The Perceptual Quality Experts.

POLQA®

The Next-Generation Mobile Voice Quality Testing Standard

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OPTICOM

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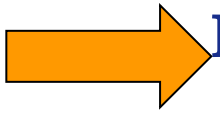
ZNIIS / ITU Workshop

Roadmap

- POLQA Development
- POLQA Performance
- Will POLQA Substitute PESQ?
- Model overview
- Who needs POLQA ?
- ... More Details

Roadmap

-  POLQA Development
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About OPTICOM

- **Founded 1995 – Profitable since then!**
  - No external funding or debt
- **Based in Erlangen, Germany**
- **Originators' of Perceptual Audio Quality Measurement:**
  - Noise-to-Mask Ratio (NMR) 1988
  - Spin-Off from Fraunhofer-Institute (Home of mp3)
- **Six Major International Standards:**
  PSQM (1996), PEAQ (1999), PESQ (2000), 3SQM (2004), PEVQ (2008), and now POLQA (2010)
- **The Leading Global Technology Vendor for Voice, Audio and Video Quality**
- **100+ Licensed OEM Vendors**
- **More than 20.000 PESQ Products Licensed today!**

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What is POLQA?

- **POLQA is** the next-generation mobile voice quality testing standard P.863 – **the successor of PESQ**
- **POLQA** stands for "Perceptual Objective Listening Quality Assessment"
- Standardised as Draft **ITU-T P.863**, following the history of P.861 'PSQM' and P.862 'PESQ'
- Specially developed for HD Voice, 3G and 4G/LTE, VoIP
- Offers a new level of benchmarking accuracy
- A joint development of the POLQA consortium in the ITU-T

POLQA - Applications

- Handset and accessory Acoustic performance
  - Coding and Audio path quality
  - Voice Enhancement processing
  - Speech with noise performance
  - Speech level and filtering effects
  - Standards Conformance

- Network Testing
  - Network Testing and Optimisation
  - Drive testing and Benchmarking
  - IP
  - HD Voice
  - etc....

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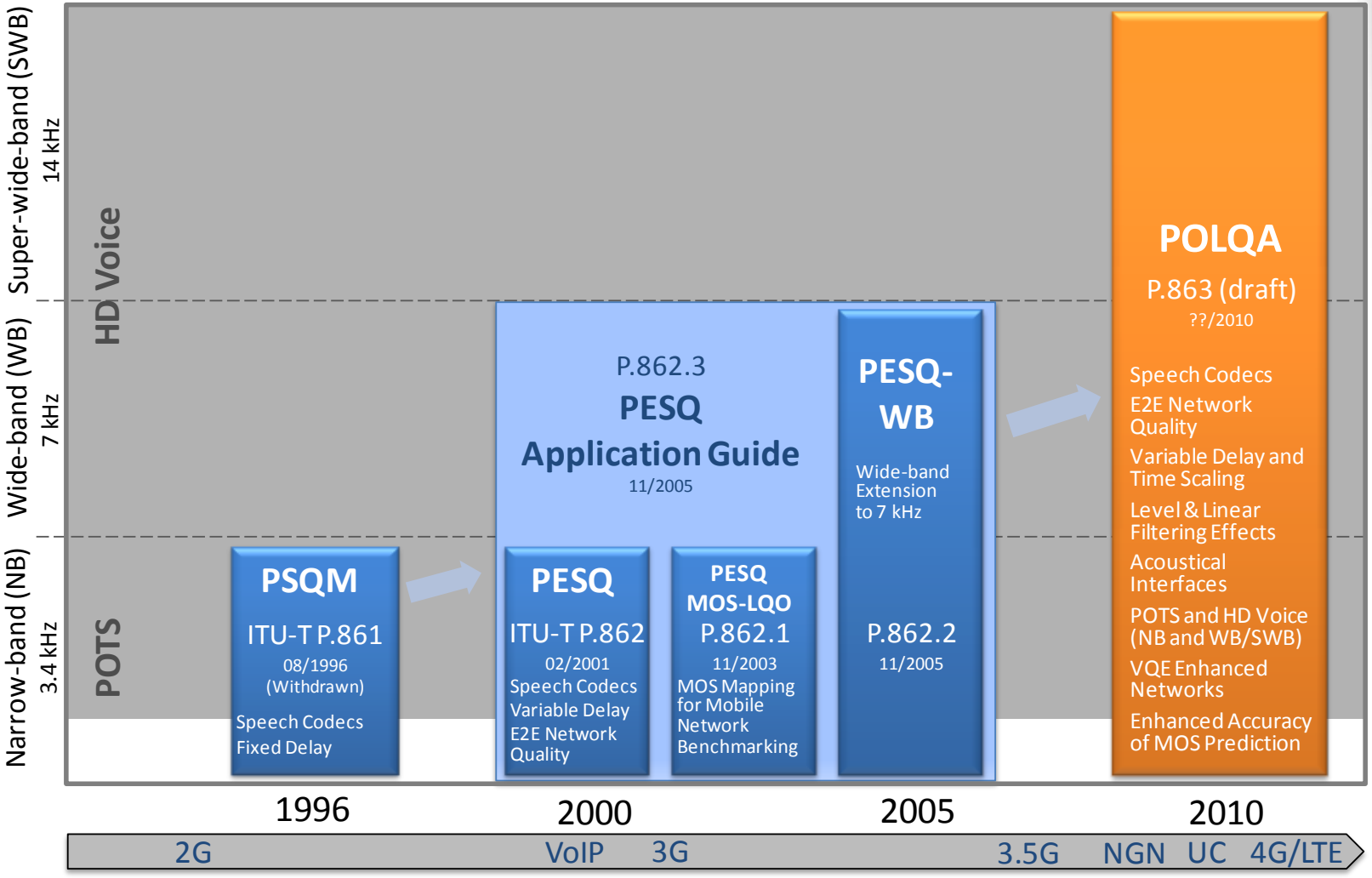
Evolution of ITU-T Recommendations for Voice Quality Testing (P.86x - Full Reference MOS-LQO)



Evolution of Network Technologies available at the time of development, i.e. included use cases for each Recommendation

