Final Year Project (ECS 852)

Topic: Improving Performance of Device to Device Communication Using Underlay Cognitive Radio Principle

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Contents:

Introduction

- The exponential growth in the number of mobile devices and need for spectrum realizes a tough constraint on the spectrum as a resource.

- The idea of cognitive radio (CR) network increases the spectrum utilization efficiencies.

- In CR to mobile networks, the primary users and the secondary users can coexist in the same licensed band In such an underlay approach

- The interference temperature limit (ITL) is the maximum interference that can be allowed by the secondary users to the primary network

- The interference should be below a certain level i.e. ITL. So that the primary transmitted signal can't be affected by the secondary interference

- Cognitive radio network should always check the estimated interference at primary network

- This paper is basically about using this underlay cognitive radio principle for improving the performance in device to device communication

❖Objective

The main objectives of this project are

- To present the expression for multiple numbers of D2D pairs and to propose a scheme where the interference level is naturally maintained.
- To determine the throughput for simultaneous transmissions by up to two D2D nodes in the same frequency band.
- To show that sum throughput improves with the increasing number of D2D pairs in a secondary network by user selection method among multiple numbers of D2D pairs.

System Model and Problem Formulation

Considering one D2D pair from given N D2D pairs which are transmitting in same frequency band.

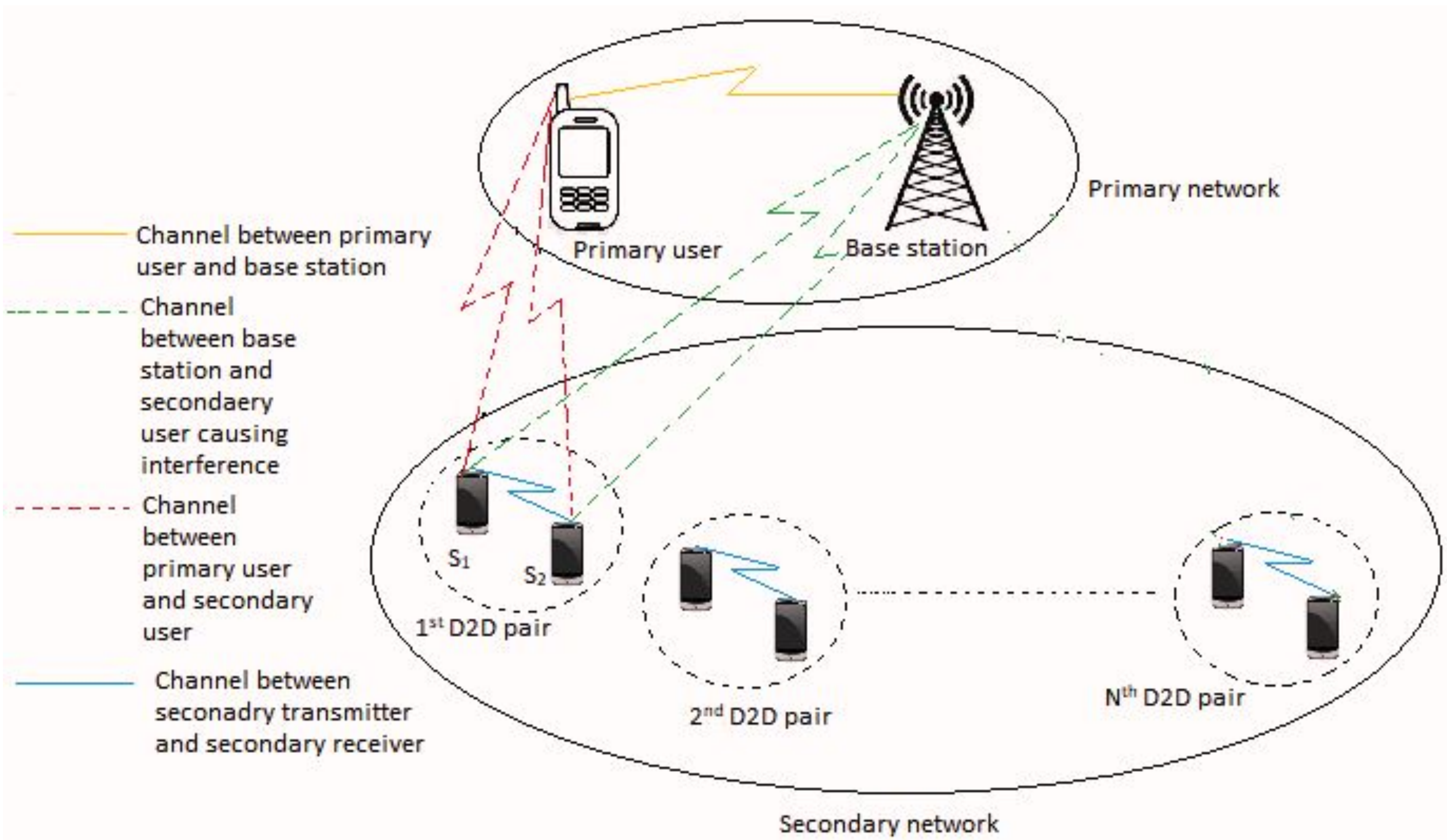
Assumptions-

1)All the channel experience with independent Rayleigh fading.

