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Selective Interference Alignment for MIMO Cognitive Femtocell Network

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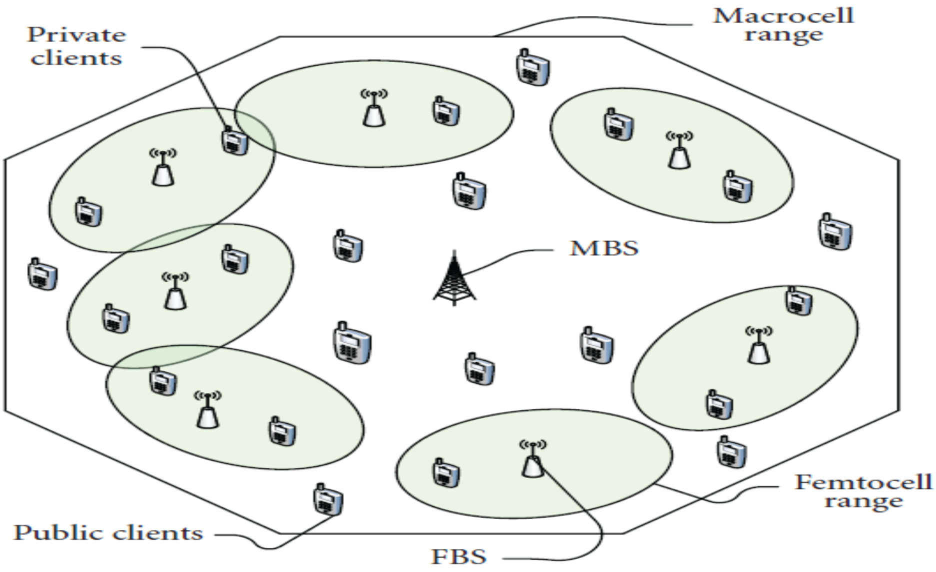
Abstract: **The cognitive users sense their environment to determine the receivers they are interfering with, and adapt to it by designing their precoders using interference alignment. To sense the spectrum using cognitive radios and finds the data transmission in the Femtocell Networks. Align the interference from the Primary users and Secondary users. A cross-tier interference management solution for coexisting two-tier networks by exploiting cognition and coordination between tiers via the use of cognitive radios is presented. This approach chooses the set of users to be aligned at each receiver as a subset of the cross tier interferers, hence is termed selective IA. The proposed solution includes identification of the subspace in which cross-tier interference signals would be aligned followed by a distributed algorithm to identify the precoders needed at the selected interferers.**

Keywords: **Interference Alignment, MIMO, Femtocell.**

I. INTRODUCTION

FEMTOCELL is a small, low-power cellular base station, typically designed for use in a home or small business. A broader term which is more widespread in the industry is small cell, with femtocell as a subset. It connects to the service provider's network via broadband such as DSL or cable, current designs typically support two to four active mobile phones in a residential setting, and eight to 16 active mobile phones in enterprise settings. A femtocell allows service providers to extend service coverage indoors or at the cell edge.



Fig[1] Femtocell Network

To summarize, the capacity benefits of femtocells are attributed to,

1. Reduced distance between the femtocell and the user, which leads to a higher received signal strength.

2. Lowered transmit power, and mitigation of interference from neighboring macrocell and femtocell users due to outdoor propagation and penetration losses.

3. As femtocells serve only around 1-4 users, they can devote a larger portion of their resources are transmit power & bandwidth to each subscriber. A macrocell, on the other hand, has a larger coverage area is covered 500m-1 km radius, and a larger number of users; providing Quality of Service for data users is more difficult.**I**nterference has been a very difficult problem in wireless communications. For instance, the capacity region of two-user Gaussian interference channels For instance, IA is a signal processing approach that attempts to simultaneously align the interference on a lower dimension subspace at each receiver so that the desired signals can be transmitted on the interference-free dimensions. The ergodic alignment scheme, for user time or frequency - selective Interference channels. In practice, since it is not possible to realize infinite dimension symbol extensions, there are a number of works and the reference therein that consider, IA in the spatial domain, without symbol extensions, in the user quasi-static MIMO interference channels. Interference alignment refers to the consolidation of multiple interfering signals into a small subspace at each receiver so that the number of interference-free dimensions remaining for the desired signal can be maximized. Interference alignment (IA) is shown to achieve the maximum number of degrees of freedom in a K-user interference channel by aligning the interfering signals in a lower dimensional subspace at multiple receivers simultaneously.

