From LPO to NPO to CPO

The open optical roadmap for AI infrastructure

A staged architecture view for pluggable optics, linear pluggable optics, near-package optics, co-packaged optics, and co-packaged copper.

CORE THESIS

Optical I/O will move closer to silicon. The real question is timing, service model, and production readiness.

Micas NETWORKS

Tim Zhou, VP, Micas Networks

Monday, October 12 · 12:30 PM

AGENDA

Where Micas is going today

01 **Thesis** p. 03
Direction is clear; timing is the open question.

02 **Architecture options** p. 04–05
Pluggable, LPO, NPO and CPO, and the problem each one solves.

03 **NPO up close** p. 06–07
Three NPO paths and the laser choice that shapes service.

04 **Standards & outlook** p. 08–10
Three new MSAs and what 2026–2029 looks like.

05 **Execution risks** p. 11
The bottlenecks that set the real ramp.

06 **Micas' role & call to action** p. 12–13
What we bring, and four asks for the OCP community.

CORE THESIS

Direction is clear. Timing is not.

01

Direction

AI cluster growth forces optical I/O closer to switch ASICs and accelerator packages.

02

Timing

The ramp depends on manufacturing maturity, qualification cycles, thermal design, and service risk.

03

Open ecosystem

Hyperscalers want to turn proprietary systems into reusable interfaces, test methods, and operational norms.

2026

Early adoption of CPO and supply-chain integration year.

2027

Highest uncertainty: readiness varies by use case.

2028 – 2030

XPO/NPO/CPO co-existence?

ARCHITECTURE ROLES

Pluggables remain necessary, but not sufficient

closer to the ASIC →

	Pluggable 800G / 1.6T	LPO	NPO	CPO
PRIMARY VALUE	Operational maturity and broad ecosystem	Lower module power and latency by reducing DSP dependency	Shorter electrical reach with better serviceability than CPO	Best density and power efficiency close to the ASIC
MAIN TRADE-OFF	Higher electrical loss and power at high lane rates	Tighter host-channel and link-margin requirements	More integration complexity than pluggable optics	System yield, thermal, repair, and field-service complexity
BEST-FIT WINDOW	NOW & ONGOING	NEAR-TERM	2026 – 2028	POST-QUALIFICATION
	Immediate and continuing volume	AI fabrics with validated SI margin	Platform transition	High-density systems

- The practical roadmap is not a single replacement cycle. It is a portfolio decision by distance, density, power, latency, cost, and service model.

COMPLEMENTARY STACK

CPO, LPO and NPO solve different problems

CO-PACKAGED OPTICS

CPO

Maximum integration for power and density.

Shortens the ASIC-to-optics electrical channel, but changes the failure boundary and requires strong yield, rework, thermal, and service strategies.

LINEAR PLUGGABLE OPTICS

LPO

Practical near-term power reduction.

Reduces module-side electronics and latency, but requires careful host-channel characterization, port selection, and platform-specific validation.

NEAR-PACKAGE OPTICS

NPO

Serviceable optical proximity before full CPO.

Shortens the electrical reach while preserving a clearer optical-engine replacement model.

The key shift for AI infrastructure is not bandwidth alone. It is bandwidth...	bandwidth **per watt**	bandwidth **per rack unit**	bandwidth **per dollar**	bandwidth **per operational risk**

SERVICEABLE OPTICAL PROXIMITY

NPO deep dive

NPO moves the optical engine close enough to reduce 200G/lane electrical reach while keeping a practical manufacturing and repair boundary.

NPO PATH	HOW IT CONNECTS	TECHNICAL VALUE	ENGINEERING RISK
Open CPX-based NPO	ASIC → CPX socket → serviceable optical engine	Open optical-engine boundary with stronger vendor flexibility	Socket, power, cooling, telemetry, firmware, and OE qualification
OBO / OCI path	Traditional BGA ASIC with very short PCB path to modular OBO optical engine	Faster platform introduction with independent optical subsystem qualification	Connector loss, external laser distribution, CMIS management, and production test

- NPO reduces CPO adoption risk only when the system vendor owns the full architecture: SI, thermals, mechanics, software, telemetry, test, and field service.

NPO DESIGN CHOICE

Laser architecture shapes the NPO service model

External laser source

+ ADVANTAGES

Keeps laser heat and aging outside the OE; enables laser redundancy and replacement.

– DISADVANTAGES

Adds light-source modules, fibers, connectors, routing, cleanliness burden, and management objects.

BEST FIT

High-density CPO or NPO where serviceable laser replacement and redundancy matter most.

Internal laser in NPO module

+ ADVANTAGES

Simplifies optical plumbing and creates a self-contained field-replaceable assembly.

– DISADVANTAGES

Places laser heat, aging, monitoring, and failure impact inside the OE module.

