Dynamic Hotspot Clustering Using White Space

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***Abstract*—The proliferation of smart phones is growing demand anywhere wireless access to data in our daily life. This issue of the increasing demand for mobile broadband with a lack of spectrum, especially in densely populated areas is a major problem. This article presents an innovative technique to solve the above problem by clustering approach. The proposed solution Clustering improves scalability and coverage of cellular networks high density animal. The proposed approach organizes the node groups; each group (cluster) has one primary node that is directly on the base station (BS) while the other node (slave) primary media through their respective nodes. The proposed configuration requires lower power consumption for transmitting and receiving data. In addition, it allows reuse of the frequency without causing disruption, and increases the scalability of the network and reduces the number blocked and stopped.**

Keywords—Clustering, TV White-Space, Wireless Networks, Cellular Networks, LTE 4G

I. INTRODUCTION

The number fast augmenting by smart devices and by mobile users established broader concepts of wireless approach gifted with ubiquity in Internet. However, in dense events like the Hajj (annual pilgrimage, every year, millions of Muslims from all over the world make the trip to Mecca, Saudi Arabia). A big number of mobile devices compete for the restricted ghost. By using the new bands of television white space ' one of the resolutions offered is to resolve this problem. The white TV - the space (TVWS) is present on 50−700 MHz following in the ranges of coverage of the years 10 of km owing to the best characteristics of spread, compared with the bands of WI-FI. The long term - Evolution (LTE) allows for the operators to use the new and broader ghost and supplementary benefits 3G networks with higher speed of transmission of data and a lower latency.

The use of a mixture of big cell and small cells allows flexible and economic deployments and provides an experience of broad uniform band the users anywhere in network [1]. In wireless cell facilities, regions are divided into cells and every cell has its own Based Station (BS) to control it. Frequencies are divided into games and reused in the uniform models so that the close cells use different frequencies to avoid the interference of co-channel.

One of the offered resolutions when a cell becomes very closely populated is to divide the cell on top of that small cell as small cells and micro-cells with the lower powers of transmission. This shape will allow the capacity of a network to be developed and the coverage of cell to be enlarged by reducing the loss of track by choosing hot spots more near in their slaves than the Based Station [2]. A study in [3] a comparison of existent plans which consider small cells in case of networks of region dense and in challenges linked from the point of view of interference, by selling and the administration of agility is introduced. Also, this study shows the main protocols and the type of approach which should be adopted in that case.

In [4] provide authors a method for grouping of the mobile nodes in the clusters using TV white spaces (TVWS) bands for some users to convey their information between BS and other units, considering the mobile users' requirements by studying the corresponding transfer scenarios and signaling schemes.

In [5], proposed a hotspot-slave configuration. A hotspot is defined as a mobile device that connects to the BS direct and aggregates his slaves (if any) uplink and downlink data with its own data, when you connect with BS. A slave is a mobile device that communicates with the BS through a hotspot. This study gives an algorithm that tries to organize all active nodes in small clusters, which allows for more efficient spectrum and power resources are allocated among users in dense areas.

The concept of clusters provides several advantages over the standard small cell installation. Clusters can be used on an ad-hoc fashion to increase capacity in a Microcell and adapt to increasing traffic demands and variations that can be observed at certain times during the day. The mobile terminals that opportunistic plays the role of cluster-heads form clusters, there is no need for an operator to implement specific fixed base station infrastructure. On the other hand, requires the formation of clusters of specific control signals and direct communication between the involved terminals, which can be enabled by appropriate changes in the relevant Radio Access Network (RAN) standards.

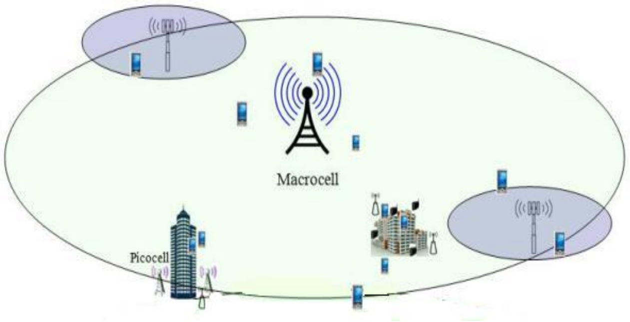

Figure 1: TVWS Clusters formed in a macro cell

II. RELATED WORK

Today, the growing demand for mobile broadband and the limited parts of the cellular spectrum, particularly in crowded places, dictate the development of more effective methods of allocation of resources. As a result, many solutions existed in the literature to consider this problem and propose possible solutions. Most of these approaches are based on the reuse of the available frequencies and using heterogeneous network (HetNets). Study in [6] proposed a new technique for QoS-Aware HetNet enhancement called Tethering in a heterogeneous wireless network using LTE and TV white spaces to improve QoS for constant Bitrate (CBR) and best effort (BE) users in dense wireless networks. It aims to boost system bandwidth and solve the crowding problems in dynamic construct HetNet new clusters. Authors in [7] proposed distributed dynamic Load Balancing (DDLB) using TVWS and LTE technology. This technique increased cellular-based devices by simply switching frequency to activate both TVWS and LTE bands.

