

The most expensive thirty centimeters in networking.

Copper Traces: High Signal Loss

Pushing a 224G signal across a circuit board loses ~40 dB of signal strength.

The ODSP Brain

The Optical DSP acts as the courier's muscle, scrubbing the degraded signal back into shape. This single chip consumes ~50% of an 800G module's power budget (up to 8W) just to survive the street leg.

Burned power turns into heat, and heat costs power to cool. Every extra watt inside the module is paid for twice on the data center's electricity bill.

Fiber is the free trunk railway.



Zero potholes,
infinite scale!

The Optical Channel

A glass strand runs for tens of kilometers, and the energy cost barely moves with distance.

The advanced packaging war (Pluggable, LPO, NPO, CPO) is not about the fiber. It is a debate over where the electrical-to-optical conversion belongs. How close to the main chip do you build the courier depot?

Pluggables keep the depot safely outside the building.

Long-reach SerDes (4.5–6 pJ/bit)

Pushing the signal all the way from the switch die to the faceplate requires the strongest, most power-hungry drivers.

Pluggables win on serviceability and multi-vendor interoperability. But at 1.6T and beyond, data centers simply cannot find the spare watts to sustain this commute.

WAAAAA!

Switch Chip

Easy to swap!
Broken module?
Just pull it out.

Exhausting commute.
An 800G link burns
~14-16W total just to
reach the outside world.

Co-Packaged Optics (CPO) moves inside, but shatters repairability.

No Hot Swaps

When a laser ages or a fiber fails in CPO, the entire package is compromised. Only the chip designer knows how to fix it. The independent module vendor is locked out.

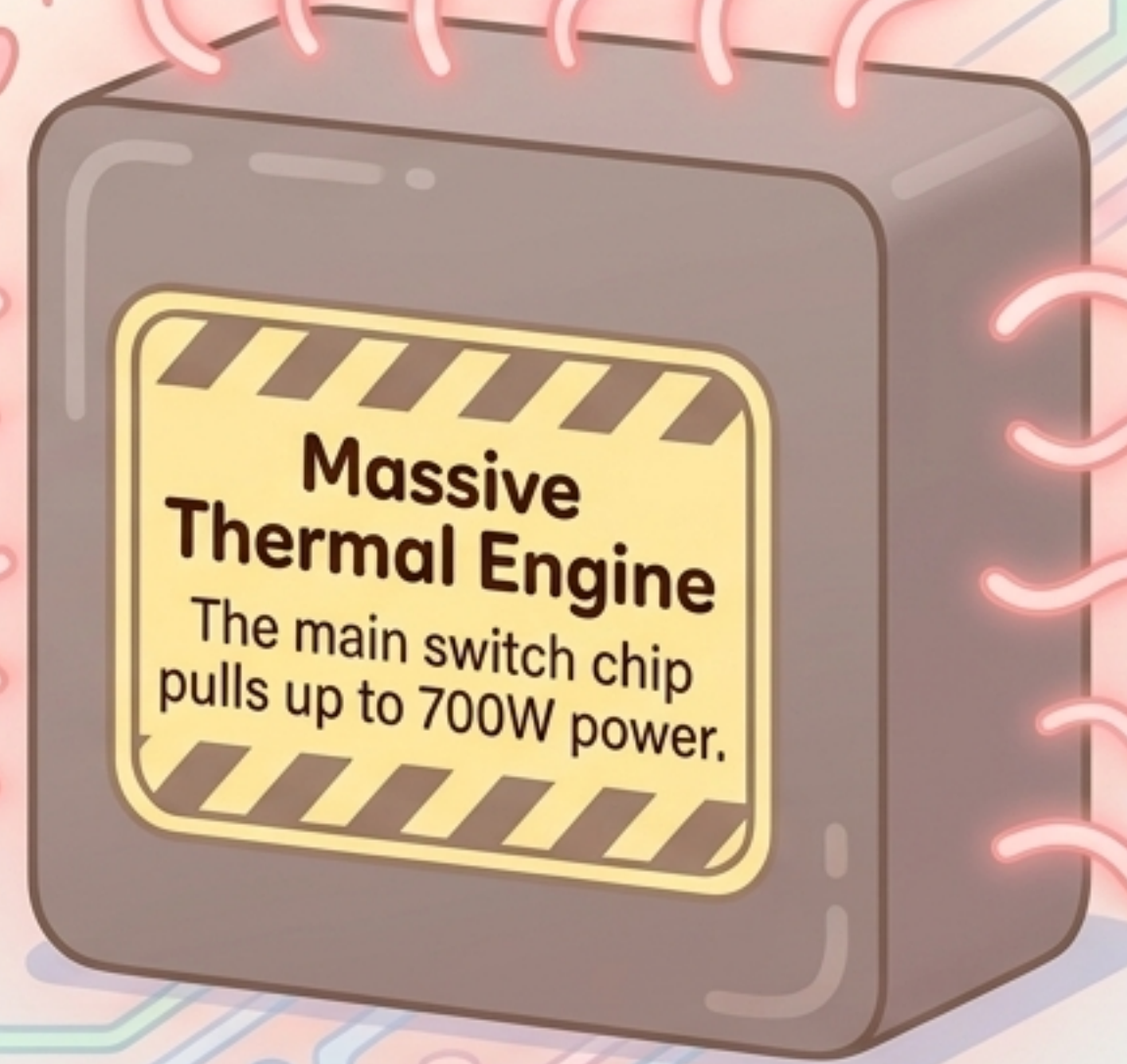
Pluggable	High Power (~15W)	Easy Repair (Hot Swap)
CPO (Broadcom Davisson)	Low Power (~3.5W)	Nightmare Repair (Soldered In)

Synthesis:
Moving the depot millimeters away from the recipient drops power drastically, but the entire optical path is now permanently sealed into the package.

The ultimate trade-off comes down to heat versus light.

Lasers hate heat...

Sharing a package substrate means the highly sensitive optical engine is permanently trapped next to a giant, radiating heater.



How many roads survive?

Pluggables & LPO

Survive on the economics of repair and flexibility.
Dominant for rack-to-rack hops.

CPO

Wins the hyperscale electricity bill. Pushed top-down by Broadcom and NVIDIA for the largest, densest AI networks.

The packaging war is a quest for the profitable middle ground.
All roads will coexist as long as data center ledgers balance differently.