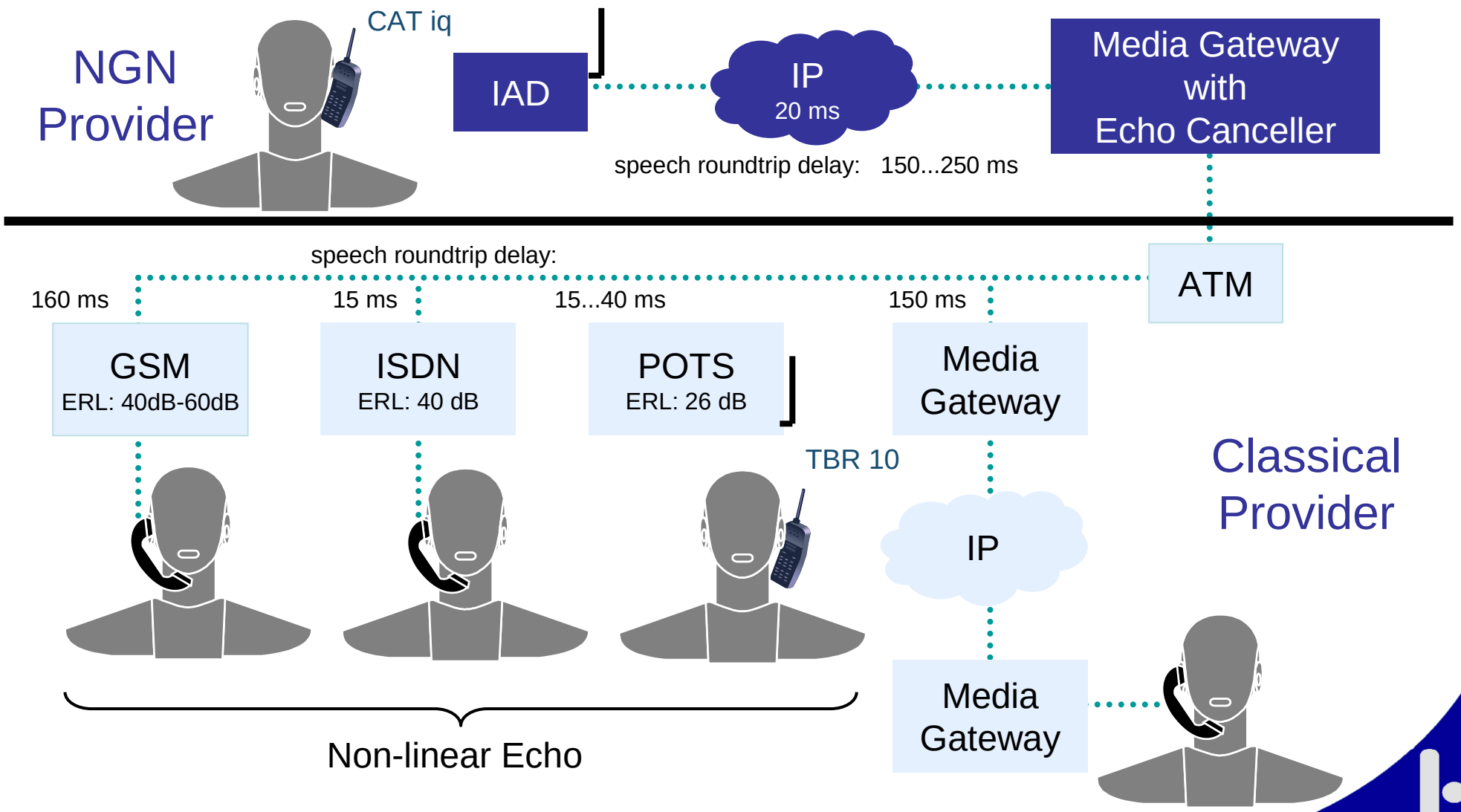
Background and Guideline for the CAT IQ 2.0 HD Audio Specification

Dr. H.W. Gierlich Christian Landauer
HEAD acoustics GmbH
christian.landauer@head-acoustics.de

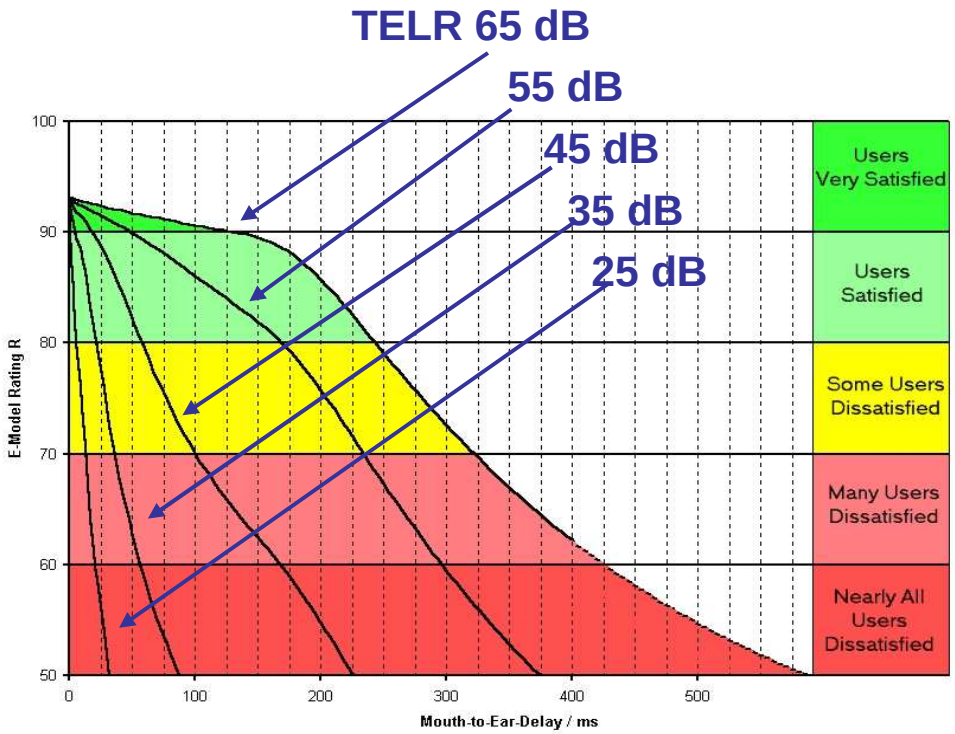
Overview

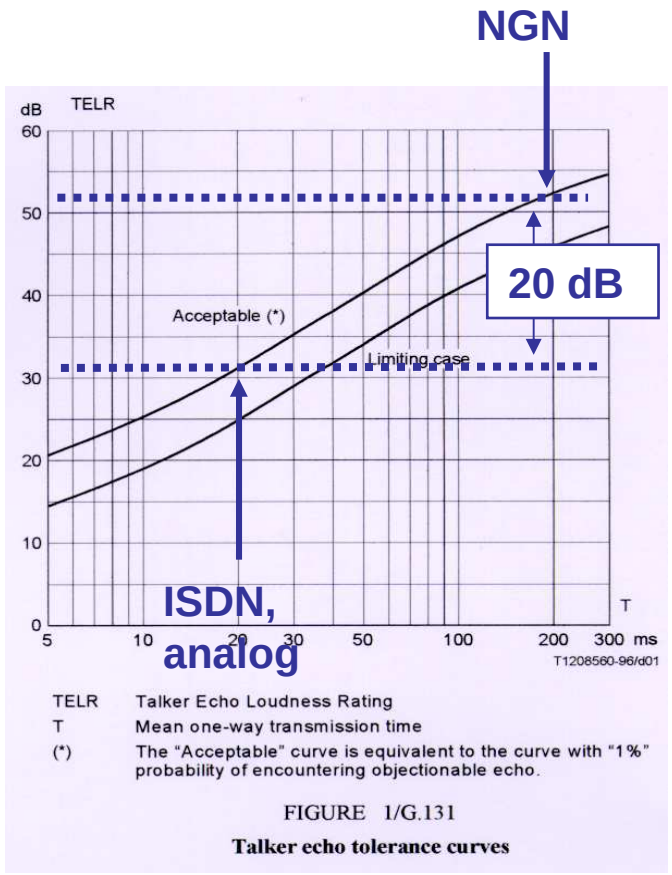
- Migration DECT to VoIP
  - Overview Network Situation today
  - Typical Signal processing
  - Conversational Speech Quality
  - Packet loss Concealment
- Migration DECT to HD Speech Quality
  - New Tolerance scheme (Send/Receive)
  - New Wideband echo tolerance scheme
  - Difference between CAT-iq™ 1.0 and CAT-iq™ 2.0
- Examples of Test signals and measurements

Network Situation Today



Delay and Echo in ITU-T Recs.





