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A Review On Spectral Efficiency In Wireless Networks

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Abstract: In the current wireless networks, massive Multiple Input Multiple Output (MIMO) plays a very important role for providing better services to users. Though there is a large demand in the wireless communication, at the same time there are issues in the wireless environment such as loss in signal energy, channel interference, difficulty in estimating the channel. These can be minimized in order to provide better quality of service for the wireless users. The wireless network service can be assessed by using the index called "Spectral Efficiency in massive MIMO networks. The MIMO system has been implemented by using large number of antennas as well as more user equipment. So it is necessary to understand the MIMO system with respect to the spectral efficiency under various channel conditions. In this paper, review will be done on the various technologies that are used in the wireless networks using spectral efficiency.

Key words: wireless networks, spectral efficiency, MIMO, massive, quality of service

1. Introduction:

Today wireless communication networks is rapidly changing with respect to the services it is providing to the users. The high data rate services are being provided by using the massive MIMO [1]. When the signals are transmitted wirelessly, then the signal will be weakened. It not only weakens but also loss in the energy and chances for various noise interferences. In these situations, the most common parameters that are used to assess the wireless network are the energy efficiency and spectral efficiency. But the spectral efficiency is has the importance when compared over the energy efficiency. To improve these two parameters, massive MIMO technique has been adapted in the wireless networks.

MIMO technology has become vital right from the third generation wireless networks [2]. This technology is still a topic of discussion among the research community for last 50 years. It

has the capability to work with the frequency below 6 GHz for the carrier frequency that supports for large number of Base Station (BS) antenna. If large carrier frequencies are chosen, then it is necessary go with large antenna arrays. The MIMO technology is a complex one with the choice of multi access technique, scheduling method, waveform representation for the signal, type of modulation scheme, antenna array design, coding techniques and safety issues. The architecture for the massive MIMO systems [2] is shown in fig.1.

