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9:30 Welcome Note, Stefan Schwarz (TU Wien)

9:35 Robert Heyn (ETH Zürich)

*Challenges of Localization with Bluetooth Low Energy in Access Control Scenarios*

The Received Signal Strength Indicator (RSSI) of Bluetooth Low Energy (BLE) is a popular means for indoor user localization and tracking. However, fading, shadowing and antenna patterns cause severe RSSI fluctuations, which pose challenges to distance estimation. In this talk, we will first take a critical look at the widely used channel model and in particular analyze the rarely considered impact of commercial antennas on the localization accuracy. Based on the findings, we provide recommendations for system implementation. As a practical example, we further present a wireless access control system with a varying level of complexity to demonstrate the possibilities of low-cost BLE-based localization and tracking.

10:20 COFFEE BREAK

10:40 Michael Joham (TU München)

*A Bilinear Equalizer for Massive MIMO Systems*

In large-scale MIMO systems, where pilot-contamination effects cannot be avoided, it is essential to explicitly consider the imperfect channel state information when designing receive and transmit filters. We investigate how receiver design based on the mean square error of the detected data symbols allows us to reduce the impact of pilot-contamination. Asymptotic analysis shows that under mild conditions on the channel covariance matrices, the mean square error goes to zero. The asymptotic results further allow us to derive a low-complexity filter design, which is also asymptotically optimal. Simulation results based on a typical spatial channel model confirm the theoretical considerations.
11:25 Erich Zöchmann (TU Wien)

*Millimeter Wave Vehicular Communications - Insights from Channel Characterization*

Two very important applications will lead to millimetre wave (mmWave) vehicle-to-everything (V2X) communications. Firstly, to improve safety and traffic flow, vehicles will share sensor information such as camera, radar, and lidar, among other vehicles in proximity to enhance perception of the surrounding environment potentially even beyond non-line-of-sight. Secondly, the immense data collected by automated vehicles will only partially be processed directly on the vehicle. Most of the data will be transferred to edge cloud servers to perform the “number-crunching” there. These applications require high data rates of 100s of Mbits/s to Gbit/s, which cannot be supported by the existing V2X communication technologies such as IEEE 802.11p. Thanks to the wide bandwidths available at mmWave frequency bands, vehicular mmWave communications has the potential to meet the high data rate. MmWave vehicular communications has two distinctive features compared to V2X communications at 6 GHz, however. A high isotropic path loss and a much higher maximum Doppler shift. The isotropic path loss is usually tackled via high gain antennas. On one hand, fortunately, these highly directive antennas reduce the Doppler spread by spatial filtering but on the hand directive antennas make classically used channel model obsolete. In this talk, we show channel models which show a good agreement with measurements and raytracing and allow for physical interpretation. We show that the deterministic two-ray model and the statistical two-wave with diffuse power (TWDP) model are suitable channel models for mmWave V2X communications. Both models make parsimonious use of model parameters and are therefore implementable with very low complexity.

12:05 LUNCH BREAK

13:50 Introduction to Stochastic Geometry, Martin Müller (TU Wien)

14:00 Gerfried Krainz

*A Tractable Approach to Coverage and Rate in Cellular Networks*

The field of stochastic geometry provides a mathematical framework for modeling multi-cell signal-to-interference-plus-noise ratio (SINR). Through its randomness of base station locations it naturally includes different cell sizes and shapes, especially important key factors for future dense networks. While
the common models usually comprise base stations distributed on a grid and mobile users randomly scattered or placed deterministically, these models suffer from being way too idealistic, complex and less tractable. The paper „Tractable Approach for Coverage and Rate in Cellular Networks“ of the authors Jeffrey G. Andrews, Senior Member, IEEE, François Baccelli, and Radha Krishna Ganti, Member, IEEE 2011 forms the basis for this presentation. They emphasize on a tractable approach for a Downlink system model with other-cell interference (OCI) and propose a general analytical model using stochastic geometry for deriving coverage probability and achievable mean data rate in cellular networks, which will cover the major discussed topic. In addition, questions regarding simplifications of these analytical results for special cases and its impact on the performance metrics will be summarized.

14:28 Bashar Tahir

Modeling Heterogeneous Network Interference Using Poisson Point Processes

Modern cellular systems are targeting a heterogeneous deployment, in which multi-tier base stations, as well as relays, and distributed antennas coexist in the same environment. For such a deployment, the characterization of the interference in the network becomes a challenging task, which in turn, complicates the evaluation of key performance metrics, such as the coverage probability and achievable rate. In this talk, by utilizing the framework of stochastic geometry and a new hybrid model, the interference is characterized in an easy and flexible manner. The proposed model comprises both co-tier, as well as, cross-tier interference. Furthermore, the interference is approximated with a Gamma distribution via second order moment matching. This greatly simplifies the calculation of the coverage probability and the achievable rate, and allows for closed-form expressions. Simulation results validate the applicability of the model and evaluate its accuracy. The talk is based on the paper: "Modeling Heterogeneous Network Interference Using Poisson Point Processes" by Robert W. Heath, Marios Kountouris, and Tianyang Bai.

