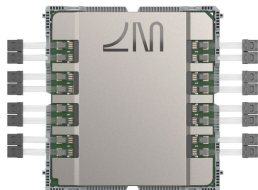


Advancing AI Infrastructure with 3D Photonics and Chiplet Integration

Sandeep Sane, Ph.D.

Senior Director, Head of Packaging Technologies





\$850mm Raised

Fidelity
Google Ventures
Sequoia
Spark Capital
Viking

T. Rowe Price
Matrix Partners
SIP Capital
MIT
Stanford

3
OFFICES



Mountain View (HQ)



Boston



Toronto

284
EMPLOYEES



Nicholas Harris, PhD
Founder, CEO



Simona Jankowski
CFO



Bob Turner
SVP, Sales & Solution Arch



Sujatha Wagle
VP, Supply Chain Ops



Boon Tan
VP, Product Engineering



Darius Bunandar, PhD
Founder, Chief Scientist



Ritesh Jain
SVP, Engineering & Ops



Beth Keil
SVP, People



Colin Sturt
General Counsel



Praveen Kukkamallla
VP, Sales



Thomas Graham
Founder



Daner Stodolsky
VP, SW Engineering & ML



Steve Klinger
VP, Product

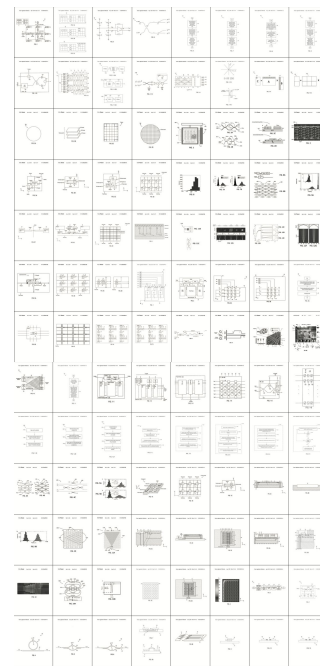


Kaushik Patel, PhD
VP, Photonics & Si Eng



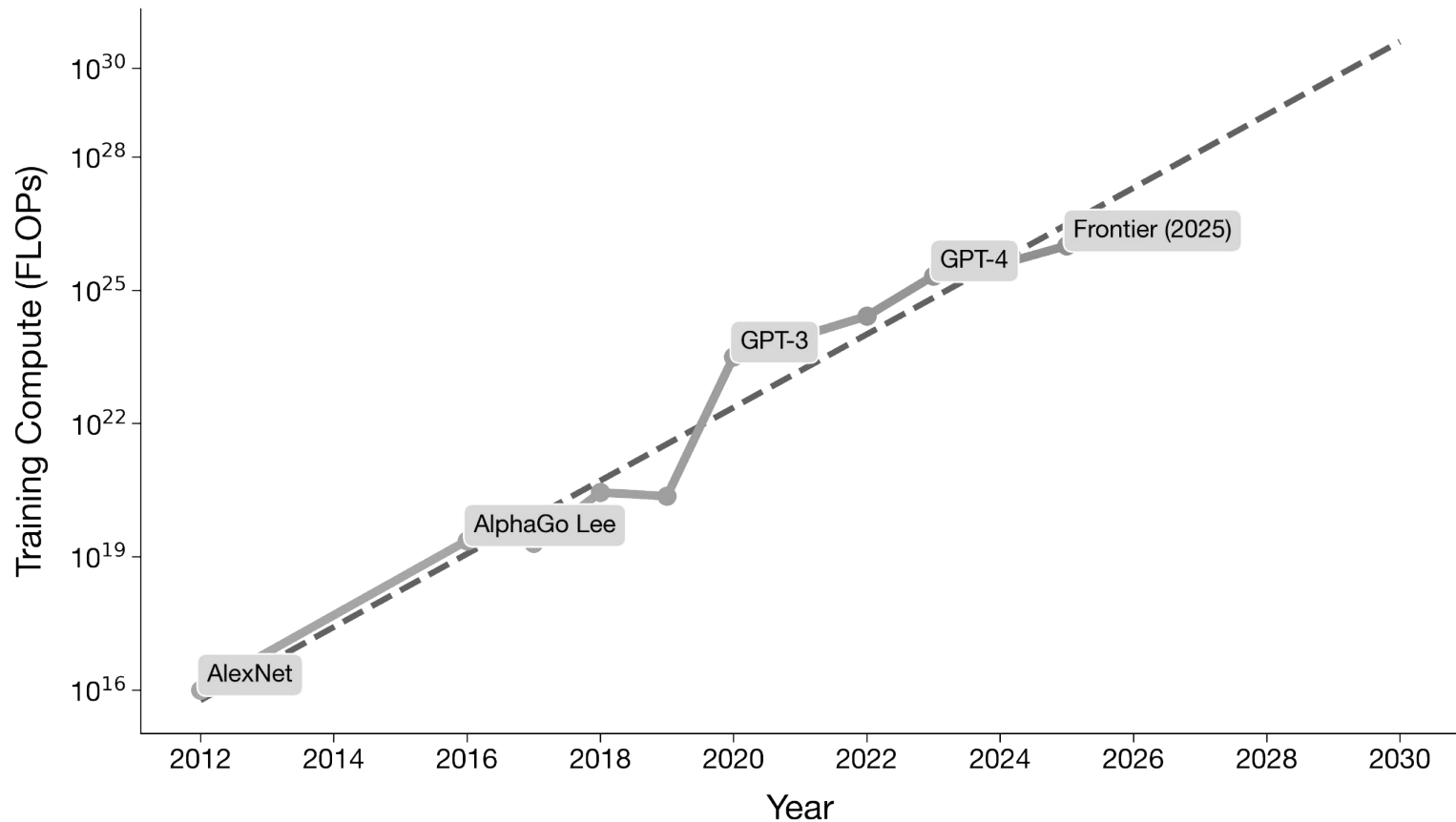
Israel Kandarian
Head of Creative Marketing

