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Solutions 1&2

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HW1 Common Mistakes

P 9 Bytes not bits

P 22 Wrong Calculation

Grading 5*10 = 50

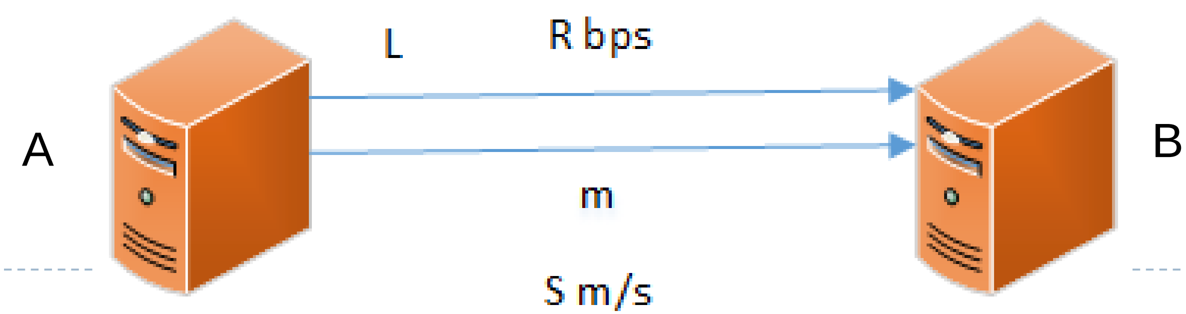
Consider two hosts, A and B, connected by a single link of rate **R** bps. Suppose that the two hosts are separated by **m** meters, and suppose the propagation speed along the link is **s** m/s. Host A is to send a packet of size **L** bits to Host B.

a. Express the propagation delay, dprop, in terms of m and s.

Ans: $d_{prop} = m/s$ (seconds)

b. Determine the transmission time of the packet, d_{trans}, in terms of L and R.

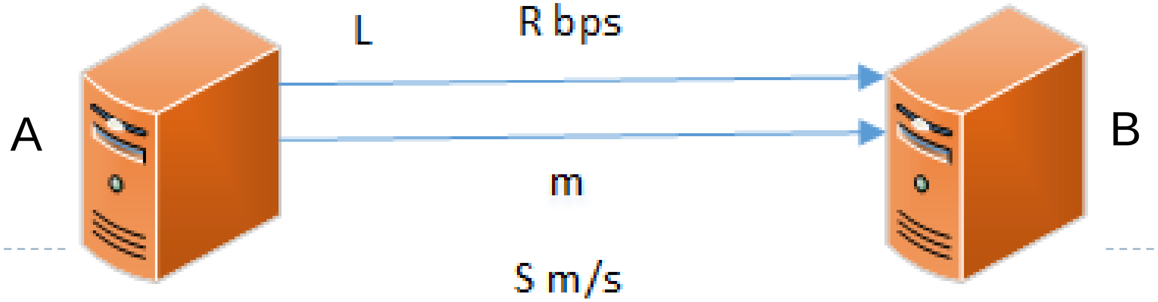
Ans: $d_{trans} = L/R$ (seconds)



c. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.
Ans: $d_{end\text{-}to\text{-}end} = d_{prop} + d_{trans} = m/s + L/R$ (seconds)

d. Suppose Host A begins to transmit the packet at time $t = 0$. At time $t = d_{trans}$, where is the last bit of the packet?
Ans: just leaving Host A

e. Suppose d_{prop} is greater than d_{trans}. At time $t = d_{trans}$, where is the first bit of the packet?
Ans: The first bit is in the link and has not reach Host B

