SERVICE QUALITY OPTIMISATION SCHEME OF MOBILE VIDEO STREAM SERVICE

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Dedicated to my beloved parents

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ABSTRACT

In video stream service over wireless and mobile network, issue of limited network resource need to be addressed in order to assure acceptable service quality. From the perspective of network resource supply, network operator attempts to address the issue by increasing network capacity. In contrast, from the perspective of network demand, service provider concentrates on using the network resource efficiently according to necessity of application or service. However, determination of network necessity is not trivial due to intermingled correlation between Quality of Service (QoS) parameters and network Channel Quality Indicator (CQI). Moreover, determination of network necessity is also associated with quality of experience. This study develops service quality scheme that elucidates the correlation among QoS parameters. This basic scheme consists of two methods, generation of video test materials and Objective Video Quality Measurement (OVQM). The videos are generated with different configuration of QoS parameters. The OVQM quantifies the videos' quality and objectively screens acceptable videos. The scheme produces Look Up Table I (LUT I) that lists configuration of QoS parameters of the acceptable video quality. In order to accommodate the quality of experience factors, the scheme is enhanced to include Subjective Video Quality Assessment (SVQA) method. SVQA method is an assessment survey to obtain user feedback of acceptable video quality listed in LUT I. The enhanced scheme has produced Look Up Table II (LUT II). This LUT II shows configuration of QoS parameters that objectively and subjectively fulfil the video quality. The proposed schemes along with both LUTs can be adopted by network operators and other service stakeholders to allocate more efficient network resource for an acceptable quality. In addition, methods used in the development of the schemes are general enough for further investigation of network resource allocation for any mobile multimedia service.

ABSTRAK

Dalam perkhidmatan aliran video melalui rangkaian tanpa wayar dan mudah alih, isu sumber rangkaian yang terhad perlu ditangani untuk menjamin perkhidmatan yang berkualiti. Dari perspektif pembekalan sumber rangkaian, operator rangkaian berusaha untuk menangani isu tersebut dengan meningkatkan kapasiti rangkaian. Sebaliknya, dari perspektif permintaan rangkaian, pembekal perkhidmatan menumpukan kepada penggunaan sumber rangkaian yang cekap mengikut keperluan aplikasi atau perkhidmatan. Namun, penentuan keperluan rangkaian bukanlah perkara yang mudah kerana terdapat korelasi yang kompleks antara parameter Kualiti Perkhidmatan (QoS) dan Penunjuk Saluran Kualiti (CQI) rangkaian. Selain itu, penentuan keperluan rangkaian juga dikaitkan dengan kualiti pengalaman yang dipengaruhi oleh faktor subjektif. Kajian ini membina skim kualiti perkhidmatan yang menjelaskan korelasi antara parameter QoS. Skim asas ini mempunyai dua kaedah iaitu penjanaan material video pengujian dan Pengukuran Objekif Kualiti Video (OVQM). Video dihasilkan dari konfigurasi parameter QoS yang bebeza. OVQM mengukur kualiti video dan menyaring kualiti video yang boleh diterima secara objektif. Skim ini menghasilkan Jadual Carian I (LUT I) yang menyenaraikan konfigurasi parameter QoS untuk kualiti video yang boleh diterima. Bagi menampung faktor kualiti pengalaman, skim ini telah ditambah baik dengan mengambil kira Penilaian Subjektif Kualiti Video (SVQA). Kaedah SVQA adalah kajian penilaian bagi mendapatkan maklumbalas pengguna terhadap kualiti video yang boleh diterima pada LUT I. Skim yang ditambahbaik ini menghasilkan Jadual Carian II (LUT II). LUT II menunjukkan konfigurasi parameter QoS yang menghasilkan kualiti video yang boleh diterima secara objektif dan subjektif. Skim cadangan ini berserta kedua-dua LUT boleh diguna pakai oleh pengendali rangkaian dan pemegang taruh perkhidmatan yang lain bagi memperuntukkan sumber rangkaian secara lebih efisien untuk kualiti perkhidmatan yang boleh diterima. Tambahan pula, kaedah yang digunakan dalam pembangunan skim adalah cukup umum untuk siasatan lanjut bagi peruntukan sumber rangkaian untuk sebarang perkhidmatan multimediaa.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACR	-	Quality of Service
AF	-	Assured Forwarding
ANN	-	Artificial Neural Network
AOVD	-	Ad hoc On Demand Distance Vector
APSNR	-	Aligned Peak Signal to Noise Ratio
AQ	-	Audio Quality
AVI	-	Audio Video Interleave
AVQ	-	Audio Video Quality
BR	-	Binary Response
BS	-	Base Station
CQI	-	Channel Quality Indicator
DCR	-	Degradation Category Ratting
DSR	-	Dynamic Source Routing
DYMO	-	Dynamic Manet on Demand
EF	-	Effective Forwarding
EURANE	-	Enhanced UMTS Radio Access Network Extension
FFT	-	Fast Fourier Transform
FR	-	Full Reference
GGSN	-	Gateway GPRS Support Node
HDTV	-	High Definition Television
HSDPA	-	High-Speed Downlink Packet Access
HTTP	-	Hypertext Transfer Protocol
IP	-	Internet Protocol
IPTV	-	Internet Protocol Television
ITU	-	International Telecommunication Union
JND	-	Just Noticeable Difference

JPEG	-	Joint Photographic Experts Group
LUT	-	Look-up Table
MANET	-	Mobile Ad hoc Network
MNB	-	Measuring Normalizing Block
MOS	-	Mean Opinion Score
MOV	-	Model Output Variable
MPSNR	-	Modified Peak Signal to Noise Ratio
MSE	-	Mean Square Error
MUSC	-	Multi-user Session Control
NR	-	No Reference
NRA	-	Network Resource Allocation
NR-B	-	No Reference Bit
NR-P	-	No Reference Pixel
NTIA	-	National Telecommunications and Information Administration
ODG	-	Objective Difference Grade
OLSR	-	Optimized Link State routing Protocol
OVQM	-	Objective Video Quality Measurement
PAMS	-	Perceptual Analysis Measurement System
PC	-	Pair Comparison
PDA	-	Personal Digital Assistant
PDM	-	Perceptual Distortion Metric
PEAQ	-	Perceptual Evaluation of Audio Quality
PESQ	-	Perceptual Evaluation of Speech Quality
PSQM	-	Perceptual Speech Quality Measure
PSNR	-	Peak Signal to Noise Ratio
P2P	-	Point to Point
QoE	-	Quality of Experience
QoS	-	Quality of Service
QoSA	-	Application-level of Quality of Service
QoSN	-	Network-level of Quality of Service
QVGA	-	Quarter Video Graphics Array
RGB	-	Red Green Blue
RNC	-	Radio Network Controller
RR	-	Reduced Reference

RRM	-	Radio Resource Management
RTP	-	Real-time Transport Protocol
SBBP	-	Switched Batch Bernoull Process
SEAM	-	Single-Ended Assessment Model
SGSN	-	Serving GPRS Support Node
SLA	-	Service Level Agreement
SNR	-	Signal to Noise Ratio
SSIM	-	Structural Similarity
SVQA	-	Subjective Video Quality Assessment
UE	-	User Equipment
UMTS	-	Universal Mobile Telecommunications System
VBR	-	Variable Bit Rate
VDP	-	Visual Differences Predictor
VGA	-	Video Graphic Array
VoIP	-	Voice over Internet Protocol
VQ	-	Video Quality
VQEG	-	Video Quality Expert Group
VTM	-	Video Test Material
WIMAX	-	Worldwide Interoperability for Microwave Access
WLAN	-	Wireless Local Area Network

CHAPTER 1

INTRODUCTION

1.1 Background of the Problem

Advancement of heterogeneous wireless and mobile network, video processing technologies, and mobile device capabilities have encouraged many new and creative video stream services. User has been exposed to wide variety of service, including video call, video teleconference, IP television, and mobile Video on Demand (mobile-VoD) which is focus of this research. User expectation to excellent services quality is also increased. It involves many aspects such as quality of streamed video, variety of content, value added service, and of course affordable price. Among of them, quality of streamed video that delivered and displayed on mobile device is the most prominent aspect. As studied by Barkowsky et al. (2015), the quality of streamed video really determines customer satisfaction.

Quality of streamed video can be achieved by high quality of original video, large allocation of network resource, and advance capability of mobile device. High quality of original video can be made by high configuration of frame rate, audio rate, and video resolution. These parameters are commonly known as Application-level of Quality of Service (QoSA) parameter. High configuration of QoSA parameter needs more allocation of network resource to transmit original video from application server to mobile device. Due to limited availability of network resource, it is not feasible to allocate large allocation resource for each service session (Chowdhury, 2011). Maximization of network utility by every session such as promoted by Kapov

et al. (2013) even gives more pressure. Wireless and mobile network resource is unable to counterbalance the growth of mobile multimedia services. Figure 1.1 summarizes the derivation of research issue.

