An EURESCOM QoS Framework for Multi-Provider Environment

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Abstract:

To provide Quality of Service (QoS) guarantees today is difficult if the provider does not have full control over *all* the resources used. In the near future, market demand will require that *one* provider guarantees QoS, even if multiple providers are involved in the delivery of the service. This paper describes the on-going work to define a framework suitable for this situation. The framework is based on entity relationships and is complementary to existing frameworks and models. The QoS provided to the user is a function of local influence and the QoS delivered by sub-providers. The framework being developed goes into some detail regarding the interchange of information between providers.

1 INTRODUCTION

For many telecommunication services, the user (and service provider) has to rely on service contributions from a number of providers. It is foreseen that more users will require more explicit guarantees of QoS (Quality of Service) for services such as those based upon the Internet. Thus, the control and verification of QoS is becoming increasingly important to service providers and their users.

Various international bodies have made efforts towards making general QoS frameworks. Some of these are:

- ITU-T Rec. E.800 [E.800] where part of this standard is adopted by IEC (International Electrotechnical Commission) as terminology standard IEC 191.
- ETSI (European Telecommunication Standards Institute) framework, [ETR003]. This framework is based on the work of the FITCE (Federation of Telecommunication Engineers of the European Community) Study Commission [FITCE93].
- Contributions to QoS in layered and distributed architectures, like:
  - The ISO (International Standards Organisation)/OSI (Open System Interconnection) QoS framework [ISO/OSI93].
  - The Telecommunication Information Networking Architecture Consortium (TINA-C) QoS framework [TINAC94].
- ETNO (European Public Telecommunications Network Operators Association) Working Group 07/95 on QoS. This group is working toward a consistently defined set of common European QoS parameters (QoS indicators). The aim is harmonised European QoS definitions and possibly performance targets for pan-European services, in order to facilitate comparison of the results of the measurements. The work is based on the approach of the FITCE Study Commission and ETSI. The work has hereto concentrated upon voice telephony.
- EURESCOM (European Institute for Research and Strategic Studies in Telecommunications).

Although a majority of Public Network Operators (PNOs) apply the ITU QoS framework in their quality work many collections of frameworks/QoS parameters – sometimes mixed with PNO internal "inventions" - make life difficult both for the user and the service provider. In addition, they create inefficiency in research programs addressing aspects of QoS.

In many research projects frameworks and architectures have been produced for QoS-related aspects; QoS management, provisioning, establishment, resources allocation, reservation, etc. These frameworks have been produced in the area of telecommunications as well as computing. An overview of the latter ones can be found in [Aurr96], [Voge95] [Camp94]. Many of these frameworks do support heterogeneous sets of applications, systems and networks. However two issues remain almost unsolved. The first is mapping QoS from the application towards the user and thereby allowing the user to compare QoS. This might be an issue if services are delivered by different providers or implemented/supplied in different ways. A second issue that requires attention is the interconnection agreements. Like the issue with RSVP; if you have multiple domains, how do you reserve resources in other domains or how do you guarantee QoS to the end-user when a service is crossing multiple domains. This requires a common understanding of QoS independent of what service is delivered. In order to realise these issues some steps back have to be made. These steps are also forward, because they are needed to create the common framework for QoS in a multi-provider environment. The word back is used because such a framework is based on many existing frameworks and service-based QoS architectures.

One of the main objectives for the work presented in this paper is to describe a QoS framework which is general applicable for the multi-provider configurations seen in several service provision situations. This may be basis for a harmonised QoS framework covered by a Memorandum of Understanding.

The principles of the framework are described in Chapter 2. A short example related to IP-based services is given in Chapter 3.

2 THE EQOS FRAMEWORK

2.1 General

In the EQoS (EURESCOM QoS) framework, the term **Quality of Service** is defined as *the degree of conformance with an agreement between user and provider*. QoS is described through the selection of a set of QoS parameters, specification of QoS target values and the choice of QoS measurements and evaluation mechanisms.

A ***QoS parameter*** *is a variable that characterises QoS.*

This is a strengthening of the QoS definition compared to the one given in [E.800] and is illustrated in Figure 1.

