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Optimization of Qos Parameters In 4th –Generation Wireless Mobile Networks-A Survey

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Abstract

Mobile communication technologies are continuously evolving. The customer's need of mobile communication and its awareness is also increasing exponentially, that's why it becomes essential to revise the quality of service (QoS) parameters for next generation wireless mobile communication. An important objective of this 4th-generation mobile communication is to provide access to the web internet all-time from anywhere, and full support for video applications with improved quality of service to meet the needs of customers. 3G wireless networks will not be able to meet the needs of the customer like video conferencing and other multimedia services in terms of QoS. 4th-generation mobile communication systems provide mobile users with a higher bandwidth (5GHz) and mobile data rate up to 1Gbps. However, this can be achieved with interoperability and continuous mobility for reliable communication to achieve end to end QoS in a single mobile terminal in 4G heterogeneous wireless environment by using intelligent buffering techniques and scheduling algorithms. So operators need to develop a very effective solution for the next generation wireless mobile network to improve quality of service and security measures. It will confirm that all subscribers are given an alternative approach for downloading and uploading multimedia and non-multimedia data in a minimum amount of time(without delay). This paper provides past achievement and future benefits related to enhancing QoS in 4G wireless Networks.

Keywords: 4G wireless networks, QoS parameters, wireless mobile networks, intelligent buffering techniques, scheduling algorithms.

Introduction

There are number of challenges and issues in 4th Generation wireless mobile networks. The most important challenging issue in next generation wireless mobile network is the QoS service provision for multimedia applications. Powerful and intelligent resource allocation schemes and High-performance physical layer technologies are required to provide increased throughput and efficient use of resources. The 1G and 2G wireless mobile computing systems were used for voice transmission only. The 3G wireless mobile systems were proposed to offer voice and paging services for teleconferencing, internet access and several other services. But this3G system provides a very limited coverage of 2mbps and WAN coverage of 384 kbps during peak rate. Therefore to provide broadband services will be the most important goals of the 4th-generation wireless systems.4G wireless communication systems are designed to facilitate enhanced wireless capabilities, network performance and audio/video technologies. 4G allows connectivity anytime, anywhere with QoS and mobility functions. QoS is required to provide high- quality audio, video and multimedia services over IP networks in 4G wireless mobile communication systems. Due to highly variable nature of wireless links and limitations of mobile devices, interaction between different layers is done to optimally select QoS parameters(e.g. modulation scheme, Forward Error Correction (FEC) scheme & congestion control).

4th-generation radio access technologies should be able to provide a variety of IP services [1]. In this paper we propose the different QoS approaches, some new challenges and related work done on QoS in 4G wireless mobile communication networks.

We arrange the contents of this paper as per given below: section I will provide a brief overview about its features of 4G wireless mobile networks, comparison between 3G and 4G and 4G wireless network architecture. Section II and III deals with issues in 4G and a survey of ongoing research work on QoS respectively. Section IV& V presents the comparative study and proposed work and the conclusion respectively.

Overview

Wireless mobile communication system generations are all the time a big topic for the research. Cellular service providers are already in the last phase of the deployment of 3G in major parts of the world to achieve higher data rates.

A. 4G wireless System features:

The 4G technology includes all types of advanced features thatmake4G technology most dominant technology in the near future.

1. It should provide support to wireless elastic multimedia, video, audio, wireless internet and other broadband services.

2. It should support for worldwide roaming or service and device portability and increased mobile networks.
3. It must be capable to provide high capacity, increased speed and minimized cost per bit data rate.
4. It should provide seamless packet switching, and other services based on the requirement of quality of service.
5. It should have good scheduling techniques and also call admission control schemes.
6. It should also support for adhoc and multi-hop networks.

4G and 5G systems have two types of networks: Mobile WiMAX and Long Term Evolution (LTE). To accommodate increased need of mobile and multimedia user applications, 3GPP developed LTE mobile networks[3]. To exchange multimedia images and live video streams from the network, the organizations requires wireless data sending abilities. But these requirements can't be achieved by existing narrowband schemes. This lead to the development of new mechanisms such as LTE, that provide transmission of high end video streams [4].

