


AI and chips Enthusiasm

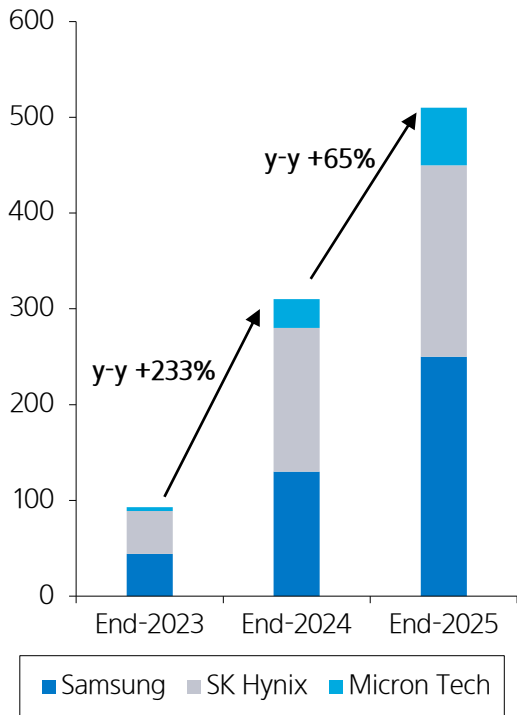
 **Tech Team | March 2024**
MS Hwang, Jongwook Lee,
Hyungkeun Ryu

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HBM, who's the winner?

HBM Capacity (Bull Case)

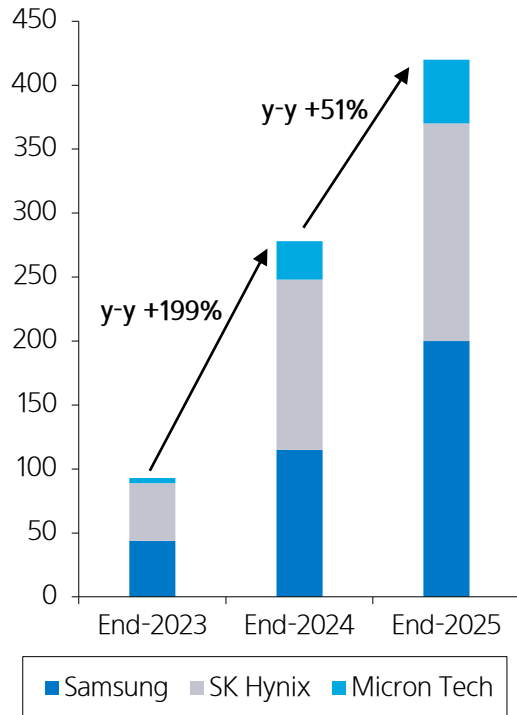
('000 wafer per month)



Source: Samsung Securities estimates

HBM Capacity (Base Case)

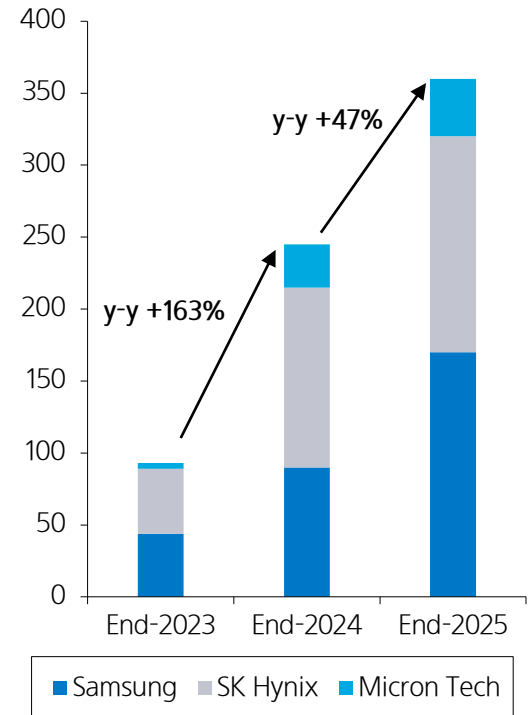
('000 wafer per month)



Source: Samsung Securities estimates

HBM Capacity (Bear Case)

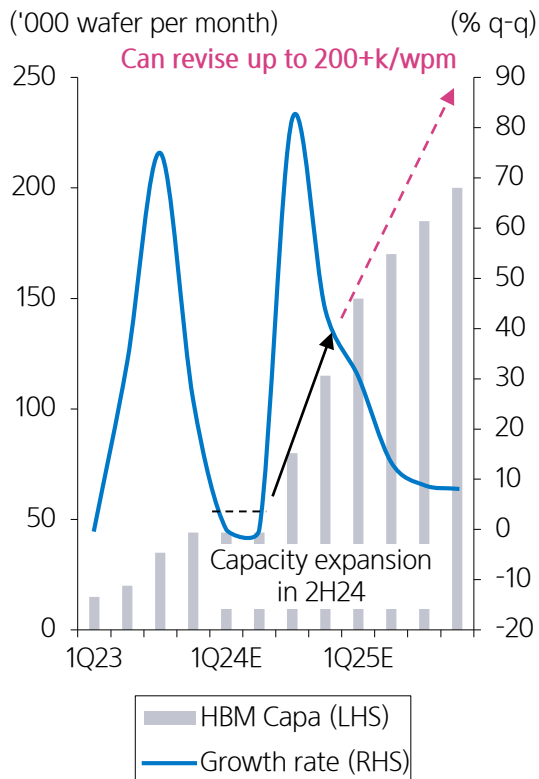
('000 wafer per month)



