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Proportional Fair Multiusers Selective and Switched Channel Scheduling Schemes

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Proportional Fair Multiusers Selective and Switched Channel Scheduling Schemes

Rupinder Kaur^α & Muhammad Ejaz Aslam Lodhi^σ

Abstract - Presents increasing demand of rates in any digital communication system that excites the research idea of scheduling channel access methodology so as to results in maximizing the sum rate. The reduction in feedback messages for channel state information provides great savings in channel bandwidth for multiuser switched diversity scheduling systems. The present proposed work demonstrates that maximization of sum capacity can be achieved using optimization of per user threshold rate along with some prior estimation of channel state information. The results shown in higher achievable rate. Furthermore the proposed novel multiuser switched diversity MUSD system also achieves proportional fairness criteria along with decentralization of optimization threshold channel.

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I. INTRODUCTION

One of the features of multiuser communication on fading channels is multiuser diversity [1]. By exploiting the fading conditions independently, the multiuser diversity gain can be obtained and scheduling only the users with good channels [2]. To maximize the capacity of information of the uplink in single-cell multiuser communications with frequency-flat fading at any given time, only one user is allowed to transmit with the best channel condition.

Transmitting over the best channel maximizes the system sum-throughput, but results in "Unfair" allocation of the wireless resources among the users. Proportional fair scheduler (PF) which has been studied in this paper provides a good compromise between multiuser diversity gains and fairness [3]. The main goal of this research work or project work is to develop a noble architecture or design of Multiuser switched diversity scheduling scheme that can accomplish the following objectives:

a) Obtain the fairness in Scheduling scheme

Design a system in which a single radio or air link resource can be used for Multi user communication scenario. In spite of conventional selection based scheduling here in this research work, a switching based scheduling scheme has to be obtained that may perform better than the existing systems.

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b) Comparison

A comparison of MUSD schemes with full-feedback multiuser selective diversity opportunistic scheduling schemes is needed to evaluate how much rate we lose due to the feedback savings.

c) Compare the developed system output

With existing full feedback multiuser diversity scheduling system In all wireless communication system, transmitter send pilot signal to all the receivers to measure the condition of channel mention in [4].in opportunistic system, mobile user continuously send the feedback information to base station which causes wastage of air link resources and mobile battery power.so there is need to reduce the feedback load by different methods[5]and [6]. Different methods that can be employed are lossy and lossless compression ,scalar quantization method, Schemes exploiting the fact that only the best user will be allowed to transmit (max-SNR scheduling), and consequently that feedback

Multiuser switched diversity is to find user with good channel condition instead of best user among all suggested in [7].so channel condition if acceptable or not will be determined by considering predefined threshold .per user channel state threshold will be used in this paper[8]. All the users are assigned with time slotted channel .each time slot channel will send one bit flag signal if its achievable rate is more than threshold [9] .so feedback in MUSD will be reduced by assigning this threshold and assigning time slotted channel to users instead of per user feedback channel. This method also removes the congestion by using ordered scheduling.

II. REVIEW OF MULTIUSER SELECTION DIVERSITY

R Knopp and Humblet in [2] explained the power control mechanism at transmitter in which capacity is increased by transmitting one user at one time over the entire bandwidth having Best channel quality. Received power is estimated at base section to control the transmit power to obtain high capacity. D. Tse in [10] provide solution to multi path fading and losses by dynamically allocation to resources to users based on condition of channel quality of users. So when

the reception at base station is weak user as allocated with more power. T. Eriksson and Tony Ottoson in [5] states that sum capacity can be increased by feedback reduction methods. Feedback can be minimized without losing gain by different methods. First: Quantization, in which SNR is quantized before transmission. Second: Max SNR, in which users with only high SNR send feedback. Users with low SNR is unnecessary. Third: Data Compression, In this lossy and lossless compression techniques are used. Lossy compression techniques are transform coding and linear prediction coding etc. lossless compression techniques are arithmetic coding and 54Lempel ziv etc. M. S Alouni in [11] explained that user transmit information only when its channel quality exceed threshold. if channel quality of number of users exceed threshold then random user is selected. But the problem occur when multiple users reply to same threshold then chances of collision occur. So Aim of this paper is to provide solution of various challenges occur in MUSD system. These challenges are; user with strong channel may not get access to the channel, so need is to obtain the fairness by scheduling the users with best channel conditions first rather than others; optimization at central scheduler is not easy because it needs knowledge of pdf of all the users [12]; comparison of multiuser switched diversity with full feedback is required to calculate how much rate is lost. We propose proportional fairness scheme in multiuser switched diversity scheduling by using per-user threshold optimization with the principal function of maximizing the sum of the logarithms of the achievable rates. For each user, independent equations are used that provide solution to optimization.

