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MAC Scheduling Strategies in LTE Advanced

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Abstract

An Efficient scheduling algorithm at the data link layer is needed in multiuser systems to efficiently exploit the benefits of multiuser multiple input multiple output (MIMO). The 3G partnership programme (3GPP) does not specify any specific scheduling for Long Term Evolution (LTE) Advanced; we can have any one of the scheduling strategies applicable for LTE Advanced. There is substantial amount of literature on scheduling algorithms for multiuser wireless systems. In this paper, we are presenting various types of scheduling schemes of LTE Advanced, their advantages, and inefficiencies.

Keywords *– Scheduling, MIMO, LTE Advanced, Channel state information (CSI) , Adaptive modulation and coding (AMC).*

The unpredictability and reasonableness of our proposed planning plan for voice over web convention in 3G long haul development brought voice over web convention advancement booking calculation is examined as of late [25].

The remainder of the paper is organized as follows. In section II, we discuss the MAC layer overview. Here, we have discussed various types of channels that are required in Cross Layer Model for Scheduling i.e. various logical, transport, physical uplink and downlink channels. The Cross layer system model for scheduling i.e. MAC Scheduler Model through eNodeB and UE, are discussed in Section III. In section–IV, we describe various schedulers that can be used in LTE Advanced. In Section V. we discuss the difficulties faced while scheduling by different schedulers. New features that are required to be implemented in the ideal scheduling are described in Section VI. In Section VII, we discuss the various limitation of the scheduling algorithm till now. Section VIII provides the factors that decide the best scheduling algorithm. Finally, we conclude our discussion with future ideas to be implemented in scheduling algorithm.

MAC LAYER OVERVIEW

LTE-Advanced MAC Layer functions are as below:

1. Mapping between Transport and Logical Channels.
2. Error Correction through Hybrid ARQ.
3. Logical Channel Prioritization.

INTRODUCTION

Recurrence area booking empowers high otherworldly efficiencies in cutting edge remote cell benchmarks, for example, Long Term Evolution (LTE) [1], [2]. To plan for the recurrence area, the base station (BS) in a perfect world has to know the momentary channel state data (CSI) for the few hundred subcarriers for each of the clients (UEs) that it serves. Every UE needs to input its CSI to the BS when the uplink and downlink channels are not proportional.

Recurrence space planning and rate adjustment empower cutting edge orthogonal recurrence division numerous get to (OFDMA) cell frameworks, for example, LTE, to accomplish essentially higher otherworldly efficiencies. LTE utilizes a commonsense mix of a few methods to diminish the channel-state criticism that is required by a recurrence space scheduler.

Typically, packets for N users are waiting in a buffer, and resources are allocated once every Transmission Time Interval (TTI) or scheduling period. Under the Time -Domain (TD) scheduling, U users of the N users are selected based on some priority metric. Once the U users have been selected, suitable sub-carriers and modulation and coding schemes (MCSs) are assigned to each user by the frequency domain Scheduler [3].

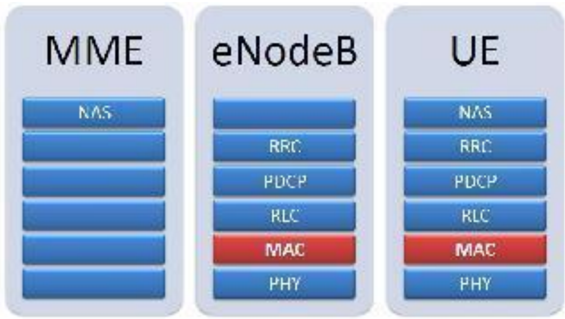

Fig.1. *MAC in LTE Protocol Stack*

RB-Radio Bearers LC-
Logical Channels TC-
Transport Channels

CCCH-Common control Channel
BCCH-Broadcast Control Channel
PCCH-Paging Control Channel
ROHC-Robust Header compression and decompression [4].

