



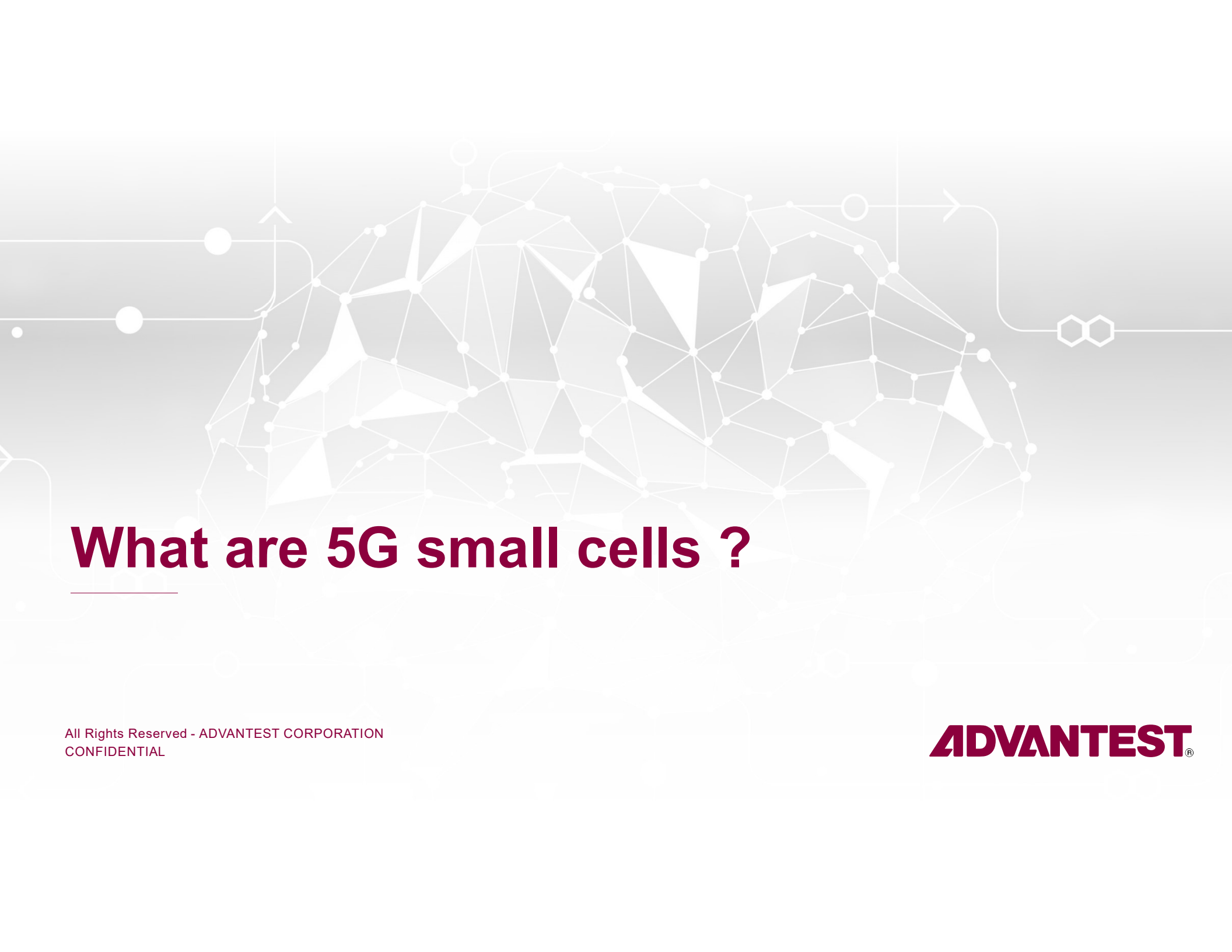
5G小基站将大量部署， 如何面对芯片的量产测试挑战

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ADVANTEST (CHINA) CO., LTD

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Outline

- What are 5G small cells ?
- HVM Test Challenges of 5G Small Cells RF Devices
- V93000 Test Solutions
- Summary



What are 5G small cells ?

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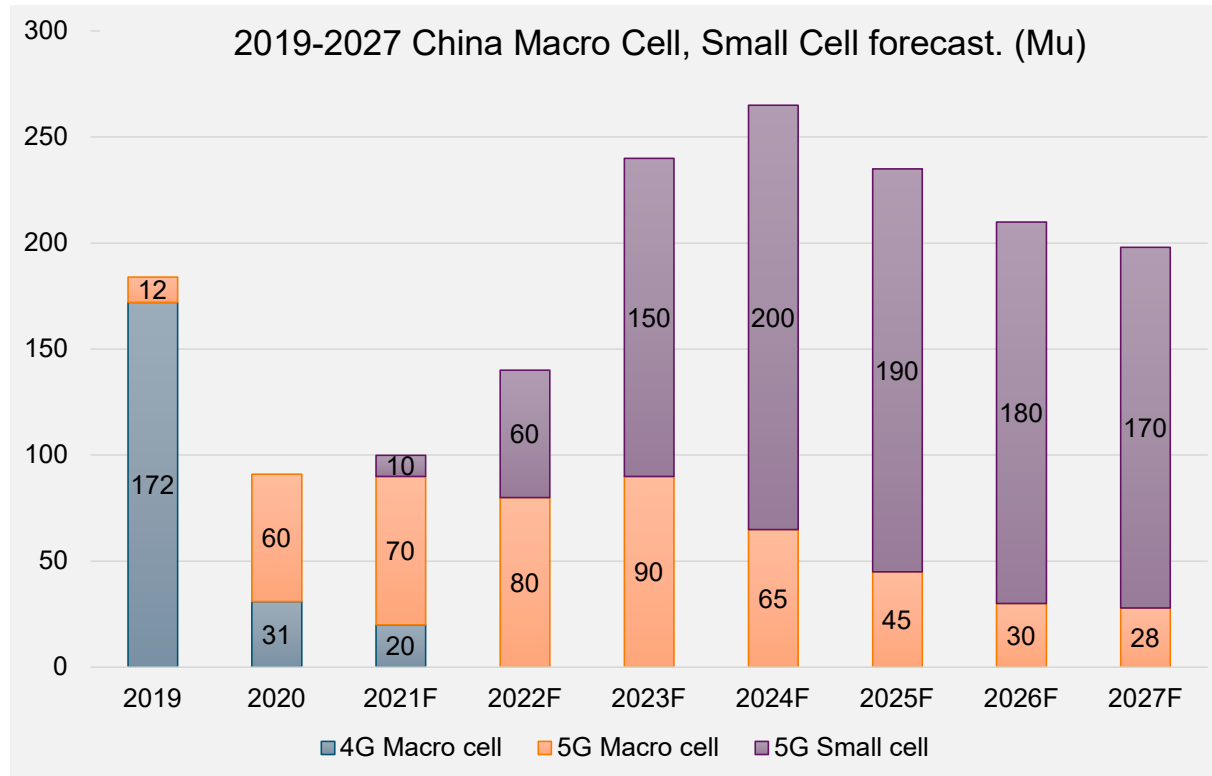
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5G Base Stations Classification



