VANIER COLLEGE – Computer Engineering Technology – Autumn 2021

Network Systems Design (247-509-VA)

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LABORATORY EXPERIMENT 6

Address subnetting and router

NOTE:
To be completed in one lab session of 3 hrs.

To be submitted via Lea before the deadline stated.

This exercise is to be done individually except where specified in the procedure. **Each** student must submit this lab with answer, plus your original ***observations and conclusions.***

OBJECTIVES:

After performing this experiment, the student will be able to:

1. Determine network information for a given IP address and network mask.
2. Perform network subnetting.
3. Configure and activate Serial and FastEthernet interfaces.

PROCEDURE

Part A: IPv4 Address subnetting

Attach your worksheet of Part A for the lab submission.

1. For each of the following given IP address and network mask, determine other information about the network and subnet information such as:
    - (1) Number of subnet bits.
    - (2) Number of subnets.
    - (3) Number of host bits per subnet.
    - (4) Number of usable hosts per subnet.
    - (5) Subnet address for this IP address.
    - (6) IP address of first host on this subnet.
    - (7) IP address of last host on this subnet.
    - (8) Broadcast address for this subnet.

	Host IP address	Network Mask
a)	172.25.114.250	255.255.255.192 (/26)
b)	172.30.1.33	255.255.255.252
c)	192.168.3.219	255.255.255.224

1a)

172.25.0111 0010.1111 1010 (172.25.114.250)
255.255.1111 1111.1100 0000 (255.255.255.192)

Yellow: subnet bits.
Green: host portion.

1. 10.
2. 1'024 (2^number of subnet bits = 2^10 = 1'024).
3. 6 (number of "0"s in host portion of subnet mask -> a.k.a number of host bits).
4. 62 (2^number of host bits – 2 = 2^6 – 2 = 62).
5. 172.25.114.192 (turn all host bits to "0"s -> 172.25.114.1100 0000 = 172.25.114.192).
6. 172.25.114.193 (subnet address + 1 = 172.25.114.192 + 1 = 172.25.114.193).
7. 172.25.114.254 (broadcast address – 1 = 172.25.114.255 – 1 = 172.25.114.254).
8. 172.25.114.255 (turn all host bits to "1"s -> 172.25.114.1111 1111 = 172.25.114.255).

b)

172.30.0000 0001.0010 0001 (172.30.1.33)
255.255.1111 1111.1111 1100 (255.255.255.252)

Yellow: subnet bits.
Green: host portion.

1. 14.
2. 16'384 (2^number of subnet bits = 2^14 = 16'384).
3. 2 (number of "0"s in host portion of subnet mask -> a.k.a number of host bits).
4. 2 (2^number of host bits – 2 = 2^2 – 2 = 2).
5. 172.30.1.32 (turn all host bits to "0"s -> 172.30.1.0010 0000 = 172.30.1.32).
6. 172.30.1.33 (subnet address + 1 = 172.30.1.32 + 1 = 172.30.1.33).
7. 172.30.1.34 (broadcast address – 1 = 172.30.1.35 – 1 = 172.30.1.34).
8. 172.30.1.35 (turn all host bits to "1"s -> 172.30.1.0010 0011 = 172.30.1.35).

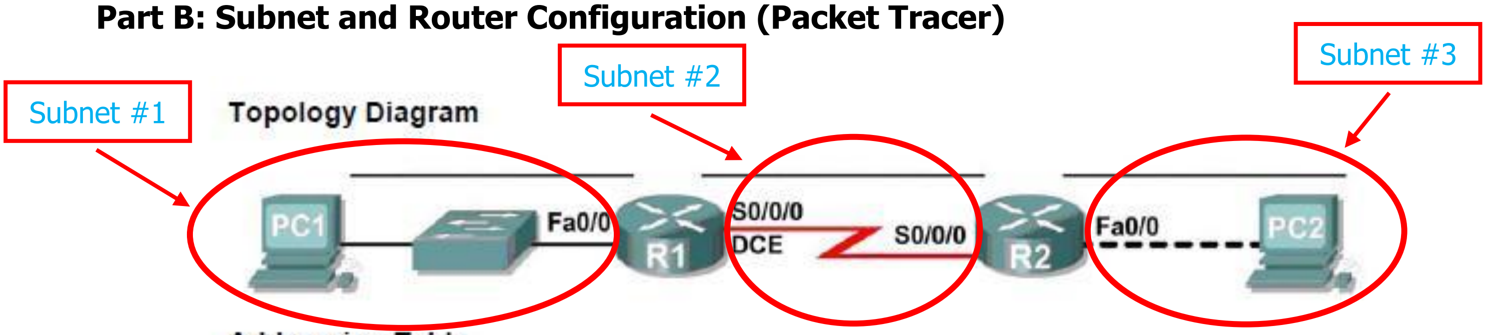
c)

