Perceptual wideband speech and audio quality measurement

Dr Antony Rix

Psytechnics Limited

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Agenda

Background

Perceptual models

- BS.1387 PEAQ
- P.862 PESQ
- Scope
- Extension to wideband

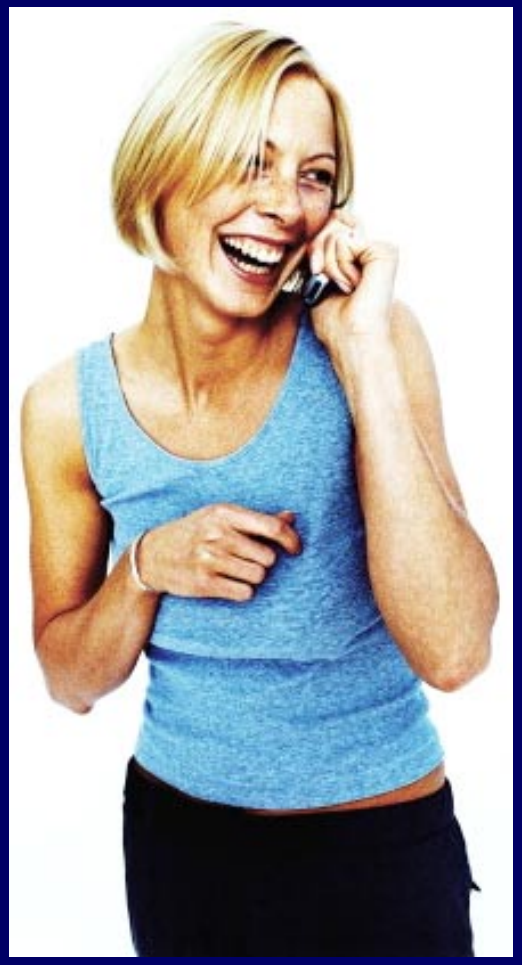
Performance of wideband PESQ

- Results for speech
- Results for audio
- Next steps – discussion

AMR-WB case study

Psytechnics background

- Solutions for measuring/monitoring speech, audio, video quality
- Extensive subjective testing background
- Main products are objective quality models (software)
  - Intrusive (P.862 PESQ, …) – for testing
  - Non-intrusive (P.VTQ/psyVoIP, P.563 SEAM/NiQA, P.562 CCI) – for monitoring
- Experience in wideband in both subjective testing and objective models (PAMS, PESQ).



BS.1387 PEAQ

- High-quality audio model for small impairments
- Comparable with BS.1116 subjective tests

- General audio model, not designed or optimised for "wideband speech"
- Mobile/IP multimedia is at edge of or outside scope
- Some issues with accuracy (see BS.1387 for results).

