August 4, 2024 08:49 PM GMT

Global Technology

Navigating 2025 AI cloud investment

Cloud capex growth and allocations between NVIDIA and other hardware companies in 2025 may create asymmetric risks. We provide the framework on investment across the cloud AI supply chain.

Key Takeaways

- The Morgan Stanley tech team's median expectation is for NVIDIA-related stocks to grow 37% Y/Y and non-NVIDIA to grow 14%.
- We have different embedded cloud capex assumptions for stocks across our coverage. Our '4 X 4 Matrix' provides investors with upside and downside risks.

Why we are writing: We continue to be positive on Cloud AI investment (e.g. Joe's Moore's Nvidia note and our latest cloud semis note) – and our global analysts have published several AI reports since 2023 (e.g. Meta Marshall's What's Built Into the Price in for AI?). However, as the technology keeps changing and the requirement to invest into devices other than servers also increases (e.g. areas such as networking, central processing unit (CPU) servers, and utilities), there are emerging debates on capex growth and allocation into 2025. Our analysts' expectations on a variety of stocks are also divergent at Morgan Stanley. Top down, our EM strategist recently downgraded the IT sector to equal-weight and suggested taking profits (link), triggering more cycle debates. We thus provide the investment framework to navigate the risk/reward heading into 2025.

Conclusion – our tech analysts' estimate consensus for cloud capex growth and potential upside/downside risks: 1) We adopt the median as our consensus result, where global cloud capex could grow at 20-25% Y/Y in 2025e vs. Cloud capex tracker of 8% growth (for more details please see IT Hardware: 2024-2025 Cloud Capex Growth Moves Higher) vs. Street consensus at ~8% Y/Y . We assume NVIDIA-related stocks' capex will grow at 37% Y/Y in 2025e with non-NVIDIA cloud capex at 14%. 2) By pinpointing our 46 covered stocks into the 16 scenarios, 11 companies (or 24% mix) lie within our base case scenario (Exhibit 5). Meanwhile, we highlight some outliers like Wiwynn and Advantest. 3) Over time, our base case may change, suggesting downside or upside movements on earnings forecasts for multiple stocks. We think this report will be a useful reference guideline for investors.

What developments to track: 1) Cloud capex commentary in the coming several quarters. 2) NVIDIA's guidance in those quarters. 3) AMD and other application-specific integrated circuit (ASIC) developers (from Broadcom, Marvell, Alchip, GUC). 4) Technology developments according to our weekly Morgan Stanley AI supply chain tracker and monthly cloud semis note.

MORGAN STANLEY TAIWAN LIMITED+

Daniel Yen, CFA
Equity Analyst
Daniel.Yen@morganstanley.com +886 2 2730-2863

Charlie Chan
Equity Analyst
Charlie.Chan@morganstanley.com +886 2 2730-1725

MORGAN STANLEY & CO. LLC

Erik W Woodring
Equity Analyst
Erik.Woodring@morganstanley.com +1 212 296-8083

Meta A Marshall
Equity Analyst
Meta.Marshall@morganstanley.com +1 212 761-0430

Joseph Moore
Equity Analyst
Joseph.Moore@morganstanley.com +1 212 761-7516

MORGAN STANLEY ASIA LIMITED+

Shawn Kim
Equity Analyst
Shawn.Kim@morganstanley.com +852 3963-1005

MORGAN STANLEY & CO. INTERNATIONAL PLC+

Adam Wood
Equity Analyst
Adam.Wood@morganstanley.com +44 20 7425-4450

Emmet B Kelly
Equity Analyst
Emmet.Kelly@morganstanley.com +44 20 7425-6830

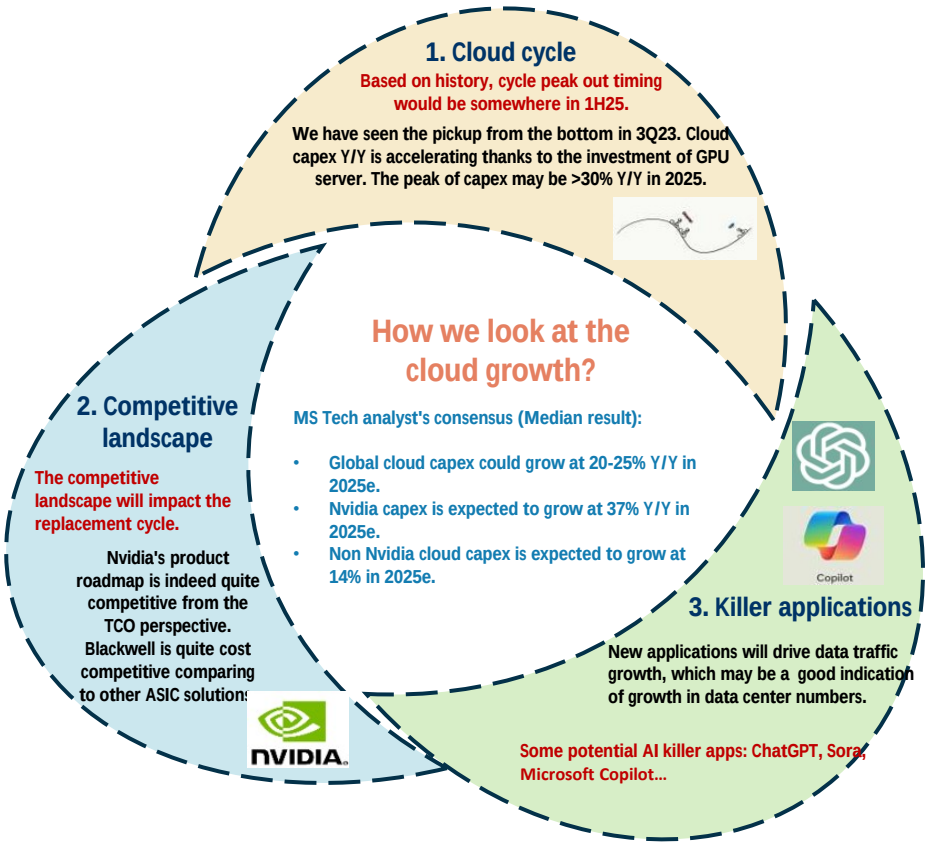
GREATER CHINA TECHNOLOGY SEMICONDUCTORS	
Asia Pacific	
Industry View	**In-Line**
ELECTRONIC COMPONENTS	
Japan	
Industry View	**In-Line**
GREATER CHINA TECHNOLOGY HARDWARE	
Asia Pacific	
Industry View	**In-Line**
S. KOREA TECHNOLOGY	
Asia Pacific	
Industry View	**In-Line**
IT HARDWARE	
North America	
Industry View	**In-Line**
SEMICONDUCTORS	
North America	
Industry View	**Attractive**

Other Contributors

Lee Simpson	Morgan Stanley & Co. International plc+	Equity Analyst	Lee.Simpson@morganstanley.com	+44 20 7425-3378
George W Webb	Morgan Stanley & Co. International plc+	Equity Analyst	George.Webb@morganstanley.com	+44 20 7425-2686
Max R Yates	Morgan Stanley & Co. International plc+	Equity Analyst	Max.Yates@morganstanley.com	+44 20 7425-1917
Sharon Shih	Morgan Stanley Taiwan Limited+	Equity Analyst	Sharon.Shih@morganstanley.com	+886 2 2730-2865
Howard Kao	Morgan Stanley Taiwan Limited+	Equity Analyst	Howard.Kao@morganstanley.com	+886 2 2730-2989
Daisy Dai, CFA	Morgan Stanley Asia Limited+	Equity Analyst	Daisy.Dai@morganstanley.com	+852 2848-7310
Ray Wu, CFA	Morgan Stanley Taiwan Limited+	Equity Analyst	Ray.Wu@morganstanley.com	+886 2 2730-2871
Dylan Liu	Morgan Stanley Taiwan Limited+	Equity Analyst	Dylan.Liu@morganstanley.com	+886 2 2730-1723
Tiffany Yeh	Morgan Stanley Taiwan Limited+	Research Associate	Tiffany.Yeh@morganstanley.com	+886 2 7712-3032
Maya C Neuman	Morgan Stanley & Co. LLC+	Research Associate	Maya.Neuman@morganstanley.com	+1 212 761-1946

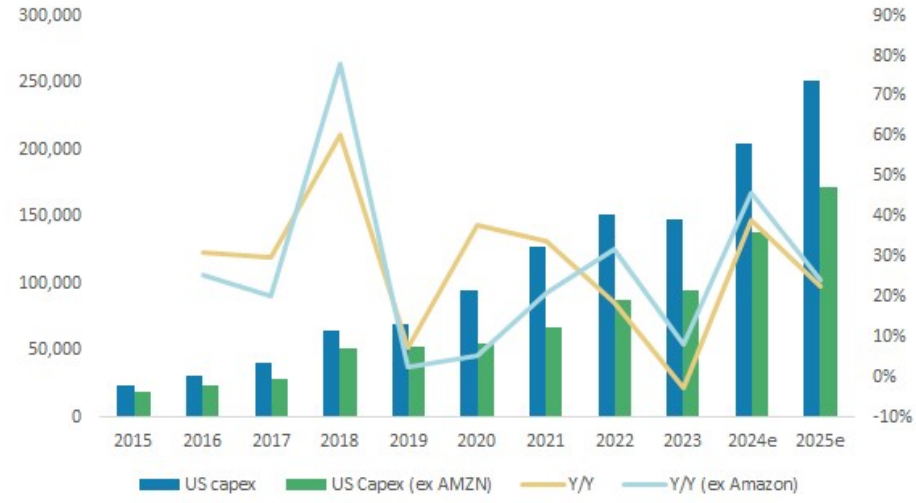
The global AI investment Key charts

Exhibit 1: How we look at cloud growth



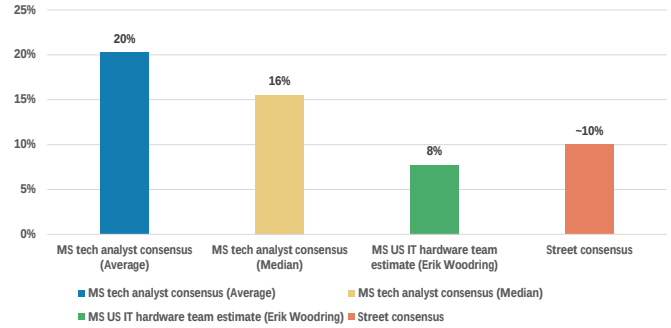
Source: Morgan Stanley Research estimates

Exhibit 2: Global hyperscaler capex; 2024e and 2025e are the MS tech analysts' estimate consensus



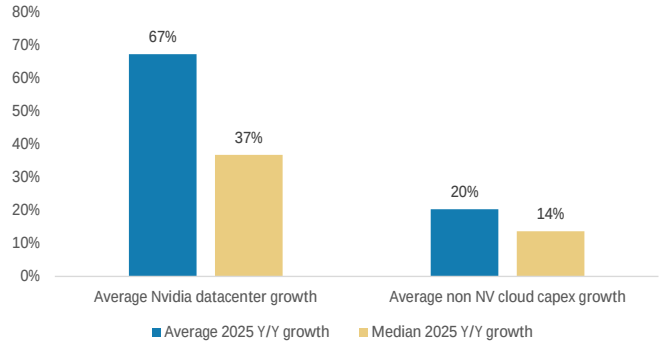
Source: Company data, Morgan Stanley Research estimates

Exhibit 3: MS tech analysts' estimate consensus on 2025 cloud capex vs. MS IT hardware team vs. Street consensus



Source: Morgan Stanley Research estimates

Exhibit 4: MS tech analysts' estimate consensus for NVIDIA-related and non-NVIDIA-related capex growth (2024e vs. 2025e)



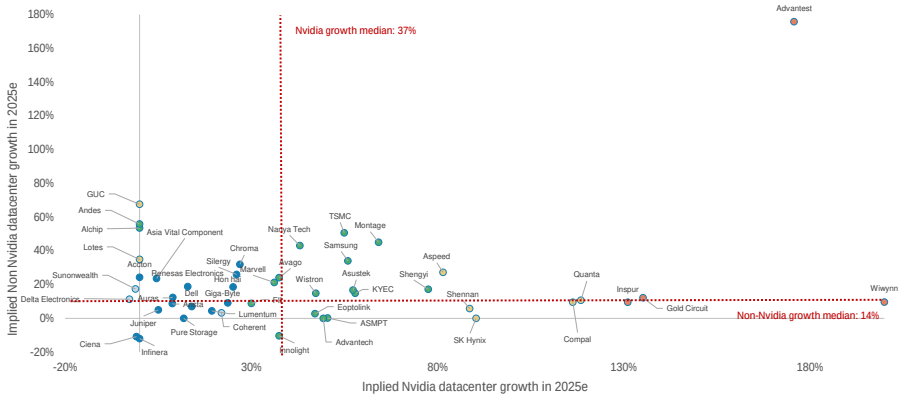
Source: Morgan Stanley Research estimates

Exhibit 5: MS global tech analysts have different underlying assumptions in the model

2025e Non Nvidia Capex Growth	2025e Nvidia Capex Growth			
	<=0%	0%~50%	50%~100%	>100%
>30%	Alchip Andes GUC Lotes	Cisco Nanya Tech	Montage TSMC Samsung	Advantest
15%~30%	Accton Sunonwealth	Wistron Broadcom Marvell Chroma Silergy Hon Hai Renesas Electronics Asia Vita Component	Aspeed Shengyi KYEC Asustek	
0%~15%	Delta Electronics	Advantech Dell Eoptolink FII Coherent Giga-Byte Lumentum Pure Storage Auras Arista Juniper	SK Hynix Shennan ASMPT	Wiwynn Gold Circuit Inspur Quanta Compal
-15%~0%	Infinera Ciena	Innolight		

Source: Morgan Stanley Research estimates

Exhibit 6: Earnings estimates will change over time



Source: Morgan Stanley Research estimates

MS global cloud coverage table

Exhibit 7: Companies under coverage most exposed to data center infrastructure

	Ticker	Rating	Target price (Local currency)	Share price (Local currency)	Upside/Downside
US IT Hardware					
Analyst: Erik Woodring					
Dell	DELL.N	Overweight	155.00	108.43	43%
Seagate	STX.O	Overweight	133.00	99.01	34%
US Semiconductor					
Analyst: Joseph Moore					
Nvidia	NVDA.O	Overweight	144.00	109.21	32%
Broadcom	AVGO.O	Overweight	176.00	147.02	20%
Marvell	MRVL.O	Equal-Weight	77.00	63.06	22%
Intel	INTC.O	Equal-Weight	25.00	29.05	-14%
US Communication system					
Analyst: Meta Marshall					
Cisco	CSCO.O	Overweight	58.00	47.39	22%
Ciena	CIEN.N	Overweight	55.00	51.29	7%
Arista	ANET.N	Overweight	355.00	338.64	5%
Infinera	INFN.O	Equal-Weight	6.65	6.00	11%
Juniper	JNPR.N	Equal-Weight	40.00	37.86	6%
Pure Storage	PSTG.N	Equal-Weight	60.00	56.82	6%
Lumentum	LITE.O	Equal-Weight	50.00	48.01	4%
Coherent	COHR.N	Equal-Weight	58.00	65.48	-11%
Analyst: Simon Flannery					
Equinix	EQIX.O	Equal-Weight	757.00	811.18	-7%
Digital Realty	DLR.N	Equal-Weight	111.00	152.29	-27%
European Capital Goods					
Analyst: Max Yetas					
Infineon	IFXGn.DE	Overweight	45.00	31.10	45%
European Semiconductors					
Analyst: Lee Simpson					
Legrand	LEGD.PA	Overweight	110.00	97.14	13%
Korea Technology					
Analyst: Shawn Kim					
SK Hynix	000660.KS	Overweight	260000.00	178500.00	46%
Samsung	005930.KS	Overweight	105000.00	81000.00	30%
Greater China Semiconductor					
Analyst: Charlie Chan, Ray Wu, Daisy Dai, Dylan Liu					
Alchip	3661.TW	Overweight	4280.00	2460.00	74%
Andes	6533.TW	Overweight	608.00	373.00	63%
ASM Pacific	0522.HK	Overweight	130.00	76.75	69%
GUC	3443.TW	Overweight	1680.00	1105.00	52%
TSMC	2330.TW	Overweight	1220.00	923.00	32%
MediaTek	2454.TW	Overweight	1588.00	1125.00	41%
KYEC	2449.TW	Overweight	140.00	107.00	31%
Silergy	6415.TW	Underweight	400.00	441.00	-9%
Nanya Tech	2408.TW	Underweight	58.00	56.70	2%
Analyst: Daniel Yen					
Montage	688008.SS	Overweight	80.00	56.69	41%
Aspeed	5274.TWO	Overweight	5150.00	4015.00	28%
Greater China IT Hardware					
Analyst: Sharon Shih					
Delta Electronics	2308.TW	Overweight	500.00	400.50	25%
Hon hai	2317.TW	Overweight	270.00	193.50	40%
Sunonwealth	2421.TW	Equal-Weight	120.00	98.20	22%
Asia Vital Component	3017.TW	Overweight	830.00	617.00	35%
Auras	3324.TWO	Equal-Weight	800.00	617.00	30%
FII	2354.TW	Underweight	48.00	65.30	-26%
Analyst: Howard Kao					
Wistron	3231.TW	Overweight	168.00	97.30	73%
Giga-Byte	2376.TW	Overweight	450.00	265.50	69%
Gold Circuit	2368.TW	Overweight	255.00	219.00	16%
Quanta	2382.TW	Overweight	340.00	275.50	23%
Compal	2324.TW	Equal-Weight	42.00	31.65	33%
Inspur	000977.SZ	Equal-Weight	40.50	37.05	9%
Wiwynn	6669.TW	Overweight	2600.00	2080.00	25%
Shengyi	600183.SS	Equal-Weight	19.00	19.57	-3%
Shennan	002916.SZ	Equal-Weight	82.00	116.96	-30%
Analyst: Derrick Yang					
Accton	2345.TW	Overweight	700.00	510.00	37%
Advantech	2395.TW	Overweight	405.00	345.00	17%
Chroma	2360.TW	Overweight	360.00	313.00	15%
Analyst: Andy Meng					
Innolight	300308.SZ	Overweight	142.86	129.90	10%
Eoptolink	300502.SZ	Equal-Weight	95.00	101.76	-7%

Source: Morgan Stanley Research, FactSet, share prices as of August 2, 2024

Stock implications

Greater China Technology Semiconductors (Charlie Chan, Daniel Yen, Ray Wu, Daisy Dai, Dylan Liu):

TSMC (Overweight, PT NT$1,220): Our supply chain checks indicate that TSMC is delivering a message that leading-edge foundry supply could be tight in 2025. We expect smartphone/PC semi wafer prices to increase by 3-4%. Mature node capacity is not tight, so a price hike is unlikely. We also heard that customers are accepting a meaningful price hike for additional CoWoS capacity, hence we believe a 20% price hike for CoWoS is achievable. We expect more optimistic wafer pricing and strong SoIC 3D IC demand (Apple Silicon adoption in 2H25, and NVIDIA adoption in 2028). Our PT implies 23x our 2025 EPS.

MediaTek (Overweight, PT NT$1,588): MediaTek expanded its partnership with Arm to server CPUs. In terms of AI, MediaTek designed Cisco's switch networking ASIC in 2018 and Google's TPU ASIC currently. By adding the Arm-based server CPU to its portfolio, MediaTek could be capable of providing the custom chip design for next-generation cloud AI chips similar to NVIDIA's Rubin graphics processing unit (GPU) architecture. We also believe MediaTek's China smartphone customers could gain market share in 2H24 by using MediaTek's 3nm Dimensity 9400 chip to drive more abundant generative AI apps with lower power consumption. With those catalysts, we remain optimistic on MediaTek.

Alchip (Overweight, PT NT$4,280): We remain Overweight on Alchip, backed by its long-term business outlook and high revenue exposure to AI. Limited new project wins in the near term have caused the stock to de-rate, but we continue to see Alchip engaging with new AI ASIC projects. The company attributes the revenue strength to 7nm projects, which we think are driven by AWS. This trend is likely sustainable into 3Q and we think it could drive AWS project revenue to grow >50% Y/Y this year, better than consensus estimates of 30-50% Y/Y.

Aspeed (Overweight, PT NT$5,150): We see Aspeed as a unique NVIDIA-related play, being the sole BMC supplier for GB200 and a key supplier to help realize Omniverse adoption. We believe Aspeed's new AST2700 is gaining high traction given the integration of LTPI protocol. This could replace the FPGA on the security board. As a result, we believe the pricing for AST2700 could be higher than the Street has expected. Aspeed's 360 is now used on building immersion real time videos for AI factories on NVIDIA's Omniverse digital twin. With ASP of US$100 per chip, we estimate the company could enjoy 90% gross margin. Valuation looks high at 45x 2025e EPS, yet the share price usually moves with the earnings momentum. Therefore, we are Overweight Aspeed and it is one of our Top Picks among the Greater China Technology Semiconductor stocks.

Montage (Overweight, PT Rmb80): With the ongoing recovery of the general server industry, we think the company could enjoy further sequential growth. DDR5 penetration should continue to improve given the new server platform migration from 45-50% in 2Q. On servers, the MRDIMM could enter into mass production in 2025, subject to designs on AI servers. PCI-E retimer is on track to gain overseas customers starting in 4Q24. CXL MXC is more a long-term product but likely also a US$1-2bn TAM. We are Overweight Montage thanks to the company's strong growth on PCI-E retimer. Valuation looks

attractive to us at 34x 2025e EPS vs. 71% earnings CAGR (2023-26e).

North America IT Hardware (Erik Woodring):

Dell Technologies (Overweight, PT US$155): We believe DELL is the best positioned company in our Hardware coverage to benefit from ramping accelerated compute demand/orders from Tier 2 CSPs, sovereigns and enterprises, as well as other data center modernization efforts across storage and services. Our checks continue to show that DELL's AI server business is gaining momentum and taking share, with component vendors and assembly partners signaling 50k HGX AI server builds for DELL in CY24, suggesting our forecast for 40k AI server shipments (~$11B of AI server revenue) in FY25 could prove conservative. This momentum reflects not only repeat purchases from existing customers, but also key competitive wins in the T2 CSP market, an emerging sovereign opportunity, and building enterprise AI server demand that we believe can drive revenue growth and operating leverage into CY25 (FY26), and an 21% total return CAGR over the next 3 years. At 10x our FY26 EPS, and 8.6x our FY26 bull case EPS, and with a catalyst in S&P inclusion ahead (timing unknown), we believe valuation is extremely attractive at current levels.

North America Semiconductors (Joe Moore):

NVIDIA (Overweight, PT US$144): We had positive data points for NVIDIA from both our Taiwan trip and our China trip that keep us confident in the near term. That said, the catalyst path remains strong, as the very strong surge in H20 builds and demand removes any concern for us about a pre-Blackwell pause. Customer enthusiasm for Blackwell continues to be strong, in particular with the strong boost in inference performance driving customer interest. However, we continue to be conservative beyond a 12 month level of visibility, given how quickly AI capex has surged amid still uncertain returns.

Broadcom (Overweight, PT US$176): AVGO has the second-largest AI exposure (in absolute dollars) in our coverage and is poised to grow as hyperscale capex increases. We expect non-AI semis will have a cyclical rebound late next year after a period of high excess inventory in the networking and storage markets. We also expect VMware to successfully integrate into the portfolio and focus operations, cut costs, and drive stable cash flows. We like this stock more than other AI competitors to NVIDIA: expectations are just lower. Lower expectations and lower valuation – at least vs. the overall AI enthusiasm – is an important part of our thesis.

Marvell (Equal-weight, PT US$77): We still put Marvell in the AI beneficiaries category with a very solid position in optical networking for AI and nice optionality around custom silicon, but we have limited enthusiasm at these levels. With numbers continuing to move basically sideways in the last twelve months, with a couple of good quarters followed by a couple of bad ones in CY23, and the stock outperforming, it is becoming quite expensive. We remain EW given valuation as well as high stock compensation expense that weighs on enthusiasm.

North America Telecom & Networking Equipment (Meta Marshall):

Cisco (Overweight, PT US$58): Cisco is trading at a near record discount to the S&P despite our CIO survey (link) noting a healthy growth environment for networking once

we get past inventory digestion. Networking has positive market growth dynamics, which helps offset headwinds from share loses, and the Splunk acquisition offers meaningful opportunities for our bull case eventually, but we have minimal expectations in the near term. Our OW rating is not necessarily pegged to the company's AI exposure, as we believe it receives more a secondary benefit vs. ANET, but we would note their $1bn FY25 AI order target, with particularly high exposure in optics.

Ciena (Overweight, PT US$55): We remain OW CIEN as we continue to see upside potential as we enter FY25, with catalysts including normalization of service provider inventory levels, WaveLogic 6 adoption, routing traction and eventual AI story. We lean positively on CIEN's exposure to the cloud, both near-term and longer-term, particularly given strong positioning ahead of the inter-data center AI opportunity. On the AI opportunity specifically, CIEN's exposure would be on the DCI (inter-data center) side, where power limitations will create size constraints on data centers, forcing more inter-data center traffic, even for AI training. CIEN has noted that there could be multiples of DCI traffic as a result (anywhere between 5-90x) – a longer-term positive. We expect CIEN to benefit from this multiplier of traffic, but think it is more an opportunity over the coming years vs. near-term.

