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

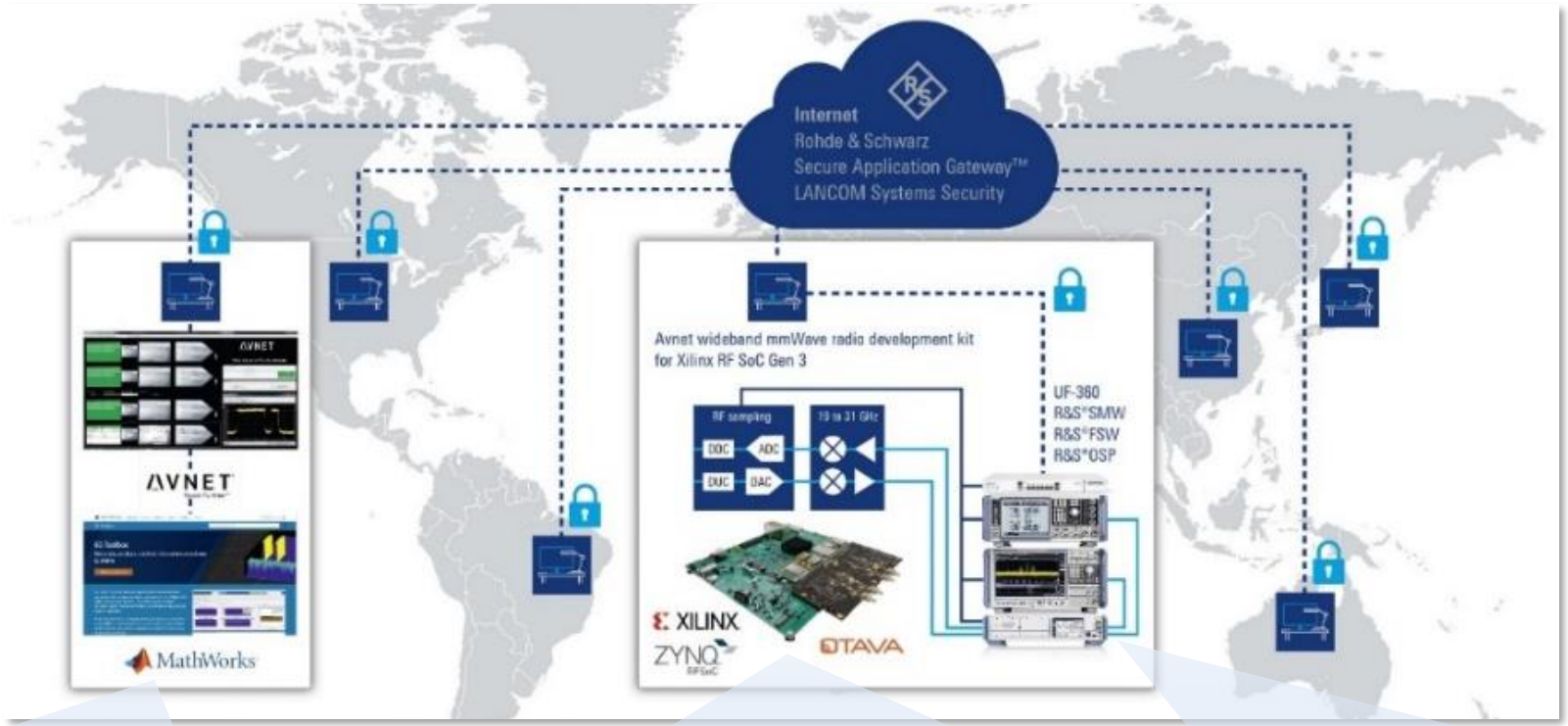
背景介绍

- 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

33G Transceivers
- 33Gb/s
- 28G Backplane Capable

Programmable Logic
- 16nm FinFET
- UltraScale+™ FPGA Fabric

DSP-Intensive
- 4,272 DSP Slices
- 7,612 GMACs

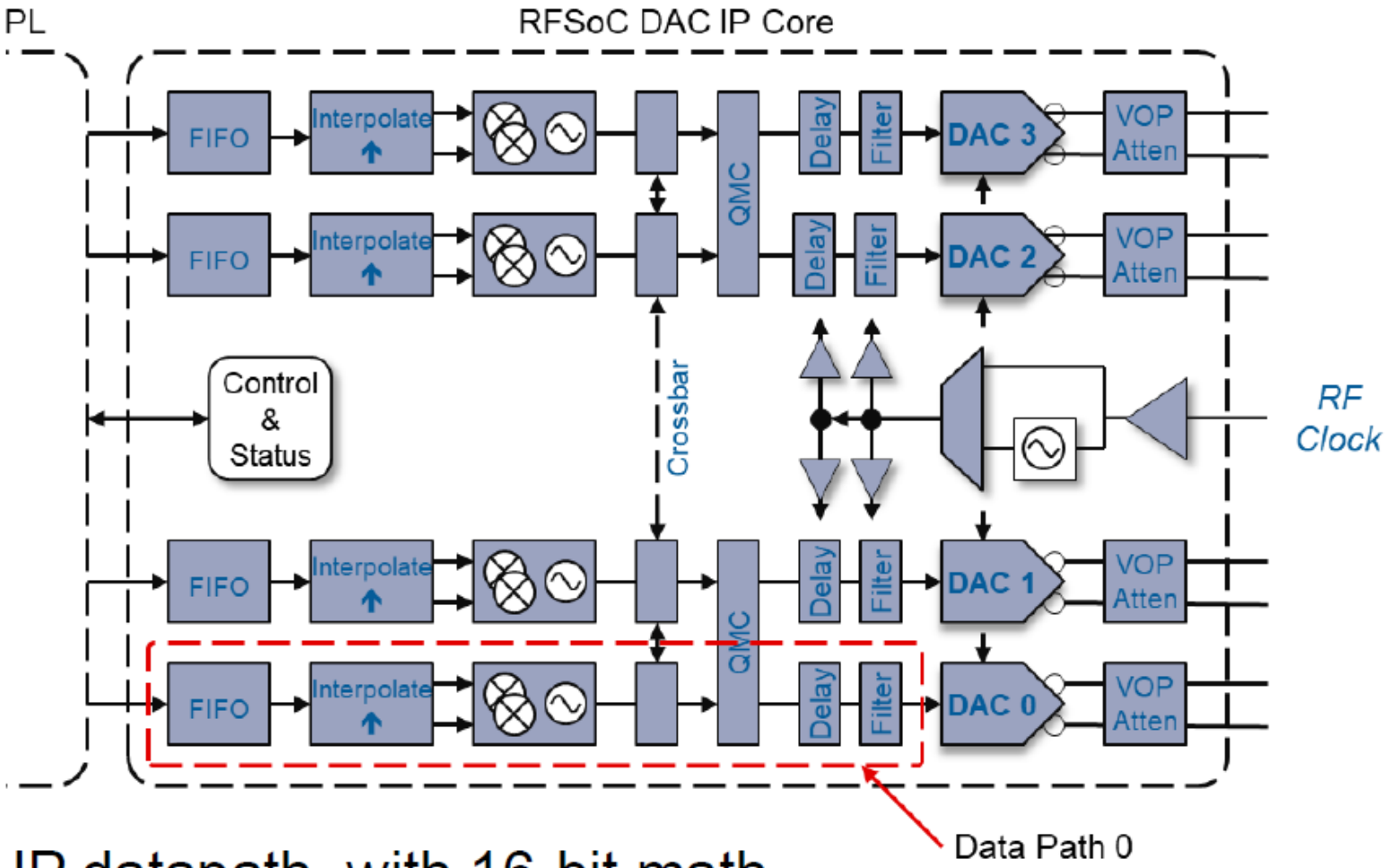
ADC
Integrated Direct-RF
Analog-to-Digital Converters
up to 5 GSPS

