



直面5G毫米波芯片的量产测试

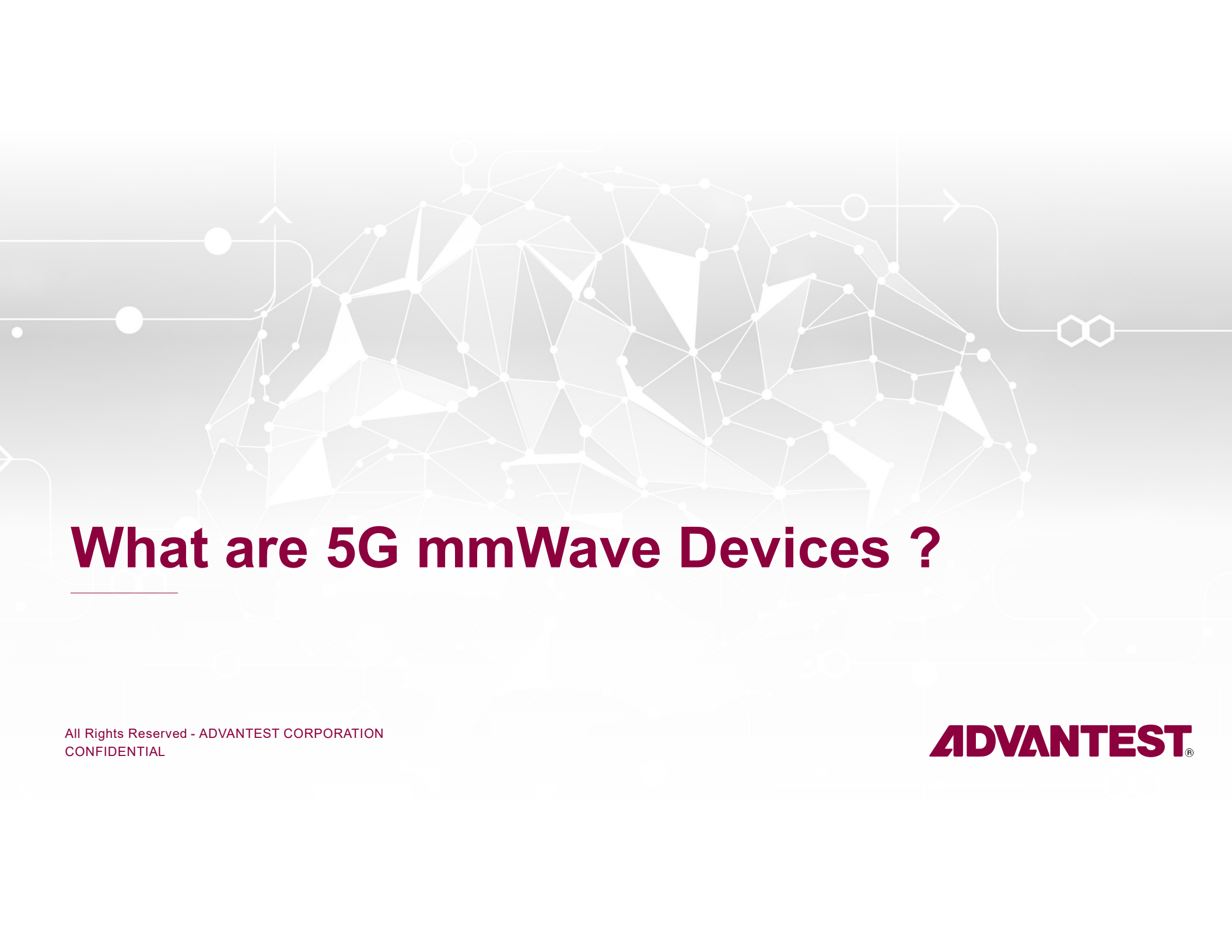
Daniel Sun

Business Development & Center of Expertise, Asia
ADVANTEST (CHINA) CO., LTD

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Outline

- What are 5G mmWave devices?
- HVM Test Challenges of 5G mmWave Devices
- V93000 Test Solutions
- Summary



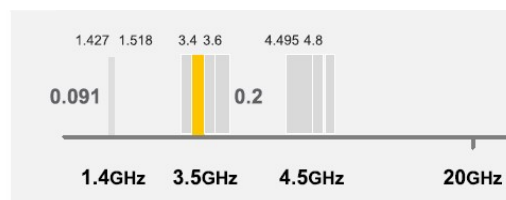
What are 5G mmWave Devices ?

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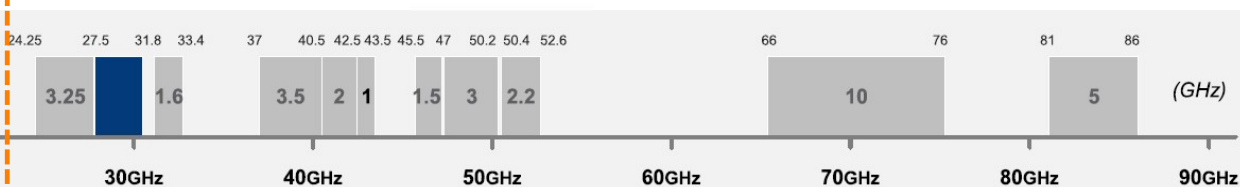
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5G NR FR2 (mmWave) Application Scenarios

5G FR1(410MHz – 7.125GHz)



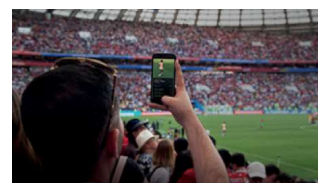
mmWave 5G FR2(24.25GHz – 52.6GHz)



