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Optimized Allocation of resources for D2D Communication

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Abstract—**Device to device Communication (D2D) is an inspiring technique for efficient spectrum utilization in the LTE-Advanced (LTE-A) Networks. The D2D communication uses the same radio resources intended for the cellular network for its communication which causes interference in the primary cellular networks in their uplink and downlink phases and it can degrade the cellular network performance. In order to reduce this interference sourced by D2D communication a heuristic algorithm approach is used in this paper. The simulation results prove that the heuristic algorithm approach performs better than then the random selection algorithm with respect to the system capacity, throughput and outage probability.**

Index Terms—D2D, System capacity, throughput, outage probablity

I.INTRODUCTION

In the recent years the third generation partnership project (3GPP) has defined a new technological component for LTE-Advanced: the D2D communication. In band D2D communication occurs over the licensed band. The D2D communication can act as an under lay to the cellular network. The D2D communication is an inspiring technique in which the user equipment's (UE's) are directly allowed to communicate with each other rather than communicating via eNodB. The spectral efficiency of the D2D communication technique is more because it shares the same resources of the cellular network. The resource sharing causes interference to the primary cellular network. The interference problem occurs both in the uplink as well as the downlink phases of the cellular. This interference need to be minimized up to a specific threshold level, so that performance of the cellular is not degraded. [1] Suggests a mode shifting resource allocation method for D2D communication some of the applications of this include peer to peer file sharing, online gaming, video streaming etc. The D2D communication was initially introduced by Doppler etal. [2] Where they outlined the D2D communication set up which could increase the overall throughput of the system. The spectrum sharing problem is also highlighted by different authors and considerable solutions are given. [3] Suggested a spectrum re use protocol where the devices are allowed to communicate only in the uplink phase as during this phase only the base station is exposed to interference. In [4] a statistical Signal to interference noise (SINR) based power allocation method was introduced, here positioned based D2D pairing is done and the SINR is formulated in such a manner that SINR of cellular does not deteriorate after a specific threshold level. [5]Formulated the D2D resource sharing issue as a mixed integer linear problem (MINLP) problem where eNodB controls connections. [6] Suggested a graph based frame work for allocation of resource blocks to the system. In this paper the spectrum sharing issue between the cellular network and D2D link is considered and then the interference problem caused by the D2D transmitter during the downlink is analyzed and to minimize this interference the analysis has been done using heuristic algorithm approach. Further simulations are carried out and it is proved that the efficiency of heuristic approach provides better performance than random selection approach.

II. SYSTEM MODEL

The LTE system architecture depicting D2D pairing and cellular interaction is depicted in Fig. 1. The LTE functions in the packet switch domain through internet protocols (IPs). The whole system can be considers as an Evolved Packet Core (EPC). In general the EPC system comprises of mobility management equipment (MME), serving gateways (SGW), packet data network gateway (PGW) and the UE's connected to eNodB. The eNodB's are connected to the MME and SGW .The UE's can also directly interact after establishing proper connection with the help of eNodB. The routing of the traffic through the internet is done through the PGW. The eNodB also takes control over the resources which are to be shared to the D2D links. Thus PGW serves an important function in LTE system architecture.

III. INTERFERENCE REDUCTION IN D2D COMMUNICATION

The interference reduction is a key issue in D2D .In the uplink phase the eNodB are exposed to interference and in the downlink the UE's are subjected to interference by the D2D. Now if we consider a network where the number of cellular users is denoted by C and the number of D2D link is denoted by D such that D<<C. Let I be the intercellular interference and mC the number of resources allocated to cellular user.

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A. Interference management for D2D pairs

In the downlink period the interference not only depends on transmitted power of D2D link but also on the channel gain of D2D link and cellular users. This can be represented as GDc. The gain between the cellular user and eNodB is represented as GeNbc. The power of base station is PeNb. The D2D link power is represented as PD.

