

CS 164 COMPUTER NETWORKS

Assignment 2

1. Compute the traffic intensity for the following three systems, and comment on the impact on queuing delay, based on the traffic intensity you find.
 - a) $L = 120$ bits, $a = 50$ pk/s, $R = 5.5$ Kpbs
 $\text{Traffic Intensity} = (L \cdot a) / R = 120 \cdot 50 / 5500 = 1.0909 > 1$.
Therefore more work is arriving than can be serviced.
 - b) $L = 32$ bits, $a = 100$ pk/s, $R = 3.2$ Kbps
 $\text{Traffic Intensity} = (L \cdot a) / R = 32 \cdot 100 / 3200 = 1$,
The system is stable, the arriving load can be serviced. However, delays become large.
 - c) $L = 100$ bits, $a = 200$ pk/s, $R = 56$ Kbps
 $\text{Traffic Intensity} = (L \cdot a) / R = 100 \cdot 200 / 56000 = 0.357 < 1$.
The arriving load can be serviced with small average queuing delay.
2. Calculate the latency of a packet transferred between two hosts A and B on a local network, where they are connected via a cable of length 6.21 m., the packet size is 2024 bytes, and the capacity of the cable is 56 bps. (Assume that queuing delays are not considered. Also recall that 1 byte = 8 bits, and the speed of light = 3.0×10^8 m/s.)
 $\text{Propagation} = \text{Distance} / \text{SpeedOfLight}$
 $= 6.21 / 3 \cdot 10^8 = 0.0207 \mu\text{s}$
 $\text{Transmit} = \text{Size} / \text{Bandwidth}$
 $= 2024 \cdot 8 / 56 = 289.14 \text{ s.}$
 $\text{Latency} = \text{Propagation} + \text{Transmit} + \text{Queue}$
 $= 0.02 \cdot 10^{-6} + 289.14 + 0 = 289.14 \text{ s.}$
3. Comment on which transport layer protocol would be appropriate to use in each of the following applications, and indicate why.
 - a) Transferring an audio stream, for which some packet losses are affordable, but real-time delivery is important.
UDP, because it is faster than TCP but doesn't guarantee lossless(errorless) packet delivery. (see slides)
 - b) Performing a web-browser application (e.g. money transfer on the webpage of your bank), for which promptness is not crucial, but packet errors/losses is fatal.
TCP, because it is a connection-oriented, reliable transport layer protocol and guarantees the successful delivery of packets (re-transmits in case of packet losses/errors).
 - c) Sending an email to another user.
Same as (b). (Note that the question asks for the transport layer protocol.)
4. Solve Exercise #5 on p.55 in your textbook.

The transfer will be considered complete when the last data bit arrives at its destination. An alternative interpretation would be to count until the last ACK arrives back at the sender, in which case the time would be half an RTT (50ms) longer. The solution below is for the former consideration (without the count for the last ACK.)

(a)

$2 \text{ initial RTT's (200ms)} + 1000\text{KB}/1.5\text{Mbps (transmit)} + \text{RTT}/2(\text{propagation})$
 $\approx 0.200 + 8\text{Mbit}/1.5\text{Mbps} + 0.050 = 0.250 + 5.33 \text{ sec} = 5.58 \text{ sec.}$

If we pay more careful attention to when a mega is 10^6 versus 2^{20} , we get $8,192,000 \text{ bits}/1,500,000 \text{ bits/sec} = 5.46 \text{ sec}$, for a total delay of 5.71 sec.

(b) To the above we add the time for 999 RTTs (the number of RTTs between when packet 1 arrives and packet 1000 arrives), for a total of $5.71 + 99.9 = 105.61$ seconds.

(c) This is 49.5 RTTs, plus the initial 2, for 5.15 seconds.

(d) Right after the handshaking is done we send one packet. (zero RTT) One RTT after the handshaking we send two packets. At n RTTs past the initial handshaking we have sent $1 + 2 + 4 + \dots + 2^n = 2^{n+1} - 1$ packets. At $n = 9$ we have thus been able to send all 1,000 packets; and the last batch arrives 0.5 RTT later. Total time is $2 + 9.5 \text{ RTTs} = 11.5 \text{ RTTs} = 1.15 \text{ sec.}$