Solutions of HW2

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Problem 1.8)

C = 3000Kb/s
$T_c = 150\ Kb/s$
$P_t = 0.1$

a) C/T_c = 3000/150 = 20
b) $P_t = 0.1$
c) The probability of exactly n client transmitting:
There are 120 independent binomial random variables, any of them might be one (transmitting) at a certain time with probability of 0.1. There are $\binom{120}{n}$ ways to have exactly n of them transmitting at the same time. The probability of each of these ways is $0.1^n(1-0.1)^{120-n}$

$$p(n) = \binom{120}{n} 0.1^n 0.9^{120-n}$$

d) This will be the same as the probability of the transmission is full and new client would lead to packet drop.

$$P_{drop} = p(21) + p(22) + \cdots + p(120) = \sum_{i=21}^{120} \binom{120}{i} 0.1^i 0.9^{120-i}$$

Using the central limit theorem, adding 100 independent binary random variable can be estimated by a Gaussian random variable, so:

$$P(\text{ “21 or more users” }) = 1 - P\left(\sum_{j=1}^{120} X_j \le 21\right)$$

$$P\left(\sum_{j=1}^{120} X_j \le 21\right) = P\left(\frac{\sum_{j=1}^{120} X_j - 12}{\sqrt{120 \cdot 0.1 \cdot 0.9}} \le \frac{9}{\sqrt{120 \cdot 0.1 \cdot 0.9}}\right)$$

$$\approx P\left(Z \le \frac{9}{3.286}\right) = P(Z \le 2.74)$$

$$= 0.997$$

$$P_{drop} \approx 0.003$$

Problem 1.9)

Follow the same logic of previous problem. This one is an easier version.

a) 10,000

b)

$$\sum_{n=N+1}^{M} \binom{M}{n} p^n (1-p)^{M-n}$$

Problem 1.20)

Using the simple definition of throughput. The maximum we can send into the pipe will be limited by the narrowest one so:

Throughput = $\min\{R_s, R_c, R/M\}$

Problem 1.23)

Let name the first packet A and the second packet B.

Label the time at which A starts to transmit as time zero: t=0.

The last bit of packet A will leave the server at time $t_1^A = \frac{L}{R_s} = d_{Trans}$

Packet B will start to transmit right after packet A left completely means at time t_1^A.

Packet B will leave the server completely after the time needed for transmitting all its packets: $t_1^B = t_1^A + \frac{L}{R_s}$

Packet A will reach to the middle router after the time takes for the propagation which will be $t_2^A = t_1^A + d_{prop}$

The first bit of packet A will leave the router destining to the client right at t_2^A.

Packet A will leave the router completely at time $t_3^A = t_2^A + L/R_c$

Packet B will reach to the middle router with the same propagation delay: $t_2^B = t_1^B + t_{prop}$

Packet B will be queued in the router if when it reaches there completely (t_2^B) packet A be still in process of transmitting i.e. $t_2^B < t_3^A$

Packet B will not be queued otherwise.

Fist bit of packet B will leave the router toward client at time $t_3^B = \min\{t_2^B, t_3^A\}$

The rest of analysis will be like before:

a) The bottleneck is the first link so the is no queuing and the inter-arrival time is: $\frac{L}{R_s}$

b) Simplifying the above equations the minimum $T = \frac{L}{R_c} - \frac{L}{R_s}$.

Problem 1.24)

40 terabytes = 40 * 10^{12} * 8 bit

it will take 40 * 10^{12} * 8 / (100 *10^{6}) =3200000 seconds = 37 days!

It make sense to pay 100$ to Fedex to deliver it overnight or 30$ to USPS to a few days delivery rather than using the network and wait for more than a month.

Problem 1.33)

Number of packets: $N = F/S$

Each packet is the data chunk and 80 bits uses for additional information.

So Length of each packet is $L = S + 80$.

Since the transmission rate is the same for all the three links there will be no queuing delay.

The last packet will leave the sender at $\frac{L}{R} \times N$ and then it takes two more link to reach the destination. So the file delivery delay will be: $delay = \frac{S+80}{R} \times (\frac{F}{S} + 2)$

Taking the derivative we can find the minimum at $S_{opt} = \sqrt{40F}$

Review 2.3)

The process which initiates the communication is the client; the process that waits to be contacted is the server.

Review 2.5)

The IP address of the destination host and the port number of the socket in the destination process

Review 2.9)

SSL operates at the application layer. The SSL socket takes unencrypted data from the application layer, encrypts it and then passes it to the TCP socket. If the application developer wants TCP to be enhanced with SSL, she has to include the SSL code in the application

Review 2.27)

For the TCP application, as soon as the client is executed, it attempts to initiate a TCP connection with the server. If the TCP server is not running, then the client will fail to make a connection. For the UDP application, the client does not initiate connections (or attempt to communicate with the UDP server) immediately upon execution