2021-03547 - PhD Position F/M Optimization of high-performance applications on heterogeneous computing nodes

Type de contrat : CDD  
Niveau de diplôme exigé : Bac + 5 ou équivalent  
Fonction : Doctorant

A propos du centre ou de la direction fonctionnelle

The CAMUS team is focusing on developing, adapting and extending automatic parallelizing and optimizing techniques, as well as proof and certification methods, for the efficient use of current and future multi-core processors.

Contexte et atouts du poste

The PhD will be in HiPACS, a joint project-team with Bordeaux INP, Bordeaux University and CNRS, and CAMUS, a joint project-team with Strasbourg University and CNRS.

The purpose of the HiPACS project is to efficiently perform frontier simulations arising from challenging research and industrial multiscale applications. The solution of these challenging problems requires a multidisciplinary approach involving applied mathematics, computational and computer sciences. In applied mathematics, it essentially involves advanced numerical schemes. In computational science, it involves massively parallel computing and the design of highly scalable algorithms and codes to be executed on future petaflop (and beyond) platforms. Through this approach, HiPACS intends to contribute to all steps that go from the design of new high-performance more scalable, robust and more accurate numerical schemes to the optimized implementations of the associated algorithms and codes on very high performance supercomputers.

The CAMUS research team focuses on parallelization, optimization, profiling, modeling, and compilation. The team has increasing interests in the approaches used and enhanced in the high-performance community. The team’s research activities are organized into five main issues that are closely related to reach the following objectives: performance, correction and productivity. These issues are: static parallelization and optimization of programs (where all statically detected parallelisms are expressed as well as all "hypothetical" parallelisms which would be eventually taken advantage of at runtime), profiling and execution behavior modeling (where expressive representation models of the program execution behavior will be used as engines for dynamic parallelizing processes), dynamic parallelization and optimization of programs (such transformation processes running inside a virtual machine), object-oriented programming and compiling for multi-cores (where object parallelism, expressed or detected, has to result in efficient runs), and finally program transformations proof (where the correction of many static and dynamic program transformations has to be ensured).

Mission confiée

The PhD thesis is funded by the European H2020 EuroHPC project TEXTAROSSA to achieve high performance and high energy efficiency on near-futureexascale computing systems, a technology gap needs to be bridged by increasing the efficiency of computation with extreme efficiency in HW and new arithmetic, as well as providing methods and tools for the seamless integration of reconfigurable accelerators in heterogeneous HPC multi-node platforms. TEXTAROSSA aims to bridge this gap by applying a co-design approach to heterogeneous HPC solutions and for HPC, AI and HPOD applications.

In the framework of the TextaRossa project, a few visits (3-5) of relatively short duration (1 to 2 weeks) will be possible between Bordeaux and the partners of the project (Italy, Spain, Germany, and Poland). Travel and accommodation costs will be covered.

The PhD should be located preferably in the CAMUS team (Strasbourg) with strong interactions with the HiPACS team (Bordeaux). But other possibilities can be discussed during the application process.

Principales activités

The objectives of the thesis will be to study how the new features of the TextaRossa computing nodes can be used to develop high performance applications. With this aim, we will study how high performance task-based applications can be adapted in order to exploit the full potential of the platform. We will thus consider two existing high performance libraries by adapting them, designing advanced scheduling strategies and considering energy consumption awareness as a major constraint of the work.

This thesis is funded by the European H2020 project TextaRossa. The thesis will be organized as follows:

- First, we will carry out a state-of-the-art study on dynamic scheduling techniques and on task-based runtime systems, such as StarPU [1]. We will also exchange ideas with the partners of the project to know all the specificities of the computing nodes that will include accelerators (GPU and/or FPGA).
- Secondly, we will focus on porting and adapting the target HPC applications by implementing new computational kernels (and improving related parts such as data structures, for example), managing the granularity and adapting the parallelization to improve efficiency. The target applications are Chameleon [2], a linear algebra package, and TBFFM [3], a fast-multipole method library.
- We will study the energy consumption behavior of the building block kernels of the considered application in order to design coarse models which will be needed by the scheduling strategies. Several implementations of the same kernels can be considered (either with different precision or with different algorithmic structure).

Informations générales

- Thème/Domaine : Calcul distribué et à haute performance  
- Ville : Illkirch-Graffenstaden / Bordeaux  
- Centre Inria : CRI Nancy - Grand Est  
- Date de prise de fonction souhaitée : 2021-09-01  
- Durée de contrat : 3 ans  
- Date limite pour postuler : 2021-07-31

Contacts

- Équipe Inria : CAMUS  
- Directeur de thèse : Bramas Bérenger / Berenger.Bramas@inria.fr

A propos d’Inria

Inria is the national institute of research dedicated to the sciences and technologies of the digital. It employs 2600 persons. Several 2000 teams agiles, in general communes with different academic partners, who request more than 3500 scientists for releasing the digital of the future, together to the interface of other disciplines. In this institute has been a number of talents in more than one of the missions set in the world, 300 persons of the European Union in the research and the innovation contribute to achieve the target and carry the works of the projects of the sciences in other disciplines. The scientists of the institute are responsible for the transformation in the field of the science, and the society and the economy.

L’essentiel pour réussir

The candidate should send a resume, a cover letter, the marks and ranking of latest Master degree, and one support letter.

Consignes pour postuler

Thank you to send CV + cover letter + copy of Master Degree

Sécurité défense :

This post is susceptible to be affected in a zone to regime restrictif (ZRR), to which defined in the decree n°2011-1425 relative to the protection of the potential scientific and technique of the nation (PPST). The authorisation of access to a zone is delivered by the chef d’établissement, after avis ministériel favorable, tel que défini dans l’arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l’annulation du recrutement.

Politique de recrutement :

Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.

Attention : Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.
Finally, as a third step, we will investigate how energy consumption can be taken into account by the scheduler. Existing schedulers like Heteroprio scheduler [4] will be the building blocks of such scheduling strategies. The major objective here is to find a tradeoff between performance and energy consumption and numerical precision.

**Compétences**

The candidate should have:
- Master degree (Computer Science or equivalent)
- Proactive, high interest in solving problems
- Experience in C/C++
- Knowledge of parallelization will be highly valuable

**References**

[2] Agullo, Emmanuel and Augonnet, Cédric and Dongarra, Jack and Etienne, Hatem and Namyst, Raymond and Thibault, Samuel and Tomov, Stanimire, Faster, Cheaper, Better – a Hybridization Methodology to Develop Linear Algebra Software for GPUs, GPU Computing Gems, 2010

**Avantages**

- Subsidized meals
- Partial reimbursement of public transport costs
- Possibility of teleworking and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

**Rémunération**

1982€ / month (before taxes) during the first 2 years, 2085€ / month (before taxes) during the third year.