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Modeling and Optimization of Self-Organizing Energy- Saving Mechanism for Het Nets

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***Abstract*- Smart and versatile wireless devices brings with them, an ever continuing challenge of finding efficient means for resource usage. Scope and avenues for capacity and coverage improvement in cellular networks are constantly explored. Deployment of small cells such as microcells, Pico cells, hotspots, and relays proved an effective solution to improve network coverage and capacity. However, this increase in performance occurs with the cost of deployment and maintenance of additional base stations. Another interesting solution to improve coverage and network capacity is the use of user equipment with relaying support. Currently, mobile devices are equipped with higher processing power and battery life and hence can act as relay nodes in idle slots for nearby users which have lower coverage. This project explores the possibility of user equipment deployed as relays node in heterogeneous networks and analyses the performance improvement for the same. And also analyses the energy efficiency aspect of such communication and show that using user equipment's as relay helps improving energy efficiency too. Obtained results are verified using extensive simulations.**

***Keywords*- Heterogeneous Network, UE, RUE, Micro-Cell, Pico-Cell, Femto-Cell, Coverage Optimization, Energy Efficiency.**

1. INTRODUCTION

Wireless communication networks are broadly deployed to provide different communication services such as voice, video, packet data, messaging, broadcast, etc. These wireless networks may be multiple-access networks capable of supporting multiple users by sharing the available network resources e.g., bandwidth and transmit power. Examples of such multiple-access networks include Code Division Multiple Access networks, Time Division Multiple Access works, Frequency Division Multiple Access networks, Orthogonal FDMA networks, Single-Carrier FDMA networks, Third Generation Partnership Project Long Term Evolution networks, and Long Term Evolution Advanced networks.

A wireless communication network may include a number of base stations that can support communication with a number of user equipment devices. A UE may communicate with a base station via the downlink and uplink. The downlink or forward link refers to the communication link from the base station to the UE, and the uplink or reverse link refers to the communication link from the UE to the base station. A base station may transmit data and control information on the downlink to a UE and or may receive data and control information on the uplink from the UE.

This communication link may be established via a single-input single-output, multiple-input single-output or a multiple-input multiple-output system. Wireless communication systems may comprise a donor base station that communicates with wireless terminals via a relay node, such as a relay base station. The relay node may communicate with the donor base station via a backhaul link and with the terminals via an access link. In other words, the relay node may receive downlink messages from the donor base station over the backhaul link and relay these messages to the terminals over the access link.

1. LTE-Advanced and Relaying

1.1 LTE-Advanced

The LTE-Advanced Release 10 is an evolution of LTE, which is to compliant with the IMT-Advanced requirements and targets. It aims to provide peak data rates of up to 1 Gbps for low mobility and 500 Mbps in DL and UL respectively. LTE-Advanced is required to reduce the user- and control-plane latencies as compared to LTE Release 8. It targets to achieve peak spectrum efficiency of 30 bps/Hz and 15 bps/Hz in DL and UL respectively.

Table 1. Comparison of LTE and LTE-Advanced Requirement

Parameter	LTE	LTE-Advanced
Peak Data Rates	100 Mbps in DL, 50-Mbps in UL	1Gbps in DL,500-Mbps in UL
Spectrum efficiency	5-bps/Hz in DL, 2.5bps/Hz in UL	30 bps/Hz in DL, 15 bps/Hz in UL
Bandwidth	20 MHz	Up to 100 MHz

Latency	U-plane 5-ms, C–Plane 50/100ms	Improved, C-plane 10/50 ms

It enables network sharing and handover with existing legacy radio-access technologies. LTE-Advanced also considers a low cost infrastructure deployment. It will allow the backhauling using LTE spectrum in order to reduce the cost per bit.

1.2 Relaying in LTE-Advanced

A relay is a specific kind of transceiver which repeats the signal of another base station usually to extend the effective coverage of the network. In figure 1.1 relays are operator deployed dbase stations positioned at strategic locations as to enable communication to users in extended regions. The primary aim of relay deployment is to improve capacity and coverage of heterogeneous network. This sharing of the spectrum results in increased interference to neighboring users. An out-of-band relay uses the spectrum that is orthogonal to the donor MBS. Consequently, this lowers the interference, but imposes a higher bandwidth requirement for system wide communication.

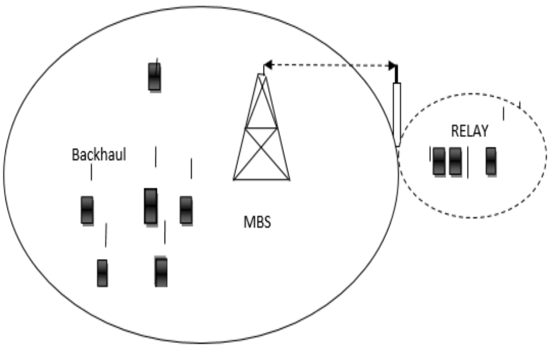

Figure 1. Relay node Network.

1.3 User Equipment Relays

The primary objective to use mobile device as relay is toextend cellular coverage whilst saving capital expenditure ofbase station deployment. An additional improvement in system capacity and energy efficiency is a plus. The motivation comesfrom the fact that if two devices are close to each other,they can communicate directly between themselves insteadof involving macro cell /Pico cell base station to route the call.

