ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 7, Issue 2, February 2019

Throughput Enhancement in LTE Network Using Enhanced Genetic Algorithm

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ABSTRACT: Femtocells are developed as a possible solution to diminish the intramural coverage holes and to handle increasing traffic needs in Long Term Evolution (LTE) networks. 'Cell range expansion' (CRE) is the significant component of LTE advanced, where low-power nodes in a diversified network increase their coverage area. Therefore, neighbor cells offload to specific users. The total expansion, however, varies from one cell to another contingent on the locality of the low-power node concerning the cell load and the neighbor cells. In that circumstance, issues like sharing the nodes equally amongst the lower-power nodes (femtocells) and the macrocells arises. A technique is proposed for sharing loads of femtocells with the macrocells utilizing CRE. The above technique augments the 'Almost Blank Subframe' (ABS) and cell range with the use of Enhanced Genetic Algorithm (EGA) for effective load sharing between femtocells and macrocells. The solution acquired from EGA is utilized in sharing the loads equally within a macro-femto network. Experimental results clearly state that the technique which is proposed produce better throughput and outperforms other conventional techniques.

Keywords: Networks, Cell Range Expansion, Throughput, Long Term Evolution, Femtocells, Evolutionary Algorithm

I. INTRODUCTION

A huge commercial prosperity and technological development emerged in wireless network in the previous two epochs. In the forthcoming years, the normal cellular structures are not adequate to acquire the traffic needs. Therefore, '3G Partnership Project' (3GPP) LTE is proposed to establish a novel technology component that meets the requisites of data demand in future [1].

The regulating 4G augments the capacity of radio mobile system in existing cellular networks and compensates the service requisites for prospective user demand, is regarded as LTE [2]. All LTE's inclusive nature makes it perfect for the incorporation of diverse mobile communication technologies. However, augmenting network traffic raises the demand for limited network resources and energy usage [3].

To meet an anticipated noteworthy growth in mobile data and to expand the network capacity and performance, the migration from traditional homogeneous Macro only networks to a more diverse heterogeneous network is necessary. Cellular networks are highly heterogeneous in two diverse dimensions [4]. Firstly, in the traffic supply dimension, the heterogeneous centered network architectures, with small cells (namely femtocells and picocells) layered upon traditional macrocells. Secondly, from the traffic demand side, new applications with diversified traffic patterns are emerging every day with the propagation of smart gadgets (e.g., smart phones, tablets, smart watches, etc.) [5].

3GPP is investigating the real deployments of lower-power base station (BS) and relay nodes in an overlay integrated with the macro and microcellular network as a way to augment system capacity and ameliorate network coverage within the LTE. It defines a network formed by macro, pico, micro, together with femtocells normally as a heterogeneous network [6]. The traditional macro eNBs have limitations in intramural coverage and throughput of hot

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Vol. 7, Issue 2, February 2019

spots. To increase the indoor coverage and the throughput of hot spots, possible solutions in HetNets (in which femtoeNBs, macro eNBs, relay eNBs and picoeNBs are possibly included) were broadly investigated [7].

The data traffic originates from intramural environments like homes or offices. Consequently, the improvement in the intramural coverage and entire network capacity, at a rational cost is accomplished by cellular operators [8]. This issue was previously resolved by raising the total of BSs, but such tactic is never possible in future as there is certainly no scalability. Immense femtocell disposition is proposed to face intramural traffic [9]. Femtocells are an auspicious solution for establishing the high intramural capacity and coverage, which assist to diminish congestion issues in overladen macrocells. Femtocells are less-power BSs utilizing cellular technology on licensed spectrum delivering capacity and coverage intramurals through internet-grade backhaul under operator management [10].

Small cells proffer added capacity yet they bring new difficulties to resource and interference management. However, strong structural isolation and less femtocell transmission power due to barriers discharge the interference issue betwixt extramural macro and intramural femto layer also, betwixt diverse femtos [11]. CRE association biases handoff boundaries in favor of small cells so that it expands the service area of small cells. CRE mitigate the interference and enhance the LB (load balancing) in the network [12].

The EGA is utilized to enhance the Femtocell extend and macrocell ABS rate. The finest fitness value is attained and sorted by enhancing the ABS and Cell Range for all the populace. Now, as of the sorted list, the best 50% of the fitness is selected, and these go through mutation along with crossover. Then, the solutions are refreshed which offers the end solution. For utilizing this streamlining computation, the clients in the cell are effectually allocated with no aggravation.

The structure of the paper is organized as: Section 2 provide the literature survey. In sections 3, the proposed methodology is presented and section 4 discuss about results.

