

Implementation of QoS Control System with QoE Parameters on Multimedia Services

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Abstract— In this paper, we propose a method to enhance service user's experience quality when various multimedia services is provided in converged network environment. With the growth of service experience quality interest, multimedia service providers need a method to control experience quality when experience quality is not satisfied by service users. In order to enhance user's experience quality, we design quality control system which can actively control transport QoS parameter according to media quality level. Service and network providers can offer enhanced quality of media service (IPTV, VoD etc) through the proposed system.

Keywords—multimedia service, QoS, QoE, NGN, interworking control

I. INTRODUCTION

Nowadays, NGN(Next Generation Network) has been evolved like type of IP-based wire-wireless convergence network and/or convergence of broadcasting and communication. Preexisting Internet service and variance multimedia service such as IPTV(Internet Protocol TV), VoIP(Voice over IP) and VoD(Video on Demand) are provided in converged network environment.

Like this, many service providers compete with each other in NGN environment, and must satisfy service user's experience quality in order to maintain a subscriber's loyalty. Currently, the satisfaction of users is becoming one of the most import topics concerned by the service and network providers. However, existing methods used for evaluation the experience quality mostly rely on user survey and scores from the user, which are too subjective and need much processing time and cost.

Also, preexisting service quality measurement methods in IP-based network recommended by international standards institutes are not suitable because this method does not reflect service user's satisfaction related with network QoS parameters such as network delay, delay variance and packet loss. The method to evaluate and manage service user's experience quality is needed in order to solve this problem.

So, we propose the system of interworking control between media quality and transport QoS parameters to enhance the service user's quality level. Service and network providers can offer the enhanced service quality to users using the proposed system.

The remainder of the paper is organized as follows. Section II outlines the QoS control architectures in NGN and the study of QoS/QoE relationship. Section III introduces the architecture of the proposed system and section IV describes functional entities and overall procedures. Finally, section V presents the conclusion and further study.

II. RELATED WORKS

In this section, QoS control architectures defined in several standards institutes are reviewed.

A. QoS control architectures in NGN

The DSL forum defines the resource control at the DSL access network. The traffic control of the DSL(digital subscriber line) network is based on the differentiated services at the upstream of the access network. The home gateway, the routing gateway (RG), classifies the data traffic into DiffServ or best effort traffic, and discriminates traffic type when it is going out to the network. The primary function of the BRAS is the Layer 2 Tunneling Protocol (L2TP) access concentrator (LAC) function. It aggregates the subscriber traffic and delivers to a network — that is, connects the access network and the network provider. The QoS control principle of the DSL network is the management base.

The resource and admission control functions (RACFs) of ITU-T [2] and the resource and admission control sub-system (RACS) [3] of ETSI define the resource control architecture in a more general aspect. The QoS control architecture in both RACF and RACS are closely related with the 3GPP effort. The 3GPP was originally founded for developing new service architecture over cellular networks, especially for the global system for mobile communication (GSM) network. During this effort, the 3GPP developed the IP multimedia subsystem (IMS) for controlling the IP multimedia services in the areas of

session control, service control, and subscriber database management.

In general, RACF and RACS are very similar. The two standards bodies closely interacted in developing their architecture. There is no significant conflict between the two, but there are still differences. One of the differences is the range of the control region. The control region of RACS covers the access network and the edge of the core network. The access network is defined as the region where the traffic is aggregated or distributed without dynamic routing.

The resource control in the access network is done in the layer 2 level. The core network is the region where the IP routing starts. The core network is out of the scope of the RACS. The RACF, however, covers both the core and the access network. The RACF covers both fixed and mobile networks while the RACS is defined for the fixed network. For the control mechanism, the RACF defines more control scenarios than the RACS does. Therefore, the RACS is considered as a subset of the RACF [1].

ITU-T defines the QoS control functions based on its NGN architecture. One of the important concepts in the ITU-T NGN architecture is the independence of the transport and the service [4]. The transport is concerned about the delivery of any type of packets generically, while the services are concerned about the packet payloads, which may be part of the user, control, or management plane. In this design principle, the NGN architecture is divided into two stratum — the service stratum and the transport stratum.

