Project 1

ECE544 Communication Networks II

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Includes teaching material from Bart Braem and Michael Voorhaen

Project Goals

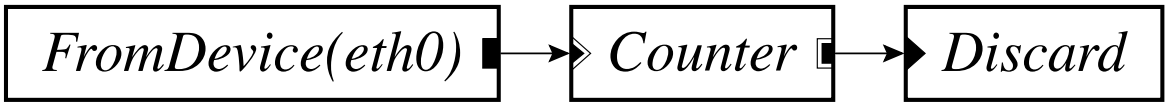
- Get familiar with our virtualized environment
- Get familiar with Click's environment
- Practice with existing elements and create first running configurations
- Use existing interfaces to communicate between multiple click instances

Before We Start

- You should be subscribed to the course mailing list by now
  - If not do not wait any longer: www.groups.winlab.rutgers.edu
- ANY technical question via email should be asked using the mailing list

Click Routers: Main Concepts

- Router: Elements connected by edges
- Output ports to input ports
- Describes possible packet flows through directed graphs



Intro to Configurations

- Text files describing the Click graph:
- Elements with their configurations
- Connections between elements
- Flexible syntax (this is just one possible format)

```
src :: FromDevice(eth0); ctr :: Counter;
sink :: Discard;
src -> ctr; ctr -> sink;
```

or

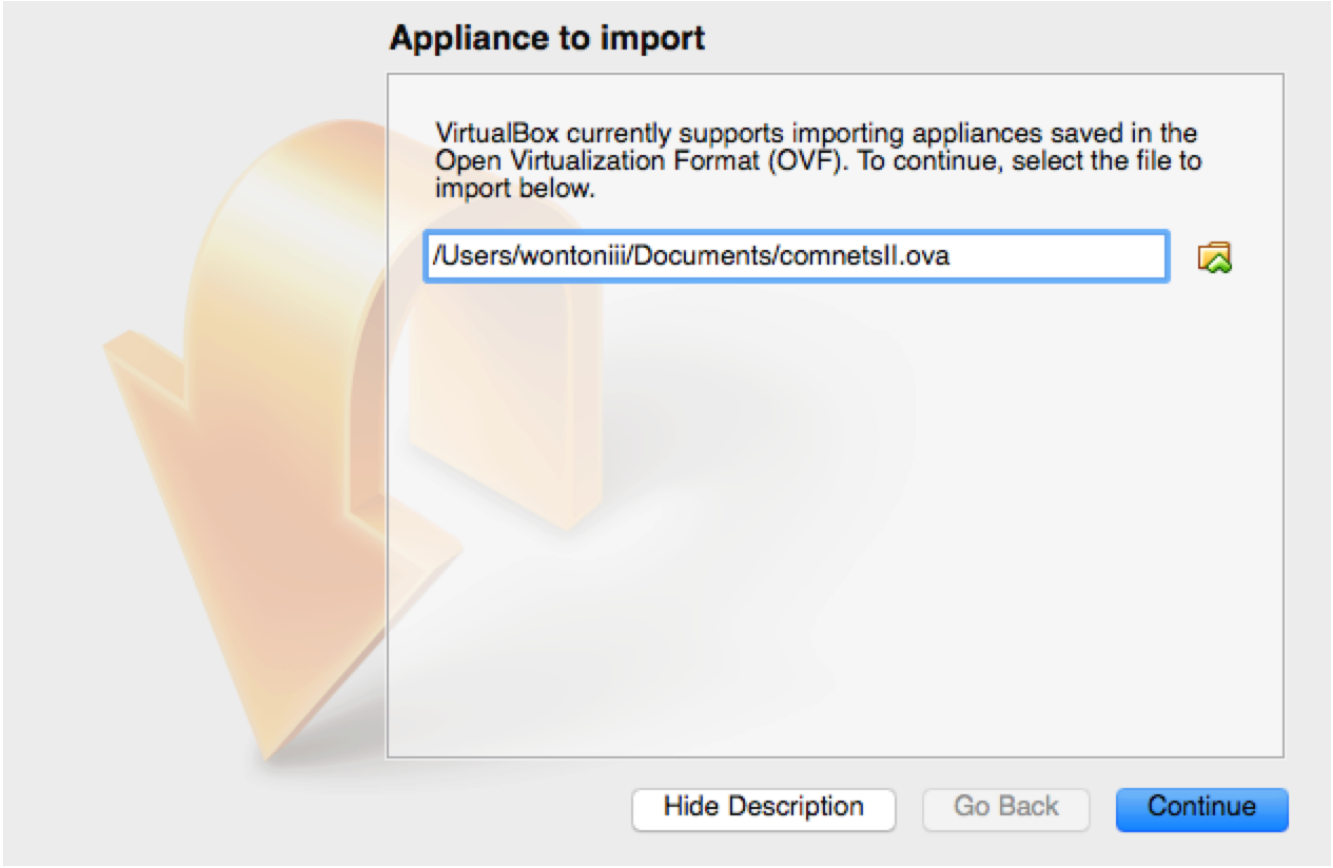
```
FromDevice(eth0) -> Counter -> Discard;
```

