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International Telecommunication Union

Speech Quality Testing for VoIP Terminals and Gateways: Input from ETSI "Plugtest" Speech Quality Test Events

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HEAD acoustics GmbH

ITU-T Workshop on "End-to-End QoE/QoS"
Geneva, 14-16 June 2006

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Overview

- Introduction - 1st, 2nd and 3rd SQTE
- Discussion of Results
  - Gateways
  - IP phones
- Summary & Outlook

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Introduction

The ETSI *S*peech *Q*uality *T*est *E*vents

- 1st SQTE October 2000
  - organized and hosted by the *ETSI "Bake-off Service"*
  - 6 participating companies
  - test labs *HEAD acoustics, Deutsche Telekom*
- 2nd SQTE April 2002
  - organized and hosted by the *ETSI "Plugtests Service"*
  - 5 participating companies
  - test labs *HEAD acoustics, Deutsche Telekom*
- 3rd SQTE June and September 2004, "twin event" EU, US
  - organized by the ETSI "Plugtests Service" and HEAD *acoustics*, hosted by HEAD acoustics
  - 11 participating companies, test lab *HEAD acoustics*
- *4th SQTE June 2006*, EU – just ongoing

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The Goal

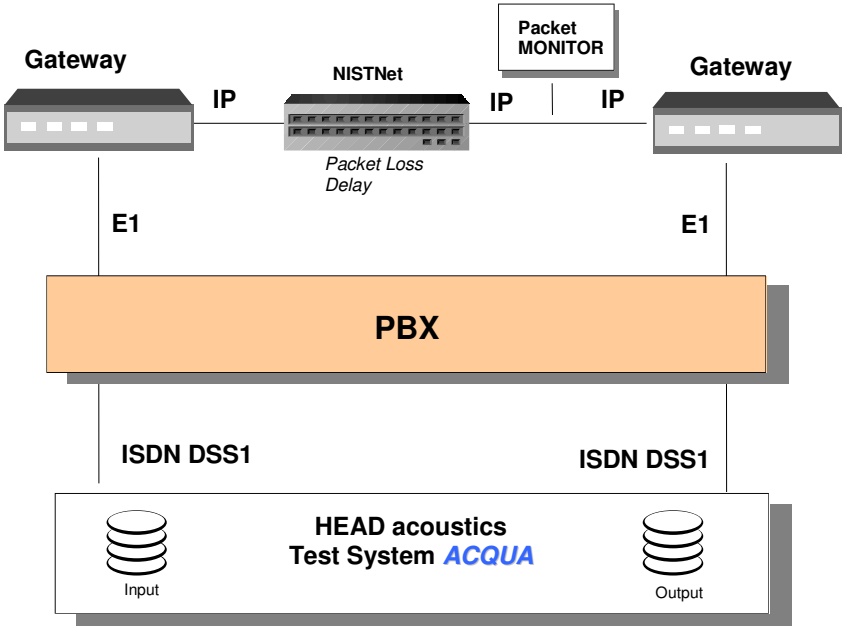
Evaluate all conversational aspects

- Listening speech quality *("**status quo**")*
- Detailed parameter tests
- Echo measurements, EC implementation
- Double talk performance tests
- Quality of background noise transmission

In order to

- *Compare different implementations*
- *Document the state of the arte of technology*
- *Give input to standardization*
- *Help companies to optimize their implementations*

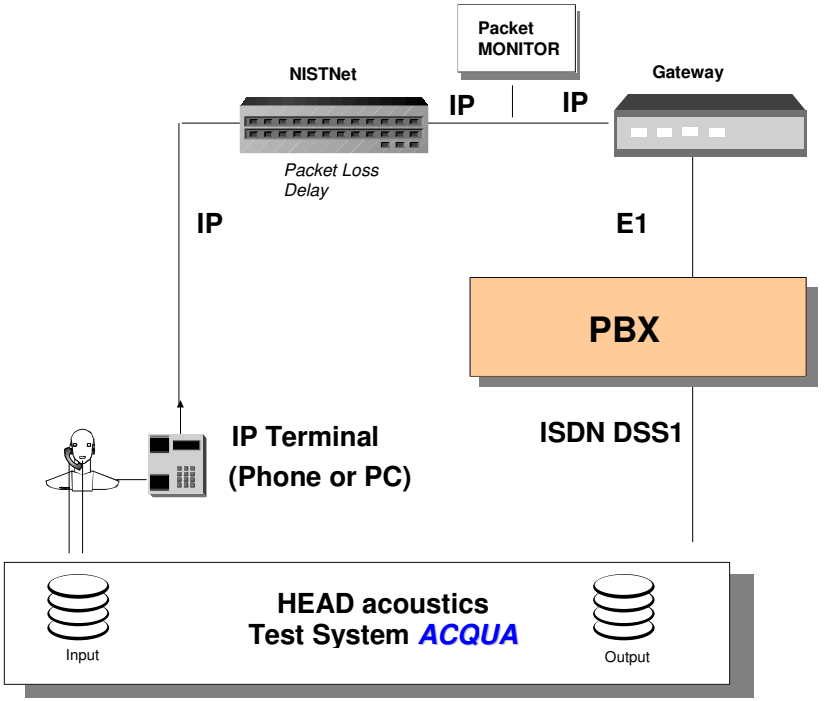
Test Setup Gateways



Condition	Packet Loss (Equal)	Additional Delay[1]	Delay Variation
1a	0	0	No
2a	1%	0	No
3a	2%	0	No
4a	3%	0	No
5a	5%	0	No
6a	1%	50 ms	20 ms (2)

Condition	Packet Loss (Equal)	Additional Delay[1]	Delay Variation
1b	0	0	No
2b	5%	0	No
3b	0	50 ms	20 ms (2)
4b	5%	50 ms	20 ms(2)

Test Setup IP-Phones



Condition	Packet Loss (Equal)	Additional Delay[1)]	Delay Variation
1c	0	100 ms	No
2c	0	100 ms	20 ms(2)
3c	1%	100 ms	No
4c	1%	100 ms	20 ms(2)
5c	3%	100 ms	No

Condition	Packet Loss (Equal)	Additional Delay[1)]	Delay Variation
1d	0	100 ms	No
2d	3%	100 ms	No
3d	0	100 ms	20 ms(2)
4d	3%	100 ms	20 ms(2)

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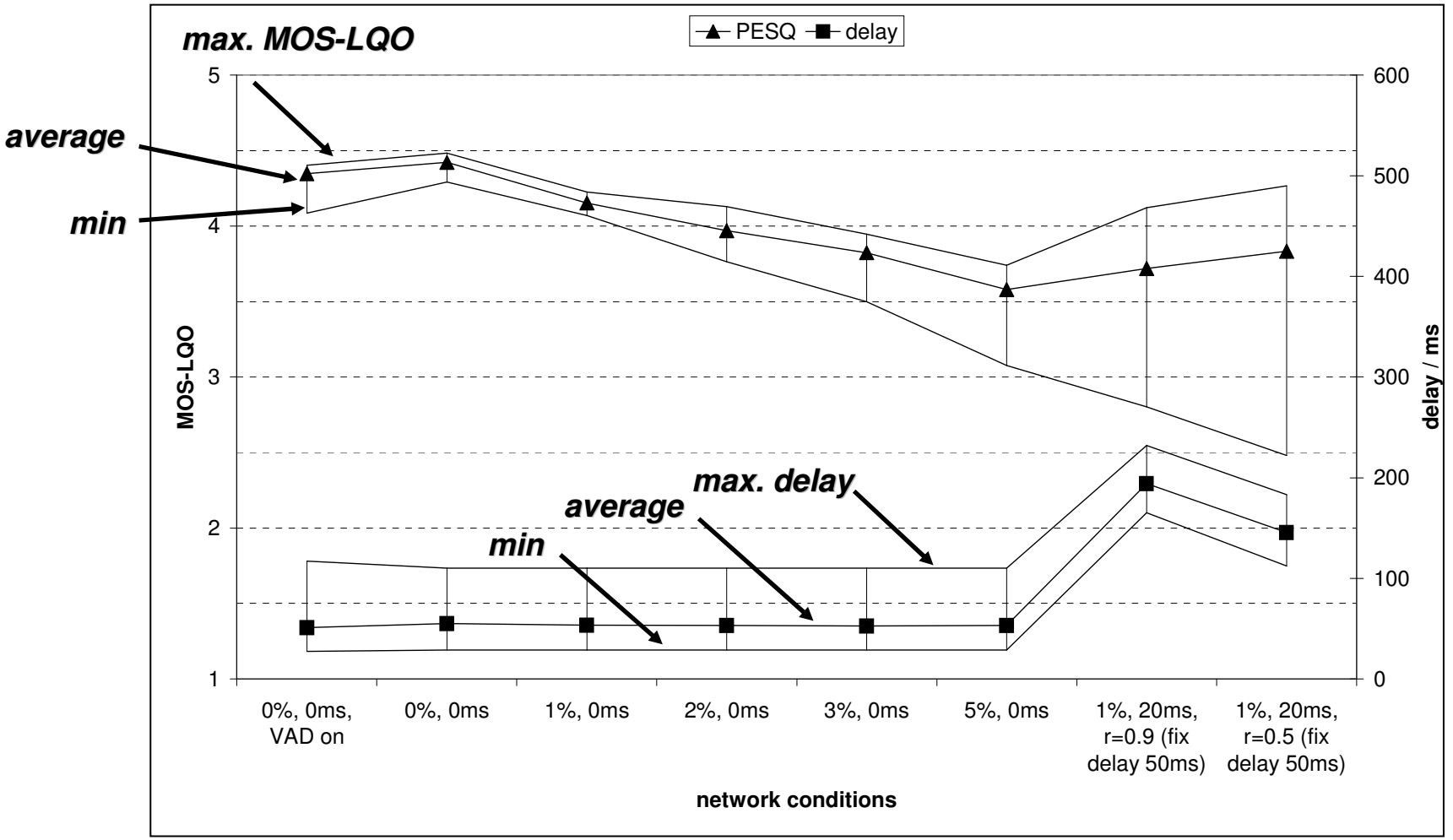
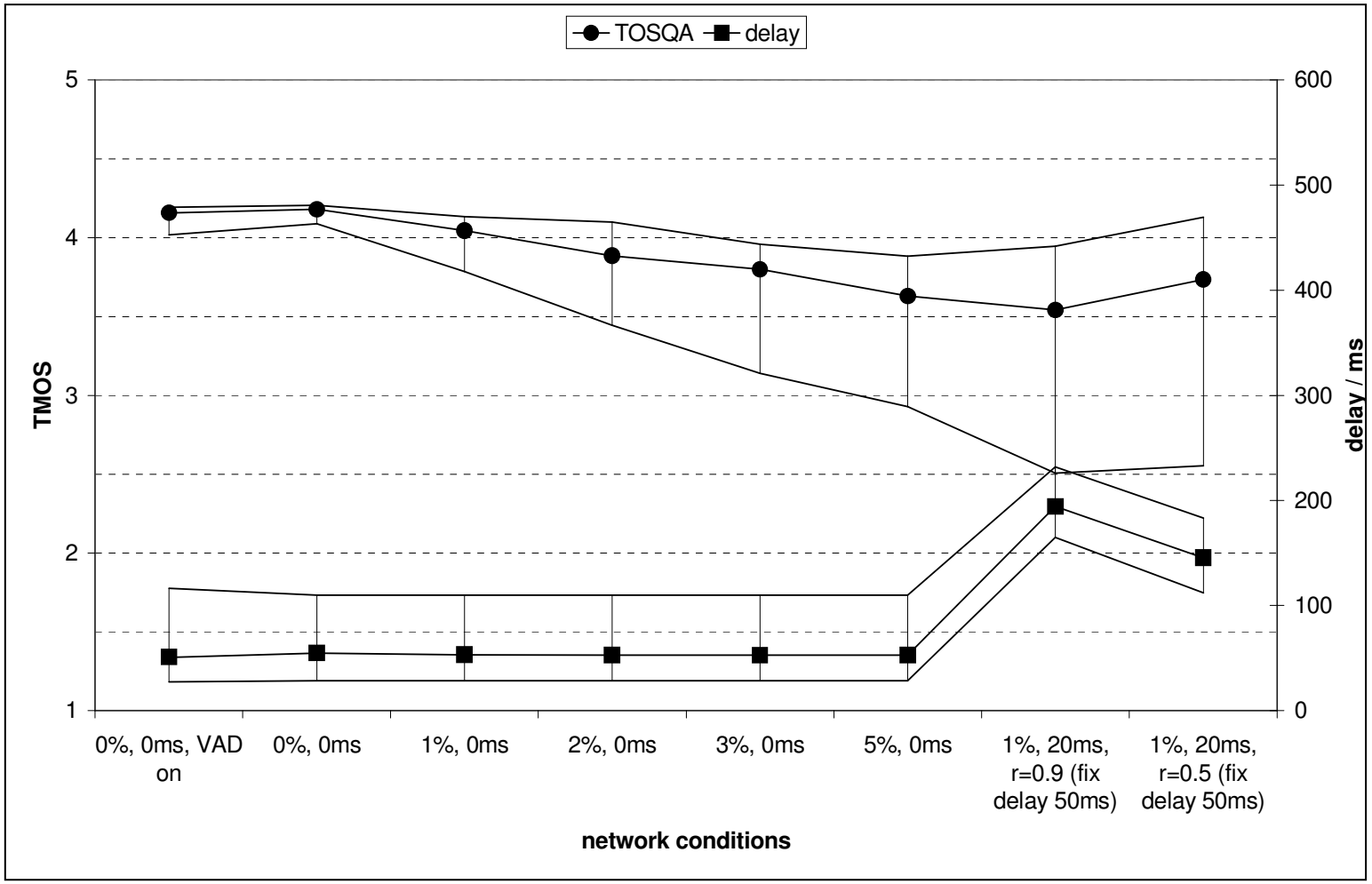
Listening Speech Quality *PESQ P.862 (MOS-LQO)*