B. Comparison between 3G and 4G systems

The following table shows a comparison between 3G and 4G wireless mobile systems under some parameters.

Table 1: Comparison between 3g And 4g

Sr. No.	Parameters	3G	4G
1	Frequency band	1.8-2.5GHz	2-8GHz
2	Bandwidth	5-20MHz	5-20MHz
3	Data rate	Up to 2Mbps and 384Kbps for WAN	Up to 1Gbps
4	Access	Wide band CDMA	Multicarrier-CDMA or OFDMA using TDMA
5	FEC	Turbo codes	Concatenated codes
6	Switching	Circuit or packet switching	Packet switching only
7	Mobile top speeds	200 Kmph	200 Kmph

Issues In 4G:

Physical and MAC layer: There are many characteristics possessed by LTE networks [2]. The frequency division multiplexing uses multi-carrier Modulation (MCM) earlier used in digital audio video broadcasts and DSL modems. It uses parallel equal bandwidth channels which is a baseband process to send information implemented using fast Fourier Transform techniques. However Multicarrier

Modulation increases the peak to average ratio (PAVR) of the signal and to avoid inter symbol interference (ISI), a guard band or cyclic code must be added to the data.

Two different types of MCM are very important for 4G as per the above listing in table. E.g. 1) CDMA (MC-CDMA) & 2) Orthogonal FDM (OFDM) using TDMA. Mostly, MC-CDMA uses quadrature phase-shift keying (QPSK) and OFDM with TDMA uses more high level modulations (HLM) e.g.(M-QAM) multilevel quadrature amplitude modulation. However, to maximize QoS, AM- adaptive modulation could be used, where the depth of quadrature amplitude modulation helps to select mobile subscribers based on some known parameters.

i) **Channel Access:** To maximize throughput spreading codes or time slots can be allocated. E.g. for very clean channel users, all the resources are allocated and for noisy channel users a very little amount of bandwidth is allocated till their channel becomes clean. While allocating these resources certain amount of fairness should be maintained.

ii) **Error control coding:** Use the channel information from recorded parameters or take the feedback of mobile terminal (MT), 4G system uses rate-adaptive coding schemes. To minimize the overhead during retransmission, a hybrid ARQ schemes can be used. For further improvement of data rates multiple antenna systems and Space, time, codes, can be used.

Higher Layer Issues:

4th-generation wireless mobile network will be based on packet switching, because it could carry voice as well as internet traffic for the provision of different level of QoS. We can discuss the network layer challenges like mobility management, congestion control and end-to-end quality of service guarantees.

1. Mobility management: Paging, handoff, Location registration, require mobility management to access the services at any place possible through the MS.The multi-hop network helps to achieve global roaming for WLANs or Satellite coverage in remote locations. The handoff schemes should be developed for routing and to avoid too often handovers.
2. Congestion control: For high performance, Congestion control is the major challenge in 4G wireless networks. Congestion Control provides two basic strategies:
   a) Prevention or avoidance b) detection and recovery after congestion. We can use the call admission control and packet scheduling techniques for congestion avoidance and we can use the flow of packets and traffic management through feedback for the congestion detection and recovery.
3. Quality of Service (QoS)**:**4G system is totally based on packet switching forproviding real-time multimedia and internet-like services. We can categorize the real-time services into two types.

I) Guaranteed: Precomputed delay bound & jitter is required for the audioand video like services. II) Better than best effort.

A) any service requires end-to-end delay bound prediction B) also service should provide dynamically changing delay C)service requires resources like bandwidth and packet processing (controlled load)guaranteed and controlled load services are presented to improve QoS of next generation mobile networks. Because of this variable QoS services, we need a new IP protocol. And the network should provide "better than best effort".

