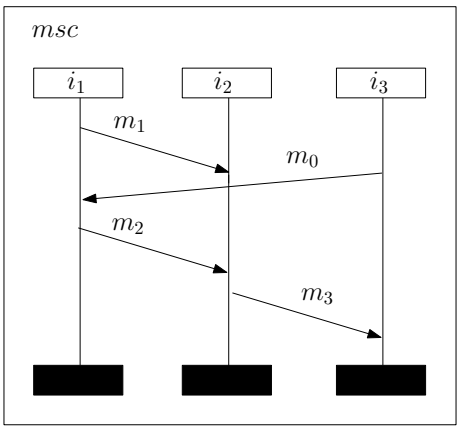
2IW05 Final Examination
Software Specification

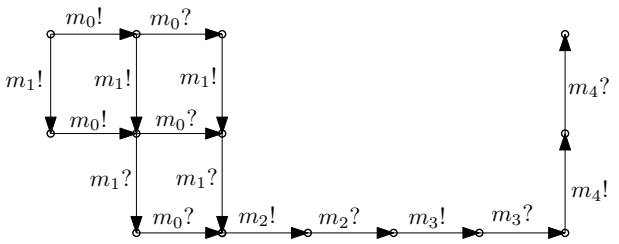
Technische Universiteit Eindhoven (TU/e)

January 26, 2011, 14.00 – 17.00

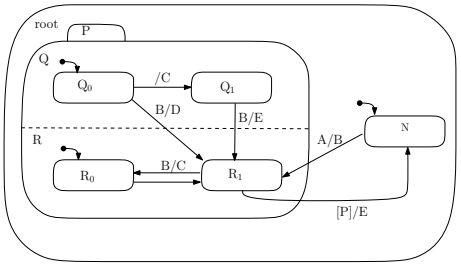
Exercise 1 (15 points) Consider the following MSC.



Is the MSC consistent with the following LTS? If yes, reason why it is consistent; if no, give the reason(s) why it is not and give an LTS (with at most two outgoing transitions for each node) which is consistent with the MSC.



Exercise 2 (25 points) Consider the following Statechart.



a. What are the scopes of the transitions labeled A/B, B/D, $/C$, $[P]/E$ and B/E. (5 points)

b. What are the exit and enter sets of the transitions labeled B/D and $[P]/E$ with respect to the situation $(\{root, P, Q, Q_0, R, R_1\}, \{B\})$. (5 points)

c. Draw its LTS when the environment first provides $\{A\}$ and then $\emptyset$. (15 points)

In all of the above cases, only giving the final answer suffices.

Exercise 3 (15 points) Give a formalization of the following informal properties in the modal μ-calculus. You may use fixed points as well as regular expressions. Assume that the set of all actions is called Act.

1. There is no deadlock. (3 points)
2. In initial state, the sequence "a followed by b followed by a" is not possible. (3 points)
3. In initial state, after each a-transition, a b-transition should be possible. (3 points)
4. Always when an a-transition is taken, a c-transition must remain enabled until a b-transition is performed. (3 points)
5. There is infinite trace of τ actions. (3 points)

Exercise 4 (25 points) Consider the following two formulae, where the set of possible actions is $\{a, b\}$:

a. $[a]X$ where $X \stackrel{\mathsf{min}}{=} ([\overline{b}]X \wedge \langle true \rangle true)$

b. $[a]\langle true^* b \rangle true$

Give an LTS, in which one of the two formulae holds and the other one does not hold. (10 points) Eliminate the regular expression in item b, compute the solutions to the resulting equations, compute the meaning of the resulting formulae, and show that indeed one of the two formulae is satisfied by the LTS and the other one is not. (15 points)

Exercise 5 (20 points) Consider the following specification in Z.

Digit

$i : \mathbb{Z}$

$0 \leq i < 10$

Inc

$\Delta Digit$
$j? : \mathbb{Z}$

$i' = i + j?$

Dec

$\Delta Digit$
$k? : \mathbb{Z}$

$i' = i - k?$

1. Calculate and simplify $Inc \fatsemi Dec$. **(15 points)**
2. Is Inc total? If yes, prove why it is; if no, define a total operation schema by combining Inc with other schemata, and prove that the result is indeed total. **(5 points)**

Answer 1

No, it is possible to send m_1 before receiving m_0 in msc_0 while this trace is not present in the LTS.

Answer 2

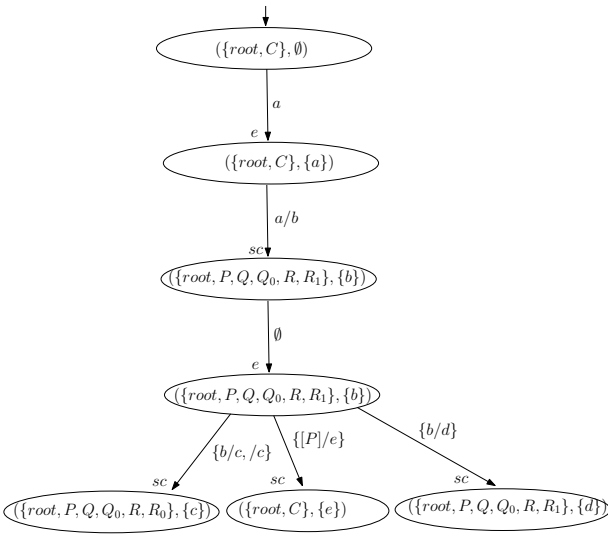
1. $scope(a/b) = root$,
   $scope(b/d) = root$,
   $scope(/c) = Q$,
   $scope([P]/e) = root$
   $scope(b/e) = root$

2.

   a. For b/d, the exit set and the enter set are both $\{P, Q, , Q_0, R, R_1\}$.

   b. For $[P]/e$, the exit set is $\{P, Q, , Q_0, R, R_1\}$ and the enter set is $\{c\}$.

3.



Answer 3 Here, we confine ourselves to the final answer but one should also give the process using which the final answer is reached.

1. $[true^*]\langle true\rangle true$.
2. $[a.b.a]false$.
3. $[a]\langle b\rangle true$.
4. $[true^*.a]X$ where $X \stackrel{\mathsf{max}}{=} [\overline{b}]X \wedge \langle c\rangle true$.
5. $[true^*]X$ where $X \stackrel{\mathsf{min}}{=} [\tau]X$.

Answer 4 The below-given LTS satisfies $[a.\overline{b}^*]\langle true^* b\rangle true$, but does not satisfy $[a]X$ where X is defined by the fixedpoint equation $X \stackrel{\mathsf{min}}{=} ([\overline{b}]X \wedge \langle true\rangle true)$. To show this one has to calculate the meaning of subformulae for each of the two formulae and show that indeed the initial state of the below-give LTS is in the meaning of the former formula but not in the meaning of the latter.