Lab assignment #1: Leader election problem

Problem description

Consider the network topology in Figure 4. The channels between the processes are all peer-to-peer and unidirectional. Let's assume, that the processes P_i are symmetric in their behavior, and do not know their position in the network. What we do know though is, that they have unique ID's. The problem now is, that all processes have to elect an unique leader. There are two properties that we would like to satisfy. First of all, we do not want two processes to be elected leader, and we also do not want a deadlock.

A possible solution for this is given in Figure 5. The assumption is that each process has an incoming channel named L and an outgoing channel name R. Also, the processes use two variables u and v to decide whether the process is the leader. The solution given in Figure 5 will elect the process to be the leader that started off with the maximal ID.

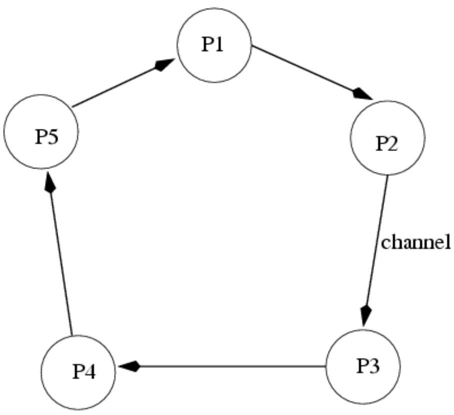

Figure 4: Network topology

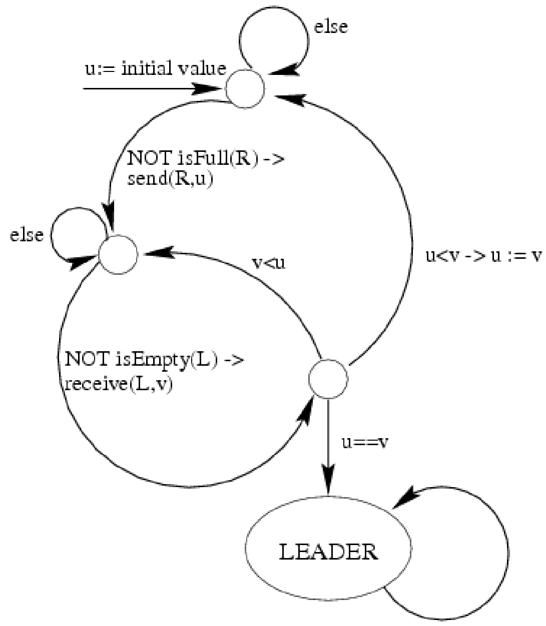

Figure 5: A solution to the leader election problem

Task:

1. Model a system of 5 electing processes using Uppaal tool.
   Hint:
   i. Define 2 Uppaal process templates, one for a process and the other one for channels.
   ii. Use template parameter field to identify a process instance and channel instances.
2. Prove that the system is self-stabilizing, i.e.
   a. the system always reaches the state where the unique leader is known to all processes („inevitable“ property A<>) and
   b. that leader, once selected, is kept forever („always“ property A[]).
3. Extend the model using more realistic assumptions:
   a. unreliable channel: transmission fails no more often than 2 time out of 10 transmissions
   b. Transmission delay is 3 TUs, reading and writing takes [3,5] TUs.
4. Try to prove the self-stabilization on extended model.