

# ArQoS<sup>®</sup>: System to monitor QoS/QoE in VoIP

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*Abstract*— The evolution of telecommunications technology from circuit to packet switching, in which the Internet is the great paradigm, offers nowadays more flexibility in services and higher efficiency in the transport infrastructure that was not experienced before. As consequence, several new services have emerged. Among them, Voice over IP (VoIP) is, indubitably, one of the most popular, mainly because it allows anyone to make low cost voice calls, making it a very attractive service. This is perhaps one of the main factors responsible for the fast development of VoIP technology. However, IP networks were not designed for services with real time requirements and factors like delay, jitter, codec distortions and packet loss lead to degradations that directly influence de VoIP user experience. The quality experienced by these users is highly dependent on network conditions and also on the subjective experience perceived by them. Thus, new challenges have brought with this evolution of telecommunications networks. In order to meet the assigned Service Level Agreement (SLA's), service providers around the world need to monitor and guarantee the agreed Quality of Service (QoS) to its customers. Consequently, an emergent way to measure QoS arises in the field of the telecommunications sector: the Quality of Experience (QoE) assessment and monitor that takes into account that subjective experience. Thus, a new challenging need arises: the development of systems and methods for assessing quality of experience, such that, network operators and service providers can actually know how users evaluate the quality of the service provided to them.

In this paper, a system for assessing QoS/QoE is described: the ArQoS<sup>®</sup>. This is an integrated system provided by Portugal Telecom Inovação (PTIn) which implements QoE assessment methods to assess the networks performance and their telecommunications services. Beyond the existing methods already supported by the system, a novel QoE monitor for VoIP services was recently integrated as a result of fundamental research carried out at PTIn Labs. The ArQoS<sup>®</sup> is a probing system based on different types of probes, actually comprising two systems operating in two different modes: the active system (intrusive mode) and the passive system (non-intrusive mode).

The ArQoS<sup>®</sup> active system is based on intrusive probing and is intended to generate test calls on different types of networks (fixed/mobile/IP), simulating typical user's activity. It is possible to create interactive or scheduled tests with a custom task pool. The system gathers QoS network parameters (KPI and KQI), and evaluates the functional aspects of its associated network services, according to the related ETSI/ITU-T/IETF/3GPP standards and recommendations.

The ArQoS<sup>®</sup> passive system is designed to analyse VoIP traffic, including signaling (SIP, Megaco, Radius, Diameter) and media

stream (RTP) protocols. Passive probes analyse multi parallel RTP voice traffic without any interference in the communication. These probes can be setup close to any element of the VoIP network, such as VoIP clients, Media Gateways or in the core of the network. Collected data is gathered, analysed and processed automatically at the server management system, providing many QoS/QoE statistics. The user system manager can also use the system to trace a VoIP call in every probing point and in every protocol involved, allowing the end user to troubleshoot any possible problem.

The ArQoS<sup>®</sup> passive probes are deployed in the Portugal Telecom VoIP Network core. A general diagram of the application scenario is depicted in Fig.1. All VoIP traffic converges in a Softswitch that controls all VoIP network. The connection to PSTN and Mobile networks is performed by a Media Gateway. The Session Border Controller (SBC) interconnects networks of different service providers, implements security functions and manages QoS guarantees, among other functions. The ArQoS<sup>®</sup> probes analyse the entire flow that converges to the Softswitch, and monitor all signaling traffic. The RTP traffic is analysed in the Media Gateway checking the performance of transmission network. In SBC, the quality of interoperability between operators is analysed.

Fig. 2 presents a block diagram of ArQoS<sup>®</sup> VoIP QoE monitor, which was developed and integrated in the ArQoS<sup>®</sup> passive probes. The voice RTP packets are captured and processed by the probe, and then the Jitter Buffer Emulator accurately predicts which packets are lost or discarded. In the Gilbert Model module, the packet loss distribution is calculated. This distribution and other network metrics are inputs for ArQoS<sup>®</sup> Speech Assessment Model, which implements the novel QoE monitoring model based on the E-Model. This model is described in detail in the paper "Quality model for monitoring QoE in VoIP services" from the same authors at EUROCON'2011. Using this enhanced QoE model, the ArQoS<sup>®</sup> passive system provides now better estimates of voice quality, than the standard E-Model. Table 1 shows that the correlation factor of estimated quality is higher and the RMSE is lower than the standard E-Model. Thus, the novel QoE monitoring system allows the translation of pure QoS metrics such as packet loss rate and jitter to a perceptual QoE metric: the Mean Opinion Score (MOS). Overall the integration of this novel QoE monitoring model in the ArQoS<sup>®</sup> system has improved its technical characteristics and proved to be a successful case of technology transfer between academic institutions and the industry.

