The Technical Issues That Affect Telephony: Speech Quality and Influencing Parameters

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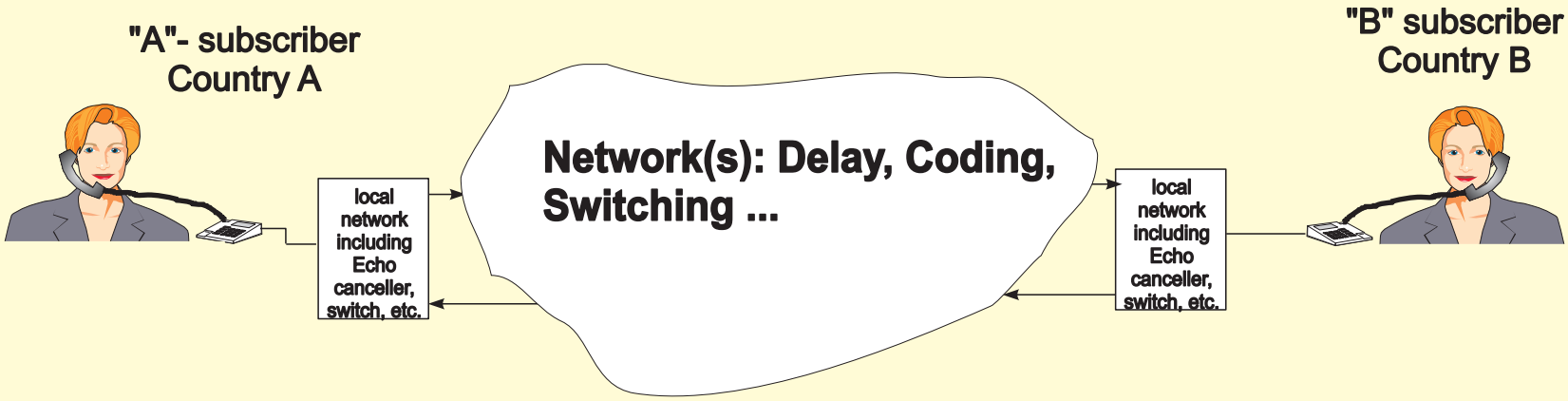
Outline

- Speech Quality and Influencing Parameter:
  The Subjective Point of View

- Signal Processing Affecting Speech Quality
  in Networks
  in Terminals

- Objective Measures and Parameters

The Telephone Conversation:



End to End Speech Quality

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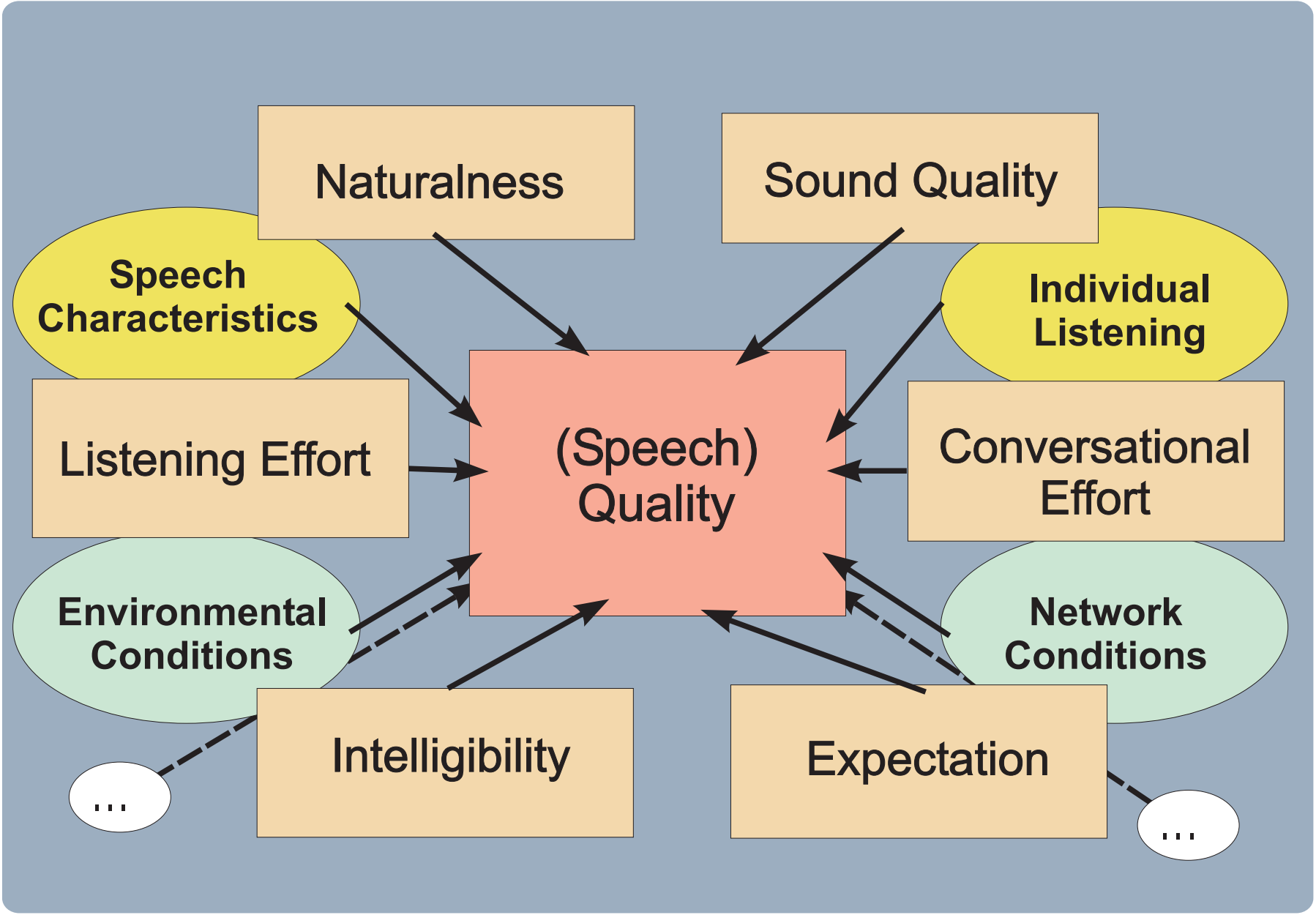
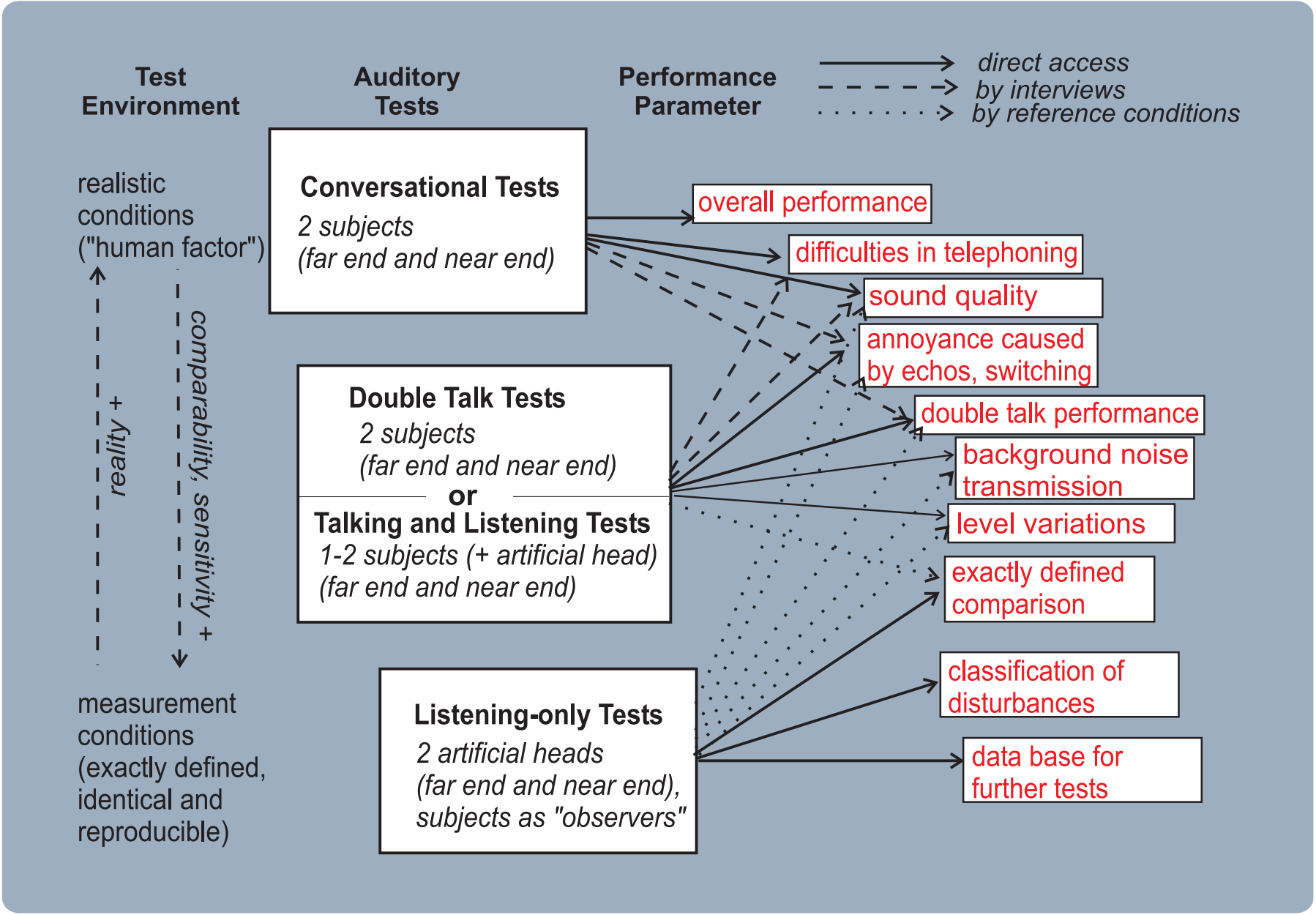
Mouth to Ear Speech Quality


Naturalness
Sound Quality
Speech Characteristics
Individual Listening
Listening Effort
(Speech) Quality
Conversational Effort
Environmental Conditions
Network Conditions
Intelligibility
Expectation
...
...


