



Road to Chiplets: Data & Test

November 9 - 11, 2021



Test Impacts of Chiplets in Packages

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November 2021

Agenda

- 1 Chiplets & End Markets
- 2 Package Integration Technologies & Landscapes
- 3 Package Applications & Aspects
- 4 Impacts & Opportunities for Test & Data

Amkor Dielet & Chiplet Integration Market Apps



Automotive, Health, Industrial

ADAS, SiP/IVI,
MEMS, Sensors,
Performance, Safety



Communications

5G, RF & Mixed Signal,
Handheld Devices,
Mobile/Smartphones,
Tablets, IoT, Satellite



Artificial Intelligence, Networking, Computing

Networking,
Data Center, Infrastructure,
PC/Laptop, Storage



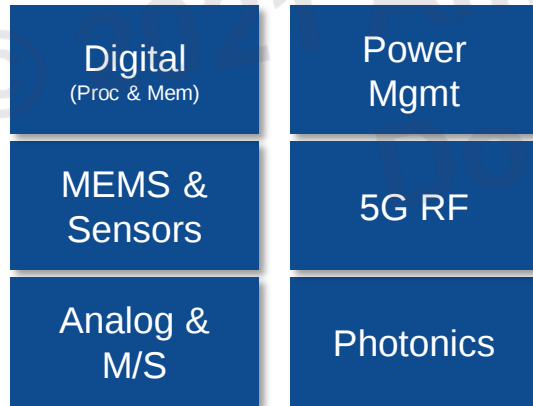
Consumer

Connected Home,
Set-top Box, Televisions,
Visual Imaging, Wearables

Multi-die packages are ubiquitous!