Source: Samsung Securities estimates

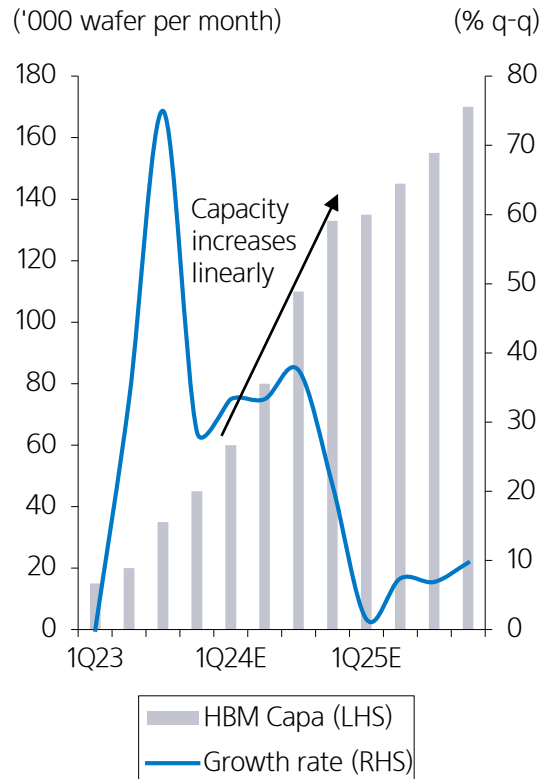
HBM demand and supply

Samsung: HBM Capa forecasts



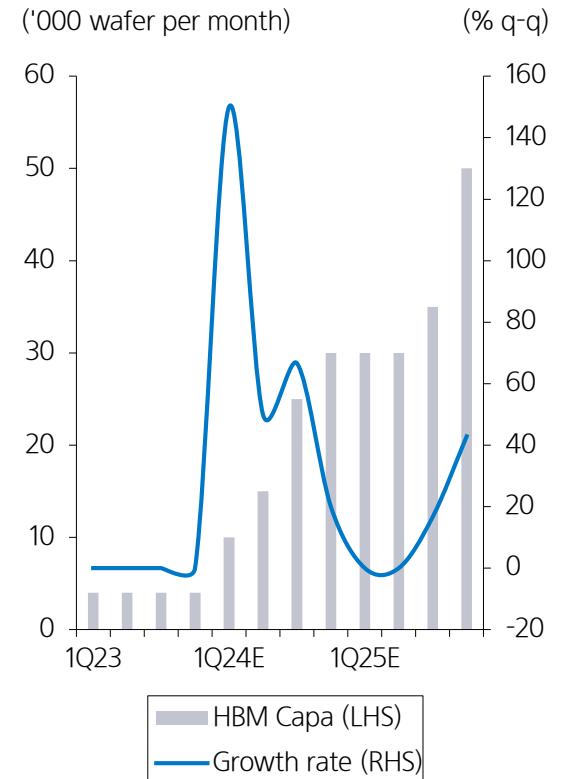
Source: Samsung Securities estimates

SK Hynix: HBM Capa forecasts



Source: Samsung Securities estimates

Micron: HBM Capa forecasts



Source: Samsung Securities estimates

HBM: Yield and the future (2025~)

HBM: Technology change by generation (Front end)

Core Die	HBM2e	HBM3	HBM3e	HBM4	HBM4e
Samsung Electronics	DRAM 1y	DRAM 1z	DRAM 1a	DRAM 1c	DRAM 1c
SK Hynix	DRAM 1y	DRAM 1z	DRAM 1b	DRAM 1b	DRAM 1c
Micron Technology	DRAM 1z	-	DRAM 1b	DRAM 1b	DRAM 1c
Logic Die	HBM2e	HBM3	HBM3e	HBM4	HBM4e
Samsung Electronics	DRAM 1y	DRAM 1z	DRAM 1a	Samsung Foundry 5nm	Samsung Foundry 2nm
SK Hynix	DRAM 1y	DRAM 1z	DRAM 1b	TSMC 12nm	TSMC 3/5nm
Micron Technology	DRAM 1z	-	DRAM 1b	DRAM 1b	TSMC 3nm

- Increase of bandwidth: Number of I/O will increase from 1,024 (HBM3e) to 2,048 (HBM4).
- Adoption of Logic/Foundry technology (HBM base/logic die): When chipmakers use foundry technology to manufacture logic die of HBM, it is possible to supply customized HBM by adding logic functions in addition to strengthening the memory controller function.

Source: Samsung Securities estimates

Easing of specification (HBM4 thickness: 720um → 775um)

Specification of HBM3 (JEDEC)

Parameter	Minimum	Nominal	Maximum	Unit
Width		10.975		mm
Length		10.975		mm
Height				
4-High	695	720	745	um
8-High	695	720	745	um
12-High	695	720	745	um
16-High	TBD	TBD	TBD	um

- We believe JEDEC will reduce the package thickness of HBM4 down to 775um for both 12-high and 16-high HBM4 stacks, making it easier.
- Given the eased terms on thickness, we expect the industry to continue its current practices (ie., TC-NCF, MR-MUF) for some time. Essentially, there is no need to adopt hybrid bonding for now.

Source: JEDEC, Samsung Securities

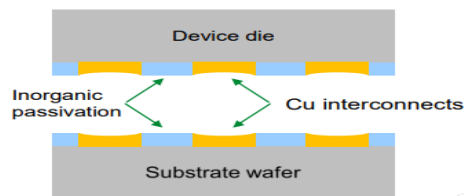
What is hybrid Bonding (Bumpless bonding)?

Hybrid Bonding process: Difficult to control dishing and particle

Hybrid Bonding Principle



Die Surface Preparation

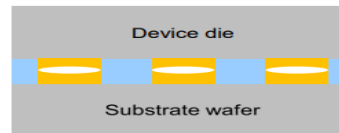


- Planarized passivation surface
- Slight dishing of Cu interconnects
- Cleaning and plasma activation of die and substrate wafers

Key Process Challenges:

- Passivation material selection
- Cu pad surface profile in CMP
- Activation of singulated dies

Die to Wafer Bonding

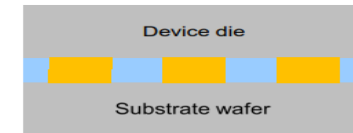


- Alignment and die placement
- Instant bonding between activated passivation surfaces
- Low bond force and time
- Sub micron placement accuracy
- Precise die tilt control
- Front-end cleanliness levels

Key Process Challenges:

- Sub micron placement accuracy
- Precise die tilt control
- Front-end cleanliness levels

Annealing



- Annealing of the bonded wafer
- Cu expansion to make contact
- Interdiffusion of Cu pads to create interconnect

Key Process Challenges:

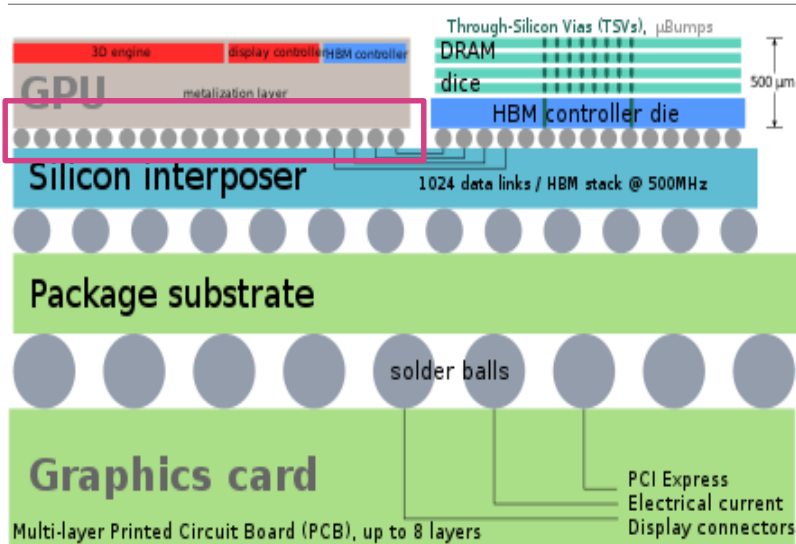
- Ensure adequate passivation bond strength
- Void free interconnect

- Hybrid bonding: High value-added tech of directly bonding between pads of copper wiring without bump, it improves electrical signal density and substantially reduces the gap between chips.
- The hybrid bonding process largely comprises: die surface preparation, die-to-wafer bonding, and annealing.
- Risks to bonding yields are predominantly dishing- and particle-related.

Source: BE Semiconductor, Samsung Securities

Will HBM makers use hybrid bonding in HBM4?

