Hindawi Publishing Corporation
EURASIP Journal on Wireless Communications and Networking
Volume 2010, Article ID 367878, 2 pages
doi:10.1155/2010/367878

Editorial

Femtocell Networks

Ismail Guvenc,[1] Simon Saunders,[2] Ozgur Oyman,[3] Holger Claussen,[4] and Alan Gatherer[5]

[1] *Wireless Access Laboratory, DOCOMO USA Communications Laboratories, Palo Alto, CA 95051, USA*
[2] *Femto Forum, Guildford, UK*
[3] *Wireless Communications Laboratory, Intel Corporation, Santa Clara, CA 95054, USA*
[4] *Autonomous Networks and System Research Department, Alcatel-Lucent Bell Labs, Dublin 15, Ireland*
[5] *CTO of Baseband SoC at Huawei Technologies, Plano, TX 75075, USA*

Correspondence should be addressed to Ismail Guvenc, iguvenc@docomolabs-usa.com

Received 3 May 2010; Accepted 3 May 2010

Femtocells are small cellular base stations that may be deployed in residential, enterprise, or outdoor areas. They utilize the available broadband connections of the users (e.g., cable or DSL) and typically have a coverage radius on the order of ten meters or more. Due to their various advantages, recently there has been a growing interest in femtocell networks both in academia and in industry. Two of the main advantages of these networks include staggering capacity gains for next generation broadband wireless communication systems and the elimination of the dead-spots in a macrocellular network. Due to very short communication distances, femtocell networks offer significantly better signal qualities compared to the current cellular networks. This makes high-quality voice communications and high data rate multimedia type of applications possible in indoor environments. Small-size coverage also implies a reasonably accurate location capability without any sophisticated positioning protocol, which implies a wide range of promising applications within the domain of location-based services.

Despite several benefits, this new type of technology also comes with its own challenges, and there are important technical problems that need to be addressed for successful deployment and operation of these networks. Standardization efforts related to femtocell networks in 3GPP and IEEE are ongoing with full speed. In the meanwhile, there is also a growing interest in the academia towards fully exploiting the benefits of this promising technology. The goal of this special issue was to solicit high-quality unpublished research papers on design, evaluation, and performance analysis of femtocell networks. Based on the submitted manuscripts, eight manuscripts have been accepted, which will be summarized briefly in this editorial letter.

Probably the most important problem in femtocell networks is the presence of interference between neighboring femtocell networks and between the femtocell networks and the macrocell network. Our special issue opens with two papers that investigates the interference characteristics in femtocell networks. In *"On uplink interference scenarios in two-tier networks"*, the authors Z. Shi et al. investigate uplink interference characteristics in a two-tier UMTS networks where a large number of femtocells are randomly deployed in the coverage area of a macrocellular network sharing the same carrier. Two severe interference scenarios are analyzed using simulations and it is shown that under these conditions both the femtocell and macrocell throughput is significantly reduced if no interference mitigation techniques are employed. In addition different interference mitigation techniques are discussed that can help to reduce this degradation.

In the second paper, Sung et al. derive the probability density function of the downlink signal-to-interference-plus-noise ratio (SINR) for neighboring femtocell networks in their paper titled *"A semi-analytical PDF of downlink SINR for femto-cell networks"*. Their realistic mathematical model considers uncoordinated locations and transmission powers of base stations (BSs) which reflect accurately the deployment of randomly located femtocells in an indoor environment, also taking into account practical propagation models. Moreover, the accuracy of the resulting analysis on the SINR PDF is validated in the paper via Monte Carlo simulations. The benefit of this contribution is that the derived PDF can be easily calculated by employing standard numerical methods, obviating the need for time consuming simulation efforts.

After discussion of interference characteristics and statistics for different scenarios within the first two papers, the remaining papers in the special issue mostly focus on handling the interference problems in femtoecell networks. In the third paper titled "*Intracell handover for interference and handover mitigation in OFDMA two-tier macrocell-femtocell networks*", Perez et al. deal with the interference problems through intracell handover and power control techniques, which reduce the outage probability of the macrocell users that are in the vicinity of femtocell networks. Number of handover attempts and thus network signaling are also decreased with the proposed intracell handover methods.