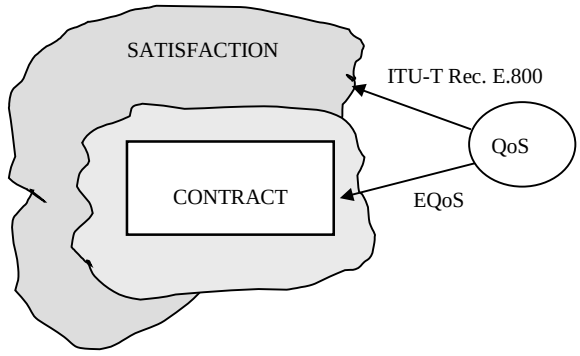

Figure 1 QoS references (contract and satisfaction)

It is essential to observe that the *quality* of a service is, basically, different from the *functions* provided by the service. The overall quality of service (end-to-end) is to be managed, even when open networks and distributed systems are involved, where individualised service profiles for the users are handled. Since each contributing provider is responsible for the QoS management in his network, this asks for the presence of adequate functionality in the interconnected systems, in order to ensure appropriate handling of the service requests.

Framework requirements

A common framework should be:

- Applicable in a multi-provision environment, where relationships between the involved actors are requested, implying provisioning of services at different types of interfaces.

- In accordance with Open Network Provision (ONP) directives.
- Applicable to all service life cycle phases of a service provision.
- Applicable to all types of services at different functional levels.
- Applicable to all types of providers, users, networks (logical as well as physical) and technologies (e.g. copper, fibre, radio).
- Applicable for QoS control and maintenance aspects, such as measurements and degradation tracing.
- As far as possible, in line with, or at least not contradictory to existing frameworks, models, methods, etc.

2.2 Basic principles

Terms and concept

Some terms have been defined in order to clarify the interpretation of the EQoS framework. They are illustrated in Figure 2.

An ***entity*** *is a generic unit characterised by its set of states and transitions*. A number of entities can be composed into a new entity.

An ***interface*** *is a boundary between two entities*.

A ***service*** *is the result from executing a set of functions and is provided at the interface*.

A ***provider*** *is an entity that provides service to another entity*.

A ***user*** *is an entity that makes use of a service provided by another entity*.

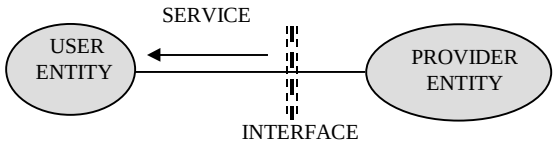

Figure 2 Provider, user, service, and interface

Recursion and dependency

In a multi-provision environment, the QoS provided by an entity might depend on adequate operation of other entities. Thus, there may be a need for relating the QoS levels obtained for the different interfaces, see Figure 3.

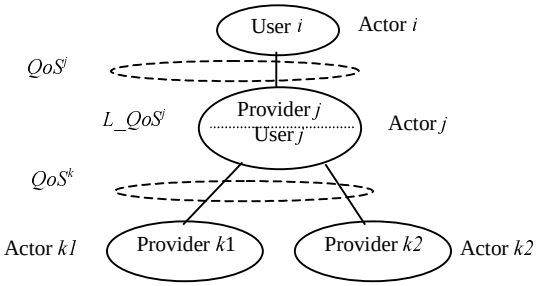

Figure 3 QoS related to interfaces between (groups of) entities

Naturally, multiple interfaces may exist between one pair of actors in an actual configuration. However, due to the potential dependencies between interfaces, mechanisms for supporting the delivered QoS at the interface may be implemented in a number of ways.

In principle, the QoS provided/delivered at the interface between entity *j* (provider) and entity *i* (user) can be formulated as a function *f*:

$$QoS^{j} = f\left(QoS^{k}, \quad L\_QoS^{j}\right) \qquad (1)$$

Where:

- QoS^j is the QoS experienced by entity *i* on the interface between entity *i* and entity *j*.
- QoS^k is the QoS experienced by entity *j* on the interface between entity *j* and set of entities *k*.
- L_QoS^j are QoS mechanisms involved, which are present "locally" to entity *j*.

QoS parameters

The QoS parameters attached to each interface can be arranged in a hierarchical manner, e.g. as described in [E.800], as well as by specialising and elaborating derived parameters, ref. [X.641]. These are to be further related to measures. Three categories of QoS parameters are identified, ref. [I.350]:

- *Speed* characterises the temporal aspects of QoS.
- *Accuracy* characterises the degree of correctness with which a given phase is realised.
- *Dependability* characterises the degree of certainty that a function is performed.

The quality of a service is expressed by assigning values (e.g. target values or actual, measured values) to a number of parameters. Different viewpoints and instances may be referred to, like the requested QoS, offered QoS, contracted QoS, delivered QoS, perceived QoS, and so forth (see [ETR003]).

Considering the various phases of service life cycles, various relevance of parameters is assumed for the phases. Furthermore, the actors involved may change their roles as the various service life cycle phases evolve.

