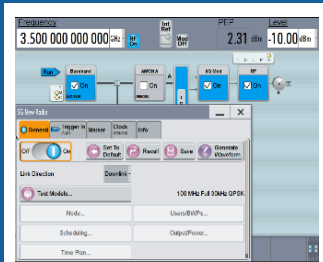


# 5G NR

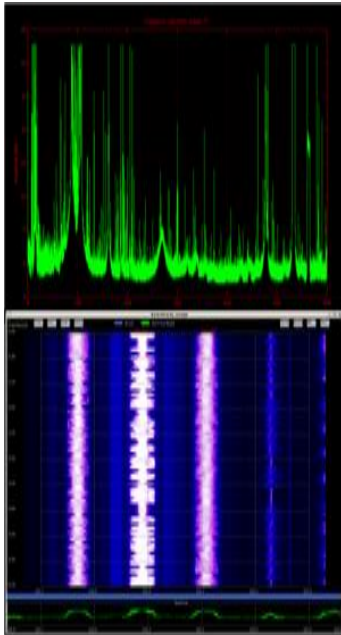
## RF T&M Portfolio Overview

## 5G NR product areas

## Signal Generation



# Signal Analysis



## One Box Testers



## OTA Solutions



# Test Systems



# R&S 5G NR Signal Generation and Power Meter

## SMW200A



up to 2 x 20 GHz RF  
up to 1 x 44 GHz RF  
up to 8 x BB  
sophisticated MIMO /  
fading  
2 GHz BW with internal  
BB  
SMW-K144 5G NR  
SMW-K444 5G NR  
(WinIQSim2)

## SMBV100B



1x 6 GHz RF  
High power  
500 MHz BW  
SMBV-K144 5G NR  
SMBV-K444 5G NR  
(WinIQSim2)

## SGT100A



1x 6 GHz RF  
1x BB  
240 MHz BW  
Optimized for  
automated production  
use  
SGT-K444 5G NR  
(WinIQSim2)

## SGS100A SGU100A



Upconversion to up to  
40 GHz I/Q  
Optimized for  
automated production  
use

## NRQ6



50 MHz ... 6 GHz  
-130 dBm ... 20 dBm  
100 MHz BW  
Frequency selective  
power meter

# R&S Vector Signal Generators

## SMW200A

### Key Features

- **One or two RF paths** in the frequency range of 100 kHz to dual 3, 6, **7.5, 20** or single **31.8, 40, 44 GHz**
- Up to **2 GHz I/Q modulation bandwidth** (in RF) with internal baseband
- Max. **eight baseband generators** with realtime coder and ARB
- Support of all important digital standards such as **5G, LTE, LTE-Advanced**, 3GPP FDD/HSPA/HSPA+, WLAN IEEE 802.11a/b/g/n/ac
- **Optional integrated fading** section for channel emulation with up to 200 MHz bandwidth
- Implementation of all key MIMO fading scenarios such as 2x2, 4x4, 8x4 and 2x4x4
- Intuitive operation via touchscreen with block diagram as a key element

### Applications

- Basestation conformance including LTE closed-loop testing
- R&D (MIMO)-Receiver tests with channel emulation
- 5G testing incl. 3GPP receiver and performance tests
- Multi-Standard-Radio
- PA tests including Envelope Tracking, DPD, Dual-Input PA test



# R&S Vector Signal Generators

## SMBV100B

### Key Features

- 9 kHz to 3 or 6 GHz with electronic attenuator
- Ultra high output power up to +34 dBm
- 500 MHz modulation bandwidth with perfect accuracy
- Easy upgrading of instrument at customer premises via software keycodes
- Internal signal generation for all important radio communication standards, incl. 5G NR, LTE, Wifi, etc.
- Fully fledged GNSS simulator with GPS, Glonass, Galileo and Beidou

### Applications

- Testing of digital radio receivers
- Aerospace and defense applications with high bandwidth
- Cost effective, general purpose vector source
- GNSS Receiver Tests including predefined A-GNSS test cases



# R&S Vector Signal Generators

## SGT100A

### Key Features

- Frequency range 1 (80) MHz up to 3 or **6 GHz**
- Smallest vector signal generator in its class: 1 height unit,  $\frac{1}{2} \times 19"$
- Very fast settling times via LAN, USB and especially via PCIe interface
- Up to **240 MHz modulation bandwidth** in RF
- Integrated ARB baseband generator
- Integrated ET (envelope tracking) and DPD (digital pre-distortion) solution
- Digital baseband interface
- Field upgradable
- Low total cost of ownership

### Applications

- Dedicated vector signal source for ATE and production
- Compact solution for ET to test PA's in characterization
- Additional RF paths for SMW200A, controlled by SMW



# R&S Power Meter

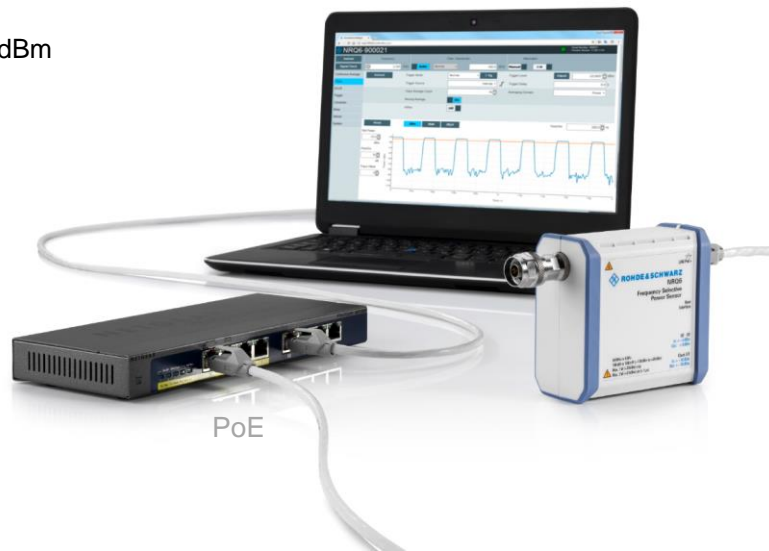
## NRQ6 Frequency Selective Power Meter

### Key Features

- ┆ 50 MHz ... 6 GHz
- ┆ Continuous average power measurements down to  $-130$  dBm and up to  $+20$  dBm
- ┆ Trace measurements / Web GUI
- ┆ Up to 100 MHz measurement bandwidth
- ┆ 0.06 dB level measurement uncertainty
- ┆ 0.02 dB linearity uncertainty
- ┆ VSWR better than 1.13 (below 2.4 GHz)
- ┆  $-72$  dBc dynamic range (with noise cancellation) for 3GPP ACLR meas.
- ┆  $-156$  dBm displayed average noise level (DANL) at 1 GHz
- ┆ I/Q data capturing for RF vector signal analysis (in sweet spot)

### Applications

- ┆ TX power calibration
- ┆ Band-limited power measurements on multi-standard radios
- ┆ Simple, functional SW regression tests for 5G NR together with R&S®VSE
- ┆ Coherent IQ capturing via synchronization of multiple NRQ6 (phase, time, frequency)