A. Cellular Networks

The concepts of cellular systems are based on the reuse of the available bandwidth as much as possible within a coverage area. The coverage area of a wireless system is divided into cells and frequency band is assigned to a cellular mobile radio system is distributed across this group of cells. This distribution is repeated within the whole area belongs to the domain operator. Thus reusable frequencies used in a cell into multiple cells. The spacing between cells, use the same frequency must be sufficient to avoid interference. Frequency reuse can increase the scalability of the network significantly and thus the number of users served. However, in a densely populated cell, will not be sufficient frequency band allocated to handle all users. Why have cellular systems introduced smaller cells, such as micro-cells and small-cells for further enhance the re-use and scalability [8]?

B. Heterogeneous Networks

Heterogeneous networks (HetNets) involve a combination of large cells (macro) and small-cell (Pico/Femto) with various radio technologies (3 g/LTE, LTE advanced). In other words, introduces new small cells inside the cell HetNet macro by adding new Pico or small cells to provide the best coverage and scalability in cellular systems. In a comparison between the existing schemes of small cell to consider the related challenges of relief, presented interference and mobility management in addition to the main protocols, to be taken in case of dense areas.

Some solutions to this problem include adding new infrastructure as a study in [9] proposed adding new infrastructure such as Wi-Fi APs and small cells to activate services for users. But the lack of Wi-Fi bands and possibly uncontrollable interference that can be generated in the ISM band may not entirely satisfy the requirements which uses and can thus not fulfill the additional capacity objectives. This approach limits the scalability of wireless network, even when there are opportunities for better use of the spectrum.

In 2004 showed the Federal Communication Commission (FCC) in the United States, to the unused TV channels in both very high frequencies (VHF) and ultra high frequency (UHF) bands could be used for fixed broadband access [10]. Later in 2008, has been published a study of the introduction of open-spectrum policies, showing that WRAN operating systems in TV bands can bring several hundred times higher spectral efficiency, and more than two times higher coverage's efficiency [11].

III. METHODOLOGY AND PROPOSED ALGORITHM

Step-1: Clustering Nodes into Hotspots and Slaves

Means of clustering is a technique of cluster analysis which aims to partition n observations into k clusters, where each observation belongs to the cluster with the nearest mean. The proposed algorithm is based on the means algorithm and considers inputs of the Euclidean distance between nodes.

The proposed algorithm is dynamic hotspots selection and resource allocation. Begins the initialization of the number of clusters to two and then assign users the coordinates using the Euclidean distance between the node and the BS, so that they are not larger than the radius of the macro cell R:

$$ED=\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \leq \mathcal{R} \quad (1)$$

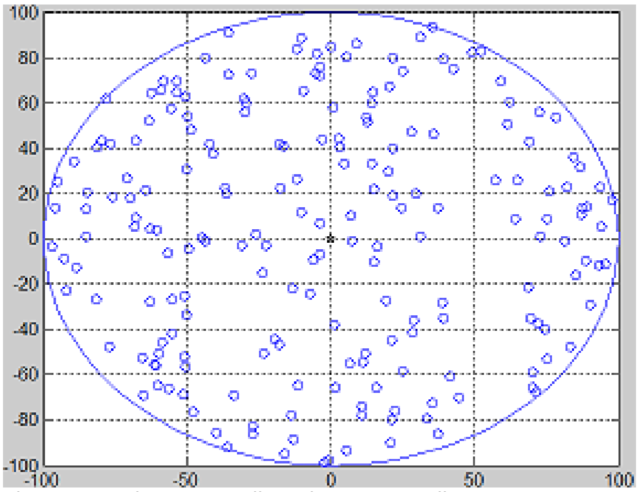

Figure 2: Load users coordinate in a macro cell

Then for each user count decrement PL which depends on the distance of the user from the base station, taking a path loss coefficient ple,

$$PL=ED^{ple} \quad (2)$$

Where PL is path loss, ED: Euclidean distance between the nodes and ple is the path loss exponent.