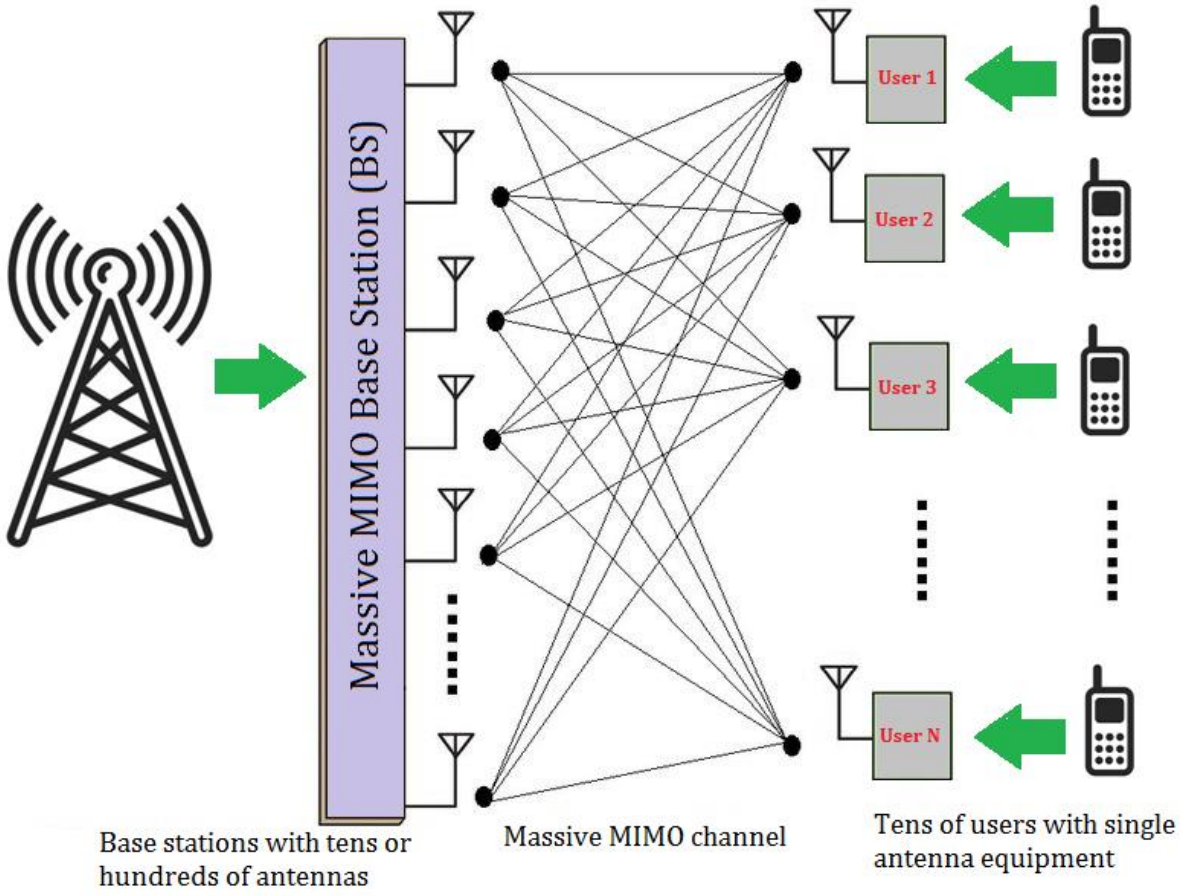

Fig.1: Architecture of Massive MIMO systems

Fig.1 shows that the multiple antennas are capable of serving more number of users at the same time. In fact, the base station hundreds of antennas that connects to tens of users with a single antenna.

The major challenges in the current wireless are increase in the mobile traffic, less availability of the network resources and more power consumption [3]. MIMO and the small cell are the two probable technologies for the future wireless networks to solve the issues in the current wireless networks. The massive MIMO technology can be adopted with the help of large number of antennas that are incorporated in order to provide the services to huge number of users. The reason behind the usage of large number of antennas is to increase the spectral efficiency. These

antennas are operated with frequency division duplex and time division duplex [4]. These are also causes additional overhead during communication.

The quality of service depends on the wireless channel conditions. To understand the data traffic, need to know the change in data traffic with respect to the years as shown in fig.2.

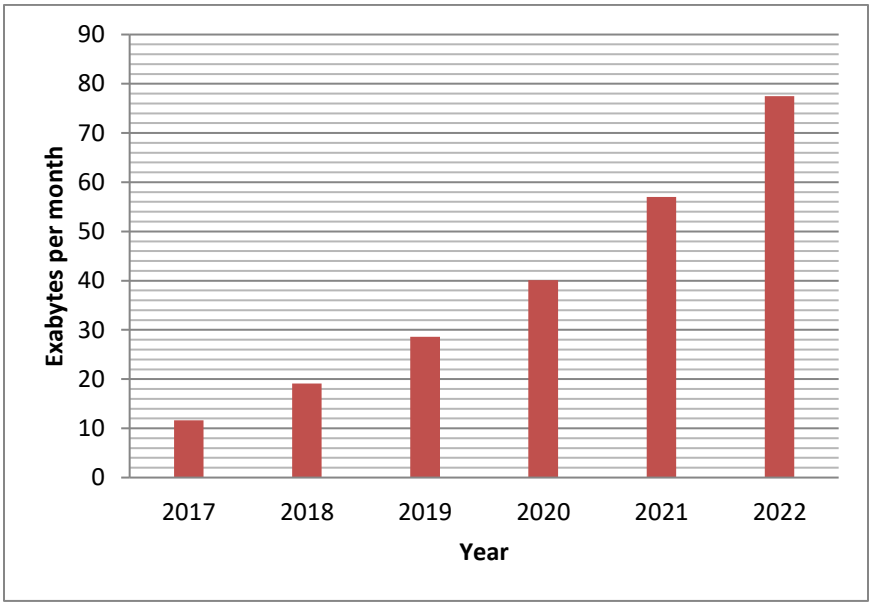

Fig.2: Forecast of user data traffic variation from 2017 to 2022 [5]

The rest of the paper is organized with the discussion on various techniques that are used to improve the spectral efficiency in MIMO technology, the scope in improving the spectral efficiency and then the conclusions of the manuscript.

2. Literature review:

In this section, various methods used to improve the spectral efficiency are discussed.

Satyasen panda proposed a method [6] for improving the spectral efficiency by using the algorithm called Joint Frame Allocation and User Matching (JFAUM). In this authors proposed the way that the pilot carriers are allocated as well as various matching techniques for clustering. Here, an uplink and downlink models have been developed that is based on the facts of channel models, number of users, number of antennas at the base station and movement of the users. But the problems with this method is, it has to be tested for various coding techniques, various carrier frequencies.

CH.Nishnathi, Ramamurthy proposed a method [7] in order to improve spectral efficiency as well as to decrease the latency in MIMO system. In this technique authors has proposed a method that uses massive MIMO system. But in this method there is a scope for the improvement in the spectral efficiency and reduced latency.

