

The Copper Wall — Switch to Optical

Why Electrons Are Failing the AI Era and How Light Becomes the New Backbone of Compute

The industry spent decades optimising compute. It is now constrained by the least advanced part of the system — the wire.

INVESTMENT THESIS

The copper-to-optical transition remains a structural theme driven by physical limits rather than cyclical demand. Each successive AI compute generation beyond Nvidia Blackwell requires higher optical content, deeper integration, and operates within increasingly constrained supply conditions. Recent developments including Nvidia's \$4bn strategic investment in Lumentum Holdings and Coherent Corp., the formation of the Optical Compute Interconnect MSA, and roadmap visibility into co-packaged optics (CPO) in the 2028 Feynman platform have shifted the debate from feasibility to execution. Supply remains tight, while incremental revenue pools such as CPO, optical circuit switching, and scale-up optical are still underrepresented in current estimates. As these revenue streams begin to emerge in reported financials over time, we would expect upward revisions to follow, supporting a constructive medium-term outlook.

At the same time, the key risk is increasingly one of timing. The long-term revenue opportunity is intact, but there is a timing gap — the transition is happening at the architecture level now, while the earnings impact won't be visible until 2027 at the earliest. In the interim, a number of optical names — including Lumentum Holdings and Coherent Corp. — have already seen significant re-rating, effectively pulling forward a portion of that future upside and raising sensitivity to delays. While the structural thesis remains intact, the gap between what is priced in today and what is likely to be delivered in the near term has narrowed, making the risk-reward increasingly dependent on execution and timing.

INVESTABLE NAMES ACROSS THE STACK

CATEGORY	NAMES
Capital Equipment	Aixtron (NASDAQ: AIXA)
Raw Materials	Soitec (EPA: SOI)
Laser Manufacturers	Lumentum (NASDAQ: LITE) · Coherent Corp. (NYSE: COHR)
Test & Measurement	Aehr Test (NASDAQ: AEHR) · Keysight (NASDAQ: KEYS) · Viavi (NASDAQ: VIAV) · FormFactor (NASDAQ: FORM)
Silicon Photonics Foundries	Tower Semiconductor (NASDAQ: TSEM) · GlobalFoundries (NASDAQ: GFS)
Semiconductor Platform	Marvell Technology (NASDAQ: MRVL) · Broadcom (NASDAQ: AVGO)

EXECUTIVE SUMMARY

AI training at hyperscale is a distributed systems problem: a frontier model is partitioned across thousands of chips, and at every training step every chip must exchange results with every other before the next step can begin. This synchronisation — called AllReduce — consumes **50–75% of total training time** at large cluster scale. The chips are not computing. They are waiting for the wire. Copper interconnects are reaching a hard physical cliff, failing simultaneously on signal integrity, power density, reach, and thermal management. The transition to optical interconnects is an active engineering programme confirmed by three events in thirty days.

Copper works well today, but it starts to break down as data speeds increase. As systems move from 800G to 1.6T, the signal travelling through copper weakens quickly, cables can only carry data reliably over very short distances (less than a metre), and additional chips are needed just to keep the signal usable — adding cost and power consumption. At even higher speeds like 3.2T, copper connections only work over a few centimetres. Optical fibre eliminates these constraints, making it the viable industry solution.

50–75% of AI training time consumed by chip-to-chip communication, not compute At clusters of 1,000+ GPUs · Source: Microsoft / Meta research, 2023	\$4B Nvidia's strategic investment in Lumentum and Coherent — March 2, 2026 \$2B each · multi-year purchase commitments · U.S. InP manufacturing expansion	2028 Confirmed inflection: optics integrated directly into the GPU chip package Nvidia Feynman generation · GTC 2026 roadmap confirmed March 17, 2026
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THE MARKET MISPRICING

The market prices Phase 1 — pluggable transceiver upgrades. It is beginning to price Phase 2 — CPO penetration into scale-up GPU fabrics. Phase 3 — optical integration directly into GPU packages — is essentially unpriced, despite being confirmed on the 2028 Nvidia roadmap. Optical infrastructure is structurally underrepresented relative to its enabling role in AI scaling.