292
PATENTS

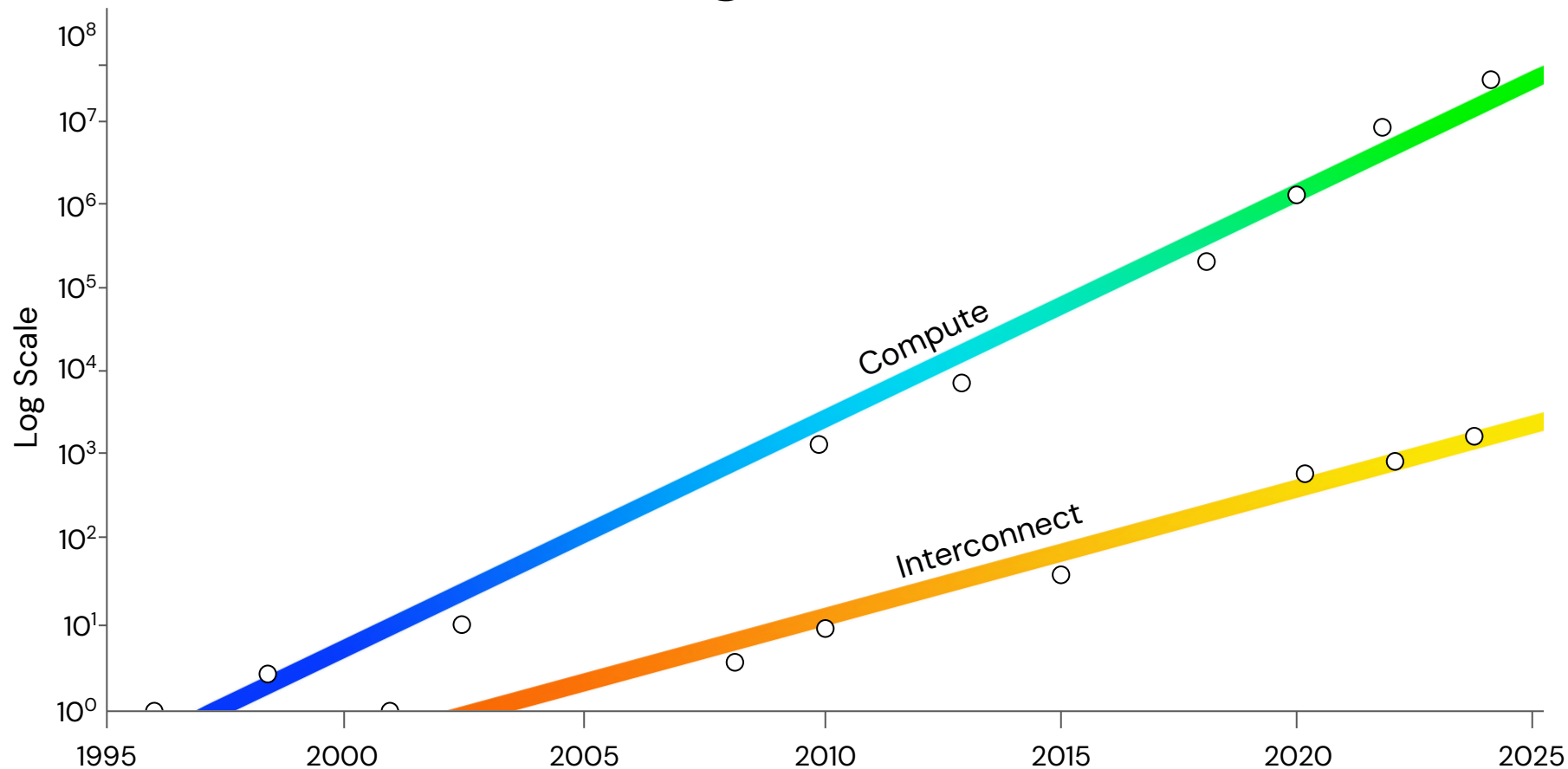


Granted & Pending

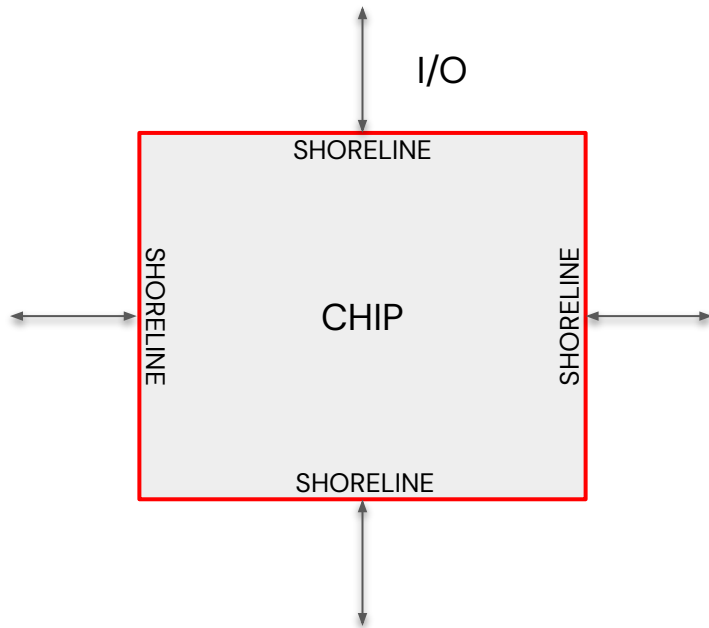
10^9 Growth in a Decade



Interconnect Progress Is Too Slow



Existing Interconnects: Shoreline Limited



