TOWARDS A MODEL FOR PERSONALIZED COMMUNICATION SERVICES BASED ON USER PERCEPTION

Cláudia M.F.A.Ribeiro
Departamento de Informática, UERN, Campus Central, Mossoró, Brazil

Nelson S.Rosa, Paulo R.F.Cunha
Centro de Informática, UFPE, Recife, Brazil

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Abstract: The emerging of the new generation applications like videoconference and the increasing in the demand of QoS services have enforced the need of new service models. As in the most new applications the user can perceives the level of quality a service is provided, data communication services are currently evolving towards more personalized ones. A direct consequence of this trend is the necessity of explicit treatment of the user perception. Challenges in this evolution include the better understanding of "how" users perceive QoS and "how" the perception is actually realised by underlying QoS mechanisms. This paper addresses these questions by presenting a formal architecture, namely ESCHER that implements a conceptual user perception model for QoS services.

1 INTRODUCTION

The emerging of new generation applications like videoconference and the increasing in the demand of QoS services have motivated some key transformations in the application development process. Meanwhile, there is a clear necessity of new service models (Pedersen, 2002).

Data communication services are currently evolving towards more personalised ones, as the users can perceives the level of quality a service is provided (Ghinea and Thomas, 1998). In fact, those services are becoming as personalised as health care services, bank services and traditional voice communication services. A direct consequence of this trend is the necessity of explicit treatment of the user perception.

However, typical users are not able to express their QoS requirements in quantitative terms, as they are not concerned with details of implementation of QoS services. For instance, they know neither what is the upper limit of tolerable packet *delay* nor *jitter* in an IP telephony session. Moreover, they cannot provide the traffic specification of their application flow.

Actually, the user has a very subjective view of QoS and he/she usually defines QoS constraints as a set of non-functional requirements (NFRs) such as performance and cost. In order to understand, precisely specify and map user QoS specifications into quantitative network parameters, new capabilities must be incorporated by QoS mechanisms.

Since Quality of Service is a key factor for differentiating service offers in a competitive market, there are many researches activities towards the definition of service models which are easily identified by users (EURESCOM, ETSI). Despite these initiatives being a progress towards the effective treatment of the individual necessities of users, two important issues are still open: it is necessary a better understanding of "how" the user perceives quality; and "how" the perception is actually realised into underlying quality of services elements.

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We addressed these mentioned issues by conceiving a layered architecture namely ESCHER[1] that implements a conceptual perception model for QoS services. This model focuses the precise specification and mapping of user QoS requirements into QoS parameters.

In ESCHER, the QoS specification and the QoS mapping are based on the QoS abstractions of each layer (user, application, middleware and QoS mechanism). For instance, in the user layer the QoS requirements are defined through non-functional requirements, which express more properly the constraints defined by the user.

Despite the high abstraction level in which NFRs are commonly stated, there is a rationale to treat with the NFRs defined by users. As resources are traditionally scarce, the resource allocation based on the quality perceived by the user yields a more effective resource management. For example, a video quality may be good for a particular user, while its quality is not acceptable to others. The optimisation of resource allocation embodies benefits to communication service providers, whilst the differentiation of services motivated by the user perception leads to money saving on behalf of the users.

This paper is organised as follows. Section 2 presents some related work. Section 3 presents the conceptual user perception model principles. Section 4 is dedicated to description of ESCHER architecture. In Section 5 is presented a modelling of VoIP application using ESCHER. The Section 6 illustrates an Implementation scenario of ESCHER operations. Finally, the last section presents the conclusions and some directions for future work.

2 RELATED WORK

There are some research activities in capturing of user QoS requirements (Bhatti et al, 2000) (Bouch et al, 2000) (Widya, 2001). Many conceptual models for the treatment of user perception were proposed. The QoE Model (*Quality of Experience*) (Moorsel, 2001) proposes an extension of RM-OSI (Zimmerman, 1980) layers by including an specific layer to treat user perception. The QoBiz Model (*Quality of Business*) (Moorsel, 2001) is an extension of the QoE model for user perception under business perspective. The QC Model (*Quality Class*) (Alfano, 1997) is a model which intends to facilitate the identification of the level of quality the users are interested.

