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Computer Networks

HomeWork 1

Assigned: April 4th 2016

Due: April 18th 2016

Units:

- 1B = 8 bits
- 1MB = 10^6 bytes
- 1Mbps = 10^6 bits/sec
- 1GHz = 10^9 Hz

1. For each of the following aspects, answer and justify in one line which of either packet and circuit switching is best. If you think it depends, say what it depends on in two lines or less

   - Quality of service guarantees

     Circuit Switching. Having a dedicated root helps with QOS compared to best effort.

- Cost

Packet Switching. Maintaining the dedicated connection is more expensive compared to connectionless.

- Flexibility adapting to dynamic workloads

Packet Switching. When a node in circuit switching exits the network, the route has to be reestablished which means it is not very adaptable compared to stateless packet switching.

- Communications overhead

Circuit Switching assuming you have an established connection as the metadata required is less However setting up the connection has a huge overhead.

ms?

2. Consider a 10 Mbps ethernet in which each link introduces a propagation delay of 10s. Calculate the latency (from first bit sent to last bit received) for transmitting a 1500 byte packet with...

- ...a single store-and-forward switch in the path. Assume the switch begins re-transmitting immediately after it has finished receiving the entire packet.

1.25 MBps

$$\frac{1500 \text{ bytes}}{1.25 \text{ MBps}} = 1.2 \text{ ms}$$

1.2ms 1.2ms

S —10s— L_1 —10s— R

20002.4 ms

Name:

- ...three store-and-forward switches in the path.

S — L1 — L2 — L3 — R

$1.2 \times 4 + 4 \times 10.000$

$\boxed{40004.8\text{ms}}$

- ...three cut-through switches in the path. Assume each switch is able to begin transmitting the packet after the first 200 bits have been received.

1.26

$12 + \frac{25}{1500} \times 3 + 4 \times 10000$

$\boxed{40001.25 \text{ ms}}$

3. Suppose Ben is transferring David a file using a transport protocol that uses stop-and-wait flow control (that is, Ben sends one packet then stops and waits for an ACK before sending the next). Suppose also that the bottleneck link between Ben and David has a bandwidth of 2 Mbps, the one-way latency is 50ms, and no one else is using the network, and Ben sends the file in 1500 byte packets.

   - What throughput does the file transfer achieve?

   0.25 MBps

   6ms

   50ms

   $\frac{1500 \text{ bytes} \times 8}{100 \text{ ms}}$

   $\boxed{120 \text{ kbps}}$

   - What is the efficiency of the file transfer? That is, what percentage of the available network capacity are they using?

   $\frac{120 \text{ kbps}}{2 \text{ Mbps}} = 6\%$

Name: ______________________________

- To achieve 100% efficiency, how much data should Ben be allowed to send before receiving an ACK?

$$\frac{a \text{ bits}}{100\text{ms}} = 2\text{Mbps}$$

$$\boxed{a = 25\text{kB}}$$

4. Ethernet has a minimum packet size to guarantee that collisions are detected.

- How does a minimum packet size help detect collisions?

The hosts have to be transmiting data in order to detect a collision. The minimum package ensures that even in the worst case (longest link) the hosts will be able to detect a collision. The host detects collisions by comparing data transmitted from and received at the wire.

- Assume the speed of propagation through copper Ethernet wire is 2 x 10^8 m/s . If the maximum size of your network is 500 m, and you transmit data at 100 Mbits/s what is the minimum packet size needed to detect collisions?

$$\frac{500}{2\times10^8 \text{ m/s}} \longrightarrow$$

$$2\times\left(\frac{500}{2\times10^8}\right)\times 100\times10^6 \text{ b/s}$$

$$\boxed{= 500 \text{ bits}}$$

$$A \xrightarrow[500]{500} B$$

Name:

- Figure out how to create a Ethernet wire that carries data at the speed of light (3×10^8 m/s). What is the new minimum packet size for your network?

$$\frac{2 \times 10^8}{3 \times 10^8} = \frac{2}{3}$$

from prev answer $\leftarrow$ $500 \times \frac{2}{3} = 333.\bar{3}$

$\boxed{334 \text{ bits}}$

- Your boss wants you to upgrade the network from 100 Mbits/s to Gigabit (1000 Mbits/s). What are the two ways that you can change the network to handle this new speed?