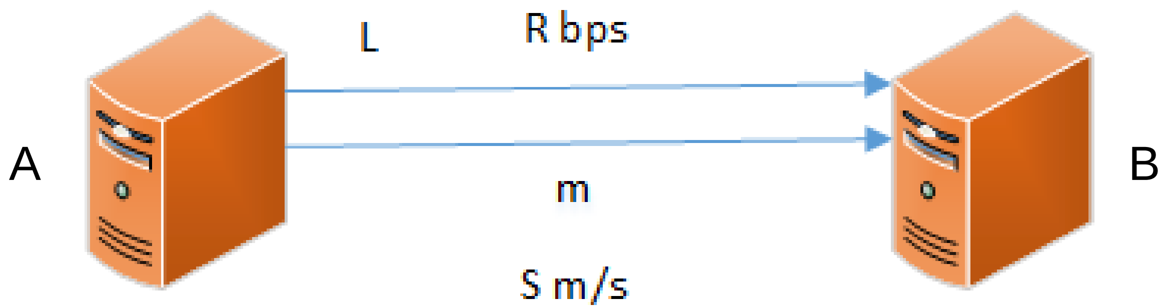


f. Suppose d_{prop} is less than d_{trans}. At time $t = d_{trans}$, where is the first bit of the packet?

Ans: The first bit has reached Host B

g. Suppose $s = 2.5 \cdot 10^8$, $L = 120$ bits, and $R = 28$ kbps. Find the distance m so that d_{prop} equals d_{trans}.

Ans: $d_{prop} = d_{trans} \Longrightarrow m/s = L/R$



Chapter 1 P7

Suppose users share a 1 Mbps link. Also suppose each user requires 100 kbps when transmitting, but each user transmits only 10 percent of the time.

a. When circuit switching is used, how many users can be supported?
   Ans: 1M/100kbps=10 users.

b. For the remainder of this problem, suppose packet switching is used. Find the probability that a given user is transmitting.
   Ans: p=0.1

Chapter 1 P7

Suppose users share a 1 Mbps link. Also suppose each user requires 100 kbps when transmitting, but each user transmits only 10 percent of the time.

c. Suppose there are 40 users. Find the probability that at any given time, exactly *n* users are transmitting simultaneously. (*Hint*: Use the binomial distribution.)

Ans: $\binom{40}{n} p^n (1-p)^{40-n}$

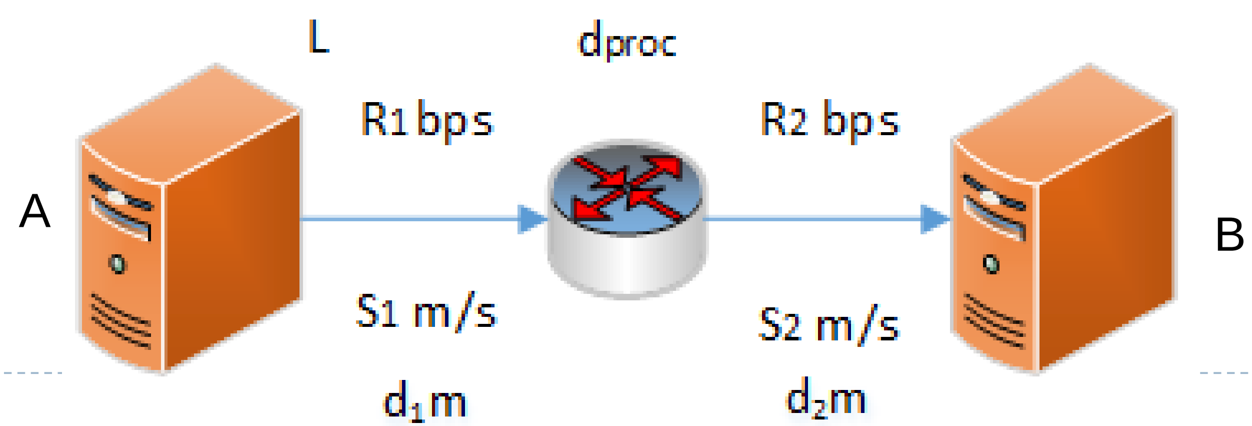
d. Find the probability that there are 11 or more users transmitting simultaneously.