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

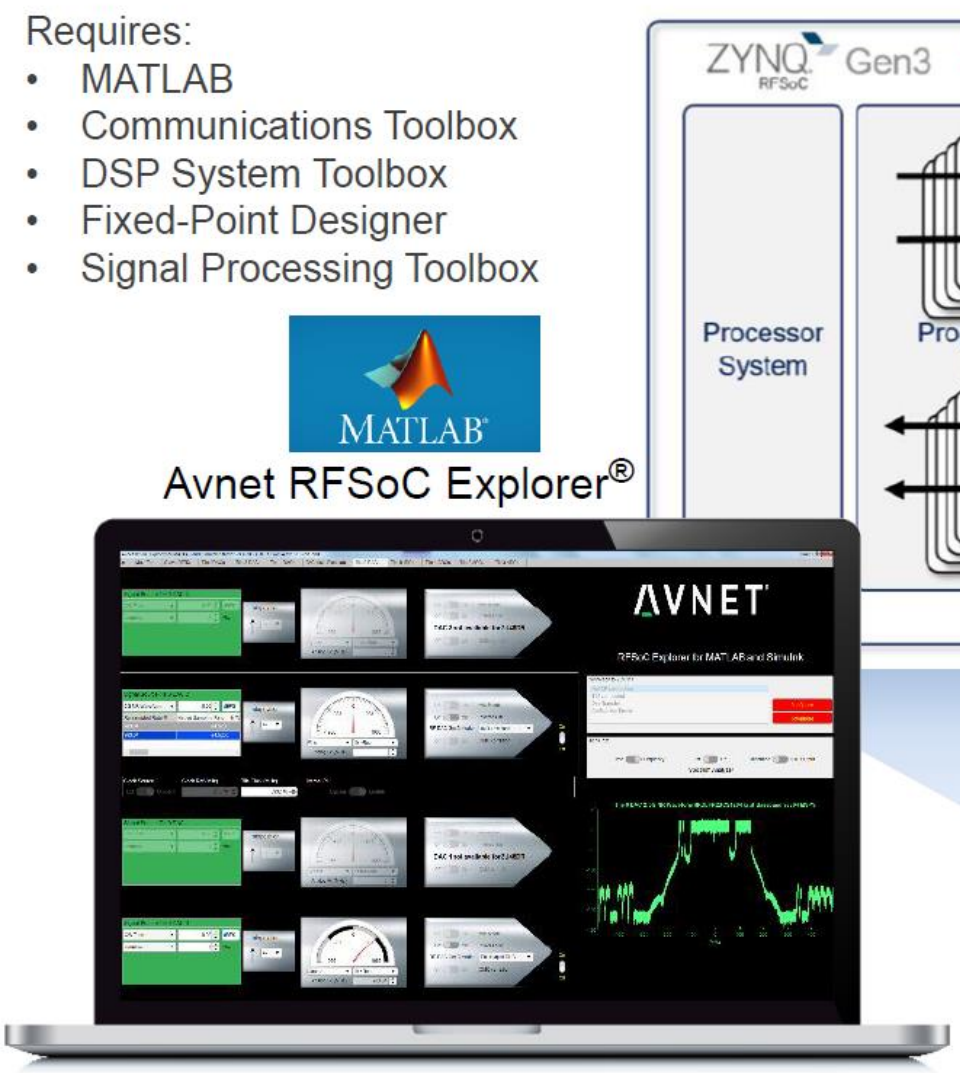
- ADCs / DACs grouped in tiles
- 14-bit ADCs / DACs up to 5 GSPS / 10 GSPS
- 6 GHz analog I/F range
- Up to 16 channels
  - ADCs 2.5 GSPS

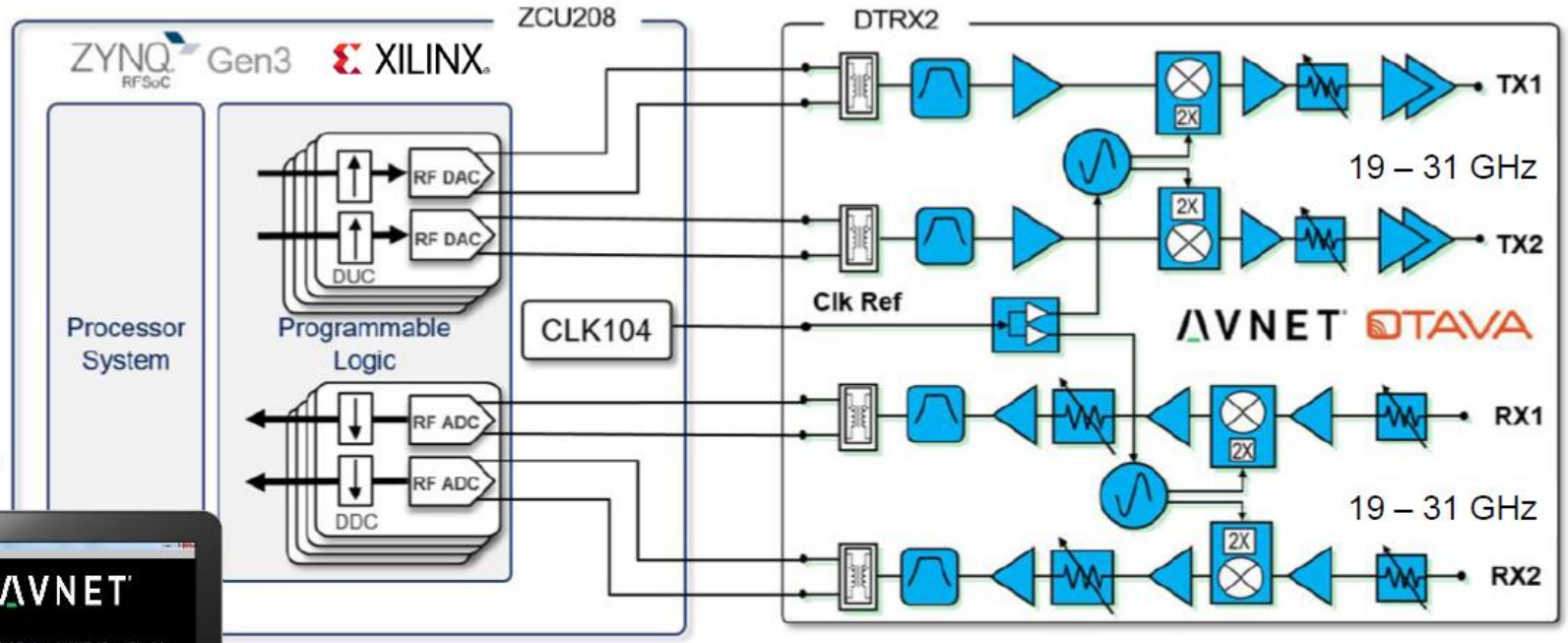


- Each data converter has hard IP datapath, with 16-bit math
  - Interpolate/decimate, NCO, complex mixer, QMC
  - Fully supported in Avnet RFSoC Explorer for MATLAB

