MU-MIMO Scheme: Single Layer Multi-User Transmission

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Abstract **—**Energy efficient multiple-input multiple-output (MIMO) with beamforming is one of the splendid ways to increase throughput in wireless networks. The existing schemes have focused on multi layer for multi-user. However, when multi layers for multi-user is implemented on wireless networks the system performance degrades in term of energy consumption, time and processing. The single layer multi-user downlink transmission method is proposed in this paper to provide multi-user data handling through single layer transmission, to minimize the existing challenges. The MIMO spatial diversity and multiplexing gain abilities are used to transmit multi-user data through a single layer transmission. The minimum mean square error (MMSE) and zero forcing (ZF) equalizers with successive interference canceller are used at the receiver site to extract the appropriate user information. The beneficial outcomes of the proposed strategy are to reduce the beamforming layer processing time and to enhance the multiuser downlink throughput. The proposed scheme is evaluated between proposed beamforming (Pr-BF) and existing beamforming (Ex-BF) transmission with 16 and 64 quadrature amplitude modulation (QAM) techniques like bit error rate (BER) and signal to noise ratio (SNR). Simulation results illustrate that the proposed multi user MIMO scheme has better BER performance and smooth multi-user transmission in single layer.

Index Terms**—**MU-MIMO, single layer multiple users, V-BLAST, energy efficient network.

I. Introduction

Over the preceding era, the requirements of higher data rate have increasing in wireless networks. Currently, network technologies are growing rapidly towards higher data rate requirements. Hence, the enhancement of data rate has become a very challenging issue in wireless networks. In wireless communication, multiple-input multiple-output (MIMO) technology matured significantly and thus provides spectacular enhancement in terms of performance of data channel(s) [1]. A multi user MIMO (MU-MIMO) system is a key technology of the MIMO networks to improve the quality of channel capacity through the benefits of diversity gain and spectral efficiency [2]. Latest technologies like worldwide interoperability for microwave access (WiMAX), long term evolution (LTE) and LTE-Advanced (4G) require new hardware to fulfill high-speed data rate necessities, where MIMO has tremendous throughput performance, through spectrum efficiency, which provides higher data rate with similar power intensity. The MIMO system is used to considerably raise the bit rate [3], [4], in order to get the spare space diversity that takes the advantage of random beamforming. Opportunity or random beamforming is the combination of transmitting beamforming with multi-user diversity [5], which can enhance the overall throughput by minimum feedback information.

The existing techniques improve the downlink throughput by managing various factors, such as, interference, delay and processing time. The intended novel opportunity beamforming method for downlink MU-MIMO was explained in [6], to develop efficient multiple user diversity and spatial multiplexing gain. To enhance the bit-rate and reduce processing delay, state-of-the-art multi-user common channel and antenna diversity are exploited for interference void. The layered random beamforming is an extended version of the random beamforming, which is designed for getting further multiple accesses via allocating multiple layers to alienate and assign the same to multi-users, concurrently [7]. However, [8] uses the single beam Opportunistic Co-phasing System (OCS) for multi-user, which confers with respect to throughput scheme on average, based on maximizing signal-to-noise ratios (SNRs) of all users. This scheme considers the SNRs based on selected users inside the single cell, for phase randomization, with constant amplitude transmission through all transmitting antennas. The single transmission for multiple users was discussed in [9], through deviation of transmitting antenna setting for a single antenna receiver, in the single cell scenario. Jiang *et al*. [10] proposed a transmission scheme (Single transmission for multiple users) with a novel codec and modular/de-modular method, by merging geometric mean decomposition (GMD) with conventional zero forcing vertical-bell laboratories layered space-time (ZFV-BLAST) decoder or the zero forcing dirty paper pre-coder (ZFDP), that can provide several indistinguishable parallel sub-channel schemes for MIMO. Most of the existing works are based on single cell multi-user approach and antenna diversity scheme. Hence, there is a need of single beam multi-user approach to reduce the delay and further enhance the throughput. Recently, MU-MIMO has been used for achieving intended capacity with higher levels of service by multiplexing gain. In this content, diversity gain and

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beamforming gain, with vertical-bell laboratories layered space-time (V-BLAST), has been investigated [11], [12].

In order to reduce the above mentioned limitations, deploying novel schemes is an intuitive way to make an energy efficient wireless network. However, to achieve better performance one needs to determine types of techniques, like reduction/avoidance method. Therefore, a single beam multi-user scheme is proposed in this paper. This scheme can reduce the delay and increase the data capacity by sharing the common channel between multiple users concurrently. In addition, antenna spatiality is used for interference voiding in single beam multi-user scenario. The major goal of this theme is to focus on downlink MU-MIMO with multi-user in single beamforming layer, to give an energy efficient wireless network. The proposed scheme is based on key features of the following techniques: water filling algorithm to provide constant energy, spatial multiplexing gain over fading channel through V-BLAST architecture and minimum mean square error (MMSE) & zero forcing (ZF) equalization, with successive interference cancellation to extract required information for each user at receiver site.

