RESOURCE ALLOCATION USING COORDINATED MULTIPOINT IN LTE-ADVANCED

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Abstract

The research shows that Coordinated Multi Point (CoMP) transmission can improve significant gains in terms of the overall capacity of cell and the throughput of cell-edge user. The main purpose of this paper is to enhance the throughput of cell and, the cell-edge user's, and the user equipment terminals (UEs) in LTE-Advanced (LTE-A) systems using CoMP[15].

In this paper we propose a scheme for coordinated multipoint (CoMP). The transmit power is allocated to spatial layer under the total base station power constraint and the per base station power constraint[1]

Keywords: LTE A, CoMP, UE, MIMO, 3GPP

Introduction

In order to maintain the competitiveness of the 3GPP cellular system, Long Term Evolution (LTE), is developed. For downlink transmission the technique selected is Orthogonal frequency division multiple access (OFDMA). In this time and frequency resources are reused in adjacent cells, inter cell interference becomes the crucial limiting factor. This problem can be overcome by using interference mitigation techniques. The interference mitigation techniques are interference cancellation, interference coordination and the third one is interference randomization currently investigated within 3GPP [13]. However, by using these techniques also the performance or improvements offered by the mitigation techniques are limited since inter cell interference is difficult to remove completely. A promising method to provide high spectral efficiency in downlink transmission is coordinated multi-point (CoMP) [2], It is called as network MIMO(multiple input multiple output). CoMP technique is one of the techniques of LTE-A under investigation to achieve the spectral efficiency requirements for LTE-A [3]. The advances in wireless communications such as the use of multiple-input-multiple-output (MIMO) systems and orthogonal frequency division multiplexing technique (OFDM) have managed to reduce the detrimental effect of fading in cellular systems. Therefore, the capacity of wireless cellular networks is mainly limited by interference.

In coordinated multipoint transmission (CoMP) technique, multiple base stations (BSs) share data and channel state information via a high-speed backbone network to coordinate their transmissions. By multiple BSs combining together to turn unwanted intercell interference (ICI) into useful signals, CoMP techniques mitigate ICI and improve spectral efficiency. In multiple input multiple output orthogonal frequency division multiple access (MIMO-OFDMA) system, its channel is braked down into parallel sub-channels in the space and frequency domains [4], [5]. It enables flexible resource allocation (RA) to improve the resource utilization and throughput of the system [6]–[9]

CoMP is a new technology based on network MIMO. The data rates targeted by LTE-A require a great improvement in the SINR at the UEs, CoMP will increase data transmission rates on LTE-A networks. By coordinating or combining signals from multiple antennas, CoMP technology makes it possible for UEs to enjoy consistent performance whatever may be the condition whether they are close to the center of the cell or at its outer edges.

The basic principle of CoMP, is to make use of multiple transmit and receive antennas from multiple antenna site locations, which may or may not belong to the same cell, to improve the received signal quality as well as to reduce interference, increase the spectrum efficiency and enhance effective coverage area by making use of the co-channel interferences. CoMP mainly has been targeted to increase the cell-edge UE experience, but despite of the location it also use to enhance system throughput to UEs those experience strong signals of different BSs/cells. The main categories of CoMP are inter-site CoMP and intra-site CoMP. In inter-site CoMP, the coordination is performed between BSs located at separated geographical areas. Where the intra-site CoMP enables the coordination between sectors of the same BS, where the coordination is done through multiple Antenna Units that allow the coordination between the sectors. Figure 1 illustrates both CoMP categories[14].

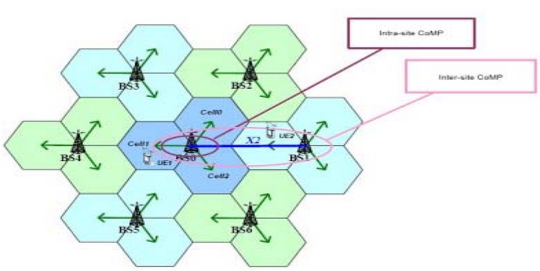


Fig 1 CoMP categories

The main objectives of CoMP are

1. To mitigate the interference;
2. To provide high spectral efficiency over the entire cell area; and
3. To increase the overall throughput especially the cell-edge throughput . [6]

Although CoMP naturally increases the complexity of system, it provides significant capacity and coverage benefits, making it worth a more detailed consideration.

