COL334/672: Computer Networks, 2017-18 Semester 1

Minor-2 exam: 60 minutes

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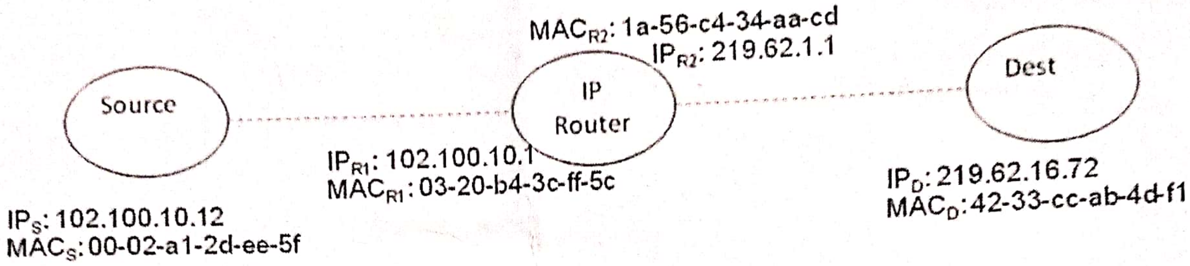
Entry #: 2015CS10210

Please write your answers neatly, there is space for roughwork given at the end.

Evaluation (leave blank)

| | Max | Marks | Re-evaluation requests |
|---|---|---|---|
| Q1 | 8 | 5 | |
| Q2 | 5 | 2 | |
| Q3 | 8 | 8 | |
| Q4 | 9 | 8.5 | |
| Q5 | 5 | 1.5 + 2 Aditya | |
| Total | 35 | 25 + 2 = 27 Aditya | |

**1.** We have the following topology: a source connected over a LAN to an IP router, which is connected over a different LAN to the destination. The IP and MAC (also called physical or hardware address) addresses of the various nodes are given. The destination has a web-server running on port 80.




a. For packets going out from the source, fill in the following information in the TCP/IP/LL headers (shaded regions):

i. Source IP (SIP)
ii. Source port (SP)
iii. Destination IP (DIP)
iv. Destination port (DP)
v. Source MAC address (SMAC)
vi. Destination MAC address (DMAC) [3]

You need not write the entire IP or MAC address in the blanks below, just fill in as "SIP: $IP_S$", "DP: 80", etc

| LL header | IP header | TCP header | Application data |
|---|---|---|---|
| SMAC: $MAC_S$<br>DMAC: $MAC_{R1}$ | SIP: 102.100.10.12<br>DIP: 219.62.16.72 | SP: Source Port (Not Known)<br>DP: 80 | GET http:// ... |

3

b. For packets arriving at the destination, fill in the same information in the appropriate places in the shaded regions. [2]

| LL header | IP header | TCP header | Application data |
|---|---|---|---|
| SMAC: $MAC_D$<br>DMAC: $MAC_{R2}$ | SIP: $IP_D$ × $IP_s$<br>DIP: $IP_s$ × $IP_D$ | SP: 80<br>DP: Port source (Not Known) | GET http:// ... |

1

c. What is the gateway for the source? What is a possible network mask for the source? Give the gateway and possible network mask for the destination as well. [3]

The gateway for the source is the Router's port with $IP_{R1}$ & $MAC_{R1}$

?

1

the gateway for the destination is Router's Port with $IP_{R2}$ & $MAC_{R2}$

?

2. The efficiency of Ethernet in a hub configuration is known to be:

$$\frac{1}{1 + 5\, t_{prop} / t_{trans}}$$

where $t_{prop}$ is the maximum propagation delay in the network, and $t_{trans}$ is the transmission delay for the largest Ethernet frame.

a. For an efficiency of 0.80 with frame sizes of 1600 bytes (including the Ethernet header), calculate the maximum distance between any two nodes in the network? Assume speed of propagation = $2 \times 10^8$ m/s and transmission rate = 100 Mbps. Use 1 Mbps = $10^6$ bps. [2]

The transmission delay $t_{trans} = \frac{1600 * 8}{100 \times 10^6} = 16 \times 10^{-6}$ sec.

