The design and implementation of a multicore real-time operating system as an experimental platform to benchmark and validate innovative research.

Antonio Paolillo François Santy

PARTS Research Center
Université Libre de Bruxelles
Brussels, Belgium

Within the PARTS research centre, we noticed that many existing real-time operating systems, be they commercial or open-source, were falling behind in terms of the features they provided compared to the actual state of the art literature of real-time systems theory. Furthermore, those systems are getting out of sync with the increasing trend of relying on powerful multi-core platforms, as those are generally primarily designed for uniprocessor platforms. This observation led us to believe that a gap had to be filled in this domain, as the current software solutions do not meet the current hardware requirements.

The design and implementation of an operating system is however a challenging task. This is especially true when it comes down to designing from scratch a system that is targeted by nature towards multi- or many-core systems, while meeting strict development rules to make that system certifiable, and thus attractive for industrial actors. The latter aspect is furthermore reinforced if the system is compliant with standards APIs such as POSIX, which are widely used in industrial domains. At the PARTS research centre, we took up the challenge, and dived into the exciting opportunity to fill the gap that exists between software solutions and hardware requirements. The result of this ongoing initiative is the HIPPEROS real-time operating system.

More precisely, with HIPPEROS, we put multicore mechanisms at the heart of our considerations, and wish to build a system that will scale well with an increasing number of processors. Therefore, we address topics as wide as:

- General kernel architecture, by improving stability, security and reliability as much as possible while having as little impact as possible on the system's efficiency and speed;
- Resource sharing, by using specific protocols which avoid having to lock the whole system;
- Inter-process communication, which is crucial for system performances;
- Scheduling, to make better use of the platform processor capabilities;
- Power awareness, to avoid wasting energy;
- ...

Many works have addressed these topics already in the literature, but most of them lack concrete implementation. A first step in the development of HIPPEROS thus consists in seeking for efficient implementations of those theoretical solutions, to integrate them into our operating system, compare them, and quantify their benefits.

We will not restrict ourselves to implement existing theoretical solutions though, and in the medium-term, we also aim at making HIPPEROS a strong and configurable experimental platform for our Ph.D research. We are indeed convinced that having at our disposal a system that has been designed by ourselves for multi-core platforms will help us benchmark and assess

the output of our research, and thus enhance its scientific value. Such a methodology also benefits HIPPEROS, as the platform will remain up to date with recent and validated results. This will furthermore allow us to target a wider public, as both theoretical researchers and engineers working in industrial domains should find interest in our work.

In particular, our Ph.D research focuses on parallelism, power/thermal awareness and mixed-criticality systems, which are topics that originate from actual requirements in industrial domains, and introduce very interesting theoretical problems. Those subjects are gaining an increasing interest from the embedded and real-time system communities, and will be addressed during the Artist Summer School.

We believe that a poster session at the Artist Summer School is a great opportunity to give visibility to our project, and share with all participants the experience we gained in this field over the development period. Furthermore, as the Artist Summer School gathers researchers in the field of embedded systems, this would also give us a chance to discuss and find solutions to problems we are facing, while potentially establish collaborations with foreign research centres and industrial actors.

Concretely, our poster would describe our work methodology, by explaining what approach we adopted in designing the system, as well as depict the interactions that exist between our PhD research and the system itself. Beyond this, we also want our poster to awaken people's curiosity, and invite them to discuss with us about the project's state, goal, and possible extensions.