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Optimization a Scheduling Algorithm of CA in LTE ADV

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Abstract
Long-Term Advancement Progressed (LTE-ADV) is the advancement of the long-term evolution, which created via 3GPP. LTE-ADV aims to offer a transmission bandwidth of (100) MHz by using Carrier Aggregation (CA) to aggregate LTE-ADV carriers. To increase the data capacity of the system and resource allocation converts a very good tool. LTE-Advanced multiple Component Carriers (CCs) becomes a difficult optimization problem. In the paper proposes a new scheduling algorithm and compares with a different scheduling traditional algorithms that are proportional fair and round robin in the CA, in order to find the best scheduler that provides high-quality throughput and improves fairness. It also evaluates mapping model types are Mutual Information Effective SINR Mapping (MIESM) and Exponential Effective SINR Mapping (EESM). The results show that the throughput in the proposed algorithm with MIESM outperforms from others mapping and scheduling.

Keywords: component carrier (CC), SINR, carrier aggregation (CA), LTE-ADV

1. Introduction

The LTE-ADV is built to meet high-speed data & voice support along with multimedia broadcast services. LTE-ADV arrangements with the greater information rate that utilized over wide-ranging transmission transfer speed [1]. The 3GPP standard productions of LTE-ADV gave that the pinnacle information rate is 1.5 Gbps for every second in the uplink over a versatile data transmission ranges from (20 – 100) MHz and 3 Gigabits for every second (Gbps) in the downlink. LTE-ADV addition a new system to LTE release 8. These systems converted a part of LTE-ADV Rel. 10. To increase the data rate associated with the one made in [2, 3] four non-continuous components (CC).

The support of this paper is to appliance LTE-ADV carrier aggregation with scheduling by using the Matlab software. This paper achieves a high speed of data transmission through a bandwidth (100) MHz by applying different mapping models of algorithm and Scheduling.

Aggregation of above to 5 (20) MHz, CCs are right now upheld in the 3GPP determinations, in this way taking into consideration a, (100) MHz achievable data transfer capacity for LTE-ADV clients [4–7]. However, the crowded spectrum makes it virtually impossible to allocate an unfragmented) 100(MHz band for LTE-ADV clients. Therefore, CA is not contiguous.

Moreover upheld, the place totaled CCs be the able stay of various switch speeds or beyond the same yet distinctive groups. Muti-RAT (Radio Access Technologies) CA is every other vicinity over main research, into which the CCs of the companies bear been placed between unique RATs. It anticipated that within after versions of LTE, CA pleasure show up in one of a kind 3GPP yet non-3GPP technologies, such as much WiFi, permitting a greater efficient use over the reachable spectrum.

While the scheduler in the MAC layer of the base station (eNodeB) attempts to make an appropriate apportionment of the resources with certain objectives like Required QoS for real-time applications, optimized spectral efficiency ensuring high throughput under existing channel conditions, Fairness among UEs and real applications and Load balancing among cells.

In [8] the evaluation concerning the authors of the L2S interface was once based over the Multiple Input Multiple Output (MIMO) primarily based on the LTE system. Several models have been considered. Author analysis has covered various MIMO transmission mode of LTE such as Spatial Multiplexing (SM) and Transmit Diversity (TxD).

In paper [9] authors act that by separating the parcel scheduler into a frequency and time domain additionally utilizing those utilizing using different algorithms, the throughput reasonableness between clients can be adequately controlled. Authors [10] examine yet to reflect on consideration on the argument over scheduling algorithm kinds: Proportional Fair then Round Robin scheduling algorithms for Constant Bit Rate.

In this paper, we evaluate the effect of scheduling algorithm with throughput performance. It is found that the proposed algorithm is the best concerning data transfer rate and equality in distribution. This paper organized namely takes after: section two represents a define regarding LTE-ADV, CA, SINR mapping and scheduling algorithms. The simulation end results in regard to spoken after of section 3 finally, section four concludes the paper.

