

Fast Narrow for Real Products & Slow Wide for AI Investment Bubble Fantasies

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Chris Cole, Applied Materials

Views presented are the author's and may or may not be those of Applied Materials

Applications Irrelevant to the WS Debate

- Telecom (long-haul, metro, campus)
 - Fast wide DWDM (driven by spectral efficiency & capacity)
 - Shipping for 30 years
 - Slow wide is a past dead-end (ex. OFDM)
 - Will stay fast wide
- Datacenter (2km, 10km, high-loss)
 - Fast wide CWDM & DWDM
 - FR4, FR8, LR4, LR8, bi-di GRn variants shipping millions for 20 years
 - Coherent-lite LR1 emerging as an option
 - Will stay fast wide

Applications Peripheral to the WS Debate

- In-rack (1m)
 - Fast narrow copper cable dominated (ex. DAC, ACC, ACE)
 - 400G CR1 copper cable in development & standardization
 - Novel RF & optics technologies support multi-rack (10-30m)
 - Slow wide alternatives in development
- In-tray (chip-to-chip)
 - Copper for foreseeable future
 - No commercially viable optical interconnect technology
 - Fundamental long-term advances in packaging required
 - Concepts like optical backplanes are not real products

Application Relevant to the WS Debate

- Datacenter (500m, high-radix)
 - Fast narrow (DR1 serial)
 - Packaged as fast wide DR4, DR8, DR16 & DR32 break-out
 - 100G serial: shipping in high volume
 - 200G serial: ramping to high volume
 - development & standardization finished
 - proposed slow wide options (ex. 4x50G) missed market window
 - 400G serial: in design & standardization but technically very challenging
- Focused WS Debate question

Is slow wide, ex. 4x100G, a credible alternative to 400G DR1 serial?

100T Switch Architecture

Broadcom Tomahawk 6 100T Switch



NVIDIA Spectrum-X 100T Switch



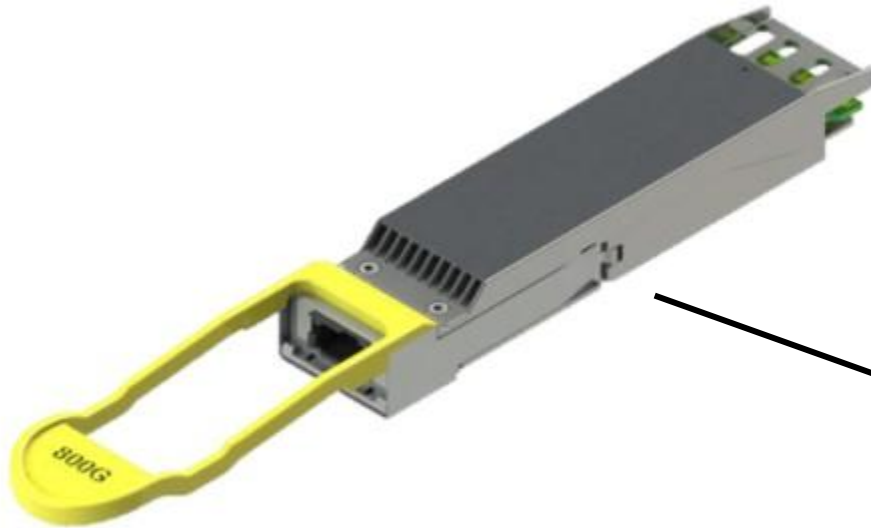
- 102.4T Switch Core w/ D2D I/O
- 8x 12.8T Chiplets each w/ 64x200G KR/CR SerDes I/O

