



AI Drives New Co-Integration and Co-Optimization of Semiconductor Systems

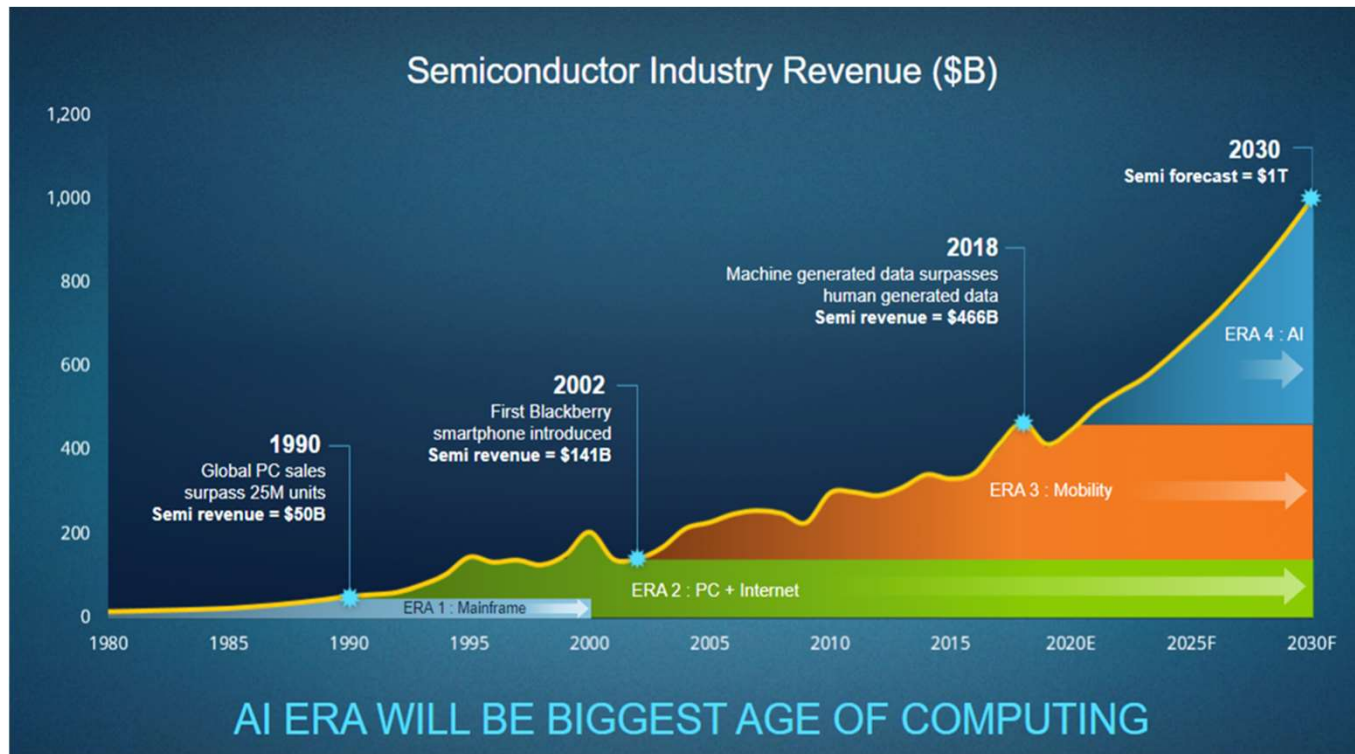
Dr. Yan Chai

Senior Director of Business Development

Adeia

AI: The Biggest Inflection Wave of Our Lifetime

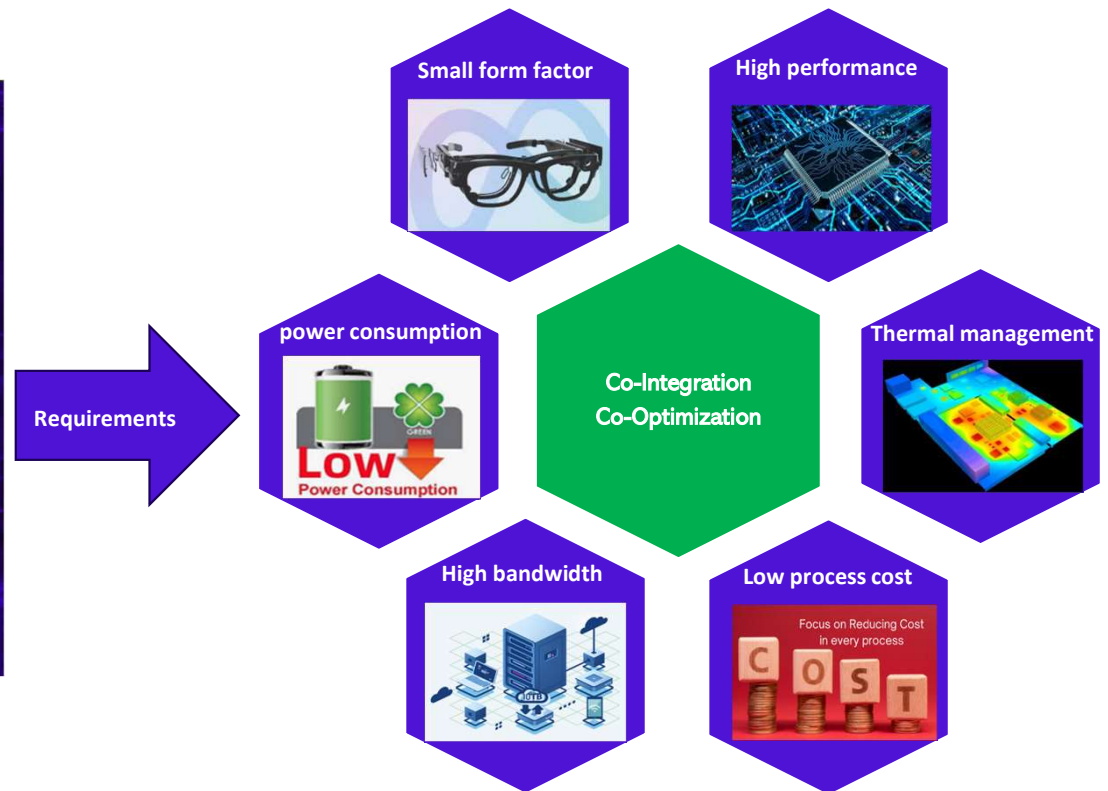
By 2027, >3 billion electronics will be equipped with GenAI capabilities



Source: Applied Materials, SEMI

AI Powered Device Drives the Co-Integration Of Multi-Chiplets

AI proliferation drives Silicon devices, optics, sensors into a unified platform



Orion AR Glasses At Meta Connect 2024

The most advanced pair of AR glasses ever made (at \$10K cost!)

A computer with Meta AI on your face..

- 7 integrated cameras and sensors
- A 70° field of view using 6 high refractive index SiC waveguides
