全球 科技

光通信网络：AI基础设施的下一个超级趋势 (摘要)

网络技术释放了单个AI芯片的算力，通过连接多个芯片（协同工作），实现无缝数据交换和低延迟，并将AI推向了新的高度。随着AI基础设施的加速发展和单机架算力的提升，我们预计所有网络配置都将迎来强劲增长，推动整个价值链的潜在市场规模增长9倍至1,540亿美元。具体而言，我们发现：(1) 横向扩展（scale out）/ 纵向扩展（scale up）的价值量分别增加16倍/45倍；(2) 光通信网络从横向扩展拓展至纵向扩展推动潜在市场规模扩大13倍；(3) 从2025年下半年AI服务器型号到2027年下半年AI服务器型号，横向扩展中可插拔光模块的价值市场扩大10倍。在本报告中，我们分析了：(1) 不同配置下的价值量；(2) 横向扩展和纵向扩展的市场机会；(3) 铜缆、可插拔光模块、CPO和PCB中板的组件贡献；(4) 整个供应链的每股盈利上行空间。我们仍看好所覆盖的光学和PCB板块，包括以下评级为买入的公司：中际旭创、新易盛、天孚通信、联亚、全新、住友电工、三菱电机、古河电工、胜宏科技（位于强力买入名单）、沪电股份、台光电和生益科技。我们预计这些公司将在2028年之前实现强劲增长，得益于AI服务器放量、规格升级以及应用扩展。

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目录

网络技术是AI基础设施的下一个前沿领域，旨在通过无缝数据交换和低延迟来增强算力。尽管投资者担心网络配置的更新换代，但我们预计所有配置都将实现强劲增长。具体而言：

横向扩展 (Scale out)：增加更多设备，并通过交换技术相连接，这是一种广泛使用的网络扩展方式。如今，AI集群支持超10万个GPU的横向扩展连接。

纵向扩展 (Scale up)：在同一设备内（通常在同一服务器机架内）增加更多的GPU和计算资源。如今还出现了跨机架连接的纵向扩展，即所谓的“超级节点”，其跨机架的网络速度经过优化，已接近同一机架内的连接速度。

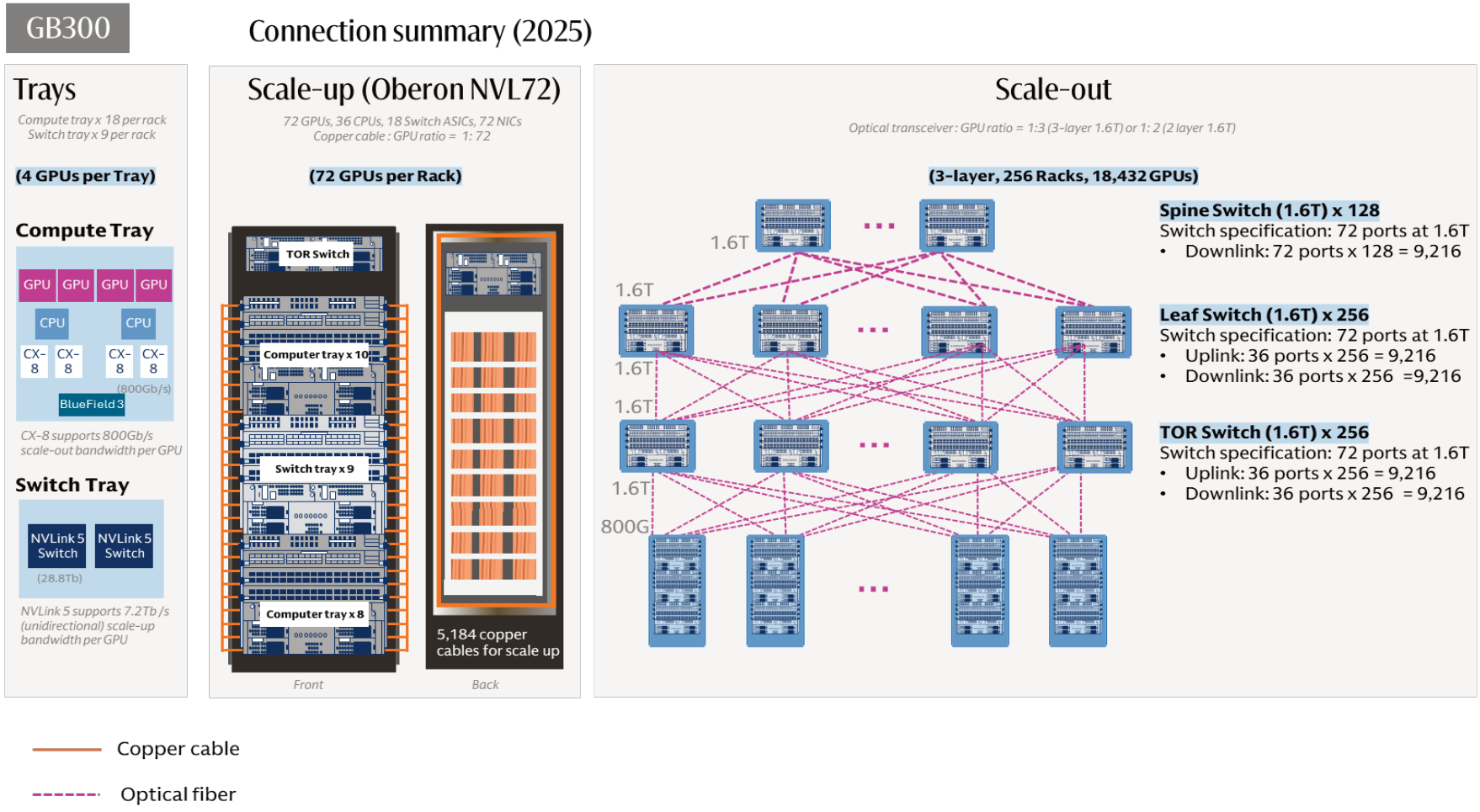
- 从GB300 NVL72（单个计算单元指单机架72个GPU达到NVL72）到Rubin Ultra NVL576（单个计算单元指单机架72个GPU，8个机架总计达到NVL576），单个计算单元的横向扩展/纵向扩展的价值量分别增加16倍/45倍，这为可插拔光模块、CPO中的光引擎、铜缆和PCB中板带来了增长机会。
- 光模块/光引擎单个计算单元从横向扩展（如GB300 NVL72）拓展至纵向扩展（如通过CPO实现的Rubin Ultra NVL576二层纵向扩展）推动潜在市场规模扩大13倍。
- 在从GB300 NVL72到Rubin Ultra NVL576的单个计算单元横向扩展中，可插拔光模块的价值市场扩大10倍，即便CPO渗透率为29%。单个计算单元的可插拔光模块（1.6T或等量））数量将从GB300 NVL72的216个增加到Rubin Ultra NVL576的2,500个。

我们预计单个计算单元在纵向扩展和横向扩展上的总价值量将从GB300 NVL72的31.5万美元增长29倍至Rubin Ultra NVL576的940万美元；假设在整个产品周期中，GB300 NVL72的机架数量为4.8万个，Rubin Ultra NVL576的计算单元数量为1.65万个，则纵向扩展和横向扩展的总潜在市场规模将从GB300 NVL72的150亿美元（主要在2026年）增长9倍至Rubin Ultra NVL576的1,540亿美元（主要在2028年）。在这1,540亿美元的总潜在市场规模中，纵向扩展占到69%（即1,060亿美元），而CPO贡献910亿美元，占到总潜在市场规模的59%（假设CPO在横向扩展中的渗透率为29%）。

我们预计，光模块和光引擎（受益于CPO/NPO采用和光模块升级）、CW激光器和EML（受益于CPO/NPO采用和光模块升级）以及PCB/CCL制造商（受益于PCB中板采用）等主要受益者存在显著的每股盈利上行潜力。我们仍看好所覆盖的光学和PCB公司，包括以下评级为买入的公司：中际旭创、新易盛、天孚通信、联亚、全新、住友电工、三菱电机、古河电工、胜宏科技（位于强力买入名单）、沪电股份、台光电和生益科技。我们预计这些公司将在2028年之前实现强劲增长，得益于AI服务器放量、规格升级以及应用扩展。我们认为，技术迁移将首先出现在全球领先的云服务提供商（CSP）中，随后是中国CSP，并将在未来五年推动光通信网络供应链实现可持续的强劲增长。

(1) Blackwell network in details

图表 1: Nvidia GB300 AI rack network summary (2025)

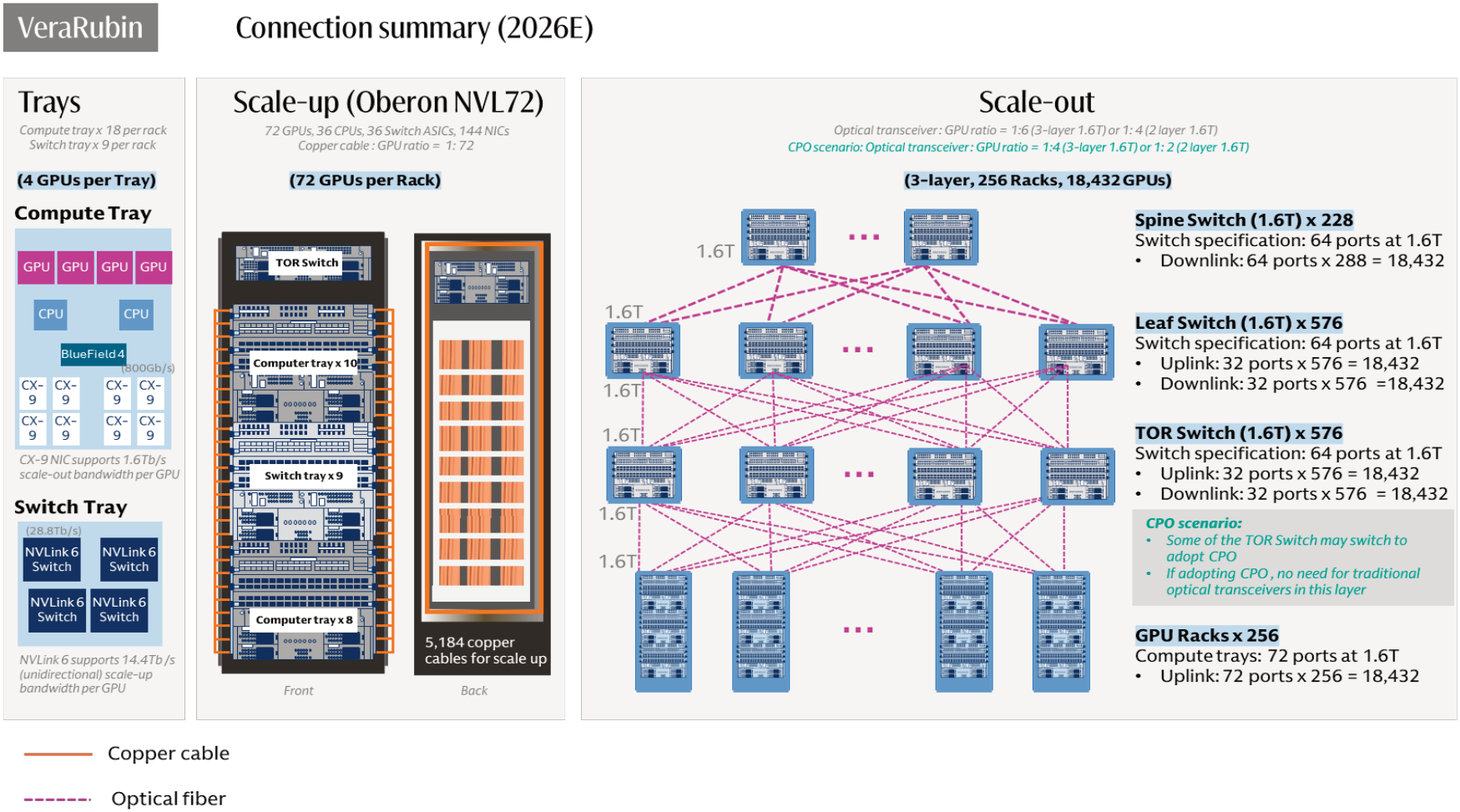


Scale out switch spec refer to Quantum-X800.