$\frac{1000}{100} = 10.$ Increase the min packet size 10X.

Reduce the max network size by an order of 10.

5. This problem illustrates possible danger of incorporating randomization in design. Let A and B be two stations attempting to transmit on an Ethernet. Each has a steady queue of frames ready to send; As frames will be numbered A1,A2 and so on, and Bs similarly. Let T = 51.2 us be the exponential backoff base unit. Suppose A and B simultaneously attempt to send frame 1, collide, and happen to choose backoff times of 0 x T and 1 x T, respectively. As a result, A transmits A1 while B waits. At the end of this transmission, B will attempt to retransmit B1 while A will attempt to transmit A2. These first attempts will collide, but now A backs off for either 0 x T or 1 x T, while B bakes off for time equal to one of 0 x T, ..., 3 X T.

- Give the probability that A wins this second backoff race immediately after his first collision.

$A \rightarrow 0 \; T_1$

$B \rightarrow 0 \; T_1 \; T_2 \; T_3$

$$\frac{1}{2} \times \frac{3}{4} + \frac{1}{2} \cdot \frac{2}{4} = \frac{5}{8}$$

Name:

- Suppose A wins this second backoff race. A transmits A3 and when it is finished, A and B collide again as A tries to transmit A4 and B tries once more to transmit B1. Give the probability that A wins this third backoff race immediately after the first collision.

0 7

$$\frac{1}{2}\cdot\frac{7}{8}+\frac{1}{2}\cdot\frac{6}{8}$$

$$? = \frac{7+6}{16} = \boxed{\frac{13}{16}}$$

- Give a reasonable lower bound for the probability that A wins all the remaining backoff races. (This scenario is known as the ethernet capture effect.)

$$\frac{1}{2}\cdot\frac{2^i-1}{2^i}+\frac{1}{2}\cdot\frac{2^i-2}{2^i}$$

when i is 8 A wins 99.51% of the time which seems like a reasonable lowerbound

- What then happens to the frame B1?

B probably gets discarded after maximum attempts to try again.

6. This problem aims to introduce you to using Wireshark for basic packet analysis. Use the following procedure to capture a packet trace of your computer exchanging ICMP echo requests/responses (i.e., pings and pongs) with Googles web servers: 1. Download

Name:

and install Wireshark (www.wireshark.org). On their website, you can find tutorials for this process, as well as everything below. 2. Find the currently used network interface on your computer (e.g., eth0 or en0) and begin capturing. 3. Open a terminal and run ping www.google.com. 4. Stop the packet capture and isolate the ping packets by entering icmp into the filter box. (Ping sends packets using the Internet Control Message Protocol, or ICMP.) Use your trace to answer the following questions:

- Wireshark displays packets by breaking down the data by layer. How many bytes are in the physical layer packet (i.e., the whole packet)? How many bytes are in the header for each other layer?

Physical Layer : 98 bytes

Headers
- Physical : 14
- Transfer : 20

- The TTL (time to live) limits life of a packet to prevent a packet from looping forever; it is a remaining hop count that is decremented by each router.
  - When your system sends a fresh packet, what is its TTL? (Look at one of the pings your computer sent.)

64

  - How many hops did each reply packet take to get back to your system from Google?

64 - 49 = 15

Name:

- Look at the fields in the ICMP echo messages.
  - Examine the Identifier field. Does it change between pings in one execution of the ping command? What is its purpose? Why cant port numbers be used?

It does not change. It is used to keep different ping requests & replies together. It doesn't have a port # as it was designed to communicate Network layer information.

  - What is the purpose of the Timestamp? How could the ping program be changed to eliminate the need for this field?

Timestamp is used to calculate the RTT time in a stateless manner. If the ping program records the time each package is sent and received it can compute that information without the need of a timestamp.