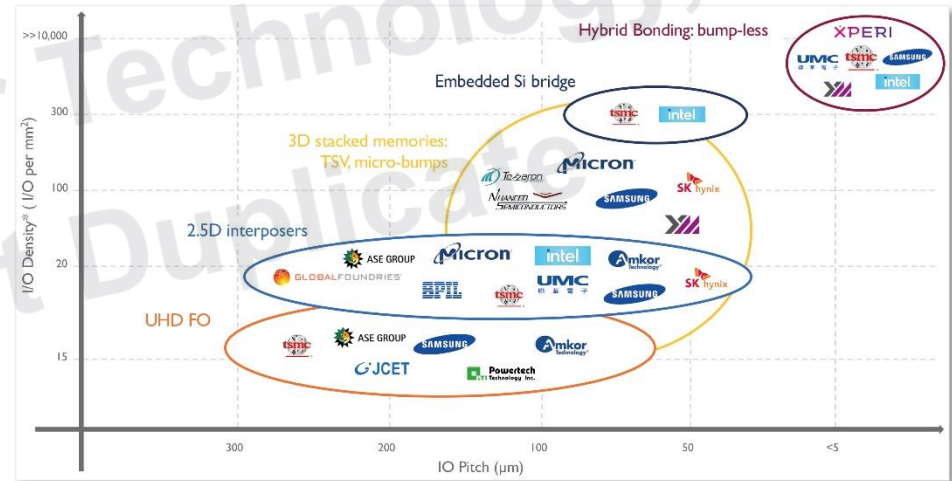
Technology Integration Processes

- ▶ SiP and module
- ▶ 3D & interconnect
- ▶ Wafer level fan-in & fan-out



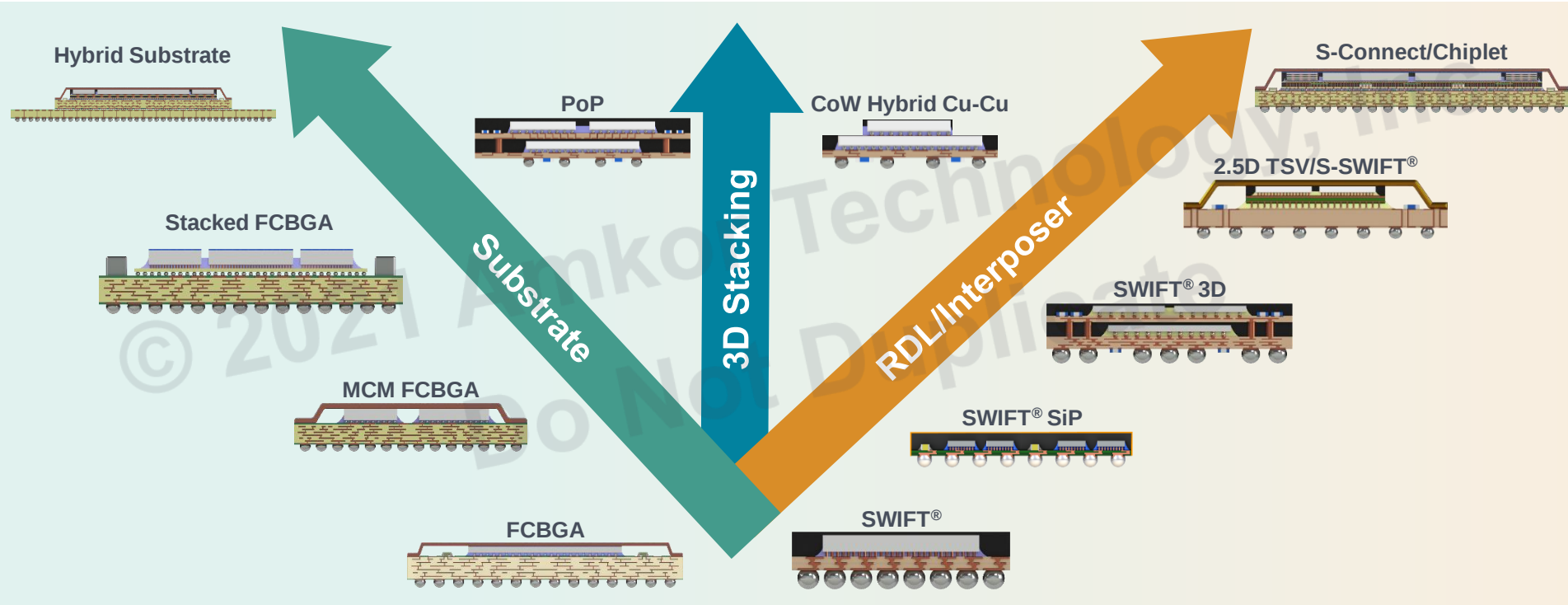
Industry level push in all segments

Mapping of High-End Packaging Players Based on Technology

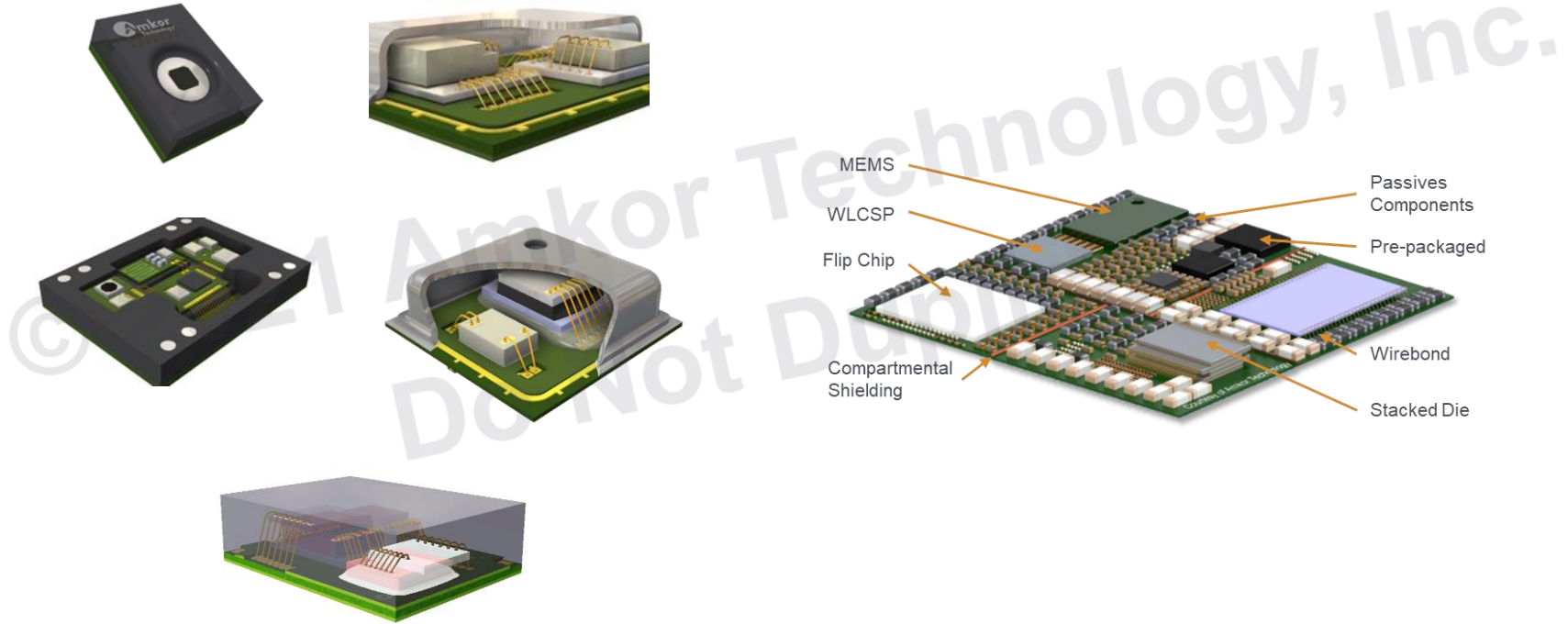


Source: High-end Performance Packaging 3D/2.5D Integration 2020 report, Yole Développement, 2020

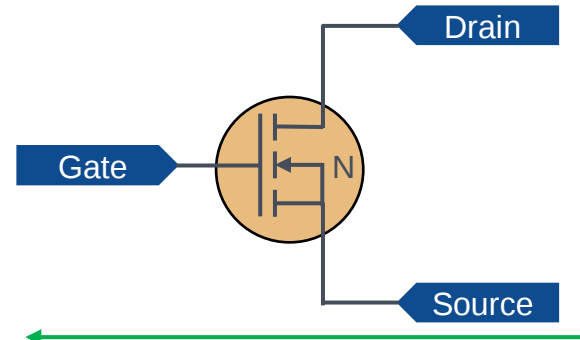
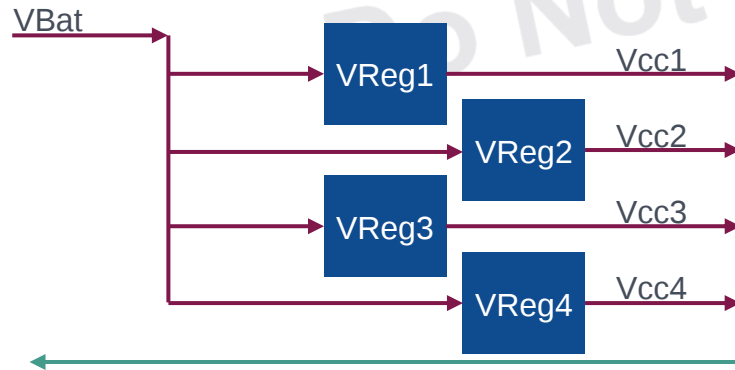
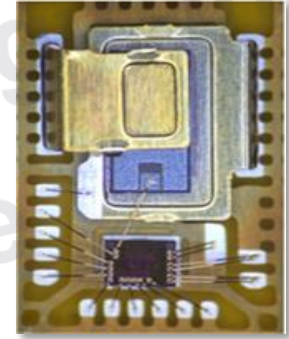
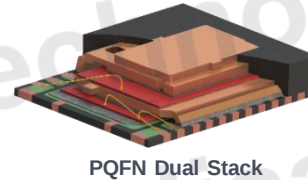
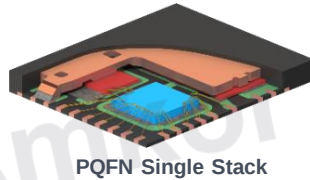
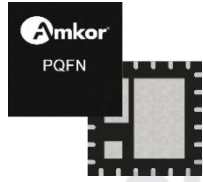
Amkor Multi-Die Package Technologies



