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SPREAD CHANNEL CATEGORIZATION FOR 28, 73, GHZ MILLIMETER-WAVE 5G FREQUENCY BAND

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ABSTRACT:The modern development in the 5G wireless technologies is challenging higher bandwidth, which is a challenging assignment to fulfill with the existing frequency spectrum i.e. below 6 GHz. It forces operators and researchers to go for higher frequency millimeter-wave (mm-wave) spectrum in order to achieve greater bandwidth. Enabling mm-wave, however, will come with various path losses, scattering, fading, coverage limitation, penetration loss and various different signal attenuation issues. Optimizing the propagation path is much essential in order to identify the behavior of channel response of the wireless channel before it is implemented in the real-world scenario. In this paper, we have analyzed the potential ability of mm-wave frequency band such as 28 and 73 GHz and compare our results with the existing 2.14 GHz LTE-A frequency band. We utilize the most current potential Alpha Beta Gama (ABG) propagation path loss model for designing urban microcellline of sight (LOS) scenario. We investigate the network performance by estimating average user throughput, average cell throughput, cell-edge user s throughput, peak user throughput, spectral efficiency and Fairness index with respect to different users capacity.

Key words: 5G; millimeter wave; Channel Propagation; Path loss

I.INTRODUCTION

As the demand for data rate grows, new technologies need to investigate in order to carry out a load of future generation networks. As the number of mobile users increases in the near future, the requirement for higher data rates, availability of services for a larger number of users and quality of service (QoS) needs to increase as well [1]. The advent of the Internet of Things (IoT) already paved the way for connecting almost all of our devices and appliances over the internet grid, which will abruptly increase the number of devices in a specific region. These devices will require different quality of service depending on their purpose and usage. In [2, 3], Ericsson predicted that the data volume may surpass 1,000 times of that is available today by the end of 2020.

The first ever standard specification of 5G is expected to be delivered by the end of 2020 by 3rd Generation Partnership Project (3GPP) [7]. 5G is under heavy development as researchers and

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scholars around the world are focusing on the challenges it proposes in the way of implementation and making it available to consumer networks. One of the major challenges is the higher data rate requirements, which need larger bandwidth. In order to achieve this, many researchers have utilized massive MIMO antenna design, which ensures that maximum bandwidth is available for the wireless channel. Massive MIMO exploits the properties of multipath propagation in pursuance of achieving higher data rates and minimal path losses.

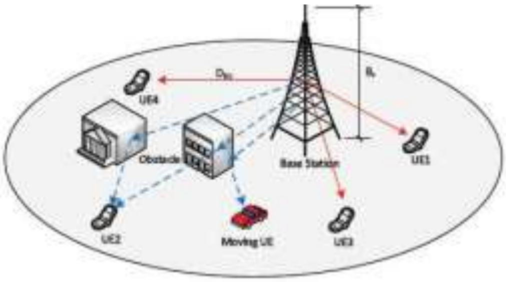
In this paper, we will be utilizing ABG free space path loss propagation model to create urban microcell LOS scenario as proposed by in [10]. We will be using the specified model on a variety of 5G frequency bands of 28 GHz and 73 GHz and compare our results with the existing LTE-A frequency band of 2.14 GHz. We investigate the network performance by estimating average user throughput, average cell throughput, user throughput of cell edge users, peak user throughput, spectral efficiency and fairness index with respect to different users capacity. The rest of this paper is organized as follows. Section II illustrates some of the literature work. The proposed model with large-scale ABG propagation path loss system model is discussed in section III. The simulation setup and results will be provided in section IV and finally, we will conclude and propose future directions in section V.

II. LITERATURE SURVEY

The random behavior of the wireless channel imposed by the communication spectrum made researchers to investigate and model different models in order predict channel path loss. This arbitrary variation of the channel can be mapped using statistical procedures and extensive testing to provide a base for wireless communication in different environments. Operators and researchers have contributed to research by providing different models and experiments over a range of frequencies to help the development of 5G technologies. [13- 15]. This section illustrates some of the work carried out by the research community for providing path loss experimental and simulation-based results over different 5G frequencies to support higher data rates in various environmental configurations.

In [16], authors have compared two large-scale propagation path loss models ABG and CI in outdoor macro and microcellular environment. The results were collected either by using measurements campaigns or ray tracing techniques over selected frequency bands between 2 GHz to 73.5 GHz. The authors concluded that CI model is far simpler to implement and offer better results due to the goodness of shadow fading standard deviation in both LOS and NLOS environments. CI model is also preferred due to its similarity to already available 3GPP FI path loss model where only one constant is to be replaced by CI free reference value. A very similar study was performed in [17] where the two models i.e. CI and ABG are categorized as models having some physics-based variables and they are dependent on curve matching techniques over the dataset. Through their results, they derived that CI model (with some physical anchor) performs better and also improves the stability of the model. In [18], authors have used CI free space path loss model in the New York City at 28 GHz and 73 GHz frequency bands. The probability of LOS communication is taken as a weight function for a specific distance of separation between communicating nodes. Same frequency bands of 28 GHz and 73 GHz were used to characterize the path loss in [19]. The results are focused on temporal statistics collected in the ultra- dense indoor scenario. The proposed model is simpler than previously available models including 3GPP and ITU propagation models and can be easily setup in the next generation technologies. 3D ray tracing software was tested for their quality of precision in [20] so that extensive testing and measurements can be avoided for a large scale implementation of the network. It is also feasible because the measurement campaigns are very time-intensive and costly and require

many resources. While ray tracing software can be used to predict the unknown values of the data provided that a large set of known values are given to the software which was collected during previous measurem
ent campaigns. The authors in [21] not o
lues for unknown parameters but also compared the results with experimental results, collected for the same scenario in an outdoor university campus.