➢ Not currently applicable to 16kHz wideband speech

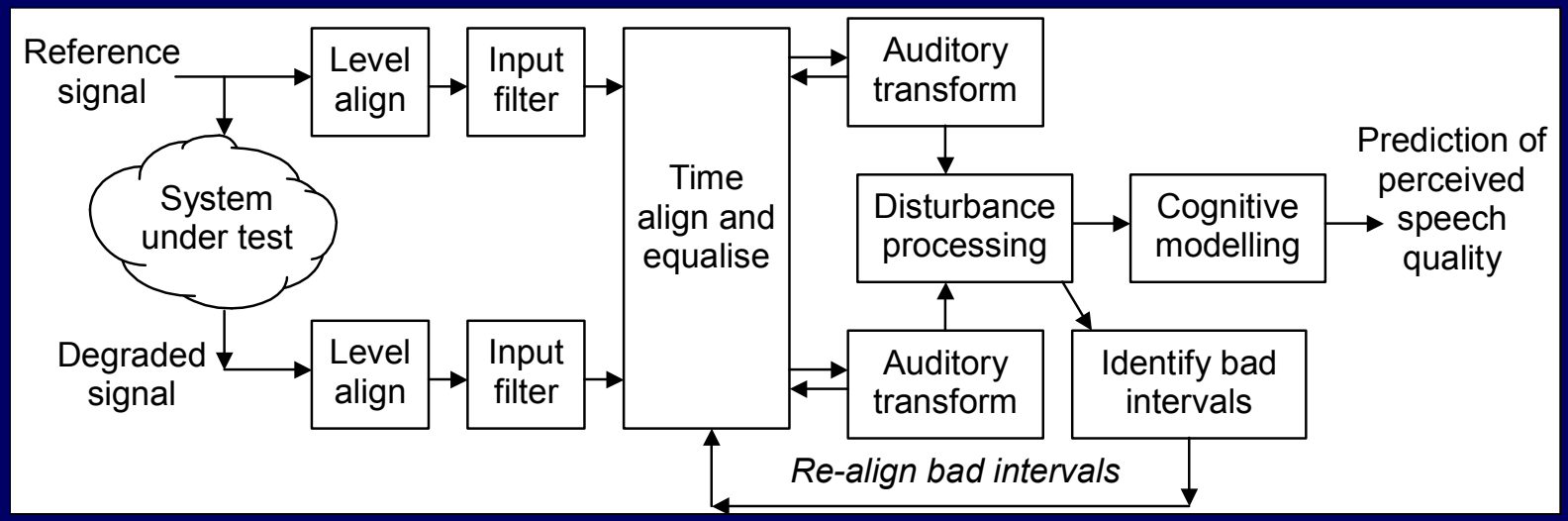
P.862 PESQ

- Speech quality model for telephony applications
- Comparable with P.800 subjective tests

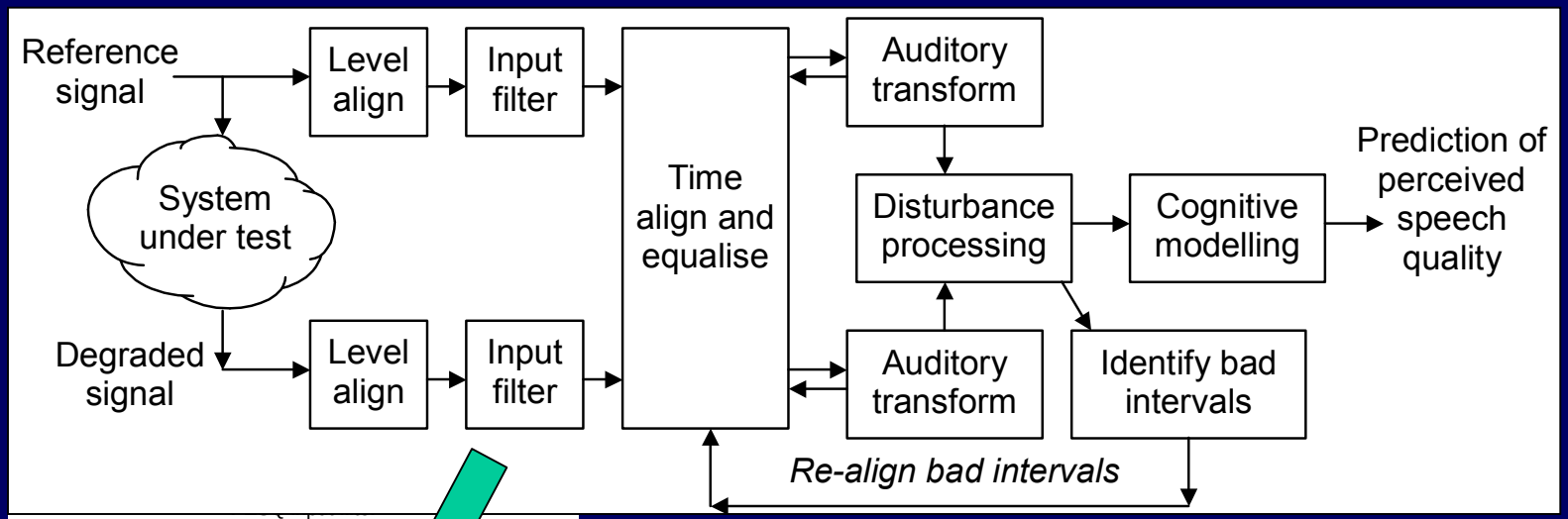
- Assumes listening through narrowband IRS handset
- Was not extensively tested on perceptual waveform codecs (e.g. MP3, AAC) or with non-speech signals

