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BER and Spectrum Efficiency Analysis of Downlink-Uplink NOMA System using Spectrum Sensing

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Abstract: Exploring NOMA for regular downlink and uplink frameworks, the utilization of NOMA is examined in downlink multiuser numerous information different yield (MIMO) frameworks, by proposing a novel MIMO-NOMA model with direct beamforming method. In this MIMO-NOMA framework, clients' get receiving wires are progressively assembled into various disjoint bunches, and inside each group a solitary bar is shared by all the get reception apparatuses those embrace NOMA. In this paper, the design of MIMO-NOMA system using Sensing Cognitive Radio Network is presented. A spectrum-sensing method is detects the free portions of the primary user's spectrum and allocates it to secondary users. It derives from cross-correlating an unknown signal with known ones to detect the unknown signal's presence based on the basis of its Signal to Noise Ratio (SNR). Accordingly, an efficient scheme is developed here that is having better SNR vs Bit Error Rate (BER), SNR vs spectrum efficiency against a different MIMO-NOMA system.

***Index Terms* – NOMA, Fifth Generation, Spectral Efficiency, 5G Wireless System**

I. INTRODUCTION

To guarantee the maintainability of portable correspondence benefits in the coming decades, new innovation arrangements are being looked for the fifth era (5G) and past 5G (B5G) cell frameworks. In the perspective on the foreseen exponential development of portable traffic, these advances are relied upon to give critical gains in the ghostly productivity (and consequently framework limit) and improved nature of client experience (QoE).

In this unique situation, non-symmetrical numerous entrance (NOMA) is considered as a promising various access innovation for 5G frameworks. By planning numerous clients over same range assets however at various power levels, NOMA can yield a noteworthy otherworldly proficiency gain and upgraded QoE when contrasted with customary symmetrical different access (OMA) frameworks.

The essential rule of NOMA is to all the while serve various clients over same range assets (for example time, recurrence, code and space) yet with various power levels, to the detriment of insignificant between client obstruction [1]. As opposed to traditional symmetrical numerous entrances (OMA), where each client is served on solely designated range assets; NOMA superposes the message sign of various clients in power area at transmitter end(s) by misusing the clients' separate channel gain [2]. Progressive obstruction abrogation (SIC) is then connected at the recipient (s) for multiuser location and translating. For a model, let us consider a downlink NOMA transmission where the base station (BS) plans m clients over a similar range assets B. Let additionally accept that the message signal for I-th client is si where E[|si|2] = 1, and transmit power is pi. At that point the superposed sign at transmitter end could be communicated as:

$$X = \sum_{i=0}^{m} \sqrt{p_i s_i} \tag{1}$$

Where $\sum_{i=0}^{m} p_i \le p_i$ for BS total transmit power budget of p_i. On the other hand, the received signal at i-th user end could be expressed as:

$$y_i = h_i X + w_i \tag{2}$$

Where h_i is the intricate channel gain between clients I and the BS. The term w_i indicates the recipient Gaussian clamor including the between cell impedance at the i-th client's collector [3, 4].

II. ADVANTAGE OF NOMA

High range proficiency:
Range proficiency is one of the very much acknowledged exhibition measurements in remote systems. NOMA shows a high range productivity to improve the total framework throughput, which is credited to the way that NOMA permits one asset square (RB) (e.g., time/recurrence/code) to be involved by various clients [5].

Reasonableness throughput tradeoff:
One key element of NOMA is to distribute more capacity to the feeble client, which is not the same as the regular mainstream control assignment (PA) strategies, for example, water filling PA1. Thusly, NOMA is equipped for ensuring a decent tradeoff between the reasonableness among clients and framework throughput [6].

Ultra-high availability:
The future 5G frameworks are imagined to help the association of billions of savvy gadgets (e.g., Internet of Things (IoT)). The presence of NOMA offers a promising way to deal with proficiently tackle this non-unimportant assignment by completely abusing the non-symmetrical trademark. All the more explicitly, dissimilar to traditional symmetrical different access (OMA) which requires equivalent number of RBs to help these equivalent number gadgets; NOMA can serve them with involving significantly less RBs [7].

