HEARING IS A FASCINATING SENSATION

Challenges in VoLTE Terminal Testing and Interworking

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Dr.-Ing. H. W. Gierlich
Managing Director Telecom Division

Outline

A variety of challenges exist in VoLTE testing and interworking - The following selected topics are addressed in this presentation:

- LTE Setup for Voice Communication - Obstacles
- Delay and Delay Testing
- Network Impairments, Delay & Jitter Profile Testing
- Challenges in Superwideband & Fullband
- Positional Dependant Testing of Mobile Terminals
- Summary

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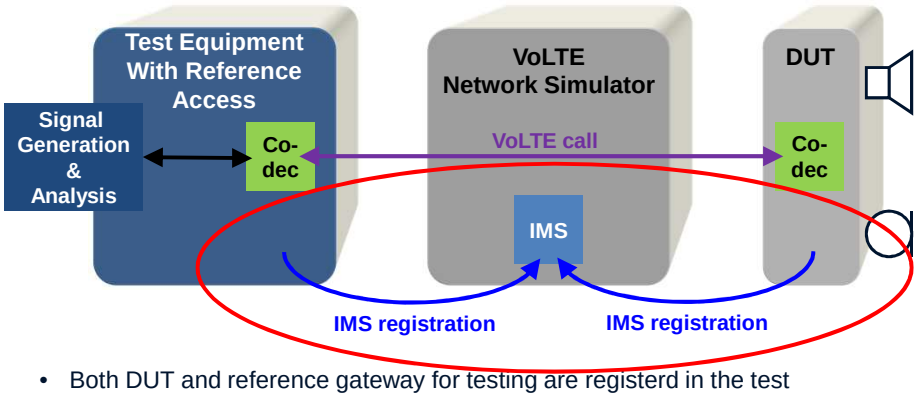
Call Handling 4G in a Test Setup



- Both DUT and reference gateway for testing are registerd in the test IMS server
- VoLTE call takes place between DUT and reference gateway
- Reference gateway takes care of encoding/decoding

Difficulties in VoLTE Call Setup

- Network provider flash their own firmware (Branding) with their special VoLTE support => special procedures for IMS Signaling/Registration are needed.
- Network providers use different LTE Cell/Signaling settings/parameters (e.g. LTE Band, MNC/MCC, Security Settings, Shared-Key, etc…). These parameters often are confidential and unknown if not provided.
- SIM-Lock, the device under test needs a special - provider specific -UICC (SIM card) for testing.
- DUTs normally are locked to their home network. In order to connect to the radio tester the correct MNC/MCC settings must be known, otherwise the roaming procedure does not allow VoLTE connections.
- The SIP/IMS registration is very sensitive to errors or unknown SIP messages depending on the implementation of the IMS in the VoLTE network simulators.
- VoLTE settings in DUTs may be fixed (e.g. P-CSCF Address set to a fixed address) -> the address used in the radio tester cannot be configured.

Difficulties VoLTE Call Setup

- Buggy VoLTE implementation in devices under test (e. g. SIP call negotiation with octet-aligned mode but DUT is sending the speech packets in bandwidth efficient mode).
- If no IMS APN (access point name) or matching PDP (packet data protocol) contexts is available in the DUT => no IMS registration => no VoLTE call.
- IPsec parameters are needed if device under test only work with a secure connection (IMS-AKA).
- No access to VoLTE settings in DUT for changing required parameters for audio tests.
- How to handle eSIM?

Difficulties in VoLTE Call Setup

=>

Most of these issues not only lead to difficulties in testing – the differences in IMS settings prevent interworking between network operators in general!

Solution for testing:
Define a generic test mode and IMS setting implemented in all terminals.

