

بسم الله الرحمن الرحيم

In the name of Allah



A Single Segment Network¹

LABORATORY MANUAL

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¹S. Panwar, S. Mao, J.-dong Ryoo, and Y. Li, "A single segment network," in TCP/IP Essentials: A Lab-Based Approach, Cambridge: Cambridge University Press, 2004, pp. 43–60.

Part I

Network Interface Exercises

The following exercises use the single segment network topology shown in Figure 1.3.

Table 1: The IP addresses of the hosts (Table 1.2)

Host	IP Address	Subnet Mask
h0	128.238.66.100	255.255.255.0
h1	128.238.66.101	255.255.255.0
h2	128.238.66.102	255.255.255.0
h3	128.238.66.103	255.255.255.0
h4	128.238.66.104	255.255.255.0
h5	128.238.66.105	255.255.255.0
h6	128.238.66.106	255.255.255.0
h7	128.238.66.107	255.255.255.0

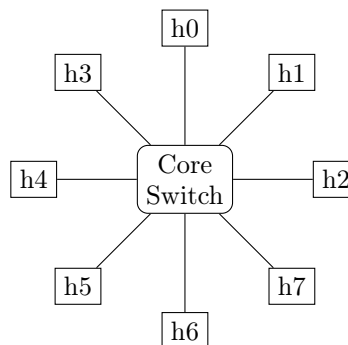


Figure 1: A single segment network (Figure 1.3)

1 Network Interfaces

Use the `ifconfig -a` command to display information about the network interfaces on your host. Find the IP address and the net mask of your machine.

Report

1. How many interfaces does the host have? List all the interfaces found, give their names, and explain their functions briefly.
2. What are the MTUs of the interfaces on your host?
3. Is network subnetted? What is the reasoning for your answer? What the experimental are the reasons for subnetting?

2 Local Host Dump

While `tcpdump -i lo`¹ is running in one command window, run `ping 127.0.0.1` from another command window.

Report

1. From the `ping` output, is the 127.0.0.1 interface on? Can you see any ICMP message sent from your host in the `tcpdump` output? Why?

¹In old linux use `tcpdump host your-host`

3 Network Statistics

By using `netstat -ie`² command, collect the statistics from all the hosts on the network. Since we use the same login name and password, we can `telnet` to other workstations and run `netstat -ie` there.³

Save the `netstat -ie` outputs.

If you don't see a significant amount of output packets in the `netstat` output, the machine was probably restarted recently. You may do this experiment later, or use the following `socket` command to generate some network traffic:

```
socket -u -i -n200 remote-host echo
```

Report

1. Calculate the average collision rate over all the hosts for the set of statistics you collected in this exercise.

Part II

ARP Exercises

In the following experiment, we shall examine the host ARP table and the ARP operation, including two interesting cases: proxy ARP and gratuitous ARP. You may need to find **MAC** addresses of the host and router interfaces, and record these **MAC** addresses. You need these **MAC** addresses for the exercises and lab report (as table of host and **MAC**).

4 ARP Table

Use `arp -a` to see the entire ARP table. Observe that all the IP addresses displayed are on the same subnet.

If you find that all the remote hosts are in your host's ARP table, you need to delete a remote host (not your workstation) from the table, using:⁴

```
arp -d remote-host
```

Save the ARP table for your lab report.

While `tcpdump -en`⁵ is running, `ping` a remote host that has no entry in your host ARP table. Then terminate the `tcpdump` program.

You can run `wireshark &` to capture network.

Observe the first few lines of the packet trace to see how ARP is used to resolve an IP address.

Run `arp -a` to see a new line added in your host's ARP table. Save the new ARP table for your lab report.

Mark the ARP request packet and the ARP reply packet in the `wireshark` window. Then go to menu *File/Print...* to print the marked packets for your lab report (See Exercise 6 of Chapter 1 of reference book).

²You can use `ifconfig` instead.

³After you are done with a remote host, you should exit the `telnet` session before you `telnet` to another remote host. Recursive `telnet` will generate unnecessary data in the `tcpdump` output and cause confusion.

⁴If you deleted your workstation's IP address from the ARP table by mistake, you must add the entry back in the table. See the `arp` manual page to add. Note that, in order for your workstation to reply to the ARP requests, the ARP entry of your workstation must have the `P` flag in the ARP table.

⁵You can add `-x` flag to see hex dump.