Ans: $1-\sum_{n=0}^{10} \binom{40}{n} p^n (1-p)^{40-n}$ or

$\sum_{n=11}^{40} \binom{40}{n} p^n (1-p)^{40-n}$

Consider a packet of length *L* which begins at end system A and travels over two links to a destination end system. The two links are connected by one packet switches. Let *di*, *si*, and *Ri* denote the length, propagation speed, and the transmission rate of link *i*, for *i* = 1, 2. The packet switch delays each packet by *dproc*. Assuming no queuing delays, in terms of *di*, *si*, *Ri*, (*i* = 1,2), and *L*, what is the total end-to-end delay for the packet?

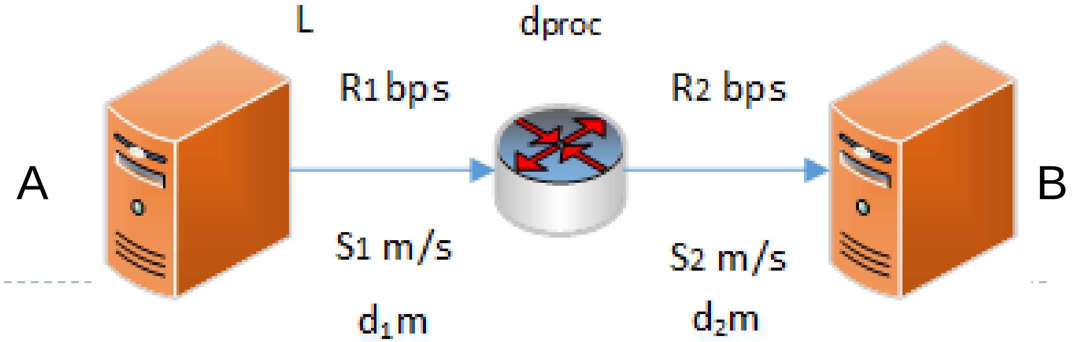
$d = d_{trans} + d_{prop} + d_{proc} = L/R_1 + L/R_2 + d_1/s_1 + d_2/s_2 + d_{proc}$



Suppose now the packet is 1,000 **bytes**, the propagation speed on all three links is $2.5 \cdot 10^8$ m/s, the transmission rates of all three links are 1 Mbps, the packet switch processing delay is 2 msec, the length of the first link is 6,000 km, the length of the second link is 3,000 km. For these values, what is the end-to-end delay?

$$d = L/R_1 + L/R_2 + d_1/s_1 + d_2/s_2 + d_{proc}$$

$$d = 1K*8/1M + 1K*8/1M + 6000k/2.5*10^8 + 3000k/2.5*10^8 + 2$$
$$= 8+8+24+12+2 = 54 \text{(ms)}$$



Chapter 1 P22

Suppose there is a 10 Mbps microwave link between a geostationary satellite and its base station on Earth. Every minute the satellite takes a digital photo and sends it to the base station. Assume a propagation speed of $2*10^8$ meters/sec.

a. What is the propagation delay of the link?

Ans: d_{prop} = s/v = 36000k/ $2*10^8$ =180ms

b. What is the bandwidth-delay product, $R \cdot d$prop?

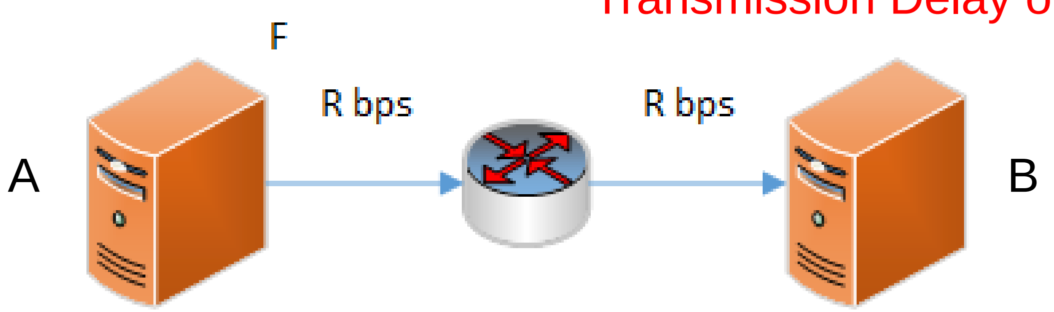
Ans: R*d_{porp} = 10Mbps*180ms = 1800bits

c. Let x denote the size of the photo. What is the minimum value of x for the microwave link to be continuously transmitting?

