FROM LAB TO LAUNCH: TESTING IN NETWORK INFRASTRUCTURE / RADIO UNIT DEVELOPMENT

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Business Development & Marketing Dept.

ROHDE&SCHWARZ
Make ideas real

OUTLINES

- Driving Beyond Limitation for Network Infrastructure Development
- Digital Design and Electronic Circuit Testing
- RF Testing and System Verification
- Production Testing
- Conclusions

OUTLINES

- **Driving Beyond Limitation for Network Infrastructure Development**
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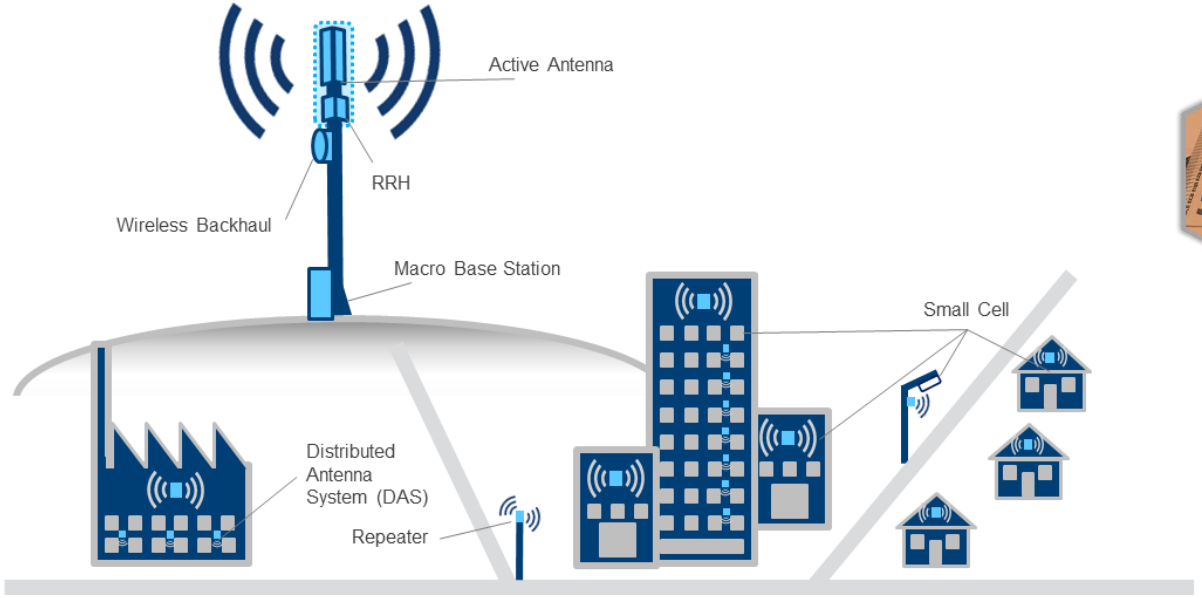
NETWORK INFRASTRUCTURE

MEET YOUR INDUSTRY DRIVERS WITH TAILORED, FUTURE-PROOF T&M SOLUTIONS

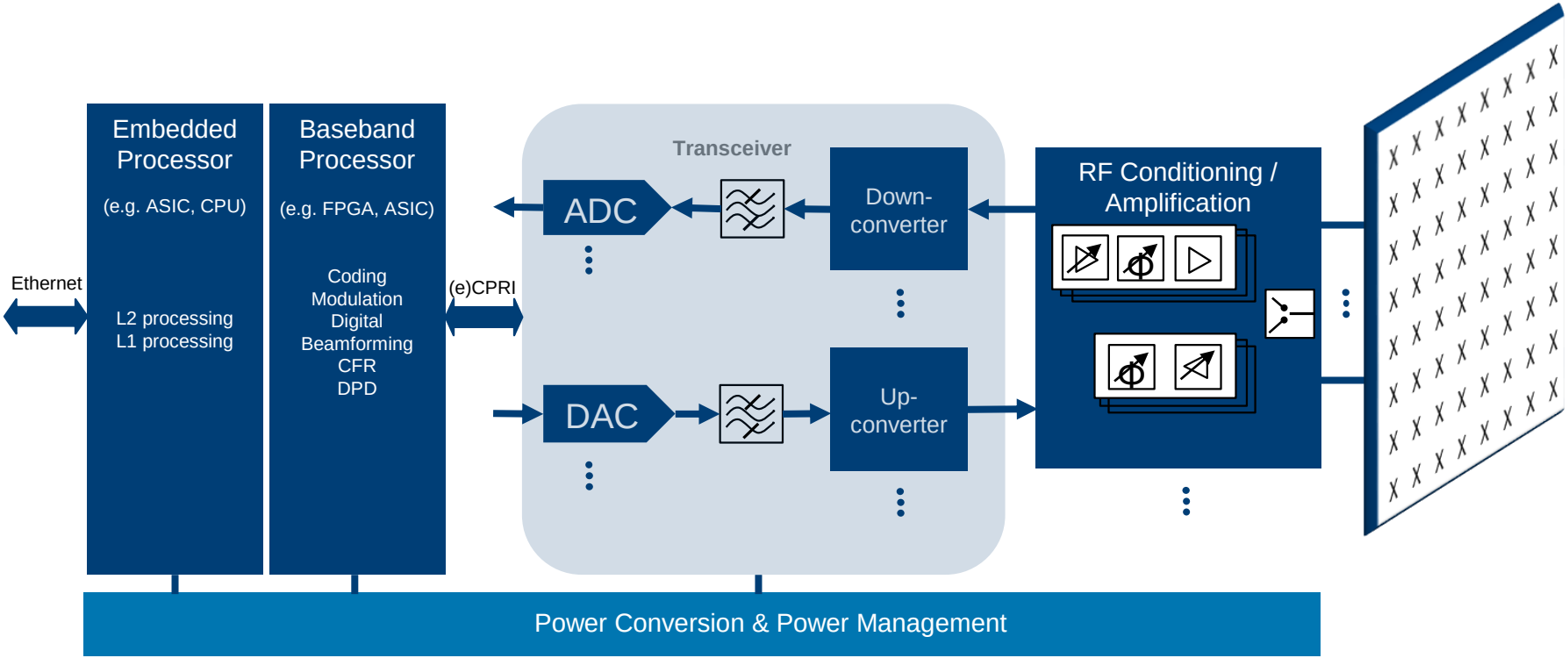


INDUSTRY DRIVERS
Which Need to Be Reflected by T&M Environment

- Increasing MIMO Degrees & Beamforming
- More Spectrum Bands Higher Frequencies
- Energy Efficiency
- Cost Efficiency Flexibility
- Disaggregation & Virtualization
- Over-The-Air
- Expanding Bandwidth
- Digital Design & Power
- Network Densification
- Private Networks
- Disaggregation & Virtualization

