Homework Assignment 3, Part a

Due: Thursday, October 21, 1999

Reading:

Chapter 8, 14, 15.1-15.4.

Problems:

1. For this exercise, define *ftraces*(A) be the set of all finite traces of automaton A.

   Prove carefully the following composition theorem for I/O automata:

   "Suppose that A, A', B, and B' are automata, where A and A' have the same external signature, B and B' have the same external signature, and A and B are compatible. If $traces(A' \times B) \subseteq traces(A \times B)$, and $traces(A \times B') \subseteq traces(A \times B)$, then $ftraces(A' \times B') \subseteq traces(A \times B)$."

   Notice that the conclusion of the theorem refers to *finite* traces. (The theorem was initially stated incorrectly in class, to refer to infinite traces also.)

2. This problem is about a *totally ordered broadcast service*, in which all recipients receive the same messages, in the same order. The implementation of this service involves *client processes* $P_1, \ldots, P_n$ plus a special *server process* S. Each client process is connected to S via reliable FIFO send/receive channels in both directions.
   When any client submits a broadcast request, the corresponding client process sends it to S, who puts all the requests in some serial order and notifies the clients about the order.

   (a) Define the P_i processes and S carefully, using precondition/effect code.

   (b) Give a simulation mapping from the (composed) implementation automaton to the broadcast service automaton B given in the text (see p. 467-468). Outline why this is a simulation mapping (give key steps only).

   (c) Devise a new specification C, stronger than B, which captures in an abstract way the extra guarantees on the ordering of messages that this implementation guarantees, over and above those expressed by B. Write C as another automaton.

   (d) Give a simulation mapping from the implementation automaton to your new specification automaton C. (You need not prove that this is a simulation mapping.)

3. Exercise 15.12.

4. Exercise 15.23. (Hint: As a possible approach, consider the Termination protocol on page 503.) For the proof, just give a sketch.