Analysis of Densification Gain for 5G Mobile Technology

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ABSTRACT

In this paper we have discussed about the 5G mobile technology and its channel capacity. Densification gain is defined as the effective increase in data rate relative to the increase in network density. In the analysis it is found that the two parameters Data rate and Network Density affect the Densification gain. By controlling Densification gain we can control channel capacity for 5G.

Keywords- MIMO, BER, LTE

INTRODUCTION

In Modern history mobile communication brought the revolutionary changes. The mobile communication developed so much in terms of speed and data rate .The four generations of mobile communication evolved very drastically. The increasing growth of mobile users is demanding the allocation of new spectrum improvements in air interface capacity. 4G wireless networks are now getting enhanced as different cell sizes with various backhaul options. Combining advanced 4G technologies (LTE) with small cells can increase the overall network capacity many fold provided that inter-cell interference is handled effectively.[2]. In the next section we have discussed about the channel capacity and how it can be enhanced.

CHANNEL CAPACITY

There are many factors which affect the channel capacity of a system like data rate, bandwidth, noise and error rate. Signal fading due to multipath propagation is dominant source of impairment in wireless communication system [14] causing high bit error rate (BER). For high capacity data rate, bandwidth of transmission media should be high and noise level, error rate and required bandwidth of transmitted signal should be less. The channel capacity is fixed by considering all above parameters for successful communication. It's expected that the wireless network capacity will be enhanced 1000 times to the year 2020.[5] Hence fifth-generation networks will have to support very large data rates and this high data rates can get by combining number of technologies like (1)- by using more than one antennas i.e. MIMO we can reduce the level of noise or interference. (2) By using multi-carrier the effect of multi-path fading is less and adaptive modulation is easily implemented.[7]

If the maximum separation between two co-channel cell D_s is based on a co-channel interference reduction factor which is expressed as $q=D_s/R$ -----(a),

where R is the cell radius.[7]. So from above expression (a), if we are using smaller cells then the capacity of system increases. Recently, there has been a growing interest for mm-wave communications for supporting short-range cellular communication. It is anticipated that mm-wave will be used on short distance in 5G[9].

Bandwidth required to transmit a signal has a very important role in deciding the channel capacity. The spectrum of a signal in the range of frequencies that it contains, and is termed on absolute bandwidth of the spectrum, but most of the energy in the signal is contained in a relatively narrow band of frequencies. This band is referred to as the Bandwidth [10]. Data service in current cellular network is growing exponentially. [2] It increased drastically due to use of facebook, whatsapp etc and this demand is increasing continuously. To fulfil this requirement high data rate supporting system is required, so that channel capacity is high. Every transmission medium has a fixed bandwidth. The rate at which data can be

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transmitted over a given communication path or channel under given condition is referred to as the channel capacity [10]. It is found that the channel capacity can be increased by reducing the cell size.[6] A related parameter is Densification gain which is defined as the effective increase in data rate relative to the increase in network density. Some analysis is done how it will affect the channel capacity in the following section.

ANALYSIS

The relationship between densification gain, relative data rate and Network Density is expressed in the given below equation.[6]

$$p = \frac{\frac{R_2 - R_1}{R_1}}{\frac{\lambda_2 - \lambda_1}{\lambda_1}}$$

where p=Densification Gain.

R_2=Data Rate corresponding to Higher Base Station Density

R_1= Initial Data Rate

λ_2=Higher Base Station Density

λ_1= Lower Base Station Density

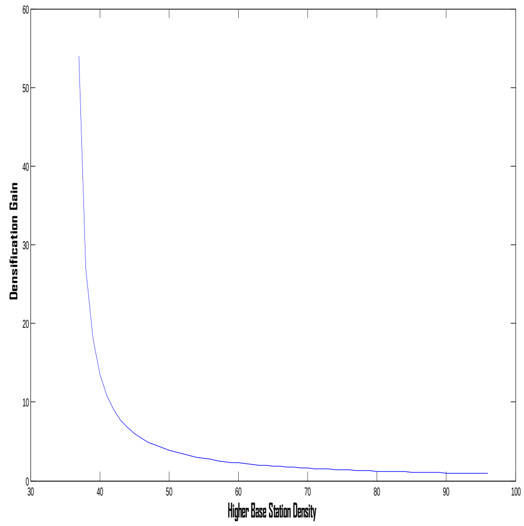

Figure 1- Densification gain versus Higher Base Station Density

An analysis is carried out for the given equation with data rate increased by 1.5 times (constant), base station density (λ_1) =36(constant) and higher base station density i.e. λ_2 is varied from 36 to 96 it has been found that at λ_2=36(approx.) densification gain is maximum and as we increase λ_2 densification gain is decreasing.

It can be seen from Figure-1 that initially the Densification ratio is maximum and then decaying rapidly as the Higher Base Station Density (λ_2) is increasing. Later on the decay is slow when value of Network Density is increased. Here, the edge Data Rate is increased by 50%.

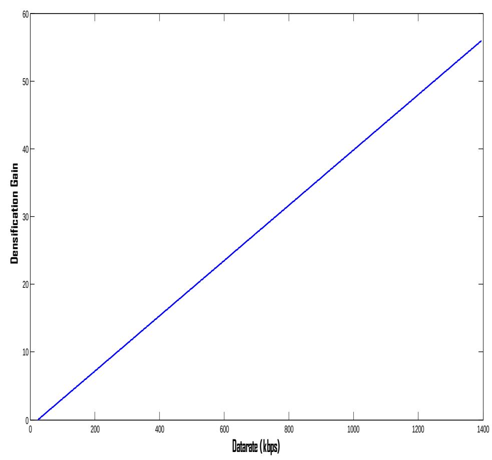

Figure 2- Densification gain versus Data rate

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Figure 2 shows the relationship between data rate and densification gain, keeping the network density $((\lambda_2 - \lambda_1)/\lambda_1)$ constant equals to 1. Increase in data rate R_2 increases the densification gain. It is clear from the figure 2 that the Densification ratio is linearly increasing as the Data rate (R_2) is increasing. For example Data rate R_2 equals to 49 kbps and 1000 kbps the Densification ratio is 1 and 39.8163 respectively. Here, R_1 is kept 24.5 kbps as constant.

CONCLUSION

It is concluded from the analysis that to get the maximum densification gain a) the value of Higher Base Station Density should be low. b) If the relative data rate is increased keeping Network Density constant the Densification Gain increased and getting maximum value.

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