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





OTAVA

DTRX2 Dual Transceiver mmWave Radio Card

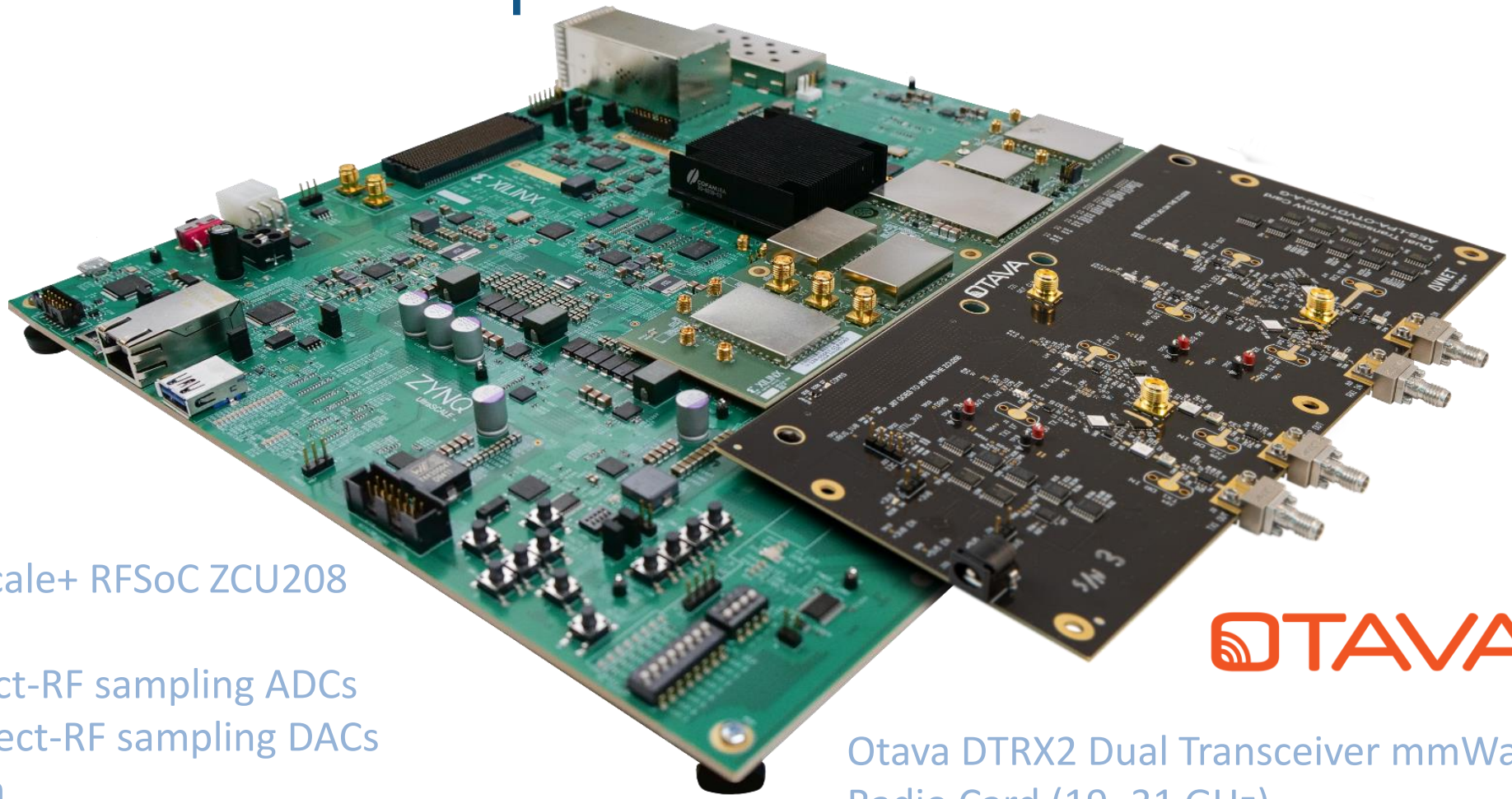
www.avnet.com/rfsoc-mmw

Radio under Test

Avnet Wideband mmWave Radio Development Kit for Xilinx RFSoC

Gen-3

AMD XILINX ZYNQ RFSoC



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

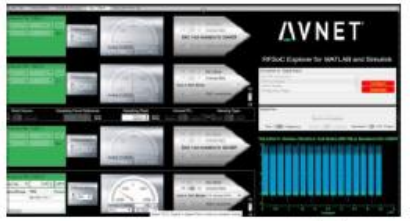
Otava DTRX2 Dual Transceiver mmWave Radio Card (19–31 GHz)

5G 毫米波远程测试系统

Low phase noise reference clock to DTRx2 mmWave PLL

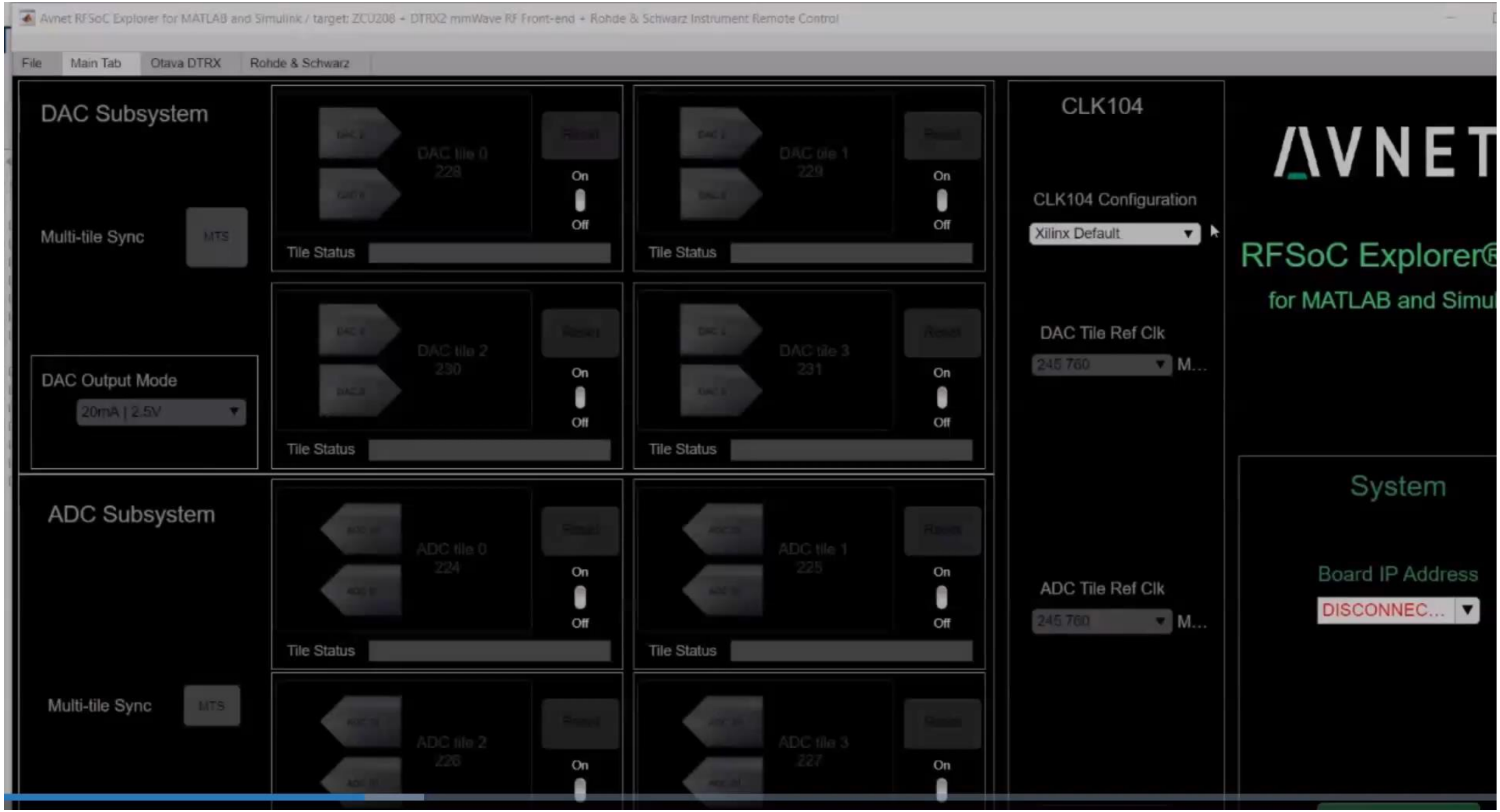
Configure DTRx2 mmWave PLL, gain control

