January - February 2020
ISSN: 0193-4120 Page No. 16882 - 16891

Optimal Load Balancing by Adaptive Data Transmission through Time Vary Scheduling in Wireless Cellular Networks

[1]Shaik.Riyazuddien, [2]Dhulipalla.Venkata Rao, [3]Madhu Ramarakula
[1]*Research Scholar, Department of ECE, University College of Engineering, JNTUK, Kakinada, India,*
[2]*Professor & Principal, QIS College of Engineering and Technology, Ongole, India.*
[3]*Assistant Professor, Department of ECE, University College of Engineering,JNTUK, Kakinada, India.*
Email: riyazvvit@gmail.com

Article Info
Volume 82
Page Number: 16882 - 16891
Publication Issue:
January - February 2020

Article History
Article Received*: 18 May 2019*
Revised*: 14 July 2019*
Accepted*: 22 December 2019*
Publication*: 29 February 2020*

Abstract:
The format of communication between cognitive devices with or without human intervention in cellular networks is sensitive in performance, which is due to the need forenhancing allocation of resource, traffic management & data traffic.Hence, achieving stablequality of serviceis most challenging, and that often reflects deprivedthroughput & terminal fairness. In this regard, correlating the requirements and resources has considered as the crucial factor in contemporary research to achieve optimality and stability in quality of service. This manuscript portrayed a novel scheduling strategy to achieve optimal load balancing to achieve the minimal drops in communication, maximum throughput and fairness towards the exchange of data through cellular networks. The proposed method enables Adaptive Data Transmission through Time-Vary Scheduling (ADTTVS) to privilege the optimal load balancing. The experimental study has carried on the proposed and the contemporary models, which portrays the significance of the proposed model compared to the other contemporary methods.

Keywords: *LTE (Long-term-evolution), ICT (Information & communication technology), RAN (radio-access-network), S-GW (serving gateways), MMEs (Management Mobility Entities), UE (user equipment)*

I. INTRODUCTION

The novel mobile-broadband-networks generations, incorporating LTE (Long-term-evolution) & advanced LTE perceives to be most appropriate networks for assisting transmission, exchange or communication between cellular devices with or without human intervention. The communication without human intervention is typical, as operators of the network require upgrading their networks for assisting these applications types deprived of disturbing conventional applications. Various challenges would oppose current operators of mobile network, which provide communication between heterogeneity instances of cognitive devices. Among them, the significant challenges were traffic patterns heterogeneity & divergent QoS pre-requisites; definite practical applications possess high pre-requisites, mainly in respect to reliability & latency while other implementations were tolerant to time & have minimum priorities.

The work [1], [2] presents that network communication must hence provide various QoS levels towards divergent Cognitive devices. The management of resource when maintaining QoS is addressed broadly in the review where numerous schemes have proposed.

The mobile communication acts as a prominent role in the existing technology-driven universe. The requirement for information & data has become pre-requisite currently. Simultaneously, the novel mobile generations have introduced & each need to fulfil the enhancing pre-requisites of consumers, since they demand enhanced QoS. Nevertheless, these developments come up with the challenges, which required addressing like high consumption of energy and adverse impacts of the environment. The ICT (Information & communication technology) domain plays to solve the crisis of energy and is enhancing its endeavours in making greener environment.

The standardization of LTE has conducted in 3GPP (3rd generation partnership-project) that is broadband mobile access scheme, which assists in enhancing the demand over maximum rates of data [3]. The significant motivation over the development of LTE is to provide maximum and trustworthy rates of data for accommodating the enhancing demands of mobile-traffic. Also, LTE could be capable of lessening delays of the packet, augment the speed of throughput, enhance the flexibility of spectrum, and lessen ownership cost & network operators operations & final users [4]. Here, Figure 1 exhibits the underlying LTE components architecture that comprises eNodeB (Evolved Node B) at RAN (radio-access-network), S-GW (serving gateways) at the core, & MMEs (Management Mobility Entities) [5].

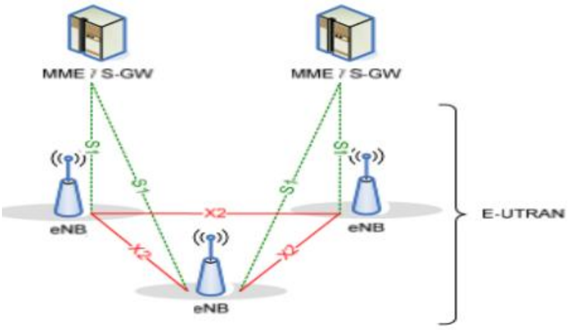

Figure 1: Overall architecture [5]

The consumption of energy in BS (Base stations) & transmission downlink perceived to be 2 significant areas where prominent conservation of energy could be attained [6]. Hence, it could be beneficial for developing a novel scheduling algorithm, where consumers might experience optimal services with minimum consumption of power. The essential advantages of this novel algorithm incorporate: augmenting throughput, & also enhanced the effectiveness of energy (EE).

