2008 Paper 8 Question 15

Topics in Concurrency

(*a*) A *simulation* between CCS terms is defined to be a binary relation S between CCS terms such that whenever $(t, u) \in S$ for all actions a and terms t'

$$t \xrightarrow{a} t' \Rightarrow \exists u'.\ u \xrightarrow{a} u' \ \&\ (t', u') \in S$$

Write $t \leq u$ iff there is a simulation S for which $(t, u) \in S$. Consider the following fragment of Hennessy–Milner logic:

$$A ::= \langle a \rangle A \mid \bigwedge_{i \in I} A_i$$

where a is an action of CCS and I is a set. In fact,

> $t \leq u$ iff for all assertions A in the fragment whenever t satisfies A then so does u.

(*i*) Explain briefly the strategy you would use to prove the "only if" direction of the fact above; state clearly any induction hypothesis you would use. [3 marks]

(*ii*) Prove the "if" direction. [7 marks]

(*b*) Describe a Petri net semantics for the following fragment of CCS:

$$t ::= rec\, x\, s \mid t_1 \parallel t_2 \mid t \setminus b$$

in which

$$s ::= \alpha.x \mid \alpha.s \mid s_1 + s_2$$

where α ranges over the actions of CCS, b over non-τ actions and x over process variables.

A diagrammatic account suffices, though you should make clear the form of labelled Petri net you are using and its "token game." Although no proof is needed, your semantics should represent the independence of actions in a parallel composition and agree with the usual transition semantics of CCS. [10 marks]