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

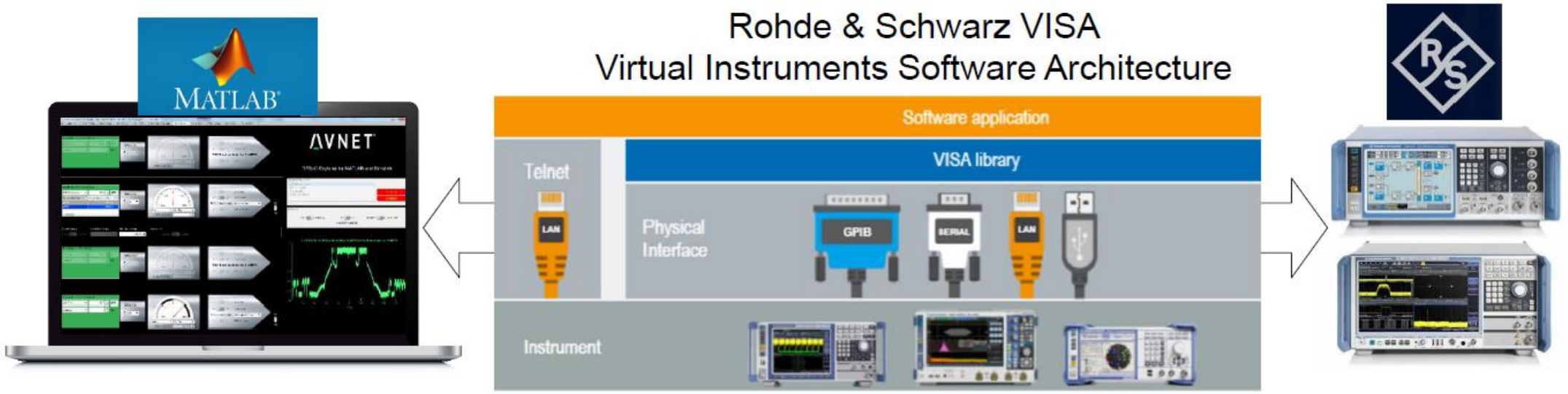


R&S FSW-K144

操作演示


Avnet RFSoC Explorer for MATLAB and Simulink / target: ZCU208 + DTRX2 mmWave RF Front-end + Rohde & Schwarz Instrument Remote Control
File
Main Tab
Otava DTRX
Rohde & Schwarz
DAC Subsystem
Multi-tile Sync
MTS
DAC Output Mode
20mA | 2.5V
DAC tile 0
228
DAC tile 1
229
DAC tile 2
230
DAC tile 3
231
On
Off
Tile Status
ADC Subsystem
ADC tile 0
224
ADC tile 1
225
ADC tile 2
226
ADC tile 3
227
CLK104
CLK104 Configuration
Xilinx Default
DAC Tile Ref Clk
245.760
ADC Tile Ref Clk
AVNET
RFSoC Explorer
for MATLAB and Simu
System
Board IP Address
DISCONNEC...

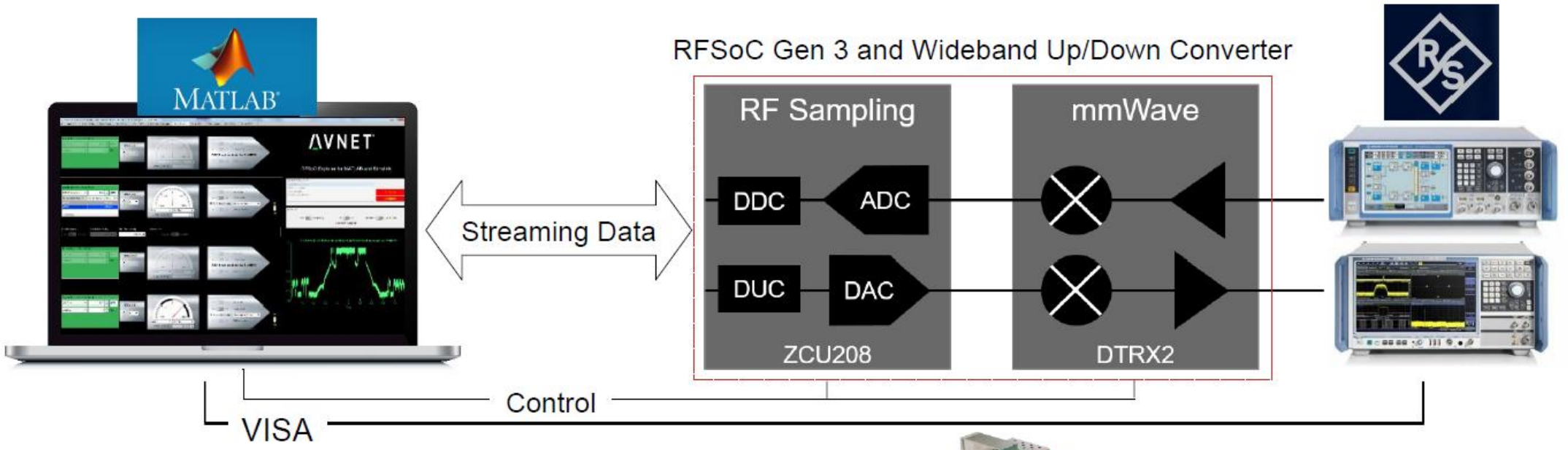
Avnet RFSoC Explorer + R&S虚拟仪器软件架构



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

OTAVA
DTRX2 Dual Transceiver
mmWave Radio Card
www.avnet.com/rfsoc-mmw

Avnet RFSoC Explorer + R&S虚拟仪器软件架构



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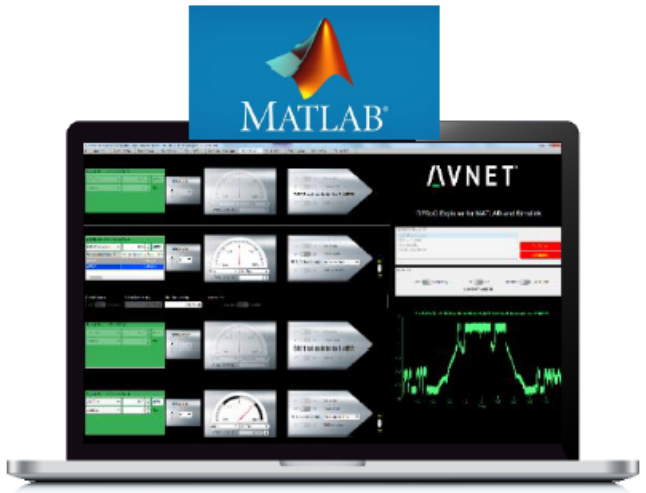
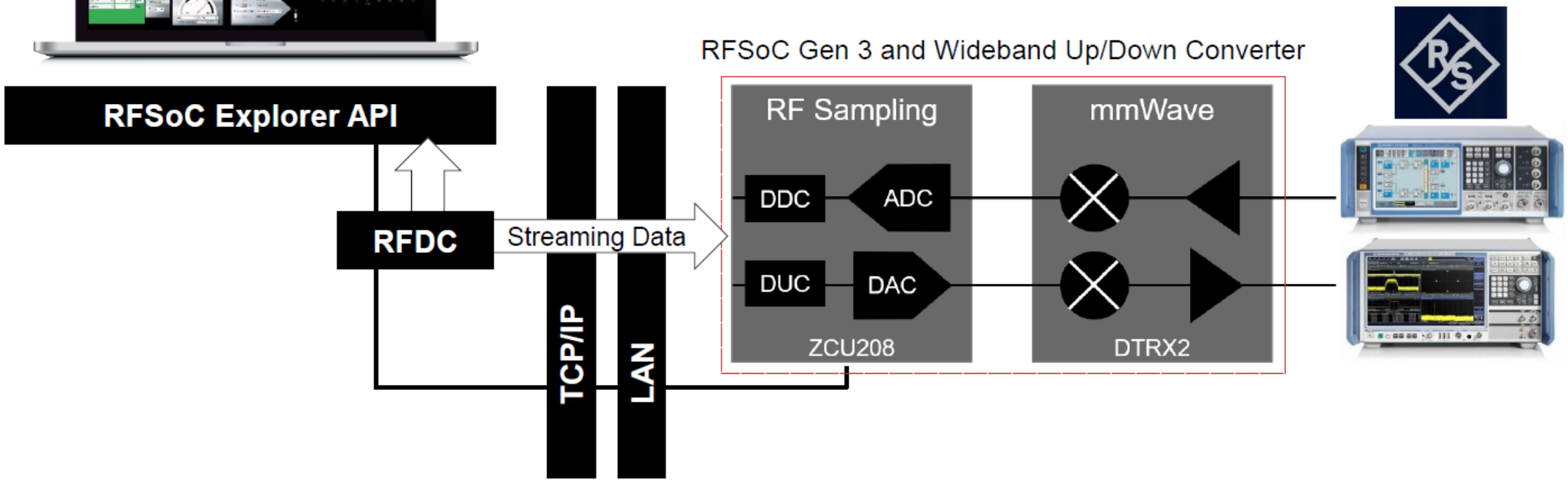
www.avnet.com/rfsoc-mmw

