CSE 3300 Homework 1

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Question 1

a) A packet-switched network would be most appropriate for this situation, as the data being transmitted is small (i.e. could fit in a small number of packets) non-continuous (only sent every k time units) and likely to be connected for long periods. If such an application was connected with a circuit-switched network, there would be large amounts of infrastructure required that would go unused in between packets being sent.

b) Given that the generous provision of link capacity exceeds the sum of application data rate for every (potential) connection, even in the worst case (simultaneous transmission of packets from every host running the application) no link in the network would exceed its capacity. Thus, no congestion control is required.

Question 2

a) $d_{prop} = \frac{m}{s}$

b) $d_{trans} = \frac{L}{R}$

c) $d_{end-end} = d_{trans} + d_{prop}$

d) At time d_{trans} the very last bit of the packet has just entered the link connecting Host A to the network.

e) If $d_{prop} > d_{trans}$, at time $t = d_{trans}$ the first segment of the packet is part way along the link between hosts A and B.

f) If $d_{prop} < d_{trans}$, at time $t = d_{trans}$ the first segment of the packet will already have reached Host B.

g)

$$d_{prop} = \frac{m}{s},\ d_trans = \frac{L}{R}$$
$$d_{prop} = d_{trans}$$
$$\frac{m}{s} = \frac{L}{R}$$

$$m = \frac{L}{R} \cdot s$$
$$m = \frac{120bits}{56 \cdot 1000bps} \cdot 2.5 \cdot 10^8 m/s$$

$m = 535714.28$ meters

Question 3

a) If we ignore propagation, queuing and processing delays, the only remaining factor is d_{trans}.

To first packet switch:

$$= \frac{L}{R}$$
$$= \frac{8 \cdot 10^6 bits}{2Mbps}$$

$$= \frac{8 \cdot 10^6 bits}{2 \cdot 1000 \cdot 1000 bps}$$
$$= 4.0s$$

Total time to destination:

$$= number\_of\_nodes \cdot d_{trans}$$
$$= 3 \cdot 4.0s$$
$$= 12.0s$$

b)

First packet to first switch:

$$d_{trans} = \frac{L}{R}$$
$$= \frac{10000 bits}{2 \cdot 1000 \cdot 1000 bps}$$
$$= 0.005s$$

Second packet to first switch:

$$= 2 \cdot 0.004768s$$
$$= 0.010s$$

c)

Total file transfer time with segmentation:

$$= 3 \cdot 0.004768s$$
$$= 0.015s$$

This is a dramatic decrease in the time taken to transmit the file between hosts and although the effect may not (in reality) be as pronounced due to mitigating factors like the other forms of delay (queuing, propagation etc.) it serves to illustrate the powerful effects of message segmentation.

Question 4

a) Bandwidth-delay product:

$$R \cdot d_{prop} = R \cdot \frac{d}{s}$$
$$= 2 \cdot 1000 \cdot 1000 bps \cdot \frac{2 \cdot 10^7 m}{2.5 \cdot 10^8 m/s}$$
$$= 160000 bits$$

b) The maximum number of bits that will be in the link at any time will be 160000.

c) The bandwidth-delay product represents the maximum amount of data that can be considered to be "in transit" in the link at any given instant (i.e. how much data is "currently in the cable").

d) A bit in the link will be $\frac{2*10^7 m}{160000} = 125m$, which is more than a football field (109.1m).

e) Width of a bit in terms of link length m, transmission rate R, and propagation speed s: $w_{bit} = \frac{m}{R \cdot \frac{m}{s}}$

Question 5

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[⇒  traceroute -q 5 digitalocean.com
traceroute: Warning: digitalocean.com has multiple addresses; using 104.16.110.208
traceroute to digitalocean.com (104.16.110.208), 64 hops max, 52 byte packets
 1  10.66.64.1 (10.66.64.1)  50.380 ms  40.148 ms  1.554 ms  1.023 ms  1.040 ms
 2  10.66.1.6 (10.66.1.6)  0.893 ms  1.271 ms  1.241 ms  1.252 ms  1.060 ms
 3  137.99.255.32 (137.99.255.32)  1.222 ms  1.478 ms  2.028 ms  1.285 ms  2.169 ms
 4  vss-core-po15.net.uconn.edu (137.99.255.242)  1.534 ms  1.907 ms  1.705 ms  1.724 ms  1.657 ms
 5  vss-core-border-inside-t2-3-5.net.uconn.edu (137.99.255.90)  2.047 ms  1.900 ms  2.038 ms  1.440 ms  1.387 ms
 6  fw-msb-i-2-ch25.682.net.uconn.edu (137.99.255.182)  1.513 ms  1.554 ms  1.507 ms  2.696 ms  1.748 ms
 7  * * * * *
 8  mx-msb-border-outside-ae52-630.net.uconn.edu (137.99.255.230)  4.813 ms  2.720 ms  2.178 ms  1.991 ms  2.094 ms
 9  enrt078hhh-mx-ae6dot636.net.cen.ct.gov (64.251.62.16)  2.525 ms  2.344 ms  2.305 ms  2.174 ms  2.457 ms
10  mass-ix.as13335.net (206.53.143.9)  4.627 ms  4.885 ms  4.444 ms  4.676 ms  4.732 ms
11  104.16.110.208 (104.16.110.208)  4.665 ms  4.667 ms  4.770 ms  4.560 ms  4.623 ms
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1) Average: $\frac{4.665+4.667+4.770+4.560+4.623}{5} = 4.657$

SD: $\sqrt{\frac{1}{N} \cdot \sum_{i=1}^{N} (x_i - \mu)^2} = 0.0686$

2) There are 10 routers along the path to the host.

3) The first 8 hosts appear to be a part of the UConn internal network, which then connects to the Connecticut Education Network (node 9) - which offers ISP-like services to education providers in CT. From there it connects to the Massachusetts Internet Exchange (node 10) and from there connects directly to the DigitalOcean server at 104.16.110.208.

Question 6

Suppose two end hosts, A and B, are connected by 10 links, each with packet loss probability p, $(0

$$P(s) = (1-p)^{10}$$

Question 7: Wireshark Lab

1) DNS, TCP, HTTP

2) 4.628ms

3) gaia: 137.99.25.14 me: 10.66.69.250

4)

187 26.539603 10.66.69.250 137.99.25.14 DNS 77 Standard query 0x1fa4 A gaia.cs.umass.edu Frame 187: 77 bytes on wire (616 bits), 77 bytes captured (616 bits) on interface 0 Ethernet II, Src: Apple_12:5e:b5 (28:cf:e9:12:5e:b5), Dst: Cisco_ff:fc:c8 (00:08:e3:ff:fc:c8) Internet Protocol Version 4, Src: 10.66.69.250, Dst: 137.99.25.14 User Datagram Protocol, Src Port: 7014, Dst Port: 53 Domain Name System (query)

188 26.544231 137.99.25.14 10.66.69.250 DNS 93 Standard query response 0x1fa4 A gaia.cs.umass.edu A 128.119.245.12 Frame 188: 93 bytes on wire (744 bits), 93 bytes captured (744 bits) on interface 0 Ethernet II, Src: Cisco_ff:fc:c8 (00:08:e3:ff:fc:c8), Dst: Apple_12:5e:b5 (28:cf:e9:12:5e:b5) Internet Protocol Version 4, Src: 137.99.25.14, Dst: 10.66.69.250 User Datagram Protocol, Src Port: 53, Dst Port: 7014 Domain Name System (response)