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Poster presentations

Poster 1

Semi-analytical evaluation of concatenated RS/LDPC coding performance with finite block interleaving

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The Monte Carlo (MC) simulation of the error performance of a concatenated coding system with finite interleaving depth between the two concatenated codes is time-consuming, especially when targeting low error rates and different interleaver settings. In this contribution we present a semi-analytical evaluation of the word error rate (WER) performance of a system with Reed-Solomon (RS) outer coding, finite block interleaving, low-density parity check (LDPC) inner coding and mapping to a symbol constellation. The proposed evaluation method relies on a simple 2-parameter statistical mixture model (involving a binomial distribution and a Kronecker delta function) for the number of byte errors in the LDPC codeword after the inner decoding. Only the WER and byte error rate (ByteER) of the inner subsystem, determined by the LDPC code and the considered constellation, are required to compute the error performance corresponding to different parameters of the RS code and the interleaver. We show that the semi-analytical WER of the concatenated system closely matches the WER resulting from MC simulations, for both the AWGN channel and the Rayleigh block-fading channel.

Poster 2

MMSE equalization of multi-Gb/s chip-to-chip interconnects affected by manufacturing tolerances

Jelle Bailleul (UGent-TELIN), Lennert Jacobs (UGent-TELIN), Paolo Manfredi (UGent-INTEC), Dries Vande Ginste (UGent-INTEC), Marc Moeneclaey (UGent-TELIN)

Abstract: Electrical chip-to-chip interconnects are characterized by an attenuation which increases with frequency, causing considerable intersymbol interference (ISI) at multi-Gb/s datarates. Hence, reliable communication at high datarates requires equalization, to compensate for the channel transfer function. As the production of interconnects is prone to manufacturing tolerances, the equalizer must be adjusted to the specific channel realization in order to achieve the best possible performance. As an adjustable equalizer implies an increased implementation complexity, we adopt a reduced-complexity solution where (part of) the equalizer is fixed. More specifically, we derive the finite-length minimum mean-squared error (MMSE) equalizer consisting of a prefilter at the transmitter and a decision-feedback filter at the receiver. When (part of) the equalizer is fixed, this constitutes a novel approach, involving the incorporation of the channel statistics into the equalizer optimization. For a 10 cm on-board microstrip interconnect with a 10% tolerance on its geometrical and material parameters, we point out that 2-PAM transmission using a fixed prefilter and an adjustable feedback filter, both with few taps, gives rise to only a moderate bit error rate (BER)

degradation, compared to the case where both filters are adjustable and very long; at a BER of 10^{-12}, these degradations are about 1.5 and 3 dB, when operating at 20 Gb/s and 80 Gb/s, respectively.

Poster 3

The effect of correlated random displacements of antenna elements on sparse UCA root-MUSIC DOA estimation

Veronique Inghelbrecht (UGent-TELIN), Marc Moeneclaey (UGent-TELIN), Herwig Bruneel (UGent-TELIN), Hendrik Rogier (UGent-INTEC)

Uniform circular antenna arrays (UCAs) are attractive configurations for direction of arrival (DOA) estimation, as their circular symmetry may be effectively exploited. However, most of these algorithms experience a significant performance loss when random antenna position errors break the symmetry property. In order to remove systematic errors calibration procedures can be used. However, there are time consuming and therefore difficult to apply in real-time applications where the antenna positions change randomly with time. Hence, it is interesting to quantify the effects of uncertainty in the positions of the sensor element by a stochastic framework. We use a stochastic collocation method to calculate the probability density functions (pdf) of the DOA-estimates due to a random displacement of two antenna elements in an electromagnetic array with mutual coupling.

Poster 4

SIW Cavity-backed Slot (Multi-)Antenna Systems for the Next Generation IoT Applications

Sam Lemey, Olivier Caytan, Dries Vande Ginste, Piet Demeester, Hendrik Rogier, Maurizio Bozzi (UGent-INTEC)

Substrate integrated waveguide (SIW) cavity-backed slot antenna topologies are promising candidates to adress the specific design challenges posed by the Internet of Things (IoT). In this contribution, we demonstrate their potential by discussing two designs on two different, application-specific, innovative substrate materials. First, a compact, ultra-wideband three-element array with very low mutual coupling is presented for integration into furniture. In the second design, the half-mode SIW technique is applied to obtain a miniaturized ultra-wideband design, enabling invisible integration into cork floor and wall tiles. The compactness, integrability, and stable, high performance of both designs in different operating conditions, make them ideal candidates for IoT applications.