14:56 Sonja Tripkovic

Modeling and Analysis of K-tier Downlink Heterogeneous Cellular Networks

Cellular networks are in a major transition from a carefully planned set of large tower-mounted base-stations (BSs) to an irregular deployment of heterogeneous infrastructure elements that often additionally includes micro, pico, and femtocells, as well as distributed antennas. In my presentation, I will elaborate on a tractable, flexible, and accurate model for a downlink heterogeneous cellular network (HCN) consisting of K tiers of randomly
located BSs, proposed by Dhillon, Ganti, Baccelli and Andrews. This model accounts for the possible differences in terms of average transmit power, supported data rate and BS density amongst the tiers, under following assumptions: each tier has BSs taken from independent Poison Point Process, maximum Signal-to-Interference-plus-Noise-Ratio (SINR) connectivity, Rayleigh fading and homogenous user distribution. Under these assumptions, the authors succeeded in deriving expressions for the probability of coverage (equivalently outage) over the entire network under both open and closed access, which assumes a strikingly simple closed-form in the high SINR regime and is accurate down to -4 dB even under weaker assumptions. Furthermore, they derived the average rate achieved by a randomly located mobile and the average load on each tier of BSs. For external validation, the comparison was made against an actual LTE network (for tier 1) with the other K-1 tiers being modeled as independent Poisson Point Processes. In this case as well, their model is accurate to within 1-2 dB.

15:25 COFFEE BREAK

15:45 Lukas Eller

Analytical Modeling of Uplink Cellular Networks

Stochastic geometry is a relatively new approach to obtain tractable expressions regarding the performance of cellular networks. As opposed to grid simulations or Wyner-type models it allows for intuitive insights into why various trends are observed. While stochastic geometry has successfully been applied to the Downlink – “Analytical Modeling of Uplink Cellular Networks” by Novlan, Dhillon and Andrews is one of the first papers expanding the concept to the Uplink. In my presentation I will elaborate on why this is a non-trivial extension - especially due to power control and the coupling between the user and base station point processes. Nevertheless the authors succeed in deriving expressions for coverage probability and average rate. This way, a wide variety of system design questions can be addressed. I will thereby especially highlight the implications of power control and the trade-off between full and partial channel inversion in order to balance the link quality between interference limited cell-edge and noise limited cell-interior users.

16:13 Kevin Niederwanger

Analysis of Blockage Effects on Urban Cellular Networks
Large-scale blockages such as buildings affect the performance of urban cellular networks, especially at higher frequencies. Unfortunately, such blockage effects are often either neglected or characterized by oversimplified models in the analysis of cellular networks. I will present a mathematical framework to model random blockages and analyze their impact on cellular network performance. Random buildings are modeled as a process of rectangles with random sizes and orientations whose centers form a Poisson point process on the plane. The distribution of the number of blockages in a link is proven to be a Poisson random variable with parameters dependent on the length of the link. The result from the paper shows that the probability that a link is not intersected by any blockages decays exponentially with the link length. A path loss model is applied to analyze the performance of cellular networks in urban areas with the presence of buildings, in terms of connectivity and coverage probability. The results show that the base station density should scale superlinearly with the blockage density to maintain the network connectivity. The analyses also show that while buildings may block the desired signal, they may still have a positive impact on the SIR coverage probability and since they can block significantly more interference.

16:41 Manuel Lobinger

*Performance Impact of LoS and NLoS Transmissions in Dense Cellular Networks*

My presentation is about the performance impact of line-of-sight (LoS) and non-line-of-sight (NLoS) transmissions in dense cellular networks. At first I talk about some previous work and then continue with the proposed system model of the authors. After that I show how their analytical results of the coverage probability and area spectral efficiency were calculated. Then I will have a closer look on two special cases with LoS probability functions provided from 3GPP. One simple case with a linear probability function and a second case with an exponential probability function, which is approximated by a piecewise linear function. The analysis demonstrates that the network coverage probability first increases with the increase of the base station (BS) density, and then decreases as the SCN becomes denser. This decrease further makes the ASE suffer from a slow growth or even a decrease with network densification. Also, the approximation of a complex probability function by a linear function provides more tractable results. For practical regime of the BS density, the performance results derived from this analysis are distinctively different from previous results, and thus shed new insights on the design and deployment of future dense SCNs.

17:10 Closing Note, Stefan Schwarz (TU Wien)

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Prof. Rupp  
Prof. Mecklenbräucher  
Prof. Wittneben  
Prof. Görtz  
Prof. Utschick  
Prof. Nossek  

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Anreise:

Mit der Straßenbahnlinie 44 bis Haltestelle Johann-Krawarik-Gasse oder Ottakringer Str./Erdbrustgasse. Dauer etwa 30 Minuten.

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Mit der U-Bahn U3 bis zur Endstation Ottakring, danach 3 Minuten zu Fuß.
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