Test Environment
Auditory Tests
Performance Parameter
direct access
by interviews
by reference conditions
realistic conditions ("human factor")
reality +
comparability, sensitivity +
measurement conditions (exactly defined, identical and reproducible)
Conversational Tests
2 subjects
(far end and near end)
Double Talk Tests
2 subjects
(far end and near end)
or
Talking and Listening Tests
1-2 subjects (+ artificial head)
(far end and near end)
Listening-only Tests
2 artificial heads
(far end and near end),
subjects as "observers"
overall performance
difficulties in telephoning
sound quality
annoyance caused by echos, switching
double talk performance
background noise transmission
level variations
exactly defined comparison
classification of disturbances
data base for further tests

Auditory Evaluation

Conversational Tests

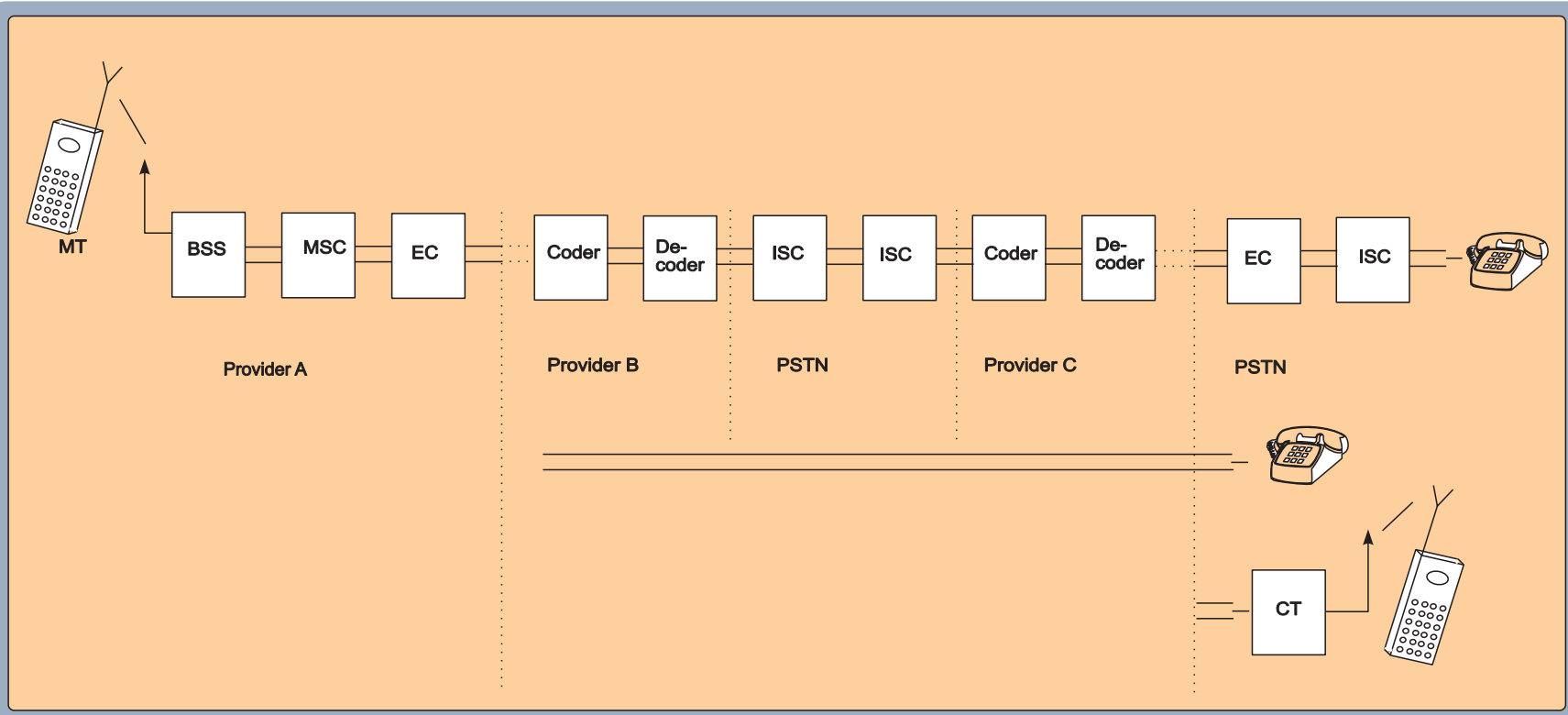
Global Quality Parameter:
- Overall Quality
- Dialogue Capability
- Double Talk Capability
(- Sound Quality)

Double Talk Tests

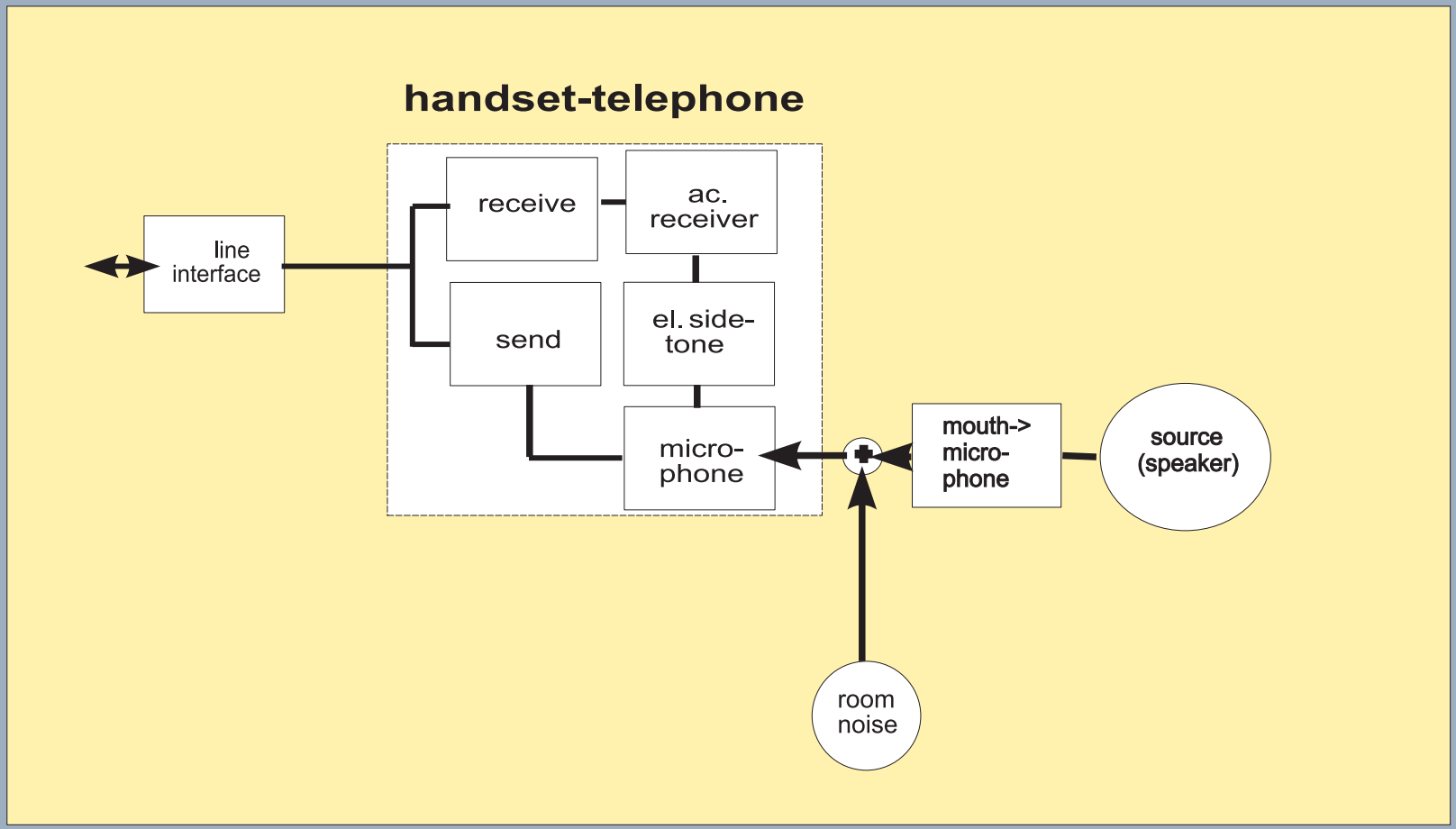
Double Talk Parameter:
- Double Talk Capability
- Completeness of Speech Transmission
- Loudness During Double Talk
- Echo Level
- Echo Characteristics
- Sound Quality
- Transmission of Background Noise