Delay and Echo

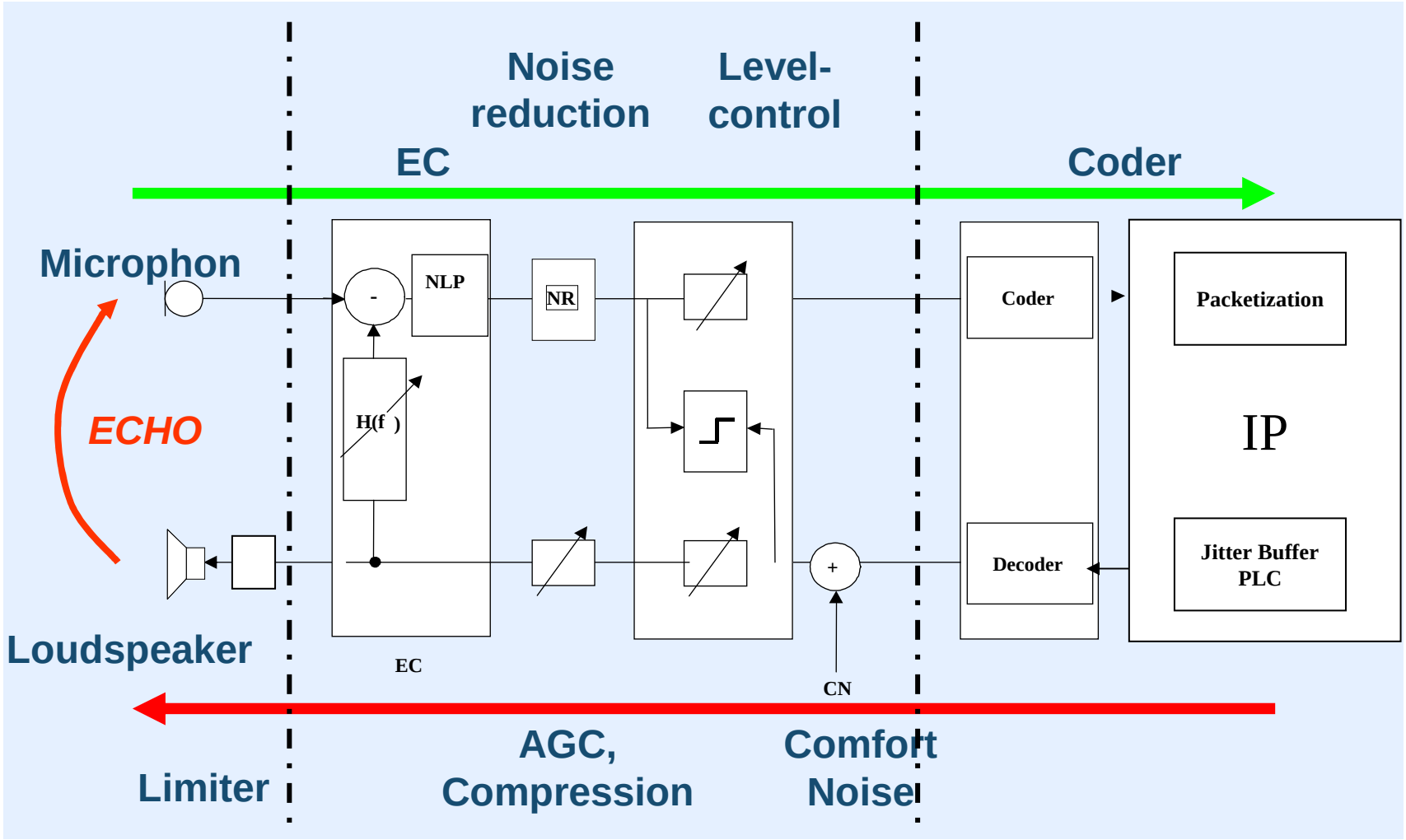
TBR 10:

- Delay FP+PP roundtrip delay < 28,5 ms
- Normal Network delay: 10 ms
- TCLw nominal seen from the network > 46dB

CAT IQ 2.0

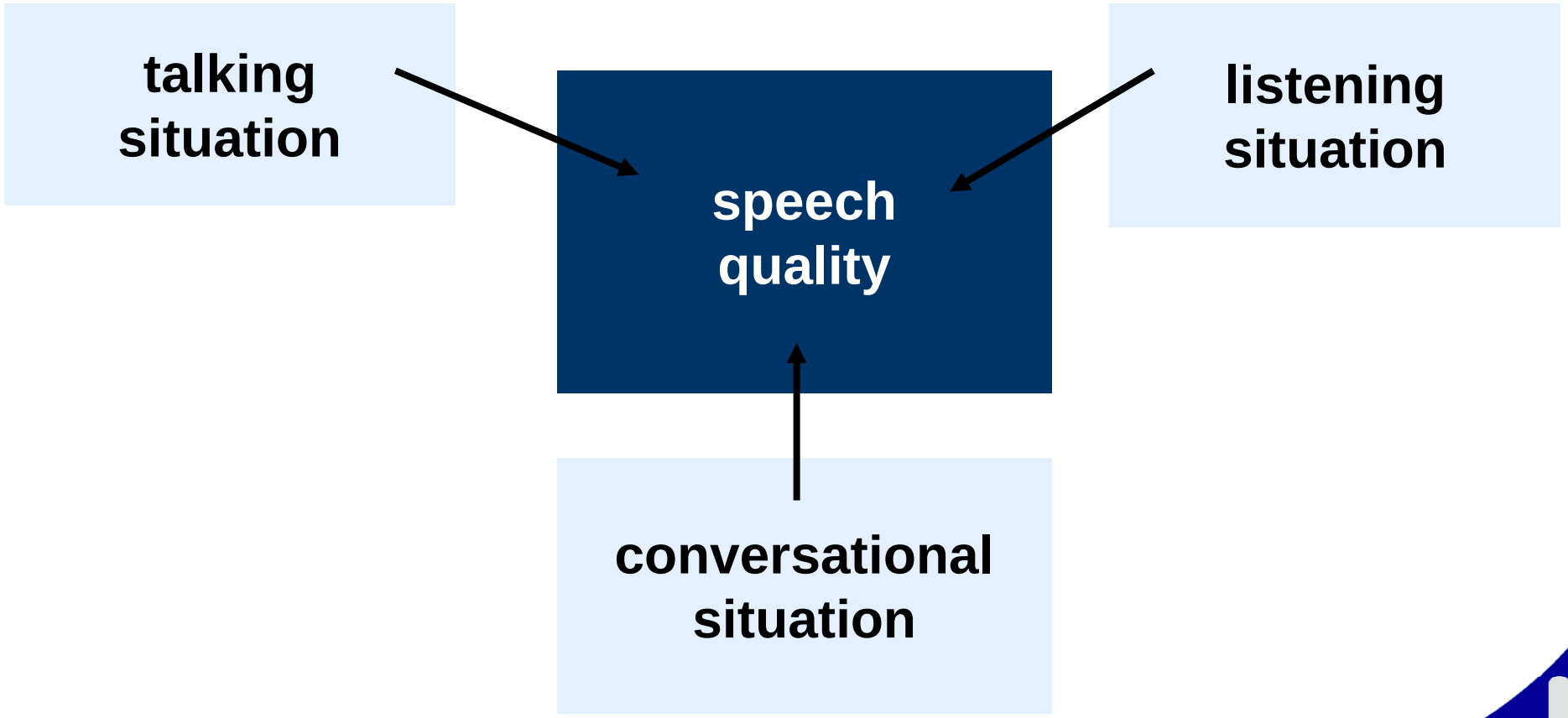
- Delay FP+PP roundtrip delay < 50ms
- Expected overall Network delay: 150 ms
- TCLw nominal seen from the network > 55dB
- Due to the higher TCLw requirement it is necessary to allow an additional delay in the signal processing (Delay 2.4.20 from CAT IQ 2.0)

