

Second Midterm for ECE374**04/16/12****Solution!!****Instructions:**

- Put your name and student number on each sheet of paper!
- The exam is closed book.
- You have 90 minutes to complete the exam. Be a smart exam taker - if you get stuck on one problem go on to another problem. Also, don't waste your time giving irrelevant (or not requested) details.
- The total number of points for each question is given in parenthesis. There are 100 points total. An approximate amount of time that would be reasonable to spend on each question is also given; if you follow the suggested time guidelines, you should finish with 10 minutes to spare. The exam is 90 minutes long.
- Show all your work. Partial credit is possible for an answer, but only if you show the intermediate steps in obtaining the answer. If you make a mistake, it will also help the grader show you where you made a mistake.
- Good luck.

Problem 1: Quickies (32 Points (4 each), 25 minutes)

- a. Briefly describe how Ethernet's exponential backoff works. What is one reason why Ethernet's exponential backoff might be better than randomizing retransmission attempts over a fixed-length time interval?

Answer: Ethernet maintains an interval of time T over which it will randomize when it will attempt a retransmission. After each collision for the same packet, it doubles the length of T up to some fixed max. This is better than just a single, fixed value of T since when there are a lot of collisions the interval over which randomization is done will be large, allowing just one node to successfully be transmitting. When there are only a small number of colliding nodes, the retransmission will be randomized initially over a small T , allowing a node to transmit more quickly.

- b. Suppose nodes A, B, and C each attach to the same broadcast LAN (through their adapters). If A sends thousands of IP datagrams to B with each encapsulating frame addressed to the MAC address of B, will C's adapter process these frames? If so, will C's adapter pass the IP datagrams in these frames to the network layer in C? How would your answer change if A sends frames with the MAC broadcast address?

Answer: C's adapter will process the frames, but the adapter will not pass the datagrams up the protocol stack. If the LAN broadcast address is used, then C's adapter will both process the frames and pass the datagrams up the protocol stack.

- c. Suppose there are three routers between source host and destination host. Ignoring fragmentation, an IP datagram sent from the source host to the destination host will travel over how many interfaces? How many forwarding tables will be indexed to move the datagram from the source to the destination?

Answer: 8 interfaces; 3 forwarding tables

- d. Explain the difference between CSMA/CD and CSMA/CA.

Answer:

In CD, collisions are detected as they occur. Senders do not signal their intent to transmit but simply start transmitting if they sense no other ongoing transmission.

In CA, collisions are avoided because each node signals its intent to transmit before actually doing so.

- e. Briefly explain the two methods through which a wireless 802.11 node learns about access points it can communicate with.

Answer:

i) Passive scanning, beacon frame from AP, association from node, reply from AP.

ii) Active scanning, probe request from node, probe responses from APs, association request from node, reply from AP.

- f. Mention three different techniques that are used in the switching fabric of a router that manage the actual switching of packets from an input port to an output port.

Answer: Switching via memory, bus, or interconnection network

- g. An IP subnet is specified by 223.1.1.0/24. What is the subnet address? What is the maximum number of nodes that can be located in this subnet? To what value would you change the subnet mask if a maximum of 20 nodes were located in this subnet?

Answer: 223.1.1, $2^8-2=254$, $32-5=27$

- h. What are IP destination and source addresses of a DHCP discover message? What are IP destination and source addresses of a DHCP offer message? What are the three values that are contained in a DHCP server offer message?