The hypothetical effective energy scheduling policy has been contributed mainly by minimum power transmission from UE (user equipment) & BS. The transmitted power quantity from BS has impacted by the quality of the channel, mode of modulation & bandwidth. The work [7] presents that architecture to measure telecommunication network EE & equipment has found in this contribution.

II. REVIEW OF LITERATURE

The work [8-14], [6] presents that some of the researchers are concentrating on this specified domain, mainly in lessening the consumption of energy in eNodeB. The schemes of packet scheduling are contributed to attain optimal EE. To assess EE, the performance of ECR of the wireless access could be pre-requisite for comparing performance of divergent scheduling strategies. The work [8] presents that there were 4 components towards trade-off in exchanging over green-communication. Primarily, the DE (deployment efficiency) that could be traded-off by EE hasa radius of cell lessened for diminishing the required power for transmitting. Next, the SE (spectrum effectiveness) trade-off has studied in contemporary research [9], [10].

The work [9] presents that EE has attained by enhancing the consumer’s pre-requisite bandwidth for the specified rate of data under non-load full circumstances. Further, the trade-off of bandwidth power that is expanding bandwidth signal lessens the power of transmitting, hence, offering EE. Finally, the trade-off of delay power is QoS& experience of user measure. The work [10] projected ratio fair-energy scheme, which is available to both high & low conditions of load.

From effective energy point of view, the 3 traditional scheduling algorithms performance called RR (round-robin) & PF (proportional fairness) and Max C/I in several cell instances have compared in transmission of LTE downlink [11], which proved that effectiveness of spectrum & effectiveness of energy of Max I/C algorithm is optimal. However, PLR & delay has not deliberated as Max C/I is not a scheduler of QoS. The work [6] projected an energy-effective algorithm for minimum conditions of load. The work [12] exhibited that algorithms of resource scheduling have adopted for enhancing gain of the system through the exploitation of manifold consumer diversity gain that has converted into saving of energy. The work [13], [14] projected energy effective scheduling scheme under minimum conditions of load for the downlink of LTE.

The work [13] presents that association among coding strategy & modulation level & saving of energy has explored that signified the spectrum feasibility in exchange of power under fewer load circumstances, & it depicts the energy effective scheme, where modulation level of users have lowered one by one. The work [14] presents that BEM (bandwidth expansion mode) scheme, which assigns more blocks of resource with minimum power of transmission towards users under minimum conditions of the load is to lessen the consumption of energy as depicted. It has to record that the schemes of BEM are unsuccessful for generating savings of energy under maximum conditions of load.

Hence, the objective of this manuscript is to attain environment green in wireless-network by utilizing the minimum power in eNodeB as per the specifications of 3GPP LTE [15]. Generally, the characteristic power value in eNodeB for the macrocell could be among 43-48dBm (20-60W). Along with that, the maximum throughput is more prominent metric to attain pre-requisite data for every UEs. Nevertheless, the maximum issue faced in the wireless network could be the requirement of high power for attaining the maximum level of throughput. This contribution depicts the novel consumption of energy-aware scheduling packet called QEEA scheduler (QoS effective energy-aware scheduler).

In regard to escalate the load balancing, earlier contribution portrayed a handoff strategy that performed under certain parametric factors of the service quality [16]. However, thishandoff strategy has limited to identify the target transceiver to improvise the throughput, minimize the call drops through enhanced load balancing. The congestion and contention appeared during the transmissions carried through target transceiver, which has addressed by the method portrayed in this manuscript. The other contemporary contribution “Packet Scheduling Algorithm (PSA)” [17] intended to achieve the maximum throughput, and minimal transmission drop in LTE and LTE-A networks, which hasn’t considered context specific factors such as time varying transmission channels and delay sensitive transmission frames.

In this regard, the method portrayed is a time-vary scheduling method that intended to optimize the load balancing, which enables to achieve the maximum throughput and minimal ratio of unsuccessful transmissions.

The method proposed has concentrated on significant task of eNodeB in LTE network framework; it could be RRM. The objective is to reject or accept the requests for network connect, assuring optimum radio resources distribution among equipment’s of users. Mainly, it comprises of 2 components called PS (Packet scheduling) & AC (Admission Control). Here, in this manuscript, we might concentrate on PS that realizes on effective radio resources allocation in both the directions namely downlink & uplink. We deliberated in our instance the direction of downlink [18], [19], and [20]. The objective of radio allocation resource algorithms is to enhance the performance of system by augments the effectiveness of spectrum & equity of network. Hence, it required for finding a compromise among effectiveness & equity among consumers. The purpose of such kind of algorithm is increasing the entire system throughput.