Source: ADLINK Technology



Surveillance and video streaming/broadcast



Crowded area capacity



Last mile fiber/copper complement



Everywhere AR/VR



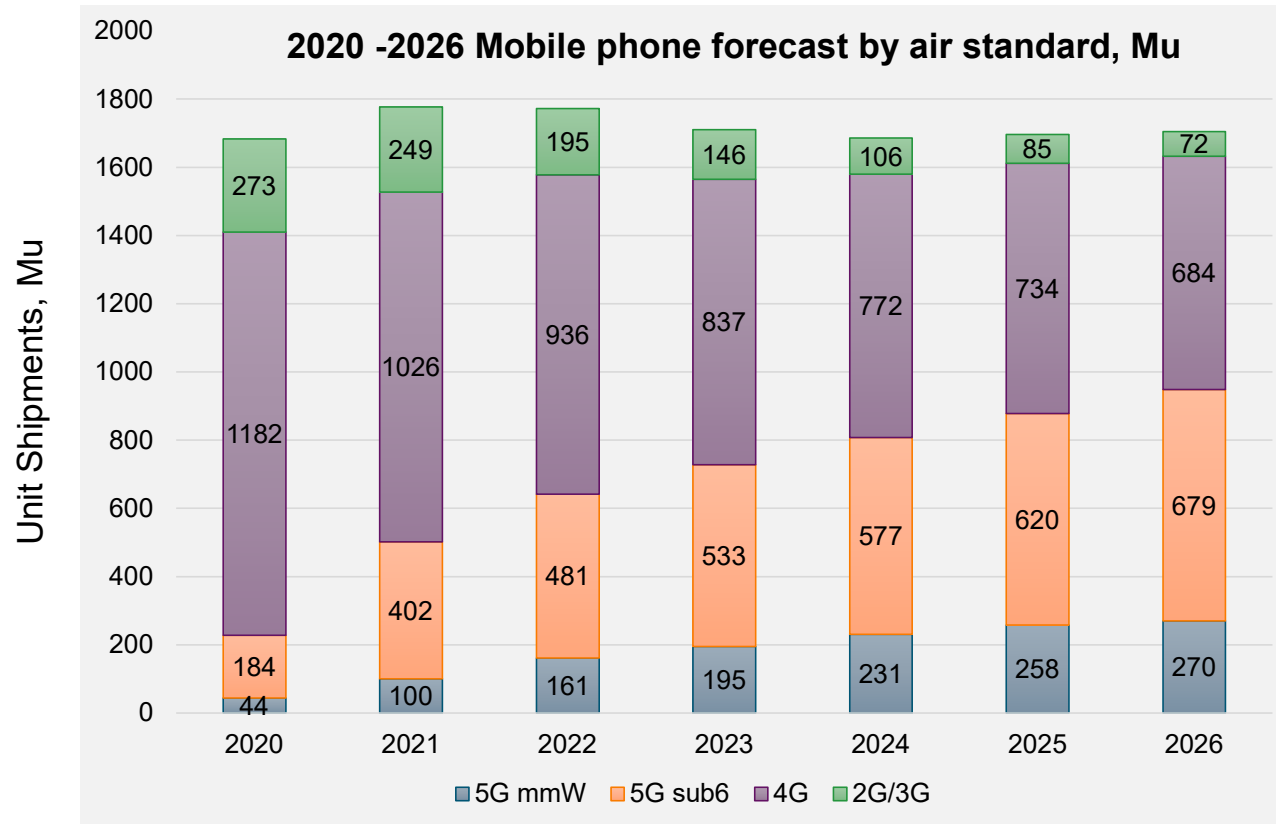
Smart factory



Street macro applications

5G mmWave application scenarios

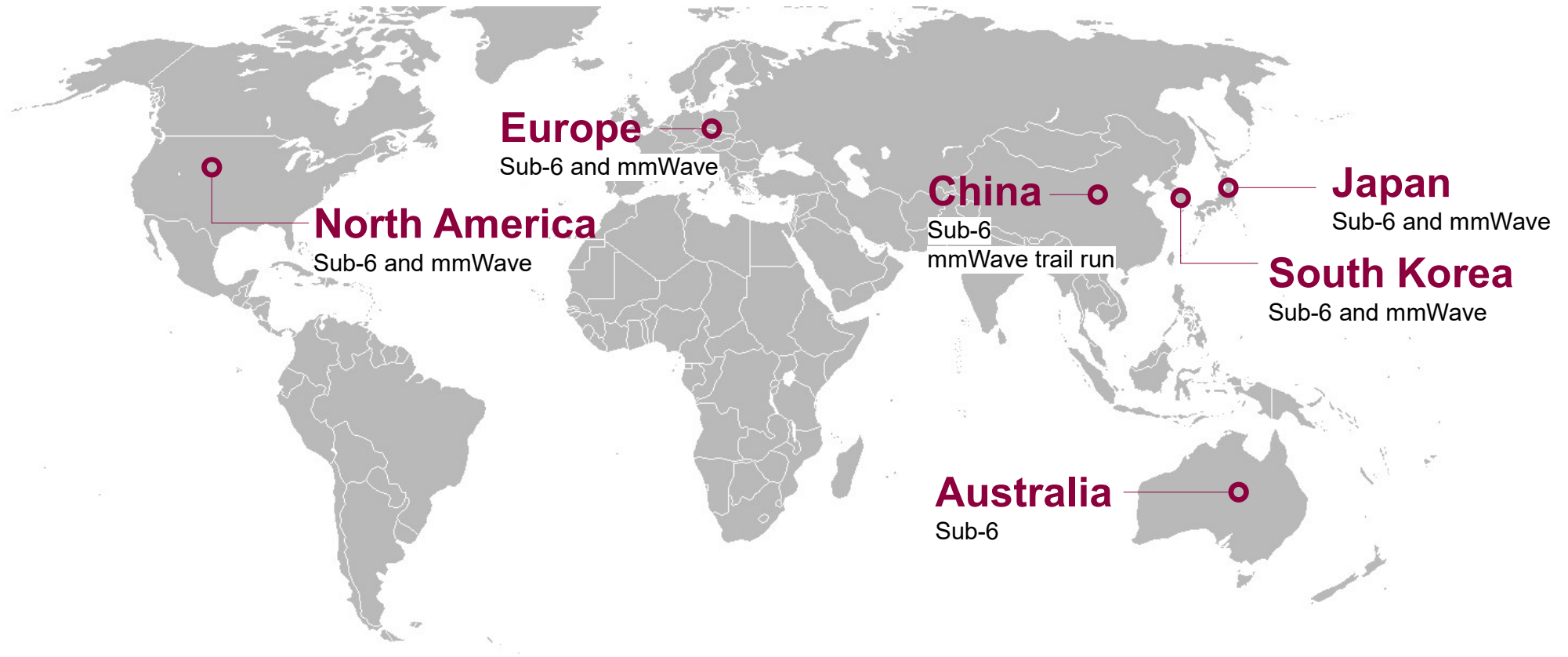
5G Mobile Phone Forecast by Air Standard



