

# Project 1

ECE544 Communication Networks II

Francesco Bronzino

Includes teaching material from Bart Braem and Michael  
Voorhaen

# Project Goals

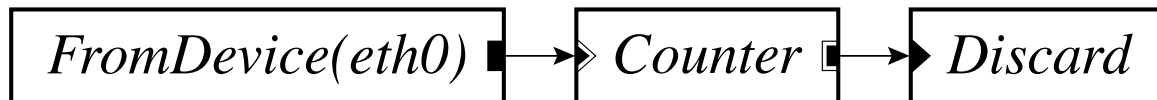
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- Get familiar with Click's environment
- Get familiar with our virtualized environment
- Practice with existing elements and create first running configurations
- Use existing interfaces to communicate between multiple click instances

# Click Routers: Main Concepts

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



# Intro to Configurations

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- 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

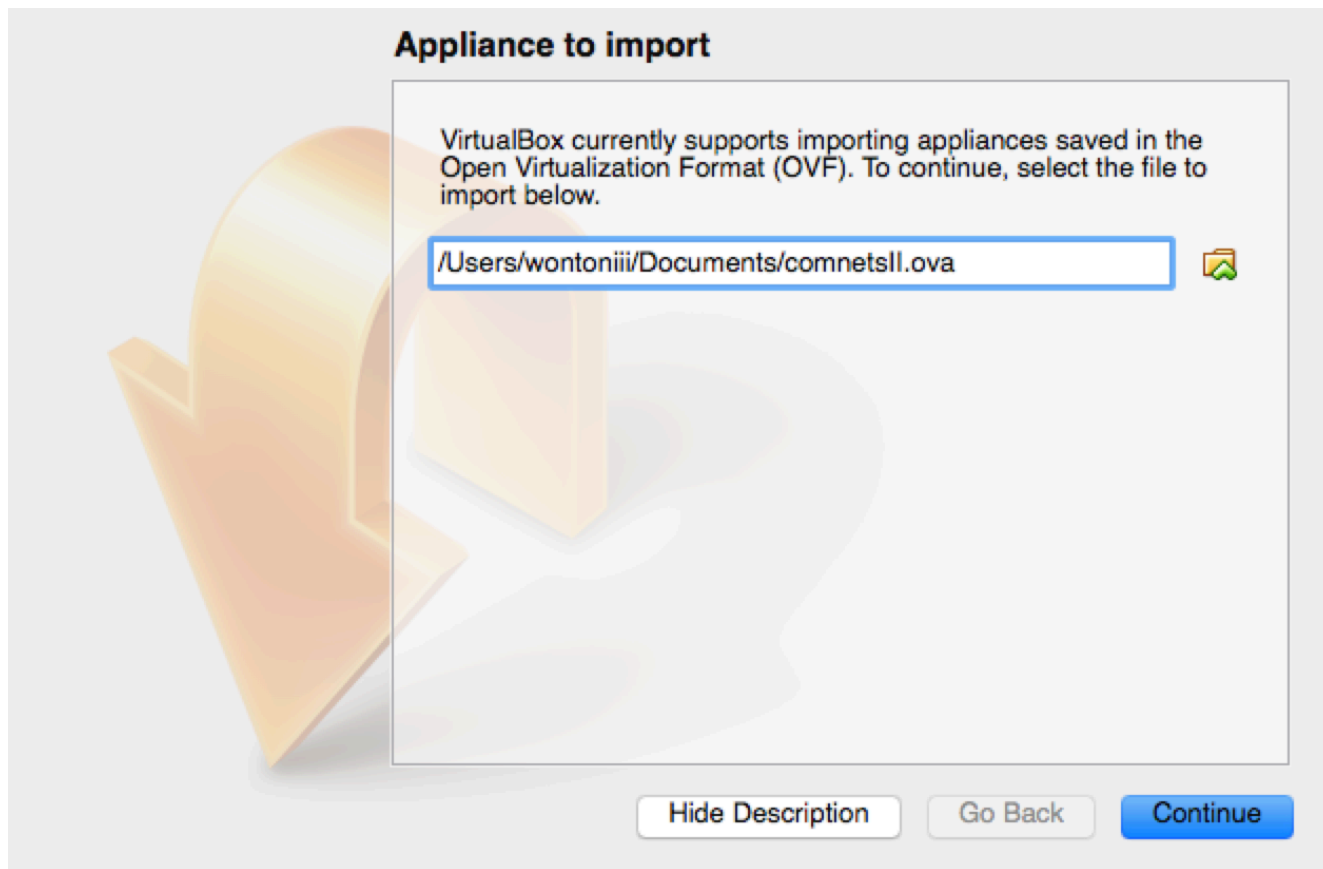
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- Download from:
  - <http://www.winlab.rutgers.edu/comnet2/Projects/downloads/comnetsII.ova>
- VM OVS Format compatible with most virtual environments.
- Suggestion: Virtual Box from Oracle. It is free, multiplatform.
- The following instructions will be based on Virtual Box.