2. Overview of LTE-ADV

3GPP defines three channels of control, a random access channel (DRACH), a physical transmission channel (PBCH) and a shared data channel (PDSCH) and reference signals for the LTE downlink. The control channels are transmitted in the control region at the beginning of each subframe; that is, in the 1st, 2 or 3 OFDM symbols [4], and the PBCH is plotted on the 72 central subcarriers (6 RB) of the available bandwidth. Figure 1 illustrates how the aforementioned logical channels mapped on physical channels in a 20 MHz transfer scenario situation (100 RB) [11]. 3GPP describes two synchronization message, the primary "synchronization" and secondary synchronization" messages correspondingly (P-SS and S-SS), which are used for the search and synchronization procedures of the UE cells. Note that in LTE, the time 'divided into '10' ms' frames, each frame divided into '10' sub frames and each subframe divided into two-time-slots [12,13]. At last, a slot partitioned into 7-OFDM symbols images (or 6 slots in the situation of amplified OFDM-cyclic-prefix).
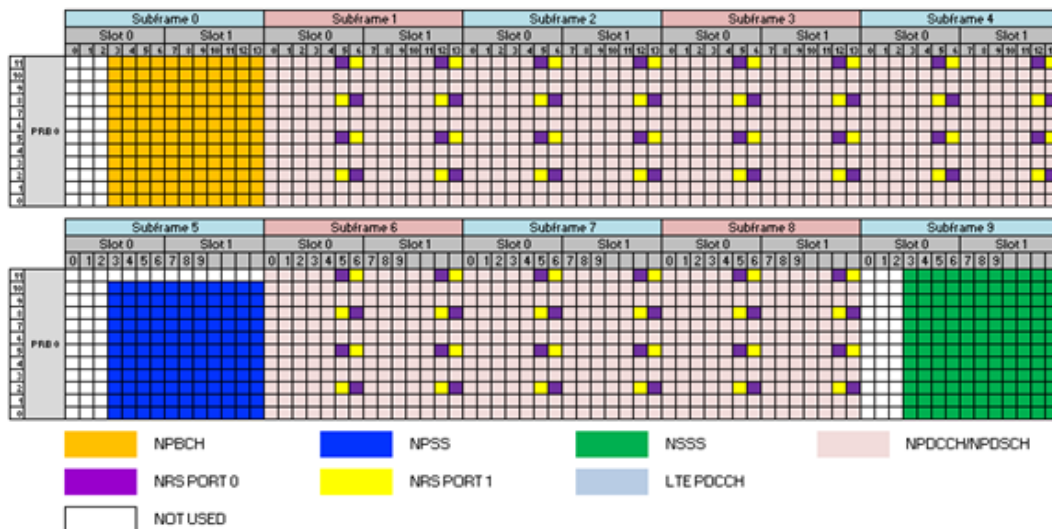

Figure 1. Logical-to-physical downlink channels mappings

Figure 1 one frame mapping, where these mappings rehashed for-the-taking after frames. In the domain of frequency, furthermore, 100 blocks of frequency are available within a bandwidth of (20) MHz. Each block of frequency is of 12 sub-carriers over 15 kHz or consequently implies one hundred eighty kHz. A frequency barrier concerning one hundred eighty kHz for the duration over a symbol is known as a resource block (RB). Finally, inside every RB, the signal references are targeted resource elements (RE) inside a pattern so much optimizes the addition and equalization of the channels, wherever a resource element is a symbol of 15 kHz sub-carrier OFDM that is presented for the_transmission. Every resource block, therefore, includes 7x12=84 blocks of resources in the normal cyclic prefix.

LTE -A is designed to support the distribution of multimedia services with IP-based, and network architecture by the division to orthogonal frequency Multiple access (OFDMA) Depends on air interface technology. LTE-ADV release-10 has characteristics, such as MIMO (Multiple Output Multiple Output) transmission, multipoint coordinate transmission and reception "COMP" and retransmission. One of the most important features of LTE-ADV described and applied in this research (subsection below) is the CA of operators.