The rest of the paper is organized as follows. Section II describes the proposed system model. The features of key technology used in proposed scheme are conferred in Section III. Methodology of proposed solution is briefly explained in Section IV, simulation results are explained in Section V and finally conclusion is end up in Section VI.

II. System Model

The system model of the MU-MIMO scheme is discussed to accommodate the multi-user in single beamforming pattern. In this scenario, constant power transmission with V-BLAST supports multiplexing gain in MIMO channel and beamforming transmission to suppress the interference and to improve the bit error rate.

The scheme is designed in accordance with the following parameters: transmitter antennas (A_1, A_2), users (U_1, U_2) and receiving antennas (R_1, R_2). Users equipped with receiving antennas (R_1 for U_1, R_2 for U_2) for constant constellation data stream sequence S_1, S_2 for U_1, U_2 respectively.

Here, assuming that the channel is flat fading for the *j*-th transmit antenna to the *i*-th receive antenna, where each transmitted symbol gets multiplied by a randomly varying complex number $h_{i,j}$. As the channel under consideration is usually a Rayleigh channel, the real and imaginary parts of $h_{i,j}$ are Gaussian distribution with mean $\mu_{h_{i,j}} = 0$ and variance $\sigma^2_{h_{i,j}} = 0.5$ [13]. At the receiver site, the noise, g, has the Gaussian probability density function with

$$P(n) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{\frac{-(n-\mu)^2}{2\sigma^2}} \tag{1}$$

where $\mu = 0$ and $\sigma^2 = N_o/2$.

The $h_{i,j}$ identifier at the receiver channel and the received signal on the R_1 antenna are defined as

$$Z_1 = [h_{1,1} h_{1,2}] \begin{bmatrix} S_1 \\ S_2 \end{bmatrix} + g_1 \tag{2}$$

and the R_2 antenna received signal is

$$Z_2 = [h_{2,1} h_{2,2}] \begin{bmatrix} S_1 \\ S_2 \end{bmatrix} + g_2 \tag{3}$$

Assume that the receiver knows $h_{1,1}$, $h_{1,2}$, $h_{2,1}$ and $h_{2,2}$. The receiver also knows Z_1 and Z_2, but S_1 and S_2 are unknown. Then equations (2) and (3) can be signified in matrix notation as follows

$$\begin{bmatrix} Z_1 \\ Z_2 \end{bmatrix} = \begin{bmatrix} h_{1,1} & h_{1,2} \\ h_{2,1} & h_{2,2} \end{bmatrix} \begin{bmatrix} S_1 \\ S_2 \end{bmatrix} + \begin{bmatrix} g_1 \\ g_2 \end{bmatrix} \tag{4}$$

Equivalently

$$Z = \mathbf{H}S + g \tag{5}$$

where Z is noisy and RR-dimensional received vector, H is $R_r \times N_A$ flat fading channel with entries $h_{i,j}$ that are assumed as i.i.d and N_A is number of transmit antennas and R_r represents the number of receiver antennas., Complex Gaussian random variable with zero-mean and unit variance E $[|h_{i,j}|^2] = 1$, S is N_A-dimensional transmit vector $\in S^N$ which is assumed to be spatially uncorrelated and uniformly distributed, complex random vector process with zero-mean and variance σ^2_s(*i.e.* R_{SS} = E $[SS^H] = \sigma^2_g \mid N_A$), g is the noise vector with dimension $R_r \times 1$ drawn from $(0, \sigma^2_g)$, or Rgg = E $[gg^H] = \sigma^2_g \mid R_r$).

The structure of zero forcing equalization and minimum mean square error equalization with MIMO were discussed in [14]. The zero forcing approach tries to find a matrix, W, satisfying WH = 1. The ZF linear detectors for meeting this constraint is given by

$$W = (H^H H)^{-1} H^H \tag{6}$$

The MMSE approach tries to find a coefficient matrix, W, which minimizes the criterion

$$E\{[W_{Z-S}][W_{Z-S}]^H\} \tag{7}$$

According to the Tikhonov regularization, we have

$$W = \left[H^H H + N_o I\right]^{-1} H^H \tag{8}$$

Here, we explore the ZF equalization with successive interference cancellation. Using beyond approach illustrated in ZF equalization, the receiver can obtain an estimate of the two transmitted symbols S_1 and S_2, i.e.

