National University of Computer and Emerging Sciences, Lahore Campus

Course:	Computer Networks	Course Code:	CS3001
Program:	BS (Computer Science)	Semester:	Fall 2025
Due Date:	17th Sep, 2025	Weight	
Section:	J	Roll No.	
Quiz #	2	Name	

Q1: Consider the following figure, for which there is an institutional network connected to the Internet. Moreover, assume the access link has been upgraded to 64 Mbps, and the institutional LAN is upgraded to 5 Gbps. Suppose that the average object size is 1,800,000 bits and that the average request rate from the institution's browsers to the origin servers is 22 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 three 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 Δ/(1 -Δb), where Δ is the average time required to send an object over the access link and b is the arrival rate of objects to the access link. **[CLO 2] [5+5]**

a. Find the total average response time.

b. Now suppose a cache is installed in the institutional LAN. Suppose the hit rate is 0.8. Find the total response time.

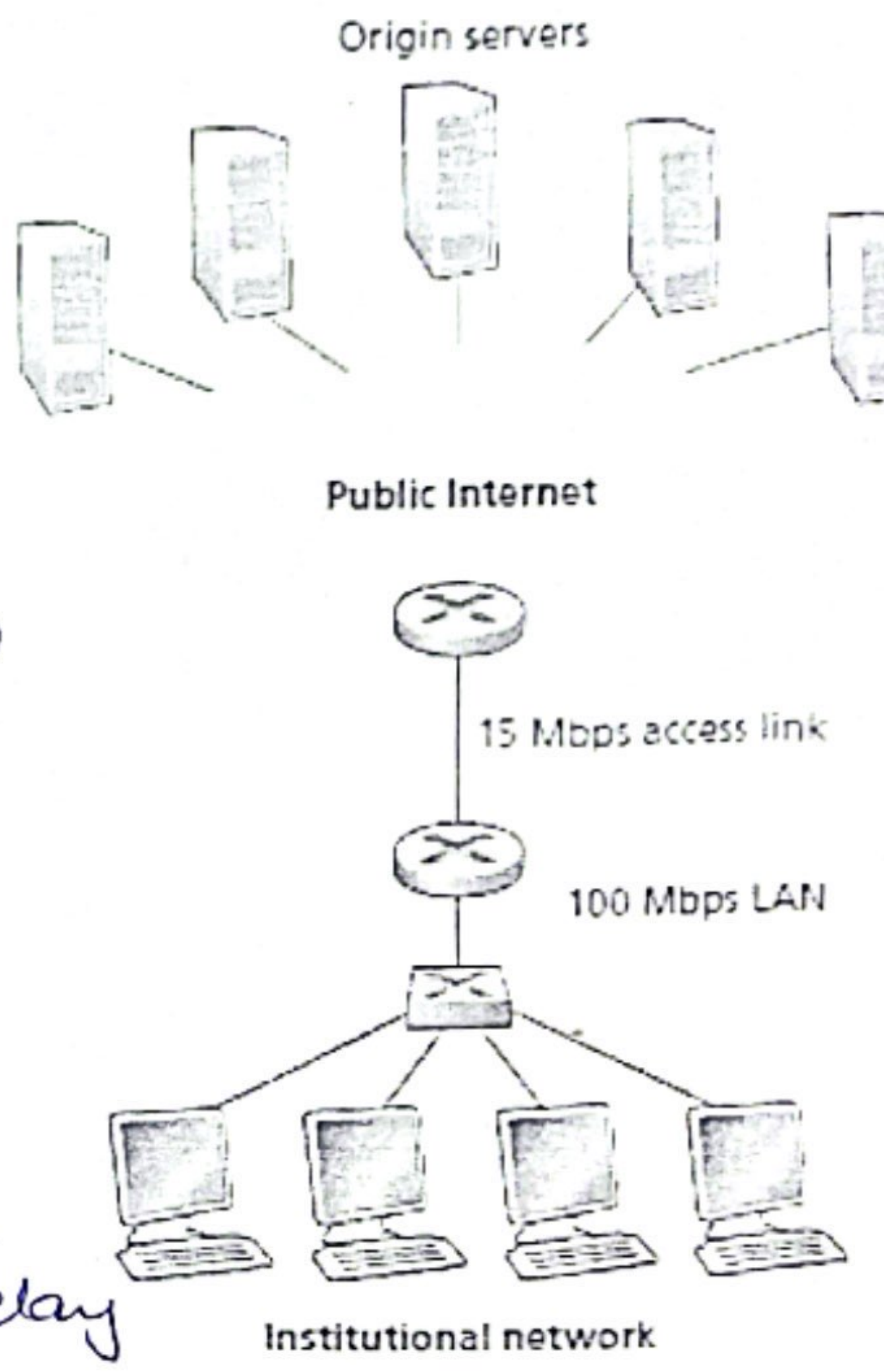
Access Link $R = 64$ Mbps $= 64{,}00{,}000$ bit/s

