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CPO Progress and Ecosystem Development

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APC January 2024

Co-Packaged Optics (CPO): Pros and Cons

PROS

Lowest Cost/Bit with massive reduction in components and interconnects

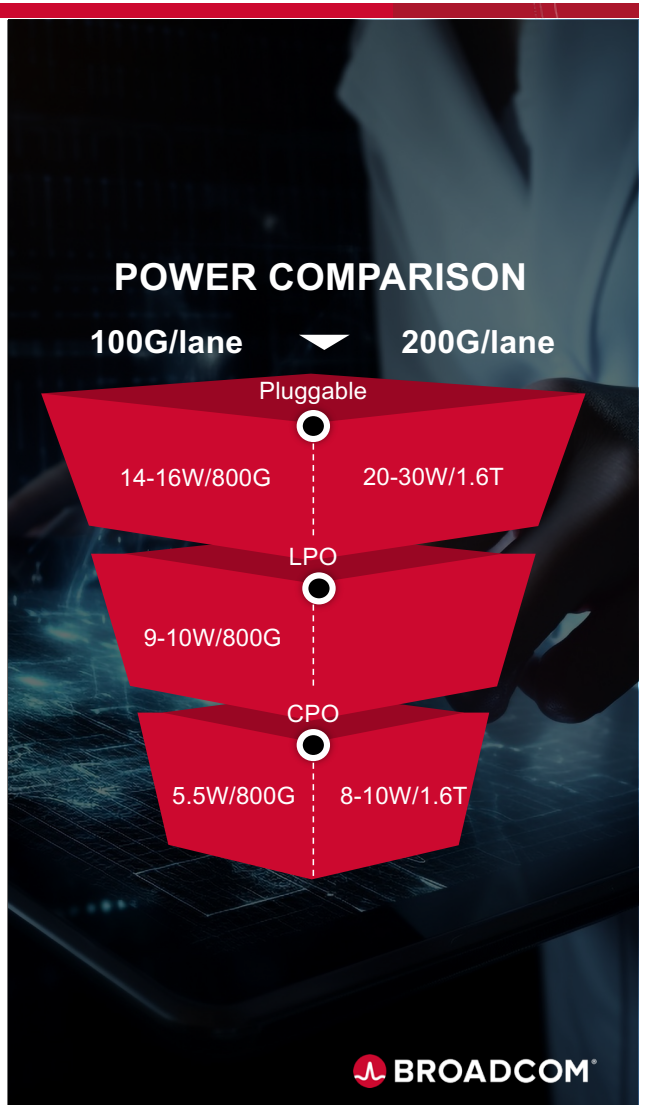
Power/Performance by eliminating the electrical interconnect power dissipation and variability

Leverage Silicon **Reliability** and eliminate practice of accepting high failure rate optics due to simple replacement

CONS

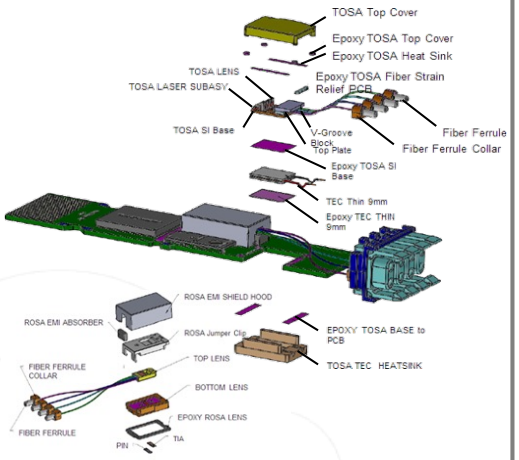
Fixed Configuration

Reliability vs Replaceability



Evolution of Optics: Discrete III-V to Co-Packaged SiPh

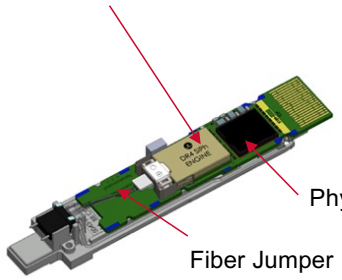
Conventional Module Design



Engineering and manufacturing limits to scale

Integrated Module Design Based w/ Silicon Photonics

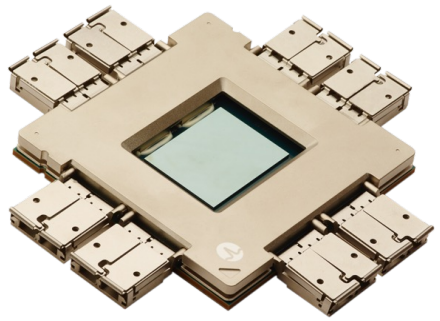
SiPh Chiplets in Package (SCIP)



30% fewer Piece Parts!

