

End of Study Internship

Portable and Distributed Execution of Dataflow Applications on Embedded Platforms

Keywords: Embedded Systems · Parallel Computing · Dataflow · RTOS · Distributed Computing

Context

Embedded systems are increasingly required to execute computationally intensive applications, such as computer vision, signal processing, and machine learning, under strict constraints on energy consumption, latency, and cost. To meet these requirements, embedded platforms have evolved towards parallel architectures, ranging from multicore processors and heterogeneous chips to systems composed of several interconnected boards.

Exploiting the parallelism of these platforms efficiently remains a major challenge. Applications must be partitioned into tasks, these tasks must be allocated to processing elements, and the data exchanged between them must be managed. These decisions have a strong impact on performance, and the best choices often depend on information that only becomes available at runtime.

Dataflow Models of Computation address this challenge by describing applications as graphs of actors that exchange data through FIFO channels, which exposes the parallelism of applications explicitly. SPIDER 2.0 [1] is an open-source dataflow runtime developed at IETR. It executes dynamic dataflow applications and allocates computing resources on the fly, adapting the scheduling and mapping of tasks as the parameters of the application evolve.

In its current form, SPIDER 2.0 executes on desktop operating systems, within a single shared-memory platform. Extending it to resource-constrained embedded boards, and to platforms composed of several interconnected devices, would broaden the range of systems that can benefit from dataflow-based resource allocation, as illustrated in Figure 1.

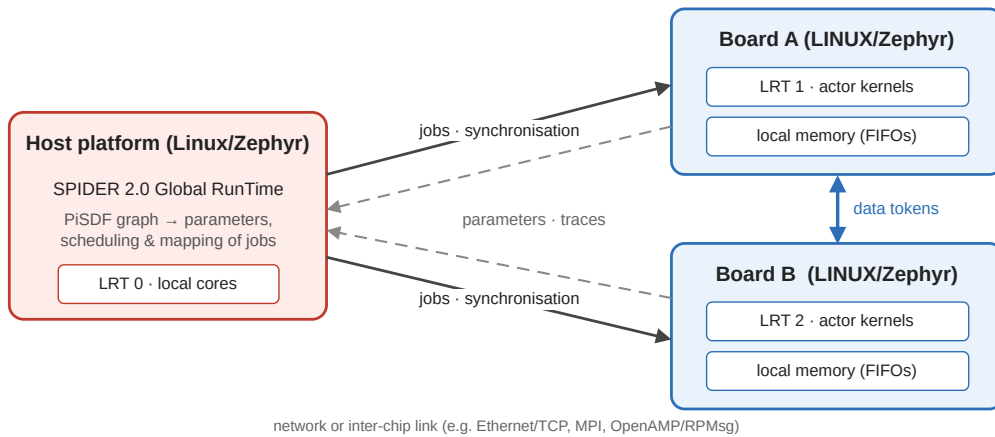


Figure 1: Targeted execution of a dataflow application with SPIDER 2.0, distributed over several embedded boards running Zephyr.

Objectives and Methodology

The objective of this internship is to make SPIDER 2.0 portable to embedded platforms and to extend it towards distributed execution. The work will be organised along the following objectives:

- Port SPIDER 2.0 to Zephyr [2], an open-source real-time operating system supported by the Linux Foundation, first on emulated targets and then on multicore embedded boards.
- Evaluate the memory footprint and the runtime overhead of SPIDER 2.0 on embedded targets, and propose adaptations suited to resource-constrained platforms.
- Extend the runtime so that the execution of a single application can be distributed over several boards connected by a network or an inter-chip link.
- Demonstrate and evaluate the distributed execution of dataflow applications on a platform composed of several Zephyr boards.

The methodology will combine software design, embedded development, and experimental validation. The intern will be encouraged to reuse and extend the existing tools of the project and to contribute to its open-source repository, and will be supported in producing reproducible experiments and clear technical documentation. Depending on the results, the work may lead to a scientific publication.

Candidate Profile

The candidate should be enrolled in a Master level program or in the final year of an engineering school, and be available for an end of study internship. The preferred profile includes the following.

- Interest in working in a scientific research laboratory.
- Programming skills in C/C++.
- Strong interest in embedded systems and parallel computing.
- Experience with microcontrollers or a real-time operating system is a plus.
- Familiarity with network programming or distributed systems is appreciated.
- Good written and spoken English. Knowledge of French is an asset.

Work Environment and Characteristics

- **Location:** VAADER team, IETR laboratory – INSA Rennes, 20 Avenue des Buttes de Coësmes, 35700 Rennes – France
- **Duration:** Four to six months
- **Start:** Flexible start date, ideally in February 2027
- **Stipend:** According to applicable regulation
- **Resources:** Access to development machines and to multicore embedded boards. Regular meetings with supervisors and participation in VAADER team scientific seminars
- **Supervisors:** Ableouahed Drissi, Hugo Miomandre, Karol Desnos (IETR, VAADER team, Rennes)
- **Application:** Applications, including a resume and a motivation letter, should be sent to hmiomand@insa-rennes.fr, abdriissi@insa-rennes.fr. *Deadline: [30.11.2026]*

References

- [1] SPIDER 2.0. <https://github.com/preesm/spider2>
- [2] Zephyr Project. <https://www.zephyrproject.org>