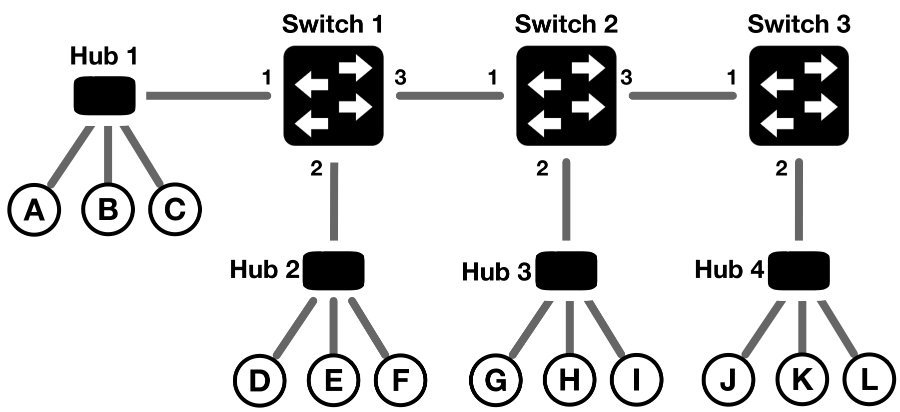
Problem 1

Consider the following network connected by three switches. The circles in the figure indicate the hosts (From host A to host L). At time=0s, the forwarding tables of all three switches are empty. Assume that all the hosts already know MAC addresses of other hosts, therefore no ARP is required. Also, assume that the TTL values of the forwarding table entries are big enough so that it will not expire in this problem. Suppose, the following seven events happen sequentially:

- Time=1s: Host A sends an IP datagram to Host G
- Time=2s: Host G sends an IP datagram to Host A
- Time=3s: Host D sends an IP datagram to Host L
- Time=4s: Host D sends an IP datagram to Host I
- Time=5s: Host F sends an IP datagram to Host A
- Time=6s: Host K sends an IP datagram to Host G
- Time=7s: Host J sends an IP datagram to Host F



(a) How many times has each switch broadcasted the received frames? (Considering all seven events above.)

Write your solution to Problem 1 in this box

Switch 1: 3
switch 2: 4
switch 3: 5

(b) List the forwarding table of each switch after the seven events. (Fill out the tables)

Switch 1	
Host	Interface
A	1
G	3
D	2
F	2
J	3

Switch 2	
Host	Interface
A	1
G	2
D	1
K	3
J	3

Switch 3	
Host	Interface
A	1
D	1
K	2
J	2

(c) At time=10s, Host A sends Broadcast IP datagram in the network. How many hosts will receive this broadcast IP datagram excluding the sender?

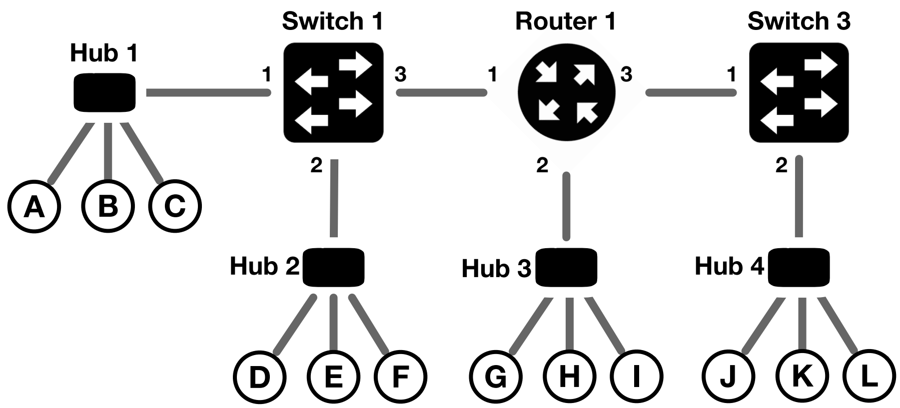
Write your solution to Problem 1 in this box

11 hosts

basically all other ones.

Problem 2

Consider, now we replace Switch 2 with Router 1 as shown in the following figure. Assume that all the hosts and the router already know MAC addresses of each other, therefore no ARP is required. The routing table is properly configured, and forwarding tables of switches are initially empty. Suppose we have the same seven events as in Problem 1.



(a) How many times have Switch 1 and Switch 3 broadcasted the received frames? (Considering all seven events.)

