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PERFORMANCE ANALYSIS OF RESOURCE SCHEDULING IN LTE FEMTOCELL NETWORK

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Abstract—*The long term evolution – advanced (LTE-A) based heterogeneous networks has started focus on the Femto based cell deployment. These Femto cells are low powered intelligent devices, which are placed in the random passion at home and office premises. Such arrangement has benefited the customers and service providers in term of network coverage and spectral efficiency. In this paper, the resource allocation strategy is improved. Then the scheduling algorithm makes use of adaptive modulation and coding technique by referring the CQI parameter.*

Keywords:- *Microcell , Pico cell , Femtocell , CQI , (M-LWDF) ,*

I.INTRODUCTION

The development of Long Term Evolution – Advanced (LTE-A) technology added a golden part in the development of wireless communications domain. To further improve the performance of LTE-A based network relay and pico cell came into picture. Basically relay is a wireless radio extension of base station (BS) and it provides limited intelligence to network operators. On the other hand, pico based deployment provide intelligent BS, which is owned, planned and placed by operator. If we observe both the deployments, customer does not come into picture. In order to give more priority to customer's, the LTE-A wireless networks suggest Femto cell based network architecture. Femto Cell provides intelligent BS, which is mostly owned and placed by consumer; no initial planning is required for Femto cell deployment. Challenging issues in Femto cell is the proper resource allocations and interference. Various scheduling algorithms are already available for resource allocation. However, the challenge is to use proper scheduling technique for appropriate applications. Comparison of different scheduling technique in Femto based deployment is explained in [1]. It compares the scheduling techniques, namely, Round Robin, Best CQI scheduler, Kawn Max Throughput Scheduler, Proportional Fair Scheduler, Max-Min scheduler and Resource Fair Scheduler. Among these schedulers, the Best channel quality index (CQI) scheduler performs better than other schedulers in term of throughput. Alternatively, the Round Robin and Fair Proportion schedulers are does not perform well under mobility conditions. The choice of optimal admission control and resource allocation for uplink traffic is discussed in [2] by Joint Admission Control and Resource Allocations algorithm. It focused on the transport layer resource allocations of Femto equipment along with interference aware resource allocation.

Once done with system architecture, we have simulated the above network with scheduling technique with Femto node (UE) immobility as well as in Femto node mobility. Under no mobility scenario, exponential scheduling at Marco eNB and fair proportional scheduling at FeNB combination shows better performance than other possible combinations. However, in mobility condition, MLWDF at Marco eNB and exponential scheduling at FeNB shows the better combination. To improve the system performance, we consider a channel quality awareness based feedback technique along with best possible combinations of scheduling under immobility and mobility scenario. Such consideration is named as heterogeneous CQI based scheduling techniques (HCBST). Channel quality awareness is identified by means of channel quality index that generally has 4 bits and numbered from 1-15. Based on the choice of the number, respective adaptive coding and modulation is carried out as shown in Table I. Further, to reduce the number of feedbacks, an M-Feedback CQI technique is considered in HCBST. In M-Feedback CQI, each subcarrier is divided into many sub channels and each user compute the SNR on this sub channels and send the indices. Based on the sub channels indices base station choose the highest index. The range of signal to noise ratio (SNR) and its respective indices is shown in Table VII.

II Effect of CQI IN BEST POSSIBLE COMBINATION

A. *Path Loss (PL) Model:*

The path loss model considered for simulating the Femto LTE scenario follows urban model and the following describes the path loss (PL) for UE and FUE is as follows:

- PL= 15.3 dB + 37.6log10(R_UE/m_eNB) for outdoor UE
  Where R_UE is the distance between UE and eNB and m_eNB is the Macro cell coverage
- PL= 15.3 dB + 37.6log10 (R_FUE/m_HeNB) +Low for indoor FUE.
  Where R_FUE is the distance between FUE and HeNB and m is the Femto cell coverage