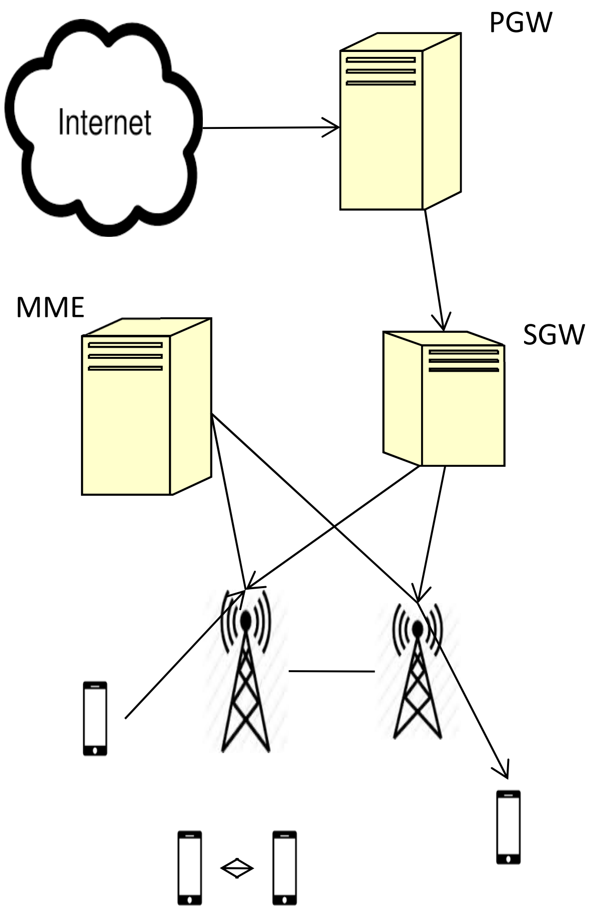

Fig1. D2D under laying LTE

GDeNb is the gain between base station and the D2D link and eNodB. GDd is the gain among two D2D links. The interference problem is shown in Fig2

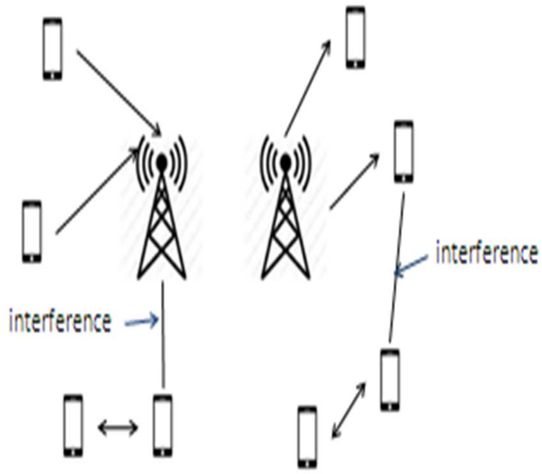

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Fig2.Uplink and downlink phases with interference

In the downlink period the interference depends on transmitted power of D2D and eNodB is subjected to interference. GDc is the gain between cellular and D2D link.. N is the thermal noise density.

The downlink SINR of user C is given as-

$$YC^{DL} = \frac{PeNb\ GeNbc}{N+\sum_D Zc\ PD\ GDc} \qquad (1)$$

The downlink SINR of D2D link is given as-

$$YD^{DL} = \frac{\sum_C Zc\ PD\ GDd}{N+\sum_C Zc\ PeNB\ GDeNb} \qquad (2)$$

The optimization problem can be solved by using heuristic algorithm approach

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.B. Heuristic algorithm

The heuristic algorithm approach finds the best possible solution among all the solutions available to the user .It is an approximating algorithm

In this algorithm-

1. Select the cellular user according Channel state information (CSI) in descending order.
2. List the D2D pairs for resource allocation.

3. Calculate minimum value of GDc matrix.
4. Calculate the SINR for UE's and D2D pair and compare it with the threshold SINR.
5. If obtained SINR is greater than threshold SINR allocate the resource to D2D pair.
6. Then find the capacity, throughput and outage probability of the overall system.

