Single-User Broadcasting Protocols over a Two-Hop Relay Fading Channel

Avi Steiner and Shlomo Shamai (Shitz)

***Abstract*— A two-hop relay fading channel is considered, where only decoders possess perfect channel state information (CSI). Various relaying protocols and broadcasting strategies are studied. The main focus of this work is on simple relay transmission scheduling schemes. For decode-and-forward (DF) relaying, the simple relay cannot buffer multiple packets, nor can it reschedule retransmissions. This gives rise to consideration of other relaying techniques, such as amplify-and-forward (AF), where a maximal broadcasting achievable rate is analytically derived. A quantize-and-forward (QF) relay, coupled with a single-level code at the source, uses codebooks matched to the received signal power and performs optimal quantization. This is simplified by a hybrid amplify-QF (AQF) relay, which performs scaling, and single codebook quantization on the input. It is shown that the latter is optimal by means of throughput on the relay-destination link, while maintaining a lower coding complexity than the QF setting. A further extension of the AQF allows the relay to perform successive refinement, coupled with a matched multi-level code. Numerical results show that for high SNRs the broadcast approach over AF relay may achieve higher throughput gains than other relaying protocols that were numerically tractable.**

***Index Terms*— Ad-hoc networks, amplify-and-forward, code layering, decode-and-forward, multi-hop relays, quantize-and-forward, single-user broadcasting.**

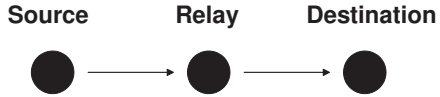

Fig. 1. Schematic diagram of a two-hop relay channel, where there is practically no direct link between source and destination.

single relay, which decodes/amplifies/quantizes its input data and forwards/retransmits its signal over to the destination. This setting is also known as a two-hop relay system [6].

Several contributions [7], [8], [9], and more, demonstrate practical examples for the two-hop relay setting. In these examples single rate codes are used and only the medium access (MAC) layer is modified so that an ad-hoc network can be supported, and a network member may serve as a relay, and thus increase the coverage and overall network capacity. This is also a special case of multi-hop relays [6]. It is observed in [10] that substantial capacity and coverage gains can be obtained with a simple two-hop relay architecture, where CSI or partial CSI is available at the transmitters. Notice that solutions in the MAC layer necessarily require