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Throughput Calculation according to User Location in LTE-A Network

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***Abstract*—** LTE-A is a very advanced and very adaptive intelligent network. Use of femto cells increases its capacity without increasing the installation cost of the network. Mostly femto cells are deployed by home users itself so a service has not to worry about installation cost. But due to co-channel operation interference increase between femto & macro users which can be reduced by using cross-tier interference cancellation strategy. In this paper analysis of LTE-A system has been done. This paper proposes a simulator that consists of practical deployment conditions, random user distribution, random building generation, MIMO and different coordinated multipoint schemes. This simulator takes into account both types of cross-tier interference, i.e., the macrocell interference to users attached to femtocell and the femtocell interference to users attached to macrocell.

***Index Terms*—** **COMP, Frequency Reuse, LTE-A, MIMO, Throughput.**

I. Introduction

The need for high data speed is rapidly increasing day by day and the main reason for this increment is the availability of smart devices, and social networking facilities. Enhancement in data rate is constantly required in wireless communication technology. Long Term Evolution-Advanced (LTE-A) is the promising solution for wireless broadband services. LTE-Advanced is also known as 4G wireless networks [1]. It is an evolution of LTE Rel-8. This paper focuses on LTE-Advanced systems and femtocell technologies. Femtocells, also referred to as femto or Femto Base Stations (FBSs) or Home Node-Bs (HNBs) are data access points installed by the subscribers to provide better indoor voice and data coverage and to increase system capacity [2]. The integrated femtocell / macrocell networks offer an efficient way to increase access capacity by improving coverage and quality of service. Femtocells are an attractive solution for providing better coverage and capacity and low cost for deployment and maintenance [3]. However, their performance is restricted by the cross-tier interference with macrocell base station coverage or between adjacent femtocell base station coverage, especially in the case of co-channel deployment. A simulator is designed that consists of practical deployment conditions, random user distribution, random building generation, MIMO and different coordinated multipoint schemes.

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Coordinated multi-point (COMP) transmission / reception are considered for LTE-Advanced technology as a tool to improve the coverage of high data rates, the cell-edge throughput and to increase the system throughput [4]. This can be achieved using coordination between nearby base stations and the serving base station. MIMO can be used to increase the throughput of cell center and edge users. In MIMO 8x8 antenna array is used. Cell center users will get different data streams at each MIMO link and cell edge users will get same data on each MIMO link. Interfering elements like walls are taken as random to create a practical scenario and to get close to genuine results as much as possible. Use of new techniques gives very high enhancement in throughput. As the enhancements in the wireless technologies are coming data rates for end users are increasing and data cost decreasing for users. As the bandwidth increase implemented with highly adaptive systems throughput increases due to decrease in interference from nearby transmissions. So implementation of LTE-A is a very good decision for serving users with high data rates.

COMP is also known as network MIMO or Co-operative MIMO. The primary difference between standard MIMO and COMP is that in the COMP, the transmitters are not physically co-located as shown in Fig. 1.1

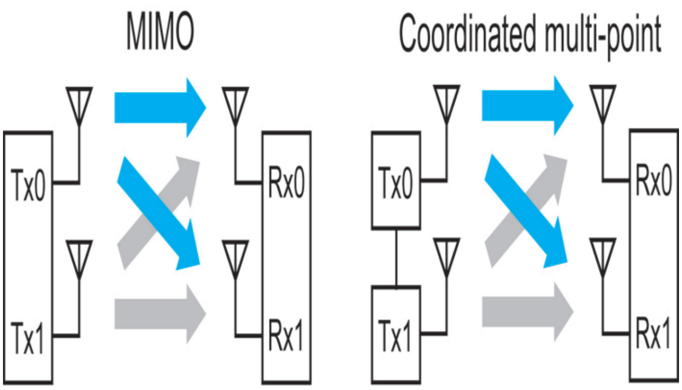

Fig. 1.1 Standard MIMO versus COMP

The paper is organized as follows. In Section 2 simulator architecture is described. In section 3 results of the work are shown. Finally, the paper is concluded in Section 4, and future scope is discussed in Section 5.

II. SIMULATOR ARCHITECTURE

Firstly, User input is given in the form of the random location coordinates of femtocells, femto users, fixed macro cell coordinates, the number of expected users required, channel bandwidth, desired femtocell range. Based on the selection of user input, path-loss and gain are calculated s shown in Fig. 2.1.

