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Summer term 2013
Problem Set 2
September 10, 2013

Verification

Problem 1: CTL model-checking with VIS [9 Points]

A priority based arbiter is an arbiter that has a fixed priority scheme over the different processes that want to access a shared resource. An example of such an arbiter for three clients is given in the following figure. A client i can make a request for accessing a shared resource by signaling `req[i]`. The arbiter grants this access by signaling the corrsponding `grant[i]`. The channels `in` and `out` are used for determining the priority of the clients.

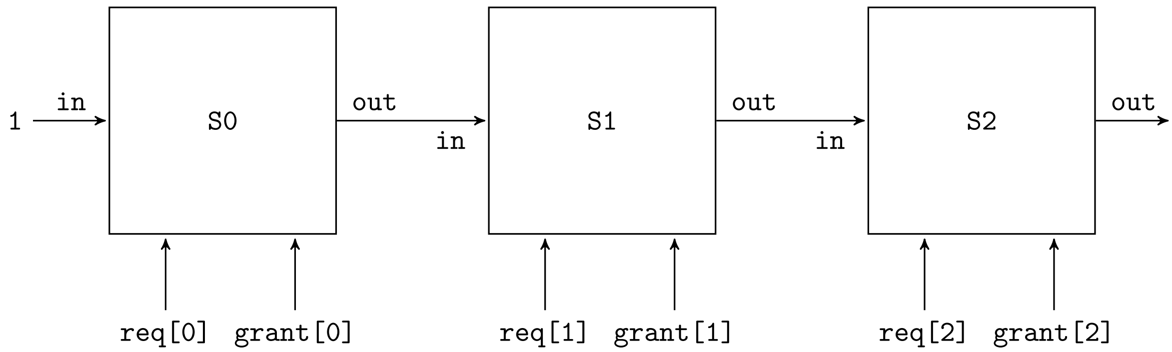


Figure 1: Example for a priority based arbiter using submodules

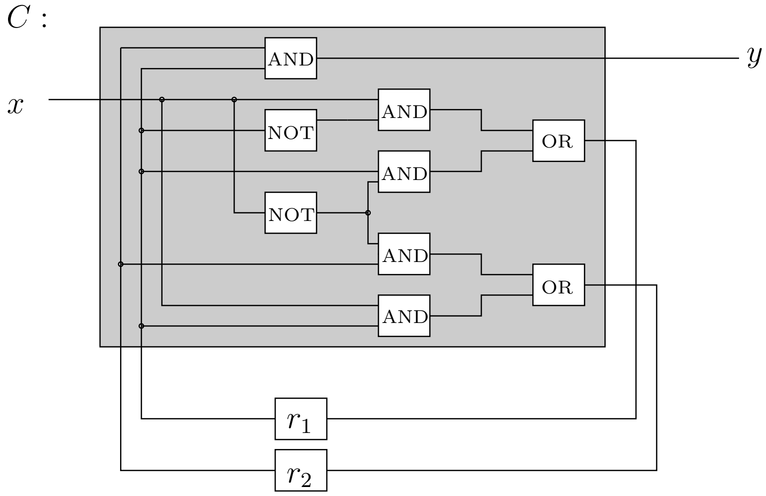
1. Create a Verilog model of a priority based arbiter that can handle accesses from 3 clients. [3 Points]
2. Verify or disprove that the following properties hold:
   a) In every state, at most one client is granted access (mutual exclusion). [1 Point]
   b) In every state, the access is only granted if there is an request. [1 Point]
   c) In every state, there is eventually a state where the access is granted when there was a request. (starvation freedom) [1 Point]
3. How can we fix the property that is not fulfilled? You do not need to implement a fix. [2 Points]

Hint: Store the input vector `requests` in an register and give the values of the register to the arbiter. The CTL model-checker can only reference values of registers. Why? Use the same trick with `grant`.

The following exercises belong to the afternoon session.

Problem 2: FSM from hardware circuit [4 Points]

Consider the following sequential hardware circuit:

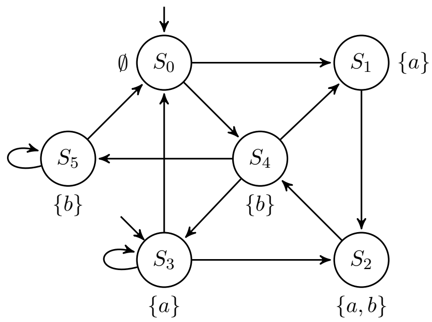


Give the transition system representation T of the circuit C.

Problem 3: CTL Model Checking [4 Points]

Consider the following CTL formulas and the state graph S shown on the right:

$$\Phi_1 = \mathsf{EG}\,\mathsf{AF}\,\neg b$$
$$\Phi_2 = \mathsf{E}\,(\mathsf{EX}\,a\ \mathsf{U}\ \neg a)$$
$$\Phi_3 = \mathsf{AX}\,(\mathsf{EG}\,\neg a\ \vee\ \mathsf{EG}\,b)$$



Give the satisfaction sets $Sat(\Phi_i)$ and decide whether $S \models \Phi_i$ holds ($1 \leq i \leq 3$).