H4H - Hybrid4HPC

Hybrid programming to optimise High Performance Computing applications on Heterogeneous Architectures

Impact highlights

- The H4H project made important contributions to the Bull Exascale Program as many project outputs were integrated during or after the project end within Bull's commercial offers, such as Bull Sequana X and the Bull SuperComputer Suite. The research and development emanating from such projects have attracted customers along the years and gained new entrants. CEA, CINES, SurfSARA, STFC, ZIH-TUD are among the major customers, accounting for several million euros.

- For Efield, participation in H4H contributed a highly competitive software package for electromagnetic analysis in the wireless communication and defence industry. In the last year of the project, a record contract was closed with a major Asian service provider for defence industry resulting in a 50% increase in revenue.

- The performance improvements achieved for RECOM's 3D combustion simulation software developed in the H4H project have enabled RECOM to make the necessary transition from traditional contracts in the coal-based power generation sector towards other industrial sectors within less than two years, allowing the company to recover more than 50% of lost turnover and stay in business.

- Several H4H improvements were integrated in open source code releases (SLURM, MAQAO, FoREST, UtoPEAK, SCILAB). The MAQAO performance evaluation framework developed by the University of Versailles Saint-Quentin-en-Yvelines, was enhanced with Xeon Phi support and is exploited by Bull, CEA, Dassault Aviation, Intel. Improvements made in FoREST and UtoPeak resulted in an average 20% gain in energy efficiency at less than 5% loss in performance.

High-performance computing (HPC) is essential in meeting the demand for increased processing power for future research and development in many domains, such as aircraft and automotive design or multimedia. The goal of the ITEA project H4H (Hybrid for HPC) was to provide a highly efficient, hybrid programming environment for heterogeneous computing clusters to enable easier development of HPC applications and optimise application performance. The project also aimed at providing a new infrastructure for HPC cloud computing and a new cooling technology to reduce energy needed to operate the HPC system. The H4H project assembled a consortium of Supercomputing Centres and HPC Research Labs, the European HPC manufacturer, HPC software tools editors and a range of HPC users to validate the proposed technology in real applications from various domains.

Project results

Key to the technological progress achieved were the extensive collaboration and workshops in which the partners engaged to develop and test the various technologies, customisation and optimisation options, and ultimately produce significant innovations to all the H4H technology components. Key results included:

- A new HPC architecture including new accelerators based on GPU and MIC technologies.
- A tailored development environment including optimisation tools and libraries supporting the new hardware architecture, allowing performance improvements (by an acceleration factor of 2 to several tens in application execution time).
- An advanced cooling design enabling a large reduction of the energy needed to operate the future Exascale HPC systems.

Exploitation

The H4H project made important contributions to the Bull Exascale Program, which aims to design and develop the next generation of supercomputers. H4H contributions were packaged within the Bull Super Computer Suites 4 & 5. In 2015, Bull launched Sequana - an open range of supercomputers that is ready to support future Exascale technologies. Bull benefited from these H4H developments as the new cooling technologies lead to new cooling improvements in the Sequana commercial offering, currently being sold as the Bull Sequana X, in which the X1210 blades integrate the latest Intel's Xeon Phi technologies.

During H4H. RECOM achieved major performance improvements of its 3D combustion simulation software. Shortly after H4H, 50% of RECOM's turnover from traditional contracts in the coal-based power generation sector disappeared due to an increasing share of renewable power generation in the European grid. This had to be compensated by expanding the applicability of the RECOM AIOLOS software to other industrial sectors, which required a huge effort in combustion model development and validation of its predictive quality in these new fields within a very short period. The performance improvements achieved in H4H have enabled RECOM to make this transition happen within less than two years.

H4H allowed Efield to drastically improve the performance of their electromagnetic solvers to successfully address the industry's evolution towards higher operating frequencies, complex materials and increased density of ICT equipment. The integration of H4H software developments resulted in major improvements in several commercial releases. Efield and Scilab enterprises (open source software for numerical computation with HPC optimisations), both H4H SME partners, were acquired by a larger company ESI group.

Optimisation strategies developed in H4H were implemented by Dassault Aviation on proto-applications referring to highly computational parts from its industrial code. Thanks to the ITEA COLOC project, which was a follow-up of H4H, Dassault Aviation was able to improve the parallel efficiency of its in-house software to maintain its competitive edge in the aeronautics industry.

Based on H4H, CEA improved its CEA Computing Complex infrastructures in terms of computational power and energy efficiency. CEA-LIST, also signed a commercial contract with the "Gendarmerie Nationale" for its image-based stolen object retrieval. The contract is still ongoing in 2018 evolving to other types of recognition features.

Thanks to H4H, Jülich Supercomputing Centre got the opportunity to work in a Siemens-funded collaboration (2014-2015) together with the Corporate Technology Multicore Expert Center of Siemens AG on runtime analysis of parallel applications for industrial software development.

09011

H4H - Hybrid4HPC

PROJECT LEADER
François Verbeck, Bull

PROJECT START
October 2010

PROJECT END
February 2015

PROJECT WEBSITE
https://itea3.org/project/h4h.html

PARTNERS

France

ATEME	⊙
Bull S.A.S.	●
Caps Entreprise	⊙
CEA DAM	○
CEA LIST	○
Dassault Aviation	●
EADS Astrium BU SATELLITES	●
Institut Mines-Télécom SudParis	◉
NUMTECH	⊙
scilab enterprises Enterprises	⊙
University of Versailles Saint Quentin	◉
XediX	⊙

Germany

Forschungszentrum Jülich GmbH	○
Fraunhofer SCAI	○
GNS	⊙
GWT Online -TUD GmbH	⊙
INTES	⊙
Magma Gießereitechnologie	⊙
RECOM Services GmbH	⊙
Technische Universität Dresden ZIH	◉
University of Stuttgart HLRS	◉

Spain

BMAT Licensing, S.L.	⊙
Datalab	⊙
Repsol YPF	●
Universitat Autònoma de Barcelona (UAB)	◉

Sweden

Efield AB	●
Rogue Wave Software	●