BEST FIT

Serviceable NPO where customers want built-in-laser modules and less external laser infrastructure.

HYPERSCALER REQUIREMENT SIGNAL

Built-in laser NPO can simplify service procedure and reduce dependency on external light-source plumbing.

MICAS EVALUATION CONTEXT

Track various NPO system approaches, including built-in-laser module concepts and optical chipset ecosystem options.

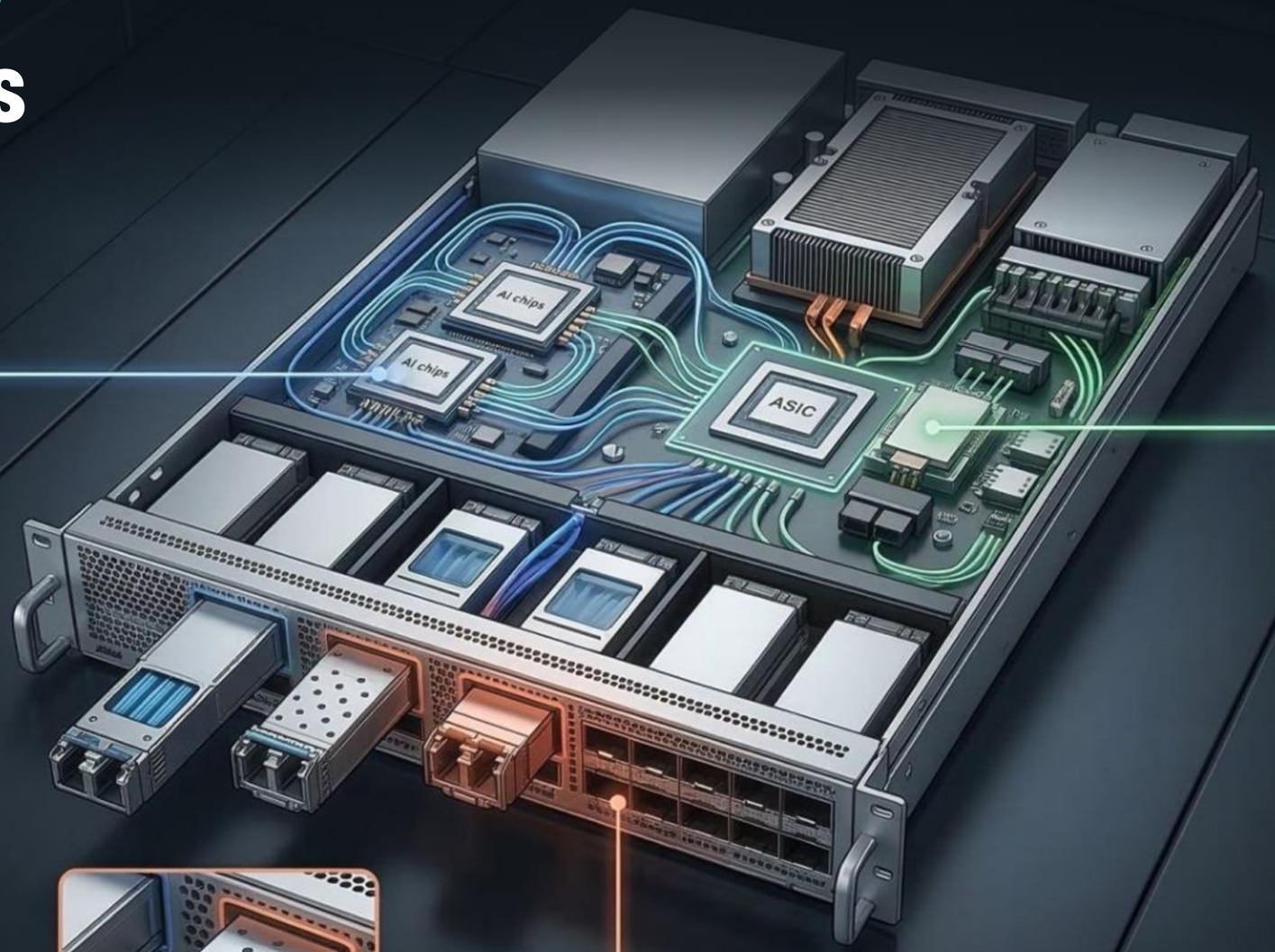
3 new MSAs



OCI MSA

Optical PHY

AMD Broadcom Meta
Microsoft NVIDIA OpenAI





Open CPX MSA

Optical Engine

Ciena Coherent Marvell
Molex Samtec TeraHop



XPO MSA

Pluggable Form Factor
Led by Arista

2026 – 2029 outlook: pluggable paths

TECHNOLOGY	SCALE-OUT ROLE	SCALE-UP ROLE	2026 – 2029 OUTLOOK	KEY CHALLENGES
Pluggable	Mainstream leaf-spine and backend Ethernet fabric	Very limited role where reach and serviceability matter more than density	Continues through 2026–2029 as the volume baseline	Power, front-panel density, long PCB channel at 200G/lane
LPO	Near-term lower-power option for AI Ethernet scale-out	Possible for short controlled links, but margin-sensitive	2026 validation and selective deployment; broader in 2027 only where SI margin is proven	Host channel loss, connector quality, SerDes tuning, thermal drift, vendor interoperability
XPO	Higher-density pluggable path between LPO and true NPO	Useful where serviceable dense optics are preferred over package-adjacent integration	2027 engineering exploration; may coexist with NPO for operators needing a pluggable service model	Still has more electrical reach than NPO/CPO; connector and module ecosystem maturity

2026 – 2029 outlook: near- & co-packaged

TECHNOLOGY	SCALE-OUT ROLE	SCALE-UP ROLE	2026 – 2029 OUTLOOK	KEY CHALLENGES
OCI MSA / OBO optical engine	Strong fit for scale-out switch ASICs using near-board optical engines	Possible optical scale-up building block where OCI-style links are adopted	2026–2028 early systems around TH6-class platforms; expands as OCI ecosystem matures	External laser distribution, OE qualification, fiber routing, CMIS/software model
Open CPX NPO · socket	Serviceable socketed OE near switch ASIC or host device	Strong candidate for modular optical scale-up if xPUs adopt CPX sockets	2027 prototype and ecosystem buildout; 2028 early deployment if interoperability improves	Socket standard execution, power delivery, cold plate, CMIS behavior, interchange rules
CPO	Best long-term option for highest radix and lowest power per bit	Later-stage option for XPU or accelerator package integration	2026 validation and selective deployment. Switch CPO grows first in 2027–2029; XPU-CPO follows later	System yield, repair boundary, external laser reliability, fiber attach, thermal, field service

- No single interconnect will replace the others. The market will segment by reach, density, power, latency, cost, maintainability, software readiness, and manufacturing maturity.

EXECUTION RISKS

Common bottlenecks determine the real ramp

