

01. INTRODUCTION

CLASSIFICATION:
OPTICAL
ARCHITECTURE

THE OPTICAL SHUFFLE

Navigating the interconnect architecture of next-generation AI Factories

Outlook: 2026 // Gen-AI Infrastructure

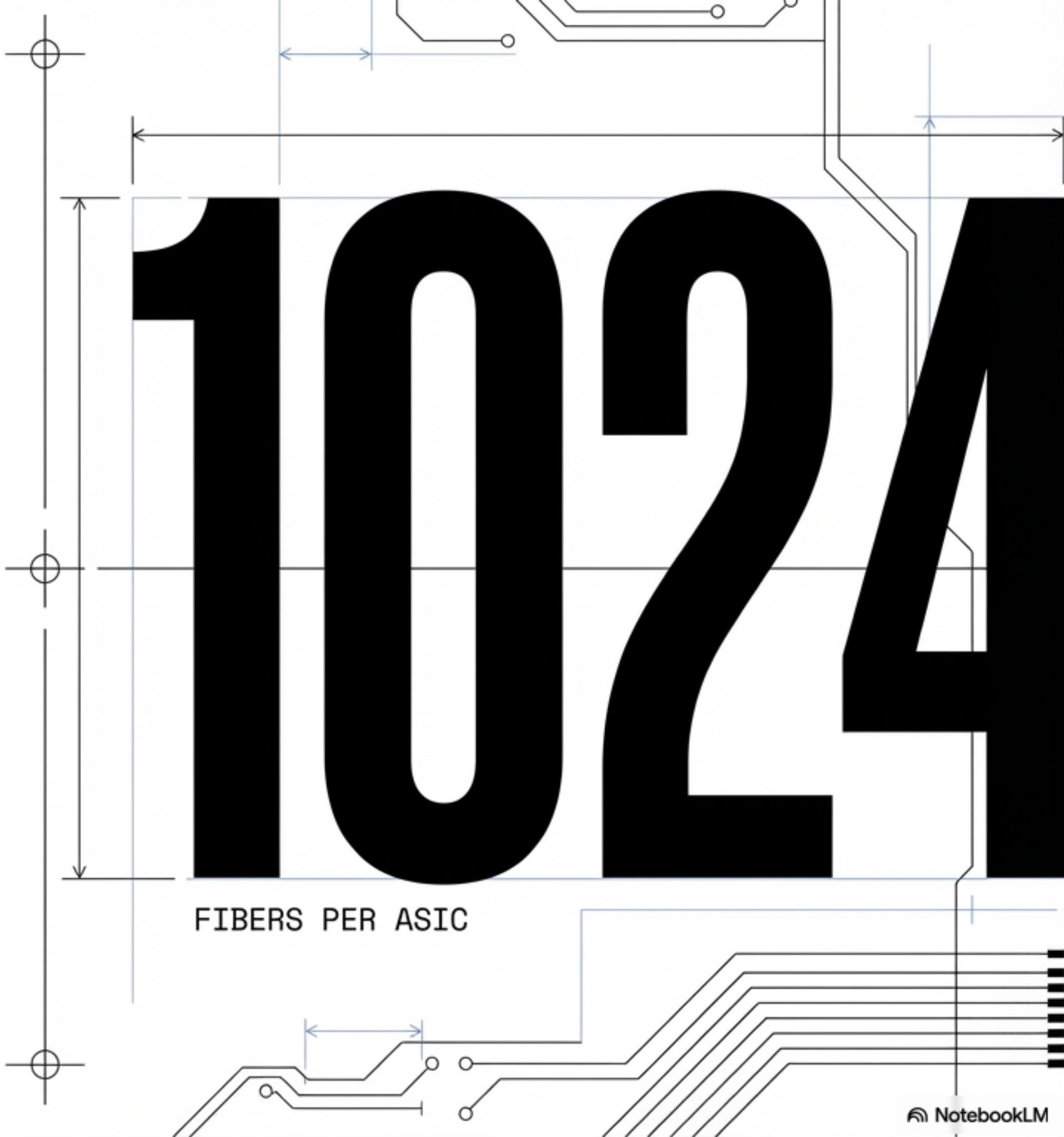
Specs:
Adtek / Molex
/ Sylex /
NVIDIA

01. INTRODUCTION

EXPONENTIAL DENSITY.

The rapid growth of AI and cloud computing is pushing data centers to physical limits. The “AI Factory” requires a density of fibers that defies traditional routing methods. We are moving from standard cabling to high-density optical fabrics.

