

# Setup ("Programming Assignment" 1): Setup Virtual Box/Mininet Environment for SDN

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Mininet is a simulation environment that creates a **realistic virtual network**, running **real kernel, switch and application code**, on a single machine (VM, cloud or native), in seconds, with a single command:

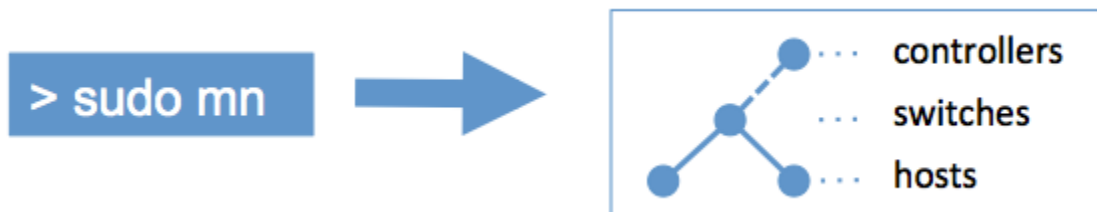


Figure 1: Mininet Virtual Environment

## Download Mininet VM

We recommend installing the following Mininet VM image:

[https://d396qusza40orc.cloudfront.net/sdn/srcs/SDN-VM\\_64bit.ova](https://d396qusza40orc.cloudfront.net/sdn/srcs/SDN-VM_64bit.ova) (64 bit image)

[https://d396qusza40orc.cloudfront.net/sdn/srcs/SDN-VM\\_32bit.ova](https://d396qusza40orc.cloudfront.net/sdn/srcs/SDN-VM_32bit.ova) (32 bit image)

You can also download it using torrent clients. The torrent files for these images are:

[https://spark-public.s3.amazonaws.com/sdn/srcs/SDN-VM\\_64bit.ova?torrent](https://spark-public.s3.amazonaws.com/sdn/srcs/SDN-VM_64bit.ova?torrent) (64 bit image)

[https://spark-public.s3.amazonaws.com/sdn/srcs/SDN-VM\\_32bit.ova?torrent](https://spark-public.s3.amazonaws.com/sdn/srcs/SDN-VM_32bit.ova?torrent) (32 bit image)

It comes pre-installed with the latest version of Mininet a.k.a. HiFi and two OpenFlow Controllers (POX and Pyretic). The download will take some time. It's ~ 800MB, compressed.

## Download Virtualization System

You can use any virtualization system of your choice, but we recommend installing VirtualBox. It's free and runs on Windows, Linux and OS X.

VirtualBox (Recommended): <https://www.virtualbox.org/wiki/Downloads>

For other virtualizations systems, visit [here](#).

## Download X Server and SSH capable terminal

- For Windows install [Xming](#) and [Putty](#).
- For MAC OS install [XQuartz](#) and Terminal.app (builtin)
- Linux comes pre-installed with X server and Gnome terminal + SSH (builtin)

## Setup Virtual Machine

- **Start up VirtualBox, then select File>Import Appliance and select the .ova file.**
- **Next, press the "Import" button.**
- This will unpack and import the VM in your local machine. It will take a while - the unpacked image is about 3 GB.

## Boot VM

At this point you should be ready to start your VM. Press the "Start" arrow icon or double-click your VM within the VirtualBox window.

In the VM console window, log in with the user name and password for your VM. The username and password for this VM are:

- User name - **mininet**
- Password - **mininet**

Note that this user is a sudoer, so you can execute commands with root permissions by typing *sudo command*, where *command* is the command you wish to execute with root permission.

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## Enable SSH

Select your VM and go to the Settings Tab. Go to Network->Adapter 2. Select the "Enable adapter" box, and attach it to "host-only network". Make sure that your VM is turned off, otherwise VirtualBox will not allow you to make these changes. (**Sidenote:** on a new VirtualBox installation you may not have any "host-only network" configured yet. To have one select File menu/Preferences/Network and "Add host-only network" button with default settings. Then you can try the attach.) **This will allow you to easily access your VM through your host machine.**

## Set Up Network Access

The course VM is shipped without a desktop environment, to reduce its size. All the exercises will be done through X forwarding, where programs display graphics through an X server running on the host OS.