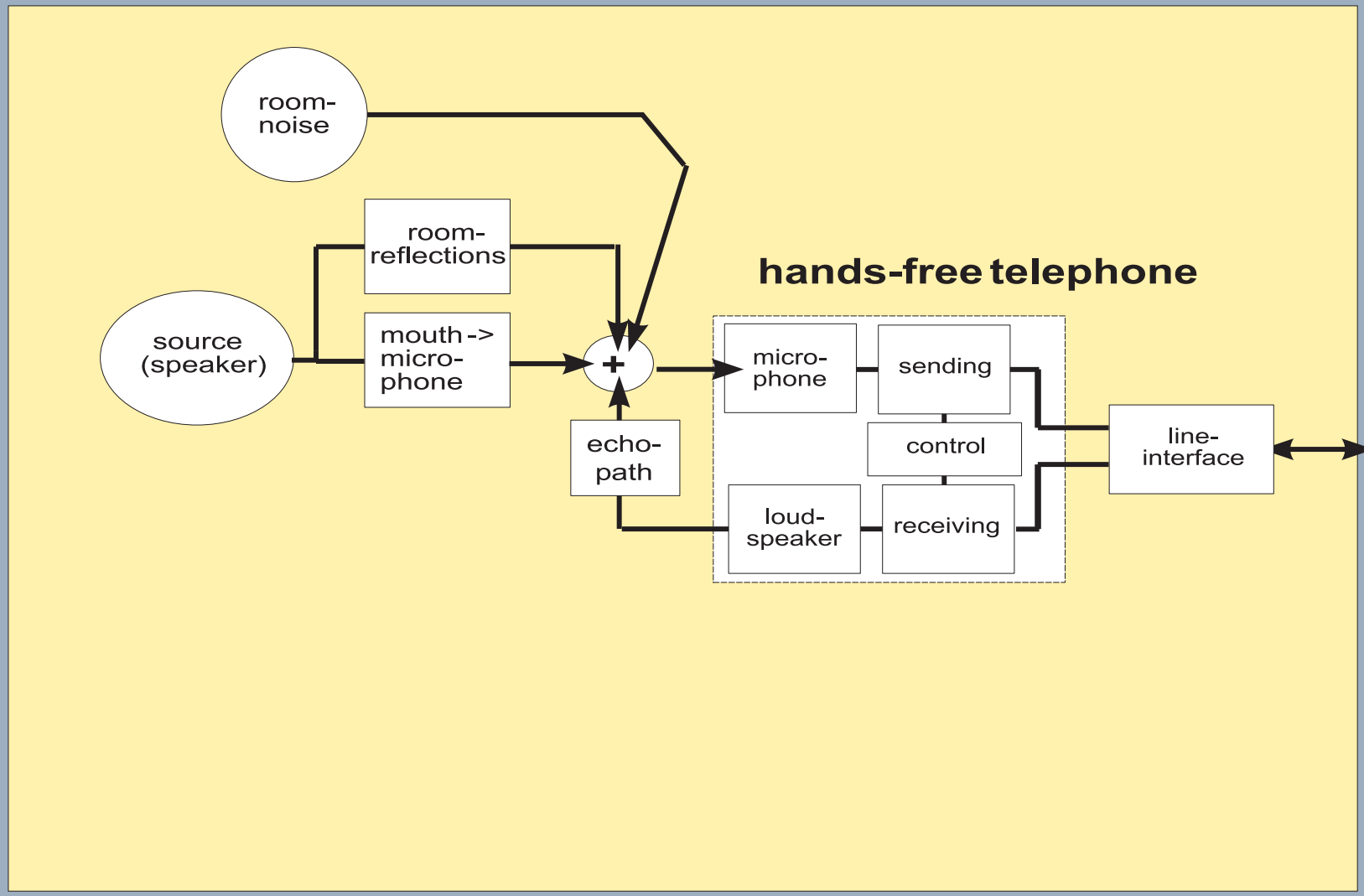
Listening Tests

Further Specialized Parameter:
- Overall Quality
- Sound Quality
- Completeness of Speech Transmission
- Disturbance Caused by Echoes
- Variation of Loudness
- Level Differences Single/Double Talk
- Switching Characteristics

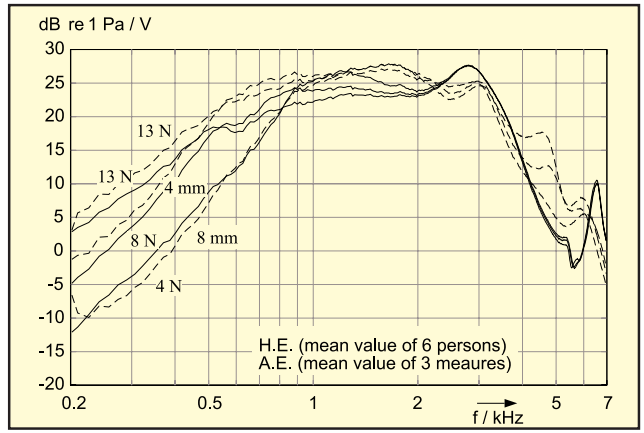


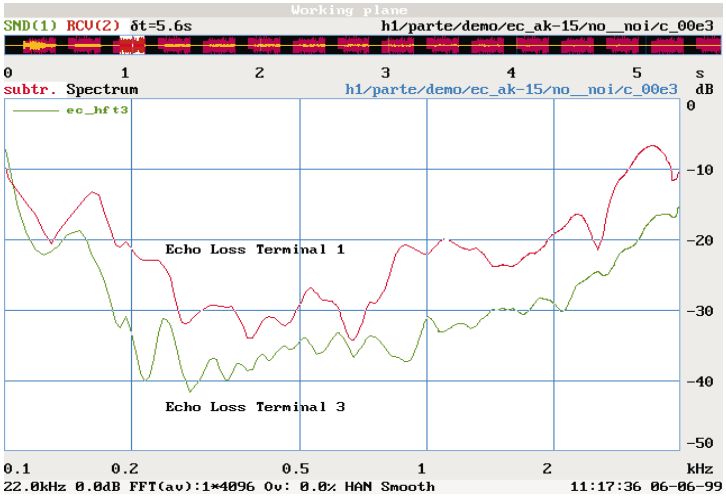
BSS - Base Station System (Basis Station)
MSC - Mobil Switching Center (Vermittlungseinrichtung Mobilfunknetz)
EC - Echo Canceller (Echokompensator)
ISC - International Switching Center (Internationale Vermittlung)
PSTN - Public Switched Telephone Network (Öffentliches Telefonnetz)
CT - Cordless Telephone (Schnurlos-Telefon)
MT - Mobile Telephone (Mobiltelefon)


handset-telephone
line interface
receive
ac. receiver
send
el. side-tone
micro-phone
mouth-> micro-phone
source (speaker)
room noise


room-
noise
room-
reflections
source
(speaker)
mouth ->
micro-
phone
+
echo-
path
hands-free telephone
micro-
phone
sending
control
loud-
speaker
receiving
line-
interface

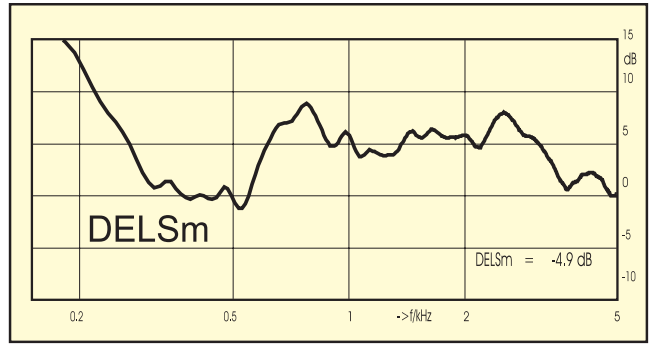
Pressure force dependant receiving characteristics of handsets and headsets

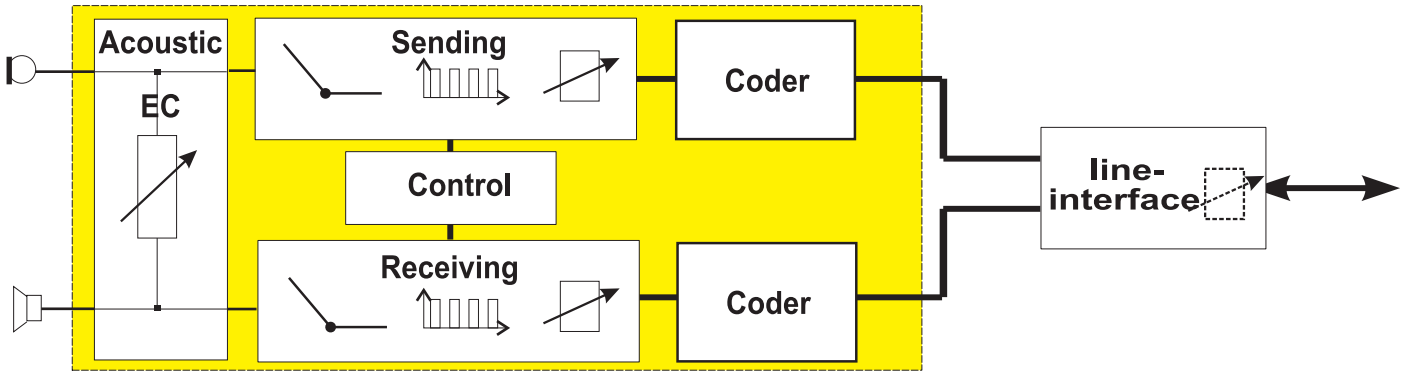




Terminal Coupling Loss (Echo Loss)

