

## Introduction to Systems Programming (System I)

### Lab #4

Max Points: 50

You should save/rename this document using the naming convention **MUId.docx** (example: ahmede.docx).

**Objective:** The objective of this exercise is to:

1. Explore tools associated with the Mac layer and Network layers
2. Experiment with domain name resolution using Linux tools `dig`.
3. Experiment with HTTP protocol using `telnet` and `wget`.
4. Experiment with HTTP GET method to fetch Web Site

Fill in answers to all of the questions. For some of the questions you can simply copy-paste appropriate text from the terminal/output window into this document. You may discuss the questions with your instructor.

**Name:** Ben Hilger



**Wait for your instructor to indicate when you can start working on each part of this exercise.** Your instructor will cover necessary concepts prior to working on this laboratory exercise. Your instructor may ask you work on one question at a time before moving on to the next question.

### Part #1: Using `ifconfig` to find MAC and IP address

*Estimated time: 12 minutes*

**Background:** Linux & Mac provides a command called `ifconfig` that displays information on all networking devices on a given computer. This command is handy to find out information about hardware and IP addresses of various devices on the computer.

**Exercise:** Find the Mac and IP address of the Ethernet device on `osl.csi.miamioh.edu` using the following procedure:

1. From a Powershell/Terminal `ssh` into `osl.csi.miamioh.edu`.
2. At the shell prompt run `ifconfig` as shown below and record the necessary information from its output in the table further below:

```
$ ifconfig
```

**Number of devices:**

2

**Information on 1<sup>st</sup> device**

Mac (ether) address: 00:50:56:87:ca:51

IP (inet) address: 172.17.0.58

**Information on 2<sup>nd</sup> device**

Mac (ether) address: none

IP address: 172.0.0.1

3. In the space below briefly (1 or 2 sentences) describe what a loopback (lo) device is and what is the typical loopback IP address?

A loopback device is a virtual device associated with the computer that's mainly used for troubleshooting and local communication on your computer and isn't associated with any hardware and can operate without any wired or wireless connection. A typical loopback IP address is 127.0.0.1.

4. In the space below briefly answer the following questions:

4.a. What network-layer is the MAC (or Ethernet) address associated with?

MAC is associated with the second network layer, which is the Data Link Layer

4.b. What network-layer is the IP address associated with?

IP is associated with the third network layer, which is the Network Layer

## **Part #2: Tracing route to a host**

*Estimated time: 12 minutes*

**Background:** Similar to ping, the Internet Control Message Protocol (ICMP) can be used to trace the route in which packets are currently taking (routes can and do change) to reach a destination. The route includes intermediate routers (that respond to ICMP requests) and other IP devices through which a packet is traversing.

**Exercise:** Trace the route from `os1.csi` to [www.google.com](http://www.google.com) using the following procedure:

1. From a Terminal `ssh` into `os1.csi.miamioh.edu`.
2. At the shell prompt run `tracert` as shown below:

```
$ tracert www.google.com
```

3. Copy-paste the route into the space below:

```
tracert to www.google.com (172.217.4.228), 30 hops max, 60 byte packets
 0  _gateway (172.17.0.254)  0.129 ms  0.118 ms  0.097 ms
 1  134.53.148.254 (134.53.148.254)  0.992 ms  0.983 ms  0.966 ms
 2  hythubrou004-2 (172.18.253.97)  1.413 ms  1.391 ms  1.490 ms
 3  172.18.253.130 (172.18.253.130)  1.268 ms  1.241 ms  1.227 ms
 4  134.53.202.254 (134.53.202.254)  1.905 ms  2.008 ms  1.992 ms
 5  cncnc-r5-et-3-3-0s285.core.oar.net (199.18.164.17)  3.626 ms  3.597 ms  3.794 ms
 6  cncno-r5-et-1-0-0s100.core.oar.net (199.218.20.114)  3.616 ms  3.912 ms  3.883 ms
 7  et-8-0-0.1243.rtsw.cinc.net.internet2.edu (64.57.29.65)  3.858 ms  3.620 ms  3.628 ms
 8  ae-2.4079.rtsw.indi.net.internet2.edu (162.252.70.87)  6.315 ms  6.287 ms  6.255 ms
 9  ae-5.4079.rtsw.chic.net.internet2.edu (162.252.70.152)  9.533 ms  9.516 ms  9.489 ms
10  lo-0.8.rtsw3.eqch.net.internet2.edu (64.57.20.28)  51.545 ms  51.745 ms  51.616 ms
11  72.14.216.92 (72.14.216.92)  9.823 ms * 9.718 ms
12  108.170.243.174 (108.170.243.174)  10.795 ms  108.170.243.193 (108.170.243.193)
    26.457 ms  26.217 ms
13  108.170.233.85 (108.170.233.85)  9.802 ms  9.449 ms  108.170.233.87 (108.170.233.87)
    26.041 ms
14  ord30s31-in-f228.1e100.net (172.217.4.228)  25.784 ms  25.798 ms  25.764 ms
```

