Interference Management Techniques for Heterogeneous Networks

N. Gauthaman, B. JesvinVeancy and P. Yogesh

1PG Scholar Dept. of ECE Easwari Engineering College, Chennai
2Assistant Professor Dept. of ECE Easwari Engineering College, Chennai
3Associate Professor Dept. of Information Science and Technology Anna University, Chennai

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ABSTRACT

The future wireless communication is expected to improve the efficiency of spectrum usage. For high data rate wireless transmission, orthogonal frequency division multiplexing (OFDM) technique is adopted. Interference management and Spectral Efficiency improvement are considered to be the key features in wireless communication networks, due to high mobile data traffic, interference problem arises which leads to the inter-cell interference and co-channel interference between the Base Stations (BS) and with User Equipment’s (UE). To outstrip this problem, several major interference management techniques are available such as interference coordination, interference cancellation, interference alignment and coordinated multipoint transmission and reception (CoMP). Interference mitigation in heterogeneous networks using coordinated multipoint transmission and reception technique is analyzed using LMMSE equalizer, which enables the User Equipment to transmit and receive signals by coordinating with multiple base stations. Interference avoidance between the base station and User Equipment improves the spectral efficiency. Channel estimation between different channels (AWGN, RAYLEIGH, RICIAN) has been compared based on SNR (dB) and BER.

KEYWORDS: Linear Minimum Mean Square Error Equalizer (LMMSE), Coordinated Multipoint Transmission and Reception (CoMP), Spectral Efficiency (SE).

INTRODUCTION

In wireless communication systems, recently there has been a rapid growth in the improvement of spectral efficiency and reliability, the main challenge is to deal with the interference problem in wireless networks. Interference may limit the throughput and reliability in the wireless communication system. In order to overcome this interference problem orthogonalize the users transmission in frequency and time or by increasing the transmission power. By reducing the interference problem in wireless communication system, we tend to enhance the spectral efficiency to achieve high performance in the network, interference management techniques is needed to manage the interference problem, some of the techniques are interference coordination, interference cancellation, coordinated multipoint (CoMP) and interference alignment.

However the interference management techniques are adopted to increase the spectral efficiency, and a new class of wireless system to manage interference are interference exploitation and interference shaping, here the interference exploitation harness interference in decoding side information to increase data rates and the interference shaping technique creates a linear combination of the interference signals when the transmitters propagating the signals to minimize the interference at each receiver, both effects tend to improve the performance of the communication system by limiting the interference signals[1] Proposed a scheme for interference management and spectral efficiency improvement which is based on signalling transmission and data transmission, this scheme faced some of the critical issues in deploying small cells in macro cells and also the cost, complexity problem are higher[2] Proposed to solve the handover problem and cooperative interference management in heterogeneous cloud small cell networks(HSCNet), here the scheme have some handover
problems and signalling flows in HSCNet because it is different from traditional small cell networks[3] In small
cell networks’adaptive resource allocation is carried out for interference management by adapting graph
coloring, here the computational complexity, design consideration and latency problem is found[4] Proposed a
scheme based on two-tier HetNet. In which small base stations are arranged near the edges of the macro cells,
here the degradation in the performance of the cell edge mobile users occurs in the UDC (user data channel)configuration[5] Interference management in OFDMA femto cell have been discussed, to reduce the
problem of interference in femto cell networks.

The Heterogeneous network is a combination of small cells (pico, femto) and macro cells, used together to
provide a larger coverage area and handoff capability between different networks, this HetNet improve the
quality of service between the users and massive accessibility within the network, however the performance of
the network and coverage area tends to be better than the other networks.

![Heterogeneous Network](image)

**Fig. 1: Heterogeneous Network**

*Interference Mitigation Techniques:*

Most critical issue in the deployment of femto cell in the macro cell are potential interferences, to reduce
the interference in the wireless communication system some of the major techniques are interference
coordination, interference cancellation, coordinated multipoint transmission and reception and interference
alignment.

