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Manet Based Advanced Cooperative Spectrum Sharing Design

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ABSTRACT:

In a MANET, nodes provide a cooperative multi-hop forwarding functionality, so no specialized devices are required for routing packets. In such self-organized networks, forwarding packets for other nodes is not in the direct interest of any node, because nodes have to spend battery life, CPU cycles, and use the available network bandwidth to forward packets. So a node may refuse to forward packets for others to save its resources, while itself using their resources and asking them to forward its own packets. This deviation from the correct behavior represents a potential threat against the availability of service, as well as the network performance. Many solutions have been recently proposed for the misbehavior nodes threat, but these suffer from many problems like false detection due to ambiguity and receiver collision, power controlled misbehavior and cooperative misbehavior. In this paper we propose a new approach that addresses above problems by providing a distributed cooperative system, in which every node participates in identifying the misbehaving node. Every node exchanges its monitored information both cooperative as well as non-cooperative. This information then helps the routing protocol to avoid misbehaving nodes. This approach also gives chance of node psilas reintroduction into the network, so in case of false detection also a node can re-enter into the network. We present a performance analysis of MANET with the proposed approach and compare it to normal MANET as well as MANET with misbehaving nodes and no solutions. C++ has been used to implement the proposed approach in the AODV routing protocol in a MANET and testing has been done by simulation on the MATLAB simulator.

Index Terms— ***Cognitive radio, cooperative diversity, spectrum sharing, MANET, stochastic geometry, transmission capacity.***

I. INTRODUCTION

COGNITIVE spectrum sharing was recently studied to accommodate growing demands for wireless broadband access, which can alleviate the problem of under-utilization of licensed spectrum. Spectrum sharing techniques can be generally classified into three categories: interweave, underlay, and overlay [1]. For the interweave spectrum sharing, the secondary system can opportunistically access spectrum holes. For the spectrum underlay, secondary users (SUs) transmit simultaneously with primary users (PUs) under the constraint.

Cooperative communications can significantly enhance the performance of wireless systems by exploiting the spatial diversity. Most of the literatures about cooperation focus on a fixed network topology where the users' location sare unchanged. Recently, Wang et al. studied the decode-and forward (DF) cooperation with best relay selection, where the relays are randomly distributed on a plane following PPP. A spatial quality of service (QoS) region around the source and destination link was applied to reduce the overhead and latency in the best relay selection.

To further reduce the excessive overhead in the coordination phase, the uncoordinated cooperation protocols were proposed assuming the PPP distribution of relay nodes. In terms of transmission capacity, the DF based incremental relaying or selection cooperation significantly outperforms the non-cooperative system. Gantiet al. studied the two-hop communication with relay selection to mitigate the dead-zone in the cell-edge area of the cellular network. In their work, the success probability of the two-hop system was analyzed with the base stations (BSs) placed on a regular grid, which is too ideal to model practical heterogeneous networks. To capture the increasingly random and dense placement of BSs in future networks, it is more practical to model the BSs as a random spatial point process. Compared with the cellular network up link, the downlink bandwidth is much broader and its data traffic is much heavier, so the spectrum efficiency can be further improved by sharing the downlink spectrum as focused on in our work.

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In this paper, we focus on modeling and analyzing the cooperative spectrum sharing between cellular networks and ad-hoc networks. The cellular network is the primary system that owns the licensed spectrum, while the ad-hoc network is the secondary system. The same spectrum is reused among different cells and the interference exists over the primary data transmission. In the cellular network, the cell-edge communication is a bottleneck to guarantee the overall QoS requirement, because the desired signal is relatively weak compared with the interference [27].

The rest of this paper is organized as follows. In Section II, the system model is introduced. Section III formulates the optimization problem and obtains the secondary transmission capacity. Section IV derives the average throughput of primary downlink based on the analysis of success probabilities. The optimal SU density and bandwidth allocation are calculated in Section V. Numerical and simulation results are presented in Section VI. Section VII concludes this paper.

II. SYSTEM MODEL

Consider cellular networks coexist with *ad hoc* networks sharing the same spectrum, as shown in Fig. **1. The spectrum**

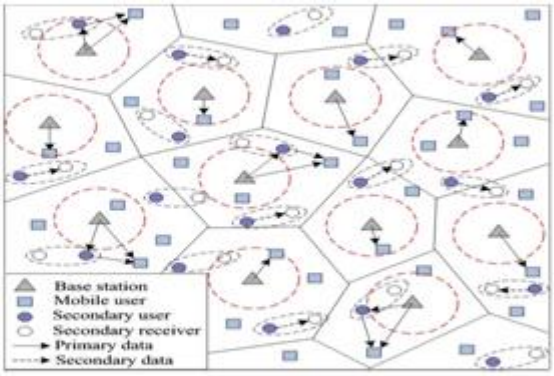

Fig. 1. The overlaid wireless network with PPP modeling for both systems.

