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1.

-Invited Talk-

Linkoping University ***Prof. Erik G. Larsson***

Title: Scaling up MIMO: Opportunities and Challenges with Very Large Arrays

Abstract:

Very large MIMO (VLM) refers to using antenna arrays with an order of magnitude more elements than in systems being built today, say a hundred antennas or more. VLM is a new research field both in communication theory, propagation, and electronics. The ultimate vision of VLM is that the antenna array would consist of small active antenna units. In cellular systems, VLM offers the prospect of increasing rates and reliability by an order of magnitude and saving an order of magnitude in transmit power. In this talk, I will discuss some of the basic opportunities and challenges associated with the introduction of VLM arrays in cellular communication.

2.

Technical University Munich

Prof. Dr. Dr. Holger Boche
Dr.-Ing. Rafael Wyrembelski

Title: Strong Secrecy in Compound Broadcast Channels with Confidential Messages

Abstract:

In this talk the compound broadcast channel with confidential messages is studied, where it is only known to the transmitter and receivers that the actual channel realization is fixed and from a pre-specified set of channels. An achievable rate region for the strong secrecy criterion is derived. Further, a multi-letter outer bound is given, which establishes, together with the achievable rate region, a multi-letter expression of the strong secrecy capacity region.

3.

Technical University Munich

Prof. Dr. Dr. Holger Boche
M. Sc. Anil Kumar Chorrpath

Title: User Centric Interference Management in Wireless Networks (UCIMa)

Abstract:

Network mechanism design aims to achieve system level goals such as maximization of aggregate user performance through specific methods on networks, where users are independent and often selfish decision-makers with individual preferences. By imposing certain rules and pricing schemes on users, the mechanism designer aligns the system-wide objectives with those of the users, and achieves the targeted goals while ensuring user incentive-compatibility or truth revelation. The methodology and algorithms developed are applied to diverse interference limited network problems such as spectrum management, uplink resource allocation of multi-carrier systems, energy efficiency, as well as analysis and mitigation of adversarial behavior. We analyze these problems from an information theoretic point of view to obtain resource allocation strategies for interference limited wireless systems. We also come up with framework for multi cell wireless systems to design fair resource allocation algorithms of polynomial time complexity and cooperation between the cells to achieve the interference management by interference.

4.

University of Ulm

Prof. Dr.-Ing Martin Bossert
M.Sc. Antonia Wachter Zeh

Title: Rank Metric Convolutional Codes for Random Linear Network Coding

Abstract:

Random Linear Network Coding (RLNC) is a technique to disseminate information in a network. In this contribution, non-coherent multi-shot RLNC is considered, that means, the unknown and time variant network is used several times. In order to create dependencies between the different shots, convolutional network codes are used, in particular Partial Unit Memory (PUM) codes. Such PUM codes based on rank metric block codes are constructed and it is shown how they can efficiently be decoded when errors, erasures and deviations occur. The decoding complexity of this algorithm is cubic with the length. Further, it is described how lifting of these codes can be applied for error correction in RLNC.

RLNC is a powerful tool for spreading information in networks. However, due to the linear combinations at the nodes, errors propagate fast. This makes coding techniques for error control in RLNC essential. For this purpose, Kötter and Kschischang used subspace codes, since the row space of the transmitted matrix is preserved during the transmission over the so-called operator channel. Silva, Kschischang and Kötter showed that lifted rank metric block codes result in almost optimal subspace codes for RLNC. In particular, they use Gabidulin codes, which are rank metric analogs to Reed--Solomon codes.

In this contribution, we consider non-coherent multi-shot network coding. Hence, we use the network N times, where the internal structure of the network is unknown and might change in each shot. Creating dependencies between the transmitted words of the different shots can help to cope with difficult error patterns. We achieve these dependencies by using convolutional network codes. In detail, we use PUM codes (introduced by Lee and Lauer) in rank metric. PUM codes are a special class of convolutional codes with memory one. They can be constructed based on block codes, which makes an algebraic description and efficient decoding possible.

