



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

PhD Student: Jessica Illiano

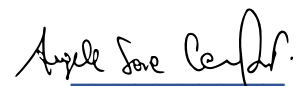
Cycle: XXXVI

Training and Research Activities Report

Year: First



Tutor: prof. Angela Sara Cacciapuoti



Co-Tutor: Dr. Antonio Manzalini

Date: October 21, 2021

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle:XXXVI

Author: Jessica Illiano

1. Information:

- **PhD student:** Jessica Illiano
- **DR number:** DR995140
- **Date of birth:** 16/12/1996
- **Master Science degree:** Ingegneria delle Telecomunicazioni **University:**
Università degli studi di Napoli Federico II
- **Doctoral Cycle:** XXXVI
- **Scholarship type:** *TIM S.p.A.*
- **Tutor:** Prof. Angela Sara Cacciapuoti
- **Co-tutor:** Dr. Antonio Manzalini

2. Study and training activities:

Activity	Type ¹	Hours	Credits	Dates	Organizer	Certificate ²
Quantum Information	Course		6	28/12/2020	Prof. Angela Sara Cacciapuoti	Y
Nanotechnologies for Electrical Engineering	Course		6	12/02/2021	Prof. Carlo Forestiere	Y
Introduzione ai circuiti quantistici	Course		9	01/02/2021	Prof. Giovanni Miano	Y
Quantum Simulators	Seminar	1	0.2	28/01/2021	Dr. Micol Benetti	Y
Robot manipulation and control	Seminar	2.5	0.5	17/11/2021	Prof. Paolo Dario	Y
How to get published with IEEE	Seminar	1.5	0.3	02/12/2020	IEEE	Y
GDPR basics for computer scientists	Seminar			20/04/2020	Dr. Alessandra Scippa	Y
Advances in Machine Learning for Modelling and Understanding in Earth Sciences	Seminar	1.5	0.3	27/01/2021	Prof. Antonio Iodice	Y
Dai mainframe all'IoT	Seminar	2	0.4	08/03/2021	Prof. Alessandro Cilaro	Y
IEEE Authorship and OA Symposium	Seminar	0.5	0.3	22/04/2021	IEEE	Y

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Second Quantum Revolution: innovation trends and expected industrial impacts	Seminar	2	0.4	22/10/2021	Prof. Angela Sara Cacciapuoti	Y
Artificial intelligence and 5g combined with holographic technology	Seminar	2	0.4	27/04/2021	Prof. Antonia Maria Tulino	Y
TeamUp5g Workshop on Ethics and Inclusiveness for Telecommunications Engineers	Seminar	10	2	2-4/03/2021	Prof. Ana Garcia Armada	Y
IEEE/DEISummer Ph.D. School of Information Engineering "Silvano Pupolin" – SSIE2021	Doctoral School	30	5	12-16/07/2021	Prof. Michele Rossi	N
Quantum Technologies PhD Summer School	Doctoral School	23	4,6	13-17/09/2021	Prof. David Vitali	Y

- 1) Courses, Seminar, Doctoral School, Research, Tutorship
- 2) Choose: Y or N

2.1. Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	6	1,1	3	0	10,1
Bimonth 2	15	0,5	0,5	0	16
Bimonth 3	0	3,1	8	0	11,1
Bimonth 4	0	0	10	0	10
Bimonth 5	0	0	9	0	9
Bimonth 6	0	4,6	6	0	10,6
Total	21	9,7	30,5	0	66,8
Expected	30 - 70	10 - 30	80 - 140	0 - 4.8	

3. Research activity:

The Quantum Internet, a network interconnecting remote quantum devices through quantum links in synergy with classical ones, is envisioned as the final stage of the quantum revolution, opening fundamentally new communications and computing capabilities. But the Quantum Internet is governed by the laws of quantum

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mechanics. Phenomena with no counterpart in classical networks, such as no-cloning, quantum measurement, entanglement and quantum teleportation, impose new challenging constraints for network design. Specifically, classical network functionalities are based on the assumption that classical information can be safely read and copied. However, this assumption does not hold in the Quantum Internet. As a consequence, its design requires a major network-paradigm shift to harness the quantum mechanics specificities.

Actually, the design of an abstract quantum network model that leads to the definition of a reference standard is still an open problem. My research works aims at studying and designing a model that harnesses the peculiarities of quantum mechanics and the intrinsic interactions between the quantum network and a classical network. In this regard, a crucial aspect is represented by the distinction between quantum data plane and quantum control plane. In fact, the aforementioned distinction allows a more effective design of the abstract quantum network model along with its functionalities.

Currently, although a standard distinction between quantum data plane and quantum control plane is still missing, preliminary works specify that classical control messages operating at the granularity of individual qubits and entangled pairs are, in terms of functionalities, closer to classical packet headers than control plane messages. Thus, they have been considered as part of the quantum data plane, by contributing to its overall overhead. As a consequence, the very concept of throughput needs to be re-defined and studied within the Quantum Internet. In this light, we conduct a theoretical analysis to understand the factors determining the overhead in the quantum data plane and their reflection on the throughput. The analysis is crucial and preliminary for designing any effective quantum communication protocol. Specifically, I derived closed-form expressions of the throughput in different scenarios, and the non-linear relationship between throughput, entanglement throughput and classical bit rate is disclosed.

Moreover, the concept of quantum entanglement affects the design of the entire network protocol stack. There is no single form of entanglement but the possible entanglement typologies vary according to the size of the quantum system. Specifically, in my recent research works I studied multipartite entanglement, i. e., entanglement between more than two parties. The properties of multi-party entangled states give birth to different scenarios that may be of interest from a communication engineering perspective. After the study of the features of the entanglement as a resource for quantum communication, I focused on the mapping of the classical protocol stack and the quantum protocol stack with an analysis of their reciprocal influence.

4. Research products:

Published conference paper

Jessica Illiano, Angela Sara Cacciapuoti, Antonio Manzalini and Marcello Caleffi. "The Impact of the Quantum Data Plane Overhead on the Throughput" Proc. of The Eight Annual ACM International Conference on Nanoscale Computing and Communication (NANOCOM '21) September 7–9, 2021

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Jessica Illiano, Angela Sara Cacciapuoti, Antonio Manzalini and Marcello Caleffi, “On the Network Protocol Stack for the Quantum Internet” –invited paper– to be submitted.

5. Conferences and seminars attended

TeamUp5G Workshop on Ethics and Inclusiveness for Telecommunications Engineers, online, 2-4 March 202.

ACM NanoCom2021, 8th ACM International Conference on Nanoscale Computing and Communication Virtual Conference, 7-9/09/2021(Conference paper” The Impact of the Quantum Data Plane Overhead on the Throughput” presented)

PhD Summer School in Quantum Technologies, jointly organized by Università di Napoli Federico II, Università di Camerino, CNR, online, 13-17/09/2021. Seminar presented “The Impact of the Quantum Data Plane Overhead on the Throughput”.

Summer School of Information Engineering (SSIE)- “Silvano Pupolin”, jointly organized by Department of Information Engineering (DEI) of UNIPD and by the EU ITN project Windmill, online, 12-16/07/2021. (Credits to be earned next year)

TIM- Remote Shadow Experience 3 hours seminar on Soft skills and 1 hour of interactive debriefing seminar

6. Activity abroad:

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7. Tutorship

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