COSC 350 Exam 2 Review

Use the network graph below for questions 1 and 2.

1. For Distance-Vector Routing (DVR), node 2's current routing table is shown below on the left. Its distances to reach its neighbors (link weights) specified as (neighbor, distance) pairs are: (3, 2), (1, 7). Node 2 now receives a DVR message from neighbor N=1 with (destination, distance) pairs: (1, 0), (3, 12), (4, 3). Fill in the (destination, next hop, distance) entries in node 2's routing table after updating **due to this DVR message**.

destination	next hop	distance
1	3	14
3	3	2
4	3	11

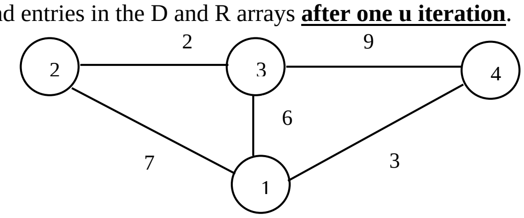
destination	next hop	distance
1	1	7
3	3	2
4	1	10

Because c=0+7<14 for dest 1, change next hop =1, dist=7; c=12+7=19>2 for dest 3, no change; c=3+7=10<11 for dest 4, change next hop=1, dist=10.

2. For Dijkstra's algorithm, assume **2 is source.** The initial set S={1, 3, 4}. The initial D (distance) and R (next hop) arrays are below. fill in values of the chosen node u, set S, v, and entries in the D and R arrays **after one u iteration**.

u	1	2	3	4
D[u]	7	-	2	∞

v	1	2	3	4
R[v]	1	-	3	0



u=3, S={1, 4}, v=1, 4

u	1	2	3	4
D[u]	7	-	2	11

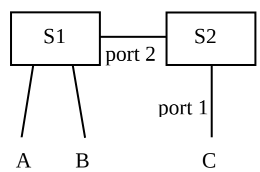
V	1	2	3	4
R[v]	1	-	3	3

Because u=3 is node in S with minimum D[u]; (3, 1), (3, 4) are edges (u, v) with v in S; d=2+6=8>D[1]=7, d=2+9=11<D[4]=∞; R[4]=R[3]=3.

3. In the figure below, S1 and S2 are Ethernet switches. They act as learning bridges to learn the switch ports where stations A, B, and C are located by using source addresses in frames. Switch S2 has two switch ports: port 1 connects to station C and port 2 connects to switch S1. If A sends a frame to C, **S2's forwarding table** has the entry shown. If next, B sends to A, and then B broadcasts, fill in S2's forwarding table entries after these frames.

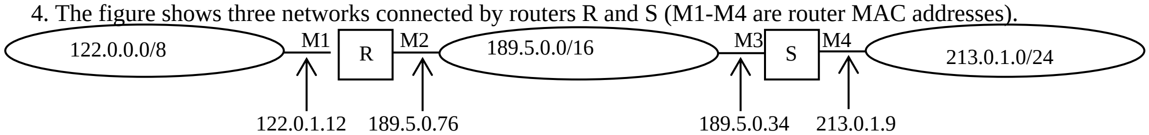
S2's Forwarding Table

Frame	Station	Switch Port
1. A sends to C	A	Port 2
2. B sends to A	-	-
3. B broadcasts	B	Port 2



S1 doesn't know where C is, so frame 1 is sent to S2 and both S1, S2 learn where A is. Now S1 doesn't send frame 2 to S2, so S2 doesn't learn where B is. When B broadcasts frame 3, it is sent to S2. So S2 learns where B is.

4. The figure shows three networks connected by routers R and S (M1-M4 are router MAC addresses).



a. Fill in below the destination/mask/next hop in table for **Router S**.

Destination	Mask	Next Hop
213.0.1.0	255.255.255.0	deliver direct
189.5.0.0	255.255.0.0	deliver direct
122.0.0.0	255.0.0.0	189.5.0.76

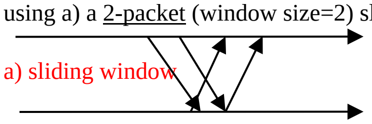
b. What are the MACs and IPs in a packet from 122.1.1.1 to 213.0.1.1 when R sends it? Source MAC=M2, Source IP=122.1.1.1, Dest MAC=M3, Dest IP=213.0.1.1.

c. What is the highest host address in the 213.0.1.0/24 network? 213.0.1.254 since 11111110=254 in last byte.