# Loading the VM into VBox

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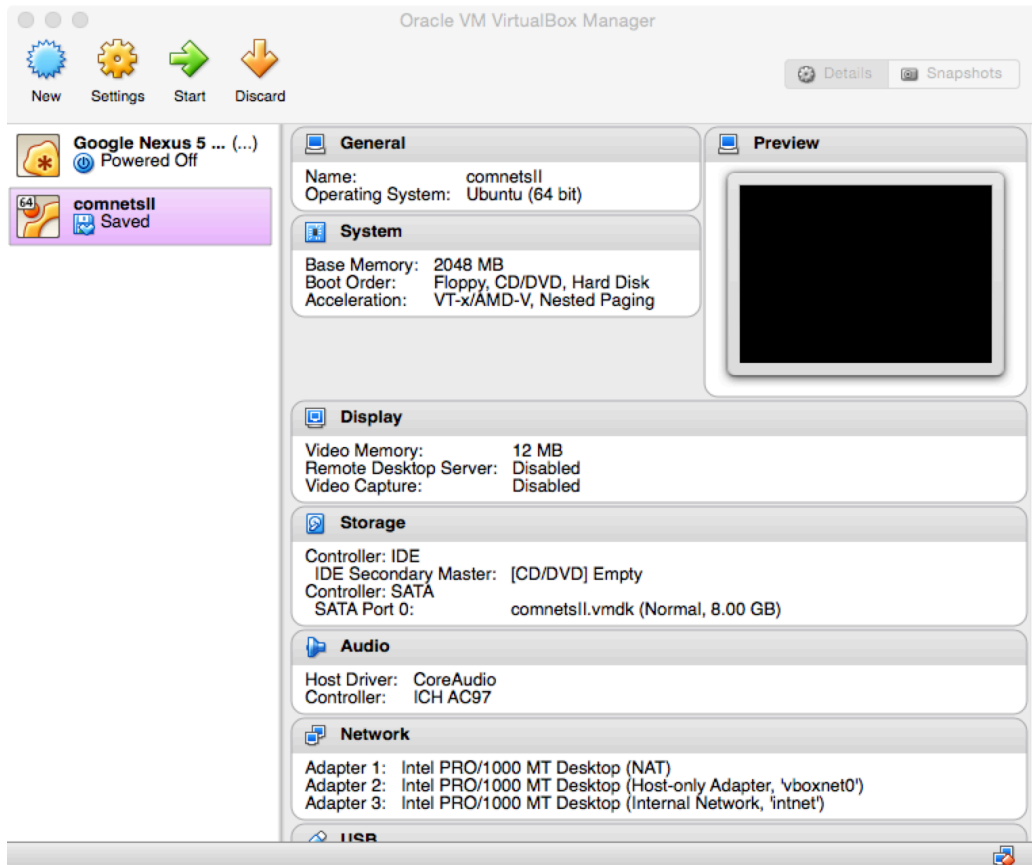
- File -> Import Appliance



# SSH into the VM

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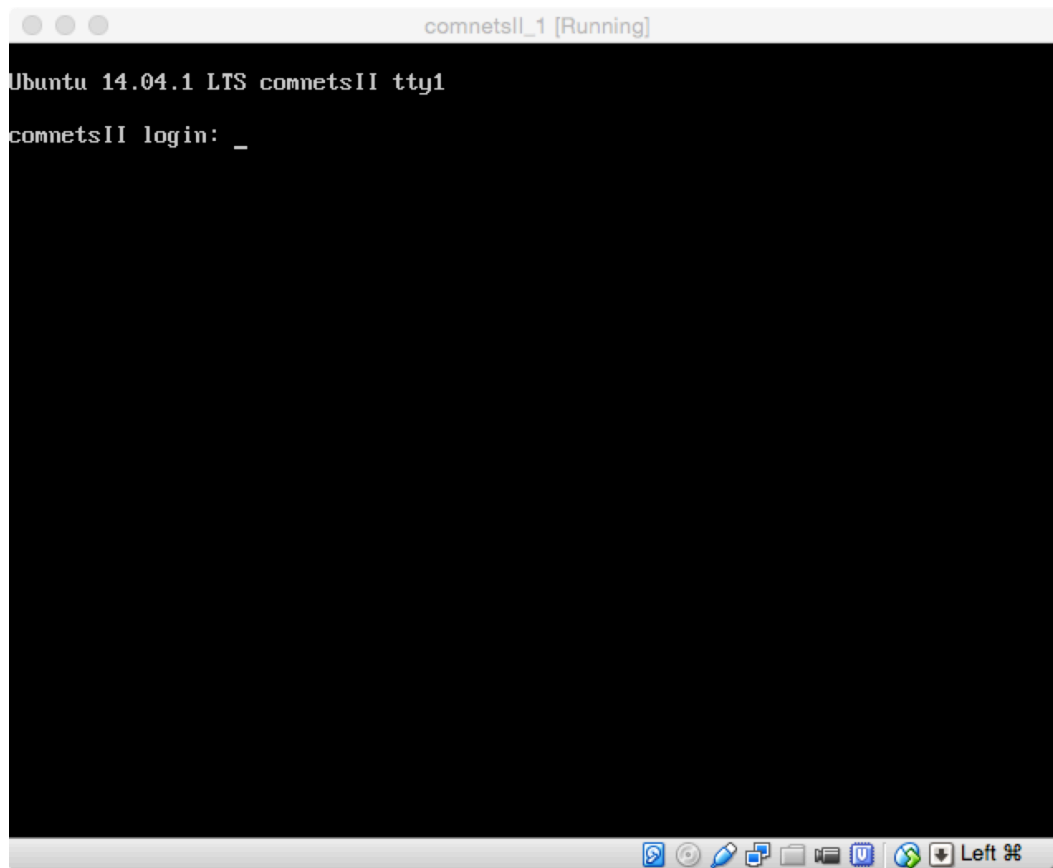
- Start the VM