Each mobile user (MU) is associated with its nearest base station (BS), so the *Voronoi* cell is formed in the cellular network. The circular area around each BS represents the cell-interior area, with radius c_0. In each *Voronoi* cell, the outside of the circular area represents the cell-edge area. The potential secondary users (SUs) in each cell can actively help the cell-edge downlink communications in exchange for a fraction of disjoint spectrum band. Each SU has a fixed receiver departed d meters away, and they are paired together by the ellipse. The Alohatype protocol is implemented in the ad-hoc network to activate the SUs to access the released disjoint spectrum band.

Belongs to the cellular network and it is reused by different cells. The locations of BSs and MUs are modeled as two independent homogenous PPPs $\Pi_b = \{x_i, i \in Z\}$ and $\Pi_m = \{y_i, i \in Z\}$ with intensities λ_b and λ_m, respectively. Each MU is served by its nearest BS.

As plotted in Fig. 1, the cellular network forms a *Poisson Tessellation* of the plane and each cell is known as a *Voronoi* cell [6]. Each BS communicates with one randomly selected MU in its cell via a downlink. The adhoc network is overlaid with the cellular network and it forms the secondary system. The locations of SUs follow another PPP with intensity λs, i.e., $\Pi s = \{zi, i \in Z\}$. Each SU has a receiver departed d meters away. This assumption may be easily relaxed but at the cost of complicating the derived expressions without providing additional insight [5], as picking the distance d from a random distribution only reduces the transmission capacity by a constant factor [28]. The Aloha-type protocol is adopted in the ad-hoc network to control the channel access of SUs. Whether a SU could access the channel or not is determined by the media access probability (MAP) $\xi \in (0, 1)$. The channel between any pair of terminals $u1$ and $u2$ undergoes small-scale block fading and large-scale path-loss. The channel power gain $Gu1,u2$ is exponentially distributed with unit mean, and it is independent across links. The path-loss is _$-\alpha u1,u2$, where _$u1,u2$ is the distance and α is the path-loss exponent. The symbol $u2$ in the subscript is omitted for brevity if $u2$ lies at the origin. The interference-limited environment is considered and the effect of noise is neglected.

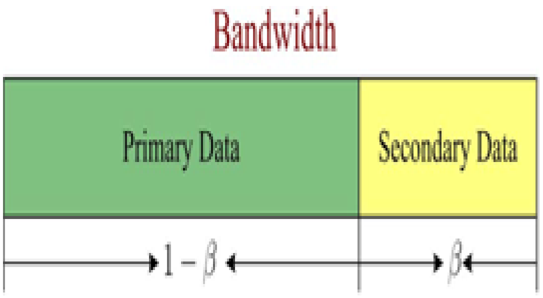

Fig. 2. Bandwidth division between primary and secondary systems.

The fraction β is released to the secondary system, while the remaining $1 - \beta$ fraction is kept by the primary system for the direct or cooperative data transmission.

A. Spectrum Sharing Model

We consider the overlay spectrum sharing, where a fraction of spectrum is released to the ad-hoc network in exchange for its cooperation for the cell-edge communication [4]. Without loss of generality, the total bandwidth is set as one and the spectrum released to the secondary system is $\beta \in (0, 1)$, while the remaining $1 - \beta$ fraction of spectrum is reserved by the primary system, as shown in Fig. 2. The primary system and secondary system do not interfere with each other as they use disjoint frequency bands.

If the randomly selected MU lies at the cell-interior of its serving BS, the direct transmission is performed, because the channel is usually good and the interference is relatively weak. The bandwidth release may be tolerated by the primary downlink. The interior area is defined as a circular area centered at the BS with radius $c0$. However, if the MU lies at the cell-edge of its serving BS, cooperative communications are employed. With the cooperation from SUs, the throughput of primary data transmission can be enhanced to combat the strong interference. Moreover, the benefits of cooperation can be exploited to combat the negative effect of spectrum release. The more spectrum is released, the higher capacity is achieved for the secondary system. However, less capacity is retained for the primary system due to the remaining narrower bandwidth. Therefore, the bandwidth allocation should be judiciously determined to maximize the secondary capacity without violating the primary performance requirement in the cooperative spectrum sharing.