For edge users for which the path-loss of the original base station is more than the adjacent base station, COMP is applied. For edge users MIMO is also applied, whose results are shown separately.

Afterwards, depending on the interference technique chosen, the signal to interference + noise ratio (SINR) is calculated, followed by the throughput evaluation.

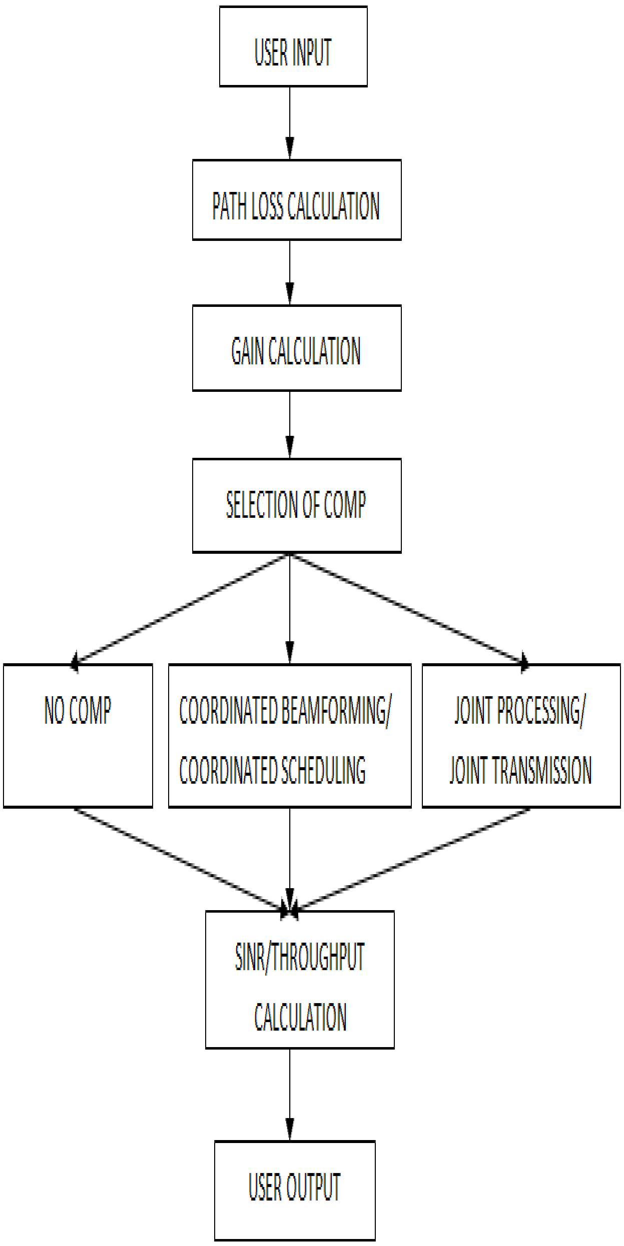

Fig. 2.1 Flowchart

III. SIMULATION RESULT

A. SIMULATOR DETAILS

The red circles shows the femto cells, the hexagonal structure shows macro cell, square structures shows the buildings which are used for interference calculation, in the middle of the picture there is an macro enodeB, blue dots shows femto users, green dots shows macro users, outdoor walls are shown between users and base stations. Distances between users and base stations are also shown. Simulator is easy to use and flexible to change for end users. The simulation parameters are shown in Table 3.1.

Table 3.1 Simulation Parameter Table

PARAMETERS	VALUE
MACROCELL RADIUS	250 m
FEMTO CELL RADIUS	20 m
FREQUENCY	2 GHz
MACRO BS POWER	46 dBm
FEMTO BS POWER	20 dBm
OUTDOOR WALL LOSS	15 dB
INDOOR WALL LOSS	7 dB
BANDWIDTH (MHz)	20
MODULATION SCHEME	64 QAM
SUBCARRIER SPACING	15 KHz
WHITE NOISE POWER DENSITY	-174 dBm / Hz

