ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 2, February 2017

Throughput Enhancement of Dynamic Point Selection (DPS) Scheme under Different Channel Conditions in LTE-A System

Jwan H. Khalif[1], Dr. Bayan M. Sabbar[2]

MSC Student, Dept. of Network., College of Information Engineering, Al-Nahrain University, Baghdad, Iraq[1]

Assistant Professor, Dept. of Communication., College of Information Engineering, Al-Nahrain University, Baghdad, Iraq[2]

ABSTRACT: To improve network performance at cell edge which it reduces due to lower signal level from the serving cell and higher interference from other cellsCoordinated Multi point operation (CoMP) introduced in 3GPP standard release 11. One of the introduced schemes is Dynamic Point Selection (DPS) which allows greater scheduling flexibility among collaborating eNodeBs.In DPS a cell-edge UE of one cell may be served by a neighboring eNodeB depending upon better radio link quality or load balancing. In this paper the throughput performance of this scheme was tested under different channel conditions introduced by LTE-A standard. The results shows that the DPS enhances the system throughput by 6.68% when it used under EPA channel, by 5.94% when it used under EVA channel and by 2.69% when it used under ETU channel.

KEYWORDS: Energy efficient algorithm; Manets; total transmission energy; maximum number of hops; network lifetime

I. INTRODUCTION

LTE (Long Term Evolution) standardization work was completed at the end of 2010. As a major enhancementof LTE, LTE-Advanced has been standardized by the 3GPP(3rd Generation Partnership Project), it aims to fulfill thehigher requirements for 4G systems. One of the major goals in LTE-A is to support higher downlinkcell average and cell edge throughput. Many of the featureswere considered to aim the requirement. CoMP (CoordinatedMultiple Point) is one of the promising techniques to improveboth the cell average and cell edge throughput [1].In LTE Release 11, support for DL CoMP transmission is provided. CoMP techniques use multi-cell cooperationto mitigate inter-cell interference and to enhance the desiredsignal quality of cell-edge users, thereby primarily improving the cell-edge throughput [2].The performance of LTE/LTE-A is largely affected by the inter-cell interferences of neighboring BSs. In heterogeneous implementation this situation becomes more severe as more UEs experience interference from other BSs due to creates more cell boundaries. As a result interference management is crucial to ensure proper QoS. In this regards, CoMP technology is the most potential solution where interfere signals from other BSs are exploited to increase overall throughput [3].In general, CoMP techniques have received increasing interest within the 3GPP community during Release 11. The primary focus has been on schemes calledjoint transmission (JT), dynamic point selection (DPS),dynamic point blanking (DPB), and coordinated scheduling/beamforming (CS/CB) [4].

In JT CoMP, two or more transmission point (TP)transmit simultaneously to a CoMP user in a coherentor non-coherent manner. JT CoMP is depicted in Figure 1. Coherent JT means that the transmitted signalsare phase aligned to achieve constructive combining ofthe signals at the receiver side, whereas in non-coherentJT such phase alignment is not performed [5].

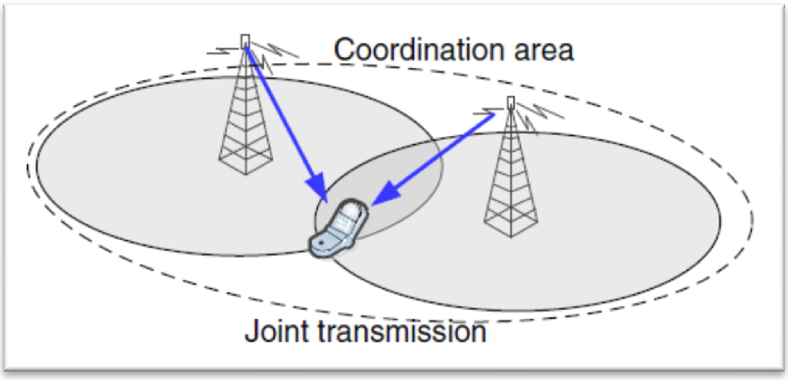


Figure 1 Joint Transmission scheme[5].

