Relay performance in uplink and downlink 4G wireless systems

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Background
The last few years have witnessed a growing interest in relay technology as a means to expand the coverage area of a base station or enhance the performance of cellular systems [1, 2]. In particular, next generation networks (NGN) such as IEEE 802.16m or 3GPP-LTE Advanced, are all defining relay extensions to the classical base station (BS) based cellular architecture as a means to fulfill the stringent quality-of-service (QoS) constraints required in future networks [3, 4]. Very recently, a comparative study has been presented in [5] where several relaying architectures are assessed in terms of sum rate capacity. In particular, four different structures have been studied, namely,

- Two-way relaying

- One-way relaying

- Shared relaying

- Base station coordination

The first three are indeed relay-based schemes where different relay-BS interactions are considered while the last one covers the coordinated transmission from several base stations, linked using a backhaul connection, to a given mobile station. The main shortcoming of this study is that it focuses on narrow-band channels whereas almost all NGN proposals are based on multicarrier principles [6] given its effectiveness in combating frequency selectivity. Consequently, the sum rate capacity for the different architectures remains unknown for practical wideband scenarios.
A recent PFC has been conducted within the Mobile Communications Group (UIB) that started exploring the performance advantages of several relay architectures within the context of a multicarrier architecture [7]. Nevertheless, several key questions remain open. Firstly, it is not yet clear when a given mobile terminal should communicate via the relay as it has been found that there are cases where direct communication with the BS is more effective. Note that the multicarrier nature of the system complicates this decision. Secondly, the previous PFC focused solely on the downlink and therefore it is necessary to expand the study to cover the uplink segment.

Keywords: Relay, base station cooperation, sum rate capacity, IEEE 802.16m/j, LTE-Advanced.

Objectives

The main objective of this project is to extend the results of [5] and [7] in order to shed some light on two problems:

1. What criteria can be used to decide when to use a relay in a BS-MS communication?

2. What are the performance advantages of relaying in the uplink?

To fulfill this goal, student are expected to:

- Acquire a reasonable amount of knowledge on some state-of-the-art wireless topics such as multicarrier and relaying and also on state-of-the-art standards such as IEEE 802.16m/j and 3GPP-LTE Advanced.

- Understand the different relaying/coordination architectures that are being considered in NGN.

- Extend the relaying/coordination architectures proposed in [5] and [7] to the uplink segment while devising strategies to switch between direct and relay-based communication.

- Become competent in the use of Matlab.

- Develop a Matlab simulation environment for evaluating the different relay architectures.

- Write a technical report describing the work done.

- Prepare an oral presentation highlighting the main points of the project.

Tools: Search engines for literature review (*scholar.google.com, www.ieeexplore.org*), Matlab for programming, LaTEX for report writing.

Pre-requisites: general knowledge of communication theory and mobile communication networks.

Bibliography

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