A brief tutorial for coursework

UG3 Computer Communications & Networks (COMN)

Myungjin Lee
myungjin.lee@ed.ac.uk

Coursework Overview

- Goal
  - Implementation and evaluation of three end-to-end reliable data transfer protocols
  - Stop-and-Wait, Go-back-N, and Selective Repeat
- Assessment: 40% of course mark
  - Part 1 (30%)
    - Part 1a (10%): rdt1.0
    - Part 1b (20%): rdt 3.0 (Stop-and-Wait)
  - Part 2 (70%)
    - Part 2a (30%): Go-back-N
    - Part 2b (40%): Selective Repeat + iperf experiment

Virtual Machine (VM) Setup

- Need Oracle's VirtualBox virtualization software

- VirtualBox exists by default on all DICE machines
- List of DICE machines can be found at
  https://piazza.com/class/j7a9hnwbwr626j?cid=16

- The VM image for the assignment
  - Can be accessed on DICE machines
  - Has dummynet link emulator and other relevant software

Creating VM

1. Log into a DICE machine
2. Open a terminal
3. Create a directory (e.g., comn-cwk) and ‘`cd`’ into it

```
mkdir comn-cwk

cd comn-cwk
```

4. mlee@dhcp-90-168: ~ (ssh)

```
mlee@dhcp-90-168:~$ ssh mlee23@staff.compute.inf.ed.ac.uk
mlee23@staff.compute.inf.ed.ac.uk's password:
Last login: Thu Oct  5 13:46:26 2017 from dhcp-90-168.inf.ed.ac.uk
This is staff.compute.inf.ed.ac.uk running Scientific Linux 7 (sl7) DICE.
Please 'nice' all processes to preserve a quick response
on the command line.  Use a nice value between 10 and 19. 'man nice' gives deta
ils.  Thanks.
[haight]mlee23:
```

Creating VM

1. Log into a DICE machine
2. Open a terminal
3. Create a directory (e.g., comn-cwk) and ‘`cd`’ into it

```
mkdir comn-cwk
cd comn-cwk
```

4. Issue the following command:

```
/disk/scratch/dummynet/createdummynetvm
```

4. mlee@dhcp-90-168: ~ (ssh)

```
#################################################################
#                                                               #
#   You don't appear to have a ~/.VirtualBox directory          #
#   Hit <Return> to initialize VirtualBox,                      #
#   (agree to the VirtualBox licence if asked)                  #
#   and then close VirtualBox.                                  #
#                                                               #
#################################################################

Hit <Return>...
```

Oracle VM VirtualBox Manager

File Machine Help

New Settings Discard Start Details Snapshots

Welcome to VirtualBox!

The left part of this window is a list of all virtual machines on your computer. The list is empty now because you haven't created any virtual machines yet.

In order to create a new virtual machine, press the **New** button in the main tool bar located at the top of the window.

You can press the **F1** key to get instant help, or visit www.virtualbox.org for the latest information and news.

4. mlee@dhcp-90-168: ~ (ssh)

```
3. Downloading the disk image...                                    [   OK
  ]
4. Registering hard disks...                                        [   OK
  ]
5. Setting-up shared folder (dummynetshared)...                     [   OK
  ]

    Your virtual machine 'DummynetSL6' is now ready.
    You can start the VM with './startvm.sh' or 'VirtualBox'.

    As root, use "mount -t vboxsf dummynetshared /mnt/shared"
    to mount the folder "/afs/inf.ed.ac.uk/user/m/mlee23/comn-cwk/dummynetshare
d" on the VM.
    Your shared folder is '/mnt/shared' on the VM.

    ##################################################################
    #                                                                #
    #   Put your data in '/work' or in '/mnt/shared' -               #
    #   otherwise data will be lost when you close the VM.           #
    #                                                                #
    ##################################################################

[evert]mlee23:
```

4. mlee@dhcp-90-168: ~ (ssh)

```
[evert]mlee23: pwd
/afs/inf.ed.ac.uk/user/m/mlee23/comn-cwk
[evert]mlee23: ls
dummynetshared  DummynetSL6  dummynetwork.vdi  startvm.sh
[evert]mlee23:
```