In DPS, only one TP transmits data to UE in each TTI (Transmission Time Interval),while other TPs can allocate the resource block (RB) to other UEs. DPS is described in Figure 2.The cooperating point may be muted or transmitting normally. When the other points are muted that means the DPB is used [1]. DPB is introduced to reduce the interference from the strongest coordinated cells by power control. The objective of power control in wireless networks is to minimize the transmitted power subject to maintaining the link quality by keeping the signal to interference ratio(SIR) above a threshold called minimum protection ratio [6]. Energy consumption in cellular networks is expected to increase with the increasing wireless traffic. Currently there are over 4 million base stations globally each consuming25 MWh per year on average [7].

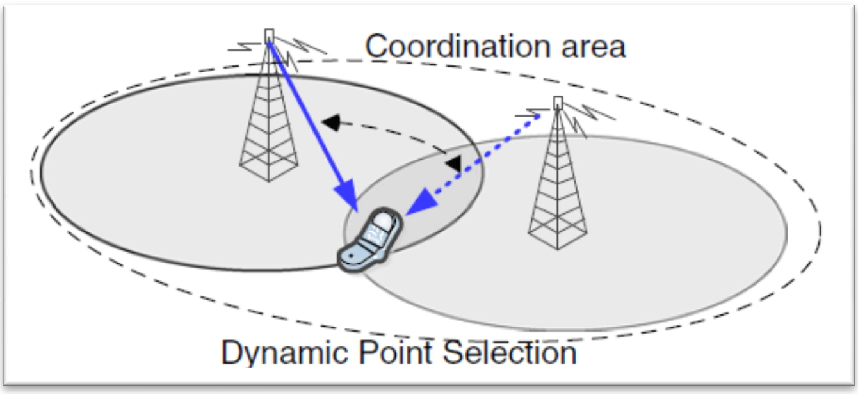


Figure 2 Dynamic Point Selection scheme [5]

In CS/CB, the scheduling decisions of neighboring points are coordinated inorder to reduce the interference, as in the scenario shown in Figure 3 [5].

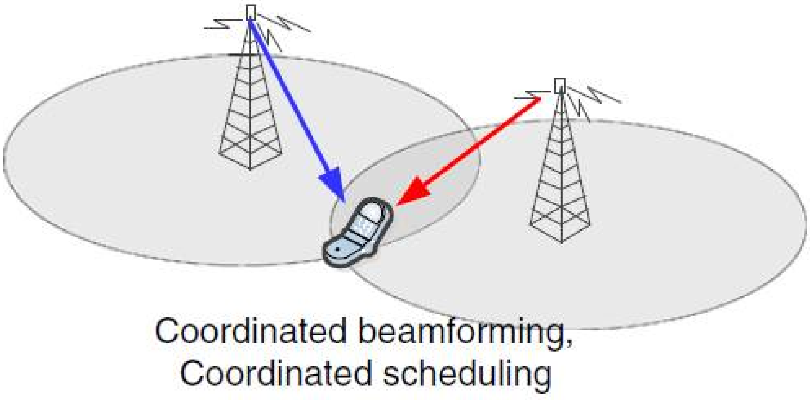


Figure 3 Coordinated Scheduling/ Beamforming Scheme [5]

II. RELATED WORK

In [8] authors discuss several Coordinated Multi Point (CoMP) schemes and investigated their benefits in a multi-antenna beamforming system and showed that the intra-site coordination brings significant gains in beamforming systems, especially with the joint transmission scheme. In [9] authors propose a *cell-edge-aware* (CEA) zero forcing (ZF) precoder. The precoder exploits the excess spatial degrees of freedom provided by a large number of base station (BS) antennas to suppress inter-cell interference at the most vulnerable user equipments (UEs). They evaluate the downlink performance of CEA-ZF, as well as that of a conventional *cell-edge-unaware* (CEU) ZF precoder in a network with random base station topology result identifies CEA-ZF as a more effective precoding scheme for massive MIMO cellular networks. In [2] authors proposed two simple DPS schemes that take into account the UE's current channel conditions and the cell loading conditions to make the UE's TP switching decisions. They showed that these schemes improvethe system performance under different practical and realisticsettings, such as, cell handover margin, TP switching periods,bursty traffic conditions, and cooperation cell cluster sizes.