$$\begin{bmatrix} \tilde{S}_1 \\ \tilde{S}_2 \end{bmatrix} = (H^H H)^{-1} H^H \begin{bmatrix} Z_1 \\ Z_2 \end{bmatrix} \tag{9}$$

Taking one of the estimated symbols (for example $\tilde{S}_2$ and subtract its effect from the received vector Z_1 and Z_2, i.e.

$$\begin{bmatrix} \alpha_1 \\ \alpha_1 \end{bmatrix} = \begin{bmatrix} Z_1 & -h_{1,2} & \tilde{S}_1 \\ Z_2 & -h_{2,2} & \tilde{S}_2 \end{bmatrix} \tag{10}$$

Expressing in matrix notation, we have

$$\begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} = \begin{bmatrix} h_{1,1} \\ h_{2,1} \end{bmatrix} S_1 + \begin{bmatrix} g_1 \\ g_2 \end{bmatrix} \tag{11}$$

i.e.

$$\alpha = h\,S_1 + g \tag{12}$$

where

$$\alpha = \begin{bmatrix} \alpha_1 & \alpha_2 \end{bmatrix}^{\mathrm{T}} \tag{13}$$

In the case of MMSE equalization, the receiver can obtain an estimate of the two transmitted symbols S_1, S_2 , i.e.

$$\begin{bmatrix} \tilde{S}_1 \\ \tilde{S}_2 \end{bmatrix} = (H^{\mathrm{H}} H + N_o I)^{-1}\, H^{\mathrm{H}} \begin{bmatrix} Z_1 \\ Z_2 \end{bmatrix} \tag{14}$$

In the classical successive interference cancellation, the receiver randomly acquires one of the expected symbols (for example the symbol transmitted in the second spatial dimension, S_2) and its effect from the received symbols Z_1 and Z_2.

The above (14) is to calculate the S_1 and S_2 in the form of sequential outcomes that will further process through (10 to 11) to gather both the α_1 and α_2 in the concluded formation. And in last the derivation outcomes are summarized of the both receiver metrics as shown in (12 and 13) respectively.

III. MU-MIMO and V-BLAST Architecture

MU-MIMO can give better spectral effectiveness of users. Multiple antenna arrangements in a wireless communication network have been a concentrated study in the past few years. Spectral architecture of antennas provide greater enhancement in capacity and auspicious linear expansion through a number of antenna groups in several situations [15].

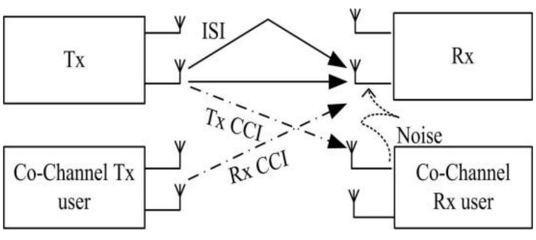

Fig. 1. Wireless channel limitations.

Wireless communication system has some channel limitation like fading, inter symbol interference (ISI), co-channel interference (CCI) and noise, as shown in Fig. 1. Fading provides a random signal amplitude due to the diverse phase of the multi path addition at the receiver side; various signals arriving with delay will cause inter-symbol interference; CCI originates from the neighbor channel interference for prime user; and lastly, the noise creates unwanted signal that adds-up in the desired signal [16].

Opportunistic communication systems mainly provide power gain, which is very useful in the low SNR systems. Spatial multiplexing gain can be achieved through antenna arrays at both sides of the link, which can give capacity gain without extra bandwidth or power consumption. The V-BLAST is the best way to achieve the required capacity in MIMO channels, which can be gotten by spatial multiplexing, which provides superior spectral effectiveness through inexplicit or explicit cipher over the faded channel. Nulling, also called as interference suppression, can be used to control the noise, whereas an interference canceller is used to neglect the interference by subtraction and also gathers required symbols [17].

A. *V-BLAST Detection Algorithms*

Linear and nonlinear algorithms can perceive V-BLAST information; linear algorithms based on interference control like ZF & MMSE and a nonlinear technique like maximum likelihood (ML) support sequential cancellation. In this paper, we mainly focus on linear equalizer algorithms.

The ZF technique is perfect in noiseless channel. It eliminates the entire inter-symbol interference (ISI). On the other hand, once the channel is noisy, zero forcing significantly magnifies the carrier frequencies, whereas the channel reaction has a short scale (i.e. in close proximity to zeroes of the channel) in the effort to overturn the entire channel. Also, it does not/may not take into account the additive noise, but may considerably magnify the noise for channels with spectral voids [18].