G.711

Listening Speech Quality *TOSQA2001 (TMOS)*



G.711

Listening Speech Quality *(MOS-LQO vs. TMOS)*

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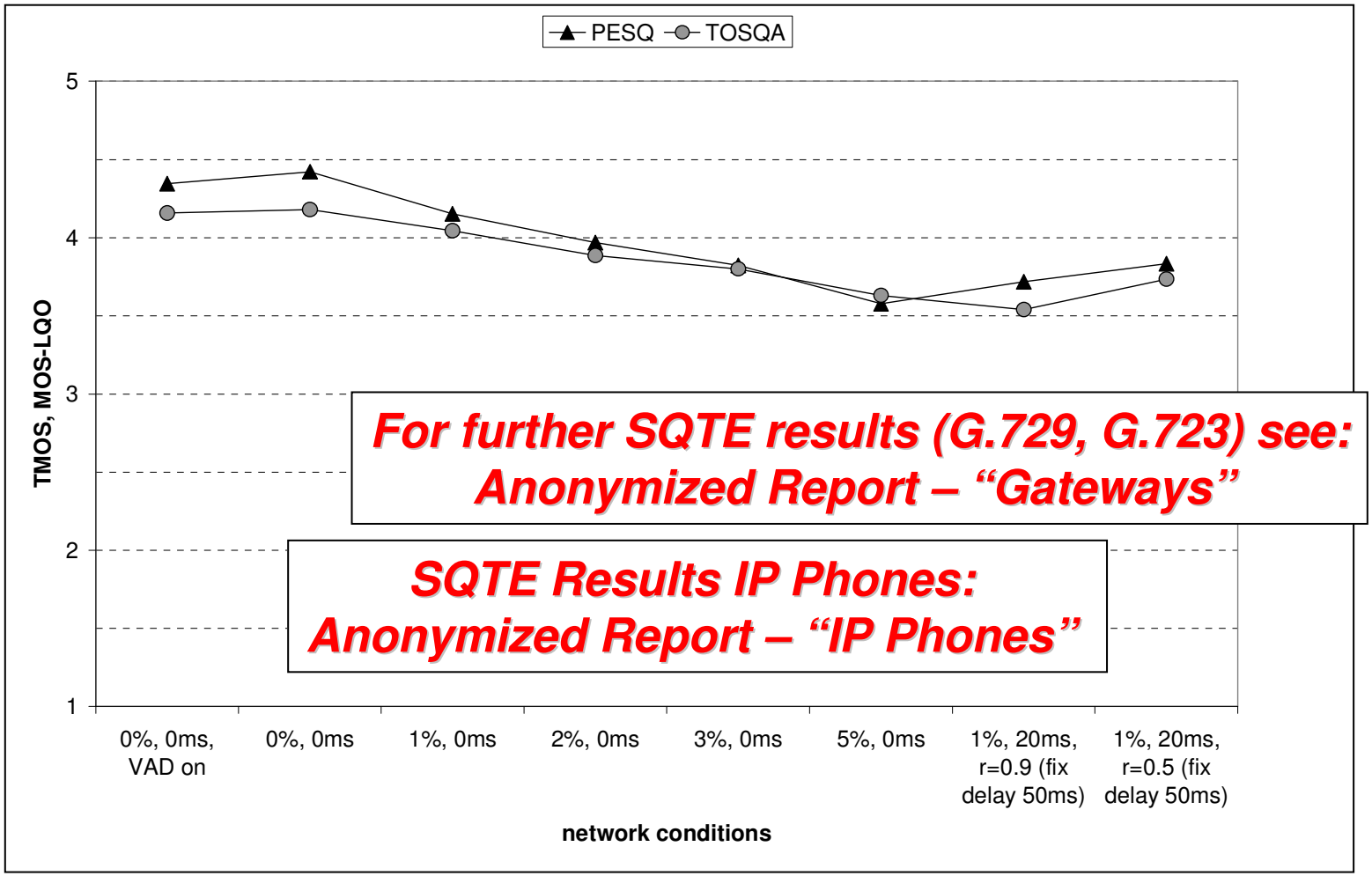


For further SQTE results (G.729, G.723) see: Anonymized Report – "Gateways"

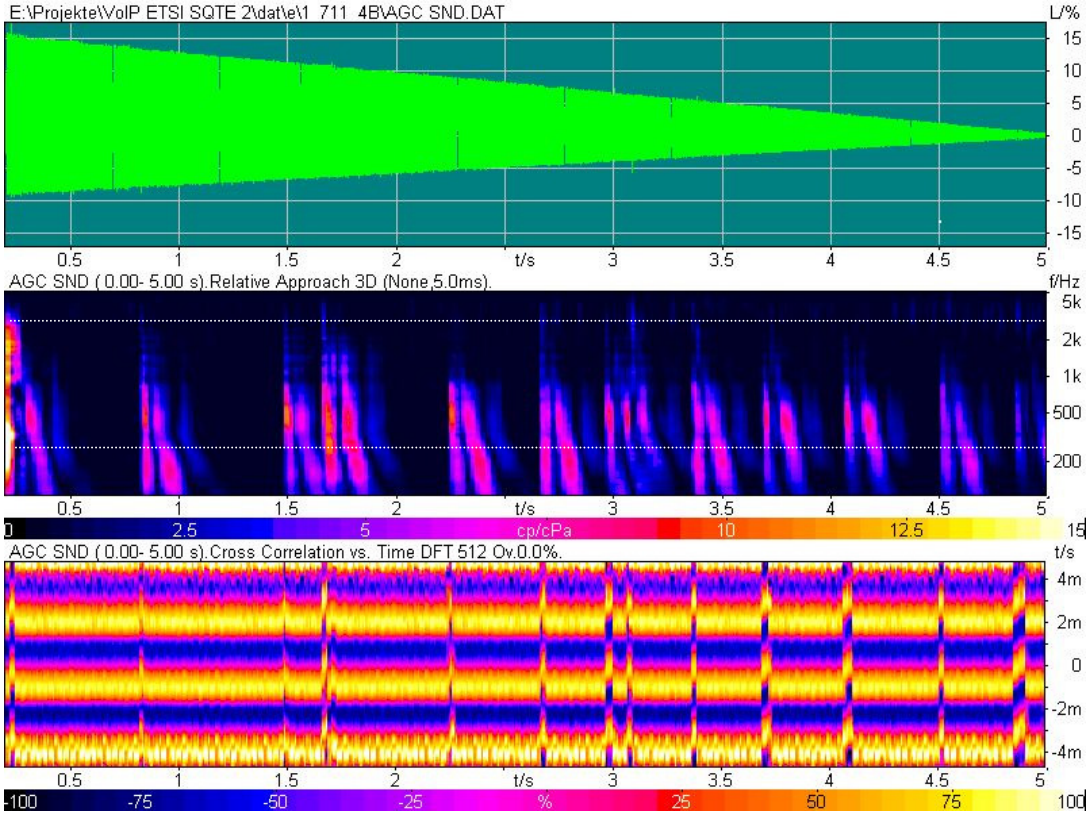
SQTE Results IP Phones: Anonymized Report – "IP Phones"

Highly influencing MOS score - optimization criteria

Test signal (5s)