- Disruptive & Bright MicroLEDs display projector with built-in software
- A custom eye-tracking system with miniaturized cameras
- Speakers, and a microphone for voice assistance
- A magnesium alloy frame for light weight and heat dissipation
- An EMG wristband with sensors, built-in processor & haptic feedback
- Custom processors to optimize power, graphic and AI functions

personalized control: through a combination of eye tracking, hand tracking, voice, and the neural wristband

AI: interpret sensory information from the surrounding environment



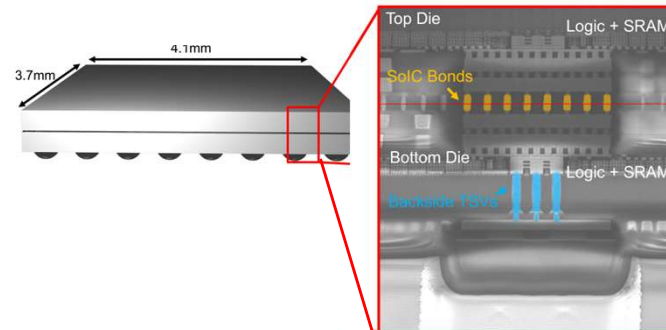
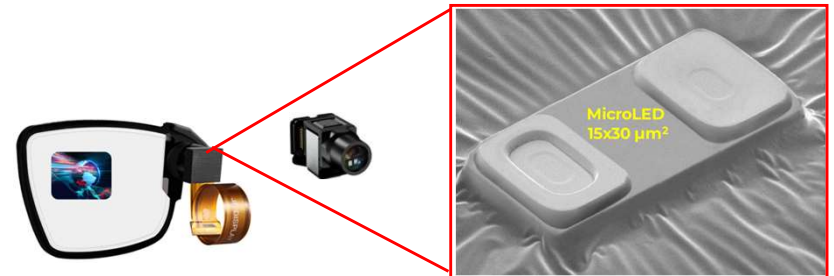
AR Glasses, The Next Big Thing After Smartphone, as Example

3D integration enables all critical requests into one platform



Meta Platforms, Inc.

