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Coverage Optimization in Heterogeneous Networks Using UER

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ABSTRACT- The main motto of this paper 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 and to use mobile device as relay is to extend cellular coverage whilst saving capital expenditure of base station deployment. Analyses the possibility of using user equipment as relay to improve Performance of cell edge users and suggest a time based resource partitioning method for relay user equipment to handle Cross-tier interference. 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.

KEYWORDS: Heterogeneous Network, Coverage Optimization, UER

I. 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. Similarly, the relay node may receive uplink messages from the terminals over the access link and relay these messages to the donor base station over the backhaul link. The relay node may, thus, be used to supplement a coverage area and help fill coverage holes.

II. PROPOSED TECHNIQUE

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. This technique is also referred as Inter Cell Interference Coordination using Almost Blank Sub frames.

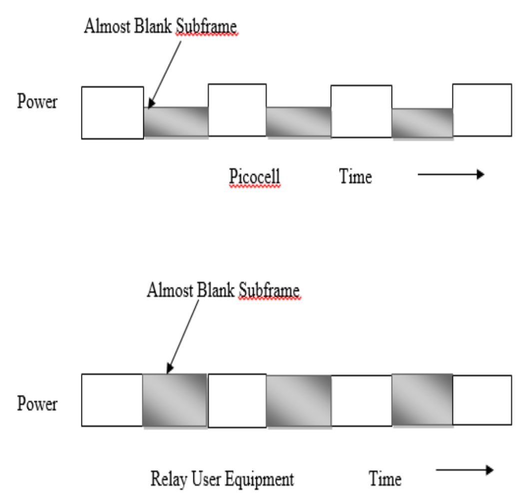

Figure 1: ICIC Scheme

1. Proposed Formula to Calculate the Maximize Throughput of Relay Deployment

In this technique, divide the available wireless resources into two partitions. First partition of FABS = αF subframes are reserved exclusively for REUEs' transmission as to protect their signal quality. While the remaining F_{nABS} = F $-F_{ABS}$ subframes are reused by MBS, PBSs and RUEs to serve their UEs. To protect the signal quality of macro and pico UEs, perform sub-channel power control over F_{nABS} subframes for REUEThe aim is to maximize throughput of relay deployment by solving the following optimization problem,

Maximize

$$\Gamma_j^k \quad \sum_{K=1}^{N_R}\sum_{J=1}^{N_U^k}\frac{F_{nABS}}{N_U^k}\log_2\left(1+\Gamma_j^k P_{tx}^k H_j^k\right)$$

$$\text{Subject to,} \quad \sum_{k=1}^{N_R}\Gamma_j^k P_{tx}^k H_j^k \le I_{max} \qquad \forall_j$$

$$\Gamma_j^k \ge 0 \qquad \forall_{j,k}$$

Where N_R and N_U^k represent to total number of RUEs and number of REUEs in k^{th} RUE, respectively.H_j^k Represent to path loss. Γ_j^k is the non negative power factor that is applied to each UE of RUEs to perform power control over F_{nABS} subframes. To solve this problem, here is convert it into Lagrange's dual problem and find out the power factor values for each REUE.

In the following example a round robin scheduler is considered where Macro-eNB users and center pico eNB users are only allowed to be scheduled in the non-ABS while the range extension Pico-eNB users are only allowed to be scheduled in the ABS. The constraint on the center Pico-eNB users is introduced for simplicity and to allow the range extension users some fairness in using the ABS because in reality ABS are shared between center and range extension Pico-eNB users and it becomes harder to determine which users are scheduled in the ABS. And an introduction about 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.