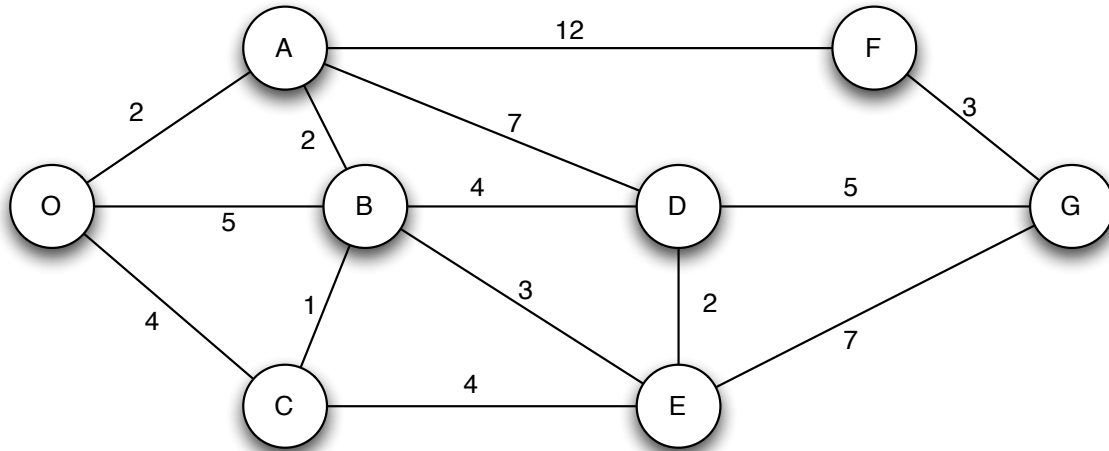
Answer:

destination: 255.255.255.255, source: 0.0.0.0

destination: 255.255.255.255, source: actual DHCP server IP address

IP address for client, network mask, IP address lease time

Problem 2: Routing (24 Points, 20 minutes)



Consider the network shown above.

- a. (7 Points) Show the operation of Dijkstra's (LinkState) algorithm for computing the least cost path from O to all destinations.

<i>N</i>	<i>D(A), P(A)</i>	<i>D(B), P(B)</i>	<i>D(C), P(C)</i>	<i>D(D), P(D)</i>	<i>D(E), P(E)</i>	<i>D(F), P(F)</i>	<i>D(G), P(G)</i>
<i>O</i>							

Answer:

<i>N</i>	<i>D(A), P(A)</i>	<i>D(B), P(B)</i>	<i>D(C), P(C)</i>	<i>D(D), P(D)</i>	<i>D(E), P(E)</i>	<i>D(F), P(F)</i>	<i>D(G), P(G)</i>
<i>O</i>	2, <i>O</i>	5, <i>O</i>	4, <i>O</i>	Inf	Inf	Inf	Inf
<i>OA</i>	-	4, <i>A</i>	4, <i>O</i>	9, <i>A</i>	Inf	14, <i>A</i>	Inf
<i>OAB</i>	-	-	4, <i>O</i>	8, <i>B</i>	7, <i>B</i>	14, <i>A</i>	Inf
<i>OABC</i>	-	-	-	8, <i>B</i>	7, <i>B</i>	14, <i>A</i>	Inf
<i>OABCE</i>	-	-	-	8, <i>B</i>	-	14, <i>A</i>	14, <i>E</i>
<i>OABCED</i>	-	-	-	-	-	14, <i>A</i>	13, <i>D</i>
<i>OABCEDG</i>	-	-	-	-	-	14, <i>A</i>	-

- b. (7 Points) From these results, show the least cost path from O to nodes A-G, and briefly describe (in a sentence) how you got that answer from your work in part a).

Answer:

O-A O-B O-C O-D O-E O-F O-G
 OA OAB OC OABD OABE OAF OABDG

- c. (4 Points) What are the distance vectors in nodes B and D?

Note: you do not have to run the distance vector algorithm; you should be able to compute distance vectors by inspection.

Answer:

$[D_B(O)=4, D_B(A)=2, D_B(C)=1, D_B(D)=4, D_B(E)=3, D_B(F)=12, D_B(G)=9]$
 $[D_D(O)=8, D_D(A)=6, D_D(B)=4, D_D(C)=5, D_D(E)=2, D_D(F)=8, D_D(G)=5]$

- d. (6 Points) Now, consider a network in which all nodes are connected to *four* other nodes. In a single time step, a node can receive all transmitted broadcast packets from its neighbors, duplicate the packets, and send them to all of its neighbors (except to the node that sent a given packet). At the next time step, neighboring nodes can receive, duplicate, and forward these packets, and so on. Suppose that uncontrolled flooding is used to provide broadcast in such a network. At time step t , how many copies of the broadcast packet will be transmitted, assuming that during time step 1, a single broadcast packet is transmitted by the source node to its three neighbors.

