Joint Optimization on Resource Allocation with Reinforcement Learning based Intercell Interference Coordination Cancellation in Heterogeneous Networks

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Abstract:- The most difficult challenge in femtocells networks is the alleviation of Inter-Cell Interference (ICI) that occurs between macro and femtocells during robust video transfer. Due to this issue, bandwidth utilization and system efficiency are reduced. To avoid this issue, a Joint dynamic Layer, Channel and Power assignment with Further enhanced ICI Coordination and Coordinated Multipoint Transmission (JLCP-FeICIC-CMT) method has been suggested for two-tier HetNets that allocates both resources and User Equipments (UEs) in each eNodeBs (eNBs) for increasing the network performance. However, it partitions the bandwidth among UEs within each cell which dissipates the bandwidth while Resource Blocks (RBs) are utilized only by few UEs. Therefore, in this article, a Reinforcement-based Interference Coordination Cancellation method is proposed with the JLCP-FeICIC-CMT method, known as JLCP-RICC-CMT. In this proposed method, the bandwidth partition is not required. The total bandwidth is distributed among UEs who are independent of their locations related to the eNB within serving cell formulates the Resource Allocation (RA) as an optimization problem. Initially, JLCP is performed by using Genetic Algorithm (GA) as a Policy Search-based Reinforcement (PSR). Then, RICC scheme is performed to allow UEs in neighbor cells to be assigned the same RBs and increase the system efficiency. Finally, the experimental results exhibit that the efficiency of the JLCP-RICC-CMT method compared to the JLCP-FeICIC-CMT method.

Keywords:- *Femtocells Network; Hetnets, JLCP-Feicic-CMT; Resource Allocation; Genetic Algorithm; Policy Space Search Reinforcement.*

I. INTRODUCTION

Typically, traditional wireless devices provide restricted exposure to video traffic that degrades bandwidth utilization. In the other side, video sharing at higher downlink speeds tends to rise throughout these days due to evolved technologies. As a end result, the Long-Term Evolution-Advanced (LTE-A)-based Heterogeneous Networks (HetNets) paradigm is adopted to improve bandwidth utilization and overall performance by enabling minimum-cost modular node configurations. These systems utilize a mix of macro, pico, femtocells and relay Base Stations (BSs) to offer consistent wireless service to all service usage. Typical Feta BSs (FBSs) are cost-effective unified configuration that can increase the efficiency of Macro BSs (MBSs) since FBSs use a similar frequency as MBSs [1]. If these FBSs are not carefully regulated, they can overpower the range of their MBSs and trigger ICI between macrocell and femtocells.

In HetNets, the main goal is to minimize ICI because it may reduce the attainable utility of femtocells. Therefore, the design is totally different. Usually, the amount of UEs at cell edges has lower bandwidth utilization owing to strong interference from a vast amount of femtocells. Essentially, FBSs are used in an adhoc network without being prepared for clients who are increasing the complexities of ICI reduction. As a consequence, one of the key fields of research is tackling the problems of ICI control. Predominantly, there have been two categories of interference, known as co-tier and cross-tier [2]. Co-tier interference can exist between adjacent FBSs, whilst cross-tier interference can happen between FBSs and MBSs. Several techniques have been introduced to reduce the ICI and improve spectrum quality. On the other side, these techniques have strong numerical difficulty due to overlaying of feta-macro frameworks. For this purpose, a Resource Allocation (RA) [3] is required for each feta-network for individually accessing the resources that are not accessed by the macro-network. The ICI is thus essentially prohibited from dealing with the Quality-of-Service (QoS) specifications.

To the above purpose, Yang et al. [4] developed a Joint dynamic Layer, Channel and Power allocation (JLCP) approach that devised the problem of flexible video services from femtocells as a restricted stochastic optimization dilemma under the pricing framework. Likewise, the real long-term mean utility problem was disintegrated as a pair of near optimization sub-problems by analyzing the Lyapunov stochastic optimization approach for obtaining a low-complexity RA and video layer activation mechanism. Additionally, the conceptual criteria for both the time-average queue sizes and the feasible usage were calculated. Alternatively, this approach only deals with sparsely situated

FBSs and requires stronger ICI control strategy. As a result, the JLCP-FeICIC [5] approach was suggested based on four steps. Initially, each client is aligned with an MBS, FD-FBS dependent on a Cell Range Expansion (CRE) bias. Then, FD-FBS clients are combined using the Hungarian algorithm to perform the FD relay. The Resource Blocks (RBs) are then allocated to each client to optimize the device performance while enforcing QoS criteria depending on the Nash Bargaining Solution (NBS)-related optimization problem. In turn, the closed-form power control functionality was obtained for the measurements of the maximal transmit energy of each client in FD mode. Nevertheless, only the CRE UEs of femtocells were reserved, whilst the core UEs were not reserved. The fairness of the distribution of RB was weakened in this situation.