Module Integration = First step to improved scale

Co-Packaged Optics



Highly Integrated Optical Engines (3.2T to 6.4T)

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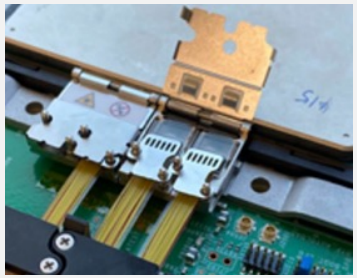
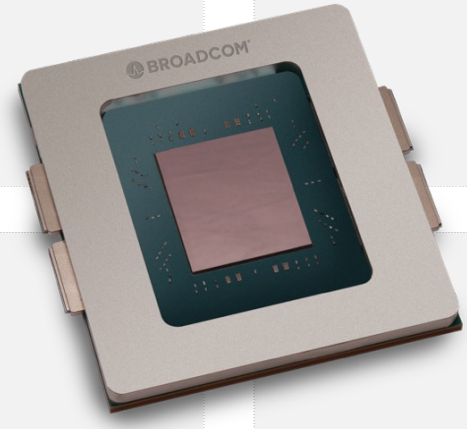
Humboldt 25.6T Co-Packaged Optics



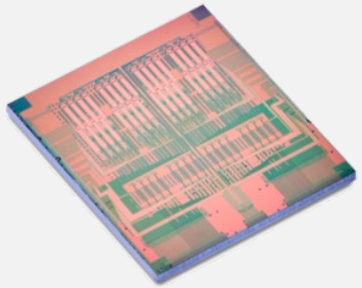
Detachable Fiber Connector



32-channel integrated TIA and driver

ODM System Integration

32 channel PIC



Key Technology and Ecosystem Demonstration

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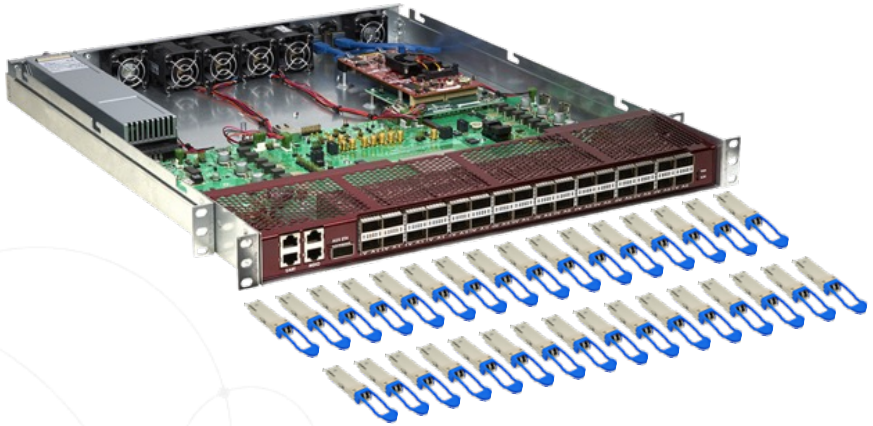
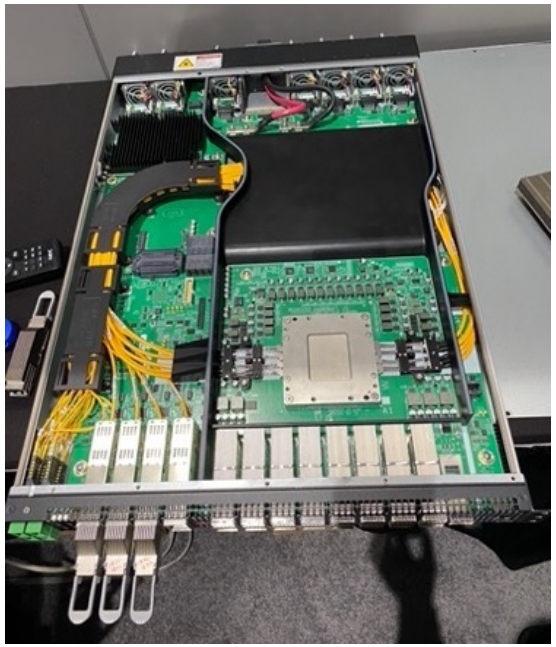
System Level Simplification Using Co-Packaged Optics





