Enhanced the Efficiency of Energy for Device-To-Device Communication Underlaying Cellular Network

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ABSTRACT

Device-to-Device (D2D) communication has attracted lots of attention as one of the most advanced wireless communication technologies which allows access to services offered by nearby devices bypassing the Base Station (BS). The potential advantages of this direct communication paradigm include high data rate, network offloading and range extension, as well as commercial proximity services and social networking. Since D2D communication is envisaged as short-range direct communication between nearby users, it is also very important to model the D2D-enabled cellular networks as different regions as opposed to fixed regions. The consideration of fixed regions allows modeling of the location dependent performance of users. In this regard it is a highly challenging open problem to analytically investigate the intra-cell interference in a D2D-enabled cellular network and the performance of underlay D2D communication when the users are confined in a finite region.

Keywords: - *D2D Communication, cellular network, power optimization, PSO, Interference, frequency reuse.*

INTRODUCTION

Device-to-Device (D2D) communication, allowing direct communication between nearby users, is envisioned as an innovative feature of 5G cellular networks. Different from ad-hoc networks, the D2D communication is generally established under the control of the base station (BS). In D2D-enabled cellular networks, the cellular and D2D users can share the spectrum resources in two ways[1-3]: in-band where D2D communication utilizes the cellular spectrum and out-of-band where D2D communication utilizes the unlicensed spectrum. In-band D2D can be further divided into two categories: overlay where the cellular and D2D communications use orthogonal (i.e., dedicated) spectrum resources and underlay where D2D users share the same spectrum resources occupied by the cellular users. Note that the spectrum sharing in in-band D2D is controlled by the cellular network, which is different than the spectrum sharing in cognitive radio networks. Underlay in-band D2D communication can greatly improve the spectrum efficiency of cellular networks and is considered [4, 5]. A key research challenge in underlay in-band D2D is how to deal with the interference between D2D users and cellular users. For traditional cellular networks with universal reuse frequency, the inter-cell interference coordination (ICIC) and its enhancements can be used to effectively manage the inter-cell interference [9-11].

D2D communication is envisaged as short-range direct communication between nearby users, it is also very important to model the D2D-enabled cellular networks as finite regions as opposed to infinite regions. In the rest part of this research work, section II – System Design Model, Section-III Process Optimization, Section-IV Experimental analysis and finally discussed the conclusion and future work in section V

II. SYSTEM DESIGN MODEL

Consider a cellular system where the D2D pairs reuse the spectrum resource already assigned to the CUs for uplink communication. We follow the conventional assumption of orthogonal spectrum resource allocation among CUs in a cell. Thus, these CUs do not interfere with each other. When a D2D pair communicates using the channel of a CU, they both cause intra-cell interference to each other. Due to orthogonal channelization within each cell, we may focus on one CU and one D2D pair as shown in Fig 1. We assume that all users are equipped with a single antenna and the BS is equipped with N antennas. The BS coordinates the transmission of the CU and D2D pair.

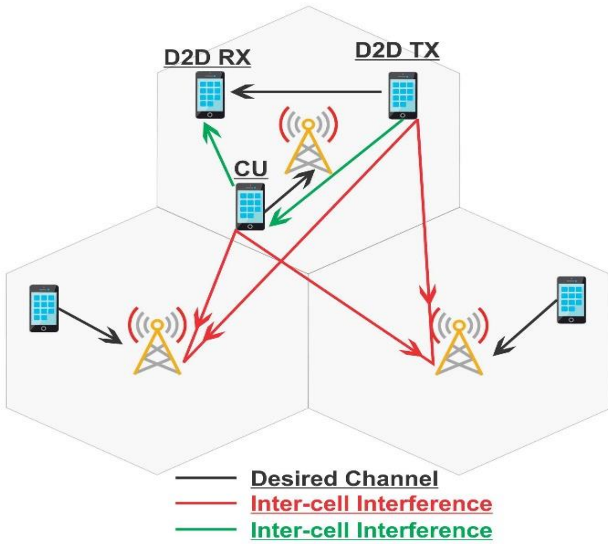

Figure 1: Process block diagram of transmitter and receiver in D2D communication mode.

