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Energy Efficiency in Massive MIMO-Based 5G Networks System

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ABSTRACT: Energy Efficiency in Massive MIMO-Based 5G Networks System the 5G of wireless networks, the bit-per-joule energy efficiency becomes an important design criterion for sustainable evolution. In this regard, one of the key enablers for 5G is massive multiple-input multiple-output (MIMO) technology, where the BSs are equipped with an excess of antennas to achieve multiple orders of spectral and energy efficiency gains over current LTE networks a comprehensive discussion on techniques that further boost the EE gains offered by massive MIMO (MM). We begin with an overview of MM technology and explain how realistic power consumption models should be developed for MM systems. We then review prominent EE-maximization techniques for MM systems and identify a few limitations in the state-of-the-art. Next, we investigate EE-maximization in "hybrid MM systems," where MM operates alongside two other promising 5G technologies: millimeter wave and heterogenous networks. Multiple opportunities open up for achieving larger EE gains than with conventional MM systems because massive MIMO benefits mutually from the co-existence with these 5G technologies. However, such a co-existence also introduces several new design constraints, making EE-maximization non-trivial.

Keywords: Energy Efficiency, Massive MIMO, 5G Networks, hybrid MM systems.

I. INTRODUCTION

5G is the next technological marvel enabling ubiquitous portable systems for the realization of Internet of Things (IoT). Millimeter-wave frequency range is a prestandardization favorite for the portable 5G applications. High performing millimeter-wave devices require efficient low-profile antennas to ensure reliable and interference-free communications. Requirements for increased power, larger bandwidth, higher gain, and insensitivity to the human user presence further complicate the antenna and propagation aspects. Enhanced techniques for multiplexing, interference mitigation, scheduling, and radio resource allocation work alongside the antenna design to realize efficient millimeter-wave systems delivering seamless and optimal performance. Being a newly developed area, simulation techniques also need to be revisited to ensure high level of accuracy of millimeter-wave antennas and systems. It solicits novel ideas and innovative solutions for the antenna design and system development [11]. In the age of digitalization, high-speed communication is on higher priority for all (consumers and enterprises). What if the wireless carriers impose caps on the rapidly growing data traffic and raise prices we run out of airwaves for our striking increase in wireless data usage on our gadgets. So, how are these basic realities – high-speed communication needs, bandwidth.

Wireless communication systems suffer from fading and signal attenuation due to the mobility factor associated with it [20]. A qualitative comparison of the existing cell association and power control schemes is provided to our thesis for interference management in 5G networks [14]. A detailed survey is included regarding current research projects being conducted in different countries by research groups and institutions that are working on 5G technologies [18].

II. DEVICE-TO-DEVICE (D2D) COMMUNICATION

1. D2D communication (already being studied in 3GPP as a 4Gadd-on) should be natively supported in 5G as another cell-tier.

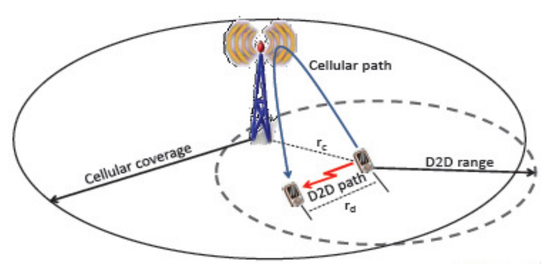

Fig. 1. Device-to-device (D2D) communication Massive MIMO Challenges.