Intro to Our VM

- Download from:
  - www.winlab.rutgers.edu/comnet2/Projects/downloads/comnetsII.ova
- VM OVS Format compatible with most virtual environments.
- Suggestion: Virtual Box from Oracle. It is free and multiplatform.
- Provided instructions are based on Virtual Box.

Loading the VM into VBox

- File -> Import Appliance

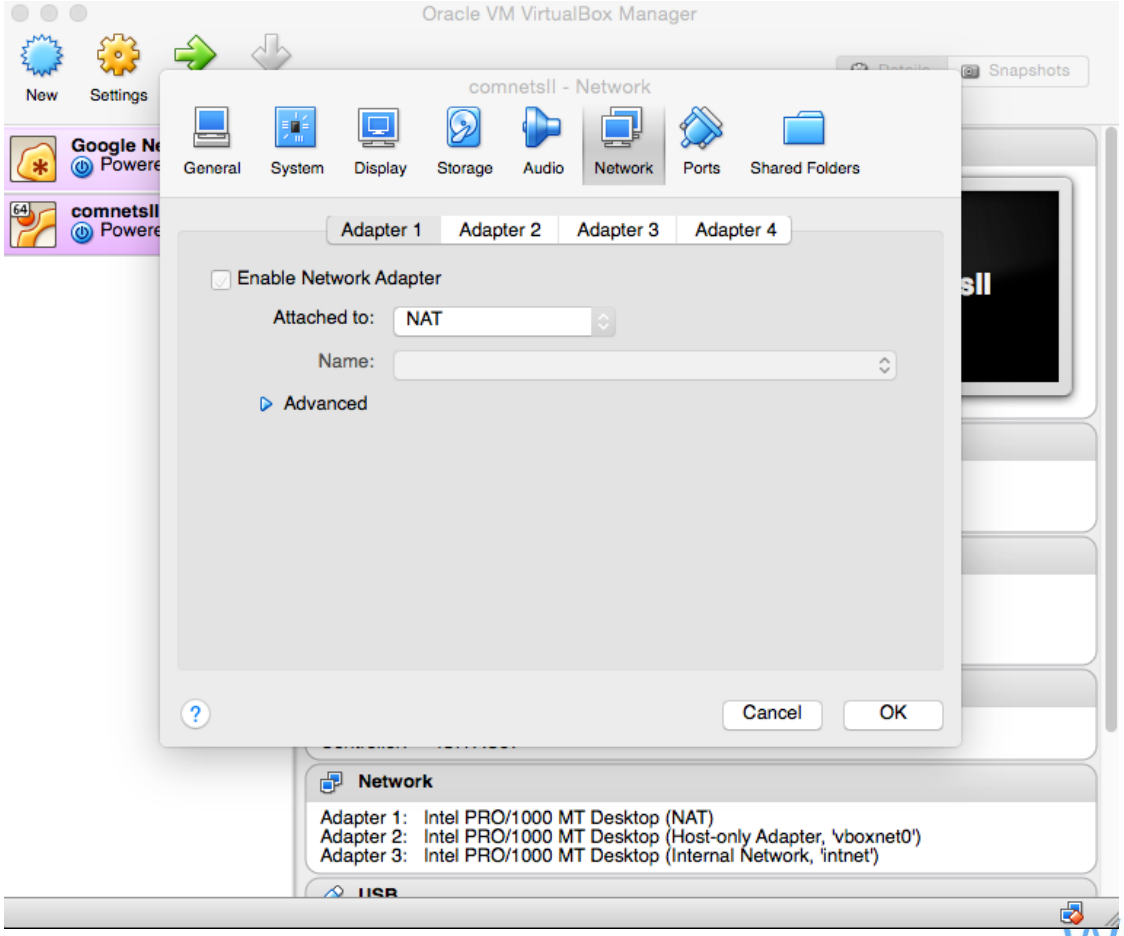


Setup Network Adapters

- The VM should have three network adapters active.
- If they are not configured as following, make any due changes in order to obtain the same configuration.
- In order to make the due changes, the VM has to be turned off.

