QoS Framework: Architecture for Providing Subjective QoS in Low-quality Connection

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Abstract *- This research is concerned with the study of mechanism for the provision of QoS guarantees for Internet access in low-quality connection. In this paper we describes the QoS framework, a QoS architecture for user's QoS specification and service enforcement, designed with the aim of solving the limitation Internet access in unreliable Internet connection. The framework supports a dynamic access model that provides users with more flexibility in controlling access behavior. This model provides the alternative option for user access if resource availability in the system is limited. The user is given opportunity to specify their subjective preferences and determine the parameter for each application which they are chosen. The system will check the resource availability and then compare to the user preferences. In the case resource availability is lower than user preferences, the system can exchange to another option as determined by user requirements.*

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Keywords*: low-quality connection, QoS framework, dynamic access model.*

1. INTRODUCTION

Given the low-quality connection, we realized that the model for accessing Internet that exists today is not compatible with the poor communication infrastructure. Until recently the Internet application such as World Wide Web (WWW) and the associated browser have provided no support for accessing Internet in low-quality connection environment. They are designed for high-bandwidth, high-connectivity environments [5]. That is, they optimize for speed, assuming that the users can quickly look through the result and immediately run a second, modified their request if they are unhappy with the results of their access. This tight feedback loop between the users and the browser is inappropriate for low-quality connection environment. We therefore need a new model that can provide support for accessing Internet in low-quality connection environment.

This research is concerned with the study of mechanism for the provision of quality of service guarantees for Internet access in low-quality connection. The research aim to propose the QoS framework for the specification of user's access and allow the users to specify their subjective preferences through the Quality of Service parameters. The framework supports a dynamic access model that provides users with more flexibility in controlling access behavior. This model provides the alternative option for user access if resource availability in the system is limited. The user is given opportunity to define their access and determine the parameter for each application which they are chosen. The system will check the resource availability and then compare to the user preferences. In the case resource availability is lower than user preferences, the system can move to access alternative as determined by user requirements.

2. QUALITY OF SERVICE

Quality of Service is very popular and overloaded term that is very often looked at from different perspectives by the networking and the application-development communities. Quality of Service was primarily used by the communications and networking areas to describe the ability to measure and guarantee transmission rates over networks [1]. In more broadly vision, Quality of Service can be defined as a relation between server and client. The server provides services with a specific quality level whereas the client requests a service with a desired quality.

Growing usage and diversity of applications on the

Internet makes Quality of Service increasingly critical. To date, the majority of research on Quality of Service is systems oriented, focusing on traffic analysis, scheduling, and routing.

The requirements for Quality of Service (QoS) of Internet access are traditionally expressed in terms of network oriented or systems oriented parameters. The term QoS refers to a set of performance metrics that provide an objective measurement of a user in a given network. Most of the researches in the provision of QoS have occurred in the context of network-oriented QoS. Those researches have focused on providing suitable traffic models and service. Many concepts have evolved to define and provide an improved QoS.

The next section contains a discussion about defining QoS, subjective QoS and previous work on user-oriented QoS.

2.1. Defining Quality of Service

The general definition of QoS provided by the International Telecommunication Union (ITU) [4] is that QoS is: "the collective effect of service performance, which determines the degree of satisfaction of a user of the service". Different user and communities can interpret QoS differently. This research is using QoS definition in the user's perspective.

There are two main aspects of QoS: subjective QoS and Objective QoS [7]. Subjective QoS is the user's overall perception of service quality. It is the user's opinion whether a service is working satisfactorily or not. Subjective QoS is difficult to be specified with objective measures; therefore user-perceived quality is often expressed non-technically [2]. Objective QoS refers to the technical aspects of QoS, so it can be specified with quantitative measures. The different scopes of QoS are described in Fig.1.

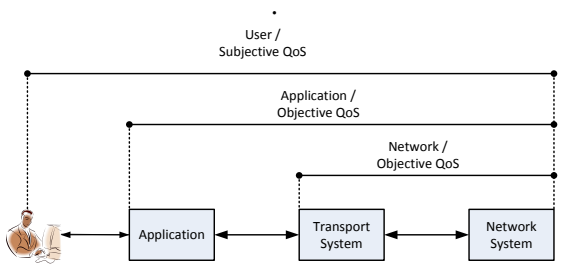

Fig. 1: Scope of QoS [8]

2.2. Subjective Quality of Service

Subjective QoS represents two aspects: user's perception and user-level QoS requirements [8]. The user has a high-level perspective over Quality of Service of the application. It is difficult for users to express their subjective QoS in network QoS parameters, such as bandwidth, delay, jitter and packet loss. Therefore, in the context of user's perception we need terms that describe user-perceivable QoS, rather than an in-depth conception of the underlying implementation and operation of the network service [8].