Great similarity:
From the theoretic viewpoint, NOMA can be an "add-on" procedure to any leaving OMA systems (e.g., TDMA/FDMA/CDMA/OFDMA), because of the way that it misuses another power measurement. Likewise, with the develop improvement of superposition coding (SC) and SIC innovations both in principle and practice, it is promising that NOMA is equipped for accomplishing great similarity with the current MA procedures.

Open adaptability:
Contrasted with other existing methods for MA, for example, multiuser shared access (MUSA), design division different access (PDMA), inadequate code various access (SCMA), NOMA gives a simple understanding and low multifaceted nature structure [8]. Truth be told, the key guideline of the previously mentioned MA plans and NOMA are fundamentally the same as, which is to allot various clients in a solitary RB. Taking the examination of NOMA and SCMA for instance, SCMA can be viewed as a created innovation of NOMA which incorporates fitting inadequate coding, adjustment and subcarrier portion.

III. 5G TECHNOLOGY

Radio technology has rapid evolution in analogue cellular system in 1980s. After analogue system digital wireless communication system comes to fulfil the increasing need of humans being. Voice and message services introduce in 1990s and mobile broadband and long term Evolution introduced in 2010.

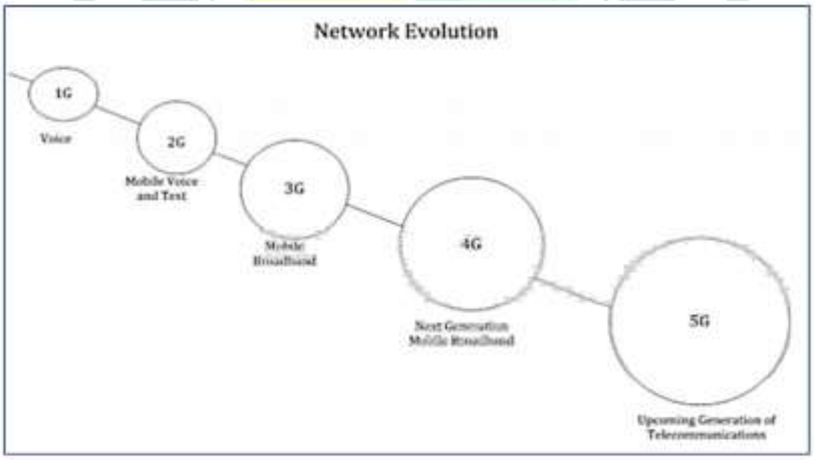

Fig. 1: Development in 5G System

After that in telecom industries demanding for mobile data and high speed services so they required to develop new generation of telecommunication system. That new generation is called Fifth generation technology. Here we discuss about the features, architecture, advantages, challenges and future scope of 5G technologies.

Each generation comes up with new ideas and introduces new services. First generation introduces voice; second generation comes up with mobile voice and text. In third generation use mobile broadband and a fourth generation is called Long Term Evolution. In 4G, all advanced features are introduced. Fifth generation, future of technology brings tremendous changes in technology. In the future, data transmission rate gets speedier as compare to previous technology similar improvement done in quality of services. 5G is based on IEEE802.11ac broadband standard. Some technological innovative done in this generation, such as Internet of Things (INTERNET OF THINGS) which is expected in 2020.Number of devices are connected to each other through the network. User equipment like smart phones or tablet can be replaced by smart devices.

