



AVNET®

## 基于赛灵思 RFSoc 的远程安全以及自动的毫米波无线 开发验证系统

陈鹏, Rohde & Schwarz

王洪胜, Avnet

MATLAB EXPO

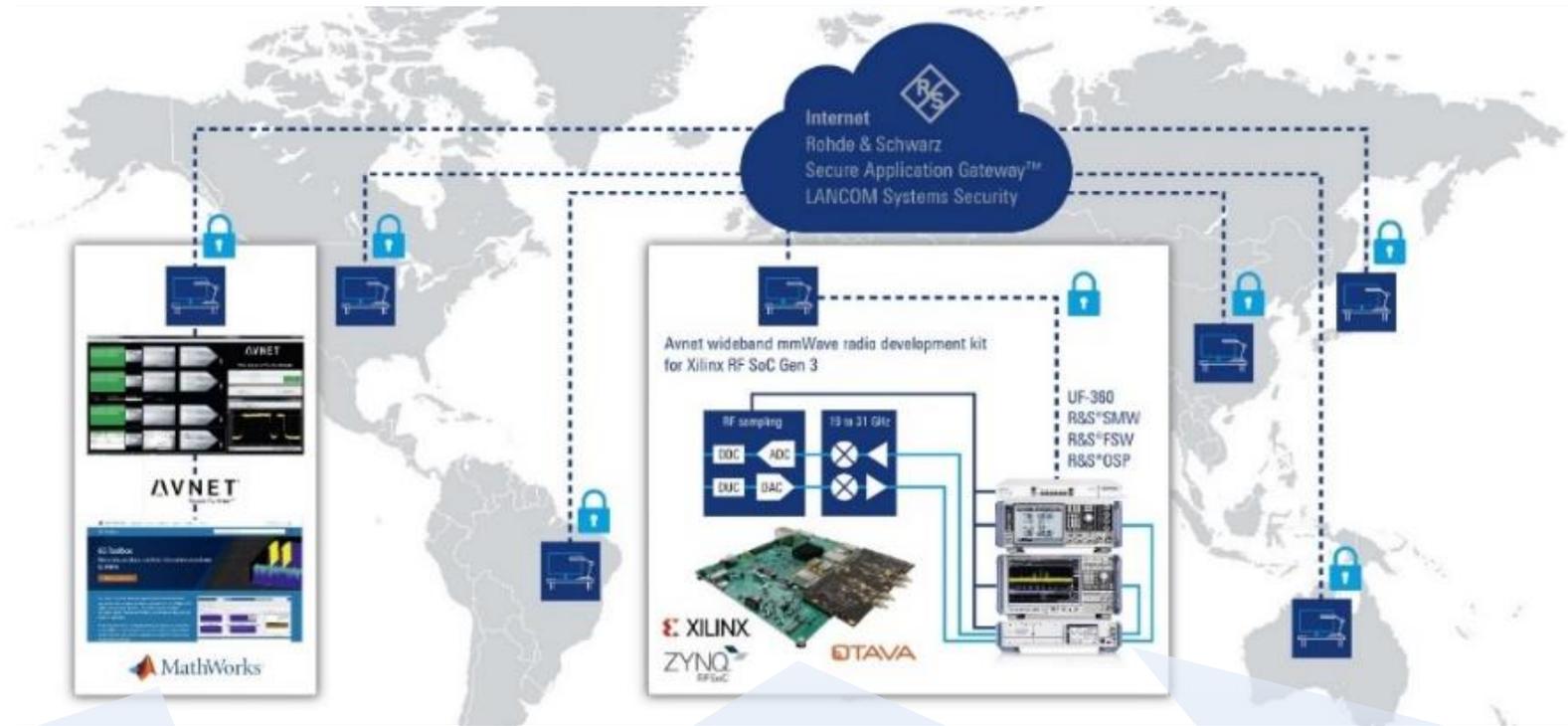
## 背景介绍

- 工程团队比以往任何时候都更加分散在各个地区和家庭办公室，如果实验室有一套软件无线电系统，并且这套系统允许远程安全可靠地控制访问，这无疑可以大大提供生产力。
- MathWorks，安富利和罗德与施瓦茨将为大家介绍基于Xilinx Zynq UltraScale RFSoc Gen 3打造的宽带毫米波无线开发验证系统，并利用罗德与施瓦茨安全网关系统实现基于Internet远程访问和控制，同时利用罗德与施瓦茨仪表可以完成各种无线信号的产生和测量。
- 作为一个开发示例，我们将演示利用MathWorks 5G Toolbox生成5G基带信号，利用Avnet RFSoc Explorer将基带信号送往RFSoc实现基带到RF信号的转换，生成的5G RF信号可以送往罗德与施瓦茨仪表实现RF信号的测量，并且这个流程可以通过远程访问来实现。

# 日程安排

- 系统框图介绍
- 基于Xilinx RFSoc的安富利毫米波无线开发系统介绍
- 基于MATLAB开发的应用 Avnet RFSoc Explorer
- 利用罗德与施瓦茨仪表实现的远程无线测量
- 总结

# 基于赛灵思 RFSoC的远程安全以及自动的毫米波无线开发验证系统



Avnet RFSoC Explorer  
产生标准的5G或者客户  
自定义的信号波形

Internet

安富利基于赛灵思RFSoC  
开发的宽带毫米波开发套  
件

罗德施瓦茨仪表  
利用Avnet RFSoC Explorer  
实现在线的测量和读取

# Xilinx Zynq® UltraScale™ RFSoc

## Monolithically Integrated

**ARM Cortex** Processing System

- Quad-Core A53 (64-bit)
- Dual-Core R5F (32-bit)