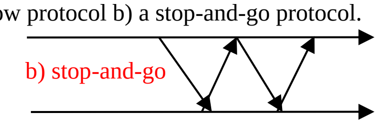
5. Does the address 10.55.98.254 match a forwarding table entry (subnet 10.55.96.0, mask 255.255.252.0)? Explain.
D&M=(10.55.98.254 & 255.255.252.0)==10.55.96.0, which is the subnet address, so it matches this entry.
Note that 98=01100010, 252=11111100, so 98 & 252=01100000=96.

6. Time increases to right. Draw figures showing packets (downwards) and acks (upwards) when 2 packets are sent using a) a 2-packet (window size=2) sliding window protocol b) a stop-and-go protocol.

a) sliding window



b) stop-and-go



time time

7. A TCP receiver advertises a window of 2000 bytes. The sender has 3000 bytes to send, and sends segments of 1000 bytes each time. Each TCP segment has seq number of the first byte in segment and ack number of next byte expected.

a. Show the segments sent, and the acks and window advertisements from the receiver before the sender blocks. bytes=1-1000, ack=1001, window=1000; bytes=1001-2000, ack=2001, window=0.
b. If the receiving application now reads 500 bytes, what window size is advertised by the receiver, and what segments, acks and window advertisements are sent? window=500, ack=2001; bytes=2001-2500, ack=2501, window=0 (bytes 2501-3000 are still unsent).

8. Give brief precise answers to each of the following:

a. What are meant by public and private addresses in NAT? A public IP is used on the interface of a NAT box/router that connects to the Internet; private (non-routable) IPs are assigned to computers and interfaces on the other side of the NAT box/router.
b. What is the purpose of a DHCP lease? DHCP manages a finite pool of IP addresses that it assigns on demand. By leasing addresses for a specific time period only, it is able to reclaim addresses of hosts that do not renew their lease.
c. What two types of messages are sent by ICMP? Messages that report errors (such as time exceeded or destination unreachable) and messages that request/provide information (such as echo request/reply i.e., ping packets).
d. What 3 MAC addresses appear in an 802.11 frame sent by a station A to its default router R via the AP? A1=MAC AP, A2=MAC A, A3=MAC R.
e. How does TCP compute the retransmission timeout? It uses the mean and variance of RTT (round trip time) estimates.
f. Explain TCP seq and ack numbers. Seq num is num of first byte sent in a TCP segment; ack is num of next byte expected from receiver. Seq numbers and ack numbers are used to detect lost segments (to be retransmitted) and to put segments in order.
g. What is the significance of the first half of an Ethernet address? It identifies the vendor of the network interface card.
h. What bits in an Ethernet address indicate that it is a global unicast address? The last 2 bits in the MSB (most significant byte). Indicate one use of VLAN switches. Managers can use them to configure switch ports to be on different broadcast domains.
i. What algorithm is used to prevent looping of broadcast packets on an Ethernet? The DST (distributed spanning tree) algorithm.
j. How does a receiver know that it is the target of an ARP broadcast? By using the target IP address field in the ARP message.
k. List three key elements in EPC (Evolved Packet Core) in LTE and LTE-A. mobility management entity (MME), serving gateway (SGW), packet data network gateway (PGW)
l. What multiplexing techniques are used in LTE? downlink (DL): OFDMA, uplink (UL): SC-FDMA
m. Which three LTE protocols are used by the UE when sending user IP data traffic? PDCP, RLC and MAC
n. What are NAS (non-access stratum) protocols in LTE? They are above the RRC layer in the UE and handle signaling (control) messages between the UE and MME.
o. Give 3 features in 5G NR. more capacity, higher data rates, and use of millimeter waves.

Exercises from the textbook:

13.13 How does a computer attached to a shared LAN decide whether to accept a packet? A frame is accepted if the destination address is its own address, the broadcast address (all 1s), or the multicast address of a group that it currently belongs to.

14.9 What is binary exponential backoff? Binary exponential backoff is a technique in which a station chooses a random delay in an interval, doubling the length of the interval each time. It is used to reduce the chances of repeated collisions in 802.11 wireless LANs.

14.11 Why is CSMA/CA needed in a wireless network? CSMA/CA is needed in 802.11 to prevent collisions that may occur due to hidden stations.
15.1 How large is the maximum Ethernet frame, including the CRC? Largest Ethernet frame usually has 1518 bytes since it has 1500 data bytes (+14-byte header+4-byte CRC).
15.2 How is the type field in the Ethernet header used? Type field is used for demultiplexing i.e., it tells which protocol (e.g., IP) handles the frame next.
15.5 When it is used, where is an LLC/SNAP header placed? When used, a SNAP header is placed at the beginning of the data (payload) area in the frame.

