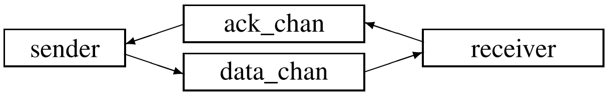
T-79.231 Parallel and Distributed Digital Systems
Homework 5, October 14, 2002 **Teemu Tynjälä**

Determining a Protocol's Performance

A protocol consists of two processes, a sender and a receiver, and data and acknowledgement channels between the two.



The sender sends two kinds of messages, `0` and `1`. The sending frequency follows exponential distribution. The data channel loses a message with 10 % probability, but the acknowledgement channel is loss-free. Both channels may contain a maximum of one message at a time.

The sender resends each message until it receives an acknowledgement from the receiver. The resending is triggered by a timer. When the sender sends a `0`, it expects to receive an acknowledgement `a0`. Similarly, the sender expects to receive `a1` acknowledgement for the data message `1`.

1. Based on the above description, form a CCS model of the protocol. Hint: divide the model into four parts: sender, receiver and the channels.

2. Fetch the Maria description of the protocol from k5.pn.

   (a) Generate the system's reachability graph with Maria.

   (b) Let's suppose the firing probabilities are the following:

λ(sender_sends_to_receiver):	0,9/s
λ(sender_loses_to_receiver):	0,1/s
λ(sender_times_out):	0,5/s
λ(sender_receives_ack_correctly):	10/s
λ(sender_receives_ack_incorrectly):	10/s
λ(receiver_receives_correctly):	10/s
λ(receiver_receives_incorrectly):	10/s
λ(receiver_acks):	10/s

   Give the Q-matrix of the system and solve the steady state probabilities. You may do this using matlab or GNU Octave. In matlab, `e*inv(Q+ones(28))` does the trick. ones(28) represents a square matrix with dimension 28 by 28, so that each element is 1. `e` in this case is a row vector with 28 elements each of which is 1.

   How many times per second does the sender's timer fire (on the average) ?

   Hint: Start with a square matric whose diagonal elements are -1 and other elements are 0. Notice that in matlab the indexes begin from 1, whereas Maria numbers the states beginning with 0. So, in Maria's reachability graph, the transition from state 0 to state 4 would correspond to Q-matrix' element Q(1,5).

Return the answer to the mailbox located between rooms B 336 and B 337 in the Computer Science Building, 3rd floor, by 4 PM, December 2, 2002. You may also return your answer in postscript or pdf format to Jukka.Honkola@hut.fi