Creating and Starting VM

1. Log into a DICE machine
2. Open a terminal
3. Create a directory (e.g., comn-cwk) and ‘`cd`’ into it

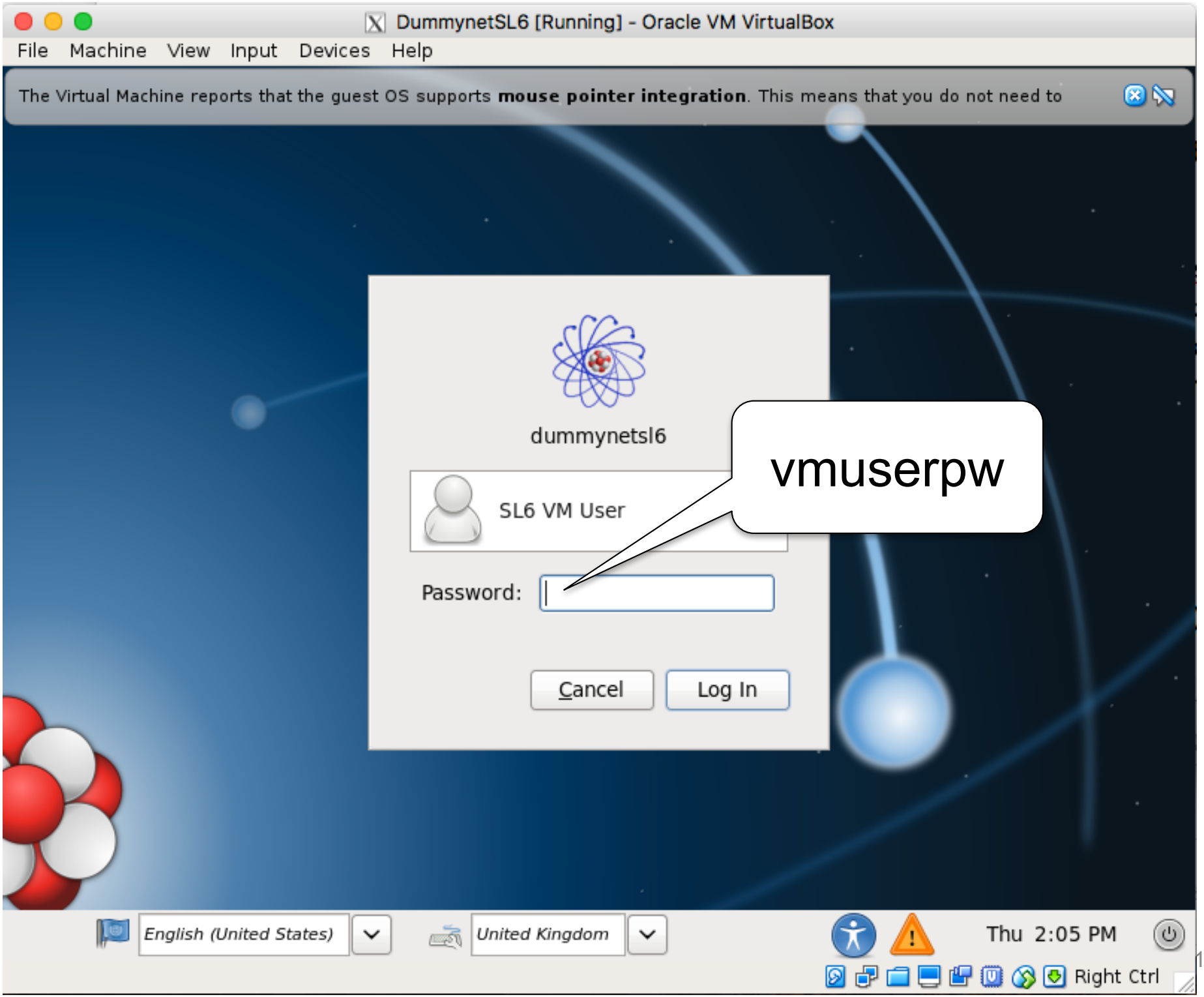
```
mkdir comn-cwk
cd comn-cwk
```

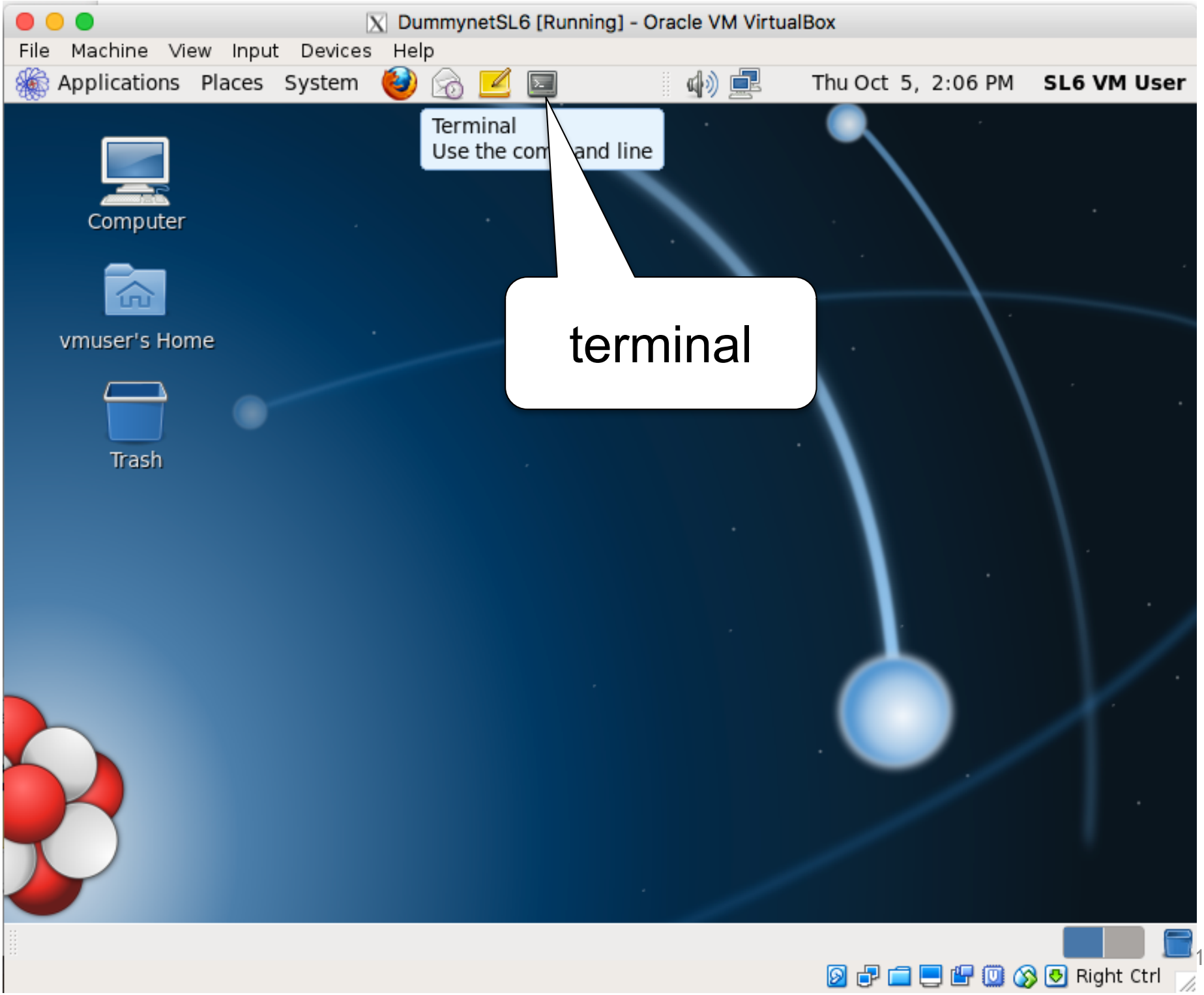
4. Issue the following command:

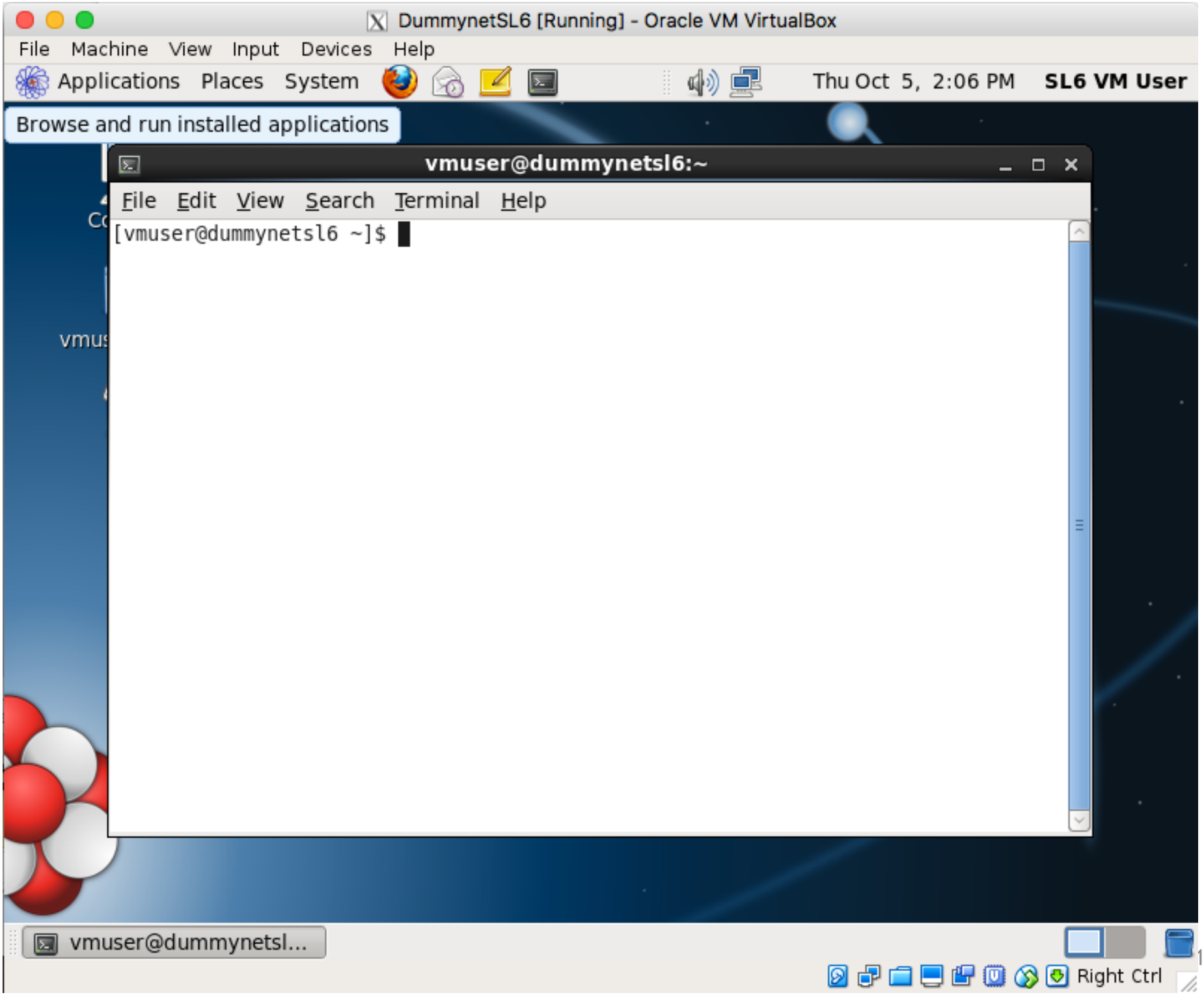
```
/disk/scratch/dummynet/createdummynetvm
```

5. Run the following command:

```
./startvm.sh
```


DummynetSL6 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
The Virtual Machine reports that the guest OS supports mouse pointer integration. This means that you do not need to
dummynetsl6
SL6 VM User
vmuserpw
Password:
Cancel
Log In
English (United States)
United Kingdom
Thu 2:05 PM
Right Ctrl


DummynetSL6 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Applications Places System
Thu Oct 5, 2:06 PM
SL6 VM User
Terminal
Use the com and line
terminal
Computer
vmuser's Home
Trash
Right Ctrl


DummynetSL6 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Applications Places System
Thu Oct 5, 2:06 PM
SL6 VM User
Browse and run installed applications
vmuser@dummynetsl6:~
File Edit View Search Terminal Help
[vmuser@dummynetsl6 ~]$
vmuser@dummynetsl...
Right Ctrl

How to shut down VM

- Become a root using ‘`su`’
  - Root password: vmrootpw

    `su`
- Run the following command:

    `shutdown –h now`

Shared Folder

- When the VM is set up for you, a directory called "dummynetshared" gets created in your assignment directory

- You can mount this in the VM by (as root):

```
mount -t vboxsf dummynetshared /mnt/shared
```

Running VM on Your Computer

1. VirtualBox should be installed on your local machine
2. Download ‘comnvm.tar.gz’ from one of two places
   - /disk/scratch/dummynet/ on DICE machine
   - https://goo.gl/gcwQAT
3. Uncompress the file

