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A Review Multiband-OFDM MIMO Based Ultra-Wideband Communication System

Sameer Khan[1] and Prof. Sneha Jain[2]

[1]Research Scholar, Department of Electronics and Communication Engineering, RITS, Bhopal, (Madhya Pradesh), India

[2]Assistant Professor, Department of Electronics and Communication Engineering, RITS, Bhopal, (Madhya Pradesh), India

(Corresponding author: Sameer Khan)

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ABSTRACT: Ultra wideband (UWB) system offers a great potential for the design of high speed short-range wireless communications. In order to satisfy the growing demand for higher data rates, one possible solution is to exploit both spatial and multipath diversities via the use of multiple-input multiple-output (MIMO) and proper coding techniques. In this paper, we propose a general framework to analyze the performance of multiband UWB-MIMO systems regardless of specific coding schemes. A combination of space-time-frequency (STF) coding and hopping multiband OFDM modulation is also proposed to fully exploit all of the available spatial and frequency diversities, richly inherent in UWB environments. We quantify the performance merits of the proposed scheme in case of Nakagami-m frequency-selective fading channels. Different from the conventional STF coded MIMO-OFDM system, the performance of the STF coded hopping multiband UWB does not depend on the temporal correlation of the propagation channel. We show that the maximum achievable diversity of multiband UWB-MIMO system is the product of the number of transmit and receive antennas, the number of multipath components, and the number of jointly encoded OFDM symbols. Interestingly, the diversity gain does not severely depend on the fading parameter m, and the diversity advantage obtained under Nakagami fading with arbitrary m parameter is almost the same as that obtained in Rayleigh fading channels.

Keywords. Ultra wideband, multipath, MIMO, OFDM.

I. INTRODUCTION

We analyze the frequency-hopping orthogonal frequency-division multiplexing (OFDM) system known as Multiband OFDM for high-rate wireless personal area networks (WPANs) based on ultra-wideband (UWB) transmission. Besides Considering the standard, we also propose and study system performance enhancements through the application of Turbo and Repeat-Accumulate (RA) codes, as well as OFDM bit-loading. Our methodology consists of (a) a study of the channel model developed under IEEE 802.15 for UWB from a frequency-domain perspective suited for OFDM transmission, (b) development and quantification of appropriate information-theoretic performance measures, (c) comparison of these measures with simulation results for the Multiband OFDM standard proposal as well as our proposed extensions, and (d) the consideration of the influence of practical, imperfect channel estimation on the performance. We find that the current Multiband OFDM standard sufficiently exploits the frequency selectivity of the UWB channel, and that the system performs in the vicinity of the channel cutoff rate. Turbo codes and a reduced-complexity clustered bit-loading algorithm improve the system power efficiency by over 6 dB at a data rate of 480 Mbps.three times more connected devices than our global population in 2020 to deal with these demands, energy and spectrum efficient wireless solutions, able to offer high capacity, are needed the nature of fifth generation (5G) wireless networks is expected to be heterogeneous, consisting of a dense network of small cells (SCs) deployed on the top of the existing macro cells [2]. The benefits of the dense SC deployment are threefold. Firstly, the user comes closer to its serving base station (BS), which results in higher signal-to interference-plus-noise ratio (SINR), and thus, higher capacity as well as lower mobile battery consumption.

