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A Rate Allocation Algorithm in Uplink SC-FDMA Systems for Enhancing Network Throughput

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Abstract— For a cellular system where mobile terminals transmit in the uplink to base stations (BSs) using single carrier- frequency division multiple access (SC-FDMA), we consider mul- ticell processing among BSs. Received signals are first quantized on a per-subcarrier basis and then forwarded to the serving BS on a backhaul with limited rate. With the aim of maximizing the network throughput we design an efficient composite signal representation and b) propose a rate allocation algorithm for the backhaul. Using a closed-form expression of the achievable throughput in the presence of quantization noise, an iterative greedy algorithm for the backhaul rate allocation is developed, where at each iteration we select the signal to be exchanged as the one providing the maximum network throughput increase per backhaul bit. In order to determine how many quantization bits are used for each received signal, we consider either a static bit allocation with a fixed number of bits, or a dynamic bit allocation (which ensures a predetermined network percentage throughput loss with respect to the unquantized case). In an LTE scenario, it is seen that the proposed bit allocation methods flexibly adapt to channel and backhaul conditions and yield similar performance, hence the static approach is preferred due to its lower complexity.

Keywords— Resource allocation and interference management; MIMO systems; static, dynamic bit,multicell processing, backhaul

I. INTRODUCTION

The major driving force behind the evolution of cellular systems is the increase of the data rate both in the uplink and in the downlink, in order to provide always new applications to the user. To this end, a significant contribution is given by multiple antennas, that bring both diversity and multiplexing gain, resulting into a multiple input multiple output (MIMO) system [1], [2]. Since the uplink is largely affected by inter-cell interference (ICI) of mobile terminals (MTs) in adjacent cells, combining signals received by many base stations (BSs) before detection is a good strategy to increase the uplink data rate without the need of increasing the number of BS antennas [3]. This cooperation among BSs, that goes under the name of multicell processing (MCP) or coordinated multipoint (CoMP), implements a distributed (network) MIMO system. CoMP brings new challenges to the cellular architecture [4]. In fact, we need a suitable communication infrastructure among BSs, that may be found in the backhaul currently carrying data signals between the radio network controller (RNC) and the BSs. Although BS-RNC communications are already used, e.g., in the soft handoff of MTs, they become much more demanding in CoMP, up to the point that the current backhaul infrastructure may constitute a bottleneck. Therefore, both the backhaul scheduling and the represen- tation of signals reconstructed over the backhaul must be properly designed. On the signal representation, efforts have been mainly focused on compression techniques exploiting the correlation among signals received at the various BSs [5], [6]. Field trial measurements have been performed in [7] to validate frequency domain compression techniques for orthogonal frequency division multiplexing (OFDM) systems. On the scheduling side, a number of solutions have been devised, including selection of transmitting MTs, adaptation of transmission rates, and selection of cooperating BSs. With regard to the selection of transmitting MTs, [8] proposes a trade-off between the wireless link rate and the backhaul occupation, while more recently, in [9] power and active subcarriers of MTs are optimized to maximize the system throughput. Concerning the adaptation of the MT transmission rates, many information-theoretic works have analyzed the performance of CoMP with a constrained backhaul. We recall in particular initial works [10], [11], and [12], characterizing achievable rate regions, while more recently, the impact of imperfect channel estimation has been considered in [13]. Since the complexity of selecting cooperating BSs grows exponentially with the number of MTs and BSs, efficient tech- niques have been considered, including genetic algorithms, use of sphere decoder [14], dynamic greedy algorithms [15], also in conjunction with the use of hybrid repeat request (HARQ) [16], [17], [18].

We focus here on the issue of cooperating BS selection, given that a set of MTs has been scheduled for transmission. We start observing that most of existing approaches have been developed for flat fading channels, or for sets of parallel flat fading channels, i.e., OFDM transmissions. However, 3GPP long term evolution (LTE) standard provides the use of single carrier frequency division multiple access (SC-FDMA) [19]. With this transmission format, a single carrier signal is allocated to a number of subcarriers in the frequency domain by means of discrete Fourier transform (DFT). A simple linear equalization is performed at the receiver, still in the frequency domain, while detection and decoding occurr in the time-domain. Although linear equalization is suboptimal with respect to non-linear receivers [20], [21] and yields a poorer performance than OFDM [20], [22], its signal structure can be exploited for interference coordination [23], [24]. Recently, in [25] the authors used the SC-FDMA transmission format to optimize the backhaul information exchange in CoMP by selecting shared subcarriers among BSs according to instantaneous channel conditions.