The PDCP Layer passes data to the RLC Layer as Radio bearers (See Fig 1). The RLC layer passes data to the MAC layer as logical channels. The MAC layer organizes and sends the logical channel data as transport channel. The physical layer encodes the vehicle channel data to physical channels

[4].The Uplink and Downlink booking as performed by different layers with various layers particular to their own function is appeared in Fig. 2 and Fig. 3.

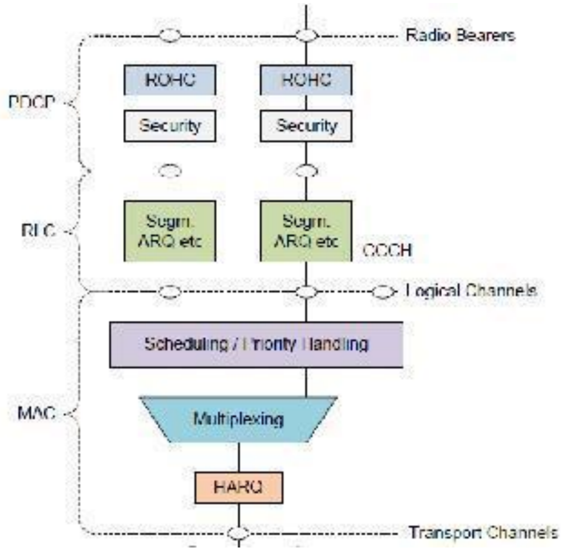

Fig.2. *Uplink PDCP, RLC and MAC Sub layer Organization*

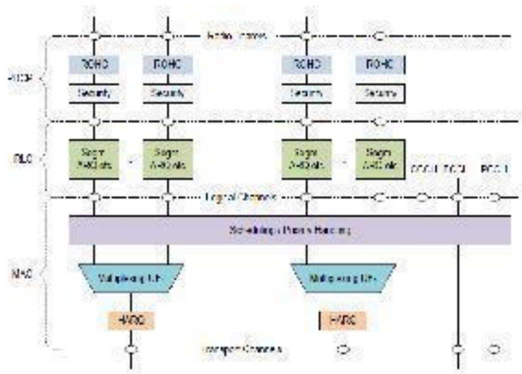

Fig 3. *Downlink PDCP, RLC and MAC Sublayer Organization*

For Complete Scheduling, we require various channels from RLC, MAC and Physical Layer. Let us discuss these channels.

LTE Downlink Logical Channels 1

Paging Control Channel (PCCH)- A downlink channel that exchanges paging data and framework data change warnings. This channel is utilized for paging when the system does not know the area cell of the UE.

Broadcast control Channel (BCCH) - A downlink channel for broadcasting framework control data.

Common Control Channel (CCCH) - Channel for transmitting control data amongst UEs and system. This channel is utilized for UEs having no RRC association with the system [4].

LTE Downlink Logical Channels 2
Dedicated Control Channel (DCCH) - An indicate point bi-directional channel that transmits devoted control data between a UE and the system. Utilized by UEs having a RRC association.
Dedicated Traffic Channel (DTCH) - An indicate point channel, committed to one UE, for the exchange of client data. A DTCH can exist in both uplink and downlink.

Multicast Control Channel (MCCH) - An indicate multipoint downlink channel utilized for transmitting MBMS control data from the system to the UE, for one or a few MTCHs. This channel is just utilized by UEs that get MBMS.

Multicast Traffic Channel (MTCH) – An indicate multipoint downlink channel for transmitting activity information from the system to the UE. This channel is just utilized by UEs that get MBMS [4].

LTE Downlink Transport Channels 1
Paging Channel (PCH) - Supports UE irregular gathering (DRX) to empower UE control sparing and Broadcasts in the whole scope region of the phone. This can be mapped to physical assets which can be utilized progressively and furthermore for movement/other control channels.