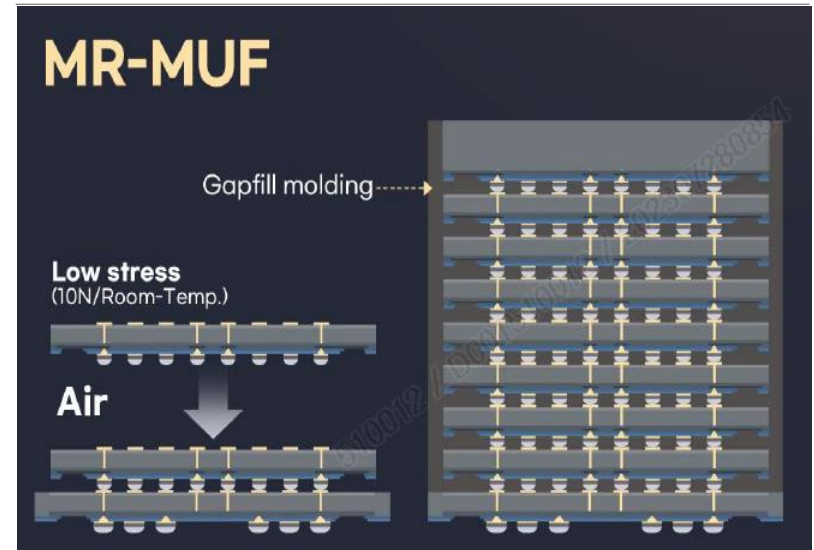
CoWoS: No multi-stacking process



- In CoWoS, hybrid Bonding is used to connect logic die and silicon interposer. It can minimize the gap between chips.
- However, only one chip is being connected to silicon interposer in CoWoS (2.5D Packaging). It doesn't need multi-stacking process.

Source: Google, Samsung Securities

HBM: Multi-stacking technology is required

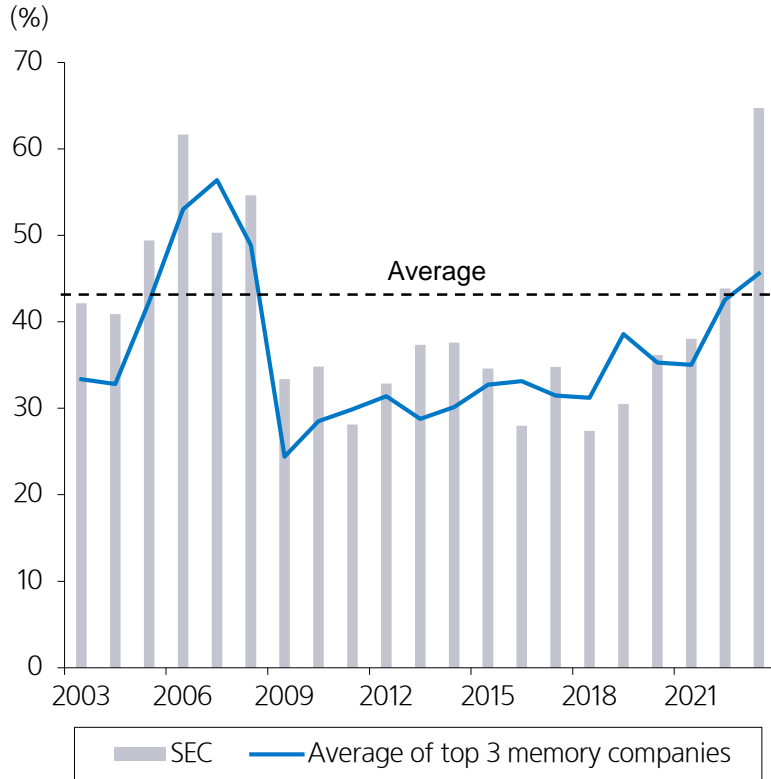


- The reason why hybrid bonding may not be adopted in HBM4: Time, Cost, Technology and eco-system
- In order to adopt hybrid bonding in HBM, it needs multi stacking technology. More technological advancement is required.

Source: Samsung Electronics, Samsung Securities

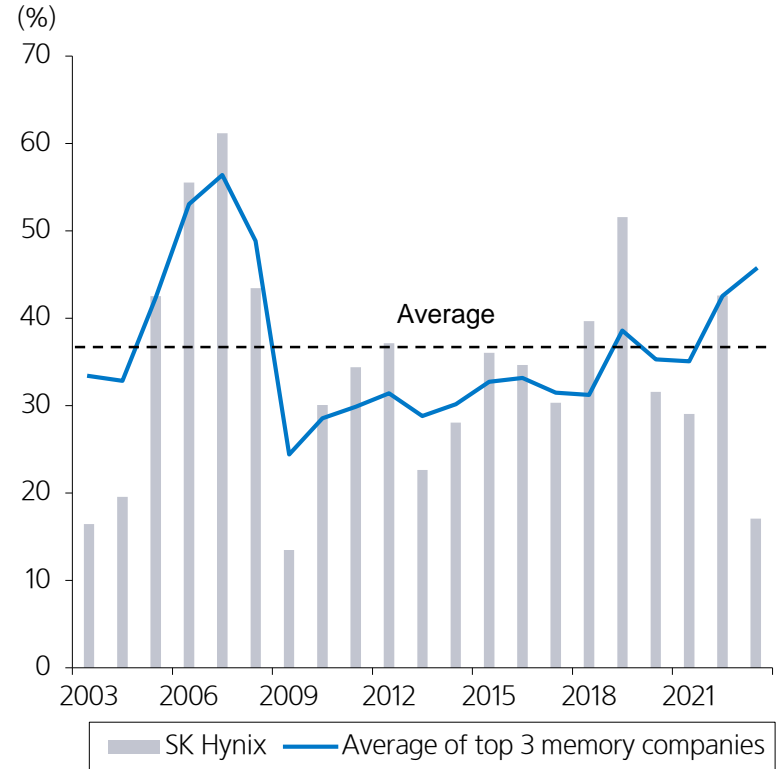
Discipline and the “fear factor”

Samsung: CAPEX / Sales (Memory)



Source: Company data, Samsung Securities

SK hynix: CAPEX / Sales

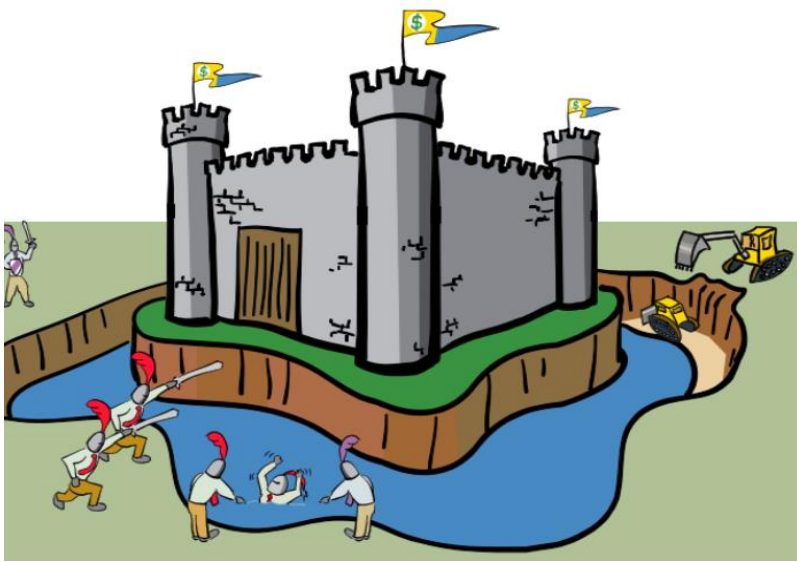


Source: Company data, Samsung Securities

Positive scenario: It is the supply, Bro.

