WS 2005/2006 Prof. R. Wattenhofer / Roland Flury / Thomas Moscibroda / Stefan Schmid

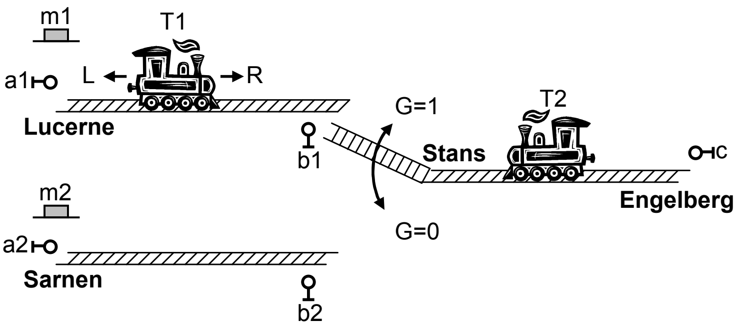
Discrete Event Systems
Exercise 5

1 The Winter Train Problem

We consider two trains T1 and T2 transporting skiers from Sarnen and Lucerne to Engelberg. Because there is only one ground rail track from Stans to Engelberg, at most one train might be between these two villages at any time. There is a switch in Stans, which either connects the track between Sarnen and Engelberg xor the track between Lucerne and Engelberg. After the train conductor has pressed a button m in (Sarnen | Lucerne), its train moves to Engelberg, but might have to wait in Stans until the other train has left the critical section. Once arrived in Engelberg, the train waits for 100s and then returns.

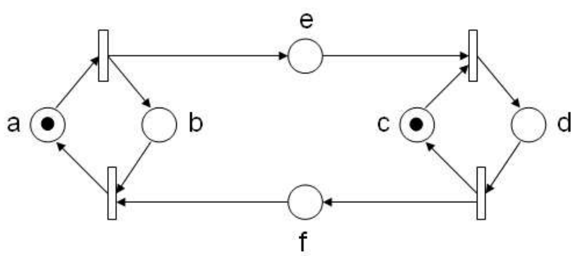
The sensors a1, a2, b1, b2 and c indicate the presence of a train with the value 1, otherwise, the value is 0. The switch in Stans is accessed through a variable G, as indicated in the picture. Finally, the motion of the trains is regulated by assigning 'R', 'L' or 'S' to the train, to move right, left, or stop, respectively.

The situation is shown below. Draw the corresponding State Chart using the notation introduced in the figure!



2 Token Game

In this exercise you are asked to study the dynamics of the following petri net with the start marking:



a) Is there a reachable marking where both places a and b have a token, i.e., where $M(\text{a}) \geq 1 \wedge M(\text{d}) \geq 1$ holds? Explain your decision.

b) Compute all reachable markings of the system or prove that there are infinitely many markings.

3 A Candlelight Dinner

Alice invites Bob for dinner. Unfortunately, in Alice' apartment-sharing community there is little cutlery.

a) As a starter, Alice prepared soup. There is only one spoon, and hence only one person can eat at any time. However, Alice and Bob are more interested in each other rather than in the food and are in no hurry. Therefore, whenever one of them has eaten some soup, the spoon is put back onto the table, and Alice and Bob have a little chat. At some later time, someone picks up the spoon again and eats some more. And so on.

(i) Model the situation using a petri net.

(ii) Prove that for your petri net, it holds that there is always at most one person having the spoon.

(iii) How would you change your net if Alice and Bob strictly alternated in eating?

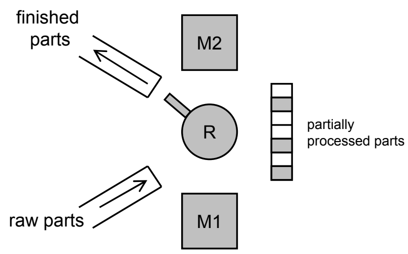
b) Additionally to the spoon, Alice finds a fork in the kitchen. As a second plate, they will have spaghetti and vegetables. "Of course", to eat spaghetti, one needs both a fork and a spoon. The vegetables on the other hand can be eaten either with a spoon or a fork (not both). Again, Alice and Bob are in no hurry and talk after each bite. At some time, someone takes the spoon and the fork and eats some spaghetti, or someone takes either the spoon or the fork and eats some vegetables. Model this situation using a petri net!

c) Assume there is a second fork. How could you change your petri net from the previous task to model also this situation?

d) Back to the situation with one fork and one spoon. Surprisingly, Trudy—Alice' room mate—comes back from a party. She takes a joghurt from the fridge and sits down at the table. As you mighty already expect, she also needs a spoon. Extend your petri net!

4 Producer-Consumer System under Mutual Exclusion

We consider a pipelined factory where raw parts are preprocessed by a machine M1, stored in a temporary buffer, and finally assembled by a second machine M2. There is a single robot R that moves the parts between the input line, M1, the buffer, M2 and the output line. The buffer can hold at most 7 preprocessed items.



a) Use a Petri net to describe this system!

b) Show that the obtained Petri net is live (L4-live) and bounded.

c) Extend the Petri net such that the output of M1 can be transferred directly to M2, without being stored in the buffer.