Source: 5G packing trends for smartphones, Market and technology report 2021 (YOLE)

- The largest proportion is still 4G, 5G sub6G mobile phones.
- CAGR of mmWave mobile phone shipments is 35%, which is faster than 5G Sub6G (24%).
- In 2026, mmWave mobile phone shipments will achieve 270M units.

Worldwide Radio Allocation For 5G



5G mmWave Status in China

- Currently in the trail run stage, yet to allocate millimeter-wave spectrum for 5G.
- The frequency band of mmWave trail run in China is 24.75 ~ 27.5GHz, 37~ 42.5GHz.
- China's three operators have launched relevant tests.

2021

- Verify typical scenarios. e.g. China Unicom deployed mmWave infrastructures in many stadiums in Olympics areas.



ZTE mmWave Base Stations at Olympics skiing center
Source: <https://new.qq.com/rain/a/20210224A0189R00>

2020

- Verify the function, performance and operation of millimeter wave base station and terminal.
- Verify high and low-frequency networking.

2019

- Verify 5g millimeter wave key technology and system characteristics.

2022



BEIJING 2022

- A milestone - early deployment and trial run @ 2022 Winter Olympics

2023 ~

- Commercial launch (planning ...)

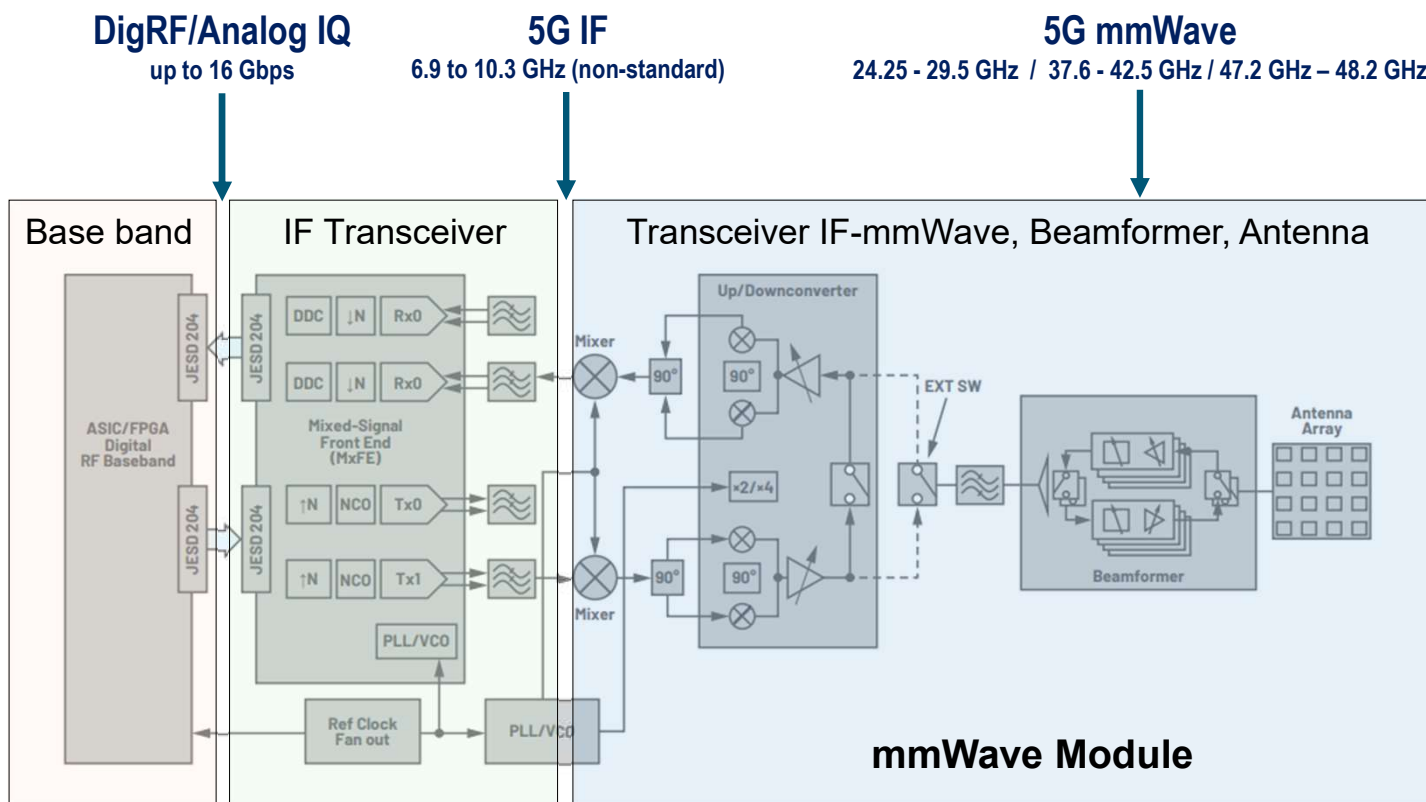


mmWave handsets (OPPO, ZTE...) testing at Olympics skiing center
Source: <https://new.qq.com/omn/20210302/20210302A06WD900.html>