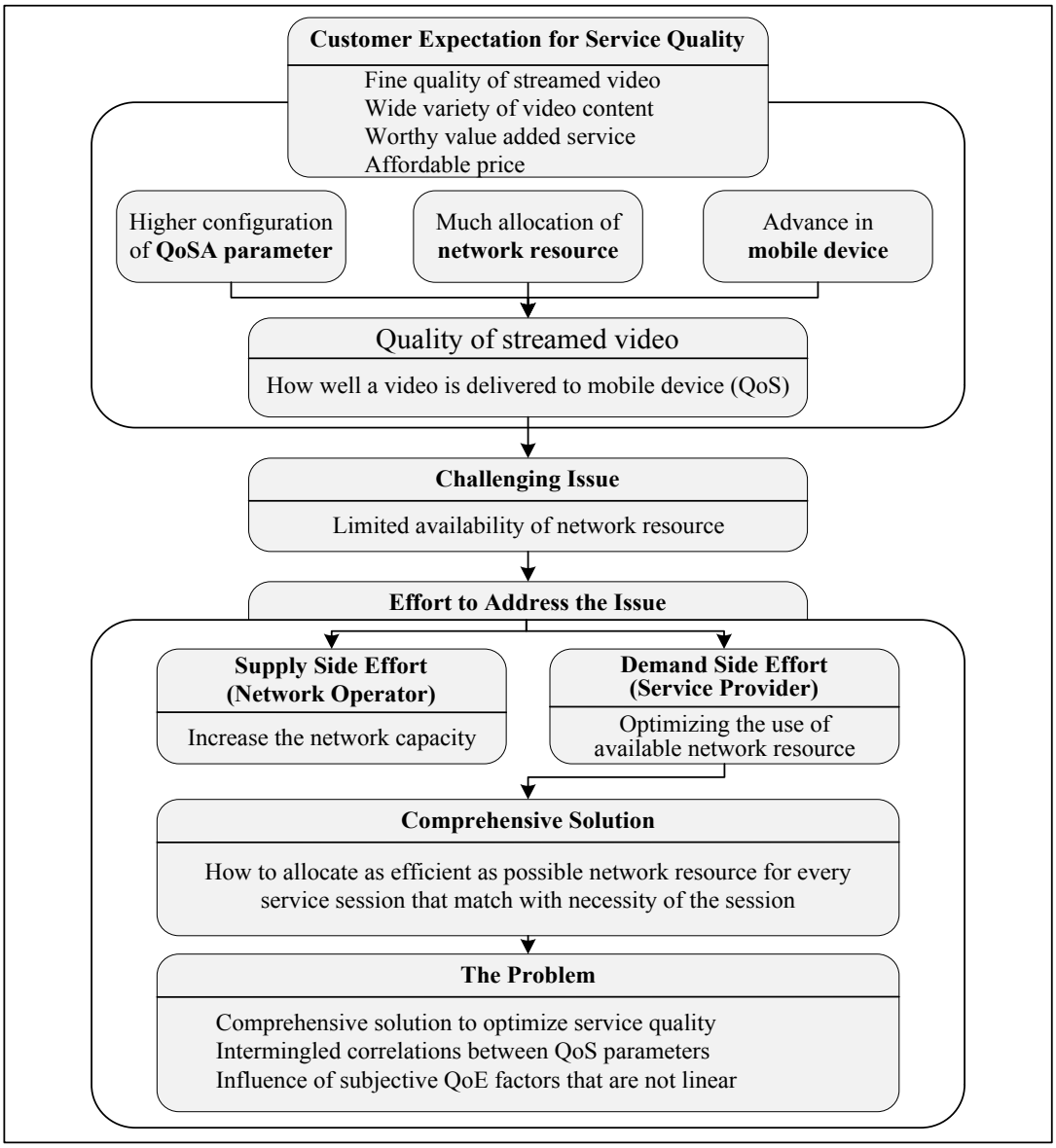

Figure 1.1 Derivation of research issue

Network operators that concern with network resource currently are in race to address the issue of limited network resource. Mostly, their effort is from the perspective of network supply or commonly known as supply side effort. The effort concentrates to attain maximum network throughput (Mung and Bell, 2004). Two

major solutions of such effort are development of new network infrastructure and enhancement of the existing infrastructure. However, both solutions and other solutions of supply side effort have typical characteristic; they are technical centric. They only focus on providing network resource without considering how the network resource is consumed at demand side.

In contrast to supply side effort, demand side effort deals with the limited network resource by optimizing the use of the available resource (Milosevic *et al.*, 2007). The basic idea is how to use the network resource as efficient as possible according to necessity of application or service. Solutions that applied by demand side effort are known as comprehensive solutions as discussed by IXIA (2013). In attempt to use network resource efficiently, the solution analyses the quality of the service in relation with allocation of the resource. Result from the analysis is used as loopback input for more efficient allocation of network resource as used in study by Li *et al.* (2012).

Many researches about comprehensive solution that is supported by Telco industry have studied solution to allocate as efficient as possible network resource for every service session that matched to necessity of the session (Koutsopoulos and Iosifidis, 2010). However, determination of the network necessity is not trivial due to intermingled correlation between QoS parameter. There are correlations between network resource allocation and configuration of QoSA parameters that are intermingled. For certain allocation of network resource, the QoSA parameters also interrelate to each other in influencing quality of streamed video. Moreover, determination of network necessity is also associated with Quality of Experience (QoE). The QoE of video stream service indicates how well the service is perceived by user. QoE is influenced by subjective factor that involves intrinsic factors and extrinsic factors.

Clear understanding on the correlation between QoS parameters in influencing service quality is very important for allocating network resource according to necessity. Previous research by Song and Li (2005) and Kangkang *et al.*

(2012) have analysed correlation between necessity of the network resource and service quality that is perceived to customer. On the other hand, clear understanding is also required on how the subjective QoE factor affect the acceptability of video stream service in relation with efficiency of network resource allocation. Previous research in quality analysis such as Verdolini and Petrangeli (2013) and Seppanen *et al.* (2014) has tried to study link between network condition and user satisfaction. However, the existing solutions from supply side effort and demand side effort are inadequate to fill gap between technical solution and quality analysis.

This study is designed to fill the gap. It attempts to optimize the use of available network resource by development of a service quality scheme of video stream service. The scheme aims for enabling optimal configuration of QoS parameters in order to provide acceptable service quality and at the same time it is also able to satisfy the user using efficient network resource. In this study, the scheme that combines both objective and subjective aspect of service quality is defined as comprehensive solution. Development of the scheme came up with two Look Up Table (LUTs). LUT I was generated during development of initial basic scheme. It elucidates correlation between QoSA parameter and network resource allocation. LUT II that has considered influence of QoE factors was generated during development of the enhanced scheme.

The schemes and both LUTs can be used as guidance by stakeholders of video stream service, especially network operator and service provider to provide acceptable service quality and satisfied user using efficient network resources. In addition the scheme and LUTs also contributes to knowledge as one of entry point and basis for more advanced solution to conserve the limited network resource.

1.2 Problem Statement

Allocation of network resource that suits to necessity is very essential in video stream service over mobile and wireless network. Allocating too less resource will cause unacceptable service quality, while too much network resource allocation beyond the necessity will not increase customer satisfaction anymore, but wasting the resource. Due to intermingled correlation between QoS parameter, efficient allocation of network resource that matches with the various necessities of every service sessions is a persistence challenge. Existing solutions are inadequate to guide service stakeholders, especially service provider and network operator to provide acceptable service quality using efficient network resource. Service quality scheme is needed as a guidance for the service stakeholders to optimise service quality that is offered to the customer.

1.3 Research Question

This research aims to answer the following research questions:

(i) How to develop a service quality scheme as comprehensive solution in order to optimize the service quality?

(ii) How correlation between QoSA parameters and network resource allocation influences the quality of streamed video?

(iii) What subjective factors affect the acceptability of video stream service in relation with efficiency of network resource allocation?

1.4 Research Objectives

The specific objectives of this research are:

(i) To develop a service quality scheme for mobile video stream service that can elucidate correlation between QoSA parameters and network resource allocation to achieve optimum service quality.

(ii) To enhance the proposed scheme by considering subjective factors in order to make sure the technically acceptable quality of video stream service also accepted by user.

1.5 Scope and Key Assumptions

This study is limited to the following:

(i) Video stream service throughout this thesis means mobile-VoD.

(ii) Video test material is limited to three video contents that have difference video and audio characteristic.

(iii) The QoS parameter configuration is limited to audio rate, frame rate, video resolution as QoSA parameters and Channel Quality Indicator (CQI) as representative of network resource allocation.

(iv) The video streaming process is conducted under simulation environment.