Avnet自动测试应用编程接口(API)




```
ADC_program
ADC_read
DAC_program
DAC_write
```



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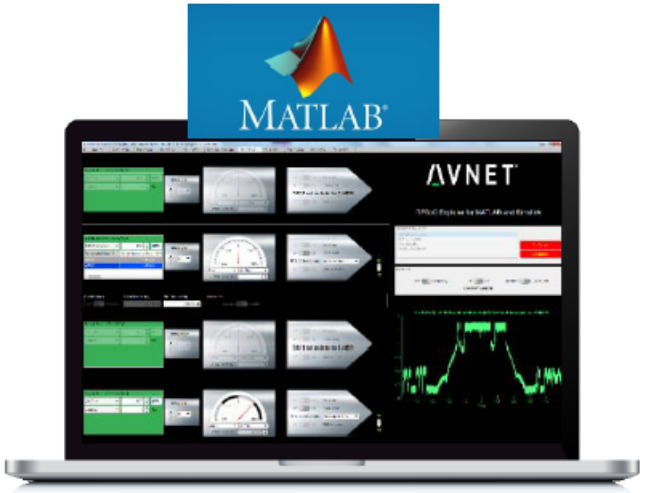
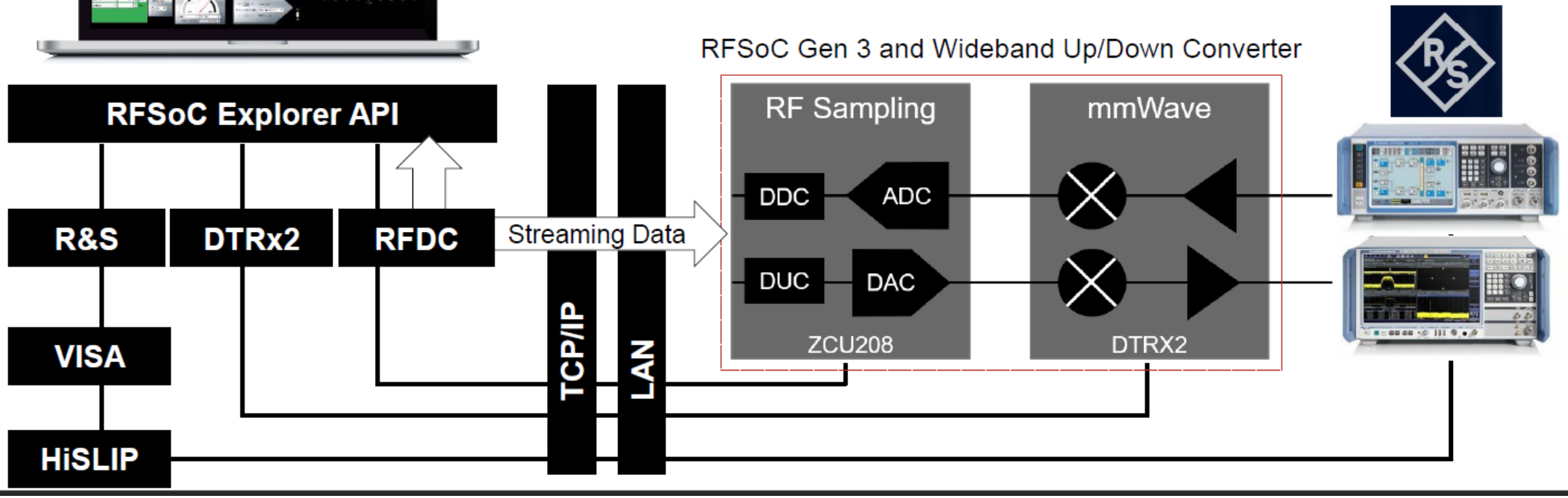
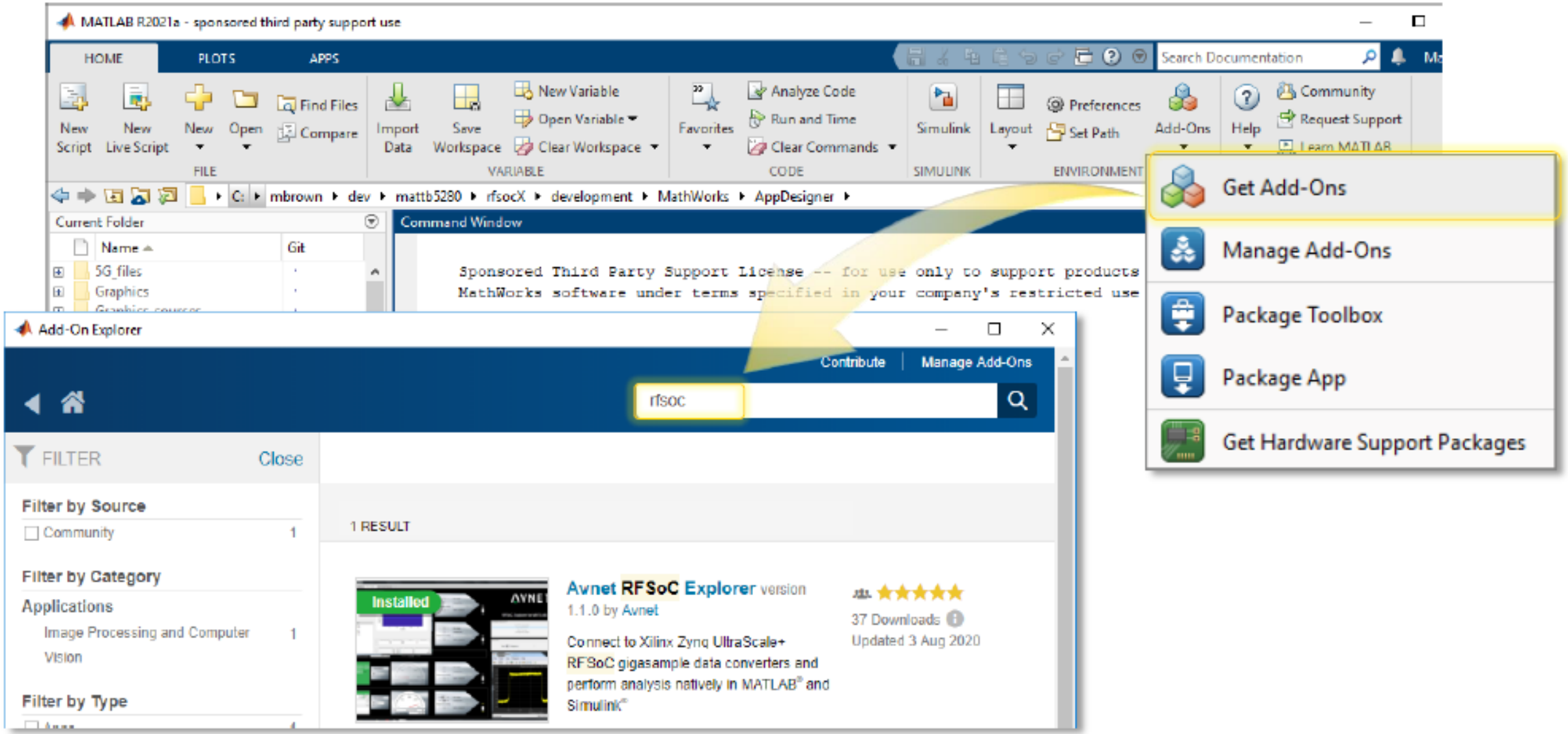


