BESTCOM meeting - Fall 2013

KU Leuven, October 24, 2013
Venue : The meeting will be held in:
Park Inn by Radisson Leuven
Martelarenlaan 36, 3010 Leuven, Belgium
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Program

- 09h15-09h45: Welcome coffee

- 09h45: Opening by L. Vandendorpe (BESTCOM coordinator)

- 10h00-10h30:

Title : Neighbor-Friendly Autonomous Algorithm for Power Spectrum Allocation in Wireless OFDM Networks

Authors : R. Torrea-Duran, P. Tsiaflakis, L. Vandendorpe, M. Moonen

Abstract : Mobile data traffic is increasing dramatically, especially due to the popular use of wireless applications. To cope with this, the widespread deployment of base stations constitutes a promising solution. However, with more overlapping cells, users may experience high levels of interference since each base station transmits with full power regardless of the damage caused to victim users from neighboring cells. Most interference management techniques assume some level of communication between base stations, which involves some undesired overhead. To tackle this problem, we propose a neighbor-friendly fully-autonomous algorithm for power spectrum allocation in OFDM networks that protects users within a certain distance from the base station. It consists of a simple waterfilling(WF)-type solution, which can be tuned according to the weights given to each user. We call it victim cell iterative waterfilling (VC-IWF). In contrast to iterative WF (IWF), VC-IWF prevents greedy behavior by protecting victim cell-edge users through a penalty factor in the power allocation level. We show that, in high interference scenarios, we can achieve a victim user data rate increase by a factor of 3.5 compared to IWF and 60 compared to equal power allocation with a marginal decrease of the center user data rate.

- 10h30-11h00:

Title : Linear Transceiver design for multiuser MIMO coordinated and uncoordinated BS systems: Centralized and distributed algorithms

Authors : Tadilo Bogale and Luc Vandendorpe

Abstract : The first part of this talk considers the joint transceiver design for multiple-input single-output (MISO) systems with coordinated base stations (BSs). We consider two problems; 1) minimizing the weighted sum of mean-square-error (MSE) with per BS antenna power constraint and 2) minimizing the total BS power with the target MSE and the per-antenna power constraints. To solve these problems, first, for fixed receivers, we propose a computationally efficient novel distributive algorithm to get the optimal BS precoders. The proposed algorithms use Lagrangian dual decomposition, modified matrix fractional minimization and an iterative method. Second, for fixed BS precoders, the receivers are updated by the minimum MSE (MMSE) criterion. These steps are repeated until

convergence is achieved. All simulation results show that the solution of our proposed distributive algorithm fits to that of the centralized algorithm. The second part of this talk considers weighted sum rate maximization constrained with a per BS antenna power problem for multiuser multiple-input multiple-output (MIMO) systems. For this problem, we propose new downlink-uplink duality based solution. We solve the problem as follows. First, by introducing additional optimization variables, we reformulate our problem into an equivalent problem that incorporates a weighted sum MSE term. Second, we establish novel weighted sum MSE duality. The duality is established by modifying the input covariance matrix of the dual uplink problem, and formulating the noise covariance matrix of the uplink channel as a fixed point function. Third, we optimize the introduced variables and powers in the downlink channel by a Geometric Program (GP) method. Fourth, using the duality result and the solution of GP, we apply alternating optimization technique to solve the original downlink problem. In our simulation results, we have observed that the duality based solution utilizes less power than that of existing algorithms. The extension of this duality solution approach for other Transceiver design problems will be discussed. The distributed implementation of the duality algorithm for coordinated BS systems will also be explained briefly.

- 11h00-11h30: Coffee break

- 11h30-12h15 : Keynote

Title : Satellite Communications - Signal Processing Challenges

Authors : Prof. Bjorn Ottersten (University of Luxembourg & KTH-Stockholm)

Abstract : Communication systems via satellite provide an unprecedented coverage at low cost. However, satellite networks as a means of content delivery are meeting increased competition from terrestrial communication systems. To stay competitive, innovative, cost efficient and scalable satellite services providing multimedia delivery, mobile communication services, public safety communications, backhaul etc. must be developed. The efficient and reliable delivery of these services poses several technical challenges. We discuss how signal processing techniques can be used to address some of these challenges, including diversity techniques, advanced multi-channel transmission and reception schemes, interference mitigation, and cognitive satellite communications.