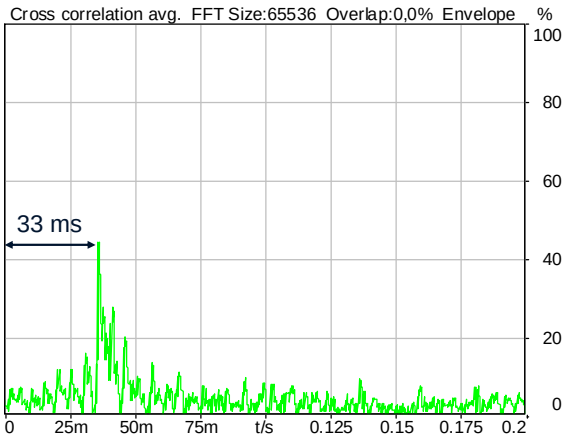
Potential solution for interworking:
Define a minimum set of IMS settings used in interworking.

Outline

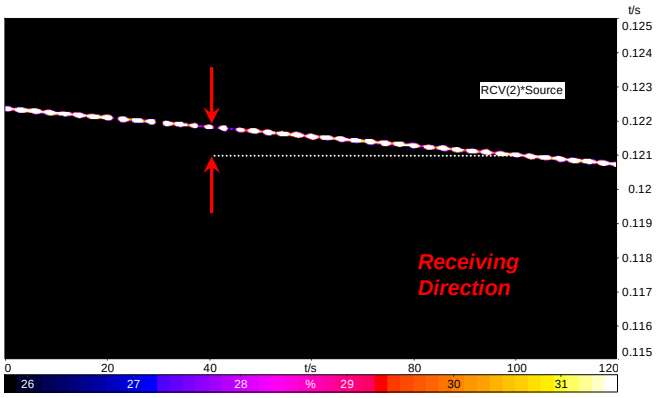
3GPP & GSMA: Delay Testing

Requirement 4G: ***Roud trip delay MTSI < 190 ms (min. Reqirement)***
Performance goal < 150 ms

Delay measurement direction by cross correlation

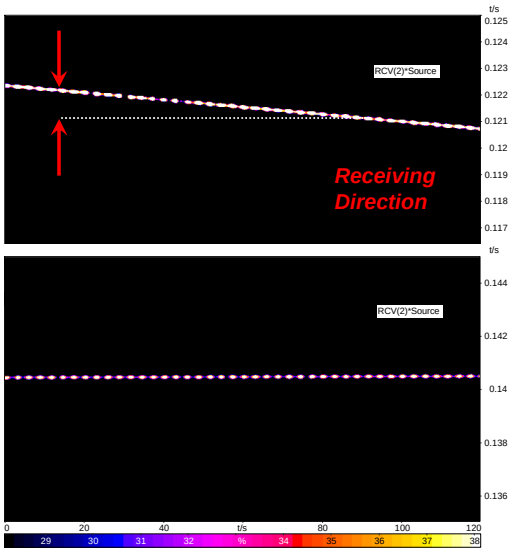


Delay in VoLTE - Not Stable, Delay Drift due to Clock Drift



Drift: 815 µs/min → 13,6 ppm

Delay Results VoLTE – Clock Drift Compensation



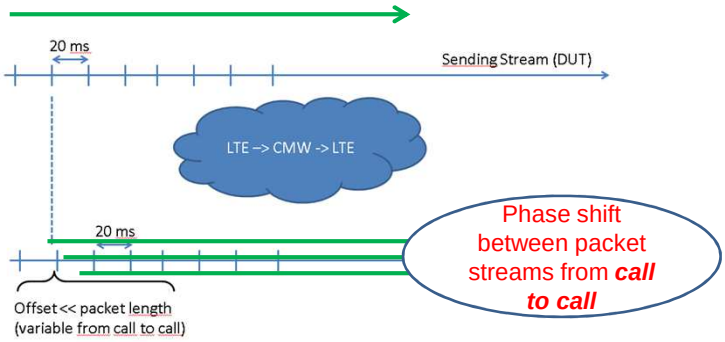
- **Clock Drift**
  - Not compensated:
    815 µs/min
    48000 Hz
  - Compensated:
    0 µs/min
    48000,67 Hz

➢ ***Synchronized testing possible***

VoLTE Terminal Delay: Call by Call Variation

Call by call delay variation and theoretical background:

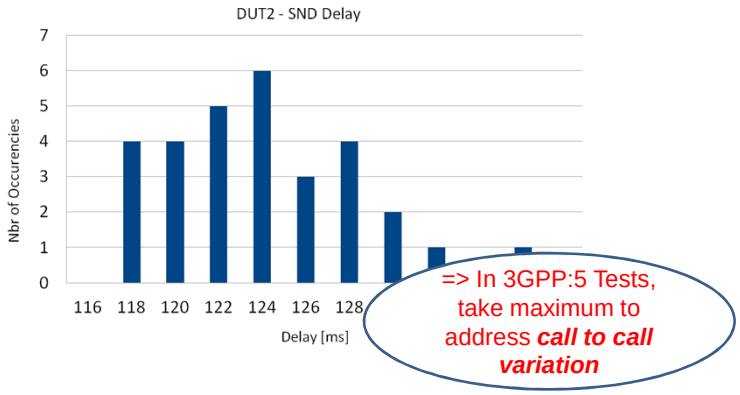
- Clock syncronization absolutely required to avoid delay drift during testing
- Clock sychronization does ***NOT*** allow packet stream synchronization



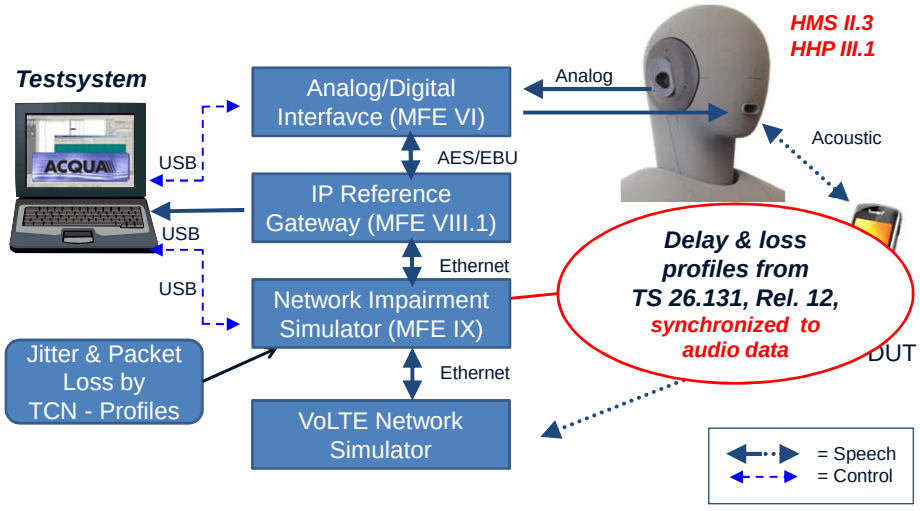
Delay Testing: Results in Sending

Call by call delay variation: measurement examples in sending

- Delay variation measured over 30 calls
- Delay variation within the expected range of 20 ms (packet size)