(v) HSDPA is used as network in the simulation.

(vi) The evaluation is focused on out-of-service evaluation.

The following essential assumption is adopted in this research:

(i) Channel Quality Indicator (CQI) is used as parameter to represent the three controllable, uncontrollable, and unpredictable behavior of HSDPA network.

1.6 Significant of the Research

This research is motivated by real problem in Telco industry. There is lack of guidance for provisioning technically acceptable streamed video quality and also can satisfy the user using efficient network resource. The problem is complex because it involves three parties, network operator, service provider, and vendor of mobile device.

This research views the problem from technical and non-technical perspectives. The idea of service quality scheme that is proposed in this research is emerged from the mix of perspectives. As an exploratory research, contribution of the research can be illustrated as hierarchy of contribution as shown in Figure 1.2. Main contribution of this research is an alternative approach that combines objective QoS analysis and subjective QoE analysis. Theoretical framework that proposed in this study consists of basic scheme and enhanced scheme. Two main concerns in the basic scheme are correlation between network resource allocation and QoSA parameters and interrelation among QoSA parameters in influencing service quality. Meanwhile, the enhanced scheme deals with influence of subjective factor to acceptability of video stream service in relation with efficiency of network resource allocation.

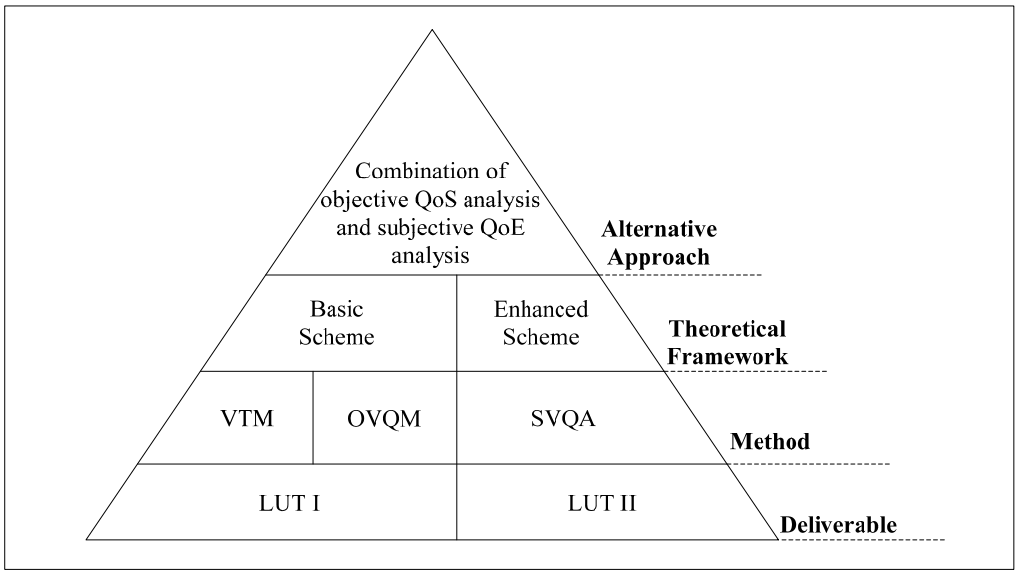

Figure 1.2 Research contributions

As a specific contribution, three methods are developed and two deliverables are generated. The methods are generating Video Test Material (VTM), Objective Video Quality Measurement (OVQM), and Subjective Video Quality Assessment (SVQA). The two deliverables are Look Up Table (LUT) I and II. The discussion for the specific contribution involves the scheme design, consideration of the design, tool development, and deliverable. Details of these research contributions are provided in Section 8.3.

1.7 Thesis Organization

This thesis is organized into eight chapters as shown in Figure 1.3. Chapter 2 provides an essential introduction to the research. It explains background information and a review of related literature. Chapter 3 describes the research methodology. Chapter 4 addresses generating process of video test material which includes selection of master video, master-to-original video conversion, and simulation of video stream over simulated network to obtain streamed video. Chapter 5 discusses on the design and analysis of basic scheme focusing on OVQM process to evaluate

the streamed video objectively. Chapter 6 deals with enhanced scheme that improves the basic scheme by considering subjective QoE factor. Chapter 7 provides an overall discussion of research findings, validations and limitations. Chapter 8 concludes the thesis with lists of conclusions, contributions and suggestions for further research.

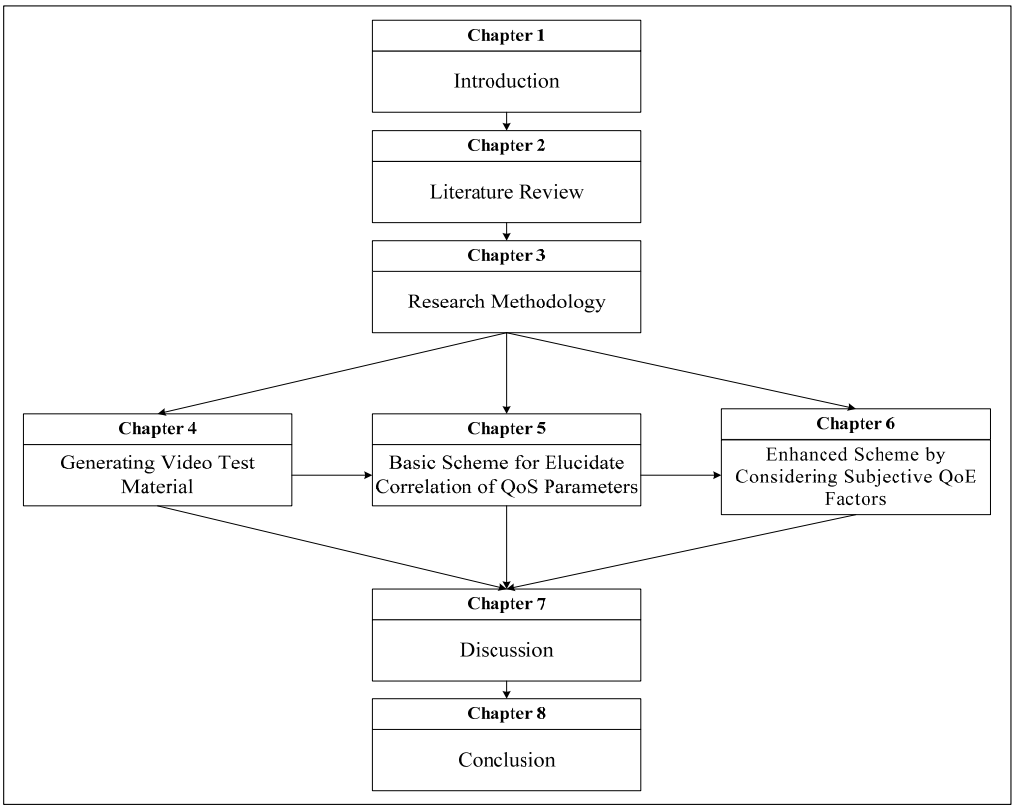

Figure 1.3 Organization of thesis

REFERENCES

Abdel-Hady, M. and Ward, R. (2007). A Framework for Evaluating Video Transmission over Wireless Ad Hoc Networks. *IEEE Pacific Rim Conference on Communications, Computers and Signal Processing*. 22-24 August. Victoria, Canada: IEEE, 78-81.

Abdulghani, A. M. A. (2006). H. 263 Video Transmission in Wireless Local Area Networks using OPNET. ICWN. 423-429. CSREA Press.

Agboma, F. and Liotta, A. (2006). User Centric Assessment of Mobile Contents Delivery. *Proc. of 4th International Conferences on Advances in Mobile Computing and Multimedia*. 4-6 December. Yogyakarta, Indonesia: Austrian Computer Society, 121-130.

Agboma, F. and Liotta, A. (2008). QoE-aware QoS Management. *The 6th International Conference on Advances in Mobile Computing and Multimedia*. 24-26 November. Linz, Austria: ACM, 111-116.

Agboma, F. and Liotta, A. (2012). Quality of Experience Management in Mobile Content Delivery Systems. *Telecommunication Systems*. 49(1), 85-98.

Ahmad, I., Xiaohui, W., Yu, S., and Ya-Qin, Z. (2005). Video Transcoding: An Overview of Various Techniques and Research Issues. *IEEE Transactions on Multimedia*. 7(5), 793-804. IEEE.

Al tamimi, A. K., Chakchai, So-In., and Jain, R. (2010). Modeling and Resource Allocation for Mobile Video over WiMAX Broadband Wireless Networks. *IEEE Journal on Selected Areas in Communications*. 28(3), 354-365. IEEE.

Alcatel. (2013). *The LTE Network Architecture*. White paper.