As a result, JLCP-FeICIC was further improved by the Coordinated Multi-point Transmission (CMT) method (JLCP-FeICIC-CMT) to improve the performance of the HetNets Core UEs [6]. In this method, the RBs were allocated to one centralized scheduler. The detection of the UEs was carried out in specific eNBs on the basis of the UE feedback details, i.e. on the basis of the estimation of interference from adjacent cells. As per the RB allocation in the centralized scheduler, the choice of the Modulation and Coding Scheme (MCS) level is provided in each eNB with and without CMT support by coordinated path adjustment i.e. depending on the hypothesis of no interference from the adjacent cell. On the contrary, the bandwidth was partitioned among UEs within each cell. This causes bandwidth dissipation if resources were used by only few UEs.

Hence in this article, a JLCP-CMT method is enhanced by the Reinforcement-based Interference Coordination Cancellation i.e., JLCP-RICC-CMT method. This method does not require the bandwidth partition. The entire bandwidth is shared among UEs regardless of their location associated with the eNB within serving cell devises the RA as an optimization problem. At first, JLCP is performed by using GA as the PSR method. Then, the RICC method is performed to allow UEs in adjacent cells to be assigned the same RBs. Thus, the overall spectral efficiency of the HetNets is improved efficiently.

II. LITERATURE SURVEY

Daeinabi et al. [7] suggested a joint Resource Block (RB) and a transmit power system for LTE downlink networks. It consists of 3 processes: 1) the client priority has been decided on the basis of the intervention range, the Quality-of-Service (QoS) and the Head-of-Line (HoL) and the delay; 2) users in each cell were scheduled on the specified subbands on the basis of their priority and 3) the transmit power was dynamically controlled by the eNBs using a fuzzy logic system and exchanging the messages to each other. But, it requires eICIC scheme for mitigating the interference in HetNets.

Poulkov et al. [8] proposed joint power and ICI management for LTE focused on the principle of role-playing games. In this method, different positions of subscribers within the LTE network cell to regulate uplink and ICI. The mobile users were categorized by roles where each role associates with few fixed parameters like position, user activity, traffic class, service quality, user satisfaction, etc. In this case to each role, a definite combination of uplink power control and ICI control mechanisms were applied for achieving the desired utility functions and maximizing the overall efficiency. But, the complexity of this approach was high while considering more parameters.

Yassin et al. [9] suggested a non-cooperative ICIC method for increasing the system efficiency and cell-edge UEs throughput. In this method, RB and power allocation decisions were prepared locally by the scheduler of each eNBs according to the user demands in each zone. But, the complexity of this method was high and requires efficient method for preventing ICI in HetNets.

Merwaday & Guvenc [10] proposed optimization of FeICIC to improve power and spectrum quality in HetNets. In this method, stochastic configuration was applied for evaluating the energy and spectrum quality of the two-tier LTE-A HetNets. Also, range expansion and FeICIC were performed for mitigating the interference problems between the macrocell and the picocells. Nonetheless, the interference power from adjacent eNBs was high.

Kim et al. [11] proposed hybrid method based on Fractional Frequency Reuse (FFR) and Almost Clear Subframe (ABS) methods to manage the ICI generated by UEs to device-to-device receivers and reusing the same resources in the cell edge area. In this scenario, these recipients were taken as victim nodes and UEs as intruder nodes because the main goal was reducing the ICI to maximize the SINR of the target recipients at the cell edge area. However, SINR was not effectively increased.

Katsinis et al. [12] proposed a two step method where the first step was focused with the efficient RB allocation to the users and the second step was the transmit power distribution. In this process, the RB distribution difficulty was conceived as the bilateral symmetric interaction game while the problem of power distribution was conceived as a linear programming problem per RB. Conversely, this method has high complexity.

