

# Specifying High-Quality Hands-Free Speech Communications in Motor Vehicles

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## Overview

- Introduction
- Speech over Hands-free Telephones
  - System Complexity
  - Microphone Position
  - Loudspeaker Position
  - Car2Car Communication
  - ...towards Wideband
- Summary and Conclusion

[www.head-acoustics.de](http://www.head-acoustics.de)

HQ HFT Speech Communications

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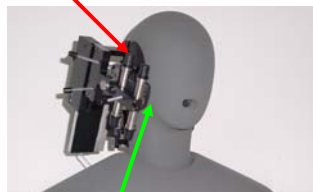
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## “The Hands-free Problem...”

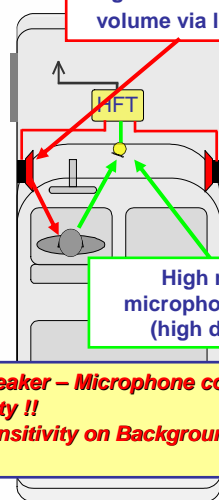
Use of handset or headset  
("close to ear")...

Low playback volume at  
loudspeaker (low distance)



Low microphone  
sensitivity (low distance)

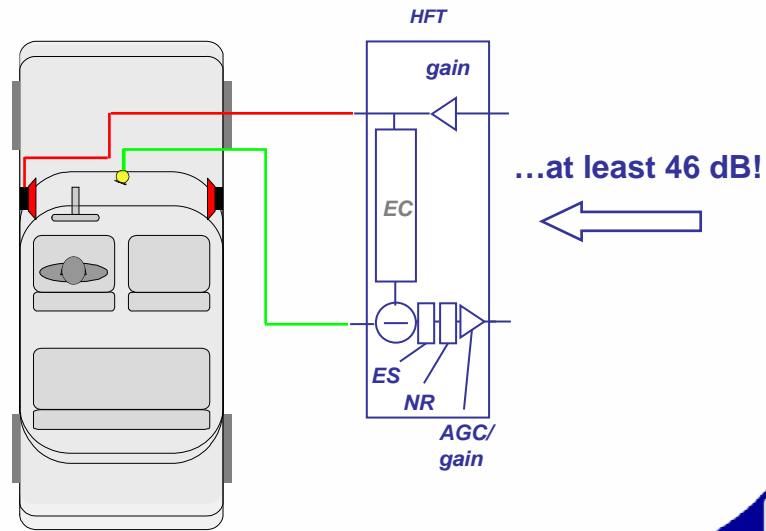
High necessary playback  
volume via loudspeaker



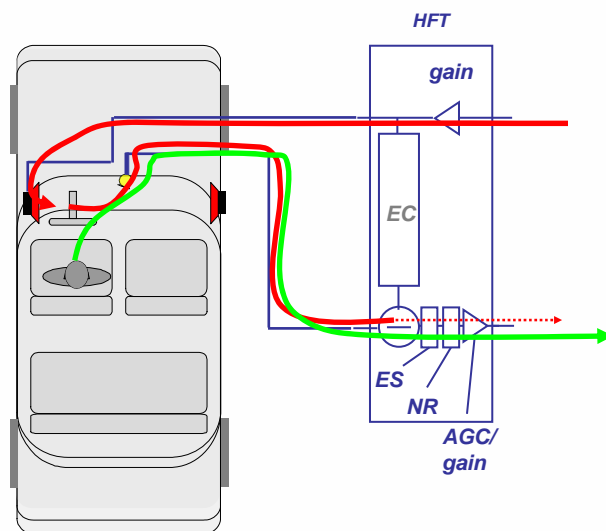
High necessary  
microphone sensitivity  
(high distance (!))

- **Loudspeaker – Microphone coupling !!**
- **Instability !!**
- **High Sensitivity on Background Noise !!**
- ...

