Be ahead in 5G. Turn visions into reality.

5G mmWave test solutions

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ROHDE&SCHWARZ

5G test challenge:
Measuring new 5G mmWave systems

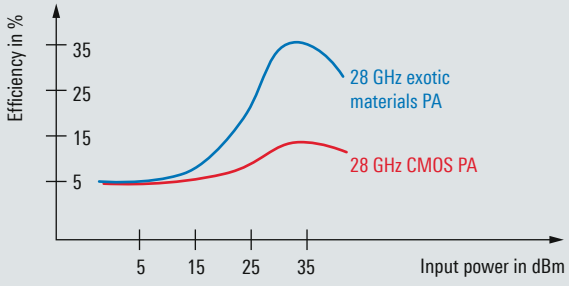
5G mmWave challenges and solutions

Challenges:
5G mmWave system

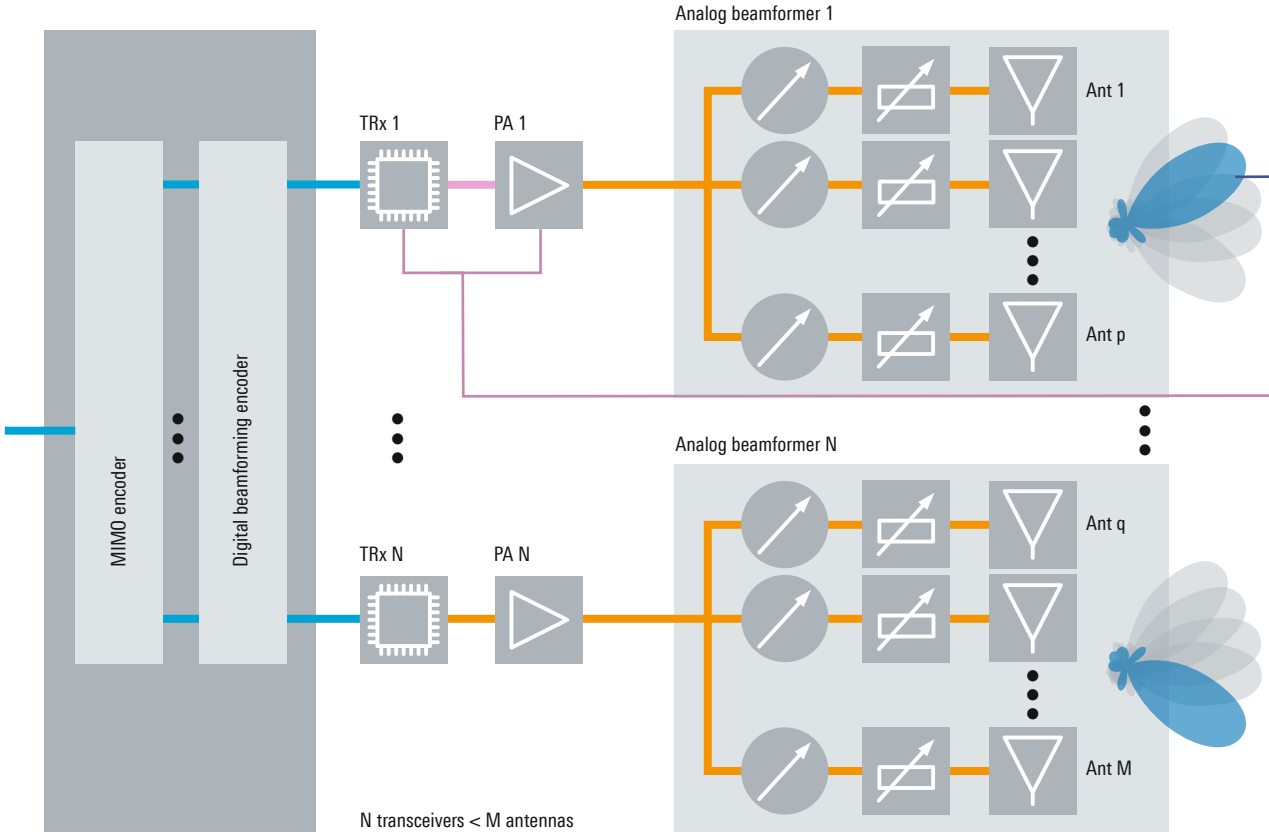
28 GHz path loss

Distance from base station	Free space	Indoor line of sight	Urban area
1 m	–61 dB	–52 dB	–92 dB
10 m	–81 dB	–69 dB	–122 dB
100 m	–101 dB	–86 dB	–151 dB
1000 m	–121 dB	–103 dB	–181 dB

High-Cost versus high-loss PAs



Solution:
mmWave transceivers with hybrid beamforming architecture

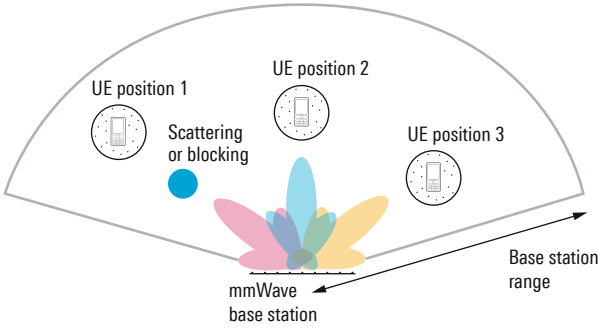


At Rohde&Schwarz, your test and measurement challenges are our motivation to provide solutions for your success: from mmWave signals to massive MIMO and other enabling technologies for 5G development and deployment.

Beam-steering and beam-tracking

Beam-tracking, blocking and acquisition

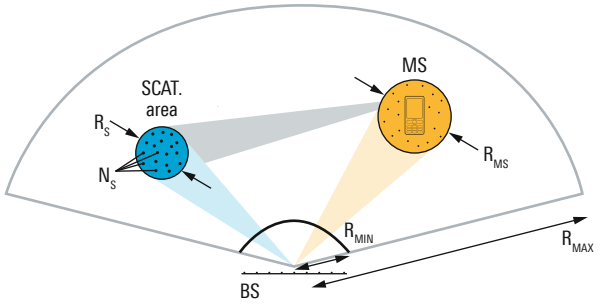