2. Relaying Advantages and Disadvantages

2.1. Advantages

1. The main purpose of relaying is to provide peak data rates in order to support high data services. Results show that Relay Enhanced Cell network has better downlink performance in terms of UE throughput as compared with single-hop eNB-only network.
2. RNs being a cost efficient deployment solution, gained the network operator interest. Due to less complex site planning, acquisition, cost-efficient and low power requirements, they can be easily mounted on structures like street lamp posts. Therefore, with low CAPEX/OPEX cost, REC networks outperform the eNB-only deployed network.

2.2. Disadvantages

1. In relaying, the DeNB utilizes the same radio resource pool among three links namely direct, relay and access links. Moreover, in band relaying, the relay and access link utilize the same radio resources through time-division multiplexing, therefore, limiting the RN performance. It creates high competition for the available radio resources at the DeNB, which requires an efficient and complex resource scheduling techniques.
2. RN possess small coverage area due to its low transmit power, low antenna gains and high path-loss exponent. Thus, less number of UEs will be connected to RNs, lead to inefficient utilization of resources as well as load imbalance between RNand macro base station. Moreover, RN-served UEs may also experience interference from high power transmission of macro base station.

3. Challenges in Rue Deployments

Here is discussing the challenges that exits when a UE acts as a relay for range extended UEs as to provide cellular connectivity. The major challenges that exists in implementation and operation of such devices are,

3.1 Implementation Challenge

A UE acts as a relay, it has to play the functionality of a base station for the E UEs to which it serves a connection to the network. And call those UEs in the extended region as Extended Region User Equipment's. For this, the protocol stack implementations in UEs need to be modified to provide this functionality.

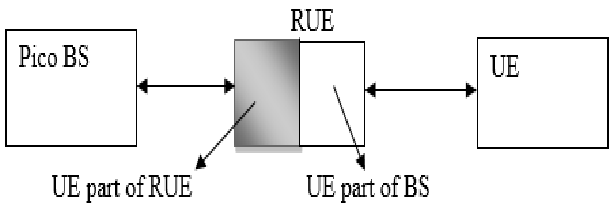

Figure 2 Relay UE Composition and Connection Model.

Explains the stack enhancements that can be done in UEs as to use them as relay. In figure2 while associating ERUEs with the RUE, suitable discovery mechanisms is one challenge, and the second challenge is how to effectively use the spectrum that can results in less interference and higher throughput. To analyses this, consider two options for unlink transmission viz. shared bandwidth and dedicated bandwidth.

3.2 Association/Discovery Challenge

In this section is discuss when a UE should start playing the role of Relay User Equipment and indicates its donor base station that it is in relay mode. Some discovery mechanism is also required to indicate availability of RUE to other UEs as a possible base station for association.

3.3 RUEas Base Station
Before any UE decides to play the role of RUE, following criteria should be considered. A RUE is a mobile device with limited battery constraints. Being a relay requires RUE to expend its energy consumption to transmit or receive data from other UEs or donor BS. This involves additional power to be expended on top of RUE's self-data communication requirements. Hence a UE can decided to play the role of a RUE whenever its power levels can support additional data transmission. Another criteria need to be considered for RUEs is mobility. A UE being mobile in nature poses a challenge to support additional devices. Hence a UE can decide to play the role of RUE when it could determine that its mobility will not hamper the communication of associated REUEs.

3.4 RUE as UE
Once a UE decides to play the role of a RUE, it should periodically transmit beacons that would enable nearby UEs to discover the RUE. Additionally, following features should be implemented in the protocol stack to maintain communication standards.

3.4.1Secured Environment- A UE can act as a RUE if it satisfies that all the necessary security protections are in place to protect the communication between RUE and REUE.

3.4.2 Access and Audit Control- All necessary functionalities are required to support authorized UEs to access the network through RUE. This can also help in tracking the amount of resources and bandwidth expended by RUE on behalf of REUEs and can be used for suitable reimbursement or credit for providing the RUE service.

3.4.3 Time bound Access- The RUE can define a duty cycle period, i.e. a period during which it would act as a relay to other UEs, while in the remaining time continue to behave as a UE and enable its own transmission. The period of duty cycle can be decided based on the factors such as mobility, power, security etc.

4. Problem Statement
Currently, mobile devices are equipped with higher processing power and battery life and hence can act as relay nodes in idle slots for nearby users which have lower coverage. The communication link between the user equipment and the base station experiences interferences due to several environmental factors such as distant dependent path loss, shadowing and multipath fading's, which degrade the network performance to provide high quality mobile services.

The expected solutions are to increase the base station transmit power or decrease the UE-infrastructure distance by increasing base station density in the existing network. However, a network operator would reluctant to deploy more base stations due to implementation and maintenance costs. To that end, relaying is emerging as one of the rising radio access techniques, which provides a cost effective solution as well as decreases the UE-Infrastructure distance by deploying low-power base stations known as Relay node, with the macro network. It ensures to provide coverage gain and improved quality of service in cell edge and indoor environments and also analyses the energy efficiency aspect of such communication and show that using user equipment's as relay helps improving energy efficiency overly.

