NAME ANSWER KEY___________________________________

1. Write a short response to the following (2 pts each):

a). Explain how a FDDI network can continue to operate with a broken link.
FDDI networks have two counter-rotating rings. If a link breaks, the two nodes at each end of the broken link can route traffic from the clock-wise partial ring onto the counter-clock-wise partial ring so that data can continue to flow to all nodes.

b). What is MACA?
Multiple Access Collision Avoidance – used in wireless.

c). What is the difference between PIO and DMA?
In PIO (Programmed I/O) the cpu uses I/O instructions to communicate with the Network Adaptor. This is generally slower than DMA (Direct Memory Access), in which the Network Adaptor interface is mapped into the computer's memory address space and the cpu uses conventional memory-access instructions to communicate with it.

d). In what types of situations should you use a Router instead of a Bridge?
Use a router to connect two networks of different types. Bridges connect networks of the same type.

e). What are the advantages of a small, fixed packet size (as used in ATM)?
More efficient flows through queues. Better telephony. Simplifies switching and packet-handling logic designs.

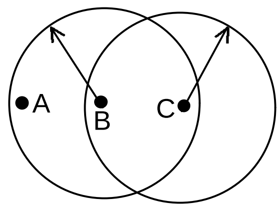
f). How is the basic switching element in a Banyan fabric different from the one in a Batcher fabric?
The Banyan switching element looks at a single address bit position and sends packets with a '0' bit in that position to the "upper" output; packets with a '1' in that position are sent to the "lower" output. Batcher switching elements compare the entire address of two incoming packets; in a "down" switch, the larger address goes to the "lower" output and the smaller one goes to the "upper" output (in an "up" switch, this is reversed). If a Batcher switching element has only one packet on it's input ports, the packet address is treated as though it is the smaller address.

g). What is the purpose of ARP?
ARP (Address Resolution Protocol) is the protocol used to associate an IP address with a physical (or MAC) address.

h). Explain what we mean when we say a Home Agent "steals" the address of a mobile IP node.
The mobile unit must be configured with the same network ID as the Home Agent. The Home Agent sends out ARP messages that associates the mobile's IP address with the Home Agent's physical address. Packets for the mobile are then routed to the Home Agent, which tunnels the packets to the mobile, wherever it is at the moment.

i). Give an example to illustrate why the "longest Match" principle is needed in CIDR.
In CIDR, 208.76.xxx.xxx and 208.76.14.xxx can both be legitimate network ID's. If a router receives a packet with the IP address 208.76.14.12, the router needs a way to decide which of the two networks the packet is supposed to go to. The Longest Match principal says that the packet will be routed to the network with the ID that matches the longest segment of the packet IP address. In this case, that would be 208.76.14.

2. (8 pts)

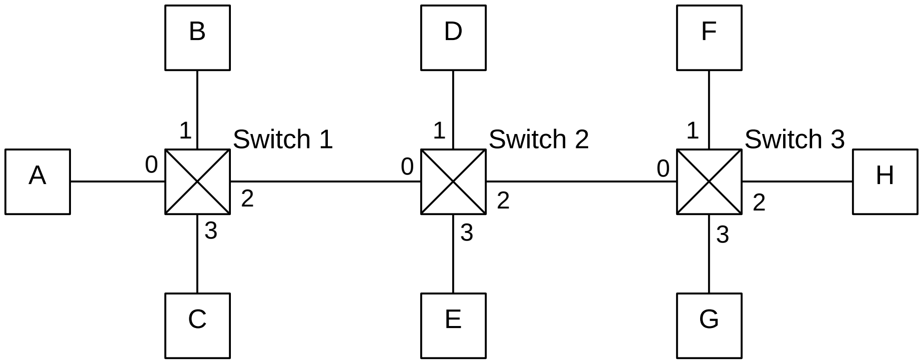


For the IEEE 802.11 network segment diagrammed above, list the events that would happen in the situations below:

a) A and C request to send to B at the same time.
The RTS's from A and B "collide" and B only hears a garbled message, so it sends no CTS and neither A nor B send. Eventually, A and B will time out and try again.

b) A requests to send to B, then C is ready to send to B while A and B are negotiating.
1. A sends RTS to B (C cannot hear this)
2. B sends CTS to A (C CAN hear this, and consequently, does not send).
3. A sends the frame to B.
4. B ACK's the end of the frame.
5. C hears the ACK and knows it can now send, so sends RTS.