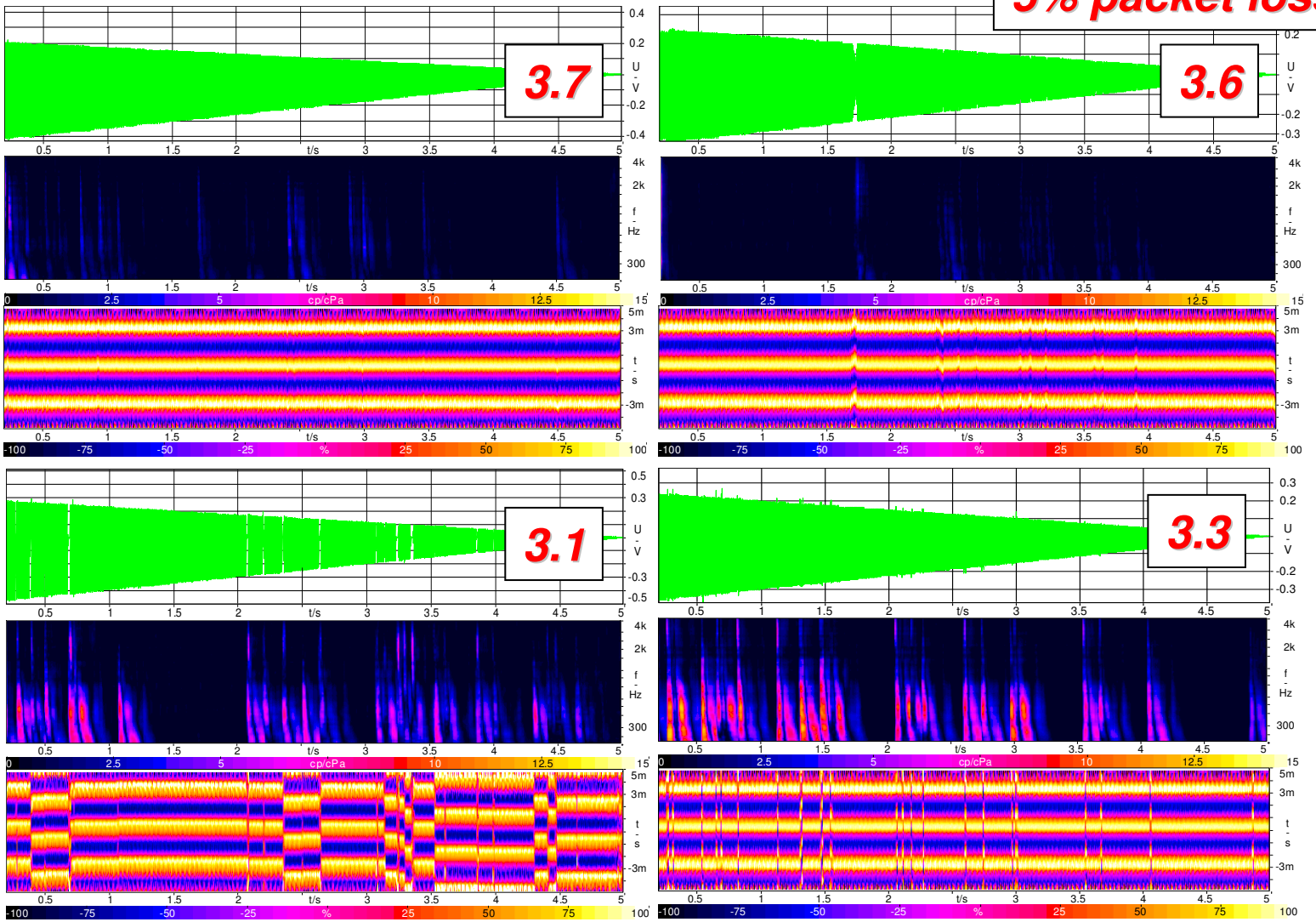
Relative Approach

Cross correlation vs. Time

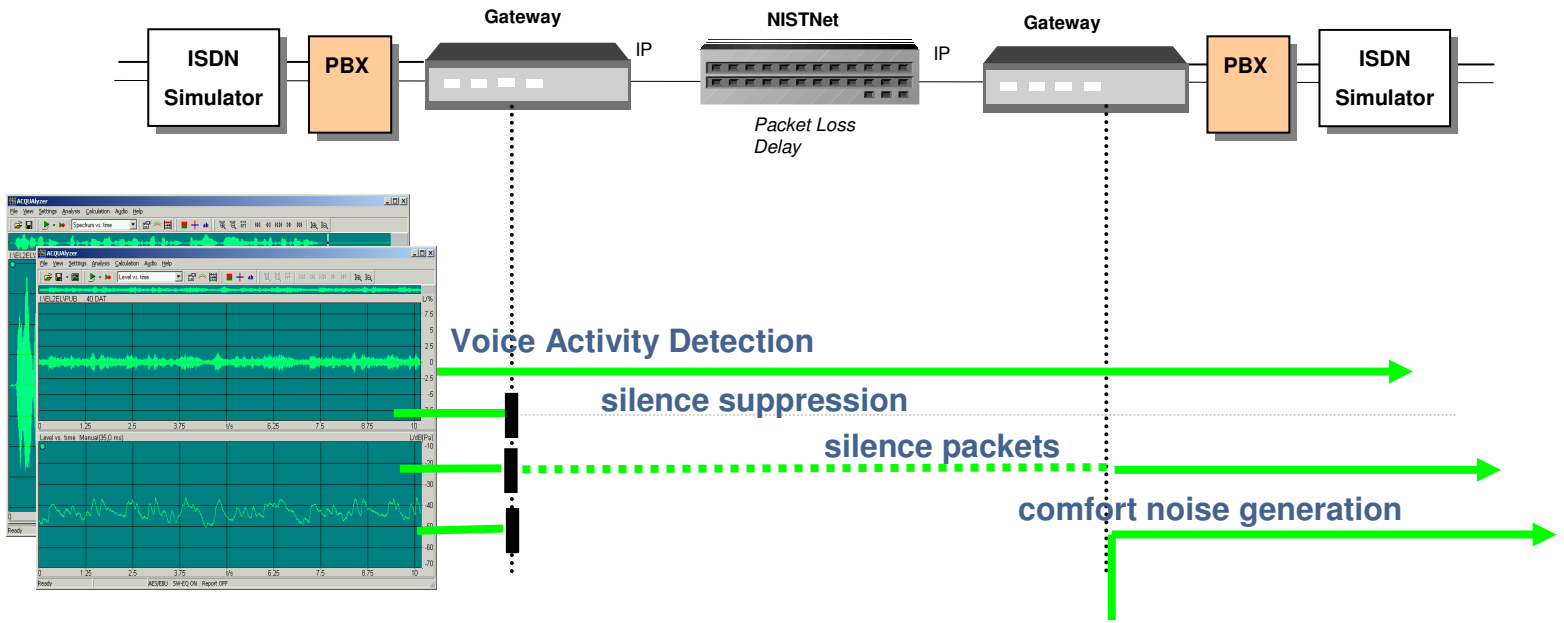


Packet Loss Concealment

MOS-LQO
5% packet loss



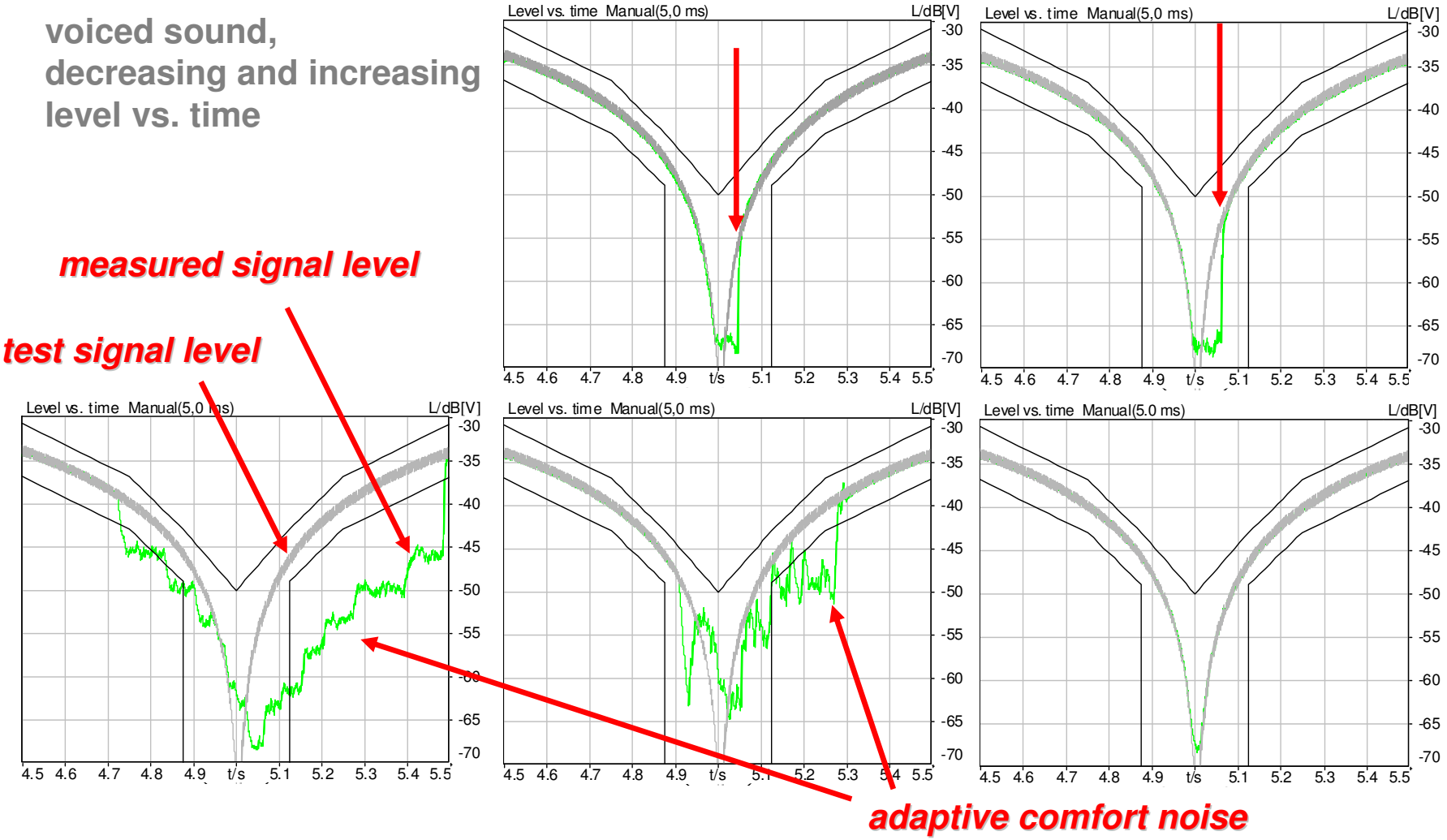
VAD and Comfort Noise



VAD und Comfort Noise

activation thresholds, "hysteresis"

