ISSN 2348 – 8034
Impact Factor- 3.155

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

A CASE STUDY ON POSSIBILITIES OF DEPLOYMENT OF RELAY STRATEGY IN COGNITIVE RADIO NETWORK USING COOPERATIVE COMMUNICATIONS

Dr Seetaiah K[*1] and Gandhi B [2]

[*1]Professor, Department of Electronics & Communication Engineering, SVEC, INDIA

[2]Assistant professor, Department of Electronics & Communication Engineering, SVEC, INDIA

ABSTRACT

The traditional cellular base stations are not suitable for high speed multimedia applications. The existed homogeneous cellular structure has limitations in speed, efficiency and reliability. To overcome these problems, heterogeneous deployments were proposed. This proposed method reduced the coverage area and also power consumption. This phenomenon should follow the proper hand off mechanism, because when cell size reduces, the number of hand offs would be increases. This needs intelligence management without high call drop rate. This deployment will increase the cost for network operator. The key idea in user-cooperation is that of resource-sharing among multiple nodes in a network. The reason behind the exploration of user-cooperation is that willingness to share power and computation with neighboring node scan lead to savings of overall network resources. In this paper, we explained the possibilities of relay strategies in Cognitive Radio Network (CRN) and the possible resource allocation schemes.

***Keywords**: relay station, homogeneous, heterogeneous, hand off, Cognitive Radio Network*

I. INTRODUCTION

Shrinking cell sizes, primarily to meet the increasing demand for higher data rates in turn increases the need for more base stations which increases the deployment cost. Thus to provide a cost effective way to extend the coverage and the capacity in cellular networks relay assignment is the optimistic way. A relay station can be used to extend the point-to-multipoint link between the base station and the mobile stations. The deployment of these relay stations costs less to those of the base stations and also the backhaul connection costs can be overcome as the connection between relays to base stations is wireless.

In the traditional cellular architecture a given coverage area is divided into smaller areas called cells. A BS, often located at the center of the cell, provides coverage to the mobile stations (MSs) within the cell. The BS is connected to the core network via a backhaul connection, typically provided by a wired or point-to-point microwave link. The area within a cell can further be subdivided into sectors. Within each sector, the BS communicates with MSs that are associated with it, using what is referred to as a point-to-multipoint (PMP) link [1]. The PMP link here refers to a specific type of multipoint link whereby a central device (BS) is connected to multiple peripheral devices (MSs).

Any transmission of data that originates from the central device is received by one or more of the peripheral devices, while any transmission of data that originates from any of the peripheral devices is only received by the central device. Each BS manages the allocation of resources to support communications between itself and the MSs it serves. The MSs are informed about the resource allocation by the BS. Coverage within a sector is commonly enhanced by the deployment of analog repeaters [2]. Repeaters are simple devices that receive the signal transmitted by the BS (as well as the signals from neighboring cells, if any) and with very little delay indiscriminately amplify and forward this signal. The traditional cellular architecture mentioned above can be enhanced using devices called relay stations (RSs), which intelligently relay data between the BS and MSs wirelessly.

The BS communicates with a multitude of RSs within its coverage using the PMP mode mentioned above, and the RSs in turn also communicate with MSs associated with them using the PMP link. The BS maintains overall control over the RSs and MSs associated with it, although the implementation of individual control functions(e.g., scheduling) may be centralized at the BS or distributed between the BS and RSs. The RSs operate using a store and forward paradigm [3]. The RSs receive the data selectively in specific time/frequency allocations indicated by the BS, decode and process the data, and subsequently transmit (relay) this data in different allocations that occur later in time.

In the simplest form the RSs might simply demodulate and subsequently remodulate the data prior to relaying. In the most advanced form RSs can decode the data, process the decoded data (which may involve operations such as error handling, fragmentation, packing, rescheduling according to quality of service [QoS]), and subsequently re-encode the data in accordance with the conditions on the next link prior to relaying. From figure 1, the area immediately surrounding the BS is the BS's coverage area. The MSs in this area associate with the BS and are served directly by the BS [8]. Each RS has a coverage area within which it serves MSs. The coverage areas of the BS and RSs can overlap to varying degrees. As Fig. 1 shows, the path between the BS and an MS can consist of one or more hops. The RSs can be thought of as being arranged in a multilevel hierarchical structure with the BS at the top of the hierarchy. RSs at the first level of the hierarchy are attached directly to the BS. RSs at the second level are attached to the first-level RSs and so on. In its simplest form the topology of the sector enhanced using RSs is a tree, with a single path between the BS and each MS. In a more complex topology, such as a mesh topology, more than one path can exist between the BS and one or more MSs, RSs on the same level may communicate with one another, and a given RS may appear in different levels on different scenarios.