Due to the high path loss and limited range of a mmWave wireless system, precise beam-tracking and fast beam-acquisition is needed for mobile users. Slow beam acquisition will lead to user churn and slow the adoption of mmWave systems for outdoor usage. Whereas previous antenna pattern measurement systems required static beam patterns, future mmWave systems will require dynamic beam measurement systems.



Channel modeling

Angle and direction of arrival

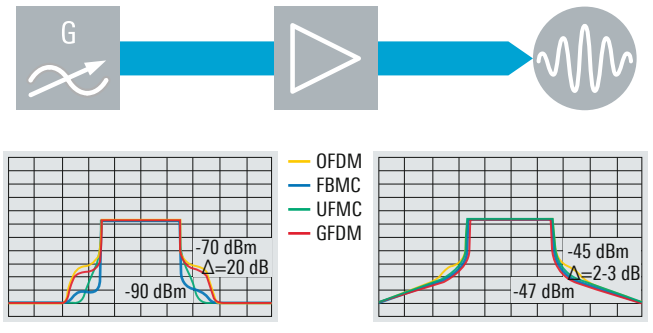
Though direct line of sight (LOS) can provide the best data link, most use cases will be non line of sight (NLOS), necessitating the use of both MIMO and beamforming. The achievable capacity of a mmWave cellular system using MIMO depends on the availability of parallel propagation paths. Therefore, it is important to be able to characterize not only the time-varying channel statistics, but also the directional propagation characteristics.



Signal/transceiver measurements

Theory versus reality

5G waveforms generally use an OFDM waveform combined with filters to reduce out-of-band (OOB) emissions. Non-linear devices such as power amplifiers in a radio transceiver create “spectral regrowth” in the OOB region, thereby reducing the benefits of new 5G waveforms. Therefore end-to-end testing is required for both component and system optimization.