- High bandwidth is critical for AI. Bandwidth = speed of bus * width of bus (Nvidia wants 1024+ over 32)
- Balloon impact: Memory shortage discounts upside in demand. What If Samsung increases the supply?
- Chain reaction: Tight supply and demand of commodity memory is inevitable
- CAPEX: We are likely to see the significant upside in CAPEX sooner or later.

Nvidia: Durable moat * high margin * strong FCF



Source: Google Image, Samsung Securities

Supply shortage inflates pricing and margin

GRAPHICS TECHNOLOGY LEADERSHIP AMD

HIGH BANDWIDTH MEMORY

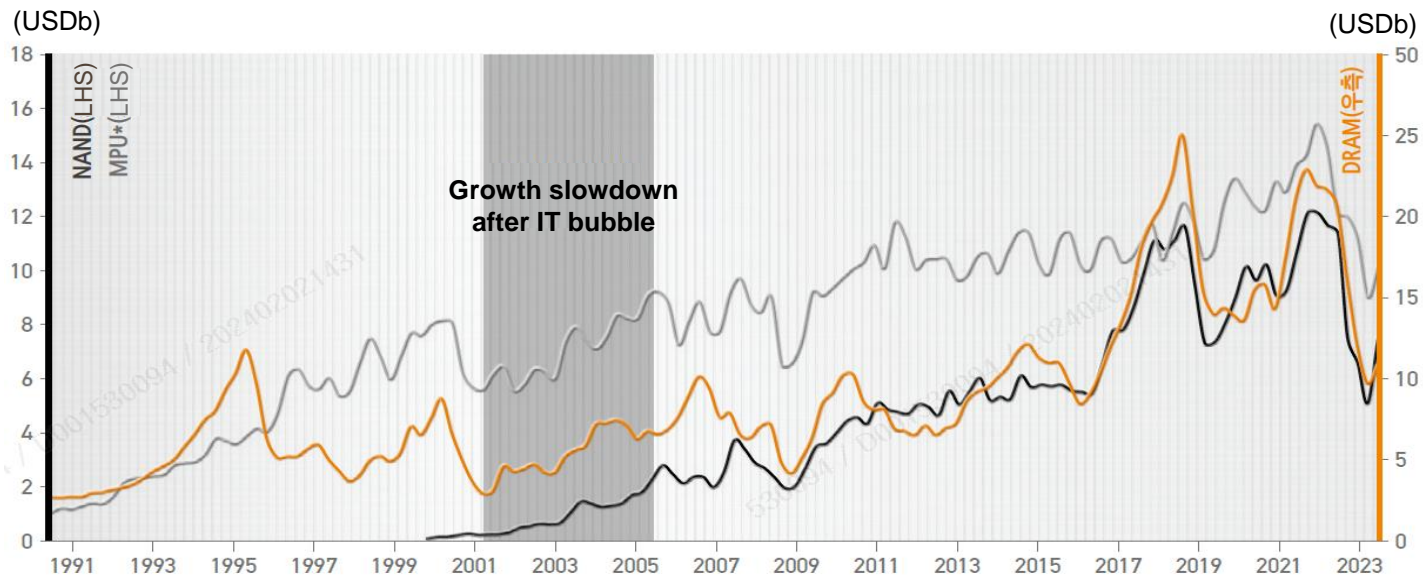
- ▲ First in the Industry with High Bandwidth Memory (HBM) Technology
- ▲ 3D HBM DRAM Die Stack on Silicon Interposer
- ▲ >3X Performance/Watt Compared to GDDR5
- ▲ >50% Power Savings Versus GDDR5

Source: AMD, Samsung Securities

Lesson from the past (feat: Internet adoption)

- No problem until 2003 (1999) → 2027 (2024): 1st 300mm ASML order by TSMC on July 2000
- Intel Timna project announced in 1999 and cancelled on Sep 2000
- Consumer interest changes faster than technology
- Internet bubble burst in 1 year. What about AI?

IT demand in the most significant slowdown after internet burst



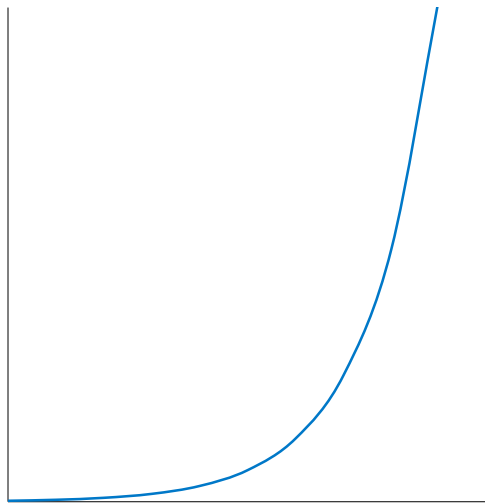
Source: WSTS, Samsung Securities

Negative scenario: Somebody is telling me a lie

- Engineers promise to present everything for infinite time and money
- Software evolution everyday. Hardware takes at least 1~2 years, after # of patches
- AI has more data today than 90s. How much more data (and cost) is necessary to perform well enough?
- Customer always wants best products at the best price. Demo always looks fantastic

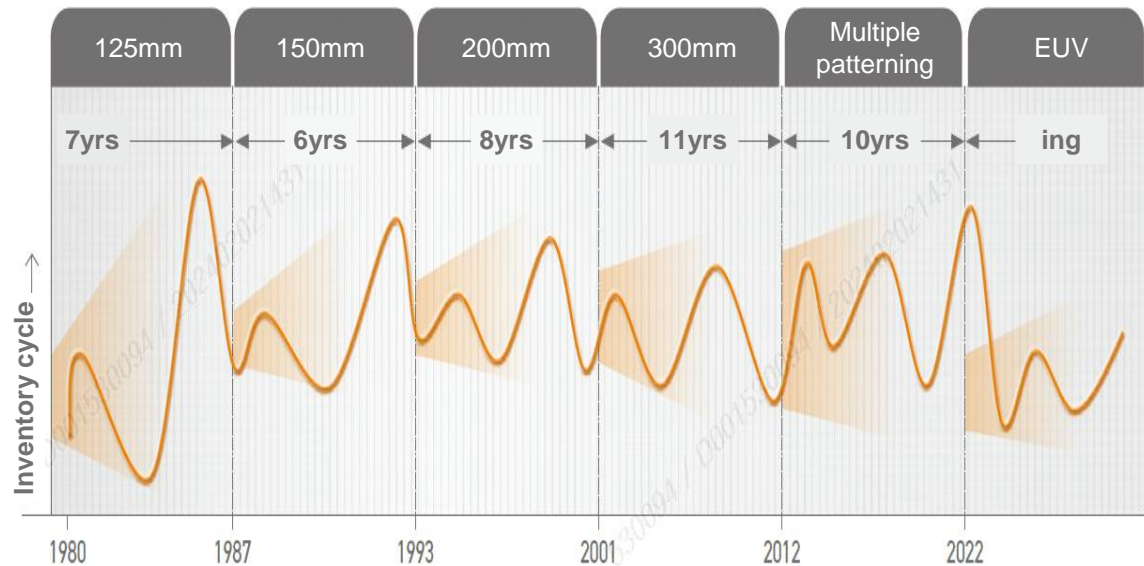
Something big is coming

(Number of user)