Communication happens at the chip **perimeter**

FLOPS $\propto$ Chip Area (L^2)

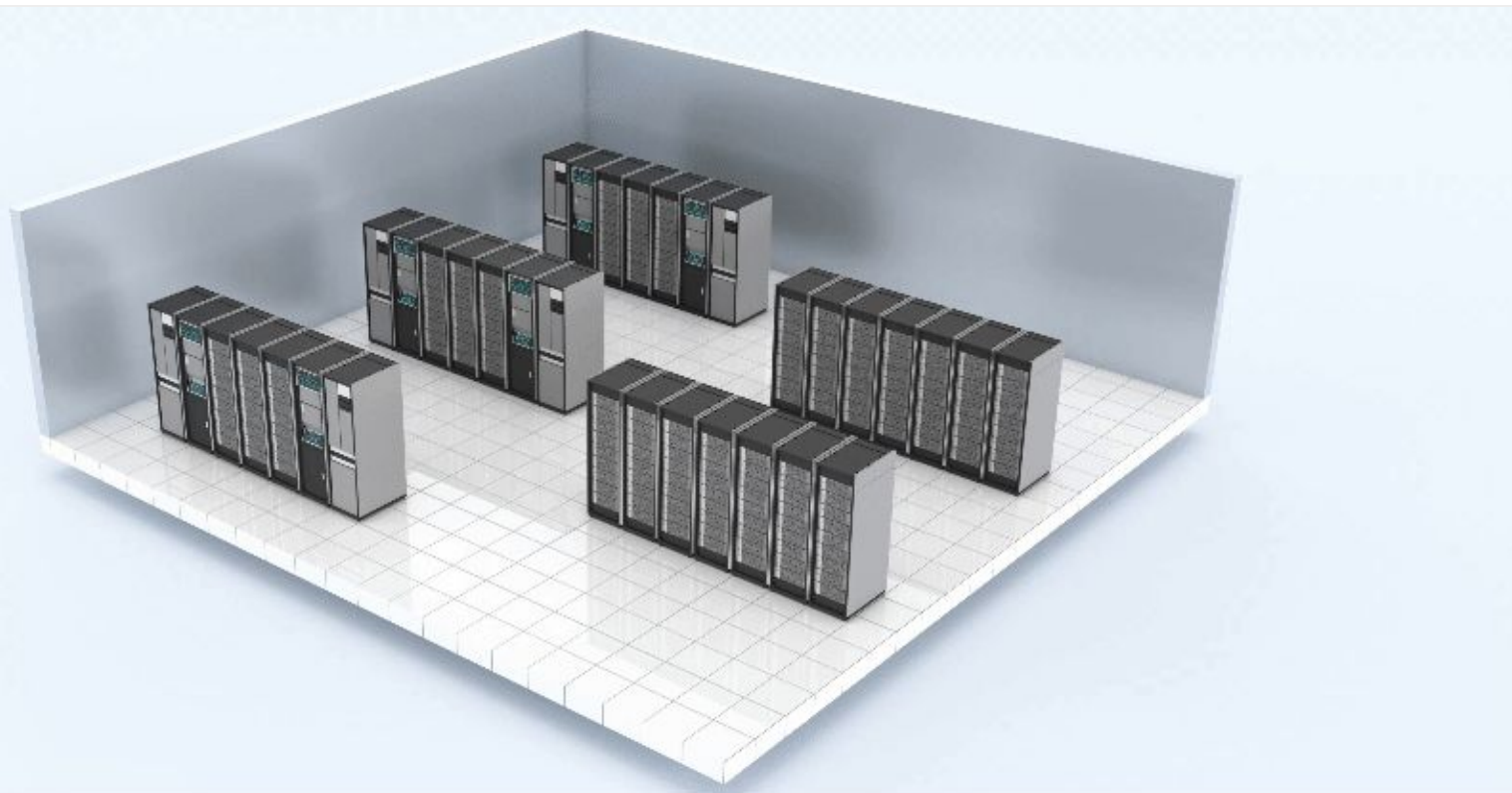
IO Bandwidth $\propto$ Chip Perimeter (L)

We need $>100\times$ the bandwidth.

