

Semiconductor Manufacturing

- When Supply Meets the Demand

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Where is Semi Manufacturing Heading?

- Economies are still booming, but...
- Semiconductor Supply is catching up the demand
- Geo-political turbulence -> **uncertainty**
 - Failing M&As
 - Supply restrictions (ZTE, Huawei)
- China's aggressive positioning in Semiconductor Manufacturing
 - Can they be successful?
- New technology drivers:
 - Datacenter & AI
 - Memory



Annual IC Billings Growth: Weekly Moving Averages vs. VLSI Weather Reports

The chart displays the annual IC billings growth over time, comparing two moving averages (13-week and 52-week) with VLSI weather reports. The 13-week moving average (purple line) shows more volatility, while the 52-week moving average (orange line) shows a smoother trend. The background is shaded light blue for positive growth and light red for negative growth. Key events are labeled: In Downturn: Jul 15, Storms break: Aug 15, Cold-Front: Oct 15, S-D in Glut: Nov 15, S-D Balanced: Jan 16, S-D Shortage: Jul 16, Bubbly: Jul 17, Hot: Mar 17, Sunny: Jan 17, Hot: Nov 16, Sunny: Aug 16, In Upturn: Jul 16, Bottoming Apr 16, Cloudy & Cooling: Jan 18, Peak called: Mar 18.

Week Ending	Sales 13 Wk MA (%)	52 Wk MA (%)
Jun-15	0.0	6.0
Sep-15	-6.0	2.0
Dec-15	-5.0	-1.0
Mar-16	-8.0	-4.0
Jun-16	-2.0	-5.0
Sep-16	4.0	-2.0
Dec-16	8.0	1.0
Mar-17	12.0	5.0
Jun-17	18.0	10.0
Sep-17	25.0	15.0
Dec-17	32.0	22.0
Mar-18	28.0	25.0
Jun-18	25.0	25.0
Sep-18	25.0	25.0
Dec-18	25.0	25.0

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Memory leads the way up and down

SEMICONDUCTOR SALES

(worldwide sales growth, in percent)

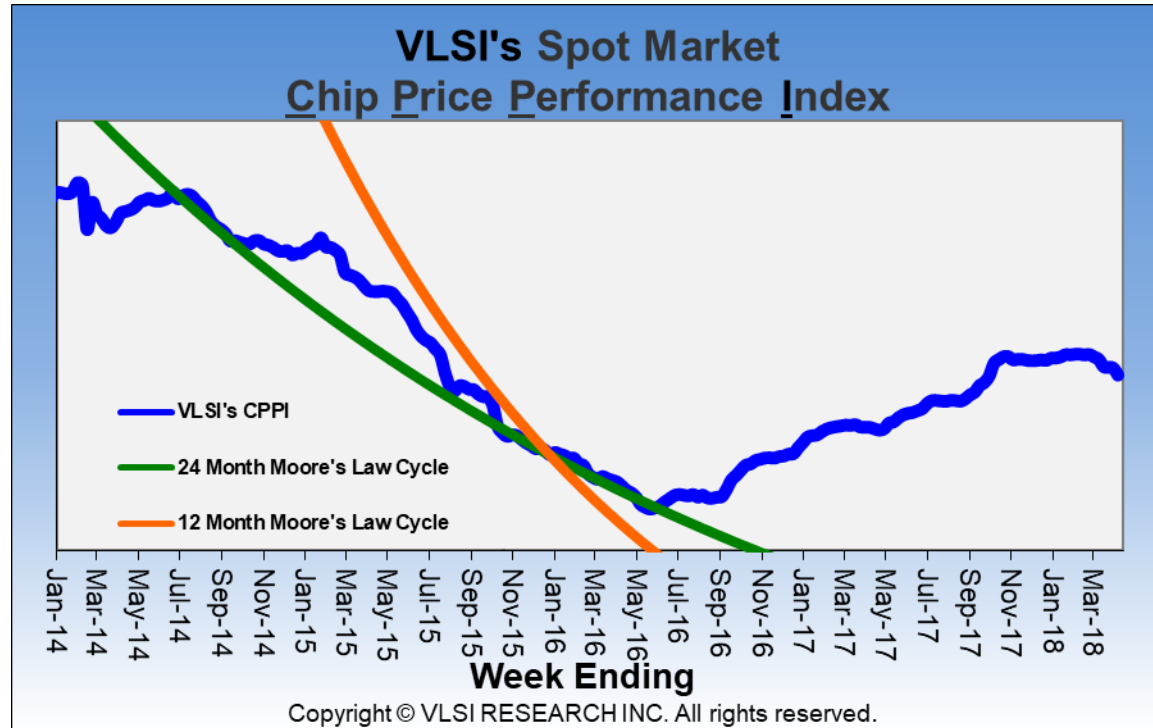
	2015	2016	2017	2018	2019
Analog	1.7%	5.9%	10.9%	8.5%	1.3%
DRAM	-4.4%	-8.3%	74.5%	27.7%	-14.7%
NAND Flash	2.5%	11.1%	46.6%	16.3%	-10.1%
MPU	-3.6%	3.9%	6.2%	6.5%	2.2%
Other Logic	-1.4%	-1.3%	6.8%	8.5%	2.3%
Discrete, Opto & Other	3.0%	-0.9%	9.7%	8.2%	-0.5%
Total	-1.3%	4.1%	20.8%	12.8%	-3.5%

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CPPI defies Moore's Law – but turning lower?

