



**PhD in Information Technology and Electrical Engineering**  
Università degli Studi di Napoli Federico II

**PhD Student: Marco Barletta**

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Cycle: XXXVII

**Training and Research Activities Report**

**Year: First**

*student signature*

**Tutor: prof. Marcello Cinque**

*tutor signature*

**Date: October 31, 2022**

# Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: XXXVII

Author: Marco Barletta

## 1. Information:

- **PhD student:** Marco Barletta
- **DR number:** DR995851
- **Date of birth:** 24/04/1998
- **Master Science degree:** Computer Engineering
- **University:** Università degli Studi di Napoli Federico II
- **Doctoral Cycle:** XXXVII
- **Scholarship type:** UNINA
- **Tutor:** Marcello Cinque
- **Co-tutor:** N/A

## 2. Study and training activities:

Activity	Type <sup>1</sup>	Hours	Credits	Dates	Organizer	Certificate <sup>2</sup>
Real-Time Industrial Systems	Course	48	6	27/12/2021	Prof. Marcello Cinque	Y
Second Quantum Revolution: innovation trends and expected industrial impacts.	Seminar	2	0.4	22/10/2021	Prof. Angela Sara Cacciapuoti	Y
Qiskit: state of the art and tools for Quantum Computers from IBM.	Seminar	2	0.4	5/10/2021	Prof. Angela Sara Cacciapuoti	Y
Possible Quantum Machine Learning Approaches in HEP	Seminar	2	0.4	12/11/2021	Prof. Angela Sara Cacciapuoti	Y
Threat Hunting Essentials	Seminar	2	0.4	03/12/2021	Proff. D.Cotroneo, S.P. Romano, R.Natella.	Y
GDPR basics for computer scientists.	Seminar	2	0.4	14/12/2021	Prof. Piero Bonatti	Y
Designing Quantum Algorithms.	Seminar	2	0.4	6/12/2021	Prof. Angela Sara Cacciapuoti	Y
All roads lead to WebRTC: an introduction to Janus.	Seminar	2	0.4	16/12/2021	Prof. S.P. Romano	Y
Complexity and the City: transitioning towards the smart cities of the future.	Seminar	1	0.2	3/11/2021	Città della Scienza.	N
Quantum Information	Course	48	6	13/01/2022	Prof. Angela Sara Cacciapuoti	Y
Virtualization technologies and their applications	Course	20	5	04/03/2022	Dr. Luigi De Simone	Y

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IEEE Authorship and Open Access Symposium: Tips and Best Practices to Get Published from IEEE Editor	Seminar	1.5	0.3	30/03/2022	IEEE	Y
Project Vāc: Can a Text-to-Speech Engine Generate Human Sentiments?"	Seminar	1	0.2	28/02/2022	Dip. Fisica, "Ettore Pancini"	N
From basic principles in spintronics to some recent developments toward spin-orbitronics	Seminar	1	0.2	31/03/2022	Prof. Claudio Serpico.	N
Potential and challenges of next generation railway signaling systems: Moving Block and Virtual Coupling	Seminar	1	0.2	06/04/2022	Prof. Valeria Vittorini	Y
Ethics and Politics of A.I.	Seminar	1	0.2	11/04/2022	Dip. Fisica, "Ettore Pancini"	N
Explainable Natural Language Inference	Seminar	1.5	0.3	3/04/2022	Prof. Francesco Cutugno	Y
An Introduction to Deep Learning for Natural Language Processing	Seminar	1	0.2	13/04/2022	Prof. Francesco Cutugno	Y
Using Delays For Control	Seminar	1	0.2	21/04/2022	Prof. Stefania Santini	Y
Statistical data analysis for science and engineering research	Course	12	4	11/05/2022	Prof. Roberto Pietrantuono	Y
A day in the life of a chief data officer	Seminar	1.5	0.3	09/05/2022	Dip. Fisica, "Ettore Pancini"	N
Imprenditorialità accademica	Course	12	4	25/07/2022	Prof. Pierluigi Rippa	Y
Privacy-preserving machine learning	Seminar	2	0.4	14/10/2022	Proff. Simon Pietro Romano, Roberto Natella	Y

1) Courses, Seminar, Doctoral School, Research, Tutorship

2) Choose: Y or N

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## 2.1. Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	6	3	4	0	13
Bimonth 2	6	0	5	0	11
Bimonth 3	5	1.8	6	0	12.8
Bimonth 4	4	0.3	7	0	11.3
Bimonth 5	4	0	7	0	11
Bimonth 6	0	0.4	7.5	0	7.9
<b>Total</b>	<b>25</b>	<b>5.5</b>	<b>36.5</b>	<b>0</b>	<b>67</b>
<b>Expected</b>	<b>30 - 70</b>	<b>10 - 30</b>	<b>80 - 140</b>	<b>0 - 4.8</b>	

## 3. Research activity:

*My research activity is about Orchestration strategies for dependable mixed-criticality software containers in IIoT and Industry 4.0 environments.*

*The Industry 4.0 vision is to automate the adaptation of the factory floors and production lines to any new business goal without the need for manual intervention. This brings the need for continuous and automatic reconfiguration of the networks, the computing infrastructure and the devices within the factory floor.*