Before, we constructed PUM codes based on the parity-check matrix of Gabidulin codes.
Here, we construct PUM codes based on the generator matrix of Gabidulin codes and calculate their distance properties. Moreover, we provide an efficient decoding algorithm based on rank metric block decoders, which is able to handle errors, erasures and deviations.
This decoding algorithm can be seen as a generalization of the Dettmar-Sorger algorithm.
Note that our extension to error-erasure-decoding can also be done for Hamming metric.
Further, we show (similar to Silva et al.), how lifted PUM codes can be applied in RLNC and how decoding in RLNC reduces then to error-erasure-deviation decoding of PUM codes based on Gabidulin codes, which can efficiently be done by the presented decoding algorithm.

Note that there are other contributions devoted to convolutional network codes, but none of these code constructions is based on rank metric and deals with the transmission over the operator channel as ours.
Our contribution can be seen an equivalent to the block code construction by Silva, Kschischang and Kötter

5.

University of Bremen

Prof. Dr. Armin Dekorsy
Prof. Dr. Steffen Paul
Dr. Dirk Wübben
Meng Wu

Title: Investigation of Two-Way Relay Systems with Multiple-Antenna Relays

Abstract:

In two-way relaying networks, a relaying node supports the bidirectional exchange of messages between two sources. In case of orthogonal transmissions 4 transmission slots are required due to the half-duplex constraint of the relaying node. To increase spectral efficiency, the principle of network coding can be applied requiring only 3 slots. In the first two slots both sources transmit successively their messages to the relay, which then constructs a network coded message to be broadcasted to both nodes in the last slot. Physical layer network coding even allows for reducing the number of transmission slots down to two, since both sources transmit their messages simultaneously to the relay leading to a superimposed received signal. Note that the half-duplex constraint at the sources prohibits exploitation of the direct link for the 2- phase scheme.
In this presentation we focus on multiple-antenna relays using digital network coding. In general, the extension to multiple antennas allows for the application of MIMO reception and transmission technologies at the relay. In particular, receive diversity can be exploited in the 4- and 3-phase scheme. For the 2-phase scheme one can either apply multilayer detection approaches to estimate both source messages explicitly before applying network coding or adapted relaying functions can be designed to estimate the relay signal directly. These different approaches for bidirectional communication are investigated and compared assuming coded OFDM transmissions.

6.

Dresden University of Technology

Prof. Dr.-Ing. Gerhard Fettweis
Dipl.-Ing. Richard Fritzsche

Title: Distributed Robust Precoding for Cooperative Multi-Cell Transmission

Abstract:

In comparison to multiuser transmission from a single base station, cooperative multi-cell transmission techniques require channel knowledge of all users involved, either at a central unit (centralized precoding), or at all collaborating base stations (distributed precoding). In order to obtain this, a user terminal typically feeds channel state information (CSI) back to the base station to which it is assigned. Afterwards, the CSI is forwarded to a central unit or exchanged between base stations using backhaul connections. Due to routing issues such connections are typically affected by high latencies. Assuming time variant channels, only imperfect CSI is available for multi-cell precoding.
For centralized precoding, CSI of all users is impaired by backhaul delays. In contrast, distributed precoding has the potential to benefit from newer CSI versions of local users, while CSI from users of other cells is more outdated due to the required exchange over high latency backhaul connections. However, for distributed precoding, since each base station does the processing independently based on local CSI, the precoded user date is affected by inconsistencies due to different CSI versions per base station.
In this contribution, a distributed robust precoding scheme is presented which accounts for the fact that different CSI versions are available at the base stations. Performance gains compared to centralized robust precoding are shown.

7.

