INTELLIGENCE TO SHAPE YOUR TOMORROW

Fan-out Panel Level Packaging: Driving Market Momentum for High-End System Integration

IMAPS DPC
6th March 2025

21ST INTERNATIONAL CONFERENCE & EXHIBITION ON
DEVICE PACKAGING
SHERATON GRAND AT WILD HORSE PASS · PHOENIX, AZ
MARCH 3-6, 2025 · WWW.DEVICEPACKAGING.ORG
New Location!

YOLE
Intelligence

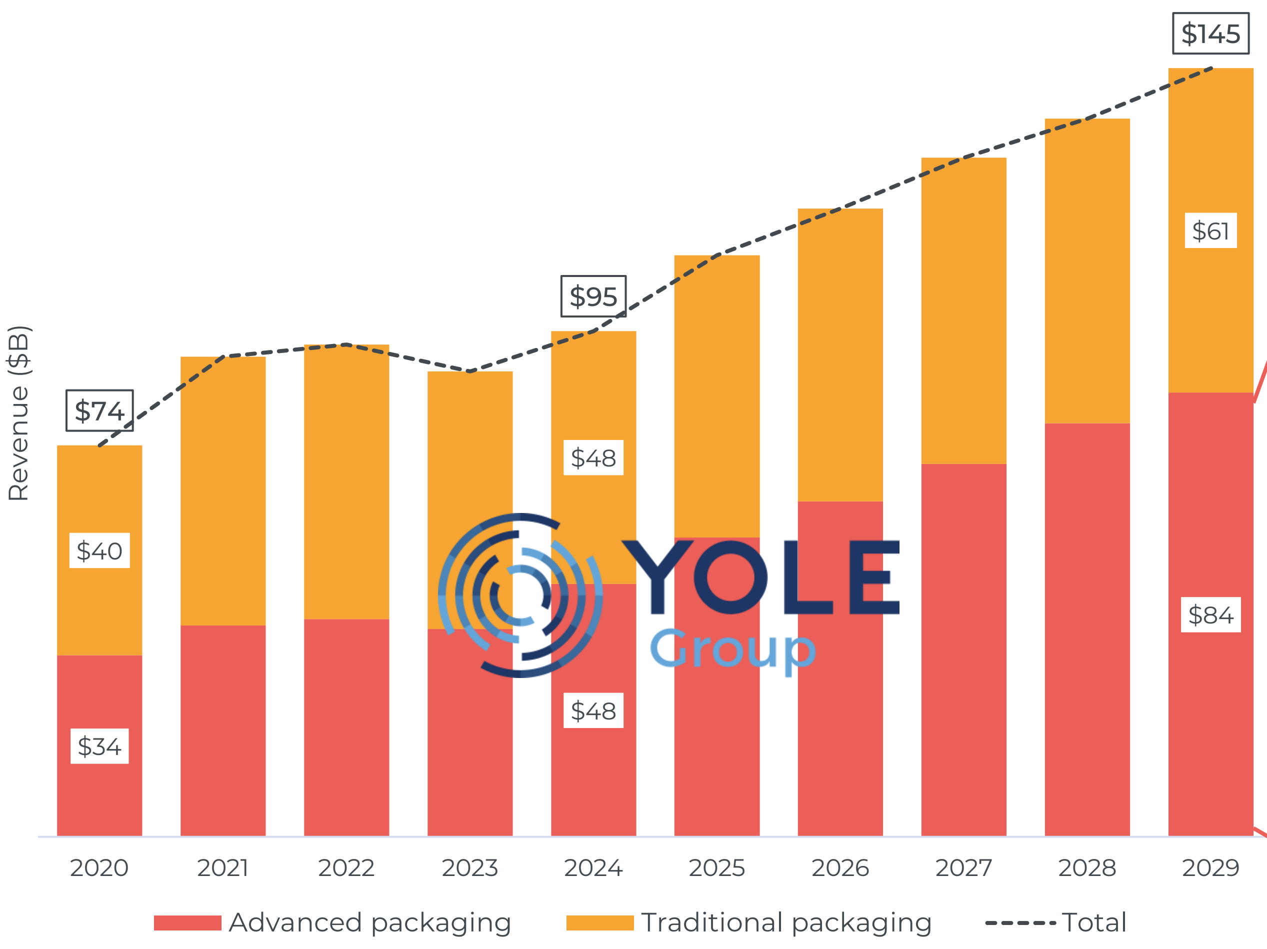
PRESENTATION OUTLINE

- Advanced Packaging Market Drivers
- Panel Level Packaging Definition
- Technology Segmentation and Supply Chain
- Panel Level Packaging Motivations
- FOPLP Market Trends and Forecast
- PLP Adoption Challenges

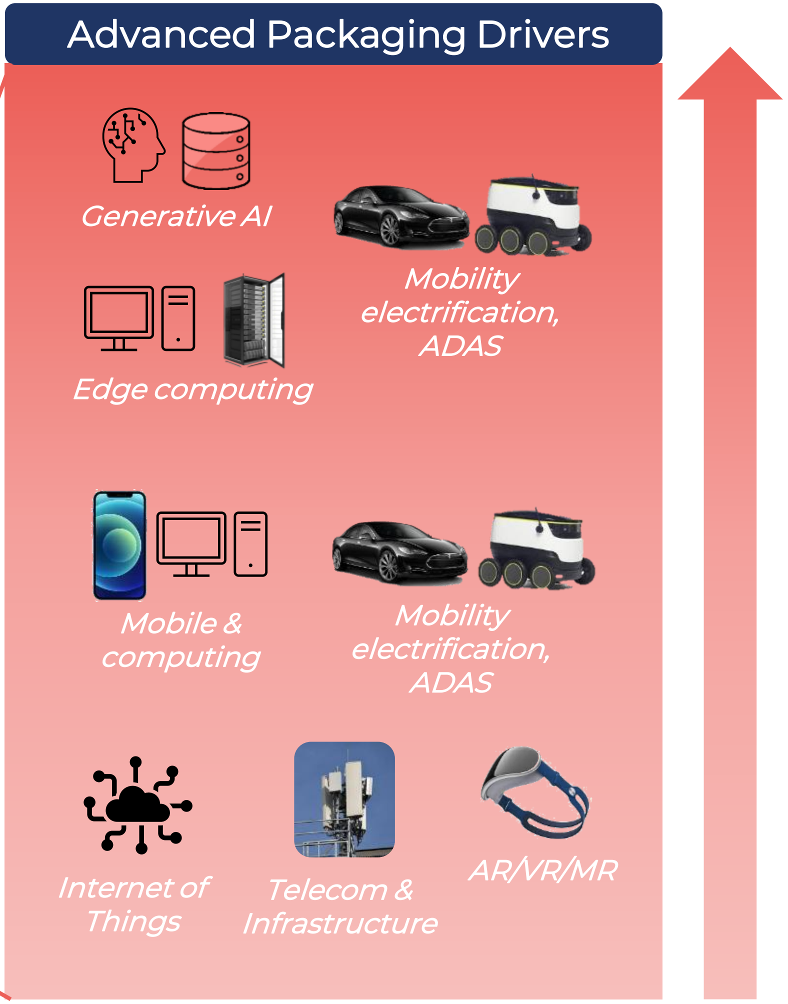
SEMICONDUCTOR PACKAGING MARKET EVOLUTION

Advanced Packaging is increasing its market share driven by AI & HPC

Semiconductor Packaging Revenue Forecast ($B)



