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# Performance Analysis of mm wave Communication Using Sub Allocation Frequency Reuse in MIMO

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**Abstract:**
For future system, millimeter wave is a promising innovation with unlicensed range that empowers gigabit multimedia applications for instance sound, video, and so forth in MIMO strategy. The reason behind going mm wave in short range separate contains higher data transmission in breaking down the range. In existing work, the single beam communicate is viewed as that don't make full conceivable utilization of mm wave. Thusly the system of single beam transmission is adequately blocked. In 5G network, the various beams are managed with directional beamforming. To conquer this issue, multi-client multi beam synchronous correspondence plot for future mm wave network is favored. In this paper sub allocation frequency reuse (SAFR) technique are utilized for effective information rate to the client without interference. Utilizing this strategy, the information rate, spectral efficiency and throughput are enhanced in the system.

**Index Terms:** 5G, millimeter wave (mm Wave), directional beam forming (BF), MIMO, sub allocation frequency reuse (SAFR).

## I. INTRODUCTION

Millimeter wave regularly compares to the radio range between 30 GHz to 300 GHz, with wavelength among one and ten millimeters. This region is likewise alluded to as the exceedingly high frequency (EHF) bands while the usage of radar phrasing [1]. The extended advancement of millimeter wave segments would give frameworks wide transmission capacities to help high date rate users and diminished sensitivity to propagation confinements separated and electro-optical systems. Furthermore, millimeter wave systems would reduce the spectral congestion of the lower frequencies. Today, mm wave frequencies are being devoured for applications, for example, streaming high-determination video inside. Customarily, those higher frequencies were currently not sufficiently vigorous for outside broadband packages due to unnecessary propagation loss and susceptibility to blockage from homes and additionally absorption from rain drops. These issues influenced mm to wave troublesome for portable broadband. Short transmission ways and high propagation loss consider range reuse by compelling the measure of obstruction between neighboring cells. With end users beginning from corporate insights facilities to youngsters with iPhones requesting higher transfer speed, the supplication for more current advances to pass on this transmission limit is superior to anything anybody may have expected sooner than. A lot of development exists for the transport of information exchange limit, with fiber optic connection thought to be the last transmission limit conveyance medium [2].In this manner each monetary related factor are considered when the fiber optics are not facilitated. Millimeter wave remote age exhibits the capacity to give transfer speed movement while like that of fiber optics however without the budgetary and strategic requesting circumstances of conveying fiber.

## II. BEAM SPACE AND BEAMFORMING IN MIMO

Beamspace MIMO maps independent information streams onto an orthogonal arrangement of essential capacities in the reception antenna far-field. A single antenna can be accustomed to communicating indistinguishable information from the two-antenna MIMO framework. This acknowledgment will be more than significant for future correspondence frameworks, then it is simpler to incorporate into equipment and it is less expensive. The radiation design is sub-isolated into two specific cases of beam using single receiving antenna. It depend on the amount of transmit and receive beam rather than that of accepting receiving antenna segments at MTX and MRX and to manufacture the transmission rate, capacity and the coverage zone [3].

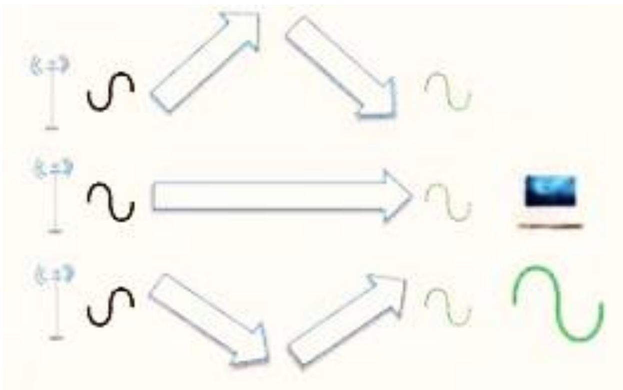

**Figure.1. With beamforming**

The Fig.1 demonstrates the beamforming method. The transmission of the signal is enhanced utilizing beamforming strategy in which the phase and amplitude of the exchanged signal are changed by the feedback procedure. On the off chance that a client introduce in a specific area and give benefit accurately to the client in specific area by utilizing some directional or array antenna. Without beamforming, a portion of the signal may lose amid communication due to the fact that the phase and amplitude of the signal is out of stage and they cancel out each other. Just frail signal reaches base at the goal. Fig.2 demonstrates the beam pattern without beamforming strategy.

