# Route Allocation using Gain and Interference for 5G Self-Backhauled mmWave Network

[1]K. Nagaraja, [2] Dr. G. Umamaheswara Reddy
[1]M.TECH- Student, [2] Professor,
[1,2] Electronics and Communication Engineering,
[1,2] Sri Venkateswara University College of Engineering, Sri Venkateswara University Tirupati,517502
Andhra Pradesh, India.

**Abstract –** ***The path selection and rate selection of multiple users from the single base station is tough task and it should follow many constraints. In the proposed method this path selection is based on the power, probability, gain and interference of the signal with other. Here, we followed a multi hop network with four flows and eight sub flows. This process provides a low delay. Though the mean arrival rate is high this method produces better efficiency when compared to state of art methods.***

**Keywords –** ***Millimeter wave, Ultra dense small cell self backhaul, Multi hop scheduling, Macro base station (MBS) andMassive multi input multi output (MIMO).***

## I. INTRODUCTION

Rapidly increasing on the demand of device technology which increases the utilization of frequency and bandwidth, so we will change into new technology that will provide number of users to serve the services to user and that new technology is called 5G. It has frequency range from 30 to 300 GHz range that will provide services to massive number of devices and will helpful for feature generation [1]. On the other hand fourth generation (4G) radio access network has poor cell edge user experience found by many researchers and industry scientist this will boost the upgrade of 5G networks [2].

In higher frequency band we must focus on improvement on spectral density and energy, to improvethiswe are using Massive Multi Input Multi Output [MIMO]. A macro base station [MBS] is a part of MIMO which consists of massive number of antennas which provides wireless connectivity to small cells. To increase network capacity we use ultra dense small cell network, which leads to increase more than 100× or more. In massive MIMO here use full duplex small cells relays data which reduces deployment cost of small cells and provides MBS to users Equipment (UE) at the same frequency band. In case power consumption a recent study in massive MIMO [7] has less. The reception has done by directional transmission of direct consequence which was main issue in the millimeter wave transmission, to overcome this problem between transceivers use the procedure of beam searching [3], by this transmission has done by sequence of pilot transmission. Time required to find beam searching will takes more time which increases the transmission delay which further increases the latency, so latency is one of the main parameter in 5G technology. Low latency will provides better communication and also increase the speed of the communication. This paper will improves Gbps data rate, low latency and reliable communication between MBS and UE's.

## II. SYSTEM MODEL

For high frequencies which have very short waves lengths, short wavelengths are very sensitive to blockage and human body also acts absorber, so to transmit long distance we use it requires large number of antennas and higher transmitted power.

Here we use multihop transmission instead of single hop which enables long distance communication but due to multihop which increases the delay, so it requires scheduling in multihop transmission in very efficient manner. Route selection and data rate allocation is one of the biggest problems in 5G network.

Hybrid beam forming is used to provide very high data rates in massive MIMO at millimeter wave frequency bands

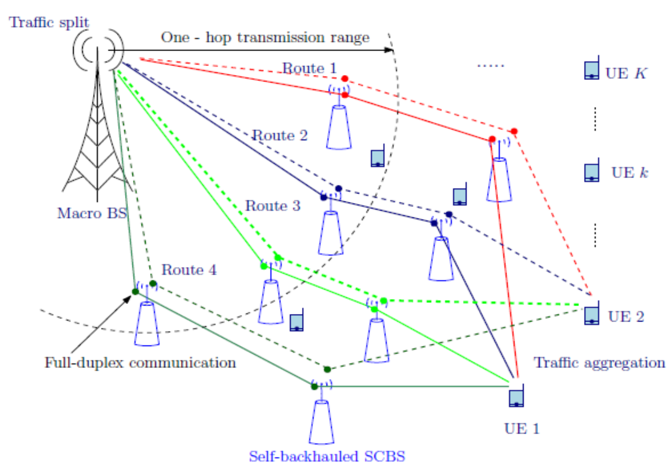


Figure 1: 5G multi-hop self-backhauled millimeter Wave networks

The above figure 1 represents first generation multi hop self backhauled millimeter wave network.

Here we have to chose two flows and four subflows, each flow has termed as one hop transmission range and each subflows defines for each flows it has four small cell ultra dense antennas.

The whole was represented by one cluster and each cluster has one macro base station and many numbers of ultra dense small cells antennas, for different flows in a cluster will have different range of frequency and for each subflow in the flows again this frequency divides.

## III.PROPOSED MODEL

A cellular network plays a vital role from four generations for uplink and downlink data transmissions. These four generations history includes the exchange of large volume of data with voice and video calls with quality of service. With this more number of subscribers are obtaining and network becomes more demanding. Therefore, data transmission to all the users through the base station becomes complex and reduction in data rate and throughput. Hence, Device-to-Device communication came into picture which transmits data from one device to another device. The detail information of D2D communication is given below.