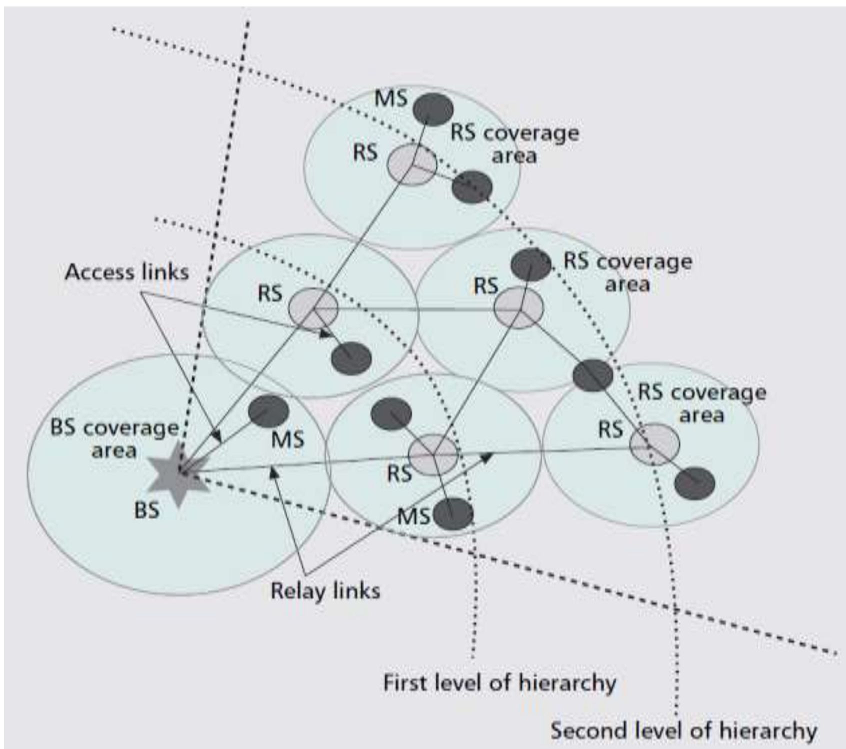

Figure 1: Base station with relay stations

We refer to the link between the BS and an RS, or between two RSs, as a relay link, while the link between the BS and an MS, or an RS and an MS, is referred to as an access link [7]. The deployment of RSs offers performance and cost benefits over the use of BSs in a traditional cellular network. Performance benefits include improvements in coverage and/or increases in capacity. Cost benefits are realized through reduction in the cost of providing service, which in turn is obtained due to a reduction of the cost of equipment, site development, and backhaul.

ISSN 2348 – 8034
Impact Factor- 3.155

The performance improvements that can be achieved due to relay are based on two factors. The first factor is the increase in frequency reuse that results when the BS and RSs within a sector each communicate at the same time to different MSs using the same frequency resources. The second factor is the increase in effective capacity of a multi hop wireless link as the number of hops is optimized to match the distance between the communicating nodes. RS deployment enhances the coverage and capacity in areas where the capacity of the direct link between the BS and MSs is low [6]. Such areas can exist at the cell edge (e.g., MS1 in Fig. 2) or in the shadows of large objects such as tall buildings (e.g., MS8), within the buildings themselves, or underground. RS deployment enhances coverage in areas where the capacity of the direct link between the BS and MS is zero (e.g., MS2 in a coverage hole or MS7 beyond the edge of the cell).

