parMERASA

Key Innovation

Increased performance at reduced costs while maintaining safety levels – these are the key demands from European avionic, automotive and automation industries. Even the latest state-of-the-art embedded single core processors cannot cope with these demands. The pursuit of higher performance, improved safety levels and lower costs requires a new solution. parMERASA combines the requirements for high-performance with time-predictable execution that is indispensable in our focused safety-critical domains. Hard real-time applications, such as flight management system, automotive engine and drilling machine control, will be parallelised and executed on an embedded multi-core processor. The parMERASA multi-core processor and system software is expected to scale up to 64 cores. Objectives include an at least eightfold improvement of the worst-case execution time for parallelised legacy applications in the avionics, automotive and construction machinery industries.

Technical Approach

The goal of our approach is to facilitate the use of multi-core processors in real-time systems. To meet this goal, the project must overcome the problems of existing timing analysis approaches, which only cover sequential program execution. The new scientific and technical innovations created specifically for the parMERASA project include:

- parallelisation techniques for safety-critical applications;
- timing analysable parallel design patterns;
- operating system virtualisation and efficient synchronisation mechanisms;
- guarantee of worst-case execution times (WCET) of parallelised applications;
- verification and profiling tools;
- timing analysable multi-core architecture with up to 64 cores.

A software engineering approach will be developed to ease sequential to parallel program transformation by developing and supporting suitable parallel design patterns that are analysable. Verification and profiling tools will be developed, and we aim to provide recommendations to enhance both automotive and avionics standards.

Demonstration and Use

The parMERASA consortium will evaluate the effectiveness of its methods, architectures and tools with applications or application patterns from the domain of real-time avionics, automotive and construction machinery. The participating application companies – Honeywell International s.r.o., DENSO AUTOMOTIVE Deutschland GmbH and BAUER Maschinen GmbH – have selected the following applications:

- flight management system that automates a wide variety of in-flight tasks,
- global navigation satellite system receiver for airplanes,
- stereo navigation using cameras for airplane localization,
- 3D path planning that computes a path between the current and goal vehicle positions,
- automotive engine control,
- compound ECU with automotive gateway and multiple control units,
- dynamic compaction system and energy management system for large construction machinery.

The SME Rapita Systems Ltd. will develop tool support for WCET analysis, verification and profiling of parallel programs to assist the applications.

Scientific, Economic and Societal Impact

By promoting products and processes that tackle time-to-market and cost pressures, Honeywell International s.r.o. will be recognised as a leader in the research and development of emerging embedded multi-core systems. DENSO AUTOMOTIVE Deutschland GmbH will gain from the potential of new tools and advanced architectures by reducing unit costs of production. BAUER Maschinen GmbH will produce faster automatic tools which will be driven by parallelised code. And the creation and use of state-of-the-art tools will enable Rapita Systems Ltd. to penetrate further into the automotive and avionics markets.

The academic partners at the universities of Augsburg, Toulouse and Dortmund and at the Barcelona Supercomputing Center will strengthen their leading position in timing analysis research by the development of the static WCET tool OTAWA, the system software and the parMERASA multi-core. All three developments will be made publicly available under an Open Source license at the end of the parMERASA project. The parMERASA partners believe parallel execution and time predictability will have a significant impact on the development of transportation systems and industrial applications across Europe. Overall, the project is expected to reinforce the EC position in the field of safety critical computing systems and give European industry and academia an advantage in the highly competitive embedded systems markets.

Project Partners	Country
University of Augsburg	Germany
Barcelona Supercomputing Center	Spain
Université Paul Sabatier	France
Technical University of Dortmund	Germany
Rapita Systems Ltd.	UK
Honeywell International s.r.o.	Czech Republic
BAUER Maschinen GmbH	Germany
DENSO AUTOMOTIVE Deutschland GmbH	Germany

Key Features
- Parallel execution of industrial hard real-time programs on 64 cores
- Speedup of at least 16 times (average) and 8 times WCET
- Provide at least four parallel execution patterns that are "time analysable"
- Provide analysis tools with less than 25% pessimism on WCET estimates.