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Efficient Improvement of Cognitive RadioNetwork with Massive Antenna

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Abstract:
Cognitive radio (CR) is assumed to bea promising innovation for future remote systems to make artful usage of the unemployed or underused licensed spectrum. The most shared issue handled by operators using portable broadband is the large usage of capacity spectrum, which can be attained by massive antennas. The pre-allocation and post-allocation methods must stood analyzed for spectral band optimization and sharing of primary users by esteem to secondary users. Hence designing cognitive radio with the massive antenna to improve the presentation of the wireless communication in terms of the average capacity of secondary users, thereby minimizing the endways delay thus maximizing the data rate to support hypermedia services.

Keywords: Cognitive radio network, massive antenna, spectrum sharing

I. INTRODUCTION

Increasing the usage of practical improvements in wireless infrastructures, it leads to band scarcity problems [1]. This problematic is overawed by the cognitive radio (CR) [2]. The cognitive radio (CR) knowledge is imagined to resolve the problems in wireless systems resulting from the limited accessible spectrum and the inefficiency of the band usage by abusing the current wireless band opportunistically [3]. Cognitive radio (CR) stands the frame of remote communication in which a handset can intellectuals identify which communication channels are in utilize and which are not, and immediately move into empty channels while maintaining a strategic distance from involved ones. Cognitive radio (CR) is the empowering innovation for supporting energetic range get, the approach that addresses the range shortage problem that is experienced in several countries. CR is broadly respected as a standout amongst the most encouraging innovations for future remote communications.
The cognitive radio remote regional area arrange standard IEEE 802.22 was made by IEEE 802 LAN/MAN standard board of trustees (LMSC) and conveyed in 2011.This standard services geolocation and range detecting spectral mindfulness. IEEE 802.22 was planned to use the unemployed frequencies or parts of time in an area. The cognitive radio cannot involve the same unused space all the time. This prepare is a shape of energetic range administration.

An authoritative need of CR is to sense the removal range of important users. The cognitive radio is a novel innovation that can possibly develop the utilization productivity of the broadcasting range [4]. As range accessibility changes, the organize adjusts to avoid impedances with authorized transmissions. Possible capabilities of cognitive radio include the capability of a receiver to decide its geographic area, distinguish and approve its user, challenge or decode signals, sense neighboring remote devices in operation, and alter yield control and twist characteristics.
Cognitive Radio is supported by spectrum detecting, spectrum distribution [5], spectrum mobility and spectrum management. Spectrum detecting strategy is proposed so as to expand the availability of spectrum with more brilliant innovation and to utilize the spectrum of a Primary user (PU) while the spectrum is unused. Range detecting is a key work of cognitive radio to expect the upsetting impedances with authorized users and distinguish the accessible range for making steps the spectrum's utilization. Range detecting [6] is the furthermost critical handle on CR usage. There are a few calculations for Range detecting in CR systems can be basically partitioned into three sorts: vitality discovery, coordinated channel discovery, and cyclostationary location. Subsequently, it has stayed totally examined both in neighborhood range detecting [7 - 9] and agreeable range detecting [10-12].

The location execution is to develop the frequently cooperated with multipath blurring, shadowing, and recipient instability issues. In arrange to uphold a strategic distance from this issue, CR has upgraded a method called Agreeable Range detecting [13-14]. This detecting process is performed together by a group of nodes or network of cognitive radio where they shares their information they gain. This depends on combining the detecting results of various cognitive radio nodes to achieve an ultimate conclusion. This gives a way better picture of the range utilization over the area wherever the cognitive radios are found. Agreeable range detecting has been appeared to be a compelling strategy to move forward the location execution by abusing spatial differing qualities. Ordinarily, a central station will get reports of signs from a range of radios in arrange and alter the generally cognitive radio organize to suit. This readiness should be possible by utilizing the massive antenna.

Massive receiving wires make the utilization of a very huge number of administration radio wires that are worked rationally and adaptively. Additional receiving wires help by centering the transmission and gathering of signal energy into ever-smaller region of space. The concept of a mobile device with embedded cognitive radios (CRs) [15] is integrated into a novel low-cost massive antenna configuration multi-hop or device-to-device wireless network that briefly utilizes any section of the spectrum for transmissions. The quantity of spectral bands (SBs) that a CR can detect inside a particular time is restricted [16]. The massive radio wire brings huge enhancements in throughput and energy efficiency, in specific when combined with the concurrent planning of a huge number of user terminals.

