

Semiconductor sector

Revisiting spec migration theme; robust ASIC demand to bolster business opportunities

Key message

1. End demand has bottomed, and we see a healthy cyclical recovery in 2024.F
2. We expect AI PC to drive upgrade cycle after 2H24F.
3. High-speed interface IC fabless firms will capitalize on spec upgrades as demand normalizes.
4. We believe ASIC TAM will grow long-term.
5. We expect stabilizing end demand to drive NPI demand in 2024F, paving the way for recovery for Taiwanese testing interface vendors.

Event

End demand has bottomed; healthy cyclical recovery in 2024F. Entering 2024, we expect the semiconductor industry to post robust growth. Although the magnitude and rate of inventory digestion varies for different ICs, resulting in slightly higher overall semiconductor inventory days than pre-COVID levels, inventory levels continue to improve across the industry. Gartner now estimates that global semiconductor market revenue will resume healthy growth in 2024-25, rising a respective 16.8% and 15.5% YoY to US\$624bn and US\$721bn, and we expect healthy cyclical recovery in 2024.

AI PC to drive upgrade cycle after 2H24F. While edge AI applications are currently limited, we believe the edge AI computing platform, which is being defined by Microsoft (US), Intel (US), AMD (US), and PC OEMs, could result in an upgrade cycle for PC, as well as continued silicon content growth. Both Intel and AMD have emphasized the integration of neural processing units (NPU) in current and future CPUs, which are designed to run on-device AI workloads. With Windows 12 expected to launch in late 2024, we could see the more extensive release of AI computers in 2025 that would meet Microsoft's AI PC computing capability requirements and accelerate the development of on-device AI applications.

High-speed interface IC fabless firms to capitalize on spec upgrades as demand normalizes. We anticipate a decent PC/NB demand rebound in 2024, which would pave the way to recovery for related high-speed interface IC fabless firms. As new PC/NB models will support Intel's and AMD's new CPU platforms in terms of specs, and given the technological readiness of Taiwanese high-speed interface IC fabless firms for related offerings, we expect to see higher USB4 revenue contribution for these companies, whether they are on the host side or device side.

ASIC TAM to grow long-term. With CSPs and hyperscalers launching their own AI ASIC, we believe long-term ASIC TAM growth is now consensus. As clients continue to actively adopt AI ASIC, aside from general GPU solutions, we believe this indicates that sales generated from the AI business are set to grow rapidly. Therefore, we believe the higher exposure to CSPs' and hyperscalers' ASIC business will help sustain resilient ASIC TAM growth in 2024-25. Overall, we believe the ASIC TAM will continue to grow long-term, whether in AI/HPC or automotive applications.

Healthy end demand recovery to drive NPI demand. After several quarters of inventory adjustments, most fabless firms' DOI have returned to healthier levels. As such, we expect stabilizing end demand to drive NPI demand in 2024, paving the way for recovery for Taiwanese testing interface vendors. Furthermore, the global system level testing (SLT) socket market will grow as HPC applications (e.g. CPU, GPU, smartphone SoC) are manufactured via more advanced nodes, leading to increased defect rates and lower yield rates, as well as higher failure costs. In order to improve test coverage and yield rates, fabless vendors need to increase SLT adoption, driving long-term SLT socket demand.

Stocks for Action

On healthy semiconductor demand recovery, we recommend investors accumulate TSMC (2330 TT, NT\$574, OP), MediaTek (2454 TT, NT\$948, OP), and Parade Technologies (4966 TT, NT\$1,075, OP). In the ASIC design service sector, we like Alchip Technologies (3661 TT, NT\$3,050, OP) and Faraday (3035 TT, NT\$380, OP) on resilient ASIC outsourcing demand. Alchip Technologies is our top pick. We are positive on its leading position in the custom AI and automotive ASIC design realm. For the testing interface sector, we are positive on MPI's (6223 TT, NT\$216, OP) 2024 outlook given strong NPI demand from major clients, and we also like WinWay (6515 TT, NT\$756, OP) for its primary supplier position for leading global GPU vendors. WinWay could be the key beneficiary of the AI/HPC trend in the next three to five years.

Risks

Weak macro environment.

The big picture – End demand has bottomed; healthy cyclical recovery in 2024F

Entering into 2024, the semiconductor industry is preliminarily expected to grow decently. Although the magnitude and rate of digestion for different ICs vary, resulting in slightly higher overall inventory days than pre-COVID levels, inventory levels continue to improve across the semiconductor industry. Since the peak in 4Q22-1Q23, there has been improvement and depletion of semiconductor inventory for two consecutive quarters. However, inventory of ICs, such as PMIC and MCU, are expected to continue to correct through 1H24.

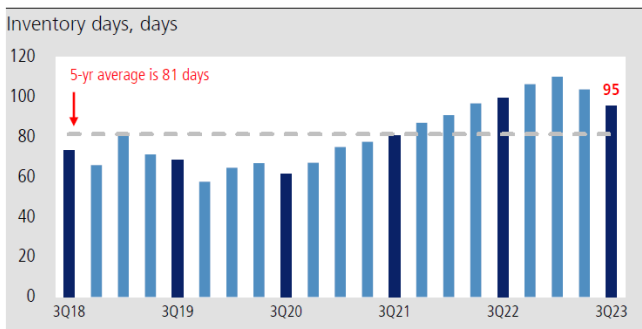
As end demand significantly declined in mid-2022, leading to major inventory adjustments, growth of the semiconductor industry in 2022 was muted. End demand and inventory adjustments continued into 2023, resulting in a low-teens YoY decline in the semiconductor industry this year. In addition to healthy recovery in end demand in 2024F, as semiconductor inventory levels have gradually retreated to relatively healthier levels, semiconductor demand will normalize. Subsequently, we believe the introduction of new products and specifications, following specification upgrades and increases in content, will return to normal, driving recovery of the overall semiconductor industry. Gartner now estimates that global semiconductor market revenue will resume healthy growth in 2024-25, up a respective 16.8% and 15.5% YoY to US\$624bn and US\$721bn, and we expect healthy cyclical recovery in 2024.