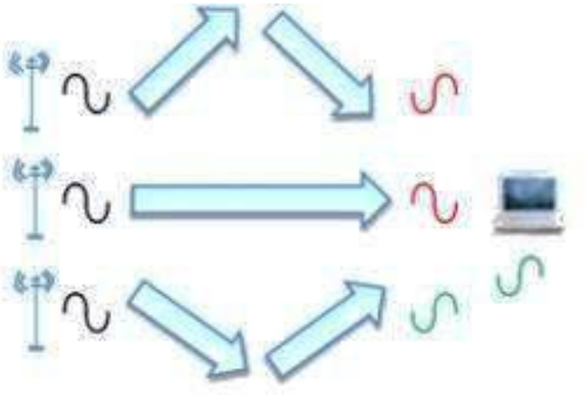

**Figure.2. Without beamforming**

In conventional Wi-Fi communications, a single receiving antenna is utilized at the transmitter, and another single reception antenna is utilized at the receiver. In a couple of occurrences, multi-path impacts are happened when the signal is transmitted from the transmitter to the receiver. At the point when the signal is transmitted, it takes different approaches to accomplish the objective because of a couple of deterrents which join slants, gorges, structures, and application wires, the wave fronts are scattered.Fig.3 demonstrates the multi cell massive MIMO.

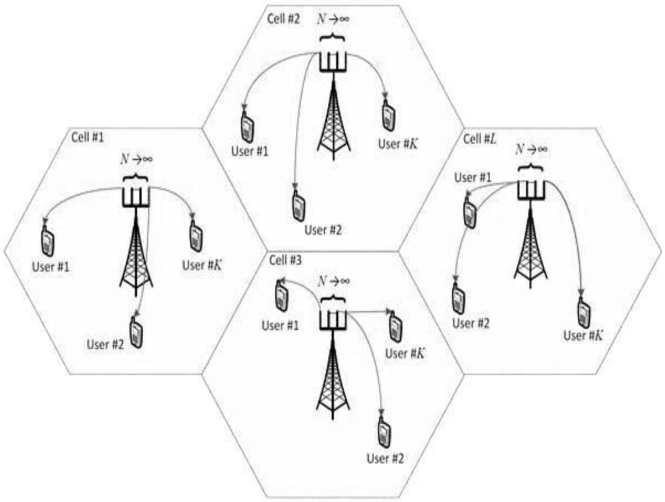


**Figure.3. Multi cell massive MIMO.**

Massive MIMO continues MIMO to the resulting stage. Generally MIMO include up to eight reception antenna on the base station and maybe a couple receiving antenna at the receiver. This licenses in inside the base station to simultaneously transmit 8 streams to eight unique clients or twofold down and drive two streams to 4 clients [4]. Huge MIMO changes with in excess of a few gathering reception antennas for giving capacities and favorable circumstances, for instance, upgraded farthest point and reliability, higher data rates and lower inactivity, fundamentally less between cell interference.

Beamforming frameworks are allowed to achieve more conspicuous profitability and better signal scope. MIMO is a radio gathering mechanical assembly advancement for improving the execution using more than one getting reception antenna. In MIMO, it impacts use of a more prominent measure of reception antenna on the transmitter and recipient to support an advancement of signals approaches to handover to the data, picking separate routes for each getting reception antennas to permit more than one signal approaches to be used. The general framework of MIMO appears in Fig.4.

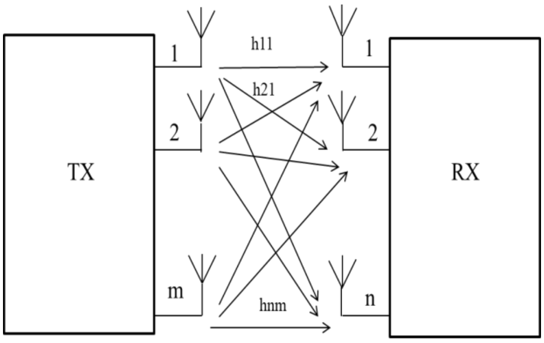


**Figure.4. General outline of MIMO**

## III.PROPOSED WORK

For future wireless framework, millimeter wave development is used to give high data rate, throughput, and spectral efficiency using beamforming technique, sub allocation frequency reuse strategy. Beamforming methodology is used to offer support of the customer particularly region for improving the propagation; and this framework is required at both the base station and recipient. In strict sub allocation frequency reuse methodology, the power factor esteem is fixed and in soft frequency reuse the power factor esteem is changed (i.e. B= 1, 2, 4, and 8) keeping in mind the end goal to reduce interference and to upgrade the execution estimations, for instance, data rate, spectral efficiency, throughput. The power control factor grants to exchange constrained power to the client. In case the client is inside the coverage range, constrained power control transmission happens. If it is used at the cell edge depends upon the location power control regard.