The transport control function is located in the transport stratum that interfaces with the service stratum. It determines the admission of the requested service based on the network policy and the resource availability. It also controls the network element to allocate the resource after it is accepted. The RACF is responsible for the major part of the admission decision and the resource control of the transport function.

Different control methods are designed for the region of the network or the transport technology of the network. The QoS control mechanisms can be static or dynamic. In a static QoS control architecture, the QoS control information is stored in the configuration file of the network device. The initial QoS setup is applied to the device when the network device is powered-on or when the management system changes the configuration. A typical example of the configuration-based QoS control can be found in the DSL forum architecture. The QoS setup in the home gateway is determined by the configuration file or remote management system.

In the dynamic QoS control, the requested QoS is provided dynamically. Voice over IP (VoIP) service, for example, is established by dynamic call setup signaling. Network resource control must be performed during the call set-up signaling. The QoS architecture defined in ETSI and ITU-T, assumes the independence of the service stratum and the transport stratum. In this case, the requested QoS from the application signaling can be dynamically changed, and the transport architecture must be able to reserve network resources for the QoS request.

However, QoS control architectures recommended by standards institutes provide resource management and admission control only but do not consider service user's experience quality. So, we propose the service quality control system allowing for experience quality.

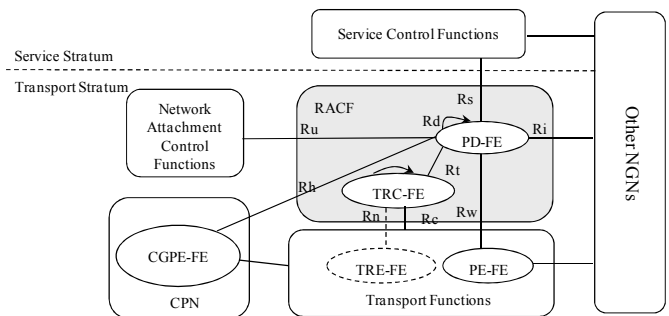


Figure 1. RACF functional architecture[2]

B. The study of QoS/QoE relationship

QoE is the term which is used to describe how it is satisfied by subscribers to the provided service quality. The poor QoE will cause dissatisfied subscribers and fall behind in contestants due to the ultimately bad market competitive power to contestants. QoE is composed of not only the network performance parameter but also the service quality parameter such as cost, reliability, availability, usability, and fidelity. Although QoE is very subjective in nature, it is very important that a strategy is devised to measure it as realistically as possible. The ability to evaluate QoE will give the provider some sense of the contribution of the network's performance to the overall level of subscriber satisfaction.

There are numerous network-related features affecting IPTV service quality. To manage the service quality effectively, the IPTV QoE should be monitored and kept in good condition by service providers. However, QoE-related QoS parameters have the different influence and they cannot be treated in a same weight. So, An IPTV QoS/QoE correlation model needs to assign QoS parameter weights and to analyze hierarchical relationships of QoS parameter and QoE items.

The investigation of a correlation between QoS and QoE has been being progressed in order to solve the limit of the satisfaction evaluation. According to NP(Network Performance), QoS and QoE items, the existing researches[6] deduced the major quality elements of the IPTV service. They used the QDF(Quality Deployment Function) methodology for analysis of relationship between the drawn QoE items and the QoS parameters.

However, it was not actually studied about the method for evaluating the IPTV QoE. They just analyzed a relationship of QoS parameters and QoE items and don't present a method for QoE evaluation.

In the IP-based network environment, the existing research [6] for the image multimedia service QoE measurement has considered only the IP Packet Loss and Bandwidth among the QoS quality parameters. However, the various QoS parameters

causing an effect in the QoE of the IPTV service aren't reflected in [6]. For this reason, it is not adequate to evaluate the subscriber satisfaction of the IPTV service in future.

