Wireless Environment Aware Adaptive Scheduling Technique for Cellular Networks

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Article Info

Article history:

Received Sep 22, 2017
Revised Nov 10, 2017
Accepted Dec 21, 2017

Keywords:

Error Rate
Imperfect bandwidth information
Mobile Ad Hoc Network (MANET)
Modified Zero Forcing (MZF)
Throughput
Zero Forcing (ZF)

ABSTRACT

It is now well known that employing channel knowledge based on signaling techniques in wireless mobile ad-hoc networks (MANET) system can yield large improvements in almost all performance metric. Here we proposed the adaptive scheduling, in which the work done is based upon the bandwidth information of channel to provide better quality of service (‘QoS’) to the cell-edge mobile stations. Channel information is critical based on which scheduling is carried out. The bandwidth channel information contains estimation delay, the pilot channel noise and pilot contamination. Afterwards, Zero Forcing precoding methodology has applied for removing the interference at user nodes, destination nodes and gateway side. By extending the characteristics of ZF, the modified Zero Forcing (MZF) has proposed to achieve higher throughput rate and higher spectrum efficiency. The achievable-rates of the ZF and MZF have derived under the comprehensive model of imperfect bandwidth information.

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1. INTRODUCTION

The wireless data-traffic (‘DT’) has been increased more in the cellular communication system (‘CCS’). As a concern, mobile DT has grown 4 thousand fold over the previous ten years and nearly 400 million fold over previous fifteen years [1]. The majorly increased demand of wireless traffic has drawn lots of research worker attention and this research works includes the increasing of bandwidth, network density and improvement in spectral density. Applying a massive multi-input multi-output (‘MIMO’) antenna model can be considered as the best technique for the enhancing spectral density in modern CCS. This may also deliver the high-energy efficiency (‘EE’), also it can make quite practicable for being apply to the green CCS [2]-[4]. MIMO model are able to transmit signal with high ‘degree of freedom’, also can serve to more number of users simultaneously with the high capacity of transmission (i.e. without increasing the transmission resource). Employment of ZF ‘or’ maximum ratio transmission (‘MRT’) method has considered for the multiuser-MIMO signal transmission [5] – [7]. The implementation of MRT model can cause the low implementation cost but it also leads to suffer from serious inter-beam interference and providing considerably less capacity than the ZF technique [8]–[10].

In this paper, we consider the MIMO (Multiple-input multiple-output) homogeneous Ad-hoc network; this consequently extended to the analysis of generalized multiple antenna CN scenarios, specifically, considering the uplink and downlink of the MANET. It has become the integral feature of several advanced communication systems and can provide the excellent increment in reliability and data rate compared with the ‘single antenna’ systems. A MIMO cellular system, which has been widely explored in the multiple-user MIMO, in that the multiple-antenna simultaneously provides an autonomous multiplicity of co-channel users [11][12]. A smart resource-allocation scheme is essential to utilize the benefits of 'cooperative technique' in order to assurance the "quality of service" (QoS) requirements in MANET. The common gateway is only responsible for the communication between users and the destination that has equipped with the multiple numbers of antennas. The nodes present at user 'or' destination side has equipped with the single-antenna. The user sends their information/signals by the gateway and transmits this information to their desired destination. The precoding with Zero Forcing (ZF) methodology has considered for removing the interference at user nodes, destination nodes and gateway side.

Figure 1 shows the system model with a common gateway, where the user numbers are randomly and uniformly circulated in assisted area, also the destination address are randomly and uniformly circulated in assisted area. In single hop, very small overlapping area has shown in Figure 1.1, which is the gateway location. In multi hop, some nodes are very far and cannot directly communicate, that is why the traffic has to transfer through the other intermediate nodes. Moreover, in single hop, nodes are in their contact area, so the communication can happen directly. The complexity of ZF pre-coding is approximating through the inversion of matrix by the 'Neumann series' expansion [13]. However, the computational complexity extension terms of three degrees are higher than the direct inversion. Therefore, it is difficult to put on the extension methodologies at the gateway nodes, which is higher than three-modules. To overcome this problem, here we proposed the modified zero forcing ('MZF') precoding technique. The 'MZF' is able to improve the "spectrum efficiency" and throughput, which also preserves the distributed processing advantage. Moreover, this paper applies the generalized imperfect bandwidth model in the derivations, which comprises the contamination and the channel noise.

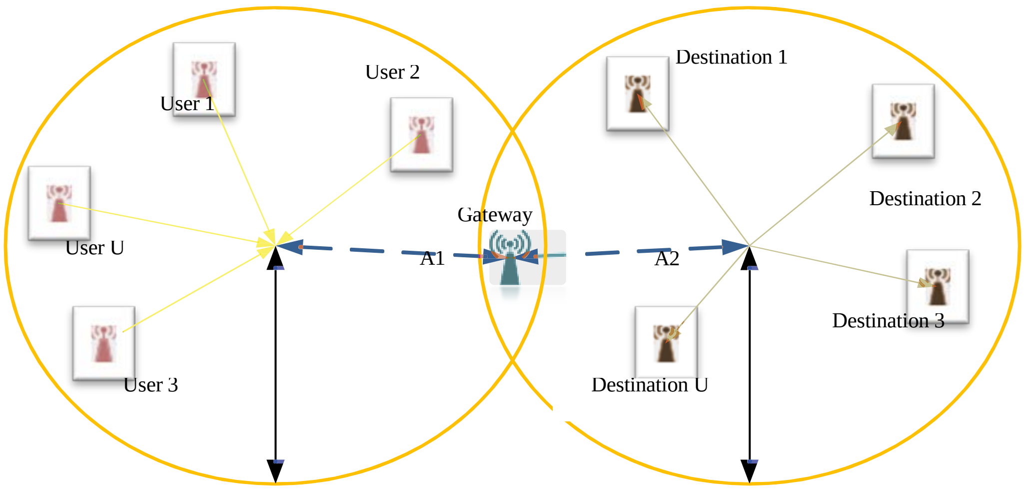

Figure 1. Common Gateway System Model

The rest of this paper organized as follows. Section 2 describes the literature survey under consideration. Section 3 describes the pre-coder ZF and MZF technique that spatially correlated '$MIMO$' channel with the adaptive scheduling at BS. Section 4 evaluates results of the existing ZF technique and our proposed MZF technique by computer simulation. Finally, Section 5 provides conclusion of this paper.