# R&S 5G NR Signal Analysis

## FSW



Premium Performance  
Class Spectrum/ Signal  
Analyzer up to 90 GHz  
Industry leading phase  
noise performance and  
optimized sweep speed  
2 GHz/ 5 GHz analysis  
bandwidth, multi-  
measurement  
FSW-K144 / -K145  
5G NR DL / UL

## FSV/FSVA



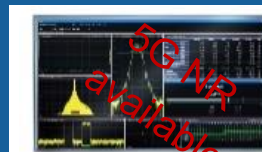
Signal Analysis  
at its best  
Mid range signal &  
spectrum analyzer  
Analysis up to 40 GHz  
and up to 160MHz  
demodulation bandwidth

## FPS



Signal Analysis for  
Production  
Exceptional fast signal &  
spectrum analyzer

## VSE



Application  
Software  
I/Q sample analysis

## NEW: FSV/FSVA3000



Mid range signal &  
spectrum analyzer up to  
44 GHz  
Signal analysis  
bandwidth up to 400 MHz  
FSV3000: Basic  
performance  
FSVA3000: Enhanced  
performance  
Manual operation like  
FSW + new features





# R&S®FSW High End Signal and Spectrum Analyzer

## FSW

### Key specifications

- Frequency range: 2 Hz to 8/ 13.6/ 26.5/ **43.5/ 50/ 67/ 85 GHz**
- Up to **2 GHz internal demodulation bandwidth** (up to **5GHz** using external RTO)
- Low phase noise of -137 dBc (1 Hz) at 10 kHz offset (1 GHz carrier)

### Main customers

- R&D for mobile & wireless communication standards:
  - **5G, LTE**, 3G, GSM, WLAN incl. 802.11ad
- A&D customers for RADAR pulse analysis, time side lobe measurements or analysis of hopping radios and RADARs
- Automotive RADAR measurement
- Monitoring authorities or R&D sites interested in detection of transient or unwanted emissions

### Highlights

- Only one box signal analyzer up to 85 GHz with 2 GHz bandwidth
- Allround high end signal & spectrum analyzer with real time capability (800 MHz BW with POI < 0.5  $\mu$ s)



# R&S®FPS Signal and Spectrum Analyzer

## FPS

### Key specifications

- R&S®FPS - exceptionally fast and compact signal and spectrum analyzer for performance oriented users in automated production and monitoring systems
- Frequency range: 10 Hz to 4/ 7/ 13.6/ 30/ **40 GHz**

### Main customers

- Component manufacturing
- Cellular base stations
- Satellite systems and their operation

### Highlights

- Control of R&S Signal generator for high speed testing of power amplifiers
- With optional YIG-bypass up to **160 MHz analysis BW** up to 40 GHz



# R&S®FSV3000 and FSVA3000 – Something new is coming ...

## FSV3000 / FSVA3000

- Frequency Range 4 / 7.5 / 13.6 / 30 / 44 GHz
- Widest IQ bandwidth in midrange: 400 MHz capture four 5G carriers
- Excellent EVM < 1 % (5G NR signal 100 MHz @ 28 GHz)
- Two RF performance categories:
  - FSV3000: max 200 MHz IQ BW, PN < -107 dBc \*)
  - FSVA3000: max 400 MHz IQ BW, PN < -120 dBc \*)
- Extended dynamic range especially at  $\mu$ Wave frequencies
- Ready for cloud based testing (10 Gbit/s LAN, PCIe 3.0 bus)
- Remote control compatible to FSV, FSVA, FPS, FSW ...
- SCPI recorder



\*) phase noise 10 kHz offset @ 1GHz

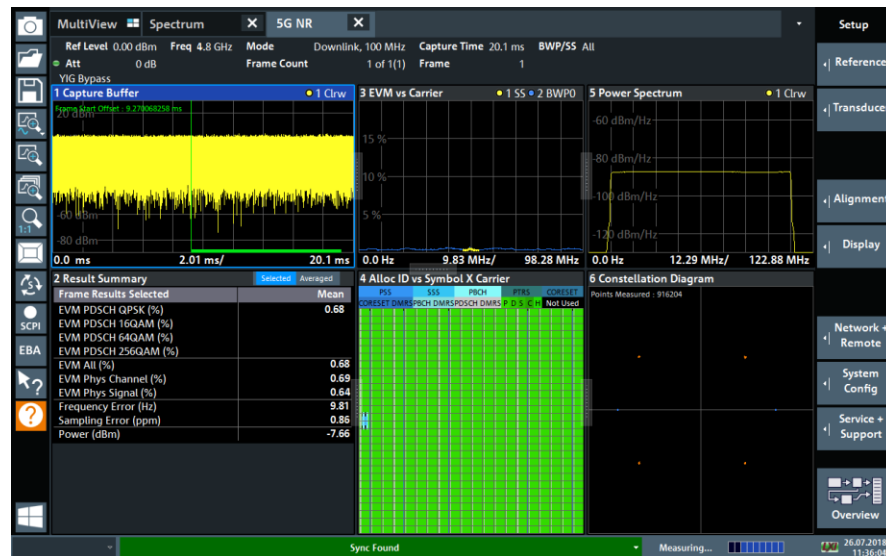
# The R&S®FSV3000 and FSVA3000

For 5G test systems in production and research



## FSV3000 / FSVA3000

- Widest analysis bandwidth (and YIG bypass)
  - 200 MHz (FSV3000) cover 2 adjacent carriers
  - 400 MHz (FSVA3000) cover 4 adjacent carriers
- Best fitting frequency models
  - 30 GHz models covers the 28 GHz band
  - 44 GHz models covers the 38/39 GHz band
- Excellent EVM < 1 % (5G signal @ 5 GHz and 28 GHz, 100 MHz)
- 5G NR options (FSV3-K144 / K145)
- Ready for the cloud

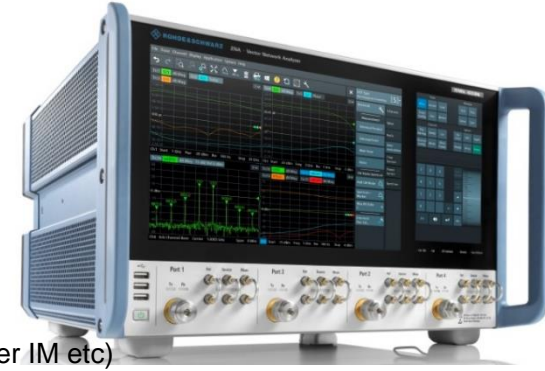




# R&S®ZNA – The new high-end vector network analyzer series

## R&S®ZNA

- Up to 26.5 GHz, and 43.5 GHz, with 2 and 4 test ports
- **Outstanding RF specifications**
  - Dynamic range > 129 dB (spec), up to 170 dB (typ., with options)
  - Up to -151 dBm sensitivity (typ, @ 1 Hz IFBW, direct rec. input)
  - Max output power +20 dBm, 100 dB power sweep range
  - Uniquely low trace noise and outstanding stability
- **HW and SW options make R&S ZNA a powerful test platform (\*)**
  - Up to 4 phase coherent RF sources, 2<sup>nd</sup> internal LO source (for multi-signal setups, mixer IM etc)
  - Up to 8 receivers (for multi-path testing, antenna testing)
  - Pulse modulators and trigger/interface board (for compact pulse signal setups and system integration)
  - Easy but high-performing mixer phase and converter group delay measurements (for satellite/radar converter testing)
- **Applications (\*)**
  - Radar & satellite technique (T/R-modules, receiver, high power or low noise amplifiers)
  - Demanding passive components (e.g. high-blocking base station filters etc)
  - mmWave, 5G, MIMO



