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5G Multi-tier Cellular Wireless Networks Higher Data Rates Transmission in MIMO System

Neha Malviya and Prof. Deepak Gyanchandani
Department of Electronic and Communication Engineering,
TIT Bhopal, (Madhya Pradesh), INDIA

(Corresponding author: Neha Malviya)
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ABSTRACT: Device-to-Device (D2D) communication is an effective way of improving area spectral efficiency, system sum rate and palliating traffic load of base stations (BSs), hence it has been included in upcoming LTE-A release and also in fifth generation mobile communication, also termed as IMT-2020. Despite of its advantages, it also brings-in some interference issues between D2D user and cellular user. For such situation, we here propose an idea of deploying an unmanned aerial vehicle (UAV) as a flying base station, which will be used to provide the fly wireless communications to a given geographical area. The use of unmanned aerial vehicles (UAVs) as flying base stations that can boost the capacity and coverage of existing wireless networks has recently attracted significant attention. One key feature of a UAV that can potentially lead to the coverage and rate enhancement is having line-of-sight (LoS) connections towards the users. Moreover, owing to their agility and mobility, UAVs can be quickly and efficiently deployed to support cellular networks and enhance their quality-of-service (QoS). On the one hand, UAV-based aerial base stations can be deployed to enhance the wireless capacity and coverage at temporary events or hotspots such as sport stadiums and outdoor events.

Keywords: LTE-A, device-to-device, line-of-sight, quality-of-service, fifth generation mobile.

I. INTRODUCTION

In recent years, Human-centric as well as connected machine-centric networks will need to be enabled. Enable any mobile application and service to connect to anything at anytime connectivity between connected people and connected machines Existing wireless systems will not be able to deal with thousand fold increase in mobile broadband data.5G: the next generation of ubiquitous ultra-broadband network Massive capacity and massive connectivity 2 Increasingly diverse set of services, applications, and users with extremely diverging requirements 1000 times higher mobile data volume per unit area (1000_ challenge) 10-100 times higher number of connecting devices and user data rate (e.g., peak data rate of 10 Gbps for low mobility and peak data rate of 1 Gbps for high mobility) Less than 1 ms latency to support real-time control applications Max 10 ms switching time between different radio access technologies (RATs) Communication scenarios in the range of 350 - 500 km/hr(compared to 250 km/hr in 4G networks) 10 times longer battery life MC-CDMA has become increasingly popular as a promising wireless access technique in wideband communication systems mainly due to its high spectral efficiency. However when the radio bandwidth becomes wider in order to meet the demands for higher data rates, the transmission performance may be seriously degraded by impulsive noise which is caused by vehicle ignitions, power lines, electrical equipment etc.In many physical channels like in urban, indoor radio and underwater acoustic channels the ambient noise is known through experimental measurements to be decidedly Non-Gaussian due to the impulsive nature of man-made electromagnetic interference and natural noise as well. Linear and Nonlinear receivers for DS-CDMA system has been investigated in [1,2]. Native support for Machine-type communication low latency and real-time operation May require radical changes at both the node and architecture Levels into the network through the use of reliable, fast and low latency backhaul connections which will be a major technical issue for upcoming multi-tier 5G networks.

In the remaining of this article, we will focus on the review of existing power control and cell association strategies to demonstrate their limitations for interference management in 5G multi-tier prioritized cellular networks (i.e., where users in different tiers have different priorities depending on the location, application requirements and so on). Design guidelines will then be provided to overcome these limitations.

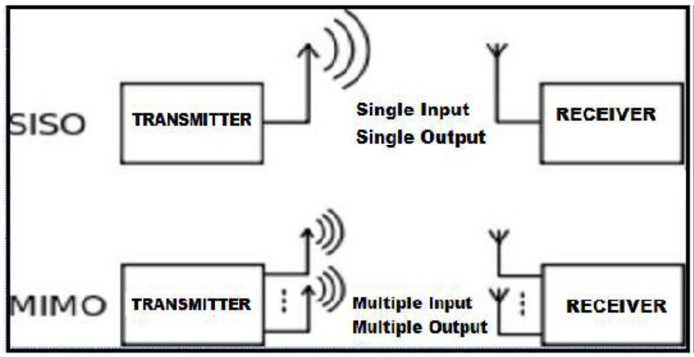

Fig. 1. Block diagram of SISO and MIMO systems.