**ZYNQ RFSoc** **XILINX**

**Hardened Engines**

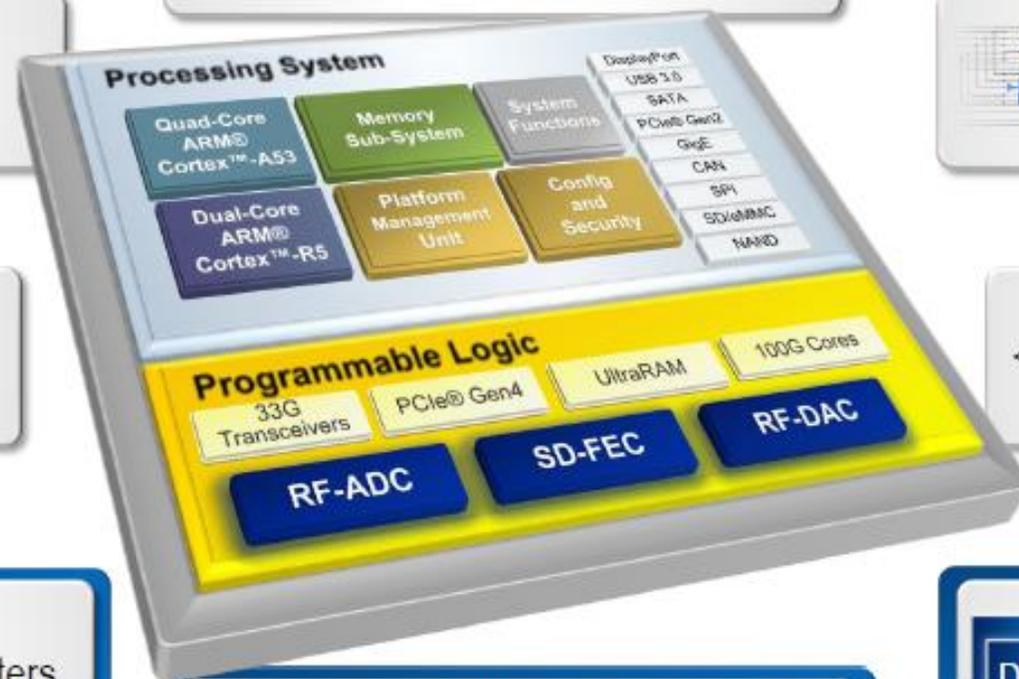
- PCIe® Gen3 & Gen4
- 100G Cores

**Programmable Logic**

- 16nm FinFET
- UltraScale+™ FPGA Fabric

**33G Transceivers**

- 33Gb/s
- 28G Backplane Capable



**DSP-Intensive**

- 4,272 DSP Slices
- 7,612 GMACs

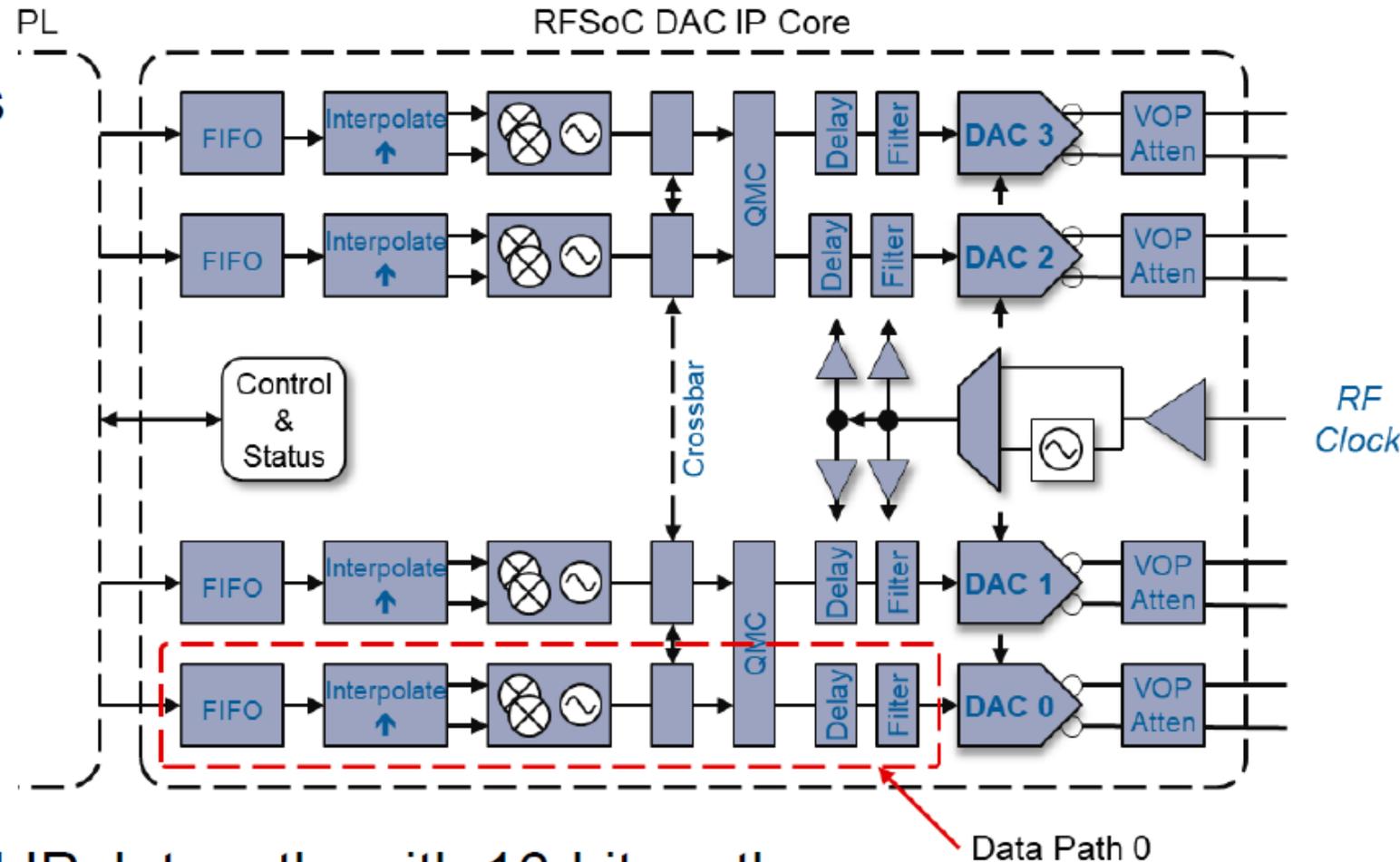
**ADC** Integrated Direct-RF Analog-to-Digital Converters up to 5 GSPS

**Soft Decision Forward Error Correction**  
LDPC & Turbo Support

**DAC** Integrated Direct-RF Digital-to-Analog Converters up to 10 GSPS

# Zynq RFSoc Gen-3 ADC and DAC Tile Structure

- ADCs / DACs grouped in tiles
- 14-bit ADCs / DACs up to 5 GSPS / 10 GSPS
- 6 GHz analog I/F range
- Up to 16 channels
  - ADCs 2.5 GSPS
- Each data converter has hard IP datapath, with 16-bit math
  - Interpolate/decimate, NCO, complex mixer, QMC
  - Fully supported in Avnet RFSoc Explorer for MATLAB