Avg object size $L = 1800{,}000$ bits

request rate $b = 22$ requests/s

Avg Internet delay $= 3$s

$$\Delta = \frac{L}{R} = \frac{1800{,}000}{64000{,}000} = 0.028125\text{s}$$



a) Total Avg Response Time (No cache)

$$\text{Access Delay} = \frac{\Delta}{1-b\Delta} = \frac{0.028125}{1-(22\times 0.028125)}$$

$$= 0.07377049\text{s}$$

Total Response Time = Access Delay + Internet delay

$$= 0.07377049 + 3$$

$$= 3.07377049\text{s}$$

$$\approx \boxed{3.07\text{s}}$$

b) Cache with hit rate $h = 0.8$ (so miss rate $m = 0.2$)

Only misses traverse the access link. Effectic traffic intensity for misses:

$$\rho_{miss} = m\rho = 0.2 \times 0.61875 = 0.12375$$

$$\text{Access Delay}_{(miss)} = \frac{\Delta}{1-\rho_{miss}} = \frac{0.028125}{1-0.12375} = 0.03209700s$$

A miss's total response $= 0.03209700 + 3 \quad 3.03209700s.$

Hits are served locally (assumed negligible).

$$T_{avg} = m \cdot (3.03209700) = 0.2 \times 3.03209700 = 0.606419s$$

$$\approx \boxed{0.61s}$$

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Q1: Consider the following figure, for which there is an institutional network connected to the Internet. Moreover, assume the access link has been upgraded to 54 Mbps, and the institutional LAN is upgraded to 10 Gbps. Suppose that the average object size is 1,600,000 bits and that the average request rate from the institution's browsers to the origin servers is 24 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 three 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 Δ/(1 -Δb), where Δ is the average time required to send an object over the access link and b is the arrival rate of objects to the access link. **[CLO 2] [5+5]**

a. Find the total average response time.

b. Now suppose a cache is installed in the institutional LAN. Suppose the miss rate is 0.3. Find the total response time.