II. COVERAGE PROBABILITY FOR D2D USERS

In this section, we are going to evaluate the coverage probability of D2D users as our prime motive. For this evaluation, we consider that UAV is flying at an altitude of h meters above the ground level and at the center of the area of service. The UAV will be serving cellular users in the downlink fashion. D2D users will be participating in the communication with other intendant D2D users in an underlaying fashion. In such a method. D2D users will not be needing any kind of assistance from the base station, hence termed as underlaying fashion. It can be understood that uniform distribution of such flying BSs in the service area will maximize the probability of the downlink users.

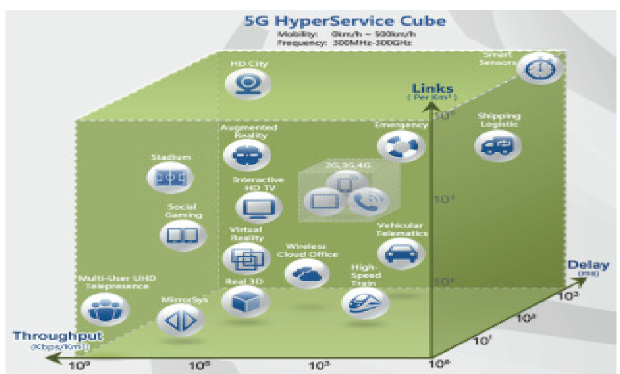

Fig. 2. A technology vision1 5G.

III. AIR-TO-GROUND CHANNEL MODEL

It is evident that in today's wireless environment, channel consist of different types of obstacles ranging from micrometers to tall buildings. These obstacles cause degradation of received signal in may ways. Among of these many ways, reflection and scattering are very common and prominent. As we have seen earlier, signal received at ground level users will consist of three sets of signal. First will be LoS component, second is strong reflected NLoS component, and last is multiple reflected components caused by multipath fading. The occurrence of these signal fading process may differ from place to place as well as from time to time. Same geographical area may see different channel conditions at different hours of day and months.

Thus channel is highly random and depends on atmospheric temperature, pressure, humidity, wind, density of obstacles, elevation angle, position of receiver and many more complex things. All these components will constitute either reflection, scattering, or fading to the received signal.

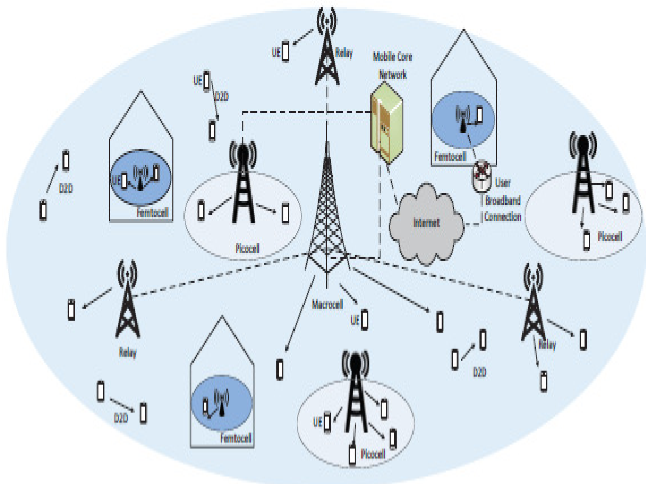

Fig. 3. Multi-tier cellular network architecture.