III. SYSTEM MODEL

Consider if there is no delay in the decision of scheduling and block fading channel are used as medium between base station and users. Time slotted channel is used in orthogonal access scheme manner [13]. Each user is allocated with slotted channel include guard band and data burst .guard band is used to send flag signal to base station if its channel quality is higher than feedback threshold. Scheduling is done on following conditions if its channel quality is better than threshold Value [14]. Users prior to given one has achievable Rate less than threshold value. Consider if r_i^* is the threshold value of user i where achievable rate of user i is r_i . User i is scheduled only if $r_i < r_i^*$. r is vector of achievable rates of m users $r = [r_1 r_2 \dots \dots \dots r_M]$ in this paper, threshold is computed in term of achievable rate.

Channels are considered to be stationary and independent to each other. Probability density function of rate is $f_R(r)$.pdf of m users are given by $\prod_{i=1}^M f_{R_i}(r_i)$.if γ_i is SNR of i th user than achievable rate in term of snr is given as $r_i = \log(1 + \gamma_i)$ and interm of PDF of snr is $f_R(r) = \exp(r) f_r(\exp(r)-1)$.

Conditional and unconditional Expected achievable rates of user i in switched scheduling systemic Average Achievable rate by each user is calculated terms of $f_{R_i}(r_i)$. The conditional expected achievable rate by user i is given as

$$R_i^c = E [r_i | r \in s_i] = \int_{r_i} r f_{R_i}(r_i) dr \tag{1}$$

Where $E[\]$ is the expectation operator. Whereas, the unconditional expected value of the achievable rate by user i , denoted as R_i , equals

$$R_i = E[r_i] = E [r_i | r \in s_i]. \Pr\{r \in S_i\} = \prod_{j < i} f_{R_j}(r_j^*) \cdot \int_{r_i^*} r f_{R_i}(r_i) dr \tag{2}$$

As the fading channels are independent so event $r \in S_i$ happens with probability $\Pr\{r \in S_i\} = \prod_{j < i} F_{R_j}(r_j^*)$ Users are scheduled by different time slotted channels. so channel access ratio can be calculated as

$$AR_i = (1 - F_{R_i}(r_i^*) \cdot \prod_{j < i} f_{R_j}(r_j^*)).$$

IV. OPTIMIZATION OF PER USER THRESHOLD

In multiuser switched scheduling different users use its different threshold. in comparison to conventional system in multiuser switched scheduling higher capacity is obtained when the optimal threshold is used. Per user threshold can be optimized by maximizing the sum capacity of all users. Optimization problem can be formulated as

$$[r_1^* \dots \dots \dots r_M^*] \arg \max_{[r_1^* \dots \dots \dots r_M^*]} \Phi \tag{3}$$

Threshold optimization of achievable rate is given by r_i^* .the sum achievable rate, Φ can be maximized by equation $\Phi = \sum_{i=1}^M R_i$ To obtain the optimal value of threshold, gradient of Φ is taken w.r.t r_i^* for three conditions .these are $i > j$, $i = j$, $i < j$ and equate it equal to 0 solved using [9]. by putting values in $\frac{\partial \Phi}{\partial r_i^*} = 0, \forall i \leq M$ M.Computing result will be

$$r_i^* = \frac{\sum_{j > i} R_j}{\prod_{k < i+1} F_{R_k}(r_i^*)} \tag{4}$$

maximize the sum capacity to obtain the optimal value of threshold is always not desirable as it causes problem in fairness so another method proportional fairness scheduler is used.