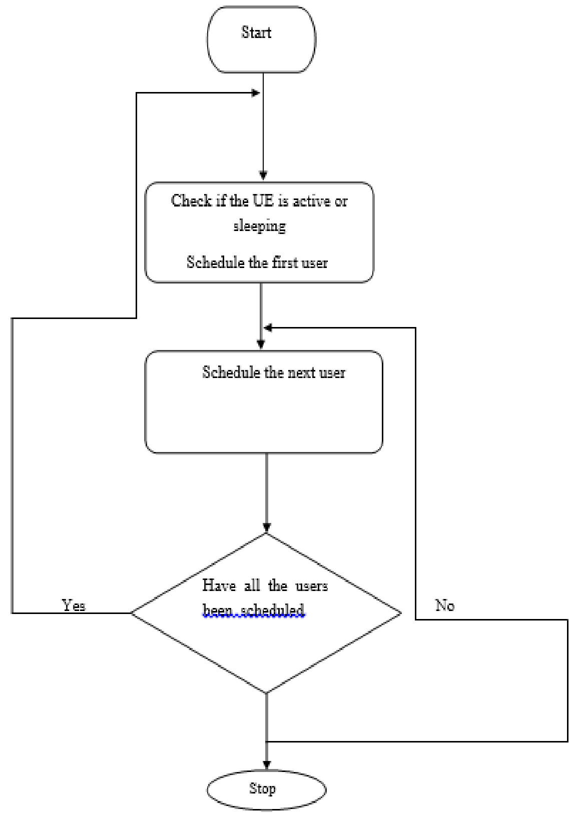

Figure 2: Round Robin Scheduler

2. Flow Diagram of the Proposed Model

I. Formulate the problem is detected by using a formula.

II. Describe the energy efficiency and throughput is the key goal in this phase.

III. Make a project plan the events of the simulation to achieve the goal.

IV. Collect Knowledge collect knowledge from survey papers.

V. Develop concept model Using ABS Technique the concept model is developed in heterogeneous networks.

VI. Collect data for the SINR and Throughput are collected.

VII. Develop bas model the base model is developed depending on proposed technique.

VIII. Experimental design simulates the developed scenario depending on various scenarios and users.

IX. The experiment design is analysed.

X. Implementation and calibration the developed model is implement and standardized according to the need.

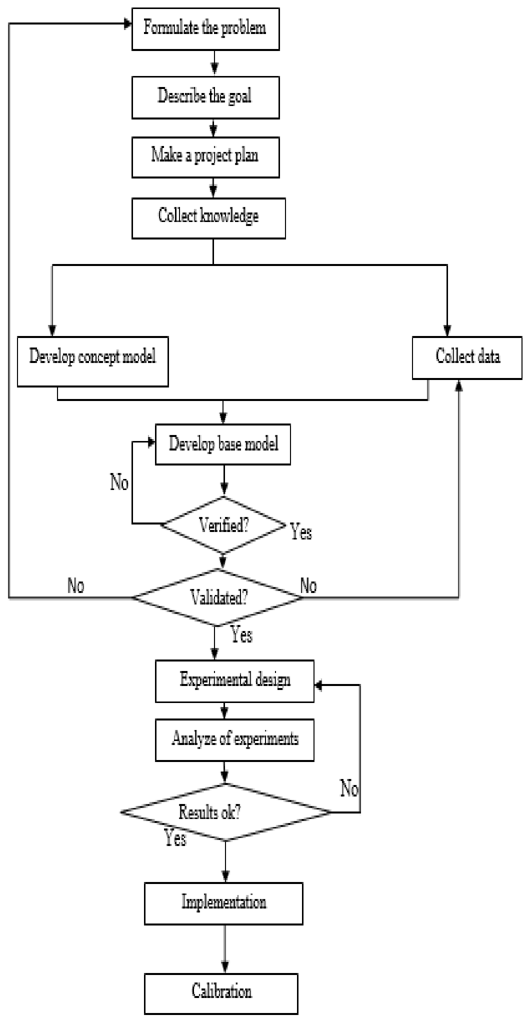

Figure 3: Flow Chart for Proposed Method

3. Channel and Interference Model

Considering OFDMA and Rayleigh flat fading sub channels, inter-channel interference is assumed to be negligible. In Reuse 1 case, the downlink Signal to Interference plus Noise ratio, SINR $\Upsilon_{m,j(d)}$, of UE j when connected to BS m over a distance d is given by,

$$\Upsilon_{m,j(d)} = \frac{P_{tx,m} S_j^m}{\sum_{l=1,l\neq m}^{N_{MBS}} P_{tx,l} I_j^l + \sum_{t=1,t\neq m}^{N_{PBS}} P_{tx,t} I_j^t + N_0}$$

Where S_j^m is the signal gain between UE_j and base station m. Similarly I_j^l is the effective interference loss at UE_j from base station l. N_0 represents the adaptive white Gaussian noise with zero mean.

