EQoM: Enhanced Quality of Experience (QoE) Framework for Multimedia Services

Asif Ali Laghari, Muhammad Ibrahim Channa, Khalil ur Rehman Laghari, Maham Aman, and Mukhtiar Ahmed Memon

***Abstract*—We proposed Enhanced Quality of Experience Framework for Multimedia Services (EQoM) for assessment of multimedia services on the network. The proposed model is useful for those users that have less information about computer technology. In this framework, we use agent technology based on automatic software components for collecting the objective QoE and QoS parameters in real time. For subjective QoE, a user web interface facility is furnished to collect user ratings. EQoM framework monitors, analyzes, generates reports and changes policy without intervention of administrators.**

***Keywords*—Agent, QoE, Multimedia servcies, QoS,**

I. Introduction

This Nowadays Internet widely used for multimedia applications, people around the world use multimedia applications for videoconference, video on demand VOD for educational tutorials and other applications [9]. The service provider wants to provide quality of service to all users those who use different devices like computers, IPAD, smart phones or simple mobiles phones. The problem is that user does not get a satisfactory experience because of various reasons such as low bit rate of video, variable network delay, low resources of user device. For ensuring quality of service (QoS) guarantees, conventionally, technical parameter are changed time by time by network administrators but despite that user satisfaction remains a big issue for service providers because it is hard to capture user needs and requirements during service usage. Quality of Experience is emerging discipline which provides an assessment of human expectations, feelings, perceptions, cognition and satisfaction with respect to a particular product, service or application [1]. The International Telecommunication Union ITU-T defines QoE [4] as "The overall acceptability of an application or service, as perceived subjectively by the end-use". This definition has further been extended in [12] by introducing objective QoE concept "QoE is a blueprint of all human subjective and objective quality needs and experiences arising from the interaction of a person with technology and with business entities in a particular context." QoE is captured using two main methods one is Objective and other is subjective [1, 12, 13]. Subjective methods rely on human participants to provide useful and reliable QoE feedback about a particular multimedia service. Subjective testing, however, is expensive and time-consuming. Objective is subdivided into two parts one is estimating user satisfaction from collected network and application layer QoS data and other is collecting human physiological data [13].

In this paper, we proposed a new framework for multimedia services, which is based on objective, subjective QoE evaluation using agent technology. "Agent is an autonomous, problem-solving computational entity capable of effective operation in dynamic and open environments" [8]. It runs between server and client to monitor network traffic and client terminal data such as available device resources.

It is very difficult to collect accurate subjective QoE data from users because not all humans have similar preferences, feelings or perceptions about a particular service and furthermore, their perceptions and preferences continuously change over the time [13]. Some users provide low ratings, some provides high ratings and few may also give negative comments and some may provide fake data on QoE too. In this situation, important challenge is how to enhance technology for accurate QoE data collection. Traditionally, QoE is collected by using manual methods, some of them used web interface for submission of QoE and few used paper questionnaire for collection of QoE data.

It is cumbersome for vendors to take decision on multi-source data emerging from same terminal but with different expectations and QoE requirements. For instance, one client terminal (PC, Laptop, smart phones) may be used by multiple people like family members or friends etc. It is also a big problem to provide differentiated quality of service to multiple users using same client system on different times. EQoM framework provides solution of above discussed problems; our proposed EQoM framework is based on agent technology, which automatically monitors environment for collecting QoE data. In first stage, EQoM collect QoS data and at second stage, user may submit subjective QoE scores in case they have any complaint related to service quality.

This is on going research work to develop a complete framework suit. In this paper, we present an overview to framework and share our first hand results obtained until now with QoE community.

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Paper is organized in V sections. In section II, we provide related work, in section III, we provide our proposal for EQOM framework and in section IV we present sequence diagram, and in section V, we conclude the work.

II. Related work

There is on-going effort both in academia and industry to develop QoE management frameworks. One such framework for video streaming service is MintMOS [2]. MintMOS framework evaluates the impact of both application level QoS (bit rate) and network level (Packet loss, delay) parameters on subjective QoE. On the other hand, some niche vendors [5, 6] use objective QoE collection methods such as PNSR (peak signal to noise ratio), PESQ (perceptual Evaluation of speech quality). Taichi Kawano use subjective QoE in his proposed model to estimates video quality by using blockiness and blur derived from only decodes videos [3] and it does not provide any reporting tool or automatic policy update mechanism.

QoM Framework [9] is a novel solution; it covers almost all the QoE management requirements. It provides QoE assessment for multimedia services. Its main focus is on subjective evaluation of QoE based on QoS parameters and reporting tool alters network administrator on the event of degradation in QoE. However, it does not support automatic policy change based on dynamic user requirements over the time. Our current framework builds on QoM framework and attempts to add more functionality to it. In our proposed framework, we monitor AQoS/NQoS parameters to estimate QoE from them. Reporting tool provides updates on network and user status. User status is normally evaluated based on user profiles. EQoM framework monitoring system gathers network traffic data, and subjective QoE score, Based on the analysis of the collected data, EQoM will fix the network issues at run time for users. Comparison of previous frameworks with EQoM is given in Table 1.