Zhang Xiu et al., proposed a method [8] for controlling the efficiency of the spectrum and to control the power in massive MIMO. In this authors have used ensemble method. This method is based on optimization of neighborhood field. To understand the concept and authors used different wireless networks. Spectral efficiency and power is observed with respect to cumulative distribution function. This method can be enhanced by using other ensemble methods for the improvement in the efficiency in the spectrum and power.

Chen Lei and Lu Zhang proposed a method [9] for the spectral efficiency analysis under Quality of service (QoS) constraint. In this method, authors have incorporated effective capacity theory of wireless networks. This paper discussed about the QoS requirements vs effective capacity, number of users vs effective capacity, QoS users vs optimal users. It has been observed from the simulation results that, the numbers of users are playing a predominant role, which means if the numbers of users are increasing the efficiency of the system is decreasing. Here, a model can be devised in order to improve the effective capacity and QoS of the system.

Hessam et al., proposed a method [10] to improve the spectral efficiency using one bit sigma delta sampling technique. In this, with the help of feedback technique the error is reduced and increasing the spectral efficiency. The problem with this technique is that, the results are assumed with the good CSI at the base station.

S Rajmane Rohan et al., proposed a method [11] for improvement in the efficiency of the spectrum in massive MIMO by using various array configurations. Here the performance is improved through suppressing the inter user interference that's been caused by the non orthogonality among channel vectors. But this work done only for single cell and it can be implemented for multi cell environment.

Xin, et al., proposed a method [12] for improving the efficiency of the spectrum in massive MIMO. Here the analysis is done over multi cell – multi user by taking the aging of channel. Here authors considering a channel model through a time varying channel. This method can be enhanced by analyzing aging channel for multi cell multiple antennas.

Francesco et al., proposed a method [13] for improving the efficiency of the spectrum in massive MIMO. In this authors used a triangular lattice arrays for improving the systems parameters. Here the operations are performed for various channels propagation scenarios. This method can be extended for large number of array elements.

Apart from the regular massive MIMO, it is obvious to use MIMO along with OFDM. Here some of the OFDM-MIMO methods that are used in massive MIMO will be discussed.

Narasaiah et al., proposed a method [14] for massive MIMO in 5G communications using OFDM technique. Here used a mechanism for data transmission valuable nip techniques and massive multiple foyer measures. In this method, the spectral efficiency can be improved by changing various channel coding techniques.

Chetana et al., proposed a method [15] for channel estimation in OFDM based massive MIMO system. This system uses a hybrid linear quadratic estimation technique for channel estimation. In the proposed method only mean signal to noise ratio and bit error rate has been used. This method unable to find the spectral efficiency and it can be done as a future work.

Hammed et al., proposed a method [16] for massive MIMO OFDM, which uses pre-coding, channel estimation, PAPR and error correcting codes. This is tested on 5G communication for the enhancement of its performance. In this technique, there is a scope for the use of various channel coding techniques that can bale to improve the spectral efficiency along with the other quality of service parameters.

Arun and saurabh proposed a method [17] that is based on different antenna configurations and its corresponding performance analysis is verified. In this author has used multi path propagation in combination with forward error correction mechanism. The coding technique used for testing the system performance is convolutional coding only. But there is a scope of using various coding mechanisms in order to verify the system performance.

Table 1: Comparison of various methods used in wireless networks

Authors	Method	Scope for enhancement
Satyasen panda	Joint Frame Allocation and User Matching (JFAUM)	Can be tested for various coding techniques, various carrier frequencies.
CH.Nishnathi & Ramamurthy	Improvement of spectral efficiency	There is a scope for decrease in latency and to improve spectral efficiency.
Zhang Xiu et al	Used optimization of neighborhood field	Can be enhanced by using various ensemble methods for improvement in spectral efficiency.
Chen Lei & Lu Zhang	It uses effective capacity theory of wireless networks	Can be tested by increasing the number of users to improve the effective capacity and QoS of the system
Hessam et al.	sigma delta sampling technique	The results are assumed with the good CSI at the base station.
S Rajmane Rohan et al.	suppressing the inter user interference	It is only for single cell and it can be implemented for multi cell environment.

Xin, et al.	the analysis is done over multi cell – multi user	It is not implemented for aging channel for multi cell multiple antennas.
Francesco et al.	Triangular lattice arrays for improving the systems parameters	This method can be extended for large number of array elements.
Narasaiah et al.	A mechanism for data transmission valuable nip techniques and massive multiple foyer measures.	The spectral efficiency can be improved by changing various channel coding techniques.
Chetana et al.	It uses a hybrid linear quadratic estimation technique for channel estimation	This method unable to find the spectral efficiency and it can be done as a future work.
Hammed et al.	It uses pre-coding, channel estimation, PAPR and error correcting codes	With the use of various channel coding techniques that can bale to improve the spectral efficiency along with the other quality of service parameters.
Arun and saurabh	With the use of different antenna configurations and its corresponding performance analysis is verified	By using various coding mechanisms in order to verify the system performance.