Signification reduction in board and system complexity

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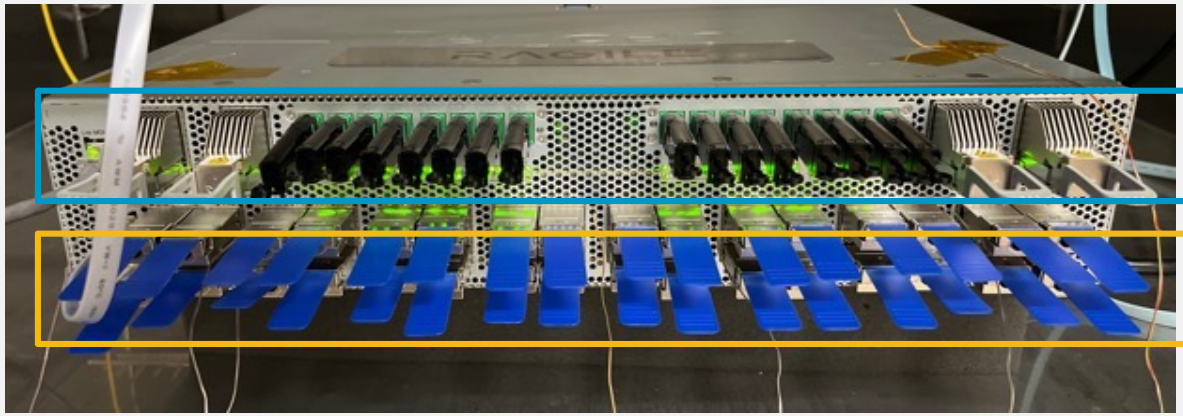
CPO System Implementations



CPO connectivity offers > 30% more faceplate area for ventilation →
Pre-heating of inlet air is 3C-5C lower for CPO solution → fan power reduction

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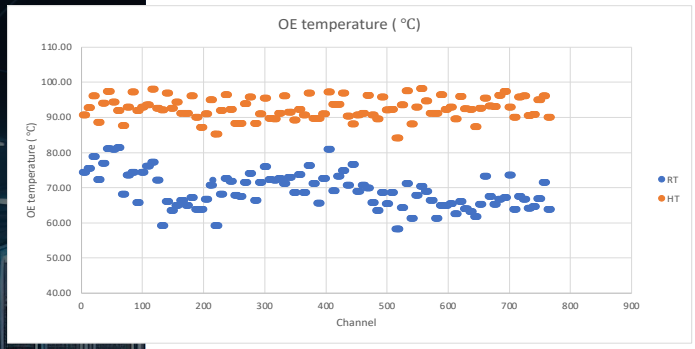
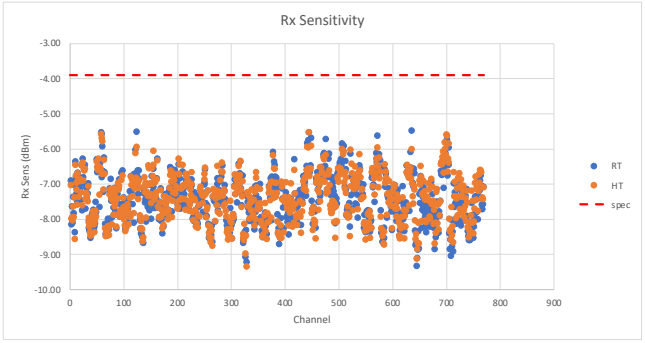
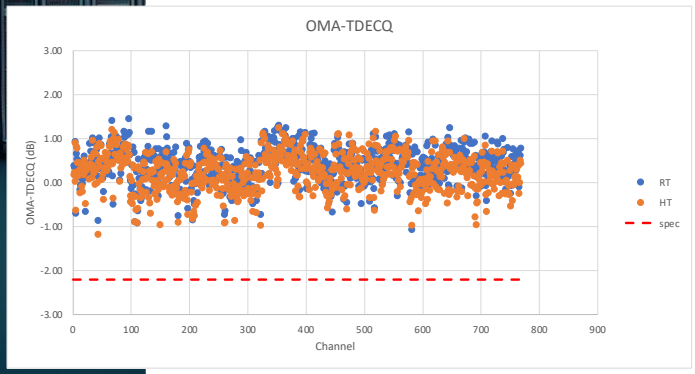
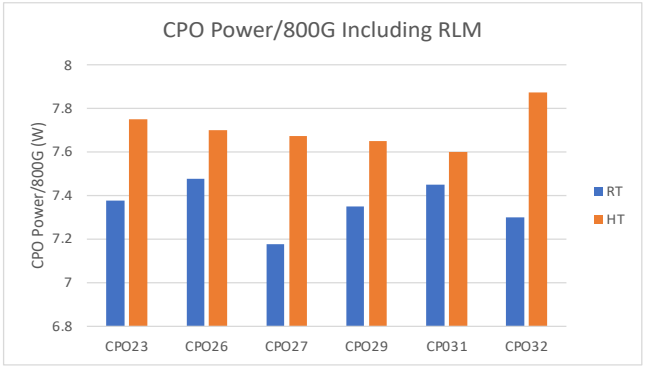
Humboldt 25.6T CPO Production Data