C) 4G Network Architecture:

Fig1 is the widely accepted IP Based 4G network architecture used for wired/wireless communication accommodating 2G, 2.5G, 3G & 4G convergence technologies[5]

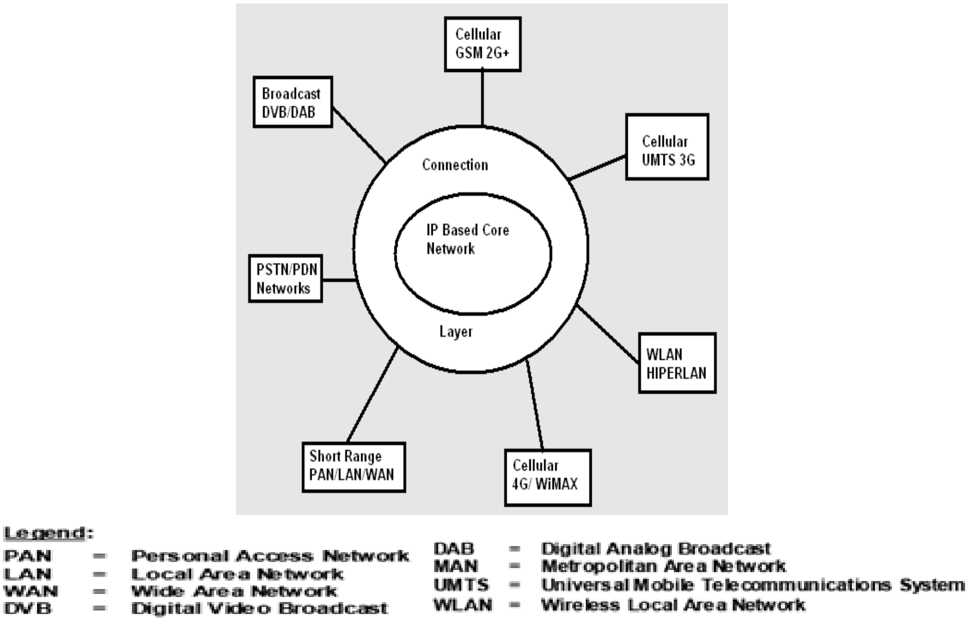

Figure 1: 4G Network Structure

Fig 2 shows protocol stack architecture of 4G networks [6]. In dynamic network conditions this protocol stack fulfills the very basic need of serving the fixed and mobile users on an "anytime, anywhere & anyhow".

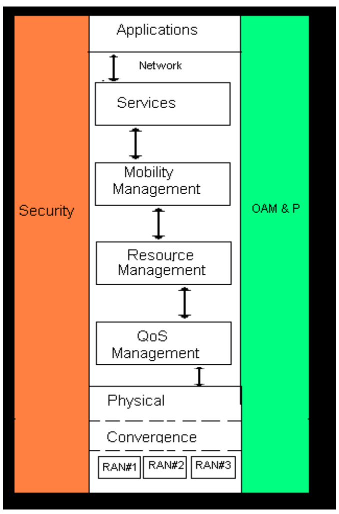

Figure 2: 4G Protocol Stack Architecture

This protocol stack uses Internet protocol version 6(IPV6). It operates at the transport layer in heterogeneous networks. It is based on the mobility, QoS & efficient resource allocation techniques.

Here we explain the services of each layer &module [7]:

1) Application layer:

This layer provides value added services as a third party applications to its subscriber.

2) Network layer:

This layer contains number of sub layers as described below:

A. Services: This layer is responsible for interaction among various value added services and network systems.
B. Mobility management: This layer is responsible for continuous services to the wireless mobile devices in heterogeneous systems. To optimize handoff latency and packet loss to the end user moving across heterogeneous networks, it updates the care of address of the mobile user called binding update and location management. It also performs Common Control Signaling for address assignment, network discovery, and handoff control techniques.
C. Resource management: This layer is responsible for the resource allocation, reallocation that are acquired while moving from one network to another networks.
   This resource allocation, deal location or reallocation can be done before or during communication activity. This layer also does the packet scheduling, packet analysis, congestion control& classification.
D. Quality of service Provisioning: The optimized utilization of the available resources is done in this layer. It also gives an option to select between end to end delay & throughput to the application user.

3) Physical layer:

The core IPV6 network of 4G & other heterogeneous access networks such as GSM,CDMA & WLAN are the parts of this layer. This layer is divided into two sub layers as described below:

A) Convergence layer: At the Physical level, the convergence layer gives Common Control Signaling mechanism between the core and heterogeneous wireless systems. E.g. resource management, mobility management and QoS management.
B) Radio access networks (RAN): RAN at the physical level contains several radio access networks communicating with each other.