Besides that spectrum allocation came to be because of the developing and union of wireless telecommunications technology which made huge needs on the radio set frequency spectrum for various services such as fast information exchange and communication.Therefore, the resolution of various spectrum designs and principles is the direction and administration of the resource (the electromagnetic spectrum) for the benefit of everybody utilizing it. Range assignment is the division of the electromagnetic range into radio recurrence groups. This range administration is controlled by managements in most states. Radio broadcast does not stop at state boundaries. Giving specialized and financial reasons, governments have looked for to harmonize the share of RF groups and their standardization. This spectrum band has to be allocated in a post-allocation method. Using the post-allocation spectrum band, the frequency band has separated into two forms, one is fixed spectral band allocation (FSBA) and another one is opportunistic spectral band allocation (OSBA).

In this method of using a massive antenna with the post-allocation leads to more spectral band wastage, more time delay, and interference due to non-cooperative sensing. In order to overcome this issue, it is addressed by using preallocation spectrum band [17]. The frequency band is allocated before to the particular user. This technique has to be assigned in a spectral band, for less negotiation time. The secondary user (SU) waiting for the primary user (PU). If nearby is an empty spectrum these spectral bands are used by the secondary user (SU). Hence, here will be nope wastage of spectrum band compared to the post-allocation spectrum band. Using the preallocation spectrum band, the frequency band has been separated into two types, one is hybrid fixed spectral band allocation (HFSBA) and another one is hybrid opportunistic spectral band allocation (HOSBA). By designing the massive antenna technology to achieve average capacity and minimizing end to end delay in cognitive radio networks and to increase the performance by using HFSBA and HOSBA. In this paper, we discuss about the cognitive radio with the massive antenna with preallocation spectrum band.

II. RELATED WORK

Most CRAHN studies on sensing issues must absorbed on providing high opportunities for spectrum access without snooping with PU operations [2], [3]. Several cooperative sensing methods must stood proposed towards capitalize on the quantity of available SBs [2], [12], [14], [17]. Researchers must planned spectrum selection [2] and towards capitalize on the sensing capacity [13]. They have described difficulties in spectrum selection, but lack to discuss the manner of addressing the SBs and cooperative CRs pre-allocations. Several studies must absorb on sensing available SBs [8], controlling the power [11], and cooperatively sensing ranges for a default spectral range [8]. Proposed a time division multiplexing-based power-control system to address the interflow and cumulative interferences so that multiple flows can be transmitted simultaneously towards capitalize on throughput [11]. These studies must absorb on employing the default spectral range to sense by using the FSBA method [18].Though, they did not determine how to allocate SBs for advanced cooperative sensing. Although an OSBA method for cooperative sensing SBs enlarges the capacity of individual SU [2], [8], [13], the SBs are not allotted according to the active link. We spread this kind of method to data fusion [4] on each link within the interference range. Current standard methods do not preallocate SSs within the interfering range [2], [4], [13], [17]. In the LSSA method, which separates the links as the SS allocation unit [6], transceivers may interfere through one another unless precautions are implemented to prevent the assortment of the same SBs for transmission. Few studies have discussed several bands and used multiple radios to enhance accuracy and efficiency levels [4], the authors proposed a parallel spectrum sensing method in which the selected SUs sense a distinct set of SBs, ensuring that multiple sets of SBs can be simultaneously sensed for an infrastructure-based network.

III. NETWORK MODEL AND PROBLEM DESCRIPTION

A. Network Architecture

Massive radio wires make the utilize of an exceptionally huge number of benefit radio wires (e.g., hundreds or thousands) that are worked coherently and adaptively. Additional receiving wires offer assistance by centering the transmission and gathering of standard energy into ever-smaller regions of space. This brings tremendous enhancements in throughput and energy efficiency, in specific when combined with the concurrent planning of an expansive number of user terminals.