2.1. Carrier Aggregation (CA)

LTE-ADV completely fulfills these necessities and indeed surpasses them in a few viewpoints [6]. CA is some about the foremost capabilities regarding LTE-ADV recommend Figure 2. The idea of CA presents in this section, its implementation modes and scenarios. For data on other progressive procedures, which were presented in LTE-ADV, the fascinated reader is reported [14], these procedures and studies challenges of research for LTE-ADV are summarized. CA points on accomplishing higher information peak rates, getting transfer speed up to (100) MHz for LTE-ADV clients, whereas keeping up with the existing up to 20 MHz transmission capacity in reverse compatibility for LTE-ADV clients. It is the method of gathering numerous LTE CCs to permit LTE-ADV gadgets to utilize carrier to attain higher transmission capacity. CA perform be accomplished among a mode of contiguous (i.e., the accumulated CCs are contiguous among frequency domain) then between a non-contiguous mode.
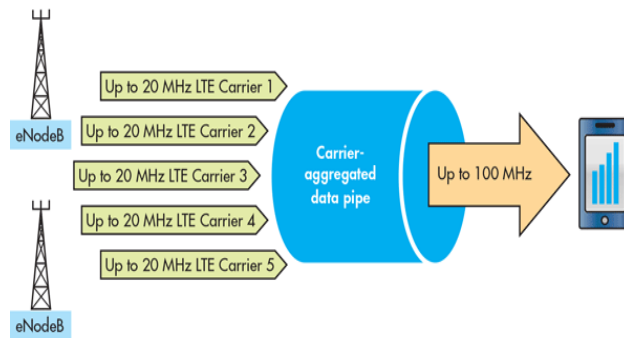
Figure 2. Carrier aggregation concept

Furthermore, non-contiguous CA performs utilize CCs from distinctive groups or same band as appeared in Figure 3. One result of this prerequisite is that allocation of contiguous resources of over (20) MHz-for-an LTE-ADV transmission client is not conceivable since this implies which the client information transmission would involve the regulator locales at the band edges. For it cause, the LTE-ADV access structure contains the grouping of the allocated bandwidth in blocks of (20). MHz [15,16].
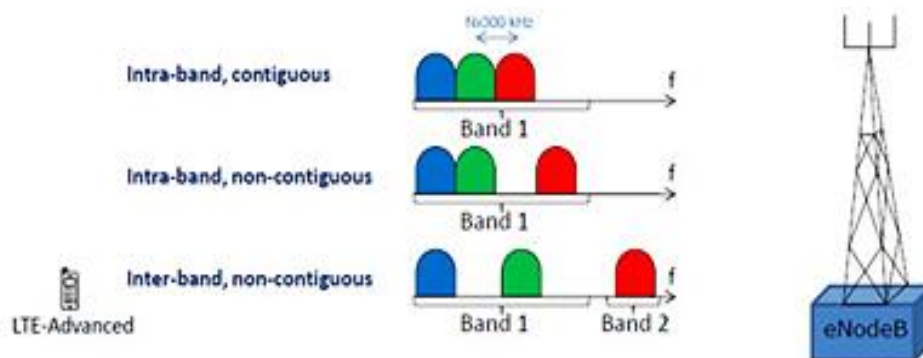
Figure 3. Carrier aggregation modes

2.2. SINR Model Mapping

The PHY abstraction, which is also called system link assignment and interface expectation, affords such large-scale simulations interface for system level simulators and link level. The abstraction of the PHY the flat frequency channels is rather unimportant since the average of the quality of the channels is sufficient for the mapping of the quality of the connection, but the of evaluation and execution for the high selective channels of frequency is not so unimportant.

In general, it is primarily due to the lower bandwidth coherence concerning the bandwidth signal that gives rise to the state of multi-channel in the collector. Though, to solve this problem, numerous link abstraction procedures have been evaluated in the drafting of these state multi- channels. EESM placed in the level of system assessments since then EESM has broadly utilized for quality system link [17]. EESM could be a reasonable for LTE wireless systems 3GPP preference or such outperforms the mean plans [18]. Advance it is outlined with the results which exercise of link abstraction is the used channel model independent. While in our outcomes it has been detected that if the exercise is done on a large number data set of embodiments of channels agreeing to frequency selective channel high, then the resulting adjustment can model a different extension of multi channels-state. The effective SINR mapping based on mutual information (MIESM) works much better concerning complexity and execution than other approaches [19].

2.3. Scheduling Algorithm

The scheduler logic is similar according to some multiplexer among who a packet that will remain forwarded additional is saved within a buffer so many purposes namely a queue system. The buffer space is cloven in a number of lines, every one as is back to keep the packet of a sequence, as is characterized by using the source and destination IP addresses. In some situation, the programming of the network algorithm decides just how the network community of the buffer check [20–23].