THE PHYSICS MOAT

Silicon cannot generate laser light efficiently — its indirect bandgap requires ~one million electron excitations per photon versus two for Indium Phosphide (InP). This is a crystal structure property, not an engineering challenge. Every CPO system ever built requires III-V laser sources from Lumentum and Coherent — a physics-permanent advantage.

THE ORCHESTRATION THESIS

Photonics will not scale as fast as demand. Bottlenecks persist — in EML lasers, in InP wafer capacity, in CPO packaging throughput. Where bottlenecks persist, value concentrates. Nvidia's \$4B investment is constraint management — the same playbook as HBM and CoWoS before the shortage became public.

SECTION 01 · SCALE-UP VS. SCALE-OUT

Two Transitions. *One Is Priced. One Isn't.*

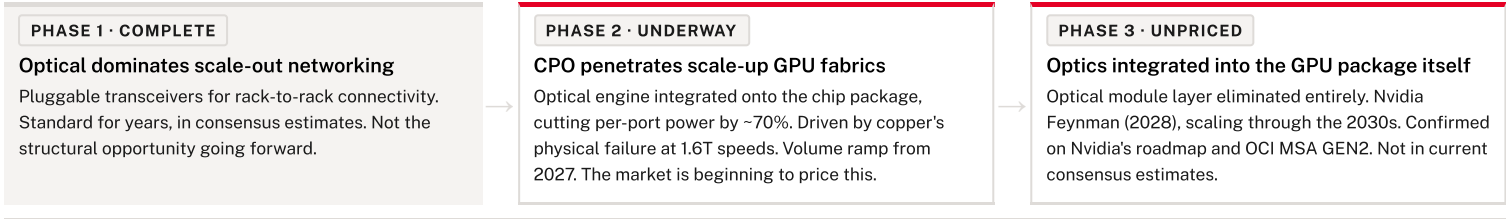
The optical transition is not a single event — it is two separate architectural problems on different timelines, and understanding the distinction is the foundation of the investment thesis.

Scale-out refers to connectivity between GPU racks and data centre pods — distances of metres to hundreds of metres, using standard InfiniBand or Ethernet protocols. This transition is **LARGELY PRICED** — pluggable transceivers at 400G–800G are already standard in hyperscale data centres, revenue is in consensus estimates, and the investment angle is limited to the ongoing speed upgrade cycle from 800G to 1.6T. The key laser component at this layer is the Electro-Absorption Modulated Laser (EML) — Lumentum holds over 50% of optical InP EML supply, with lead times already pushed past 2027 from Nvidia pre-allocation. There is no structural re-rating opportunity remaining in scale-out optical, but EML supply constraints continue to drive pricing power at the laser layer even within this priced cycle.

Scale-up refers to connectivity between all GPUs within the same tightly-coupled training cluster — all-to-all communication at nanosecond latency, across extreme bandwidth density, over Nvidia's proprietary NVLink fabric that enables hundreds or thousands of GPU dies to operate as a single unified memory system. This is where copper is failing. At the speeds required for AI scale-up fabrics, copper's signal attenuation, power consumption, and reach limitations are no longer engineering problems that can be incrementally solved — they are physics constraints. The transition to optical scale-up begins with CPO in Nvidia's 2028 Feynman generation and is **SUBSTANTIALLY UNPRICED** — the CPO supply chain, comprising laser manufacturers, silicon photonic foundries, and precision packaging, remains underrepresented in institutional portfolios and absent from consensus earnings models.

SECTION 02 · THE THREE-CYCLE BUILDOUT

Three Phases. *The Most Important Is Barely in Consensus.*



SECTION 03 · MARKET SIZING

The Numbers Are *Structural, Not Cyclical.*

\$73B Core AI optical communications market by 2030 ~29% of the \$245B total AI networking market. Optical ports to reach 71% of all networking ports. Source: Bank of America, March 2026.	\$45.4B Pluggable optical modules market by 2030 From \$12.6B in 2025. The current-cycle revenue base growing at scale. Source: Bank of America, March 2026.	137% CPO market annual growth 2024–2030 \$46M → \$8.1B. Volume ramp not before 2027. Source: Yole Group.	46% Silicon photonics annual growth 2024–2030 \$278M (2024) → \$2.7B (2030). Fastest-growing sub-market within optical. Source: Yole Group.
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"Is copper going to still be important? The answer is yes. Are you going to scale up optical? Yes. Are you going to scale out optical? Yes. For the first time, we will scale up with both copper and co-packaged optics."