Optics Packaging Alternatives

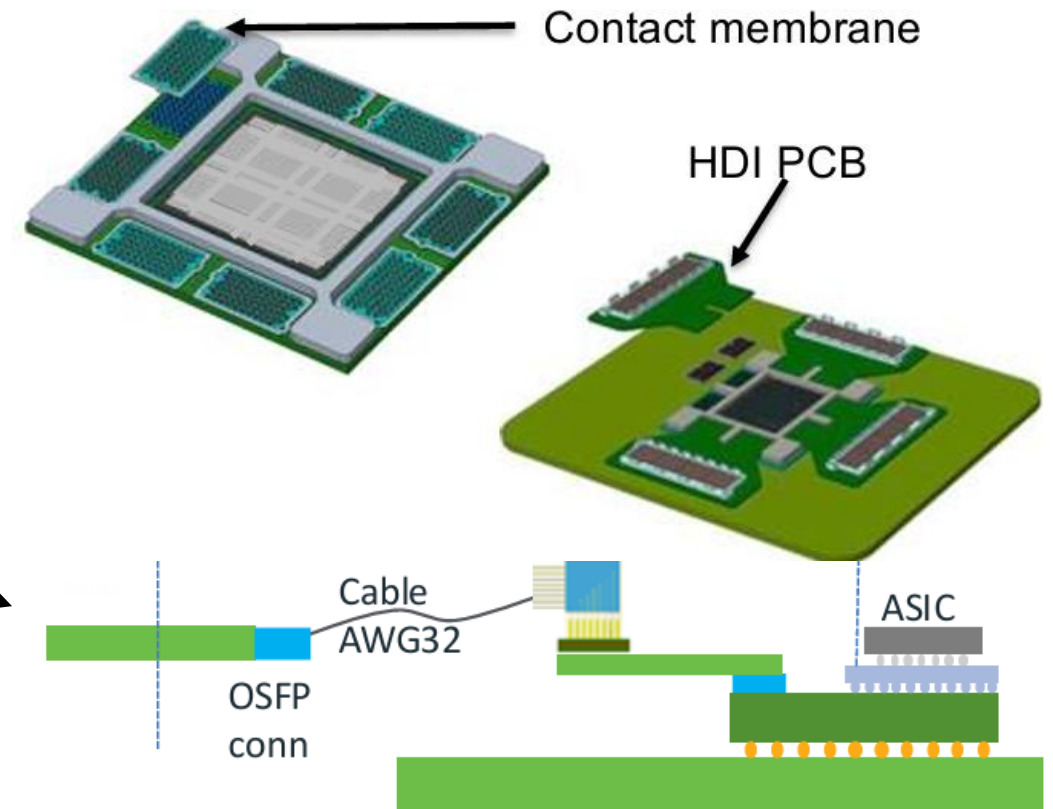
Modular			
Front-Pluggable (FPO)	Near-Package (NPO)		Co-Packaged (CPO)
• FPO • <i>FP</i> • <i>FPP</i>	Host PCBA	Secondary Substrate	Main Substrate
	Cabled/flex		Shared Interposer
	• NPO-PCB • <i>OBO</i>	• NPO-HDI • <i>NPO</i>	• CPO-SP • <i>CPO</i>
			• CPO-AP • <i>CIO</i>

FPO

Coherent 1.6T DR8 OSFP (8x DR1)



Broadcom ICA (Integrated Attach Copper)



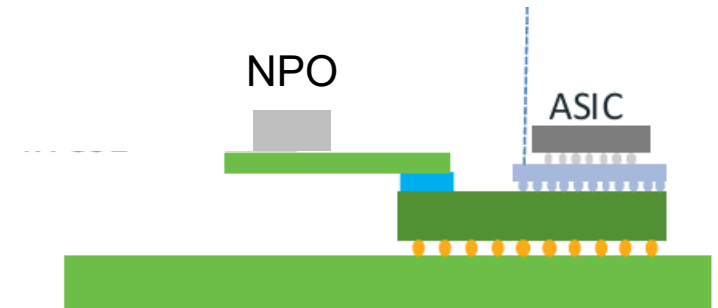
Will remain an important high-volume alternative

NPO

Ciena Open 6.4T CPX module (32x DR1)