II. LITERATURE REVIEW

The related researches that are with regard to the proposed work are elaborated in this section as described below.

Raman Paranjape and Diego Castro-Hernandez [13] implemented a contrastive analysis of the performance of three LB algorithms. They estimated the effectiveness of those algorithms in view of a typical 2-tier HetNet deployment subject to a realistic traffic distribution and considering the influences of user mobility on the LB process. Those three LB algorithms were proffered with similar performance in concerning fairness in the allocation of the load and macrocell offloading. Normally, an average of one-third of the macro cell load gets offloaded to microcells that result in a reasonable allocation of the demanded load across several BSs. Consequently, high data rates were attained. But, the improvements in spectral efficacy weren't as large as conveyed in preceding studies, where steady-state assessments were made.

Sonia et. al [14] suggested an LB strategy centered on traffic scheduling. Several Traffic scheduling algorithms were considered earlier to allow shared resources amongst users to utilize the LTE systems' performance in an effectual manner. Three sorts of algorithms contrasted, concerning their respective performance were FCFS ('first come first serve'), RR ('round robin') and hybrid algorithm which were the mixture of FCFS and RR in extremes conditions. Hybrid algorithm outcomes were signified as an edge over the FCFS and RR algorithm. The error rate was decreased and job scheduling competency was increased in hybrid scheduling algorithm. The number and size of packets gave diminished symbol error rate (SER) on considering SNR (signal to noise ratio) by executing the suggested algorithm. The conferred scheduling algorithms' performance was dignified reliant on SNR and SER.

AleksandarIchkovet. al [15]targeted a 2-tier heterogeneous centered LTE network which comprised, femto and macro tiers. It presented arbitrary assignment of resources on the femto, a new active offloading system in the user association stage and in a new femto tier access control. System level simulation outcomes concerning rate distribution, i.e. the users attained certain rate in the system, displayed that an optimum RRM strategy could be intended for diversified network situations. The suggested active offloading system in the association stage enhanced the congested

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networks' performance by effectually utilizing the prevailing femto tier based resources. Moreover, the presented femto hybrid access permitted 20 times maximal data rates for the licensed users, compared to the non-licensed users in the network. Operators assured minimum average rates and privileged access for subscribers, proffering a chance for employment of richer and newer services and utilized it to motivate the utilization of femtocells, specifically in intramural environments of homes, offices etc.

Louis Christodoulou et. al [16] presented a Hybrid Unicast-Broadcast Synchronization (HUBS) structure to concurrently convey multiple stream contents. It was perceived that the HUBS structure was established to function within the limitations imposed by the LTE specifications. Performance assessment of this structure was performed through the simulation of possible future situations. The suggested structure formed a "HUBS group" that observes the radio bearer queues to form a time lead or lag betwixt unicast and broadcast streams. Since unicast and broadcast shares particularly the same radio resources, the total subframes assigned to the broadcast transmission were then dynamically enlarged or diminished to limit the average lead/lag time offset betwixt the streams. Dynamic allocation displayed developments for every service through the cell, as keeping the streams synchronized despite maximal user loading.

Chongdeuk Lee [17] suggested a combined control structure centered on power control and assignment of resources for D2D with LTE networks. To do the suggested results, it employed the object SINR ('signal to interference and noise ratio') and concrete feedback SINR to alter dynamic power, assured that the receiver retrieves the signal well, and also prevented the sender from wasting power or from interrupting other devices. This study concentrated on D2D communications, with regard to the cellular communications to diminish the interferences. Consequently, considering RA (resource allocation), cellular communications utilized RBs (resource blocks) first, then D2D communications dissemination and utilized the lasting RBs.

III. LOAD SHARING USING ENHANCED GENETIC ALGORITHM (EGA)

The heterogeneity in cellular networks that encompasses several BSs enforces new difficulties in a deployment of a forthcoming generation of cellular networks and network planning. The dealing of resources as prevailing dynamic sharing fixes the whole network efficiency and capacity. The proffered paper proposes a technique for sharing loads of femtocells with the macrocells utilizing CRE. The above technique augments the ABS and cell range with the assistance of EGA for effectual load sharing betwixt the femto and the macrocells. Firstly, a network is built by generating hexagonal sectors which are the macrocells and next femtocells are positioned inside the macrocells betwixt certain distances and then the users are generated inside the cells. Now, optimization of parameters as ABS and cell range is done utilizing EGA. Finally, the solution attained from EGA is utilized in sharing the loads equally within a macro-femto network.