2. LITERATURE SURVEY

In paper [14], the concentration has given to the research state of limited feedback in the wireless communication ('WC') systems. From the last few years, the interest in limited feedback applications has increased so much and surely it will grow with the 'standardization' and 4G deployment with beyond wireless networks but there are still many problems remaining. Generally, there is no such theory of the single 'or' multiuser ('WFC') wireless-feedback communication networks. This may 'or' may not be such type of tractable problems. However, issues are much complicated such as the fundamental difficulty in a source coding, delay effect also the accompanying is important for the small feedback block-length signal, interaction between the reverse and forward links, errors effect in the 'feedback messages', also the uncertainty in optimum way to join the 'encode-message information' with the channel feedback state. The difficulties in the placement of inadequate feedback-systems also ties directly with the assumed channel quality model in a system design. Mismatches and changes in the distribution of channel must be projected and considered in the reliable system.

The relays part in recent generation are generally half-duplex (HD) because of their simplicity in implementation. A relay in Half-Duplex decreases the spectral efficiency and it cannot transmit 'or' receive on a similar spectral resource. The technology of full duplex currently become more popular after the studies in significant loop interference. This causes the reception and transmission on identical channel [15] [16]. A full-duplex ('FD') relay, usually known as a one-way relay, therefore, it can also receive and transmit on the equivalent spectral resource, also it able to double the theoretically spectral efficiency, comparatively to the HD relay [17] [18].

Two-way relaying of full duplex has considered in [19]-[21], where two users interchange two information data units in a single channel using a relay, moreover this advances the spectral efficiency. The 2-way relaying of FD is recently extend to the 'multi-pair two-way FD relaying' [22]-[24] where the multiple pairs of user exchange the data through a relay with a use of single channel. Multi-pair relay of two-way FD, however it suffers from the addition of inter-pair loop interference through the relay of transmit antenna to receive antenna that can also decrease its spectral efficiency.

Enormous 'MIMO' systems has become very popular if they terminate multi-user interference through using the simple process schemes of linear transition e.g., maximum ratio combining ('MRC') and zero forcing (ZF) [25]-[28], also significantly progress the spectral efficiency ('SE'). Several MIMO has also integrated with one and two-way relays of FD to terminate the inter-pair interference and loop [22]-[24], [29]. In paper [22], they derived the power allocation module and an achievable rate to minimalize ergodic sum-rate for the multi-pair one-way and the massive forward 'MIMO FD' relaying. Dai et al. [29], correspondingly derived from closed achievable-rate, also the power allocation process has used to maximize the sum-rate for multi-pair 2-way substantial 'MIMO HD' to amplify and forward (AF) relay with the inadequate linear processing and channel state information ('CSI'). Zhang et al. [23], proposed the 4-power scaling module for the 2-way 'FD relaying' to maximize its energy and spectral efficiency. In paper [24], the power allocation structure has developed to minimalize the sum-rate for a multi-pair 2-way 'FD MIMO AF' relaying through the estimated CSI values with least squares and processing of MRC at the relay.

Yang et al. [30] proposed the cell-edge-aware (CEA)-ZF pre-coder, which can exploits the additional spatial degrees of independence availability at enormous MIMO base antennas (BSs) to suppress the interference of inter-cell at a most susceptible user equipment's (UEs) in the network. The CEA-ZF precisely targets the UEs, which are neighbor to the 'BS' coverage area, therefore fewer requirement in spatial dimensions are to mitigate the inter-cell interference and, leaving maximum dimensions for the intra-cell 'spatial multiplexing'. Furthermore, it can be realized in the distributed method. In order to develop the practical organizations, they has analyzed the CEA-ZF performance and, CEU-ZF precoding in the arbitrary asymmetric 'cellular network' (CN). Through using CEA-ZF pre-coder, the better type of network coverage has obtained. More significantly, the 95-percentage rate namely and the minimum data-rate has significantly improved, in which any UE can supposed to achieve. Afterwards the particular interest is, the given ambitious 'edge rate' supplies for the 5G that aims at an uninterrupted user practice. In addition, this study measured the CSI imperfect impact, also by confirming the controlling importance of the pilot contamination, throughout the channel approximation phase.

The energy efficiency ('EE') metric, that can acquires the "Pareto-optimality" between a throughput and energy consumption has currently drawn an attention towards the performance measurement [31]. This paper studies about the EE metric of downlink of the cell-free single-hop immense 'MIMO system' with ZF precoding. In paper [32], they discusses about the uplink EE metric of immense MIMO system whenever, the non-linear receivers termination are employed at base station. The successive rate of bandwidth signals becomes the main problem in ZF scheme, due to presence of interference/noise in real world scenario.

3. PROPOSED METHODOLOGY

In precoding scheme, the gateway node is having A number of transmit antennas. Here, we assume that a gateway node acquires bandwidth through the imperfect bandwidth estimation. The comparison of ZF and MZF by introducing the imperfect bandwidth that originating from the imperfect reverse-link approximation in a TDD system.

Theoretically, users are able to feedback the different numbers of 'channel dimensions' that depends on the limited kind of long-term arithmetical bandwidth, nonetheless that would decrease the coverage (through favoring the cell center users) and, the necessity of a flexible 'system operation' with more number of control signaling. Therefore, we assume that a system acquires dimensions/user (U_d) from a casually selected user data, where $U_d \geq 1$ is fixed but also depends upon the proposed precoding strategy. Here the base station is considered as the gateway node.

Figure 2 represents the basic block diagram of our proposed system Architecture. A modified zero-forcing based precoding scheme was proposed, which considers BS-MSs (Mobile stations)/Users with adaptive scheduling to provide 'QoS' guarantee to cell-edge MS's. The channel bandwidth information is critical based on which scheduling is carried out at both uplink and downlink side.