# SSH into the VM

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- Login: username=comnetsii password=comnetsii



The image shows a terminal window titled 'comnetsII\_1 [Running]'. The terminal output is as follows:

```
Ubuntu 14.04.1 LTS comnetsII tty1
comnetsII login: _
```

The terminal window is set against a black background with white text. At the bottom of the window, there is a standard Linux desktop taskbar with various icons and the text 'Left ⌘'.



# SSH into the VM

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

```
comnetsii@comnetsII [Running]
comnetsii@comnetsII:~$ ifconfig
eth0      Link encap:Ethernet  HWaddr 08:00:27:9a:04:e5
          inet addr:10.0.2.15  Bcast:10.0.2.255  Mask:255.255.255.0
          inet6 addr: fe80::a00:27ff:fe9a:4e5/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:26 errors:0 dropped:0 overruns:0 frame:0
          TX packets:43 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:3517 (3.5 KB)  TX bytes:4073 (4.0 KB)

eth1      Link encap:Ethernet  HWaddr 08:00:27:3e:0b:11
          inet addr:192.168.56.101  Bcast:192.168.56.255  Mask:255.255.255.0
          inet6 addr: fe80::a00:27ff:fe3e:b11/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:2751 errors:0 dropped:0 overruns:0 frame:0
          TX packets:1036 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:283593 (283.5 KB)  TX bytes:131635 (131.6 KB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

comnetsii@comnetsII:~$
```

# SSH into the VM

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- You can now ssh into the VM from your hosting OS
- On Unix machines:
  - \$ ssh [comnetsii@192.168.56.101](mailto:comnetsii@192.168.56.101)
- On windows: use Putty or similar tools that provide ssh

# Available Resources

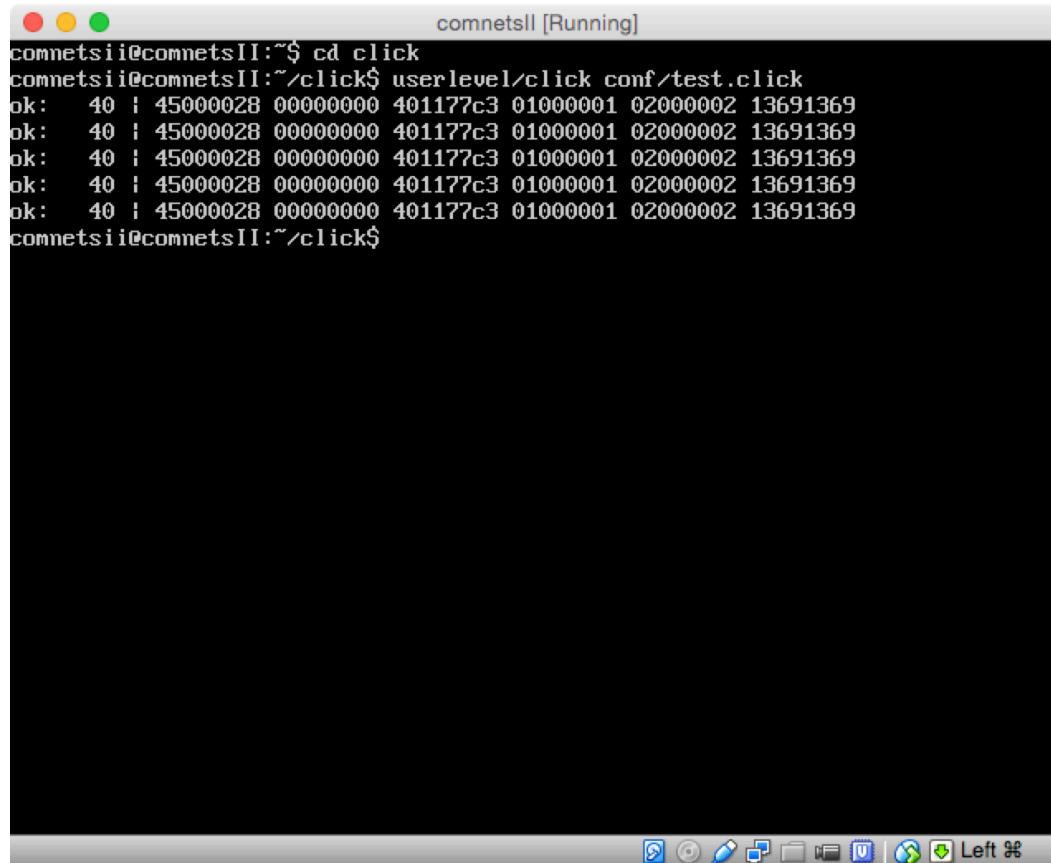
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- In the home folder you will find the following resources:
  - click: click sources and resources.
  - examples: small set of examples that can be used as reference
  - elements: a few provided elements used in the exercises
  - tools: script utilities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