Sensitivity against room noise DELsm

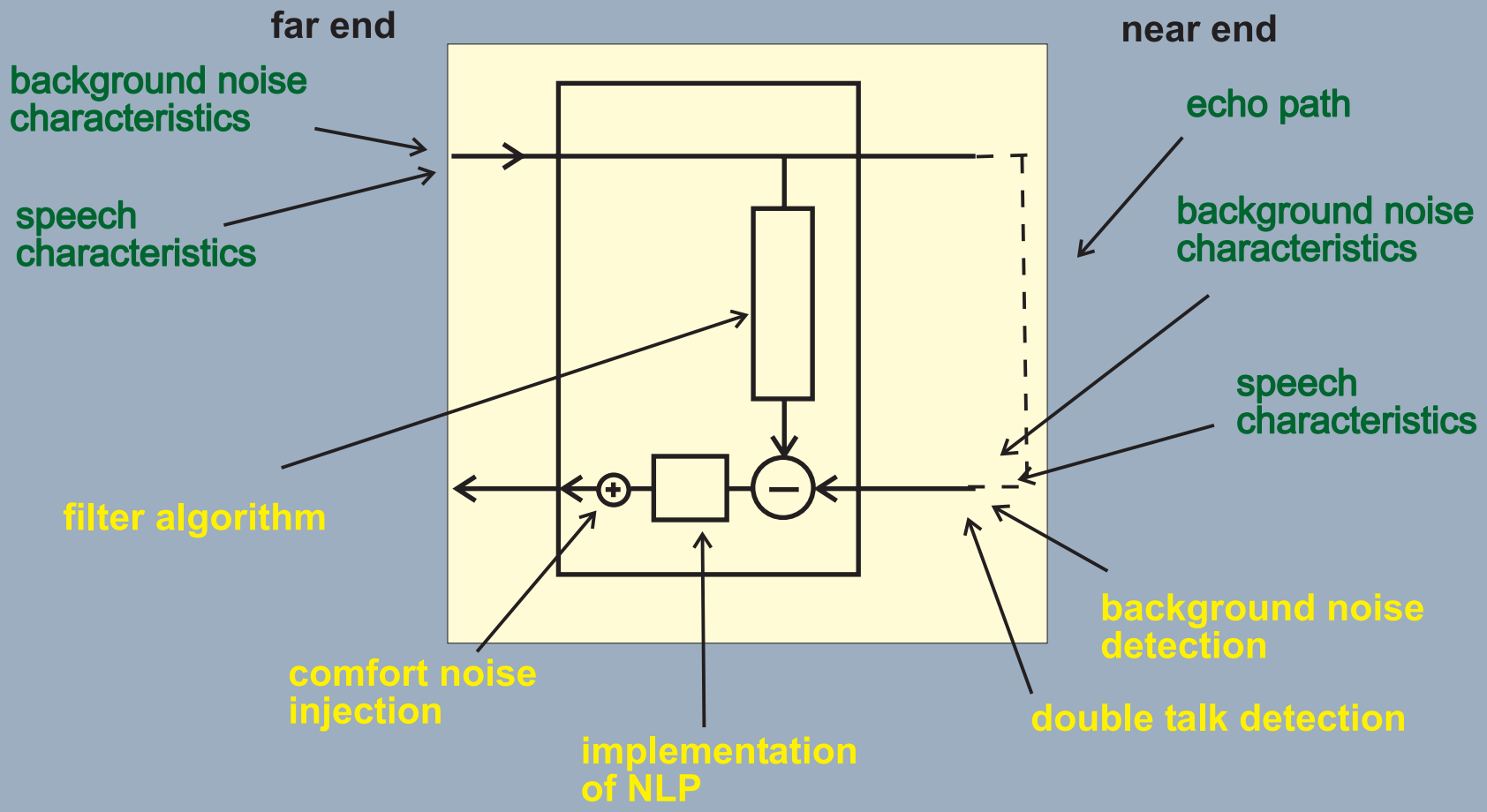


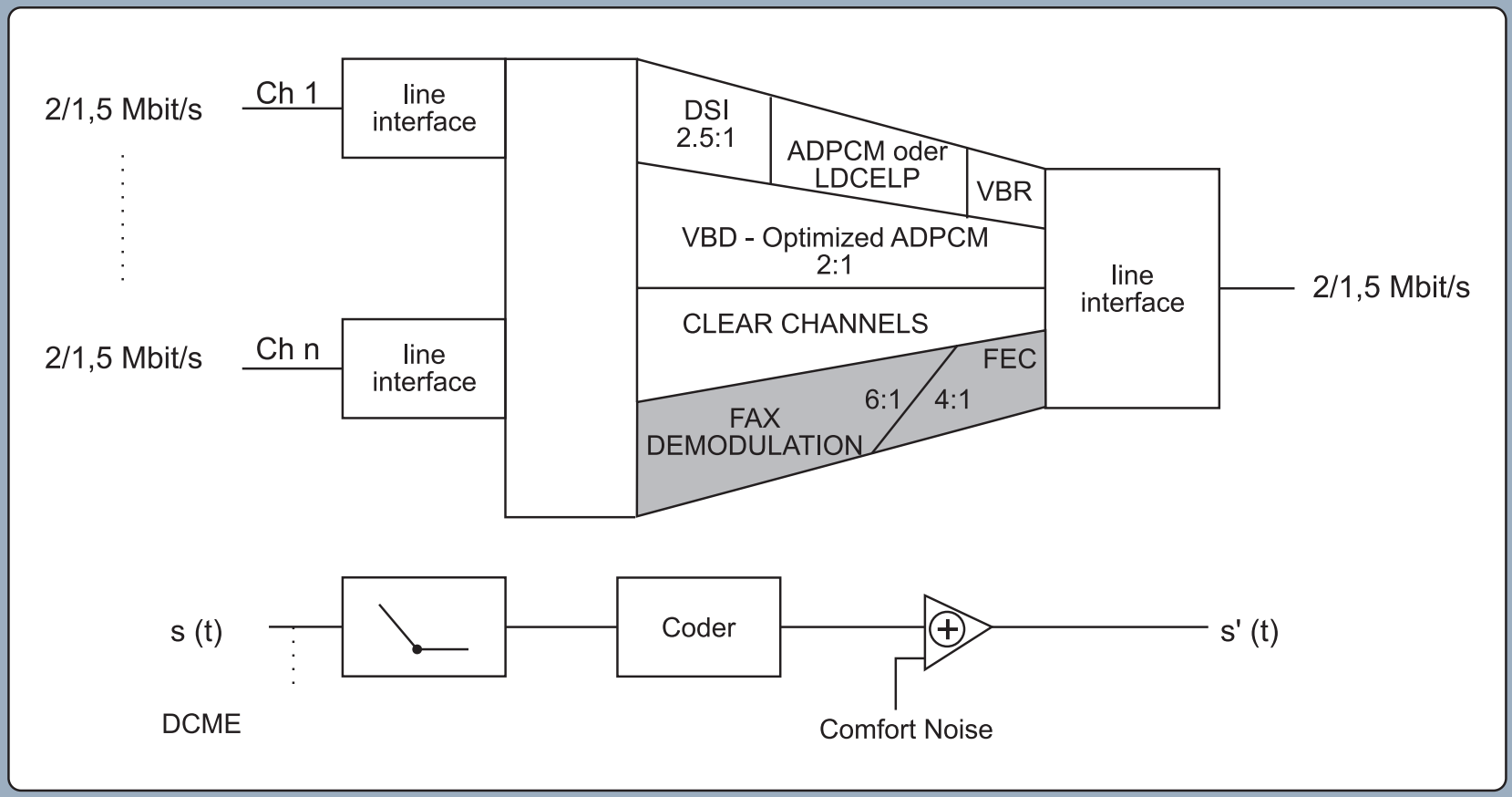


Signal processing in a typical terminal
- echocancellation
- speech switching
- subband frequency division
- coding
- noise reduction
....