University of Ulm *Prof. Dr.Ing. Robert Fischer*

University of Erlangen-Nuremberg *Prof. Dr.-Ing. Johannes Huber*
Dipl.-Ing. Michael Cyran

Title: Differential Precoding for Random Linear Network Coding

Abstract:

Aim of the project is to enlight the similarities, dualities, and differences between the fields of precoding for the broadcast channel and network coding. In both scenarios, a number of signals are treated jointly by forming modulo-linear combinations. Utilizing the connections, methods and transmission schemes well-established in the one field can be carried over to the other. In digital communications over channels with unknown phase the application of differential precoding in combination with differential detection is popular. This procedure can be seen as a universal precoding for an entire class of channels. Besides this, in multi-antenna transmission, differential space-time coding is well-known. In this talk, we will present and assess a differential precoding approach to random linear network coding.
Random linear network coding is a method for efficiently distributing information in networks by utilizing linear combinations of data packets. The resulting end-to-end network cannel exhibits a multiplicative and an additive disturbance (additive and multiplicative matrix channel).
Recently, approaches for transmission over this network channel- mainly based on channel sounding in combination with subspace coding- have been represented. As an alternative, we study differential precoding to deal with the unknown multiplicative part of the network channel. Assuming that the network channel is constant over two transmission blocks and no additive error occurs (error-free network coding), a differential receiver is able to perfectly reconstruct the transmitted data without the need to explicit channel sounding (identity matrix preceeding the transmit matrix). For the case of an additive disturbance (noisy network coding, packet errors in the network), differential precoding/detection has to be combined with an error control technique. We will assess error control schemes based on error trapping and rank metric codes for the present setting. A comparison between the differential approach and methods known from the literature will be given. The advantages and drawbacks of both variants will be discussed and the setting where the differential approach is preferable will be complied.

8.

Jacobs University Bremen

Prof. Dr.-Ing. Werner Henkel
Alexandra Filip
Oana Graur

Title: Network Coding Concepts for Large Networks and Quantization of RECAP Channels for Physical-Layer Security

Abstract:

Our earlier works provided network coding schemes, e.g., based on an auctioning procedure for a fair allocation of so-called global encoding kernels according to different levels of importance of data and sink preferences. However, such procedures did not scale well. We will now present possibilities for setting up network codes for bigger networks, even in a way that would act somewhat locally, without knowing the complete network topology. For test purposes, of course, a real huge network had to be queried for its topology and packet-loss information to derive statistics that could serve as realistic scenarios. We will outline the effort needed to collect such data. As network coding procedures, we will discuss ant colony optimization and also a hierarchical possibility.

As far as physical-layer security is concerned, the cooperation with our project partners lead to quantization patterns for randomly reconfigurable antennas which allows key generation in a non-mobile, line-of-sight scenario and may significantly diverge from a complex Gaussian channel, at least for smaller antenna structures.

9.

Karlsruhe Institute of Technology

Prof. Dr. rer.nat. Friedrich K. Jondral
Dipl.-Ing. Ralph Tanbourgi
Dipl.-Ing. Holger Jäkel

Title: Cooperative diversity in interference-limited wireless networks
Part 1: Outage performance in the presence of correlated interference

Abstract:

Relay communication is considered a powerful technique to counteract channel fading and to extend coverage in both cellular and decentralized networks. To date, the potential benefits of relaying are well- studied for power- and noise-limited links. However, with the extensive densification of wireless devices in both cellular and decentralized networks, coming along with rapidly increasing data rate demands, it is clear that the relay paradigm is becoming a core component also in interference-limited networks. A detailed performance assessment of relay techniques in the presence of interference, which typically appears random due to various types of dynamics, is hence required. Most notably, node mobility and varying channel conditions are the stochastic quantities driving the interference, for which an accurate modeling can be obtained using the theory of point processes. Since interference is spatially and temporally correlated, its impact on relaying is not fully understood yet.
In this talk, we propose a stochastic model for analyzing this impact. The model inherently takes into account interference correlation at the relay and destination node. We aim at deriving the correct outage probability expressions, thereby focusing on Decode-and-Forward relaying with different combining schemes. We finally characterize the effect of interference correlation on the achievable diversity gain.

10.

