Overcoming Self- Interference in SM-OFDMA with ESINR and Dynamic Subcarrier Allocation

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1. INTRODUCTION

▪ Combined benefits of MIMO architecture and OFDM(A) technology make it an attractive technology for future wireless communications, such as 3GPP LTE, WiMAX (802.16) and MBWA (802.20).

▪ However, MIMO suffers from severe impairment effects due to Co-channel interference (CCI), also known as self-interference, inherent in the MIMO architecture.

▪ This research aims to minimized the CCI effect in the MIMO-SM scheme by exploiting the knowledge of the channel gain and combine it with Dynamic Subcarrier Allocation (DSA).

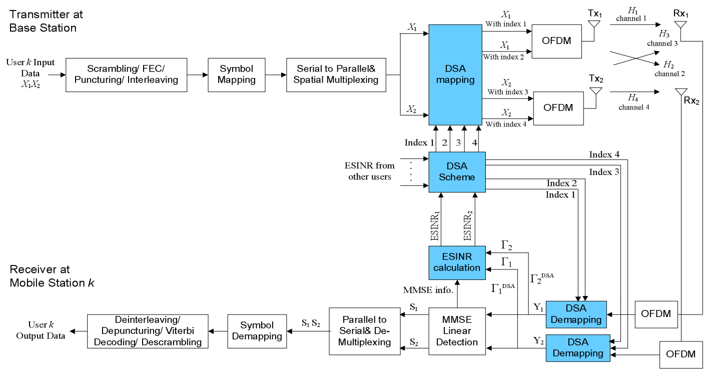
2. OBJECTIVES

▪ Utilise the multi-user channel to mitigate channel fading and exploit it as a source of diversity.

▪ Consider the interference that exists between the spatial sub-channels.

▪ Provide fair benefit across all users.

3. SYSTEM MODEL



4. METHODOLOGY

Allocation strategy

ESINR metric has the knowledge of self-interference from the other transmitted data stream within the same channel.

DSA allows user with the lowest ESINR to have the 'best' ESINR that is available for the next transmission.

(1) Initialization

Set $ESINR_{k,m'}=0$ for all users, $k=1\ldots K$; Set allocated subcarrier index, $C_{k,s,m'}=0$ for all users, whereby s is the allocated subcarriers and spatial sub-channels, $m'=\{1,2,M'\}$; Set $s=1$

(2) Main Process

While $N_{m'}\neq 0_{Nsub}=$

{ (a) Sort users, start with users with less ESINR metric. Find user k satisfying:

$$ESINR_{k,m'} \leq ESINR_{i,m'}, \text{ for all } i,\ 1\leq i\leq K$$

(b) For the user k in (a), find subcarrier n satisfying:

$$\Gamma_{k,m'} \geq \Gamma_{j,m'}, \quad \text{for all } j\in N$$

(c) Update $ESINR_{k,m'}$, N and $C_{k,s,m'}$ with the n from (b) according to

$$ESINR_{k,m'} = ESINR_{k,m'} + \Gamma_{k,m'}$$

$$N_{m'}=N_{m'}-n$$

$$C_{k,s,m'}=n$$

$$s=s+1$$

(d) Go the next user in the short list define in (a), until all users are allocated another best subcarrier, $N_{m'}=0$

}

5. SIMULATION PARAMETERS

▪ Using a 2 × 2 SM-OFDMA system, with 64 QAM, ¾ rate modulation scheme in an uncorrelated Rayleigh fading channel environment.

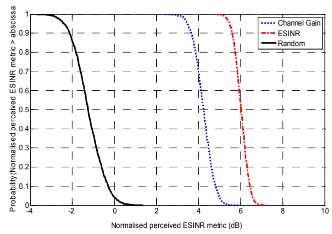
▪ Adopted ETSI-BRAN Channel Model 'E', which simulates typical large open space outdoor environments for NLOS conditions, with excess delay spread of 1760ns, sampling period of 10ns and RMS delay spread of 250ns.

▪ Simulated for 16 MS users and each MS is allocated a single sub-channel consisting 48 useable subcarriers.

▪ 2000 independent identically distributed (i.i.d.) quasi-static random channels samples per user.

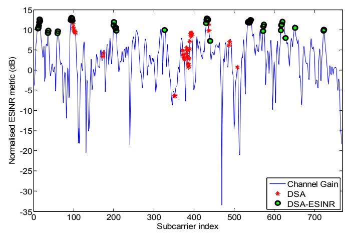
Operating frequency	5 GHz
Bandwidth	100 MHz
FFT Size	1024
Useful Subcarriers	768
Subcarrier spacing	97.656 KHz
Useful symbol duration	10.24 µs
Total symbol duration	12.00 µs
Channel Coding	Punctured ½ rate convolution code, constraint length 7, {133, 171}octal

6. RESULTS& ANALYSIS



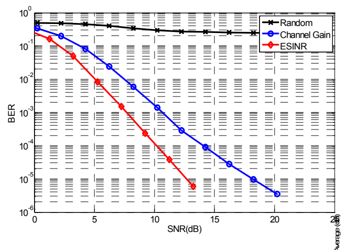
▪ From the CCDF comparison, DSA-ESINR metric outperforms the random allocation strategies by up to 7 dB.

▪ DSA-channel gain has slightly lower gain; approximately 2 dB compared to DSA using the ESINR metric.



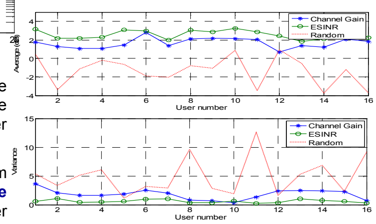
▪ DSA-ESINR have consistent high ESINR metric compare to DSA-channel gain.

▪ This shows that **DSA-channel gain does not consider the effect of self-interference** (and its impact upon system capacity and BER) for the selected subcarriers.



▪ DSA-ESINR has better BER performance than DSA-channel gain by 4 dB (at 10^{-5} BER).

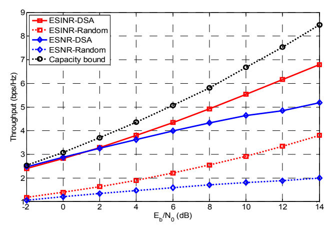
▪ This implied that DSA-ESINR has the **benefit of minimizing the effect of self-interference**, resulting in improvement of BER.



▪ DSA using the ESINR metric has the smallest variance and the largest average channel response, compared to other types of allocation algorithm.

▪ It shows that the proposed algorithm **offers fairness whilst maximizing the average channel gain** of any given user without minimizing it in the other users.

Algorithm	ESINR	Channel gain	Random
Mean (dB)	1.815	1.658	-1.336
Variance	0.6061	1.882	4.972



▪ Average data rate performance for both the ESINR and ESNR systems increases at approximately twice the capacity of random subcarrier allocation.

▪ The proposed algorithm is **able to achieve the desired balance between fairness and system capacity**.

7. CONCLUSIONS

▪ Initial investigation has revealed that the next generation of wireless system would be capable of improving the capacity performance while providing fair gain and improved BER performance.

▪ The proposed algorithm considers co-antenna interference within a SM-OFDMA system.

▪ Future work will focus on investigating BER and capacity performance of the system in correlated channels where the effect of self-interference is more dominant. Based on the initial results, the proposed algorithm can be expected to provide even greater benefits.

ACKNOWLEDGEMENT: Travel grant for this conference is funded by University of Bristol's Alumni Foundation, whose financial support is gratefully acknowledged.