

Prof. Antonio PAOLILLO

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Software engineer - Computer scientist
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Short bio

Most of my experience is in **R&D** environments, where I solved practical, industry-related problems with foundational theoretical roots. I strongly focus on **performance analysis** and **reproducible research**.

My interests gravitate towards **low-level** and **system software** development, with demanding constraints such as safety and performance that require parallelism and concurrency. During my Ph.D. thesis, I specialised in **embedded real-time software** and **operating system design** running on modern heterogeneous multi-core platforms (also with GPUs & FPGAs). Recently, I have a growing interest for machine learning (especially reinforcement learning) and how it could be applied to improve system software.

Former co-workers describe me as fast, result-driven, sharp, empathetic and generally bringing lots of motivation into the group. **Teamwork** is key for me and I can demonstrate **good leadership**.

Professional experience

- **Vrije Universiteit Brussel, Assistant Professor**
Brussels, Belgium

November 2023 - Today

I started as tenure-track professor in VUB in the DINF/SOFT lab (<http://soft.vub.ac.be/>). My research area stays in software systems, operating systems, real-time, performance metrics and benchmarking, and I will also dive more deeply into software for robotics & automotive, and into performance modeling of heterogeneous systems, exploring GPUs, FPGAs, and more.

- **Interuniversity Microelectronics Centre (IMEC),
Real-Time Operating System Lead Engineer & Consultant**
Brussels, Belgium

October 2023 - Today

I lead the implementation and support the design of the processing part of the SAFEBOT project, aiming to create robots that are both efficient and safe for humans to work with. I define the support layer including operating systems, drivers and libraries. The goal is to provide to SAFEBOT with a robust real-time operating system platform for the whole system. I also train the team in multi-threaded programming, networking, and software development lifecycle methodologies. Finally, I co-apply for funding with imec PIs.

- **Huawei, Operating System Software Architect & Expert** *November 2019 - September 2023*
Dresden, Germany 4 years

The Dresden Research Center targets R&D contributions (both internally and externally) in the field of Operating Systems. I built low-level software platforms, benchmarks and experiments to explore new breakthroughs in kernel mechanisms on Linux, home-brewed kernels or bare-metal platforms. See our SOSP'21 CLoF results: <https://dl.acm.org/doi/10.1145/3477132.3483557>

I actively **mentored** one industrial Ph.D. student and I was involved in research projects and proposals. I was also responsible for the daily tasks and workload of an external consultant.

I spent **2 months in China** to work in headquarters, applying our findings into product lines, contributing to large production OS codebases (>30MLoC) and improving end-to-end performance.

I obtained the following individual awards: Outstanding contribution to the Sanyapo project (China, 2022), Central Software Institute President's Award - Best Newcomer Award (2021), and Future Star Award (2020).

- **Freelance software engineer**

Brussels, Belgium

June 2019 - October 2019

6 months

Past missions include:

- Re-implement complex algorithms modelling physics phenomena from Python to **C++** and **CUDA**, obtaining speedups up to **x600**
- Planning for start-ups including roadmapping, requirements analysis and funding applications
- Training and consulting regarding embedded software engineering for IoT companies, including analysing business requirements and designing a verification and validation methodology (embedded debugging, emulations, continuous improvement, continuous delivery)

- **HIPPEROS, senior software engineer**

Louvain-la-Neuve, Belgium

December 2012 - May 2019

6 years, 5 months

University spin-off developing embedded real-time operating systems. I was a core kernel developer prior to the creation of the company.

- Kernel Research & Development **Team Leader** (3-4 senior software engineer reports since December 2017; mentored 4 successful master's students)
- **Software engineering**, including requirements analysis, development and testing of operating system and application products, mainly in **C**, **C++** and **Python**
- RTOS consultant for customers, partners and leads
- **Project Manager** and **major contributor** in the Horizon 2020 **Tulipp** European project (<http://tulipp.eu>), notably with **Thales**, featuring cutting-edge **hardware acceleration** technology for embedded **image processing** and computer vision applications
- Design and implementation of the multi-core HIPPEROS Real-Time Operating System
- Research work on low-power parallel real-time embedded systems, with strong focus on **power management**, **scheduling** and **multi-threading** modules of the kernel
- Contributions to several work packages of the FP7 CRAFTERS funded project