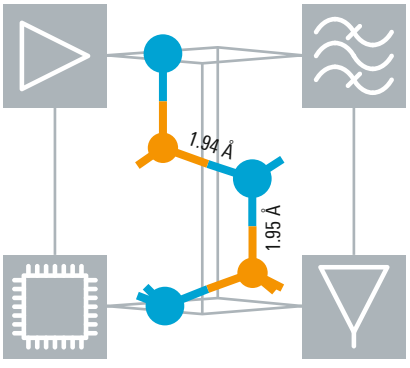
Ideal system

Practical system with non-linear amplifier

mmWave components

High frequencies = high demands

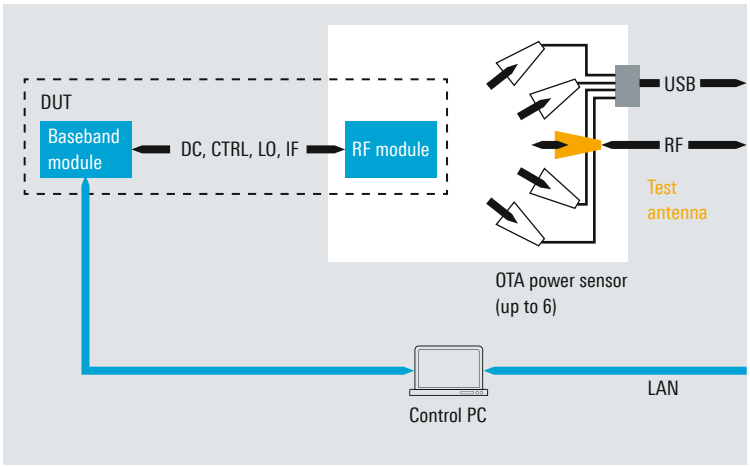
Higher frequency bands in the mmWave range also place high demands on the components used in 5G communications devices and systems, e.g. filters, mixers, amplifiers and antennas. Measurement systems for efficient and reliable characterization of these components need to address several challenges in order to ensure wide frequency coverage, high dynamic range, high output power, signal stability and signal quality with as little distortion and harmonic content as possible.

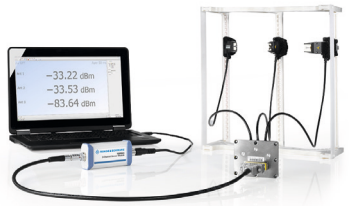


Exotic materials required for mmWave components

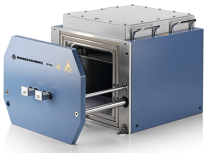
Beamforming and beam-tracking

Rohde&Schwarz offers a cost-efficient OTA power measurement solution that measures the magnitude (power) from the radiating device under test such as a mmWave access point or device. The OTA power probe is an integrated antenna plus power sensor so a digital signal is transmitted from the probe to the power meter (to prevent high attenuation of power at mmWave frequencies inside the coaxial cable). This system is designed for all mmWave systems from 27.5 GHz to 75 GHz, allowing engineers to perform real-time beam-steering, beam-tracking, and beam-acquisition measurements. This system can be used in conjunction with an OTA performance test system (R&S®TS8991) for 3D radiation pattern measurements or with the R&S®TS7124 RF shielded box for in-situ measurements for production or rapid prototyping.





R&S®NRPM



R&S®TS7124

mmWave signal characterization

mmWave signal generation and analysis poses a new set of challenges due to the shorter wavelengths, for example spurious emissions resulting from multiplier harmonics and mixers. This makes it difficult to achieve low EVMs in the signal analyzer and flatness in the signal generator for large bandwidths (up to 2 GHz in signal bandwidth). The R&S®FSW85 has an ultra-low EVM and the R&S®SMW200A a flatness less than 0.4 dB across the entire 2 GHz signal bandwidth. Combined with the R&S®FS-K96 OFDM signal analysis software, OFDM-based signals and 5G waveform candidates, the R&S®FSW85 is the optimal tool for both sub-6 GHz and mmWave R&D. Additionally using the R&S®FSW-K18 provides a throughput power amplifier characterization test solution for both CW and modulated signals.

