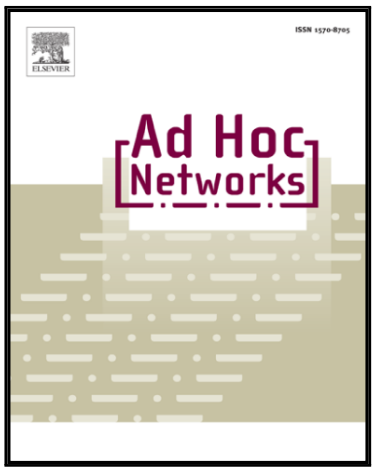

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Abstract

Full-duplex relaying (FDR), which can receive and transmit simultaneously over the same frequency band, enables a significant enhancement of spectral efficiency and has attracted much attention. In this paper, we investigate the performance of multi-hop decode-and-forward (DF) FDR systems, in which the relay nodes suffer not only from self-interference but also from inter-relay interference (IRI). Two cases are considered for the IRI, i.e., the mth relay only knows the channel state information (CSI) from the $(m-1)$th relay or knows perfect CSI from all other relays. Assuming that all the channels including the residual self-interference (RSI) and IRI are subject to Rayleigh fading, we first determine the cumulative distribution function (CDF) of the end-to-end signal-to-interference-plus-noise ratio (SINR) for each case. Then based on these results, we derive the outage probability, symbol error probability and ergodic capacity, for each case respectively. Finally, we compare the performance of multi-hop FDR with multi-hop half-duplex relaying (HDR) and validate our analysis by the simulation results.

Keywords: Multi-hop relaying, Full-duplex, Decode-and-forward, Outage probability, Symbol error probability, Ergodic capacity

1. Introduction

Multi-hop wireless relaying in which a source communicates with a destination via multiple intermediate relays, is an important ingredient in *ad hoc* wireless networks [1, 2]. Compared with direct transmission, multi-hop wireless relaying can save transmitter power, improve the transmission reliability and extend the network coverage [3, 4, 5].

Traditionally, multi-hop wireless relaying operates in a half-duplex mode, where each relay receives and retransmits the signals over orthogonal channels (e.g., time, frequency). Although multi-hop half-duplex relaying (HDR) can simplify the system design and implementation, it incurs significant loss of spectrum efficiency. Recently, encouraged by the advance in antenna design and interference cancellation algorithms [6, 7, 8, 9], full-duplex relaying (FDR), where the relay node receives and transmits at the same time and over the same frequency band, has been regarded as a promising way to overcome the spectrum efficiency loss of HDR and therefore has drawn significant research interests.

So far, most of the works on FDR systems have focused on a single relay network (i.e., dual-hop relaying). Early works on performance analysis of FDR assumed perfect isolation between the relay's transmit antenna and receive antenna and therefore the self-interference can be neglected [10, 11]. However, the self-interference cannot be completely mitigated in practice. As such, several works have taken the effect of residual self-interference (RSI, i.e., the effect of the self-interference after mitigation) into account. In [12], the outage probability of an infrastructure-based FDR were derived both in downlink and in uplink. In [13], the authors investigated the performance of classic three-node FDR and proposed a hybrid relaying which could switch between full-duplex and half-duplex mode. In [14], the exact outage probability of FDR was derived by modelling the RSI as a Rayleigh fading channel. In [15], the authors analyzed the outage performance of a selective decode-and-forward (DF) FDR that captures the joint effect of RSI and direct link. Different from [12, 13, 14, 15], which assumed that the variance of the RSI is proportional to the relay transmit power, reference [16] and [17] assumed that the variance of RSI was proportional to the λ-th power of the average transmitted power and investigated the bit error rate (BER) and capacity of amplify-and-forward (AF) FDR systems, respectively.

Different from dual-hop relaying, in multi-hop FDR, the relay nodes suffer not only from RSI, but also from inter-relay interference (IRI). Therefore, the performance analysis and design of multi-hop FDR is more challenging. In [18], the authors defined a new parameter PLIR which denotes the ability of the relays to isolate transmission from reception and investigated the outage performance of multi-hop HDR. However, [18] considered all the inter-relay signals except the signal sent from previous relay as interference, which results in bad performance.

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