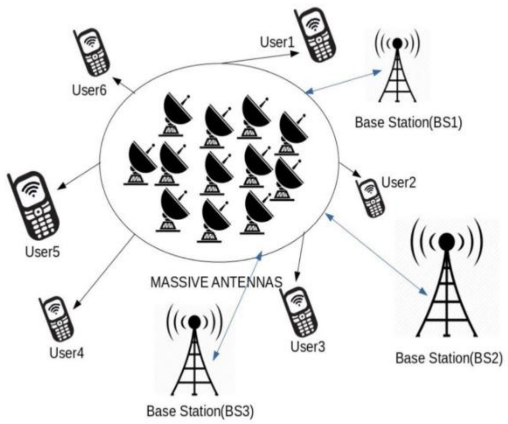

Fig. 1: Network architecture of massive antenna

Fig. 1 illustrate the entire designing of massive receiving wire, the base station will pass through the control signal for a few specific areas of the range. For sensing the spectrum, by using the cooperative spectrum detecting method. The cooperative detecting method, same spectrum sensing task is assigned to multiple base station with specific end goal to sense the empty spectrum and report to the user, to make usage of the spectrum. If the authorized base station (BS) is not available to sense the spectrum means, the base station with a nearby location to perform the task. To identify the spectrum, the user will be using the spectrum or not. If any empty spectrum has to be identified. The acknowledgment will be send through the base station, the antenna will be transmitting the signal to some particular location of the spectrum. The user will be using this spectrum efficiently, particularly the secondary user. This spectrum sharing must be allocated to the secondary users.
By adding the numbers of secondary users for sharing the spectrum and the secondary users will be using the spectrum efficiently. This provides to achieve high average capacity by utilizing the quantity of radio wires regarding the secondary

users (SU). Using the quantity of antennas will reduce the interference then the performance will be improved and also decreases the endways delay regarding the secondary users. The foremost benefit of a massive antenna is to decrease the negotiation time, and to achieve the high average capacity and also to decrease the interference by deploying massive antenna technique.

B. Cooperative-sensing CR Assignment Model

In cooperative sensing, neighboring CRs help sense the same set of spectrum sections to decrease the rates of error and interference and to circumvent the PU-hidden terminal issue. The issue may happen in case the extent of a PU is lower than the run of the SU, which may assist cause the SU to be incapable to sense the signal sent by the PU. Fig. 2 appears a case that the signal of PU_2 cannot be recognized by SUs c or d. The SUs can sense the signal only when the range of PU_S is greater than the detection threshold of SU_S. Hence, the effective sensing and negotiation ranges are determined by the maximal transmission ranges of the SU and PU.

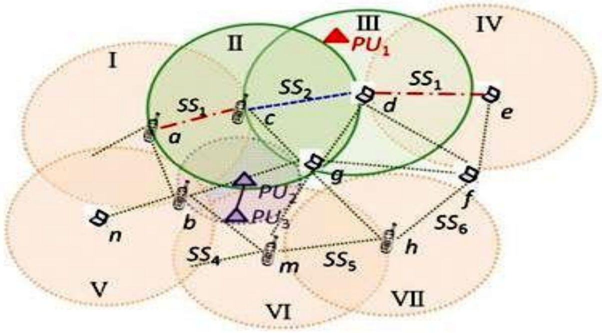

Fig. 2: Signal range of a PU and the cover area of effective available bands

When an active link uses the available bands sensed by cooperative CRs, the cooperative-sensing area is available within the part of the link. Fig. 2 illustrates an example of the effective area, in which node c transfer the data to node d, which replies with the acknowledgement (ACK) after receiving the packet. For a neighboring node w, for which the sensing area SA (w_i, SS_x), where CR i $\in e_w$ sense SS_x, is out of the range of the link (c, d), the sensed available bands are useless. The areas of the available bands sensed by CRs m_i, n_j , and h_k are not covered by the nodes c and d due to the transmission area TA(c,d,SS_x) with SS_x is not covered by union sensing area SA(m_i , SS_x)∪ SA(n_j ,SS_x)∪ SA(h_k ,SS_x), as shown in (1).

TA(c,d,SS_x)⊄ SA (m_i,SS_x)∪SA(n_j,SS_x)∪SA(h_k,SS_x) ∀(c,d)∈ L; $m_i \in e_m$;$n_j \in e_n$;$h_k \in e_h$;$SS_x \in$ M. (1)

- SU-to-PU interference: A PU is unaffected outside of the SU transmission range and the sensing range must cover only the broadcast range. Thus, the sensing ranges are limited to the maximal broadcast range of an SU and the widest interference range to a PU.
- SU-to-SU interference: It occurs when two active links need the same SBs. However, the signal does not cover the transceiver two hops away that have been evaluated as having less influence on interference.
- PU-to-SU interference: The interference from a PU to an SU causes the interruption of the transmission of an SU.