Aldridge, R., Davidoff, J., Ghanbari, M., Hands, D., and Pearson, D. (1995). Measurement of Scene-dependent Quality Variations in Digitally Coded Television Pictures. *IEEE Proceedings Vision, Image and Signal Processing*. 142(3), 149-154. IEEE.

Aoude, M. and Rahal, K. (2008). Scheduling Algorithms Performance of HSDPA over Wireless Channels. *3rd International Conference on Information and Communication Technologies: From Theory to Applications*. 7-11 April. Damascus, Syria: IEEE, 1-5.

Apteker, R. T., Fisher, J. A., Kisimov, V. S., and Neishlos, H. (1995). Video Acceptability and Frame Rate. *IEEE MultiMedia*. 2(3), 32-40. IEEE.

Arnold, M., Chen, X. M., Baum, P., Gries, U., and Doërr, G. (2014). A Phase-based Audio Watermarking System Robust to Acoustic Path Propagation. *Transactions on Information Forensics and Security*. 9(3), 411-425. IEEE.

Arshad, K., MacKenzie, R., Celentano, U., Drozdy, A., Leveil, S., Mange, G., *et al.*, (2014). Resource Management for QoS Support in Cognitive Radio Networks. *Communications Magazine*. 52(3), 114-120. IEEE.

Azarbad, B. and Sali, A. B. (2012). DVB-S2 Model in Matlab: Issues and Impairments. In Katsikis, V. N. (Ed.) *MATLAB - A Fundamental Tool for Scientific Computing and Engineering Applications - Volume 2* (pp. 217-234). Rijeka, Croatia: InTech.

Barkowsky, M. (2009). *Subjective and Objective Video Quality Measurement in Low-bitrate Multimedia Scenarios*. Hut.

Barkowsky, M., Sedano, I., Brunnstrom, K., Leszczuk, M., and Staelens, N. (2015). Hybrid Video Quality Prediction: Reviewing Video Quality Measurement for Widening Application Scope. *Multimedia Tools and Applications*. 74(2), 323-343.

Bashar, S., and Ding, Z. (2009). Admission Control and Resource Allocation in a Heterogeneous OFDMA Wireless Network. *IEEE Transactions on Wireless Communications*. 8(8), 4200-4210. IEEE.

Batkauskas, V. and Kajackas, A. (2010). Quality of Heterogeneous Mobile Data Services: Capabilities and End–user Achievements. *Electronics and Electrical Engineering*.–Kaunas: Technologija. 5(101), 43-46.

Beerends, J. G., Hekstra, A. P., Rix, A. W., and Hollier, M. P. (2002). Perceptual Evaluation of Speech Quality (PESQ) the New ITU Standard for End-to-end Speech Quality Assessment Part II: Psychoacoustic Model. *Journal of the Audio Engineering Society*. 50(10), 765-778. AES.

Besson, A., De Simone, F., and Ebrahimi, T. (2013). Objective Quality Metrics for Video Scalability. *20th IEEE International Conference on Image Processing*. 15-18 September. Melbourne: IEEE, 59-63.

Bradeanu, O., Munteanu, D., Rincu, I., and Geanta, F. (2006). Mobile Multimedia End-User Quality of Experience Modeling. *International Conference on Digital Telecommunications*. 29-31 August. Cote d'Azur: IEEE, 49.

Brandt, J., and Wolf, L. (2010). Impact of Adaptation Dimensions on Video Quality. *14th International Symposium on Consumer Electronics (ISCE)*. 7-10 June. Braunschweig: IEEE, 1-6.

Braun, T., Diaz, M., and Staub, T. (2008). *End-to-End Quality of Service Over Heterogeneous Networks*. Berlin: Springer-Verlag.

Brouwer, F., de Bruin, I., Silva, J. C., Souto, N., Cercas, F., and Correia, A. (2004). Usage of Link-level Performance Indicators for HSDPA Network-level Simulations in E-UMTS. *IEEE Eighth International Symposium on Spread Spectrum Techniques and Applications*. 30 August-2 September. Sydney, Australia: IEEE, 844-848.

Câmpeanu, D., and Câmpeanu, A. (2005). PEAQ–An Objective Method to Assess The Perceptual Quality of Audio Compressed Files. *Proceedings of International Symposium on System Theory*. 12, 487-492.

Cerqueira, E., Veloso, L., Curado, M., and Mendes, P. (2007). Mobility Support for Multi-user Sessions over Heterogeneous Networks. *12th IEEE Symposium on Computers and Communications*. 1-4 July. Aveiro, Portugal: IEEE, 297-304.

Chan, A., Zeng, K., Mohapatra, P., Lee, S. J., and Banerjee, S. (2010). Metrics for Evaluating Video Streaming Quality in Lossy IEEE 802.11 Wireless Networks. *Proceedings IEEE INFOCOM*. 14-19 November. San Diego, CA: IEEE, 1-9.

Chen, H., Kumar, S., Huang, L., and Kuo, C. C. J. (2004). *Radio Resource Management for Multimedia QoS Support in Wireless Networks*. USA: Kluwer Academic Publishers.

Chia-Yu, Y., Chih-Heng, K., Reuy-Shin, C., Ce-Kuen, S., Munir, B., and Chilamkurti, N. (2007). MyEvalvid_RTP: A New Simulation Tool-set Toward More Realistic Simulation. *Future Generation Communication and Networking*. 6-8 December. Jeju, Korea: IEEE, 90-93.

Chih-Heng, K., Cheng-Han, L., Ce-Kuen, S., and Wen-Shyang, H. (2006). A Novel Realistic Simulation Tool for Video Transmission over Wireless Network. *IEEE International Conference on Sensor Networks, Ubiquitous, and Trustworthy Computing*. 5-7 June. Taichung: IEEE, 7.

Chih-Wei, H., Shiang-Ming, H., Po-Han, W., Shiang-Jiun, L., and Jenq-Neng, H. (2012). OLM: Opportunistic Layered Multicasting for Scalable IPTV over Mobile WiMAX. *IEEE Transactions on Mobile Computing*. 11(3), 453-463. IEEE.

Chikkerur, S., Sundaram, V., Reisslein, M., and Karam, L. J. (2011). Objective Video Quality Assessment Methods: A Classification, Review, and Performance Comparison. *IEEE Transactions on Broadcasting*. 57(2), 165-182. IEEE.

Choi, K., Choi, J. K., Min, G. J., Lee, J. (2008). Comparison of Video Streaming Quality Measurement Methodologies. *International Conference on Advanced Communication Technology*. 17-20 February. Gangwon-Do: IEEE, 993 – 996.

Chowdhury, M. Z., Young-il, K., Won, R., and Yeong Min, J. (2011). Popularity Based Bandwidth Allocation for Video Broadcast/Multicast over Wireless Networks. *International Conference on ICT Convergence*. 28-30 September. Seoul: IEEE, 373-376.

Chowdhury, M.Z., Noor Islam, M., Seo, Y. M., Lee, Y. K., Kang, S. B., Choi, S. W., *et al.* (2008). Characterizing QoS Parameters and Application of Soft-QoS Scheme for 3G Wireless Networks. *10th International Conference on Advanced Communication Technology.* 17-20 February. Gangwon-Do: IEEE, 760–764.

Ciubotaru, B., Muntean, G., and Ghinea, G. (2009). Objective Assessment of Region of Interest-aware Adaptive Multimedia Streaming Quality. *IEEE Transactions on Broadcasting*. 55(2), 202-212. IEEE.

Corte, A. L., and Scata, M. (2011). Security and QoS analysis for Next Generation Networks. *International Conference on Information Society*. 27-29 June. London: IEEE, 248 – 253.

Cranley, N. and Davis, M. (2006). The Effects of Background Traffic on the End-To-End Delay for Video Streaming Applications over IEEE 802.11B WLAN

Networks. *IEEE 17th International Symposium on Personal, Indoor and Mobile Radio Communications*. 11-14 September. Helsinki: IEEE, 1-5.

Daly, S. (1993). The Visible Differences Predictor: An Algorithm for the Assessment of Image Fidelity. *Digital images and human vision*. 4, 124-125. ACM.

Dao, N. D. and Fernando, W. A. C. (2003). Channel Coding for H.264 Video in Constant Bit Rate Transmission Context over 3G Mobile Systems. *2003 International Symposium on Circuits and Systems*. 25-28 May. Bangkok: IEEE, 896-899.

Darabkh, K.A., Awad, A.M., and Khalifeh, A.F. (2013). Intelligent and Selective Video Frames Discarding Policies for Improving Video Quality over Wired/Wireless Networks. *IEEE International Symposium on Multimedia*. 9-11 December. Anaheim: IEEE, 297-300.

De Castro Monteiro, C. and De Lira Gondim, P. R. (2009). Improving Video Quality in 802.11 Networks. *IEEE INFOCOM Workshops*. 19-25 April. Rio de Jenario: IEEE, 1-6.