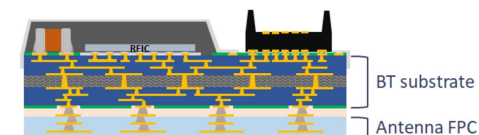
5G NR FR1 versus RF2 comparison

	FR1- Frequency Range1	FR2 – Frequency Range2
Specification	5G NR NSA and SA	5G NR NSA
Frequency Range	410MHz ~7125MHz	24.25GHz ~ 52.6GHz
Duplex Mode	FDD, TDD	TDD
Bandwidth	up to 100MHz	up to 400MHz
Maximum CCs	8	8
Subcarrier spacing	15/30/60kHz	60/120kHz
Slot length	1/0.5/0.25mS	0.25/0.125mS
Waveform	DL:CP-OFDM UL:CP-OFDM or DFT-s-OFDM	DL:CP-OFDM UL:CP-OFDM or DFT-s-OFDM

mmWave Device Block Diagram and Package Trend



Source: 5G mmW Mixed-Signal and RF Front-End Solution, September 2022 (ADI)



mmWave AiP module sketch map

Source: https://ase.aseglobal.com/en/technology/antenna_in_package



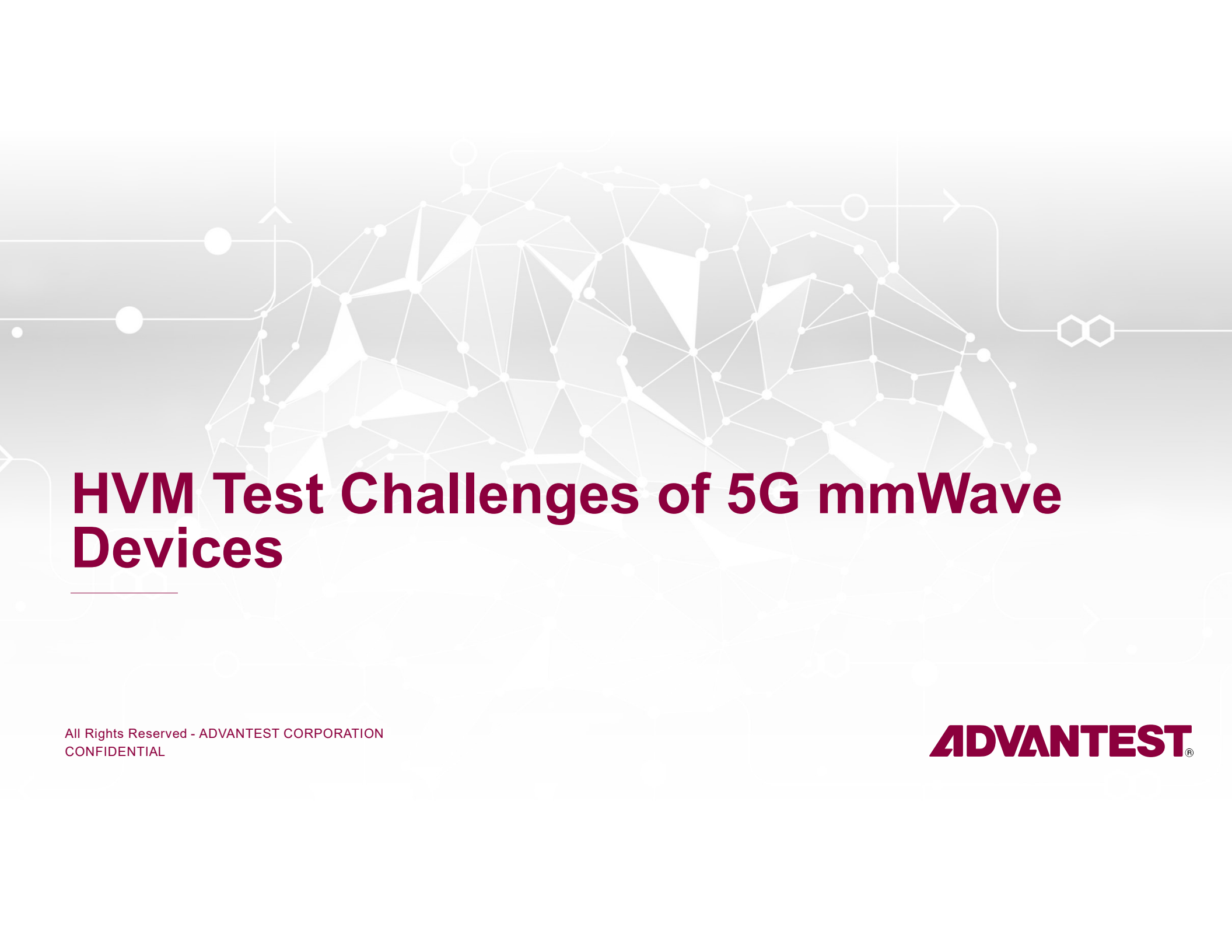
mmWave AiP module bottom view



mmWave AiP module top view

Source: Qualcomm's first 5G mmWave chipset (System Plus Consulting)

mmWave Module AiP
(Antenna in package)