Another approach to deal with the interference is to suppress it using multiple antenna techniques such as beamforming methods. In the article "*Interference suppression by practical transmit beamforming methods in closed femtocells*" by Husso et al., the authors utilize the availability of a control-only connection between a user equipment (UE) and an interfering femtocell base station (FBS) for interference suppression purposes. A simple two neighboring femtocell scenario is considered where the interfered UE requests the interfering FBS to replace its beamforming vector appropriately so that interference power directed to the interfered UE is minimized. While this reduces beamforming gain for a user connected to the interfering FBS, if used intelligently, it may prevent outages at neighboring femtocells with minimum performance degradation of the own users of the interfering FBS.

Efficient resource allocation techniques also carry critical importance for alleviating the impact of interference in femtocell networks. In "*Joint power control, base station assignment, and channel assignment in cognitive femtocell networks*" by Torregoza et al., the authors integrate cognitive radio and femtocell network technologies for developing joint power control, base station assignment, and channel assignment methods for femtocell networks. In order to address this complex problem, they define a multiobjective optimization framework with mixed integer variables; a pareto optimal solution is found through weighted sum approach, and the framework is shown to be both stable and converging. The results in the paper show that as the number of users in the network increases, significant gains can be obtained in the aggregate throughput when the proposed approach is deployed.

In a different paper titled "*Bayesian game-theoretic approach for distributed resource allocation in fading multiple access channels*" by He et al., a Bayesian game-theoretic model is developed to design and analyze the resource allocation problem in multiuser fading multiple access channels (MAC), where the users are assumed to selfishly maximize their average achievable rates with incomplete information about the fading channel gains. The major result of the paper is that it proves that there exists exactly one Bayesian equilibrium in such a game. Further studies on the network sum-rate maximization problem are also presented in this contribution considering symmetric user coordination strategies.

In "*Dynamic resource partitioning for downlink femto-to-macro-cell interference avoidance*" by Z. Bharucha et al., the problem of femtocell to macrocell interference for the downlink in LTE is addressed through dynamic resource partitioning, where femtocells are denied access to radio resources used by macro-UEs in their vicinity. The proposed coordination is achieved by using the downlink high interference indicator messages that are configured based on macro-UE measurements and sent by the eNB over the wireline backbone to HeNBs if required. It is demonstrated through simulations that in the investigated closed-access femtocell scenario the capacity of affected macro-UEs in vicinity of a femtocell can be increased by up to tenfold for a sacrifice of 4% of the overall femtocell downlink capacity.

Finally, in "*Extremal signal quality in cellular networks: asymptotic properties and applications to mobility management in small cell networks*", V. M. Nguyen et al. investigate the critical issues of extremal signal quality and mobility management in small-cell networks accounting for the characteristics of high density and randomness of small cells. Considering the asymptotic regime as the number of cells tends to infinity, the paper utilizes extreme value theory to derive the distribution of the extremal signal quality and establishes an analytical model to find the optimal number of cells to be scanned for maximizing the data throughput, leading to an optimized random cell scanning scheme.

We would like to take this opportunity to express our gratitude to the Editor-in-Chief of EURASIP Journal of Wireless Communications and Networking, Dr. Luc Vandendorpe, for giving us the opportunity to initiate this special issue; the editorial staff at Hindawi Publishing for their tremendous assistance during the progress of the special issue; the anonymous reviewers for their detailed and timely reviews which helped us to select the best papers among the submitted papers; and all the authors who considered our special issue for submitting their papers. We hope that you will enjoy reading this special collection of high-quality articles on femtocell networks and also hope that these papers will trigger new research ideas and directions for the successful deployment of this new technology.

Ismail Guvenc
Simon Saunders
Ozgur Oyman
Holger Claussen
Alan Gatherer