Spectrum Sharing Using Meta Heuristic Genetic Model for Cellular Users and Ad-Hoc Device-To-Device Users

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Abstract: ***D2D users communicate with each other on the same frequency channels used by macro users. We develop a distributed dynamic spectrum protocol in which ad-hoc device-to-device users opportunistically access the spectrum actively in use by cellular users. In our proposed work, First, channel gain estimates by using high power node based chain optimality to set feasible transmit data using device-to-device users that keeps the interference they cause within the allowed interference temperature by using dynamic traffic assignment model(DTSM) and network information is distributed by route discovery packets in a random access way by using meta heuristic genetic model(MHGM) manner to help establish either a single-hop or multi-hop route between two device-to-device users. We improve outage probability with minimum gap analysis of device to device that network information in the discovery packet can decrease the failure rate of the route discovery at high distance based threshold and reduce the number of necessary transmissions to find an efficient route that would be simulated in MATLAB tool.***

Keywords: Meta heuristic genetic model, spectrum sharing, Ad-hoc network, MATLAB etc.

1. Introduction

As the number of Ad-hoc network users is increasing at a much faster rate, the service provider cannot obtain new spectrum resources. With the rising number of users in mobile communication system in future, to fulfill the rising demands on bandwidth is impractical since the spectrum is already fully allocated. As another method to meet the high demand for service the dynamic spectrum access techniques become increasingly popular. In most of the existing spectrum policies the frequency spectrum is statically partitioned into fixed bands and that fixed bands are allocated to a specific standard or technology. As a result of these spectrum policies spatial locations are reserved to use a spectrum band for all time. The advantage of reserving frequency resources for all time is that it is the quickest and easiest way. If the spectrum is not shared interference will be less and higher data rates can be achieved. But the cost of this easy solution is very high. And also the problem arises whether it is the most efficient method of utilizing the limited resource like spectrum. Thus to efficiently use the spectrum an opportunistic strategy called spectrum sharing can be used. Spectrum sharing occurs. When a given set of frequency resources are actively in use by one set of users and if they are interested in sharing the spectrum resources simultaneously with another set of users they it can be said as the spectrum sharing scheme. To bring efficiency to an underutilized resource spectrum sharing can be used, but interference management must be considered while designing and it should be strictly avoided. To manage the interference between users and between standards the frequency spectrum is licensed and strictly controlled. More and more transmitting users will be added to today's Ad-hoc networks by sharing the spectrum, which will in turn cause more interference.

2. Device to Device Communication Using Multi Hop Route

In Ad-hoc network data packets find their paths through routers. Each time a packet is passed to the next router a hop occurs, if only one hop occurs between source and destination then its single hop. In multi-hop Ad-hoc networks there are one or more intermediate hops along the path that receive and forward packets via Ad-hoc links.

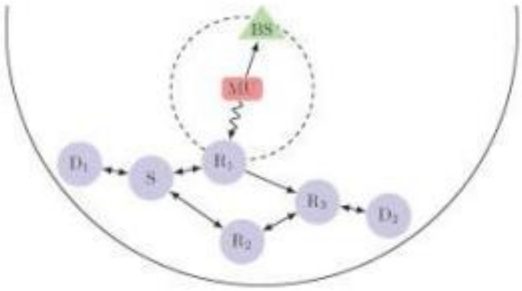

Figure 1.1: An example realization of what a cellular network with an under laid D2D network may look like.

The source (S) communicates over a single-hop if possible, as to D1, or uses idle D2D users RIas relays over a multi-hop route, as to D2. The interference from the macro user (MU) causes too much Interference for a two-way route to be used with relay R1.

In our work, we use the distributed dynamic spectrum protocol(DSP)to discover D2D links in the network. DSP is a source initiated packet based discovery protocol. The DSP protocol floods the network with discovery packets and in doing so, exchanges the address of relay nodes in the network so the destination will have a virtual map of how to reach the source. If node j is the D2D destination, then a single-hop route exists with the D2D source. If a single-hop route does not exist, then node j can continue the discovery process and serve as a relay. However, it will only continue the discovery if it knows that a two-way link exists with the

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D2D source. It rebroadcasts the discovery packet adding its own transmission power and interference power.