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ITU-T P.OLQA project

2006 P.OLQA work initiated by ITU-T

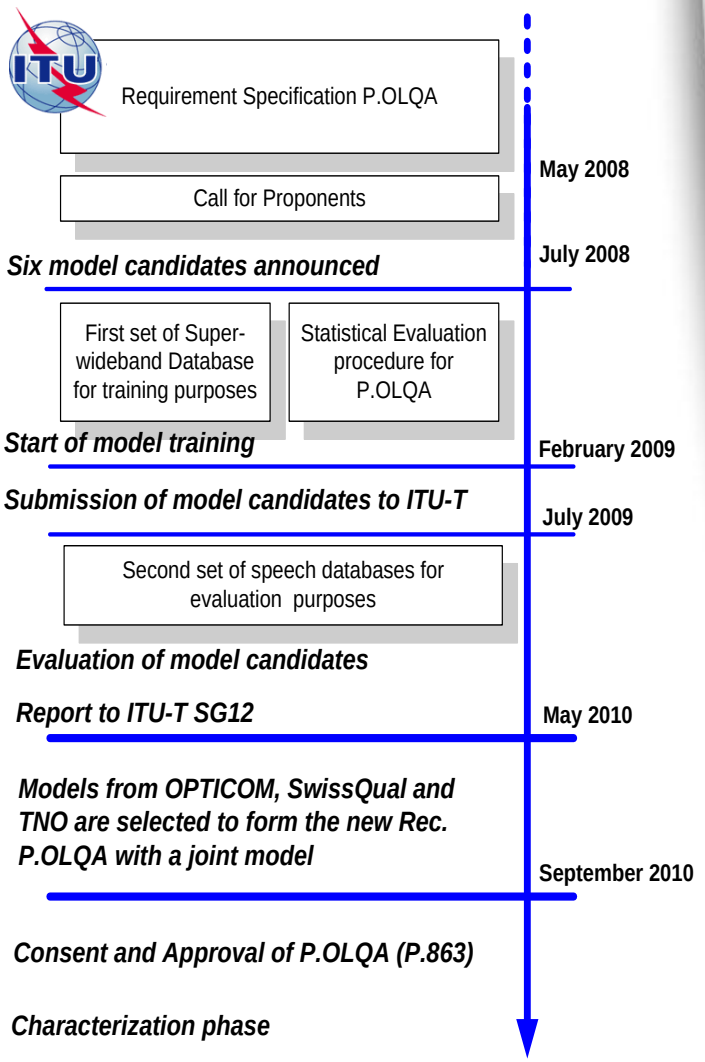
2008 Six proponents were evaluated to each other and benchmarked to P.862 ,PESQ

2010 OPTICOM, SwissQual, TNO met the requirements and agreed to form a coalition and jointly develop POLQA

2010 September: POLQA model consented by ITU-T

2011 January: POLQA approved as ITU-T Rec. P.863

2011 February: POLQA product launch @



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Why Migrate to POLQA?

- When P.862 PESQ was designed, conditions seen in current and emerging telecommunication networks were not recognised.

- POLQA includes enhancement of performance for latest technologies within networks and handsets
  - Suitable for new types of speech codecs as used in 3G/4G/LTE and also audio codecs , e.g. AAC, MP3
  - Suitable for Voice Enhancement (VQE/VED) systems using non-linear processing to increase intelligibility
  - Suitable for codecs that change or extend the audio bandwidth (e.g. using SBR)
  - Allows for measurements with very high background noise
  - Correct modelling of effects caused by variable sound presentation levels
  - Offers narrowband and super-wideband (50Hz to 14000Hz) mode
  - Can handle time-scaling and time-warping as seen in VoIP and 3G
  - Can be used for signals recorded at acoustic interfaces
  - Uses correct weighting of reverberation, linear and non-linear filtering
  - Allows for direct comparison between AMR (GSM/UMTS) and EVRC (CDMA) coded transmissions

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PESQ versus POLQA Overview

	PESQ	POLQA
Acoustic measurements	☹ Not easy	☺
Correct scoring with high background noise	☹	☺
AMR vs EVRC codec comparison	☹	☺
Representative scoring of reference signals	☹	☺
Effects of speech level in samples	☹	☺
Narrowband (300Hz -3400Hz)	☺	☺
Wideband (100Hz-7000Hz)	☺	Use SWB
Superwideband, SWB (50Hz – 14000Hz)	☹	☺
Linear Frequency distortion sensitivity	☹	☺

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Performance Validation

- The ITU has validated POLQA on:
  - 47000 file pairs across
  - 64 subjective experiments
- Languages included in the POLQA validation:
  - American English and British English
  - Chinese (Mandarin),
  - Czech,
  - Dutch,
  - French,
  - German
  - Swiss German
  - Italian,
  - Japanese,
  - Swedish

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Performance : Compared to PESQ

- POLQA significantly outperforms PESQ relative to subjective test results

	rmse*		
narrow-band	**PESQ P.862.1**	**POLQA**	**Improvm.**
Averaged rmse*	0.1857	0.1363	**27%**
wideband	**PESQ P.862.2**	**POLQA**	**Improvm.**
Averaged rmse*	0.3450	0.1506	**56%**

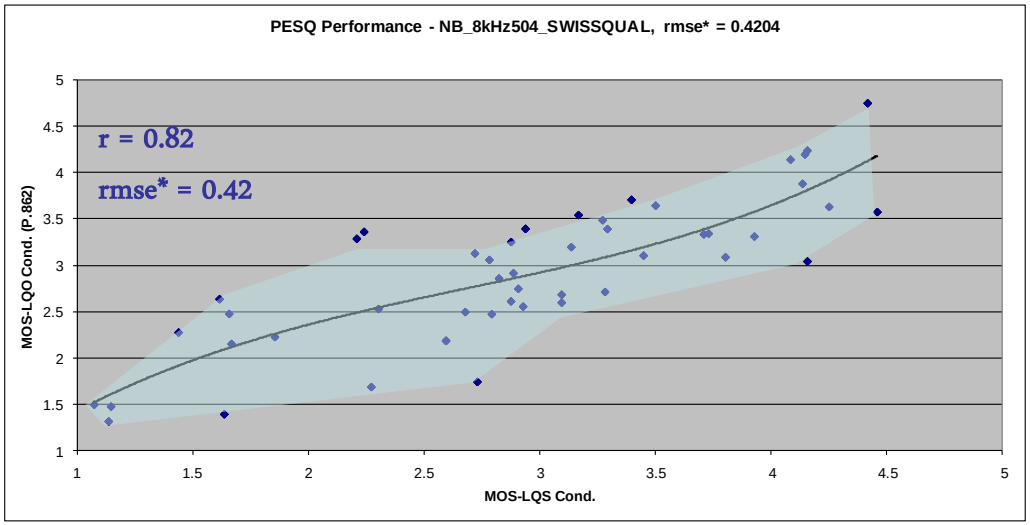
The root mean square error (RMSE) is a measure of the differences between values predicted by a model and the subjective values obtained. It is a better measure of precision than the correlation factor. The rmse* is similar to the rmse, but also takes the accuracy of the subjective experiment into account (ci_{95}).

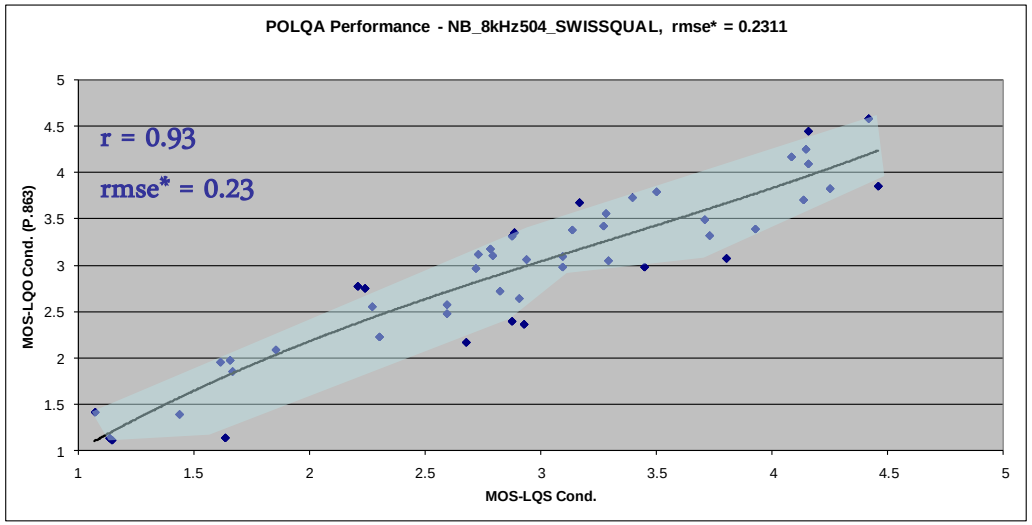
$$rmse* = \sqrt{\left(\frac{1}{N-d}\sum_{N} Perror(i)^2\right)}$$