$t_{prop} = \frac{\text{distance}}{\text{speed}} = \frac{d}{2 \times 10^8}$

1.5

$\therefore$ efficiency $= \frac{1}{1 + 5 \cdot \frac{d}{2 \times 10^8} \times \frac{1}{16 \times 10^{-6}}} = \frac{1}{1 + \frac{d}{32 \times 20}}$

For efficiency atleast 0.8

$\frac{1}{1 + \frac{d}{640}} \geq 0.8 \Rightarrow 1 + \frac{d}{640} \leq \frac{5}{4}$

$d \leq 160$ m

$\therefore$ Max distance $= 160$ m $* 8$

b. Use the maximum distance computed in the previous part to calculate the minimum frame size of an Ethernet frame for nodes to be able to detect a collision while they are still transmitting? [3]

Again, Now $d_{prop} = \frac{160}{2\times10^8}$ sec. 0.5

$d_{trans} = \frac{\text{Frame size}}{R} = \frac{L}{100\times10^6}$ sec

∴ Nodes can detect collision if

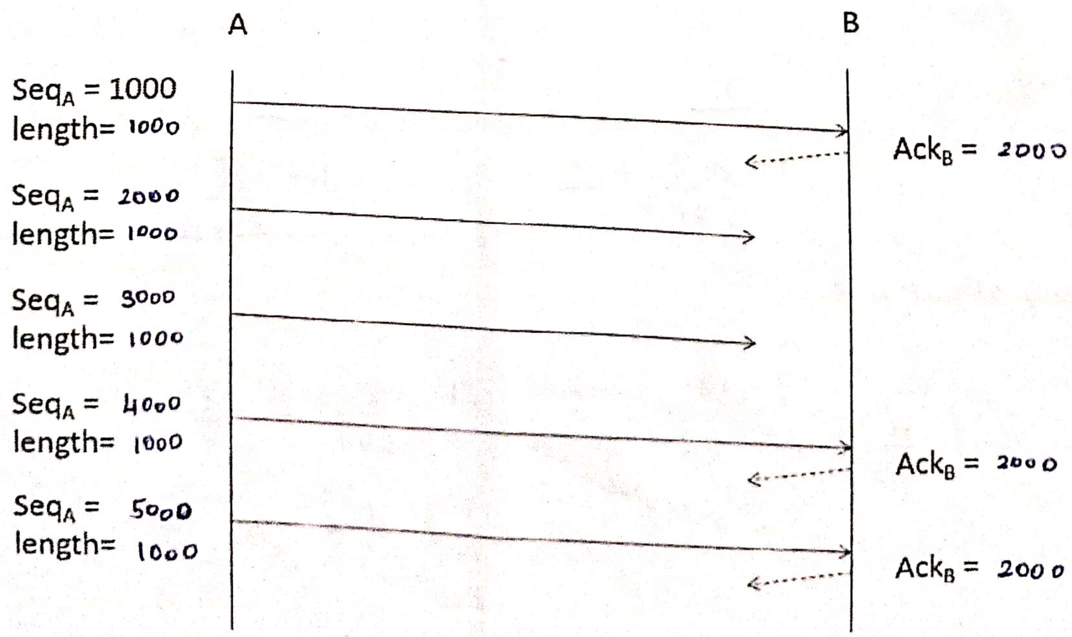
$\frac{L}{R} \geq \cancel{4}\,2\, d_{prop}$