Write your solution to Problem 2 in this box

Swch 1: 1
swch 3: 1

(b) List the forwarding table entries of each switch after the seven events. (Fill out the tables)

Switch 1	
Host	Interface
A	1
R1 (interface 1)	3
D	2
F	2

Switch 3	
Host	Interface
Router (interface 3)	1
K	2
J	2

(c) At time=10, Host A sends Broadcast IP datagram in the subnet. How many hosts will receive this broadcast IP datagram excluding the sender?

Write your solution to Problem 2 in this box

5 hosts (B,C,D,E,F)

(d) Suppose, we have the following network IP address, `11.22.33.0/27`. Assign IP addresses with IP addresses and proper subnet masks to All hosts. Do not use special IP addresses for host addresses.

Write your solution to Problem 2 in this box

11.22.33 = X

X.1/29 → A
X.2/29 → B
X.3/29 → C

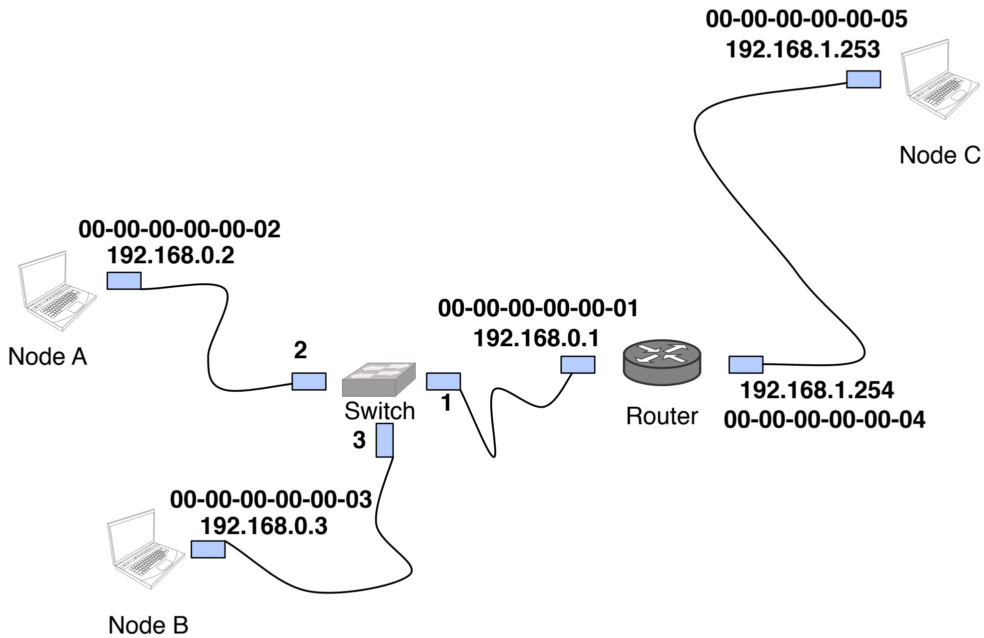
X.4/29 → D
X.5/29 → E
X.6/29 → F

X.9/29 → G
X.10/29 → H
X.11/29 → I

X.17/29 → J
X.18/29 → K
X.19/29 → L

Problem 3

Consider the following network topology with specified MAC addresses for network interfaces and the configured IP addresses:



Assume the network mask for both subnetworks is 255.255.255.0.

(a) Assume that routing tables are properly configured and the network just started (i.e., all ARP caches and switch tables are empty), fill the following table to enumerate Ethernet frames (in chronological order) needed for node B to send an IP packet to 192.168.0.2 and receive a response back.

frame #	dst MAC addr	src MAC addr	device(s) that can get the frame, excluding the sender	new entries added into the switch's table (if any)
1	FF-FF-FF-FF-FF-FF	00-00-00-00-00-03	Switch, Node A, Router	Address: 00-00-00-00-00-03 Interface: 3
2	00-00-00-00-00-03	00-00-00-00-00-02	Switch, Node B	Address: 00-00-00-00-00-02 Interface: 2
3	00-00-00-00-00-02	00-00-00-00-00-03	Switch, Node A	
4	00-00-00-00-00-03	00-00-00-00-00-02	Switch, Node B	

(b) Assume that the previous operation is done, fill the following table to enumerate Ethernet frames (in chronological order) for node B to send a packet to 192.168.1.253 and receive a reply.

