

ECE 466 - Computer Networks II

Problem Set #3

1. Consider the network with two buffered links with (with rates C_1 and C_2) and a delay element (with delay W) as shown in the figure.

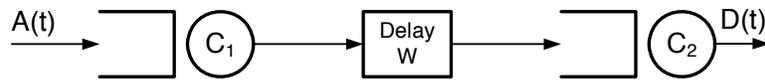
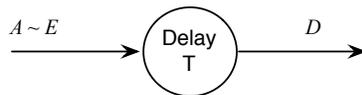


Figure 1:

- (a) Express the service curve of the entire network in terms of C_1 , C_2 , and W .
 - (b) Determine the value of the network service curve at time $t = 10$ with parameters $C_1 = 20$ kbps, $C_2 = 30$ kbps, and $W = 5$ ms.
2. Consider the arrivals to a delay element. The arrivals $A(t)$ are given by $A(t) = \sigma + \rho \cdot t$ ($t > 0$). Consider two versions of the delay element:
- *Version 1:* The delay of each arrival is exactly T time units ($T > 0$).
 - *Version 2:* The delay is variable with a maximum delay of T_{max} time units.



- (a) Characterize the service curves for both versions of the delay element.
- (b) For the first version, provide a sketch of an arrival function A and the corresponding departure function D at the delay element, and provide an expression for the departure function. Describe the departures that occur in any time interval of length $\tau > 0$.
- (c) For the second version, show that the departures in a time interval of length $\tau > 0$ satisfy cannot exceed $\sigma + \rho \cdot T_{max} + \rho \cdot \tau$.

3. Consider a non-work-conserving FCFS server that takes vacations every other T seconds, i.e., for T seconds, the server services traffic in FCFS order at rate C , and for the next T seconds, the server services no traffic, even if traffic is queued.
- (a) What is the lower service curve of this server.
 - (b) Derive an expression for the maximum delay d_{\max} for $N(\sigma, \rho)$ flows multiplexed at this server. Justify your answer with a graphical illustration.