$L \geq \frac{\cancel{4}\,2\times160\times10^8}{2\times10^8}$

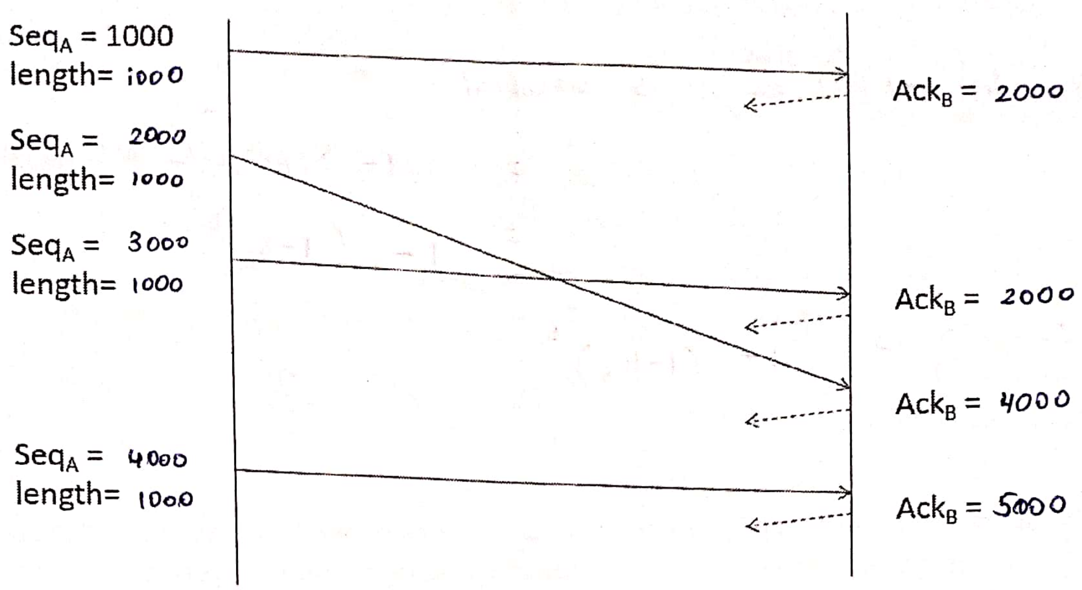
$L \geq 320$ bytes bits

∴ Minimum frame size = ~~1600~~ 320 bytes

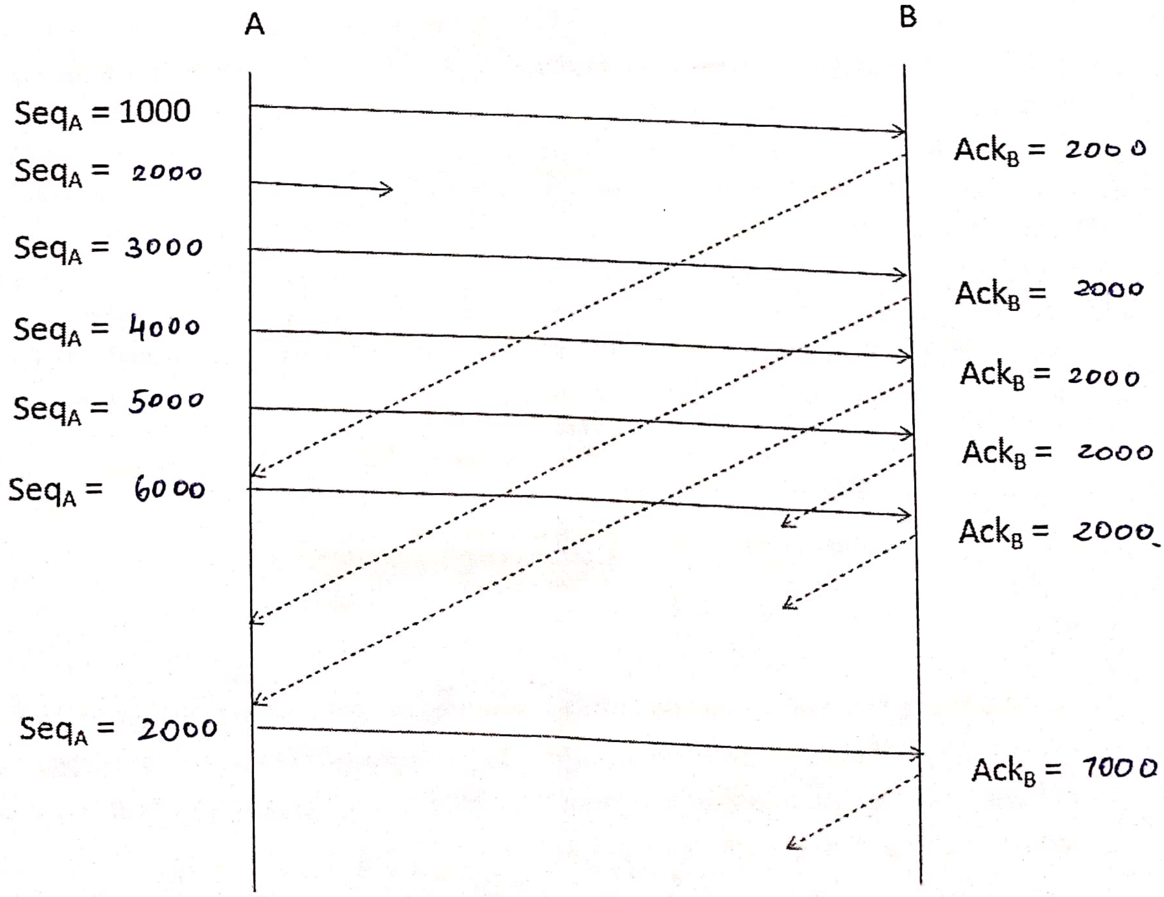
3. A pair of nodes A and B are using TCP to communicate with each other, with A having data to send to B. Cumulative acks are being used in the protocol. In the diagram below, assume all packets are 1000 bytes long and the starting sequence number A is using is 1000. Fill the information below for the sequence numbers in the packets sent from A to B, and the acknowledgement numbers in the replies sent from B to A. The second and third packets sent by A are lost and do not reach B. [3] 3