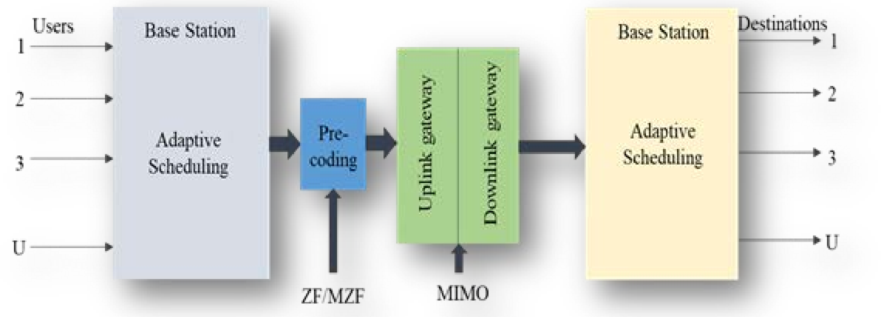

Figure 2. Basic Block Diagram of System Architecture

3.1. Time Division Duplex (TDD)

In cyclic system operation, we consider the Time division duplex ('TDD'), the operation of respective cyclic baseline system are illustrated above in Figure 3.1. In TDD scheme [33], the system toggles in between downlink and uplink transmission on a same channel, therefore, the signal training enables in both directions. The perfect channel reciprocity has assumed and the coherent time creates obtainable bandwidth. In a figure 3.2 the block to optimize/correct until the similar block arises in the 'next cycle' and careful calibration is essential to employ the reciprocity in training.

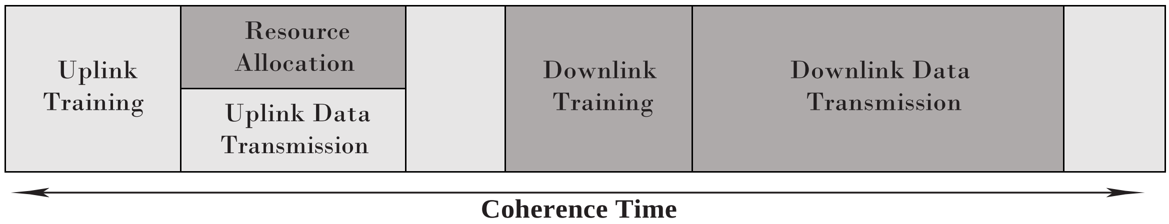

Figure 3. Basic Block-fading System Operation of TDD Systems. The System Operation Has Repeated in a Cyclic Manner.

3.2. Adaptive Scheduling based upon the Bandwidth Information

Initially, Linear precoding strategies is consider to generalize problem formulation and the transmitted signal can be given as

$$T = \sum_{U=1}^{U} W_U \cup_{dU} \tag{1}$$

Where, $W_U \in \mathbb{C}^{A \times \cup_{dU}}$ is the pre-coding matrix, $\cup_{dU} \sim \mathbb{C}\aleph\left(0, I_{\cup_{dU}}\right)$ is the data-signal and, the $\cup_{dU}$ is number of multiplexed 'data-streams' to user U. Each user from the cell applies a 'semi unitary' receive combination matrix $R_U = \mathbb{C}^{B \times \cup_{dU}}$ (i.e., $R_U^E R_U = I_{\cup_{dU}}$) and provides inter-user interference as the Gaussian noise. The achievable rate of information given as

$$q_U(\{W_l\}, R_U) = \log_2 \frac{\det(I_{\cup_{dU}} + \sum_{l=1}^{U} R_U^E E_U W_l W_l^E E_U^E R_U)}{\det(I_{\cup_{dU}} + \sum_{l \neq U} R_U^E E_U W_l W_l^E E_U^E R_U)} \tag{2}$$

Where, l denotes the arbitrary user index and W_l denotes for the precoding matrices set [38]. The transmission signal is limited thru a SNR constraint/average power of S, therefore

$$\Lambda\{T^{E}T\} = \sum_{U=1}^{U} \text{trans}(W_U W_U^{E}) \leq S \tag{3}$$

Preferably, we select these parameters $W_U, R_U, \cup_{dU}$ to maximize the sum rate; such as

$$\text{Max}\{W_U, R_U, \cup_{dU}\} \sum_{U=1}^{U} q_U(\{W_l\}, R_U)$$

$$\text{That subject to} \quad \sum_{U=1}^{U} \text{trans}(W_U W_U^{E}) \leq S \quad R_U^{E} R_U = I_{\cup_{dU}}, \cup_{dU} \geq 0 \tag{4}$$

The selection of parameter $W_U, R_U, \cup_{dU}$ done, accordance to achieve the tractable problem solution.

The users scheduled sequentially with the adaptive scheduling technique. This will avoids the exhaustive search at all data-stream allocation and it is almost infeasible when A and U grow large. We have simplified the scheduling problem by.

$$\underset{\{\widetilde{W_U}\}}{\text{maximize}} = \sum_{U\in\beta} \log_2 \det(I_{\cup_{dU}} + \tilde{R}_U^{E} E_U W_U W_U^{E} E_U^{E} \tilde{R}_U)$$

$$\text{Subject to} \quad \sum_{U\in\beta} \text{trans}(W_U W_U^{E}) \leq S, \tag{5}$$

$$\tilde{R}_U^{E} E_U W_l = 0_{\cup_{dU}\times\cup_{dl}}, \quad \forall U \in \beta, \forall l \in \beta\backslash\{U\}$$

For each user U, a scheduling set β^{ZF} is consider of ZF and β^{MZF} is consider of MZF.

3.3. Estimation of Bandwidth information

Here we acquires the bandwidth through an imperfect bandwidth estimation and mainly focus will be on the TDD systems, where each channel approximation has obtained by signaling training in the uplink. This approach is very much similar as the analog bandwidth information feedback in the FDD systems, where an 'un-quantized channel coefficients' are sent to an uplink subcarrier [33] [34].

The uplink-received signal at gateway of the system model [33] has given by

$$\tilde{R}_U = E_U^{\alpha} \tilde{T}_U + \tilde{\mu}_k \tag{6}$$

Where, $\tilde{R}_U \in C^{A\times 1}$ is received uplink signal, transmitted uplink signal denoted by

$$\tilde{T}_U \in C^{B\times 1} \tag{7}$$

$\tilde{\mu}_U$ represent the noise vector. The downlink 'noise vector' has normalized on the way to channel matrix in a system model. Assuming the perfect statistical bandwidth, the mean square error (MSE) estimation $\hat{E}_U$ of $\tilde{C}_U^{E} E_U$ and the resultant error co-variance matrix F_U are [35]

$$\text{vec}(\hat{E}_k^{T}) = \frac{1}{\rho^2} F_U \tilde{\alpha}_U^{E} \text{vec}(R_U), \tag{8}$$

Where $\tilde{\alpha}_U = (\alpha_k^{\alpha} \otimes I_A)$ and R_U is received signal from the training signaling.

