Applications of wait/lock-free protocols to real-time systems

Project plan and new milestones for the 2nd student

August 20

1 Project plan

Our plan, for the project titled "Applications of wait/lock-free protocols to real-time systems" was to have two graduate students doing their doctorate research within the project, one at Mälardalens University at Västerås and one at Chalmers University at Göteborg.

More precisely the theme of the work that the two students had to get involved in is to explore research advances in the area of lock-free synchronisation and non-blocking concurrent data structures implementation and apply them for gaining in efficiency in the OS kernel level; the target is to develop an OS prototype, with a lock-free (non-blocking) kernel. The plan of the proposed work was the following:

- First we plan to study some existing real-time operating systems and the architectures for which they are applicable for. The purpose of this study is twofold: (a) to identify the data structures whose implementation is a significant factor for the performance of the respective real-time OS (b) to identify the synchronisation capabilities (via the wait-free agreement protocols that they support) of the architectures on top of which these OS are running. These will lead to the identification of the most efficient feasible ways for lock-free implementation of these basic kernel data structures for the respective architectures.

- In the second step of this project we plan to gradually incorporate the new data structure implementations in the existing kernels and use simulation platforms for their testing and evaluation. We believe that it is very important not to build a new OS from scratch but modify already existing ones; in this way we will be able first to concentrate on the wait-free/lock-free aspects on real time OS and, second, to measure exactly at the end the improvements as we expect that the new techniques will give to the systems; third but not least the expected benefits of the OS will thus be immediately available to the community that already is using these OS.

- The last phase of the plan will be to test all aspects of the performance of the new kernel by running the kernel on the targeted real architecture with real data.
- The study and development will throughout the project be guided by case-studies. Initially we will concentrate on using wait-free snapshots in an automotive diagnostics system

On a more concrete level, the individual roles of the two (cooperating) graduate students will roughly be the following:

- The MdH student will focus on aspects related to the implementation of wait-free techniques in Real-Time kernels. This will, in addition to the actual implementation work, include evaluation and analysis of implementations and applications.
- The Chalmers student will focus on wait-free techniques and algorithms. This includes study of applications and existing kernels, development and analysis of algorithms, as well as evaluation of the use of algorithms.

We managed to recruit two good students: B Allvin and H. Sundell. Unfortunately B. Allvin left the project some months after the project started. Henceforth, the project had to run with only one student in its first year course. This affected the speed of the project and we expect the luck of one student to affect us more in the future when the implementation and evaluation part (the part that B. Allvin was more involved with) is going to be more crucial.

In order to be able to continue the project as planed we would like to try to recruit a student that will be responsible for the part of the research that B. Allvin was recruited for. The new students will be placed at the Chalmers now as the ARTES board has suggested.

2 Milestones

In the initial two year period we expect the following results:

- Year 1:

1. Implementation of wait-free mechanisms in ENEA OSE (together with H. Sundell)
2. Evaluation of the above mentioned mechanisms (together with H. Sundell)
3. Study the applicability of non-blocking techniques for implementing shared "multi-objects" for real-time systems.

- Year 2:

1. Results on the applicability of non-blocking techniques for implementing shared "multi-objects" for real-time systems.
2. Implement a wait/lock-free high-level communication library to support higher level communication mechanisms for multi-processor real time operating systems (ENEA OSE included). Many real time operating systems support only very low level of communication primitives when it comes to multi-processor systems, mostly, for efficiency reasons.