CS170–Spring 2013 — Solutions to Homework 1

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1.

(1.) **<u>4.4 ms</u>**
Time to transmit the packet:

$$t_p = 1200bytes \times \frac{8bits/byte}{4Mbits/sec} = 2.4ms$$

Latency:

$$l = \frac{600km}{3 \times 10^8 m/s} = 2.0ms$$

Total Time:

$$l + t_p = 4.4ms$$

(2.) (a.) **<u>21202 ms</u>**

$$\text{number of chunks to be sent} = \frac{10MB}{1000byte} = 10^4 chunks$$

$$\text{time to transmit file} = \frac{10^4 \times (1000+60)bytes}{4Mbps} \times 1000ms/sec \times 8bits/byte + 2ms = 21202ms$$

(b.) <u>500 **bytes/ms**</u>

$$goodput = \frac{10^4 * (1000+60)bytes}{21200ms} = 500bytes/ms$$

(3.) **<u>6.81 ms</u>**

$$\text{latency} = 2.2ms$$

$$\text{time for 1000 byte packet to reach B} = \frac{1000bytes}{4Mbps} + latency = 2ms + 2.2ms$$

$$\text{time to send ack} = \frac{80bytes}{4Mbps} = 0.160ms$$

$$\text{total time for ack to arrive at A} = 0.160ms + 2.2ms$$

$$\text{total time} = 2ms + 2.2ms + 0.160ms + 2.2ms + 0.250ms = 6.81ms$$

(4.) **<u>6560 ms</u>**

$$\text{number of chunks} = \frac{10MB}{1000bytes} = 10^3\text{chunks}$$

$$\text{time for 1000 byte packet to reach B} = 2.2ms + 2.0ms$$

$$\text{time for ACK to reach A} = 2.2ms + 0.160ms$$

$$\text{total time} = 10^3\text{chunks} \times (2.2ms + 2.0ms + 2.2ms + 0.160ms) = 6560ms$$

2.

(1.) **108 ms**

$$\text{alice to a} = \frac{1500bytes \times 8bits/byte}{1mbps} + 2ms = 14ms$$

$$\text{a to b} = \frac{1500bytes \times 8bits/byte}{500kbps} + 20ms = 44ms$$

$$\text{b to c} = \frac{1500bytes \times 8bits/byte}{1mbps} + 30ms = 42ms$$

$$\text{c to bob} = \frac{1500bytes \times 8bits/byte}{2mbps} + 20ms = 8ms$$

$$\text{total time} = 14 + 44 + 42 + 8 = 108ms$$

(2.) **184 ms**

Alice

Arrive	Depart
–	0ms
–	12ms
–	24ms

A

Arrive	Depart
14ms	14ms
26ms	46ms
38ms	58ms

B

Arrive	Depart
58ms	58ms
90ms	120ms
102ms	132ms

C

Arrive	Depart
100ms	102ms
162ms	164ms
174ms	176ms

Bob

Arrive	Depart
110ms	–
172ms	–
184ms	–

(3.) (a.) **15 packets**

(b.) **12, 14, 16, 18, 20 are dropped**

(4.) **3/4ths of the packets are lost**
Half of the packets are lost from C to B and another half of *those* packets are lost from B to A. There are no packets lost from A to Alice because the bandwidth along that link is greater than B to A.

(5.) (a.) **204ms**
The bottleneck is at router A. So assuming A's queue fills up and the packet is the last in the queue, it will take $5 \times 24ms$ to transmit the packet and another 20ms to propogate to router B.

$$\text{total time} = 14ms + 5 \times 24ms + 20ms + 42ms + 8ms = 204ms$$

(b.) **252ms**
Using simliar reasoning from part (a.), routers C and B drop packets. So if C's queue fills up, our packet from Bob will have to wait $5 \times 12ms$ before being transmitted. If B's queue fills up, from B to A, our packet will have to wait $5 \times 25ms$ before being transmitted. No packets are lost from A to Alice because the bandwidth is greater from A to Alice than from B to A.

$$\text{total time} = 8ms + 5 \times 12ms + 30ms + 5 \times 24ms + 20ms + 14ms = 252ms$$

3.

(1.) $\underline{\frac{M}{P} \times \frac{D}{B} + 2ms + (\frac{D}{B} + 2ms) \times (Z-1)}$
Time for packets to travel from first switch to second switch

$$\frac{M}{P} \times \frac{D}{B} + 2ms$$

Since packets are transmitted as soon as they arrive at a switch, this is the additional delay to pass the first packet to the next router:

$$(\frac{D}{B} + 2ms)$$

There are $(Z-1)$ switches so the total delay for passing the first packet is:

$$(\frac{D}{B} + 2ms) \times (Z-1)$$

So the total time to send the file is:

$$\frac{M}{P} \times \frac{D}{B} + 2ms + (\frac{D}{B} + 2ms) \times (Z-1)$$

(2.) $\underline{\frac{M}{P} \times \frac{D}{B} + 2ms + (h + 2ms) \times (Z-1)}$
The answer is similar to part (1.) except instead of waiting D/B to transmit, we only wait h.

(3.) $\underline{2 \times [(\frac{k}{B} + 2ms) \times Z] + \frac{M}{P} \times \frac{D}{B} + 2ms \times Z}$

The time to send the setup packet from Alice to Bob and back is:

$$2 \times [(\frac{k}{B} + 2ms) \times Z]$$

The time to transmit the file is:

$$\frac{M}{P} \times \frac{D}{B} + 2ms \times Z$$

(4.) (a.)

(b.) 1. There are a lot of routers between here and the destination which increases the latency. 2. Some ISPs will play "hot potato" where they reroute a packet as soon as it get its. Where the packet is routed may not necessarily be the best route.

4.

(1.)

(2.)