B. Cooperation Model

The truncated automatic repeat request (ARQ) scheme with one-time retransmission is adopted for the communication between BS and its cell-interior MU. If the original transmission is successful, the acknowledgement (ACK) frame is fed back and the BS continues to transmit a new data packet. Otherwise, the negative acknowledgement (NACK) frame is released and the BS retransmits the same data packet. The received signals in both the original and the retransmission phases are maximal ratio combined (MRC) by the cell-interior MU for the detection.

The existing cooperative truncated ARQ scheme based on DF protocol [29], which is also known as the DF based incremental relaying [22], is adopted to assist the data transmission between the BS and its cell-edge MU. As shown in Fig. 3, a cooperation region is applied between the BS and its cell edge MU, which can be designated by the BS through a handshake process or determined automatically by each SU using its estimated location obtained from the localization technique [30]. The distance between BS and the center of cooperation region is denoted as $rv = \zeta r0$ with $0 < \zeta < 1$, while the distance between the center of cooperation region and the cell-edge MU is ˜$rv = (1 - \zeta)r0$. The SUs in the cooperation region will help the primary data transmission. In the original phase, the BS broadcasts its data to the intended cell-edge MU and all the SUs in the cooperation region. The SUs that can correctly decode the original primary data are called *decoding SUs*. Three cases will occur according to whether the MU and the SUs correctly receive the primary data or not.

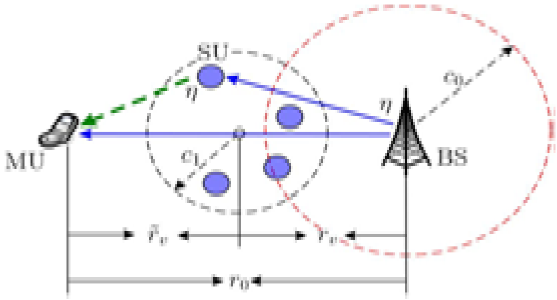

Fig. 3. The cooperation model for the cell-edge MU. The corresponding receiver for each SU is not plotted in this figure.

- Case I: The cell-edge MU correctly receives the data packet, and the ACK frame is broadcast. The SUs in the cooperation region refresh their memories and the BS continues to transmit a new data packet.

- Case II: The cell-edge MU erroneously receives the primary data and a NACK frame is fed back. There are no SUs or no decoding SUs in the cooperation region. In this case, the BS retransmits its original data and all the SUs in the cooperation region keep silent.

- Case III: The cell-edge MU erroneously receives the primary data and a NACK frame is released. There exists at least one decoding SU in the cooperation region and the one with best channel state towards the cell-edge MU retransmits. The best decoding SU can be selected in a distributed way using the time back-off [17] or signaling burst scheme [31]. When the selected SU performs the retransmission, the BS together with all the other SUs in the cooperation region will keep silent.

III NON-COOPERATIVE SCHEME

In the non-cooperative scheme, the destination decodes the data using the signal received from the relay on the second phase, which results in the signal power boosting gain. The signal received from the relay node which retransmits the signal received from the source node is written as:

$$r_{d,r} = h_{d,r} r_{r,s} + n_{d,r} = h_{d,r} h_{r,s} x_s + h_{d,r} n_{r,s} + n_{d,r}$$

Where $h_{d,r}$ is the channel from the relay to the destination nodes and $n_{r,s}$ is the noise signal added to $h_{d,r}$.

The reliability of decoding can be low since the degree of freedom is not increased by signal relaying. There is no increase in the diversity order since this scheme exploits only the relayed signal and the direct signal from the source node is either not available or is not accounted for. When we can take advantage of such a signal and increase in diversity order results. Thus, in the following we consider the cooperative scheme which decodes the combined signal of both the direct and relayed signals.

a. Cooperative Scheme

For cooperative decoding, the destination node combines two signals received from the source and the relay nodes which results in the diversity advantage. The whole received signal vector at the destination node can be modeled as:

$$\mathrm{r} = \begin{bmatrix} r_{d,s} & r_{d,r} \end{bmatrix}^T = \begin{bmatrix} h_{d,s} & h_{d,r}h_{r,s} \end{bmatrix}^T x_s + \begin{bmatrix} 1 & \sqrt{|h_{d,r}|^2+1} \end{bmatrix}^T n_d = \mathrm{h}x_s + \mathrm{q}n_d$$

where $r_{d,s}$ and $r_{d,r}$ are the signals received at the destination node from the source and relay nodes, respectively. As a linear decoding technique, the destination combines elements of the received signal vector as follows:

$$y = \mathbf{w}^H \mathbf{r}$$

where $\mathbf{w}$ is the linear combining weight which can be obtained to maximize signal-to-noise ratio (SNR) of the combined signals subject to given the complexity level of the weight calculation.