资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

(2) Rubin network in details

图表 2: Nvidia Vera Rubin AI rack network summary (2026E)

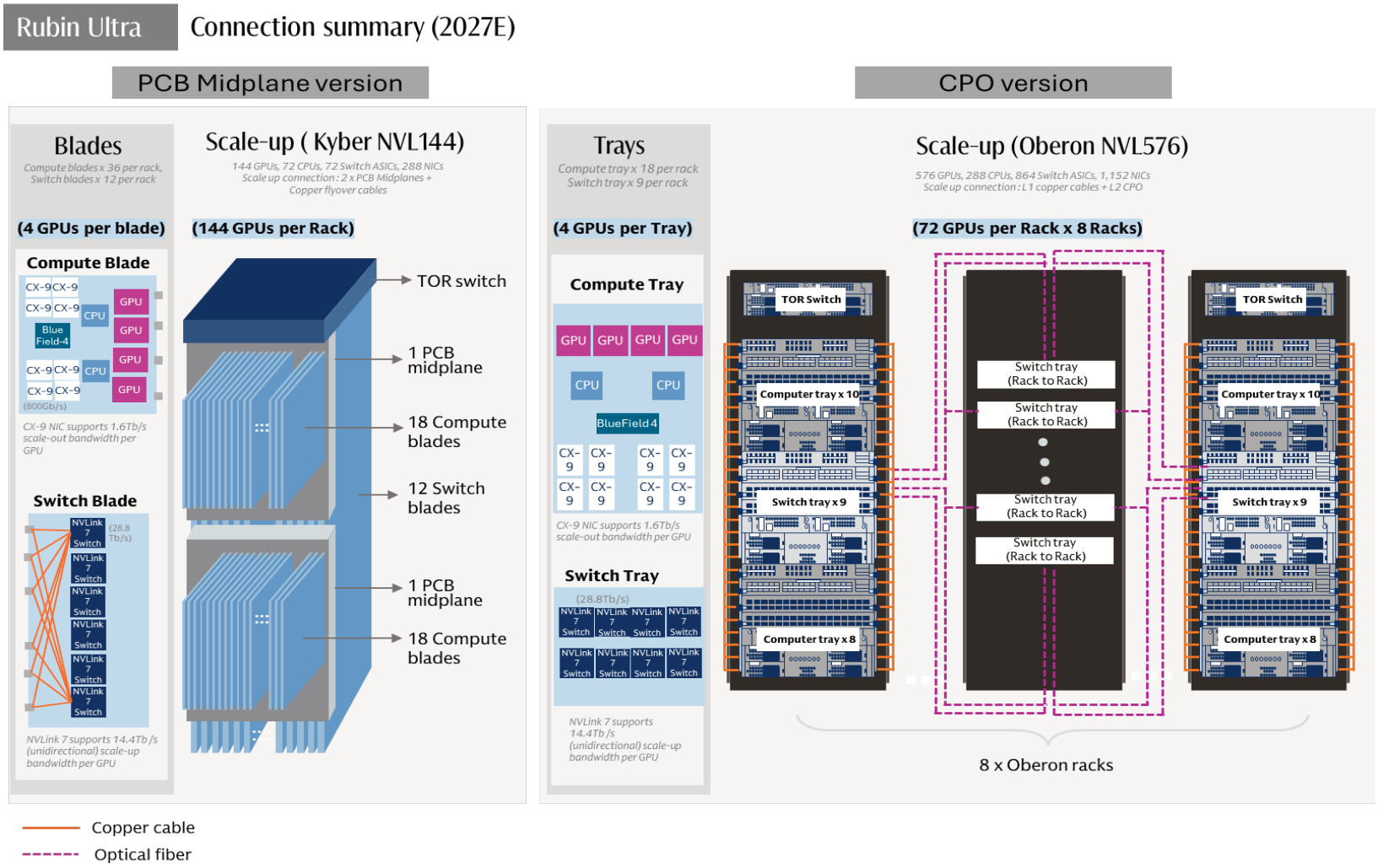


Scale out switch spec refer to Spectrum-6. The data in this exhibit is inferred by GS based on technology roadmap of Nvidia and our supply chain check.

资料来源：公司数据, 高盛全球投资研究部

(3) Rubin Ultra network in details

图表 3: Nvidia Rubin Ultra AI rack network summary (2027E)



The data in this exhibit is inferred by GS based on technology roadmap of Nvidia and our supply chain check.

资料来源：公司数据, 高盛全球投资研究部

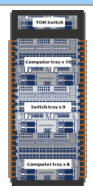
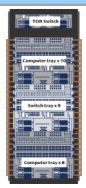
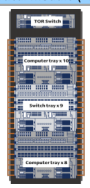
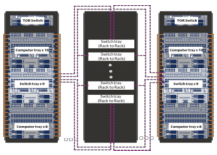
(4) Optical networking supply chain

图表 4: Optical supply chain

资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

(5) Scale up / Scale out TAM and EPS implications

图表 5: Spec Table: We outline four possible rack structure for the upcoming GPU platforms (GSe)
The connection architecture and specifications below are based on Nvidia technology roadmap, supply chain check and our inference based on the networking connections

Connection assumptions		Vera Rubin Spec A	Vera Rubin Spec B	Rubin Ultra Spec A	Rubin Ultra Spec B	
Model	**GB300 NVL72**	**Vera Rubin NVL 72**	**Vera Rubin NVL 72 (25% CPO scale out)**	**Rubin Ultra NVL 144 (29% CPO scale out)**	**Rubin Ultra NVL 576 (29% CPO scale out)**	**Remarks**
Shipment period	2H25-2026	2H26-2027	2H26-2027	2H27-2028	2H27-2028	
Scale up	Copper cable	Copper cable	Copper cable	PCB Midplane	Copper cable + CPO	
Scale out	Optical modules (1.6T)	Optical modules (1.6T)	CPO TOR Switch (1.6T) + Optical module (1.6T)	CPO TOR Switch (3.2T) + Optical module (3.2T)	CPO TOR Switch (3.2T) + Optical module (3.2T)	
						
# of GPU package	72	72	72	144	72	* For Rubin Ultra NVL576, we show per rack
# of NV Switch ASIC	18	36	36	72	108	data in the table, despite it's a 8-rack scale up
# of NIC	72	144	144	288	144	system
Scale up						
Scale up Bandwidth (unidirectional, Tb/s)	**518**	**1,037**	**1,037**	**2,074**	**2,074**	
Total Switching Capacity (Tb/s)	**1,037**	**2,074**	**2,074**	**4,147**	**6,221**	
Copper cable backplane bandwidth (Tb/s)	518	1,037	1,037	-	2,074	
Notes	*100% copper cable*	*100% copper cable*	*100% copper cable*	-	*L1 scale up within rack*	
# of copper cables (units)	5,184	5,184	5,184	-	5,184	Total bandwidth = # of copper cales x Bandwidth of each cable / 2 (unidirectional)
Bandwidth of each copper cable (Gb/s)	200	200	200	-	400	
PCB midplane bandwidth (Tb/s)	-	-	-	2,074	-	
Notes	-	-	-	*PCB all to all connection*	-	
# of PCB Midplane (units)	-	-	-	2	-	Total bandwidth = # of PCB Midplane x Bandwidth of each PCB
Bandwidth of each PCB (Gb/s)	-	-	-	1,036,800	-	
CPO/ NPO bandwidth (Tb/s)	-	-	-		1,037	
Notes	-	-	-	-	*L2 scale up among racks*	
# of optical fiber (units)	-	-	-	-	5,184	Total bandwidth = # of copper cales x
Bandwidth of each optical fiber (Gb/s)	-	-	-	-	400	Bandwidth of each cable / 2 (unidirectional)
# of optical engine (units)	-	-	-	-	324	Total bandwidth = # of optical engine x
Data rate of Optical engine (Tb/s)	-	-	-	-	3.2	Bandwidth of each optical engine
Scale out						
Scale out Bandwidth (unidirectional, Tb/s)	**58**	**115**	**115**	**230**	**115**	
Total Switching Capacity (Tb/s)	**346**	**691**	**691**	**1,382**	**691**	**Assuming 3-layer network**
GPU uplink (Tb/s)	58	115	115	230	115	GPU uplink = # of GPU per rack x GPU uplink speed (800G/ 1.6T/ 3.2T)
# of GPU (units)	72	72	72	144	72	
GPU uplink per chip (Tb/s)	0.8	1.6	1.6	1.6	1.6	
# of layer	3	3	3	3	3	
Optical module						
# of optical module (units)	216	432	324	307	153	# of optical module = Total switch capacity in scale-out network x % in optical module / Data rate of each optical module (1.6T/ 3.2T)
Optical module penetration (GSe)	100%	100%	75%	71%	71%	
Data rate of optical module (Tb/s)	1.6	1.6	1.6	3.2	3.2	
Attach rate (Optical module ports: GPU)	**3.0**	**6.0**	**4.5**	**2.1**	**2.1**	
CPO/ NPO						
# of CPO ports (units)	-	-	108	125	63	# of CPO ports = Total switch capacity in scale-out network x % in CPO / Data rate of each CPO port (1.6T/ 3.2T)
CPO penetration (GSe)	-	-	25%	29%	29%	
Data rate of CPO (Tb/s)	-	-	1.6	3.2	3.2	
Attach rate (CPO ports: GPU)	**-**	**-**	**1.5**	**0.9**	**0.9**	
Among which:						
# of optical engine (units)	-	-	108	125	63	# of CPO optical engine = Total switch capacity in scale-out network x % in CPO / Data rate each optical engine (3.2T)
Data rate of Optical engine (Tb/s)	-	-	1.6	3.2	3.2	
Attach rate (Optical engine: GPU)	-	-	**1.5**	**0.9**	**0.9**	

Attach rate summary					
Optical module : GPU - scale out	**3.0**	**6.0**	**4.5**	**2.1**	**2.1**
Optical engine : GPU - scale up	**-**	**-**	**-**	**-**	**4.5**
Optical engine : GPU - scale out	**-**	**-**	**1.5**	**0.9**	**0.9**
Scale out sum	**3.0**	**6.0**	**6.0**	**3.0**	**3.0**

(1) Shipment period is based on the Nvidia’s product roadmap; (2) # of GPU/ NV Switch ASIC/ NIC per rack are based on Nvidia’s product roadmap, industry check and our calculation based on the announced specifications; (3) Bandwidth and switching capacity are based on Nvidia’s product roadmap.

资料来源：公司数据, 高盛全球投资研究部

Following the 2026 GTC , where a clear technology roadmap of the next generations of GPU, server rack, and networking solutions are outlined, we present an in-depth analysis of the specification changes for the next two generations of GPU platforms (Vera Rubin and Rubin Ultra). By integrating insights from the company’s announcement (link) and our industry checks with the supply chain, we intend to delineate the inter-connection architecture of the forthcoming server racks (图表 5),

breakdown the dollar content for each networking component (图表 6), forecast the TAM opportunity for each component (图表 8) and assess the EPS impact for our key coverage names (图表 13). With these, we aim to address the frequently asked investor question about how to evaluate the market size resulting from complex server networking upgrades ahead.

The next generation racks: Networking technology continues to evolve in both scale out (across racks / computing unit) and scale up (within one computing unit). Based on the GTC 2026 announcement (link), we discuss the major four configurations in Vera Rubin and Rubin Ultra platform, to evaluate the TAM opportunities and EPS impact across the supply chain. Separately, we consider the CPO penetration rate in scale-out connections in our analysis (图表 5), which is based on industry checks and our optimistic perspective on CPO adoption. As CPO is a next-generation technology, its pace of adoption will significantly influence the connection TAM opportunity, especially given its dollar content per rack. Detailed specification assumptions are shown in 图表 5 and below.

- Vera Rubin Spec A – NVL72. Scale up adopts copper cable cartridge, i.e. the Oberon rack. Scale out adopts pluggable optical module connections.
- Vera Rubin Spec B – NVL72 (CPO scale out). Scale up adopts copper cable cartridge, i.e. the Oberon rack. Scale out could use CPO or pluggable optical module, and we assume 25% CPO penetration rate.
- Rubin Ultra Spec A – NVL144 (CPO scale up). Scale up adopts PCB midplane for connection, i.e. the Kyber rack. Scale out could use CPO or pluggable optical module, and we assume 29% CPO penetration rate.
- Rubin Ultra Spec B – NVL576 (CPO scale up). 72 GPU per rack, and eight racks as a full NVL576 (one computing unit). Scale up adopts copper cable cartridge for the first layer connection (i.e. Oberon rack design for the connections within the server rack) and CPO for the second layer connection (i.e. the connections between the eight racks). Scale out could use CPO or pluggable optical module, and we assume 29% CPO penetration rate.

Based on above, we derive: (1) dollar content per rack across different configurations, (2) value TAM opportunities (dollar content per rack * number of server racks), and (3) implication to supply chain EPS. Key takeaways: (1) Rubin Ultra brings dollar content increases across scale up and scale out compared to GB300, (2) Rubin Ultra scale up brings dollar content increases across copper cables, PCB midplane, and CPO switch, (3) pluggable optical modules would continue to increase dollar content increase per rack in scale out compared to GB300 despite our assumption of 25-29% CPO switch penetration rate, (4) CPO appears costly considering 3D packaging, high integration, and the need to upgrade devices to semiconductor processing levels; however, the total cost of ownership (TCO) is attractive especially in high bandwidth requirement (e.g. 6.4T, 12.8T) considering the constraints of pluggable optical module and the power efficiency and energy savings, and (5) On the EPS opportunity, we see most suppliers benefiting from strong EPS contribution from a single configuration that is higher than their 2025 full

year EPS, given the AI server racks shipment ramp up and specification upgrades driving the dollar content increase.

