
CHAPTER 24

Congestion Control and Quality of Service

Solutions to Odd-Numbered Review Questions and Exercises

Review Questions

1. In *congestion control*, the load on a network is prevented from exceeding the capacity. *Quality of service* refers to the characteristics that a flow of data seeks to attain. If there is good congestion control, then the QoS is also good and vice versa.
3. The *average data rate* is always less than or equal to the *peak data rate*.
5. *Open-loop* congestion control policies try to prevent congestion. *Closed-loop* congestion control policies try to alleviate the effects of congestion.
7. Congestion can be alleviated by *back pressure*, *a choke point*, and *explicit signaling*.
9. Frame Relay uses the *BECN* bit and the *FECN* bit to control congestion.
11. *Scheduling*, *traffic shaping*, *admission control*, and *resource reservation* can improve QoS.
13. *Differentiated Services* was developed to handle the shortcomings of IntServ. The main processing was moved from the core of the network to the edge of the network. Also, the *per-flow service* was changed to *per-class service*.
15. The attributes are *access rate*, *committed burst size*, *committed information rate*, and *excess burst size*.

Exercises

17. The bit pattern is 10110000 0001011. The *FECN* bit is **0** and the *BECN* bit is **1**. There is no congestion in the forward direction, but there is congestion in the backward direction.
19.
Input: $(100/60) \times 12 + 0 \times 48 = \mathbf{20}$ gallons
Output: **5** gallons
Left in the bucket: $20 - 5 = \mathbf{15}$

- 21.
- a. The access rate is the rate of T-1 line (**1.544 Mbps**) that connects the user to the network. Obviously, the user cannot exceed this rate.
 - b. The user data rate cannot exceed the access rate, the rate of the T-1 line that connects the user to the network. The user should stay below this rate (**1.544 Mbps**).
 - c. The CIR is **1 Mbps**. This means that the user can send data at this rate all the time without worrying about the discarding of data.
 - d. The user can send data at the rate of **1.2 Mbps** because it is below the access rate. However, the user sends 6 million bits per 5 seconds, which is above B_c (5 million per 5 seconds), but below B_c+B_e (6 million per 5 seconds). The network will discard no data if there is no congestion, but it may discard data if there is congestion.
 - e. The user can send data at the rate of **1.4 Mbps** because it is below the access rate. However, the user sends 7 million bits per 5 seconds, which is above B_c and above B_c+B_e (6 million per 5 seconds). In other words, the user rate is beyond its share. The network will discard some data to limit the data rate.
 - f. To be sure that the network never discard her data, the user should stay at or below CIR rate all the time, which means below or at **1 Mbps**.
 - g. If the user can accept possible data discarding in case of congestion, she can send at a higher rate if the number of bits is below B_c+B_e (6 million per 5 seconds in this case). This means that the user can send at **1.2 Mbps** all the time if she accepts this risk.
23. CTD is the average *cell transfer delay*. If each cell takes $10 \mu\text{s}$ to reach the destination, we can say that $\text{CTD} = [(10 \mu\text{s} \times n) / n]$ in which n is the total number of cells transmitted in a period of time. This means that $\text{CTD} = \mathbf{10 \mu\text{s}}$