5. Research Objective
The main motto of this project is to explore user equipment deployed as relays node in heterogeneous networks and analyses the energy efficiency aspect of such communication and show that using user equipment's as relay helps improving energy efficiency too.

- To use mobile device as relay is to extend cellular coverage whilst saving capital Expenditure of base station deployment.
- To analyses the possibility of using user equipment as relay to improve Performance of cell edge users.
- To suggest a time based resource partitioning method for relay user equipment to handle Cross-tier interference.
- To simulate the SINR and bit rate received at UEs.
- To compare performance, two scenario viz. macro only and macro plus Pico Deployment is considered as baseline.

II. LITERATURE SURVEY

Mary Adedoyin et al: In this paper, they have proposed a Self-Organizing Radio Resource Allocation Algorithm (SORRAA) for two-tier net- works. The performance of the proposed algorithm has been evaluated and compared with that of existing algorithms. Simulation results show that the proposed algorithm has a better performance, in terms of interference mitigation, improvement in the overall network throughput, and enhancement of transmit power efficiency.

Jin Li et al: In this paper, we propose a resource allocation optimization mechanism to minimize mean packet transmission delay in 3D cellular network with multi-layer UAVs. Numerical results demonstrate effectiveness of the proposed algorithm, where optimal spectrum and power allocation can provide minimum packet transmission delay.

Jiang Huilin et al: This paper first proposes a centralized CRE bias adjusting algorithm based on Gibbs sampling to achieve the optimal solution of cell-specific CRE bias based on global information. After that, decentralized Gibbs sampling based CRE bias adjusting algorithm without the need of the entire knowledge of global channel gains is designed to deal with the computational

complexity and message exchange overhead problem caused by scale expansion of UDN. Finally, to further reduce the increasing computational complexity, message exchange overhead and time complexity caused by scale expansion of UDN, this paper constructs a neighbor graph based on the mutual bias influence among cells, develops a graph coloring based clustering algorithm to classify cells into groups and proposes a central aided distributed CRE bias adjusting algorithm to obtain optimal solution of the rate-related utility optimization problem based on local information
.

Wenjie Chen et al: This paper explores how the coverage performance and the energy efficiency of heterogeneous small cell network vary with the SBS deployment density. Firstly, based on PPP and statistical geometry theory, the analytical expression of the success probability for each tier is derived under disjoint sub-channel allocation scheme. Then the energy efficiency optimization problem is formulated for the system model in terms of the throughput performance and the resource allocation fairness. Base on the theoretical analysis, numerical simulation results show that the relationship between the coverage performance and the nodes deployment density in the corresponding tier. And an optimal pico-femto density ratio is identified that maximizes the energy efficiency of the two-tier heterogeneous cellular. In general, this paper provides guidance to us on improving the performance of heterogeneous small cell network by adjusting the nodes deployment density in it.
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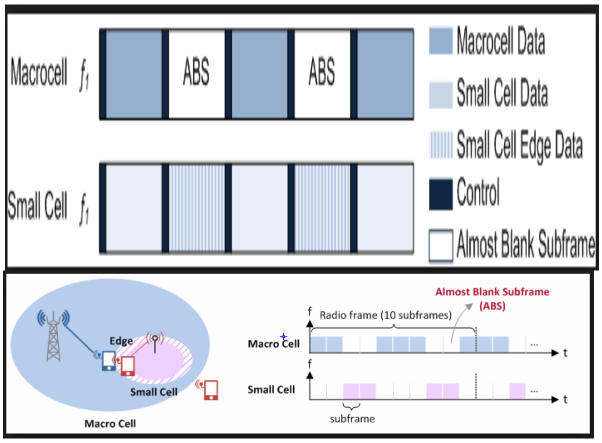
Rajkarn Singh et al: Propose that to protect these macro-cell VUEs, macro-cells and pico-cells should operate in a cooperative manner, such that not only macro-cells should use ABS, but pico-cells should also use ABS to provide interference-free resources. We also introduce the concept of universal blanking pattern to coordinate among various base stations. We propose two methods for joint ABS density calculation for macro-cells and pico-cells bitrate utility based optimization and physical resource block (PRB) allocation ratio-based formulation.

Xiaojuan Wang et al: The paper presents a joint optimization algorithm for coverage and capacity in heterogeneous cellular networks. A joint optimization objective related to capacity loss considering both coverage hole and overlap area based on power density distribution is proposed. The optimization object is a NP problem due to that the adjusting parameters are mixed with discrete and continuous, so the bacterial foraging (BF) algorithm is improved based on network performance analysis result to find a more effective direction than randomly selected. The results of simulation show that the optimization object is feasible gains a better effect than traditional method.

III. PROPOSED METHODOLOGY

In this section, propose a time based resource partitioning method where in one set of devices are allowed to transmit in certain sub frames and the rest in the remaining sub frames so that there transmission never overlap. Thus, able to mitigate interference by achieving time domain orthogonality in spectrum access. In figure 3.1 this technique is also referred as Inter Cell Interference Coordination using Almost Blank Sub frames.



Almost Blank Sub frame .

