

Quality of Service in the ETSI TIPHON Project

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Introduction

Voice over IP (VoIP) is a service that captures the imagination of many people. It started out as a tool for hobbyists on the Internet, who could talk to each other without incurring long distance costs. And now there is probably no traditional telecommunications operator who does not offer VoIP services in some form, and to some community.

The ETSI TIPHON project has been working on standardisation of VoIP issues (the project is now on its fourth year) in the very changing environment of IP networks. An aspect that was included right from the beginning is Quality of Service (QoS), which was identified as a major factor in the VoIP service offer.

Very early, TIPHON defined four Quality Classes, each with a different requirement on the carrying IP network and each (presumably) being priced differently. However, over time there have been underlying problems, which has prevented these Quality Classes from being deployed in a large scale.

This paper discusses some of these problems and the efforts made by the TIPHON Working Group 5 to overcome them.

QoS Issues

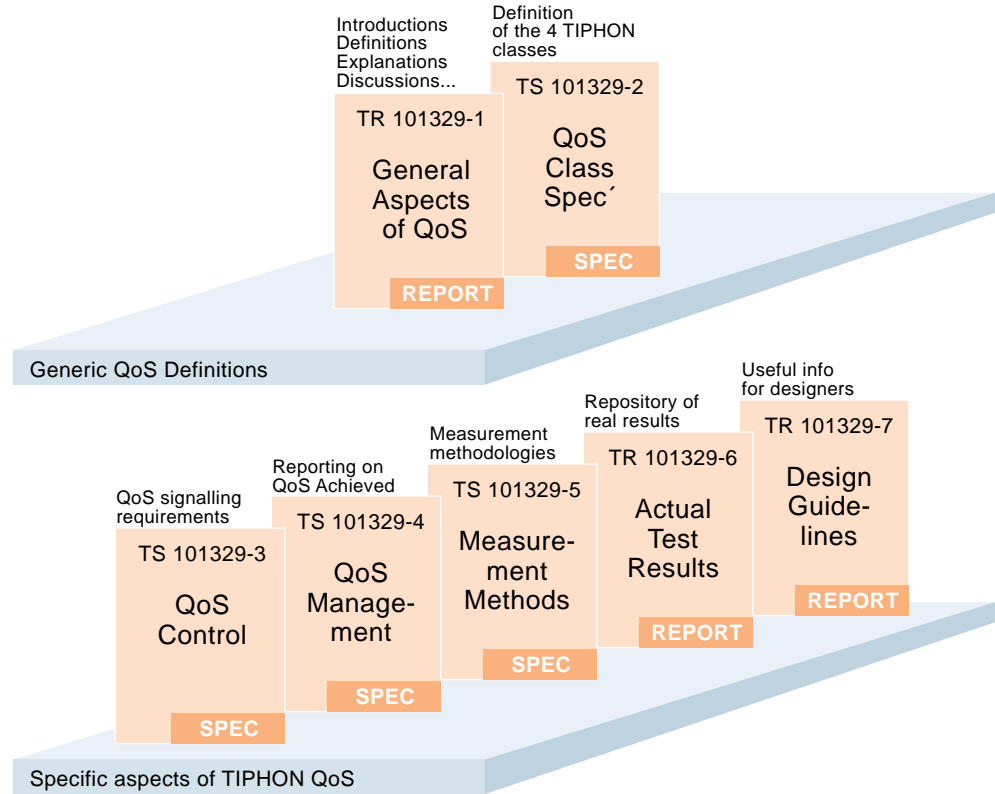
For QoS to be a deployable (and sellable) property of a VoIP network, a number of issues need to be solved. Some of these are:

1. The customer must be able to decide which Quality Class to select. A possible solution would be to only let customers decide when they order the service. Several research projects are working on solutions where the customer selects in real-time. In a previous article in *Teletronikk* [1], some principles for how this can be done are outlined. A EURESCOM project has investigated solutions which are close to these ideas. Some documents describing results of that work can be found at [2]. The TIPHON group has not addressed this issue explicitly.
2. The VoIP application needs to be able to signal to the network its QoS requirements (and the network needs to be able to signal back the

achieved QoS). The TIPHON project has done significant work on the first issue, as we shall see below. The second issue is targeted for the near future.