Conclusion:

This paper is concluded that, though there are a number of methods/techniques that has been proposed to improve the spectral efficiency. The massive MIMO system that uses more number of antennas is able to provide better services for the users with respect to quality of service. Massive MIMO system has been tested with the help of OFDM technique. Though, the performance was analyzed under various channel conditions. Most of the researches reveal that the major QoS parameters such as spectral efficiency, power, and noise cancellation, reduced inter channel interference and cross talk. Instead of all, there is a scope for improving the spectral efficiency of the system with various channel coding techniques along with the traditional massive MIMO that is based on OFDM system.

References:

[1]. Zhang, Xiu, et al. "Spectral efficiency improvement and power control optimization of massive MIMO networks." IEEE Access 9 (2021): 11523-11532.

[2]. Albreem, Mahmoud A., Markku Juntti, and Shahriar Shahabuddin. "Massive MIMO detection techniques: A survey." IEEE Communications Surveys & Tutorials 21.4 (2019): 3109-3132.

[3]. Chen, Lei, and Lu Zhang. "Spectral efficiency analysis for massive MIMO system under QoS constraint: an effective capacity perspective." Mobile Networks and Applications 26.2 (2021): 691-699.

[4]. Rajmane, Rohan S., and V. Sudha. "Spectral efficiency improvement in massive MIMO systems." 2019 TEQIP III Sponsored International Conference on Microwave Integrated Circuits, Photonics and Wireless Networks (IMICPW). IEEE, 2019.

[5]. Cisco, "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update," 2017–2022 White Paper, Tech. Rep., 2018.

[6]. Panda, Satyasen. "Spectral Efficiency Optimization of Massive MIMO System Under Channel Varying Conditions." Wireless Personal Communications 117.2 (2021): 1319-1335.

[7]. Nishanthi, C. H., and N. Ramamurthy. "Improving spectral efficiency and low latency in 5G framework utilizing FD-MIMO." Journal of Ambient Intelligence and Humanized Computing 12.7 (2021): 6955-6967.

[8]. Zhang, Xiu, et al. "Spectral efficiency improvement and power control optimization of massive MIMO networks." IEEE Access 9 (2021): 11523-11532.

[9]. Chen, Lei, and Lu Zhang. "Spectral efficiency analysis for massive MIMO system under QoS constraint: an effective capacity perspective." Mobile Networks and Applications 26.2 (2021): 691-699.

[10]. Pirzadeh, Hessam, et al. "Spectral efficiency of one-bit sigma-delta massive MIMO." IEEE Journal on Selected Areas in Communications 38.9 (2020): 2215-2226.

[11]. Rajmane, Rohan S., and V. Sudha. "Spectral efficiency improvement in massive MIMO systems." 2019 TEQIP III Sponsored International Conference on Microwave Integrated Circuits, Photonics and Wireless Networks (IMICPW). IEEE, 2019.

[12]. Xin, Yuanxue, et al. "Spectral efficiency analysis of multi-cell multi-user massive MIMO over channel aging." IET Communications 14.5 (2020): 811-817.

[13]. Dicandia, Francesco Alessio, and Simone Genovesi. "Exploitation of triangular lattice arrays for improved spectral efficiency in massive MIMO 5G systems." IEEE Access 9 (2021): 17530-17543.

[14]. Naraiah, R. "Spectral efficiency improvement techniques in massive mimo for 5G communications." Turkish Journal of Computer and Mathematics Education (TURCOMAT) 12.2 (2021): 1457-1465.

[15]. Chetana et al., "A Hybrid Linear-Quadratic Estimation (LQE) Technique for Channel Estimation in MIMO-OFDM System." International Journal of Intelligent Engineering and Systems, Vol.14, No.6, 2021: 453-463.

[16]. Hammed, Zainab Sh, Siddeeq Y. Ameen, and Subhi RM Zeebaree. "Massive MIMO-OFDM Performance Enhancement on 5G." 2021 International Conference on Software, Telecommunications and Computer Networks (SoftCOM). IEEE, 2021.

[17]. Agarwal, Arun, and Saurabh N. Mehta. "Design and performance analysis of MIMO-OFDM system using different antenna configurations." 2016 International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT). IEEE, 2016.