TABLE VII. LTE-A CQI with ACM

CQI	Modulation	SNR(dB)	Code rate
0	Out Of Range	Out Of Range	Out Of Range
1	QPSK	-7.27	1/12
2	QPSK	-4.96	1/9
3	QPSK	-2.06	1/6
4	QPSK	0.61	1/3
5	QPSK	2.81	½
6	16 QAM	4.69	3/5
7	16 QAM	6.29	1/3
8	16 QAM	8.69	½
9	16 QAM	11.37	3/5
10	16 QAM	13.11	½
11	64 QAM	16.44	½
12	64 QAM	19.62	3/5
13	64 QAM	23.01	¾
14	64 QAM	26.19	5/6
15	64 QAM	28.66	11/12

Fig. 14 and 15 display the flow chart of HCBST algorithm. It consists of five iterations. In each iteration user equipment changes its position. Initially set i=1. Create a scenario of Marco first along with its equipment. After that deploy Femto cell inside it. While deployment of Marco and Femto assigned the respective scheduling techniques shown in Fig3 and Fig4. In case of mobility condition, hand-off aware resource allocations are to be done based on the velocity. Once done with above configuration, next task is to assign the CQI based technique. The CQI feedback checks the channel condition and measures its performance in term of SNR. Based on the SNR, adaptive coding and modulation mechanism is carried out explained in Table VII. This process is carried out continuously until i>5. Once i>5, its reach to the end command.

