BESTCOM meeting – Spring 2013
UGent, Gent, May 2, 2013

Venue

The meeting will be held in meeting room "Rector Vermeylen", *het Pand*, B-9000 Gent. To reach *het Pand*, more information can be found at http://www.ugent.be/het-pand/en/accessibility.

Program

- 09h15: Welcome

- 09h45-10h00: opening by L. Vandendorpe

- 10h00-10h30:

  Title: Signal and Spectrum coordination for the multitone MIMO interference channel
  Authors : R. B. Moraes, P. Tsiaflakis and M. Moonen, KULeuven

  In this presentation we focus on the problem of resource allocation in a multitone MIMO interference channel. We focus on two aspects of the problem. First, for the spectrum coordination part we change the variables of the problem to spherical coordinates. It is demonstrated how structure can be found on the radial and on the angle dimensions, which makes the problem much easier to solve. Second, we focus on the multitone MIMO problem and propose an algorithm to distribute power through the sub-carrier for each tone and user depending, among other things, on how much damage power causes to other users.

- 10h30-11h00:

  Title : Investigating the Impact of Sensing Rate of Secondary Users in Cognitive Radio Networks
  Authors: Osama Salameh, Koen De Turck, Sabine Wittevrongel, Stijn De Vuyst, Herwig Bruneel

  The first phase in the operation of a Cognitive Radio Network (CRN) is the investigation of the availability of idle channels through channel sensing. In this presentation we study the impact of the sensing rate of Secondary Users (SUs) in a CRN. We develop a continuous-time Markov chain (CTMC) to study the effect of the sensing rate_ on the performance measures of the CRN including the expected SU delay, the SU interruption probability, the probability a SU is discarded after entering the system and the SU blocking probability. The obtained results reveal that the sensing rate has a crucial impact on these measures.

- 11h00-11h15: poster spotlight presentation : each poster presenter will have one minute to introduce his/her poster by means of a single slide to be sent in pdf format to L. Vandendorpe for Monday April 29 at the latest.

- 11h15-11h45: coffee break and poster session (all posters) (poster boards are 2m high and 1m wide; stickers should be available on site)

- 11h45-12h30 : Keynote

  Title : Stochastic variations in a standard EMC wire test setup; theory and experiment
  Authors : O.O. Sy, J.A.H.M. Vaessen, M.C. van Beurden, B.L. Michielsen and A.G. Tijhuis

Results from the IOP project “stochastic electromagnetic fields” will be reviewed. The aim of this project was to develop a systematic approach to model the effects of stochastic variations in electromagnetic field problems, and validate this approach for a representative geometry. In particular, we were interested in the case where the configuration is near a resonance. To keep the analysis tractable, we initially focused on the standard EMC test setup of a finite wire above a perfectly electrically conducting ground plane. Variations in the wire location as well as in the incident field were accounted for. Results of Monte-Carlo simulations based on deterministic modeling, of a completely stochastic approach, and of experiments with a dedicated test setup were compared. The observable in all cases was the voltage induced along the line. We monitored both the probability density and the statistical moments of the observed voltage. In the project, we also took the first steps towards understanding more complicated geometries, in particular a vibrating plate and a mode stirrer. In the presentation, however, we will restrict ourselves to the wire setup.

- 12h30-13h30: lunch and PI meeting

- 13h30-14h00:

Title : Energy-Aware Generalized Nash Game for Relay-Assisted Multicell Network
Authors: I. Stupia and L. Vandendorpe
In the last few decades, the vision of seamless and pervasive wireless communication systems providing even more advanced multimedia services (the so-called “wireless vision”) has paved the way to an extraordinary proliferation of network infrastructures with the consequent dramatic escalation of energy demands. This trend conflicts with the international guidelines on greenhouse gas emissions targeting a substantial reduction of the carbon footprints. After Durban conference on climate changes in 2011, EU is increasing the target from 20 per cent of carbon emission reductions by 2020 to 30 per cent by 2030. This is a major signal to business to start investing in green technology as the world moves towards a low carbon future. In this situation, one of the main challenge for researchers and mobile operators is to provide an adequate capacity growth supporting the new traffic demands and, at the same time, contribute to the global engagement in reducing the impact of the human activities on global warming. To meet these challenges, *green radio* research direction, encompassing advanced physical layer techniques, new network architectures like heterogeneous networks, as well as radio and network resource management techniques including optimization algorithms, dynamic power saving, signal and spectrum coordination, etc, has become an important trend in both the academic and industrial worlds. This talk focuses on the energy efficiency maximization problem for the uplink of relay-assisted mobile terminals in a multicell network, wherein multiple relays competing for the usage of the shared resources are deployed at the cells edge with the aim of mitigating the intercell interference. In this scenario, the Nash equilibrium problem for the competitive multipoint-to-multipoint scenario is examined. More in details, the equilibrium problem is reformulated as a max-rate equilibrium problem with coupling among the strategy sets of the players. Unfortunately, the analysis of this kind of games can not be addressed using traditional theoretical tools. To cope with this challenge, the equilibrium problem is formulated as a quasi-variational inequality for which existence results are given. This formulation provides us with all the mathematical tools necessary to devise novel distributed algorithms for competitive relaying in multicell networks.