*Although Information Technology have already been spreading in the last decades into industrial environments, allowing an automatic and precise control of machinery, a complete autonomous management and reconfiguration of the whole floor is not possible yet.*

*Currently, the problem is that, in order to meet strict regulatory non-functional requirements of timeliness, reliability, security, safety, etc., recent IT computing paradigms are not applicable to industrial contexts, that still rely on IT products with little flexibility and programmability compared to the level required by the I4.0 vision.*

*The full flexibility and programmability can be enabled by the softwarization of industrial components, and their automatic orchestration. Orchestration systems are distributed systems in charge of automatically placing, deploying, monitoring, and migrating the packaged software across the computing infrastructure. Nevertheless, orchestration systems are designed for cloud computing, and there are several limitation that prevent their use in I4.0, that can be described through a fog/edge computing model.*

*During the first year of my PhD, I used some time to depict the state of the art and the practice regarding orchestration systems for mixed-criticality environments, i.e. systems that integrate functionalities at different criticality levels into common platforms to reduce the size, weight, power, and cost of hardware. Criticality can be defined as “designation of the level of assurance against failure needed for a system component” (A.Burns, R. Davis “Mixed-Criticality systems, a review”). Hence, I identified four essential problems in the available orchestration systems that prevent their use in I4.0:*

- They are seamlessly integrated with containers, i.e. OS-level technology to easily pack and deploy the software. Anyway containers are known to suffer from reduced isolation with regard co-located workloads in terms of faults and performance. This prevents their use in industrial environments.*

- *The placement strategies are based on metrics oriented to the overall resource utilization, and they do not take into account non-functional requirements, that are paramount in industrial contexts. Both nodes and workloads are not characterized by suitable abstractions to take into account the criticality level of the workloads, isolation level of computing resources, timeliness requirements, and so on.*
- *The architecture, the monitoring and the failure mitigation policies of orchestration systems are not designed for industrial contexts, where several nines of availability/reliability are required, along with downtimes in the scope of milliseconds.*
- *Networking resources and computing resources are managed independently, with network-aware application placement, or application-aware networking. To reach a full programmability, a joint management of the overall infrastructure is required.*

*I identified possible research paths to address the described limitations, sketching some ideas and building some prototypes. I showed these ideas and prototypes to the community to have a feedback as soon as possible to better define the research direction to undertake. To this aim, I had to deep dive into the knowledge and technicalities of several virtualization technology to understand their advantages and disadvantages, I enhanced my knowledge of hard real-time systems and studied industrial contexts to better understand requirements, use cases, and limitations.*

#### 4. Research products:

*“Hierarchical Scheduling for Real-Time Containers in Mixed-Criticality Systems”*

*M. Barletta, M. Cinque, R. Della Corte*

*32nd IEEE International Symposium on Software Reliability Engineering (ISSRE 2021) – Fast abstracts  
Published*

*“Achieving isolation in mixed-criticality industrial edge systems with real-time containers”*

*M. Barletta, M. Cinque, L. De Simone, R. Della Corte*

*34th Euromicro Conference on Real-Time Systems (ECRTS 2022)  
Published*

*“Achieving isolation in mixed-criticality industrial edge systems with real-time containers (Artifact)”*

*M. Barletta, M. Cinque, L. De Simone, R. Della Corte*

*34th Euromicro Conference on Real-Time Systems (ECRTS 2022)  
Published*

*“Introducing k4. 0s: a Model for Mixed-Criticality Container Orchestration in Industry 4.0”*

*M. Barletta, M. Cinque, L. De Simone, R. Della Corte*

*7th IEEE Cyber Science and Technology Congress (CyberSciTech 2022)  
Accepted, to be published*

*“RunPHI: Enabling Mixed-criticality Containers via Partitioning Hypervisors in Industry 4.0”*

*M. Barletta, M. Cinque, L. De Simone, R. Della Corte, G. Farina, D. Ottaviano*

*33rd IEEE International Symposium on Software Reliability Engineering (ISSRE 2022) – Fast abstracts  
Accepted, to be published*

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*“SLA-Driven Software Orchestration in Industry 4.0”*

*M. Barletta, M. Cinque, C. Di Martino*

*IEEE Internet of Things Magazine (IEEE IoTM)*

*Submitted, under review*

## 5. Conferences and seminars attended

*34th Euromicro Conference on Real-Time Systems (ECRTS 2022)*

*05 to 08 July 2022, Modena. I attended the conference as presenting author of “Achieving isolation in mixed-criticality industrial edge systems with real-time containers” and “Introducing k4. 0s: a Model for Mixed-Criticality Container Orchestration in Industry 4.0”*

## 6. Activity abroad:

*I spent from 01/06/2022 to 30/09/2022 in Stuttgart (Germany) at Nokia Bell Labs for a Ph.D. internship, studying 5G network orchestration for industrial environments. There, supervised by Catello Di Martino, I identified the fourth and part of the third limitations described in Section 3. I designed failure mitigation strategies for industrial workloads at different criticality levels, and advocated the need for such strategies through real use cases gathered at the research campus ARENA 2036. We summed up the work of the internship in the “SLA-Driven Software Orchestration in Industry 4.0” magazine paper, currently under revision.*

*I spent in Stuttgart four (4) months of my first year.*

## 7. Tutorship

*None*