

ECE 6970: Solutions to Real-Time Systems Homework 4

(1) Suppose you have packets arriving at two of the nodes at times 1, 2. Let the deadlines of both of them be 16. Then, if $\eta = 4$, they will not be eligible to be transmitted until real time 4. At this point, there is nothing to prevent them from colliding with each other indefinitely.

If $\eta = 10$, the packet arriving at time 1 will start transmitting at time 1.6. This transmission will end at time 6.6. The VC at this point will be initialized to 6.6 and start running at the rate of 10 virtual seconds/second. In another 0.94 seconds, it will reach 16 and the second packet will be eligible for transmission.

Now, let us construct a case in which the $\eta = 4$ case works while the $\eta = 10$ case does not. Consider two packets arriving at the same time at two of the nodes at time 5, with deadlines 10 and 40, respectively. The system is idle until that time. If $\eta = 10$, both packets will be eligible for transmission immediately they arrive, and can keep colliding for an arbitrarily long time. If $\eta = 4$, the packet with deadline 10 will become eligible immediately it arrives while that with deadline 40 will not. So, there will be no collisions, and both packets will meet their respective deadlines.

(2) We know that each node is guaranteed its synchronous quota every $2TTRT$ seconds. So, we must set $TTRT \leq 0.5 \min(P_1, P_2, P_3, P_4) = 5$ ms.

Since the overheads are negligible, the synchronous quotas can sum to $TTRT$. Denote the quota for node i by q_i . We have $q_1 + q_2 + q_3 + q_4 = 5$. Also, there will be at least one cycle of the token in P_1 , at least two cycles in P_2 , at least two cycles in P_3 , and at least four cycles in P_4 .

The bandwidth is 10^3 bits per millisecond.

$$b_1 = 1000 \Rightarrow q_1 \geq 1000 \times 10^{-3} = 1 \text{ ms.}$$

$$b_2 = 3000 \Rightarrow q_2 \geq 1500 \times 10^{-3} = 1.5 \text{ ms.}$$

$$b_3 = 1000 \Rightarrow q_3 \geq 500 \times 10^{-3} = 0.5 \text{ ms.}$$

$$b_4 = 1000 \Rightarrow q_4 \geq 250 \times 10^{-3} = 0.25 \text{ ms.}$$

Any allocation of quotas which satisfies the above constraints and sums to 5 will work.

(3) As the bus length increases, the propagation time goes up. This means that the slot duration (time to send out one bit) also has to go up, since any collisions occurring on any bit has to be noticed by every node before the next bit is transmitted. Hence, the bandwidth of the bus will be limited by the propagation time.