frame #	dst MAC addr	src MAC addr	device(s) that can get the frame, excluding the sender	new entries added into the switch's table (if any)
1	FF-FF-FF-FF-FF-FF	00-00-00-00-00-03	Switch, Node A, Router	
2	00-00-00-00-00-03	00-00-00-00-00-01	Switch, Node B	Address: 00-00-00-00-00-03 Interface: 1
3	00-00-00-00-00-01	00-00-00-00-00-03	Switch, Router	
4	FF-FF-FF-FF-FF-FF	00-00-00-00-00-04	Node C	
5	00-00-00-00 00-04	00-00-00-00-00-05	Router	
6	00-00-00-00-00-05	00-00-00-00-00-04	Node C	
7	00-00-00-00-00-04	00-00-00-00-00-05	Router	
8	00-00-00-00-00-03	00-00-00-00-00-01	Switch, Node B	

Problem 4

(a) For CSMA/CA, after a station successfully transmits a frame, it does not transmit the second frame immediately even if the channel is sensed idle. Instead, it chooses a random backoff value for the second frame as if the channel is busy. Why?

(b) Suppose an 802.11b station is configured to always reserve the channel with the RTS/CTS sequence. This station suddenly wants to transmit 1,000 bytes of data, and all other stations are idle at this time. As a function of SIFS and DIFS, and ignoring propagation delay and assuming no bit errors, calculate the time required to transmit the frame and receive the acknowledgment. Suppose the station uses the maximum data rate of 802.11b.

Write your solution to Problem 4 in this box

a) station chooses random backoff val for 2nd frame pretending that channel Is busy because then there will be fairness between stations. If station Keeps sending frames in the process of checking if channel is idle, it will take over the connection and starve other stations who want to transmit Frames. The other stations will keep backing off. If random backoff time is used, other stations can send frames

b) 802.11b - max 11 Mbps; frame w/o data = 32 bytes. Time to transmit CTS
RTS or Ack = 32/11e6 * 8/1 = 23 microsec
Time to transmit DF = 1032/11e6 * 8 = 751 microsec
total time to transmit frame and get ACK = DIFS + RTS + SIFS + CTS + SIFS + Data + STTF + ACK = DIFS + 3 * SIFS + 820 microsec

Problem 5

Suppose there are two ISPs, providing WiFi access in a particular caf, with each ISP operating its own AP and having its own IP address block.

(a) Further suppose that by accident, each ISP has configured its AP to operate over channel 11. Will the 802.11 protocol completely break down in this situation? Discuss what happens when two stations, each associated with a different ISP, attempt to transmit at the same time.

(b) Now suppose that one AP operates over Channel 1 and the other over Channel 11. How do your answers change?

Write your solution to Problem 5 in this box

a) will not completely break down, but won't completely work either. APs Have different MAC/SSID addresses. New wireless station can select a diff AP to be with. If frame is sent, now we can go to correct AP. Other AP will Receive frame, but will not be processed because destination address is different. If two stations in diff ISPs transmit same time over channel 11, Collision will happen, and 802.11 will not work

b) 2 wireless stations in diff ISPs with diff channels attempting to send At same time -> no collision and 802.11 will work. In part (a) it says how it will operate correctly, but the correct AP will get frames from Wireless station

Problem 6

In this problem, you will put together much of what you have learned about Internet protocols. Suppose you walk into a room, connect to Ethernet, and want to download a Web page. What are the protocol steps that take place, starting form powering on your PC to getting the Web page? Assume there is nothing in DNS, or browser caches when you power on your PC. Explicitly indicate in your steps how you obtain the IP and MAC addresses of a gateway router.

Write your solution to Problem 6 in this box

1) send DHCP discover msg to find DHCP associated with network to get IP addr

2) DHCP sends back IP addr which is then used in DHCP offer msg. Computer Sends DHCP req msg to accept IP and server sends DHCP ack. Provides computer with IP address of first hop routers, local DNS server, and subnet mask of current subnet in DHCP ack. All of this through ethernet frames.

3) get IP addr of website through DNS. ARP cache is empty, so send ARP Query broadcast, gets MAC address of first hop router and local DNS server. Reply with ARP replies and MAC addresses.

4) send DNS req to local DNS server. Returns IP address associated with website from cache, through querying DNS servers.

5) get IP, send HTTP req to site via first hop router, or from local proxy server if site cached

6) HTTP req put into TCP packets -> IP datagrams -> ethernet frames -> sent to first hop router -> route packet through subnets using inter/ intra as routing. Will somehow reach web server

7) web server sends base HTML of req page through TCP pkts wrapped in IP (after being pushed to network layer) back to first hop router -> re attach ethernet header (link layer) and sent frame to computer

8) computer checks base html by stripping away all layers and keep doing last two steps for each object that HTML request requests.