Report

1. From the saved `tcpdump` output, explain how ARP operates. Draw the format of a captured, ARP request and reply including each field and the value.

Your report should include the answers for the following questions.

- What is the target IP address in the ARP request?
- At the **MAC** layer, what is the destination Ethernet address of the frame carrying the ARP request?
- What is the **frame** type field in the Ethernet frame?
- Who sends the ARP reply?

5 ARP Timeout

While `tcpdump` host *your-host* is running to capture traffic from your machine, execute `telnet 128.238.66.200`. Note there is no host with this IP address in the current configuration of the lab network.

Save the `tcpdump` output of the first few packets for the lab report.

After getting the necessary output, terminate the `telnet` session.

Report

1. From the saved `tcpdump` output, describe how the ARP timeout and retransmission were performed. How many attempts were made to resolve a non-existing IP address?

6 ARP Proxy

The network topology for this proxy ARP exercise is shown in [Figure 2.9](#). The IP addresses and network masks for the hosts are also given in [Figure 2.9](#). Change the IP address and network mask of your host accordingly (see Section 2.3.2 of reference book). Change the IP addresses and network masks of the *Router4* interfaces according to [Figure 2.9](#).

Note Network mask of the hosts in the 128.238.65.0 network is 255.255.0.0.

Note Only use *h0*, *h1*, *h4*, *h5* hosts (Do not start extra hosts).

Set IP of each network by running the following command in the hosts:

1. `ifconfig eth0 x.x.x.x/mask`
2. `route add default gw x.x.x.x`

Next we will enable the proxy ARP function on the ethernet1 interface of *Router4*.

1. `telnet` to *Router4*. (Use `telnet 128.238.64.4`, or right click on the Router and open console on GNS3.)
2. Log in to the router, type `enable` to enter the *Privileged EXEC* mode.⁶
3. Enter the *Global Configuration* mode by typing `config term`.
4. Then type the following lines for each interfaces:

⁶We will discuss bridge and router configuration in Chapter 3.

```
config term
  interface f0/0 ! use f0/1 for the other interface7
  ip addr x.x.x.x 255.255.255.0
  no shut
  ip proxy-arp
  Ctrl-Z
wr
```

Now *Router4*'s *ethernet1* interface can perform proxy ARP for the hosts in the 128.238.64.0 subnet.

Run `tcpdump -enx` on the *h1* and *h5*.

Then let the hosts in the 128.238.65.0 subnet send UDP datagrams to the hosts in the 128.238.64.0 subnet. For example, on *h4* type:

```
socket -i -u -n1 -w1000 host-in-64-0-subnet echo
```

When you are done with all the hosts in the 128.238.64.0 subnet, save the `tcpdump` output for the lab report.

Run `arp -a` to display the new ARP table in your host. Save the ARP table for your lab report.

After the lab instructor restores the network into a single subnet (see [Figure 1.3](#)), change the IP address and network mask of your host's interface back to their default values as in [Figure 1.3](#).

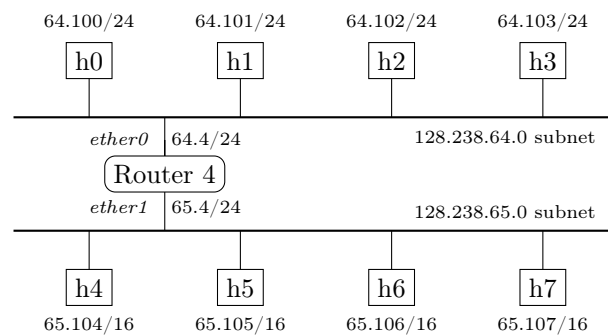


Figure 2: Network configuration (Figure 2.9)

Report

1. Explain the operation of proxy ARP.
2. Why can a host in the 128.238.65.0 subnet reach a host in the 128.238.64.0 subnet, even though they have different subnet IDs?
3. What are the **MAC** addresses corresponding to hosts in the 128.238.64.0 subnet, in the ARP table of a host in the 128.238.65.0 subnet?
4. Give one advantage and one disadvantage of using proxy ARP.

7 Gratuitous (Unsolicited) ARP

While `tcpdump -ex` (or run `wireshark`) is running on all the hosts, reboot host *h7*. You can send the gratuitous ARP manually by execute:

```
arping -c 4 -A -I eth1 h6-ip
arping -c 4 -U -I eth1 h7-ip
```

⁷The name of the router interfaces may be different for various routers. You can find the names by typing `write term` in the *Privilege EXEC* mode.