Dresden University of Technology

Prof. Dr.-Ing. Eduard Axel Jorswieck
Ms. Fei Shen

Title: Universal Cheat-proof Pricing for Multiple Access Channels without SIC under QoS Requirements

Abstract:

We study universal cheat-proof pricing by a repeated game for the general multiple access channel (MAC) without successive interference cancellation (SIC). We model the system by three entities: regulator, system optimizer and users. The regulator is designed to ensure the signal-to interference plus noise ratio (SINR) based quality-of-service (QoS) requirements of all users and prevent cheating. The feasible utility region, power allocation, corresponding weights, the universal pricing which is linear in pricing parameters and logarithmic in power, and the resulting cost terms are provided. The user misbehavior to maximize their own user utility is analyzed. A repeated game is formulated with worst case strategy for all the honest users and trigger strategy with trigger pricing for the malicious user once cheating is detected. Analysis and simulation results show that it is possible for the regulator to compute a trigger pricing such that misbehavior is prevented in the repeated game.

11.

University of Duisburg-Essen

Prof. Dr.-Ing. habil. Peter Jung
M. Sc. Andrey Skrebtsov

Title: Cooperative diversity in interference-limited wireless networks (Part2)

Abstract:

The investigation of the interference-limited wireless ad hoc networks uses the tools from stochastic geometry, where the nodes within the network interact in a more sophisticated way to coordinate medium access or to cooperate for information transmission. The main benefit of modeling such networks by stochastic geometry is that the resulting network performance can be averaged over all possible spatial configurations and hence, no longer depends on only a single predefined topology. This will reveal the average performance of the candidate strategies and allow a better benchmarking between them.
The Poisson point process and its extension, Poisson-cluster process are widely used for the analysis of wireless networks. Both the Poisson point and Poisson-cluster point process models were implemented within the StoCCNets-project. The simulator allows flexibly setup the network topology based on different stochastic geometry models. In this presentation the Simulation results for the Poisson-cluster process-based network topology are considered.
To improve the network performance cooperation techniques might be implemented in a wireless network. The relaying is considered in this study. In case the networks nodes are able to retransmit the received signal the signal-to-interference ratio improvement is expected. The influence of relaying in the wireless network with Poisson-cluster topology is investigated; the possible performance gain is estimated and compared to the known theoretical bounds. The simulation results will be introduced and compared to the results for the network with Poisson point process topology.

12.

Darmstadt University of Technology

Prof. Dr.-Ing. Anja Klein
M.Sc. Rakash SivaSiva Ganesan

Title: Pair aware interference alignment in multi-user two-way relay networks

Abstract:

In the joint project of TU Darmstadt and University of Rostock, the concept of utilizing relays for aiding interference alignment is investigated. In this presentation, a bidirectional communication between K communicating node pairs is addressed considering two-way relaying. There is no direct link between the nodes. A single relay with multiple antennas assists in the communication. In the first time slot, all the nodes simultaneously transmit to the relay and in the second time slot, after linear processing of the received signals, the relay broadcasts the processed signals to the nodes. The relay does not have enough antennas to perform transceive zero forcing. The nodes have less antennas than required to perform spatial interference alignment in a K-user interference channel. Hence, the relay and the nodes need to cooperate in performing interference alignment. Using the fact that the nodes can cancel the self interference, a new relay-aided interference alignment scheme called pair-aware interference alignment is presented. In this scheme, the process of interference alignment is decomposed into three steps called Partial Signal Alignment (PSA), Partial Channel Alignment (PCA) and transceive Zero Forcing (ZF). After PSA and PCA, interference alignment can be achieved by transceive ZF of the effective data streams at the relay. The proposed scheme provides a method to modify the effective channel between the nodes by modifying the relay coefficients so that interference alignment becomes possible in the resulting channel. Interestingly, the conventional schemes like pair-aware transceive zero forcing and perfect signal alignment based interference alignment can be shown to be special cases of the proposed scheme.

13.

University of Rostock

Prof. Dr.-Ing. habil. Tobias Weber
Xiang Li

Title: Interference Alignment Aided by Non-Regenerative One-Way Relays

Abstract:

In the joint project of TU Darmstadt and University of Rostock, the concept of utilizing relays for aiding interference alignment (IA) is investigated. In this presentation we will focus on unidirectional communication employing one way relaying. A scenario consisting of K single-antenna node pairs and R one-way relays is considered. The nodes are connected by a flat Rayleigh fading interference channel. The relays may be equipped with a single antenna or in general with multiple antennas. Even in the latter case, the number of antennas at a relay is assumed to be insufficient to decode the signals from all source nodes. Hence, the relays simply amplify and forward their received signals. In the first time slot, every source node transmits to the relays and to the destination nodes. In the second time slot, the relays forward the signals received in the previous time slot and, additionally, the source nodes transmit the signals a second time to the destination nodes.