b. Trade-off

It is noteworthy that cooperative diversity can increase the diversity gain at the cost of losing the wireless resource such as frequency, time and power resources for the relaying phase. Wireless resources are wasted since the relay node uses wireless resources to relay the signal from the source to the destination node. Hence, it is important to remark that there is trade-off between the diversity gain and the waste of the spectrum resource in cooperative diversity.

c. Channel Capacity of Cooperative Diversity

In June 2005, A. Host-Madsen published a paper in-depth analyzing the channel capacity of the cooperative relay network.

We assume that the channel from the source node to the relay node, from the source node to the destination node, and from the relay node to the destination node are where the source node, the relay node, and the destination node are denoted node 1, node 2, and node 3, subsequently.

$$c_{21}e^{j\varphi_{21}}, c_{31}e^{j\varphi_{31}}, c_{32}e^{j\varphi_{32}}$$

d. The capacity of cooperative relay channels

Using the max-flow min-cut theorem yields the upper bound of full duplex relaying

$$C^+ = \max_{f(X_1,X_2)} \min\left\{ I\left(X_1;Y_2,Y_3|X_2\right), I\left(X_1,X_2;Y_3\right) \right\}$$

where X_1 and X_2 are transmit information at the source node and the relay node respectively and Y_2 and Y_3 are received information at the relay node and the destination node respectively. Note that the max-flow min-cut theorem states that the maximum amount of flow is equal to the capacity of a minimum cut, i.e., dictated by its bottleneck. The capacity of the broadcast channel from X_1 to Y_2 and Y_3 with given X_2 is

$$\max_{f(X_1,X_2)} I\left(X_1;Y_2,Y_3|X_2\right) = \frac{1}{2}\log\left(1+\left(1-\beta\right)\left(c_{21}^2+c_{31}^2\right)P_1\right)$$

while the capacity of the multiple access channel from X_1 and X_2 to Y_3 is

$$\max_{f(X_1,X_2)} I\left(X_2,X_2;Y_3\right) = \frac{1}{2}\log\left(1+c_{31}^2P_1+c_{32}^2P_2+2\sqrt{\beta c_{31}^2c_{32}^2P_1P_2}\right)$$

where β is the amount of correlation between X_1 and X_2. Note that X_2 copies some part of X_1 for cooperative relaying capability. Using cooperative relaying capability at the relay node improves the performance of reception at the destination node. Thus, the upper bound is rewritten as

$$C^+ = \max_{0\le\beta\le1} \min\left\{ \frac{1}{2}\log\left(1+\left(1-\beta\right)\left(c_{21}^2+c_{31}^2\right)P_1\right), \frac{1}{2}\log\left(1+c_{31}^2P_1+c_{32}^2P_2+2\sqrt{\beta c_{31}^2c_{32}^2P_1P_2}\right) \right\}$$

e. Achievable rate of a decode-and-forward relay

Using a relay which decodes and forwards its captured signal yields the achievable rate as follows:

$$R_1 = \max_{f(X_1,X_2)} \min\{I(X_1;Y_2|X_2), I(X_1,X_2;Y_3)\}$$

where the broadcast channel is reduced to the point-to-point channel because of decoding at the relay node, i.e., $I(X_1;Y_2,Y_3|X_2)$ is reduced to $I(X_1;Y_2|X_2)$. The capacity of the reduced broadcast channel is

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f. Time-Division Relaying

The capacity of the TD relay channel is upper-bounded by

$$C^+ = \max_{0\le\beta\le1}\min\{C_1^+(\beta), C_2^+(\beta)\}$$

with

$$C_1^+(\beta) = \frac{\alpha}{2}\log\left(1+(c_{31}^2+c_{21}^2)P_1^{(1)}\right)+\frac{1-\alpha}{2}\log\left(1+(1-\beta)c_{31}^2P_1^{(2)}\right)$$

$$C_2^+(\beta) = \frac{\alpha}{2}\log\left(1+c_{31}^2P_1^{(1)}\right)+\frac{1-\alpha}{2}\log\left(1+c_{31}^2P_1^{(2)}+c_{32}^2P_2+2\sqrt{\beta C_{31}^2P_1^{(2)}C_{32}^2P_2}\right)$$

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IV. EXTENSION SYSTEM

a. Mobile ad hoc network

A mobile ad hoc network (MANET) is a continuously self-configuring, infrastructure-less network of mobile devices connected without wires. Ad hoc is Latin and means "for this purpose".

Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Such networks may operate by themselves or may be connected to the larger Internet. They may contain one or multiple and different transceivers between nodes. This results in a highly dynamic, autonomous topology.

MANETs are a kind of Wireless ad hoc network that usually has a routable networking environment on top of a Link Layer ad hoc network. MANETs consist of a peer-to-peer, self-forming, self-healing network in contrast to a mesh network has a central controller (to determine, optimize, and distribute the routing table). MANETs circa 2000-2015 typically communicate at radio frequencies (30 MHz - 5 GHz)

The growth of laptops and 802.11/Wi-Fi wireless networking have made MANETs a popular research topic since the mid-1990s. Many academic papers evaluate protocols and their abilities, assuming varying degrees of mobility within a bounded space, usually with all nodes within a few hops of each other. Different protocols are then evaluated based on measures such as the packet drop rate, the overhead introduced by the routing protocol, end-to-end packet delays, network throughput, ability to scale, etc.

b. Types

- Vehicular Ad hoc Networks (VANETs) are used for communication between vehicles and roadside equipment. Intelligent vehicular ad hoc networks (InVANETs) are a kind of artificial intelligence that helps vehicles to behave in intelligent manners during vehicle-to-vehicle collisions, accidents.

- Smart Phone Ad hoc Networks (SPANs) leverage the existing hardware (primarily Bluetooth and Wi-Fi) in commercially available smart phones to create peer-to-peer networks without relying on cellular carrier networks, wireless access points, or traditional network infrastructure. SPANs differ from traditional hub and spoke networks, such as Wi-Fi Direct, in that they support multi-hop relays and there is no notion of a group leader so peers can join and leave at will without destroying the network.

- Internet based mobile ad hoc networks (iMANETs) are ad hoc networks that link mobile nodes and fixed Internet-gateway nodes. For example, multiple sub-MANETs may be connected in a classic Hub-Spoke VPN to create a geographically distributed MANET. In such type of networks normal ad hoc routing algorithms don't apply directly. One implementation of this is Persistent System's CloudRelay.

- Military / Tactical MANETs are used by military units with emphasis on security, range, and integration with existing systems. Common waveforms include the US Army'sSRW, Harris's ANW2 and HNW, Persistent Systems' Wave Relay, Trellisware's TSM and Silvus Technologies' StreamCaster.

- A mobile ad-hoc network (MANET) is an ad-hoc network but an ad-hoc network is not necessarily a MANET.

c. Simulations

There are several ways to study MANETs. One solution is the use of simulation tools like OPNET, NetSim and NS2.

Data monitoring and mining

MANETS can be used for facilitating the collection of sensor data for data mining for a variety of applications such as air pollution monitoring and different types of architectures can be used for such applications. It should be noted that a key characteristic of such applications is that nearby sensor nodes monitoring an environmental feature typically register similar values. This kind of data redundancy due to the spatial correlation between sensor observations inspires the techniques for in-network data aggregation and mining. By measuring the spatial correlation between data sampled by different sensors, a wide class of specialized algorithms can be developed to develop more efficient spatial data mining algorithms as well as more efficient routing strategies. Also, researchers have developed performance models for MANET by applying queueing theory.

Security

A lot of research has been done in the past but the most significant contributions have been the PGP (Pretty Good Privacy) and trust based security. None of the protocols have made a decent tradeoff between security and performance. In an attempt to enhance security in MANETs many researchers have suggested and implemented new improvements to the protocols and some of them have suggested new protocols.

Since any node may communicate with any other, many, and/or all nodes asymmetrical encryption (aka 1:1 tunneling) cannot work in a MANET. Rather, symmetrical encryption (where all nodes share the same en/decryption key) is far more efficient. The security challenge therefore becomes 1) enforcing hardware-to-logical presentation of identity and 2) preventing exfiltration of keys.