# How to Run a Click Instance

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



```
comnetsii@comnetsII [Running]
comnetsii@comnetsII:~$ cd click
comnetsii@comnetsII:~/click$ userlevel/click conf/test.click
ok: 40 | 45000028 00000000 401177c3 01000001 02000002 13691369
ok: 40 | 45000028 00000000 401177c3 01000001 02000002 13691369
ok: 40 | 45000028 00000000 401177c3 01000001 02000002 13691369
ok: 40 | 45000028 00000000 401177c3 01000001 02000002 13691369
ok: 40 | 45000028 00000000 401177c3 01000001 02000002 13691369
comnetsii@comnetsII:~/click$
```

# Exercise 1

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- Single Click instance
- Create a new packet with payload “hello”
- Print its content to terminal
- Drop the packet
- Hints:
  - Only use of existing elements
  - Configuration should use 3 elements
  - Click provides a collection of “source” elements

# Interaction Between Multiple Instances: Interfaces Use

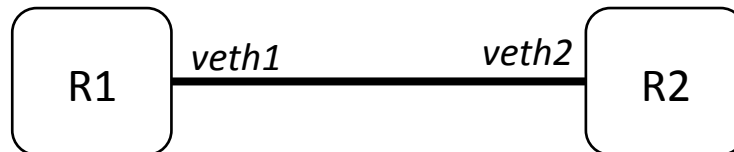
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- Click provides elements used to interact with the system network interfaces
- FromDevice: read packets from the device
  - Element with one outgoing push port
- ToDevice: write packets into the device
  - Element with one incoming pull port
- Multiple click instances can interact using these elements
- Which interfaces to use?
  - We will provide scripts to simplify your life
  - Feel free to explore what these scripts do

# Exercise 2

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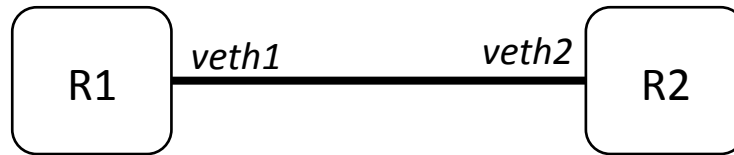
- Use provided script to create 2 virtual interfaces
  - Run: `$ sudo createNet1`
  - The script will create the virtual interfaces *veth1* and *veth2*
  - Run: `$ ifconfig`
  - You should see a list of available interfaces, complete with their IP and MAC addresses
- Obtained topology



# Exercise 2

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- 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?
  - Encapsulation elements are available and ready to be used.



# Multi-Directional Communications

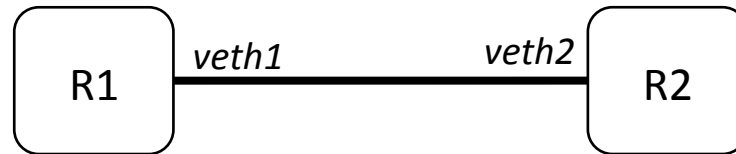
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- For now we only implemented a generator and a sink
- Normally a router processes packets and forwards them...

# Exercise 3

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- 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

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- 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:
    - <http://www.read.cs.ucla.edu/click/tutorial1>
    - <http://www.pats.ua.ac.be/software/click/>

# General Info

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- Due: March 13<sup>th</sup>, 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](mailto:bronzino@winlab.rutgers.edu) with subject “ECE544 Project 1”
  - Include in the archive 3 folders named “exercise1”, “exercise2”, “exercise3”. 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!