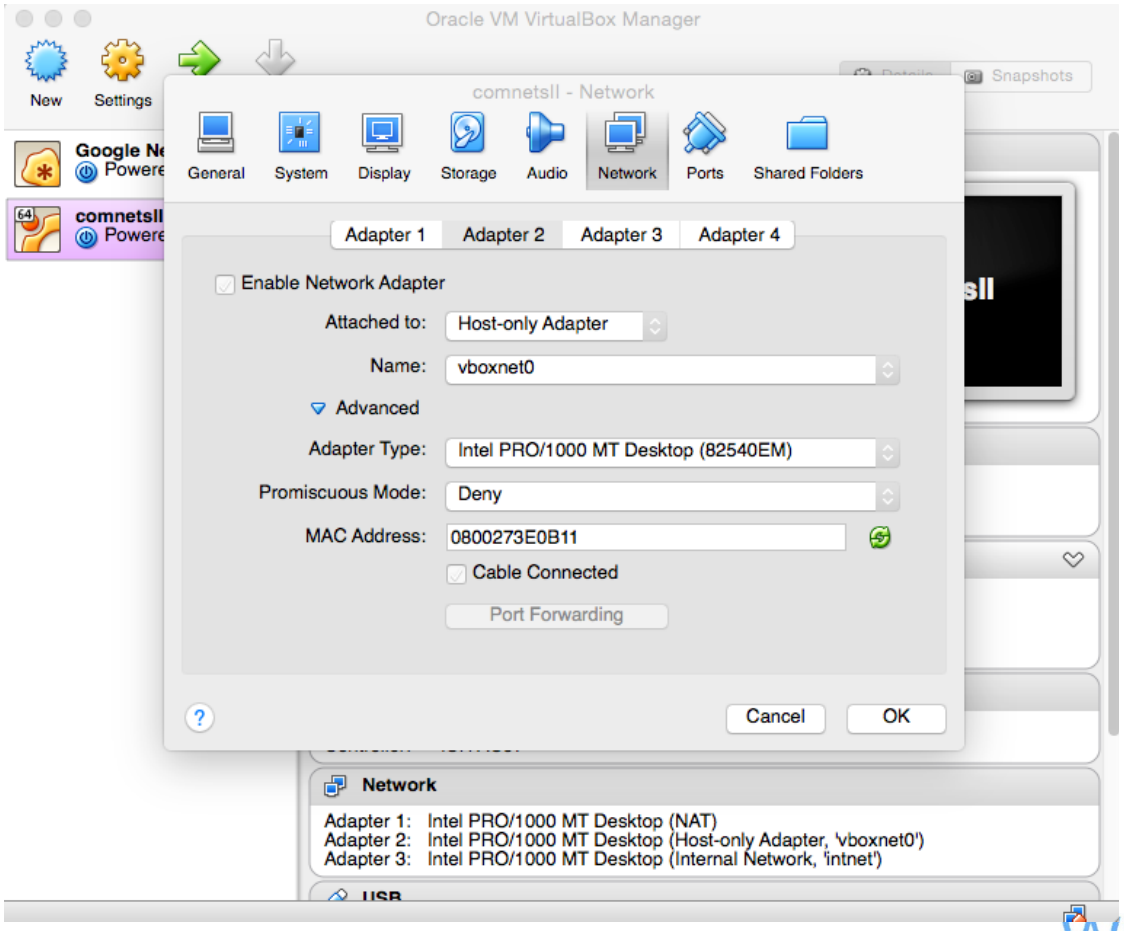
Setup Network Adapters

- Adapter 1 (make sure is *enabled*)



Setup Network Adapters

- Adapter 2 (make sure is *enabled*)