The coordination in CoMP technology are as simple as in the techniques that focus on interference avoidance or more complex as in the scenario where the same data is transmitted from multiple transmission channels. In CoMP systems, two approaches are mainly considered. The first is coordinated scheduling (CS) where the data is transmitted from one RRE at a time with scheduling decisions made with coordination between all RREs. The second approach is joint processing (JP) where the data is made available at each RRE and then transmitted from various RREs simultaneously to each UE. JP is achieved by means of precoding, typically precoding matrices are selected so that the received signal-to-interference-plus noise ratio (SINR) is maximized at each scheduled UE.[13]

In this case, the transmission to a single scheduled UE is performed by a unique RRE (each UE receives the data from its serving RRE), see Figure 2[15] for reference, where the solid line indicates signal and the dotted one indicates interference. However; the scheduling, including any transmission weights, is dynamically coordinated between the RREs in order to control and/or reduce the unnecessary interference between different transmissions. In principle, the set of best serving UEs will be selected so that the transmitter beams are constructed to decrease the interference where as UEs, while increasing the served UE’s signal strength. So, the cell-edge user throughput can be improved due to the increase in the received Signal-to-Interference-plus-Noise-Ratio (SINR)

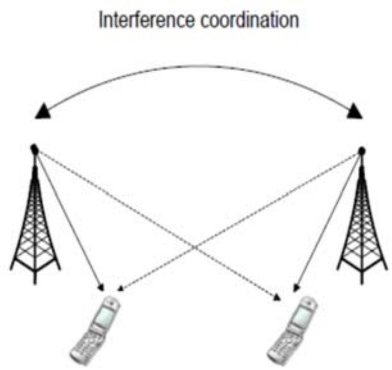


Fig.2 Coordinated Scheduling CoMP

Finding an optimal RA for CoMP schemes so as to maximize the sum rate is a very complicated problem. Hence, many suboptimal strategies have been proposed. In, RB optimization was explored considering a single RB. Two sectors and two UEs were considered such that each sector serves one UE. The purpose was to maximize the sum rate for both UEs. The conclusion was that the optimal power allocation is binary; either both sectors transmit with full power or just one of them transmits at full power and the other is turned off. In the case of multiple RBs, an algorithm must determine which RB should be allocated to a specific UE and how much power should be allocated to each of the scheduled RBs given the overall power limitation. An optimization problem should be solved to maximize the sum rate subject to power and bandwidth constraints while taking into consideration the interference between sectors. In, a model with two sectors and multiple RBs was considered. It was proved that if one RB is used by both sectors, then all RBs need to be used by both sectors (i.e. a frequency reuse of 1). Similarly, if one RB is used by exactly one sector, then all RBs need to be used by exactly one sector.

System Model

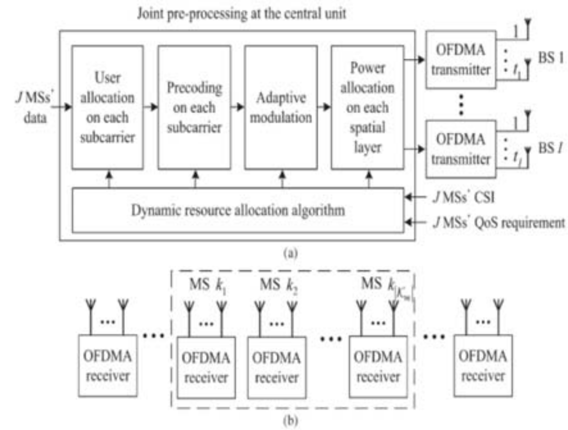


Fig.3 System model. (a) Transmitter structure. (b) Receiver structure.

The system model consist of :

1. Transmitter structure
2. Receiver structure

In the proposed schemes[1], the pre- and post processing of data are used to cancel inter user interference and decompose a single-user MIMO channel into parallel non interfering spatial layers. The transmit power is devoted to the spatial layers to maximize the sum rate. When adaptive modulation is adopted , the transmit power is sequentially allocated to increase the number of bits per symbol on every spatial layer under TBPC and PBPC according to the channel condition.

Algorithm:

Algorithm 1: TBPC

Set $M = \{1,2,\dots\dots,M\}$,

$K=\{k_1, k_2, \dots\dots, k_{|km|}\}$,

$L_{m,kj} = \{1,2,3\dots,l_{m,kj}\} \forall m,kj$

Set $b_{m,kj,l} = 0$ and $p_{m,kj,l} = 0 \forall m,kj,l$

Step 2:

Calculate $P_{m',kj',l'} = g(b'_{m',kj',l'} + 2,$

$\sum'_{m',kj',l'} BER^{target}_{m',kj',l'})$

Step 3: TBPC

$if\ \sum_{i=1}^{I}\sum_{m=1}^{M}\sum_{kj\in Km}\sum_{l=1}^{Lm,kj}\|P^{\ i}_{m,kj,l}\|^2\ P_{m,kj,l}\ \leq P_{tot},\ \ Calculate\ b'_{m',kj',l'} = b'_{m',kj',l'} + 2$

If $b'_{m',kj',l'} = 6, then\ L_{m',kj'} = L_{m',kj'} - \{l'\}$

And go to step 2,

Otherwise go to step 2.

