CN practice problems of Chapter#01

NOTE: practice given below questions and similar questions from book exercise. Also do the exercise numerical for each topic we studied in the classroom(slides).

Q#01

The problem is to distribute a file of size F = 4Gbits to each of these 7 peers. Suppose the server has an upload rate of u = 72 Mbps.

The 7 peers have upload rates of: u1 = 13 Mbps, u2 = 29 Mbps, u3 = 26 Mbps, u4 = 25 Mbps, u5 = 24 Mbps, u6 = 12 Mbps, and u7 = 14 Mbps

The 7 peers have download rates of: d1 = 23 Mbps, d2 = 24 Mbps, d3 = 36 Mbps, d4 = 28 Mbps, d5 = 31 Mbps, d6 =33 Mbps, and d7 = 27 Mbps.

A) What is the minimum time needed to distribute this file from the central server to the 7 peers using the client-server model?

Solution# Dc-s > max{NF/us,,F/dmin}

N= 7, F= 4Gbits, us = 72Mbps, dim = 23Mbps

NF/us = (7)(4x109)/72x106

= 388.8

F/dmin = 4x109/23x106

= 173.9

The minimum time needed to distribute this file from central server is 388.8

B) For the previous question, what is the root cause of this specific minimum time?

Solution# the root cause the upload time rate of sever

C) What is the minimum time needed to distribute this file using peer-to-peer download?

Solution# DP2P > max{F/us,,F/dmin,,NF/(us + ∑ui)}

F/us = 4x109/72x106 =55.5

F/dmin = 4x109/23x106

= 173.9

NF/(us + ∑ui) = (7)(4x109)/(72x106+ (13 Mbps+29 Mbps+26 Mbps+25 Mbps+24 Mbps + 12 Mbps +14 Mbps))

NF/(us + ∑ui)= 130.23

D) For part C, what is the root cause of this specific minimum time: the server (s), client (c), or the combined upload of the clients and the server (cu)?

Solution: client minimum download rate.

Q#02

Consider distributing a file of F = 30 Gbits to N peers. The server has an upload rate of us = 30 Mbps, and each peer has a download rate of di = 2 Mbps and an upload rate of u. For N = 10, 100, and 1,000 and u = 300 Kbps, 700 Kbps, and 2 Mbps, prepare a chart giving the minimum distribution time for each of the combinations of N and u for both client server distribution and P2P distribution.

Q3

Consider the scenario shown below, with four different servers connected to four different clients over four three-hop paths. The four pairs share a common middle hop with a transmission capacity of R = 200 Mbps. The four links from the servers to the shared link have a transmission capacity of R_S = 100 Mbps. Each of the four links from the shared middle link to a client has a transmission capacity of R_C = 70 Mbps. [4points]

A) What is the maximum achievable end-end throughput (in Mbps) for each of four client-to-server pairs, assuming that the middle link is fairly shared?

Solution# R = 200Mbps/4 = 50Mbps. End to End Throughput = min {Rs, R, Rc} = {100Mbps, 50Mbps, 70Mbps} = End to End throughput = 50Mbps

B) Which link is the bottleneck link?

Solution# The middle link is bottleneck link

C) Assuming that the servers are sending at the maximum rate possible, what are the link utilizations for the server links (R_S)?

Solution# Rs link Utilization = 50/100 = 0.5 or in % it is 50%

D) Assuming that the servers are sending at the maximum rate possible, what are the link utilizations for the client links (R_C)?