Source: Samsung Securities

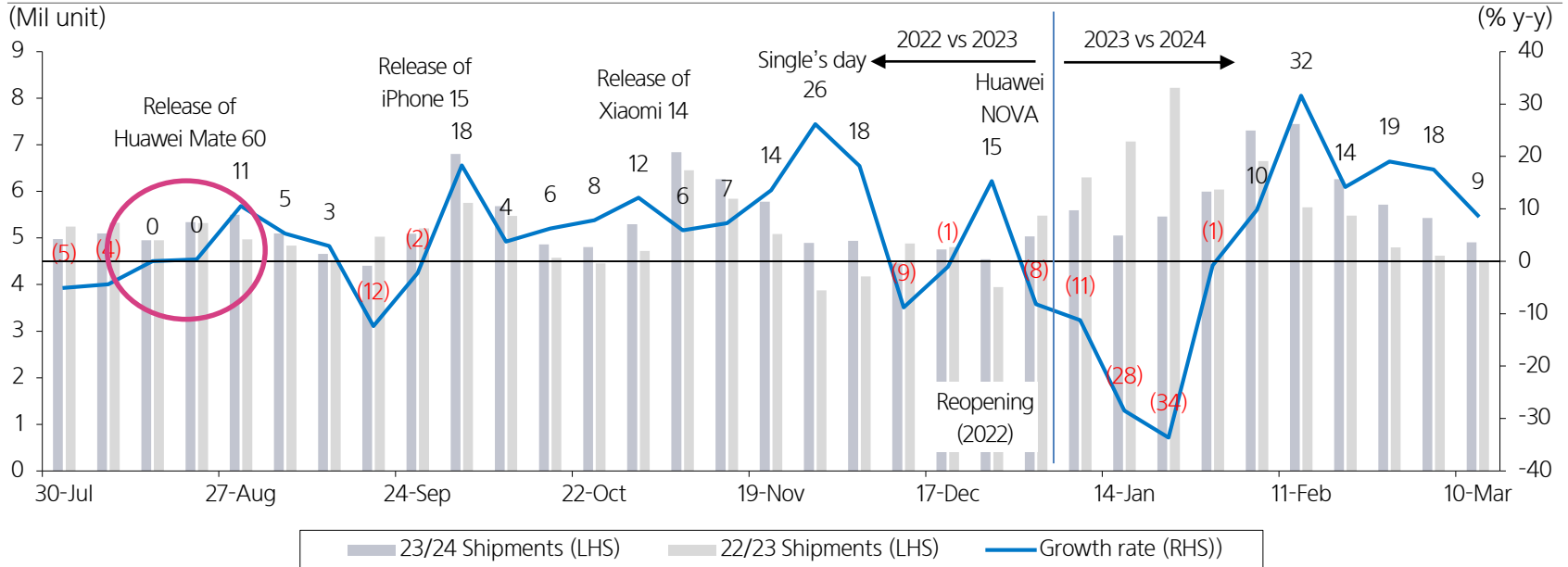
We need cheaper pricing based on better manufacturing process



Source: Samsung Securities

Demand recovery of China smartphone (Low basis vs recovery)

Smartphone sales in China, by week

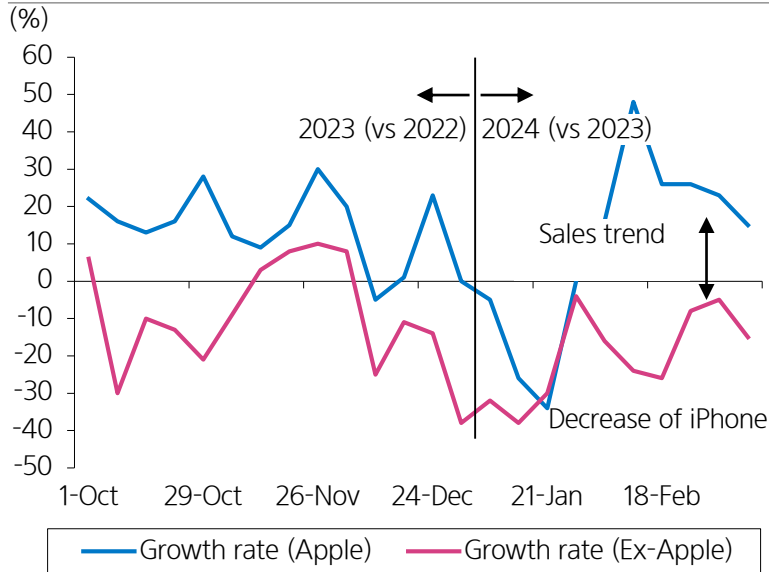


- A turnaround in Aug 2023 was caused by Huawei Mate 60 and Large restocking of Xiaomi. It lasted until Dec 2023. Apple still sluggish
- Reverted to a decline in Dec 2023. Order also declined. The shipment trend began to differ from vendors
- Another turnaround in Feb 2024. Maintaining 10+% growth y-y since Feb.

Source: Industry data, Samsung Securities

iPhone shipments continued to decrease in February

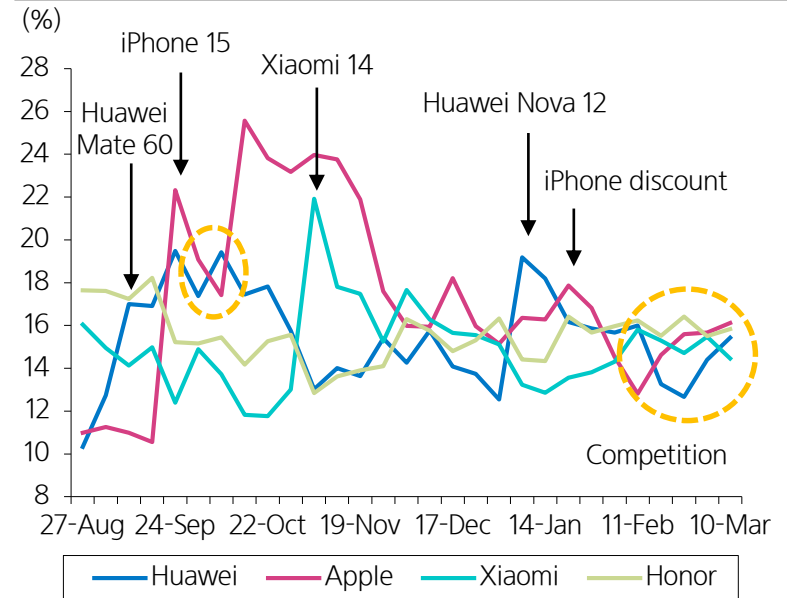
Growth rate of China smartphone sales (y-y, %)



- Poor performance of iPhone in China (After 3rd week of Sep, 2023).
- Growth rate turned negative after Nov 2023 (Nov: Low basis)
- Reverse growth rate widened to 38% y-y. Recently, reverse growth has eased to within 20%.