The end goal to additionally enhance the SINR and throughput for cell edge users, power control is done on the downlink.

$$P_m = \begin{cases} P_0 \text{ if m is a cell center user} \\ P_1 \text{ if m is a cell edge user} \end{cases} \quad (1)$$

Where,

$P_0 < P_1$.

For soft frequency reuse, the bandwidth for inner and outer region is

$B\_so_{in} = C_{sub} * (r/R)^2$ (2)

$B\_so_{out} = \min((C_{sub}/3), (C_{sub} - B\_so_{in}))$ (3)

Where,

$B\_so_{in}$ – The bandwidth of the soft frequency reuse in inner region.

$B\_{SO}_{out}$ – The bandwidth of the soft frequency reuse in the outer region.

$C_{sub}$ – sub carrier.

For strict sub allocation frequency reuse, the bandwidth for inner and outer region is

$B\_st_{in} = C_{sub} * (r/R)^2$(4)

$B\_st_{out} = (C_{sub} - B\_st_{in}) / 3$ (5)

Where,

$B\_st_{in}$ – The bandwidth of the strict SAFR inthe inner region.

$B\_st_{out}$– The bandwidth of the strict SAFR in the outer region.

R – Radius.

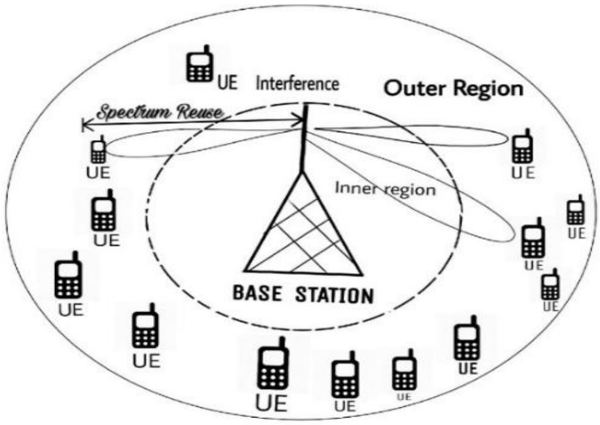


**Figure.5. Schematic diagram using SAFR techniques**

From the Fig.5, the cell is isolated into cell center and cell edge utilizing sub allocation frequency reuse. The base station is arranged at the cell center and the client hardware at the cell edge area. In beamforming, the base station sends the control signal and the client hardware respond to that base station by sending affirmation for giving high information rate utilizing sub allocation frequency reuse for upgrading the execution without interference. The frequency reuse factor is more important in cell edge client than the cell center, the true objective to diminish interference by utilizing effective range.

***POWER ALLOCATION IN MU-MIMO:***

Every client is equipped with various receive antenna and numerous information streams. The power allocation issues end up complex issue in multi-client network. It similarly transmits powers for all client-BS pairs disregard the basic need to scan for the ideal power allocation approach; based on the total rate maximization methodology, they don't yield the entire advantage of the system's aggregate power and the power is allocated among all the client-BS pairs in the system.

## IV.RESULTS AND DISCUSSION

The beam patterns of around measure up to beam width however unequal gain is appeared in Fig.6. The amplitude versus angle is estimated by the weight vectors at each phase at the transmitter or receiver. The narrow beam pattern delivered toward most extreme power utilizing beamforming method to maintain a strategic distance from interference. The most extreme peak signifies to the narrow beam to give high information rate to the client by using the spectrum effectively.