III. METHODS AND MATERIALS

The proposed model called Adaptive Data Transmission through Time-Vary Scheduling (ADTTVS) that performstime varying channel selection, which includes white space (idle time between consecutive scheduling time intervals) scheduling. The White-space scheduling strategy schedules data-frames to respective projected transceivers in regard to available channel bandwidth and possibility of idle time usage. However, the other QoS factors are not considering in regard to channel scheduling. Hence, it often evinces the lower side of the transmission performance against crowded transmission requests at public eNodeB. In addition to white-space scheduling, theproposed method ADTTVSassesses the impact of multiple objectives of the transmission quality of projected transceivers, such as deferment rate, transceiver arbitration rate, channel desertion rate, transmission realization rate, transceiver against data-frame load, and Schedule Interval. In regard to this here we proposed a new scale called transceiver optimality rate (tor) that explores the scope of respective channel quality metrics. The higher values of the transceiver optimality rate (tor) indicate the significance of that channel. The process of ADTTVS strategy follows:

The controller of the respective eNodeB, buffers the packets to balance their transmission latency. Further assembles the set of packets as data-frame, and shares the information to scheduler regarding data-frame that includes arrival time, transmission session time out, data-frame size, and required transceiver. This information sharing can be figured out through a control packet in respective to data-frame transmission. The arrival time is the sum of time required for a data-frame to reach access point, and the time taken to share the information related respective data-frame that commonly referred as offset -time.

Let $p(cf_i)$ be the time taken to process control frame cf_i, $\tau(cf_i)$ be the time taken by the cf_i to reach the scheduler from the assembler and $\tau(df_i)$ be the assessed time to transmit data-frame df_i from assembler to scheduler. Then total expected transmission time $ett(df_i)$ will be measured as explored in (Eq 1).

$$ett(df_i) = p(cf_i) + \tau(cf_i) + \tau(df_i) \quad \ldots\ldots (1)$$

Here in the (Eq1), $ett(df_i)$ is the total time expected to be taken by data-frame df_i to reach the scheduler.

Optimal Load Balancing by Dynamic Scheduling of the Data Transmission Channels

Once the control frame arrives, the scheduler initiates the process of scheduling. In regard to this the scheduler explores the desired transmission properties called optimal transceiver, required Existence-Span of the transceiver. Further transceiver allocation process under ADTTVS that explored following.

Initially the said model is assessing the values of the projected transceiver's transmission quality metrics of all available projected transceivers and orders these projected transceivers according to one of the projected quality metric that considered as primary requirement of the transmission quality. The strategic approach to assess the scope of each transmission quality metric that projected in regard to the available projected transceivers is explored in following section.

The transmission controller of a scheduler receives transmission frames from multiple devices and buffers according to their latency in arrival time, and further, data-frames that is a pool of buffered transmission frames. Further, access point schedules these data-frames to optimal projected transceivers that transmit data to destination. The objective of this manuscript is an optimum transceiver scheduling in regard to achieve maximal transmission quality.

The set of projected transceivers controlled and scheduled by scheduler s_i are $ts_{s_i} = \{t_1, t_2, t_3, \ldots., t_x\}$. Henceforth the transceiver allocation under the scheduler s_i is from set of x projected transceivers available.

The scheduling of a transceiver to a data-frame is needed to be transmission quality specific. The scheduled transceiver often not optimal under all of the Quality metrics considered. The order of priority in regard to the selected quality metrics is a contextual reference. The transceiver that rated high under one quality metric is often not optimal under the other quality metrics. Hence it is obvious to select the transceiver that rated reasonably under most of the quality metrics is most preferable to schedule.

The transceiver selection by transceiver optimality rate that scheduled to corresponding data-frame is proposed in this manuscript. The quality metrics adapted to assess the transceiver optimality ratio are explored following:

- Transceiver arbitration rate (-): This metric indicates the ratio of elapsed schedules of the transceiver against number of times that transceiver scheduled. This metric can be measured as follows:

  $$arr(t_i) = \frac{es(t_i)}{ts(t_i)} \quad \ldots\ldots(2)$$

  - The notation $arr(t_i)$ in (Eq5) the transceiver arbitration rate, which is the ratio of elapsed schedules $es(t_i)$ of the transceiver t_i against total schedules $ts(t_i)$.
- Desertion rate: This metric denotes the unsuccessful transmissions observed against the total number of times the corresponding transceiver scheduled. The (Eq 3) depicts the assessment of the metric

  $$dr(t_i) = \frac{ds(t_i)}{ts(t_i)} \quad \ldots\ldots (3)$$

  - The notation $dr(t_i)$ in (Eq 3) depicts ratio of abandoned transmissions $ds(t_i)$ against the total number of schedules $ts(t_i)$ of respective transceiver t_i.
- Transmission realization rate: This metric is the ratio of transmission realizations against the number of times that transceiver was scheduled, which can be measured as follows:

$$trr(t_i) = \frac{ts(t_i) - ds(t_i)}{ts(t_i)} \quad \ldots\ldots (4)$$

- The notation $trr(t_i)$ in (Eq 4) claims the transmission realization rate of transceiver t_i, the difference between total schedules $ts(t_i)$ and the deserted schedules $ds(t_i)$ depicts the total number of successful schedules.

