Feedback Reduction in Switched Channel Scheduling Scheme

Rupinder Kaur
Dept. of EXTC
KCCEMSR
Thane, India

Abstract - In the proposed system we provide a comprehensive study to answer the technical challenges of multiuser switched diversity scheduling (MUSD) schemes. Furthermore, we aim in this work to persuade that MUSD scheduling systems are actually attractive options for practical implementation in emerging mobile broadband communication systems. Toward this end, we take the following steps; we provide detailed discussions to enhance our understanding about the attributes of the system and how to optimize its performance. In particular, we characterize the achievable rate region of MUSD systems. Also, we show that the achievable rates in MUSD systems are comparable with selection-based systems although they are significantly more economic in terms of CSI feedback load. Furthermore, we propose a novel MUSD scheduling scheme that achieves the proportional fairness criterion, which is preferable for practical implementation. We show that this can be achieved by proper per-user threshold optimization based on the objective function of maximizing the sum of the logarithms of the achievable rates. We demonstrate that our proposed scheme has a special interesting feature that the solution of the corresponding optimization problem yields independent equations for each user, and hence the threshold optimization can be decentralized, which overcomes the centralized optimization challenge.

Keywords- *Multiuser diversity; per user threshold; proportional fairness scheduling*

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.

B. Comparison

A comparison of MUSD schemes with full-feedback multiuser selective diversity (MUSelD) 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) andthat feedback from other users than the best is unnecessary. 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] provides solution tomulti path fading and losses by dynamically allocation of resources to users based on condition of channel quality of users. So when the reception at base station is week, user is allocated with more power. T Ericksson 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 technique is used. lossy compression techniques are transform coding and linear prediction coding etc. lossless compression techniques are arithmetic coding and Lempel 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 principalfunction 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 isr_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 $\mathrm{f_R(r)}$.Pdf of m users are given by$\prod_{I=1}^{M} f_{R_i}(r_i)$.If γ_i is SNR of ith user than achievable rate in term of SNR is given as $r_i = log\ (1+\gamma_i)$and in term of PDF of snr isf_R(r) = exp(r). fr (exp(r)-1).

Conditional and unconditional Expected achievable rates of user

In switched scheduling system, Average Achievable rate by each user is calculated terms of $f_{r_i}(\gamma_i)$. The conditional expected achievable rate by user i is given as

$$R_i^c = E\ [r_i | r \epsilon s_i] = \int_{r_i^*}^{\infty} r\ f_{R_i}(r_i)\ dr \qquad (1)$$

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

$$R_i = E[r_i] = E\ [r_i | r \epsilon s_i].\ P_r\{r \in S_i\} =$$

$$\Pi_{j<i} f_{R_j}(r_j^*). \int_{r_i^*}^{\infty} r\ f_{R_i}(r_i)\ dr \qquad (2)$$

As the fading channels are independent so event r ∈Si happens with probability $P_r\{\mathrm{r} \in S_i\} = \prod_{j<i} F_{R_j}(r_j^*)$ .Users

are scheduled by different time slotted channels. So channel access ratio can be calculated as

$$AR_{i\,=} (1 - F_{Ri}(r_i^*)\ .\Pi_{j<i} f_{Rj}(r_j^*)).$$

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

$$[\widehat{r_1^*} \ldots\ldots\ldots\ldots \widehat{r_M^*}]\ arg\ max_{[\widehat{r_1^*}\ldots\ldots\ldots\ldots\widehat{r_M^*}]}\ \emptyset \tag{3}$$

Threshold optimization of achievable rate is given by $\widehat{r_i^*}$.The sum achievable rate, Φ can be maximized by equation $\emptyset = \sum_{i=1}^{M} R_i$.To obtain the optimal value of threshold, gradiant of $\emptyset$ 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

$\frac{\partial\emptyset}{\partial r_i^*} = 0, \forall i \leq M$.Computing result will be

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

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 users [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 $\emptyset = \sum_{i=1}^{M} \log(R_i)$.After taking the gradient and equate it equal to zero, optimal value of threshold is obtained.

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

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 determine 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 channels thus eliminate the challenge of centralized threshold optimization of conventional MUSD schemes. Optimal value of threshold in the form of SNR is

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

VI. SIMULATION RESULTS COMPARISON WITH FULL-FEEDBACK SCHEMES

The performance of MUSD scheduling schemes is compared with the performance of full-feedback MUSelD scheduling schemes in fig1, fig2 and fig3.We analyze the case of independent and identically distributed (i.i.d.) Rayleigh block-faded channels as well as the case of independent and non-identically distributed Rayleigh channels.Fig. shows the comparison between MUSD and MUSelD schemes under i.i.d. Rayleigh block-fading conditions.It is concluded that the degree of fairness for the purposed multiuser switched diversity system provides very high values of fairness and in total the ultimate performance. The purposed multiuser switched diversity scheduler is an attractive option for the practical implementation of wireless mobile communication system.