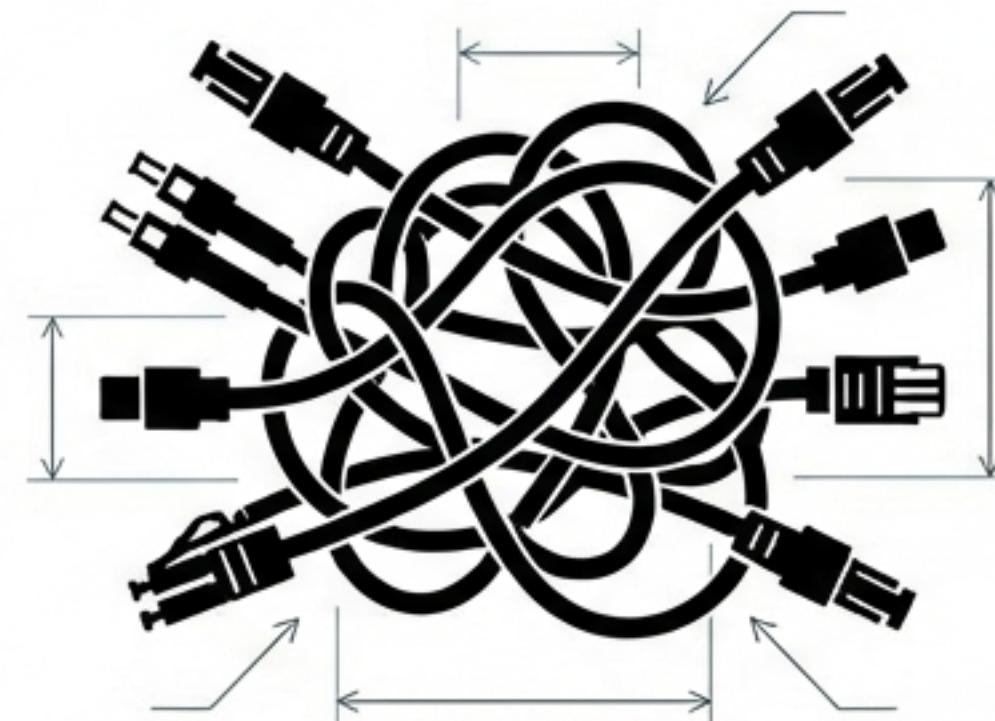
Source: Adtek / NVIDIA Spectrum-X.



01. INTRODUCTION

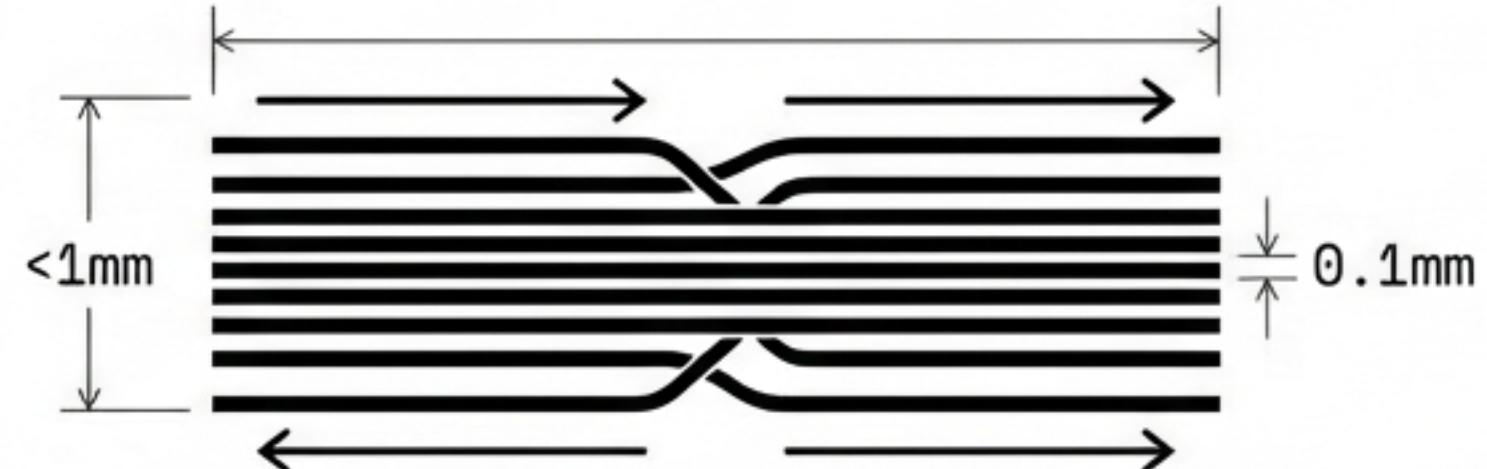
THE TANGLE

Traditional MPO/LC cabling is too bulky for Co-Packaged Optics (CPO). In restricted spaces, these cables compete with PSUs and cooling systems, blocking airflow and increasing signal crosstalk.



THE SHUFFLE

A precision-engineered optical circuit. The Shuffle organizes chaos into a flexible film substrate less than 1mm thick. It manages routing with 0.1mm accuracy, maximizing airflow.



Ref: Molex Customer Challenges

02. TECHNOLOGY

ORGANIZED LIGHT.

The Fiber Shuffle acts as a flexible optical circuit board. It routes thousands of fibers from the Optical Engine to the front plate within a Polyimide Substrate.

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02. TECHNOLOGY

PRECISION ROUTING.