The effects of impulsive noise for both MCM systems and single-carrier modulation (SCM) system have previously been analyzed in [8] where the BER of orthogonal frequency-division multiplexing (OFDM) QAM based systems has been derived by varying impulse power and probability. Robust detection of DS-CDMA and OFDM based signals under similar channel conditions has been studied and various nonlinear detection techniques have been investigated in [3,6,15,16]. The BER performance of MC-CDMA in the presence of impulsive noise and frequency-selective multipath fading has been investigated in [12,7]. However it was inconclusive that MC-CDMA systems are more robust to impulsive noise than the equivalent DS-CDMA as the performance was demonstrated in the presence of frequency-selective fading thus it was not evident that the gain obtained was due to robustness to impulsive noise or frequency selectivity. We will compare the performance of MC-CDMA and MC-DS-CDMA in mixture impulsive noise model which is widely used to model impulsive noise environments [1,3,15]. The theoretical analysis and simulation results evidently illustrate the conventional MC-CDMA is more sensitive to impulsive noise than DS-CDMA and OFDM. However it is not true that MC-CDMA structure fails in the presence of impulsive noise. Furthermore we propose a modified MC-CDMA structure called MC-SI-CDMA with sub carrier interleaving which outperforms DS-CDMA and OFDM in impulsive noise. Interference has become a real problem because of the limited available bandwidth resources.As telecommunication systems rapidly growing so that the interference among such systems is becoming increasingly serious, especially in industrial environments. Measurement of interfering signals is the main initial step for realizing coexistence of these systems. Numerous works have studied the impact of impulsive interference into multiple modulation schemes but they have not performed real measurements [1]. The main objective in this thesis is to develop three different measurement setups to test the performance of multiple modulation schemes under certain interference. Two types of noise models are generally used to describe noise interference. These models include the Gaussian noise and the Non-Gaussian noise (impulsive noise). Actual wireless systems are designed to work under certain signal to noise ratio, considering this noise as Additive White Gaussian Noise (AWGN). However impulsive interferences have different statistical properties than AWGN and so that their effects can be different into the communication system.

The man-made environments are much more impulsive that can drastically degrade the performance of the systems to operate effectively against background noise. So that there is really requirement to combat against the interfering noise and to improve the quality of communication system also requires to parameterize the interference noises in a statically way. For high quality communications required a low BER and it is not always obtained in some cases due to impulsive noise. But we cannot fight against only the impulsive noise in order to get a realistic noise model it should be a combination of the both noises Gaussian and Non-Gaussian where Middleton's class A model is the one that fits better with most of Non-Gaussian noises [2]. The main parameter of the Gaussian model is the average noise power across the channel. The Gaussian probability density function and a constant power spectral density characterize in this model. On the other hand impulsive noise is completely random and has an unpredictable power and cannot know when it is going to occur. The only way to get statistical information about it is doing measurements in a specific place and characterizing it [3]. Gaussian noise is defined as noise with some particular statistical properties. This noise has a probability density function as a normal distribution also known as Gaussian distribution. That means the power of the noise is Gaussian distributed for an specific case of this noise and the noise we are going to work with is Additive White Gaussian noise which besides of the values of the noise in two different times are statistically independent and uncorrelated which makes it appear in broadband [4]. Impulsive noise is non-stationary and is compounded by irregular pulses of short duration and signifier energy spikes with random amplitude in spectral content so this is why impulsive noise is considered the main cause of burst error occurrence in data transmission causing a temporary loss of signal. Therefore this is essential to know the statistical nature of impulse noise in order to be able to evaluate its impact on a communication system. These pulses are made by two main causes ambient electromagnetic interferences (storms) and natural electromagnetic interference or errors on telecommunications systems by man-made. Impulsive noise is a sequence of pulses characterized by three parameters and those are pulse amplitude, time-duration of the pulse and the time between consecutive pulses.

IV. DEVICE-TO-DEVICE (D2D) COMMUNICATION

D2D communication (already being studied in 3GPP as a 4G add-on) should be natively supported in 5G as another cell-tier. 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)4Dense spectrum reuse, irregular interference topology Spectrum overlay or spectrum underlay.

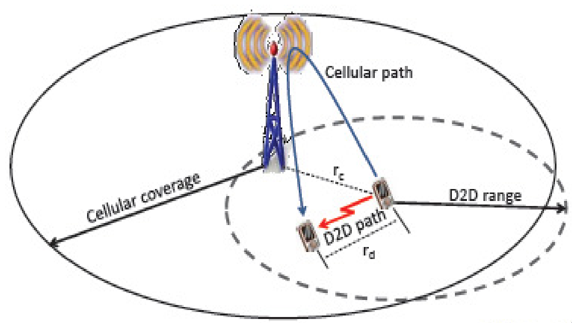

Fig. 4. Device-to-device (D2D) communication.