3. Spectrum Sensing

One of the most important elements in the CR network is spectrum sensing [6].when we decreasing the optimal threshold value to decrees the probability of missed detection also increase the probability of false alarm and when increasing the threshold value to probability of false alarm would increase the probability of missed detection. Since both are unwanted and both can't be deceased simultaneously. Many different signal detection techniques can be used in spectrum sensing to improve the detection probability.Fig.4 gives classification of the Spectrum Sensing. The Ad-hoc radio should describe between used and unused spectrum bands. In spectrum sensing Transmitter detection method is based on the detection of the weak signal from a primary transmitter through the different techniques:

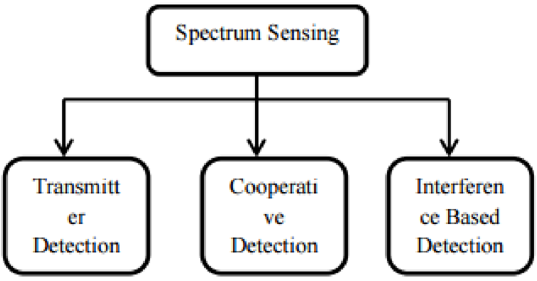

Figure 1.2: Classification of spectrum sensing techniques

4. Challenges in Device to Device Spectrum

The primary challenge for D2D communication includes interference management among coexisting D2D users, development of interference mitigation techniques with minimal signaling overheads.

- **Management of Interference among D2D**

The introduction of D2D communication in cellular networks is challenging for both D2D and Cellular users due to the cross-tier interference coming from the synchronous transmission of cellular and D2D users. This issue is more challenging in multi-tier networks where low-power small cells are densely deployed over existing single-tier networks (as will be in the emerging fifth generation, 5G, cellular Ad-hoc networks). These small cells result in additional cross-tier interference on top of that from the macro Base station and Cellular users. Thus there is a need of an efficient interference management technique (e.g., power control, spectrum allocation, multiple antenna beam forming). Furthermore, an interference experienced by D2D receiver from neighboring D2D transmitters (referred to as inter-D2D interference) also needs to be mitigated through proper user pairing and frequency assignment techniques.

- **Ad-Hoc Spectrum Access**

Spectrum sharing between Cellular users and D2D pairs allows higher spectrum reuse. However, it may lead to severe cross-tier interference at D2D links when they coexist with Cellular users and other tiers such as the small cell tier in a multi-tier cellular network. Further, static spectrum splitting among different tiers wipes out cross-tier interference. This technique could significantly reduce spectral efficiency depending on the number of D2D terminals and the proportion of available spectrum for them. Thus with minimum control of base station Ad-hoc spectrum access methods can adapt to the traffic load intensities of Cellular users and D2D pairs

5. Evaluation Performance of Genetic Algorithms

Implementation of GA in Ad-hoc network

Our research focuses on the spectrum management with a hypothesis that inputs are provided by either sensing information from the radio environment or the secondary user and they specifies the QoS requirements condition to the radio. The CR senses the radio frequency parameter form the environment at its receiver and engages itself in a decisionmaking process in order to provide new spectrum allocation as demanded by the user. This requires a decision-making for requirements of SU as parameters like, its modulation method, bandwidth, data rate and power utilization etc. The SU node that needs the spectrum to perform its communications according to QoS requirements, which depends on inputs of SU and CR as gets the information about the RF environment from a sensing components. This permits the decision-making process to make an evaluation between the SU's specifications against the accessible collection of the solutions received from the RF environment. The information that has been sensed from the environment serves as the initial population for the genetic algorithm. We will create random values that will provide as the initial population, which is, assumes as information received from the RF environment and then obtain the decision for allocation as an optimization with the best solution. To maintain the simplicity in the research, the four parameters viz. frequency bands, the modulation method, power and BER will be used. We will use the genetic algorithms that optimized the best function for user QoS requirements from a number of solutions in the pool. The genetic algorithm approach starts with the definition of the structure of a chromosome. This structure is a sets of genes i.e. frequency, modulation, power and BER in this particular each genes will be considered for the decision-making process fact that a part of the solution.

