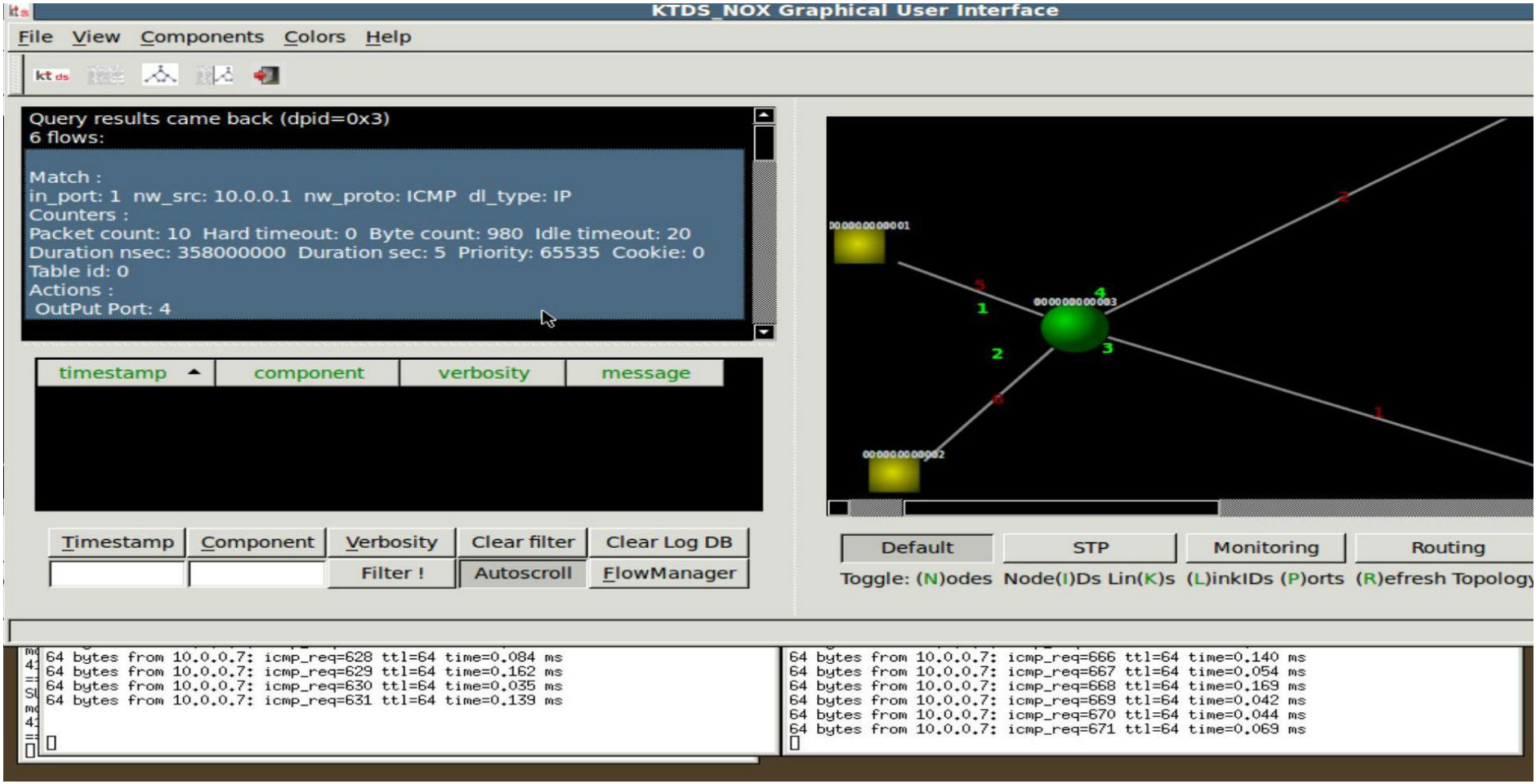
4-7 NOX GUI, a littile work

- Flow manage



4-8 NOX GUI, a littile work

- **Flow entry**