- Small form factor, light weight
- High performance with 3D Stack integration
- Low power, better thermal
 - Tiny MicroLED + waveguide as new gen display
 - Hybrid bonded Logic/SRAM on Logic/SRAM



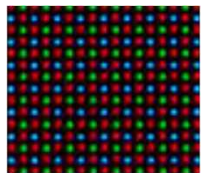
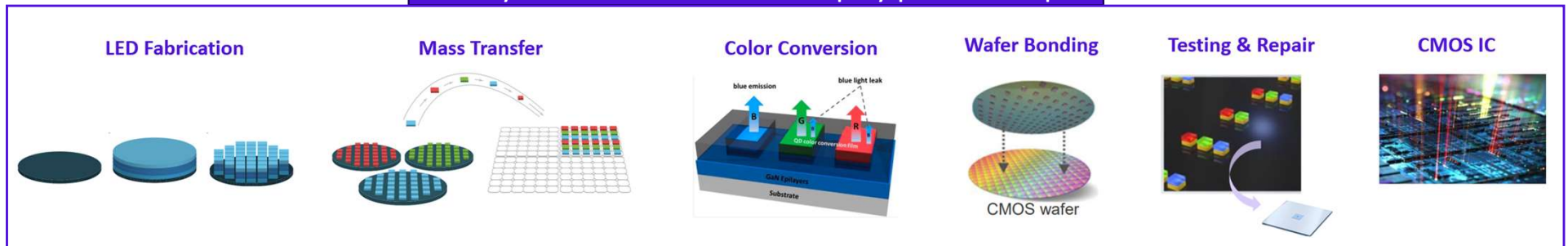
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D11.2 A 3D Integrated Prototype System-on-Chip for Augmented Reality Applications Using Face-to-Face Wafer Bonded 7nm Logic at <2 μm Pitch with up to 40% Energy Reduction at Iso-Area Footprint

Why is AR Glass Not Moving to HVM After 10 Years?

High cost due to lack of eco-system and co-optimization

Today's common MicroLED display process steps



LED Die Size

→ Largest contributor to \$

Transfer
Assembly

→ Integration cost and complexity

Backplane IC

→ Missing the PPAC benefits of advanced CMOS

Yield
(Test & Repair)