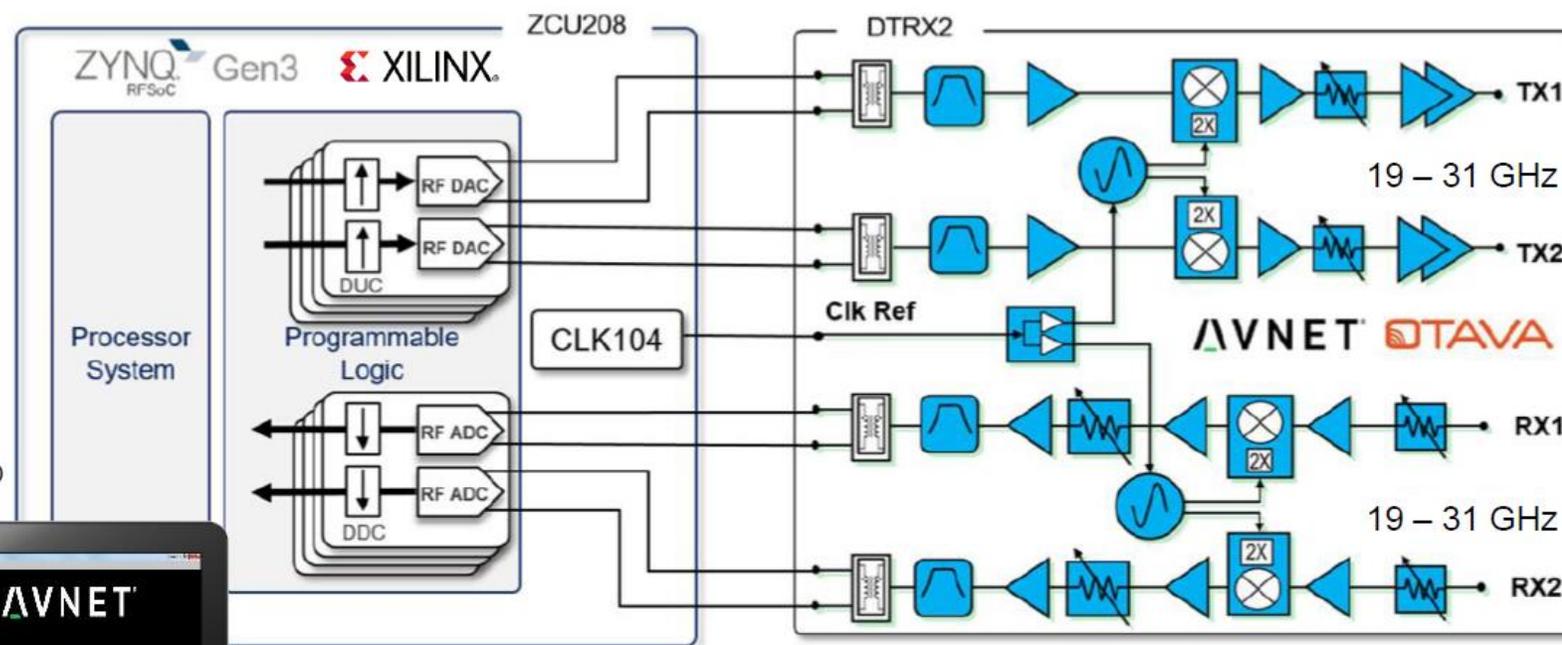
# 基于RFSoc的安富利毫米波开发套件

Requires:

- MATLAB
- Communications Toolbox
- DSP System Toolbox
- Fixed-Point Designer
- Signal Processing Toolbox



Avnet RFSoc Explorer®



AVNET TAVA

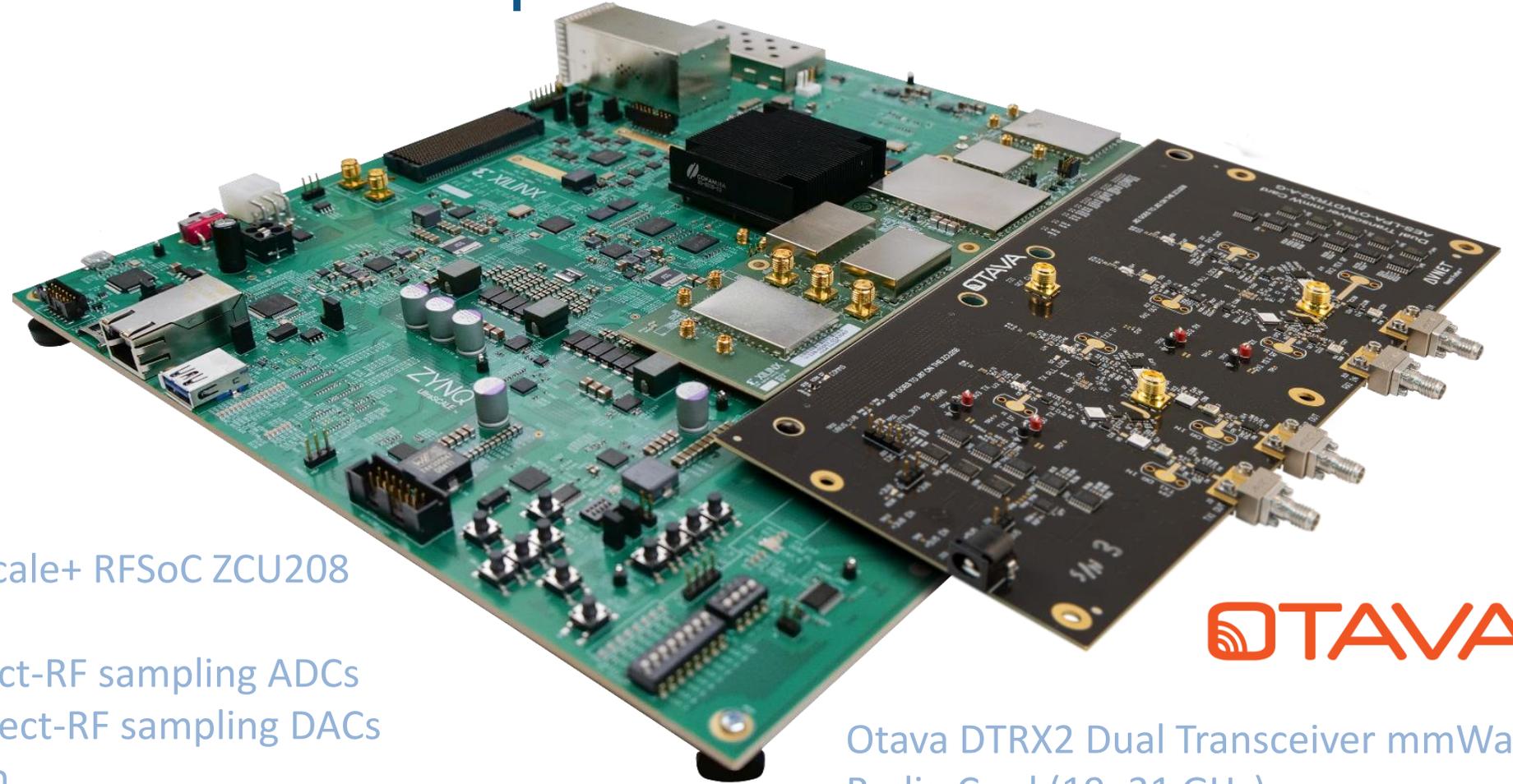
DTRX2 Dual Transceiver  
mmWave Radio Card

[www.avnet.com/rfsoc-mmw](http://www.avnet.com/rfsoc-mmw)

Radio under Test

# Avnet Wideband mmWave Radio Development Kit for Xilinx RFSoc

## Gen-3



AMD/Xilinx Zynq UltraScale+ RFSoc ZCU208 Evaluation Kit

8 x 14-bit, 5.0 GSPS direct-RF sampling ADCs

8 x 14-bit, 9.85 GSPS direct-RF sampling DACs

6 GHz analog bandwidth



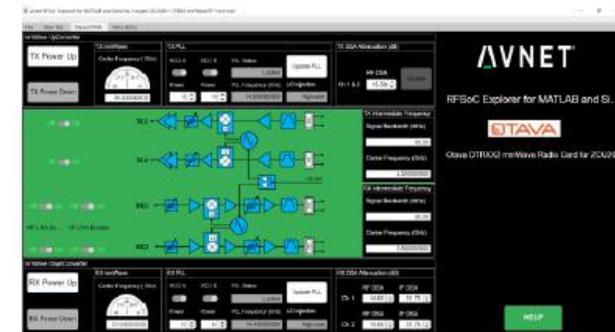
Otava DTRX2 Dual Transceiver mmWave Radio Card (19–31 GHz)