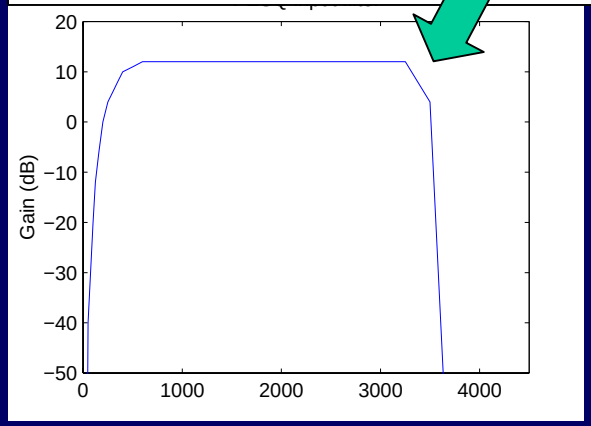
➢ Not currently applicable to 16kHz wideband speech or audio

P.862 PESQ – scope



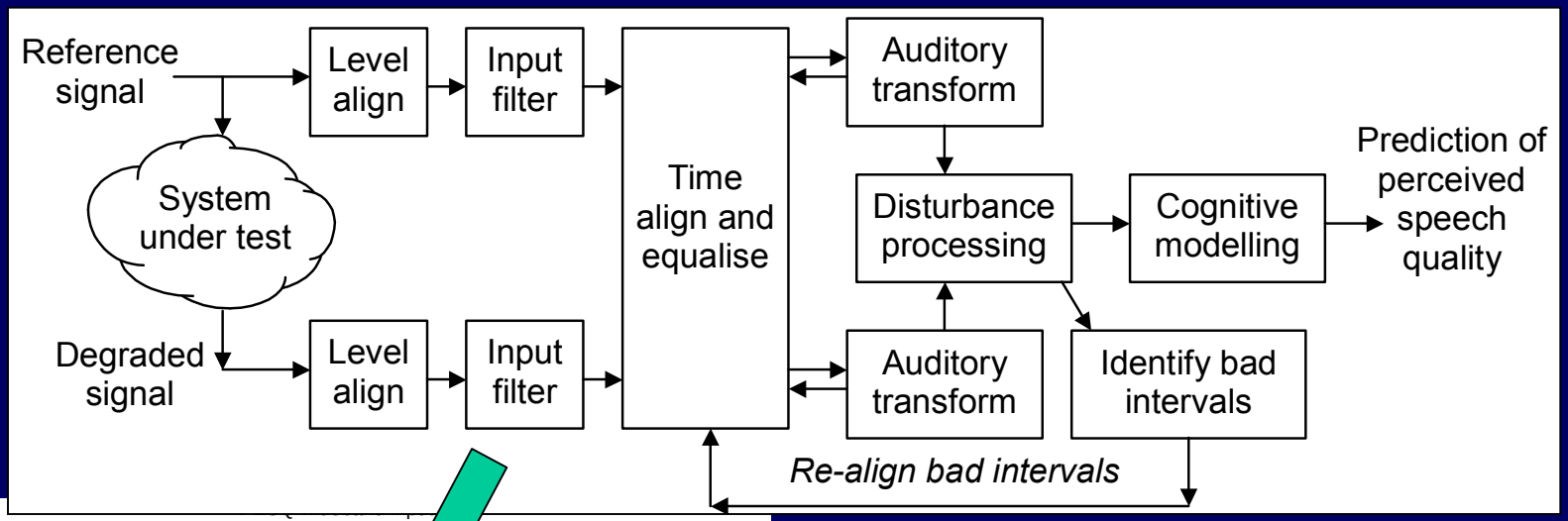
P.862 PESQ – scope

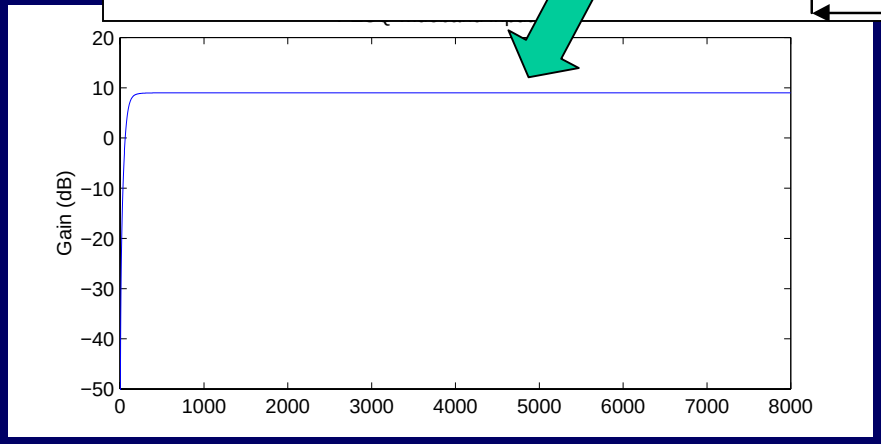




Scope assumes narrowband telephone handset listening, and speech signals