16.9 Why must a wireless computer associate with a specific base station? In 802.11, a station must associate with a specific AP (base station) because it may be within range of two APs and must choose one for sending and receiving frames from the network.
16.11 What are SIFS and DIFS, and why are they needed? SIFS, DIFS are delays in 802.11 with DIFS>SIFS; defines priority for acquiring channel; sender waits for DIFS (channel must be idle for DIFS) before sending RTS and waits for SIFS before sending CTS or ACK or data.
18.12 What are the two basic approaches used to perform a distributed route computation, and how does each work? In LSR (link state), each node broadcasts link status messages to all nodes, which enables each node to build a graph of the network and use Dijkstra's algorithm to compute shortest paths and next-hop information. In DVR (distance-vector), each node sends DVR messages to its neighbors (containing distances to other nodes), which enables each node to update its next-hop information.
21.8 If an ISP assigned you a /28 IPv4 address block, to how many computers could you assign an address? In a /28 address block, 32-28=4 bits are left, so 2^4-2(=14) addresses can be assigned (2 reserved addresses).
21.21 How many IPv4 addresses are assigned to a router that connects to *N* networks? Explain N interfaces since each router interface that connects to a network has an IP address.
22.6 What is the maximum length of an IP datagram? TOTAL LENGTH field in IP header (Figure 22.2) has 16 bits, so max length is 2^{16}-1(=65535) bytes.
22.8 If the payload of an IPv4 datagram contains one 8-bit data value and no header options, what values will be found in header fields H. LEN and TOTAL LENGTH? If there are no options, the IP header has 20 bytes (see Figure 22.2) so H.LEN=5 since it is number of 4-byte units. Since the datagram has 1 byte of data, the TOTAL LENGTH=20+1=21 bytes (which is total length of header and data).
22.16 If an IPv4 datagram with a payload of 1480 bytes must be sent over a network with an MTU of 500 bytes, how many fragments will be sent? Explain. If MTU=500, there can be at most 480=500-20 bytes of data in each fragment since the 20-byte IP header plus the data must fit in 500 bytes. For a payload of 1480 bytes=480*3+40, there are 4 fragments; first 3 fragments each have 480 bytes of data and the last has 40 bytes of data (each fragment also has a 20-byte IP header).
22.18 In the Internet, where are fragments reassembled? Fragments are reassembled at the destination host.
22.19 When reassembling fragments, how does IP software know whether incoming fragments belong to the same datagram? ID field in all fragments of a given datagram from a given sender have the same value.
23.6 How does a computer know whether an arriving frame contains an IP datagram or an ARP message? The Ethernet type field has different values for ARP (0x806) and IP (0x800) as in Figure 12.2.
23.9 When does Algorithm 23.1 (ARP algorithm) create a new entry in an ARP cache? When it receives an ARP request, the target of the request creates a new cache entry (i.e., IP address/MAC address binding) for the sender of the request. When the sender of a request gets an ARP response from the target, it creates a new cache entry with binding for the target. When an ARP request is broadcast, a computer that is not the target but has the sender's binding already in their cache will replace it with the binding in the request.
23.15 Given an Ethernet frame, what fields does a host need to examine to determine whether the frame contains an ICMP message? The Ethernet type field (says it's an IP datagram) and the IP type field (says it's an ICMP message)
23.24 Expand Figure 23.14 (Example of NAPT Translation in slides) to show the mappings that will be used if a third application also attempts to reach the same web server. 192.168.0.3: 30000→128.10.24.6: 40003 (out); 128.10.24.6: 40003→192.168.0.3: 30000 (in)
24.10 What is a pseudo header, and when is one used? UDP's pseudo header has IP addresses, protocol (type) and UDP length field from the IP header. It is appended to the UDP datagram when computing the checksum (the pseudoheader is not sent). UDP uses the checksum to discard packets that may have been misdelivered due to an error. TCP uses a pseudo header in a similar way.
25.14 What is a *SYN*? A *FIN*? SYN segments are used to establish TCP connections with a 3-way handshake. Each side sends a FIN segment to close its side of the connection (SYN or FIN bit in Flags field in TCP header are set in the respective segments).
25.16 What problem in a network causes TCP to reduce its window size temporarily? When congestion occurs, TCP reduces the window size.