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Exercises for
Embedded Systems
Wintersemester 19/20

Exercise Sheet 9 (Practice)

(10 Points)

Please note: Submitting written solutions to this exercise sheet is not necessary. Discussion: 02.-06.12.2019.

Open a terminal and execute the command **ssh -X youraccount@ls12pc5.cs.tu-dortmund.de**, whereat you need to substitute *youraccount* with your user name. Download the archive `wcet` from the course website using **wget**. If you are not familiar with the command line, please ask Google for help.

Preparation

Whenever you start a new session, you have to re-register some components. For this reason, enter the following command into a terminal window:

- **cd wcet**
- **./env.sh**
- **m+ tricore-gcc**
- **m+ ait**

1 Step 1: Simple Analysis (5 Points)

Execute the command `cd ~/wcet/step1` to change in the directory used for this assignment. Compile the example program with the command **tricore-gcc -g -T ../tc1796.lds test.c** and inspect the source code, e.g., via `kate test.c`, `gedit test.c`, `gvim test.c`, or `cat test.c`.

What does the program do?

Then, execute the command `a3tricore` to start the Tricore analyzer. Under Configuration→Files, choose the file `a.out` as executable and the file `a.ais` as "AIS file". Click on the pen symbol in the "AIS file" line to start the AIS editor. **How are the loop bounds annotated by means of this file?**

Select the entry "Analyses→Create" in the navigation box on the left hand side and click on "aiT" (Safe WCET Analysis). In the newly opened screen displaying the analysis parameters, `main` must be chosen as symbol for the start of the analysis, before it can be started with a click on the "Play" button in the toolbar (the right one showing a triangle without a dot).

What is the WCET of the program? You can display additional details by clicking on the entry "WCET contributions" in the navigation box (left hand side).

Contemplate the control flow graph (Analysis→Control-Flow Graph).

How does the control flow graph represent the program? Consider carefully, how loops are represented in the CFG.

Repeat the analysis by means of the interactive analysis (play symbol with a dot). Examine the additional information shown in the boxes and open some of these via a double click. **Which information do they contain?**

2 Step 2: Scratchpad Allocation (5 Points)

A scratchpad (SPM, scratchpad memory) is a very fast, internal memory which is used as temporary storage for calculation results, data or program parts. In contrast to a cache, a scratchpad memory is maintained by the programmer and not automatically by the hardware.

Which parts of a program should be swapped out to an SPM?

Which are the differences between a "normal" system and a real-time system with respect to the usage of SPM?

Change to the directory `step2` (`cd ~/wcet/step2`), where a second version of the program considered in the previous assignment can be found. Here, two functions are swapped out to the SPM. Compile the program analogously to the `step1` program and perform an analysis with aiT.

Which impact does the usage of SPM have on the program's execution time?

If you could choose another function to be swapped out to the SPM, which one would you choose? Why?