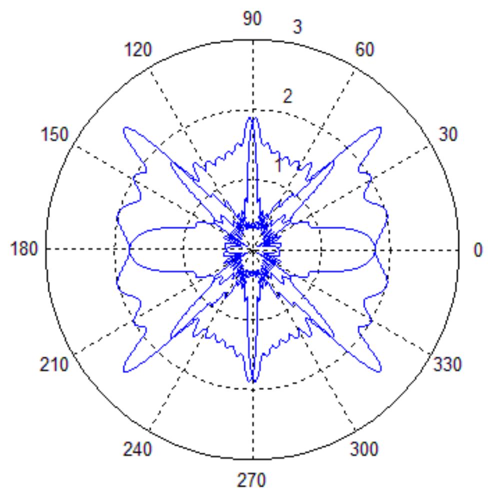


**Figure.6. Beam patterns according to weight vectors**

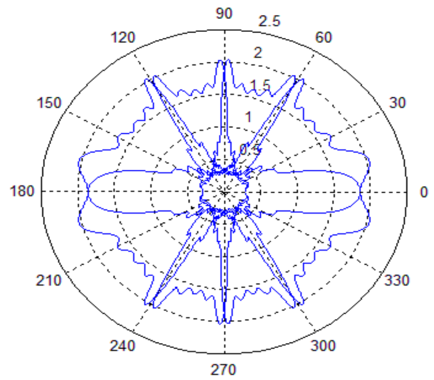


**Figure.7. Beam patterns according to weight vectors**

The amplitude versus angle is estimated at each phase of the weight vectors is appeared in Fig.7. The distinctive beam patterns result in dissimilar gain in various directions. The beam patterns of almost identical gain yet beam widths are more extensive on the end-fire and smaller on the broadside of the uniform linear array. In beamforming, the Sub Allocation Frequency Reuse strategies are utilized to stay away from interference and the beams is created toward most extreme power and give service to the client by using the spectrum effectively.

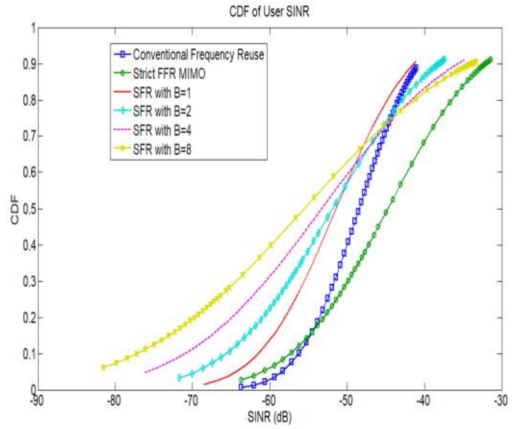


**Figure.8. CDF of user SINR**

The SINR in dB value is increased when the cumulative distribution function reaches to maximum value of 1 by utilizing the procedure strict Sub Allocation Frequency Reuse and by changing the power control value B=1,2,4,8 in soft frequency reuse. In strict SAFR, the power control value is fixed and provides better performance than the SFR.If the power control value is larger i.e., B=8, it increases the SINR value than the other value of B =1, 2, 4. Hence strict SAFR and SFR offer better performance than the conventional frequency reuse technique is shown in Fig.8.

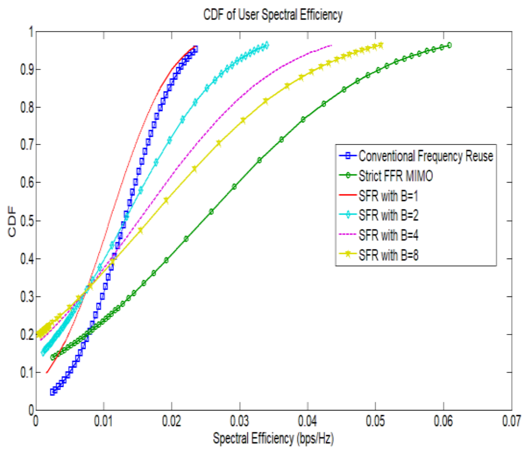


**Figure.9. CDF of user spectral efficiency**

From the Fig.9, the graph represents the CDF of user spectral efficiency. The spectral efficiency (bps/Hz) is increased slowly when CDF reaches to a maximum value of 1. The spectral efficiency is increased by varying the power control value i.e., B=1, 2, 4, 8 in soft frequency reuse and not in strict Sub Allocation Frequency Reuse technique. For low power control value B=1 gives less performance than the higher power control value B=2, 4, 8. In both strict SAFR and SFR, the spectral efficiency is increased than the conventional frequency reuse technique.