Answer: After 1 step 4 copies are transmitted, after 2 steps 12 copies are transmitted. After 3 steps, 36 copies are transmitted, and so on. After k steps, $4 \cdot 3^{k-1}$ copies will be transmitted in that step.

Problem 3: Wireless (20 Points, 15 minutes)

The figure below shows three wireless nodes and their transmission ranges. (A and C use directional antennas and can communicate with B but not with each other.)

- a. (4 Points) Use the figure below to explain the “hidden node” problem. What happens when nodes A and C start sending a message simultaneously?

Answer: A cannot detect a transmission from C and vice versa. If A and C start sending simultaneously to B a collision at B will happen but A and C will not become aware of the collision.

- b. (8 Points) Use the diagram below to explain how CSMA/CA is realized in the case of the IEEE 802.11 protocol. For your explanation, assume that A wants to send a frame to the destination.

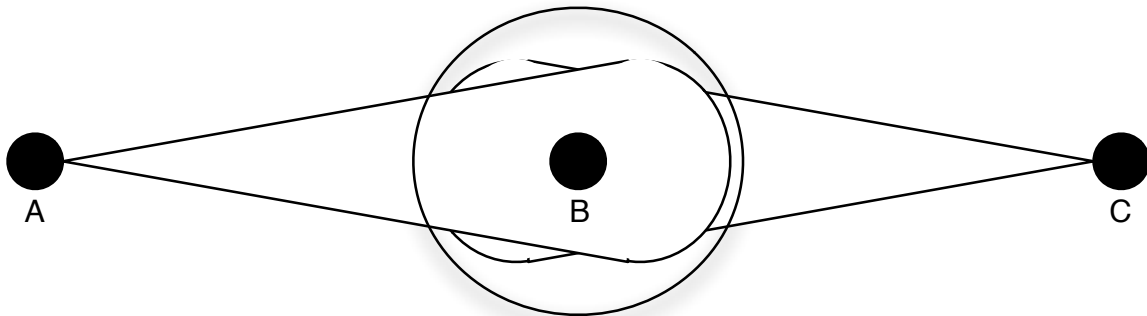
Answer: See diagram below

- c. (4 Points) Why are acknowledgements used in 802.11 but not in wired Ethernet?

Answer: Usually no packet loss in wired Ethernet. This is much more likely in a wireless scenario. Robustness is increased through retransmissions. To be able to perform retransmissions ACKs are required.

- d. (4 Points) Why does the 802.11 protocol require sequence numbers?

Answer: Because ACKs can get lost, the sender may send multiple copies of a given frame. Sequence numbers allow a receiver to distinguish between a newly transmitted frame and a retransmitted one.