Arista (Overweight, PT US$355): We are OW ANET as we continue to believe in the eventuality of Ethernet's move back into the back end (or training) portion of the data center, with the name best positioned to capture a growing portion of this AI networking opportunity. While we acknowledge this move is likely gradual, depth of ecosystem and economics continue to benefit Ethernet, and ANET sees an incremental $5bn AI networking (back end) opportunity unfolding by 2027 ($750mm revenue target in '25). A large debate remains around InfiniBand vs. Ethernet, but we continue to believe Ethernet is far more economical and has a much broader vendor / support ecosystem – a benefit in the longer term. Dell'Oro estimates that the back-end networking opportunity will grow at a 90% CAGR for Ethernet over the next 4 years, outpacing InfiniBand and front-end AI opportunity (not even including the general non-AI market which is ~$10bn+ today). That ultimately leaves us favoring Ethernet's positioning, and Arista, given we see it as the best pure-play way to play Ethernet's success in cloud AI networks.

Infinera (Equal-weight, PT US$6.65, Pending Acquisition by Nokia): Similar to CIEN, we believe optical systems vendors are unlikely to see as large a benefit from AI spend until there is an increase in data center to data center traffic. This would be catalyzed by power constraints on data centers, forcing more inter-data center traffic, creating multiple times more DCI traffic. We expect INFN to benefit from increased traffic, but see it as a longer-term opportunity vs. today. However, with the latest ICE-D product, the company is also focused on capturing intra-data center opportunities as well. We note Infinera has a pending acquisition by Nokia.

Juniper (Equal-weight, PT US$40, Pending Acquisition by HPE): We believe JNPR should receive more secondary benefits from the AI networking opportunity, as ANET should be the largest beneficiary given its exposure to multiple hyperscaler customers and Ethernet opportunity. JNPR would benefit from network upgrades to higher-speed switches, in our view. We note Juniper has a pending acquisition by HPE.

Pure Storage (Equal-weight, PT US$60): We view three primary opportunities in AI for PSTG. 1) AI training (where high performance storage is directly feeding into GPUs) is

where most storage AI use cases are today, which the company estimates at ~$1bn TTM. While this includes both small and large customers, this area is becoming more concentrated in more advanced AI firms. 2) Inference opportunity and 3) Accelerating infrastructure upgrades and modernization are expected to be mostly Enterprise and the largest area of opportunity. While these opportunities are still in the early stages, the company has seen some initial customer use cases. Cloud interest around PSTG continues to be around its potential to win large hyperscaler deals.

Lumentum (Equal-weight, PT US$50): We view the datacomm transceiver market as the nearest-term beneficiary of the optical networking AI opportunity. LITE has noted a ~ $16bn cloud data center photonics opportunity by 2028 and near-term upside should remain around 800G transceivers, with ramps towards 1.6T shipments in '25 (though we remain cautious on the scale of 1.6T in 2025). LITE is currently undergoing a vertical integration transition post-acquisition of Cloud Light, a positive, but questions remain on datacom transceiver margins into the second half of the year. We would like to see more evidence that LITE datacom opportunity can ramp and generate meaningful profitability before turning more positive.

Coherent (Equal-weight, PT US$58): Similar to LITE, the datacom transceiver market has been the primary area of benefit from optical AI spend, and we believe COHR remains best positioned to capture incremental opportunity as 1.6T shipments ramp (AI transceiver revenue grew $75-90mm sequentially in FQ3). This is due to the company's leadership in EML lasers as well as its leading market share in the transceiver market as a whole. COHR also maintains the broadest tranceiver portfolio in the market, spanning across all protocols and speeds, which combined with its market-leading vertical integration, creates long-term competitive differentiation. While we lean positively on positioning, we remain more cautious on margin ramp given datacom remains price-sensitive/competitive over the long-run.

European Semiconductors (Lee Simpson):

Infineon (Overweight, PT €45): Possible Power Supply Architecture shift

Infineon is poised to be a stronger player in AI servers over the next few years with its class-leading offering in vertical power delivery.

Infineon, as far as we can tell, is the only full stack, vertical power delivery (VPD) player in the market. As such it is well placed to offer rack scale power where resistance/heat has become a large TCO problem for data centre owners, especially hyperscalers.

Why is this happening? The need to supply power vertically to new high performance, AI server racks stems from the current high resistance met in driving power horizontally (standard today) from the edge of the rack. Driving current across the board at ever higher power creates resistance which is then converted to heat in the system. Excess heat at scale can stymie the performance of new AI server racks loaded with high performance GPUs, which can be an issue for communications service providers (CSPs). Many use liquid cooling solutions (sidecar cabinets) to abate this but some are also expected to turn to new power supply architectures such as VPD to stem some of the issues and reduce total cost of ownership (TCO) to boot.

This won't happen all at once. Existing horizontal solutions are likely to remain the standard for now. As with many architecture shifts in semiconductors before, the move typically follows at a moment of 'must have'. With the rollout of next generation Blackwell designs from the likes of NVIDIA (covered by our college Joe Moore), for instance, we don't expect deployment as yet for VPD. And yet IFX is already qualified with several hyperscalers and leading AI chipmakers alike, and a sales ramp could happen as early as 2026-27.

Why Infineon? The solution comes as a VPD stack which includes an inductance layer to couple directly with the board above. To the best of our knowledge this full-stack solution is unique to Infineon now. We think, however, names such as Vicor in the US can make a solution if it collaborates with large players. Incumbents in the existing server power supply includes Renesas in Japan (covered by Kazuo Yoshikawa) and Monolithic Power (not covered) in the USA.

What would be the impact? Infineon claims to gain US$1100-1800 per cabinet of BoM. We are sceptical of adoption by NVIDIA near term and think the GPU maker has stuck with horizontal solutions for its upcoming Blackwell architecture (B100, B200 and GB200 designs). That said, we think others are taking a closer look and we may see initial sales in 2026 – at least as pilot sampling begins. Thereafter we see an adoption ramp up beginning 2026-27 and growing as the industry ramps use of higher-powered racks. The company expects sales of €1bn + in FY28 to follow.

European Capital Goods (Max Yetas):

Legrand (Overweight, PT €110). In European Capital Goods we see Legrand as a key beneficiary of data center investment with 16% of group revenues exposed to this theme. Schneider also stands to benefit with 19% of sales – see our recent Data center Equipment report, A key piece in the AI puzzle (link), for further detail. Legrand's data center equipment offering is primarily in the 'white space' of data centers with a focus on products that are important in improving data center efficiency and PUE (Power usage effectiveness). These include busways, power distribution units and rear-door cooling, and Legrand continues to be acquisitive in data center markets expanding its regional presence. More broadly on the Legrand investment case, organic growth has been subdued coming out of Covid due to softness in global construction markets. We expect these markets to stabilize and improve as interest rates start to fall, and combined with accelerating data center growth, we see mid-single digit organic growth as achievable for the group in 2025-27. For a high quality, cash generative, earnings compounder we see the current 2025e valuation of 14x as attractive.

How to think about AI supply chain growth in 2025

As we move into 2H24, we believe the debate on the AI cloud supply chain is shifting to the growth potential in 2025. The answer becomes complicated as AI supply chain growth will be dependent on overall cloud capex growth in 2025 and the allocation between NVIDIA-related and non-NVIDIA-related capex. It's tough to give a clear answer on how much global cloud capex can grow in 2025. However, in this report we provide a framework on how to think about growth in 2025,

There are usually three ways to look at the cloud outlook: (i) the cloud cycle; (ii) the competitive landscape; and (iii) the new applications.

In this note, we also leverage our global tech analysts' forecasts to give investors an idea about how we think about cloud capex growth in 2025 and the upside/downside risks for different stocks.

Where are we in the cycle?

In the cloud semis segment, we usually take a top-down approach (through cloud capex) to track where we are in the cycle. Cloud capex is split between the US and China. Given that capex in the US is still larger than in China, we use US quarterly cloud capex as the primary indicator and China quarterly cloud capex as a secondary reference. In past cycles, a 2-3 year upcycle has typically been followed by 2-4 quarters of downturn. A downturn is defined as Y/Y growth slowdown, especially from the US hyperscalers.

For more details, see our previous cloud semis Insight reports:

Global Semiconductors: Cloud capex semi plays bottoming out (3 Mar 2019)

Global Semiconductors: How will China chip in? Seizing cloud semi strength in China (25 Mar 2020)

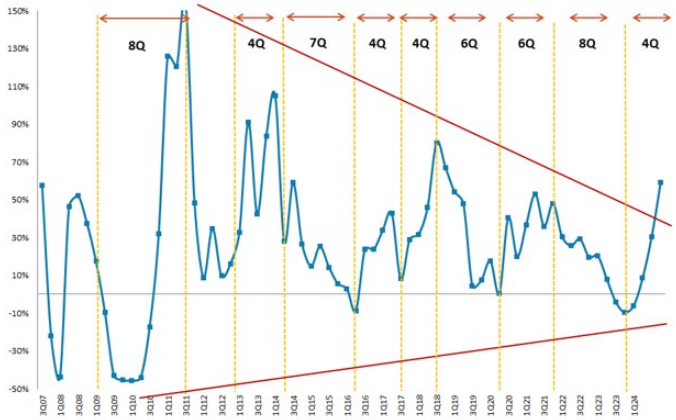
Asia Technology: Cloud Semis – Not a Safe Haven (10 Jan 2023)

Based on the latest C2Q24 US cloud capex data, we have already seen a pickup from the bottom in 2Q23/3Q23. Cloud capex Y/Y is accelerating thanks to investment in the GPU server. If the cycle repeats, the upcycle could continue into 1H25. Looking at history, when data center construction was in its initial stage (2005-2015), it's easier to see a big increase in capex growth. The normalization of capex growth after 2015 is due to a 'Moore's law' slowdown and sales growth deceleration from CSPs. As GPU is migrating fast with potential monetization in the future, the capex peak may be above 30% Y/Y in 2025.

As for China, 2Q/3Q its capex also found a bottom, as China capex Y/Y was -24% and 0% in 2Q and 3Q23, respectively. After that, Tencent capex showed acceleration due to investment in AI servers, similar to Alibaba. Baidu also shows strength, with rising AI infrastructure capex, but starts to trend down due to enough GPU on hand. Overall China has also tried to buy more AI servers especially on NVIDIA's H20.

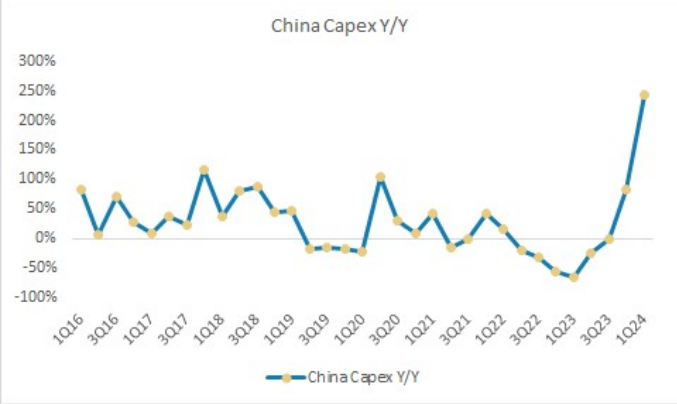
To summarize, a cycle peak should be somewhere in 1H25, based on historical trends.

Exhibit 8: US cloud capex in 2Q24 was +59% Y/Y, up from +9% Y/Y in 4Q23



Source: Company data, Morgan Stanley Research

Exhibit 9: China cloud capex Y/Y – bottom was also 2H23



Source: Company data, Morgan Stanley Research

How is the competitive landscape?

The competitive landscape or spec migration will impact the replacement cycle. For example, before 2015, due to the migration of Moore's law, a lot of the CSPs are willing to replace servers within 2-3 years. There's also only one valid supplier, which is Intel. The dominance of the supplier also makes the cycle more volatile especially during the time of intense competition among hyperscalers.

Now, NVIDIA's product roadmap is indeed quite competitive from a TCO (Total cost of ownership) perspective. The recently announced Blackwell series is quite cost competitive compared to other ASIC solutions. During intense competition for AI development, CSPs will usually buy more than needed until they have enough inventory, spec migration slows down or competitors catch up.

Exhibit 10: NVIDIA product migration vs. ASIC

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025e	2026e
NVDA	Pascal		Volta		Ampere		Hopper		Blackwell		Rubin
AMD								MI300X	MI325X	MI350	MI400
Intel				Gaudi			Gaudi 2		Gaudi 3		
Google	TPU	TPU_v2	TPU_v3		TPU_v4			TPU_v5e "Maple"	TPU_v5p TPU_v6 Axion	TPU v7 inference	TPU v7 training
AWS			Graviton	Inferentia	Graviton2		Inferentia2 Graviton3		Trainium2 Graviton4	Inferentia3 Inferentia2.5	
Microsoft									Maia 100 Cobalt 100	Maia 200	3nm AI ASIC
Meta								MTIA v1 MSVP	MTIA v2		3nm Arm CPU

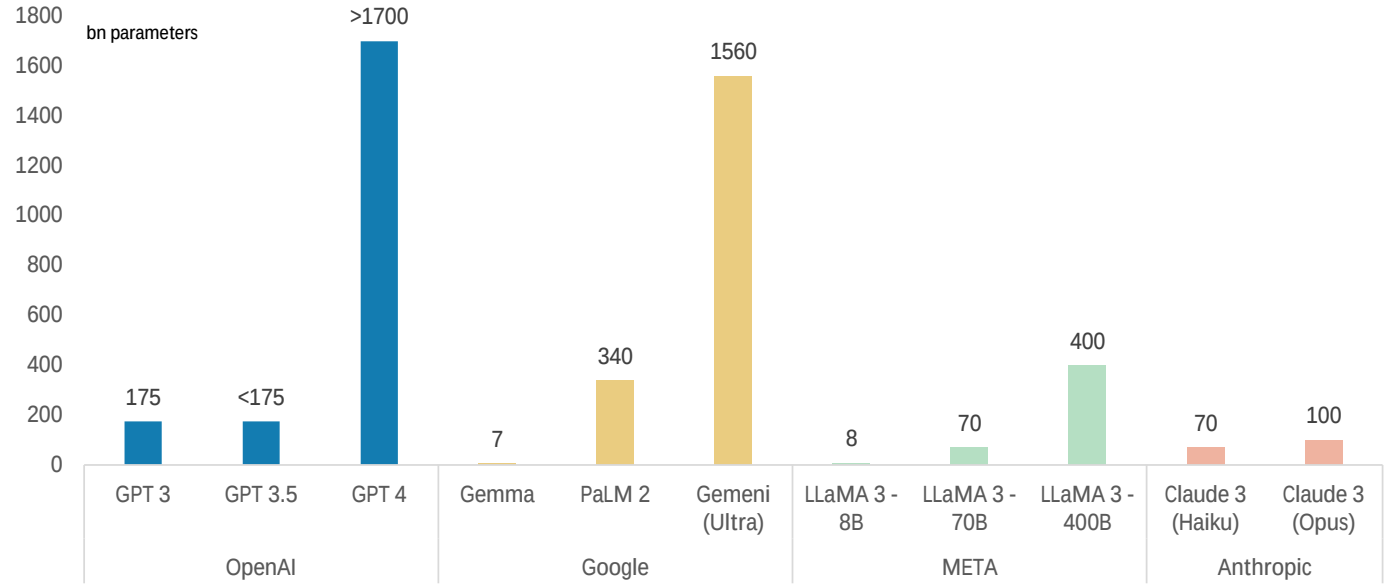
Source: Company data, Morgan Stanley Research

What are the applications?

In the past, the growth in datacenter numbers was all coming from data traffic growth, which is the best way to form a view on cloud capex growth, as the fundamental reason to build a datacenter is to deal with the increasing data traffic to the cloud. Data traffic showed grow at 20-30% CAGR over 2018-22, which should be a good indicator of growth in datacenter numbers. Public cloud adoption and rise of the advertising business also helped CSPs to monetize investment and create the 'Big 4' CSPs in the US.

For AI investment, we do see a lot of the new applications starting from Chat GPT. There are also other applications like Sora, Microsoft's Copilo, and other LLMs. The key questions are how are we going to monetize and invest, and how many GPUs are needed to train the models?

Exhibit 11: Model size of LLMs has increased rapidly given surging capex



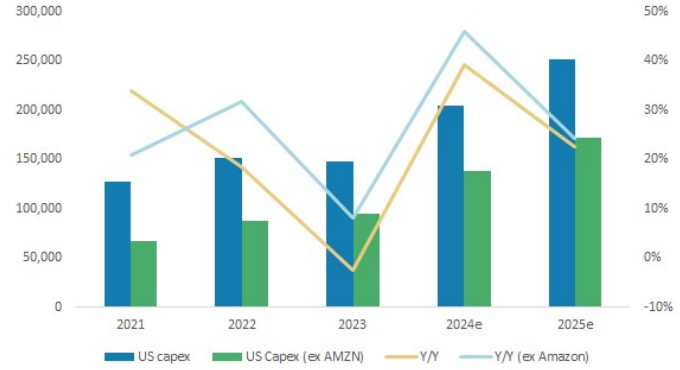
Source: Company data, Morgan Stanley Research

Morgan Stanley's expectations on cloud capex next year

Our cloud capex tracker is maintained by our US tech analyst, Erik Woodring (refer to Erik's report). We haven't had a clear view on the capex projection for 2025 yet, given there are multiple factors to consider as aforementioned.

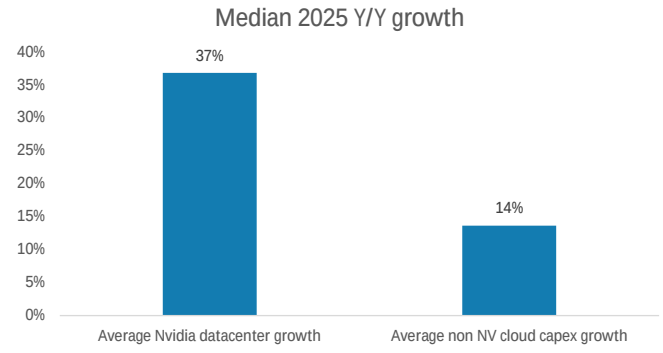
That said, we leverage our global tech analysts forecasts on ~50 companies to form the view on cloud capex next year. Detailed methodology is in the next section. Our conclusion is that the implied cloud capex growth for 2025 is 20-25% Y/Y in 2025, with NVIDIA-related spending growing at 37% Y/Y in 2025 and non-NVIDIA-related spending growing 14% Y/Y. For reference, our US analyst, Joe Moore, currently expects NVIDIA datacenter revenue to grow at 18% Y/Y in 2025e.

Exhibit 12: MS analysts forecast total cloud capex to grow at 20-25% Y/Y (median) in 2025



Source: Company data, Morgan Stanley Research

Exhibit 13: Median 2025 Y/Y growth of NV datacenter revenue and non-NV cloud spending will reach 37% and 14%, respectively



Source: Company data, Morgan Stanley Research

Pinpointing the stocks into different growth scenarios

There are different embedded assumptions on total cloud capex growth - between NVIDIA-related and non-NVIDIA-related stocks for 2025. We have complied our global Morgan Stanley tech analysts' model assumptions detailing underlying assumptions for capex growth. From here, we can glean our Morgan Stanley analysts' estimate consensus. We have formed a '4 X 4 Matrix (or 16 scenarios) to map out all our covered cloud supply chain stocks against these 16 scenarios.

The underlying assumptions are also different across stocks. We thus believe it will be helpful to pinpoint different companies into a '4 X 4 Matrix' as below. As the technology, competitive landscape and applications for AI keep changing, investors can use the following matrix to think about the potential downside or upside risks to earnings estimates.

The horizontal rows represent NVIDIA-related datacenter growth assumptions for 2025, while the columns are non-NVIDIA-related capex growth forecasts for 2025.

Exhibit 14: MS global analysts have different underlying assumptions in the model

2025e Non Nvidia Capex Growth	2025e Nvidia Capex Growth: <=0%	0%~50%	50%~100%	>100%
>30%	Alchip Andes GUC Lotes	Cisco Nanya Tech	Montage TSMC Samsung	Advantest
15%~30%	Accton Sunonwealth	Wistron Broadcom Marvell Chroma Silergy Hon Hai Renesas Electronics Asia Vita Component	Aspeed Shengyi KYEC Asustek	
0%~15%	Delta Electronics	Advantech Dell Eoptolink FII Coherent Giga-Byte Lumentum Pure Storage Auras Arista Juniper	SK Hynix Shennan ASMPT	Wiwynn Gold Circuit Inspur Quanta Compal
-15%~0%	Infinera Ciena	Innolight		

Source: Morgan Stanley Research estimates

From the Matrix, we highlight some outliers:

Stocks with both high NV-related growth and high non-NV-related growth assumptions:

Advantest stands out as the most bullish stocks. It is benefiting from the longer testing time from Blackwell as well as the overall recovery from the non-AI market.

Stocks with low NV-related growth but high non-NV-related growth assumptions:

Alchip and GUC are mainly driven by the high growth from the ASIC. We continue to believe ASIC will show high growth in the coming years.

Andes shows growth with the RISC V ASIC. We think the RISC V could be better at parallel computing (refer to our RISC V note).

HPE will have high growth on traditional servers given the recovery on the CPU server market.

Stocks with both low NV-related growth and low non-NV-related growth assumptions:

We have conservative assumptions on Infinera and Ciena. According to our US analyst, Meta Marshall, Infinera has been a company with great technology but not enough scale, which made it difficult to expand market share when cloud rapidly became a bigger portion of the market. Nokia (covered by Terrence Tsui) announced to acquire Infinera in June 2024, and we are expecting to see more synergies from this acquisition on completion. (Infinera Corp: Nokia Announces Acquisition of Infinera for $2.3bn (June 28, 2024)) Our US analyst, Meta Marshall, is Overweight Ciena, as FY24 setup seems more achievable, with upside potential in FY25 driven by both service providers and cloud verticals (Ciena Corporation: Optics Are Clearer; Upgrading to Overweight (June 11, 2024)).

What datapoints or events are we tracking?

1. CSP commentary

The top four US hyperscalers (Amazon, Microsoft, Google, Meta) and top three China hyperscalers (Alibaba, Tencent, Baidu), will provide their capex commentary at quarterly earnings.

Exhibit 15: Summary of US cloud vendors' commentary in C2Q24

Company	Date	C2Q24 Cloud Capex Quotes
Google	7/23/2024	*"Our reported CapEx in the first quarter was $12 billion, once again driven overwhelmingly by investment in our technical infrastructure with **the largest component for servers followed by data centers.** Looking ahead, we continue to expect quarterly CapEx throughout the year to be roughly at or above the Q1 CapEx of $12 billion."* *"We are at an early stage of what I view as a very transformative area in technology...the risk of underinvesting is dramatically greater than the risk of overinvesting."* *"We continue to invest in designing and building robust and efficient infrastructure to support our efforts in AI given the many opportunities we see ahead."*
Microsoft	7/30/2024	*"Capital expenditures, including financing leases, were **$19 billion**, in line with expectations and cash paid for PP&E was $13.9 billion. **Cloud and AI-related spend represents nearly all of our total capital expenditures.**"* *"We expect **capital expenditures to increase on a sequential basis**, given our cloud and AI demand as well as **existing AI capacity constraints.**"* *"To meet the growing demand signal for our AI and cloud products, we will scale our infrastructure investments with **FY 2025 capital expenditures expected to be higher than FY 2024.**"* *"We think about lead time and duration of the asset, land, network, construction, the system or the kit, and then the ongoing cost. So if you think about it that way, then **you know how to adjust the capital spend based on demand signal**."*
Meta Platforms	7/31/2024	*"Capital expenditures, including principal payments on finance leases were $8.5 billion driven by investments in **servers, data centers and network infrastructure**."* *"We expect that having sufficient compute capacity will be central to many of these opportunities, so we are **investing meaninfully in infrastructure to support our core AI work** in content ranking and ads as well as our generative AI and advanced research efforts."* *"**We anticipate our full year 2024 capital expenditures will be in the range of $37 billion to $40 billion** updated from our prior range of $35 billion to $40 billion. While we continue to refine our plans for next year, **we currently expect siginificant CapEx growth in 2025** as we invest to support our AI research and our product development efforts"* *"Another major area of focus is figuring out the right level of infra capacity to support training more and more advanced models. Llama 3 is already competitive with the most advanced models and we're already starting to work on Llama 4… **the amount of compute needed to train Llama 4 will likely be almost 10 times more than what we used to train Llama 3.**"*
Amazon	8/1/2024	*"For the first half of the year, CapEx was $30.5 billion. Looking ahead to the rest of 2024, **we expect capital investments to be higher in the second half of the year.** The majority of the spend will be to support the growing need for AWS infrastructure as we **continue to see strong demand in both generative AI and our non-generative AI workflows.**"* *"For the third quarter specifically [on CapEx], I would highlight **a few seasonal factors** to keep in mind."* *"**We expect AWS operating margins to fluctuate over time**, driven in part by the level of investments we're making at any point in time."* *"**The cost to compute for training and inference is critical, especially as models to get to scale.** We have a deep partnership with Nvidia and the broader selection of Nvidia instances available but we have heard loud and clear from customers that they relish better price performance. It's why we have invested in our own custom silicon."*

Source: Company data, Morgan Stanley Research

Exhibit 16: Summary of China's cloud vendors' commentary in 1Q24

Company	Date	1Q24 Cloud Capex Quote
Alibaba	5/14/2024	"The decrease mainly reflected the increase of RMB 7.7 billion in capital expenditure, the majority of which reflected our investments in Alibaba Cloud infrastructure..." "We believe that this wave of generative AI-driven technological innovation is in the early stages of the industry cycle , around 10-year IT cycle. Starting in 2024, we've seen a rapid increase in customer demand for AI ." "we are actively investing in our cloud computing product matrix, especially in AI infrastructure..." "Alibaba's proprietary foundational model, Tongyi, released a 110 billion parameter model in late April...we will deeply integrate our Tongyi large model with other advanced AI infrastructure to realize synergies and optimization across software and hardware. "
Tencent	5/14/2024	"we're making a version of Hunyuan providing text-to-image generative AI available on an open source basis..." "We're made investment in GPUs and servers to support our Hunyuan and AI app recommendation algorithms..." "we are increasingly going to be deploying AI, including generative AI in areas such as accelerating the creation of animated content..." " Tools also allow advertisers who previously were able to create advertisements for search, which are text in nature but not to create advertisements for social media, which are image and video in nature, to now use generative AI to create advertisements in social media."
Baidu	5/16/2024	"Our reinvestments are mainly related to capex for model training and inference." "Because of the limited availability of high-performance chips in China in this year, 2024, we expect our capex to be smaller versus last year." " 2024 is the second year of our march on the GenAI path ...looking beyond the near term, GenAI and foundation models will bring us tremendous opportunities, offering a new innovation cycle." "We believe one of the most important long-term opportunities is model inferencing which will be a key growth driver for our AI cloud revenue in the future." "Another growth driver for AI cloud is cross-selling of our CPU cloud services to our GPU cloud customers." "I believe that search will be one most likely killer app in the GenAI era ..." "GenAI and foundation models are transforming the cloud industry from general purpose computing to AI computing." "If we're looking to longer term, the normalized margin for the GenAI related cloud businesses should be higher than the legacy cloud businesses ."

