Key Issues and Their Implications for Automotive Industry
Tendencies - Narrowband

Narrowband Roundtrip Delay

33 devices

Narrowband Overall Performance

1st Test Event 2014

18 devices

2nd Test Event 2016

All devices support AT+NREC=0
Tendencies - Narrowband

Narrowband Roundtrip Delay

- 33 devices

Narrowband Overall Performance

- 1st Test Event 2014
- 2nd Test Event 2016

Most devices turn off signal processing
Tendencies - Narrowband

Narrowband Roundtrip Delay

33 devices

Narrowband Overall Performance

1st Test Event 2014

18 devices

2nd Test Event 2016

Gains often not in range
Tendencies - Narrowband

Narrowband Roundtrip Delay

33 devices

Narrowband Overall Performance

18 devices

Strange tendency to disable signal proc. also when AT command is not sent
Tendencies - Wideband

Wideband Roundtrip Delay

14 devices

Wideband Overall Performance

1st Test Event 2014

Requirement updated After 1st Test Event

2nd Test Event 2016
AT+NREC=0 (Bluetooth® HFP)

EC Test: Simulated 20 dB echo path

NR Test: Application of stationary noise (pink, car)

What about other aspects…
- Equalizers ?
- Gains ?
- Non-linear signal processing e.g. Automatic Gain Control (AGC) ?
- Volume control activity ?
Roundtrip delay [ms] comparison with and without AT+NREC=0 command sent:

<table>
<thead>
<tr>
<th></th>
<th>Device 1</th>
<th>Device 2</th>
<th>Device 3</th>
<th>Device 4</th>
<th>Device 5</th>
<th>Device 6</th>
<th>Device 7</th>
<th>Device 8</th>
<th>Device 9</th>
<th>Device 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+NREC=0 sent</td>
<td>151,7</td>
<td>181,6</td>
<td>175,6</td>
<td>181,7</td>
<td>265,5</td>
<td>174,9</td>
<td>225,0</td>
<td>292,9</td>
<td>154,7</td>
<td>139,3</td>
</tr>
<tr>
<td>AT+NREC=0 not sent</td>
<td>166,8</td>
<td>215,0</td>
<td>170,9</td>
<td>173,8</td>
<td>281,5</td>
<td>164,2</td>
<td>238,1</td>
<td>352,8</td>
<td>156,3</td>
<td>140,2</td>
</tr>
<tr>
<td>Δ (ATnot sent-ATsent)</td>
<td>15,1 ms</td>
<td>33,4 ms</td>
<td>-4,7 ms</td>
<td>-7,9 ms</td>
<td>16,0 ms</td>
<td>-10,7 ms</td>
<td>13,1 ms</td>
<td>59,9 ms</td>
<td>1,6 ms</td>
<td>0,9 ms</td>
</tr>
</tbody>
</table>

→ **AT+NREC=0 does not “bypass” signal processing, delay is typically not reduced.**
→ **More likely: the DSP is configured into an “idle“ configuration (e.g. EC and NR set to 0)**
Junction Loudness Rating (JLR)

**Overview ITU-T Test Events**

**Uplink**
- **JLR SND** ~ 0 dB
- **JLR SND** ~ -5 dB (Amplification)
- **JLR SND** ~ -10 dB (Strong Amplification)

**Downlink**
- **JLR RCV** ~ 0 dB
- **JLR RCV** ~ -5 dB (Amplification)

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**Ideal behaviour:**
Transparent transmission to and from the car HFT

**Risk for signal saturation / signal compression**

**Strong signal saturation / compression in uplink**

**HFT Volume control range in downlink compromised (downlink)**
Remote Audio Volume Ctrl. (RAVC) and Phone Volume Ctrl.

What is RAVC?
Remote control of the HFTs audio gains via dedicated AT commands from phone (Optional Feature)
Some phones keep their own volume control active and apply strong attenuation in downlink to the audio path (apparently to support older Bluetooth® accessories w/o integrated volume control)

→ Strong impact on car HFT:
  - playback volume for comfortable signal-to-noise ratio under driving conditions may not be sufficient
  - The user may be incited to adjust volume control on the phone (safety issue!)
Equalizing

Ideal behaviour:
Spectral shape of speech to and from the car HFT practically not modified

Equalizing filter active:
Spectral shape of speech to and from the car HFT modified
Conclusions & Outlook

- Non-transparent phones are still an issue in automotive industry
  - Tuning effort (!!), performance, customer complaints…
- ITU-T Test Events initiated by automotive industry and suppliers
- Test Events address audio performance of mobile phones
  - Help phone manufactures to detect it and improve quality
  - Feedback into the standardization process (ITU SG 12)
- ITU-T “Whitelist” provides transparency for car maker and customers
  [http://www.itu.int/en/ITU-T/C-I/Pages/HFT-mobile-tests/HFT_testing.aspx](http://www.itu.int/en/ITU-T/C-I/Pages/HFT-mobile-tests/HFT_testing.aspx)
- New requirements and clarifications from SG12 Meeting (01/2017) to be considered in upcoming Test Events/Tests