Broadcast Channel (BCH)- It has settled, pre-characterized transport organization and communicate in the whole scope range of the cell.

Multicast Channel (MCH) - Communicates in the whole scope region of the cell and backings MBSFN joining of MBMS transmission on various cells and furthermore bolsters semi-static asset designation e.g. with a time period of a long cyclic prefix [4].

LTE Downlink Transport Channels 2
Downlink Shared Channel (DL -SCH) – Supports Hybrid ARQ and dynamic connection adjustment by changing the modulation, coding and transmit control. It alternatively underpins broadcast in the whole cell and beam shaping. Both dynamic and semi-static asset allotment, UE broken gathering (DRX) to empower UE control sparing, and MBMS transmission are additionally upheld [4].

LTE Downlink Physical Channels 1
Physical Downlink Shared Channel (PDSCH) - Carries the DL-SCH and PCH and does help in QPSK, 16-QAM, and 64-QAM Modulation.

Physical Downlink Control Channel (PDCCH) - Educates the UE about the asset assignment of PCH and DL-SCH, and Hybrid ARQ data identified with DL-SCH. It conveys the uplink booking stipend and help in QPSK Modulation.

Physical Hybrid ARQ Indicator Channel (PHICH) - Conveys Hybrid ARQ ACK/NAKs in light of uplink transmissions and aides in QPSK Modulation [4].

LTE Downlink Physical Channels 2
Physical Broadcast Channel (PBCH) –

The coded BCH transport square is mapped to four sub-outlines inside a 40 ms interim. 40 ms timing is aimlessly distinguished i.e. there is no unequivocal flagging showing 40 ms timing

•Each sub-edge is thought to act naturally decodable, i.e. the BCH can be decoded from a solitary gathering, accepting adequately great divert conditions and aides in QPSK Modulation.

Physical Multicast Channel (PMCH) - Conveys the MCH and aides in QPSK, 16-QAM, and 64-QAM Modulation [4].

LTE Uplink Logical Channels
Common Control Channel (CCCH) – This Channel is utilized for transmitting control data amongst UEs and arrange and is utilized for UEs having no RRC association with the system.

Dedicated Control Channel (DCCH) – This is an indicate point bi-directional channel that transmits devoted control data between a UE and the system and is utilized by UEs having a RRC association.

Dedicated Traffic Channel (DTCH) – This is an indicate point channel, devoted to one UE, for the exchange of client data. A DTCH can exist in both uplink and downlink [4].

LTE Uplink Transport Channels
Random Access Channel (RACH) – This channel conveys negligible data and transmissions on the channel might be lost because of crashes.

Uplink Shared Channel (UL-SCH) –

This has Optional support for shaft shaping and element connect adjustment by differing the transmit control and possibly adjustment and coding. It additionally bolsters Hybrid ARQ and element and semi-static asset portion [4].

LTE Uplink Physical Channels
Physical Radio Access Channel (PRACH) – This conveys the arbitrary get to prelude. The irregular get to preludes are created from Zadoff-Chu arrangements with zero connection zone, produced from one or a few root Zadoff-Chu groupings.

Physical Uplink Shared Channel (PUSCH) – This Carries the UL-SCH and helps in QPSK, 16-QAM, and 64-QAM Modulation.