Running VM on Your Computer

4. In the folder, open a terminal and run the following command:
   - For linux and Mac OS

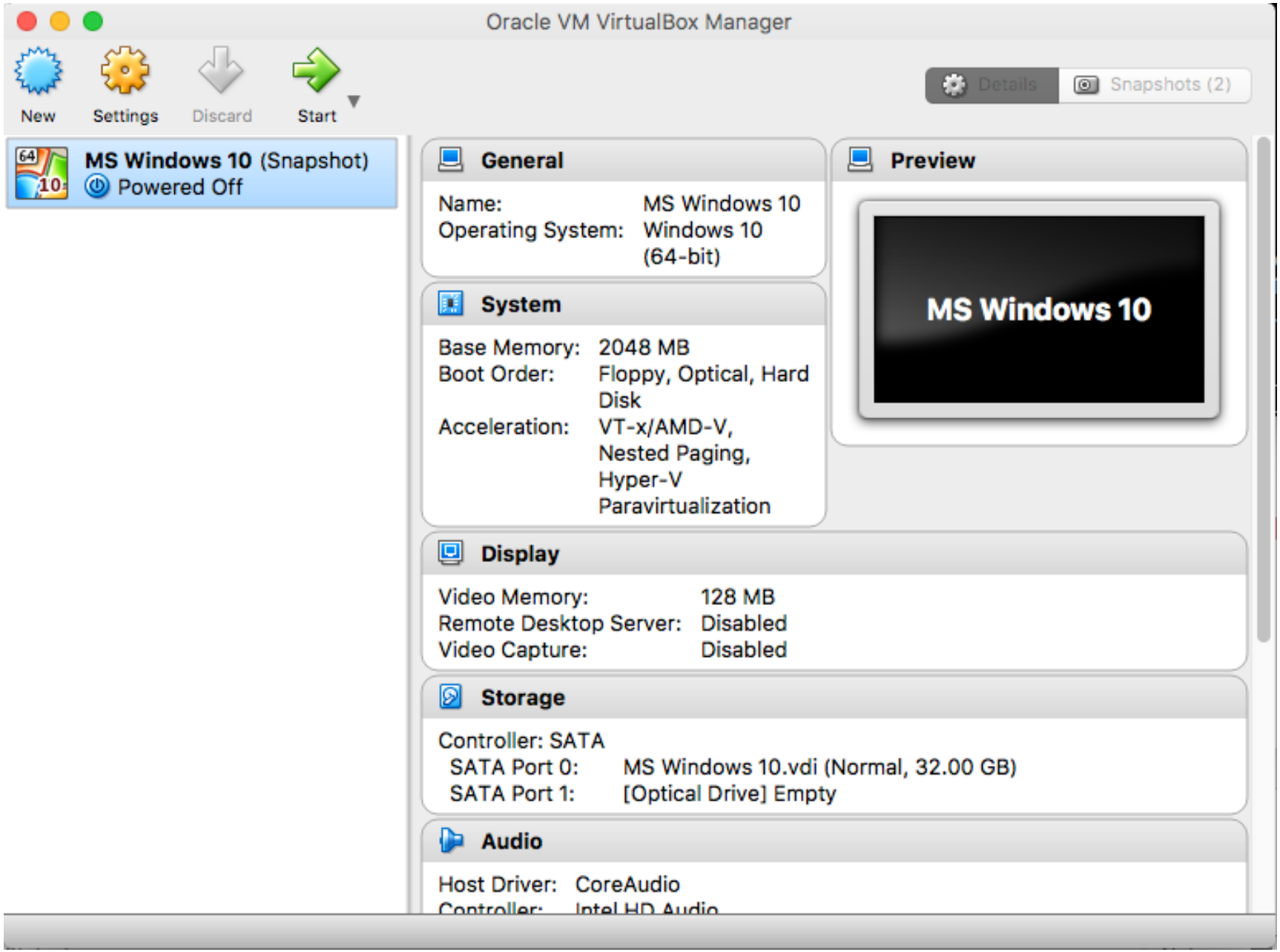
     ```
     ./configvm.sh
     ```

   - For MS Windows

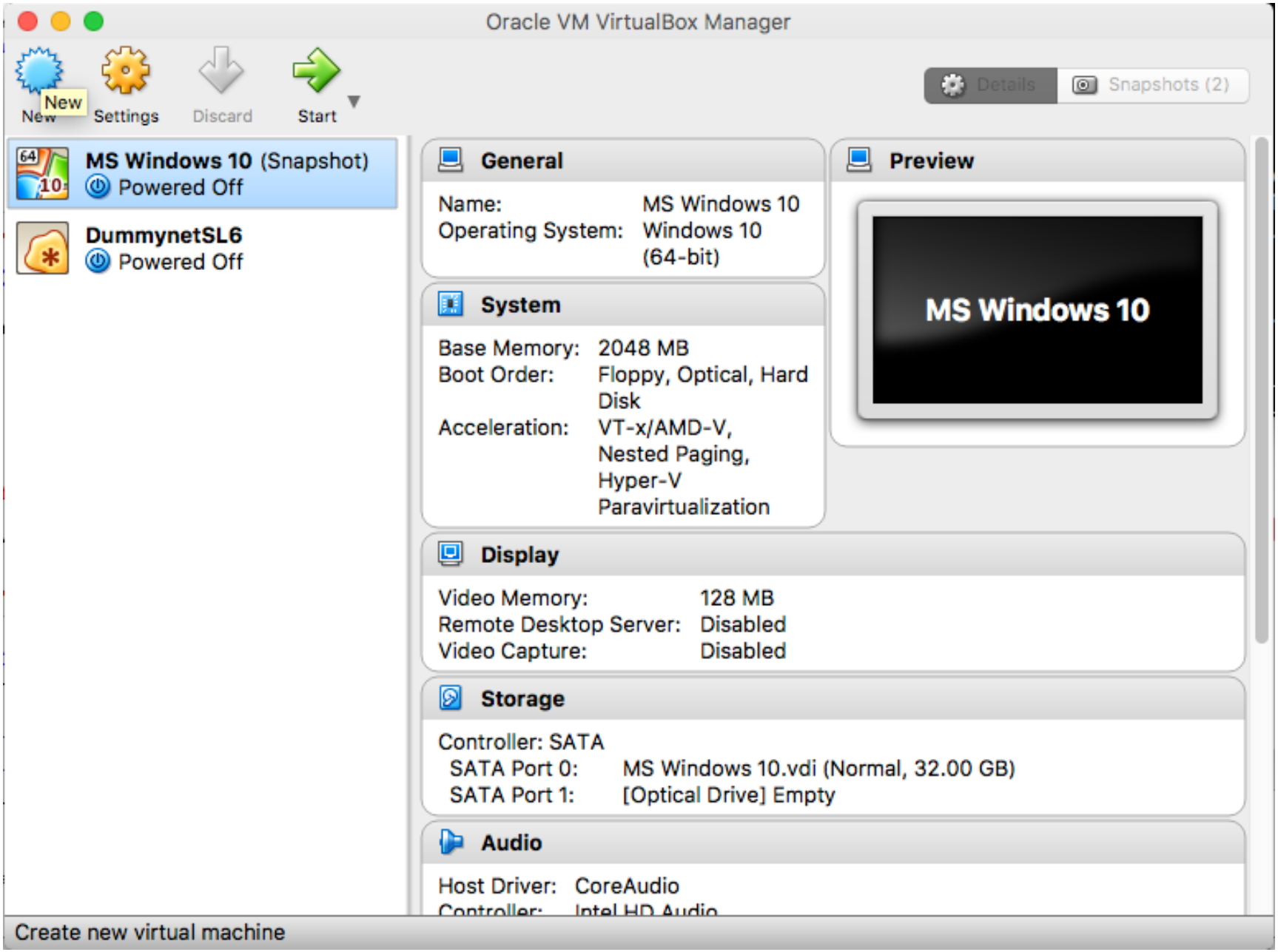
