CMP-4005 -- Homework 2

1. Let A and B be two stations attempting to transmit on an Ethernet. Each has a steady queue of frames ready to send; A's frames will be numbered A1, A2, and so on, and B's similarly. Let T= 51.2µs be the exponential backoff base unit. Suppose A and B simultaneously attempt to send frame 1, collide, and happen to choose backoff times of 0 x T and 1 x T, respectively, meaning A wins the race and transmits A1 while B waits. At the end of this transmission, B will attempt to retransmit B1 while A will attempt to transmit A2. These first attempts will collide, but now A backs off for either 0 x T or 1 x T, while B backs off for time equal to one of 0 x T, . . ., 3 x T.

    a. Give the probability that A wins this second backoff race immediately after this first collision; that is A's first choice of backoff time k x 51.2 is less that B's.

    $$k_A(2)\ can\ be\ (0,1)$$

    $$k_B(2)\ can\ be\ (0,1,2,3)$$

    All have equal probability respectively

    $$P[A_{WR}] = P[k_A(2) < k_B(2)]$$

    $$P[A_{WR}] = P[k_A(2) = 0] \times P[k_B(2) > 0] + P[k_A(2) = 1] \times P[k_B(2) > 1]$$

    $$P[A_{WR}] = \frac{1}{2} \times \frac{3}{4} + \frac{1}{2} \times \frac{2}{4}$$

    $$P[A_{WR}] = \frac{5}{8}$$

    b. Suppose A wins this second backoff race. A transmits A3, and when it is finished, A and B collide again as A tries to transmit A4 and B tries once more to transmit B1. Give the probability that A wins this third backoff race immediately after the first collision.

    $$k_A(3)\ can\ be\ (0,1)$$

    $$k_B(3)\ can\ be\ (0,1,2,3,4,5,6,7)$$

    $$P[A_{WR}] = P[k_A(3) < k_B(3)]$$

    $$P[A_{WR}] = P[k_A(3) = 0] \times P[k_B(3) > 0] + P[k_A(3) = 1] \times P[k_B(3) > 1]$$

    $$P[A_{WR}] = \frac{1}{2} \times \frac{7}{8} + \frac{1}{2} \times \frac{6}{8}$$

    $$P[A_{WR}] = \frac{13}{16}$$

    c. Give a reasonable lower bound for the probability that A wins all the remaining backoff races.

If B attempts to send the frame 16 times and considering the cap for k choosing 0 – 2^n-1 (capped at 1023), which means the probability for n within 10 and 16 will be the same.

$$For\ 1\ \leq n \leq 9$$

$$P[k_A(n) < k_B(n)] = P[k_A(n) = 0] \times P[k_B(n) > 0] + P[k_A(n) = 1] \times P[k_B(n) > 1]$$

$$P[k_A(n) < k_B(n)] = \frac{1}{2} \times \frac{2^n - 1}{2^n} + \frac{1}{2} \times \frac{2^n - 2}{2^n}$$

$$P[k_A(n) < k_B(n)] = \frac{2^{n+1} - 3}{2^{n+1}}$$

$$For\ 10\ \leq n \leq 16$$

$$P[k_A(n) < k_B(n)] = P[k_A(n) = 0] \times P[k_B(n) > 0] + P[k_A(n) = 1] \times P[k_B(n) > 1]$$

$$P[k_A(n) < k_B(n)] = \frac{1}{2} \times \frac{2^{10} - 1}{2^{10}} + \frac{1}{2} \times \frac{2^{10} - 2}{2^{10}}$$

$$P[k_A(n) < k_B(n)] = \frac{2^{11} - 3}{2^{11}}$$

$$P[A_{WR4-16}] = \prod_{n=4}^{9} \frac{2^{n+1} - 3}{2^{n+1}} \times \prod_{n=10}^{16} \frac{2^{11} - 3}{2^{11}}$$

$$P[A_{WR4-1}\ ] \approx 0.82$$

d. What then happens to the frame B1?

B1 is dropped and B2 is sent as next frame.

2. Suppose Ethernet physical addresses are chosen at random (using true random bits).
   a. What is the probability that on a 1024-host network, two addresses will be the same?

$$P[Repeat] = \sum_{i=0}^{1023} \frac{n}{2^{48}}$$

$$P[Repeat] = 1.8608E - 9$$

   b. What is the probability that the above event will occur on some one or more of 2^20 networks?

$$P[Repeat] = 1.8608E - 9\ \times\ 2^{20}$$

$$P[Repeat] = 1.9511E - 3$$

   c. What is the probability that of the 2^30 hosts in all the network of (b), some pair has the same address?

$$P[Repeat] = 1.9511E - 3$$

3. Why might a mesh topology be superior to a base station topology for communications in a natural disaster?

   A base station topology means that all nodes are connected to a base central station. Should this central station fail, no matter the reason, all nodes will lose communication and thus the entire network will fail. On the other, in mesh topology nodes are connected to each other which creates a redundant, decentralized network. If a node were to fail, the rest of the nodes can still communicate with each other and maintain the network. This redundancy is a good reason why this structure is superior when it comes to natural disasters.