2.3.1. Round Robin (RR) Scheduling

RR is the best scheduler, which disperses the assets similarly to all the clients. It works by apportioning the resource blocks to the non-unfilled Radio link control (RLC) "queues in cyclic order. These non-empty RLC "lines are also referred" as active streams. If all the flows are apportioning to much of RBGs (Resource block Group) and they all are transmitted within in sub frame of the same. Otherwise, on the off chance that a few of the streams are cleared out unassigned at that point the assignment within the next frame will begin from the final. The modulation and coding scheme for (MCS) distinctive transmission channels distributed agreeing to the received Channel Quality Indicator (CQI).
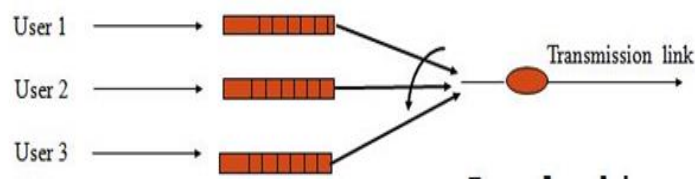

Figure 4. RR scheduling mechanism

2.3.2. Proportional Fair (PF) Scheduling

PF supports the high use of resources while maintaining good equity between network flows [24,25]. A user is likely to be programmed when the quality of the immediate channel is high compared to its normal channel condition over time. Let Ml be MCS assigned to a client depending upon the corresponding CQI.

When (Mj, B) Mj is the TBS where B is the No. of RB, used. The RB number is decided based on the bandwidth of the transmission channel. Where (t) be the last normal throughput customer performance j. Thus, the rate obtainable by the client given by

$$R(k,t) = \frac{S(Mj,B)}{\tau} \tag{1}$$

where τ is time interval of the transmission. Scheduling of the users done concurring to the taking after relation.

$$l(k,t) = \underset{j=1\ldots N}{\mathrm{argmax}}(R(k,t))/T \tag{2}$$

$$\left.\begin{aligned} Tj &= (1-\lambda)\,Tj\,(t) + \lambda Tj * (t) \\ &= (1-\lambda)j\,(t) \end{aligned}\right] \qquad \begin{aligned} &\text{if j is schedule} \\ &\text{otherwise} \end{aligned}$$

λ is a constant, which is very close to unity. $Tj^{*}(t)$ is throughput actual accomplished by user the actual the j in the sub frame t.
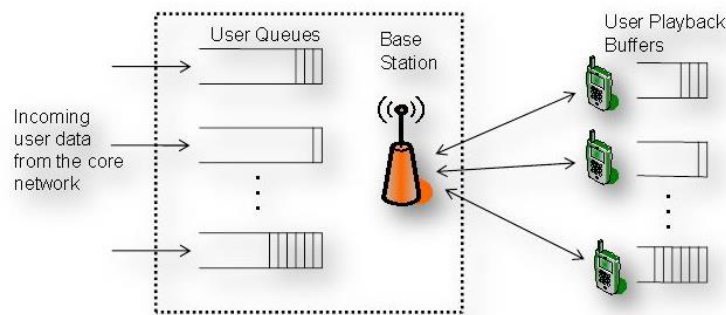

Figure 5. PF scheduling mechanism

2.3.3. Proposed Algorithm Scheduling

The scheduler maximizes the data of the base station. The greatest throughput accomplished by distributing assets on the premise of channel condition as it were. The client with the largest value of CQI index wideband scheduled first. The scheduling and calculation of the throughput is very similar to algorithm of PF expect divided by T. Achievable throughput for sub frame t is given by (1)

$$l(k,t) = \underset{j=1\ldots N}{\mathrm{argmax}}(R(k,t)) \tag{3}$$

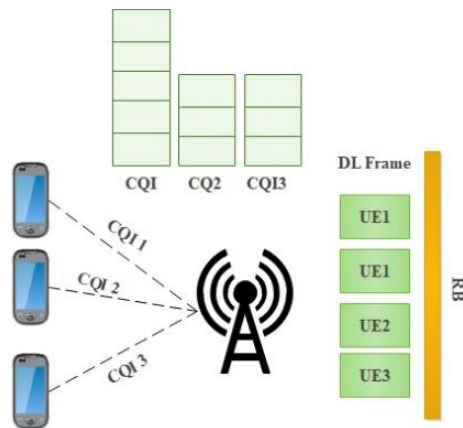thus, it selects the client with highest throughput.