- Inference Rate: Sufficient transceiver is essential to perform transmission with minimum guarantee. The available transceiver should compatible to corresponding data-frame transmission, such that at its lower side, should overcome the attenuation, and at its higher side, should not allow the inference of noise. If the transceiver is less than the required level (usually 850nm) or greater than the level (usually 1550nm) that enables the inference of the noise, then it represents the corresponding transceiver is not optimal and if it is in between required levels, then the corresponding transceiver is considerable. The transceiver in given range and it is distinct at given threshold from the other projected transceivers that scheduled in parallel measuring of transceiver compatibility is as follows:

$$ir(t_i) = \sqrt{\left(t(i) - nt(i)\right)^2} \quad \ldots\ldots (5)$$

  - The notation $ir(t_i)$ in (Eq 5) concludes the distance of the corresponding transceiver from its nearest transceiver, the notation $t(i)$ indicates corresponding transceiver in nanometers, and the notation $nt(i)$ indicates the nearest transceiver in nanometers.
  - This $ir(t_i)$ must be greater than the given inference threshold irt, since $ir(t_i) < irt$ indicates that transceiver t_i causes inference with transceiver t_j for current scheduling requirement.

- Transceiver Data Rate: This factor is valued QoS factor as it plays the critical role to achieve minimum guaranteed data-frame delivery at destination. The data rate of the transceiver must be greater than the desired level of the respectivedata-frame load and must not exceed the sum of data rate required and enduring threshold given. The data rate shall evince as greater than the required andshall evince as lesser than the both aggregate of the data rate required and enduring threshold of the data rate to portray the corresponding transceiveras optimal to schedule. Themeasuring of data rate compatibility is as follows:

$$tdr(t_i) = dra(t_i) - drr(t_i) \quad \ldots\ldots (6)$$

  - He notation $tdr(t_i)$ in (Eq 6) concludes the transceiver data-rate of transceiver t_i, $dra(t_i)$ is indicating the data-rate available at transceiver t_i and the ‘ $drr(t_i)$ ’ is the data-rate required at t_i for corresponding data-frame to be scheduled.
  - This $drc(t_i)$ must be less than the given enduring data-rate threshold $rdrt$, since $drc(t_i) > rdrt$ indicates that transceiver t_i is oversized in regard to the required data-rate of the transmission.

- TransceiverExistence-Span (tes): Unless the Existence-Span shall greater than the enduring life span of corresponding data-frame, the respective transceiver is not fit to schedule. Since the Existence-Spanshall evince more than theenduring life span of the data-frame and the absolute difference of the Existence-Span of the transceiver and enduring life span of the data-frame must be less than the enduringExistence-Span threshold est. The transceiver that meats the said criteria is optimal, if the absolute difference between Existence-Span of the transceiver and the enduring life span of the data-frame is greater than the $rdrt$ then it is infeasible to schedule, which is since the corresponding transceiver can be reserved for further load that desired more Existence-Span of the transceiver. This can be measured as follows:

$$tes(t_i) = aes(t_i) - rls(df) \quad \ldots\ldots (7)$$

  - The notation $tes(t_i)$ in (Eq 7) evinces the TransceiverExistence-Span of transceiver t_i, the notation $aes(t_i)$ indicates the available Existence-Span of the transceiver t_i, and the notation $rls(t_i)$ indicates the enduring life span of the data-frame df to transmit the target data-frame.

○ If $0 < tes(t_i) \le est$ then the transceiver t_i is optimal if not infeasible to schedule.

Evaluation strategy of Optimality Ratio of Projected transceivers

Let transceiver arbitration rate (arr), desertion rate (dr), transmission realization rate (trr), inference rate (ir), Transceiver Data Rate (tdr), and TransceiverExistence-Span (tes) as a set of QoS metrics $M = \{[arr(t_i), dr(t_i), trr(t_i), ir(t_i), tdr(t_i), tes(t_i)] \forall i = 1...x\}$ of available projected transceivers $T = \{t_1, t_2, ..., t_x\}$ under scheduler s_j