MMSE equalizer is used to reduce the entire noise power and ISI factors from output signals which are called balanced linear equalizer. It reduces the MMSE among the conveyed symbols and the output of the equalizer through the information of several cross-correlation functions, which can be calculated through shared information over control channel [18].

B. *Beamforming Patterns for Directed Receiver*

In wireless communication systems, a smart antenna has the capability to increase the subscriber capacity and decrease the interference. It is all done through spotlighting the directed emission and auto modification of signal characteristics, with respect to the atmosphere variation. Steering the maximum energy prototype towards a sought receiver is also an ability of a/the smart antenna. It can also diminish multipath fading and split the power of interference by spatial arrays. A general symbolic illustration of the angular solubility of an aerial group is the recipient of a beamforming blueprint. In the receiver beamforming vector, whenever the signal appears from a particular direction θ_O, subsequently the best possible recipient projects the received signal on the vector $e_r(cons\ \theta_O)$ [19]. Receiving signal from angle of direction θ is attenuated by a factor,

$$\left| S_r(\cos\theta_0)^* \ S_r(\cos\theta) \right| = \left| R_f(\cos\theta - \cos\theta_0) \right| \quad (15)$$

where the periodicity of receiving frequency R_f follows from the periodicity of the spatial signature S_r.

IV. A Single Beam Multi-User Transmission Method

Our scheme is based upon the efficient utilization of beamforming strength in wireless communication systems. The signal strength and beam direction vary according to user mobility and location, in general adaptive beamforming schemes, in which the data beam is generated from node-B by twisting the time and signal strength parameters to accommodate the multiple users that increase the processing time and delay factor in the network, which indirectly effect on the throughput of the system.

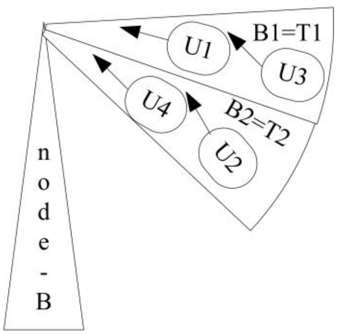

Fig. 2. Single beam multiuser transmissions.

In this paper, we propose a scheme to increase the user number within single beam strength, which reduces processing time and delay, to increase network capacity. As shown in Fig. 2, data stream is forwarded to multiple users through beamforming for those users who are located in same direction and within the single beam strength.

The motivation behind our idea is to increase the number of users with constant power consumption within single beamforming, which is also enhancing the user data rate. As discussed above, boosting the user data within the same power utilization is called energy efficiency. In the proposed methodology, following attributes are considered: 16 and 64 quadrature amplitude modulation (QAM) constellations, water filling algorithm to keep constant power, V-BLAST architecture with multi-user MIMO scheme and beamforming.

In the proposed scheme, transport blocks (TB_1, TB_2) are represented as U_1 and U_2 data symbols, respectively. Various constellation schemes are used to examine the maximum and the minimum user required data rate in the transmission. In node-B, A_1 and A_2 antenna are used to generate downlink beamforming signal with the same frequency, time slot, angle and power. At the user site, R_1 and R_2 are to receive the information.

The symbols are multiplex with each transmit antenna, through a complex quantity consequent to the reverse of the phase of the channel, to produce the constructive signals at the receiver's end. Water-filling algorithm is adopted to monotonously enhance the value of waterline, so that the channels having noise level lower than the waterline are transmitted. Moreover, transmitting channels use power that is equal to the difference between the noise level of the channel and waterline. The summation of the power consumed by all the channels transmitting should assure the power resources within the specified threshold. Power will be allocated to a sub-channel, based on its strength, according to the water-filling policy [20]

$$P_i^* = \left(\mu - \frac{N_o}{\lambda_i^2} \right)^+ \quad (16)$$

where P_i^* is the power allocation of water-filling, with μ to gratify the total power $\sum_i P_i^* = P$, and λ_i correspond to Eigen-channel.