Currently, the investigation of QoS and QoE correlation is continued. Khirman and Henriksen were trying to relate the objective network service conditions with the human perception of the quality of the service. Their subject has been widely investigated for voice delivery and it is widely acknowledged that the relationship between voice transmission conditions and the human perception of quality is far from linear[7]. They discuss in detail how the human satisfaction of HTTP service is affected by the two main network QoS parameters, namely network delivery speed and latency. However, it is difficult to represent the feature of the provided and various services from only the bandwidth and latency time in the integrated network environment.

In [8] the authors thought that pervasive computing environment brings the method of evidence context related to QoE. They studied the QoE evaluation method in pervasive computing environment, and proposed the enhanced QoE evaluation parameter model. In [8] rough-set based algorithm is proposed to reduce context attributes and determine the weight of each attribute, the algorithm has been validated on video streaming service, and the architecture of QoE evaluation system is described. As a mass of evidence information related to the experience of users can be gathered through the context-awareness computing, the calculation results of QoE evaluation method can highly match the real feeling of users. However, the method needs to be enhanced along with the development of pervasive computing.

III. DESIGN OF THE PROPOSED METHOD

In this section, we describe architectures of the proposed system which can actively provide QoS control value to service quality control system according to media quality level and its network environment for operation.

Figure 2 shows operation environment of the proposed system of interworking control between media quality and transport QoS(QCS). In this figure, service users request multimedia service such as IPTV and VoD(Video on Demand) to media server. Then, media server provides appropriate service according to requested quality level. Service Control System(SCS) manages network resources and applies appropriate QoS policies(priority, shaping and policing etc) to maintain service user's quality level.

UE(User Equipment) receives multimedia service(IPTV, VoD etc) from stream servers and monitors service quality. MQMS and QCS are implemented in one UE. MQMS can measure media experience quality such as voice MOS(Mean Opinion Score) and video MOS, and forward them to QCS. QCS is composed of network control packet collecting module, QoS Parameter Measurement Module, Media Quality Evaluation Module, Media Quality Analysis Module and QoS Control Value Transport Module in order

to analyze correlation of service experience quality and network performance.

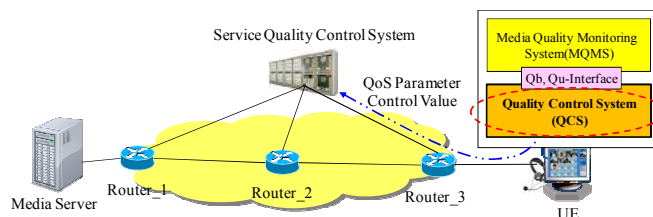


Figure 2. Operation environment of the proposed system of interworking control between media quality and transport QoS(QCS)

Figure 3 shows the proposed QCS system architecture which can actively enhance user's experience quality by controlling network performance. In order to perform the aforementioned key function, QCS is composed of 5 kinds modules, 3 exterior interfaces(Qb, Qu and Qm) and 4 interior interfaces(Qr, Qq, Qe, and Qc).

Qr is the interior interface in order to forward packets collected in Control Packet Collection Module to QoS Parameter Measurement Module. Qq is implemented between QoS Parameter Measurement Module and Media Quality Evaluation Module to forward QoS parameter information. Qe is implemented between Media Quality Evaluation Module and Media Quality Analysis Module to forward media quality by using network QoS parameters. Qc is used to forward network QoS parameter control information related with multimedia service quality to QoS Control Value Transport Module.

As Qb is exterior interface, it is used to receive bandwidth information from MQMS. This bandwidth information is used to evaluate or predict multimedia quality. Qu is used to forward measured voice MOS and video MOS information in MQMS to QCS, and Qm is used to forward QoS control value deduced in QCS to SCS.