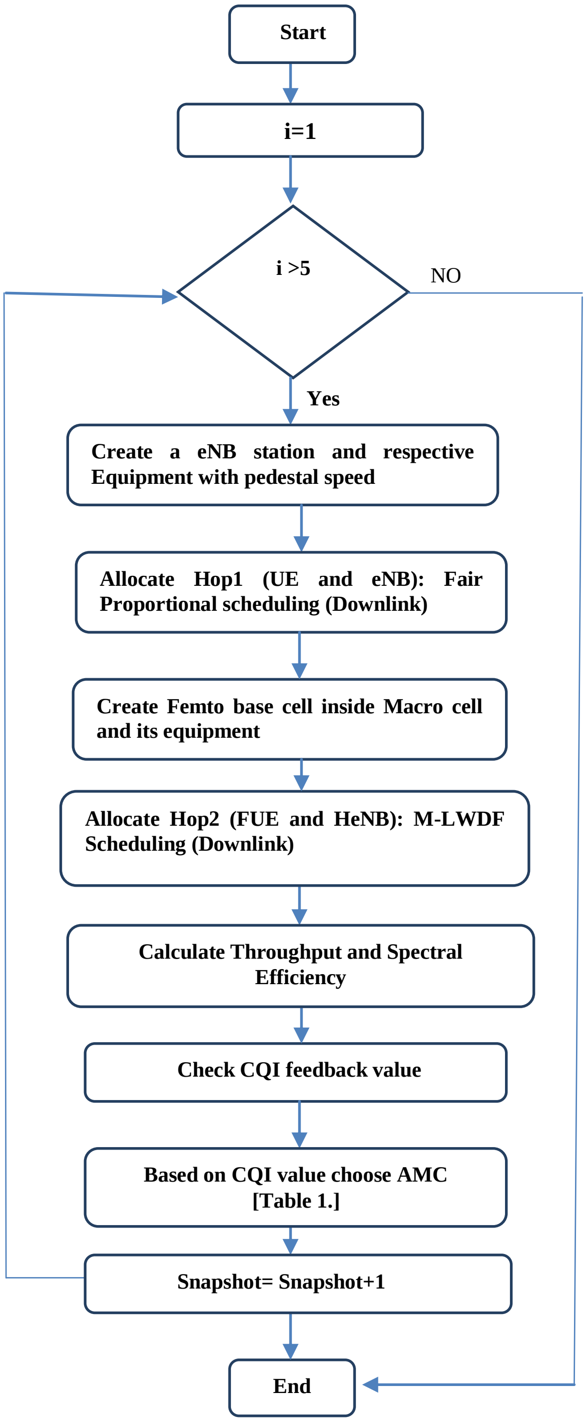

Fig 14: Flow chart of Femto-Marco with EXP-FP-CQI and without mobility scenario

Results and Discussion

The paper used different combination of scheduling with mobility and without mobility status. The Cellular terrain is chosen distance of 10km hexagonal shape. To distinguished the eNB and HeNB, set the power level preciously i.e. for eNB 46dBm and for HeNB 23dBm. All the simulations parameters describes in details shown in Table VIII.

Table VIII. Simulation Parameter

PARAMETERS	VALUES
Cellular Layout	Hexagonal grid
Inter-site distance	500 m
Carrier Frequency	2000 MHz
Shadowing standard deviation	8 dB
Shadowing correlation	Between cells: 0.5 fixed Between sites: 1.0 fixed
Macro/Femto UE noise figure	9 dB
Maximum FUE velocity 3 km/h	3 Km/hr.
Number of Tx, Rx antennas for Macro and Femto	2x2
Total macro eNB TX power	46 dBm
Total femto HeNB TX power	20 dBm
Minimum distance between eNB and macro eNB	2 Km
Minimum distance between eNB and Femto HeNB	20 m

Table IX show the list of abbreviation used for the simulation.

Table IX. Abbreviations used in simulations

Parameters	Scheduling used in Marco	Scheduling used in Femto
FP-ML	Fair Proportional	MLWDF
FP-EXP	Fair Proportional	Exponential
ML-EXP	MLWDF	Exponential
ML-FP	MLWDF	Fair Proportional
EXP-FP	Exponential	Fair Proportional
EXP-ML	Exponential	MLWDF
EXP-FP-CQI	Exponential With CQI	Fair Proportional With CQI
ML-EXP-CQI	MLWDF With CQI	Exponential With CQI

A. *Heterogeneous scheduling in Macro-Femto scenario under immobile FUE*

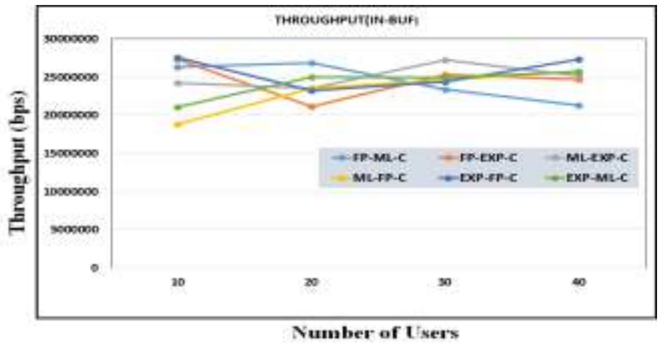

Fig. 16 Throughput of the heterogeneous network with IN-BUF application without node mobility

The curves in Fig. 16 show the throughput of heterogeneous scheduling in Macro-Femto scenario under immobile node with INF-BUF application. EXP-FP show better performance in case of immobile node. For the considered scenario an average throughput of 25.633 Mbps, which is 2.145% better compared to the second best ML-EXP based resource allocation. The resource allocation by ML-FP exhibits a least throughput of 23.195 Mbps due to inappropriate combination of scheduling at Macro eNB and Femto HeNB. Through the curves, it could be inferred that the throughput of FP-EXP changes drastically with increase in the number of users.