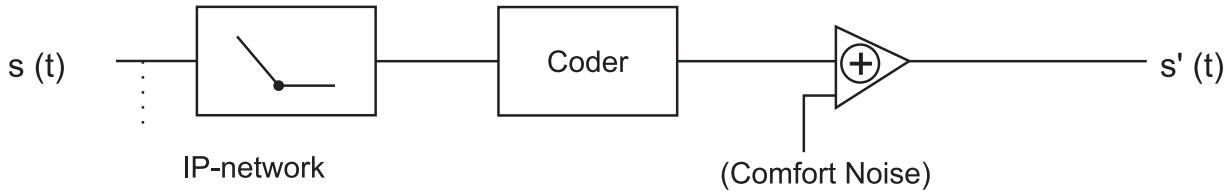
Echo Path and Echo Canceller

Typical technical implementation and factors determining speech transmission

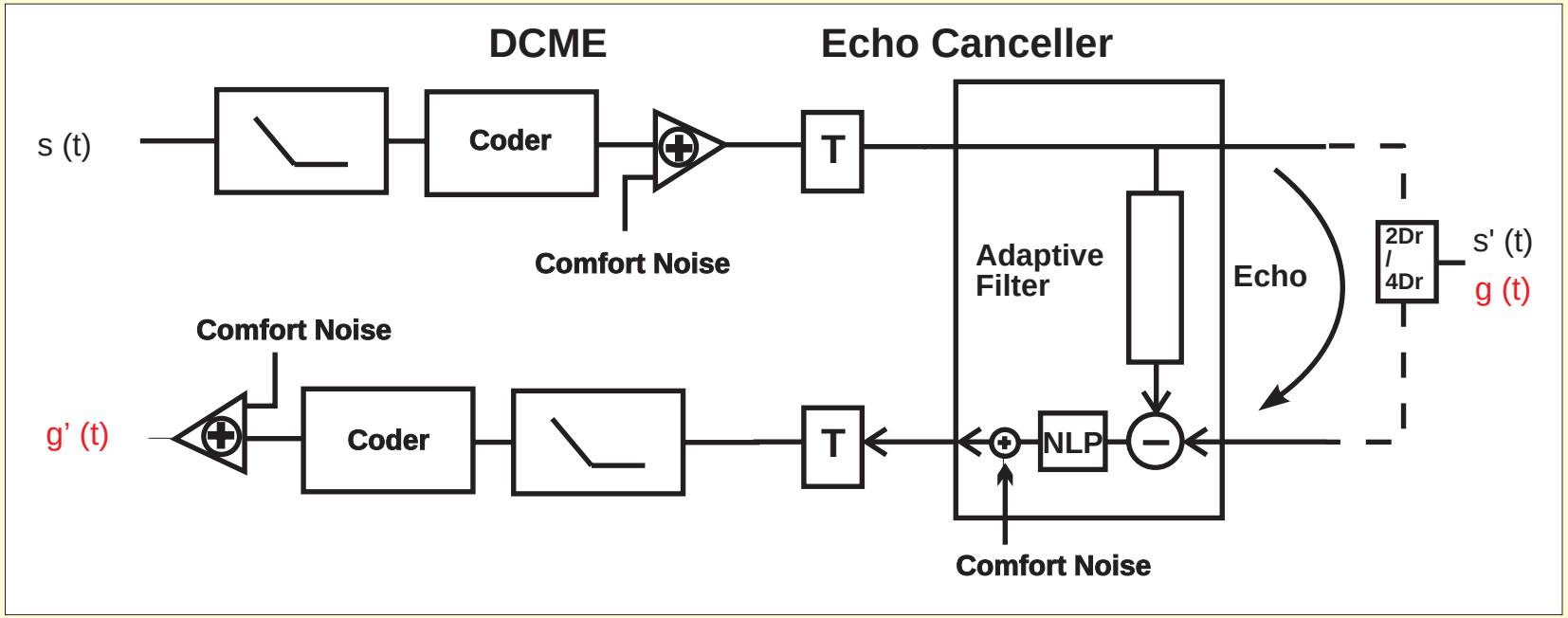




DCME with signal processing blocks and influence on speech transmission quality (simplified)

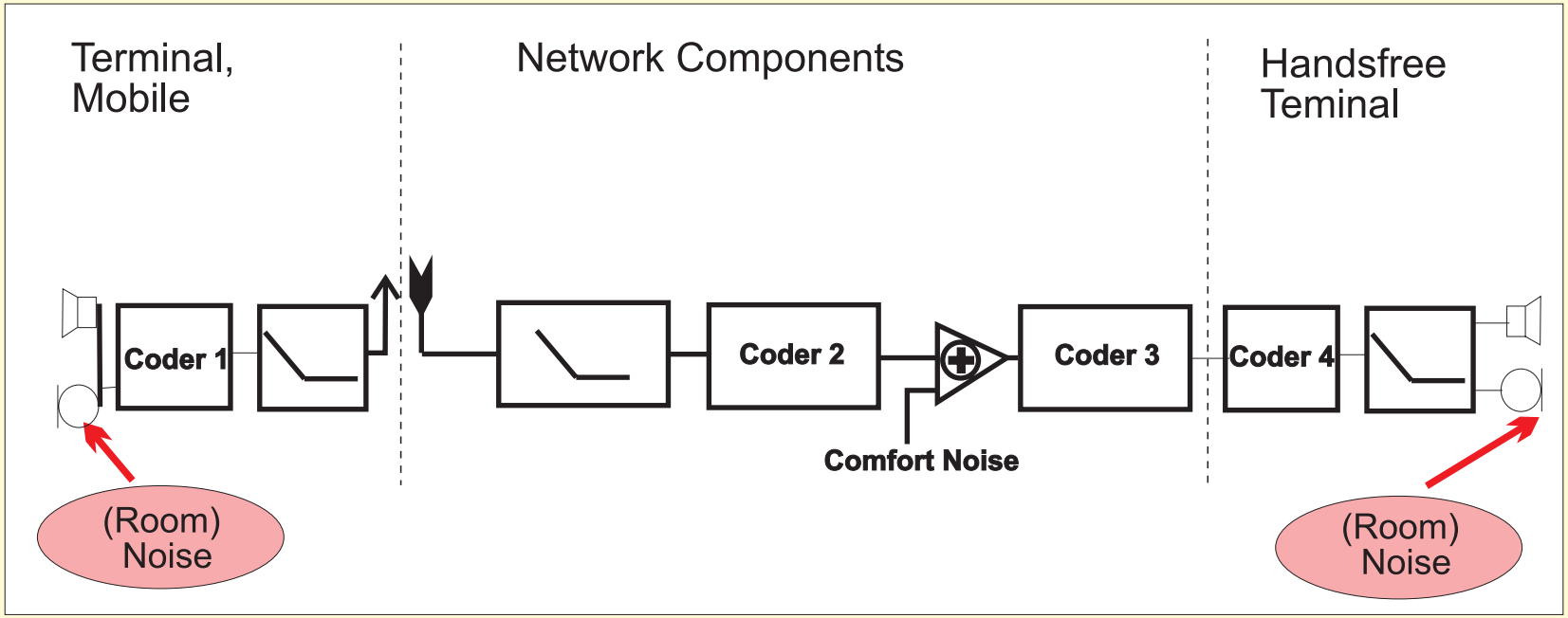


Switching different to typical speech detectors:
- **not typically frontend clipping**
- **speech clipping may occur at any time**
- **length, duration and distribution in time of the clipping is typically unknown**
- **strong effect on low rate speech coding**

