Trends in Advanced Packaging and The Impact on Test

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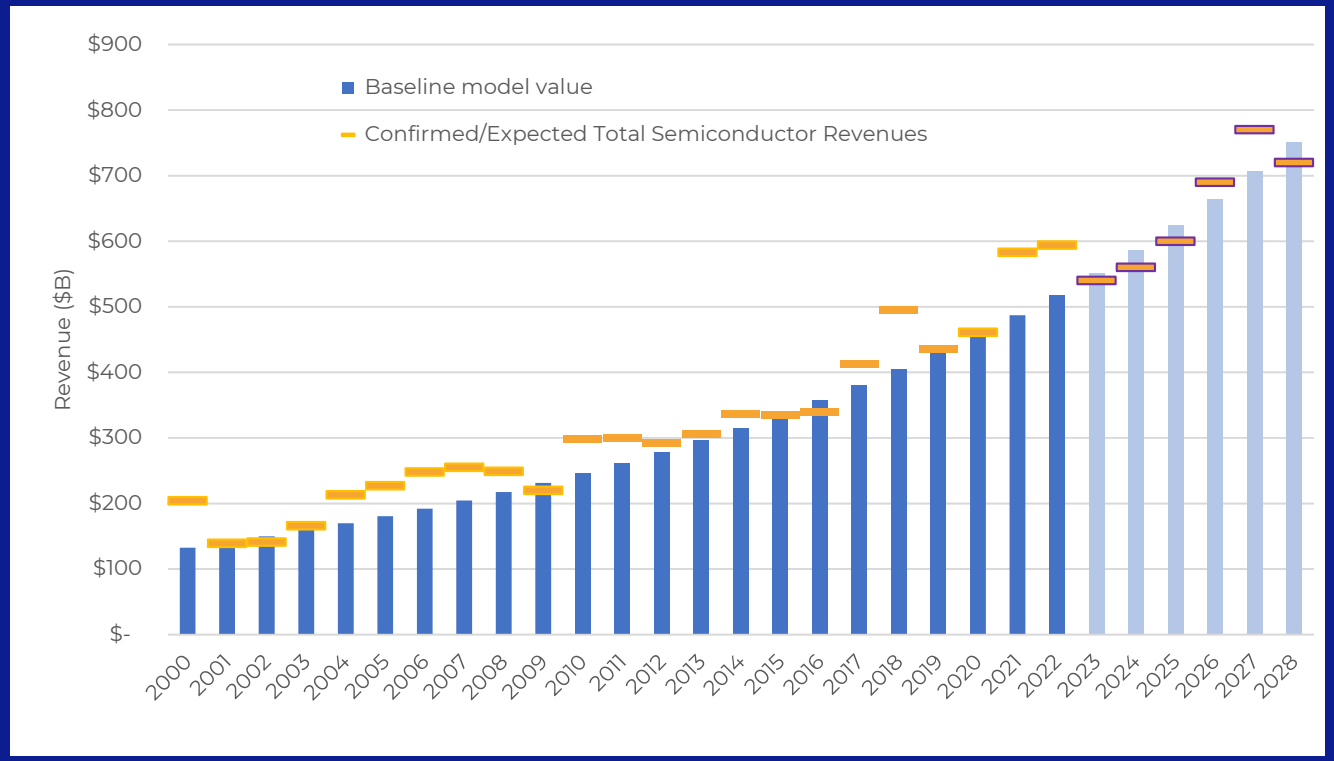
Overview

- Semiconductors
- Test Equipment and Consumables
- Cost of Test
- Advanced Packaging
  - Drivers
  - Technologies
- Impact on Test