192.168.3.1101 1011 (192.168.3.219)
255.255.255.1110 0000 (255.255.255.224)

Yellow: subnet bits.
Green: host portion.

1. 3.
2. 8 (2^number of subnet bits = 2^3 = 8).
3. 5 (number of "0"s in host portion of subnet mask -> a.k.a number of host bits).
4. 30 (2^number of host bits – 2 = 2^5 – 2 = 30).
5. 192.168.3.192 (turn all host bits to "0"s -> 192.168.3.1100 0000 = 192.168.3.192).
6. 192.168.3.193 (subnet address + 1 = 192.168.3.192 + 1 = 192.168.3.193).
7. 192.168.3.222 (broadcast address – 1 = 192.168.3.223 – 1 = 192.168.3.222).
8. 192.168.3.223 (turn all host bits to "1"s -> 192.168.3.1101 1111 = 192.168.3.223).

Part B: Subnet and Router Configuration (Packet Tracer)



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0			N/A
	S0/0/0			N/A
R2	Fa0/0			N/A
	S0/0/0			N/A
PC1	NIC			
PC2	NIC			

2. You have been given the 192.168.1.0/24 address space to use in your network design. The network consists of the following segments. The plan should have equal size subnets and use the smallest subnet sizes that will accommodate the appropriate number of hosts.
   - The LAN connected to router R1 will require enough IP addresses to support 15 hosts.
   - The LAN connected to router R2 will require enough IP addresses to support 30 hosts.
   - The link between router R1 and router R2 will require IP addresses at each end of the link.

192.168.1.0000 0000 (192.168.1.0)
255.255.255.1110 0000 (255.255.255.224)

Yellow: subnet bits.
Green: host portion.

Subnet ID	Subnet Address	Usable Host Range	Broadcast Address
0 (000)	192.168.1.0 (192.168.1.0000 0000)	192.168.1.1 to 192.168.1.30	192.168.1.31 (192.168.1.0001 1111)
1 (001)	192.168.1.32 (192.168.1.0010 0000)	192.168.1.33 to 192.168.1.62	192.168.1.63 (192.168.1.0011 1111)
2 (010)	192.168.1.64 (192.168.1.0100 0000)	192.168.1.65 to 192.168.1.94	192.168.1.95 (192.168.1.0101 1111)
3 (011)	192.168.1.96 (192.168.1.0110 0000)	192.168.1.97 to 192.168.1.126	192.168.1.127 (192.168.1.0111 1111)
4 (100)	192.168.1.128 (192.168.1.1000 0000)	192.168.1.129 to 192.168.1.158	192.168.1.159 (192.168.1.1001 1111)
5 (101)	192.168.1.160 (192.168.1.1010 0000)	192.168.1.161 to 192.168.1.190	192.168.1.191 (192.168.1.1011 1111)
6 (110)	192.168.1.192 (192.168.1.1100 0000)	192.168.1.193 to 192.168.1.222	192.168.1.223 (192.168.1.1101 1111)
7 (111)	192.168.1.224 (192.168.1.1110 0000)	192.168.1.225 to 192.168.1.254	192.168.1.255 (192.168.1.1111 1111)

a) How many subnets are needed for this network?
   - Only three subnets are needed (in use) for this network, as shown in the topology diagram above. As for the other subnets that are available (as shown in the subnetting table above), they are not being used. As a result, there is a lot of wasted IP addressing space. If the VLSM method was used, a lot of this wasted IP addressing space would not exist.

b) What is the subnet mask for this network, in both dotted decimal format and slash format?
   - Decimal format: 255.255.255.224
   - Slash format: /27

c) How many usable hosts are there per subnet?
   - There are 30 usable hosts per subnet (2^number of host bits – 2 = 2^5 – 2 = 30). This is a fixed size applied to all the subnets; therefore, all the subnets listed above have the same usable host size.