# 5G 毫米波远程测试系统

Low phase noise reference clock to DTRx2 mmWave PLL



Configure DTRx2 mmWave PLL, gain control



Download 3GPP-compliant 5G NR test waveform to ZCU208 in Rohde & Schwarz remote SAG lab; demodulate through FSW



R&S FSW-K144



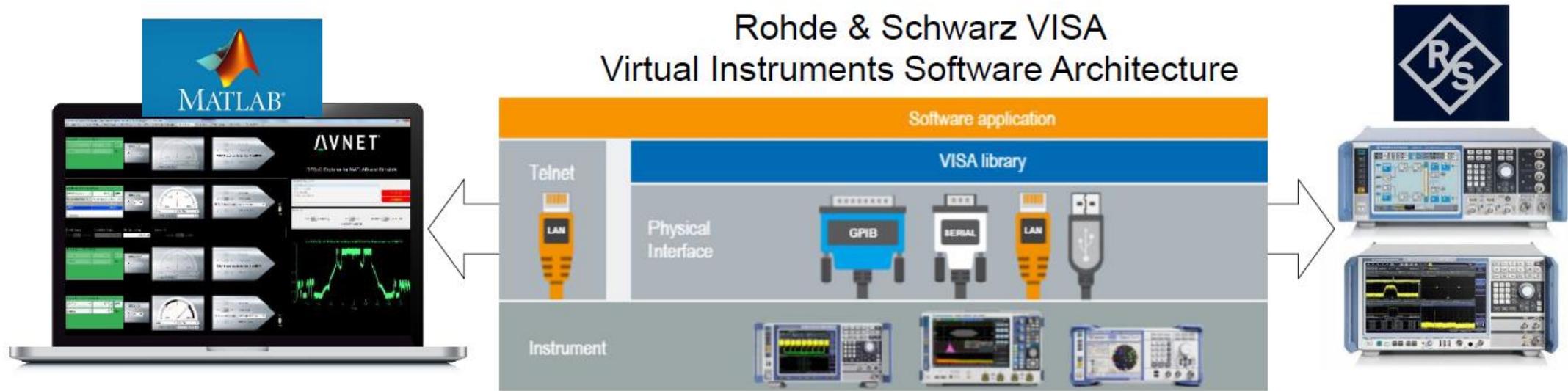
# 操作演示

The screenshot displays the Avnet RFSoc Explorer for MATLAB and Simulink interface. The window title is "Avnet RFSoc Explorer for MATLAB and Simulink / target: ZCU208 - DTRX2 mmWave RF Front-end + Rohde & Schwarz Instrument Remote Control". The interface is divided into several sections:

- DAC Subsystem:** Contains four DAC tile controls (DAC tile 0-3) with DAC A and DAC B channels. Each tile has a "Reset" button and an "On/Off" toggle. DAC tile 0 (228) and DAC tile 1 (229) are currently "Off", while DAC tile 2 (230) and DAC tile 3 (231) are "On".
- ADC Subsystem:** Contains four ADC tile controls (ADC tile 0-3) with ADC A and ADC B channels. Each tile has a "Reset" button and an "On/Off" toggle. ADC tile 0 (224) and ADC tile 1 (225) are currently "Off", while ADC tile 2 (226) and ADC tile 3 (227) are "On".
- Multi-tile Sync:** Includes an "MTS" button.
- DAC Output Mode:** A dropdown menu set to "20mA | 2.5V".
- CLK104:** Configuration section with a dropdown set to "Xilinx Default".
- DAC Tile Ref Clk:** A dropdown menu set to "245 760".
- ADC Tile Ref Clk:** A dropdown menu set to "245 760".
- System:** A section with "Board IP Address" set to "DISCONNECT...".

The Avnet RFSoc Explorer logo is visible in the top right corner of the interface.

# Avnet RFSoc Explorer + R&S 虚拟仪器软件架构



- Avnet RFSoc Explorer interface to Rohde & Schwarz test instruments through VISA connectivity
- Automated control of RFSoc data converters, mmWave signal chain and test instruments



ZCU208

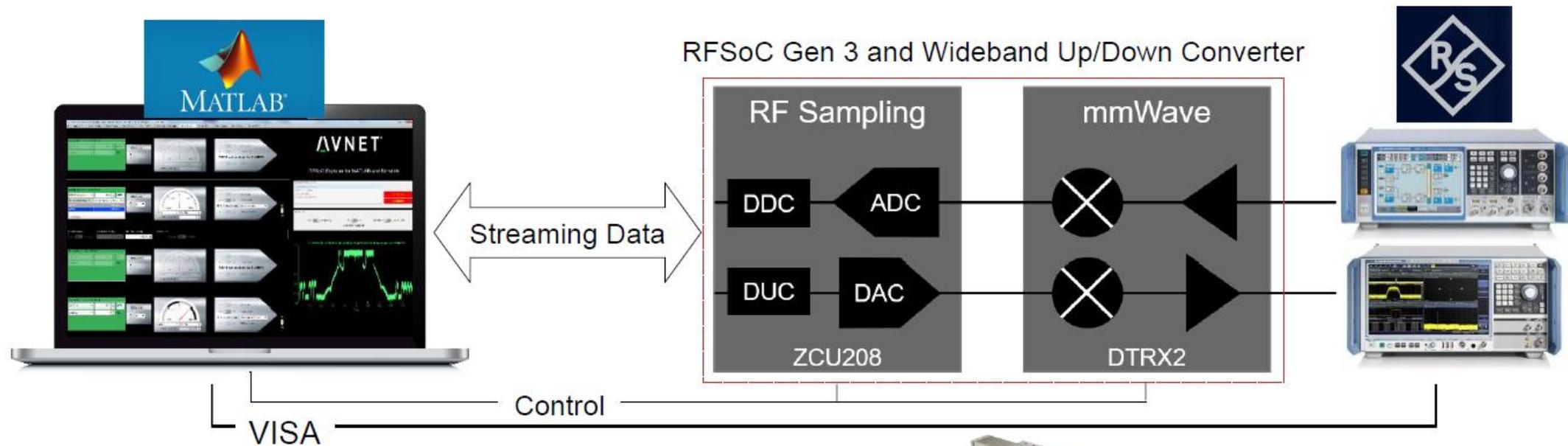
XILINX  
ZYNQ  
RFSoc

TAVA

DTRX2 Dual Transceiver  
mmWave Radio Card

[www.avnet.com/rfsoc-mmw](http://www.avnet.com/rfsoc-mmw)