ROUTING ACCURACY:
< 0.1 MM



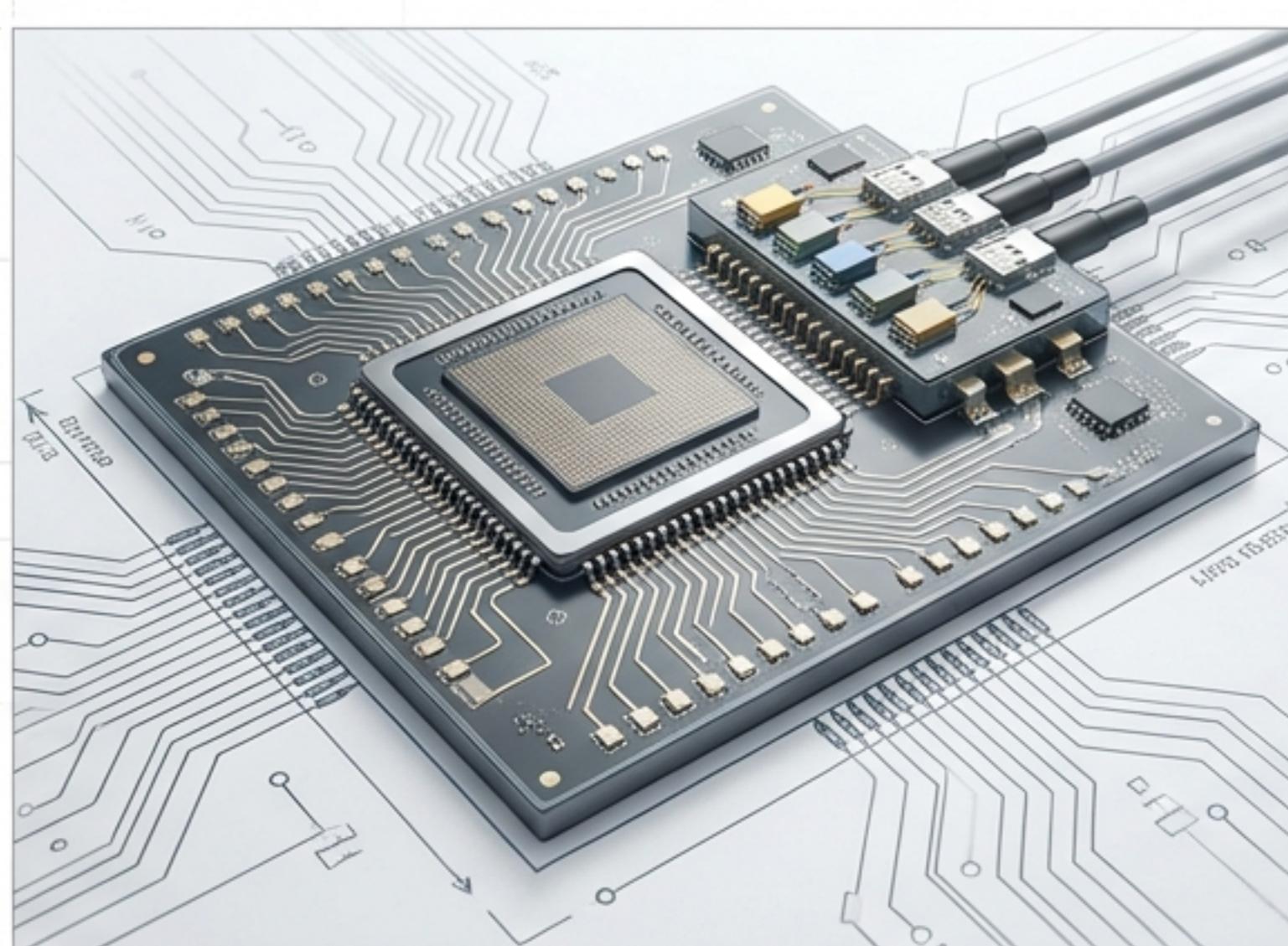
FIBER SUPPORT:
200 – 900 µm



SUBSTRATE PROFILE:
< 1.0 MM

MANUFACTURING:
FLEXPLANE AUTOMATION

CO-PACKAGED OPTICS (CPO)



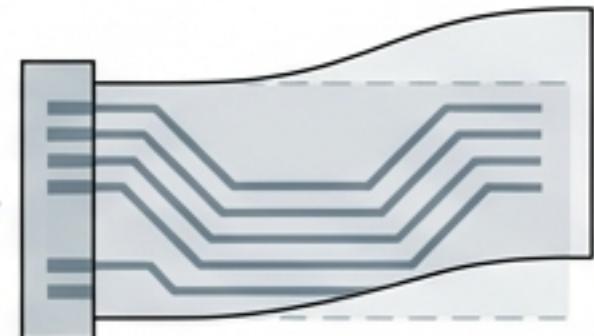
- 1. PROXIMITY:** Optical Engine moves to the ASIC.
- 2. EFFICIENCY:** 5x power reduction per 1.6 Tb/s port.
- 3. RESILIENCE:** 5x longer link uptime.
- 4. SERVICEABILITY:** Segregated cables allow individual O/E maintenance.