Extending PESQ for wideband speech & audio





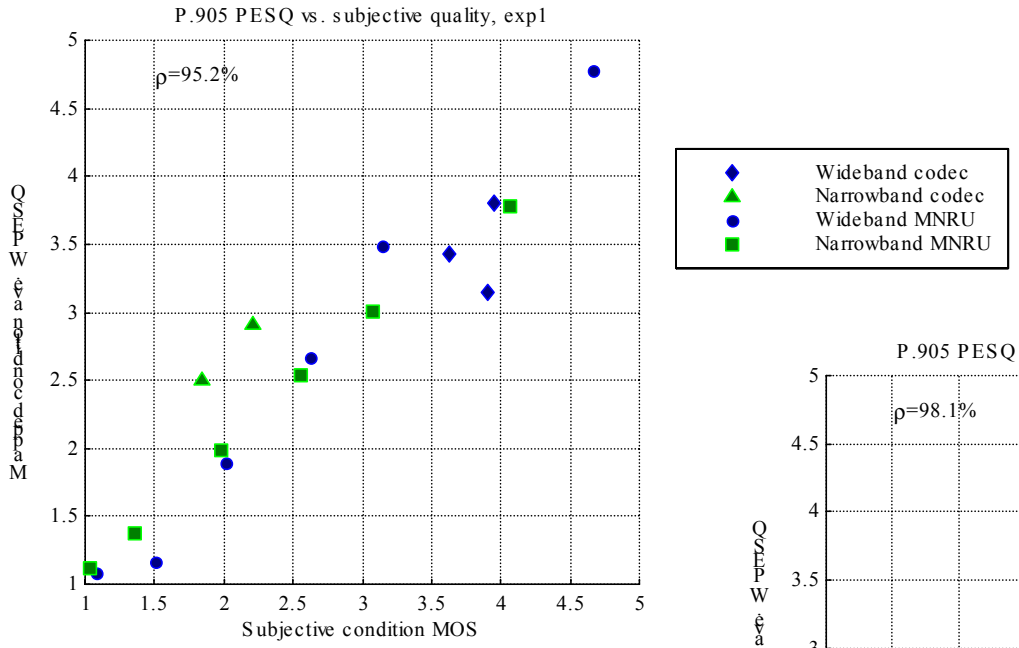
Modification proposed in COM12-D7:

Input filter replaced by 100Hz high-pass with 9dB additional gain.
No other changes (e.g. same psychoacoustic model).