A new paradigm is needed: 3D photonics

Present Day AI Supercomputers

Mini-clusters lashed together with spaghetti

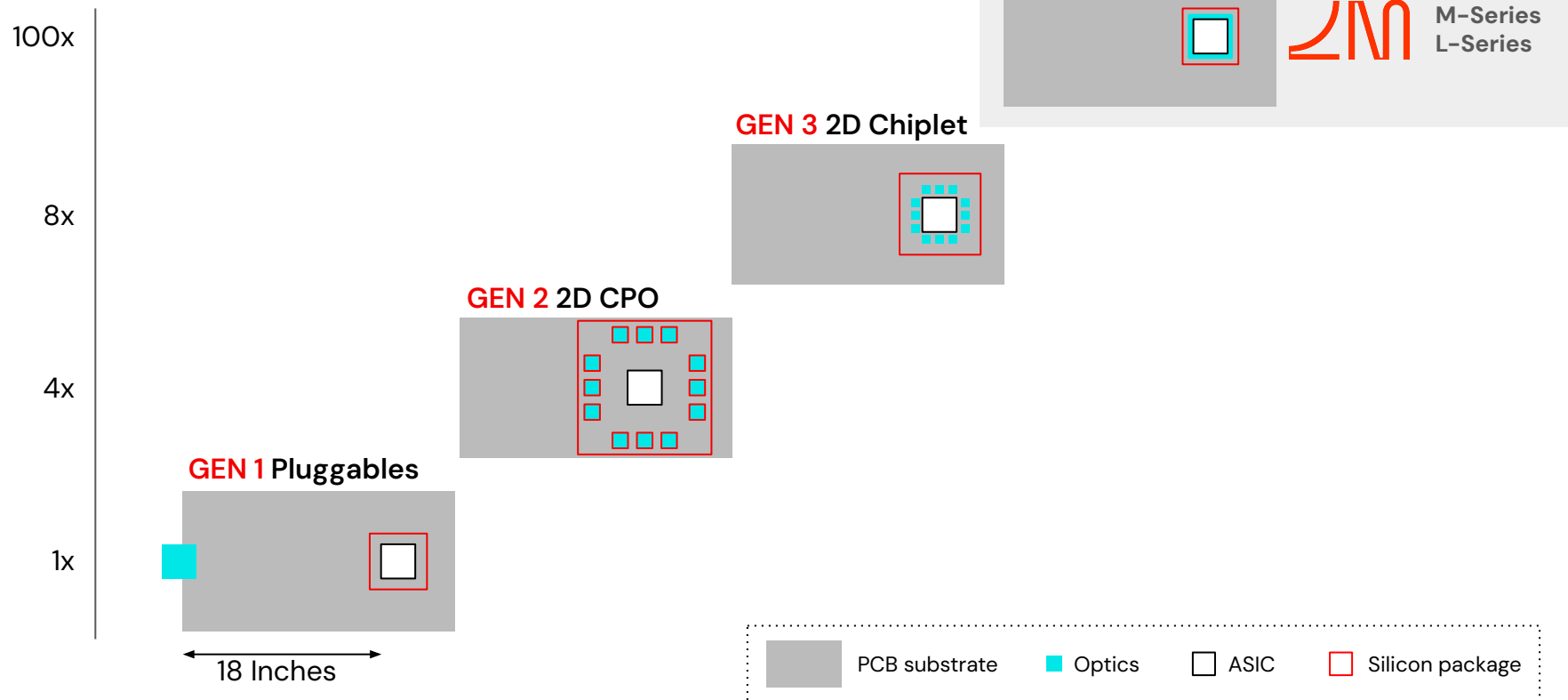


Next Generation

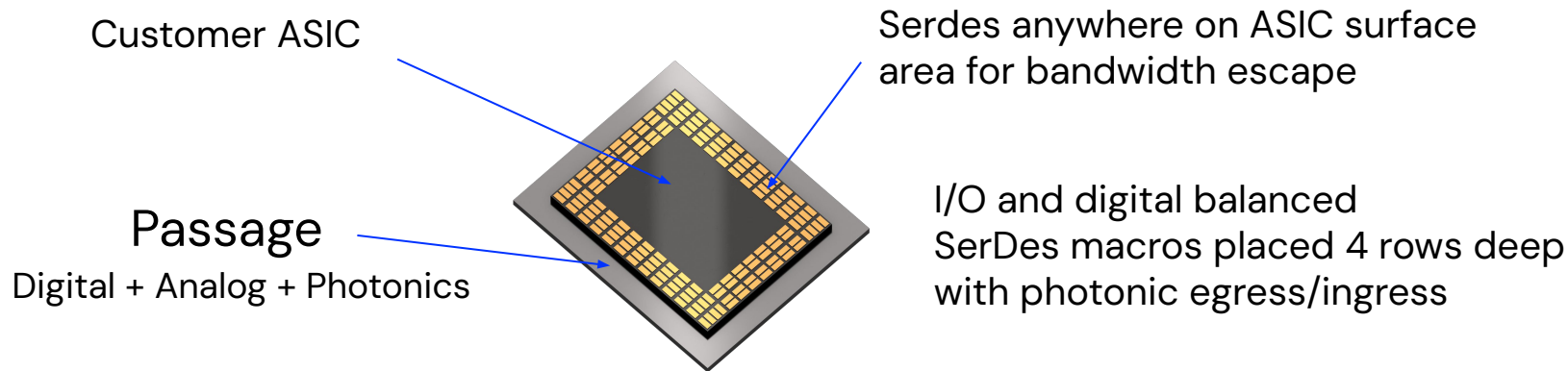
Highly interconnected, composable AI supercomputers