     ```
     ./configvm.bat
     ```

- Make sure that your implementations run correctly on VM in DICE machine
- For more details, refer to README

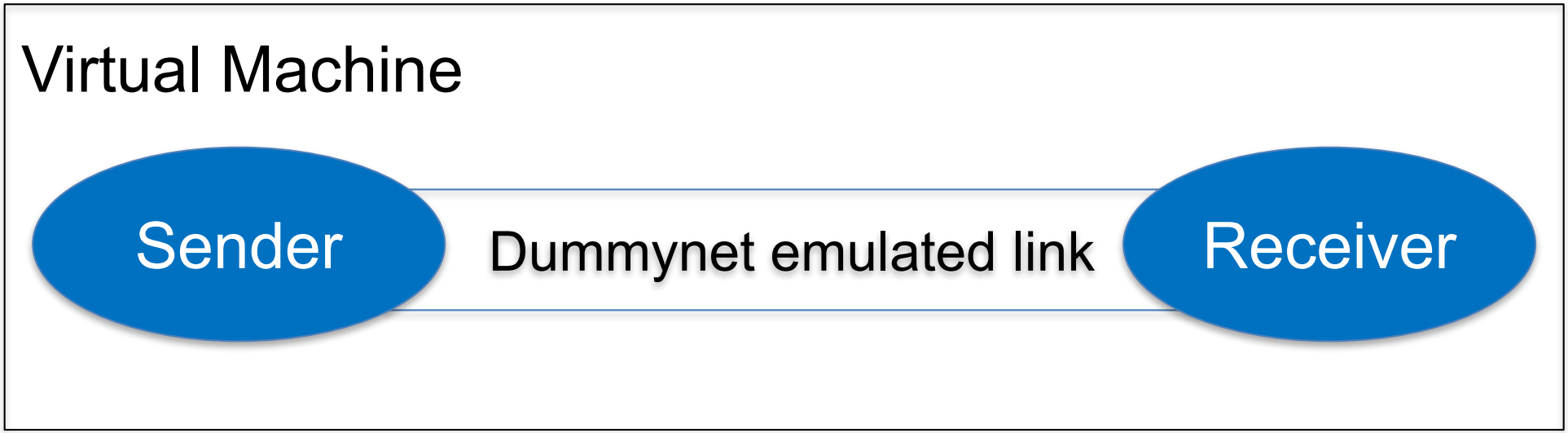
Before Running configvm.sh (or .bat)



After Running configvm.sh (or .bat)