R&S®SMW200A

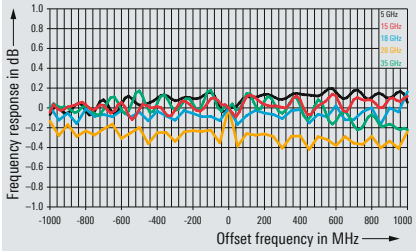
OTA or conductive interface → DUT → OTA or conductive interface

R&S®FSW

100 kHz to 40 GHz
1 to 2 RF channels
Internal BW = 2 GHz
Additional channels

Up to 2 GHz bandwidth
2 Hz to 85 GHz
Ultra-low EVM

I/Q modulation frequency response

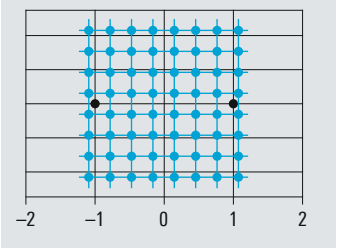


Customized solution available for 5G mmWave

Based on 3GPP and Verizon test specifications

Wideband flatness and low EVM

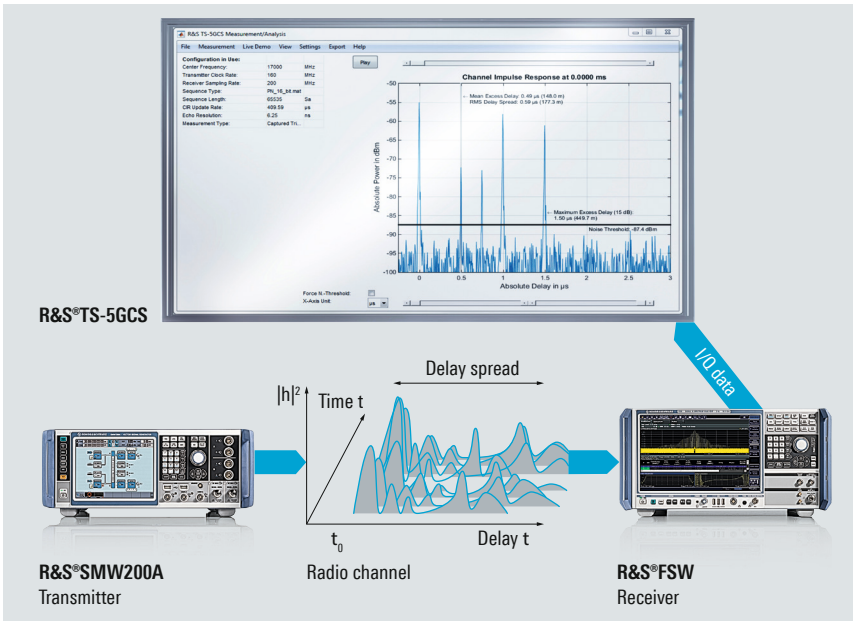
EVM < 1% across 10 dB sweep at 28 GHz



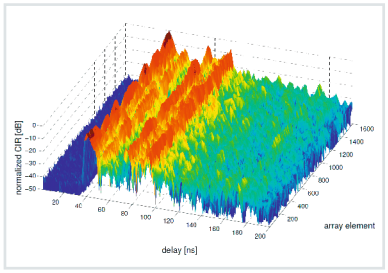
Channel sounding

The Rohde&Schwarz channel measurement system uses temporal MIMO in a SISO-type environment in order to measure the channel impulse response. A SISO system is less complicated with fewer instruments and more accurate measurements. Rohde&Schwarz can measure the channel impulse response using only an R&S®SMW200A signal generator and an up to 85 GHz R&S®FSW85 spectrum analyzer (the angle of arrival can be calculated using additional software and hardware). This system has been used by operators, universities and research institutes for modeling and planning future 5G mmWave networks.