Photonics Evolution: Moving Closer to the Chip



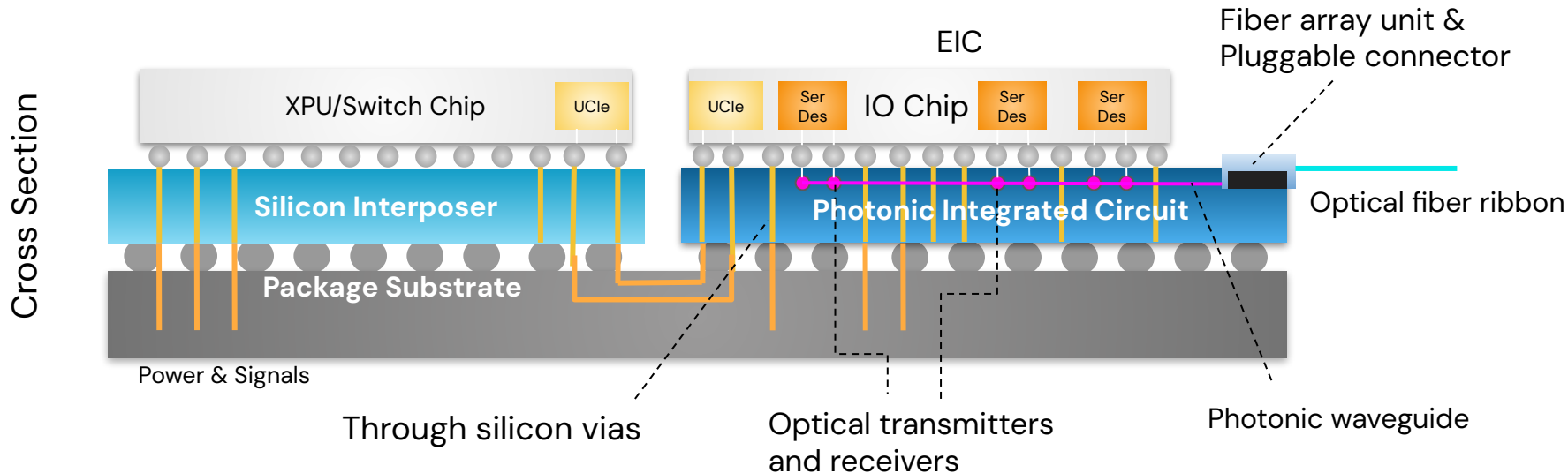
Introducing Passage™ Photonic Interconnect



Built on 3D packaging technology and a Chip-on-Wafer assembly flow

Passage Photonic Integrated Circuit: Single Reticle or Multi-Reticle

3D CPO Requires Compact Optical Modulators and Receivers

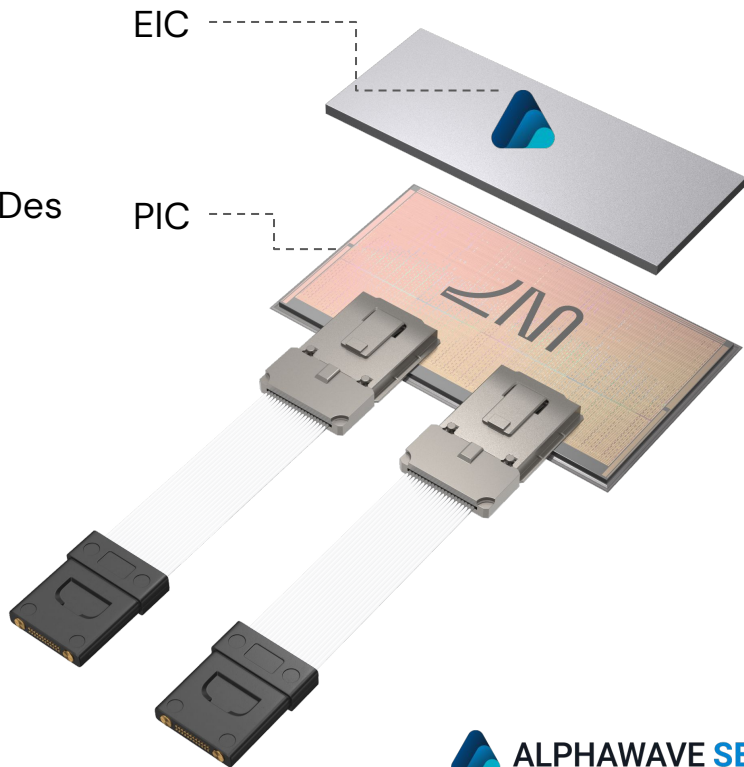


Standard processes today

- Bump pitch: $\sim 120\ \mu\text{m}$
- Bump size: $\sim 80\ \mu\text{m}$
- Area for a transmitter/receiver: $0.015\ \text{mm}^2$

Passage™ L200 3D CPO

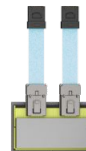
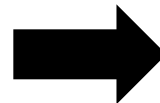
- Fastest Co-Packaged Optics
- L200 3D Photonic Engine blank I/O tile with SerDes
- Alphawave Semi's I/O EIC with UCle & SerDes
- Shoreline is no longer the limit
- >1.5 Tbps/mm