Let P_D and P_C denote the transmit power of the D2D pair and the CU, respectively. The uplink received SINR at the BS from the CU is given by

$$\gamma_c = \frac{P_c\,[W^H h_c]^2}{\sigma^2 + P_D[W^H g_D]^2}$$

where $h_c \in C^{N\times 1}$ is the channel between the CU and the BS, $g_D \in C^{N\times 1}$ is the interference channel between the D2D transmitter and the BS, w is the receive beam vector at the BS with unit norm, i.e., llwll^2 =1, and σ2 is the noise variance at the BS. The SINR at the D2D receiver is given by

$$\gamma_D = \frac{P_D\,[h_D]^2}{\sigma_D^2 + P_c[g_c]^2}$$

where $h_D \in C$ is the channel between the D2D pair, $g_C \in C$ is the interference channel between the CU and the D2D receiver, and σ_D^2 is the noise variance at the D2D receiver.

In a multi-cell network, both D2D and CU transmissions cause ICI in a neighboring cell. In this work, we consider ICI for uplink transmission at b neighboring BSs. However, our approach can be applied also to ICI in the downlink scenario. Let $f_{C,j} \in C^{N\times 1}$ and $f_{D,j} \in C^{N\times 1}$ denote the ICI channels from the CU and the D2D transmitter to neighboring BS j, respectively. Since the beam vector at neighboring BS j is typically unknown to the CU and D2D pair, we consider the worst-case ICI given by

$$P_{I,j} = P_c\left\|f_{c,j}\right\|^2 + P_D\left\|f_{D,j}\right\|^2$$

We assume perfect instantaneous CSI is available only for $\{h_C , g_D\}$, i.e., the direct channels from the CU and D2D to the BS in Figure. However, only partial CSI is available for h_D, g_C , $\{f_{\dot{D},j}\}_j^b = 1$, and $\{f_{\dot{C},j}\}_j^b = 1$. In particular, only distance-based statistical knowledge is available at the BS scheduler.

We assume $|h_D|^2 \sim exp(\eta_1)$ and $|g_C|^2 \sim exp(\eta_2)$, which is a common assumption corresponding to Rayleigh fading, but the distributions of $\{f_{D,j}\}$ =1 and $\{f_{C,j}\}$ =1 can be general.

Instead of instantaneous CSI, we assume η_1 and η_2 are known at the BS. Note that measuring and transmitting these statistical parameters is much easier than the instantaneous CSI. This substantially reduces the signaling overhead due to D2D communication. For the ICI channels,

we assume $E\left[\left|f_{D,j}\right|^2\right] = \lambda_{D,j}$ and $E\left[\left|f_{C,j}\right|^2\right] = \lambda_{C,j} = \lambda_{C,j}, for\ j = 1,\cdots, b,$

where only $\{\lambda_{D,j}\}_{j=1}^b$ and $\{\lambda_{C,j}\}_{j=1}^b$ are known at the BS scheduler. These statistical parameters can be estimated in neighboring BSs and shared with the BS in the desired cell through the wired backhaul.

III. PROCESS OF OPTIMIZATION

In this section describe the process of particle swarm optimization for the optimization of high power optimization in device to device communication. The process of optimization reduces the signal distortion in terms of optimal selection by the define fitness constraint function. In section a describe the process of swarm intelligence and in b describe the process of optimization [15].

(a) Particle swarm optimization

Particle of swarm optimization is dynamic population-based searching technique. The process of working define in manner of particle of swarm optimization is birds fork. The global best solution is better result in case of optimality. The process of optimization applies on blocks searching and mapping parameter for the process of encode. The process of particle of swarm optimization describe as. In Particle Swarm Optimization [10] optimizes an objective function by undertaking a population-based search. The population comprise of possible solutions, named particles, which are metaphor of birds in flocks. These particles are at random initialized and freely fly across the multi-dimensional seek space. During flight, each particle updates its own velocity and position based on the best experience of its own and the entire population. The different steps involved in Particle Swarm Optimization Algorithm are as follows[15]:

Step 1: All particles' velocity and position are randomly place to within pre-defined ranges.

Step 2: Velocity update – At every iteration, the velocities of all particles are updated based on below expression

$$v_i = v_i + c_1 R_1 (p_{i,best} - p_i) + c_2 R_2 (g_{i,best} - p_i) \quad ....(1)$$

where p_i is the position and v_i are the velocity of particle i, $p_{i,best}$ and $g_{i,best}$ is the position with the 'best' objective value found so far by particle i and the entire population respectively; w is a parameter controlling the dynamics of flying; R_1 and R_2 are random variables in the range [0,1]; c_1 and c_2 are factors controlling the related weighting of equivalent terms. The random variables facilitate the PSO with the ability of stochastic searching.

