Exploiting constructive interference for simultaneous wireless information and power transfer in multiuser downlink systems

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Abstract: In this paper we propose a power-efficient approach for information and energy transfer in multiple-input single-output downlink systems. By means of data-aided precoding, we exploit the constructive part of interference for both information decoding and wireless power transfer. Rather than suppressing interference as in conventional schemes, we take advantage of constructive interference among users, inherent in the downlink, as a source of both useful information signal energy and electrical wireless energy. Specifically, we propose a new precoding design that minimizes the transmit power while guaranteeing the quality of service (QoS) and energy harvesting constraints for generic phase shift keying modulated signals. The QoS constraints are modified to accommodate constructive interference, based on the constructive regions in the signal constellation. Although the resulting problem is nonconvex, several methods are developed for its solution. First we derive necessary and sufficient conditions for the feasibility of the considered problem. Then we propose second-order cone programming and semi-definite programming algorithms with polynomial complexity that provide upper and lower bounds to the optimal solution and establish the asymptotic optimality of these algorithms when the modulation order and SINR threshold tend to infinity. A practical iterative algorithm is also proposed based on successive linear approximation of the non-convex terms yielding excellent results. More complex algorithms are also proposed to provide tight upper and lower bounds for benchmarking purposes. Simulation results show significant power savings with the proposed data-aided precoding approach compared to the conventional precoding scheme.