# R&S®RTP High-Performance Oscilloscope

## RTP

### Key specifications

- Bandwidth models: 4, 6, 8 GHz (13, 16 GHz planned for Q2'19)
- Deep Memory: up to 2 GSample

### Main customer benefits

- Superior analog performance (e.g. +/- 0.25 dB flatness)
- Fastest update rate: approx. 1,000,000 wfms/s
- Realtime deembedding (distortion correction in HW)
- Trigger up to full bandwidth
- Multiple instruments in one (spectrum-, protocol-, logic-, power analyzer, AWG, pulse source, etc.)
- Fits to any lab (small footprint, most quiet, upgradable)

### Applications

- Multi-channel RF Signalanalysis (MIMO, 5G, Radar, etc.)
- Highspeed digital interface debugging (DDR, USB3.2, PCIe, etc.)
- System Validation (time-synchronized debugging on multiple system interfaces)



**ROHDE & SCHWARZ**

# R&S 5G NR One Box Tester

## CMW100



non-signaling one-box  
tester for sub6 5G NR  
production  
bandwidth up to 160MHz  
Multi-technology solution  
supporting cellular + non-  
cellular  
Multi DUT testing on up  
to eight RF ports

## CMP200



non-signaling one-box  
tester for mmW 5G NR  
production  
1xVSA and 1xARB  
Generator  
IF interface 4 to 20 GHz  
USB Interface for R&S  
Wideband Power  
Sensors

## CMX500



Signaling one-box tester  
for 5G NR  
To be combined with  
existing CMW500  
Support of NSA and SA  
Support of sub6 and  
mmW

## RRH



R&S Remote Radio Head  
Including up- and down-  
converter IF <-> mmW  
5G mmW multi-band incl.  
28/39 GHz  
Integrated mmW RF  
switch matrix  
Compact size

## Antenna Sensors



Vivaldi antenna with  
integrated diode detector  
Absolute power  
measurement directly on  
the antenna  
Frequency range  
18...90GHz  
dual-polarized broadband  
Vivaldi antenna  
Broad frequency range  
up to 87GHz



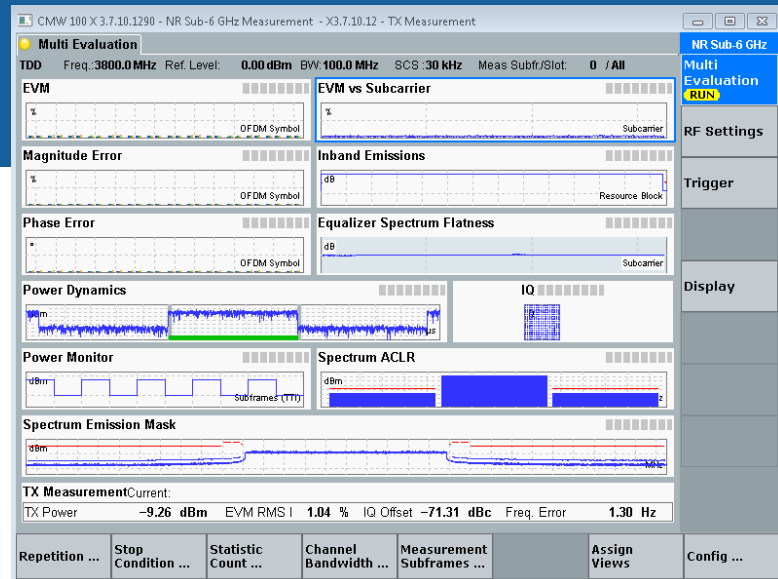
# 5G NR Non-Signaling Test @ Sub6 GHz

CMW100 V06 / 160 MHz bandwidth

- Continuous frequency range up to 6GHz, bandwidth up to 160MHz
- Multi-technology solution supporting cellular + non-cellular (GSM, WCDMA, LTE, WLAN, BT, ...)
- Multi-DUT testing on up to eight RF ports
- High measurement performance / accuracy
- Support of a wide range of methods for reducing test time and maximizing capacity utilization



**5G NR Sub6 Non-Signaling test solution via software upgrade**  
**Measurement personality and ARB generator**



**ROHDE & SCHWARZ**

# R&S NR FR2 One Box Test Solution Key Facts

## General

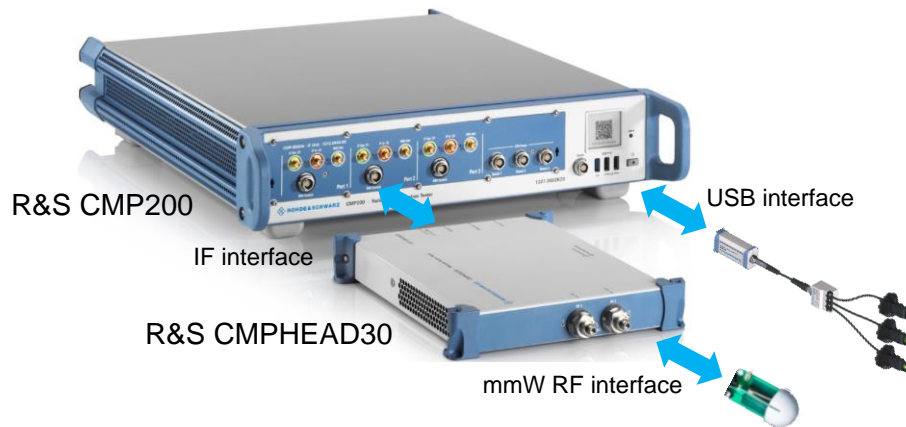
- Split concept with separated IF tester and remote radio head
- Access to IF frequency for mmW RFIC testing
- Optimized link budget due to short mmW cabling
- System bandwidth 1 GHz

## R&S CMP200 Radio Communication Tester

- Contains 1x vector signal analyzer + 1x ARB generator
- Frequency range 4 to 20 GHz (NR IF frequency)
- Integrated switch matrix for up to 3x remote radio heads
- R&S Power Sensors NRPM can be connected directly
- Compact size 19" / 2HU

## R&S CMPHEAD30 Remote Radio Head

- Including up- and down-converter IF  $\leftrightarrow$  mmW
- One single hardware supports all essential NR FR2 bands incl. 28 and 39 GHz
- Integrated mmW RF switch matrix providing 2x mmW RF paths
- Compact size 25x19x3 cm



