Home assignment sets 1 and 2

August 29, 2018

Set 1: Traffic models

Problem 1

a) You would like to model the traffic flow a voice source with a two state Markov modulated fluid model. After extensive measurements, you see that high-bitrate and silent periods follow each other, and you have the following statistical data. In high-bitrate periods the source generates data with 64kbit/s. The average length of the high-bitrate periods is 10 sec, the average length of the silent periods is 30 sec.

Define the Markov modulated fluid model that describes the flow. Give the state transition intensities and the "fluid generation rate" in the two states. What is the probability that the source is silent at an arbitrary point of time?

b) Evaluate the effect of multiplexing such traffic flows. Increase the number of flows transmitted on a link, at the same time increasing the link transmission capacity. Assume, that there are no buffers, that is, data if lost, if the data generation rate is higher than the link transmission capacity. (This may sound stupid, but is a rather good solution, if late arriving packets needs to be dropped anyway).

Consider the specific case, where for n multiplexed flows the link capacity is set to $n \cdot 32$kbit/s. Prepare a graph that shows the probability that data is lost at an arbitrary point of time, as a function of the number of sources multiplexed.

(Note, from these results we actually do not know how much data is lost, but let us assume, we do not care about that.)

Problem 2

In this assignment you need to prepare a statistical analysis of a packet arrival trace. The trace gives the packet arrival times in seconds to a 10 Mbps Ethernet link (it also gives the packet sizes in the second column, but we are not interested in that now.) Analyse the trace considering the properties we discussed in the first two lectures. You can select freely what properties you want to discuss and how you want to analyse them. See the link to the trace on the web.

Problem 3

When we discussed short range dependence, we have stated that for a two state, continuous time on-off Markov process with parameters α and β the auto-correlation decays Exponentially, according to $r(t) = e^{-(\alpha+\beta)t}$. Present a derivation of this result. (Does not have to be your own derivation if you can find it in the literature.)

Set 2: Medium Access Control

Problem 1

Consider a TDMA transmission scheme. The frames are 4 slots long. The slot length (that is, the packet transmission time, given by the ratio of the packet length and the link transmission rate) is one time unit. The propagation time is considered to be zero. The slots are allocated for 3 sources as follows:

- slots 1 and 3 for source 1
- slot 2 for source 2
- slot 4 for source 3.

a) What can be the reasons to do such slot allocation?

b) Assume Poisson packet arrival process. Compare the average delay (waiting and transmission) experienced by the sources, if their packet arrival rate is the same. What can you conclude?

c) Again considering Poisson packet arrival process, compare the maximum load each of the sources can generate, if each of them can have a maximum of 5 time slots average delay.

Problem 2

In a slotted ALOHA network delay sensitive traffic is transmitted as follows: once a node has a packet to transmit, it attempts transmission in the coming time slot. If collision happens, packets are lost and will not be retransmitted, since they would arrive late to the destination anyway. A large number of nodes are in the network, and altogether they generate packets according to a Poisson process with intensity λ. Packet transmission times (that are the same as the time slot lengths) are one time unit.

a) Assume, the sources can tolerate a packet loss probability of 0.1. What is the maximum allowed arrival intensity?

b) To cope with the packet losses, so called forward error correction is introduced in the ALOHA system described above. It means that each piece of information is transmitted twice, in two separate packets with random delay. Due to the random delays the packet generation process can still be modeled as Poisson. Give an analytic model of the system, expressing the probability that the information is received. Can such a solution increase the probability that a piece of information is received by the destination?

Problem 3

Consider the slotted ALOHA model described from the bottom of page 50 to page 52 in the Rom-Sidi book. Assume that the time slots are 1ms, the packet arrival intensity is 0.2 packets per ms. The packet transmission time is one time slot. Calculate the average length of the idle periods, the average length of the busy periods, the average number of useful slots in a busy period, and finally the throughput. Double check the result using $S = Ge^{-G}$.