To achieve IA at the destination nodes, we can choose the relays' scaling factors as free variables and fix the transmit and the receive filters. Then the IA problem can be formulated as a linear system of equations. With a sufficient number of relays and number of antennas at the relays, the linear system of equations is solvable. Alternatively, together with the relays' scaling factors, we can also adapt the transmit and the receive filters in order to reduce the required number of relays and relay antennas.

Besides the basic schemes, the cases when the number of the relays' scaling factors resulting from the number of relays and relay antennas is smaller or larger than the minimum required one are considered as well. We introduce the idea of imperfect IA for the former case, which leads to a least squares solution. For the latter case, an optimized solution which minimizes the relays' retransmitted energy is proposed. Furthermore, the power allocation among the source nodes and the relays is also addressed.

14.

Darmstadt University of Technology

Prof. Dr.-Ing. Anja Klein
Dipl.-Ing. Holger Degenhardt

Title: Non-regenerative multi-pair two-way relaying

Abstract:

Non-regenerative multi-pair two-way relaying is investigated. The considered scenario consists of multiple multi-antenna nodes which perform pair wise bidirectional communications via an intermediate multi-antenna relay station. In such a scenario, the required data rates for each direction of transmission are typically different which is considered by introducing asymmetric rate requirements. Each multi-antenna node can simultaneously transmit one up to M data streams, where M is the number of antennas per node. To maximize the achievable data rates under consideration of asymmetric rate requirements, the optimization of the numbers of simultaneously transmitted data streams is crucial, because it determines the spatial dimensions which are required to transmit the data streams of each node and therewith influences the achievable data rates of all nodes. Therefore, an approach for multi-pair two-way relaying under asymmetric rate requirements is introduced which is based on optimizing the number of simultaneously transmitted data streams of each node. Furthermore, different filter designs at the nodes are proposed and investigated and a self-interference aware relay transceive filter is presented. The proposed optimization of the numbers of simultaneously transmitted data streams in conjunction with the presented self-interference aware relay transceive filter shows significant performance gains compared to conventional approaches for the considered scenario.
The achievable data rates depend on the available channel state information (CSI). To obtain the required CSI, a new pilot transmission scheme for non-regenerative multi-pair two-way relaying is introduced. Furthermore, the impact of imperfect CSI on the achievable data rates is investigated. In addition, a robust relay transceive filter design which considers the imperfections of the available CSI is proposed to increase the achievable data rates compared to non-robust relay transceive filter designs in case of imperfect CSI.

15.

-Invited Talk-

EURECOM ***Prof. David Gesbert***

Title: Precoding in multiple antenna channels with obsolete feedback

Abstract:

The exploitation of delayed feedback for precoding over multiple antenna channels has received much attention lately. In this talk, we extend known results by Maddah Ali and Tse to more general settings, allowing to bridge information theoretic findings with practical schemes. Previously reported precoding methods for delayed feedback take a degree-of-freedom only point of view (large SNR regime) and consider a worse case feedback delay. We first consider the finite SNR regime and propose an efficient precoding method trading-off interference canceling for signal enhancement. We then consider the problem of exploiting delayed feedback in time correlated channels. There, the transmitter has access to delayed channel state information in addition to imperfect knowledge on the current channel state, obtained e.g. from linear prediction over past samples. By representing the quality of the current channel state information as P^{-\alpha}, we characterize the optimal degree of freedom region for a two-user MISO broadcast correlated channel and reveal an optimal scheme for combining delayed and current feedback. The essential ingredients of the proposed scheme lie in i) the use of current-CSIT precoding, no matter how imperfect it is, ii) Quantization and multicasting of the residual interferences.

16.