Block diagrams used in extension:

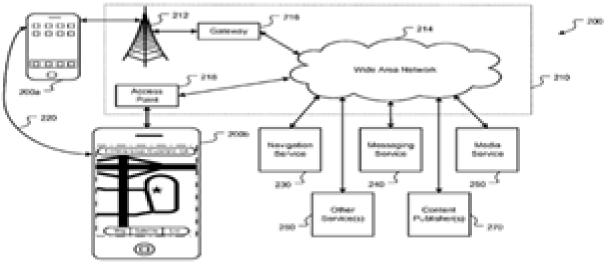

Fig: 2.3 Block diagram of MANET based advanced Cooperative Spectrum Sharing design

V. SIMULATION AND NUMERICAL RESULTS

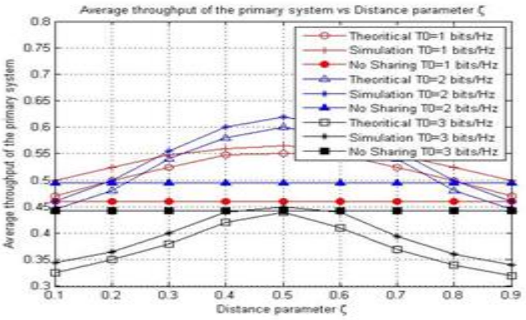

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Fig: 3.1 Average throughput of the primary system Vs distance parameter

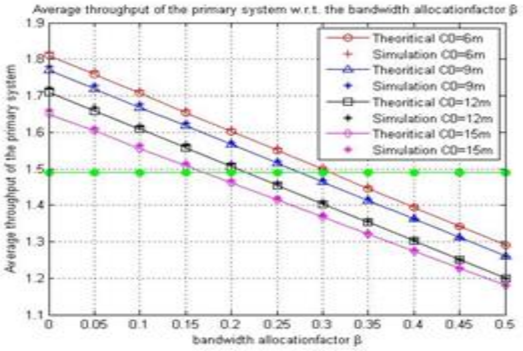

Fig: 3.2 Average throughput of the primary system w.r.t the bandwidth allocation factor β

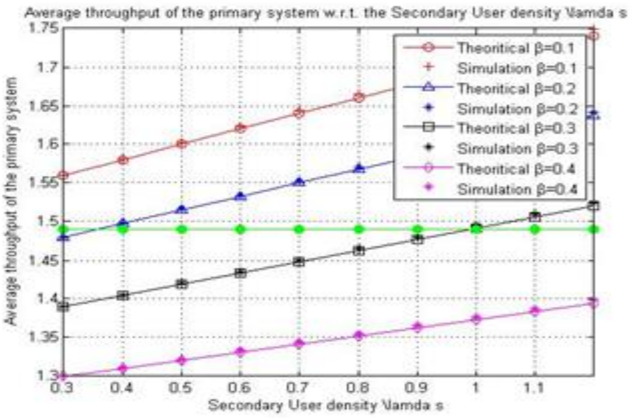

Fig: 3.3 Average throughput of primary system w.r.t the secondary user density

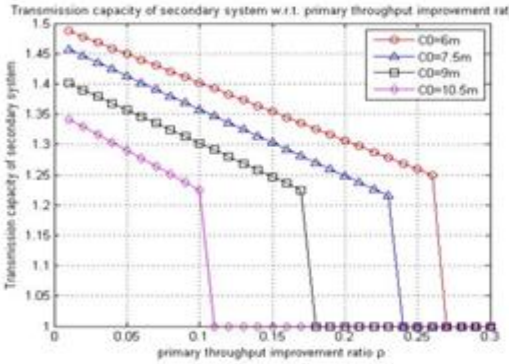

Fig: 3.4 transmission capacity of secondary system w.r.t primary throughput improvement ratio p

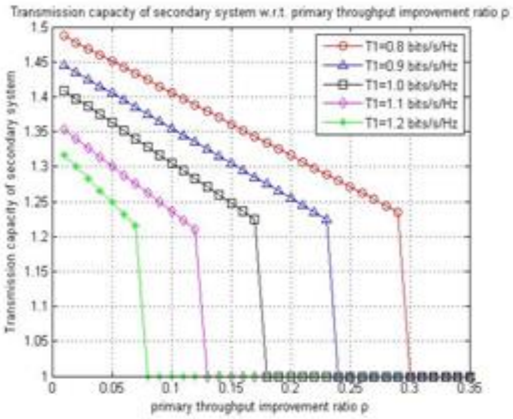

Fig: 3.5 Transmission capacity of secondary system w.r.t primary throughput ratio p

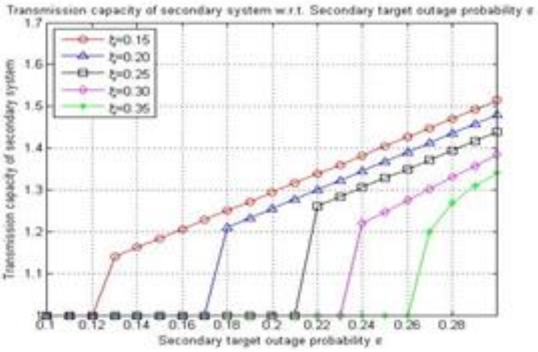

Fig: 3.6 Transmission capacity of secondary system w.r.t secondary target outstage probability ε