Now consider a different scenario in the diagram below where the second packet gets reordered in the network and reaches B after the third packet. Fill in the missing information. Assumption → TCP buffers the packets not recieved in order. [2] 2




In the scenario below, the second packet gets lost and TCP uses a fast retranmit to recover from the packet loss. Assume TCP's window size is 5000 bytes and is fixed, ie. congestion control is turned off. And selective acknowledgements are not being used. Fill in the missing information. [3] 3



4. Long distance wireless links are susceptible to bit errors that can lead to packet corruption.

a. The bit error rate on a wireless link = $p_B$, is the probability that a bit under transmission may get corrupted. What is the packet error rate $p_P$ for large packets of s bits, if the bits errors are independent of each other? [2]

Probablity ~~not~~ that some bit is corrupted

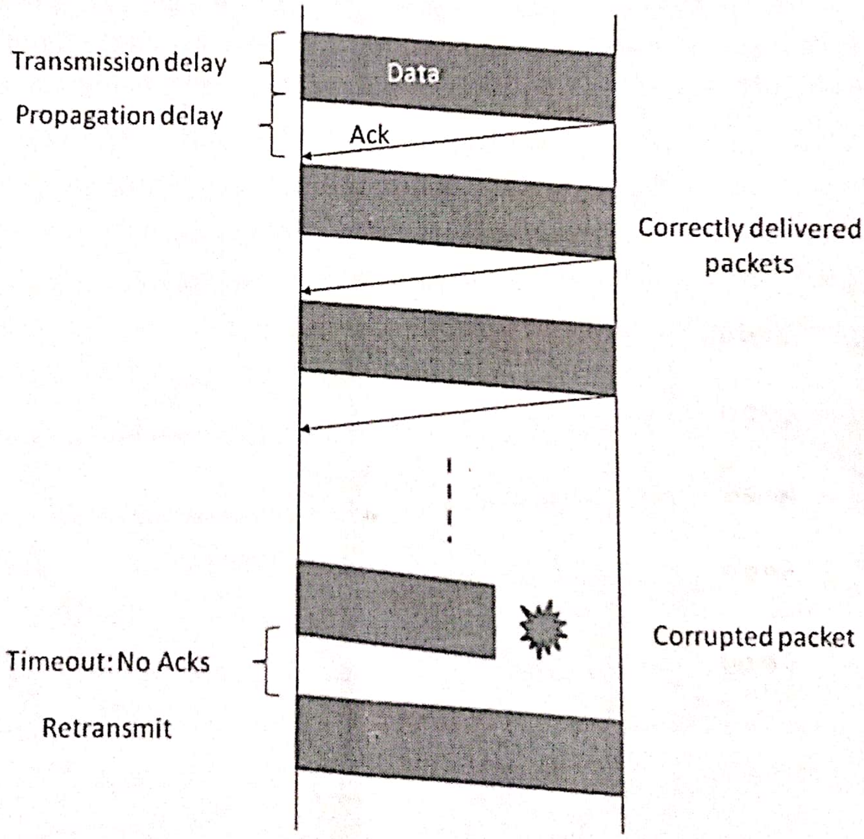
$$= 1 - P(\text{All bits correct})$$

$$= 1 - (1-p_B)^s.$$

$$\therefore \; P_p = 1 - (1-p_B)^s$$

2

b. An acknowledgement protocol is used to improve reliability, as shown below. The protocol works as follows: an acknowledgement is sent for every packet; if the Ack is not received within a maximum timeout then the packet is retransmitted.




What is the effective throughput of this scheme, in terms of the packet error rate $p_P$, packet size s, channel transmission rate r, propagation distance = d, and speed of propagation = c. Assume that the timeout = maximum propagation round trip delay. Ignore the size of acknowledgement packets. [3]

If there were no packet loss.

then efficiency of sending one packet

$$= \frac{\frac{s}{r}}{RTT + \frac{s}{r}} = \frac{\frac{s}{r}}{\frac{2d}{c} + \frac{s}{r}}$$

Now since the probablity of error happening is $p_p$

$\therefore$ Effective effeciency $(e_{eff})$ $= \dfrac{(1-p_p)\frac{s}{r}}{\frac{2d}{c} + \frac{s}{r}}$

$\therefore$ Effective throughput $= r \cdot e_{ff} = \dfrac{(1-p_p)s}{\frac{2d}{c} + \frac{s}{r}}$