Amkor Multi-Die Package Assembly w/Sensors

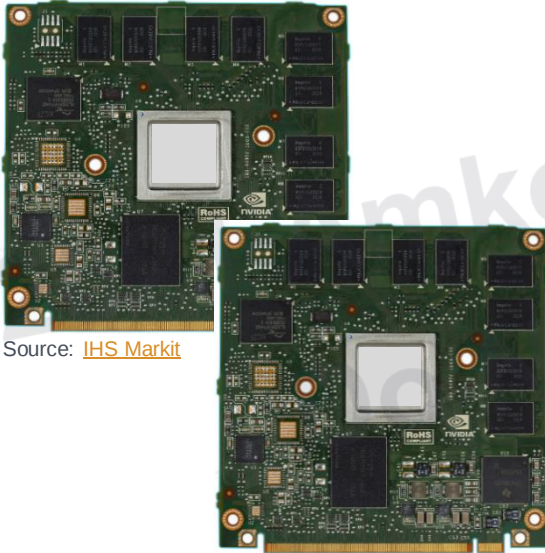


Amkor Multi-Die Package Assembly for Power



Amkor Package Assembly for SiPs

2x Modules



Source: [IHS Markit](#)

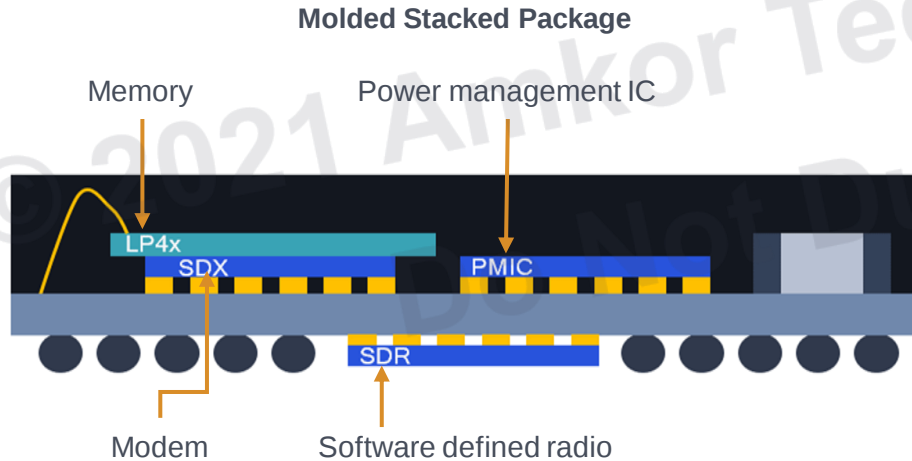
1x SiP



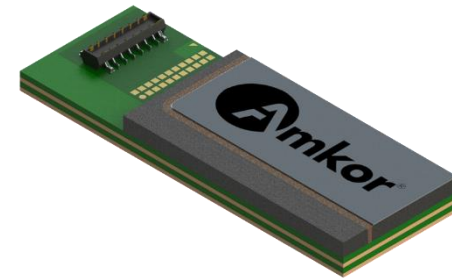
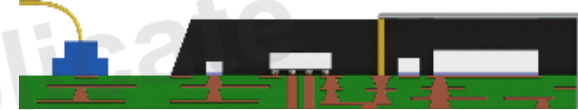
Source: [IHS Markit](#)