5G BASE STATION ARCHITECTURE

Digital Design, Power and RF Components



OUTLINES

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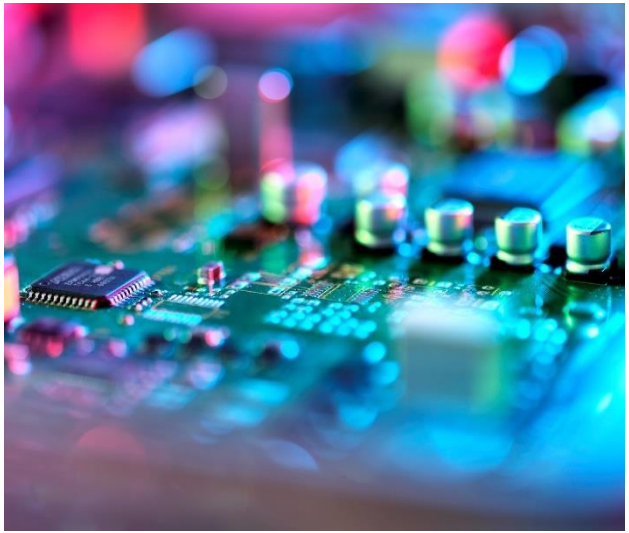
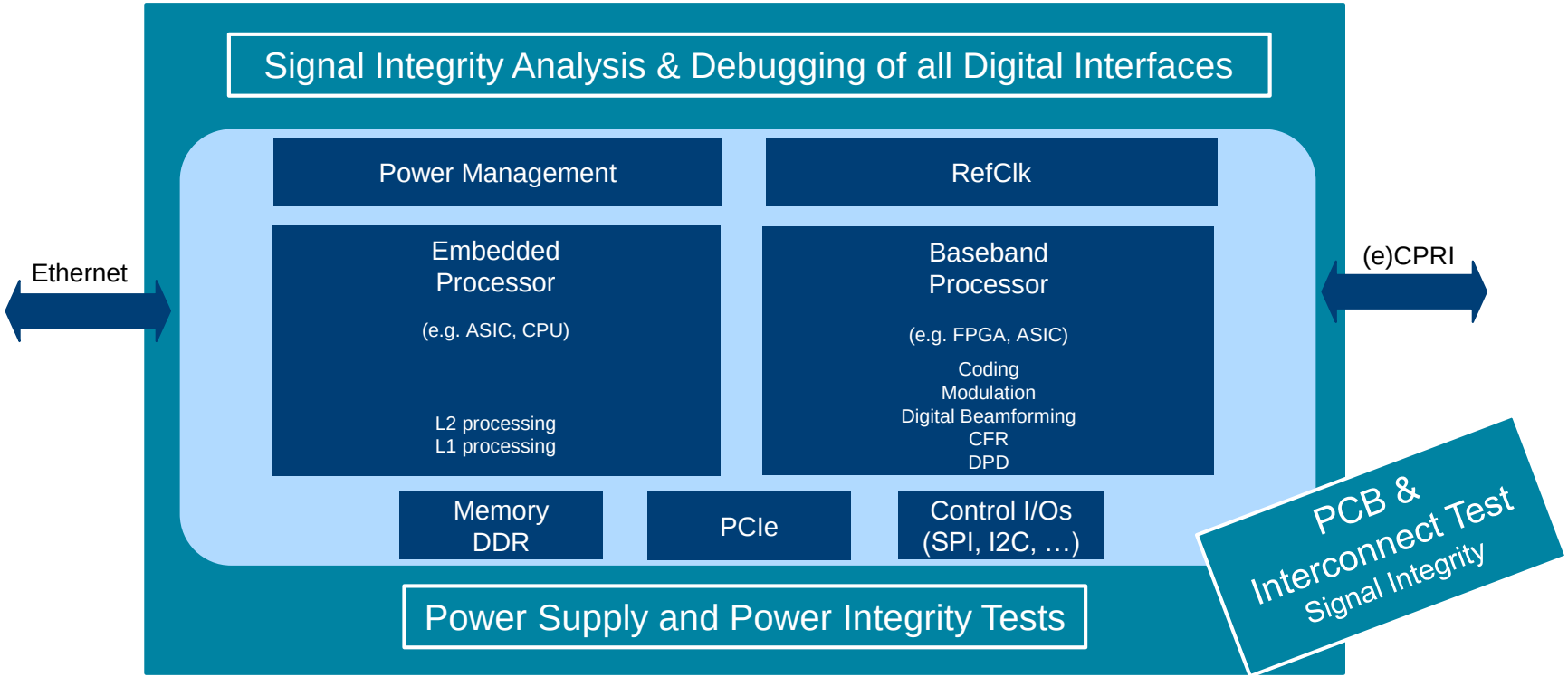
- Conclusions



5G BASE STATION ARCHITECTURE

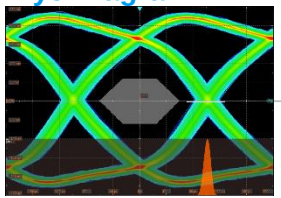
The Digital Part: Typical Test Areas for Every New Designs