Secondly, frequency reuse can be applied among SCs that are located far from each other, hence offering higher area spectrum efficiency. Thirdly, millimeter wave (mmWave) is favored to offer high capacity wireless backhaul (BH) links, i.e., set of links between the BSs and the core network. This is mainly due to two reasons: 1) the connection of each SC to the core by fiber is highly cost-inefficient and 2) the anticipated short BH link length among neighboring SCs will result in line-of-sight (LOS) opportunities, essential for good mmWave coverage. In particular, most macro cells are already connected through fiber to the core. Therefore, exploiting the existing connection and providing core connectivity to SCs through it with the use of mmWave, a mesh BH network of LOS mmWave links is expected, where each SC will forward its traffic to its neighbors, selecting among a broad set of alternative paths, to reach the core. This topology combines the mmWave benefits with the mesh networking advantages. On the one hand, mmWave offers high spectrum availability, and consequently, high capacity links. In addition, the very small mmWave wavelength enables higher antenna gains, resulting in highly directional links. Therefore, mmWave is able to compensate the higher path loss experienced at higher frequencies [3]. On the other hand, mesh networking can increase reliability and redundancies through self-forming and self-healing in case of a BH link failure [2]. In this context of hyper-dense 5G heterogeneous networks with complicated BH topologies, selecting the serving BS of a user equipment (UE), becomes challenging, as it impacts both the network and UE performance. Hence, new low-complexity UE association and BH traffic routing algorithms are needed, able to maximize the network energy and spectrum efficiency. However, the majority of user association algorithms proposed so far focus on the performance optimization of the access network (AN), i.e., the links between the UEs and their serving BSs. Specifically, LTE-Advanced (LTE-A) employs two metrics: the reference signal received power (RSRP) and the reference signal received quality (RSRQ) [4]. Equivalently, the best-SINR algorithm connects a UE to the BS with the highest received power. Although the aforementioned criteria maximize the spectrum efficiency, they do not maximize the network throughput, as few UEs connect to SCs. This limitation was overcome by range expansion (RE), where a bias was applied for signals originated by SCs [5]. Thereby, the connections with SCs were favored, resulting in load balancing between SCs and macro. Finally, in the extreme biasing case, a UE connects to the BS with the lowest experienced path loss, i.e., minimum path loss (MPL) [6]. MPL achieves the highest offloading to SCs at the expense of low spectrum efficiency. On the other hand, there are few works that consider the BH conditions in the user association decision. In particular, [7] proposes a user association analytical framework, which jointly considers the AN and BH. Specifically, spectrum efficiency, base station load, BH link capacity and topology, as well as different types of traffic are taken into account. In [8], the authors study the joint problem of user association and resource allocation, considering the resource consumption. and the energy budget of BSs, as well as the maximum BH capacity. However, in all these BH-aware approaches, there is no study of energy consumption, and hence, their high performance in terms of energy efficiency cannot be ensured. To this end, in [9] the authors study the aforementioned problem focusing on the energy and spectrum efficiency maximization of a network with tree BH links. Specifically, the in [9] selects among the BSs that maximize the network spectrum efficiency, while taking into account the number of BH link hops to reach the core network. Nevertheless, due to the simplicity of the applied criterion, its high energy efficiency in scenarios with heterogeneous BH links, i.e., links that differ in length, allocated bandwidth, or even in applied frequency, cannot be ensured. Therefore, in [10], the authors proposed a solution that takes into account the amount of power consumed in each BH link, thereby relaxing the limitation of homogeneous BH links. Still, in both works, the proposed solutions focus on tree topologies, where a single BH link route is available for each SC. However, in such 5G networks consisting of mesh BH links, the BH routing problem is another challenge that should be jointly considered. Therefore, in this paper, we study the joint problem of user association and BH traffic routing with the aim of maximizing the energy and spectrum efficiency of the network, while guaranteeing the UE quality of service (QoS). A low-complexity UE association which is able to provide good tradeoffs between the two competitive objectives. Moreover, in order to demonstrate the benefits of load balancing in the performance, two different cases are studied, i.e., with or without load balancing. Finally, the proposed algorithm is compared with existing solutions. In recent years, many efforts from different aspects have been devoted to low-latency mm-wave communications. In [4], several critical challenges and possible solutions for delivering end-to-end low-latency services in mm-wave cellular systems were comprehensively reviewed, from the perspectives of protocols at the medium access control (MAC) layer, congestion control, and core network architecture. By applying the Lyapunov technique for the utility-delay control, the problem of ultra-reliable and low-latency in mm-wave-enabled massive.

