# EE122–Spring 2013 — Solutions to Homework 1

Alexander Tom (ID: 20964861), `ee122-ki`

October 3, 2013

## 1.

(1.) **4.4 ms**
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.) **21202 ms**

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

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

(b.) **3.774 bytes/ms**

$$goodput = \frac{10^4 chunks}{21200ms} \times \frac{1000 * 8bits}{1000ms} = 3.774Mbps$$

(3.) **6.41 ms**

$$\text{latency} = 2.0ms$$

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

$$\text{time to send ack} = \frac{80 * 8bits}{4Mbps} = 0.160ms$$

$$\text{total time for ack to arrive at A} = 0.160ms + 2.0ms$$

$$\text{total time} = 2.0ms + 2.0ms + 0.160ms + 2.0ms + 0.250ms = 6.41ms$$

(4.) **61.6ms**

$$\text{number of chunks} = \frac{10KB}{1000bytes} = 10\text{chunks}$$

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

$$\text{time for ACK to reach A} = 2.0ms + 0.160ms$$

$$\text{total time} = 10\text{chunks} \times (2.0ms + 2.0ms + 2.0ms + 0.160ms) = 61.6ms$$

## 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.) **156 ms**

| Alice | A |
|---|---|
| 0ms | 14ms |
| 12ms | 26ms |
| 24ms | 38ms |

| A | B |
|---|---|
| 14ms | 58ms |
| 38ms | 82ms |
| 62ms | 106ms |

| B | C |
|---|---|
| 58ms | 110ms |
| 82ms | 123ms |
| 106ms | 148ms |

| C | Bob |
|---|---|
| 110ms | 118ms |
| 124ms | 132ms |
| 148ms | 156ms |

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

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

Packets start dropping at packet 12 because the queue fills up. When the next packet comes in, the queue has one empty slot, but the packet after that is dropped. This pattern continues.

(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.) **228ms**
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.

$$\text{total time} = 14ms + 5 \times 24ms + 24ms + 20ms + 42ms + 8ms = 228ms$$

(b.) **288ms**
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.

$$\text{total time} = 8 + 5 \times 12 + 12 + 30 + 5 \times 24 + 24 + 20 + 14 = 288ms$$

## 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.) $\underline{\frac{M}{P} \times \frac{D}{B} + 2ms + (\frac{h}{B} + 2ms) \times (Z-1)}$
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:

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

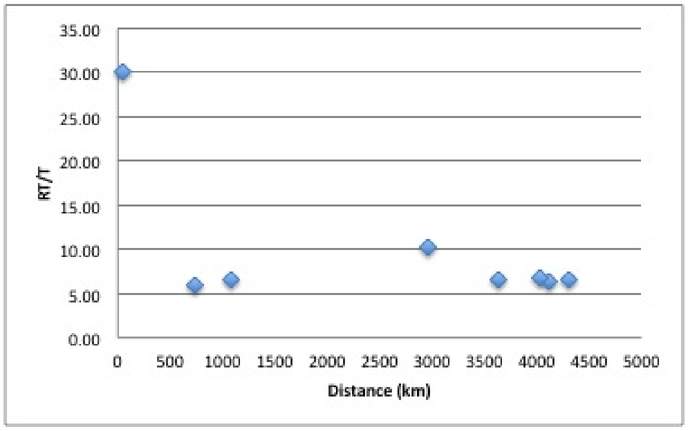
The time to transmit the file is:

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

(4.) (a.) **Cut Through**
Plugging in the values into the derived equations above:
Store and Forward: 18.23ms
Cut Through: 16.55ms
Circuit Switching: 48.20ms

(b.) **Circuit Switching** Plugging in the values into the derived equations above:
Store and Forward: 4977.74ms
Cut Through: 4976.06ms
Circuit Switching: 4848.14ms

## 4.




(1.)

(2.) 1. There are a lot of routers between here and the destination which increases the latency. The more routers there are, the higher the latency. 2. The links between the routers may be fast or week. The propagation delay can very.