Poster 5

Pareto Analysis and Multi-Objective Optimization in Wireless Networks

Michael Mehari, Ingrid Moerman (UGent-INTEC)

Wireless Networks have a number of objectives which are optimized in search of the optimal settings. These objectives are usually conflicting towards one another and the challenge of locating the optimal settings is not a trivial task. Typical conflicting objectives are optimization of throughput and power consumption, audio quality and transmission exposure, intrusion detection accuracy and memory usage, power consumption and signal-to-noise quality and others. All these conflicting objectives exhibit multiple optimal operating points which in literature is known as the Optimal Pareto Front (OPF). The OPF is a collection of operating points of the wireless system which cannot

be further improved without affecting the performance of at least one performance objective. Furthermore, locating the OPF of a wireless system is the ultimate task of a multi-objective optimization since the optimal settings are associated to them. To this end, the simplest approach will be to exhaustively search all performance objectives and locate the OPF. However, this approach is not practical because it takes a great deal of time even for the simplest wireless networks. In this research work, a Multi-Objective Surrogate-Based Optimization (MOSBO) tool is used to approximate the OPF of a Wi-Fi conferencing system. The benefits of the MOSBO optimizer is demonstrated by approximating the OPF using 82 iterations and dominating 98.36% of the complete design space (7680 design points).

Poster 6

An Extension of the RiMAX Algorithm for Ultra-Wideband Channels
Brecht Hanssens, Emmeric Tanghe, Davy P. Gaillot, Martine Liénard, Claude Oestges, David Plets, Luc Martens, Wout Joseph (UGent-INTEC)

This work presents an extension of the high-resolution RiMAX multipath estimation framework, enabling the analysis of frequency-dependent propagation parameters for Ultra-Wideband (UWB) channel modeling. Due to the fact that RiMAX is a narrowband algorithm, it does not account for the frequency-dependency of the radio channel or the environment. As such, the impact of certain materials in which these systems operate can no longer be considered constant with respect to frequency, preventing an accurate estimation of multipath parameters for UWB applications. The UWB-RiMAX framework makes it possible to re-evaluate common radio channel parameters for DMC in the wideband scenario, and to extend the well-known deterministic propagation model comprising of SMC alone, towards a hybrid model containing the stochastic contributions from distributed diffuse scattering as well.

Poster 7

A comparison between human body compensation models for localization
Jens Trogh, David Plets, Arno Thielens, Luc Martens, Wout Joseph (UGent-INTEC)

This work presents a comparison between empirical and simulated human body compensation models for localization purposes. These compensation models eliminate the influence of the human body on location and tracking systems which improves robustness and accuracy. The simulated models are based on three-dimensional electromagnetic simulations with a human phantom. The empirical models are obtained through measurements in a wireless testbed with a mobile robot and a person. Both models are compared and validated in terms of location accuracy.

Poster 8

Time–Domain Variability Analysis of General Linear Multiport Systems
Yinghao Ye, Domenico Spina, Tom Dhaene (UGent-INTEC)

We present a technique for the time–domain variability analysis of generic linear multiport systems. The proposed method calculates a stable and passive Polynomial Chaos-based macromodel of a system under stochastic variations. The combination of the Galerkin projections method, a Polynomial Chaos-based model of the system scattering parameters and the modeling power of the

Vector Fitting algorithm allows to describe with accuracy and efficiency the system variability features in the time-domain. Thanks to its versatility, the proposed technique is suitable to be applied to a large range of complex modern electrical systems (e.g. interconnections, filters).