— Jensen Huang, CEO Nvidia · GTC 2026 Keynote, March 17, 2026

SECTION 03B · NVIDIA ARCHITECTURE ROADMAP — GTC 2026 VERIFIED

The Generation-by-Generation *Confirmation of Timing.*

Nvidia's GTC 2026 roadmap is the single clearest industry articulation of the copper-to-optical transition timeline. It resolves every apparent ambiguity about when and how optical enters each layer of the stack.

GENERATION	GPU DOMAIN	SCALE-UP INTERCONNECT	SCALE-OUT	TIMELINE
Blackwell / Vera Rubin Oberon NVL72	72 GPU dies · 13.5 TB unified HBM · 130 TB/s	Copper backplane — 5,184 cables, 3.2 km total	Optical pluggable 800G	NOW → H2 2026
Vera Rubin Oberon NVL144	144 GPU dies · 72 packages · same Oberon rack	Copper midplane (replaces cable cartridge)	Optical CPO (Spectrum-X)	H2 2026
Rubin Ultra Kyber NVL576	576 GPU dies · ~600 kW · new Kyber rack	Copper + direct optical cross-rack (hybrid)	Optical CPO (Spectrum-X)	H2 2027
Feynman Inflection Point	1,152 GPU dies · 8 Kyber racks · full CPO domain	CPO — NVLink optical (first in history)	Optical CPO (Spectrum-7)	2028+

SECTION 04 · THE OPTICAL SUPPLY CHAIN — FROM RAW MATERIAL TO AI SYSTEM

Every AI System *Runs Through This Stack.*

The transition from copper to optical creates value at every stage of a seven-layer production chain. Understanding which companies control which layers — and which represent true structural chokepoints — is the basis for identifying where value concentrates as the transition scales. The most durable advantages sit where physics creates permanent barriers: laser sourcing at Layer 2, where silicon's crystal structure ensures Indium Phosphide will always be required.

