Name: Solutions

ECE 4380/6380: Computer Communications **Spring 2018**

Exam 2 (Each of the 4 problems is worth 25 points) **Wednesday, April 11**

6380 students: For problem 1, you only need to answer any 8 of the short answer questions.

4380 students: For problem 1, you only need to answer any 5 of the short answer questions. Extra credit earned on any extra answers will be added to your total homework score.

1 Short Answer. Your answer to each question should be twenty words or less.

1.1 In the distributed spanning tree algorithm, why does the root bridge periodically send configuration messages even after the system has stabilized?

to detect any changes. All bridges monitor for control packets on all ports

1.2 Assume router R8 receives a broadcast ARP query that is requesting host H25's MAC address. The other fields in R8's ARP table include H25's IP address and the IP and MAC addresses for the source of the ARP packet, which is host H19. If R8 finds that H25's IP address **is** in its ARP table but H19's IP address **is not** in its ARP table, how does R8 update its ARP table and what ARP reply packet does R8 send?

R8 does nothing

- it is H25's jobs to respond to the query
- since H19 is not in R8's table, it does not add it.

1.3 How do IP routers catch packets that have been going around in loops?

A router decrements the TTL (hop count) field in an IP packet. If the hop count is zero, the packet is discarded.

1.4 For the global Internet, describe a scaling concern that is addressed by classless interdomain routing (CIDR).

CIDR allows aggregation of address blocks, which can reduce the size of forwarding tables

1.5 What is the triangle routing problem that arises in Mobile IP, and how can it be addressed?

Occurs when a sending host forwards packets to a mobile host, and the mobile host has registered with a foreign agent. Packets first go to the home agent, then are forwarded to the foreign agent.

Solution: the FA sends care-of-address to sending host, and sending host tunnels IP packet to FA. (or home agent can send binding update to sending host.)

1.6 BGP has replaced EGP because a design assumption made in EGP no longer applies to the modern Internet. What was this assumption, and what was added to BGP because this assumption is no longer true?

EGP assumed the network has one backbone and a tree organization so there were no loops between AS's.

BGP includes a list of all AS's in each route so can determine if a route between AS's has a loop

1.7 The traceroute function allows a network engineer to discover the IP addresses for the routers in the path to some destination. What features of IP and ICMP make this capability easy to implement?

Set the TTL field in an IP packet to one. At first router the packet is discarded and an ICMP error message is returned to the source. Repeat for successively larger hop counts

1.8 A host that receives an IP packet that has been fragmented must wait until it collects all of the fragments associated with this packet. What actions does that host take if, after a suitably long period of time, there are still one or more fragments missing?

The host discards the fragments. It can send an ICMP reassembly failure message, but IP does not handle packet retransmissions

1.9 Multiprotocol label switching (MPLS) combines some of the properties of virtual circuits with the flexibility and robustness of datagrams. Name the two main applications of MPLS that have led to its widespread deployment.

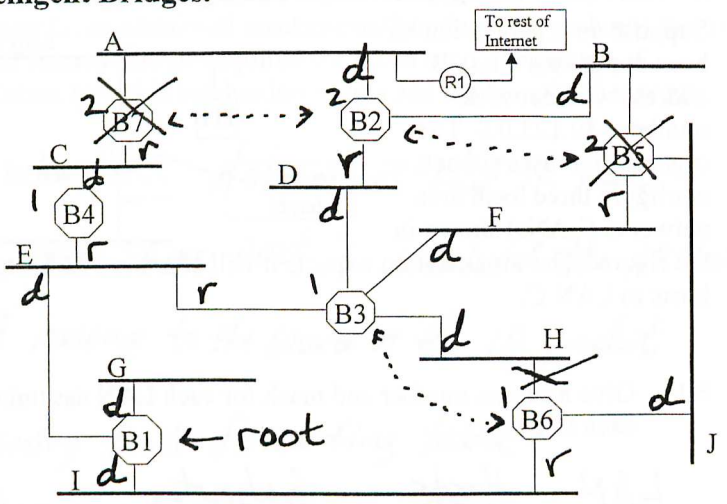
Support for VPN's and traffic engineering

1.10 Protocol-independent multicast (PIM) was developed in response to the scaling problems of earlier protocols. In PIM sparse mode (PIM-SM), routers explicitly join the multicast distribution tree using PIM protocol messages known as Join messages. Where does a router send the Join message?

A router explicitly adds itself to the tree by sending a join message to the rendezvous point (RP).

