OPTIMA

Optimizing Industrial Applications for Heterogeneous HPC systems

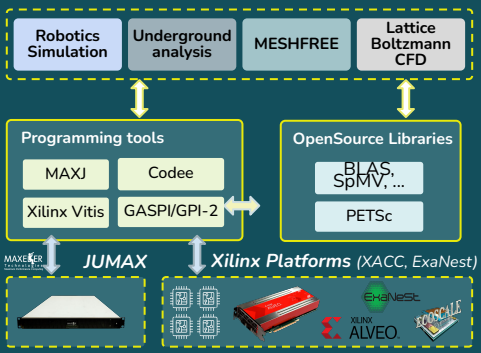
OBJECTIVE

In order to support the growing demands for processing power from emerging HPC applications, within a pragmatic energy envelope, future HPC systems will incorporate accelerators. A promising approach, to this end, is the use of FPGA boards. These devices can be reconfigured at will, to tailor application accelerators, and their principal advantage is their energy efficiency and/or performance, which, in most cases, is far superior to that of CPUs and GPUs.

The applications and libraries are expected to run on these heterogeneous HPC systems with significantly greater energy efficiency, as described by the Energy Delay Product (EDP) metric. In particular, the EDP of OPTIMA applications and libraries running on targeted FPGA-based HPC systems is expected to be more than ten times greater than those on CPU-based systems, and more than three times higher than those on GPU-based systems.

INNOVATION

OPTIMA will provide the efficiency of FPGA-based technologies in several industrial applications; thus, the European industry shall benefit from a new class of HPC resources strongly characterised by advancing State-of-the-Art and delivering truly innovative solutions. These solutions shall take advantage of the novel heterogeneous HPC systems and commoditise the access and utilisation of such resources transforming them into a service that can be accessed by everyone from SMEs to large organisations.



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PROJECT SUMMARY

OPTIMA is an SME-driven project that aims to port and optimize industrial applications and a set of open-source libraries into two novel FPGA-populated HPC systems. Target applications are from the domain of robotics simulation, underground analysis and computational fluid dynamics (CFD), where data processing is based on differential equations, matrix-matrix and matrix-vector operations. Moreover, the OPTIMA OPen Source (OOPS) library will support basic linear algebraic operations, sparse matrix-vector arithmetic, as well as computer-aided engineering (CAE) solvers. The OPTIMA target platforms are JUMAX, an HPC system that couples an AMD Epyc Server with Maxeler FPGA-based Dataflow Engines (DFEs), and server-class machines with Alveo FPGA cards installed.

RESULTS

OPTIMA has successfully mapped its target applications on its hardware prototypes. Experimental results on applications up to now, show that performance on robotic simulation can be enhanced up to 3.4x when comparing the execution speed of the FPGA implementation to the CPU implementation, and CFD calculations up to 4.7x. Finally, OPTIMA's open-source library (OOPS) enables energy-efficient HPC for BLAS and CAE solvers. When compared to Intel's MKL, OOPS provides energy efficient implementations up to 50x for L1 BLAS kernels, 20x for specific L2 BLAS kernels, 1.5x for specific L3 BLAS kernels, 1.45x for a Jacobi preconditioner, and 1.5x for LU matrix decomposition.

PARTNERS

TSI · Cyberbotics · EXAPSYS Exascale Performance Systems · Fraunhofer · MAXELER · JÜLICH Forschungszentrum · ENGINSOFT · codee

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