As per the quantized CSI, we compute the pre-coding through assuming $\hat{E}_U$ as a true channel. Which results the performance in a lower bound and the rates of information with ZF and MZF can be given by

$$q_U^{ZF-EST}(S) = \log_2 \frac{\det\left(I_B + \sum_{l\in\beta^{ZF}} E_U\, \widehat{W}_l^{ZF}\, \hat{\gamma}_l\, \widehat{W}_l^{ZF,E} E_U^E\right)}{\det\left(I_B + \sum_{l\in\beta^{ZF}\setminus\{U\}} E_U\, \widehat{W}_l^{ZF}\, \hat{\gamma}_l\, \widehat{W}_l^{ZF,E} E_U^E\right)} \quad 9)$$

$$q_U^{MZF-EST}(S) = \log_2\left(1 + \frac{\hat{S}_U \left|C_U^E\, E_U\, \widehat{W}_U^{ZF}\right|^2}{1 + \sum_{l\in\beta^{ZF}\setminus\{U\}} \hat{S}_l \left|C_U^E\, E_U\, \widehat{W}_l^{ZF}\right|^2}\right) \quad 10)$$

The users adaptive scheduling sets has given by β^{ZF} and β^{MZF} respectively.

3.4. Average rate loss

The given below equation provides the upper bound on the ‘performance loss’ under ZF due to the imperfect bandwidth estimation. Let’s assume that $\frac{A}{B}$ users has scheduled randomly at ZF and the average loss rate for user $U \in \beta^{ZF}$ (with the equal power allocation) because of bandwidth estimation in upper bound given as

$$\begin{aligned}\varphi^{ZF} &= E\left\{q_U^{ZF}(S) - q_U^{ZF-EST}(S)\right\} \\ &\le \log_2\left(I_B + \frac{S(A-B)}{A}\left(R_{R,U}^{-\alpha} + \frac{\alpha_U^E \alpha_U}{\rho^2}\right)^{-1}\right)\end{aligned} \quad 11)$$

This equation (11) result will be compare with our corresponding Modified ZF results. Moreover, the MZF is alike to applying ZF to effective channels $e_U^E = \tilde{c}_U^E\, E_U$, but a significant difference is that the operative channel are not ‘Rayleigh fading’ due to $\tilde{c}_U$ depends on the realization of current channel.

Here, we provides an “upper bound” on the performance loss at MZF for the imperfect bandwidth estimation. Assuming that A users has scheduled randomly at MZF, where (maximum ratio combining) MRC is applied. Average loss of rate for the user $U \in \beta^{MZF}$ because of estimates bandwidth is upper bounded and given by [35]

$$\begin{aligned}\varphi^{MZF-EST} &= E\left\{q_U^{MZF}(S) - q_U^{MZF-EST}(S)\right\} \\ &\le \log_2\left(1 + \frac{S(A-1)}{A}\right)\frac{1}{E\{\|e_U\|_2^2\}^{-1} + \frac{\psi}{\rho^2}}\end{aligned} \quad 12)$$

This expression of rate loss in equation (11) and (12) indicates the combined impact of imperfect bandwidth estimation and spatial correlation on the ZF and MZF performance respectively. ZF is extra resilient to bandwidth uncertainty, meanwhile the ZF expression has $(A - B)$ where, and the MFZ expression has $(A - 1)$. The performance of both algorithm has calculated against the similar pre-coding strategy with imperfect bandwidth, where the analytic conclusion is slightly difficult [33]. A MZF has only one ‘effective antenna’ per user and can accommodate B times extra users that the ZF at the similar estimation overhead.

4. RESULT AND SIMULATION

We In this section, we continue the simulation by introducing the imperfect bandwidth estimation. Moreover, we use a MSE-minimizing ‘training matrices’ from [35 (Theorem 1)] and the training power $\psi = SU_d$ (to estimate the U_d dimension/user). The capacity-based “suboptimal user selection” (CBSUS) algorithm from [36] is modified to add the average interference in the scheduling (because of bandwidth estimation errors). The contribution of estimated errors at an average interference of $\frac{S(|\beta|-1)}{|\beta| P_{re}}$,

Where,

$$P_{re} = \left(R_{R,U}^{-\alpha} + \frac{\alpha_U^E \alpha_U}{\rho^2}\right)^{-1} \quad \text{for ZF} \quad (13)$$

$$P_{re} = \left(1/E\{\|e_U\|_2^2\} + \psi/\rho^2\right)^{-1} \quad \text{for MZF} \quad (14)$$

Number of transmit antennas at gateway node is 'A' and the number of receive antennas per user is 'B'. The number of user ranging from A to 65, at the interval of M and the number of Monte Carlo realization is consider to provide optimum estimated results. Here all users will be situated' at the same distance, which called as the cell edge. Additionally, we adopting the simple user activity model from [37], where, the user activity (ρ) ranges in between 0 to 1 ($0 \leq \rho \leq 1$). The magnitude of ρ is the activity factor between the adjacent antennas, where no user activity at $\rho = 0$ and at $\rho = 1$ means full user activity.

Table 1 shows the simulation parameter that used in this paper. Here, we considering three case of user activity; where in first case user activity is zero, in second case, the user activity is 0.4 and in third case, we consider 0.8 as user activity. For each case, we computed the average performance with respect to the total number of user to find the difference between ZF and MZF.