Source: Company data, Morgan Stanley Research

2. NVIDIA quarterly guidance and GTC/computex

NVIDIA will provide its quarterly guidance and has now become the most important event.

Jensen shares the new roadmap for NVIDIA in the latest Computex. He introduced the next generation Rubin platform to be launched in 1H26. Chips based on "Rubin" architecture will be made on the TSMC 3nm node and it is likely to see initial production ramp in 2H25. The following Rubin Ultra is to be launched in 2027. According to the keynote, the Blackwell Ultra will carry 8x 12-layer HBM3Es, Rubin 8x 16-layer HBM4s and Rubin Ultra 12x HBM4s. Hopper, which is Nvidia's current offering, is only equipped with 6x HBM3Es.

3. AMD quarterly guidance

AMD is so far the strongest competitor to NVIDIA and will provide quarterly guidance, as well as keynote announcements on major events. At Computex Taipei, Dr. Lisa Su, announced AMD's roadmap for its data center GPU lineup. MI325X will be launched in 2H24, and MI350 series will be launched in 2025, both of which will adopt the same OCP baseboard designs as the MI300, which will help the customers to adopt to new series easily.

4. ASIC tracker development

- Intel commentaries on the gaudi sell-through

- Broadcom, Marvel, Alchip commentaries on the development of ASIC designs.

5. Datapoints we track

- Quarterly Aspeed shipments Y/Y and Intel+ AMD CPU shipment Y/Y

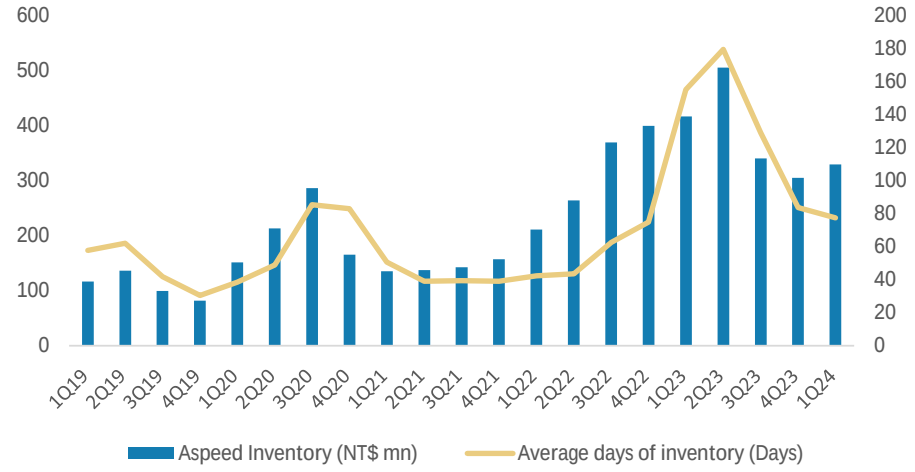
- Aspeed's quarterly inventory level

- Monthly server KPI tracker Y/Y (refer to server KPI tracker); add Gigabyte

Exhibit 17: Quarterly Aspeed shipments Y/Y and Intel + AMD CPU shipments Y/Y

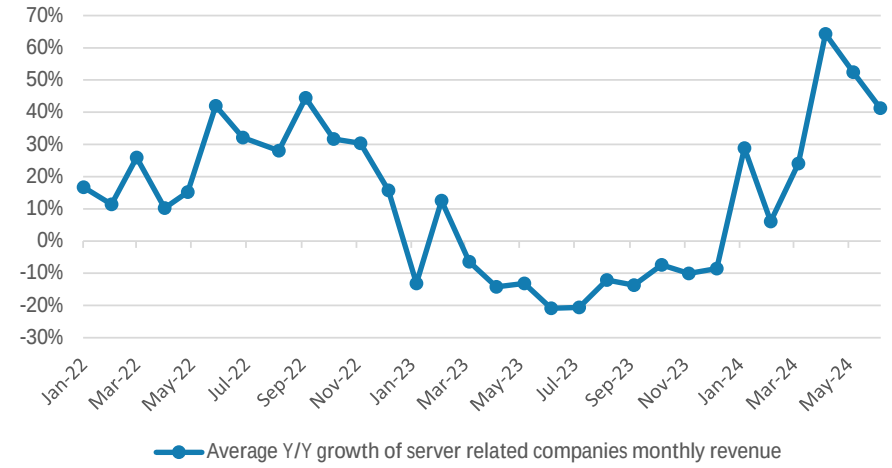
Source: Company data, Morgan Stanley Research

Exhibit 18: Aspeed's quarterly inventory level has been back to normal at around 80 days



Source: Company data, Morgan Stanley Research

Exhibit 19: Monthly server KPI tracker Y/Y



Source: Company data, Morgan Stanley Research

Global AI comps table

Exhibit 20: Global AI comps table

Ticker	Company	Price 8/2/2024	Curr ency	Price Target	Upside/ Downside	Rating	Dividend Yield (%)	FCF Yield (%)	Market Cap (US$M)	3M Avg. Daily Trading (US$M)	P/E Ratio (x) 2023	2024e	2025e	EPS Growth 2023	2024e	2025e	ROAE 2023	2024e	2025e	P/B Ratio (x) 2023	2024e	2025e
5274.TWO	Aspeed	4,015.00	Taiwan Dollar	5,150.00	28%	O	1.1%	1.3%	4,790	51.2	150.6	76.8	40.3	-52%	96%	91%	24%	45%	62%	39.6	30.5	21.4
ANET.N	Arista	338.64	U.S. Dollar	355.00	5%	O	0.0%	1.9%	105,739	820.4	56.4	48.0	44.9	55%	18%	7%	31%	27%	22%	14.6	10.9	8.4
CIEN.N	Ciena	51.29	U.S. Dollar	55.00	7%	O	0.0%	3.5%	7,428	71.5	27.7	90.2	35.7	41%	-69%	152%	8%	3%	6%	2.6	2.6	2.5
PSTG.N	Pure Storage	56.82	U.S. Dollar	60.00	6%	E	NA	3.5%	18,155	213.0	153.4	125.0	81.2	11%	23%	54%	11%	10%	12%	14.3	10.6	8.2
DLR.N	Digital Realty	152.29	U.S. Dollar	111.00	-27%	E	4.2%	1.7%	47,455	277.9	51.8	87.6	115.9	160%	-41%	-24%	5%	3%	3%	2.6	2.7	2.8
JNPR.N	Juniper	37.86	U.S. Dollar	40.00	6%	E	2.3%	NA	12,127	78.2	27.0	34.2	22.2	5%	-21%	54%	10%	8%	11%	2.7	2.5	2.3
MRVL.O	Marvell	63.06	U.S. Dollar	77.00	22%	E	0.4%	1.1%	54,578	766.3	96.2	92.5	38.5	-52%	4%	140%	4%	4%	10%	3.7	3.7	3.6
COHR.N	Coherent	65.48	U.S. Dollar	58.00	-11%	E	NA	4.7%	9,140	142.8	45.4	25.2	19.1	-56%	80%	32%	11%	5%	8%	2.0	1.6	1.5
NVDA.O	Nvidia	109.21	U.S. Dollar	144.00	32%	O	0.0%	1.3%	2,690,934	99,121.4	90.5	43.7	32.7	362%	107%	34%	92%	105%	78%	62.6	35.5	20.1
AVGO.O	Broadcom	147.02	U.S. Dollar	176.00	20%	O	1.4%	5.1%	608,663	11,566.3	43.5	36.1	28.4	-7%	20%	27%	69%	36%	29%	25.4	8.2	7.0
INTC.O	Intel	29.05	U.S. Dollar	25.00	-14%	E	1.3%	4.9%	122,823	1,498.5	102.6	NM	376.0	-69%	-296%	-114%	1%	-2%	0%	1.2	1.1	1.0
INFN.O	Infinera	6.00	U.S. Dollar	6.65	11%	E	0.0%	-2.5%	1,386	28.0	NM	NM	32.9	-71%	322%	-216%	-4%	-19%	23%	6.4	7.8	6.2
LITE.O	Lumentum	48.01	U.S. Dollar	50.00	4%	E	NA	10.4%	3,188	57.4	622.3	NM	38.2	-98%	-934%	-295%	10%	-5%	2%	2.4	2.8	2.7
STX.O	Seagate	99.01	U.S. Dollar	133.00	34%	O	2.7%	5.3%	20,792	237.5	NM	15.9	9.4	-113%	-1238%	68%	NM	NM	NM	NA	NA	NA
CSCO.O	Cisco	47.39	U.S. Dollar	58.00	22%	O	3.1%	5.9%	192,688	936.4	13.6	18.0	17.0	17%	-24%	6%	32%	27%	24%	4.3	4.2	4.3
DELL.N	Dell	108.43	U.S. Dollar	155.00	43%	O	1.8%	15.0%	76,443	1,898.8	15.2	13.5	10.5	-6%	12%	29%	NM	NM	NM	NA	NA	NA
LEGD.PA	Legrand	97.14	Euro	110.00	13%	O	2.2%	3.4%	27,759	65.3	22.6	23.1	20.7	16%	-2%	12%	17%	16%	16%	3.8	3.5	3.2
IFXGn.DE	Infineon	31.10	Euro	45.00	45%	O	1.1%	3.4%	44,196	155.0	12.6	15.1	11.3	15%	-17%	34%	22%	14%	16%	2.4	2.2	1.9
6669.TW	Wiwynn	2,080.00	Taiwan Dollar	2,600.00	25%	O	2.5%	-7.7%	11,483	139.0	30.2	17.0	13.4	-15%	78%	27%	30%	44%	45%	8.6	6.6	5.4
000977.SZ	Inspur	37.05	China Renminbi	40.50	9%	E	0.5%	-17.8%	7,577	312.4	29.9	27.4	18.2	-14%	9%	50%	10%	10%	14%	3.0	2.7	2.4
2345.TW	Accton	510.00	Taiwan Dollar	700.00	37%	O	1.9%	0.6%	8,988	54.1	31.9	25.3	19.7	9%	26%	28%	39%	40%	41%	11.3	9.1	7.3
300308.SZ	Innolight	129.90	China Renminbi	142.86	10%	O	0.6%	0.3%	20,283	481.9	48.0	28.7	21.2	77%	67%	35%	17%	31%	31%	10.2	7.7	5.8
2330.TW	TSMC	923.00	Taiwan Dollar	1,220.00	32%	O	1.8%	1.8%	755,796	1,332.7	28.5	22.0	17.5	-18%	30%	26%	26%	28%	29%	6.9	5.7	4.7
2408.TW	Nanya Tech	56.70	Taiwan Dollar	58.00	2%	U	0.1%	13.6%	5,547	35.0	NM	685.1	10.7	-149%	-104%	6314%	-4%	0%	9%	1.1	1.1	1.0
300502.SZ	Eoptolink	101.76	China Renminbi	95.00	-7%	E	0.3%	-1.6%	10,036	364.4	104.9	52.3	41.4	-46%	101%	26%	14%	23%	24%	13.2	10.9	8.9
000660.KS	SK Hynix	178,500.00	South Korean Won	260,000.00	46%	O	1.1%	7.4%	88,440	621.5	NM	5.7	4.2	-510%	-348%	37%	-16%	36%	37%	2.3	1.7	1.3
2382.TW	Quanta	275.50	Taiwan Dollar	340.00	23%	O	3.7%	-9.5%	33,532	281.7	26.8	18.5	15.1	37%	45%	22%	21%	28%	30%	5.5	4.9	4.3
3231.TW	Wistron	97.30	Taiwan Dollar	168.00	73%	O	4.3%	-44.1%	8,909	150.0	24.0	15.2	9.8	3%	58%	55%	9%	14%	20%	2.2	2.1	2.0
3017.TW	Asia Vital Component	617.00	Taiwan Dollar	830.00	35%	O	1.1%	0.8%	7,468	291.4	43.7	31.1	21.8	20%	41%	42%	25%	27%	31%	9.2	7.7	6.2
3324.TWO	Auras	617.00	Taiwan Dollar	800.00	30%	E	0.9%	2.1%	1,654	159.7	43.2	29.7	22.3	-3%	45%	33%	19%	24%	27%	7.6	6.4	5.4
2421.TW	Sunonwealth	98.20	Taiwan Dollar	120.00	22%	E	3.7%	-2.6%	778	13.2	19.0	15.4	14.5	19%	23%	7%	21%	23%	22%	3.4	3.1	2.9
002916.SZ	Shennan	116.96	China Renminbi	82.00	-30%	E	0.8%	0.2%	8,334	82.3	42.9	42.1	38.3	-15%	2%	10%	11%	11%	11%	4.6	4.3	4.0
600183.SS	Shengyi	19.57	China Renminbi	19.00	-3%	E	1.6%	4.1%	6,402	75.2	38.3	22.9	18.7	-24%	67%	23%	8%	12%	14%	2.9	2.7	2.6
3661.TW	Alchip	2,460.00	Taiwan Dollar	4,280.00	74%	O	1.2%	5.1%	5,773	235.3	56.9	33.9	23.5	77%	68%	44%	21%	30%	35%	10.1	8.4	7.0
6533.TW	Andes	373.00	Taiwan Dollar	608.00	63%	O	0.0%	0.3%	597	7.4	NM	94.3	27.4	-129%	-297%	244%	-2%	4%	14%	4.1	3.9	3.6
2324.TW	Compal	31.65	Taiwan Dollar	42.00	33%	E	3.8%	-32.8%	4,355	31.4	18.3	13.3	10.4	5%	37%	28%	6%	8%	9%	1.0	1.0	0.9
2376.TW	Giga-Byte	265.50	Taiwan Dollar	450.00	69%	O	1.7%	7.5%	5,329	92.8	35.6	16.8	12.7	-28%	112%	32%	13%	24%	27%	4.4	3.7	3.1
2368.TW	Gold Circuit	219.00	Taiwan Dollar	255.00	16%	O	1.1%	3.2%	3,366	50.2	30.3	17.8	12.8	-18%	70%	39%	23%	31%	34%	6.3	5.0	3.8
2354.TW	Fii	65.30	Taiwan Dollar	48.00	-26%	U	2.3%	4.2%	2,917	65.5	20.6	22.7	22.2	4%	-9%	2%	4%	4%	4%	0.9	0.9	0.8
2308.TW	Delta Electronics	402.50	Taiwan Dollar	500.00	25%	O	2.3%	0.9%	32,850	137.0	31.2	28.3	23.8	2%	10%	19%	14%	14%	16%	4.3	3.9	3.7
005930.KS	Samsung	81,000.00	South Korean Won	105,000.00	30%	O	2.8%	2.4%	396,148	1,154.3	36.4	11.2	7.5	-75%	225%	49%	4%	11%	16%	1.5	1.4	1.3
2317.TW	Hon hai	193.50	Taiwan Dollar	270.00	40%	O	3.6%	-13.9%	84,695	595.3	18.9	16.7	13.0	0%	13%	29%	9%	9%	11%	1.6	1.5	1.4
6415.TW	Silergy	441.00	Taiwan Dollar	400.00	-9%	U	0.2%	1.3%	5,335	44.4	233.4	68.2	35.5	-88%	242%	92%	2%	8%	14%	5.4	5.0	4.4
2360.TW	Chroma	313.00	Taiwan Dollar	360.00	15%	O	2.2%	5.4%	4,188	24.4	33.5	26.2	23.2	-22%	28%	13%	18%	21%	21%	5.9	5.2	4.7
2395.TW	Advantech	345.00	Taiwan Dollar	405.00	17%	O	2.6%	3.0%	9,345	12.7	27.3	29.3	23.2	-9%	-7%	26%	24%	21%	25%	6.3	6.1	5.6
EQIX.O	Equinix	811.18	U.S. Dollar	757.00	-7%	E	2.1%	-0.4%	76,640	422.8	78.7	78.9	71.5	34%	0%	10%	8%	8%	9%	6.1	6.3	6.4
2454.TW	MediaTek	1,125.00	Taiwan Dollar	1,588.00	41%	O	4.6%	0.9%	56,549	290.7	23.3	18.1	14.1	-35%	29%	28%	19%	25%	29%	4.8	4.4	3.8
0522.HK	ASM Pacific	76.75	Hong Kong Dollar	130.00	69%	O	0.8%	6.4%	4,068	25.4	44.4	62.2	22.6	-73%	-29%	175%	5%	3%	9%	2.0	2.0	1.9
2449.TW	KYEC	107.00	Taiwan Dollar	140.00	31%	O	3.1%	1.6%	4,131	92.2	22.6	13.2	16.0	-14%	70%	-17%	16%	24%	17%	3.4	2.9	2.7
3443.TW	GUC	1,105.00	Taiwan Dollar	1,680.00	52%	O	1.3%	4.7%	4,676	133.7	42.5	40.4	31.6	-5%	5%	28%	40%	35%	37%	15.3	12.9	10.4
688008.SS	Montage	56.69	China Renminbi	80.00	41%	O	0.5%	-0.7%	8,968	144.5	142.9	45.7	32.2	-65%	213%	42%	4%	13%	17%	6.3	5.7	5.0
Mean:							**1.7%**	**1.9%**			**69.3**	**33.1**	**26.6**	**-26%**	**96%**	**17%**	**20%**	**24%**	**24%**	**8.3**	**7.2**	**6.0**
Median:							**1.3%**	**1.6%**			**42.5**	**40.4**	**31.6**	**-14%**	**70%**	**28%**	**16%**	**24%**	**17%**	**6.3**	**5.7**	**5.0**

Source: FactSet, Company data, Morgan Stanley Research, share prices as of August 2, 2024

Our Methodology for MS consensus estimates

1. Global cloud capex growth mix; divided between NVIDIA-related and non-NVIDIA-related spending

Global cloud capex includes NVIDIA-related spending (all products; GPU, networking, liquid cooling and etc.), other AI chips (AMD+ASIC), CPU servers, storage/switches and other infrastructure. To make it simple, we classify them into cloud spending on NVIDIA-related and other non-NVIDIA-related spending

2. Compiling the revenue forecasts for all global tech companies

MS analysts cover around 330 tech stocks globally. Each analyst has their own forecasts on the AI revenue mix and growth in 2025 vs. 2024. We compile all the data from our global tech analysts.

3. Identify the company-specific share or content gain/loss

Growth on cloud AI-related revenue could be from the implied market growth and the stock-specific upside or downside. For example, Hon Hai is taking market share from Wistron. Aspeed is taking share in AI servers. We take out the company-specific content/ share gain/ loss and calculate the implied NVIDIA-related datacenter revenue and non-NVIDIA-related spending assumptions from different analysts on different companies.

4. Use the data to understand the upside and downside risks

The data will be useful in: 1) forming the cloud capex consensus growth for 2025e (both NVIDIA and non-NVIDIA-related); 2) understanding potential downside and upside risks on revenue/earnings estimates for each company; 3) mapping the cloud capex commentaries and NVIDIA-related earnings for the next year.

Key watch point #1: 2025 Cloud capex growth

Morgan Stanley's view: Cloud capex is usually highly dependent on sales growth. However, given the investment on AI, the pattern could be different to prior cycles. We thus lay out different growth scenarios for 2025.

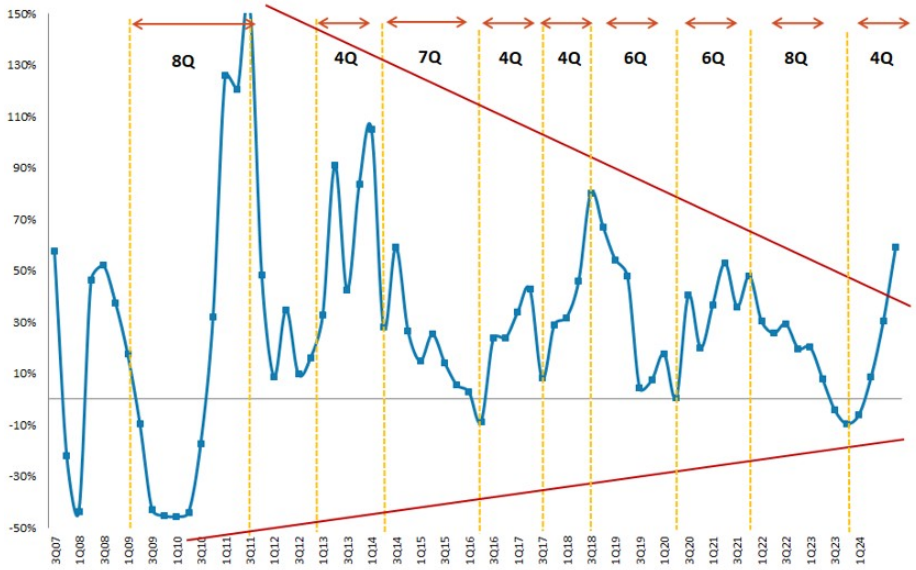
A. The cycle itself – we are in the third quarter of positive cloud capex growth

Our top-down approach starts from cloud capex itself, mainly from the US hyperscalers (Microsoft, Amazon, Google, and Facebook). We define an upcycle as cloud capex Y/Y accelerating, and a downturn as cloud capex Y/Y decelerating (see Exhibit 21). An upcycle typically lasts for 2-3 years whereas a downturn goes on for 2-4 quarters.

Looking at past cycles, given the more mature investment from hyperscalers, the peak of the cloud capex is getting lower, while the bottom of the cloud capex was still around 0% Y/Y in past years.

The upcycle this time is different than past cycles, as the key investment is now shifting to AI servers and related architecture. The susceptibility to what the trend of current cycle will be is then a big debate.

Exhibit 21: Cloud capex cycle: We are in an upcycle; the trough was 3Q23



Source: Amazon, Microsoft, Meta and Google; Morgan Stanley Research

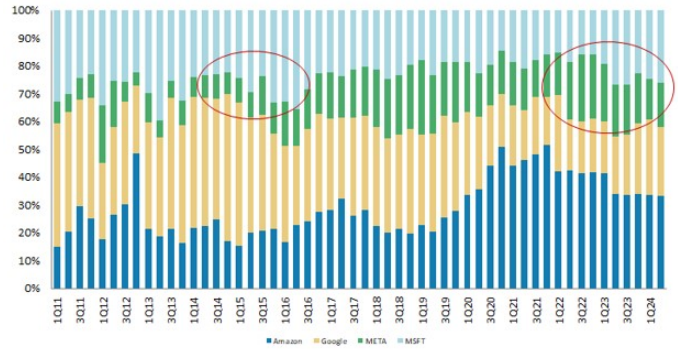
B. The sales growth suggests 2024 shall only show limited growth

To form a more precise forecast of cloud capex growth, we step back and look at future sales growth rates at Amazon, Microsoft, Facebook and Google. Please refer to the growth rate exhibits below.

We note that sales growth for the hyperscalers and their spending have had very high correlation in past years. We believe the key reason for the high correlation is the supply chain management plans from the hyperscalers. Procurement is undertaken weekly, in alignment with business growth opportunities and the utilization rate.