#	LAYER	KEY COMPANIES	ROLE & INVESTMENT SIGNIFICANCE
0	Capital Equipment Epitaxy · wafer growth · lithography	Aixtron (NASDAQ: AIXA) · PVA TePla · SUSS MicroTec	Aixtron supplies MOCVD reactors used to deposit the compound semiconductor epitaxial layers — the active material in every InP laser die. As CPO volumes scale, reactor capacity and throughput for III-V epitaxy become a binding upstream constraint. Aixtron is the leading pure-play capital equipment name with direct exposure to the InP/GaAs laser supply ramp.
1	Raw Materials InP / GaAs / Si wafers	Soitec (EPA: SOI) · AXT Inc (NASDAQ: AXTI) ▲ See note · Sumitomo Electric · Shin-Etsu · Wafer Works	Soitec is the investable name at this layer — dominant supplier of SOI wafers used in silicon photonic integrated circuits, with a clear CPO volume ramp driver. AXT Inc supplies InP and GaAs substrates but carries significant Chinese regulatory risk: its InP crystal growth operations are based in China and are directly exposed to a potential indium or compound semiconductor export restriction — we do not recommend AXTI as an investable position on this basis. An export restriction that hurts the supply chain broadly would impair AXT simultaneously.
2	Laser Sources EMLs · CW lasers · VCSELs	Lumentum · Coherent · Mitsubishi Electric · Sumitomo · Broadcom	Highest-value chokepoint. Lumentum holds >50% optical InP share; EML lead times already past 2027 from Nvidia pre-allocation. Silicon's crystal structure forbids laser action — InP permanently required in every CPO system ever built.
3	SiPh Foundry 300mm wafer fab + CPO packaging	TSMC (COUPE) · Tower Semi · GlobalFoundries (Fotonix/AMF) · UMC	TSMC's COUPE platform gates Nvidia's CPO switch volume. Tower Semi SiPh revenue doubled to \$228M in 2025; \$920M capex targets >5× capacity by Q4 2026; >70% pre-reserved through 2028. GlobalFoundries acquired AMF Singapore (Nov 2025).
4	Photonic IC Design DSPs · CPO light engines	Marvell (CPO engine) · Broadcom (CPO ASIC) · Intel · Ayar Labs · Lightmatter	Marvell's ~\$3.25B Celestial AI acquisition is the most aggressive single bet that CPO becomes standard multi-rack infrastructure. Broadcom's CPO ASIC straddles both copper-bridge and CPO phases — lowest binary risk of any semiconductor player.
5	Transceiver / Module Pluggable · LPO · CPO	Coherent · Lumentum · Acacia (Cisco) · II-VI / Finisar · GIGALIGHT	Current volume layer. 800G pluggables mainstream in 2025–26; 1.6T entering volume H2 2026. CPO modules not yet in commercial volume — target 2027+. GIGALIGHT OSFP HYBRID (Dec 2025) demonstrated a stepping stone toward CPO.
5b	Test & Measurement Qualification & burn-in	Aehr Test (AEHR) · Keysight (KEYS) · Viavi (VIAV) · FormFactor (FORM) · Spirent · EXFO	Every SiPh chip entering CPO must pass wafer-level burn-in — no optionality on skipping this step. Aehr Test received a follow-on CPO qualification order March 3, 2026. Viavi won six Lightwave Innovation Awards at OFC 2026 including the ONE-1600ER 1.6Tbps module. FormFactor provides probe cards for SiPh wafer characterisation at the foundry level.
6	Contract Assembly Precision optical manufacturing	Fabrinet · Foxconn Interconnect · Venture Corp	Fabrinet assembles and tests optical transceivers and CPO modules for Lumentum, Coherent, and others. 23% EPS CAGR compounded over the past five years (FY2021–FY2025). Technology-agnostic — benefits from every speed generation regardless of which optical technology wins.
7	Systems Integration Switches · NICs · racks	Nvidia (Quantum-X, Spectrum-X) · Arista · Nokia (post-Infinera) · Ciena · TE Connectivity	Nvidia's CPO switches are the commercial proof points: Quantum-X800 at 28.8 Tbps / 144 InfiniBand ports (early 2026); Spectrum-X at 409.6 Tbps / 512 Ethernet ports (H2 2026). Nokia's Infinera acquisition (2025) internalised coherent optics expertise.

Source: Lighthouse Canton, Yole Group, LightCounting, company disclosures, Bank of America Global Research (March 2026), SemiAnalysis, Nvidia GTC 2026 keynote (March 17, 2026), OCI MSA formation press release (March 12, 2026) · March 2026

SECTION 05 · INVESTMENT POSITIONING — WHERE VALUE CONCENTRATES

The most distinctive opportunities lie lower in the supply chain — laser, test, foundry, and capital equipment layers — where supply constraints and qualification barriers create sustained pricing power ahead of the volume ramp. System-level players are extensively owned; the layers below are not.