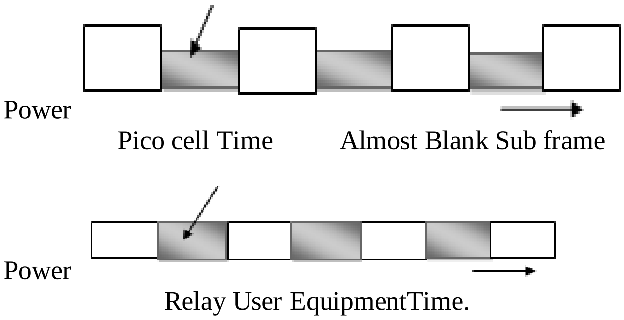


Figure 3 Almost Blank Sub-Frames

1. Inter Cell Interference Co-ordination Mechanism

The enhanced Inter-Cell Interference Coordination in heterogeneous networks introduced in LTE-Advanced has been a hot topic lately as without an efficient inter-cell interference scheme the range extension concept loses its advantage and efficiency. The problem with ICIC schemes in releases 8 and 9 was that they were only considering data channels and did not focus on the interference between control channels, so LTE release 10 solves this problem with the solutions in the following subsections.

2. Time Domain Multiplexing ICIC Scheme

In this approach transmissions from Macro-eNBs inflicting high interference onto Pico-eNBs users are periodically muted or stopped during entire sub frames, this way the Pico-eNB users that are suffering from a high

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level of interference from the aggressor Macro-eNB have a chance to be served.

3. Performance Metrics

In this section discusses the performance metrics for the proposed dynamic allocation system. In this section discusses the some proposed formula to calculate the maximum throughput and less energy consumption after deployment the system resources.

4. Round Robin Scheduler

Round robin is a simple scheduling method that is based on assigning the resources to the terminals in turn, one after another, which means that all the users have equal chances to be scheduled without considering their channel quality indicator which is explained in the flow chart in Figure 3.2.

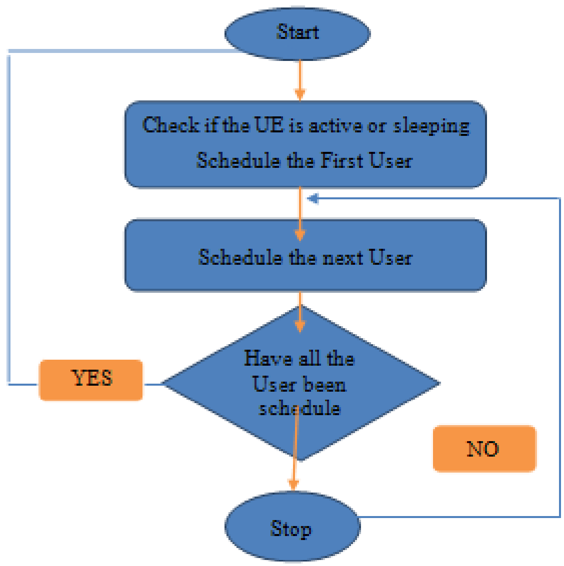

Figure 4: Flow chart explaining the round robin scheduler

IV.SYSTEM MODEL AND DESIGN

This network model consists of three interfering Macro cell Base Station providing coverage in a given geographical area. Additionally, in order to handle hotspot data demands, Pico cells Base Stations are deployed on cell edges. Both PBSs and User Equipment's are distributed as Homogeneous Spatial Poisson Point Process in the region. All PBSs are assumed be in Open Access mode i.e. they can serve any UE under their coverage.

4.2 Orthogonal Frequency Division Multiple Access

Orthogonal Frequency Division Multiple Access is a multiple access technique, exploiting the OFDM characteristics. OFDM allows only one user to use the system bandwidth for a given time. While OFDMA is multi-user OFDM, that enables the orthogonal subcarriers scheduling among multiple users at the same time, in order to efficiently utilize the radio resources.

4.3 Downlink Resource Scheduling

Scheduling is a process to efficiently utilize the network radio resources among the multiple UEs. In dynamic scheduling the radio resources are assigned to UEs per TTI.