Kim et al. [13] proposed an adaptive Coordinated Multi-Point (CoMP) approach using pre-coding for increasing the reliability in a Heterogeneous Network (HetNets) system. Also, the constructive Spatial Phase Coding (SPC) scheme was used for preventing the received SNR reduction owing to the interference signal. While the mobile was situated in the cell edge, the communication signal was distorted by the transmitted signal from the neighboring cell. The interference signals were suppressed by the destructive SPC scheme. But, this approach does not mitigate the interference and has high power consumption.

III. PROPOSED METHODOLOGY

In this section, the proposed JLCP-RICC-CMT method is explained briefly. Consider a set of LTE cells and UEs which are assigned in random way for every cell. Every cell's bandwidth channel is divided into RBs to be assigned to active UEs involved to each eNB. Each EU experiences ICI triggered by nearby cells. The primary component collects Channel State Information (CSI) from clients. Every UE is subject to different ranges of SINR for every RB. The mobility of the UE is taken into consideration and the speed of the UE shall be taken as 3km/h that denotes the signals of the channel are set to be constant over 1 Time-To-Interval (TTI). RBs are allocated to every TTI of UEs. Every UE has 2 data queues. The main queue comprises information for main communication and the second one includes information for rebroadcast. The rebroadcast queue is taken into account due to the system's disrupted characteristics, as the UEs have weak channel signals on the cell edge.

The queue sizes are finite. Asynchronous adaptive Hybrid Automatic Repeat Request (HARQ) with the maximum rebroadcast value for downlink in LTE is taken into consideration. Particular data is broadcasted to every allocated RB to reduce the difficulty. The queues and HOL delay are changed. If queues are completely occupied, then prior data are eliminated for the UE. Also when the highest HoL latency is reached, earlier packets for that UE are deleted. The packet loss rate is identified at the last part of the RA phase via dividing the entire number of data isolated and the overall number of data left to the buffers either lost or sent effectively. While RBs are allocated to the UE, the latency of the UE is reduced. In the case of UEs not allocated to RBs, HoL is maximised. The proposed JLCP-RICC-CMT method has the following steps:

- At first, UEs are chosen on the basis of their priority using HoL to reduce the latency and packet loss rate. If the packet waits for greater than satisfactory delay, then the packet is discarded and the loss of the packet is reduced.
- After the selection of the UEs, RBs are allocated.
- After that, the transmission power of every eNB on every RB is determined to increase the SINR for all UEs on the allocated RBs.
- Depending on the SINR, the data to be rebroadcasted are noticed. There is no need to transfer a data when the SINR on the allocated RB is extremely small so that the data is not retrieved. Subsequently, the data is sent to rebroadcast queue.
- Moreover, the ICI cancellation method is applied to regenerate and subtract the interfering signal from the desired signal.

Each eNB has the task of allocating RBs within a cell while transmit power evaluation is centralized. For both RA and power control processes, GA is used as the PSR learning which is described by different elements such as an agent, an environment, a rule, a incentive factor, a value and an environment model if needed.

A. Selection of UE

This process is used to choose the UEs that are suitable for RBs allocation. If there are no packets to be transmitted to the UEs, then it does not need to assign RBs to UEs. Also, packets must be transmitted within acceptable delay, or else they will be neglected. The option of UEs is considered to be buffer status, i.e. broadcast and rebroadcast queues and HoL delay, so that only UEs data to collect can be picked. The UEs are selected depending on 2 procedures to decrease the state space for the RA step:

- Initially, the UEs are planned in accordance with the state of the buffer. Because the RB should be allocated to the UEs which can use it effectively to retain it only the UEs that have data to collect are appropriate to be picked. The broadcast and rebroadcast queues are considered and two lists are obtained. The primary list consists of UEs having data in their broadcast queue, while the second list consists of UEs have data in their rebroadcast queue.
- After, these 2 lists are joined together to create a new list.
- After that, UEs are chosen on the basis of their priority.

The priority is defined by the HoL. The UEs whose HoL is closer to the limit permitted for the service consider are placed at the top of the list. The amount of UEs elected is superior to the amount of RBs accessible.