B. DEPLOYMENT SCENARIO

In this the simulation is done on centre macro base station. Adjacent base stations as well as adjacent to adjacent base stations are taken, to take into account the interference from adjacent base stations. If the scenario is co-channel the interference will be from adjacent base stations on the centre base station users. If the scenario is IFR, the interference will be from adjacent to adjacent base stations because same frequencies are not allocated to adjacent base stations. Fig. 3.1 shows the perfect deployment of base stations but practically this is not possible at all times in an urban area scenario, as shown in Fig. 3.2, due to social and other factors. There are coverage gaps left in between which can be overcome by relaying at the cell edges to increase the coverage of macro cells in the areas of low and no coverage. These two types of scenarios are shown to understand the practical network deployment. By seeing these scenarios a viewer can easily understand how the network has been deployed in the practical environment.

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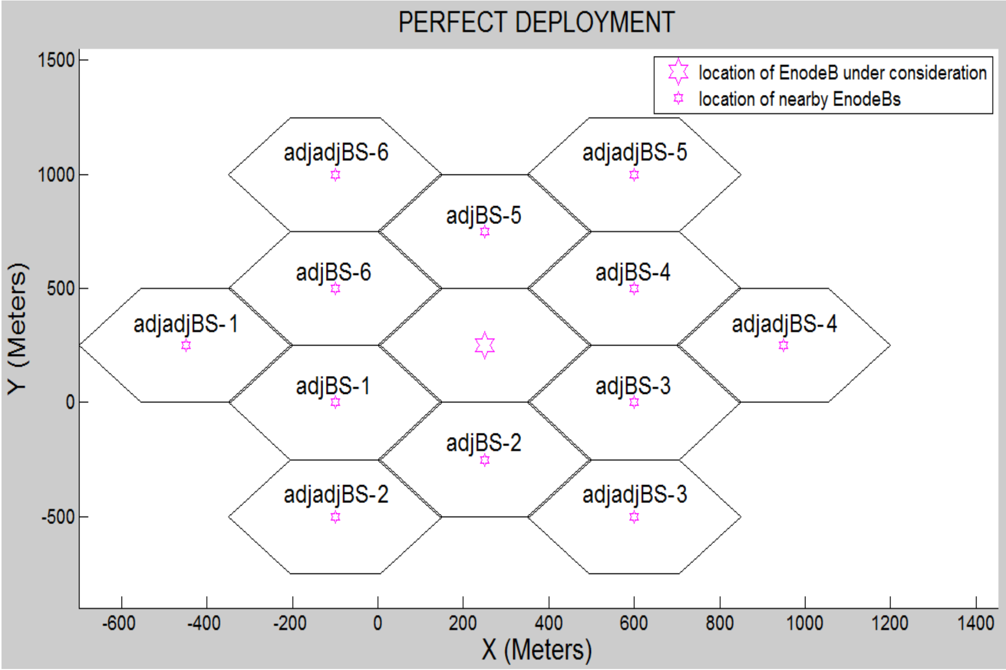