- 14h00-14h30:

Title : Variability Analysis of Multiport Systems using Polynomial Chaos and Stochastic Collocation Methods
Authors: D. Spina, K. Chemmangat, F. Ferranti, T. Dhaene, L. Knockaert, UGent INTEC
Abstract: The performances of modern integrated circuits are influenced by the variability of geometrical and electrical design parameters. Design tools and stochastic models for the variability analysis of a circuit are highly desirable for a robust and successful design. The Monte Carlo method is the standard approach for variability analysis, which gives accurate results with a straightforward implementation, but at a very high computational cost. Recently, Polynomial

Chaos and Stochastic Collocation methods have attracted a lot of attention as efficient alternatives to the computationally expensive Monte Carlo-based techniques. In this presentation, we propose a comparative study of four main techniques used to build stochastic models to perform variability analysis: 1) a standard Monte Carlo method, 2) a recently proposed Polynomial-Chaos-based method, 3) a Stochastic Collocation method based on standard interpolation schemes, 4) a new Stochastic Collocation method based on novel scaling-shifting-interpolation schemes. Pros and cons of all techniques are qualitatively and quantitatively discussed. Pertinent numerical results are used to support the comparative analysis by means of some variability analysis results.

- 14h30-15h00:

Title : "Complex patterns devoted to physical compression of MoM matrices"
Authors : N. Ozdemir. E. Martini, C. Craeye, S. Maci

Abstract : The human body has dramatic effects on the radiation pattern of a nearby located antenna. In view of the level of details and size of the structure, integral-equation methods requiring less memory and computation time are needed. For both iterative and direct solution methods, the compression of matrices standing for interactions between subdomains is very useful. Such compression is often carried out in a purely algebraic way. This contribution proposes a physical method based on proper decompositions of the scalar Green's function. First, decompositions based on multipoles and inhomogeneous plane waves are compared, then the latter approach is improved through a new representation of the radiation pattern obtained for complex wavenumbers.

- 14h30-15h00 : coffee break and poster session (all posters)

POSTERS

P1
Title: Low Complexity Autonomous Power Spectrum Allocation in LTE Heterogeneous Networks
Authors: R. Torrea-Duran, P. Tsiaflakis, L. Vandendorpe and M. Moonen
Abstract : Mobile data traffic is increasing dramatically, essentially due to the widespread use of wireless applications. To cope with this demand, the deployment of small cells, such as pico and femtocells, constitutes a very promising solution. However, in such an heterogeneous environment, users may experience high levels of interference due to overlapping cells. Most interference management techniques assume some level of communication between cells, which is not desirable in plug-and-play type femtocells. In this paper we propose an autonomous power spectrum allocation algorithm with a closed-form waterfilling (WF)-type solution for an LTE heterogeneous network, called virtual cell iterative waterfilling (VC-IWF). In contrast to iterative WF (IWF), VC-IWF prevents greedy behaviour by protecting virtual cell-edge users in terms of their average bit rate. In addition, VC-IWF displays an improved tunability in attaining full power data rate tradeoffs. We benchmark our approach against well-known techniques such as equal power allocation, soft frequency reuse (SFR), IWF, and state-of-the-art autonomous and distributed spectrum balancing algorithms (ASB-2 and DSB). We show that by fixing a target data rate for the cell-center users, we can achieve up to 41% increase in the data rate for the cell-edge users compared to IWF with much less complexity than ASB-2 and DSB.