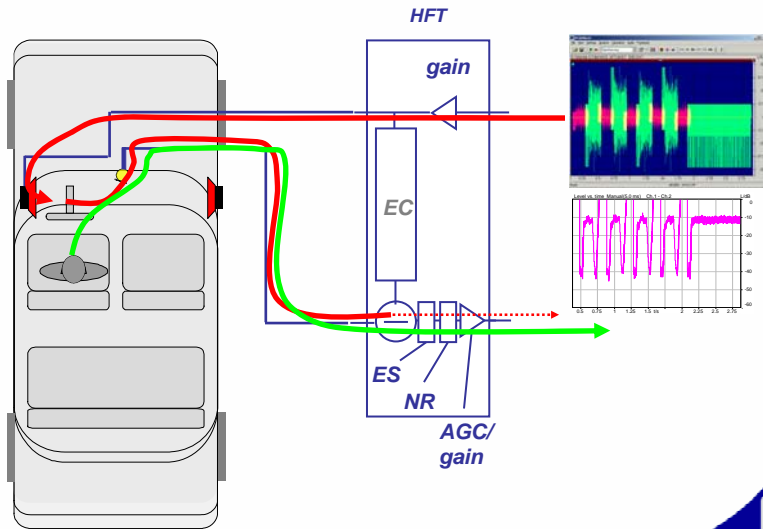
## Algorithms



## “The Hands-free Problem...”

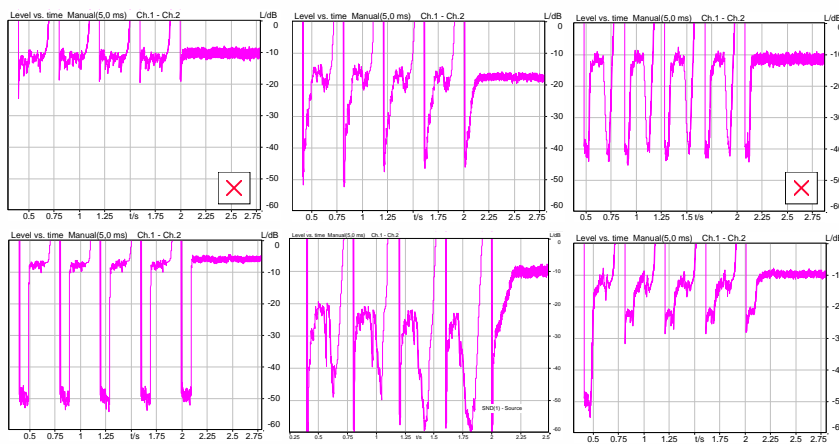


# “The Hands-free Problem...”



# Double Talk Performance

Attenuation range in sending direction (P.340) - examples



## Mobile Hands-free Terminals

### HFT in Vehicles

Massive customer complaints !

Speech Sound in Vehicle

Speech Sound at Landside

Echo Problems...

Double Talk Performance

Transmission Aspects in the  
Presence of Background  
Noise

VDA Specification

ITU-T P.1100

for "built-in" hands-free  
systems

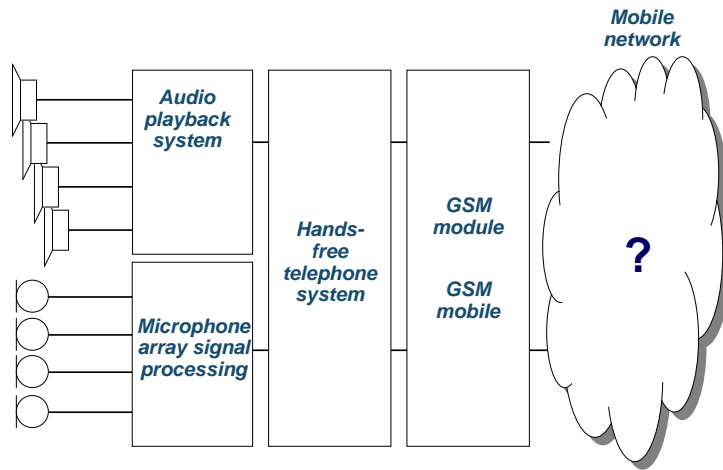
for aftermarket products in all  
target vehicles