Practical IA schemes have been developed to date, including minimizing the leakage interference maximizing the SINR, or minimizing MSE. These algorithms are developed for single-tier K-user interference channels, in which each transmitter has an intended receiver, and the remaining transmitters are considered as interferers for that receiver. As an example, the minimum leakage interference/max SINR algorithms proposed in use channel reciprocity and iterate between the receivers and transmitters in order to minimize the leaked interference/maximize the SINR of the intended signal, respectively. Due to the fact that not all the interferers can be aligned at each receiver, there will be residual interference at the receiver. The receiver has interference detection (ID) capability. Specifically, the receiver detects and cancels. The residual interference based on the constellation map derived from the discrete constellation inputs. However, there is a window of unfavorable interference profile for ID at the receiver.

II. LITERATURE REVIEW

H. Huang and V. Lau [1] proposed in this a low complexity Partial Interference Alignment and Interference Detection scheme for -user quasi-static MIMO interference channels with discrete constellation inputs is presented. This method consider QPSK constellations2 at the inputs of the transmitters and each transmit-receive pair may have different path losses. The proposed PIAID scheme dynamically selects the interference alignment set at each receiver based on the path loss information to create a favorable interference profile at each receiver for ID processing. Interference alignment is applied only to the members of the alignment set. Then it derives the average SER by taking into account the non-Gaussian residual interference due to discrete constellation. Using graph theory, it transforms the combinatorial problem into a linear programming problem and obtains a low complexity user set selection algorithm for the PIAID scheme, which minimizes the asymptotically tight bound for the average end-to-end SER performance. Furthermore, using Semi-Definite Relaxation technique, this method proposes a low complexity ID algorithm at the receiver. The SER performance of the proposed PIAID scheme is shown to have significant gain compared with various conventional baseline solutions.

H. Yu and Y. Sung [2] proposed in this problem of interference alignment for -a user time-invariant multi-input multi-output interference channel is considered. The necessary and sufficient conditions for interference alignment are converted to a system of linear equations that have dummy variables. Based on this linear system, a new algorithm for beam design for interference alignment is proposed by minimizing the overall interference misalignment. The proposed algorithm consists of solving a least squares problem iteratively. The convergence of the proposed algorithm is established, and its complexity is analyzed. The performance of the proposed algorithm is also evaluated numerically. It is shown that the proposed algorithm has faster convergence and lower complexity than the previous method with a comparable sum rate performance in the most practical case of two receive antennas.

Shuying Shi et al [3] proposed this problem of mean square error transceiver design for point-to-multipoint transmission in multiuser multiple-input–multiple-output systems is presented. It mainly focus on four optimization problems like minimizing the maximum weighted layer-wise or user-wise MSE under a total power constraint, minimizing the total transmit power subject to a set of layer-wise or user-wise MSE requirements. The iterative algorithms are proposed and prove the monotonic convergence of the algorithms. The major advantages of the proposed algorithms are their low complexity and fast convergence behavior during the first little iteration. The proposed algorithms are suitable not only for downlink transmission, but also for uplink transmission with a total power constraint.

S. Ulukus and A. Yener [4] proposed the iterative transmitter and receiver design algorithms, based on the optimization of the MSE function is developed. The major difference of the MSE from the sum capacity and the TWSC is that the MSE depends on both the transmitters or signature sequences and the receivers or receiver filters. As we will see, even though minimizing the MSE, minimizing the TWSC, and maximizing the sum capacity all yield the same transmitter–receiver pairs in single-cell synchronous CDMA systems, minimizing the MSE produces an alternative iterative algorithm that offers two important advantages over the existing algorithms that minimize the TWSC: it enables online and parallel implementations. The TWSC is a function of the signature sequences only. Algorithms based on the minimization of the TWSC assume either of the following. As the signature sequences are updated, the receiver filters are changed to be the corresponding matched filters instantaneously. The iterations are run off-line only in terms of the signature sequences, and once the signature sequences converge to an optimum set, corresponding matched filters are deployed as receivers.