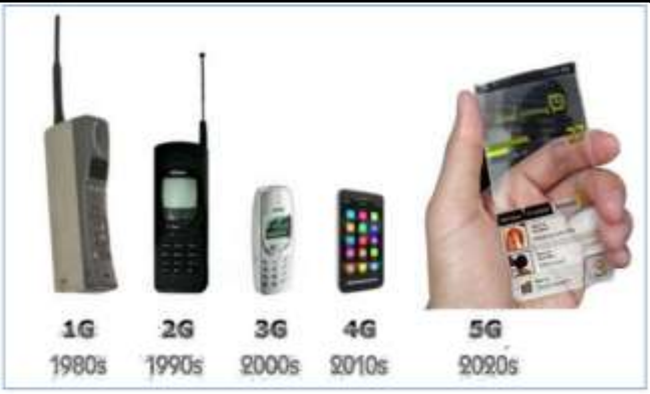

Fig. 2: Various Hand-set used in all Generation

This thesis tells about evolution of communication technology in each generation, detailed study of LTE, detailed 5G frame work and explanation of various applications of 5G. With examples and detailed analysis it is proved that the data transmission in 5G is much better than 4G in terms of connectivity, there is relatively less end to end delay and it has enhanced packet delivery ratio. Various applications that will become popular in 5G technology are also discussed in detail. Many research laboratories and many mobile companies are examining new possible standards for new upcoming technology which nothing but 5G network to overcome disadvantages of 4G or LTE.

FEATURE OF 5G TECHNOLOGIES

Feature of 5G technology is much more than other cellular technology. It has ultra-high speed. Because of ultra-high speed, it changes the scenario in cellular world. With these innovative features your smart phone is similar to your laptop. Broadband connection can used in smart phone, available variety gaming options, broad multimedia option, you can connect every ever. Other most important feature is low latency, faster response time and high quality picture can be transferred from one cell phone to another cell phone without disturbing and with quality of video and audio.

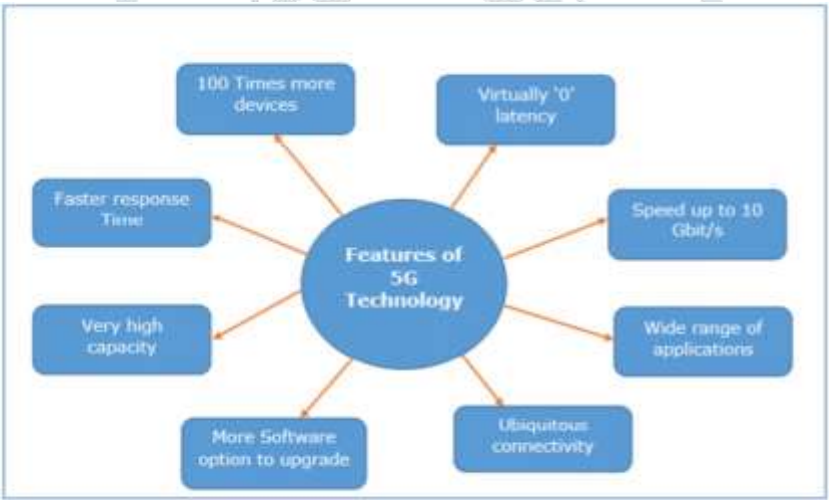

Fig. 3: Feature of 5G technology

IV. SPECTRUM SENSING

A major challenge in cognitive radio is that the secondary users need to detect the presence of primary users in a licensed spectrum and quit the frequency band as quickly as possible if the corresponding primary radio emerges in order to avoid interference to primary users. This technique is called spectrum sensing. Spectrum sensing and estimation is the first step to implement Cognitive Radio system [5]. We can categorize spectrum sensing techniques into direct method, which is considered as frequency domain approach, where the estimation is carried out directly from signal and indirect method, which is known as time domain approach, where the estimation is performed using autocorrelation of the signal. Another way of categorizing the spectrum sensing and estimation methods is by making group into model based parametric method and period gram based nonparametric method. In this case, the detection of primary users is performed based on the received signal at CR users. This approach includes matched filter (MF) based detection, energy based detection, covariance based detection, waveform based detection, cyclostationary based detection, radio identification based detection and random Hough Transform based detection.