4. Suppose an IP packet is fragmented into 10 fragments, each with a 1% (independent) probability of loss. To a reasonable approximation, this means there is a 10% chance of losing the whole packet due to loss of a fragment. What is the probability of net loss of the whole packet if the packet is transmitted twice

$$P[Packet\ Loss] = \frac{1}{10}$$

   a. Assuming all fragments received must have been part of the same transmission?

$$P[Packet\ Loss] = \frac{1}{10} \times \frac{1}{10} = \frac{1}{100}$$

   b. Assuming any given fragment may have been part of either transmission?

$$P[Packet\ Loss] = \frac{1}{100} \times \frac{1}{100} = \frac{1}{10000}$$

   Taking into consideration 10 fragments

$$P[Packet\ Loss] = \frac{1}{10000} \times 10 = \frac{1}{1000}$$

   c. Explain how use of the ident field might be applicable here
   Receiver and sender use the same ident field, if the ident field is the expected they fragments get arranged and the packet is reformed. If a fragment is missing then the packet is lost.

5. For the network given in the figure below, give the datagram forwarding table for each node. The links are labeled with relative costs; your tables should forward each packet via the lowestcost path to its destination

Node A		
Destination	Next Node	Cost
A	-	-
B	C	6
C	C	3
D	C	6
E	C	4
F	C	9

Node C		
Destination	Next Node	Cost
A	A	3
B	E	3
C	-	-
D	E	3
E	E	1
F	F	6

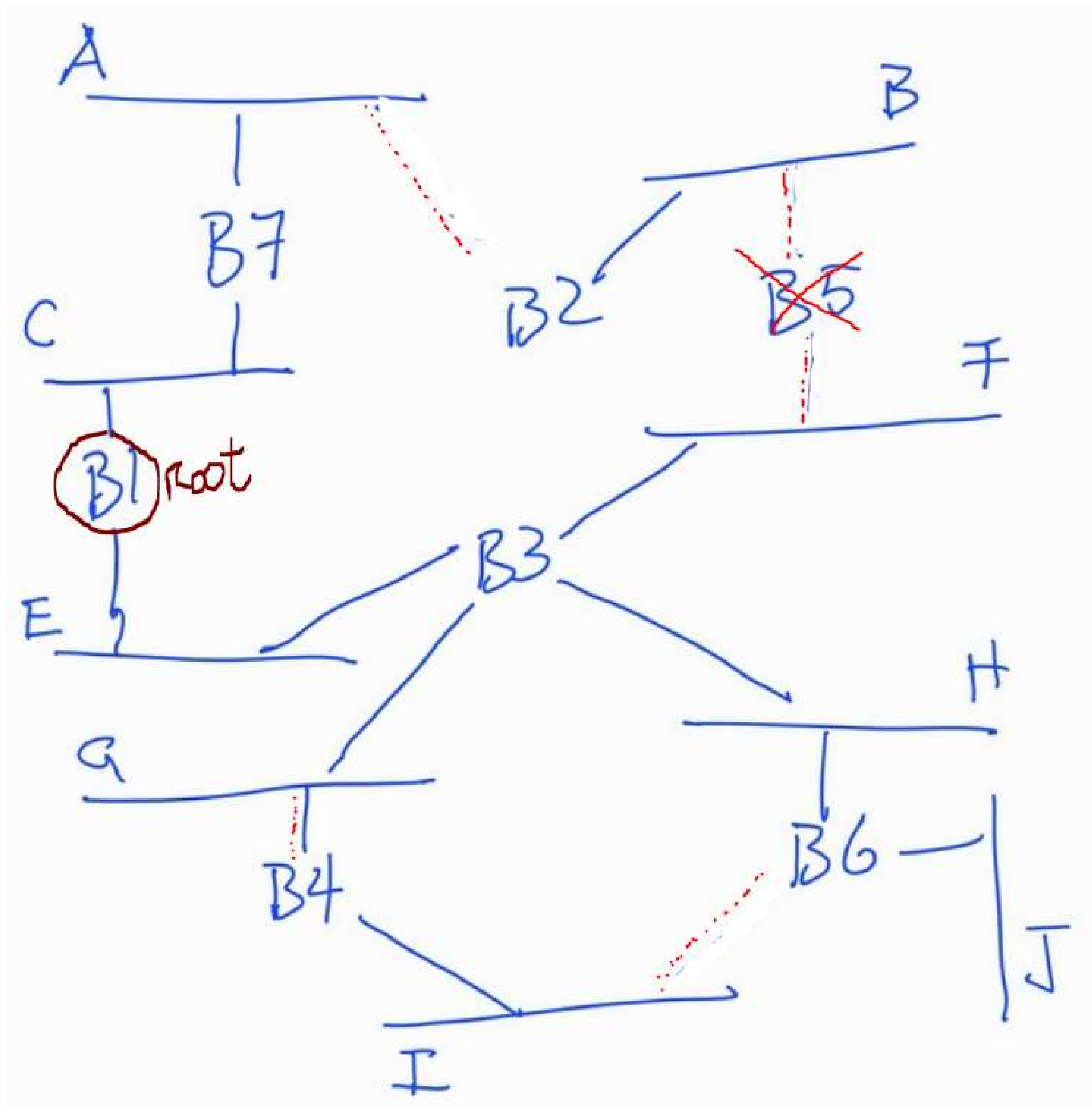
Node B		
Destination	Next Node	Cost
A	E	6
B	-	-
C	E	3
D	E	4
E	E	2
F	E	9