Table 1. Simulation Parameters

Parameter	Value
Number of transmit antennas (at gateway node)	10
Number of receive antennas (per user)	5
Range of number of users	10 to 65
SNR (SdB)	5, 10 dB
Monte Carlo realization	500
Cell Radius	1000m
Minimal User Distance (between a user and the BS)	150m
Path loss Coefficient	3
Standard deviation of shadow fading	8 dB
User Activity	0, 0.4 and 0.8

The average achievable 'sum rate' has shown in above Fig. 4.1 and Fig. 4.2 as the function of total number of users, where we obtain estimated bandwidth of ZF and MZF. All users contain the same 'average (SNR' 5 dB at Figure 4.1 and 10 dB at Figure 4.2) and, MZF outperforms ZF in terms of a performance with some users and in multi-user diversity. At zero user activity the average sum-rate is less for both ZF and MZF but with the increasing in user activity, both (ZF and MZF) sum-rate has increased. This means that increases in ρ will cause the improvement in system performance. Moreover, to analyze deeply we go for the each case user activity and analyze the difference between ZF and MZF at throughput and error rate of signals.

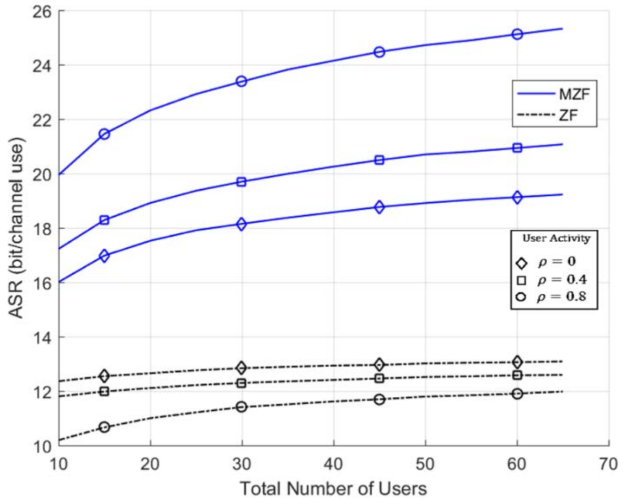

Figure 4. The average achievable 'sum rate' in a system with bandwidth estimation errors, B = 5 receive antennas, A = 10 transmit antennas and, the similar average SNR among all the users (5 dB). The performance with ZF and MZF strategies has shown as the function of 'total number of users' and for the different user activity factors ρ among the 'receive antennas'.

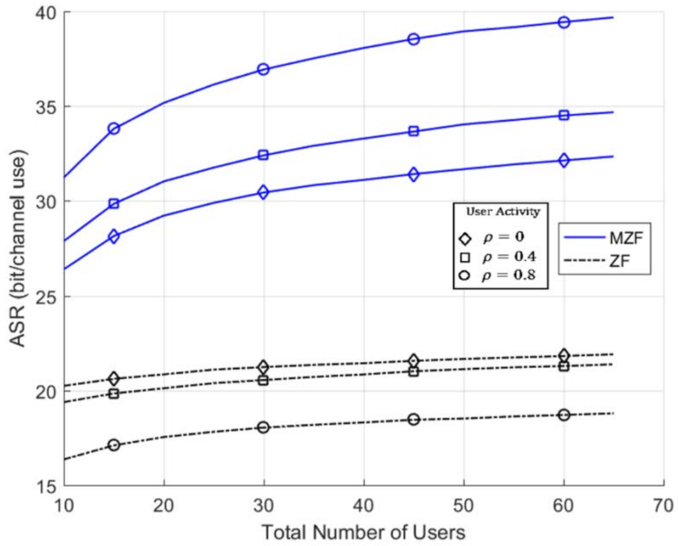

Figure 5. The average achievable 'sum rate' in a system with bandwidth estimation errors, B = 5 receive antennas, A = 10 transmit antennas and, the similar average SNR among all the users (10 dB). The different user activity factors ρ considered.

4.1. Case 1: User Activity Zero

Figure 6 and Figure 7 shows the variation in throughput with respect to increasing number of antennas (considering SNR value of 5dB and 10 dB). In Figure 4.3, shows the comparison of ZF and MZF in throughput rate, where the initial MZF throughput signal transmitted at 0.8 kbps (initial antenna number) and the maximum throughput signal is 6.24 kbps (at 325 transmitted antennas). Whereas, the initial ZF throughput signal transmitted at 0.617 kbps (at 10 transmitted antenna) and the maximum throughput signal is 4.25 kbps (at 325 transmitted antennas). The average throughput difference between ZF and MZF is 30.5%, means the MZF system can transmit more data packets. In Figure 4.4, the initial ZF throughput signal transmitted at 1.01 kbps and the rate of transmitted signal goes up to 7.12 kbps. Whereas, the initial throughput of MZF signal transmitted at 1.32 kbps and the maximum throughput of signal is 10.51 kbps. In average, the MZF system performs 31.05% better compare to the ZF system.

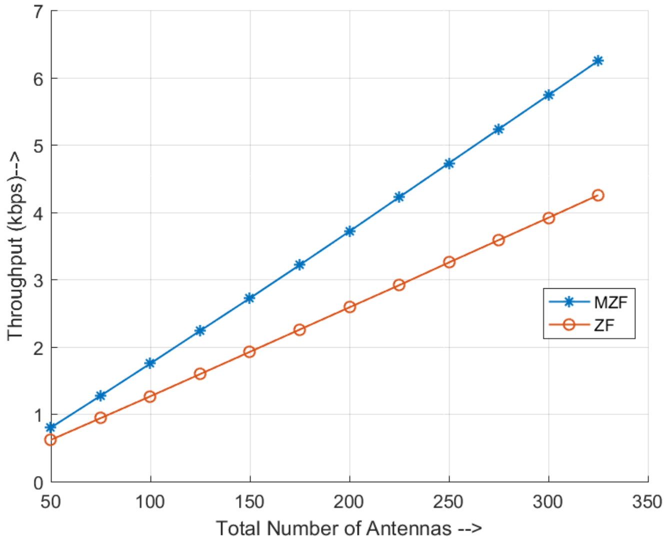

Figure 6. SNR-5dB, Variation in Throughput with the Increasing Number of Antennas