2 Spanning Tree Algorithm for Intelligent Bridges.

Consider the spanning tree algorithm for the network shown to the right. The seven bridges numbered 1 to 7 run the spanning tree algorithm. Router R1 is connected to LAN A and provides a connection to the Internet.

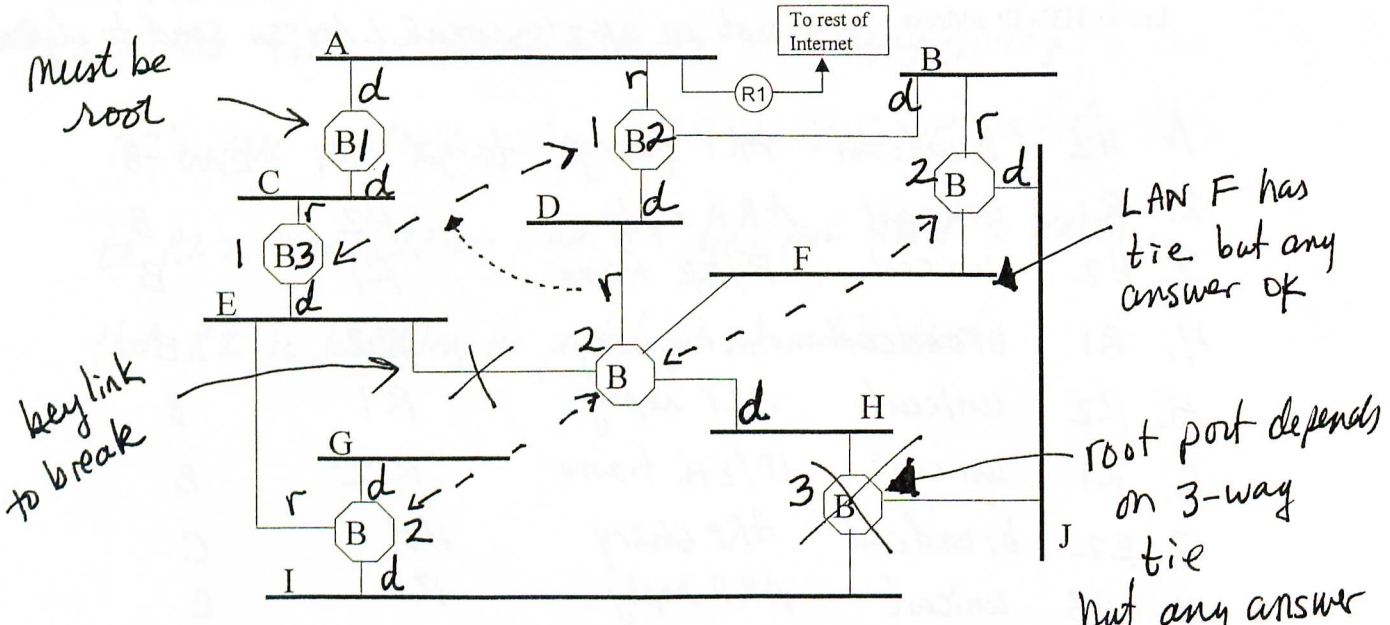


2.1 Indicate on the figure the spanning tree. Be sure to indicate the root port for each bridge (except the root bridge), the designated port for each LAN, and the links and bridges that do not participate in forwarding data frames.

2.2 Assume that hosts attached to LAN J generate traffic with destinations found through the router to the rest of the network, and the bridges have learned which port to use for forwarding traffic between LAN J and R1. Which bridges forward frames generated by hosts on LAN J to R1?

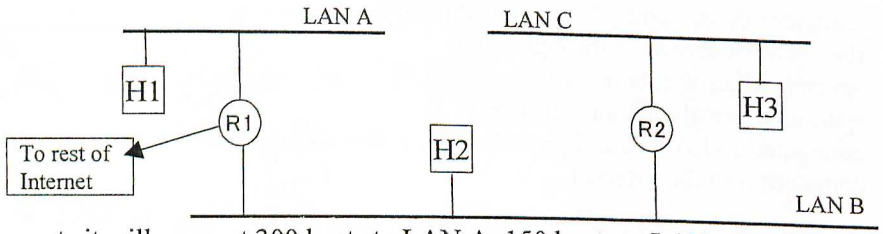
J → B6 → I → B1 → E → B3 → D - B2 → A → R1

2.3 Assume that hosts attached to LAN's H, I, and J generate traffic with destinations found through the router to the rest of the network. Renumber the bridges so that the traffic from the hosts on LAN H traverses LAN D to LAN A, LAN I traverses LAN E to C to A, and LAN J traverses LAN B to A. Draw the resulting spanning tree in the figure below showing the new bridge numbers and root and designated ports. You can only change the numbers assigned to the bridges (e.g., links cannot be moved and no new links can be added).