voiced sound,
decreasing and increasing
level vs. time



VAD und Comfort Noise II

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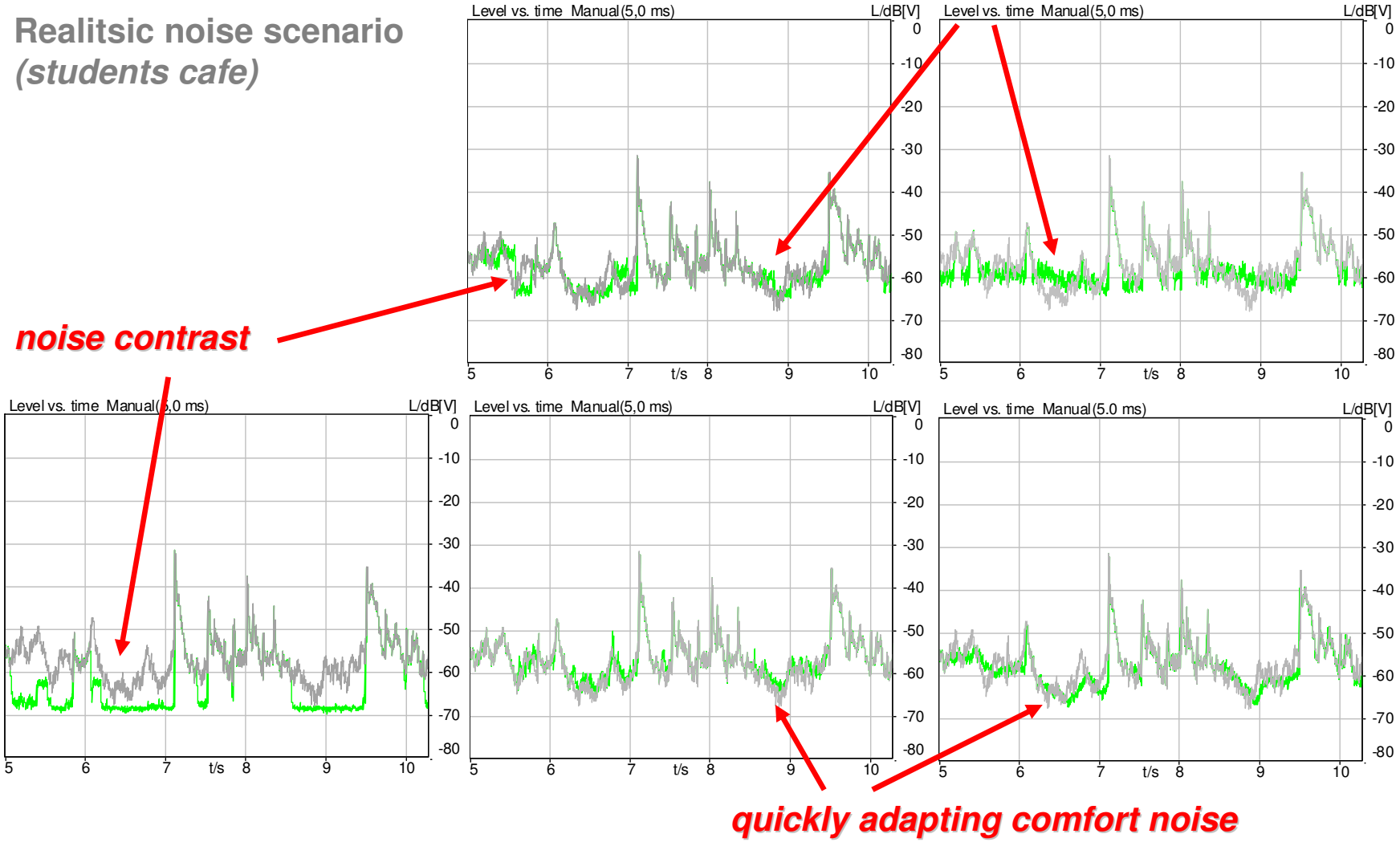
comfort noise level slightly too high

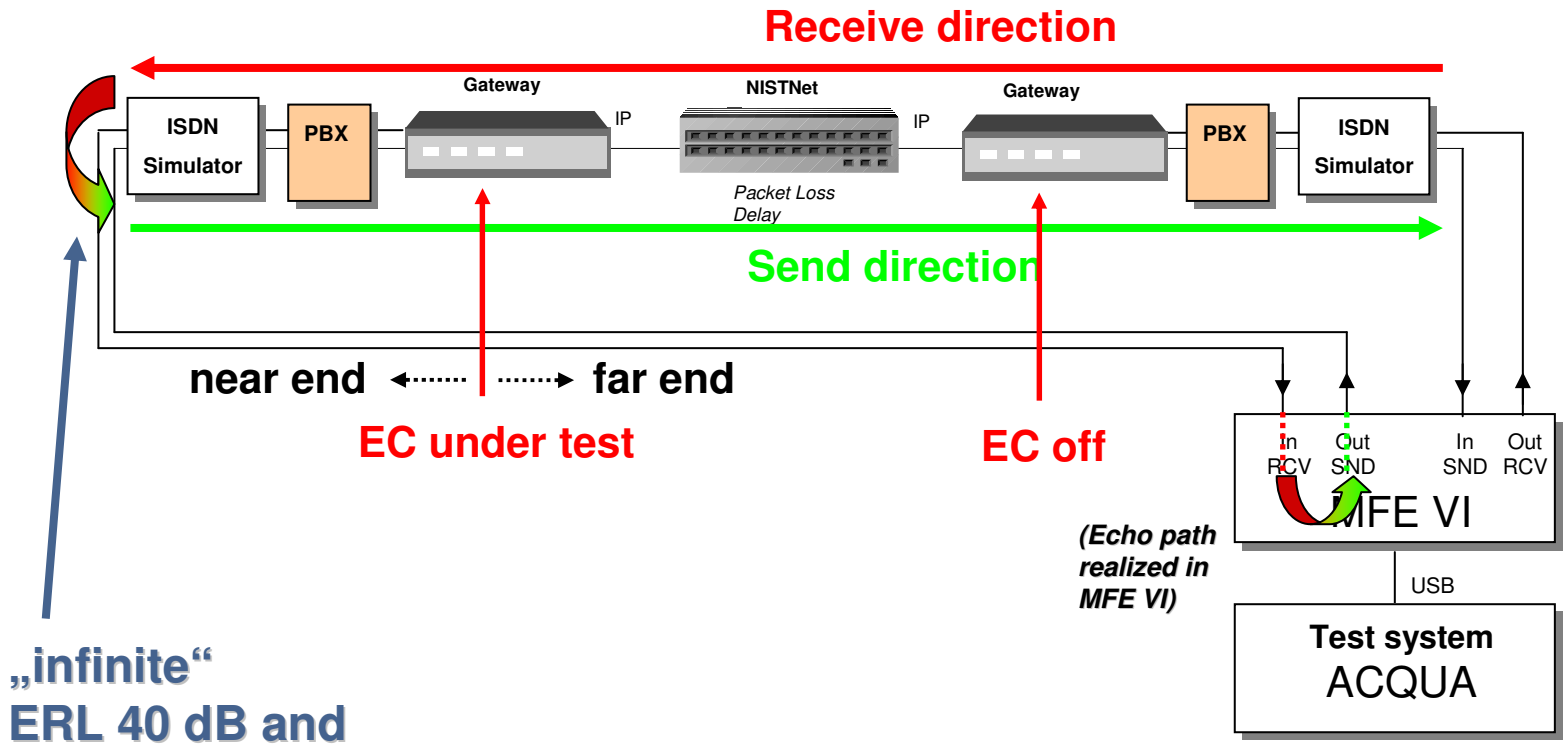
Realitsic noise scenario
(students cafe)