Figure 1: Semiconductor market revenue to return to growth track in 2024F

End market forecast (US\$m)	2022	2023F	2024F	2025F	2026F	2027F	
Automotive Electronics	67,530	78,569	88,816	104,198	115,250	122,723	
Communication Electronics	192,841	154,553	179,407	205,556	211,671	209,672	
Consumer Electronics	66,739	59,870	68,007	73,847	75,124	74,998	
Data Processing Electronics	198,764	167,043	203,496	243,233	260,177	245,566	
Industrial and Military/Civil Aerospace Electronics	73,688	74,419	84,625	94,336	102,927	111,012	
Total	599,562	534,456	624,350	721,170	765,148	763,972	
YoY growth rate	2022	2023F	2024F	2025F	2026F	2027F	2022-27 CAGR
Automotive Electronics	23.8%	16.3%	13.0%	17.3%	10.6%	6.5%	12.7%
Communication Electronics	0.9%	-19.9%	16.1%	14.6%	3.0%	-0.9%	1.7%
Consumer Electronics	-1.0%	-10.3%	13.6%	8.6%	1.7%	-0.2%	2.4%
Data Processing Electronics	-9.4%	-16.0%	21.8%	19.5%	7.0%	-5.6%	4.3%
Industrial and Military/Civil Aerospace Electronics	11.7%	1.0%	13.7%	11.5%	9.1%	7.9%	8.5%
Total	0.2%	-10.9%	16.8%	15.5%	6.1%	-0.2%	5.0%

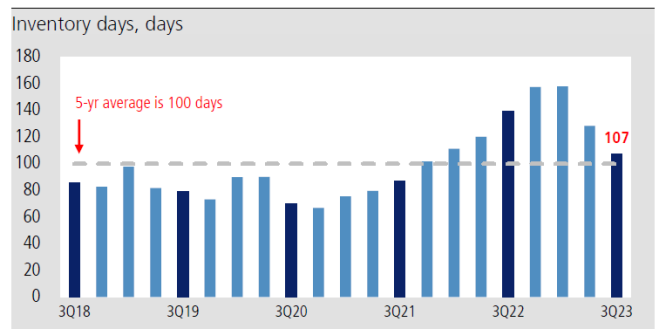
Source: Gartner, KGI Research

Figure 2: Taiwan semiconductor inventory days



Source: TEJ, KGI Research

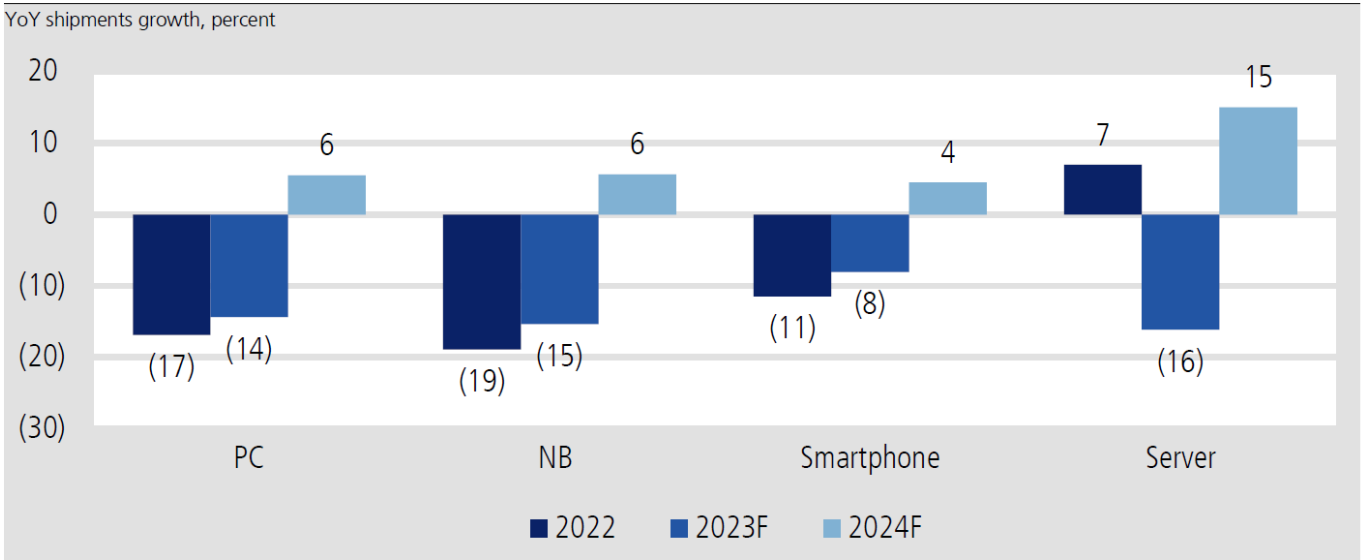
Figure 3: Taiwan fabless inventory days



Source: TEJ, KGI Research

We forecast healthy end device shipment recovery in 2024, for YoY shipment growth of mid- to high-single digits for PC/NB, low- to mid-single digits for smartphones, and mid-teens for overall servers, with a boost from AI servers. However, YoY shipment growth for general servers will be mid-single digits. Following a significant YoY decline in end device shipments in 2023F, we believe recovery to 2022 shipment levels is unlikely until 2025. For 2024, we believe cloud AI sales momentum will continue, and additionally, more developments in edge AI are expected in 2H24, beginning in the commercial domain.