Figure 6. Proposed scheduling mechanism

3. Simulation Results

Different number of UEs are set arbitrarily in two-sector sector of two eNodeB as shown in Figure 7. The parameters of simulation utilized are decided by the 3GPP simulation cases. Performance with PF, RR and proposed scheduling [9]. It was observed from 10 to 30 EUs with various distances from the eNodeB and the mapping of UE is described in Table 1.
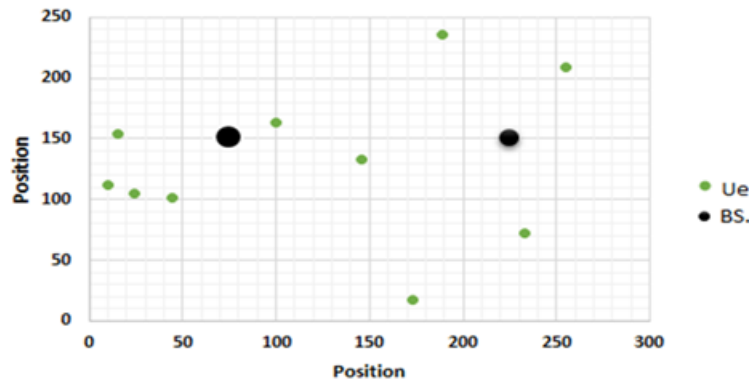

Figure 7. Shows LTE advanced nodes

Table 1. Parameters of Simulation

Parameters	Assumptions
heightUE	1.5
mobilityModel	Random Way Point
multipathModel	3GPP
powerUE	20 dB
Maximum number of carrier component	5
heightBS	30
powerBS	46 dB
Frequency band	[800 1800 2000 2800 2900]
fft_size	2048

In Figure 8 shows, that RR more sent data is 242 Mb/s at 15 numbers of UEs because RR is less efficiency of resource allocation and this algorithm some of the streams are left unassigned, so the assignment in the next frame will start from the last stream that was not assigned.
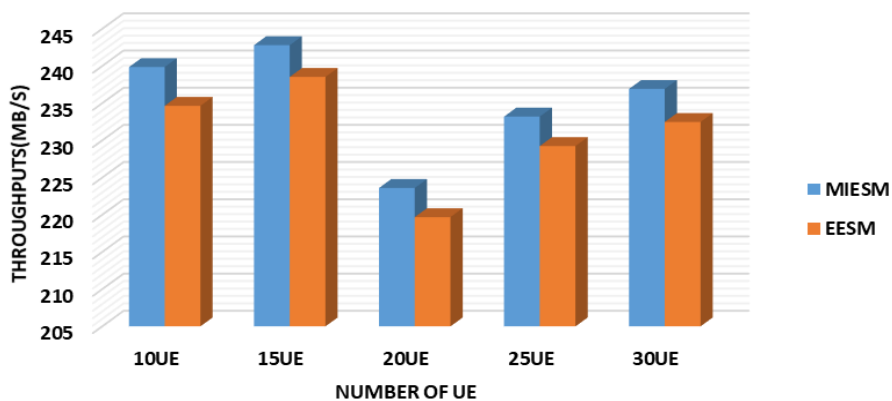

Figure 8. Simulation results for throughput (Mbps) vs UEs for RR

In PF present in Figure 9, almost the same throughput with different number of UEs except when the number 30 of Ues. This algorithm is more outperform from RR Regarding the amount of data sent, and the stability of data transfer rate is 283 MB/s with different numbers of UE because this algorithm admits a high use of resources while maintaining good equity between the network flows.
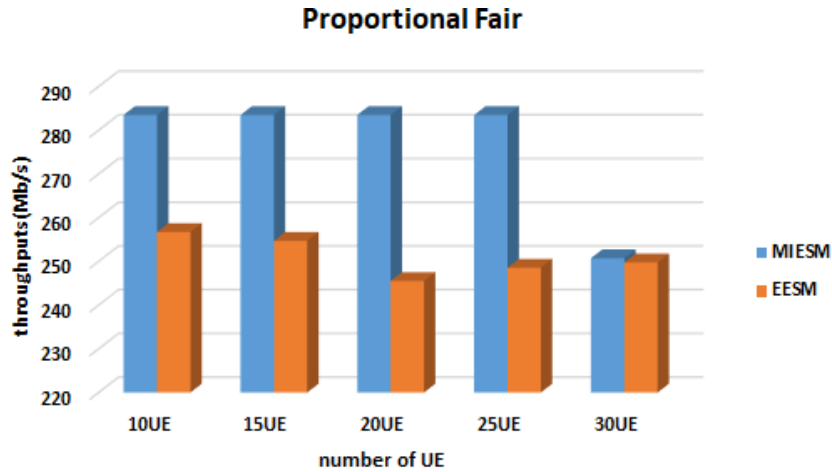