Fig. 3.1 Perfect deployment

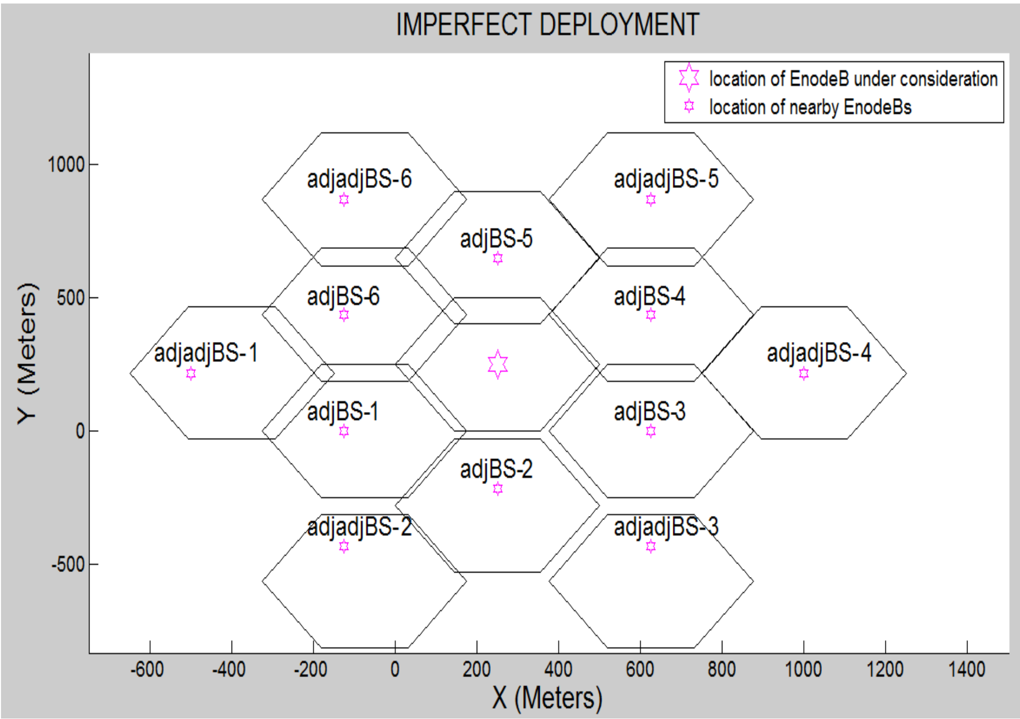

Fig. 3.2 Imperfect deployment

C. THROUGHPUT AT DIFFERENT USER POSITIONS

In this different positions of femto and macro users, with different no. of walls in between users and base stations, with user distances from their serving base stations, users indoor or outdoor are shown and their effect on throughput. Fig. 3.3 shows the first position of users. In this femto user is 19 m away from FBS and is indoor user with no wall in between user and its serving base station having throughput 46.0858 Mbps whereas macro user is 67 m away from MBS and is indoor user with one wall in between user and its serving base station with throughput 95.463 Mbps. With user new position which is shown in Fig. 3.4. In this femto user is 5m away from FBS and is indoor user with no wall in between user and its serving base station having throughput 108 Mbps whereas macro user is 215 m away from MBS and is indoor with one wall in between user and its serving base station having throughput 48.3328 Mbps.