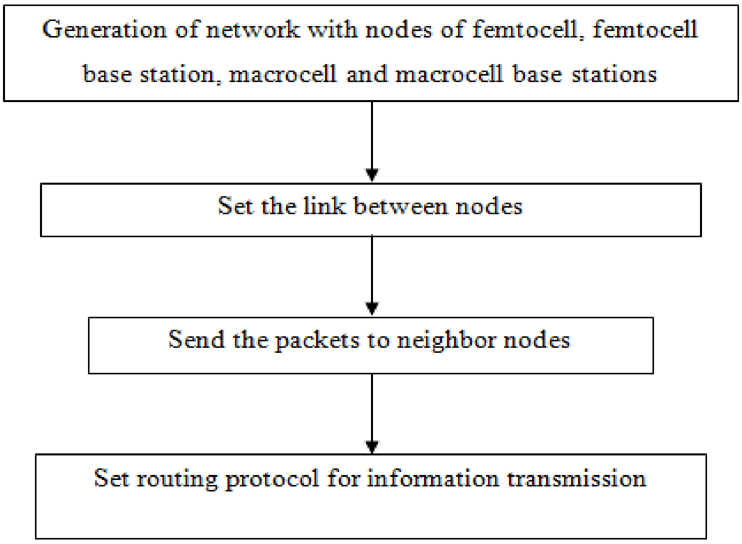
C. M. Yetis, et al [5] proposed the feasibility of interference alignment through beam forming in MIMO interference networks. Accordingly, the proposed scheme considers the alignment problem for an interference network as the solvability of its corresponding multivariate polynomial system. Ideally, it would like to find the conditions that would show the direct link between the feasibility and infeasibility of an interference network and the solvability/non solvability of its corresponding polynomial system. For single beam cases, our results indicate that the solvability of corresponding polynomial systems is based on counting the number of equations and variables in the polynomial systems. The support of this intuition is provided by numerical results for a variety of cases, by presenting closed form solutions for new systems, and by providing rigorous proofs for some important cases. On the other hand, for multi beam cases, the current advancements in algebraic geometry are insufficient to prove the solvability of corresponding polynomial systems. Based on numerical results, it show that the connection between feasible and proper systems can be further strengthened by including information theoretic i.e., general and cooperative outer bounds to our proper system condition. In addition, based on numerical results, we also observe that if the system is improper, then it is infeasible.

Wing-Kin MaTimothy et.al [6] in this paper titled Quasi-Maximum-Likelihood Multiuser Detection Using Semi-Definite Relaxation with Application to Synchronous CDMA proposed the approximation of the MLD solution using relaxation methods. Relaxation is an effective approximation technique for certain difficult optimization problems. Its rationale is simple in that it relaxes some of the constraints of the optimization problem such that the relaxed problem is easier to solve than the original problem. In this work, most of our emphasis will be placed on semi-definite relaxation, which is an accurate and efficient approximation method for certain kinds of NP-hard problems. We will describe the SD relaxation algorithm for the Boolean quadratic-programming problem and will show how this algorithm can be applied to the MLD problem with anti-podal data transmission. There are three advantages of employing SD relaxation. The SD relaxation algorithm is based on solving a convex optimization problem.

III. PROPOSED SYSTEM

A network is designed that tackles the interference management problem in a two-tier cognitive femtocell or macrocell network, where all femto and macrocell users transmit in the same band. The cognitive users sense their environment to determine the receivers they are interfering with, and adapt to it by designing their precoders using interference alignment. Interference alignment with user selection and is appropriately termed selective interference alignment. This is aligning the interference from the Primary user to the secondary users with the help of spectrum sensing. The main objective is to demonstrate the effectiveness of selective IA for both uplink and downlink interference management. Align the interference from the Primary user to the secondary users for data transmission. The cognitive users sense their environment to determine the receivers they are interfering with, and adapt to it by designing their precoders using interference alignment. To sense the spectrum using cognitive radios and finds the data transmission in the Femtocell Networks.