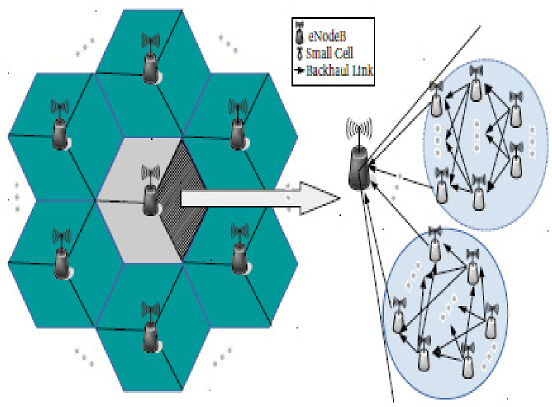

Fig. 1. System model.

Wireless communications in millimeter-wave (mm-wave) bands (from around 24 GHz to 300 GHz) is a key enabler for multi-gigabits per second (Gbps) transmission [1]–[3]. In contrast to conventional wireless communications in sub- 6 GHz bands, many appealing properties, including the abundant spectral resources, lower component costs, and highly directional antennas, make mm-wave communications attractive for future mobile communications standards. As an important metric for evaluating the quality of service (QoS), low latency plays a crucial role in the forthcoming fifth generation (5G) mobile communications [4]–[6], especially for various delay-sensitive applications, e.g., high-definition television (HDTV), intelligent transport system, vehicle-to everything (V2X), machine-to-machine (M2M) communication, and real-time remote control. The overall delay in wireless communications consists of four components as follows [7], [8]: propagation delay (time for sending the one bit to its designated end via the physical medium), transmission delay (time for pushing the packet into the communication medium in use), processing delay (time for analyzing a packet header and making a routing decision), and queuing delay (the time that a packet spends in the buffer or queue, i.e., waiting for transmission). Normally, the overall delay for queuing system is dominantly determined by the queuing delay, while the contributions by the other types of delay are nearly negligible. Thus, for low-latency buffer-aided systems, the major task is to largely decrease the queuing delay. Multiple-input multiple-output (MIMO) networks was studied in [9]. Regarding hybrid beam forming in mm-wave MIMO systems, a novel algorithm for achieving the ultra-low latency of mm-wave communications was proposed in where the training time can be significantly reduced by progressive channel estimations.

Furthermore, for systems with buffers at transceivers, the probabilistic delay for point-to-point mmwave communications is analyzed in where the delay bound is derived based on network calculus theory. Due to unprecedented data volumes in mm-wave communications, the transceivers for many applications are commonly equipped with large-size buffers, such that the data arrivals that cannot be processed in time will be temporarily queued up in the buffer until corresponding service is provided. Hence, the low-latency problem for mm-wave communications with buffers can be interpreted as a delay problem in queuing systems, equivalently. By queuing theory, it is known that the key idea for effectively reducing the queuing delay is to keep lower service utilization. That is, the average arrival rate of data traffic should be less than the service rate of server as much as possible. Commonly, low service utilization can be fulfilled mainly through two distinct methods: offloading arrival traffic and improving the service capability. In a wireless network, offloading arrival traffic can be realized by adopting the traffic dispersion scheme, and service enhancement can be realized by adopting the network densification scheme. Traffic dispersion stems from the application of distributed antenna systems (DASs) or distributed remote radio heads (RRHs) in mm wave communications, and network densification is motivated from the trend of dense deployment for mm-wave networks.