Source: Advanced Packaging Market Monitor Q4 2024, Yole Group



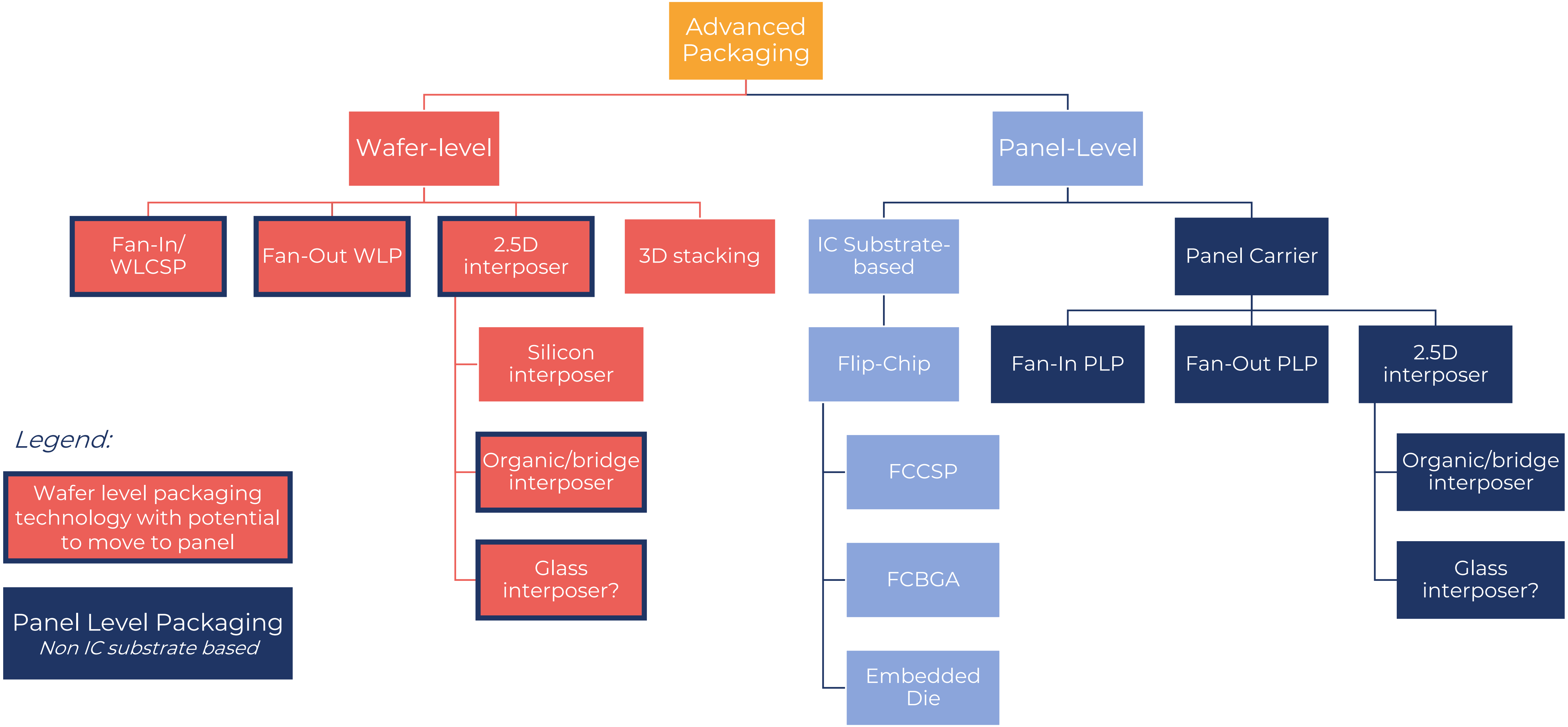
High-end packaging

- Logic
- Memory

- Power
- RF
- Sensing
- Imaging
- Logic
- Memory

Low/mid-end packaging

ADVANCED PACKAGING SEGMENTATION: WAFER VS. PANEL



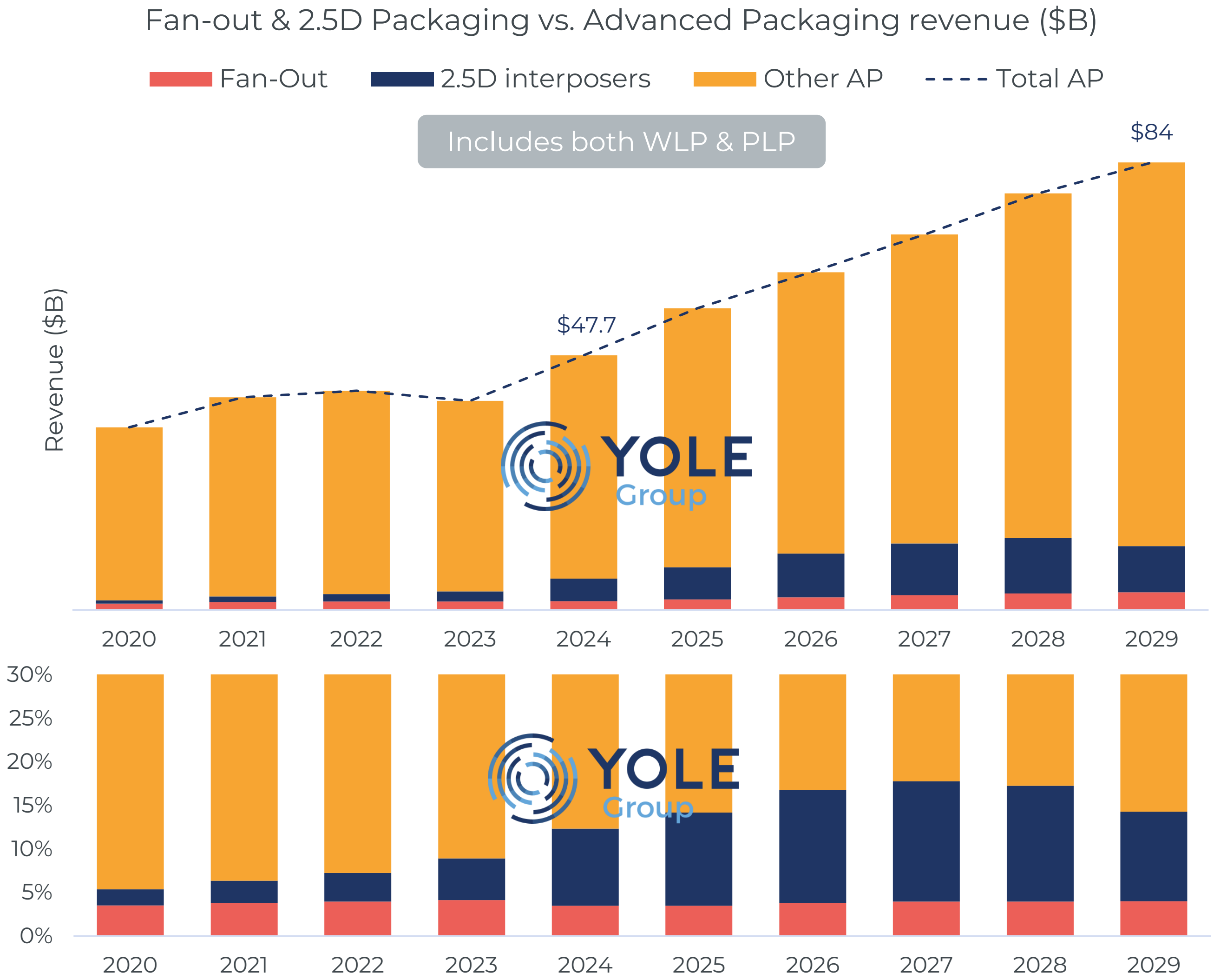
- Advanced Packaging
  - Wafer-level
    - Fan-In/ WLCSP
    - Fan-Out WLP
    - 2.5D interposer
      - Silicon interposer
      - Organic/bridge interposer
      - Glass interposer?
    - 3D stacking
  - Panel-Level
    - IC Substrate-based
      - Flip-Chip
        - FCCSP
        - FCBGA
        - Embedded Die
    - Panel Carrier
      - Fan-In PLP
      - Fan-Out PLP
      - 2.5D interposer
        - Organic/bridge interposer
        - Glass interposer?

Legend:

- Wafer level packaging technology with potential to move to panel
- Panel Level Packaging *Non IC substrate based*

ADDRESSABLE MARKET OF FAN-OUT PANEL LEVEL PACKAGING

Fan-out and 2.5D interposers can move from wafer to panel platforms

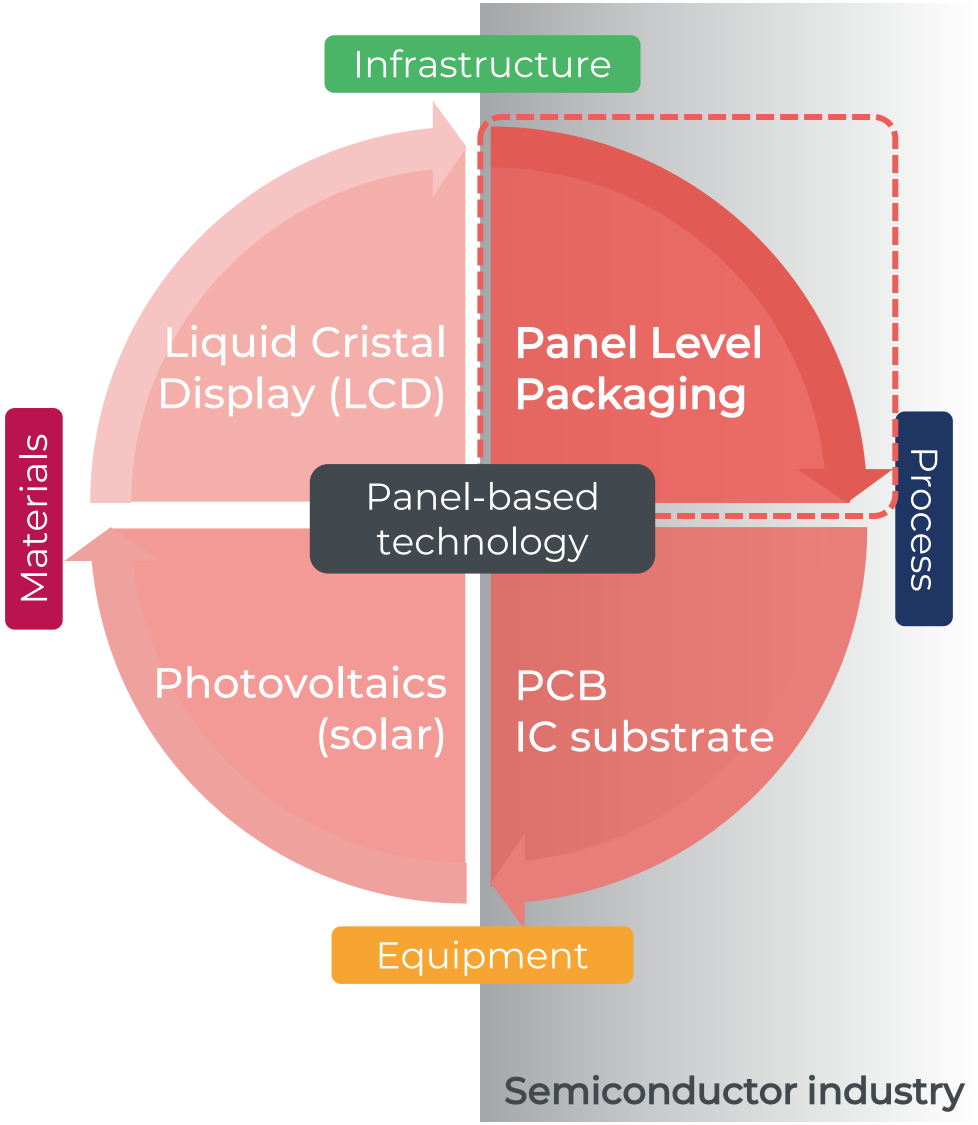


Source: Advanced Packaging Market Monitor Q4 2024, Yole Group

- Fan-Out PLP can replace wafer-level processes in fan-out (low to high-density) and **2.5D interposers**.
- In 2024, FO and 2.5D interposers took together 12% of the advanced packaging market revenues.
- 2.5D interposer technologies are stronly driven by the generative AI, server and high-end computing markets, taking an increasingly higher portion of the market.