When the V-BLAST is used to provide the spatial multiplexing gain over fading channel, it will assist the beamforming transmission to increase capacity of the networks. It is represented as;

$$Y[d] = Hs_{[d]} + w_{[d]},\ d = 1, 2 \cdots\cdots \quad (17)$$

When the channel matrix, H, is known to the transmitter, the optimal strategy is to transmit independent streams in the directions of the eigenvectors of H × H, i.e., in the coordinate system defined by the matrix V, where H = $U \wedge V^*$ is the singular value decomposition (SVD) of H . The capacity of a MIMO channel proved in [4, 21, and 22] can be estimated by the following equation

$$C = \max_{tr(R_{SS}) \le p} \log_2 \left[\det(I + H R_{ss} H^{\rm H}) \right] \quad (18)$$

where H is the $N_R \times N_A$ channel matrix, R_{SS} is the co-variance matrix of the transmitted vector s; H^H is the transpose conjugate of the H matrix and p is the maximum normalized transmit power. The above mentioned work determines the challenging issue of single beam multi-user transmission with the help of multiplexing gain technique. Another exigent matter is to retrieve the original user information from multiple user multiplexed data at the recipient site. Therefore, the MMSE and ZF equalizations, with successive interference cancellations, are used to extract the original information at user site. In this aspect, the received signal is as

$$Z = \begin{bmatrix} h_1 & h_2 \end{bmatrix} \begin{bmatrix} e^{-j\theta_1} \\ e^{-j\theta_2} \end{bmatrix} S + g \quad (19)$$

where

$$h_1 = |h_1| e^{j\theta_1} \quad (20)$$

$$h_2 = |h_2| e^{j\theta_2} \tag{21}$$

The signal at the receiver is represent as,

$$Z = (|h_1| + |h_2|) S + g \tag{22}$$

At the receiving site, to extract the user required information, MMSE and ZF equalizations, with successive interference cancellation are utilized, in which two different scenarios have been discussed as shown in Fig. 3. In the first case, performance of the proposed solution is verified with MMSE and, in the second case, evaluation is done through ZF equalizer with same parameters. The procedure of extracting the true information in both end receivers from multiplexed data transmission is shown below.

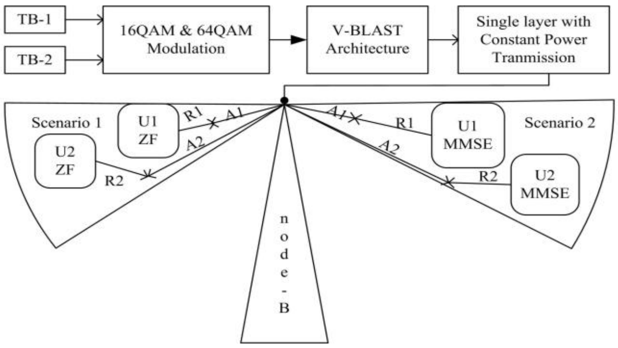

Fig. 3. Transmission system of proposed model.

A. Theorem 1

First scenario is defined as the process of thriving retrieve information of U_1 and U_2 by ZF to complex data.

Step 1) As U_1 and U_2 is getting the following multiplexed information, Z_1 and Z_2 form channels as mentioned in (2) and (3).

Step 2) Input data of both U_1 and U_2 is hoarded as Z_1 and Z_2 vectors, such as (4), to select the appropriate information at each receiver.

Step 3) In (9), the successive interference cancellation is applied with ZF method to retrieve the original information at both sites respectively.

Step 4) At the end, each user is able to successfully gather the desired data, S_1 and S_2, from the multiplex information Z_1 and Z_2, through drive metrics equation (12).

B. Theorem 2

The second scenario employs the process of flourishing to recover information of U_1 and U_2 through MMSE toward multiplex data.

Step 1) As U_1 and U_2 are receiving subsequent multiplexed information, Z_1 and Z_2 form conduit as mentioned in (2) and (3).

Step 2) The input data of both U_1 and U_2 are stockpiled as Z_1 and Z_2 vectors (4) to select suitable information at each receiver.

Step 3) The next process (14) is the implementation of the successive interference cancellation with MMSE technique, to recover the unique information at both sites correspondingly.

Step 4) At the end, each user is able to successfully gather the desired data, S_1 and S_2, from multiplex information Z_1 and Z_2 through drive metrics equation (12).

The MRC (Maximal ratio combining) is implemented at both receivers to effectively gather the information for optimum demodulation of data. The receive signal is in a matrix form shown as (12), where (13) represents the received symbols from all the receiver antennas. The channel on all the receiver antennas is as

$$h = [h_1 h_2 ... h_n] \tag{23}$$

And the noise represented as on all the receiver antennas;

$$g = [g_1 g_2 ... g_n]^T \tag{24}$$

The equalized symbols are

$$\hat{S} = \frac{h^H Z}{h^H h} = \frac{h^H S}{h^H h} + \frac{h^H g}{h^H h} = S + \frac{h^H g}{h^H h} \tag{25}$$

The sum of all receive antennas are

$$h^H h = \sum_{i=1}^{n} |h_i|^2 \tag{26}$$

The major benefit of the proposed strategy is to increase the throughput by handling multiple-users within a single layer transmission. It also reduces the processing time of beamforming in the sense that general multiple layers are used for multiple-users; but in proposed method, we accommodate multiple users within a single layer beamforming to reduce the processing period.