图表 6: Dollar content per rack: GB300, Vera Rubin and Rubin Ultra
Volume assumptions are from the spec table (Exhibit 5), ASP assumptions are based on spec table and our industry checks

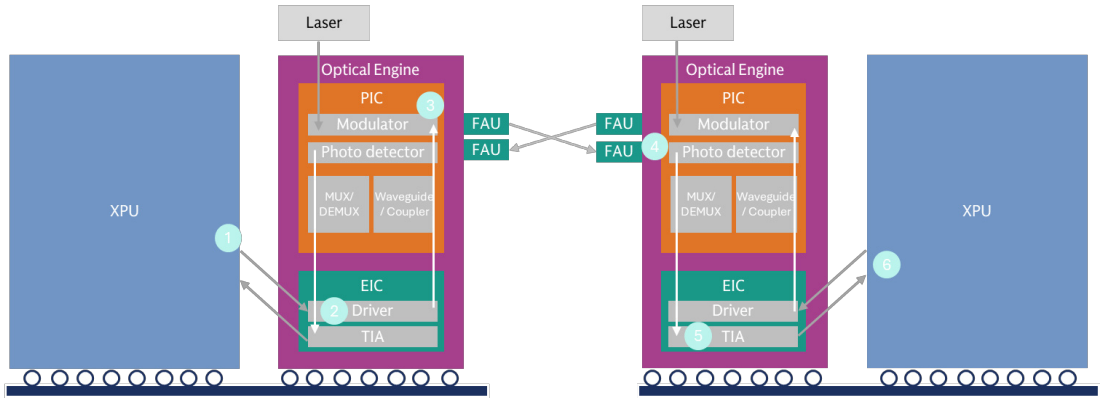
图表 8: Scale up / Scale out TAM opportunities
The TAM opportunity is based on the connection content value of each rack (Exhbit 6) multiple by GSe shipment of Vera Rubin / Rubin Ultra racks

Value TAM		Vera Rubin Spec A	Vera Rubin Spec B	Rubin Ultra Spec A	Rubin Ultra Spec B
	GB300 NVL72	Vera Rubin NVL 72	Vera Rubin NVL 72 (25% CPO scale out)	Rubin Ultra NVL 144 (29% CPO scale out)	Rubin Ultra NVL 576 (29% CPO scale out)
Scale up	Copper cable	Copper cable	Copper cable	PCB Midplane	Copper cable + CPO
Scale out	Optical modules (1.6T)	Optical modules (1.6T)	CPO TOR Switch (1.6T) + Optical module (1.6T)	CPO TOR Switch (3.2T) + Optical module (3.2T)	CPO TOR Switch (3.2T) + Optical module (3.2T)
Scle up + Scale out TAM (US$m)	**15,070**	**28,291**	**29,158**	**73,458**	**154,313**
Copper cable - backplane	12,742	25,369	20,375	32,390	52,918
Copper cable - flyover in switch tray	2,234	2,697	7,691	23,494	23,494
PCB Midplane	-	-	624	16,504	1,654
Optical engine & FAU	93	225	225	428	43,196
ELS	-	-	243	643	9,197
Fiber cable and MPO	1	1	1	1	20,530
Shufflebox	1	1	1	1	3,327
Scale up TAM (US$ m)	**6,702**	**8,090**	**8,090**	**25,114**	**105,970**
Copper cable - backplane	4,468	5,393	5,393	-	20,529
Copper cable - flyover in switch tray	2,234	2,697	2,697	10,264	10,264
PCB Midplane	-	-	-	14,850	-
Optical engine & FAU	-	-	-	-	42,768
ELS	-	-	-	-	8,554
Fiber cable and MPO	-	-	-	-	20,529
Shufflebox	-	-	-	-	3,326
Mix %	**100%**	**100%**	**100%**	**100%**	**100%**
Copper cable - backplane	67%	67%	67%	0%	19%
Copper cable - flyover in switch tray	33%	33%	33%	41%	10%
PCB Midplane	0%	0%	0%	59%	0%
Optical engine & FAU	0%	0%	0%	0%	40%
ELS	0%	0%	0%	0%	8%
Fiber cable and MPO	0%	0%	0%	0%	19%
Shufflebox	0%	0%	0%	0%	3%
Scale out TAM (US$ m)	**8,367**	**20,200**	**21,067**	**48,344**	**48,344**
Optical module	8,274	19,976	14,982	32,390	32,390
Optical engine & FAU	-	-	4,994	13,230	13,230
ELS	-	-	624	1,654	1,654
Fiber cable and MPO	93	225	225	428	428
Shufflebox	-	-	243	643	643
Mix %	**100%**	**100%**	**100%**	**100%**	**100%**
Optical module	99%	99%	71%	67%	67%
Optical engine & FAU	0%	0%	24%	27%	27%
ELS	0%	0%	3%	3%	3%
Fiber cable and MPO	1%	1%	1%	1%	1%
Shufflebox	0%	0%	1%	1%	1%
Assumption: GPU Rack forecast (GSe, k units, full lifecycle)					
GB300	48				
Vera Rubin		58	58		
Rubin Ultra				66	132

(1) Spec A come with lower connection value while Spec B come with higher connection value; (2) Read more about GPU rack shipment in our Global Server Model

资料来源：公司数据, 高盛全球投资研究部

图表 9: How CPO works in data transmission



资料来源：公司数据, Compiled by Goldman Sachs Global Investment Research

图表 10: Our high end estimate imply a CPO TAM totalling US$97bn in 2026-28E
High-end based on GB300, Vera Rubin/Rubin Ultra Spec B; Low-end based on GB300, Vera Rubin/ Rubin Ultra Spec A

Value TAM by year

Value TAM range (high-end, Spec B)	2026E	2027E	2028E
Scale up TAM (US$ m)	**7,228**	**30,697**	**82,837**
Scale out TAM (US$ m)	**10,921**	**27,023**	**39,835**
CPO TAM (US$ m)	**1,024**	**24,840**	**70,881**
Optical engine & FAU	864	16,269	43,858
ELS	108	2,763	7,961
Fiber cable and MPO	10	4,734	15,965
Shufflebox	42	1,074	3,096
Value TAM range (low-end, Spec A)	**2026E**	**2027E**	**2028E**
Scale up TAM (US$ m)	**7,228**	**12,321**	**20,358**
Scale out TAM (US$ m)	**10,771**	**26,408**	**39,733**
CPO TAM (US$ m)	**-**	**3,557**	**12,093**
Optical engine & FAU	-	3,007	10,223
ELS	-	376	1,278
Fiber cable and MPO	-	28	96
Shufflebox	-	146	497

(1) CPO TAM refers to CPO components applied in both scale up and scale out connections; (2) By year estimate is based on the Server rack allocation among years and the full lifecycle TAM in Exhibit 7; (3) High end is based on Spec B and Low end on Spec A of each model

资料来源：公司数据, 高盛全球投资研究部

图表 11: Our high end estimate imply a demand for 110k scale out CPO switch in 2028E
High-end based on GB300, Vera Rubin/Rubin Ultra Spec B; Low-end based on GB300, Vera Rubin/ Rubin Ultra Spec A

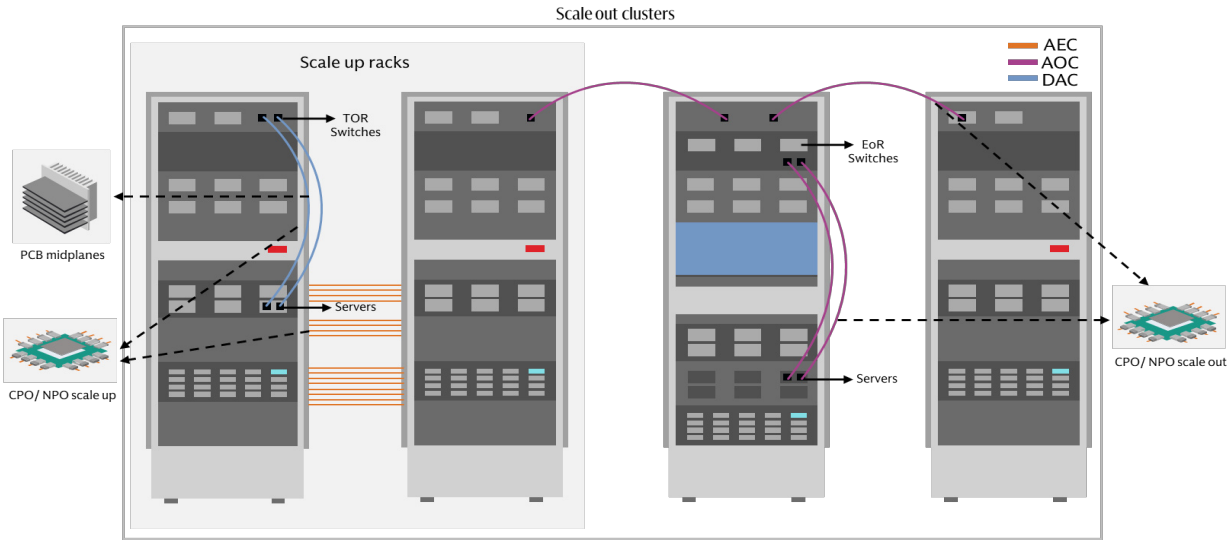
Volume TAM by year

Volume TAM range (high-end, Spec B)	2026E	2027E	2028E
CPO TAM (k units)			
Optical engine & FAU	1,080	16,027	40,172
ELS	270	6,907	19,902
Fiber cable and MPO	540	158,674	532,330
Shufflebox	60	1,535	4,423
Key data			
Nvidia AI rack shipment (k units)	*50*	*77*	*121*
Scale out CPO penetration	*5%*	*25%*	*29%*
Scale out CPO switch (k units)*	*15*	*88*	*110*
Volume TAM range (low-end, Spec A)	**2026E**	**2027E**	**2028E**
CPO TAM (k units)			
Optical engine & FAU	-	1,879	6,389
ELS	-	940	3,195
Fiber cable and MPO	-	940	3,195
Shufflebox	-	209	710
Key data			
Nvidia AI rack shipment (k units)	*50*	*77*	*121*
Scale out CPO penetration	*0%*	*11%*	*27%*
Scale out CPO switch (k units)*	*-*	*26*	*89*

(1) CPO TAM refers to CPO components applied in both scale up and scale out connections; (2) assume 72 optical engines per scale out switch (*); (3) By year estimate is based on the Server rack allocation among years and the full lifecycle TAM in Exhibit 7; (4) High end is based on Spec B and Low end on Spec A of each model

资料来源：公司数据, 高盛全球投资研究部

图表 12: Connections in data center: Scale-up vs. Scale out



TOR Switch: Top of rack switch; EoR Switch: End of row switch

资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

图表 13: Earning implications to key suppliers
Earnings impact based on the Value TAM (Exhibit 8) x market share assumption (GSe) x margin assumption (GSe) for each supplier

Earning implications

Model		2025 Actual	GB300 NVL72	Vera Rubin Spec A Vera Rubin NVL 72	Vera Rubin Spec B Vera Rubin NVL 72 (25% CPO scale out)	Rubin Ultra Spec A Rubin Ultra NVL 144 (29% CPO scale out)	Rubin Ultra Spec B Rubin Ultra NVL 576 (29% CPO scale out)	Products
Shipment period			2H25-2026	2H26-2027	2H26-2027	2H27-2028	2H27-2028	
Key assumptions					Key assumptions			
Scale up			100% copper cables	100% copper cables	100% copper cables	PCB miplane	L1 copper cables; L2 CPO	Key assumptions are based on the spec table (Exhibit 5)
Scale out			100% pluggable OM (1.6T)	100% pluggable OM (1.6T)	75% pluggable OM (1.6T); 25% CPO	71% pluggable OM (3.2T); 29% CPO	71% pluggable OM (3.2T); 29% CPO	OM refers to optical module
EPS implications (LCY)		2025 Diluted EPS			EPS opportunities (LCY)			
Optical module/ Optical engine								
Innolight	300308.SZ	9.8	6.0	14.6	11.4	24.8	28.6	Optical engine, Optical module
Eoptolink	300502.SZ	9.5	4.2	10.0	8.0	17.5	21.6	Optical engine, Optical module
TFC Optical	300394.SZ	2.7	2.7	3.9	3.3	6.0	12.4	FAU, Optical module
Sumitomo	5802.T	345.9	-	-	29.6	69.2	311.0	FAU, Optical engine
Mitsubishi	6503.T	162.9	-	-	8.8	23.3	98.6	Optical engine
Furukawa	5801.T	747.3	-	-	103.0	245.5	1,092.1	FAU, Optical engine
Fujikura	5803.T	582.4	-	-	18.8	24.9	153.6	FAU
CW laser/ EML								
Landmark	3081.TWO	4.6	2.3	6.1	7.1	14.4	73.4	CW laser
VPEC	2455.TW	3.0	0.6	1.7	1.9	3.9	20.1	EPI wafer
Sumitomo	5802.T	345.9	8.6	21.0	22.5	49.6	142.4	CW laser/EML
Mitsubishi	6503.T	162.9	4.1	9.7	8.3	21.3	43.9	CW laser/EML
Furukawa	5801.T	747.3	1.2	7.0	20.3	41.3	210.6	CW laser/EML
PCB								
Victory Giant	300476.SZ	5.0	-	-	-	13.3	-	PCB Midplane
WUS	002463.SZ	2.0	-	-	-	2.4	-	PCB Midplane
Unimicron	3037.TW	4.3				0.9		PCB Midplane
CCL								
EMC	2383.TW	40.8	-	-	-	100.7	-	CCL for PCB Midplane
Shengyi	600183.SS	1.3	-	-	-	0.3	-	CCL for PCB Midplane
Net income implications (US$ m)		2025 Net income			Net income opportunities (US$ m)			
Optical module/ Optical engine								
Innolight	300308.SZ	1,510	947	2,286	1,785	3,894	4,497	Optical engine, Optical module
Eoptolink	300502.SZ	1,326	577	1,394	1,111	2,435	3,004	Optical engine, Optical module
TFC Optical	300394.SZ	290	291	421	357	651	1,348	FAU, Optical module
Sumitomo	5802.T	1,740	-	-	149	348	1,565	FAU, Optical engine
Mitsubishi	6503.T	2,142	-	-	116	306	1,297	Optical engine
Furukawa	5801.T	340	-	-	47	112	497	FAU, Optical engine
Fujikura	5803.T	1,037	-	-	33	44	273	FAU
CW laser								
Landmark	3081.TWO	14	7	19	22	44	225	CW laser
VPEC	2455.TW	18	4	10	12	24	123	EPI wafer
Sumitomo	5802.T	1,740	43	105	113	250	717	CW laser/EML
Mitsubishi	6503.T	2,142	53	128	109	279	577	CW laser/EML
Furukawa	5801.T	340	1	3	9	19	96	CW laser/EML
PCB								
Victory Giant	300476.SZ	603	-	-	-	1,622	-	PCB Midplane
WUS	002463.SZ	535	-	-	-	647	-	PCB Midplane
Unimicron	3037.TW	222	-	-	-	45	-	PCB Midplane
CCL								
EMC	2383.TW	488	-	-	-	1,188	-	CCL for PCB Midplane
Shengyi	600183.SS	449	-	-	-	114	-	CCL for PCB Midplane

(1) We estimate the potential EPS/ Net income contributed from a certain server model. (2) We assume all the lasers for CPO are CW lasers. (3) OM refers to optical module; (4) Eoptolink and Shengyi's 2025 financials are GSe as results are not announced.