V. PROPORTIONAL FAIR SCHEDULER SCHEME

Proportional fairness that provides a good trade-off between the aggregate rate over the network and fairness among user [15]. Contention problem in system can be resolved by Proportional fairness scheme by allocating each user with capacity according to its channel condition.in proportional fairness scheme

optimization can be obtained by maximizing the sum of log of achievable rates $\phi = \sum_{i=1}^M \log(R_i)$. After taking the gradient and equate it equal to zero, optimal value of threshold is obtained.

$$\frac{r_1^* f_{R_1}(r_1^*)}{\int_{r_1^*}^{\infty} r f_{R_1}(r) dr} = M - i \tag{5}$$

M independent equations are used for optimizing the system instead of solving dependent equations in case of MUSD scheduling schemes. So channel of each individual user and location of each user will determines its optimal value of achievable threshold. so threshold value of each user is obtained locally in this case. so in this base station need not to have knowledge of pdf of all user channel thus eliminate the challenge of centralized threshold optimization of conventional MUSD schemes. Optimal value of threshold in the form of SNR is

$$\frac{\log(1+\gamma_1^*) F_{r_1}(\gamma_1^*)}{\int_{\gamma_1^*}^{\infty} F_{r_1}(\gamma) \log(1+\gamma) d\gamma} = M - i \tag{6}$$

VI. SIMULATION RESULTS COMPARISON WITH FULL-FEEDBACK SCHEMES

The performance of MUSD scheduling schemes is compared with the performance of full-feedback selective scheduling schemes in given figures. Sum capacity for multiuser selective diversity is evaluated and then compared with switched diversity in which feedback bits are minimized by comparing the achievable rate with optimal threshold value. Analyse the case of independent and identically distributed Rayleigh block-faded channels. Comparison between multiuser switched and multiuser selective diversity schemes under i.i.d. Rayleigh blockfading conditions is considered for average SNR of 30db and eight no of users. The maximum sum achievable rates are used for the comparison. The sum capacity were computed for the MUSD scheme and selective system where the per-user thresholds optimization shows that switched diversity scheduling schemes operate within 0.3 bits/sec/Hz from the ultimate network capacity of full feedback systems in Rayleigh block fading conditions over wide range of SNR and for any number of users. Also proportional fairness is achieved as the no of user are increased.

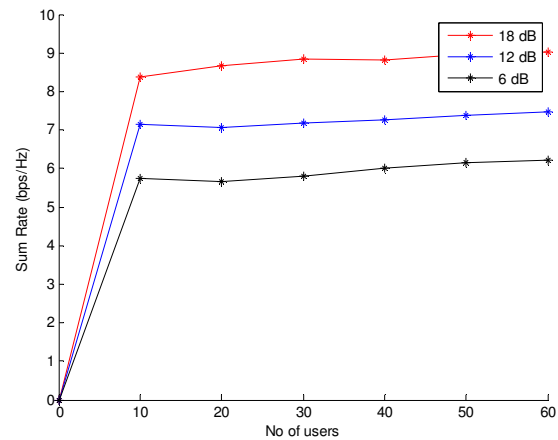


Figure 1: Maximum sum achievable rate of the selection diversity system

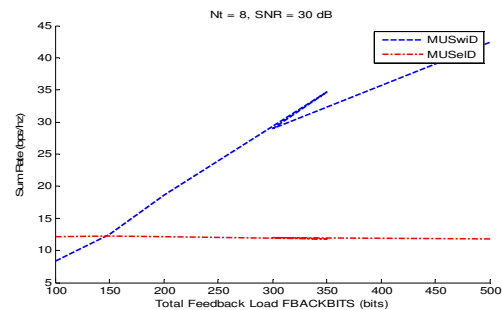


Figure 2 : Maximum sum achievable rate (capacity) comparison between the selection diversity system (dashed red lines) and the switched diversity system (dashed blue lines) as a function of the total feedback load in feedback bits. Results are based on average SNR of 30 db

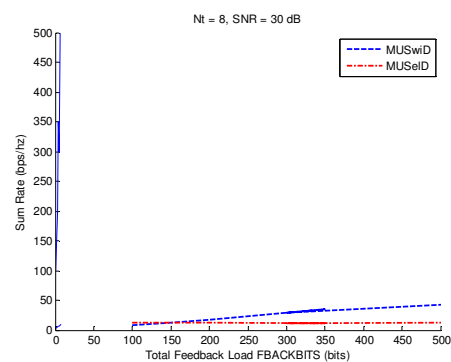


Figure 3 : Maximum sum achievable rate (capacity) comparison between the selection diversity system (dashed red lines) and the switched diversity system (dashed blue lines) as a function of the total feedback bits. Result is based on average SNR of 30db

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