Step 3: Position updating – The positions of all particles are updated according to,

$$p_i = p_i + v_i \quad ...(2)$$

Following updating, p_i should be verified and limited to the allowed range.

Step 4: Memory updating – Update $p_{i,best}$ and $g_{i,best}$ when condition is met,

$$p_{i,best} = p_i \quad if\ f(p_i) > f(p_{i,best})$$

$$g_{i,best} = g_i \quad if\ f(g_i) > f(g_{i,best}) \quad ..(3)$$

Where $f(x)$ is to be optimized and it is a objective function.

Step 5: Stopping Condition – The algorithm repeats steps 2 to 4 until certain stopping circumstances are met, such as a pre-defined number of iterations. Once closed, the algorithm reports the values of g_{best} and $f(g_{best})$ as its solution [8]. PSO utilizes several searching points and the searching points gradually get close to the global optimal point using its $pbest$ and $gbest$. Primary positions of $pbest$ and gbest are dissimilar However, using thee different direction of $pbest$ and $gbest$, all agents progressively get close to the global optimum

(b) Process of optimization

(c) Let $v_i = [v_{i1}, v_{i2}, \ldots, v_{iks}]$ is the estimated vector of stich of define objective function $f(v_1, v_2, \ldots, v_{ks})$.
(d) For each vector, $b = 1$ to Q do
(e) Define $S_0^b = S^b, T_0^b = \emptyset, U_0^b = T^b, M_{0b}^c = I$
(f) For iteration, k=1 to K do
(g) With $\theta_{u_b p}^c \in (S_K^b + T_k^b), Pp \in \{1, \ldots, P_{u_b}\}$
(h) Estimate $Pl_b \in S_k^b, I2C(A_{l_b}, c)$
(i) With $\theta_{l_b p}^c \in (S_k^b + T_k^b - l), P_p \in \{1, \ldots, P_{l_b}\}$
(j) Update $S_{k+1}^b,\ T_{k+1}^b, U_{k+1}^b$
(k) And finally proceed the signal distortion and finally process the level of power as
(l) A set of vectors $A_{ni} = \{a_1, a_2, \ldots, a_j\}$, and each vector a_i with the symmetry vectors c_i and the moves d_i, the velocity move position of vectors C, and the constant rate of velocity for vectors update.
(m) $f(v_1, v_2, \ldots, v_{ks}) = 100$
(n) $\times [\left|M - \frac{|V_1|}{sV_{dc}}\right| + (\frac{|V_5|+|V_7|+\cdots\ldots+|V_{3ks-2\ or\ 3ks-1}|}{sV_{dc}})]$
(o) $f(v_1, v_2, \ldots, v_{ks}) = 100$
(p) $\times [\left|M - \frac{|V_1|}{sV_{dc}}\right| + (\frac{|V_5|+|V_7|+|V_{11}|+\cdots\ldots+|V_{49}|}{sV_{dc}})]$

IV. EXOERIMENTAL ANALYSIS

S. No.	PARAMETER	VALUE	UNIT
1	P-TOTAL	-10	dB
2	P-CIRCUIT	0.05	W
3	FREQUENCY	2.15	GHz
4	ISD	250	-
5	λ (LAMBDA)	20/(π*1500^2)	-
6	NUMBER OF USER	5	-
7	ITERATION	26500	-
8	PATHLOSS	3.5	-

Table 1: show that the several parameter values with their units.

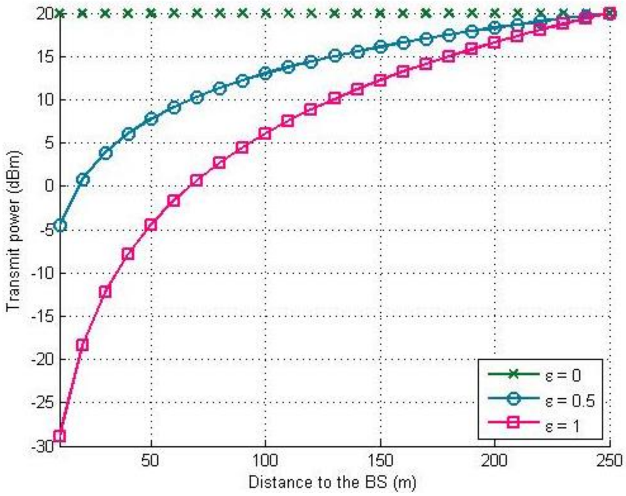

Figure 2: show that the performance between transmit power and distance to BS.