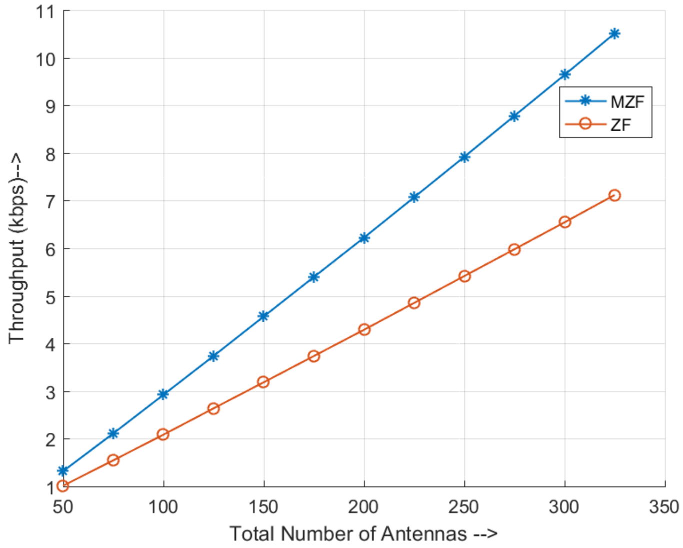

Figure 7. SNR-10dB, Variation in Throughput with the Increasing Number of Antennas

Figure 8 shows the error rate (kbps) with respect to number of antennas, the error rate is 9.29% less at MZF comparatively to ZF at 50 number of antennas. In MZF, we can see that error rate has decreased as per increasing in number of antennas while in ZF the error rate is varies from 0.76 to 0.795 kbps. The average error rate is 11.27% lesser at MZF, compared to the ZF system. Similarly, Figure 9 shows for the 10 dB SNR, where the error rate is less respect to Figure 8 Here also the error rate has decreased as per increasing in number of antennas whereas in ZF, the error rate started from 0.607 kbps and it goes up to 0.657 kbps. The average error rate in ZF is 0.646 kbps and 0.494 kbps in MZF, means the average error rate is 23.41% lesser in MZF.

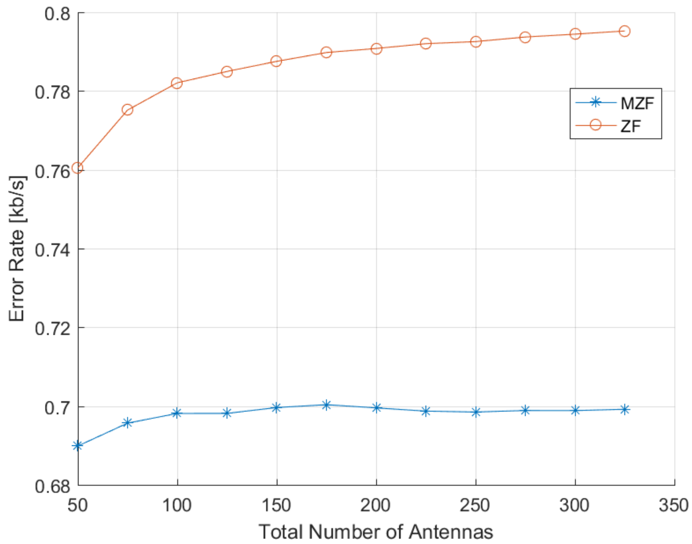

Figure 8. SNR-5dB, Error Rate in kbps

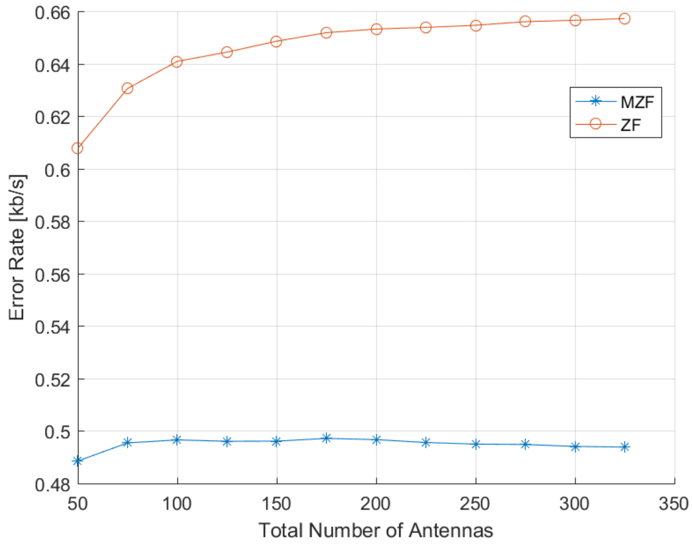

Figure 9. SNR-10dB, Error Rate in kbps

4.2. Case 2: User Activity 0.4

Figure 10 and Figure 11 shows the variation in throughput with respect to increasing number of antennas by considering the SNR value of 5dB and 10 dB. In Figure 10, shows the comparison has done in terms of throughput rate, where the initial MZF throughput signal transmitted at 0.861 kbps and the maximum throughput signal is 6.85 kbps. Whereas, the initial ZF throughput signal transmitted at 0.59 kbps and the maximum throughput signal is 4.092 kbps. The average throughput rate at MZF is 4.07 kbps and 2.49 kbps at ZF system, therefore the difference between ZF and MZF is 38.95%, means the MZF system can transmit more data. In Figure 11, the initial ZF throughput signal transmitted at 0.969 kbps and the rate of transmitted signal goes up to 6.95 kbps. Whereas, the initial throughput of MZF signal transmitted at 1.4 kbps and the maximum throughput of signal is 11.27 kbps. In average, the MZF system performs 37.34% better compare to the ZF system.

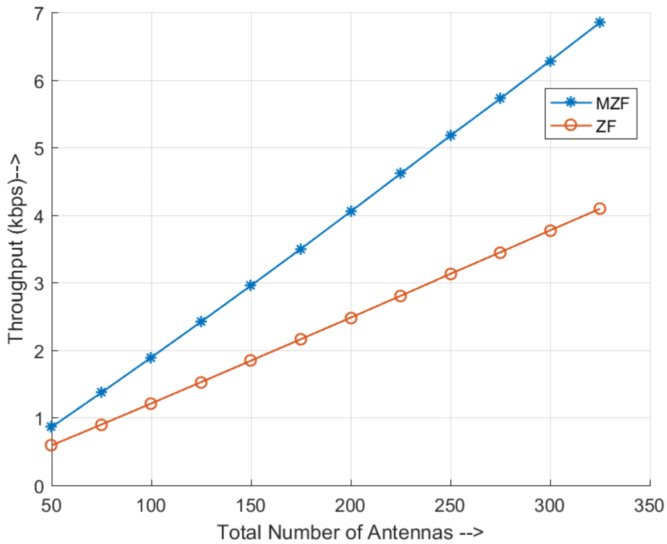

Figure 10. SNR-5dB, Variation in Throughput with the Increasing Number of Antennas