Figure 4: IT hardware devices – NB, PC, smartphone, & server shipments to all grow in 2024F



Source: Gartner, KGI Research estimates

AI PC to drive upgrade cycle after 2H24F

Intel (US) recently announced its AI PC acceleration program, which aims to enable AI functionality on more than 100mn PC units over the next two years, by connecting independent hardware vendors (IHVs) and independent software vendors (ISVs) with Intel resources. Intel will launch its mobile Meteor Lake CPU (Intel Core Ultra processor) in December 2023F, which is compatible with neural processing units (NPU), while next-generation CPUs for both DT and NB, including Arrow Lake, Lunar Lake, and Panther Lake, will provide more advanced performance. Based on PC brands’ designs, AI-enabled PCs will have AI and machine learning capabilities, which will allow them to perform various intelligent applications and tasks. These will completely change the user experience for productivity and entertainment, and will help users conduct more effective collaboration and communication, improving work quality. AI-enabled PCs will help users create, edit, optimize, and compress videos and audio, improving quality and efficiency, and will protect data and privacy, preventing various threats and attacks. AI PC development is focused on edge AI, which improves reasoning ability of PCs, versus the current AI architecture based on cloud data centers, and requires the addition of more sensors to enable more intuitive operation. We expect new AI PCs to launch in 2H24-2025, which would be another driver of PC demand growth.

While limited current edge AI applications, we believe the edge AI computing platform, which is being defined by Microsoft, Intel, AMD, and PC OEMs, could result in an upgrade cycle for PC, as well as continued silicon content value growth, which would benefit TSMC. Both Intel and AMD have emphasized the integration of NPU in their current and future CPUs, which are designed to run on-device AI workloads. With Windows 12 expected to launch in late 2024, we could see more extensive release of AI computers in 2025 that would meet Microsoft’s AI PC computing capability requirements and accelerate the development of on-device AI applications. Furthermore, we think the smartphone industry

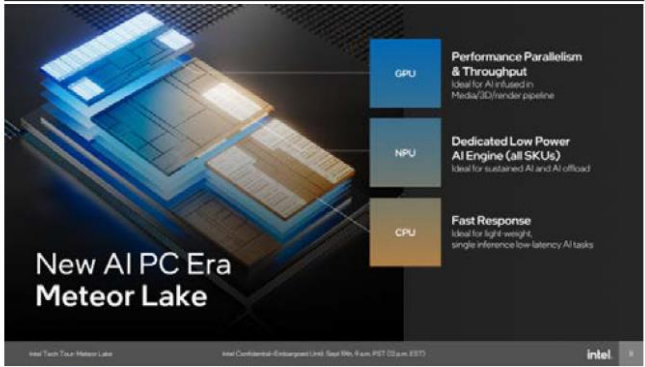
will follow suit as Qualcomm (US) and MediaTek have both highlighted the integration of more powerful AI engines in their upcoming SoCs to run on-device AI applications, in addition to their upcoming ARM (UK)-based computing solutions for Windows and Chromebook.

Figure 5: Intel's AI PC acceleration program



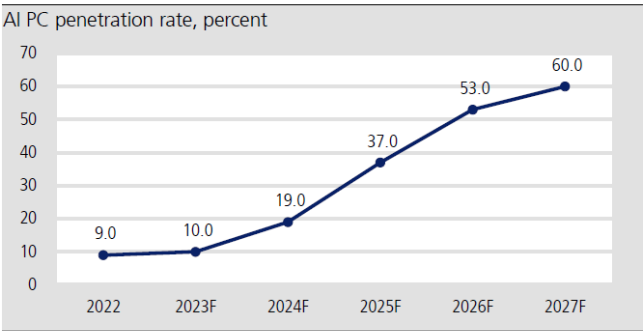
Source: Intel

Figure 6: Meteor Lake CPU to support AI



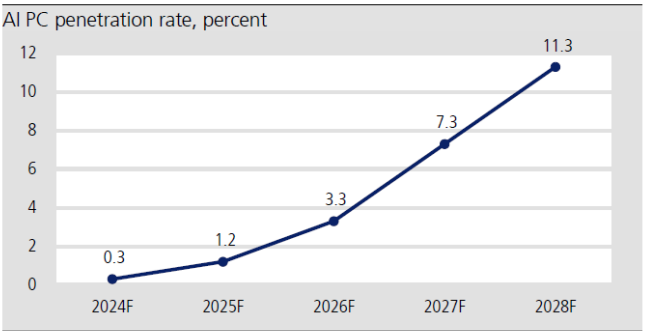
Source: Intel

Figure 7: Canlys forecasts AI PC penetration of 60% in 2027



Source: Canlys, KGI Research

Figure 8: Omdia estimates AI PC penetration of 7.3% in 2027 & over 10% in 2028



Source: Omdia, KGI Research

Foundry sector – TSMC our top foundry sector pick on healthy end demand recovery & continued silicon content value growth in AI/HPC applications

Apple (US), TSMC's top HPC client, has launched a new MacBook series, which will upgrade from M2-series CPU to M3-series CPU. Furthermore, we expect Apple to also upgrade from M2-series CPU to M3-series CPU for its iPad products. We estimate silicon content per socket will rise 5-35% from the M2-series to M3-series, given higher transistor count and migration from N5 to N3.