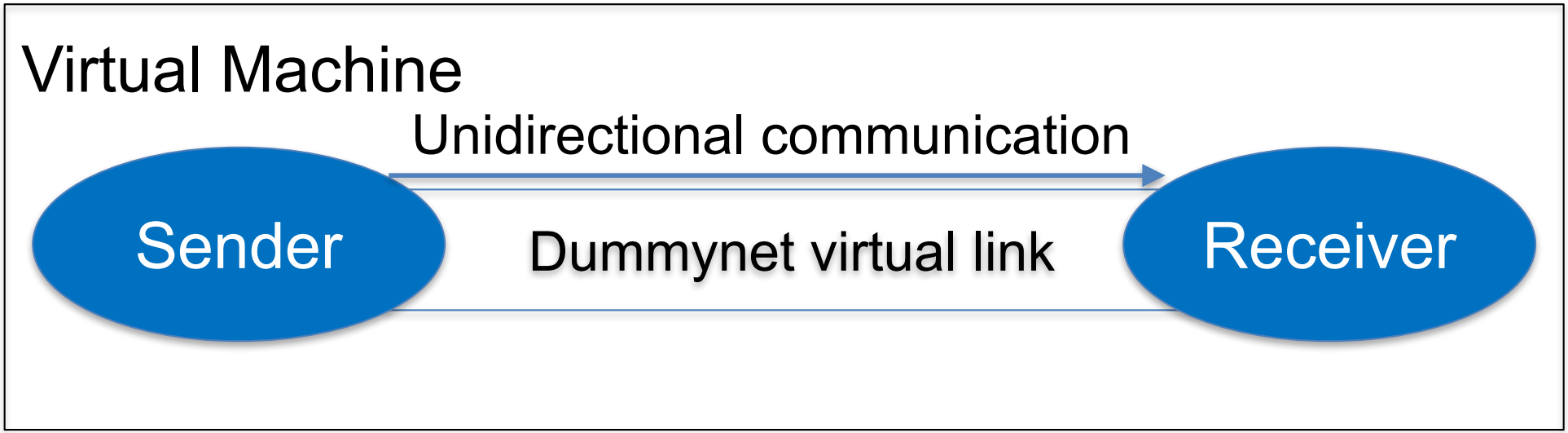


Conceptual Structure



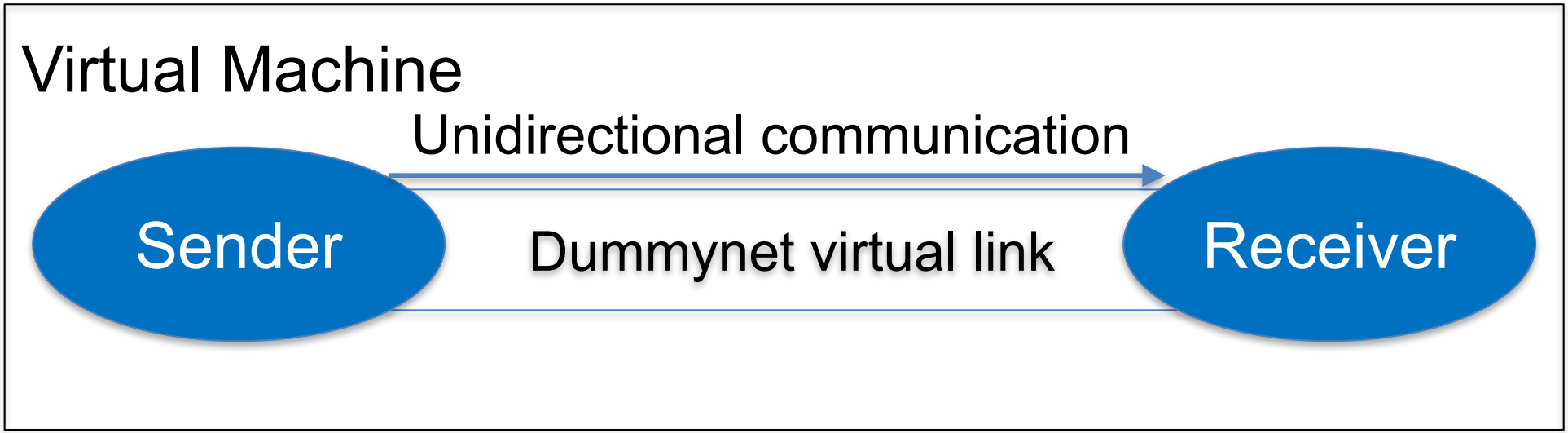
- Dummynet
  - Creates emulated network link(s)
  - Configuration of link characteristics (BW, delay, loss)
  - Command-line program: *ipfw*

Conceptual Structure



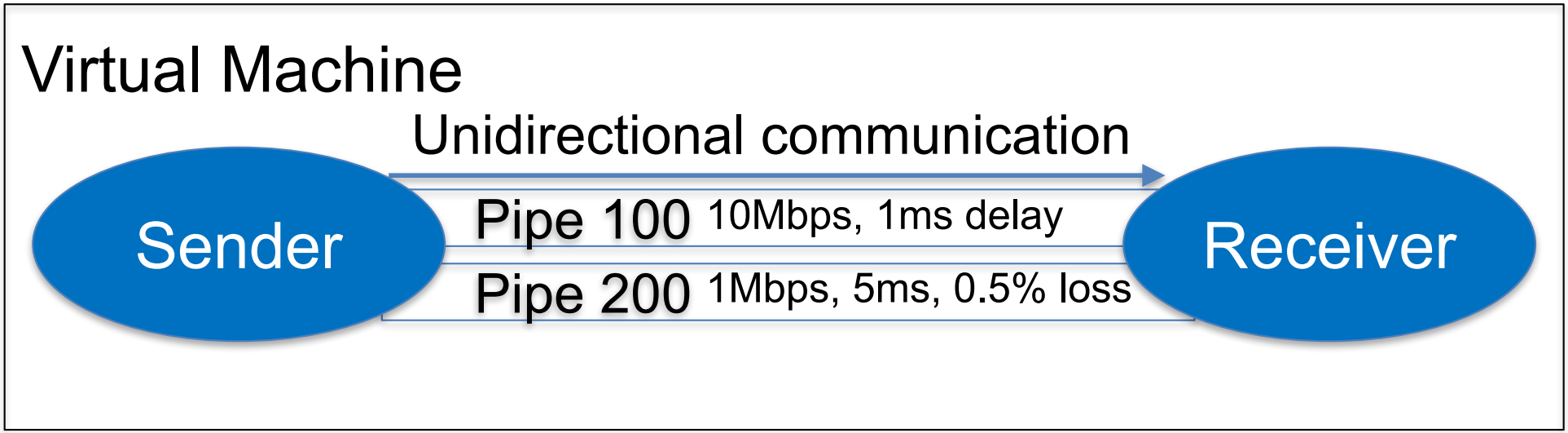
- Sender
  - Reads a file and breaks it into a number of packets
  - Sends the packets to a receiver over a simulated network link
- Receiver
  - Receives the packets; extracts data in the packets; and saves the data in a file

Conceptual Structure



- Sender and Receiver
  - Support reliable data transfer protocol at the application layer using UDP