# 5G NR NSA Signaling Test Solution

5G NR

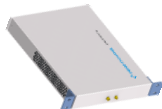
LTE Anchor

R&S CMX500



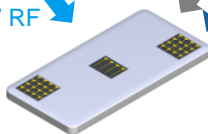
5G NR IF

R&S Remote  
Radio Head



5G NR mmW RF

5G NR DUT



R&S CMWflexx

LTE RF

5G NR Sub6 RF

R&S OTA Solutions  
Shielded Chambers



R&S Wideband Power Sensors



R&S Wideband Antennas



# R&S – 5GNR CMX500 HW key facts

High performance re-configurable computing with massive number of CPU-cores and massively scalable FPGA-based acceleration

High speed backplane to support 20+ Gbps e2e & large RF bandwidths

Modular and scalable HW-Architecture to address multiple applications

Asset-saving 5GNR Extension for CMW500 install base

Investments in Legacy SW-Licenses secured

Modern WebBased User Interface  
Single User Interface for RF-, Functional-, Application- and Protocoltest

R&S®CMX500



Directly connect Multi-Band-RRH's to the tester

# 5G NR Signaling Setups

Minimum Footprint Setup



Extended Setup

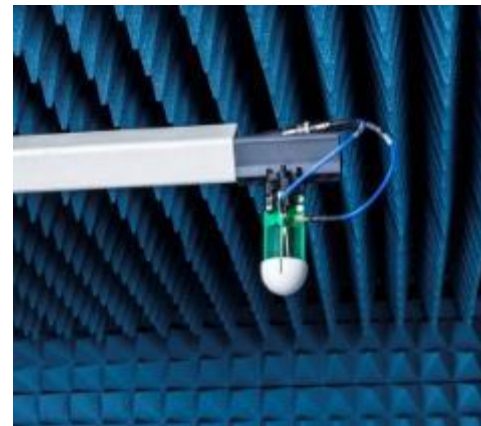


# Measurement Antenna: TC-TA85CP

## Patented dual-polarized broadband Vivaldi measurement antenna

Advantages compared to a SGH antenna

- Minimum scattering (RCS)
- No reflections coming from the antenna's material (metal vs. PCB)
- Broad frequency range:  
no need for recalibration when changing frequency



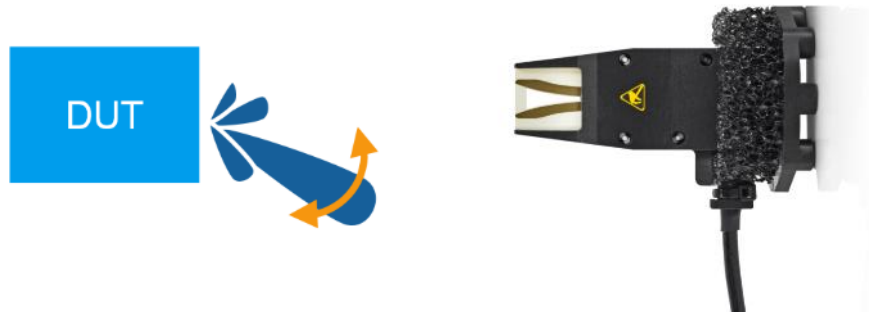
Parameter	Value
Frequency range	4 - 87 GHz
VSWR	<2.5
Gain	> 10 dBi from 20 GHz
Cross-polarization rejection	>20 dB up to 40 GHz, >15 dB
Radar cross section (RCS)	-20dBsm
Dimensions	76 x 48 x 34 mm <sup>3</sup>



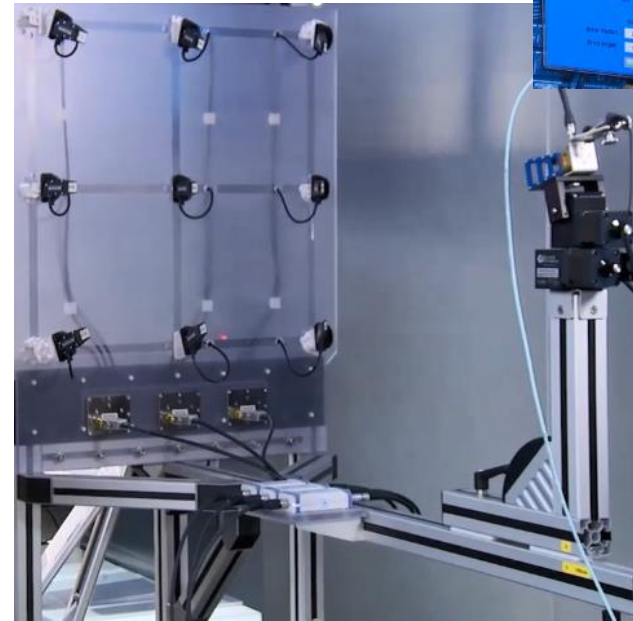
# NRPM – OTA power measurements

## Vivaldi antenna with integrated diode detector

- Absolute power measurement directly on the antenna
- NRPM-A90: Frequency range 18...90GHz
- Absolute accuracy 0.49...0.97dB
- Relative accuracy 0.09dB
- Also available as dual polarized model NRPM-A90D



- Up to 9 NRPM can be connected to CMP200 for beamsteering power measurements





# R&S 5G NR OTA Solutions

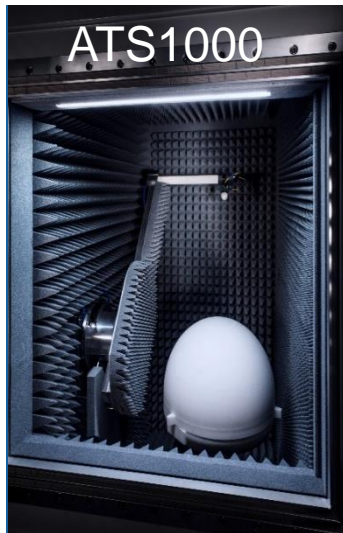
## Antenna Design

- Highest Bandwidth
- Flexible system



## Early Stage R&D

- High Test Speed
- Climatic Testing



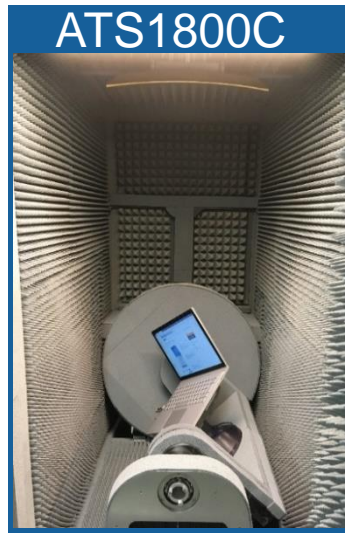
## R&D / Regression

- Cost efficient
- Space for instruments



## RF Conformance

- large QZ
- IB/OOB up to 90GHz



## mmW Production

- One stop shop solution
- High automation





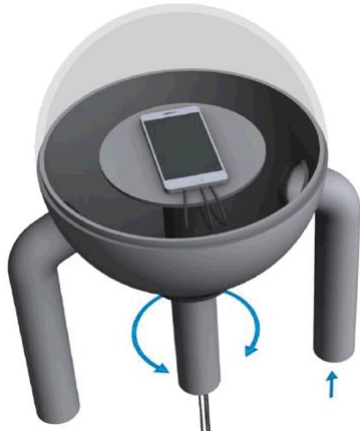
# ATS1000 – fast and compact mmW OTA solution



