Offer #2025-08578

PhD Position F/M Modular compilation of real-time programs

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

About the research centre or Inria department

The Inria University of Lille centre, created in 2008, employs 360 people including 305 scientists in 15 research teams. Recognised for its strong involvement in the socio-economic development of the Hauts-De-France region, the Inria University of Lille centre pursues a close relationship with large companies and SMEs. By promoting synergies between researchers and industrialists, Inria participates in the transfer of skills and expertise in digital technologies and provides access to the best European and international research for the benefit of innovation and companies, particularly in the region.For more than 10 years, the Inria University of Lille centre has been located at the heart of Lille's university and scientific ecosystem, as well as at the heart of Frenchtech, with a technology showroom based on Avenue de Bretagne in Lille, on the EuraTechnologies site of economic excellence dedicated to information and communication technologies (ICT).

Context

The PhD student will be part of the [SyCoMoRES team](#) of Inria Lille & CRIStAL lab, which currently hosts 3 fellow PhD students and one postdoc. Lille is a city close to Brussels, Paris & London, easily reachable by train, with a large student population and a number of cultural places & events.

PhD students are appointed for a duration of 3 years. We plan to organize weekly research meetings with the PhD student.

Assignment

A real-time system controls a physical device in its environment, at a rate adapted to the device evolution. This requires not only to compute correct values, but also to compute values at the right time. Real-time systems can be found in several industrial domains, such as automotive, aeronautics, nuclear plants or automated production lines.

Many ERTS are of critical nature; a malfunction may damage properties or even put human lives in danger. So as to ensure the safety of ERTS, a wide range of formal techniques have been proposed to support their design, implementation and validation. Unfortunately, one of the main drawbacks of formal methods is their poor scalability, thus limiting their applicability to complex modern ERTS. A classical approach to reduce complexity is the component-based approach. First, the system is decomposed into smaller components, each developed and analyzed in isolation. Then, the components are integrated together, and a simpler analysis is performed at the integration level.

In the current industrial practice for the development of ERTS, timing requirements are specified and analyzed only at the global level, when assembling all components. Thus, timing analysis suffers from the scalability issues mentioned previously.

The objective of the thesis is to contribute to a framework for the component-based development of real-time systems, by focusing on modular compilation.

The system will be programmed with the synchronous data-flow language Prelude, which was specifically designed for the development of critical ERTS. The language already contains constructs to structure a program as a hierarchical set of components. However, the Prelude compiler flattens the program before translating it into a non-hierarchical set of concurrent threads implemented in C.

The applicant we will study the compilation of a Prelude program into C modules structured with a hierarchy similar to that of the source program. They will define a notion of real-time interface for modules, which will expose the temporal characteristics necessary to compose modules together. The compiler will target execution with a Real-Time Operating System equipped with a hierarchical scheduler. In this scheduling model, each module is assigned a partition of the system resources and its sub-modules are executed by a local scheduler. Top-level modules are executed by a global scheduler. Particular care will go into ensuring that the semantics of the Prelude program is preserved by the compilation, especially regarding the temporal characteristics of the module interfaces.

Main activities

The following activities will be carried out during the thesis:
- Bibliographic research
- Proposing solutions for the identified research directions
- Writing research papers on the thesis results
- Teaching (optional)

Skills

Technical skills: a good background on computer science and embedded systems.

Languages: English. French is *not* required.

Other valued, appreciated: compilation, synchronous languages, real-time systems, OCaml

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- 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

General Information

- **Theme/Domain :** Embedded and Real-time Systems
  Software Experimental platforms (BAP E)
- **Town/city :** Villeneuve d'Ascq
- **Inria Center :** Centre Inria de l'Université de Lille
- **Starting date :** 2025-09-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2025-04-30

Contacts

- **Inria Team :** SYCOMORES

- **PhD Supervisor :**
  Forget Julien / julien.forget@inria.fr

About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

The keys to success

- Curiosity;
- Enjoying intellectual stimulation and facing new challenges

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

Instruction to apply

Defence Security :
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :
As part of its diversity policy, all Inria positions are accessible to people with disabilities.