PROARTIS for Space (P4S) - Schedulability Analysis Techniques and Tools for Cached and Multicore Processors

This research project was aimed at addressing a wide range of issues relating to time analysability of next generation space systems. The key challenge was addressing how to use multi-core processors in an effective way, and achieving adequate levels of guarantee of the timing correctness. There were four main themes to the work undertaken:

- Choice of scheduling and schedulability analysis and their relation with the timing analysis techniques in multicores.
- Incorporation of software randomisation at run time to enable probabilistic worst-case execution time analysis.
- Hardware support for observing timing behaviour. This includes the provision of a data logger to capture timing data and hardware changes on-chip to support the data logger.
- Evaluation of the performance and worst-case behaviour of NGMP advanced features.

The project has critically evaluated the scheduling algorithms available to support multi-core processors. Based upon the results of this study, a prototype scheduler has been developed and evaluated in conjunction with a representative use-case application operating in a multi-core environment and running under a real time operating system.

A suite of software randomization tools and techniques have been developed, targeted at execution within a multi-core platform designed for space applications. The software randomization tools have been integrated with the other software tools developed as part of the project and evaluated in a number of test scenarios as well as operating as part of the representative use-case application.

The project has also undertaken a survey of the technology available to support observation of timing behaviour and data logging of the observed results. A number of methods have been implemented and evaluated, through modification of the multi-core platform hardware and also through the use of an external data logger.

Additionally, the project has also implemented and refined existing tools to perform Probabilistic Timing Analysis (PTA) and also provide execution trace visualization.

The original scope of the project was also extended to undertake an investigation of the potential use of Performance Monitoring Counters (PMCs) on board a multi-core platform to be able to support and augment execution timing analysis. A number of candidate PMCs were implemented in the hardware and experiments were undertaken to demonstrate their utility.