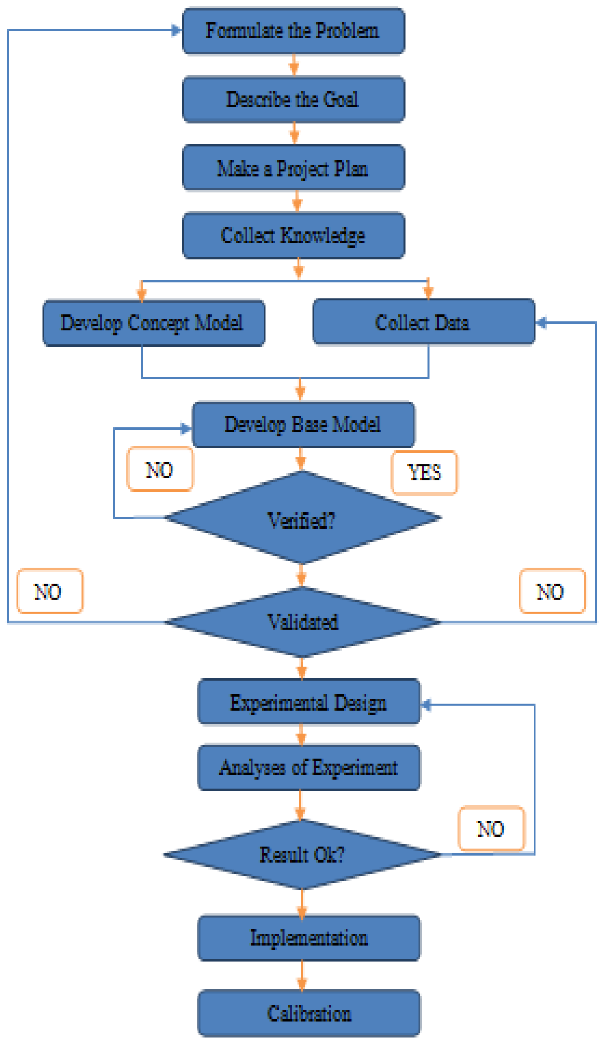

Figure 5: Flow diagram of the proposed model

Channel Quality Indicator (CQI) is a parameter which is a UE feedback on the basis of downlink reference signal from eNB. It enables the eNB to exploit an appropriate modulation and coding scheme for specific downlink channel conditions. It also informs the eNB about the UE's receiver characteristics. The CQI is calculated for each code word on either the full transmission bandwidth configuration or Wideband CQI or on groups of resource blocks known as sub-bands. It can be also used to calculate the wideband Signal-to-Interference plus Noise-Ratio. In figure 4.1 gives an overview for CQI procedure between UE and eNB.

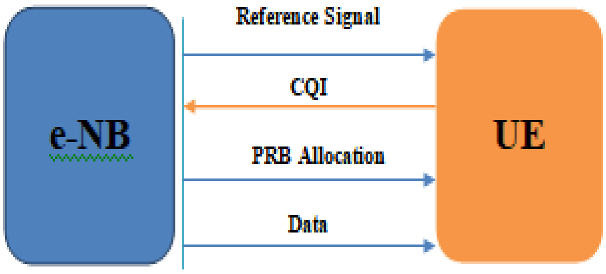

Figure 6 down link resource schedule.

4. Relay Categorization
The RN categorization can be done according to different measure as follow;

4.1. Amplify-and-forward and Decode-and-forward relaying

4.1.1. Amplify-and-forward Relaying- The Amplify-and-forward is a full duplex relaying, amplifying a signal received from the first hop and retransmits to the second hop. AF possesses a drawback of amplifying the interference and noise with desired signal which deteriorates the overall SINR level as well as limits the system throughput.

4.2.2. Decode-and-forward Relaying: On the other hand, Decode-and-forward is a relaying technique, where the entire received signal from first hop is decoded and retransmit to second the receiver.

5. Infrastructure Based Relaying
RN can be classified from the deployment perspective, where the coverage is required. During the UE mobility within the network, RN may go through different usage models in network.

5.1. Protocol Based Relaying

5.1.1. Layer 1 RN- Layer 1 RN may be considered as an analogue repeater or booster, possesses part of physical layer functionalities. It simply receives the DeNB signal, amplify it and retransmit to UE.

5.2.2. Layer 2RN- This type of RN incorporates the Layer 2 functionalities, i.e. medium access control layer. It provides a higher link quality in the RN coverage area by decoding the received signals from DeNB, re-encode it and retransmit it to UEs.

5.2.3. Layer 3 RN- A Layer 3 RN includes all the eNB protocol functionalities. Layer 3 RN use a normal LTE air interface to connect with eNB rather than using an expensive microwave backhaul link.

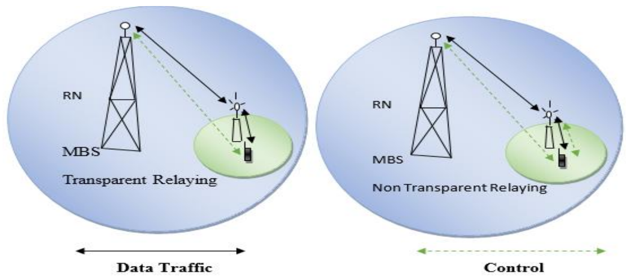

Figure 7 Transparent and Non Transparent Relaying.

IV. UE KNOWLEDGE BASED RELAYING

Relays can also be classified according to the UE's knowledge as follow;
1. Transparent RN-In transparent relaying, UE is unaware of, whether the communication with e-NB is done directly or via a RN, while the UE is present in e-NB coverage area as shown in figure 4.2.
2. Non-transparent RN- In non-transparent relaying, UE is aware the communication with e-NB is carried out via a RN as shown in figure 4.2

V.SIMULATION RESULTS & DISCUSSION

1. Simulation Tool (Net-Beans)
NetBeans is an integrated development environment for developing primarily with Java, but also with other languages, in particular PHP, C/C++, and HTML5. It is also an application platform framework for Java desktop applications and others. The NetBeans IDE is written in Java and can run on Windows OS.