HIGH-SPEED DIGITAL INTERFACES CHALLENGES

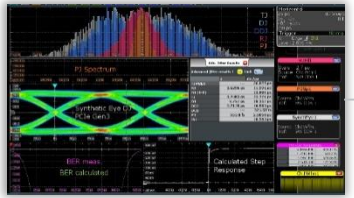
INCREASING DATA RATES AND INCREASING LEVEL OF INTEGRATION

Eye Diagram

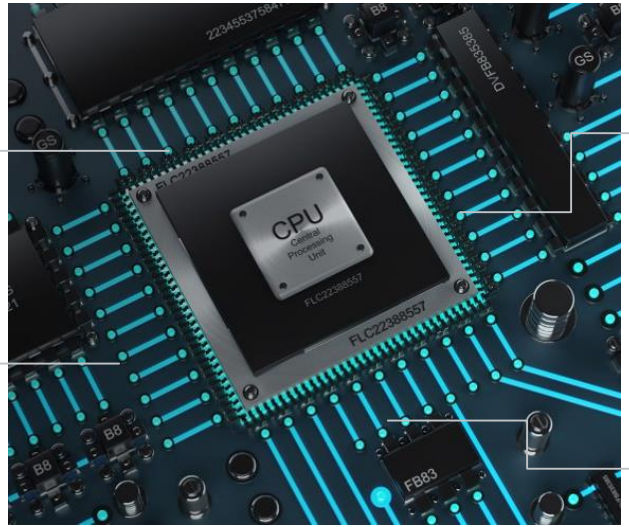


- Statistical confidence (fast update rate)
- Continuously operating Clock-Data-Recovery (CDR)
- Mask tests
- Compensation of transmission loss

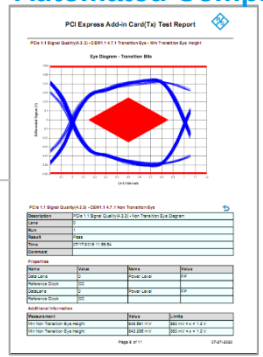
Jitter Analysis and Decomposition



- Histograms
- Track and Spectrum views
- Eye diagram, BER bathtub
- Step/Frequency response

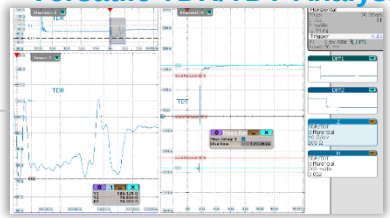


Automated Compliance Test



- Compliance for interface standards
- Test Report

Versatile TDR/TDT Analysis

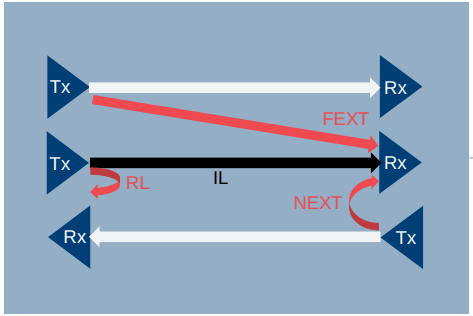


- Differential pulse source
- TDR / TDT analysis
- Guided calibration & measurement
- PacketMicro Probe

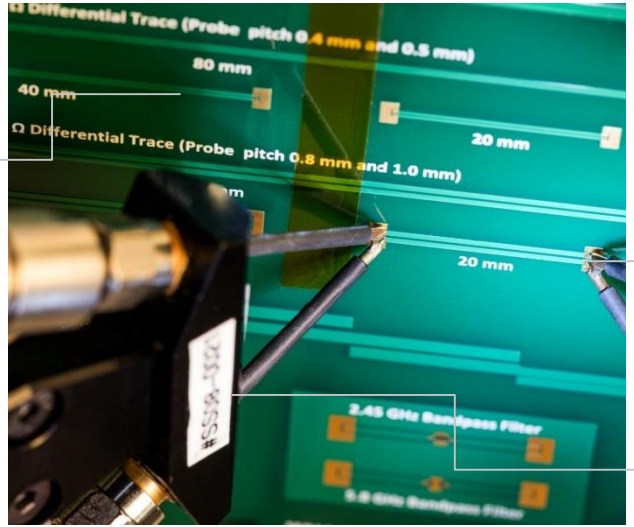
HIGH-SPEED PCBS AND INTERCONNECTS CHALLENGES

INCREASING DATA RATES, DENSE DESIGNS, AND COST PRESSURE

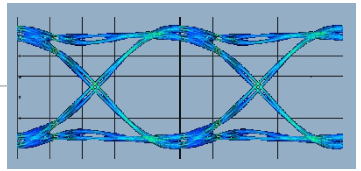
Frequency and Time Domain Analysis



- Reflection and transmission loss
- Near-end and far-end crosstalk
- Impedance matching
- Timing skew