Poster 9

Adaptive Subcarrier Modulation for Indoor Public Safety Body-to-Body Networks
Thijs Castel (UGent-INTEC), Sam Lemey (UGent-INTEC), Sam Agneessens (UGent-INTEC), Patrick Van Torre (UGent-INTEC), Hendrik Rogier (UGent-INTEC), Claude Oestges (UC Louvain)

On this poster, we present the Bit Error Rate characteristics for an indoor, wideband body-to-body channel between two firefighters when using IEEE 802.11 ac, which is proven a very suitable standard for future, wideband public safety networks. Moreover, the BER and throughput characteristics, when applying both transmission blocking, fixed and adaptive, subcarrier modulation are presented. These characteristics show an increased throughput when applying adaptive subcarrier modulation. We have conducted a wideband, indoor channel sounder campaign at 3.6 GHz with 120 MHz useful bandwidth, simulating real-life rescue operations performed by two simultaneously moving members of the Rapid Intervention Team. Both firefighters were equipped with low-profile, lightweight and energy-efficient Ultra-Wideband Cavity-Backed slot antennas in Substrate Integrated Waveguide technology, unobtrusively deployed inside the front and back sections of their jackets, providing 2x2 MIMO capability.

Poster 10

Revenue maximization in an optical router node – allocation of service windows
Murtuza Ali Abidini, Onno Boxma, Ton Koonen and Jacques Resing (TU Eindhoven)

We present the study of a revenue maximization problem for optical routing nodes. The routing node is modeled as a single server polling model with the aim to assign visit periods (service windows) to the different stations (ports) such that the mean profit per cycle is maximized. Under reasonable assumptions regarding retrial and dropping probabilities of packets the optimization problem becomes a separable concave resource allocation problem, which can be solved using existing efficient algorithms.

Poster 11

Joint Clock Parameter and Transmitter Position Estimation using TDOA in One Way Packet Transmission
J. Shrestha, L. Vandendorpe (UC Louvain)

This work investigates a source localization problem using time difference of arrival (TDOA) measurements in the presence of non-ideal clock parameters between sensors. A joint estimation of the clock offset and of the clock skew of an imperfect clock of an asynchronous receiver under the assumption of affine clock model is proposed. To achieve synchronization among sensors, we opt for a receiver to receiver synchronization based on received signal measurement. The Minimum Variance Unbiased Estimator (MVUE) for the clock skew and the clock offset is derived assuming a known reference transmitter position. The performance of these MVUEs is compared against the corresponding Cram´er Rao Lower Bounds (CRLB) that are derived for both cases of reference

transmitter absent or present. The performance of the estimators is evaluated by means of the Root Mean Squared Error (RMSE). Prior to estimating the position of an unknown target transmitter, an appropriate correction to the clock is applied. The CRLB of the transmitter position is also derived assuming the clocks have been properly corrected.

Poster 12

On the use of Blind Interference Alignment for Practical Cellular Networks
Maximo Morales-Cespedes (UC Louvain), Jorge Plata-Chaves (KU Leuven, ESAT/STADIUS), Marc Moonen (KU Leuven, ESTA/STADIUS), Luc Vandendorpe (UC Louvain)

Recently, Blind Interference Alignment (BIA) was proposed as a means of achieving a growth in Degrees of Freedom (DoF) without the need for Channel State Information at the Transmitter (CSIT). Several BIA schemes have been proposed for different configurations such as the Broadcast Channel, the Interference Channel, or cellular networks. However, the implementation of any BIA scheme in practical networks is subject to two main hurdles, namely finite SNR and time-varying channels. In this work, we address both issues by employing BIA to transmit to different sets of users in an orthogonal fashion. Although the proposed scheme involves a typically small penalty in DoF, it aims at maximizing the sum-rate at a finite SNR regime and allow to handle the supersymbol length according to the actual coherence time of the channel. On the other hand, the whole set of transmit antennas can also be grouped in sets of antennas that transmit exactly the same signal in order to reduce the coherence time considerably and gain spatial diversity. Moreover, both approaches, i.e. grouping both users or antennas, allow to reduce the amount of pilots required to provide Channel State Information at the Receiver (CSIR) for coherence detection. Interestingly, when implementing any BIA scheme, these features also reduce the dependence between the number of transmit antennas and the length of the pilots sequence. This reduction results suitable for the implementation of BIA schemes in Frequency Division Duplex (FDD) Massive MIMO systems.