Evaluation

Meta-heuristic algorithm is an illustrious method consummated to credit, commence or stipulate a lower-level scenario or heuristic (partial exploration algorithm) that execute a relevantly admissible definition to optimization dilemma, confined with remarkable compressed intelligence or cramped data processing capability. They are pertinent for various complications that make deficient hypothesis about the optimization problem being elucidated like travelling salesman problem, maximum clique problem,operational research, flow shop scheduling problem, P – median problem and NP-hard. Previously we have generated the first generation population of the chromosomes, now next step is to obtain the fitness evaluation of each chromosome in the population. This 1st population of chromosomes has a different pool of possible solutions that meet the QoS needs of the SU or the application. Some of these solutions may exactly satisfy the QoS requirement while others is just nearby to specifications.

So, choosing amongst this pool to make the trade-off conditions. In this paper, assumption has been made that fitness function that is equally dependent on all the four parameters defined as above as genes and the fitness function uses weighted sum approach in GA. All the four parameters set as an equal weight each. The input is given by SU or application for QoS requirements are compared against the population of chromosomes. As discussed earlier, GA has capability of multi objective optimization, so that overall fitness is computed as the cumulative sum of the individual fitness of each parameter (gene) according to the procedure described as following.

Let parameter x_1, x_2, x_3 and x_4 be the frequency gene, power gene, BER gene and modulation gene respectively. Therefore these requires fitness function fi for each parameter given by

$$f_i = \begin{cases} \left[\dfrac{w_i \cdot \left| x_i - x_i^d \right|}{x_i^d} \right] & \text{if } \left| x_i - x_i^d \right| < x_i^d \\ w_i & \text{otherwise} \end{cases} \quad (1)$$

The overall fitness function value of chromosome F can be calculated as cumulative sum of individual fitness value of all the genes i.e.

$$F = \sum_{i=1}^{4} f_i \ . \quad (2)$$

The overall fitness value of chromosome in percentages is given by

$$\text{Total fitness value}(\%) = 100 \cdot \left[1 - \sum_{i=1}^{4} f_i \right] \quad (3)$$

Where, x^d_i is desired QoS parameter, wi is a weight and $\sum_{i=1}^{4} w_i = 1.$ where i = 1, 2, 3 and 4 be the gene order of concern parameter Note that each gene having equal weight i.e. w = 25%, however in true practical case in Ad-hoc communication weighting factor w can be vary according to QoS specifications. Also note that using (2), the more the fitness value of the gene, results in the less suitable solution. So, obtaining best solution with the fitness value of the gene converging to zero. On the other hand, using (3) comparison of the total fitness of the chromosomes, the larger the fitness value the better the solution obtained and vice versa. Selection operator of GA engages the selection of the best children within the pool of existing chromosomes. There are two methods uses the selection operator first is “Roulette Wheel selection” method. Probability of selection with each individual best chromosome from population, given by

$$p_i = \frac{f_i}{\sum_{i=1}^{n} f_i}$$

Where, Pi is probability of the individual chromosome fi is the fitness of an individual gene i in the pool and n is the total number of chromosomes in the population. The chromosomes with the maximum probability value transferred to the next generation and not to allow the lower fitness value chromosomes to the next population of chromosomes. Subsequently each generation the fittest chromosomes are transfer to the new population until the new population achieves the maximum given limits.

Second selection method is “Elitism” used in decision-making process that selects the best among the population of chromosomes and transfers to the next generation. In reality, it copies a small number of the best chromosomes and transfers to the new population. It stops the loss of the best possible solution.

The next step is that after the selection of the best chromosomes existing in the pool, to perform the crossover operation. The crossover operation is carrying out on a pair of chromosomes, selected arbitrarily. The operation is completes at the crossover points that define the joint of the genes in the chromosome structure. The crossover operation is shown in figure 4.1.

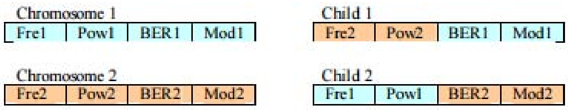

Figure 4.1: Chromosomes crossover representation

Next step is that the mutation operation engages the flip to corresponding single binary digit with single chromosome at a time. In mutation, a randomly selected bit fit in to any of the 4 genes. This provides new solution in search space shown in figure 4.2.