To start up the X forwarding, you'll first need to find the guest IP address.

## VirtualBox

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. For example, your NAT interface could be eth0 and have a 10.x IP address, and your host-only interface could be eth1 and have a 192.168.x IP address. You should ssh into the host-only interface at its associated IP address. Both interfaces should be configured using DHCP. If they are not already configured, you may have to run dhclient on each of them, as described below.

### Access VM via SSH

In this step, you'll verify that you can connect from the host PC (your laptop) to the guest VM (Mininet) via SSH.

From the virtual machine console, log in to the VM, then enter:

```
$ ifconfig -a
```

You should see three interfaces (eth0, eth1, lo). Both eth0 and eth1 should have IP address assigned. If this is not the case, type

```
$ sudo dhclient ethX
```

Replacing ethX with the name of a downed interfaces; sometimes the eth ports appear as eth2 or eth3, you can fix this by editing /etc/udev/rules.d/70-persistent-net.rules and removing the existing configuration lines. To avoid running this command each time you boot the VM, append the following lines in your /etc/network/interfaces file. (You will need *sudo* to edit this file)

```
auto eth1
```

```
iface eth1 inet dhcp
```

Note the IP address (probably the 192.168 one) for the host-only network; you'll need it later.

Next, follow the instructions below for your OS to log in.

### 1. Mac OS X and Linux

Open a terminal (Terminal.app in Mac, Gnome terminal in Ubuntu, etc). In that terminal, run:

```
$ ssh -X [user]@[Guest IP Here]
```

Replace [user] with the correct user name for your VM image.

Replace [Guest IP Here] with the IP you just noted. If ssh does not connect, make sure that you can ping the IP address you are connecting to.

Enter the password for your VM image. Next, try starting up an X terminal using

```
$ xterm
```

and a new terminal window should appear. If you have succeeded, you are done with the basic setup. Close the xterm. If you get a 'xterm: DISPLAY is not set error', verify your X server installation from above.

### 2. Windows

In order to use X11 applications such as xterm and wireshark, the Xming server must be running, and you must make an ssh connection with X11 forwarding enabled.

- **First, start Xming** (e.g. by double-clicking its icon.)  
No window will appear, but if you wish you can verify that it is running by looking for its process in Windows' task manger.
- **Second, make an ssh connection with X11 forwarding enabled.**

If you start up puTTY as a GUI application, you can connect by entering your VM's IP address and enabling X11 forwarding.

To enable X11 forwarding from puTTY's GUI, click puTTY->Connection->SSH->X11, then click on Forwarding->"Enable X11 Forwarding", as shown below:

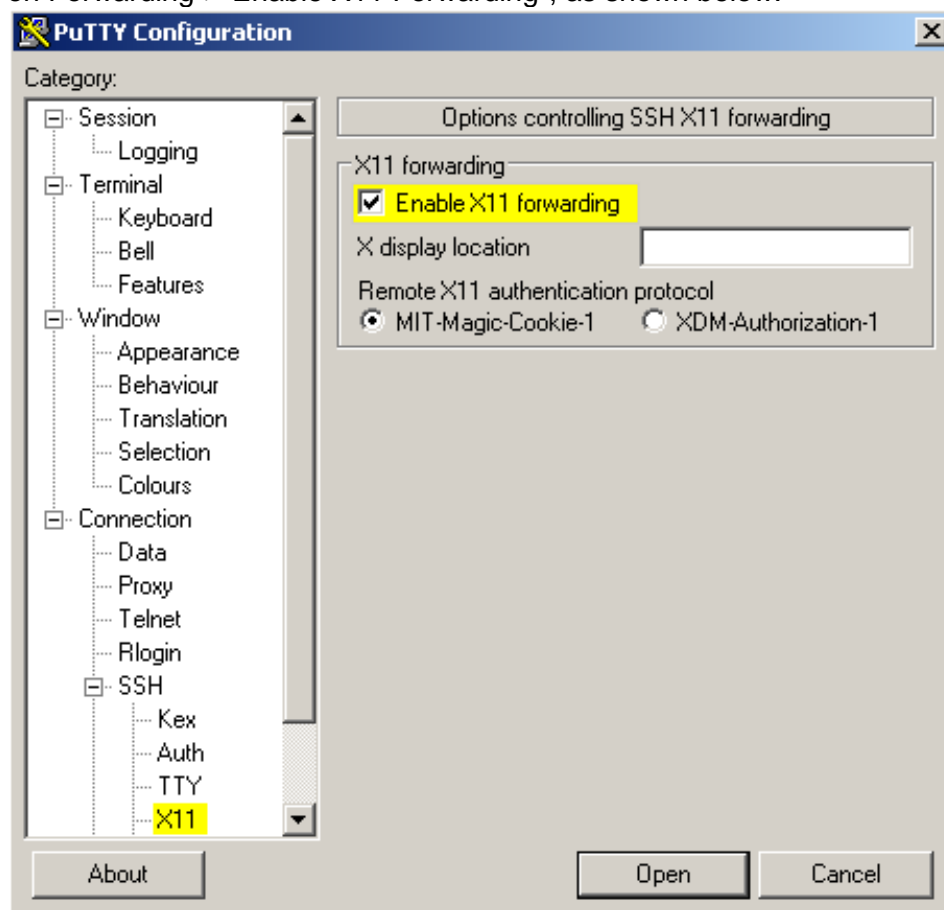


Figure 2: Putty Configuration

You can also run putty (with the -X option for X11 forwarding) from the Windows command line:

- Open a terminal: click the Windows 'Start' button, 'run', then enter 'cmd'.
- Change to the directory where you saved putty.

```
C:> cd <dir>
```

- Run:

```
C:> putty.exe -X openflow@[Guest IP Here]
```

- Replace [Guest IP Here] with the IP you just noted.
- If putty cannot connect, try pinging the VM's IP address to make sure you are connecting to the correct interface.

```
C:> ping [Guest IP Here]
```

- Once the ssh connection succeeds or a terminal window for the VM pops up, log in to the VM. Now, type:

```
$ xterm -sb 500
```

to start an X terminal (the -sb 500 is optional but gives 500 lines of scrollbar.)

A white terminal window should appear. If you have succeeded, you are done with the basic setup. Close the xterm.

If the xterm window does not appear, or if you get an error like "xterm: DISPLAY is not set," make sure that Xming is running in Windows and that you have correctly enabled X11 forwarding.

#### Alternative: Run X11 in the VM console window (optional)

As an alternative to running X11 on your host machine, you may find it useful or convenient to install X11 into the VM itself. For information on installing X11 visit [here](#).

## Test Mininet Installation

Final step is to test the Mininet installation.

Login to your VM and type:

```
$ sudo mn
```

This will start a basic mininet virtual environment with one switch (s1) and two hosts (h1 & h2). You will now see a Mininet CLI. In this CLI, type:

```
$ xterm h1
```

```
$ xterm h2
```

You will see two new white terminal windows popping out.

If all this works out without any error, then we have successfully completed Mininet Setup.

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## **Basic Terminologies**

- **VirtualBox console terminal:** connects to Mininet VM. This is the one created when you started up the VM. You can't copy and paste from this page to the console terminal, so it's a bit of a pain. Minimize this NOW, if you haven't already done so. Once you've used it to set up networking, it won't be needed.
- **SSH terminal:** connects to Mininet VM. Created by using putty on Windows or SSH on OS X / Linux, as described in the previous section. Copy and paste should work on this terminal.
- **xterm terminal:** connects to a host in the virtual network. Will be labeled at the top with the name of the host.