ITEA 2

INFORMATION TECHNOLOGY FOR EUROPEAN ADVANCEMENT

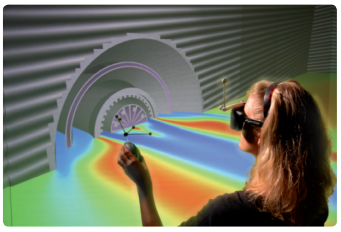
Project Results

Improving high-performance computing

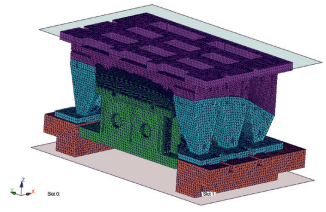
Harnessing multicore architectures for modelling, simulation and engineering

Efficient computational power is a key differentiator in research and industrial applications for modelling, simulation and engineering design. The ParMA project has developed advanced technologies to exploit the power of multicore architectures, delivering substantial performance improvements in high-performance computing applications. These technologies will help achieve new goals and enable development of innovative computer-intensive applications to accelerate research as well as speed design of better products in industry.

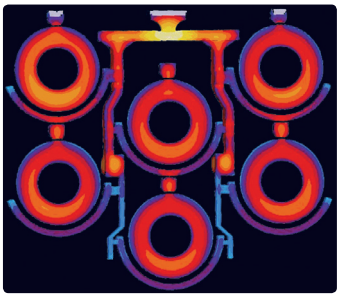
Simulation of a 3D-Boiler with RECOM-AIOLOS (Visualization of computational results)



3D - Model of entire molding press with several millions elements (GNS-INDEED)



Simulation of the solidification of a break disc pattern (MAGMA)



For over 20 years, device manufacturers increased processor performance by raising clock frequencies. Problems with heat dissipation, power consumption and leakage have now forced them to put several cores on the same die. Parallel programming is the key to taking full advantage of such multicore architectures. However, existing parallel programming methods and tools were not able to cope with a high number of tasks or threads.

The techniques available were diverse, could not be easily combined and only applied to main parallel programming techniques and on a limited number of platforms. Moreover, libraries were not optimised for multicore-based architectures. In addition, most high-performance computing (HPC) applications had poor scalability and often existed in several variants.

HPC applications developers also had little experience of parallelisation in terms of how to restructure code and organise the data. At the same time, embedded software developers knew very little about multicore architectures – particularly in multiprocessor system-on-chip (MPSoC) devices.

CRUCIAL FOR RESEARCH AND INDUSTRIAL APPLICATIONS

ParMA set out to develop a comprehensive, innovative, integrated and validated set of programming methods and tools to harness multicore architectures. Such advanced technology was seen as crucial for European research organisations and industry to improve competitiveness and independence.

The ITEA 2 project involved simulation software developers, tools developers and HPC platform and MPSoC-based embedded system providers as well as industrial HPC users, research organisations and supercomputing centres. Bull provided the partners with a powerful common HPC platform – a cluster on which all tools were

ParMA
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Partners

Allinea (not funded)
Bull
CAPS Entreprise (not funded)
CEA-LIST
Dassault Aviation (DA)
Forschungszentrum Jülich
GNS
GWT
HLRS / Universität Stuttgart
INDRA
MAGMA
RECOM Services
Robotiker
Telecom-SudParis, formerly INT (Institut National des Telecommunications)
Universitat Autonoma de Barcelona (UAB)
Université de Versailles Saint-Quentin-en-Yvelines (UVSQ)
ZIH / Technische Universität Dresden

Countries involved

France
Germany
Spain
UK

Project start

June 2007

Project end

May 2010

Contact

Project leader :
Jean-Marc Morel, Bull
Email :
Jean-Marc.Morel@bull.net

Project website :
www.parma-itea2.org

Project Results

installed and where application developers could experiment with these tools.

A series of advanced and new technologies and methodologies were developed. These included mature debugging and performance-analysis tools that have been integrated in a single package available at http://apps.fz-juelich.de/unite/. At the same time, project partners dramatically improved the performances of more than a dozen industrial HPC applications. In addition, superior platforms emerged – such as bullx, partly optimised by ParMA, named as the world's best supercomputer by HPCWire in November 2009.

BUSINESS IMPACT ALREADY OBSERVED

The impact on the business of the partners has already been observed: The main one is customer satisfaction for simulation software tools. An important contract has been signed by RECOM because work with ParMA resulted in a generic algorithm for an automatic 3D-combustion optimisation in a plant that involves several billion possible combinations of parameters. As a result, it is possible to reduce fuel consumption, saving around €125,000 a year while reducing CO2 emissions by16,000 tonnes a year.

Other simulation software tool providers are also able to provide customers with superior capabilities, resulting in better performance, refined simulations and more accurate models, and automatic automation.

INTEGRATING DEVELOPMENT TOOLS

Establishment of a closer relationship between partners was also an important outcome. As an example, before the project, the German tool developers operated separately, so their tools – MARMOT, KOJAK and VAMPIR – could not work together. Different trace formats meant that a user facing a difficult problem had to run each tool separately. As a result of ParMA, all these tools use the same trace format and interoperate. The UNITE package developed in ParMA makes it possible to install and use the tools as a powerful, comprehensive and integrated set of functions.

ParMA also benefited from projects or initiatives such as VI-HPS and POPS which were working on some aspects that complemented and thus enriched the ParMA results. Several new projects will continue this work such as in the framework of ITEA with 'hybrid parallel programming for heterogeneous architectures' (H4H), at national level with SILC and eeClust in Germany and at EU level with the Seventh Framework Programme (FP7) TEXT project.

Major project outcomes

DISSEMINATION

- 55 papers (including conference presentations)
- 17 presentations/demos at events
- 9 Tutorials
- 7 workshops
- 6 journal articles
- 4 seminars / symposia

EXPLOITATION

- 5 new parallel programming tools (DDT, MARMOT, SCALASCA, VAMPIR, NoCMaker). These tools are not new but they evolved heavily within ParMA
- 12 optimized HPC applications (RECOM-AIOLOS, MAGMASOFT, GNS-INDEED, etc.)
- 1 winning award system - Bullx blade system
- 3 promising prototypes (UVSQ/MAQAO, CEA-LIST/OASIS, TSP/STEP)

STANDARDISATION

- Started defining three extensions for MPI

ITEA 2 Office
High Tech Campus 69 - 3
5656 AG Eindhoven
The Netherlands
Tel : +31 88 003 6136
Fax : +31 88 003 6130
Email : info@itea2.org
Web : www.itea2.org

■ ITEA 2 – Information Technology for European Advancement – is Europe's premier co-operative R&D programme driving pre-competitive research on embedded and distributed software-intensive systems and services. As a EUREKA strategic Cluster, we support co-ordinated national funding submissions and provide the link between those who provide finance, technology and software engineering. Our aim is to mobilise a total of 20,000 person-years over the full eight-year period of our programme from 2006 to 2013.

■ ITEA 2-labelled projects are industry-driven initiatives building vital middleware and preparing standards to lay the foundations for the next generation of products, systems, appliances and services. Our programme results in real product innovation that boosts European competitiveness in a wide range of industries. Specifically, we play a key role in crucial application domains where software dominates, such as aerospace, automotive, consumer electronics, healthcare/medical systems and telecommunications.

■ ITEA 2 projects involve complementary R&D from at least two companies in two countries. We issue annual Calls for Projects, evaluate projects and help bring research partners together. Our projects are open to partners from large industrial companies and small and medium-sized enterprises (SMEs) as well as public research institutes and universities.

EUREKA

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