NETWORK DESIGN:



Fig[2] Node Formation

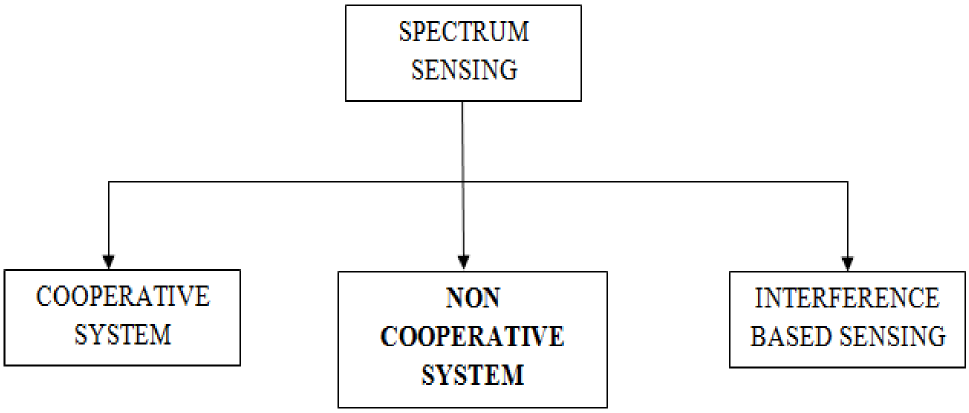
Network Planning and design is an iterative process, encompassing topological design, network-synthesis and network realization and is aimed at ensuring that a new telecommunication networks or service meets the needs of the subscriber and operator. The process can be tailored according to each new network or services. Network planning process,

Topological design:

This stage involves determining where to place the components and how to connect them. The optimization methods that can be used in this stage come from an area of mathematics called Graph Theory. These methods involve determining the costs of transmission and the cost of switching, and there by determining the optimum connection matrix and location of switches and concentrators.

SPECTRUM SENSING:

The major challenge of the cognitive radio is that the secondary user needs to detect the presence of primary user and to quickly quit the frequency band if the corresponding primary radio emerges in order to avoid interference to primary users.



Fig[3] Spectrum Sensing

Interference temperature detection:

In this approach, CR system works as in the ultra wide band technology where the secondary users coexist with primary users and are allowed to transmit with low power and are restricted by the interference temperature level so as not to cause harmful interference to primary users.

Primary receiver detection:

In this method, the interference and spectrum opportunities are detected based on primary receiver's local oscillator leakage power.

INTERFERENCE BY SECONDARY USERS:

Interference alignment for femtocell networks has recently been considered in settings different than ours, namely with orthogonal resource allocation. IA methods proposed for K user Interference channels have been used for mitigating the intra-tier femtocell interference in the downlink of a split-frequency femtocell-macrocell network, in which macrocell and femtocells are assigned separate frequency bands.

In order to align the dominant SU interferers, we define the interference subspaces at each PR such that the received signals from the selected SUs at each PR will span the subspace specific to that PR. For this purpose, we define matrices $\mathbf{V}1,\mathbf{V}2, \ldots, \mathbf{V}F$ such that the columns of these matrices define the basis for the subspaces for the aligned interference at each receiver. That is, each column of $\mathbf{H}jko\mathbf{W}oj$ can be written as a linear combination of the columns of $\mathbf{V}k, \forall j \in Sk$, and $\forall k \in \{1, \ldots, F\}$. The IA condition requires that the received signals from the SU set defined for each PR span the same subspace, which is given as:

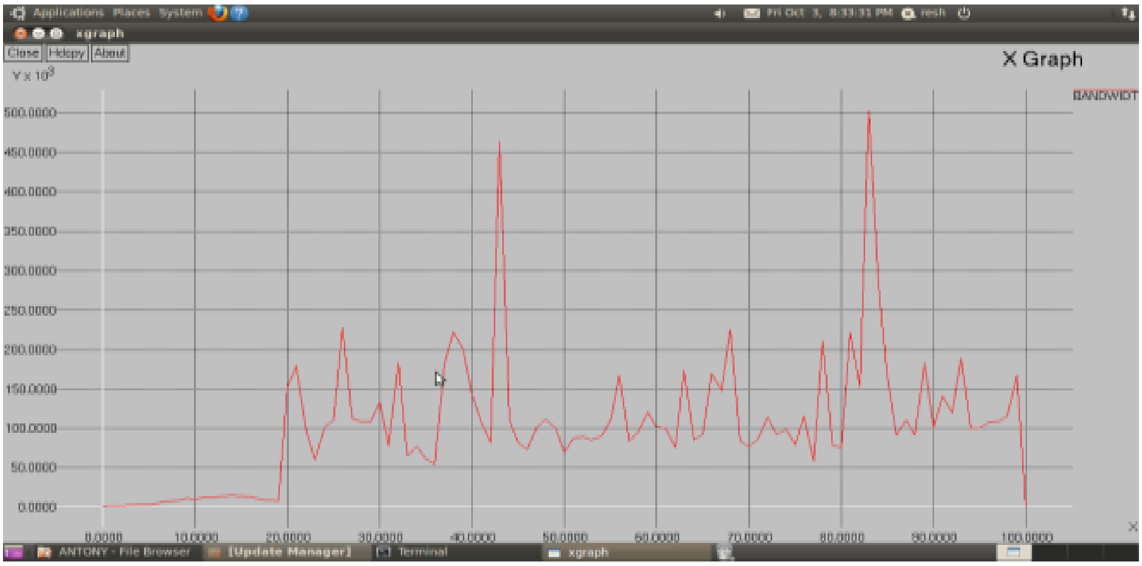
$\mathbf{H}jko\mathbf{W}oj \rightarrow \mathbf{V}k,\ \forall j \in Sk,\ \forall k \in \{1, \ldots, F\}$

INTERFERENCE ALIGNMENT:

Interference channels, where multiple transmit and receive user pairs communicate using the same radio resources, are a building block of wireless networks. The interference channel is a good model for communication in cellular networks, wireless local area networks, and ad-hoc networks. Conventional thinking about the interference channel is that each user pair has no information about other users in the network and therefore its optimum strategy is to be greedy and maximize its own rate. Unfortunately, the sum of the data rates achieved across all user pairs with this strategy is of the same order as the rate of a single communication link. However, has shown that sum rates can scale linearly with the number of users at high SNR, using a transmission strategy known as interference alignment. Interference alignment is a linear precoding technique that attempts to align interfering signals in time, frequency, or space.