PANEL-BASED TECHNOLOGY ACROSS DIFFERENT INDUSTRIES

Leveraging Infrastructure From Other Industries



Infrastructure

Liquid Cristal Display (LCD)

Panel Level Packaging

Materials

Panel-based technology

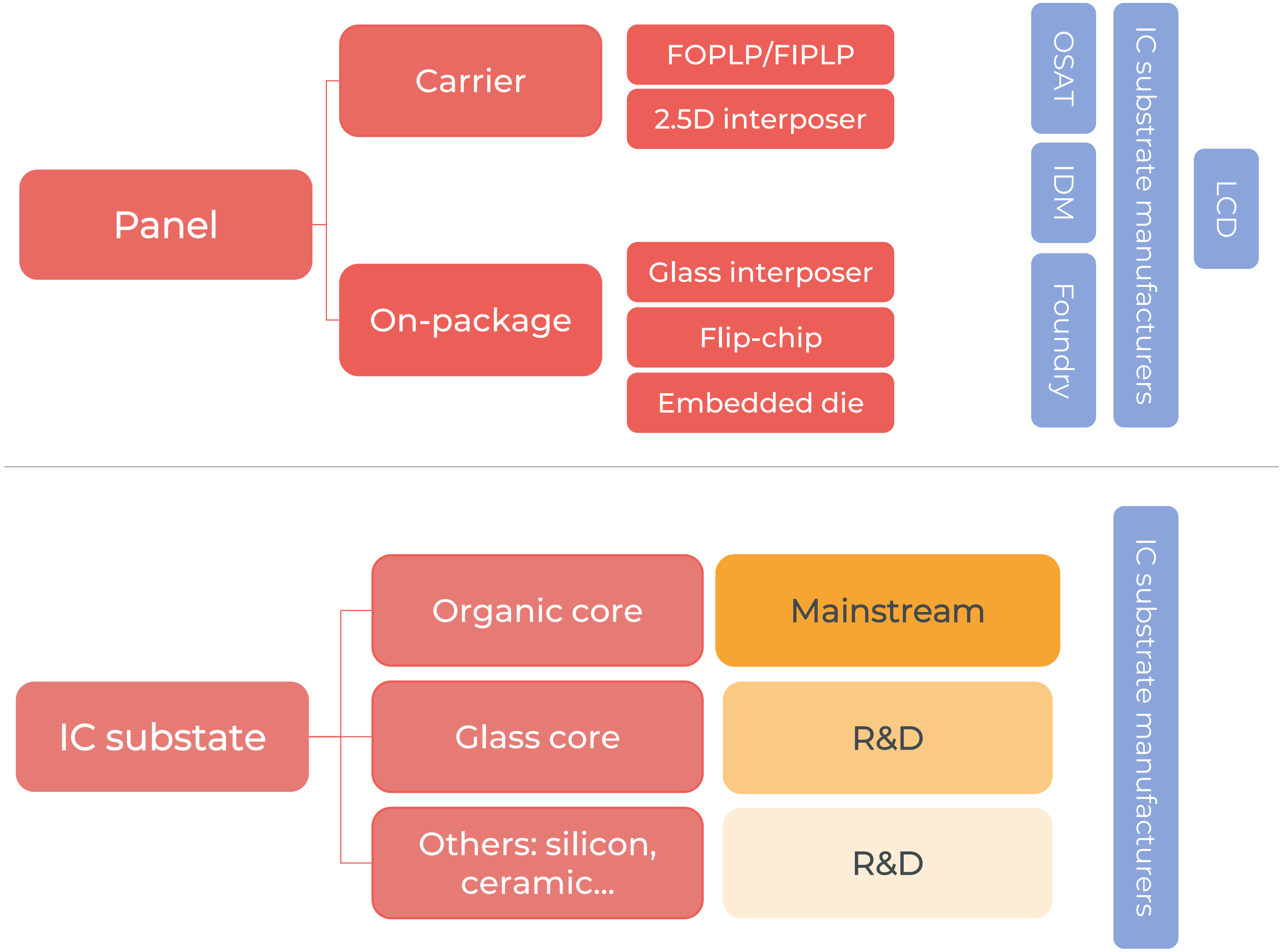
Process

Photovoltaics (solar)

PCB
IC substrate

Equipment

Semiconductor industry



- Panel
  - Carrier
    - FOPLP/FIPLP
    - 2.5D interposer
  - On-package
    - Glass interposer
    - Flip-chip
    - Embedded die

OSAT

IDM

Foundry

IC substrate manufacturers

LCD

- IC substate
  - Organic core: Mainstream
  - Glass core: R&D
  - Others: silicon, ceramic…: R&D

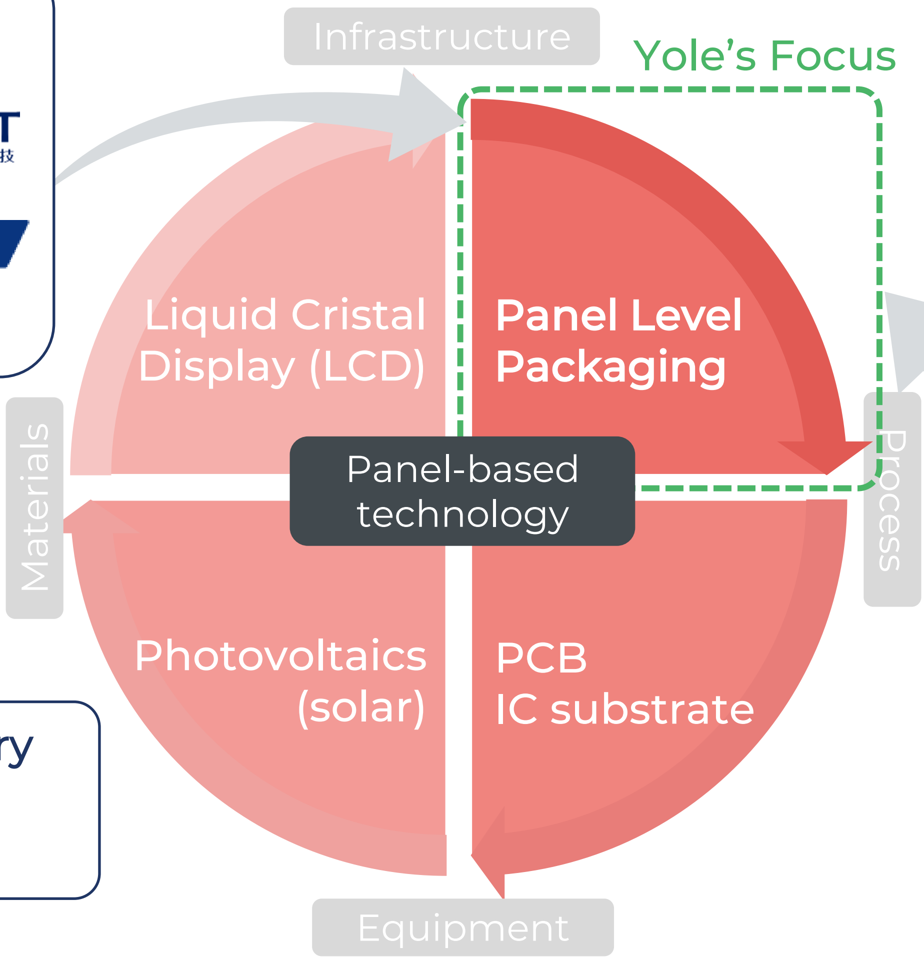
IC substrate manufacturers

PANEL-BASED TECHNOLOGY ACROSS DIFFERENT INDUSTRIES

LCD And IC Substrate Players Penetrating The PLP Supply Chain

LCD players investing on PLP*

INNOLUX
INNOLUX CORPORATION
CORNING
CMMT
誠美材料科技
SHARP
AUO
BOE
AGC
SCHOTT



Infrastructure

Yole's Focus

Liquid Cristal Display (LCD)

Panel Level Packaging

Panel-based technology

Photovoltaics (solar)

PCB
IC substrate

Materials

Process

Equipment

Solar industry

AUO

IC Substrate players investing on PLP*

FOPLP

Emdedded Die

SCI 天芯互联
ACCESS
SHINKO
SCHWEIZER
SMAT
Phoenix Pioneer technology
SAMSUNG
AT&S
MCT
Unimicron
TDK

Glass substrate

intel
DNP
IBIDEN
absolics
BOE
AGC
LG Innotek
SAMSUNG
SAMSUNG ELECTRO-MECHANICS
CORNING
SCHOTT
鈦昇科技
E&R Engineering Corp.
manz
YES

