차세대 유무선통신망의 QoE 측정 및 관리를 위한 프레임워크의 제안

論 文
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A Framework of QoE Measurement and Management for Next Generation Wired/Wireless Communication Networks

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Abstract

The Quality of Experience (QoE) of next Generation wired/wireless network services based upon IP networking is becoming a popular issue in recent years. The user experience of Internet services such as IPTV, online game, web surfing and etc, are becoming the most desirable factors to service providers to improve service performance and customer's satisfaction. However, collecting user experience from customers and obtaining the QoE parameters from the Quality of Service (QoS) parameters such as bandwidth, delay, jitter or admission control algorithm, are difficult subjects because of the various service types and user characteristics. In this paper, we propose a framework which contains service classification, QoE analysis and service enhancement steps for a suitable QoE measurement and management protocol. We define the user satisfaction indicators of the Internet services, classify the categories of each type of services, and analyse the Key Performance Indicator (KPI) in each type of services to perform the QoS parameters and improving the service qualities.

Keywords : QoE, QoS, measurement, management, framework

I. Introduction

The Quality of Experience (QoE) is related to Quality of Service (QoS), which is defined as the user experiences based on Internet service quality [1]. QoS can be reflected by the traffic policy when the network resources are limited. Measuring the QoE from the user's perspective is an important metric for the design of systems and engineering processes. The relationship between QoS and QoE in Internet services could be resolved as user's requirement of service performance and vendor's resources of networks or applications because users are always expect higher service quality on the limited service resources. As an example, by the limited bandwidth and channel interference in wireless local area network (WLAN), IEEE 802.11 specifies some access control algorithms such as DCF (Distributed Coordination Function) and PCF (Point Coordination Function) [2]. They provide collision-free network and utilize the network resources. However, as they are designed by best effort services and still could decrease the network quality and user satisfaction in realtime-services such as IPTV, a better admission control algorithm may be needed for QoE guarantees [4-5, 9]. Therefore, how to collect the user experiences and adjust the QoS parameters to obtain a better service performance are becoming highly interested to researches in recent years. However, by the different properties of each type

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of Internet services, the requirement of user experience factors are not equal; defining Key Performance Indicator (KPI) for mapping QoE to QoS is difficult; a reliable protocol for QoE measurement or management for various types of services is highly required in today's network services.

Services in Internet are various such as IPTV, online game, web surfing, and etc. Management of QoE for each type of services may need different types of network and application parameters. We focus on customer's requirement, and carry out the factors which the service customers may generally perceive.

In this paper, the classification by various property of services and some example of requiring QoS parameters of each category will be introduced and a QoE management framework will be proposed.

II. Definition of user satisfaction indicators

Although the service properties of Internet services have many types, the user perception of the services are always concerned with the common questions:

1. Does the service work?
2. How good is the service?
3. Does the service keep working?
4. How is the delay for the responses?

And we can define the factors based on the questions as followings:

1. Availability
2. Quality
3. Reliability
4. Latency

These factors will be the basic QoE parameters. The QoS management system will search the mapping QoS parameters to these factors and adjust them to provide better service environment.

III. A QoE management framework

As explained above, every type of Internet services may have its own properties and causes them to focus on different types of user experience. For example, in an IPTV service, user's consideration is always at the video quality and processing latency such as channel mapping time [3,5], but in an online game service, the service reliability based on game server performance is the first consideration to players.

A framework to manage QoE in the Internet service must be as follows: First, the service category should be classified to allocate corresponding QoE parameters; Second, it have to carry out the Key Performance Indicators (KPI) such as QoS parameters which are mapping to the QoE parameters and then perform the service based on the KPIs; Finally, the service provider should monitor the service performance by measuring by engineers or requesting user's feedback. If it is not as good as expected, back to the step 2 and remap the KPIs by the collected QoE parameters from monitoring. This process is illustrated on Fig. 1.

1. Classify the service

Services in network today may be classified into 3 types as bellowing:

- Type I: Real-time service including IPTV, online game, and etc.
- Type II: None-real-time service covering FTP service, online music, and etc.
- Type III: Best effort (BE) service such as web surfing [6].

Since every QoE parameter does not have the equal importance in the wired and wireless network; for example, the highest importance of quality in mobile IPTV services and the highest importance of latency in web surfing services, the weightiness of each parameters have to be classified.

For different services with different properties,

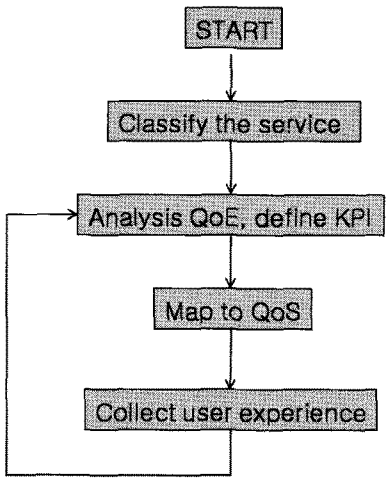

그림 1. QoE 관리 프레임워크

Fig 1. A QoE management framework

we tabled the example of user experiences required in each type of services with 3 grades as shown in Table 1: high, medium, and low. We call it as "weight".

