2004 Paper 7 Question 11

Topics in Concurrency

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 $(t, u) \in S$.

(a) Write down the transition rules for CCS parallel composition. Show that for CCS terms if $t \leq u$ and $t' \leq u'$, then $(t \parallel t') \leq (u \parallel u')$ holds between their parallel compositions. [6 marks]

(b) By exhibiting suitable CCS terms show that $t \leq u$ and $u \leq t$ together does not necessarily imply that t and u are strongly bisimilar. [6 marks]

(c) 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. Show that $t \leq u$ iff for all assertions A in the fragment, whenever t satisfies A then so does u. [8 marks]