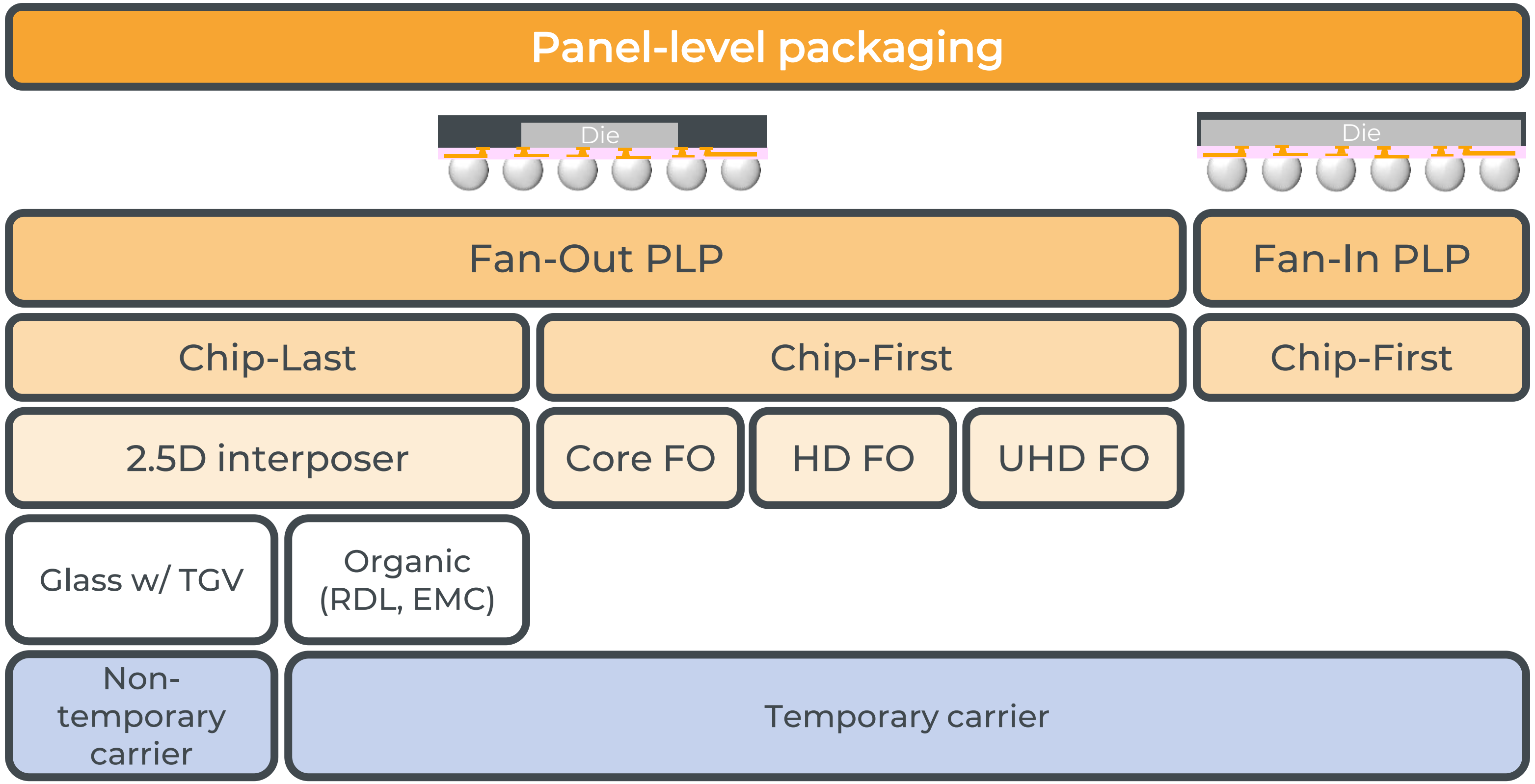
YOLE Intelligence

* Non-exhaustive list of players

PANEL LEVEL PACKAGING DEFINITION

Yole’s Definition and scope

Panel-level packaging (PLP) refers to any semiconductor packaging technology that uses a rectangular panel as a carrier during manufacturing.



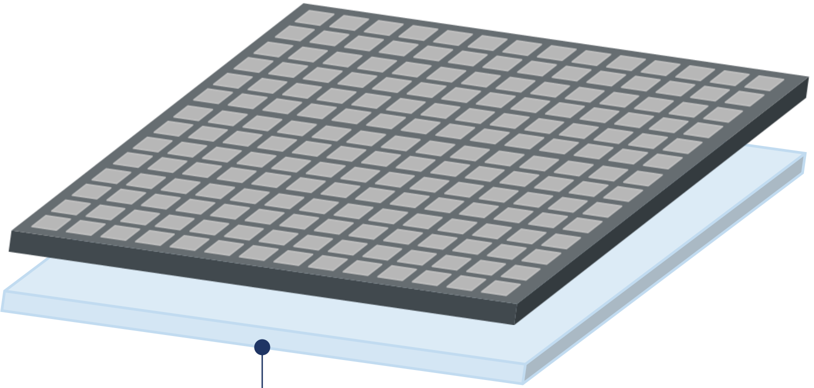
Panel-level packaging

Fan-Out PLP
- Chip-Last
  - 2.5D interposer
    - Glass w/ TGV
    - Organic (RDL, EMC)
- Chip-First
  - Core FO
  - HD FO
  - UHD FO

Fan-In PLP
- Chip-First

Non-temporary carrier

Temporary carrier

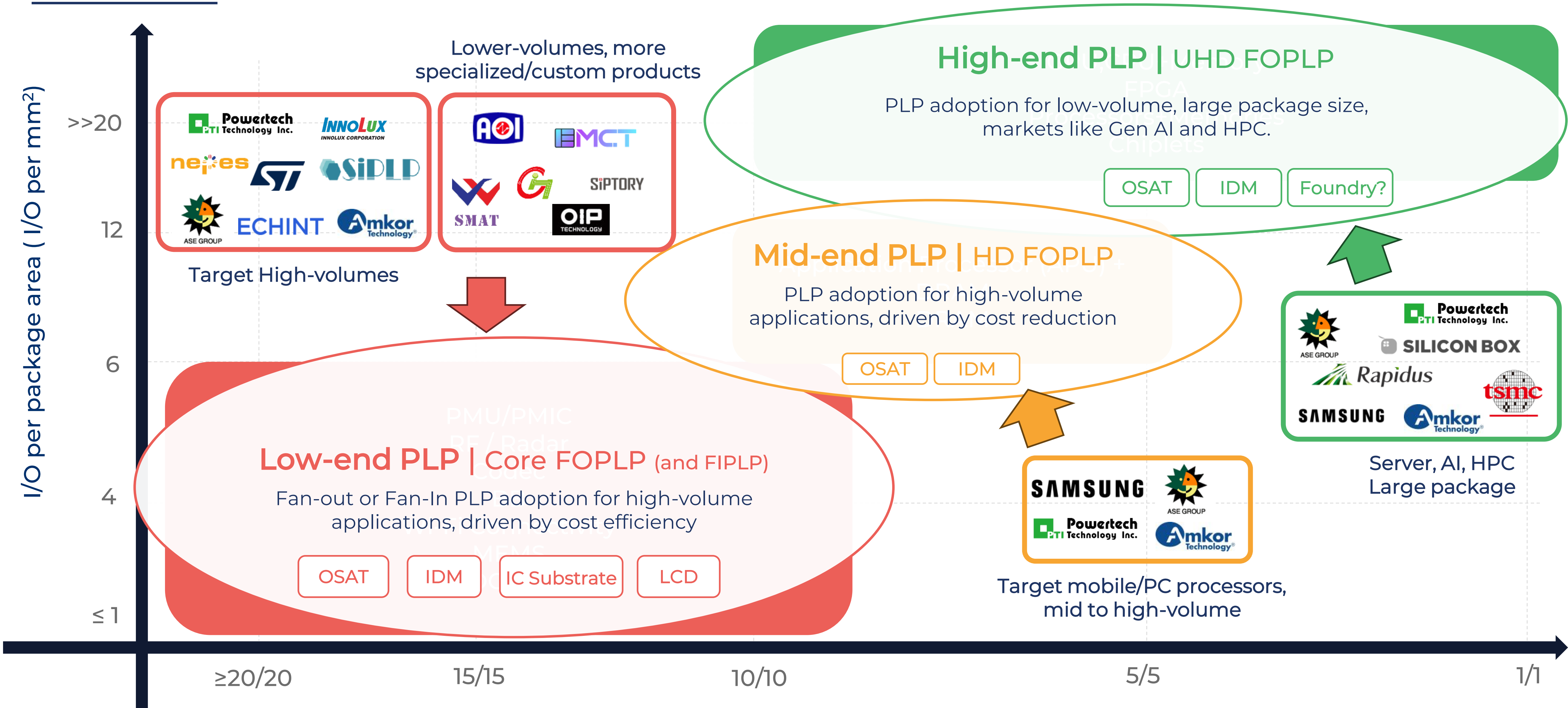


Carrier material:

Glass | Silicon | Organic | Metal

PANEL LEVEL PACKAGING TECHNOLOGY SEGMENTATION

Low-end, Mid-end and High-end PLP



Lower-volumes, more specialized/custom products

Powertech Technology Inc., InnoLux, nepes, ST, SiPLP, ASE Group, ECHINT, Amkor Technology

AOI, EMCT, SMAT, SiPTORY, OIP Technology

Target High-volumes

High-end PLP | UHD FOPLP

PLP adoption for low-volume, large package size, markets like Gen AI and HPC.

OSAT | IDM | Foundry?