Base Station Type	Macro cell	Micro cell	Pico cell	Femto cell
Transmit power	45 dBm	33 – 37 dBm	24 dBm	20 dBm
Distance coverage	> 200 Meters	50 – 200 Meters	20 – 50 Meters	10 – 20 Meters
Deployment	Outdoor	Airport, Railway station	Shopping Mall	Home, Coffee shop
Number of users	1000+	128-512	64-128	8-16
Installation	Operator	Operator	Operator	User

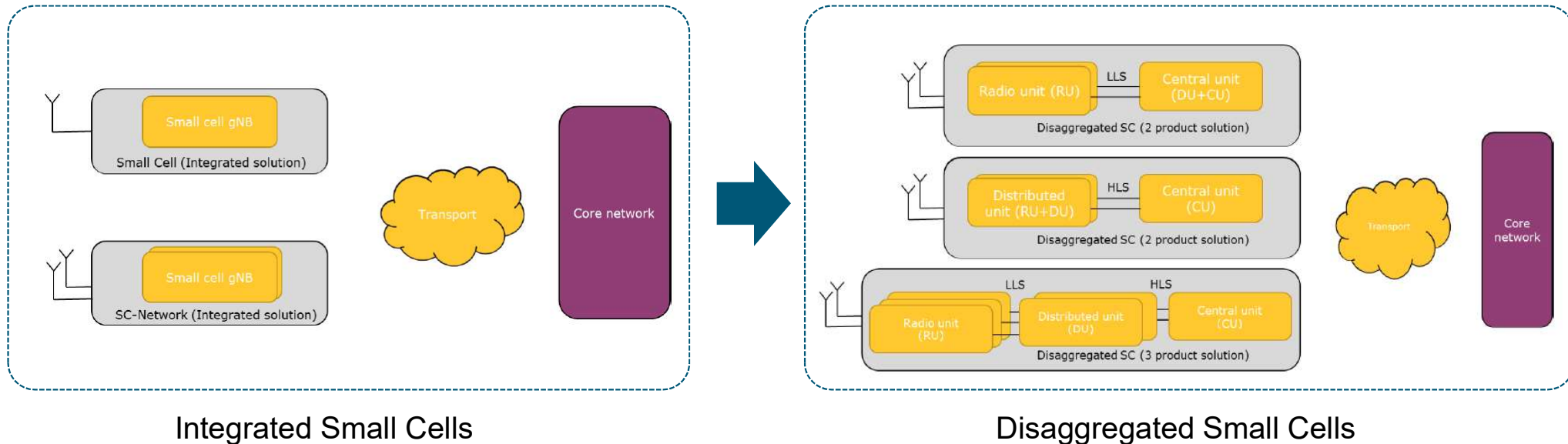
Small Cell Forecast in China



Source: 工信部《通信业统计公报》前瞻产业研究院整理

- 5G macro cells are deployed first, followed by small cells.
- Since the frequency of 5G is higher than 4G, small cells need to be massively deployed in order to achieve better coverage indoor.
- The number of 5G small cells should be twice that of 5G macro cells.
- 5G small cells have been deployed from 2021Y, and the peak volume will be in 2024Y, the total number of 5G small cells will achieve 960 million units.