Let Rc^{DL} and Rd^{DL} be rate of the SINR Yc^{DL} and Yd^{DL} respectively. Here we maximize the sum rate of primary cellular UE's and the D2D pairs. mC is the number of resources allocated to the D2D pair during downlink

$$Maximize = \sum_{C} mC\ RC^{DL} + \sum_{D} 1 \sum_{C} Zc\ mC\ RD^{DL} \quad (3)$$

$$PeNB\ GeNbc \geq\ Y_{Ctgt}^{DL}\ (N + I + \sum_{C} 1Zc\ PeNB\ GDeNB) \quad (4)$$

$$\sum_{C} Zc\ PD\ GDd \geq YC_{tgt}^{DL}\ (N + I + \sum_{D} Zc\ PeNb\ GDeNB) \quad (5)$$

$$\sum_{C} Zc^{C} \leq 1\ \forall c\epsilon C \quad (6)$$

$$\sum_{D} Zc^{D} \leq 1 \forall d\epsilon D \quad (7)$$

Here Zc is a binary variable whose value becomes 1 when resource is allocated.

IV. SIMULATION RESULTS

Simulations parameter is depicted in table 1. This is used to plot the capacity, throughput and outage probability. Also the path loss model using lognormal shadowing is also discussed.

Table1. Simulation Parameters

Parameter	Value
Spectrum allocation	20MHz
Carrier Frequency	2GHz
Max eNodB power	2W
Max UE transmission power	250 mW
Max distance of D2D	< 1 km (LTE-A)

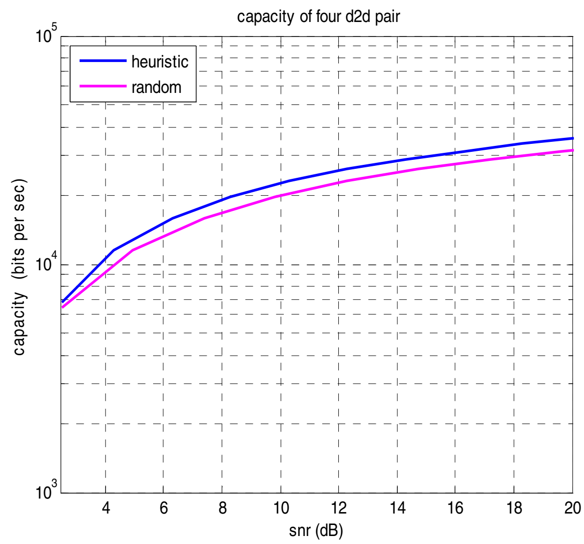

Fig3. Capacity of 4-D2D pairs

Fig3. shows the capacity of 4-D2D pairs by heuristic and random approach .From simulations it is found that at 10 dB the Capacity using heuristic scheme is $2.44 * 10^4$ and the capacity of random scheme is $2 * 10^4$ Thus heuristic approach proves to be 18% more efficient than random approach.

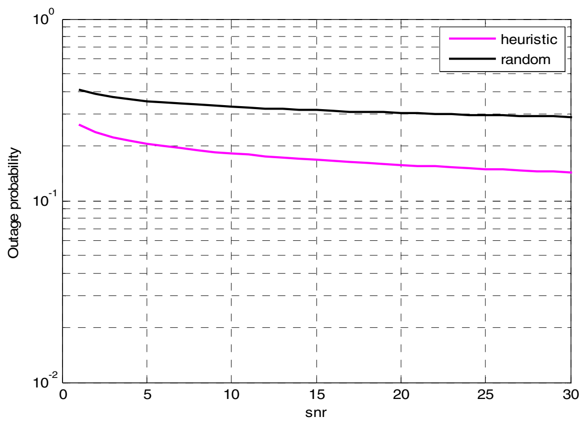

Fig 4.Outage probability of cellular user

Fig4. Illustrates the relationship between the outage probability and signal to noise ratio using random and heuristic approach and from results it is observed that heuristic approach provides better performance than random approach