Figure 9. Simulation results for throughput (Mbps) vs UEs for PF

Figures 10 and 11 show the proposed algorithm is better than the previous algorithms concerning the transfer rate of data transfer to the highest number of users, the worst case of throughput when the number is 10 UEs this rate is equal 282 MB/s. This algorithm is more efficient because it depends on channel conditions.
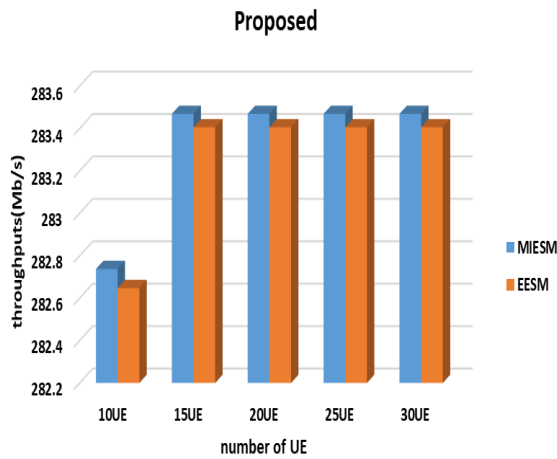

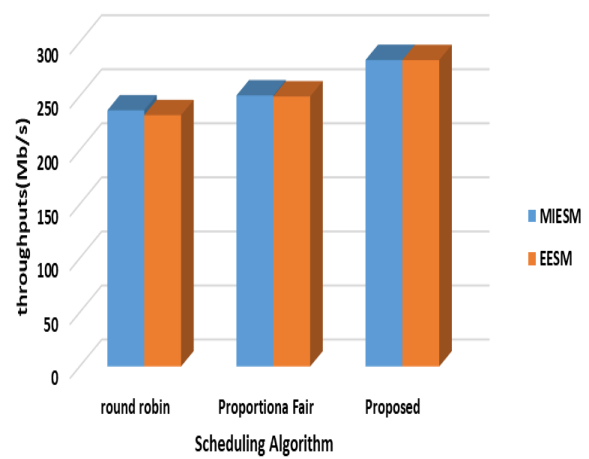Figure 10. Simulation results for throughput (Mbps) vs UEs for proposed

Figure 11. Simulation results for throughput (Mbps) and different scheduling algorithm

4. Conclusion

This paper has compared the performances Carrier Aggregation between Traditional scheduling algorithm (RR and PF) and the proposed algorithm by using two type of SINR. It has found the performance of the proposed algorithm with MIESM could provide more the throughput and the fairness better than PF and RR for various UEs at EESM and MIESM, Regarding data transfer rate and in the equal distribution among the number of users. Also,

results show the small gap between two SINR mappings in the proposed algorithm, unlike the other two algorithms. RR algorithm neglected users CQI feedback, which led to degradation in system show. PF was not good when the user fair distance from the base station.

