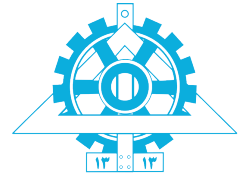


بسم الله الرحمن الرحيم

In the name of Allah



UDP and Its Applications¹

LABORATORY MANUAL

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دانشگاه تهران
دانشکده‌ی مهندسی برق و کامپیوتر

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¹S. Panwar, S. Mao, J.-dong Ryoo, and Y. Li, "UDP and its applications," in TCP/IP Essentials: A Lab-Based Approach, Cambridge: Cambridge University Press, 2004, pp. 100–110.

Part I

Using the socket Program

In this lab, you will not need to a router, only two workstations and one hub to connect two host together as show in Figure 5.0 and Table 5.0.

Table 1: Host IP addresses for Figure 5.0

Host _A		Host _B	
Name	IP Address	Name	IP Address
h0	128.238.61.100/24	h1	128.238.61.101/24

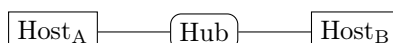


Figure 1: Simple router experiment (Figure 5.0)

1 Socket Operation

Use the following commands in *h0* and *h0* to observe the basic operation of `socket`¹ and `echo` service.

```
socket [-u] host echo2
socket -s 5555
socket -i -n3 -w2048 server-host 5555
```

Report

1. Explain the operation of each command.

2 socket -h

Study various options associated with the `socket` program. A brief list of options can be displayed by typing `socket`. More detailed discussion on socket can be found in Appendix C of [5] in the reference book.

3 Segment Size

While running `tcpdump -nv` on *your-host* or *remote-host*, execute the following command with different values of size (i.e. the size of the datagram).

```
socket -u -i -n1 -w size remote-host echo
```

The `-u` option is used to send UDP datagrams rather than TCP segments.

Increase *size* (i.e. the size of the datagram) until fragmentation occurs.

Use `netstat -in` to find out the MTU of the Ethernet interface.

¹Basic command is `sock` use alternative `socket` (rename of `sock`)

²Type any text in socket and press enter.

Report

1. What is the maximum value of *size* for which the UDP datagram can be sent without IP fragmentation? Justify your answer with the `netstat` output.

4 Datagram Fragmentation

Capture the data packets generated by the following command `tcpdump src host your-host on h1`.

```
socket -u -i -n1 -w10000 host echo
```

Save the `tcpdump` output for the lab report.

Report

1. Explain the `tcpdump` output in terms of the IP header fields that are used in fragmentation.
2. When IP fragmentation occurs, only the first fragment has the UDP header. How do you verify this fact from the `tcpdump` output?

5 Maximum Datagram Size

While running `tcpdump src host your host`, execute the following command with different values of *size*,

```
socket -u -i -n1 -w10000 host echo
```

in order to find out the maximum size of a UDP datagram that the system can send or receive, even when fragmentation is allowed.

Report

1. What is the maximum size of user data in a UDP datagram that the system can send or receive, even when fragmentation is allowed?

Part II

Path MTU Discovery Exercise

Connect the routers and the workstations as shown in [Figure 5.5](#) Change the IP addresses of your workstation accordingly. Note that the router IP addresses are the same as their default.

Change the MTU of the `ethernet1` interfaces of `Router4` to 500 bytes.

```
R1(config-if)# ip mtu 500
```

Test connectivity by `ping` ing hosts in the other subnets. After you can reach the hosts in the other subnets, run `tcpdump -nx` on your workstation.

Start a UDP socket server on `remote-host`, using `socket -u -s 5555`. Then run the socket client from `your-host`:

```
socket -i -u -n10 -w1200 -p5 remote-host 5555
```

Table 2: Router and Host IP addresses for Figure 5.5 (Table 5.5)

Router		Host _A		Host _B	
eth0	eth1	Name	IP Address	Name	IP Address
128.238.61.1/24	128.238.62.1/24	h0	128.238.61.101/24	h1	128.238.62.101/24



Figure 2: The network setup for Path MTU Discovery Exercise (Figure 5.5/Figure 4.10)

Observe the DF bit of the first datagram and that of the following datagrams. Save the `tcpdump` output for your lab report.

