Network Performance

CS 640, Spring 2015

1) Computing single packet latency
   a. Consider two hosts that are 200km apart and connected by a series of fiber optic links whose minimum bandwidth is 8Mbps. Assume light travels through optical fiber at a speed of $2 \times 10^8$ m/s. What is the one way delay for a 1000 Byte packet assuming there is 20ms of queueing delay?

   $$\frac{200 \text{km} \times 10^3}{2 \times 10^8} + \frac{1000 \text{B} \times 8}{8 \text{Mbps} \times 10^6} + \frac{20 \times 10^{-3}}{10^3} + \frac{1}{10^3} + \frac{20}{10^3} = 0.0225 = 22\text{ms}$$

   b. What is the one way delay if the hosts are 2000km apart, the bandwidth is 1Gbps, and there is 30ms of queueing delay?

   $$\frac{2000 \text{km} \times 10^3}{2 \times 10^8} + \frac{1000 \text{B} \times 8}{1 \text{Gbps} \times 10^9} + 30 \times 10^{-3}$$

   $$\frac{1}{10^2} + \frac{8}{10^6} + \frac{20}{10^3} = 10\text{ms} + 0.008\text{ms} + 30\text{ms} = 40.008\text{ms}$$

   c. If the hosts are 4km apart, at what bandwidth would propagation delay equal transmit delay?

   $$\frac{4 \text{km} \times 10^3}{2 \times 10^8} = \frac{1000 \text{B} \times 8}{\gamma}$$

   $$\gamma = 4 \times 10^8 \text{bps}$$

   $$\gamma = 4000 \text{Mbps}$$

2) Computing file transfer time
   a. Assume we want to transfer a file over a path whose round trip time (propagation + queueing delay) is 80ms and bandwidth is 8Mbps. Before transferring the file, we must setup the connection using the TCP three-way handshake. Assuming, the SYN, SYN+ACK, and ACK packets are all 40B long, how long will it take to complete the handshake?

   $$3 \left( \frac{40 \times 8}{8 \times 10^6} \right) + 1.5 \left( \frac{80}{10^3} \right)$$

   $$\frac{120}{10^6} + \frac{120}{10^3} = 0.120\text{ms} = 120.120\text{ms}$$
b. Now, assume the file is 10MB and will transferred using 1000B packets. How long will it take to transfer the file (ignoring the time for the handshake)?

\[
\frac{10 \text{ MB} \times 10^6 \times 8}{8 \text{ Mbps} \times 10^6} + 0.5 \left( \frac{80}{10^3} \right) = 10 + 0.040 = 10.040 \text{s}
\]

c. Now, assume we can only transmit 100 packets a time, and must wait for a 40B acknowledgement before we can transfer more packets. How long will it take to transfer the file (ignoring the time for the handshake)?

\[
\frac{10 \text{ MB} \times 10^6}{1000 \text{ B} \times 100} = 106 \text{ groups}
\]

\[
\frac{100 \times 1000 \text{ B} \times 8}{8 \text{ Mbps} \times 10^6} + \frac{40 \text{ B} \times 8}{8 \text{ Mbps} \times 10^6} + 1 \left( \frac{80}{10^3} \right)
\]

\[
= \frac{1}{10} + \frac{40}{10^6} + \frac{8}{10^2} = 0.18 \text{ seconds}
\]

\[
0.18 \text{ seconds} \times 106 \text{ groups} = 180.040 \text{s}
\]

3) Importance of performance

For each of the following operations on a remote file server, are there more likely to be delay sensitive or bandwidth sensitive? Why?

a. Open a file

\[\text{Delay - request to open is small}\]

b. Read the contents of a file

\[\text{Bandwidth - file is large}\]

c. List the contents of a directory

\[\text{Delay - directories usually have only a short list of files}\]

d. Display the attributions of a file

\[\text{Delay - metadata is small}\]