Ph.D. in Information Technology: Theses Defenses

February 15th, 2019

Room Seminari – 9.00 am

Maria Antonieta ALVAREZ VILLANUEVA – XXIX Cycle

"Distributed Synchronization for Dense Wireless Network Systems"

Advisor: Prof. **Umberto Spagnolini**

Abstract:

Dense networks call for inter-connectivity of a large number of devices, and in this context, the diversity of interconnected devices introduces challenges to be considered for management and coordination of the network. Synchronization of timing (TO) and carrier frequency offsets (CFO) are critical aspects to be considered to guarantee the proper network interconnectivity. This Thesis propose a novel distributed synchronization method for dense (say >50 nodes), compact and possibly strongly connected wireless network where the inter-node distance is small and propagation delay of the entire network is not negligible compared to the inverse of signal bandwidth. Signatures are periodically transmitted by every node to mark the start of the payload and to broadcast the synchronization state that is iteratively minimized by all nodes in aligning jointly the TO/CFO skew with consensus-type algorithms. Here the same signature is broadcasted by every node and it collides with those of the others to perform as a reference (compound) signature for receiving nodes that embeds the reference TO/CFO of the network for synchronization. In view to make distributed TO/CFO synchronization practicable, this Thesis aims to: i) compensate the propagation delays between nodes to mitigate their impact on the global TO/CFO synchronization of the network; ii) design and validate chirp-like signatures based on Zadoff-Chu sequences that enable the estimate of the TO and CFO mismatch on every node and decouple TO and CFO estimates; iii) evaluate the convergence conditions for nodes employing realistic and unstable oscillators, and iv) optimize the distributed synchronization based on an optimal duplexing strategy, and an optimal synchronization protocol.

Lorenzo COMBI – XXXI Cycle

"Radio-relaying over Optical Fiber for Cloud Radio Access Networks"

Advisor: Prof. **Umberto Spagnolini**

Abstract:

The Thesis deals with analog signal transport and processing for future mobile radio access. The focus is on four aspects: (i) the proposal and experimental validation of optical pulse width modulation for analog fronthauling, (ii) the analysis of space-frequency multiplexing of fronthaul signals without channel

equalization, (iii) the design and analysis of hybrid beamforming for the millimetre wave radio access, with analog optical signal processing and transport, and (iv) cost-effective signaling to support analog optical signal processing at the remote antennas.

Andrea MATERA – XXXI Cycle

"Interference Mitigation Techniques in Hybrid Wired-Wireless Communications Systems for Cloud Radio Access Networks with Analog Fronthauling"

Advisor: Prof. **Umberto Spagnolini**

Abstract:

Nowadays, the majority of indoor coverage issues arise from networks that are mainly designed for outdoor scenarios. Outdoor networks, somewhat uncontrollably, may penetrate indoors with the consequence of coverage holes and outage issues, hence reducing network performances. Moreover, the ever-growing number of devices expected for 5G worsens this situation, calling for novel bandwidth-efficient, low-latency and cost-effective solutions for indoor wireless coverage. This is the focus of my thesis, which introduces an analog Centralized Radio Access Network (C-RAN) architecture augmented by copper-cable, possibly pre-existing, to provide dense coverage inside buildings. This fronthaul architecture, referred to as Analog MIMO Radio-over-Copper (AMIMO-RoC), is an extreme RAN functional-split-option: the all-analog Remote Radio Units take the form of tiny, simple and cheap in-home devices, and Base Band Unit includes also signals' digitization. The theoretical feasibility of the A-MIMO-RoC architecture is asserted in the thesis by providing extensive analysis and numerical results. Then, the overall discussion is complemented by results obtained with a prototype platform, which experimentally prove the capability of A-MIMO-RoC to extend indoor coverage over the last 100-200m. Prototype results thus confirm that the proposed A-MIMO-RoC architecture is a valid solution towards the design of dedicated 5G indoor wireless systems for the billions of buildings which nowadays still suffer from severe indoor coverage issues.

PhD Committee:

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Prof. **Stefano Tomasin**, Universita' di Padova