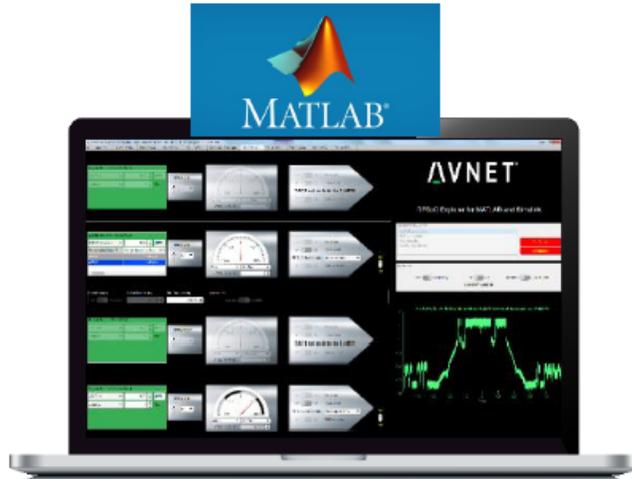
# Avnet RFSoc Explorer + R&S 虚拟仪器软件架构



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# Avnet自动测试应用编程接口(API)



```
ADC_program
ADC_read
DAC_program
DAC_write
```

RFSoc Explorer API

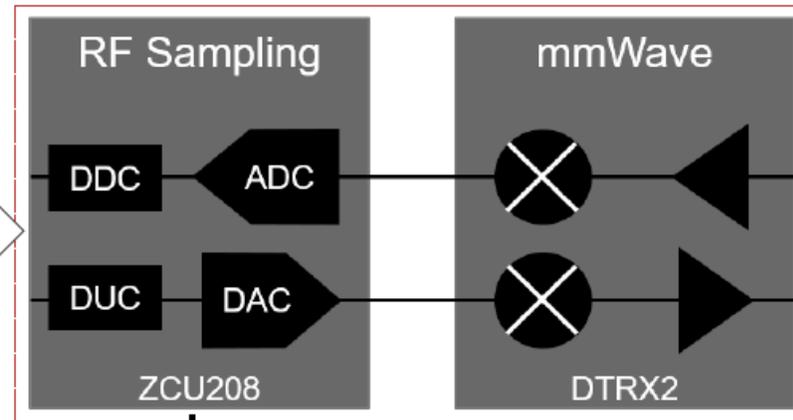
RFDC

Streaming Data

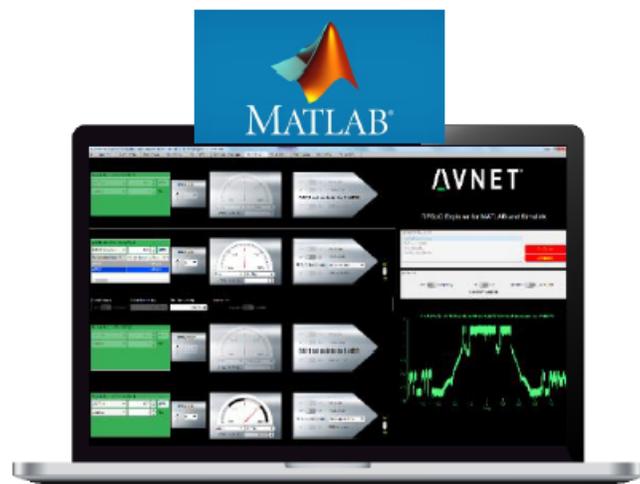
TCP/IP

LAN

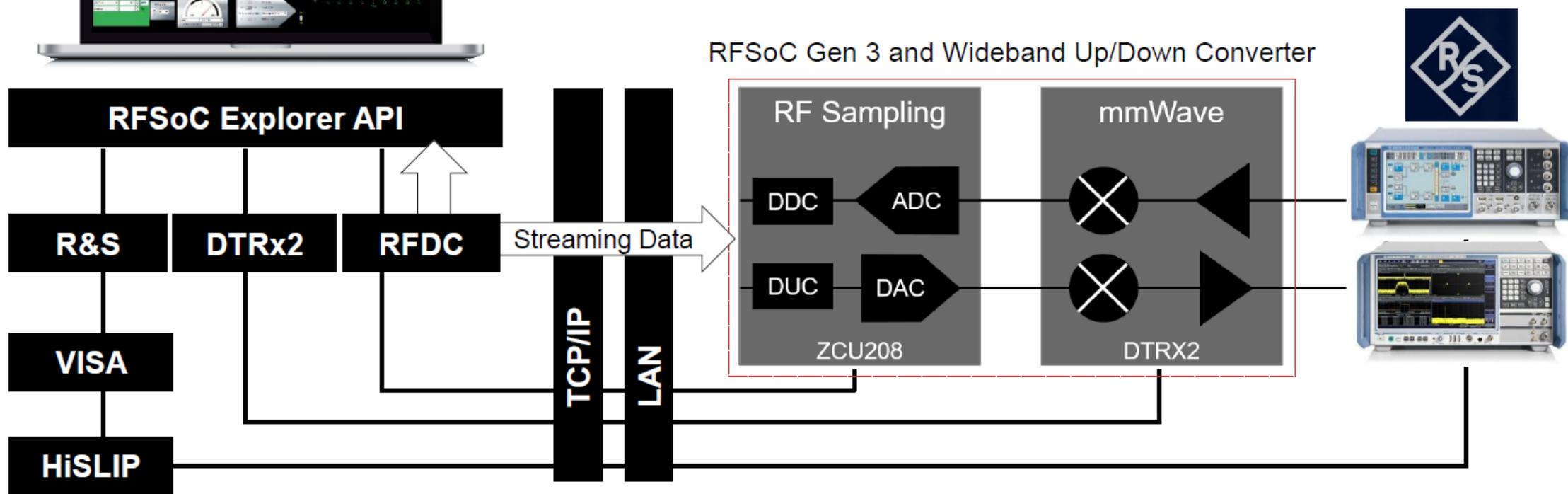
RFSoc Gen 3 and Wideband Up/Down Converter



# Avnet自动测试应用编程接口(API)



- API enables automated command sequences
- User-extendable add-ons to the main application
- ... or MATLAB scripts external to the application



# Avnet RFSoc Explorer 安装

The image shows the MATLAB R2021a interface with the Add-On Explorer window open. The Add-On Explorer window displays a search for 'rfsoc' and shows the 'Avnet RFSoc Explorer' add-on as the only result. The add-on is marked as 'Installed' and has a 5-star rating. The description of the add-on is: 'Connect to Xilinx Zynq UltraScale+ RFSoc gigasample data converters and perform analysis natively in MATLAB® and Simulink®'. The 'Get Add-Ons' menu is also visible, highlighting the 'Get Add-Ons' option.