TABLE I. COMPARISON OF EQOM WITH OTHER VIDEO QUALITY TOOLS

QoE Frameworks	**MintMos** [2]	**Tiachi Kawano** [3]	**Niche Vendors** [5, 6]	**QOM** [9]	**EQoM**
Parameters	NQoS & AQoS	Video Blur & Blocking	PSNR, PESQ VQM	NQoS & AQoS	NQoS & AQoS
Monitoring Support	Yes	Yes	Yes	Yes	Yes
Analysis Support	Quantitative	Quantitative	Quantitative	Quantitative & Qualitative	Quantitative & Qualitative
Reporting	No	No	No	Yes	Yes
Policy Change	No	No	No	No	Yes
Remarks	Subjective Evaluation	Subjective Evaluation	Objective Evaluation	Objective & Subjective Evaluation	QoS & Subjective Evaluation

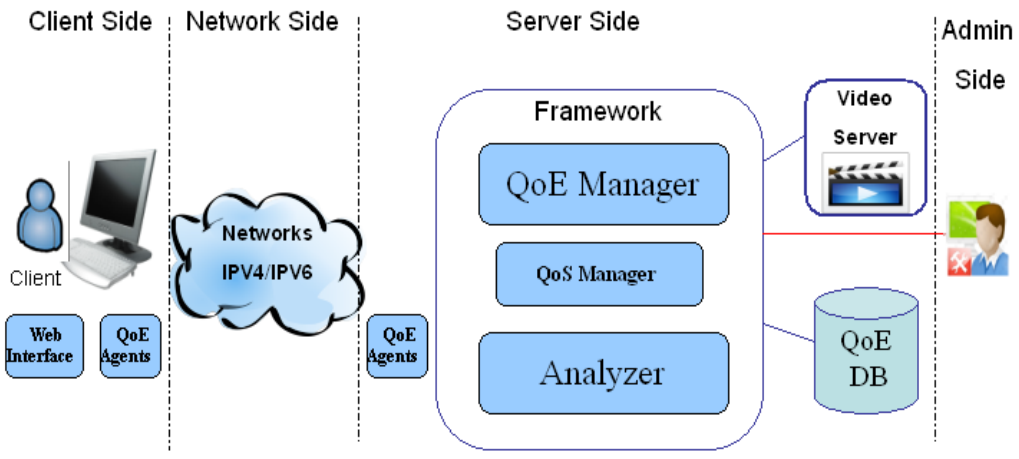

Figure 1. Architecture of the proposed QoE framework for Multimedia services (named as EQOM framework)

III. Architecture of the proposed EQoM framework

In this paper, we propose an Enhanced Quality of Experience framework for multimedia services (EQoM). The proposed EQoM is semi-automatic management framework that works on agent based technology. In EQoM framework, server side software contains following components QoE manager, QoE database, QoS manager, Analyzer and video streaming server. Video streaming server provides VOD service to clients. During video streaming, QoE and QoS manager start process to collect information from server to client's system. QoE manager, QoS manger and analyzer is connected to database for storing and retrieving data of a particular client. Mysql database is used on server side for storing information of every client and his experience about the network services. Web form is front-end interface of database for viewing and inserting information where on the backend mysql is operational database.

Client side contains web interface and web interface. Web interface will be used by clients for registering their complaints and the subjective quality scores. Figure 2 is a screenshot of a proposed EQoM client interface. This web interface provides facility to user to view network service statistics and submit his experience with service. The form contains two portions; one is related with user profile information such as user name, IP address, user ID, Time, Date. 2nd part contains information of network parameter collected by agents before opening of this form. 2nd part of from provides information to user about packet loss, delay, reorder, and packet corruption [11]. For instance, if parameters such as packet loss, reorder and delay are increased as displayed in web form then quality of a service has also deteriorated compared to last time access. If this happens then user has to fill two fields one is about satisfaction with a networked service and other is to assign category to current service status from best to worse.