ADTEK APPROACH.

01

FLEXIBLE FILM

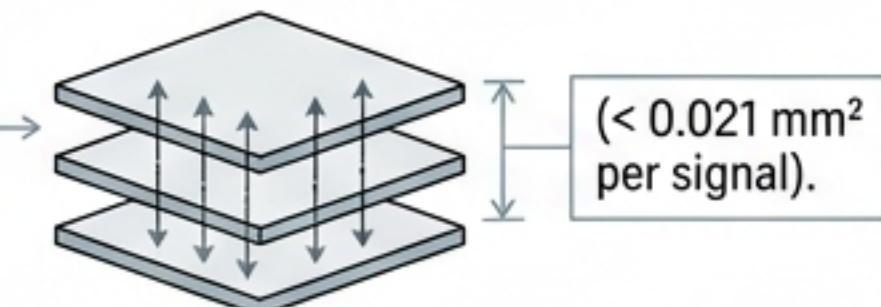
Polyimide substrates support custom routing matrices on flame-retardant materials.



02

STACKED DESIGN

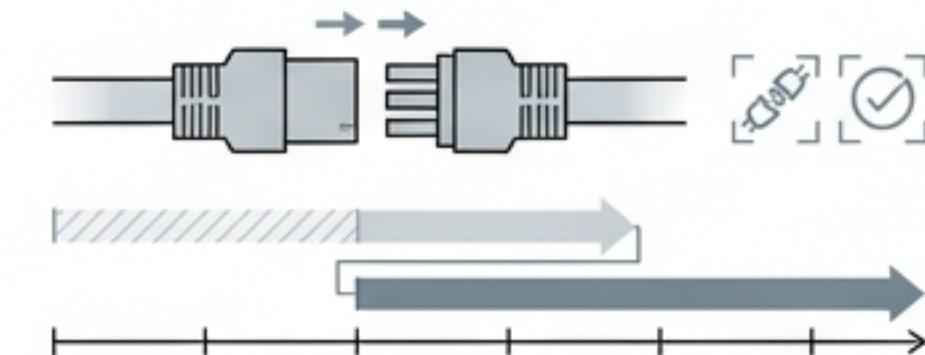
Multi-layer capability allows for thousands of fiber cross-connections in a minimal footprint ($< 0.021 \text{ mm}^2$ per signal).



03

PLUG & PLAY

Pre-terminated and factory-tested (IL/RL) to reduce on-site deployment time.





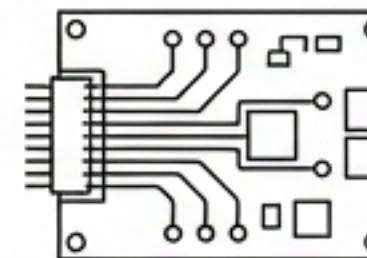
03. SOLUTIONS

ECOSYSTEM: MOLEX & SYLEX



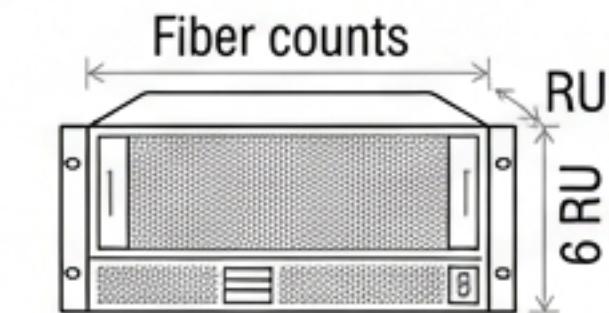
MOLEX OPTOCONNECT

Uses FlexPlane optical circuitry to solve intricate port-mapping issues with automated manufacturing.



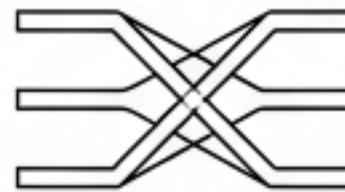
AGGREGATION

Supports enclosures from 72 up to 6,400 fibers in 1RU to 6RU sizes.



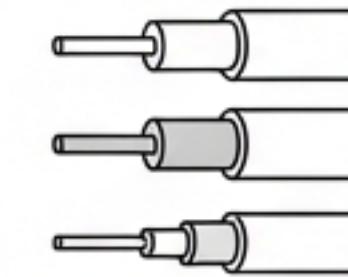
SYLEX CROSSOVER

Permits fiber paths to intersect during manufacturing without sustaining damage or micro-bending.