Access Link Rate $R = 54$ Mbps $= 54{,}000{,}000$ bits/s

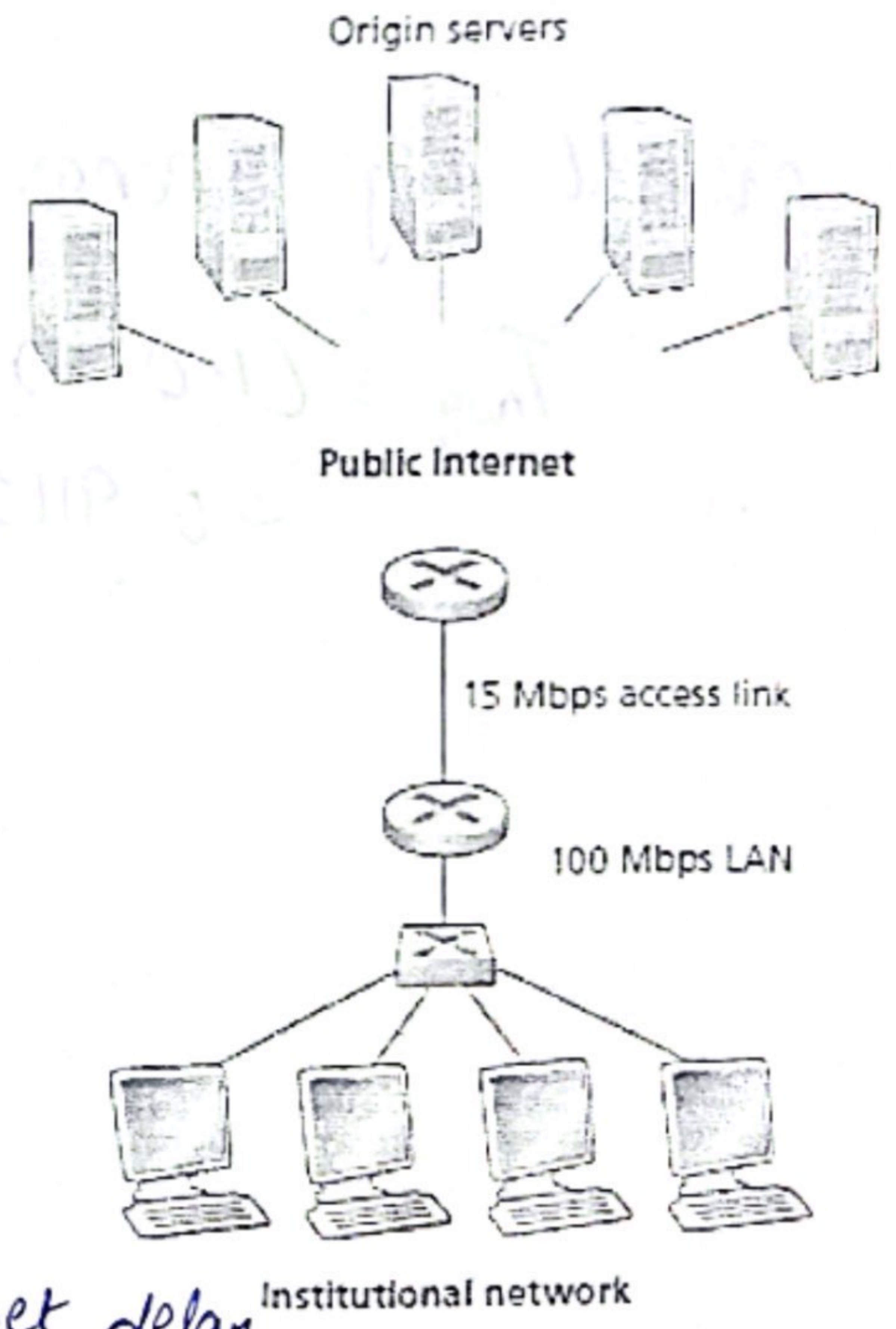
Average object size $L = 1{,}600{,}000$ bits

Request rate $b = 24$ requests/s

Avg Internet delay (router → origin → router) $= 3s$

Time to transmit an object over the access link

$$\Delta = \frac{L}{R} = \frac{1{,}600{,}000}{54{,}000{,}000} = 0.0296\,s$$



Traffic Intensity on access link

$$\rho = b\Delta = 24 \times \Delta = 0.7111$$

a) Avg Access delay: $\frac{\Delta}{1-\rho} = \frac{0.0296}{1-0.7111} = 0.1025\,s$

Total Avg response time = access delay + Internet delay

$= 0.1025 + 3 = 3.1025641s \approx \boxed{3.10s}$

b) With Cache, miss rate $= 0.3$

Only misses traverse the access link. Effective traffic intensity for misses:

$$\rho_{miss} = (\text{miss rate}) \times \rho$$

$$= 0.3 \times 0.7111 = 0.2133$$

Access Delay experienced by a miss:

$$\text{Access Delay}_{(miss)} = \frac{\Delta}{1-\rho_{miss}} = \frac{0.0296}{1-0.2133} = 0.03766$$

Hit responses are assumed ≈ 0 (negligible). A miss's total response $=$ access delay for miss $+$ Internet delay

$$= 0.03766 + 3$$

Overall Avg response (weighted):

$$T_{avg} = (1-0.3) + 0.3 \cdot (0.03766 + 3)$$

$$= 0.91129945 \approx \boxed{0.915}$$