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On the Multi-Resolution Techniques for LTE-Advanced

Mário Marques da Silva · Américo Correia · Nuno Souto · José Seguro · Paulo Gomes · Rui Dinis

Abstract A coordinated multi-resolution and multi-point MIMO transmission method for the LTE-Advanced is presented considering the Evolved-Multimedia Broadcast/Multicast Service (E-MBMS). Fixed relays with MIMO and different adaptive frequency reuse schemes are considered in the proposed scheme to improve the E-MBMS spectral efficiency at the cell borders and/or to save transmission power from the base stations and relays. In order to provide additional diversity over Rayleigh multi-path fading channels, a signal space diversity based on Complex Rotation Matrices (CRM) is used, associated to MIMO, as a multi-resolution technique. The decoding of these signals are facilitated with the use of Maximum Likelihood Soft Output (MLSO) criterion, included in the proposed receiver. The link performance of the MIMO system turbo-coded with hierarchical constellations and CRM is analyzed in terms of bit and block error rate (BER/BLER). The corresponding system level coverage and throughput gains are also evaluated associated to the presence or not of fixed relays and measuring the maximum spectral efficiencies at cell borders of single cell point-to-multipoint or single frequency network. The influence of the cell radius in the

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performance of the previous cellular topologies with coordinated MIMO transmissions is also evaluated.

Keywords OFDM · Multiple antennas · CRM · MIMO · Coordinated multi-point transmissions · Multi-resolution techniques

1 Introduction

Next mobile cellular communication systems beyond 3G aim at allowing subscribers ubiquitous access to a virtually unlimited amount of multimedia content with a guaranteed QoS [1]. This constitutes extensive requirements for improvements to present mobile cellular communication systems to provide a greater throughput to the subscribers. The expected data rates for the Fourth Generation cellular system (4G) are in the range of 100 Mbps for vehicular mobility to 1 Gbps for nomadic access (in both indoor and outdoor environments).

New topological approaches like multihop or distributed antennas solutions and relaying [2] allow an increased coverage of high data rate transmission, as well as improved system performance and capabilities [3]. Standardization of LTE-Advanced (4G) is expected to be finalized in 3GPP Release 11.

Within 4G, voice, data and streamed multimedia will be delivered to the user based on an all over IP packet switched platform, using IP version 6 (IPv6) [3]. The goal is to reach the necessary QoS and data rates in order to accommodate the emergent services as mobile TV, High Definition Television (HDTV), DVB, Multimedia Messaging Service (MMS), video chat, etc [3]. All of these services must be delivered in the concept of "anywhere" and "anytime".

Potential technologies for the air interface of LTE-Advanced include the following options [2]:

- Carrier aggregation composed of e.g. multiple components of 20 MHz in order to support transmission bandwidths of up to 100 MHz;
- Advanced antenna systems increasing the number of downlink transmission layers to eight and the number of uplink layers to four;
- Multihop relay (adaptive relay, fixed relay stations, configurable cell sizes, hierarchical cell structures, etc.) in order to improve coverage and data rates;
- Advanced inter-cell interference cancellation schemes [2];
- Multi-resolution schemes (hierarchical constellations, MIMO systems, OFDM transmission technique, etc.).

The E-MBMS framework [4] is envisaged to play an essential role for the LTE-A proliferation

The E-MBMS framework [4] is envisaged to play an essential role for the LTE-A proliferation in mobile environments. E-MBMS constitutes the evolutionary successor of MBMS, which was introduced in the Release 6 of Universal Mobile Telecommunication System (UMTS). In E-MBMS there are two transmission scenarios. In the first, Single-Cell Point-to-Multipoint (SC-PTM) introduced in Release 6, there is one radio link between the closest base station and the mobiles. It does not require any time synchronism between the transmissions from different base stations, resulting in interference from all cells with the same frequency reuse pattern. In the second scenario designated as, Multimedia Broadcast over a Single Frequency Network (MBSFN), there are at least three radio links, between the three closest base stations and the mobiles. Time synchronism is assumed between the transmissions from these closest base stations resulting in much lower interference level from the cellular environment. Soft-combining of the best radio links is done at the mobile receivers. With E-MBMS the

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Introduction

In the past few years, multimedia communication has gained significant attention, particularly over mobile and embedded devices (such as wireless sensors). Multimedia applications are data-intensive, therefore...

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Modulation is the process whereby message information is embedded into a radio frequency carrier. Such information can be transmitted in either the amplitude, frequency, or phase of the carrier, or a combinati...
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In recent years, wireless video transmission has emerged as one of the high growth applications of wireless communication technology. However, this error-prone network is packet based where many potential reas...
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