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World's First CPO System Development Timeline

First public demonstration

First public demonstration on SVK

800G operational (out of 12.8T)

MAR'22

3 MONTHS

Full Optical Engine

Demonstration with ODM system

3.2T operational – first full optical engine

OCT'22

1 MONTH

Fully functional system

Public demonstration of fully functional 25.6T CPO (HE/HO)

MAR'23

2 WEEKS

In qualification

OCT'23

1 DAY

Time from CPO installation to traffic testing

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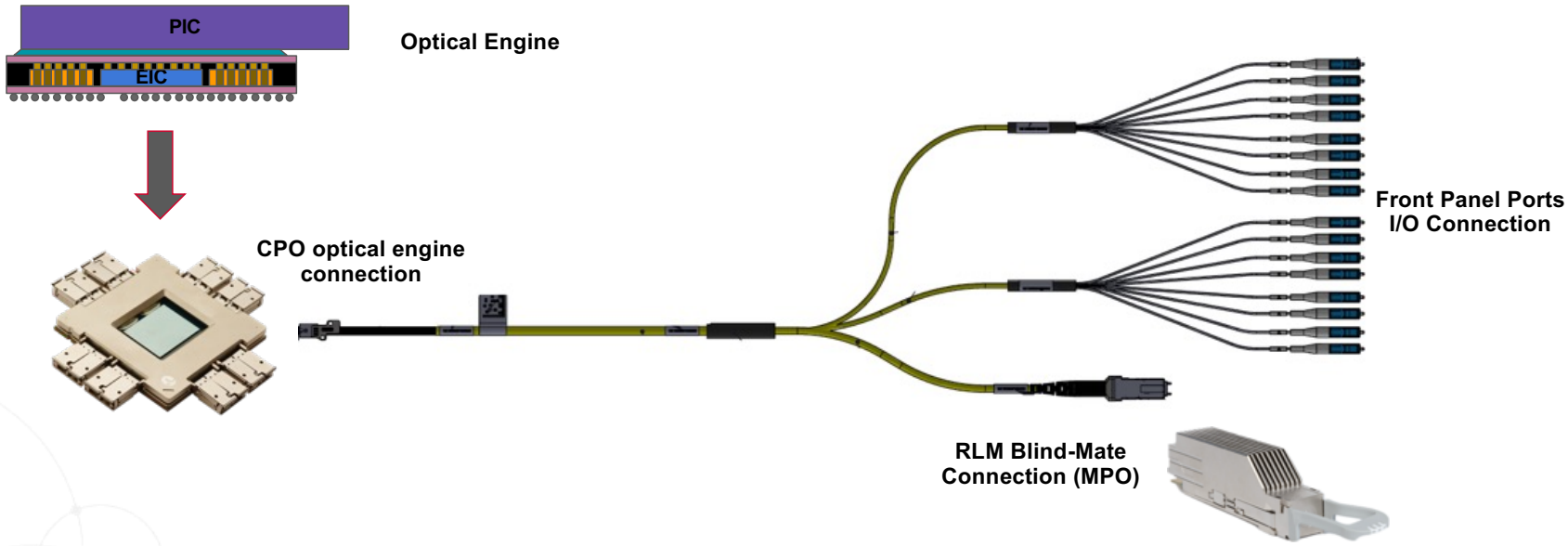
Critical Components of CPO Optical Path



