# End-to-end speech and audio quality evaluation of networks using AQuA - competitive alternative for PESQ (P.862)

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# Overview

- Significance of speech and audio quality
- Problems with end-to-end evaluation
- Solutions and ITU standard approaches
- AQuA approach: challenges and benefits
- Applications
- Summary
- Contacts

# Speech and audio quality matters

- Customers want to hear and be heard
- Nothing else matters, but customers' perception of audio quality

# End-to-end speech and audio quality is the heart of QoS

- Voice quality is essential in

  - Installation

  - Fault detection and monitoring

  - SLAs

  - Networks optimization

- Quality will be always an important issue due to at least limited bandwidth and computational power. Mobile networks are a typical example.
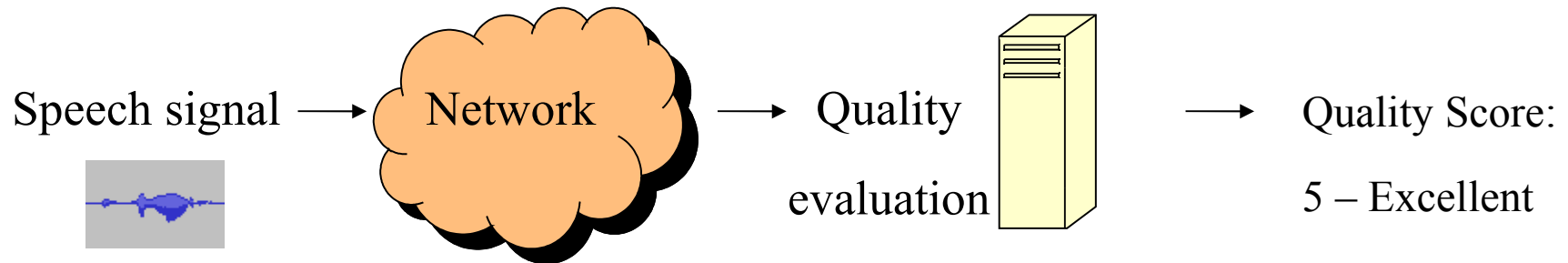
# Origins of voice and audio quality degradation

- Noise

- Silence

- Low bit-rate encoding

- Network errors (both in mobile and packet-switched)

- Delays, Echo, Jitter, etc

- Handsets/terminals

# Objective voice quality testing model

Speech signal → Network → Quality evaluation → Quality Score:

5 – Excellent
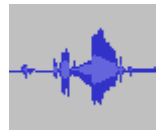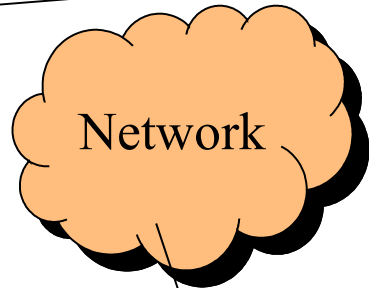
4 – Good

3 – Fair

2 – Poor

1 - Bad

Demand:

Accurate measurement of end-to-end voice quality applicable for a wide range of factors as codecs, carriers, networks, etc

# Objective voice quality testing model

Reference audio



AquA Model

Network

Degraded audio

Quality Score

%, MOS, PESQ

- Intrusive (reference audio)

- Based on human audio perception model

The model should rely on audio perception of a human ear. Consideration of codec influence and loss of packets as well as other metrics received from network signaling are not enough

# Problems with end-to-end evaluation

- Previously developed models used as standards (P.861 PSQM, P.861 MNB, PSQM+, P.862 PESQ, BS.1387 PEAQ etc) were whether mainly applicable for codecs testing or are not completely suitable in modern networks, in particular VoIP and LTE/4G

- Lacking accuracy in predicting quality of codecs

- Unable to consider noise or packet loss

- Unable to deal with variable delays

- Unable to consider effect of analogue elements

# Problems with end-to-end evaluation

- Lacking support for variable sampling rate and sampling higher than 48kHz (BS.1387 PEAQ)

- Models scope does not include effects of loudness loss (ITU-T P.862 Table 2)

- Models scope does not include frequency response variations of less than 20dB (ITU-T P.862 10.2.6)

- Models are not validated for acoustic terminal testing (ITU-T P.862 Table 3)

# Problems with end-to-end evaluation

- *P.862 PESQ should be used in addition to other methods when evaluating the performance of a telephone terminal

- *P.862 PESQ alone cannot ensure good telephone quality. In order to fully evaluate a telephone it is important to use methods like those asked for in the TIA/EIA-810-A standard.