The Net Beans Platform is a reusable framework for simplifying the development of Java Swing desktop applications. The NetBeans IDE bundle for Java SE contains what is needed to start developing NetBeans plug-in and NetBeans Platform based applications; no additional SDK is required. Applications can install modules dynamically. Any application can include the Update Centre module to allow users of the application to download digitally-signed upgrades and new features directly into the running application. Reinstalling an upgrade or a new release does not force users to download the entire application again.
The platform offers reusable services common to desktop applications, allowing developers to focus on the logic specific to their application. Among the features of the platform are;

- User interface management e.g. menus and toolbars
- User settings management
- Storage management or saving and loading any kind of data
- Window management

- Wizard framework (supports step-by-step dialogs)
- NetBeans Visual Library
- Integrated Development Tools

2. Discrete Event Simulation (Overview)

A discrete event simulation, models the operation of a system as a discrete sequence of events in time. Each event occurs at a particular instant in time and marks a change of state in the system. Between consecutive events, no change in the system is assumed to occur; thus the simulation can directly jump in time from one event to the next. This contrasts with continuous simulation in which the simulation continuously tracks the system dynamics over time.

Instead of being event-based, this is called an activity-based simulation; time is broken up into small time slices and the system state is updated according to the set of activities happening in the time slice. Because discrete-event simulations do not have to simulate every time slice, they can typically run much faster than the corresponding continuous simulation. Another alternative to event-based simulation is process-based simulation. In this approach, each activity in a system corresponds to a separate process, where a process is typically simulated by a thread in the simulation program. In this case, the discrete events, which are generated by threads, would cause other threads to sleep, wake, and update the system state. In addition to the logic of what happens when system events occur, discrete event simulations include the following:

1. State- A system state is a set of variables that captures the salient properties of the system to be studied. The state trajectory overtime S (t) can mathematically represented by a step whose values change in correspondence of discrete events.

2. Clock- The simulation must keep track of the current simulation time, in whatever measurement units are suitable for the system being modelled. In discrete-event simulations, as opposed to real-time simulations, time ‘hops’ because events are instantaneous the clock skips to the next event start time as the simulation.

3. Events List- The simulation maintains at least one list of simulation events. This is sometimes called the pending event setbecause it lists events that are pending as a result of previously simulated event but have yet to be simulated themselves. An event is described by the time at which it occurs and a type, indicating the code that will be used to simulate that event. It is common for the event code to be parameterized, in which case, the event description also contains parameters to the event code.

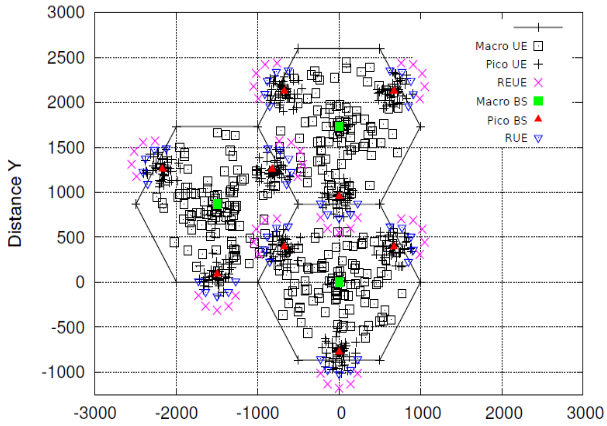

Figure 8: A sample distribution used in simulation tests.

This simulation scenario consists of three interfering macro cells base stations providing coverage in the region. Each MBS supports three PBSs at the cell edge.

Additionally, few cell edge UEs are selected as RUE to support other UEs in the extended region. At least 20% UEs are assumed to be deployed inside homes/offices. UEs are distributed in the covered region as SPPP. UEs are in full buffer traffic model i.e. they always have some data to send. Only downlink data transmission is considered in our case. In figure 5.1 discrete event simulations are performed with snapshots are taken after fixed time interval. All values are obtained by averaging over 600 iterations for 98% confidence interval. Rest of the simulation parameters are given in Table 5.1.

Table 2. Simulation parameters

Parameter	Value	
Bandwidth	10 MHz	
No. of Sub channels	256	
MBS Transmit Power	46dBm	
UE Transmit Power	23dBm	
Wall Loss	10 dB	
Gaussian Noise Figure	-174dBm/Hz	
UE Power Consumption	1Watt	
Zero-Load MBS Power Consumption	500 Watt	
Zero-Load PBS Power Consumption	150 Watt	
Path Loss Coefficient	Macro cell Pico cell Relay UE	2 2.5 2.5
Antenna Gain	Macro cell Pico cell User Equipment	14 dB 7 dB 0 dB

International Journal of Scientific Research & Engineering Trends
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4. Simulation Results

To analyses the performance of the technique, here is compare the SINR and bit rate received at UEs. To compare performance, two scenario viz. macro only or M and macro plus Pico or MP deployment are considered as baseline.