Secondary substrate example

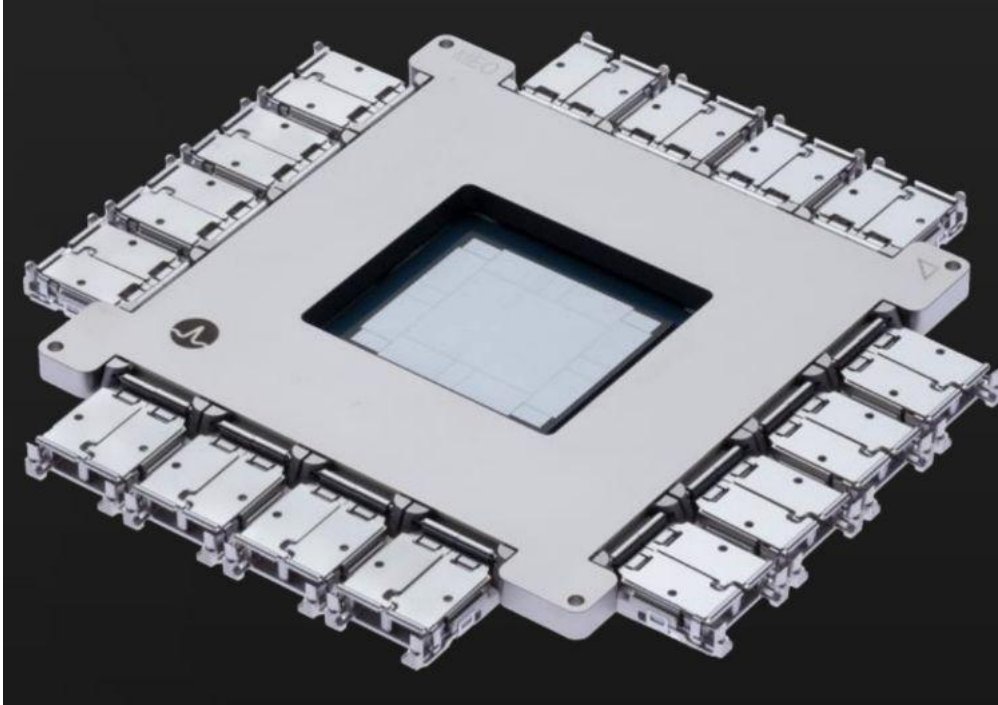


NPO expected to become high-volume optics form factor

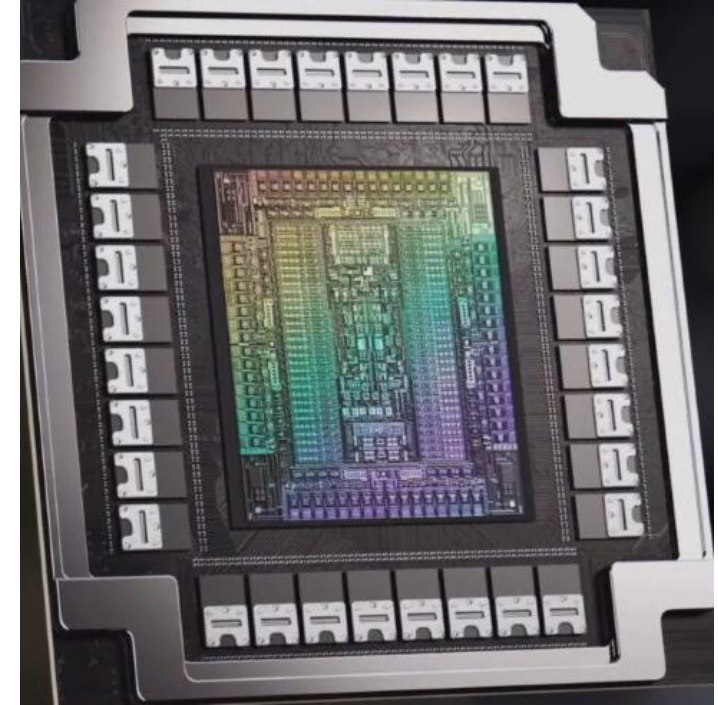
CPO

100T Switch w/ 32x 3.2T CPOs (each 16x DR1)