PL Total=10*$\log 10\left(PL * 10^{s/10}\right)$

Path Loss Exponent = 0.05 and s= shadowing

Then assumes that users with the least path loss (i.e., those closer to the macro BS) to connect to the base station of the macro.

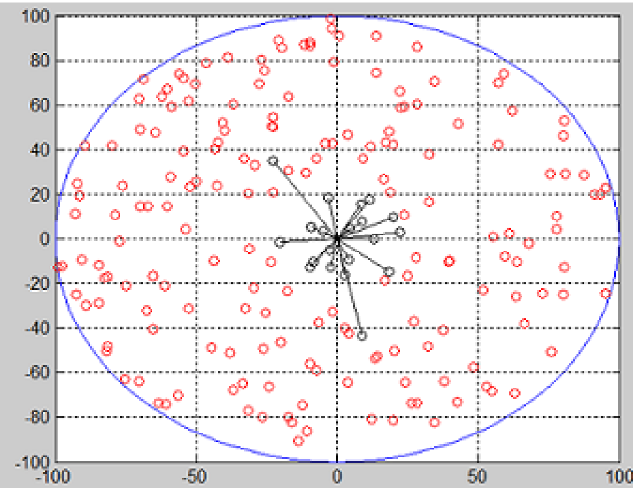

Figure 3: User Association with macro BS User Association with macro BS

Step-2: Resource Allocation Among users

In this step of the algorithm which election hotspots k-mean clustering and power of victor contains sub-steps.

(i) Resource Allocation among Slaves:

Each hotspot points resource block groups RBGs to his slaves on the basis of an OFDMA-like approach with speed and power restrictions [12]. In this approach, each slave has only one RBG

(ii) Allocating RBGs and Transmission Powers:

After defining each user transmission power, and with knowledge of the required rate of each slave, lost each hotspot the following optimization problem:

$$\text{Minimize}_{P,X} \; \sum_{i \epsilon c_j} \sum_{f=1}^{F} \{p_{ij}^f\} \quad (4)$$

$$\sum_{f=1}^{F} x_{ij}^f \, b \log\left(1 + \frac{p_{ij}^f g_{ij}^f}{x_{ij}^f}\right) \geq R_i, \forall i \in C_j \quad (5)$$

$$\sum_{i \epsilon c_j} x_{ij}^f \leq 1, \forall f \quad (6)$$

$$p_{ij}^f \geq 0, \forall f, \forall i \in C_j \quad (7)$$

$$x_{ij}^f = \{0,1\} \forall f, \forall i \in C_j \quad (8)$$

Where j corresponds to the transmitter (hotspot), and corresponds to the operating frequency range (a set of C_j channels) for example, LTE or TVWS band, g-gain channel average noise power ratio, a group of slaves associated with hot point j, p_{ij}^f The total transmission power and R rate constant to the destination node. In this approach, you can use only one slave each RBG. The purpose of this algorithm is to reduce the total transmission power at all constraints available with minimum rate constraints (5) determine enrollment. Constraints (7) a positive force and impose restriction (8) channel x_{ij}^f Selection variables to get binary values.

(iii) Resource Allocation among Hotspots: BS assigns its resources along with the selected hotspots j∈ H.

$$\text{Minimize}_{P,X} \; \sum_{j \in H} \sum_{n=1}^{N} \{p_{jj}^n\} \quad (9)$$

$$\sum_{n=1}^{N} x_{jj}^n b \log\left(1 + \frac{p_{jj}^n g_{jj}^n}{x_{jj}^n}\right) \geq R_j + \sum_{i \in C_j} R_i, \forall j \in H \quad (10)$$

$$\sum_{j \in H} x_{jj}^n \leq 1, \forall n \quad (11)$$

$$p_{jj}^n \geq 0, \forall n, \forall j \in H \quad (12)$$

$$x_{jj}^n = \{0,1\} \forall n, \forall j \in H \quad (13)$$

Where H is the hotspots and N corresponds to a different frequency band (a series of channels). Constraint (10) specifies that the rate of hotspot (j) is greater than or equal to the sum of the rate of the slaves, or their own requirement

Step-3: BS Rate and Power Constraint Check

In this last step is the feasibility of the resource assignment done in previous steps controlled in order to ensure that all nodes have successfully gotten their desired resource in order to satisfy their requirements and rate whether we cluster has reached the maximum number of iterations. If that is not possible, it means that there are not enough resources, and this step is not yet completed with success. BS clusters re nodes of clusters increase figures and calculation of the limited users.