III. LTE DOWNLINK CHANNEL

In a multipath environment, a transmitted symbol takes different times to reach the receiver through different propagation paths. The multipath channel can be Rayleigh orRician [10]. In case of Rayleigh fading channel there is no LOS path exists in between transmitter and receiver,but only have indirect path than the resultant signal received atthe receiver will be the sum of all the reflected and scatteredwaves.While Rician fading channel occurs when there is a LOS as well as the non-LOS path inbetween the transmitter and receiver, i.e. the received signalcomprises on both the direct and scattered multipath waves [11]. 3GPP defines the LTE down link fading channel as a Rayleigh fading channel

The multipath channel properties can be specified as a combination of the Doppler spectrum, the delay spread profile, and the effect of multiple antennas in a MIMO system by using the correlation matrices. The delay spread profile is described as a tapped delay line with delay elements and associated power contributions. There are three scenarios in this condition

1. Extended Pedestrian A Model: This scenario supports speeds up to 3 km/h (walking users). The delay tap model consists of 7-taps with delays [0, 30, 70, 90, 110, 190, 410] ns, and associated power [0.0, −1.0, −2.0, −3.0, −8.0, −17.2, −20.8] dB and in this scenario the maximum Doppler shift is 5 Hz [12].
2. Extended Vehicular A Model: This scenario support speeds up to 50 km/h for moving vehicles. The model consists of 9-taps with delays [0, 30, 150,310, 370, 710, 1090, 1730, 2510] ns and associated power [0.0, −1.5, −1.4, −3.6, −0.6, −9.1, −7.0, −12.0, −16.9] dB. In this scenario the maximum Doppler shift is between 5 and 70 Hz [12].

DOI: 10.15680/IJIRCCE.2017. 0502173

3. Extended Typical Urban Model: This scenario supports speeds up to 90 km/h for moving vehicles. The model consists of 9-taps with delays [0, 50, 120, 200, 230, 500, 1600, 2300, 5000] ns and associated power [−1.0, −1.0, −1.0, 0.0, 0.0, 0.0, −3.0, −5.0, −7.0] dB. In this scenario the maximum Doppler shift is between 70 and 300 Hz [12].

IV. DPS SCHEME

Considering a downlink multi-cell system with total of M transmission points, where each point has Nt transmitantennas and each user has Nr receive antennas. The received signal $y_k$by the user $z$can be writtenas [5]:

$$\gamma k_{Nr\times 1} = H_{k,i_{Nr\times Nt}} W_{i_{Nr\times Nt}} X_{i_{rk\times 1}} + \sum_{j\neq i} H_{k,j_{Nr\times Nt}} W_{j_{Nt\times rj}} X_{j_{rj\times 1}} + n_{k_{Nr\times 1}} ,$$

where **H**z,$i$is the Nr × NtMIMO channel between the serving base station $i$and user k, and **n**$k$denotes thescaled noise vector whose entries are complex Gaussianvariables with zero mean and variance σ^2 /P, where $\sigma^2$is the variance of additive white Gaussian noise and P isthe transmitted signal power. The precoding matrix **W**$i$applied for the transmission has rkcolumns, and rkisthe transmission rank for user k. The transmitted signal**x**i is of length rk × 1. Assuming spatially uncorrelatedand equal-variance transmit signal elements, we have$E$(**x**i**x**Hi) = **I**$rk$and the total transmission power is controlledby precoding matrix by requiring Tr(**W**$^{\mathrm{H}}$$i$**W**$i$)= 1.

Each element of **x**i, or each column of**W**i, corresponds to a transmission layer for user z. The matrices **H**k,j, whereindex j ∈ {1, . . . ,M}, j _= i, are the MIMO channelsbetween interfering transmission points and user z. Theinterfering transmission points are transmitting rjlayers,where each signal vector **x**$j$is precoded by the precodingmatrix**W**j, where index j ∈ {1, . . . ,M}, $j \neq i$.[5].

