Improving of Rate and Energy Efficiency in LTE based OFDMA System with Multicarrier Base Stations

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Abstract— Mobile devices have become an integral part of our daily lives to stay connected to the world around us. In our recent research it has been proved that roughly 49% of traffic has been increased due to the fast growing requirement and development. Green communication technology has led to many energy-saving designs in mobile networks. Because it is necessary to minimize the dependence of communication networks on nonrenewable energy sources, considering the critical importance of communications in economic growth and national security. Recently, the term "Green Communications" has been marketed as a solution to addressing the growing cost and environmental impact of telecommunications. One component carrier (cc) at base station where the decrement of complexity is very less. To control energy consumption, more than one component carrier (CC) can now be jointly utilized in a base station (BS) to regularize the energy consumption. In this paper, a novel green rate-and-power control transmission scheme is therefore proposed for the BS transmission to address the problem of energy minimization at BS transceivers subject to certain quality-of-service and fairness requirements for all users. OFDMA based multi CCs with BS in downlink transmission are considered for analysis. Simulation results demonstrate that the energy consumption of the proposed novel energy-saving scheme is much better than that of existing schemes.

Key words: LTE, OFDMA System, Multicarrier Base Stations

I. INTRODUCTION

Multi-antenna techniques cannot continuously increase transmission performance, because the constraints on terminal size, complexity, and cost limit the number of antennas that can be installed on a UE unit. In order to achieve the performance requirements of IMT-Advanced systems, carrier aggregation (CA) has been recently proposed in [3] to aggregate two or more component carriers for supporting high-data-rate transmission over a wide bandwidth (i.e., up to 100 MHz for a single UE unit), while preserving backward compatibility to legacy systems.

There are two types of CA techniques have been proposed for the LTE-Advanced mobile systems:

- Continuous CA when multiple available component carriers are adjacent to each other
- Non-continuous CA when multiple available component carriers are separated along the frequency band

In both cases multiple LTE/component carriers are aggregated to serve a single unit of LTE Advanced UE. Regarding UE complexity, cost, capability, and power consumption, it is easier to implement continuous CA without making many changes to the physical layer structure of LTE systems. It is possible to use a single fast Fourier transform (FFT) module and a single radio frequency (RF) component to achieve continuous CA for an LTE-Advanced UE unit, while providing backward compatibility to the LTE systems. In addition, compared to non-continuous CA, it is easier to implement resource allocation and management algorithms for continuous CA.

To improve the energy efficiency in LTE cellular systems Radio access network should be considered as the foremost. So far most existing scheme has focused on energy efficient algorithm. In that some schemes have been investigated here. The energy efficient algorithm scheme for allocating sub-carrier to the users. Water filling packet scheduling algorithm. Resource Blocks is allocated to the users by resource scheduling. Energy efficient power allocation algorithm for wireless channel with no QOS guarantee. Opportunistic RB allocation algorithm for LTE uplink network has less connectivity.

Novel layered dynamic resource allocation algorithm for spectrum sharing made high usage of spectrum. QoS aware energy efficient resource allocation algorithm for energy efficient in LTE made RB allocated to user which finds it work in low network load case and no Qos guarantee. In this paper resource and energy allocation algorithm has been implemented where it gets QoS and traffic load cases but not implemented in LTE networks. Resource allocation problem to QoS requirements of M2M and H2H users energy efficient resource allocation in uplink LTE networks under statistical QoS provisioning the dual problem.

Semi-Markov decision process (SMDP) model-based Stochastic optimization scheme for optimal trade-off between power saving and QoS provisioning over multicell cooperation networks to minimize the power consumption at base stations while QoS no Guarantee. The two-tier network for energy efficient transmission at Base station and many more schemes has been studied. Out of all none of the schemes has no algorithm has been satisfying Energy efficient in Base station and also QoS to the users. Hence this motivated me to do the project on energy efficiency in LTE networks using MIMO OFDMA. In this paper, our aim is to minimize the energy consumption in Base Station (BS) transceiver with the help of Multiple-In Multiple-

Out - Orthogonal frequency division multiple access systems based on multiple Carrier component (CC) and also certain Quality of Services (QOS) in LTE system.