3.1 Network Layout

The network signifies a heterogeneous network encompassing 2 network nodes, macro and femto BSs. The network possesses four macrocell type BSs where each one positioned in the hexagonal sectors. Each macrocell comprises of two femtocells, which is a minor, lower-power cellular BS called Femto BSs. A single macro cell is detached as of the other macrocell at 400 m distance. The femtocells existing inside the macrocell are located at 100 m distance as of the macrocell. In this network layout, it possesses 2 femtocells per macro and hence one femtocell is separated from the other at 50 m distance. This network possesses three users, namely, Macro Users (MUs), Range Expansion (RE) users, in addition, FUs (Femto users). The macrocell range is 94 dBm whilst the femtocell range is 55 dBm. The total users for each macrocell are 40.

3.2 Cell Range Expansion

CRE extends the coverage region of minor cells to maximize the traffic offloaded as of the macro-cell. This is performed by changing the cell selections criterion to include the cell selections offset. In LTE networks, the serving cell selection criteria are typically ABS and Cell Range (CR). Adding cell selections offset to cell selectionscriterion diminishes the downlink/uplink coverage asymmetrically. Offloading MUs to femtocells free the macrocell resources but it happens at the price of the FUs. The bigger the CSO, further MUs get added to the femtocell and the higher the throughput loss for the prevailing femtocell users. Yet, the recently added users see an enhancement in their throughput

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Website: www.ijircce.com

Vol. 7, Issue 2, February 2019

specifically if they were on the macrocell's edge. In this proposed work, it is presumed that the macrocells do not display any RE, whereas femtocells undergo RE. On expanding the femtocells' range, the users assisted by macrocells becomes the femtocells' range. Therefore, sharing of loads equally amongst the cells gets critical. The user in the extended cell arena, where the power retrieved as of the macro type BS is much higher considering the power retrieved from femto BS, which results in grave interference as of the macro type BS. To lessen the effects of interference connected with CRE, ABS approach is utilized.

3.3 Load Sharing using Almost Blank Subframe

The sharing of loads betwixt macro and femtocells is managed using a 'Time Division Multiplexing' (TDM) known as ABS. In particular, the transmit data power on certain subframes of the macro cell's radio frame is muted to reduce interference on implicated small cells like femtocells. Such sub-frames are named as ABSsince the transmission power is muted on the resource fundamentals of the data channel, but not on other necessary control and reference signals resource elements. The fundamental idea is to have some subframes during which the macrocells is not permitted to transmit data allowing the range expansion of FUs, who is suffering from interference from the macrocell transmission, to transmit with better conditions. To leverage ABS-based technique, the ABS design at macrocells gets exchanged with the femtocells in coordination. Femtocellsmake the most of the opportunity of reduced interference by scheduling users in range expansion on ABSs. The model of ABS is displayed in Fig 3.1.

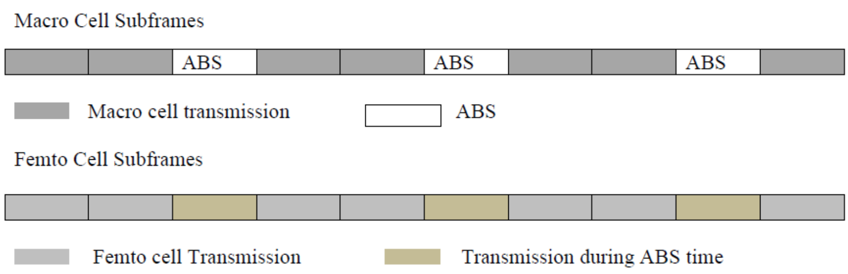

Figure 3.1 ABS Allocation

The absolute blank subframe is utilized in two cases. In the initial case, the femtocell's range is extended within the macrocell and in the next case; the femtocell's range is extended to the nearby macrocell so that the femtocell is in a condition to assist the user of the nearbymacrocell.

3.4 Enhanced Genetic Algorithm

'Genetic Algorithm' (GA) is stimulated by the mechanism called natural selection, which is a biological process where the stronger ones are the winners in a challenging environment. It supposed that the solution for a provided issue is an individual and is signified by parameters. Those parameters are considered as the chromosomal genes; it is then structured and signified by some parameters. GA searches parallel from a population points. Therefore, it possesses the capability to elude trapping on local optimum solution, which searches from one point. Thus, a GA to define the finest ABS design that upsurges the network's performance is executed. Fig 3.1 demonstrates the process flow of the proposed work.

To assess individuals' performance of a given population, a fitness function has to be defined. The assessment is done by the fitness function which returns a fitness value reflecting how optimum the solution is: greater the number, excellent the solution. In ABS design optimization problem, the throughput of UEs positioned in the femtocells, in addition, all other users are also enhanced. The target of this algorithm is to fix the finest ABS sequence that raises the total throughput of all users. The reason of enhancement is to make sure that the traditional algorithm is to obtain a substantially high value of throughput in the proposed system.