Permits transmitter-receiver pairs coexisting in close proximity to establish direct peer-to-peer connections without the use of BSs (social networking, peer-to-peer content sharing, public safety communications) Enables short-range, low-power links to coexist with cellular links (improves spectral efficiency, decreases power consumptions of UEs, improves total network throughput) 4 Dense spectrum reuse, irregular interference topology Spectrum overlay or spectrum underlay. Antennas are very significant components in communication systems. In existing wireless systems, number of antennas and the structures of antennas may affect the performance of cellular networks. Massive MIMO is originally envisioned from time division duplexing (TDD), but it can be applied to frequency division duplexing (FDD). Massive MIMO can be considered as another technology candidate for 5G systems because it increases total system capacity and enables to increase number of sub-channels. This increment can be verified. This technology includes [9] MIMO principle for both receiver and transmitter sides. Also it allows to attain high resolution beam forming and this is very useful especially for higher frequencies and hence antenna size can be minimized significantly [1]. Massive MIMO includes significant improvements in terms of reliability, spectral efficiency and energy efficiency. In Massive MIMO systems, the transmitter or receiver modules are equipped with multiple antenna elements (e.g., ten or hundreds). Massive MIMO systems provide significant improvement on both energy efficiency and spectral efficiency. They make significant enhancement in cellular throughput. Another benefit of massive MIMO is reduced latency. Furthermore, massive MIMO systems have simplified medium access control (MAC) layer [5] design and reduced intra-cell interference that uses simple pre-coding method. Right along with the advantages of the massive MIMO systems, there are also important problems which are given below:

1) Fast processing algorithm. As with Massive MIMO, massive amount of data are transmitted and/or received. To interest in a huge amount of data from the RF chain, extremely fast algorithm is required in order to process these huge data.

2) Extra antenna requirement. Massive MIMO technology uses a large number of antenna arrays. Thus, this technology becomes costly in the short term because of extra antennas. Nevertheless, this effect can be ignored in the long term [4].

3) Channel estimation. Massive MIMO is originally envisioned from TDD operation. In existing systems, there is only time division duplexing process can be used for massive MIMO due to channel estimation and feedback [6]. When the number of antennas initiates to increase, channel calibration operation will become more complex than traditional MIMO systems. Massive MIMO (multiple-input multiple-output) antenna technology can provide significant performance improvement for cellular systems in terms of both throughput and energy efficiency. It is widely recognized that inter-user interference can be eliminated with a large number of antennas because of the asymptotical orthogonality among users when linear MF (Matched Filter) downlink precoding is used in the eNodeB. Due to the complexity and deployment consideration in practical scenarios at individual eNodeBs, cooperative massive MIMO [CM-MIMO] where multiple base stations cooperate together and form a distributed antenna array to serve multiple users [3] simultaneously is an attractive alternative. Furthermore, cooperative massive MIMO can also help increase the system performance especially for cell edge users because of the cooperative transmission among neighboring cells.

Table 1: System Simulation Configuration.

Parameters	Assumption
Cellular layout	Hexagonal grid, 7 cell sites, 1 sector per site wrap around
Cell radius	500 meters
Path loss model	3GPP 36.942 urban model
Lognormal Shadowing	Fading mean: 0 dB Standard deviation: 10 dB Shadowing corrlelation between sites: 0.5
Antenna pattern	Omni-directional
eNodeB antennas	ULA 15, 25, and 50 antennas
UE antennas	1 antenna
Carrier frequency/Duplex mode	TDD 2GHz
System bandwidth	20 MHz
Channel model	ITU Typical Urban (TU)
Receiver noise figure	9 dB
UE speed	30 km/h
Total BS TX power	46 dBm
Number of UEs	10 full buffer UEs in each cell
Scheduler	All-user Full bandwidth scheduling

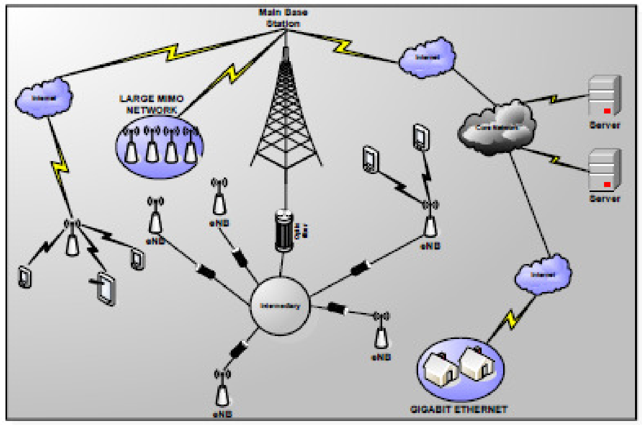

Fig. 2. A 5G cellular heterogeneous network (HetNet) architecture.

