First Year Report
Node-level Fault Tolerance for Fixed Priority Scheduling
June 13, 2000

Project start: 99-04-01
Student: Joakim Aidemark

Introduction
Distributed real-time systems are increasingly being used to control critical functions in automotive and aerospace applications. These systems must be fault-tolerant to be safe and reliable. The goal of this project is to develop techniques for node-level transient fault tolerance for distributed real-time systems using fixed priority scheduling. A case study will be performed, where a small real-time kernel that achieves transient fault-tolerance will be implemented and validated using fault injection. The real-time kernel will be implemented for the Thor microprocessor, developed by Saab Ericsson Space AB.

Two fault injection tools developed at Chalmers - FIMBUL and MEFISTO – will be used to conduct the fault injection experiments. FIMBUL injects faults into a real Thor-microprocessor via scan-chains (i.e. built-in test logic), while MEFISTO performs fault injection using a simulation model written in VHDL.

Progress year 1
The following has been achieved during Year 1:

- A small real-time kernel has been developed for the Thor microprocessor. This has been the main task for Joakim during the first year.
- The MEFISTO-tool has been used to perform fault injections on the Thor microprocessor during execution of a quick-sort algorithm. The purpose of these experiments was to introduce Joakim to the MEFISTO-tool.
- The FIMBUL-tool has been adapted for experimental validation of the real-time kernel. This adaptation provided Joakim with valuable insight into the FIMBUL-tool.
- A new user interface has been developed for the FIMBUL-tool. Joakim conducted this work together with another PhD student. Several new features were added to FIMBUL-tool, which will facilitate the evaluation of the real-time kernel.
- After studying the two fault injection tools, Joakim has decided to first use the FIMBUL tool for the validation of the real-time kernel.

Deviations from the project plan.
There are no major deviations from the project plan. The fault injection experiments with the real-time kernel will start in August, which is 1 – 2 months behind schedule. The reason for the delay is that the modification of the FIMBUL-tool required more time than expected.

Publications

- An extended abstract was presented by Joakim at the ARTES Graduate student conference, Chalmers, Göteborg, March 16-17, 2000.
- A fast abstract has been accepted for presentation at the International Conference on Dependable Systems and Networks in New York, USA, June 25-28, 2000.

We plan to write a full research paper during the autumn for submission to a major technical conference. (Most likely the International Conference on Dependable Systems and Networks, which will be held in Göteborg in June 2001. Submission deadline is around Nov 1, 2000). This paper will describe the design principles as well as the experimental validation of the real-time kernel.

Johan Karlsson
Project leader

Interaction with Saab Ericsson Space

The project is carried out in co-operation between Chalmers and Saab Ericsson Space AB. Saab

Ericsson Space AB has provided a computer board with the Thor microprocessor and a VHDL model of the Thor microprocessor. The computer board is used for physical fault injection experiments with the FIMBUL-tool, while the VHDL-model is used for simulation-based fault injections carried out with the MEFISTO-tool.

Two project meetings have been held during the year. In addition, staff from Saab Ericsson Space has on a regular basis answered questions from Joakim regarding the technical details of the Thor microprocessor, the computer board and the VHDL-model.

Joakim has not yet participated in the development of any product at Saab Ericsson Space, but we are investigating the potential use of both the FIMBUL-tool and the MEFISTO-tool in commercial projects. Joakim has demonstrated the MEFISTO-tool for representatives of Saab Ericsson Space. A demonstration of the FIMBUL-tool is planned for the autumn.

Torbjörn Hult
Chief Engineer, Digital Products Division
Saab Ericsson Space