Semiconductors in Correction Territory

Back to baseline from 2023 to 2025



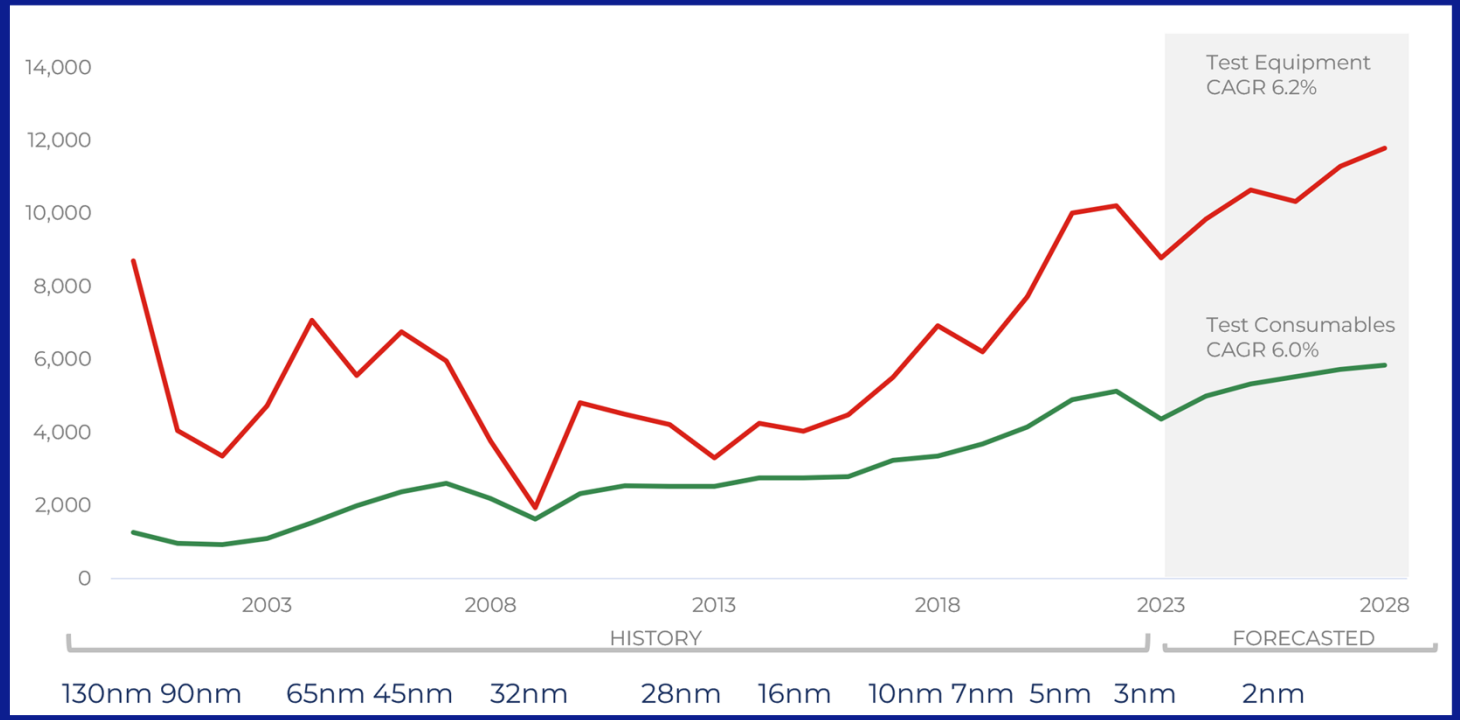
2021 and 2022 were running way ahead of the baseline forecast

2023 was a tough correction year

2024 and 2025 back to growth but tracking baseline forecast

May have to wait a few years longer to break into the Trillion Dollar era!