III. PROPOSED SYSTEM

In wireless communication, the quality of the link largely depends on the signal propagation characteristics and path loss characteristics of the channel. The overall effect of path loss is contributed by absorption of signals by the medium, shadowing caused by buildings and objects within the environment, reflection, diffraction, refraction, free space path loss, aperture medium coupling and some other parameters. For this system model, we will be considering an isolated environment where no outer interference is acting upon and only interferences available are those generated by the devices inside the system. A basic model is presented in Fig. 1, where a single cellular base station (BS) is located in the center with tri-sector MIMO antennas. The height of the base station is denoted by BS and DBU represents the separation distance between BS and user. For the purpose of example, we consider that the BS is located in an outdoor urban environment with average height buildings where UE utilizes both LOS and NLOS links for the purpose of communication with the BS. While most users in the region are considered to be stationary, there may be some users who are not stationary and are in constant movement with an average speed of 5 km/hr.

$$PL^{ABG}(f,D_{BU})[dB]=10\alpha\log_{10}\left(\frac{D_{BU}}{1m}\right)+\beta+10\gamma\log_{10}\left(\frac{f}{1GHz}\right)+\chi_{\sigma}^{ABG}$$

$$\text{where } d\geq 1\text{m}$$

$$B=PL^{ABG}(f,D_{BU})[dB]\text{, } D=10\log_{10}(D_{BU})$$

$$\alpha\sum D^2+\beta\sum D+\gamma\sum DF-\sum DB=0$$

$$\alpha\sum D+N\beta+\gamma\sum F-\sum B=0$$

$$\alpha\sum DF+\beta\sum F+\gamma\sum F^2-\sum FB=0$$

Fig. 1. A cell with a single BS with tri-sector MIMO antennas in an outdoor.

Here, the large-scale ABG (alpha, beta, and gamma) path loss model presented in [10] is mentioned below:

Where PLABG(f,DBU) refers to path loss measured in dB as a function of frequency and distance, α and γ are the path loss coefficients for distance and frequency respectively as shown in the equation (1).β is the offset value in dB which can used to optimize the path loss based on collected results if any. DBU is the separation distance between the transmitter (base station) and the receiver (user equipment), f is the carrier frequency in GHz. χABCis a random variable with zero mean gaussian standard deviation σ in decibels which defines signal fluctuation in large scale (i.e. shadowing) about mean path loss based on some specific separation distance and operating frequency.

Assuming

And in (1), the SF is given by

Then, the SF standard deviation

$$\sigma^{ABG}=\sqrt{\frac{\sum\chi_{\sigma}^{ABG^2}}{N}}=\sqrt{\frac{\sum(B-\alpha D-\beta-\gamma F)^2}{N}}$$

Minimizing the fitting error is equivalent to minimizing, which means its partial derivative with respect to , and should be zero, as shown by

Through calculation and simplification, one can find the closed-form solutions for α,β and γ from equations, which can also be found.

A. Simulation Setup

Several simulation scenarios have been carried out for 3 different frequency bands of

2.14, 28, and 73 GHz and these results are compared in order to compute the performance of the ABG model using 2x2 MIMO antenna arrays. For the purpose of simulating the scenario presented in Fig. 1, MATLAB based Vienna LTE-A System level simulator is used in outdoor environment. A number of active users in the cell are varying from 10 to 50 users per cell whose physical positions are random but equally scattered and dispersed throughout the coverage area of the cell. The available bandwidth is 40 MHz and the transmission power is 46 dBm as recommended by [25]. The users are the height of 1m from the ground and either static or in random motion with an average speed of 5 km/hr. The coordination between UE with BS is done by proportionally fair (PF) scheduling algorithm. The results are presented here to assess network performance by estimating average user throughput, average cell throughput, user throughput of cell edge users, peak user throughput, spectral efficiency and fairness index.