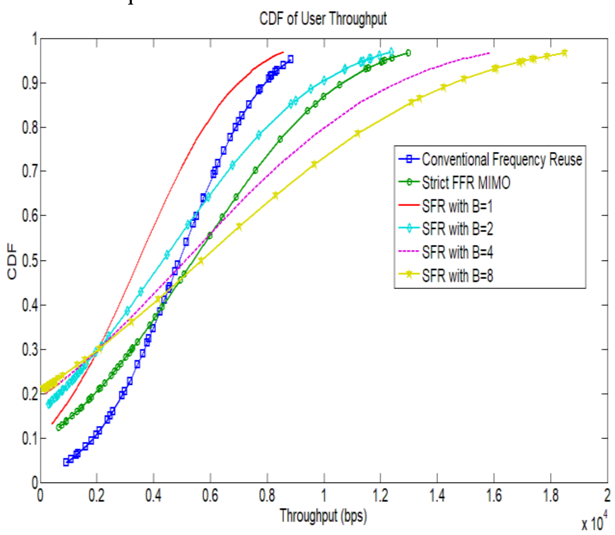


**Figure.10. CDF of user throughput**

From the Fig.10, the graph shows that the cumulative distribution function reaches to maximum value of 1. The throughput increases by varying the power control value of B=1, 2, 4, 8 in soft frequency reuse and in strict SAFR, the power control value is remain fixed. If the power control value is low i.e., B=1 it provide less performance than the high power control value B=2, 4, 8 in SFR. Therefore by utilizing the spectrum, the throughput is increased in strict SAFR and SFR than the conventional frequency reuse technique.

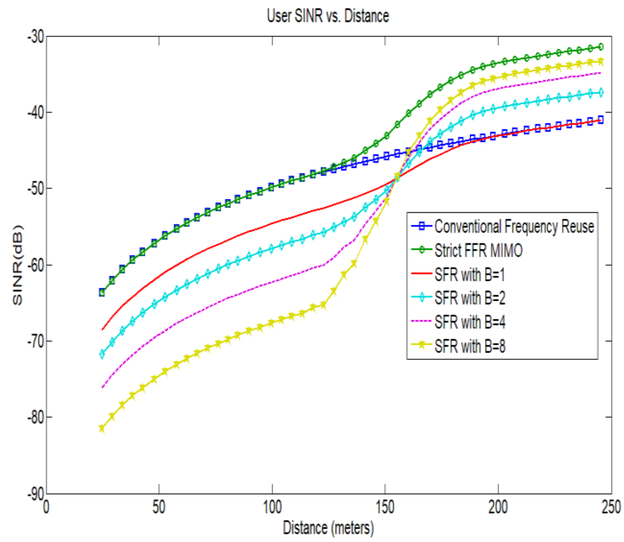


**Figure.11. User SINR vs. Distance**

From the Fig.11, the graph shows that the SINR value increases linearly with respect to the distance of 250 meters. Strict SAFR gives better SINR value than the SFR and SFR provides better SINR value by varying the power control value i.e., B= 1, 2, 4, 8 than the conventional frequency reuse technique. Therefore SINR value increases for a longer distance of 250 meters by efficiently using the spectrum to provide high data rate to the user without any interference.

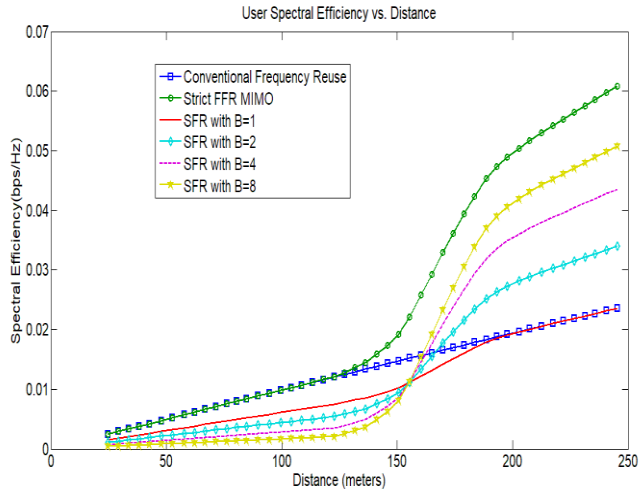


**Figure.12. User spectral efficiency vs. Distance**

From the Fig.12, the graph shows that the user spectral efficiency with respect to the distance. The spectral efficiency (bps/Hz) increases to a distance of 250 meters by varying the power control value in soft frequency reuse B= 1, 2, 4, 8. For higher power control value the spectral efficiency is improved in SFR. In strict SAFR the power control value is fixed and it gives the better performance than SFR and conventional FR technique. Hence the spectral efficiency is increased to a maximum distance of 250 meters to provide service to the uses without any wastage of spectrum and to avoid interference using strict SAFR and SFR.