Test Equipment and Consumables, $M



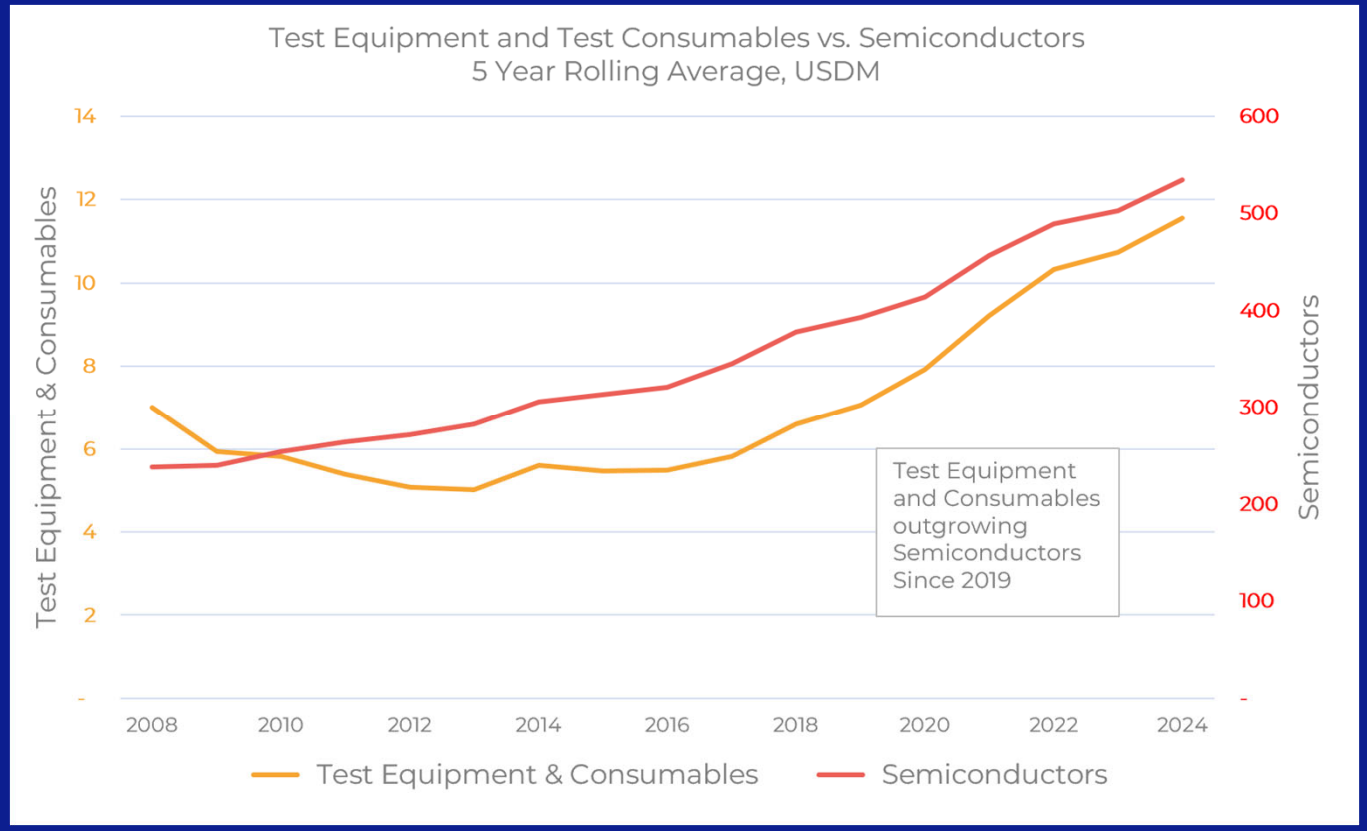
Test Equipment:

- Spend on declining trend until 2016 due to efficiency gains
- Increasing device complexity driving up costs from 2016 onwards

Test Consumables:

- Persistent upward trend
- Downturn in 2008/9 due to external factors
- Downturn in 2023 not fully understood yet

Test Equipment and Consumables Outgrowing Semiconductors



Cost structure of semiconductor manufacturing changing in response to higher fabrication, test and packaging costs

Costs are being passed onto end customer through higher prices

Long-term outlook for semiconductor test is for growth in line with semiconductor demand

