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Joint Carrier Aggregation and Scheduling algorithm for multi service in (LTE-Advanced)

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الإستهلال

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قال تعالى :

﴿ اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ (1) خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ (2) اقْرَأْ وَرَبُّكَ الْأَكْرَمُ (3) الَّذِي عَلَّمَ بِالْقَلَمِ (4) عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ ﴾ صدق الله العظيم

سورة العلق الآية ﴿ 1–5 ﴾

DEDICATION

This Thesis is dedicated to My Parents

For their endless love, support and encouragement

Also my Brothers, Sisters and All Who Are in My Mind…

ACKNOWLEDGEMENT

First of all and always we thank ‘Allah ‘ to make us live these moments and for always being there for us.

We have to thank our parents for their love and support throughout our life. Thank you both for giving us the strength to reach the stars and chase our dreams.

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We send our greetings to our department, faculty, and our dear university “S.U.S.T”, and all there who helped us to achieve the bachelor degree.

ABSTRACT

LTE an initialize of Long Term Evaluation, marketed as 4G LTE is standard for wireless communication of high data rate, increasing the capacity and speed using different radio interface together with core network improvement.

In today's wireless communication systems, it is required to view video, listen to audio, browse the internet, upload media and use cloud-based services that will make high demands of data rates. However, it is very difficult to achieve such high data rates using conventional Communication method without increasing the bandwidth. In those methods use bandwidth by each user in band that may be not sufficient to offer the required data rate, while there is unused bandwidth in other or same band. There is need for new scheme to effectively utilizing the available bandwidth in same or different frequency bands.

In this research using joint carrier aggregation with scheduling algorithm, it is possible to utilize more than one block of subcarrier and in this way increase the overall transmission bandwidth.

The effectiveness of joint carrier aggregation and scheduling algorithm is investigated by using MATLAB code written in m-file. It provides high throughput for multi user for VOIP by about (250%), for video by about (175%). In addition, it improves bandwidth utilization for multi user for VOIP by about (300%), for video by about (287.5%) as compared with no carrier aggregation. Further, it also enhances the spectral efficiency for multi user for VOIP by about (13%), for video by about (71.4%). Lastly, the average delay performance also decrease for multi user for VOIP by about (76%), for video by about (73%) as compared with no carrier aggregation used.

المستخلص

التطوير بعيد المدى المتقدم للجيل الرابع والذي يعتبر كمقياس في الاتصالات اللاسلكية التي تعطي بيانات عالية،وتزيد من السعة والسرعة مستخدمة واجهات راديو مختلفة من شبكة ارسال محسنة.

في انظمة الاتصالات اللاسلكية الحالية مطلوب معدلات بيانات عالية لمشاهدة الفيديو، والاستماع إلى الصوت، وتصفح الانترنت، وتحميل وسائط الاعلام واستخدام خدمات اخرى. ومع ذلك، فإنه من الصعب جدا تحقيق هذه المعدلات العالية من البيانات بإستخدام طريقة الاتصالات التقليدية دون زيادة عرض النطاق الترددي عند زيادة أعداد المستخدمين المتشاركين في عرض حزمة واحدة، قد يكون عرض النطاق الترددي غير كافي لتقديم معدل البيانات المطلوبة لكل واحد، في حين أن هناك عرض نطاق ترددي غير مستخدم في نفس عرض الحزمة او في عرض حزم اخرى. لذلك كانت الحاجة لنظام جديد للإستفادة بشكل فعال من عرض النطاق الترددي المتوفر في نفس نطاقات التردد او في نطاقات تردد اخرى.

باستخدام تجميع الناقلات مع خوارزمية الجدولة في هذا البحث، اصبح من الممكن الاستفادة من اكتر من كتلة واحدة من الناقلات الجزيئية وبهذه الطريقة زاد عرض النطاق الترددي ومعدل ارسال البيانات.

يتم التحقق من فعالية تجميع الناقلات مع خوارزمية الجدولة باستخدام برنامج الماتلاب. هذه الطريقة وفرت انتاجية عالية لعدد من المستخدمين للصوت عبر برتوكولات الانترنت بنسبة (250%)، وللفيديو بنسبة (175%)، وتحسين استخدام عرض النطاق الترددي لعدد من المستخدمين للصوت عبر بروتوكولات الانترنت بنسبة(300%)، وللفيديو بنسبة (287.5%)، مقارنة مع عدم استخدام تجميع الناقلات، وايضا تحسين الكفاءة الطيفية لعدد من المستخدمين للصوت عبر بروتوكولات الانترنت بنسبة (13%)، وللفيديو بنسبة (71.4%)، ويقلل ايضا من متوسط اداء التأخير لعدد من المستخدمين للصوت عبر بروتوكولات الانترنت بنسبة (76%)، وللفيديو بنسبة (73%)، بالمقارنة مع عدم استخدام تقنية تجميع الناقلات.

