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MIMO

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Abstract
Wireless networks are increasingly going complex. Cell site architectures and infrastructure have evolved over four generations of technology. The amount of traffic they support is staggering. Base station and microwave antenna technologies have evolved to match the amplified usage demands. MIMO technology has been developed over many years. A channel may be affected by fading and this will affect the signal to noise ratio. In turn this will impact the error rate, assuming digital data is being transmitted. Diversity helps to stabilize a link and improves performance, reducing error rate. For many years antenna technology has been used to improve the performance of systems. Beam forming techniques can be used with any antenna system - not just on MIMO systems. Multi-user MIMO or MU-MIMO is an enhanced form of MIMO technology that is gaining acceptance. MU-MIMO, Multi-user MIMO enables multiple independent radio terminals to access a system enhancing the communication capabilities of each individual terminal. One of the key issues with any MIMO system is the placement of the antennas.

Index Terms **Amplify-and-Forward (AF), Multiple-Input Multiple-Output (MIMO), Peer-to-Peer Communications (P2P).**

1. INTRODUCTION

Multi-input multi-output (MIMO) has been identified as a key technology to improve communications over a wireless channel. Multi-user MIMO (MUMIMO) techniques were then studied starting in the early 2000s, with the target of allowing simultaneous Communications of multiple users over the same time-frequency resources. Long Term Evolution (LTE) was one of the first wireless standards designed with MIMO [1]. With ever increasing demands for multimedia services and web-related content, a high data rate is becoming one of the major features in the next generation of wireless communication systems. However, channel desertion, an inherent property of wireless communication links, severely limits the increase of the data rate. Among many diversity techniques that can be used for improving communiqué performances and combat channel fading, spatial diversity techniques are particularly attractive since they provide diversity gain without incurring extra costs of transmission time and bandwidth. customarily, spatial diversity is achieved by using multiple antennas at the transmitter and/or receiver, where the spacing between antennas is with the order of a half of wavelength. These multiple-input multiple-output (MIMO) systems are known as collocated MIMO. Because of the diversity gain, collocated MIMO architectures are effective in improving bit error rate (BER), system capability, spectrum efficiency, energy efficiency, etc . Apart from being employed in a point-to-point communication linkage between mobile station (MS) and base station (BS), MIMO systems are also implemented in a distributed mode, with a goal to improve performance in cooperative and relay networks, where every node can be outfitted with only one antenna. Further, the benefits of the collocated MIMO technique can be improved with a distributed or virtual MIMO. Problem with nodes size limitation, i.e. problem with providing adequate space separation between antennas with a purpose to achieving uncorrelated channels can be overcome with virtual MIMO. The major distinction between the virtual and collocated MIMO is that multiple antennas are distributed among widely separated [4].

1.1 Amplify-and-Forward (AF) Multiple-Input Multiple-Output (MIMO):

These systems attracted a lot of attention recently, as it has a great potential to enhance the communication range of a simple point-to-point system, while providing spatial diversity and multiplexing gains. AF MIMO relaying systems have a large range of potential applications including resource exploration, vehicle communications, military ad hoc networks, satellite communications, etc. This system has also been considered to be adopted in the emerging wireless systems, such as LTE Advanced and WINNER project. In general, there are two goals in transceiver designs: transmitting as much information as feasible and recovering the signal at receiver as accurately as possible. The latter one is the starting point of this paper. For multiple-antenna systems with fixed bit rates, it is well-known that nonlinear transceivers usually have performance advantage in terms of bit error rate (BER) than their linear counterparts . Recently, nonlinear transceiver design for AF MIMO relaying systems assuming perfect CSI, was introduced in. There are two kinds of nonlinear transceiver design: decision-feedback equalization (DFE) based design and Tomlinson-Harashima precoding (THP) based design [2].

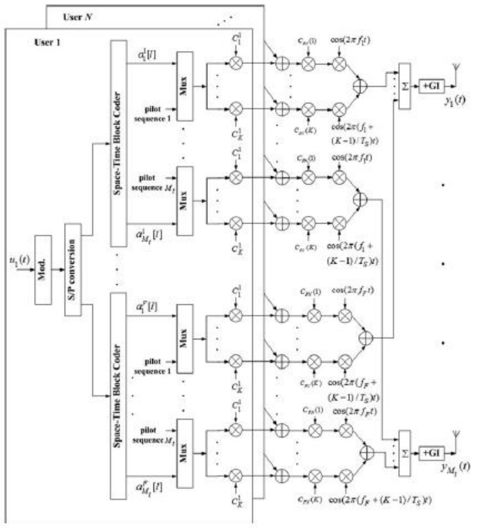
1.2 Role of MIMO in performance improvement of OFDM–CDMA:

Future mobile-radio systems should be able to cope with continuously increasing user requires for high bandwidth services and applications. Multi-carrier (MC) techniques can be considered as attractive solutions for achieving necessary requirements in that sense. Additionally, improved downlink capacities can be accomplished by the combination of MC and code division multiple access (CDMA). OFDM– CDMA downlink scheme with pilot tone and threshold discovery combining technique at the receiver (optimum TDC) is presented. It has been shown that optimum TDC out performs some of the other combining schemes considered, such as: orthogonal restoring combining (ORC) and controlled equalization combining (CEC). Therefore, in order to achieve better BER performance and more efficient frequency spectrum utilization, possibilities for further modifications of the OFDM–CDMA system from should be investigated. Multiple-input multiple-output (MIMO) OFDM– CDMA system with space–time block coding (STBC) is a solution for improving BER performance and spectrum efficiency of the OFDM–CDMA scheme. Scheme enables better BER performance even with the reduced frequency bandwidth. The transmitter of the MIMO OFDM–CDMA downlink transmission system is shown in Fig. 1. With N users A single cell system is assumed, with binary transmitted data mapped at the base station according to a chosen modulation scheme. OFDM–CDMA symbols formed in the previously described way are then transmitted by Mt antennas [3].

1.3 MIMO Cellular Networks in Device-to-Device Communications:

Multiple-input multiple-output (MIMO) antenna system has become a key technology for many wireless network standards (e.g., the 3GPP LTE-advanced network and wireless local area network). Taking advantages of the MIMO technologies, D2D communication as an underlay to MIMO cellular networks can obviously further improve the spectral efficiency. However, D2D communications using MIMO is not well understood. Multiple D2D user pairs attempt to share the radio resource of the uplink cellular network with multiple cellular users. It is assumed that each uplink channel has been allocated to one cellular user. The cellular users have priority to access the channels over the D2D users and the pre allocated channels of the cellular users cannot be changed. The D2D user pairs utilize the cellular users' radio resource under the condition that the cellular users' services are not disrupted. With MIMO antennas, it is well understood that power control and recoding are an effective means to mitigate interference [5].

Fig. 1 Transmitter of the proposed MIMO OFDM–CDMA downlink transmission system



1.4 Distributed MIMO solutions for Peer-to-Peer Communications:

P2Peer communication in licensed band is one of the key enablers toward a more innovative and cost-effective communication systems. A key motivation for D2D connectivity is the potential for operators to offload traffic from the core network. A major breakthrough was achieved when 3GPP (LTE-A release, 12 June 2012) agreed on starting a study item for D2D technology. In the past, cellular operators did not consider P2P communication as an approach to enhance the performance of network because the benefits are limited to local communication services. However, as mobile applications based on immediacy of mobile devices has become increasingly popular, cellular operators are considering introducing P2P communication into the networks. Implementation of P2P communication in the system introduces many benefits compared to the conventional infrastructure-based communication, such as improved spectrum and energy efficiency, increased overall system capacity, decreased traffic load, etc. Several applications of P2P are shown in Fig. 2.

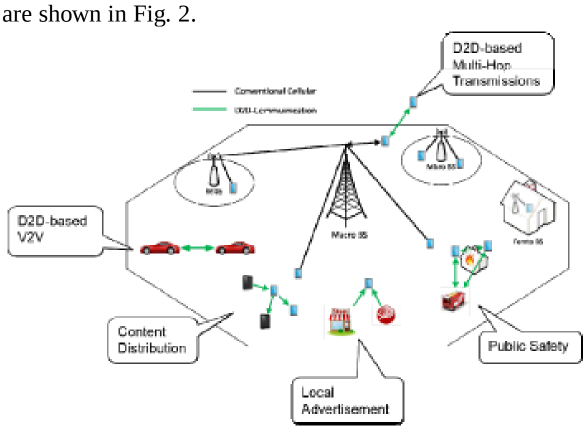


Figure 2 . Examples of a P2P communications

P2P can also be applied in more advanced scenarios, such as multiuser MIMO (MU-MIMO) enhancement, cooperative relaying, and virtual or distributed MIMO, E.g. in the MU-MIMO, BS determines precoding weights based on channel state feedback of terminals to create nulls and eliminate interference between users. With P2P introducing paired peers can directly exchange information about channel states, so terminals can feed the joint channel states information to BS and improve the performance of MU-MIMO [6].