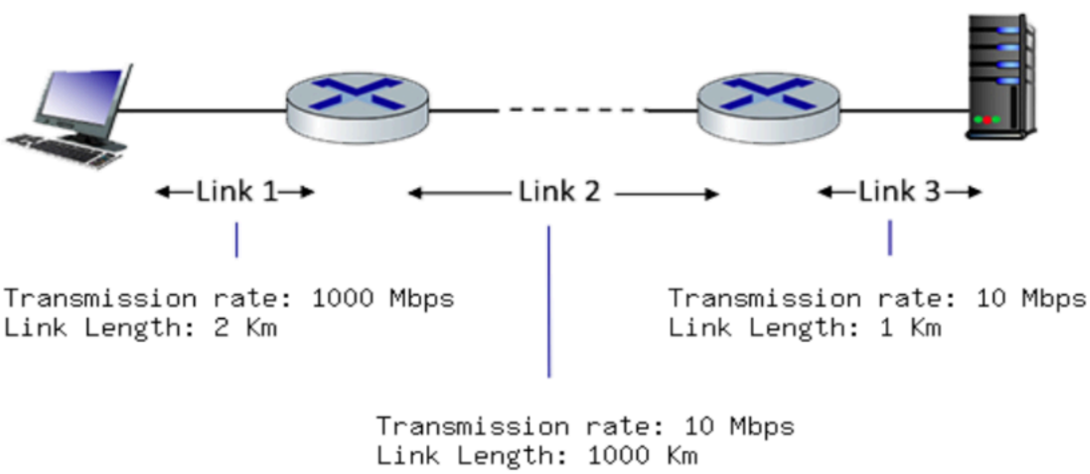
Solution# Rc link utilization = 50/70 = 0.71 or in % it is 71%

E) Assuming that the servers are sending at the maximum rate possible, what is the link utilizations for the shared link (R)?

Solution# R link utilization = 50/50 = 1 or in % it is 100%

Q4

Consider the figure below, with three links, each with the specified transmission rate and link length. Store & forward technique is used by switches. [5points]



Assume the length of a packet is 8000 bits. The speed of light propagation delay on each link is 3x10^8 m/sec.

A) What is total Transmission delay?

Solution# T1 + T2 + T3 = L/R1 + L/R2 + L/R3

Total transmission delay= $(8000/1000x10^6)$ + $(8000/10x10^6)$ +

$(8000/10x10^6)$ Total Transmission delay = 1.608msec

B) What is total Propagation delay?

Solution# P1 + P2 + P3 = d1/s + d2/s + d3/s = $(2x10^3/3x10^8)$ + $(1000x10^3/3x10^8)$ +

$(1x10^3/3x10^8)$ Total Propagation delay = 3.43 msec

C) Calculate the total end to end delay?

Solution# Total end to end delay = Total transmission delay + total propagation

delay Total end to end delay = 1.608msec + 3.43msec = 5.038msec

D) What is end-end throughput & which link is bottleneck link?

Solution# Throughtput is 10Mbps & link 2 & 3 are bottleneck link

E) How many packets each link can send in a second?

Solution# R/L

Link 1 = $1000x10^6/8000$ = 125000 packets in one sec

Link 2 & 3 = $10x10^6/8000$ = 1250 Packets in one sec

Q5

Consider distributing a file of F = 30 Gbits to N peers. The server has an upload rate of us = 30 Mbps, and each peer has a download rate of di = 2 Mbps and an upload rate of u. For N = 10, 100, and 1,000 and u = 300 Kbps, 700 Kbps, and 2 Mbps, prepare a chart giving the minimum distribution time for each of the combinations of N and u for both client server distribution and P2P distribution.

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Client - Server Distribution:

Time to distribute F to N clients using client - server approach $\Rightarrow$ $D_{c-s} \geq \max \{ N \frac{F}{u_s},$

(i)

$N = 10$

$F = 30$ Gbps

(server upload rate) $u_s = 30$ mbps

(download rate) $d_i = 2$ Mbps $\Rightarrow d_{min} = 2$ Mb

$N \times \left(\frac{F}{u_s}\right) = ?$ $\quad \cancel{10} \times \left(\frac{\cancel{30} \times \cancel{10^9} \text{ bps}}{\cancel{30} \times \cancel{10^6} \text{ bps}} \right)$

$N \times \left(\frac{F}{u_s}\right) = 10^4 \Rightarrow \boxed{10k}$

$\frac{F}{d_{min}} = ?$ $\quad \frac{\overset{15}{\cancel{30}} \times \cancel{10^9} \text{ bps}}{\cancel{2} \times \cancel{10^6} \text{ bps}} \Rightarrow \boxed{}$

$D_{c-s} \geq \max \{ 10k, 15k$

$\boxed{15K}$

(ii)

$N = 100$

$F = 30$ Gbps

$u_s = 30$ mbps

$d_i = 2$ Mbps $\Rightarrow d_{min} = 2$ Mbps.