In the user's perspective, subjective QoS requirements are parameters that describe the visible aspect of quality to users. The different subjective QoS requirement is influenced by the goal of the interaction and the ideal QoS profile of an application. Three parameters for subjective QoS requirements are defined in this research: time_access (t), successful_access (s) and content_relevance (c), as shown in Table 1.

Table 1. Subjective QoS Parameters

Para-meter	Attribute	Description
t	Time_access	Time required to receive a response from the service requested
s	Successful_access	Availability of the service requested
c	Content_relevance	Degree of matching between output/response and the service requested

2.3. Previous Work on Subjective QoS

While there is work in the general area of QoS, there is limited research in the specific area of user-oriented QoS for accessing Internet over low-quality connection. It is remarkable that research in QoS have been focusing mainly on network QoS (e.g. IntServ, DiffServ and RSVP) and multimedia application [1]. Many concepts have evolved to define and provide an improved QoS. The QoS concept is referred to Policy-based Networking. It is lets the network managers define service policies that govern how much bandwidth goes to specific applications and end users [6]. Another concept refers to QoS as network ability to provide service guarantees appropriate for various applications while at the same time making efficient use of network resources [9]. More specifically, QoS refers to a set of metrics performance that provides an objective measurement.

In the area of user-oriented QoS, few researchers have investigated the QoS and its contributing factors from user's perspective. Tradistional QoS parameters cannot sufficiently describe the QoS as perceived by users. Most researchers in the field user-oriented QoS agree that user QoS parameters must not include technical aspect in describing QoS because there is a lot of subjectivity and context relevance relate to the user's perception of QoS [3]. Research on user-oriented QoS is focused on user's subjective perception of quality for multimedia application, as in [3] is presented some of the general work done on user level QoS. Bhatti et. al. studied

the effect of latency on user's tolerance to delay when loading web page in the context of e-commerce. Ghinea et. al. studied the effect of frame rate on user's satisfaction. Mcllhagga et. al. talked about the relation between the user's preference and application adaptation. Hafid et. al. stated that any QoS management function in a multimedia system should take into account the cost to be charged to the user when selecting among several possible system configurations.

In our first stage of the study, we proposed the conceptual model for specification of subjective QoS that deals with limited access in low-quality connection. The conceptual model is designed to provide mechanism for user's access specification. The specification is used to state the user's QoS requirements and preferences. The conceptual model for specification of subjective QoS is shown in Fig. 2

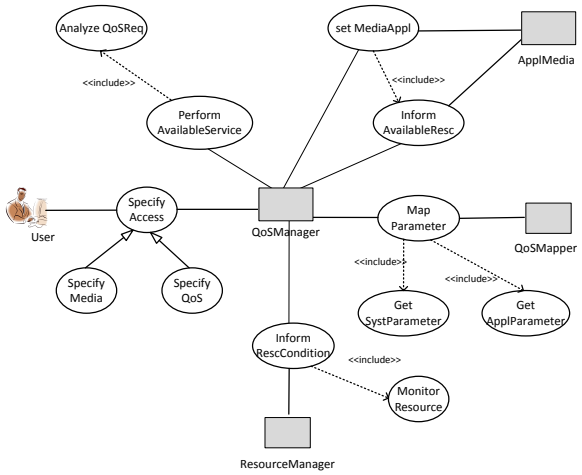

Fig. 2: Conceptual Model for Specification of Subjective QoS

Users specify their QoS requrements and preferences over the application interface. The user's requirement may be specified for one or more subjective QoS parameters. QoSManager coordinates and performs the mechanism on behalf of the interacting components. In order to decide on the solution (i.e. selection of appropriate service based on user's preferences), the QoSManager has to make a reference to: (i) user's Quality of Service requirements and preferences, (ii) available resource conditions, and (iii) the operational point of application media. For this purpose, *ResourceManager* informs the *QoSManager* regarding the state of the resources. *QoSMapper* would convert high-level user QoS specifications to a set of resource requirements. QoS parameters have to be translated between different levels of abstraction to be meaningful for the mechanism present at a particular level. Finally, *MediaAppl* performs the available media and the parameters related to the application that requested by users.