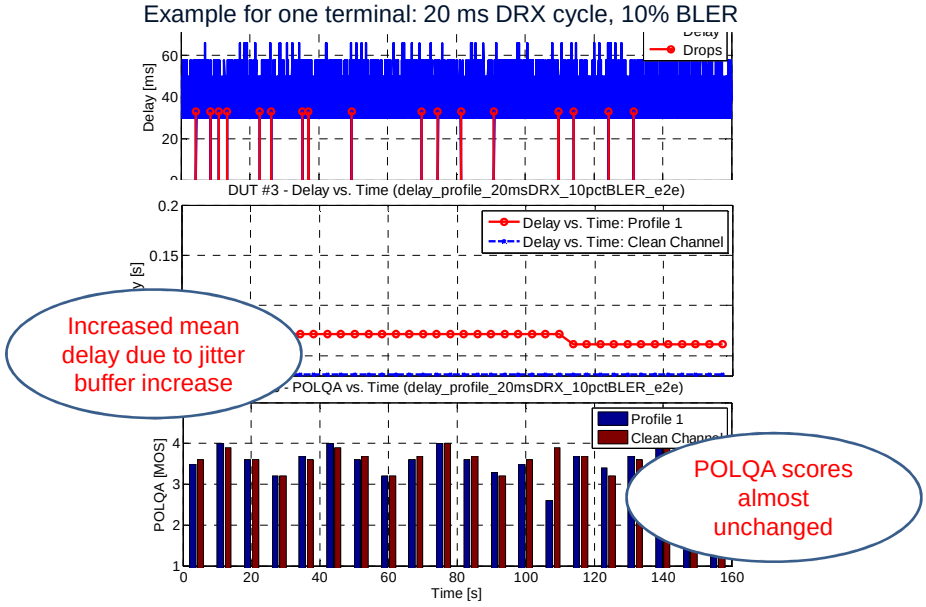


Jitter & Packet Loss – Simulation in Testing



Simulated Jitter & Packet Loss: Typical Test Results

Example for one terminal: 20 ms DRX cycle, 10% BLER



Increased mean delay due to jitter buffer increase

POLQA scores almost unchanged

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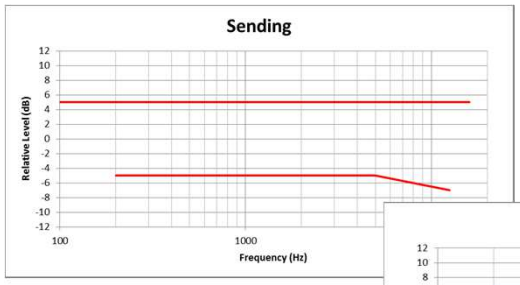
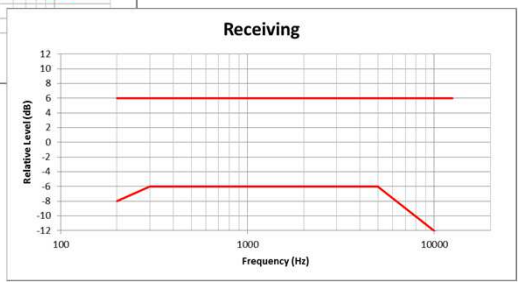
Superwideband & Fullband with EVS

How does it sound?

Frequency response tolerance schemes under discussion;



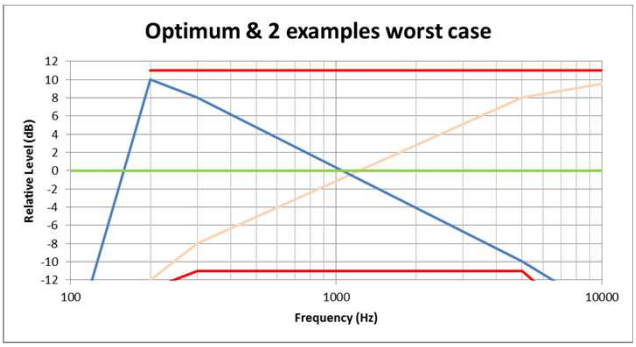


EVS FB @ 16,4 kbit/s

Interoperability - Superwideband & Fullband with EVS

How does it sound?

….when combining 2 terminals performing ***within the limits***



Fullband:
Optimum
Worst highpass
Worst lowpass

For comparison narrowband:
Optimum
Worst highpass
Worst lowpass

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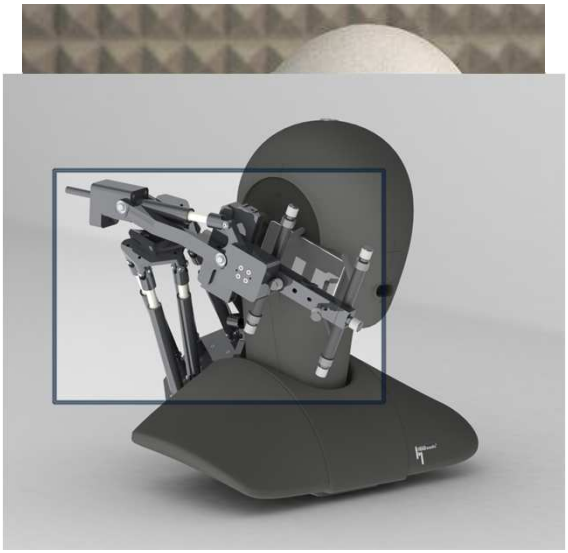
Artificial Head & Artificial Ear