Source: Industry data, Samsung Securities

Smartphone market share trend, by week

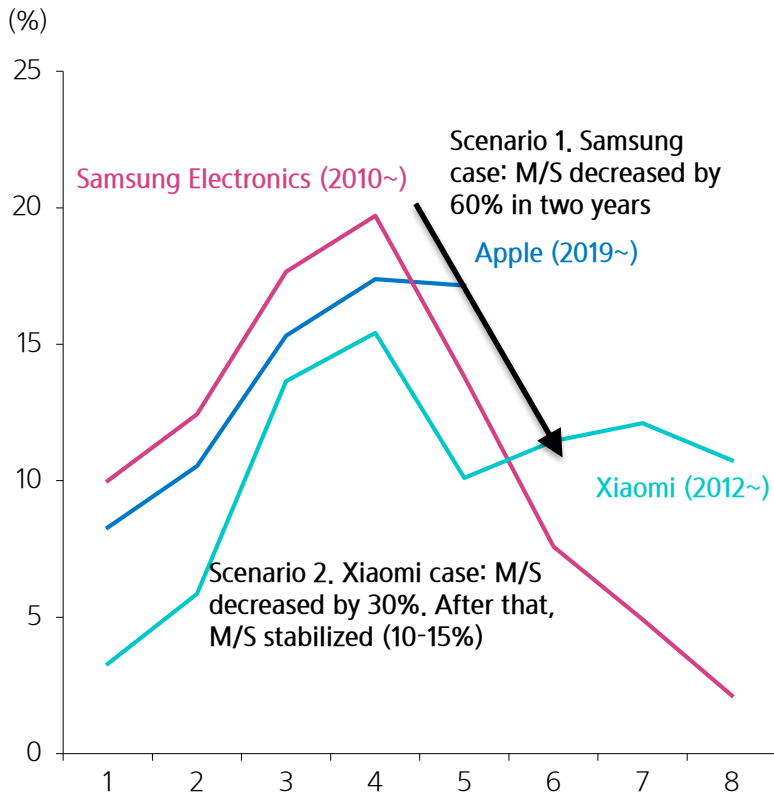


- iPhone sales in China continued to remain sluggish even after its release in the 3rd week of September.

Source: Industry data, Samsung Securities

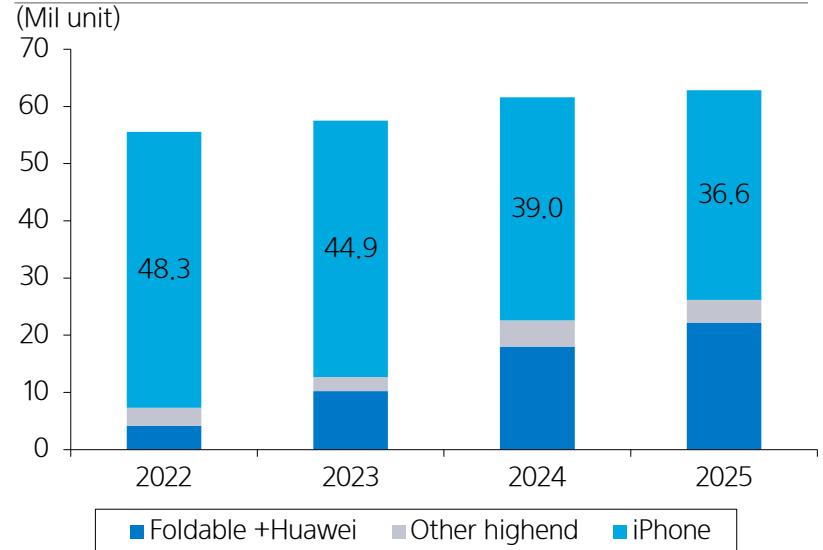
Scenario analysis of iPhone market share in China market

Scenario Analysis (Samsung, Xiaomi case)



Source: TechInsights, Samsung Securities

iPhone portion: 87% to 60%



	Foldable	Huawei	Foldable + Huawei	Other high-end	iPhone	TAM
2022	3.3	2.2	4.2	3.1	48.3	55.6
2023	7.0	6.0	10.2	2.5	44.9	57.5
2024	10.0	12.0	18.0	4.6	39.0	61.6
2025	12.0	15.0	22.2	4.0	36.6	62.8

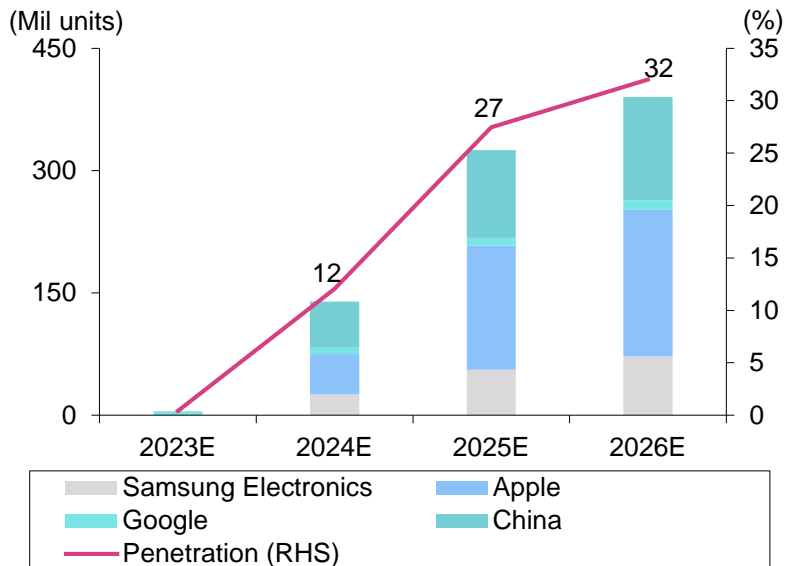
Assumption: Portion of high-end smartphone (>\$500) in China - 20% in 2022, 22% after 2023