Multiple access/interference management and advanced waveform technologies combined with advances in coding and modulation algorithms (for massive IoT connectivity) Miniaturized multi-antenna technologies and significantly advanced baseband and RF architecture (e.g., for massive MIMO computations) Advanced RF domain processing, single-frequency full-duplex radio technologies Device technologies to support a vast range of capabilities Backhaul design for ultra dense networking Virtualized and cloud-based radio access infrastructure. Open challenges are highlighted and guidelines are provided to schemes in order to overcome these and make them suitable for the emerging 5G systems. The multi carrier code division multiple access (MC-CDMA) systems and analyze the performance by examining the MC-CDMA system model in time domain. We have discovered that conventional Walsh-code based MC-CDMA is less robust as compared in presence of impulsive noise than the direct sequence DS-CDMA and the multi carrier modulation based (MCM) systems.

It is cleared that the performance of MC-CDMA depends strongly on the selection of the utilized spreading codes and modified MC-CDMA structure is called as MC-SI-CDMA and it is investigated in impulsive noise that employs sub carrier interleaving (SI) to reduce the cross correlation between the time domain MC-CDMA waveforms and the impulsive noise. From Computer simulation results it is cleared that to support our analysis the proposed MC-SI-CDMA system in impulsive noise can gives a performance improvement of 2.5 dB at a bit error rate (BER) level of 10−3 and it is compared with the DS-CDMA system.

V. SIMULATION RESULT

Evolution Towards 5G Multi-tier Cellular Wireless Networks Higher Data Rates Transmission in MIMO Systems 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 db is the energy transmitted per information bit and N0 is the one-sided noise power spectral density. For comparison purposes, both theoretical performance and simulation results of the linear receivers for MC-CDMA in impulsive noise are plotted. It can be seen that the computer simulation results match the theoretical analysis perfectly. Evolution Towards 5G Multi-tier Cellular Wireless Networks Higher Data Rates Transmission in MIMO Systems. In addition to setting their transmit power for tracking their objectives, the LPUEs limit their transmit power to keep interference caused to HPUEs below a given threshold. HPUEs can notify the nearby LPUEs when the interference exceeds the given threshold (high-priority cell tier and low-priority celltier) with same target SIR for all users25 HPUEs per high-priority cell and 4 LPUEs per low-priority cell, each user is associated with only one BS of its corresponding tier. LPUEs employ either TPC, TPC-GR, prioritized TPC, or prioritized TPC-GR, and HPUEs use TPC (i.e., rigidly track their target-SIRs). Although outage ratio for HPUEs are improved by TPC-GR, as compared to TPC, protection of HPUEs is not guaranteed. Prioritized TPC and TPC-GR guarantee protection of HPUEs at the cost of increased outage ratio for LPUEs. Also, with prioritized OPC for LPUEs and TPC for HPUEs, protection of HPUEs is guaranteed at the cost of decreased throughput for LPUEs (compared to non-prioritized OPC).

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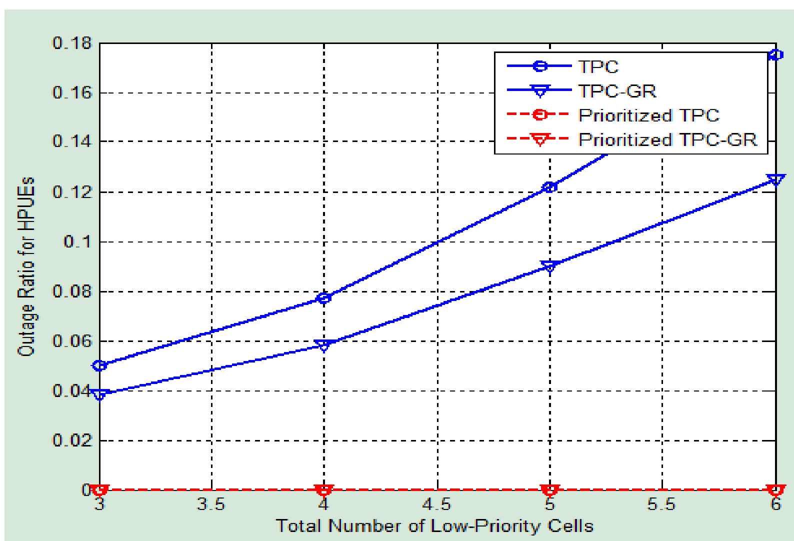

Fig. 5. Performance of TPC,TPC-GR, Prioritized TPC, Prioritized TPC, GR and total number of low –Priority Cell.

