

Verification of Real-Time Systems SS 2015

Assignment 1

Deadline: May 7, 2015, before the lecture

Exercise 1.1: Real-Time Systems (8 = 1.5+2+1.5+2+1 Points)

1. What are the differences between hard and soft real-time systems?
2. Find two examples for each, and describe possible consequences if these systems miss their deadlines.
3. Find one example each, for distributed, event-triggered, and multiperiodic systems.
4. Describe two reasons why the execution times of a program can vary.
5. Explain why the “maximal observed execution time” is not sufficient for the verification of hard real-time systems.

Exercise 1.2: Interval & Path Analysis (12 = 2+4+2+4 Points)

You are given the following program:

```
R1 = R1 % 6
R2 = 1
R3 = 1
R4 = 1
while (R1 > 2) do (
  R4 = R2 + R3
  R2 = R3
  R3 = R4
  R1 = R1 - 1
)
return R4
```

Hint: The modulo operation yields non-negative values.

1. Build the corresponding control-flow graph with nodes as basic blocks and edges modeling potential control flow between basic blocks.
2. Determine (tight) enclosing intervals on the values of all four registers. Give your results per edge in the control-flow graph, and briefly explain how you obtained them.
3. Can you come up with lower and upper loop bounds? Briefly explain how. Why could a lower loop bound be useful?
4. Formulate an integer-linear-program for the path analysis via implicit path enumeration. Assume that the underlying architecture can execute each operation in one cycle. Obtain a solution to the ILP. Give the computed bound as well as a worst-case path through the program. *Hint: You are allowed to use auxiliary programs, such as `lpsolve`.*