HIGH-END PERFORMANCE PACKAGING MARKET TRENDS

Value creation opportunity for high computational applications

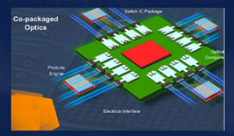
Datacenter Networking

Server – Cloud Computing

Switches – HPC

Internet of things

Cryptocurrency Mining



Co-packaged Optics

High-Performance Computing

Workstations

High-Performing Desktop/Laptop

Big-data AR/VR

AI-powered Content

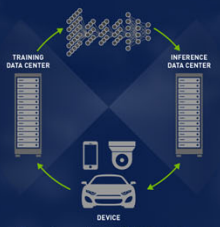
Metaverse

Autonomous Vehicles

AI-enabled Passenger Cars

Robotaxi

Machine Learning

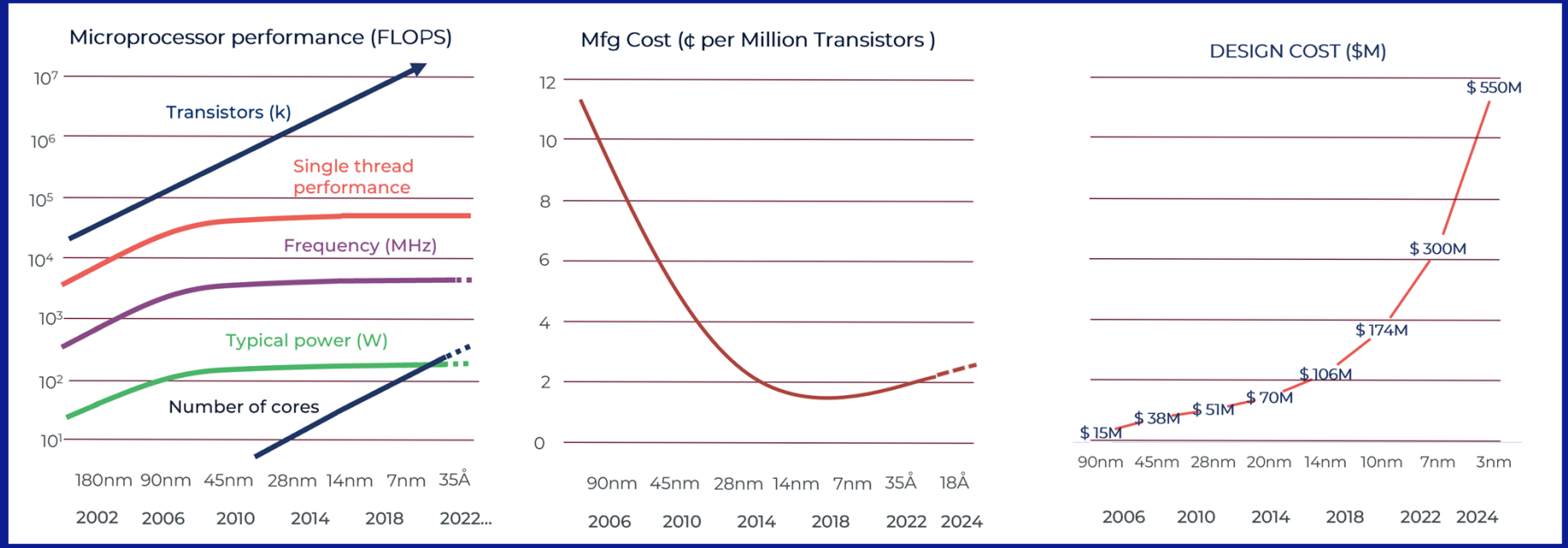


Autonomous Driving

High End Performance Packaging 2023 | Report| www.yolegroup.com | ©2023 26

The Pursuit of Moore's Law

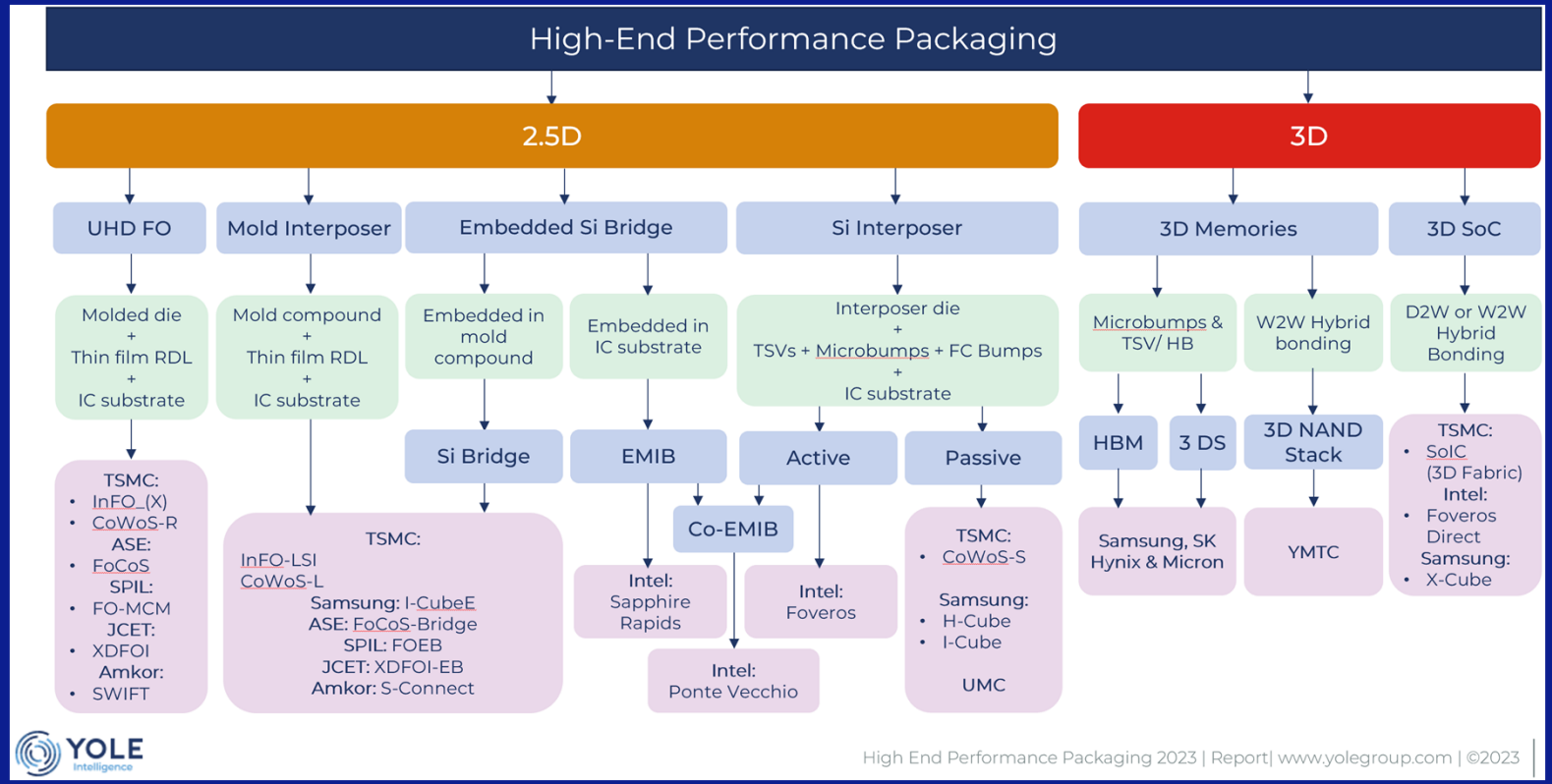
Slowed down by increasing design costs but backed up by Advanced Packaging