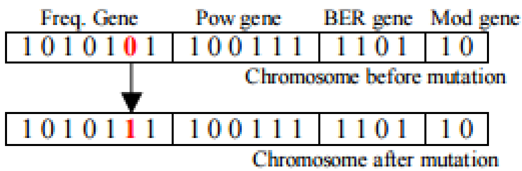

Figure 4.2: Chromosome mutation representations

The process of all GA operators will repeat until best solution found as shown in below figure. Next section analyses the results with mat lab simulation.

K_Means Clustring

Sleep mode

It initially set at the sleep modes and turned to active modes only when there is a target. Therefore, they can save their energy and make their life time long and while light sleep modes have quick and inexpensive switching to active mode with a higher current draw. Our proposed proposes adaptive radio low-power sleep modes based on current traffic conditions in the network

Active mode

Whenever device get in interference the active mode for each acoustic sensor to make these acoustic sensor nodes save their important energy. Sensors in the vicinity of the active CH(cluster head) are "invited" to become members of the cluster and will report their sensor data to the CH. They are set at active mode all the time so that they can detect whether a target enters the sensor network. corresponding region. They are initially set at the sleep modes and turned to active modes only when there is a target.

6. Result and Discussion

The proposed network is simulated and verified using MATLAB tool. We consider different parameter interval and packet size for simulation. For different values of interval and packet size the network is verified and graphs are plotted.

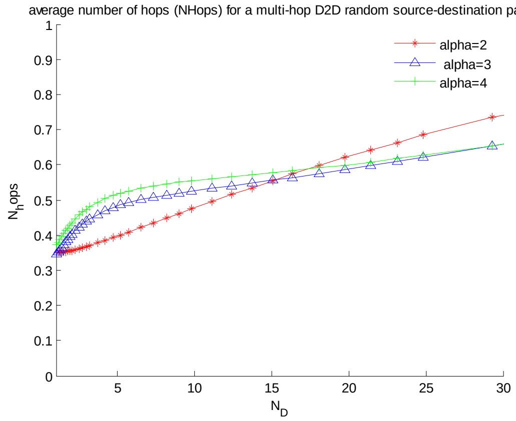

Figure 5.1: Average no of hops for a multi-hop devic to device random source destination pair.

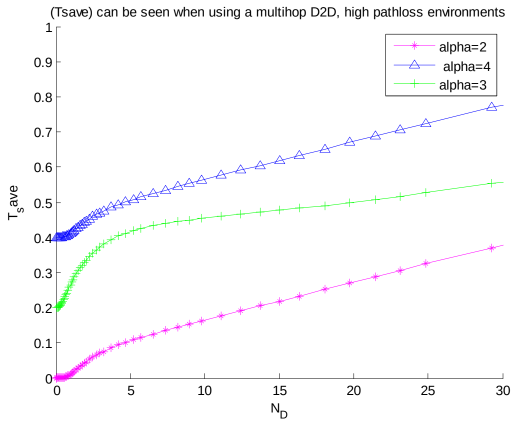

Figure 5.2: The percentage savings in the number of discovery transmissions made (Tsave) when network information is used in the high path loss environment.

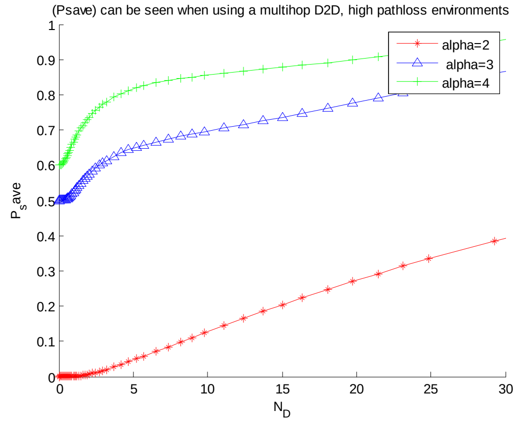

Figure 5.3: Significant power savings (Psave) can be seen when using a multi-hop D2D route rather than the cellular mode in high pathloss environments. High pathloss environments result in meager savings as there is often a strong channel with the base station.