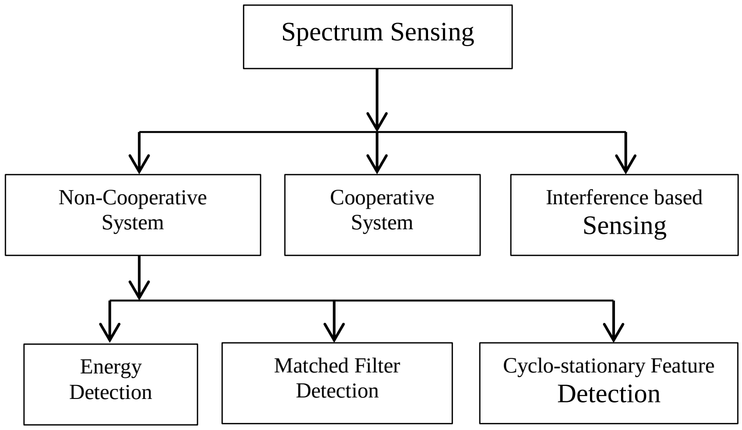

Fig. 4: Classification of spectrum sensing techniques

In this approach, the primary signals for spectrum opportunities are detected reliably by interacting or cooperating with other users, and the method can be implemented as either centralized access to spectrum coordinated by a spectrum server or distributed approach implied by the spectrum load smoothing algorithm or external detection. Figure 4 shows the detailed classification of spectrum Sensing techniques. They are broadly classified into three main types, transmitter detection or non-cooperative sensing, cooperative sensing and interference based sensing. Transmitter detection technique is further classified into energy detection, matched filter detection and cyclostationary feature detection [12]. There are a number of ways in which cognitive radios are able to perform spectrum sensing.

V. PROPOSED METHODOLOGY

In this purposed CoMP-NOMA model for downlink transmission, CoMP transmission is utilized for clients encountering solid get signals from numerous phones under a downlink co-channel homogeneous system. Different CoMP plans are connected to the CoMP-clients encountering between cell obstruction under two-cell coMP set, while disseminated control portion for NOMA clients is used in each planning cell. This model initially decides the clients requiring CoMP transmissions from numerous phones and those requiring single transmissions from their serving cells. From that point onward, unique NOMA bunches are framed in individual cells in which the CoMP-clients are grouped with the non-CoMP-clients in a NOMA group.
In the proposed CoMP-NOMA model, I use the NOMA throughput equation in an unexpected request in comparison to past parts however the working rule is actually same. Here, in every NOMA group, the CoMP-clients are characterized earlier than the non-CoMP-clients in any case their separate channel gains, so as to guarantee the bunching of a CoMPuser at various cells in a the CoMP set. First I characterize the feasible throughput for a NOMA client as indicated by their deciphering request under the proposed COMP-NOMA model. From that point forward, various CoMP plans are talked about thinking about single radio wire BS and client gear (UE), and recognize their pertinence for a NOMA-based transmission model.
Give us a chance to accept a downlink NOMA group with n clients and the accompanying unraveling request: UE1 is decoded first, UE2 is decoded second, etc. Along these lines, UE1's sign will be decoded at all the clients' closures, while UEn's sign will be decoded distinctly at her own end. Since UE1 can just disentangle her own sign, it encounters the various clients' sign as obstruction, while UEn can translate every one of clients' sign and evacuates between client impedance by applying SIC. Accordingly, the reachable throughput for the I-th client can be composed as pursues:

$$R_i = B\log_2(1+\frac{p_i y_i}{\sum_{j=i+1}^{n} p_i y_i + 1}) \tag{3}$$

Where y is the standardized channel gain as for commotion control thickness over NOMA transmission capacity Bi, and pi is the assigned transmit control for UEi. The important condition for power portion to perform SIC is:

$$(p_i - \sum_{j=i+1}^{n} p_j)\ \ y_j \geq p_{tol} \tag{4}$$

We implemented our circuit (Figure 4) in MATLAB software, with the main parameters described below. We generated a random binary signal in a serial manner. To analyses a signal in the time domain, we apply IFFT (Inverse Fast Fourier Transform) and convert it from parallel to serial NOMA signal to Add a cyclic prefix (CP), which helps avoid interference between OFDM symbols. We then feed this signal through an Additive White Gaussian Noise (AWGN) channel. At the receiver end, the CP is removed and the signal converted from serial to parallel to get the original, with FFT applied to each symbol for analysis in the frequency domain. After demodulation, the signal is cross correlated with that of a time-shifted local oscillator.