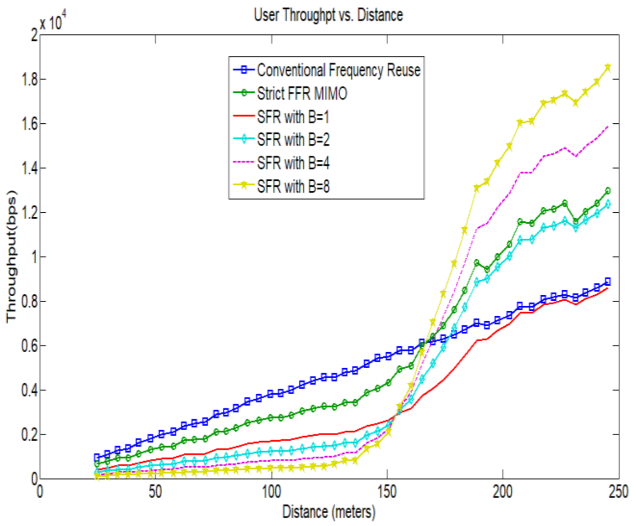


**Figure.13. User throughput vs. Distance**

From the Fig.13, the graph shows the user throughput with respect to distance. The throughput increases slowly to a maximum value with respect to the distance of 250 meters. Here the power control value of B=8, 4 in SFR provide maximum throughput than the strict SAFR and SFR with low power control value of B= 1, 2. Therefore the throughput increases to a maximum distance of 250 meters in both strict SAFR and SFR than the conventional frequency reuse technique. Compared to the strict SAFR, SFR provides better throughput value. From the Fig.14, the graph signifiesthe CDF of cell user throughput. The cumulative distribution function of cell total throughput is linearly increased and the CDF reaches to a maximum value of 1. The total throughput for each user is increased by using strict SAFR and SFR technique to avoid interference for providing high data rate to the user. Based on the power control value, the performance of the network such as throughput, spectral efficiency and SINR are improved in strict SAFR and SFR than the conventional frequency reuse technique.

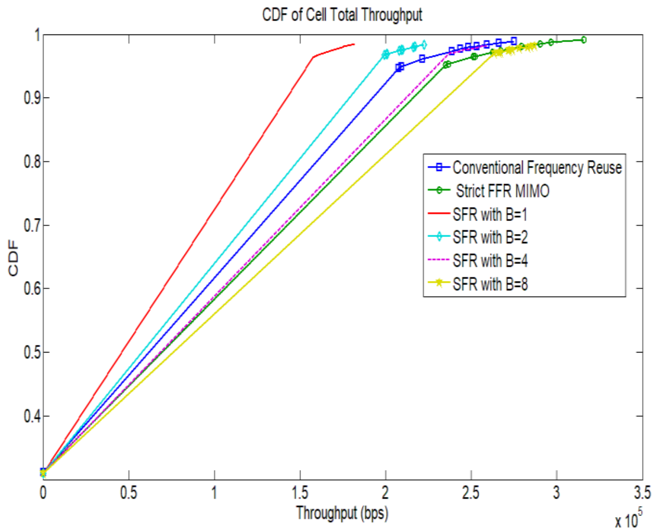


**Figure.14. CDF of cell total throughput**

## V.CONCLUSION

A network is designed with certain cells size and allocated sub band using sub-allocation frequency band for each users in a way to overcome interference, and to achieve good spectrum efficiency, Signal plus interference noise ratio, throughput maximization compared to the conventional frequency reuse. A mm Wave communication network with sub allocation frequency reuse (SAFR) have been proposed and executed with directional antennas to accomplish beamforming to client equipment's to achieve directivity and SAFR make the potential utilization of the spectrum in a proficient way to accomplish great spectrum efficiency, Signal plus interference noise ratio (SINR), throughput maximization contrasted with the conventional frequency reuse with mathematical model of cumulative distribution function CDF expecting the client accessible in an random environment, the simulation output have been inferred out.

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