LITERATURE SURVEY

Federico Boccardi et al. [2012] In this article author discuss the different multiple antenna techniques introduced in LTE Advanced. Rather than describing the technical details of the adopted solutions, author approach the problem starting from the design targets and the antenna deployments prioritized by the operators. Then author present the main enabling solutions introduced for downlink and uplink transmissions, and consequently assess the performance of these solutions in different scenarios. Finally, we discuss some possible future developments.

Chengwen Xing et al. [2012] In this paper, strong transceiver design with Tomlinson-Harashima precoding (THP) for multi-hop amplify and forward (AF) multiple-input multiple-output (MIMO) relaying systems is investigated. At source node, THP is adopted to mitigate the spatial inter symbol interference. However, due to its non linear nature, THP is very sensitive to channel estimation errors. In order to decrease the effects of channel estimation errors, a joint Bayesian robust design of THP at source, linear forwarding matrices at relays and linear equalizer at destination is proposed. With novel applications of graceful characteristics of multiplicative convexity and matrix-monotone functions, the optimal structure of the nonlinear transceiver is first derived. Based on the derived structure, the transceiver design problem minimizes to a much simpler one with only scalar variables which can be efficiently solved. Finally, the performance advantage of the projected robust design over non-robust design is demonstrated by simulation results.

Ugljesa Urosevic et al. [2013] In this paper, MIMO OFDM–CDMA downlink scheme is proposed as a way out for improving performance of the OFDM–CDMA downlink system with pilot tone and threshold discovery combining (optimum TDC). The new presented system with MIMO included uses space–time block coding applied to two, three and four put out antennas and it has an arbitrary number of receive antennas. Bit error rate performance in the case of Ricean frequency selective fading is evaluated for the unique system as well as for the one with MIMO included. For that reason an adequate simulation model is developed. The results show that the proposed system significantly outperforms the OFDM–CDMA downlink system with pilot tone and optimum TDC.

Ugljesa Urosevic et al. [2014] In this paper author present a new simple cooperative relaying scheme. The proposed scheme is compared with simple cooperative schemes with virtual (OSTBC) orthogonal space time block coding and quasi orthogonal space time block coding (QOSTBC). Every of these three schemes consist one base station with two antennas, two relay stations each with a single antenna and one mobile station with a single antenna. The aim of the proposed scheme is to preserve, as much as it is possible bit error rate (BER) performance of the cooperative method with virtual OSTBC, but with increased code rate. It is shown that the presented scheme obviously outperforms simple cooperative scheme with virtual QOSTBC, while in evaluation with simple cooperative scheme with virtual OSTBC has very similar BER performance and increased code rate.

Wei Zhong et al. [2015] This paper presents a resource allocation framework for device-to-device (D2D) communications underlaying uplink MIMO cellular networks. At first, our aim is to address the sum-rate maximization problem of the cellular network with equally D2D and cellular users. An algorithm based on pure random search is presented for obtaining the optimal resource allocation without using an exhaustive search. Then, author propose a non cooperative resource allocation game for the joint self-optimization of channel allocation, power control, and precoding of the D2D users in a more practical setting. The feasibility and existence of the clean strategy Nash equilibrium are then established. An iterative algorithm based on best response dynamic is then projected to determine the feasible pure strategy Nash equilibrium under specific conditions. As the algorithm may not always converge, author devises a strategy refinement mechanism to deal with this issue based on the sum-rate criterion. Simulation results verify our theoretical analysis and findings.

Ugljesa Urosevic et al. [2016] The future generation of wireless networks is expected to support a significantly large amount of mobile data traffic, massive number of wireless connections and devices, achieve better cost, increased energy and spectral efficiency, improved quality of service (QoS) in terms of communication delay, capacity, reliability and security. The main techniques that will enable these features are massive multiple-input, multiple-output (MIMO), utilization of higher frequencies, particularly millimeter-wave (mmWave) frequencies, super dense and deployment of cells, peer-to-peer (P2P) communications, heterogeneous network (HetNet) implementation, etc. Here we present new solutions for implementing distributed MIMO techniques for P2P communications.

Shiqi Gong et al. [2016] Gigahertz unlicensed bandwidth spectrum endows millimeter wave (mmWave) communications with the large potential of realizing high data transmission rates. Related to all wireless transmission technologies, mmWave communications are also susceptible to security threatening. This problem becomes more severe for cooperative networks that need more information exchanges. In this paper, we investigate the secrecy beam forming designs for mmWave two-way amplify-and-forward multiple-input multiple-output (MIMO) relaying networks. In order to control hardware size and cost, an additional rank restriction is posed on the forwarding matrix at relay to direct the number of analog-to-digital converters. In general, the considered optimization problem is non convex and very challenging. Based on iterative optimization algorithms, the secrecy beam forming designs are successfully decoupled into a series of convex sub problems that can be efficiently solved. Lastly, numerical experiments are conducted to demonstrate the performance advantages of the proposed secrecy beam forming designs.

