Solver: Kurniawan Aryanto Famili

Email Address: KURN0002@e.ntu.edu.sg

1. (a) Collision domain is the range in a network sharing the same medium in which a collision of messages(packets) may happen. In other words, the more number of hosts sharing the same medium are there in a network, the bigger the collision domain is. Hence, by splitting a larger LAN into smaller ones, less number of hosts will share the same medium of communication, subsequently decreasing the chance of a collision happening.

   (b)
   (i)

   Throughput = u / (u + (v / Sr))
   u (transmission phase) = (100 *5) / 10 Mbps = 8 * 10^{-5} seconds
   v (reservation phase) = (5 * 8) / 10 Mbps = 4 * 10^{-6} seconds
   Sr = Ge^{-G}
   G = np
   n = 1000 users / 5 wireless channels = 200
   p = 0.01
   G = 2
   Sr = $2e^{-2}$
   Substitute everything in to get Throughput = 0.844.

   (ii)
   Throughput is maximum for slotted Aloha protocol when G = 1. So,
   G = 1
   np = 1
   n = 1 / 0.01 = 100
   100 = 1000 users / x wireless channels
   x = 10 channels needed

   Substitute everything in (same as previous part, but with Sr = e^{-1}), Throughput = 0.88.
   Max throughput gain (difference of throughput) is 0.88 – 0.844 = 0.036 = 3.6%.

   (c)
   Rate of failure = 100% - 99.9999% = 0.0001%
   In 1 year, there are 365 days * 24 hours * 3600 seconds = 31536000 seconds.
   Maximum tolerable downtime = 0.0001% * 31536000 = 31.536 seconds
   31.536 / MTTR = 31.536 / 10 = 3.1536
   The maximum number of allowable non-overlapping network failures per year is **3 times**.

2. (a)

Propagation delay = 20 microseconds / km

Link A

Throughput = 1 / (T_{frame} + $2T_{prop}$)

T_{frame} = (250 * 8) bit / 20 Mbps = 10^{-4} seconds

T_{prop} = 10km * propagation delay = 100 microseconds

Throughput = 1 / (10^{-4} + 2 * 10^{-4}) = 3333,33 frames / second = 6.67 Mbps

Link B

Throughput = W / (T_{frame} + $2T_{prop}$)

W = 4

T_{frame} = (250 * 8) bit / 25 Mbps = 8 * 10^{-5} seconds

T_{prop} = 20km * propagation delay = 400 microseconds

Throughput = 4 / (8 * 10^{-5} + 2 * 4 * 10^{-4}) = 4545.45 frames / second = 9.09 Mbps

Comparison

Throughput A : Throughput B = 6.67 : 9.09

(9.09 – 6.67) / 6.67 = 0.3628 = 36.28%

So, Link B has 36.28% more throughput than Link A.

(b)

(i) Maximum playback rate is achieved when both links are working fine, so playback rate is 6.67 + 9.09 = 15.76 Mbps or 7880 frames/sec. (Not confident about this)

(ii)

λ = 40 Mbps

$T_{upper} = T_{lower}$

$T = T_{queue} + T_{prop}$

$T_{queue} = \rho / (\mu - \lambda)$

$\rho = \lambda / \mu$

μ_{upper} = 20 Mbps

μ_{lower} = 25 Mbps

Assume α is the ratio of usage of the upper link. So,

$\lambda_{upper} = \alpha * \lambda$

$\lambda_{lower} = (1 - \alpha) * \lambda$

Upper

T_{queue} = (α * 40 / 20) / (20 - α * 40)

Lower

T_{queue} = ((1 – α) * 40 / 25) / (25 – (1 – α) * 40)

T_{prop} values can be seen from the previous part. The equation then becomes,
$T_{upper} = T_{lower}$
(α * 40 / 20) / (20 - α * 40) + 100 microseconds = ((1 – α) * 40 / 25) / (25 – (1 – α) * 40) + 400 microseconds
Note: You can use your calculator to solve the equation and find α. If you don't know how, now is a good time to find out.

α (upper link utilization) = 0.438
1 - α (lower link utilization) = 0.562

3. (a)

Network Prefix	Next Hop	AS Path
203.181.248.0/24	221.5.8.5	30 20 10
203.181.194.0/24	221.5.8.5	30 20
202.90.128.0/17	221.5.8.5	30
211.79.61.0/24	221.5.5.2	50

Preferred path to each ASes is the contents of AS Path column.

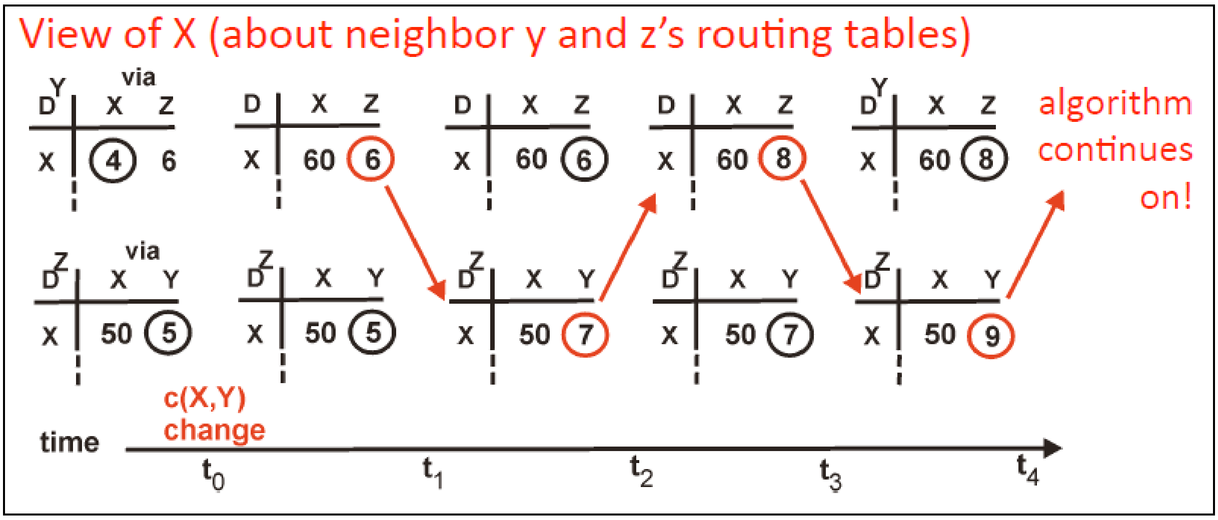
(b)
(i)