In this paper, system level simulation performance for the downlink, based upon current LTE systems, provides an indication of the achievable potential system performance improvement by employing CM-MIMO in future (5G) cellular networks. It is demonstrated that CM-MIMO can improve the system performance of cell edge users significantly even if the cell average performance is very slightly degraded or maintained caused by the power imbalance of received signal from different cooperative neighboring cells. The channel estimation techniques for pilot-based OFDM systems are investigated. The channel estimation is studied for low delay spread and high delay spread channels [15]. The MIMO-OFDM system is the combination of the MIMO technique and OFDM technique, which is enhancing the capacity, improve the link reliability high data rate transmission for future broadband wireless communication and also use for avoid Inter Symbol Interference (ISI) [16,19]. In 5G HetNets, macro and small cells are connected to each other via ideal or non-ideal backhauls. This causes to different levels of coordination problems across the network for mobility and interference management. If the network cooperation is increased significantly, the network capacity will be enhanced and coordination problems in the network will be solved inherently [9]. When direct access to the ideal backhaul is not available, anchor-booster architecture can be used to coordinate macro and small cells. For this architecture, the macro cell operates as an anchor BS, and it is primarily responsible for control and mobility. Furthermore, the small cell operates as a booster BS and it is mainly responsible for offloading data traffic [6]. The separation of data and control plane in anchor-booster architecture facilitates the integration of WiFi or future mm-wave communications and VLC as booster cells within the LTE framework.

III. RESULTS

Energy Efficiency in Massive MIMO-Based 5G Networks System outage ratio for HPUEs performance of the MC-CDMA system, the theoretical performance and computer simulation results are presented. TPC,TPC-GR, Prioritized TPC, Prioritized TPC,GR QAM modulation is employed for all investigated systems. For MC- CDMA and PSK 16 systems, MMSE for MC-CDMA based systems, the parameters of TPC,TPC-GR, Prioritized TPC, Prioritized TPC,GR performance versus signal-to-noise ratio (SNR) db/N0, where dbis the energy transmitted per information bit and N0 is the one-sided noise power spectral density.

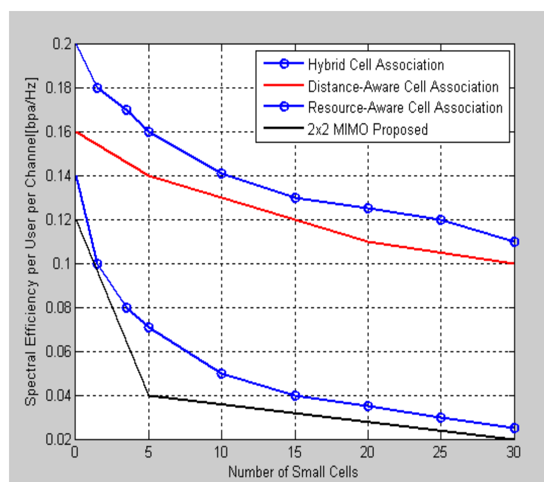

Fig. 3. Energy Efficiency in Massive MIMO-Based 5G Networks System outage ratio.

IV. CONCLUSION

Energy Efficiency in Massive MIMO-Based 5G Networks System 5G mobile communication systems operating at high carrier frequencies, and several techniques are currently being proposed. In this thesis, we first give a brief to 5G millimeter wave systems, initial access procedures as well as the codebook-based beam forming. Then, we study the performance of initial access beam forming schemes in the cases with large-but-finite number of transmit antennas and MIMO-antenna users. Particularly, we develop an efficient beam forming scheme using is generic in the sense that it can be effectively applied with different beam forming at both the transmitter and the receivers. The system performance with different beam forming approaches in the millimeter wave multi-user multiple-input- multiple output networks.

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