R&S 5G & mm Wave
Test Solution
New Standards for Mobile Communication

- **WLAN 802.11ad and 802.11ay**
  - Frequency range: > 57 GHz
  - Signal bandwidth: 2 GHz
  - Short range data transmission (10 m)
  - Data rates (up to 7 Gbs)
  - Video transmission

- **5G**
  - Frequency range: 28 GHz, 37 GHz, … (under discussion)
  - Signal bandwidth: 1 GHz (split in multiple subcarriers)
  - Mobile broadband
  - Very high data rate
  - Very high capacity
  - Internet of Things (IoT)

- **Mandatory Feature for WLAN 802.11ad, 802.11ay and 5G**
  - Beamforming to optimize the power at the receiver
  - Implemented by Phased-Array-Antennas
R&S test solutions to investigate, develop and standardize 5G

<table>
<thead>
<tr>
<th>Wideband Signal Tests</th>
<th>Channel Sounding Solution</th>
<th>Component Characterization</th>
<th>Massive MIMO - Beamforming</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;S®SMW200</td>
<td>R&amp;S®SMW200+</td>
<td>R&amp;S®ZVA</td>
<td>R&amp;S®SMW200+ 6x R&amp;S®SGT100</td>
</tr>
<tr>
<td>Signal generator</td>
<td>Spectrum Analyzer</td>
<td>Network Analyzer</td>
<td>R&amp;S®ZNB7</td>
</tr>
<tr>
<td>&lt;40 GHz</td>
<td>w/ in-build amplifier</td>
<td></td>
<td>Phase-coherent RF generation</td>
</tr>
<tr>
<td>DUT</td>
<td>Data Analysis Software</td>
<td></td>
<td>Multi-port VNA</td>
</tr>
<tr>
<td>R&amp;S®FSW67</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spectrum Analyzer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital Oscilloscope</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&amp;S®RTO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 GHz signal generation without need for up-conversion</td>
<td>fast measurement directly in time domain</td>
<td>Component Characterization</td>
<td></td>
</tr>
<tr>
<td>85 GHz analysis w/o down-conv.</td>
<td>Support for in- and outdoor sounding</td>
<td>Component Characterization</td>
<td></td>
</tr>
<tr>
<td>2 GHz bandwidth analysis</td>
<td>very high dynamic range</td>
<td>Component Characterization</td>
<td></td>
</tr>
</tbody>
</table>

New 5G PHY Candidates

- 40 GHz signal generation
- 85 GHz analysis w/o down-conv.
- 2 GHz bandwidth analysis

| Component Characterization | R&S®ZVA                   | Direct measurements up to 67GHz |
| Data Analysis Software    |                           |                                  |
| Digital Oscilloscope      |                           |                                  |
| Spectrum Analyzer         |                           |                                  |
| Signal generator R&S®SMW200 |                       |                                  |

E2e Application Testing

- Analyze application behavior like signaling load, delay, power etc.

R&S Seminar 3
R&S Test Solution
Signal Generation / Signal Analysis

- Signal Generation up to 40 GHz (one or two RF out)
- Signal Analysis up to 85 GHz
- Harmonic Mixer opt.
- Channel bandwidth up to 2GHz (external baseband)
R&S Test Solution

Signal Generation / Signal Analysis - mmWave

- Signal Generation / Analysis up to 85 GHz
- Channel bandwidth up to 2GHz BW

R&S®FSW Signal and Spectrum Analyzer
Analysis up to 85 GHz in a single instrument...

R&S®SMW200A Vector Signal Generator
RF
LO

i.e. 65 GHz

2 GHz
IQ modulator

mm-wave reference plane
DUT is inserted here

Two path up to 20 GHz each,
e.g. $f_{\text{LO}}=15$ GHz and $f_{\text{IF}}=5$ GHz

RPG HM4 50-75

Analysis up to 85 GHz in a single instrument...
R&S Test Solution

mm-Wave Component Characterization

R&S ZVA Millimeter Wave Setup

Characterize e.g. High-Pass filter

Characterization of a high-pass filter
Insertion loss vs. frequency

Insertion loss IL vs. frequency f:
- IL = 0 dB at f = 0.9f₀
- IL = 3 dB at f = f₀
- IL = 40 dB at f = f₀ + 4 GHz

Typical frequency range: 1.3 GHz

5G Seminar
R&S Test Solution

Generation of Phase Coherent Signals

- The two path SMW + SGS/SGU allows to generate 4 RF paths per set
- Sets can be cascaded by LO distribution across instruments, which creates coherent and phase stable RF
- Phase relations are set via baseband of SMW
- SMW + SGS
- SMW + SGS + SGU
- Complete setup is controlled from the GUI of the SMW

Example: Two sets provide 8 phase coherent signals
R&S Test Solutions

Using Vector Analyzers to Characterize e.g. Antenna Arrays

- Parallel measurements
- The R&S®ZNBT8 / ZNBT20 is the first multiport vector network analyzer offering up to 24 /16 integrated test ports. The instrument can simultaneously test multiple DUTs or measure one DUT with up to 24 ports.
- Frequency range from 9 kHz to 20 GHz
R&S Test Solutions

Using Vector Analyzers to Characterize e.g. Antenna Arrays

- The R&S®ZNB analyzer features high measurement speed, outstanding precision and exceptional ease of operation
- Frequency range from 9 kHz to 40 GHz
- Realizing 48 ports with switch matrix
- Sequential measurements
OTA Measurement

Example setup

- RF antenna array
- beam forming/electronic sector selection
- cost efficient production solution

- Use for Tx power meas.
- Use of multiple sensors for assessment of beam steering capabilities

Either RF module/antenna or complete DUT is placed in shielded chamber.
NRPM - OTA power measurement system
NRPM-A66 Antenna Module

- Frequency range: 27.5 GHz to 75 GHz (WLAN 802.11ad and 5G bands)
- Measurement range: -75 dBm to -25 dBm (Continuous Average)
  -62 dBm to -25 dBm (Trace)
- Vivaldi antenna with integrated diode detector for power measurements directly on the antenna
- Very low radar cross section, < -20 dBsm
- Compensated frequency response
NRPM - OTA power measurement system
The complete picture

Monitoring PC
with Power Viewer Plus

NRPM-A66
NRPM-ZD3
NRPM-ZDK3
NRPM3
NRPM - OTA test applications
Level calibration

Power level calibration

R&S® NRPM-A66
single-polarized antenna module
NRPM - OTA test applications
Level calibration and 2D Beamforming verification

Power level calibration and 2D beamforming test

DUT

R&S®NRPM-A66
single-polarized antenna modules
NRPM - OTA test applications
Level calibration and 3D Beamforming verification (horizontal/vertical beamforming)

Power level calibration and 3D beamforming test

R&S®NRPM-A66
single-polarized antenna modules
Perfect fit to TS7124

- Shielded chamber TS7124
  - Rack mountable
  - Manual or automated use version available
- Antenna ring
  - Frame for multiple test antennas inside TS7124
  - Provides variable mounting positions
  - Customized antenna configurations
OTA Power Sensor
Feasibility Study @ 28 GHz

- Linearity performance

- General proof-of-concept for 28 GHz
- OTA sensors have very good linearity also at other frequencies, e.g. 28 GHz
- Design can be further optimized or adapted to other frequencies
“If you want to go fast, go alone. If you want to go far, go together!”

African proverb