2.3 User – provider agreement

QoS aspects as part of agreements would be related to most interfaces, for instance starting from the end-user and considering the set of providers involved. As discussed in the previous section, a number of providers/operators can be involved in the service provisioning. However, the "one-stop-responsibility" concern implies that ONE provider would be responsible for the (aggregated) effect of the service present at the interface. The QoS-related issues of a generic agreement are depicted in Figure 4.

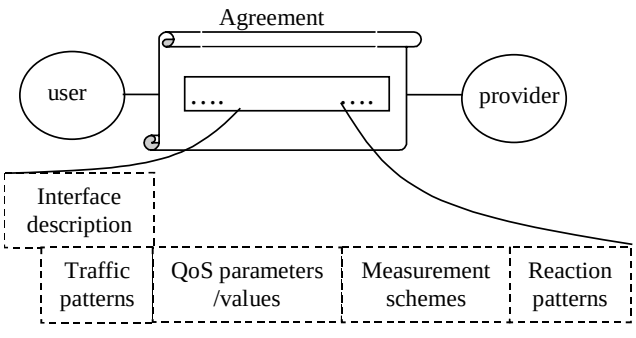

Figure 4 An agreement established for an interface between a user and a provider

A generic structure for interconnection agreements can be identified by describing possible aspects that should be

included. One motivation for this is to allow for more rapidly, accurately and automatically establishments of such agreements. In particular, this is requested because of the multitude of providers that could be involved.

The considered issues includes:

- Interface description
- Traffic flow patterns expected at the ingress point including relevant traffic parameters
- QoS/NP parameters and related target values
- Measuring mechanisms and scheme description
- Reaction patterns to apply in case agreed restrictions on traffic patterns or QoS parameter values are not fulfilled

Several of the terms (like traffic flows) could be generalised in order to be applicable for every service life cycle phase. The corresponding terms might then be adapted in order better to describe the relevant aspects.

3 EXAMPLE – IP-BASED NETWORKS

Provision of Internet-based services commonly relies on proper operations of a number of network domains and systems. For instance, looking at a www surfing session, a number of domains could be traversed between the end-user and the location of the page addressed. See Figure 5 below. As the different Internet providers seek such interconnection configurations, adequate agreements should be made covering QoS-related issues at the interfaces.

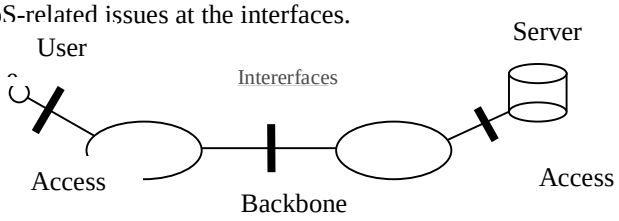

Figure 5 A web service with several providers

Deriving the actual values, end-to-end requirements should be considered. In the following, an example of issues to include in an agreement are described:

- *Interface description*: A description of the services, e.g. protocols, used. Here the version of IP, possibly based on an underlying data link layer protocol, would be stated.
- *Traffic pattern*: Characteristics of the traffic flows, e.g. specified as mean value (and higher order moments) of bitrates. Different types of traffic flows, like user-related, routing updates, and so forth, could be given. Example of such characteristics, referring to a certain period are:
  - total traffic between ISPs
  - peak traffic load
  - duration of sustained peak traffic load
- *QoS parameters*: Parameters could refer to mean values and higher order values. Aggregates of parameters might also be of relevance. In addition, there may be differences for the different traffic flows. A selection of parameters categorised as described in Chapter 2 could be:
  - IP- packet transfer delay (Speed)
  - IP- packet error ratio (Accuracy)
  - IP- packet loss ratio (Dependability)
  - IP- transfer availability (Dependability)
- *Measurements*: Schemes for how to carry out measurements have to be described in order for the two entities at the interface to obtain an unambiguous view of the situation. Traffic characteristics and QoS parameters have to be measured.
- *Reaction patterns*: The reactions related to the non-conformant traffic incoming at the interface can be alert/warning/error messages, load control, traffic shaping, re-configuration of reserved resources, etc. The reactions regarding QoS parameters could be re-routing of traffic flows, re-configurations, penalties, and so forth.

4 CONCLUDING REMARKS

In this paper the preliminary ideas on the EQoS framework are outlined. Based on investigations of its applicability, further refinements may take place.

Some work has been undertaken demonstrating how the EQoS framework relates to the existing QoS results presented by the different forums. Due to its generic approach, the EQoS framework allows for adaptations of several of those results, which commonly are derived on more specific basis.

The EQoS framework would contribute to an essential part of an MoU suggested to be established within this area.

5 ACKNOWLEDGEMENTS

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