~~$u_s = 300$ M~~ kbps

$N \times \left(\frac{F}{u_s}\right) = ?$ $\quad \boxed{10 \text{kbps}}$

(ii)

$N = 100$

$F = 30\ Gbps$

$u_s = 30\ Mbps$

$d_i = 2\ Mbps \Rightarrow d_{min} = 2\ Mbps$

$N \times \left(\frac{F}{u_s}\right) = ?$ $\quad 100 \times \left(\frac{30 \times 10^9\ bps}{30 \times 10^6\ bps}\right)$

$N \times \left(\frac{F}{u_s}\right) = 10^5 \Rightarrow 100K$

$\frac{F}{d_{min}} = ?$ $\quad \frac{30\ Gbps}{2\ Mbps} \Rightarrow \frac{30 \times 10^9\ bps}{2 \times 10^6\ bps} \Rightarrow 15k$

$D_{c-s} \geq \{100k \quad 15k\}$

$100k$

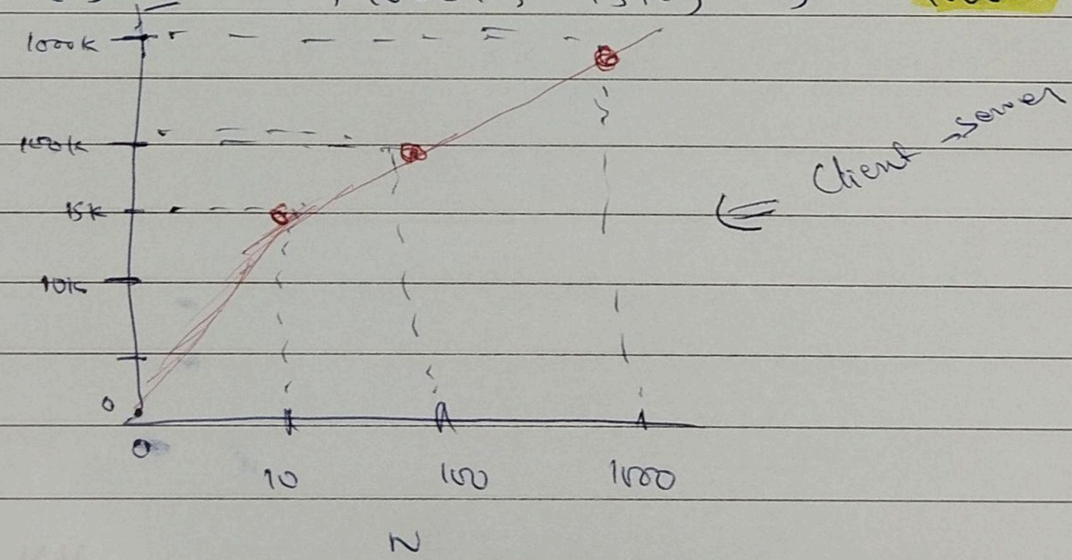
(iii)

$N = 1000$

$N \times \left(\frac{F}{u_s}\right) \Rightarrow ?$ $\quad 1000 \times \left(\frac{30 \times 10^9}{30 \times 10^6}\right)$

$10^6 \Rightarrow 1000k$

$D_{c-s} \geq \max\{1000k, 15k\} \Rightarrow 1000k$



Peer 2 Peer

time to distribute f to N clients using P2P approach

$$D_{p2p} \geq \max\left\{\frac{F}{u_s}, \frac{F}{d_{min}}, \frac{NF}{(u_s + \Sigma u_i)}\right\}$$

(i) $N = 10$

$F = 30$ Gbps

$d_i = 2$ Mbps $= d_{min} = 2$ Mbps

$u_s = 30$ Mbps

$u = 300$ kbps

$\frac{F}{u_s} = ?$ $\left(\frac{30 \times 10^9}{30 \times 10^6}\right) \Rightarrow \underline{1000 \text{ bps}}$

$\frac{F}{d_{min}} = ?$ $\frac{30 \times 10^9}{2 \times 10^6} \Rightarrow \underline{15k \text{ bps}}$