If the transmission points cooperate, the interference conditions changea UE may be scheduled to receive data only from one point, but one or more points coordinatescheduling or mute to reduce the interference.A general signal model for the hybrid CoMP, where M isthe total number of interfering points and $N \leqslant M$ pointscooperate for user k, reads [5].

$$y_K = \sum_{I=1}^{L} H_{K,I}\ W_{IXI} + \sum_{n=N-L+1}^{N} a_n\ H_{Kn}\ W_{nXn} + \sum_{m=M-N+1}^{M} H_{K,m} W_{mXm}\, n_K\ .$$

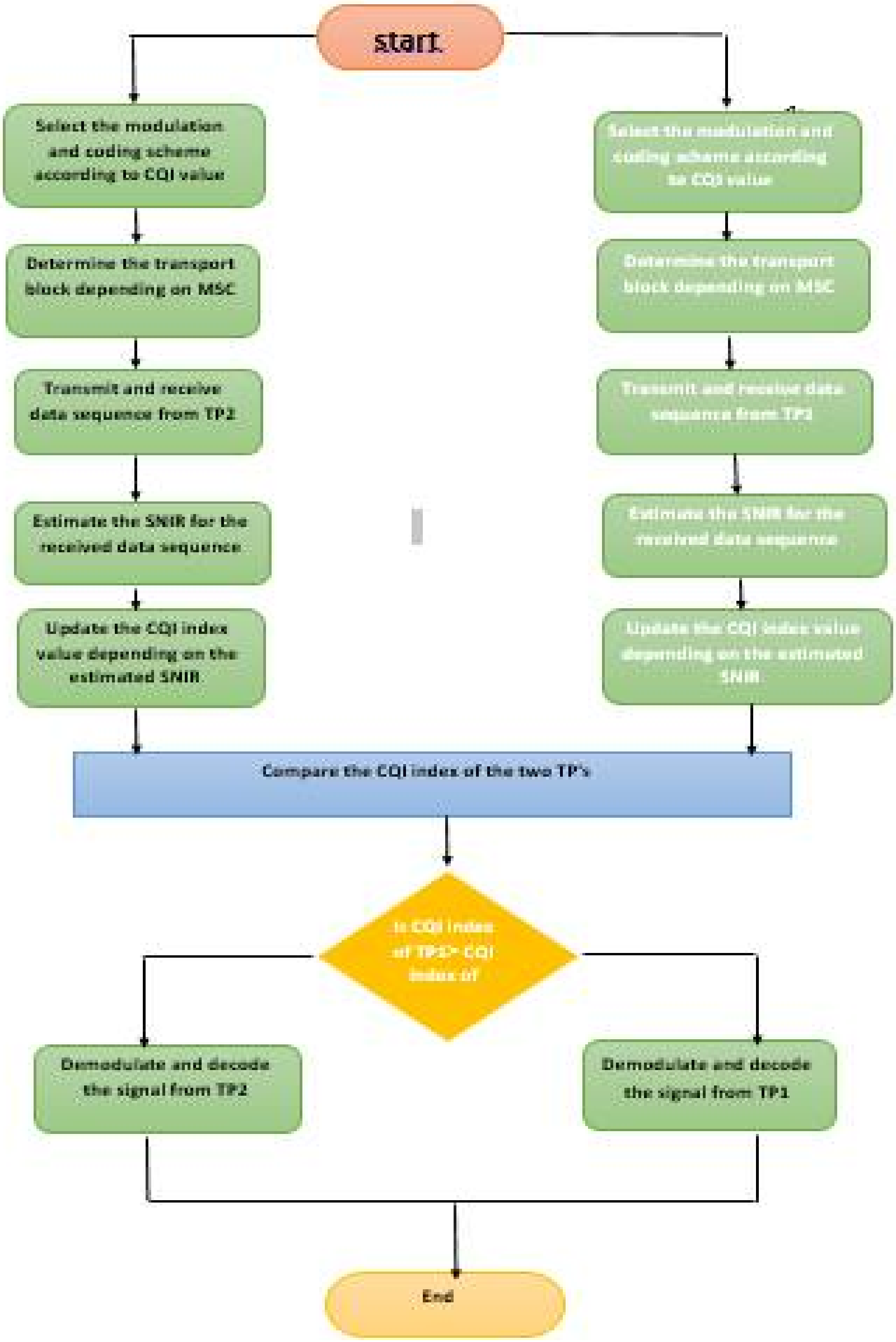
Here $L \leqslant N$ denotes the number of points that operate in JT. N is the total number of points that cooperate whichmeans that $N - L$ points cooperate by reducing interference.M is the total number of points in the network.Thus M–N points are operating in an uncoordinated waywith respect to the other points. The termαn describes thelevel by which the interference is reduced by cooperationof the $N - L$ points, and the subscript n is the point index.If αn = 0 it means that point n is muted and if αn = 1 thatpoint n is in normal operation [5].