The QoS factors $tdr(t_i), tes(t_i)$ are primary metrics, which are using to find the compatibility scope of each transceiver. This primary score is used to order the projected transceivers, which assessed as follows
Then find the primary score as follows:
Initial process normalizes the bandwidth compatibility and Existence-Span as follows:

```
step 1. $\overset{x}{\underset{i=1}{\forall}}\{t_i \exists t_i \in T\}$ Begin
    step 2. $diff \leftarrow rdrt - tdr(t_i)$ // the set $diff$ contains the difference between the enduring data rate $tdr(t_i)$ of each transceiver $t_i$ against enduring bandwidth threshold $rdrt$
    step 3. $diff_{abs} \leftarrow abs(diff\{t_i\})$ //The set $diff_{abs}$ contains the absolute values of the entries in $diff$
step 4. End
step 5. $\overset{x}{\underset{i=1}{\forall}}\{t_i \exists t_i \in T\}$ Begin
    step 6. $tdr(t_i) = 1 - \frac{1}{(diff\{t_i\} + \max(diff_{abs}) + 1)}$ // normalizing the transceiver data rate such that the transceiver with most optimal in regard to data rate will have higher value, which is between 0 and 1.
step 7. End
step 8. $\overset{x}{\underset{i=1}{\forall}}\{t_i \exists t_i \in T\}$ Begin
    step 9. $diff \leftarrow est - tes(t_i)$ // the set $diff$ contains the difference between the EnduringExistence-Span $tes(t_i)$ of the projected transceivers against enduringExistence-Span threshold $est$
    step 10. $diff_{abs} \leftarrow abs(diff\{t_i\})$ //The set $diff_{abs}$ contains the absolute values of the entries in $diff$
step 11. End
step 12. $\overset{x}{\underset{i=1}{\forall}}\{t_i \exists t_i \in T\}$ Begin
    step 13. $tes(t_i) = 1 - \frac{1}{(diff\{t_i\} + \max(diff_{abs}) + 1)}$ // normalizing the TransceiverExistence-Span such that the transceiver with most optimal TransceiverExistence-Span will have higher value, which is between 0 and 1.
step 14. End
step 15. $\overset{x}{\underset{i=1}{\forall}}\{t_i \exists t_i \in T\}$ Begin
    step 16. $ps(t_i) = 1 - (tdr(t_i) \times tes(t_i))$ //The product of two decimal fractions result the lesser decimal fraction. Hence, the product of depicted data rate $tdr(t_i)$ and existence transceiver span $tes(t_i)$ is subtracted from 1, which is to obtain higher value of the product.
step 17. End
```

Further, all of these projected transceivers will be indexed according to their QoS metric values, such that each projected transceiver will have divergent indices for different QoS metrics, and more than one transceiver can have the same index about one of the QoS metric. The index of the transceivers in regard to a QoS metric can obtain by sorting the projected transceivers in ascending order of the respective QoS metric, which is optimal with larger values. If the QoS metric is optimal with lower values, then the projected transceivers will be sorted in descending order of the respective QoS metric values. In regard to any of the QoS metric, the index of the more than one transceiver in ordered list can be identical, iff the values of the respective QoS metric obtained for corresponding transceivers are same. According to this description,

- All of the projected transceivers will be considered as a set T_{ps} that sorted in ascending order of their primary score.
- All of the projected transceivers will be considered as a set T_{arr} that sorted in descending order of their transceiver arbitration rate.
- All of the projected transceivers will be considered as a set T_{dr} that sorted in descending order of their desertion ratio.
- All of the projected transceivers will be considered as a set T_{trr} that sorted in ascending order of their transmission realization ratio.
- All of the projected transceivers will be considered as a set T_{ir} that sorted in descending order of their inference ratio.

Further, the model depicts the transceiver optimality rate tor for the each of the projected transceivers as follows.

$\overset{x}{\underset{i=1}{\forall}} \{t_i \exists t_i \in T\}$ Begin // for each projected transceiver

$$\mu(t_i) = \frac{\{T_{ps}\{t_i\} + T_{arr}\{t_i\} + T_{dr}\{t_i\} + T_{trr}\{t_i\} + T_{ir}\{t_i\}\}}{|Q|} \quad \text{.....(8)}$$

// the (Eq8) assess the mean of the indices projected for multiple metrics of transceiver t_i. The notations $T_{ps}\{t_i\}, T_{arr}\{t_i\}, T_{dr}\{t_i\}, T_{trr}\{t_i\}, T_{ir}\{t_i\}$ indicate the index of the transceiver t_i in respective sets.

$$d(t_i) = \sqrt{\frac{1}{|Q|}\left\{\begin{array}{l}(\mu(t_i) - T_{ps}\{t_i\})^2 + (\mu(t_i) - T_{arr}\{t_i\})^2 + \\ (\mu(t_i) - T_{dr}\{t_i\})^2 + (\mu(t_i) - T_{trr}\{t_i\})^2 + \\ (\mu(t_i) - T_{ir}\{t_i\})^2\end{array}\right\}} \quad \text{.........(9)}$$

The (Eq9) formulated from the statistical metric called root mean square deviation of the indices allocated to corresponding transceiver for divergent QoS metrics. The notation $\mu(t_i)$ that used in this equation concludes the average of the indices of the corresponding transceiver t_i those obtained for different QoS metrics.

$$tor(t_i) = \frac{1}{d(t_i)}$$

Then choose set of optimal entries of the set T_{ps}, which are the projected transceivers having primary score greater than the given threshold. Further, sort these selected transceivers, which is in descending order of their transceiver optimality rate tor and the same order is the preferred order to choose projected transceivers in regard to schedule the corresponding data-frame.

The negative factors such as (i) no transceiver available with desired values of primary QoS metrics or (ii) data-frame arrival time threshold lapses will be handled under ADTTVS as follows:

If desired transceiver projection is not happened, if delay found in data-frame arrival that evinces arbitration in transceiver utilization, or if multiple data-frames competent to corresponding transceiver then data-frame restructuring in to multiple data-frames will be done and the ADTTVS scheduling will done recursively till the scheduling process succeed.