Based on the received SINR at user, an instantaneous bitrate is assigned using the following formula

$$\textbf{Bitrate} = N * W * \log_2(l + \Upsilon_{m,j(d)})$$

Where N is the number of sub channels assigned to UE_j and W is the bandwidth of each sub channel.

4. Energy Consumption

In this section, the total energy consumption of the system has been evaluated. This model consists of two different types of base stations viz. MBS/PBS and RUE. MBS and PBS serve quite large number of users over much higher distance. Energy consumption of MBS/PBS is considered to be load dependent with some fixed "zero-load" power loss. While, RUE is assumed to serve only a small number of UEs over much smaller distance 10-15 Meters. Due to this, their energy consumption is assumed to linear with offered load. Energy consumption of MBS/PBS can be calculated using the following equation,

$$E_{MBS} = E_{zero} + \left(\frac{Tm}{\varsigma PA} + P_{SP}\right)$$

Where E_{zero} is fixed "Zero Load" energy consumption and ςPA, P_{SP} represent power amplifier efficiency and signal processing loss, respectively? Here Tm is the total power at which base station transmission is done. In order to analyze energy efficiency of the system, Energy Consumption Rating has been used as energy efficiency metric. This metric gives the energy consumption normalized to capacity (Watts/Mbps) [40].

ECR = System Capacity/Energy Consumption

5. Allocation Challenge

As seen earlier, a relay BS can either work in in-band mode or in out-of-band mode. Since UEs are generic equipment's, the support required in them to handle multiple bands poses a challenge. Hence, it is a natural choice to reuse the spectrum that is used between the RUE and the donor base station. UEs, being power restricted, are designed to use lower frequency bands for uplink transmission to the base station while higher frequency bands are reserved for its downlink transmission.

When a UE decides to be an RUE, it can adopt one of the following options

1. **High Frequency Transmission**
2. **Low Frequency Transmission**

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III. RESULTS AND DISSCUSSION

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**

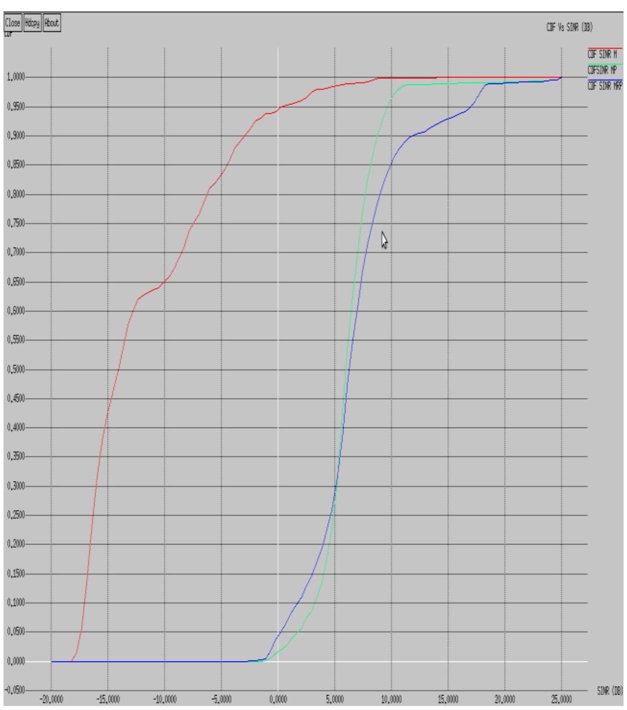

Figure 4: CDF of UE SINR

To analyze 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. In these figures 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 figure is show that UE SINR of MPR or Proposed technique is better as compare to MP and M.