4) Operation, Administration, Maintenance and Provisioning:

This layer provides the network monitoring, controlling, fault detection &resource management of various heterogeneous &basic networks which is present in all the layers.

5) Security:
This layer is also present in all the layers. This layer performs different kinds of security services such as the authentication, authorization, encryption, decryption, establishment & implementation of service policy agreement between the various operators.

Related Work

Number of scheduling schemes and algorithms for fine tuning the QoS service, the next generation wireless mobile network have been proposed and implemented in the past. To provide QoS for 4th generation mobile network, we need to assume different service classes such as throughput, various delay and Bit Error Rate(BER) properties. Based on the nature of service categories, these services have different priorities. There are two types of requests i) new call ii) handover calls based on priorities. In this paper[8], the signal strength is measured, and we require to maintain distinct queues for each type of service. Based on the traffic type real time or non-real time service and class of service, four groups are formed as below:

Group 1) a handover request with real-time traffic (**rtt)**
Group 2) a handover request with non-real-time traffic(**nrtt**)
Group 3) a new request with real-time traffic (**rtt**)
Group 4) a new request with non-real-time traffic (**nrtt**)

The aim of this paper [8] is to provide packet transmission priority for the real-time flow and bandwidth priority [14] simultaneously. Without violating the realtime flow QoS requirements, it avoids non-real-time flow starvation for the same end user.

In heterogeneous network based on many user preferences, a new network optimal selection algorithm is proposed in paper [9]. It is a common observation that, all the users expect low billing rate, high data rate and high bandwidth. User also expects high security and low call drop with an increased number of quality parameters. Hence the network selection complexity increases. To optimize network selection complexity, different algorithms and various criteria are applied in the paper [10, 11, 12, and 13]. For the distance function as per the paper [13], it has been normalize dall the parameters to take values in the range of zero and one. We can assign these values such that the higher the value for better user selection e.g. with higher mobile bills say 0.80 is more economical than the one with mobile bills 0.40 for network selection or user selection. Weighted distance function implements this level of customization. In this function based on the level of user interest, extra weight is added to the QoS parameters for the calculation of the priority. We require multi-parameter technique for automatic cell selection, while moving from one cell to another cell. Multimode and reconfigurable devices are the basic requirements for interworking of different networks in the 4G wireless systems. Based on the multiple user ratings and level of interest, the proposed algorithm in paper [13] uses distance function to generate ordered list of available access networks in a particular areas. With different QoS requirements a dynamic QoS based bandwidth allocation (DQBA) scheme is proposed in paper [14] to support heterogeneous traffic. To achieve QoS (fairness, utilization, delay and throughput), based on traffic characteristics and service demand, this algorithm dynamically changes the bandwidth allocation (BA) for ongoing and new call arrival connections. For this an efficient call admission control scheme, a dynamic BA technique and a two level packet scheduling scheme is applied. The paper [15] presented a new scheduling algorithm to improve QoS in 802.16. The throughput optimization consists of the linear algorithm, and Heuristic algorithm that uses fair scheduling algorithm for achieving QoS.

To deal with handoff call and new call, an efficient call admission control algorithm is proposed in paper [16]. In this paper, it assumed that the system uses a Reservation Channel Scheme and Queuing strategy for maintaining the HO priority. The model must maintain a balance between maximizingutilization of resources and minimization of forced handover call dropping rate. It tries to establish priority between a new and handover calls. Call admission control (CAC) decides whether to accept or to reject a call, based on four methods:

i) A real time new call treatment. ii) A non-real-time new call treatment.iii) Real-time-hand off calls (HO) treatment. iv) Non-real-time handoff (HO) call treatment.

The paper [17] proposed the quality of service for real-time sessions based on OFDMA (orthogonal frequency division multiple access) for optimal bandwidth& power to each user in wireless systems. The paper [17] proposes a QoS for real time sessions. In optimization it exploits time factor for data users by assuming the long term averaged received rate. For this, it uses proportional fair scheduling algorithm that supports data traffic as well as delay sensitive real-time traffic. Various parameters used are bandwidth, power, path loss, exponent, user distance, frame length and voice traffic. The paper[25] presented a simple suboptimal solution which fairly allocates and efficiently converges close to optimal, that meets the QoS criteria. It uses the following algorithms: i) Fair scheduling algorithm, ii) Greedy releasing algorithm, iii) Horizontal swapping algorithm, & iv) Vertical swapping algorithm.