II. BACKGROUND

A. Component Carrier

The signaling towards an end user device for carrier aggregation affects only certain layers, not the entire protocol stack. For instance, the device is permanently connected via its PCC to the serving Primary Cell. Non-Access Stratum (NAS) functionality such as security key exchange and mobility information are provided by the PCell. All secondary component carriers are understood as additional transmission resources. For the Packet Data Convergence Protocol (PDCP) and Radio Link Control (RLC) layer carrier aggregation signaling is transparent. A terminal is conFig. d on the Radio Resource Control (RRC) layer, to handle secondary component carriers.

Moreover, on RRC the parameters of the SCell(s) are conFig. d. The Medium Access Control (MAC) layer acts as multiplexing entity for the aggregated component carriers as they are activated or deactivated by MAC control elements. In case of activation in subframe n, than 8 subframes (8 ms) later the resources are available to the device and it can check for scheduling assignments. While the MAC acts as multiplexer, note that each component carrier has its own Physical Layer (PHY) entity, providing channel coding, HARQ, data modulation and resource mapping.

B. OFDMA

OFDMA is a technique that allots various clients to groups of orthogonal subcarriers so they can access the air interface in the meantime. The subcarrier mapper appeared in Figure (a) is key in executing OFDMA on the grounds that it is the subcarrier mapper that appoints clients to subcarriers. All the more precisely, it is the subcarrier mapper that doles out clients' information images to subcarriers. Figure and Figure demonstrate a train of OFDM signal along both time and recurrence measurements, and these figures thoroughly analyze OFDM and OFDMA in a circumstance where three clients (A, B, and C) might want to get to the air interface. There is a sum of eight subcarriers, and the figures indicate how these clients are deals with subcarriers as a function of time

Though OFDM assign one block (in time) to one client, OFDMA is a technique that deals with various blocks of subcarriers (in frequency) to various clients. Thusly, more than one client can get to the air interface in the meantime. Review that in OFDM all K subcarriers are utilized to convey information for one client as it were. OFDM deals with all subcarriers to a single user in the meantime, and one and only client can transmit at once. On the off chance that various clients need to transmit utilizing OFDM, then those clients need to go ahead in time. For instance, in OFDM every client can be allocated one OFDM image in time, and OFDM signals are allotted to their separate clients before OFDM signals enter the OFDM transmitter

C. Green Communication

Green Communication for 4G Wireless Systems for the most part covers vitality productive strategies in physical, MAC and system layers. Cross-layer vitality productivity improvement in time and recurrence has been additionally talked about with two basic tradeoffs, vitality proficiency and otherworldly effectiveness. This specialized prologue to Green Communication in 4G remote frameworks, clarifying the fairly complex gauges (3GPP Releases R10 and R11), is an absolute necessity read for architects, chiefs and understudies inspired by Green Communication, and in addition different analysts and researchers from this developing field.

Data and correspondences innovation utilization has developed at an amazing rate worldwide with an expected 6 billion memberships. Consistently, 120,000 new BS's are sent serving 400 million new versatile endorsers around the globe. The creating locales are progressively swinging to remote as a jump frog innovation bypassing settled foundation and the versatile membership increments for an element of ten. From 2000 till 2010, the versatile membership in created areas increments by around 200%, while that in creating locales increments by around 1300%. Measurements likewise appear that in 2000 around 40% of every single portable membership were credited to the creating scene and in 2009 this rate developed to around 70%.

III. PROPOSED METHOD

A. Admission Control Mechanism

The considered framework model is adroitly appeared in Fig. 1. The session-level transmission is expected in the model. Expect that the greatest number of sessions that every CC can suit is consistent indicated as S. At the point when a session demand arrives, the classifier in the framework will first group it into either RT or NRT session, and after that it will be sent to the booking line. Next, the confirmation control component is proposed to be utilized to Fig. out if to obstruct the session demand in the booking line and further which CC ought to be relegated to the session in the event that it is permitted to access the system.