资料来源：公司数据, 高盛全球投资研究部

(6) Choice of connection: PCB vs. Copper vs. Optics

图表 14: Copper vs. Optics vs. PCB



	PCB	Copper	Optics
Typical distance	<0.5m	5-10m	>50m
Speed	up to 224G	448G	1.6T/ 3.2T
Power consumption	Lowest	Low	Higher, needed electro-optical conversion
Signal integrity	The most challenge (Dielectric Loss, Conductor loss, Skin effect)	Challenge (Conductor loss, Skin effect)	Stable (Dispersion)
EMI	Sensitive	Medium	Immune
Cost	Lowest at scale, but costs will increase drastically if migrate to higher speed/ frequency	Lower than Optics	Higher, needed transceivers

资料来源：公司数据

Copper cables and PCBs are commonly used materials for short-distance connections. PCBs handle the short connections within servers, while copper cables connect inside or between servers. Both offer lower cost and power consumption in short distances; however, signal quality degrades rapidly over longer distances or higher speeds, leading to optical fiber connections to stand out for long distance or high speed interconnections. AI data centers are being designed for faster bandwidth, larger scale, easier deployment and lower costs. There are many different options for AI data center connections (as we list in 图表 15), and connection technologies change over time. Major trends recently include (1) copper cables evolving from DAC to ACC to AEC, toward longer distance connection, (2) PCBs evolving from intra-tray use to intra-rack connections, and (3) optics evolving from scale out to scale up, with AOC and CPO switches, covering shorter distance connection.

图表 15: From PCB to Fiber: different types of connections for different distances

Category	PCB		Copper			Optics		
Connection materials	PCB traces	PCB midplane	DAC (Direct Attach Copper)	ACC (Active Copper Cable)	AEC (Active Electrical Cable)	AOC (Active Optical Cable)	Transceiver + Fiber (DR)	Transceiver + Fiber (FR)
Distance	<1m	<1m	0.5-3m	7-15m	5-30m	30-100m	30-500m	500m-2km
Cost	Lowest	Higher	Lowest	Low	Medium	Higher	Higher	Higher
Medium	PCB	PCB	Twinax Copper	Twinax Copper + Redriver	Twinax Copper + Retimer	Multimode Fiber with integrated transceivers (VCSEL)	Singlemode Fiber + discrete DR transceivers	Singlemode Fiber + discrete FR transceivers
Typical application	Same tray: GPU to GPU	Intra-rack: GPU to GPU	Intra-rack: GPU to GPU, GPU to ToR	Intra-/ Inter-rack: GPU to GPU, GPU to ToR	Intra-/ Inter-rack: GPU to GPU, GPU to ToR	Inter-rack: GPU to ToR	Intra-builidng: ToR to Spine, Leaf to Spine	Inter-building: Spine to super spine
Scale up or Scale out	Scale up	Scale up	Scale up	Scale up (Inter-rack)	Scale up (Inter-rack)	Scale up (Inter-rack), Scale out	Scale out	Scale out

资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

Scale up configurations: (1) From short to longer distances: In general, PCB traces are for connections within a server tray, DAC copper cables for connections within a server rack (e.g. GB200’s copper cartridge) and AEC copper cables for connections among server racks (e.g. AmazonTrn2-Ultra64). AEC cables come with retimers that drives the connection distance to reach 5-30m (vs. <3m of DACs). (2) PCB midplane: Server trays and switch trays could be connected directly to a PCB midplane, which is likely to feature M9 CCL materials and 78 or more layers. The initial costs could be higher, though the midplane could be easier to assemble and more competitive in costs-to-performance ratio for higher speed requirements (e.g. Rubin Ultra NVL144). (3) Optics show strength in longer interconnections and larger bandwidth, which Google uses in part of its scale-up 3D torus. To meet the larger bandwidth demands and shorten connection distances, Optics connections are expanding from pluggable optical modules to onboard optics (NPO), and co-packaged optics (CPO), which could be seen in scale up configurations (e.g. Rubin Ultra NVL576 level 2 scale up). Scale out configurations: in general, optics are for AI cluster scale out given the requirement on high speed and larger interconnection size.

图表 16: Connection solutions of mainstream AI servers

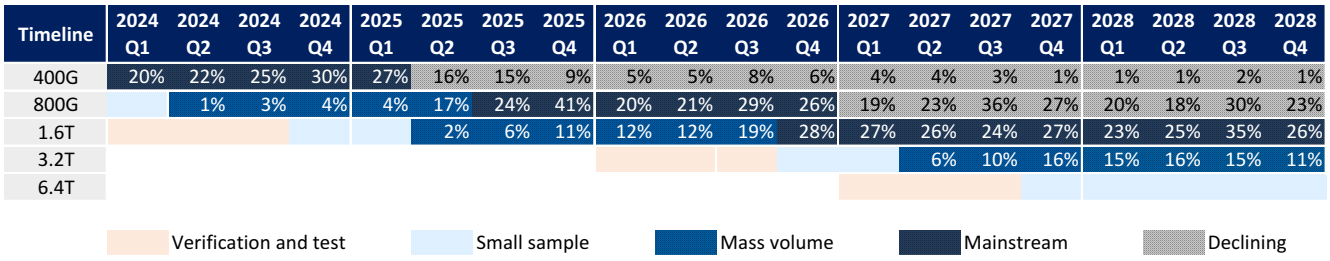
Model		Year	Scale-up	Scale-out
Nvidia	GB200	2024	Copper	Optical (400G, 800G)
	GB300	2025	Copper	Optical (800G, 1.6T)
	VR200 (1.6T)	2026	Copper	Optical (800G, 1.6T)
	Rubin Ultra	2027	Copper, PCB, Optical	Optical (1.6T, 3.2T)
Google	V6	2024	Copper, Optical (800G)	Optical (800G)
	V7	2025	Copper, Optical (1.6T)	Optical (1.6T)
	V8e	2026	Copper, Optical	Optical
	V8p	2026	Copper, Optical	Optical
Amazon	Trainium 2	2025	Copper	Copper, Optical (400G)
	Trainium 3 (Teton 3 PDS/ MAX)	2026	Copper	Copper, Optical
	Trainium 4	2027	Copper	Copper, Optical
Meta	MITA-T V1 (Minerva)	2026	Copper	Optical (800G)
Huawei	Cloud Matrix 384	2025	Copper, Optical	Optical

400G/ 800G/ 1.6T/ 3.2T refers to the fastest data rate in the network, while there can be lower speed ports in the network

资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

(7) Optics: speed upgrade continues

图表 17: Roadmap of data center connection speed

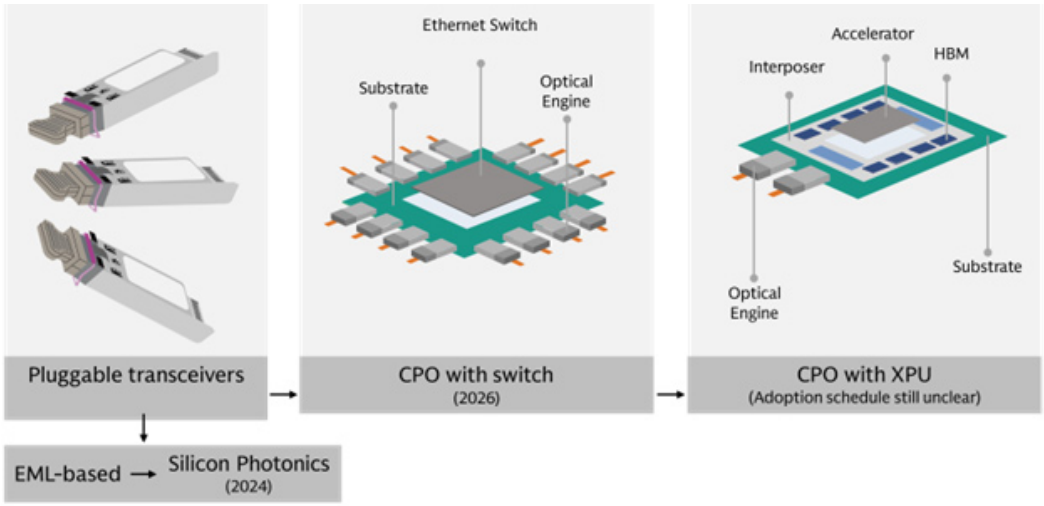


Penetration rates do not sum up to 100%, as there are modules below 400G; Data from our Global Optical Module TAM.

资料来源：公司数据, 高盛全球投资研究部

We expect the speed migration to continue through 2028E, from 800G to 1.6T in 2026, and toward 3.2T and above in the following years, and followed by China Cloud speed migration to lengthen the migration cycle. To meet the increasing demand on bandwidth, power consumption, and miniaturization, the form of optical connection is evolving (图表 18): (1) pluggable optical module are shifting towards silicon photonics from EML, which come with higher integration, lower cost and reduced reliance on laser supply, (2) expanding from pluggable optical module to onboard optics (NPO) and co-packaged optics (CPO), covering short distance connection with high bandwidth and better power efficiency. CPO will initially be integrated with switch ASIC, followed by XPUs (GPU, CPU, ASICs, etc.).

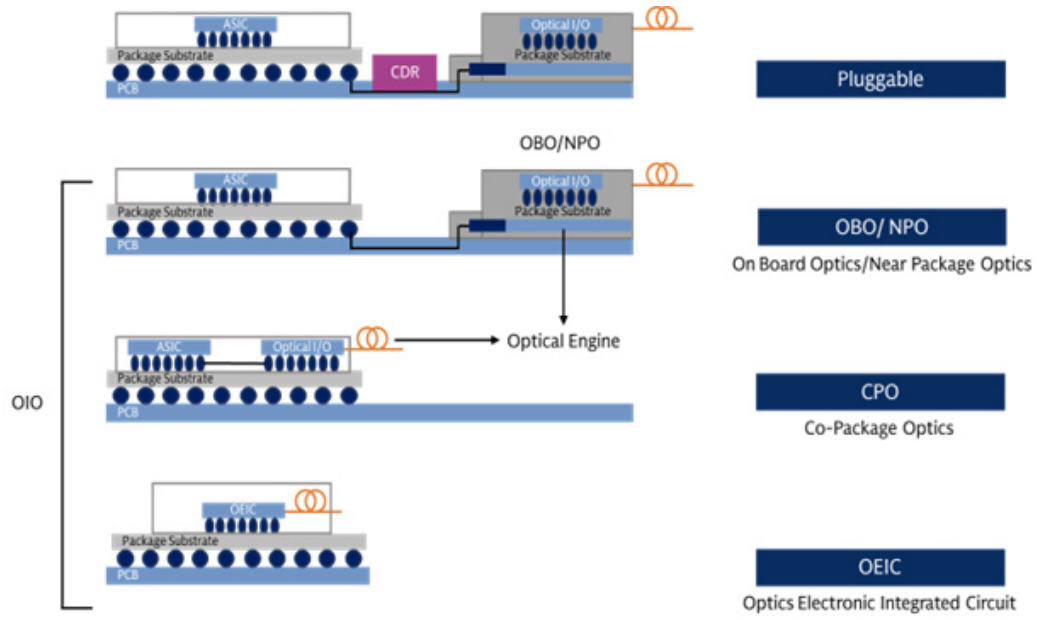
图表 18: Optics technology migrations



资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

(8) CPO with Switch kick off in 2026

图表 19: CPO Technology migrations



资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

CPO expands optics to cover short distance connection and higher bandwidth. It places optical engines as close as possible to the chips, shortening the electrical paths from several centermeters to millimeter level and lower power consumption. The shorter transmission path could also reduce latency and save DSPs and retimers, along with the power consumption by these devices. The higher integration also brings smaller size. On other hand, CPO requires supply chain technology migration rather than single devices upgrade, which could take time to develop; in addition, the co-packaging leads to higher maintenance costs: in a pluggable optical module, if the optical engine fails, one replaces the optical module, and the switch system remains intact, while in (1) onboard optics / NPO, it

would need to replace the switch PCB, (2) CPO with the switch, failure would affect the switch ASIC, and (3) CPO with XPU, failure would affect the XPU (e.g. GPU, CPU, NPU, etc.). The lifecycle of PIC and EIC are different, with PIC are more delicate, leading to the design of pluggable optical module. As a result, we expect (1) pluggable optical module would co-exist with NPO / CPO, and on continuous speed migration toward 3.2T, (2) CPO would be more attractive to clients in short distance and higher bandwidth that pluggable optical module could not achieve, and (3) pluggable optical module suppliers would also enjoy new optics devices opportunities in NPO / CPO, such as optical engine, FAU, ELS module, etc.

