QoS Assignment with GSS for Incoming IP Sessions in UMTS

Carelia Gaxiola-Pacheco[1], Ernesto Quiroz-Morones[1] and Oscar-Iván Lepe-Aldama[2]

[1] Centro de Investigación y Desarrollo de Tecnología Digital (CITEDI-IPN). Tijuana, Baja California, México
[2] Universidad Autónoma de Baja California (UABC). Ensenada, Baja California, México
{cgaxiola, eequiroz}@citedi.mx, oscarlepe@uabc.mx,

Abstract. This article analyzes and characterizes the Generic Service Specification (GSS) framework proposed by Maniatis et. al [3]. GSS is constituted by a generic scheme of specification for the service class and an algorithm for intelligent mapping. The scheme of generic specification allows network administrators to describe the classes of their domain according to GSS. An intelligent mapping algorithm deployed at the point where different networks converge performs the correspondence of the requested session specification to a specific service class when crossing a domain on the end-to-end path. The proposal of Maniatis is extended by applying fuzzy logic for the calculation of the degree of correspondence between two network service specifications.

Keywords: QoS, GSS, UMTS, mapping.

1 Introduction

The existing quasi-ubiquitous Internet, the increasing reliance in data transport over IP networks in preference to other technologies (i.e. circuit switched networks), and the worldwide expansion of the wireless IP based network, has brought about a Quality of Service (QoS) provision dilemma. Actual IP networks are unable to allocate consistent QoS characteristics to a user's session going through diverse administrative domains. Universal Mobile Telecommunications System's (UMTS) classes of service [1], differ from those of the legacy wireline world. Integrated Services (IntServ), Differentiated Services (DiffServ) and Multiprotocol Labeling Switching (MPLS) technologies provide partial solution in the inter-domain realm of QoS provision. The ever-growing types of multimedia applications exert a burden on the capability of the networks to provide the expected performance to users applications.

In view of this panorama, the Internet Engineering Task Force (IETF) started in 2004 the initiative "Next Steps in Signaling" (NSIS) [2], a signaling system for IP networks aimed to provide QoS assurance. Over this foundation, Maniatis, et. al. propose the Generic Service Specification (GSS) framework, consisting of a "universal" template of QoS and traffic attributes, which is passed on from one domain to another, and

© A. Gelbukh, S. Suárez. (Eds.) *Received 07/07/06*
Advances in Computer Science and Engineering. *Accepted 07/10/06*
Research in Computing Science 23, 2006, pp. 173-180 *Final version 11/10/06*

interpreted at the edge of the networks by an Intelligent Mapping Algorithm (IMA), in charge of deciding the best correspondence for the incoming session with one of the native classes of service. This paper deals with a GSS framework implementation for incoming inter-domain sessions in UMTS.

2 The Generic Service Specification Schema

The GSS framework defines a GSS schema stating a Network Service Specification, comprised of QoS objectives and traffic classification of a session that needs to traverse two or more administrative domains. The schema is handed on from one domain to the next. With this information the IMA can calculate and decide the best native service correspondence for the incoming session. Fig. 1 shows the Network Service, QoS, and Traffic Specifications of the GSS schema, and the particular parameters that describe them.