3. Assign subnet addresses to the Topology diagram based on the following requirements.
   a) Assign second subnet to the network attached to R1.
      - Assign the first valid host address to the LAN interface on R1.
      - Assign the last valid host address in second subnet to PC1.

   b) Assign third subnet to the link between R1 and R2.
      - Assign the first valid host address to the WAN interface on R1.
      - Assign the last valid host address to the WAN interface on R2.

   c) Assign sixth subnet to the network attached to R2.
      - Assign the first valid host address to the LAN interface of R2.
      - Assign the last valid host address to PC2.

Addressing Table:

Device	Physical Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	192.168.1.33	255.255.255.224	N/A
	S0/0/0	192.168.1.65	255.255.255.224	N/A
R2	Fa0/0	192.168.1.161	255.255.255.224	N/A
	S0/0/0	192.168.1.94	255.255.255.224	N/A
PC1	NIC	192.168.1.62	255.255.255.224	192.168.1.33
PC2	NIC	192.168.1.190	255.255.255.224	192.168.1.161

4. Implement the above network topology using packet tracer software.
   a) Configure interfaces on the R1 and R2 routers with IP addresses from your network design, using the Config Tab.

   b) Configure the Ethernet interfaces of PC1 and PC2 accordingly.

5. Answer the following question to verify the network is operating as expected. Perform screen shots to show results of your ping, for each of the following scenarios.

   a) From the host attached to R1, is it possible to ping the default gateway?

      ➢ PC1, which is connected to R1 (through the switch), is able to ping the default gateway (Fa0/0 on R1) successfully. Therefore, all communication going from PC1 to R1 will work. Refer to screenshot below for proof.

```
Packet Tracer PC Command Line 1.0
C:\>ping 192.168.1.33

Pinging 192.168.1.33 with 32 bytes of data:

Reply from 192.168.1.33: bytes=32 time=1ms TTL=255
Reply from 192.168.1.33: bytes=32 time<1ms TTL=255
Reply from 192.168.1.33: bytes=32 time<1ms TTL=255
Reply from 192.168.1.33: bytes=32 time=2ms TTL=255

Ping statistics for 192.168.1.33:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 2ms, Average = 0ms
```

Default gateway (R1) IP.

Successful communication!

Figure 1. Successful "ping" command issued to default gateway (R1) from PC1 shown above.

   b) From the host attached to R2, is it possible to ping the default gateway?

      ➢ PC2, which is connected directly to R2, is able to ping the default gateway (Fa0/0 on R2) successfully. Therefore, all communication going from PC2 to R2 will work. Refer to screenshot below for proof.

```
Packet Tracer PC Command Line 1.0
C:\>ping 192.168.1.161

Pinging 192.168.1.161 with 32 bytes of data:

Reply from 192.168.1.161: bytes=32 time=1ms TTL=255
Reply from 192.168.1.161: bytes=32 time<1ms TTL=255
Reply from 192.168.1.161: bytes=32 time<1ms TTL=255
Reply from 192.168.1.161: bytes=32 time<1ms TTL=255

Ping statistics for 192.168.1.161:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms
```

Default gateway (R2) IP.

Successful communication!

Figure 2. Successful "ping" command issued to default gateway (R2) from PC2 shown above.

   c) From the router R1, is it possible to ping the Serial 0/0/0 interface of R2?

      ➢ R1, which is connected directly to R2 through the serial link, is able to ping R2 (on S0/0/0) successfully. Therefore, all communication going from R1 to R2 will work. Refer to screenshot below for proof.