B. Affirmation Control Mechanism

To begin with characterize $(m, j)_{RB}$ as the RB on the m^{th} time space and the jth subchannel. At that point characterize the perfect transmission rate of the $(m, j)_{RB}$ on CC k for supporting client session n as $r^{(k)}_{m,j\_n}$. Based on $r^{(k)}_{m,j\_n}$ can be given as

$$r_{m,j\_n}^{(k)} = \beta \log_2\left(1 + \frac{KP_{m,j}^{(k)}\left|H_{j\_n}^{(k)}\right|}{\beta N_0}\right) \quad (1)$$

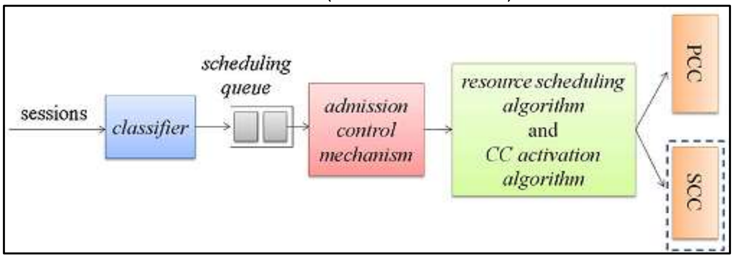

Fig. 1: Admission Control Mechanism

Note in (1) that is the channel pick up between subchannel N_0 is the commotion power unearthly thickness, j and client session n on CC k, β = 12 · 15000 is the data transmission in Hz for a RB, since one subchannel incorporates 12 subcarriers what's more, each subcarrier is characterized to have 15 000 Hz, K = −1.5 log(5B E R), where BER is the wanted (steady) piece blunder rate, and $P_{m,j}^{(k)}$ is the required transmission energy to accomplish $r_{m,j\_n}^{(k)}$ under the plan structure in (1). In light of (1), the transmission force of $(m, j)_{RB}$ on CC k can be given as

$$P_{m,j}^{(k)} = \frac{\beta N_0}{K\left|H_{j\_n}^{(k)}\right|}\left(2^{\frac{r_{m,j\_n}^{(k)}}{j}} - 1\right) \quad (2)$$

In like manner, the aggregate vitality utilization in this considered in the subframe on CC k indicated as E_k is given to be

$$E_k = \frac{t_{Sub\_frame}}{2} \sum_{(m,j)_{RB} \epsilon \Omega_k} P_{m,j}^{(k)} \quad (3)$$

Where t_{Sub_frame} edge is the length of each sub frame in seconds furthermore, Ω_k is the arrangement of all RBs in each subframe of CC k.

At the point when another session arrives, the system will in the first place do the vitality check by looking at E_k and $\rho\ E_{max}$where E_{max} implies the most extreme accessible vitality in each subframe also, ρ is the upper negligible element. In the event that permitted, the component will facilitate check the SCC status to recognize if the SCC can be utilized. Notice that the PreOnFlag is a pointer speaking to whether the new client session can get to the SCC. To be more point of interest, if PreOnFlag==0, the new session can't get to the

