Introduction to specification and verification, exercise 5, December 8, 2011

1. The following figure represents the partially minimized global state graph of Dekker’s mutual exclusion algorithm. In the mutual exclusion, there are two participants trying to use the same resource, but only one can use the resource at a time. In order to realize this requirement, the algorithm reserves the resource with the enter message and frees it with the exit message. Thus after enter1 exit1 should come and after enter2 exit2. Specify the service of Dekker’s algorithm as a transition diagram.

Is the global state graph weak bisimulation equivalent with the service? Is it trace equivalent with the service? What should you think of the use of equivalences?

2. Construct a temporal logic formula which guarantees, if true in the model, that Dekker’s algorithm satisfies the mutual exclusion.

3. Which of the following claims are true in all the models:
   a) \( \Diamond q \land \Box p \iff \Diamond (p \land q) \),
   b) \( \Diamond p \land \Box q \iff \Box (\Diamond p \land q) \),
   c) \( (p U q) U q \iff p U q \).

   Give reasons or a counterexample.

4. Which of the following claims are true in all the models:
   a) \( \Box \Diamond p \land \Diamond \Box q \iff \Box (\Diamond (p \land q)) \),
   b) \( \Box \Diamond p \land \Box \Diamond q \iff \Box (\Diamond (p \land q)) \),
   c) \((p U q) \iff (((q U p) \Rightarrow (p U q)) \).

   Give reasons or a counterexample
5. Consider the following Kripke structure.

For every formula a)-f), find an infinite path that satisfies the formula. Furthermore, which of the formulas are true in the model. If a formula is not true, find a path that does not satisfy the formula.

a) \((a_1 \land a_2) \land (a_2 \lor b_1) \land \neg b_2\)
b) \(\Box (a_1 \lor \neg c_2)\)
c) \(\Box (b_2 \Rightarrow \Diamond c_2)\)
d) \(\Box (b_1 \Rightarrow \Diamond (c_1 \land \neg c_2))\)
e) \(\Box \Diamond b_2 \Rightarrow \Box \Diamond c_2\)
f) \(\Diamond ((b_1 \lor b_2) \mathcal{U} (c_1 \lor a_2))\)