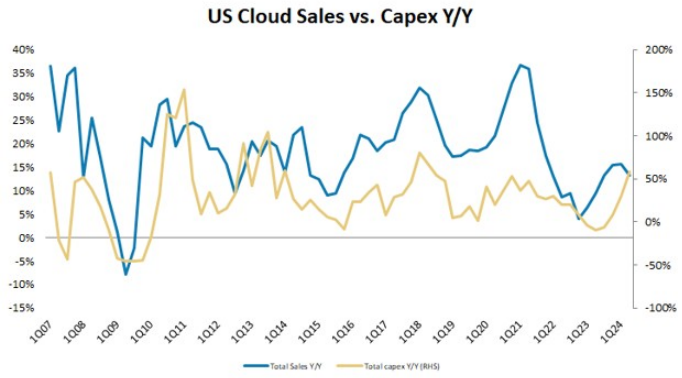
US sales growth has been accelerating since 4Q22, from 4% Y/Y to 13% Y/Y in 2Q24. This revenue growth has coincided with a substantial increase in capex by leading cloud service providers. While the trend of artificial intelligence-generated content (AIGC) is a major factor driving up spending, it is equally significant that rising revenue is supporting future investment plans. If we assume the growth rate pattern of cloud to be in line with sales growth rate, cloud capex growth could be 12-13% in 2025.

Exhibit 22: US cloud capex mix: Google mix is increasing in latest two quarters



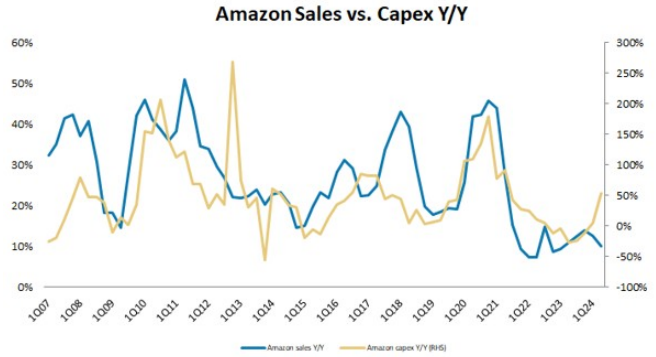
Source: Company data, Morgan Stanley Research (e) estimates

Exhibit 23: US Sales versus capex Y/Y



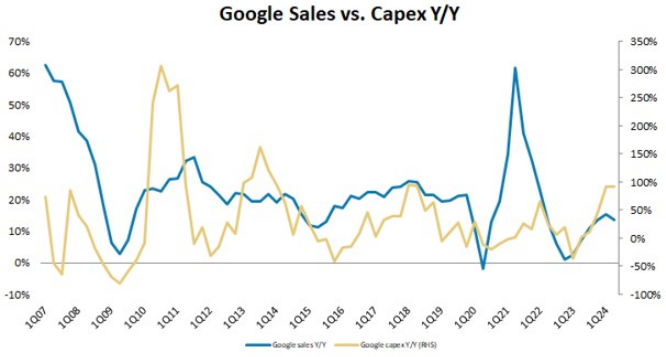
Source: Company data, Morgan Stanley Research (e) estimates

Exhibit 24: Amazon capex versus sales growth



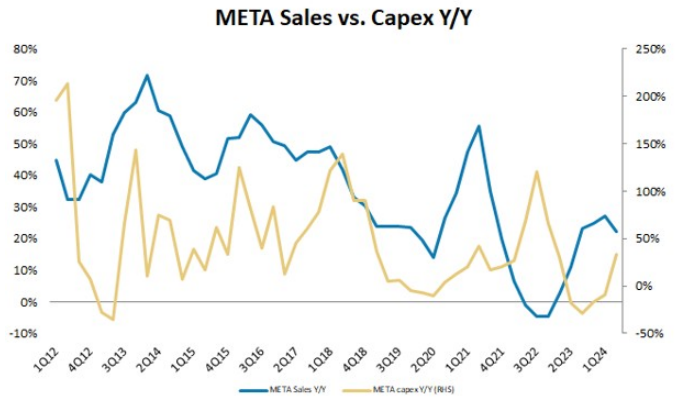
Source: Company data, Morgan Stanley Research (e) estimates

Exhibit 25: Google capex versus sales growth



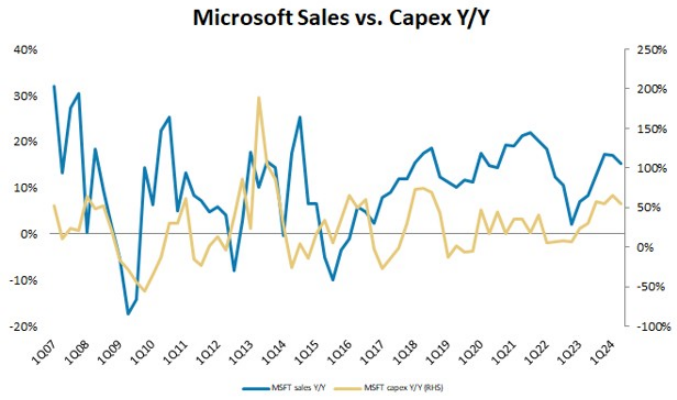
Source: Company data, Morgan Stanley Research (e) estimates

Exhibit 26: META capex versus sales growth



Source: Company data, Morgan Stanley Research (e) estimates

Exhibit 27: Microsoft capex versus sales growth



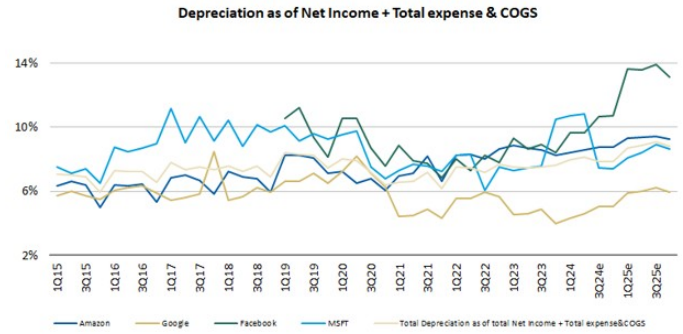
Source: Company data, Morgan Stanley Research (e) estimates

C. Looking at the depreciation burden and cash flow analysis

We also look at depreciation as a percentage of total expense. In past years, given the heavy investment in datacenters, depreciation on datacenter customers' total expenses has risen substantially (from 3-7% in 2012 to 5-10% in 2023). We expect the depreciation will continue to grow given rising capex from the top 4 US hyperscalers, up to 6-14% in 2025e.

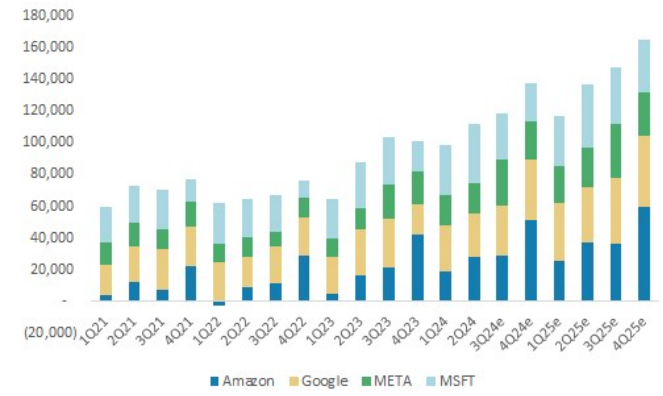
We think a cash flow analysis could better support our idea of rising capex from large cloud service providers. Morgan Stanley forecasts that the top 4 US hyperscalers will generate US$176bn OCF in calendar 2025. Thus, we believe these companies do have the capability to keep investing in datacenters for AI purposes.

Exhibit 28: Depreciation has become a higher portion of expense in recent years



Source: Company data, Morgan Stanley Research estimates

Exhibit 29: Rising OCF could continue to support Hyperscalers' capex to grow



Source: Company data, Morgan Stanley Research estimates

D. Our global tech analysts expect 25-30% total cloud capex growth in 2025e.

After running analysis from our global team, the median forecast for global cloud capex lies at 25-30% Y/Y. This suggests that quarterly cloud capex needs to grow around mid single digits Q/Q in 2025e.

E. Summary of C2Q24 earnings – most cloud customers are still too bullish despite chipmakers toning down

According to cloud vendor commentary in C2Q24, we saw capex of US$8.4-17.6bn for each of the four US leading CSPs. With the guidance of rising capex sequentially, we think the capex hype will continue in 2024 so that US hyperscalers can keep making efforts on generative AI to introduce their groundbreaking products. With the growing trend of CSP capex, we think this may continue to benefit NVIDIA's data center revenue.

Exhibit 30: Summary of US' cloud vendors' commentary in C2Q24

Company	Date	C2Q24 Cloud Capex Quotes
Google	7/23/2024	*"Our reported CapEx in the first quarter was $12 billion, once again driven overwhelmingly by investment in our technical infrastructure with **the largest component for servers followed by data centers.** Looking ahead, we continue to expect quarterly CapEx throughout the year to be roughly at or above the Q1 CapEx of $12 billion."* *"We are at an early stage of what I view as a very transformative area in technology...the risk of underinvesting is dramatically greater than the risk of overinvesting."* *"We continue to invest in designing and building robust and efficient infrastructure to support our efforts in AI given the many opportunities we see ahead."*
Microsoft	7/30/2024	*"Capital expenditures, including financing leases, were **$19 billion**, in line with expectations and cash paid for PP&E was $13.9 billion. **Cloud and AI-related spend represents nearly all of our total capital expenditures.**"* *"We expect **capital expenditures to increase on a sequential basis**, given our cloud and AI demand as well as **existing AI capacity constraints.**"* *"To meet the growing demand signal for our AI and cloud products, we will scale our infrastructure investments with **FY 2025 capital expenditures expected to be higher than FY 2024.**"* *"We think about lead time and duration of the asset, land, network, construction, the system or the kit, and then the ongoing cost. So if you think about it that way, then **you know how to adjust the capital spend based on demand signal**."*
Meta Platforms	7/31/2024	*"Capital expenditures, including principal payments on finance leases were $8.5 billion driven by investments in **servers, data centers and network infrastructure**."* *"We expect that having sufficient compute capacity will be central to many of these opportunities, so we are **investing meaninfully in infrastructure to support our core AI work** in content ranking and ads as well as our generative AI and advanced research efforts."* *"**We anticipate our full year 2024 capital expenditures will be in the range of $37 billion to $40 billion** updated from our prior range of $35 billion to $40 billion. While we continue to refine our plans for next year, **we currently expect siginificant CapEx growth in 2025** as we invest to support our AI research and our product development efforts"* *"Another major area of focus is figuring out the right level of infra capacity to support training more and more advanced models. Llama 3 is already competitive with the most advanced models and we're already starting to work on Llama 4… **the amount of compute needed to train Llama 4 will likely be almost 10 times more than what we used to train Llama 3.**"*
Amazon	8/1/2024	*"For the first half of the year, CapEx was $30.5 billion. Looking ahead to the rest of 2024, **we expect capital investments to be higher in the second half of the year.** The majority of the spend will be to support the growing need for AWS infrastructure as we **continue to see strong demand in both generative AI and our non-generative AI workflows.**"* *"For the third quarter specifically [on CapEx], I would highlight **a few seasonal factors** to keep in mind."* *"**We expect AWS operating margins to fluctuate over time**, driven in part by the level of investments we're making at any point in time."* *"**The cost to compute for training and inference is critical, especially as models to get to scale.** We have a deep partnership with Nvidia and the broader selection of Nvidia instances available but we have heard loud and clear from customers that they relish better price performance. It's why we have invested in our own custom silicon."*

Source: Company data, Morgan Stanley Research

Exhibit 31: Summary of China's cloud vendors' commentary in 1Q24

Company	Date	1Q24 Cloud Capex Quote
Alibaba	5/14/2024	**"The decrease mainly reflected the increase of RMB 7.7 billion in capital expenditure, the majority of which reflected our investments in Alibaba Cloud infrastructure..."** **"We believe that this wave of generative AI-driven technological innovation is** in the early stages of the industry cycle **, around 10-year IT cycle. Starting in 2024, we've seen** a rapid increase in customer demand for AI **."** **"we are actively investing in our cloud computing product matrix, especially in AI infrastructure..."** **"Alibaba's proprietary foundational model, Tongyi, released a 110 billion parameter model in late April...we will deeply integrate our Tongyi large model with other advanced AI infrastructure to realize synergies and optimization across software and hardware. "**
Tencent	5/14/2024	**"we're making a version of Hunyuan providing** text-to-image generative AI **available on an open source basis..."** **"We're made investment in GPUs and servers to support our Hunyuan and AI app recommendation algorithms..."** **"we are increasingly going to be deploying AI, including generative AI in areas such as accelerating the creation of animated content..."** **" Tools also allow advertisers who previously were able to create advertisements for search, which are text in nature but not to create advertisements for social media, which are image and video in nature, to now use generative AI to create advertisements in social media."**
Baidu	5/16/2024	**"Our reinvestments are mainly related to capex for model training and inference."** **"Because of the limited availability of high-performance chips in China in this year, 2024, we** expect our capex to be smaller **versus last year."** **"** 2024 is the second year of our march on the GenAI path **...looking beyond the near term, GenAI and foundation models will bring us tremendous opportunities, offering a new innovation cycle."** **"We believe one of the most important long-term opportunities is** model inferencing which will be a key growth driver for our AI cloud revenue **in the future."** **"Another growth driver for AI cloud is** cross-selling of our CPU cloud services **to our GPU cloud customers."** **"I believe that** search will be one most likely killer app in the GenAI era **..."** **"GenAI and foundation models are transforming the cloud industry from general purpose computing to AI computing."** **"If we're looking to longer term,** the normalized margin for the GenAI related cloud businesses should be higher than the legacy cloud businesses **."**

Source: Company data, Morgan Stanley Research

Key watch point #2: NVIDIA-related datacenter revenue growth in 2025

Morgan Stanley's view: NVIDIA is going to ramp up its new product, Blackwell, in 2025. The key debate here is that how much hyperscalers are going to spend on the new products. Our analysts are assuming different volumes, so we lay out several scenarios.

NVIDIA remains the dominant supplier of AI GPU in 2025. Most CSPs have commented that AI will remain the focus for spending. However, our analysts are assuming different revenue from hypercalers for NVIDIA-related stocks next year. We thus lay out several different assumptions.

NVIDIA assumptions from Joe Moore

Our NVIDIA analyst is assuming datacenter revenue to grow 18% Y/Y in 2025 (link). In his assumption, there will be 3.2mn Blackwell chips, including both B100 and B200. He also forecasts that there will a total of 17k NVL72 units, but without much mention of the GB200 rack.

Exhibit 32: NVIDIA: data center revenue forecasts by Joe Moore

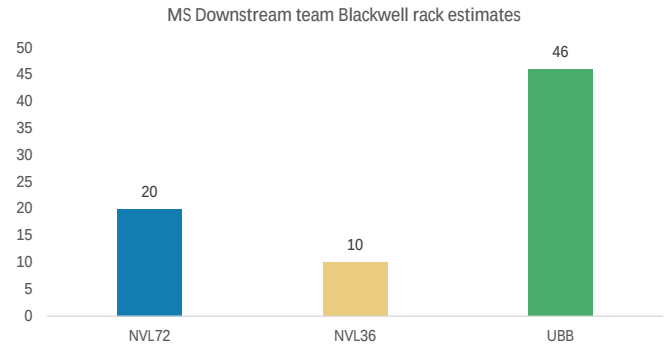
	FY2023	FY2024E	FY2025E	FY2026E	FY2027E
Data center GPU revenue (USD mn)	**$ 38,013**	**$ 86,073**	**$ 101,296**	**$ 103,559**	**$ 119,798**
y/y	258%	126%	18%	2%	16%
A100 revenues (USD mn)	$ 2,866	$ -	$ -	$ -	$ -
% of DC GPU Revenue	8%	0%	0%	0%	0%
A100 units (K)	265	0	0	0	0
A100 prices (USD K)	$ 10.8	$ -	$ -	$ -	$ -
H100/200 revenues (USD mn)	$ 31,153	$ 68,019	$ 21,505	$ 1,175	$ -
% of DC GPU Revenue	82%	79%	21%	1%	0%
H100 units (k)	1,038	2,482	860	47	0
H100 prices (USD K)	$ 30.0	$ 27.4	$ 25.0	$ 25.0	$ -
B100/200 revenues (USD mn)	$ -	$ 9,447	$ 68,424	$ 22,234	$ -
% of DC GPU Revenue	0%	11%	68%	21%	0%
Blackwell units (k)	0	315	2,138	741	0
Estimated NVL72 units (k)	0	0	11	6	0
Blackwell prices (USD K)	$ -	$ 30.0	$ 32.0	$ 30.0	$ -
"R"100 revenues (USD mn)	$ -	$ -	$ 1,237	$ 66,269	$ 107,819
% of DC GPU Revenue	0%	0%	1%	64%	90%
R100 units (k)	0	0	31	1,657	2,695
R100 prices (USD k)	$ -	$ -	$ 40.0	$ 40.0	$ 40.0
Mainstream GPU units (k)	**1,304**	**2,797**	**3,029**	**2,445**	**2,695**
y/y		115%	8%	-19%	10%

Source: Company data, Morgan Stanley Research estimates

NVIDIA-related estimates from Morgan Stanley's downstream hardware team

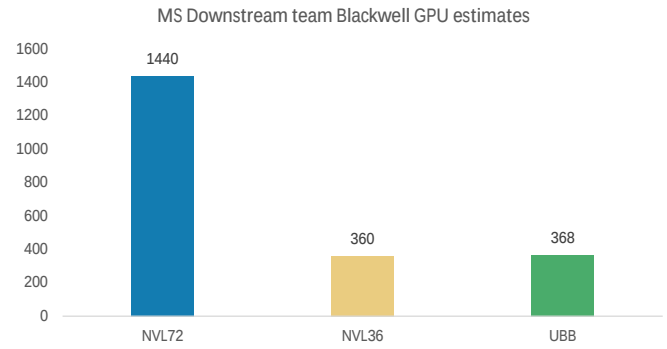
Our downstream team has made the following assumptions in its Hon Hai model (refer to Sharon Shih's Hon Hai Idea report). If we assume 60% of the revenue of NVIDIA-related stocks comes from hyperscalers in 2024e and 80% in 2025e, this will drive NVIDIA-related datacenter revenue from hyperscalers to grow at ~57% Y/Y in 2025e.

Exhibit 33: Life-cycle Blackwell rack forecasts by Morgan Stanley's downstream team



Source: Morgan Stanley Research estimates

Exhibit 34: Life-cycle Blackwell GPU forecasts by Morgan Stanley's downstream team



Source: Morgan Stanley Research estimates

Exhibit 35:
Life-cycle Blackwell GPU spending estimates by Morgan Stanley's downstream team

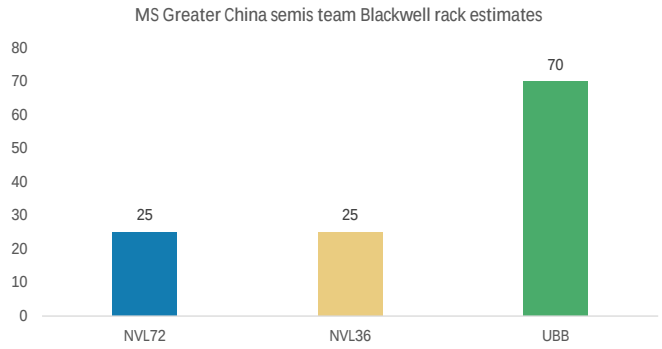
Blackwell demand		
Total Blackwell demand (k units)		2,168
Chip per CoWoS		14
TSMC CoWoS demand for Blackwell (k units)		155
Pricing		
NVL72	$	3,000,000
NVL36	$	1,800,000
UBB	$	300,000
Spending (USD mn)		
NVL72	$	60,000
NVL36	$	18,000
UBB	$	13,800
Total	$	91,800
Others (USD mn)	$	15,000
Total spending (USD mn)	$	106,800
% bought from hyper scaler		80%
GPU spending from hyper scaler	$	85,440.00
Revenue growth in 25e for Nvidia datacenter revenue from hyperscalers		57%

Source: Morgan Stanley Research estimates

NVIDIA-related estimates from Morgan Stanley's Greater China semis team

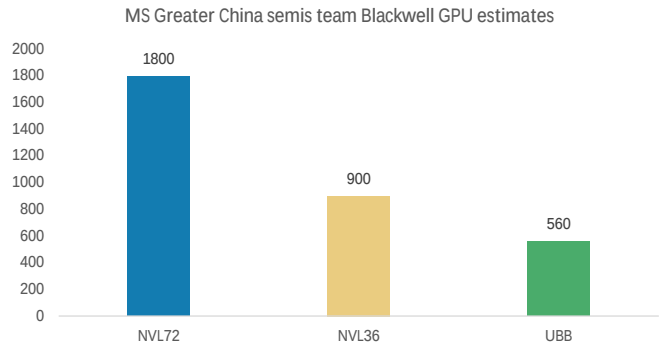
Our team's forecast is that there will be around 50k rack of the GB200 and 70k of the UBB board in 2025e. If we assume 60% of the revenue of NVIDIA-related stocks comes from hyperscalers in 2024 and 80% in 2025e, this will mean NVIDIA-related datacenter revenue to hyperscalers will grow at around 140% Y/Y in 2025.

Exhibit 36: Life-cycle Blackwell rack forecast by MS Greater China semis team



Source: Morgan Stanley Research estimates

Exhibit 37: Life-cycle Blackwell GPU forecast by MS Greater China semis team



Source: Morgan Stanley Research estimates

Exhibit 38:
Life-cycle Blackwell GPU spending estimates by Morgan Stanley's Greater China semis team

Blackwell demand		
Total Blackwell demand (k units)		3,260
Chip per CoWoS		14
TSMC CoWoS demand for Blackwell (k units)		233
Pricing		
NVL72	$	3,000,000
NVL36	$	1,800,000
UBB	$	300,000
Spending (USD mn)		
NVL72	$	75,000
NVL36	$	45,000
UBB	$	21,000
Total	$	141,000
Others (USD mn)	$	20,000
Total spending (USD mn)	$	161,000
% bought from hyper scaler		80%
GPU spending from hyper scaler	$	128,800.00
Revenue growth in 25e for Nvidia datacenter revenue from hyperscalers		137%

Source: Morgan Stanley Research estimates

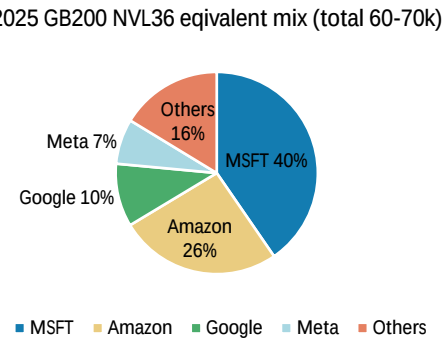
Our projections of customer mix on the GB200 in 2025

Given the strong demand of AI infrastructure, we expect overall GB200 demand to move

up close to 60-70k NVL36 equivalent in 2025 (Cloud Semis: More Visibility on Blackwell, July 16 2024). We think the GB200 rack will be mainly procured by the hyperscalers. Microsoft and Amazon should be the largest two buyers in 2025. Currently, only Microsoft and Oracle are requesting the NVL72. If the NVL72 is not ready, both companies may still be willing to take NVL36 products.

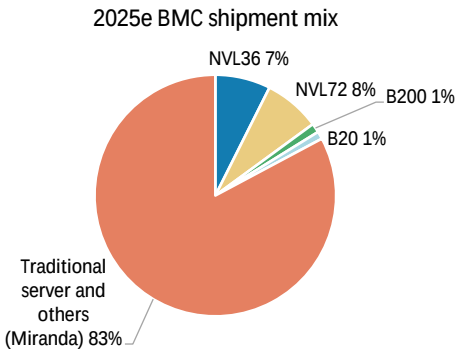
Therefore, we expect to see rising NVL72 shipment mix vs. NVL36 within GB200. The NVL72 mix could be potentially bigger than NVL36 in 2025, subject to qualification in 4Q. We also think the B200 HGX ramp-up schedule may come earlier, likely starting in 4Q24. This is because of easier platform migration, which could make up the gap before full ramp-up of GB200 in 2Q25.