3. The Network needs to be able to provide differentiated levels of Quality. While TIPHON has been active, the IETF (Internet Engineering Task Force) has worked on solutions for this (e.g. the DiffServ architecture [3]), which is now becoming available in equipment from major manufacturers. However, the components of DiffServ need to be put together into services that are provided end-to-end. Work on this issue is ongoing in many places. The outcome of this work may affect the TIPHON solutions.
4. Networks belonging to different operators need to be able to agree on how traffic traversing from one network to another should be treated. The EURESCOM Project EQoS [4] has looked at this issue. (Results from that project related to TIPHON are presented in another place in this issue of *Teletronikk*). While related to the issue described in the item above, inter-provider issues are wider than the inter-network issues. Work on these issues is also ongoing in several places (also in EURESCOM).
5. The network and service need to be manageable, i.e. a management system must be in place, so that network management systems can perform traffic control actions and (when this fails) customers can be informed when the requested quality level cannot be reached. This is an important area and the TIPHON group will do some work here.
6. How to measure the different aspects of QoS is also an area where complete understanding is lacking. The TIPHON group provides valuable contribution to this subject. But, as is indicated below, there is much more to be done. Maybe there is a possibility for TIPHON to take onboard more efforts in this direction. If so, this would be appreciated. If there are no such possibilities, the outcome of work in other groups will hopefully complement the work done by the TIPHON group.

Figure 1 TIPHON WG 5 document structure



TIPHON Working Group 5 Documents

Those who have followed TIPHON WG 5 for some time may remember the first version of the document TR 101 329. This was a good docu-

ment, but it contained many things. Because of this it was issued as a TR – Technical Report. However, an analysis revealed that some parts were actually specifications, while others were pure comments.

Table 1

TS/TR 101329	Title	First approved	Current version
Part 1	General Aspects of Quality of Service	TIPHON18 (May 2000)	V3.1.1
Part 2	Definition of Quality of Service Classes	TIPHON18 (May 2000)	V1.1.1
Part 3	The signalling and control of End-to-end Quality of Service in TIPHON Systems	TIPHON21 (Dec 2000 ¹⁾)	V0.9.5
Part 4	Quality of Service Management in TIPHON Systems	– ²⁾	–
Part 5	Quality of Service measurement methodologies	TIPHON20 (Sep 2000)	V0.2.6
Part 6	Actual measurements of network and terminal characteristics and performance parameters in TIPHON networks and their influence on voice quality	TIPHON18 (May 2000)	V1.1.1
Part 7	Design Guide for Elements of a TIPHON connection from an End-to-end speech transmission performance point of view	TIPHON20 (Sep 2000)	V0.2.1

¹⁾ Planned date.

²⁾ No approved document exists yet.

	4 (Best)	3 (High)	2 (Medium)	1 (Best Effort)
Speech Quality	Better than G.711	Equivalent or better than G.726 at 32 kb/s	Equivalent or better than GSM-FR	Not defined
Reasoning behind Quality Class	Better than today's SCN, i.e. probably conference quality with 7 kHz Codecs	Equivalent to today's SCN	Equivalent to analogue wireless	Equivalent to today's Internet. Usable but possibly degraded
End-to-end Delay	< 100 ms	< 100 ms	< 150 ms	< 400 ms

(2, 3, and 4 are guaranteed; 1 is not.)

The working group realised this and created a structure, which is shown in Figure 1. Document 101 329 now consists of seven parts. The first two parts relate to high level generic issues. The other five are more specific in their nature.

