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Computer Fundamentals
4/25/2024

Homework 4

Due: 11:59 PM on Thursday, April 25, 2024.

1. (20 points) Consider a datagram network using 32-bit host addresses. Suppose a router has four links, numbered 0 through 3, and packets are to be forwarded to the link interfaces as follows:

Destination Address Range	Link Interface
11100000 00000000 00000000 00000000 through 11100000 00111111 11111111 11111111	0
11100000 01000000 00000000 00000000 through 11100000 01000000 11111111 11111111	1
11100000 01000000 00000000 00000000 through 11100001 01111111 11111111 11111111	2
otherwise	3

   a. Provide a forwarding table that has five entries, uses longest prefix matching, and forwards packets to the correct link interfaces.

Link Interface: 0
Longest matching prefix: 11100000 00
224.0.0.0/10
Link Interface: 1
Longest matching Prefix:
11100000 01000000
224.64.0.0/18
Link Interface: 2
Longest matching prefix: 11100000 01
1) 224.65.0.0/11
2) 224.72.0.0/13
Link Interface: 3
Match all: 0.0.0.0/0

   b. Describe how your forwarding table determines the appropriate link interface for datagrams with the following destination addresses:

11001000 10010001 01010001 01010101 Otherwise: LPR
11100001 01000000 11000011 00111100 Interface 2: LPR
11100001 10000000 00010001 01110111 Interface 2: LPR

   Be sure to identify the link interface for each address.

2. (20 points) Consider the following questions on IP addressing using CIDR:

   a. Suppose that you request IP addresses for 1,200 hosts and are allocated a subblock from the `23.40.*.*` address range as follows:

   ```
   23.40.0.*
   23.40.1.*
   23.40.2.*
   23.40.3.*
   23.40.4.*
   ```

   Using address and prefix format (e.g., 128.2/16), what is the smallest set of network addresses that can describe this network under CIDR? (Hint: Take 23.40.0.* and compute relevant CIDR to support 1200 users)

If we were to determine the necessary coverage needed for the range of addresses listed above, we would find the addresses need to be incremented to 23.40.4.0/24, because this would cover just a little more than the necessary addresses.

   b. Now suppose that another (i.e., remote) router has produced the following forwarding table:

Destination	Next Hop
213.40/16	1.2.3.4
213.40.0/22	1.2.3.5
213.40.4/24	1.2.3.6
213.40.1/24	1.2.3.7

   What is the next hop that the router should use for a packet destined for `213.40.0.1`? Note that this question is not related to the answer for part (a) above.

The match we are looking for here is the address with the longest prefix, which is going to be hop 1.2.3.5, considering the addresses here have the prefixes of 213.40.0, respectively.

   c. Determine the network address and total number of IP addresses in the subnet for the following IPv4 address and CIDR mask: `146.143.1.55/26`.

Network Address: If we run an 'and' operation here, we find that there are no matching bits. therefore the address must be 146.143.1.0.
With regards to the total number of IP addresses, the answer would be:
64, or two raised to the sixth after we find 32-26 = 6, and we have 2 raised to the sixth.

   d. Suppose that the first IP address in the block is 230.8.16.0 and the last address in the block is 230.8.23.255. Find the number of bits in the subnet portion of the address (i.e., the CIDR). Justify your answer (i.e., describe the process you used to determine the CIDR).

. 2^12 = 4096 bits.

3. (20 points) Consider a subnet with prefix `128.119.40.128/27`.

   a. Provide an example of one IP address (using the form xxx.xxx.xxx.xxx) that can be assigned to this network.

   An example of an assignable IP address would be:
   128.119.40.155.

   b. Suppose an ISP owns the block of addresses of the form `121.19.30.128/25`. Suppose the ISP then wants to create four subnets from this block, with each block having the same number of IP addresses. What are the prefixes (using the form `a.b.c.d/x`) for the four subnets?

   1. 121.19.30.128/27
   2. 121.19.30.160/27
   3. 121.19.30.192/27
   4. 121.19.30.224/27

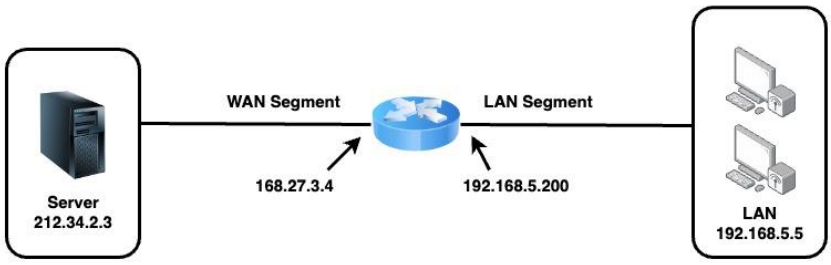
4. (20 points) Consider that your ISP assigned the IP address `168.27.3.4` to your home router running NAT, while your computer's IP address is `192.168.5.5`. Suppose you want to download a web page from the server `212.34.2.3`. Fill in the NAT table entry for the connection as well as the source and destination IP address and port in the diagram below.