V. Simulation and Result Discussion

To evaluate proposed scheme performance, the simulation results of proposed methodology are presented. The proposed scheme is based on the performance of multi-user in single layer downlink transmission and is compared with the proposed beamforming (Pr-BF) and existing beamforming (Ex-BF) methods. The simulation scenario has been divided into two different scenarios. The proposed scheme is evaluated for 16 and 64 QAM techniques on ZF (first scenario) and MMSE (second scenario) equalizers. Single layer transmission is done with V-BLAST multiplexing gain technique through two antennas. Both antennas will generate beam with same characteristics like frequency, time, angle and constant signal power. At the receiving end, two users equipped with a single antenna will get the information from the medium for further processing, to ZF and MMSE equalizers.

Input (I/p) and output (O/p) scenario of the simulation model is discussed, where I/p signal S multiplies with noise g and transmits through antenna A_1 and A_2. At the receiving site, R_1 and R_2 receive and process the information to extract the $\tilde{S}_1$ and $\tilde{S}_2$ data from the transmitted information as shown in Fig. 4.

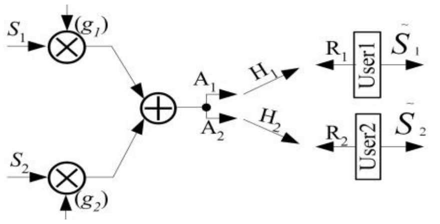

Fig. 4. Design of simulation input and output data.

The steps of the simulation results are based on subsequent constraints: First, produce 0's and 1's of haphazard binary series; subsequently, group it into twosome of two cipher and throw them in solitary time period; before transmission multiply them by the channel with the addition of white Gaussian noise. At the receiving end, in both cases, ZF and MMSE equalizers match the received symbols; then deduct the received symbol to the second space aspect information and at last, decipher the information and count the bit error rate (BER). This replicates for multiple times of E_b/N_o(dB) and then draws the simulation results.

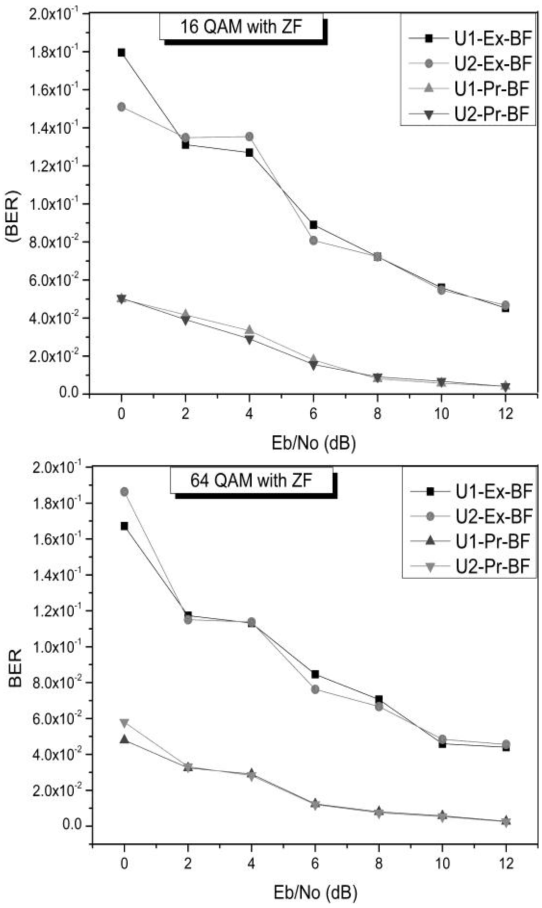

Fig. 5. ZF with 16QAM & 64QAM

C. Simulation 1: ZF with 16 & 64 QAM

The simulation is conceded for ZF decoder of both users with Pr-BF and Ex-BF scheme for 16 and 64 QAM in Fig. 5. The simulation results are measured with respect to BER and SNR factor. We can see from the Fig. 5 that it has less BER in 16 and 64 QAM with ZF at zero level, and it is still getting less BER till 12 (dB) to prove that the proposed strategy is better than existing results. When comparing with Pr-BF and Ex-BF transmission, in case of ZF equalizer, it can be observed that Pr-BF method has a better performance than Ex-BF approach. Moreover, it can be visualized that our major goal of multi-user in single beamforming transmission has been transited smoothly for both users simultaneously, with better Pr-BF approach.