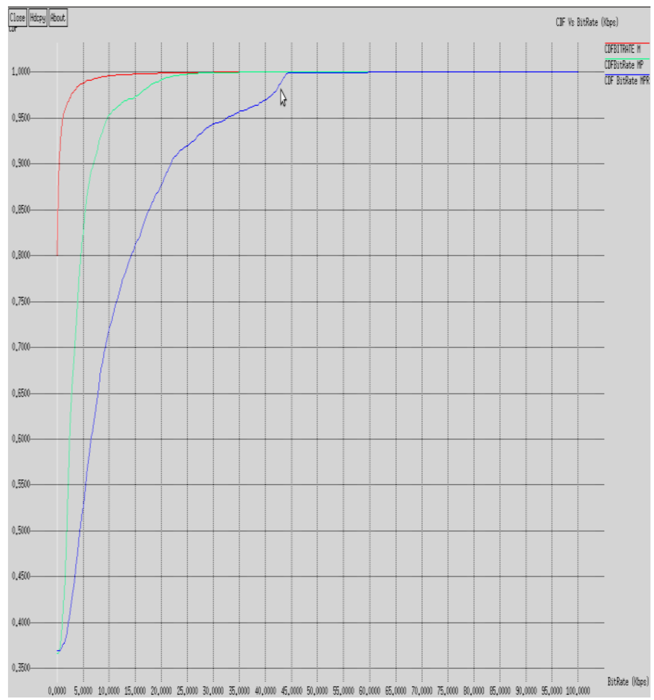

Figure 5: CDF of UE Bitrate

In figure is show that UE bit rate of MPR is better as compare to MP and M.

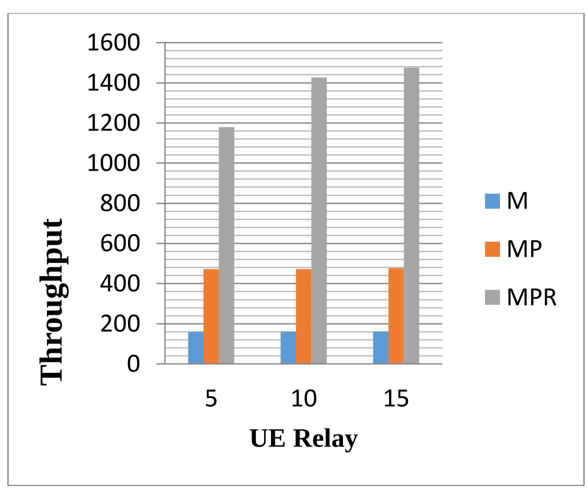

Figure 6: Throughput vs. Number of RUEs

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, where can see huge gain in system capacity is observed for suggested technique. Additionally, now more UEs are served using RUE, no additional power.

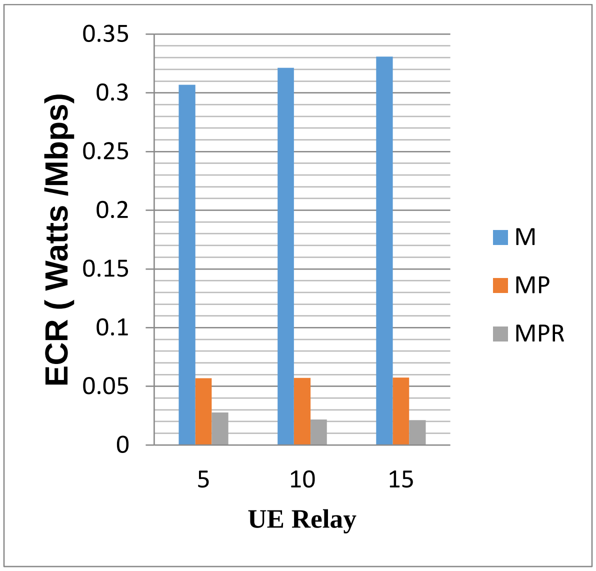

Figure 7: Energy Consumption Rating vs. Number of RUEs

In this figure 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.

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.

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