Mid-end PLP | HD FOPLP

PLP adoption for high-volume applications, driven by cost reduction

OSAT | IDM

Low-end PLP | Core FOPLP (and FIPLP)

Fan-out or Fan-In PLP adoption for high-volume applications, driven by cost efficiency

OSAT | IDM | IC Substrate | LCD

Samsung, ASE Group, Powertech Technology Inc., Amkor Technology

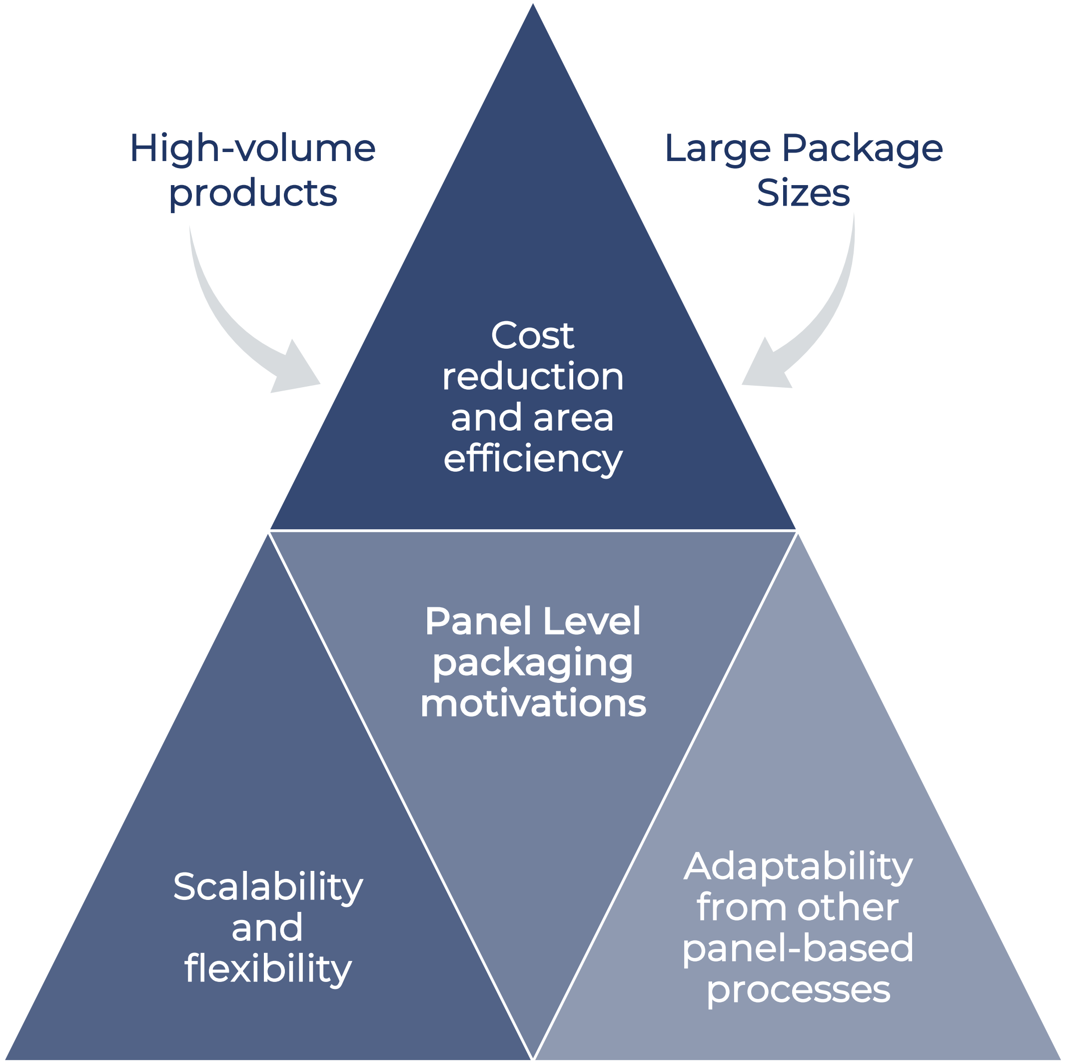
Target mobile/PC processors, mid to high-volume

ASE Group, Powertech Technology Inc., Silicon Box, Rapidus, tsmc, Samsung, Amkor Technology