References

[1] Sirait F, Dani AW, Pangaribowo T. Capacity Improvement and Protection of LTE Network on Ethernet Based Technique. *TELKOMNIKA Indonesian Journal Electrical Engineering*. 2018; 16(1): 200-9.
[2] Mostafa W, Mohamed E, Zekry A. Software implementation of LTE - advanced using matlab Simulink. *Int J Eng Technol*. 2017; 6(4): 116-23.
[3] Mohamed MA, Raslan WM. Performance Analysis of LTE-Advanced Physical Layer. *Int J Comput Sci*. 2014; 11(1): 80-7.
[4] Galih R. Carrier Aggregation Technique to Improve Capacity in LTE-Advanced Network. *TELKOMNIKA Telecommunication Computing Electronics and COntrol*. 2016; 14(1): 119-128.
[5] Mai Y, Chen J. *IP Multimedia Relay Architectures with Multi-RAT Support in LTE-Advanced*. 7th Asia Model Symp. 2013: 283-8.
[6] Alkhansa R, Artail H, Gutierrez-estevez DM. LTE-WiFi Carrier Aggregation for Future 5G Systems : A Feasibility Study and Research Challenges. *Procedia - Procedia Comput Sci*. 2014; 34: 133-40.
[7] Stefania S, Issam T, Matthew B. LTE, the UMTS long term evolution: from theory to practice. A John Wiley and Sons, Ltd. 2009; 6: 136-144.
[8] Hanzaz Z, Schotten HD. *Analysis of Effective SINR Mapping Models for MIMO OFDM in LTE System*. 9th International Wireless Communications and Mobile Computing Conference (IWCMC). 2013: 1509-15.
[9] Trivedi RD, Patel MC. Comparison of Different Scheduling Algorithm for LTE. *Int J Emerg Technol Adv Eng*. 2014; 4(5): 334-9.
[10] Mohankumar NM, Devaraju JT. Performance Evaluation of Round Robin and Proportional Fair Scheduling Algorithms for Constant Bit Rate Traffic in LTE. *IJCNWC*. 2013; 3: 41-5.
[11] Soni G, Verma C. *Performance Investigation of LTE Systems based on NI PXIe-5644R Vector Signal Transceiver*. Global Conference on Communication Technologies (GCCT 2015). 2015: 755-60.
[12] Mohammed EIRVS. LTE-Advanced: Technology and Performance Analysis. Thesis: University of Vaasa Faculty. 2011.
[13] Yonis AZ, Abdullah MFL, Ghanim MF. LTE-FDD and LTE-TDD for Cellular Communications. 2012: 1467-71.
[14] Akyildiz IF, Gutierrez-estevez DM, Balakrishnan R, Chavarria-reyes. LTE-Advanced and the Evolution to Beyond 4G (B4G) Systems. *Phys Commun*. 2013.
[15] Zhang R, Zheng Z, Wang M, Shen X, Xie LL. Equivalent capacity in carrier aggregation-based LTE-A Systems: A probabilistic analysis. *IEEE Trans Wirel Commun*. 2014; 13(11): 6444-60.
[16] Hämäläinen J. The Future of LTE: The Femtocells perspective. 2013.
[17] Networks N. OFDM Exponential Effective SIR Mapping Validation, EESM Simulation Results for System-Level Performance Evaluations. 2004.
[18] Santos RB, Jr WCF, Stancanelli EMG, Cavalcanti FRP. *Link-to-System Level Interface Solutions in Multistate Channels for 3GPP LTE Wireless System*. Simp Bras TELECOMUNICACOES. 2007.
[19] Brueninghaus K, D Astely TS. *Link Performance Models for System Level Simulations of Broadband Radio Access Systems*. 16th International Symposium on Personal, Indoor and Mobile Radio Communications. 2005: 2306-11.
[20] Fouziya SS, Nakkeeran R. Study of Downlink Scheduling Algorithms in LTE Networks. *J Networks*. 2014; 9(12): 3381-91.
[21] Iosif O, Ion Banica. LTE Performance Evaluation Based on two Scheduling Models LTE downlink and uplink analysis. *Int J Adv Netw Serv*. 2012; 5(1): 58-68.
[22] Dikamba T. Downlink Scheduling in 3GPP Long Term Evolution (LTE). Thesis: Delft University of Technology. 2011.
[23] Lin C, Wang Y, Sandrasegran K, Zhu X, Fei J, Kong X. Frequency and Time Domain Packet Scheduling Based On Channel Prediction With Imperfect CQI in LTE. *Int J Wirel Mob Networks*. 2013; 5(4): 157-70.
[24] Dhameliya N, Bhoomarker R, Zafar S. *Maximization of throughput with advanced Proportional Fair algorithm for LTE-Advanced*. IEEE Students' Conference on Electrical, Electronics and Computer Science. 2014.
[25] Jalali A, Padovani R, Pankaj R. *Data Throughput of CDMA-HDR a High Efficiency-High Data Rate Personal Communication Wireress System*. VTC2000-Spring 2000 IEEE 51st Vehicular Technology Conference Proceedings. 2000: 1854-8.