II. SYSTEM MODEL

We consider the uplink of a cellular system where a set $K = \{1, 2, \dots, K\}$ of MTs is transmitting toward a set $J = \{1, 2, \dots, J\}$ of BSs. To simplify the notation we assumethat both MTs and BSs are equipped with only one antenna.The generalization of the discussed problems to the multiple antenna case is outlined at the end of this section.

Each MT is anchored to only one BS and we denote with $K^{(j)} \subseteq K$ the set of MTs anchored to BS $j \in J$. Sets $K^{(j)}$, $j \in J$, define a partition of K, i.e.

A. BS Received Signal

In SC-FDMA, the bandwidth available for transmission is divided into N subcarriers. In turn, these subcarriers are grouped into S adjacent frequency sub-blocks (FSBs),each comprising M subcarriers, i.e., $N = SM$. Let $N = \{0, 1, \dots, N-1\}$ be the set of available subcarriers, and $N_S = \{sM, sM + 1, \dots, sM + M - 1\}$ the set of subcarriers associated to FSB $s = 0, \dots, S-1$. With reference to MT $k \in K$, we indicate with $N^{(k)}$ the set of subcarriers allocatedto MT k. According to SC-FDMA, the transmission performed by MT k is organized into data blocks, each composed by N symbols. The power available at each MT is assumed to be unit.Cooperation among BSs is allowed thanks to a RNC whichis connected to each BS by a zero latency and error freebackhaul link as in Fig. 1. Hence, there is no direct connectionbetween BSs. We also assume that detection and decoding aredistributed, i.e., BS j ∈ J decodes all and only the messagessent by the MTs in K(j) . The exchange of received signals among the BSs on thebackhaul follows a two phase scheme. In the first phase, (jj quantizes Yn for the subcarriers belonging to a subset o (k)and a representation of the quantized values is k∈K(j) Nforwarded to the RNC. In the second phase, the RNC sends the bits to the intended BSs. (i,j)∈ N, n ∈ N , i ∈ J , j ∈ J ,Let us denote with bi = j, the number of bits used to represent at BS i signal Yn2) received by BS j on subcarrier n, bn /2 for tpart and bn /2 for the imaginary part. The corresponding quantized signal received at BS i from the RNC is denotedby Cooperation is limited by

We evaluate the performance of the proposed signal quanti-zation and backhaul rate allocation by considering the cellularsystem of Fig. 1, where J = 3 BSs are serving K = 9 MTs,with 3 MTs assigned to each BS. Note that we assume a hexagonal grid with 3 BSs/sectors per site, and the J = 3BSs involved in the cooperation are the three sectors ofadjacent sites. We consider an LTE simulation setup with anavailable bandwidth of 3 MHz organized in 256 subcarriers (including virtual subcarriers): data subcarriers are groupedinto S = 15 FSBs, each one comprising M = 12 subcarriers.The subcarrier bandwidth is B (sc) = 15 kHz [31]. We assume that 5 adjacent FSBs are allocated by a BS to each served MT. Let d(max) = 500 m be the maximum distance betweena MT and its anchor BS, i.e., d(max) is the length of the hexagon edge in Fig. 1 and d(min) = 35 m the minimum distance between each couple BS-MT. We assume that eachMT is randomly dropped in the coverage area of its anchor BS.Channel model includes path-loss and Rayleigh fading, and weconsider independent channels with typical urban power delay profile with six taps [32]. By denoting with d(j,k) the distance between MT k and BS j, the average SNR is given by means of discrete Fourier transform (DFT). A simple linear equalization is performed at the receiver, still in the frequency domain, while detection and decoding occurr in the time-domain. Although linear equalization is suboptimal with respect to non-linear receivers [20], [21] and yields a poorer performance than OFDM [20], [22], its signal structure can be exploited for interference coordination [23], [24]. Recently in [25] the authors used the SC-FDMA transmission format to optimize the backhaul information exchange in CoMP by selecting shared subcarriers among BSs according to instantaneous channel conditions

considering a constraint on themaximum rate that can be exchanged through the RNC on the backhaul. For simplicity, we assume that the same backhaulbandwidth is allocated to each of the two phases and denot with b(BH) the maximum number of bits that can be sent inhe first phase and received in the second phase by each BSand for each SC-FDMA block. In fact, we also observe that the number of bits bn used by BS j to quantize the signal

