ARCO5G (Advances in 5G Communications Networks) Workshop

Co-located with the 27th Annual IEEE International Symposium on Personal, Indoor, and Mobile Radio Communications (PIMRC2016)

Thursday, September 8th, 2016

Universitat Politècnica de Valencia, Nexus Building, Valencia, SPAIN

Detailed Program

09:00 – 10:40 Session I

Session Chair: José F. Monserrat del Rio (Universitat Politècnica de València, Spain)

09:00 **Opening: ARCO5G Excellence Network – Perspective and Opportunities**

Narcis Cardona – Universitat Politècnica de València, Spain

09:25 **Invited Talk: System-Level Evaluation of 5G Access Networks**

Ramon Agüero – Universidad de Cantabria, Spain

The talk will first discuss some of the tools and methods that are more commonly used to assess the performance of 5G access networks, identifying their limitations. It will also introduce the main design guidelines, implementation and initial validation tests of a generic tool to overcome such shortcomings. The validation tests will tackle the possibility of carrying out optimization-based analysis, using various techniques.

09:50 **Network-Assisted Distributed Radio Resource Allocation for D2D Communications**

Authors: Javier Gozalvez, Mª Carmen Lucas-Estañ, Baldomero Coll-Perales – Universidad Miguel Hernández, Spain.

Abstract: *Device-to-Device (D2D) communications are expected to improve user experience and network efficiency. Cellular and underlaying D2D communications will share the same cellular spectrum, and radio resource allocation policies are hence necessary to avoid their mutual interference. Most of the proposed policies are centralized schemes, and the base station decides the allocated radio resources. Centralized schemes can efficiently control interference levels, but their feasibility can*

be compromised by their complexity and signaling overhead. In this context, a novel distributed radio resource allocation scheme for D2D communications underlaying cellular networks is proposed in this work. The proposed scheme allows D2D nodes to select radio resources from a pool identified by the infrastructure to limit the interference caused by D2D links to cellular communications. The proposed scheme includes a control process in order to guarantee that user QoS requirements are satisfied. The conducted study demonstrates that the proposed network-assisted distributed scheme significantly improves spectrum efficiency compared to existing distributed proposals while guaranteeing QoS requirements to both cellular and D2D communications. The proposed scheme achieves performance levels close to that obtained with an optimized centralized allocation scheme, but presents better implementation perspectives due to its lower complexity and signaling overhead.

10:15 Multi-carrier Waveforms for Machine-Type-Communications in 5G

Authors: Kun Chen Hu, Ana García Armada

Abstract: *Machine-type-communications (MTC) have requirements that are very different from the conventional communications that have driven the development of today's mobile networks. In the context of the evolution towards a 5th generation of mobile communications (5G) there is a discussion aboit what waveforms can provide the characteristics required for MTC and at the same tie guarantee the performance increase that is needed for a new generation. In this presentation we focus on the waveforms that evolve from the well-known OFDM that is used in 4G. We propose improvements to achieve a better spectrum confinement while maintaining the good behavior of OFDM in multipath environments. The interference and the error probability are analyzed in coexistence scenarios with MTC.*

10:40 – 11:10 Coffee break

11:10 – 12:50 Session II

Session Chair: José Ignacio Alonso (Universidad Politécnica de Madrid, Spain)

11:10 Future 5G SON: University of Málaga - Mobilenet Group Approach and Perspectives

Authors: Pablo Oliver, Sergio Fortes, Matías Toril, David Palacios, Salvador Luna, Raquel Barco – Universidad de Málaga, Spain.

Abstract: *The Mobile Optimisation Group (mobilenet), belonging to Grupo de Ingenieria de Comunicaciones at University of Malaga, has been more than 15 years researching in the optimisation of radio access networks. The group has worked in projects with the main vendors and operators of cellular networs and has more than 50 publications in the area of Self-Organising Networks (SON). In this presentation, the group will present their current working areas. In particular, this presentation will be focused on two main areas. Firstly, on current trends in self-healing, including context-awareness, unsupervised learning and the use of mobile traces. Secondly, several automatic techniques for QoE management in cellular networks will be described. Experiments will be presented comprising a big-data empowered QoE modeling based on connection traces collected at radio and core segments.*

11:35 Wideband Scheduling and Resource Allocation Using Advanced MIMO Processing

Authors: Guillem Femenias, Felip Riera-Palou – Universitat Illes Balears, Spain.

Abstract: *Part of our research efforts over the last 2-3 years, likely to continue in the short-term, has focused on the development of cross-layer framework suitable for different advanced MIMO processing in a downlink wideband setting. Rather than striving for closed-form solutions for different metrics, our approach focuses on the derivation of a physical layer (PHY) abstraction based on the signal-to-interference ratio (SINR) for each specific form of MIMO processing. This PHY abstraction then allows the evaluation of existing and novel scheduling and resource allocation strategies, and allows a meaningful comparison to be established among them. In particular, MU-MIMO, N-MIMO and LS-MIMO have been tackled formulating the design problem as a weighted sum rate maximization problem where the weights can serve to implement different scheduling policies that take into account user fairness*

and QoS constraints. Remarkably, the resulting framework is able to cater for different traffic classes, a variety of scheduling techniques, uniform or adaptive power allocation, and various rate allocation policies (continuous or discrete). Given its prevalence in 4G systems, our activities so far have concentrated on OFDMA but, in the context of 5G, adaptation to other waveform designs, FBMC in particular, is currently underway. Our end goal will be a cross-layer framework able to support FBMC, which, by suitably adapting its parameters, can then be particularized to the classical OFDMA scheme. Eventually, massive MIMO (M-MIMO) techniques will also be brought in within our cross-layer framework.