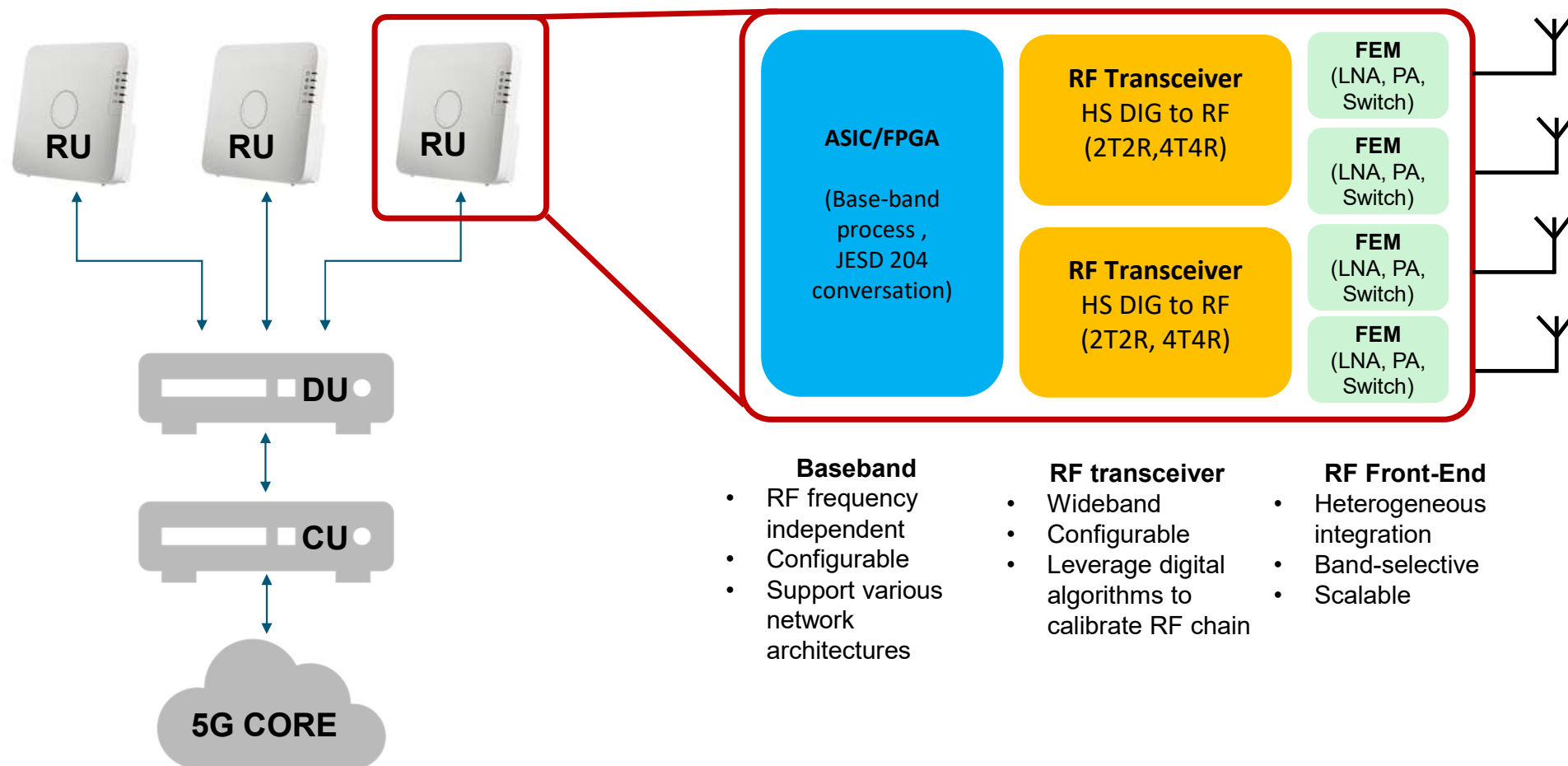
Small Cells Architectures Trend



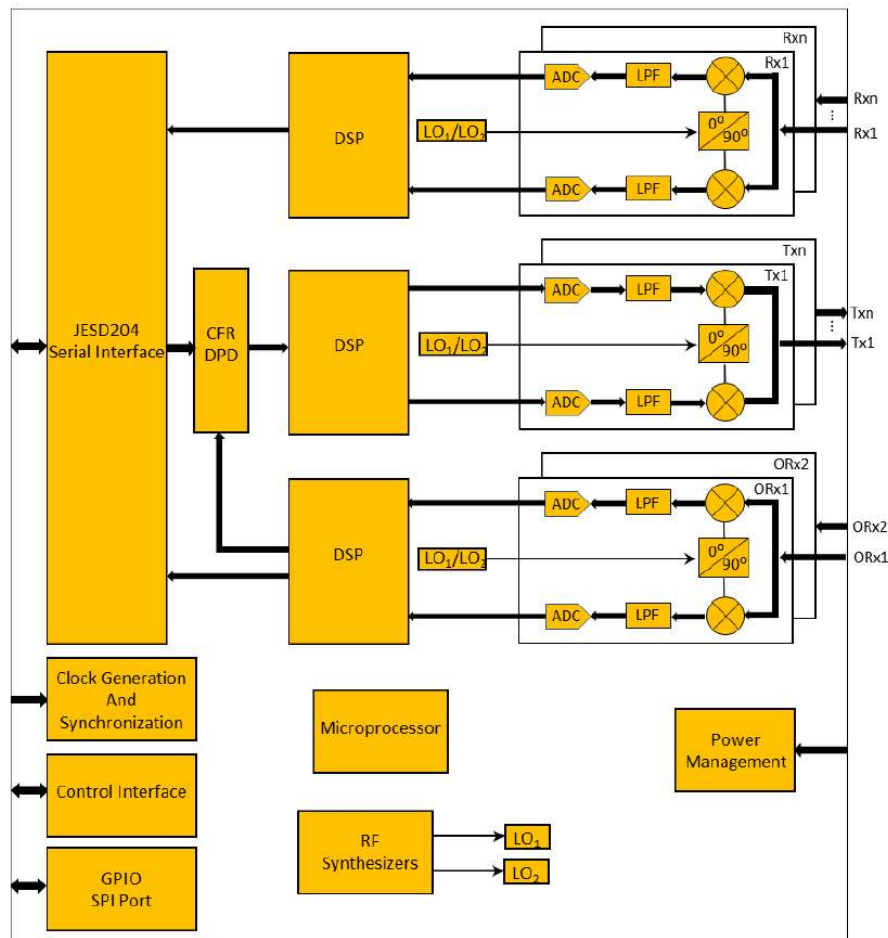
- Integration of software and hardware => open and intelligent
- Disaggregated architectures are being standardized by three industry organizations:
3GPP, Small Cell Forum and O-RAN Alliance
- In 2024 more than half of new small cell deployments will be based on open RAN interfaces, it will rise to 77% in 2026.

