Performance Analysis by Using GA in the Reduction of Power Consumption in Wireless D2D Communication

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Abstract

In wireless D2D communication, it mainly has communication links set up between devices. In implementing power control mechanisms in D2D communication, it will generate many benefits in D2D communication such as interference effect reduction, saving power consumption and spectrum efficiency improvement etc. In this paper, we consider two search mechanisms, Random Access and GA algorithm, in the search of the target UE when a source UE is initiating to setup a D2D communication. The search procedure of each mechanism is considered and the system performance such as the system power consumption, system capacity and the number of targeted users can be located etc. associated with each mechanism are simulated and evaluated. It has the result that by using GA mechanism it has the power consumption advantage than that by using the Random Access method.

Keyword: D2D、GA、Power Control、Power Consumption

1. Introduction

D2D is an important task in beyond 4G (B4G) wireless communications; it is a technique applying in cellular network that devices in the cellular network can communicate with each other through LTE-Advanced protocol directly without passing through the base station as that implemented and regulated in the conventional communication protocol. D2D communication can reduce the load of base stations and efficiently utilize the spectrum resource [1].

In D2D communication, power control is an important issue [2-5]. In the power control mechanism as discussed in [2], it uses targeted SINR as the performance criterion with open and close loop operation for D2D mode UEs and also for cellular mode UEs. In [3], performance of D2D communication is evaluated with interference coordination between the cellular and the D2D communications. In the coexistence system of D2D mode and cellular mode communications, it can with power control algorithm to mitigate interference effectively [4], and to achieve better sum rate [5].

In this paper, we develop the methods of GA and Random Access in the pairing and grouping of D2D UEs and comparing their resulting system performances and it appears that by using GA will make ‘better’ pairing between UEs to achieve better interference mitigation effect and to use less power consumption in D2D communication.

2. Proposal on D2D link allocation

In D2D communication when one SUE (Source UE) makes a request to initiate a D2D communication, it will ask its grant from eNB and the eNB then assists the SUE to find its communication partner TUE (Target UE); and then the eNB will notify the SUE and TUE a communication link has set up for them.

During UEs D2D communication it saves UE’s power consumption[6] when power control mechanism is implemented. Due to power constraint in UE it then has the limitation in the range in finding the intended TUE when SUE is initiating a D2D communication link. However if the communication link is not set up for a particular TUE but for gaming, advertisement and social network etc. then the eNB can connect the SUE to its nearest TUEs to save the possible path loss so as to minimize the total power consummations.

In D2D UEs pairing two methods are considered, i.e. Random Access and GA method. It uses GA to generate two pairs of chromosomes in the D2D pairing one set is used as the TX and the other set is for RX. The procedures of using GA algorithm in the UEs pairing are summarized in the following steps;

Step 1) Initialization: Users are normally distributed in the cell and then users are categorized into two sets of chromosomes; one set is SUE and the other set is TUE; the genes of the chromosomes are used as the UEs identification numbers and these identifications numbers are used in the users pairing.

Step 2) Fitness function evaluation: It calculates the path loss for each pair of UEs and then the total system attenuation loss is evaluated; if the sum is not a minimum it enters the GA evolution process.

Step 3) Mutation: It randomly selects 2 genes of a chromosome to do the mutation process.

Step 4) Crossover: It randomly selects two genes from two chromosomes to do the crossover.

Step 5) Iteration: After successfully complete the pairing; it will implement power control mechanism to reduce the interference between UE pairs and also to reduce the UEs power consumption.

The path loss between TXUE and RXUE can be expressed as:

$$P_t = min(P_{max}, P_0 + 10*log10(M) + a*PL) \quad (1)$$

where

P_t : Transmitting power

P_{max}: The transit power of UE

P_0 : UE specific parameter

M: Number of assigned PRBs

a : Cell-specific path-loss compensation factor

PL is using from 3GPP Urban Micro(UMI) D2D model [4], with the following equation:

$$PL = 40\log10(R) + 30\log10(f) + 49 \quad (2)$$

R:distance between device and device in kilometer

f:Carrier frequency in GHz

The received signal strength at the base station/UE can be estimated from the following equation:

$$P_r(dBm) = P_t - PL \quad (3)$$

3. Performance evaluation

Two mechanisms such as Random Search and GA have been implemented to test the system performance such as the system capacity and the total power consumption. In the Random UE search the SUE searches for the TUE that it intends to communication with. In the GA search it uses GA algorithm to find the unknown TUE; the eNB searches for the TUE with a shortest distance and minimum path loss from the SUE. The system implemented in the system performance evaluation has parameters as shown in Table 1. The UEs are distributed in equal area of environment having a shape of square, circular or rectangular. The square area environment is a mimic of the city park, the circular one is as the regular cell and the rectangular one is for the tunnel. We have 200 UEs in the simulation and the resulting UEs distribution with uniform distribution assumption in different communication environments are shown in Figures 1. Link budget is used to evaluate the received signal strength. In the GA algorithm the path-losses of total links are accumulated and use this number as the fitness function. With GA search it will search for the pairings of SUEs and TUEs to reach a minimum of the total path-losses.