A reader should always start with parts 1 and 2, but may then select among the other parts, depending on interest.

Table 1 shows the status of the different documents and when they were first approved.

Overview of Document Contents

This section provides a short overview of the contents of the different documents.

Part 1: General Aspects of Quality of Service

Since QoS is a concept with different meanings to different people, the TIPHON group has gone back to some safe ground and provides in the first part some very basic definitions and descriptions of the scenarios that the project looks at. Even the experienced researcher/engineer should browse through this document.

Part 2: Definition of Quality of Service Classes

One of the highlights of the TIPHON project is that they have defined a set of concrete Quality Classes! Four classes are described in this document, together with some explanation on how they differ, and which parameters affect them mostly. The four Classes are presented briefly in Table 2 (see the document for details).

The concept of Terminal Modes and Network Classes also help to explain how the Quality Classes can be provided using different terminals and networks. The Network Classes are presented briefly in Table 3 (see the document for details).

The document contains a discussion on which of the three parameters (Delay, Jitter and Loss) plus Codec Type are associated with which compo-

nent (i.e. terminal or network). The conclusion of this is that Codec Type is associated with the terminal only, while Loss is associated with the network only. The remaining parameters (Delay and Jitter) are associated with both the terminal and the network. The "budget" for these parameters must thus be split between the two end terminals and the intermediate network.

Part 3: The Signalling and Control of End-to-end Quality of Service in TIPHON Systems

This is an important document! The ideas presented here are perhaps not revolutionary, but provide a path towards a system architecture, where the application layer can negotiate the Quality Class end-to-end and then negotiate this information to the network. The descriptions of Reference points, Interfaces, Primitives and QoS Parameter Groups provide a very coherent framework. It remains to be seen if it holds true when put to the test in a real system.

As a bonus information, a conversion table is provided, mapping the TIPHON functional elements to functional elements used in other fora. The reader is thus relieved of the effort of trying to find the difference between e.g. a TRM (Transport Resource Manager) and a Bandwidth Broker.

Part 4: Quality of Service Management in TIPHON Systems

This document remains to be written! When part 3 is approved (assumed to happen in November/December 2000), work will commence on this work item. The work started over a year ago, but major changes to the TIPHON architec-

Table 2

Table 3

Network Class	Packet Loss	Delay Variation (Jitter)
I	< 0.5 %	< 10 ms
II	< 1 %	< 20 ms
III	< 2 %	< 40 ms

ture has prevented work on Service Management to start from a stable foundation. Also the work going into the part 3 document has cleared up many of the open issues related to how inter-provider QoS will be handled. When discussing Service Management (which of course must be done by each provider along the chain of providers a call goes through) the responsibilities of each provider must be clear.

It seems likely that now that these issues are being removed, work on Service Management will provide useful results in a reasonably short time.

Part 5: Quality of Service Measurement Methodologies

Measurements are very much the basis for the management of a service and managing QoS is no exception. One can assume that SLAs (Service Level Agreements) will specify how measurements are being done, in order to avoid disputes when interpreting measurement data related to QoS.

As always, standards are useful in these cases. One would expect that a document like part 5 would contain a complete set of references to different standard definitions that leave no room for misunderstanding.

However, the document in its present version does not really live up to that goal! Regarding Voice Quality, it seems to fulfil the role (even if I am not an expert on Voice Quality matters). On measurement on the Transport Layer (i.e. measurements on Delay, Jitter/delay variation, and Loss) it should probably be regarded as a contribution to the ongoing discussion, rather than as a normative reference document (even if the sections are labelled “Normative”).

As a contribution to a general understanding of Measurements in IP networks it even contains some new aspects. One such aspect is the concept of Packet Loss Correlation, which is a measure of the “Burstiness” of packet loss. The document contains a comprehensive section with material on this subject.