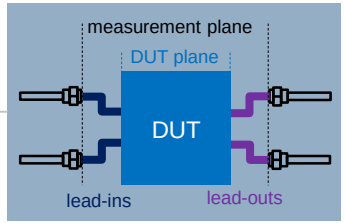


Signal Domain Analysis



- Channel parameter with emphasis and equalizer
- Eye diagrams and eye mask

De-embedding

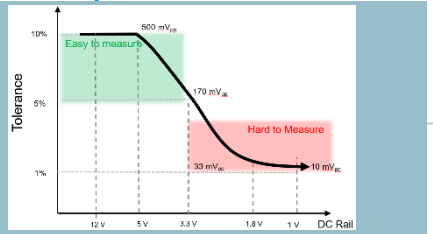


- Fast and accurate de-embedding of test connectors and fixtures

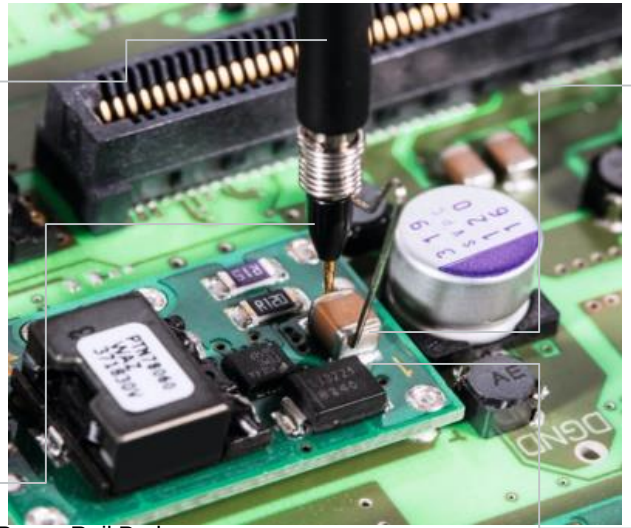
POWER INTEGRITY CHALLENGES

INCREASING POWER RAILS, LOWER SUPPLY VOLTAGES, AND INTERFERENCE DUE TO DENSE DESIGN

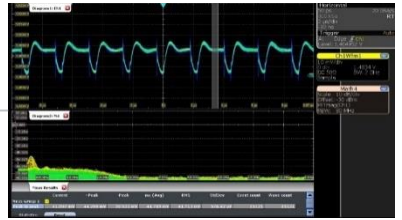
The Scope



- Fast update rate
- Min. vertical scale: 1..2 mV/div in HW at full bandwidth
- Low noise



Analysis and Statistics



- Ripple, Load step response
- Power-up/down, Sequencing
- Drift over temperature and input voltage
- R&S Probe Meter for precise DC measurements (0.05%)

Specialized Probes

- 1:1, 2/4 GHz Power Rail Probes
- Highest extended offset: +/-60 V
- Browser and solder-in tips
- Portfolio of current probes
- Multi-channel 18 bit power probes
- Unique R&S Probe Meter (high accuracy DC voltmeter)

FFT debugging

- EMI debugging / harmonic analysis
- Fast and responsive FFT to detect interferer

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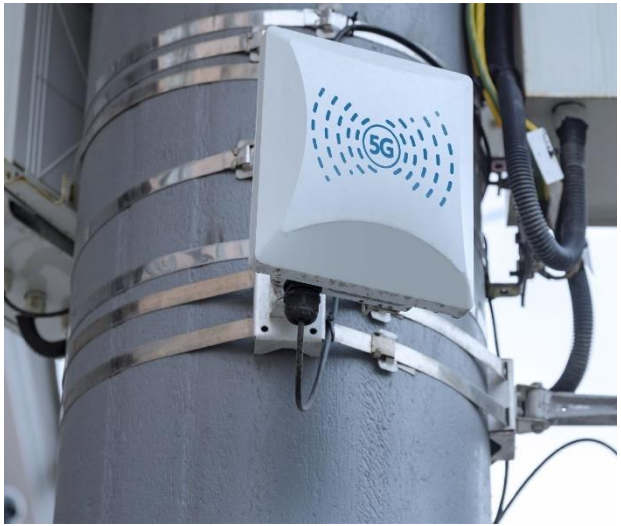


5G NR BASE STATION CONFORMANCE TESTING
From Conducted to OTA

All 38.141 measurements supported

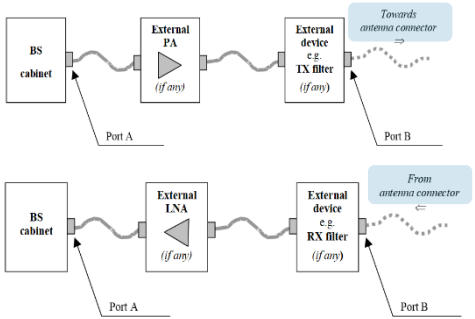
5G NR 3GPP specification	
38.104	Base station (BS) radio transmission and reception
38.141 - 1	BS conducted conformance testing chapter 6, 7 and 8
38.141 - 2	BS radiated conformance testing chapter 6, 7, 8 (OTA)