CROSS-LAYER SYSTEM MODELFOR SCHEDULING

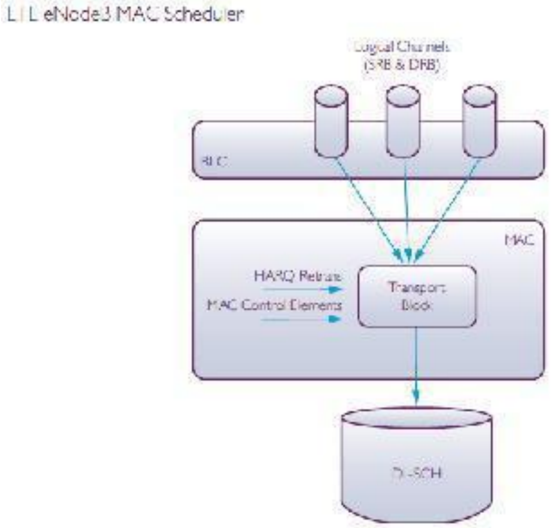

Fig 4. *Cross Layer MAC Scheduler diagram.*

- As appeared in Fig. 4, the Radio Link Control (RLC) element sits over the Medium Access Control (MAC) sub layer in the eNodeB and UE convention stacks. RLC works with logical channels. Each reliable channel maps to either a hailing radio transport (SRB) or data radio bearer (DRB).
- SRBs pass on control-plane data between the Radio Resource Control (RRC) sub layers in the eNodeB and UE.
- DRBs pass on the customer plane data related with the organizations provided for the end customer. Each DRB is connected with a UE and a specific nature of organization (QoS) – a UE may use separate DRBs for discrete applications, e.g. voice and web examining.

- Data is exchanged between the MAC sub layers in the UE and eNodeB utilizing transport pieces which are sent by means of the downlink and uplink shared transport channels (DL-SCH and UL-SCH). The MAC sub layer is behind development of transport squares utilizing data from the accompanying sources:
- RLC genuine channels. Data is scrutinized from no less than one authentic channels and stuffed into transport prevents in order to meet the QoS requirements for the radio bearer(s).
- MAC Control Elements. These are utilized for appropriated control purposes between the eNodeB and UE MAC sub layers.
- Hybrid-ARQ (HARQ) retransmissions.

The eNodeB MAC sublayer is in charge of booking transmissions over the LTE air interface in both the downlink and uplink headings. The eNodeB MAC sublayer consists of the MAC Scheduler. The MAC Scheduler exercises the planning calculations which figure out what is sent when and to/by whom. The MAC Scheduler is in charge of actualizing the QoS qualities doled out to radio bearers.

The eNodeB MAC Scheduler gets contributions from different sources which direct the planning calculations. The yield of the MAC Scheduler is a progression of asset assignments for a downlink and uplink subframe. Asset assignments are characterized as far as asset squares. An asset square involves 1 opening in the time space and 12 subcarriers in the recurrence area.

The resource assignments output by the eNodeB MAC Scheduler indicate the size of each transport block and what Physical layer resources are to be used in sending it to the UE/eNodeB via the DL-SCH/UL-SCH transport channel. This asset task data is communicate to all UEs on the Physical Downlink Control Channel (PDCCH). Every UE screens the PDCCH to decide when to get and transmit on the DL-SCH and UL-SCH transport channels..Figure 4 illustrates how the contents of a radio bearer are transferred between eNodeB and UE via transport blocks which in turn use a number of resource blocks at the Physical layer.For a VoIP call for instance, the DRB transports the RTP/UDP/IP bundles with the eNodeB MAC Scheduler booking consistent transmission openings in the downlink and uplink.

The MAC Scheduler in the eNodeB is instrumental in:

- Providing the suitable QoS to radio bearers empowering
- administrators to give a blend of administrations. This may incorporate 4 copying the QoS related with 3G circuit-exchanged radio bearers, i.e. ensured throughput, low inactivity.
- Optimizing and augmenting the air interface usage to limit the cost-per-bit to clients and administrators.

A pluggable MAC Scheduler as a segment of the general eNodeB MAC sublayer empowers LTE systems to be conveyed with a fundamental arrangement of planning elements which can then be improved and altered so as to accomplish the genuine advantages of LTE.

Planning and executing an eNodeB MAC Scheduler is an unpredictable procedure including various difficulties:

1. Optimizing UL and DL assignments for capacity, throughput and cell edge performance.
2. Appropriate selection and implementation of QoS algorithms.
3. Utilizing propelled reception apparatus strategies, e.g. 2x2 MIMO in the DL.