Broadcom Davisson



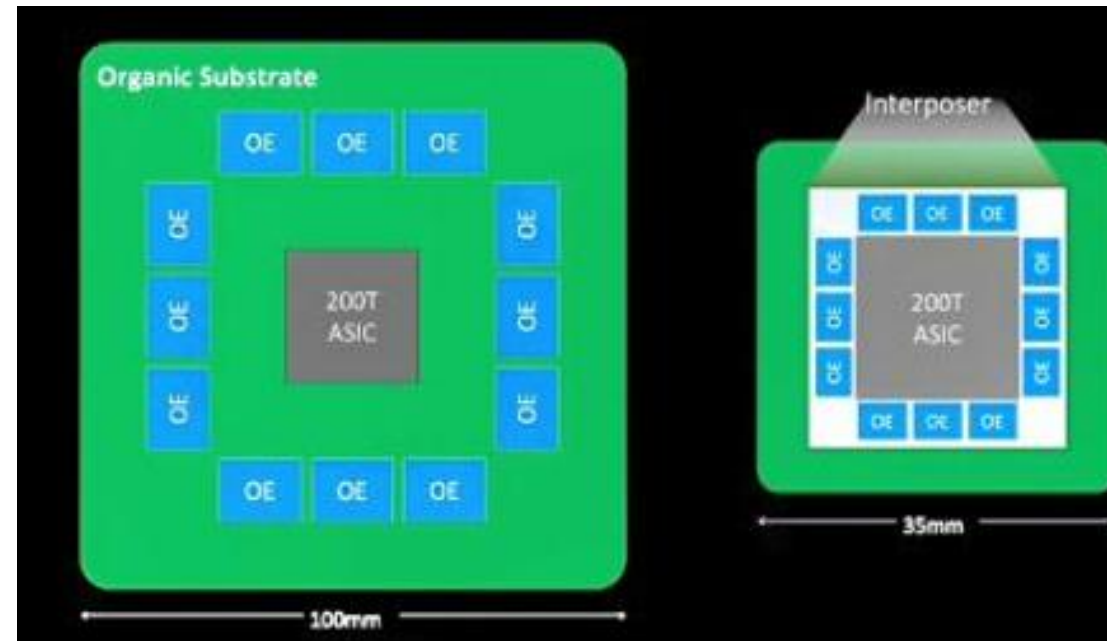
NVIDIA Spectrum-X



- CPO switches will remain high-performance, closed-ecosystems
- Volume fraction of standard switch solution like TH6 w/ multi-sourced optics

CIO (CPO-AP)

NVIDIA 200T ASIC CPO (l) to CIO (r) comparison



CIO
increases
shoreline
density by
3x to 10x

- 200T ASIC I/O: 400G PAM4 SerDes
- CIO basic problem: commercially viable packaging many years away

200T Switch Optics Alternatives Feasibility

Type	Retiming	FPO	NPO	CPO	CIO
Fast Narrow 400G serial	Full	Yes	Yes	Yes	Yes
	Half (RTLr)	Maybe	Yes	Yes	n/a
	None (Linear)	No	Maybe	Yes	n/a
Slow Wide 4x100G or slower	Full	Yes, but reverse gearbox required			Yes
	Half (RTLr)	No			n/a
	None (Linear)	No			n/a

Fast Narrow vs. Slow Wide for 400G 500m Optics

- FPO, NPO, CPO
 - Fully-retimed: slow wide needs reverse gearbox; similar metrics vs. serial
 - RTLIR & Linear: slow wide higher cost, power, size & latency vs. serial
- CIO
 - Slow wide lower cost, power, size & latency vs. serial, but ...
 - Packaging technology is many years away again missing market window
- Fast narrow DR1: only timely option for 400G 500m & likely 800G (ex. 2x400G)
- Fast narrow will move to fast wide to meet BW demand (ex. FR2, FR4 -500)
- Slow wide is a future technology: great for AI investment & research
- Slow wide designed today will be obsolete when the future arrives (ex. $\Delta\lambda$)

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Thank you