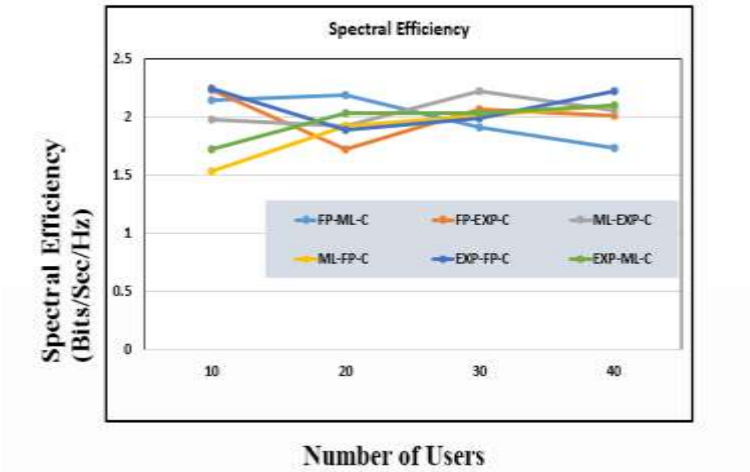

Fig. 17 Spectral efficiency of users in heterogeneous resource allocations with immobile node

The curves in Fig. 17 display the spectral efficiency of heterogeneous scheduling in Macro-Femto scenario under immobile nodes. Among the schedulers, the EXP-FP shows the best spectral efficiency of 2.085185 b/s/Hz. Conversely, the ML-EXP show least spectral efficiency of 1.8831 b/s/Hz. Among these schedulers, the EXP-FP shows an improvement of 10.7315% than ML-EXP. If we observe the immobile node scenario, exponential scheduling is used in Marco, where nodes are in mobile condition. In addition, FP shows best performance in Femto immobile condition. It tries to maintain the maximum throughput along with minimal service to the users. Further, exponential scheduling is better for high mobile conditions.

B. Heterogeneous scheduling in Macro-Femto scenario under mobile FUE

The curves in Fig. 18 display the throughput of heterogeneous scheduling in Macro-Femto scenario under mobility conditions. The scheduling with ML-EXP shows the best possible combination under mobile condition. It gives throughput of 24.833 Mbps. Alternatively, the ML-FP shows minimum throughput of 23.54 Mbps. Further, it result in 5.49277 % less as compared to ML-EXP based resource allocation.

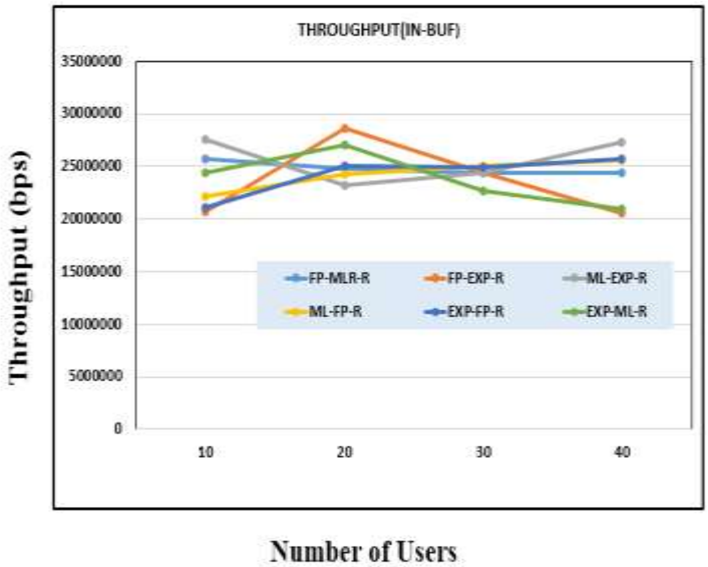

Fig. 18 Throughput of the heterogeneous network with IN-BUF application with node mobility