Report

1. Explain the operation of path MTU discovery based on the `tcpdump` outputs saved.
2. Which ICMP message is used in path MTU discovery? Give the decimal value of each field of the captured ICMP message.
3. What is the MTU of the destination network of the UDP datagram? Verify your answer using both the ICMP message and the IP fragmentation trace saved.

Part III

Exercises with FTP and TFTP

Use first network (section Using the `socket` Program) topology for this exercise.

We will study the performance of FTP and TFTP for file transfer between two machines. By transferring the same file using these two protocols, we can compare the operations and performances of UDP and TCP.

Three files (`large.dum`, `med.dum` and `small.dum`) with random contents are stored in the `/home/netlab` directory and in the `/home/netlab3` directory of each workstation in the lab. We will use the `get` command to retrieve files from a remote host. When FTP is used, you need to change directory to `/home/netlab/` by `cd /home/netlab` before retrieving the file. If you don't know how to use `tftp`, refer to its manual page.

6 TFTP and FTP

In order to compare the transfer rates of FTP and TFTP, we will retrieve a large file from a remote server using FTP and TFTP, respectively.

First run First run the following `tcpdump` command:

```
tcpdump host your-host and remote-host
```

```
$ ls /etc/xinetd.d/ # see services in xinetd
$ tftp host
tftp> get $filename # small,med,large
tftp> quit
$ ftp host # Enter user and password -> netlab
ftp> ls
ftp> get $filename
ftp> quit
```

³We change original path (`/tftpboot`) to `/home/netlab` to be same as ftp user path.

Also, from the `ftp` window, record the transfer rate (time) displayed.

Restart the above `tcpdump` session.

Report

1. Examining the saved `tcpdump` output. Identify the starting and ending time of actual data transfer. Don't include the time spent establishing the TCP connection. Calculate the time spent for data transfer.
2. Compare the time with the value displayed in `ftp` window. Are they consistent? If there exists any significant difference, what might be the reason?
3. Now, from the second session, carefully determine the starting and ending time of data transfer for the `tftp` program.
4. Compare the time with the value displayed in `tftp` window. Are they consistent? If there exists any significant difference, what might be the reason?
5. By comparing the actual data transfer times of `ftp` and `tftp`, which of these two is faster, and why?

7 TFTP Analysis

Capture the packets that are exchanged during a `tftp` session for the `/home/netlab/small.dum` file between `h0` and `h1`, using:

```
tcpdump -x host your-host and remote-host
```

Observe the protocol in action. Analyze various types of TFTP messages. Save `tcpdump` output for the lab report.

Report

1. List all the different types of packets exchanged during the `tftp` session. Compare them with the TFTP message format in Figure 5.3 of reference book.
Why does the server's port number change?
2. In most cases, `tftp` service is restricted.⁴ Why is `tftp` service not generally available to users?
3. In section 5, we found the maximum size of a UDP datagram in your machine. With `tftp`, which uses UDP, we transferred a file larger than the maximum UDP datagram size. How do you explain this?

8 FTP Small File

Repeat the above experiment, but use `ftp`. Capture a trace of the packets exchanged when downloading the `/home/netlab/small.dum` file using `ftp`.

Examine the port numbers used.

Report

1. How many well-known port numbers were used? Which machine used the well-known port numbers? What were the other machine's port numbers?
2. As can be seen from the `tcpdump` output, FTP involves two different connections, `ftp-control` and `ftp-data`. Why are two different connections used, instead of one connection?

⁴This is not the case in our lab, where we deliberately enabled the `tftp` service and use it as a tool to study the UDP protocol.

9 FTP Debug

Run `ftp` in *your-host* using the debug mode: `ftp -d remote-host`.

After logging into the remote host, type `dir /home/netlab/small.dum` in the `ftp` window.

Then type `quit` to terminate the `ftp` session, and save the `ftp` window output.

Report

1. Submit what you saved in this exercise, explaining each line of the output. Explain how the `PORT` command works. Which connection, the control connection or the data connection, did the server send the response (the `LIST` output) on?