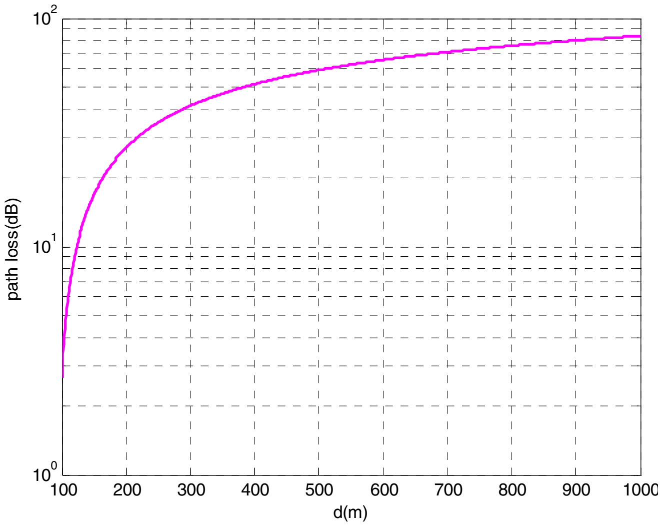

Fig 5 Path loss Vs SNR

Fig 5 illustrates the path loss using the log normal shadowing model and from the graph the path loss value at 500 meter is 65dB for the heuristic scheme.

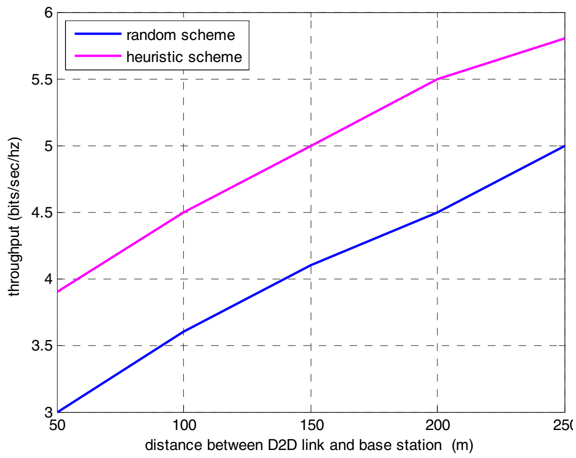

Fig6.Average throughput

Fig. 6 shows the average throughput of the D2D link at different distances from the enodB and it is observed at 200 meter the throughput of random scheme is 4.4 bits /sec /Hz and that heuristic scheme is 5.5bits /sec/Hz .Thus it is observed that heuristic scheme improves the throughput by 20%.

V. CONCLUSION

In this paper heuristic algorithm approach has been considered for resource allocation in D2D communication and from simulations it is observed that under same complexity the heuristic algorithm scheme improves the performance of the Network by increasing the network capacity by 18% and throughput by 20% when compared to random selection approach.

REFERENCES

[1] Junshu Gao, Xuewen Liao, Jianguo Deng, Pinyi Ren " A Mode Shifting Resource Allocation Scheme for Device to Device Underlaying Cellular Network" *Proc of AASRI Conference on Parallel and Distributed Computing and Systems*.2013, pp. 40-47.

[2]K. Doppler, M. Rinne, C. Wijting, C. Ribeiro, and K. Hugl, "Device to-Device communication as an underlay to LTE-advanced networks," *IEEE Communication. Magazine.*, vol. 47, no. 12, pp. 42–49, Dec. 2009.

[3]B. Kaufman and B. Aazhang, "Cellular networks with an overlaid device to device network," *Proc. of Asilomar Conference on signals, systems and computers, Pacific, Grove, CA*, 2008, pp. 1537–1541.

[4]C.-H. Yu, O.Tirkkonen, K. Doppler, and C. Ribeiro, "On the performanceof device-to-device underlay communication with simple power control," *IEEE Vehicular Technology Conference, spring ,* 2009, pp.1-5.

[5]M.Zulhasnine, C.Huang, and A.Srinivasan, "Efficient Resource Allocation for Device-to-Device Communication underlaying LTE Network," *Proc IEEE 6th Int. Conf. Wireless mobile computing,* Oct-2010.

[6] V. Noor Mohammed, J. Siddharth, V.S. Kaushikbhai, "Resource Allocation for Wireless Network Environment," *Proc. of the International Conference on Soft Computing Systems*, vol. 398, pp. 501-508, Dec. 2015.