Figure 9: Apple M CPU silicon content value growth per socket averaged 20% from M2-series to M3-series

	M1	M2	M3	M1 Pro	M2 Pro	M3 Pro	M1 Max	M2 Max	M3 Max
Foundry	TSMC	TSMC	TSMC	TSMC	TSMC	TSMC	TSMC	TSMC	TSMC
Node	N5	N5+	N3	N5	N5+	N3	N5	N5+	N3
Silicon content per socket (US\$)	40-45	50-55	70-75	100-105	120-125	120-125	200-205	265-270	330-335
Incremental wafer revenue per socket (%)		20-25%	30-35%		15-20%	0-5%		30-35%	20-25%

Source: Company data, KGI Research estimates

On the other hand, AMD, TSMC's other top HPC client, will launch its next-generation APU Ryzen 8000 (Zen 5) in 2H24F. We expect sales contribution per socket to rise 35-40%, from US\$65-70 for the Ryzen 7000 series (Zen 4) to US\$90-95 for the Ryzen 8000 series, due to its bigger die size, which is driven by higher NPU computing capability.

Figure 10: AMD's Zen 5 NB APU silicon content value per socket is around 40% higher than that of Zen 4

	Ryzen 7000 (Zen 4)	Ryzen 8000 (Zen 5)
Foundry	TSMC	TSMC
Node	N4	N4
Wafer sales contribution per socket to TSMC (US\$)	65-70	90-95
Incremental wafer revenue per socket (%)		35-40

Source: Company data, KGI Research estimates

For x86 servers, AMD's server CPU shipments have been dominated by Milan in 2023, which is manufactured via TSMC's N7 process. However, we expect AMD's 2024 server CPU shipments to be dominated by Genoa, which is produced via TSMC's N5 process. In addition, we expect well over 50% of server product shipments to be based on N5 and N4 processes, and some products to be manufactured via the N3 process, which will further drive silicon content growth in 2024.

Figure 11: AMD Genoa (Genoa-X) CPU silicon content value per socket almost 90% higher than that of Milan (Milan-X)

	Milan	Genoa	Milan-X	Genoa-X
Foundry	TSMC	TSMC	TSMC	TSMC
CCD numbers (units)	8	12	8	12
Wafer sales contribution per socket to TSMC (US\$)	220-225	415-420	305-310	575-580
Incremental wafer revenue per socket (%)		85-90		85-90

Source: Company data, KGI Research estimates

AI server demand has been significantly rising, which has driven the deployment of more powerful AI accelerators, such as H100, MI 300, and Google's (US) TPU, which could boost silicon content growth. We think production of Nvidia's (US) H100 will continue to ramp-up in 2024, and we forecast H100 GPU shipments will grow over 200% YoY in 2024. In addition, GH200 will enter mass production in 2024F, and Nvidia will also launch its B100 GPU in 2H24F. Based on our understanding, B100 GPU utilizes a chiplet architecture and the N4 process, which could further drive silicon content value growth. Overall, with MI 300 and H100 continuing to ramp-up, and production of more powerful products set to ramp-up in late 2024F, we expect HPC and AI to be meaningful silicon content value growth drivers for TSMC in 2024F.

Figure 12: Wafer sales contribution per socket from MI 300 around 20% higher than that of MI 250

	MI 250 (CDNA 2)	MI 300 (CDNA 3)		
	GCD	CCD	XCD	AID
Foundry	TSMC	TSMC	TSMC	TSMC
Node	N5	N5	N5	N6
Die count (unit)	25	3	6	4
Wafer sales contribution per socket to TSMC (US\$)	700-750	850-900		
Incremental sales per socket (%)		~20		

Source: Company data, KGI Research estimates

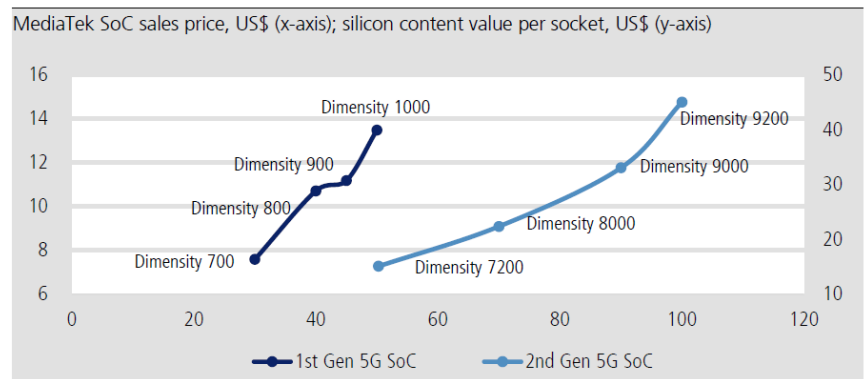
Figure 13: Silicon content value per socket averaged 20% from GA100 to GB100

	GA100 (Ampere)	GH100 (Hopper)	GB100 (Blackwell)
Foundry	TSMC	TSMC	TSMC
Node	N7	N4	N4
Wafer sales contribution per socket to TSMC (US\$)	460-465	570-600	650-700
Incremental wafer revenue per socket (%)		25-30	10-15

Source: Company data, KGI Research estimates

We believe node migration for 5G smartphone SoC is also a healthy driver of silicon content. MediaTek has announced its flagship 5G smartphone SoC (via TSMC's N3 process) has been taped-out and will enter mass production in 2H24. More importantly, we think most of MediaTek's 2023 smartphone SoC shipments are being manufactured via TSMC's N7 and N6 processes (Dimensity 700, 800, 900, and 1000). However, we believe most smartphone SoC shipments will be produced via N5 and N4 processes (Dimensity 7200, 8000, 9000, and 9200) in 2024, which will boost silicon content growth. Qualcomm's Snapdragon 8 Gen 3, which is produced via TSMC's N4 process, will enter mass production in 4Q23. Based on our calculations, Snapdragon 8 Gen 3 silicon content per socket will increase by around 25-30% compared to the Snapdragon 8 Gen 2, due to its larger die size. Therefore, we expect silicon content growth for smartphones to continue to be a strong driver of wafer sales contribution, in addition to smartphone end demand recovery in 2024F.