$N\left(\frac{F}{(u_s + \Sigma u_i)}\right) = ?$ $10 \times \left(\frac{30 \times 10^9}{30 \times 10^6 + 3 \times 10^6}\right)$

$= \cancel{10}\left(\frac{30 \times \cancel{10^{10}}}{33 \times \cancel{10^6}}\right)$

$= 0.909 \quad 10^4 \Rightarrow \underline{9.909 \text{ kbps}}$

$D_{p2p} \geq \max\{1000, 15k, 9.909k\}$

$\boxed{15k}$

(ii) $N = 100$

$u = 700\ kbps$

$F = 30\ Gbps$

$u_s = 30\ Mbps$

$d_i = 2\ Mbps \Rightarrow d_{min} = 2\ Mbps$

$N \times \left(\frac{F}{u_s + \Sigma u_i}\right) = ?$ $\quad 100\left(\frac{30 \times 10^9}{30 \times 10^6 + 7 \times 10^5}\right)$

$= 10^2\left(\frac{30 \times 10^9}{300 \times 10^5 + 7 \times 10^5}\right)$

$= \cancel{10^2}\left(\frac{30 \times \cancel{10^9}}{307 \times \cancel{10^5}}\right)$

$= \frac{30}{307} \times 10^6$

$= 0.09771 \times 10^6$

$= 97.71\ K$

$D_{P2P} \geq \max\{1000,\ 15k,\ 97.71k\}$

97.71k

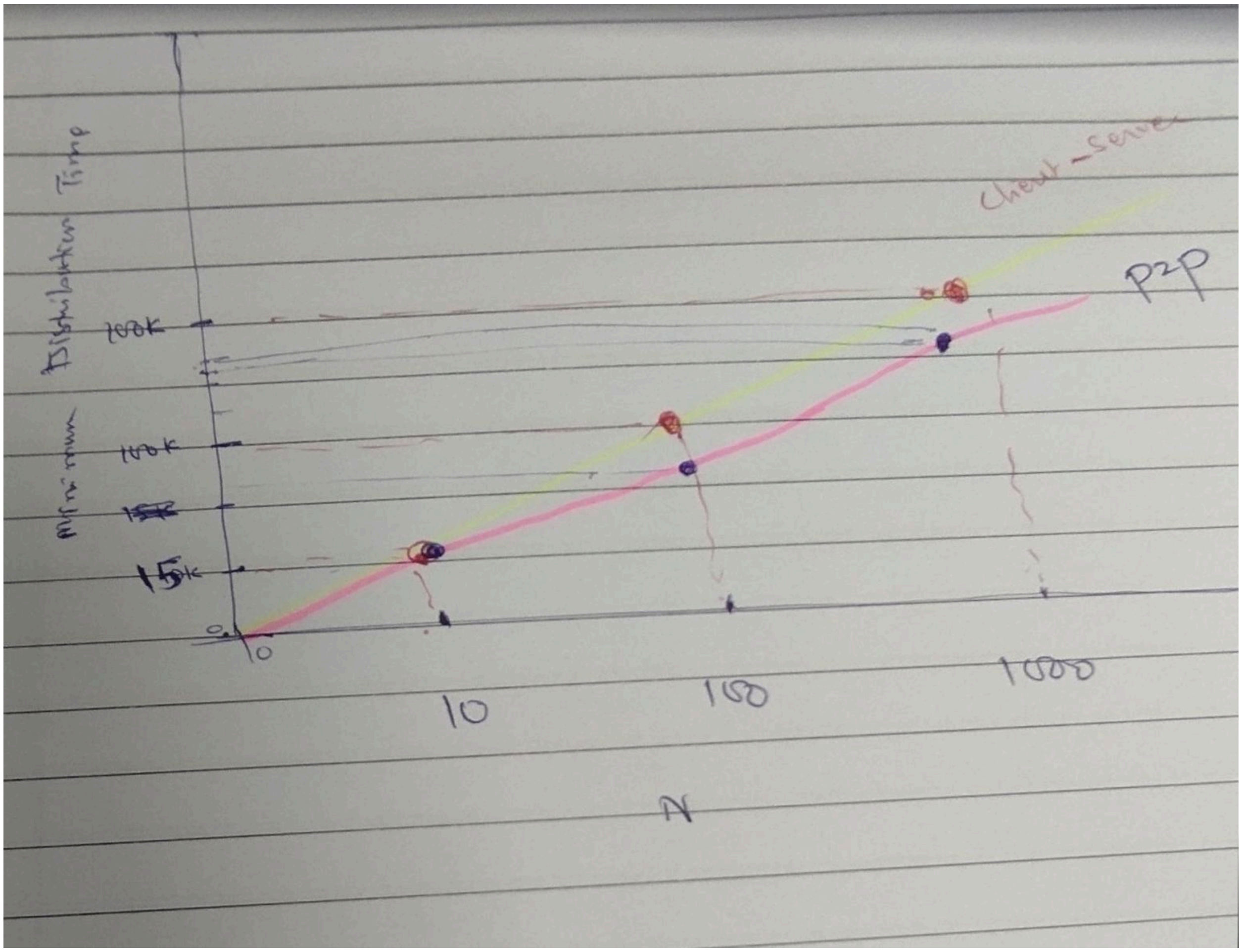
(iii) $N = 1000$, $u = 2\ Mbps$

$N \times \left(\frac{F}{u_s + \Sigma u_i}\right) = 10^3 \times \left(\frac{30 \times 10^9}{30 \times 10^6 + 2 \times 10^6}\right)$

$= \cancel{10^3}\left(\frac{30 \times \cancel{10^9}}{32 \times \cancel{10^6}}\right)$

$= 0.9375 \times 10^6 \Rightarrow 937.5\ k$

$\max\{1000,\ 15k,\ 937.5k\}$



Q6

Consider the scenario shown below, with four different servers connected to four different clients over four three-hop paths. The four pairs share a common middle hop with a transmission capacity of R = 300 Mbps. The four links from the servers to the shared link have a transmission capacity of R_S = 200 Mbps. Each of the four links from the shared middle link to a client has a transmission capacity of R_C = 80 Mbps. [3points]

[Solution is provided below, and it is also defined in the book on page#43 to 46]

A) What is the maximum achievable end-end throughput (in Mbps) for each of four client-to-server pairs, assuming that the middle link is fairly shared?