Table 1

Sr. No	Year	Tech. used	Outcome
1	2012	different multiple antenna techniques adopted in LTE-Advanced	MIMO and CoMP techniques, where antennas of multiple cell sites (also called transmission points) are utilized in such a way that they can contribute in improving the received signal quality.
2	2012	Joint Bayesian robust transceiver design for multi-hop AF MIMO	results showed that the robust design has much better performance than the non-robust design.
3	2013	MIMO technique used as a solution for improving BER performance of the OFDM–CDMA system with pilot tone and optimum TDC combining.	significantly lower BERs can be achieved while at the same time providing more efficient use of the frequency resources.
4	2014	new cooperative relaying scheme	has better BER performance in comparison with cooperative relaying scheme with virtual QOSTBC
5	2015	practical distributed algorithm, established a game theoretic model to study the joint resource allocation problem.	This algorithm also can lead to the pure strategy Nash equilibrium of proposed game under specific condition.
6	2016	New approach for improving performances of virtual MIMO communications between peers is used	transmission on mmWave frequencies, i.e. utilization of higher frequencies, implementation, improve P2P communications through distributed MIMO systems.
7	2016	an alternating optimization algorithm is used	algorithm has both faster convergence rate and better security performance in comparison to the existing schemes

Conclusion

As a requirement of the use of multiple antennas, MIMO wireless technology is able to considerably increase the capacity of a given channel. By increasing the number of receive and transmit antennas it is probable to linearly increase the throughput of the channel with every pair of antennas added to the system. This makes MIMO wireless technology one of the most important wireless techniques to be employed in current years. As spectral bandwidth is becoming an ever more valuable commodity for radio communications systems, techniques are needed to use the available bandwidth more effectively. MIMO beam forming using phased array systems requires the overall system to determine the direction of arrival of the incoming signal and then switch in the most appropriate beam. Even though the MIMO technique can be used with any modulation, OFDM and its derivatives are particularly well suited to it because for each sub-carrier they transform the channel selective fading into near-flat fading, which is simple to model and equalize. This greatly simplifies the implementation of MIMO that can work individually on these sub-carriers. MIMO wireless technology is one of these techniques. Multi-user MIMO is still in its infancy, and many developments are underway to determine the optimum formats for its use.

References

1.Federico Boccardi, Bruno Clerckx,Arunabha Ghosh, Eric Hardouin, George Jöngren, Katsutoshi Kusume,Eko Onggosanusi,Yang Tang,"Multiple-Antenna Techniques in LTE-Advanced", IEEE Communications Magazine ,pp.114-121, March 2012.

2. Chengwen Xing, Minghua Xia, Feifei Gao, and Yik-Chung Wu," Robust Transceiver with Tomlinson-Harashima Precoding for Amplify-and-Forward MIMO Relaying Systems", IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 30, NO. 8, pp.1370-1382, SEPTEMBER 2012.

3. Ugljesa Urosevic , Zoran Veljovic ,Milica Pejanovic-Djurisic," MIMO solution for performance improvements of OFDM–CDMA system with pilot tone", Springer Science+Business Media New York,pp.1-8, 2013.

4.Ugljesa Urosevic ,Zoran Veljovic ,Milica Pejanovic-Djurisic," A New Solution for Simple Cooperative Relaying", Wireless Pers Commun,pp. 1235-1250, 2014.

5. Wei Zhong, Yixin Fang, Shi Jin, Kai-Kit Wong, Sheng Zhong, and Zuping Qian," Joint Resource Allocation for Device-to-Device Communications Underlaying Uplink MIMO Cellular Networks", IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 33, NO. 1, pp.41-53, JANUARY 2015.

6. Ugljesa Urosevic, Zoran Veljovic," Distributed MIMO solutions for Peer-to-Peer Communications in Future Wireless Systems", 24th Telecommunications forum TELFOR 2016, Serbia, Belgrade, pp.1-4,November 22-23, 2016.

7. Shiqi Gong, Chengwen Xing, Zesong Fei, and Shaodan Ma," Millimeter-Wave Secrecy Beamforming Designs for Two-Way Amplify-and-Forward MIMO Relaying Networks", IEEE, PP.1-12, 2016

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