It has the simulation result with UE's average path-loss as shown in Figure 2; it appears that in the GA search it has lower power consumption than that with Random Search. With Random Search it has 3 dB to 8 dB gain, 25 dBm vs. 21 dBm~16 dBm in the average UE power consumption over the system without implementing any power control, while it has more than 35 dB gain with GA implementation.

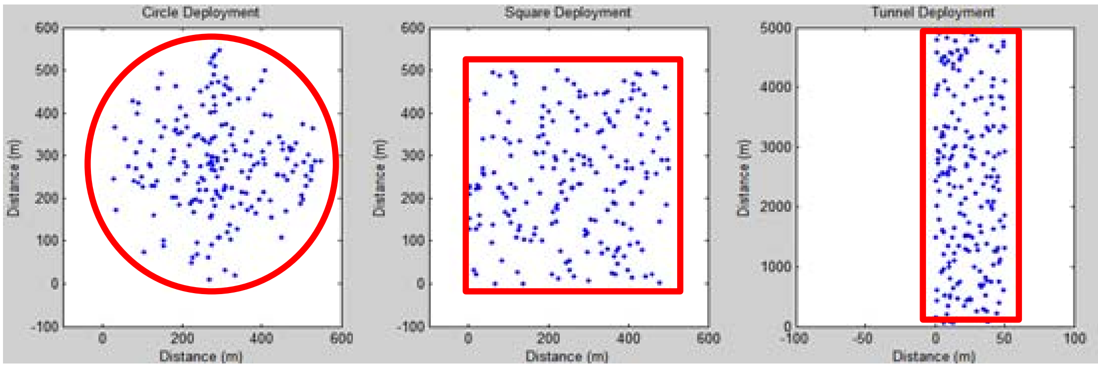

Figure 1 UE Deployments

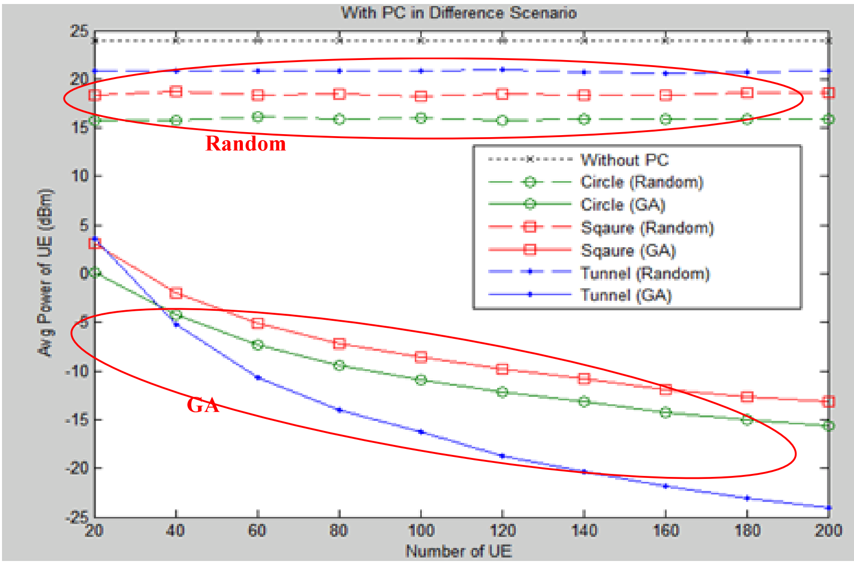

Figure 2 Simulation Results with Random Search and GA Algorithm in Different Communication Environments

Table.1 Simulation Parameter

Evaluation parameter	
Number of UE	Min : 20, Max : 200
UE Distribution	Normal Randomly
	Square 500(m) * 500(m)
Grid of UE distribution	Tunnel 50(m) * 5000(m)
	R= 282(m)

Power Control parameter	
P_{max}	24dBm
P_0	-78
M	1
a	0.8

System parameter	
Bandwidth	10M
Carrier frequency	2Ghz

4. Conclusion

From the simulation results as executed in this paper it concludes that we can use GA algorithm in the base station to perform D2D users pairing and with the inclusion of power control algorithm the UE can use a minimum power in its data transmission while maintaining the system performance at certain acceptable level. With this power control algorithm it will possibly increase the UEs transmission time even with limitation of power resource at the UE terminal. From the simulation results with various power control algorithms applied to different communication environments we list in Table 2 the comparisons of various power control algorithms. It has the best performance with Random UEs deployed when UEs are deployed in the circular type cell while it has better performance for UEs deployed the Tunnel when GA algorithm is implemented.

Table.2 Simulation Compare table

Scenario / Method	Tunnel	Circle	Square
Random	Bad	Best	Middle
GA	Best	Middle	Bad

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[2]International Telecommunication Union (ITU) web site, http://www.itu.int/en/Pages/default.aspx

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