IV. SIMULATION RESULTS

A. Simulation Setup

Like the wireless cell crowded as 100 x 100 meter square area complete with hundreds of mobile phone users with BS in the middle of the cell. LTE BS supposed to work on the 20 MHz band and we focused on transmission. Consider a similar environment as it is in downtown San Francisco, where BS on channel 26 (difference frequency MHz 542-547). In addition, it is assumed the simplified path-loss model with the path loss exponent 4 between the radio transmitters and receivers.

B. Discussion and Results setup

For the purposes of simulation and to illustrate the flow of the proposed algorithm, it is assumed that the three TVWS channels are available everywhere in the area of 100 × 100 in the cell. Figure 4 (a, b) shows the result of the clustering step during resource allocation steps with 200 users step resource allocation. If not satisfy hotspot cluster limits per user the BS re-clusters a node based on K-means algorithm. This proposed algorithm iteratively cluster node to hotspots and slaves, then allocate resources with the purpose to Maximize network spectrum reuse.

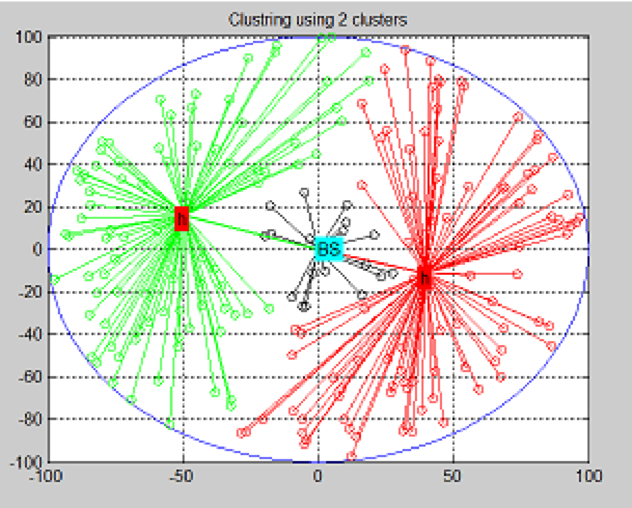

Figure 4 a: iteration number 1

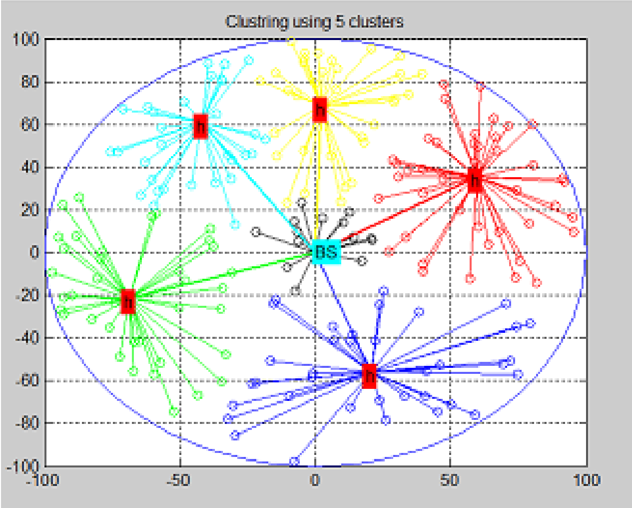

Figure 4 b: iteration number 4

Users No	***200 Users***			
Iteration	1	2	3	4
No. Of Cluster	2	3	4	5
Restricted Users	90	45	8	0

Table 1: Number of iterations, clusters and restricted users

When we have 200 users can we form the 5 clusters supported by 5 hotspots. When a node is chosen to be a hotspot, it has to satisfy its own rate requirements in addition to slave's rate requirements. Table 1 shows that a number of restricted users decrease as a number of cluster increase and iteration increases until it reaches zero which means all the users are covered. Table 2 shows the total force required in each cluster. The results indicate that the HS power depends on the number of slaves it serves and its distance from the BS.

Hotspot #	***Power of each HS mW***
HS1	0.0666
HS2	0.2474
HS3	0.2722
HS4	0.0715
HS5	0.2857
Total power of Clusters	0.6712

Table 1: Power in each cluster made by a hotspot

V. CONCLUSION

Due to limited resources the large spectral signal overhead in densely populated areas, one base station cannot absorb such large numbers of simultaneous users. In this paper, we proposed an algorithm for clustering nodes and those Mobile hotspots of slaves, and then allocate resources dynamically in LTE and TVWS in order to reduce the total number of users is limited, power transmission network. Simulations results show that the total use of the coverage area can increase considerably in the algorithm suggested using configure hotspot-slave compared to traditional direct mode communication (LTE).

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