Industry solution is to use different advanced packaging technologies to mitigate costs, improve time to market, and enhance system performance

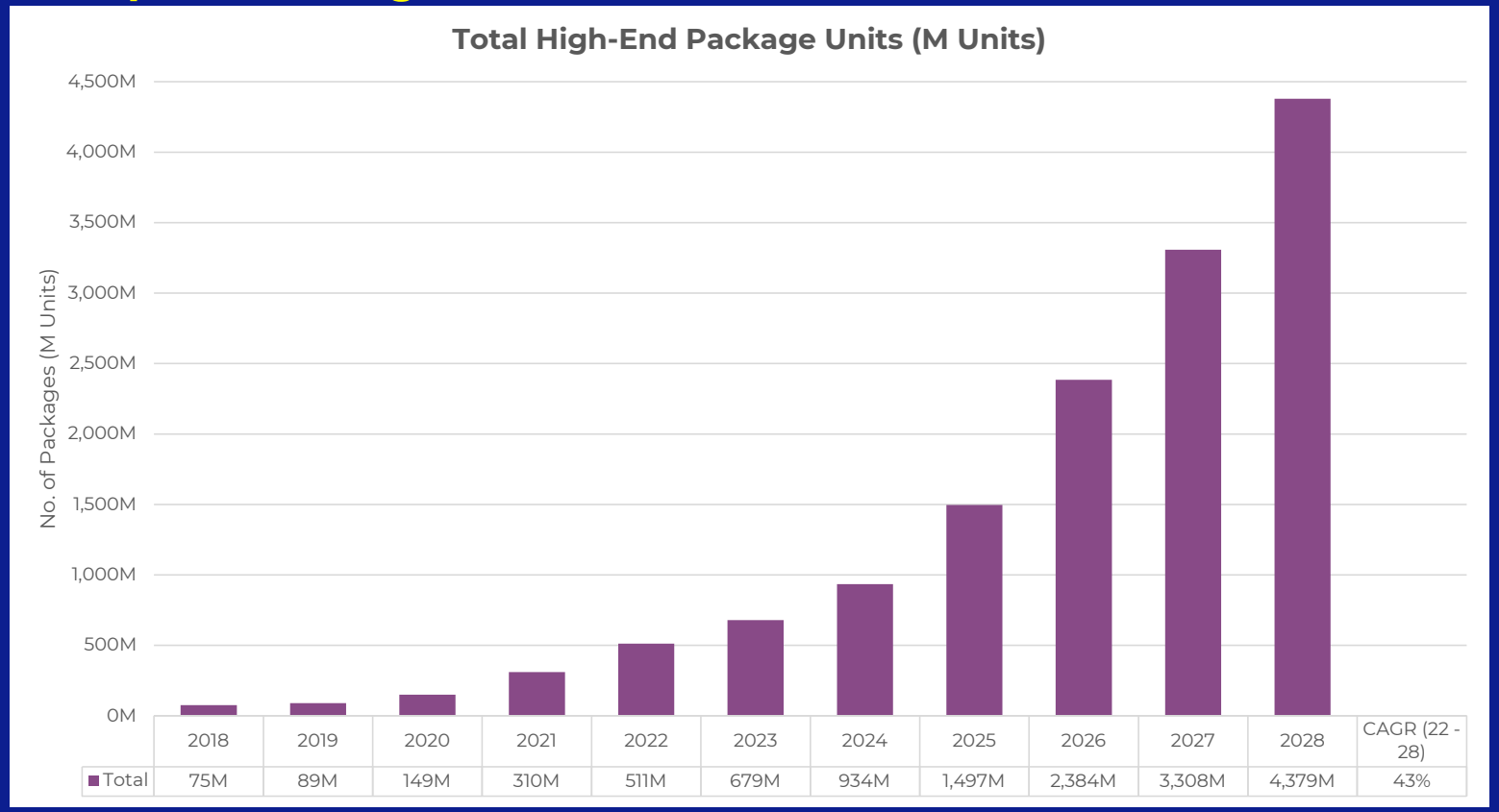
High-End Performance Packaging: All Platforms

