

Chapter 13

Space–Time Coding For Non–Coherent Cooperative Communications

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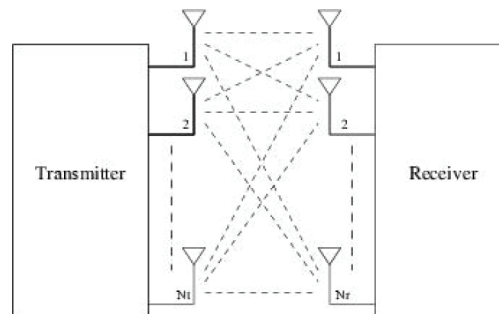
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ABSTRACT

Cooperative communication in a wireless network can be based on the relay channel model where a set of users act as relays to assist a source terminal in transmitting information to a destination terminal. Recently, the idea of space-time coding (STC) has been applied to wireless networks wherein the relay nodes cooperate to process the received signal from the source and forward them to the destination such that the signal received at the destination appears like a space-time block code (STBC). Such STBCs (referred as distributed space time block codes [DSTBCs]) when appropriately designed are known to offer spatial diversity. It is known that separate classes of DSTBCs can be designed based on the destination's knowledge of various fading channels in the network. DSTBCs designed for the scenario when the destination has either the knowledge of only a proper subset of the channels or no knowledge of any of the channels are called non-coherent DSTBCs. This chapter addresses the problems and results associated with the design, code construction, and performance analysis (in terms of pairwise error probability [PEP]) of various noncoherent DSTBCs.

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Figure 1. MIMO Channel model



INTRODUCTION

For a point to point communication in a wireless fading channel, deploying multiple antennas at the source and the destination terminals (referred as a collocated Multiple Input and Multiple Output (MIMO) channel: (See Figure 1)) has been proved to be effective in combating the degrading effects of multi-path fading in addition to providing higher capacities than the Single Input Single Output (SISO) fading channel (single antenna at both the source and the destination). In particular, it is well known that the capacity of a collocated MIMO channel scales linearly with the minimum of the number of transmit and receive antennas for high receive Signal to Noise Ratio (SNR) (The ratio of the received signal power to the additive noise variance at every antenna of the receiver is referred as the receive SNR. Receive SNR has been defined in detail in Section on *MIMO channel model*) when perfect estimates of the channel are available at the receiver [Teletar, 1999]. Also, a spatial diversity order equal to the product of the number of the transmit antennas and receive antennas can potentially be obtained in slow-fading scenarios. When perfect estimates of the channel are available at the destination, the channel is referred as a coherent collocated MIMO channel [Foschini, 1996; Tarokh, Seshadri & Calderbank, 1998]. However, the overhead and/or the difficulty involved in obtaining these perfect estimates at the receiver leads to the need for designing signaling schemes assuming that the receiver doesn't have the knowledge of the channel. Such a channel is referred as non-coherent collocated MIMO channel and the corresponding signaling schemes are called non-coherent signaling schemes. Signal design for coherent and non-coherent collocated MIMO channels has been fairly well developed. Throughout the chapter, unless specified, MIMO channels refer to collocated MIMO channels.

In a wireless network, if the source terminal and the destination terminal are engaged in a point to point communication and are precluded from using multiple antennas, then spatial diversity is forbidden. Recently, a promising technique called '**cooperative communication**' has attracted a lot of attention in the research community wherein several users in the network which are geographically separated support the source in transmitting information to the destination (see Figure 2). Since, the destination receives the source signal through several independent paths, a potential spatial diversity order of at most the number of relays (including the source terminal) is promised. Such a method of obtaining spatial diversity is termed as '**cooperative diversity**' [Jing & Hassibi, 2006; Laneman, Tse & Wornell, 2004; Laneman & Wornell, 2003; Nabar, Bolcskei & Kneubehler, 2004; Sendonaris, Erkip & Aazhang, 2003]. Moving one step further, the idea of space-time coding which was originally devised for a MIMO channel has been applied to wireless networks under the frame-work of cooperative communication. In this scenario, the

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