**Avnet RFSoc Explorer** version 1.1.0 by Avnet

Connect to Xilinx Zynq UltraScale+ RFSoc gigasample data converters and perform analysis natively in MATLAB® and Simulink®

37 Downloads Updated 3 Aug 2020

- Get Add-Ons
- Manage Add-Ons
- Package Toolbox
- Package App
- Get Hardware Support Packages

# 罗德施瓦茨用于毫米波测试的安全应用网关演示系统

Avnet RFSoc Explorer<sup>®</sup>  
for MATLAB

Future Lab – A ONE Rohde & Schwarz Project

## SECURE APPLICATION GATEWAY

**Services**  
T&M Device Handling

**Applications**  
Edge Computing Platform

**Connectivity**  
AI-based Inspection

**Security**  
Next-Generation Firewall

LANCOM R&S<sup>®</sup> Unified Firewall

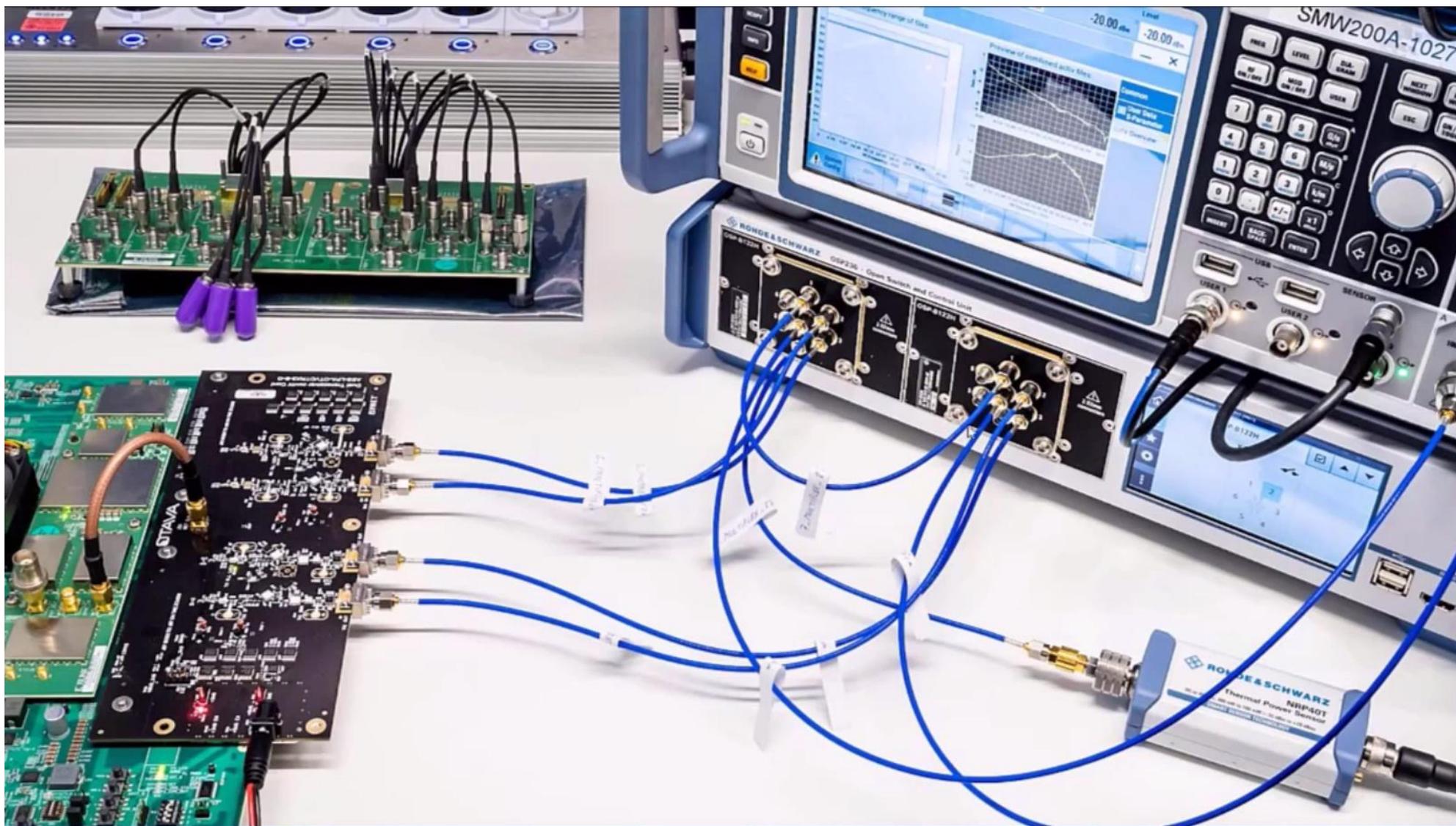
FSW High End Signal and Spectrum Analyzer