Poster 13

A New Multiobjective Game for the Design of Wireless Transceivers with Local Coordination Ability
Ivan Stupia, Luc Vandendorpe (UC Louvain)

Assume that making coordinated decisions is a viable strategy to achieve Pareto optimality in a wireless network composed of transmitter receiver pairs (TRPs) targeting the maximisation of their own energy efficiency. At what price this coordination can be established? How to define a solution concept whenever only local coordination is suitable or possible? How to implement coordination without the need of any centralised node? The aim of this paper is to shed a light on these open issues. To achieve this, we model the energy efficiency maximisation problem as a game with vector payoff. This formulation will provide the mathematical tools to study how local coordination impacts on the users' performance in the presence of severe multiuser interference. Further, we develop a successive convex approximation (SCA) technique that solves the original game through a set of convexified multiobjective equilibrium problems. Eventually, we propose a distributed implementation of the SCA technique for power control in a Gaussian interference channel and we validate it by means of numerical results.

Poster 14

Stepped frequency radar for automotive application: Range Doppler coupling and distortions analysis
T. Feuillen, A. Mallat, L. Vandendorpe (UC Louvain)

In this paper, the use of the stepped frequency modulation for an automotive application is studied. This modulation suffers from the Range-Doppler coupling and quadratic phase variations. To address this issue, a repetitive modulation scheme is used and a method to compensate for the effect of the distortions is introduced. To remain at a low computational cost, the estimator is based on IDFTs and the quadratic phase terms are considered as distortions. The resulting distortions are studied.

Poster 15

Generalized Optimal Pilot Allocation for Channel Estimation in Multicarrier Systems
François Rottenberg, François Horlin, Eleftherios Kofidis, Jérôme Louveaux (UC Louvain)

This paper addresses the design of MSE-optimal preambles for multicarrier channel estimation under a maximum likelihood or minimum mean squared error criterion. The derived optimality condition gives insight on how to allocate the position and the power of the pilots that compose the preamble. While many papers show that equispaced and equipowered allocation is optimal, the generalized condition demonstrates that there exist many different configurations that offer the same optimal performance. Furthermore, the condition applies not only to maximum likelihood but also to minimum mean squared error channel estimation. An application of the generalized condition in the presence of inactive subcarriers (virtual subcarriers problem) is shown such that a non equispaced allocation can achieve the same optimal performance as if an equispaced one could be used.

Poster 16

Energy Efficient Resource Allocation in MIMO-OFDMA Downlink Systems
Zijian Wang, Luc Vandendorpe (UC Louvain)

This paper studies subcarrier allocation and precoder design for energy efficiency (EE) maximization in downlink multiple-input-multiple-output (MIMO)- orthogonal frequency-division multiple access (OFDMA) systems. We first propose a subcarrier allocation approach based on time-sharing. Then we show that the proposed subcarrier allocation results in a discontinuous quasi-concave EE function. Finally, we propose an algorithm to maximize EE. Numerical results show that the proposed algorithm efficiently finds the maximum of EE.

Poster 17

Joint Multi-objective Transmit Precoding and Receiver Time Switching Design for MISO SWIPT Systems
Nafiseh Janatian, Ivan Stupia, Luc Vandendorpe (UC Louvain)

In this paper, we consider a time-switching (TS) co-located simultaneous wireless information and power transfer (SWIPT) system consisting of multiple multi-antenna access points which serve multiple single antenna users. In this scenario, we design jointly the optimal transmit precoding covariance matrix and the TS ratio for each receiver to maximize the utility vector made of the achieved data rates and the energy harvested of all users simultaneously. This is a non-convex multi-objective optimization problem which has been transformed into an equivalent non-convex

semidefinite programming and solved using local optimization method of sequential convex programming. Numerical results illustrate the trade-off between energy harvested and information data rate objectives and show the effect of optimizing the precoding strategy and TS ratio on this trade-off.

Poster 18

MIMO Indoor Propagation: A Geometry-Based Model Including Time-Variant Fading Statistics
Evgenii Vinogradov, C. Oestges (UC Louvain)

A geometry-based reference model for Second Order Scattering Fading (SOSF) distributed multiple-input-multipleoutput (MIMO) channels is proposed for mobile-to-mobile scenarios. From this model, a spatial correlation function is derived.The time-variant nature of channel statistics is modeled by using a Hidden Markov Model (HMM) based approach. The proposed method enables to implement a generator of channel realizations for a wide range of indoor MIMO channels, including Fixed-to-Mobile and Mobile-to-Mobile transmission; Rician, Rayleigh, Double Rayleigh, Second Order Scattering fading, etc.