A new call admission control and flow scheduling algorithm (ACFS) is proposed in paper [18]. It guarantees the QoS parameters (minimum bandwidth, optimum packet delay, and jitter). The packet scheduling algorithm proposed in the paper [19] admits and schedules any mix of flows that includes all types of traffic classes to support QoS. It consists of QoS architecture, packet scheduling method, and call admission control mechanism. Parameters used are bandwidth, frame duration, time slot, an arrival time, service time, delay and token bus. The paper [20] can guarantee the QoS for the EF (Expedited Forwarding) and AF (Assured Forwarding) traffics. It avoids the starvation of BE (Best Effort) traffic during the high traffic load.

The paper[21] gives the comparative assessments of scheduling algorithms for different WiMAX networks. Resource Reservation Protocol is a signaling protocol for advanced resource allocation presented in the paper[22] in wireless mobile communication systems. This paper presents the issues of scalability in RSVP with lower per connection state storage and lesser control messaging. It provides wireless application QoS parameters such as loss negotiability, loss profile and the handover quality.

Video traffic will be dominant in the future over next generation mobile networks. So to overcome on this, 4G should be remodeled and re-standardized to provide mobile users with more bandwidth and higher data rate. Currently, design of 4G networks, called, LTE networks provide high data rate communication tunnels between the internet and mobile subscribers. Communication tunnels increase both user delay, operating expenses and decreases end-to-end QoS. We can use video caching to optimize this in 4G wireless mobile networks[23].It addresses the following important questions:

1) What type of content can be cached?
2) What method can be used to cache?

With a fast algorithm, it proved that the formulated problem is NP-Hard. Multimedia or video quality of service assessment can be Human Centric under Quality of Experience (QoE). The business parameters, network layer QoS parameters, and content, affect the multimedia service.

A new framework is proposed in paper [24] for the management of video streaming service and for run time quality evaluation. In this paper the proposed algorithm takes network and application layer QoS data, qualitative QoE data, quantitative user ratings and content information to enhance QoS for multimedia data. Using this descriptive information and multiple linear regressions, one can evaluate Quality of Experience. In the case of any variation in QoE, an alert message is sent to the coordinator for further investigation and improvement.

Comparative Study & Proposed Scheme

In this survey paper we assumed number of scheduling algorithms, methods for radio resource allocation, bandwidth allocation (BA) and traffic types. For call admission control with four priority levels, we consider following classes:

1. Handover real-time
2. Handover non-real-time
3. New call real-time
4. New call non-real-time.

It supports following five classes for end-to-end service to optimize Quality of service (QoS) in next generation wireless networks:

1) UGS – Unsolicited Grant Scheme.
2) Ertps-Extended real time polling service.
3) rtps- real-time polling service.
4) nrtps- non-real-time polling service.
5) BE- Best Effort.

We can see in table1,the different scheduling algorithms and traffic types supported by them and their applications. Here we considered various algorithms like priority queuing model, fair queuing model & adaptive queuing model from different papers. Here the parameters used are data type, priority, packet interval, data rate & bandwidth for scheduling requests.

In this proposed work we present a modified packet scheduling and call admission control algorithm. For CAC we use aging field/bit for scheduling of user requests to avoid starvation of low priority calls in 4G wireless mobile networks. We also propose a new intelligent buffering technique and packet scheduling scheme to achieve end-to-end quality of service (QoS) for 4G wireless networks. This proposed method requires queuing model and buffering techniques to enhance the system throughput and to reduce the jitter and delay time of multimedia and non-multimedia data in 4G wireless mobile networks.