SMW200A vector signal generator to 44 GHz

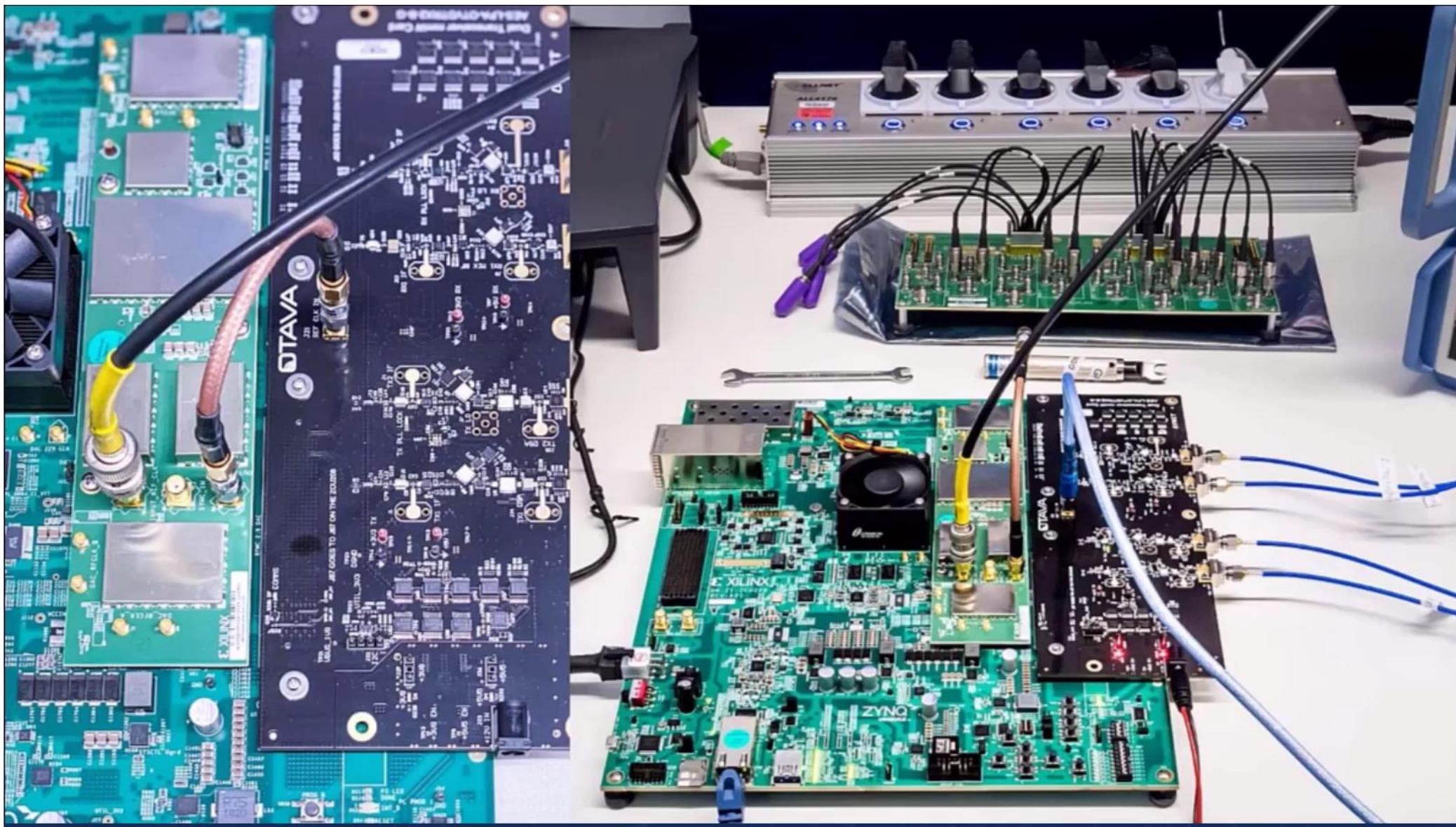
OSP Open Switch and Control Platform

Avnet mmWave Radio Kit for Xilinx Zynq RFSoc Gen-3

## 罗德施瓦茨用于毫米波测试的安全应用网关演示系统



# 罗德施瓦茨用于毫米波测试的安全应用网关演示系统





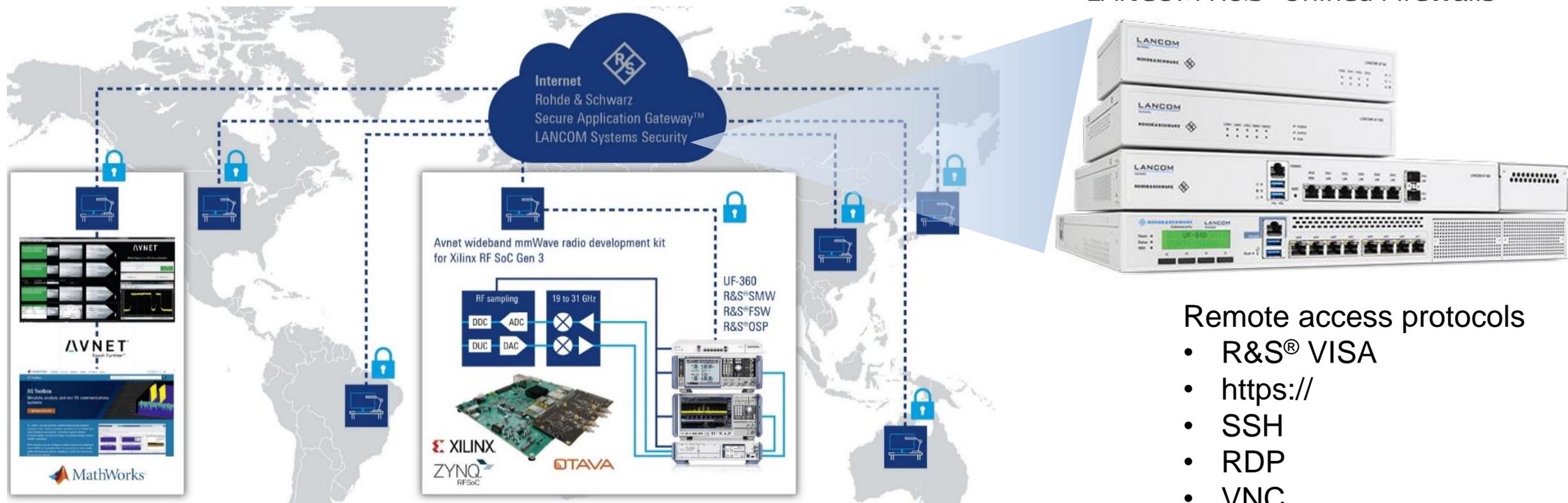
**Applications**  
Edge Computing Platform

**Connectivity**  
AI-based Inspection

**Security**  
Next-Generation Firewall

The image shows a stack of three Rohde & Schwarz test instruments. The top instrument is a power supply with a digital display showing 12.000 V and 767.2 mA. The middle instrument is a spectrum analyzer displaying a spectrum plot and various measurement parameters. The bottom instrument is a vector signal generator displaying a waveform plot. The instruments are connected to a network switch and various cables. The background is a dark blue wall with three icons and text blocks.

# Rohde & Schwarz 基于安全应用网关的网络安全设计



## Remote access protocols

- R&S® VISA
- https://
- SSH
- RDP
- VNC
- Proprietary ports

- 通过基于MATLAB的RFSoC Explorer连接测试仪器
- 最先进的安全和统一的威胁管理

# R&S®SMW200A 高端微波矢量源



## 主要特点：

- 100 kHz to 3/6/7.5/20/31.8/40/44/56/67 GHz
- 可选配双通道：44 GHz
- 2 GHz 内置射频带宽
- 高达+18 dBm输出功率
- 高达8个独立通道
- 相位相参
  
- 内置 fading 和 AWGN
- MIMO, 载波聚合
- 5G NR, LTE, Wi-Fi, ...
- 8x4 / 4x8/ 8x8 MIMO
  
- 内置实时多标准无线通信：5G NR, LTE, Wi-Fi , .....
- GNSS
- 雷达、电子战：Pulse sequencer

# R&S®SMA100B微波模拟源



## Key Specifications

Frequency Range	8 kHz to 67 GHz(72GHz overrange)
Output Power	>+30dBm
Phase noise	-152 dBc/Hz@1 GHz,20kHz offset
Code Compatibility	HP, Agilent,Keysight,Aeroflex,IFR,Anrutsu...

- 优异的射频性能
  - 超低相位噪声
  - 超高功率输出
  - 低谐波、低杂散
- 应用
  - 模拟调制
  - 脉冲调制
  - 差分时钟源
  - Scan AM
- 操作灵活
  - 图框式操作界面
  - SCPI自动记录

# R&S®FSW高端信号与频谱分析仪

## 关键参数

- 频率范围：2 Hz到8/ 13.6/ 26.5/ 43.5/ 50/ 67/ 85 / 90 GHz
- 内置分析带宽高达8.3GHz
- 超低相噪：-140 dBc/Hz (1 GHz载频，10 kHz偏移)
- 实时频谱分析(800 MHz带宽，POI < 0.5  $\mu$ s)

## 主要应用

- 通用：
  - 噪声系数
  - 相位噪声
  - EMI诊断
- 蜂窝通信、无线连接研发应用：
  - 5G、LTE、3G、GSM
  - WLAN包括802.11 ac/ax/ad/ay
  - 整机或元器件测试
- 军工：雷达脉冲和跳频分析
- 卫星载荷测试
- 汽车雷达分析