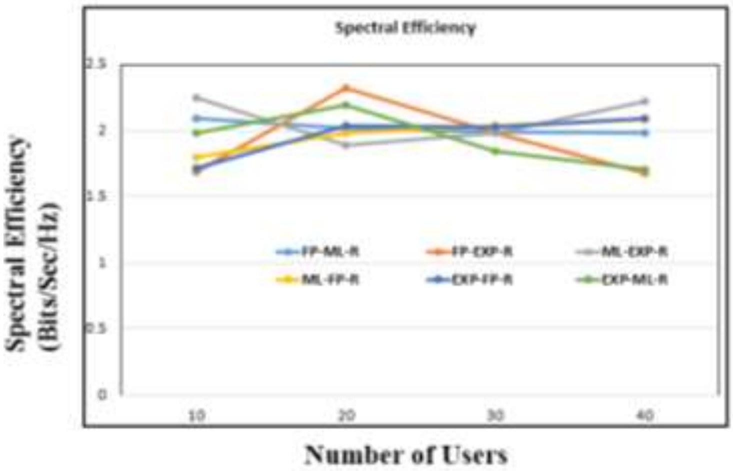

Fig. 19 Spectral efficiency of users in heterogeneous resource allocations with mobility

The curves in Fig. 19 display the spectral efficiency of heterogeneous scheduling in Macro-Femto scenario under mobility. The ML-EXP scheduling shows the best spectral efficiency of 2.0123 and ML-FP show least performance, which correspond to a spectral efficiency value of 1.97365. The ML-EXP scheduler performs 1.9315 % perfect better than ML-FP scheduler. Hence, ML-EXP is considered as the best combination under mobility condition. Here, ML-EXP resource allocation considers Marco eNB with MLDWF scheduling and Femto HeNB using exponential scheduling. In this scenario, we can observe that FP scheduling has not been chosen for scheduling. The reason behind is FP is not suitable candidate in mobile condition. MLDWF is suitable for high mobile condition because it generally ensure that delay packet probability doesn't exceed the minimum allowable packet loss. Exponential scheduling is more suitable for multimedia service and can stands well in mobile condition.

C. EXP-FP and EXP-FP-CQI in Femto node immobile scenario

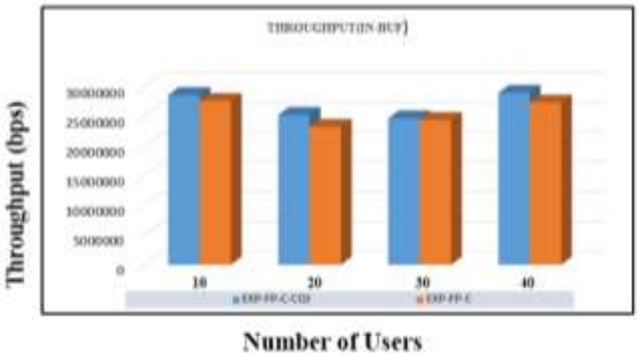

Fig 20. Throughput Comparison of EXP-FP-C-CQI with EXP-FP-*C*

The bar graph in Fig. 20 and Fig. 21 display the throughput comparison between EXP-FP-CQI and EXP-FP-C scheduling under Femto node immobility conditions. From the graph it can be observed that EXP-FP-CQI show better performance compared to EXP-FP scheduling. In particular, the EXP-FE-CQI scheduling provide a throughput 26.128 Mbps and spectral efficiency 2.1231 b/s/Hz. It is 1.8945 % and 5.504% better in term of throughput and spectral efficiency as compared to EXP-FP-C scheduling.