Source: small cell forum

5G Small Cells RU Chipsets

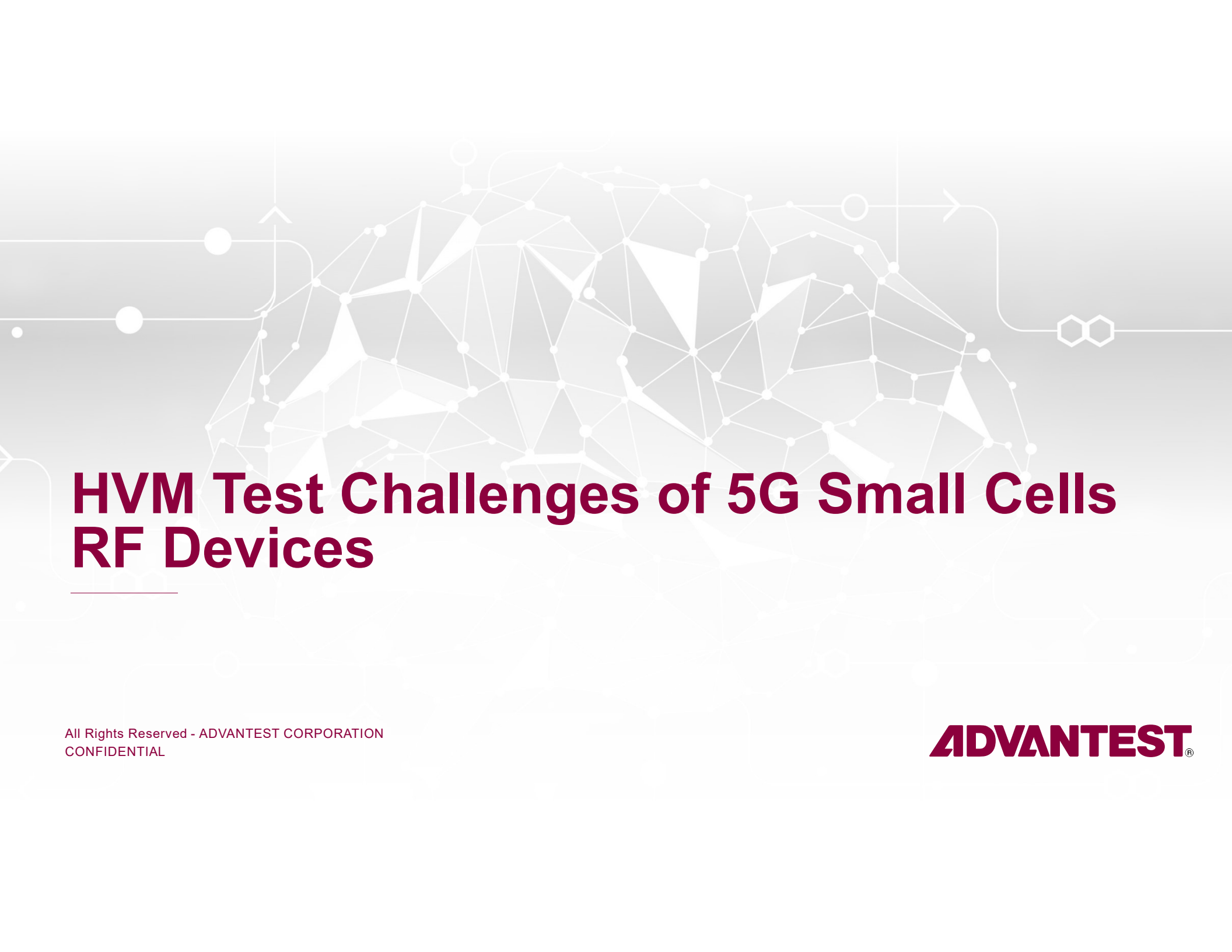


The Typical RF Transceiver Architecture



- The transceivers contain independently controlled transmitters, dedicated observation receivers, independently controlled receivers, integrated synthesizers, and digital signal processing functions with high speed SerDes interfaces.
- The frequency range is from 410MHz up to 6 GHz (or up to 7.125GHz). Depending on the number of controlled transmitters and receivers in the single-chip transceiver device (2T2R, 4T4R, etc.), the transceiver bandwidth performance can be specified.
- To achieve a high level of RF performance, the transceiver includes integrated phase-locked loops (PLLs) which provide low-noise RF synthesis for each signal path.

Source: small cell forum

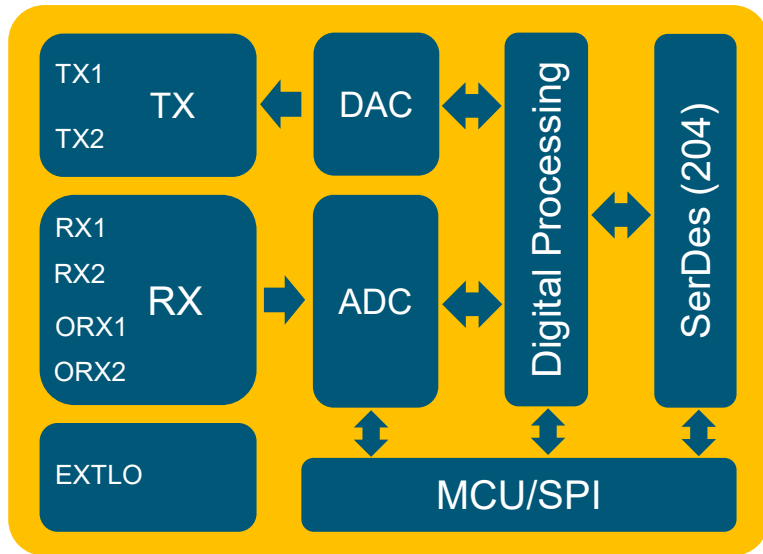


HVM Test Challenges of 5G Small Cells RF Devices

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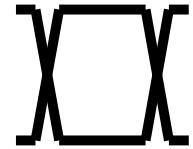
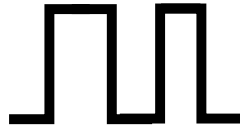
HVM Test Challenges



Typical 5G Small Cell RF Devices

- **Tester Software Requirements**
 - ✓ 5G NR Waveform Generation and Analysis
- **Tester Hardware Requirements**
 - ✓ RF frequency 410MHz ~ 6GHz (extending to 7.125GHz)
 - ✓ RF bandwidth 200MHz and above
 - ✓ High performance EVM (i.e. 3GHz ~ 6GHz, <1.2%)
 - ✓ High performance phase noise (i.e. -140dBc/Hz @10MHz offset, 1.2GHz)
 - ✓ High speed IO coverages (i.e. 204B, 12.288Gbps)
 - ✓ Test efficiency for many RF ports (2T2R, 4T4R ...)
- **Comprehensive Solutions**
 - ✓ Wafer test + Package test

Typical Test Items



	DC tests	Digital tests	RF tests	HSIO tests (optional)
Test Items	Open short Power short LDO Leakage Current	SCAN BIST Efuse	TX: Power/OIP3/ACPR/EVM RX: Gain/IIP2/IIP3/EVM PLL: Phase noise	Eye width Jitter



V93000 Test Solutions

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V93000 EXA Scale – Complete SOC Test Platform

Pin Scale 1600B

128 pins at 1.6Gbps
Universal pin
1mV accuracy



Pin Scale 9G

64 pins at >8Gbps
Parallel and serial interfaces
PHY test



Pin Scale SL

8 lanes (diff drive + diff receive)
Pattern & loopback at 16Gbps
Native protocol support



MultiLane

Up to 32 lanes
8 lanes 112Gbps PAM4
50GHz bandwidth scope



Pin Scale 5000

256 pins at 5000Mbps
3.5Gvec per pin scan memory
Advanced universal pin



NEW

DC Scale DPS128 / 64

General purpose DPS



DC Scale UHC4T

High-current DPS



DC Scale AVI64

Universal analog VI



DC Scale FVI16

Floating high power VI



Power MUX

"Sea of switches"