Server, AI, HPC Large package

PANEL LEVEL PACKAGING ADOPTION DRIVERS

Number Of Active Dies Per Carrier For Different Carrier Sizes



High-volume products

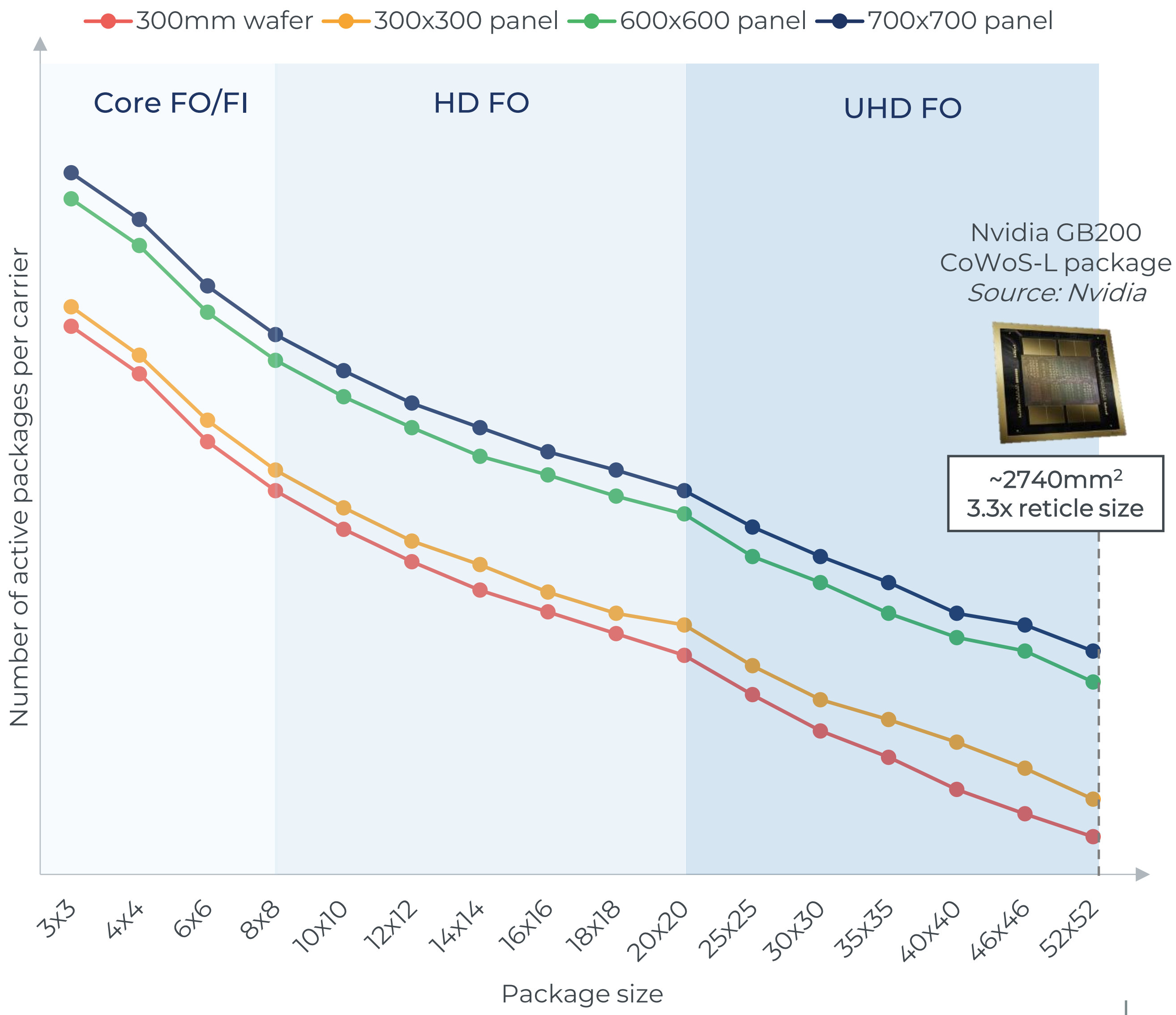
Large Package Sizes

Cost reduction and area efficiency

Panel Level packaging motivations

Scalability and flexibility

Adaptability from other panel-based processes

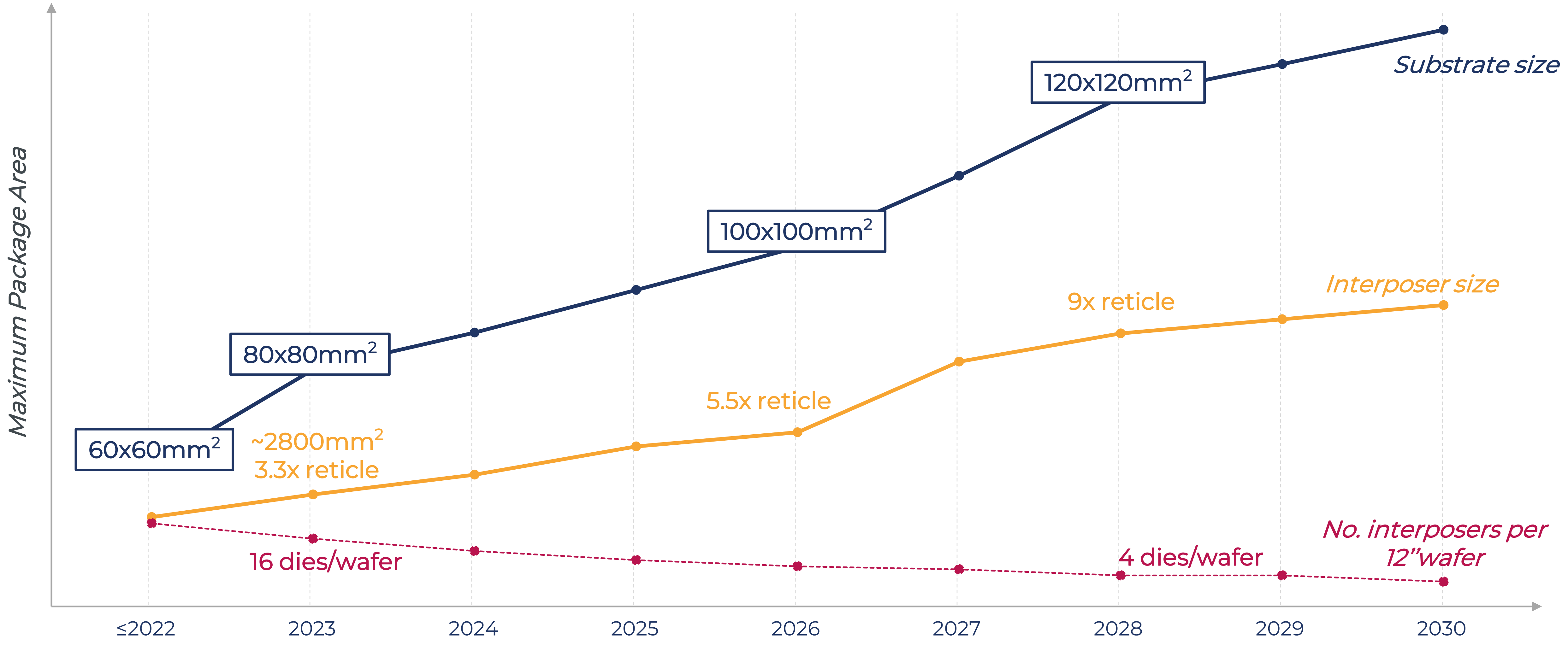


Nvidia GB200
CoWoS-L package
Source: Nvidia

~2740mm^2
3.3x reticle size

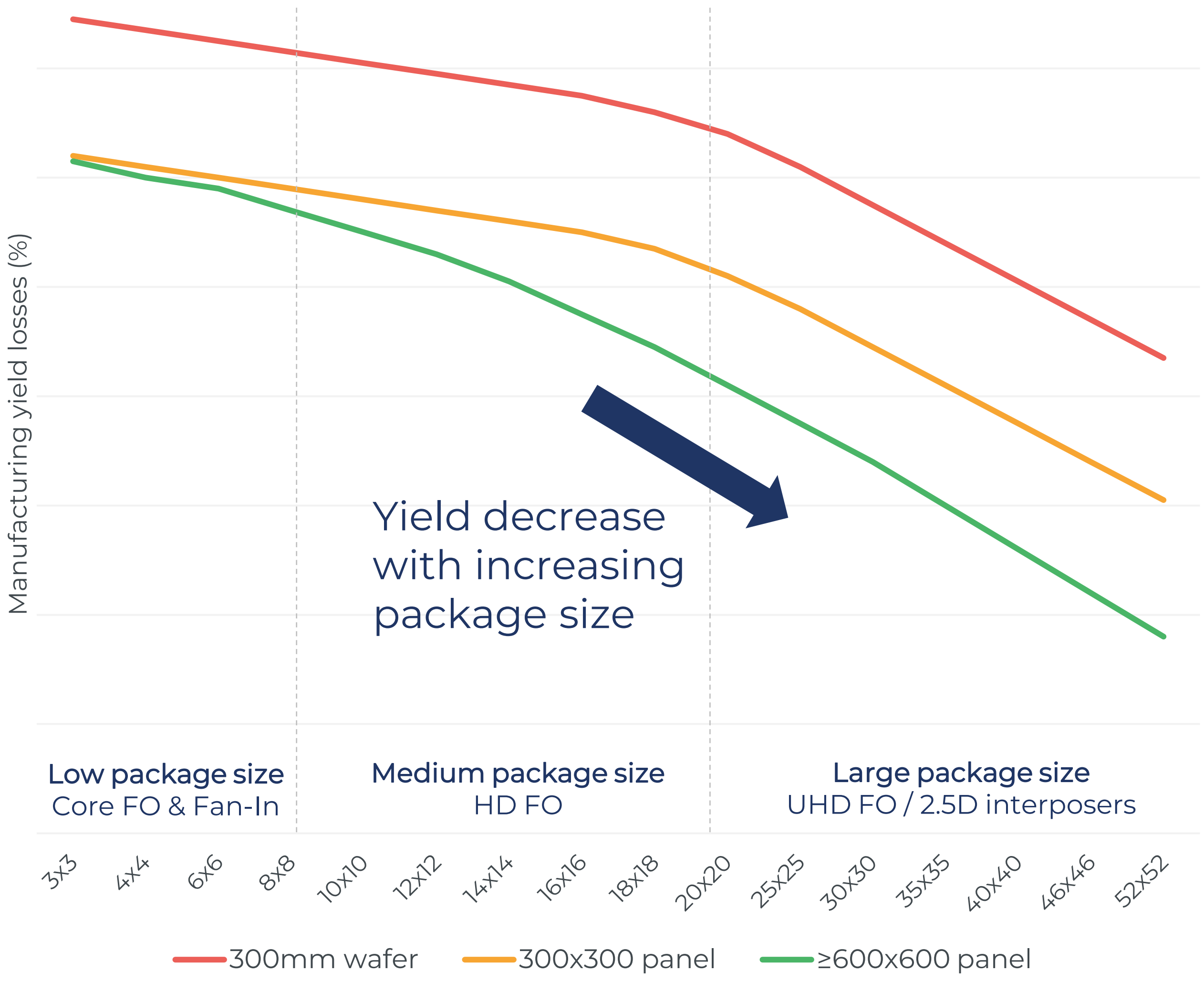
ADVANCED PACKAGING GROWING TOWARDS LARGER PACKAGE SIZE

IC Substrate and 2.5D Interposer size roadmap

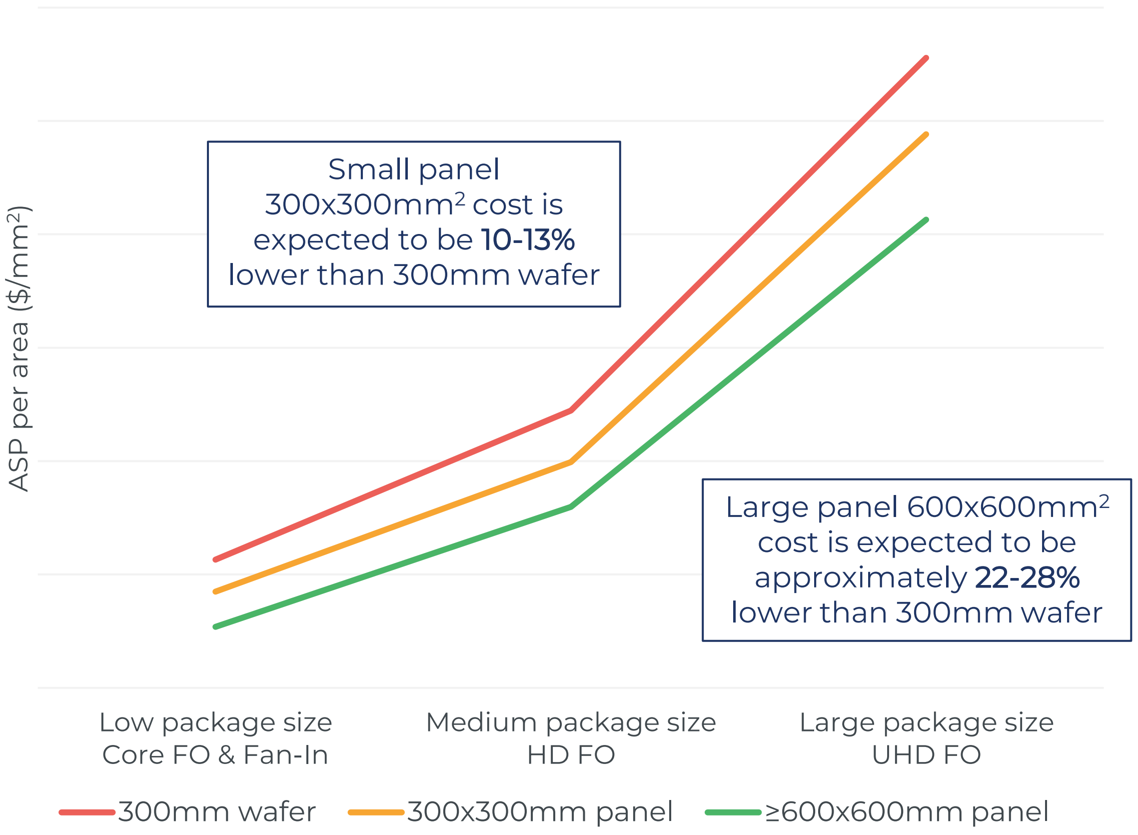


PANEL LEVEL PACKAGING ADOPTION DRIVERS

Yield Assumptions for Different Carrier Sizes and Package Sizes


Package Manufacturing Average Yield (%)

Yield decrease with increasing package size


ASP per area ($/mm²) by Package Size

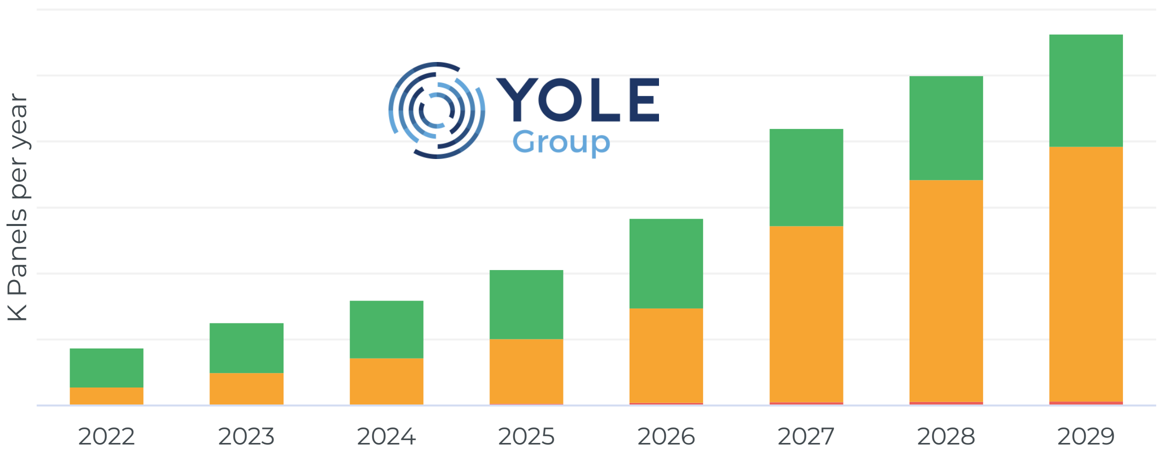
Small panel 300x300mm² cost is expected to be **10-13%** lower than 300mm wafer