75% area reduction

Amkor Package Assembly



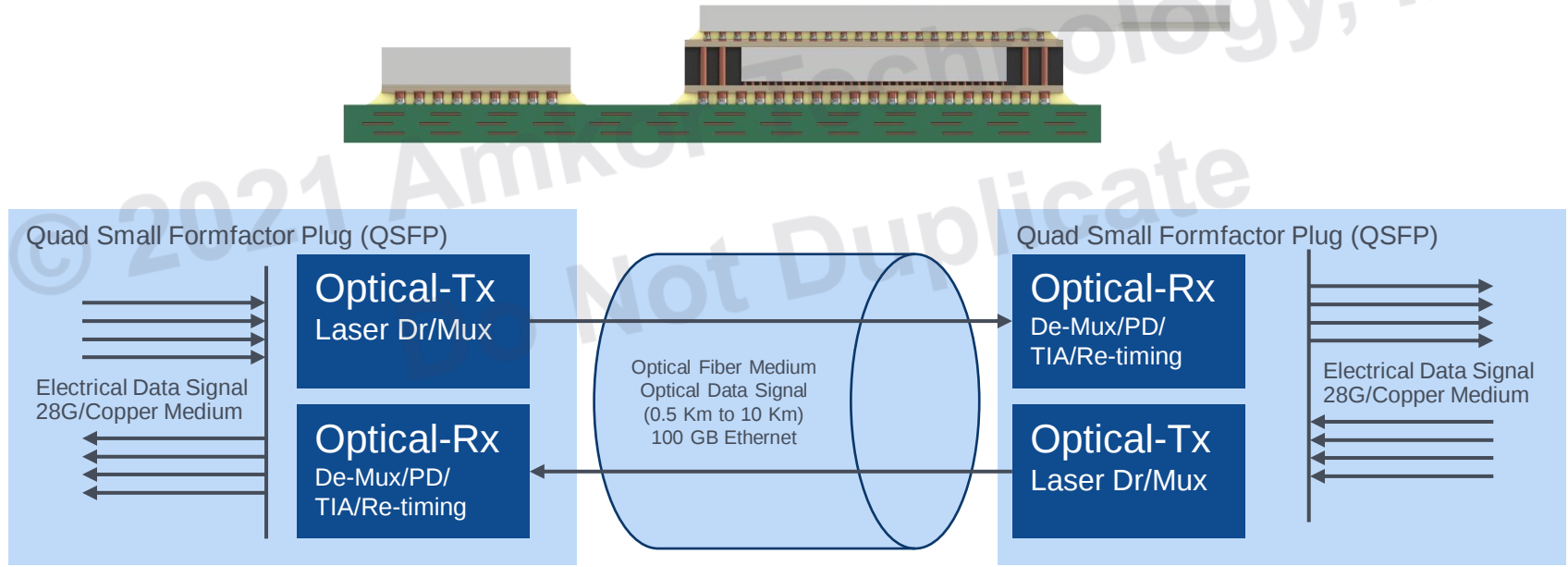
External or
chip antenna



Embedded patch antenna

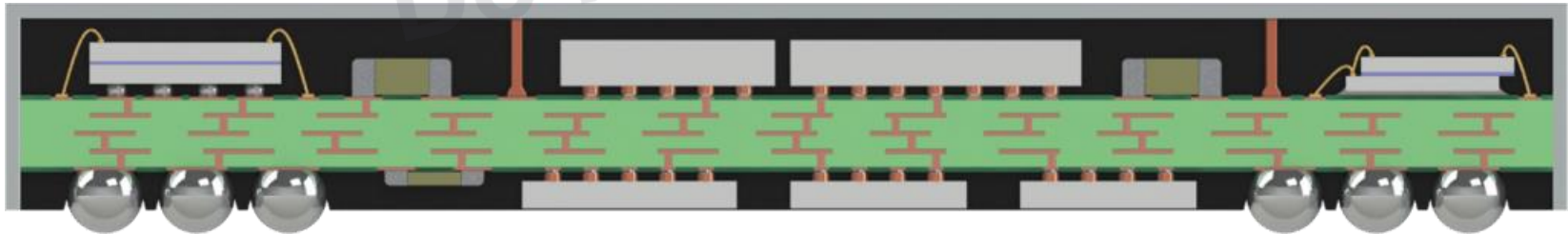
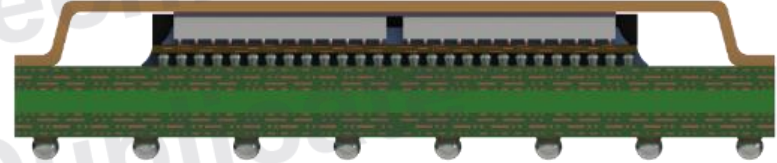
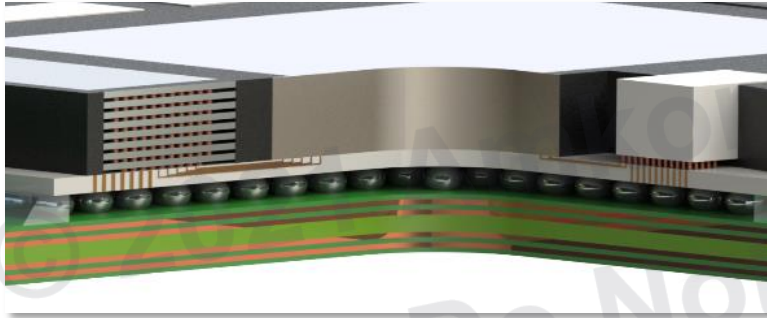
Amkor Package Assembly for Si Photonics