for mobile navigation systems  
incl. hands-free functionality

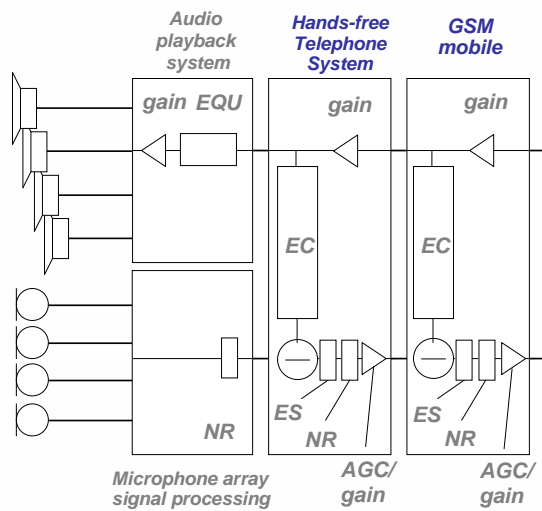
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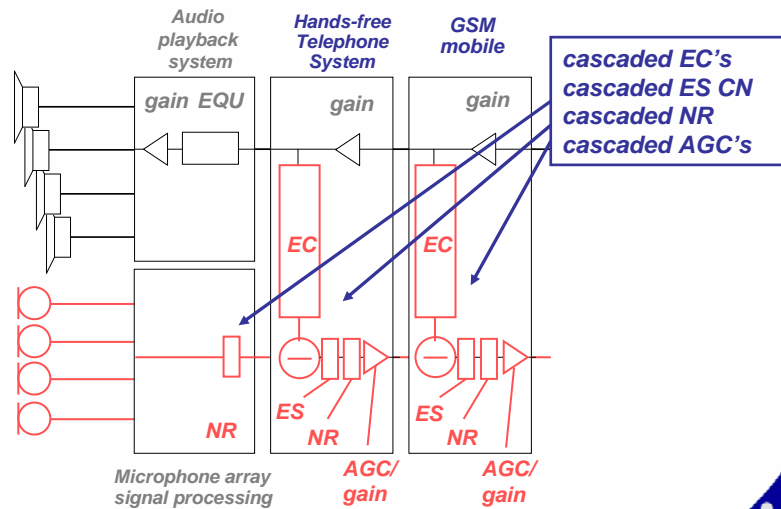
## Complex Systems



## Complex Systems



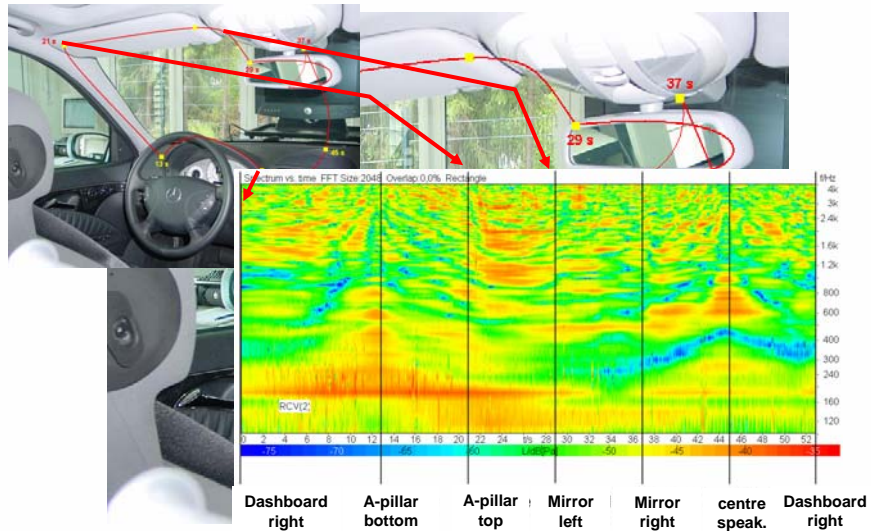
## Sending (Uplink)