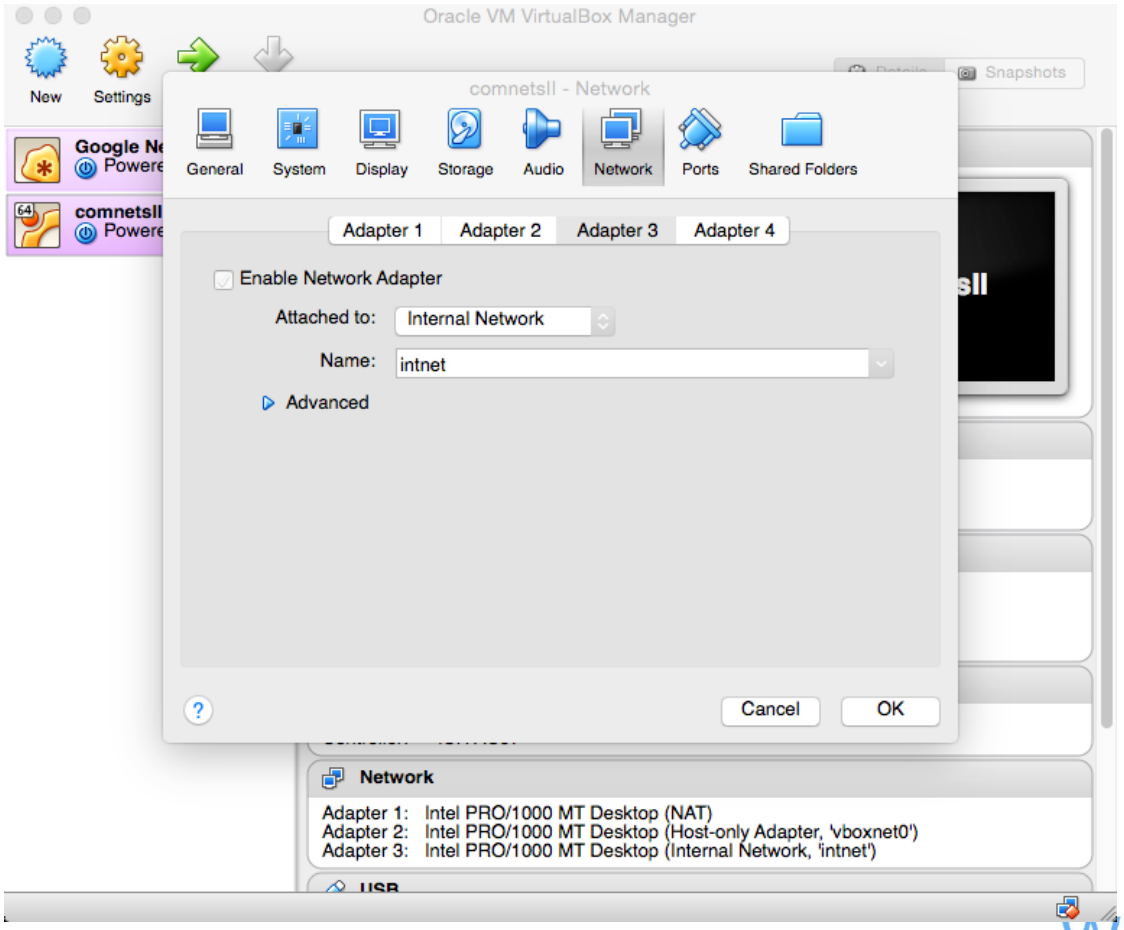


Setup Network Adapters

- If under “name” you do not have anything, you need to create a host-only adapter.
- Open the virtualbox settings.
- Under settings->network->host-only networks add a new adapter (it should be called vboxnet0)
- Go back to the VM settings and select for the “name” option the newly created adapter.

