ECE - Computer Networks II
Winter 2008

Problem Set #3

1. Consider the graph of the evolution of an arrival sample path at a buffered leaky bucket regulator with burst size L and rate r, as shown in Figure 1. The figure shows the arrivals $A(t)$ as solid line, and the cumulative amount of tokens entering the leaky bucket as a dashed line. Figure 2 shows the leaky bucket and the arrivals.

   (a) In Figure 1, draw the departure function $D(t)$, i.e., the output from the regulator.

   (b) Use Figure 2, to indicate the content of the leaky bucket and the backlog at times $t1, t2, t3, t4, t5$.

   (c) Provide a drawing that depicts the content of the backlog $X(t)$ and the content of the leaky bucket $LB(t)$ as a function of time.

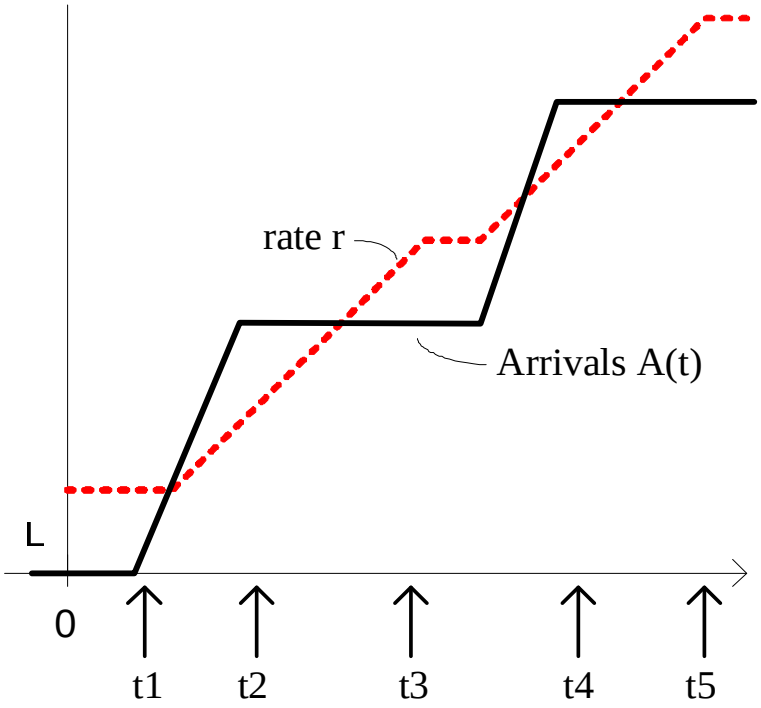

Figure 1:

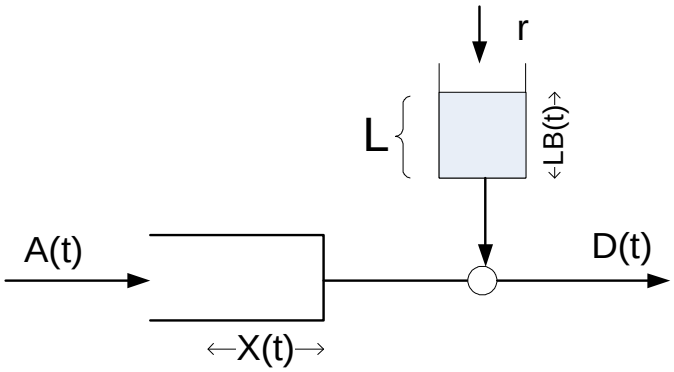

Figure 2:

2. Consider the graph of the evolution of an arrival sample path shown in Figure 3.

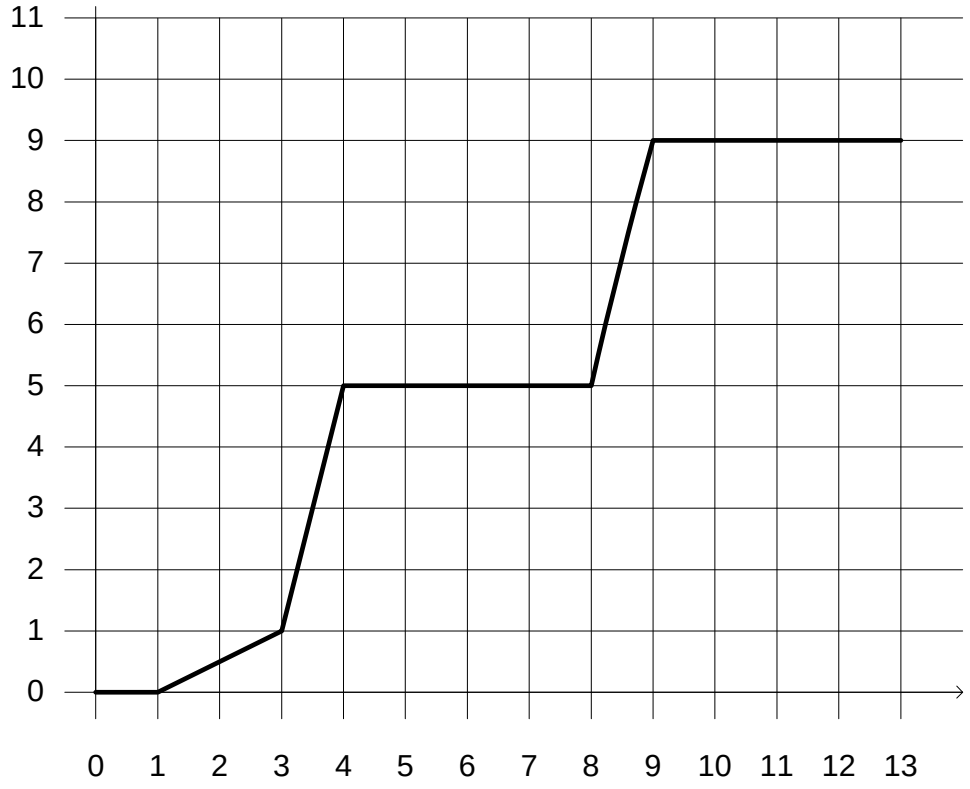

Figure 3:

(a) Suppose that the arrivals are regulated by a buffered leaky bucket regulator with parameters $\sigma = 2$ and $\rho = 1$. Indicate in the figure the content of tokens in the leaky bucket for the time interval $[0, 13]$ (starting with a full bucket at time $t = 0$).

(b) Indicate in the figure the maximum backlog and the maximum delay for arriving traffic.

(c) Draw the empirical envelope for the arrivals shown in Figure 3.

(d) Select values σ and ρ for the regulator so that traffic is never backlogged at the regulator.

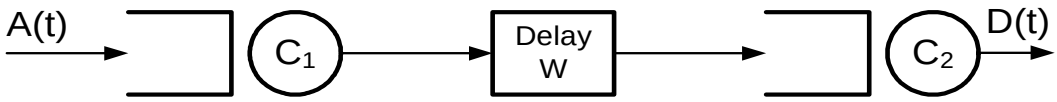

Figure 4:

3. Consider the network with two constant rate links (with rates C_1 and C_2) and a delay element (with delay W) as shown in Figure 3.

   (a) *(4 marks)* Express the service curve of the entire network in terms of C_1, C_2, and W.

   (b) *(1 marks)* 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.

   (c) *(5 marks)* Suppose that the arrivals from A are regulated by a dual leaky bucket with peak rate $P = 1\ Mbps$, average rate $\rho = 0.5\ Mbps$ and burst size $\sigma = 15,000\ bits$. Also, suppose that $W = 10\ ms$.

   Determine the minimum rates for C_1 and C_2 so that the backlog in the network does not exceed 1000 $bits$.