C. Problem Formulation

A set of source-to-destination pairs is denoted by R. The end-to-end delay d_r,∀r ∈ R is evaluated with the average delay function D as in (2), which yields (3) to (13) for |T| time slots.

$$D = \sum_{r\in R} \frac{d_r}{|R|} \quad (2)$$

The variable $y_{\tau(u,v)}$ set to 1 indicates that a link (u,v) is an active link; otherwise, the value is 0 at time τ. The sets of link variables $y_{\tau r(u,v)}$ denote the link (u,v) is used on routing path r ∈ R. Hence, Equation (3) shows that $y_{\tau(u,v)}$ must be 1 for any flow routes using a link (u,v) at time τ.

$$y_{\tau r(u,v)} \le y_{\tau(u,v)}, \forall (u,v)\in L, \upsilon \in V_{SU}, \tau \in T \quad (3)$$

If CR i belongs to the group of active links (u,v), decision variable $\varphi_{i\tau(u,v)}$ is set to 1; otherwise, the value is set to 0, as shown in (4). Since CR i is assumed to be limited to one group, the summation of all links for CR i is less or equal to 1, as formulated as (5).

$$\varphi_{i\tau(u,v)} \le y_{\tau(u,v)}, \forall (u,v)\in L, i\in e_\upsilon, \upsilon \in V_{SU}, \tau \in T \quad (4)$$

$$\sum_{(u,v)} \varphi_{i\tau(u,v)} \le 1, \forall i\in e_\upsilon, \upsilon \in V_{SU}, \tau \in T \quad (5)$$

At least one SS is allocated to an active link, but not larger than n SSs (6). If s $\in SS_{(u,v)}$ is assigned to link (u,v), the value of $\alpha_{\tau s}$ is set to 1; otherwise, it is set to 0. The connection state $\delta_{\tau(u,v)}$ equals 1 if nodes u and v are connected; otherwise, it is 0 for each time τ. An SS is assigned to a link for which $\delta_{\tau(u,v)}$ = 1.

$$\delta_{\tau(u,v)} \le \sum_{s\in SS_{(u,v)}} \alpha_{\tau s} \le n, \forall (u,v)\in L, \tau \in T \quad (6)$$

An SS must be allocated to CR i ($\in e_u$ or e_v) or all cooperative CRs in a group, indicated by $\zeta_{\tau is}$, where $\zeta_{\tau is}$ is equal to 1, to ensure that any pair of CRs selects the same set of SSs for link (u,v) at time τ, as shown in (7). However, the total number of times an SS is assigned to a cooperating CR is less or equal to 1, as shown in (8).

$$Z_{\tau js} = Z_{\tau is}, \forall s \in SS_{(u,v)}, i\in e_\upsilon, j\in e_{\upsilon'}, (u,v)\in L, \tau \in T \quad (7)$$

$$\sum_{s\in SS(u,v)} Z_{\tau is} \le 1, \forall i\in e_v, (u,v)\in L, v\in V_{SU}, \tau \in T \quad (8)$$

The bandwidth $c_{\tau(u,v)}$ of a link based on a set of available bands $M_{\tau(u,v)}$ is calculated by (9). In this case, the interference power received on CR v is weightless only if the received powers are lower than a threshold value.

$$c_{\tau(u,v)} = \sum_{m\in M_{\tau(u,v)}} b_m \log_2\left(1 + \frac{g_{(u,v)} w^m_{\tau(u,v)}}{\eta b_m + \sum\limits_{\substack{i\in V_{SU}\\ i\ne u,v}} \sum\limits_{\substack{j\in V_{SU}\\ j\ne u,v}} g(i,v) w^m_{\tau(i,j)}}\right), \quad (9)$$

$$\forall (u,v)\in L, \tau\in T$$

The limits on the aggregated flow $f_{\tau(u,v)}$, which is the sum of the traffic requirements $\gamma_r(\forall r \in R)$ Mbps from the flow r transmitted through a link (u,v) at time τ, is represented by(10). The value of $f_{\tau(u,v)}$ ensures that the aggregated flow does not exceed the link bandwidth, as shown in (11).