Enabling 100 to >400 Gbps data rates



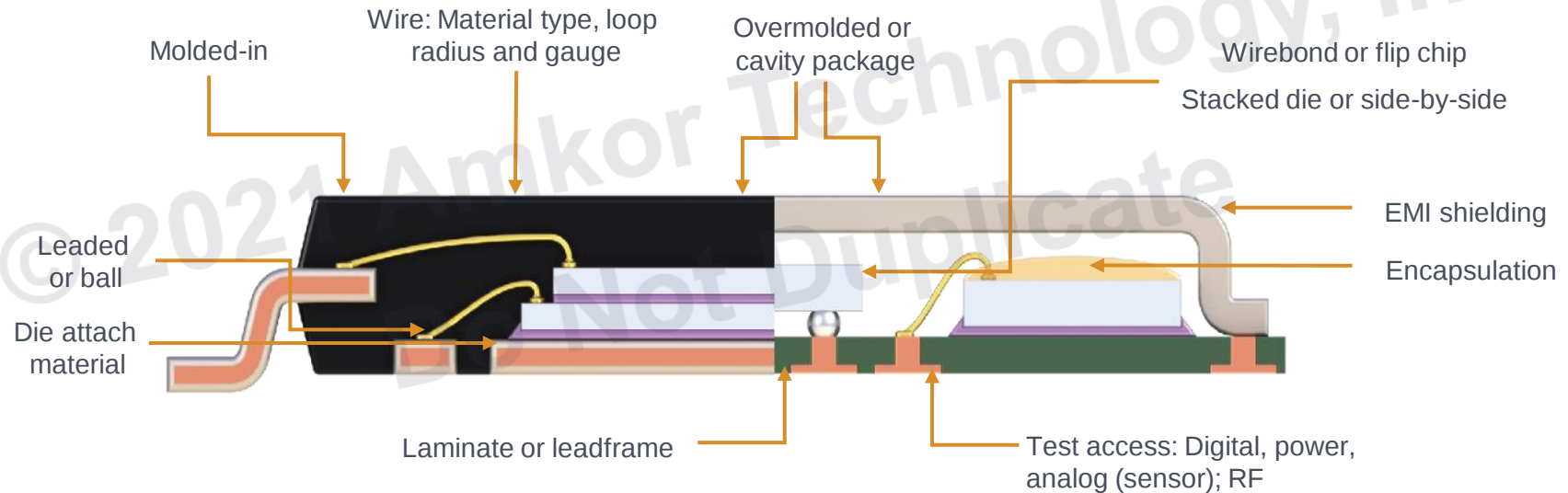
Amkor Package Assembly

High Bandwidth Memory

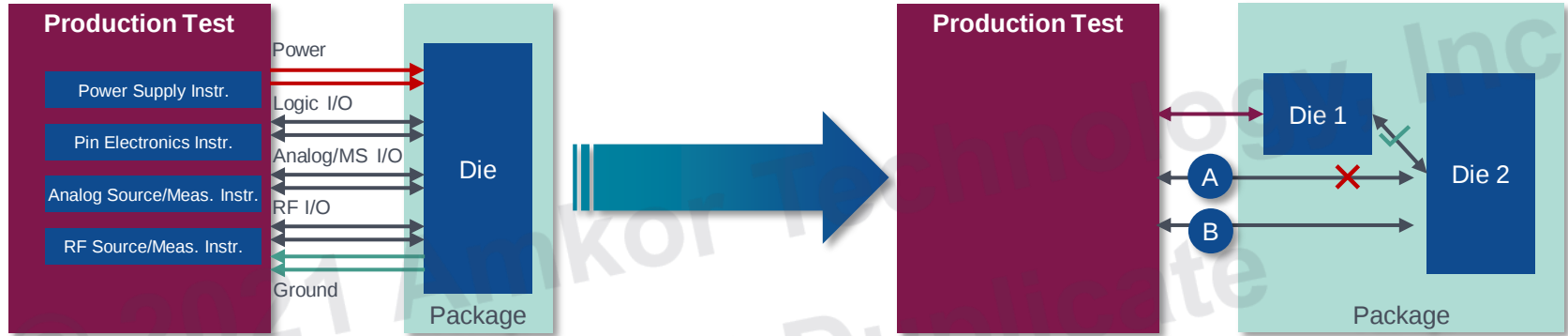


As packaging complexities increase, new matching test methodologies must be architected