→ Generations behind semiconductor production

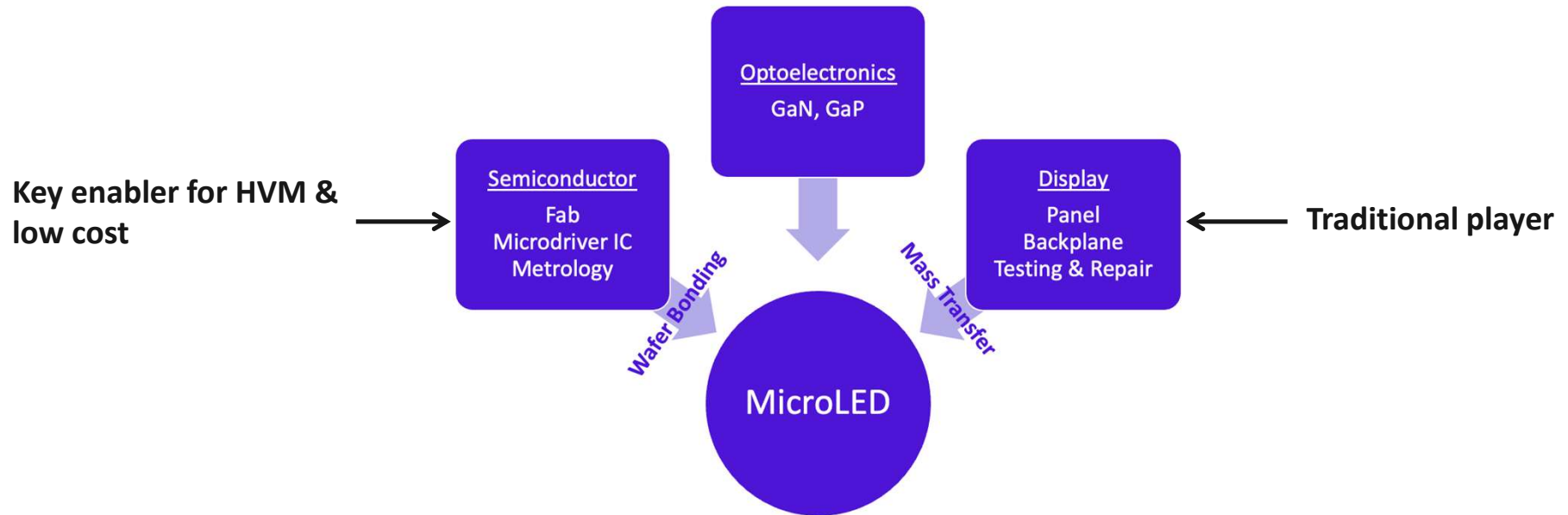
Manufacturing
Efficiency

→ Throughput, Automation

How to Address The Biggest Challenge?

Continue developing disruptive technologies & evolve into semi-like supply chain

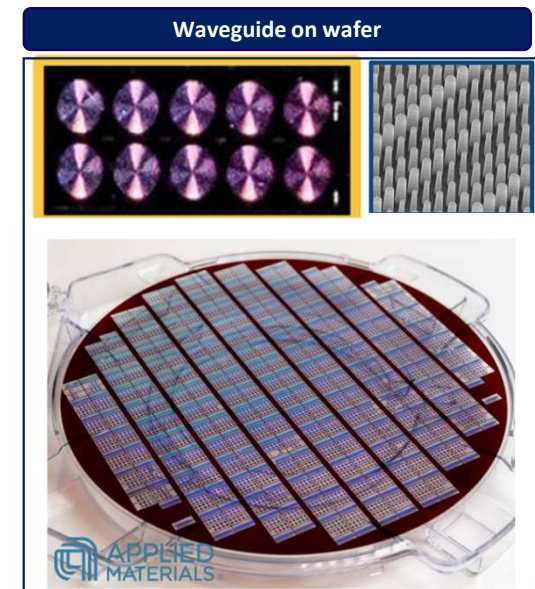
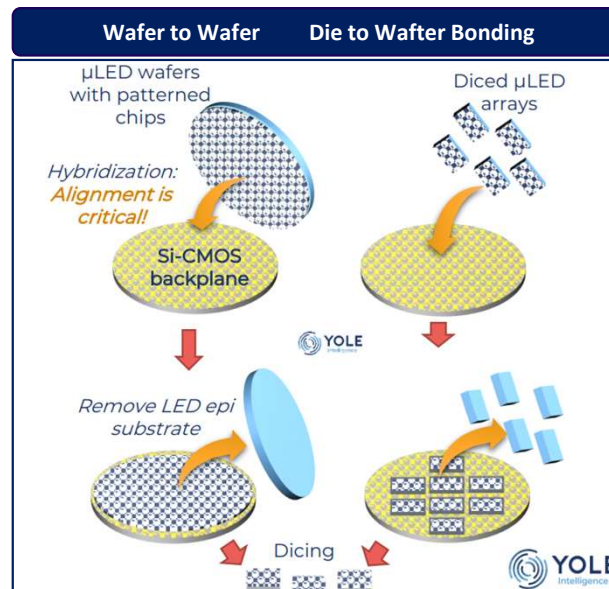
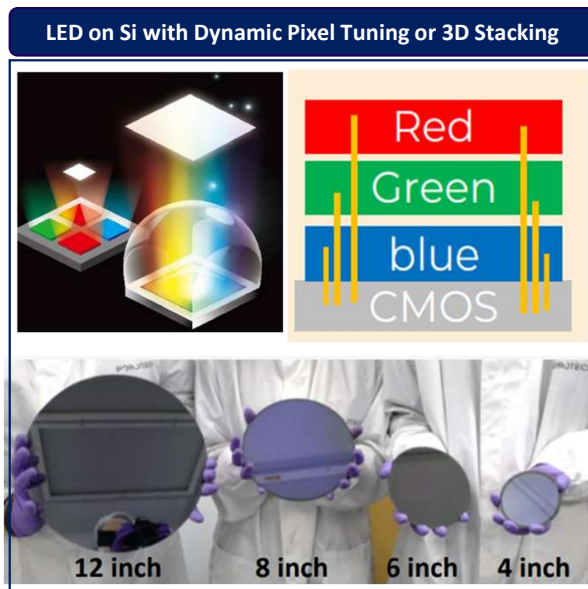
- Innovate & optimize MicroLED structure & process steps to reduce mass transfers and waveguide cost
- Change traditional supply chain to Semi-like high-volume manufacturing (HVM) & high Yield fab
- Focus upon cost!