4. Hard constant necessities. The 1 ms transmission time interim utilized by LTE puts tight ongoing imperatives on the MAC Scheduler.
5. Minimizing the measure of flagging utilized over the air interface.
6. Minimizing eNodeB and UE control utilization.
7. Providing a structure for future upgrades in regions for example, agreeable planning for obstruction lessening [5].

SCHEDULERS THAT CAN BE USED FOR LTE-ADVANCED

The maximum min reasonableness scheduler picks the client with the littlest mean throughput at each time in opening [6]. Greatest transporter to-obstruction proportion (max C/I) scheduler boosts the framework limit without thinking about the reasonableness [7].The maximum sum rate for various kinds of linear receivers was used as a performance metric for scheduling [8].

To give nature of administration and solidness of lining for greatest throughput in remote frameworks most extreme weight coordinating (MWM) scheduler was presented for single recieving wire frameworks. The MWM scheduler chooses the client k encountering the most extreme qk×rk where qk is the line length of client k, and rk is its transmission rate [9]. Relative Fair (PF) booking guarantees a tradeoff between the augmentation of normal throughput and client decency. At each time moment, the client encountering the most elevated immediate rate as for its normal rate is planned [10][11]. In another planning plan an equation named (weighted) alpha control has been proposed for MIMO frameworks. This control gives a tradeoff between the total throughput and the per-client reasonableness by changing the estimation of a solitary parameter, when that parameter is set to one or boundlessness, the alpha govern gets to be PF or max–min, separately [12]. In another booking plan the framework throughput thought is made under hard decency and PF limitations, where "hard reasonableness" shows that each client transmits at its fancied rate autonomously of its channel conditions, and the framework battles to suit each user"s rate ask [13]. An adjusted PF planning was suggested that considers the "consistency" condition of the client terminals and outflanks the established PF within the sight of forecast blunders [14]. Another booking plan was proposed with the point of boosting the aggregate framework limit while having limitations on the aggregate accessible power and PF [15]. A circulated planning calculation for multiuser MIMO downlink with versatile input was presented [16].

None of the aforementioned existing schemes have considered the traffic - arrival process; instead, they assume an infinite amount of data backlogged for all users waiting to be selected by the scheduler [17]. An overview of radio asset planning and obstruction relief in LTE is given in et al [24].

A user utility function that together considers the throughput and fairness is proposed for MIMO systems in scheduling [18], mainly for a high- speed downlink packet- access network, the function ensures an adaptive PF among the users. Another scheduling proposed, provides a flexible balance between the system achievable capacity and the fairness [19]. The proposed booking plans are basically in view of the SNR of various clients. Moreover, one component of the relating sensible arranging is that if lines are not endlessly collected, then there are different possible implications of the figuring, dependent upon how it oversees lines containing basically zero data [20]. The above versions are for unbounded lines with amassed data packages. By the day's end, for the occasion of constrained lines, the unmistakable adjustments can be plot depending whereupon customers are met all requirements for organization and how the ordinary throughput of each customer is revived [21]. Another booking arrangement, arranges divides circulates resources, for instance, channel, bit, and vitality to the arranged customers to increase the utility limit that considers each reserved user‟s delay need, the head-of-line (HOL) wrap holding up time, the line length, and the data rate [22]. In yet another booking, the transmitter picks which set of recipients to serve in each space to enhance the base institutionalized ordinary data rate recognized by each recipient [23]. None of the past schedulers was planned with the capacity of various parcel lengths as a top priority, and henceforth, they are not ready to give both reasonableness and a low normal bundle transmission delay [21].