Exhibit 39: GB200 procurement mix by customer in 2025 (NVL36 equivalent)



Source: Morgan Stanley Research estimates

Exhibit 40: 2025e BMC shipment mix by spec; likely NVL72 mix could be higher

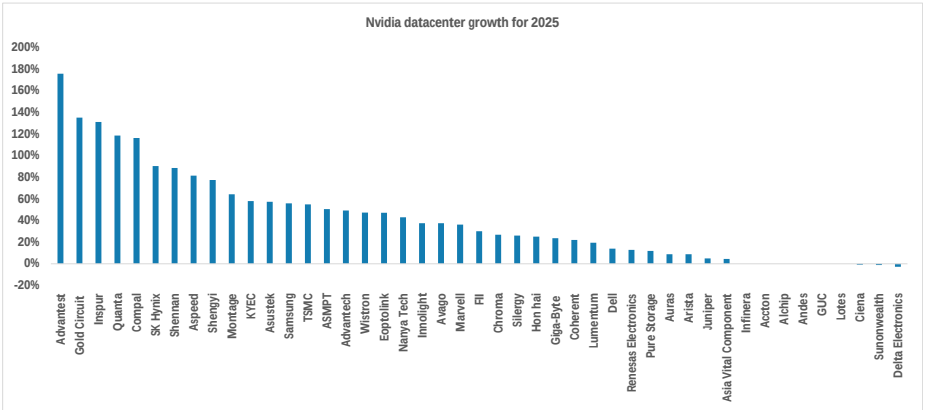


Source: Morgan Stanley Research estimates

Different scenarios for NVIDIA-related datacenter growth in 2025

Our global tech analysts are embedding different assumptions within their models for NVIDIA-related datacenter growth in 2025e, as below:

Exhibit 41: Morgan Stanley Tech analysts forecasts for NVIDIA-related capex growth for 2025



Source: Morgan Stanley Research estimates

We assume 0-50% Y/Y growth for 39% of stocks, 50-100% Y/Y growth for 22% of stocks, and over 100% Y/Y growth for 16% of stocks.

We define the Morgan Stanley Tech analyst consensus as the median of all the growth, which is 37% Y/Y growth in 2025e vs. Joe Moore's forecast of 18% Y/Y. From this perspective, we think NVIDIA may continue to shine in the 2025 with robust demand for AI infrastructure.

Key watch point #3: How we should think about non-NVIDIA-related cloud capex growth

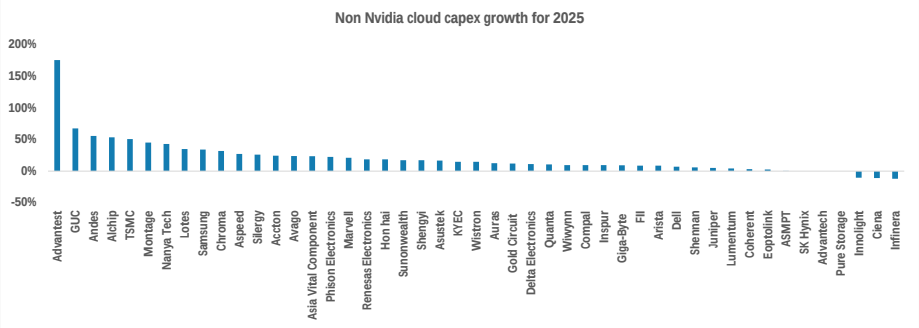
Our view: We believe capex is better planned into 2025 than in previous years, which will translate into less NVIDIA cannibalization. Also, power consumption and networking become more important, where they should also enjoy some growth.

Other than from the NVIDIA-related segment, there are several components that need to be procured for datacenters

There are several other components including other AI chips (AMD and ASIC), CPU servers, storage/switches, and other infrastructure (e.g. Power plants) that hyperscalers need to purchase. We think spending in general will rise in 2025.

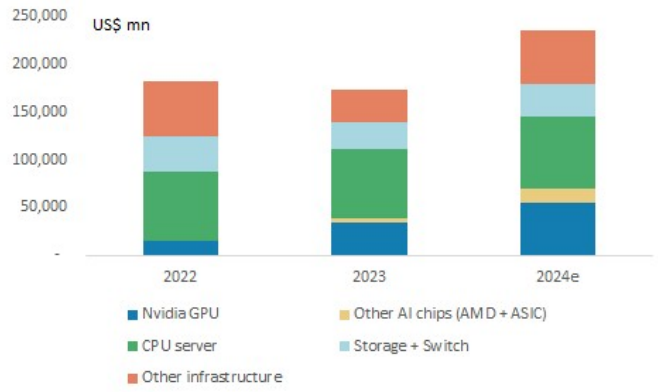
Morgan Stanley's Tech team's consensus forecasts the median of non-NVIDIA-related capex growth for 2025 will reach 14% at median.

Exhibit 42: Morgan Stanley's Tech team's forecasts for non-NVIDIA-related capex growth for 2025



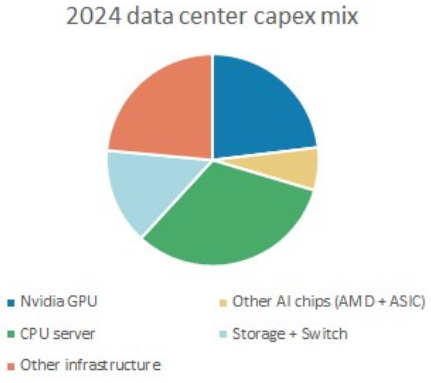
Source: Morgan Stanley Research estimates

Exhibit 43: Datacenter capex breakdown



Source: Morgan Stanley Research estimates

Exhibit 44: GPUs and ASICs will continue to be the major expenditure for datacenter capex



Source: IDC, Morgan Stanley Research

Other AI chips (ASIC and AMD GPU)

We believe ASIC remains the key strategic investment from hyperscalers and we are also seeing custom chip designs accelerating, driving up the penetration from large hyperscalers' AI ASICs (such as Google's TPU, AWS's Inferentia, Microsoft's Maia, and Meta's MTIA). By developing their own ASIC chips, hyperscalers can effectively reduce their costs of buying NVDA's GPU and servers for AI training and inference purposes.

Exhibit 45: Design services: Custom chip projects mapping table

	Alchip	Global Unichip	Broadcomm	Marvell	TSMC direct	Samsung direct	MediaTek	Socionext
AWS – Annapurna	Inferentia2/Tranium1 (7nm) Inferentia3 (3nm)			Inferentia2.5/Trainium2 (5nm)	Graviton 1 (16nm) Graviton 2 (7nm) Graviton 3 Nitro Security Chip			
Amazon – Lab 126	Kindle processor Echo processor (12nm)	Echo processor (5nm)						
Google		Security Chip	TPU 1/TPU 2 TPU 3/TPU 4 TPU 5/TPU 6 **TPU 7 Training**	Maple CPU (5nm)	Axion CPU (5nm) Tensor (3nm)	Tensor (7nm) Tensor (5nm)	TPU 3 **TPU 7 Inference**	
Microsoft		Maia 100 (5nm) Cobalt 100 (5nm) **Maia 200 (3nm)?**		AI accelerator **(3nm)?**			Azure IoT XBox Bluray	
Meta	Oculus ASIC		MTIA				Oculus ASIC	**CPU (3nm)?**
Sony	TV ASIC Smartphone ISP	DSC ASIC					PS5 South Bridge	
Tesla	D1/Dojo (7nm)				D1/Dojo (7nm) D2/Dojo (5nm)	Autopilot 3.0/FSD 1 (14nm) Autopilot 4.0/FSD 2 (7nm)		
Li Auto	ADAS (5nm)							
GM – Cruise								5nm
Intel – Habana	Gaudi 1 (16nm) Gaudi 2/Goya 2 (7nm) Gaudi 3/Goya 3 (5nm)	Goya 1 (16nm)						
Baidu					Kunlun 2 (5nm)	Kunlun 1 (7nm)		
Alibaba – T-head		Generation 1			Hanguan Xuantie			
Tencent					Zixiao (12nm)			
ByteDance			AI accelerator (7nm) **5nm?**					

Source: Company data, Morgan Stanley Research

AMD may see some issues given the lag behind NVIDIA on the product roadmap. While NVDA unveiled its AI GPU roadmap out to 2027, including its newly introduced Blackwell Ultra GPU for 2025 (8hi/12hi HBM3e), its Rubin GPU for 2026 and 2027 (12hi HBM4) during the Computex keynote, AMD only released its AI GPU roadmap to 2026 with MIX400X. We believe AMD's AI GPU may continue to lag behind NVDA by one generation. In addition, as hyperscalers continue to push their AI ASIC roadmap, we believe AMD may also face competition from custom AI chips.

Exhibit 46: NVDA and AMD roadmap

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025e	2026e
NVDA	Pascal		Volta		Ampere		Hopper		Blackwell		Rubin
AMD								MI300X	MI325X	MI350	MI400

Source: Company data, Morgan Stanley Research

CPU servers

We believe the CPU server still remains dominant of the different workloads vs. the GPU server. Thus it may take some time that we will see the CPU server replacement. Another key trend is power consumption. The migration of the CPU server to GPU server is not only due to its faster computing capability, but also for its power saving capacity.

Upgrading a CPU could save more power

Moore's Law drives the performance improvement on Intel's server CPU. In the past six decades, the server CPU has shown 2x performance enhancement given the denser logic density in every 1.5-2 years. Migration has slowed down in the past seven years especially after 14nm came out – Intel has been stuck on 14nm for many years with improvement only seen in transistor performance. The new Intel server CPU, Sapphire Rapids, based on Intel 7 (7nm node) is essentially an improvement on Intel's 10nm technology, which may present a much better performance and power efficiency.

Exhibit 47: Intel server CPU migration

Launch	Family Branding	Process Node
1995	Pentium	0.35 micron
1996		
1997		
1998	Pentium II	0.25 micron
1999	Pentium III	0.18 micron
2000	NetBurst - Cascades	180nm
2001		
2002	NetBurst - Prestonia	130nm
2003		
2004	NetBurst - Nocona	90nm
2005		
2006	Core - Woodcrest	65nm
2007		
2008	Core - Wolfdale	45nm
2009	Nehalem - Tylersburg	45nm
2010	Nehalem - Westmere	32nm
2011		32nm
2012	Sandy Bridge - Romley	32nm
2013	Sandy Bridge - Ivy Bridge	22nm
2014	Haswell - Haswell	22nm
2015	Haswell - Rockwell	14nm
2016		
2017	Sky Lake	14nm+
2018	Cascade Lake	14nm++
2019		
2020	Cooper Lake	14nm++
2021	Ice Lake	10nm+
2022	Sapphire Rapids	Intel 7
2023	Emerald Rapids	Intel 7
2024	Granite Rapids & Sierra Forest	Intel 3
2025	Clearwater Forest	Intel 3 ?

Source: Intel, Morgan Stanley Research

However, we need to upgrade the server to save power

According to Morgan Stanley's Utilities team, power usage from GenAI will show surprisingly rapid growth, with a 70% CAGR from 2024-27. By 2027, GenAI power demand

is expected by the team to reach 224 terawatt-hours (TWh) on average (refer to Energy and utilities: Powering AI (Jan 29, 2024)).

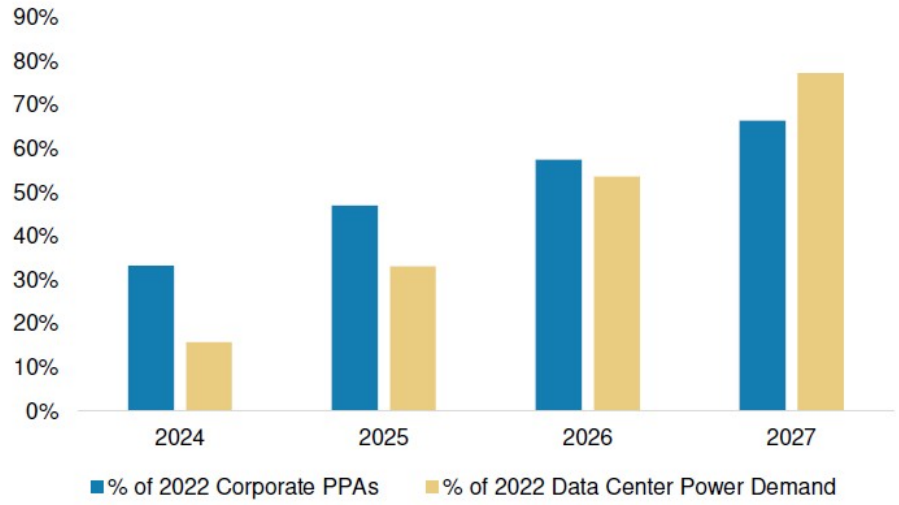
To save power from datacenters, we expect to see enhanced server CPUs and other components with better power consumption performance. We're seeing more aggressive moves on hyperscalers' developments of custom server CPUs. Before hyperscalers developed their own custom server CPUs, there were limited ARM-based merchant options. According to Google, the rate of improvement for CPUs did not meet cost, performance, and sustainability goals.

Exhibit 39 Custom server CPU strategies – comparison table

	First official announcement for custom Arm CPU	Latest custom CPU project	ASIC partners	Arm-based CPU's benefits vs. x86 merchant solutions	Chip sourcing strategies
Google	2024	Axion (2024)	Broadcom	50% better performance 60% better energy efficiency	Google released 5 generations of in-house TPU since 2015, but believes that general-purpose compute is and will remain a critical portion of its customers' workloads. Several of Google's services have been deployed on current-gen Arm-based servers and will soon be deployed and scaled on Axion.
AWS	2018	Graviton (2023)	N/A	60% less energy consumption vs. comparable processors	AWS uses multiple sources of chips to support customers' different workloads. For example, custom ASICs (Trainium/Inferentia AI chips, Graviton CPU) and GP CPU/ GPUs (Intel, NVIDIA and AMD). Graviton is used by both external (AWS' customers) and internal (Amazon) workloads.
Apple	2020	M3 (2023) M3 Pro (2023) M3 Max (2023) M2 Ultra (2023)	N/A	75%/80% less power consumption for CPU/GPU workloads vs. 12-core PC laptop chip	Apple introduced its M series Apple Silicon in 2020, and has adopted its custom silicon in all of its new PC devices. It remains to be seen if Apple will announce deployment of Apple Silicon to its data center infrastructure as well.
Microsoft	2023	Cobalt 100 (2023)	GUC	To deliver greater efficiency and performance in cloud native offerings	Microsoft's Azure Cobalt 100 CPU aims to optimize performance per watt throughout its datacenters, for both internal and external workloads.
Meta	N/A	3nm CPU (2026?)	Socionext	(to be announced)	Our foundry supply chain checks suggest Meta is working with Socionext and Arm to build a custom CPU based on Arm's Neoverse cores. We expect 2026 for the targeted time of mass production.

Source: Company data, Morgan Stanley Research

Exhibit 48: GenAI power as % of 2022 data center power, corporate power agreements



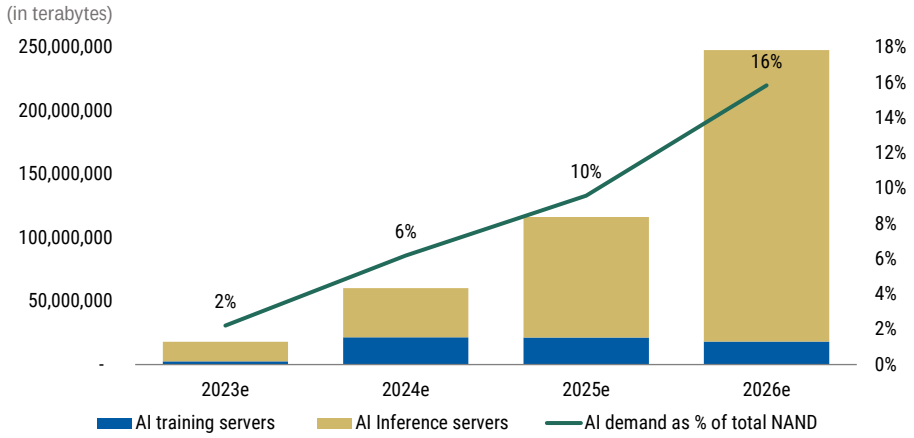
Source: Company data, Trendforce, Morgan Stanley Research

Storage and networking

Despite the robust demand for high-bandwidth memory (HBM), we view NAND demand in AI data center and enterprises would also be significant. This is driven by hyperscalers' AI inference demand for higher efficiency and data transmission performance speed. Therefore, we believe the solid-state drives (SSD) market is likely to face significant supply shortages, especially in the enterprise SSD segment, according to our tech analyst, Shawn Kim (Asia Technology: NAND – Time For A Major Upgrade (April 15, 2024)). As supply shortage of high-density QLC enterprise SSD continued into 3Q24, enterprise grade NAND contracts are up more than 20%.

On Shawn's estimation, AI Inference NAND demand will account for 16% global NAND demand by 2026, given the incremental demand uplift that the AI trend could potentially bring to the NAND market.

Exhibit 49: AI demand for NAND



Source: Gartner, TrendForce, Morgan Stanley Research (e) estimates

Exhibit 50: AI server NAND demand forecasts

Server Units Forecast	2023	2024e	2025e	2026e
Units				
General Servers	11,866,759	11,968,684	12,741,559	13,536,031
AI Training Servers	650,000	672,000	668,000	568,000
AI Inference Servers	961,000	1,211,000	1,483,000	1,795,000
Total Servers	13,477,759	13,851,684	14,892,559	15,899,031
NAND Content Assumption				
TB				
AI training servers	4	32	32	32
AI Inference servers	16	32	64	128
Incremental AI Demand				
TB				
AI training servers	2,600,000	21,504,000	21,376,000	18,176,000
AI Inference servers	15,376,000	38,752,000	94,912,000	229,760,000
Total AI NAND Demand	17,976,000	60,256,000	116,288,000	247,936,000
Global Traditional NAND demand				
TB				
Global NAND demand from SSD	420,837,000	437,988,000	525,585,600	630,702,720
Global total NAND demand	794,218,000	914,023,000	1,096,827,600	1,316,193,120
AI demand as % of total				
AI demand as % of total SSD	***4%***	***12%***	***18%***	***28%***
AI demand as % of total NAND	***2%***	***6%***	***10%***	***16%***
NAND ASP (US$ per GB)	*0.05*	*0.05*	*0.05*	*0.05*
NAND Market (US$bn)				
AI	1	3	6	12
Traditional	40	46	55	66
Total	41	49	61	78

Source: Gartner, TrendForce, Morgan Stanley Research (e) estimates

Exhibit 51: NAND contract pricing

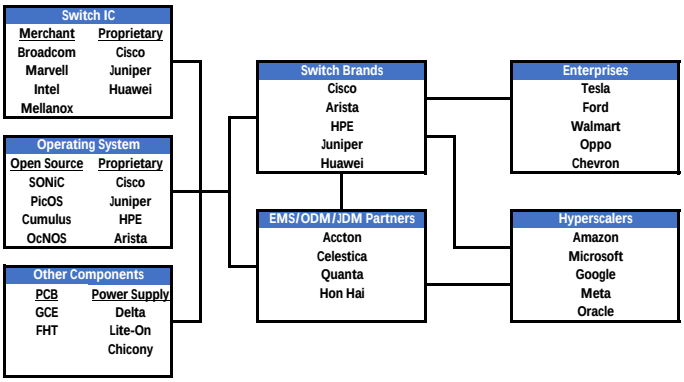
	1Q24E	2Q24E (Old)	2Q24E (New)	3Q24E	4Q24E
eMMC UFS	up 25-30%	consumer: up 0-5% mobile: up 10-15%	consumer: up 0-5% mobile: up 10-15%	consumer: mostly flat mobile: up 3-8%	down 0-5%
Enterprise SSD	up 23-28%	up 20-25%	up 20-25%	up 15-20%	up 0-5%
Client SSD	up 23-28%	up 20-25%	up 20-25%	up 3-8%	down 0-5%
3D NAND Wafers (TLC & QLC)	up 23-28%	up 5-10%	up 5-10%	mostly flat	down 0-5%
Total NAND Flash	up 23-28%	up 15-20%	up 15-20%	up 5-10%	down 0-5%

Source: Trendforce estimates, Morgan Stanley Research

We also anticipate Gen AI will create more demand for networking due to parallel computing, leading to higher deployment of network switches and spec upgrades for higher throughput (AI Supply Chain – AI Datacenter Network Switch Also Growing (June 24, 2024)). We forecast a 55% revenue CAGR for AI datacenter network switches over 2023-26e.

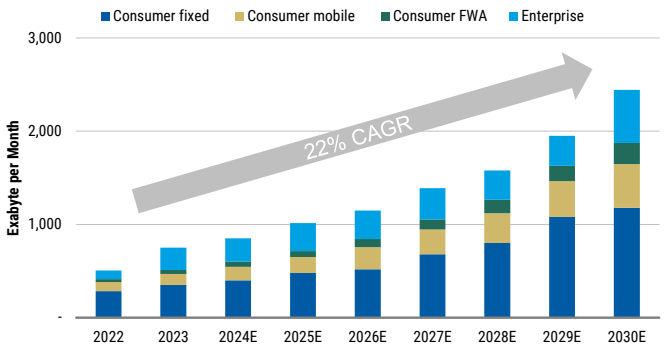
Although NVIDIA puts emphasis on InfiniBand, we believe Ethernet may regain share, due to more diversified adoption of non-NVIDIA GPUs and ASICs where Ethernet could be preferred as hyperscalers opt for a more open ecosystem to mitigate potential supply chain risks. We forecast Ethernet to expand its revenue share in AI datacenters to 49% in 2026 from 38% in 2023.

Exhibit 52: Network Switch Supply Chain



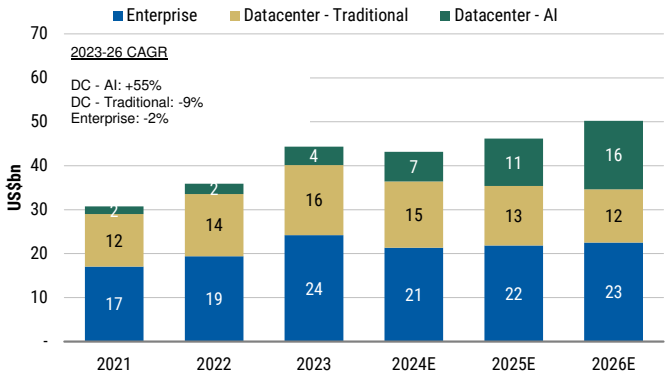
Source: Company data, Morgan Stanley Research

Exhibit 53: Global Network Traffic to Rise at a 22% CAGR, 2023-30e



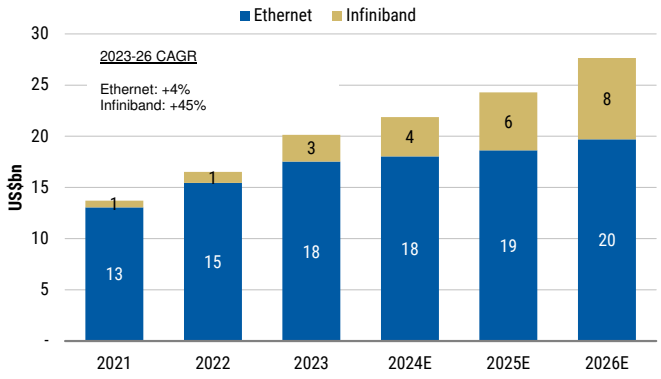
Source: Nokia, Morgan Stanley Research. E = Nokia's Global Network Traffic 2030 Report.

Exhibit 54: Global Network Switch Market Forecast



Source: IDC, Dell'Oro, Morgan Stanley Research. E = Morgan Stanley Research estimates.

Exhibit 55: Global Datacenter Network Switch Market Forecasts



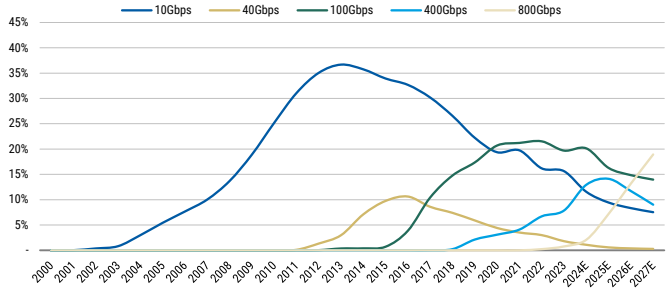
Source: IDC, Dell'Oro, Morgan Stanley Research. E = Morgan Stanley Research estimates.

Exhibit 56: Comparison between InfiniBand and Ethernet

	InfiniBand	Ethernet
Latency	Low	Fair
Speed (Gbps per port)	Up to 800	Up to 800
Efficiency	Good	Fair
Cost	High	Low
Applications	Datacenters	Datacenters, PCs, Peripherals, etc.
Deployment	Backend	Frontend
Supplier/Ecosystem	Nvidia (Mellanox)	Arista, Cisco, Intel, AVGO, HPE etc…
Open source?	Practically proprietary	Open source

Source: Company data, Morgan Stanley Research.

Exhibit 57: Port Speed Upgrade in Ethernet Switches (Revenue-based Shares)

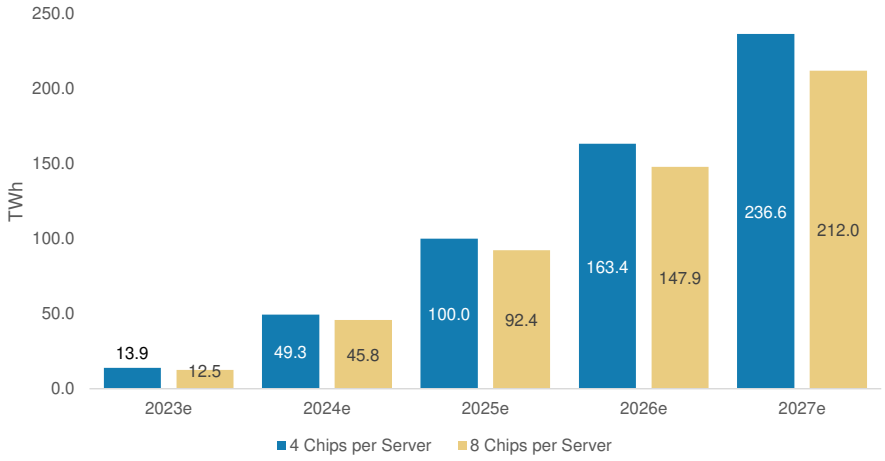


Source: IDC, Dell'Oro, Morgan Stanley Research. E = Morgan Stanley Research estimates.