Table 1: Comparative Study

Sr. No.	Paper Name	Method/ Technique	Traffic type supported	Application	Limitation
1	QoSbased Adaptive Admission controller for next generation wireless networks[8]	Transmission priority and bandwidth priority	real-time andnon-real-time flow service	SSH, FTP video, VOIP	Starvation of low priority requests.
2	QoS based network selection algorithm for 4G system[9]	Transmission priority and bandwidth priority	real-time &Non-real-time flow service	FTP, video	Starvation of low priority requests
3	A smart decision model for vertical Handoff[11]	The Score based function.	Non real-time service.	SSH, FTP.	Poor performance, if the score not matched..
4	Terminal controlled mobility management in heterogeneous wireless networks [13].	The Score based function.	Non real-time service.	SSH, FTP.	Poor performance, if the score not matched.
5	Dynamic QoS based bandwidth Allocation framework for broadband wireless networks(DQBA)[14].	Two level packet scheduling, admission control policy, Dynamic bandwidth Allocation mechanism.	Heterogeneous traffic.	HTTP, FTP.	Starvation of low priority requests.
6	Efficient and fair scheduling of uplink and downlink in IEEE 802.16 OFDMA networks [15].	Linear algorithm and Heuristic algorithm, packet scheduling model.	Real-time&Non real-time traffic.	SSH,FTP, Video.	It won't support for heterogeneous networks.
7	The CAC model for QoS management in wireless multi services network [16].	Handoff priority using queuing strategy and reservation channel scheme.	Real-time&Non-real-time flow service.	SSH, FTP, Video, VOIP.	Starvation of low priority requests.
8	Packet scheduling for QoS support in IEEE 802.16 broadband wireless access systems [19].	Packet scheduling.	Real-time and Non-real-time traffic.	FTP, Video.	Starvation of low priority requests.
9	Adaptive weighted fair queuing with priority (AWFQP) Scheduler for Diffservnetworks [20].	Weighted fair queuing with priority scheduler.	EF, AF traffics and BE.	HTTP.	Poor performance, if weights not matched.
10	WLRP: A resource Reservation protocol for quality of service in next generation wireless networks [22].	RSVP.	Real-time and Non-real-time traffic, Video traffic.	FTP	Scalability&QoSproblem, interaction of multiple application mobile device not possible.
11	EP Cache: In-network video caching for LTE core networks [23].	Cache concepts- a novel in-network video caching algorithm.	Video traffic.	SSH, FTP, Video.	Live video streaming problem.

Conclusion

The content of this paper is on the basis of survey status of Quality of Service (QoS) in next generation wireless mobile communication networks to provide all time connectivity. We present a brief overview of all the algorithms for call admission control to achieve the QoS as shown in table1. Here comparative study has been done for various methods and algorithms.

This paper proposes a novel algorithm for call admission control, resource allocation and multimedia messaging services based on multiple user preferences and intelligent buffering techniques under heterogeneous networks. The algorithm and techniques used in this proposal provide to optimize different delay, jitter, throughput for multimedia and non-multimedia data in the packet based 4G wireless mobile networks

References:

[1] Parul Datta and Sakshi Kaushal, "Exploration and comparison of different 4G technologies Implementations: A survey", proceedings of 2014 RAES UIET Panjab University Chandigarh, 06-08 March 2014 pp. 1-6.

[2] Hassan Gobjuka, "4G wireless networks: opportunities and challenges".

[3] Amit Kumar, Jyotsna Sengupta and Yun-Fei Liu, "3GPP LTE: The structure of mobile Broadband wireless Personal Communications, vol 62, issue 3, February 2012, pp 671-686.

[4] J. Brouet and She Feng, "LTE and Future Evolutions for the benefits of security wireless networks", wireless mobile and computing (CCWMC 2011), IET International communication conference, 2011, pp 447-454.

[5] A.H Khan, M. A. Qadeer, J. A. Ansari and S.Waheed, "4G as a Next generation wireless network", future computer and communication, 2009, ICFCC 2009, International conference, April 2009,pp 334-338.

[6] Kibria, M.R. Mirchandani, V. Jamaupour, A.,"A consolidated Architecture for 4G/B3G networks", wireless communications and networking conference, 2005, IEEE vol 4, March 2005, pp: 2406- 2411.

[7] Piyush Gupta Priyadarshan Patil,"4G- A new ERA in wireless Telecommunication ", school of Innovation, design and Engg, Hogskoleplan1, Vasteras, Sweden.