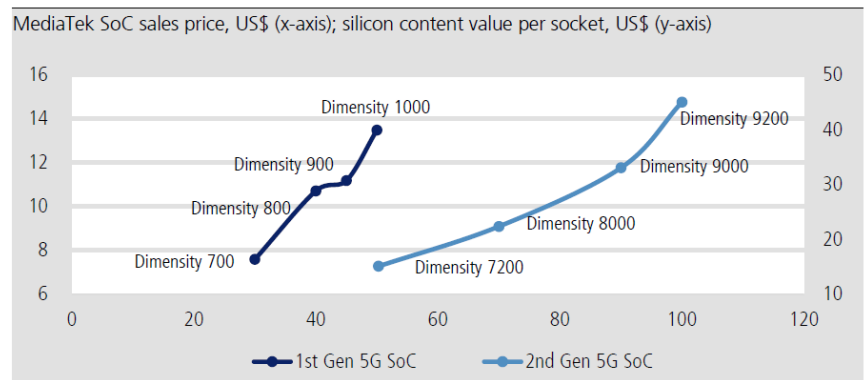
Figure 14: Silicon dollar content value of MediaTek's second-generation 5G SoC is 2-3x higher than that of first-generation 5G SoC



Source: Company data, KGI Research estimates

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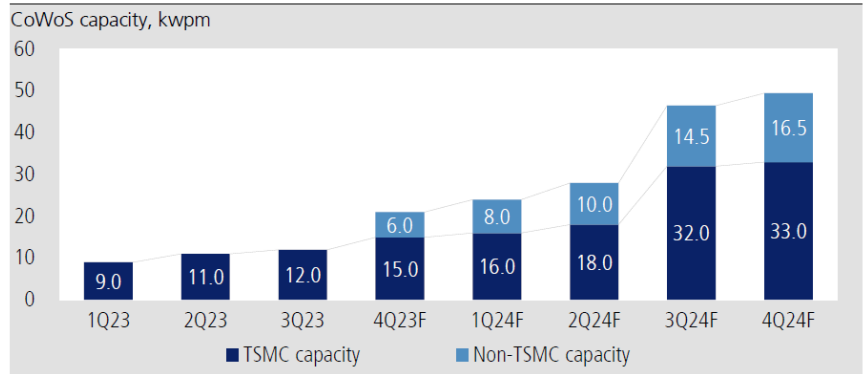
Figure 15: Qualcomm Snapdragon 8 Gen 3 silicon content is 25% higher than that of Snapdragon 8 Gen 2

	Snapdragon 8 Gen 2	Snapdragon 8 Gen 3
Foundry	TSMC	TSMC
Node	N4	N4
Wafer sales contribution per socket to TSMC (US\$)	40-45	50-55
Incremental sales per generation (%)		25-30

Source: Company data, KGI Research estimates

On the CoWoS capacity front, TSMC noted that the capacity of CoWoS in 2024 will double, and CoWoS capacity will further expand in 2025. This implies that bookings for the company remain strong. We estimate CoWoS capacity in 4Q23 will reach 15-16kwpm, and capacity will increase to 32-33kwpm in 2024, further reaching 40-42kwpm by 2025. Therefore, we anticipate robust AI demand in 2024-25.

