Prof. Dr. P. Liggesmeyer
M.Sc. Michael Roth

Technical University of Kaiserslautern
Dept. of Computer Sciences
AG Software Engineering: Dependability

Safety and Reliability of Embedded Systems
(WS 14/15)

Problem Set 3

Problem 1: Reliability estimation by using RBD's

The safeguarding system of a railroad crossing consists of three heterogeneous controllers and a component "C" that rectifies if any of them has failed. In normal conditions, the three controllers and "C" are functional. For the system to remain functional at least one controller and "C" have to be functional. The three controllers fail independently from each other.

1. Draw the corresponding reliability block diagram for the safeguarding system.

To simplify the analysis of the safeguarding system, it is further assumed that C has a reliability R_c of 1 which means that it never fails.

2. Please calculate the reliability R_{sys} of the safeguarding system if each controller has a reliability $R_{ctrl} = 0.95$

Now assume that the reliability R_c of C is 0.9.

3. Recalculate the resulting reliability R_{sys} of the system.

Problem 2: Markov Processes

Assume that the configuration of the safeguarding system has undergone some changes. Unlike the old configuration, the new one includes three controllers which are identical and there is no component "C", which rectifies if the controllers have failed. In normal operating conditions, the total load of the safeguarding system is distributed equally among its controllers (Each controller runs at 1/3 of their maximum capacity). Whenever one controller fails, the remaining two take over its load (1/6). The system fails if two controllers have failed.

1. Please draw the corresponding Markov process model under the assumption that if the complete safeguarding system has failed, the system remains in this state (no repair will take place).

2. For the states of your Markov model, develop the set of related differential equations

Problem 3: Petri Nets

1. Please draw a Petri Net corresponding to the Markov Process of Problem 2. Which type of Petri Net would this be?

2. Describe briefly the following Petri Net types: C/E Net, P/T Net, Pr/TNet, and SPN. How do they differ from each other?

3. Consider the water pump example in the lecture (see chapter 4, page 44). If the repair strategy is changed to repair 2 pumps separately instead of repairing them together, how would you draw your Petri Net to reflect this situation?

4. Consider the DSPN of the streetlight example in the lecture (chapter 4, slide 49). Remember the semantically mistake that a broken lamp shifts the day-night cycle. How would you correct the DSPN that this anomaly will no longer be present (hint: Petri Nets are able to model parallelism)?