[8] Ch. Sreenivasa Rao, K. Chennakeshava Reddy and D. Sreenivasa Rao, "QoS based Adaptive Admission controller for next generation wireless networks.", International journal of computer theory and Engineering vol 3, No. 5 October 2011 pp:684- 689.

[9] Amit Sehgal, Rajeev Agarwal member IEEE, " QoS based network selection scheme for 4G systems", IEEE Transmissions on consumer Electronics, vol 56, No. 2, may 2010, pp:560-565.

[10] L. Suciu, J. M. Bonnin, "A survey of multicriteria network selection algorithms", Global mobile congress, 2004 Shanghais.

[11] L. Chen T. Sun, B. Chen, V. Rajendran, M. Gerla, "A smart decision model for vertical Handoff", Proceedings of 4th ANWIRE International workshop on wireless Internet and Configurability (ANWIRE-2004), Greece, 2004

[12] Leesk, Sriram K, Kim K. Lee JH, Kim Y H, Golmie N (2007), "vertical Handoff decision algorithms for providing optimized performance in heterogeneous wireless networks", in IEEE GLOBCOM 2007, Washington DC, November.

[13] Nguyen-Vuong Q.T., Agoulmine N, Ghamri-Doudane (2007), "Terminal controlled mobility management in heterogeneous wireless networks", in IEEE-M_COM, April.

[14] Amir Esmailpour and Nidal Nasser, member IEEE,"DynamicQoS based bandwidth Allocation framework for broadband wireless networks", IEEE Transactions on vehicular Technology, vol 60, No. 6 July 2011.
[15] Vandana Singh and vinod Sharma," Efficient and fair scheduling of uplink and downlink in IEEE 802.16 OFDMA networks"
[16] Sonia Ben RejebZied Choukair, Sami Tabbane," The CAC model for QoS management in wireless multi services network", International Journal on computer science and Engineering(IJCSE) vol. 02,No. 02, 2010,pp: 333-339.
[17] Tolga Girice, Chenxi Zhu, Jonathan R. Agre and Anthony Ephremides, "Proportional fair scheduling Algorithm in OFDMA based wireless systems with QoS constraints", Journal of Communications and Networks, vol. 12, No. 1, February 2010.
[18] Kalyana Chakravarthy Chilukuri and Prasad Reddy P.V.G.D, "Admission control and scheduling for IEEE 802.16WiMAX networks with QoS Requirements", International Journal of computer Applications (0975-8887) volume 42, No. 18, March 2012.
[19] Kitti Wangthavarawatan, Y and Aura Ganzz, "Packet scheduling for QoS support in IEEE 802.16 broadband wireless access systems", International Journal of communication systems 2003, pp 81-96.
[20] I. Shyan Hwang, Bor-Jiunn Hwang and ching-shyan ding, "Adaptive weighted fair queuing with priority (AWFQP) Scheduler for Diffserv networks", Journal of Informatics and Electronics, vol. 2, No. 2, PP 15-19, March 2008.
[21] Ahmed H. Rashwan, Hesham M. Elbadawy, Hazem H. Ali, " Comparative Assessments for different WiMAX scheduling Algorithms", Proceedings of the world congress on Engineering and computer science 2009 vol. 1 WCECS 2009, October, pp. 20-22, 2009, Sanfrancisco, USA.
[22] Sunder Parmeswaran, "WLRP: A resource Reservation protocol for quality of service in next generation wireless networks", Proceedings of the 28th Annual IEEE International conference on local computer networks (LCN'03), 0742-1303/03.
[23] Jiawai Zhu, Jun He, Hao Zhou, Baohua Zhao," EP Cache: In-network video caching for LTE core networks" ,978-1-4799-0308-5/2013 IEEE.
[24] Khalil ur Rehman Laghari, Thanh Tung Pham, Hang Nguyen, Noel Crespi, " QoM: A new Quality of Experience Framework for multimedia services." 978-1-4673-2713-8/2012 IEEE.
[25] Mustafa Ergen, Sinem Coleri, and pravinvaraiya, "QoS Aware Adaptive Resource Allocation Techniques for fair scheduling in OFDMA based broadband wireless Access systems, "IEEE Transactionson Broadcasting VOL. 49, No 4, December 2003.