Figure 16: CoWoS capacity to rise in 2023-25F

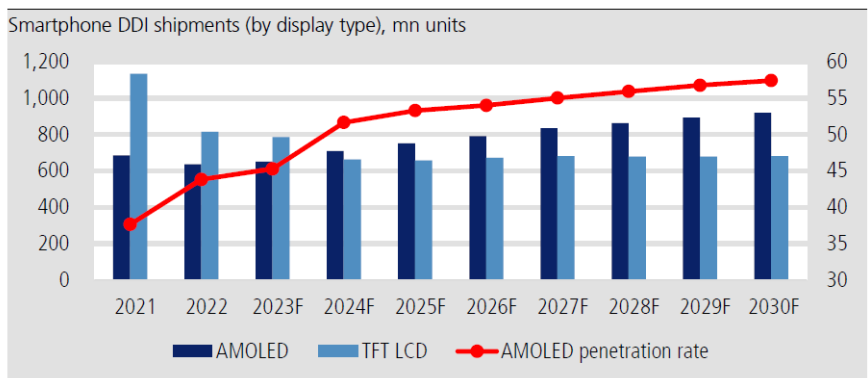


Source: KGI Research estimates

DDI sector – Smartphone OLED DDI a bright spot for DDI fabless in 2024F

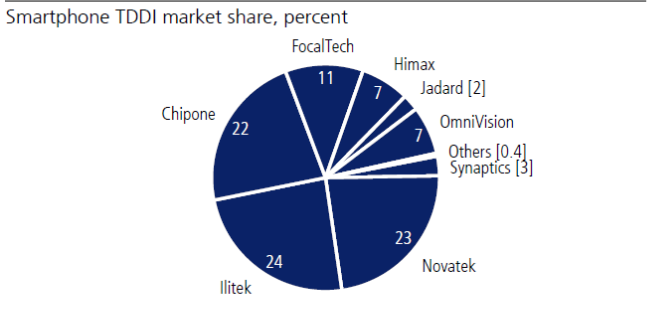
Within the smartphone domain, we foresee resilient growth of the smartphone OLED DDI market in 2024. We expect OLED displays to continue to cascade down from high-end to midrange smartphone models next year. In addition, smartphone brands are more actively experimenting with RAM-less OLED DDI solutions. Thus, we forecast smartphone OLED DDI penetration will grow YoY from mid-40% to over 50% in 2024. Novatek (3034 TT, NT\$512, N), on a US smartphone brand's smartphone OLED DDI market share gains, has announced a more positive outlook for 2024. However, the pricing of smartphone TDDI is expected to remain under pressure next year, compounded by the substitution by OLED DDI. Thus, we believe the TDDI market will be more challenging in 2024. As for Taiwanese DDI fabless firms, Novatek's TDDI sales weighting has decreased to around 10% in 2023F, while Raydium (3592 TT, NT\$406, N) has no exposure to smartphone TDDI. Therefore, we believe the negative impact of the smartphone TDDI market on the aforementioned players will be limited and manageable.

Figure 17: Smartphone AMOLED DDI shipments to grow long-term; penetration of over 50% in 2024F



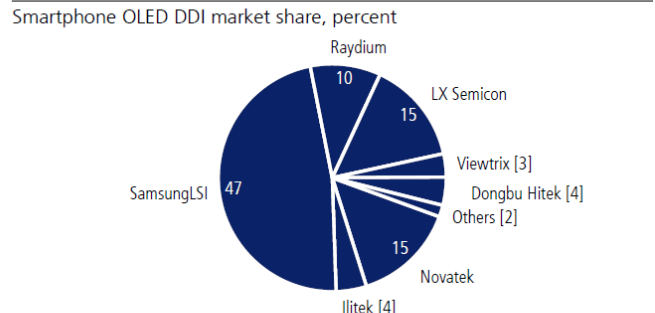
Source: Omdia, KGI Research

Figure 18: Rising competition in TDDI market, with total Chinese DDI fabless firm market share of 30%+



Source: Omdia, KGI Research

Figure 19: Market share of Novatek & Raydium continue to rise as OLED display shipments from China grow



Source: Omdia, KGI Research

We believe the continued growth of automotive display TAM, which has enhanced auto DDI and TDDI orders, will bolster Novatek and Raydium’s automotive DDI and TDDI businesses. We anticipate YoY shipment recovery for LDDI due to stable TV shipments, a healthy rebound in PC/NB shipments, and ongoing resolution upgrades.

High-speed interface sector – High-speed interface IC fabless firms to capitalize on spec upgrade as demand normalizes, especially USB4 advancements

We anticipate a decent PC/NB demand rebound in 2024, which will pave the road to recovery for related high-speed interface IC fabless firms, such as Parade Technologies, ASMedia Technology (5269 TT, NT\$1,455, NR), Genesys Logic (6104 TT, NT\$136.5, NR), and VIA Labs (6756 TT, NT\$242.5, NR), benefiting their high-speed interface solution segments. As new PC/NB models will support Intel and AMD’s new CPU platforms in terms of specs, and given the technological readiness of Taiwanese high-speed interface IC fabless firms for related offerings, we expect to see higher USB4 revenue contribution for these companies, no matter if they’re on the host side or device side.

The emerging edge AI PC/ NB domain is also likely to initiate an upgrade cycle for PCs, and this shift will accelerate the transition to USB4 retimers, in line with platform upgrades, and will also promote USB4 peripheral enhancements in 2024-25F.

Figure 20: USB protocol advancements underway

Generation	USB 1.0	USB 2.0	USB 3.2 Gen 1	USB 3.2 Gen 2x1	USB 3.2 Gen 2x2	USB4 Version 1.0	USB4 Version 2.0
	-	-	USB 3.0 USB 3.1 Gen 1	USB 3.1 USB 3.1 Gen 2	USB 3.2	-	-
Year of release	1996	2000	2008	2013	2017	2019	2022
Maximum data rate	1.5Mbps	480Mbps	5Gbps	10Gbps	20Gbps	40Gbps (dual lanes)	80Gbps (dual lanes)
Marketing name	Low-Speed	High-Speed	SuperSpeed USB 5Gbps	SuperSpeed USB 10Gbps	SuperSpeed USB 20Gbps	USB4 40Gbps	USB4 80Gbps
Connector type	USB-A/B	USB-A/B, Micro A/B, USB-C	USB-A/B, Micro A/B, USB-C	USB-A/B, Micro A/B, USB-C	USB-C	USB-C	USB-C
Standard bus power	2.5W (0.5A@5V)	2.5W (0.5A@5V)	4.5W (0.9A@5V)	4.5W (0.9A@5V)	7.5W (1.5A@5V)	7.5W (1.5A@5V)	7.5W (1.5A@5V)
Power delivery	Optional	Optional	Optional	Optional	Optional	Required 240W (5A@48V in PD 3.1)	Required 240W (5A@48V in PD 3.1)

Source: USB-IF, KGI Research

ASIC design service sector – ASIC TAM to grow long-term, whether in AI/HPC or automotive applications

Regarding the design sector, as nodes for production of ASIC, especially for AI/HPC, gradually migrate to sub-7nm, costs for single projects are escalating as substantial resources are required. On resilient AI/HPC demand, mass production has naturally become the primary focus for both customers and design service vendors. It has become the norm for CSPs to release multiple projects to design service vendors for bidding. Moreover, much of the spec-in and architecture process is now typically kept within internal teams of CSPs, with design service vendors mainly engaged in back-end design and turnkey business.

Given strong demand from AI ASIC, we have seen higher requirements for time-to-market, better visibility for projects entering the mass production phase, and stronger differentiation attempts by CSPs. Additionally, with strong AI demand offsetting early design resource input, with cost down advantages over general GPU products offered by Nvidia and AMD, strong demand for initiating projects has become common. We also note some CSP customers, not wanting to be overly reliant on leading design service vendors' IP portfolios, are starting to distribute projects more widely among different entities.