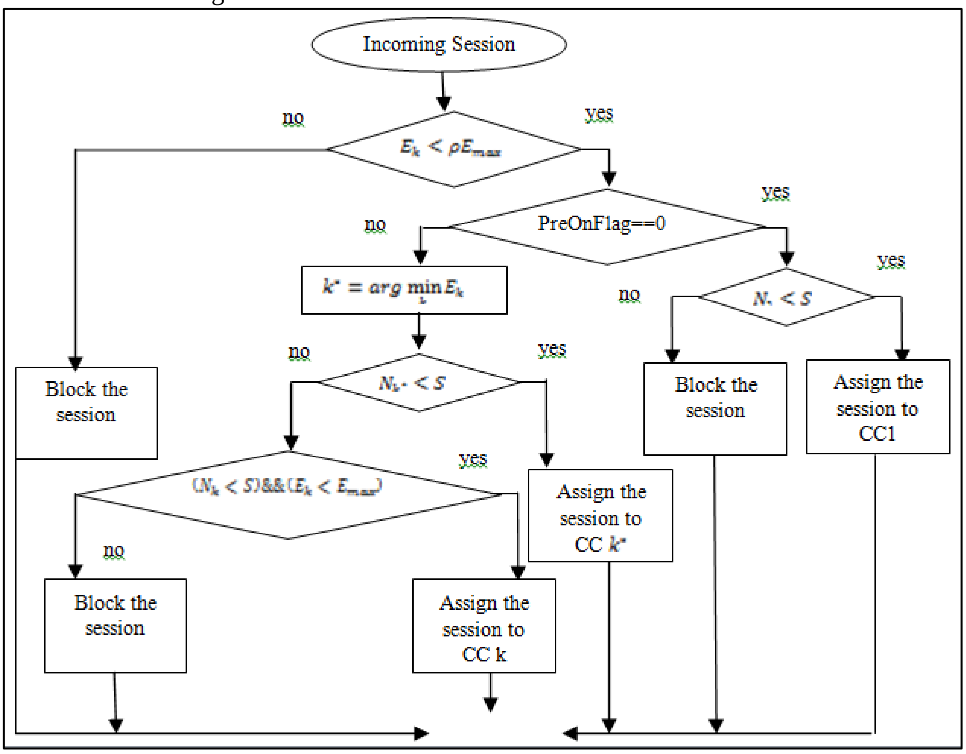

Fig. 2: Flow chart of the admission control mechanism

SCC regardless of the possibility that the SCC is still dynamic and the new session can just utilize PCC if N1 < S, where N_k speaks to the number of client sessions in the framework on CC k. In the other case, in the event that PreOnFlag==1, CC k* that has the base Ek will be chosen. Taking after that, the instrument will check whether $N_{k*} < S$. On the off chance that yes, CC k* will be doled out to the new session; something else, the instrument will promote check whether N_k < S furthermore, $E_k < E_{max}$ to Fig. out whether the new session can get to CC k. Notice that the operation and count of the system is executed toward the start of each subframe.

C. Objective of the Novel Energy-Saving Transmission

Scheme In view of the considered framework demonstrate, the aggregate vitality utilization in each subframe at the BS handsets is pointed to be minimized, while keeping up the blocking likelihood of all client sessions, the base required information rates for every kind of clients, and the reasonableness among all clients in an satisfactory level. To productively and adequately accomplish the above objective, a novel vitality sparing plan, which incorporates an asset booking calculation in Section III and a CC initiation calculation in Section IV, is proposed

D. Resource Scheduling Algorithm

The introduced asset booking calculation incorporates two calculations that are independently proposed for the operation as takes after: 1) vitality versatile rate control calculation (EARCA) also, 2) radio asset designation calculation (RRAA). The RRAA calculation is further isolated into two sub algorithms named B.1) data transfer capacity task calculation (BAA) and B.2) asset piece designation calculation (RBAA), separately. EARCA is intended to powerfully alter the NRT client's allotted limit in view of his/her way misfortune criticism and the current utilized vitality. After the NRT client's information rate is set, BAA decides what number of RBs ought to be doled out to each client session, while RBAA is utilized to encourage decide the set of RBs for those sessions.