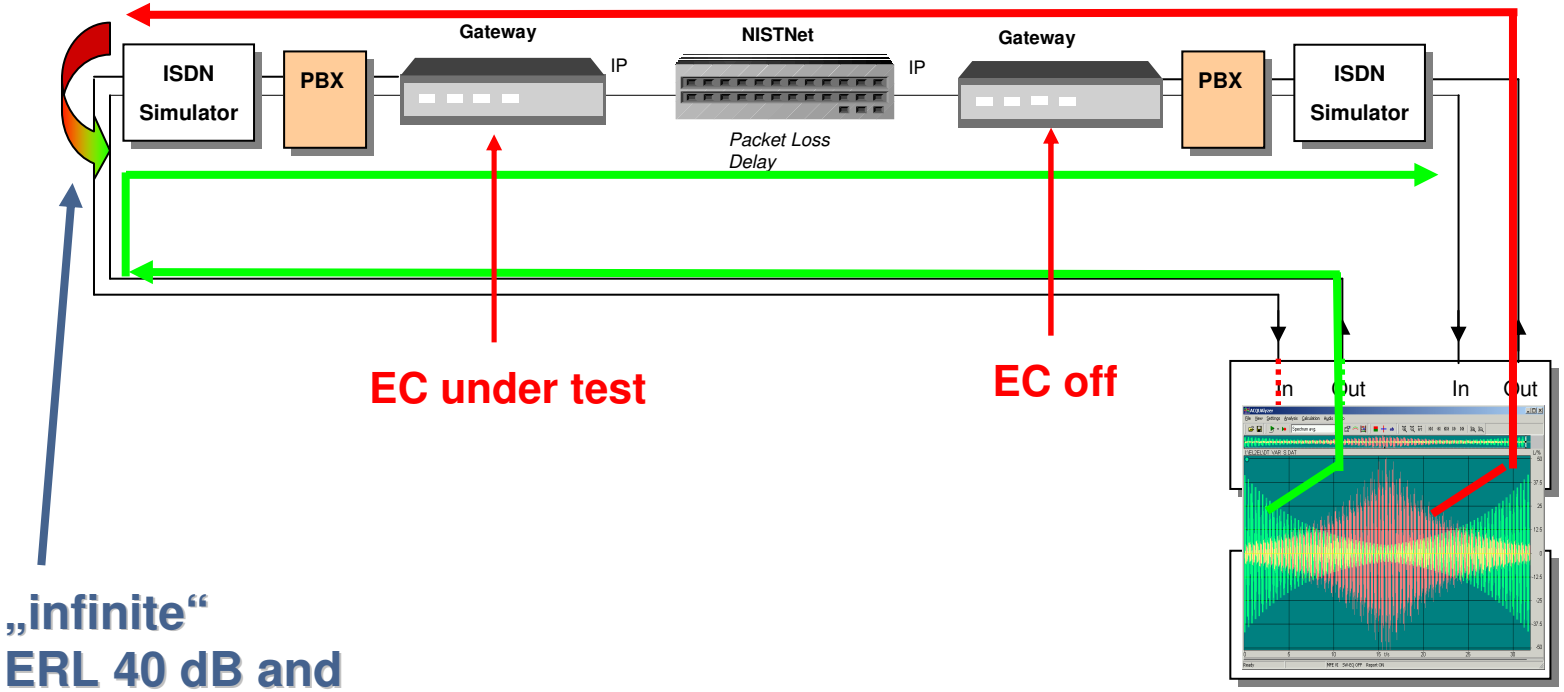
noise contrast

quickly adapting comfort noise

Setup for Echo Canceller Testing



Double Talk Performance



„infinite“
ERL 40 dB and
ERL 6 dB

Double Talk Performance *6 dB ERL*

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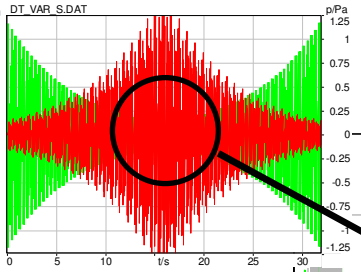
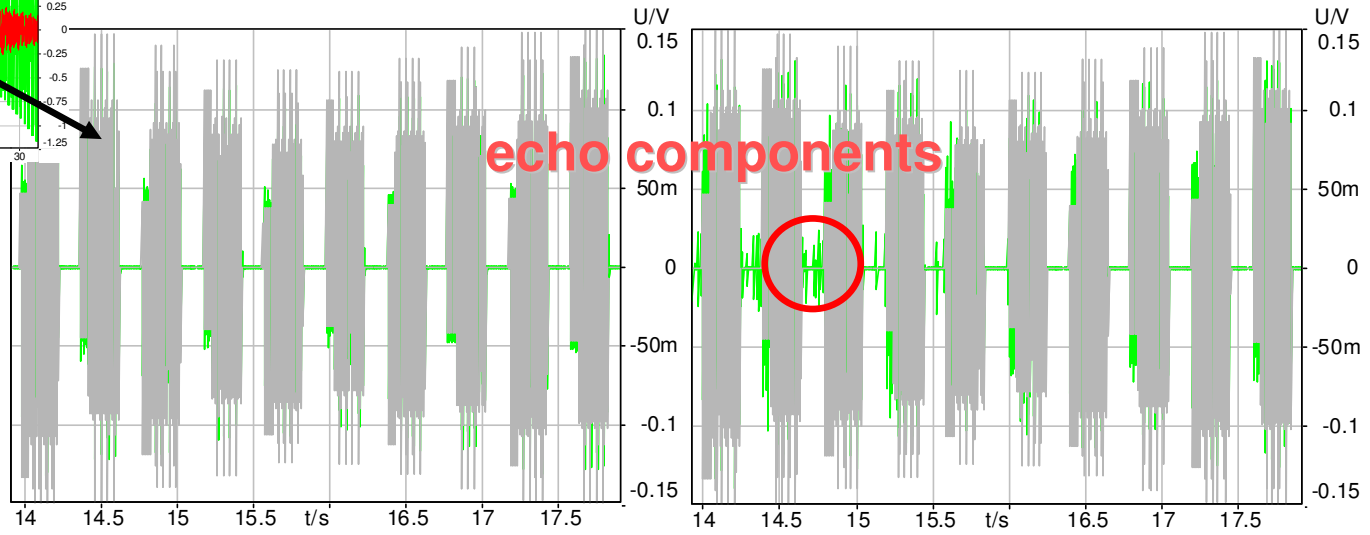
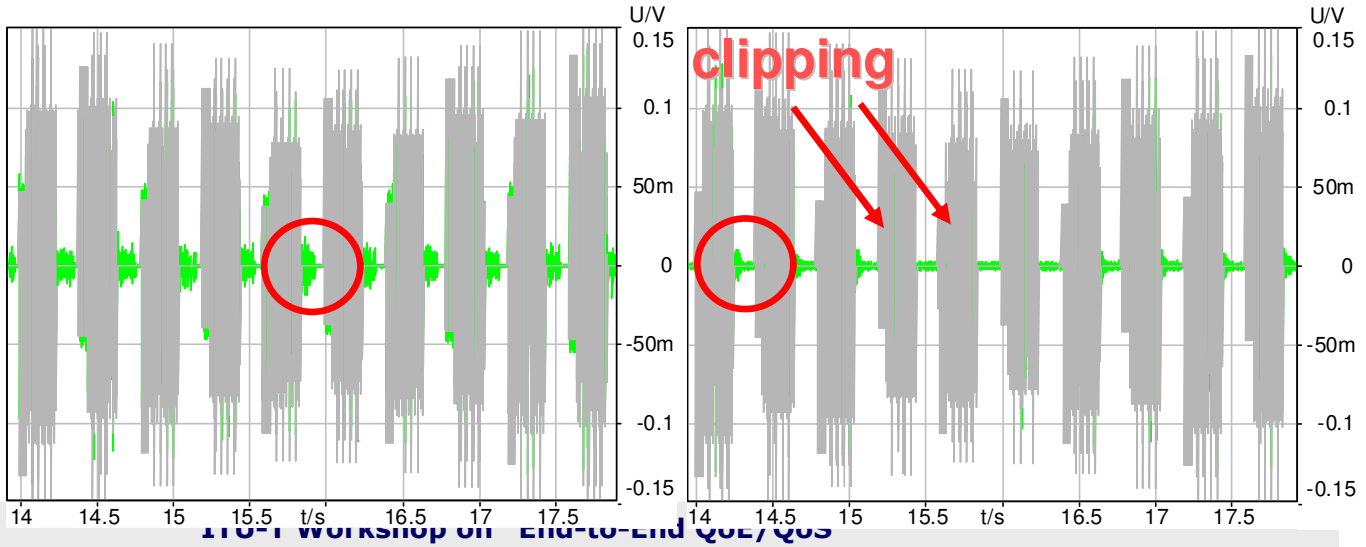
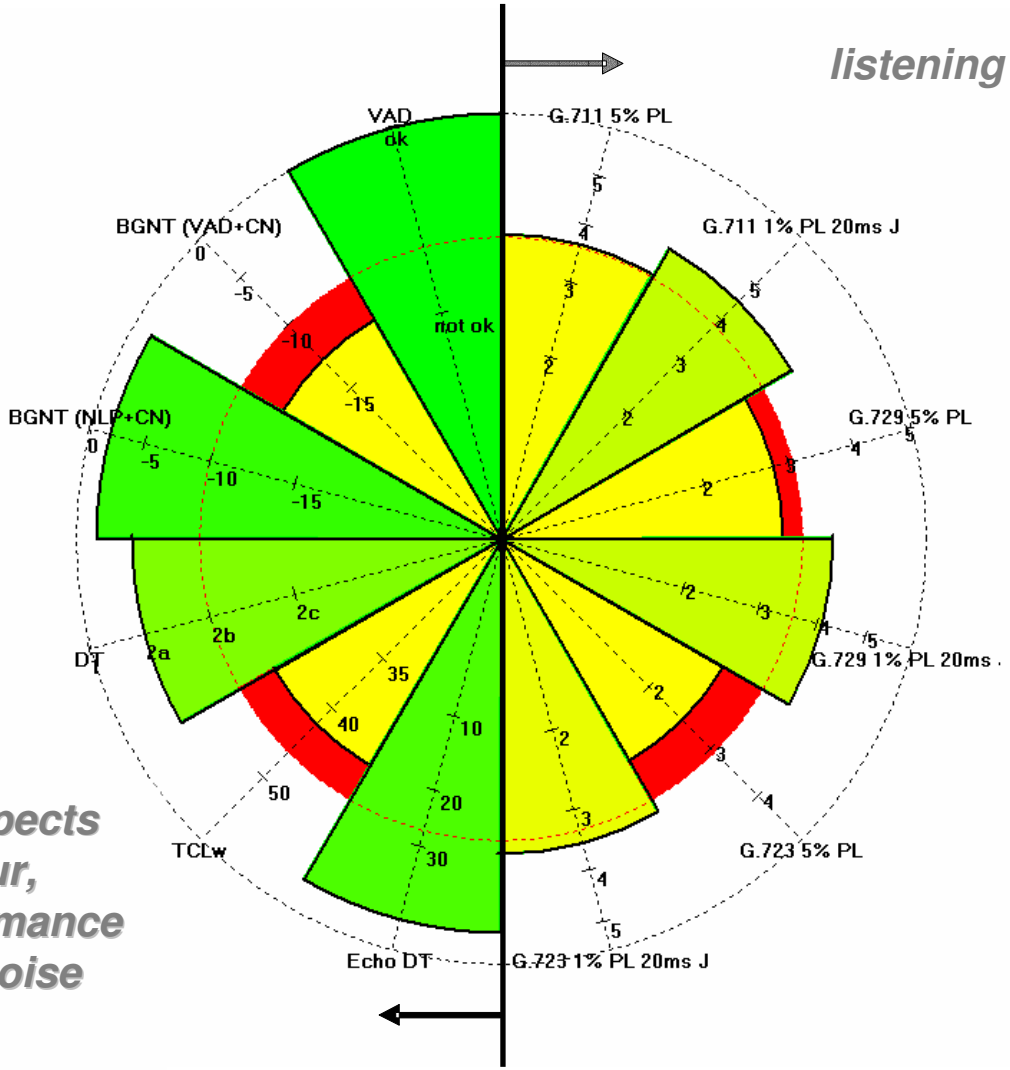






Summary Results: „Gateway Pie“

listening speech quality



conversational aspects like echo behaviour, double talk performance and background noise transmission

Summary Results: „Gateway Pie“ (ITU-T P.505)

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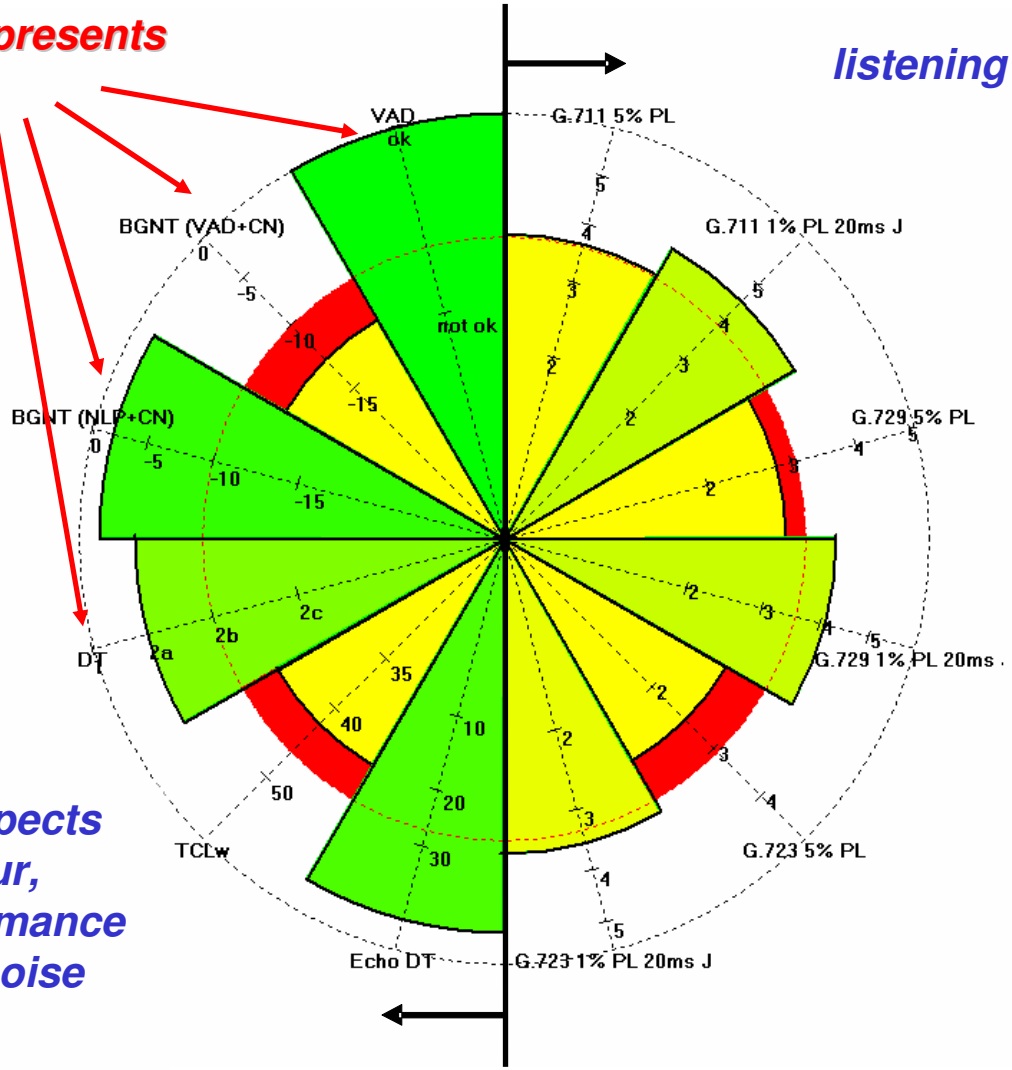
Each “slide“ represents one parameter

listening speech quality



conversational aspects like echo behaviour, double talk performance and background noise transmission

Summary Results: „Gateway Pie"(ITU-T P.505)

