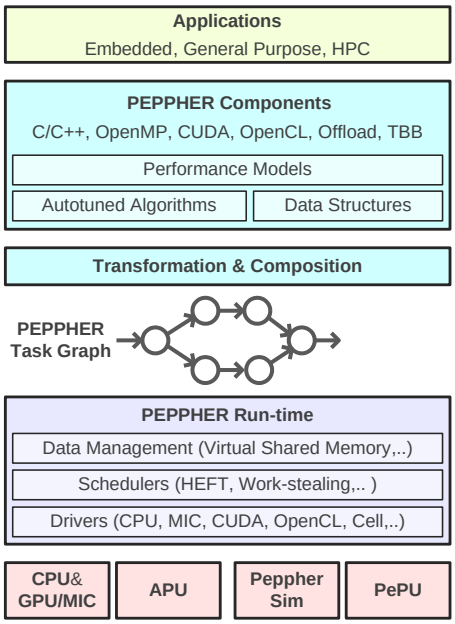
PERFORMANCE PORTABILITY AND PROGRAMMABILITY FOR HETEROGENEOUS MANY-CORE ARCHITECTURES

PEPPHER

Key Innovation



The emergence of heterogeneous many-core processors, in a large spectrum of systems from embedded and general-purpose to high-end computing systems, poses major challenges to the European software industry. In general, there is no guarantee that software developed for a particular architecture will be executable on another, related architecture. For instance, H.264 codecs are essentially rewritten for each generation of DSP processor in heterogeneous architectures, a practice that is clearly wasteful in resources and should be avoided as far as possible. A related issue is the coding of multiple versions of H.264 codecs to play back or encode different resolutions of video (QVGA, VGA, WVGA, D1, 720p, 1080i, or 1080p) using differing numbers of cores and memory in order to meet the processing requirements for each resolution. **The PEPPHER project is developing a unified framework for programming and optimizing applications for heterogeneous many-core processors to ensure functional and performance portability with reasonable programming effort**. PEPPHER envisions two kinds of programmers: (1) “mainstream programmers” who build applications using the PEPPHER framework and specify performance-expectations, (2) “expert programmers” who implement and extend the PEPPHER framework. Once an application is developed using the PEPPHER methodology and framework, no further porting effort of the mainstream programmer is needed for efficient execution of application on any of the target PEPPHER platforms.

Contract number

248481

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Project website

www.peppher.eu

Community contribution to the project

2 553 615 Euro

Project start date

01 January 2010

Duration

36 months

Technical Approach

PEPPHER is distinguished by a holistic approach, which addresses functional and performance portability at multiple layers from high-level component-based programming, tion, library and run-time support, to hardware mechanisms for performance monitoring and feedback. The basic **idea of PEPPHER for enabling performance portability is to provide performance-critical parts of the applications in multiple variants** that are suitable for different types of cores, usage contexts and performance criteria. Implementation variants are supplied incrementally by hand, by compilation, by component composition, by auto-tuning, or

taken from expert-written, adaptive libraries. Pre-selection and specialization of variants for a given heterogeneous architecture are performed statically as far as possible by component composition techniques, while the final selection of the most appropriate variants is delegated to a resource-aware run-time system.

Demonstration and Use

The PEPPHER framework will be demonstrated for a collection of target applications from various domains (embedded, general-purpose, HPC) including: suffix array construction, Bullet (games physics engine), computational photography, GROMACS.

Currently, Codeplay is using the PEPPHER compiler technology in commercial games engines, and is evaluating the PEPPHER component libraries in industrial context. OpenCL and CUDA Light-Field codes developed by Movidius are being used in business development and customer design-win activity in Light-Field and array cameras together with commercial partners. INRIA is using SPLAGMA linear algebra parallel library for evaluation of the efficiency of PEPPHER run-time system. Intel is using the PEPPHER prototype to test new and future tools and technologies as well as updated products. Intel will proactively test the PEPPHER prototype with the goal of having a robust and stable implementation, which demonstrates the individual components as well as the complete prototype and its functionality.

Scientific, Economic and societal Impact

Movidius is already using PeppherSim for internal 28nm SoC platform development as well as internal software development for external customers and partners to support existing 65nm Myriad Silicon platform. There is initial interest from potential customers in using PEPPHER FPGA Demonstrator boards to build products/systems and do evaluations of Movidius chips. Codeplay is aiming to license the PEPPHER compiler technology to GPU companies that will impact their next-generation graphics solutions. The run-time technology developed in the context of PEPPHER is being integrated into the INRIA's StarPU open-source software, which is used by many international research groups. Intel will use the PEPPHER prototype to test the interoperability of Intel Threading Building Blocks as well as other parallel programming models and research software. Additionally, Intel will use the PEPPHER framework and the benchmarks for evaluation of new processor architectures as well as Intel tools prior to release. Several PEPPHER partners are active in Khronos Group, and PEPPHER results are used to influence the next version of OpenCL standard. Academic partners are using PEPPHER to develop high-impact scientific publications and deliver state-of-the-art knowledge from this domain to students. In this manner the project will enable that in future European companies can hire the best trained work force.

As developing at a higher level of abstraction and optimising at the architectural level is known to produce more optimal results, it is expected that PEPPHER will allow applications developers to extract optimal performance with fast time-to-market without requiring large numbers of programmers to optimise programs at low-level producing major economic and time-to-market benefits to European concerns including SMEs. Many-core processors will be used in almost all segments of European ICT markets. This will indirectly lead to better and cheaper ICT products that will impact on a large number of societal areas, such as health and safety, security, education, social inclusion, leisure and recreation.

Selected achievements

- ✓ High-level support for pipeline parallelism on heterogeneous many-core architectures
- ✓ Tuned sorting algorithms for multi-core and GPU with world-leading performance
- ✓ StarPU-based run-time system supports various schedulers, target devices, power-based optimization, and mixed-mode parallelism
- ✓ PeppherSim simulator supports temporal and energy metrics

Project partners	Country
University of Vienna	AT
Chalmers University	SE
Codeplay Software Ltd.	UK
INRIA	FR
Intel GmbH	DE
Linköping University	SE
Movidius Ltd.	IE
Karlsruhe Institute of Technology	DE
Vienna University of Technology	AT

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