COMPANY	CATEGORY	INVESTMENT THESIS	KEY SIGNAL TO WATCH
LASER MANUFACTURERS Physics Moat · Highest-Value Chokepoint in the Supply Chain			
Lumentum NASDAQ: LITE	LASER	Dominant EML supplier with >50% InP optical share; already a live production input to Nvidia's Spectrum-X CPO deployments at Meta and Microsoft, with a multi-hundred-million-dollar CPO order received ahead of the \$4B public announcement. The advantage is physics-permanent — InP is required in every CPO system ever built. Entry discipline warranted after ~900% appreciation; CPO revenues reaching 10–15% of total is the next re-rating catalyst.	CPO mix at 10–15% of revenue. EML lead time trends. 2027 earnings guidance.
Coherent Corp. NYSE: COHR	LASER	Broader optical product family, 20-year Nvidia relationship, silicon photonics already in Nvidia's production CPO switches, and a supply agreement to end of the decade. \$5.81B revenue (FY25, +23% YoY) and a more diversified base reduce binary concentration risk relative to Lumentum. JPMorgan noted the deal covers broader optical networking products across the full stack beyond CW lasers.	CPO as % of total revenue. Nvidia switch volume ramp confirmation.
TEST & MEASUREMENT Scales Directly with CPO Qualification — No Optionality on Skipping This Step			
Aehr Test Systems NASDAQ: AEHR	TEST	Every silicon photonic chip entering a CPO system must pass wafer-level burn-in — there is no optionality on skipping this step. Follow-on production order received March 3, 2026 for CPO-bound chip qualification, with delivery confirmed late 2026 to early 2027; management tied orders to recently announced products from major AI chip suppliers. Small-cap with outsized direct sensitivity to the CPO volume ramp.	Purchase order flow and customer identification. Production ramp H2 2026.
Keysight Technologies NASDAQ: KEYS	TEST	Provides photonic characterisation tools required for CPO qualification at 800G and 1.6T — optical power meters, lightwave component analysers, tunable laser sources. Testing and qualification represents a substantial portion of per-unit CPO cost, and Keysight's photonic test division scales with every incremental CPO unit shipped across the industry regardless of which component supplier wins.	Photonics test division revenue growth. CPO customer programme announcements.
Viavi Solutions NASDAQ: VIAV	TEST	Won six Lightwave Innovation Awards at OFC 2026 including the ONE-1600ER 1.6Tbps Testing Module; positioned at the intersection of SiPh manufacturing qualification and deployed network testing, both of which scale with the CPO ramp. Diversified revenue base provides stability relative to pure-play optical component names.	SiPh manufacturing tool adoption. 1.6T testing deployment wins.
FormFactor NASDAQ: FORM	TEST	Provides wafer probe cards and advanced packaging test solutions used in the characterisation and qualification of silicon photonic wafers before they proceed to CPO integration. As SiPh volumes scale at Tower Semi, TSMC, and GlobalFoundries, FormFactor's probe infrastructure scales with every incremental wafer started. A less-covered name with direct upstream exposure to the SiPh foundry ramp, benefiting from both the volume increase and the shift to more complex, higher-ASP photonic test configurations.	SiPh probe card order flow. Revenue mix from photonics customers. Tower Semi and TSMC capacity ramp timelines.
SILICON PHOTONICS FOUNDRIES Capacity Race Underway · Design-Wins Being Locked Now for 2027–28			
Tower Semiconductor NASDAQ: TSEM	SIPH FOUNDRY	SiPh revenue doubled to \$228M in 2025; \$920M capex targets >5× monthly wafer output by Q4 2026 with >70% of new capacity already reserved through 2028. Nvidia partnership for 1.6T data centre optical modules confirmed February 2026, and a dedicated CPO Foundry platform for 3D-IC heterogeneous integration was launched alongside. Strong near-term visibility with below-consensus CPO ramp appreciation.	Quarterly SiPh revenue. Capacity utilisation. Nvidia design-win announcements.
GlobalFoundries NASDAQ: GFS	SIPH FOUNDRY	Fotonix platform is the industry's first 300mm photonics + 300GHz RF-CMOS integration; acquired Advanced Micro Foundry (AMF) Singapore in November 2025, significantly expanding SiPh technology portfolio, capacity, and IP. Less concentrated CPO exposure than Tower but meaningful optionality as multi-vendor sourcing becomes standard for hyperscalers.	AMF integration milestones. Fotonix platform design-wins. SiPh revenue disclosure.