### **Part #3: Using ping to estimate communication latency**

*Estimated time: 10 minutes*

#### **Background**

The command `ping` is available on Linux, Mac, and Windows. `ping` uses the Internet Control Message Protocol (ICMP's) mandatory ECHO request datagram to elicit an ICMP ECHO response from a host or gateway. The ECHO request datagrams ("pings") have an IP and ICMP header, followed by a timestamp. On receiving the echo response the timestamp (that was sent before in request) is compared with local system time to estimate Round Trip Time (RTT) between your computer and the destination computer.

#### **Key aspects to note:**

- ICMP works at the network layer. So it does not have port numbers
- ICMP measures Round Trip Time (RTT) which can vary between packets
- Not all hosts may respond to ICMP ping requests as security measure

### Exercise

By suitably modifying the following ping command estimate and record the average Round Trip Time (RTT) [**reported in the last line of ping output**] to the hosts shown in the table further below:

```
$ ping -c 10 <HostName>
```

Host	Estimated RTT
www.miamioh.edu	1.047ms
www.yahoo.com	30.468ms
cds.cern.ch	114.015ms
www.shu.edu.cn	233.115ms

Using the statistics from ping answer the following questions:

Which server is the closest? **Why?**

[www.miamioh.edu](http://www.miamioh.edu), because it had the lowest average RTT of 1.047ms whereas the other servers had a time of 30.468ms, 114.015ms, and 233.115ms respectively showing that this server has the lowest latency.

Which server is the furthest one? **Why?**

[www.shu.edu.cn](http://www.shu.edu.cn), because it has the highest average RTT of 233.115ms whereas the other servers had a time of 1.047ms, 30.468ms, and 114.015ms respectively showing that this server has the highest latency.

Assume two servers have exactly the same information. They also have exactly same average ping times as shown in the table below:

Host	Estimated RTT
Server1	min/avg/max/mdev = 4/ <b>5</b> /10/2 ms
Server2	min/avg/max/mdev = 5/ <b>5</b> /9/4 ms

Which one of the above 2 servers would be a better one to use? **Why?**

The first server would be better to use because it has a lower min ping time and a lower mdev, which means it'll be more consistent than Server2.

## Part #4: Query name servers to resolve domain names

*Estimated time: 10 minutes*

### Background

Linux provides a command called `dig` that can be used to query DNS records on name servers. This command is used to determine the IP address for a given Host.

### **Exercise**

Using the `dig` command discussed in class, use `dig` to resolve the IP address for the following domain names:

Host name. <b>Note: here www is name of a machine!</b>	The dig command as typed in the terminal.	IP selected from dig output
<a href="http://www.miamioh.edu">www.miamioh.edu</a>	<code>dig +short www.miamioh.edu</code>	10.5.32.12
<a href="http://www.gnu.org">www.gnu.org</a>	<code>dig +short www.gnu.org</code>	209.51.188.148
<a href="http://www.gov.cn">www.gov.cn</a>	<code>dig +short www.gov.cn</code>	65.153.158.203 65.153.158.200 65.153.158.199 65.153.158.202 65.153.158.204 65.153.158.198 65.153.158.201

## **Part #5: Experimenting with HTTP**

*Estimated time: 12 minutes*

**Background:** A web-server is an application layer program that processes HTTP requests and generates responses. Recollect that HTTP is a multi-line text protocol that is used by web-browsers to interact with web-servers. In this homework you will be developing a program to respond to HTTP requests. Overall this program is essentially just string processing from I/O streams.