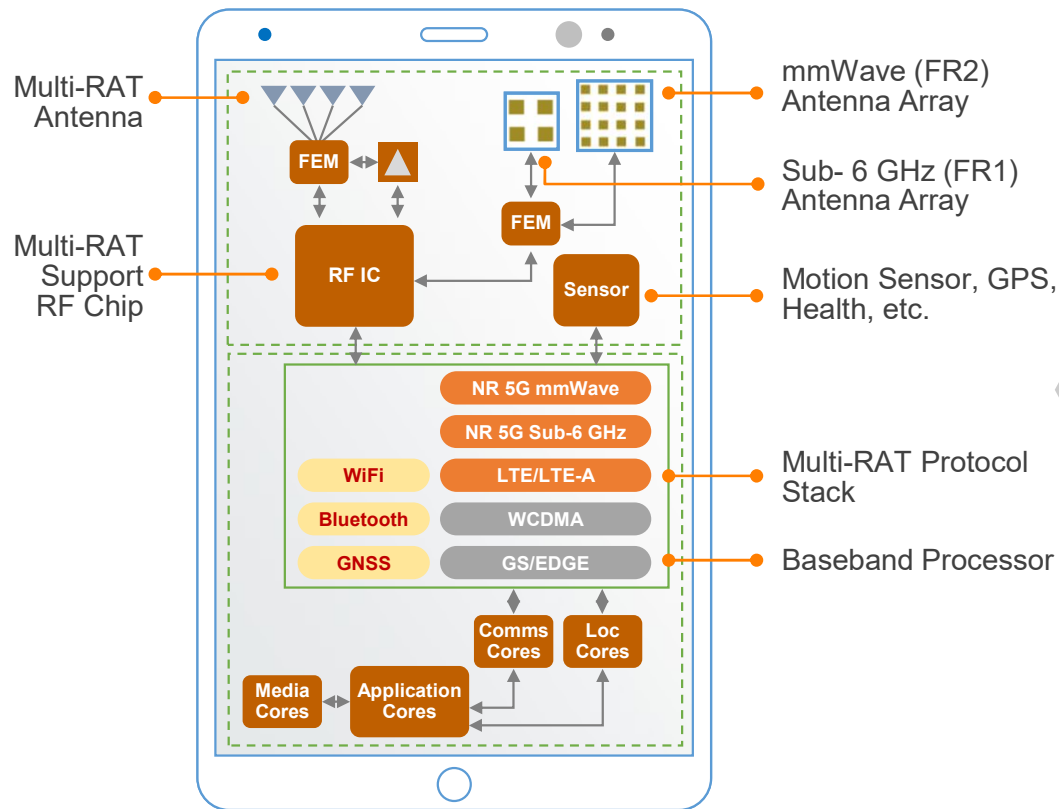


HVM Test Challenges of 5G mmWave Devices

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5G-NR mmWave Device Test Challenges



TEST CHALLENGES

1. mmWave frequencies and higher bandwidths
2. Various device Arch, flexible RF port count at mmWave
3. OTA test requirements, new test methodologies emerging

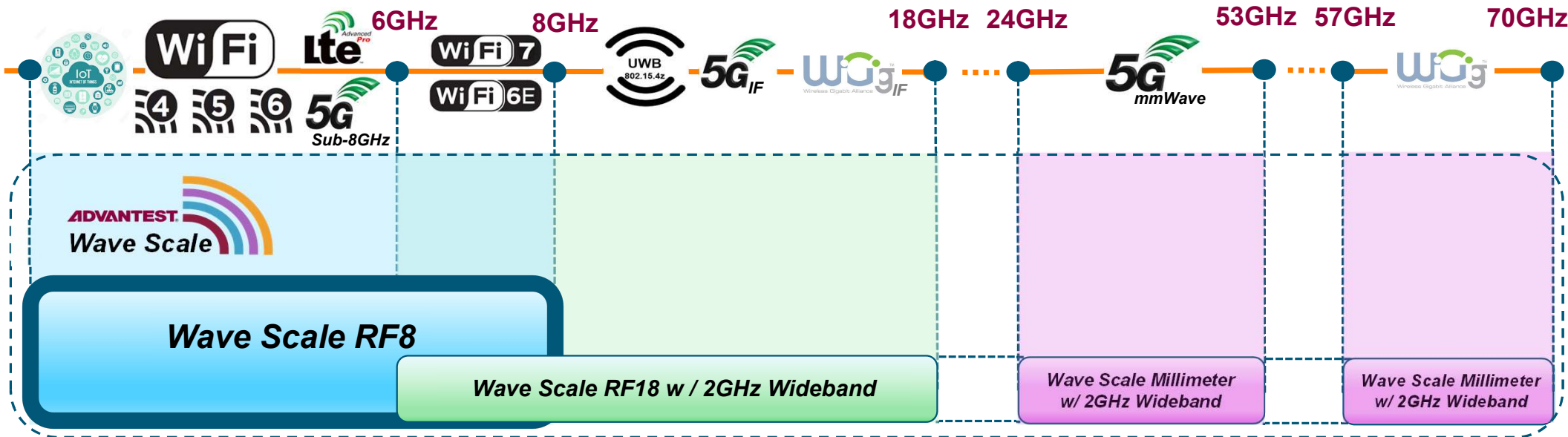


V93000 Test Solutions

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V93000 Wave Scale Wireless Technology



A Single Scalable Platform from Standard RF to mmWave RF

- Industry leading RF architecture to address all current and future RF & wireless technologies
- Same RF solution for all RF SoCs and RF modules (SIP/AIP)
- High multi-site and lowest cost of test with highly integrated density
- Lowest maintenance cost with zero footprint system in production environment
- Future-proof for new emerging technologies with smaller CapEx investment

1. V93000 Solutions – mmWave frequencies and higher bandwidths

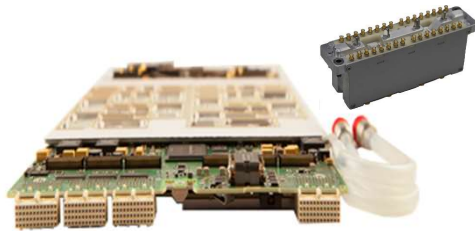
An Integrated Scalable ATE Platform up to mmWave Testing



10 MHz – 8 GHz

4 RF subsystems per card
32 RF ports per card

Modulation BW: 200 MHz
(Up to 350MHz Undersampling)