Poster 19

Scattered fields of a rotating object : hybrid integration scheme using PO approximation
T. Pairon, C. Oestges, C. Craeye (UC Louvain)

A method is proposed for computing the scattered fields of large objects compared to the wavelength. Due to their size, classical methods such as the Method of Moments (MoM) is computationally consuming. Considering an electrically "big" object with a smooth shape, the Physical Optics (PO) approximation is used in order to compute the surface currents. Those are integrated with a hybrid integration scheme which consists of an analytical integration in one dimension using the Stationary Phase Method (SPM) and a numerical integration in the other dimension.

Poster 20

Energy-vs-Performance trade-offs in speech enhancement in wireless acoustic sensor networks
Fernando de la Hucha Arce (KU Leuven, ESAT/STADIUS), Fernando Rosas (KU Leuven, ESAT/MICAS), Marc Moonen (KU Leuven, ESAT/STADIUS), Marian Verhelst (KU Leuven, ESAT/MICAS) and Alexander Bertrand (KU Leuven, ESAT/STADIUS)

Distributed algorithms allow wireless sensor networks (WSNs) to divide the computational load of signal processing tasks, such as speech enhancement, among the sensor nodes. However, current algorithms focus on performance optimality, oblivious to the energy constraints that battery-powered sensor nodes usually face.To extend the lifetime of the network, nodes should be able to dynamically scale down their energy consumption when decreases in performance are tolerated. The main responsible of energy consumption in the nodes is the wireless communications module, and because of this optimizing the data exchange among nodes is a crucial task, but the computational cost of data processing cannot be ignored. To reduce the data exchange we focus on two parameters, signal bandwidth and quantization resolution. We study the energy-vs-performance trade-offs associated with reducing the bandwidth and bit resolution of the exchanged signals, and

how they add flexibility to scale the energy consumption and the estimation performance. For quantization resolution, we have developed a generalized utility metric which can be computed and tracked at virtually no additional cost. This metric can be used to assign the number of bits that each sensor should employ to encode its observations according to their contribution to the MSE, for a given tolerated MSE increase.

Poster 21

Capturing and exploiting spatial information and correlation in contention based flooding networks
Yuri Murillo (KU Leuven, ESAT/TELEMIC), Sofie Pollin (KU Leuven, ESAT/TELEMIC)

Flooding networks constitute a simple and robust but inefficient method of transmitting a packet generated by a source to a sink. Classical flooding contention protocols focus on reducing the number of retransmissions rather than ensuring successful message delivery. In this work, we propose a contention scheme based on channel gain prediction and autonomous decision making. An elementary subnet in which two nodes competing to transmit a packet to a common destination is studied. In this scenario, both nodes compare the own measured channel gain to the destination with the predicted one of the neighbour, and decide to transmit if the former is higher. The prediction is based on spatial correlation of shadow fading and knowledge of both the local channel gain to the destination and the channel gain between the two transmitters. With this contention scheme, simulation results show that the effective packet delivery ratio of the elementary subnet can be increased more than 200%.

Poster 22

Optimal UAV Positioning for Terrestrial-Aerial Communication in Presence of Fading
Mahdi Azari (KU Leuven, ESAT/TELEMIC), Sofie Pollin (KU Leuven, ESAT/TELEMIC)

Aerial communication platforms have been recently recognized as an effective solution to provide wireless access to terrestrial users, which promise to offer superior coverage. In this paper, we explore the impact of the height of an Unmanned Aerial Vehicle (UAV) on the area over which it can provide wireless service. We investigate the problem by characterizing the coverage area for a target outage probability, showing that for the case of Rician fading there exist a unique optimum height that maximizes the coverage area. The optimum UAV height guarantees a beneficial tradeoff between path loss and fading, which vary as function of distance and the elevation angle with respect to the ground terminals. Moreover, a closed-form approximated solution is provided, which is valid for any functional dependency between the elevation angle and the Rician factor.