Typical Signal Processing



Introduction

… from the user's perspective

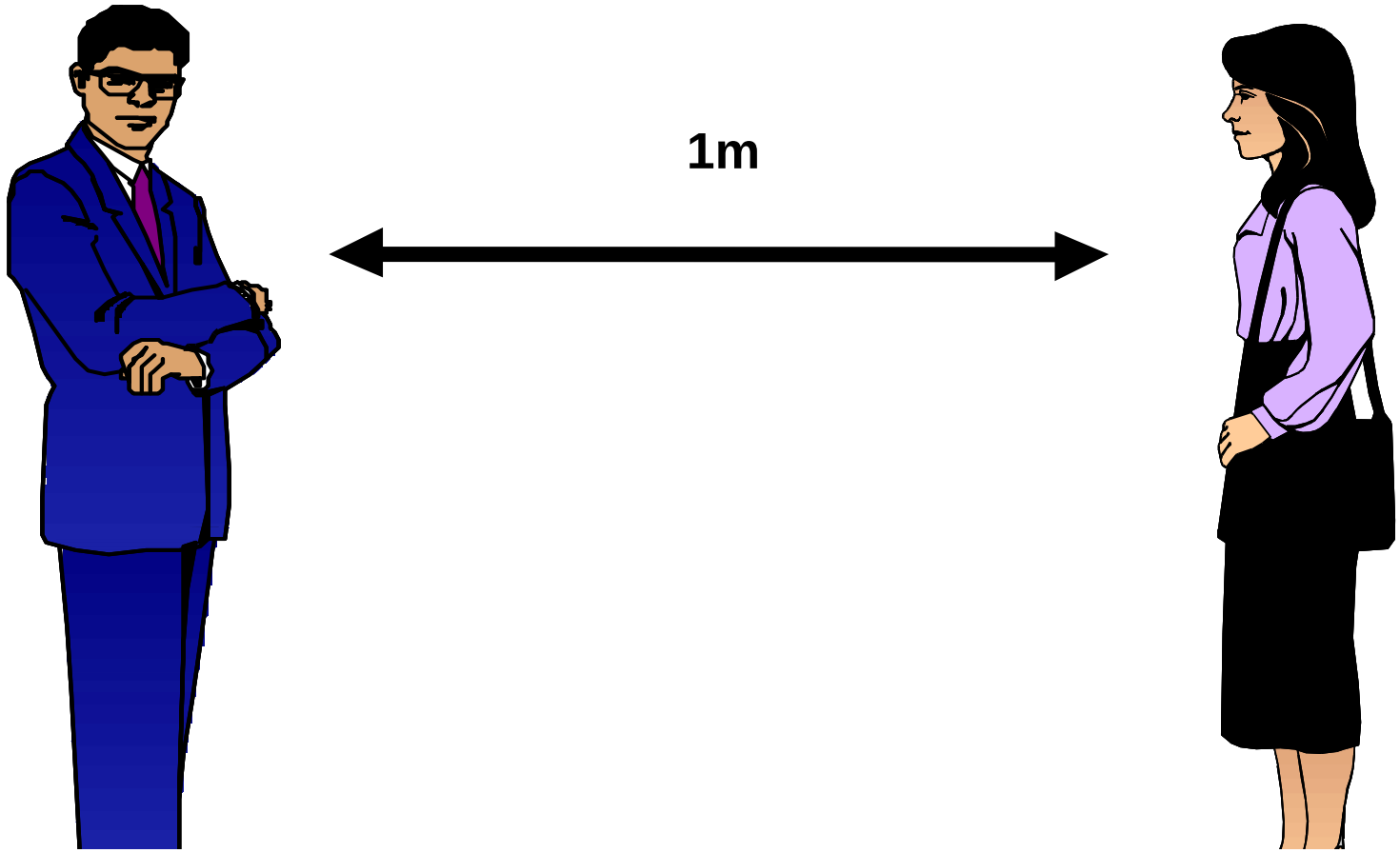


HD Voice

Migration to HD Voice

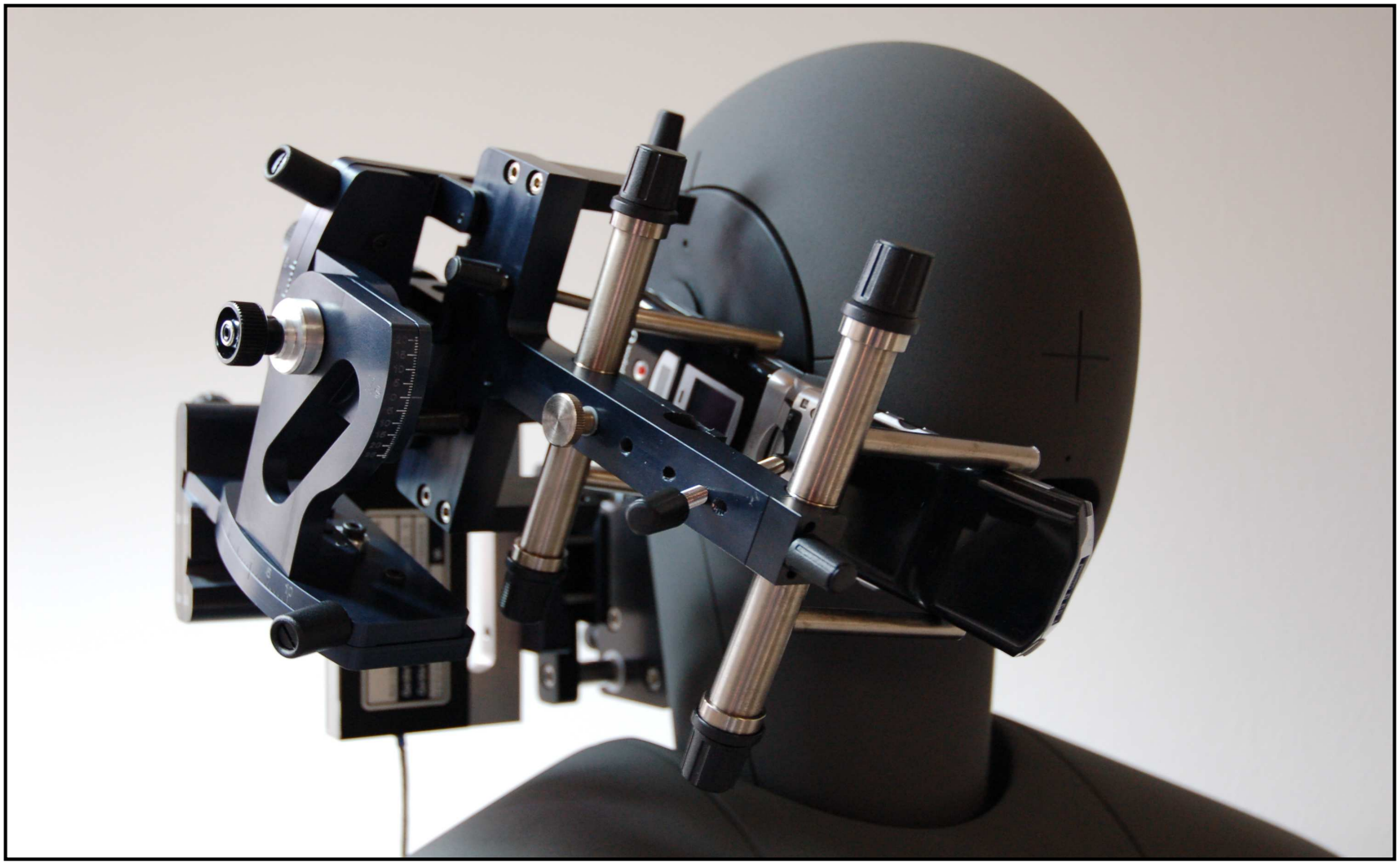
- New Frequency Response Characteristics
- New Spectral Echo Loss Requirement
- New Noise Level Requirement
- New Double Talk Requirement (still missing..)

