PARALLEL PARADIGMS AND RUN-TIME MANAGEMENT TECHNIQUES FOR MANY-CORE ARCHITECTURES

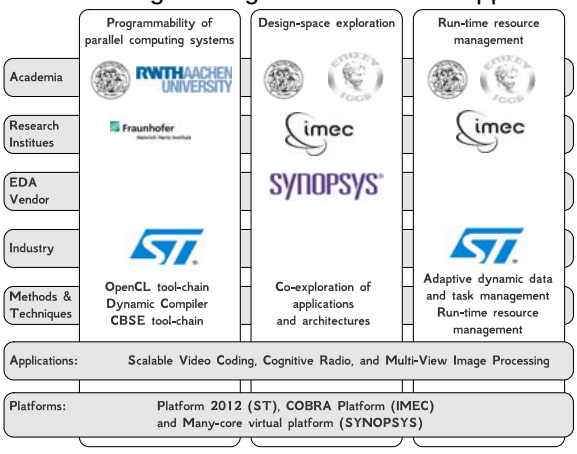
2PARMA

Key Innovation

The current trend in computing architectures is to integrate in embedded devices an increasing number of processing cores. Latest generation smart phones carry two processors plus graphic accelerators while in the near future we can envision to scale up to 16 or 32 processors. This trend requires a global rethinking of software and hardware design methodologies, due to the increased complexity of creating and running applications on such embedded devices.
The 2PARMA project aims at overcoming these issues by providing tools and software components to facilitate the application development and execution on many-core systems. The goal is to speedup the application development by a factor of 2 and to optimize the usage of system resources (such as battery power) from 20% to 35% with respect to conventional power management strategies, while preserving the target Quality of Service.

Technical Approach

The project tackles the issue of programmability of Multi-core Computing Fabrics at both the programming language and the Operating System level. The project focuses on the **definition of a compilation toolchain supporting a parallel programming model** combining component-based and single-instruction multiple-thread (OpenCL) approaches. The project will also provide a **run-time resource management framework** driven by **design space exploration** to automatically generate energy-delay operating points for multiple applications running on Many-core Computing Fabrics. The project leverages the increasingly popular Component-Based Software Engineering and it identifies opportunities for parallelisation at a high level in the design phase. Then, 2PARMA employs extensions of existing standards for parallel programming, such as OpenCL, to express data and pipeline parallelism. Using instruction set virtualisation, 2PARMA provides the means to tailor the application to the subset of the computing resources given by the co-existence of multiple applications on the computing platform, employing dynamic compilation and optimisation techniques. Given the opportunities for adaptation of the application to the available resources, the project develops policies to manage the system resources taking into account the Quality of Service requirements imposed by the application,



Contract number

FP7-ICT-2009-4-248716

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Project website

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Community contribution to the project

2.74 Mio Euro

Project start date

01 01 2010

Duration

36 months

while optimising the resource usage for system-wide performance and energy consumption goals. The continuous adaptation and run-time management require large amount of information on the system and applications to take effective and timely decisions. 2PARMA goes beyond traditional design space exploration by defining a methodology to provide synthetic information about the points of operation of each application with respect to the subsets of resources available to it.

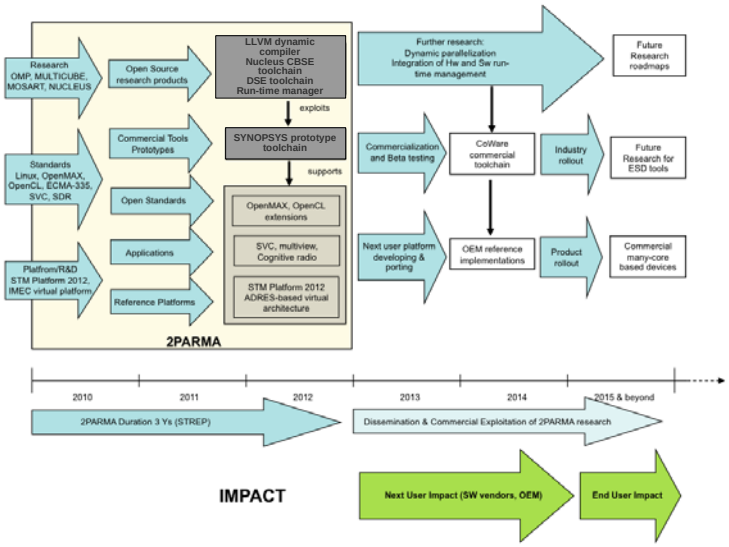
Demonstration and Use

Project partners	Country
Politecnico di Milano	IT
STMicroelectronics	IT/FR
Fraunhofer - HHI	DE
IMEC	BE
ICCS	GR
RWTH Aachen	DE
Synopsys	BE

All concepts and components developed in the project will be evaluated by demonstrating the methodologies, techniques and tools by using innovative hardware platforms provided and developed by the partners, including “Platform 2012”, an early implementation of Many-core Computing Fabric provided by STMicroelectronics, ADRES-based Many-core COBRA platform provided by IMEC and Virtual Many-core platform provided by Synopsys. To demonstrate the widespread applicability of the 2PARMA methodologies and tools, commercial multi-core Intel/AMD based clustered platforms will also be considered as additional platforms for demonstration. To ensure a wide range of application scenarios comprising the typical computation-intensive workload of a general purpose computing system, a set of industrial high-performance demanding applications will be used and customized by using the developed techniques. The selected applications are: Scalable Video Coding, Cognitive Radio, and Multi View Image Processing.

Scientific, Economic and Societal Impact

STMicroelectronics will obtain faster time-to-market by exploiting improved programmability and demonstrable adaptability of P2012 to multi-application scenarios, while Synopsys will consider the inclusion of 2PARMA methodologies and tools in their EDA tool portfolio, thus enhancing European competitiveness in the global computing market and ultimately leading to new high technology jobs in Europe. The public availability of research results and related tools will benefit industry and academic embedded systems community. Industrial and academic partners will benefit from the availability of an integrated application/architecture platform featuring Many-core Computing Fabric validated on a set of demanding applications, which will serve as research platform after the project completion. The demonstration of concepts and porting of tools on standard platforms represent another fast vehicle to achieve a wider and fast dissemination and exploitation of the project results in both academic, research and industrial communities. The cooperation between industrial and academic partners will lead to faster technology transfer and increased influence on international standards (such as Khronos OpenCL). On the long term, the project will benefit the European citizens by providing them faster and lower power multi-application embedded devices such as smart phones and set-top boxes.



First year achievements

1. Definition of design techniques and tools requirements as well as many-core architectures and applications to be used for valifdation and integration purposes.
2. Definition of specifications of application programming interfaces and data exchange formats related to technologies and tools to be developed in the project.
3. Release of the initial implementation of the NoCTrace profiling tool for parallel computing platforms.
4. Several dissemination activities started during the first period to create awareness about the project and to ensure the spreading of the project’s outcomes among external industrial and academic organizations.