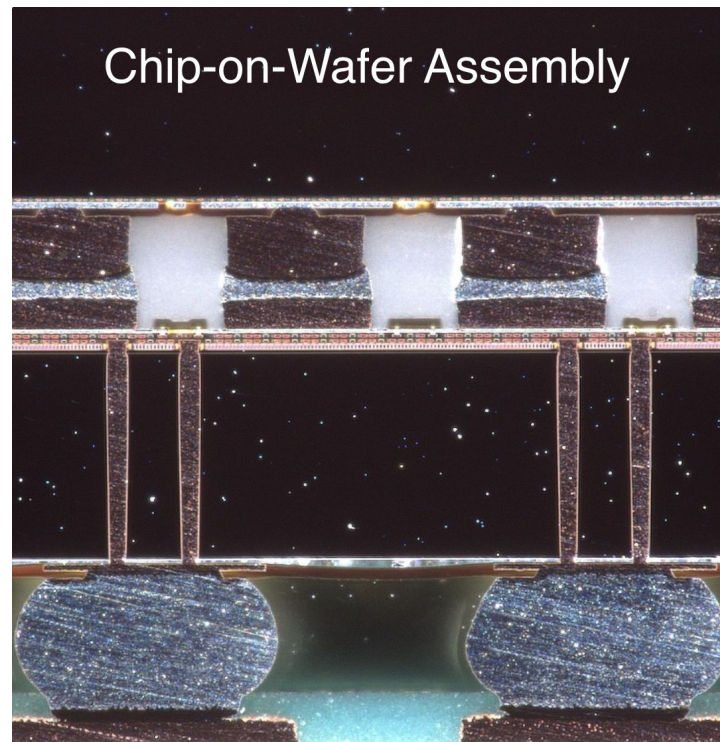
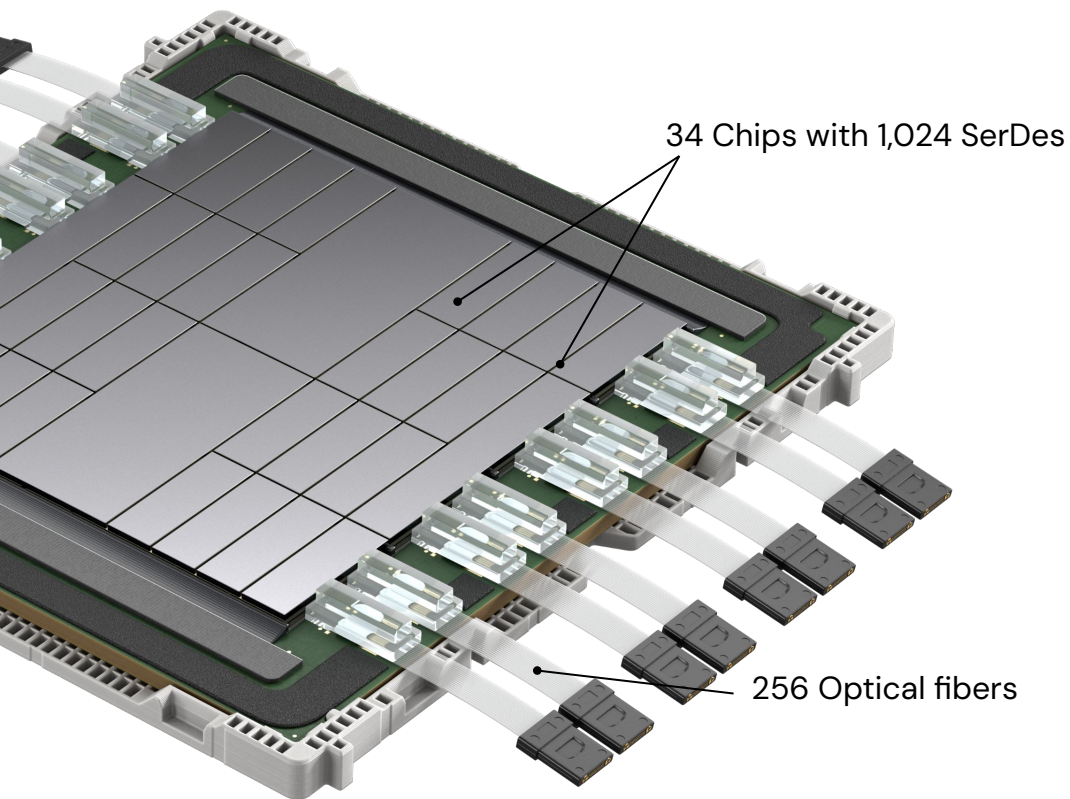
Bandwidth Equivalent of 40 Pluggables



in a tiny fraction
of the area.

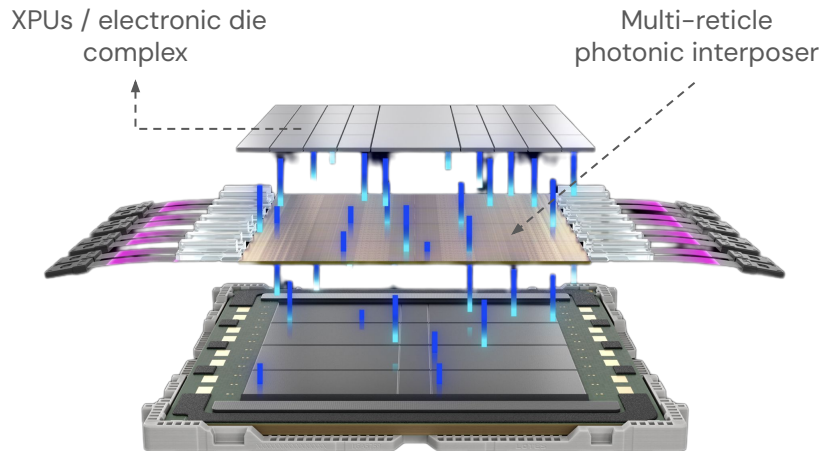


Passage™ M1000 Photonic Interposer: Multi-Reticle PIC



Enables **114 Tbps** total bandwidth.