III. NUMERICAL RESULTS

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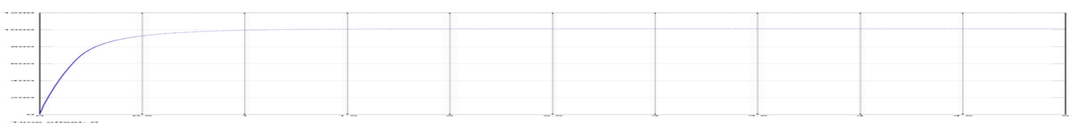
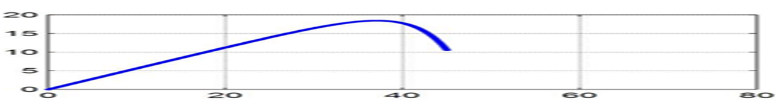
Fig.3.1Average network throughput with respect to the maximum backhaul rate when SBA is used: *b*(sba) = 2, 6, 10.





IV. CONCLUSIONS

In this paper we have considered CoMP for the uplink ofa cellular system where MTs transmit by using SC-FDMA.By assuming that detection and decoding are distributed at each BSs, and considering a constraint on the number of bits exchanged on the backhaul, we have developed a resource allocation algorithm for the scheduling of backhaul transmissions. By considering an efficient composite bit rep-presentation of different quantized versions of received signals, the proposed algorithm iteratively schedules the subcarrier signal providing the maximum network throughput increase per backhaul bit. We have compared two criteria: static bit allocation (SBA), where the number of quantization bits is fixed, and dynamic bit allocation (DBA), where the number of bits is chosen by imposing a fixed percentage throughput loss with respect to sharing the unquantized subcarrier signal. Numerical results in a LTE scenario show that the two methods provide similar performance, hence SBA is preferred due to its lower complexity.

REFERENCES

[1] H. Ekstr¨ m, A. Furusk¨ r, J. Karlsson, M. Meyer, S. Parkvall, J. Torsner,oa and M. Wahlqvist, “Technical solutions for the 3G long-term evolution,”IEEE Commun. Mag. vol. 44, no. 3, pp. 38–45, Mar. 2006.

[2] R. Irmer, H. Droste, P. Marsch, M. Grieger, G. Fettweis, S. Bruek, H.-P.Mayer, L. Thiele, and V. Jungnickel, “Coordinated multipoint: concepts, performance, and field trial results,” IEEE Commun. Mag., vol. 49, no. 2, pp. 102–111, Feb. 2011.

[3] D. Gesbert, S. Hanly, H. Huang, S. Shamai Shitz, O. Simeone, andW. Yu, “Multi-cell MIMO cooperative networks: a new look at inter-ference,” IEEE J. Sel. Areas Commun., vol. 28, no. 9, pp. 1380–1408,Dec. 2010.