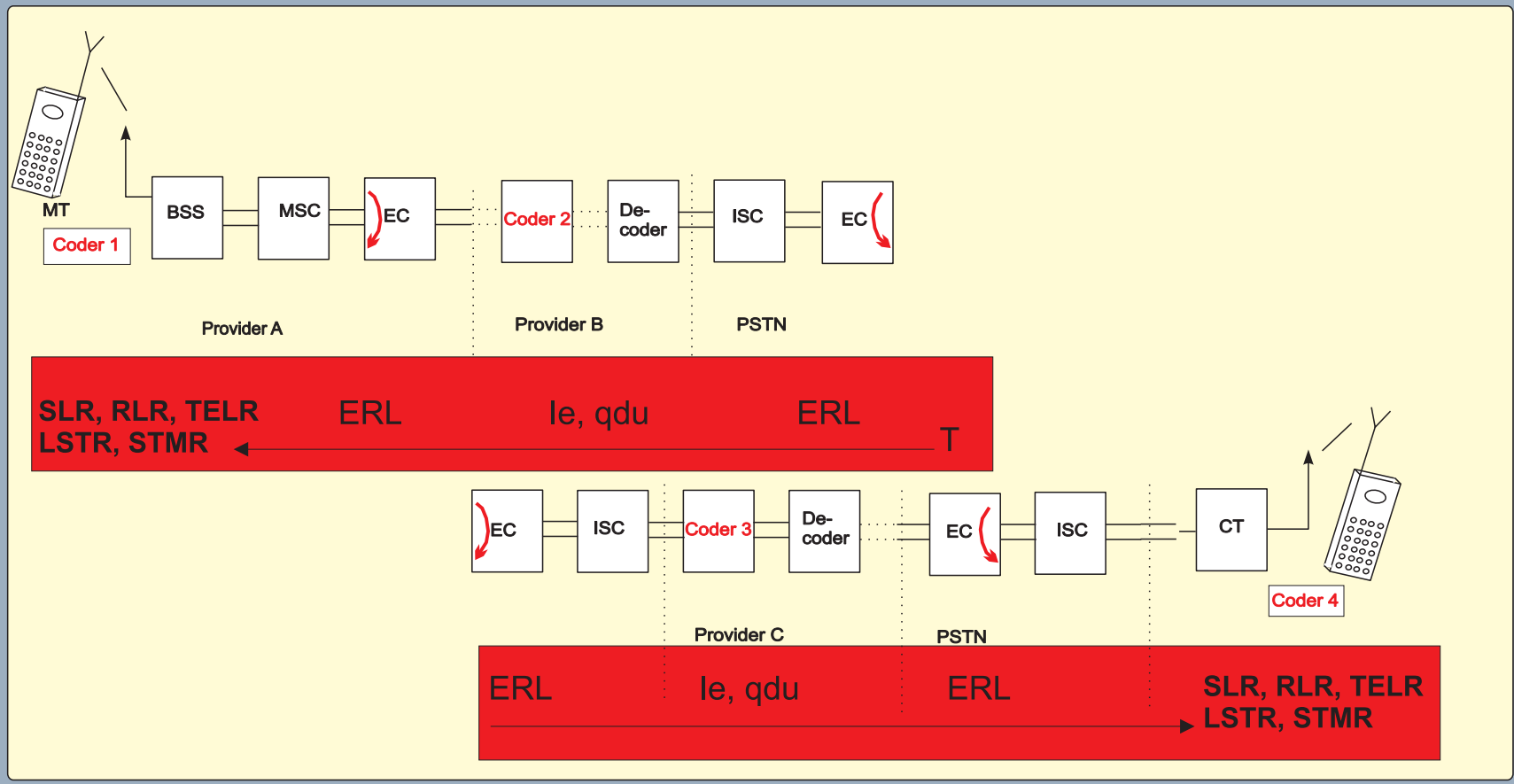


Example DCME and Echo Canceller:

- Addition of very Comfort Noise (Echo Signal as well)
- Concatenation of Switching (Echo Signal as well)
- Double Talk Detection



Example of Interaction Terminal/Network Components (only one way transmission):
- **Noise and Addition of Comfort Noise**
- **Concatenation of Switching**
- **Speech Detection and Noise**
- **Speech Coding, Cascaded, with Various Types of Noise**



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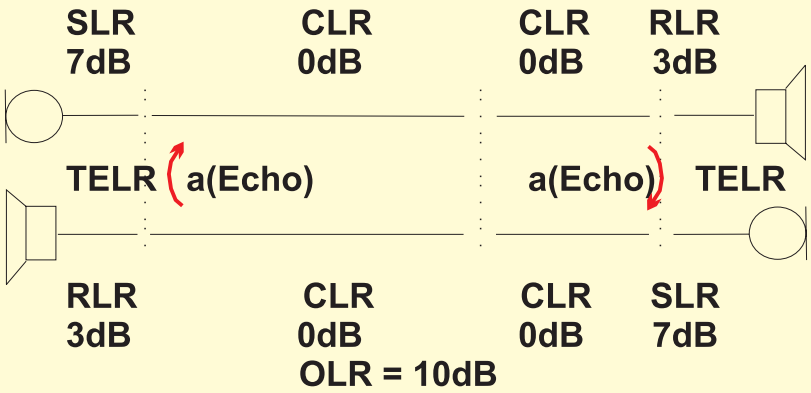


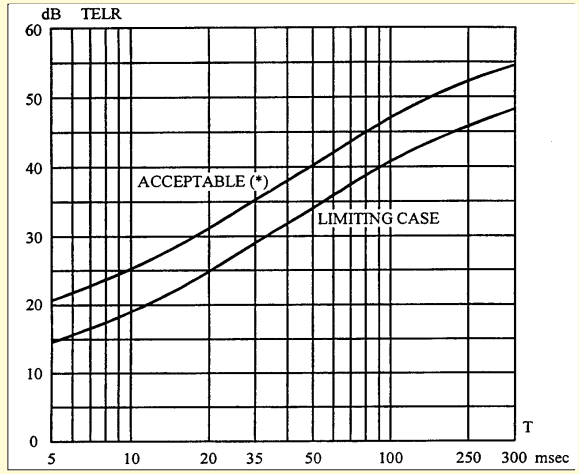


Fig. 1 G.131

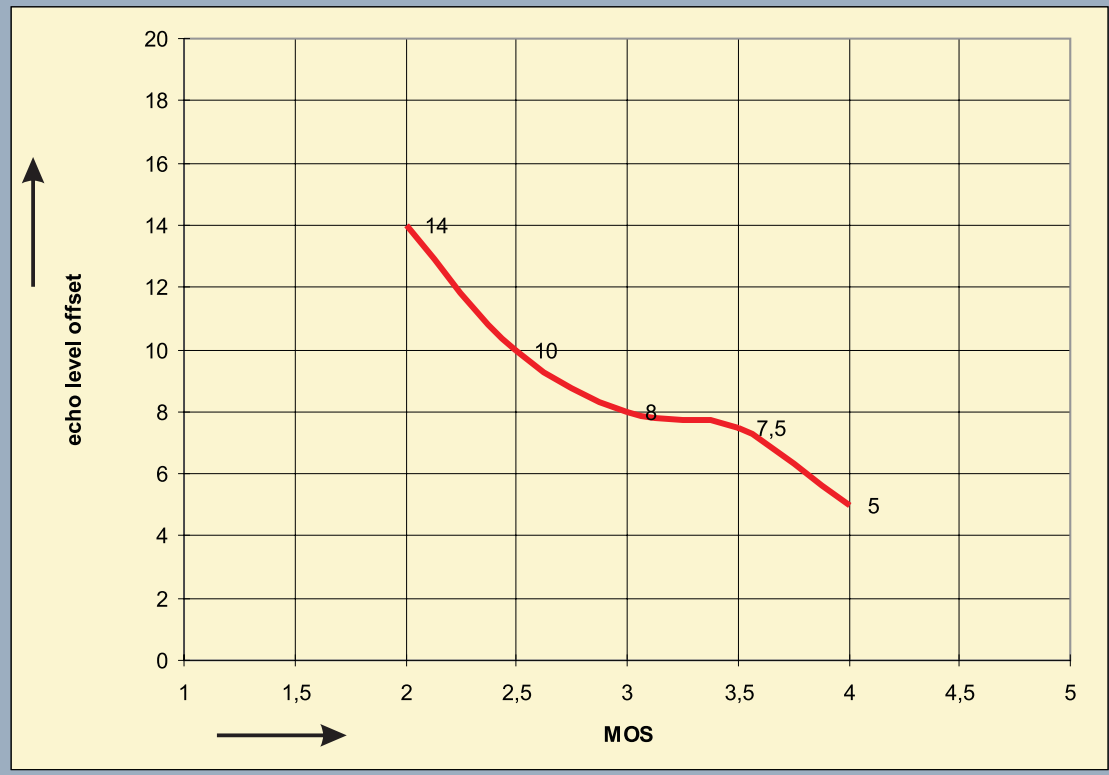
planning values:

- **loudness ratings**
- **quantization distortion(qdu)**
- **delay -> echo cancellation/suppression**

problems:

- frequency dependant values
- non linear, time variant transmission properties
- proper consideration of codes, cascading of codecs, echo cancellers etc.
- interaction of different transmission systems (e.g. PSTN, IP..), influence on speech quality

Echo level offset during double talk to achieve the same MOS score

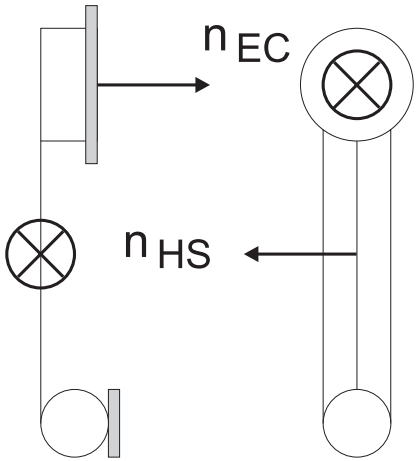


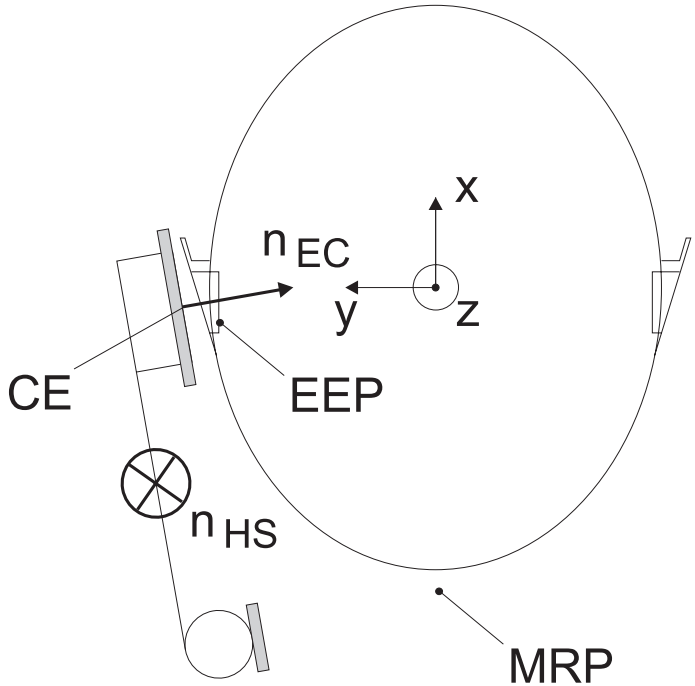
MOS under single talk conditions, use of handset

