EDGE INFORMATION TECHNOLOGY

9.30 Andrea Maioli, **The Sustainable Internet of Things**

Several billions of small-scale battery-powered devices enable intelligent Internet of Things (IoT) applications, such as environmental monitoring, industrial automation, and traffic management. Current embedded IoT technology requires batteries to be periodically replaced and eventually disposed, resulting in high maintenance costs that drastically diminish the return on investment and cause significant environmental impact. Ambient energy harvesting enables the deployment of battery-less devices, potentially yielding zero-maintenance IoT systems with greater long-term sustainability. My PhD research unlocks this potential by increasing the efficiency and dependability of battery-less IoT devices, which are subject to frequent and unpredictable power failures due to the nature of harvested energy.

9:36 Eleonora D'Arnese, **CHiMEra: A Framework for Optimizing Medical Image Analysis**

CHiMEra is a comprehensive approach aiming to optimize some pre-processing and processing procedures of medical images. Precisely in medical imaging, CHiMEra has explored various computer architectures and computational approaches to speed up and expand the application of rigid image registration, image segmentation, and radiomic-based mass characterization.

9:42 Serena Curzel, **Modern High-Level Synthesis: Improving Productivity with a Multi-Level Approach**

Most High-Level Synthesis tools automatically generate Verilog/VHDL code starting from C/C++ code annotated with optimization directives. A good quality of results requires hardware design knowledge and non-trivial design space exploration. My research confronts such limitations through a compiler-based toolchain based on the Multi-Level Intermediate Representation (MLIR), bridging the gap between HLS and high-level frameworks and using domain-specific abstractions to solve domain-specific problems.
Users and developers of HLS tools thus obtain increased productivity, portability, and performance.

9:48 Niccolò Lucci, **Increasing Human-Robot Awareness for Better Cooperation in a Collaborative Environment**

This research aims at making the human-robot interactions more integrated both from a robot programming point of view, making the robot intuitive to use, and from a collaborative point of view, making the collaboration as natural and seamless as possible. This is possible thanks to a complete digitalization of all the components of the workspace: the robot, the human, the manipulated objects, and the executed tasks. It is indeed paramount to provide more awareness to the robotic agent both about the environment it is in (human, objects, ...) and the task it needs to perform (programming). Consequently, it is necessary to gather all possible information coming from the workspace or human task demonstrations and digitalise them to enhance the robot's perception. In light of the above, this research project is focused on creating an architecture that can make human-robot collaboration easier to achieve and, at the same time, gives a straightforward interface to reprogram the robot to perform a different task.

9:54 Michele Bolognini, **Applying Drones to Structural Inspections**

The popularity of Unmanned Aerial Vehicles in Structural Health Monitoring is soaring: these quick and versatile tools can perform a wide range of inspection tasks remotely and autonomously, thus substituting humans. We will see how they can support vision-based modal analysis, thermal modeling, and energy efficiency assessment, revealing structural parameters and potential defects deep below the surface.

10:00 Stefano Radrizzani, **Optimal Sizing and Analysis of Hybrid Battery Packs for Electric Racing Cars**

The electrification trend is spreading not only in the field of traditional vehicles, but also in the racing one, where more and more power and mileage are going to be required in the upcoming future. As an example, the next generation of Formula E will increase power up to 600 kW, almost triplicating the actual standards. In this project, the potential benefits of hybrid battery packs, that combine different Li-ion cells technologies, are investigated in such a racing scenario. To this purpose, a co-design optimization problem has been formulated aiming at optimizing the hybrid battery pack configuration to minimize the race time, on a given circuit, considering the 2021 Rome Formula E ePrix as case study. Results showed a significant gain in terms of race time. Indeed, thanks to high power cells, more power can be delivered and regenerated in addition to the weight reduction, given by the ultra-high energy cells, representative of the current trend in cells design.

10:06 Luca Franceschetti, **HMDrive: Augmented Reality for Drivers**

Each year, more than 50M accidents occur just in off-road contexts due to professional vehicles. The main causes are distraction, low visibility and occlusion, which are all visual-related issues. Augmented Reality (AR) is a unique technology, able to add visual information and contents in the user's field of view as placed in the real world, thanks to innovative head mounted displays (HMD). HMDrive has developed the enabling technology layer for the in-vehicle usage of AR HMD. Thanks to HMDrive the future of ADAS is going to be transformed for improved safety, productivity and driving experience.