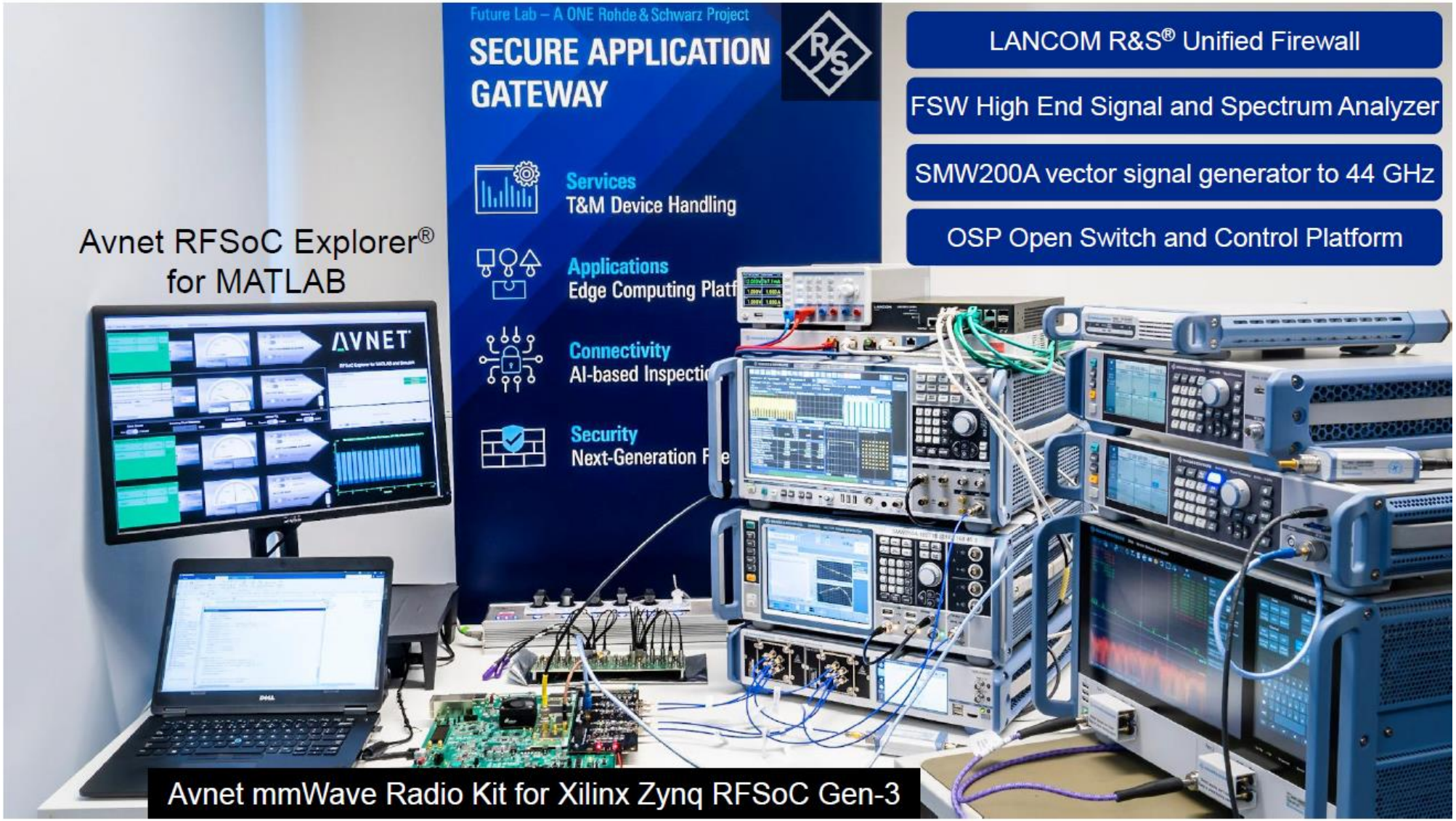
- API enables automated command sequences
- User-extendable add-ons to the main application
- … or MATLAB scripts external to the application



Avnet RFSoC Explorer安装



罗德施瓦茨用于毫米波测试的安全应用网关演示系统



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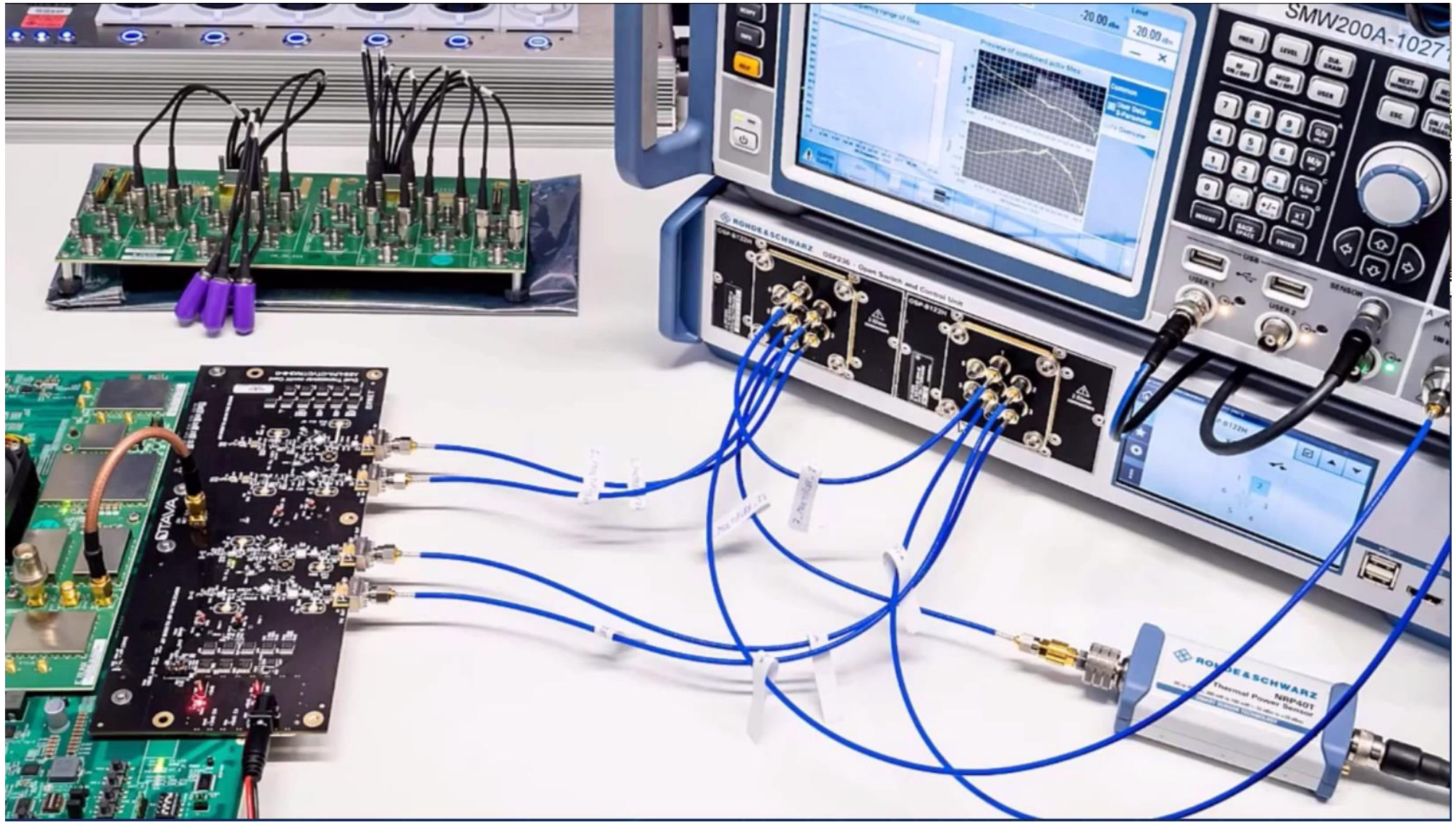