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## Microphone Position



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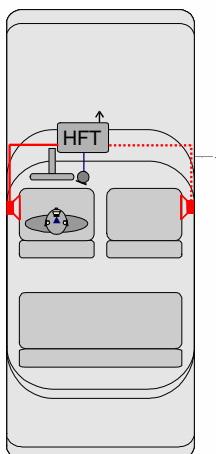
## Loudspeaker Position and Mounting

Intelligibility outside vehicles ...

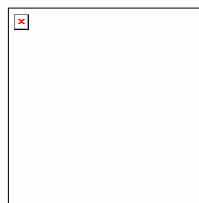


## Test Setup

- Analysis of loudness, ...
- Two audio-visual analysis methods:
  - Laser Vibrometer



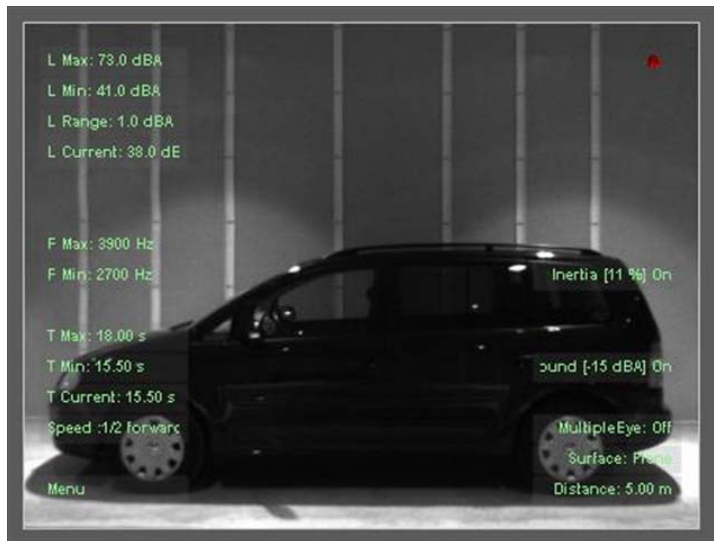
- Acoustical Camera ("Visor")



## Analysis: Acoustical Camera



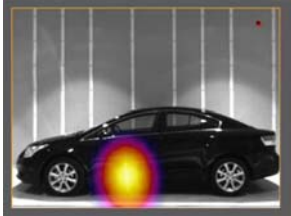
## Analysis: Acoustical Camera



(slow)

## Different cars

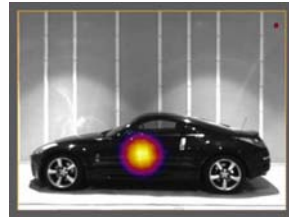
### Speech in cars with different speaker systems