With CSPs and hyperscalers launching their own AI ASIC, we believe this is now consensus. As clients continue to actively adopt AI ASIC aside general GPU solutions, we believe this indicates that sales generated from the AI business will grow rapidly. Therefore, we believe the higher exposure to CSPs and hyperscalers' ASIC business should help sustain resilient growth in 2024-25. Overall, we believe the ASIC TAM will continue to grow long-term, whether in AI/HPC or automotive applications.

We reaffirm that although ASIC for AI has been around for years, we are seeing rising demand from CSPs and start-ups, especially increased outsourcing to Taiwanese design service providers, thanks to: (1) strong AI demand offsetting early design resource input; (2) differentiation attempts by CSPs; (3) future design resource constraints; (4) higher overseas labor costs, IP licensing, and EDA tools increasing costs and lowering efficiency; and (5) new entrants in the 7/5nm design service market. On the other hand, given their design capabilities, resources, and experience, IC design clients can more easily switch design platforms than CSPs and system houses. Higher involvement in the AI/HPC and automotive sectors provide design service companies better resilience against potential fabless or system house entrants due to the elevated design capability threshold. This exposure also aids in securing long-term client relationships and extending product lifespans. Alchip Technologies is our top pick within our design service coverage universe due to its greater sales emphasis on CSP clients and system houses, as well as services for AI, HPC, and auto applications.

Figure 21: AI semiconductor market to post CAGR of 23.3% in 2021-27F, according to Gartner

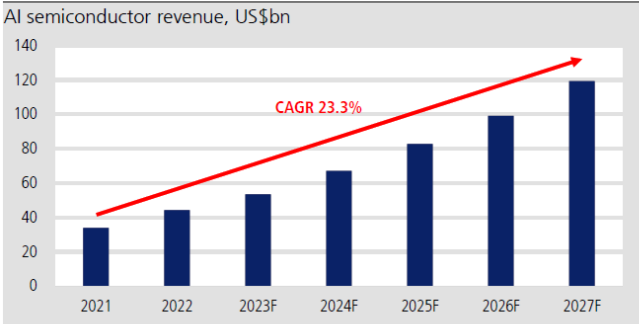


Figure 22: Gartner estimates 2021-27 ASIC & FPGA revenue CAGR of 16.8%

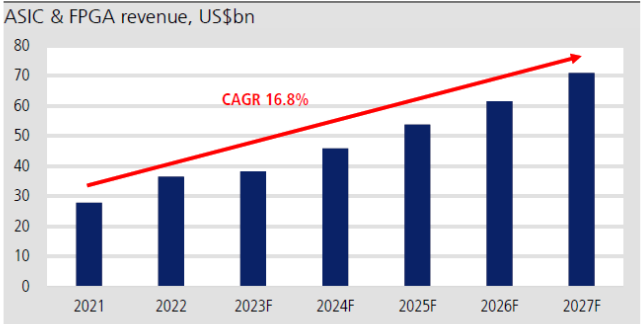


Figure 23: AI/HPC projects from hyperscalers

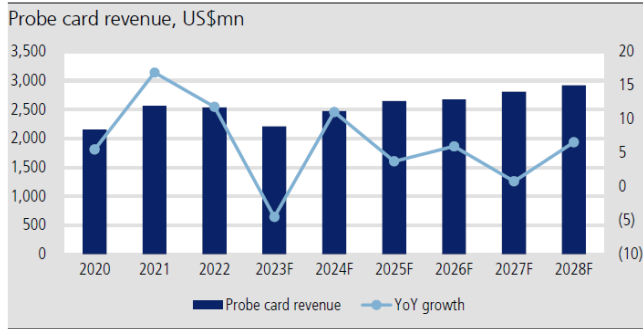
Hyperscalers	Chip	Workload	Launch	ASIC partner	Foundry	Process node
Google	TPU v1	Inference	2016	Broadcom	TSMC	28nm
	TPU v2	Training/Inference	2017	Broadcom	TSMC	16nm
	TPU v3	Training/Inference	2018	Broadcom	TSMC	16nm
	TPU v4 lite	Training/Inference	2020	Broadcom	TSMC	7nm
	TPU v4	Training/Inference	2021	Broadcom	TSMC	7nm
	TPU v5	Training/Inference	2023	Broadcom	TSMC	5nm
	TPU v5e	Training/Inference	2023	Broadcom	TSMC	5nm
	TPU v6	Training/Inference	2024E	Broadcom	TSMC	5/4nm
	TPU v7	Training/Inference	2025E	? (Broadcom/Marvell/MediaTek)	TSMC	4nm or 3nm
	Maple	?	2024E		TSMC	5nm
Cypress	?	2024E	Marvell	TSMC	5nm	
Granite Redux	Networking	2024E	Marvell	TSMC	5nm	
Amazon AWS	Trainium	Training	2020	Alchip	TSMC	7nm
	Trainium2	Training	2024E	Marvell	TSMC	3nm
	Inferentia	Inference	2018	Alchip	TSMC	16nm
	Inferentia2	Inference	2022	Alchip	TSMC	7nm
	Inferentia3	Inference	2025E	Alchip	TSMC	7nm
	Graviton	CPU	2018		TSMC	16nm
	Graviton2	CPU	2019		TSMC	7nm
	Graviton3	CPU	2022		TSMC	5nm
	Graviton4	CPU	2025E		TSMC	3nm
	Nitro v1	DPU	2014	Marvell	TSMC	16nm
	Nitro v2	DPU	2017	Marvell	TSMC	16nm
	Nitro v3	DPU	2018	Marvell	TSMC	7nm
Nitro v4	DPU	2020	Marvell	TSMC	7nm	
Nitro v5	DPU	2022	Marvell	TSMC	5nm	
Microsoft	Azure Maia 100	Training/Inference	2024	GUC	TSMC	5nm
	Azure Cobalt 100	CPU	2024		TSMC	5nm
Meta	MTIA v1	Inference	2021	Broadcom	TSMC	7nm
	MTIA v2	Training/Inference	2025E	Broadcom	TSMC	5nm
	MSVP	Video processing	2021	Broadcom	TSMC	

