Network and Cybersecurity Exercises

Kristoffer Klokker

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1 Preparaiton

1.1 Generalize a formula for sending P such packets back-to-back over the N link

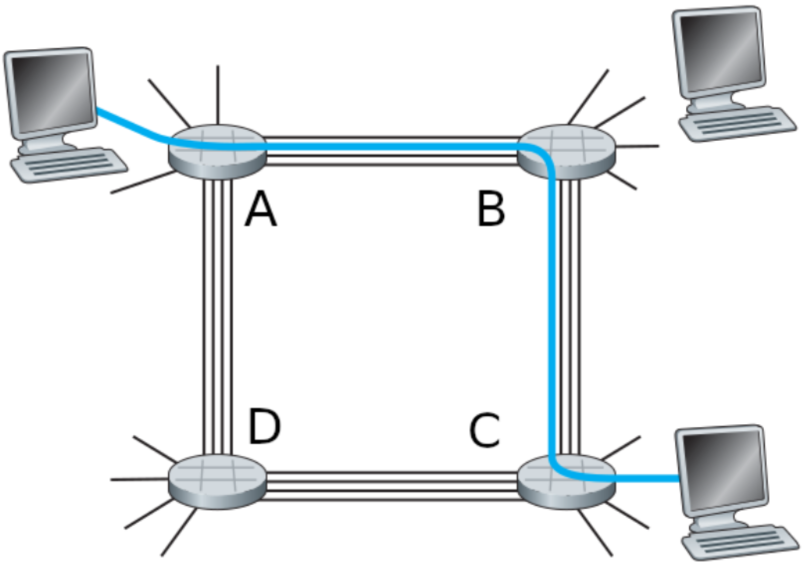
For a single package the sending time will be:

$$d_{end-to-end} = N\frac{L}{R}$$

For a number of packages P the formular wil lbe:

$$d_{end-to-end} = (P+N)\frac{L}{R}$$

1.2 Consider the circuit-switched network in this figure



1.2.1 What is the maximum number of simultaneous conections that can be in progress at the same time in this network

Assuming each host can have 4 ingoing and 4 outgoing connections the total number of active connections would be 12. This is where 4 simultaneous connections between the neightboor host.
In case each computer can maximux have 4 ingoing or outgoing connections the total connections would be halfed to 6.

1.2.2 Suppose that all connections are between switches A and C. What is the maximum number of simultaneous conections that can be in progress

There can only be 4 connections between A and C.

1.2.3 Suppose we want to make four connections between switches A and C, and another four connections between B and D. Can we route these calls through the four links to accomodate all eight connections

To make a connection one pair can have the two outer links and the other pair can have the two inner links, resulting in 4 links between the pairs.

1.3 This elementary problem begins to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to Host B

1.3.1 Express the propagation delay, d_{prop} in terms of m and s.

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

1.3.2 Determine the transmission time of the packet d_{trans} in terms of L and R

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

1.3.3 Ignoring processing and queuing delays, obtain an expression for the end-to-end delay

$$d_{trans} + d_{prop} = \frac{m}{s} \cdot \frac{L}{R}$$

1.3.4 Suppose Host A begins to transmit the packet at time $t = 0$. At time $t = d_{trans}$ where is the last of the packet

It would be in the link, since it would then have gathered the entire package

1.3.5 Suppose d_{prop} is greater than d_{trans}. At time $t = d_{trans}$ where si the first bit of the packet.

It would be in the link, since the link have to gather the entire package before sending it off

1.3.6 Suppose $s = 2.5 \cdot 10^8$, $L = 120$bits and $R = 56$kbps. Find the distance m so that $d_{prop} = d_{trans}$

$$d_{trans} = \frac{L}{R} = \frac{120}{56000} = 0.00214$$
$$d_{prop} = \frac{m}{s} = \frac{m}{2.5 \cdot 10^8} = d_{trans}$$
$$m = d_{trans} \cdot 2.5 \cdot 10^8 = 535.714$$

Assuming that s is in the unit meters/sec the distance would be 535.714 meters

1.4 Suppose N packets arrive simultaneously to a link at which no packets are currently being transmitted or queued. Each packet is of length L and the link has transmission rate R.

1.4.1 What is the average queing delay for the n packets

$$\frac{L \cdot P/2}{R}$$

On average the packet would be in the middle of queue and therefore be half of P

1.4.2 Now suppose that N such packets arrive to the link every LN/R seconds. What is the average queuing delay of a packet?

Since the package arrival is faster than the package handling time, in the case of an infinite size buffer the aver delay would be infinite

1.5 Suppose two hosts A and B are speareated by 20,000 kilometers and are conencted by a direct link of R=2 Mbs. Suppose the propagation speed of the link is $s = 2.5 \cdot 10^8$ meters/sec

1.5.1 Calculate the bandwidth-delay product $R \cdot d_{prop}$

$$R \cdot \frac{m}{s} = 2 \cdot 10^6 b/s \cdot \frac{20,000,000m}{2.5 \cdot 10^8 m/s} = 160Kb$$

1.5.2 Consider sending a file of 800,000 bits from Host A to Host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time

160Kb as found in last exercise

1.5.3 Provide an interpretation of the bandwidth-delay product

Bandwidth-delay product is the number if bits which can exist in the link at one time every second.

1.5.4 What is the width of a bit in the link

$$\frac{20,000,000m}{160,000b} = 125m$$

1.5.5 Derive a general expression for the width of a bit in terms of the prpagation speed s, the transmission rate R and the length of the link m.

$$\frac{m}{R \cdot \frac{m}{s}} = \frac{s}{R}$$

1.6 Suppose there is a 10 Mbps microwave link between a geostationary satellite and its base station on Earth. Every minut the satellite takes a digital photo and sends it to the base station. Assume a propagation speed of $s = 2.5 \cdot 10^8$ meters/sec.

1.6.1 What is the propagation delay of the link

$$\frac{m}{s} = \frac{35,786,000m}{2.5 \cdot 10^8 m/s} = 0.143s$$

1.6.2 What is the bandwidth delay product of the link

$$R \cdot \frac{m}{s} = 10^7 b \cdot \frac{35,786,000m}{2.5 \cdot 10^8 m/s} = 1.43Mb$$

1.6.3 Let x denote the size of the photo. What is the minimum value of x for the microwave link the be contrinously transmitting

There are 86400 seconds in a day, therefore the minumum size of the photo would be:

$$1.43Mb/s \cdot 86400s = 123.5Gb$$

1.7 Would it be faster to ship 300 terabytes over night than transfer with 1 Gbps

$$\frac{300,000Gb}{1Gb/s} = 300,000s = 83.33hours$$

it would therefore be faster to ship the harddrive