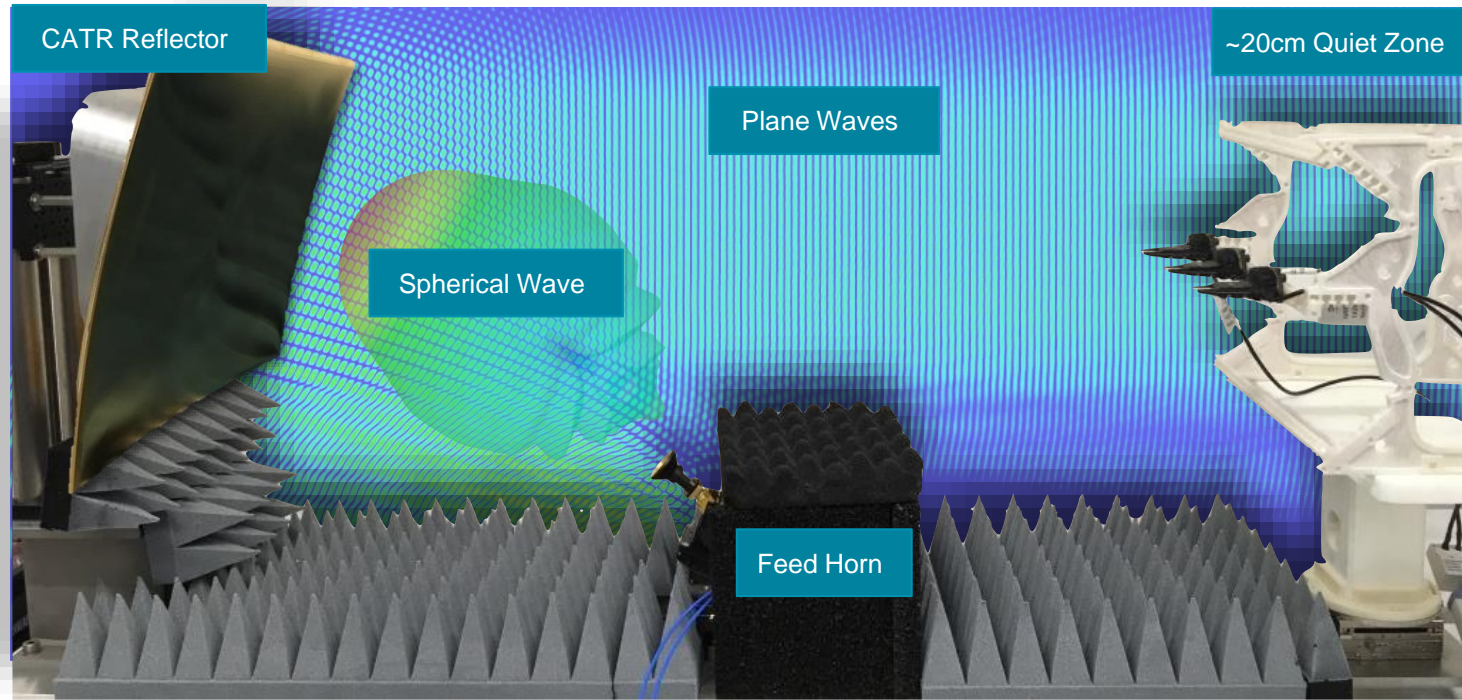
- Compact conical cut concept dedicated to mmW DFF and NFFF
- $<0.1^\circ$  positioner accuracy and laser alignment ensure high radiation pattern measurement accuracy
- DUT: devices up to 14" and 20 kg
- Current frequency coverage: 18 GHz to 50 GHz
- Cable management through rotary joint and energy chain
- TRP test at 28 GHz with 4 degree angular step takes about 7 min

# ATS1000 full 3-D OTA solution for extreme conditions

- Full spherical measurement under controlled temperature condition from  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- $100^{\circ}\text{K}$  temp change within approx. 10 minutes ( $-40\dots+60$  /  $+85\dots-15$ )

