

Instrumental speech quality measures – principles and trends within international standardisation activities

Harald Klaus, Jens Berger

T-Systems Nova, Berkom

Introduction

Quality of evolving networks is a two-folded issue: On one hand, quality is derived from the requirements of development and production of products or of operation of services. On the other hand, the quality of products and services is determined by the expectations of the users. Consequently, the product or service should comply to competing demands. Within today's communications networks that are based on a large number of different technologies (e.g. analogue telephony, ISDN, xDSL, ATM, IP, GPRS, WAP, UMTS), follow different and inconsistent network concepts to provide quality of service (e.g. IPv6, RSVP, IntServ, DiffServ, MPLS), inhomogeneous or sometimes competing quality management strategies, it is rather difficult for product manager and/or development engineers to reach the QoS objectives.

In order to support marketing, service and product development and management, T-Systems Nova offers a new, integrative, customer- and user-oriented approach called **“User-Centred Quality Engineering”**. It includes all important aspects of usability, acceptability and quality assessment in order to ensure high quality and best user satisfaction. Different teams with dedicated expertise take care of the customers' needs for plan, build and run their activities.

Activities described below were performed by experts of the section “Quality Assessment of Tele-Services”.

Principles of instrumental speech quality measures

Instrumental speech quality measures made substantial progress of reliability and accuracy during the last years. A number of ITU-T Recommendations have been completed for different techniques and applications of speech quality assessment:

- *Speech quality monitoring tools* according to ITU-T Rec. P.561 (In-service non-intrusive measurement devices-INMD) will be implemented at specific locations in the telephone network and randomly pick up the speech signals of life traffic. The INMD calculates parameters like signal-to-noise ratio, echo delay and level which represents a certain speech quality of analogue and ISDN connections. ITU-T Rec. P.562 (Call Clarity Index-CCI) uses the parameters of INMD to derive an estimate of the quality which is expressed by numbers between 5 (representing 'excellent' speech quality) and 1 ('bad') – comparable to Mean Opinion Scores (MOS) of auditory tests.
- *Psycho-acoustically motivated speech quality measures* have been compared in an extensive investigation within ITU-T Study Group 12. These methods compare a speech signal transmitted over a telephone connection, with its source in order to estimate the speech quality on psycho-acoustic principles. In 2001 the measurement algorithm called 'Perceptual Estimation of Speech Quality' (PESQ) was approved as the new ITU-T Rec. P.862. It

yields the best similarity compared to results of auditory tests for a wide range of network conditions of mobile, IP and fixed network telephone connections.

- Several approaches for *speech quality analysis* have been developed recently in order to assist service and support of network operators in problem identification of telephone networks. The speech signal pairs (as used in P.862 and other psycho-acoustically motivated speech quality measures) will be analysed in more detail. The derived characteristics will be evaluated by heuristic and/or statistical models based on a knowledge database. For example, the method 'Telecommunications Analysis of Speech Quality' (TASQ) which was developed by T-Systems, will determine the most probably reason of degraded speech quality.

Trends within international standardisation organisations

Speech quality measures currently are considered most intensively within three standardisation organisations. These activities can be summarised as follows:

- Within the **ETSI Project TIPHON** Working Group 5, quality specifications, quality measures and results of quality investigations for voice over IP (VoIP) are considered. Furthermore, guidelines for applications of planning and measurement tools for TIPHON networks are developed. In addition, ETSI TIPHON is managing VoIP speech quality measurement events where manufacturers will be able to

compare the speech quality of their equipment and will be consulted in order to improve their quality. The measurement will be carried out by speech quality experts of T-Systems Nova Berkom together with HEAD acoustics.

- The **ETSI Technical Committee STQ** is responsible for speech transmission quality, in particular for regulatory issues of interconnection and user requirements. It works as a pool of expertise where speech quality experts of supporting organisations of specific areas support other Technical Committees or Projects (e. g. TIPHON, 3GPP) with their knowledge.
- Within the **ITU-T, Study Group 12** is the lead Study Group for Quality of Service and is in particular responsible for speech transmission quality for terminals and networks. Instrumental speech quality methods are dealt with in Question 9 (perceptual models based on signal comparison) and Question 16 (non-intrusive models). Currently, a number of new measurement methods are under investigation, namely
 - Speech quality assessment models for end-to-end transmission quality including the terminals
 - Non-intrusive measurement methods for circuit and packet-based networks
 - 7 kHz wideband speech transmission
 - assessment of talker quality

New ITU-T Recommendations for speech quality assessment are expected to be completed before end of 2003.