A diverse and ever-changing landscape



Total High-End Performance Package Units

Fast paced unit growth

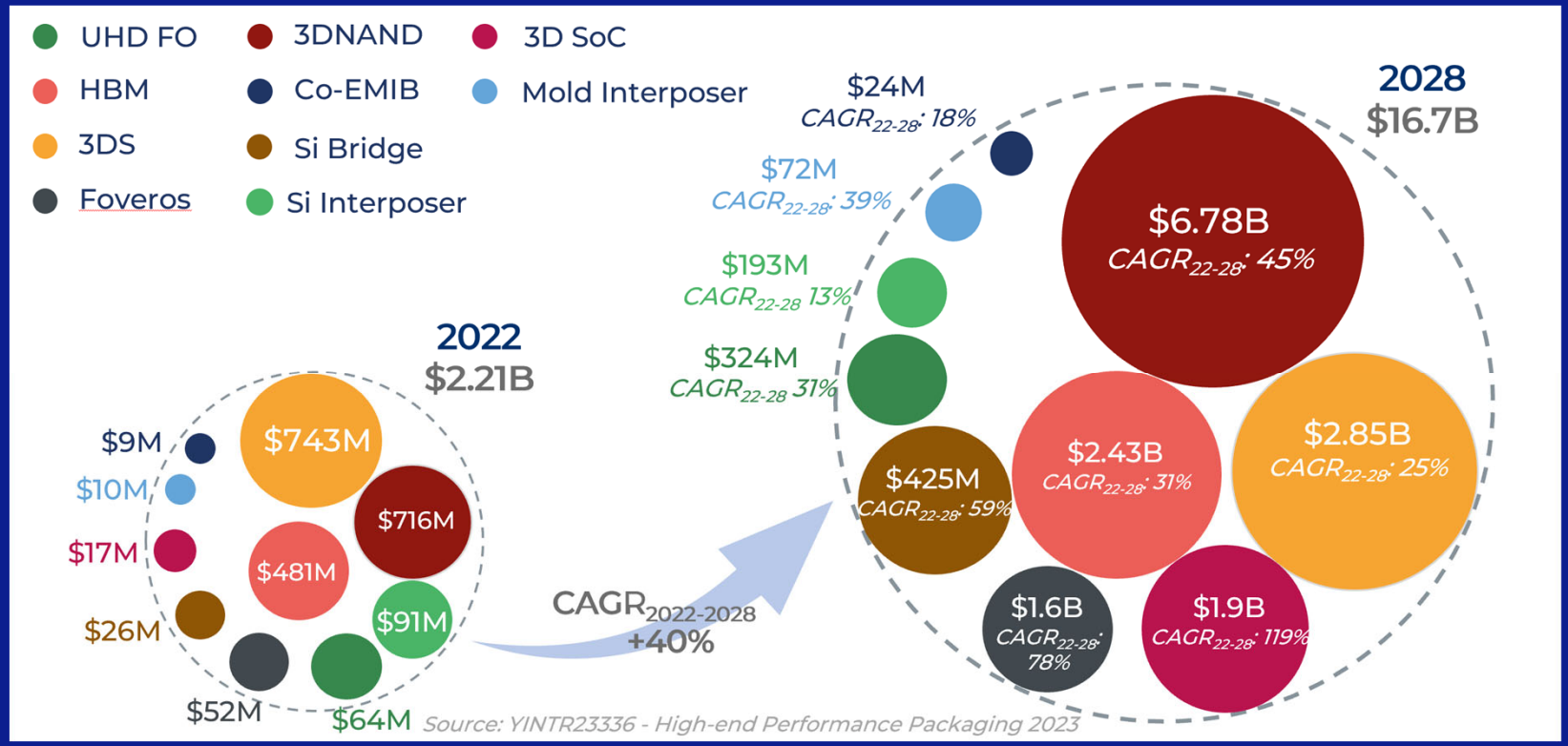


	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	CAGR (22 - 28)
Total	75M	89M	149M	310M	511M	679M	934M	1,497M	2,384M	3,308M	4,379M	43%