E. Radio Resource Allocation Algorithm (RRAA)

RRAA is outlined on the premise of the asset allotment approach utilized, for its computational multifaceted nature advantage. Pseudo codes for the point by point operation are composed in Figs. 5 and 6, separately. In every choice age of each subframe, the BAA subalgorithm in Fig. 5 will be executed first. Every single remote client will criticism their channel additions to the BS so that found the middle value of squared channel increases can be computed as information contentions. Likewise, the quantity of required RBs for all the client sessions will be set to 0 at first. After instatement, all the client sessions will be distributed 1 RB to begin with, to ensure least information rate prerequisites. Next, the rest of the RBs will be assigned as indicated by the distribution metric. It plans to apportion the RB to the client who can best advantage in term of the vitality utilization diminish in the wake of getting the RB, and the quantity of required RBs for the chose client will be included 1 after the allotment. After the execution of BAA, the RBAA subalgorithm in Fig. 6 will in this manner be executed.

1) Pseudo code of EARCA

```
If((E_k > γE_max) || (E_k < ρE_max))
if((E_k > γE_max)&&(level < 2))
level=level+1;
else if ((E_k < γE_max)&&(level > 0))
level=level-1;
end
end
NRT users
Set their capacities according to the level ;
If((E_k > γE_max) || (E_k < ρE_max))
if((E_k > γE_max)&&(level < 2))
level=level+1;
else if ((E_k < γE_max)&&(level > 0))
level=level-1;
end
end
NRT users
Set their capacities according to the level;
end
```

In RBAA, channel picks up and the quantity of each client session' required RBs are utilized as info contentions. For every RB, the subalgorithm means to discover the client who has the biggest channel pick up among all the clients. In the wake of finding the client, check whether the quantity of the current allotted RBs of the client equivalents to the quantity of its required RBs. In the event that yes, set the channel increase of the client approach to 0, and discover another client whose channel increase is the biggest among every one of the clients till the while circle is over. After the while circle, designate the RB to the client session picked amid this run. Once the two subalgorithms are done in grouping, each client session's accessible RBs are resolved. Next, the craved information rate of every client session will be circulated similarly over its designated RBs, and the vitality for every RB is thusly decided.

F. Component Carrier Activation Algorithm

The CC initiation calculation is to decide the useful utilization of the SCC as indicated by the fluctuating system activity burden to really moderate the primary vitality utilization of the BS. In particular, let p be the blocking likelihood of the framework, which is characterized as the proportion of the quantity of client sessions being obstructed to add up to arriving client sessions. Likewise, characterize p_{th}, N_{th1}, and N_{th2} as edges used to distinguish when to turn on what's more, kill the SCC, separately. The OnFlag is a marker speaking to whether the SCC has been killed.

1) Pseudo code of BAA

/$\left|\overline{H_{j\_n}^{(k)}}\right|$:l the average squared channel gain across all j sub channels for user session n on CC k, which is expressed $\left|\overline{H_{j\_n}^{(k)}}\right|=\frac{1}{j}\sum_{j=1}^{j}\left|\overline{H_{j\_n}^{(k)}}\right|$/

∀ users ∈ CCk

Allocate each user session 1 RB;

While $\left(\sum_{n=1}^{N_k} m_n^{(k)} < 2j\right)$

For n=1: N_k

Calculate the allocation metric expressed as

$$G_n^{(k)} = \frac{\beta N_0}{K\left|\overline{H_{j\_n}^{(k)}}\right|}\left[(m_n^{(k)}+1)\cdot 2^{\frac{r_n^{(k)}}{\beta\left((m_n^{(k)}+1\right)}} - m_n^{(k)}\cdot 2^{\frac{r_n^{(k)}}{\beta\left(m_n^{(k)}\right)}}\right];$$