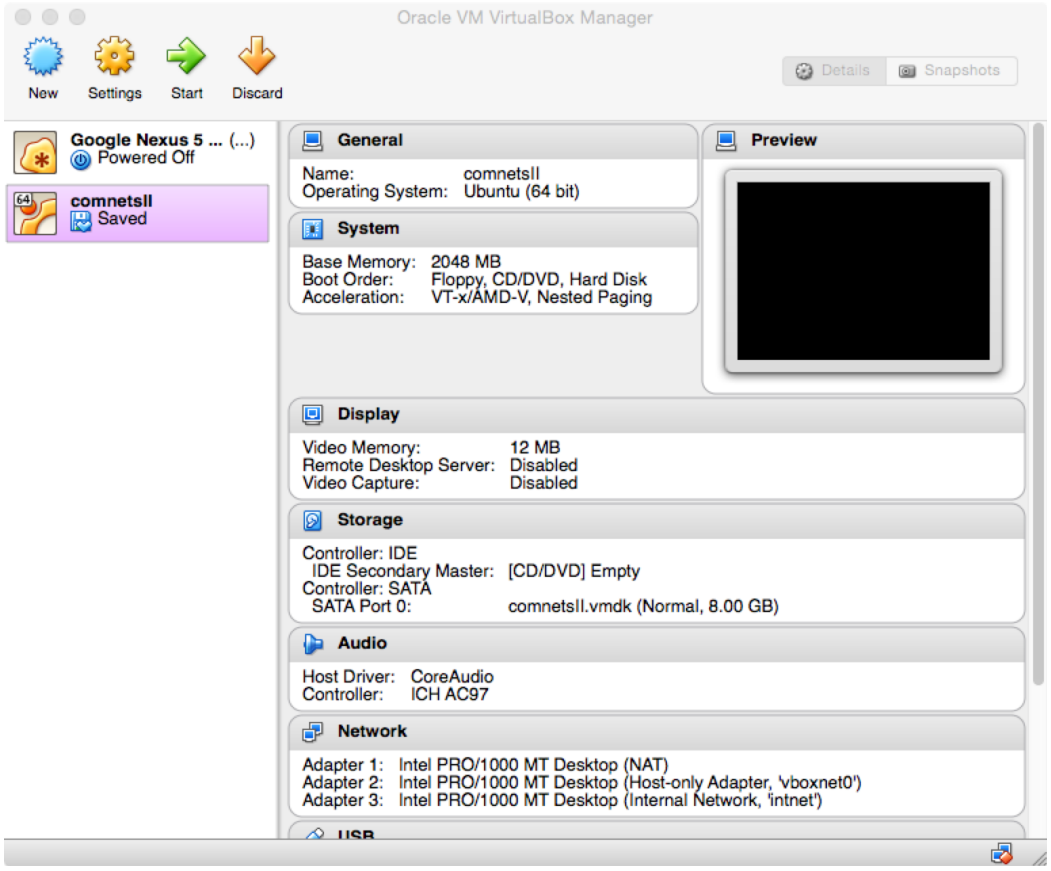
Setup Network Adapters

- Adapter 3 (make sure is *enabled*)