P2
Title: Variability Analysis of Patch Antenna Parameters Using 2D Polynomial Chaos Expansion Techniques
Authors: Marco Rossi, Arnaut Dierck, Hendrik Rogier, Dries Vande Ginste, UGent INTEC

Abstract: A novel technique that quantifies the effect of stochastic variations of design parameters on the performance of patch antennas is developed and tested. The analysis is based on a 2D polynomial chaos expansion to relate the probability density functions (PDFs) of the figures of merit of patch antennas to the PDFs describing the stochastic variations of two design parameters. Suitable

Wiener-Askey expansions based on custom-made quadrature rules are generated using Mathematica, after which Matlab and ADS Momentum are used to determine the unknown coefficients appearing into the polynomial chaos expansion. This expansion is then applied to quickly produce the Probability Density Function (PDF) of the antenna's figures of merit. We will demonstrate this approach by evaluating the effect of a random permittivity and the height of the substrate, both varying according to a truncated Gaussian distribution, on the bandwidth of the scattering parameter S_{11}. The method has proved to be far faster than the direct use of the Monte Carlo method.

P3

Title : Improved Reception of In-Body Signals by Means of a Wearable Multi-Antenna System
Authors : Thijs Castel, Patrick Van Torre, Emmeric Tanghe, Sam Agneessens, Günter Vermeeren, Wout Joseph, Hendrik Rogier, UGent INTEC

Abstract : High-data rate wireless communication between in-body human implants and the outside world poses important challenges in terms of link reliability, as power available for wireless transmission must be constrained to avoid health issues and to guarantee sufficient autonomy. As miniaturization is important for in-body devices, designers have limited options to improve link quality by deploying a better antenna at the implant side. Yet, at receive side, one can exploit the large surface provided by a garment to deploy highly efficient wearable antennas that capture the signals transmitted by the implant directly on the body surface. In this paper, we implement a wearable textile multi-antenna system suitable for integration in a jacket worn by a patient, and evaluate its potential to improve the In-to-Out Body wireless link reliability by means of spatial receive diversity. The system operates in the 2.45GHz Industrial, Scientific and Medical band, which combines sufficiently large bandwidth, convenient size of transceiver and antenna with an acceptable, yet high, signal attenuation. We study the optimal distribution and the minimum number of on-body antennas required to ensure signal levels that are large enough concerning wireless endoscopy-capsule applications, for all potential positions and orientations of the implant in the human body.

P4

Title: Automatic Scalable macromodel construction for microwave system responses using sequential sampling of the design space.
Authors: Krishnan Chemmangat, Tom Dhaene and Luc Knockaert, UGent INTEC

Abstract: This poster presents a method for automatic construction of stable and passive scalable macromodels for parameterized frequency responses of microwave systems. The method improves on the state-of-the-art scalable macromodeling methods which need a priori information on the distribution of samples required for generating accurate models. The proposed sequential sampling method brings considerable automation into the scalable macromodeling and reduces burden on the designer who need not have to tune the modeling parameters beforehand. The proposed method uses an efficient sequential sampling strategy with as little expensive simulations as possible to generate accurate macromodels. The models thus build can be used as a replacement model for the actual simulator in overall design processes for considerable speed-up. Pertinent numerical results demonstrates the proposed sequential sampling.

P5

Title: Efficient Measurement Procedure for Hotspot Detection in Near-Field Pattern of Electronic Devices
Authors: Prashant Singh, Dirk Deschrijver, Tom Dhaene (Universiteit Gent), UGent INTEC, Davy Pissoort (KHBO – Katholieke Hogeschool Brugge-Oostende)

Abstract: The poster describes a new automated scanning algorithm to identify hotspots (regions with electric or magnetic near-field values above a specific threshold) in the planar near- field profile of electronic systems. The algorithm sequentially determines a set of optimal scanning coordinates where experimental measurements should be performed and results in a heat map that clearly outlines the presence and localization of hotspots. The algorithm has been applied to real and simulated examples.

P6

Title: A Low-Complexity Resource Allocation Algorithm in Multi-Cell DF Relay Aided OFDMA Systems

Authors: Zhiwen Jin, Tao Wang, Ji-Bo Wei and Luc Vandendorpe

Abstract: This paper considers a multi-cell OFDMA downlink system with several decode-and-forward (DF) relay stations (RSs) aiding the base station (BS) transmissions. The opportunistic DF protocol proposed in \cite{Vandendorpe1} is applied. The problem considered is the maximization of the system sum rate with a total power constraint in each cell. An iterative low-complexity resource allocation (RA) algorithm is proposed to optimize mode selection (decision whether relaying should be used or not and which relay), subcarrier assignment (MSSA) and power allocation (PA) alternatively. During the MSSA stage, instead of the original objective function, a lower bound is maximized so that the problem is decoupled into subproblems which can be solved in linear time. During the PA stage, an algorithm based on single condensation and Lagrange duality PA (SC-LDPA) is designed to optimize PA with the tentative MSSA results. Through numerical experiments, the convergence of the low-complexity algorithm (LCA) as well as its benefit compared with a centralized algorithm (CA) are illustrated.