Where....

$$Perror(i) = \max(0, |MOSLQS(i) - MOSLQO(i)| - ci_{95}(i))$$

Performance: Narrowband





PESQ

27% improvement*

POLQA

Narrowband average rmse improvement observed for all ITU tests

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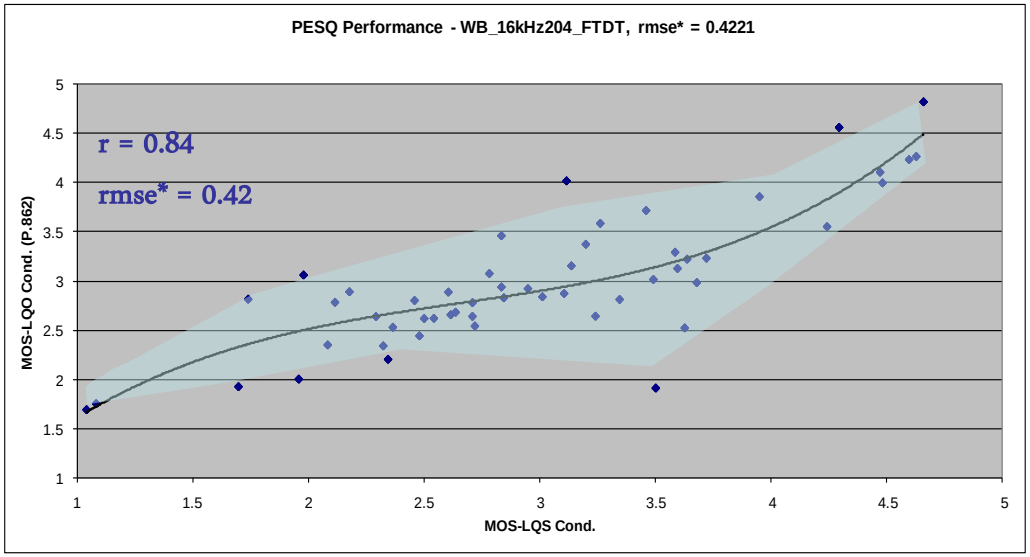
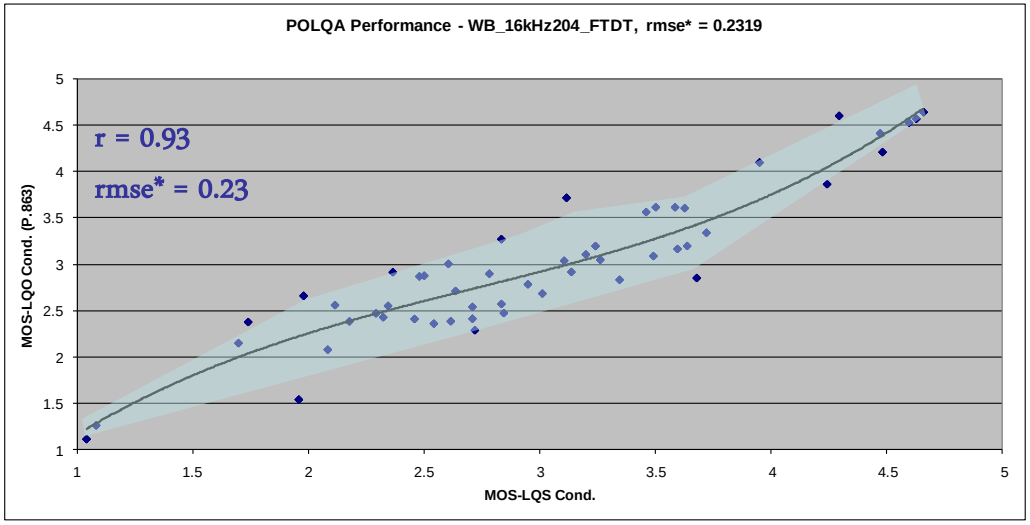
Performance: Wideband (1)





PESQ

56% average Improvement*

POLQA

*Wideband Average Improvement observed for all ITU tests

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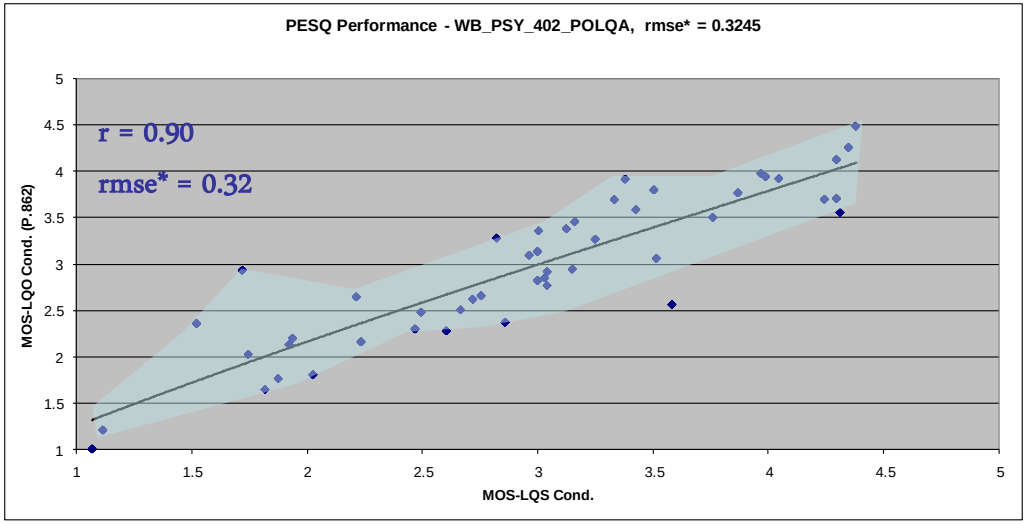
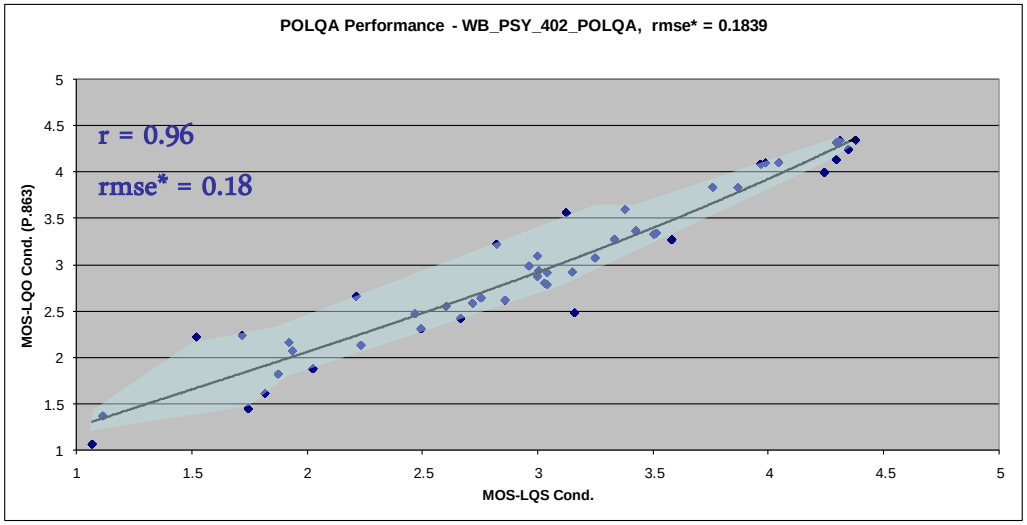
Performance: Wideband (2)