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3.4.1 Algorithm Implementation

Figure 3.2 represent the pseudocode of the enhancement module used in the implementation of the proposed system.

Begin

Initialize a random variable $rand$

Initialize the learning factors c_1 and c_2

Obtain the values of $ABSBest$, ABS, $CRBest$ and CR.

$S_1 = ABSBest - ABS$

$S_2 = CRBest - CR$

Calculate the velocity of each solution using the following equation.

$v = v_0 + (c_1 * rand * S_1) + (c_2 * rand * S_2)$

End

Figure 3.2 Pseudocode of the enhancing module

3.4.1.1 Algorithm Steps

Step 1: The process begins with individuals' set that is the arbitrarily selected population. Population alludes to the group of solutions that that used in the algorithm that are selected on a random basis. The group of solutions belongs to two distinct populations. The 1st population refers to the CR and the 2nd population indicates the ABS. A solution form here is optimized.

Step 2: Fitness function determines how fit an individual is, which expressed utilizing equation (2). It provides a fitness score to every individual. The probability that an individual get selected for the reproduction is centered upon its fitness score. The fitness function is calculated for each of the individuals that are present in the population.

Step 3: Individuals are chosen centered on their fitness score. Individuals having high fitness have more probability to be chosen for reproduction.

Step 4: In the fourth stage, check the condition, if the terminal condition is not true then do the subsequent steps, Crossover, Mutation, and Enhancing.

Step 5: Crossover is the notable phase on the GA. For mating of each pair, a crossover point is selected at arbitrary from the two distinct populations.

Step 6: Mutation occurs to sustain diversity within both of the population and to evade premature convergence. This step gives the value of the ABS and $CRBest$ values.

Step 7: In this phase, the CR and ABS are optimized, this is called the enhanced method which is derived utilizing equation that is,

$$(v) = (v_0) + (c_1 * rand * S_1) + (c_2 * rand * S_2) \quad (1)$$

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Vol. 7, Issue 2, February 2019

Where (v_0) is the velocity rate of every individual, c_1 and c_2 are learning factors that are coefficients which are chosen based on the algorithm's convergences properties. The variable $rand$ is a random number. The value of S_1 indicates the difference betwixt the best value of ABS and the current values of the ABS. The numerical value of the parameter S_2 gives the difference betwixt the best value of CR and the current values of CR. This is the step that indicates the enhancement in this algorithm.

Step 8: do again those conditions until the best solution is met.

Step 9: Finally, return the best-optimized solutions.

3.4.2 Load Estimation

The equal sharing of loads is reliant on the fitness function which relies on JFI. It is said that the loads are equally shared, as the JFI value is 1. For a network of N cells, JFI for cells' loads is of the form given below,

$$Jain's\ Fairness\ Index = \frac{\sum_{i=1}^{N} L_i^2}{N \cdot \sum_{i=1}^{N} L_i^2} \tag{2}$$

Where, L specifies Loads. Here, cell loads are not capped at 1 for optimum efficiency. Despite of the actuality that 100% is the maximum cell resource utilization, high degrees of cell overload is better measured in the optimization by not capping cell loads to 1. Jain's fairness index for cell loads provides insight on the level of LB in the network. The fairness index (FI) has a range between 1 and 1/N. The maximal value of 1 is attained when every cell has the same load. On the contrary, networks of a large degree of imbalanced load yield a low JFI.

During optimization, the cell loads are estimated using load coupling equation given in equation (3).

$$L_i = \sum_{j \in (users in cell\, i)} \frac{d\_rate_j}{Max\_DR_{ij}} \tag{3}$$

Where, d_rate_j is the demanded data rate by a user j . Max_DR_{ij} is the maximal attainable data rate for a user j , assuming maximum utilization of time and frequency resources of a cell i .