Ans: t_{trans}=60s$\Longrightarrow$L=60s*10Mbps=600M

Consider sending a large file of F bits from Host A to Host B. There are two links (and one switches) between A and B, and the links are uncongested (that is, no queuing delays). Host A segments the file into segments of S bits each and adds 40 bits of header to each segment, forming packets of $L = 40 + S$ bits. Each link has a transmission rate of R bps. Find the value of S that minimizes the delay of moving the file from Host A to Host B. Disregard propagation delay.

Transmission Delay only!



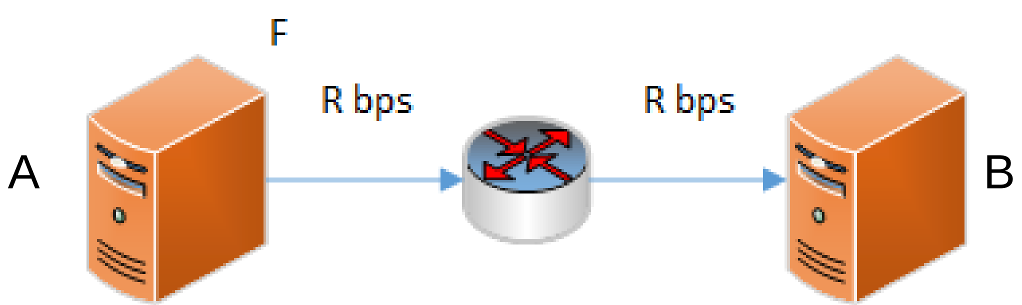
The first packet arrived at the destination at time $2*\frac{S+40}{R}$

After that, one packet is received at destination every $\frac{S+40}{R}$ seconds.

delay $= 2*\frac{S+40}{R} + (\frac{F}{S} - 1)(\frac{S+40}{R}) = (\frac{F}{S} + 1)(\frac{S+40}{R})$

$$\frac{d}{dS}delay = 0 \Rightarrow \frac{F}{R}\left(\frac{1}{S} - \frac{40+S}{S^2}\right) + \frac{1}{R} = 0 \Rightarrow S = \sqrt{40F}$$

Transmission Delay only!



HW2 Common Mistakes

P 7,8 No Detailed Calculation Procedures

P 9 Wrong Calculation

P 16 The difference between 1024 and 1000

P 16,19 Different textbook-> Different Answers

Grading 5*10 = 50

Chapter 2 P7

Suppose within your Web browser you click on a link to obtain a Web page. The IP address for the associated URL is not cached in your local host, so a DNS lookup is necessary to obtain the IP address. Suppose that n DNS servers are visited before your host receives the IP address from DNS; the successive visits incur an RTT of $RTT_1, \ldots, RTT_n$. Further suppose that the Web page associated with the link contains exactly one object, consisting of a small amount of HTML text. Let RTT_0 denote the RTT between the local host and the server containing the object. Assuming zero transmission time of the object, how much time elapses from when the client clicks on the link until the client receives the object?

Chapter 2 P7

Get IP address first

Time for DNS lookup:

$RTT_1+RTT_2+\ldots+RTT_n$

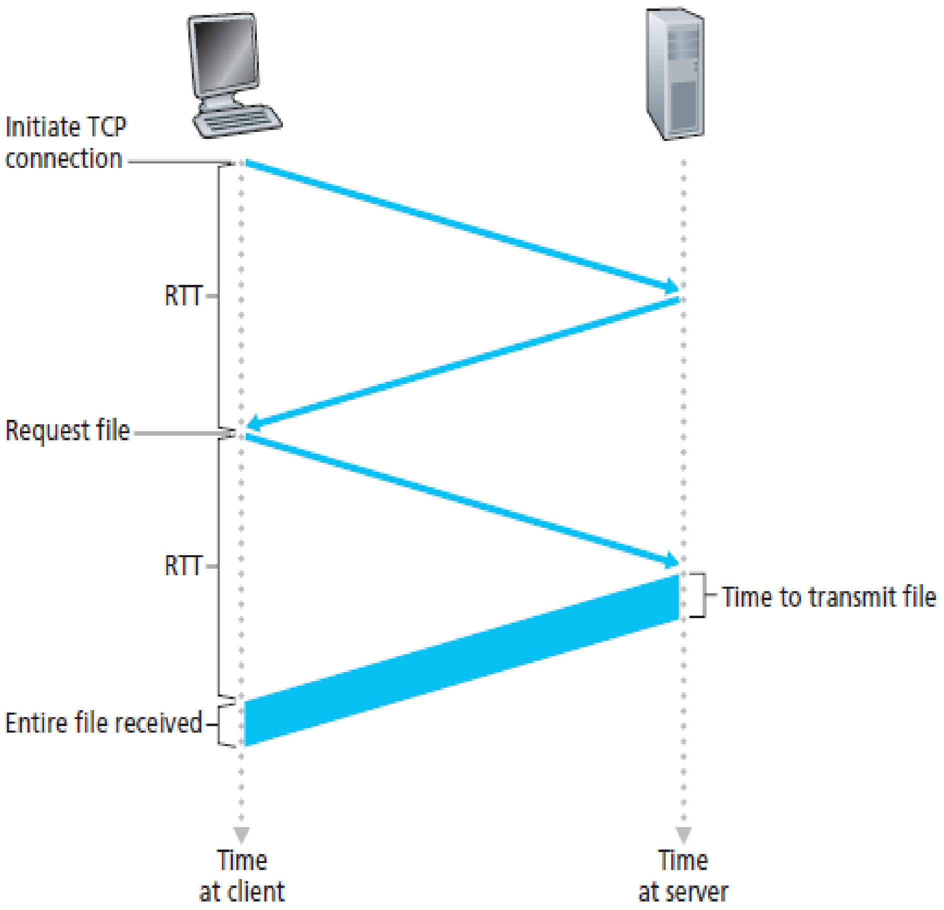
Then request the object

Time for HTTP object request:

$2RTT_0$

Total Time for whole process:

$2RTT_0+RTT_1+RTT_2+\ldots+RTT_n$

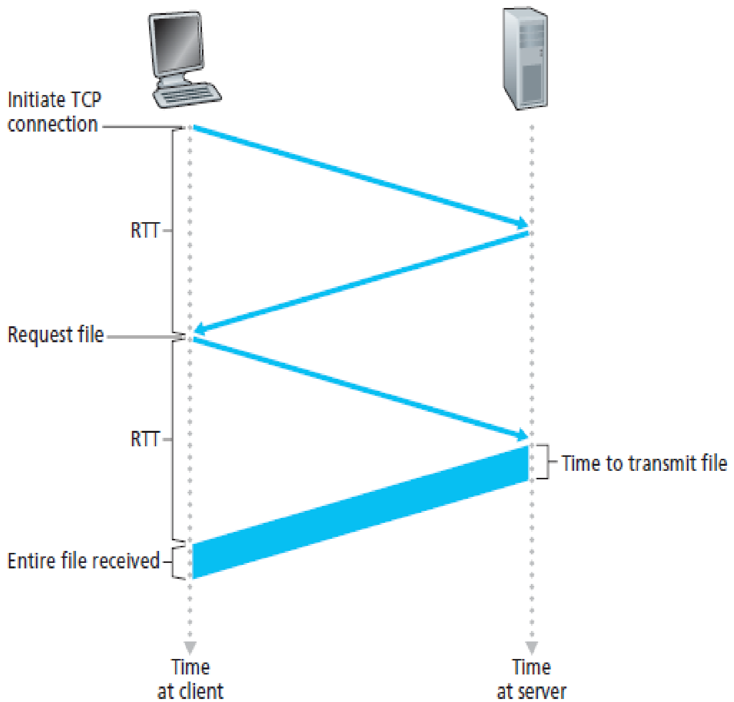


Referring to Problem P7, suppose the HTML file references three very small objects on the same server. Neglecting transmission times, how much time elapses with

a. Non-persistent HTTP with no parallel TCP connections?