- *Frequency Response, Loudness ratings and other traditional telephone measurements used in conjunction with PESQ can guarantee that VoIP telephones provide a quality of service that is equal to or better than conventional POTS telephones.

* Based on Microtronix research, http://www.microtronix.ca/pesq-disc.html

# Problems with end-to-end evaluation

- Typically the problems are discovered during:

    - Comparing objective scores with MOS results from ITU subjective tests P.800/P.830

    - Real measurements done on handsets

    - Advanced simulations

    - Codecs (also wideband, transcoding, error introduction)

    - Live VoIP networks

    - Other real systems

# Typical issues

- P.861 quality score is wrong when filtering is present (same for PSQM and MNB)

- P. 861 has a very low correlation for audio with variable delay common in VoIP

- None suits HD Voice or Wideband (higher than 48kHz in PEAQ)

- No standard available for LTE/4G voice and audio quality testing

- Delays, Echo, Jitter, etc

- Handsets/terminals

# Solution demanded

- AquA is specifically designed to address the needs of those who require more than existing models can offer

- The quality issues are still significant:

    – VoIP

    – LTE/4G

    – All existing networks: fixed, mobile, packet switched

# Replacement of P.861 by P.862

- P.861 was established as ITU recommendation in 1996 to test codecs, but not networks. MNB was added to P.861 in 1998 also for codec testing only.

- P.862 is a result of collaboration of BT (Psytechnics) and KPN.

- PESQ was found providing quite accurate prediction of voice quality scores, however, could not properly evaluate some cases of signal degradation*

* Based on Microtronix research, http://www.microtronix.ca/pesq-disc.html

# Challenge: replacement of P.862 by AQuA

- AQuA (Audio Quality Analyzer) introduced in 2009 as a competitive alternative for existing quality testing models.

- AQuA is available for all platforms (32bit and 64bit machines, Windows, Linux, MAC OS)

- AQuA has a competitive computational performance

- AQuA does not have annual royalty fee

- AQuA has the most attractive pricing on the market

- AQuA is already used in VoIP PBXs and other systems

# Challenge: replacement of P.862 by AQuA

There is only one big challenge:

## AQuA is **not** a recognized ITU standard...

… but is it really a problem?

# AQuA Codecs Conformance Test

| Codec | MOS, P.800 | AQuA MOS | ITU PESQ |
|---|---|---|---|
| a-law | 4.1 | 4.18 | 3.0 |
| μ-law | 4.1 | 4.18 | 3.0 |
| g.723.6.3 | 3.9 | 3.9 | 2.93 |
| g.723.5.3 | 3.62 | 3.65 | 2.91 |
| gsm.6.10 | 3.16 | 3.7 | 2.87 |
| g.729 | 3.9 | 3.85 | 4.08 |

To test codecs quality AQuA is using special test signal in order to achieve the best precision of the estimation.

# AQuA VoIP Conformance Test

| Reference | Degraded | Sampling | PESQ | AquA, % | AquA MOS | AquA PESQ |
|-----------|----------|----------|-------|---------|----------|-----------|
| or105.wav | dg105.wav | 8000 | 2.237 | 54.10 | 2.32 | 2.82 |
| or109.wav | dg109.wav | 8000 | 3.180 | 56.15 | 2.48 | 2.85 |
| or114.wav | dg114.wav | 8000 | 2.147 | 45.32 | 1.77 | 2.68 |
| or129.wav | dg129.wav | 8000 | 2.680 | 33.85 | **1.48** | 2.52 |
| or134.wav | dg134.wav | 8000 | 2.365 | 53.18 | 2.26 | 2.81 |
| or137.wav | dg137.wav | 8000 | 3.670 | 21.49 | **1.70** | **2.19** |
| or145.wav | dg145.wav | 8000 | 3.016 | 27.72 | **1.54** | 2.42 |
| or149.wav | dg149.wav | 8000 | 2.558 | 44.80 | 1.74 | 2.69 |
| or152.wav | dg152.wav | 8000 | 2.768 | 39.53 | **1.55** | 2.61 |
| or154.wav | dg154.wav | 8000 | 2.694 | 24.95 | **1.60** | 2.33 |
| or179.wav | dg179.wav | 8000 | 1.828 | 45.65 | 1.78 | **2.70** |

AQuA doest NOT tend to be like PESQ or other method,

AQuA's task is to give objective voice and audio quality perceptual estimation expressed as a predicted MOS score.