The DPS operation will decide which cell is better to receive from depending on channel quality indicator CQI which it estimated depending on signal to interference plus noise ratio SNIR of each cell which can be estimated as below

$$SINR_{K,i}^{DPS}(\alpha_n) = \frac{\left|g_k^H\ H_{K,i}\, W_i\right|^2}{\left|g_k^H\ \sum_{n=N-L+1}^{N} \alpha_n H_{k,n} W_n\right|^2 + \left|g_k^H \sum_{m=M-N+1}^{M} H_{k,m} W_{mXm}\right|^2 + \alpha^2}$$

$SINR_{K,i}^{DPS}(\alpha_n)$is the SINR for user k from point $i$with single stream transmission**and** $g_k$is the normalized receiver combiner for user $k$and σ2 is the noise variance

The DPS scheme can be explained by the following flow chart



V. SIMULATION RESULTS

LTE Downlink is modeled and simulated using MATLAB simulation R2015a. A 2×2 closed loop spatial multiplexing MIMO simulated under a bandwidth of 10 MHz with FFT size of 1024 and subcarrier spacing 15 KHz with normal cyclic prefix the modulation order varying with the coding rate depending on the CQI feedback value and precoding matrix, transition layers varying depending on PMI and RI feedback respectively

Figure 4 shows a throughput comparison when DPS is used under EPA channel effect and when this procedure is not used.The result shows a throughput enhancement of 6.68% when DPS is used compared with normal transmission from serving cell. This enhancement because EPA multipath channel can be considered as slow fading channel as the channel coherence time T_c is longer than the symbol time. So when the DPS algorithm decide that on channel is better than the others according to its CQI value it will remain better in the next transmission as the channel does not change in a fast manner.