**Sweep to locate speaker positions depending on emitted frequency**  
(760 Hz - 1800)



**Front speaker used, car well damped, low level outside**  
(1400 - 1800 Hz)

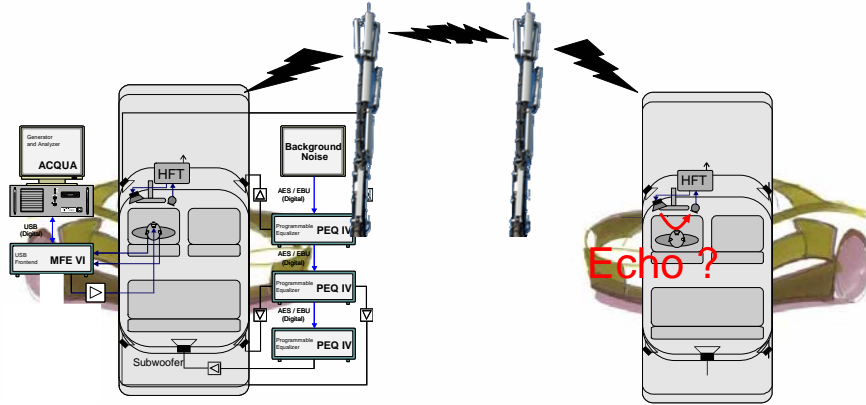


**Door speaker used**  
(1000 - 1500 Hz)

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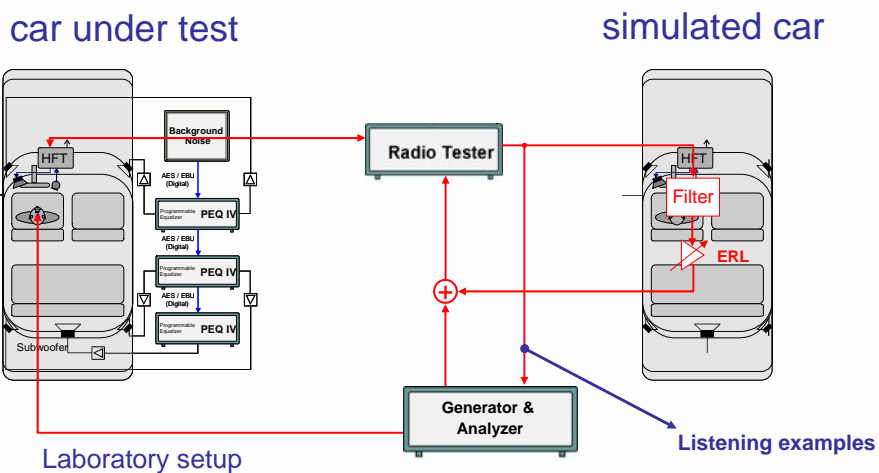
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# Car2Car Communication