Algorithm:

1. Detect the UEs with data in their broadcast and rebroadcast queues;
2. $\boldsymbol{for}(each\ UE\ having\ packet\ in\ rebroadcast\ queue)$
3. $\boldsymbol{for}(each\ packet\ in\ rebroadcast\ queue)$
4. $\boldsymbol{if}(highest\ rebroadcast\ is\ reached\ for\ a\ given\ packet)$
5. Eliminate packet from UE's rebroadcast queue;
6. $\boldsymbol{end\ if}$
7. $\boldsymbol{if}(UE\ is\ existing\ in\ both\ lists)$
8. Packets in rebroadcast queue is sent over assigned RBs;
9. $\boldsymbol{else}$
10. Packets in broadcast queue is sent over assigned RBs;
11. $\boldsymbol{end\ if}$
12. $\boldsymbol{end\ for}$
13. $\boldsymbol{end\ for}$
14. Rank these UEs according to their HoL latency;
15. Choose the UEs with minimum HoL;

B. Allocation of RBs

This method is dependable for conveying the RBs to the EUs selected in the previous step. In this process, the policy space-based reinforcement training is applied rather than value function space for assigning the RBs to the selected UEs. The PSR schemes employ explicit policies and alter them via search operators. In this approach, GA is employed as a rule space search where a rule is represented as a chromosome. A mediator communicates with his environment and discovers the appropriate strategy for assigning RBs to UEs. The atmosphere is collected of the UE queue status and UE HoL.

The state determines the number of UEs with their HoL, queue position, the whole data failure rate and the QoS holders. The mediator is a data scheduler located at every eNB. The rule is the act of a mediator in a given state. The act will pick the UE for every RB. Later, an incentive is related to every act performed by the mediator. If the act performed by the mediator raises the failure rate of the data, then the mediator will collect a negative incentive; or else the mediator will collect a positive incentive.

The chromosome is specified by a particular rule. A successful rule should have a fitness rate less than threshold related to the QoS criterion of the service. The RA-GA's fitness is the sum amount of the HoL. The RB signifies the gene and its rate relates to the UE which the RB has been allocated. A chromosome is a collection of available RBs which are allocated every TTI. All genes are encoded in decimal form to shorten the computational task. The amount of the populace does not vary. To maintain the best solution and eliminate the least feasible solution, elitism strategy is utilized.

The RA can be modelled by a matrix where each row and column denotes the cells and a RB to be assigned, accordingly. Assume that n cells and a bandwidth respected to m RBs where C_i and RB_i signify the cells and RBs, respectively. Then, the RA matrix can be described as follows:

$$\begin{array}{cccccc}
\cdot & RB_1 & RB_2 & \cdots & RB_{m-1} & RB_m \\
Cell_1 & UE_{11} & UE_{12} & \cdots & UE_{1(m-1)} & UE_{1m} \\
Cell_2 & UE_{21} & UE_{22} & \cdots & UE_{2(m-1)} & UE_{2m} \\
\vdots & \vdots & \vdots & \cdots & \vdots & \vdots \\
Cell_{n-1} & UE_{(n-1)1} & UE_{(n-1)2} & \cdots & UE_{(n-1)(m-1)} & UE_{(n-1)m} \\
Cell_n & UE_{n1} & UE_{n2} & \cdots & UE_{n(m-1)} & UE_{nm}
\end{array}$$

At the beginning of the reinforcement training, a real populace of policy is developed. A mediator tests every policy by a policy assessment which uses the fitness value. Every policy is tested and improved for accomplishing the most excellent policy. The most excellent policy is a rule which attains a data failure rate less than or the same to the maximum permissible data loss in relation to the QoS requirements. The policies population is modified by crossover and mutation operations over a known quantity of generation with the aim of seeking solutions that converge to the most excellent result. This is in accordance with the training task wherein policies are improved.

In the crossover task, a small number of chromosomes are elected based on crossover probability and divided into two classes. Pair of chromosomes is collected by picking single chromosome for every of the two classes to be crossed for the generation of new chromosomes. In the mutation process, a small number of chromosomes are selected based on the probability of mutation and 6 genes are chosen at random to mutate on every chromosome selected for mutation in order to add diversity to the population.

The value of the gene denotes the UE in which the corresponding RB is allocated. The gene mutation determines the deallocation of the RB from the UE and its portion to other UEs. The RB is allocated to the UE in the waiting record that consist of the client selected during main step. The most excellent rule is obtained after preference, crossover, mutation and assessment are repeated until a certain number of generations have reached the training task is terminated.