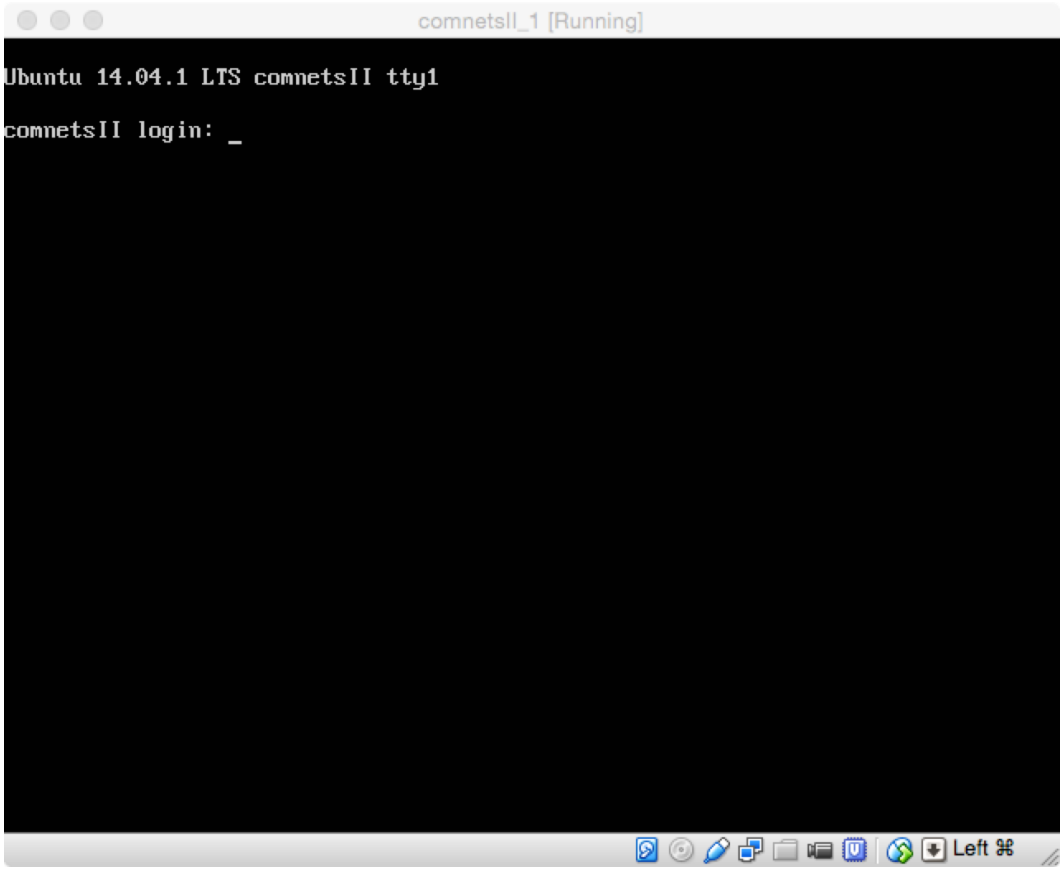
SSH into the VM

- Start the VM



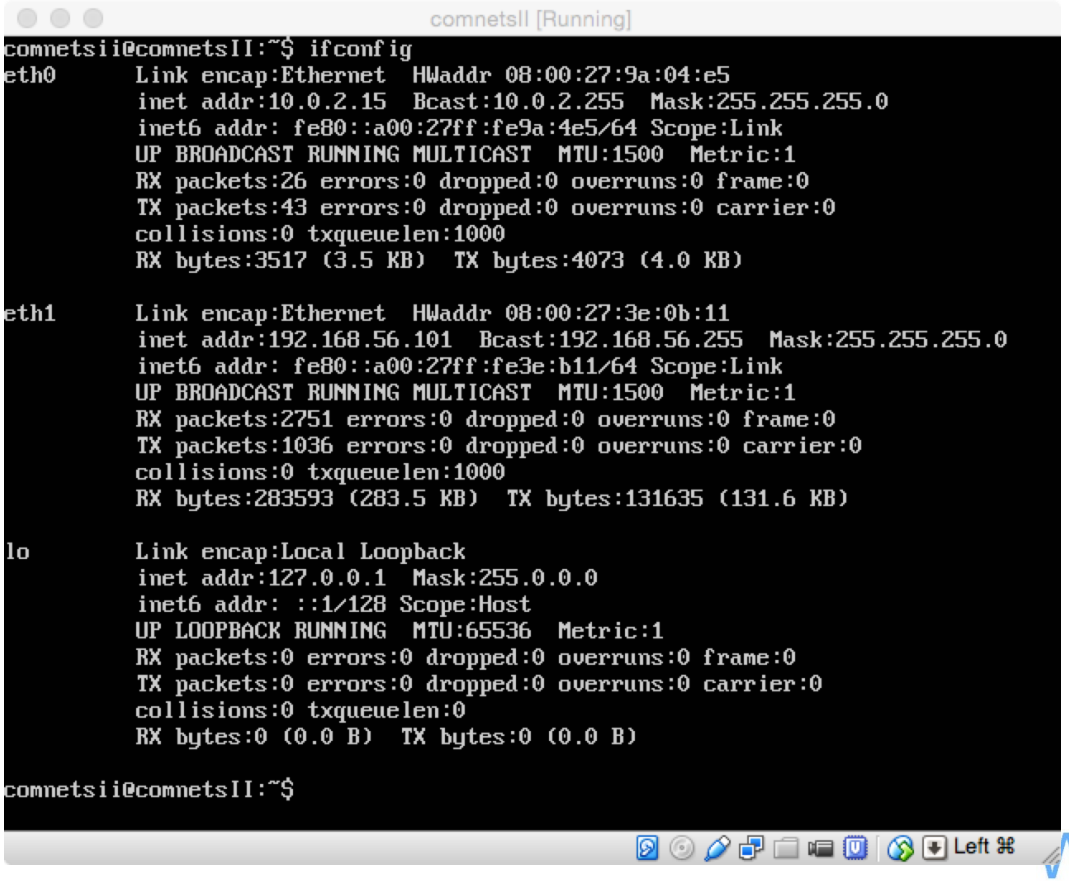
SSH into the VM

- Login: username=*comnetsii* password=*comnetsii*



SSH into the VM

- Activate interface eth1:
  - $ sudo ifconfig eth1 up
  - $ sudo ifconfig eth1 192.168.56.101