Large panel 600x600mm² cost is expected to be approximately **22-28%** lower than 300mm wafer

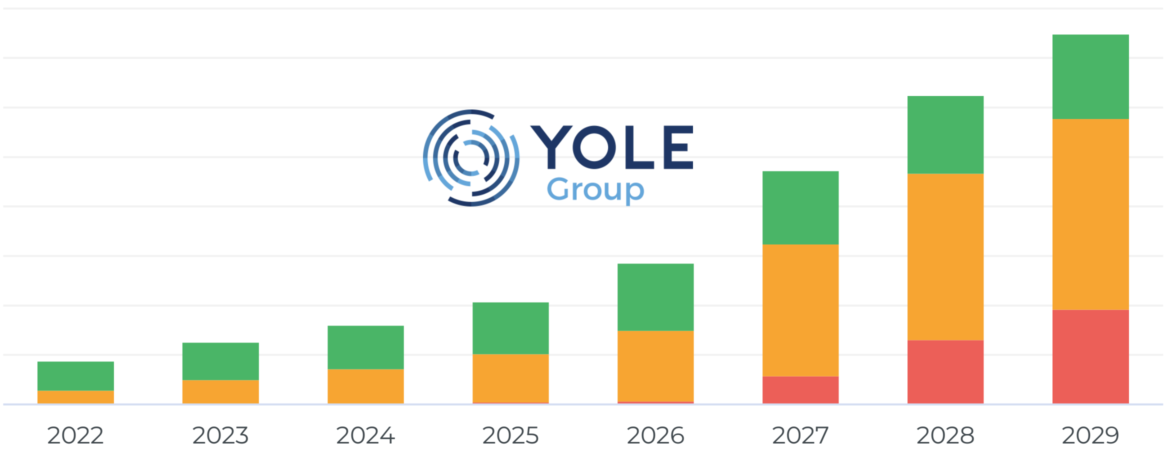
But is panel actually less costly considering equipment price can be several times higher?

FOPLP PANEL UNIT FORECAST - 2 DIFFERENT SCENARIOS

Scenario 1 - FOPLP units (KPPY)



Scenario 2 - FOPLP units (KPPY)



Core FO

- Current main applications: PMIC, RF, Audio Codec.

HD FO

- Samsung using FOPLP technology since 2018 for APU.
- Companies qualifying FOPLP for other HD FO packages.

UHD FO

Scenario 1:

- TSMC not adopting FOPLP until 2029.

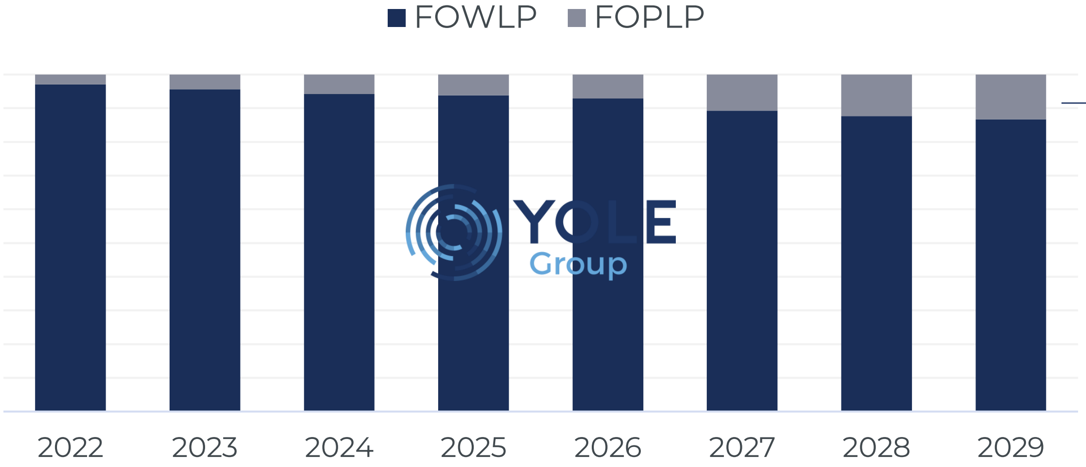
Scenario 2:

- TSMC adopting FOPLP starting in 2027.

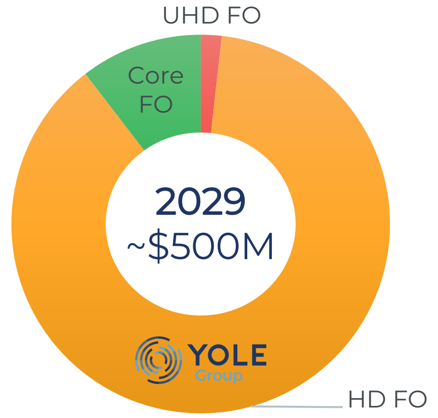
Source: Advanced Packaging Market Monitor Q4 2024, Yole Group

FAN-OUT WAFER AND PANEL REVENUE BREAKDOWN FORECAST

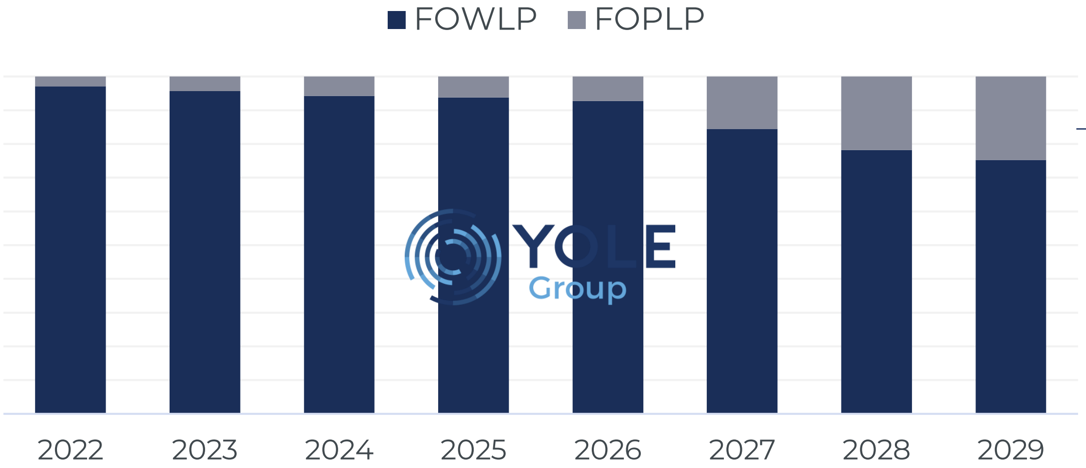
Scenario 1 - FOWLP vs. FOPLP revenue (%)



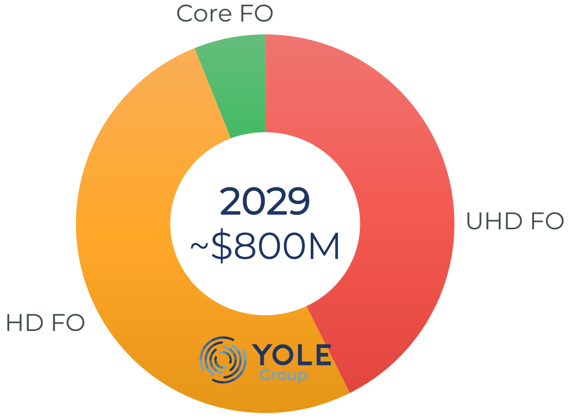
Scenario 1 – FOPLP, 2029



Scenario 2 - FOWLP vs. FOPLP revenue (%)



Scenario 2 – FOPLP, 2029



Source: Advanced Packaging Market Monitor Q4 2024, Yole Group

PANEL LEVEL PACKAGING CHALLENGES

Panel level packaging allows…

Cost reduction and area efficiency

Scalability and flexibility

Adaptability from other panel-based processes

But still comes with hurdles…

Economical & supply chain challenges

Why is it difficult to enter PLP business?

- Large investments
- Uncertainty that there will be enough demand
- Lack of a standard panel size

Technical challenges

What is affecting yields, reducing cost-effectiveness?

- Resolution
- Warpage
- Die placement accuracy
- Process uniformity

THANK YOU

FOR DRIVING THIS INDUSTRY FORWARD!

Your contact:
gabriela.pereira@yolegroup.com

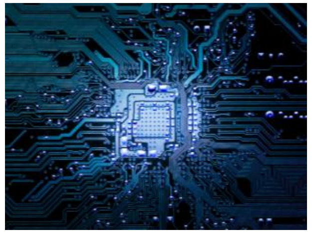
YOLE GROUP RELATED PRODUCTS

Reports

Contact our Sales Team for more information

COMING SOON

Panel Level Packaging 2025



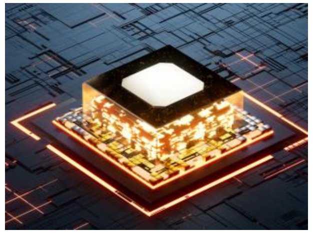
Advanced Packaging Market Monitor

Status of the Advanced Packaging Industry 2024

COMING SOON

Google APU Tensor G4 in Google Pixel 9 Pro

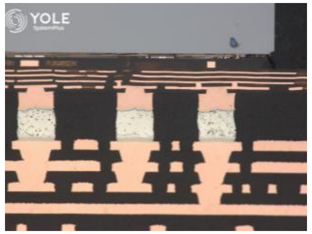
Google APU in Google Pixel 8



High-End Performance Packaging 2024

Smartphones SoC Packaging Comparison 2024

Status of the Advanced IC Substrate Industry 2024



Advanced Packaging in AMD Radeon RX 7900 XTX

HOW TO USE OUR DATA?