DC Scale XPS256

256x 1A, unlimited ganging



NEW



Wave Scale MX

Up to 16 AWG / DGT
Up to 64 PMUs
High-speed / High-resolution



Wave Scale RF 6/8

6/8GHz, up to 32 RF ports
200MHz bandwidth
4 independent RF subsystems



Wave Scale RF18

5.85GHz to 18GHz
Up to 2 GHz bandwidth



Wave Scale Millimeter

24GHz to 70GHz
Up to 2GHz bandwidth
Conductive and OTA test



Direct-Probe™

Same DUT Interface



V93000-CX



V93000-SX

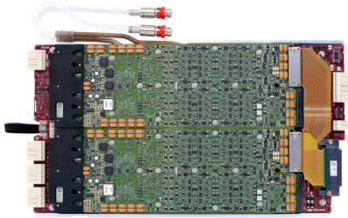


V93000-LX

NEW

SmarTest + Libraries + Test Programs + InstaPin™ Licensing

Various Tester Resources For Different Items



DPS128/64

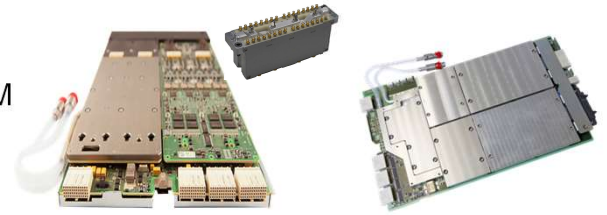
128/64 pins
-2.5V to +7V
1.0A@2.5V, 0.5A@7V

DC tests

- OS, power short
- LDO
- Leakage
- Current

RF tests

- TX:
Power/OIP3/ACPR/EVM
- RX:
Gain/NF/IIP3/IIP2/EVM
- PLL: Phase noise



Wave Scale RF

10MHz - 8GHz
Up to 32 RF ports
200 MHz bandwidth
4 Independent AWG/DGT

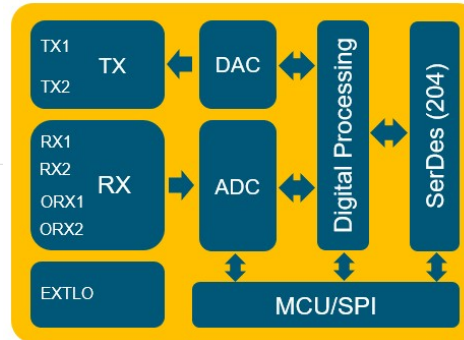
Wave Scale PS

10MHz - 8GHz
High precision source



Pin Scale 1600/B

128 pins at 1.6G
1mV accuracy
Universal pin

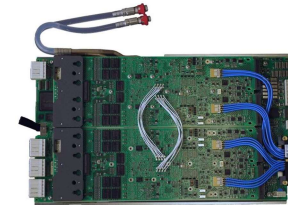


Digital tests

- Scan
- MBIST
- Efuse

HSIO tests

- Eye Width
- Jitter ...



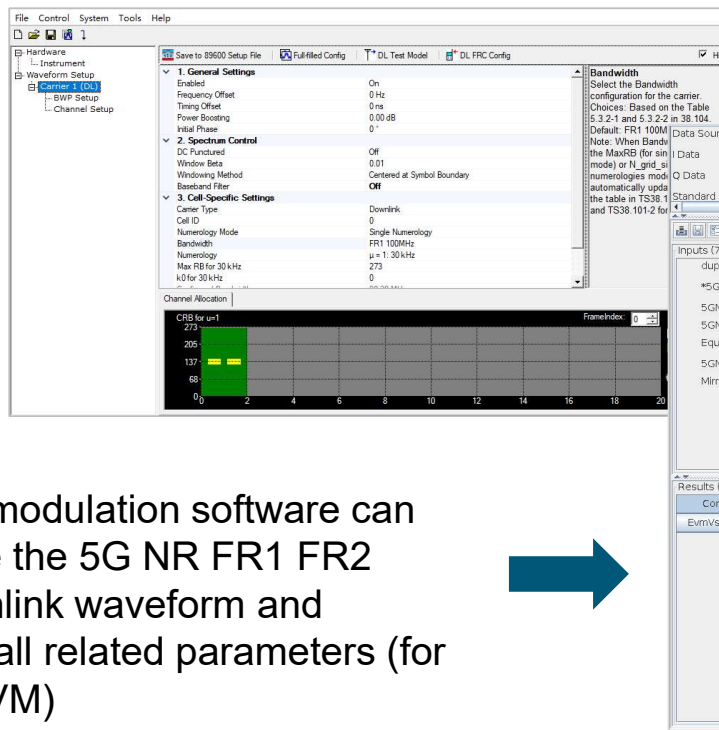
Pin Scale SL

8 lanes (diff drive + diff receive)
Pattern & loopback at 16Gbps

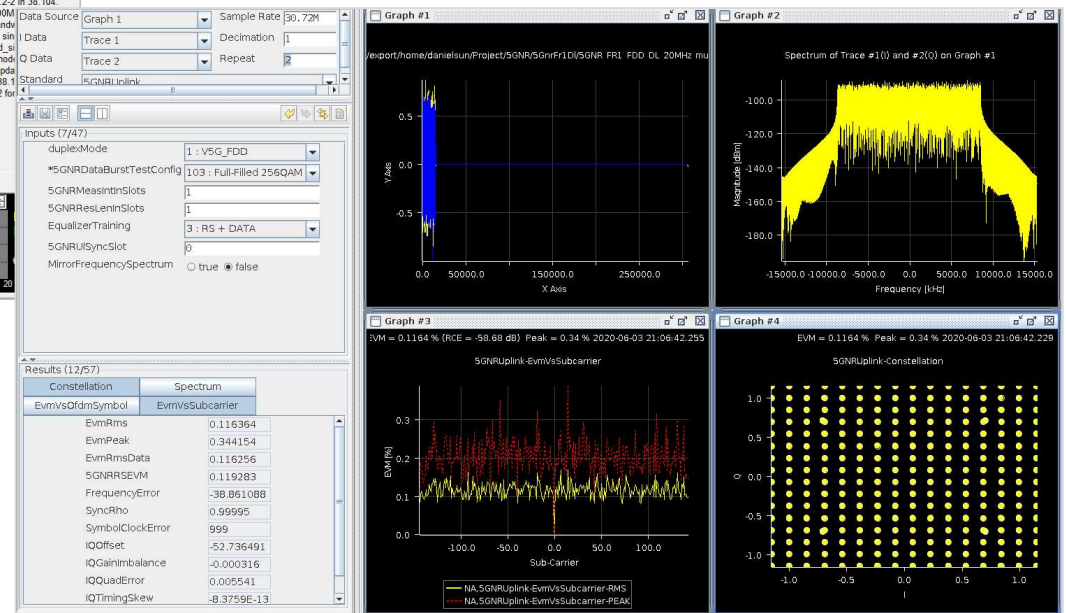
V93000 Solutions – 5G Waveforms Generation and Analysis

- **Tester Software Requirements**
 - ✓ 5G NR Waveform Generation and Analysis

User can use the tools, like Keysight Signal Studio to generate 5G NR BB waveform and load to tester (V93000)



