
UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

**DOTTORATO DI RICERCA / PhD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING**

Activities and Publications Report

PhD Student: **Alberto Moriconi**

Student DR number: DR995869

PhD Cycle: XXXVII

PhD Cycle Chairman: Prof. Stefano Russo

PhD program student's start date: 1/11/2021

PhD program student's end date: 31/10/2024

Supervisor: Prof. Nicola Mazzocca

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PhD scholarship funding entity: No scholarship

General information

Alberto Moriconi received in year 2019 the Master of Science degree in Computer Engineering from the University of Napoli Federico II. He attended a curriculum in Computer Engineering within the PhD program in Information Technology and Electrical Engineering. He enrolled into the ITEE PhD program without a grant.

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1 st	Virtualization technologies and their applications	Ad hoc course	5	Prof. Luigi De Simone, DIETI	ITEE

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
1 st					

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1 st	Complexity and the City	0.3			Futuro Remoto 2020
1 st	Threat Hunting Use-Cases	0.4			Prof. D. Cotroneo, Prof. S.P. Romano, Dr. R. Natella, DIETI – Unina
1 st	Designing Quantum Algorithms	0.4			Prof. A. S. Cacciapuoti, DIETI – Unina
1 st	GDPR Basics for Computer Scientists	0.4			Prof. Piero Bonatti, DIETI – Unina
1 st	Intelligenza artificiale e sistemi d'arma autonomi	0.4			Gruppo Interdisciplinare su Scienza, Tecnologia e Società (GI-STES) dell'Area della Ricerca di Pisa del CNR
1 st	The learning landscape in deep neural networks and its exploitation by learning algorithms	0.4			CQB, ITEE and ICTH PhD courses, DIETI
1 st	Potential and challenges of next generation railway signaling systems: Moving Block and Virtual Coupling	0.2			Prof. Valeria Vittorini (DIETI, UNINA)
1 st	Piattaforma ACC di RFI	3.2			Rete Ferroviaria Italiana S.p.A.

Activities and Publications – Final Report

UNINA PhD in Information Technology and Electrical Engineering – XXXVII Cycle

PhD candidate: **Alberto Moriconi**

1 st	Introduction to MBSE & System Validation with SLRT	0.4			The Mathworks srl, Rete Ferroviaria Italiana S.p.A.
2 nd	Enhancing qubit readout with Bayesian Learning	0.2			Quantum Science and Technologies @Naples
2 nd	Traffic Engineering with Segmented Routing: optimally addressing popular use cases	0.2			Prof. V. Persico, DIETI, Unina
2 nd	Exploring Advanced Aerial Robotics: A Journey Into Cutting-Edge Projects and Neural Control	0.2			Ing. Eugenio Cuniato, ETH Zurich
2 nd	Models of human motor coordination – a critical assessment and some open problems	0.2			John Hogan, University of Bristol, UK
2 nd	BGP & Hot-Potato Routing: graceful and optimal convergence in case of IGP events	0.2			Prof. V. Persico, DIETI, Unina
2 nd	Ricerca e formazione nella società della transizione digitale	1			CINI (Consorzio Interuniversitario Nazionale per l'Informatica)
2 nd	Unina Quantum Day – Come può tornarci utile la scienza	0.4			Proff. Francesco Tafuri, Giovanni Piero Pepe, Dipartimento di Fisica "Ettore Pancini",

Research activities

Alberto Moriconi participated in research on Approximate Computing under the supervision of prof. Nicola Mazzocca, working on methodologies and tools that enhanced the state of the art for the automatic generation of approximate variants of combinatorial circuits. His research has been focused on state-of-the-art approaches, algorithms and data structures, starting with applications on area reduction on ASICs, then exploring the application of the devised methodologies and tools to FPGA technology, showing improvements in other relevant metrics such as switching activity.

An important part of the research activity has been done in collaboration with Rete Ferroviaria Italiana S.p.A., focusing on several topics relevant to strategic projects for the Italian railway infrastructure. Here, the main topics of research have been the development of real-time operating systems for resource-constrained devices in safety critical applications, the development of safe architectures for autonomous train operation and the development of innovative board equipment such as Balise Transmission Module and Odometry.

Tutoring and supplementary teaching activities

Exercitations on datapath and control unit implementation based on the microprogrammed design paradigm for the Digital Systems Design course (Architettura dei Sistemi Digitali) – Prof. Nicola Mazzocca - 12 hours on the second year, 2 hours on the third year.

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1 st	5	6.1	36	
2 nd		2.4	56	0.5
3 rd			73,8	0.2

The significative deviations from the directions of the Ph. D. course organization are motivated by the strong effort applied to both academical and industrial research.

The candidate has participated in numerous strategic projects for the manager of the Italian railway infrastructure, Rete Ferroviaria Italiana S.p.A., also contributing to activities in collaboration with the DIETI Department ad University of Naples Federico II and the CINI Consortium, with roles spanning design, implementation, V&V and certification.

In the last year, most of the training and study has been centered around the V&V and certification process for safety critical system. These topics, recorded as Research Credits, have been covered by the study of relevant standards and subsets, industrial meetings, direct

participation in V&V and certification activities, study on online platforms, and formed the basis for both the industrial training and the subset of the research stemmed from the need to address specific industrial demands.

