Schedule: December 20, 2023 at 10:00 Italian time – Room "Aldo Biancofiore", Coppito 1

Speakers (in order of presentation): Dr. Daniele Di Pompeo, Dr. Alice Lemmo, Prof. Giorgio Leuzzi, Dr. Fabio Franchi, Dr. Roberta Marziani, Dr. Michele Tucci, Dr. Roberto Valentini (Department of Information Engineering and Computer Science and Mathematics)

Daniele Di Pompeo (10:00 – 10:25)

Advancing Software Quality through Many-Objective Optimization and Model-Driven Performance Engineering

Abstract. The research activities mainly target the intricate domain of software quality enhancement through a dual focus on many-objective optimization and model-driven refactoring. Drawing insights from our recent studies, we aim to establish a cohesive framework for optimizing non-functional attributes, including performance and reliability. Furthermore, we leverage model-driven engineering techniques to address performance challenges in the microservices landscape.

Alice Lemmo (10:25 – 10:50)

Outlook for research in mathematics education

Abstract. The challenges in mathematics education are many and can be approached from different point of view. Research in this field has two main purposes, one pure and one applied: the first one focuses in understanding the nature of mathematical thinking, teaching, and learning; then, the second one aims to examine how to use such understandings to improve mathematics instruction. In this contribution I present some ideas for research that I have been conducting in recent years, with a particular focus on assessment in mathematics.

Giorgio Leuzzi (10:50 – 11:15)

High Frequency Electronics

Abstract. The research activities of Giorgio Leuzzi are devoted to the study of High Frequency Electronics, in the range 1GHz to 1THz. They can be divided into three main subjects:

1. Theoretical study of the instabilities arising in circuits in nonlinear regime, e.g. in the presence of large electrical signals, as in power amplifiers or oscillators. The study requires the solution of nonlinear partial differential equations, either in the time or in the frequency domain, in search of spurious solutions corresponding to unwanted signals.
2. Design of advanced monolithic circuits in the microwave and millimetre-wave frequency range, toward the THz frequencies. The circuits include low-noise amplifiers, oscillators, frequency dividers, active filters, active baluns, etc., from a few hundred MHz up to 500GHz. The chips are fabricated in several technologies, including GaAs, SiGe, GaN, InP by external technology providers. Applications are mainly aerospace and imaging systems.
3. Collaboration with industries in the frame of commercial or research activities. These include Thales Alenia Space, Elettronica S.p.A, Leonardo S.p.A., IHP, European Space Agency, etc. Applications are mainly space and airborne systems. Research collaborations are active with several international entities, e.g. Technical University Wien, Technical University Lyngby, Bologna University, IHP, Warsaw Polytechnic, etc.

Fabio Franchi (11:25 – 11:50)

Human Smart City: toward a secure and sustainable way of living the territory

Abstract. The pervasiveness of digital transformation is changing the city-citizen relationship. Lock-down, smart working, distance learning, streaming, e-commerce, etc. are pushing to redesign time and space in cities, posing new challenges to Public Administration. This calls municipalities, including small towns, to work on their attractiveness to present themselves as an area where people live and work well. We could rethink cities by redesigning infrastructure, services and sub-services by combining technological development and sustainability, with citizens' quality of life at the center. The EU

defines Smart City as a place, characterized by six dimensions, where traditional services and networks are made more efficient by the use of digital and telecommunication technologies, benefiting inhabitants and businesses. The Smart City is co-designed, i.e., based on dialogue between administration and citizens (urban co-governance), on model of quintuple helix, on stable public-private partnerships. We can think of a smart city composed of layers, where the first layer represents the foundation on which all smart city activities are based. It is the layer of networks, infrastructure, and enabling technological equipment (e.g., 5G and beyond, Wi-Fi and Li-Fi connections, cloud-edge computing architecture, etc.). The ICT network is the basis for the development of a smart city. Security is the basis of decision making in any PA, large or small. Maintaining security (in terms of safety and security) is at the top of the goals. The shift from Smart City to Safe City implies prioritizing physical safety, data protection in accordance with GDPR, cybersecurity that is an essential aspect of any digital initiative. This will lead to a security-oriented question: how can we ensure a secure ICT infrastructure on which to develop innovative services that create value for various stakeholders, and how do these configurations impact the territory? The research will be oriented towards identifying innovative technological strategies and solutions to modernize the network infrastructure, with low visual impact and reduced EMF exposure compared to standard solutions and with respect for cultural heritage, with a focus on cybersecurity. The research activity will also support PAs in the process of selecting and adopting enabling technologies, and thus modernization and digitization, to increase territorial capital to enable innovation and rational management of city life and the attractiveness that makes municipalities investment hubs. As a real-world case study, the 2009 seismic crater towns will be the experimental environment with a strong collaboration with “SICURA - caSa Intelligente delle teCnologie per la sicURezza - L’Aquila”, funded by the National Ministry of Economic Development (MiSE) aimed at carrying out experimentation, applied research and technology transfer on the use of emerging technologies blockchain, Artificial Intelligence (AI), Internet of Things (IoT), connected to the development of next generation networks (5G and beyond).

Roberta Marziani (11:50 – 12:15)

Calculus of Variations in Material Science: from line defects to fracture mechanics

Abstract. In this talk I will discuss some variational models in material science. The first one is a 3d elastic model for line-defects, called dislocations, which are the main source of plastic slip in crystals. In this context, I will present some Gamma-convergence result which produces in the limit the decoupling of elastic and plastic contribution. Afterwards, if time permits, I will discuss a gradient damage model à la Ambrosio-Tortorelli for materials with heterogeneities at small scale. Also in this case, I will consider a Gamma-convergence analysis to show some homogenization result.

Michele Tucci (12:25 – 12:50)

Improving software quality through models, measurements, and their interplay

Abstract: In the ever-evolving landscape of software development, ensuring high-quality software is paramount for meeting user expectations and maintaining a competitive edge. This talk delves into the intricate relationship between models, measurements, and their synergistic interaction as a key catalyst for enhancing software quality. We will see how software design models can be augmented with information gathered from running applications, how such models can be transformed into quantitative models to support decision-making, and how software can be automatically evolved to improve multiple quality aspects. The talk concludes by addressing challenges in this domain and outlining a possible path forward.

Roberto Valentini (12:50 – 13:15)

Novel Communication Paradigms for Beyond 5G Applications and Services

Abstract. The forthcoming 6G cellular networks will enable a plethora of heterogeneous applications and services for many emerging use cases (including vehicular communications, industrial-IoT, tactile Internet) by integrating frontiers technologies and novel communication paradigms in a unified networking vision. This calls for research efforts towards a re-design of medium access and physical layer mechanisms, with particular attention to energy efficiency. In particular, the scarcity of communication resources according to orthogonality paradigms represents a bottleneck for the expected massive connectivity. In this context, Non-Orthogonal Multiple Access (NOMA) techniques represent an opportunity as they avoid the use of orthogonal physical resources, and endogenous interference is deliberately allowed and managed through interference cancellation (IC) algorithms. Moreover, to cope with highly stringent energetic constraints, Backscattering Communication (BackComm) is expected to play a crucial role in enabling Machine Type Communications (MTCs) and IoT services. Finally, Reconfigurable Intelligent Surfaces (RISs) have recently emerged as a promising new paradigm given their capability to make the radio propagation environment flexibly controllable. In this talk I will present an overview on the mentioned technologies and discuss their role for the development of next generation wireless systems and services. Moreover, my research contributions will be presented, including the electromagnetic characterization of RISs and the possible integration strategies of NOMA, BackComm and RISs.