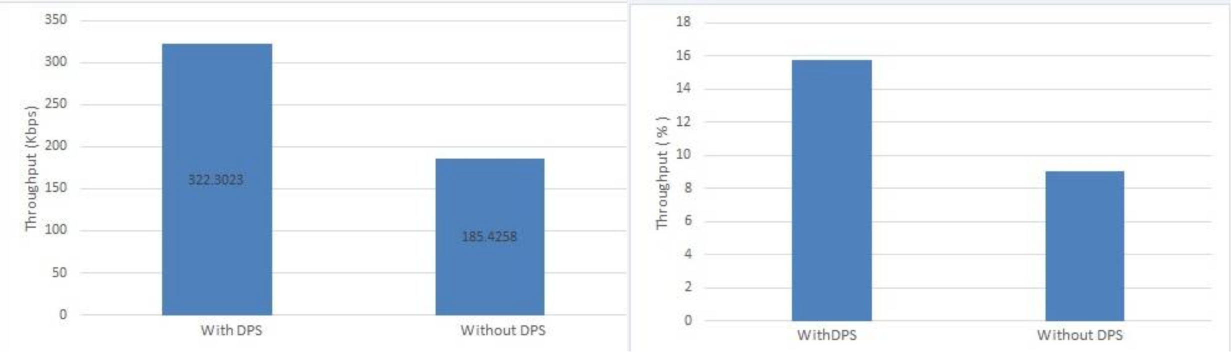


Figure 4. DPS operation enhancement of throughput under EPA channel effect

Figure 5 shows a throughput comparison when DPS is used under EVA channel effect and when this procedure is not used.The result shows a throughput enhancement of 5.94% when DPS is used compared with normal transmission from serving cell. The enhancement reduced as the EVA channel has shorter Tc compared to EPA multipath channel and this make the channel vary faster. So when UE choose one of the cells to receive from in the next transmission the channel may change and another cell may be better to receive from instead the selected one. So the DPS performance reduced in EVA channel compared with EPA multipath fading channel.

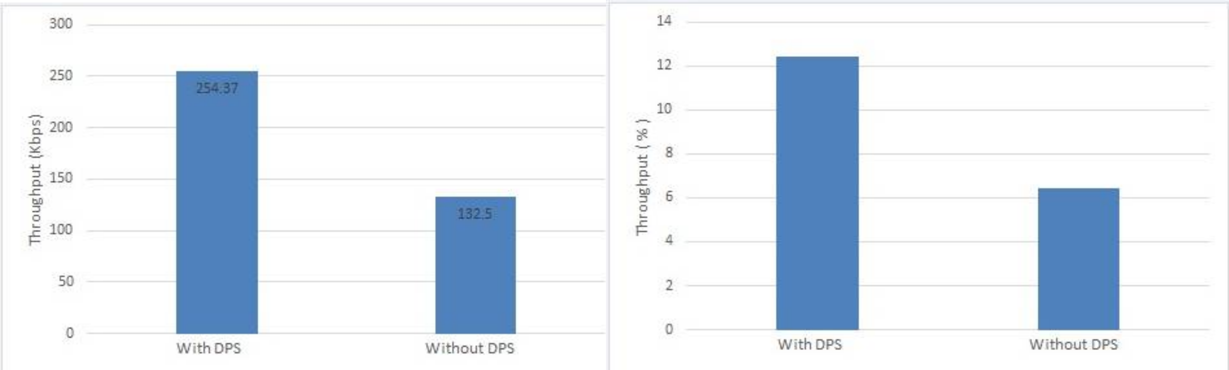


Figure 5. DPS operation enhancement of throughput under EVA channel effect

Figure 6 shows a throughput comparison when DPS is used under ETU channel effect and when this procedure is not used.The result shows a throughput enhancement of 2.69% when DPS is used compared with normal transmission from serving cell. The ETU multipath fading channel is fast fading channel where Tc is shorter than the symbol period. So the channel vary dramatically and the current channel state is not necessary remains to the next transmission. So the DPS performance reduced in ETU channel environment compared to EPA and EVA channel enviroments.

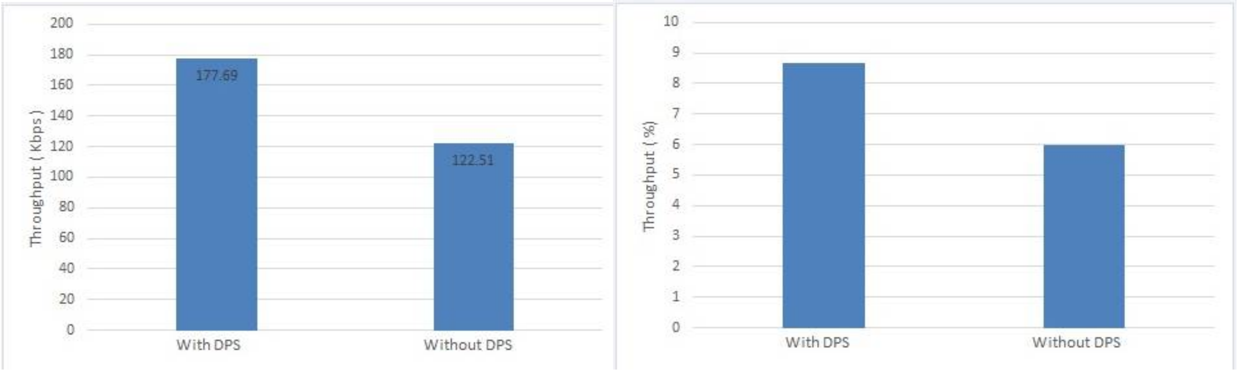


Figure 6. DPS operation enhancement of throughput under ETU channel effect

VI. CONCLUSION AND FUTURE WORK

From the previous results we can conclude that the DPS operation throughput enhancement is not fixed under channel conditions and the throughput enhancement will reduce as the user velocity increases.