After the submission of form, QoE manager stores the information in user profile. Analyzer checks the user service statistics spanning over different time sessions and try to debug it by relating it to network traffic. A user rating could turn low or harsh, perhaps due to poor network speed during peak service time. Different network parameters (packet loss, packet reorder, delay, is different) leave different impact on user perception. So user QoE requirements may be different from their previous experience. Analyzer at service side also analyses the different forms submitted by multiple users related to a single client machine and it sets service parameters for particular user. For example Alice uses multimedia services with two Vmware machines [11], Bob browses only educational site every time and Eve browses social networking sites. By storing and analyzing

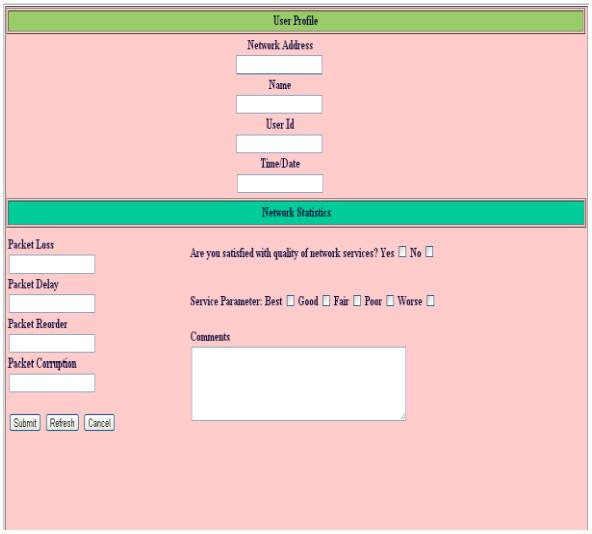

Figure 2. Proposed EQoM framework's Client Interface

usage pattern and session timings of these three different users, EQoM framework could differentiate and develop user profile as their requirements. A predefined policy of fair QoE levels can be set based on the findings of subjective experiment with computer experts. So that every time a user submits QoE data, it is evaluated with respect to predefined QoE policy and QoS based service level agreement (SLA). QoE manager checks whether services meet SLA or not. If a service is violating SLA limits, then QoE manager upgrades the service requirements, otherwise it stores information for future use. If a short path router crashes due to heavy traffic load, then agents reroute traffic to other routers with lower load. In our proposed framework, we also propose that agent checks the resource utilization of client system because client device could also influence QoE, for instance quality of video may also get affected due to interleaving of processing unit between the running process. If video quality degrades due lake of client side resources then framework may report to user by email or pop up with a message that quality has been decreased due to low resources of client system. Agents check resources same like in gird computing, Globus toolkit software components runs across the firewalls from the user system and check the availability of resources in client system and report to central management to discovery of resources of utilization on client's system [10].

IV. Sequence diagram of proposed EQOM

The sequence diagram explains how EQOM framework will perform operations from server to client system. We present two actions.

- At the start user invokes service, request goes to video server for video streaming. As videos stream start on user side, QoE Admin check user profile and collect objective QoE. QoS of client is automatically collected by framework and submitted to database. After automatic QoS collection, user submits QoE by using web interface. Objective QoE is evaluated by agents then resend to QoE admin, which stores updated QoE in database. Analyzer checks previously submitted QoE data and if required, new update QoE rules are developed, and upgraded policy will be applied for client as per his/her profile.
- Admin also can generate user log reports. QoE admin is connected to database, it retrieve records and generate report for admin.

V. Conclusion

In this paper, we presented new framework for multimedia services based on agent technology that automatically manages QoE. At first, the EQoM framework collects QoS parameters and QoE is estimated from it. And based on user score and comments, subjective QoE will also be measured. EQoM also ensure quality of service to those users who are not the expert users. EQoM framework supports functionality such as QoE monitoring, evaluation, reporting and service quality assurance as user profile (policy). This is on-going work, in future we intend to develop complete suit and test its beta version using some enterprise network.

References

[1] Khalil Ur Rehman Laghari, N. Crespi, B. Molina, and C.E Palau, "QoE Aware Service Delivery in Distributed Environment," in Advanced Information Networking and Applications (WAINA), 2011 IEEE Workshops of AINA Conference , Singapore, 22-25 March

[2] Venkataraman M, Chatterjee M, and Chattopadhyay S, "Lighweight, real-time, no-reference framework for inferring subjective-QoE," in IEEE Globecom, 2009.

[3] Kawano Taichi, Yamagishi Kazuhisa, Watanabe Keishiro, and Okamoto Jun, "NO REFERENCE VIDEO-QUALITY-ASSESSMENT MODEL," in *Proceedings of 2010 IEEE 18th International Packet Video Workshop*, Hong Kong, 2010.Video Lan VLC player. [Online]. http://www.videolan.org/vlc/

[4] ITU-T, "Definition of Quality of Experience (QoE), ," International Telecommunication Union, Liaison Statement Ref.: TD 109rev2 (PLEN/12, 2007.