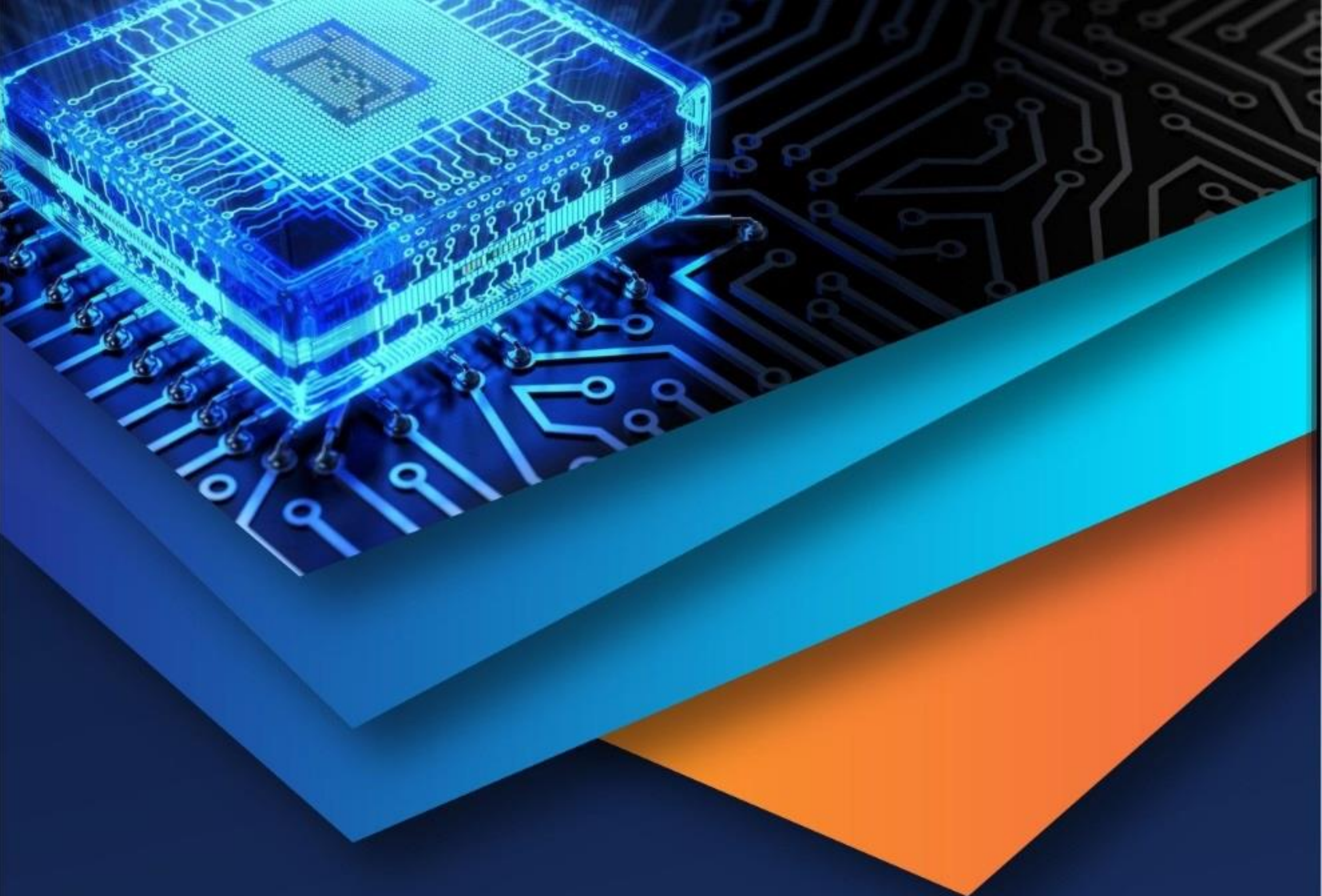
[4] K. Balachandran, J. H. Kang, K. Karakayali, and K. M. Rege, “Ananalysis of uplink base station cooperation with practical constraints,” IEEE Trans. Wireless Commun., vol. 11, no. 3, pp. 1056–1065, Mar.2012.

[5] A. Del Coso and S. Simoens, “Distributed compression for MIMOcoordinated networks with a backhaul constraint,” IEEE Trans. WirelessCommun., vol. 8, no. 9, pp. 4698–4709, Sept. 2009.

[6] O. Simeone, O. Somekh, H. V. Poor, and S. Shamai, “Local base statio cooperation via finite-capacity links for the uplink of linear cellular networks,” IEEE Trans. Inf. Theory, vol. 55, no. 1, pp. 190–204, Jan2009.

[7] M. Grieger, S. Boob, and G. Fettweis, “Large scale field trial resultson frequency domain compression for uplink joint detection,” in Proc. 2012 IEEE Global Telecomm. Conf., pp. 1128–1133.

[8] F. Diehm, P. Marsch, G. Fettweis, and B. Ramamurthi, “A low-complexity algorithm for uplink scheduling in cooperative cellular networks with a capacity-constrained backhaul infrastructure,” in Proc2009 IEEE Global Telecommun. Conf., pp. 1-6.



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