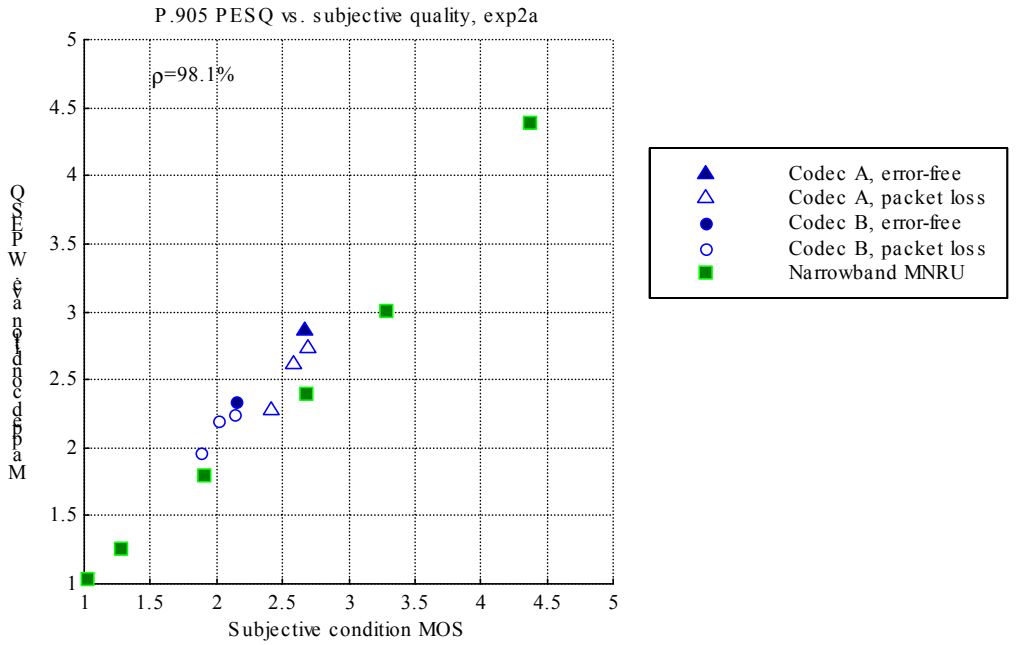
Use of WPESQ

- Select wideband mode whenever headphone listening is used
- Also operates at 8kHz sampling rate (same filter frequency response)
- Be careful about mixing narrowband and wideband PESQ – binaural headphone listening is more sensitive, so the results are different
- Reference signal should normally be full bandwidth