3. (8 pts)



For the network above,

a) Assume the network uses Datagram routing. Show the routing table for Switch 2.

Dest Address	Port
A	0
B	0
C	0
D	1
E	3
F	2
G	2
H	2

b) Assume the network uses Virtual Circuits. If circuits have been established from A to D, from C to H, and from F to A, show the Virtual Circuit table for Switch 2.

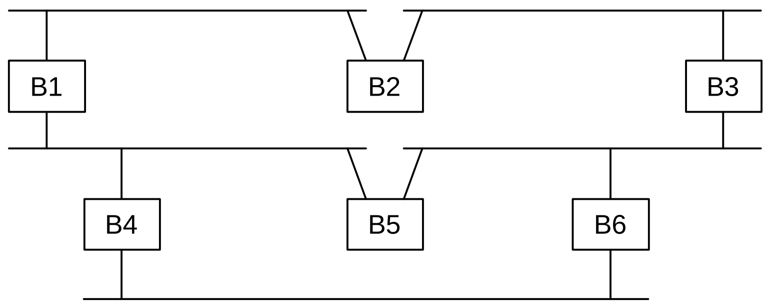
In Port	VC ID	Out Port	VC ID
0	0	1	0
0	1	2	0
2	1	0	2

Many other answers are acceptable as long as the two VC Ids on In port 0 are different. (In some systems, it may also be necessary to make the VC Id on Out Port 0 differnet from the ones for In Port 0 – I did not count off for this).

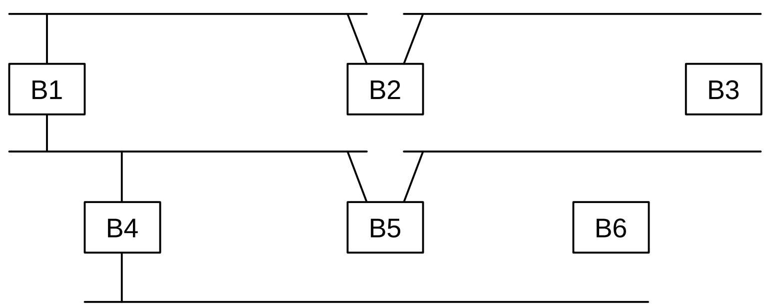
4. (8 pts)

a) Write the forwarding rules for a learning bridge.
   1. When a packet arrives, inspect the Destination Address.
   2. If the Dest. Address is in the forwarding table, forward it selectively.
   3. If the Dest. Address is not in the table, send the packet to both networks.
   4. Add the Source Address (together with the network it came from) to the table.
   5. Entries in the table time out.

b) Draw a spanning tree for this network:

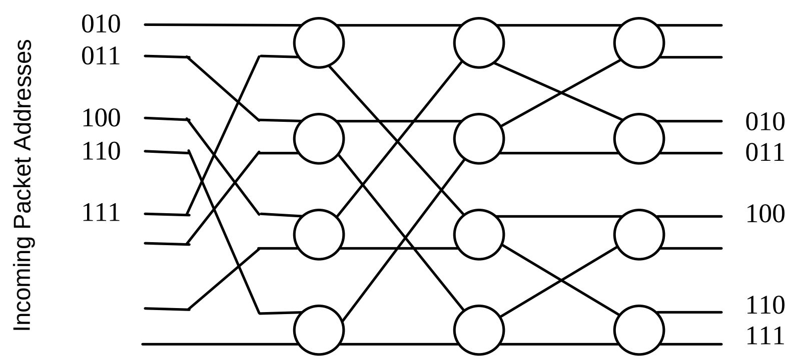


Here's one. Note that the Spanning Tree we're looking for must include ALL of the networks – the bridges don't have to be included