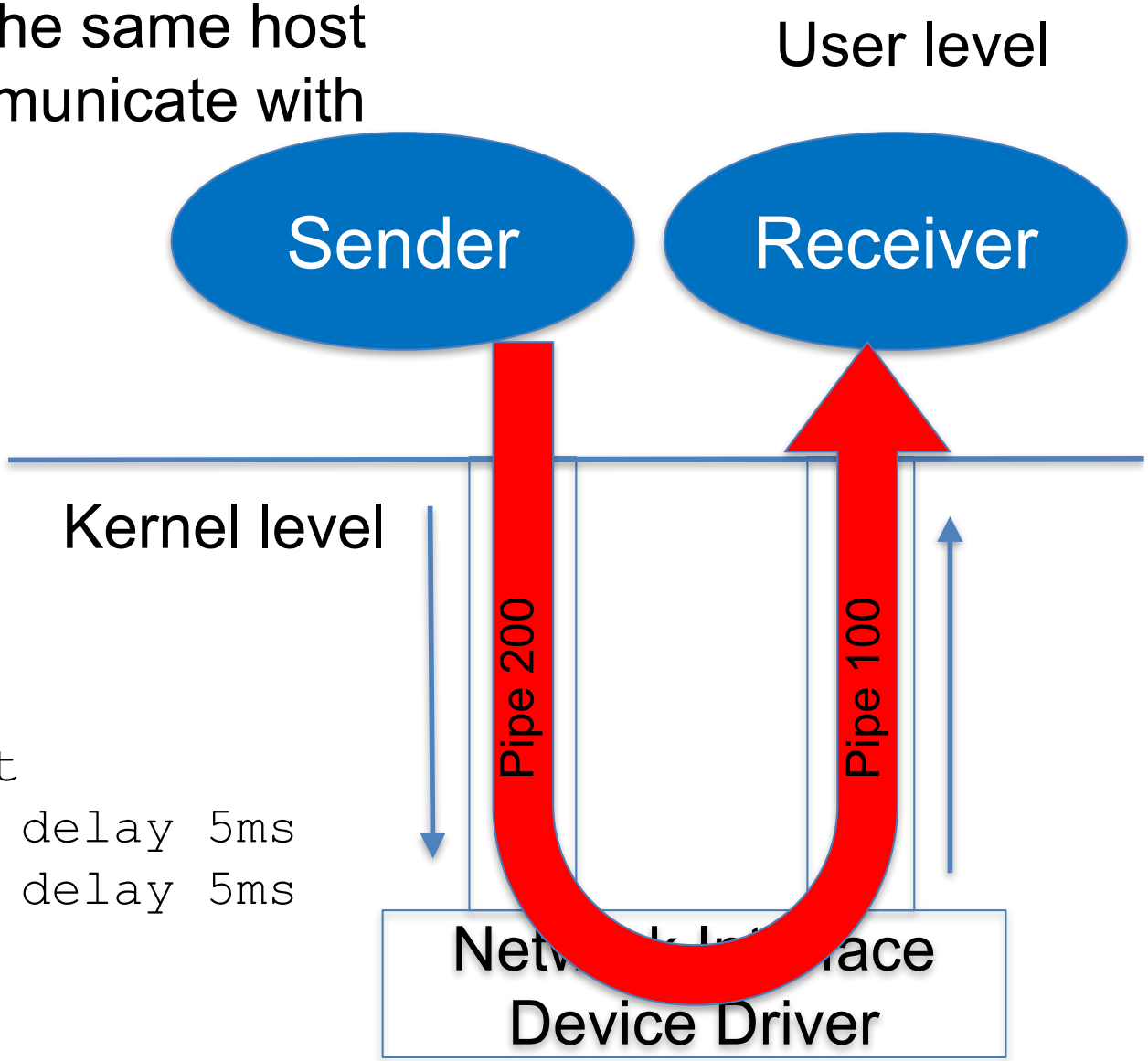
Dummynet Configuration Example




```
% ipfw add pipe 100 in
% ipfw add pipe 200 out
% ipfw pipe 100 config delay 1ms bw 10Mbits/s
% ipfw pipe 200 config delay 5ms plr 0.005 bw 1Mbits/s
```

Effect of Dummynet

When processes within the same host (or virtual machine) communicate with each other




```
% ipfw add pipe 100 in
% ipfw add pipe 200 out
% ipfw pipe 100 config delay 5ms
% ipfw pipe 200 config delay 5ms
```

Miscellaneous

- Binary programs for the assignment are available at https://drive.google.com/drive/folders/0B6rUEJFM3QjTdkkxT21XclNtcUU?usp=sharing
  - First read README file
  - Sender1b, Receiver1b, Sender2a, Receiver2a, Sender2b and Receiver2b
  - Use these binary programs ONLY FOR debugging your implementations
  - Using them for other purposes is completely prohibited

Miscellaneous

- Some essential Java packages for the assignment
  - java.io.File
  - java.io.FileInputStream
  - java.io.FileOutputStream
  - java.net.DatagramPacket
  - java.net.DatagramSocket
  - java.net.InetAddress

- FAQs on the assignment available at https://piazza.com/class/j7a9hnwbwr626j?cid=19

Header format

- The following formats should be used for both parts
  - Exception: no ACK packets for part1a

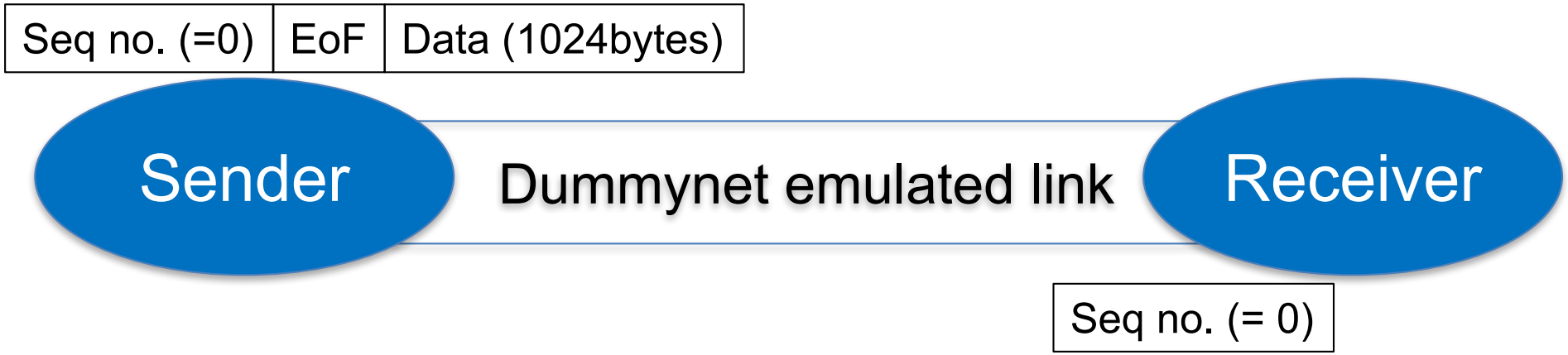
Data packet (sender → receiver)