Solution:

R = 300Mbps/4 = 75Mbps. End to End Throughput = min {Rs, R, Rc} = {200Mbps, 75Mbps, 80Mbps} = End to End throughput = 75Mbps

B) Which link is the bottleneck link?

Solution:

The middle link is bottleneck link

C) Assuming that the servers are sending at the maximum rate possible, what are the link utilizations for the server links (R_S)?
Solution:

Rs link Utilization = 75/200 = 0.37 or in % it is 37.5%

D) Assuming that the servers are sending at the maximum rate possible, what are the link utilizations for the client links (R_C)?
Solution:

Rc link utilization = 75/80 = 0.937 or in % it is 93.75%

E) Assuming that the servers are sending at the maximum rate possible, what is the link utilizations for the shared link (R)?
Solution:

R link utilization = 75/75 = 1 or in % it is 100%

Q7

Consider the scenario shown below, with four different servers connected to four different clients over four three-hop paths. The four pairs share a common middle hop with a transmission capacity of R = 300 Mbps. The four links from the servers to the shared link have a transmission capacity of R_S = 200 Mbps. Each of the four links from the shared middle link to a client has a transmission capacity of R_C = 70 Mbps. [3points]

[Solution is provided below, and it is also defined in the book on page#43 to 46]

A) What is the maximum achievable end-end throughput (in Mbps) for each of four client-to-server pairs, assuming that the middle link is fairly shared?

Solution:

R = 300Mbps/4 = 75Mbps. End to End Throughput = min {Rs, R, Rc} = {200Mbps, 75Mbps, 70Mbps} = End to End throughput = 70Mbps

B) Which link is the bottleneck link?

Solution:

The middle link is bottleneck link

C) Assuming that the servers are sending at the maximum rate possible, what are the link utilizations for the server links (R_S)?