3 IP Forwarding, LAN Forwarding, ARP, and Subnet Masks.

Suppose an organization has been assigned a Class B address with network number 149.123.0.0 The organization uses subnets to configure three local area networks (LANs) shown in the figure. The organization expects it will connect 300 hosts to LAN A, 150 hosts to LAN B, and 75 hosts to LAN C.



3.1 Give a subnet number and mask for each LAN assuming that only one subnet can be assigned to each LAN.

LAN	Hosts	Subnet	MASK	#addresses	host bits
A	300	149.123.2.0	255.255.254.0	512	9
B	150	149.123.4.0 (notice not 3)	255.255.255.0	256	8
C	75	149.123.5.0	255.255.255.128	128	7

(can make subnets larger but not smaller)

3.2 Suppose that H2 is configured with only a default route to R1 in its IP forwarding table. Assume that IP address and subnet masks are correctly assigned for all hosts and routers. Give the sequence of *all* Ethernet frames that are transmitted on the LAN's when H2 has a packet to forward for H3. For each Ethernet frame, specify its destination address and the type of packet the frame contains. (Assume that network has been idle long enough so that all ARP caches have timed out and H2 has not forwarded any packets to hosts on LAN C since it was booted. Also, assume H2 knows H3's IP address.) H3 not on H2's local LAN. so send to default router

1.	H2	broadcast	ARP query	target R1	LAN B
2.	R1	unicast	ARP reply	H2	B
3.	H2	unicast	IP/Eth frame	R1	B
4.	R1	broadcast	ARP query	R2	B
5.	R2	unicast	ARP reply	R1	B
6.	R1	unicast	IP/Eth frame	R2	B
7.	R2	broadcast	ARP query	H3	C
8.	H3	unicast	ARP reply	R2	C
9.	R2	unicast	IP/Eth frame	H3	C

3.3 Because the nodes build ARP caches, not all the frames listed in part 3.2 are required for H2 to send a sequence of packets to H3. Describe an additional mechanism (besides ARP caching) that is available in IP to reduce the number of frames that are required for H2 to send a sequence of packets to H3. Include in your description how this mechanism works and the benefits that result.

ICMP-redirect. when R1 determines that it has forwarded the IP packet out same port it received the packet on. It sends icmp redirect message to the source of the IP packet

This causes H2 to add entry to its forwarding table with R2 as next hop for destination H3.

(the ICMP message is after frame 6 in part 3.2)

3.4 Assume that R2 is upgraded to serve as an 802.11 access point. The access point assigns IP addresses for the mobile hosts that associate with it from LAN B's allocation. Also, Mobile IP is enabled and router R2 serves as the home agent. Suppose an IP packet arrives at R1 from the Internet with a destination address corresponding to a mobile host associated with this access point. Describe the frames that are transmitted on LAN B in delivering this packet to the mobile host. In particular, R1 is an old router and does not know about Mobile IP or 802.11.

Proxy-ARP is the key to get IP packets from R1 to R2. When R1 broadcasts an ARP-query for the mobile's IP address R2 responds with an ARP reply giving R2's MAC address. Thus, R1 sends the IP packet to R2's MAC address and R1 does not need to know that R2 is handling the packet for the mobile host.

4 Distance-Vector Routing.

Consider a network that has nodes designated as A, B, C, … . There is a cost assigned to each link in the network, and do not assume that the cost is the same in each direction on a link. Node C's forwarding table is shown below.

Beginning forwarding table for C		
Destination	Next Node	Cost to destination
A	A	9
B	B	7
C	C	0
D	D	5
E	B	13
F	A	11
G	D	13

Assume that all the nodes are asynchronously executing a distributed version of the Bellman-Ford algorithm. Consider just the basic Bellman-Ford algorithm and not any of the extensions (such as split horizon or poison reverse).

4.1 Based on the entries in the forwarding table, which nodes must be neighbors of node C and what is the cost of the link from C to each of these neighbors?

A 9
B 7
D 5

4.2 The cost assigned to the link from node C to node B changes to 9. Clearly mark in the table below changes (if any are necessary) that node C should make to its forwarding table.

increase cost of C→B by 2

Forwarding table for C		
Destination	Next node	Cost to destination
A	A	9
B	B	~~7~~ 9
C	C	0
D	D	5
E	B	~~13~~ 15
F	A	11
G	D	13