De Koning, T., Veldhoven, P., Knoche, H., and Kooij, R. (2007). Of MOS and men: bridging the gap between objective and subjective quality measurements in mobile TV. *Proceeding of SPIE forMultimedia on Mobile Devices*. 6507. SPIE.

Do, N. M., Hsu, C.-H., and Venkatasubramanian, N. (2014). Video Dissemination over Hybrid Cellular and Ad Hoc Networks. *IEEE Transactions on Mobile Computing*. 13(2), 274-286. IEEE.

Dong, X., Lawey, A., El-Gorashi, T. E., and Elmirghani, J. M. (2012). Energy-efficient Core Networks. *16th International Conference in Optical Network Design and Modeling*. 17-20 April. Colchester: IEEE. 1-9.

Dymarski, P., and Markiewicz, R. (2013). Audio Watermarking in Frequency Domain using Walsh Functions and LDPC Codes. *20th International Conference in Systems, Signals and Image Processing*. 7-9 July. Bucharest: IEEE, 155-158.

Eduardo, A. F. and Garzon, H. F. (2010). Analysis and Simulation of Radio Resource Management for Quality of Service in Universal Mobile Telecommunications System. *IEEE ANDESCON*. 15-17 September. Bogota: IEEE, 1-6.

Ee Ping, O., Shiqian, W., and Loke, M. H. (2010). IN-service Video Quality Monitoring. *IEEE International Symposium on Circuits and Systems*. 30 May- 2 June. Paris: IEEE, 3381-3384.

Engelke, U., Barkowsky, M., Le Callet, P., and Zepernick, H. J. (2010). Modelling Saliency Awareness for Objective Video Quality Assessment. *Second International Workshop on Quality of Multimedia Experience*. 21 - 23 June. Trondheim, Norway: IEEE. 212 – 217.

Ennaji, Y., Boulmalf, M., and Alaoui, C. (2009). Experimental Analysis of Video Performance over Wireless Local Area Networks. *International Conference on Multimedia Computing and Systems*. 2-4 April. Ouarzazate: IEEE, 488-494.

Fiedler, M., Hossfeld, T., and Tran-Gia, P. (2010). A Generic Quantitative Relationship between Quality of Experience and Quality of Service. *IEEE Network*, 24(2), 36-41. IEEE.

Fitzek, F. H. P., Zorzi, M., Seeling, P., and Reisslein, M. (2004). Video and Audio Trace Files of Pre-encoded Video. *First IEEE Consumer Communications and Networking Conference*. 5-8 January. Las Vegas, NV, USA: IEEE. 245 – 250.

Fliegel, K. (2014). *QUALINET Multimedia Databases v5. 0*.

Frank, P. and Incera, J. (2006). A Neural Network Based Test Bed for Evaluating the Quality of Video Streams in IP Networks. *Electronics, Robotics and Automotive Mechanics* Conference. 26 - 29 September. Cuernavaca, Mexico: IEEE. 178 - 183.

Galatchi, D., and Zoican, R. (2005). IntServ Operation over DiffServ Networks. *International Symposium in Signals, Circuits and Systems*. 14-15 July. Iasi: IEEE, 525-528.

Galetzka, M., Roder, D., and Finger, A. (2006). Simulation of User-Perceived QoS in Hybrid Broadcast and Telecommunication Networks. *International conference on Networking and Services*. 16-18 July. Slicon Valley, CA: IEEE, 49-49.

Gangadharan, D., Phan, L. T. X., Chakraborty, S., Zimmermann, R., and Lee, I. (2011). Video Quality Driven Buffer Sizing via Frame Drops. *IEEE 17th International Conference on Embedded and Real-Time Computing Systems and Applications*. 28-31 August. Toyama: IEEE, 319-328.

Gastaldo, P., Rovetta, S., and Zunino, R. (2002). Objective Quality Assessment of MPEG-2 Video Streams by using CBP Neural Networks. *IEEE Transactions on Neural Networks*. 13(4), 939-947. IEEE

Girella, D. (2007). *Downlink TCP Proxy Solutions over HSDPA with Multiple Data Flow*. Master, School of Electrical Engineering Royal Institute of Technology, Stockholm.

Goldmann, L., De Simone, F., Dufaux, F., Ebrahimi, T., Tanner, R., and Lattuada, M. (2010). Impact of Video Transcoding Artifacts on the Subjective Quality. *Second International Workshop on Quality of Multimedia Experience*. 21-23 June. Trondheim: IEEE, 52-57.

Gross, J., Klaue, J., Karl, H., and Wolisz, A. (2004). Cross-layer Optimization of OFDM Transmission Systems for MPEG-4 Video Streaming. *Computer Communications*. 27(11), 1044-1055. Elsevier.

Hamadicharef, B. and Ifeachor, E. (2005). Perceptual Modeling of Piano Tones. *Audio Engineering Society Convention 119*. Audio Engineering Society

Hands, D. S. (2004). A Basic Multimedia Quality Model. *IEEE Transactions on Multimedia*. 6(6), 806 – 816. IEEE.

Hansen, J. P., and Hissam, S. A. (2013). Assessing QoS trade-offs for Real-time Video. *14th International Symposium and Workshops in World of Wireless, Mobile and Multimedia Networks*. 4-7 June. Madrid: IEEE, 1-6.

Hellerud, E., Voldhaug, J. E., and Svensson, U. P. (2006). Perceptually Controlled Error Protection for Audio Streaming over IP Networks. *International Conference on Digital Telecommunications*. 29-31 August. Cote d'Azur: IEEE, 30-30.

Hestnes, B., Heiestad, S., Ulseth, T., Schliemann, T., Brooks, P., Følstad, A., *et al*. (2003). *Fitness-for-Purpose Guidelines for Person-Person Communication*. EC Deliverable IST11577/TEL/RAD/DS/Pub/065/b1.

Hossain, E., Niyato, D., and Han, Z. (2009). *Dynamic Spectrum Access and Management in Cognitive Radio Networks*. New York: Cambridge University Press.

Hu, H. T., Ku, C. H., and Chen, S. H. (2013). Exploiting Psychoacoustic Properties to Achieve Transparent and Robust Audio Watermarking. *International Conference in Information Science and Applications*. 24-26 June. Suwon: IEEE. 1-5.

Huynh-Thu, Q. and Ghanbari, M. (2008). Temporal Aspect of Perceived Quality in Mobile Video Broadcasting. *IEEE Transactions on Broadcasting*. 54(3), 641-651. IEEE.

Huynh-Thu, Q., Garcia, M. N., Speranza, F., Corriveau, P., and Raake, A. (2011). Study of Rating Scales for Subjective Quality Assessment of High-definition Video. *IEEE Transactions on Broadcasting*. 57(1), 1-14. IEEE.

ITU. (1996). *Recommendation P.861 - Objective Quality Measurement of Telephone-band (300-3400 Hz) Speech Codecs*. Geneve: International Telecommunication Union.

ITU. (1997). *Recommendation BS.1116- Methods for the Subjective Assessment of Small Impairments in Audio Systems Including Multichannel Sound Systems*. Geneve: International Telecommunication Union.

ITU. (1998). *Recommendation P.911 - Subjective Audiovisual Quality Assessment Methods for Multimedia Applications*. Geneve: International Telecommunication Union.

ITU. (1999). *Recommendation P.910 - Subjective Video Quality Assessment Methods for Multimedia Applications*. Geneve: International Telecommunication Union.

ITU. (2001). *Recommendation P.862 - Perceptual Evaluation of Speech Quality (PESQ): An Objective Method for End-to-end Speech Quality Assessment of Narrow-band Telephone Networks and Speech Codecs*. Geneve: International Telecommunication Union.

ITU. (2001). *Recommendation G.1000 - Communications Quality of Service: A Framework and Definitions*. Geneve: International Telecommunication Union.

ITU. (2002). *Recommendation BT.500-11 - Methodology for the Subjective Assessment of the Quality of Television Pictures*. Geneve: International Telecommunication Union.

ITU. (2003). *Recommendation BS.1284-1 - General Methods for the Subjective Assessment of Sound Quality*. Geneve: International Telecommunication Union.

ITU. (2004). *Recommendation P.563 - Single-ended Method for Objective Speech Quality Assessment in Narrow-band Telephony Applications*. Geneve: International Telecommunication Union.

ITU. (2014). *Recommendation P.913 - Methods for the Subjective Assessment of Video Quality, Audio Quality and Audiovisual Quality of Internet Video and Distribution Quality Television in Any Environment*. Geneve: International Telecommunication Union.

IXIA. (2013). *Quality of Service (QoS) and Policy Management in Mobile Data Networks*. White paper.

Jasani, H. (2011). Quality of Service Evaluations of On Demand Mobile Ad-Hoc Routing Protocols. *5th International Conference on Next Generation Mobile Applications, Services and Technologies*. 14-16 September. Cardiff: IEEE. 123-128.