But another important task of AQuA is....

# AQuA VoIP Conformance Test

(with energy normalization)

| Reference | Degraded | Sampling | PESQ, ITU P.862 | AquA, % | AquA MOS | AquA PESQ |
|-----------|----------|----------|------------------|---------|----------|-----------|
| or105.wav | dg105.wav | 8000 | 2.237 | 49.4 | 2.00 | 2.76 |
| or109.wav | dg109.wav | 8000 | 3.180 | 56.24 | 2.49 | 2.85 |
| or114.wav | dg114.wav | 8000 | 2.147 | 37.55 | 1.51 | 2.58 |
| or129.wav | dg129.wav | 8000 | 2.680 | 58.57 | 2.68 | 2.87 |
| or134.wav | dg134.wav | 8000 | 2.365 | 48.53 | 1.94 | 2.75 |
| or137.wav | dg137.wav | 8000 | 3.670 | 51.21 | **2.12** | 2.78 |
| or145.wav | dg145.wav | 8000 | 3.016 | 60.54 | 2.83 | 2.88 |
| or149.wav | dg149.wav | 8000 | 2.558 | 51.82 | 2.16 | 2.79 |
| or152.wav | dg152.wav | 8000 | 2.768 | 73.55 | **4.00** | 2.93 |
| or154.wav | dg154.wav | 8000 | 2.694 | 45.37 | **1.77** | 2.70 |
| or179.wav | dg179.wav | 8000 | 1.828 | 50.94 | 2.10 | **2.78** |

… to let you tune your voice and audio quality testing software to the actual conditions of your network, no matter whether it's VoIP, PSTN, GSM, CDMA, UMTS, LTE/4G, TETRA or any combination of those..

AQuA also provides a special type of audio signal (speech model) to obtain most precise estimations of voice quality over networks

# AQuA Value Proposition

- Replacing 1 license of P.862.x by AQuA gives you:

  - Savings on license cost from 500 EUR to 1500 EUR

  - Savings on royalties of at least 20000 EUR per annum

- Replacing 100 licenses of P.862.x by AQuA gives you:

  - Savings on license cost up to 300 000 EUR

  - Savings on royalties of at least 150 000 EUR

  **Pay less if the only thing you need is to know that your customers were happy about voice quality in your network!**

# AQuA Value Proposition

- Utilizing AQuA besides a quality score you receive:

  - Ability to tune your voice quality software to particular needs of your network

  - Ability to receive extensive information on reasons for audio quality loss

  - Ability to develop your own applications seemlessly integrated with AQuA library

  - Ability to have software conform to your hardware and OS

  - Ability to have VQT QoS enabled in your VoIP PBX at the lowest cost possible

  - Ability to customize your AQuA projects at the lowest cost possible

  - … and much more

**Why not to give it a try already now as AQuA evaluation is freely available?**

# NIQA – Non-intrusive Quality Analyzer

- Available for evaluation

- Strong competitor for ITU P.563/P.564

- Ability to be trained to detect reasons for quality loss

- Ability to be trained for customer specific needs

- Multi-platform

- High performance

- Outstanding pricing

# AQuA Applications

- Continuous monitoring

- Equipment testing

- Network testing, characterization and optimization

- Fault detection

- All other PESQ relevant applications **plus**:

  - HD Voice and Wideband audio quality testing

  - Feedback on reasons for audio quality loss

  - Stable non-speech signals quality testing

  - Audio quality measurement in any network (LTE/4G as well)

# AQuA Benefits

- AQuA is available as a server solution without any limitations for amount of simultaneous tests

- AQuA license does not involve any royalty or other annual fee

- AQuA is available for all platforms and servers (32 bit and 64 bit, Windows, Linux, MAC)

- AQuA is easy to deploy and use for software products development (available as a DLL library for Windows)

- AQuA provides perceptual estimation of audio quality and can be utilized in VoIP, PSTN, ISDN, GSM, CDMA, LTE/4G networks and combinations of those

- AQuA is also available as a service

# AQuA Customers

- Testing conference bridges quality when accessing from different locations

- Monitoring quality live at a conference bridge to detect who from the conference participants f.e. introduces more noise

- Monitoring quality to certain destinations depended on load

- Monitoring quality at different terminations by end-to-end testing with termination's echo server

- Testing quality in converged networks (f.e. Mobile-VoIP)

.... and more

# Contact us

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