Informations générales

- Thème/Domaine : Calcul distribué et à haute performance
- Calcult Scientifique (BAP E)
- Ville : Lyon
- Centre Inria : CRI Grenoble - Rhône-Alpes
- Date de prise de fonction souhaitée : 01-10-2018
- Durée de contrat : 3 ans
- Date limite pour postuler : 01-05-2018

Contacts

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- Recruteur : Moy Matthieu / matthieu.moy@inria.fr

Conditions pour postuler

The campaign is not open to local students who have not done any significan mobility.

 Sécurité défense :
Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après 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.

Mission confiée

Scientific context:

In the beginning of the 2000’s, the clock frequency of computation units reached its limits. Energy-efficiency is becoming a major bottleneck for supercomputers [1]. Increasing the clock frequencies implies a loss of energy efficiency that is no longer acceptable. Most gains in performance now come from the augmentation of the number of computation units (processor cores, specialized processors). New programming paradigms have to be found to continue increasing performance in a given energy budget.

One solution is to implement the main algorithms of a computation in hardware, and map it to reconfigurable circuits (FPGA, Field Programmable Gate Array) [2]. To execute an application on FPGA, new technological locks must be overcome. Among them is the automatic and efficient translation of
Translating a program into a circuit is done in several steps. First, the front-end generates an intermediate representation adapted to circuit synthesis. In the tools developed by CASH, this formalism is called `Data-aware Process Network` (DPN) and represents a network of processes that captures the parallelism of an application and the communications between parallel processes. Then, the back-end translates each component of the process network into hardware while ensuring a good reuse of hardware resources. In the end, the circuit can be seen as a very large network of pipelined processes, reading inputs and producing outputs periodically.

The newly created CASH (http://www.ens-lyon.fr/LIP/CASH/) team works on novel approaches to extract parallelism from an imperative program to an intermediate representation. To evaluate the quality and correctness of the generated process network, one option is to execute them, either by simulating them or by running them through the back-end and execute the result on an FPGA. However, this would not provide strong correctness guarantees, just like testing software doesn't prove its correctness.

**Principales activités**

Objectives of the Thesis:

The overall objective of the thesis is to explore the possibilities of formal verification of DPN (Data-aware Process Networks). The main technique we envision is model-checking, i.e. exploration of the state-space.

The first step is to connect to existing verification tools. A good candidate is the CADP toolchain (http://cadp.inria.fr/), developed at Inria by the CONVECS team. This connection can take the form of a compiler that reads DPNs and produces the input format for CADP (LOTOS, or some lower-level formalism like AUT or BCG).

Once a basic connection is done, we can start verifying properties on the generated automata, like absence of deadlocks, temporal logic properties, or equivalence with a reference automaton.

The particular structure of DPN (static control, lot of FIFO-based communication) should make model-checking easier. For example, we expect partial-order reduction techniques to be very efficient on DPN.

The next steps of the Ph.D will therefore be to apply reduction techniques to make the verification scale to large DPN. Many techniques are already implemented in model-checking tools like CADP, and new techniques may be proposed as part of the Ph.D.

Another direction to explore is the feedback we can get from verification, in particular when the verification fails. Typical model-checkers provide a counter-example (a trace violating the property) in this case, but we can use the information provided by the model-checker to get a better diagnosis (e.g. notice that the verification failed because of an incorrect channel dimensioning, or because the execution order is wrong) and ideally suggest a fix.

**Compétences**

Expected skills:

The candidate should have good background in compilation. A good knowledge of parallel programming, both from the practical point of view and from the formal point of view (semantics, state-machine, ...) is required. Prior experience with model-checking is obviously appreciated. The Ph.D consists in theoretical aspects and practical ones, hence the candidate should have both a good theoretical background and good programming skills.

References:


Supervisors:

This thesis will be supervised by Christophe Alias (Inria Researcher, ENS-Lyon) and Matthieu Moy (Assistant professor, HDR, UCBL).

Christophe Alias (http://perso.ens-lyon.fr/christophe.alias/)’s research interests includes automatic parallelization, polyhedral compilation and high-level synthesis for FPGA circuits. He wrote a process-network compiler that he transfered to the Xtremlogic startup.

Matthieu Moy (https://matthieu-moy.fr/)’s main research area is hardware simulation (using SystemC) and formal verification (model-checking, abstract interpretation, SMT solving). More recently, he started working on worst-case execution time for software and worst-case traversal time for
networks-on-chip, and compilation for critical systems. He joined the LIP laboratory in 2017 and started working on HLS and polyhedral methods.

Keywords:
Compilation, model-checking, formal methods, parallelism, high-level synthesis.

Avantages sociaux
- Subsidised catering service
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Rémunération
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