Jin, B., Xie, J., Wang, T., and Yang, Z. (2009). Online Network Resource Allocation Mechanism with the Continuous High Satisfaction. *Second International Symposium In Information Science and Engineering.* 26-28 December. Shanghai: IEEE, 254-258.

Joly, A., Montard, N., and Buttin, M. (2001). Audio-visual Quality and Interactions between Television Audio and Video. *Sixth International, Symposium on Signal Processing and its Applications*. 13-16 August. Kuala Lumpur: IEEE, 438-441.

Jumisko-Pyykkö, S., Häkkinen, J., and Nyman, G. (2007). Experienced Quality facTors-Qualitative Evaluation Approach to Audiovisual Quality. *Proc. SPIE for Multimedia on Mobile Devices*. 6507-6521.

Junghyun, H., Yo-Han, K., Jangkeun, J., and Jitae, S. (2010). Video Quality Estimation for Packet Loss based on No-Reference Method. *The 12th International Conference on Advanced Communication Technology*. 7-10 February. Phoenix Park: IEEE, 418-421.

Kabal, P. (2002). *An examination and interpretation of ITU-R BS. 1387: Perceptual evaluation of audio quality*. Canada: McGill University.

Kangkang, L., Yang, X., Mengyuan, Z., Qiang, Y., and Su, P. (2012). Network Resource Allocation Algorithm Optimization based on User's Satisfactory Level. *International Conference in Automatic Control and Artificial Intelligence*. 3-5 March. Xiamen: IEEE, 1386-1389.

Kanumuri, S., Cosman, P. C., Reibman, A. R., and Vaishampayan, V. A. (2006). Modeling Packet-loss Visibility in MPEG-2 video. *IEEE Transactions on Multimedia*. 8(2), 341-355. IEEE.

Kapov, L., et al. (2013). Approaches for Utility-Based QoE-Driven Optimization of Network Resource Allocation for Multimedia Services. *Data Traffic Monitoring and Analysis*. 7754. 337-358. Springer Berlin Heidelberg.

Khan, A., Sun, L., and Ifeachor, E. (2008). An ANFIS-Based Hybrid Video Quality Prediction Model for Video Streaming over Wireless Networks. *Second International Conference on Next Generation Mobile Applications, Services, and Technologies*. 16 - 19 September. Washington DC, USA: IEEE. 357 - 362.

Khan, A., Sun, L., and Ifeachor, E. (2010). Learning Models for Video Quality Prediction over Wireless Local Area Network and Universal Mobile Telecommunication System Networks. *IET Communications*. 4(12), 1389-1403. IEEE.

Khater, J. (2006). *NS-2 Simulation Based Study of E2E Video Streaming Over Ultra-Wideband (UWB) Wireless Mesh Networks*. Master. Athens Information Technology, Athens.

Khorsandroo, S., Noor, R. M., and Khorsandroo, S. (2012). A Generic Quantitative Relationship between Quality of Experience and Packet Loss in Video Streaming Services. *Fourth International Conference on Ubiquitous and Future Networks*. 4-6 July. Phuket: IEEE. 352-356.

Kim, H. J., Lee, K. H., and Zhang, J. (2010). In-service Feedback QoE Framework. *Third International Conference on Communication Theory, Reliability, and Quality of Service*. 13-19 June. Athens, Greece: IEEE. 135 – 138.

Klaue, J., Rathke, B., and Wolisz, A. (2003). EvalVid - A Framework for Video Transmission and Quality Evaluation. *Proceeding of the 13th International Conference on Modelling Techniques and Tools for Computer Performance Evaluation*. 2-5 September. Urbana, USA: Springer . 255-272

Knoche, H., Mc Carthy, J. D., and Sasse, M. A. (2005). Can Small Be Beautiful? Assessing Image Size Requirements for Mobile TV. *Proceedings of the 13th Annual ACM International Conference on Multimedia.* 6 - 12 November. Singapore: ACM. 829 - 838.

Korhonen, J., Reiter, U., and Myakotnykh, E. (2010). On the Relative Importance of Audio and Video in the Presence of Packet Losses. *Second International Workshop on Quality of Multimedia Experience (QoMEX)*. 21 - 23 June. Trondheim, Norway: IEEE. 64 - 69.

Koutsopoulos, I.and Iosifidis, G.(2010). Auction Mechanisms for Network Resource Allocation. *Proceedings of the 8th International Symposium on Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks (WiOpt)*. 31 May - 4 June. Avignon, France: IEEE, 554 - 563.

Kserawi, M., Lee, D., Sung, J., and Rhee, J. (2014). Multipath Video Real-Time Streaming by Field-Based Anycast Routing. *IEEE Transactions on Multimedia*. 16(2). 533-540. IEEE.

Lan, Y., Geng, Y., Rui, L., & Xiong, A. (2012). Video Quality Assessment and QoE-Driven Adjustment Scheme in Wireless Networks. *14th International Conference in Communication Technology*. 9-10 November. IEEE, 46-50.

Lazaro, O., Girma, D., and Dunlop, J. (2001). Real-time Generation of Synthetic MPEG-4 Video Traffic Using Wavelets. *IEEE VTS 54th Vehicular Technology Conference*. 7-11 October. USA: IEEE, 418-422.

Lei, H., Kumar, S., and Kuo, C. C. J. (2004). Adaptive Resource Allocation for Multimedia QoS Management in Wireless Networks. *IEEE Transactions on Vehicular Technology*. 53(2), 547-558. IEEE.

Li, M., Chen, Z, and Tan, Y. (2012). QoE-Aware Resource Allocation for Scalable Video Transmission over Multiuser MIMO-OFDM Systems. *Visual Communications and Image Processing*. 27-30 November. San Diego: IEEE, 1 – 6.

Liao, R., Tu, W., Excell, P. S., and Grout, V. (2009). QoS Analysis Models for Wireless Networks.

Lin, D. C. C. and Chau, P. M. (2006). Objective Human Visual System Based Video Quality Assessment Metric for Low Bit-Rate Video Communication Systems. *8th Workshop on Multimedia Signal Processing*. 3-6 October. Victoria, BC: IEEE, 320-323.

Lin, M., Chenwei, D., Ngan, K. N., and Weisi, L. (2013). Recent Advances and Challenges of Visual Signal Quality Assessment. *China Communications*. 10(5), 62-78.

Liu, T. J., Liu, K. H., and Liu, H. H. (2010). Temporal Information Assisted Video Quality Metric for Multimedia. *IEEE International Conference on Multimedia and Expo*. 19-23 July. Suntec City: IEEE, 697-701.

Livingston, M. A., Barrow, J. H., and Sibley, C. M. (2009). Quantification of Contrast Sensitivity and Color Perception using Head-worn Augmented Reality Displays. *IEEE Virtual Reality Conference*. 14-18 March. Lafayette, LA: IEEE, 115-122.

Lombaedo, A., Schembra, G., and Morabito, G. (2001). Traffic specifications for the transmission of stored MPEG video on the Internet. *IEEE Transactions on Multimedia*. 3(1), 5-17. IEEE.

Lopez, I., Ameigeiras, P. J., Wigard, J., and Mogensen, P. (2001). Downlink Radio Resource Management for IP Packet Services in UMTS. *IEEE VTS Vehicular Technology Conference*. 6-9 May. Rhodes: IEEE, 2387-2391.

López-Vicario, J. and Antón-Haro, C. (2004). Joint Transmit Antenna Selection and Adaptive Modulation in Cross-layer Oriented Designs for HSDPA Systems. *Sensor Array and Multichannel Signal Processing Workshop Proceedings*. 18-21 July. Barcelona, Spain: IEEE, 523-527.

Lubin, J. and Fibush, D. (1997). Sarnoff JND Vision Model. *Contribution to IEEE Standards Subcommittee*. IEEE.

Lucio, G. F., Paredes-Farrera, M., Jammeh, E., Fleury, M., and Reed, M. J. (2003). OPNET Modeler and NS-2: Comparing the Accuracy of Network Simulators for Packet-level Analysis using a Network Testbed. *WSEAS Transactions on Computers*. 2(3), 700-707.

Machado, V. A., Silva, C. N., Oliveira, R. S., Melo, A. M., Silva, M., Frances, C. R. L., *et al*. (2011). A New Proposal to Provide Estimation of QoS and QoE over WiMAX Networks: An Approach based on Computational Intelligence and Discrete-event Simulation. *IEEE Latin-American Conference on Communications*. 24-26 October. Belem do Para: IEEE, 1-6.

Maoqiang, S., Jie, S., Xiangling, F., and Wenkuo, X. (2010). Design and Implementation of Media Player Based on Android. *6th International Conference on Wireless Communications Networking and Mobile Computing*. 23-25 September. Chengdu: IEEE, 1-4.