R2 IP.

```
Router>ping 192.168.1.94

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.94, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 10/10/11 ms
```

Successful communication!

Figure 3. Successful "ping" command issued to R2 from R1 shown above.

d) From the router R2, is it possible to ping the Serial 0/0/0 interface of R1?

- R2, which is connected directly to R1 through the same serial link mentioned before, is able to ping R1 (on S0/0/0) successfully. Therefore, all communication going from R2 to R1 will work. Refer to screenshot below for proof.

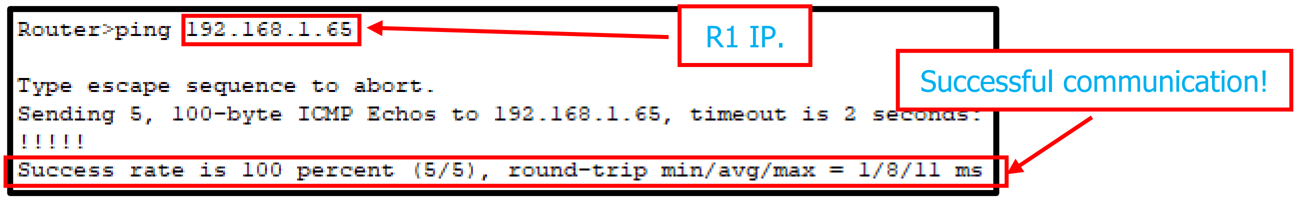


Figure 4. Successful "ping" command issued to R1 from R2 shown above.

6. Can you ping between the 2 PC hosts? If not, why? What can be done to fix this situation? Explain your approach and modify your packet tracer design accordingly. Submit your design via **Lea**.

- Initially, a "ping" command issued from PC1 to PC2 does not work. This is because there were no routes ever configured for R1 and R2 when they were added to the PT diagram. This means that the local routing table for R1 and R2 is partially empty. This also means that since PC2 is not connected to R1 like PC1, there will be no successful communication between PC1 and PC2 until some routes are defined for R1 and R2. Therefore, the obvious solution to fix this situation is to apply the appropriate route in R1's and R2's local routing table.

  To apply a new route in R1's and R2's local routing table, the same steps that were followed to apply the initial IP configuration for R1 and R2 need to be followed (with slight exception: click the corresponding router -> config tab -> click RIP under "Routing" instead of any of the interfaces under "Interface"). In the RIP window on R1 and R2, a route for 192.168.1.0 was added. Refer to screenshot below for proof.