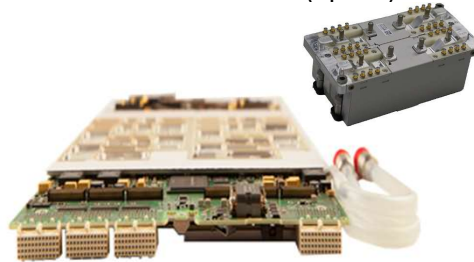
Standard
RF



5.85 GHz – 18 GHz
(UWB/5G-IF/WiGig-IF)

16 IF ports per card
32 IF ports per system

Modulation BW: 200 MHz
2 GHz bandwidth (option)



mmWave
RF

NOW SUPPORTED
V93000 EXA Scale



24 GHz – 53 GHz (5G)
57 GHz – 70 GHz (Wi-Gig)

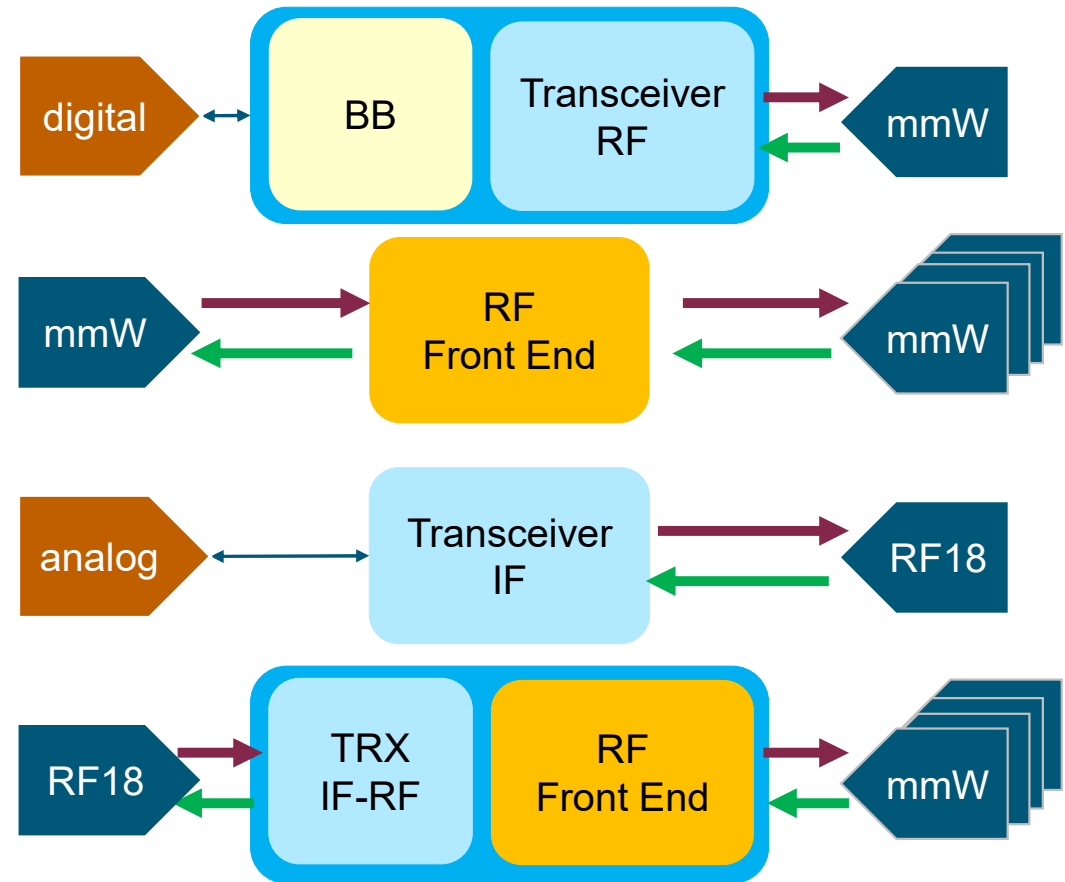
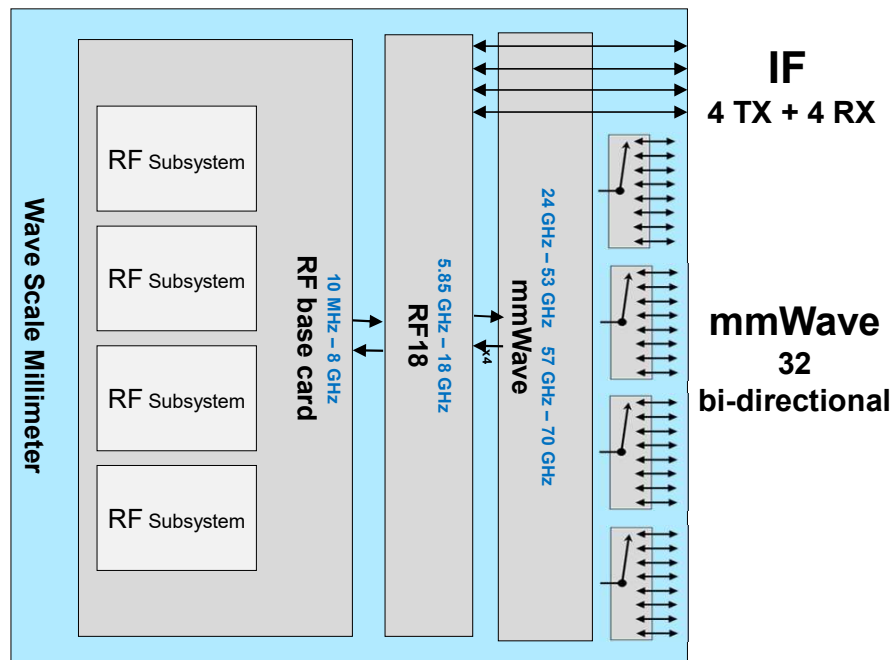
64 bi-directional ports 5G and/or Wi-Gig
16 IF ports (5.85 GHz – 18 GHz)