图表 20: CPO: key development of major players

Key players	Progress	Progress details	Highlights
Nvidia	- CPO Switch commercially avaiable in 2026 (Scale out)	**Mar-2025:** Announced CPO switch (Quantum-X InfiniBand, Spectrum-X Ethernet) **Early 2026:** Commercial availability of CPO switch	Adopt **MRM (Micro Ring Modulator)** technology, achieving higher density and efficiency
Broadcom	- Davisson (102.4T) CPO switch sampling in Oct 2025 (Scale-out and scale-up)	**Mar-2022**: world's first 25.6T CPO Demo **June-2023:** 51.2T CPO sampling **Mar-2024:** Bailly (51.2T) CPO switch deliverd to customers **Oct-2025:** Davisson (102.4T) CPO switch delivered to customers	Adopt **MZM** (Mach-Zehnder Modulator), which is more matured, while also developing MRM
Marvell	- CPO ethernet swith sampling in 2027 (Scale-out) - Developing CPO for XPUs (Scale-up)	**Feb-2026:** Acquired Celestial AI, a startup focusing on CPO for XPUs **2027:** CPO (204T) Ethernet switch sampling	CPO solution to combine with custom XPUs for CSPs
Ranovus x Mediatek	Announced co-developed CPO for ASIC in 2024	**Mar-2024:** Announced Odin CPO solutions (6.4T) collaborating with Mediatek's ASIC platform	Targeting CPO technology on XPU

资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

图表 21: CPO development: Nvidia and Broadcom taking the lead
Nvidia and Broadcom’ s ecosystem

Ecosystem	Nvidia	Broadcom
Time line	**Mar-2025:** Announced CPO switch (Quantum-X InfiniBand, Spectrum-X Ethernet) **Early 2026:** Commercial availability of CPO switch	**Oct-2025:** Davisson (102.4T) CPO switch delivered to customers **2026:** Davisson to start production
Compute		
GPU	Nvidia (Blackwell, Rubin etc)	Open (Nvidia, AMD, Intel etc)
Network		
Switch ASIC	Nvidia	Broadcom (Tomahawk 5/ Tomahawk 6)
Switch system	Nvidia (Spectrum-X, Quantum-X)	Open ecosystem (Delta Electronics, Micas Networks)
Optics		
CPO chip		
CPO platform name	N.A.	Bailly/ Davission
CPO chip fabrication	TSMC (2330.TW)	TSMC (2330.TW)
CPO chip test	SPIL (3711.TW)	TBA
Other componets		
Optical engine	TFC Optical (300394.SZ), Browave (3163.TWO), TSMC (2330.TW), Innolight (300308.SZ), Eoptolink (300502.SZ), PCL Tech (4977.TW)	
FAU	FOCI (3363.TWO), TFC Optical (300394.SZ), Innolight (300308.SZ), Advanced Fiber Resources (300620.SZ)	
CPO connector	Nextronics (8417.TWO)	COXOC (6205.TW)
Optical connectors	Senko (Private)	TBA
Shuffle Box	Browave (3163.TWO)	
Laser Sources/ CW Laser	Sumitomo (8053.T), Furukawa (5801.T)/ VPEC (2455.TW), Landmark (3081.TWO), YJ Semitech (688498.SS), Lumentum (LITE), Coherent	
ELS module	Senko (Private), Sumitomo (8053.T), Innolight (300308.SZ), PCL Tech (4977.TW)	
Fiber	Corning (GLW)	
Cage thermal module	Nextronics (8417.TWO)	COXOC (6205.TW)
System-level assembly	Hon Hai (2317.TW), Fabrinet (FN)	TBA
Equipment		
CPO coupling	Robotechnik (300757.SZ), ASMPT (0522.HK), All Ring (6187.TWO)	
CPO test	Robotechnik (300757.SZ), All Ring (6187.TWO)	

资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

图表 22: CPO Switch BoM breakdown, by value (GSe)

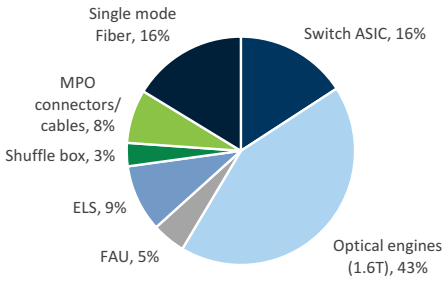
CPO switch BoM (Quantum-X Photonics)

US$	#	ASP	Value
Switch ASIC	4	3,000	12,000
Optical engines (1.6T)	72	450	32,400
FAU	72	50	3,600
ELS	18	400	7,200
Among which: CW laser (300mw)	144	30	4,320
Shuffle box	1	2,500	2,500
MPO connectors/ cables	144	40.0	5,760
Single mode Fiber	1,152	11	12,343
BoM			**75,803**
Markup			62,220
Selling price			**130,000**

ASP estimates are based on industry checks

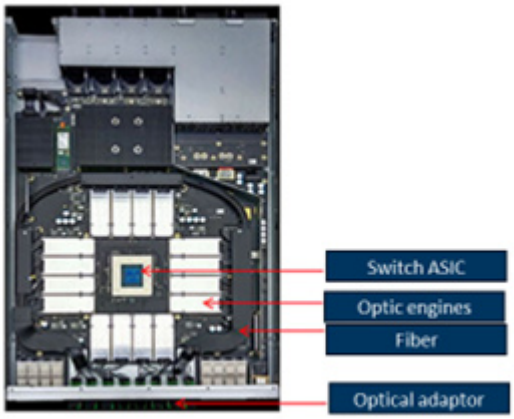
资料来源：公司数据, 高盛全球投资研究部

图表 23: CPO Switch BoM breakdown, by % (GSe)



资料来源：公司数据, 高盛全球投资研究部

图表 24: NPO Switch by Ruijie



Picture from Ruijie

资料来源：公司数据

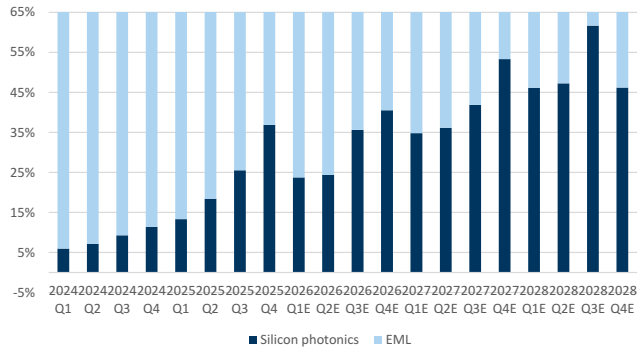
图表 25: NPO Switch by Ruijie

Picture from Ruijie

资料来源：公司数据

(9) Pluggable optical modules: SiPh-based in expansion

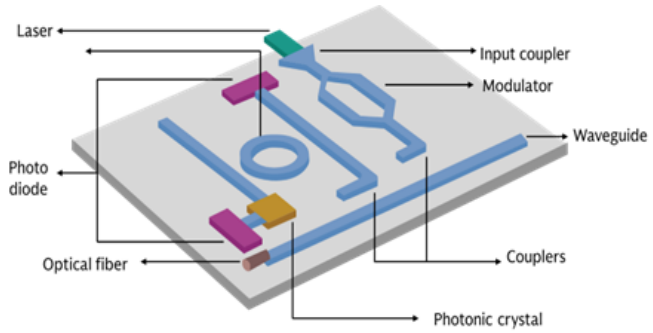
图表 26: We expect SiPh’s penetration in datacom market to increase from 6% in 1Q24 to 46% in 4Q28E



Global Optical Module TAM.

资料来源：公司数据, 高盛全球投资研究部

图表 27: Inside a Silicon photonics chip



资料来源：公司数据

We expect the adoption of silicon photonics in optical transceiver modules to grow from 6% in 1Q24 to 45% in 4Q28 (图表 26). Silicon Photonics provides advantage over traditional discrete optical transceivers due to (1) a higher level of integration and smaller size, (2) lower power consumption, and (3) lower costs. These advantages will become more prevalent when the industry migrates to faster speeds. Nevertheless, the EML would also co-exist in AI data center, especially for long distance transmission given CW lasers require high power to deliver similar performance to EML in long distances. In short distance, some clients would still choose EML considering it is a long-established technology with a longer track record, and the reliability of the network is critical for AI computing, and GPU remains the major cost contributor, making the cost reduction from the light source less significant. The price of like for like products declines as scale ramps up, similar to many other technology components; nevertheless, the speed migration toward

800G / 1.6T / 3.2T would continue to drive the blended ASP expansion. Gross margin of optical module suppliers will ramp to 48%-55%, driven by product mix migration, as higher speed products would shift towards SiPh-based optical modules, benefiting from lower laser costs.

图表 28: 800G: SiPh has 26% BoM advantage and 15% price advantage
800G Optical module BoM

800G BoM (US$)	EML		Silicon Photonics		Diff
Components	#	Value	#	Value	*Value*
TOSA (excl. laser, driver)	1	**15**	-	**-**	*(15)*
Laser	8 x 100G EML	**96**	4 x 70mw	**16**	*(80)*
Driver	2	**20**	2	**20**	-
ROSA (excl. TIA)	1	**20**	-	**-**	*(20)*
TIA	2	**20**	2	**20**	-
Silicon Photonics chip	-	**-**	2	**40**	*40*
DSP	1	**80**	1	**80**	-
PCBA	1	**30**	1	**25**	*(5)*
Others		**29**		**29**	-
Total BoM		**310**		**230**	*-80*
Cost advantage of SiPh					*-26%*
ASP		**430**		**365**	*-65*
GM		**28%**		**37%**	*-23%*
Price advantage of SiPh					*-15%*

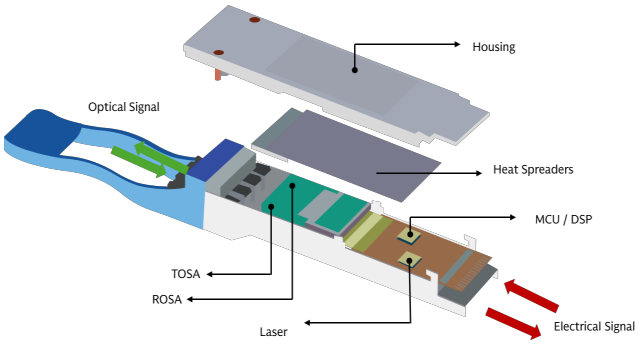
资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

图表 29: 1.6T: SiPh has 32% BoM advantage and 20% price advantage for 1.6T applications
1.6T Optical module BoM

1.6T BoM (US$)	EML		Silicon Photonics		Diff
Components	#	Value	#	Value	*Value*
TOSA (excl. laser, driver)	1	**15**	-	**-**	*(15)*
Laser	8 x 200G EML	**160**	4 x 70mw	**16**	*(144)*
Driver	2	**30**	2	**30**	-
ROSA (excl. TIA)	1	**60**	-	**-**	*(60)*
TIA	2	**30**	2	**30**	-
Silicon Photonics chip	-	**-**	2	**70**	*70*
DSP	1	**130**	1	**130**	-
PCBA	1	**35**	1	**25**	*(10)*
Others		**40**		**40**	-
Total BoM		**500**		**341**	*-159*
Cost advantage of SiPh					*-32%*
ASP		**1,000**		**800**	*-200*
GM		**50%**		**57%**	*21%*
Price advantage of SiPh					*-20%*

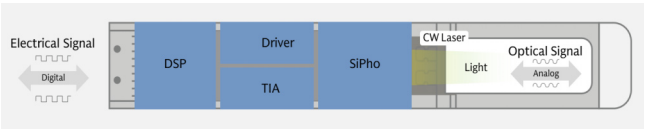
资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

图表 30: EML-based optical transceivers: more discrete devices inside



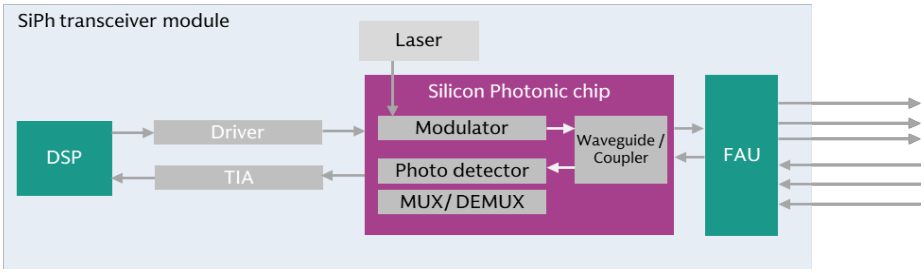
资料来源：公司数据

图表 31: Silicon photonic optical transceivers: higher integration with simplified structure



资料来源：公司数据

图表 32: Silicon photonic optical transceivers: how data transmission works



资料来源：公司数据, Compiled by Goldman Sachs Global Investment Research

(10) Light sourcing: Supply chain and Shortage

图表 33: Optical chip supply chain

	Substrates			
Substrate	**InP substrate**	JX Advanced Metals, Freiberger, Sumitomo Electric, AXT, Yunnan Germanium	**GaAs substrate**	Sumitomo Electric, AXT, Yunnan Germanium

	EML-based		**SiPh-based**	
Photonics Chips	**EML transmitters**	IDM: **Lumentum, Coherent, Broadcom, Sumitomo, Mitsubishi**, YJ Semi, Source Photonics, Everbright Photonics, Shijia Photons, Accelink	**CW Lasers**	IDM: **Sumitomo**, Broadcom, Lumentum, Mitsubishi, Coherent, YJ Semi, Shijia Photons, Everbright Photonics, Accelink EPI wafer + laser chip: **Landmark, Landmark + LuxNet/ TrueLight, VPEC + Furukawa**
	Photodiode	IDM: **Broadcom** EPI wafer + PD chip: **IET / VPEC + Lumentum/ Coherent/ Mitsubishi/** Hamamatsu/ Accelink/ GCS	**SiPh Photonic IC (PIC)**	Design and Packaging: **Lumentum, Coherent, Broadcom, Innolight, Eoptolink, Accelink, Mellanox + TFC Optical, CISCO** Foundry: Towerjazz, GlobalFoundries, TSMC

	EML-based / SiPh- based	
Modules	**Optical modules**	Innolight, Coherent (Finisar), Broadcom, Lumentum, Eoptolink, Accelink, Fabrinet, Huawei, Halma Plc

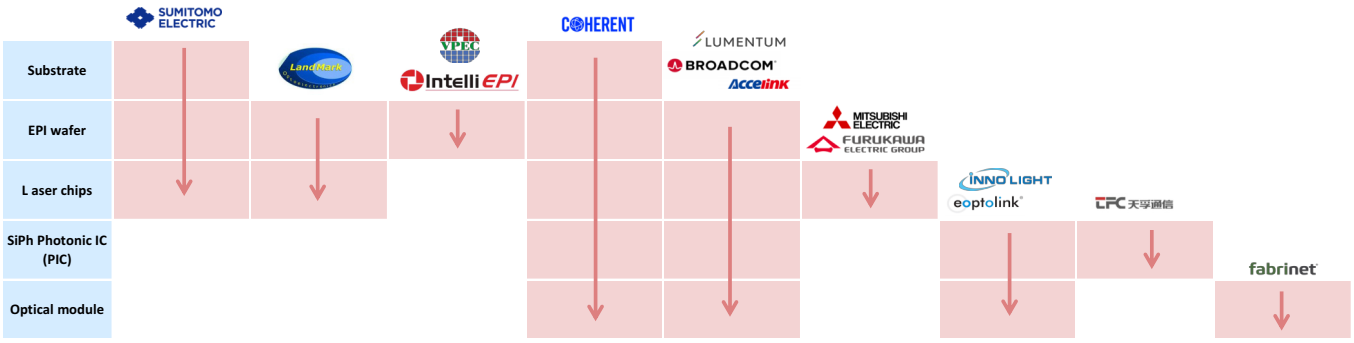
资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

Supply tightness remains in 2026, across both EML and CW lasers, due to (1) strong demand driven by AI servers ramp up, speed migration, and optical connections expansion, (2) InP substrate supply constraints, which are used in both EML and CW lasers, and across PD (receivers) and LD (transmitters), and under geopolitical tension / export controls by the China government, and (3) it takes time for capacity expansion and ramp up across the supply chain. Nevertheless, we see continuous capacity expansion plans from the supply chain, such as: VPEC plans to expands InP MOCVD from 60 units to 64 units in 2H26, both Landmark and YJ Semi commits on significant capacity expansion in 2026, Lumentum plans to expand capacity by 40% from CY3Q25 to CY2Q26, and likely to bring more capacities online in 2026 (Read more in FY2Q26 earnings call), and Coherent has also committed to doubling the capacity (Read more in FY2Q26 earnings call). Overall, we expect light source supply to remain tight through 2027, and could turn more balanced in 2H28 post supply chain capacity expansion, or a slowdown in AI servers specification upgrades as the industry shifts to inferencing from training, or ease of geopolitical tension / export controls by the China government.