Because HTTP is an ASCII protocol, it is easy for a person at a terminal (as opposed to a browser) to directly talk to Web server. All that is needed is a TCP connection to port 80 on the server. Experiment with the following command sequence. It will work in most UNIX/Linux shells and the command window on Windows (once the telnet program is enabled).

```
telnet gaia.cs.umass.edu 80
GET /kurose_ross/interactive/index.php HTTP/1.1
Host:gaia.cs.umass.edu
```

---

This sequence of commands starts up a telnet (i.e., TCP) connection to port 80 on umass's Web server, gaia.cs.umass.edu. Then comes the GET command naming the path of the URL and the protocol. The next line is the mandatory *Host* header. A blank line following the last header is mandatory. It tells the server that there are no more request headers. The server will then send the response. Depending on the server and the URL, many different kinds of headers and pages can be observed.

You may try the following server and URL as well:

```
telnet cis.poly.edu 80
GET /~ross/ HTTP/1.1
Host:cis.poly.edu
```

---

Attach in the report what you get from above two sites.

### From First Website:

```
hilgerbj@os1:~$ telnet gaia.cs.umass.edu 80
```

```
Trying 128.119.245.12...
```

```
Connected to gaia.cs.umass.edu.
```

```
Escape character is '^['.
```

```
GET /kurose_ross/interactive/index.php HTTP/1.1
```

```
Host:gaia.cs.umass.edu
```

```
HTTP/1.1 200 OK
```

```
Date: Tue, 03 Mar 2020 15:59:14 GMT
```

```
Server: Apache/2.4.6 (CentOS) OpenSSL/1.0.2k-fips PHP/5.4.16 mod_perl/2.0.11 Perl/v5.16.3
```

```
X-Powered-By: PHP/5.4.16
```

```
Content-Length: 7097
```

```
Content-Type: text/html; charset=UTF-8
```

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN" "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
```

```
<html xmlns="http://www.w3.org/1999/xhtml">
```

```
<head>
```

```
<meta http-equiv="content-type" content="text/html; charset=utf-8" />
```

```
<title>Interactive Problems, Computer Networking: A Top Down Approach</title>
```

```
<meta name="keywords" content="" />
```

```
<meta name="description" content="" />
```

```
<link href="default.css" rel="stylesheet" type="text/css" />
</head>
<body>
<table width="780" border="0" align="center" cellpadding="0" cellspacing="0" class="bg1">
  <tr>
    <td>
      <table border="0" cellpadding="0" cellspacing="0" width="780">
        <tbody>
          <tr>
            <td height="22" colspan="3" valign="top"></td>
            <td></td>
          </tr>
          <tr>
            <td height="138" valign="top" width=610>
              <p class="text7" ><br />
                <font face="Arial, Helvetica, sans-serif" size="5">Interactive end-of-chapter exercises </font><br>
                <font face="Arial, Helvetica, sans-serif" size="4"><font size="3">Supplement to <i><a>
...

```

## From second website

hilgerbj@os1:~\$ telnet cis.poly.edu 80

Trying 128.238.26.21...

Connected to cis.poly.edu.

Escape character is '^['.

GET /~ross/ HTTP/1.1

Host: cis.poly.edu

HTTP/1.1 200 OK

Date: Tue, 03 Mar 2020 16:01:19 GMT

Server: Apache/2.4.6

Last-Modified: Mon, 12 Nov 2018 16:25:17 GMT

ETag: "cf-57a7a257df256"

Accept-Ranges: bytes

Content-Length: 207

Content-Type: text/html; charset=UTF-8

```
<head>
<meta http-equiv="Content-Type" content="text/html; charset=windows-1252">
<meta http-equiv="refresh"content="0;url=http://nyu.edu/projects/keithwross/">
<title> Automatic Forwarding </title>
</head>
```

Connection closed by foreign host.

## **Part #6: Submit to Canvas**

- No late assignments will be accepted!
- This work is to be done individually
- This MS-Word document (duly filled-in) **saved as a PDF document.**
- The submission file will be saved with the name ***Lab4\_yourMUID.pdf***
- Assignment is Monday/Tuesday, March 2/3 during Lab time
- On or before the due time, drop the *electronic copy* of your work in the *canvas*

**Don't forget to Turn in the file! Lab4\_yourMUID.pdf**