Here in the process of ADTTVS, it initially attempts to trace the optimum transceiver under the impact of divergent QoS metrics, if scheduling process failed to link the data-frame with corresponding transceiver, then restructures the respective data-frame in to two data-frames such that one of that definitely fits to current transceiver. However repeats the depicted approach on other part of the data-frame till it scheduled to an optimal transceiver.

IV. EXPERIMENTAL SETUP AND EMPIRICAL ANALYSIS

In this segment, the significant scheduling algorithms utilized in network of LTE are examined for assessing network QoS by utilizing open source LTE simulator [21]. Here, we deliberated the instance of one cell with interference, and we utilized a cell environment with 1km radius, where cognitive device cluster is selected in range & devices operated by human intervention are set uniformly at 30 in distributed & mobility of cell. Every user receives void flows & video. The objective of this experiment is to assess the LTE network performance in high traffic.

The simulation study and the outcomes from the phase are presented in this chapter. The LTE and

LTE-A architecturehas evaluated by interconnecting 38 senders via a one-way communication path enabling two-way order using LTE-Sim[21]. Every data-frame volume has fixed as 1,024*64 bytes.

Overall 16 communication paths with different volumes of time-periods and bandwidths are engaged in the experimentation process. The mean experiment duration was 10 minutes. The simulation has been executed over the suggested approachADTTVS along with other standard approaches present in the recent literature. The standard approaches sharing similar idea but having a different approach include DQFH [16], PSA [17].

The parameters designed to assess the efficiency of the tested models include-

a. Data-frame drop rate against variable loads and non-variable time periods;
b. Drop rate against variable time periods and non-variable load;
c. Transmission path usage ratio against variable loads and non-variable time period;
d. Transmission path usage ratio against variable time period and non-variable loads;
e. Mean scheduling duration.

The data-frame drop rate is the cumulative number of data-frames lost as compared to complete number of data-frames sequenced for transmission. The transmission path usage rate is calculated by dividing the paths under usage with the total number of paths existing. Mean scheduling duration is the average time required for sequencing each data-frame in the complete data-frames considered. Data-frame load volumes in the simulation study varied between 10 and 90 while the time durations incorporated in the study varied between 10 μs and 50 μs .

Performance Assessment

The outcomes observed from the experimental setup depicted that the suggested sequencing approach termed as ADTTVS posted superior performance as compared to standard benchmark approach- PSA. Further, on comparison with the earlier approach- DQFH, it recorded superior scheduling optimality. The performances were observed over the metrics considered for assessment, which are mentioned in the previous paragraph. The data-frame dropping rate over multiple loads and non-variable time duration of 35 μs is presented in Figure 2 that depicts that the dropping in ADTTVS method is 2% smaller than DQFH and 8% smaller than PSA approach.

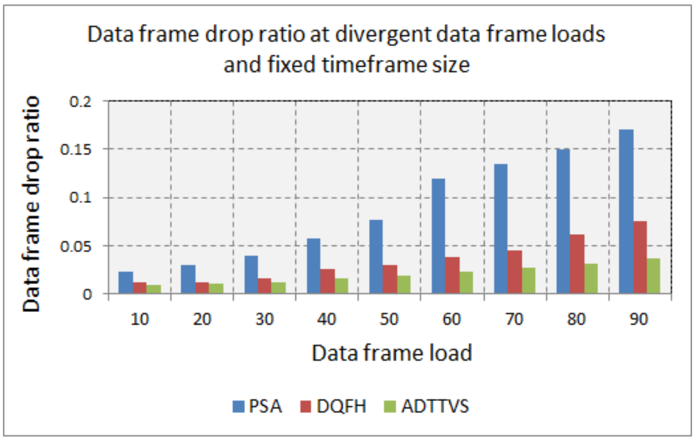

Figure 2: Data-frame drop ratio against divergent data-frame load and fixed timeframe of size of 35

The data-frame drop rate with respect to varying time durations and non-variable data-frame load of 35,840 bytes or different approaches is presented in Figure 3. The chart depicts that the proposed model had 2.5% and 7% smaller data-frame dropping as compared to DQFH and PSA respectively.

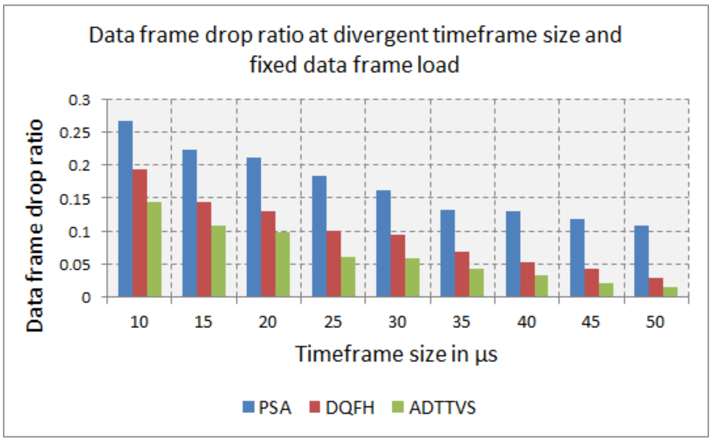

Figure 3: Depiction of data-frame drop ratio against divergent size of timeframes and fixed data-frame size of 35480 bytes

With respect to variable data-frame size but non-variable time duration, the transmission path usage ratio for ADTTVS model is 3% higher than DQFH approach while 7% higher than PSA approach as presented in Figure 4.