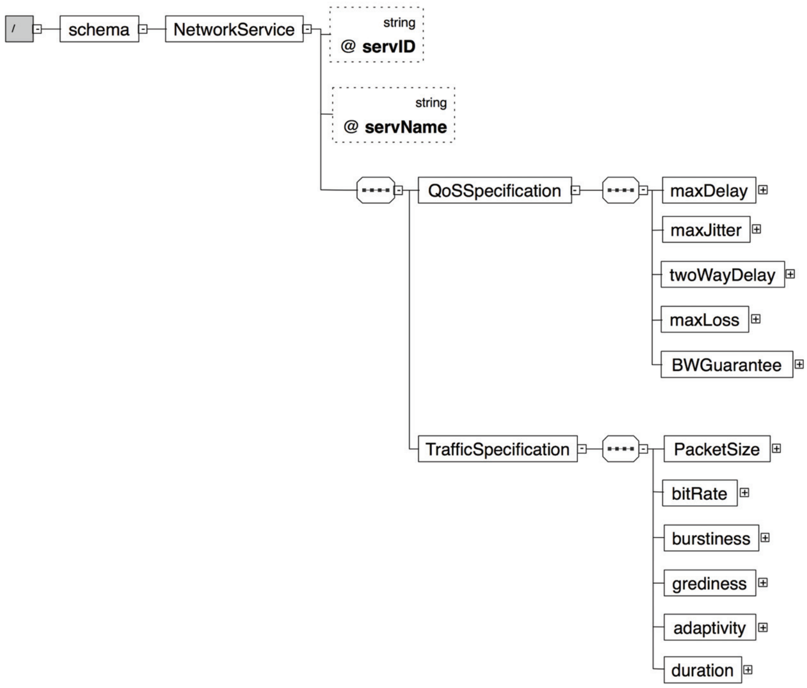

Fig. 1. Logic Diagram of the GSS schema

The QoS specification can have either numeric or descriptive values, when using the latter, the range of each parameter has six levels: veryLow, low, medium, high, veryHigh, and unspecified.

Traffic specification descriptors can adopt the following values: Bit rate (constant or variable {veryLow, low, medium, high, veryHigh, and unspecified }), packet size (constant or variable {verySmall, small, medium, big, veryBig, and unspecified }), burstiness (veryLow, low, medium, high, veryHigh, and unspecified), greediness (yes, no, unspecified), adaptativity (yes, no, unspecified), and duration (shortLife, longLife, and unspecified). This data allows the receiving domain to effect operations of admission control, policing and resource management.

To convey the relative importance among the eleven unitary components of the network service specification, they are assigned a weight, whose integer values span from zero (not relevant), to ten (capital importance). The weights differentiate applications, i.e. voice needs a weight ≈ 10 in maxDelay, whereas web requires a weight ≈10 on maxLoss.

The GSS schema is structured with the Extensible Markup Language (XML) [4], as suggested by [3].

3 The Intelligent Mapping Algorithm

Since different QoS models specify non-homogeneous classes of service, the IMA at the edge router of a UMTS domain has the purpose of deciding (with a criteria described in this section) which of its native classes is the one that more resembles that of the GSS schema received.

Each class of traffic in the UMTS domain is described in a Network Service Specification by means of a XML document, following the same pattern of the GSS scheme.

The fundamental operation for the selection of a certain network service specification is the calculation of the correspondence degree, which denotes the grade of similarity between two different network service specifications. Absolute or relative conformance can be used to calculate the correspondence degree. In the case of absolute conformance, the attribute's values are compared, if they are identical the weight associated to the attribute is added to the total correspondence degree, otherwise it is subtracted. In the case of relative correspondence, the calculation involves a more complex process, stemming from the fact that numerical values and descriptive values (rank of numerical values, i.e. 200 ms to 600 ms) may exist for the same attribute [3]. Furthermore, the correspondence degree implies an uncertainty factor, because it makes reference to a degree of similarity between two data sets. Fuzzy logic is used to deal with the uncertainty present in the structure of the Network Service Specification data set. The IMA models the QoS specification's parameters (maxDelay, twoWayDelay, maxLoss, maxJitter, bwGuaranteed) as linguistic variables, whose descriptive values (veryLow, low, medium, high, veryHigh, and unspecified) represent a linguistic value. For each linguistic value numerical figures (known as support) must be defined. In this work, the support for each linguistic value is allocated on the basis of the recommendation [6]. The numerical value within each support that holds the greater degree of similarity is known as core. Table 1 gives an example the support and core for maxDelay.

Table 1. Numerical values correspondent to maxDelay

maxDelay	Min. limit	Core	Max. limit
verylow	0 ms	100 ms	300 ms
low	200 ms	400 ms	600 ms
medium	500 ms	1 s	2 s
high	2 s	4 s	6 s
veryhigh	5 s	10 s	5 min

The membership degree takes on values between 0 (non-member) and 1 (identical member) [5]. In order to ascribe a degree of similarity to the discrete values of the support, a Membership Function has to be defined. A Triangular MF (Fig. 2) is invoked by the IMA to compute the membership degree. The MF is expressed by Equation 1, where a < b < c take up the values of recommendation [6], as exemplified in Table 1.