- **S.W.I.F.T., junior software developer**

La Hulpe, Belgium

October 2011 - November 2012

1 year, 2 months

SWIFT provides a private and secured transactions network to financial institutions and banks. I was involved in the complete **software life-cycle** (design, development, testing, qualification and maintenance) of a real-time gross settlement software used by the **Euro Banking Association** (<https://www.ebaclearing.eu/>) written in **C/C++/C#** and using Oracle databases and XML.

Background

- **Ph.D. degree in Computer Science**

Université Libre de Bruxelles (ULB)

December 2012 - October 2018

Brussels, Belgium

For 6 years, in parallel to my commitment in the HIPPEROS project, I carried out research work at the University in the field of **parallel Real-Time Operating Systems** with **low-power constraints**. This led me to publish 11 papers.

I wrote a 382-page dissertation titled “*Optimization of Performance Metrics of Embedded Hard Real-Time Systems using Software and Hardware Parallelism*”. The text is available online: <https://difusion.ulb.ac.be/vufind/Record/ULB-DIPOT:oai:dipot.ulb.ac.be:2013/277427/Holdings>
A video recording of the public defence is also available: <https://youtu.be/RjffZA61tas0>

I presented results in international conferences, participated in research projects and was involved in many activities of my research lab, called PARTS (<http://parts.ulb.ac.be/>). I mentored 5 successful master students and directed their theses; 2 obtained the “Babbage award” for their master's theses (in 2019, see <https://babbage.ulb.be/prix-babbage/>).

- **Master degree in Computer Science**
Université Libre de Bruxelles (ULB)

September 2006 - June 2011
Brussels, Belgium

- Master's thesis: *Multi-criteria performance prediction for embedded system design*
- Master obtained *magna cum laude* (major in embedded system design)
- Bachelor obtained *summa cum laude* (major in electrical engineering)
- *Fleurice Mercier* prize: Award for the best Grade Point Average in first year at Science Faculty (Academic year 2006-2007)

Languages

French – Native language **Italian** – Second native language **English** – Fluent (C1)

Technical skills

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|--------------------------------|--|
| Languages | C , C++ , Embedded C , Rust (basics), Python , bash, POSIX shell, L^AT_EX |
| Assembly | ARMv7-A , ARMv8-A , IA32 |
| HW Parallelism | VHDL, HLS, OpenMP, CUDA |
| Build system | Make , CMake , Yocto |
| OS & Virtualisation | Linux , Unix-like, Docker , Docker Compose, Oracle VirtualBox, SSH, Ansible |
| Data analysis & ML | R, Jupyter , Pandas , Matplotlib, PyTorch, OpenAI gym, MuJoCo |
| Text editors & IDE | vim, CLion , Pycharm |
| VCS | Git , SVN |
| Embedded tools | OpenOCD (JTAG), U-Boot , GDB , fastboot, adb, Lauterbach Trace32, Xilinx Vivado/SDx, FPGA |
| Platforms | i.MX6, Zynq 7000, Zynq UltraScale+ (FPGA/CPU interfaces) Intel/AMD many-core servers, HiSilicon Kunpeng 920 Hikey960, Raspberry Pi, RocksPi |
| OS design | Micro-kernel , scheduling , virtual memory, multi-core, low-power, concurrency (spinlocks , mutexes & semaphores), frequency scaling , Kernel programming (Linux, custom kernels), performance monitors (perf) |
| Methodologies | Agile: Scrum, Kanban, Scrumban |
| Electronics | Power measurement, oscilloscope probe |
| CS Theory | Operating systems (Unix, RTOS), processor architecture, real-time systems , computer networks (TCP/UDP, socket programming), weak memory models, computational geometry, computer security and cryptography (basics) |
| Machine learning | Statistical foundations (probability & statistics), feature selection, supervised learning (regressions, random forests, DNNs, SVMs, etc.), reinforcement learning (MDP, Deep Q-learning, policy gradient) |
| Databases & DBMS | MySQL, PostgreSQL, LevelDB, RocksDB, Kyoto cabinet |
| Formal verification | GenMC and Dartagnan model checkers |
| Game engines | Godot |
| Repos & CI/CD | GitHub, GitLab , GitLab-CI , Jenkins |