Amkor Package Assembly – Aspects & Test



Production Test Challenges

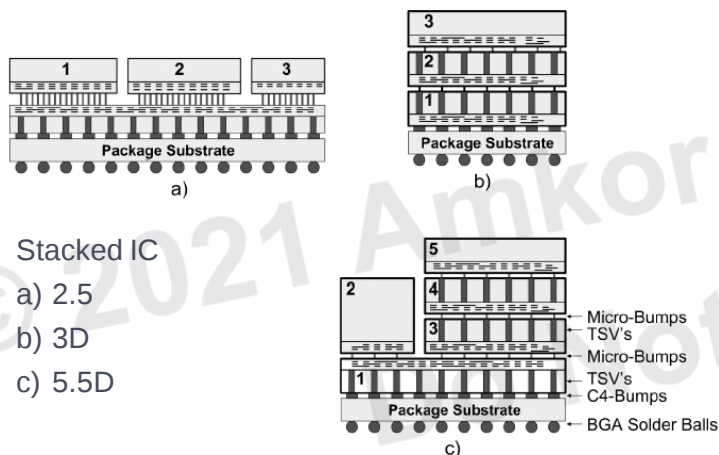


- ▶ No direct access
- ▶ Radiative access
- ▶ Digital system bus protocol

Die 2 interface physically

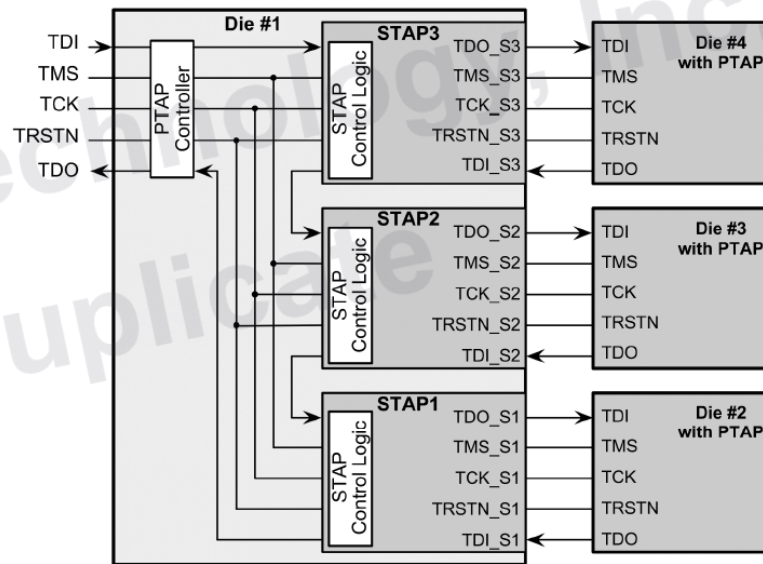
- A Not pinned out
- B Pinned out

High Density Digital Packages – TAPS



3D-IC stacks to a 2.5D-IC silicon interposer

Multiple numbered STAPs connected to a stacked next die

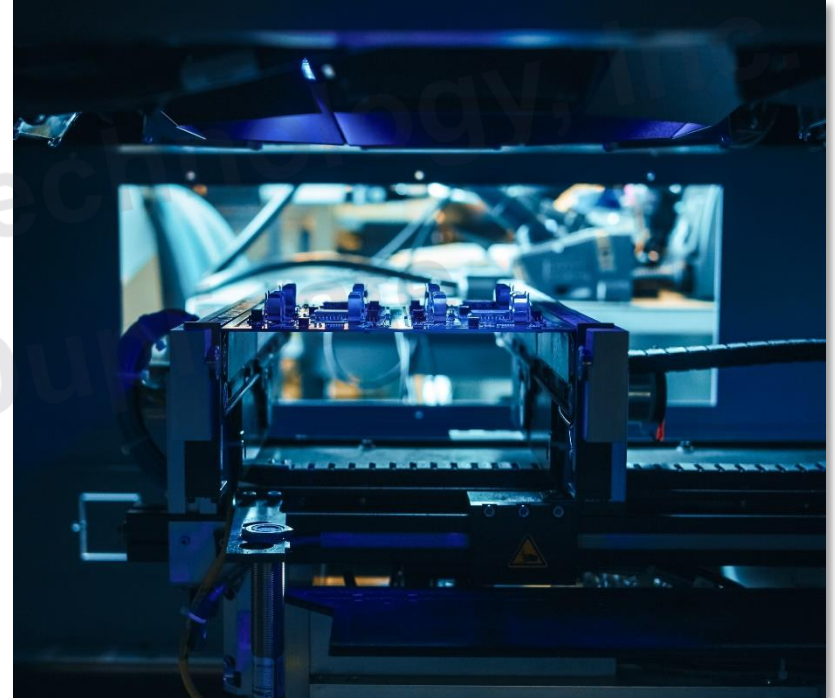


P/S TAP: Primary & secondary test access port

Source: "IEEE Standard for Test Access Architecture for Three-Dimensional Stacked Integrated Circuits," in IEEE Std 1838-2019, vol., no., pp.1-73, 13 March 2020, DOI: 10.1109/IEEESTD.2020.9036129.

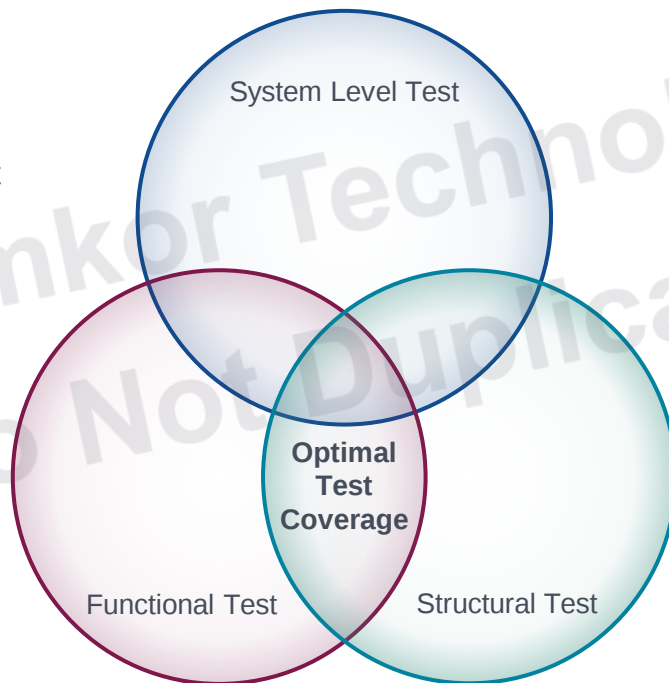
Impact to Production Test Methodology

- ▶ Functional & structural test content
 - ▷ BIST, SBFT, scan – IEEE 1149.x, 1500, 1687
- ▶ Digital test equipment may require protocol aware instrumentation
- ▶ Concurrency – e.g., multi-site & within single DUT



System Level Production Test – Coverage

- ▶ High-speed serial interface, e.g., USB, PCIe, MIPI, UFS, Ethernet
- ▶ Test access port, serial, e.g., IEEE 1149.x, 1500, 1687, SPI/I²C...
- ▶ Contactless interface e.g., Wi-Fi, 5G NR RF, Zigbee...