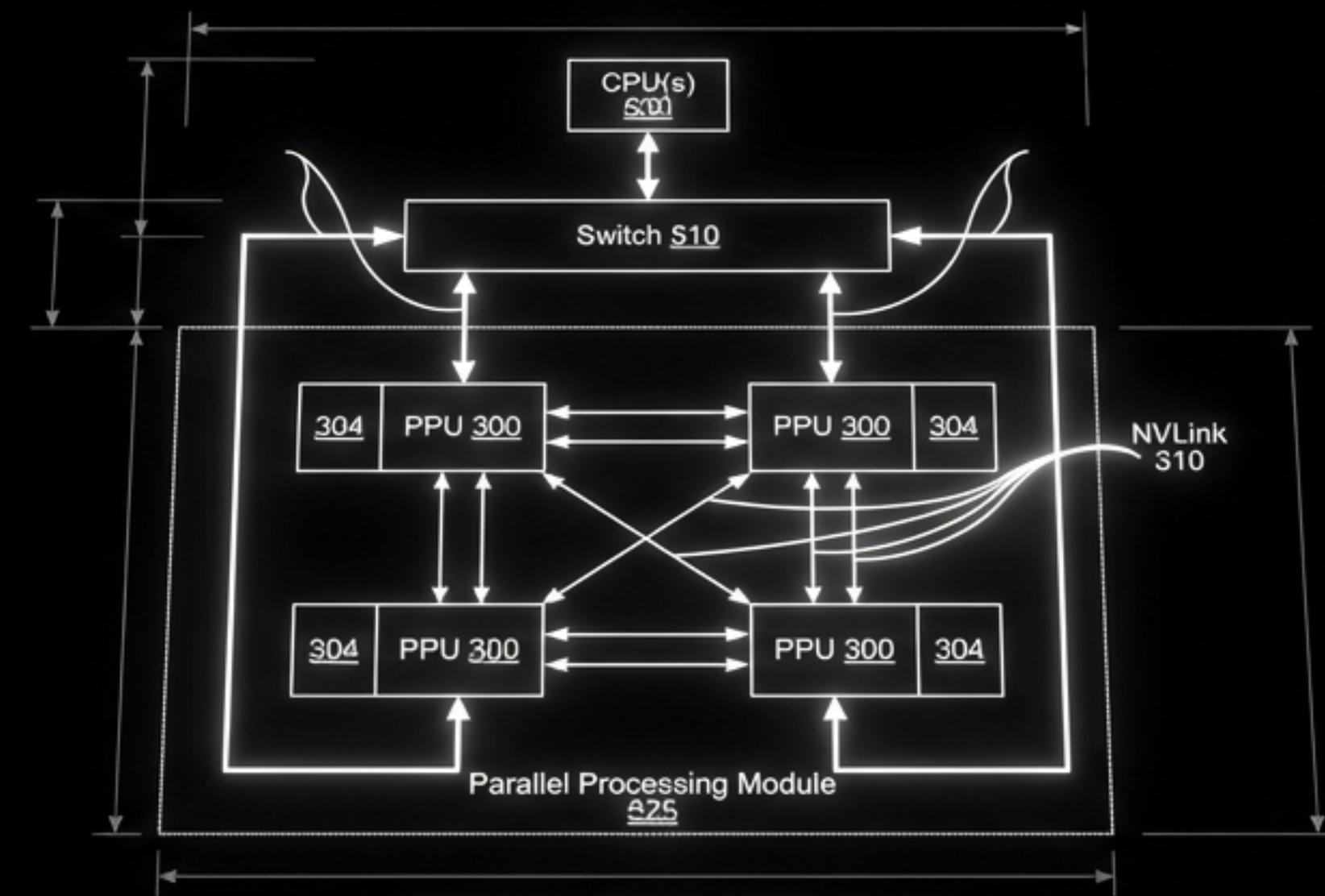


VERSATILITY

Supports Single-mode, Multi-mode, and Rad-Hard specialty fibers.