End

$$n^* = \arg\min_n G_n^{(k)};$$

$m_{n*}^{(k)} = m_{n*}^{(k)} + 1;$

2) Pseudo code of RBAA

/$S_n^{(k)}$: the set of current allocated RBs for user session n on CC K/

For each $(m,j)_{RB}$

$$n^* = \arg\max_n \left|H_{j\_n}^{(k)}\right|^2;$$

While $\left(\left|S_n^{(k)}\right| = m_{n^*}^{(k)}\right)$

$$\left|H_{j\_n}^{(k)}\right|^2 = 0;$$

$$n^* = \arg\max_n \left|H_{j\_n}^{(k)}\right|^2;$$

End

$$S_{n^*}^{(k)} = S_{n^*}^{(k)} \cup \{(m,j)_{RB^*}\}$$

End

IV. RESULTS

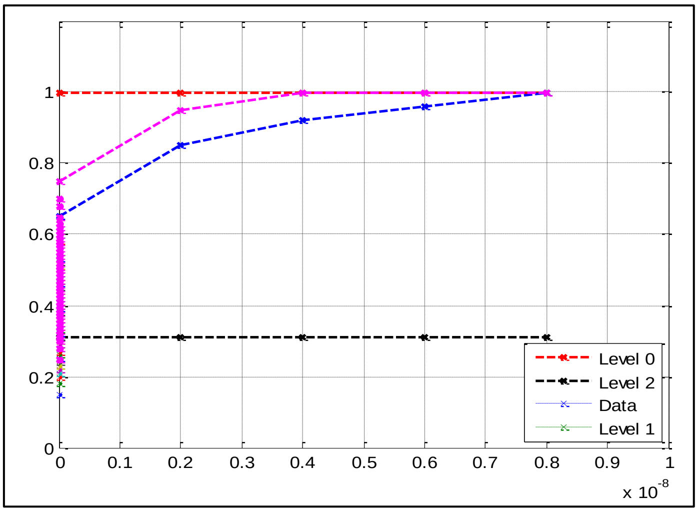

Fig. 6: Illustration of the reduction ratio as a function of the channel gain being used to determine the allocating capacity for the NRT users

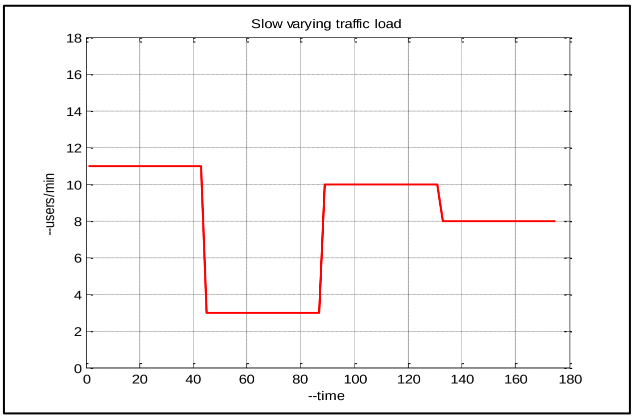

Fig. 7: Slow time-varying traffic loads versus time

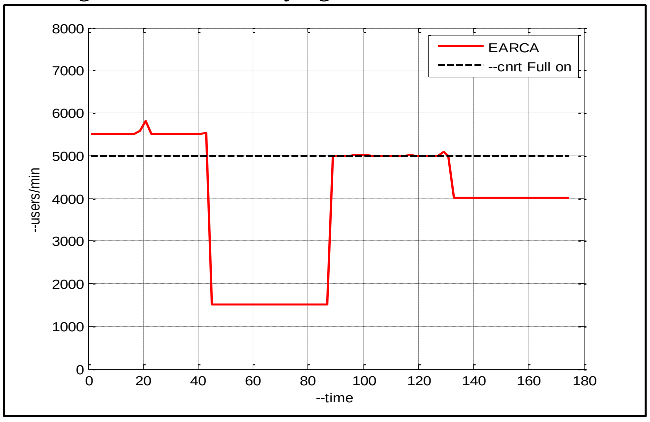

Fig. 8: Comparison of the energy consumption between the proposed scheme with EARCA, Level 2, and the comparison scheme.

