TKK HELSINKI UNIVERSITY OF TECHNOLOGY
Department of Communications and Networking
S-38.1145 Introduction to Teletraffic Theory, Spring 2008

Exercise 5
26.2.2008

1. Consider elastic data traffic on a link between two routers at flow level. The traffic consists of TCP flows sharing the link, and arriving with intensity λ. The link capacity is denoted by C and the random flow size by L. In addition to the shared link, the rate of TCP flows is limited by access links. Let r denote the capacity of each access link. A single flow is thus served with rate $\min\{r, C/n\}$, where n refers to the number of concurrent flows on the shared link. Model the system as a birth-death process, and determine the throughput θ for $\lambda = 100$ flows/s, $E[L] = 1$ Mb, $C = 150$ Mbps, and $r = 100$ Mbps. (*Hint:* This is a modification of the M/M/1 model with one of the death rates changed.)

2. As in the previous problem, consider elastic data traffic on a link. Thus, the traffic consists of TCP flows sharing the link, arriving with intensity λ. The link capacity is denoted by C and the random flow size by L. Assume that flow sizes are independent and identically distributed with an exponential distribution. In addition, assume that the flows are randomly canceled by impatient users. Let the cancellation time (related to a single flow) be an independent and exponetial random variable with intensity γ. Thus, if there are n concurent flows, their number decreases by one with intensity $n\gamma$. Model the system as a birth-death process, and prove that the system is stable for any link capacity C. (*Hint:* It is enough to consider the existence of the equilibrium distribution for the case $C \to 0$.)

3. The continuous distribution with value set $(0, \infty)$ and cumulative distribution function

$$F(x) = 1 - \left(\frac{1}{1+bx}\right)^{\beta}, \qquad x > 0,$$

is called the Pareto(β, b) distribution $(\beta, b > 0)$. Using the inverse transform method, generate four random numbers from the Pareto$(2, 1)$ distribution. (*Hint:* Utilize the (pseudo) random numbers generated in D11/1.)