Lecture Design and Analysis of Distributed, Interacting Systems (DIS)

Assignment 1:

Solutions to the assignment sheets must be submitted in groups of two or three students. (No submissions by just one student.)

If you have any questions about this assignment, please contact: Raphael.Pham@inf.uni-hannover.de

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To be collected on April 18, 2013, before the lecture starts!

Exercise 1: Transition Systems (6 Marks)

Consider a railway crossing as sketched in Figure 1. Trains drive along the track from left to right where they pass sensors installed in the track bed. These sensors send events to a controller, which is also responsible for closing and opening the barriers of the crossing. The behavior of the train and the barriers is already modeled as transition systems $B$ and $T$. You are in charge of designing the controller's software.

Figure 1: Sketch of the crossing.

Figure 2, above: Transition system $B$ of the barrier.

Figure 3, left: Transition system $T$ of the train.

a) Briefly describe the intuition of the transition systems of the barrier and the train.

b) Given are the following requirements:
R1: When a train approaches the crossing, the barrier must close.
R2: When the train exits the crossing, the barriers must open.

Model the controller as a transition system $C$ such that the transition system $TS = T \parallel G \parallel C$ (where $T$, $G$, and $C$ are composed via pairwise handshaking) satisfies the given requirements. Provide a figure of the transition system $C$ as well as the resulting composed transition system $TS$.

*Hint: Four states are enough to model the controller $C$. Remember: Handshaking needs shared actions!*

c) The transition system $TS = T \parallel G \parallel C$ should comply with requirements of R1 and R2. However, does your controller also ensure that the barriers are always closed when the train enters the crossing? Can you modify the controller so that the overall system satisfies the requirement? Do you think that it is the controller that requires modification? Provide a brief discussion and a Figure of how you propose to modify any of the above transition systems.

**Exercise 2: Networks of Automata in UPPAAL (6 Marks)**

Download and install the latest version of the UPPAAL model checker.

a) Briefly describe the difference between broadcast channels and (“normal”) binary channels in UPPAAL. (Hint: Search the documentation accessible via the help menu of the tool.) Suppose a given network of automata where edges synchronize via binary channels. Can I always replace a binary channel with a broadcast channel? Provide a brief explanation with a small example where you illustrate that this may have dire consequences.

(Provide either an illustration of the automata network or submit an UPPAAL model via email.)

b) Model the above railway crossing system in UPPAAL by a network of three automata that correspond to the transition systems $T$, $G$, and $C$ in Exercise 1. Briefly describe the model and why you think that its behavior is equivalent or at least similar to the transition system $TS = T \parallel G \parallel C$ of Exercise 1 b).

(Provide either an illustration of the automata network or submit an UPPAAL model via email.)