

Chapter 14

Resource Allocation for a Cooperative Broadband MIMO–OFDM System

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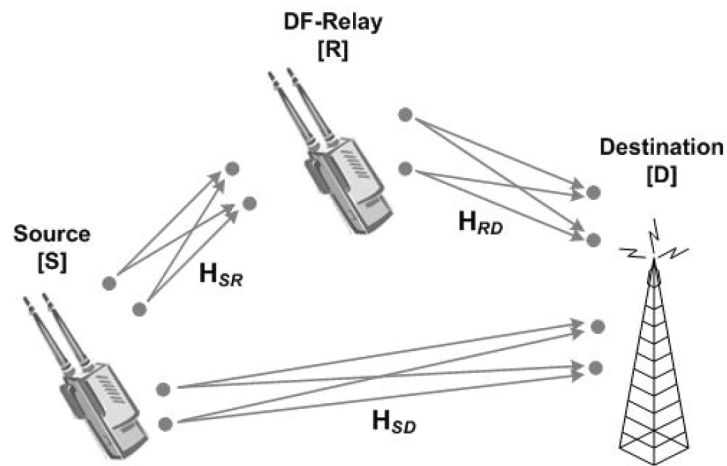
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ABSTRACT

In this chapter, a cooperative broadband relay-based resource allocation technique is proposed for adaptive bit and power loading multiple-input-multiple-output/orthogonal frequency division multiplexing (MIMO-OFDM) system. In this technique, sub-channels allocation, M-QAM modulation order, and power distribution among different sub-channels in the relay-based MIMO-OFDM system are jointly optimized according to the channel state information (CSI) of the relay and the direct link. The transmitted stream of bits is divided into two parts according to a suggested cooperative protocol that is based on sub-channel-division. In this protocol, the first part is sent directly from the source to the destination, and the second part is relayed to the destination through an indirect link. Such a cooperative relay-based system enables us to exploit the inherent system diversities in frequency, space and time to maximize the system power efficiency. The BER performance using this cooperative sub-channel-division protocol with adaptive sub-channel assignment and adaptive bit/power loading are presented and compared with a noncooperative ones. The use of cooperation in a broadband relay-based MIMO-OFDM system showed high performance improvement in terms of BER.

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Figure 1. Relay-based wireless communication system



INTRODUCTION

It is well-known that, due to space separation, multiple-input-multiple-output (MIMO) systems have the advantages of improving the received signal-to-noise ratio (SNR) and suppressing the co-channel interference (CCI) (Winters, 1994). The use of orthogonal frequency division multiplexing (OFDM) gives the system the advantage of inter-symbol-interference (ISI) resistance, due to the use of a cyclic prefix, in addition to the advantage of its spectrum efficiency as compared to the conventional frequency division multiplexing (FDM) (Keller, 2000). When MIMO technique is combined with OFDM, the advantages of both techniques, such as CCI rejection and ISI resistance, can be jointly utilized. Furthermore, the MIMO-OFDM adaptive resource allocation benefits from combined frequency- and space-domain freedom as well as multiuser diversity (Zhang, 2003). Converting a frequency-selective MIMO channel into a number of parallel flat-fading MIMO sub-channels using linear precoding/decoding - based on single value decomposition (SVD) - enables the MIMO processing on a per subcarrier basis. Linear precoding/decoding requires full channel state information (CSI) at both the transmitter and receiver (Sampath, 2001; Scaglione, 2002).

The first formulation of general relaying problems appeared in the information theory community in (Cover, 1979; Van der Meulen, 1971) and served as the inciting cause of the concurrent development of the ALOHA system at the University of Hawaii. The traditional relay channel model is comprised of three nodes: a source that transmits information, a destination that receives information, and a relay that both receives and transmits information to enhance the communication between the source and the destination, as shown in Fig. 1. Recently, many new models with multiple relays have been examined (Kramer, 2005; Schein, 2000).

Adaptive resource allocation for cooperative MIMO-OFDM benefits from the combined frequency- and space-domain freedom as well as cooperative multiuser diversity due to the spatial parallelism and frequency selectivity of the channel. Cooperative relay-based MIMO-OFDM systems will allow the reuse of OFDM subcarriers by means of optimal precoder and decoder matrix transformations that partitions the MIMO channel into parallel non-interfering single-input-single-output (SISO) channels. In this chapter, a cooperative sub-channel division protocol is presented to improve the bit error rate

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