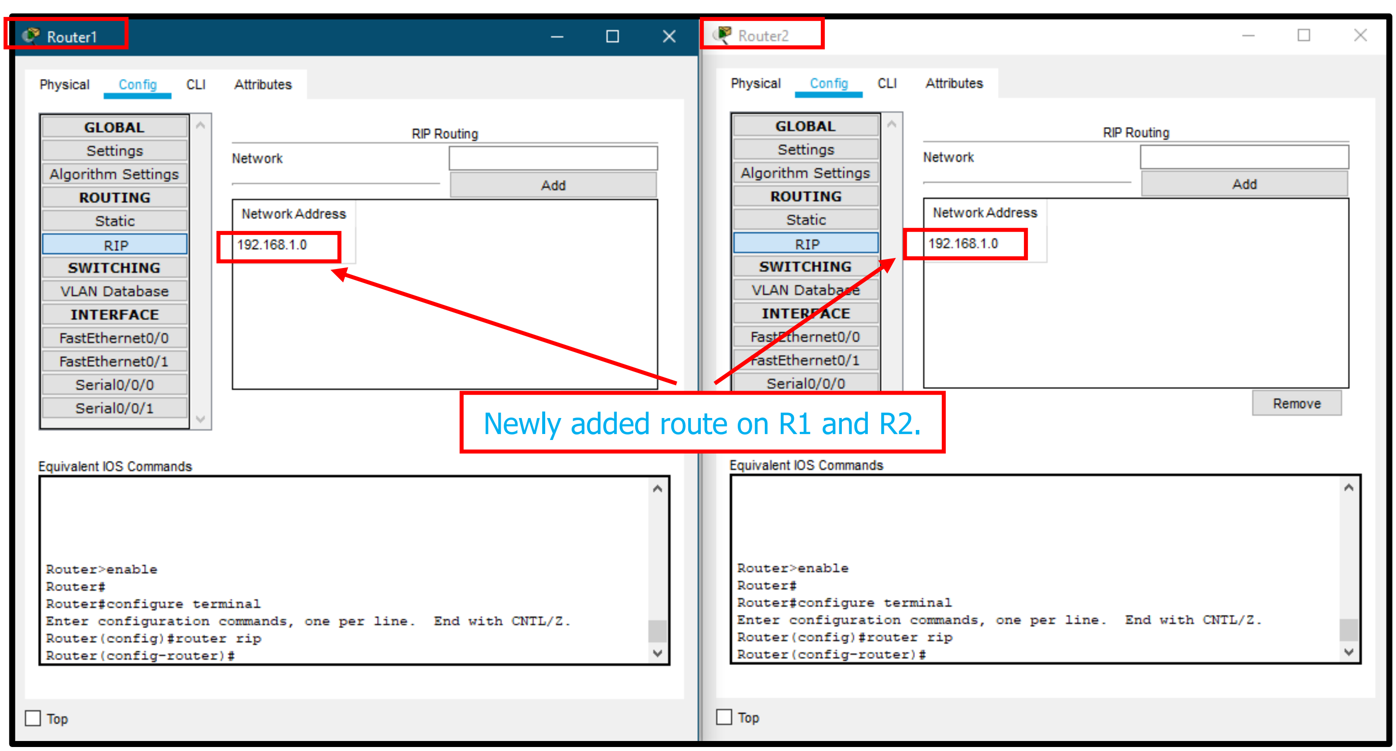


Figure 5. Routing parameters for R1 and R2 and newly added route for R1 and R2 shown above.

After the routes were applied to the local routing table on R1 and R2, a “ping” command issued from PC1 to PC2 finally yields successful. Refer to screenshot below for proof.