MIMO parcel based corresponding reasonableness (MP-PF) scheduler makes utilization of adaptable bundle transmission calculation at the medium get to control (MAC) to create and propose novel scheduler. This scheduler monitors work and contemplates the parcel length, the client line length, client transmission rate identified with its channel quality and the administration ensure for the heterogeneous clients. The notable perfect administration reasonable scheduler called max-min can be altogether enhanced utilizing the above structure by mulling over the movement attributes [21].
In a planning named as "QoS mindful particular Feedback and ideal direct Allocation in Multiple Shared Channel 5

Condition," the creator has attempted to build up a QoS mindful specific criticism model and strategy to do the ideal asset portion. Here the criticism utilizes those channel sets that meet the QoS prerequisites by abusing the client differing qualities [26]. In addition this is an input procedure i.e. a piece of planning. The previously mentioned thought can likewise be executed in booking however it is not a planning in itself.

In [27], the creator has built up the planning calculation for Multicell agreeable preparing (MCP). For down connection transmission in recurrence division duplexing (FDD) frameworks, clients need to criticism their channel state data (CSI) to the MCP scheduler, and the client information should be traded between all coordinating base stations (BSs) through the backhaul systems. The client has attempted to bring down the backhaul heap of the framework in two levels.

The created approach in a booking to cut down the influence use, especially manhandle the Queue state information to arrange the action while meeting the throughput, delay and mishap necessities [28]. In [29], the creators consider the outline of a nature of-administration (QoS) mindful parcel scheduler for the ongoing downlink correspondence. Consequently a novel two level booking calculation was produced where the upper layer misuses the imaginative approach in view of discrete time direct control hypothesis and lower layer utilizes Proportional Fair calculation.

Here particular attention has been devoted to the evolution of quality of Experience (QoE) provided to end users.

Logarithmic (LOG) Rule for Scheduling and Exponential (EXP) manage for planning are sight and sound particular booking. Besides EXP and LOG rules have been exhibited as the most encouraging methodologies for downlink planning for LTE frameworks with defer delicate components [42][29]. Adaptive Token bucket is another type of scheduling algorithm used for non real time traffic.

Greedy scheduler is a specific multimedia service scheduler. Utility scheduling algorithm was designed for mixed traffic services to guarantee the packet drop ratio and outage ratio of video streaming [30].

The Maximum Throughput (MT) approach is another scheduler but this does not support real time traffic [31]. There are other schedulers such as QoS Oriented Time and Frequency Domain Packet Scheduler [32], CABA [33], Proportional Fair Multiuser Scheduling [34], ATBFQ [35], Quality-Driven Cross- Layer Scheduler [36], Packet Scheduling Scheme to Support Real-Time Traffic [37], Frequency-Time Scheduling for Streaming Services [38], Multi-Service QoS Guaranteed Based Downlink Cross-Layer Scheduler [39], EXP-PF [40], M-LWDF [40] etc.

DIFFICULTIES IN SCHEDULING

In a pragmatic multiuser framework, every client has an alternate activity entry. The scheduler needs to mull over this to have the capacity to give reasonable administrations to the clients with high framework execution. Offering need to high transmission-rate sers with insufficient activity to be served may bring about a misuse of assets.

In the first ten scheduling algorithms discussed in the Section-IV, the difficulty is that it can be applicable only when there is infinite queue of backlogged data packets. These scheduling algorithms fail to produce the same throughput whenever there is finite queue. For finite queue version they have different characteristics.

The first fourteen schedulers discussed in Section-IV were designed for the uniform packet size length hence do not produce same characteristics when compared with the non-uniform packet scheduler. Hence the designed schedulers not able to provide both fairness and a low average packet transmission delay.

In the fifteenth scheduler i.e. MP-PF, the Head Of Line (HOL) packet is selected from the users queue and assigns it to a transmit antenna of a BS based on the novel PF concept, taking into consideration the packet length, the user transmission rate, the user backlogs, and the user service guarantees. But still it fails to delete the backlogged packets which have crossed the threshold delay for Real Time traffic. The above scheduler also fails to discuss the priorities of the different kinds of traffic i.e. Real time (RT) and Non-Real time (NRT)

The first fifteen schedulers presented in the Section-IV are for Non-Cooperative networks. Hence can’t be used for

Cooperative network. If we use it for the Cooperative network then the Characteristics presented by the authors of the respective scheduling algorithms change. This Non-Cooperative network causes Intercell Interference (ICI).