b. Non-persistent HTTP with parallel connections?

c. Persistent HTTP?



a. Extra handshake three times

$2RTT_0+RTT_1+RTT_2+\ldots+RTT_n+3*2RTT_0$

b. Extra handshake one time

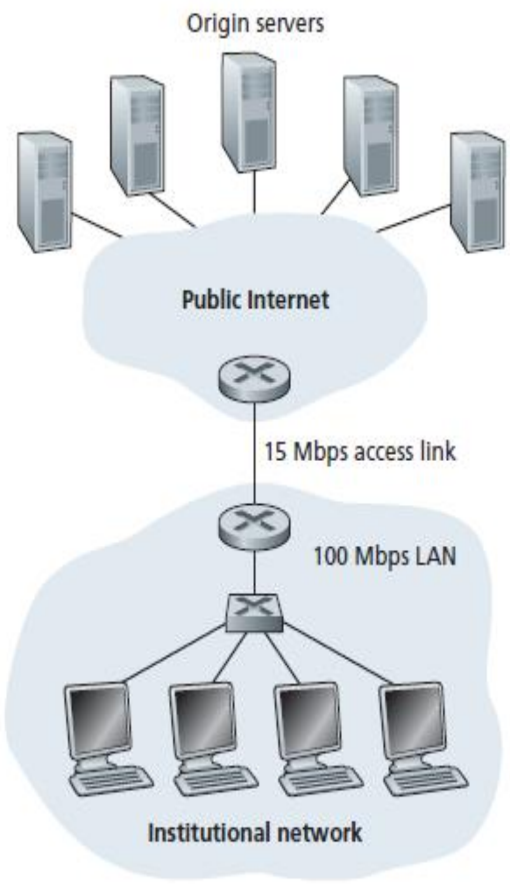
$2RTT_0+RTT_1+RTT_2+\ldots+RTT_n+2RTT_0$

c. Extra request one time

$2RTT_0+RTT_1+RTT_2+\ldots+RTT_n+RTT_0$

Chapter 2 P9

Consider Figure 2.12, Suppose that the average object size is 900,000 bits and that the average request rate from the institution's browsers to the origin servers is 10 requests per second. Also suppose that the amount of time 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 on average.

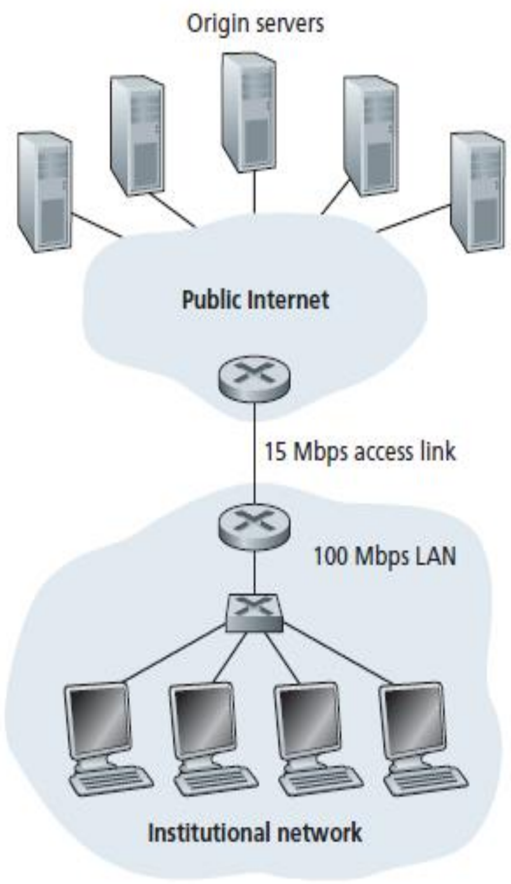


Model the total average response time as the sum of the average access delay (that is, the delay from Internet router to institution router) and the average Internet delay. For the average access delay, use $\Delta/(1 - \Delta\beta)$, where Δ is the average time required to send an object over the access link and β is the arrival rate of objects to the access link.