Max_DR_{ij} of users j assisted by a cell i for RE users are evaluated using the equation (4).

$$Max\_DR_{ij} = ABS_i^{R\_Power}\% \cdot \alpha_{Downlink} \cdot R \cdot B \cdot \log_2(1 + SINR_{ij}) \tag{4}$$

Max_DR_{ij} of user j served by a cell i for Non-Range Expansion (NRE) users is evaluated utilizing the equation (5).

$$Max\_DR_{ij} = (1 - ABS_i^{R\_Power}\%) \cdot \alpha_{Downlink} \cdot R \cdot B \cdot \log_2(1 + SINR_{ij}) \tag{5}$$

Max_DR_{ij} of user j -assisted by a cell i for macrocell users is estimated utilizing the equation (6).

$$\begin{aligned} Max\_DR_{ij} = (1 - ABS_i^{R\_Power}\%) \cdot \alpha_{Downlink} \cdot R \cdot B \cdot \log_2(1 + SINR_{ij}) + \\ ABS_i^{R\_Power}\% \cdot \alpha_{Downlink} \cdot R \cdot B \cdot \log_2(1 + SINR_{ij}) \end{aligned} \tag{6}$$

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Where, $ABS_i^{R\_Power}\%$ is the section of the radio time frame that is almost blanked with reduced power, $\alpha_{Downlink}$ is the alpha downlink correction factor, which is utilized to evaluate the downlink level capacity of the channel, R is the number of RBs of the carrier, B is the Bandwidth (in Hertz) per resource blocks reserved for data transmission and $SINR_{ij}$ is the SINR aimed at a user j -assisted by cell i .

For a network utilizing Reduced Power – ABS, $SINR_{ij}$ of user j -assisted by a small cell i is formed as given in equation (7) for RE users.

$$SINR_{ij} = \frac{T_p l_{ij}}{\sum_{s \in SC/\{i\}} T_s l_{sj} + \sum_{m \in MC} T_m l_{mj} (PC)_{i,m}^{ABS} + \sum_{m \in MC} \frac{T_m}{TR_m} l_{mj} \left(1 - PC_{i,m}^{ABS}\right) + tn} \tag{7}$$

$SINR_{ij}$ of user j served by a small cell i is formulated as given in equation (8) for Non-Range Expansion (NRE) users.

$$SINR_{ij} = \frac{T_p l_{ij}}{\sum_{s \in SC/\{i\}} T_s l_{sj} + \sum_{m \in MC} T_m l_{mj} (PC)_{i,m}^{NonABS} + \sum_{m \in MC} \frac{T_m}{TR_m} l_{mj} \left(1 - PC_{i,m}^{NonABS}\right) + tn} \tag{8}$$

For macrocells, the SINR depends on whether the user is scheduled on a regular subframe or reduced power subframe. For a user j served in a regular subframe by macrocell i , $SINR_{ij}$ is calculated as given in equation (9).

$$SINR_{ij} = \frac{T_p l_{ij}}{\sum_{s \in SC} T_s l_{sj} + \sum_{m \in MC/\{i\}} T_m l_{mj} (PC)_{i,m}^{NonABS} + \sum_{m \in MC/\{i\}} \frac{T_m}{TR_m} l_{mj} \left(1 - PC_{i,m}^{NonABS}\right) + tn} \tag{9}$$

For a user j served in RP-ABS by macrocell i , $SINR_{ij}$ is calculated as given in equation (10).

$$SINR_{ij} = \frac{T_p l_{ij}}{\sum_{s \in SC} T_s l_{sj} + \sum_{m \in MC/\{i\}} T_m l_{mj} (PC)_{i,m}^{ABS} + \sum_{m \in MC/\{i\}} \frac{T_m}{TR_m} l_{mj} \left(1 - PC_{i,m}^{ABS}\right) + tn} \tag{10}$$

Where, T_p is the transmit power of cell i , l_{ij} is the path loss betwixt cell i and user j masked by the antenna gain for a cell i . tn is considered as the thermal noise over the system bandwidth. SC is the set of small cells in the network and MC is the set of macrocells in the network. $PC_{i,m}^{ABS}$ is the probability of collision betwixt cells i and m in a regular subframe. A collision in this context means interference from one cell to other cells in the indicated type of subframe. As the small cells not blank any section of their subframes, interference from small cells is concerned with probability 1. TR_m is based on the power reduction.

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ISSN (Print) : 2320-9798

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Within an LTE radio frame, if the starting instances of all blank subframes are synchronized and aligned, $PC_{i,m}^{ABS}$ and $PC_{i,m}^{NonABS}$ are calculated using the equations (11) and (12) respectively.

$$PC_{i,m}^{ABS} = \frac{\max\left(0, ABS_i\% - ABS_m\%\right)}{ABS_i\%} \tag{11}$$

$$PC_{i,m}^{ABS} = \frac{1 - ABS_i\% - \max\left(0, ABS_m\% - ABS_i\%\right)}{1 - ABS_i\%} \tag{12}$$

The finest fitness by optimizing ABS and Cell Range for all the population is determined and is sorted. Now, the best half of the fitness is chosen from the sorted list and undergoes mutation together with crossover. Then, the solutions are updated which gives the last end solution.