V93000 demodulation software can demodulate the 5G NR FR1 FR2 uplink/downlink waveform and calculation all related parameters (for example EVM)

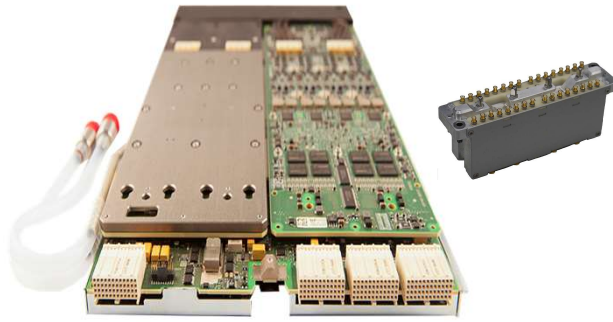


FR1 downlink demodulation, 256QAM, 100MHz Bandwidth

V93000 Solutions – Higher Frequency, Wider Bandwidth

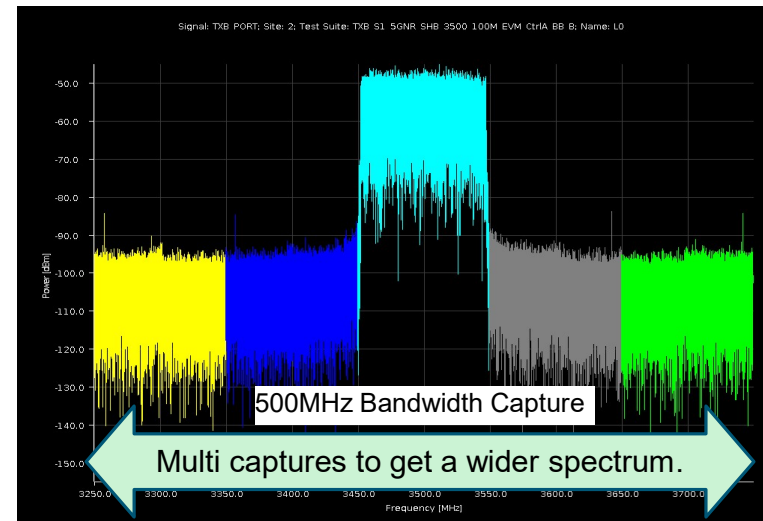
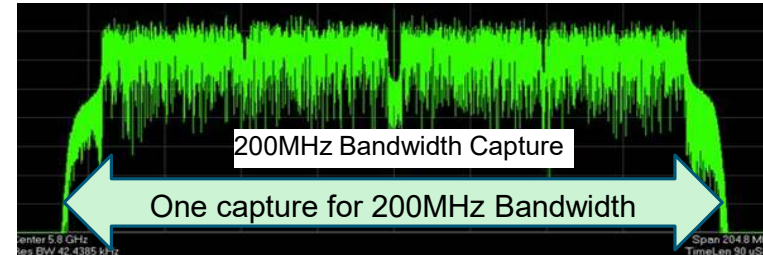
- **Tester Hardware Requirements**

- ✓ RF frequency 410MHz ~ 6GHz (extending to 7.125GHz)
- ✓ RF bandwidth 200MHz and above



Wave Scale RF

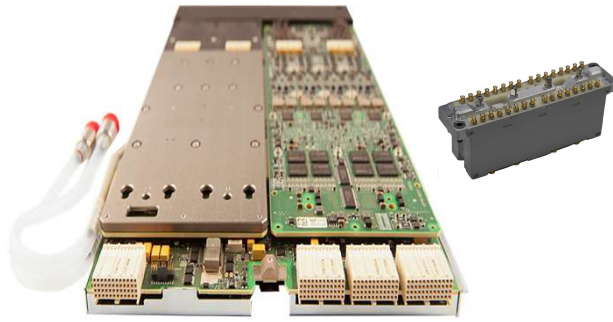
- 10MHz - 8GHz
- Up to 32 RF ports
- 200 MHz bandwidth
- 4 Independent AWG/DGT



V93000 Solutions – High Performance EVM

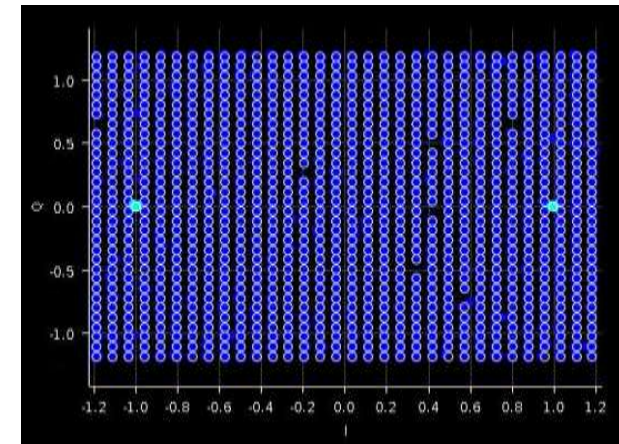
- **Tester Hardware Requirements**

- ✓ High performance EVM (i.e. 3GHz ~ 6GHz, <1.2%)



Wave Scale RF

- 10MHz - 8GHz
- Up to 32 RF ports
- 200 MHz bandwidth
- 4 Independent AWG/DGT

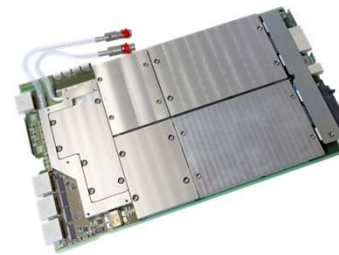
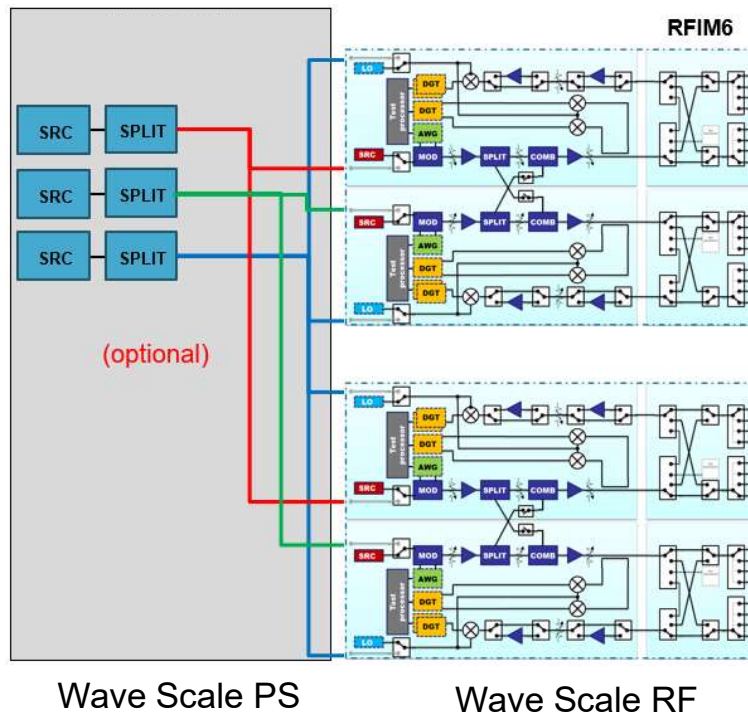