While the software artifacts are not publicly disclosed, numerous research products in international journals and conferences have been produced, as detailed in the following sections.

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities

PhD Thesis

In the PhD Thesis, Alberto Moriconi contributes to currently emerging research in Approximate Computing, with particular attention to the automatic generation of approximate variants of combinatorial circuits and their applications on relevant modern technologies, such as multipliers used in accelerator circuits for image processing and convolutional neural networks.

The thesis details the state of the art of design space exploration tools at different levels of the system design: from the system level to the software level, down to the hardware level.

The problem of approximation of combinatorial circuits is then approached by a fully automatic methodology and tool based on non-trivial local rewriting of and-inverter graphs, obtained by describing the optimization problem as a Satisfiability Modulo Theories (SMT) problem and applying multi-objective optimization to gradually introduce the approximation, providing state-of-the-art improvements in the resulting circuit area.

While directly tailored for ASICs, the proposed methodology is then shown to be able to successfully address approximation of circuits targeting FPGAs, obtaining notable improvements in the resulting circuit switching activity.

A number of improvements for the FPGA case is then applied, by devising a switching activity-based energy dissipation model to use as an optimization metric and by exploiting specific approaches based on properties of the underlying circuits (specifically the use of Grobner bases for error evaluation of arithmetic circuits) in order to reduce the complexity of the optimization problem and allow the methodology to be applied to bigger circuits.

Research products

Research results appear in 3 papers published in international journals, 3 contributions to international conferences, 1 book chapter.

List of scientific publications

International journal papers

M. Barbareschi, S. Barone, N. Mazzocca, A. Moriconi,

A catalog-based AIG-rewriting approach to the design of approximate components,

IEEE Transactions on Emerging Topics in Computing,

11(1), 70-81, 2022, DOI: [10.1109/TETC.2022.3170502](https://doi.org/10.1109/TETC.2022.3170502)

A. Amendola, M. Barbareschi, S. De Simone, G. Mezzina, A. Moriconi, C. L. Saragaglia, D. Serra, D. De Venuto,

A real-time vital control module to increase capabilities of railway control systems in highly automated train operations

Real Time Systems,

59(4), 636-661, 2023, DOI: <https://doi.org/10.1007/s11241-023-09401-5>

M. Barbareschi, S. Barone, N. Mazzocca, A. Moriconi,

FPGA approximate logic synthesis through catalog-based AIG-rewriting technique,

Journal of Systems Architecture,

150, 103112, 2022, DOI: <https://doi.org/10.1016/j.sysarc.2024.103112>

M. Al-Shanawani, A. B. Gok, A. Costanzo, D. Masotti, A. Moriconi, T. Salmon Cinotti

Efficient Telepowering Unit for Balise Transmission Modules Using Class-E Amplifier,

Submitted to: *IEEE Transactions on Transportation Electrification*, Currently undergoing peer review

International conference papers

M. Barbareschi, S. Barone, V. Casola, P. Montone, A. Moriconi,

A Memory Protection Strategy for Resource Constrained Devices in Safety Critical Applications

2022 6th International Conference on System Reliability and Safety (ICSRS),

Venice, Italy, Oct. 2022, pp. 533-538, IEEE, DOI: [10.1109/ICSRS56243.2022.10067350](https://doi.org/10.1109/ICSRS56243.2022.10067350)

G. Mezzina, A. Amendola, M. Barbareschi, S. De Simone, G. Mascellaro, A. Moriconi, C. L. Saragaglia, D. Serra, D. De Venuto

A Step Toward Safe Unattended Train Operations: A Pioneer Vital Control Module.

2023 Design, Automation & Test in Europe Conference & Exhibition (DATE),

Antwerp, Belgium, Apr. 2023, pp. 1-4, IEEE, DOI: [10.23919/DATE56975.2023.10137186](https://doi.org/10.23919/DATE56975.2023.10137186)

G. Mezzina, C. L. Saragaglia, M. Barbareschi, D. Serra, S. De Simone, A. Moriconi, D. De Venuto

Model-Based Vital Control Architecture for Highly Automated Train Operations2022

International Conference on Applications in Electronics Pervading Industry, Environment and Society

Genova, Italy, Sept. 2023, pp. 163-170, Springer Nature Switzerland, DOI: https://doi.org/10.1007/978-3-031-30333-3_21

Book chapters

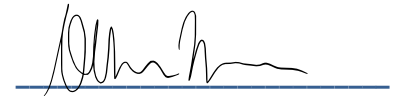
M. Barbareschi, S. Barone, N. Mazzocca, A. Moriconi,
Design Space Exploration Tools
In: A. Bosio, D.Ménard, O. Sentieys (eds) Approximate Computing Techniques: From Component- to Application-Level,
215-259, Springer, Cham, 2022, DOI: https://doi.org/10.1007/978-3-030-94705-7_8

Awards and Prizes

The International conference paper “A Memory Protection Strategy for Resource Constrained Devices in Safety Critical Applications” has been selected as the best of his session at the the 2022 6th International Conference on System Reliability and Safety (ICSRS 2022) held during November 23-25, 2022 in Venice, Italy.

Date: 15/10/2024

PhD student signature



Supervisor signature