Conditions:
HATS mounted handset for recording,
variable echo loss conditions
experts listener test, 5 point scale

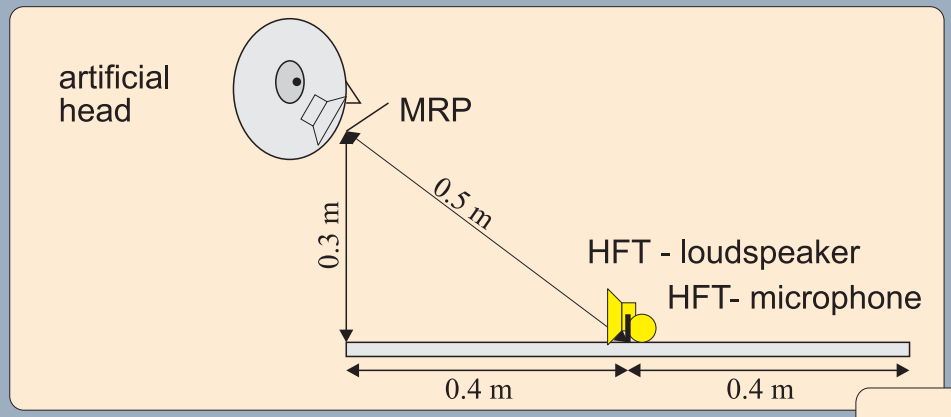
Subjectively relevant parameter	More detailed situational description	Description of Signal Processing	Measurement Parameters
quality of background noise transmission	typically the transmission in SND direction • at idle mode • with far end speech • with near end speech	• design of noise reduction systems • design of NLP or center clippers in conjunction with EC's • design of speech/noise activated AGC	• attenuation range • attenuation in SND direction • switching characteristics • minimum activation level in SND direction • frequency response • sensitivity of background noise detection (activation level, absolute level, level fluctuations)
double talk performance	typically in SND and RCV direction • loudness variation between single and double talk periods • loudness variation during double talk • echo disturbances • occurrence of speech gaps	• design of echo cancellers • design of double talk detectors • design of background noise detection • design of level control	• attenuation range • attenuation in SND/RCV direction during double talk • switching characteristics • minimum activation level to switch over from RCV to SND direction and from SND to RCV direction • echo attenuation • spectral and time dependent echo characteristics • design of NLP or center clippers in conjunction with EC's

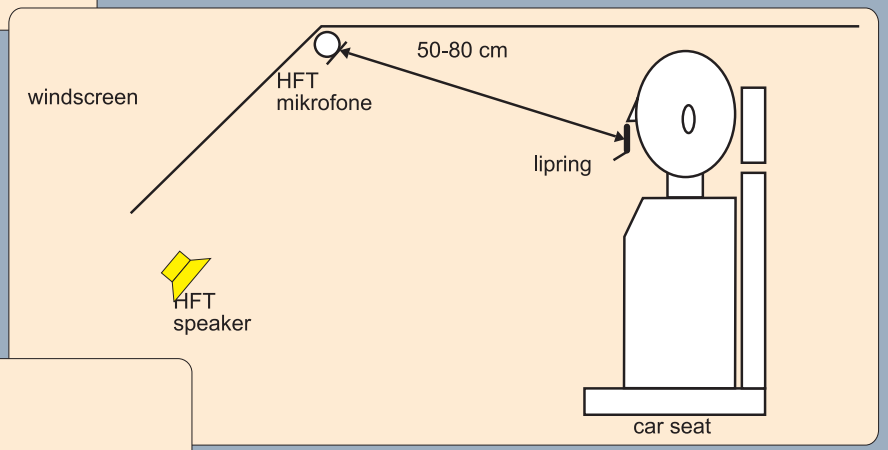
echo disturbances under single talk conditions	• measured between RCV and SND direction	• design of echo cancellers • design of background noise detection • design of level control	• echo level • echo level fluctuation vs. time • spectral echo attenuation
speech sound quality	• in SND and RCV direction	• design of microphones and speakers • mechanical design (terminals) • design of filters and electronics • design of codecs	• frequency responses • distortions
loudness	• in SND and RCV direction	• design of microphones and speakers • mechanical design (terminals) • design of filters and electronics • (design of codecs)	• loudness ratings in SND and RCV
noise	• in SND and RCV direction	• design of microphones and speakers • mechanical design (terminals) • design of filters and electronics • design of codecs	• noise level • level fluctuations • spectral characteristics

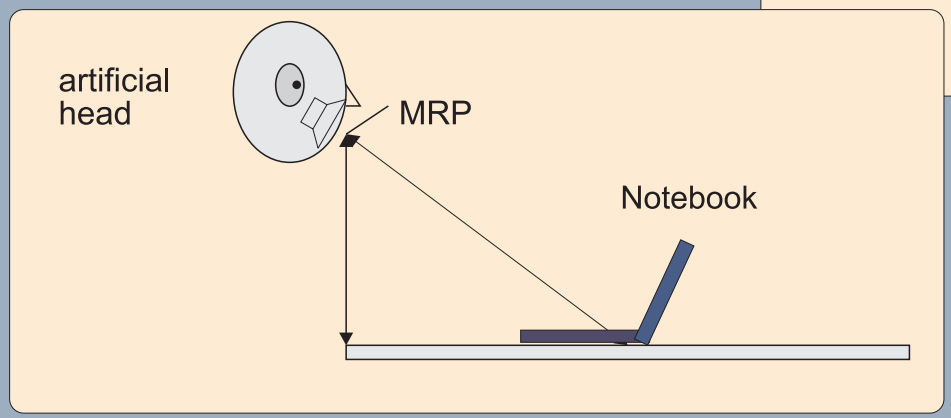




In P.64 two positions are defined:
"Standard" is close to LRGP
"Alternative" should be chosen for flat handsets


artificial
head
MRP
0.5 m
0.3 m
HFT - loudspeaker
HFT- microphone
0.4 m
0.4 m


windscreen
HFT
mikrofone
50-80 cm
lipring
HFT
speaker
car seat

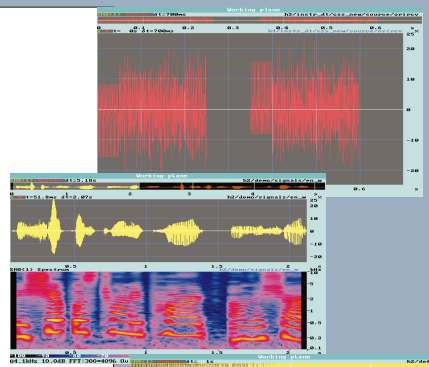

artificial
head
MRP
Notebook

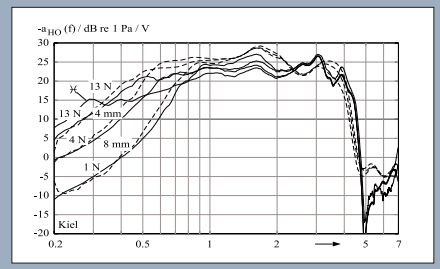
“Traditional” Instrumental Measurements, Single Talk Situation:

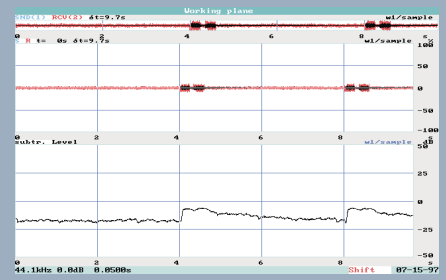
- Transfer Function
- Loudness Ratings
- Distortion
- System-Dynamic
- System-Linearity

