

Specification and Verification II 2004 – Paper 7 Question 7(MJCG)

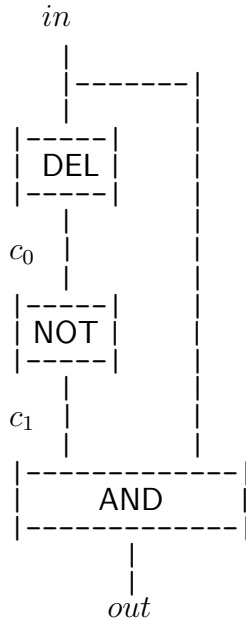
(a) Devices can be modelled as relations between sequences of inputs and sequences of outputs. These sequences represent histories of values over time (normally represented as functions from time to values). If Dev is a binary relation modelling a device, then $\text{Dev}(in, out)$ should be true if and only if the pair (in, out) is a pair of possible input/output histories for the device. Combinational and sequential devices are modelled similarly. With combinational devices the outputs at time t are always functions of the inputs at time t , but with sequential devices an output at time t may depend on values input earlier times. Devices may have more than one input or output, as illustrated by AND in (b) below.

(b) NOT, AND and DEL are modelled by:

$$\begin{aligned} \text{NOT}(in, out) &= \forall t. out(t) = \neg(in(t)) \\ \text{AND}(in_1, in_2, out) &= \forall t. out(t) = in_1(t) \wedge in_2(t) \\ \text{DEL}(in, out) &= \forall t. out(t+1) = in(t) \end{aligned}$$

(c) Rose is defined by: $\text{Rose } f \ t = \neg(f(t-1)) \wedge f(t)$.

(d) Roselmp can be implemented as follows:



(e) The diagram above is represented in higher order logic by

$$\text{Roselmp}(in, out) = \exists c_0 \ c_1. \text{DEL}(in, c_0) \wedge \text{NOT}(c_0, c_1) \wedge \text{AND}(c_1, in, out)$$

The correctness implication is easy logical reasoning after expanding the definitions of Rose, Roselmp, DEL, NOT and AND.

This question refers to the part of the course concerning the modelling of devices in higher order logic and how such models are proved correct.

For (a) and (b) the candidate should show he/she understands the main ideas. For (c) the correct definition in logic should be given. For (d) an implementation, such as the one in the model answer should be drawn. For (e) the diagram needs to be captured in logic (3 marks) and an indication given (e.g. see model answer) that the candidate knows how to verify the implication given in the question (3 marks).