IV. RESULTS AND ANALYSIS

This section displays the performance estimation of the proposed Optimized Load Sharing using Enhanced Genetic Algorithm with the other existing techniques. The performance metrical like, FI along with throughput based on considering interference and devoid of considering interference are utilized for assessing the technique which is proposed. The proposed technique is done in the MATLAB platform.

The fundamental intention is to equally share the loads among the macrocells in addition to the femtocells by optimizing ABS and also cell range using the proposed EGA. The experiments are performed in a basic network with 4 macrocells each located in the hexagonal sectors. Each macrocell comprises of 2femtocells. The performance of optimized load sharing using EGA is assessed in two situations. One is through considering interference and also the other is without considering interference amongst the macrocellsas well as the femtocells on a network.

4.1 Throughput

Throughput alludes to the measure of data units a framework can process within a particular quantity of time. With regards to communication networks say the internet; throughput stands as the rate at which data are conveyed effectively. In the proposed technique, throughput is grounded on the manner in which the loads are shared at the time of RE. The comparison of throughput for the technique which is proposed centered upon certain metrics is delineated in the accompanying graphs.

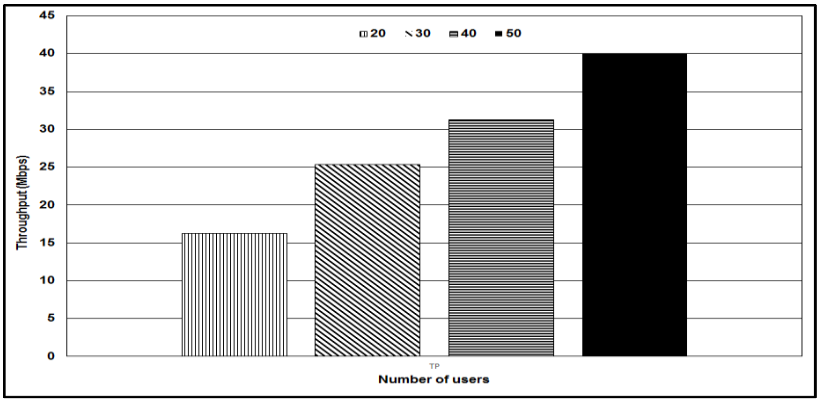

Figure 4.1 Throughput of the proposed technique in terms of Number of Users

Figure 4.1 analyses the throughput of the proposed work concerning a number of users on the network. In the graph, x-axis signifies the number of users and y-axis signifies the values of throughput. For 20 users, throughput is

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ISSN (Print) : 2320-9798

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Vol. 7, Issue 2, February 2019

16.28308, which is the lowest for the compared total users. But, as the users are increased, it can be inferred that the throughput as well increases. For 50 users, throughput is 40.04754, which is above the values for 30 and 40 users. So, it is said that the throughput for equal load sharing increases even as the total users are increased.

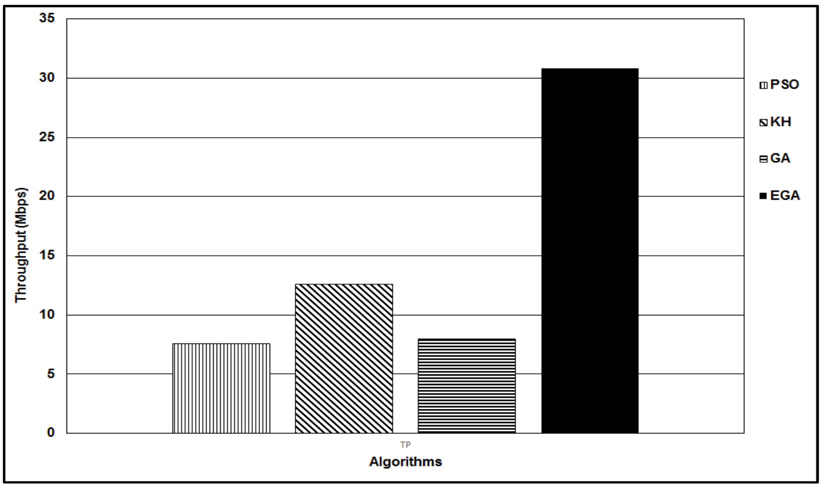

Figure 4.2 Throughput of the proposed technique by considering interference

Figure 4.2 analyses the proposed technique's throughput by considering interference in the macro-femto centered network. The concern of interference entails that the expanded area of the femtocell spreads out to the close bymacrocell. In the graph, x-axis signifies the algorithms that were compared and also y-axis implies the throughput values. Here, existing algorithms say PSO, KH and GA and the proposed EGA are compared. Amongst all the compared algorithms, PSO has the lowest throughput which is 7.604111 and throughput of GA is approximately equal to PSO which is 7.999796. The proposed EGA has 30.8554, which is the maximal throughput furthermore as an outcome it indicates the domination of the proposed EGA. This is the impact of the optimization of the proposed system.