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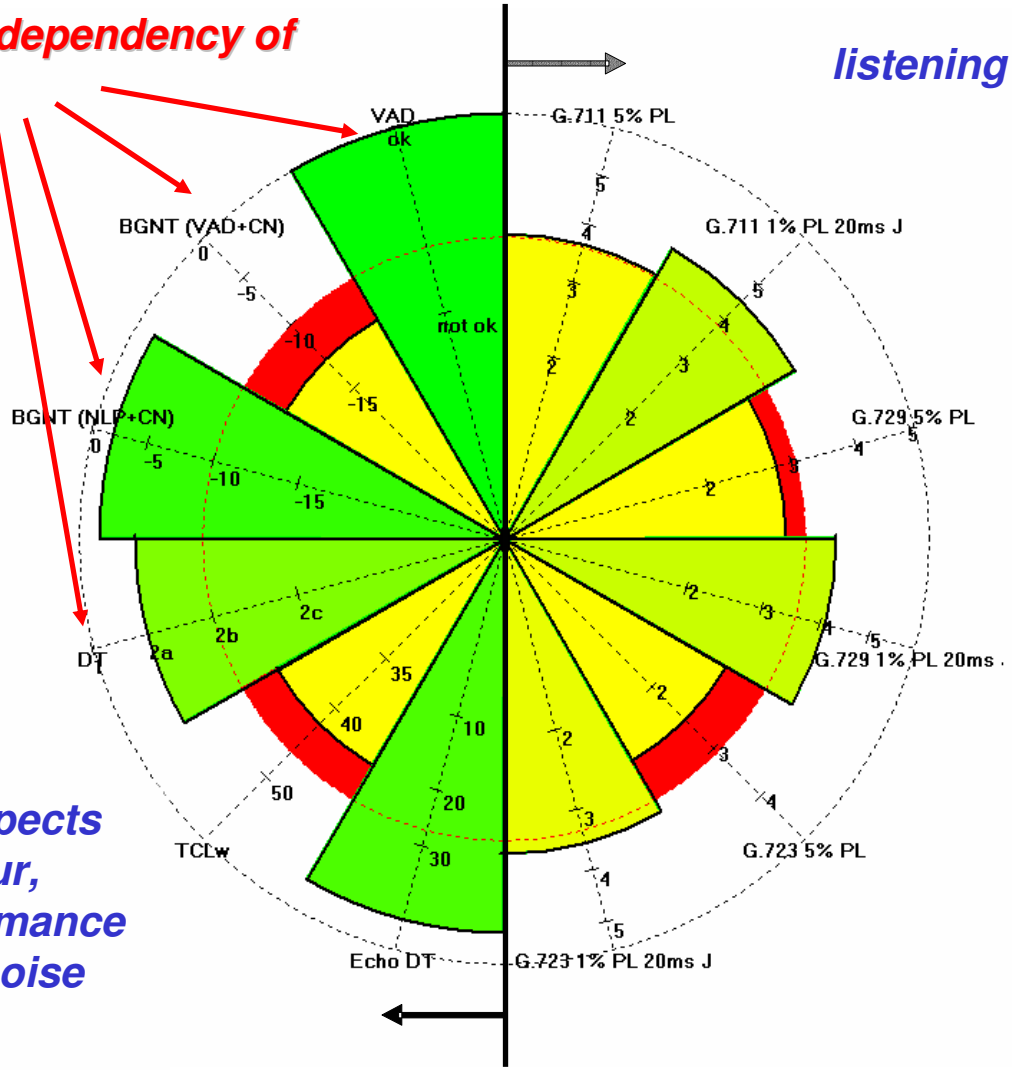
Assumption: Independency of parameters, no interaction aspects

listening speech quality



conversational aspects like echo behaviour, double talk performance and background noise transmission

Summary Results: „Gateway Pie"(ITU-T P.505)

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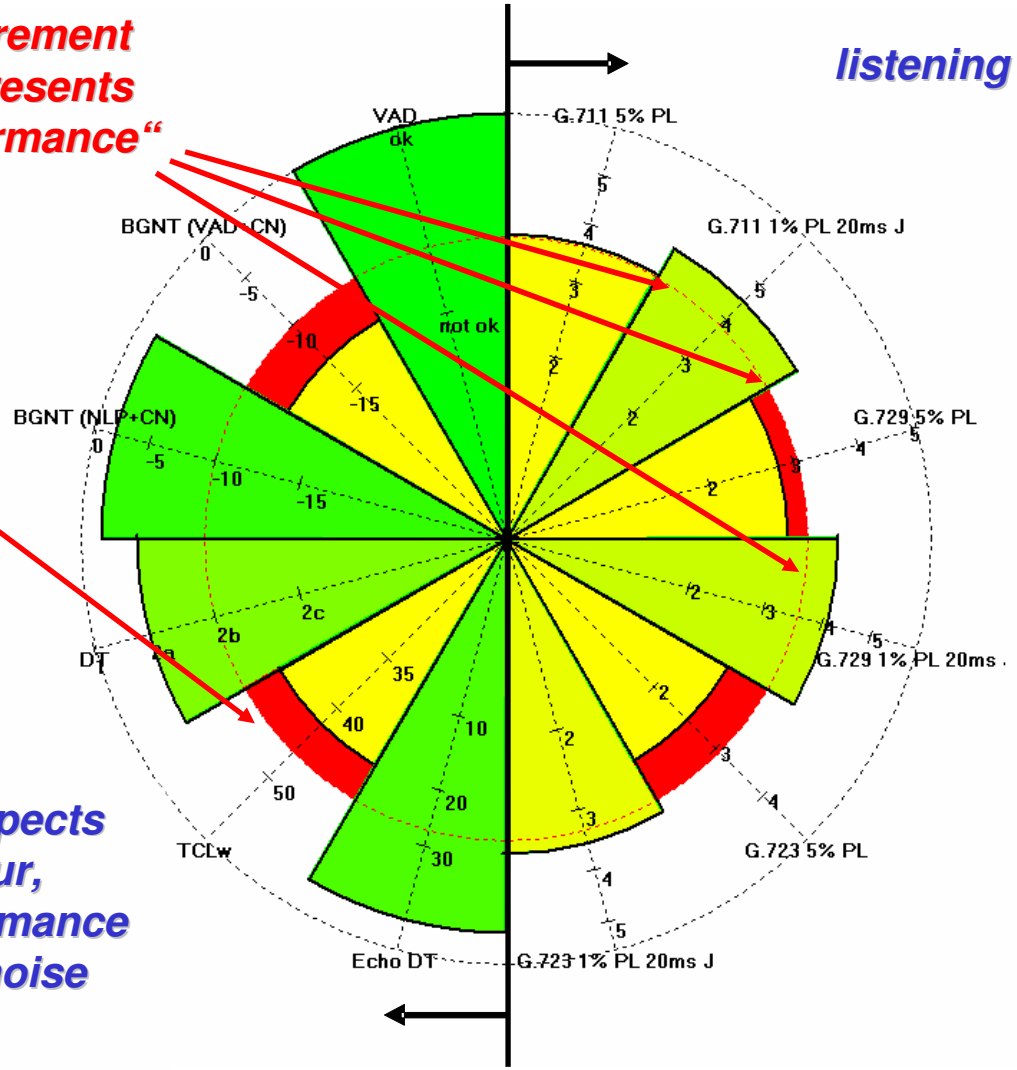
Minimum requirement (red circle) represents "average performance" of 3rd SQTE

...or recommended numbers

listening speech quality



conversational aspects like echo behaviour, double talk performance and background noise transmission

Example Results (4 of 10)

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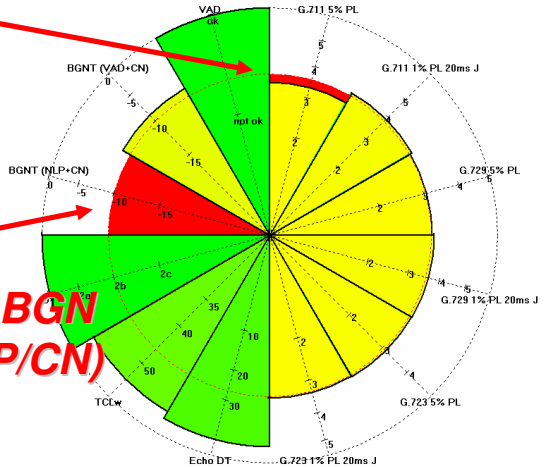
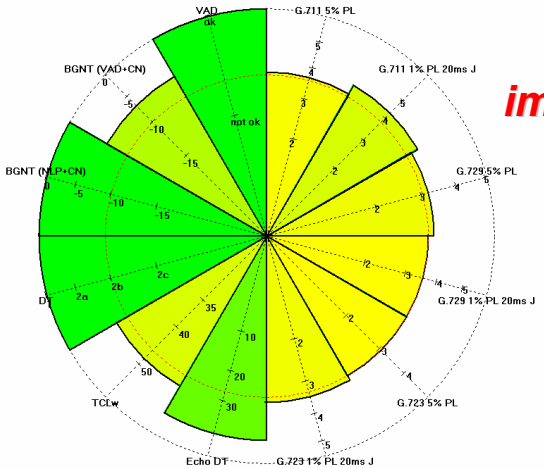
G.711 PLC

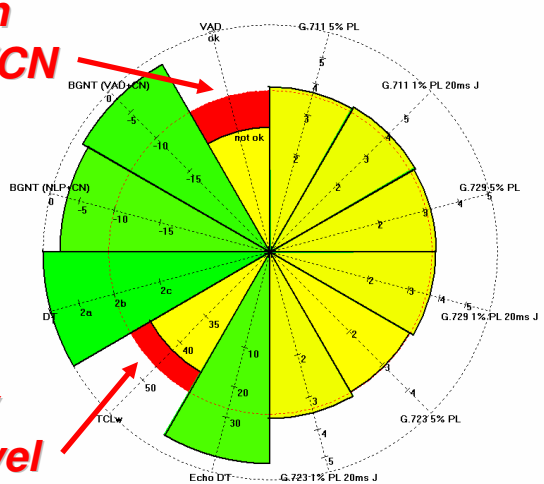
EC inserts high BGN modulation (NLP/CN)



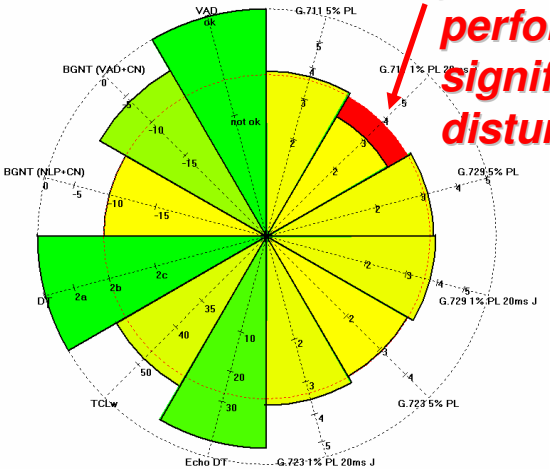


"balanced" implementation

BGN modulation caused by VAD/CN



violation of requirement only caused by CN level
(echo attenuation high enough)