SSH into the VM

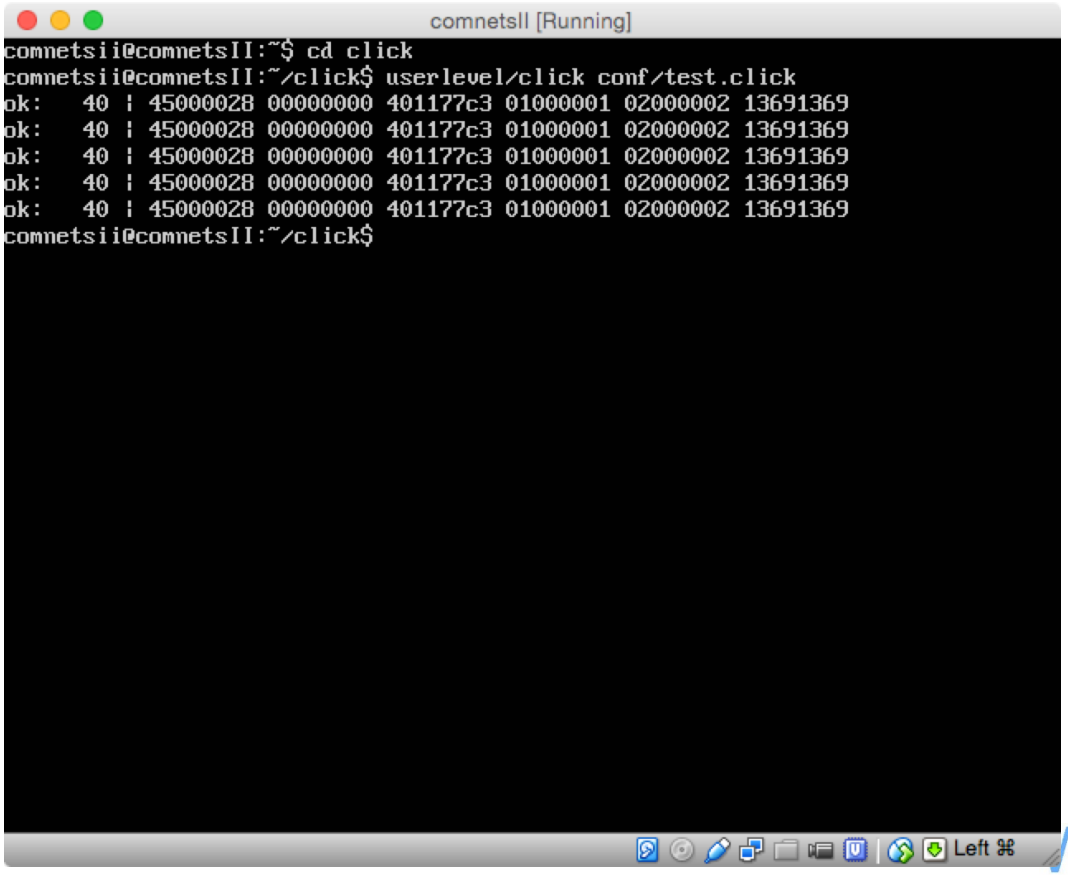
- Using the VM from the guest OS might be less convenient
- You can ssh into the VM from your hosting OS
- On Unix machines:
  - $ ssh comnetsii@192.168.56.101
- On windows: use Putty or similar tools that provide ssh

Available Resources

- In the home folder you will find the following resources:
  - click: click original sources and resources (e.g. binaries).
  - examples: small set of examples that can be used as reference
  - elements: a few provided elements used in the exercises
  - tools: script utilities used to model our virtual environment (more on this later..)

How to Run a Click Instance

- Run your first click instance (inside the click folder):
  - $ ~/click/userlevel/click ~/click/conf/test.click



Exercise 1

- GOAL: write your first Click configuration
- GOAL: run your first Click instance
- Create a new packet from a Source with payload "hello"
- Print its content to terminal
- Discard the packet
- Hints:
  - Only use of existing elements (red words suggest their name..)
  - Configuration should use only 3 elements
  - You will submit a single click file

Interaction Between Multiple Instances: Interfaces Use

- Click provides elements used to interact with the system network interfaces
  - Normally used to *intercept* or *inject* packets from and to the external world
- FromDevice (intercept): read packets from the device
  - Element with one outgoing push port
- ToDevice (inject): write packets into the device
  - Element with one incoming pull port
- We use our framework to run multiple click instances that interact using these elements
- Which interfaces to use?
  - We will provide scripts to simplify your life
  - Feel free to explore what these scripts do
- NOTE: when running a Click configuration that uses *FromDevice* or *ToDevice* you need to have sudo privileges (i.e. run click doing *sudo click configuration.click*)

Interaction Between Multiple Instances: Example

- Use provided script to create 2 virtual interfaces
  - Run: $ sudo createNet1
  - The script will create the virtual interfaces *veth1* and *veth2*
  - Run: $ ifconfig
  - You should see a list of available interfaces, complete with the their IP and MAC addresses
- Obtained topology

