Next Generation Test Chambers
Bluetest Background

• Founded in 2001 by Professor Kildal at Chalmers University, Gothenburg, Sweden

• The vision was to perform tests:
  - Fast
  - Easy
  - Cost effectively

• 2006: High Performance (HP) chamber

• 2006 – 2009: large sales growth
Bluetest Today

• 35 customers world wide

• CTIA TRP and TIS procedure ready

• Proposed for 3GPP MIMO OTA tests

• Bluetest delivers:
  
  - World leading MIMO/Diversity tests
  - Fastest available TRP/TIS tests
  - Test for all leading cellular standards
  - Most cost effective OTA tests
How can a Bluetest Reverberation Chamber solve the problems?
What is a Reverberation Chamber?

- Reverberation chamber – isotropic Rayleigh fading
- Easy and fast measurements of:
  - Antenna efficiency, TRP and TIS
  - Antenna diversity gain
  - Correlation
  - MIMO capacity, MIMO throughput
Statistical representation

Rayleigh fading

Theoretical value versus measured value in a Bluetest Chamber

Rayleigh distribution

Normalized signal amplitudes (dB)

Time (s)

Cumulative probability

Normalized signal amplitudes (dB)
Measurements Comparisons
Anechoic vs. Reverb. Chamber
Comparison of radiation efficiency

Large near-field chamber vs. Bluetest chamber

Measured TRP of 21 channels

<table>
<thead>
<tr>
<th>Band</th>
<th>Channels</th>
<th>Frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSM 850</td>
<td>128 190 251</td>
<td>824 837 849</td>
</tr>
<tr>
<td>GSM 900</td>
<td>975 38 124</td>
<td>880 897 915</td>
</tr>
<tr>
<td>GSM 1800</td>
<td>512 699 885</td>
<td>1710 1747 1785</td>
</tr>
<tr>
<td>GSM 1900</td>
<td>512 661 810</td>
<td>1850 1880 1910</td>
</tr>
<tr>
<td>WCDMA 850</td>
<td>4132 4182 4233</td>
<td>826 836 846</td>
</tr>
<tr>
<td>WCDMA 1900</td>
<td>9262 9400 9538</td>
<td>1852 1880 1908</td>
</tr>
<tr>
<td>WCDMA 2100</td>
<td>9612 9750 9888</td>
<td>1922 1950 1977</td>
</tr>
</tbody>
</table>
TIS: Comparison anechoic - HP reverberation chamber

UMTS (W-CDMA) band I
Downlink frequencies: 2110-2170 MHz

Same phone measured in anechoic chamber and reverberation chamber
Diversity and MIMO Throughput Measurements
Bluetest unique MIMO and diversity features

- Direct fast MIMO/Diversity antenna tests
- Active MIMO/Diversity throughput tests
- System tests to optimize:
  - Scheduling software in base stations
  - Multi-user MIMO
  - Complete RF chain
  - System capacity
  - Handover performance
  - Co-operative MIMO
HSPA Active Diversity : TIS

- Two cases tested: QPSK and 16 QAM modulation
- Significant and repeatable difference between diversity on/off cases

*Measurement results from anonymous terminal manufacturer*
MIMO Throughput Measurements

Tests performed in collaboration with Sony Ericsson and presented at AP-S 2008 in San Diego
Unbalanced Channel Cases

- Antennas in the MIMO set having different efficiencies,
- Two antennas used in router, one of them attenuated with 0, 3, 6 or 10 dB.
- Secondary antenna with low efficiency improves the throughput as long as the efficiency is not too bad.
Connected Reverberation Chambers

MIMO channel simulator

Advantages with Bluetest Reverberation Chambers

• No quiet zone
  - Easy and fast placement of the DUT
  - DUT Size up to 0.8m
  - Complete systems tests are fast, easy and cost effective

• Reflections do not cause errors

• Easy to calibrate

• Easy and cost effective to service and maintain
Summary

• The most cost effective solution on the market

• The fastest available solution

• Future proof
  - Echoic chamber, simulates a real environment
  - Easily adapted to new technology

• MIMO and Diversity test available today

• Proven Technology, 30 customers World Wide:
  - The Biggest Operators
  - The Largest Mobile Phone Manufacturers
  - Antenna Manufacturers
HP 700 - High Performance Chamber
## General Specification

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range:</td>
<td>650 – 6000 MHz</td>
</tr>
<tr>
<td>Accuracy TRP:</td>
<td>0.5 dB (STD)</td>
</tr>
<tr>
<td>Accuracy TIS:</td>
<td>0.7 dB (STD)</td>
</tr>
<tr>
<td>Repeatability:</td>
<td>0.2 dB (STD)</td>
</tr>
<tr>
<td>Test time TRP (typical):</td>
<td>1 min/channel</td>
</tr>
<tr>
<td>Test Time TIS (typical):</td>
<td>10 min/channel</td>
</tr>
<tr>
<td>Test Time TIS (Fast TIS option):</td>
<td>3 min/channel*</td>
</tr>
</tbody>
</table>

*GSM and WCDMA

## Dimensions (outside)

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length:</td>
<td>2000 mm</td>
</tr>
<tr>
<td>Height:</td>
<td>2000 mm</td>
</tr>
<tr>
<td>Depth:</td>
<td>1400 mm</td>
</tr>
</tbody>
</table>
Supported Technologies

TRP/TIS Measurements:
- GSM
- GPRS/EDGE
- WCDMA
- HSPA
- CDMA2000
- EVDO Rev 0 and A
- LTE (MIMO 2x2)
- Bluetooth
- WLAN 802.11b/g

Throughput Measurements:
- LTE (MIMO 2x2)
- WLAN 802.11b/g /n

Supported Base Station Simulators

- Agilent: 8960/N4010A
- Anritsu: MT8815/8820/8860
- Rohde & Schwarz: CMU 200/CMW 500