R&S®SMW200A

R&S®FSW

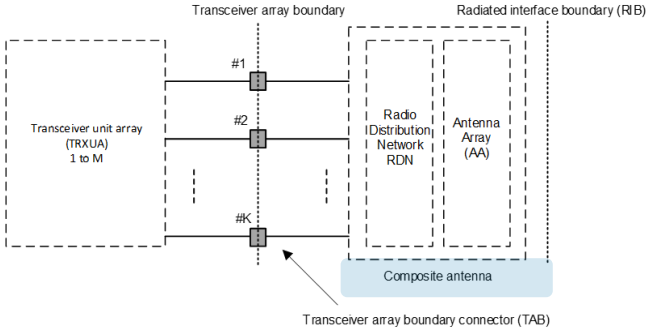
Conducted

BS type 1-C transmitter/receiver interface



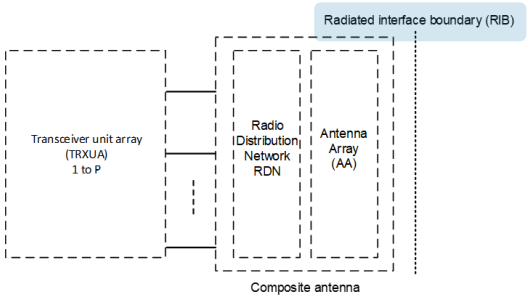
Hybrid

General architecture of *BS type 1-H*



OTA

General architecture of *BS type 1-O* and *BS type 2-O*

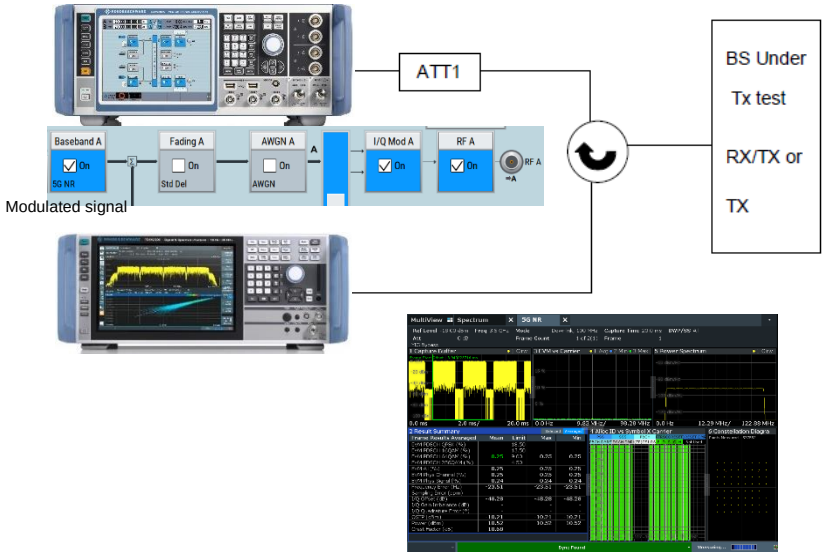


TRANSMITTER CHARACTERISTICS CHAPTER 6

► Analysis of transmitter characteristics and intermodulation testing with VSG and VSA

	FR1 test model	FR2 test model
BS type	Conducted, Hybrid, OTA	OTA
Bandwidth (MHz)	5, 10, 15, 20, 25, 30, 40, 45, 50, 60, 70, 80, 90, 100	100, 200, 400
Duplexing	TDD and FDD	TDD
Test Items	6.2 Base station output power	
	6.3 Output power dynamics	
	6.4 Transmit ON/OFF power	
	6.5 Transmitted signal quality - Frequency error - Modulation quality - Time alignment error	
	6.6 Unwanted emissions - Occupied bandwidth - Adjacent Channel Leakage Power Ratio (ACLR) - Operating band unwanted emissions (SEM) - Transmitter spurious emissions	
	6.7 Transmitter intermodulation	

R&S setup

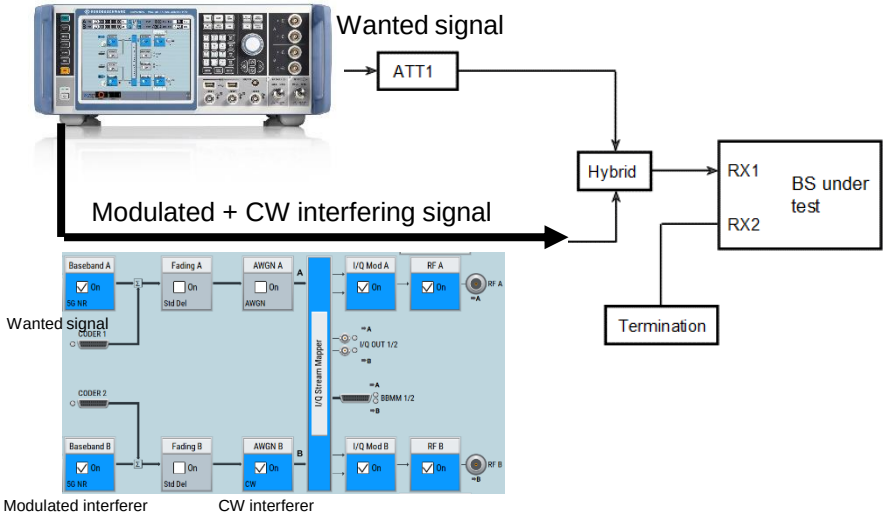


RECEIVER CHARACTERISTICS CHAPTER 7

- Generation of all required signals (wanted and interferer) in one instrument for 2 RX

	FR1 test model	FR2 test model
BS type	Conducted, Hybrid, OTA	OTA
Bandwidth (MHz)	5, 10, 15, 20, 25, 30, 40, 45, 50, 60, 70, 80, 90, 100	100, 200, 400
Duplexing	TDD and FDD	TDD
Test Items	7.2 Reference sensitivity level	
	7.3 Dynamic Range	
	7.4 In-band selectivity and Blocking	
	7.5 Out-of-band blocking	
	7.6 Receiver spurious emissions	
	7.7 Receiver intermodulation	
	7.8 In-channel selectivity	

R&S setup

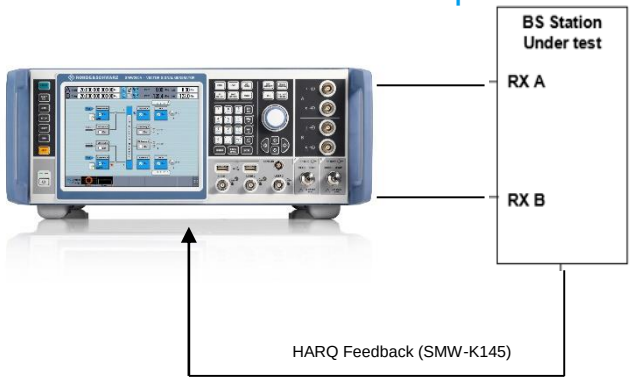


PERFORMANCE CHARACTERISTICS CHAPTER 8

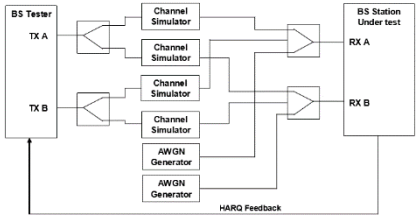
► Signal generation, channel simulation and AWGN generator in one instrument

	FR1 test model	FR2 test model
BS type	Conducted, Hybrid, OTA	OTA
Bandwidth (MHz)	5, 10, 15, 20, 25, 30, 40, 45, 50, 60, 70, 80, 90, 100	100, 200, 400
Duplexing	TDD and FDD	TDD
Test Items	8.2 Performance requirements for PUSCH - transform precoding disabled/enabled - high speed train - UL timing adjustment - 0.001% BLER - repetition Type A - Mapping Type B with non-slot transmission - msgA for 2-step RA type	
	8.3 Performance requirements for PUCCH - Format 0/1/2/3/4 - multi-slot PUCCH - Interlaced PUCCH 0/1/2/3	
	8.4 PRACH false alarm probability and missed detection	