PESQ

56% average Improvement*

POLQA

Wideband average rmse improvement observed for all ITU tests

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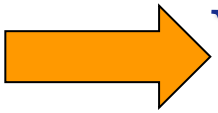
-  Will POLQA Substitute PESQ?
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Will POLQA Substitute PESQ?

- 'Backward Compatible' MOS-Scale in narrow-band mode for major speech codecs (AMR, GSM) ➔ Easy migration from PESQ to POLQA:

  1 ... 4.5 for PESQ-NB

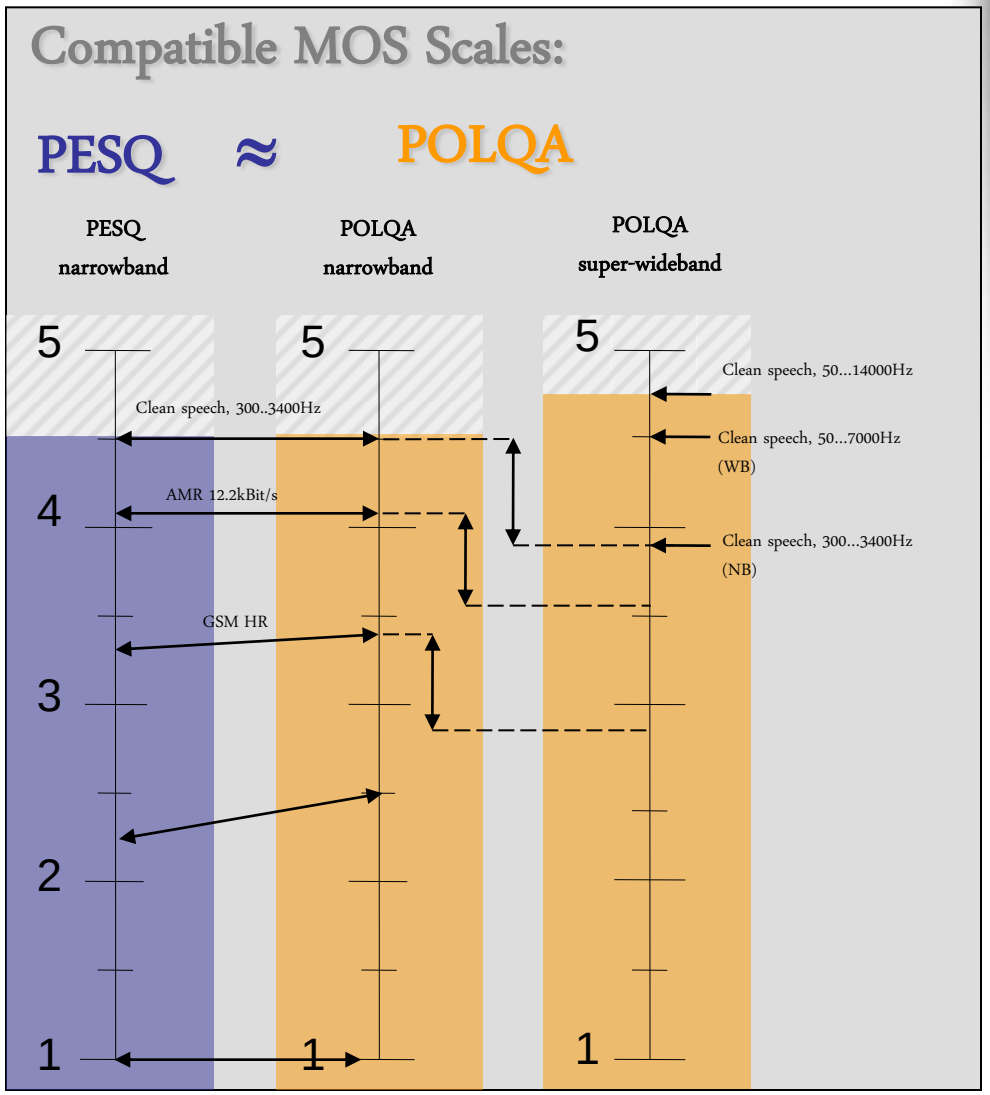
  1 ... 4.5 for POLQA-NB

- Extended MOS-Scale for Super-wideband takes HD-Voice into account:

  1 ... 4.75 for POLQA-SWB

Two MOS Scales for All:

- Fs = 8kHz ➔ MOS NB
- Fs = 48kHz ➔ MOS SWB



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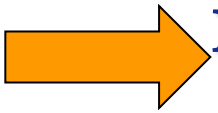
-  Model overview
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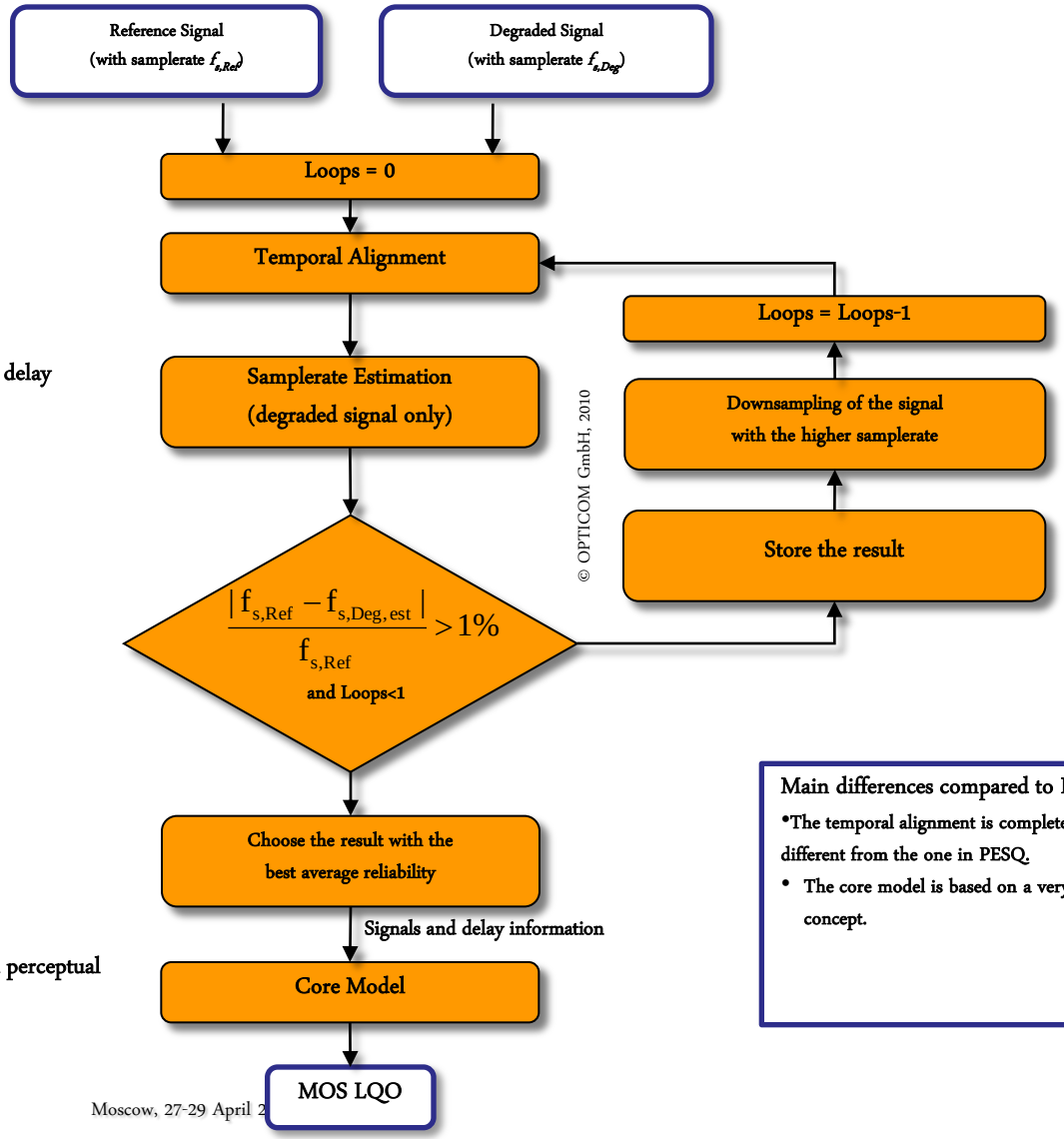
Basic Block Diagram

Each frame can have a different delay

Sample rate is estimated from histogram of delay variations

Correlation per frame serves as reliability masure

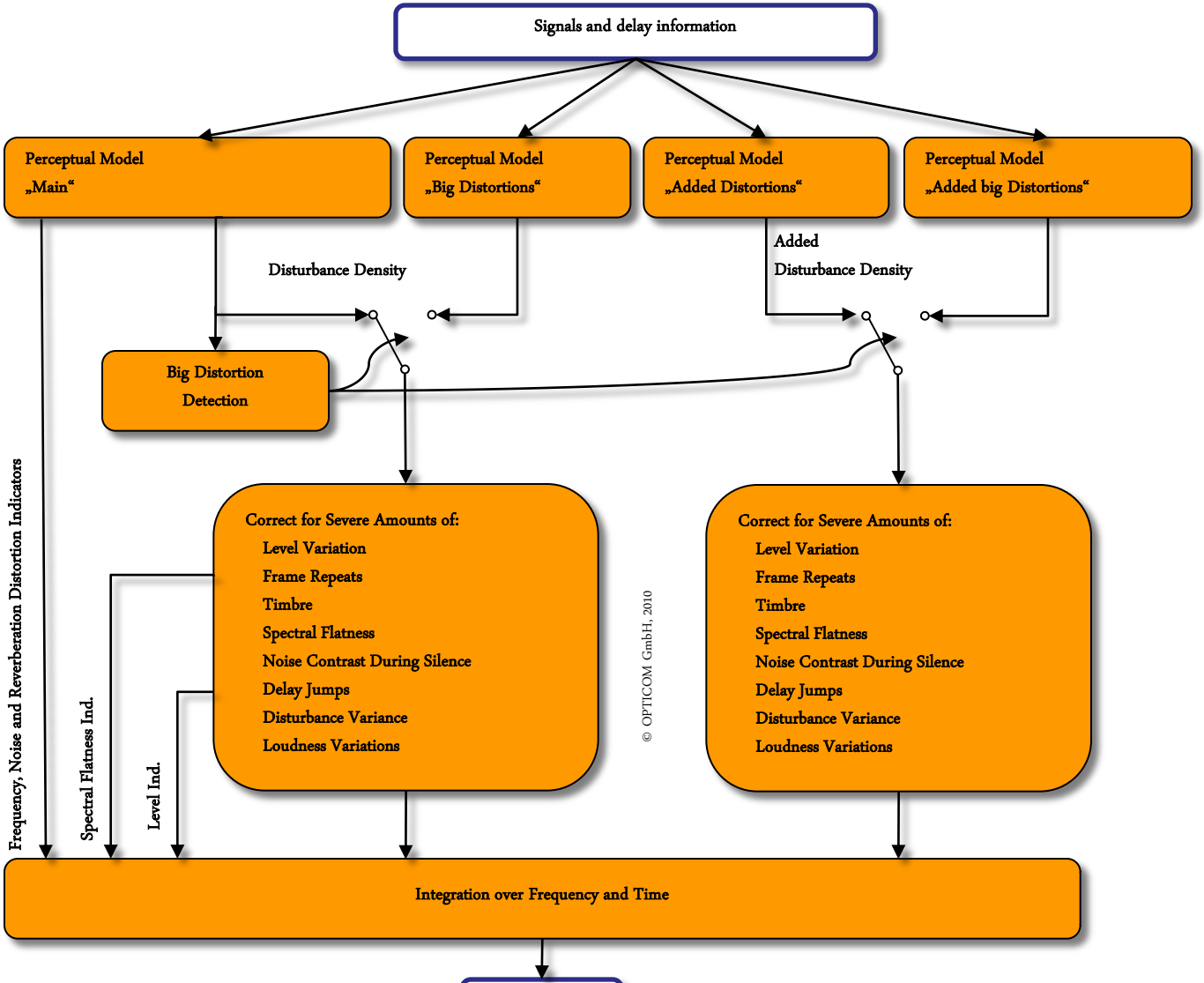
The core model includes a newly developed perceptual model



Main differences compared to PESQ:

- The temporal alignment is completely new and totally different from the one in PESQ.
- The core model is based on a very different perceptual concept.