Modulation BW: 200 MHz
2 GHz bandwidth (option)



Modular, Flexible and Scalable RF to mmWave Solution

2. V93000 Solutions—Various device Arch, flexible RF port count at mmWave

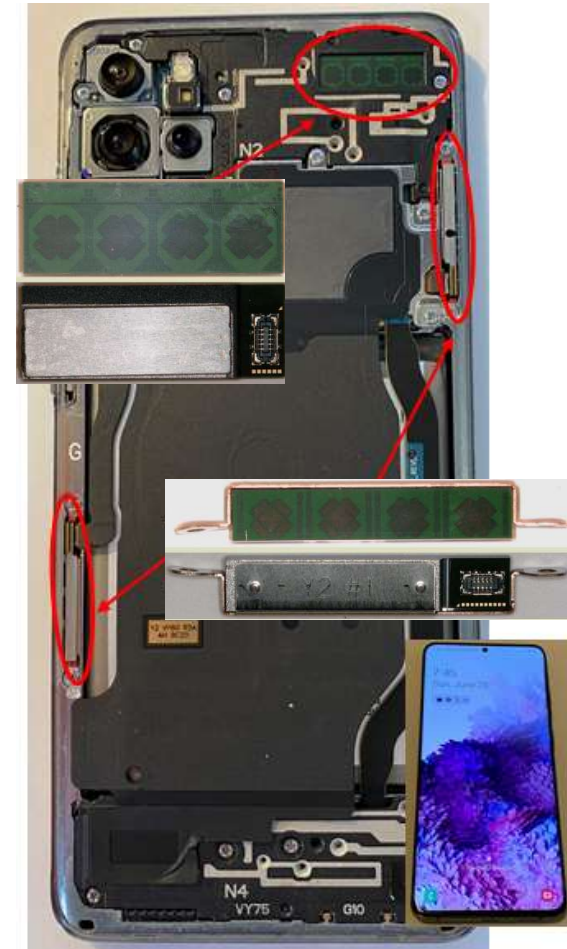
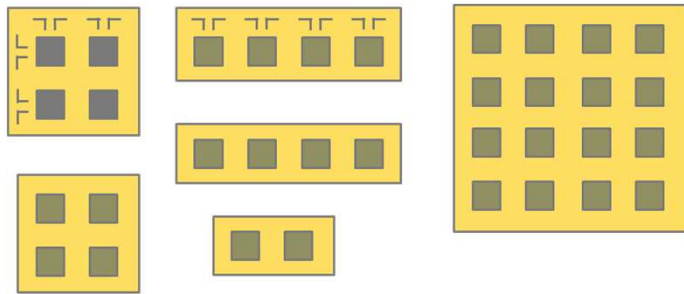


3. V93000 Solutions —OTA test requirements, new test methodologies emerging

Why OTA Testing?

Antenna-in-Package(AiP)

- No contact access for mmWave ports
 - Antennas are built-in.
 - Antenna is the only access for mmWave.
- AiP package substrates can be very complex:
 - Multiple layers.
 - Complex routing and via interconnect.



Source: Samsung

3. V93000 Solutions —OTA test requirements, new test methodologies emerging

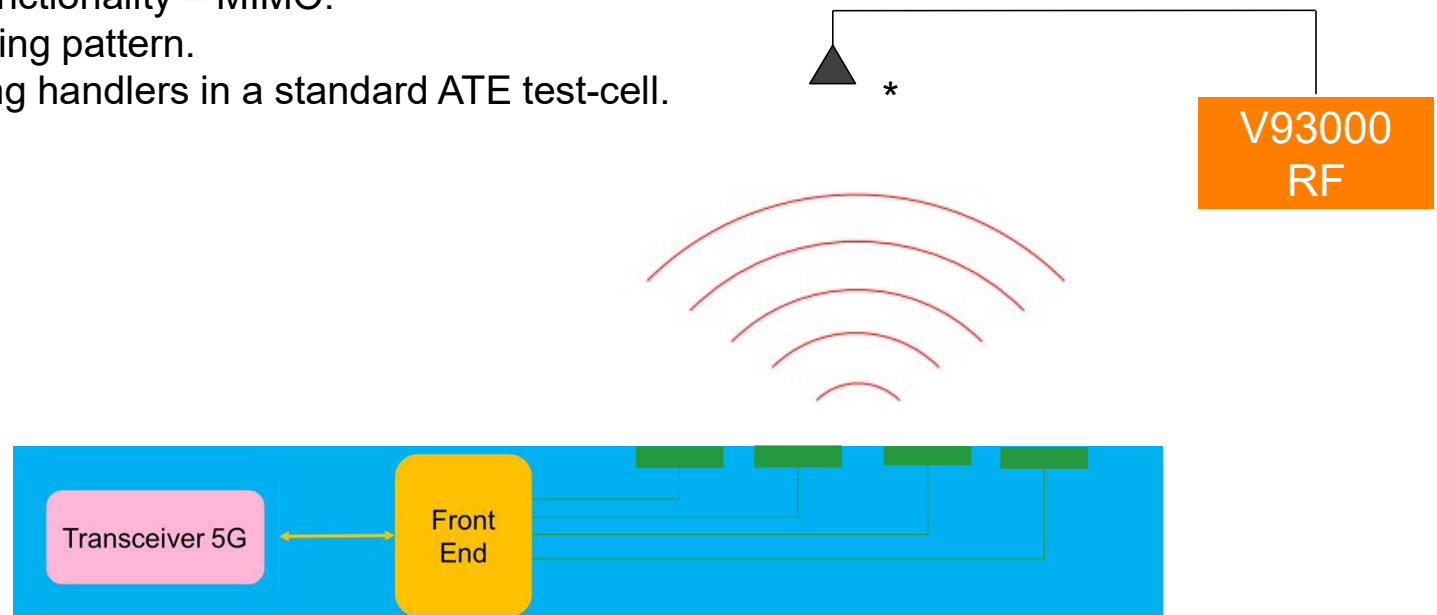
HVM OTA Testing

HVM AiP OTA testing: Testing the silicon using the antenna

- Measures the silicon performance.
- Validate antenna's functionality – MIMO.
- Not measuring radiating pattern.
- Mass production using handlers in a standard ATE test-cell.