DFx

- ▶ Mfg: Yield optimization, fault isolation
- ▶ Quality & reliability – burn-in, stress
- ▶ Thermal design
- ▶ Test: High-speed serial, 5G RF, analog, digital content generation

Amkor has the equipment and engineers for these test challenges

System Level Test Equipment

Tester

- ▶ Power, signal, clock, protocol
- ▶ SLT Requirements – eased by FPGA based instrumentation & popularity

Handler

- ▶ Package size range
- ▶ Massively parallel
- ▶ High UPH

Test Hardware

- ▶ Mimic end application
- ▶ Increased complexity
- ▶ Increased test coverage

TechWing



Hontech



Chroma



Advantest

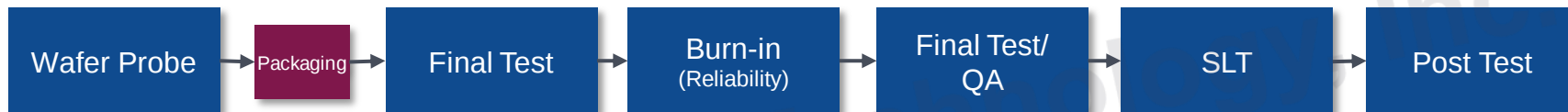


Teradyne

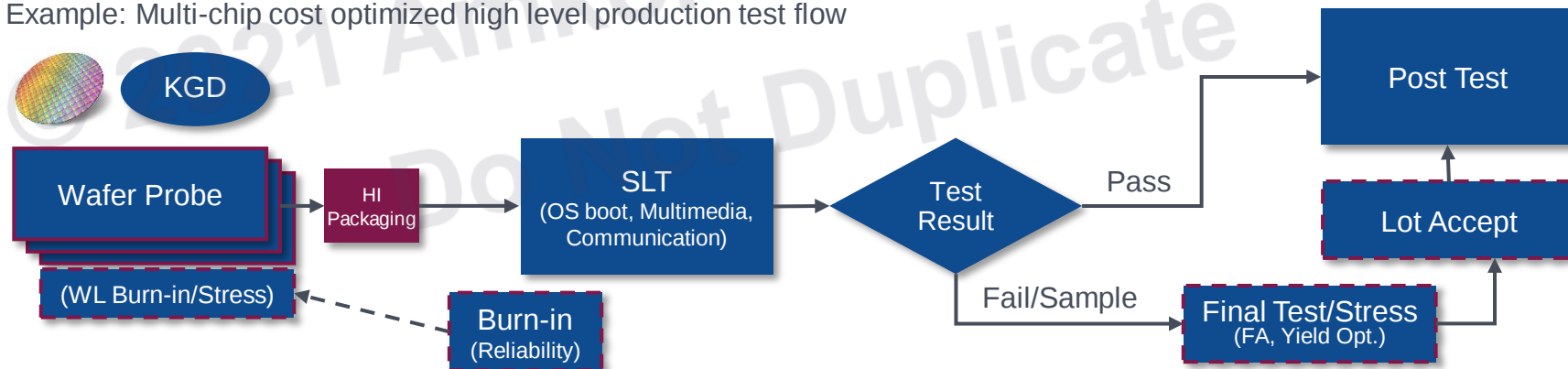


Production Test – Impact to Test Flow

Example: Single chip production test flow



Example: Multi-chip cost optimized high level production test flow

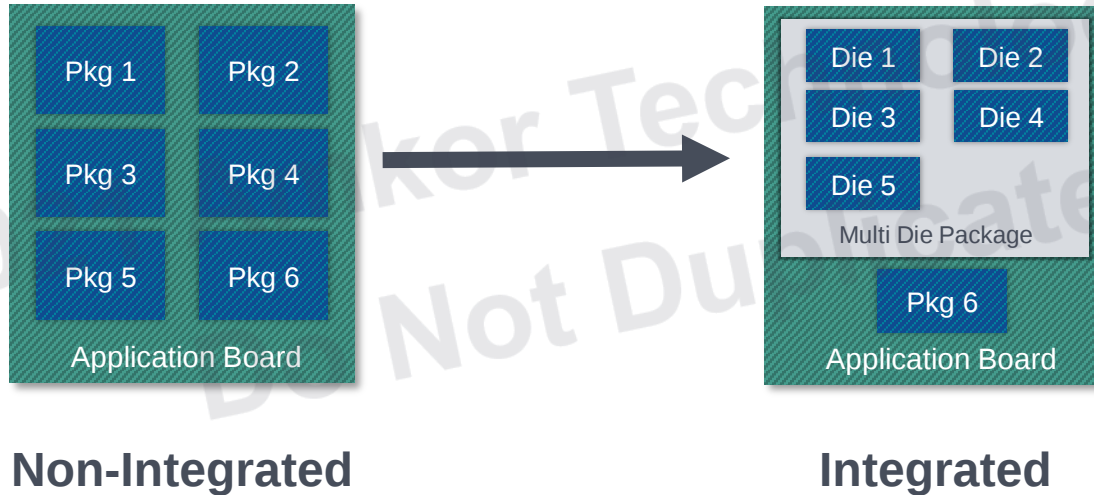


Altered Test Flow

Test Content Re-distributed

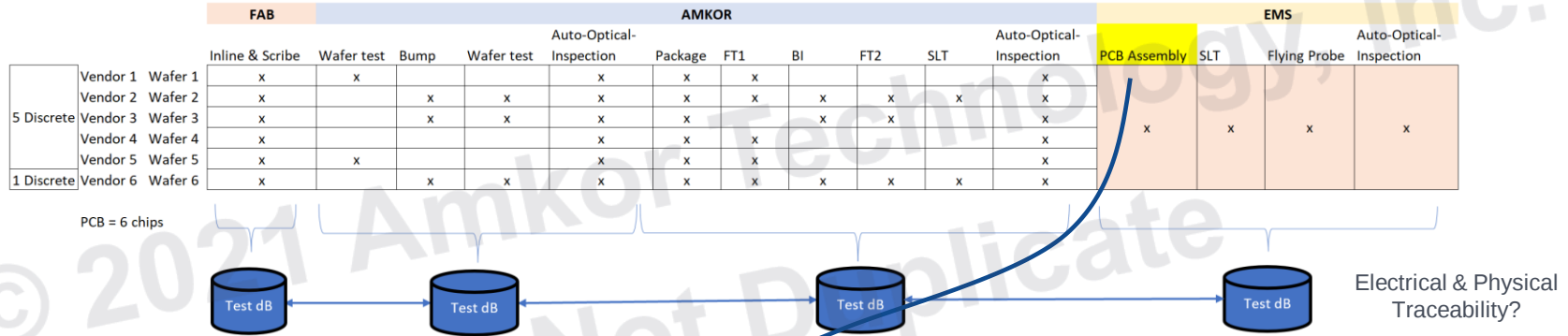
Platform Level Test Quality

Test Data Enabled Advanced Manufacturing

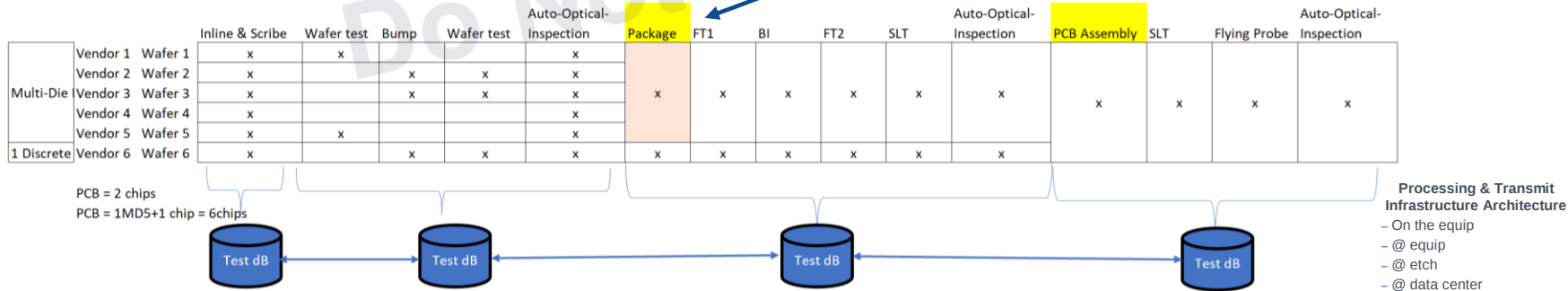


Test Data Enabled Advanced Manufacturing

Non-Integrated



Integrated



Amkor Test Services

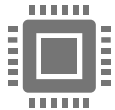


24/7

Operation of fully
networked test floors

**>2300 TESTERS
in 7 LOCATIONS**

2000+ Amkor, 300+ consigned



TESTED ANNUALLY

**>6 Billion units
>6 Million wafers**



Test Development

Software & hardware for probe,
strip, final and system level test



Testing For Commercial, Industrial & Automotive Devices

Discrete, power, mixed-signal,
memory, RF, MEMS
and SiP devices

ACCURATE AND THOROUGH TEST SERVICES

Wafer probe, final test, strip test,