After *h7* is started, terminate `tcpdump` and run `wireshark -r exe7.out &` to load the `tcpdump` trace. Print the gratuitous ARP request for your lab report.

Report

1. What is the purpose of gratuitous ARP?
2. List the sender IP address, target IP address, sender **MAC** address, and target **MAC** address of the gratuitous ARP you saved.
3. What is the ARP table in *h5*?

Part III

Exercise with ICMP and ping

8 ping ICMP

Use `ping -sv remote-host` to test whether the remote host is reachable, while running:
`tcpdump -enx host your-host and remote-host`. Save the `tcpdump` and `ping` output for the future study on `ping`.

Report

1. What ICMP messages are used by `ping` ?

9 ICMP Port Unreachable

While running `tcpdump -x -s 70 host your-host and remote-host`, execute the following `socket` command to send a UDP datagram to the remote host:

```
socket -i -u -n1 -w1000 remote-host 88888
```

Save the `tcpdump` output for the lab report.

Report

1. Study the saved ICMP port unreachable error message (See Figure 2.7 of reference book.). Why are the first 8 bytes of the original IP datagram payload included in the ICMP message?

10 ping ICMP

While `tcpdump` is running to capture the ICMP messages, `ping` a host with IP address **128.238.60.100**. Save the `ping` output.

Report

1. Can you see any traffic sent on the network? Why? Explain what happened from the `ping` output.
2. List the different ICMP messages you captured in `Exercise with ICMP and ping`. Give the values of the type and code fields.

Part IV

Exercises with IP address and subnet mask

In this section, we will observe what happens when the same IP address is assigned to two different hosts. We will also set an incorrect subnet mask for hosts and see what are the consequences. For the next two exercises, we use only four host from single segment network (Figure 1.3).

Table 2: Host IP addresses and network masks for Duplicate IP (Table 2.3)

Host	IP Address	Subnet Mask
h0	128.238.66.100	255.255.255.0
h1	128.238.66.100	255.255.255.0
h2	128.238.66.102	255.255.255.0
h3	128.238.66.103	255.255.255.0

11 Duplicate IP

Change the IP address of your workstation as shown in Table 2.3.

Delete the entries for all hosts other than your own workstation from your workstation's ARP table.

Run `tcpdump -enx` on all the hosts. Then, do the following three experiments:

1. Execute `telnet` from one of two hosts with the duplicate IP address to a host with unique IP address (e.g. $h0 \rightarrow h2$).
Now, from the other host with the duplicate IP address, execute `telnet` command to the same host ($h1 \rightarrow h2$).
Observe what happens and save the `tcpdump` output and the ARP tables in all the hosts in your group.
2. Execute `telnet 128.238.66.100` (or `telnet 128.238.66.104`) from $h2$. Which host provides the telnet connection? Why?
3. Execute `telnet 128.238.66.100` (or `telnet 128.238.66.104`) from $h3$. Which host is connected to $h3$? Why?

Report

1. Explain what happened in the first case and why. Answer the questions for the second and third cases.

12 IP Subnets

Change the host IP addresses and the subnet masks as shown in Table 2.4. Note that two hosts in each group ($h0$ and $h3$) are assigned an incorrect subnet mask.

Capture the packets with `tcpdump -e` for the following cases.

1. When $h0$ `ping` s one of the hosts that have the correct subnet mask.
2. When $h3$ `ping` s one of the hosts that have the correct subnet mask.

Now, copy the output displayed from the `ping` window in $h3$. Share the saved output message with other students.

3. When a host with the correct subnet mask `ping` s $h0$.

4. When a host with the correct subnet mask `ping` s *h3*.

To avoid confusion, only one machine in each group should generate traffic in each case. Clearly, this exercise has to be performed as a team.

Table 3: Host IP addresses and network masks for IP Subnets (Table 2.4)

Host	IP Address	Subnet Mask
h0	128.238.66.100	255.255.255.240
h1	128.238.66.101	255.255.255.0
h2	128.238.66.102	255.255.255.0
h3	128.238.66.120	255.255.255.240

Report

1. Explain what happened in each case according to the `tcpdump` outputs saved. Explain why *h3* could not be reached from other hosts, whereas *h0*), which has the same incorrect subnet mask, could communicate with the other hosts.