Sudan University of Science and Technology

College of Engineering

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QoS Aware Radio Resource Management in LTE Advanced

A Research Submitted in Partial fulfillment for the Requirements of the Degree of B.Sc. (Honors) in Electronics Engineering (communication)

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الآيـة

قال تعالي :

(وَلَقَدْ آتَيْنَادَاوُودَوَسُلَيْمَانَعِلْمًاوَقَالَاالْحَمْدُلِلَّهِ الَّذِي فَضَّلَنَا عَلَىٰ كَثِيرٍ مِنْ عِبَادِهِ الْمُؤْمِنِينَ) صدق الله العظيم.

سورة النمل الآية 15

DEDICATION

To the fountain of patience and optimism and hop, to each of the following in the presence of God and His Messenger…

Dear our mothers

To the big heart, who did not spare the days something…

Dear our fathers

To those have demonstrated to me what is the most beautiful of life…

To all those distinct peoples in excellence and creativity…

To all those struggling the insensibility…

To all those supports modernization and development…

To all those looking for a new that sprung from their history and themselves...

To all those refuse to occupy the minds…

If you are one of those,

We dedicate this effort for you and you alone

ACKOWLEDGEMENTN

The writing of this project was one of the most significant challenges in our academicLife. Without the support, guidance, and patience of many people it would not have been done up to this standard.

We express our sincere gratitude and appreciation to our advisor **DR. FATH ELRHMAN ESMAAIL.** Without his unwavering patience and confidence in us, thesis would not have been possible. We thank all our teachers in the Sudan University, especially in communication engineering department for their guidance, supporting and understanding.

We cannot express in words how deeply we feel about the support and confidence our parents have shown in us over the years. Everything seems insignificant compared to the sacrifices they have made to educate their children. Thank you, thank you very much.

We would like to thank our friends for standing by us when we needed them.

ABSTRACT

In LTE advanced, there are so many services can be offered to the users; however, good schemes of resource management are needed. So, scheduling algorithms are used to provide proper QoS for multi-services and optimize the trade-off between QoS and resource efficiency.

In a network when the number of users available is increase in high priority services here consequently the outage probability increase because the resource blocks available is limited.

To solve this problem and manage the resource blocks using scheduling algorithms (priority, round robin, weight) also benefiting from the remaining resource block. A comparison has been conducted between the above mentioned algorithms in a number of performance metrics has been calculated using mathematical equation and by using MATLAB code retrieved a results.

The outage probability of higher priority service of round robin and weight algorithm is greater than priority algorithm by 52% and 30%. In low priority service (video) the priority algorithms outage probability has a 2.7% increase over that of weight algorithm and 7.4% greater than round robin algorithm.

One of other metrics that should be calculated is the delay of video. When it is calculating use priority algorithm its result is 22% greater than the result retrieved when using round robin, and 78.5% greater than the result retrieved when using weight algorithm. The result of the priority algorithm is greater than round robin result by 50% and the priority algorithms results are also greater than those of the weight algorithm by 80%.

المستخلص

فيالتطور بعيد المدى، يمكن تقديمالعديد من الخدماتللمستخدمين، ومع ذلك، هناك حاجة إلىبرامججيدة لإدارة الموارد .لذلك، يتم استخدامخوارزمياتجدولةلتوفيرجودة الخدمةالمناسبة للخدمات المتعددةوتحسينالمفاضلةبينجودة الخدمةوكفاءة الموارد .

في الشبكةعند زياده عددالمستخدمينفي الخدماتذات الأولوية العاليةيترتب علي ذلك زيادةاحتمالالانقطاعلأنكتلالمواردالمتاحةمحدودة.

لحلهذه المشكلةنعمل إدارةلكتل المواردباستخدام خوارزمياتالجدولة(الأولوية، روند روبن، الوزن)الاستفادةأيضامن كتلةالمواردالمتبقية.وقد أجريتمقارنة بينالخوارزمياتالمذكورة أعلاهفي عدد منمقاييس الأداءتمحسابها باستخدامعادلات رياضيةوباستخدام تعليمات برمجيةماتلاب واسترجاعالنتائج.

احتمالانقطاعالخدمة في الخدمات ذات الأولوية العاليه في خوارزمية الروندروبنو خوارزمية الوزنأكبر منخوارزميةالأولويةبنسبة 52% و 30%.

فيخدمة منخفضةالأولوية(فيديو)خوارزميةالأولوية لديها احتمالانقطاعبزيادة2.7٪من خوارزميةالوزنو 7.4% منخوارزميةروند روبن .

واحدةمن المقاييسالأخرى التي ينبغيأن يحسبهوتأخيرالفيديو.عندمايتمحسابهباستخدامخوارزمية الأولويةنتيجتهأكبر ب 22٪من خوارزمية روند روبن، تكون اكبر بنسبه 78.5٪ عند استخدامخوارزميةالوزن.نتيجةالخوارزمية الأولويةأكبر من خوارزمية روند روبنبنسبة 50% و أيضاأكبر من خوارزميةالوزنبنسبة 80%.

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LIST OF SYMBOLS

BW	Band Width.
d_ frame	duration_ frame.
M	mile.
M	Modulation Levels.
Mbps	Megabits per second.
MHz	Megahertz's.
No	Numbers.
P	Priority.
rem RB	remaining resource blocks.
RR	Round robin.
S	Second.
T	Time.
T_RB	Total Resource Blocks.
W	Weight.