802.11ax 160MHz signal
7.125GHz 1024 QAM → ~ 0.5% EVM

V93000 Solutions – High Performance Phase Noise

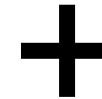
- **Tester Hardware Requirements**

- ✓ High performance phase noise
(i.e. -140dBc/Hz @10MHz offset, 1.2GHz)



Wave Scale PS

8GHz
High precision source



Wave Scale RF

8GHz,
up to 32 RF ports

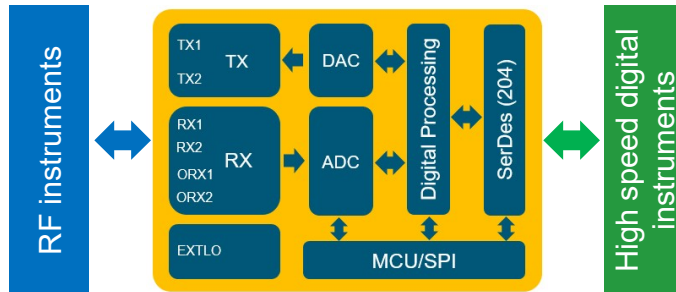
The natural phase noise typical specifications of WSRF+WSPS can definitely cover these requirements.

V93000 Solutions – High-Speed IO Test Approaches

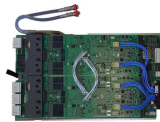
- Tester Hardware Requirements**

- ✓ High speed IO coverages (i.e. 204B, 12.288Gbps)

Direct measurements via highspeed instruments

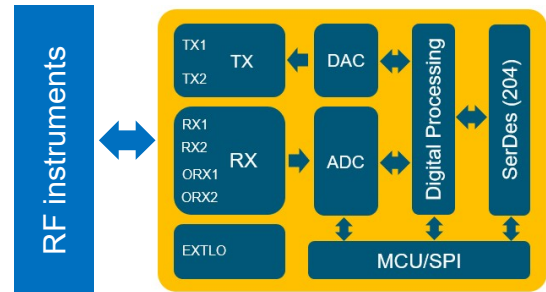


Wave Scale RF
8GHz, up to 32 RF ports



Pin Scale SL
16Gbps / 8 lanes
Available solutions to handle JESD204 decode.