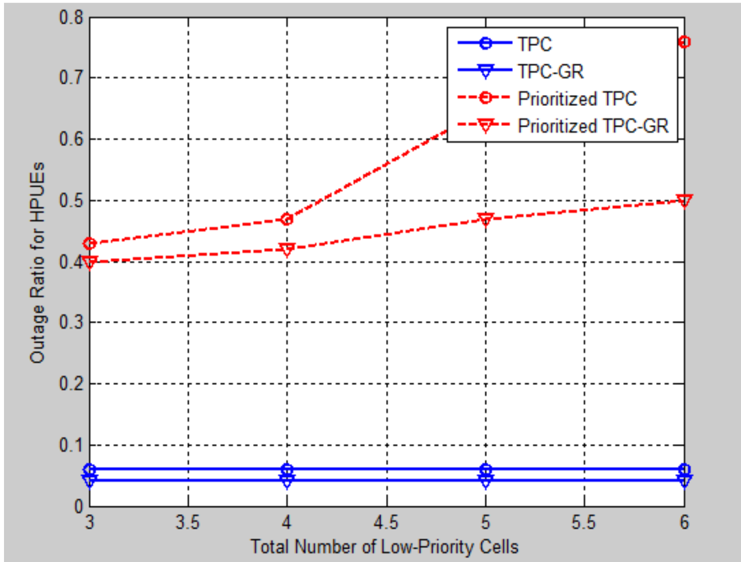

Fig. 6. Performance Prioritized power control A two-tier system.

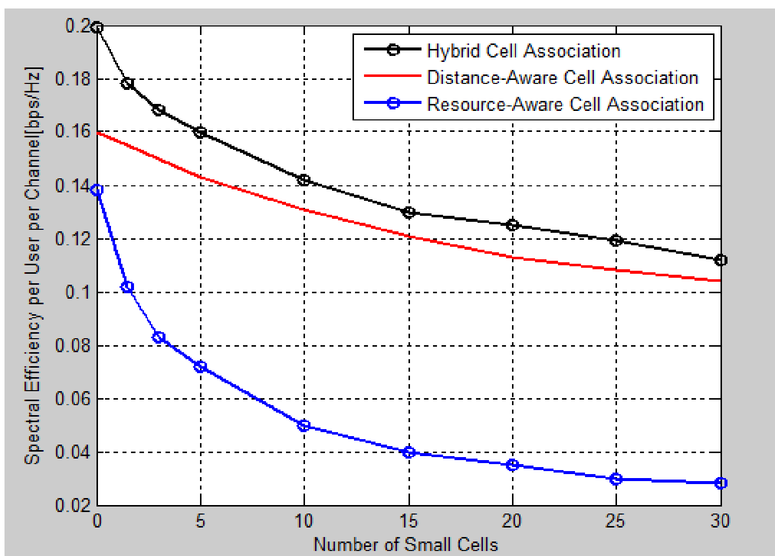

Fig. 7. Hybrid cell association scheme Combine resource-aware and distance-aware criteria.

A user selects a cell with the maximum of product of distance-based channel gain and pi. If pi = 0 (i.e., high or innate traffic load), a user will not select cell i even if it is the closest cell and vice versa. Hybrid scheme achieves a balance between traffic load balancing and throughput maximization. Quantitative comparison among resource-aware, distance-aware, and hybrid cell association schemes: two-tier macrocell-small cell network, downlink transmission, round-robin scheduling.

VI. CONCLUSION

Here we looked into the performance of a UAV that acts as a flying base station in an area in which users are capable of D2D communication. We have considered two types of users in the network: the downlink users served by the UAV and D2D users that communicate directly with one another.

We have derived coverage probability, outage probability and system sum rate for D2D communication. Analyzing system sum rate was our sole purpose. The results have shown that SINRCDF and outage probability of D2D users increases with increase in SINR threshold. Outage probability increase even with $_{d}= _{du}$ ratio. Finally we have shown that our D2D system sum rate can be increased with SINR-threshold and D2D user density. This increase in D2D users system sum rate decreases if both SINR-threshold and $_{d}$ are in-creased beyond a range. Hence maximum value is attained over a small range of and $_{d}$ and this is where a trade off is made.

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