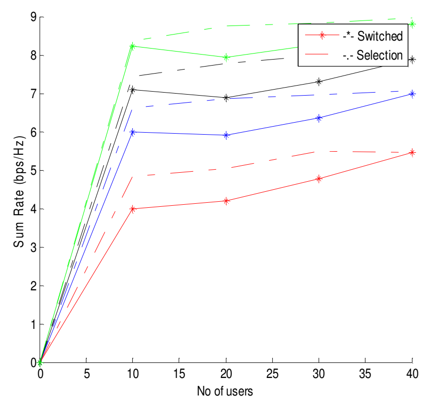

Fig.1. Maximum Sum achievable rate of switched and selection diversity

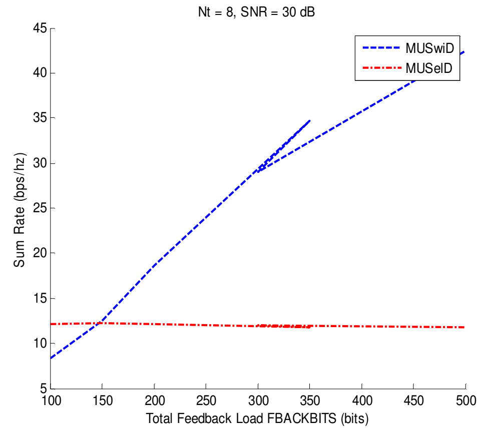

Fig.2. Maximum sum achievable rate (capacity) comparison between the selection diversity system (dashed red lines) and the switched diversity system (dashed blue lines) as a function of the total feedback load in feedback bits. Results are based on average SNR of 30 db.

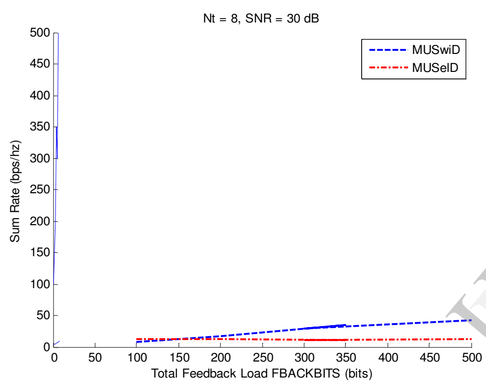

Fig.3. Maximum sum achievable rate (capacity) comparison between the selection diversity system (dashed red lines) and the switched diversity system (dashed blue lines) as a function of the total feedback bits. Result is based on average SNR of 30db.

REFERENCES

[1] D.Tseand P.Viswanath, Fundamentals of Wireless Communication. Cambridge University Press, 2005.

[2] R. Knopp and P. A. Humblet, "Information capacity and power controlin single-cell multiuser communications," in Proc. IEEE Int. Conf.Commun., pp. 331–335.

[3] X. Wang, G. Giannakis, and A. Marques, "A unified approach to QoSguaranteed scheduling for channel-adaptive wireless networks," Proc.IEEE, vol. 95, no. 12, pp. 2410–2431, Dec. 2007.

[4] A. Dual-Hallen, "Fading channel prediction for mobile radio adaptive transmission systems," Proc. IEEE, vol. 95, no. 12, pp. 2299–2313, Dec.2007.

[5] T. Eriksson and T. Ottosson, "Compression of feedback for adaptivtransmission and scheduling," Proc. IEEE, vol. 95, no. 12, pp. 2314– 2321, Dec. 2007.

[6] D. Love, R. Heath, V. Lau, D. Gesbert, B. Rao, and M. Andrews, "An overview of limited feedback in wireless communication systems," IEEEJ. Sel. Areas Commun., vol. 26, no. 8, pp. 1341–1365, Oct. 2008.

[7] B. Holter, M.-S.Alouini, G. E. Oien, and H.-C. Yang, "Multiuser switched diversity transmission," in Proc. 2004 IEEE Veh. Technol. Conf.–Fall, vol. 3, pp. 2038–2043.

[8] H. Nam and M.-S.Alouini, "Multiuser switched diversity scheduling systems with per-user threshold," IEEE Trans. Commun., vol. 58, no. 5, pp. 1321–1326, May 2010.

[9] H. Nam andM.-S.Alouini, "Multiuser switched diversity scheduling systems with per-user threshold and post-user selection," in Proc. 2010IEEE Int. Symp. Inf. Theory, pp. 2173–2177.

[10] D. Tse and S. Hanly, "Multiaccess fading channels–part 1: polymatroid structure, optimal resource allocation and throughput capacities," IEEETrans. Inf. Theory, vol. 44, no. 7, pp. 2796–2815, Nov. 1998.

.[11] L. Yang and M.-S. Alouini, "Performance analysis of multiuser selection diversity," IEEE Trans. Veh. Technol., vol. 55, no. 6, pp. 1848–1861, Nov. 2006.

[12] R. Suoranta, K. Estola, S. Rantala, and H. Vaataja, "PDF estimation using order statistic filter bank," in 1994 Proc. IEEE Int. Conf. Acoust.,Speech, Signal Process., vol. 3, pp. 625–628

[13] P. Viswanath, D. Tse, and R. Laroia, "Opportunistic beamforming usingdumb antennas," IEEE Trans. Inf. Theory, vol. 48, no. 6, pp. 1277–1294,June 2002.

[14] H. Nam, Y. Ko, and M.-S. Alouini, "Performance analysis of joint switched diversity and adaptive modulation," IEEE Trans. Wireless Commun., vol. 7, no. 10, pp. 3780–3790, Oct. 2008.

[15] R. Jain, D. Chiu, and W. Hawe, "A quantitative measure of fairness and discrimination for resource allocation in shared computer systems," DEC Research Report TR-301. Available: http://www.cs.wustl.edu/ jain/papers/ftp/fairness.pdf