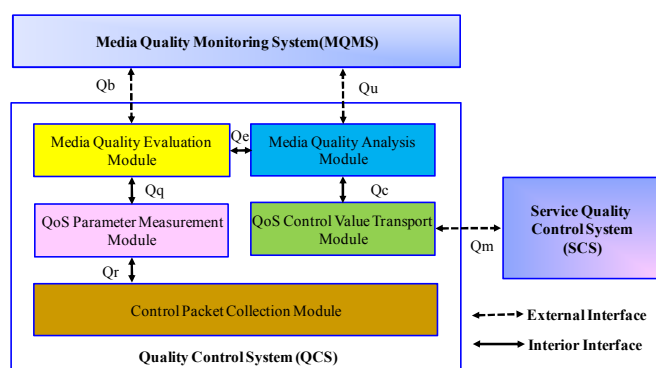


Figure 3. The proposed QCS system architecture

A. The Functional Entities of the Proposed System

Figure 4 shows the functional entities of Control Packet Collection Module. Network Interface and Device Interface control the Ethernet card for collecting packet from network

circuit. Packet Header Preceding Processor separates service flows according packet IP address or session ID. Control Packets Filtering Interface filters control packets from separated service flows according IP address or session ID. Packet Storage & Forwarding temporarily stores the filtered control packets and forwards them to QoS Parameter Measurement Module.

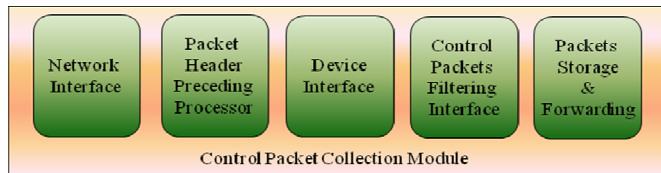


Figure 4. The functional entities of Control Packet Collection Module

Figure 5 shows the functional entities of QoS Parameter Measurement Module. They deduce QoS parameters such network delay, jitter(delay variance) and packet loss from the collected control packets. Here, ICMP(Internet Control Message Protocol) and/or RTCP(Real-time Transport Control Protocol) can be used to deduce QoS parameters.

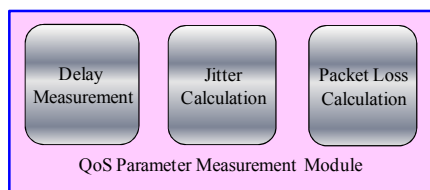


Figure 5. The functional entities of QoS Parameter Measurement Module

Figure 6 shows the functional entities of Media Quality Evaluation Module. B/W Info Receive can receive bandwidth information from MQMS when multimedia service is initially requested. QoS Value Calculation regulates network condition using network QoS parameters such as delay, jitter, packet loss rate and bandwidth information. Media Quality Evaluation can evaluate user's experience quality of service using regulated QoS value in QoS Value Calculation.

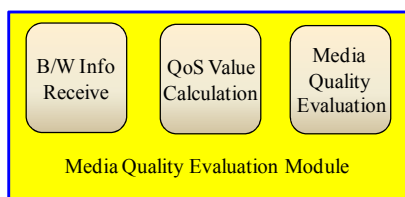


Figure 6. The functional entities of Media Quality Evaluation Module

Like figure 7, Media Quality Analysis Module is comprised of Media Quality Comparison, QoS Parameter Analysis and QoS Control Value Deduction. This module compares voice and/or video MOS which is measured in

MQMS with evaluated service quality in QCM, and analyzes them. When service quality degradation occurs, this module deduces the related QoS parameter control value using service quality analysis results and relative importance of QoS parameters according to multimedia service characteristic.

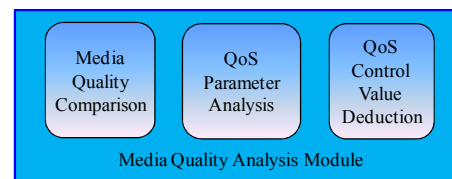


Figure 7. The functional entities of Media Quality Analysis Module

Figure 8 shows QoS Control Value Transport Module which forwards QoS control value to SCS in order to control network QoS mechanism and policy.

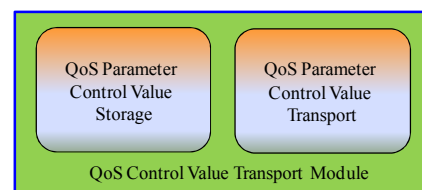


Figure 8. The functional entities of QoS Control Value Transport Module

B. QoS Parameter Control Value Deducing Algorithm

In this section, we describe detailed procedures of proposed system. Prior to description, we assume that multimedia streaming service is offered to service user. Also, we use RTCP protocol as an example for control messages to derive QoS parameter. This may use different kind of protocols such as ICMP and SIP.