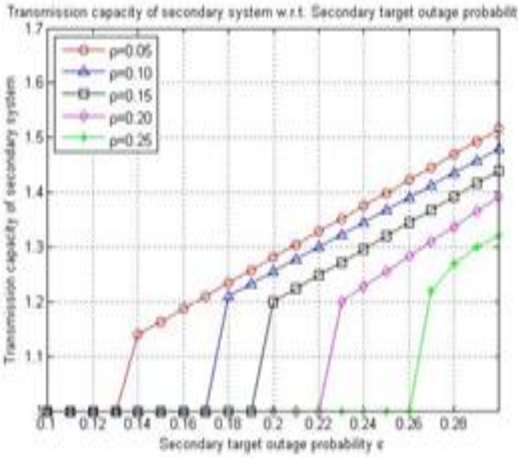

Fig: 3.7 Transmission capacity of secondary system w.r.t secondary target outstage probability ε

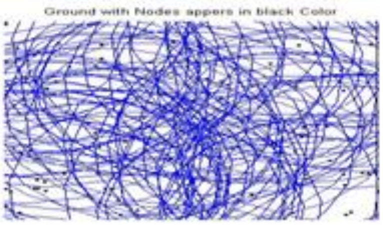

Fig: 3.8 Ground with Nodes appears in black colour

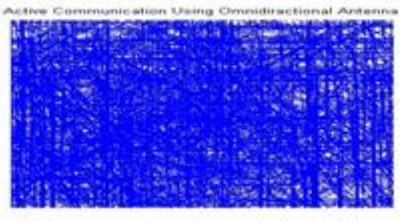

Fig: 3.9 Active communications using omnidirectional Antenna

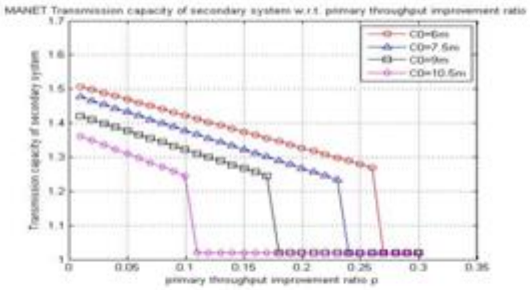

Fig: 3.11 MANET Transmission of secondary system w.r.t primary throughput improvement ration

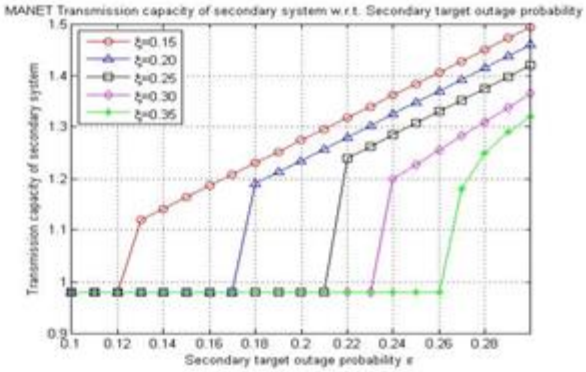

Fig: 3.12 MANET Transmission of secondary system w.r.t secondary target outstage probability

VI. CONCLUSION AND SCOPE OF WORK

In this paper, we design a cooperative spectrum sharing scheme between cellular network downlink and ad-hoc network. The secondary users can actively help the primary cell edge communication to improve the primary performance by a predefined ratio. As a reward, a fraction of disjoint bandwidth can be released for the secondary data transmission. The transmission capacity of secondary system and the average throughput of primary downlink are analyzed using the stochastic geometry theory. The optimization problem is formulated to maximize the secondary transmission capacity under the QoS constraints of secondary outage probability and primary throughput improvement. The optimal secondary user density and bandwidth allocation are numerically calculated. Performance results are provided to demonstrate that the primary performance can be conservatively improved and the secondary transmission can be well accommodated.

By Adopting the MANET process the we are getting the usage of secondary user in a rare case only so most of the data distribution or sharing done with in the primary user section only by which throughput of the system is going to increase. After the insertion of MANET as it contains the omni directional antenna the network range is going to increase by which we can have more user participation in the network coverage area.

REFERENCES

1.Goldsmith, S. A. Jafar, I. Maric, and S. Srinivasa, “Breaking spectrum gridlock with cognitive radios: An information theoretic perspective,” *Proc. IEEE*, vol. 97, no. 5, pp. 894 914, May 2009.