$$\sum_{r\in R} y_{\tau r(u,v)}\gamma_r \le f_{\tau(u,v)}, \forall(u,v)\in L, \tau\in T \quad (10)$$

$$f_{\tau(u,v)} \le c_{\tau(u,v)}, \forall(u,v)\in L, \tau\in T \quad (11)$$

The delay is computed using (12) at each time slot τ. The function $g(SS_{(u,v)})$ calculates the amount of megahertz for the assigned SSs $SS_{(u,v)}$. On the basis of derivations from the research [16], link delay $D(c_{\tau(u,v)},f_{\tau(u,v)})$ and nodal delay $Q(SS_{(u,v)},\psi_u,n_u)$ functions are related to 1) the width of SSs $g(SS_{(u,v)})$megahertz and how far ψ_u the spectrum to be sensed for node u, 2) the number of negotiating nodes n_u, and 3) the switching time ε of a CR to switch and modulate a set of available bands to construct a channel or a subcarrier for OFDM; both delays are calculated for a node u transmitting packet to a node v. When the average rate of interruption $\theta_{\tau(u,v)}$ for link (u,v) is considered, other available bands must be found for retransmission; thus, the expected number of retransmissions is formulated with a geometric distribution.

$$\frac{D(C_{\tau(u,v)}, f_{\tau(u,v)}) + Q(SS_{(u,v),}\varphi_u, n_u)}{1-\theta_{\tau(u,v)}} \le t_{\tau(u,v)}, \forall(u,v)\in L, \tau\in T \quad (12)$$

The link and nodal delay functions are used for various models. This study considers the link delay function according to the aggregated traffic $f_{\tau(u,v)}$. The nodal delay function is $Q(SS_{(u,v)},\psi_u,n_u) = \omega \times g(SS_{(u,v)})\times \psi c\ u + \beta \times n_u + \varepsilon$. The end-to-end delay is calculated on the left-hand side of (13), along with the routing path for each flow r. The average delay of all flows is derived using (2).

$$\sum_{\tau\in T}\sum_{(u,v)\in L} y_{\tau r(u,v)}.t_{\tau(u,v)} = d_{r,}\forall_r \in R \quad (13)$$

IV. EVALUATION AND DISCUSSION

A. Evaluation algorithm

The proposed hybrid preallocation spectrum sharing algorithm is applied to the preallocation technique. The spectral resource preallocation (i.e., HFSBA and HOSBA) and evaluating the spectrum sensing followed by sharing with preallocated hybrid technique.

Algorithm 1: hybrid preallocation spectrum sharing

Input: Number of massive antennas-100, secondary users-100, and bandwidth-25MHz

Output: The average capacity for a number of secondary users, end-to-end delay with respect to the number of spectral bands and sensing with negotiation time

Step1: Creating a coverage region of a 1000m network
Step2: PU and SU assignment in that area
Step3: Deployment of massive antennas-100
Step4: int SU=0
SU=100 user equipment
Step5: Assign spectral band
Initial band=1MHz
Maximum number of band=25MHz
Step6: if (PU= = 0) in spectrum
SU_usage= (1:100);
Spectrum_usage= SU(u);
Else
(usage of spectrum for PU-default)
End
Step7: for (i = 1, i ≥ 100)
i_antenna = power_initial
total power = initial power + i^th maximum power of antenna
end
step8: evaluate the spectrum sensing followed by sharing with preallocated hybrid technique

TABLE 1: Simulation Parameters

Parameters	**Values**
Number of SU	100
Number of network type	2
Maximum sensing range	250m
Time slot	2ms
Transmission power level D_L	20dBm
Transmission power level U_L	10dBm
Maximum radius	1000m
Bandwidth / SB	25MHz

B. Simulation results

In order to evaluate the performance of average capacity for a number of secondary users, end-to-end delay with respect to the number of spectral bands and sensing with negotiation time. This performance will be achieved in massive antenna technology. The simulations are done by using simulation tool MATLAB. The simulation results of average capacity vs sensing with negotiation time per spectral band will be shown in Fig. 3