- Chip Price/Performance
 - Cost/Performance Declining
- Profits still soaring
- CPPI hovering at a very high level
 - Signs of turning



Capex has become top heavy

- Still very healthy capex growth
 - Driven by memory
- Top six companies account for nearly 70% of total spending

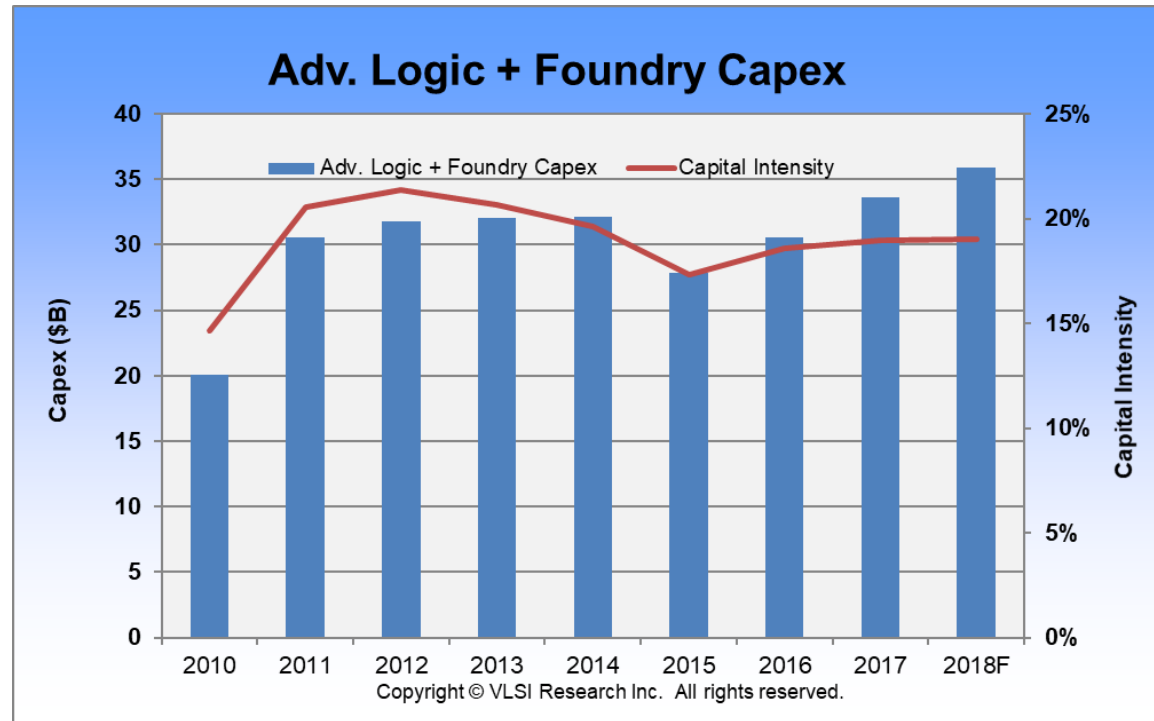
2017 TOP CAPEX SPENDERS

(Capital expenditures by company, \$B, ranked by 2018 Forecast)

	2015	2016	2017	2018F
Samsung	13.1	11.5	24.2	24.0
Intel	7.3	9.5	11.8	14.0
TSMC	8.1	10.2	10.9	11.0
SK hynix	6.0	5.2	8.1	11.0
Micron Technology	4.4	6.2	5.8	8.5
Toshiba/WD	3.3	4.7	6.5	7.3
GLOBALFOUNDRIES	4.1	2.5	2.8	4.5
SMIC	1.6	2.6	2.5	1.9
UMC	1.9	2.8	1.5	1.1
Sony	1.7	0.7	0.8	1.0
Others	17.7	19.1	25.1	30.7
Total	69.2	75.1	99.9	115.0
<i>y-o-y growth</i>	-1%	8%	33%	15%