The Reference of Speech Communication



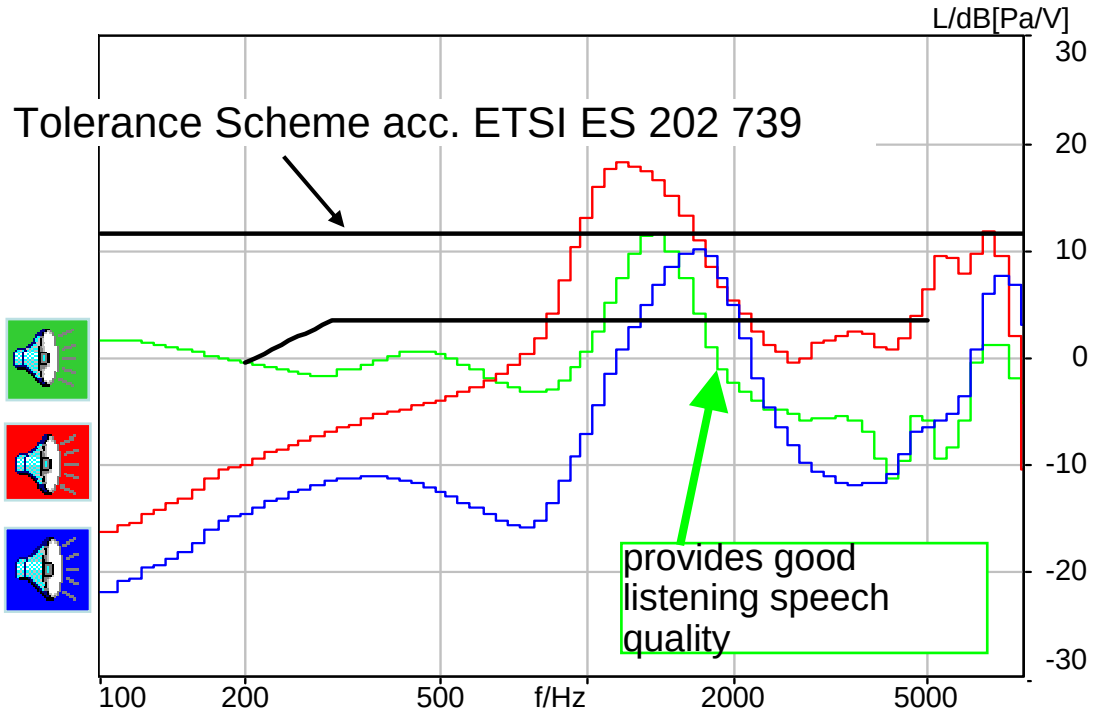
“orthotelefonic reference position”

HMS II.3 & HHP III



Receiving Frequency Response Characteristics - ETSI

Receiving frequency response of 3 wideband phones (handset mode, 3.4 ear, 8N, free-field)



Test Conditions

- Use 3.4 or 3.3 artificial ear
- Use 8N application force
- Use artificial voice or composite source test signal
- ***NEW: use DRP to FF correction***

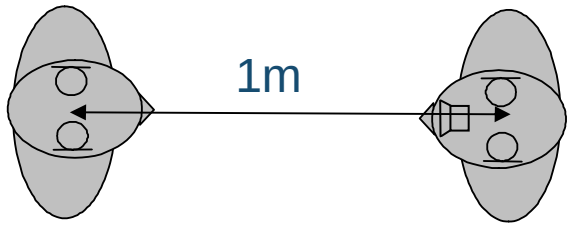
-> Is the tolerance scheme really desirable?

Step 3: Listening Only Test

Test Conditions

4 speakers: 2 female, 2 male

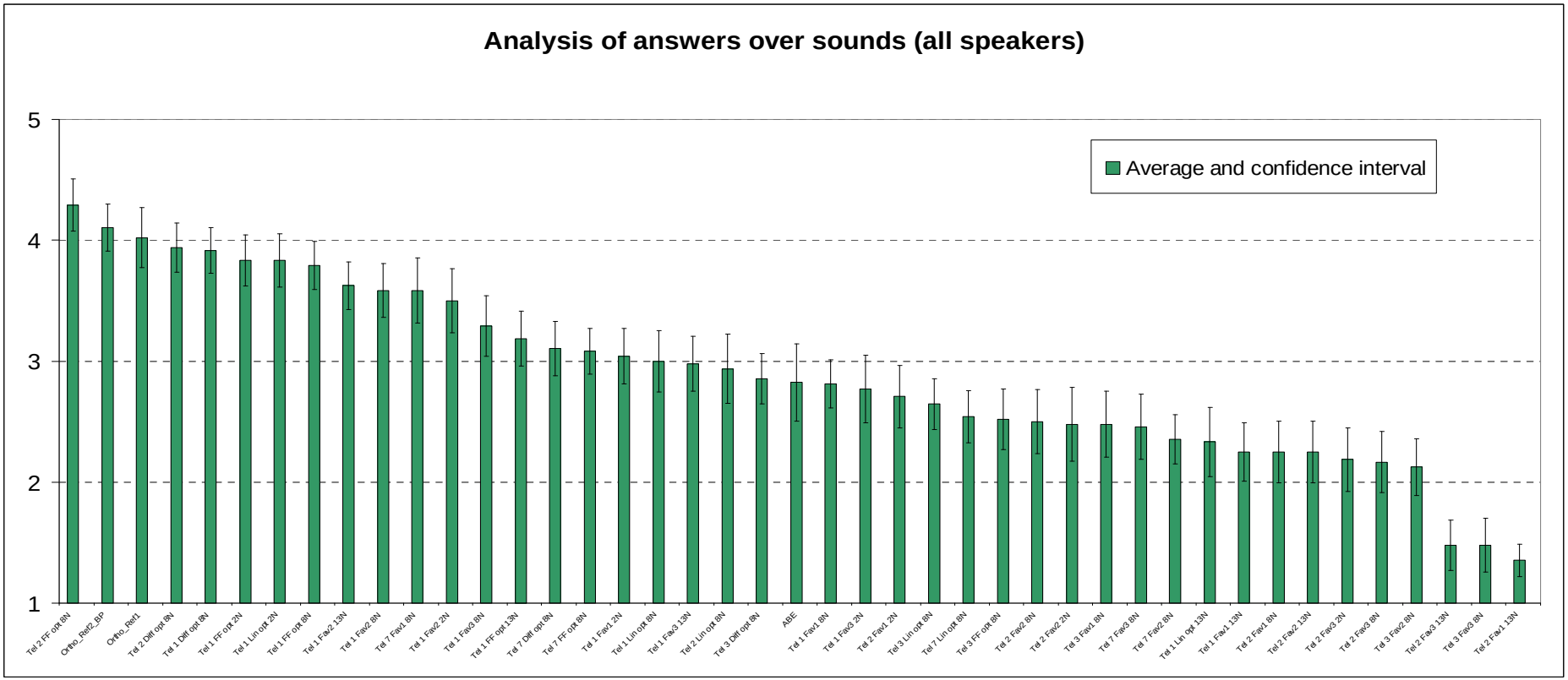
- 4 wideband phones, each combined with several frequency responses
- 1 artificial bandwidth extension
- 1 ortho-telephonic reference