Core Model Block Diagram



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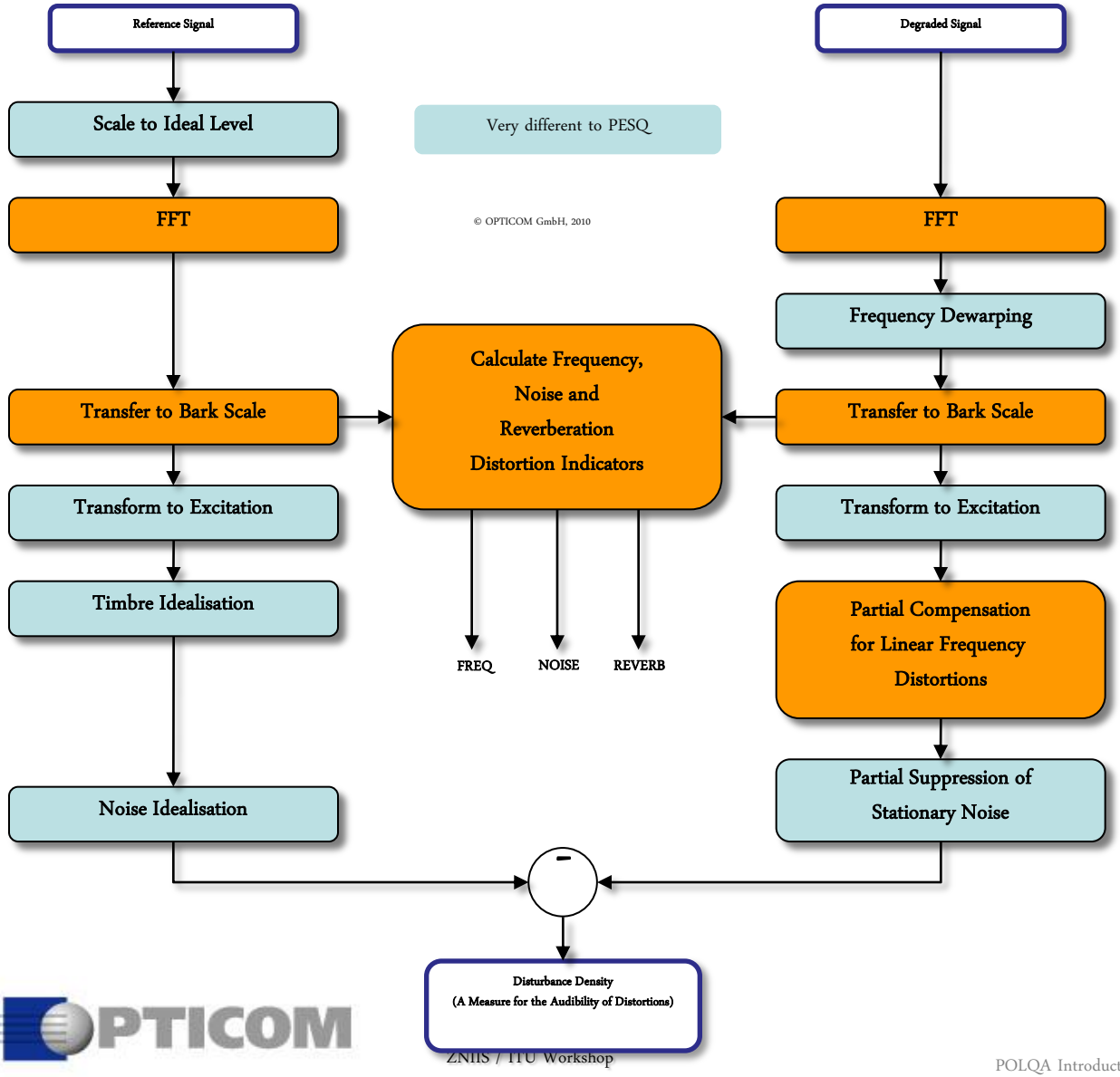
Perceptual Model Block Diagram



Note: The perceptual model is calculated four times with different parameters, resulting in the Disturbance Densities:
„Main“,
„Big Distortions“,
„Added Distortions“ and „Added big Distortions“.

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What we Perceive ...

In a subjective ACR experiment POLQA, PESQ and human beings perceive the following distortions (this list is far not complete):

Factor	Human	POLQA	PESQ
Level too high or too low	x	x	0
Strong linear filtering	x	x	0
Noise in the reference signal	x	x	0
High timbre in the reference signal	x	x	0
Level variation	x	x	poor
SWB noise on NB/WB signal	x	x	0

→ Consequently, the hardware used for recording must support this as well!

POLQA Requirements

... or: What is the main difference to PESQ as far as the product design is concerned?

	SWB	NB
Sample Rate	48kHz	8, 16, 48kHz
Ref. Bandwidth	50..14000Hz	300..3400Hz
Ref. Level	-26dBov (73/79dBSPL)	-26dBov (79dBSPL)
Deg. Level	-21..-46dBov	-26dBov

Like PESQ, but now compulsory!

POLQA requires exact control over record and playback levels!

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Who needs POLQA?

- 3G and 4G/LTE operators requiring accurate benchmarking and optimisation should migrate to POLQA now
- NGN operators optimising HD-Voice services should also consider POLQA immediately
- Test and Measurement as well as DTT system vendors should prepare for POLQA migration

  PESQ based measurements will continue to be recognised for several years for results comparison and compatibility

➔ PESQ and POLQA may coincide on the same system for backward compatibility of results

➔ OPTICOM will offer PESQ+POLQA packages and upgrades for existing PESQ products.

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How to buy POLQA?

Advanced OEM Libraries for: T&M Manufacturers, DTT Vendors, System Integrators and Mobile Operators

- **POLQA OEM Libraries**
  for Windows, Linux
- **POLQA Mobile OEM**
  for Symbian, Android, ...
- **Voice*plus* Package**
  incl. POLQA+PESQ+ECHO
- **POLQA Conformance Testing**

NEW: 24/7 Web-based Licensing

For End-Users:
PEXQ All-in-One Software Suite for Windows incl. Voice and Video Analysis

- **Scalable Framework for** Voice, Video, or Voice+Video
- **Voice*plus* Package**
  incl. POLQA+PESQ+ECHO

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GLOBAL SALES NETWORK

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Europe, Middle East:	USA, Canada:	Asia-Pac:	
OPTICOM Headquarters, Erlangen, GERMANY	telchemy	TRANSCOM	China
		iTel	Taiwan
		yalesystems.co.kr	Korea

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POLQA Summary

- POLQA is an evolution of PESQ for current and new network technologies
- Compared to PESQ, POLQA has higher correlation with subjective listening quality tests
- It will be required by 3G, 4G/LTE NGN operators optimising HD-Voice services
- Test, measurement and DTT system vendors should prepare now for POLQA migration.
- OPTICOM offers licensed solutions with both PESQ and POLQA
- OPTICOM does not compete in the OEM T&M marketplace
  - Vendors/OEMs are assured of commercial confidentiality

OPTICOM OEM Co-operation

10 Years of profitable Business Experience

15 Years of Scientific Expertise

6 International Standards (= 100% Conformance)

Essential Patents and License Agreements

Excellent Reference Customer Base

The Perceptual Quality Experts:

OPTICOM is the leading Vendor for Perceptual Voice, Audio and Video Quality Testing.