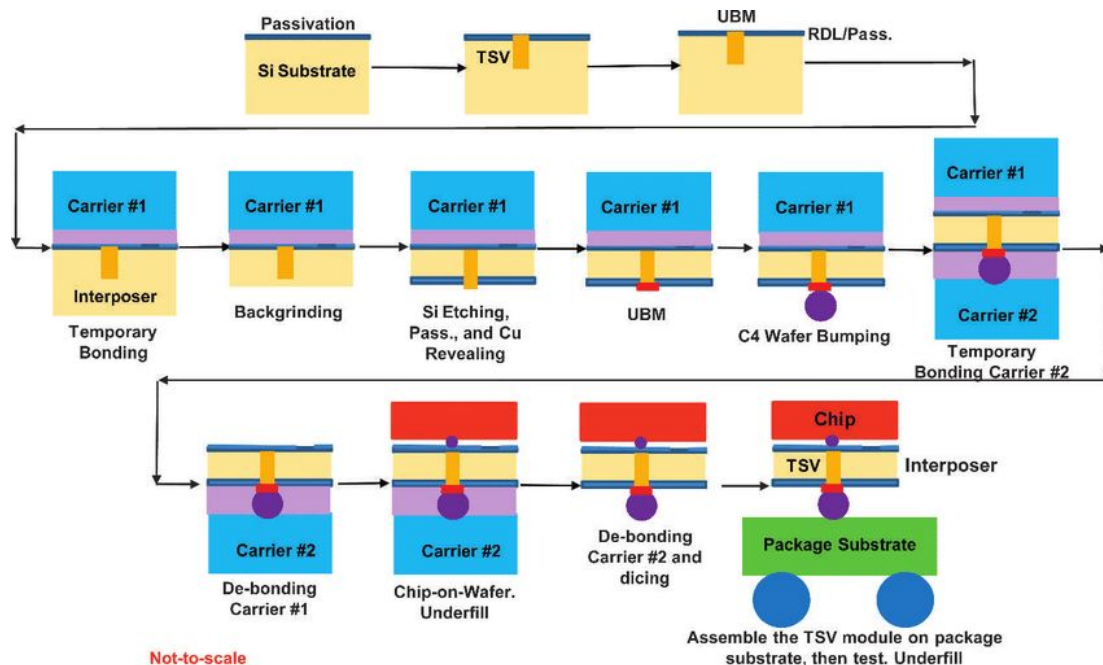
Passage™ M1000 3D Photonic Superchip



- Photonic interposer reference platform
- Fastest AI Interconnect
- M1000 enables 114 Tbps total bandwidth.
- Passage M series lives underneath die complex

Packaging Technology & Key Challenges

L200 and M 1000 Series Leverage 3D CoW Flows!

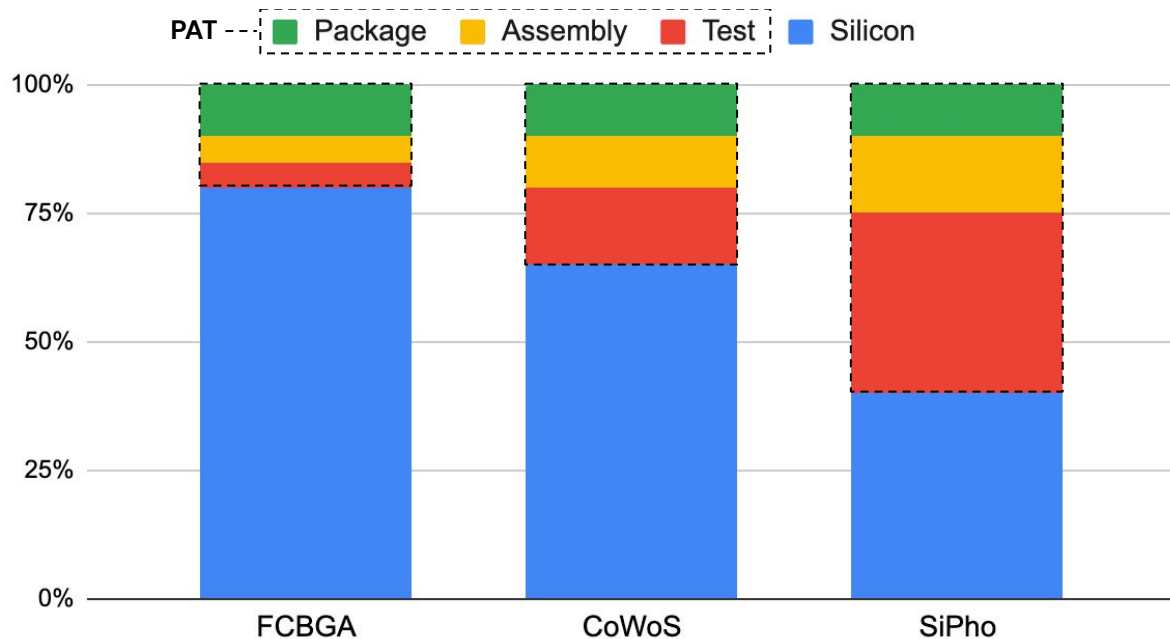


- Strong partnerships with Amkor and ASE
- LM is driving innovation in technology for fiber attach, power delivery, thermals and optical test