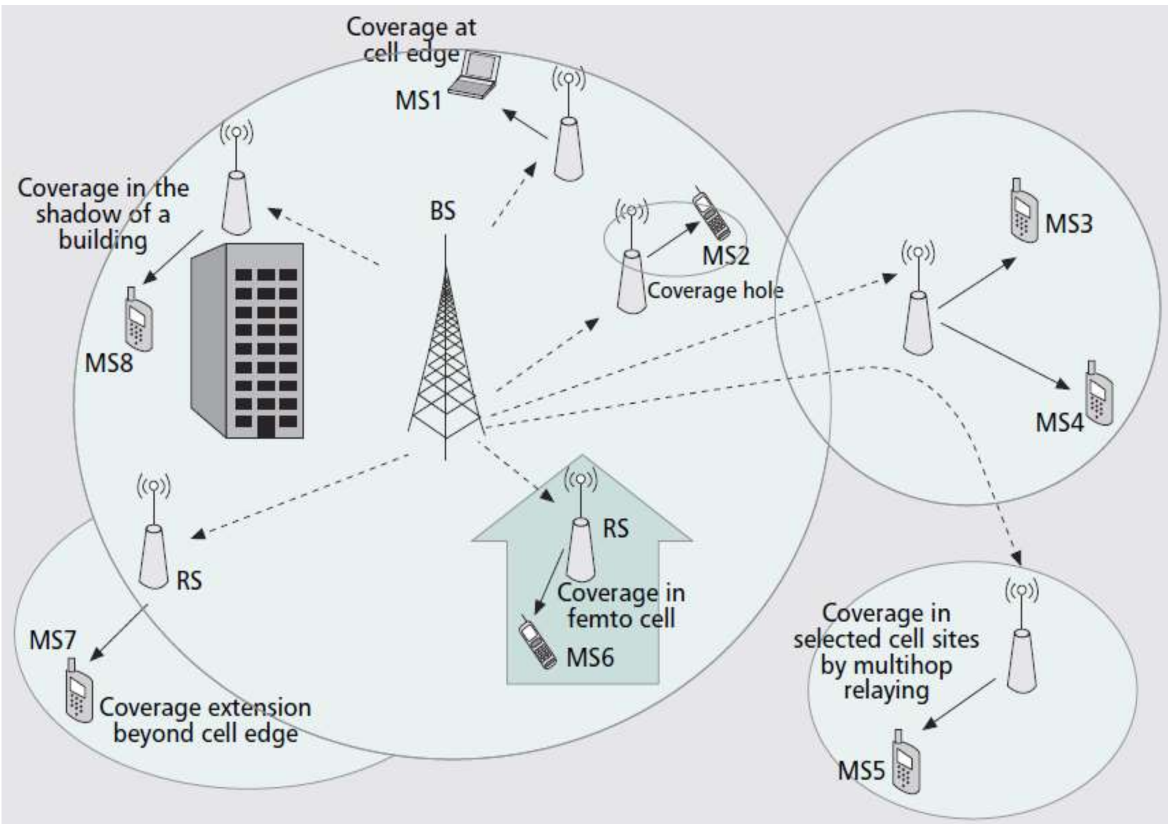

Figure 2: Different RF Deployment scenarios

RS deployment enhances capacity throughout the cell due to increased frequency reuse. Compared to a traditional BS, the equipment cost associated with an RS is likely to be lower due to the (expected) lower complexity, and lower cost of the chassis and power amplifier. It is likely that RS antennas are deployed on top of buildings or on lamp posts; therefore, RS cell sites are likely to be less expensive to develop and maintain than traditional cell sites with tall towers. These differences in cost are expected to decrease over time, however, as the coverage area of BSs becomes smaller. The primary advantage of deploying RSs in terms of the cost is expected to come from the differences in the cost of the backhaul.

When an RS is deployed, instead of a BS with a wired backhaul connection, there are no direct backhaul costs. There is no cost for provisioning the wired connection, and there are no monthly charges for the backhaul. Similarly, when an RS is deployed, instead of a BS with wireless backhaul, the use of an RS eliminates the need to purchase, set up, and maintain microwave link equipment, and to purchase the rights to additional spectrum in which this equipment operates. RSs are also expected to be less costly to deploy because they do not require line of sight channel conditions on the relay link, allowing greater flexibility in site selection than for a BS with wireless backhaul.

II. COOPERATIVE COMMUNICATION

The key idea in user-cooperation is that of resource-sharing among multiple nodes in a network. The reason behind the exploration of user-cooperation is that willingness to share power and computation with neighboring node scan lead to savings of overall network resources. The benefits of the cooperative communication come at cost of sharing the terminal's transmission power and computation resources with others. However, this loss of own power may be counteracted when helping terminal sends its own signal, which can be then relayed by others. Thus, although the benefits depend of users' willingness to cooperate, the cooperation may potentially lead to significant resource savings for the whole network. The fundamental block of the cooperative communication, the so-called relay channel, was firstly introduced by van der Meulen in 1968 Further, Cover and El Gamal analyzed the relay channel from the information theoretic point of view and developed several fundamental relaying strategies [1,5,7].