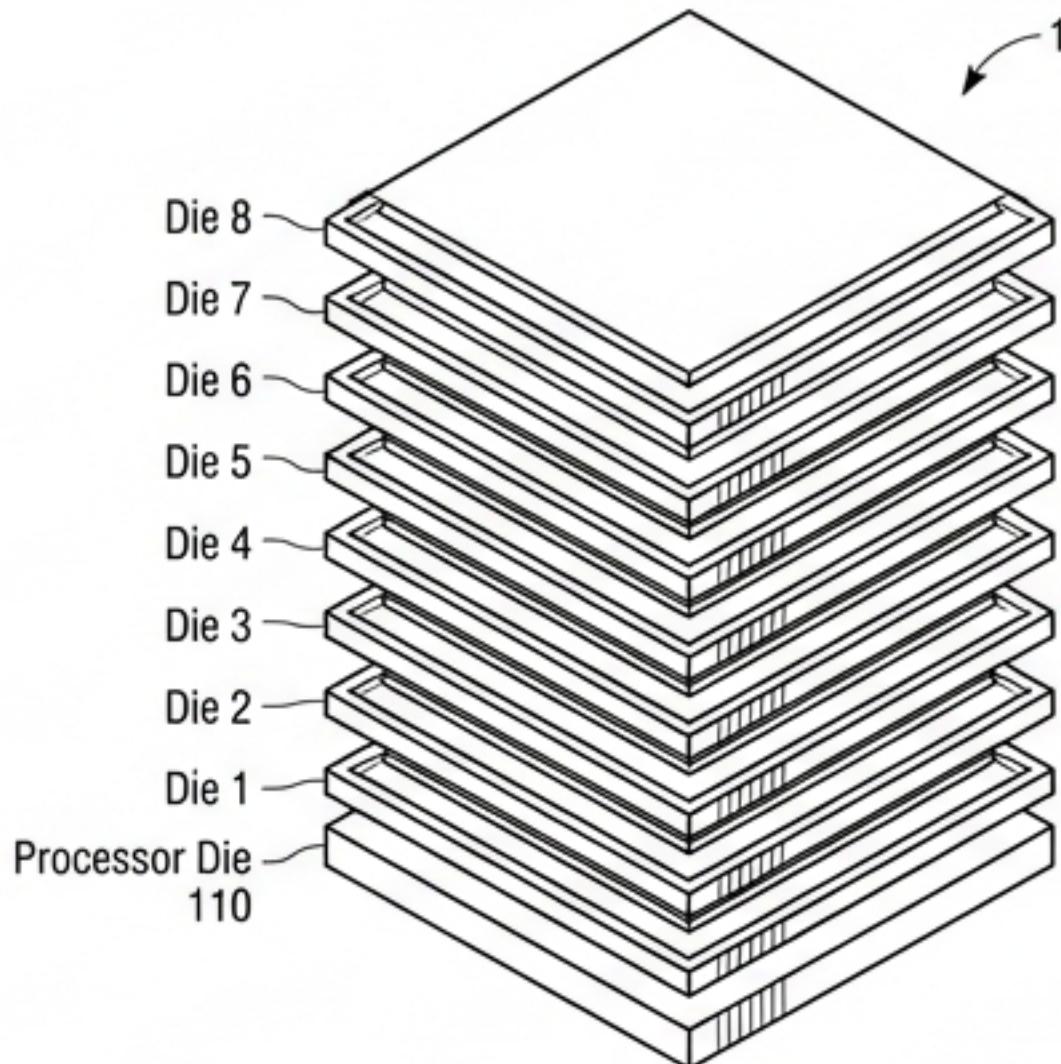


THE AI FACTORY STANDARD

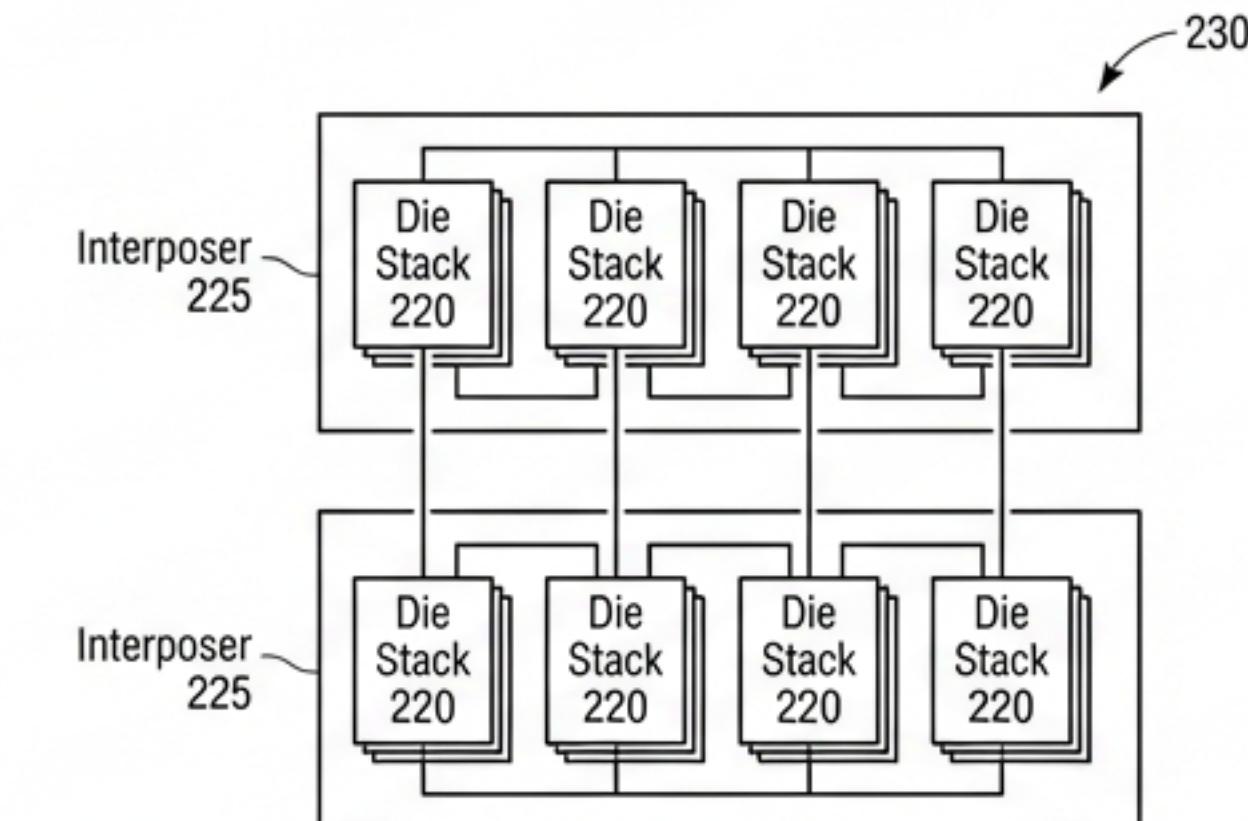


Utilizes integrated fiber shuffles to deliver 409.6 Tb/s total bandwidth. A fully integrated 512-lane system designed for multi-trillion-parameter AI infrastructure.