IV. RESULTS

Main control

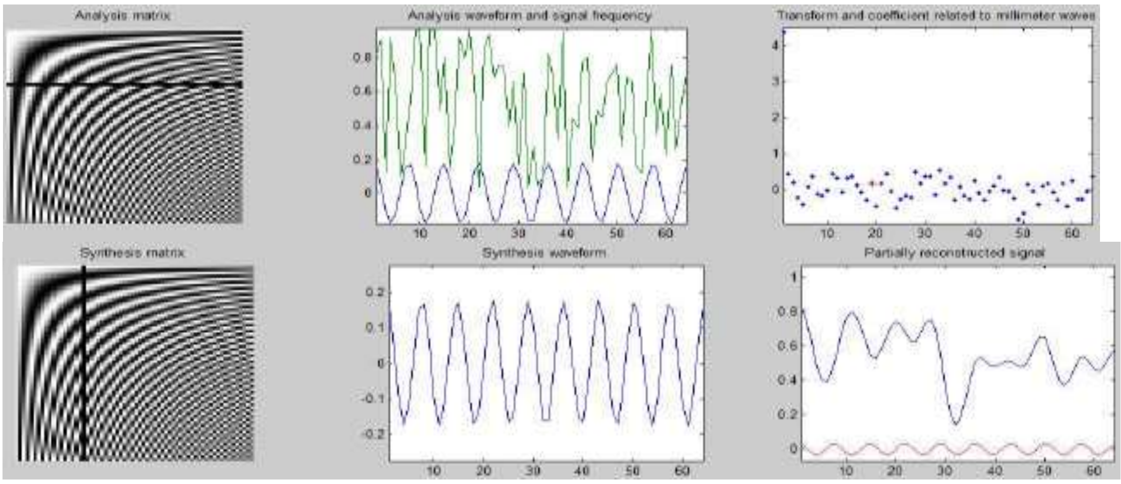


Fig : Channel Allocation

The discussion will be carried out based on the results that are presented in this section. Since higher frequencies face more path losses due to scattering and fading, therefore MIMO architecture exploit the multi propagation property of wireless channel and provides higher data rates and is easy to set up. The Average user throughput of all the users in the cell area including cell edge users as well as cell center users receiving ample amount of power in the cell. Fig. 2 shows the average user throughput for different frequency bands including 2.14, 28 and 73 GHz. It is clear that as the number of users increases in the region, average user throughput decreases for all the frequency channels. When a number of users are minimum, 28 and 73 GHz performs 42.8% and 53.7% better as compared to 2.14 GHz respectively, while when the number of users is 50, there is not much difference in 2.14 and 28 GHz throughput. Capacity to fulfill the required demand.

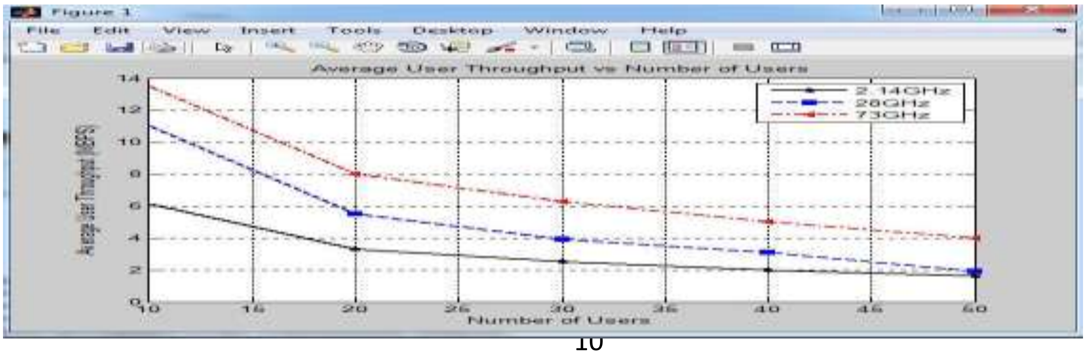


Fig 4: 28 and 73GHz at 14 mbps

In Fig. 4, user throughput of cell edge users is presented with varying number of users. The Cell edge users can be identified by the separation distance from the base station. A threshold distance specifies which users will be termed as cell edge users. Fig. 4 displays the throughput in Mbps for cell Edge capacity. As the number of users is increasing, the data rate is decreasing for all the frequencies but higher frequency offers higher data rates as compared to lower frequencies. The achieved cell-edge user throughput at minimum users of 10 is 3.2, 6.8 and 9.3 Mbps for 2.14, 28 and 73 GHz frequency band, respectively. When the numbers are of users are maximum of 50 users, the throughput decreases up to 1.1, 1.8 and 2.7 Mbps for 2.14, 28 and 73 GHz frequency band, respectively.

V. CONCLUSION

The proliferation reaction of the mm- wave signals is should have been explore, before it is actualized in the real world condition. Keeping in mind the end goal to consider the potential capacity of mm-wave range, this paper displays the channel portrayal of 28 and 73 GHz recurrence range by contrasting it and the at present utilized LTE-A, 2.14 recurrence range. We utilize the most potential ABG way misfortune show and compute different diverse execution parameters, for example, normal client throughput, normal cell throughput, cell-edge client throughput, crest client throughput, unearthly productivity and decency record with different number of clients in the cell.

The general accomplished system execution for a mm-wave recurrence band is substantially higher than 2.14 recurrence band. We trust that our discoveries are valuable to test and execute for genuine condition and give a sight for the cutting edge 5G remote correspondences organize. As a future work, more strong spread channel model, for example, shut in (CI) and gliding capture (FI) with different MIMO setup will be considered, alongside various booking approaches like most extreme Largest Weighted Delay First (M-LWDF) and Exponential/Proportional Fair (EXP/PF) bundle planning calculations.

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