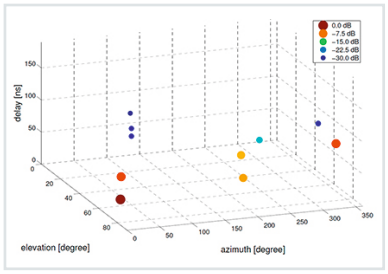
Basic channel sounder setup



Channel impulse response



Direction of arrival

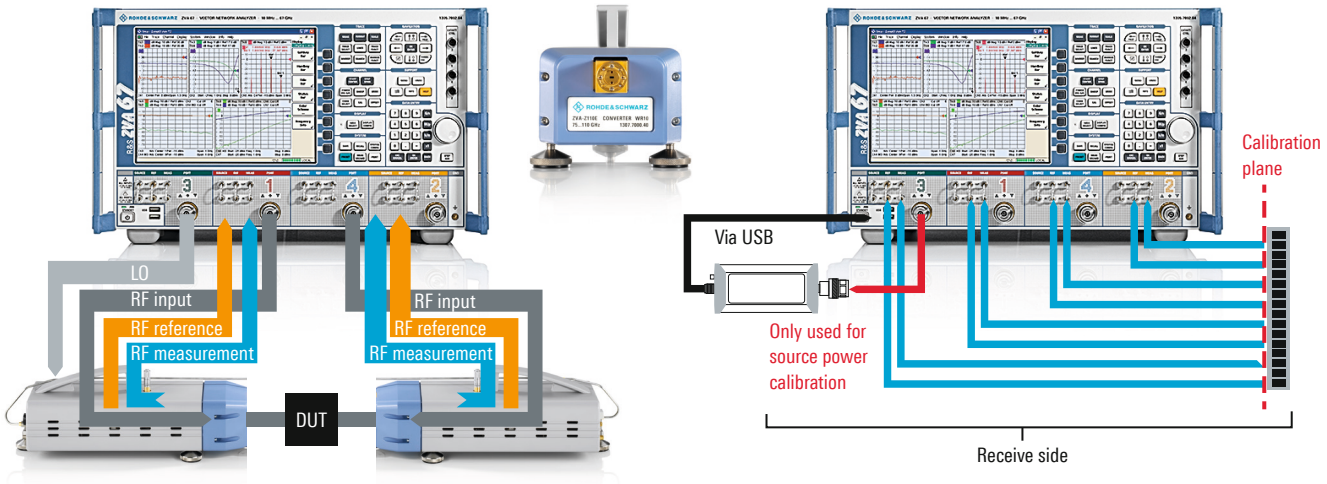


mmWave component characterization (S-parameters)

The R&S®ZVA vector network analyzer family is an ideal choice for demanding measurements in the lab as well as in production – from filter measurements requiring maximum dynamic range to linear and non-linear measurements on amplifiers and mixers as well as on receivers and transceivers. The analyzer features easy operation and high measurement speed with a wide scope of functions and high flexibility. With four internal (phase-coherent) sources up to 67 GHz, the four-port R&S®ZVA enables fast two-tone measurements on amplifiers and mixers – eliminating the need for external generators. Direct access to up to eight phase coherent receivers further facilitates phased antenna array measurements.

R&S®ZVA
Vector network analyzer

R&S®ZVA-Z110E



Rohde&Schwarz millimeter wave setup for frequencies up to 110 GHz

Service that adds value

- Worldwide
- Local and personalized
- Customized and flexible
- Uncompromising quality
- Long-term dependability

Rohde&Schwarz

The Rohde&Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

Sustainable product design

- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

Certified Quality Management
ISO 9001

Certified Environmental Management
ISO 14001

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PD 3606.8620.32 | Version 01.00 | March 2017 (md)
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3606862032