Efficiency Increase of Information Services in3G and 4G Networks, Using MIMO-Systems

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Abstract - **The basic idea of a CDMA system to overcome the multipath problem is built on the fact that a spread spectrum signal has a much wider bandwidth occupancy than its original baseband signal, such that the spread spectrum signal will offer a unique property that multipath diversity can be made possible due to its excellent time resolution derived from its very wide bandwidth signaling. A RAKE receiver can be used to resolve different multipath returns individually and combine them again in a coherent or non-coherent way, to achieve the multipath diversity capability, which has become one of the most important technical features that make CDMA a very attractive multiple access technology for 2G and 3G wireless communications.**

Keywords - **CDMA, MIMO, Antenna.**

I. Introduction

In the frequency domain, the capability of a CDMA system to overcome the multipath interference problem can be explained by using the following text. Also, due to the very wide spectral width of CDMA signaling, the loss of energy owing to the nulls of a frequency-selective fading channel will not cause too much damage to the total energy of the CDMA signal due to its relatively wide spectral occupancy in the frequency domain. Therefore, it can be shown that the resilience of a CDMA system against frequency-selective fading is much stronger than any other traditional multiple access technologies, such as FDMA and TDMA, which are also called narrowband technologies.

The loss of energy in the CDMA signaling due to the nulls of a frequency-selective fading channel will still have some negative impact on the signal detection efficiency at a CDMA receiver.

Therefore, some methods were proposed to recover or minimize the energy loss of CDMA signaling due to frequency-selective fading. Multi-carrier CDMA is one of them.

One possible implementation of a multi-carrier CDMA system can be described as follows. The input bit stream should first go through a serial to parallel conversion to form N sub-channels and then the N different parallel data streams will be spreading modulated by N different spreading codes, followed by carrier modulation by N distinct carrier frequencies. Of course, another possible scheme to implement multi-carrier CDMA is that after the serial to parallel conversion the N different sub-channels will be spreading modulated by using one spreading code. In this case, the N modulated multi-carrier signals are not separable in the CDMA code space, but only separated by different carrier frequencies.

II. Power Control

With increasing demands on current wireless systems put forth by high-speed packet data and multimedia streaming services, technologies that will deliver increased capacity have enamored researchers in recent years. While a prolific literature is available on increasing user data rate, spreading gain, they do so at the expense of reducing the total system throughput. A true high-speed multiuser wireless system can only be achieved through an increase in system spectral efficiency, measured in bits per second per Hertz per sector.

The wireless MIMO [1, 2]communication systems seek to achieve capacities close to Shannon limit by employing multiple transmit and receive antenna, with advanced space time signal processing techniques. Multicarrier that spread spectrum techniques, offer tremendous scope for next generation (4G) high-speed wireless technologies, where spectral efficiency and flexibility are important.

To support multiple users, the multicarrier transmission technique can be combined with a CDMA scheme. Due to wide bandwidth requirement of wireless communication system, the combination of MIMO MC-DS/CDMA with spreading in both time and frequency domain has recently attracted a lot of interest in wireless communication and provides an efficient approach to reduce the chip rate and the spreading code length [2-6].

The problem stems from the fact that in a CDMA system a user close to a cell site or BS would saturate the BS receiver and swamp the signals coming from all other users further away, unless the transmitting power is controlled. The near-far effect can be better explained in terms of the properties of auto-correlation and cross-correlation functions of a CDMA code set, which is used in a CDMA system for channelization, just like the 64-ary Walsh codes in the forward link of an IS-95A system. To make a good CDMA system, the difference between the auto-correlation peak and out-of-phase auto-correlation functions (also called auto-correlation side lobes) should be made as big as possible. Assume that there are two mobiles inside a cell, with mobile A being very close to the BS and mobile B being located further away from the BS. Now, the BS receiver wants to receive the signal from mobile B. The BS receiver will never detect the auto-correlation peak of the signal from mobile B because the cross-correlation function generated by the strong signal from mobile A will overwhelm the auto-correlation peak of mobile B.

Therefore, we must find a way to control the transmitting power of all mobiles in a cell to make their signals almost the same level seen from the BS receiver. Due to the imperfect cross-correlation functions of the CDMA codes, any currently available CDMA system, including IS-95A, is an interference-limited system. The success of an IS-95 system lies in controlling the total power in the system.

In a CDMA environment every MS is a source of interference to others. At the MS receiver we see the radio environment around it as a cumulative addition of information for itself and interference.

The interference is actually the information for other MSs plus noise from others sources. Hence if the interference is higher, the information signal cannot be retrieved. A mobile has a special receiver called a RAKE receiver that can make estimates of multipath fading and retrieve the information for a particular mobile.

III. MULTIPLE ANTENNAS IN CELLULAR NETWORKS

Different works related to cooperative OFDM, some examples of which are listed above, either consider a one sided cooperation strategy, or a mutually cooperative strategy based on two parallel dedicated relay channels, or mutual cooperation based on a time division protocol. In this paper, without imposing any prior constraints on which users will use these sub channels, we propose two full duplex cooperative encoding strategies: intra-sub channel and intersubchannel cooperative encoding. These strategies use decode and forward (DF) approach and are based on block Markov superposition encoding. Intra-subchannel cooperative encoding is an extension of the two user cooperative strategy in [7] and [8] to OFDMA, and inter-subchannel cooperative encoding is a new method which allows re-partitioning and reencoding of the cooperative messages across subchannels. We obtain the achievable rate regions for both strategies, and compare them with non-cooperative OFDMA capacity region.

We demonstrate through simulations that new encoding strategies provide significant rate improvements.

This channel was first studied in [4]. Later, in the seminal paper [5], fundamental capacity and achievable rate theorems for the relay channel were proved, and several coding and decoding techniques were proposed. The extension of the one sided cooperative relay model to mutual cooperation became possible by the introduction of multiple access channels (MAC) with generalized feedback [6]. In [7], an achievable rate region, which was larger than that of [6], was obtained by utilizing block Markov superposition encoding and backward decoding. More recently, in [8], the MAC with generalized feedback was used to model a fading cooperative additive white Gaussian noise (AWGN) channel, and the results therein made cooperative communications very attractive.

The block Markov encoding strategy relies on users decoding part of each other’s messages in each block, and re-encoding them in the next block. Although this can be done on a subchannel (and hence submessage) basis, it can also be done by re-encoding the overall message received over all subchannels, by an appropriate repartitioning of that message to subchannels, to be used in conjunction with the message generation process describe.

For decoding, each user uses joint typicality check at the end of each block. The receiver on the other hand uses backwards decoding [7] to determine the transmitted messages.

So, possible bottlenecks on achievable rates, caused by the per-subchannel constraints, are removed, and the rates obtained by inter-subchannel cooperative encoding are always greater than or equal to those obtained by intra-subchannel cooperation. The rate regions achievable by both strategies will be compared for some sample fading scenarios.

IV. CONCLUSION

In this paper we introduced a two user cooperative OFDMA systems and proposed two encoding strategies: intrasubchannel cooperative encoding and inter-subchannel cooperative encoding, based on block Markov superposition encoding. We derived rate region expressions for both encoding strategies and showed that re-partitioning and re-encoding of the cooperative messages across subchannels, i.e., inter-subchannel cooperative encoding, is always superior to intra-subchannel cooperative encoding, and provides significant rate gains.

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