3. RESULTS AND DISCUSSIONS

3.1. Modeling for User's QoS Specification

Based on the previous work, the conceptual model for the specification of the user QoS represented by the following scheme:

$$\mathbf{S_i : \{\ pre:(S_{pre} \wedge e[guard])\ [\vee\ (S_{pre} \wedge e[guard])]^*\ \mid\ action:(a_i\ ,\ q_{exp})\ \mid\ post:\ S_{post}\ [\vee\ S_{post}\ ]^*\ \}}$$

where:

Si : denotes an identifier of state that distinguishes one state to another state

pre : A predicate which denote a precondition that defines one or more previous states Spre and a transition e containing a guard. The transition e[guard] represents an event that triggers a state in which a process action: (ai,qexp) is executed.

post : A predicate which denote a postcondition that defines one or more states that can possibly be reached from Si. How a possible state is selected is defined by the result of parameter evaluation (i.e., specified as a guard of a next possible state).

action : An ongoing activity that is performed as long as the model element is in the state or until the computation specified by the action expression is completed.

3.2. QoS Framework

QoS framework architecture is shown in Fig. 3.

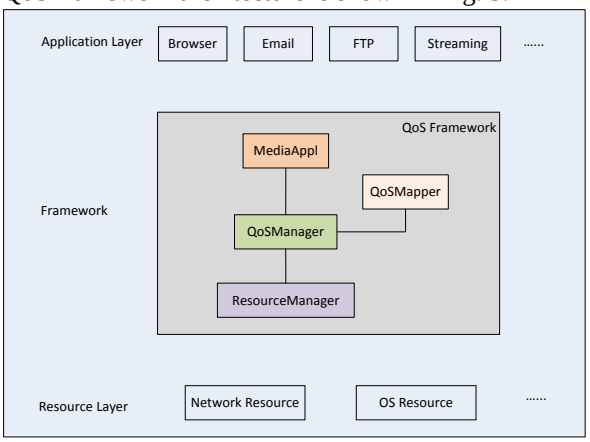

Fig. 3: QoS Framework Architecture

The QoS framework is designed based on conceptual model for specification of subjective QoS. It has the following interaction among its components: (i) The user should be able to specify his/her requirements; (ii) The *QoSMapper* would convert high-level user QoS specification to a set of resource requirements; (iii) The *ResourceManager* would indicate resource availability and inform to *QoSManager*; (iv) Based

on these the *QoSManager* would make a decision which would be then activated *MediaAppl* to perform the available application.

The QoS framework works as an intermediate layer connecting the existing mechanism at the application layer with the mechanism in the resource layer or as an integrated modul in the aplication. Through this architecture, Internet applications can take advantage of the QoS framework mechanism to change the behavior of applications so that applications can provide access to quality services for users in the low-quality connection environments.

3.3. Implementation

A software model of QoS framework has been implemented in order to analyze its behavior and validate the applicability of QoS framework in the provision subjective QoS for Internet access in low-quality connection. Based on the conceptual model we use the following scenario to illustrate how the framework works using browsing scenario.

1. A user wants to download a file "eMule-installer.exe" from the location http://sourceforge.net with a response time parameter *(t_user)*. The user specifies that he does not want to wait for longer than 10 seconds.
2. If the requirement cannot be satisfied due to some network problems, the user specifies an alternative:
   a. The download process is to be retried.
   b. If the requirement still cannot be met, then the download process is put on background and the downloaded file is emailed to a specific address.

3.3.1. User specification

Specification for the the scenario is described as follows.

S_1 : {(Initial(), e1[nil]) | (Get("eMule-installer.exe", http://sourceforge.net, t_user ≤ 10)) | ($S_2 \vee S_3$)}

S_2 : {($S_1 \wedge$ e2[t_process ≤ t_user]) ∨ ($S_3 \wedge$ e4[t_process ≤ t_user]) | (NormalDL("eMule-installer.exe", http://sourceforge.net, t_user ≤ 10)) | (S_4)}

S_3 : {($S_1 \wedge$ e3[t_process ≤ t_user]) | ((Retry("eMule-installer.exe", http://sourceforge.net, t_user ≤ 10)) | ($S_2 \vee S_5$)}

S_4 : {($S_2 \wedge$ e5[true]) | (SaveFile("eMule-installer.exe", MyDirectory, true)) | (End)}

S_5 : {($S_3 \wedge$ e6[t_process > t_user]) | (BackgroundDL("eMule-installer.exe", http://sourceforge.net, t_user > 10)) | (S6)}

S_6 : {($S_5 \wedge$ e7[true] / act := S_5) | (SendEmail("eMule-installer.exe", ratna@uny.ac.id, true)) | (End)}

A graphical illustration of the specification is given by Figure 4.