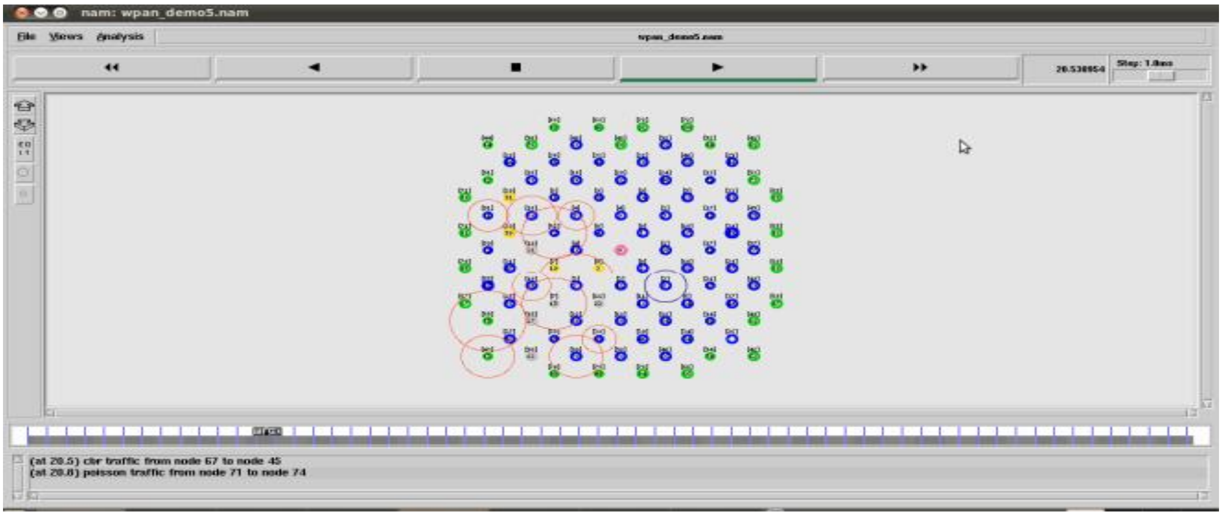
IV. RESULTS AND DISCUSSION

BANDWIDTH:



The maximum data rates of the transmission between Primary and Secondary users in the bandwidth graph.

INTERFERENCE ALIGNMENT:



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(at 20.5) cbr traffic from node 67 to node 45
(at 20.8) poisson traffic from node 71 to node 74
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Align the interference to the secondary users with the help of sensing their environment. The interference was aligned and which is denoted by the round shape. Interference channels, where multiple transmit and receive user pairs communicate using the same cognitive radio resources, are a building block of wireless networks.

V. CONCLUSION

This scheme uses a cognitive radio principle that is applicable to a two-tiered network where the interferers from one tier are distributed over the whole network. It mainly focuses on a heterogeneous system with coexisting cognitive femtocells and a macrocell, and proposed using user selection at the FBSs combined with a distributed IA algorithm to eliminate the destructive uplink macrocell interference at the FBSs. The proposed algorithm is constructed in such a way that is specifically applicable to the tiered network and that it mitigates the problems that may arise from using a centralized IA algorithm, due to backhaul limitations and the excessive load caused on the network. Future work includes considering QoS requirements of the MUs, and designing robust systems with reduced complexity, and incomplete/estimated channel state information.

REFERENCES

[1] Cadambe .V.R and Jafar.S.A (2008), 'Interference alignment and degrees of freedom region for the K user interference channel,' IEEE Trans. Inf. Theory, vol. 54, no. 8, Aug.

[2] Huang.H and Lau.V, (2011) 'Partial interference alignment for K-user MIMO interference channels,' IEEE Trans. Signal Process., vol. 59, no. 10, pp. 4900–4908.

[3] Lv.H, T. Liu .T, Hou .X, and Yang .C (2010), 'Adaptive interference alignment for femtocell networks," in Proc. IEEE Int. Conf. Signal Process. (ICSP).

[4] Pantisano .F, Bennis .M, Saad.W and Debbah .M (2011), 'Cooperative interference alignment in femtocell networks,' in Proc. IEEE Global Telecom. Conf. (Globecom).

[5] Shuying Shi, Martin Schubertand Holger Boche (2008), 'Downlink MMSE Transceiver Optimization for Multiuser MIMO Systems: MMSE Balancing', IEEE Transactions On Signal Processing, Vol. 56, No. 8.

[6] Ulukus. S and Yener. A (2004), 'Iterative transmitter and receiver optimization for CDMA networks,'IEEE Trans. Wireless Commun., vol. 3, no. 6, pp. 1974–1979.

[7] Wing-Kin MaTimothy, Davidson .N, Kon Max Wong, Zhi-Quan Luoand Pak-Chung Ching, (2002), 'Quasi-Maximum-Likelihood Multiuser Detection Using Semi-Definite Relaxation With Application to Synchronous CDMA', IEEE Transactions On Signal Processing, Vol. 50, No. 4.

[8] Yetis. C.M, Gou. T, Jafar. S.A, and Kayran. A.H (2010), 'On feasibility of interference alignment in MIMO interference networks,'IEEE Trans. Signal Process. vol. 58, no. 9, pp. 4771–4782.

[9] Yu.H and Sung.Y,(2010) 'Least squares approach to joint beam design for interference alignment in multiuser multi-input multi-output interference channels,' IEEE Trans. Signal Process., vol. 58, no. 9.