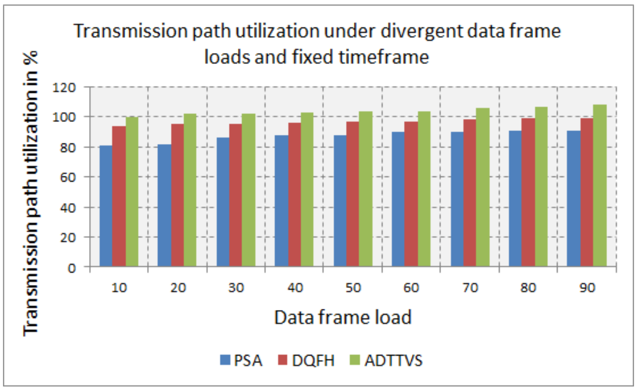

Figure 4: Depiction of transmission path utilization ratio under divergent data-frame load and fixed timeframe of size 35

In conditions of non-variable data-frame load and variable time duration, the proposed model ADTTVS recorded 2% and 8% higher transmission path usage ratio over DQFH and PSA respectively as depicted in Figure 5.

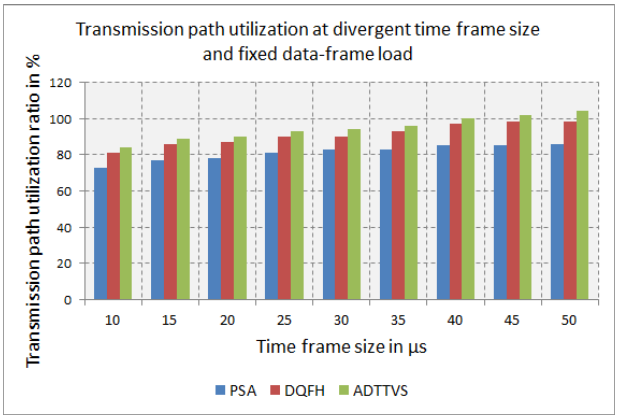

Figure 5: Depiction of transmission path utilization under divergent sizes of timeframes and fixed data-frame load of 35680 bytes

In addition, the simulation study also assessed the performance of ADTTVS approach with other two benchmark approaches in terms of mean scheduling duration. With non-variable time duration of 35 $^{\mu s}$ and varying data-frame sizes is presented in Figure 6. Further, variable time duration and non-variable data-frame size of 35,680 bytes is presented in Figure 7. In either condition, the mean scheduling duration taken by ADTTVS was comparable to the duration taken by DQFH and was significantly smaller with respect to the time taken by PSA approach.

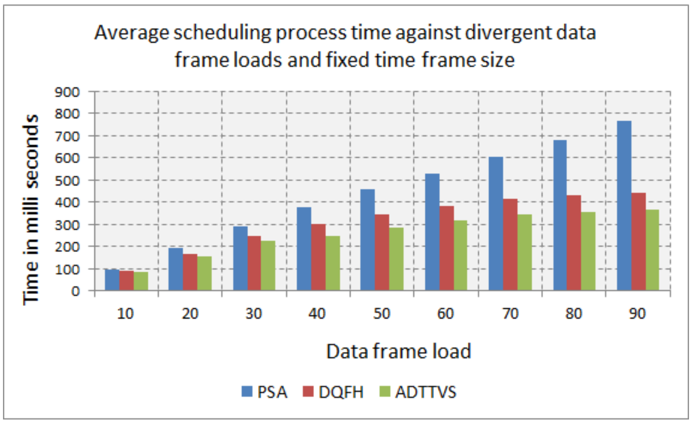

Figure 6: Depiction of average time to schedule data-frames at divergent data-frame loads with fixed timeframe of size 35

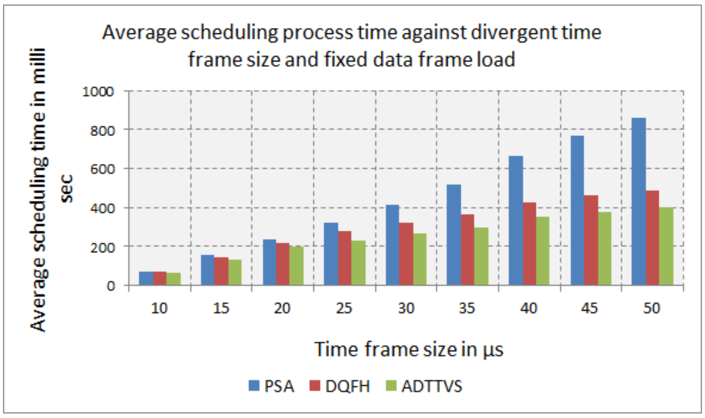

Figure 7: Depiction of average time to schedule data-frames at divergent sizes of timeframes and fixed data-frame load of 35680 bytes