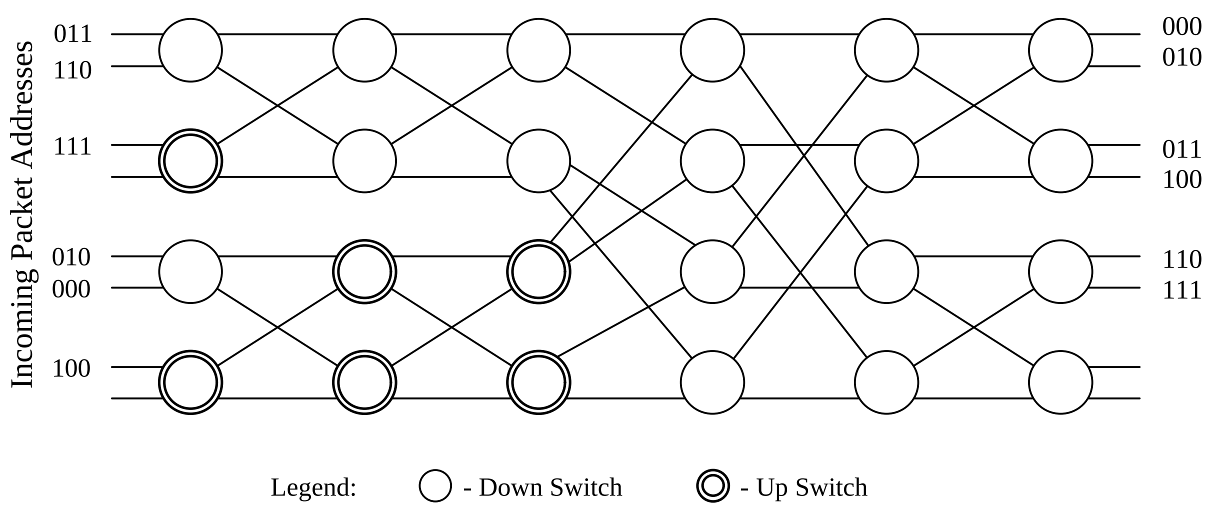


5. (9 pts)

a) Show which output link each of the incoming packets is routed to in this Banyan switch:



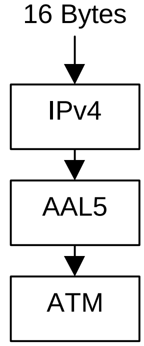
b) Show which output link each of the incoming packets is routed to in this Batcher switch:



b) Draw a line between the switch type and its scalability:

Switch Type	*Scalability Measure*
Crossbar	$O(\log_2^2 n)$
	$O(n^2)$
Batcher	$O(n\log_2 n)$
	$O(n\log_2^2 n)$
Banyan	$O(n^2\log_2 n)$

6. (15 pts)
An ATM network operates under AAL5 and IPv4. Sketch the IP packet, CS-PDU, and SAR-PDU for the transmission of a 16-Byte message:



Use the same level of detail that we used in class and on the homework. Show the calculation of the length of the AAL5 PAD field.

IP Packet

H1			
			H20
D1			
			D16

AAL5 CS-PDU

IP Packet (36 Bytes)	Pad (4 Bytes)	CS Trailer (8 Bytes)

CS-PDU length without Pad = 36+8 = 44 Bytes. CS-PDU must be multiple of 48, so Pad = 4 bytes)

AAL5 SAR-PDU

ATM Cell Header (5 Bytes)	CS-PDU (48 Bytes)

7. (10 pts)

a) For each of the following IP addresses, show what class the address comes from, the maximum number of networks allowed in this class, and the maximum number of hosts per network in this class (Assume standard "classfull" addressing without subnetting)

IP Address	***Class***	***Max # of Networks in this class***	***Max # hosts per network in this class***
190.14.250.250	B	2^{14}	2^{16}-2
198.104.16.0	C	2^{21}	2^{8}-2
120.0.0.0	A	2^{7}	2^{24}-2

b) A host has the IP address 128.75.6.6 and the Subnet mask 255.255.255.128. What is the host's subnet number? (show your answer using dotted-decimal notation).
128.75.6.6 AND 255.255.255.128 = 128.75.6.0

8. (8 pts)

a) What is the primary motivation for the development of IPv6?
To increase the IP address space.

b) What IPv4 feature is often used to run IPv6 packets over an IPv4 network?
Tunneling

c) What is the length in Bytes of the IPv6 header we discussed in class?
40 Bytes

9. (8 pts)

a) What are the advantages of Datagram Switching over Virtual Circuit Switching?
- If a link fails, the packet can be re-routed.
- No initial set-up overhead

b) What are the advantages of Virtual Circuit Switching over Datagram Switching?
- The sender knows the receiver is ready before data transfer.
- Lower per-packet overhead is possible.
- Network Resources can be pre-allocated.

c) List the steps involved in establishing a generic virtual circuit.
1. Sender sends a circuit set-up packet into the network.
2. The set-up packet is forwarded through the network using Datagram routing.
3. Each pair of nodes on the set-up packet's path negotiate a VC number.
4. Each node on the path builds a VC table entry for the circuit.
5. The receiver returns an ACK packet to the sender, saying it is ready to receive.