Laboratory setup

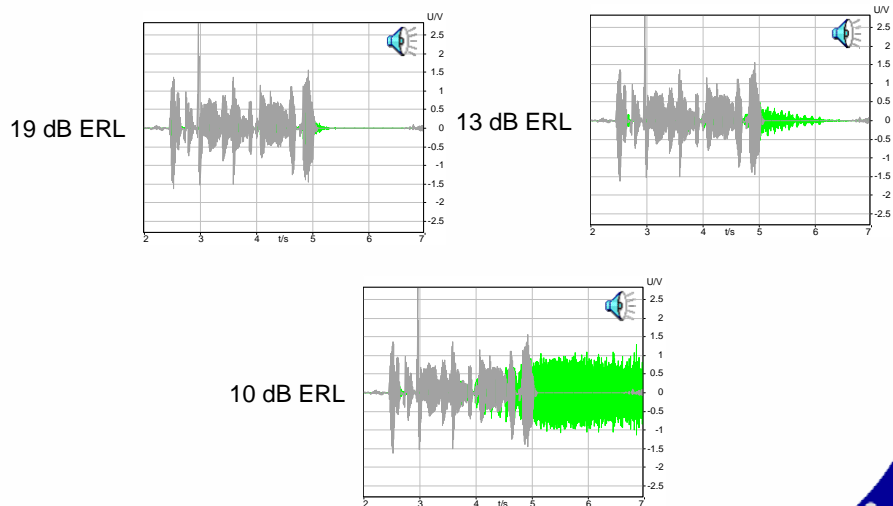
# Car2Car Communication



Laboratory setup

Listening examples

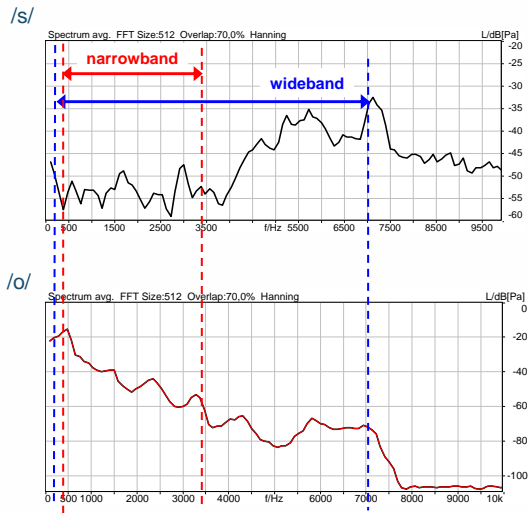
## Car2Car Communication



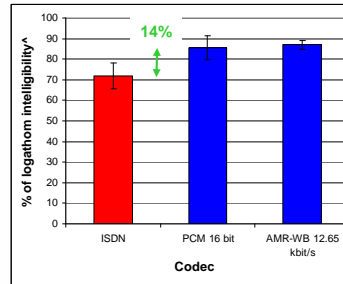
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# "Idea" behind Wideband

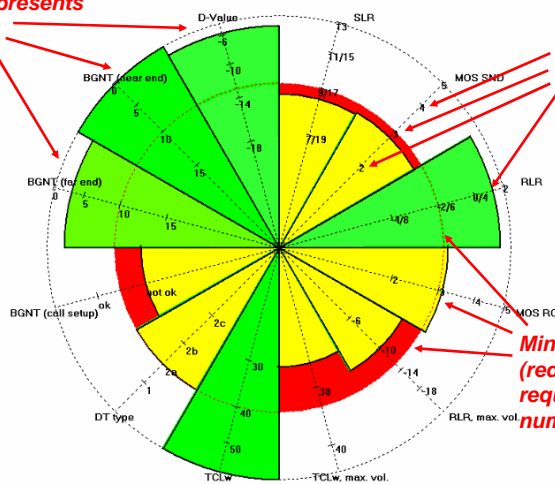


## Quality and intelligibility!



# ITU-T P.505 "HFT Quality Pie"

Each "slide" represents one parameter

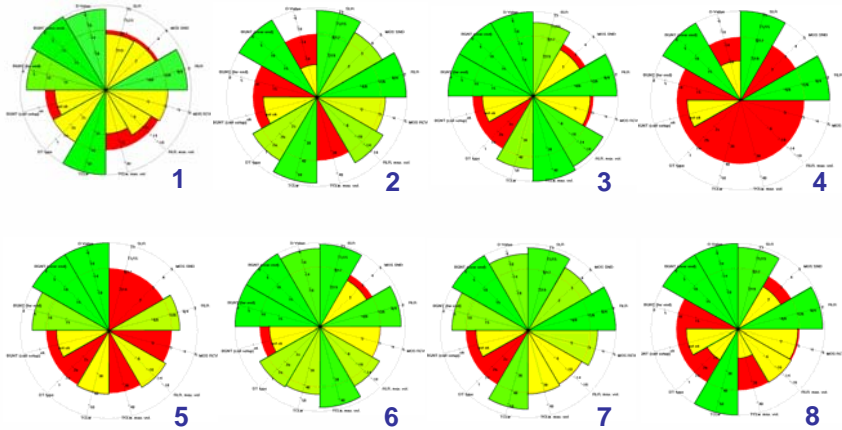


Size of each slice correlates to quality

Minimum requirement (red circle) represents required / recommended numbers

## ITU-T P.505 “Quality Pie“

Some typical results ...



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## Summary and Conclusion

- Optimum car hands-free solution requires the involvement of the audio engineers in the construction phase of a car
- Positioning of microphones and loudspeakers in cars is of critical importance for the overall quality of the system
- Signal processing needs to be optimized for each car individually in order to get the best possible solution
- Cascaded signal processing should be avoided or at least considered and optimized

## Test Setup

**HEAD acoustics Driving simulator** (for stand-alone solutions / aftermarket products)



**Mobiles Sound Playback System** (can be installed in any vehicle)

**Test System**