The number of units of high-end packaging will rise at a CAGR of 43% from 511M in 2022 to 4,379M by 2028

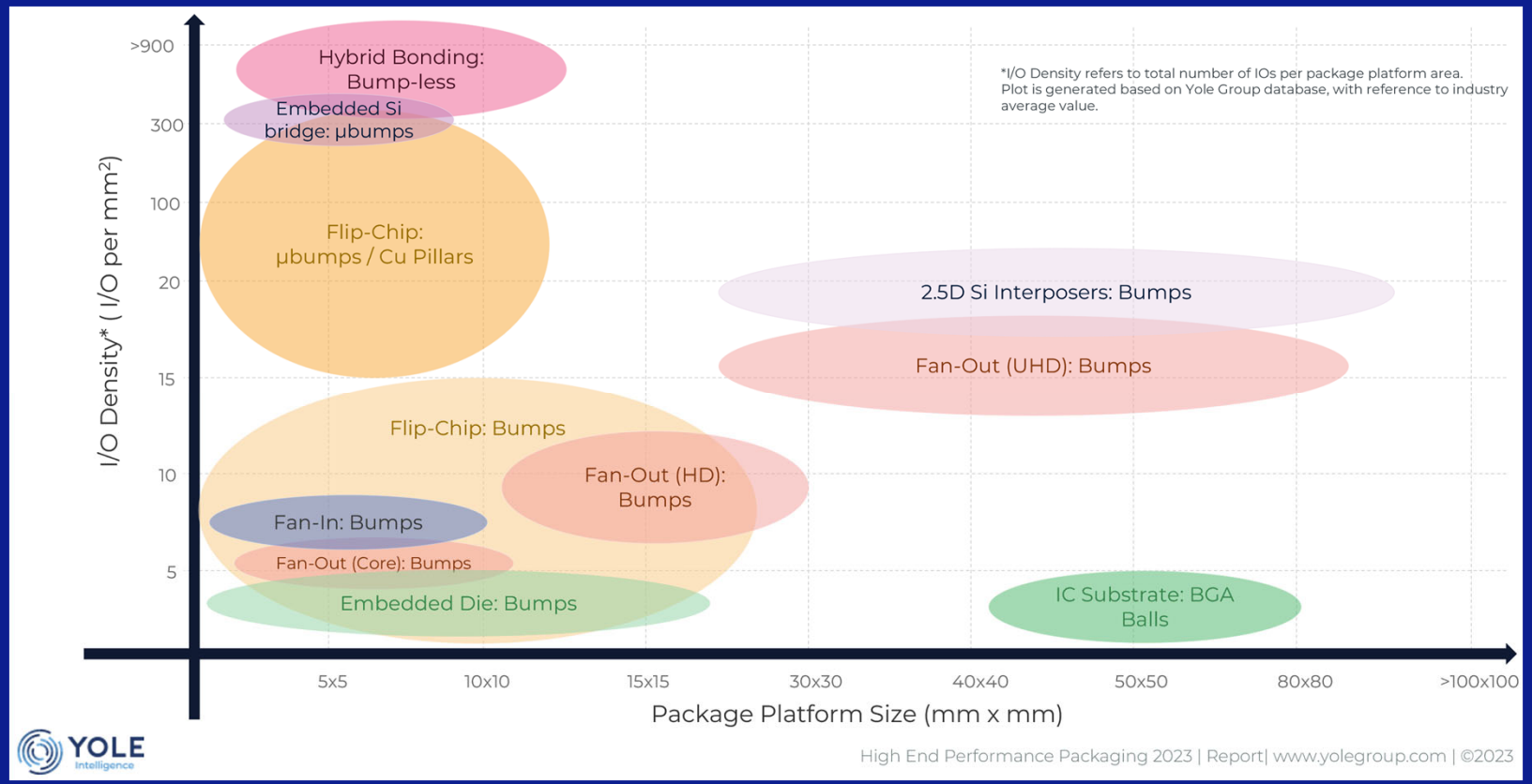
2022 – 2028 High-End Performance Packaging, $Bn