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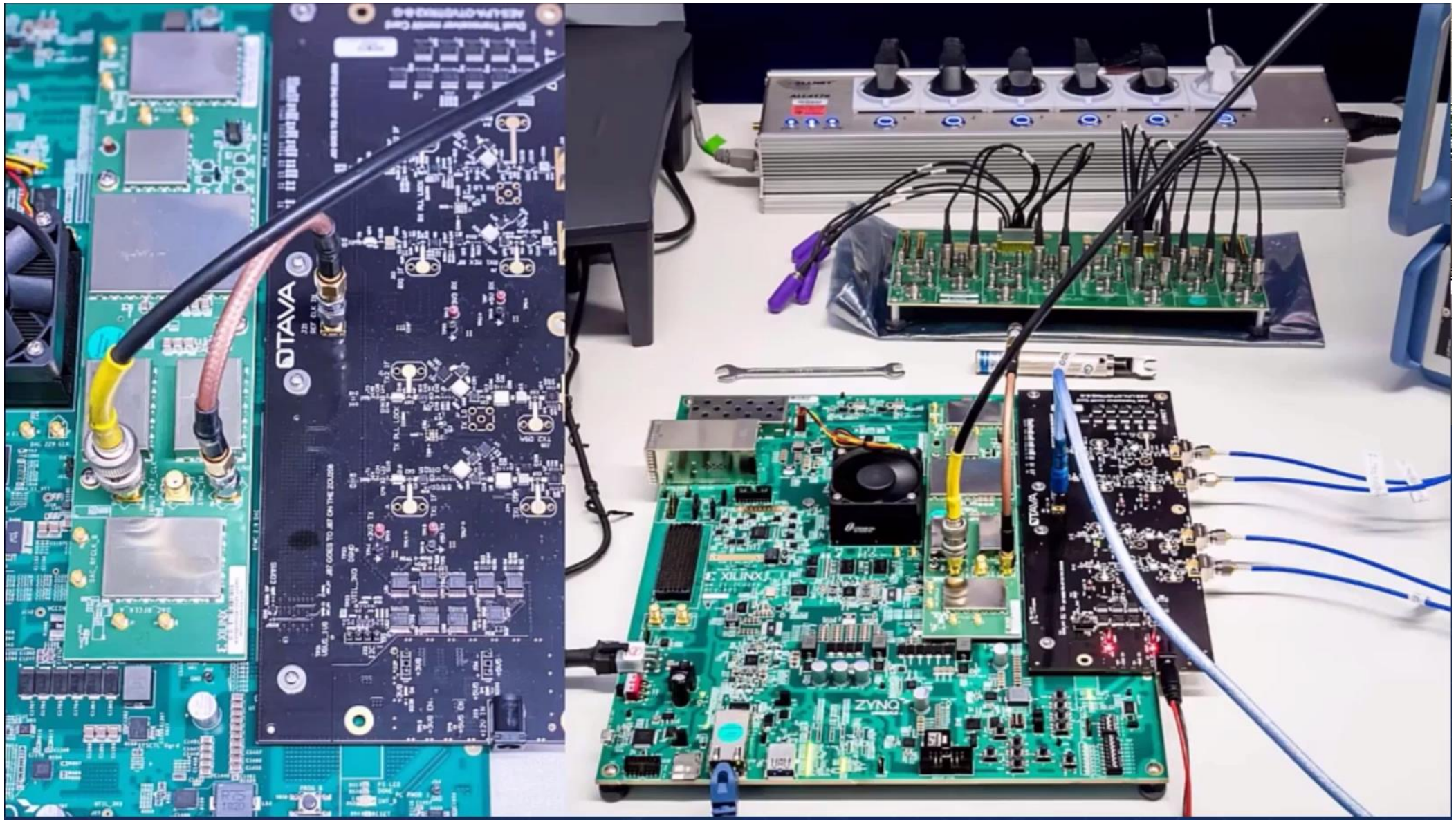
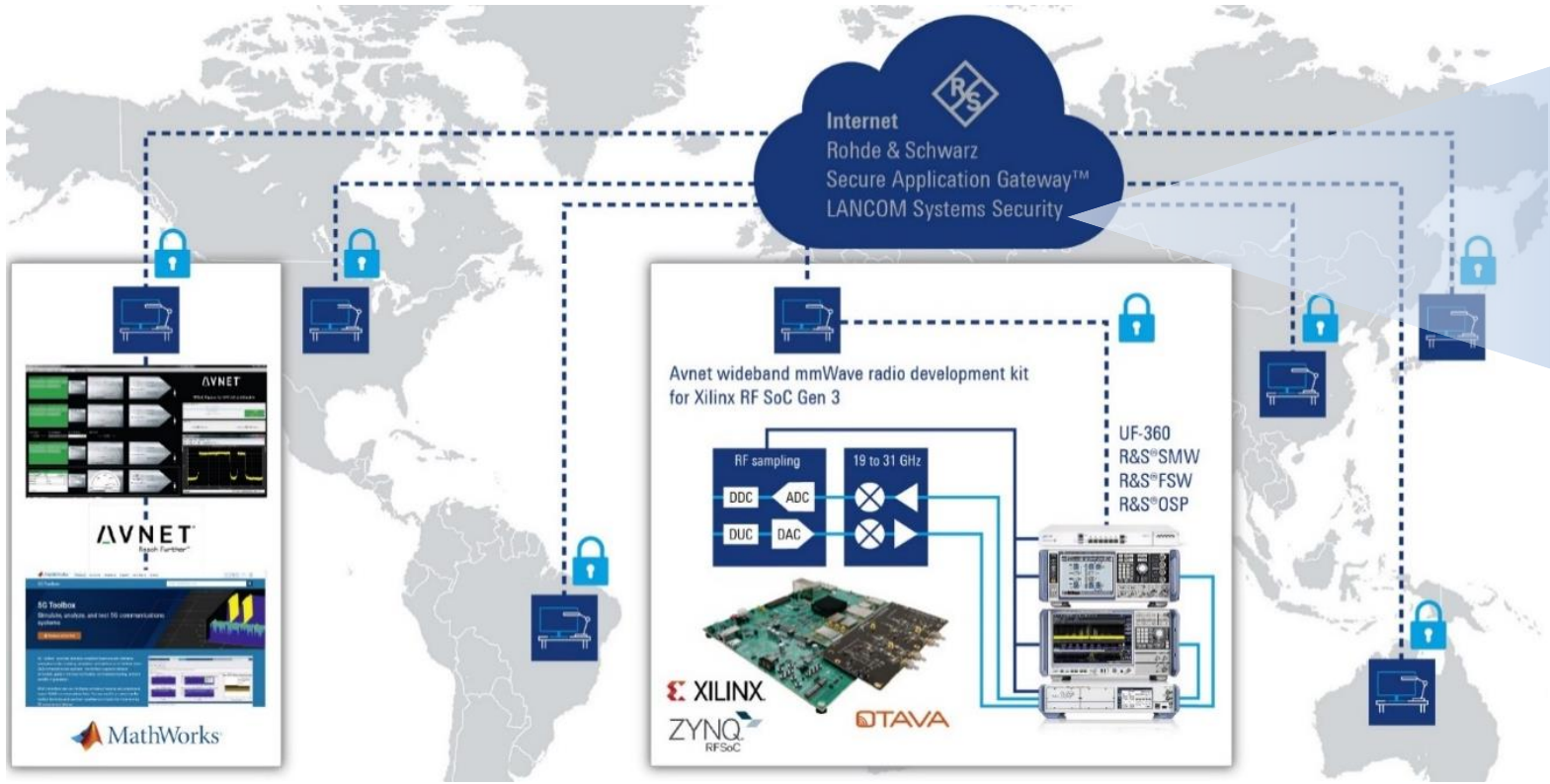