RWTH Aachen University

Univ.-Prof. Dr. rer. nat. Rudolf Mathar
Dipl.-Ing. Henning Maier

Title: Cyclic Interference Alignment by Propagation Delay

Abstract:

Interference Alignment (IA) by propagation delay is a communication scheme for multi-user interference channels that is based on constant integer-valued propagation delays between the transmitters and the receivers. Interestingly, IA by delay has mainly been used as an illustrative example in the literature to explain the basic principle of IA itself.
The well-known idea of IA by delay is to keep dedicated signals distinct from interference signals of multiple users within a limited number of time-slots. Thus, the transmitters are forced to exploit the channel delays as efficiently as possible using the knowledge of the inter-user delays. In order to receive the dedicated signals interference-free and still exploiting the channel in an optimal manner, the interfering signals must combine in the least number of time-slots at each receiver.
In this work, we formally introduce a corresponding communication model based on cyclic groups describing the delay-based channel. We derive conditions on perfect IA and on the separability of dedicated signals at the receivers. We investigate Cyclic IA schemes for scenarios such as the X-channel and the K-user interference channel. We provide necessary conditions on the propagation delays and derive optimal IA schemes.
Furthermore, we remark that Cyclic IA is not limited to the delay-based model. It might be generalized to any communication system that includes comparable cyclic properties.

17.

Polytechnic University of Catalonia *Prof. Dr. Ana Perez-Neira*

Title: Transmit beam forming and power control for open spectrum communication systems

Abstract:

Array and MIMO processing are promising techniques for relieving the total amount of interference at the receive side and; thus, improving the quality-of-service of the users. While cognitive communication are becoming mature from both the research and the regulation side, open (free) spectrum systems are one of the major success of wireless communication systems. Indeed, most of the data from internet is delivered to the final user via a wireless LAN and, also, it will not be a surprise that the future machine-to-machine communications will completely rely on free spectrum communications.
Within this context:
- Decentralized beamforming and power control designs are key for highly non-stationary interference scenarios. Almost optimal decentralized and non-iterative design that also enjoys of secrecy features are desirable.
- Power control is key as a RRM technique to dramatically increase the number of users or the bit rate (i.e. efficiency), see for instance the success of the company InToTally. However, transmit power control becomes obsolete and total received power control mask is to be considered. Instead of the current spectrum management where the frequency usage is delivered by a quasi-permanent license and its costs is extremely high, it is interesting a more 'packetized' licensing system, which will promote the frequency usage by means of using the new spatial dimension. The idea behind is that the licensed user will now set a wireless networks with their own base stations. Notice that the regulation body should control the radiated power inside the licensed area so that it does not interfere with other sub-systems. For this case and as said at the beginning, transmit power control becomes obsolete since in the same area more than one base station will be transmitting.
- Co-channel interference mitigation in frequency selective channels (i.e. ICI in the multiuser, frequency and multiantenna dimension, ISI in the temporal domain) is becoming a need. For example, in LTE there is the SC-FDMA mode in order to relax synchronization issues in the uplink. ICI among users arises because there is no orthogonality in frequency, if the channel is frequency selective ISI may also appear. This transmission mode is also a good alternative not for MAC channels, but also for IC channels as those present in, for instance, M2M communications.

The mathematical tools to face both designs are: multiobjective optimization and game theory.

18.

Berlin Institute of Technology

PD Dr.-Ing. Slawomir Stanczak
Dipl. Ing. Mario Goldenbaum

Title: On Concurrent Transmission vs. Time Sharing in Interference Networks and the Computation of Vector- Valued Functions over Wireless Channels

Abstract:

Wireless sensor networks have increasingly been gaining importance because of their applications in many domains, including remote sensing, traffic management, disaster alarm, and anomaly detection. In many of these applications, sensor nodes cooperate in obtaining an estimate of a control or environmental parameter to achieve capabilities that cannot be achieved by letting the nodes work individually. Cooperation may take on many forms, but it usually involves the computation of weighted averages, maximum values, or polynomial functions of sensor readings. As the readings are available at spatially distributed nodes, wireless communication resources have to be used a efficiently as possible in the computation of the underlying functions. In this talk, we discuss novel techniques that exploit recent ideas on analog computation coding over wireless channels and show how the proposed techniques can be applied in real-world estimation problems. We compare the performance of the proposed methods against that of traditional digital approaches, which separate the process of computation from communication.

