CSED353: Chap. 2 Exercises (due Mar. 18)

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1 Problem #1

1.1 Solution for (a)

From the parameters given in the question, we can determine the parameters for internet access link as follows:

$$L = 2,000,000 \text{ bits/req} \quad R = 54,000,000 \text{ bps} \quad a = 20 \text{ req/s}$$

Then, the utilization for access link is

$$\rho = \frac{La}{R} = 0.741$$

So the access link delay can be calculated as

$$\frac{L}{R}\left(\frac{\rho}{1-\rho}\right) + \frac{L}{R} = 0.143 \text{ s}$$

For LAN, we can use $R = 10,000,000,000$ bps and obtain the LAN utilization of

$$\rho = \frac{La}{R} = 0.004$$

so the LAN delay can be calculated as

$$\frac{L}{R}\left(\frac{\rho}{1-\rho}\right) + \frac{L}{R} = 0.000201 \text{ s}$$

Since the internet delay is given as 3 seconds, we obtain the final result as

$$0.143 \text{ s} + 3 \text{ s} + 0.000201 \text{ s} = 3.143 \text{ s}$$

1.2 Solution for (b)

By taking cache into account, we can obtain utilization for access link as

$$\rho = 0.4 \times \frac{La}{R} = 0.296$$

Assuming that round trip from and to the local web cache is negligible in the case of cache miss, the delay from the origin servers can be obtained as

$$\frac{L}{R}\left(\frac{\rho}{1-\rho}\right) + \frac{L}{R} + 3 \text{ s} = 3.05 \text{ s}$$

The utilization of LAN is

$$\rho = 0.6 \times \frac{La}{R} = 0.0240$$

Then the delay for cache server can be obtained as

$$\frac{L}{R}\left(\frac{\rho}{1-\rho}\right) + \frac{L}{R} = 0.00205 \text{ s}$$

The final result is

$$0.4 \times 3.05 \text{ s} + 0.6 \times 0.00205 \text{ s} = 1.22 \text{ s}$$