3

c. An alternate scheme called FEC (Forward Error Correction) encodes the packets so that for every m packets, (m + k) encoded packets are sent such that if any m of these (m + k) packets are received correctly then the original m packets can be reconstructed. No acknowledgements are used – the sender simply blasts away the encoded packets. The efficiency of this scheme is clearly m / (m + k) = $e_{FEC}$ and the effective throughput therefore is r x $e_{FEC}$. Use the previous result to express the propagation distance d in terms of $e_{FEC}$ for which the effective throughput with FEC will be better than the effective throughput of the previous acknowledgement scheme. [2]

$$r \cdot e_{FEC} > \frac{(1-p_p)s}{\frac{2d}{c} + \frac{s}{r}}$$

$$\therefore \frac{2d}{c} + \frac{s}{r} > \frac{(1-p_p)s}{r.e_{FEC}}$$

$$\therefore d > \frac{cs}{2r}\left(\frac{(1-p_p)}{e_{FEC}} - 1\right)$$

2

d. Evaluate the expression above for FEC efficiency $e_{FEC} = 2/3$, packet error rate $p_P = 0.1$, propagation speed $c = 3 \times 10^8$ m/s, packet size s = 1000 bytes, and transmission rate r = 5 Mbps. What does this tell you about how to do reliable transmission over long distance wireless links? [2]

$$\therefore\ d > \frac{3\times10^8 \times 1000}{2\times 5\times10^6}\left(\frac{(1-0.01)}{2/3} - 1\right)$$

S = 1000 B

conversion to bits needed

$$> 3\times10^4\left(\frac{\overset{0.45}{0.9\times3}}{2} - 1\right)$$

$$> 3\times10^4\,(0.35) = 1.05\times10^4 \text{ m.}$$

1.5

Effective throughput with FEC = $2/3 \times 5 = \frac{10}{3}$ Mbps

~~Effective throughput with Acknowledgement = $\frac{0.9\times1000}{5\times10^6}$~~

We see that if the distance is more than about a kilometer, it is better to do transmission with FEC as it will give us more effeciency.

this is because over long links the propagation time or RTT which is $\frac{2d}{c}$ can ~~shoot up~~ become large in comparison to the transmission time

5. Answer the following short-answer questions.

a. CSMA/CD is difficult to be used as a MAC protocol on a wireless broadcast network because... [1]

~~1) Wireless signals attenuate & it can be difficult to~~

1) wireless signals can attenuate & it can become difficult to detect alredy in use channel

1

2) There can be hidden terminal problem for eg: A B C where B can sense both A, C but A, C cannot sense each other

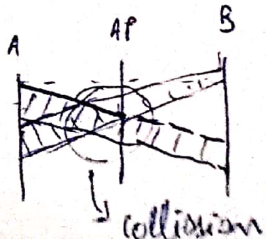
b. CSMA alone is not sufficient as a MAC protocol on a wireless broadcast network because... [1]

Even if 2 nodes sense the channel to be free, they can transmit at same time leading to collision.

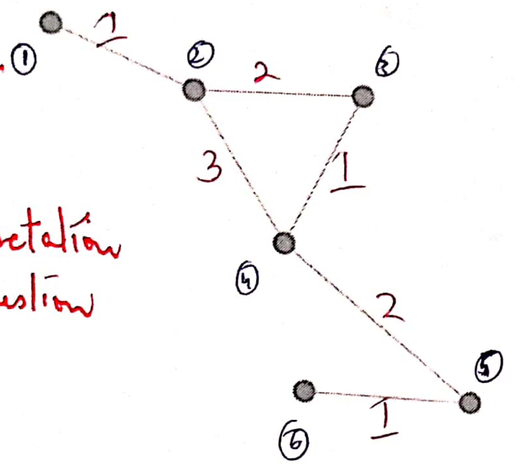
So we need a better method to actually avoid collisions all together

0.5

eg:-



c. The graph below shows nodes in a wireless network and the edges connect nodes which are within communication range of each other. If FDMA is being used and all the nodes want to be able to send data to any of their neighbours at any time, then what is the least number of frequencies that will be required on the network below? Explain your answer. [2]




correct interpretation given the question

2

We need a Minimum of 6 frequencies ✗ need 3 freqs.

as the max neighbours of any node in the graph is 3

So to send & recieve at the same time we need atleast 6 frequencies

For eg:- node 4 has 3 neighours i.e. ② ③ ⑤

So we need 6 frequencies for it to send and listen at same time

d. In a generic graph, can you reduce the above problem to a well-known NP-hard problem in graphs. [1]

this can be a ~~[illegible]~~ graph cut problem

0 graph coloring.

------- Rough work -------