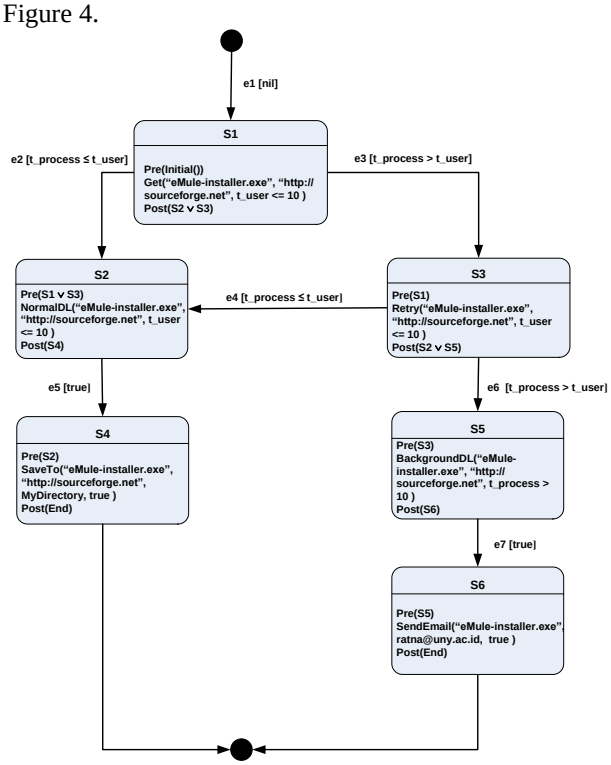

Fig. 4: State Transition Model for Subjective QoS

3.3.2. Browser Architecture

QoS framework architecture for browsing scenario is shown in Fig. 5.

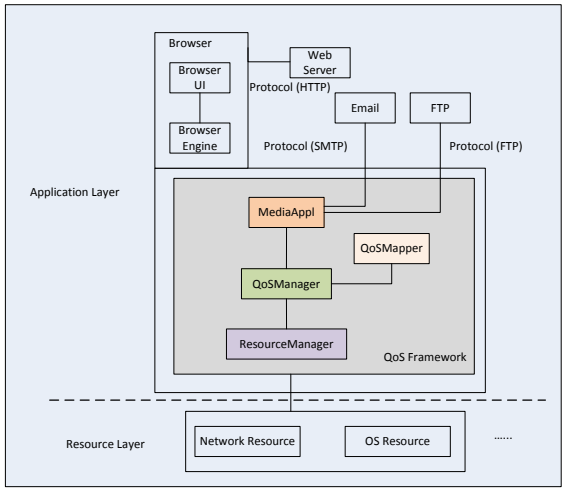

Fig. 5: QoS Framework Architecture for Browsing Scenario

There are 2 approaches to implement the QoS framework, namely i) implementation framework as a mediated layer between Internet applications and mechanisms that exist in the layer system / network and (ii) implementation through the integration of QoS into the application. This paper describes ramework implemantation using the second approach.

The second implementation shows the flexibility of using the QoS framework. In other words, the QoS framework can be pulled out of the intermediate layer and the mechanism defined in the QoS framework is integrated directly into the browser.

3.3.3. QoS Framework Mechanism

The QoS framework essentially implements the User, *QoSManager*, *QoSMapper*, *ResourceManager*, and *MediaAppl*. On the client side, a user specifies his/her QoS requirements over the browser UI to *QoSManager*. The *QoSManager* accepts user specification on access parameters that defines his or her subjective requirement, maps the user parameters into system parameters, performs calculation and comparison between system performance and user requirement, and calls the specified action accordingly.

4. CONCLUSIONS

This research recommends a new Internet access model for accessing Internet in low-quality connection environment. We use 3 subjective parameters: (i) time_access parameter (t); (ii) successful_access parameter (s); and content_relevance parameter (c). These three parameters can be represented to different attributes according to type of application.

This research also has developed a QoS framework for implementing the subjective QoS mechanism as the basis for Internet access.

Implementation of QoS framework on Internet application shows that the mechanism of specification and determination of user access services allow the application behavior is controlled according to conditions of low-quality connection and subjective QoS requirements of users.

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