In gathering stage of RTCP packet, QCS collects RTCP packet for measuring and collecting QoS parameter information by request message of media stream. QCS saves RTCP protocol filtered using protocol type of the packet header among packets from Internet. In measurement stage of QoS parameter, QCS gathers information regarding network delay, jitter and packet loss and also receives bandwidth information from MQMS.

In evaluation stage of media quality, QCS uses measured QoS parameter and weight of corresponding parameter for normalized QoS value. Media quality is predicted through correlation between media quality indicator and QoS quality indicator. QCS maintains and manages estimation value of media quality and periodically transmitted media quality from media measurement system of user equipment.

Next, When QCS periodically receives measured media quality value, it determines whether corresponding media quality is satisfied with standard quality level. If measured media quality value is more than fixed quality level, QCS determines that media quality is normal and returns to gathering stage of RTCP packet.

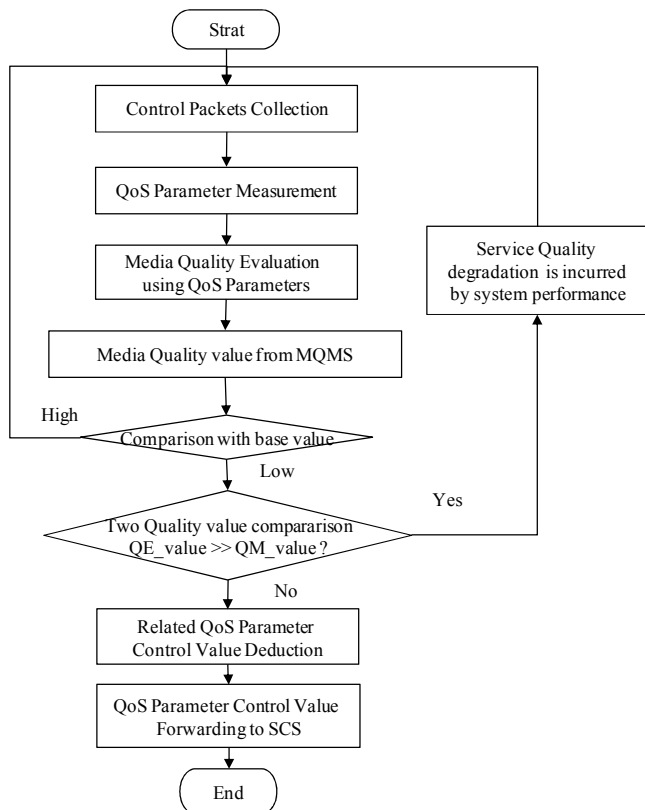


Figure 9. QoS parameter control value deducing algorithm on the proposed system

In case of less than fixed quality level, QCS compares QE_value evaluated in QCS with QM_value measured in user equipment for determining whether quality decline is caused by QoS parameter. Here, if QE_value is same or larger than QM_value, media quality is determined that it isn't quality deterioration by network parameter but is by different external cause. QCS transmits the result to SCS

However, in case QE_value is declined by QoS parameter, QCS derives related QoS parameter and notifies to SCS by deriving information regarding relative contribution and control value regarding quality deterioration of corresponding QoS parameter

In the above, QCS obtains QoS parameter of current network using control protocol like RTCP. Also, in case measured quality is deteriorated in application, QCS can deliver control value of QoS parameter to service quality network of core network through related QoE quality element and relative importance analysis between QoS parameters. By a series of procedures, service and network provider can improve service user's experience quality.

IV. IMPLEMENT ISSUES AND TEST RESULTS ANALYSIS

We design the QoS control system to deduce QoS control value according to measured video quality. SCS organizes network environment to enhance service quality if the

deduced QoS control value is forwarded to SCS. Figure 10 shows network configure to test the proposed system. QCS is implemented in the terminal of User_B, and periodically forwards QoS control value to SCS.