Source: Techinsights, Samsung Securities

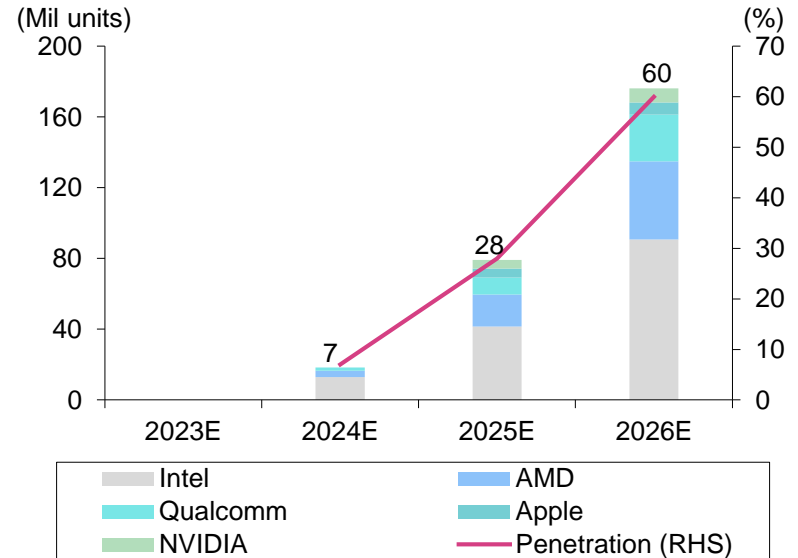
Penetration rate of On device AI: 60% for PC and 30% for mobile in 2026

- 390 million units of smartphones and 180 million units of PCs should adopt more NPU in 2026 for language models
- ASP of processors will increase by \$30-\$40 due to increase in NPU adoption
- 25.8 trillion won of added value in system semiconductor market will be attainable