D. Simulation 2: MMSE with 16 QAM & 64 QAM

The simulation is carried out with MMSE decoder of both users for Pr-BF and Ex-BF schemes with 16 and64 QAM as in Fig. 6. The simulation results, again, are measured with respect to BER and SNR factor. We can see from the Fig. 6 that the 16 and 64 QAM with MMSE at zero level has less BER compared with existing scheme, and it is still getting less BER until 12 (dB) to prove that the proposed strategy is better than existing results. In case of MMSE equalizer, we can see from Fig. 6 that the Pr-BF method has a better performance than Ex-BF method. Moreover, we can also envision that our key objective of multi-user in single beamforming transmission has a smooth transmission for multi-user's simultaneously with better Pr-BF approach.

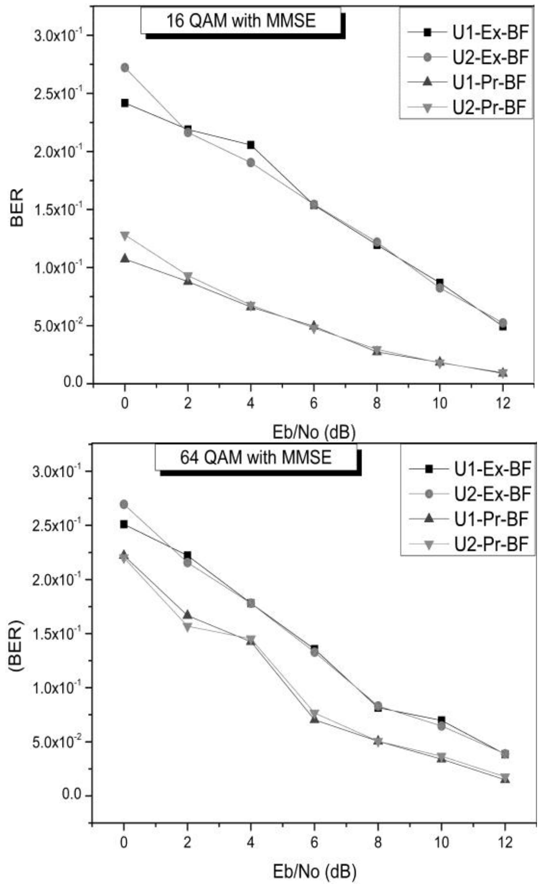

Fig. 6. MMSE-with-16QAM-&-64QAM.

Results clearly depict that the users equipped with Pr-FB techniques have better performance than general transmission due to projected information at receiver's site. Beamforming systems are generating directed radiation beams towards receivers, which establishes less noisy channel, rather than without beamforming transmission. As projected transmissions of beamforming are less noisy than general communication, that assists user equipments to get information from channel with less BER. It also clarifies that our major theme of single layer transmission can smoothly handle the multi-user transmission with better performance of beamforming technique.

VI. Conclusion

In communication, many researches focus on MU-MIMO and beamforming technique to improve the downlink throughput capacity. In this paper, the proposed scheme is employed to upgrade the existing systems in terms of growing the user number in single layer beamforming from single user to multi-user reception. The proposed method is based on V-BLAST, water filling algorithm and beamforming technique, to transmit single beam transmission. At the receivers', that are equipped with linear equalizers like MMSE and ZF decoders, simulation results are compared between Pr-BF and Ex-BF transmission for multi-user in single layer transmission, and thereby illustrate that the proposed solution outperformed when compared to the existing solutions, where single layer beamforming can handle multiple users simultaneously. Future work will be based on perfect channel state information (CSI) measured by direction of arrival (DOA), angle of arrival (AOA) and other techniques to find the multi-user location in single layer for data transmission.

Acknowledgment

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References

[1] A. Tarighat, M. Sadek, and A. H. Sayed, "A multi user beamforming scheme for downlink MIMO channels based on maximizing signal-to-leakage ratios," in *Proc. IEEE International Conference on Acoustics, Speech, and Signal Processing*, New York, USA, vol. 3, March 2005, pp. iii/1129- iii/1132.

[2] D. Gesbert, M. Kountouris, R. W. Heath, C. B. Chae, and T. Salzer, "From single user to multiuser communications: Shifting the MIMO paradigm," *IEEE Signal Processing Magazine*, vol. 24, no. 5, pp. 36-46, Sept. 2007 .

[3] E. Telatar, "Capacity of multi-antenna Gaussian channels," *European Trans. on Telecommunication*, vol. 10, no. 6, pp. 585-595, 1999.

[4] G. J. Foschini, "Layered space-time architecture for wireless communication in a fading environment when using multiple antennas," *Bell Labs Technical Journal*, vol. 1, no. 2, pp. 41-59, Oct. 1996.

