Spectrum and physical resources allocation optimization in broadband cellular networks

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ABSTRACT

In current (4G) and future (5G) broadband cellular networks, network architectures proposals, novel physical resources allocation optimization techniques, and dynamic spectrum allocation optimization frame works provide good opportunities for mobile service providers (MSPs) to improve their return on investments (ROI), and for mobile equipments manufacturers to increase their profit and market share. Despite the attractive opportunities that network architecture, resources allocation optimization offers, there are many challenges and difficulties that are facing MSPs when planning and operating networks to cope with the tremendous increase in mobile applications and to satisfy different users requirements. Physical resources allocation, spectrum allocation optimization, and network architecture enhancement are major issues in broadband cellular networks. The work accomplished in this thesis aims at enhancing the network performance by optimizing the planning and operations of the network. Different optimization techniques are used throughout this thesis to help increase the spectral and energy efficiency in 4G and 5G networks. The objectives of this study are three objectives, first to propose a physical resources allocation utility based frame work using a novel utility function that can jointly optimize the maximum normalized spectral efficiency (NSE) and power consumed locally in each cell in order to increase the mobile service providers ROI. The ROI is enhanced by increasing the profits through maximizing the network spectral efficiency and decreasing the operational costs by minimizing the power consumption in the network. The second objective is to determine the optimal down-link frequency partition configuration that can efficiently allocate the spectrum resources to different network frequency partitions in order to globally achieve the same joint optimization objective by addressing the DFPCs dynamic behavior according to the network topology, load conditions, and users distribution. The last objective is to propose a new network architecture that consists of a data collection system that aid as a traffic data repository and a decision support system (DSS) introduced as a new self optimization module within the self organized networks (SON) framework to automate the optimization of the dynamic spectrum allocation. In order to achieve the previously mentioned objectives a detailed study to the state of the art in network planning, physical resource allocation, dynamic spectrum allocation, network architecture and SON frame work is conducted. Different methodologies such as integer linear programming, stochastic programming and non-parametric estimation analysis are presented to propose a novel physical resources and dynamic spectrum allocation schemes. A plan-do-control-act model is also proposed within the DSS in the new suggested network architecture for continuous improvement of spectrum allocation. Simulations and results are conducted to validate the proposed methodologies and to compare it against state of the art work.