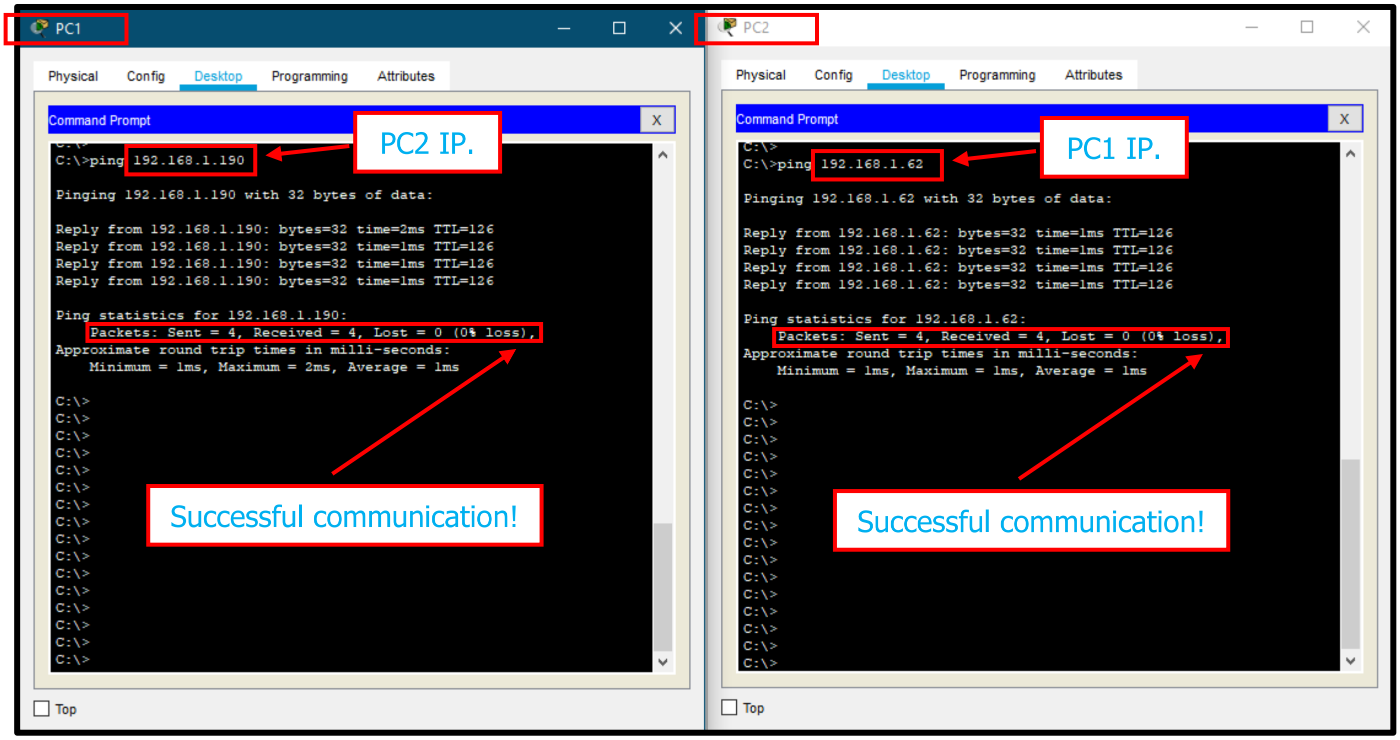


Figure 6. Successful “ping” command issued to PC2 from PC1 shown above.

Report discussion and conclusion:

Discussion:

- To begin, we began by refreshing our subnetting knowledge by performing some basic subnetting exercises. For example, we were asked to find the total number of subnets that could be created from a given IP address and subnet mask to determining broadcast addresses and subnetwork addresses. Three basic subnetting exercises were given to us to solve.

  Secondly, after performing some basic subnetting exercises, we were given the task of creating a small-scale network based off of given constraints, such as separate network sizes and physical connections of all the network devices. A starting IP address and subnet mask was given. From the given IP address and subnet mask, a complete subnetting table for the given IP address was done. At the end, eight subnets were available, but only three were required to be implemented in our small-scale network in Cisco PT. As mentioned previously in this report, the obvious problem with this method of subnetting is that the IP addressing space is not used efficiently. If the VLSM method was followed, there would be much less waste. For the three subnets that were required, they were applied to the addressing table given to us, so that we could assign the physical network adapters in our small-scale network with the appropriate IP addresses. As a final step, once all the physical network adapters in our small-scale network had an IP address assigned, several ping tests were done from all the network devices to verify basic communication between certain network devices.

  On a minor sidenote, when the small-scale network was initially implemented in Cisco PT, the Cisco 1841 routers (R1 and R2) did not have the appropriate Serial network cards installed. Therefore, the Serial connection that was required to be connected from R1 to R2 was not possible. Once the Serial network cards were installed on R1 and R2, the Serial connection was able to be established. The remaining physical connections for the remaining network devices were done without encountering any problems.

Lastly, as a final step, we were asked to verify the communication between PC1 and PC2 by performing a "ping" test between the two. The initial result yielded unsuccessful, and it was determined that there were no routes defined on R1 and R2 so that PC1 could successfully communicated to PC2. Once the appropriate route was defined in the local routing table on R1 and R2, a "ping" command issued from PC1 to PC2 (and vice-versa) yielded successful. This also meant that any communication that needed to go beyond the LAN connected to R1 or beyond the LAN connected to R2 would work.

The overall lab was a success.

Conclusion:

- Understood the basic concepts of subnetting (using CIDR method).
- Successfully determined networking information based on a given IP address and network mask.
- Successfully created a complete small-scale network based on simple subnetting techniques in Cisco PT.
- Successfully assigned IP addresses to physical network adapters based on simple subnetting techniques in Cisco PT.
- Successfully configured and activated Serial and Fast Ethernet interfaces on Cisco routers.