2. Analysis of QoE

Since the service category is classified, the KPIs (Key Performance Indicator) with corresponding QoE parameters, basically important for improving user satisfaction, have to be extracted out from the network and application layer such as bandwidth, delay, or video/audio frame rate in multimedia services [1, 3-4]. And in a wireless network, KPIs for each service also could be reflected by QoS parameters such as number of channels, traffic policy, admission control algorithm, and so on [2]. We list 3 examples (IPTV, online game, and web surfing) to indicate the KPIs that are mapping to the QoE parameters of each type of services in Table 2. 3, 4.

표 1. 서로 다른 종류의 서비스에서 필요 되는 사용자 체감품질의 등급 예

Table 1. Examples of user experience be required in difference type of services

	A	Q	R	L
IPTV	M	M	H	M
Online game	H	M	H	M
Online music	M	H	L	M
FTP service	H	L	M	M
Web surfing	H	M	L	H

* A => Availability, Q=> Quality, R=> Reliability, L=> Latency

표 2. IPTV 서비스에서 필요되는 KPI의 예

Table 2. Example for KPIs in IPTV service

Ex. IPTV	QoS parameters (Network)	QoS parameters (Application)
Availability	-	Video/audio codec type
Quality	Bandwidth, bit error rate, video/audio synchronization	Frame rate, resolution, encoding quality
Reliability	Bandwidth, loss rate, jitter	-
Latency	Server delay, Number of channels, IGMP join latency	STB booting time, channel zapping time

표 3. 온라인 게임 서비스에서 필요되는 KPI의 예

Table 3. Example for KPIs in Online game service

Ex. Online game	QoS parameters (Network)	QoS parameters (Application)
Availability	-	Server performance
Quality	Bandwidth	Graphic quality
Reliability	Bandwidth, loss rate, jitter	-
Latency	Server delay, IGMP join latency, authentication latency	-

표 4. 웹 서핑 서비스에서 필요되는 KPI의 예

Table 4. Example for KPIs in web surfing service

Ex. Web surfing	QoS parameters (Network)	QoS parameters (Application)
Availability	-	Server performance
Quality	Bandwidth	Design
Reliability	Loss rate, jitter	-
Latency	Server delay, IGMP join latency	-

3. Mapping to QoS

In the area of researches related to QoE measurement and management, how to map QoS parameters to QoE parameters in order to improve server performance is the most popular key issue in recent years. As a server resources are limited, but with

suitable combinations of each performance of QoS parameters, the service quality could be improved [7-8]. The common method can be explained as following formulas.

Measurement of QoE with MOS (Mean Opinion Source) scores:

$$\begin{aligned} QoE_{total} = {} & W_1 * MOS_{availability}(QoS_{band}, \\ & QoS_{delay}, QoS_{jitter} \cdots) + \\ & W_2 * MOS_{quality}(QoS_{band}, \\ & QoS_{delay}, QoS_{jitter} \cdots) + \\ & W_3 * MOS_{reliability}(QoS_{band}, \\ & QoS_{delay}, QoS_{jitter} \cdots) + \\ & W_4 * MOS_{atency}(QoS_{band}, \\ & QoS_{delay}, QoS_{jitter} \cdots) \end{aligned} \quad (1)$$

Measurement of QoE with only "good" and "bad":

$$\begin{aligned} QoE_{total} = {} & W_1 * P(QoE_{availability} | (QoS_{band}, \\ & QoS_{delay}, QoS_{jitter} \cdots)) + \\ & W_2 * P(QoE_{quality} | (QoS_{band}, \\ & QoS_{delay}, QoS_{jitter} \cdots)) + \\ & W_3 * P(QoE_{reliability} | (QoS_{band}, \\ & QoS_{delay}, QoS_{jitter} \cdots)) + \\ & W_4 * P(QoE_{latency} | (QoS_{band}, \\ & QoS_{delay}, QoS_{jitter} \cdots)) \end{aligned} \quad (2)$$

where W for weight as shown in Table 1 of QoE parameters in each service category and P for probability of "good."

The feedbacks of user experience such as QoE scores could be improved by changing the combination of each QoS parameters. However, according to the various of human factors, most of user experiences may not be equal by temporal or spacial reasons in real services. It will be the further works to find out the algorithms for calculating the relationship between human factors and QoE indicators.

4. Collecting user experience

Collecting user experiences is the most important subject but may be the most troublesome one to the vendors and service engineers. In gathering user experiences, the best method that may be suitable to any type of service does not exist by the variance of service properties and human factors. It may be subjective method (collecting by users) or objective method (collecting by testing engineers). And while using subjective method such as MOS (Meaning Opinion Score) 5 stage, the period of collecting user experience must be considered. For example, in real-time services, user feedbacks have to be collected during the services; otherwise it may be meaningless. In none-real-time services, real-time feedback may not be necessary. The feedbacks could be collected after the services.

VI. Conclusion

To improve the performance of network services, it highly needed user experiences from the user's satisfaction and performed the limited resources of service providers based on the user experiences. The wired/wireless Internet services have plenty varieties of properties, also, user experiences matching to different services may have various types. In this paper, we define most general user satisfaction indicators and present a QoE management framework that to classify the services and map the QoS parameters to QoE indicators to improve performance of network services.

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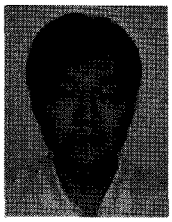

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