**Titre (Anglais):** The Impact of scheduling algorithms on execution times of programs executed on multicore processors

**Laboratoires:** Laboratoire d'Informatique Gaspard-Monge (LIGM) et en collaboration avec le centre de recherche Inria de Paris

**Site web du laboratoire:**
LIGM http://ligm.u-pem.fr/accueil/
Inria Paris : https://www.inria.fr/fr/centre-inria-de-paris

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**Filière visée :** Systèmes Embarqués

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**Présentation générale du projet de recherche (en Anglais)**

High-performance applications requiring complex computations are nowadays emerging in the industry of embedded critical systems, e.g., autonomous vehicles implementing artificial intelligence technologies. In addition to functional properties, these critical applications have to fulfill strict timing constraints in order to provide a high level of safety, e.g., in an autonomous vehicle a braking induced by the recognition of a pedestrian that takes longer time than expected, may have dangerous consequences.

In order to achieve these complex computations, designers of such applications have to use the latest generation of embedded processors incorporating several cores. Although multicore processors increase the computation power, execution times of programs running on such processors can have significant variations between their smallest and largest values, introducing time unpredictability [1]. This time unpredictability makes the use of such processors unsafe for critical applications with real-time constraints.

If the system is using a real-time operating system, a scheduling algorithm is used by this real-time operating system to define at each instant which program, among a set of programs, will be executed on a given processor. Given a scheduling algorithm, schedulability analyses are used to prove that the set of programs satifies some timing constraints using this algorithm. These schedulability analyses are based on some parameters, among these parameters, the worst-case execution times of the programs (WCETs) is of crucial importance. In classical schedulability analysis, the WCET of a program is supposed to be constant whatever is the scheduling algorithm used by the operating system. However, due to the processor internal architecture (pipline, caches, ...) the execution time of a program, may have an impact on the execution time of another program through the scheduling algorithm.

In this context, the research project will address the problem of **time predictability** of sequential real-time [2] programs executed on multicore processors. More precisely, we focus in this internship on the impact of the scheduling algorithm on the time unpredictability of programs executed on a processor based on ARM Cortex-A53.

The stages of the research project are:

1. The choice of a real-time operating system to be installed on the target,
2. The definition of a set of example programs, configurations of the architecture and scheduling algorithms to be used to measure the impact of the scheduling algorithm on the execution times of programs,
3. Tests and interpretation of the results using statistical methods.

[1] Wilhelm, Reinhard and Engblom, Jakob and Ermedahl, Andreas and Holsti, Niklas and Thesing, Stephan and Whalley, David and Bernat, Guillem and Ferdinand, Christian and Heckmann, Reinhold and Mitra, Tulika and Mueller, Frank and Puaut, Isabelle and Puschner, Peter and Staschulat, Jan and Stenstrom, **The Worst-case Execution-time Problem: Overview of Methods and Survey of Tools,** ACM Trans. Embed. Comput. Syst., 2008.

[2] Robert I. Davis and Alan Burns, **A survey of hard real-time scheduling for multiprocessor systems,** ACM Comput. Surv, 2011