Algorithm:

1. Initialize UE's HoL vector, transmission and retransmission queues;
2. Set the data inter-arrival period, the number of RBs to be allocated, the amount of the population policy, the crossover and the mutation rate;
3. $\boldsymbol{for}(each\ TTI)$
4. $\boldsymbol{for}(each\ cell)$
5. Develop primary populace of policies with chosen UEs;
6. $\boldsymbol{for}(each\ generation)$
7. Decide chromosomes and execute crossover;
8. Choose chromosomes and implement mutation;
9. Compute populace of policies by fitness function;
9. Decide chromosome to create fresh populace;
10. $\boldsymbol{end\ for}$
11. Choose the most excellent chromosomes based on the fitness value;
12. Assign RBs to UEs in the best policy;
13. $\boldsymbol{for}(each\ UE)$
14. Remove packets that have achieved the highest latency;
15. Eliminate packets that have attained the highest retransmission number;
16. Update UE's HoL, transmission and retransmission queues;
17. $\boldsymbol{end\ for}$
18. $\boldsymbol{end\ for}$
19. $\boldsymbol{end\ for}$

C. Dynamic Power Allocation development

A mediator discovers the most excellent policy for increasing the value of SINR for every UE cell. The mediator surrounding is a multi-cell LTE network made up of eNBs and UEs environmental locations. The state is the location of the UE and its SINR. Only the UEs which are allocated the minimum single RB are considered. The mediator shall be located in a centralised unit which may be positioned on one of the eNBs and shall collect the geological location of the UEs on every eNB. The mediator trains the most excellent policy to allocate the broadcast power for every eNB on all RB allocated to the UEs depending on their locations.

The incentive relates to every action i.e. the SINR engaged by the mediator. If the SINR arriving is less than the least acceptable SINR, a negative incentive shall be given to the mediator. Or else, the mediator will obtain a positive incentive. A particular policy is a chromosome, and the broadcast power of the eNB on the RB is a gene. A chromosome is a collection of transmitting power on every eNB of all RBs. All policies shall be assessed on the basis of the least SINR achieved with the corresponding broadcast power of the eNB. The power distribution problem is modelled through a matrix where the cells are denoted by all rows and the broadcast power of the eNB to be allocated is denoted by all columns. The power distribution matrix is defined as follows:

$$\begin{cases} \cdot & RB_1 & RB_2 & \cdots & RB_{m-1} & RB_m \\ Cell_1 & P_{11} & P_{12} & \cdots & P_{1(m-1)} & P_{1m} \\ Cell_2 & P_{21} & P_{22} & \cdots & P_{2(m-1)} & P_{2m} \\ \vdots & \vdots & \vdots & \cdots & \vdots & \vdots \\ Cell_{n-1} & P_{(n-1)1} & P_{(n-1)2} & \cdots & P_{(n-1)(m-1)} & P_{(n-1)m} \\ Cell_n & P_{n1} & P_{n2} & \cdots & P_{n(m-1)} & P_{nm} \end{cases}$$

The actual population of policies is generated at the beginning of the training task. Every gene in a rule is randomly assigned a broadcast power between the minimum and the maximum broadcast power. The mediator will evaluate every rule through a policy assessment. The least SINR is utilized as the fitness value of the GA power distribution. On each UE, the SINR is calculated only on the RBs to decrease the computational period. Every policy is tested through a task in which the real population is modified by crossover and mutation operations. An excellent policy is one which has the least SINR greater than the least acceptable SINR. Policies analysis is continued until the maximum number of generations reached for discovering the best policy. Both crossover and mutation processes are achieved similar to the performed in RA.

Algorithm:
1. Set location of UEs in each cell;
2. Assign the highest and lowest transmit power values;
3. Set size of policies population; generation number, crossover and mutation rates;
4. $\boldsymbol{for}(each\ TTI)$
5. Create initial policies population;
6. $\boldsymbol{for}(each\ generation)$
7. Choose chromosomes and perform crossover;
8. Choose chromosomes and execute mutation;
9. Decide new policies for creating new population;
10. Calculate policies population;
11. $\boldsymbol{end\ for}$
12. Choose the most excellent chromosome based on the fitness value;
13. $\boldsymbol{for}(each\ eNB)$
14. $\boldsymbol{for}(each\ RB)$
15. Allocate the transmission power with the respective range in the best policy;
16. $\boldsymbol{end\ for}$
17. $\boldsymbol{end\ for}$
18. $\boldsymbol{end\ for}$

E. Packets Detection for Retransmission

In this phase, the packets to be retransmitted will be detected. Remember that the packet transmitted to the corresponding RBs cannot be precisely decoded at the end of the receiver. Such data should be transmitted to the corresponding UE's rebroadcast queue. The HARQ regulator controls the rebroadcast. Data rebroadcast is occurred at any period related to the real broadcast, because the HARQ procedures are asynchronous in the LTE downlink.

