IL2212 EMBEDDED SOFTWARE

Theoretical Homework 1 (Part A)

VERSION 1.0

Revision History

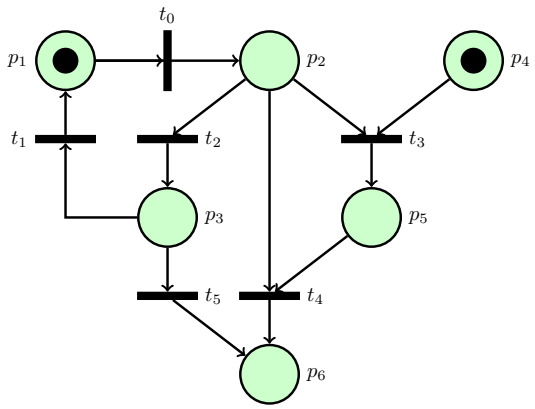
- Version 1.0: Initial version

Requirements

The total amount of points in the homework is 20 points. To pass the homework corresponding to Part A, 12 points in this homework are required. To pass the theoretical part of the course (TENA; 4.5 credits), 42 points are required from the three individual theoretical homework assignments.

Homework Tasks

1. (1.5 POINTS) Given is the following Petri-Net.



   (a) Will the Petri-Net always reach a final state? If not, give the set of transitions that causes that the Petri-net does not reach a final state.

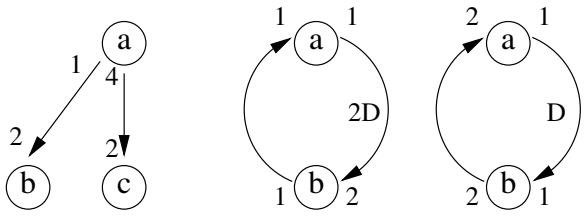
   (b) Does this Petri-Net have a single or several final states? In this case, for each final state, give the set of transitions, which lead to a final state and also give the number of tokens in each place p_i.

2. (1.5 POINTS)

   (a) How can you model the functions to acquire a semaphore lock (`Wait(S)`) and to release a semaphore lock (`Signal(S)`) by means of a Petri-net?

   (b) Draw a Petri-net where a semaphore is used to protect a shared resource that is accessed by two tasks.

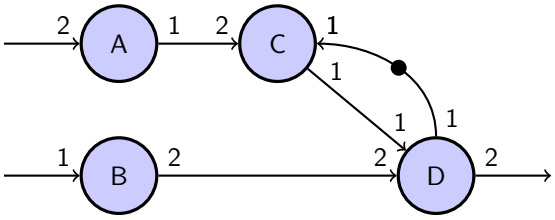
3. (1.5 POINTS) Given are the following synchronous data flow graphs (a), (b), and (c).



(a) (b) (c)

   Which of these graphs have a periodic admissable sequential schedule? Give a short motivation, e.g. in form of a schedule.

4. (7.5 POINTS) Given is the following synchronous data flow graph.



   (a) Give a mathematical representation of the SDF graph, and use this representation to derive a *periodic admissible sequential schedule* with the minimal buffer requirements, where you show each step of your calculation. What are the required buffer sizes for this schedule?

   (b) What is the maximum throughput for a single processor, defined as output tokens per time unit, given the following parameters:

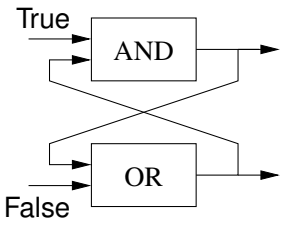
   - the execution times for the data flow actors are $C_A = 25$, $C_B = 60$, $C_C = 40$, and $C_D = 50$, and the
   - communication time for sending tokens and receiving can be neglected.

   (c) Give also the necessary input data rate $R_{\text{single},i}$, as tokens per time unit on input arc i, on both input arcs to be able to achieve the maximum throughput for both subtasks. What happens, if the input rate is higher or lower than $R_{\text{single},i}$.

   (d) Give a *periodic admissible parallel schedule* for an architecture with two processors aiming to maximise the throughput. Use the same execution times as above and neglect also the communication time for sending and receiving tokens.

   (e) Which throughput can be achieved with this schedule for the two processor architecture? Give also the necessary input data rates $R_{\text{double},i}$ on both input arcs.

5. (2 POINTS) Assume that the following system is modelled in one of the following languages, where the components 'AND' and 'OR' execute the corresponding Boolean function.

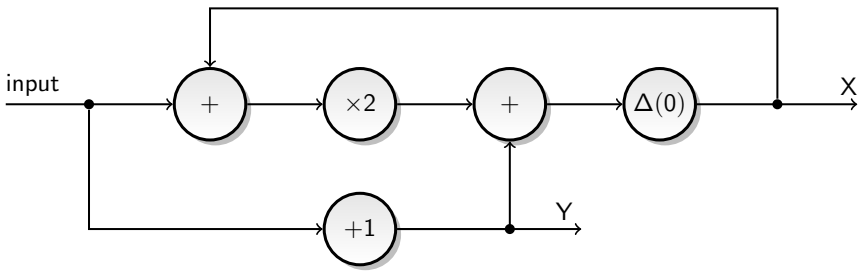


What will be the result, if the model has been created and is simulated with the following language:

(a) Lustre
(b) Esterel
(c) Signal
(d) VHDL

Give a short motivation. You do not need to implement the model in the corresponding language.

6. (3 POINTS) Given is the following synchronous process network. All processes are synchronous processes, which execute according to the perfect synchrony hypothesis that also forms the base for the synchronous languages.

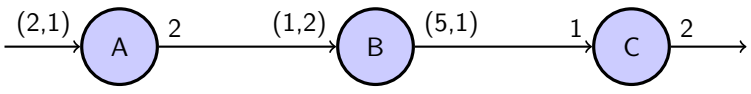


All processes execute simple mathematical functions except the process $\Delta(0)$. The process $\Delta(0)$ delays an input event one event cycle and has 0 as value for its first output event.

Given are the values of the following sequence of the first three input events: 1, 2, 3.

(a) Is it possible to determine the output sequence with the given information? Motivate!
(b) If it is possible, give also the output sequence. Show also the order relation between the individual output events on X and Y.
(c) Explain the terms *tag*, *value*, *event*, *signal*, and *process* as defined in the *tagged signal model*.
(d) What relation can you establish between the tags of the signals `input`, `X`, and `Y`.

7. (1.5 POINTS) Give the periodic admissable sequential schedule that minimises the buffer sizes for the following *cyclo-static data-flow graph*. Give the required buffer sizes on all arcs.



8. (1.5 POINTS) The synchronous model of computation used in the synchronous languages and the Homogeneous SDF model of computation seem to be very similar, because in both models a process or actor always consumes exactly one token from each input signal and produces always one token on each output signal.

Are these models equivalent? Otherwise, point out the differences of these models of computation. In both case give a convincing explanation.