Source

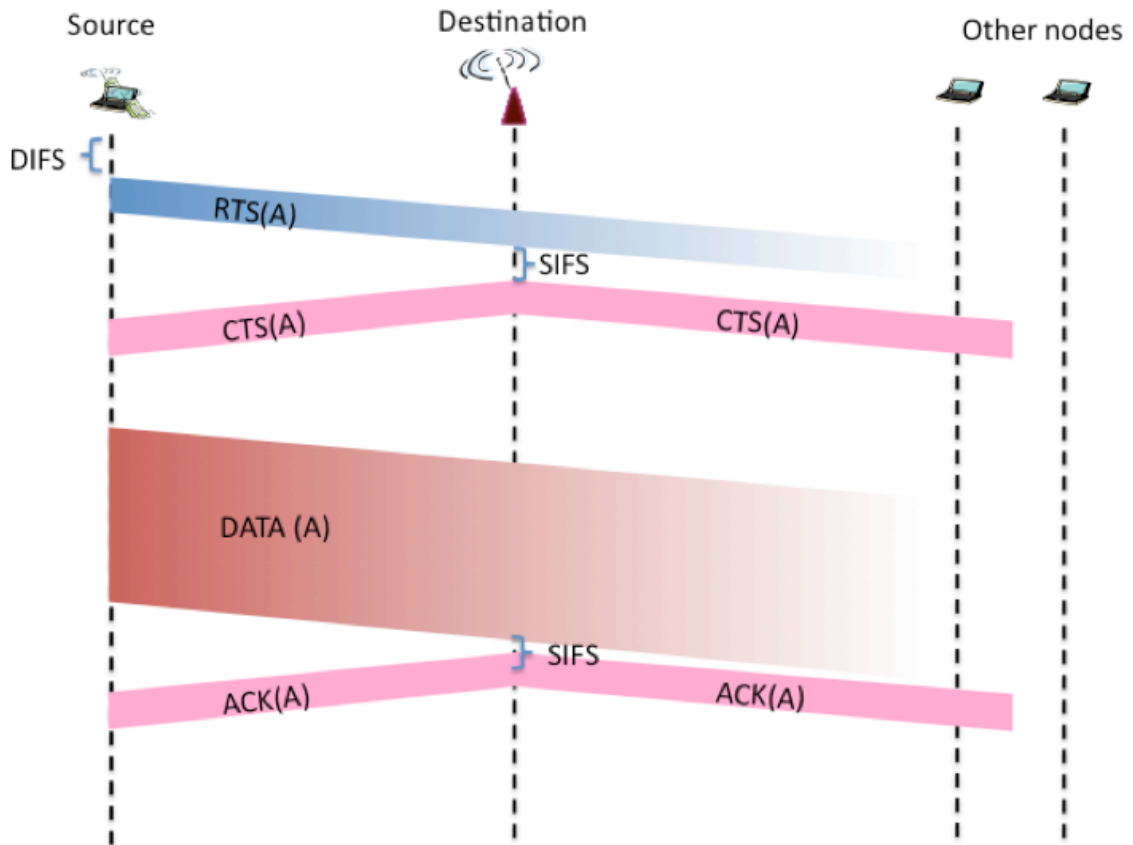


Destination

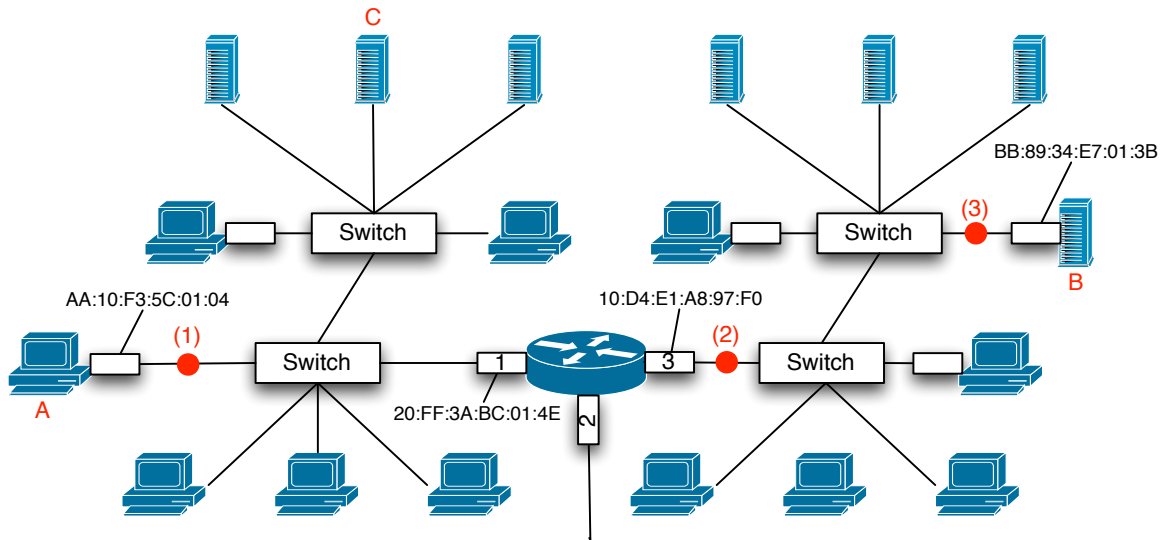


Other nodes





Problem 4: LAN Potpourri (24 Points, 20 minutes)



Consider the network shown above.