Roughly, the traffic dispersion scheme applies the “divide-and conquer” principle, which enables parallel transmissions to fully exploit the spatial diversity, such that a large single queue (or large delay, equivalently) can be avoided. On the other hand, the network densification scheme departs from reducing the path loss, via shortening the separation distance between adjacent nodes, such that the end-to-end service capability can be improved. Clearly, both the traffic dispersion and network densification schemes are promising and competitive candidates for low latency mm-wave communications. Though there are many research contributions in low-latency communications based on above two principles, the existing literature focus on either the dispersion scheme or multi-hop relaying scheme It is not clear yet which scheme can provide better delay performance. For designing or implementing mm-wave networks, it is essential to explore the respective strengths of traffic dispersion and network densification, and know the their applicability and capability for realizing low-latency mm-wave networks. Moreover, a combination of traffic dispersion and network densification, termed as “hybrid scheme”, is worthy of study. Intuitively, the hybrid strategy takes advantages of both traffic dispersion and network densification, and potentially. Due to the ever-increasing data traffic, fifth generation (5G) wireless networks call for sustainability in terms of capacity growth.

To that end, the dense deployment of small cells (SCs), overlaid on the existing macrocell forming a heterogeneous network (HetNet), is expected to play a key role. When a dense SC network is deployed, the SC radius is reduced, shorter distance between user equipments (UEs) and SCs and thus higher signal-to-interference-plus-noise ratio higher area spectral efficiency (bps/Hz/m2). Despite the aforementioned benefits, the high number of SCs complicates their direct connection to the core network. Fiber backhaul (BH) links are prohibitive in this case due to their high deployment cost [1]. Hence, a promising solution lies in exploiting the existing connection between the eNB site and the core network (mainly fiber), and to provide core network connectivity to SCs through the eNB site [2]. Still, in order to connect the SCs to the eNB site, new cost-efficient and high capacity wireless BH solutions are required. To that end, the use of millimeter wave (mmWave) is favored, due to its high bandwidth availability, able to provide high capacity BH [1]. It has been shown, however, that mmWave can provide good coverage for distances shorter than 200 m, otherwise, links may not be established [1], [2]. Given that the eNB radius is typically on the order of 500 m, a multi-hop architecture is needed, to allow each SC to reach the eNB site [2], [3]. In this 5G context, user association problem, which impacts both the network and user performance, becomes even more challenging, since it directly affects the traffic that passes through each BH link and thus its energy consumption. Nevertheless, traditional user association algorithms only consider the radio access network (AN), i.e., the links between UEs and their serving base stations (BSs)1. In LTE-Advanced (LTE-A), user association is based on the reference signal received power (RSRP) and reference signal received quality (RSRQ). The first measures the average received power over the resource elements that carry cell-specific reference signals within certain bandwidth, while the latter measures the portion of pure reference signal power over the total power received by the UE. [3]. Although these metrics maximize the instantaneous SINR of UEs [4], it has been shown that they do not increase the overall throughput significantly, since few UEs are connected to SCs [5]. Hence, range expansion (RE) was motivated, where a bias is introduced in the case the signal comes from a SC, thus favoring the UE association with SCs [5]. In this case, although a UE may be associated with a BS not providing the best SINR, better load balancing is achieved between eNB and SCs. However, the network topology changes stress the need for new BH-aware strategies, which will consider both BH capacity and energy impact.

II. CONCLUSION

Different schemes UWB, OFDM and CDMA and which are further classified into digital modulation scheme. First of all simulation block diagram are essential for these and after that main tedious task to design smart antenna so that quality of service could be provided. Matlab 2009a used for our research work and using Communication tool box simulation block diagram is designed. After that smart antenna was designed which was the most difficult task of our thesis work? After that bit is transmitted and received and receiver and then finally BER calculated. If BER would be least then that scheme would be considered best one and vice versa, besides this signal to noise ratio also analysed in DB. Considering various parameters like BER, SNR, constellation diagram and Mean Square Error and analysing finally we are able to compare different digital modulation technique and conclusion carried out for best one. Quadrature phase shift keying modulation technique is best one for OFDM and Quadrature Amplitude Modulation is best for Code Division Multiple Access and Ultra Wide Band system having minimum Bit Error Rate.

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