19.

Ruhr-University Bochum

Prof. Dr.-Ing. Aydin Sezgin
M.Sc. Anas Chaaban

Title: Interference Alignment and Neutralization in a Cognitive 3-User MAC-Interference Channel: Degrees of Freedom

Abstract:

A network consisting of a point-to-point (P2P) link and a multiple access channel (MAC) sharing the same medium is considered. The resulting interference network, with three transmitters and two receivers is studied from degrees of freedom (DoF) perspective, with and without cognition. Several cognition variants are examined. Namely, the setup is studied with (1) no cognitive transmitters, (2) a cognitive P2P transmitter, (3) one cognitive MAC transmitter, and (4) with two cognitive MAC transmitters. It is shown that having a cognitive P2P transmitter does not bring any DoF gain to the network. This is obtained by showing that the DoF of the two former cases (1) and (2) is 1. However, it is shown that a cognitive MAC transmitter is more beneficial since the latter two cases (3) and (4) have 3/2 DoF. The achievability of 3/2 DoF is guaranteed by using a combination of interference neutralization and interference alignment.

20.

-Invited Talk-

Northwestern University, USA ***Prof. Michael Honig***

Title: Dynamic Spectrum Markets

Abstract:

Dynamic spectrum markets are emerging as a key paradigm for rethinking current spectrum allocations. Such markets could improve the efficiency of radio spectrum allocations by allowing under-utilized spectrum to be re-allocated (traded) over short time-scales in response to changing demand. While technical advances, such as frequency-agile and cognitive radios, are needed to facilitate flexible spectrum use and distributed interference management, introducing markets raises additional issues that intersect technology, micro-economics, and policy.
We first motivate and relate dynamic spectrum markets to current and proposed spectrum sharing mechanisms. Potential market structures that could emerge will be discussed along with associated interference management issues. We conclude with a discussion of spectrum sharing mechanisms for TV white spaces along with possible implications for interference management and wireless system design.

21.

Technical University Munich

Univ.-Prof. Dr. Wolfgang Utschick
M.Sc. (hons) Maximilian Riemensberger

Title: Wireless Broadcast Advantage – Models, Opportunities & Challenges

Abstract:

For a large class of wireless communication networks, the wireless broadcast advantage can be modeled as an information flow polymatroid. This model gives rise to a class of max-flow min-cut theorems on communication networks as well as various algorithmic tools for solving network optimization problems considering the broadcast advantage. The theoretical properties of these types of networks can be applied to opportunistic routing and network coding problems in practical wireless packet networks. The gain in performance from exploiting the wireless broadcast advantage is significant in theory and practice, as demonstrated by network coding based opportunistic routing protocols such as COPE and MORE. Despite these gains, opportunistic routing introduces new challenges to medium access design and traffic routing. The reason is that enough overhearing and coding opportunities need to be generated. On the other hand, interference management and medium access design becomes more difficult since traditional transmitter- receiver link relationships, which are characterized by a single information flow rate, are replaced by transmitter-multireceiver broadcast relationships, which are characterized by a seemingly more complex information flow polymatroid. Furthermore, many practical protocols, e.g. MORE, are focused around unidirectional traffic and occasionally multicast or broadcast traffic. This ignores an important class of traffic patterns which is bidirectional traffic, including approximately symmetric bidirectional data traffic, e.g. voice and video chat, as well as more asymmetric traffic types such as coding feedback, repeat requests and higher layer protocol traffic. This type of traffic is especially suited to network coding based protocols from a theoretical perspective but lacks comparable attention in practical protocol designs.

22.

