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.
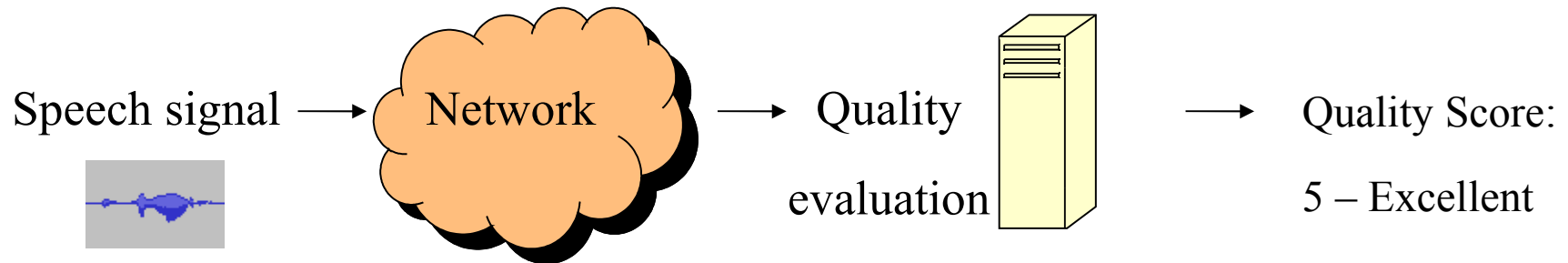
Origins of voice and audio quality degradation

- 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

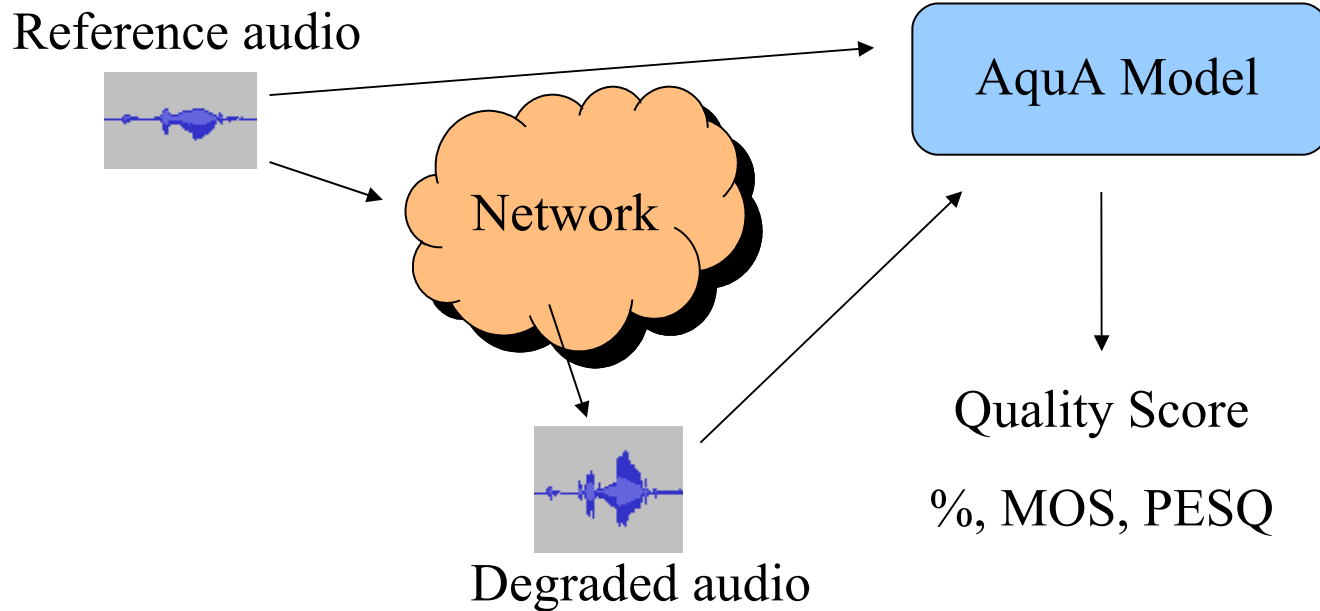2 – Poor

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

Network

AquA Model

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*

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

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