The DPS scheme makes the user equipment UE operations more complex and consumes the neighboring cells resources as the data will be available at the neighboring cellsand this should take more attention when UE travelling in higher speeds as the throughput enhancement is less significant.

As a future work we can find a way to stop the DPS operation when the throughput enhancement is not that significant to reduce the UE operations complexity and save the other calls resources.

REFERENCES

1.Mingju Li*, Xiang Yun*, Satoshi Nagata,Lan Chen*,"Power Allocation of Dynamic Point Blanking for Downlink CoMP in LTE-Advanced", IEEE.2013

2.Rajeev Agrawal, AnandBedekar, Richa Gupta, Suresh Kalyanasundaram, Hans Kroener and Balamurali Natarajan, "Dynamic Point Selection for LTE-Advanced: Algorithms and Performance"IEEE WCNC'14 Track 2 (MAC and Cross-Layer Design).2014

3. Md. Shipon Ali, " On the Evolution of Coordinated Multi-Point (CoMP) Transmission in LTE-Advanced", International Journal of Future Generation Communication and Networking,Vol.7, No.4, pp.91-102, 2014.

4.3rd Generation Partnership Project; Technical Specification Group Radio Access Network; ordinated multi-point operation for LTE physical layer aspects (Release 11), 3GPP TR 36.819 V11.2.0 (2013-09).

5. Helka-Liina Maattanen ,Kari Hamalainen1, Juha Venalainen2, Karol Schober3,Mihai Enescu1 and Mikko Valkama2," System-level performance of LTE-Advanced with joint transmission and dynamic pointselection schemes",*EURASIP Journal on Advances in Signal Processing,2012.*

6.Farrokh Rashid-Farrokhi, K.J.RayLiu,LeandrosTassiulas,"Downlink Power Control and Base station Assignment", IEEE COMMUNICATION LETTERS,Vol1,No4.July1997.

7. Olli Apilo1 , Mika Lasanen1 , AarneMa¨mmela ," Energy-Efficient Dynamic Point Selection and Scheduling Method for Intra-cell CoMP in LTE-A", Wireless PersCommun (2016) 86:705–726

8. AhlemKhlass, Thomas Bonald, Salah-EddineElayoubi. "Analytical Modeling of Downlink CoMP in LTE-Advanced" VTC, 2015, Glasgow, United Kingdom. 2015, <10.1109/VTC- Spring.2015.7145704>. <hal-01244192>

9. Howard H. Yang, Giovanni Geraci, Tony Q. S. Quek, and Jeffrey G. Andrews," Cell-Edge-Aware Precoding for Downlink Massive MIMO Cellular Networks", IEEE Transactions on Signal Processing,2016.

10.Sanjiv Kumar , P. K. Gupta, G. Singh, D. S. Chauhan," Performance Analysis of Rayleigh and Rician Fading Channel Models using Matlab Simulation", *I.J. Intelligent Systems and Applications,* 2013, 09, 94-102

11.*NuzhatTasneemAwon, Md. Mizanur Rahman, Md. Ashraful Islam, A.Z.M. Touhidul Islam,"* Effect of AWGN & Fading (Raleigh &Rician) channels on BER performance of a WiMAX communication System", *(IJCSIS) International Journal of Computer Science and Information Security, Vol. 10, No. 8, August 2012*

12. Lingyang Song, JiaShen.," Evolved cellular network planning and optimization for UMTS and LTE", International Standard Book Number: 978-1-4398-0649-4 (Hardback),2011.