Technical University Munich

Univ.-Prof. Dr. Wolfgang Utschick
Dr.-Ing. Michael Joham
M.Sc. (hons) Andreas Gründinger

Title: Downlink Beamforming for Static and Mobile Receivers with Rank-One Channels

Abstract:

We consider a wireless communication system with a multi-antenna transmitter, static receivers, and single-antenna mobiles. For static receivers, perfect channel state information (CSI) is available at the multi-antenna transmitter, while only the channel statistics are known for the mobiles' channels. Contrary to the usual rate requirements for the perfect CSI receivers, we consider either ergodic or outage constrained rate requirements for statistical CSI receivers. To manage systems with a large number of transmit antennas and receivers, we focus on computationally efficient linear beamformer designs, e.g., based on quality of service (QoS) power minimization and balancing.
Efficient state-of-the-art beamformer optimizations rely on problem reformulations into signal-to- interference-and-noise-ratio (SINR) based design criteria. Unfortunately, neither the ergodic nor the outage rate constraints can generally be transformed into SINR form. Therefore, a simplified model is created: each fading vector channel is assumed to be Gaussian with rank-one covariance matrix. The motivation is that the spatial channel signatures remain essentially constant in scenarios with a large distance from the transmitter to slowly moving receivers that are locally surrounded by scatterers. A particular example is the feed-forward link in land-mobile-satellite communication.
While the resulting outage constraints can directly be transformed to equivalent SINR requirements, this is not possible for the ergodic constraints. However, rewriting each of these constraints as a fraction of the useful signal power over a function of the interference and linearizing this function, the usual SINR representations are obtained. Based on this observation, a sequential approximation algorithm is proposed that solves a standard QoS power minimization in each iteration. In the same manner, a sequential algorithm can be used for the balancing optimization. The convergence and the achieved performance of these sequential optimizations are discussed via numerical results.

23.

Jacobs University Bremen

Prof. Dr. Jon Wallace
Rashid Mehmood

Title: Physical-layer secure key generation in arbitrary fading and static channels: analysis, methods, and measurements

Abstract:

We present a new study whose purpose is to overcome the limitations of our previous work based on simple Gaussian channels. First, methods for computing available and secure key bits for arbitrary fading channels are presented that employ direct numerical computation using expectations. An in-depth error analysis of the method reveals that close estimates of key-generation rates can be obtained in reasonable computation time for low dimensionality (i.e. when Alice, Eve, and Bob have 1-2 antennas each), but for high dimensionality, more efficient methods must be developed. Second, we consider the solution of using a programmable antenna with multiple states to overcome low security for static channels, allowing fading to be generated synthetically. The security of artificial fading is investigated through detailed simulations and measurements, indicating the number of antenna states that is required to ensure that secure keys can be generated at a high rate. The position and proximity of the eavesdropper, as well as eavesdroppers with SNR and array-size advantages are also considered, indicating that key generation using this technique is secure for most practical cases of interest.

24.

Berlin Institute of Technology

Dr. Gerhard Wunder
Martin Kasparick

Title: Wireless Network Design Under Service Constraints

Abstract:

In this talk we consider the design of control policies in a joint framework combining network layer queueing control and physical layer resource allocation for interference mitigation. In control policy design, special focus is put on application-dependent service constraints. In particular we consider streaming traffic induced requirements such as avoiding buffer underflows, which significantly complicate the control problem compared to guaranteeing throughput optimality only. Since state-of-the-art approaches for enforcing minimum buffer constraints in broadcast networks are not suitable for application in general networks, we argue for a cost function based generalization of the well-known MaxWeight policy, called mu-MaxWeight, which combines throughput optimality with flexibility regarding service constraints. Important concepts behind mu-MaxWeight are explained and new theoretical stability results are presented. Moreover, various candidate cost functions are investigated concerning their suitability in wireless networks with streaming media traffic. Furthermore we show how the cost function based approach can be used to aid wireless network design with respect to important system parameters. We further demonstrate how the proposed control policy design approach can be embedded in a cross-layer control framework for wireless multihop networks. Thereby we combine the advantages of mu-MaxWeight with advanced wireless physical layer resource allocation techniques for interference mitigation based on power control. To circumvent the difficult non-convex nature of the latter problem, we employ powerful convex approximation techniques. The performance is demonstrated by numerical simulation results.