Source: Company data, KGI Research estimates

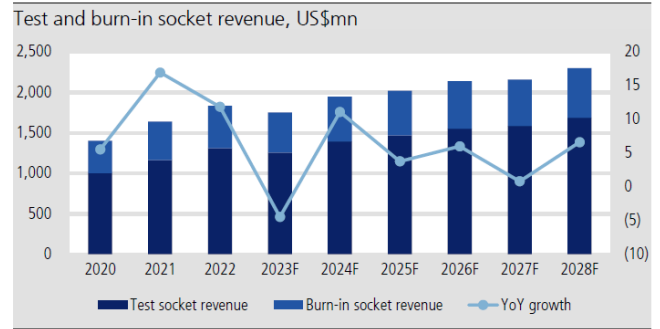
Testing interface sector – Heathy end demand recovery to drive NPI demand, benefiting testing interface vendors

The testing interface market has been facing challenges in 2023 as end demand remains lukewarm and on slower-than-expected inventory correction, leading to lower NPI demand. According to Yole Group, 2023 global probe card and test/burn-in socket market revenue will decline by a respective 13.0% and 4.5% YoY to US\$2.21bn and US\$1.75bn. However, after several quarters of inventory adjustments, most fabless firms' DOI have returned to relatively healthier levels. As such, we expect stabilizing end demand to drive NPI demand in 2024, paving the way to recovery for Taiwanese testing interface vendors. Yole Group now estimates global probe card and test/burn-in socket market revenue will grow by a respective 12.0% and 11.1% YoY to US\$2.48bn and US\$1.95bn in 2024, for 2023-28 CAGRs of 5.8% and 5.6%.

Furthermore, global SLT test socket market will grow by a CAGR of 13.2% in 2022-27, according to Yole Group, as HPC applications, such as CPU, GPU, and smartphone SoC, are manufactured via more advanced nodes, leading to larger defect rates and lower yield rates, as well as higher failure costs. In order to improve test coverage and yield rates, fabless vendors need to increase SLT adoption, which will drive long-term SLT socket demand.

Figure 24: Global probe card market to post CAGR of 5.8% in 2023-28F, according to Yole Group


Source: Yole Group, KGI Research

Figure 25: Yole Group estimates 2023-28 global test & burn-in socket CAGR of 5.6%


Source: Yole Group, KGI Research

Stock picks

On healthy demand recovery, we recommend investors accumulate TSMC, MediaTek, and Parade Technologies. For TSMC, we expect a strong cyclical recovery in 2024, driven by: (1) restocking demand; (2) end-demand recovery; (3) market share gains; and (4) continued silicon content value growth in HPC and 5G applications. We remain positive on MediaTek given its healthy near- to mid-term outlook, and anticipate improving smartphone demand and a stabilizing gross margin outlook. We also expect Parade Technologies to return to the growth track, driven by several key factors, including: (a) healthy 5-10% YoY growth in global PC/NB shipments in 2024F; (b) OLED display market expansion, which will enhance Parade Technologies' DisplayPort segment revenue; and (c) advancements in USB4 and PCIe 5.0 technologies, which will strengthen the company's high-speed interface business.

In the ASIC design service sector, we also like Alchip Technologies and Faraday on resilient ASIC outsourcing demand. Alchip Technologies remains our top pick. We are positive on its leading position in the custom AI and auto ASIC design realm. We note a more promising outlook for Alchip Technologies' AI ASIC shipments, particularly to a major US hyperscaler and IDM customers, which are positioned to be the top two clients in 2024. Beyond the potential surge in AI ASIC project shipments, substantial sales contribution is expected from diverse large-scale projects across consumer electronics, mobile/smart devices, and stationary PCs, which would boost gross margin in 2024. As for Faraday, we foresee a promising growth trajectory for the IP segment in 2024-25. Furthermore, we believe the firm will secure 40-50 projects in the NRE segment each year. The steady transition to 28nm and 22nm, increased transparency in FinFET processes, and advanced packaging domains will increase NRE revenue in 2024-25F. As for the MP segment, we believe Faraday has achieved more balanced inventory in 2H23, and expect client inventories to normalize by 1H24. We predict growth will resume for the MP business in 2024.

For the testing interface sector, we are positive on MPI's 2024 outlook, driven by: (1) strong NPI demand from its major clients for networking IC and AI ASIC; (2) multiple new project wins; and (3) rising adoption of advanced semiconductor test (AST) and its thermal test equipment, along with continued market share gains. We also believe WinWay will return to a growth track, given: (a) next-generation GPU is expected to launch in 2024, according to global leading GPU vendor's roadmap, which would boost the firm's VPC revenue; (b) ongoing CoWoS capacity expansion will drive AI server GPU shipments in 2024F, benefiting WinWay's coaxial socket revenue; and (c) rising revenue contribution from VPC and coaxial sockets will pave the way for gross margin improvement. We believe WinWay's primary supplier position for leading global GPU vendors will continue to provide secular growth for the firm over the next three to five years.

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