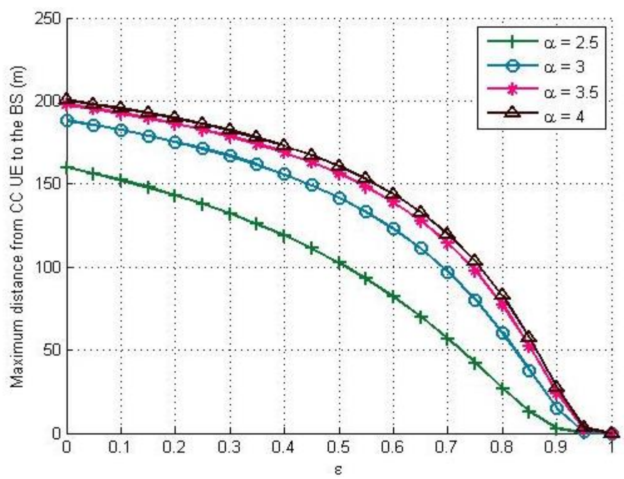

Figure 3: show that the performance between maximum distance from CC UE to the BS and ε.

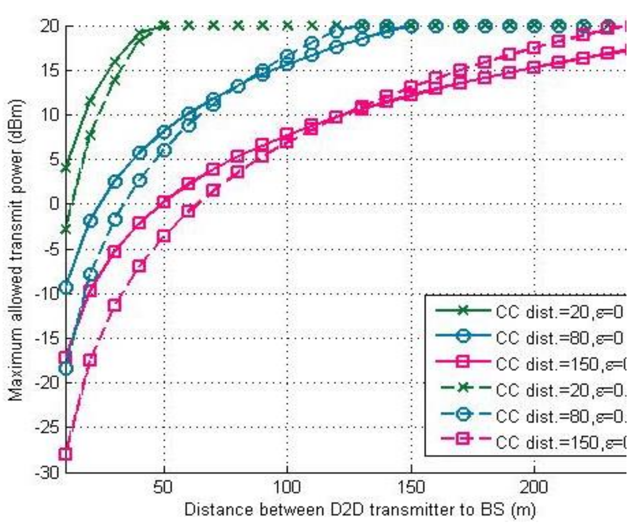

Figure 4: show that the performance maximum allowed transmit power with respect to distance between D2D transmitter to BS.

S. No.	PARAMETER	VALUE	UNIT
1	P-TOTAL	-10	dB
2	P-CIRCUIT	0.05	W
3	FREQUENCY	2.15	GHz
4	ISD	250	-
5	λ (LAMBDA)	20/(π*1500^2)	-
6	NUMBER OF USER	5	-
7	ITERATION	10000	-
8	PATHLOSS	3.5	-
9	AVERAGE THROUGHPUT	556.5119	-

Table 2: show that the several parameter values with their units and average throughput result.