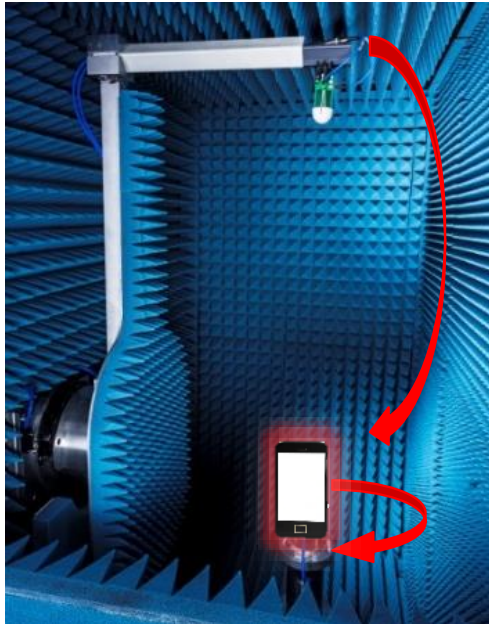


# Possibilities to shrink the chamber size – indirect far field (CATR)



## DFF solution for Whitebox

Direct far field: typically smaller QZ



Elevation  
arm  
0-168°

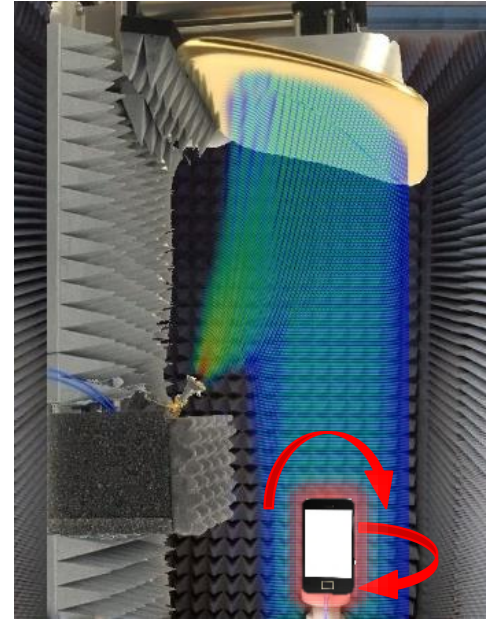
Azimuth  
+/- 180°

✓ Both systems fit  
in ATS form factor



## IFF solution for Blackbox

Indirect far field: typically larger QZ

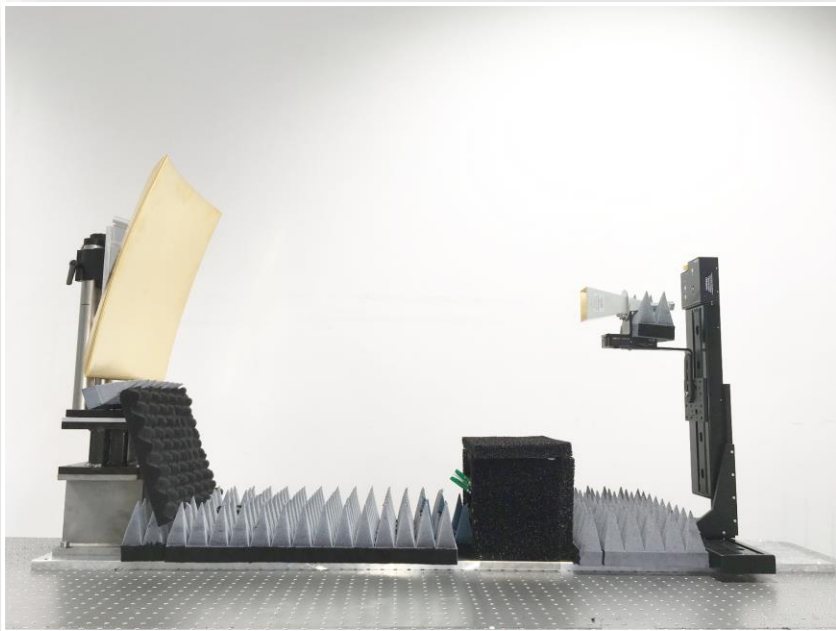


Azimuth  
& Theta  
+/- 180°



ROHDE & SCHWARZ

# ATS800 – large QZ at affordable price for R&D / pre-conformance



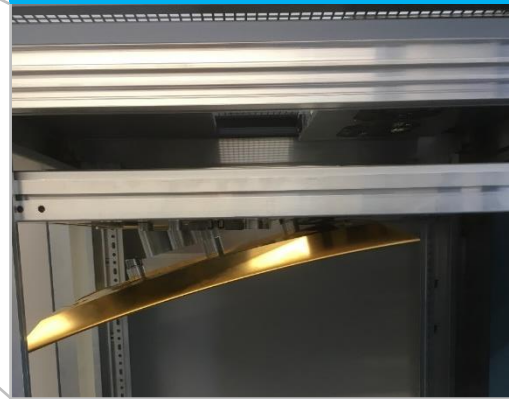
- High-accuracy gold reflector
  - Solid block
  - Roll-edged
  - 1 $\mu$ m RMS surface roughness
- Wideband dual-polarized feed for both IB and OOB up to 90 GHz
- 20 cm quiet zone
- 2D positioner option
- Cost-effective, small footprint and versatile R&D testing solution



# ATS800 – rack version



Reflector Rack Mounting  
Adjustable Tilts in 2 planes



Front View



- Main Frequency range: 20-50 GHz
- Quiet zone: D 20 cm
- Maximum DUT size: 20x20 cm
- 14 HE space for instruments: CMP, SMW, FSW, ZVA, etc.
- Wide band feed antenna



# ATS1800C - full conformance / compliance testing solution



- High-accuracy gold reflector
  - Solid block
  - Roll-edged
  - 1 $\mu$ m RMS surface roughness
- Broadband dual-polarized feed for both IB and OOB up to 90 GHz and high-accuracy IB corrugated horn+OMT feed
- Optional phantom head/hand for CTIA tests
- 30 cm quiet zone
- All-in-one conformance / compliance solution for: 3GPP FR2 RFCT, 3GPP FR2 PCT, 3GPP RRM 1 AoA, CTIA FR2 compliance



# R&S CMQ200 shielding cube key facts

Ready for 5G and extra technologies -> absorber range 20 to 75 GHz

Prepared for automated handling -> drawer concept with automatic opening

Robust for million cycles -> solid, well known design

Reduced floor space -> fits into 19" racks

Scalable for most DUT's -> smart devices , CPEs, RFICs, prototypes

Efficient for big lot sizes -> layouts with simplified geometry

Flexible for small lot sizes -> layout with floor positioner

Integrated OTA solution with CMP200/RRH -> reliability + efficiency





# Integrated R&S solution:

Make 5G mmW OTA testing as reliable and efficient as sub6 testing.

## reliable

R&S as reliable and experienced partner.

Deep R&S in-house know how of all items (tester + shielding + accessories).

Guaranteed system parameters and responsibility.

One stop shopping.

Worldwide service and maintenance out of one hand.



Repeatability. Risk minimization. Customer product quality.

## efficient

One hardware for all important FR2 frequencies -> bands from 24,25 to 43,5 GHz.

Scalable for different use cases and lot sizes -> R&D or production.

Supports most device types -> smart phones, tablets, CPE's, RFIC's, prototypes.

Compact 19" solution -> save floor space.

Use the same technology for signaling + non-signaling setups -> traceability + synergy effects.

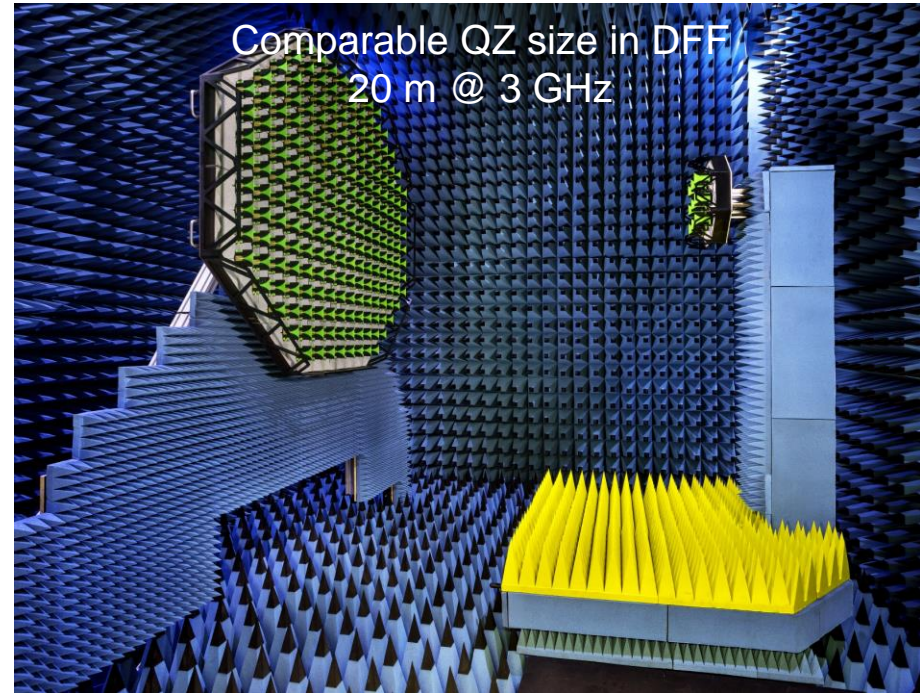


Best use of investment.