Otherwise calculate $P_{m',kj',l'} = g(b'_{m',kj',l'} \sum'_{m',kj',l'} BER^{Target}_{m',kj',l'}\ )$

Finish the algorithm

Algorithm 2: PBPC

Steps 1 and 2:These are the same as step 1 and step 2in algorithm 1

Step 3: PBPC

If

$$\sum_{m=1}^{M}\sum_{kj\in Km}\sum_{l=1}^{L_{m,kj}}\|P^{i}_{m,kj,l}\|^2\ P_{m,kj,l} \leq P_{per}\forall i$$

Calculate $b'_{m',kj',l'} = b'_{m',kj',l'} + 2$

If $b'_{m',kj',l'} = 6, then\ L'_{m',kj'} = L'_{m',kj'} - \{l'\}$

And go to step 2

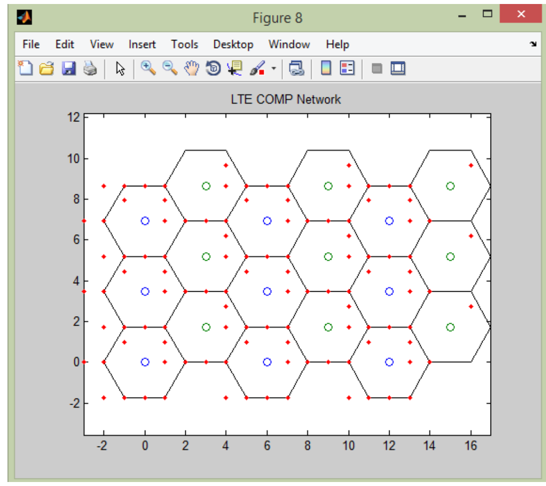
Otherwise go to step 2.

Otherwise calculate $P_{m',kj',l'} = g(b'_{m',kj',l'} \sum'_{m',kj',l'} BER^{Target}_{m',kj',l'}\ )$

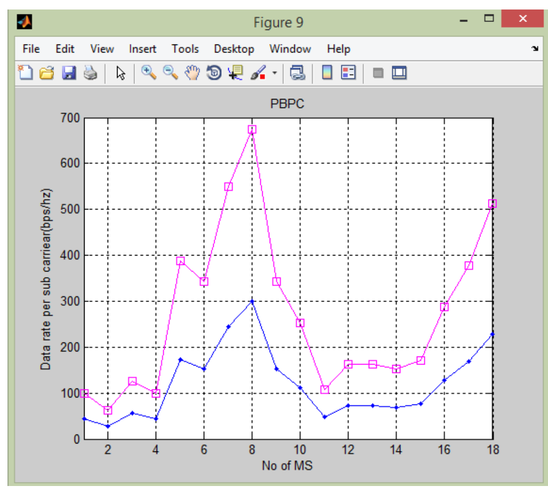
Finish the algorithm

Result :

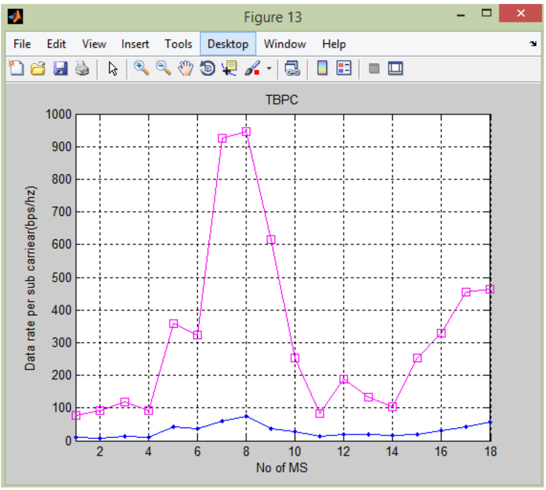
1. LTE network
   Here we have shown the CoMP network. In this we have created the cluster of cells and mobile users.



2. PBPC Algorithm
   In PBPC algorithm we have plotted the graph of number of mobile stations verses Data rate per subcarrier. Here we have plotted the graph for Per Base station Power constraints.



3. TBPC Algorithm
   In TBPC algorithm we have plotted the graph of No. of mobile stations verses data rate per subcarrier.
   In TBPC method we achieve higher data rate as compared to PBPC



Conclusion :

In LTE Advanced technology by using coordinated multipoint technology we can achieve higher data rate as compared to normal scenario.

It is shown that the proposed schemes achieve higher data rate than the conventional cellular system with multiuser MIMO-OFDMA. The reason is that the proposed schemes can cancel ICI

By using TBPC algorithm we can achieve higher data rate than PBPC algorithm because PBPC is more stringent than TBPC.

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