Within the context of cooperative communication, the AF strategy was firstly introduced and investigated by Lanemann et al. in .Since the source is generally further away from the destination than the relay; the received signal at the destination due to the source would be much weaker than the relay signal. However, when fading is also taken into account, this scheme would incur considerable loss, especially in diversity, compared to one in which the destination processes both signals. Hence one can use multi-hop not just to overcome path loss, but also to provide diversity. Motivated by the above observation, cooperative communication involves two main ideas: (i) Use relays (or multi-hop) to provide spatial diversity in a fading environment, (ii) Envision a collaborative scheme where the relay also has its own information to send so both terminals help one another to communicate by acting as relays for each other (called "partners"). One can think of a cooperative system as a virtual antenna array, where each antenna in the array corresponds to one of the partners. The partners can overhear each other's transmissions though the wireless medium, process this information and re-transmit to collaborate. This provides extra observations of the source signals at the destinations, the observations which are dispersed in space and usually discarded by current implementations of cellular systems. However, since the elements of this array are not co-located and are connected via noisy, fading links, it is not clear a priori how much the benefits of this cooperation would be. In a cooperative communication system two or more active users in a network share their information and jointly transmit their messages, either at the different times or simultaneously, to obtain greater reliability and efficiency than they could obtain individually.

Communication from a single source to single destination without the help of any other communicating terminal is called direct/ single user/ point to point communication. User cooperation is possible whenever there is at least one additional node willing to aid in communication. The simplest and oldest form of user cooperation is perhaps multi hopping which is nothing but a chain of point to point links from source and destination. No matter what the channel is there is some attenuation of signal with the distance, which makes long range point to point communication impractical. This problem is overcome by replacing a single long range link with a chain of short range links where at each intermediate node there is a booster or repeater to enhance signal quality.

III. RELAY AND THEIR STRATEGIES

The relay channel is the three terminal communication channels. The terminals are labeled as source(s), destination (d), and the relay (R). All information originates at source and must reach destination. The relay aids in communicating information from s to d without actually being an information source or sink. A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several

ISSN 2348 – 8034
Impact Factor- 3.155

circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations. The main idea of the relay channel is that a relay terminal can overhear the signal from the transmitter and retransmit it towards the receiver. We may roughly divide relaying strategies into two classes: non-regenerative and regenerative. A typical representative of non-regenerative strategies is the so-called amplify-and-forward (AF) strategy. The basic underlying principle of the strategy is the amplification of the noisy received signal at the relay terminal and its retransmission towards the destination [5,8]. This is quite an old technique used by radio engineers to increase the coverage of the microwave transmission almost sixty years ago. The most frequently used regenerative relaying strategy is decode-and-forward (DF), originally suggested in . The key idea of the DF strategy is that the received signal is first decoded at the relay, then re-encoded and retransmitted to the destination. Another representative of the class of regenerative strategies is compress-and-forward (CF), also initially suggested in. The idea here is that the relay quantizes the received signal and encodes the samples into a new message which is forwarded to the destination serving as additional redundancy for the signal received directly from the source.

COGNITIVE RADIO

Cognitive radio is the radio which changes its transmitter parameters based on the interaction with its environment. Its transceivers are designed to use the best wireless channels in its vicinity. This radio automatically detects the available radio channels. It has been proposed to improve the spectrum utilization by allowing secondary users (like micro waves, cordless phones, television remote control) to use the underutilized licensed frequency bands.

Depending on transmission and reception parameters, there are two main types of cognitive radio:

1. Full cognitive radio in which every possible parameter observable by a wireless node (or network) is considered.

2. Spectrum-Sensing Cognitive Radio, in which only the radio-frequency spectrum is considered

Cognitive radio technology is used **to assign anew frequency band** for new standardized wireless communication systems Three types: (1) Underlay (2) Overlay (3) Aggregation of conventionally assigned systems

The main functions of cognitive radio to support intelligent and efficient utilization of frequency spectrum are as follows:

1) **Spectrum sensing**: Spectrum sensing determines the status of the spectrum and activity of the primary users. An intelligent cognitive radio transceiver senses the spectrum hole without interfering with the primary users. Detecting primary users is the most efficient way to detect empty spectrum. The secondary unlicensed users keep sensing the spectrum to determine if a primary user is transmitting or not; and then they occupy the idle band and leave it as soon as the primary users kicks on.