Split by Technology



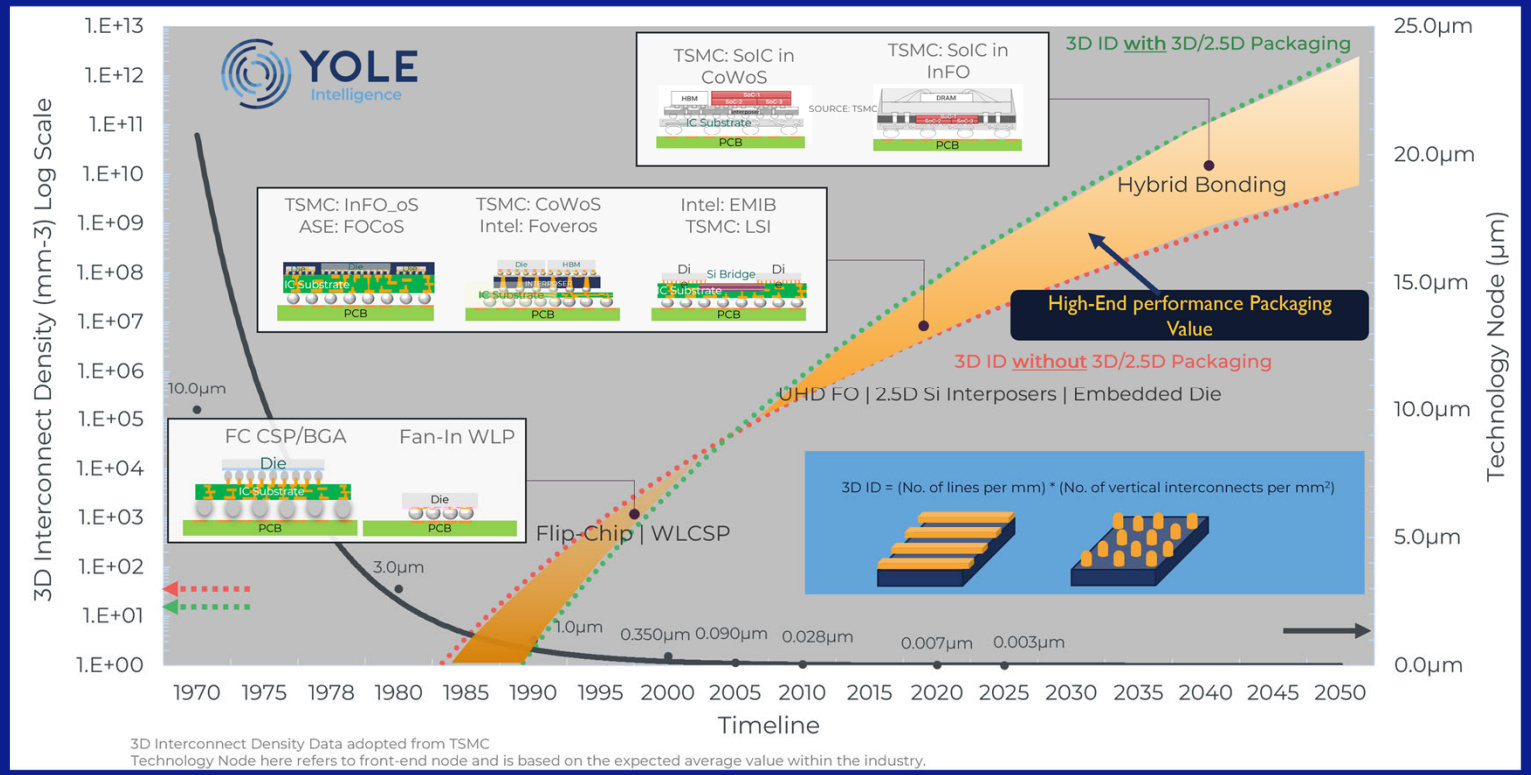
Technology Trends

Roadmap by I/O Density vs. Package Platform Size



Technology Trends

Roadmap by I/O Density and Technology Node



Impact of Advanced Packaging Trends on Test

- Increased device complexity drives up test times
- Higher pin counts = larger packages and/or finer pitches
- New pin materials and designs required
- Getting harder to test at wafer level = more test at package and system level
- Thermal management during test a growing concern
- Advanced packaging evolution not just a problem for high performance computing applications – automotive and photonics are also in the mix

Impact of Advanced Packaging Trends on Test

- Number of high-end performance packages relatively small compared to overall IC units < 2% of total
- Growing to ~ 5% of total ICs by 2028
- Estimated cost of testing high-end performance packages (equipment and consumables) between 10% and 15% of current total test costs

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