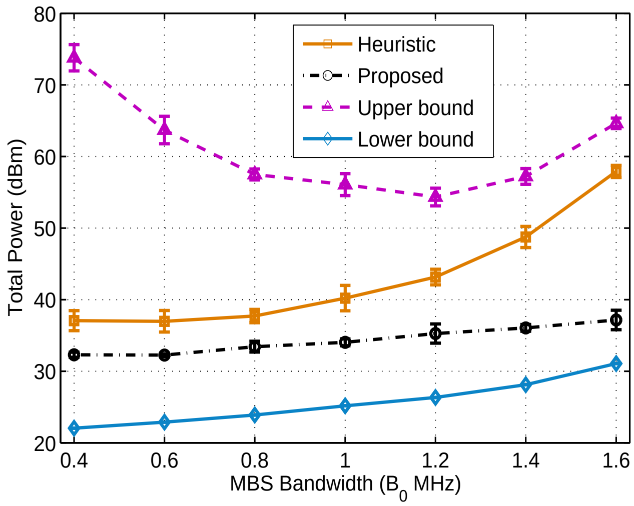

Figure 7. Total power vs. bandwidth of MBS.

5. Related Work

Femtocells have attracted considerable interest from both industry and academia. Technical and business challenges, requirements and some preliminary solutions to femtocell networks are discussed in [3, 6, 17]. Since FBS's are distributedly located and are able to spatially reuse the same channel, considerable research efforts were made on interference analysis and mitigation [7, 18]. A distributed utility based SINR adaptation scheme was presented in [7] to alleviate cross-tire interference at the macrocell from co-channel femtocells. Lee, Oh and Lee [18] proposed a fractional frequency reuse scheme to mitigate inter-femtocell interference. In our prior work [11, 13], the problem of streaming scalable videos in cognitive radio femtocell networks was investigated. We developed a greedy algorithm to compute near-optimal solutions and proved a closed-form lower bound for its performance.

There are some recent work considering the potential collaborations between femtocells and macrocells. Instead of decoding the signals at the base stations, the work in [8] analyzes the outage rate of joint decoding the signals from macrocell and femtocell in the operator's network. Despite the theoretical benefit, this will make retransmission difficult in case of packet loss or error. In the work of FemtoHall [23], the backhaul networks of the femtocells are used to alleviated the bottleneck effect of the cellular backhaul network. In [28], the femtocell users serve as relays for the macrocell users to facilitate load balancing. In a recent work [15], the authors investigate the impact of access strategies for the femtocells, where spectrum resource is used as an incentive to encourage femtocells to serve more macrocell users. In [29], the cell association problem is studied and a handover algorithm is developed to reduce the number of unnecessary handovers using Bayesian estimation.

Cognitive femtocells have been investigated in a few recent papers, where cognitive radios are exploited [2, 11, 20, 21, 25, 26]. In [21], the authors develop a scheme that femtocells autonomously sense the radio resource usage of the Macrocell so as to mitigate interference. However the unavoidable inaccuracy in the sensing results is not considered. In [26], the authors study effective spectrum sharing among the femtocells assuming that the set of available channels are given and accurate. In a recent work [25], a network with one primary link and one secondary link is considered (although later extended to the case of more than one secondary users). The paper focuses on the scenario that the secondary user can sue cooperation to increase the primary user's data rate. In our recent work [11], CR is exploited to assist multi-user video streaming in femtocell networks. In [20], the problem of cell association is investigated to derive a green resolution, while CR is adopted for sharing spectrum between the MBS and FBS's. In [2], the radio resource and power management problem is investigated in the context of cognitive femtocell networks.

SIC has high potential of sending or receiving multiple signals concurrently, which improves the transmission efficiency. In [19], the authors developed MAC and routing protocols that exploit SC and SIC to enable simultaneous unicast transmissions. Sen, et al. investigated the possible throughput gains with SIC from a MAC layer perspective [24]. Power control for SIC was comprehensively investigated and widely applied to code division multiple access (CDMA) systems [1, 4, 5, 14, 22]. Applying game theory, Jean and Jabbari proposed an uplink power control under SIC in direct sequence-CDMA networks [14]. In [22], the authors introduced an iterative two-stage SIC detection scheme for a multicode MIMO system and showed the proposed scheme significantly outperformed the equal power allocation scheme. A scheme on joint power control and receiver optimization of CDMA transceivers was presented in [5]. In [1, 4], the impact of imperfect channel estimation and imperfect interference cancellation on the capacity of CDMA systems was examined.

In this paper, we consider the challenging problem of data multicast in femtocell networks with an SC/SIC approach, aiming to minimize the overall BS power consumption. We propose a simple heuristic scheme and a near-optimal power allocation scheme with low computational complexity and proven performance bounds. The proposed algorithms are shown to perform well for achieving the design goals.

6. Conclusions

In this paper, we investigated data multicast in femtocell networks consisting of an MBS and multiple FBS's. We adopted SC and SIC for multicast data and investigated how to assign transmit powers for the packet levels. The objective was to minimize the total BS power consumption, while guaranteeing successful decoding of the multicast data at each user. We developed optimal and near-optimal algorithms with low computational complexity, as well as performance bounds. The algorithms were evaluated with simulations and are shown to outperform a heuristic with considerable gains.

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