Other infrastructure

According to our US power analyst, Stephen Byrd, utilities that provide the power infrastructure needed for data centers may also see great growth potential. Our analysis of power usage from GenAI shows surprisingly rapid growth, with a 70% CAGR in 2024-27e in our base case. By 2027, our base case GenAI power demand is 224 terawatt hours (TWh) on average (refer to Powering GenAI: How Much Power, and Who Benefits? (Jan 29, 2024)).

Exhibit 58: Global projected GenAI power demand in Morgan Stanley's base case forecast



Source: Company data, TrendForce, Morgan Stanley Research estimates

Conclusion

Given the more well planned capital budgets and the requirement to upgrade some content, MS Tech analysts' estimate consensus is that there will be increasing spending on non-NVIDIA capex as well in 2025.

Our US team's views on cloud capex

Erik Woodring (MS North America IT Hardware)

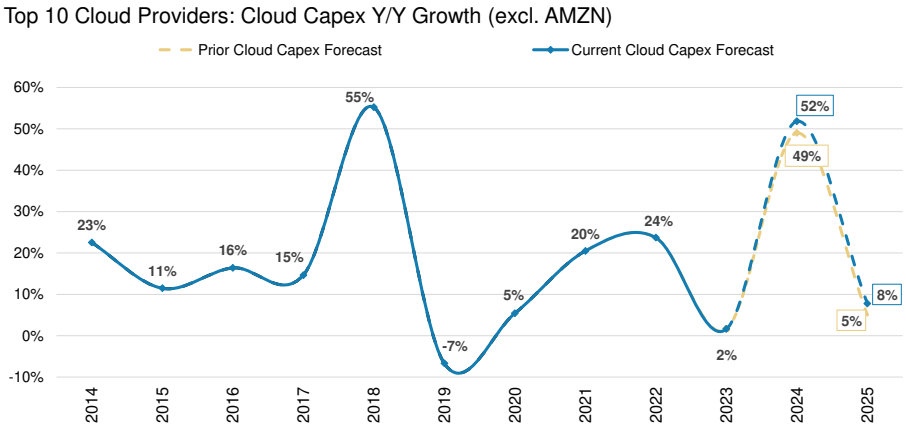
2024 cloud capex 'supercycle' strengthens, with 2025 forecasts already upticking. Our cloud capex tracker now points to 52% Y/Y capex growth in 2024, or $182bn total capex excluding Amazon (+52% Y/Y and $251B including Amazon), up from +49% Y/Y growth in our outlook from just 12 days ago, implying the strongest Y/Y acceleration in cloud capex since we began tracking these estimates a decade ago (Exhibit 59). As we look to 2025, consensus is preliminarily forecasting 8% Y/Y cloud capex growth, or $196bn of total cloud capex ($267B including Amazon), up from 5% 12 days ago.

Looking back over the last three cycles, consensus cloud capex revisions have been mixed (Exhibit 60), with the positive revisions to 2024 capex much more significant than the 2022/2023 cycles (2023 notably suffering from cloud optimization efforts). However, the combination of 1) bullish commentary from the major hyperscalers this earnings cycle (i.e. Llama 4 requiring 10x the compute of Llama 3); 2) positive directional supply-chain build feedback; and 3) positive feedback from our 2Q24 CIO Survey supports our view that there is likely more upside rather than downside risk to 2025 consensus cloud capex budgets, though the pace of cloud revenue growth bears watching given the deceleration expected in 2H24 (and into 1H25).

Lastly, we note that despite the Y/Y slowdown to 8% Y/Y cloud capex growth in 2025, based on where consensus revenue forecasts stand today, this would still imply cloud vendors are spending 11.6% of revenue on capex, down just 30bps from all-time highs in 2024 but still well above the trailing 10-year average (Exhibit 61).

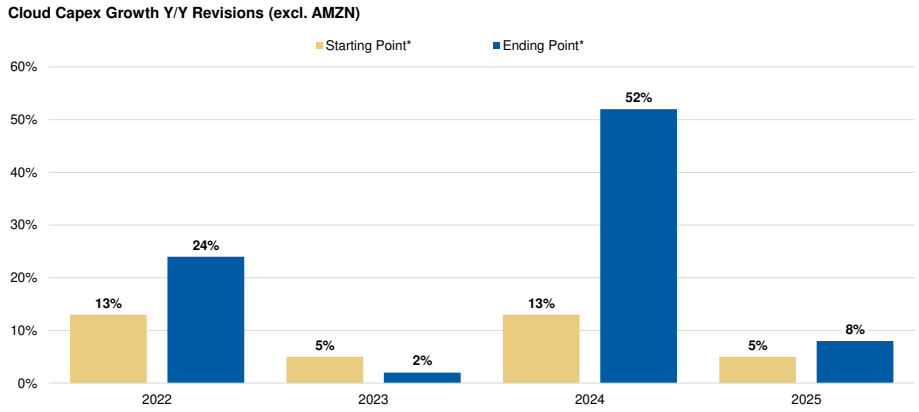
For more details on our cloud capex forecast, please see IT Hardware: 2024-2025 Cloud Capex Growth Moves Higher.

Exhibit 59: Our cloud capex tracker now points to 52% Y/Y growth (ex-Amazon) in 2024, up from the prior forecast of +49% Y/Y



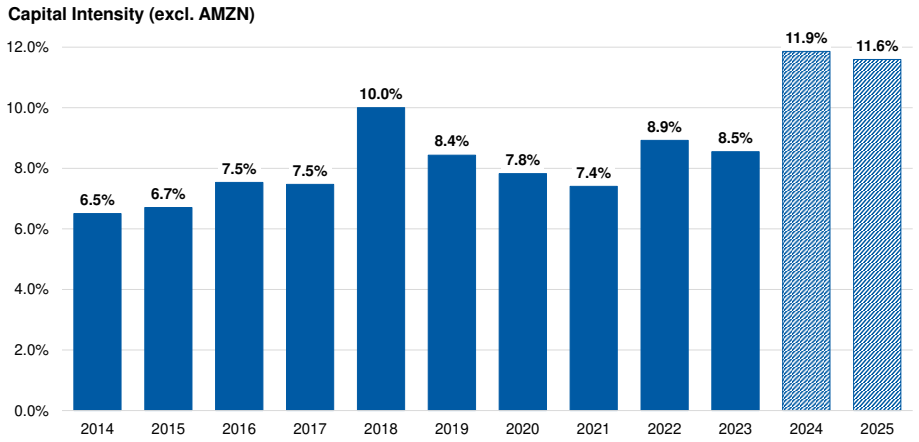
Source: Company data, Refinitiv, Morgan Stanley Research, irs.gov. Note: Cloud capex includes capex from Alphabet, Microsoft, Meta Platforms, Tencent, Baidu, Apple, IBM, and Oracle. Forward estimates include MSe for Tencent and Baidu, consensus est. for the others.

Exhibit 60: Cloud capex growth was revised 11 points higher in 2022 and 3 points lower in 2023. To-date 2024 and cloud capex growth expectations have been revised higher by 39 and 3 points, respectively.



Source: Company data, Refinitiv, Morgan Stanley Research, irs.gov. Note: Cloud capex includes capex from Alphabet, Microsoft, Meta Platforms, Tencent, Baidu, Apple, IBM, and Oracle. Forward estimates include MSe for Tencent and Baidu, consensus est. for the others.*Note: Starting point reflects estimates after C2Q earnings in the prior year. Ending point for 2024 and 2025 are as of 8/2/2024.

Exhibit 61: Our cloud capex tracker estimates capital intensity will reach a 10+ year high of 12% in 2024 and 2025.

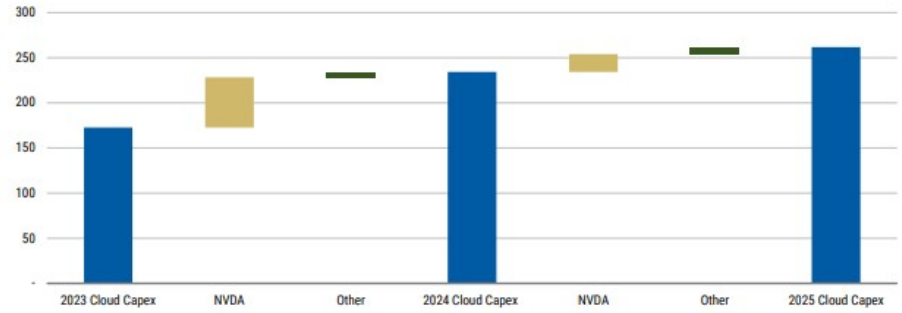


Source: Company data, Refinitiv, Morgan Stanley Research, irs.gov. Note: Cloud capex includes capex from Alphabet, Microsoft, Meta Platforms, Tencent, Baidu, Apple, IBM, and Oracle. Forward estimates include MSe for Tencent and Baidu, consensus est. for the others

Meta Marshall (MS North America Telecom & Networking Equipment)

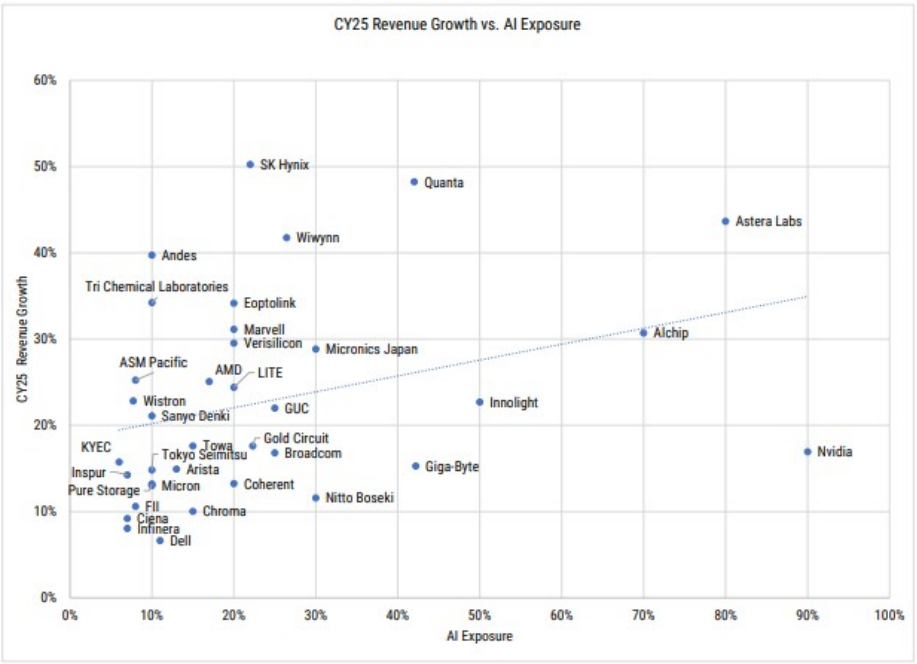
According to Meta's recent update (Global Technology & Data Center Infrastructure: Data Center Semis and Infrastructure: What's Built Into the Price for AI? (June 11, 2024)), the MS North America Telecom team's forecast on average growth of AI exposed is ~13% vs. 20-25% for MS tech analysts' estimate consensus and ~10% for cloud budgets. As shown in Exhibit 63, there is rough correlation between revenue growth to cloud budgets, causing us to look at the implied growth of these names vs. AI budgets. What it shows is that in general vs. cloud budgets, the market is somewhat more optimistic. But if we put GPUs purchased needing to be installed into consideration (NVDA's expected growth is ~16% for 2025), the numbers look more reasonable.

Exhibit 62: MS North America Telecom team: NVDA Still Accounts for Much of Cloud Capex Growth, Though Overstated Since Not All NVDA Going to Clouds



Source: Morgan Stanley Research estimates, Capex in billions

Exhibit 63: MS North America Telecom team: Market Building in ~13% Growth for Names, Fairly Coordinated to AI Exposure



Source: Morgan Stanley Research estimates

How our European team looks at the big picture of data centers

Emmet Kelly (MS European Telecommunication): Upcoming cloud boom in Europe

We expect the European DC market to grow 5x by 2035. There are a number of drivers of this IT capacity growth: 1) Increased rates of Cloudification, notably in laggard European markets such as Spain, France, Italy; 2) AI will boost Cloud growth rates by +50%, even if there is likely to be a 1-2 year lag vis-à-vis the US, given delayed investments, energy constraints and lower chip supply; 3) The emergence of data sovereignty as a core decision driver for CIOs and end users (Merlin estimates there is 3GW of European data, 50% of the European data center pie, that needs to be near-shored back to Europe).

We have also identified other core supply-side drivers of Cloud growth across Europe:

1) Accelerating Hyperscale investments (by AWS, Google Cloud & Microsoft Azure – see below), while we believe the likes of Meta, Facebook and TikTok will follow; 2) The construction of larger DC campuses (100MW-500MW facilities); 3) The emergence of new / secondary DC hubs (beyond the Big Five FLAPD markets of Frankfurt, London, Amsterdam, Paris & Dublin) – including Aragaon/Madrid (Spain), Milan, Zurich, Marseille (subsea cable connections), Warsaw (macro growth) and across Scandinavia (instant access to cheap renewable energy, cool climate). These markets often have easier planning permission rules, and better grid connections.

There has been a surge of announcements, relating to construction of new European data centers / Cloud capacity, notably in the UK and France:

Spain: AWS has announced a US$17bn investment in data centers (in its Aragon Cloud region). Our estimates suggest these investments will cover both Cloud and AI, and will equate to ca 600MW of capacity. In a separate announcement, Amazon has disclosed that it is investing in 12 new renewable energy projects, comprising ca 600MW, across four wind farms and eight solar plants.

UK: In Q4 2023, Microsoft announced a £2.5bn investment in AI data centers. In January 2024, Google announced a US$1bn investment in DCs.

France: Azure will invest €4bn in France, in AI. Meanwhile, Amazon Web Services has committed to investing >€1.2bn euros into its French DC operations, while Equinix plans to invest c€630m in French DCs (via a partnership with the French start-up, Alice & Bob).

However, there are a number of constraints to European DC growth: 1) Energy. DCs consumed 21% of the Irish grid / energy during 2023 (MSe). Ireland has therefore imposed a moratorium on new DC build; 2) Construction capacity. Planning permission and construction labour shortages; 3) DC wiring, HVAC & electronics.

Disclosure Section

The information and opinions in Morgan Stanley Research were prepared or are disseminated by Morgan Stanley & Co. LLC and/or Morgan Stanley C.T.V.M. S.A. and/or Morgan Stanley México, Casa de Bolsa, S.A. de C.V. and/or Morgan Stanley Canada Limited and/or Morgan Stanley & Co. International plc and/or Morgan Stanley Europe S.E. and/or RMB Morgan Stanley Proprietary Limited and/or Morgan Stanley MUFG Securities Co., Ltd. and/or Morgan Stanley Capital Group Japan Co., Ltd. and/or Morgan Stanley Asia Limited and/or Morgan Stanley Asia (Singapore) Pte. (Registration number 199206298Z) and/or Morgan Stanley Asia (Singapore) Securities Pte Ltd (Registration number 200008434H), regulated by the Monetary Authority of Singapore (which accepts legal responsibility for its contents and should be contacted with respect to any matters arising from, or in connection with, Morgan Stanley Research) and/or Morgan Stanley Taiwan Limited and/or Morgan Stanley & Co International plc, Seoul Branch, and/or Morgan Stanley Australia Limited (A.B.N. 67 003 734 576, holder of Australian financial services license No. 233742, which accepts responsibility for its contents), and/or Morgan Stanley Wealth Management Australia Pty Ltd (A.B.N. 19 009 145 555, holder of Australian financial services license No. 240813, which accepts responsibility for its contents), and/or Morgan Stanley India Company Private Limited having Corporate Identification No (CIN) U22990MH1998PTC115305, regulated by the Securities and Exchange Board of India ("SEBI") and holder of licenses as a Research Analyst (SEBI Registration No. INH000001105), Stock Broker (SEBI Stock Broker Registration No. INZ000244438), Merchant Banker (SEBI Registration No. INM000011203), and depository participant with National Securities Depository Limited (SEBI Registration No. IN-DP-NSDL-567-2021) having registered office at 18th Floor, Tower 2, One World Center, Plot- 841, Jupiter Textile Mill Compound, Senapati Bapat Marg, Lower Parel, Mumbai 400013, India Telephone no. +91-22-61181000; Compliance Officer Details: Mr. Tejarshi Hardas, Tel. No.: +91-22-61181000 or Email: tejarshi.hardas@morganstanley.com; Grievance officer details: Mr. Tejarshi Hardas, Tel. No.: +91-22-61181000 or Email: msic-compliance@morganstanley.com which accepts the responsibility for its contents and should be contacted with respect to any matters arising from, or in connection with, Morgan Stanley Research, and their affiliates (collectively, "Morgan Stanley").

For important disclosures, stock price charts and equity rating histories regarding companies that are the subject of this report, please see the Morgan Stanley Research Disclosure Website at www.morganstanley.com/researchdisclosures, or contact your investment representative or Morgan Stanley Research at 1585 Broadway, (Attention: Research Management), New York, NY, 10036 USA.

For valuation methodology and risks associated with any recommendation, rating or price target referenced in this research report, please contact the Client Support Team as follows: US/Canada +1 800 303-2495; Hong Kong +852 2848-5999; Latin America +1 718 754-5444 (U.S.); London +44 (0)20-7425-8169; Singapore +65 6834-6860; Sydney +61 (0)2-9770-1505; Tokyo +81 (0)3-6836-9000. Alternatively you may contact your investment representative or Morgan Stanley Research at 1585 Broadway, (Attention: Research Management), New York, NY 10036 USA.

Analyst Certification

The following analysts hereby certify that their views about the companies and their securities discussed in this report are accurately expressed and that they have not received and will not receive direct or indirect compensation in exchange for expressing specific recommendations or views in this report: Charlie Chan; Daisy Dai, CFA; Howard Kao; Emmet B Kelly; Shawn Kim; Dylan Liu; Meta A Marshall; Joseph Moore; Sharon Shih; Lee Simpson; George W Webb; Adam Wood; Erik W Woodring; Ray Wu, CFA; Max R Yates; Daniel Yen, CFA.

.

Global Research Conflict Management Policy

Morgan Stanley Research has been published in accordance with our conflict management policy, which is available at www.morganstanley.com/institutional/research/conflictpolicies. A Portuguese version of the policy can be found at www.morganstanley.com.br

Important Regulatory Disclosures on Subject Companies

The analyst or strategist (or a household member) identified below owns the following securities (or related derivatives): Maya C Neuman - Apple, Inc.(common or preferred stock); Erik W Woodring - Ambarella Inc(common or preferred stock), NVIDIA Corp.(common or preferred stock).

As of June 28, 2024, Morgan Stanley beneficially owned 1% or more of a class of common equity securities of the following companies covered in Morgan Stanley Research: AAC Technologies Holdings, Accton Technology Corporation, ACM Research Inc, Advanced Micro Devices, Advanced Wireless Semiconductor Co, AirTAC International, Alchip Technologies Ltd, ALPS ALPINE, Ambarella Inc, Analog Devices Inc., Anritsu, Apple, Inc., Asia Vital Components Co. Ltd., ASMedia Technology Inc, Aspeed Technology, Asustek Computer Inc., AU Optronics, Auras Technology Co Ltd, Broadcom Inc., Cadence Design Systems Inc, CDW Corporation, Ciena Corporation, Cisco Systems Inc, CMK, Compal Electronics, Cricut Inc, Dell Technologies Inc., Delta Electronics Inc., E Ink Holdings Inc., Elan Microelectronics Corp, Eoptolink Technology Inc Ltd, Genius Electronic Optical Co. Ltd., Global Unichip Corp, GoerTek Inc, Hewlett Packard Enterprise, HP Inc., Ibiden, IBM, Infineon Technologies AG, Intel Corporation, IonQ Inc, IRISO Electronics, Japan Aviation Electronics Industry, King Slide Works Co. Ltd., King Yuan Electronics Co Ltd, Kornit Digital Ltd., Kyocera, Largan Precision, Legrand, Logitech International SA, Lotes Co. Ltd., Marvell Technology Group Ltd, Maxell, Microchip Technology Inc., Micron Technology Inc., Nan Ya PCB, NCR Corp., NetApp Inc, Nippon Chemi-Con, Nutanix Inc, NVIDIA Corp., NXP Semiconductor NV, ON Semiconductor Corp., Parade Technologies Ltd, Phison Electronics Corp, Pure Storage Inc, Qorvo Inc, Qualcomm Inc., Realtek Semiconductor, Resideo Technologies Inc, RichWave Technology Corp., Seagate Technology, Shenzhen Goodix Technology Co Ltd, Shinko Electric Industries, Silergy Corp., Silicon Laboratories Inc., Silicon Motion, SK hynix, Skyworks Solutions Inc, Sonos Inc., Sunny Optical, Synopsys Inc., Taiyo Yuden, TDK, Texas Instruments, Tong Hsing, TSMC, Unimicron, Visual Photonics Epitaxy Co Ltd, Western Digital, Will Semiconductor Co Ltd Shanghai, WIN Semiconductors Corp, Wolfspeed, INC, WPG Holdings, Xerox Corp, Xiaomi Corp, Yageo Corp., Zhejiang Crystal-Optech Co Ltd, Zhen Ding.

Within the last 12 months, Morgan Stanley managed or co-managed a public offering (or 144A offering) of securities of Amkor Technology Inc, Analog Devices Inc., Astera Labs Inc, Cisco Systems Inc, Dell Technologies Inc., GlobalFoundries Inc, Intel Corporation, Micron Technology Inc., Navitas Semiconductor Corp, Resideo Technologies Inc, Seagate Technology.

Within the last 12 months, Morgan Stanley has received compensation for investment banking services from Amkor Technology Inc, Analog Devices Inc., Astera Labs Inc, AU Optronics, Broadcom Inc., Cisco Systems Inc, Dell Technologies Inc., Intel Corporation, Mabuchi Motor, MediaTek, Micron Technology Inc., Niterra, ON Semiconductor Corp., Qorvo Inc, Resideo Technologies Inc, Seagate Technology, Shinko Electric Industries, Texas Instruments.

In the next 3 months, Morgan Stanley expects to receive or intends to seek compensation for investment banking services from AAC Technologies Holdings, Acer Inc., Advanced Micro Devices, Advantech, Aeva Technologies Inc, Alchip Technologies Ltd, ALPS ALPINE, Ambarella Inc, Amkor Technology Inc, Analog Devices Inc., Andes Technology Corp, Anritsu, Apple, Inc., Arm Holdings plc, ASE Technology Holding Co. Ltd., ASMedia Technology Inc, ASMPT Ltd, Astera Labs Inc, Asustek Computer Inc., AU Optronics, Broadcom Inc., Cadence Design Systems Inc, Catcher Technology, CDW Corporation, Ciena Corporation, Cisco Systems Inc, CMK, Compal Electronics, Daishinku, Dell Technologies Inc., Delta Electronics Inc., E Ink Holdings Inc., Ecopro BM, Garmin Ltd, Giga-Byte Technology Co. Ltd., GlobalFoundries Inc, GlobalWafers Co Ltd, GoerTek Inc, Gold Circuit Electronics Ltd., GoPro Inc, Hamamatsu Photonics, Hewlett Packard Enterprise, Hirose Electric, Hon Hai Precision, HP Inc., HTC Corporation, Ibiden, IBM, Infineon Technologies AG, Innolux, Intel Corporation, IonQ Inc, IRISO Electronics, Japan Aviation Electronics Industry, King Yuan Electronics Co Ltd, KOA, Kornit Digital Ltd., Kyocera, L&F Co Ltd, Legrand, Lenovo, LG Display, LG Electronics, Lite-On Technology, Logitech International SA, Luxshare Precision Industry Co., Ltd., Mabuchi Motor, Maxell, MediaTek, Microchip Technology Inc., Micron Technology Inc., Minebea Mitsumi, Murata Manufacturing, Navitas Semiconductor Corp, NCR Corp., NetApp Inc, Nichicon, Nidec, Nihon Dempa Kogyo, Nippon Chemi-Con, Niterra, Novatek, Nutanix Inc, NVIDIA Corp., NXP Semiconductor NV, ON Semiconductor Corp., Pegatron Corporation, POSCO FUTURE M, Pure Storage Inc, Qorvo Inc, Qualcomm Inc., Quanta Computer Inc., Realtek Semiconductor, Resideo Technologies Inc, Samsung Electronics, Samsung SDI, Seagate Technology, Shenzhen

Transsion Holdings Co Ltd, Shinko Electric Industries, Silergy Corp., Silicon Laboratories Inc., Silicon Motion, SK hynix, Skyworks Solutions Inc, SmartRent, Inc., Sonos Inc., Synopsys Inc., Taiyo Yuden, TCL Corp., TDK, Teradata, Texas Instruments, TSMC, UMC, Unimicron, Universal Scientific Ind. (Shanghai), Vanguard International Semiconductor, Winbond Electronics Corp, Wistron Corporation, Wiwynn Corp, Wolfspeed, INC, WPG Holdings, Xiaomi Corp, Yageo Corp., Zhen Ding, Zhongji Innolight Co Ltd.