Representation & Assessment

- 43 conditions x 4 speakers, each assessed by 12 naïve test persons
- Assessment of “speech sound” on a five point MOS-scale:
  - 5 – excellent
  - 4 – good
  - 3 – fair
  - 2 – poor
  - 1 – bad

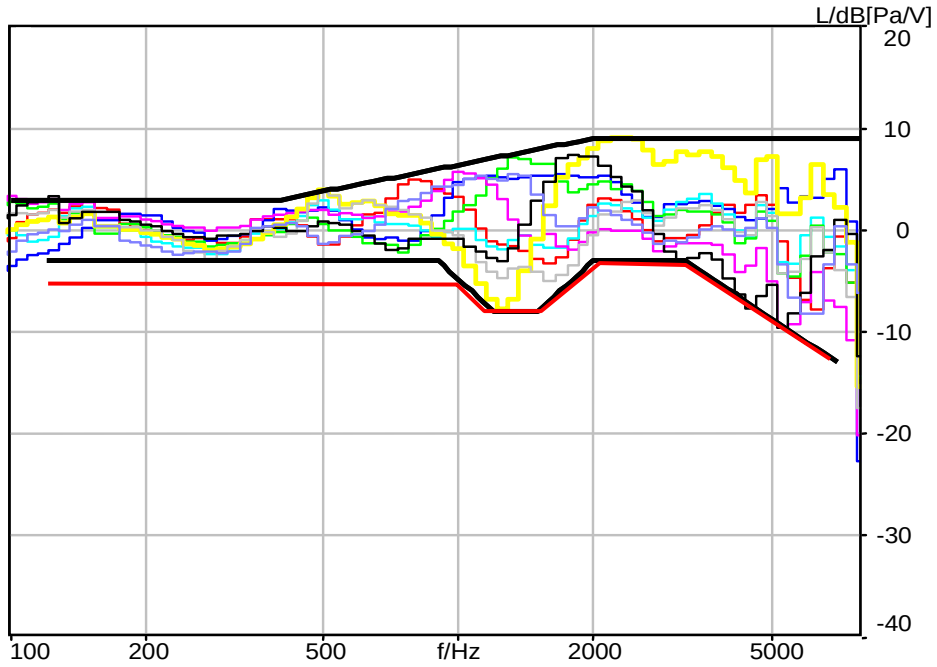
Results of LOT



- whole quality range is covered
- “winners”: ortho-telephonic reference, flat frequency response with DF or FF EQ
- -> extract for new tolerance scheme

New Tolerance Scheme for Receiving

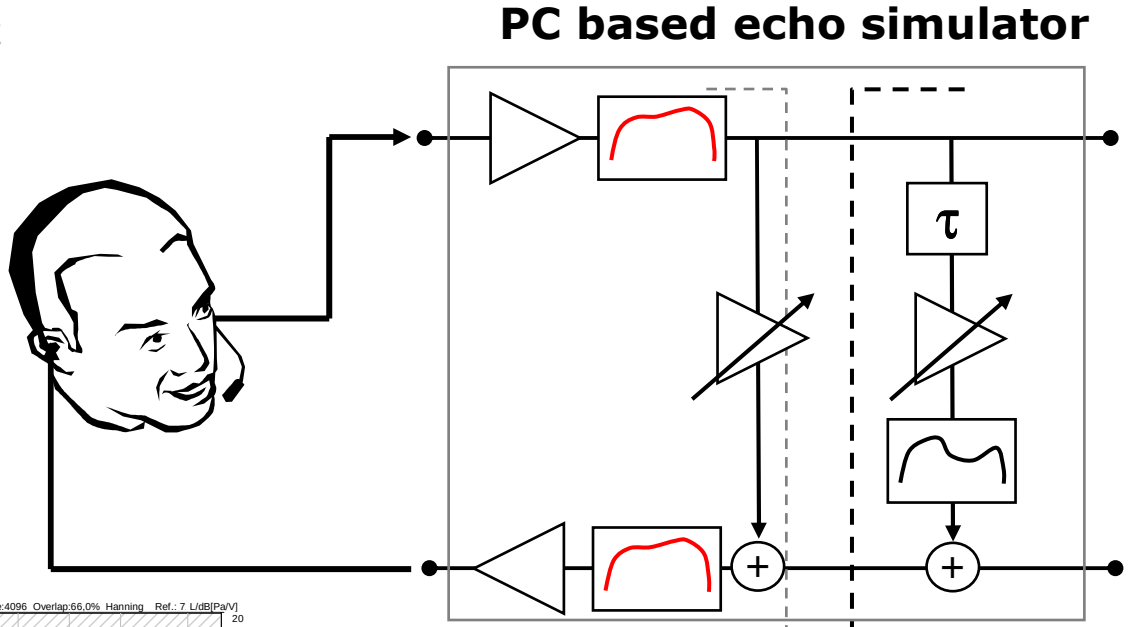
Basis for a possible new tolerance scheme with diffuse field reference:

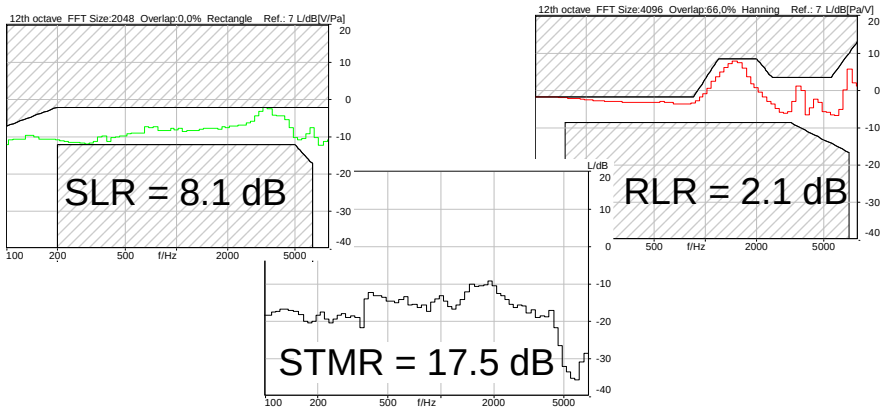


- 9 frequency responses with MOS-LQS ≥ 3.6 (average over all speakers)
- black lines: “most tight” tolerance possible
- red line: possible “smoothed” version of lower tolerance line
- ***Results discussed in ETSI STQ and ETSI NG DECT – positive feedback***

Test Setup for Wideband Echo Performance*

- Use of echo simulator:
  - PC with connected headset (Sennheiser PC130)
  - Simulation of different echo delays, attenuations and spectral shapes
- Connected headset is simulating a wideband phone providing typical phone characteristics:

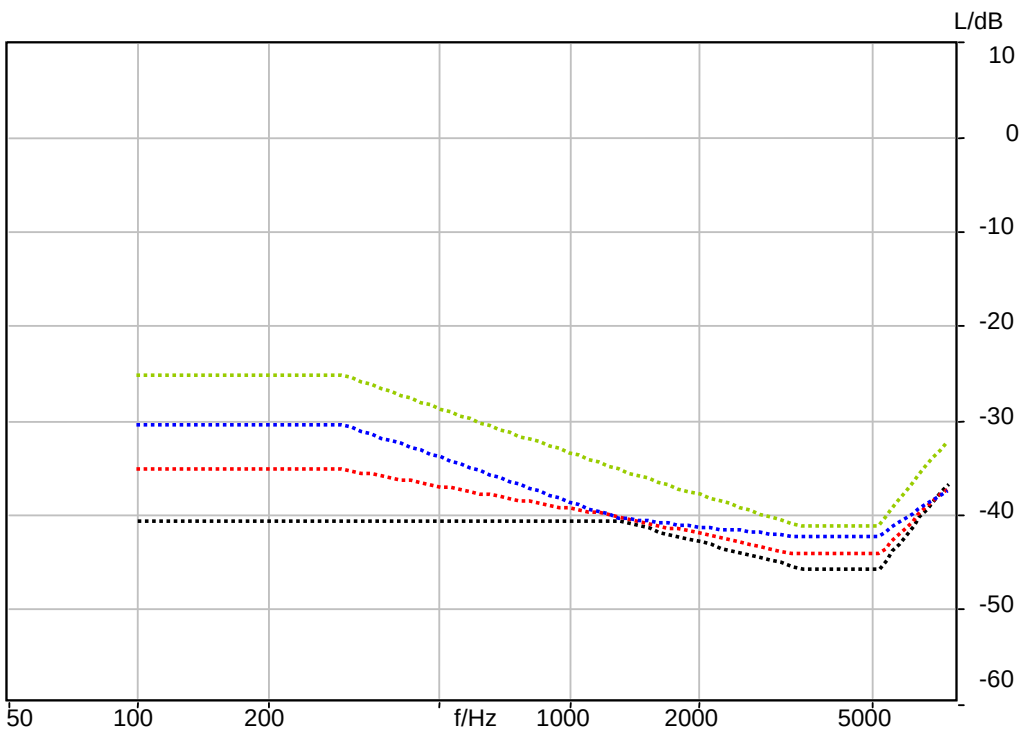




**** Results from a project with Deutsche Telecom T-labs***

Spectral Echo Loss Requirement

Based on subjective Tests: wideband spectral echo loss requirement*



Requirements for

100 ms

200 ms round-trip delay

300 ms

500 ms

*ITU-T workshop "From Speech to Audio: bandwidth extension, binaural perception“, Lannion, Sept. 10-12, 2008

Overview of Tests for CAT-iq™ Testing

CAT-iq™ 1.0

- Based on ITU-T P.311 and ETSI TBR 10
- Loudness Ratings
  - Sending Loudness Rating (SLR)
  - Receiving Loudness Rating (RLR)
- Frequency Responses
- Idle Channel Noise
- Distortion and Out-of-band Signals
- Side Tone and Side Tone Distortion
- Weighted Terminal Coupling Loss – TCL_W
- Stability Loss

CAT-iq™ 2.0

- Requires measuring fixed part only and portable part only → Reference FP + PP needed like TBR 10
- Based on ETSI EN 300 175-8
  - Advanced tests incl. conversational parameters
  - Tests HATS-based with DF reference point!
  - Tests in CAT-iq™2.0 based mostly on EN 300 175-8
  - Additional tests for fixed part (delay, clock accuracy, jitter buffer performance…)
- Double Talk performance (based on ITU-T P.340)
- Switching characteristics
- Activation in sending
- Quality of echo cancellation (temporal and spectral echo impairments)