Innovative Path is Happening: Move to GaN/Si Wafer Process!

Leveraging semiconductor scaling and cost reduction journey

- MicroLED Epi growth using 8/12" Silicon wafer instead of 4/6" sapphire
- W2W or D2W Bonding to avoid multiple massive mass transfers
- 3D Stack interconnection
- Wafer level waveguide manufacturing and bonding



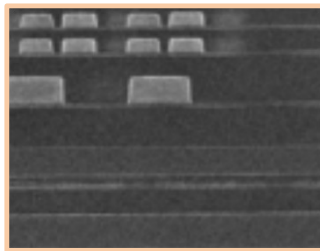
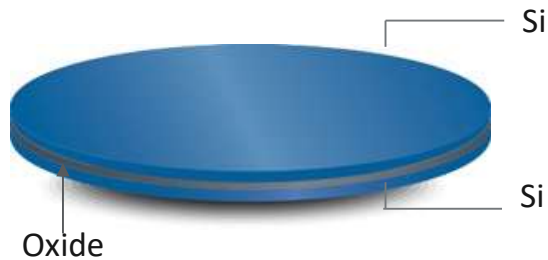
3D Integration Technology

Pioneered by Adeia to Enable New Architectures (including MicroLED)

ZiBond®



Wafer-to-Wafer Direct Bonding

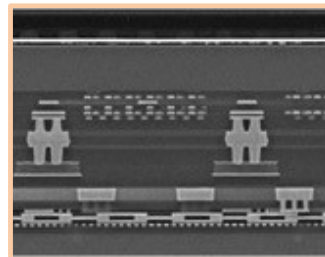
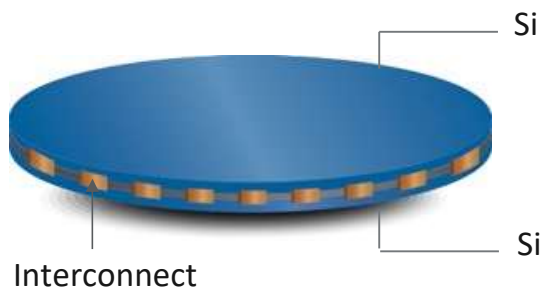


Courtesy of Chipworks/Sony

DBI®



Wafer-to-Wafer Hybrid Bonding

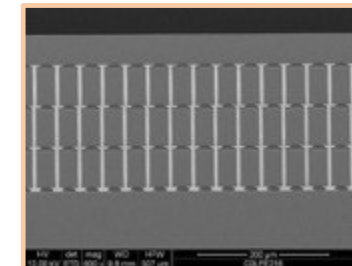
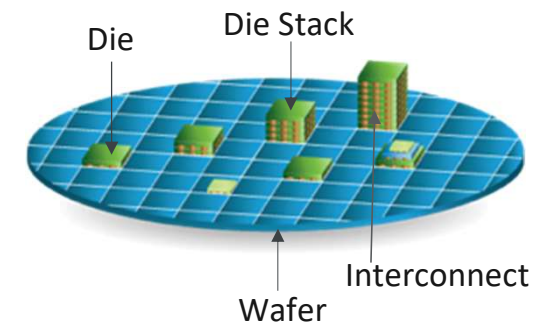


Courtesy of Chipworks/Sony

DBI® Ultra



Die-to-Wafer/Die Hybrid Bonding



adeia™ 9

Hybrid Bonding Adoption Trends in Co-Integration...

