Optimal resource allocation for relay-assisted wireless communication systems

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The design, analysis and optimization of cooperative/relaying communication systems have recently become a very active research area within both the information theory as well as communications engineering societies. It is now well understood that relaying strategies can improve the coverage of wireless networks by providing higher data rates or better transmission reliability to user terminals at the edge of a wireless cell, or terminals having faded connectivity with the base station. Relaying technologies are also becoming part of the telecommunication standards. Although we can find studies, in the academic literature, on advanced relaying schemes, which are based on user terminals cooperating to help each other while applying decentralized resource allocation strategies, the first actual deployment step which will take place within the 3GPP long-term evolution (LTE)-advanced standard is based on fixed access points to do the relaying and within a centralized scheme in which the e-nodeB (base station with backhaul connection) takes the scheduling and resource allocation decisions.

One major objective in 3GPP evolution is to utilize the scarce wireless system resources efficiently because achieving the high quality of service (QoS) targets through over-provisioning is uneconomical due to the relatively high cost for transmission capacity in cellular access networks.

Our objective here is to obtain the optimal (from an information theory perspective) resource allocation schemes taking into considerations the system constraints that are relevant to the LTE-advanced standard. We have been able to derive optimal resource allocation polices that are provably based on closed-form formulations which are practical for implementation. They include the policies for (i) transmission mode selection (i.e. deciding whether the user needs the assistance of a relay or not), (ii) power allocation for the base station and the relays, and (iii) criterion for user scheduling over the available air-link resource units.

Simulation results demonstrate that our proposed resource allocation scheme provides considerable throughput gains especially for users receiving low power through the direct link with the base station.