Márquez, F. G., Rodriguez, M. G., Valladares, T. R., De Miguel, T., and Galindo, L. A. (2005). Interworking of IP Multimedia Core Networks between 3GPP and WLAN. *IEEE Wireless Communications*. 12(3), 58-65. IEEE.

McCarthy, J. D., Sasse, M. A., and Miras, D. (2004). Sharp or Smooth?: Comparing the Effects of Quantization vs. Frame Rate for Streamed Video. *Conference*

on Human Factors in Computing Systems. 24-29 April. New York, US: ACM, 535-542.

McDonagh, P., Pande, A., Murphy, L., and Mohapatra, P. (2013). Toward Deployable Methods for Assessment of Quality for Scalable IPTV Services. *IEEE Transactions on Broadcasting*. 59(2), 223-237. IEEE.

Milosevic, D., Kunegis, J., and Albayrak, S. (2007). Resource-Aware Update Policy for Highly Dynamic P2P Networks. International Conferences on Web Intelligence and Intelligent Agent Technology. 5-12 November. Silicon Valley: IEEE, 419 – 423.

Mok, R. K. P., Chan, E. W. W., and Chang, R. K. C. (2011). Measuring the Quality of Experience of HTTP Video Streaming. *IFIP/IEEE International Symposium on Integrated Network Management*. 23-27 May. Dublin: IEEE, 485-492.

Msakni, H. G., and Youssef, H. (2013). Is QoE Estimation based on QoS Parameters Sufficient for Video Quality Assessment? *9th International Wireless Communications and Mobile Computing Conference*. 1-5 July. Sardinia: IEEE, 538-544.

Mubeen, T., Tasadduq, I. A., and Zubairi, J. A. (2007). Hand Off Issues in 3G UMTS Networks. *International Bhurban Conference on Applied Sciences & Technology*. 8-11 January. Islamabad : IEEE, 44-48.

Mückenheim, J. and Bernhard, U. (2001). A Framework for Load Control in 3rd Generation CDMA Networks. *Global Telecommunications Conference*. 25-29 November. San Antonio: IEEE, 3738-3742.

Mullner, R., Ball, C. F., Ivanov, K., Lienhart, J., and Hric, P. (2009). Contrasting Open-Loop and Closed-Loop Power Control Performance in UTRAN LTE Uplink by UE Trace Analysis. *IEEE International Conference on Communications*. 14-18 June. Dresden:IEEE, 1-6.

Mung, C., and Bell, J. (2004). Balancing Supply and Demand of Bandwidth In Wireless Cellular Networks: Utility Maximization Over Powers and Rates. Paper presented at the INFOCOM 2004. *Twenty-third Annual Joint Conference of the IEEE Computer and Communications Societies*. 7-11 March. IEEE, 2800-2811.

Muntean, G. M., Perry, P., and Murphy, L. (2005). Subjective Assessment of the Quality-Oriented Adaptive Scheme. IEEE Transactions on Broadcasting. 51(3), 276-286. IEEE.

Na, T., and Kim, M. (2014). A Novel No-Reference PSNR Estimation Method With Regard to Deblocking Filtering Effect in H. 264/AVC Bitstreams. *IEEE Transactions on Circuits and Systems for Video Technology*. 24(2), 320-330. IEEE.

Nen-Fu, H., Ming-Hung, W., Tzu-Chien, W., and Shiu-Shun, P. (2011). Measuring QoE/QoS of Large Scale P2P IPTV Service. *13th Asia-Pacific Network Operations and Management Symposium*. 21-23 September. Taipei: IEEE, 1-8.

Neruda, M., and Bestak, R. (2008). Evolution of 3GPP Core Network. *15th International Conference in Systems, Signals and Image Processing*. 25-28 June. Bratislava: IEEE, 25-28.

Oelbaum, T., Baroncini, V., Tan, T. K., and Fenimore, C. (2004). Subjective Quality Assessment of the Emerging AVC/H. 264 Video Coding Standard. *International Broadcasting Conference (IBC)*.

Osso, R. (1999). *Handbook of emerging communications technologies: the next decade* (Vol. 6). Boca Raton, Florida: CRC Press.

Paneda, X. G., Garcia, R., Melendi, D., Vilas, M., and Garcia, V. (2006). Popularity Analysis of a Video-on-demand Service with a Great Variety of Content Types: Influence of the Subject and Video Characteristics. *20th International Conference on Advanced Information Networking and Application*. 18-20 April. Vienna: IEEE.

Papadakis, A. and Zachos, K. (2011). Subjective and Objective Video Codec Evaluation. *15th Panhellenic Conference on Informatics*. 30 September-2 October. Kastonia: IEEE, 194-198.

Paulikas, S., Sargautis, P., and Banevicius, V. (2011). Impact of Wireless Channel Parameters on Quality of Video Streaming. *Electronics and Electrical Engineering*. 108(2), 27-30.

Pauliks, R. Tretjaks, K. Belahs, K. and Pauliks, R. (2013). A Survey on Some Measurement Methods for Subjective Video Quality Assessment. *World Congress on Computer and Information Technology*. 22-24 June. Sousse: IEEE, 1-6.

Pennock, S. (2002). Accuracy of the Perceptual Evaluation of Speech Quality (PESQ) Algorithm. *Proceding of MESAQIN*.

Peppas, K., Lazarakis, F., Alexiou, A., Alexandridis, A., and Dangakis, K. (2006). Reconfigurability to Antenna Correlation: System Level Performance Enhancements in HSDPA. *First European Conference on Antennas and Propagation*. 6-10 November. 1-6.

Piamrat, K., Viho, C., Bonnin, J. M., and Ksentini, A. (2009). Quality of Experience Measurements for Video Streaming over Wireless Networks. *Sixth International Conference on Information Technology: New Generations*. 27-29 April. Las Vegas, NV: IEEE, 1184-1189.

Pinson, M. and Wolf, S. (2003). Comparing Subjective Video Quality testing Methodologies. SPIE Video Communications and Image Processing Conference. *International Society for Optics and Photonics*. 573-582.

Pinson, M., and Wolf, S. (2009). *Batch Video Quality Metric (BVQM) User's Manual*. NTIA Handbook HB-09-441c. National Telecommunications and Information Administration. Department of Commerce, USA.

Redl, A., Keimel, C., and Diepold, K. (2013). Saliency based Video Quality Prediction using Multi-way Data Analysis. *Fifth International Workshop in Quality of Multimedia Experience*. 3-5 July. IEEE, 188-193.

Reichl, P., Egger, S., Schatz, R., and D'Alconzo, A. (2010). The Logarithmic Nature of QoE and the Role of the Weber-Fechner Law in QoE Assessment. *IEEE International Conference in Communications*. 23-27 May. Cape Town: IEEE, 1-5.

Reiter, U., and Korhonen, J. (2009). Comparing Apples and Oranges: Subjective Quality Assessment of Streamed Video with Different Types of Distortion. *International Workshop on Quality of Multimedia Experience*. 29-31 July. San Diego, CA: IEEE, 127-132.

Rezende, C., Mammeri, A., Boukerche, A., and Loureiro, A. A. F. (2014). A Receiver-based Video Dissemination Solution for Vehicular Networks with Content Transmissions Decoupled from Relay Node Selection. *Ad Hoc Networks*, 17(0), 1-17. Elsevier.

Ries, M., Puglia, R., Tebaldi, T., Nemethova, O., and Rupp, M. (2005). Audiovisual Quality Estimation for Mobile Streaming Services. *2nd International*

Symposium on the Wireless Communication Systems. 5-7 September. Sienna: IEEE, 173-177.

Rios Chavez, J., Aquino Ruiz, C., and Garcia Sanchez, S. (2012). Audio Watermarking of WAV Files by Echo Modulation. *22nd International Conference on Electrical Communications and Computers.* 27-29 February. Cholula, Puebla: IEEE, 350-354.

Rix, A. W., and Hollier, M. P. (2000). The Perceptual Analysis Measurement System for Robust End-to-end Speech Quality Assessment. *IEEE International Conference on Acoustics, Speech, and Signal Processing*. 5-9 June. Istanbul: IEEE, 1515-1518.

Rodriguez, D. Z., Rosa, R. L., and Bressan, G. (2014). Video Quality Assessment in Video Streaming Services Considering User Preference for Video Content. *International Conference in Consumer Electronics*. 10-13 January. Las Vegas: IEEE, 570-571.

Schmitt, J. B. (2001). *Heterogeneous Network Quality of Service Systems*. Massachusetts: Kluwer Academic Publishers.

Schoenen, R.; Yanikomeroglu, H. (2014). User-in-the-loop: Spatial and Temporal Demand Shaping for Sustainable Wireless Networks. *IEEE Communications Magazine*. 52(2), 196-203. IEEE.