2) The primary transmitter is located far away from the secondary receivers and hence the primary interference at the secondary node can be neglected.

3) We assume that the secondary network is located relatively far apart so that the same frequency can be reused by two transmitters concurrently.

System model of co-existing underlay CR network



S_1 transmits with power P_{S1} and S_2 transmits with power P_{S2}.

$P_{s1} \leq I_P / |h_{1c}|^2$

and

$P_{s2} \leq I_P / |h_{2c}|^2$ should be maintained

Where, h_{1c} and h_{2c} : Channel gain from secondary network to primary network

I_P : Interference Temperature Limit

 The outage probability of D2D link:

$= P_r\,((I_p\,|hc|^2)/\sigma_n^2 \min(P_{Out}\,|h1c|^2, |h2c|^2) \leq \gamma_{th}),$

where $\gamma_{th} = (2^R - 1);$

R: transmission rate of secondary network

$(I_p\,|hc|^2)/\sigma_n^2 \min(|h1c|^2, |h2c|^2$: Instantaneous SINRs

- For N number of D2D pairs are considered then the outage probability corresponding to the best D2d pair is being chosen out of N such pairs is:

$$P_{Out} = P_r\ (\text{maxi}\ \epsilon_{\{1,n\}}(\ xi \leq \gamma th\ )$$

X_i : Maximum SNIR among each D2D pair

- We use minimum peak power(P) as If the channel is very weak, then the power may shoot up very large.

$$\therefore\ P_s = \min(P\ ,\ I_p/|h_{sp}|^2)$$

- SNR at the receiver will be:

$\gamma_{D1} = (min(P, I_p/|h_{D2C}|^2)\ |h_D|^2)/((P_C/|h_{CD1}|^2)+\sigma_n^{\ 2})$;
when S_2 is transmitting.

$\gamma_{D2} = (min(P, I_p/|h_{D1C}|^2)\ |h_D|^2)/((P_C/|h_{CD2}|^2)+(\sigma_n)^2)$;
when S_1 is transmitting.

- Then the non-outage probability will be:

$P_{NO}^{\ S} = Pr[\{\gamma_{D1} > \gamma_{th}\} \cap \{\gamma_{D1} > \gamma_{D2}\}] + Pr[\{\gamma_{D2} > \gamma_{th}\} \cap \{\gamma_{D2} > \gamma_{D1}\}]$