The allocation of spectrum for D2D communications can be of two types. They are In-band and Out-band spectrum allocation techniques. Out band communications involves the D2D data transmission in unlicensed spectrum in which the cellular user information is not present. Whereas, In-band spectrum allocation involves both the D2D and cellular data transmission in licensed spectrum by dividing it into overlapping regions. This In-band spectrum allocation may be of two types they are underlay and overlay cellular communications.The fifth wireless network technology (5G) is supposed to reach a few gigabits in line with second (Gbps) and have a large number of wirelessly linked devices. The coverage and network ability increases by using full duplex ultra dense small cell antennas. In addition to an unparalleled rise in records and system traffic, low latency and high reliability are other crucial problems in 5 G networks and in various areas. The researcher has found in the heterogeneous multi hop network model using NUM paradigm has a problem in joint path selection and traffic management in the data link, so to over this by using NUM paradigm introduces a suggested model of testing with 3 interface models and these are 1) real interface 2) loose interface and 3) more extreme interface.

In Heterogeneous cellular network, the upper limit is restricted for the real assessment of the system handle by loose interference which provides great performance.To maximizes the network capacity and one path transmission to achieve this it mainly focus on adjustment of latency, dependable constraints and dynamic direction diversity need to studied. If MBS takes more time to discover path then it leads to longer conversion time else if MBS only exploits on action then it may leads to loose best possible [path so latency should adjust in bounded period.

The block diagram of proposed method is given by using the below figure:

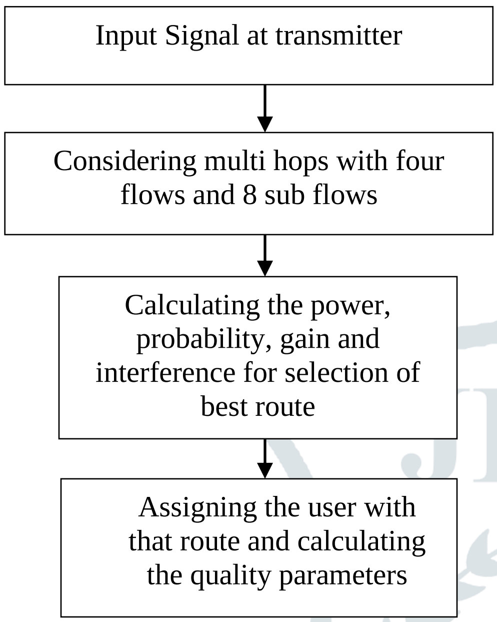


Figure 2: Block diagram of proposed method

To improve backhaul load and quality of service in an effective manner by introducing cache content at the every base station. To optimize the distribution resources of large MIMO enabled Het-net with self backhaul power constraints.

The delay is reduced with the help parameters like gain, interference and power as shown below:

### A. Gain calculation

To increase the power or amplitude of the signal from input to output port of two-port circuit (often an amplifier) is nothing but gain. It is commonly defied as the mean ration of the signal amplitude or power at the output to that of signal amplitude or power at the input port of two-port circuit . for an active circuit gain is greater the one and for passive circuit gain is less then one. gain is usually expressed in logarithmic decibel(dB) units.

The gain of the channel can be calculated between the user's by using angles. Firstly angle between the user's is calculated later on gain is calculated by using the formula given below.

$$Gain(G) = 8 - min\left(12 * \left(\frac{angleusr}{15}\right)^2, 20\right)$$

Where, min= Minimum distance between users.

angleusr = Angle between the users.

Here we assume that gain of antenna at the initial node which is 8. Total number of routes from the base station to end user is 12 and 20 is the total number of users. The number of angles between the base station to nodes and nodes to end user are 15.

### B. Interference calculation

When unwanted signal disturbed the original signal then it leads to interference then received signal is distorted. interference can be reduced at the receiver but it may cause temporary loss of the signal or may effect the quality of the audio or video of the signal. Interference can be man-made interference and natural interference, man-made interference are transmitter and electrical equipment. Interference can be generated in all communication systems. The transmitter capable of producing undesired frequencies known as 'harmonics'.

Then the interference of CTs with the DTs can be formulated as

$$Int = PowDT * DTgain * Noise$$

In existing works, the hop transmission range is splitted for two which means eight hops, where as in our proposed method traffic is splitted into twice that of the existing work which means sixteen hops. If the hops increased then automatically routes are increased. There are four routes in existing works and eight routs in proposed work.

## IV. MATLAB RESULTS

In this article we got more accurate values by using MATLAB version R22018a.