2) **Dynamic spectrum access**: (DSA) is defined as real-time spectrum management in response to the time varying radio environment e.g: change of location, addition or removal of some primary users, available channels, interference constraints .There are 3 models here exclusive-use model, common-use model and shared-use model [1].
3) **Exclusive model**: The exclusive-use model has two approaches, spectrum property rights and dynamic spectrum allocation. In spectrum property rights, owner of the spectrum can sell and trade spectrum; and is free to choose the technology of interest. Dynamic spectrum allocation improves spectrum efficiency by exploiting the spatial and temporal traffic statistics of different services.

4) **Common-use Model:** The common-use model is an open sharing regime in which spectrum is accessible to all users Spectrum underlay and overlay approaches are used in the shared-use model. In spectrum overlay, the secondary users first sense the spectrum and find the location of a spectrum hole (vacant frequency band). After locating the vacant frequency bands, the secondary users transmit in these frequency bands. In spectrum underlay technique, the secondary users can transmit on the frequency bands used by the primary users as long as they do not cause unacceptable interference for the primary users. This approach does not require secondary users to perform spectrum sensing; however, the interference caused by the secondary user's transmission must not exceed the interference threshold [3]**.**

IV. RESOURCE ALLOCATION

There are some basic elements of resource allocation in CRN with cooperative communication.Figure-1 shows the basic elements of resource allocation in cooperative CRN. The elements include

1) **Power allocation**: Efficient power allocation of system is the key factor deciding in all wireless networks. In case of cooperative CRN, the efficient power allocation is more challenging than non-cognitive wireless network. There are some traditional power allocation schemes for non-cognitive wireless network. But these schemes are not applicable to cooperative CRN. The schemes that we follow for non-cognitive network may cause unacceptable interference to the primary network. Even though there is probability of interference, power allocation is performed under the constraint of acceptable interference to the primary users.

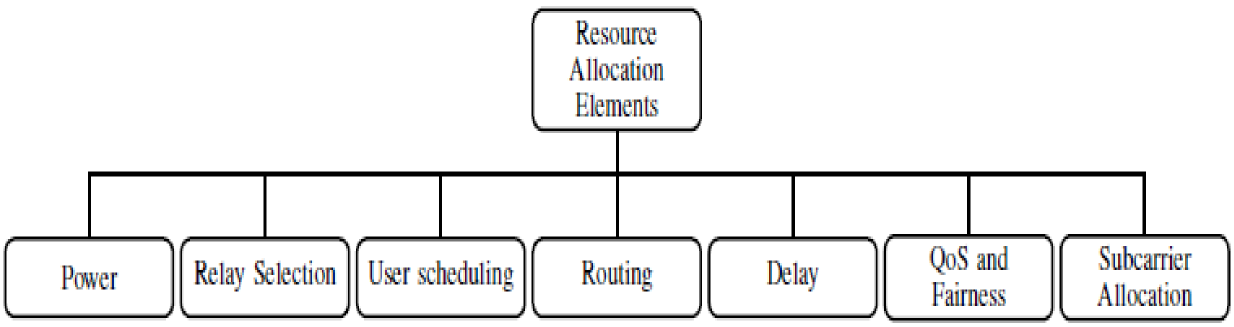

Figure 3: Allocation schemes

The performance of the system in terms of bit error rate and capacity depends on the performance of each relaying node, bandwidth, and transmission power. An optimum resource allocation system assigns different fractional bandwidth, time slots, power for each transmission between two nodes.

2) **Relay assignment/selection:** The use of relays in a CRN can benefit in two ways. First it can increase the transmission rate and secondly the use of relays can reduce the overall transmission power of the systems. The use of multiple relays simultaneously can further increase the performance of a cognitive radio network. A well designed multiple relay assignment and power allocation scheme can be helpful in two ways. It reduces the interference induced to the primary users in multi user CRN and increases the connectivity of the wireless network. In a multiple relay system, if any relay is dead or in deep fade the receiver can still get data from other relays.