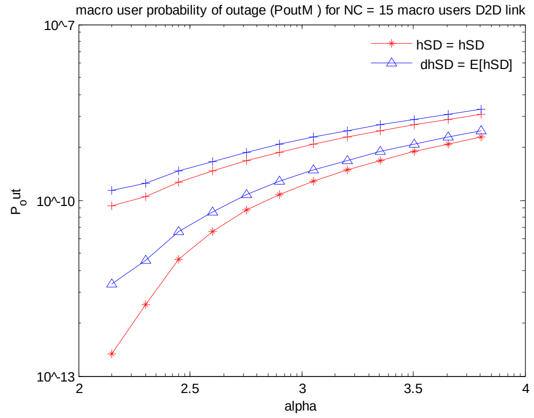

Figure 5.4: Results for the macro user probability of outage (PoutM) for NC = 15 macro users sharing their channel with a single D2D link for a varying radius ratio r=R. Perfect channel gain estimates and statistical estimates in the D2D source's power control are considered.

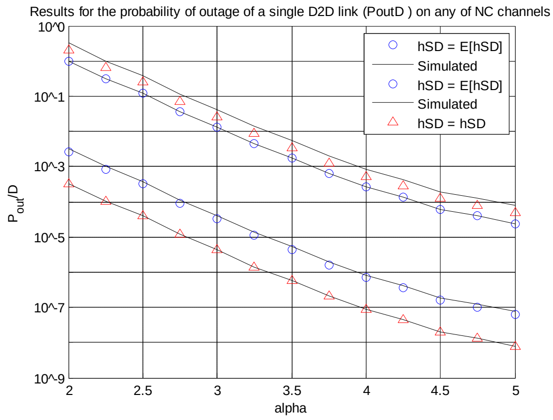

Figure 5.5: Results for the probability of outage of NC macro users (Pout M) sharing their channel with a single D2D link for a radius ratio of r=R = 0:25. Perfect channel gain estimates and statistical estimates in the D2D sources power control are considered.

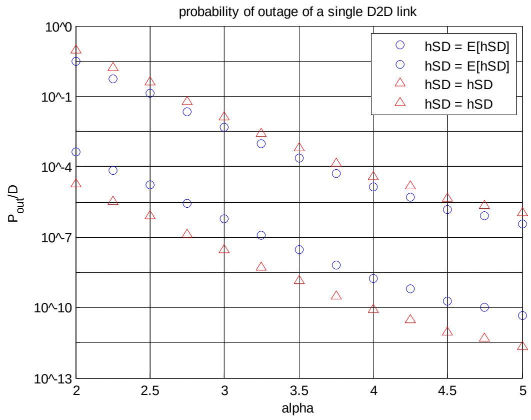

Figure 5.6: Probability of outage of a single D2D link

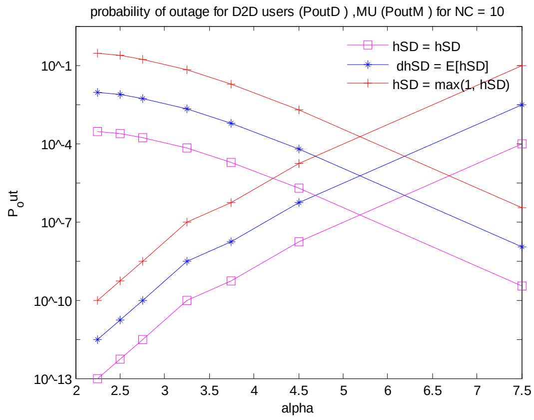

Figure 5.7: Probability of outage for D2D (Pout), MU (PoutM) for NC=10

7. Conclusion

In this paper, we have discussed and implemented the progression of anAd-hoc device to device communication in a cellular network model on the network simulator. The idea behind the research is to utilize upcoming technologies to increase the reliability of multimedia communication. The fallouts show that the utility of the spectrum gets an increase when Ad-hoc D2D is implemented in cellular networks.Ad-hoc network is a promising technology to improve the spectrum utilization and ease the shortage of spectrum resources, and the quality of spectrum allocation directly determines the spectrum utilization. In order to explore a better solution for spectrum allocation in Ad-hocnetworks, a spectrum allocation model based on dynamic spectrum protocolis established to describe the problem in this paper, and the novel Meta heuristic genetic algorithmis used to facilitate to maximize the Ad-hoc network spectrum utilization and secondary user fair within the interference constraint. Finally, the simulation results demonstrate that the proposed spectrum allocation algorithm can perform better than a set of existing algorithms in network reward, secondary user's fairness and convergence.

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