Figure 3 represents on average one hop latency with respect to mean arrival rate , here we assumed that each traffic flow will divides equally into two subflows, the mean arrival rate of each subflow is varying from 1 to 3 Gbps. The requirement of maximum delay is β =10 ms and the target reliability probability ε = 5%.

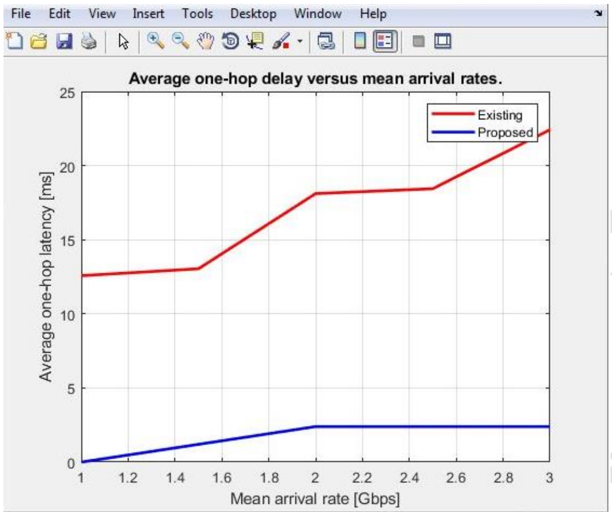


Figure 3: Average one hop latency (ms) vs mean arrival rates (Gbps)

Figure 4 represents the tail distribution of one hop latency versus the guaranteed probability ε, this figure will indicates the tradeoff between reliability and latency.

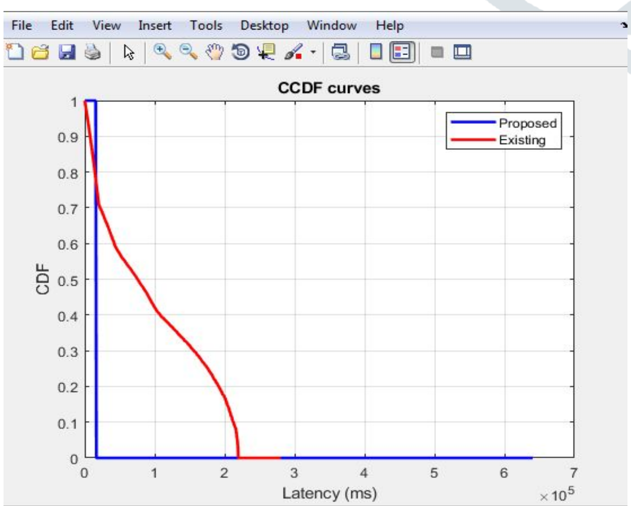


Figure 4: Cumulative distribution function vs latency

Figure 5 reports the average MBS queue length in Giga bits and mean arrival rate in Gbps is extracted to find the average achievable rate. So we plot the average MBS queue length is a function of mean arrival rate. Here we increase the mean arrival rate from 0 to 7 Gbps then average queue length of MBS increases from 0 to 0.014 Gb, does means average delay at the MBS increases from 0.3 ms to 2 ms.

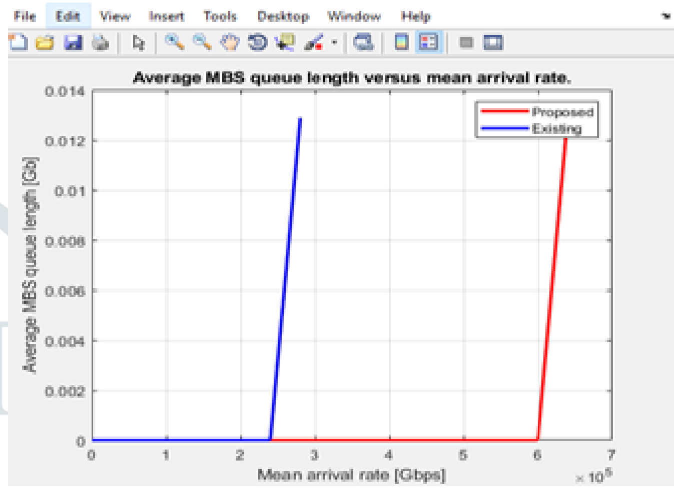


Figure 5: Average MBS queue length (Gb) vs mean arrival rates (Gbps)