VERTICAL ARCHITECTURE.



Redrawn from Fig. 1A of US 2023/0275068 A1



Redrawn from Fig. 2C of US 2023/0275068 A1

Modern processors stack memory directly on the die to improve bandwidth-to-floating-point ratios. The Fiber Shuffle is the critical "exit strategy" for this density, routing data from the stack to the external network.

Source: US Patent 2023/0275068 A1.

PATENT LEADERSHIP.

INTEL	TSMC	BROADCOM	CISCO
NVIDIA	HUAWEI	LIGHTMATTER	AYAR LABS

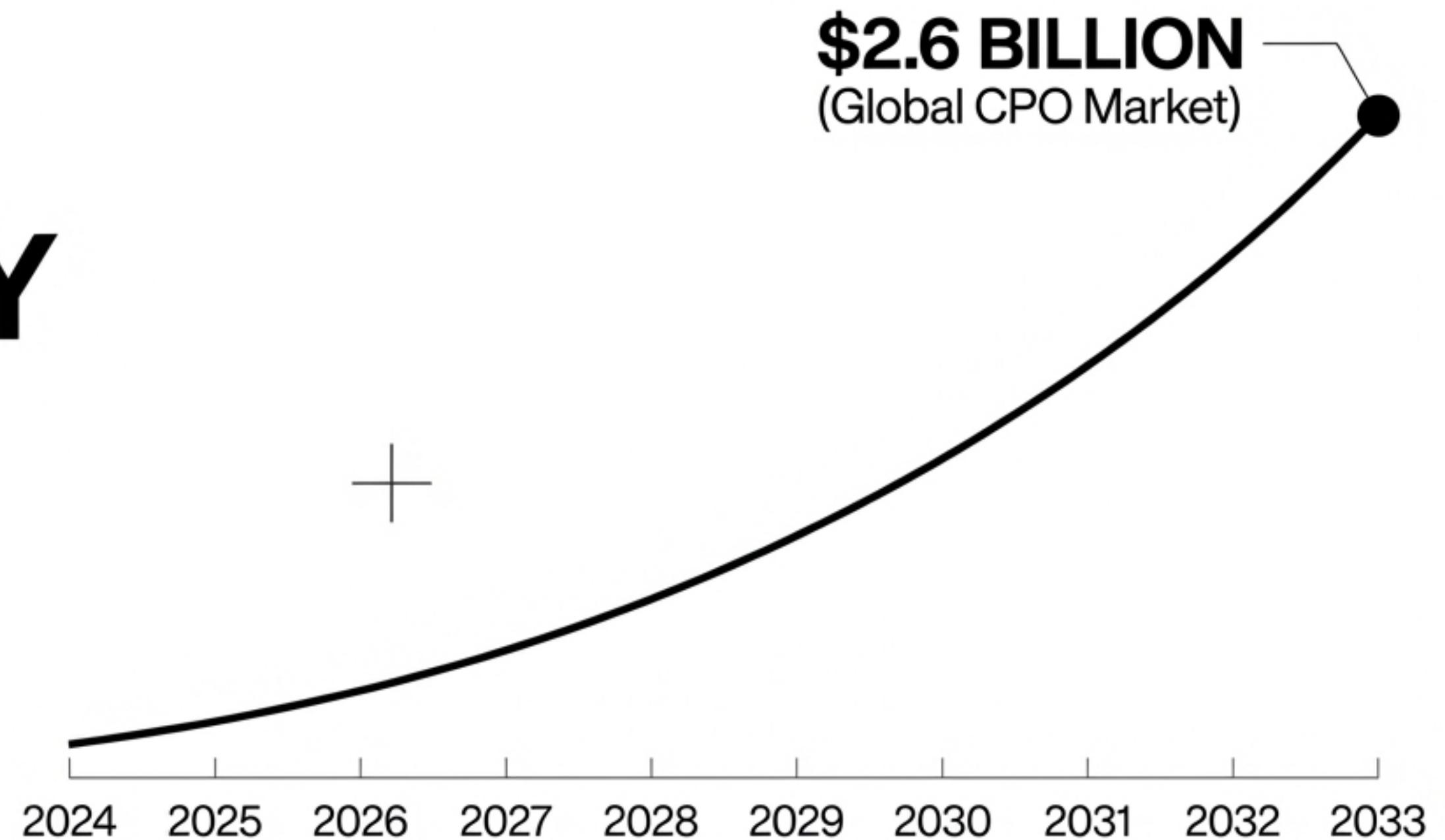
TSMC and Intel lead the patent race, shifting strategic focus from electrical to optical I/O architectures.