Despite the advances the aforementioned researches represent, there are open questions to be addressed to explicit treatment of user perception for effective offers of personalised QoS services. The User Perception Model, described in next Section, presents a service model to solve the questions above mentioned, by considering the explicit treatment of user quality of perception. It serves as a basis for QoS management service implemented by ESCHER architecture proposal.

3 THE CONCEPTUAL USER PERCEPTION MODEL

The conceptual user perception model follows some basic principles in order to explicitly treat the user perception:

- The user may require different levels of quality for multimedia services. In a personalized service model, the user has the opportunity of defining her/his desired quality level together the cost limit;
- The user perceives quality by considering personal characteristics. People react physically in a different way to audio and visual stimulations. Moreover, another factors, like the interest on the particular activity in execution and personal preferences also influence the way people perceives quality;
- The user satisfaction level related to quality perceived is more properly represented by the trade-off between non-functional requirements like performance, security and cost. Traditionally, the quality of service has been managed by considering only aspects related to performance (Aurrecoechea, 1995);
- The effective treatment of the user perception by low-level QoS mechanisms, suppose an intermediary step to map subjective specification defined by the user into objective underlying parameters (Yamazaki and Matsuda, 1999). This important task can be used to guide the process of resource allocation.

In addition to these principles, another key feature of this model is the separation of concerns in the requirement specification. By adopting this principle, both the specification of non-functional

[1] Maurits Cornelis Escher (1898-1972) is a graphic artist. He is most famous for his so-called “impossible” structures in which allow multiple perceptions

requirements (including QoS requirements) and functional requirements of a given application may be treated separately. Additionally, it allows legacy applications to use QoS services without any code change.

4 THE ESCHER ARCHITECTURE

In this section, we show how the principles of the model proposed, can be implemented through an abstract architecture which is mainly focused on the capture and the map of user perception into underlying QoS parameters.

Figure 1 illustrates the ESCHER layers and the relationships between QoS abstractions of each layer.

There are two basic elements in ESCHER: layers and relationships. The first one represents a particular entity together its respective view of QoS. The second one relates abstractions used to specify quality requirements in each layer.

The ESCHER architecture (Ribeiro et al, 2003) is structured into four independent but interconnected layers: user, application, middleware and QoS mechanism.

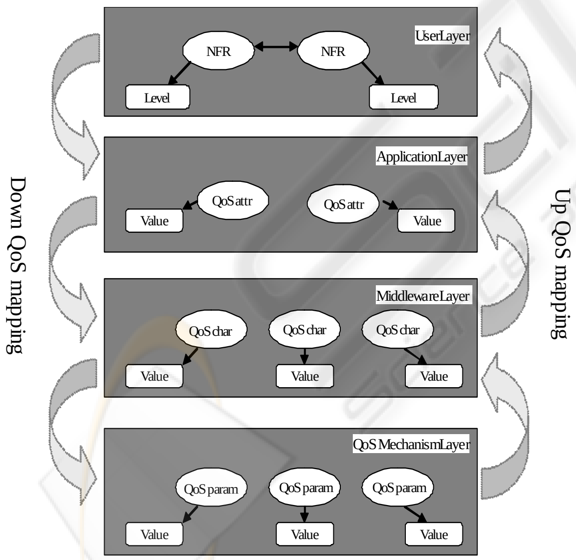

Figure 1: The ESCHER Architecture Overview

At the User Layer, the user requirements specification is defined through non-functional requirements (*NFR*) like performance and cost, their associated constraint level, e.g. “high” or “low”, and the relationship of priorities between them. At the Application Layer, a set of QoS attributes (*QoSattr*) realizes NFRs defined at User Layer. For instance, the QoS attributes “frame rate” and “resolution” can be used to realize a NFR “quality of video”.