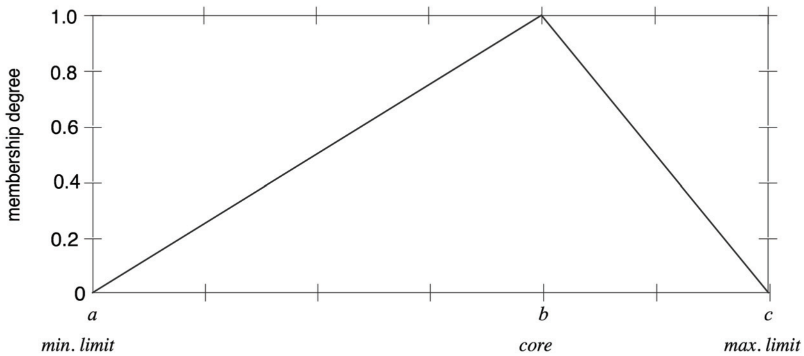

Fig. 2. Triangular membership function [5]

$$\text{triangular}(x; a, b, c) = \begin{cases} 0, & x < a \\ \dfrac{x-a}{b-a}, & a \le x \le b \\ \dfrac{c-x}{c-b}, & b \le x \le c \\ 0, & c < x \end{cases} \qquad (1)$$

Upon obtaining the membership degree, the IMA can figure out the relative correspondence. First it calculates the relative weight multiplying the numerical value of the membership degree times the attribute's weight. Then an addition of the relative weights is performed. When the membership degree equals 0, the weight is subtracted (the whole value of the weight, or a fixed fraction of it). Once the relative correspondence estimate is obtained, the IMA yields the name of the local network service specification that has the greater correspondence degree. Whenever the relative correspondence outcome is negative, Best Effort service should be assigned.

Fig. 3 depicts the action diagram of the IMA.

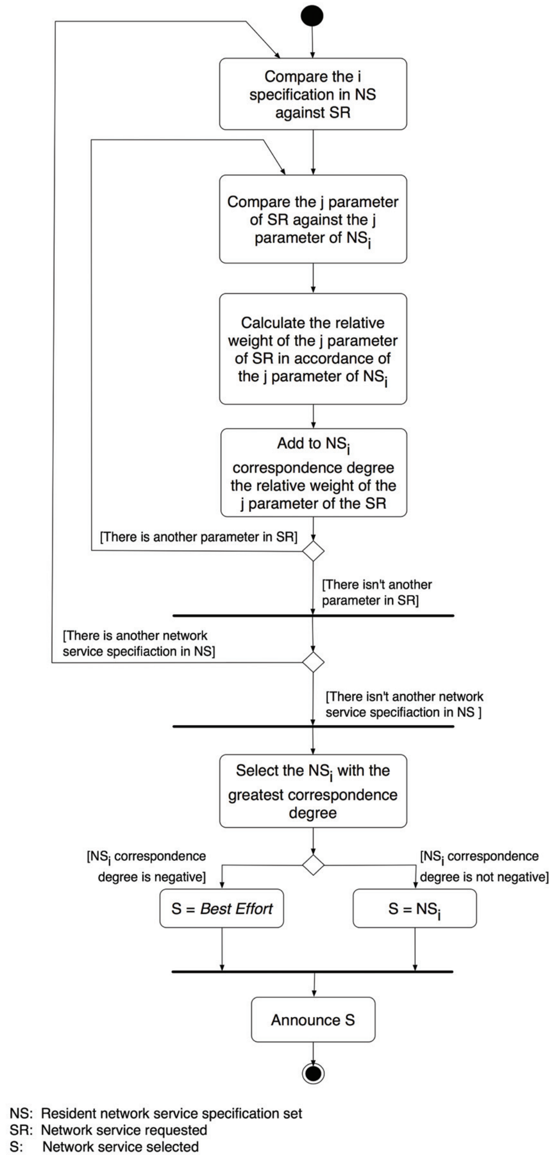

Fig. 3. Intelligent mapping algorithm action diagram

4 GSS Framework Results

To evaluate the GSS framework implementation, an iterative program that generates network service specifications was elaborated and tested with the following conditions: When the membership degree between two values is zero: (a) the parameter's weight is subtracted (b) a fraction of the weight is subtracted. The value and weight of the QoS attributes (maxDelay, maxJitter, maxLoss, twoWayDelay and bwGuarantee) were set according to Table 2. The UMTS domain holds 17 network service specifications. Because of space limitations, a sample of these specifications is enlisted in Table 3.

Table 2. Set of network service specifications attribute's values generated

Attribute	Content	Weight		
	Value	Min. Value	Max. Value	Increment
maxDelay	from 100 to 5000 with increments of 10%	1	10	1
maxJitter	[1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 7.5, 10]	2	10	2
maxLoss	[0, 0.001, 0.01, 0.03, 0.05]	2	10	2
twoWayDelay	unspecified	0	0	0
bwGuarantee	unspecified	0	0	0

Table 3. Network service specifications sample

Application	*maxDelay*			*maxJitter*		
	Descriptive value	Weight	Numerical value	Descriptive value	Weight	Numerical value
1. Voice	veryLow	10	100	veryLow	10	1
2. Video-conference	veryLow	10	100	veryLow	10	1
3. Interactive games	low	10	250	unspecified	0	
4. Telemetry/two way	low	10	250	unspecified	0	

Upon receiving a service request, the IMA selects a network service specification from this set of alternatives. For negative correspondence, though best effort is suggested, the algorithm yields the network service specification whose correspondence degree associate is equal to the maximum calculated.