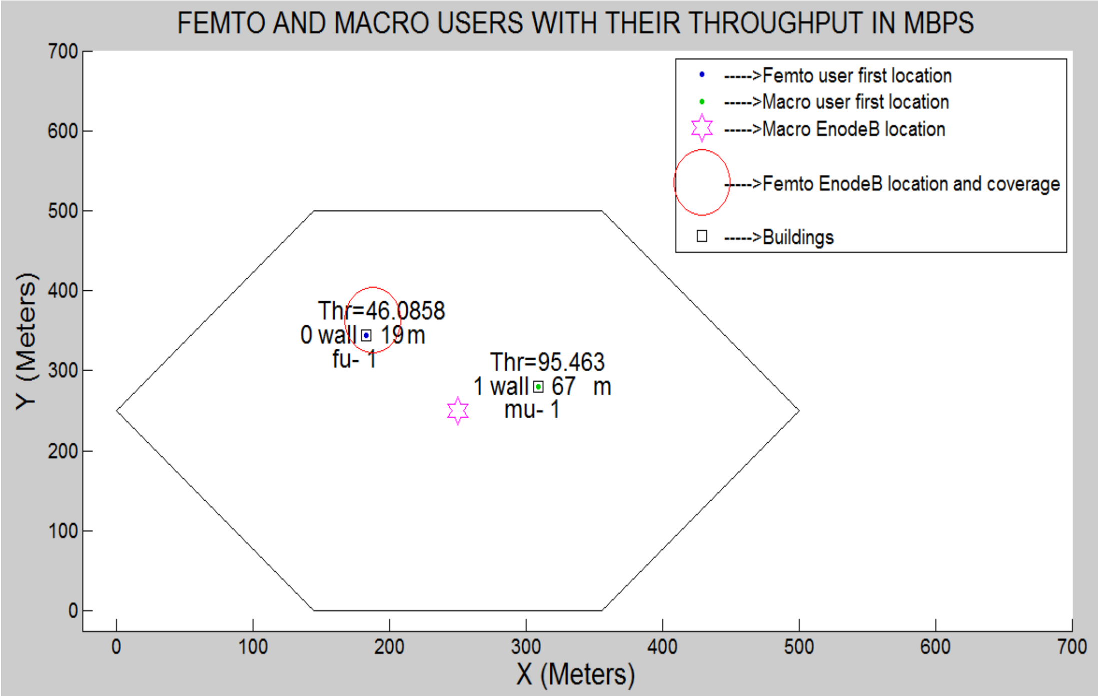

Fig. 3.3 First position of users

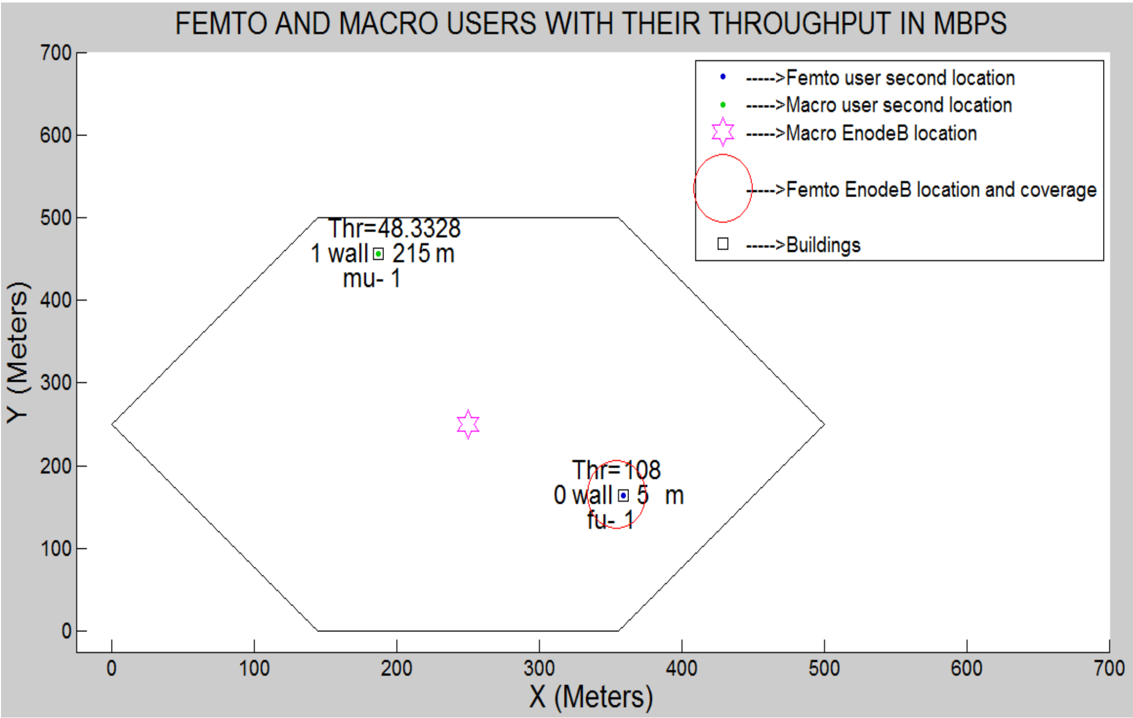

Fig. 3.4 Second position of users

D. THROUGHPUT AT DIFFERENT COORDINATED MULTIPOINT MECHANISMS

COMP mechanism is used to increase the throughput of macro edge users in which users are served from one or more adjacent base stations simultaneously when the path loss of serving cell is more as compared to adjacent base station. Coordinated multipoint (COMP) is of two types coordinated beam-forming / coordinated scheduling (CB / CS) and joint processing / joint transmission (JP / JT). Fig. 3.5 shows throughput of macro user at edge when it is 245m away from MBS with no COMP applied and is indoor user with one wall in between user and its serving base station having throughput approx 0.62317 Mbps. Fig. 3.6 shows throughput of macro user at edge when it is 245m away from MBS with coordinated beam-forming / coordinated scheduling (CB / CS) COMP applied and is indoor user with one wall in between user and its serving base station having throughput approx 6.6534 Mbps. In this the user is served from one base station but not from center base station but from adjacent base station 3, Fig. 3.7 shows throughput of macro user at edge when it is 245m away from MBS with joint processing / joint

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transmission (JP / JT) COMP applied and is indoor user with one wall in between user and its serving base station having throughput approx. 19.9009 Mbps. In this the user is served from three base stations simultaneously i.e. centre base station and adjacent base stations 3 and 4. MIMO diversity is used at the edge with all the same conditions as in comp and the throughput is 4.9722 Mbps as shown in Fig. 3.8