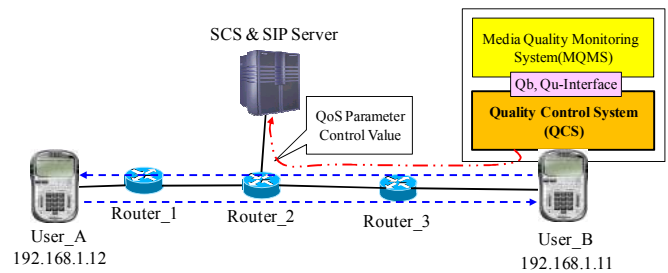


Figure 10. The network configure to test the proposed system

We consider transport delay of QoS control value in order to implement the proposed QCS system. Typically, RTCP protocol is used to control real-time multimedia service and its transport interval is roughly within 5 seconds. So, quality measurement period must be selected in this scope.

The Transport delay of QoS control value is very important in order to enhance QoE when it is poor. If the QoS control value against poor QoE is lately forwarded, unnecessary QoS control function is performed after network is stable. This phenomenon may degrade other service quality due to additive control messages.

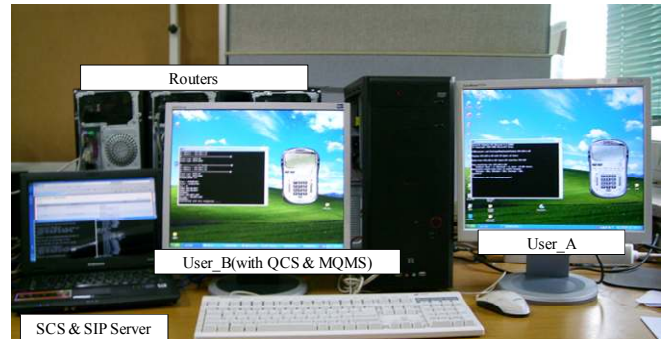


Figure 11. The picture of QCS implementation

Figure 11 shows picture of QCS implementation. Here, we use the X-lite program and the Brekeke SIP Server for VoIP service.

Figure 12 shows the results of deduced QoS control value in QCS. We only consider major QoS parameters related to multimedia service QoE, and allocate the weight of QoS parameter reflecting character of video service. So, this weight value may change according to character of various multimedia services such as real-time, voice, video and reliability.

```

[RECV] MQ_NOTI
msg_type : MQ_NOTI
  session.protocol : 6
  session.src_addr : 192.168.1.11
  session.src_port : 3001
  session.dst_addr : 192.168.1.12
  session.dst_port : 3002
  wei_bwd : 11.300000
  rel_fbwd : 0.565000
  rel_bbwd : 0.565000
  wei_delay : 15.900000
  rel_delay : 0.795000
  wei_jitter : 16.100000
  rel_jitter : 0.805000
  wei_loss : 56.700001
  rel_loss : 2.835000

[SEND] MQ_NOTI_ACK
[RECV] MQ_NOTI
msg_type : MQ_NOTI
  session.protocol : 6
  session.src_addr : 192.168.1.11
  session.src_port : 3001
  session.dst_addr : 192.168.1.12
  session.dst_port : 3002
  wei_bwd : 11.300000
  rel_fbwd : 1.130000
  rel_bbwd : 1.130000
  wei_delay : 15.900000
  rel_delay : 1.590000
  wei_jitter : 16.100000
  rel_jitter : 1.610000
  wei_loss : 56.700001
  rel_loss : 5.670000

[SEND] MQ_NOTI_ACK

```

Figure 12. The results of deduced QoS control value in QCS

V. CONCLUSIONS AND FURTHER STUDY

In this paper, we propose a system to enhance service user's experience quality when various multimedia services are provided in converged network environment. In order to enhance user's experience quality, we design quality control system which can actively control transport QoS parameter according to media quality level. Through proposed system,

service and network provider can provide service user with multimedia service of improved quality.

In order to control accurate quality, analysis regarding feature of quality parameter and correlation among network parameters is required. We plan to study how QoS control value derived in QCS is applied to in network configuration element(router, switch, etc).

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