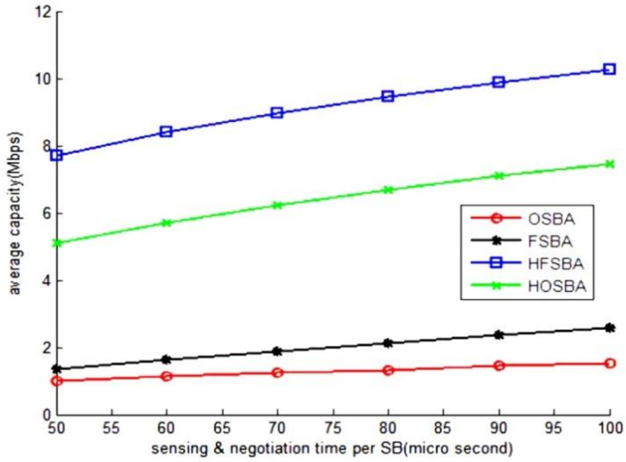

Fig. 3: Average capacity vs sensing and negotiation time

Fig. 3 depicts average capacity versus sensing with negotiation time in cognitive radios network with the assumption of secondary users in absence of a primary user. When increasing the number of antennas which is known as HFSBA and HOSBA. There will be using hundreds of antennas that will be measured for a microsecond and the average capacity it's measured for the Mbps. The sensing with negotiation time for OSBA and FSBA, the minimum average capacity will be achieved. When compared to the HOSBA and HFSBA, to achieve the high range of average capacity.

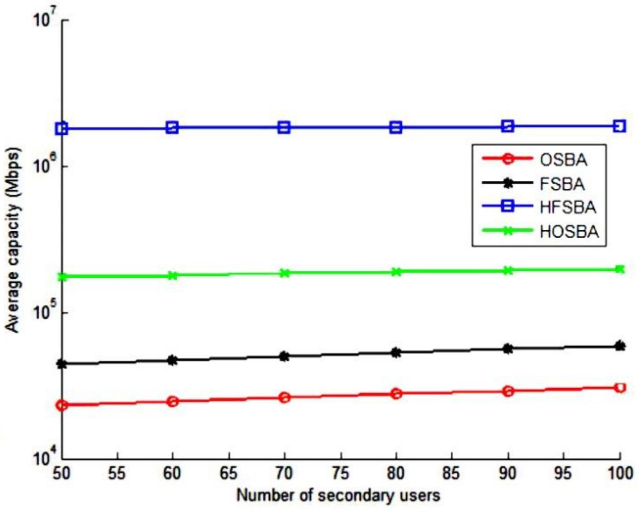

Fig. 4: average capacity vs number of SU

Fig. 4: depicts that the average capacity vs the number of secondary user, there will be using hundreds of secondary users with respect to the antennas and the average capacity will be measured in Mbps. By using the number of secondary users for OSBA and FSBA, to achieve the minimum average capacity that will be linearly achieved. When compared to the HOSBA and HFSBA, to achieve the better performance of the average capacity that will be linearly achieved.

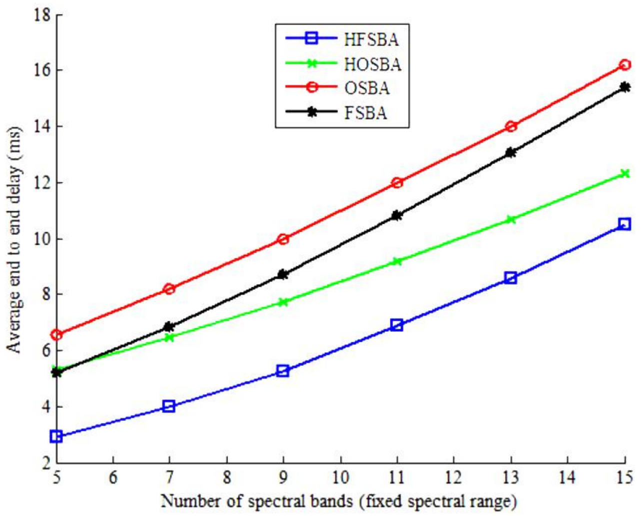

Fig. 5: end-to-end delay vs number of spectral bands

Fig.5: depicts the average that is overall delay time in a millisecond with spectral bands, the number of spectral bands vs average end-to-end delay to be considered. By using the number of spectral bands that must be in fixed spectral range, the average end-to-end delay will be increasing for the OSBA and FSBA. When compared to the HOSBA and HFSBA, the average end-to-end delay will be minimizing.

V. CONCLUSION

In this paper, we analyze the preallocation mechanisms and designed the massive antenna network with higher user capacity for SU, lesser negotiation time and Interference reduction by deploying massive antennas technique. By implementation of Cognitive radio with massive antennas techniques the interference have been reduced and also by using the algorithm such as hybrid fixed spectral band allocation (HFSBA) and hybrid opportunistic spectral band allocation (HOSBA), the average capacity of the SU has been increased when compared to the existing post allocation spectral band method.

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