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ABBREVIATIONS

1G	First Generation
2G	Second Generation
3G	Third Generation
3GPP	Third Generation Partnership Project
4G	Fourth Generation
AMC	Adaptive Modulation and Coding
ARQ	Automatic Retransmission Requests
CA	Carrier Aggregation
CC	Component Carrier
CDMA	Code Division Multiple Access
CQI	Channel Quality Indicator
EDGE	Enhanced Data rates for Global Evolution
FDD	Frequency Division Duplexing
FDMA	Frequency Division Multiple Access
FEC	Forward Error Correction
FIFO	First-in-First-out
GSM	Global System for Mobile Communication
GPRS	General Packet Radio Service
HOL	Head of Line
ITU	International Telecommunication Union
LTE	Long Term Evaluation
LTE-A	Long Term Evaluation Advance
MCS	Modulation and Coding Scheme
MIMO	Multi Input Multi Output
NRT	non real-time
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiplexing Access

QOS	Quality Of Service
RB	Resource Block
RN	Relay Node
RNC	Radio Network Controller
RT	Real-Time
SINR	Signal to Interference Noise Ratio
SC-FDMA	Single-Carrier Frequency Division Multiple Access
TDD	Time Division Duplexing
TDMA	Time Division Multiple Access
TTI	Transmit Time interval
UMTS	Universal Mobile Telecommunications System
UE	User Equipment
VOIP	Voice Over Internet protocol

CHAPTER ONE

INTRODUCTION

CHAPTER ONE

INTRODUCTION

In this chapter a background of cellular systems and primary aspects of the project will be presented.

1.1 Preface

Within thirty years a big step in communication systems has been done. Going from the First Generation (1G) to the fourth made possible more and more services available on the mobile phones. This evolution has been obtained due to the digitalization of the information and the updating of the used technology [1].

The first Generation was implemented around 1970s and it was launched in United States as First Generation of mobile system. It was based on frequency division multiple access (FDMA) technology and it was a system which allowed users to make voice call within one country. No data traffic was available yet, the voice itself was the main traffic [2].

At the end of 1980s the Second Generation (2G) was developed. Digitalization of the control link between mobile and base station and digitalization of the voice signal were the most advanced characteristics. The new system provided better quality and higher capacity. Global system for mobile communications (GSM) and general packet radio service (GPRS) were the services available and time division multiple access (TDMA) the technology used [3].

The first Third Generation (3G) network was deployed in Japan in 2001. The systems in this standard are an update from 2G, going from circuit switched nodes to packet oriented nodes. The advantages of 3G systems are mainly the increase of available bandwidth per single user and the possibility to have multimedia entertainment services on the mobile phones. A lot of technology are being standardized for the 3G system all around the World, but the most important change comparing with the 2G is the use of code division multiple access (CDMA) as access technology. Regarding the 3G, some of the services have been standardized are enhanced data rates for global evolution (EDGE) and universal mobile telecommunications system (UMTS) [4].

Looking forward for the 4G Communication System, its services are the advanced version of the 3G services. The 4G services are expected to be broadband, with large capacity, with high-speed transmission and to provide optimum services everywhere and anywhere. Going from 3G to 4G, the infrastructure will have only packet switched traffic also named as all-IP. Voice, data and multimedia application all on the same Communication System. The 4G systems are OFDM-based system, which is a technology that increases the system capacity and the spectrum utilization in order to have a wide band communication. The technologies which are considered to be pre-4G are WiMax and 3GPP LTE [1][5].

1.2 problem statement

In today's wireless communication systems, it is required to view video, listen to audio, browse the internet, upload media and use cloud-based services that will make high demands of data rates. However, it is very difficult to achieve such high data rates using conventional Communication method without increasing the bandwidth. When the numbers of users sharing one

band are increased, there may be not sufficient bandwidth to offer the required data rate to each one, while there is unused bandwidth in other or same band. There is need for new scheme to effectively utilizing the available bandwidth in same or different frequency bands.

1.3 Proposed Solution

In order to achieve higher data rates and efficiently utilize the available resources, techniques such as joint carrier aggregation with scheduling algorithm will be examined in this project.

1.4 Research Objectives

The aim of this research to investigate the transmit of multi-services, such as video and VoIP, with high QOS by using joint carrier aggregation and scheduling algorithm.

In order to evaluate the effectiveness of the proposed schemes a simulation code written in MATLAB is used considering the following performance metrics

- Increase throughput.
- Improve bandwidth utilization.
- Increase spectral efficiency.
- Decrease delay.

1.5 Methodology

This research has gone through multiple phases which are:

- **Phase 1:** general data collected about the research such as LTE&LTE-A and their features , technologies, multiple access technique applied in LTE&LTE-A such as OFDM and OFDMA, carrier aggregation, scheduling algorithm.

- **Phase 2:** Mathematical representation of performance metrics such as throughput, delay, bandwidth utilization and Spectral efficiency are constructed.

- **Phase 3:** MATLAB code simulates the relationship between the system parameters and performance metrics such throughput, bandwidth utilization, Spectral Efficiency and delay with carrier aggregation and without carrier aggregation was written.

- **Phase 4:** Results from simulation obtained, and then the thesis is written.

1.6 Thesis Outlines

This thesis will consist of five chapters their details are as follows:

- **Chapter one:** presents background of cellular systems and the primary aspects of the project.
- **Chapter two:** shows the necessary theoretical aspects of this project such as LTE, LTE-Advanced, their features and technologies.
- **Chapter three:** gives the mathematical expressions used to explain the concepts of scheduling technique and Carrier Aggregation.
- **Chapter four:** presents the simulation process and resulting graphs for joint Carrier Aggregation and scheduling.
- **Chapter five:** concludes the project and proposes some subjects that can be investigated for a future work.

1.7 Summary

This chapter clarified the problem statements and its proposed solution and the main objective of the project, the literature review and LTE Advanced features and technologies will be shown in the next chapter.