LIST OF ABBREVIATIONS

3G	Third Generation.
3GPP	Third Generation Partnership Project.
4G	Fourth Generation.
AC	Admission Control.
BE	Best effort.
COMP	Coordinated Multipoint.
CQI	Channel Quality Indicator.
DL	Downlink.
eNB	eNodeB.
EPC	Evolved Packet Core.
E-UTRA	Evolved Universal Terrestrial Radio Access.
E-UTRAN	Evolved Universal Terrestrial Radio Access Network.
FD	Frequency Domain.
FDD	Frequency Division Duplexing.
GBR	Guaranteed Bit Rate.
GP	Guaranteed performance.
HARQ	Hybrid Automatic Repeat Request.
HETNET	Heterogeneous Network.
IEEE	Institute of Electrical and Electronic Engineers.
IP	Internet Protocol.
ITU_R	International Telecommunication Union Radio Communication Sector.
IMT	International Mobile Telecommunications.
LA	Link Adaptation.
LTE	Long Term Evolution.

MIMO	Multiple-Input Multiple-Output.
MME	Mobility Management Entity.
OFDM	Orthogonal Frequency Division Multiplexing.
OSA	Optimized Service Aware.
PDN - GW	Packet Data Network Gateway.
PF	Proportional Fairness.
PRB	Physical Resource Blocks.
PS	Packet Scheduler.
QoS	Quality of Service.
RAN	Radio Access Network.
RB	Resource Blocks.
RRM	Radio Resource Management.
SAE	System Architecture Evolution.
S-GW	Serving Gateway.
TDM	Time Domain Multiplexing.
TTI	Transmission Time Interval.
UE	User Equipment.
UL	Uplink.
VoIP	Voice-over-IP.

CHAPTER ONE

INTRODUCTION

CHAPTER ONE
INTRODUCTION

1.1 Preface

The Long Term Evolution project was initiated in 2004. The motivation for LTE included the desire for a reduction in the cost per bit, the addition of lower cost services with better user experience, the flexible use of new and existing frequency bands, a simplified and lower cost network with open interfaces, and a reduction in terminal complexity with an allowance for reasonable power consumption LTE advanced achieve high throughput environment for key facilities with large numbers of users. And achieve high network capacity for areas with high traffic demand and large number of users [1].

The main objective of the RRM algorithm could simply be to maximize the system fairness factor, minimize the outage probability and delay. To this end, scheduling, routing, bit loading and adaptive modulation constitute some of the tools that are commonly employed in RRM solutions [2].

The proposed resource allocation schemes are enhanced using an intelligent link adaptation mechanism which takes the weighted CQI of all allocated resource blocks for a user as input and determines the MCS (Modulation and Coding Scheme) mode. The weighted-CQI based link adaptation helps in achieving correct balance between transmission rate and error rate [3].

Scheduling is a key Radio Resource Management (RRM) mechanism for realizing Quality of Service (QOS) requirements and optimizing system performance of Long Term Evolution (LTE) network. Scheduling is the process of dynamically allocating physical resources to User Equipment's.

(UEs) based on scheduling algorithms implemented at the LTE. The choice of scheduling algorithm critically impacts resource utilization and the overall performance of LTE network.

Using the weight algorithms to determine performance metrics such as: outage probability, fairness factor, QOS satisfaction and delay. It this algorithm compare between another algorithms such as: Round Robin and Priority algorithms.

1.2 Problem Statement

LTE advanced has the capability to support high transmission rates and QOS for different applications. Due to the limited resources in this network, efforts to improve resource utilization are vital issues. In order to effectively support the heterogeneous traffics expected in this network, great challenges are anticipated in the radio resource management entity.

1.3 Proposed Solution

The resource management including QOS and fairness aware scheduling are used in order to realize an efficient and optimum network performance.

1.4 Aim and Objectives

The general aim of this research is to improve the performance of multi-service offered to users in LTE advanced**.**

The detailed objectives include:

- To increase the requirements for high data rates of the wireless communication networks rapidly.
- To provide the requirements for QOS.
- To minimize the outage probability of lower priority services by using weight.
- To ensure higher level of fairness for services.
- To minimize delay for video by using weight algorithms.

1.5 Methodology

In order for this project to be finalized and completed certain steps had to be followed, all of them being five procedures.

The first phase being the overview of the LTE and LTE advanced along with their features and their accompanying technologies.

The second phase being also the overview of QOS aware and radio resource management.

Thirdly research must be conducted on the algorithms related to scheduling, these algorithms being both round robin and priority, where compared them to each other in the performance metrics.

Fourthly based on the weight of the resource blocks a new algorithm was created in order to solve the issues found in the previously mentioned algorithms. Moreover the performance metrics was also calculated.

The fifth phase an operation was carried out being the code use MATLAB, with the results in the end performing a discussion on the matter.

1.6 Thesis Outlines

- Chapter 1. Introduction: This chapter includes problem statement, proposed solution and objective.
- Chapter 2. Literature review: This chapter presents somebasic background on LTE, LTE - Advanced and radio resource

management and describes the main features and technology.

- Chapter 3. QoS aware radio resource management: include all the details of methodology such as algorithms, blocks diagram and mathematical Equation of performance metrics (outage probability, fairness factor and delay).
- Chapter 4. Results and discussion: design simulation code by using MATLAB language and in this chapter provides results from a performance metrics and discussion.
- Chapter 5. Conclusions and Recommendations: explain the result can be achieved and remained future works.

1.7 Summary

This chapter clarified the problem statements, proposed solution and the main objectives of the project, the literature review includes overview of LTE, LTE Advanced and RRM will be shown in the next chapter.