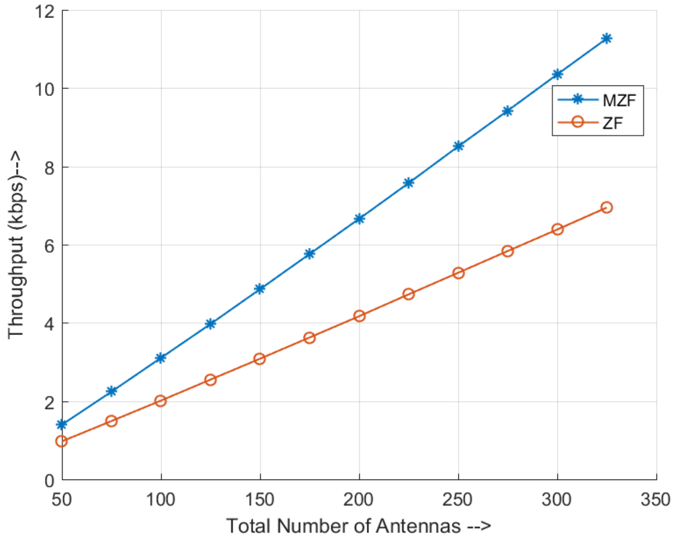

Figure 11. SNR-10dB, Variation in Throughput with the Increasing Number of Antennas

Figure 12 shows the error rate (kbps) with respect to number of antennas at 5 dB SNR, the error rate is 13.63% less at MZF comparatively to ZF at 50 number of antennas. In MZF, we can see that error rate has decreased as per increasing in number of antennas while in ZF the error rate is varies from 0.77 to 0.80 kbps. The average error rate is 15.56% lesser at MZF, compared to the ZF system. Similarly, Figure 13 shows for the 10 dB SNR, where the error rate is less respect to Figure 4.8. Here also the error rate has decreased as per increasing in number of antennas whereas in ZF, the error rate started from 0.624 kbps and it goes up to 0.665 kbps. The average error rate in ZF is 0.656 kbps and 0.46 kbps in MZF, means the average error rate is 29.84% lesser in MZF.

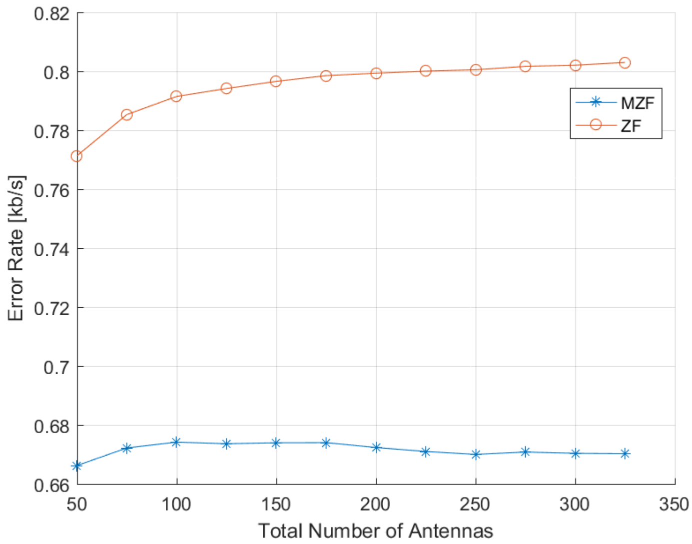

Figure 12. SNR-5dB, Error Rate in kbps

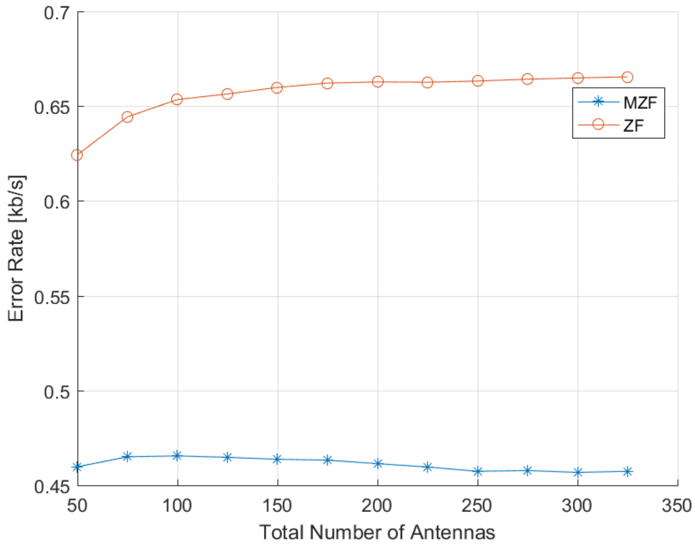

Figure 13. SNR-10dB, Error Rate in kbps

4.4. Case 3: User Activity 0.8

In Figure 14, shows the comparison between ZF and MZF in throughput rate at 5 dB SNR, where the average rate of MZF throughput signal transmitted at 4.54 kbps. Whereas, the average rate of ZF throughput signal transmitted at 2.3 kbps. The average throughput difference between ZF and MZF is 48.72%, means the MZF system is more efficient than ZF. In Figure 15, the average rate of MZF throughput signal is 7.15 kbps whereas, the average rate of ZF throughput signal is 3.92 kbps. In average throughput rate, the MZF system performs 45.12% better compare to the ZF system.