图表 34: Light source supply

资料来源：高盛全球投资研究部

图表 35: Different level of vertical intergration of optical chip suppliers



As of Apr 2026

资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

VCSEL: Vertical-Cavity Surface-Emitting Laser

Light sourcing in CPO could also vary: CW lasers stand out as the most widely adopted light source in optical modules, and could serve longer-distance connection, fulfilling both scale out and scale up. VCSEL also benefits from technology readiness and has higher energy efficiency (lower power consumption) than CW laser solutions. Although its effective reach is shorter than that of CW laser, the distance is sufficient for scale up. MicroLED is another potential choice in scale up, with high energy efficiency, and low latency, while the technology readiness is lower compared to CW lasers and VSCEL.

图表 36: Different choices of laser for CPO

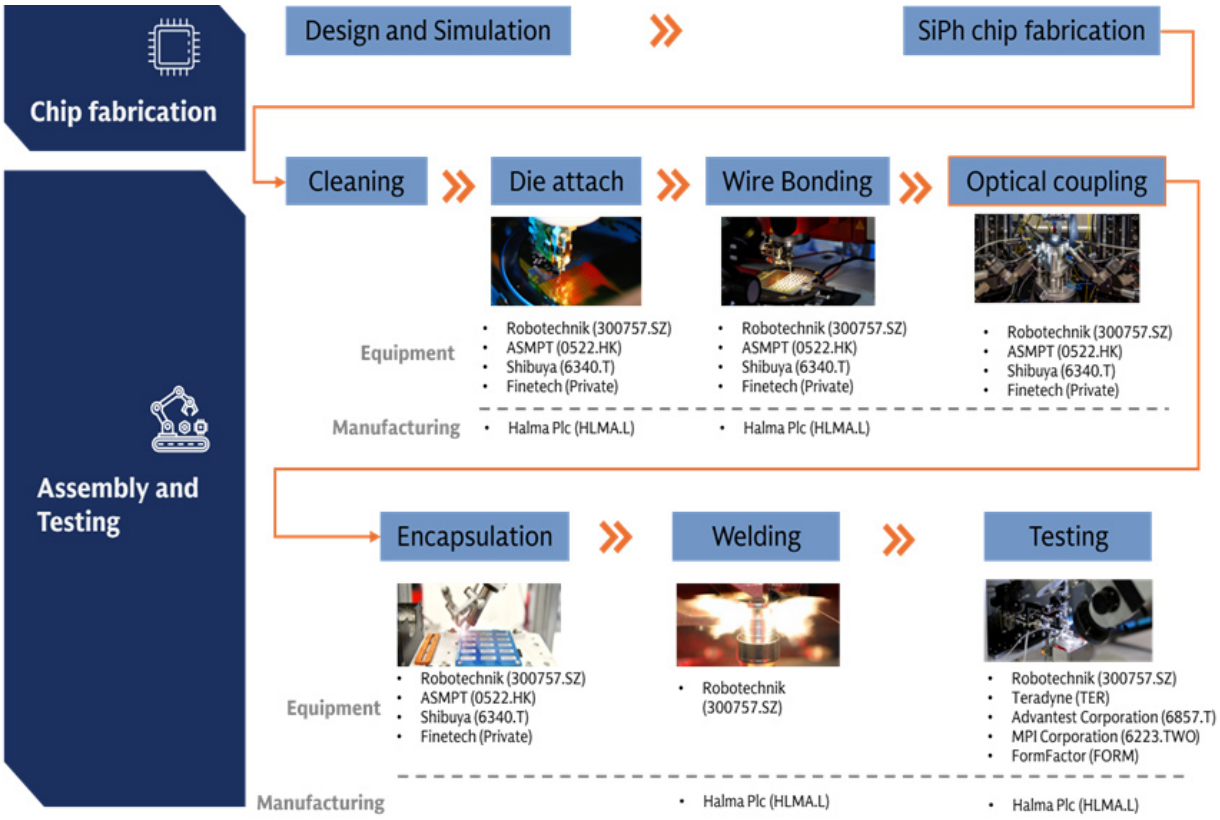
	SiPh + CW Laser	VCSEL	MicroLED
Energy efficiency	Lower	High	High
Effective reach (meter)	>1km	<100m	<20m
Latency	Low to Medium	Low to Medium	Low
Cost per bit	Medium	Low	Low
Technology readiness	High	High	Low

资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

(11) Manufacturing: how to make SiPh optical modules and

engines in CPO

图表 37: Optical module assembly and test process and key equipment suppliers



Optical coupling: Highly impacts production yields
- Sub-micron alignment precision is required
- Compounded Failure: In a co-packaged environment, the failure of a single coupling channel can lead to the rejection of the entire module
- Irreversibility: Once the fiber is glued or laser-welded to the PIC, it is nearly impossible to rework

Testing and inspection: Highly impacts production yields
- The complicated combination of multiple components, including PIC, EIC, lasers and FAU means that the yield rate of each step is vital
- "Testing Shift Left", the final product is integrated with expansive GPUs, and therefore it's vital to test and discover bad dies as early as possible
- Optical alignment need to be ±0.1μm, positing high requirement on coupling test & inspection

资料来源：公司数据, Compiled by Goldman Sachs Global Investment Research

(12) Attach rate: Pluggable optical modules to GPU / ASIC in

scale out

图表 38: Optical transceiver attach rate

Model		Year	Attach rate (GSe)	Data rate
Nvidia	GB200	2024	**1: 2~3**	800G
	GB300	2025	**1: 2~3**	1.6T
	VR200	2026	**1: 4~6**	1.6T
	Rubin Ultra	2027	**TBA**	3.2T (GSe)
Google	V6	2024	**1:4**	800G
	V7	2025	**1:4**	1.6T
Amazon	Trainium 2	2025	**1:4**	400G
	Trainium 3 (Teton 3 PDS/ MAX)	2026	**1:4**	TBA
Meta	MITA-T V1 (Minerva)	2026	**1:8~12**	800G (GSe)
Huawei	Cloud Matrix 384	2025	**1:18**	400G
Biren	BR20x	2026	**TBA**	400G/800G

400G/ 800G/ 1.6T/ 3.2T refers to the fastest data rate in the network, while there can be lower speed ports in the network

资料来源：公司数据, Compiled by Goldman Sachs Global Investment Research

The Chip-to-optical module attach ratio depends on (1) network structure: a large cluster with 10 thousand GPUs requires three layers of network, while smaller clusters can be supported by two layers. (2) the adoption % of optics in connections. Nvidia’s upcoming VR200 racks will come with an attach ratio of 1: 4~6 (1.6T), doubling comparing to GB300’s 1: 2~3 (1.6T). The increase of optical module usage is driven by the increase in port rate on the server side (i.e. VR200’s compute tray support 1.6T per GPU, while GB300’s compute tray is at 800G per GPU), while the data rate at the networking side remains the same at 1.6T. The Optical module attach rate of Google and Amazon ASIC are at similar level of 1:4, as they adopt copper cables and OCS switch in scale-up/ scale-out networking. Meta’s ASIC can come with a higher attach ratio of 1:8~ 1:12 (800G), per our industry check, given their complicated DSF (Disaggregated Scheduled Fabric) network design. Similarly, Huawei’s Cloud Matrix 384 comes with attach ratio of 1:18 as it adopts all optics connection. Other Chinese GPU/ ASIC other than Huawei usually use a standardized 8 GPU per server design, and 1:4~6 attach ratio (800G) is commonly seen.

图表 39: Ruijie’s network solution: optical module attach rate at 1:4/ 1:6 for 2-/ 3-layer network (800G)

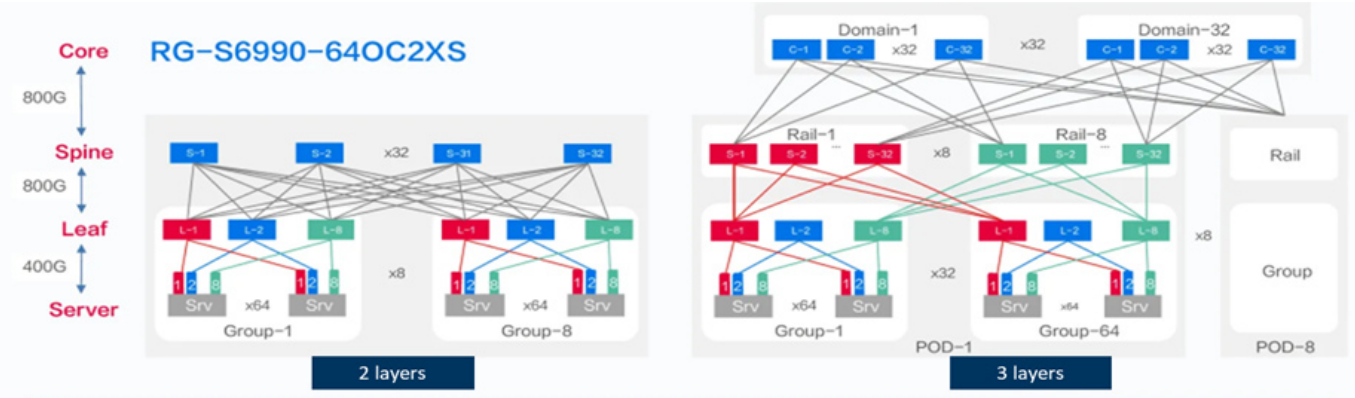
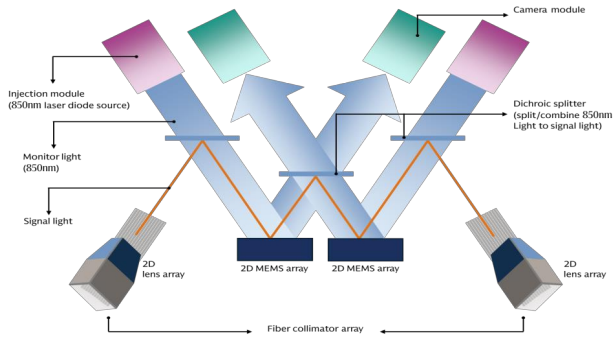


Exhibit from Ruijie

资料来源：公司数据

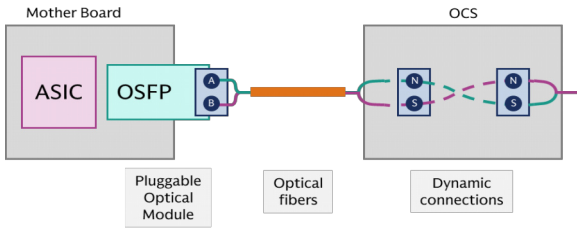
(13) Optical Circuit Switch: Achieving all optics networking

图表 40: Google’ s Palomar OCS based on MEMS technology



资料来源：公司数据, 高盛全球投资研究部

图表 41: Optical modules are not needed on OCS switch, while still needed on server motherboards



资料来源：公司数据, Compiled by Goldman Sachs Global Investment Research

As more optical connections are adopted in data centers, OCS (Optical Circuit Switch) will be an alternative option. Compared to traditional data center switches, which require optical-electrical-optical transformation, the OCS switch is completely based on optical signals, which allowsor higher bandwidth, power e fficiency, and scalability. The OCS switch provides an analog light path from the input fiber to the output fiber, and it passes through 800G/ 1.6T/ 3.2T lights in the same way. Therefore, by deploying the OCS switch, AI data center does not need to replace their switch when upgrading toaster data rate, and a same OCS switch can support different data rate at the same time. Thiseature makes it an optimal solutionor today’ sast changing AI clusters. Key progress: (1) Innolight targets SiPh OCS in 2027, (2) Robotechnik announced that they obtained an order of “ fully automated OCS (Optical Switch) packaging line” from its Europe customer. The order is worth EUR 7.7m, (3) Lumentum ‘s optical circuit switches (OCS) backlog reached beyond $400 million in Feb 2026, (4) Coherent: per management, the company has engaged with over 10 customers on OCS as of Feb 2026. Shipments and backlog include 64x64 systems and 320x320 systems, and expected OCS revenue to grow sequentially in the coming quarters after Feb 2026.