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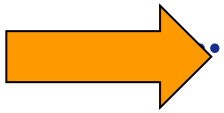
-  .. More Details

Terminology

P.OLQA: Perceptual Objective Listening Quality Assessment

Originally a working title of a new objective "instrumental" approach for prediction of Listening Quality, ITU-T SG12 / Question 9

ITU-T Study Group 12:

Lead study group on quality of service and quality of experience

SG12 Question 9:

Subcommittee of ITU-T Study Group 12, dealing with perception-based objective methods for voice, audio and visual quality measurements in telecommunication services

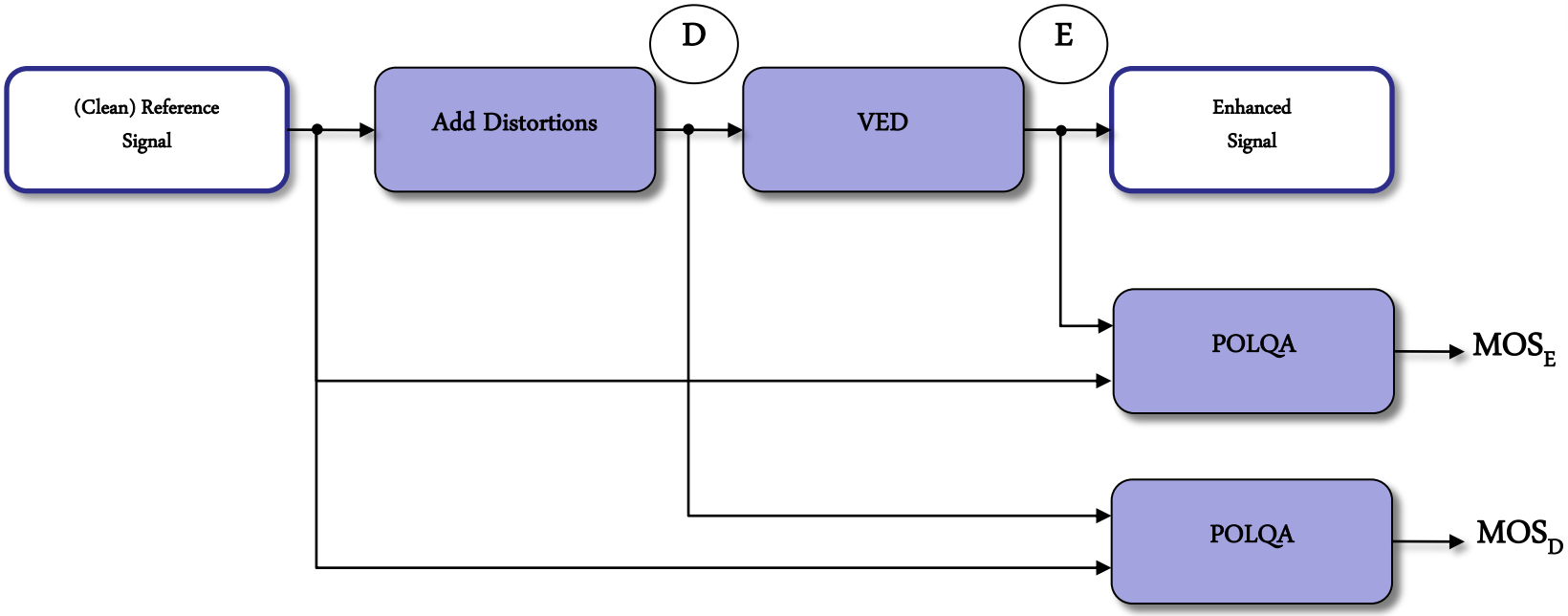
Subjective testing:

Perceptual experiments where the human listeners and viewers in those experiments are named "subjects".

Objective measurement:

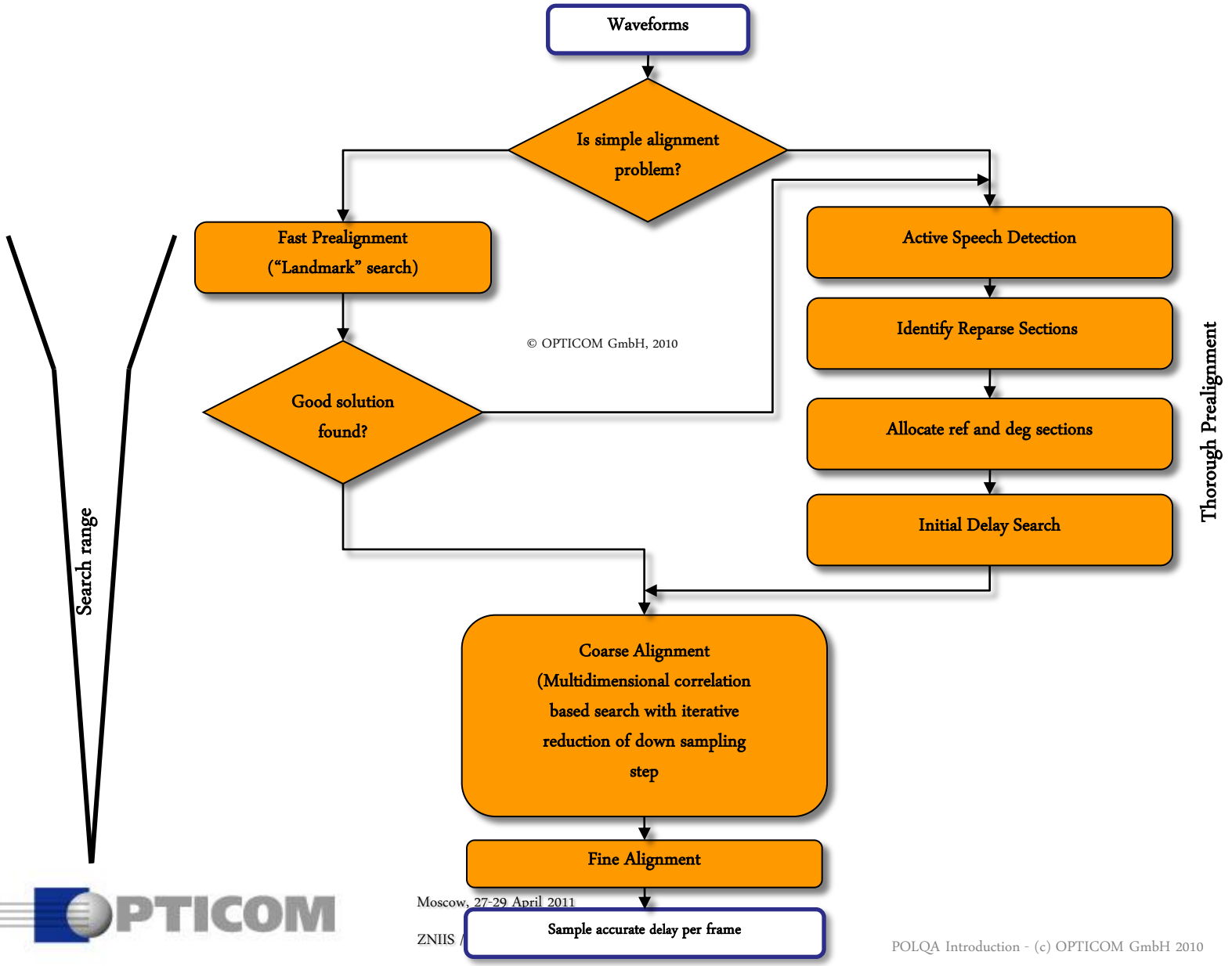
Instrumental prediction of quality. Measures made model a certain type of perceptual (subjective) experiment.