COMPANY	CATEGORY	INVESTMENT THESIS (CONTINUED)	KEY SIGNAL TO WATCH
SEMICONDUCTOR PLATFORM PLAYERS			
Marvell Technology NASDAQ: MRVL	SEMICONDUCTOR	~\$3.25B Celestial AI acquisition is the most concentrated single semiconductor bet that CPO becomes standard multi-rack AI infrastructure; the CPO light engine is the critical integration layer between laser supply and switch ASICs. High upside if CPO penetrates on the confirmed Nvidia roadmap timeline; binary risk if adoption is slower than expected.	Celestial AI CPO engine revenue ramp. Hyperscaler design-win announcements.
Broadcom NASDAQ: AVGO	SEMICONDUCTOR	Lowest binary risk in the optical transition: SerDes IP extends copper viability through 2027–28 while CPO matures, and CPO ASIC platform (Tomahawk 6) plus founding OCI MSA membership position it for Phase 2. CEO Hock Tan's "beyond 2028 we see optics coming in dramatically" is precisely aligned with Nvidia's roadmap, not contradictory to it.	Tomahawk 6 CPO chip announcements. SerDes design-win disclosures. OCI MSA certifications.

KEY RISKS

Timing — Earnings Realisation Lags Architecture Adoption. The structural thesis is intact, but the key risk is increasingly one of timing. Meaningful CPO revenue and full system-level integration are unlikely to be visible in reported financials before 2027. In the interim, Lumentum Holdings and Coherent Corp. have already seen significant re-rating — effectively pulling forward a portion of future upside and raising sensitivity to any delays. The gap between what is priced in today and what is likely to be delivered in the near term has narrowed, making the risk-reward increasingly dependent on execution and timing rather than directional thesis.

CPO Reliability — "Link Flap". Optical link failures caused by temperature instability and mechanical stress remain documented in early CPO deployments. A failed port may require replacing the entire switch rather than just a pluggable module, significantly raising operational cost and service disruption risk. This is not a theoretical concern — it is an active engineering problem being worked on by every CPO platform vendor. A yield or reliability shortfall at TSMC's COUPE advanced packaging platform could delay large-scale CPO rollouts by 12–18 months beyond current roadmap expectations, compressing the Phase 2 revenue window materially.

Copper Extends Further via AEC. Active Electrical Cable technology continues improving. Broadcom's SerDes development can extend 200G and 400G copper viability into the 2027–28 window at lower cost than optical alternatives. Faster-than-expected AEC gains would compress the intermediate revenue window for pure-play optical names — not by eliminating the CPO transition, but by delaying the point at which copper's physical failure forces the switch. For names priced on a 2027 CPO ramp, even a two-quarter delay is a material re-rating event given the current valuation multiples.

Chinese Indium Export Restriction. China controls a significant share of global refined indium — the key input for InP laser fabrication. China restricted gallium and germanium exports in 2023, demonstrating both the willingness and the administrative framework to impose such controls. An InP-equivalent restriction would simultaneously impact Lumentum, Coherent, and the entire CPO supply chain upstream. Both companies have taken steps to diversify substrate supply, but the concentration of indium refining capacity creates a low-probability, high-impact tail risk that cannot be fully hedged through supply chain investment alone. AXT Inc's China-based operations make it uniquely exposed, which is why we do not recommend it as an investable position.

Intel Absent — Ecosystem Fragmentation Risk. Intel's non-participation in the OCI MSA founding group is the most significant structural uncertainty in the standards landscape. A proprietary Intel optical PHY — developed independently and achieving meaningful adoption among hyperscalers who use Intel Gaudi infrastructure — would fragment the ecosystem into competing optical standards, slowing multi-vendor certification and extending the timeline for hyperscalers to commit to open-stack CPO procurement. This would not derail the transition, but could push Phase 2 timelines outward by 18–24 months and reduce the pricing power that an open standard enables for laser and SiPh suppliers.

CONCLUSION

The first phase of AI was defined by compute. The next phase is defined by connectivity. The bottleneck has moved — from transistors, to systems architecture, to the physical medium itself. Copper enabled the first generation of AI infrastructure. At scale, it reaches a wall. Light does not. The future of AI will be built not just on silicon — but on photons. The question is no longer whether this transition happens. The question is how fast each layer of the supply chain can scale to meet a demand that is structural, growing, and already binding.

Data Sources: Company disclosures, Bank of America Global Research (March 2026), Yole Group, LightCounting, SemiAnalysis, Nvidia GTC 2026 keynote (March 17, 2026), OCI MSA formation press release (March 12, 2026).

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