P7

Title : Cooperative cognitive radio with best-relay selection

Authors : Jeroen Van Hecke

Abstract : In this contribution the outage probability of a cooperative secondary user network with best-relay selection is minimized by properly selecting the transmit powers under a constraint of average interference power at the primary user receiver. Substantial performance gain is achieved as compared to the case of an instantaneous interference power constraint.

P8

Title : On Multiaccess Channel with Unidirectional Cooperation and Security Constraints

Authors : Z. Awan, L. Vandendorpe, A. Zaidi

Abstract : We study a special case of Willems's two-user multi-access channel with partially cooperating encoders from a security perspective. This model differs from Willems's setup in the following aspects — only one encoder, Encoder 1, is allowed to conference, Encoder 2 does not transmit any message, and there is an additional passive eavesdropper from whom the communication should be kept secret. For the discrete memoryless (DM) case, we establish inner and outer bounds on the capacity equivocation region. The inner bound is established by a careful combination of Willems's coding scheme, noise injection scheme and additional binning that provides randomization for security. For the memoryless Gaussian model, we establish lower and upper bounds on the secrecy capacity. We also studied some extreme cases of cooperation between the encoders and showed that, under certain conditions, these bounds coincide.

P9

Title

Authors : C. Paasch, O. Bonaventure

Abstract : In scientific research, a solid statistical approach is key for validating a proposed solution. The necessary methodologies are well-established within the scientific community and allow the researchers to have reasonable confidence in their results. Contributions in computer networking research often do change parts of a complex protocol or propose entirely new ideas. The proposal is accompanied by a performance evaluation, showcasing the benefits of the proposed scheme. However, the networking environment is a very complex system where many interactions do have an influence on the performance. Nevertheless, computer networking research seldom takes a statistical approach to validate a proposed solution. Thus, due to the complexity of the system it is often not possible to draw statistically solid conclusions about the performance of the proposed idea. We make a call for a more statistical founded approach in computer networking research. The evaluation of a new solution in computer networking should use the well-established statistical methodologies to

validate the well- functioning of the proposal. We present the methodology to evaluate end-to-end transport layer protocols like TCP or Multipath TCP. Our proposal shows that it is possible to apply the statistical methods in computer networking research and allows to validate the performance of the proposal within the considered parameter space. This approach also allows to identify existing performance bottlenecks of the networking system, opening the door to further research challenges.

P10
Title : Towards space-time models of Internet traffic
Authors : Juan Antonio Cordero Fuertes, O. Bonaventure

Abstract : How is the traffic between the wireless edge and the core of the Internet? What does it look like? Which are the more requested destinations in the Internet, and how they evolve in time? And those consuming more traffic? Are they many hops away from the source? Does everybody in an edge network access (roughly) to the same destinations in the Internet or traffic is diverse? Is it routed mostly in the same way or it follows many different paths?
The traffic between an edge network and the rest of the Internet can be represented as a dynamic loop-free graph. Understanding in depth the dynamics in time and space (topological breadth, edge renewal, traffic dominating paths) of this graph would provide significant insight on the Internet internal architecture and capabilities, the way that content providers deploy their resources and they way that intermediate agents distribute the traffic load.
We analyze the evolution of this graph by monitoring periodic Netflow digests reports in the border router of UCL. These digests report the traffic flows (sources and destinations) between wireless networking prefixes at UCL and the rest of the Internet. Router-level Internet paths from UCL towards requested destinations are reproduced in real time via paris-traceroute queries. The evolution of the resulting graph and its topological properties (bradth, depth, volume) in the day is extracted from this data.
The final goal is to build a mathematical that captures the main aspects of the space-time dynamics of the outgoing traffic graph. The structure of the traffic graph at any particular time being similar to a tree (except for load-balancers), one of the questions to answer is whether it can be reasonably assumed to be a dynamic tree, once load-balanced subpaths are collapsed into a single path class. In this case, it would be possible to provide a model of the traffic graph as a branching process over the number of hops, and extract from such a model information about the network behavior and the evolution of traffic loads over time.