Within the last 12 months, Morgan Stanley has received compensation for products and services other than investment banking services from AAC Technologies Holdings, Accton Technology Corporation, Acer Inc., Advanced Micro Devices, Amkor Technology Inc, Analog Devices Inc., Apple, Inc., ASE Technology Holding Co. Ltd., Asustek Computer Inc., AU Optronics, Broadcom Inc., BYD Electronics, Cadence Design Systems Inc, CDW Corporation, Ciena Corporation, Cisco Systems Inc, Compal Electronics, Dell Technologies Inc., Foxconn Technology, Garmin Ltd, Giga-Byte Technology Co. Ltd., GlobalFoundries Inc, GoerTek Inc, GoPro Inc, Hewlett Packard Enterprise, Hon Hai Precision, HP Inc., HTC Corporation, IBM, Infineon Technologies AG, Innolux, Intel Corporation, King Yuan Electronics Co Ltd, Kyocera, Legrand, Lenovo, Marvell Technology Group Ltd, MediaTek, Microchip Technology Inc., Micron Technology Inc., Nanya Technology Corp., NCR Corp., NetApp Inc, Nihon Dempa Kogyo, Novatek, Nutanix Inc, Nuvoton Technology Corporation, NVIDIA Corp., NXP Semiconductor NV, ON Semiconductor Corp., Qorvo Inc, Qualcomm Inc., Quanta Computer Inc., Realtek Semiconductor, Resideo Technologies Inc, Samsung SDI, Seagate Technology, Silicon Laboratories Inc., Silicon Motion, SMIC, Sonos Inc., Synopsys Inc., Texas Instruments, UMC, Universal Scientific Ind. (Shanghai), Western Digital, Winbond Electronics Corp, Xerox Corp, Xiaomi Corp, Yageo Corp..

Within the last 12 months, Morgan Stanley has provided or is providing investment banking services to, or has an investment banking client relationship with, the following company: AAC Technologies Holdings, Acer Inc., Advanced Micro Devices, Advantech, Aeva Technologies Inc, Alchip Technologies Ltd, ALPS ALPINE, Ambarella Inc, Amkor Technology Inc, Analog Devices Inc., Andes Technology Corp, Apple, Inc., Arm Holdings plc, ASE Technology Holding Co. Ltd., ASMedia Technology Inc, ASMPT Ltd, Astera Labs Inc, Asustek Computer Inc., AU Optronics, Broadcom Inc., Cadence Design Systems Inc, Catcher Technology, CDW Corporation, Ciena Corporation, Cisco Systems Inc, CMK, Compal Electronics, Dell Technologies Inc., Delta Electronics Inc., E Ink Holdings Inc., Ecopro BM, Garmin Ltd, Giga-Byte Technology Co. Ltd., GlobalFoundries Inc, GlobalWafers Co Ltd, GoerTek Inc, Gold Circuit Electronics Ltd., GoPro Inc, Hamamatsu Photonics, Hewlett Packard Enterprise, Hon Hai Precision, HP Inc., HTC Corporation, IBM, Infineon Technologies AG, Innolux, Intel Corporation, IonQ Inc, IRISO Electronics, King Yuan Electronics Co Ltd, Kornit Digital Ltd., Kyocera, L&F Co Ltd, Legrand, Lenovo, LG Display, LG Electronics, Lite-On Technology, Logitech International SA, Luxshare Precision Industry Co., Ltd., MediaTek, Microchip Technology Inc., Micron Technology Inc., Minebea Mitsumi, Murata Manufacturing, Navitas Semiconductor Corp, NCR Corp., NetApp Inc, Nidec, Novatek, Nutanix Inc, NVIDIA Corp., NXP Semiconductor NV, ON Semiconductor Corp., Pegatron Corporation, POSCO FUTURE M, Pure Storage Inc, Qorvo Inc, Qualcomm Inc., Quanta Computer Inc., Realtek Semiconductor, Resideo Technologies Inc, Samsung Electronics, Samsung SDI, Seagate Technology, Shenzhen Transsion Holdings Co Ltd, Shinko Electric Industries, Silergy Corp., Silicon Laboratories Inc., Silicon Motion, SK hynix, Skyworks Solutions Inc, SmartRent, Inc., Sonos Inc., Synopsys Inc., TCL Corp., TDK, Teradata, Texas Instruments, TSMC, UMC, Unimicron, Universal Scientific Ind. (Shanghai), Vanguard International Semiconductor, Winbond Electronics Corp, Wistron Corporation, Wiwynn Corp, Wolfspeed, INC, WPG Holdings, Xiaomi Corp, Yageo Corp., Zhen Ding, Zhongji Innolight Co Ltd.

Within the last 12 months, Morgan Stanley has either provided or is providing non-investment banking, securities-related services to and/or in the past has entered into an agreement to provide services or has a client relationship with the following company: AAC Technologies Holdings, Accton Technology Corporation, Acer Inc., Advanced Micro Devices, ALPS ALPINE, Ambarella Inc, Amkor Technology Inc, Analog Devices Inc., Apple, Inc., ASE Technology Holding Co. Ltd., Asustek Computer Inc., AU Optronics, Broadcom Inc., BYD Electronics, Cadence Design Systems Inc, CDW Corporation, Ciena Corporation, Cisco Systems Inc, Compal Electronics, Dell Technologies Inc., Foxconn Technology, Garmin Ltd, Giga-Byte Technology Co. Ltd., GlobalFoundries Inc, GoerTek Inc, GoPro Inc, Hewlett Packard Enterprise, Hon Hai Precision, HP Inc., HTC Corporation, IBM, Infineon Technologies AG, Innolux, Intel Corporation, Japan Aviation Electronics Industry, King Yuan Electronics Co Ltd, Kyocera, Legrand, Lenovo, Marvell Technology Group Ltd, MediaTek, Microchip Technology Inc., Micron Technology Inc., Murata Manufacturing, Nanya Technology Corp., NCR Corp., NetApp Inc, Nihon Dempa Kogyo, Niterra, Novatek, Nutanix Inc, Nuvoton Technology Corporation, NVIDIA Corp., NXP Semiconductor NV, ON Semiconductor Corp., Pure Storage Inc, Qorvo Inc, Qualcomm Inc., Quanta Computer Inc., Realtek Semiconductor, Resideo Technologies Inc, Samsung SDI, Seagate Technology, Silicon Laboratories Inc., Silicon Motion, SMIC, Sonos Inc., Synopsys Inc., Texas Instruments, TSMC, UMC, Universal Scientific Ind. (Shanghai), Western Digital, Winbond Electronics Corp, Wolfspeed, INC, Xerox Corp, Xiaomi Corp, Yageo Corp..

An employee, director or consultant of Morgan Stanley is a director of HP Inc.. This person is not a research analyst or a member of a research analyst's household.

Morgan Stanley & Co. LLC makes a market in the securities of ACM Research Inc, Advanced Micro Devices, Ambarella Inc, Amkor Technology Inc, Analog Devices Inc., Apple, Inc., ASE Technology Holding Co. Ltd., Astera Labs Inc, Broadcom Inc., Cadence Design Systems Inc, CDW Corporation, Ciena Corporation, Cisco Systems Inc, Cricut Inc, Garmin Ltd, GlobalFoundries Inc, GoPro Inc, Hewlett Packard Enterprise, HP Inc., IBM, Intel Corporation, Kornit Digital Ltd., LG Display, Logitech International SA, Marvell Technology Group Ltd, Microchip Technology Inc., Micron Technology Inc., Navitas Semiconductor Corp, NCR Corp., NetApp Inc, Nutanix Inc, NVIDIA Corp., NXP Semiconductor NV, ON Semiconductor Corp., Pure Storage Inc, Qorvo Inc, Qualcomm Inc., Resideo Technologies Inc, Seagate Technology, Silicon Laboratories Inc., Silicon Motion, Skyworks Solutions Inc, Sonos Inc., Synopsys Inc., Teradata, Texas Instruments, TSMC, UMC, Western Digital, Wolfspeed, INC, Xerox Corp.

The equity research analysts or strategists principally responsible for the preparation of Morgan Stanley Research have received compensation based upon various factors, including quality of research, investor client feedback, stock picking, competitive factors, firm revenues and overall investment banking revenues. Equity Research analysts' or strategists' compensation is not linked to investment banking or capital markets transactions performed by Morgan Stanley or the profitability or revenues of particular trading desks.

Morgan Stanley and its affiliates do business that relates to companies/instruments covered in Morgan Stanley Research, including market making, providing liquidity, fund management, commercial banking, extension of credit, investment services and investment banking. Morgan Stanley sells to and buys from customers the securities/instruments of companies covered in Morgan Stanley Research on a principal basis. Morgan Stanley may have a position in the debt of the Company or instruments discussed in this report. Morgan Stanley trades or may trade as principal in the debt securities (or in related derivatives) that are the subject of the debt research report.

Certain disclosures listed above are also for compliance with applicable regulations in non-US jurisdictions.

STOCK RATINGS

Morgan Stanley uses a relative rating system using terms such as Overweight, Equal-weight, Not-Rated or Underweight (see definitions below). Morgan Stanley does not assign ratings of Buy, Hold or Sell to the stocks we cover. Overweight, Equal-weight, Not-Rated and Underweight are not the equivalent of buy, hold and sell. Investors should carefully read the definitions of all ratings used in Morgan Stanley Research. In addition, since Morgan Stanley Research contains more complete information concerning the analyst's views, investors should carefully read Morgan Stanley Research, in its entirety, and not infer the contents from the rating alone. In any case, ratings (or research) should not be used or relied upon as investment advice. An investor's decision to buy or sell a stock should depend on individual circumstances (such as the investor's existing holdings) and other considerations.

Global Stock Ratings Distribution

(as of July 31, 2024)

The Stock Ratings described below apply to Morgan Stanley's Fundamental Equity Research and do not apply to Debt Research produced by the Firm.

For disclosure purposes only (in accordance with FINRA requirements), we include the category headings of Buy, Hold, and Sell alongside our ratings of Overweight, Equal-weight, Not-Rated and Underweight. Morgan Stanley does not assign ratings of Buy, Hold or Sell to the stocks we cover. Overweight, Equal-weight, Not-Rated and Underweight are not the equivalent of buy,

hold, and sell but represent recommended relative weightings (see definitions below). To satisfy regulatory requirements, we correspond Overweight, our most positive stock rating, with a buy recommendation; we correspond Equal-weight and Not-Rated to hold and Underweight to sell recommendations, respectively.

	Coverage Universe		Investment Banking Clients (IBC)			Other Material Investment Services Clients (MISC)	
Stock Rating Category	Count	% of Total	Count	% of Total IBC	% of Rating Category	Count	% of Total Other MISC
Overweight/Buy	1427	38%	335	44%	23%	663	40%
Equal-weight/Hold	1740	46%	347	46%	20%	779	46%
Not-Rated/Hold	3	0%	0	0%	0%	1	0%
Underweight/Sell	585	16%	76	10%	13%	233	14%
Total	3,755		758			1676	

Data include common stock and ADRs currently assigned ratings. Investment Banking Clients are companies from whom Morgan Stanley received investment banking compensation in the last 12 months. Due to rounding off of decimals, the percentages provided in the "% of total" column may not add up to exactly 100 percent.

Analyst Stock Ratings

Overweight (O or Over) - The stock's total return is expected to exceed the total return of the relevant country MSCI Index or the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis over the next 12-18 months.
Equal-weight (E or Equal) - The stock's total return is expected to be in line with the total return of the relevant country MSCI Index or the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis over the next 12-18 months.
Not-Rated (NR) - Currently the analyst does not have adequate conviction about the stock's total return relative to the relevant country MSCI Index or the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.
Underweight (U or Under) - The stock's total return is expected to be below the total return of the relevant country MSCI Index or the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.
Unless otherwise specified, the time frame for price targets included in Morgan Stanley Research is 12 to 18 months.

Analyst Industry Views

Attractive (A): The analyst expects the performance of his or her industry coverage universe over the next 12-18 months to be attractive vs. the relevant broad market benchmark, as indicated below.
In-Line (I): The analyst expects the performance of his or her industry coverage universe over the next 12-18 months to be in line with the relevant broad market benchmark, as indicated below.
Cautious (C): The analyst views the performance of his or her industry coverage universe over the next 12-18 months with caution vs. the relevant broad market benchmark, as indicated below.
Benchmarks for each region are as follows: North America - S&P 500; Latin America - relevant MSCI country index or MSCI Latin America Index; Europe - MSCI Europe; Japan - TOPIX; Asia - relevant MSCI country index or MSCI sub-regional index or MSCI AC Asia Pacific ex Japan Index.

Important Disclosures for Morgan Stanley Smith Barney LLC & E*TRADE Securities LLC Customers

Important disclosures regarding the relationship between the companies that are the subject of Morgan Stanley Research and Morgan Stanley Smith Barney LLC or Morgan Stanley or any of their affiliates, are available on the Morgan Stanley Wealth Management disclosure website at www.morganstanley.com/online/researchdisclosures. For Morgan Stanley specific disclosures, you may refer to www.morganstanley.com/researchdisclosures.
Each Morgan Stanley research report is reviewed and approved on behalf of Morgan Stanley Smith Barney LLC and E*TRADE Securities LLC. This review and approval is conducted by the same person who reviews the research report on behalf of Morgan Stanley. This could create a conflict of interest.

Other Important Disclosures

Morgan Stanley & Co. International PLC and its affiliates have a significant financial interest in the debt securities of Advanced Micro Devices, Analog Devices Inc., Apple, Inc., Broadcom Inc., Cisco Systems Inc, GlobalFoundries Inc, Hewlett Packard Enterprise, Hon Hai Precision, HP Inc., IBM, Intel Corporation, L&F Co Ltd, Lenovo, Microchip Technology Inc., Micron Technology Inc., NCR Corp., NetApp Inc, Nichicon, Nidec, NVIDIA Corp., ON Semiconductor Corp., Qorvo Inc, Qualcomm Inc., SK hynix, Sonos Inc., Taiyo Yuden, Texas Instruments, TSMC, UMC, Western Digital, Wiwynn Corp, Wolfspeed, INC, Xerox Corp, Zhen Ding.
A member of Research who had or could have had access to the research prior to completion owns securities (or related derivatives) in the Cisco Systems Inc, NVIDIA Corp.. This person is not a research analyst or a member of research analyst's household.
Morgan Stanley Research policy is to update research reports as and when the Research Analyst and Research Management deem appropriate, based on developments with the issuer, the sector, or the market that may have a material impact on the research views or opinions stated therein. In addition, certain Research publications are intended to be updated on a regular periodic basis (weekly/monthly/quarterly/annual) and will ordinarily be updated with that frequency, unless the Research Analyst and Research Management determine that a different publication schedule is appropriate based on current conditions.
Morgan Stanley is not acting as a municipal advisor and the opinions or views contained herein are not intended to be, and do not constitute, advice within the meaning of Section 975 of the Dodd-Frank Wall Street Reform and Consumer Protection Act.
Morgan Stanley produces an equity research product called a "Tactical Idea." Views contained in a "Tactical Idea" on a particular stock may be contrary to the recommendations or views expressed in research on the same stock. This may be the result of differing time horizons, methodologies, market events, or other factors. For all research available on a particular stock, please contact your sales representative or go to Matrix at http://www.morganstanley.com/matrix.
Morgan Stanley Research is provided to our clients through our proprietary research portal on Matrix and also distributed electronically by Morgan Stanley to clients. Certain, but not all, Morgan Stanley Research products are also made available to clients through third-party vendors or redistributed to clients through alternate electronic means as a convenience. For access to all available Morgan Stanley Research, please contact your sales representative or go to Matrix at http://www.morganstanley.com/matrix.

Any access and/or use of Morgan Stanley Research is subject to Morgan Stanley's Terms of Use (http://www.morganstanley.com/terms.html). By accessing and/or using Morgan Stanley Research, you are indicating that you have read and agree to be bound by our Terms of Use (http://www.morganstanley.com/terms.html). In addition you consent to Morgan Stanley processing your personal data and using cookies in accordance with our Privacy Policy and our Global Cookies Policy (http://www.morganstanley.com/privacy_pledge.html), including for the purposes of setting your preferences and to collect readership data so that we can deliver better and more personalized service and products to you. To find out more information about how Morgan Stanley processes personal data, how we use cookies and how to reject cookies see our Privacy Policy and our Global Cookies Policy (http://www.morganstanley.com/privacy_pledge.html).

If you do not agree to our Terms of Use and/or if you do not wish to provide your consent to Morgan Stanley processing your personal data or using cookies please do not access our research.

Morgan Stanley Research does not provide individually tailored investment advice. Morgan Stanley Research has been prepared without regard to the circumstances and objectives of those who receive it. Morgan Stanley recommends that investors independently evaluate particular investments and strategies, and encourages investors to seek the advice of a financial adviser. The appropriateness of an investment or strategy will depend on an investor's circumstances and objectives. The securities, instruments, or strategies discussed in Morgan Stanley Research may not be suitable for all investors, and certain investors may not be eligible to purchase or participate in some or all of them. Morgan Stanley Research is not an offer to buy or sell or the solicitation of an offer to buy or sell any security/instrument or to participate in any particular trading strategy. The value of and income from your investments may vary because of changes in interest rates, foreign exchange rates, default rates, prepayment rates, securities/instruments prices, market indexes, operational or financial conditions of companies or other factors. There may be time limitations on the exercise of options or other rights in securities/instruments transactions. Past performance is not necessarily a guide to future performance. Estimates of future performance are based on assumptions that may not be realized. If provided, and unless otherwise stated, the closing price on the cover page is that of the primary exchange for the subject company's securities/instruments.

The fixed income research analysts, strategists or economists principally responsible for the preparation of Morgan Stanley Research have received compensation based upon various factors, including quality, accuracy and value of research, firm profitability or revenues (which include fixed income trading and capital markets profitability or revenues), client feedback and competitive factors. Fixed Income Research analysts', strategists' or economists' compensation is not linked to investment banking or capital markets transactions performed by Morgan Stanley or the profitability or revenues of particular trading desks.

The "Important Regulatory Disclosures on Subject Companies" section in Morgan Stanley Research lists all companies mentioned where Morgan Stanley owns 1% or more of a class of common equity securities of the companies. For all other companies mentioned in Morgan Stanley Research, Morgan Stanley may have an investment of less than 1% in securities/instruments or derivatives of securities/instruments of companies and may trade them in ways different from those discussed in Morgan Stanley Research. Employees of Morgan Stanley not involved in the preparation of Morgan Stanley Research may have investments in securities/instruments or derivatives of securities/instruments of companies mentioned and may trade them in ways different from those discussed in Morgan Stanley Research. Derivatives may be issued by Morgan Stanley or associated persons.

With the exception of information regarding Morgan Stanley, Morgan Stanley Research is based on public information. Morgan Stanley makes every effort to use reliable, comprehensive information, but we make no representation that it is accurate or complete. We have no obligation to tell you when opinions or information in Morgan Stanley Research change apart from when we intend to discontinue equity research coverage of a subject company. Facts and views presented in Morgan Stanley Research have not been reviewed by, and may not reflect information known to, professionals in other Morgan Stanley business areas, including investment banking personnel.

Morgan Stanley Research personnel may participate in company events such as site visits and are generally prohibited from accepting payment by the company of associated expenses unless pre-approved by authorized members of Research management.

Morgan Stanley may make investment decisions that are inconsistent with the recommendations or views in this report.

To our readers based in Taiwan or trading in Taiwan securities/instruments: Information on securities/instruments that trade in Taiwan is distributed by Morgan Stanley Taiwan Limited ("MSTL"). Such information is for your reference only. The reader should independently evaluate the investment risks and is solely responsible for their investment decisions. Morgan Stanley Research may not be distributed to the public media or quoted or used by the public media without the express written consent of Morgan Stanley. Any non-customer reader within the scope of Article 7-1 of the Taiwan Stock Exchange Recommendation Regulations accessing and/or receiving Morgan Stanley Research is not permitted to provide Morgan Stanley Research to any third party (including but not limited to related parties, affiliated companies and any other third parties) or engage in any activities regarding Morgan Stanley Research which may create or give the appearance of creating a conflict of interest. Information on securities/instruments that do not trade in Taiwan is for informational purposes only and is not to be construed as a recommendation or a solicitation to trade in such securities/instruments. MSTL may not execute transactions for clients in these securities/instruments.

Certain information in Morgan Stanley Research was sourced by employees of the Shanghai Representative Office of Morgan Stanley Asia Limited for the use of Morgan Stanley Asia Limited. Morgan Stanley is not incorporated under PRC law and the research in relation to this report is conducted outside the PRC. Morgan Stanley Research does not constitute an offer to sell or the solicitation of an offer to buy any securities in the PRC. PRC investors shall have the relevant qualifications to invest in such securities and shall be responsible for obtaining all relevant approvals, licenses, verifications and/or registrations from the relevant governmental authorities themselves. Neither this report nor any part of it is intended as, or shall constitute, provision of any consultancy or advisory service of securities investment as defined under PRC law. Such information is provided for your reference only.

Morgan Stanley Research is disseminated in Brazil by Morgan Stanley C.T.V.M. S.A. located at Av. Brigadeiro Faria Lima, 3600, 6th floor, São Paulo - SP, Brazil; and is regulated by the Comissão de Valores Mobiliários; in Mexico by Morgan Stanley México, Casa de Bolsa, S.A. de C.V which is regulated by Comision Nacional Bancaria y de Valores. Paseo de los Tamarindos 90, Torre 1, Col. Bosques de las Lomas Floor 29, 05120 Mexico City; in Japan by Morgan Stanley MUFG Securities Co., Ltd. and, for Commodities related research reports only, Morgan Stanley Capital Group Japan Co., Ltd; in Hong Kong by Morgan Stanley Asia Limited (which accepts responsibility for its contents) and by Morgan Stanley Bank Asia Limited; in Singapore by Morgan Stanley Asia (Singapore) Pte. (Registration number 199206298Z) and/or Morgan Stanley Asia (Singapore) Securities Pte Ltd (Registration number 200008434H), regulated by the Monetary Authority of Singapore (which accepts legal responsibility for its contents and should be contacted with respect to any matters arising from, or in connection with, Morgan Stanley Research) and by Morgan Stanley Bank Asia Limited, Singapore Branch (Registration number T14FC0118J); in Australia to "wholesale clients" within the meaning of the Australian Corporations Act by Morgan Stanley Australia Limited A.B.N. 67 003 734 576, holder of Australian financial services license No. 233742, which accepts responsibility for its contents; in Australia to "wholesale clients" and "retail clients" within the meaning of the Australian Corporations Act by Morgan Stanley Wealth Management Australia Pty Ltd (A.B.N. 19 009 145 555, holder of Australian financial services license No. 240813, which accepts responsibility for its contents; in Korea by Morgan Stanley & Co International plc, Seoul Branch; in India by Morgan Stanley India Company Private Limited having Corporate Identification No (CIN) U22990MH1998PTC115305, regulated by the Securities and Exchange Board of India ("SEBI") and holder of licenses as a Research Analyst (SEBI Registration No. INH000001105); Stock Broker (SEBI Stock Broker Registration No. INZ000244438), Merchant Banker (SEBI Registration No. INM000011203), and depository participant with National Securities Depository Limited (SEBI Registration No. IN-DP-NSDL-567-2021) having registered office at 18th Floor, Tower 2, One World Center, Plot- 841, Jupiter Textile Mill Compound, Senapati Bapat Marg, Lower Parel, Mumbai 400013, India Telephone no. +91-22-61181000; Compliance Officer Details: Mr. Tejarshi Hardas, Tel. No.: +91-22-61181000 or Email: tejarshi.hardas@morganstanley.com; Grievance officer details: Mr. Tejarshi Hardas, Tel. No.: +91-22-61181000 or Email: msic-compliance@morganstanley.com; in Canada by Morgan Stanley Canada Limited; in Germany and the European Economic Area where required by Morgan Stanley Europe S.E., authorised and regulated by Bundesanstalt fuer Finanzdienstleistungsaufsicht (BaFin) under the reference number 149169; in the US by Morgan Stanley & Co. LLC, which accepts responsibility for its contents. Morgan Stanley & Co. International plc, authorized by the Prudential Regulation Authority and regulated by the Financial Conduct Authority and the Prudential Regulation Authority, disseminates in the UK research that it has prepared, and research which has been prepared by any

of its affiliates, only to persons who (i) are investment professionals falling within Article 19(5) of the Financial Services and Markets Act 2000 (Financial Promotion) Order 2005 (as amended, the "Order"); (ii) are persons who are high net worth entities falling within Article 49(2)(a) to (d) of the Order; or (iii) are persons to whom an invitation or inducement to engage in investment activity (within the meaning of section 21 of the Financial Services and Markets Act 2000, as amended) may otherwise lawfully be communicated or caused to be communicated. RMB Morgan Stanley Proprietary Limited is a member of the JSE Limited and A2X (Pty) Ltd. RMB Morgan Stanley Proprietary Limited is a joint venture owned equally by Morgan Stanley International Holdings Inc. and RMB Investment Advisory (Proprietary) Limited, which is wholly owned by FirstRand Limited. The information in Morgan Stanley Research is being disseminated by Morgan Stanley Saudi Arabia, regulated by the Capital Market Authority in the Kingdom of Saudi Arabia, and is directed at Sophisticated investors only.