Low speed measurements using device buffers

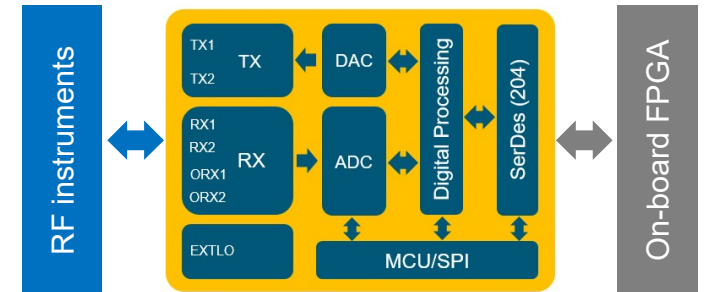


Wave Scale RF
8GHz, up to 32 RF ports



Pin Scale 1600
1.6Gbps / 128 pins

Low speed measurements using external FPGAs



Wave Scale RF
8GHz, up to 32 RF ports

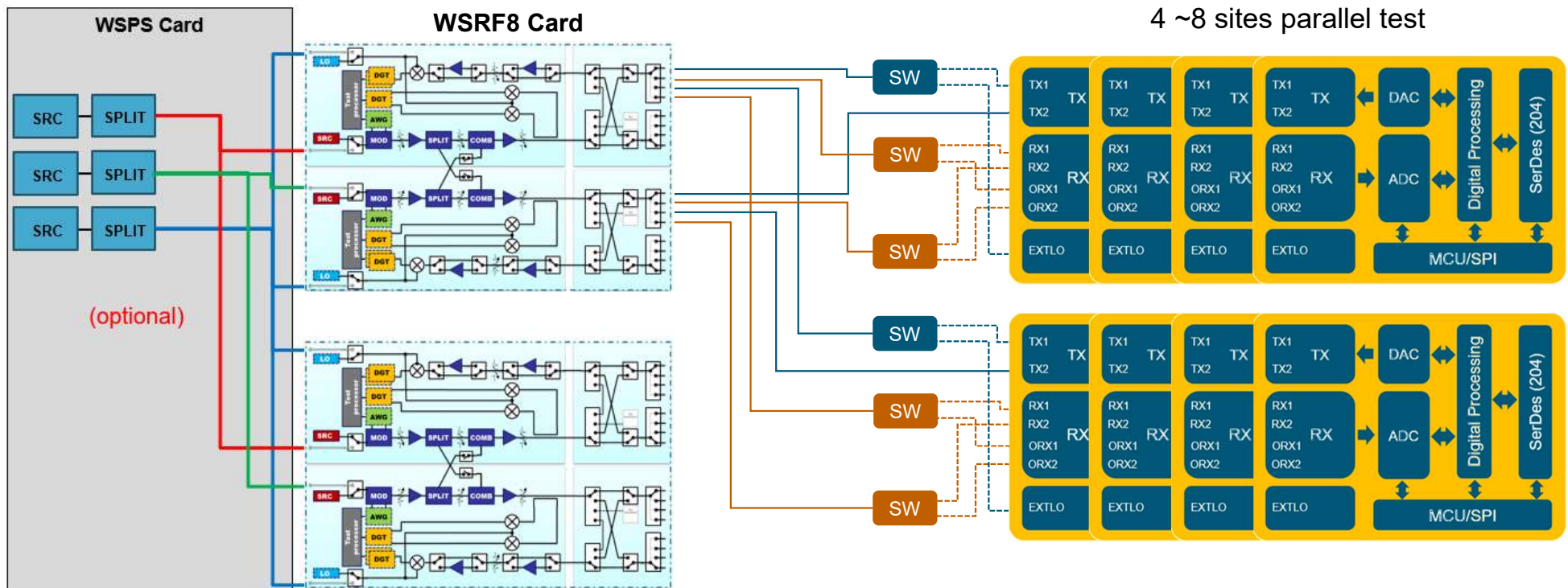


Pin Scale 1600
1.6Gbps / 128 pins

V93000 Solutions – High Test Efficiency

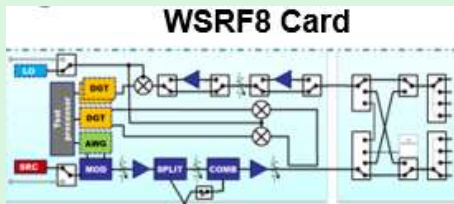
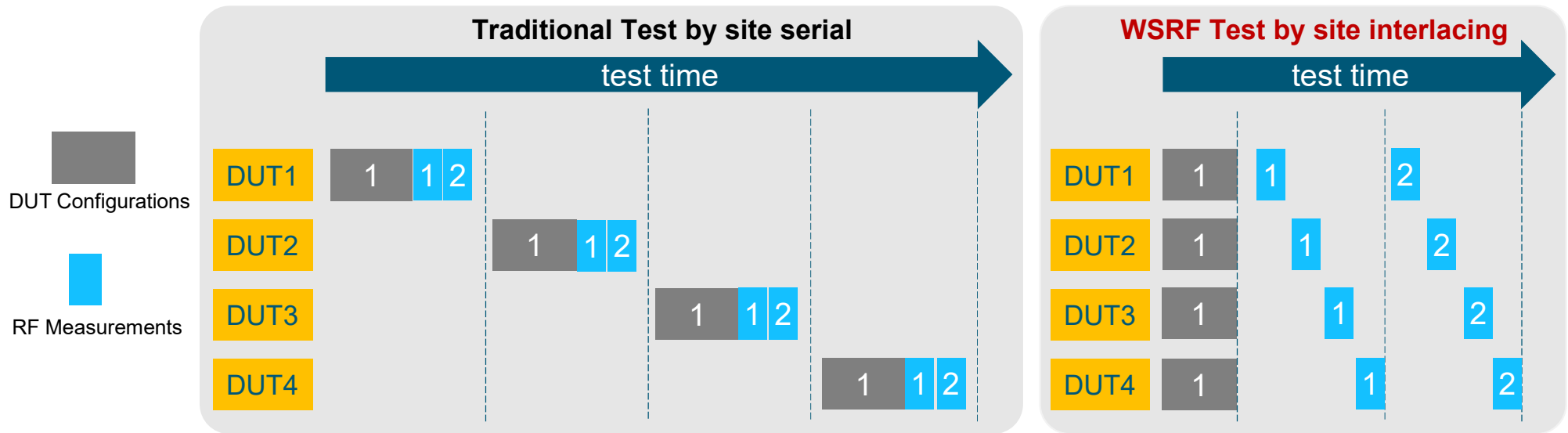
- **Tester Hardware Requirements**

- ✓ Test efficiency for many RF ports (2T2R, 4T4R ...)



Wave Scale RF has abundant test resources that can support high site count parallel approaches.

V93000 Solutions – High Test Efficiency



A typical Multi-site sharing RF resources scenario

- Wave Scale RF has site interlacing features that can significantly improve test time using shared resources
- The execution time using site interlacing is shorter by around 20 ~ 50% compared to that for site serial.

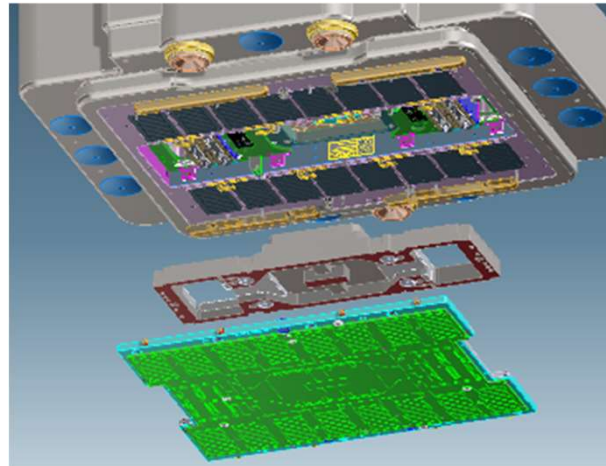
V93000 Solutions – RF Wafer Test

- **Comprehensive Solutions**
 - ✓ Wafer test + Package test



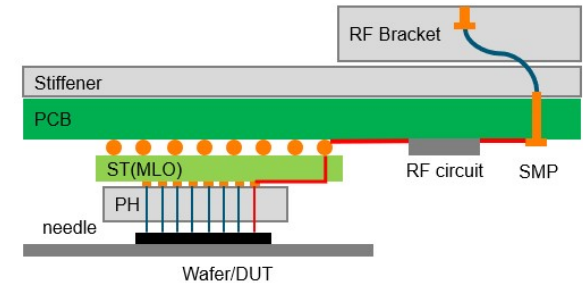
The same tester platform for wafer test and package test

- Wave Scale RF
- Wave Scale PS
- Pin Scale 1600
- Pin Scale SL (optional)
- DPS128



V93000 direct probe solution for wafer test

- Simpler Structure
- Signal Integrity
- Bigger Application Area



RF Prober card signal flow



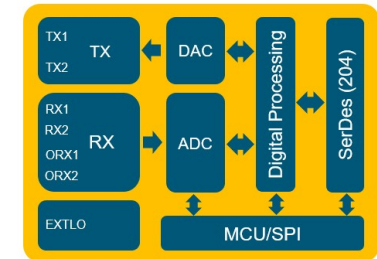
Summary

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Summary

- 5G Small Cells is ramping up very soon in the next few years, the products of open RAN architectures would be popular.
- The high-performance RF transceiver is the key component of the small cell system, it has many RF ports that frequency covers 410MHz to 7.125GHz and bandwidth is more than 200MHz which would be challenging for high volume mass production.
- V93000 has total solutions for such high-performance RF devices for wafer test and package test, the hardware and software not only cover the test requirements but also can support multi-site parallel testing for cost down.



Full 5G Spectrum from Advantest V93000 Portfolio

Thank you!



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