3) **User scheduling:** In multiuser cooperative CRN, due to resource limitations and interference constraints, user scheduling in intelligent way can achieve high throughput. User scheduling schemes select the best group of users at each time slot to maximize the total throughput. The complexity of an exhaustive search for user scheduling increases exponentially with the number of users. For example, if K is the total number of users, then the number of possible ways of scheduling/selecting k users is (kck).Enumerating all possible combinations to find the one that gives the best performance is computationally inefficient.

4) **Routing:** In cellular and wireless local area networks, wireless communication only occurs on the last link between a base station and the wireless end system. In multi-hop wireless networks, there are one or more intermediate nodes along the path that receive and forward packets via wireless links. Multi-hop wireless links, multi-hop wireless networks can extend the coverage of a network and improve connectivity. Moreover, they enable higher data rates resulting in higher throughput and more efficient use of the wireless medium. Most of the research on cooperative CRN to data has focused on one or two-hop scenarios. Now multi-hop networks are in use. But to get the benefits of multi-hop transmission, new challenges must be addressed and solved.

5) **Quality of service:** Performance and guaranteed quality of service, the desirable attributes of these systems are determined by the architecture and technologies used and the number of streams of a system capacity and performance. QOS is a general term referred to customer satisfaction. It comprises high throughput and less noise. But providing a better QOS is a challenging task in cooperative CRN.

6) **Delay:** In digital wireless communication systems, transmitted information reaches the receiver after passing through a radio channel, which can be represented as an unknown time-varying filter. Transmitted signals are typically reflected and scattered, arriving at the receiver through multiple paths. When the relative path delays are on the order of a symbol period or more, images of different symbols arrive at the same time, causing inter symbol interference. Delay is crucial tool in real-time applications such as voice and multimedia. Delay in cooperative CRN is still an unexplored area of research.

7) **Subcarrier allocation:** The available frequency band is divided into a large number of small bands called sub-carriers that use specific frequencies so as to be completely orthogonal to each other. In every time-slot, each user is assigned a disjoint set of sub-carriers across which the user may spread information for transmission purposes. Subcarrier allocation and pairing play a significant role in future cooperative CRN that employs OFDM in physical layer. One can increase the throughput of cooperative CRN with the intelligent utilization of subcarriers.

V. CONCLUSION

As we mentioned Relay assignment/selection is primary factor which enables us to reduce overall interference as well as power transmission of the system will be reduced. But when we use more number of relays then the interference is reduces as well as power transmission is increased. So, there is a need to optimize the number of relays as well as decreasing the overall transmission power of system. In future, there is a need to carry research on optimum allocation of resource deployment in CRN.

REFERENCES

1. *O. Oyman, J. N. Laneman, and S. Sandhu, "Multihop Relaying for Broadband Wireless Mesh Networks: From Theory to Practice," IEEE Commun. Mag., June 2007.*
2. *IEEE 802.16 WG SG on Mobile Multihop Relay, "IEEE802 Tutorial: 802.16 Mobile Multihop Relay"; http:// www.ieee802.org/16/sg/mmr/docs/80216mmr- 06_006.zip*

3. *Usage Model Ad Hoc Group, "Harmonized Contribution on 802.16j (Mobile Multihop Relay) Usage Models," J. Sydir , Ed.; http://www.ieee802.org/16/relay/docs/ 80216j-06_015.pdf*
4. *IEEE P802.16j/D9, "Air Interface for Fixed Broadband Wireless Access Systems: Multihop Relay Specifications," restricted site; http://wirelessman.org/pubs/ 80216j.html*
5. *IEEE P802.16Rev2/D9, "Local and Metropolitan Area Networks Part 16: Air Interface for Broadband Wireless Access Systems," draft standard*
6. *Seetaiah Kilaru "**Ability of OFDMA in handling interference of femto cell under random access process**" in* **Journal of Engineering science and technology review (JESTR), 2014,** *ISSN 1791-2377*
7. *Seetaiah Kilaru, Y Ashwini Prasad, K Sai kiran, N V Sarath Chandra published "**Design and Analysis of Heterogenious networks**" in* **International Journal of Applied Engineering Research (IJAER),** *ISSN 0973-4562 Volume 9, Number 17 (2014) pp. 3197-3204*
8. *Seetaiah Kilaru, Dr Mazher iqbal "**Public Safety Communication using Relay Node in LTE-Advanced Technology**" was published in International Journal of Engineering Research and Technology (IJERT), ISSN: 2278- 0181*