Offset	Octet	0	1	2	3 ~ up to 1026
		16-bit sequence number		8-bit EoF flag	Data

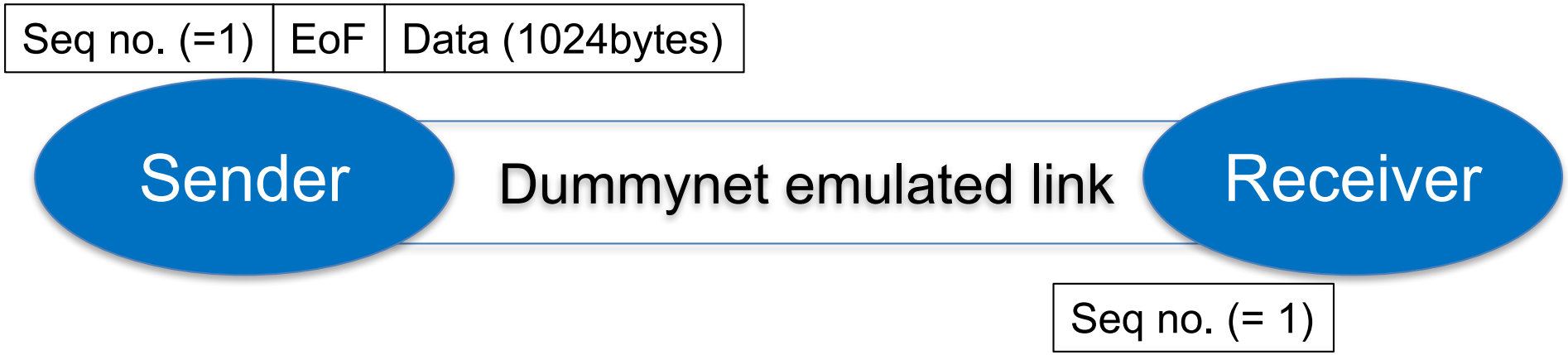
ACK packet (receiver → sender)

Offset	Octet	0	1
		16-bit sequence number	

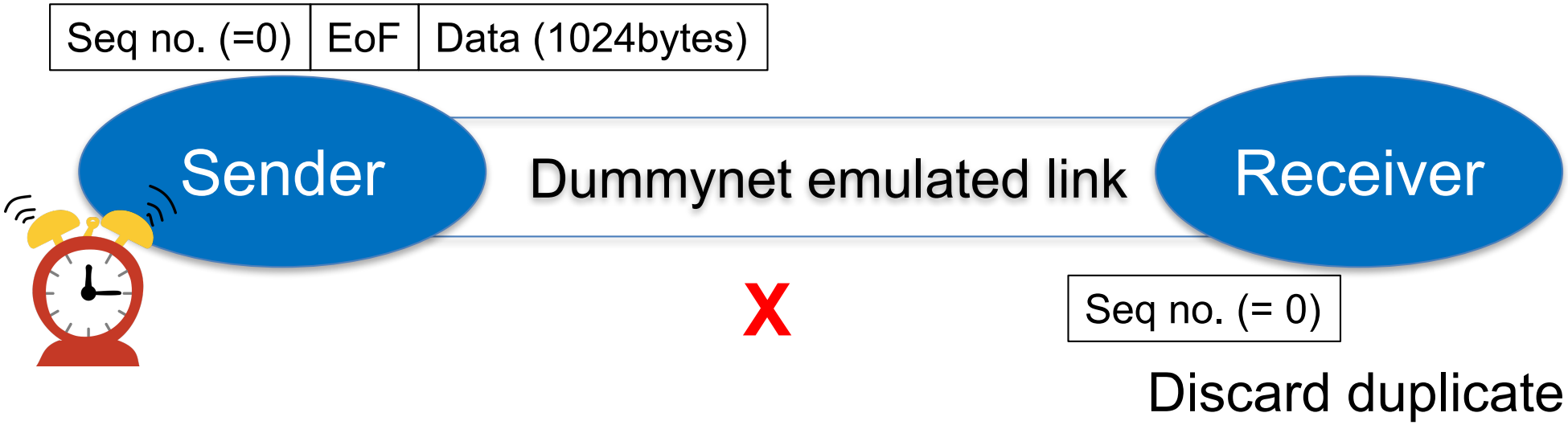
Example scenario for Part 1b



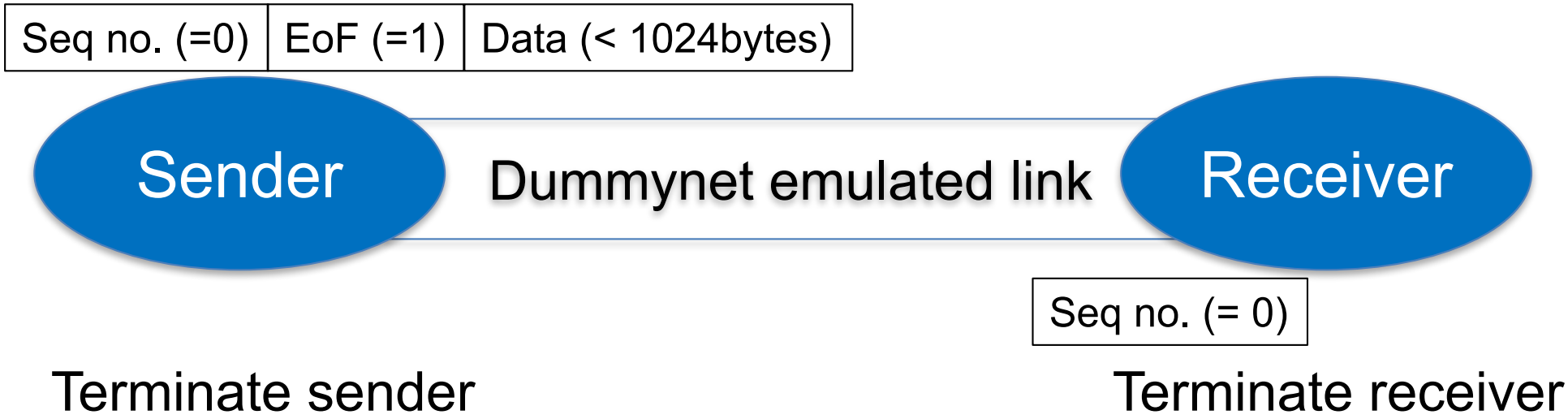
Example scenario for Part 1b



Example scenario for Part 1b



Example scenario for Part 1b



Q&A