2.O. Simeone *et al.*, “Spectrum leasing to cooperating secondary ad hoc networks,” *IEEE J. Sel. Areas Commun.*, vol. 26, no. 1, pp. 203–213,Jan. 2008.

3.C. Zhai,W. Zhang, and P. C. Ching, “Cooperative spectrum sharing based on two-path successive relaying," *IEEE Trans. Commun.*, vol. 61, no. 6, pp. 2260–2270, Jun. 2013.

4.W. Su, J. D. Matyjas, and S. Batalama, "Active cooperation between primary users and cognitive radio users in heterogeneous ad-hoc networks," *IEEE Trans. Signal Process.*, vol. 60, no. 4, pp. 1796–1805, Apr. 2012.

5.S. P. Weber, X. Yang, J. G. Andrews, and G. de Veciana, "Transmission capacity of wireless ad hoc networks with outage constraints," *IEEE Trans. Inf. Theory*, vol. 51, no. 12, pp. 4091–4102, Dec. 2005.

6.K. Huang, V. K. N. Lau, and Y. Chen, "Spectrum sharing between cellular and mobile ad hoc networks: Transmission–capacity tradeoff," *IEEE J. Sel. Areas Commun.*, vol. 27, no. 7, pp. 1256–1267, Sep. 2009.

7.J. Lee, J. G. Andrews, and D. Hong, "Spectrum sharing transmission capacity," *IEEE Trans. Wireless Commun.*, vol. 10, no. 9, pp. 3053–3063, Sep. 2011.

8.C. Yin, C. Chen, T. Liu, and S. Cui, "Generalized results of transmission capacities for overlaid wireless networks," in *Proc. IEEE ISIT*, Seoul, Korea, Jun. 2009, pp. 1774–1778.

9.M. Vu, N. Devroye, and V. Tarokh, "On the primary exclusive region of cognitive networks," *IEEE Trans. Wireless Commun.*, vol. 8, no. 7, pp. 3380–3385, Jul. 2009.

10.X. Hong, C.-X. Wang, and J. Thompson, "Interference modeling of cognitive radio networks," in *Proc. IEEE VTC Spring*, May 11–14, 2008, pp. 1851–1855.

11.C.-H. Lee and M. Haenggi, "Interference and outage in Poisson cognitive networks," *IEEE Trans. Wireless Commun.*, vol. 11, no. 4, pp. 1392–1401,Apr. 2012.

12. R. Menon, R. M. Buehrer, and J. H. Reed, "On the impact of dynamic spectrum sharing techniques on legacy radio systems," *IEEE Trans. Wireless Commun.*, vol. 7, no. 11, pp. 4198–4207, Nov. 2008.

13.A. Rabbachin, T. Q. S. Quek, H. Shin, and M. Z.Win, "Cognitive network interference," *IEEE J. Sel. Areas Commun.*, vol. 29, no. 2, pp. 480–493, Feb. 2011.

14.A. Ghasemi and E. S. Sousa, "Interference aggregation in spectrumsensing cognitive wireless networks," *IEEE J. Sel. Topics Signal Process.*, vol. 2, no. 1, pp. 41–56, Feb. 2008.

15.T. V. Nguyen and F. Baccelli, "A stochastic geometry model for cognitive radio networks," *Comput. J.*, vol. 55, no. 5, pp. 534–552, Jul. 2011.

16.H. Wang, S. Ma, and T.-S. Ng, "On performance of cooperative communication systems with spatial random relays," *IEEE Trans. Commun.*, vol. 59, no. 4, pp. 1190–1199, Apr. 2011.

17.A. Bletsas, A. Khisti, D. P. Reed, and A. Lippman, "A simple cooperative diversity method based on network path selection," *IEEE J. Sel. Areas Commun.*, vol. 24, no. 3, pp. 659–672, Mar. 2006.

18.B. Zhao and M. C. Valenti, "Practical relay networks: A generalization of hybrid ARQ," *IEEE J. Sel. Areas Commun.*, vol. 23, no. 1, pp. 7–18, Jan. 2005.

19.S.-R. Cho, W. Choi, and K. Huang, "QoS provisioning relay selection in random relay networks," *IEEE Trans. Veh. Technol.*, vol. 60, no. 6, pp. 2680–2689, Jul. 2011.

20.L. Xiong, L. Libman, and G. Mao, "On uncoordinated cooperative communication strategies in wireless ad-hoc networks," *IEEE J. Sel. Areas Commun.*, vol. 32, no. 2, pp. 280–288, Feb. 2012.