jitter buffer performance G.711, significant disturbances

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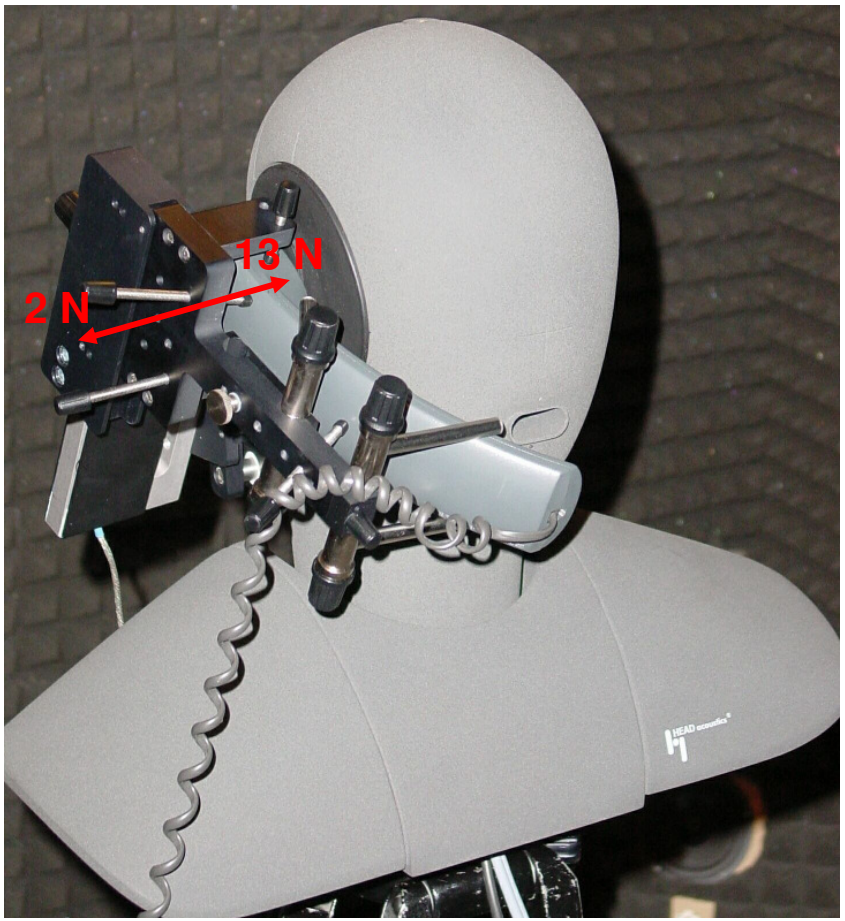
Testing IP Phones @ 3rd SQTE

Tests in handset and hands-free mode



For handset

- **Frequency response, …**
- **TMOS using TOSQA2001**
- **Echo measurements**
- **Double talk performance**
- **Quality of background noise transmission**

Testing IP Phones @ 3rd SQTE

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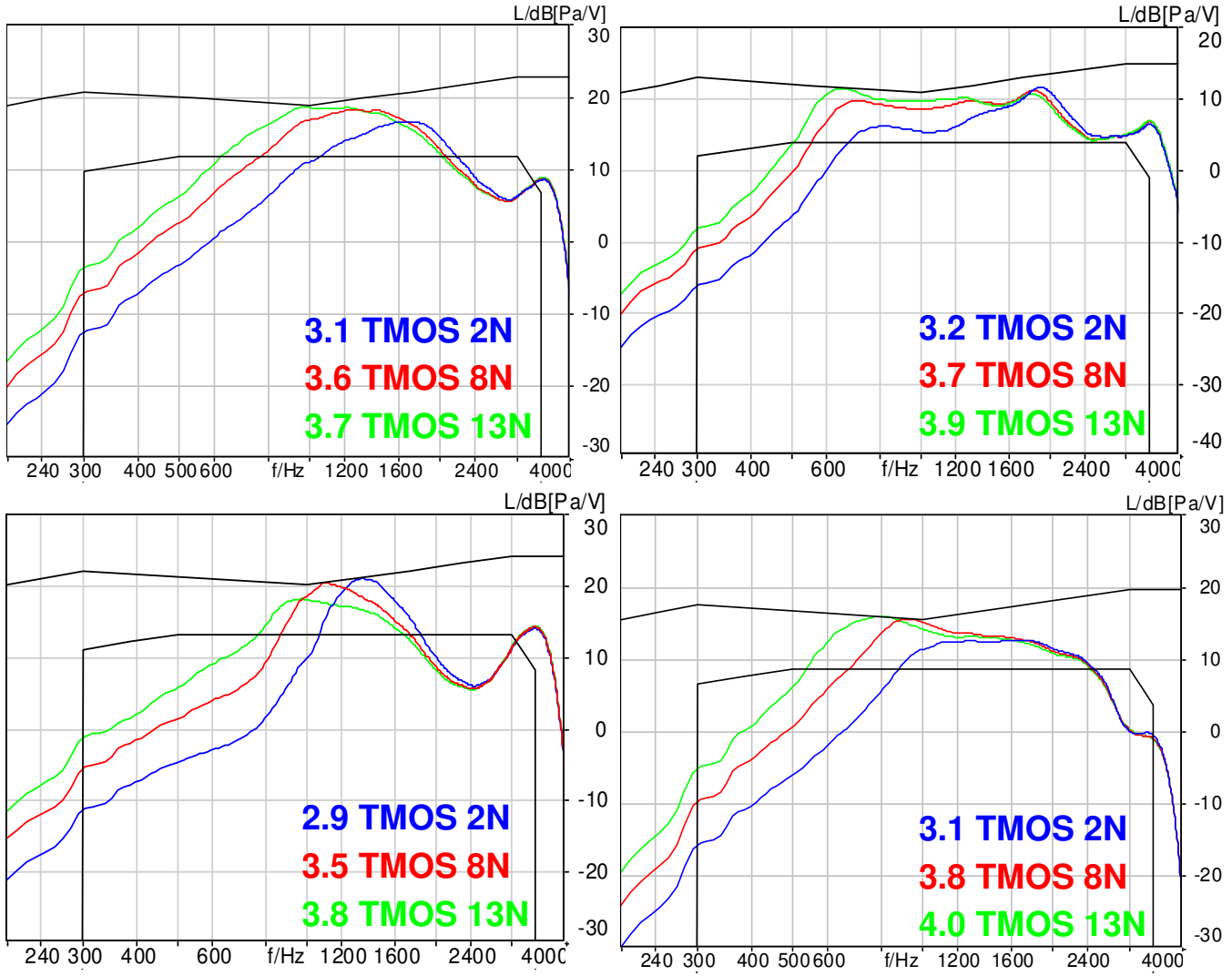
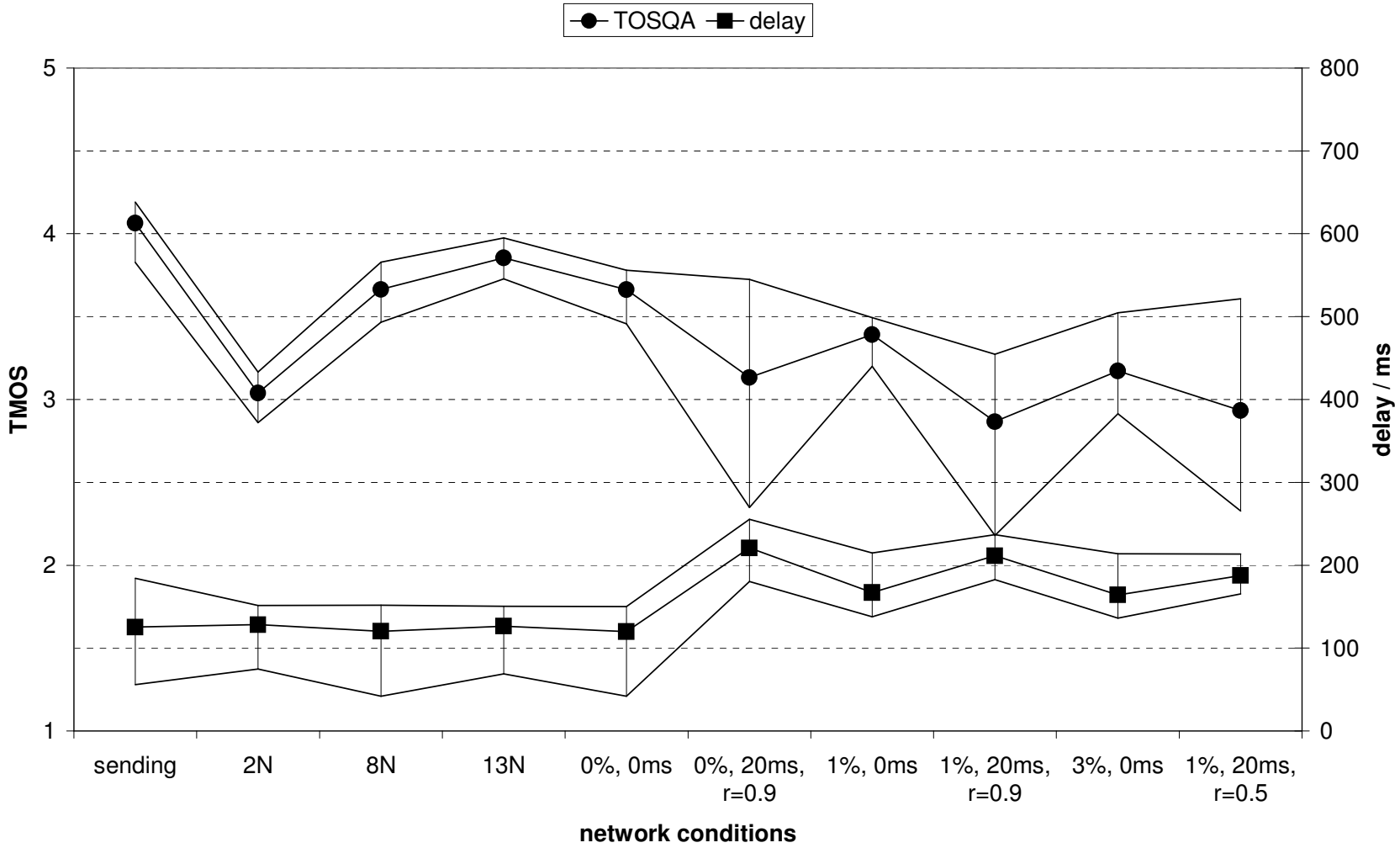
Receiving frequency responses and TMOS