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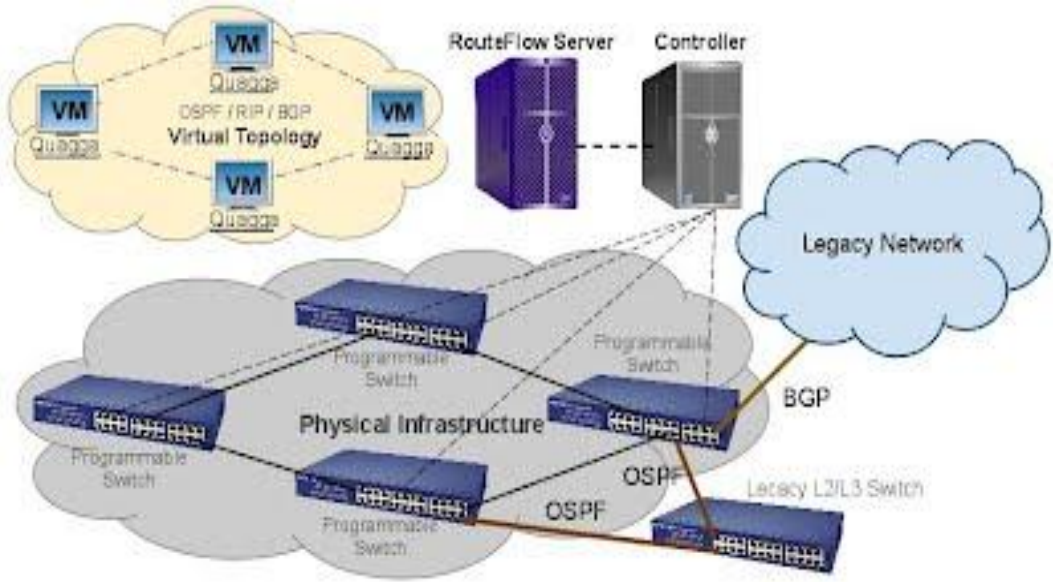
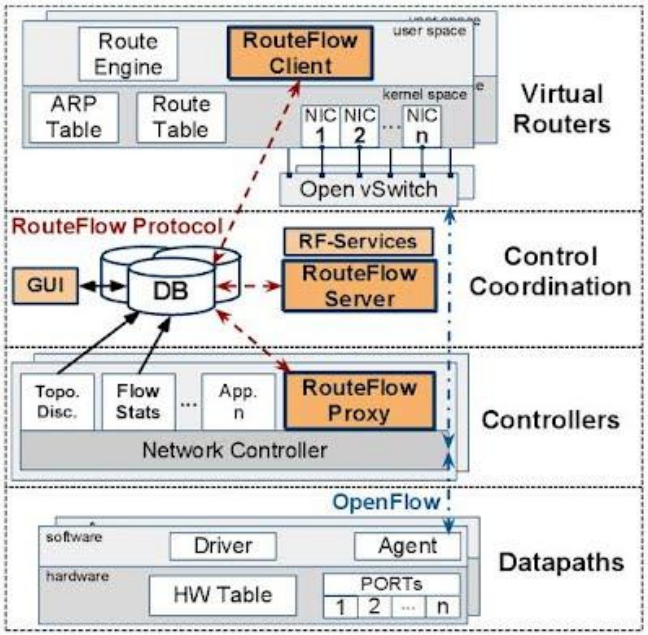
5-1 What is RouteFlow?