Solution:

Rs link Utilization = 75/200 = 0.37 or in % it is 37.5%

D) **Assuming that the servers are sending at the maximum rate possible, what are the link utilizations for the client links (Rc)?**
Solution:

Rc link utilization = 75/70 = 1.071 or in % it is 107.1%

E) **Assuming that the servers are sending at the maximum rate possible, what are the link utilizations for the shared link (R)?**
Solution:

R link utilization = 75/75 = 1 or in % it is 100%

Q8

Consider the following Network. Suppose the average object size is 1Mbits, and the average request rate from the institution browsers to the origin servers is 15 requests per second. Suppose the HTTP request messages are small and thus create no traffic in the network. Also suppose that the amount of time that it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is 2 seconds. a. What is the 'traffic intensity' on the access link (from internet router to institution router)? [3points]

a. **What is the 'traffic intensity' on the access link (from internet router to institution router)?**
Solution:

Traffic intensity = (1 Mbits * 15 requests/second)/ 15 Mbps = 1

b. **Suppose the access link is upgraded from 15 Mbps to 100 Mbps, then what would be the 'traffic intensity' on the access link (from internet router to institution router)?**
Solution:

Traffic intensity = (1 Mbits * 15 requests/second)/ 100 Mbps = 0.15

c. ~~**Suppose that the access link is left as is, at 15Mbps and instead a Web Cache is provided with the institution network that has a hit rate of 0.4, then what is the average delay in getting a web page**~~**.** **[This was excluded from the quiz]**
Solution:

(see page 113 of textbook)

Q9

P5. Review the car-caravan analogy in Section 1.4. Assume a propagation speed of 100 km/hour. a. Suppose the caravan travels 175 km, beginning in front of one tollbooth, passing through a second tollbooth, and finishing just after a third toll booth. What is the end-to-end delay? b. Repeat (a), now assuming that there are eight cars in the caravan instead of ten.

Solution

Tollbooths are 75 km apart, and the cars propagate at 100km/hr. A tollbooth services a car at a rate of one car every 12 seconds.

a) There are ten cars. It takes 120 seconds, or 2 minutes, for the first tollbooth to service the 10 cars. Each of these cars has a propagation delay of 45 minutes (travel 75 km) before arriving at the second tollbooth. Thus, all the cars are lined up before the second tollbooth after 47 minutes. The whole process repeats itself for traveling between the second and third tollbooths. It also takes 2 minutes for the third tollbooth to service the 10 cars. Thus the total delay is 96 minutes.

b) Delay between tollbooths is 8*12 seconds plus 45 minutes, i.e., 46 minutes and 36 seconds. The total delay is twice this amount plus 8*12 seconds, i.e., 94 minutes and 48 seconds.

Q10

R18. How long does it take a packet of length 1,000 bytes to propagate over a link of distance 2,500 km, propagation speed 2.5 # 108 m/s, and transmission rate 2 Mbps? More generally, how long does it take a packet of length L to propagate over a link of distance d, propagation speed s, and transmission rate R bps? Does this delay depend on packet length? Does this delay depend on transmission rate?

Solution

10msec; d/s; no; no

Q11

R19. Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates R1 = 500 kbps, R2 = 2 Mbps, and R3 = 1 Mbps. a. Assuming no other traffic in the network, what is the throughput for the file transfer? b. Suppose the file is 4 million bytes. Dividing the file size by the through put, roughly how long will it take to transfer the file to Host B? c. Repeat (a) and (b), but now with R2 reduced to 100 kbps.

Solution

a) 500 kbps

b) 64 seconds

c) 100kbps; 320 seconds

Homework

NOTE: Solve such question from book exercise

Suppose users share a 2 Mbps link. Also suppose each user transmits continuously

at 1 Mbps when transmitting, but each user transmits only 20 percent

of the time. (See the discussion of statistical multiplexing in Section 1.3.)

a. When circuit switching is used, how many users can be supported?

b. For the remainder of this problem, suppose packet switching is used. Why will there be essentially no queuing delay before the link if two or fewer users transmit at the same time? Why will there be a queuing delay if three users transmit at the same time?

c. Find the probability that a given user is transmitting.

d. Suppose now there are three users. Find the probability that at any given time, all three users are transmitting simultaneously. Find the fraction of time during which the queue grows

NOTE: Practice book exercise of chapter#01 and 02