10:12 Silvia Mura, **6G Vehicle-to-Everything Technologies for Connected and Automated Driving**

The evolution of connected and automated vehicles (CAVs) technology is encouraging the development of innovative solutions for the sixth generation (6G) of Vehicular-to-Everything (V2X) networks. High mobility scenarios and harsh propagation conditions determine the necessity for new approaches for wireless systems to guarantee stable communications, and consequently high road safety, efficiency, and vehicular sensing augmentation.

10:18 Antonino Favano, **Energy Efficient Modulation Schemes in MIMO Systems**

Energy costs and the environmental impact of modern wireless communication systems make power consumption one of their most relevant issues. From an information theoretic viewpoint, designing energy efficient modulation schemes can both improve the energy savings of wireless multiple-input multiple-output (MIMO) systems, while also maximizing the spectral efficiency. In this pitch, capacity-achieving (in the sense of Shannon) input distributions are presented for nonfading amplitude-constrained MIMO channels.

10:24 Oscar Adrian Jimenez Gordillo, **Photonics Testing for Next Generation Infrastructure**

Photonic Integrated Circuits (PICs) are becoming more and more pervasive and spread and successfully used in a number of applications. The scaling of photonic devices is increasing the integration density and complexity, in this scenario there is an urgent necessity for an effective standardized testing process. This work focuses on the synthesis of an automatic testing technique for complex PICs, leading to a complete quality check in a sub-second time scale.

10:30 Mëmëdhe Ibrahimi, **Design of Metro Optical Networks Through Cross-Layer Optimization Techniques**

Metro optical networks play a crucial role for 5G-and-beyond communications, as they provide a cost-effective platform to support unprecedented requirements in terms of capacity, reliability, and latency. In my thesis, I developed new cross-layer optimization techniques that minimize network cost by optimizing the deployment of optical equipment and guaranteeing Quality-of-Transmission of optical signals. Such techniques include developing Integer Linear Programming (ILP) models, metaheuristics such as Genetic Algorithms, and state-of-the-art Machine Learning approaches. The research conducted during this PhD thesis has been performed in coordination with an industrial partner, SM-Optics.

10:36 Andrea Costa, **DAQ Electronics for Signals Readout from DSSC Cameras**

The DEPFET Sensor with Signal Compression (DSSC) project is developing the world's fastest megapixel X-ray camera at the European X-ray Free Electron Laser (XFEL) facility in Hamburg, for ultra-fast imaging at 4.5 MHz frame rate. It will allow studies of electronic, spin and atomic structures at the nanoscale. The detector is able to generate as much data as 134 Gbit/s continuously, which is a constraint that has led to the development of a compact, high-performance DAQ system composed of 2 different FPGA stages. This PhD resource is focused on the advancement and renewal of the current DAQ system for the DSSC camera, in order to guarantee future proofness, simplify the readout mechanism and unlock new margins for improvements of the overall camera system performance.

10:42 Matteo Farronato, **Advanced Memory Devices Based on 2D Semiconductors for Hardware Training of Artificial Intelligence**

Artificial intelligence (AI) is the most important enabling technology for industry, economy, health, information technology and society. AI relies on deep neural networks containing several parameters which require a long and expensive training process. Training can be made more affordable by in-memory computing, where parameters are updated directly within memory arrays thus suppressing data movement, which is the most critical contributor to the energy consumption in conventional digital computing system. This work presents a novel memory device based on 2D semiconductors showing ultra-low current, record-high linearity and the capability of integration in 3D by vertical memory nanotransistor architecture.

10:48 Enrico Ronconi, **Innovative Digital Architectures for Real-Time Elaboration of Time-to-Digital Converter Data on FPGAs**

Time-to-Digital converters (TDC) are measurement instruments used to measure time interval between events. Nowadays, TDCs are widely used in particle physics as well as in industrial and commercial applications. This research is focused on a fully-FPGA implemented TDC, able to guarantee flexibility and performance currently unattainable.