In the cases where the proposed methodology differs from state-of-the-art in other fora (e.g. IETF – the Internet Engineering Task Force) it remains to be proven that the methodology proposed by the TIPHON group is of higher value. This can only be done through practical tests. Results from such tests will be met with great interest.

Part 6: Actual Measurements of Network and Terminal Characteristics and Performance Parameters in TIPHON Networks and their Influence on Voice Quality

As indicated already by the document title, the content is very focused on Voice Quality. A set of measurements has been performed (both subjective as well as objective), which report on the effects of Delay and Packet Loss on the perceived Voice Quality.

Since the nature of packet transportation in an IP network is somewhat different from packet transportation in a “traditional” PCM (Pulse Coded Modulation) system, these measurements are extremely valuable. If heuristics can be built up on how the three parameters (Delay, Jitter and Loss) affect Voice Quality, the perceived quality can be predicted in different situations. The provisioning of the four Quality Classes defined by TIPHON (see part 2 above) can perhaps be reduced to a matter of measuring/monitoring and managing the values of these three parameters in the transport network. The people behind these measurements also assisted in the development of the E-model (ITU-T Rec. G.107/G.109). A motivation for that model is to allow comparisons in a simpler manner.

However, the voice quality measurements are only one type of measurement that is interesting. As was indicated in the section above, results of measurements on the network level parameters will certainly be welcome.

Part 7: Design Guide for Elements of a TIPHON Connection from an End-to-end Speech Transmission Performance Point of View

The four Quality Classes of TIPHON are described in terms of Voice Quality equivalents, and are presented with some values for end-to-end Delay and Packet Loss. As was described in the section presenting part 2 above, the design of a terminal must take into account the target values for the main parameters, and how the budget for them can be split between the terminal and the network.

The part 7 document goes into some detail on e.g. how the delay is a function of codec type and how delay can be split into a set of realistic scenarios (a discussion on how each of the TIPHON Quality Classes can be reached is also given).

Being a designers guide, the documents contain a comprehensive bibliography.

Conclusion

When the TIPHON project started in the spring of 1997, the ambition was to profile (i.e. decide on how to use some of the options) the H.323 recommendation in order to enable interworking between H.323 terminals, H.323 Gatekeeper (where applicable) and terminals connected to the circuit switched network. This sounded like a not too difficult task and the estimated timetable was set at one year.

Now, three and a half years later, there are more open issues than ever. However, TIPHON has changed with the world around it, and has adopted a much more generic approach to how VoIP systems will be deployed on a broad scale.

The TIPHON architecture has changed several times (version 3 is now being finalised), but it is nice to see that the Quality Classes that were defined very early, still seem to be useful. The description of them has changed over the years, but the basic concept remains (i.e. having a discrete set of Quality Classes) and seems to gain increasing industry acceptance.

In Working Group 5 (QoS), the work has been concentrated around a limited set of work items. This approach, together with the division of the original document into seven parts, seems to have worked well.

Readers not acquainted with QoS work in TIPHON are recommended to read the different parts in the right order. Readers with knowledge on the Quality Classes and with an interest in a specific area can find useful material in the individual part documents. However, even experienced researchers/engineers should browse through the first part.

Since my primary interest is in architectures for QoS support in transport networks, I found the part 3 a very interesting document. From reading the other documents as well, I have the impression that the people behind the TIPHON QoS work should be commended for their good work!

References

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- 3 Blake, S et al. *An Architecture for Differentiated Services*. 1998. (IETF RFC 2475 (12/98).)
- 4 *EURESCOM Project EQoS – A Common Framework for QoS/Network Performance in a multi-Provider Environment*. 2000, November 3 [online] – URL: <http://www.eurescom.de/public/projects/p800-series/P806/P806.htm>
- 5 ETSI. *Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON); End to End Quality of Service in TIPHON Systems*. (ETSI TR/TS 101 329 – parts 1 through 7.)
[<http://www.etsi.org/tiphon/>]