$\Delta = 900{,}000\text{bits}/15\text{Mbps} = 0.06\text{s}$

$\beta = 10$ request/sec

$d_{access} = \Delta/(1 - \Delta\beta) = 0.15\text{s}$



a. Find the total average response time.

$d_{respon} = d_{access} + d_{inter} = 0.15+2=2.15s$

b. Now suppose a cache is installed in the institutional LAN. Suppose the miss rate is 0.4. Find the total response time.

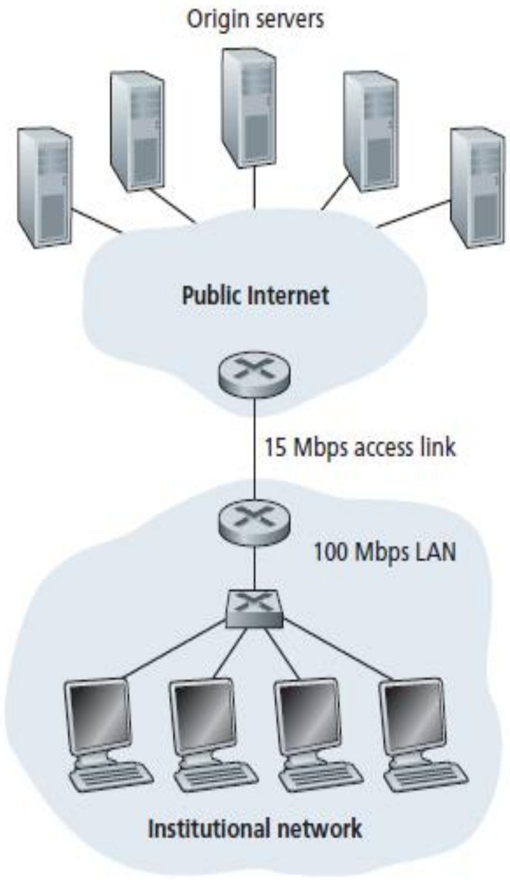
β is change to 4, Access delay will be changed.

$d_{access}=\Delta/(1 - \Delta\beta) = 0.07s$

$d_{respon} = 2+0.07=2.07s$

Only 40% requests suffer from the response delay, so

$d_{aver\_respon}= 0.6*0+0.4*2.07=0.83s$



Consider distributing a file of F = 5 Gbits to N peers. The server has an upload rate of u_s = 20 Mbps, and each peer has a download rate of d_i = 1Mbps and an upload rate of u. For N = 10, 100, and 1,000 (three values!)and u = 100 Kbps, 250Kbps, and 500Kbps, 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.

$$D_{cs} = max\left\{\frac{NF}{u_s}, \frac{F}{d_{min}}\right\}$$

		N		
		10	**100**	**1000**
u	100K	5120	25600	256000
	250K	5120	25600	256000
	500k	5120	25600	256000

Consider distributing a file of $F = 5$ Gbits to N peers. The server has an upload rate of $u_s = 20$ Mbps, and each peer has a download rate of $d_i = 1$Mbps and an upload rate of u. For N = 10, 100, and 1,000 (three values!)and u = 100 Kbps, 250Kbps, and 500Kbps, 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.

$$D_{p2p} = max\left\{\frac{F}{u_s}, \frac{F}{d_{min}}, \frac{NF}{(u_s + \sum_{i=1}^{N} u_i)}\right\}$$

		N		
		10	**100**	**1000**
	100K	5120	17201.05	43516.60
u	250K	5120	11527.88	19383.61
	500K	5120	7438.82	10073.16

Consider an overlay network with 100 active peers, with each pair of peers having an active TCP connection. Additionally, suppose that the TCP connections pass through a total of 10 routers. How many nodes and edges are there in the corresponding overlay network?

Nodes: 100

Edges: $\binom{100}{2}$

The edges in an overlay network is abstract link, not physical link!

So the number of routers affects only the topology of the network, not abstract link!

Q&A

- Thanks！

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