- 12h15-12h45: Poster spotlight presentation : each poster presenter will have one minute to introduce his/her poster by means of a single slide

- 13h00-14h00: Lunch and PI meeting

- 14h00-15h00: Poster session (all posters)

- 15h00-15h30:

Title : Distributed Dynamic Resource Allocation for Cooperative Cognitive Radio Networks with Multi-Antenna Relays

Authors : Jeroen Van Hecke, Filippo Giannetti, Vincenzo Lottici, and Marc Moeneclaey

Abstract : A cognitive radio scenario is considered where the signals transmitted by a secondary user (SU) are relayed using an amplify-and-forward cooperation protocol. The relay nodes are equipped with multiple transmit and receive antennas. We derive a distributed strategy for power allocation that minimizes the outage probability of the SU network under both a transmit power constraint on the SU network (consisting of the source

node and the relay nodes), and a constraint on the average interference power generated at the primary user (PU) receiver. The numerical results show that the use of multiple antennas will significantly improve the performance of the SU network. The gain is explained by the ability of the relay nodes to steer the transmit beam away from the PU receiver.

- 15h30-16h00:

Title : Benchmarking wireless network solutions and the use of surrogate modeling tools for multi-parameter optimization

Authors : Michael Mehari, Dirk De Schrijver, Eli De Poorter, Tom Dhaene, Ingrid Moerman

Abstract : Experimentally-driven research is gaining attention for the performance evaluation of novel wireless solutions, complementing theoretical analysis and simulations. However, wireless experiments are not trivial. It is not obvious to set up a controlled wireless environment for experiments (such as relevant application scenarios and repeatable interference conditions). Wireless experiments can further be very time-consuming if multiple parameters have to be explored and optimised. We propose an automated benchmarking solution that allows exploration and optimisation of multiple performance parameters. We will show how surrogate modeling tools can be integrated in the benchmarking framework in order to find the optimal operating point in a multi-parameter space within a minimal number of experimentation cycles. We will present some results for a wireless conferencing scenario, where we aim at the same to maximise audio quality and to minimise wireless exposure.

- 16h00-16h30 : Coffee break and poster session (all posters)

POSTERS

(P1) Title : Iterative channel estimation in quantize-and-forward cooperative communication systems

Authors : Iancu Avram, Nico Aerts, and Marc Moeneclaey

Abstract : Cooperative communication systems can effectively be used to combat fading. A cooperative protocol that can be used with half-duplex terminals is the quantize and forward (QF) protocol, in which the relay quantizes the information received from the source before forwarding it to the destination. Most studies on the QF protocol are carried out under the assumption of perfect channel state information (CSI) at the destination, which is not often the case in real-life systems. Therefore, in the present contribution, the effect of incomplete CSI is analyzed for flat Rayleigh fading channels with a frequency offset. To limit the complexity of the estimation, the destination terminal assumes that the relay operates in an amplify and forward (AF) mode. By using the expectation maximization (EM) algorithm to refine the initial pilot-based estimates, the resulting error performance can be made very close to that of a system with perfect CSI.

(P2) Title : On the effect of movement on the localization accuracy in practical wireless networks

Authors : Samuel Van de Velde and Heidi Steendam

Abstract : The problem of localization involves estimating the position of a user from a number of noisy sensor measurements. In a practical wireless network, these sensor measurements cannot be collected instantaneously and some may arrive after a certain delay. In a dynamic scenario where the users move around, this delay may render some measurements out-dated and, if not taken into account, will have a negative effect on the

localization performance. For cooperative localization this effect becomes even more prevalent due to the large number of measurements that are required. This is especially true for centralized algorithms that first collect all measurements in one central node. However, even distributed algorithms will be affected due to their iterative nature. This paper consists of two parts, in the first part we investigate the effect of user movement on the measurement models. In the second part we use these models to analyze the impact of movement on the accuracy of the position estimate by means of the Cramer-Rao lower bound (CRLB) which bounds the performance of the estimation.

(P3) Title : Using shared wavelength converters effectively in optical switching

Authors : Kurt Van Hautegem, Wouter Rogiest & Herwig Bruneel

Abstract : As internet traffic will further increase in coming years, the current network infrastructure will have to grow along in terms of capacity. To this end, optical packet/burst switching have been proposed, allowing more efficient use of the available fiber capacity. To resolve packet contention in the involved optical switches, Fiber Delay Lines (for delay assignment) and wavelength converters (for wavelength conversion) are used to reschedule the contending packets, by means of a scheduling algorithm. Existing algorithms are effective when employed with an infinite number of converters, but generally perform poorly when the number of wavelength converters is small, as is the case in most switch prototype architectures. In this paper, several parametric cost-based scheduling algorithms are proposed that take scarcity of both FDLs and converters into account. Results obtained by Monte Carlo simulation show that these algorithms not only enable improved performance (in terms of packet loss probability), but also reduce the usage of the wavelength converters, and thus, the switch's overall energy consumption.