LM building on established 3D CoW flows to drive high-volume SiPho assembly and production

SPAT Costs and the Need for Innovation

Shares of Total Cost



Packaging, Assembly and Test (PAT) cost % is increasing

PAT cost challenges in SiPho:

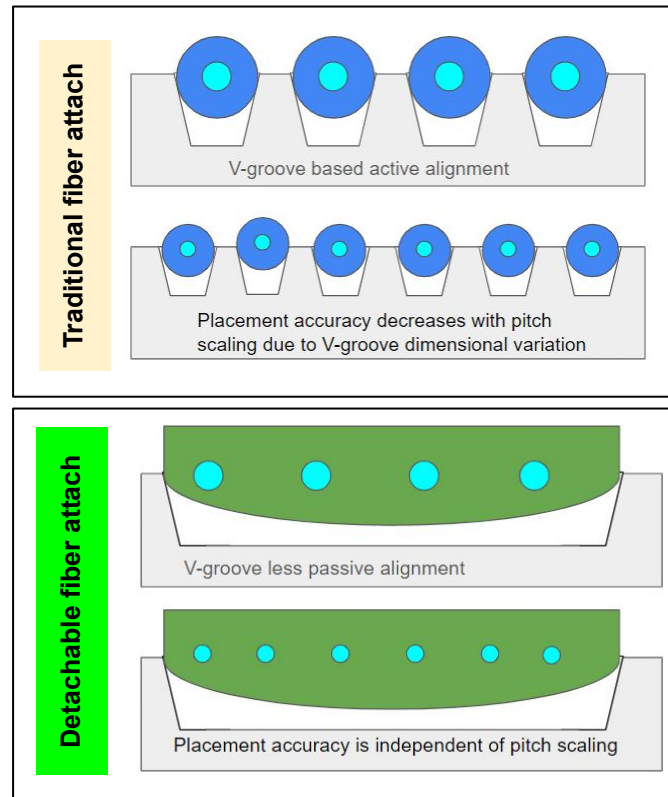
1. In assembly: fiber attach yields
2. In test: test times are much higher

LM leading with DFM/DFT-driven product architecture for high volume SiPho manufacturing and cost reduction

Note: Graph shown for demonstration purposes only

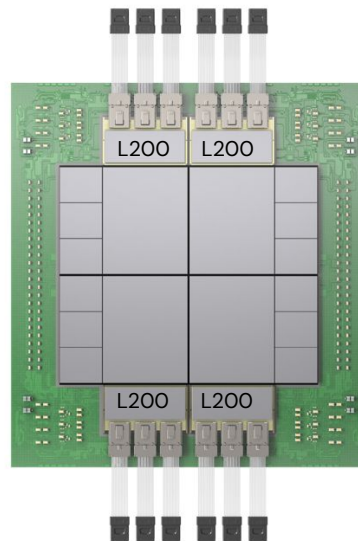
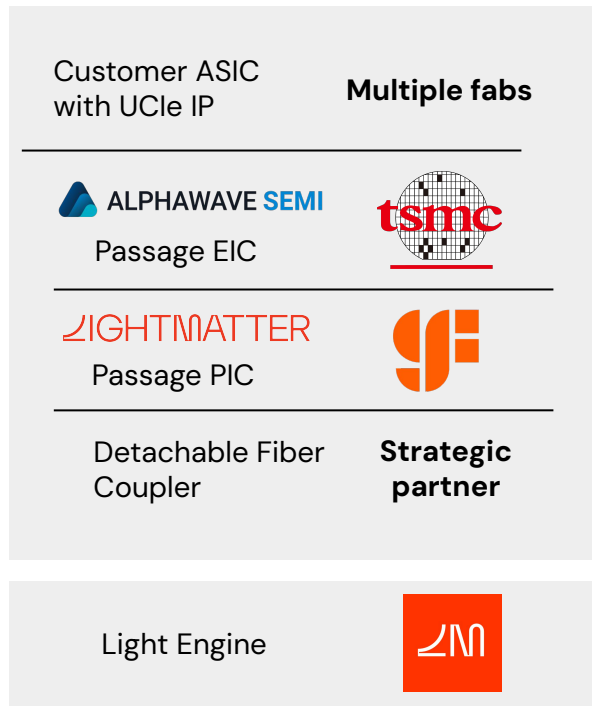
Fiber Attach Technology Comparison

Traditional: V-Groove	HVM scale: Detachable
Package level assembly	Wafer level assembly
V-groove based attached	V-groove less attach
Placement accuracy decreases with pitch scaling due to V-groove dimensional variation	Placement accuracy is independent of pitch scaling
Active alignment w/loop back	Passive alignment is possible
Throughput time ~ 15-30 min/attach	Higher TPT ~ <5 min
Known good optical unit only after PKG assembly -> higher risk for yield loss	Known good optical unit before PKG assembly -> Higher assembly yield
Limited scalability to HVM (\$\$\$)	HVM scalable solution (\$)

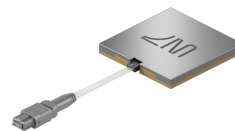


LM driving strong ecosystem partnership to bring detachable FAUs to HVM scale

End-to-End Optimized and Production-Ready



- Complete ecosystem
- High-volume readiness
- Quality and reliability



THANK YOU