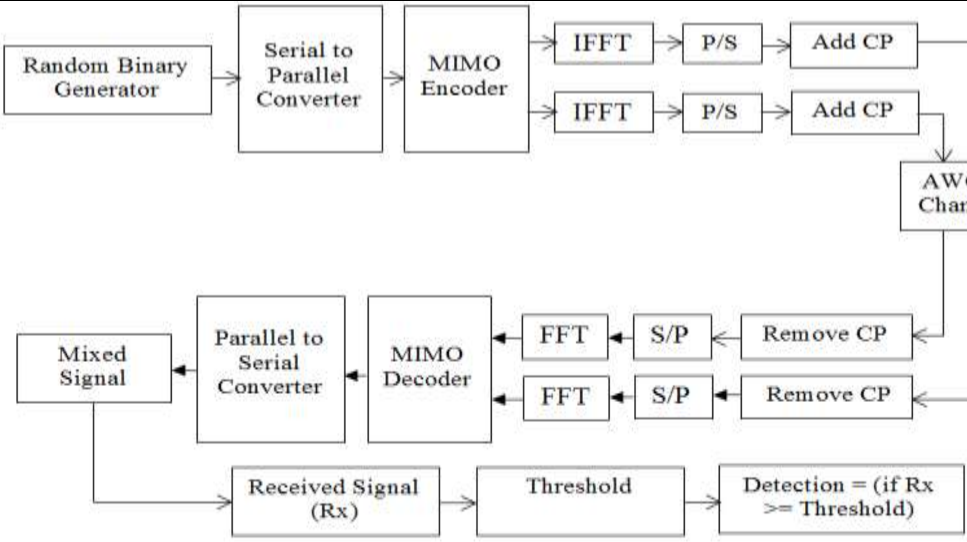

Fig. 5: Design of MIMO-OFDM System using Compressive Sensing Cognitive Radio Network

VI. RESULTS AND DISCUSSION

In Massive MIMO-NOMA system, a bit error rate (BER) and spectrum efficiency estimator is an cognitive radio network which minimizes the BER and increase the spectrum efficiency.
The bit error rate of massive MIMO system are defined by the following equations

$$BER = \frac{1}{2}\left(1 - \sqrt{\frac{E_b/N_0}{E_b/N_0 + 2}}\right) \quad (5)$$

E_b/N_o is the relation between symbol energy and the bit energy of the signal.

Spectral efficiency usually is expressed as "bits per second per hertz," or bits/s/Hz. In other words, it can be defined as the net data rate in bits per second (bps) divided by the bandwidth in hertz.

$$SpectrumEfficiency = Bits/\sec/Hz \quad (6)$$

Figure 6 shows the simulation results using four transmit antenna and four receive antennas which provide the matched filter detection spectrum sensing MIMO system. It is observed that transmit diversity has a 3 dB disadvantage when compared to MRC receive diversity. From the analysis of MIMO system, the 32x32 antenna combination gives a minimum bit error rate.