# Plane-wave synthesis system realization

- Signal distributes to 156 Vivaldi antennas through phase shifters and attenuators
- The fields generated by the antennas combine in the target region to generate a plane-wave front (reciprocal device)
- 1 m spherical quiet zone (QZ) at 1.5 m distance
- Frequency range FR1



R&S®PWC200 Plane Wave Converter

# R&S 5G NR Test Systems

## TS8980FTA-3A

sub6  
RF conformance



## TS8980FTA-3AM

sub6 + mmW  
RF conformance



Plus mmW chamber

## TS8980FTA-M1

mmW  
RF conformance



Plus mmW chamber

## TS8980PRE-M1

mmW  
RF pre-conf.



Plus mmW chamber

## TS8991

OTA and passive  
Antenna measurements



Plus chamber



# TS8980: Hardware capability check for Sub-6 / FR1

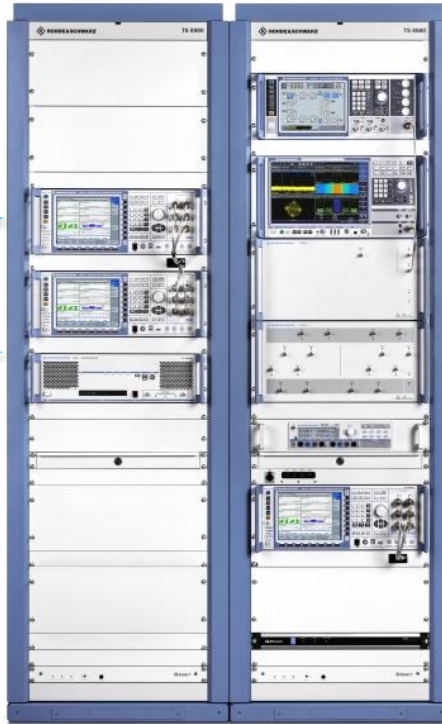
Upgrade TS8980FTA-3 → TS8980FTA-3A (for RF + RRM)

❗ Existing CMWs:

TRX160 / MUA upgrade

✓ CMWC

❗ New CMX



✓ SMW 6/20 GHz

✓ FSW 26 GHz

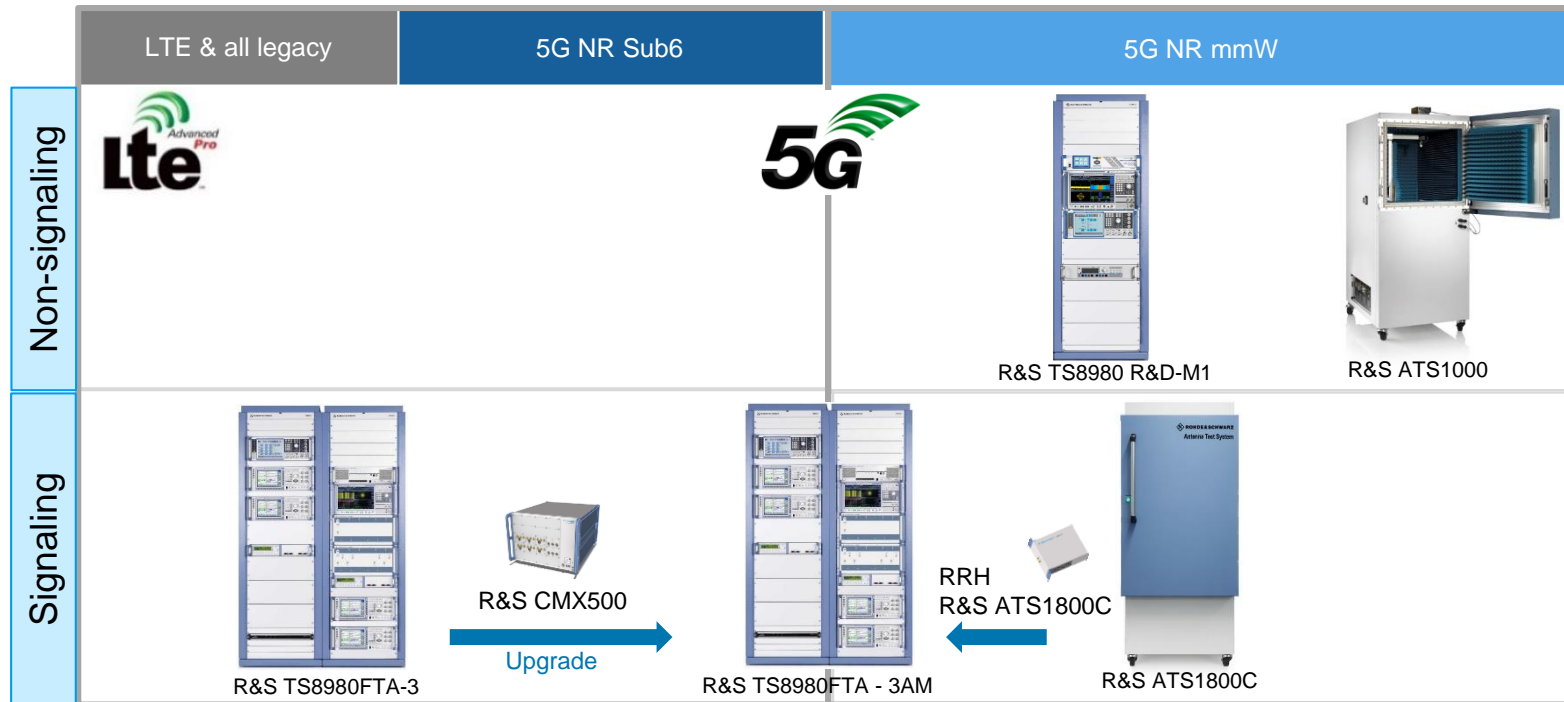
✓ SSCU3

✓ Power Supply

✓ Rubidium refer.



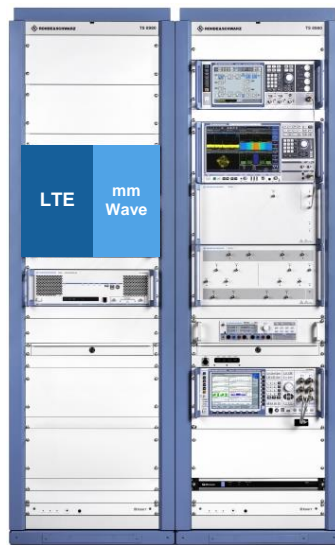
# RF conformance – upgrade path



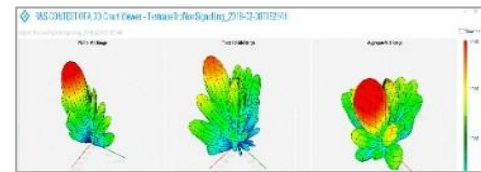
# TS8980FTA-3AM: Final conformance test setup