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*ArQoS<sup>®</sup>, E-MODEL, PESQ, Quality of Service, Quality of Experience, VoIP*

TABLE 1 – MODELS PERFORMANCE

	<i>Pearson Correlation</i>	<i>RMSE</i>
E-MODEL (ITU-T G.107)	0,868	0,451
ArQoS® Speech Assessment Model	0,960	0,197

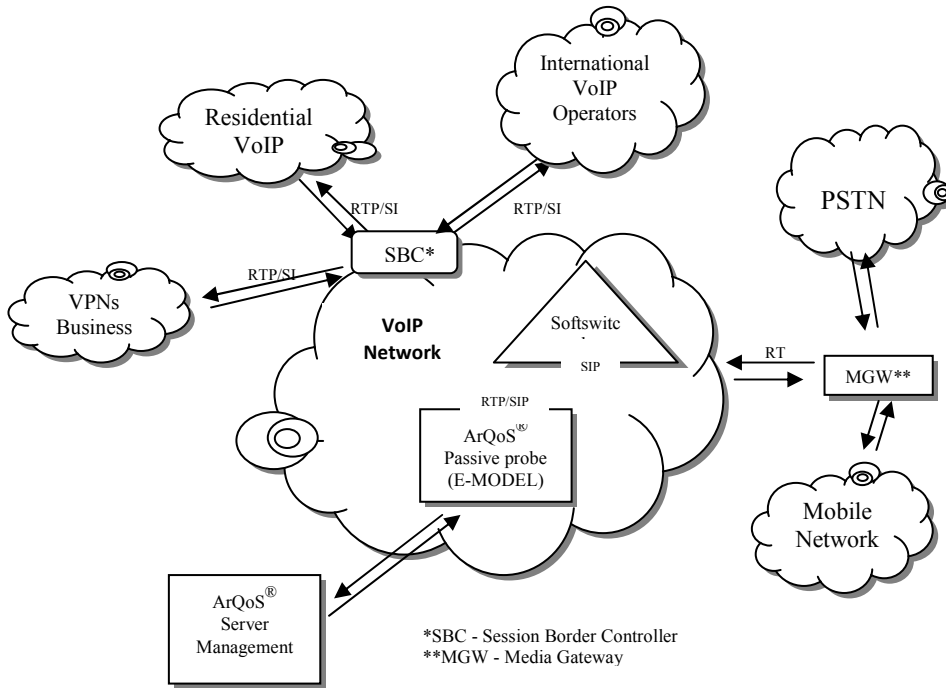


Figure 1. Portugal Telecom VoIP Network;

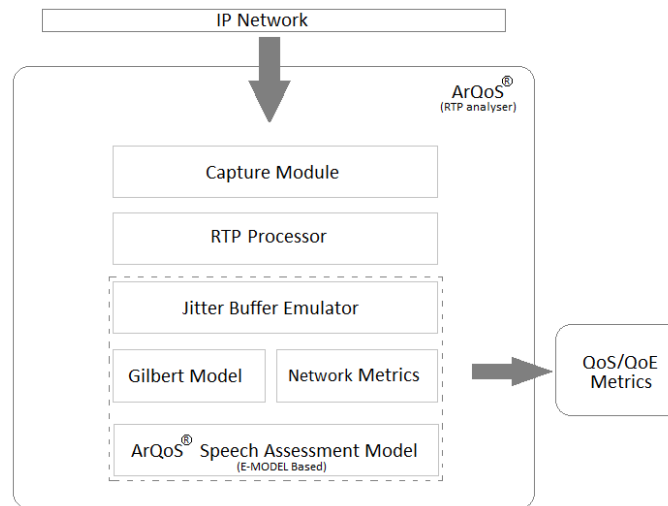


Figure 2. ArQoS® VoIP QoE Monitor;