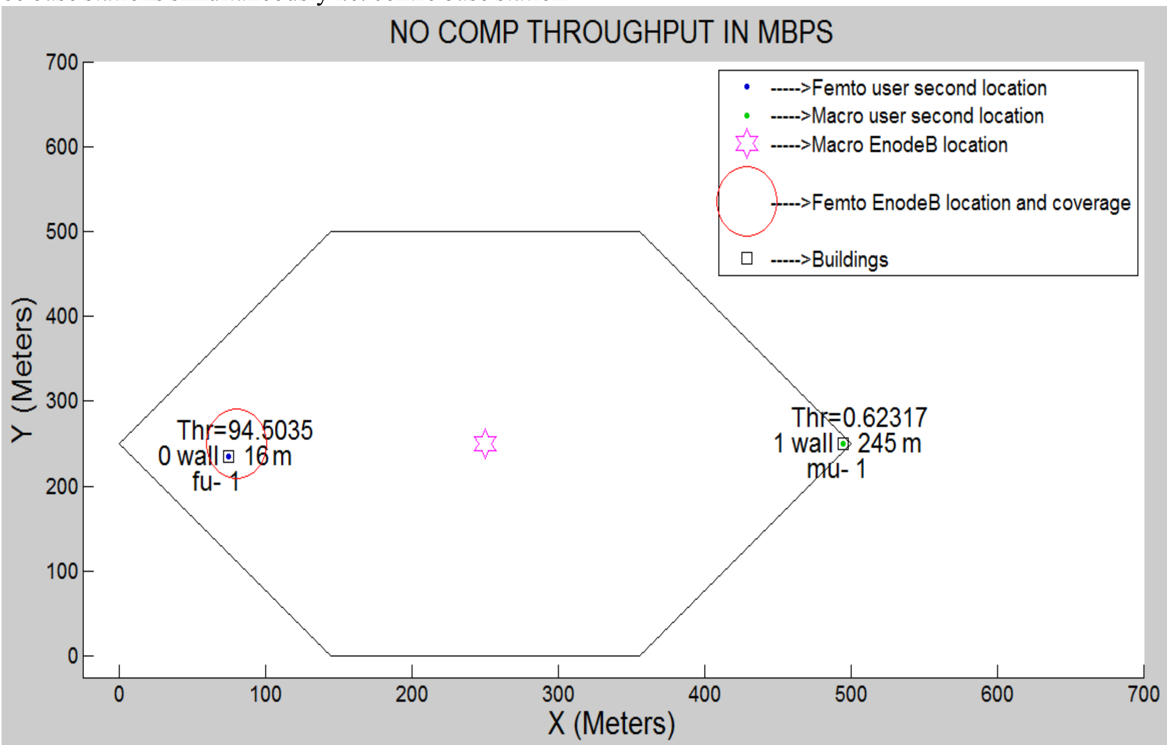

Fig. 3.5 Throughput with no COMP applied

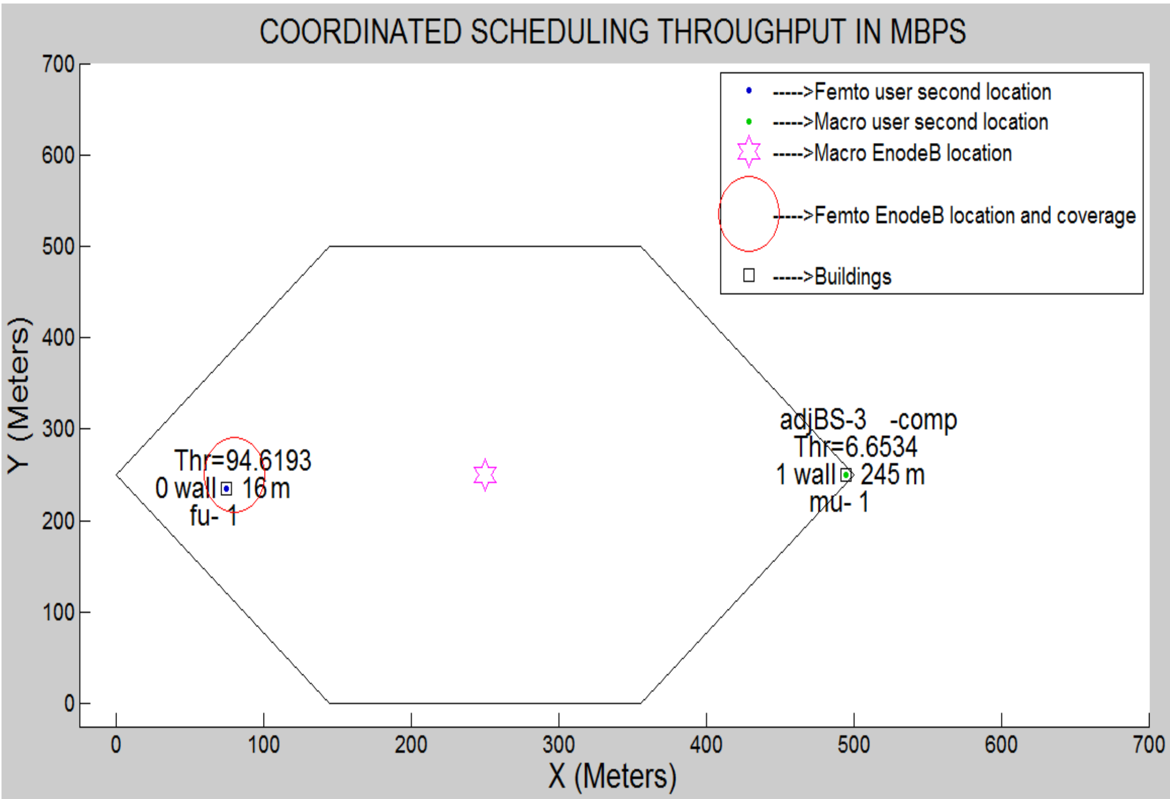

Fig. 3.6 Throughput with single COMP applied

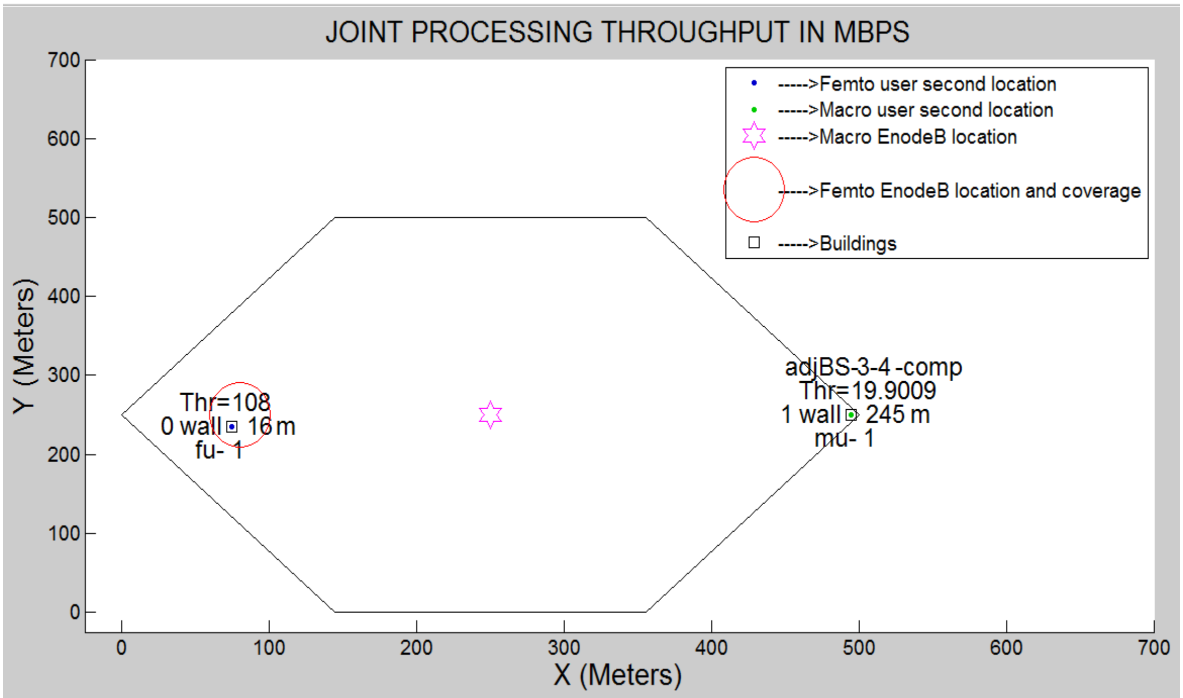

Fig. 3.7 Throughput with joint COMP applied

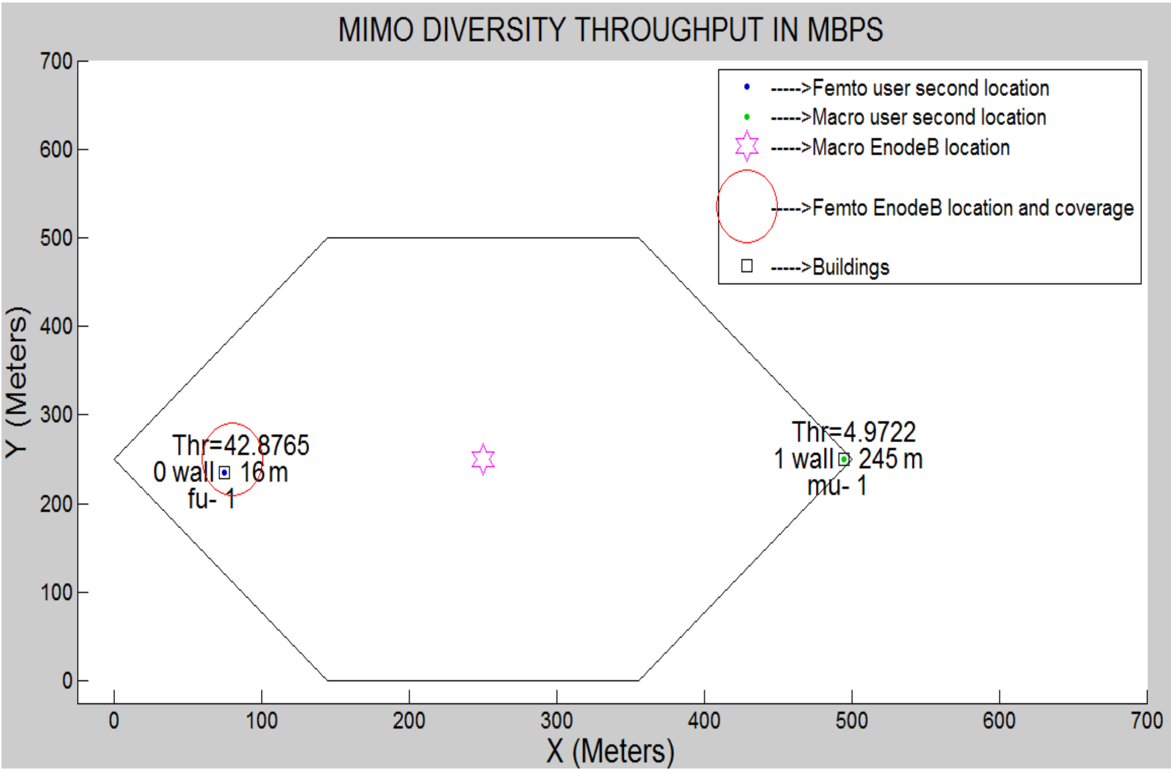

Fig. 3.8 Throughput with MIMO applied at edge

IV. CONCLUSION

In this paper, analysis of LTE-A system has been done. This paper presented a simulator consists of MIMO and COMP. This simulator takes into account most of the all major types of interference. With the use of COMP, MIMO user throughput gets increased due to reduction in interference. This paper gives a clear view of throughput a user get in a practical network area which also helps in deployment of original network.

V. FUTURE SCOPE

Future scope is to make more adaptive and more optimized network by including release 11, 12, 13 features and also to include original terrain in the simulator to get exactly the same result as a user get at a particular location in the included terrain. Advanced fractional frequency reuse in combination with power control can be applied to increase capacity.

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With the current simulator consisting of MIMO and COMP the throughput is increased to a large extent. For more enhancements in throughput, advanced power control algorithm and interference mitigation techniques can be used .Also with the help of adaptive beam forming excellent data rates can be achieved.

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