Algorithm:
1. Assign $minSINR$;
2. $\boldsymbol{for}(each\ cell)$
3. $\boldsymbol{for}(each\ user)$
4. $\boldsymbol{for}(each\ RB)$
5. $\boldsymbol{if}(SINR > minSINR)$
6. Broadcast data to the rebroadcast queue of UE;
7. Renew broadcast queue of the UE;
8. $\boldsymbol{end\ if}$
9. $\boldsymbol{end\ for}$
10. $\boldsymbol{end\ for}$
11. $\boldsymbol{end\ for}$

F. Interference Mitigation Method

Originally, the interfering from UE_2 to UE_n is regenerated for which the signal and channel parameters of the interfering UEs need to be measured. Initially, the data on the Reference Symbol (RS) sequences used by interfering users UE_2 to UE_n is obtained by the BS receiver. Then, the channel gain, phase and the latency measures of the interfering signals from this RS data are estimated. By using these measures, the BS receiver can regenerate the interfering signals of UE_2 to UE_n. Then, those measures are subtracted from the received signal. If the channel measures are precise, the regenerated signal will be a precise measure of the original interfering signal and the subtraction process can substantially cancel the interfering from the signal of the desired UE_1. Hence, it is important that specific channel measures, frequency offset measures, latency measures and received power measures are accessible under all fading situations. This process allows UEs in neighbor cells to be allocated the same RBs and so the overall system spectral efficiency is increased efficiently.

IV. EXPERIMENTAL RESULTS

In this part, the efficiency of JLCP-RICC-CMT method is analyzed and compared with JLCP-FeICIC-CMT method by using MATLAB 2017b. This comparative analysis is carried out in terms of performance metrics such as average Peak Signal-to-Noise Ratio (PSNR) per Femtocells UE (FUE), average utility, average monetary cost and average Playback Interruption Rate (PIR). The simulation parameters are given in Table I.

TABLE I. SIMULATION PARAMETER

Parameters	Value
Carrier frequency	2.2GHz
Network bandwidth	20MHz
Number of sub-channels	20
Number of FUE	13
Power limit of FBS	23dbm
Allocation of channel gain between FBS and FUE	Rayleigh with variation 0.376
Allocation of channel gain between FBS and macro UE	Rayleigh with variation 0.05
Allocation of interference cost	Gaussian (Mean=50 & Standard deviation=10)
Number of RBs	120

A. Average PSNR per FUE

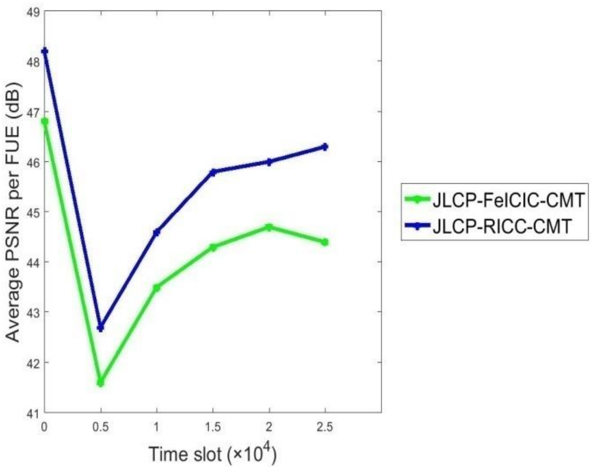

Fig. 1. Average PSNR per FUE vs. Time Slot

Fig. 1 shows the average PSNR per FUE for JLCP-RICC-CMT and JLCP-FeICIC-CMT methods. In this graph, x-axis denotes the time slot and y-axis denotes the average PSNR per FUE in dB. From this analysis, it is observed that the JLCP-RICC-CMT method achieves higher PSNR than the JLCP-FeICIC-CMT.