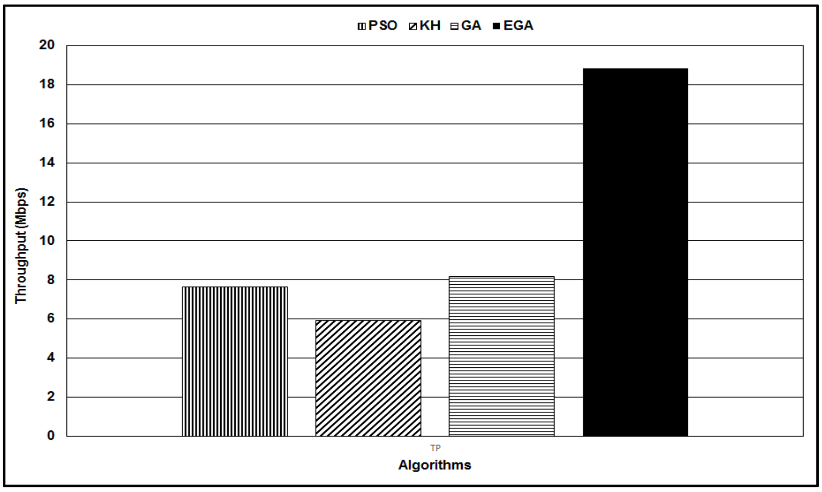

Figure 4.3 Throughput of the proposed technique without considering interference

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 7, Issue 2, February 2019

Figure 4.3 analyses the proposed technique's throughput without concerning interference in the macro-femto centered network. The inconsideration of interference implies that the expanded region of the femtocellspreads within its own macrocell. In the graph, x-axis implies the algorithms which were compared and also y-axis implies the values of throughput. The proposed EGA is compared with the existing PSO, KH, and GA. Here, KH shows very poor performance which has the throughput 5.915192 and that of PSO and GA have 7.659465 and 8.18076 respectively. The proposed EGA has a greater throughput which is 18.81396 and shows the greater performance for the perfect sharing of loads. The large variation is observed to the inefficiency of the existent algorithm. The enhancement in the traditional GA, lead to the significant increase in throughput. The proposed system framed an approach that yielded outstanding results.

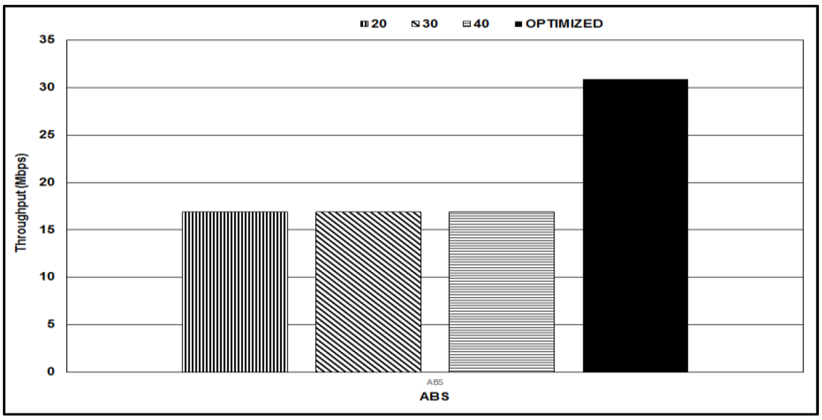

Figure 4.4 Throughput of the proposed technique with Fixed ABS

Figure 4.4 analyses the proposed technique's throughput with fixed ABS in the macro-femto network. Here, x-axis implies the ABS and also y-axis implies the throughput. For fixed ABS values of 20, 30 and 40, the throughput is approximately similar to a very few differences. When ABS is fixed to 20, 30 and 40, the throughput values are 16.90164, 16.91642 and 16.9236 respectively. But, for the optimized ABS values, the throughput is 30.8554, which is the maximal amongst the compared.