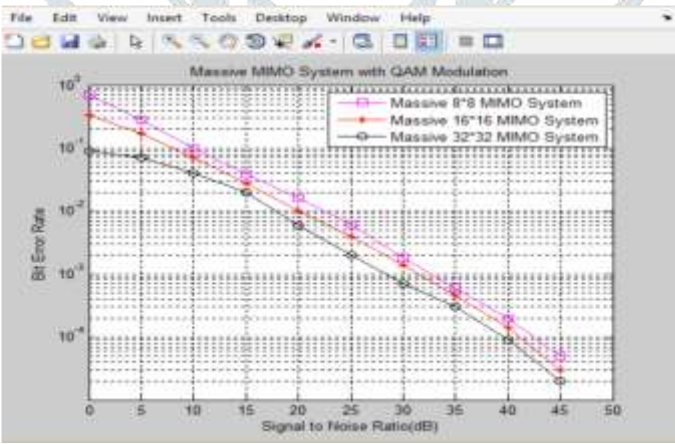

Fig. 6: BER vs SNR for Compressive Spectrum Sensing Different System

As shown in figure 7 and figure 8 the spectrum efficiency result are obtained for the implemented 16×4 single and five user compressive spectrum sensing algorithm and previous algorithm**.** From the analysis of the results, it is found that the proposed compressive spectrum sensing algorithm gives a superior performance as compared with previous algorithm.

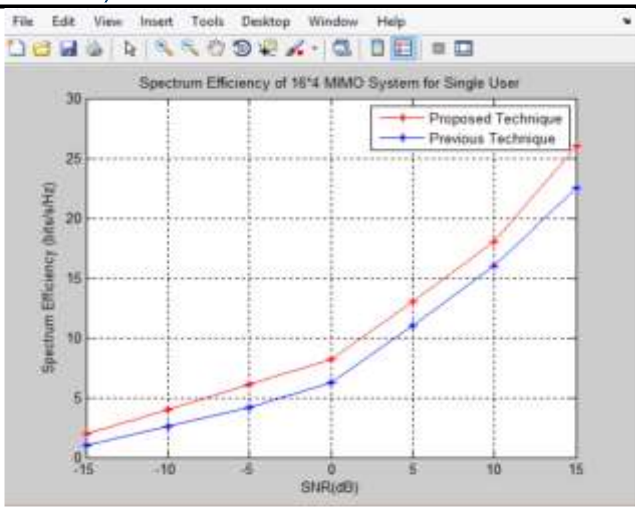

Fig. 7: Comparison Result for Previous and Proposed Sensing Technique of 16×4 MIMO System with Single User

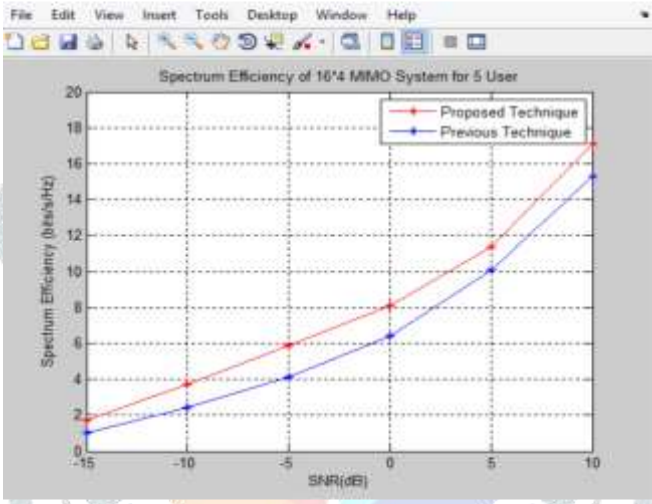

Fig. 8: Comparison Result for Previous and Proposed Sensing Technique of 16×4 MIMO System with Five User

As shown in figure 9 and figure 10 the spectrum efficiency result are obtained for the implemented 64×16 single and five user compressive spectrum sensing algorithm and previous algorithm.

The effectiveness of network is enhanced due to interfacing of routing and allotment of channel is predominant extent of the work. The benefit is to determine the discrepancy among the cost to meet a demand and the sales got from request met. To enhance the effectiveness, the price of the scheme to calculate the path and determination for spectrum allocation must be decreased.