WPESQ results – speech



Eurescom P905 exp1
Multiple audio bandwidths



Eurescom P905 exp2a
8kHz conditions only

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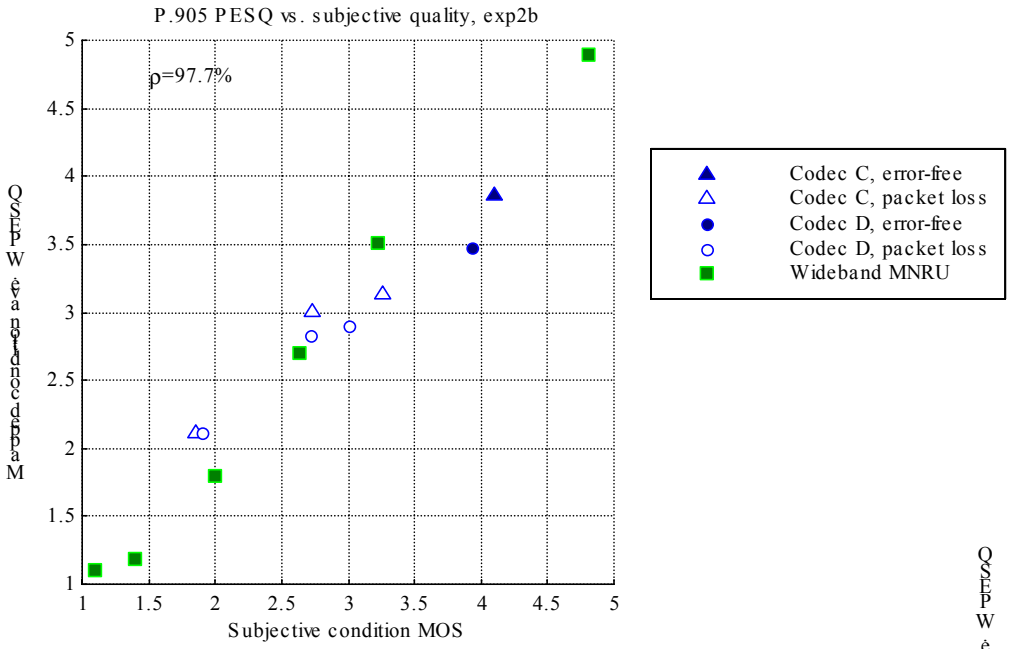
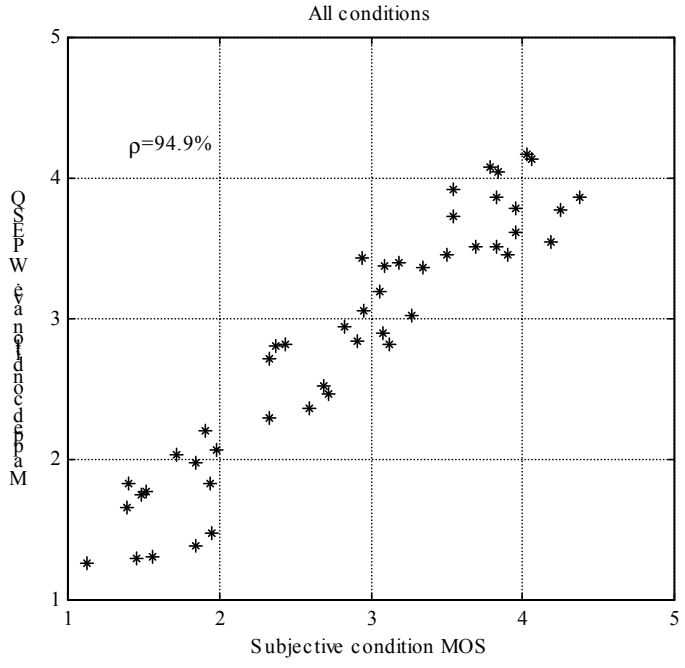
WPESQ results – speech



Eurescom P905 exp2b
16kHz conditions only



BT AES experiment
Multiple audio bandwidths

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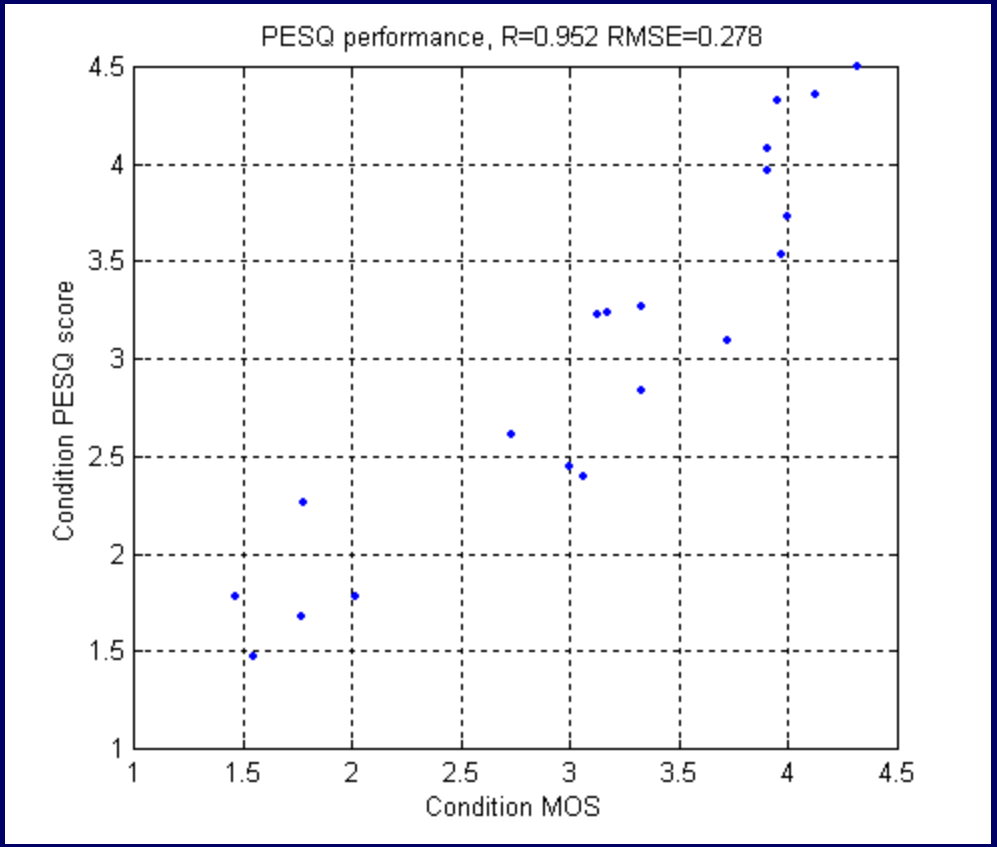
WPESQ results – NTT