Intercell interference and co-channel interference is reduced by the intercell interference coordination
technique (ICIC).In [6] the interference coordination and cancellation for 4G network has been proposed to
solve the interference coordination problem. The main aim of this concept is to coordinate the resource
(frequency and power) in nearby cells. For SE, AFFR (adaptive fractional frequency reuse) is the flexible
technique for adjusting the femto cell location and the dynamic information.

Initially coordinated multipoint transmission and reception technique has been proposed by [7] the main
concept behind this technique is coordinate the multiple base stations, so that the users can transmit and receive
signals without any interference between the UE and base stations, however this CoMP can be achieved by joint
processing and joint transmission. Which tends to increase the spectral efficiency using zero forcing algorithm.
Also the CoMP technique is achieved by MIMO (MU-MIMO) network. In [8] proposed the interference
mitigation in cellular networks which is based on the network-centric cooperation scheme. In [9] manage the
interference based on fractional frequency reuse scheme; here the frequency factor is reused in HetNet in LTE
advanced.

In [10] proposed the scheme to reduce the interference in the 4G network based on interference cancellation
and coordination (i.e.) coordinate the resource (power and frequency) factors. In [11] small cell networks,
manage the interference by high capacity hotspots technique. In [12] referring this paper, interference mitigation
is carried out by using almost blank sub frames in HetNet LTE networks while transmitting the information.
Another technique to reduce the interference at high signal to noise ratio (SNR), here in this technique each user
reaches high degrees of freedom (DoF). DoF measures the improvement of the sum rate accordance with the
signal to noise ratio (SNR). In IA, the receiver subspace is divided in to two types namely interference subspace
(ISS) and useful subspace (uss). The core technique is to (USS) align the interference signal to the (ISS) at the
receiver. In [13] cognitive radio technique is proposed to manage interference in the small cell or macro cell
(combination of small cell and macro cell is the HetNet). In [14] proposed the adaptive fractional frequency
reuse technique to manage the interference in the inter-femto cell interference. In [15] uplink multi-cell system,
interference mitigation is done, here proposed the green inter-cluster technique to manage the interference
towards uplink system.
The main concept of interference cancellation is to regenerate the interference signals by coding techniques and subtract them from the desired signals. This IC technique is divided into two schemes, namely pre IC (by dirty paper coding) and post IC (successive interference cancellation (SIC)). SIC technique combined with OFDM to form SIC-OFDM, which is implemented at the receiver side.

Analysis of Comp Technique:

Coordinated multipoint transmission and reception:

Coordinated multipoint transmission and reception technique enable the user equipment to transmit and receive signals by coordinating with multiple base stations. CoMP transmission are classified as Coordinated Scheduling, Coordinated Beam-Switching, Joint Transmission and Dynamic Point Selection. CoMP technique transmit and receive antenna signals from multiple antenna site regions, which may be or may not be the same physical cell, also it increase the received signal quality and thereby decreases the received spatial interference. However, besides power and frequency, spatial resource can be utilized for coordination. CoMP is based on the multi user (MIMO) networks, which can be achieved by joint processing and joint transmission.

The analysed technique involves dynamic allotment (or) transmission and reception with multiple separated eNBs, the main aim is to increase the overall performance of the system, utilizing the resources efficiently and then improving the end user service quality.

Fig. 2: CoMP Flow Diagram.

CoMP technique coordinate the multiple base stations, which makes the user equipment to transmit and receive signals. Consider the base stations BS1, BS2 and BS3, which covers the maximum cell range as shown in Figure 2 and the mobile users are UE1, UE2 and UE3 within the boundary range. Each base station and user UE can simultaneously send and receive signals without any interference between them. LMMSE equalizer is used to improve the spectral efficiency, thereby reduces the interference problem between the base station and the user terminal. SE achieved higher than the previous work and the cost, complexity problem is reduced by without deploying the base stations.