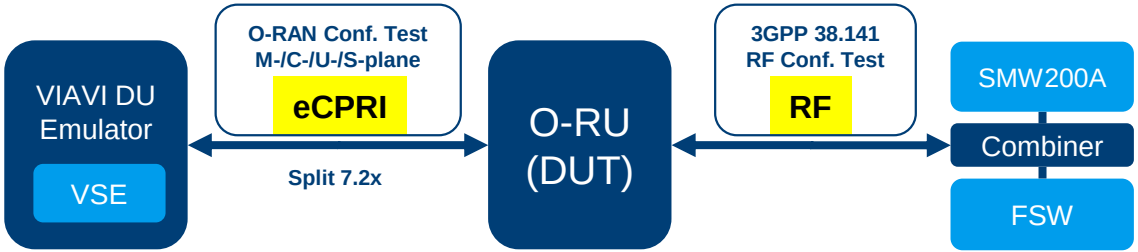
R&S setup

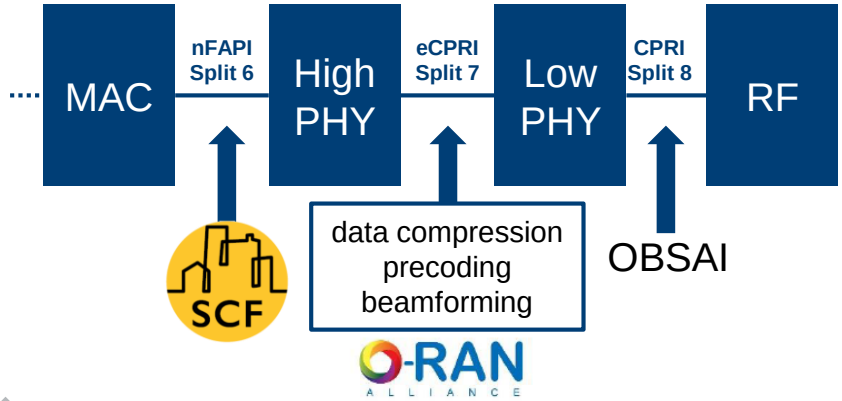


Measuring system set-up from 3GPP TS 38.141-1

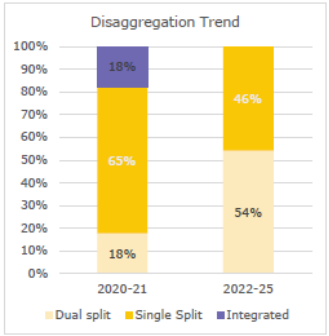


O-RU MEASUREMENT SETUP





SCF market survey result:



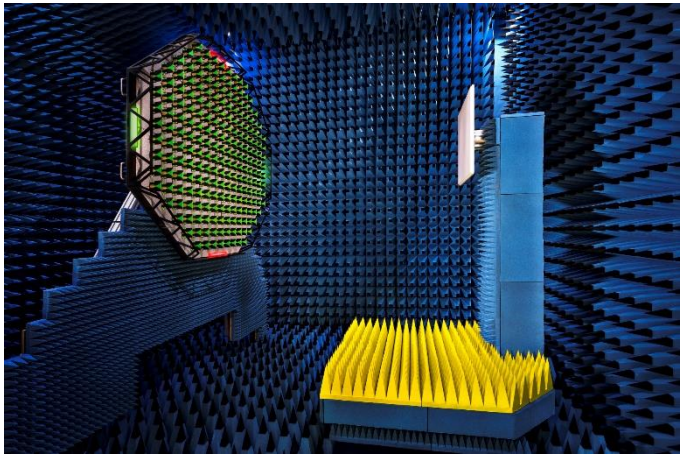
Advantage of split 7.2x

- Flexibility
- Efficiency
- Low latency

OVER THE AIR TESTING
Overall System Design Is Key for Precise Measurements

FR1

Verify of Massive MIMO devices at mid-band spectrum

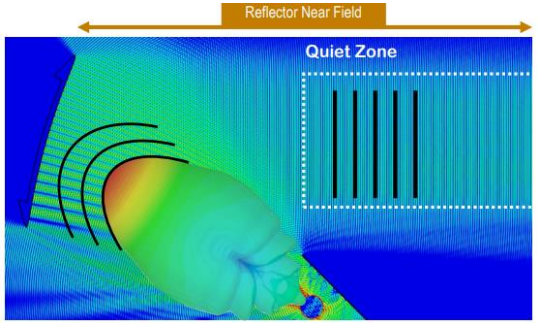


Plane Wave Converter

R&S®PWC200

FR2

High quality quiet zone in a compact test system



Ø 30/40cm quiet zone

High shielding effective chamber
with CATR (indirect far-field) solution

R&S®ATS1800C

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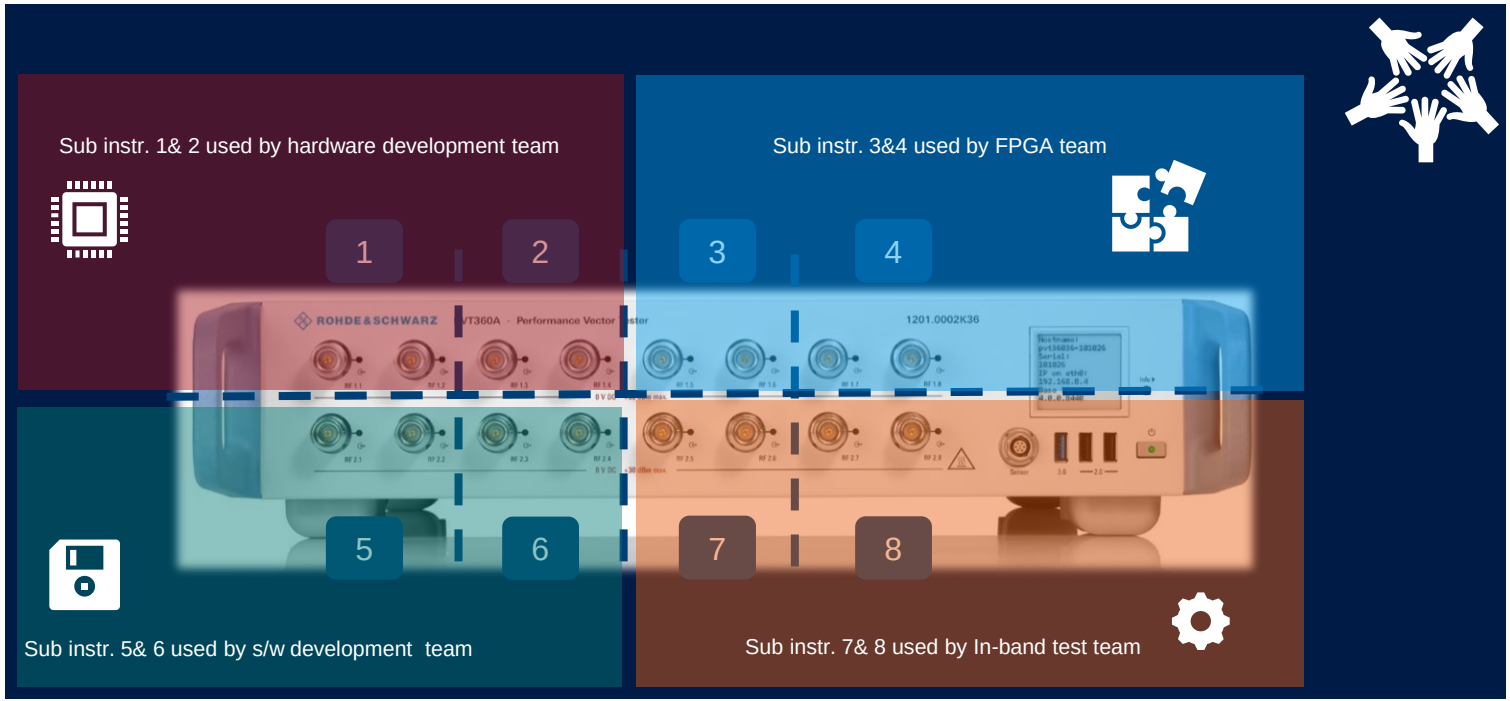
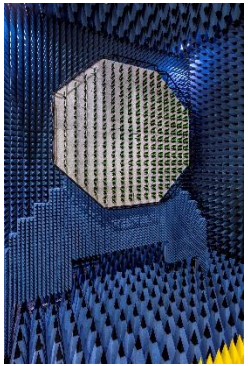
SMART CHANNEL FACILITATES RESOURCE SHARING BETWEEN LABS



NON-SIGNALING OBT WITH SHIELDING CHAMBER

R&S®PVT360A

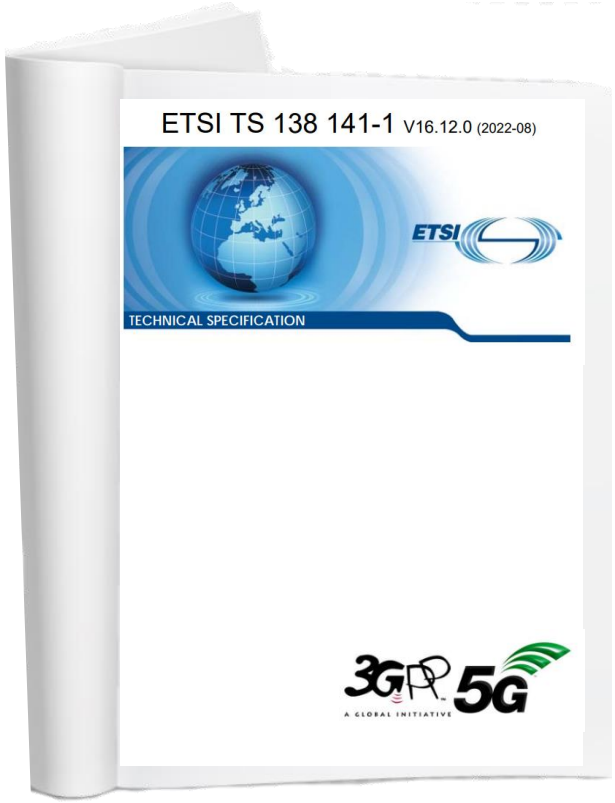


R&S®CMP200

R&S®HEAD30/50

R&S®CMQ200/500

FINAL TESTING – VERIFICATION



Transmitter characteristics	6.2	Base station output power	✓
	6.3	Output power dynamics	✗
	6.4	Transmit ON/OFF power	✗
	6.5	Transmitted signal quality	✓
	6.5.2	Transmitted signal quality - Frequency error	✓
	6.5.3	Transmitted signal quality - Modulation quality (EVM)	✓
	6.5.4	Transmitted signal quality - Time alignment error	✓
	6.6	Unwanted emissions - Occupied bandwidth	✓
	6.6.2	Unwanted emissions - Adjacent channel leakage power ratio (ACLR)	✓
	6.6.3	Unwanted emissions - Operating band unwanted emissions (SEM)	✓
	6.6.5	Unwanted emissions - Transmitter spurious emissions	✗
	6.7	Transmitter intermodulation	✗
Receiver characteristics	7	Receiver characteristics	✓
	7.2	Sensitivity reference level	✓
	7.3	Dynamic range	✗
	7.4	In band selectivity and blocking	✗
	7.5	Out-of-band blocking	✗
	7.6	Receiver spurious emissions	✗
	7.7	Receiver intermodulation	✗
	7.8	In-channel selectivity	✓