- Morioka & Takahashi have published an independent evaluation of wideband PESQ
  - Wideband results: 91.2% correlation
  - Main issue is slight offset between G.722.1 and other conditions – will be investigated further
  - Problem with analysis – used narrow-band PESQ for 8kHz (wideband headphone) conditions although WPESQ should be used for this.
  - This caused offset between 8kHz and 16kHz conditions
    - Wideband PESQ is more critical than narrowband
  - 8kHz and overall results not included here.

WPESQ results – audio

- New subjective test by Psytechnics using:
  - 8 audio signals representative of PC and mobile multimedia (advertisement, movies, news documentary, pop music, speech, sports), of duration 8-12sec
  - 20 conditions
  - Range of codecs (AAC, AMR, G.711, G.722, and direct)
  - Range of bandwidths (8, 11.025, 12, 16kHz sample rates)
  - Presented to subjects and model at 16kHz, mono
  - Wideband binaural free field equalised headphones at 76dB SPL
  - Bit-rates from 4.75-256kbit/s

WPESQ results – audio



WPESQ results – overall

Test	R %
P905 exp 1 (speech)	95.2
P905 exp 2a (speech)	98.1
P905 exp 2b (speech)	97.7
AES107 (speech)	94.9
NTT wideband results (speech)	91.2
Psytechnics multimedia (16kHz mono audio)	95.2
Overall mean	95.4

WPESQ discussion

- WPESQ shows excellent correlation with MOS, comparing favourably with narrowband PESQ.
- Explore issues identified in P905 exp1 and NTT test:
  - Bandwidth and context effect
  - G.722.1 codec
- Can be used for both wideband speech and 16kHz mono audio – e.g. mobile multimedia applications
- Mapping between WPESQ and subjective MOS is required (like P.862.1 MOS-LQO).

Case study – Validation of AMR-WB (G.722.2) floating-point codec

- Fixed-point AMR-WB codec had been approved; needed to validate non-bit-exact floating-point version
- Used WPESQ to compare speech quality of codecs over 1280 test cases.

➢ Identified bug in fixed-point codec mode-switching

➢ Showed bug was corrected in floating-point and modified fixed-point codecs

➢ Found no significant difference in quality between (corrected) fixed-point and floating-point codecs.

➢ Took just 2 days of processing and analysis.

Conclusions

- BS.1387 PEAQ and P.862 PESQ not originally designed for wideband speech quality measurement
- By changing PESQ to use an appropriate input filter, WPESQ is able to make accurate quality measurements of wideband speech and 16kHz audio
- WPESQ allows interesting new applications in wideband speech and 16kHz audio quality testing, such as codec development, multimedia quality
- Some issues with subjective tests remain to be explored and further testing is desirable.

References

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Dr Antony Rix
Psytechnics Limited
antony.rix@psytechnics.com
www.psytechnics.com

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