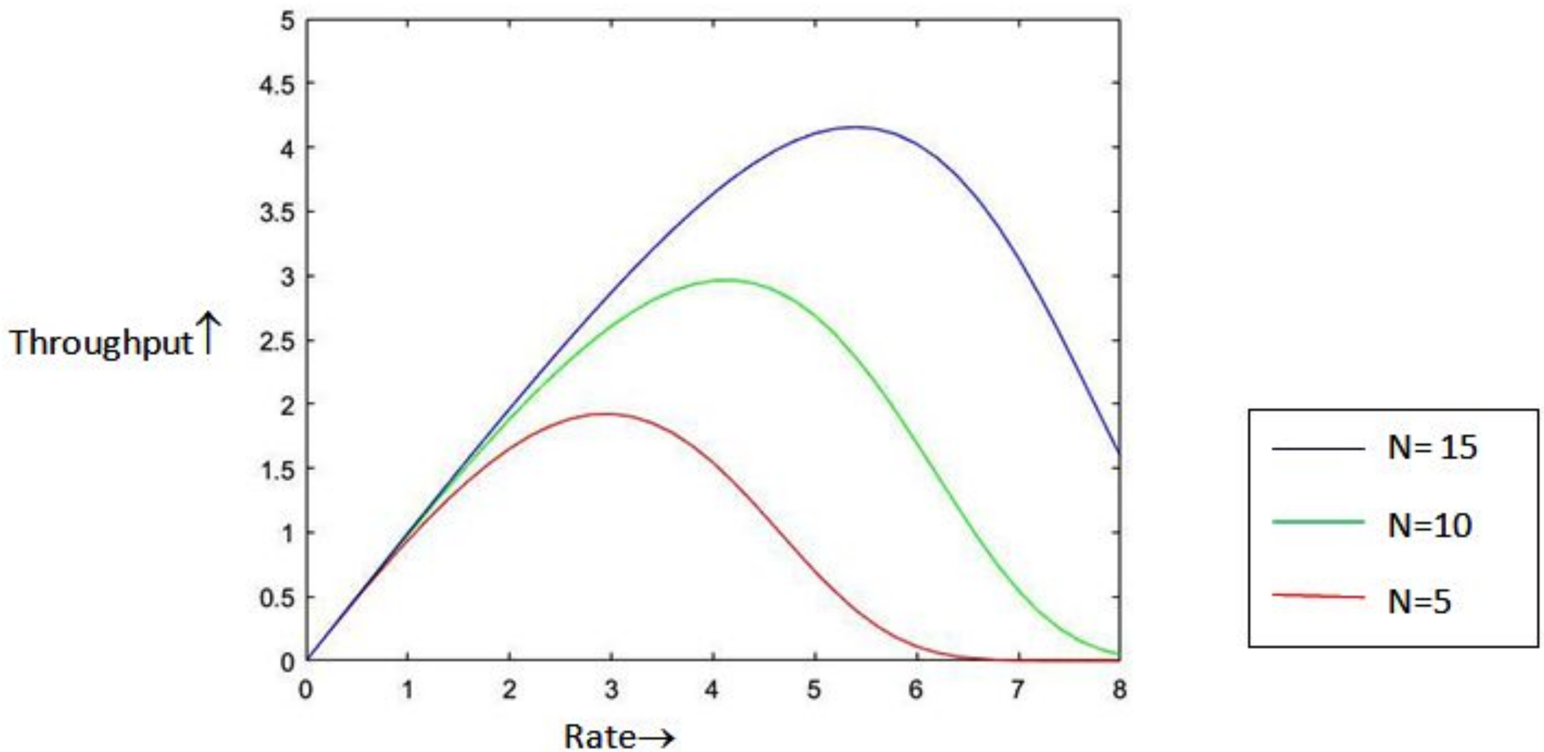
❖ Simulation Results

We have used Monte-Carlo simulation method in MATLAB for simulating this problem.

- The number of iterations =10^6
- The path loss exponent (ple) = 3
- Ip = 20 dB :Interference Temperature Limit
- d = 2 units :Normalized distance between device 1 to 2
- bd1=bd2=5 units :Normalized distances between the base station and two secondary users
- pd1=pd2 = 4 units :Normalized values of distances between the primary user and the devices in a device pair

All these values have been used for simulation purpose.

Matlab Plot



Throughput achieved for three different values of N

- The throughput at first increases upto a certain value and then decreases to minimum with the change of rate. Overall we have observed a bell shaped curve in throughput vs rate graph.

- Three different N values are taken which are respectively 5, 10 and 15 and it is observed that throughput increases with increasing number of D2D pair in the secondary network. Overall we can conclude that the performance increases with increase in the number of d2d pairs in the network.

Conclusion

In this project, we addressed the spectrum reuse and power assignment issue within D2D communications underlay D2D network where the simulation scenario was chosen according to a realistic underlay cognitive network. The effectiveness of our proposed solution was proved through simulation results. So, the D2D communication enables the devices to communicate directly with each other without the drawbacks regarding interference and power control.