VED Assessment



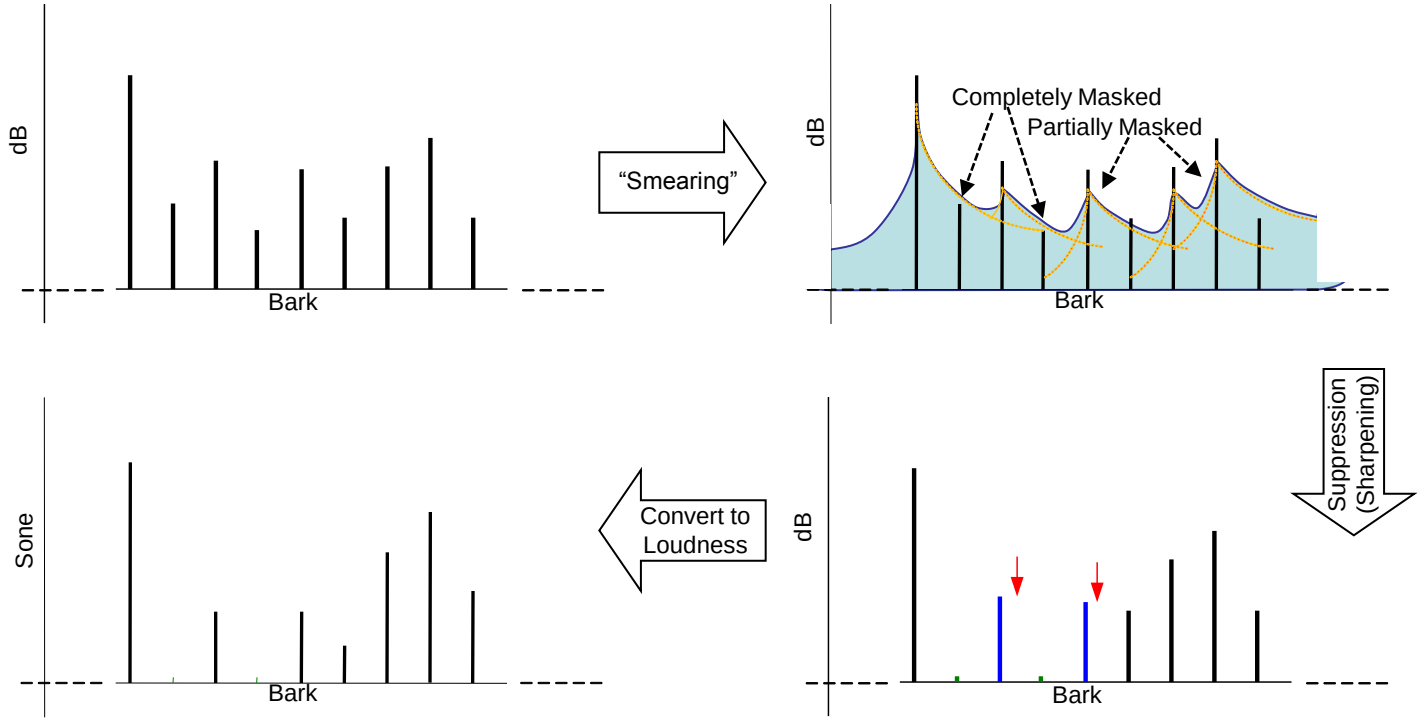
The difference between MOS_E and MOS_D is a measure for the improvement caused by the Voice Enhancement Device (VED).

Basic Temporal Alignment

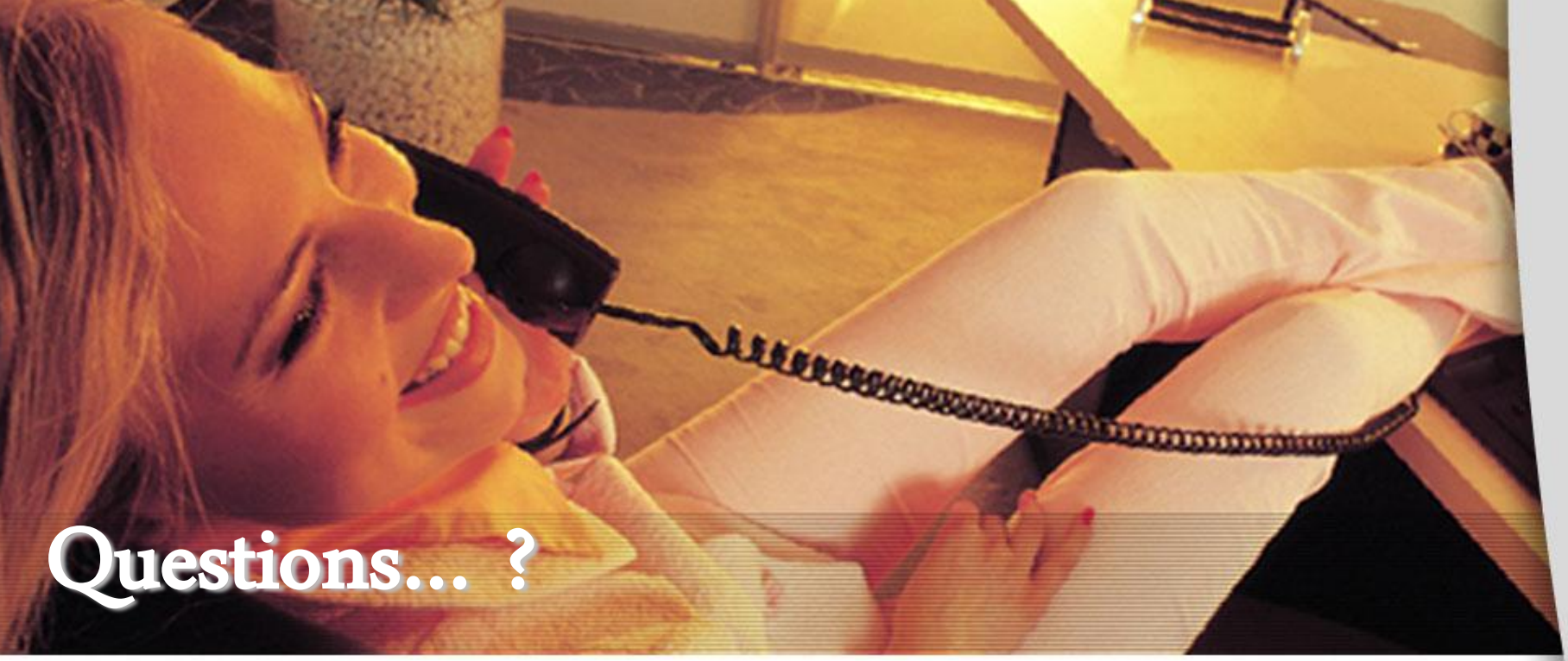


POLQA Sharpened Loudness

- In POLQA the smeared spectrum is only used as a factor in the sharpening of the spectrum



- Advantage 1: High resolution in the pitch domain remains, analysis of the spectral fine structures is possible
- Advantage 2: Masked threshold is not a ‚hard clipper'. A small range above the threshold may remain.



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