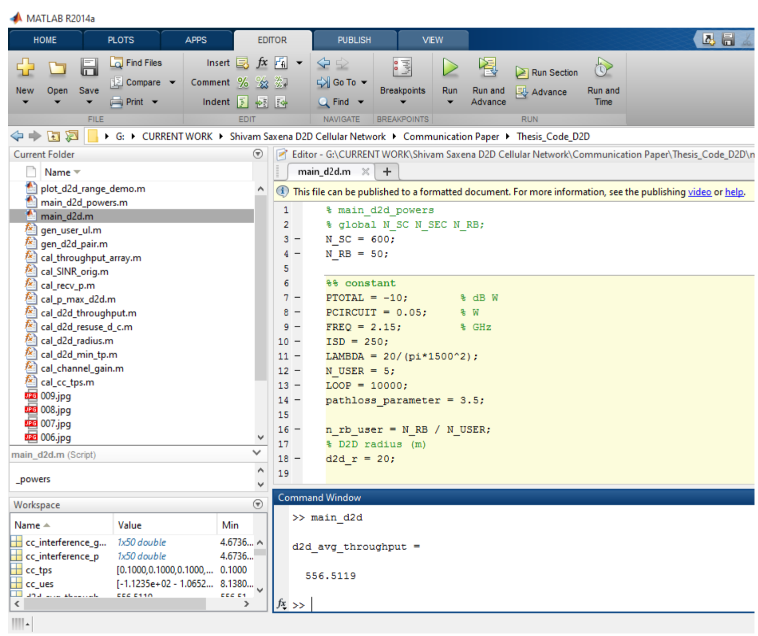

Figure 5: window show that the implementation analysis of our simulation with number of user is 5 and calculate the average throughput.

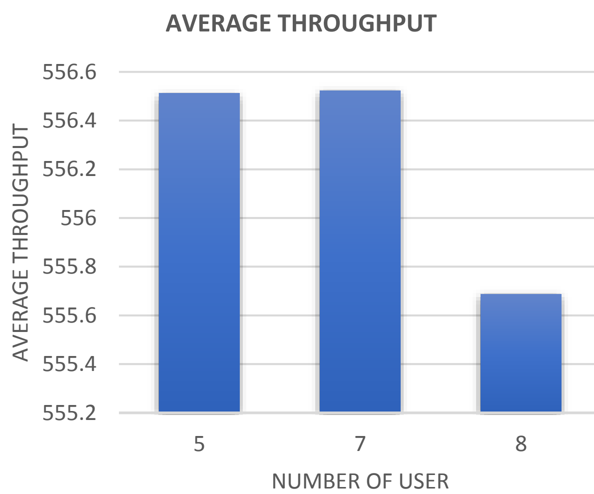

Figure 6: show that the performance between average throughput and number of user.

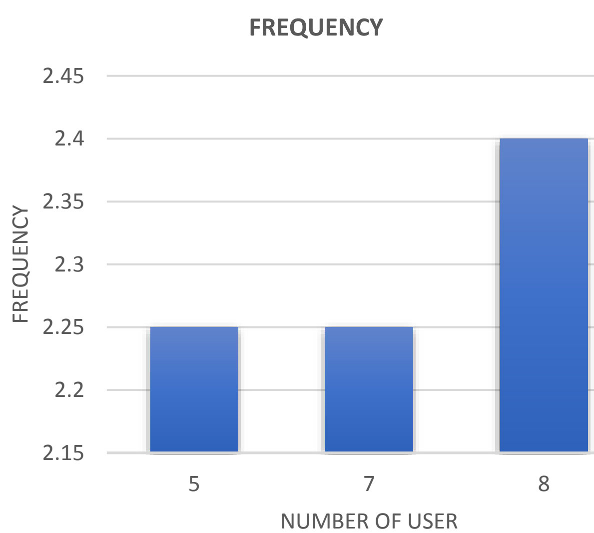

Figure 7: show that the performance between frequency and number of user.

V. CONCLUSIONS

In this dissertation analyzed the performance of optimization of energy value of device to device communication underlaying cellular network. The process of optimization proceeds in two phases Firstly, both cellular and D2D communications are treated as competing services without priority. A greedy sum-rate maximization is applied under a maximum transmit power constraint. In the second case, we give priority to the cellular user by guaranteeing a minimum transmission rate, under the same maximum transmit power constraint. Furthermore, in the second case we set an upper limit to the transmission rate to simulate the maximum transmission rate constrained by the highest modulation and coding scheme (MCS) of a practical system. The results show that the sum rate improvement over the fixed transmit power case is significant. The power control is also tackled under prioritized cellular communication and an upper transmission rate limit. In nonorthogonal resource sharing mode, we show that the optimized power allocation resides on one of at most 3 feasible solutions. The sum rate is comparable to that of the fixed transmit power case in most of the cell area, while the cellular user rate is effectively guaranteed. The proposed algorithm simulated in MATLAB software and tested under different parameter such as path loss, number of user distance of base station.

In this dissertation optimized the utilization of energy in device to device communication and analyzed. The proposed optimization algorithm further extended as

- Extend or propose advanced optimization scheme for both D2D and cellular network for control over their resource sharing to meet their requirements, using transmission power.
- Extend the proposed algorithm, to enhance the performance of resource allocation based on the mode of power selection.

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