图表 42: The development timeline of OCS

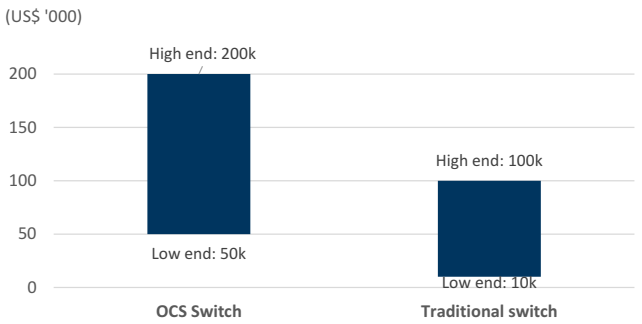
2015	**Google** launched the Apollo OCS project to develop the OCS switch
2023	**Google** announced TPU v4 is the first supercomputer to deploy OCS, with 4096 chips interconnected by 48 internally-developed OCS
2025	**Google's** TPU v7 SuperPod adopts OCS to interconnect 9,216 chips **OCP** announced new OCS project, with participants including **Lumenutm, iPronics, Google, Nvidia, Coherent, Microsoft**, etc.
2026	**Lumentum** announced that it's scaling rapidly to meet extraordinary customer demand that has already driven our backlog well beyond $400 million **Coherent** expects OCS revenue to ramp through this year and next, with over 10 customers engagements now

图表 43: OCS: major technology options

	MEMS	LC/LCoS	Piezo/ DLBS	SiPh
What does it mean	MEMS Mirror or Micro-electromechanical systems	Liquid crystal	Direct Light Beam-Steering	Silicon Photonics
How does it work	Control the deflection of the mirrors by applying voltage, thereby changing the propagation path of the light.	Beam deflection utilizing the electro-optic effect of liquid crystals and the cascading of crystal wedges.	Two collimator arrays are placed face to face to form a switch matrix. Electric field drive the the collimators to shift and tilt, aligning corresponding ports and achieve optical switching.	Constructing defined optical path matrix on a silicon-based chip, allowing optical signals to be transmitted along a predetermined path.
Advantages and Disadvantages	Matured solution with mass production track record	**Pros:** Higher reliability as there's no mechanical moving parts, low voltage and low power consumption **Cons:** switching time is slow	**Pros:** More reliable and Lower loss than MEMS **Cons:** hard to support very large port numbers	**Pros:** Fast switching time. Potential low cost for mass production **Cons:** High insertion loss
Progress	Mass production, now the major solutoin	Mass production	In qualification	In qualification
Switching time	Medium (<100ms)	Slow (>100ms)	Medium (<100ms)	Low (nanosecond)
Reliability	Low	High	High	High
Drive voltage	~ 100V	<= 10V	~ 10V	Low
Insertion Loss	Low (~ 3dB)	Low (~ 4dB)	Low (~ 2.5dB)	High (~ 6dB)
Crosstalk	Low	Low	High	High
Key players	Google LUMENTUM Accelink Calient.AI **OCS switch designer: Gooogle** (GOOGL), Lumentum (LITE), Calient (Private), Accelink (002281.SZ)	COHERENT **OCS switch designer:** Coherent (COHR)	HUBER+SUHNER Polatis **OCS switch designer:** Huber+Suhner (HUBN.SW)	INNOLIGHT iPRONICS Taclink **OCS switch designer:** Innolight (300308.SZ), iPronics (Private), Taclink (688205.SS)
Supply chain	**MEMS:** Sai MicroElectronics (300456.SZ), XDLK Microsystem (688582.SS) **VSCEL:** Lumentum (LITE), Coherent/Finisar (COHR) **FAU:** Corning (GLW) **Optical fiber cable:** Ezconn (6442.TW) **System ODM:** Advanced Fiber Resource (300620.SZ) **Equipment:** Robotechnik (300757.SZ) **Packaging:** Halma Plc (HLMA.L)	**Optical component:** Optowide (688195.SS) **Equipment:** Robotechnik (300757.SZ) **Packaging:** Halma Plc (HLMA.L)	**System ODM:** Luster (688400.SS) **Equipment:** Robotechnik (300757.SZ)	**SiPh chip:** HGTech (000988.SZ) **System ODM:** Taclink (688205.SS), Innolight (300308.SZ) **Equipment:** Robotechnik (300757.SZ)

资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

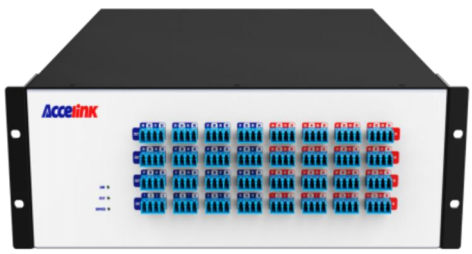
图表 44: ASP of OCS vs. traditional switch



As of Apr 2026

资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

图表 45: OCS switch by Accelink



资料来源：公司数据

(14) Technology adoption: pace varies on infrastructure

图表 46: Technology adoption by CSP

	Nvidia	Google	Microsoft	Meta	Amazon	Oracle	Chinese CSP
Optical module							
800G	√	√	√	√	√	√	√
1.6T	√	√	O (2027)	O (2026)	O (2027)	O (2027)	O
3.2T	O (2028)	O (2028)					
CPO							
Scale up	O			O			
Scale out	O	O		O			
OCS							
Scale up or scale out		√					

Note: √: adopted O: See progress in adoption

资料来源：公司数据, Data compiled by Goldman Sachs Global Investment Research

While the networking technology migration is a certain trend, the pace of adoption varies depending on the clients' data center infrastructure readiness and their specific design needs. Key factors that affect technology migrations include: (1) Depreciation and utilisation of older facilities. If current generation capacities have not yet been fully depericiated, the financial pressure of moving quickly to the next generation can be significant. (2) New infrastructure readiness. Sometimes the technology migration is slowed by the construction time for new buildings, power grids and heat dissipation infrastructure. (3) Waiting for cost reduction . When a new technology is put into use, the cost can be substantially higher than in the later stage where it enters mass production. (4) Uncertain technology direction. When the technologies are still developing and there are multiple potential directions, heavy early investment could pose a risk in an evolving technology landscape.

Appendix: Prysmian (PRY.MI, Buy): Largest global cable maker

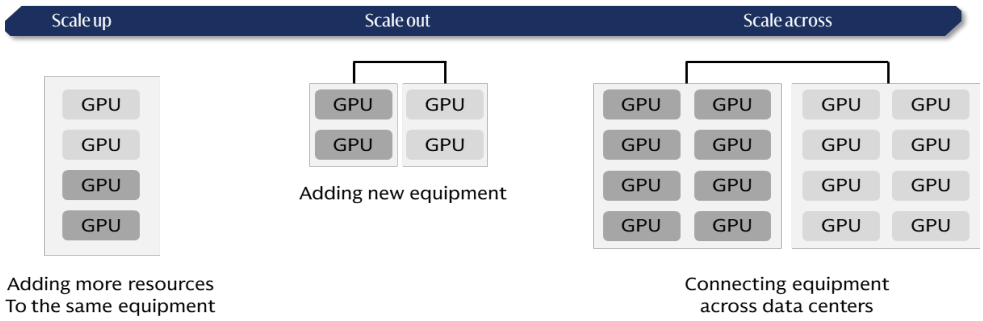
Prysmian (PRY.MI, Buy, covered by Daniela Costa) Prysmian is the largest global cable maker focused primarily on electricity cables, with 8% of revenues from fiber and fiber optic cable sales. It is one of the largest manufacturers of raw fiber along with Corning, Sumitomo, Fujikura and others. Prysmian's Digital Solutions sales exposure is ~4% to raw fiber sold to other OEMs and ~96% to cables, of which Telecom Solutions account for ~66% and data centers ~16%, mainly exposed to long distance and intra campus connectivity. Within its Digital Solutions business, Prysmian has ~46% exposure to EMEA, ~40% to North America, ~10% to APAC, and ~4% to Latin America. In 2025, Prysmian acquired Channell, strengthening its positioning by adding fiber management systems, enclosures, and connectivity hardware, and enabling a more complete end to end offering alongside its cable portfolio.

We expect Prysmian to see strong pricing tailwinds from higher fiber prices, driven by data center demand. The company notes it has a full order book through 2026 from its Fiber customers and is seeing customers willing to sign long term framework agreements at current price levels. Prysmian's vertically integrated production capabilities—covering preform, fiber drawing, and cabling—allow it to

benefit from tight market conditions, with the group producing around two-thirds of its fiber requirements in-house and outsourcing lower spec products. Given sustained demand, Prysmian is planning brownfield capacity expansions in fiber. Alongside its leading manufacturing footprint, the company continues to invest in next generation technologies, including hollow core fiber to reduce latency in high density environments and the first commercially available 160 micron bend insensitive fiber.

Appendix: Scale up vs. Sale out vs. Scale across

图表 47: Illustration of scale up, scale out and scale across connections



资料来源：公司数据, 高盛全球投资研究部

Given the increasing need for high speed AI computing, the industry has been trying to connect more GPUs to expand the size of AI clusters. There are three major ways of expansion: (1) Scale up: adding more GPUs and computing resources within the same piece of equipment, typically within the same server rack (e.g. Nvidia’s Vera Rubin rack connects 72 GPUs in a rack); nowadays there are scale-up expansions that connect across racks, or the so-called supernodes, where the networking speed across racks are optimized to close to the connections within the same rack; (2) Scale out: adding more equipment and connecting them through switching technologies, a traditional way of network expansion. Nowadays, AI clusters support scale out connections of 100k+ GPUs; (3) Scale across: connecting servers across data centers in different locations; Nvidia introduced their solutions for scale-across networking via in-house Ethernet switch and NIC (network interface controller) products.

Appendix: Closed vs. Open ecosystems

Nvidia is also a participant of ESUN although its the major beneficiary of closed scale-up ecosystem.

There is an ongoing competition of closed ecosystem and open ecosystem for networking in data centers. In scale-up networking, it is dominated by Nvidia’s closed ecosystem, in which Nvidia design its own switch ASICs and switch equipment and delivery “full rack” designs such as Vera Rubin racks. However, the establishment of ESUN (Ethernet for Scale-Up Networking) in Oct 2025, OCP marked a step forward of the open ecosystem entering the scale up domain; the goal of ESUN is to adopt the Ethernet technology to scale-up applications. UALink is

another open networking initiative focusing on GPU-GPU scale-up networking, and has announced 200G 1.0 Specification in May 2025. In scale-out networking, Nvidia’ s infiniBand (closed ecosystem) is challenging the dominance of Ethernet. InfiniBand comes with higher performance including lower latency and higher bandwidth, while Ethernet remains the cost effective and compatible choice. In order to upgrade the Ethernet performance, the UEC (Ultra Ethernet Consortium) was established in Aug 2023 with the goal of optimizing Ethernet for AI and HPC application, and the consortium announced the 1.0 specification in June 2025.

图表 48: Scale up networking: Closed vs. Open ecosystems

Scale up networking	Closed ecosystem			Open ecosystem	
	NVIDIA			UALink	Ethernet for Scale-up Networking (ESUN)
Technology	**Nvlink 5.0**	**Nvlink 6.0**	**Nvlink 7.0**	**UALink 1.0**	**ESUN (Ethernet for Scale-Up Networking)/ SUE-T**
Major players	Nvidia	Nvidia	Nvidia	**Promoters**: Alibaba, AWS, AMD, Apple, Astera Labs, CISCO, Google, HPE, Intel, Meta, Microsoft, Synopsys	AMD, Arista, ARM, Broadcom, CISCO, HPE, Marvell, Meta, Microsoft, Nvidia, OpenAI, Oracle
Year	2024	2026	2027	2025	2025
Network base	/	/	/	Physical Layer: Ethernet PHY	Ethernet
High speed I/O	**224 Gbps**	**400 Gbps**	**TBA**	**224 Gbps**	**TBA**
Max. scalability	576 GPUs	TBA	TBA	1024 GPUs	TBA
Openess	Closed (Nvidia)	Closed (Nvidia)	Closed (Nvidia)	Open	Open
Example	Nvidia Blackwell Racks	Nvidia Rubin Racks	Rubin ultra Racks	AMD Helios Racks	-

资料来源：Data compiled by Goldman Sachs Global Investment Research, 公司数据

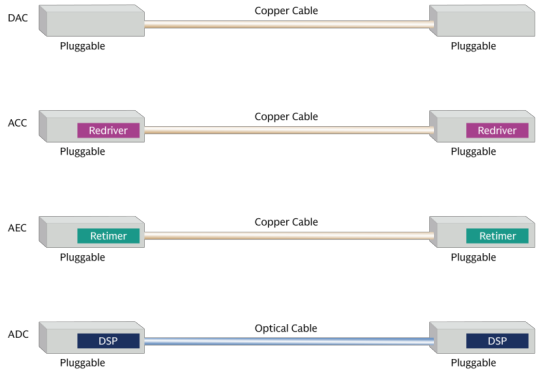
图表 49: Scale out networking: Closed vs. Open ecosystems

Scale out networking	Closed ecosystem			Open ecosystem	
	INFINIBAND TRADE ASSOCIATION NVIDIA			RoCE	Ultra Ethernet Consortium
Technology	**InfiniBand NDR**	**InfiniBand XDR**	**InfiniBand GDR**	**RoCE v2 (RDMA over Converged Ethernet)**	**UEC (Ultra Ethernet) 1.0**
Major players	Nvidia (Mellanox)	Nvidia (Mellanox)	Nvidia (Mellanox)	**Steering Committee of IBTA**: HPE, IBM, Intel, Nvidia (Mellanox)	**Steering Members:** AMD, Arista, Broadcom, CISCO, Eviden, HPE, Intel, Meta, Microsoft, Oracle
Year	2022	2025	2027-2028 (GSe)	2014-2025	2025
Network base	/	/	/	Ethernet with Data Center Bridging	Ethernet
Single Lane (1x)	100 Gbps	200 Gbps	400 Gbps	200 Gbps (Ethernet in 2025)	200 Gbps (Ethernet in 2025)
Port Rate (8x)	800 Gbps	1600 Gbps	3200 Gbps	1600 Gbps (Ethernet in 2025)	1600 Gbps (Ethernet in 2025)
Openess	Closed (Nvidia)	Closed (Nvidia)	Closed (Nvidia)	Open	Open
Latency	**< 2 µs**	**< 2 µs**	**< 2 µs**	**< 5 µs**	**< 2 µs**
TCO		**1.5-2.5x higher than RoCE**		**Medium cost**	**Lower cost**
Supported switch	Quantum-2 InfiniBand Switch	Quantum-X800 InfiniBand Switch	TBA	Ethernet Swith of Arista, Juniper, Cisco, HPE, etc; NVIDIA Spectrum-4 Ethernet Switch	Ethernet Swith of Arista, Juniper, Cisco, HPE, etc;
Example	Nvidia Blackwell Racks	Nvidia Blackwell Racks	Nvidia Rubin Racks	Meta Llama 3 Cluster (with 24k H100 GPUs)	TBA