For 5G RF mmWave and optional Sub-6

## Planned: GCF / PTCRB RF Conformance Test Cases



for FR-2  
testing



### Contest Sequencer Software

CMX for NR

ATS1800C

Shielded  
chamber

CMW for LTE  
anchor

NRPM Power  
Meter

SSCU / OSP  
Switch Matrix

SMW  
Signal  
Generator

Optional (for Out-of-band): FSW85



# R&S test solutions to deploy 5G NR networks

## Field Services, Interference Hunting



## Site Acceptance

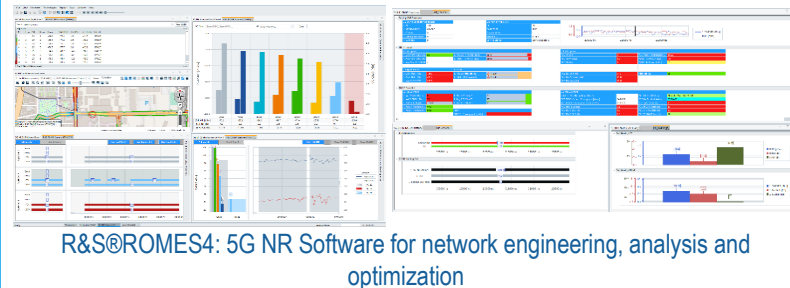
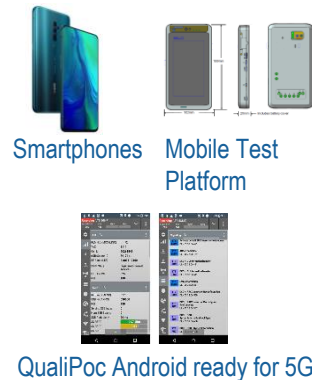


## 5G NR network measurement solution

### Passive measurements

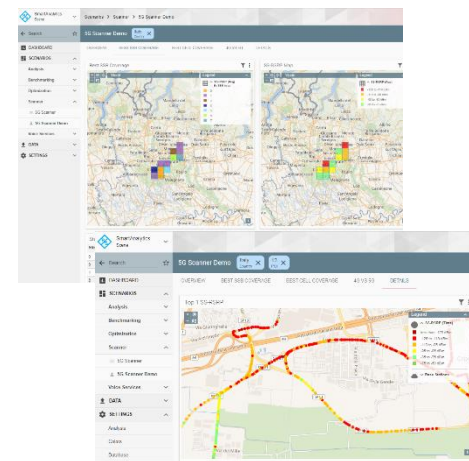


### Active measurements



## Data Analytics

### SmartAnalytics Scene



### SmartAnalytics Scene - NPS



# Rohde & Schwarz 5G NR Mobile Network Testing

A complete solution for

- Engineering
- Coverage and Co-existence
- Network Performance
- Application QoS
- Site acceptance
- Benchmarking

**R&S®TSME6  
and TSME30DC**



**R&S®ROMES**



**5G mmW  
Backpack**



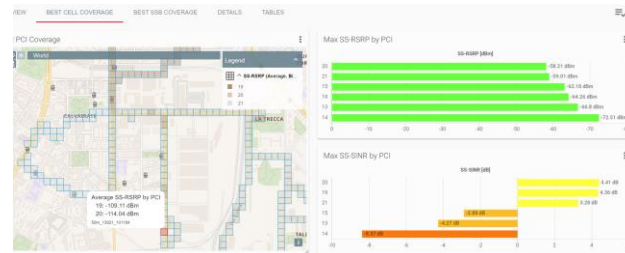
**R&S®QualiPoc  
Android**



**R&S®FR4**

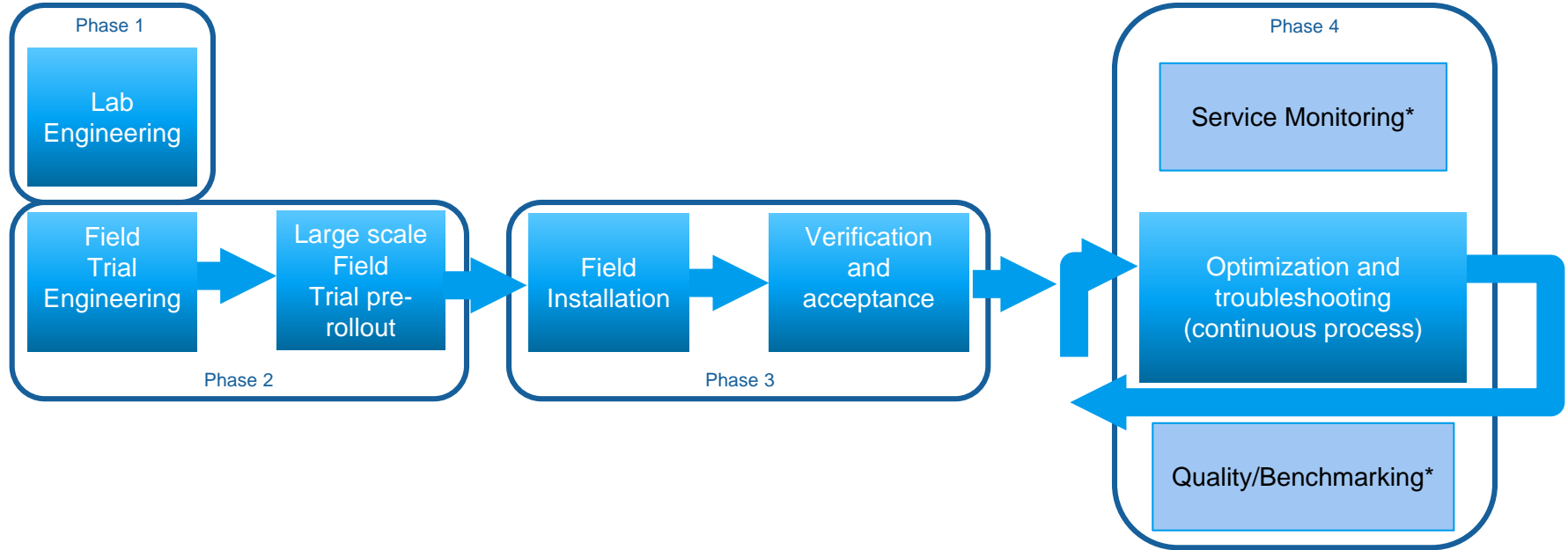


**R&S®SmartAnalytics**





# The phases of 5G NR testing



Rohde & Schwarz for entire test lifecycle

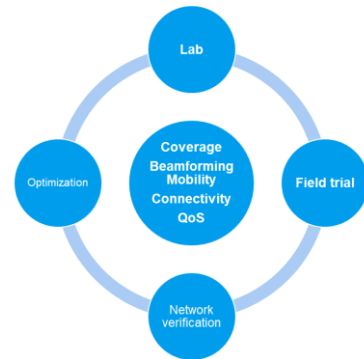


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# SmartAnalytics

With Smart Analytics and its versatile **use-case driven analytics** features, R&S MNT enables customers to get **more value out of collected data** and deeper insights with **less manual intervention**

This results in **higher productivity and efficiency** than comparable products from competition



Obtain meaningful and new insights that will **drive investment decisions**



Work easily and seamlessly with the data; **from statistical analysis to root-cause evaluation**



Easily **share the knowledge** with all the stakeholders



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