Test Signals
&
Measurements

Frequency / Loudness – P.50

Test signal

Artificial Voice

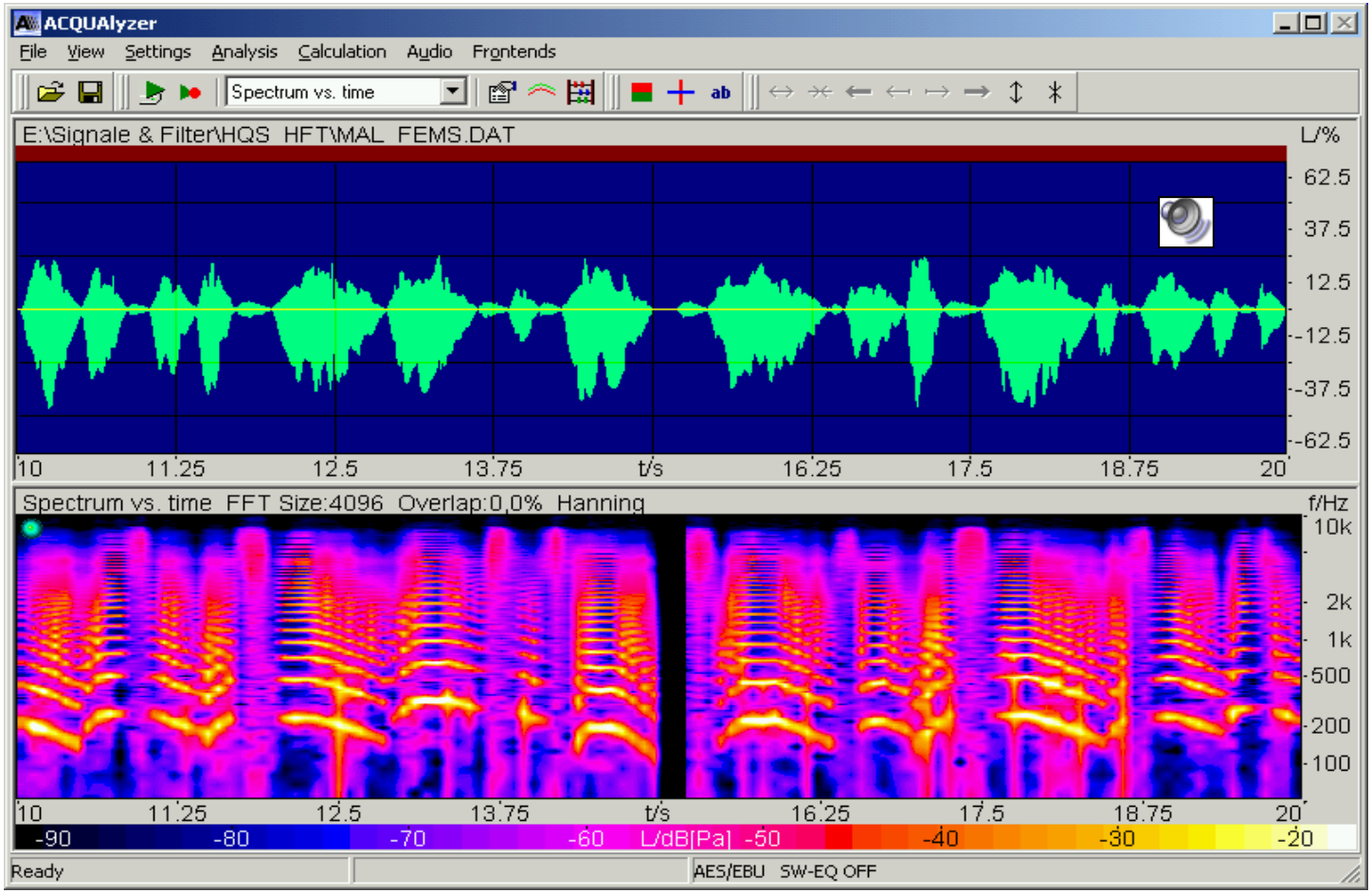
-4.7 dB_{Pa}

-16 dB_{m0}

Test / Analysis

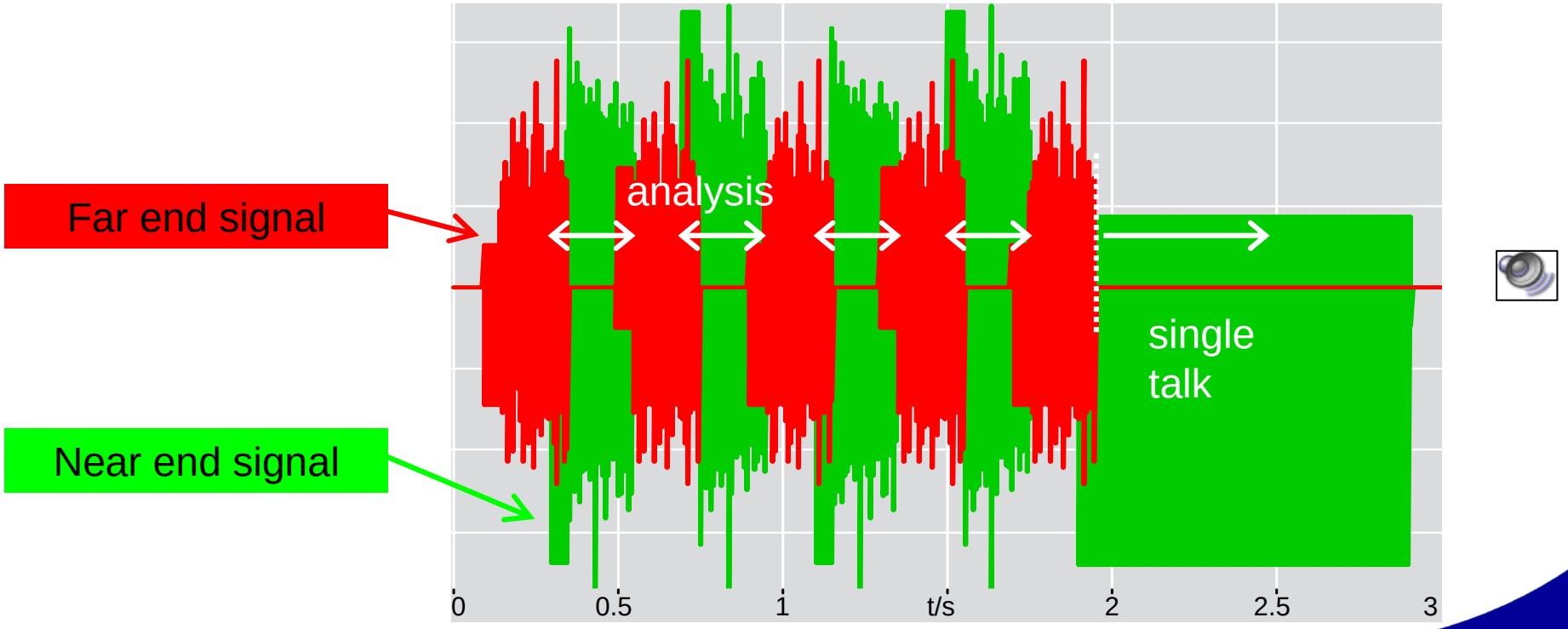
P.79, band 4-17

LR: „attenuation!“



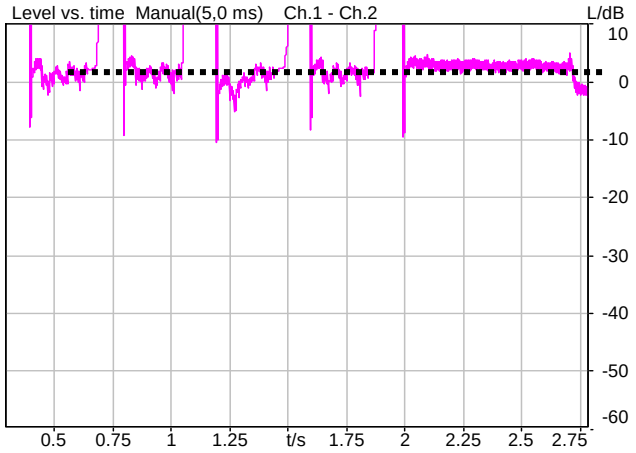
Double Talk 1/3

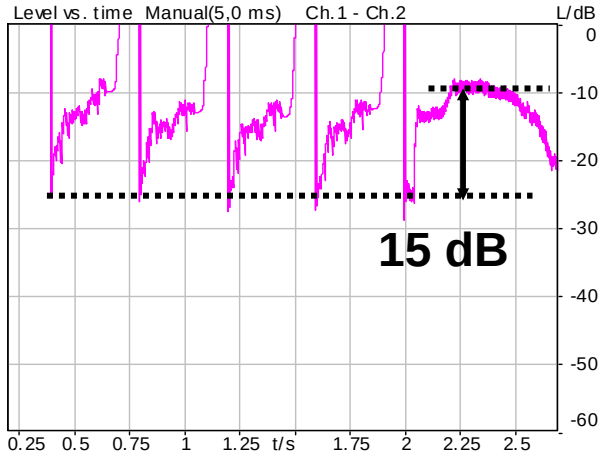
- Combination of two composite source signals
- Signal description in ITU-T P.501
- Description of analysis methods in ITU-T P.502



Double talk testing

Sensitivity vs. time analyzing the double talk performance:



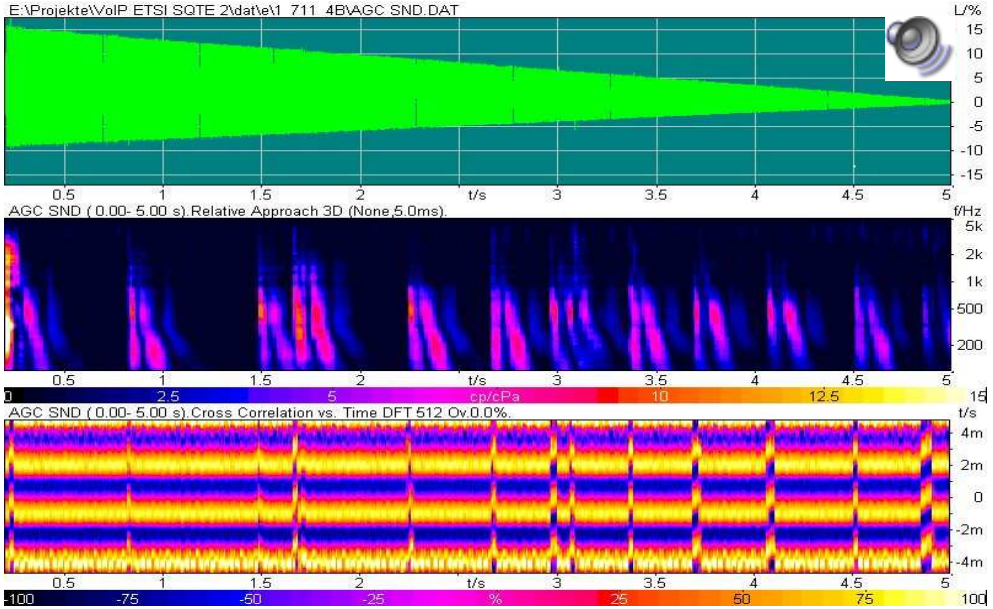


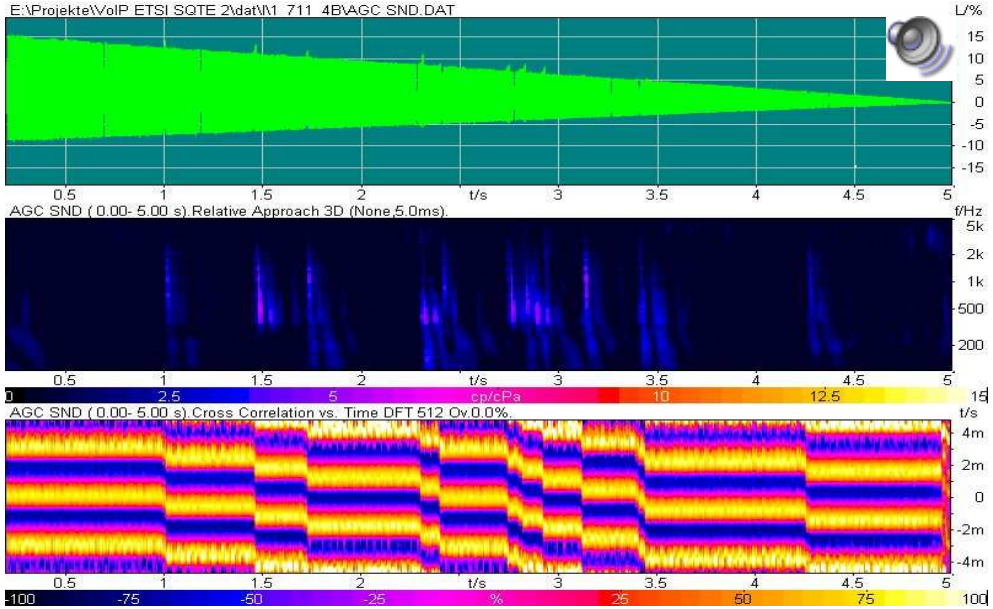
Good double talk capability
(‘Type 1’ acc. to ITU-T P.340)

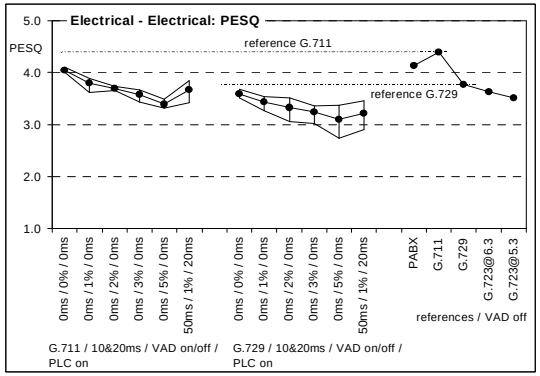
No double talk capability
(‘Type 3’ acc. to ITU-T P.340)

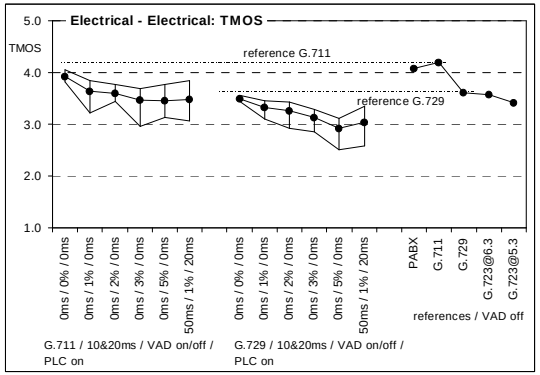
PLC Implementation 2/2

Example: 5% packet loss



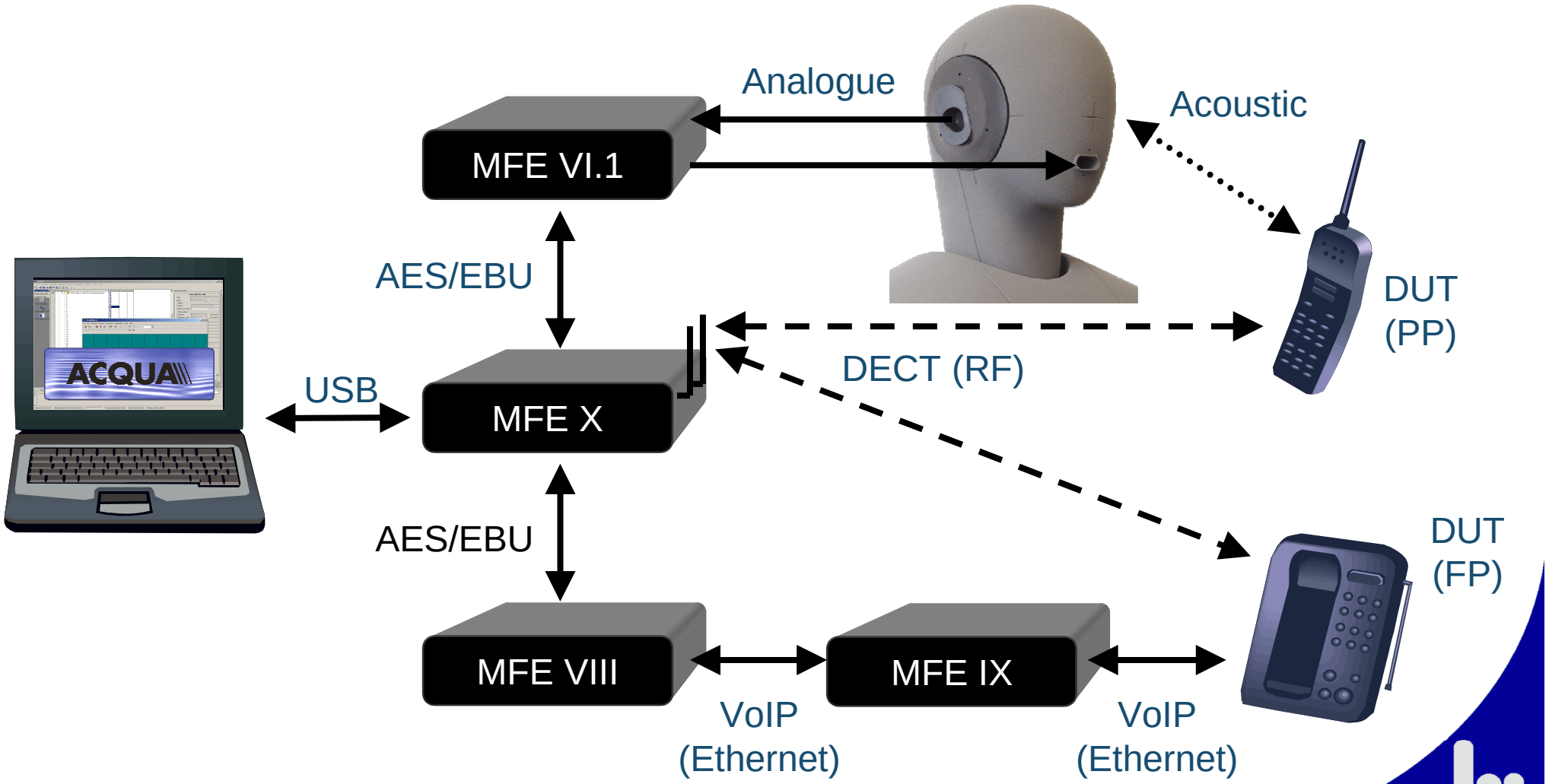






Test Setups for CAT-iq™ Tests

PP Only / FP Only Tests (CAT-iq™ 2.0)



Contact

HEAD acoustics®

For more information on the CAT IQ measurement system ACQUA, please do not hesitate to contact us!

- **Phone: +49-(0)2407-577-0**
- **Fax: +49-(0)2407-577-99**
- **Email: telecom@head-acoustics.de**