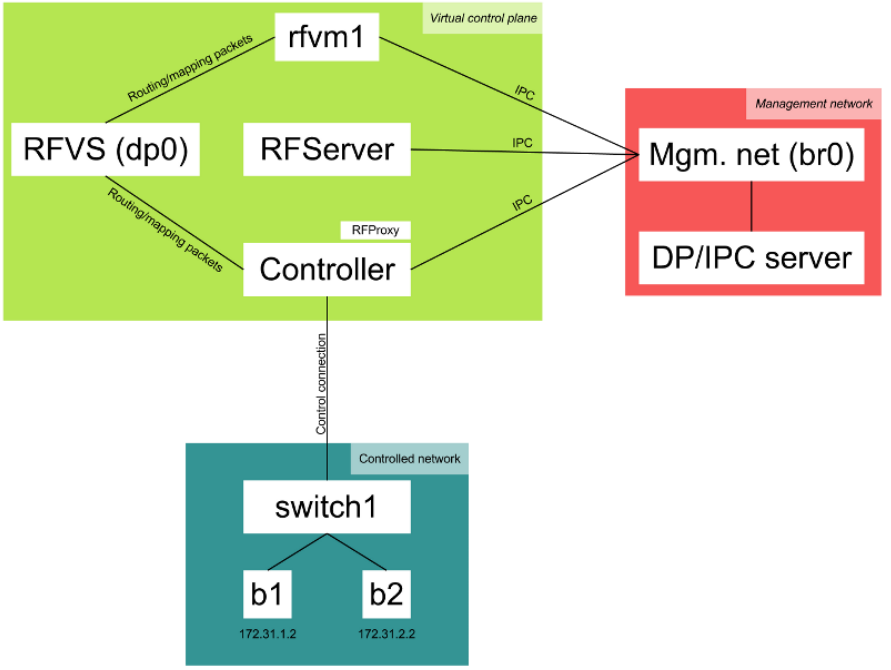


RouteFlow is an open source solution to provide legacy IP routing services (e.g., OSPF, RIP) over OpenFlow networks. As a consequence of running the routing protocols flow entries are installed in the OpenFlow devices that correspond to the FIB generated by the routing engine (Quagga).

5-2 RouteFlow Guide

- start using RouteFlow
  1. Download the pre-configured VM
     ftp://ftp.cpqd.com.br/pub/routeflow/RouteFlow.zip
  2. Start VM
  3. Get **Open vSwitch**
  4. Get Mongo DB & install

The diagram below illustrates what we're running in this test: one switch (switch1), connecting two hosts (b1 and b2).
This switch is being controlled by RouteFlow, and a virtual machine (rfvm1) is running Linux and doing the forwarding intelligence tasks for switch1.



https://github.com/CPqD/RouteFlow/blob/master/README.md#test-cases

appendix

- pox
- floodlight

6-1 POX controller Tutorial

- **Install the POX openflow controller**

1) Download : http://www.noxrepo.org/pox/versionsdownloads/
2) or Clone from GitHub, even easier!
   $ git clone http://www.github.com/noxrepo/pox
   $ cd pox
   $ ./pox.py openflow.of_01 --address=<your ip> --port=6633
   (ex. $ **./pox.py openflow.of_01 --address=10.1.1.1 --port=6634**)
   Ready.
   POX>Yay!

Selecting Branch/version
   $ git clone http://github.com/noxrepo/pox
   $ cd pox
   /pox$ git checkout betta

https://openflow.stanford.edu/display/ONL/POX+Wiki#POXWiki-SelectingaBranchVersion

6-2 POX GUI Tutorial

- **POX gui guide**

```
git clone https://github.com/noxrepo/pox
cd pox
git checkout betta
cd ext
git clone https://github.com/MurphyMc/poxdesk
cd poxdesk
wget http://downloads.sourceforge.net/qooxdoo/qooxdoo-2.0.2-sdk.zip
unzip qooxdoo-2.0.2-sdk.zip
mv qooxdoo-2.0.2-sdk  qx
cd poxdesk
./generate.py
cd ../../..
./pox.py samples.pretty_log web messenger messenger.log_service messenger.ajax_transport openflow.of_service poxdesk
```

6-3 Floodlight controller Tutorial

- **Install guide**

Prerequisites

sudo apt-get install build-essential default-jdk ant python-dev eclipse

1. Download and build

   git clone git://github.com/floodlight/floodlight.git

   cd floodlight

   git checkout stable

   ant;

2. running floodlight

   java -jar target/floodlight.jar

Tutorial site:
http://floodlight.openflowhub.org/getting-started/

Thank you

kt ds