[5] P. Viswanath, D. N. C. Tse, and R. Laroia, "Opportunistic beamforming using dumb antennas," *IEEE Trans. on Information Theory*, vol. 48, no. 6, pp. 1277-1294, Jun 2002.

[6] E. Y. Kim and J. Chun, "Random beamforming in MIMO systems exploiting efficient multiuser diversity," in *Proc. IEEE 61st Vehicular Technology Conference, Stockholm, Sweden*, vol. 1, Jun. 2005, pp. 202- 205.

[7] C. Han, S. Armour, A. Doufexi, J. McGeehan, and Y. Sun, "Performance analysis of layered random beamforming OFMDA with feedback reduction," in *Proc. IEEE 18th International Symposium on Personal, Indoor and Mobile Radio Communications, Athens, Greece*, Sept 2007, pp. 1-5.

[8] N. Sharma and L. H. Ozarow, "A study of opportunism for multiple-antenna systems," *IEEE Trans. on Information Theory*, vol. 51, no. 5, pp. 1804-1814, May 2005.

[9] M. Schubert and H. Boche, "Solution of the multiuser s beamforming problem with individual SINR constraints," *IEEE Trans. on Vehicular Technology*, vol. 53, no. 1, pp. 18- 28, Jan. 2004.

[10] Y. Jiang, L. Jian, and W. W. Hager, "Joint transceiver design for MIMO communications using geometric mean decomposition," *IEEE Tran.s on Signal Processing*, vol. 53, no. 10, pp. 3791- 3803, Oct. 2005.

[11] I. H. Kim, K. Lee, and J. Chun, "A MIMO antenna structure that combines transmit beamforming and spatial multiplexing," *IEEE Trans. on Wireless Communications*, vol. 6, no. 3, pp. 775-779, Mar 2007.

[12] L. Zhongding, F. Chin, and Y. C. Liang, "Combined beamforming with space-time block coding for wireless downlink transmission," in *Proc. IEEE 56th Vehicular Technology Conference, Vancouver, Canada*, vol. 4, 2002, pp. 2145- 2148.

[13] N. Parveen and D. S. Venkateswarlu, "Multipath interference cancellation in MIMO mobile cellular system," *International Journal of Distributed and Parallel Systems*, vol. 3, no. 3, pp. 35-48, May 2012.

[14] A. H. Mehana and A. Nosratinia, "Diversity of MMSE MIMO receivers," *IEEE Trans on Information Theory*, vol. 58, no. 11, pp. 6788-6805, Jun 2012.

[15] P. W. Wolniansky, G. J. Foschini, G. D. Golden, and R. A. Valenzuela, "V-BLAST: An architecture for realizing very high data rates over the rich-scattering wireless channel," in *Proc. URSI International Symposium on Signals, Systems, and Electronics*, Pisa, Italy, Oct. 1998, pp. 295-300.

[16] A. J. Paulraj, D. A. Gore, R. U. Nabar, and H. Bolcskei, "An overview of MIMO communications - a key to gigabit wireless," in *Proc.the IEEE*, vol. 92, no. 2, Feb. 2004, pp. 198- 218.

[17] B. Niramalendu, B. Rabindranath, and M. Mitra, "Capacity and V-BLAST techniques for MIMO wireless channel," *Journal of Theoretical and Applied Information Technology*, vol. 14, no. 1, pp. 11-22, 2010.

[18] O. Arafat, K. Dimyati, F. Seeme, A. M. Mushtaq, and H. M. Farhad, "A comparative simulation of mobile Wimax physical layer performance for Zero-Force (ZF) And Minimum Mean Square Error (MMSE) channel equalizers," *International Journal of the Physical Sciences*, vol. 5, no. 16, pp. 2503-2515, Dec. 2010.

[19] D. Tse and P. Viswanath, *Fundamentals of Wireless Communication*, Cambridge University Press, 2005, pp. 290-331.

[20] M. F. Flanagan and A. D. Fagan, "A simple proof of the water filling theorem for multichannel modulation," in *Proc. Irish Signals and Systems Conference*, Limerick, Ireland, 2003.

[21] D. Shiu, G. J. Foschini, M. J. Gans, and J. M. Kahn, "Fading correlation and its effect on the capacity of multi element antenna systems," *IEEE Trans. on Communications*, USA, vol. 48, no. 3, pp. 502-513, 2000.

[22] A. Paulraj, R. Nabar, and D. Gore, *Introduction to Space-Time Wireless Communications*, Cambridge University Press, 2003.

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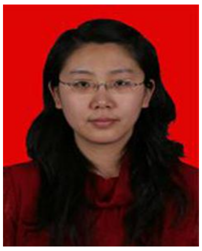

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