Yole Group, including Yole Intelligence and Yole SystemPlus, is pleased to provide you a glimpse of our accumulated knowledge.

Please note that the entire document and its data is copyrighted © Yole SystemPlus 2025.

To share our data with your own network, within your presentations, press releases, dedicated articles and more, please **contact our Public Relations department to make sure you get up-to-date, licensed materials**.

We will be more than happy to provide you our latest results and appropriate formats of our approved content.

Public Relations & External Communications
publicrelations@yolegroup.com

Visit our website: www.yolegroup.com

FROM TECHNOLOGIES TO MARKET

Corporate Presentation

2025

yolegroup.com

YOLE GROUP

We provide industrial companies, financial investors, and R&D organizations, with market research, technology, supply chain, and cost analysis, along with performance evaluation. Our services support informed decision-making on business and manufacturing strategies in the semiconductor, photonic, and electronic sectors.

3 CORE ACTIVITIES BASED ON DEEP SYNERGIES

Market & technology

- Market, technology and supply chain analysis
- Markets trends and forecasts

Teardown reverse engineering and costing

- Technology, process and cost analysis
- Teardown and reverse engineering
- Performance analysis

Custom project

- Strategy consulting
- M&A, due diligence and evaluation of companies

OUR PRODUCTS & SERVICES

REPORTS

INSIGHT
- Yearly published reports
- Market, technology and strategy analysis
- Reverse costing and reverse engineering
- Performance analysis

FORMAT
- PDF files with analyses
- Excel files with graphics and data
- Web access

TOPICS
- All thematic

115+ reports per year

QUARTERLY MONITORS

INSIGHT
- Quarterly analysis with market data and technology trends in units, value at wafer level
- Direct access to the analyst (except for Wafer Data Monitor)

FORMAT
- Excel files with data
- PDF files with analyses graphs and key facts
- Web access

TOPICS
- Advanced Packaging
- Compound semiconductor: SiC, GaN and RF GaN
- Computing: Processor and µcontroller
- Memory: DRAM, NAND
- Semiconductor Manufacturing and Test Equipment
- Wafer Data

15 different monitors quarterly updated

TEARDOWN TRACKS

INSIGHT
- Teardowns of phones, smart home, wearables and automotive modules and systems
- Bill-of-Materials
- Block diagrams
- Interactive zooming

FORMAT
- Web access
- PDF and Excel files
- High-resolution photos

TOPICS
- Consumer
- Automotive
- Telecom

315+ Single Teardowns Tracks per year - Daily updates

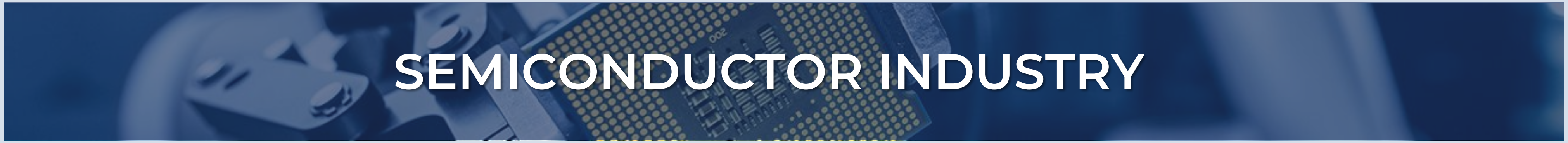
CUSTOM SERVICES

INSIGHT
- Specific and dedicated projects
- Strategic, financial, technical, supply chain, market and other semiconductor-related fields
- Reverse costing & reverse engineering

FORMAT
- Direct work with the analyst team
  PDF files with analyses
- Excel files with graphics and data

190 custom projects per year

OUR EXPERTISE



SEMICONDUCTOR INDUSTRY

- Battery
- Compound Semiconductor
- Computing and Software
- Display
- Electronic Systems
- Global Semiconductor Trends
- Imaging
- Memory
- Photonics and Lighting
- Power Electronics
- Radio Frequency
- Semiconductor Equipment
- Semiconductor Packaging
- Sensing and Actuating

— ACROSS THE SEMICONDUCTOR SUPPLY CHAIN & MARKETS —

MOBILE & CONSUMER

AUTOMOTIVE & MOBILITY

TELECOM & INFRASTUCTURE

MEDICAL

DEFENSE & AEROSPACE

INDUSTRIAL

Academic/ research

Design & engineering

Material & equipment

Front-end manufacturing

Back-end manufacturing

OEMs & system integrator

Consulting & finance

YOLE GROUP – KEY FIGURES

26+
Years in the semiconductor industry

900+
Products

10+
Fields of expertise

5,000+
Interactions with the industry

180+
Worldwide collaborators

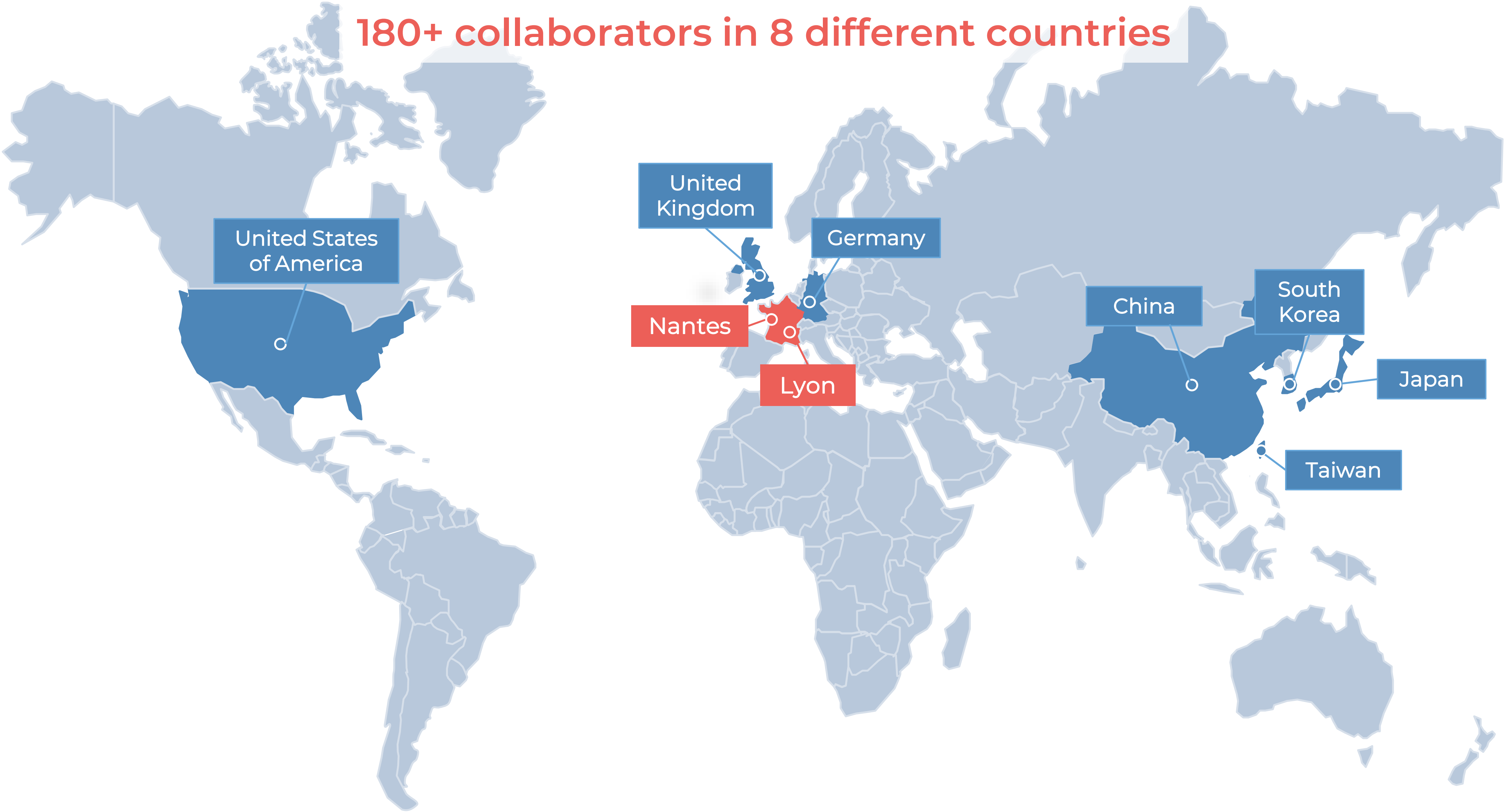
160+
Worldwide trade shows & conferences

125,000+
Contacts in our database

16,000+
Mentions in Media
(EETIMES, Forbes, Thomson Reuters…)

YOLE GROUP – A WORLDWIDE PRESENCE

180+ collaborators in 8 different countries



CONTACTS

REPORTS, MONITORS & TRACKS

NORTH AMERICA
sales.us@yolegroup.com
+1 833 338 4999

EMEA
sales.emea@yolegroup.com
+49 69 9621 7675

JAPAN, KOREA, REST OF ASIA
sales.japan@yolegroup.com
sales.korea@yolegroup.com
sales.restofasia@yolegroup.com
+81 3 4405 9204

GREATER CHINA
sales.gc@yolegroup.com
+886 922 408 282

GLOBAL OPERATIONS

CUSTOM SERVICES
custom@yolegroup.com

MARKETING
marketing@yolegroup.com

PUBLIC RELATIONS & EXTERNAL COMMUNICATIONS
publicrelations@yolegroup.com
communication@yolegroup.com

GENERAL INQUIRIES
contact@yolegroup.com | +33 4 72 83 01 80

FOLLOW US ON

General terms and conditions of sales