01	**Electrical channel**	200G/lane and future 400G/lane margins depend on connector transitions, return loss, crosstalk, skew, package escape, and low-loss materials.
02	**Thermal/Power design**	CPO and NPO place temperature-sensitive optics near 1–2 kW class ASIC packages, requiring reliable cold plates, TIMs, leak detection, and coupled control.
03	**Yield & serviceability**	OE, fiber coupling, package interface, and laser failures must not turn every issue into expensive ASIC or full switch replacement.
04	**Fiber & connectors**	High fiber count drives bend radius, routing, contamination control, automated assembly, density, and field repair complexity.
05	**Software & operations**	SONiC and platform management must handle OE bank mapping, CMIS, shared lasers, coordinated state changes, firmware lifecycle, and fault isolation.

- The ramp will be won through production engineering, not headline architecture labels.

SYSTEM SUPPLIER CONTRIBUTION

Micas' role in an open optical ecosystem

FOCUS AREA	TECHNICAL CAPABILITY	CUSTOMER VALUE
CPO platforms	CPO system integration, ELS control, fiber routing, thermal design, diagnostics, and SONiC integration	Lower power per bit and higher density once qualification and service models are ready
LPO enablement	Host-channel characterization, port selection, SI/PI validation, module interoperability, and thermal margin testing	Near-term power reduction without waiting for full CPO deployment
NPO readiness	Near-package architecture planning, short-reach electrical design, OE placement, maintainability analysis, and software abstraction	Lower-risk transition between pluggable optics and fully integrated CPO
SONiC & platform software	Device drivers, CMIS management, DOM telemetry, firmware workflows, port mapping, diagnostics, and automation	Consistent operating model across pluggable, LPO, NPO, and CPO

- Open collaboration matters because customers need interchangeable learning across interfaces, optics, cooling, management, and manufacturing test.

OPEN EXECUTION AGENDA

OCP call to action

1 Open interface definition

Align CPX, OCI/OBO, ICA-based NPO, CPO, and CPC around common electrical, thermal, power, and service boundaries.

2 Common validation methods

Standardize SI, BER, thermal, laser, firmware, and field-service test practices.

3 Open software control

Expose optical engine state, laser health, alarms, firmware, and recovery workflows through SONiC and platform management.

4 Interoperable supply chain

Enable multi-vendor optical engines, sockets, lasers, connectors, cooling, and manufacturing test ecosystems.

We opened with one thesis: optics move closer to silicon. The question was never *if*, only timing and readiness.

Thank you.

Tim Zhou
VP, Micas Networks



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Open AI Factory After Hours

Wed, Oct 14 · 6:00 – 9:30 PM
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Food, drinks and the newest CPO from Micas and Broadcom.

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