38.141 APPLICATION NOTES

- Application notes for 38.141 BS conformance testing available
- Example program for Quickstep Test Execution Software enables remote operation
- 5G NR Basestation transmitter tests (FR1)

www.rohde-schwarz.com/appnote/GFM313

- 5G NR Basestation receiver tests (FR1)

www.rohde-schwarz.com/appnote/GFM314

- 5G NR Basestation performance tests (FR1)

www.rohde-schwarz.com/appnote/GFM315

- 5G NR Base Station OTA Transmitter Tests

www.rohde-schwarz.com/appnote/GFM324

- 5G NR Base Station OTA Receiver Tests

www.rohde-schwarz.com/appnote/GFM325

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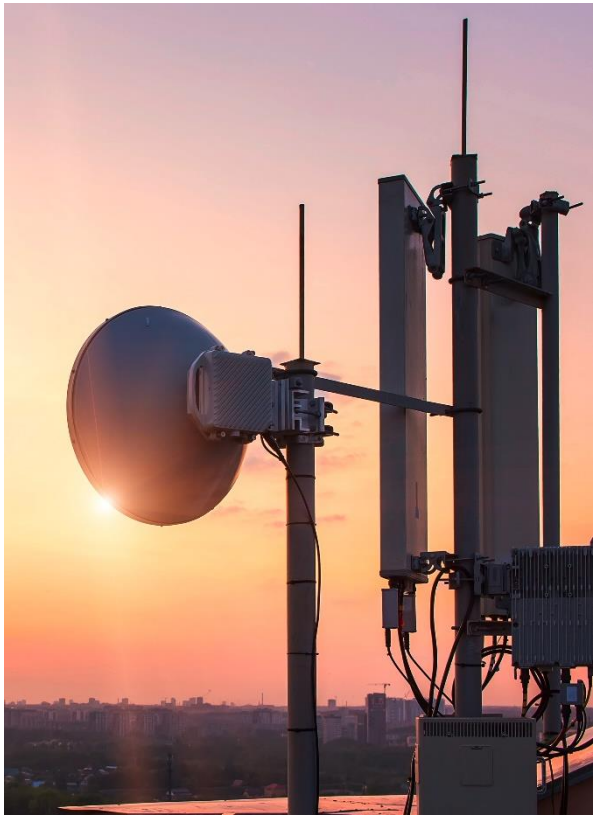
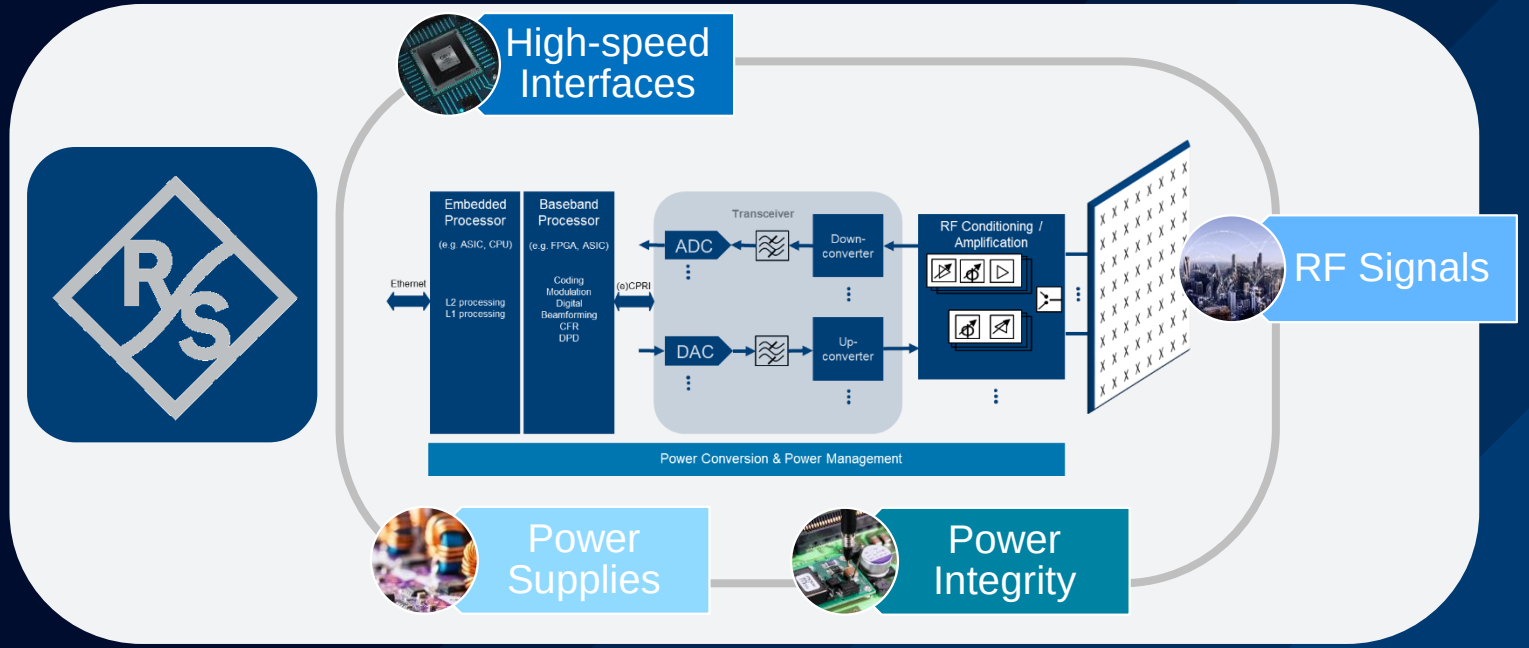
CONCLUSIONS

- Technological evolution, economic efficiency, and new use cases are driving forces for network infrastructure development.
- Dense design and high data rate interferer RF circuit design have become the most challenge topic from signal/power integrity to EMC and RF performance.
- The base station has been evolved from integrated structure to single or dual split distribution network structure.
- As a reliable testing expert, R&S provide overall T&M solutions



Verify your network Mobile Infrastructure



THANKS FOR YOUR ATTENTION