Fig 21. Spectral Efficiency Comparison of EXP-FP-C-CQI with EXP-FP-*C*

D. EXP-FP and EXP-FP-CQI in Femto node mobility

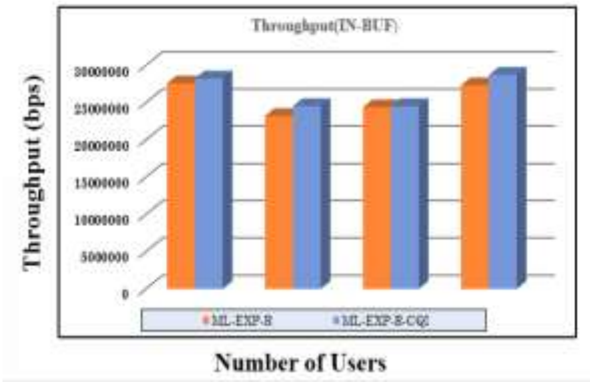

Fig 22. Throughput Comparison of ML-EXP-R-CQI with ML-EXP-*R*

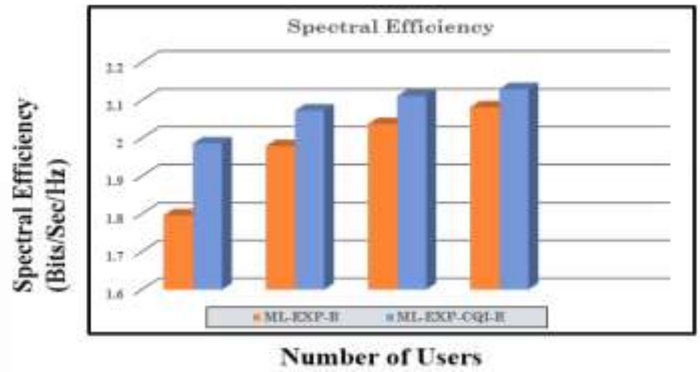

Fig 23. Spectral Efficiency Comparison of ML-EXP-R-CQI with ML-EXP-*R*

The bar graph in Fig. 22 and Fig. 23 display the throughput comparison between ML-EXP-R-CQI and ML-EXP-R scheduling under Femto node immobility conditions. Here, ML-EXP-R-CQI based scheduling show better performance compared to ML-EXP-R based scheduling. In particular, ML-EXP-R-CQI gives a throughput 25.128 Mbps and spectral efficiency of 2.1324 b/s/Hz. Further, it is 1.1879 % and 2.85 % better in term of throughput and spectral efficiency as compared to ML-EXP-R based scheduling.

Table X. Mean comparison of the scheduling mechanisms with Femto immobile nodes

Scheduling Type	**Throughput (Mbps)**	**Spectral Efficiency (b/s/Hz)**	**Delay (μsec)**
Existing [5]	13.26	1.54	113.12
FP-ML	24.47	1.9927375	62.11
FP-EXP	24.62	2.003925	61.73
ML-EXP	25.05	2.001575	60.67
ML-FP	23.195	1.8880975	65.53
EXP-FP	25.633	2.01234	59.29
EXP-ML	24.19	1.96886	62.38
EXP-FP-CQI	26.128	2.1231	57.8689

Table XI. Mean comparison of the scheduling mechanisms with Femto node mobility

Scheduling Type	Throughput (Mbps)	Spectral Efficiency (b/s/Hz)	Delay (μsec)
Existing [18]	13.26	1.54	113.12
FP-ML	24.64	2.021945	60.90
FP-EXP	23.54	1.9166475	64.27
ML-EXP	24.833	2.085185	60.886
ML-FP	24.622	1.97365	61.44
EXP-FP	24.19	1.96886	62.54
EXP-ML	23.79	1.9329075	63.55
ML-EXP-CQI	25.128	2.1342	60.17

This chapter showed the detail discussion of resource allocation in scenarios with Femto immobile nodes and with Femto node mobility. In Femto immobile nodes, exponential scheduling at Marco eNB and fair proportional at Femto eNB shows the better performance. However, with M-Based CQI consideration, the performance of the combined scheduler is increased by 1.8945 % and 5.504% better in term of throughput and spectral efficiency than the heterogeneous scheduler without considering CQI. Similarly, in case of Femto node mobility, MLDWF scheduler at Marco eNB and exponential at Femto eNB showed the best possible combinations. In addition, with combining M-Based CQI with the aforementioned heterogeneous scheduler, the system performance is increased by 1.1879 % and 2.85 % better in term of throughput and spectral efficiency than without considering CQI.

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