(P4) Title : Intrusive polynomial chaos for a 1-D dielectric slab

Authors : Ellaheh Barzegar, Martijn C. van Beurden, Stef J.L. van Eijndhoven, and Anton G. Tijhuis

Abstract : For wave propagation in and through a 1-dimensional dielectric slab with stochastic properties, we investigate the use of intrusive polynomial chaos as a potential alternative to the classically applied sampling methods, which include Monte-Carlo methods and techniques like sparse-grids and space-filling curves. Sampling methods have the distinct advantage that they can use existing Maxwell solvers as a black box and all samples can be evaluated indepent from each other. Nevertheless, these methods require a substantial amount of samples to reach a sufficient level of accuracy in e.g. the stochastic moments of the observable of interest. For a domain-integral equation formulation, we illustrate the implications for the corresponding numerical scheme when intrusive polynomial chaos is applied and we address the conditioning and efficiency of the scheme.

(P5) Title : Performance Loss Due to Diffuse Multipath for IEEE 802.11 Systems

Authors : Frederic Heereman

Abstract : In this work, we present an analytical estimation of the performance loss due to diffuse multipath for a narrowband OFDM system. The propagation parameters required for this loss estimation, are experimentally determined in different large conference rooms. The resulting loss due to multipath is calculated and discussed for IEEE 802.11n/ac.

(P6) Title : Diversity Performance of Off-body UWB-MIMO

Authors : Marina Marinova, Emmeric Tanghe, Arno Thielens, Luigi Vallozzi, Günter

Vermeeren, Wout Joseph, Hendrik Rogier, Luc Martens

Abstract : Body Area Networks (BANs) are widely researched for a variety of potential applications. Due to the proximity of these systems to the human body, there are certain limitations in terms of radiated and consumed power, device size, etc. Furthermore, the performance of the system not only depends on the surrounding environment but also on the body condition and activities, the antennas positions and their interaction with the body. The poster introduces a way to meet the requirements for BANs and improve the performance of an off-body system by implementing multiple Ultra Wide Band (UWB) antennas, positioned strategically on the body. A methodology is presented for determining the minimum number of UWB antennas and their optimal positions on the body, necessary to provide a reliable diversity antenna system operating in the FCC (Federal Comminications Commission) frequency band between 3.1 and 10.6 GHz.

(P7) Title : Simulation of a Patch Antenna on a Human Body by means of a Non-Conformal 3D Hybrid FE-BIE Method

Authors : Freek Boeykens, Hendrik Rogier

Abstract : The design of on-body antennas can be carried out by means of a 3D full wave simulation technique such as the finite element (FE) method, which offers the ability to model complex inhomogeneous materials and also allows integrating electrical circuits near the feeding structure of the antenna. However, this approach suffers from domain truncation and approximate absorbing boundary conditions. Moreover, since it is of paramount interest to also take into account the effect of the human body, a system with a vast number of unknowns has to be solved. Therefore, we propose to improve the effectiveness of the FE method by combination with the boundary integral equation (BIE) method. In this formulation, the FE and BIE domains are allowed to have different discretisations and are coupled in a weak sense. The patch antenna is then modelled by the FE method and the human body and open space are simulated by means of the BIE method. The simulation time is decreased by simply adding a small homogeneous block behind the antenna instead of relying on a detailed body model, since the size and shape of the human body were found to only have small influence on the resonance frequency.

(P8) Title : Energy-efficient off-body communication nodes with receive diversity

Authors : Patrick Van Torre, Peter Vanveerdeghem, Hendrik Rogier

Abstract : Off-body wireless communication applications range from fall-detection systems for the elderly to monitoring networks for rescue workers. Further development of practical body-worn systems requires compact, low-cost and low-power battery-powered equipment. A versatile wearable network node offering all these features, including a powerful microcontroller for data processing and additional memory for local data logging was designed and implemented. The node allows receive diversity, mitigating the negative impact of fading, which is typically present in indoor propagation environments. Channel measurements are performed for an indoor Non Line-of-Sight communication between two nodes. Mobile-to-base-station as well as mobile-to-mobile links are considered. A statistical analysis of the performance determines outage probability with and without receive diversity for both link types, showing a significant diversity gain in all cases. Correlation properties, level crossing rate and average fade duration are also determined.

(P9) Title : Numerical analysis for circular arrays devoted to tracking of people in movement

Authors : Simon Hubert, Khaldoun Alkhalifeh, Sylvain Druart, Maxime Drouguet, Nilufer Ozdemir, Christophe Craeye

Abstract : Phased arrays with digital beamforming are under development for tracking of assets and people wearing a tag. Due to the arbitrary orientation of the tag, the incident fields are randomly distributed. The strategy that has been developed consists of estimating direction and polarisation at the same time, using a circular array of rotated antennas, providing a perfect polarisation diversity. This paper proposes a fast and compact analysis of the embedded element patterns of such a circularly symmetric array by computing the spherical wave coefficients directly from the current distribution on one antenna. The quantitative equivalence between the proposed method and a classical numerical analysis is shown on an array made of compact slot antennas.