Node D		
Destination	Next Node	Cost
A	E	6
B	E	4
C	E	3
D	-	-
E	E	2
F	E	9

Node E		
Destination	Next Node	Cost
A	C	4
B	B	2
C	C	1
D	D	2
E	-	-
F	C	7

Node F		
Destination	Next Node	Cost
A	C	9
B	C	9
C	C	6
D	C	9
E	C	7
F	-	-

6. Given the extended LAN shown in the figure below, indicate which posts are not selected by the spanning tree algorithm



7. Use the Unix tool traceroute (Windows tracert) to determine how many hops it is from your host to other hosts in the internet (usfq.edu.ec, google.com, amazon.com, etc). How many routers do you traverse to get out of your local site? Read the documentation of this tool, and explain how it is implemented.
   The one tracert that actually worked for me (didn't get stuck in timed out requests) was the one to google.com

```
Tracing route to google.com [2800:3f0:4005:409::200e]
over a maximum of 30 hops:

  1    <1 ms    <1 ms    <1 ms  2800:bf0:1fff:f700:cebb:feff:fe1b:5f86
  2    10 ms     3 ms     3 ms  2800:bf0:1fff:f700::1
  3     1 ms     1 ms     1 ms  fd00:0:0:a51::1
  4     2 ms     2 ms     2 ms  2001:4860:1:1::d1b
  5    14 ms    14 ms    14 ms  2800:2a0:21:10::16
  6    17 ms    17 ms    17 ms  2800:3f0:8050::1
  7    15 ms    15 ms    17 ms  2001:4860:0:1::4d98
  8    14 ms    14 ms    14 ms  2001:4860:0:1::4d95
  9    14 ms    14 ms    14 ms  2800:3f0:4005:409::200e
```

2 hops to get to the gate and 7 hops to get to google. Also I looked it up and that address was registered as google Argentina.

ROUTING INFO

ASN	AS15169
ASN Route	2800:3f0:4005::/48
ASN Organization	Google LLC
Location	Argentina

Routing and ASN

The ASN (Autonomous System Number) provides routing and location information for traffic flowing to this IP address.

The tracert command, once given a destination it will send TTLs with increasing values, 1 for the first hop and incrementing one per hop. So, the tracert command will retrieve the information of every router until it reaches its destination, or maxes out the number of hops it can make (30 by default in my case).

8. An ISP with a class B address is working with a new company to allocate it a portion of address space based on CIDR. The new company needs IP addresses for machines in three divisions of its corporate network: Engineering, Marketing, and Sales. These divisions plan to grow as follows: Engineering has 5 machines as of the start of year 1 and intends to add 1 machine every week; Marketing will never need more than 16 machines; and Sales needs 1 machine for every two clients. As of the start of year 1, the company has no clients, but the sales model indicates that by the start of year 2, the company will have six clients and each week thereafter gets one new client with probability 60%, loses one client with probability 20%, or maintains the same number with probability 20%

   a. What address range would be required to support the company's growth plans for at least seven years if marketing uses all 16 of its addresses and the sales and engineering plans behave as expected?

      Marketing PCs: 16

      Subnet of 16 addresses

      ________.________.________.____0000 /28
      ________.________.________.____1111 /28

      Engineering PCs:

      $$EPCs = 5 + 1\frac{PC}{week} \times 4\frac{weeks}{month} \times 12\frac{months}{year} \times 7years = 341PCs$$

      Subnet of 512 addresses

      ________.________.______0.00000000 /23
      ________.________.______1.11111111 /23

      Sales PCs:

      $$SPCs = \frac{number\ of\ costumers}{2} = \frac{6+(4\frac{weeks}{month}\times12\frac{month}{year}\times6years)(0.6-0.2)}{2} \approx 61$$

      Subnet of 64 addresses

      ________.________.________.__000000 /26
      ________.________.________.__111111 /26

   b. How long would this address assignment last? At the time when the company runs out of address space, how would the addresses be assigned to the three groups?

      Marketing PCs: Will not run out of addresses as they have what they need.

      Engineering PCs: $512 = 5 + 1\frac{PC}{week} \times 4\frac{weeks}{month} \times 12\frac{months}{yea} \times t\ years$

      $$t\ years = \frac{(512-5)PC}{1\frac{PC}{week} \times 4\frac{weeks}{month} \times 12\frac{months}{year}} = 10.5625$$

      Engineering will run out of addresses at approximately the end of the first half of year 10

      Sales PCs: Sales PCs only have 3 addresses left, thus 0 years.

   c. If CIDR addressing were not available for the 7-year plan, what options would the new company have in terms of getting address space?

Sales and marketing could use a /24 Class C while Engineering would require a /16 Class B