Trials were run for 0%, 25%, 50% and 100% of the attribute's weight being subtracted for negative correspondence. In this paper we exhibit results for the two latter instances. Table 4 displays the overall results for the case when 50% is subtracted.

Table 4. Test 1: 50% of the weight is subtracted

A network service specification was identified as adequate for the requested service	The use of the *BestEffort* class was recommended for the requested service
330,675 [57.26%]	246,825 [42.74%]

Table 5 shows a set (randomly chosen) of the results obtained.

Table 5. Service specification outcomes (50%)

maxDelay		*maxJitter*		*maxLoss*		Correspondence degree	Specification selected
ms	Weight	ms	Weight	FER	Weight		
146.41 ms	2	1	8	0.010	6	12.535	2
235.79	5	5	8	0.001	10	-0.420	5
459.50	3	10	10	0.030	6	-0.500	1
895.43	10	5	6	0.030	2	-6.000	1
1311.00	4	2	2	0.000	6	3.000	5, 4, 17
1919.43	1	4	8	0.000	6	1.500	5, 14, 17

ms: miliseconds FER: frame error rate

Table 6 shows overall results for the 100% case.

Table 6. Test 2: 100% of the weight is subtracted

A network service specification was identified as adequate for the requested service	The use of the *BestEffort* class was recommended for the requested service
170,465 [29.52%]	407,035 [70.48%]

In the Table 7 is a set of the results obtained during the test 2 of the algorithm

Table 7. Service specification outcomes (100%)

maxDelay		*maxJitter*		*maxLoss*		Correspondence degree	Specification selected
ms	Weight	ms	Weight	FER	Weight		
146.41	2	1	8	0.010	6	9.535	2
235.79	5	5	8	0.001	10	-4.420	5
459.50	3	10	10	0.030	6	-7.000	1
895.43	10	5	6	0.030	2	-14.000	1
1311.00	4	2	2	0.000	6	0.000	5, 4, 17
1919.43	1	4	8	0.000	6	1.500	5, 14, 17

By comparison of the outcomes in Tables 4 and 6, it can be seen that subtracting the whole weight narrows the number of correspondence instances with respect to subtracting 50% of the weight. The decision on which one to apply lies on the system administrator, since on the one hand the figures indicate that the first case is more "accurate" or selective, but on the other hand, that sessions which could be given a set of QoS characteristics will be either rejected or assigned best effort service.

5 Conclusions

End-to-end QoS assurance without degradation in an interdomain scenario is still an unattained goal for IP networks. The IETF has ongoing work to define the NSIS, with the aim of providing a respectable solution to this goal.

In this paper we describe a GSS and IMA implementation, which in the context of the NSIS, yields QoS conformance for IP sessions coming from any administrative domain into a UMTS mobile network.

The IMA defines fuzzy logic sets out of each network service specification's attribute, to compute an overall relative correspondence benchmark, to search for the local service with the greater likeness to the specified by the GSS.

Results show that in many cases a one to one correspondence is achieved, nevertheless, there are frequent multiple selections, because the relative correspondence degree obtained from overall weight calculation can be met by various local services. These results lead to the need of further research on the definition of the fuzzy group's membership function applied and the weight manipulation criteria, for the purpose of obtaining more convergence in the local service selection

References

1. C. Chioariu, "QoS in UMTS," Helsinki University of Technology Seminar on Internetworking, 2004.
2. Next Steps in Signaling (NSIS) charter, http://www.ietf.org/html.charters/nsis-charter.html
3. Sotiris I. Maniatis, Eugenia G. Nikolouzou, Iakovos S. Venieris, "End-to-end QoS specification issues in the converged all-IP wired and wireless enviroment", IEEE Communications Magazine, vol. 42, no. 6, pp. 80-86, Jun 2004.
4. 4 Extensible Markup Language (XML), http://www.w3.org/XML
5. Jyh-Shing, Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, Pearson Education, 1st edition September 26, 1996
6. 3GPP, ''Service Aspects; Services and Service Capabilities (Release 6)'', 3GPP TS 22.105, version 6.2.0, June 2003.