资料来源：Data compiled by Goldman Sachs Global Investment Research, 公司数据

Appendix: Illustration of different connection products

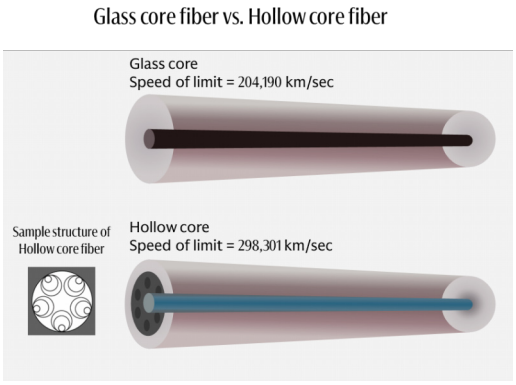
图表 50: DAC/ ACC/ AEC/ ADC: widely used in scale up and scale out connections
Copper (DAC/ AAC/ AEC) vs. Optical cables (ADC)



Micron

资料来源：公司数据

图表 51: Hollow core fiber: potentially for scale-across connections
Hollow core fiber support extra low latency comparing to traditional fiber



资料来源：公司数据

信息披露附录

申明

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本报告首页所列作者为高盛全球投资研究部分析师，除非另有说明。

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本报告披露的“贡献作者”为高盛全球投资研究部分析师，除非另有说明。

高盛要素概要

高盛要素概要部分通过将一只股票的主要指标与市场（即我们给予评级的股票范围）和可比同业相比较来评价该股的投资背景。四个主要指标是增长、财务回报、估值倍数（估值）和综合状况（增长、财务回报、估值倍数的综合情况）。增长、财务回报和估值倍数是运用每只股票具体指标的正常化排名计算。随后取这些指标正常化排名的均值并转化为相关指标的百分位。每项指标的具体计算方式可能随着财务年度、行业和所属地区的不同而有所变化，但标准方法如下：

增长指标是基于一只股票的预期销售增速、EBITDA增速和每股盈利增速（金融股仅采用每股盈利和销售增速），较高的百分位表示公司增长较快。财务回报是基于一只股票的预期净资产回报率、ROCE和CROCI（金融股仅采用净资产回报率），较高的百分位表示公司的财务回报较高。估值倍数基于一只股票的预期市盈率、市净率、股价/股息、EV/EBITDA、EV/FCF、EV/DACF（EV/经债务调整的现金流）（金融股仅采用市盈率、市净率和股价/股息），较高的百分位表示公司的估值倍数较高。综合状况百分位为增长百分位、财务回报百分位和（100% - 估值倍数百分位）的平均值。

财务回报和估值倍数使用高盛分析师在财政年度末对未来至少3个季度的预测。增长使用未来至少7个季度的财政年度预测与未来至少3个季度的财政年度预测的比较（所有指标均使用每股数据）。

如需了解高盛要素概要更具体的计算，请联络您的高盛代表。

并购评分

在我们的全球覆盖范围中，我们使用并购框架来分析股票，综合考虑定性和定量因素（各行业和地区可能会有所不同）以计入某些公司被收购的可能性。然后我们按照从1到3对公司进行并购评分，其中1分代表公司成为并购标的的概率较高(30%-50%)，2分代表概率为中等(15%-30%)，3分代表概率较低(0%-15%)。对于评分为1或2的公司，我们按照研究部统一标准将并购因素体现在我们的目标价格当中。并购评分为3被认为意义不大，因此不予体现在我们的目标价格当中，分析师在研究报告中可以予以讨论或不予讨论。

Quantum

Quantum是提供具体财务报表数据历史、预测和比率的高盛专有数据库，它可以用于对单一公司的深入分析，或在不同行业和市场的公司之间进行比较。

信息披露

Rating and pricing information

Prysmian (Buy, €121.45)

Logo Disclosure

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评级分布/投资银行关系

高盛投资研究部的全球研究覆盖范围

	评级分布			投资银行关系		
	买入	持有	卖出	买入	持有	卖出
全球	50%	34%	16%	65%	60%	45%

截至2026年4月1日，高盛全球投资研究部对3,074种股票评定了投资评级。高盛给予股票在各种地区投资名单中的买入和卖出评级；未给予这些评级的股票被视为中性评级，根据FINRA的披露要求，这些评级分别对应买入，持有及卖出。详情见以下“公司评级，研究范围和相关定义”部分。投资银行关系表反映了高盛在过去12个月已提供投资银行服务的公司在各评级类别中所占的比例。

法定披露

美国法定披露

任何本报告中研究企业所需的特定公司法定披露见上文：包括即将进行交易的承销商或副承销商，1%或其他股权，特定服务的补偿，客户关系种类，之前担任承销商或副承销商的公开发行，担任董事，担任股票做市及／或专家的角色。高盛担任或可能担任本报告中所涉及发行方的债券（或相关衍生品）的交易对手。

以下为额外要求的披露：股权及重大利益冲突: 高盛的政策为禁止其分析师、分析师属下专业人员及其家庭成员持有分析师负责研究的任何公司的证券。分析师薪酬: 分析师薪酬部分取决于高盛的盈利，其中包括投资银行的收入。 分析师担任高级职员或董事: 高盛的政策通常禁止其分析师、分析师属下人员及其家庭成员担任分析师负责研究的任何公司的高级职员、董事或顾问。 非美国分析师: 非美国分析师可能与高盛无关联，因此可以不受FINRA 2241条FINRA 2242条对于与所研究公司的交流、公开露面及交易分析师所研究证券的限制。

评级分布: 见上文评级分布披露。 价格表: 见上文价格表，其中包括之前的评级变化和价格目标的变化，若为电子报告，或本报告分析对象包含多家公司，请参阅高盛网站：https://www.gs.com/research/hedge.html。

美国以外司法管辖区规定的额外披露

以下为除了根据美国法律法规规定作出的上述信息披露之外其他司法管辖区法律所要求的披露。 澳大利亚: Goldman Sachs Australia Pty Ltd及其相关机构不是澳大利亚经授权的存款机构（1959年《银行法》所定义），因此不在澳大利亚境内提供银行服务，也不经营银行业务。本研究报告或本报告的其他形式内容只可分发予根据澳大利亚公司法定义的”批发客户”，在事先获得高盛许可的情况下可以有例外。在撰写研究报告期间，Goldman Sachs Australia全球投资研究部的职员可能参与本研究报告中所讨论证券的发行公司或其他实体组织的现场调研或会议。在某些情况下，如果视具体情形Goldman Sachs Australia认为恰当或合理，此类调研或会议的成本可能部分或全部由该证券发行人承担。如本报告内容包含任何金融产品建议，则该建议仅为一般建议，且高盛提出该建议时并未考虑客户的目标、财务状况或需求。客户在就此类建议采取行动之前，应结合其自身目标、财务状况和需求来考虑该建议的适当性。 高盛澳大利亚和新西兰的利益披露，以及高盛澳大利亚卖方研究独立性制度声明请参见https://www.goldmansachs.com/disclosures/australia-new-zealand/index.html。 巴西: 与CVM Resolution n. 20相关的信息披露请参阅https://www.gs.com/worldwide/brazil/area/gir/index.html。根据CVM Resolution n. 20第20条，在适用的情况下，对本研究报告内容负主要责任的巴西注册分析师为本报告开头部分标明的第一作者，除非报告未另有说明。 加拿大: 这些信息仅供您参考，在任何情况下都不应被理解为Goldman Sachs & Co. LLC对加拿大证券购买者进行有关任何加拿大证券交易的广告、要约或征求行为。Goldman Sachs & Co. LLC 未在适用的加拿大证券法规下注册为任何加拿大司法管辖区内的交易商，通常不被允许交易加拿大证券，并且可能被禁止在加拿大某些司法管辖区内销售某些证券和产品。若您想在加拿大交易任何加拿大证券或其他产品，请联系 Goldman Sachs Canada Inc. (高盛集团的关联机构) 或其他已注册的加拿大交易商。 香港: 可从高盛（亚洲）有限责任公司获取有关本报告中所研究公司的证券的额外资料。 印度: 可从高盛（印度）证券私人有限公司 （分析师 – 印度证券交易委员会(SEBI) 编号INH000001493，地址10th Floor, Ascent-Worli, Sudam Kalu Ahire Marg, Worli, Mumbai-400 025, India, 公司编号 U74140MH2006FTC160634, 电话 +91 22 6616 9000, 传真 +91 22 6616 9001） 获取有关本报告中研究对象或所提及公司的额外资料。高盛可能持有本报告中研究对象或所提及公司的证券（1956年印度《证券合同(管理)法》条款2(h)之定义）的1%或更高比例。 证券市场投资会受到市场风险的影响。请在投资之前仔细阅读所有相关文件。在SEBI注册并获得NISM认证并非对该中间机构表现的担保，亦不能对投资者回报做出保障。高盛（印度）证券私人有限公司投资者支持部门联系方式请参见https://www.goldmansachs.com/worldwide/india/documents/Grievance-Redressal-and-Escalation-Matrix.pdf，点击此链接https://publishing.gs.com/content/site/india-annual-compliance-report.html可获得年度审计合规报告副本。 日本: 见下文。 韩国: 除非高盛另行同意，本报告无论以何种方式取得，仅供《金融服务与资本市场法》定义的“专业投资者”使用。可从高盛（亚洲）有限责任公司首尔分公司获取有关本报告所研究公司的额外资料。 新西兰: Goldman Sachs New Zealand Limited及其关联机构并非1989年新西兰储备银行法定义的“注册银行”或“存款机构”。本研究报告以及本报告的其他形式内容只可分发给2008年财务顾问法案定义的 “批发客户”，在事先获得高盛许可的情况下可以有例外。 高盛澳大利亚和新西兰的利益披露请参见 https://www.goldmansachs.com/disclosures/australia-new-zealand/index.html。 俄罗斯: 在俄罗斯联邦分发的研究报告并非俄罗斯法律所定义的广告，而是不以产品推广为主要目的的信息和分析，也不属于俄罗斯法律所界定的评估行为。 研究报告不构成俄罗斯法律法规定义的个性化投资建议，并非针对某个具体客户，在报告准备阶段也未分析客户的财务状况、投资特征或风险特征。高盛不对某个客户或任何其他人基于本报告可能做出的任何投资决策承担责任。 新加坡: 高盛（新加坡）私人公司（公司编号：198602165W）（受新加坡金融管理局监管）为本研究报告承担法律责任，若有由本研究报告所引发或与本研究报告相关的任何事宜，请联系高盛（新加坡）私人公司。 台湾: 本信息仅供参考，未经允许不得翻印。投资者应当谨慎考虑他们自身的投资风险，投资结果由投资者自行负责。 英国: 在英国根据金融市场行为监管局的定义可被分类为私人客户的人士参阅本报告的同时应当参阅高盛以往对本报告研究企业的研究报告，并应当参考高盛国际已经发给这些客户的风险警告资料。该风险警告资料复本，以及本报告中采用部分金融辞汇的解释可向高盛国际索取。

欧盟和英国: 与欧盟委员会实施条例 (EU) (2016/958)（欧盟议会和欧盟理事会条例(EU) No 596/2014的补充条款,规定了有关投资建议或其他投资策略的推荐或建议之信息的客观陈述,以及对特定利益或利益冲突进行披露的技术安排应达到的监管技术标准；英国脱离欧盟和欧洲经济区之后该实施条例被纳入英国国内法律法规）第6(2)条相关的披露信息可在https://www.gs.com/disclosures/europeanpolicy.html上获取，该网址介绍在处理和投资研究有关的利益冲突时应参照的欧洲政策。

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买入、中性、卖出：分析师建议将评为买入或卖出的股票纳入地区投资名单。一只股票在投资名单中评为买入或卖出由其相对于所属研究范围的总体潜在回报决定。任何未获得买入或卖出评级且拥有活跃评级（即不属于暂停评级、暂无评级、处于初期阶段的生物科技公司、暂停研究或没有研究的股票）的股票均被视为中性评级。每个地区管理着地区强力买入名单，该名单选自各地区投资名单上评级为买入的股票，以总体潜在回报规模和/或实现回报的可能性为主要依据确立各自研究范围内的投资建议。将股票加入或移出此类强力买入名单，由各地区的投资评估委员会或其他指定委员会进行管理，并不意味着分析师对这些股票的投资评级发生了改变。

总体潜在回报：代表当前股价低于或高于一定时间范围内预测目标价格的幅度，包括所有已付或预期股息。分析师被要求对研究范围内的所有股票给出目标价格。总体潜在回报、目标价格及相关时间范围在每份加入投资名单或重申维持在投资名单的研究报告中都有注明。

研究范围：每个研究范围的所有股票名单可登陆https://www.gs.com/research/hedge.html通过主要分析师、股票和研究范围进行查询。

暂无评级(NR)：在高盛于涉及该公司的一项合并交易或战略性交易中担任咨询顾问时，或由于高盛参加一项交易而存在法律、监管或政策的限制时，并在某些其他情况下，投资评级、目标价格和盈利预测（如相关）根据高盛的政策被移除。处于初期阶段的生物科技公司：在该公司尚未拥有已通过II期临床试验的药品、治疗方案或医疗设备，或者尚未获得经销II期临床试验完成后药品、治疗方案或医疗设备的执照的情况下，根据高盛政策，不给予投资评级和目标价格。暂停评级(RS)：由于缺乏足够的基础去确定投资评级或价格目标，我们已经暂停对这种股票给予投资评级和目标价格。此前对这种股票作出的投资评级和目标价格(如有的话)将不再有效，因此投资者不应依赖该等资料。 暂停研究(CS)：我们已经暂停对该公司的研究。 没有研究(NC)：我们没有对该公司进行研究。

全球产品；分发机构

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