



University  
of Victoria

Graduate Studies

Notice of the Final Oral Examination  
for the Degree of Doctor of Philosophy

of

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MSc (University of Westminster, 2013)

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**“Power Allocation and Cell Association in Cellular Networks”**

Department of Electrical and Computer Engineering

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1:00 P.M.

Engineering Computer Science Building

Room 468

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## Abstract

In this dissertation, power allocation approaches considering path loss, shadowing, and Rayleigh and Nakagami- $m$  fading are proposed. The goal is to improve power consumption, and energy and throughput efficiency based on the user target signal to interference plus noise ratio (SINR) requirements and outage probability threshold. First, using the moment generating function (MGF), the exact outage probability over Rayleigh and Nakagami- $m$  fading channels derived. Then upper and lower bounds on the outage probability are derived using the Weierstrass, Bernoulli and exponential inequalities. The relationship between outage probability in Rayleigh and Nakagami- $m$  fading is then obtained given the SINR. Second, the problem of minimizing the user power subject to outage probability and user target SINR constraints is considered. The corresponding power allocation problems are solved using Perron-Frobenius theory and geometric programming (GP). A GP problem can be transformed into a nonlinear convex optimization problem using variable substitution and then solved globally and efficiently by interior point methods. Then, power allocation problems for throughput maximization and energy efficiency are proposed. As these problems are in a convex fractional programming form, parametric transformation is used to convert the original problems into subtractive optimization problems which can be solved iteratively. Simulation results are presented which show that the proposed approaches are better than existing schemes in terms of power consumption, throughput, energy efficiency and outage probability.

Prioritized cell association and power allocation (CAPA) to solve the load balancing issue in heterogeneous networks (HetNet) is also considered in this dissertation. A Hetnet is a group of macrocell base stations (MBSs) underlaid by a diverse set of small cell base stations (SBSs) such as microcells, picocells and femtocells. These networks are considered to be a good solution to enhance network capacity, improve network coverage, and reduce power consumption. However, HetNets are limited by the disparity of power levels in the different tiers. Conventional cell association approaches cause MBS overloading, SBS underutilization, excessive user interference and wasted resources. Satisfying priority user (PU) requirements while maximizing the number of normal users (NUs) has not been considered in existing power allocation algorithms. Two stage CAPA optimization is proposed to address the prioritized cell association and power allocation problem. The first stage is employed by PUs and NUs and the second stage is employed by BSs. First, the product of the channel access likelihood (CAL)

and channel gain to interference plus noise ratio (GINR) is considered for PU cell association while network utility is considered for NU cell association. Here, CAL is defined as the reciprocal of the BS load. In CAL and GINR cell association, PUs are associated with the BSs that provide the maximum product of CAL and GINR. This implies that PUs connect to BSs with a low number of users and good channel conditions. NUs are connected to BSs so that the network utility is maximized, and this is achieved using an iterative algorithm. Second, prioritized power allocation is used to reduce power consumption and satisfy as many NUs with their target SINRs as possible while ensuring that PU requirements are satisfied. Performance results are presented which show that the proposed schemes provide fair and efficient solutions which reduce power consumption and have faster convergence than conventional CAPA schemes.