P11
Title : On the sidelobes of UW-OFDM"
Authors : Morteza Rajabzadeh, Heidi Steendam

Abstract : Unique word (UW)-OFDM is a new type of OFDM system, where the definition of the guard interval is different from the standard OFDM techniques. In these standard OFDM techniques, like e.g. cyclic prefix (CP)-OFDM, the guard interval extends the length of the transmitted data block. In UW-OFDM, the guard interval is part of the transmitted block: the last Nu time-domain samples of the FFT interval of length N are known samples, called the unique word. In order to obtain a signal where the last Nu time domain samples of the FFT interval are known samples, we have to add redundancy in the frequency domain. In this presentation, we will look what is the effect of the new structure of UW-OFDM on the spectrum and the out-of-band radiation. It turns out that UW-OFDM has much lower sidelobes than CP-OFDM, if no countermeasures are taken against sidelobes. Further, we will present an algorithm to reduce the sidelobe power. In UW-OFDM, we are able to reduce the sidelobe power to virtually zero, whereas in CP-OFDM the resulting sidelobe power reduces much less. Hence, UW-OFDM is a better candidate for cognitive radio, as we are better able to avoid interference to primary users and vice versa.

P12
Title: Determining optimal weights for Generalized Processor Sharing
Authors: Jasper Vanlerberghe, Tom Maertens, Joris Walraevens, Stijn De Vuyst, Herwig Bruneel

Abstract: Generalized Processor Sharing (GPS) is a simple mechanism to provide fair quality-of-

service differentiation between heterogeneous application classes. In GPS packets of the different classes are backlogged in different queues and the different queues are served according to predetermined weights. Choosing these weights to optimize a certain objective function is in practice very hard, resulting from the notoriously difficult analysis of GPS systems. Using results from strict priority scheduling we derive theoretical bounds on when GPS is more optimal than strict priority. This way we minimize the necessary simulation effort to find the optimal weights.

P13

Title : Experimental Evaluation of Multi-User Separation in Urban Microcellular Networks
Auteurs: Nizabat Khan and Claude Oestges

Abstract: Multi-user MIMO channels have become more popular due to their inherent potential for capacity improvement, but at the cost of increasing interference. The latter is reduced when the channel matrices show a sufficient spatial separation. In this poster, MU- MIMO channels separation is characterized using experimental measurements in an urban microcellular scenario. A base station (equipped with a polarized directional antenna) transmits to a receiver comprising of a vertical antenna array of 8 elements. To characterize the multi-user separation, three metrics are evaluated namely: (i) shadow fading correlation (SFC), (ii) correlation matrix distance (CMD) and (iii) spectral divergence (SF). The experimental evaluation shows that different users placed at 5-10 m distance can have acceptable separation in microcellular networks.

P14

Titre: Modeling time-variant fast fading statistics in indoor peer-to-peer scenarios
Auteurs: Evgenii Vinogradov and Claude Oestges
Abstract: Investigation of fast fading in indoor peer-to-peer networks based on radio channel measurements shows that Rayleigh or double-Rayleigh fading with or without line-of-sight (LOS) component can occur. Additionally, the measurements show that the fading statistics change over time over time even for small-motions of the nodes, since the propagation environment is inhomogeneous. Appearing fading depends on the mobility and on the scattering properties of the environment. While the predominant fading mechanism is a combination of Rayleigh and double-Rayleigh fading, Rician fading and fading caused by combination of LOS and Double Rayleigh components also occasionally occur. We model these effects using a hidden Markov model, parameterized from our measurements.

P15

Titre: Compress-and-Forward on a Multiaccess Relay Channel With Computation at the Receiver
Auteurs: Mohieddine El Soussi Abdellatif Zaidi Luc Vandendorpe
We study a system in which two sources communicate with a destination with the help of a half-duplex relay. We consider a decoding strategy, based on the compute-and-forward strategy, in which the destination decodes two integer-valued linear combinations that relate the transmitted codewords. In this strategy, the relay compresses its observation using Wyner-Ziv compression and then forwards it to the destination. The destination appropriately combines what it gets from the direct transmission and the relay. Then, using this combination, it computes two integer-valued linear combinations. We discuss the encoding/decoding strategy, and evaluate the achievable symmetric-rate. Next, we consider the problem of allocating the powers and selecting the integer-valued coefficients of the recovered linear combinations in order to maximize the symmetric-rate. For the model under consideration, the optimization problem is NP hard. We propose an iterative algorithm to solve this problem using coordinate descent method. The results are illustrated through some numerical examples.