Applications
Edge Computing Platform
Connectivity
AI-based Inspection
Security
Next-Generation Firewall
ROHDE&SCHWARZ
SMW200A-102716 @192.168.40.3

Rohde & Schwarz 基于安全应用网关的网络安全设计



LANCOM R&S® Unified Firewalls

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 µs)

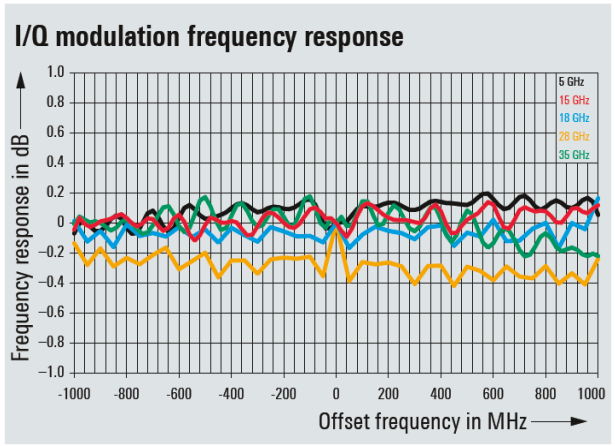
主要应用

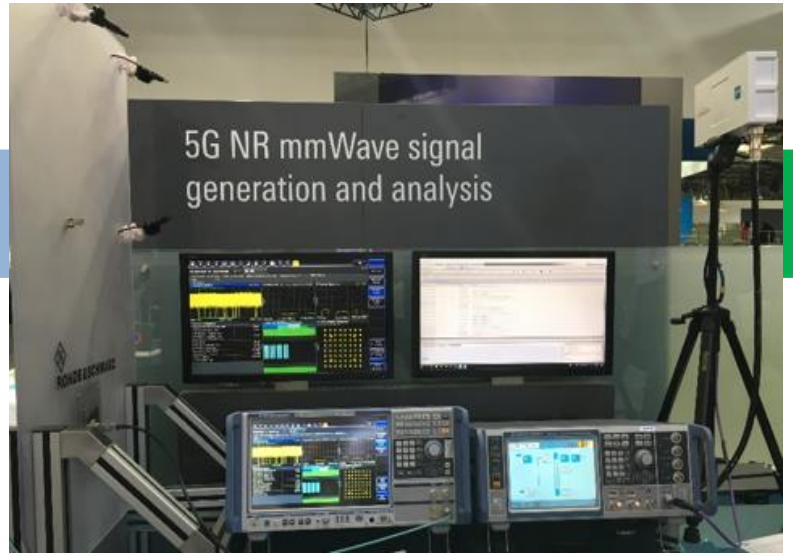
- 通用：
  - 噪声系数
  - 相位噪声
  - EMI诊断
- 蜂窝通信、无线连接研发应用:
  - 5G、LTE、3G、GSM
  - WLAN包括802.11 ac/ax/ad/ay
  - 整机或元器件测试
- 军工：雷达脉冲和跳频分析
- 卫星载荷测试
- 汽车雷达分析

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



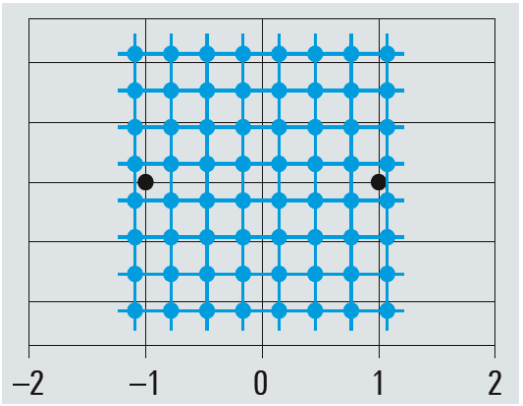


R&S FSW

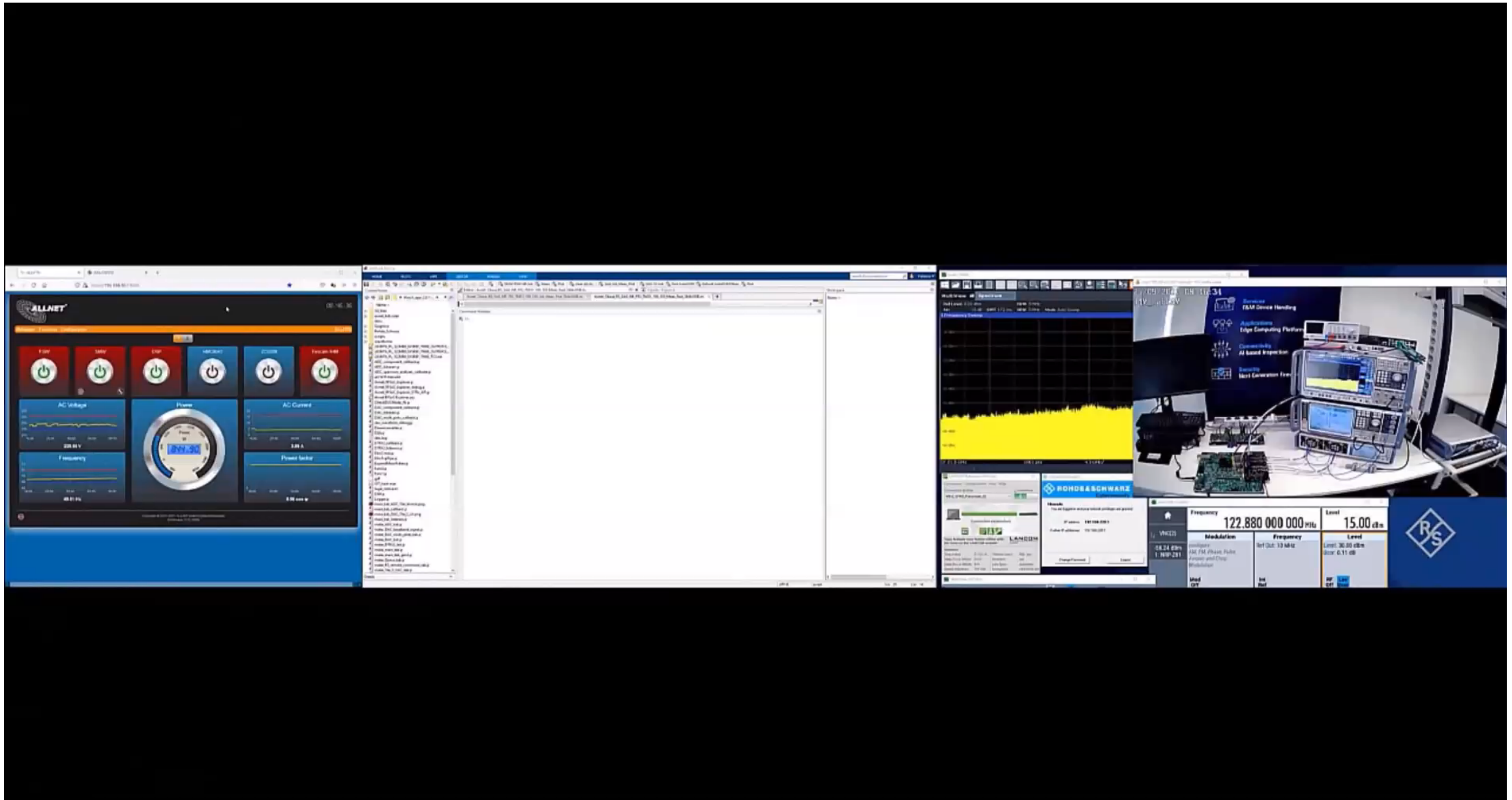
- 2 Hz至8/13.6/… 85/90 GHz
- 内置分析带宽8.3GHz
- 800 MHz实时频谱分析

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


ALLNET
AC Voltage
Power
AC Current
Frequency
Power factor
ROHDE&SCHWARZ
Frequency
122.880 000 000 MHz
Level
15.00 dBm
Modulation
Frequency
Level

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