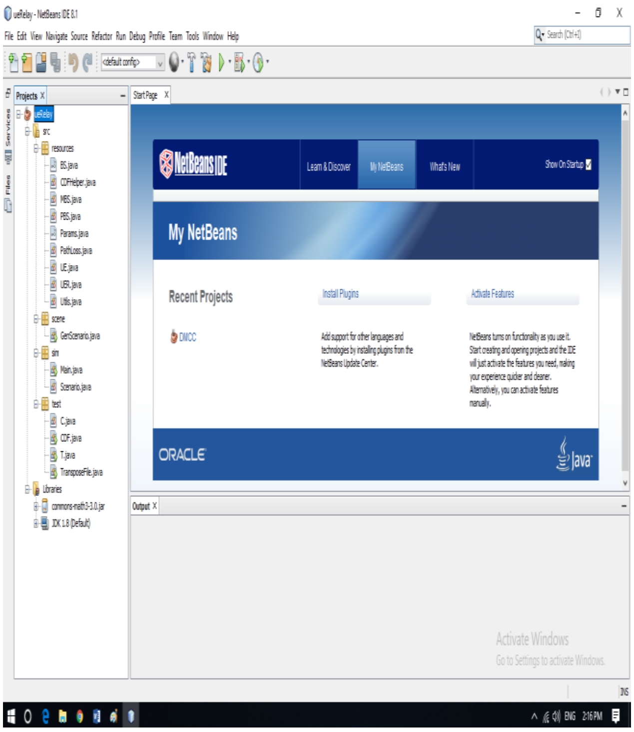

Figure 9: Simulation Software Environment

As above depicted figure 5shows that the simulation software environment window.

Table 3: Throughput Vs Number of UE Relay

UE Relay	ECR (Watt)		
	M (Macro)	MP (Macro + Pico)	MPR (Macro + Pico + Relay)
5	0.3117	0.3220	0.3050
10	0.3329	0.3189	0.2955
15	0.3335	0.3051	0.3016

As above depicted table 5.2 and table 5.3 shows that values of throughput and energy consumption rate in watt with increasing number UE relay circuit. As above depicted table 5.2 shows that the value of throughput with increasing number of UE relay by using different cells i.e. (M) Macro, (MP) (Macro + Pico) and MPR (Macro + Pico + Relay).From this table 5.2 conclude that the proposed MPR method gives better throughput as compare to other M and MP method. As above depicted table 5.3 shows that the value of ECR with increasing number of UE relay by using different cells i.e. (M) Macro, (MP) (Macro + Pico) and MPR (Macro + Pico + Relay). From this table 5.3 conclude that the proposed MPR method gives less energy consumption as compare to other M and MP method.

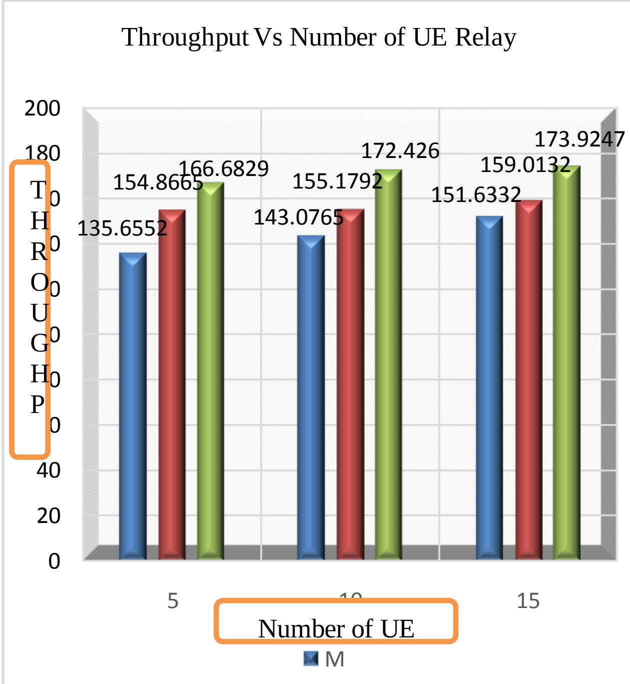

Figure 10 Throughput vs. Number of RUEs

As above depicted figure 5.3 shows that the value of throughput with increasing number of UE relay by using different cells i.e. (M) Macro, (MP) (Macro + Pico) and MPR (Macro + Pico + Relay). From this figure 5.3 conclude that the proposed MPR method gives better throughput as compare to other M and MP method.

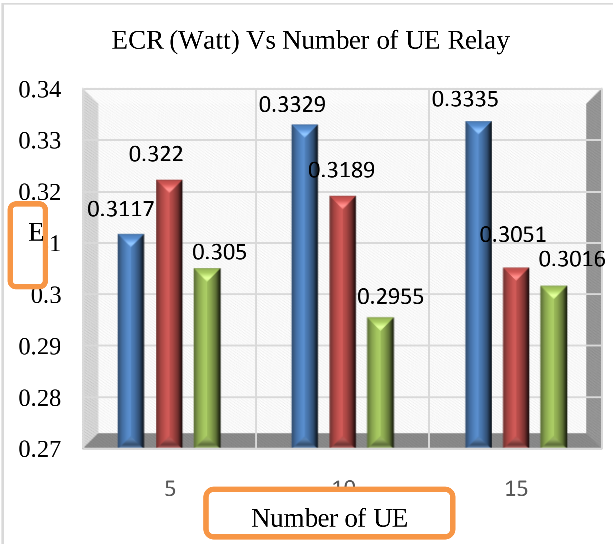

Figure 10: ECR (Watt) vs. Number of RUEs

As above depicted figure 5.4 shows that the value of ECR with increasing number of UE relay by using different cells i.e. (M) Macro, (MP) (Macro + Pico) and MPR (Macro + Pico + Relay). From this figure 5.4 conclude that the proposed MPR method gives less energy consumption as compare to other M and MP method. RUE deployment, more and more users now able to communicate whilst is improving overall network utilization. With slight loss in RUE throughput, not only able to support more users but also reduce per user energy expenditure. Consequently, this improvement in throughput is clearly visible in figure 5.3 and table 5.2, where can see huge gain in system capacity is observed for suggested technique. Additionally, now more UEs are served using RUE, no additional power.