(P10) Title :' Distributed Energy-Efficient Power Control Strategy for Heterogeneous Two-Tier Networks

Authors : I. Stupia, L. Sanguinetti, G.Bacci, L. Vandendorpe

Abstract : Energy-efficient communications are becoming increasingly important as battery technology has not kept up with the increasing requirements of ubiquitous multimedia applications. In this work, we start dealing with the power allocation problem in a multipoint-to-multipoint network in which the transmit and receiver pairs are modeled as rational players that engage in a non-cooperative game in which each one aims at selfishly maximizing its own energy efficiency. This game is first reformulated as a generalized Nash equilibrium (GNE) problem in which players aim at maximizing their own rates while satisfying coupling constraints and it is then solved using the advanced theory of quasi variational inequality (QVI). The above results are eventually extended to a more general and heterogeneous framework in which each player may indifferently follow a rate or an energy-efficient maximization strategy. The equivalence between the GNE problem and the QVI provides us with all the mathematical tools to study the existence and uniqueness of the GNE points of such a heterogeneous game and to derive an alternative algorithm based on the sequential penalty approach that allows the network to converge to its GNE in a distributed manner. A two-tier network is eventually considered as a possible case study of this heterogeneous scenario. In particular, we focus on a small-cell network in which an irregular deployment of low-power consumption base stations cooperating among each other in a distributed manner coexist with a macro-cellular network.

(P11) Title : UWB testbed: design and evaluation

Authors : Achraf Mallat, Pierre Gerard, Farshad Keshmiri, Claude Oestges, Christophe Craeye, Denis Flandre and Luc Vandendorpe

Abstract : We present a testbed for impulse radio ultra wideband based ranging and positioning. We show the characteristics of the generated, transmitted and received pulses. We consider both the maximum likelihood estimator and a threshold-based estimator for the estimation of the time of arrival. We measure the variances for ranging and positioning and compare them to the Cramer-Rao lower bounds for range and position estimation. We discuss the impact of both false multipath component detection and false sidelobe detection on the estimation accuracy. The obtained variances are close to the Cramer-Rao lower bounds when the mainlobe of the first multipath component is detected. In realistic multipath environments we can use a threshold-based time of arrival estimator in order to detect the first multipath component which may be missed by the maximum likelihood estimator. We show also that the errors on positioning due to false multipath component and sidelobe detection can be highly mitigated by increasing the number of receivers. For a radiated energy of 8.1 pJ and a distance of 5 meters between the transmit and receive antennas, the obtained accuracy is in the order of one centimeter.

(P12) Title : Intercarrier Interference in DSL Networks due to Asynchronous DMT Transmission

Authors : Rodrigo B. Moraes, Paschalis Tsiaflakis and Marc Moonen

Abstract : We focus on the effects of intercarrier interference (ICI) in digital subscriber line (DSL) systems due to asynchronous discrete multitone (DMT) transmission and its impact on dynamic spectrum management (DSM). ICI arises when the DMT blocks of interfering users in the network are not aligned in time and it may significantly impact the system performance. Our contribution is the derivation of a simple and accurate model for the effect of the ICI. We propose both an ICI model based on the particular delay between two users and an ICI model averaged over the delays between two users. Simulation results show that an accurate characterization of the ICI positively impacts the performance of DSM solutions.

(P13) Title : Modeling and Simulation of Fast Fading Channels in Indoor Peer-to-Peer Scenarios

Authors : Evgenii Vinogradov and Claude Oestges

Abstract : The radio channels between nodes of an indoor peer-to-peer network show specific fast fading characteristics. Depending on the mobility and on the scattering properties of the environment, different kinds of fading distributions can occur: Ricean fading between static nodes, but also Rayleigh or even double-Rayleigh fading between mobile nodes. We investigate fast fading in indoor peer-to-peer networks based on radio channel measurements. It turns out that the fading statistics change over time. While the predominant fading mechanism is a combination of Rayleigh and double-Rayleigh fading, Ricean fading also occasionally occurs. On top of that, indoors, the statistics of the fast fading change over time even for small-motions of the nodes, since the propagation environment is inhomogeneous. We comprehensively model these effects using a hidden Markov model, parameterized from our measurements. The model is validated, revealing a convincing fit between the model and the measurements.