

Sheet 1 answers:

Rules:

$$\text{Delay}_{\text{Total}} = \text{Delay}_{\text{Queueing}} + \text{Delay}_{\text{Processing}} + \text{Delay}_{\text{Transmission}} + \text{Delay}_{\text{Propagation}} \text{ [seconds]}$$

$$\text{Delay}_{\text{Transmission}} = \text{Packet Size (L) [bits]} / \text{Bandwidth (R) [bps]}$$

$$\text{Delay}_{\text{Propagation}} = \text{Distance (D or M) [meters]} / \text{Speed (S) [m/s]}$$

Note:

- It's important to read the question very well before answering the questions and understanding the requirement of the question.
- Draw the described network in each question between the hosts and routers.
- If any of the 4 delays aren't mentioned in the question then its values are assumed to be 0.

Exercise 1-1:

$$-D_{\text{prop}} = M/S \text{ seconds}$$

$$-D_{\text{trans}} = L/R \text{ seconds}$$

$$-D_{\text{total}} = D_{\text{que}} + D_{\text{proc}} + D_{\text{trans}} + D_{\text{prop}}$$

$$-D_{\text{prop}} = D_{\text{trans}}$$

$$M / S = L / R$$

$$M / 2.5 * 10^8 = 100 / 28 * 10^3$$

$$M = 2.5 * 10^8 * 100 / 28 * 10^3$$

$$M = 89.28 * 10^4 \text{ meters}$$

Exercise 1-2:

Given:  $M = 100\text{km}$ ,  $S = 2 * 10^8 \text{ m/s}$ ,  $L = 100 \text{ Bytes}$

Required: R

$$D_{\text{prop}} = D_{\text{trans}}$$

$$M / S = L / R$$

$$100 * 10^3 / 2 * 10^8 = 100 * 8 / R$$

$$R = 16 * 10^5 \text{ bps}$$

Exercise 1-3:

Given:  $L = 1\text{Mbyte}$ ,  $S = 2 \times 10^8$ ,  $R = 2\text{Mbytes/sec}$

Distance from host A to Router R = 1km

Distance from host B to Router R = 2km

$D_{\text{processing}} = 10 \text{ msec}$

Required: Total time taken to transfer packet from host A to host B.

Delay from host A to Router R:

$$D_{\text{trans}} = L / R = 1 \times 10^6 \times 8 / 2 \times 10^6 \times 8 = 0.5$$

$$D_{\text{prop}} = M / S = 1 \times 10^3 / 2 \times 10^8 = 0.5 \times 10^{-5}$$

$$D_{\text{AR}} = D_{\text{trans}} + D_{\text{prop}}$$

Delay from Router R to host B

$$D_{\text{trans}} = L / R = 1 \times 10^6 \times 8 / 2 \times 10^6 \times 8 = 0.5$$

$$D_{\text{prop}} = M / S = 2 \times 10^3 / 2 \times 10^8 = 10^{-5}$$

$$D_{\text{RB}} = D_{\text{trans}} + D_{\text{prop}}$$

Assuming all  $D_{\text{que}} = 0$

$$D_{\text{proc}} = 10 \times 10^{-3}$$

$$D_{\text{total}} = D_{\text{proc}} + D_{\text{AR}} + D_{\text{RB}}$$

Exercise 1-4

Fraction of headers in bandwidth, assuming bandwidth fits one complete packet per second.

Size of header =  $N \times H$

Total size of packet =  $M + N \times H$

Then fraction of headers =  $N \times H / M + N \times H$