HELSINKI UNIVERSITY OF TECHNOLOGY
Networking Laboratory
S-38.145 Introduction to Teletraffic Theory, Spring 2005

Exercise 2
10.2.2005

Problems 2–4 are homework exercises. Mark the problems you have solved in the beginning of the exercise class.

1. *Demo*
   Traffic measurements over Funet are available at

   `http://www.csc.fi/suomi/funet/noc/looking-glass/wm`.

   Click the link between nodes `helsinki0-rtr` and `NORDUnet` to get access to the traffic measurements related to the link. All measurements are presented graphically. The two curves represent the two different directions of the link (`in` = from Stockholm to Helsinki and `out` = from Helsinki to Stockholm). A single point on the curve tells the average traffic at the corresponding time and with the resolution given. The default or raw resolution is 3 minutes. Find the curves from which you can estimate the following quantities (in both directions):

   (a) The average traffic and time of the busiest and the lightest 3-minute periods on Tuesday, 1 February 2005.

   (b) The average traffic and time of the busiest and the lightest 1-hour periods on Tuesday, 1 February 2005.

   (c) The average traffic and date of the busiest and the lightest days in January 2005.

2. *Homework exercise (1 point)*
   Consider telephone traffic on a link in an interval $[0, T]$, where $T = 16$ (time unit: minute). The system is empty at time $t = 0$. New calls arrive at times

   - 1, 2, 4, 5, 6, 9, and 12.

   The holding times of these calls (if they are not blocked) are, respectively,

   - 9, 5, 4, 2, 7, 2, and 4.

   The capacity of the link is $n = 3$ channels.

   (a) Construct a figure that describes the call arrival times, channel-by-channel occupation, and the number of channels occupied (that is, the traffic process) as a function of time $t \in [0, T]$.

   (b) What is the ratio between the number of blocked calls and the total number of calls?

   (c) What is the ratio between the time the system is full and the total time?

   (*Tip*: Cf. Lectures: Slide 2/15)

3. *Homework exercise (1 point)*
   Consider data traffic at packet level in an output port of a router in an interval $[0, T]$, where $T = 16$ (time unit: μs). The system is empty at time $t = 0$. New packets arrive at times

   - 1, 2, 4, 5, 6, 9, and 12.

The transmission times of these packets are, respectively,

- 2, 5, 2, 1, 2, 1, and 2.

No packets are lost due to a full buffer.

(a) Construct a figure that describes the packet arrival times, the waiting and transmission times for all packets, and the number of packets in the system (that is, the traffic process) as a function of time $t \in [0, T]$.

(b) What is the average waiting time of a packet?

(c) What is the average total delay (including both the waiting and the transmission time)?

(*Tip*: Cf. Lectures: Slide 2/20)

4. *Homework exercise (1 point)*
Consider elastic data traffic at flow level on a link with speed 1 Mbps in an interval $[0, T]$, where $T = 16$ (time unit: second). The system is empty at time $t = 0$. New flows arrive at times

- 1, 2, 5, 7, and 13.

The sizes (in Mbits) of these flows are, respectively,

- 2, 7, 3, 1, and 2.

(a) Construct a figure that describes the flow arrival times, the delays for all flows, and the number of flows in the system (that is, the traffic process) as a function of time $t \in [0, T]$.

(b) What is the average delay of a flow?

(c) What is the average transmission rate for a flow?

(*Tip*: Cf. Lectures: Slide 2/30)