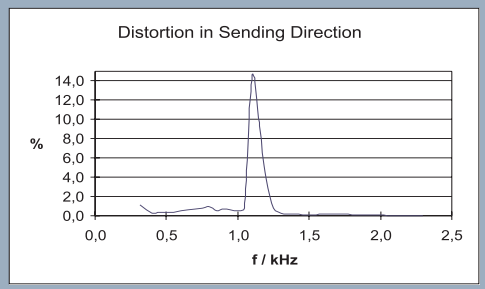
- Sensitivity against Room Noise

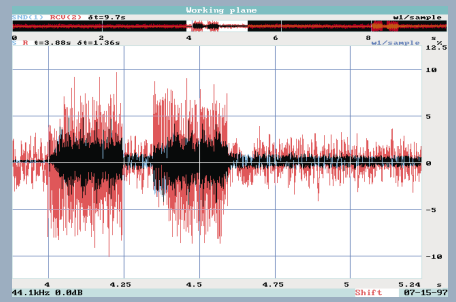
- Switching Characteristics







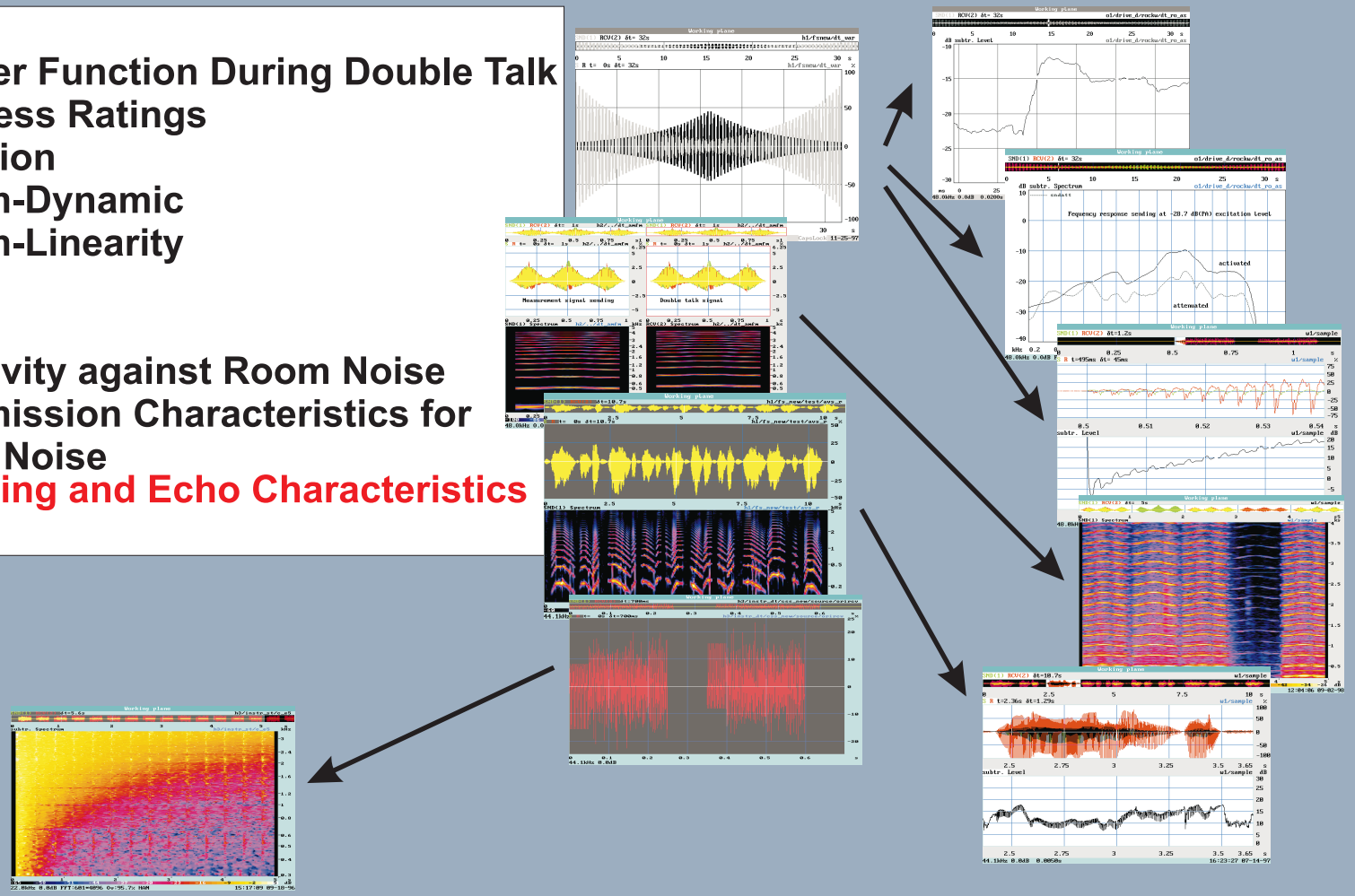




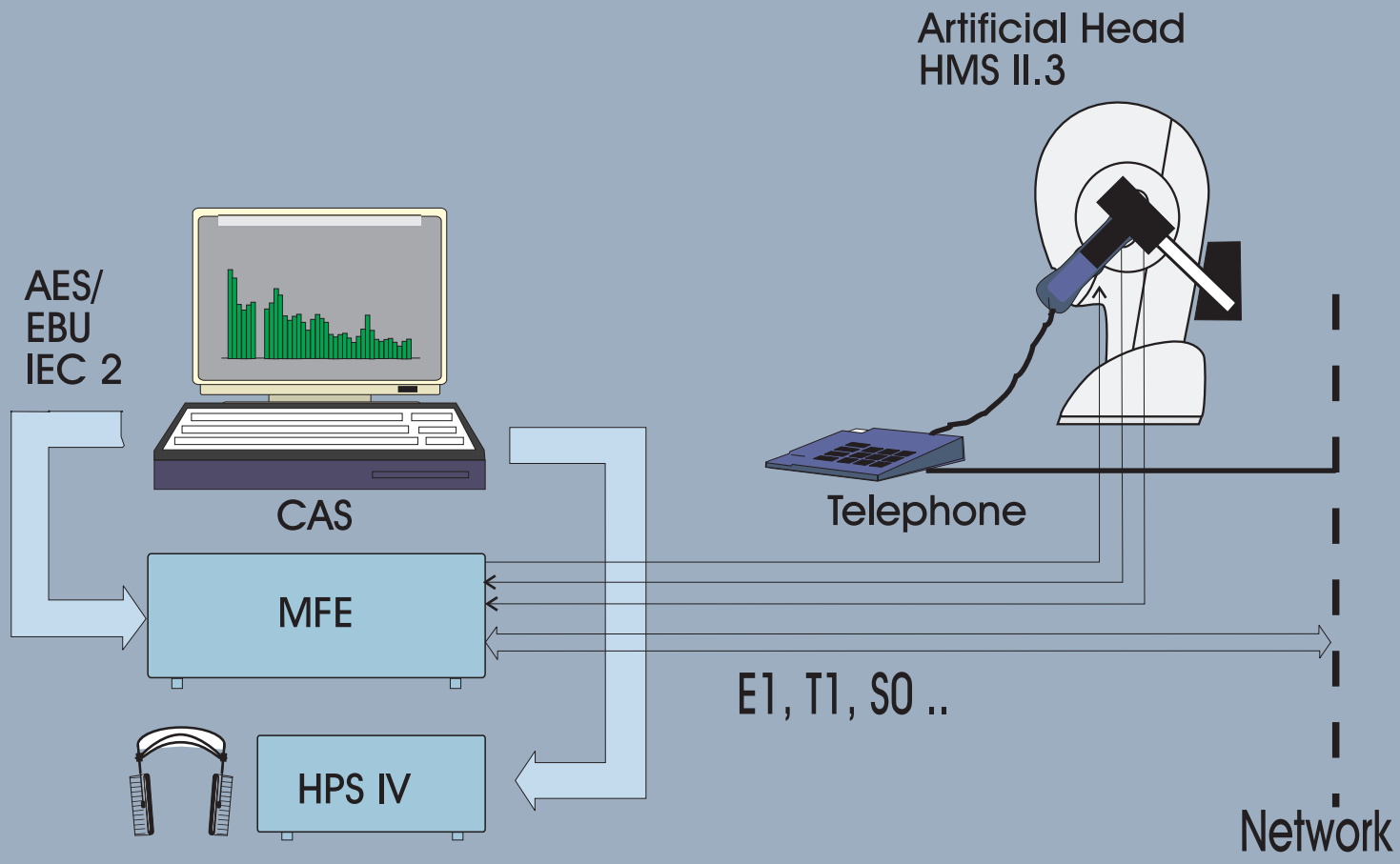
Instrumental Measurements, Double Talk Situation:

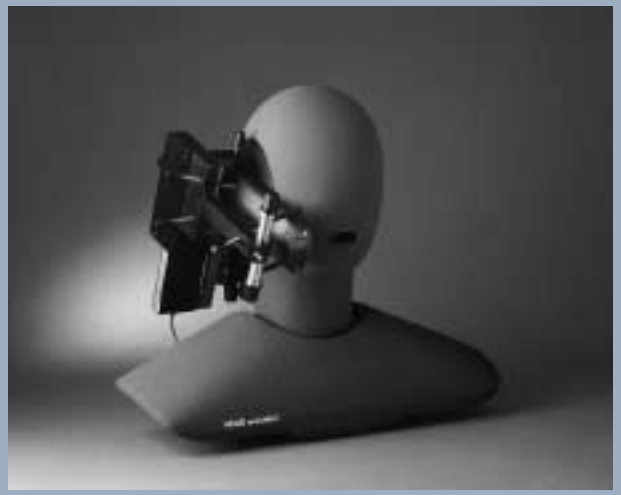
- Transfer Function During Double Talk
- Loudness Ratings
- Distortion
- System-Dynamic
- System-Linearity

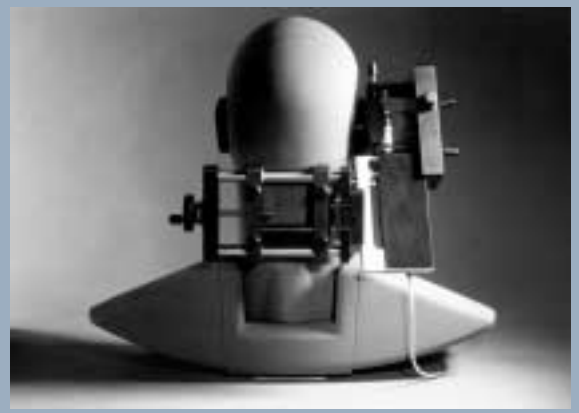
- Sensitivity against Room Noise
- Transmission Characteristics for Room Noise
- Switching and Echo Characteristics



Measurement Arrangement for Determining the Transfer Characteristics End to End







System Components

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See also our web page:

http://www.head-acoustics.de