Morgan Stanley Hong Kong Securities Limited is the liquidity provider/market maker for securities of AAC Technologies Holdings, BYD Electronics, Hua Hong Semiconductor Ltd, Lenovo, Sunny Optical, Xiaomi Corp, ZTE Corporation listed on the Stock Exchange of Hong Kong Limited. An updated list can be found on HKEx website: http://www.hkex.com.hk.

The information in Morgan Stanley Research is being communicated by Morgan Stanley & Co. International plc (DIFC Branch), regulated by the Dubai Financial Services Authority (the DFSA) or by Morgan Stanley & Co. International plc (ADGM Branch), regulated by the Financial Services Regulatory Authority Abu Dhabi (the FSRA), and is directed at Professional Clients only, as defined by the DFSA or the FSRA, respectively. The financial products or financial services to which this research relates will only be made available to a customer who we are satisfied meets the regulatory criteria of a Professional Client. A distribution of the different MS Research ratings or recommendations, in percentage terms for Investments in each sector covered, is available upon request from your sales representative.

The information in Morgan Stanley Research is being communicated by Morgan Stanley & Co. International plc (QFC Branch), regulated by the Qatar Financial Centre Regulatory Authority (the QFCRA), and is directed at business customers and market counterparties only and is not intended for Retail Customers as defined by the QFCRA.

As required by the Capital Markets Board of Turkey, investment information, comments and recommendations stated here, are not within the scope of investment advisory activity. Investment advisory service is provided exclusively to persons based on their risk and income preferences by the authorized firms. Comments and recommendations stated here are general in nature. These opinions may not fit to your financial status, risk and return preferences. For this reason, to make an investment decision by relying solely to this information stated here may not bring about outcomes that fit your expectations.

The following companies do business in countries which are generally subject to comprehensive sanctions programs administered or enforced by the U.S. Department of the Treasury's Office of Foreign Assets Control ("OFAC") and by other countries and multi-national bodies: Samsung Electronics.

Indicators and trackers referenced in Morgan Stanley Research may not be used as, or treated as, a benchmark under Regulation EU 2016/1011, or any other similar framework.

The issuers and/or fixed income products recommended or discussed in certain fixed income research reports may not be continuously followed. Accordingly, investors should regard those fixed income research reports as providing stand-alone analysis and should not expect continuing analysis or additional reports relating to such issuers and/or individual fixed income products.

Morgan Stanley may hold, from time to time, material financial and commercial interests regarding the company subject to the Research report.

Registration granted by SEBI and certification from the National Institute of Securities Markets (NISM) in no way guarantee performance of the intermediary or provide any assurance of returns to investors. Investment in securities market are subject to market risks. Read all the related documents carefully before investing.

INDUSTRY COVERAGE: Greater China Technology Semiconductors

COMPANY (TICKER)	RATING (AS OF)	PRICE* (08/02/2024)
Charlie Chan		
ACM Research Inc (ACMR.O)	O (03/07/2023)	US$15.64
Advanced Micro-Fabrication Equipment Inc (688012.SS)	O (11/06/2023)	Rmb158.60
Alchip Technologies Ltd (3661.TW)	O (05/14/2021)	NT$2,335.00
Andes Technology Corp (6533.TW)	O (08/04/2022)	NT$352.00
ASE Technology Holding Co. Ltd. (3711.TW)	E (06/25/2024)	NT$143.50
Global Unichip Corp (3443.TW)	O (07/27/2024)	NT$1,060.00
Jiangsu Changjiang Electronics Tech (600584.SS)	E (07/07/2023)	Rmb32.22
King Yuan Electronics Co Ltd (2449.TW)	O (03/03/2023)	NT$103.50
MediaTek (2454.TW)	O (09/12/2023)	NT$1,090.00
Nanya Technology Corp. (2408.TW)	U (11/06/2023)	NT$54.90
Phison Electronics Corp (8299.TWO)	E (05/13/2024)	NT$492.50
Silergy Corp. (6415.TW)	U (05/20/2021)	NT$417.00
SMIC (0981.HK)	U (02/22/2023)	HK$16.70
TSMC (2330.TW)	O (02/07/2022)	NT$903.00
UMC (2303.TW)	O (09/14/2020)	NT$52.90
Vanguard International Semiconductor (5347.TWO)	E (06/13/2024)	NT$117.50
Will Semiconductor Co Ltd Shanghai (603501.SS)	O (07/07/2023)	Rmb99.01
Daisy Dai, CFA		
ASMPT Ltd (0522.HK)	O (06/12/2023)	HK$78.00
Elan Microelectronics Corp (2458.TW)	O (04/29/2024)	NT$139.00

Empyrean Technology Co Ltd (301269.SZ)	O (06/26/2023)	Rmb79.19
Hangzhou Silan Microelectronics Co. Ltd. (600460.SS)	E (04/09/2024)	Rmb23.25
Shanghai Anlogic Infotech Co Ltd (688107.SS)	E (05/14/2024)	Rmb22.60
Shanghai Fudan Microelectronics (1385.HK)	E (10/18/2022)	HK$11.38
Unigroup Guoxin Microelectronics Co Ltd (002049.SZ)	U (01/10/2023)	Rmb52.29
Universal Scientific Ind. (Shanghai) (601231.SS)	O (05/27/2024)	Rmb15.04
Yangjie Technology (300373.SZ)	O (06/10/2022)	Rmb42.06
Daniel Yen, CFA		
AP Memory Technology Corp (6531.TW)	O (09/04/2023)	NT$307.50
ASMedia Technology Inc (5269.TW)	O (01/23/2024)	NT$1,510.00
Aspeed Technology (5274.TWO)	O (11/08/2023)	NT$3,745.00
Egis Technology Inc (6462.TWO)	E (03/26/2024)	NT$234.00
Espressif Systems (688018.SS)	O (05/15/2023)	Rmb110.31
GigaDevice Semiconductor Beijing Inc (603986.SS)	E (08/14/2023)	Rmb83.06
Macronix International Co Ltd (2337.TW)	U (10/19/2021)	NT$28.15
Montage Technology Co Ltd (688008.SS)	O (11/08/2023)	Rmb56.60
Novatek (3034.TW)	O (03/18/2024)	NT$521.00
Nuvoton Technology Corporation (4919.TW)	U (08/02/2024)	NT$100.50
Parade Technologies Ltd (4966.TWO)	U (06/04/2024)	NT$738.00
Realtek Semiconductor (2379.TW)	O (02/22/2023)	NT$500.00
Shenzhen Goodix Technology Co Ltd (603160.SS)	E (06/12/2024)	Rmb61.35
Sino Wealth Electronic (300327.SZ)	E (03/18/2024)	Rmb19.89
Winbond Electronics Corp (2344.TW)	E (06/04/2024)	NT$23.20
WPG Holdings (3702.TW)	E (11/16/2023)	NT$85.00
Dylan Liu		
M31 Technology Corp (6643.TWO)	O (06/26/2023)	NT$1,040.00
Ray Wu, CFA		
Advanced Wireless Semiconductor Co (8086.TWO)	O (09/11/2023)	NT$105.50
China Resources Microelectronics Limited (688396.SS)	U (07/08/2022)	Rmb39.39
Episil Technologies Inc (3707.TWO)	O (06/05/2023)	NT$58.70
GlobalWafers Co Ltd (6488.TWO)	E (02/22/2023)	NT$503.00
Hua Hong Semiconductor Ltd (1347.HK)	O (06/13/2024)	HK$19.34
Maxscend Microelectronics Co Ltd (300782.SZ)	U (01/11/2021)	Rmb74.02
NAURA Technology Group Co Ltd (002371.SZ)	O (11/06/2023)	Rmb336.93
Powerchip Semiconductor Manufacturing Co (6770.TW)	E (06/13/2024)	NT$23.20
RichWave Technology Corp. (4968.TW)	O (07/05/2024)	NT$196.00
SG Micro Corp. (300661.SZ)	O (06/17/2024)	Rmb75.36
SICC Co Ltd (688234.SS)	O (09/18/2023)	Rmb52.99
Silicon Motion (SIMO.O)	O (05/06/2024)	US$62.50
StarPower Semiconductor Ltd (603290.SS)	O (03/01/2022)	Rmb89.60
UPI Semiconductor Corp. (6719.TW)	E (04/18/2023)	NT$249.00
WIN Semiconductors Corp (3105.TWO)	O (06/28/2024)	NT$130.00

Stock Ratings are subject to change. Please see latest research for each company.
* Historical prices are not split adjusted.

INDUSTRY COVERAGE: Electronic Components

COMPANY (TICKER)	RATING (AS OF)	PRICE* (08/02/2024)
Akihiko Uchino		
Anritsu (6754.T)	E (03/07/2024)	¥1,044
Maxell (6810.T)	O (03/07/2024)	¥1,581
Shoji Sato		
ALPS ALPINE (6770.T)	++	¥1,447
Hamamatsu Photonics (6965.T)	O (08/21/2023)	¥4,186

Hirose Electric (6806.T)	O (07/10/2024)	¥17,345
Ibiden (4062.T)	U (01/17/2024)	¥5,061
IRISO Electronics (6908.T)	E (08/02/2022)	¥2,855
Japan Aviation Electronics Industry (6807.T)	E (01/17/2024)	¥2,187
Kyocera (6971.T)	E (06/25/2020)	¥1,720
Mabuchi Motor (6592.T)	E (11/03/2022)	¥2,198
Minebea Mitsumi (6479.T)	E (04/10/2024)	¥3,181
Murata Manufacturing (6981.T)	O (04/11/2022)	¥2,989
Nichicon (6996.T)	E (11/10/2021)	¥1,039
Nidec (6594.T)	E (01/24/2023)	¥6,266
Nippon Chemi-Con (6997.T)	E (07/09/2021)	¥1,302
Niterra (5334.T)	O (01/17/2024)	¥3,931
Shinko Electric Industries (6967.T)	++	¥5,657
Taiyo Yuden (6976.T)	E (10/19/2023)	¥4,066
TDK (6762.T)	O (08/02/2022)	¥9,331
Sota Harashima		
CMK (6958.T)	O (03/07/2024)	¥472
Daishinku (6962.T)	E (03/07/2024)	¥662
KOA (6999.T)	E (05/08/2024)	¥1,223
Nihon Dempa Kogyo (6779.T)	E (03/07/2024)	¥1,231

Stock Ratings are subject to change. Please see latest research for each company.
* Historical prices are not split adjusted.

INDUSTRY COVERAGE: Greater China Technology Hardware

COMPANY (TICKER)	RATING (AS OF)	PRICE* (08/02/2024)
Andy Meng, CFA		
AAC Technologies Holdings (2018.HK)	O (01/29/2024)	HK$27.55
Accelink Technologies Co. Ltd. (002281.SZ)	U (05/12/2022)	Rmb32.01
BYD Electronics (0285.HK)	O (04/28/2023)	HK$29.30
China TransInfo Technology Co Ltd (002373.SZ)	E (07/18/2023)	Rmb8.69
Dahua Technology Co. Ltd. (002236.SZ)	U (07/18/2023)	Rmb14.71
Eoptolink Technology Inc Ltd (300502.SZ)	E (05/16/2024)	Rmb92.41
Genius Electronic Optical Co. Ltd. (3406.TW)	O (05/16/2023)	NT$503.00
Gosuncn Technology Group Co Ltd (300098.SZ)	U (11/07/2022)	Rmb4.38
HIKVision Digital Technology (002415.SZ)	O (11/02/2015)	Rmb28.38
Largan Precision (3008.TW)	O (01/31/2024)	NT$2,770.00
LianChuang Electronic Technology Co Ltd (002036.SZ)	U (06/12/2024)	Rmb6.68
OFILM Group Co Ltd (002456.SZ)	U (06/12/2024)	Rmb7.99
Q Technology (Group) Company Ltd (1478.HK)	E (11/10/2023)	HK$4.17
Quectel Wireless Solutions Co Ltd (603236.SS)	O (11/07/2022)	Rmb44.39
Shenzhen Transsion Holdings Co Ltd (688036.SS)	O (10/24/2023)	Rmb75.94
Sunny Optical (2382.HK)	O (05/16/2023)	HK$41.95
Suzhou TFC Optical Communication Co Ltd. (300394.SZ)	U (05/16/2024)	Rmb91.00
Wingtech Technology Co Ltd (600745.SS)	E (11/10/2023)	Rmb29.00
Xiaomi Corp (1810.HK)	O (04/14/2021)	HK$16.08
Yangtze Optical Fibre and Cable JSC Ltd (601869.SS)	U (10/13/2021)	Rmb23.23
Yangtze Optical Fibre and Cable JSC Ltd (6869.HK)	E (04/20/2023)	HK$7.85
Yongxin Optics Co Ltd (603297.SS)	E (11/15/2022)	Rmb57.45
YuTong Optical Technology Co Ltd (300790.SZ)	E (04/05/2022)	Rmb13.19
Zhejiang Crystal-Optech Co Ltd (002273.SZ)	O (11/15/2022)	Rmb17.86
Zhongji Innolight Co Ltd (300308.SZ)	O (11/06/2023)	Rmb118.98
ZTE Corporation (0763.HK)	E (03/11/2024)	HK$16.92
ZTE Corporation (000063.SZ)	U (07/02/2021)	Rmb26.61
Derrick Yang		

Accton Technology Corporation (2345.TW)	O (06/06/2024)	NT$496.00
Advantech (2395.TW)	O (01/20/2021)	NT$347.00
AirTAC International (1590.TW)	E (08/04/2022)	NT$827.00
AU Optronics (2409.TW)	U (04/23/2024)	NT$17.75
BOE Technology (000725.SZ)	O (09/06/2019)	Rmb3.87
BOE Varitronix Ltd (0710.HK)	O (06/20/2023)	HK$4.27
Chroma Ate Inc. (2360.TW)	O (10/05/2021)	NT$298.50
E Ink Holdings Inc. (8069.TWO)	O (06/10/2024)	NT$268.00
Ennostar Inc (3714.TW)	U (09/23/2022)	NT$40.75
GIS Holding Limited (6456.TW)	E (05/06/2023)	NT$63.40
Hiwin Technologies Corp. (2049.TW)	E (08/11/2023)	NT$203.50
Innolux (3481.TW)	E (04/23/2024)	NT$15.30
King Slide Works Co. Ltd. (2059.TW)	O (11/08/2023)	NT$1,065.00
Lens Technology (300433.SZ)	E (07/22/2020)	Rmb17.74
Leyard Optoelectronic Co Ltd (300296.SZ)	E (11/03/2020)	Rmb4.29
Radiant Opto-Electronics Corporation (6176.TW)	E (03/01/2024)	NT$179.50
Sanan Optoelectronics (600703.SS)	U (08/21/2023)	Rmb11.72
TCL Corp. (000100.SZ)	E (06/11/2019)	Rmb3.85
Tianma Microelectronics (000050.SZ)	U (01/24/2018)	Rmb6.95
Wuhan Jingce Electronic Group Co Ltd (300567.SZ)	E (11/26/2021)	Rmb59.71
Howard Kao		
Acer Inc. (2353.TW)	E (05/01/2023)	NT$44.75
Asustek Computer Inc. (2357.TW)	O (05/22/2024)	NT$472.00
Compal Electronics (2324.TW)	E (05/01/2023)	NT$31.65
Giga-Byte Technology Co. Ltd. (2376.TW)	O (12/15/2022)	NT$262.50
Gold Circuit Electronics Ltd. (2368.TW)	O (10/06/2022)	NT$207.50
Guangdong Fenghua Adv. Tech. (Hldg) Co (000636.SZ)	E (05/12/2021)	Rmb14.11
Inspur Electronic Information (000977.SZ)	E (08/28/2023)	Rmb36.00
Kinsus Interconnect Tech. (3189.TW)	U (12/21/2022)	NT$104.50
Lenovo (0992.HK)	++	HK$9.69
Lotes Co. Ltd. (3533.TW)	O (10/06/2022)	NT$1,415.00
Nan Ya PCB (8046.TW)	U (12/21/2022)	NT$156.00
Pegatron Corporation (4938.TW)	E (03/07/2022)	NT$103.00
Quanta Computer Inc. (2382.TW)	O (05/01/2023)	NT$266.00
Shengyi Technology Co Ltd. (600183.SS)	E (05/26/2022)	Rmb18.87
Shennan Circuits Co Ltd (002916.SZ)	E (08/24/2023)	Rmb111.00
Unimicron (3037.TW)	U (02/22/2023)	NT$166.00
Wistron Corporation (3231.TW)	O (07/12/2023)	NT$96.30
Wiwynn Corp (6669.TW)	O (07/29/2024)	NT$1,985.00
Yageo Corp. (2327.TW)	O (01/04/2022)	NT$743.00
Zhen Ding (4958.TW)	E (08/02/2022)	NT$134.00
Sharon Shih		
Asia Vital Components Co. Ltd. (3017.TW)	O (07/30/2024)	NT$594.00
Auras Technology Co Ltd (3324.TWO)	E (05/04/2023)	NT$602.00
Catcher Technology (2474.TW)	E (05/22/2024)	NT$219.00
Delta Electronics Inc. (2308.TW)	O (07/13/2017)	NT$390.00
Foxconn Industrial Internet Co. Ltd. (601138.SS)	O (07/10/2019)	Rmb22.33
Foxconn Technology (2354.TW)	U (05/22/2024)	NT$64.30
GoerTek Inc (002241.SZ)	E (12/05/2022)	Rmb21.16
Guangzhou Shiyuan Electronic Tech Co Ltd (002841.SZ)	E (10/28/2021)	Rmb29.60
Hon Hai Precision (2317.TW)	O (03/15/2024)	NT$186.50
HTC Corporation (2498.TW)	E (12/06/2023)	NT$42.95
LandMark Optoelectronics Corporation (3081.TWO)	U (04/27/2023)	NT$115.50
Lingyi Itech Guangdong Co (002600.SZ)	E (08/28/2023)	Rmb6.82
Lite-On Technology (2301.TW)	U (03/28/2024)	NT$106.00

Luxshare Precision Industry Co., Ltd. (002475.SZ)	O (10/24/2016)	Rmb37.19
Sunonwealth Electric Machine Industry Co (2421.TW)	E (02/23/2024)	NT$97.00
Tong Hsing (6271.TW)	E (03/18/2019)	NT$135.00
Visual Photonics Epitaxy Co Ltd (2455.TW)	E (09/11/2023)	NT$140.00

Stock Ratings are subject to change. Please see latest research for each company.
* Historical prices are not split adjusted.

INDUSTRY COVERAGE: S. Korea Technology

COMPANY (TICKER)	RATING (AS OF)	PRICE* (08/02/2024)
Ryan Kim		
Duk San Neolux Co Ltd (213420.KQ)	E (01/12/2023)	W32,800
Ecopro BM (247540.KQ)	U (03/20/2023)	W185,900
Fadu Inc (440110.KQ)	E (11/09/2023)	W16,640
L&F Co Ltd (066970.KS)	O (02/22/2024)	W111,100
Lotte Energy Materials Corp (020150.KS)	E (04/10/2024)	W37,550
POSCO FUTURE M (003670.KS)	E (07/25/2024)	W226,000
SK IE Technology (361610.KS)	E (02/02/2024)	W36,550
Solus Advanced Materials Co Ltd (336370.KS)	U (10/31/2022)	W14,880
Wonik IPS Co Ltd (240810.KQ)	O (09/07/2020)	W33,850
Shawn Kim		
LG Display (034220.KS)	E (04/23/2024)	W11,100
LG Electronics (066570.KS)	O (01/04/2022)	W99,100
LG Innotek (011070.KS)	O (07/15/2024)	W243,000
Samsung Electro-Mechanics (009150.KS)	E (07/15/2024)	W150,600
Samsung Electronics (005935.KS)	O (11/18/2019)	W62,000
Samsung Electronics (005930.KS)	O (11/18/2019)	W79,600
Samsung SDI (006400.KS)	E (10/26/2021)	W336,500
Samsung SDS (018260.KS)	U (01/06/2022)	W143,500
Seoul Semiconductor (046890.KQ)	U (04/04/2018)	W9,110
SK hynix (000660.KS)	O (10/04/2022)	W173,200

Stock Ratings are subject to change. Please see latest research for each company.
* Historical prices are not split adjusted.

INDUSTRY COVERAGE: IT Hardware

COMPANY (TICKER)	RATING (AS OF)	PRICE* (08/02/2024)
Erik W Woodring		
Apple, Inc. (AAPL.O)	O (05/26/2009)	US$219.86
CDW Corporation (CDW.O)	E (12/12/2023)	US$209.85
Cricut Inc (CRCT.O)	U (08/12/2021)	US$5.86
Dell Technologies Inc. (DELL.N)	O (05/01/2023)	US$102.29
Garmin Ltd (GRMN.N)	E (01/07/2015)	US$168.52
GoPro Inc (GPRO.O)	U (12/12/2023)	US$1.36
HP Inc. (HPQ.N)	O (12/12/2023)	US$33.72
IBM (IBM.N)	E (01/18/2023)	US$189.12
Kornit Digital Ltd. (KRNT.O)	O (08/10/2023)	US$14.71
Logitech International SA (LOGI.O)	U (04/15/2024)	US$87.51
NCR Corp. (VYX.N)	E (09/19/2022)	US$13.47
Resideo Technologies Inc (REZI.N)	E (03/16/2021)	US$20.30
Seagate Technology (STX.O)	O (03/26/2024)	US$94.57
SmartRent, Inc. (SMRT.N)	++	US$1.71
Sonos Inc. (SONO.O)	O (12/12/2023)	US$12.54
Teradata (TDC.N)	E (02/13/2024)	US$30.46
Xerox Corp (XRX.O)	U (02/03/2021)	US$10.14

Meta A Marshall		
Hewlett Packard Enterprise (HPE.N)	E (11/30/2023)	US$18.03
NetApp Inc (NTAP.O)	E (07/26/2023)	US$119.05
Nutanix Inc (NTNX.O)	E (05/28/2019)	US$47.23
Pure Storage Inc (PSTG.N)	E (06/11/2024)	US$54.29

Stock Ratings are subject to change. Please see latest research for each company.
* Historical prices are not split adjusted.

INDUSTRY COVERAGE: Semiconductors

COMPANY (TICKER)	RATING (AS OF)	PRICE* (08/02/2024)
Joseph Moore		
Advanced Micro Devices (AMD.O)	E (06/09/2024)	US$132.50
Aeva Technologies Inc (AEVA.N)	E (07/19/2021)	US$3.16
Ambarella Inc (AMBA.O)	O (03/29/2016)	US$43.73
Amkor Technology Inc (AMKR.O)	E (11/08/2023)	US$28.63
Analog Devices Inc. (ADI.O)	O (11/16/2023)	US$207.96
Astera Labs Inc (ALAB.O)	E (04/15/2024)	US$42.38
Broadcom Inc. (AVGO.O)	O (06/09/2024)	US$143.82
GlobalFoundries Inc (GFS.O)	O (03/03/2022)	US$45.47
Intel Corporation (INTC.O)	E (02/22/2023)	US$21.48
IonQ Inc (IONQ.N)	E (04/25/2023)	US$7.08
Marvell Technology Group Ltd (MRVL.O)	E (09/14/2015)	US$59.25
Microchip Technology Inc. (MCHP.O)	E (07/10/2024)	US$75.43
Micron Technology Inc. (MU.O)	E (05/20/2024)	US$92.70
Navitas Semiconductor Corp (NVTS.O)	E (08/28/2023)	US$3.25
NVIDIA Corp. (NVDA.O)	O (03/16/2023)	US$107.27
NXP Semiconductor NV (NXPI.O)	E (04/08/2021)	US$237.75
ON Semiconductor Corp. (ON.O)	U (07/10/2024)	US$67.95
Qorvo Inc (QRVO.O)	O (12/07/2023)	US$107.93
Qualcomm Inc. (QCOM.O)	E (12/07/2023)	US$159.31
Silicon Laboratories Inc. (SLAB.O)	E (01/19/2021)	US$104.16
Skyworks Solutions Inc (SWKS.O)	E (11/28/2018)	US$104.70
Texas Instruments (TXN.O)	U (04/13/2020)	US$187.46
Western Digital (WDC.O)	O (01/23/2020)	US$57.23
Wolfspeed, INC (WOLF.N)	E (12/07/2020)	US$15.27
Lee Simpson		
Arm Holdings plc (ARM.O)	O (07/19/2024)	US$113.45
Cadence Design Systems Inc (CDNS.O)	O (02/14/2024)	US$249.63
Synopsys Inc. (SNPS.O)	O (11/10/2023)	US$505.78

Stock Ratings are subject to change. Please see latest research for each company.
* Historical prices are not split adjusted.