The third layer represents the QoS middleware view, a key architectural element for the “transparent” support of QoS. At this layer, QoS requirements are defined by QoS characteristics (*QoSchar*) such as *delay*, *jitter* and *loss*. Finally, the lower layer is the QoS Mechanism Layer. The abstraction used in this layer is QoS parameters (*QoSparam*) that represent low-level parameters used by specific mechanisms such as RSVP protocol (Braden et al, 1997).

In ESCHER, the mapping process is bidirectional, from the highest layer to the lowest one which is called *downQoS mapping* and the opposite flow, called *upQoS mapping*. Each flow consists of a three steps process involving the mapping between two layers each. The detailing of the form and use of each one of these flows will be subject of section 6 that deals with implementation scenarios. Despite the effective enforcement of services with QoS guarantees is out of the scope of this work, it was established a formal interface with mechanisms which address this issues.

5 MODELLING USER PERCEPTION

Figure 2 illustrates an IP Telephony application modelled through ESCHER architecture abstractions. It is possible to observe the QoS mapping process along the layers. At ESCHER, the user identifies the type of application and defines QoS constraints and QoS priorities.

In this example, the user requires a “High” “Quality of Speech” and a “Medium” level to the “Cost” requirement. These two NFRs are conflicting, since the user is interested in an increasing of “Quality of Speech” (*QofSpeech*) and a decreasing in the “Cost” (*Cost*). In this particular case, we assume that the user considers “Cost” more restrictive in the sense that it has priority over the “Quality of Speech”.

In order to realize each NFRs defined, a set of typical QoS attributes with respective values was identified. It includes more specific parameters to describe quality of speech (*R*, *LSR*, *e2e* and *Codec*) for Quality of Speech and one parameter more general to describe Cost (*perSec*). These attributes are mapped to a reduced set of QoS characteristics which can be managed by the middleware.

The values of each one of these QoS characteristics are well-known and respect the level of quality defined for NFR quality of speech.

Finally, a set of underlying parameters is derived from the last step of mapping process.

The relevance of this example is to show that it is possible to integrate different requirements specifications of quality, in an uniform way. From the qualitative specification defined by the user to quantitative parameters that adjust the network functions. In addition, the precise definition and formalization of mapping rules through ESCHER elements, makes possible to create mechanisms to adapt dynamicaly the service quality level.

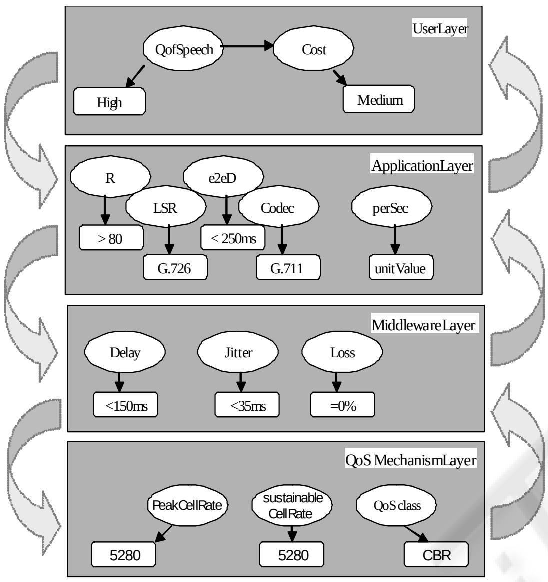

Figure 2: An Illustrative Example of User Perception Modelling

6 ESCHER IMPLEMENTATION SCENARIO

Figure 3 depicts an abstract implementation scenario of ESCHER architecture. In this abstract scenario, three actors are directly involved: User/Customer - Residential users and smaller enterprises connected to the Internet by some type of connection; Service Provider (SP) - delivering content, application services or simply service management; and Network Provider (NP) - delivering IP QoS connectivity.