Seppänen, J., Varela, M., and Sgora, A. (2014). An Autonomous QoE-driven Network Management Framework. *Journal of Visual Communication and Image Representation*, 25(3), 565-577. Elsevier.

Seshadrinathan, K., Soundararajan, R., Bovik, A. C., and Cormack, L. K. (2010). A Subjective Study to Evaluate Video Quality Assessment Algorithms. *IS&T/SPIE Electronic Imaging*. International Society for Optics and Photonics.

Shioda, S., and Mase, K. (2005). Performance Comparison between IntServ-based and DiffServ-based Networks. *Global Telecommunications Conference*. St. Louis: IEEE, 529-534.

Siomina, I., and Di, Y. (2008). Enhancing HSDPA Performance via Automated and Large-Scale Optimization of Radio Base Station Antenna Configuration. *Vehicular Technology Conference*. 11-14 May. Singapore: IEEE, 2061-2065.

Soldani, D., Li, M., and Cuny, R. (2007). *QoS and QoE Management in UMTS Cellular Systems*. West Sussex: Wiley.

Song, G., and Li, Y. (2005). Utility-based Resource Allocation and Scheduling in OFDM-based Wireless Broadband Networks. *IEEE Communications Magazine*. 43(12), 127-134. IEEE.

Srinivasan, K., Ramamurthi, V., and Chatha, K. S. (2004). A Technique for Energy Versus Quality of Service Trade-off for MPEG-2 Decoder. *IEEE Computer society Annual Symposium on VLSI*. 19-20 February. Lafayette, LA, USA: IEEE, 313-316.

Syahbana, Y. A., Herman, Rahman, A. A., Bakar, K. A. (2011). Aligned-PSNR (APSNR) for Objective Video Quality Measurement (VQM) in Video Stream over Wireless and Mobile Network. *World Congress on Information and Communication Technologies*. 11-14 December. Mumbai, India: IEEE, 330-335.

Taleb, T., Nakamura, T., and Hashimoto, K. (2008). Multi-source Streaming in Next Generation Mobile Communication Systems. *IEEE International Conference on Communications*. 19-23 May. Beijing: IEEE, 296-300.

Thiede, T., Treurniet, W. C., Bitto, R., Schmidmer, C., Sporer, T., Beerends, J. G., *et al*. (2000). PEAQ-The ITU Standard for Objective Measurement of Perceived AUDIO quality. *Journal of the Audio Engineering Society*. 48(1/2), 3-29. AES.

Thompson, C. (2001). *Supply and Demand Analysis in Convergent Networks*. Master, Massachusetts Institute of Technology, Cambridge.

Thu-Huong, T., Tai-Hung, N., and Huu-Thanh, N. (2012). On Relationship between Quality of Experience and Quality of Service Metrics for IMS-Based IPTV Networks. *IEEE RIVF International Conference on Computing and Communication Technologies, Research, Innovation, and Vision for the Future*. 27 February-1 March. Ho Chi Minh City: IEEE, 1-6.

Ukommi, U., Kodikara Arachchi, H., Dogan, S., and Kondoz, A. M. (2013). Content-Aware Bitrate Adaptation for Robust Mobile Video Services. *IEEE International Symposium in Broadband Multimedia Systems and Broadcasting*. 5-7 June. London: IEEE. 1-4.

Uzun, E., and Sencar, H. T. (2014). A Preliminary Examination Technique for Audio Evidence to Distinguish Speech from Non-Speech using Objective Speech Quality Measures. *Speech Communication*. 61, 1-16. Elsevier.

Vakili, A., and Gregoire, J. C. (2012). QoE Management in a Video Conferencing Application. *Computer Networks*. 57(7), 1726-1738. Elsevier.

Verdolini, A., and Petrangeli, S. (2013). A Smartphone Agent for QoE Evaluation and User Classification over Mobile Networks. *Fifth International Workshop In Quality of Multimedia Experience*. 3-5 July. Austria: IEEE. 230-235.

Verscheure, O., Frossard, P., and Hamdi, M. (1999). User-oriented QoS Analysis in MPEG-2 Video Delivery. *Real-Time Imaging*. 5(5), 305-314. Elsevier.

Vishwanath, A., Dutta, P., Chetlu, M., Gupta, P., Kalyanaraman, S., and Ghosh, A. (2010). Perspectives on Quality of Experience for Video Streaming over WiMAX. *ACM SIGMOBILE Mobile Computing and Communications Review*. 13(4), 15-25. ACM.

VQEG. (2008). *VQEG Multimedia Group Test Plan*. Sweden: Video Quality Expert Gourp.

Vranjes, M., Rimac-Drlje, S., and Grgic, K. (2008). Locally Averaged PSNR as a Simple Objective Video Quality Metric. *50th International Symposium ELMAR*. 10-12 September. Zadar: IEEE, 17-20.

Watanabe, K., Umezu, T., and Otani, M. (2011). Development of a Video Streaming Module for Moodle. *International Conference on Complex, Intelligent and Software Intensive Systems*. 30 June-2 July. Seoul: IEEE, 634-638.

Watson, A. and Sasse, M. A. (1998). Measuring Perceived Quality of Speech and Video in Multimedia Conferencing Applications. *Proceedings of the Sixth ACM International Conference on Multimedia.* 13 - 16 September. Bristol, United Kingdom: ACM. 55 - 60.

Winkler, S. (1999). Perceptual Distortion Metric for Digital Color Video. *Electronic Imaging*. 175-184. International Society for Optics and Photonics.

Winkler, S., and Faller, C. (2005). Audiovisual quality evaluation of low-bitrate video. *Electronic Imaging*. 18 March. International Society for Optics and Photonics, 139-148.

Winkler, S. and Faller, C. (2006). Perceived Audiovisual Quality of Low-Bitrate Multimedia Content. *IEEE Transactions on Multimedia*. 8(5), 973 - 980. IEEE.

Winkler, S. and Mohandas, P. (2008). The Evolution of Video Quality Measurement: From PSNR to Hybrid Metrics. *IEEE Transactions on Broadcasting*. 54(3), 660 - 668. IEEE.

Winkler, S., and Ramanathan, S. (2013). Overview of Eye tracking Datasets. *QoMEX*. 3-5 July. IEEE, 212-217.

Wolf, S. (1997). Measuring the End-To-End Performance of Digital Video Systems. *IEEE Transactions on Broadcasting*. 43(3), 320 - 328. IEEE.

Xiao-Dong, H., Yuan-hua, Z., and Rong-fu, Z. (2004). A multiscale Model for MPEG-4 Varied Bit Rate Video Traffic. *IEEE Transactions on Broadcasting*. 50(3), 323-334. IEEE.

Yang, S., and Daigle, J. N. (2005). A Source Model of Video Traffic based on Full-length VBR MPEG4 Video Traces. *IEEE Global Telecommunications Conference*. 28 Nov.-2 Dec. St. Louis: IEEE, 766-770.

Yantai, S., Minfang, Y., Jiakun, L., and Yang, O. W. W. (2003). Wireless Traffic Modeling and Prediction using Seasonal ARIMA Models. *IEEE International Conference on Communications*. 11-15 May. Anchorage: IEEE, 1675-1679.

Yeap, B. L., Maunder, R. G., Ng, S. X., and Hanzo, L. (2004). Turbo Detection of Space-time Trellis-coded Constant Bit Rate Vector-quantised Videophone System using Reversible Variable-length Codes, Convolutional Codes and Turbo Codes. *IEEE 60th Vehicular Technology Conference*. 26-29 September. Los Angeles: IEEE, 1358-1362.

Yu, T. L., Turner, D., Stover, D., and Concepcion, A. (2009). Incorporating Video in Platform-Independent Video Games using Open-source Software. *3rd IEEE International Conference on Computer Science and Information Technology*. 9-11 July. Chengdu: IEEE, 466-470.

Yuhong, Y., Hongjiang, Y., Ruimin, H., Song, W., and Songbo, X. (2013). A New Mobile Audio Quality Assessment using Jitter Distortion Measure Approach. *Fifth International Workshop in Quality of Multimedia Experience*. 3-5 July. IEEE. 182-187.

Zhang, F., Li, J., Chen, G., and Man, J. (2009). Assessment of Color Video Quality with Singular Value Decomposition of Complex Matrix. *Fifth International Conference on Information Assurance and Security*. 18-20 August. Xi'an: IEEE, 103-106.

Zhou, W., Ligang, L., and Bovik, A. C. (2002). Video Quality Assessment using Structural Distortion Measurement. *International Conference on Image Processing*. 22-25 September. Rochester: IEEE, 65-68.

Zinner, T., Hohlfeld, O., Abboud, O., and Hossfeld, T. (2010). Impact of Frame rate and Resolution on Objective QoE Metrics. *Second International Workshop on Quality of Multimedia Experience*. 21-23 June 2010. Trondheim: IEEE, 29-34.