The sixteenth scheduler discussed in the Section-IV is for cooperative network, hence mitigate interference and also reduces system backhaul. But this fails to provide the required scheduling model for different classes of traffic based on priority, also the above scheduler doesn’t discuss about reducing the power consumption. The seventeenth scheduler discussed the power reduction but its complexity increases when more than one queue is assumed. Hence the complexity of the Real Time system increases. The eighteenth scheduler discussed in the Section-IV has the disadvantage i.e. frame level scheduler (FLS) will be able to guarantee the bounded delays if and only if the channel quality of each UE receiving multimedia flow is large enough to accommodate FLS assignments. On the off chance that the given client sees the terrible channel condition, FLS calculation would not have the capacity to ensured focuses for which the framework has been outlined.

The nineteenth, twentieth and twenty first scheduler discussed in the Section-IV can cater the need for multimedia delay constrained traffic but when considered for high priority level traffic of FTP etc which are non multimedia, they fail. The nineteenth scheduler discussed in the Section-IV works well for QoE services when compared with other multimedia RT scheduling algorithms.

The twenty second scheduler that is greedy scheduler fails to provide fairness in service. The twenty third scheduling algorithm called Utility Scheduling Algorithm discussed in Section-IV fails for priority queue traffic of both RT and Non-RT.

The Maximum Throughput scheduler uses SINR as parameter and does not support Real Time Traffic. The QoS Oriented Time and Frequency Domain Packet Scheduler does not consider Packet delay, Head-of-Line Delay, Target Packet Loss Ratio, End–User Buffer Status and line delay into contemplations. The CABA Scheduler additionally doesn‟t consider Packet delay, Head-of-Line Delay, Target Packet Loss Ratio and line delay into contemplations however it considers End–User Buffer Status. The Proportional Fair Multiuser Scheduling and ATBFQ don't comparably consider Packet delay, Head-of-Line Delay, Target Packet Loss Ratio, End–User Buffer Status and line delay. Quality-Driven Cross-Layer Scheduler doesn't take into account the Throughput, Head-of-Line Packet delay, Target Packet Loss ratio, queue Length and End User buffer status.

The Packet Scheduling Scheme to Support Real-Time Traffic also doesn't take into account the Throughput, Head-of-Line Packet delay, Target Packet Loss ratio and End User buffer status. But it considers queue Length status. Frequency-Time Scheduling for Streaming Services scheduler consider most of the parameters (e.g. SINR, Throughput, Head-of -Line Packet Delay and Target Delay) but doesn't considers Target PLR (Packet Loss ratio), Queue Length and End-User Buffer Status. The Multi-Service QoS Guaranteed Based Downlink Cross-Layer Scheduler is same as Frequency-Time Scheduling for Streaming Services with the exception that it also considers Target PLR. EXP-PF and M-LWDF schedulers consider all the parameters considered by Multi-Service QoS Guaranteed Based Downlink Cross-Layer Scheduler. But this doesn't consider the parameters Queue Length and End-user Buffer Status.

REQUIRED FEATURES IN IDEAL SCHEDULING

The Quality of service (QoS) should be high as well as Quality of experience (QoE) to the maximum extent. The Average Queuing delay (AQD) and Packet drop Ratio (PDR) should be as low as possible. The Average Outage delay (AOR) and Outage Ratio (OR), especially in heavy load condition should be lowest. Buffer Status Reports (BSR) that are needed to provide support for QoS-Aware Packet scheduling and elapsed time needed to be provided as and when required by the scheduler.