Source: KnowMade Patent Landscape Analysis.

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NotebookLM

04. MARKET & FUTURE

MARKET VELOCITY

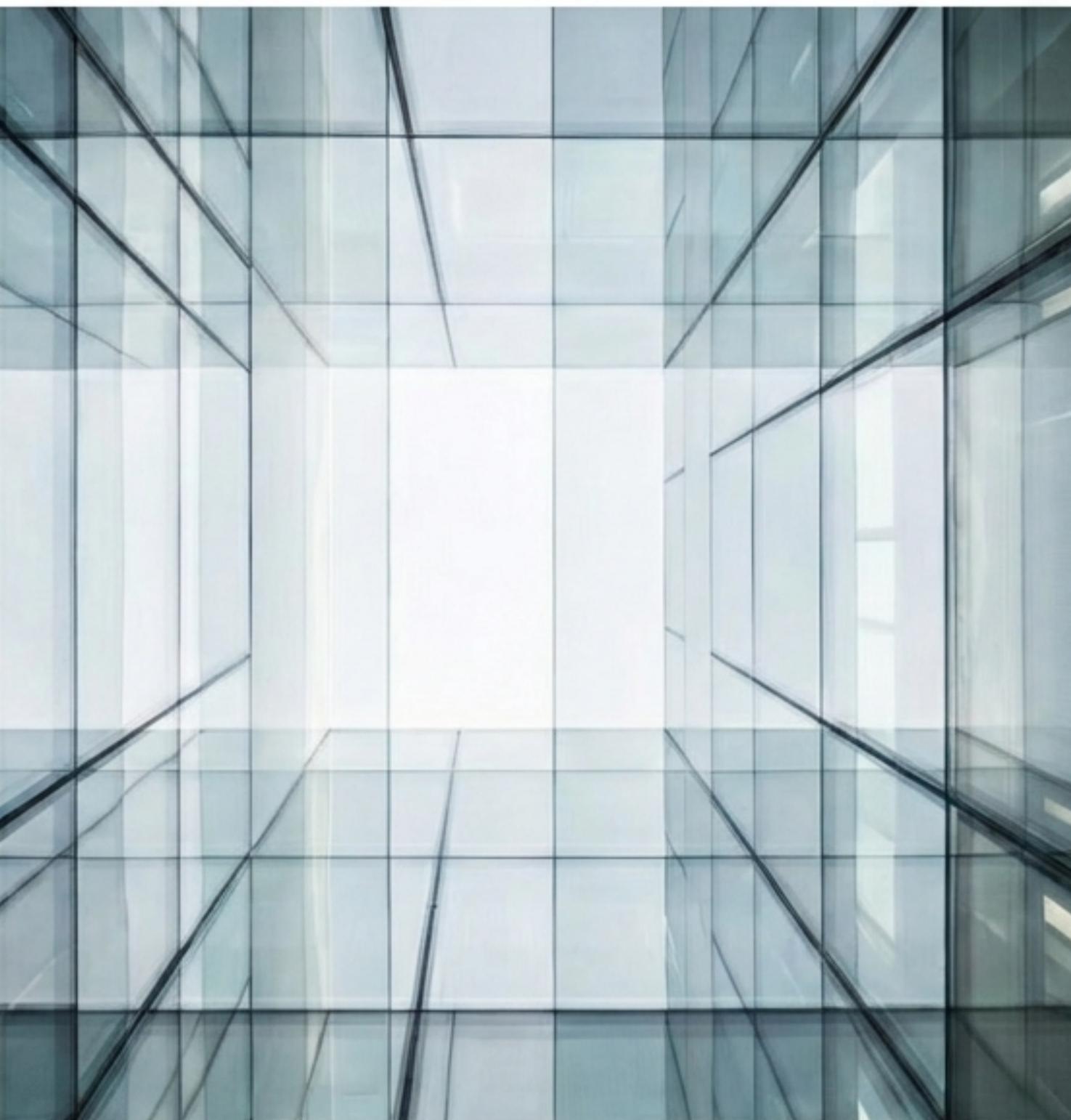


Growth driven by the iteration of SerDes rates and the inevitable choice of CPO for the computing revolution.

INNOVATION ROADMAP.

- **NOW**
100Gb / 200Gb Channels.
- * ○ **NEXT**
400Gb Channels at High Density.
- **FUTURE**
Surface-normal Optical I/O with detachable connectors.

GOAL: Ultra-low-latency AI Fabrics.



ARCHITECTURAL INTEGRITY.

- **EFFICIENCY.**

Managed routing = Better Signal Integrity.

- **DENSITY.**

Solves the space constraint in 1024+ fiber switches.

- **SCALE.**

The physical backbone of the AI era.

FROM COPPER TO LIGHT.

**The Optical
Interconnect Shuffle.**

Presentation based on technical specifications
from Adtek, Molex, Sylex, and NVIDIA.