B. Average Utility

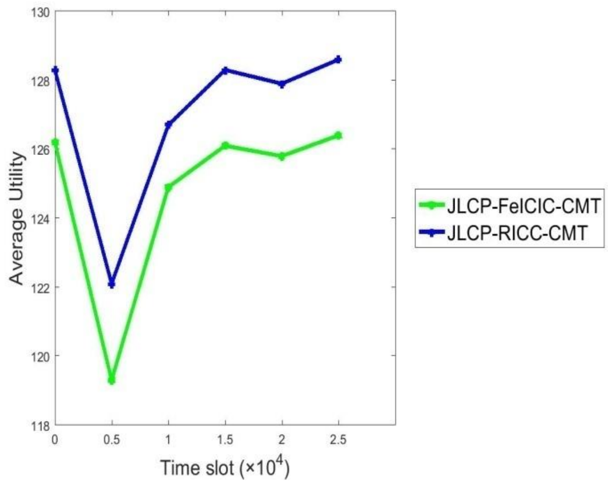

Fig. 2. Average Utility vs. Time Slot

Fig. 2 shows the average utility for JLCP-RICC-CMT and JLCP-FeICIC-CMT methods. In this graph, x-axis denotes the time slot and y-axis denotes the average utility. From this analysis, it is observed that the JLCP-RICC-CMT method achieves higher utility than the JLCP-FeICIC.

C. Average Monetary Cost

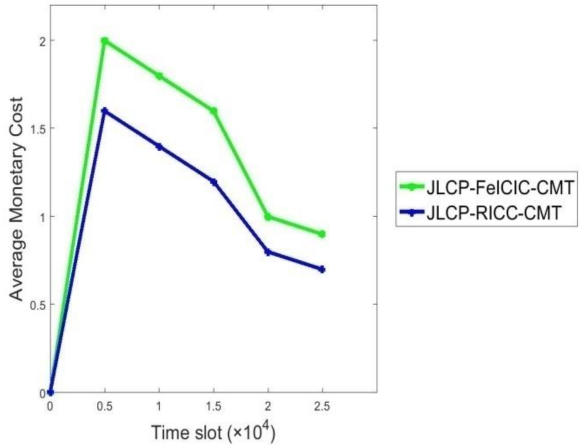

Fig. 3. Average Monetary Cost vs. Time Slot

Fig. 3 shows the average monetary cost for JLCP-RICC-CMT and JLCP-FeICIC-CMT methods. In this graph, x-axis denotes the time slot and y-axis denotes the average monetary cost. From this analysis, it is observed that the JLCP-RICC-CMT method achieves less monetary cost than the JLCP-FeICIC-CMT.

D. Average Playback Interruption Rate

Fig. 4 shows the average PIR for JLCP-RICC-CMT and JLCP-FeICIC-CMT methods. In this graph, x-axis denotes the time slot and y-axis denotes the average PIR per minute. From this analysis, it is observed that the JLCP-RICC-CMT method achieves less PIR than the JLCP-FeICIC-CMT.

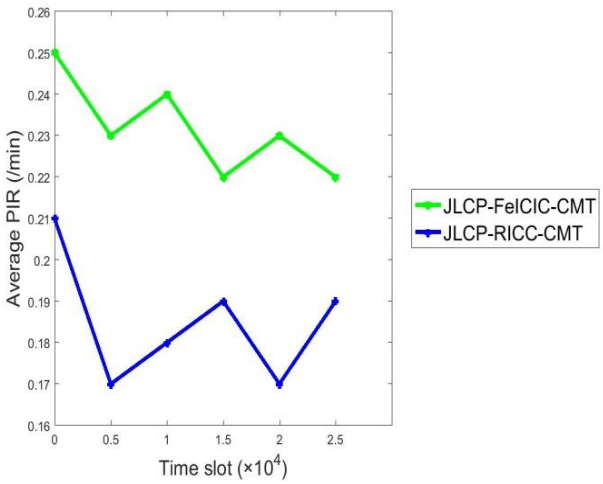

Fig. 4. Average PIR vs. Time Slot

V. CONCLUSION

In this article, a JLCP-RICC-CMT method is proposed for avoiding the bandwidth partition among UEs within each cell and reducing the unwanted bandwidth loss when RBs are used by only few UEs. In this method, the overall bandwidth is shared among UEs who are separate from their locations related to the eNB within serving cell devises the RA as an optimization problem. At first, GA is applied as the PSR learning for achieving the selection of UEs and their respective RBs, transmit power including the packets to be retransmitted. Then, ICI cancellation is also achieved that allows UEs in the neighbor cells to be allocated similar RBs for increasing the overall system spectral efficiency. Eventually, the experimental results proved that the efficiency of the proposed JLCP-RICC-CMT method compared to the JLCP-FeICIC-CMT method.

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