Relevant coursework

- **Reinforcement Learning - XCS234** *March 2022 - May 2022*
Stanford University - Grade: 100% Stanford, California, United States (remotely)

<https://online.stanford.edu/courses/xcs234-reinforcement-learning>

Introduction to reinforcement learning concepts such as RL planning & learning, value function approximation, TD learning, deep q-learning, policy gradient algorithms, multi-armed bandits, Thompson sampling, bayesian regret. Using Python and Pytorch for most implementation tasks (with OpenAI Gym and MuJoCo as a testing framework).

Projects: training DQN on Atari Pong as in DeepMind's paper in Nature (2015); training various models in MuJoCo using REINFORCE; estimating Warfarin dose for patients and comparing the performances of a linear model, a disjoint linear UCB algorithm, a ϵ -greedy method and Thompson sampling.

- **Statistical foundations of machine learning - INFO-F422** *February 2021 - June 2021*
Université Libre de Bruxelles (ULB) - Grade: 20/20 Brussels, Belgium (remotely)

<https://www.ulb.be/en/programme/info-f422>

Independent course taken as a refresher for probability theory, statistics, estimation (bias & variance trade-offs), ML concepts (resampling, bootstrapping, feature selection, model selection) and supervised learning algorithms (DNNs, random forests, decision trees, SVM, KNN, Naive-Bayes, etc.). Using the R language in most implementation tasks.

Project: DrivenData.org competition, trying different supervised models to improve accuracy

(<https://www.drivendata.org/competitions/7/pump-it-up-data-mining-the-water-table/>).

Publications & scientific activities

Scientific committee

- ECRTS'24: Works in Progress & Real-Time Pitches chair
- RTNS'19: Junior Workshop co-chair

Book chapter

- Tobias Kalb, Lester Kalms, Diana Göhringer, Carlota Pons, Ananya Muddukrishna, Magnus Jahre, Boitumelo Ruf, Tobias Schuchert, Igor Tchouchenkov, Carl Ehrensträhle, Magnus Peterson, Flemming Christensen, **Antonio Paolillo**, Ben Rodriguez, and Philippe Millet. *Developing Low-Power Image Processing Applications with the TULIPP Reference Platform Instance*, pages 181–197. Springer International Publishing, Cham, 2019.

Technical notes and reports

- **Antonio Paolillo**, Hernán Ponce de León, Thomas Haas, Diogo Behrens, Rafael Chehab, Ming Fu, and Roland Meyer. Verifying and Optimizing Compact NUMA-Aware Locks on Weak Memory Models, 2022. <https://arxiv.org/abs/2111.15240>.