In figure 5.4 and table 5.3, Consumption is involved at BS, thereby improving energy efficiency of the system. Here is also analyses the lifetime of RUEs and found that average life time of RUEs reduced by just 10% and also analyses the blocking probability of the system. As RUE able to support additional UEs in extended region, the overall blocking probability of the system also greatly improved. For deployment scenario, initial blocking probability of 5.6% drop down to as low as 0.23 percentages.

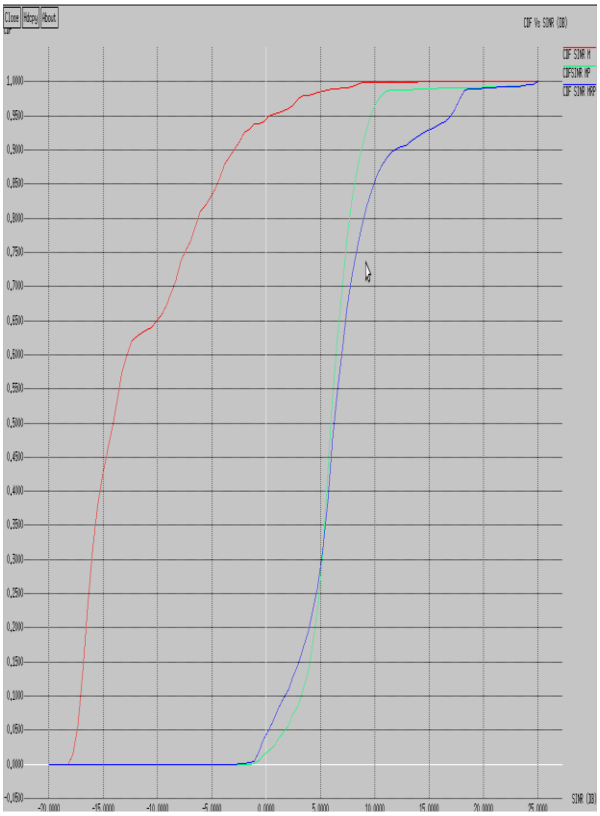

Figure 11 CDF of UE SINR

To analyses the performance of the technique, here is compare the SINR and bit rate received at UEs. To compare performance, two scenario viz. macro only or M and macro plus Pico or MP deployment are considered as baseline.

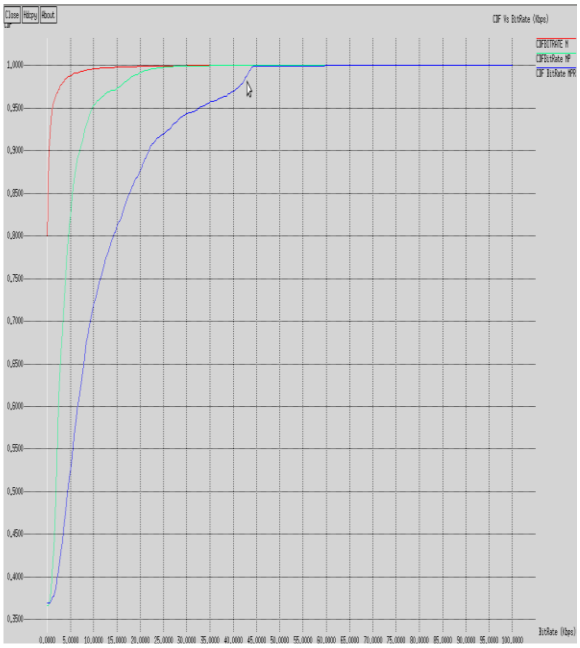

Figure12: CDF of UE Bitrate.

Figure 5.5 and 5.6 depicts the CDF of SINR and CDF of received bit rate at UEs, respectively. As can be seen, the CDF of UEs for proposed allocation technique outperforms the macro only and macro + Pico deployment scenario. In fig 5.5 is show that UE SINR of MPR or Proposed technique is better as compare to MP and M.

VI. CONCLUSION

Deployment of Relay User Equipment's in a heterogeneous network not only shows improvement in coverage and capacity of the network, but also helps in decreasing networks' energy consumption. While the current simulation is done with fixed almost blank frame density, the same can be made dynamic based on system load and relay node availability. Combined with the efficient discovery algorithms, let's see relay user equipment as a natural extension for heterogeneous cellular networks to improve capacity and coverage.

VII. FUTURE SCOPE

In future work, try to explore the possibility of dynamic slot size selection for time based allocation whilst incorporating unlinks data transmission in the scenario.

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