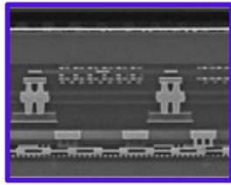
Continues innovation with hybrid bonding in AI, Data Center &

MicroLED

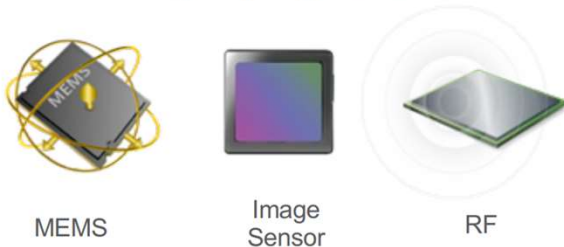
Sensor & Edge Devices

Wafer to Wafer Bonding

(Courtesy Chipworks)



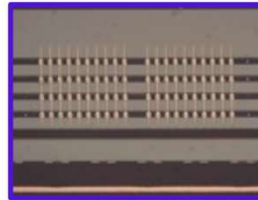
Eg. Sony Image Sensor



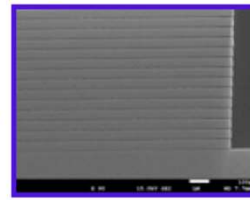
Memory Devices

Die or Wafer to Wafer Bonding

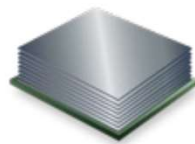
(Courtesy Chipworks)



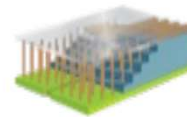
(Adeia Internal)



Eg. HBM



3D DRAM

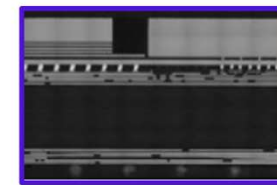


3D NAND

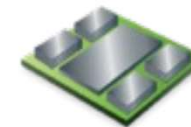
Computing Devices

Die to Wafer Bonding

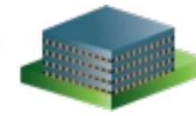
(Courtesy nVidia/Chipworks)



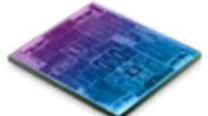
(Adeia Internal)



2.5D Logic
(CPU/GPU/ASIC)
+ Memory



3D Logic
+ Memory



3D SoC

Mega Trends in the Semiconductor Ecosystem

Now a System-Driven Value Chain

AI Momentum Acceleration

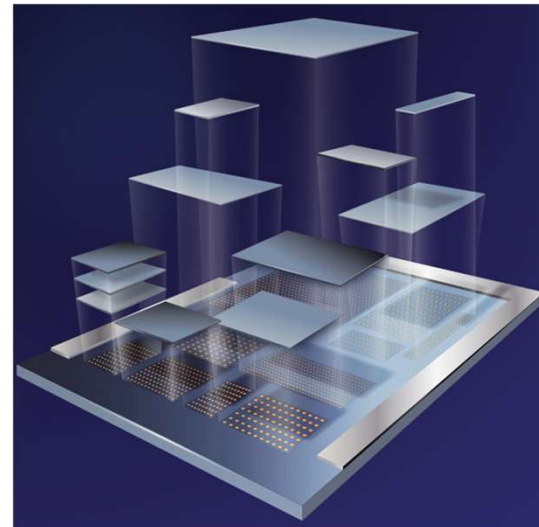
- Generative AI: data center proliferation (hyperscalers, sovereign AI)
- On-Device AI: PC, smartphone, edge intelligence
- AI in AR (Augmented Reality): always on and wearable
- Autonomous driving: “Data center on wheels”

Emergence of System Foundry

- Silicon foundries leading advances in multi-chip integration & packaging
 - Logic, RF, sensors, co-packaged optics
 - Even including memory (e.g. HBM in CoWoS)
- Serving the increasing needs of 2.5D and 3D heterogeneous system architectures

Summary

- AI powered device drives the biggest inflection wave in our lifetime
- Heterogeneous photonic and electronics integration played a key integration scheme for future AI driven mega trend
- Co-optimization and eco-system development become a must in moving a complex design to reality -AR glass development lesson learned
- Adeia is a pioneer in 3D integration and advanced packaging technologies, let us collaborate to meet these challenges





Thank you

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