Conference papers

- Rafael Lourenco de Lima Chehab, **Antonio Paolillo**, Diogo Behrens, Ming Fu, Hermann Härtig, and Haibo Chen. CLoF: A Compositional Lock Framework for Multi-Level NUMA Systems. In *Proceedings of the ACM SIGOPS 28th Symposium on Operating Systems Principles, SOSP '21*, 2021. CORE rank: **A***.
- Jonas Oberhauser, Lilith Oberhauser, **Antonio Paolillo**, Diogo Behrens, Ming Fu, and Viktor Vafeiadis. Verifying and optimizing the hmcs lock for arm servers. In *Proceedings of the 9th International Conference on NETworked sYStems, NETYS '21*, 2021.
- Jonas Oberhauser, Rafael Lourenco de Lima Chehab, Diogo Behrens, Ming Fu, **Antonio Paolillo**, Lilith Oberhauser, Koustubha Bhat, Yuzhong Wen, Haibo Chen, Jaeho Kim, and Viktor Vafeiadis. Vsync: Push-button verification and optimization for synchronization primitives on weak memory models. In *Proceedings of the 26th ACM International Conference on Architectural Support for Programming Languages and Operating Systems, ASPLOS 2021*, page 530–545, New York, NY, USA, 2021. Association for Computing Machinery. **Distinguished paper award**. CORE rank: **A***.
- Joël Goossens, Xavier Poczekajlo, **Antonio Paolillo**, and Paul Rodriguez. Acceptor: A model and a protocol for real-time multi-mode applications on reconfigurable heterogeneous platforms. In *Proceedings of the 27th International Conference on Real-Time Networks and Systems, RTNS '19*. ACM, 2019.
- Juan M. Rivas, Joël Goossens, Xavier Poczekajlo, and **Antonio Paolillo**. Implementation of Memory Centric Scheduling for COTS Multi-Core Real-Time Systems. In *31th Euromicro Conference on Real-Time Systems (ECRTS 2019)*, Leibniz International Proceedings in Informatics (LIPIcs), 2019. CORE rank: **A**.
- Ahmad Sadek, Ananya Muddukrishna, Lester Kalms, Asbjørn Djupdal, Ariel Podlubne, **Antonio Paolillo**, Diana Goehringer, and Magnus Jahre. Supporting utilities for heterogeneous embedded image processing platforms (sthem): An overview. In *Applied Reconfigurable Computing. Architectures, Tools, and Applications*, pages 737–749, Cham, 2018. Springer International Publishing.

- **Antonio Paolillo**, Paul Rodriguez, Nikita Veshchikov, Joël Goossens, and Ben Rodriguez. Quantifying energy consumption for practical fork-join parallelism on an embedded real-time operating system. In *Proceedings of the 24th International Conference on Real-Time Networks and Systems*, RTNS '16, pages 329–338. ACM, 2016.
- T. Kalb, L. Kalms, D. Göhringer, C. Pons, F. Marty, A. Muddukrishna, M. Jahre, P. G. Kjeldsberg, B. Ruf, T. Schuchert, I. Tchouchenkov, C. Ehrenstrahle, F. Christensen, **A. Paolillo**, C. Lemer, G. Bernard, F. Duhem, and P. Millet. Tulipp: Towards ubiquitous low-power image processing platforms. In *2016 International Conference on Embedded Computer Systems: Architectures, Modeling and Simulation (SAMOS)*, pages 306–311, 7 2016.
- **A. Paolillo**, J. Goossens, P. M. Hettiarachchi, and N. Fisher. Power minimization for parallel real-time systems with malleable jobs and homogeneous frequencies. In *2014 IEEE 20th International Conference on Embedded and Real-Time Computing Systems and Applications*, pages 1–10, 8 2014. CORE rank: **B**.

Workshop papers

- **Antonio Paolillo**, Paul Rodriguez, Vladimir Svoboda, Olivier Desenfans, Joël Goossens, Ben Rodriguez, Sylvain Girbal, Madeleine Faugère, and Philippe Bonnot. Porting a safety-critical industrial application on a mixed-criticality enabled real-time operating system. In *Proceedings of the 5th Workshop on Mixed-Criticality Systems*, 12 2017.
- Martin Cornil, **Antonio Paolillo**, Joël Goossens, and Ben Rodriguez. Research and implementation challenges of rtos support for heterogeneous computing platforms. In *Heterogeneous Architectures and Real-Time Systems Seminar*, 5 2017.
- **Antonio Paolillo**, Olivier Desenfans, Vladimir Svoboda, Joël Goossens, and Ben Rodriguez. A new configurable and parallel embedded real-time micro-kernel for multi-core platforms. In *Proceedings of the ECRTS Workshop on Operating Systems Platforms for Embedded Real-Time applications*, 7 2015.
- Olivier Desenfans, **Antonio Paolillo**, Vladimir Svoboda, Ben Rodriguez, Joël Goossens, and Dragomir Milojevic. Design and implementation of a multi-core embedded real-time operating system kernel. In *ACTRISS OPRTC-ULB*, 4 2014.
- **Antonio Paolillo** and François Santy. The design and implementation of a multicore real-time operating system as an experimental platform to benchmark and validate innovative research. In *Nano-Tera/Artist International Summer School on Embedded System Design*, 9 2013.