Network	Cost	Next Hop
N1	3	-
N2	8	-
N3	4	RB
N4	6	RB
N5	10	RB

(ii) I am not sure about this, but I answered 4 cycles. RA can only have the info of the routing table of RD after 2 cycles, then RA needs to forward its routing table to RD, which takes 2 cycles again. In total, 4 cycles.

(c)

"Bad news travel slowly" characteristic is the count-to-infinity problem. You can refer to the lecture slides of Distance Vector Routing for clearer illustrations. Fundamentally, the problem states that if the link cost between 2 routers becomes much bigger, it will lead to an endless loop of routing table updates.



Source: http://www.cs.princeton.edu/courses/archive/spr11/cos461/docs/lec14-distvector.pdf

In the perspective of Z, at t1, the cost of going directly to X is 50, but the routing table received from Y says that it only costs 6, Z will record the cost of going to X from Y as 7 (6 + 1), then Z propagates its routing table. Y will meet the same dilemma and the updating process keeps going indefinitely.

4. (a)

1 frame = 512 * 64 * 8 = 262144 bits

The time it takes to transfer 1 frame:

T_{frame} of Singapore = 262144 / 1 Mbps = 0.262144 seconds.

T_{frame} of London = 262144 / 2 Mbps = 0.131072 seconds.

RTT to Singapore / T_{frame} of Singapore = 50 * 10^{-3} / 0.262144 = 0.1907 frames.

We cannot even send 1 frame during the transmission of the first frame since T_{frame} of Singapore is bigger than RTT to Singapore. Which means we need to wait another 50 ms before sending another frame.

RTT to London / T_{frame} of London = 200 * 10^{-3} / 0.131072 = 1.5 frames.

We can send 1 extra frame during the transmission of the first frame.

Therefore, we can send the data faster via **London** than via Singapore. There may be a more decisive calculation method, but I did it this way and I think it is adequate enough.

(b)

(i)

a = 100

b = 1000

c = 101

d = 1001

e = 101

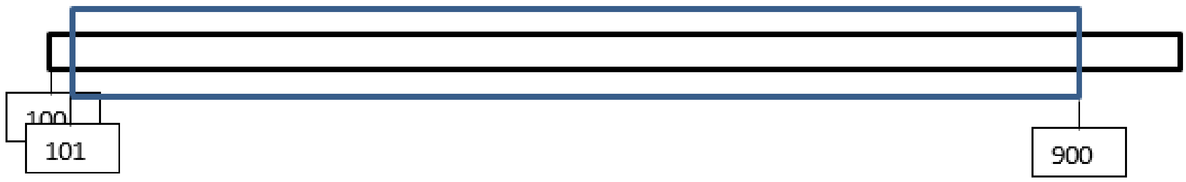
f = 301

g = 301

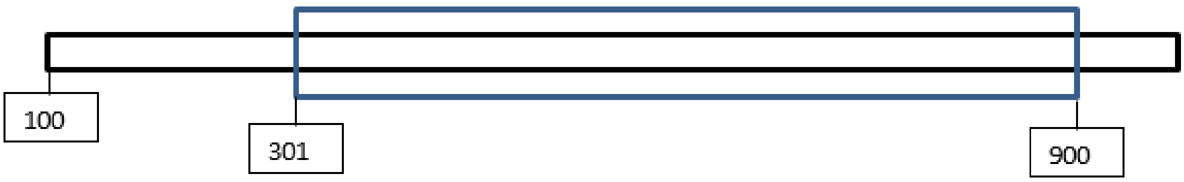
h = 601

(ii)

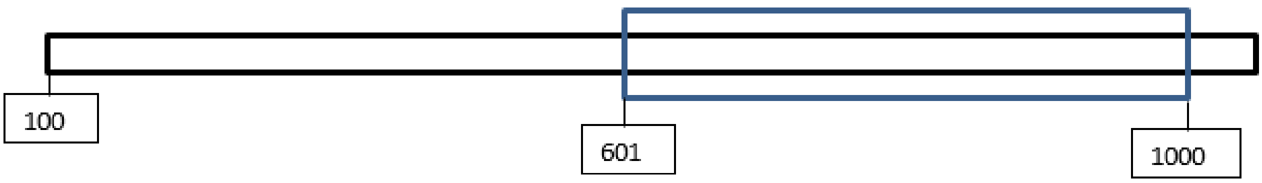
SYN+ACK(1000,101), W = 800



ACK(301), W = 600



ACK(601), W = 400



Apologies for any miscalculations/errors. Good luck for your exam!

For reporting of errors and errata, please visit pypdiscuss.appspot.com

Thank you and all the best for your exams! ☺