Queue State Information (QSI) should be taken into consideration. Interference Mitigation Scheme of scheduling are needed to be followed such as cooperative network in order to reduce the Inter cell interference. The Backhaul load should be least in case of Multicell Cooperative Network (MCP). The Scheduler should take into considerations all the parameters such as SINR, Throughput, Head-of-Line Packet Delay, Target Delay, Target PLR, Queue Length, End-User Buffer Status.

The Downlink (DL) and Uplink (UL) Primary transporter Components (PCCs) ought to be hearty and ought to be picked with the end goal that they give the most pervasive scope as well as best general flag quality [41]. In Ideal scheduler the Queue ought to be limitedly multiplied and ought to serve for various bundle sizes with a specific end goal to decrease the required data transfer capacity. The Ideal Scheduler ought to manage RT and Non-RT movement in view of Priority and limit postpone requirement. The multifaceted nature of the Scheduling Algorithm ought to be less. The bit mistake rate (BER) and bundle misfortune proportion (PLR) ought to be limited to the conceivable develop. The power utilization ought to be less and in addition the idleness.

The Sub-band CQI should be used for closed-loop system and Effective Exponential SNR Mapping (EESM) should be used for open-loop type of system network [48][49]. The Modulation and coding scheme (MCS) should be chosen correctly with mimimum possible error.

LIMITATIONS OF SCHEDULING ALGORITHM

Classical approaches based on Maximum throughput (MT), PF [42]-[45], Weighted Round robin [46], and Adaptive Token bucket [47] are not strictly applicable to handle real time multimedia services. Hence any of the variants or modified scheduling algorithms of PF, Round Robin and Token buckets schemes are not applicable for Real-Time traffic.

LOG Rule, EXP Rule, Greedy and FLS with two levels are schedulers which are best suited for Real Time multimedia traffic but fail to provide the fairness in service. Non Real-Time traffic having priority was not taken into consideration by any of the scheduling algorithms. Whenever a multiple queue having both RT and Non RT network traffic is considered, the complexity of scheduling algorithm will increase exponentially. Whenever CQI feedback has a coarse frequency granularity the BS station schedules over a narrow Physical resourse block [PRB] leading to incorrect choice of MCS [38]. Algorithms specific for Backhaul reduction, Interference reduction, power consumption reduction and QoE service provision are specific to the particular service itself. There is a need to develop a scheduling algorithm that carries all the advantages of an Ideal Scheduler discussed Section VI.

APPROPRIATE SCHEDULING ALGORITHM

For RT Traffic EXP Rule, LOG Rule, Greedy and the below mentioned scheduler can be used. For RT multimedia Traffic
and QoE service Two leveled Downlink Scheduling for Real time Multimedia services‟ Scheduling Algorithm proposed by authors of [29] to be used. For fairness in the services Max-Min, PF, Round Robin,Leaky Bucket and modified Leaky bucket Scheduler algorithms can be used. For Backhaul reduction and Interference mitigation scheduler proposed by the authors of [27] can be used.

For Low power consumption the Scheduling proposed by the authors of [28] are to be used. For finite queue length without the assumption of infinite backlogged and Non-uniform Packet size the MP-PF scheduling should be used. For mixed type of traffic dual two level schedulers which combines Greedy with PF etc are to be used. Similarly utility scheduling algorithm is also used for mixed type of traffic.

CONCLUSION

We finally conclude that most of the scheduling algorithms are specific to certain scenario or criteria. Few are Specific to Multimedia RT traffic and few are Fairness oriented. Some are confined to the power consumption reduction, QoE and Interference mitigation. After all, none of the scheduling Algorithm discussed speak about priority of RT and Non- RT traffic. Hence an effective Scheduling Algorithm should be developed that should have high throughtput (QoS) and should satisfy delay constraint, power constrainst, QoE service, priority queues, Interference Mitigation for both kinds of RT and Non-RT Traffic.

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