[5] www.witbe.net

[6] www.qoesystems.com

[7] http://calcium.dcs.kcl.ac.uk/841/1/al2roadmap.pdf

[8] www.agentlink.org

[9] Khalil ur Rehman Laghari.; Thanh Tung Pham; Hang Nguyen; Crespi, N.; , "QoM: A new quality of experience framework for multimedia services," *Computers and Communications (ISCC), 2012 IEEE Symposium on* , vol., no., pp.000851-000856, 1-4 July 2012

[10] http://www.globus.org/toolkit/about.html

[11] http://www.vmware.com/products/workstation/overview.html

[12] Khalil ur Rehman Laghari,.; Connelly, K.; , "Toward total quality of experience: A QoE model in a communication ecosystem," *Communications Magazine, IEEE* , vol.50, no.4, pp.58-65, April 2012

[13] Khalil ur Rehman Laghari, Omneya Issa, Filippo Speranza, Tiago Falk "Quality-of-Experience Perception for Video Streaming Services: Preliminary Subjective and Objective Results", APSIPA 2012 USA.

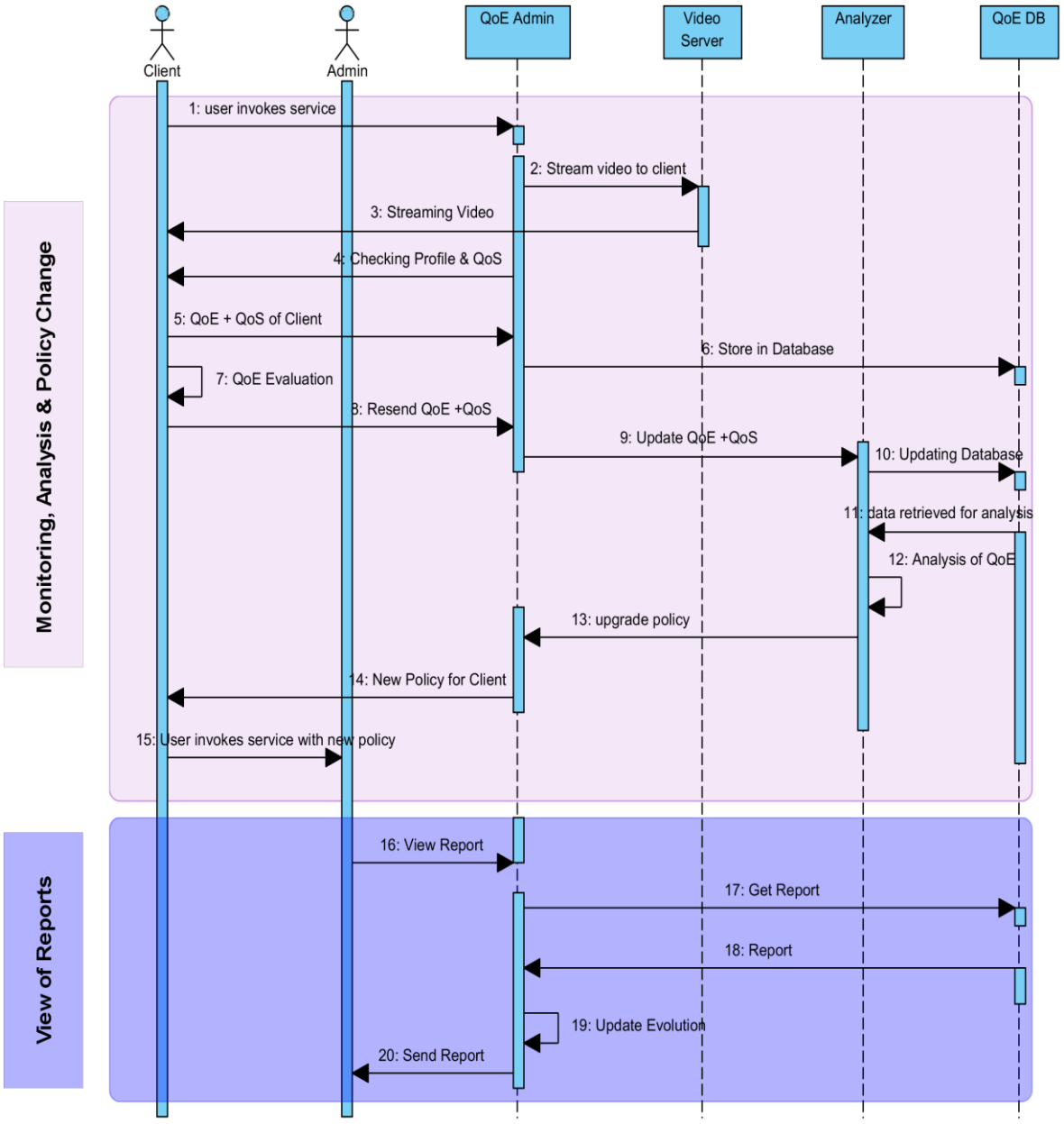

Figure 3. Proposed EQOM Framework's Sequence Diagram

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