CPO is a new deployment paradigm, important to drive commonality on what is on the fiber across multiple applications in networking and compute

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Remote Laser Module

Key Characteristics

- High Power Laser Source
- Front Panel Pluggable (FRU)
- Uncooled 8 laser TOSA, Class 1 Eye Safe
- Operating Case Temperature: 0 – 45C
- QSFP-DD host connector w/ integrated MPO
- CMIS Management Interface through I2C

Short-term Ecosystem Opportunity and Needs

- Continued investment in high power CW laser diodes
- Front panel flexibility for various form factors

More time needed to determine which optimization vectors are most critical in applications: Cooled vs uncooled, laser diode power vs quantity

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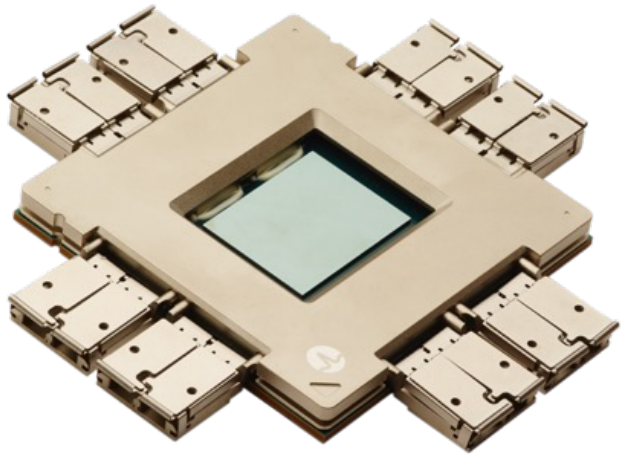
CPO: ASIC + Optical Engines

Key Characteristics

- 51.2T CPO (all optical 128 x 400G ports)
- IEEE 400GBase-FR4
- 8 x 6.4T optical engines with Integrated CMOS TIA & DRVR
- Detachable package fiber connectivity

Ecosystem Opportunity

- Emphasis on optical devices in advanced packaging: double side attach, cleanliness



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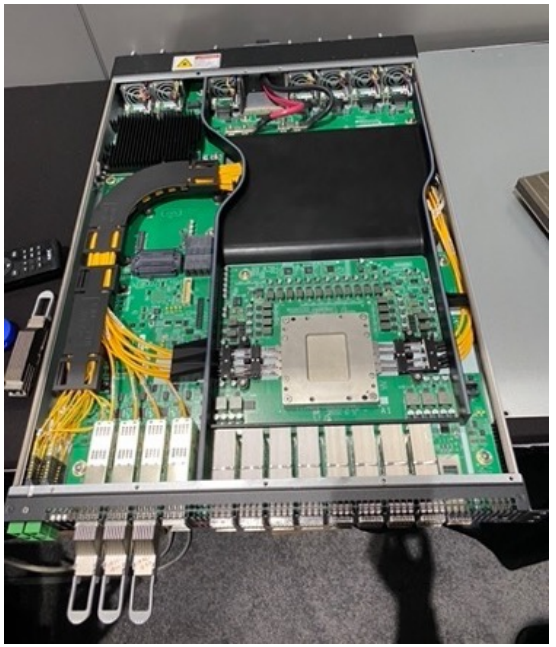
System Implementations

Key Characteristics

- Optical high-speed routing optical (vs electrical for standard system)
- Front-panel I/O optical ports
- RLM blind mate connectors

Short-term Ecosystem Opportunity and Needs

- Collaboration and standardization on stress factors for qualification and reliability



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Summary

- No technical show-stoppers for CPO
- Emerging appliance ecosystem to integrate and deploy
- Next key steps are reliability and yield to achieve CPO value prop – lowest cost, power and latency – lowest TCO

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