In the next step we will focus on defining a novel design space exploration methodology and models developed during the first part, will be mapped with the corresponding fault tolerant classes. Each of the classes will be classified into a binary classification scheme. During the second part, we will define the set of relevant fault tolerant techniques within our domain and up to the architecture level.

During the first part of this thesis, we will study the impact of faults on the basic components of a multicore architecture, i.e., the memory, the core and the interconnection, based on a shared-memory multicore based on RISC-V cores specified at the C-level through high-level synthesis and designed with a 28nm technology. To achieve this, we require to develop models to describe the faulty behaviors of these components by raising the abstraction of the existing fault models on the gate level and the architecture level.

During the second part, we will define the set of relevant fault tolerant techniques within our domain and classify these methods into a binary classification scheme. Each of the classes will be characterized with respect to the reliability that they can offer and the overhead that they impose on the design (performance, area, energy). The different possible fault scenarios, based on the abstract models developed during the first part, will be mapped with the corresponding fault tolerant classes.

In the next step we will focus on defining a novel design space exploration methodology and assigning the fault-tolerant methods developed during the first part to the corresponding design flows (compilation and synthesis tools) to enable their automatic design from high-level specifications. (iii) The interaction between algorithms and architectures especially for our main application domains (wireless communications, wireless sensor networks and digital security).

Contexte et atouts du poste
The consumer market has shifted towards multicore architectures, since the clock speeds of the single processors could not be further increased due to power consumption and heat dissipation limits [4]. Multicore provide Space, Weight and Power reductions (SWaP) and massive computing capabilities compared with single core processors, while they can integrate diverse applications on the same platform [1]. However, the reduction of the transistors size with technologies at 28nm and below has led the multicores to become more and more sensitive to the environmental impacts [2], such as ionizing, particle and high-energy electromagnetic radiation, extreme weather conditions, high temperature peaks and electromagnetic interferences. Such stimuli trigger violations on the system impacting the normal system functionality and creating faults during its operation [3]. To provide correct system functionality, the reliability of multicore architectures has become a very essential aspect. Several different fault tolerant approaches have been proposed in the literature to improve the system reliability. However, no general solution can exist to provide the required reliability in low cost for all the problems under study. The promising fault tolerant method is determined by the real faults occurring during execution, the application and the platform of each problem under study.

Mission confiée
Assignments: 3-year PhD Thesis
This PhD focuses on fault tolerant multi-core architectures and has as main goals: 1) to gain insight on the impact of faults on multicore architectures in order to model the impact of simple (SEU, SET) and multiple (MBU) errors at different levels of abstraction, and 2) to design and develop a novel method to explore the design space of the promising set of fault tolerant techniques.

Principales activités
During the first part of this thesis, we will study the impact of faults on the basic components of a multicore architecture, i.e. the memory, the core and the interconnection, based on a shared-memory multicore based on RISC-V cores specified at the C-level through high-level synthesis and designed with a 28nm technology. To achieve this, we require to develop models to describe the faulty behaviors of these components by raising the abstraction of the existing fault models on the gate level and up to the architecture level.

During the second part, we will define the set of relevant fault tolerant techniques within our domain and classify these methods into a binary classification scheme. Each of the classes will be characterized with respect to the reliability that they can offer and the overhead that they impose on the design (performance, area, energy). The different possible fault scenarios, based on the abstract models developed during the first part, will be mapped with the corresponding fault tolerant classes. In the next step we will focus on defining a novel design space exploration methodology and
designing the corresponding tools in order to efficiently explore the different fault tolerance design options. The methodology will be based on pruning methods over the binary classification and optimizations strategies. The results of the proposed methodology are the set of the most promising fault tolerant approaches under given fault scenarios and platform characteristics that reduce the system cost, while providing reliability and real-time guarantees. A RISC-V multicore architecture will be used to perform the evaluation of the proposed methodology.

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References

Compétences

The student is expected to develop techniques for design space exploration of computer architectures and fault tolerance. We also expect to have prototype implementations of the developed techniques on FPGA and ASIC. The designs will primarily be done through High-Level Synthesis tools.

Desired skills include:
- Computer architecture, hardware design, VLSI circuit design.
- Basic knowledge in compilers, fault tolerance.
- Familiarity with the C/C++ language or other languages.
- Familiarity with FPGA design and/or High-Level Synthesis.

Mostly importantly, we seek highly motivated and active students.

Avantages sociaux

- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities

Rémunération

Monthly gross salary amounting to 1982 euros for the first and second years and 2085 euros for the third year.