Types of OTA :

1. Far-field.
2. Radiating near-field.
3. Reactive near-field.



*Note: Radiating pattern is not correct but act as an illustration of effects of each antenna

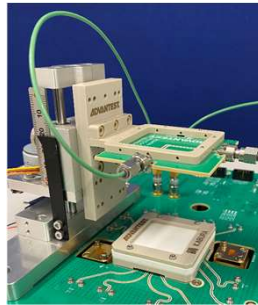
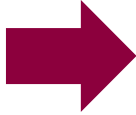
3. V93000 Solutions —OTA test requirements, new test methodologies emerging

The Path for a Successful Parametric OTA



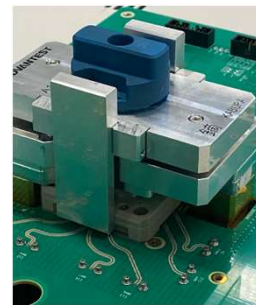
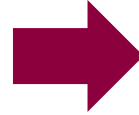
1

Far-Field OTA Setup



2

Near-Filed Linear Stage



3

Manual Engineering Socket



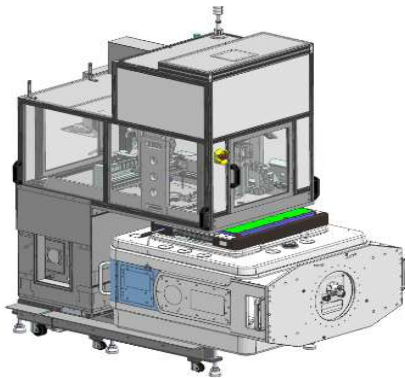
4

Full handler Integration

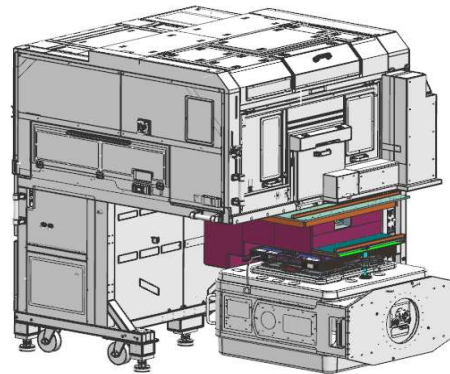
Advantest OTA parametric solution is designed to provide in HVM parametric OTA measurements that can be correlated with far-field/chamber.

3. V93000 Solutions —OTA test requirements, new test methodologies emerging

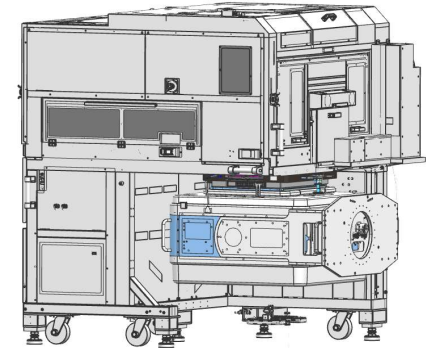
HVM OTA Test Cell



**Far-Field/Near-Field Engineering
OTA Handler (single site)**



**Far-Field/Near-Field Mass production
OTA Handler (up to 8 sites)**



3. V93000 Solutions —OTA test requirements, new test methodologies emerging

OTA Tests

TX	RX
Gain, Gain Steps	Gain, Gain Steps
P1db	IP3
Phase Shift (Beamforming)	Phase Shift (Beamforming)
Flatness	Flatness
EVM	EVM
ACPR	Isolation
Spurs	Noise Figure
Isolation	



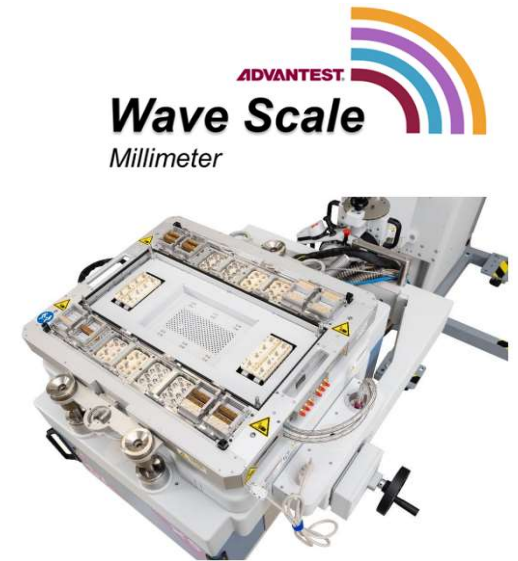
Summary

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Summary

1. 5G NR FR2 (mmWave) brings more instantaneous communications and the bandwidth to move enormous amounts of information in real-time, it has been deployed in some countries, China's three operators have launched relevant tests for mmWave trail run.
2. mmWave devices have several architectures, and most of them use AiP (antenna-in-package). It brings testing challenges in terms of high frequency, wide bandwidth, and OTA (over-the-air).
3. Advantest provides a complete turn-key solution for OTA characterization and volume production of 5G AiP modules. This consists of the V93000 test system with millimeter wave capabilities, DUT board and socket design, OTA measurement antennas, and device handlers.



Full 5G Spectrum from Advantest V93000 Portfolio

Thank you!



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For questions, contact: daniel.sun@advantest.com