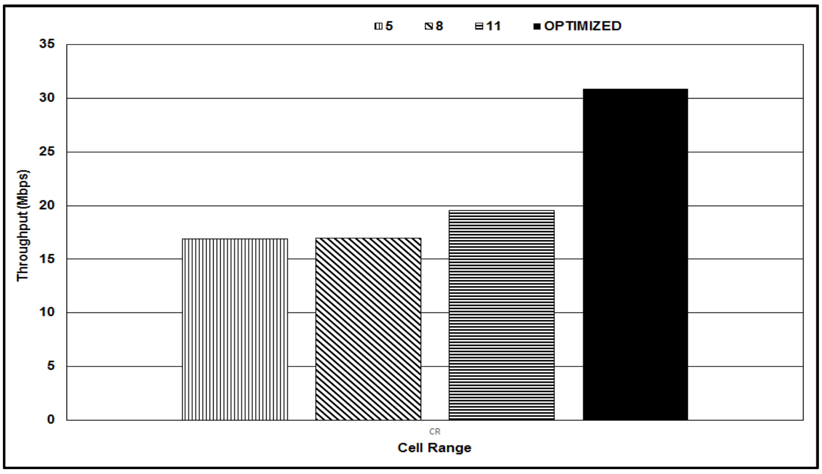

Figure 4.5 Throughput of the proposed technique with Fixed Cell Range

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

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Figure 4.5 analyses the proposed technique's throughput with fixed Cell Range in the macro-femto network. In the figure, x-axis implies the cell range and axis, y implies the throughput. For fixed cell range values of 5 and 6, the throughput is approximately similar with small differences. When a cell range is fixed to 5, 6 and 11, the values of the throughput are 16.9236, 16.95509 and 19.54641 respectively. But, for the proposed optimized cell range values, the throughput is 30.8554, which is the maximal amongst the compared.

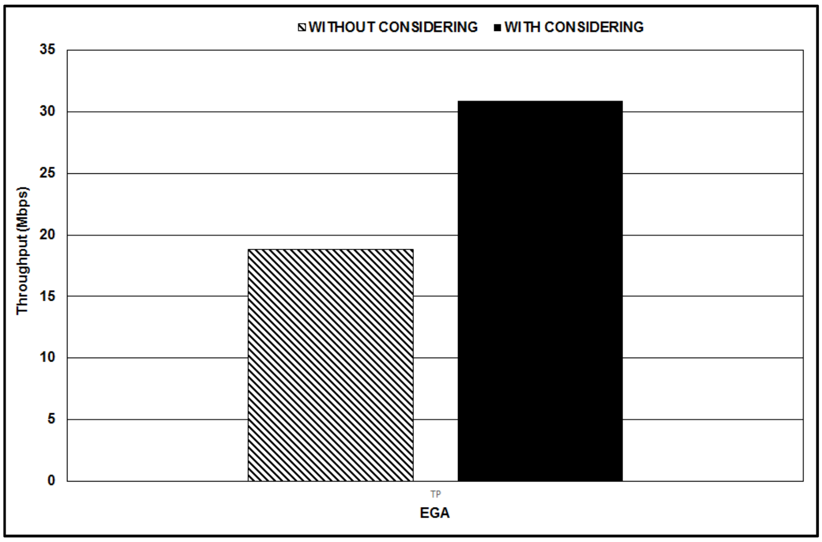

Figure 4.6 Throughput of the proposed technique with and without considering interference

Figure 4.6 analyses the proposed technique's throughput by considering or not considering interference on the macro-femto network. At this point, x-axis infers the technique which is proposed EGA and also y-axis implies the values of the throughput. The consideration of interference entails that the expanded area of the femtocell spreads out to the close bymacrocell. The inconsideration of interference implies that the expanded region of the femtocell spreads within its own macrocell. The value of the throughput by without considering interference is 18.81396 and the value for in consideration of interference is 30.8554. It can well be inferred that the sharing of loads is more efficient even in the case when the femtocell is extended to the nearby macrocell.

V. CONCLUSION

Range Expansion technique aspires to balance loads of the macrocell and the femtocell by enlarging the section of femtocell area and augmenting the total users who are fixed for the femtocell. In such range expanded environment, a problem arises in sharing the nodes equally among the macrocells and the low-power nodes, for instance, femtocells. The given paper proposes a technique for sharing loads of macrocells with the femtocells by means of range expansion. The proposed technique optimizes the ABS and cell range with the assist of EGA for effectively sharing the loads between the macrocell and the femtocell. The proposed technique's performance is analyzed with the aid of metrics, for instance, FI along with throughput. The proposed EGA is compared with the existing PSO, KH, and GA. Also, the performance of throughput using EGA is evaluated in two situations. One is through considering interference and also the other is without considering interference amongst the macrocellstogether with the femtocells in a network. Results clearly indicate that the proposed techniqueenhances the throughput than other conventional techniques.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 7, Issue 2, February 2019

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