AI smartphone shipments



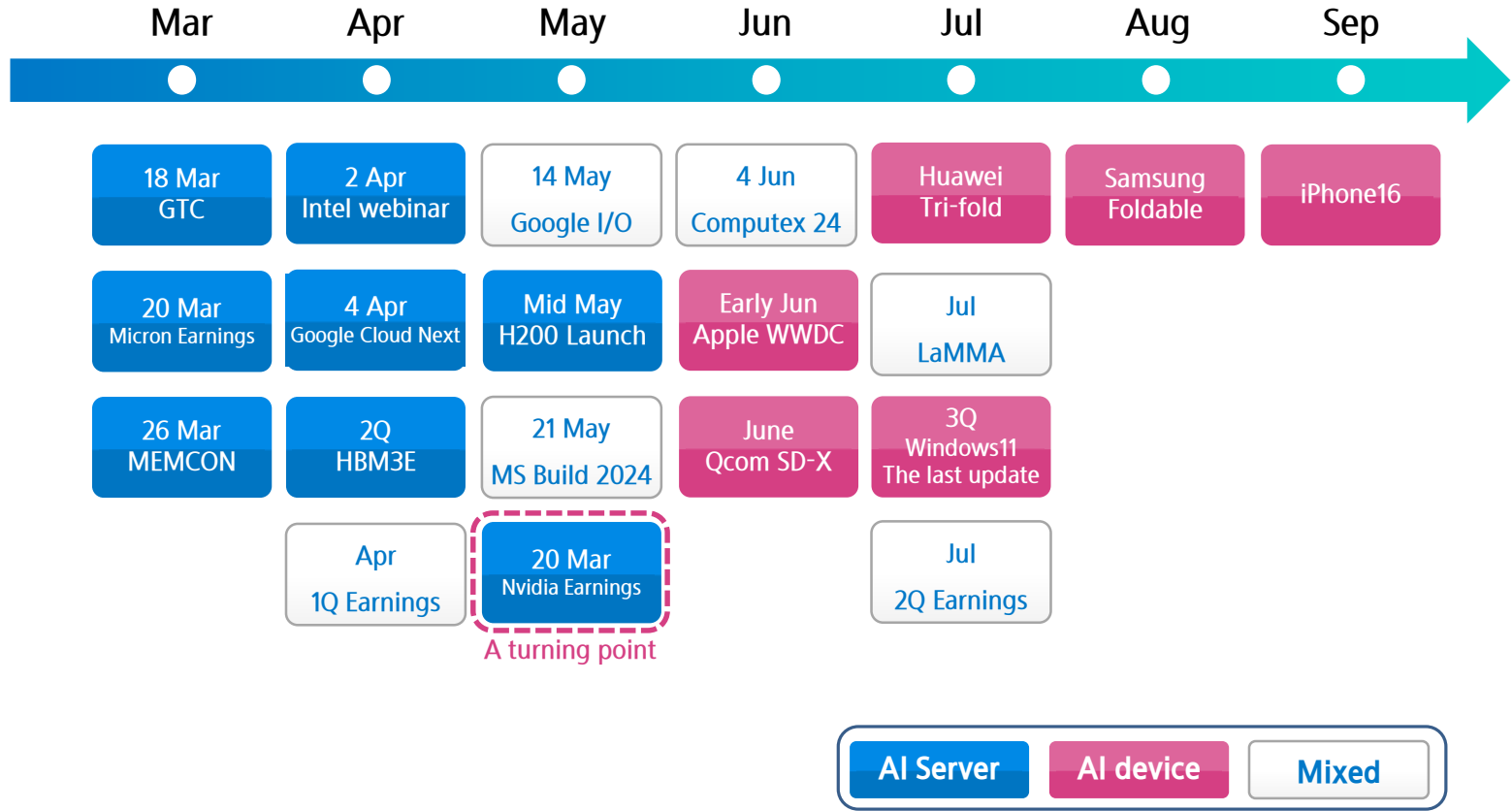
AI PC shipments



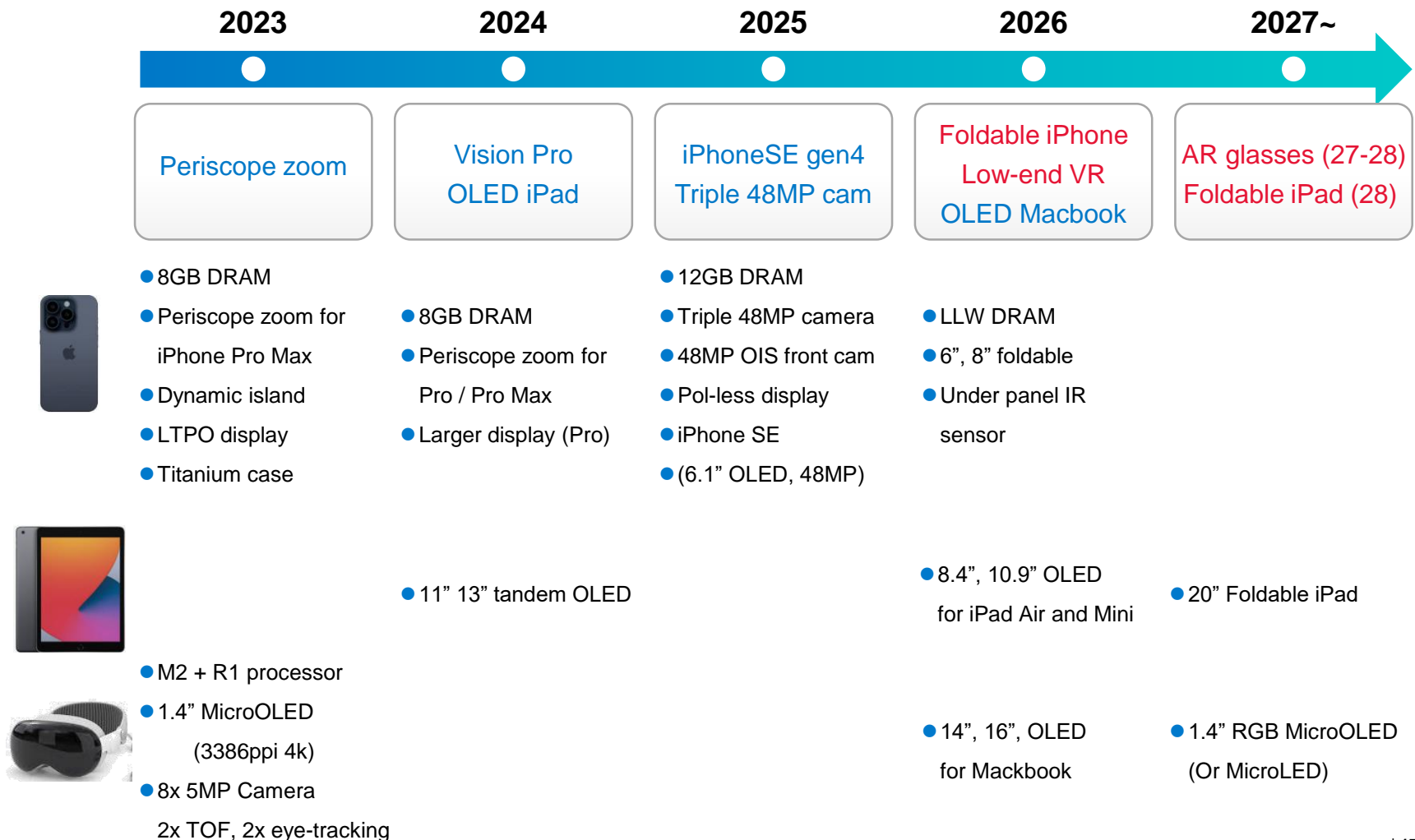
Source: Samsung Securities estimates

Source: Samsung Securities estimates

2024 timeline: Rising interest in AI device in June



Apple Roadmap: Vision Pro and Foldable devices are the milestones



Investment idea: Increasing yield (SKH) + Large-scale investment (SEC)

SK Hynix Value Chain

- 1) Key Idea: Limited fab space → Increasing yield + More outsourcing of backend process (Legacy DRAM/NAND)
- 2) Investment idea: Nextin, Intekplus, Hana Micron

SEC Value Chain

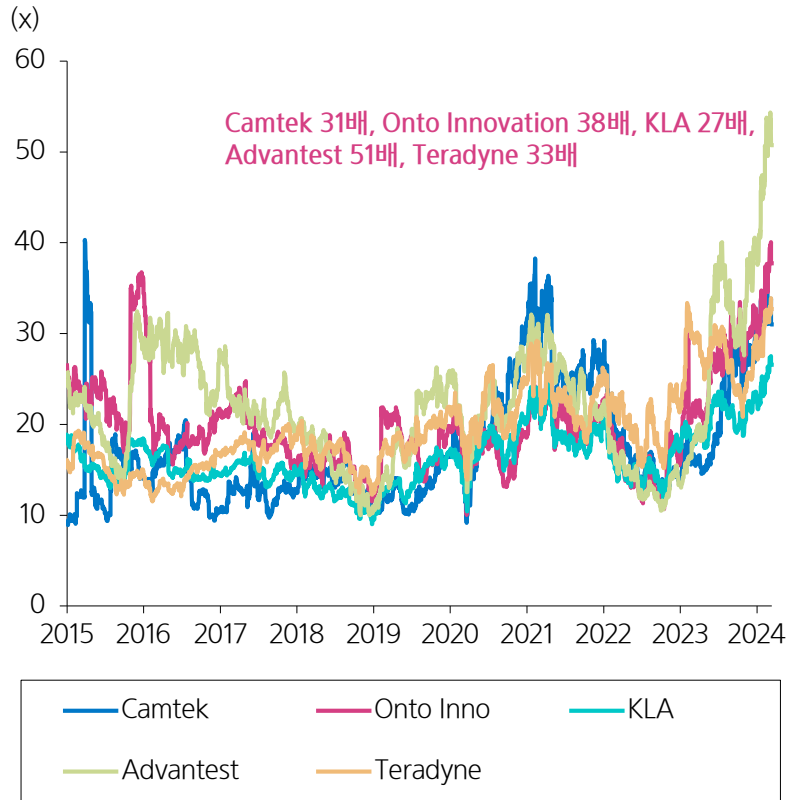
- 1) Key Idea: Uncertain whether to use MR-MUF or not. One sure thing is that SEC will invest largely on HBM capacity to increase M/S.
- 2) Investment idea: PSK Holdings, Koh Young

Semiconductor materials

- 1) Key Idea: CMP step increases in HBM (Frontend + Backend)
- 2) Investment idea: Soulbrain

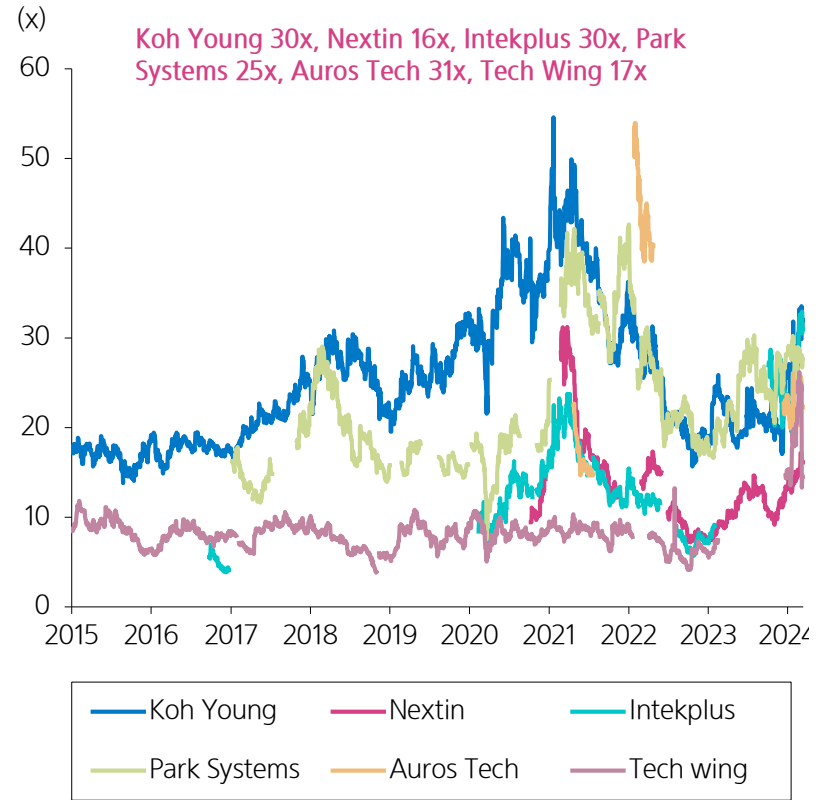
Process control equipment: Korea companies are trading cheaper

Global equipment maker (process control): 12m Fwd P/E



Source: Bloomberg, Samsung Securities

Korea equipment maker (process control): 12m Fwd P/E



Source: Quantwise, Samsung Securities

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