source: 168.27.3.4
destination:212.34.2.3
SP: 5001
DP:80

Source IP	
Destination IP	
Source Port	
Destination Port	

Source IP	
Destination IP	
Source Port	
Destination Port	

source: 192.168.5.5
destination:192.168.5.200
SP: 3345
DP:80



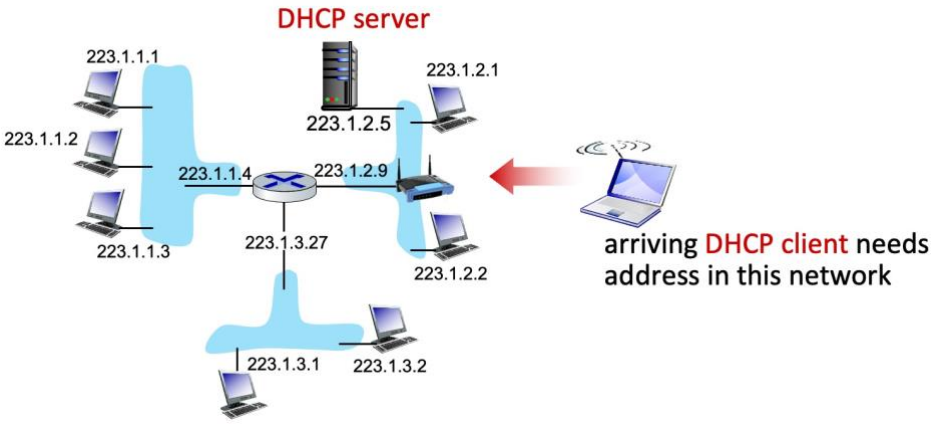
source: 212.34.2.3
destination: 168.27.3.4
SP: 80
DP:5001

Source IP	
Destination IP	
Source Port	
Destination Port	

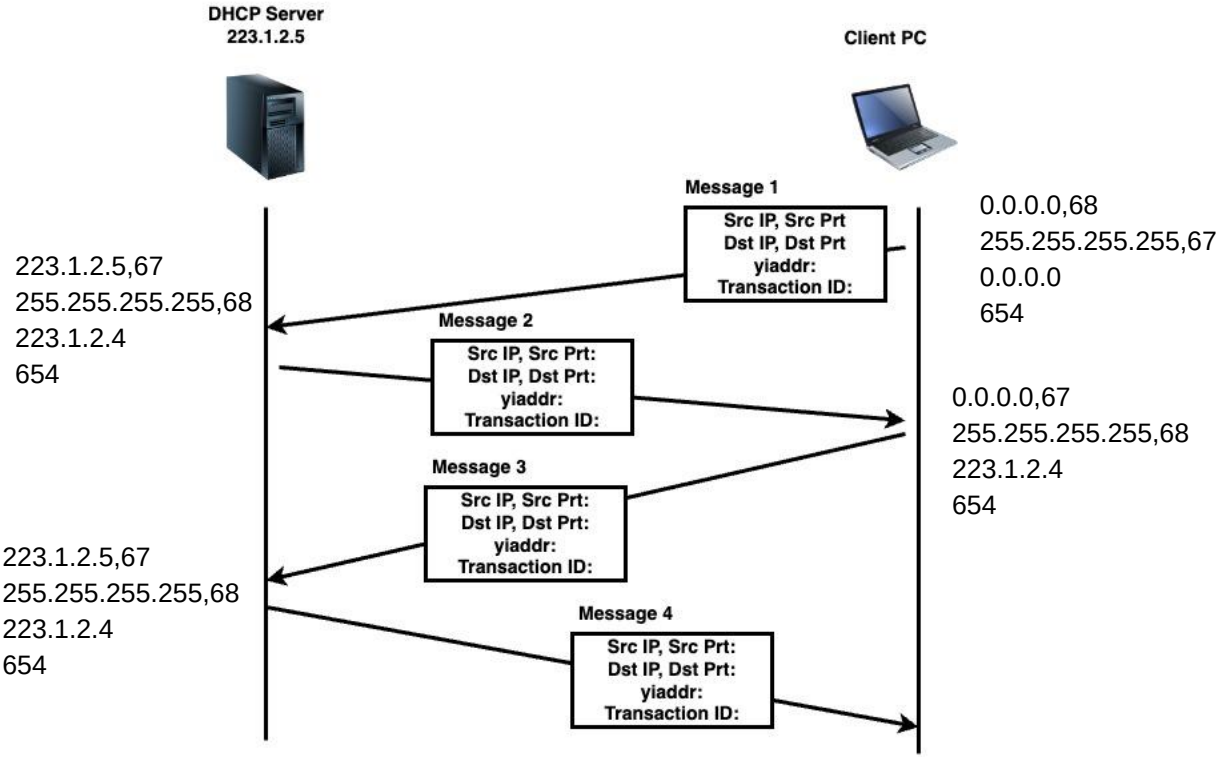
Source IP	
Destination IP	
Source Port	
Destination Port	