- a. (4 Points) Assign IP address ranges to the subnets containing hosts A and B, and assign IP addresses in these ranges to hosts A and B. (You don't have to assign IP addresses to any hosts except A and B, but you do need to specify the address range being used by each subnet). Your subnet addressings should use the smallest amount of address space possible.

*Answer: Because there are less than 16 but more than 8 nodes in each subnet, we'll need four address bits for each subnet. So let's assign the left subnet $XX.YY.ZZ.xxx0****/28$, where the $XX.YY.ZZ$ are 8 bit numbers. Each x is a bit and the three $*$'s correspond to the three address bits for this network. For the right subnet, we'll use $XX.YY.ZZ.xxx1****/28$. A will have an IP address of $XX.YY.ZZ.xxx00000$ and B will have an IP address of $XX.YY.ZZ.xxx10000$.*

- b. (4 Points) What IP address range can the router advertise to the outside for all of the hosts reachable in these two subnets? Again, you should choose your answer in a) above so that the minimum-size address space is advertised here. *Answer: $XX.YY.ZZ.xxx/27$.*
- c. (4 Points) Does the router interface 1 with link-layer address 20:FF:3A:BC:01:4E have an IP address? If so, what is the role of the IP address of the router's IP interface in forwarding datagrams through the router.

Answer: Yes. That's the address that a host in the left network will use to determine the MAC address to send frames to, containing datagrams that need to be routed through the router. The router address however, won't appear in the IP datagram.

- d. (4 Points) Consider an IP datagram being sent from A to B using Ethernet as the link layer protocol in all links in the figure above. What are the (i) Ethernet source and destination addresses and (ii) IP source and destination addresses of the IP datagram encapsulated within the Ethernet frame at points (1), (2), and (3) in the above example for a datagram going from A to B.

Answer:

(1): ETH source: aa:12:F3:5C:01:BC, ETH dest: 20:FF:3A:BC:01:4E IP source: XX.YY.ZZ.xxx00000; IP dest: XX.YY.ZZ.xxx10000 see (a) above

(2) ETH source: 10:D4:E1:A8:97:F0, ETH dest: BB:89:34:E7:01:3B IP source: XX.YY.ZZ.xxx00000; IP dest: XX.YY.ZZ.xxx10000 same as (1) above

(3) same as (2)

- e. (4 Points) Suppose all switches in the above example are learning switches. Consider the datagram being sent from A to B; neither A nor B have sent any frames or datagrams in the network before.
- How many of the 18 hosts in the network receive the frame containing the datagram sent by A? Explain your answer briefly.
Answer: all 18, since no switch knows where B is located (since B hasn't sent anything), all switches will broadcast the frame containing the IP datagram from A. Note that different frames are broadcast on the left and right subnets (e.g., the frames have different source and destination MAC addresses, see above), but both contain the datagram from A.
 - Suppose the server C in the upper part of the left network sends a datagram to A shortly after the A-to-B datagram is sent. How many of the 18 hosts in the network receive the frame containing the datagram sent by this server? Explain your answer briefly.
Answer: Only A will receive that, since all of the switches know the outgoing port leading to A, as a result of learning where A is, as a result of the initial A-to-B transmission.
- f. (4 Points) Suppose C sends out an ARP request, and this ARP request is in the very first frame sent in the network above (i.e., even before the original A-to-B datagram). How many of the 18 hosts in the network receive the frame containing this ARP request? Explain your answer briefly.
Answer: ARP broadcasts are restricted to a subnet and generally do not pass through the router, so all 9 other hosts in the left network will receive the ARP broadcast (as will the leftmost interface on the router).