Interaction Between Multiple Instances: Example

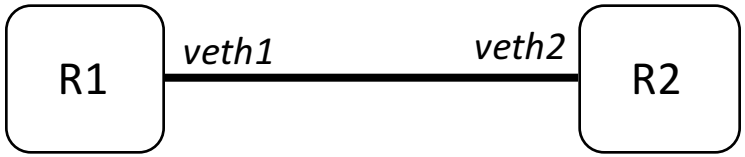
- The topology


```
ovs-bridge Link encap:Ethernet  HWaddr c2:90:e8:d6:b0:4c
          inet6 addr: fe80::98b9:56ff:fe6b:a88f/64 Scope:Link
          UP BROADCAST RUNNING  MTU:1500  Metric:1
          RX packets:12 errors:0 dropped:0 overruns:0 frame:0
          TX packets:6 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:1016 (1.0 KB)  TX bytes:508 (508.0 B)
veth1     Link encap:Ethernet  HWaddr 12:2e:d4:6a:ec:e8
          inet addr:192.168.1.1  Bcast:192.168.1.255  Mask:255.255.255.0
          inet6 addr: fe80::102e:d4ff:fe6a:ece8/64 Scope:Link
          UP BROADCAST RUNNING  MTU:1500  Metric:1
          RX packets:11 errors:0 dropped:0 overruns:0 frame:0
          TX packets:6 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:926 (926.0 B)  TX bytes:508 (508.0 B)

veth2     Link encap:Ethernet  HWaddr ae:1f:2e:01:b4:ca
          inet addr:192.168.1.2  Bcast:192.168.1.255  Mask:255.255.255.0
          inet6 addr: fe80::ac1f:2eff:fe01:b4ca/64 Scope:Link
          UP BROADCAST RUNNING  MTU:1500  Metric:1
          RX packets:10 errors:0 dropped:0 overruns:0 frame:0
          TX packets:6 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:836 (836.0 B)  TX bytes:508 (508.0 B)
comnetsii@comnetsII:~$
```

Interaction Between Multiple Instances: Example

- With the given topology:



- One click instance: generates packets and transmits them into the device
- Second click instance: reads the packets and print them
- Hints:
  - ***Ethernet*** and ***IP*** encapsulation? (all packets need a proper header)
  - Encapsulation elements are available and ready to be used.
  - The final product will be 2 different Click configuration files run by 2 separate Click instances in 2 separate consoles

Interaction Between Multiple Instances: Example

- Instance generating packets:

Source -> IPEncap(which parameters?) ->

EtherEncap(which parameters?) ->

ToDevice(veth1)

- Instance receiving packets:

FromDevice(veth2) -> Print

- What if you want to remove the IP and Ethernet headers?
- Source and Print are the elements you used in exercise 1

Interaction Between Multiple Instances: Example

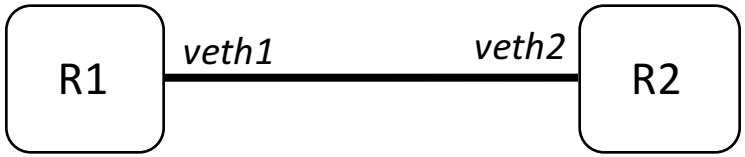
Demo

Multi-Directional Communications

- For now we only implemented a generator and a sink
- Normally a router processes packets and forwards them…

Exercise 2

- Same as exercise 2, but the message has to be echoed back to the origin router
- If you need to recreate the network, use the same script from the previous exercise



- Hints:
  - Nothing new, except for a bigger collection of elements

General Suggestions

- Get comfortable with the Virtual Machine as soon as possible
  - You do not want to get stuck at the last minute without even having the chance to do the exercises
- These exercises are just a Click warm up
  - There is a lot more to learn
  - Some will be covered in the next project
  - More exercises can be found here:
    - www.read.cs.ucla.edu/click/tutorial1
    - www.pats.ua.ac.be/software/click/

General Info

- Due: February 19th, by the end of the day
- Technical questions: use the **mailing list**. It is better for me, it is better for you.
- Submission instructions:
  - Submit a single archive (zip or tar.gz) to bronzino@winlab.rutgers.edu with subject "ECE544 Project 1"
  - Include in the archive 2 folders named "exercise1", "exercise2". They should contain only the click configuration files. If you want to include additional information, write a README file.
  - **Do not** include the whole click resources!

General Info

- Solutions will be posted on the mailing list on February 26th