source: 192.168.5.200
destination:192.168.5.5
SP: 80
DP: 5001

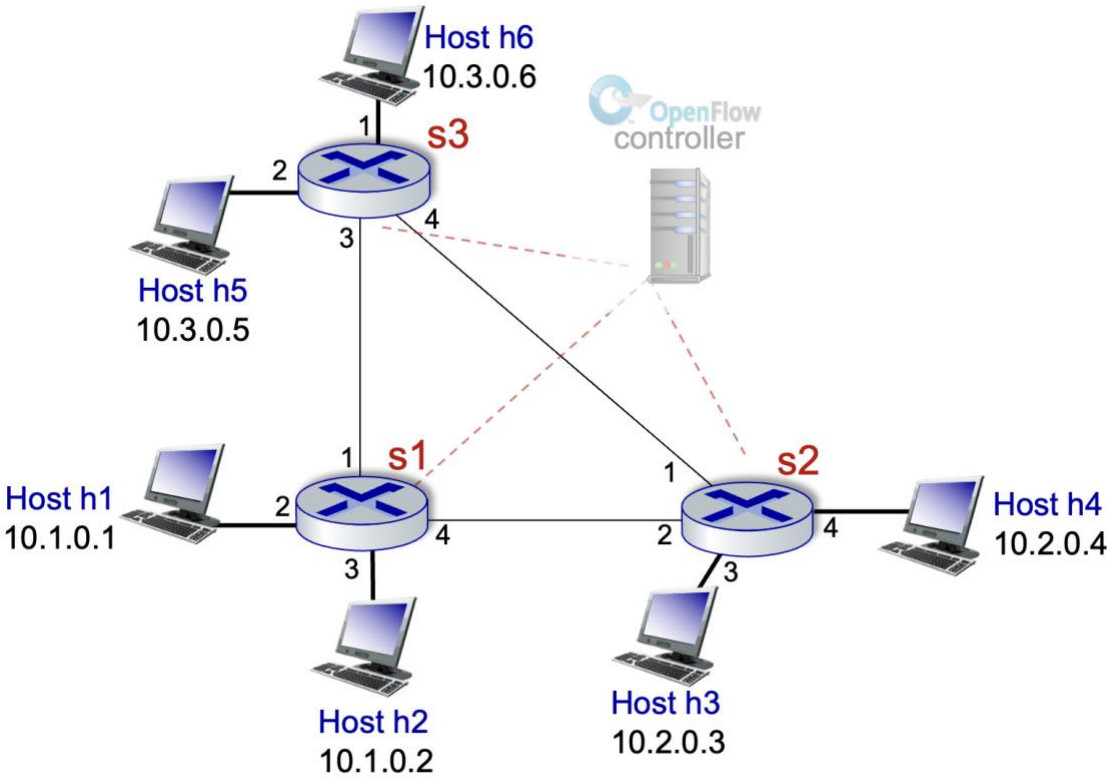
5. (20 points) Consider the scenario where a DHCP client arrives and requests an IP address from the DHCP server:



In the simplest case, four DHCP messages will be exchanged according to the figure below. Identify and fill in the missing fields for each DHCP message. You may assume that the subnet to which the DHCP client arrives is a /24 network and that all addresses below 223.1.2.10 are occupied. You may select a reasonable transaction ID and suitable IP address (based on requirements just mentioned).(Hint: See page 373 of the textbook)



6. (10 points) Consider the SDN OpenFlow network shown below:



Suppose that the desired forwarding behavior for datagrams arriving from host `h3` or `h4` at `s2` is as follows:

- Any datagrams arriving from host `h3` and destined for `h1`, `h2`, `h5`, or `h6` should be forwarded in a clockwise direction in the network.
- Any datagrams arriving from host `h4` and destined for `h1`, `h2`, `h5`, or `h6` should be forwarded in a counter clockwise direction in the network.

Specify the flow table entries in `s2` that implement this forwarding behavior.

(Hint: See video lecture from 16th April and Lecture 4_2 slide 34)