film frame test, system level test,
opens/shorts test, burn-in and
complete end-of-line



Full End-of-Line Processing

Bake, scan, pack, ship
and finished good services

Summary

- ▶ Dielet/Chiplet integration allows for scaling in the future
- ▶ Business continues to have cost and performance challenges
- ▶ Call to action – advanced test methods
- ▶ Amkor is the industry leader in advanced packaging and production test solutions





Thank You

George Harris, george.harris@amkor.com

Learn more: <https://amkor.com/test-services/>

amkor.com



Thank you sponsors!

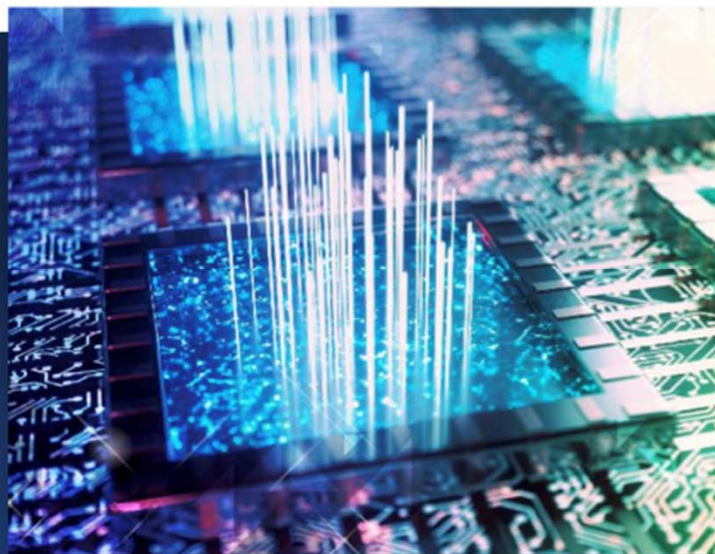
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Engineering Services
Broad Portfolio



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QualityFIRST Culture
Execution
Automation



Service

Design & Test Through Drop Ship
Manufacturing Footprint
Local Sales & Support

Global Companies Rate Advantest THE BEST ATE Company 2021



Advantest receives highest ratings from customers in annual VLSIresearch Customer Satisfaction Survey for 2 consecutive years.

Global customers name Advantest THE BEST supplier of test equipment in 2020 and 2021, with highest ratings in categories of:

**Technical Leadership – Partnership – Trust
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“Year-after-year the company has delivered on its promise of technological excellence and it remains clear that Advantest keeps their customers’ successes central to their strategy. Congratulations on celebrating 33 years of recognition for outstanding customer satisfaction.”

— **Risto Puhakka**, President VLSIresearch

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