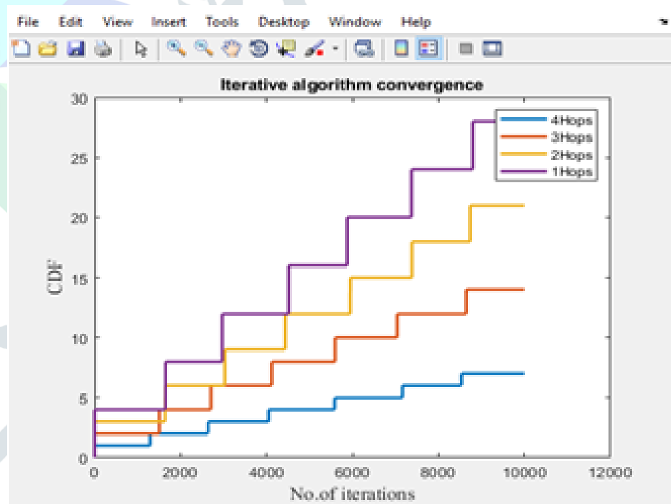


Figure 6: Cumulative distribution function vs number of iterations

Generally, speaking as (6) if number of hops increases, then it requires more number of iterations which leads to increase the variables and thus convergence is higher, but our proposed algorithm will needs only few iterations because it predefined the estimation of queue length at every small cell antenna by calculation of gain, interface and power so it leads to low latency.

## CONCLUSION

The path selection and rate selection of multiple users from the single base station is tough task and it should follow many constraints. In the proposed method this path selection is based on the power, probability, gain and interference of the signal with other. Here, we followed a multi hop network with four flows and eight sub flows. This process provided a low delay. Though the mean arrival rate is high this method produces better efficiency when compared to state of art methods.

## REFERENCES

[1] L. Schnack, C. Wolfe, and D. Olps, "In-band wireless communication network backhaul," Jan. 22 2008, US Patent 7,321,571.

[2] T. S. Rappaport et al., "Millimeter wave mobile communication for 5G cellular: It will work!" IEEE Access, vol. 1, pp. 335–349, 2013.

[3] S. Hur et al., "Millimeter wave beamforming for wireless backhaul and access in small cell networks," IEEE Trans. Commun., vol. 61, no. 10, pp. 4391–4403, Oct. 2013.

[4] J. G. Andrews et al., "What will 5G be?" IEEE J. Sel. Areas Commun., vol. 32, no. 6, pp. 1065–1082, June 2014.

[5] N. Bhushan et al., "Network densification: the dominant theme for wireless evolution into 5G," IEEE Commun. Mag., vol. 52, no. 2, pp.82–89, 2014.

[6] A. Alkhateeb, O. El Ayach, G. Leus, and R. W. Heath, "Channel estimation and hybrid precoding for millimeter wave cellular systems," IEEE J. Sel. Topics in Signal Process., vol. 8, no. 5, pp. 831–846, 2014.

[7] A. Anpalagan, M. Bennis, and R. Vannithamby, Design and deployment of small cell networks. Cambridge University Press, 2015.

[8] O. Semiari,W. Saad, Z. Daw, and M. Bennis, "Matching theory for backhaul management in small cell networks with mmWave capabilities," in Proc. IEEE Int. Conf. Commun. (ICC). IEEE, 2015, pp. 3460–3465.

[9] E. Björnson, E. G. Larsson, and T. L. Marzetta, "Massive MIMO: Ten myths and one critical question," IEEE Commun. Mag., vol. 54, no. 2,pp. 114–123, 2016.

[10] T. K. Vu, M. Bennis, S. Samarakoon, M. Debbah, and M. Latva-aho, "Joint load balancing and interference mitigation in 5G heterogeneous networks," IEEE Trans. Wireless Commun., vol. 16, no. 9, pp. 6032– 6046, Sep. 2017.

[11] T. K. Vu, C.-F. Liu, M. Bennis, M. Debbah, M. Latva-aho, and C. S. Hong, "Ultra-reliable and low latency communication in mmWaveenabledmassive MIMO networks," IEEE Commun. Lett., vol. 21, no. 9, pp. 2041–2044, Sep. 2017.

[12] T. K. Vu, C.-F. Liu, M. Bennis, M. Debbah, and M. Latva-aho, "Path selection and rate allocation in self-backhauled mmWave networks," in Proc. IEEE Wireless Commun. and Netw. Conf. (WCNC), Barcelona, Catalonia, Spain, Apr. 2018.

[13] F. Gómez-Cuba, E. Erkip, S. Rangan, and F. J. González-Castaño, “Capacity scaling of cellular networks: Impact of bandwidth, infrastructure density and number of antennas,” IEEE Trans. Wireless Commun., vol. 17, no. 1, pp. 652–666, 2018.

[14] M. Bennis, M. Debbah, and H. V. Poor, “Ultra-reliable and low-latency wireless communication: Tail, risk and scale,” Proceedings of the IEEE, vol. 106, no. 10, pp. 1834–1853, 2018.

[15] T. K. Vu, M. Bennis, M. Debbah, M. Latva-aho, and C. S. Hong, “Ultrareliable communication in 5G mmWave networks: A Risk-sensitiveapproach,” IEEE Commun. Lett., vol. 22, no. 4, pp. 708–711,2018