Algorithm for Comp Analysis:

Step 1: Orthogonal signal generation.
Step 2: Assign the number of femto base stations.
Step 3: Assign the scale factor (0.7071) and zero forcing factor (-1.2500).
Step 4: Orthogonal signal is generated and transmitted over the channel length.
Step 5: Coordinate the multipoint femto base stations.
Step 6: Perform joint processing and joint transmission.
Step 7: Transmission of multi sequence signal with multiple base stations.
Step 8: Calculate the average value.
Step 9: Calculate the spectral efficiency.

Simulation Results:

Comparison of Different Interference Mitigation schemes on Signaling Transmission by Comp Technique using LMMSE Equalizer:

Consider a HetNet with three base stations and about three user equipment’s. The number of femto base stations located within the coverage range is about 2-16 with 10m radius. Lines plotted in Figure 3 compares the spectral efficiency of the existing method with eICIC on signalling transmissions and without any
IM on signaling transmissions. Result shows that our scheme improves the spectral efficiency with high network performance. It is obvious that as the number of FBSs incremented, spectral efficiency first increases quickly and then becomes lower. This is because, spectrum resource scarcity occurs and the interference problem becomes higher, also the utilization rate of spectrum is lower.

Fig. 3: Comparison of different interference mitigation schemes on signaling transmission.

The analysed scheme compares the different interference mitigation schemes on signaling transmission by CoMP technique using LMMSE equalizer as shown in Figure 4. While the lines with stars represent the no IM signaling transmissions using LMMSE Equalizer, the line with sphere represents the eICIC on signaling transmissions using LMMSE Equalizer, the triangle line represents the improved SE, simulating that our analysed scheme achieves better spectral efficiency.

Fig. 4: Comparison of different interference mitigation schemes on signaling transmission by comp technique using LMMSE equalizer.

Channel Estimation using ZF algorithm is shown in Figure 5. In the OFDM systems, ZF beam forming is required to convey the information from transmitter to receiver. Comparisons of different MIMO OFDM channel estimation schemes (AWGN, RAYLEIGH, and RICIAN) are discussed. Transmission of information through AWGN channel is better than the RAYLEIGH and RICIAN channels. While the signal to noise ratio (SNR) increases by reducing the Bit Error Rate (BER).
The power dissipation minimization using ZF PSD (Power Spectral Density) in which power and capacity constraints are investigated as shown in Figure 6. Comparisons of power dissipation minimization over different channels are discussed. Simulation results indicate that the power dissipation is lower in AWGN channel than the other channels (RAYLEIGH, RICIAN), when the power dissipation is reduced, the energy factor (Eb/N0) is increased.

Inter carrier interference reduction using ZF beam forming is shown in Figure 7. Orthogonal frequency division multiplexing (OFDM) transmission is widely used for the transmission of orthogonal signals. If the signal is transmitted in a band limited channel. Some spectrum shortage problem arises in the channel, which leads to the interference between the signals. In order to overcome this interference problem, window function is multiplexed to the transmitted signal. Inter carrier interference is reduced if the product of the window function satisfies the Nyquist criterion.
Conclusion:

Deploying femto base stations in the macro cell is a promising technique to improve the spectral efficiency. Efficiency increased slowly by large number of femto cells are deployed in a macro cell. Here intercell interference problem arises in the HetNet. To overcome this problem several major interference management techniques are proposed. The analysed scheme based on interference management in HetNet using CoMP technique by LMMSE equalizer reduces the interference between the base station and user terminal and thereby improving the SE. Channel estimation using ZF algorithm based on OFDM, such that the information on each subcarrier has to be conveyed from transmitter to the receiver and then reduce the channel feedback requirements in OFDM system. Power dissipation minimization using ZF PSD is done by comparing the power and energy. When the power desperation decreases, energy will be increased gradually. Inter carrier interference reduction using ZF beam forming is carried out by comparing the SNR and BER (jitter effect). Thus the simulated result achieves a better spectral efficiency.

REFERENCES