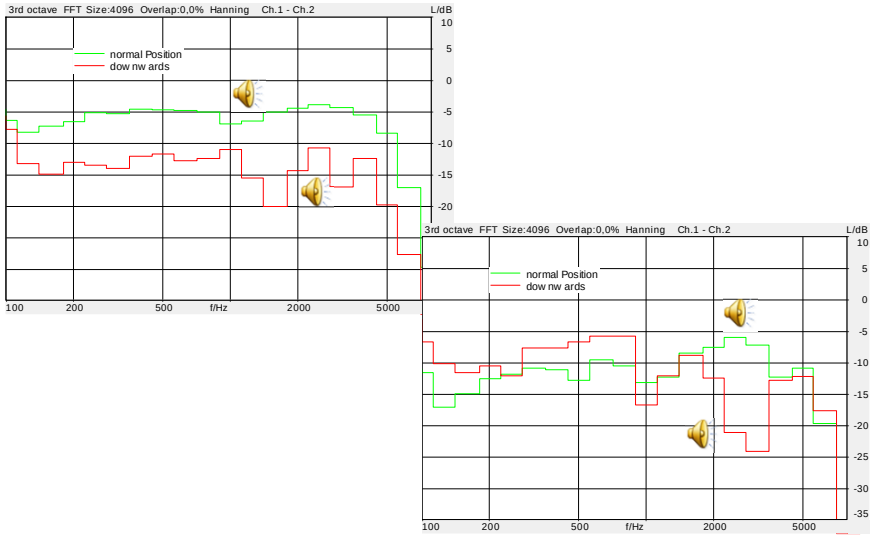
- **HATS acc. to ITU-T P.58**
- **Artificial ear acc. to ITU-T P.57**
- **Positioning acc. to ITU-T P.64**



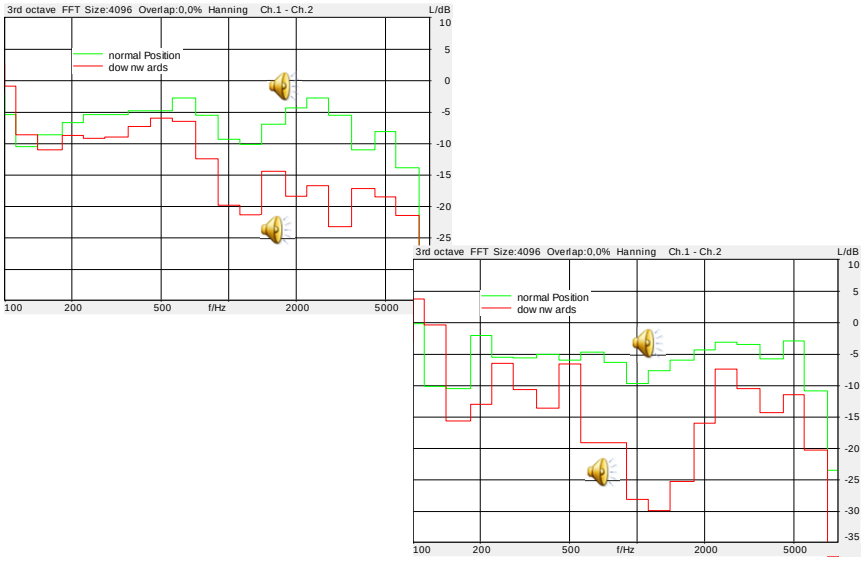
HHP IV Video

HEAD acoustics

Positional Robustness 1 / 2 Without Background Noise



Positional Robustness 2 / 2 With Background Noise



Summary

- **Advanced mobile terminals require more advanced and more realistic testing procedures**
- ***Still many unresolved issues in VoLTE call setup and IMS-based interworking***
- **VoLTE introduces more variability in communicational quality – e.g. for delay and delay variation**
- **Terminal interworking concerning sound quality in super-wideband and fullband from mouth to ear is critical and still an unresolved topic**
- **Testing taking into account time variant user behavior and signal processing gets more important – e.g. positional robustness testing**

Dr.-Ing. H. W. Gierlich
Head of Telecom Division

info@head-acoustics.de
www.head-acoustics.de