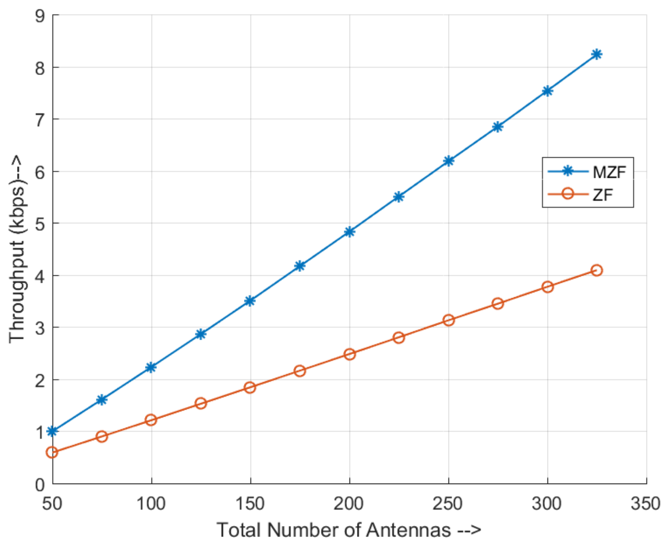

Figure 14. SNR-5dB, Variation in Throughput with the Increasing Number of Antennas

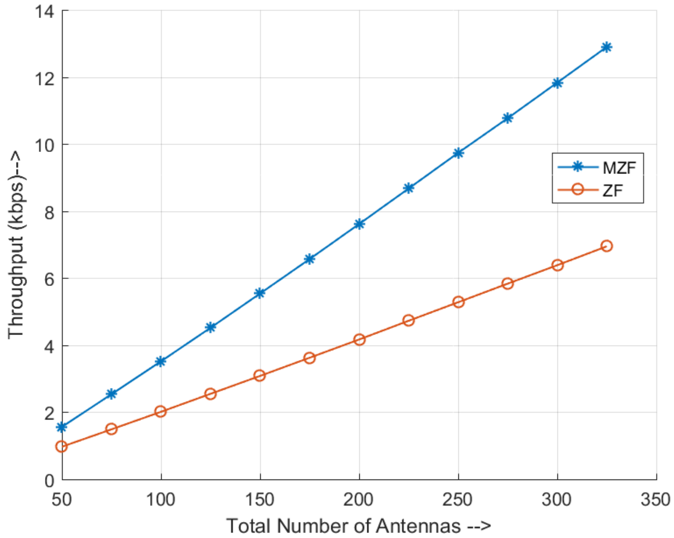

Figure15. SNR-10dB, Variation in Throughput with the Increasing Number of Antennas

Figure 16 shows the error rate (kbps) with respect to number of antennas. In MZF, we can see that error rate has decreased as per increasing in number of antennas while in ZF the average error rate is 0.79 kbps and 0.67 kbps in MZF. Means that average error rate is 15.56% lesser at MZF, compared to the ZF system. Similarly, Figure 17 shows for the 10 dB SNR, where the error rate is less respect to Figure 16. Here also the error rate has decreased as per increasing in number of antennas whereas in MZF, the average error rate is 0.46 kbps in MZF and 0.66 kbps in ZF. The average error rate is 29.84% lesser in MZF.

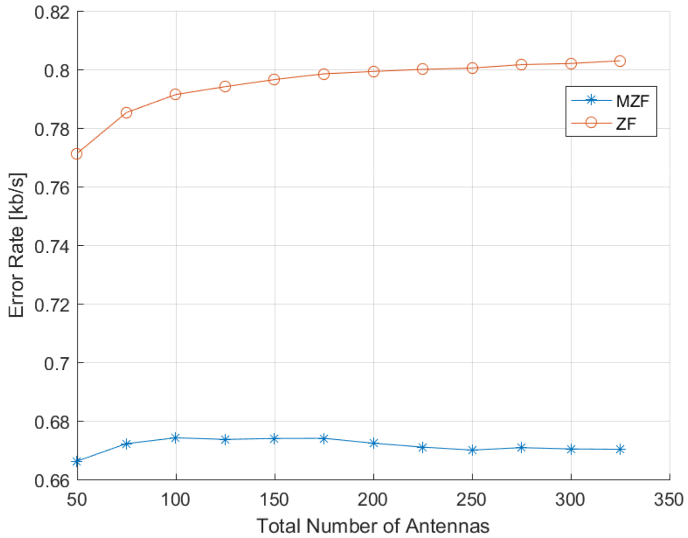

Figure 16. SNR-5dB, Error Rate in kbps

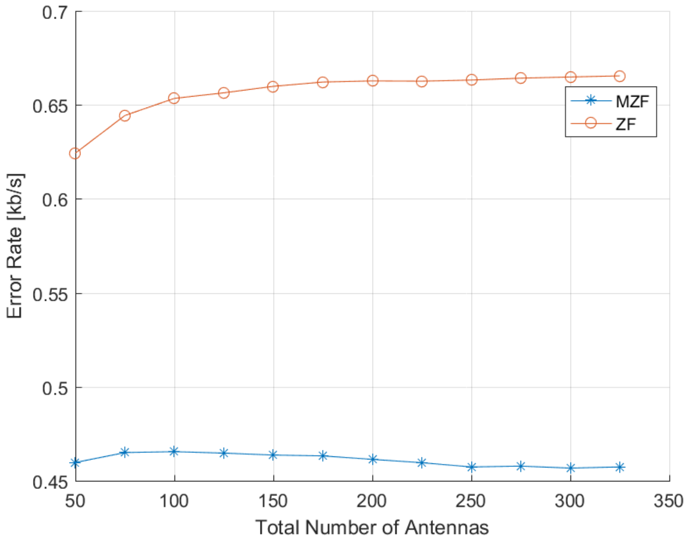

Figure 17. SNR-10dB, Error Rate in kbps

5. CONCLUSION

In this paper, we analyzed the system performance in details when a several number of 'active users' interconnect with their destination nodes. The destination has equipped with the receiver antennas, the user equipped with the gateway node antenna, and it communicate through its CN gateway. To eliminate noise and interference, ZF and MZF processing has performed. We derived the analytical expressions for the performance in a lower bound and the rates of information with ZF and MZF. Moreover, the Monte Carlo realization has performed to obtain the optimized bandwidth results. We observed the effect with increasing number of users in the network and, the number of gateway node antenna on the system performance. We observed that increment in user numbers would cause the increment in average sum rate of bandwidth to provide 'QoS' at MS's. Finally, we presented the effect of significant factors in our proposed and existing model on the 'system performance', such as user activity, throughput signal and error rate. The analytical results should match with the simulations to get the optimal results. Future works includes the extension of MZF scheme to obtain more generally used case in which U>A.

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