V. CONCLUSION

This manuscript depicted the “Adaptive Data Transmission through Time Vary Scheduling (ADTTVS)”for cellular networks of LTE and LTE-A. Here, the metrics performance such as Drop ratio, Transmission path utilization ratio, and ratio of time to schedulehave examined for transmissions over LTE, and LTE-A cellular networks. Further, the outcomes from simulation exhibited that, the projected scheduling strategy performed better than other scheduling strategies in entire traffic flows as it offered maximum optimality in transmission load balancing. Hence the proposed method ADTTVS affirmed as appropriate method to balance the load, which in-turn avoids congestion and contention in transmissions over cellular networks. Further, researches are required to enable the batch scheduling to handle the massive transmissions over cellular networks.

VI. REFERENCES

[1] Zheng, Kan, et al. "Radio resource allocation in LTE-advanced cellular networks with M2M communications." IEEE communications Magazine 50.7 (2012): 184-192.

[2] Fritze,G.:SAE:The core Network for LTE (2012).

[3] Taha, Abd-Elhamid M., Najah Abu Ali, and H. Hassanein. "LTE, LTE-advanced, and WiMAX: towards IMT-advanced networks." (2012).

[4] Keating, Walter, and J. McManis. "Reducing energy consumption in access networks." Final Report, Master of Engineering in Telecommunications Engineering (2011): 1-5.

[5] 3GPP Technical Report. 3GPP TS 36.300 version 13.2.0 Release 13LTE; Evolved Universal Terrestrial Radio Access (E-UTRA) and EvolvedUniversal Terrestrial Radio Access Network (E-UTRAN); Overall description;Stage(2016) 2, 1-299.

[6] Sabagh, Mohammad R., et al. "A heuristic energy efficient scheduling scheme for VoIP in 3GPP LTE networks." 2013 IEEE International Conference on Communications Workshops (ICC). IEEE, 2013, 413-418.

[7] Alimian, A., B. Nordman, and D. Kharitonov. "Network and telecom equipment–energy and performance assessment: Metrics, test procedure and measurement methodology, Draft 3.0. 1." (2010), Draft 3.0.1, 1-32.

[8] Chen, Yan, et al. "Fundamental trade-offs on green wireless networks." IEEE Communications Magazine 49.6 (2011): 30-37.

[9] Miao, Yali, and Kai Wen. "An energy-efficient scheduling strategy in LTE system." 2013 IEEE 11th International Conference on Dependable, Autonomic and Secure Computing. IEEE, 2013, 497-501.

[10] Turyagyenda, Charles, Timothy O'Farrell, and Weisi Guo. "Long term evolution downlink packet scheduling using a novel proportional-fair-energy policy." 2012 IEEE 75th Vehicular Technology Conference (VTC Spring). IEEE, 2012, 1-6.

[11] Sabella, Dario, Marco Caretti, and Roberto Fantini. "Energy efficiency evaluation of state of the art packet scheduling algorithms for LTE." 17th European Wireless 2011-Sustainable Wireless Technologies. VDE, 2011, 1-4.

[12] Han, Congzheng, et al. "Power efficient dynamic resource scheduling algorithms for LTE." 2010 IEEE 72nd Vehicular Technology Conference-Fall. IEEE, 2010, pp:1-5.

[13] Han, Congzheng, and Simon Armour. "Adaptive power and resource allocation strategies for green radio." 2011 IEEE Global Telecommunications Conference-GLOBECOM 2011. IEEE, 2011, pp:1-5.

[14] Videv, Stefan, and Harald Haas. "Energy-efficient scheduling and bandwidth-energy efficiency trade-off with low load." 2011 IEEE International Conference on Communications (ICC). IEEE, 2011, pp:1-5.

[15] 3GPP Technical Report. TR 36.942 version 13.0.0 Release 13, LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Frequency(RF) system scenarios, (2016), 1-111.

[16] Shaik.Riyazuddien, Dhulipalla.Venkata Rao, Madhu Ramarakula, Load Balancing by Diversified Quality Factors based Handoff (DQFH) in Wireless Cellular Networks

[17] Shukla, Sidharth, and Vimal Bhatia. "Packet Scheduling Algorithm in LTE/LTE-Advanced-based Cellular Networks." IETE Technical Review 35.6 (2018): 551-561.

[18] Coupechoux, M., Martins, P.: Vers les systèmes radio mobiles de 4e generation - de l'UMTSau LTE (2013)

[19] Bouguen, Y., Hardouin, E., Wolff, F.X.: LTE et les réseaux 4G (2012)

[20] Monikandan, S.B., Sivasubramanian, A., Babu, S.P.K.: A review of MAC scheduling algorithms in LTE system. Int. J. Adv. Sci. Eng. Inf. Technol. 3, 1056–1068 (2017)

[21] Piro, G., Grieco, L.A., Boggia, G., Capozzi, F., Camarda, P.: Simulating LTE cellularsystems: an open source framework. IEEE Trans. Veh. Technol. 60(2), 498–513 (2010).