The activities played for ESCHER elements can be grouped in two phases: configuration and monitoring. The first one is made up of the specification of user QoS requirements, the mapping of QoS requirement into QoS parameters and the negotiation for establishment of the QoS contract (SLA – Service Level Agreement) (Bouillet et al, 2002). The second one is composed by the activities of monitoring contracts (SLA), the reverse mapping to identify possible changes on agreed QoS level and the adaptation process.

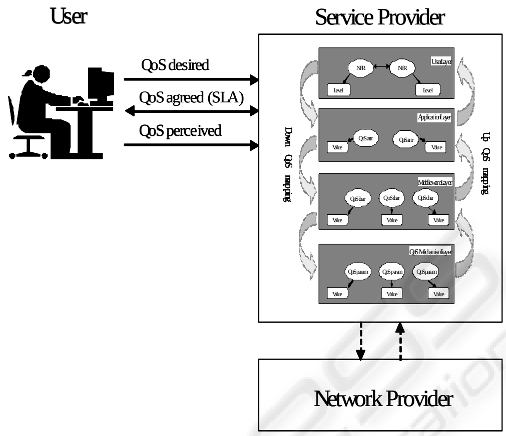

Figure 3: ESCHER Implementation Scenario

One important characteristic of ESCHER is the facility in specifying the QoS requirements. The user basically defines the QoS desired (*QoS desired*) by the minimum set of requirements related to constraints, priorities and the application type (Figure 4). Since the ESCHER architecture focuses the explicit treatment of user perception, the service specification is the most important task to be executed.

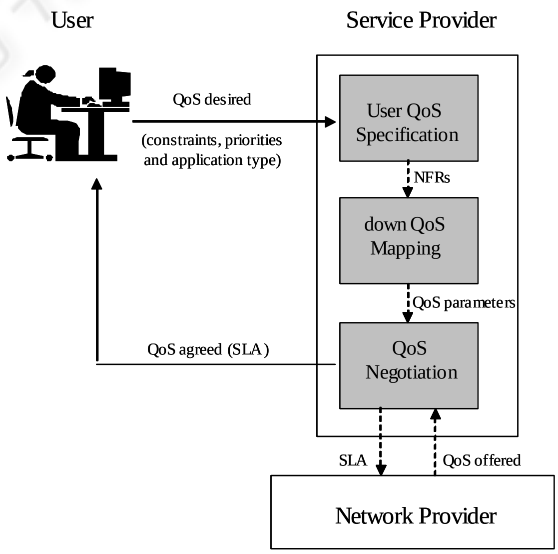

Figure 4: ESCHER Service Configuration Phase

The mapping process flow is made from the top to the bottom of ESCHER architecture layers (*down QoS Mapping*) that is responsible for translating the user QoS requirements, defined through NFRs, into QoS parameters treated by the underlying QoS mechanisms.

After the down QoS mapping, it is initiated the negotiation to allocate resources to satisfy the required QoS. The mapping process becomes available a set of specific QoS parameters treated by underlying mechanisms.

7 CONCLUSIONS AND FUTURE WORK

We have presented an architecture, namely ESCHER, which explicitly taken in account the user perception, whilst it also proposes a systematic mapping of QoS requirements (at user level) into QoS parameters (treated by QoS mechanisms).

Besides the high level of abstraction the user QoS requirements is specified, the benefits of our proposal also include: the separation of concerns in QoS specification and the treatment of user satisfaction as a trade-off between NFRs. The first one allows legacy applications to use QoS services offered by the middleware. The second one serves as a basis for more flexible QoS adaptation mechanism.

In terms of future work, we intend to concentrate on the QoS mapping by identifying and formalizing the rules to make this process automatic. We also intend to verify some properties of our model. For example, the capacity of our model to reflect changes in the level of provided QoS and vice-versa.

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