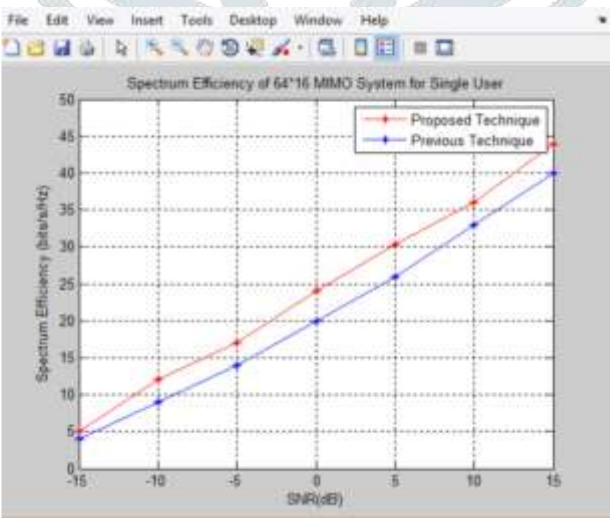

Fig. 9: Comparison Result for Previous and Proposed Sensing Technique of 64×16 MIMO System with Single User

From the analysis of the results, it is found that the proposed compressive spectrum sensing algorithm gives a superior performance as compared with previous algorithm.

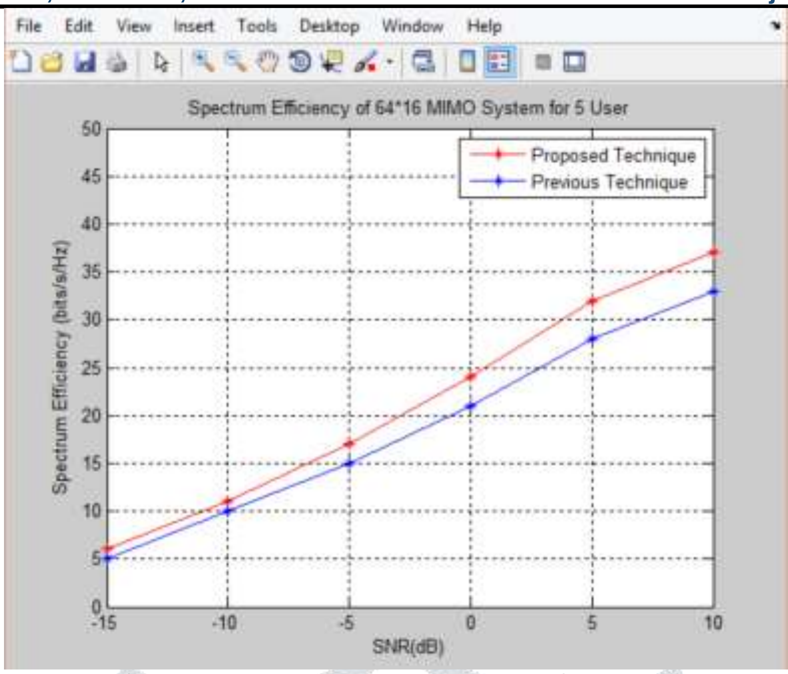

Fig. 10: Comparison Result for Previous and Proposed Sensing Technique of 64×16 MIMO System with Five User

VII. CONCLUSION

The channel distribution is primarily based upon spectrum benefit that is the discrepancy among the recompense to meet the demand and the corporal price. The dissimilarity is considered as fee to allocate the channel. If the fee is advantageous, the channel may be allocated else no longer. After allocating the channel if the primary user enters into the channel once more the fee is evaluated and channel allocation could be revised. If the spectrum is burdened, affiliation with secondary user might be disconnected and transported to another direction if reachable. This will enhance spectrum utility.

Convolution does essentially with two functions that it places one function over another function and outputs a single value suggesting a level of similarity, and then it moves the first function an infinitesimally small distance and finds another value. The end result comes in the form of a graph which peaks at the point where the two images are most similar. The matched filter is the optimal linear filter for maximizing the Signal to Noise Ratio (SNR) in the presence of additive White Gaussian Noise. The performance of implemented method including wireless communication is better as compared to the previous technique algorithm.

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