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Adaptive multi-channel downlink assignment for overloaded spectrum-shared multi-antenna overlaid cellular networks

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Overlaid cellular technology has been considered as a promising candidate to enhance the capacity and extend the coverage of cellular networks, particularly indoors. The deployment of small cells (e.g. femtocells and/or picocells) in an overlaid setup is expected to reduce the operational power and to function satisfactorily with the existing cellular architecture. Among the possible deployments of small-cell access points is to manage many of them to serve specific spatial locations, while reusing the available spectrum universally. This contribution considers the aforementioned scenario with the objective to serve as many active users as possible when the available downlink spectrum is overloaded.

The case study is motivated by the importance of realizing universal resource sharing in overlaid networks, while reducing the load of distributing available resources, satisfying downlink multi-channel assignment, controlling the aggregate level of interference, and maintaining desired design/operation requirements. These objectives need to be achieved in distributed manner in each spatial space with as low processing load as possible when the feedback links are capacity-limited, multiple small-cell access points can be shared, and data exchange between access points can not be coordinated.

This contribution is summarized as follows. An adaptive downlink multi-channel assignment scheme when multiple co-channel and shared small-cell access points are allocated to serve active users is proposed. It is assumed that the deployed access points employ isotropic antenna arrays of arbitrary sizes, operate using the open-access strategy, and transmit on shared physical channels simultaneously. Moreover, each active user can be served by a single transmit channel per each access point at a time, and can sense the concurrent interference level associated with each transmit antenna channel non-coherently. The proposed scheme aims to identify a suitable subset of transmit channels in operating access points such that certain limits on the aggregate interference or number of serving access points are satisfied, while reducing the load of processing. The applicability of the results for some scenarios, including the identification of interference-free channels in operating access points is explained. Numerical and simulations results are shown to clarify achieved gains with the use of the proposed scheme under various operating conditions.