Listening Speech Quality *TOSQA2001 (TMOS)*



G.711, sending & receiving direction

Double Talk Test Hands-Free Terminals

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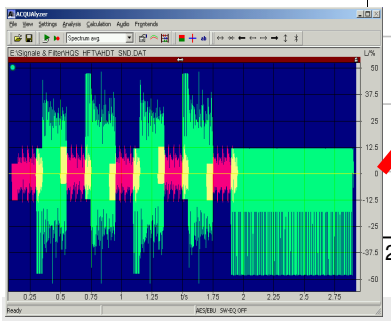
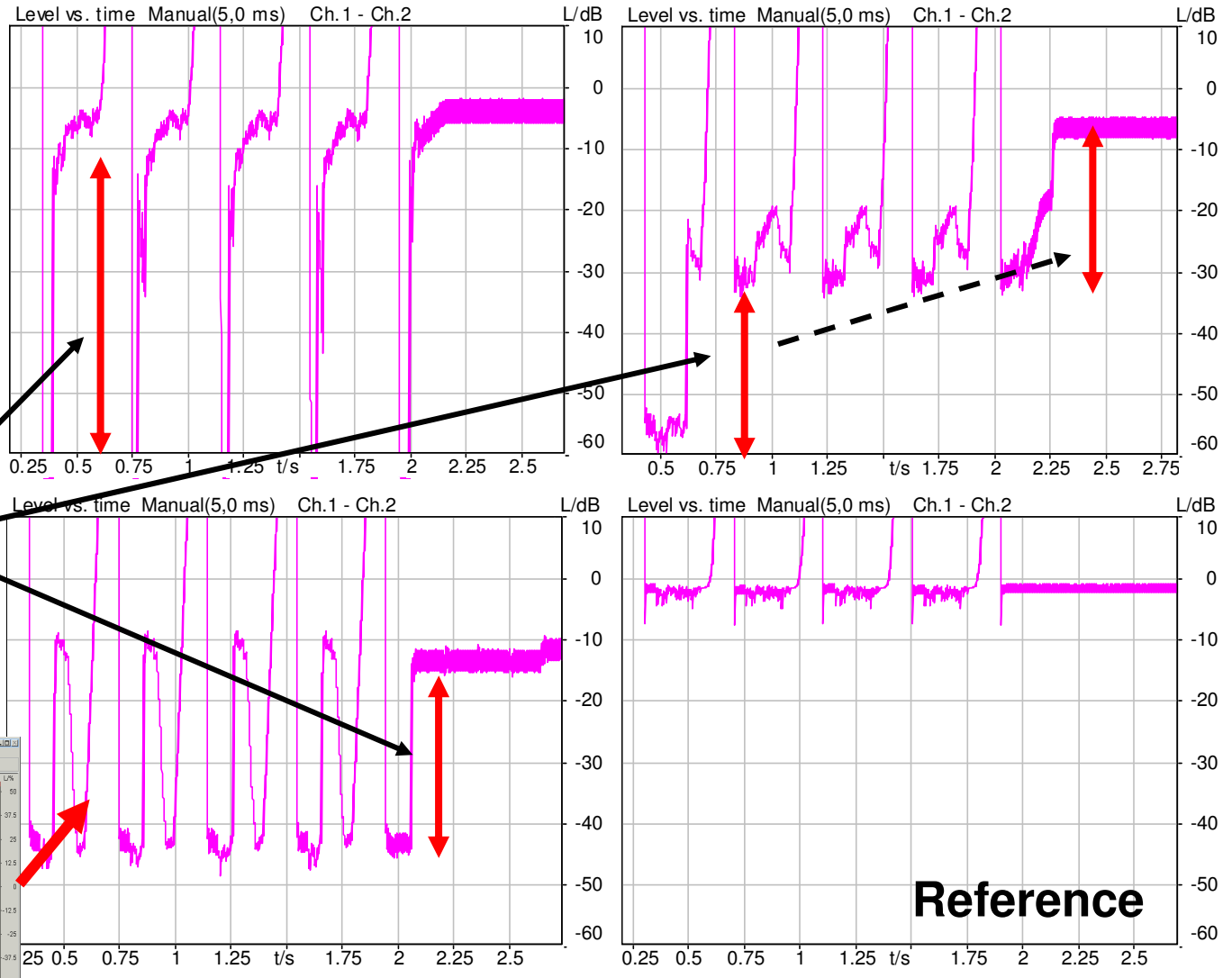
Double talk test:

Attenuation range in sending direction (P.340)

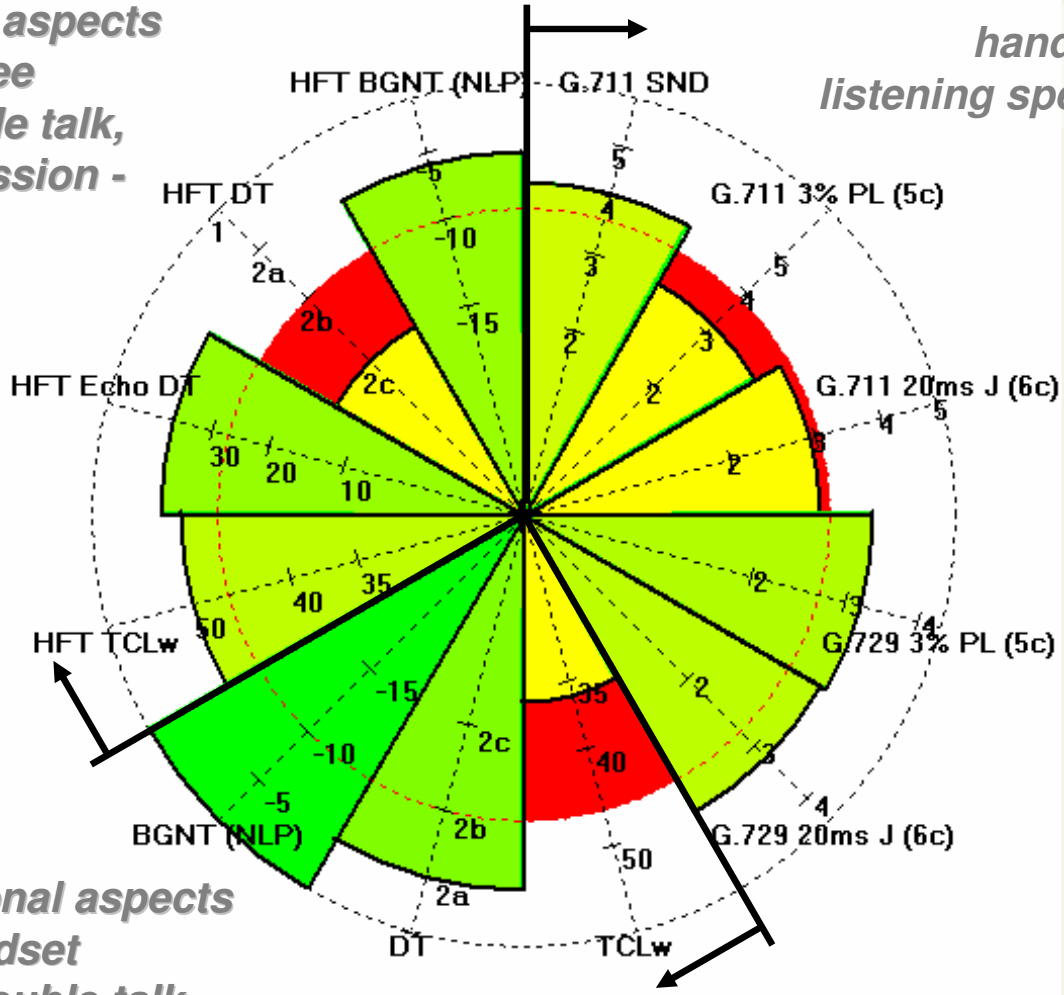




Summary Results: "IP-Phone Pies"(ITU-T P.505)

conversational aspects
hands-free
- echo, double talk,
BGN transmission -

handset
listening speech quality



conversational aspects
handset
- echo, double talk,
BGN transmission -

Summary Results: "IP-Phone Pies"

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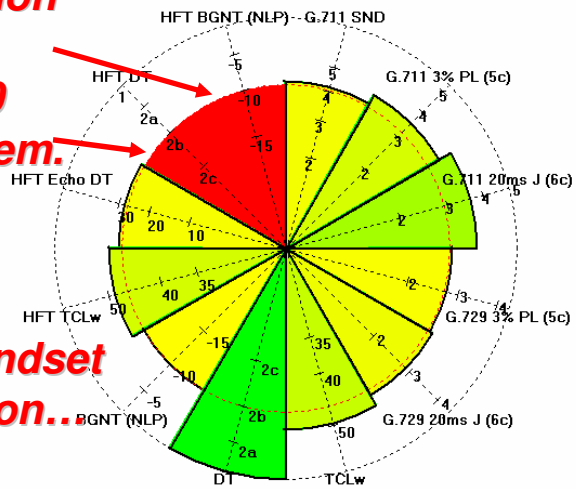
BGN modulation

ITU-T P.340 "type 3" implem.

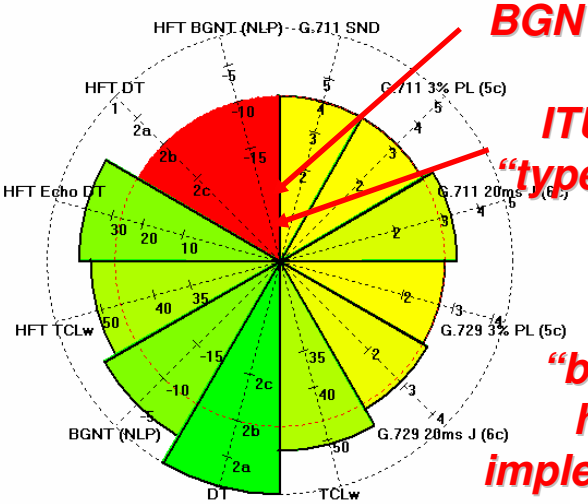
"balanced" handset Implementation…



BGN modulation

ITU-T P.340 "type 3" implem.

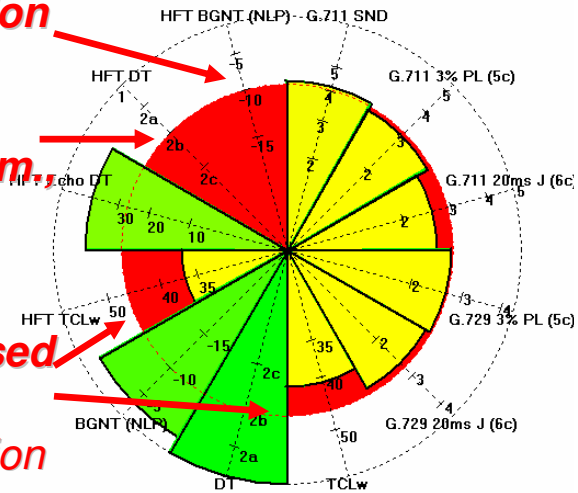
"balanced" handset implementation…

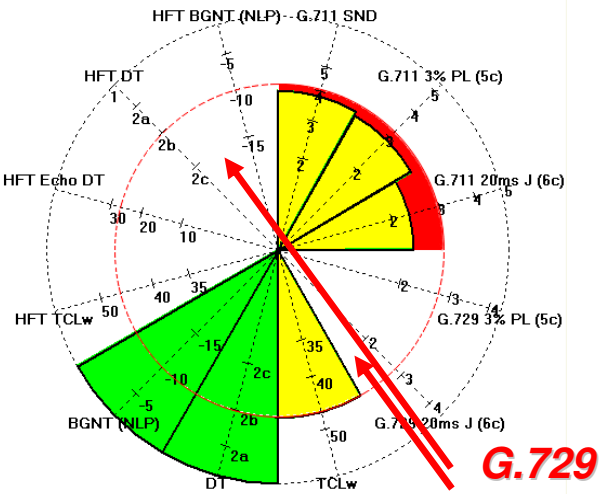


BGN modulation

ITU-T P.340 "type 3" implem…

Violation caused by noise level (echo attenuation high enough)





G.729 and hands-free not tested

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Some quotes from the 3rd SQTE event:

- ***Michael Metzger**, Executive Director of Marketing, Mindspeed Technologies*:
  - "... bringing together the world leaders in VoIP technology in a co-operative and neutral environment, this prestigious event continues to improve the quality of VoIP...„
- ***Peter Faxel**, member of the executive board, AVM*;
  - "... The ETSI event has helped us towards achieving our goals, and given us valuable information about the market trend and technological developments."
- ***Daniel Hartnett**, Infineon Technologies:*
  - Plugtests(tm) service of ETSI is an invaluable exercise for a company that sees voice quality as a key element for the success of our telephone terminal product families. Infineon will continue to "The VoIP Speech Quality Test Event (SQTE) organised by the work closely with HEAD acoustics and ETSI to benchmark their products for voice quality excellence"

Overall quality of the event: Score 4.6 out of 5