12:00 Exploring 94 GHz as a new mmW Frequency Band for 5G

Authors: José María Molina-Garcia-Pardo, María Teresa Martínez Inglés, Juan Pascual García, José Víctor Rodríguez, Davy Gaillot, Martine Lienard – Universidad Politécnica de Cartagena, Spain.

Abstract: *The aim of this contribution is to experimentally and theoretically treat the problem of propagation and channel modeling in the 94 GHz frequency band and thus explore the possibilities of using it for 5G. A complete polarimetric measurement campaign will be performed in an indoor environment, and detailed analysis will be done in terms of wideband and small scale parameters, double directional extraction, ray tracing simulations and hypothetical wireless link performance.*

12:25 On the Use of Serious Game Engineering for 5G System Performance Evaluation

Authors: Carlos Herranz, David Martín-Sacristán, Saúl Inca, Jose F. Monserrat y Narcís Cardona. – Universitat Politècnica de València, Spain.

Abstract: *This presentation summarizes the current proposal of the METIS-II project on the use of serious game engineering approach for the evaluation and visualization of 5G technologies. Based on UNITY 3D, a realistic scenario has already been implemented, including a portion of a city with every level of detail. This presentation focuses on the representation of results and interaction with a conventional simulation tool, showing clear cohesion between these two entities.*

12:50 – 14:30 Lunch

14:30 – 16:00 Session III

Session Chair: Ana García Armada (Universidad Carlos III, Spain)

14:30 Link Error Prediction for WideBand Multicarrier Systems Based on Machine Learning

Authors: Alberto Carreras Mesa, Francisco Blánquez-Casado, María del Carmen Aguayo-Torres, Gerardo Gómez, José Tomás Entrambasaguas – Universidad de Málaga, Spain.

Abstract: Multicarrier modulation with adaptive coding and modulation techniques are widely used to achieve high throughput in current cellular systems. In order to accurately manage link adaptation, Block Error Rate (BLER) prediction is required for each possible modulation scheme spread over a changing number of subcarriers. Moreover, even if the average SNR remains the same for different links, channel frequency diversity leads to different instantaneous link performance. The well-known Exponential Effective SNR Mapping (EESM) is able to predict BLER performance with good narrowband accuracy regardless the channel type. On the contrary, wideband approximations are not as precise. Furthermore, EESM needs to be calibrated for each transport block size, code rate and modulation. We propose a method to predict BLER performance based on machine learning by using one of the most popular algorithms called logistic regression. Frequency diversity is taken into account by considering mean besides standard deviation of the SNR over the set of subcarriers. This method not only achieves good prediction accuracy for any bandwidth but also provides lower calibration complexity. Moreover, it can be designed accurate prediction functions which are independent of the transport block size and/or code rate. Both methods are compared and results illustrate the improvement of logistic SNR mapping over EESM.

14:55 4G and 5G Link Performance Prediction Based on Link Abstraction Techniques

Authors: Joan Olmos, Mario García-Lozano, Silvia Ruiz-Boqué – Universitat Politècnica de Catalunya, Spain.

Abstract: *Current (4G) and forecasted (5G) mobile communication systems physical layer makes use of some form of multicarrier (MC) modulation combined with a variable rate encoder/decoder. The set of all possible modulation and coding schemes (MCS) allows adapting the PHY capacity to the channel conditions and obtaining an average throughput close to the Shannon bound.*

Usually modulation and coding are decoupled by applying a BICM scheme. In BICM each encoded bit experiences a different SNR when going across the channel due to factors like the frequency selectivity of multipath fading, the different bit to symbol mappings, MIMO processing, etc.

link abstraction (LA) techniques allow the system to compute, in a fast way, the best MCS for the current channel taking as input the SNR of each resource -in the time, frequency and space domains- allocated to the user and obtaining an "effective SNR" that can predict the BLER of the link.

The LA problem will be introduced and several methods to predict the BLER will be discussed. Simulation results for LTE will allow us to test the validity of the proposed methods, which are of application in real-time link adaptation algorithms as well as in mobile communication system level simulators.

15:20 **Spatial UWB In-Body Channel Characterization by Using Novel Phantoms at 5G Frequencies**

Authors: Carlos Andreu, Sergio Castelló-Palacios, Concepcion Garcia-Pardo, Alejandro Fornes-Leal, Ana Vallés-Lluch, Narcis Cardona – Universitat Politècnica de València, Spain.

Abstract: *Enhancing the current Wireless Body Area Networks (WBAN) is one of the most relevant challenges of 5G technologies. Next generation devices aim at improving the healthcare and wellbeing qualitatively. In-body communications are included within this field. In this kind of communications, streaming data is sent from inside the body. UWB systems have emerged as a potential candidate for next generation of wireless in-body communications. However, in-body channel characterization is complex. The animal experimentation is usually restricted and*

software simulations can imply a high computational cost. Synthetic chemical solutions, known as phantoms, can be used to solve this issue. However, achieving reliable phantoms within a large bandwidth can be challenging due to the frequency dependence of human body tissues. In this work, a measurement campaign using a new UWB phantom is performed. Currently, this phantom achieves the best known approximation to the permittivity of human muscle from 3.1 to 18 GHz. Measurements were performed in different spatial positions, in order to investigate also the diversity of the in-body channel in the spatial domain as well as UWB in-body channel characterization. Two experimental in-body to in-body (IB2IB) and in-body to on-body (IB2OB) scenarios are considered. From the measurements, new path loss models are obtained. Besides, the correlation in transmission and reception is computed for both scenarios. This new phantoms family can enable a reliable cost-effective solution in order to reproduce high realistic heterogeneous scenarios.

15:45 Closing

Narcis Cardona –Universitat Politècnica de València, Spain