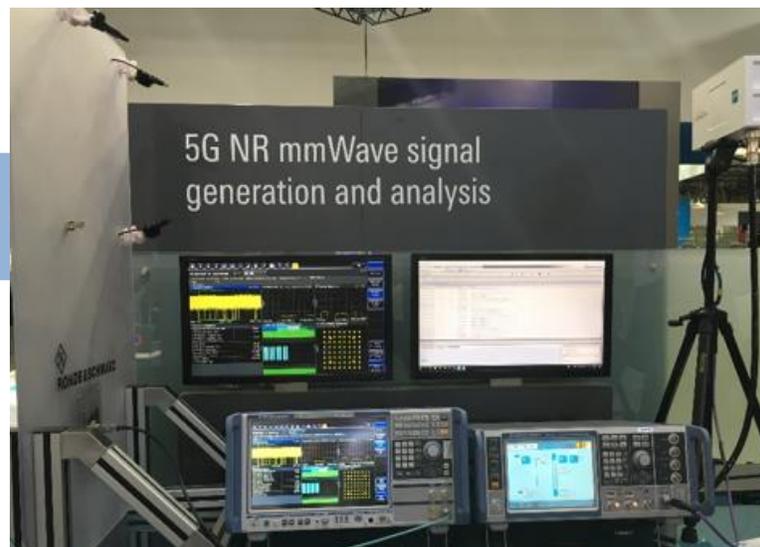
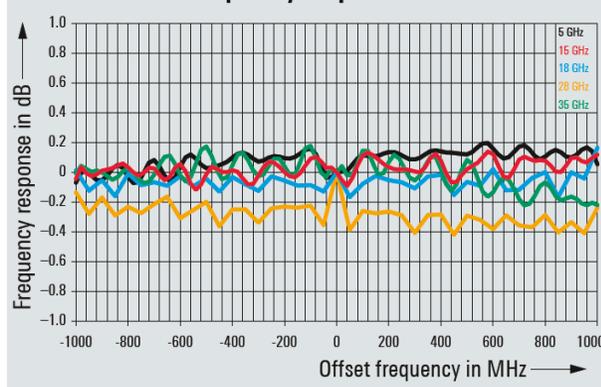
# 5G超宽带信号产生与分析

R&S SMW200A



- 100 kHz到6/7.5/12.75/.../44/56/67 GHz
- 单表信号产生带宽2 GHz
- 支持双通道

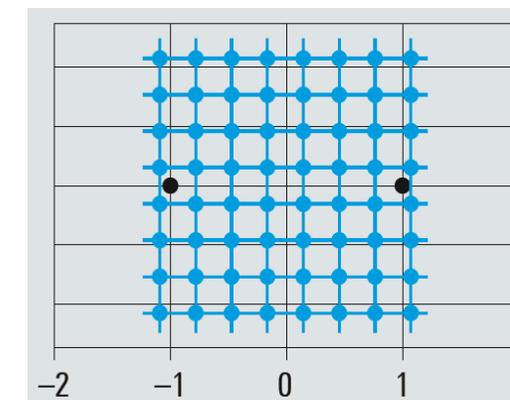
I/Q modulation frequency response



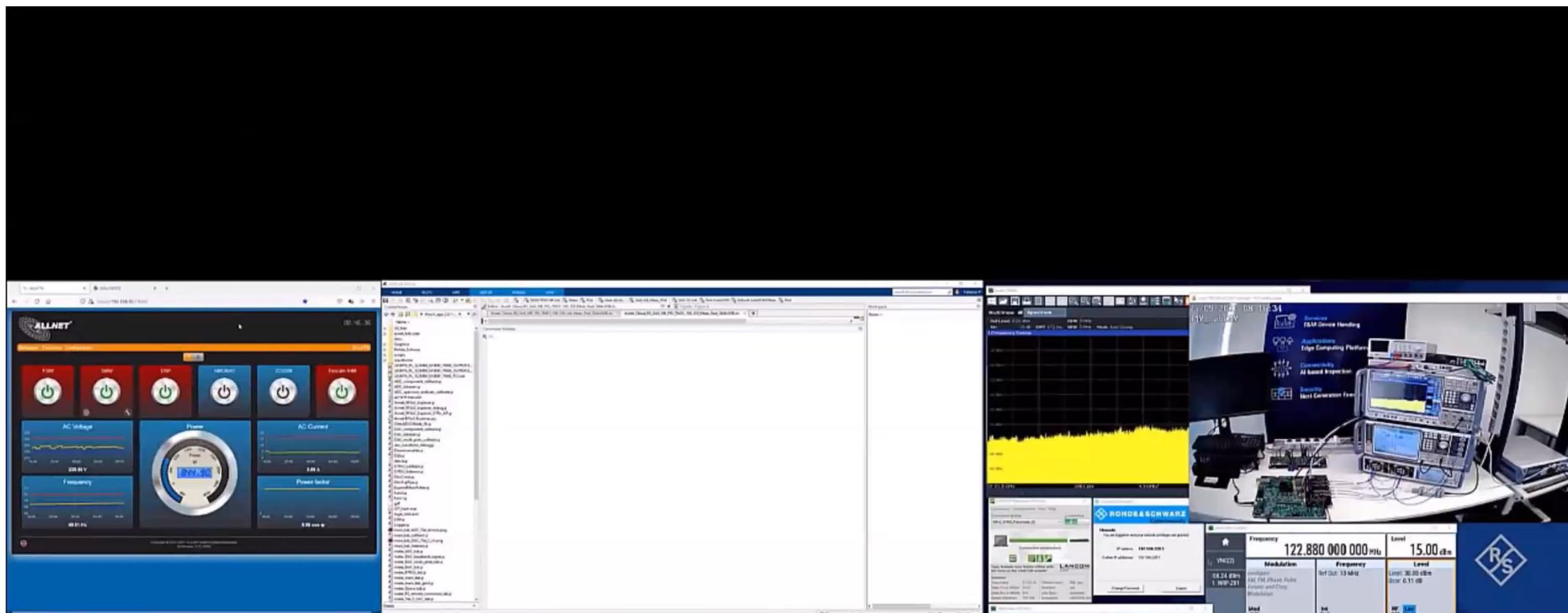
- 2 Hz至8/13.6/... 85/90 GHz
- 内置分析带宽8.3GHz
- 800 MHz实时频谱分析

## 应用

- 整机：发射机和接收机传导或OTA测试
- 板级射频研发：基站或终端研发调试
- 芯片和元器件：PA/RFIC/天线等特性测试
- 预研：无线传播特性测量(Channel Sounding)  
外场射频信号记录
- 产线：毫米波基站, ...



# 操作流程演示



## 结论

- mmWave射频系统需要安全、可靠的测试自动化
- Avnet RFSoc Explorer是MATLAB环境下编写的APP，可支持算法和半实物，实物仿真。借助于罗德施瓦茨安全网关可是远程实现“带仪表”的测试和算法验证
- 罗德施瓦茨的安全应用网关可实现远程，安全实时仪器控制，其安全性有保障。

# MATLAB EXPO

Thank you



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