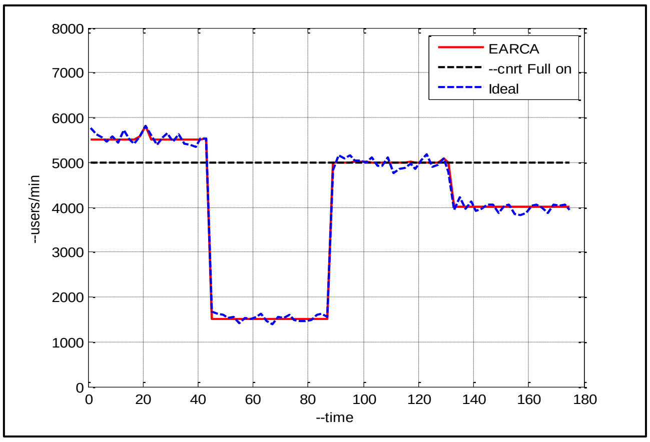

Fig. 9: Comparison of the energy consumption between the proposed scheme with EARCA, Level 0, and the comparison scheme.

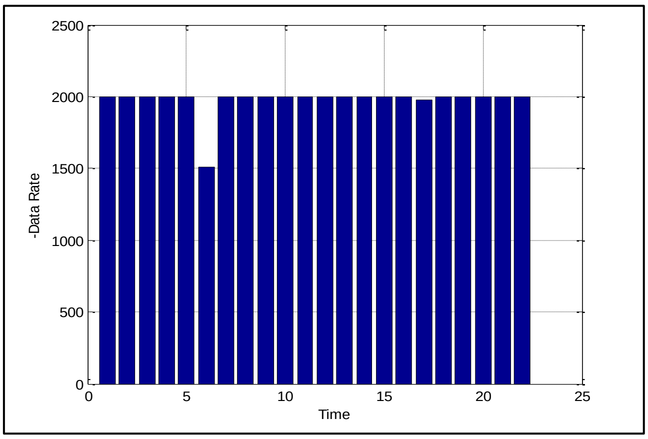

Fig. 10: NRT users' average data rate every 10 minutes of the proposed scheme with EARCA.

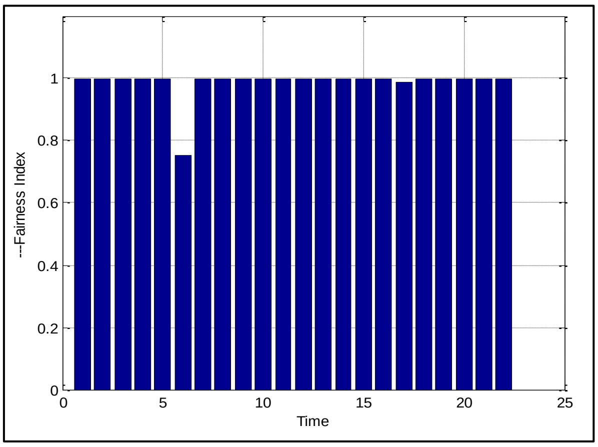

Fig. 11: Fairness index of the proposed scheme.

V. CONCLUSION

A novel and efficient power-saving scheme for data transmission in multi-CC cellular systems has been proposed and successfully tested. The proposed scheme is more adaptive and flexible than the conventional scheme with regard to SCC usage, while also maintaining the capacity to satisfy the respective minimum required data rates of all the user sessions and simultaneously manage the fairness indexes for different user types. In terms of limitations, it should be noted that the significant gains of the proposed scheme in terms of power consumption come at the expense of some degradation in fairness indexes for the different types of users whenever the traffic load is significantly increased. However, those degradations are always brief, with the fairness levels for the different types of users being re-established within minutes.

Furthermore, in addition to providing energy savings/efficiency, another key goal of 5G and future cellular systems will be ensuring spectral efficiency [33]. As such, the question of how these two different objective performance metrics can be efficiently coupled and integrated should be given far greater attention in the coming years [34]. Lastly, it is reasonable to believe, in any event, that continued efforts in this research direction may aid in mitigating the problem of global warming by contributing to the establishment of environmental sustainability. Moreover, by conserving and utilizing energy in a judicious manner, various other types of environmental degradation and resource depletion can be avoided or ameliorated.

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