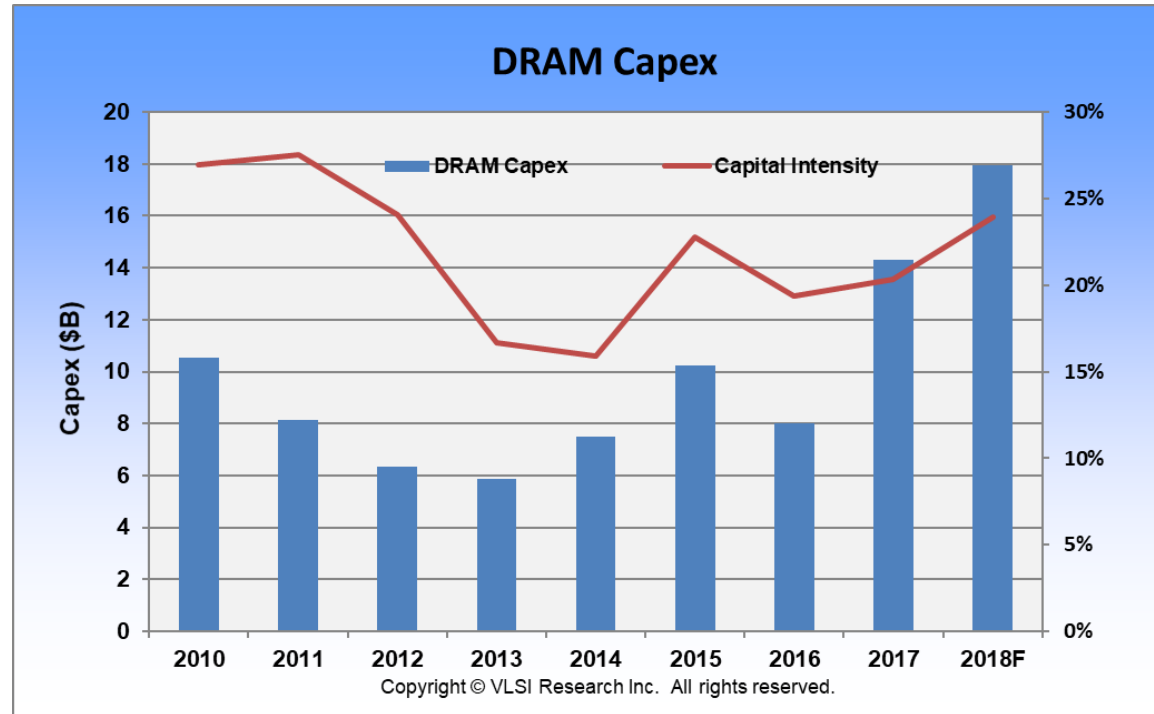
Foundry and Adv. Logic Capex

- Race to 7nm
- EUV will be implemented at 7+nm
- Spending is not out of line historically



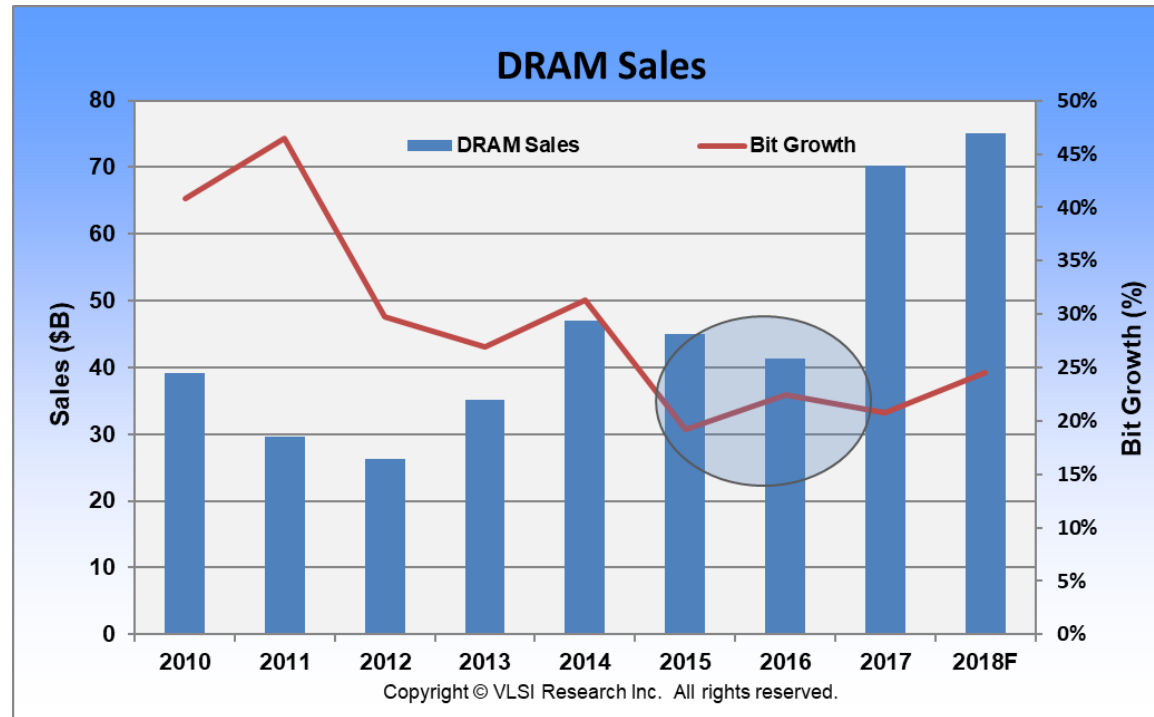
DRAM Capex

- DRAM Capex nearly doubled to \$15B in 2017
- Samsung accounted for more than half of DRAM spending
- Other suppliers will have to respond with increased spending in 2018 to prevent share losses



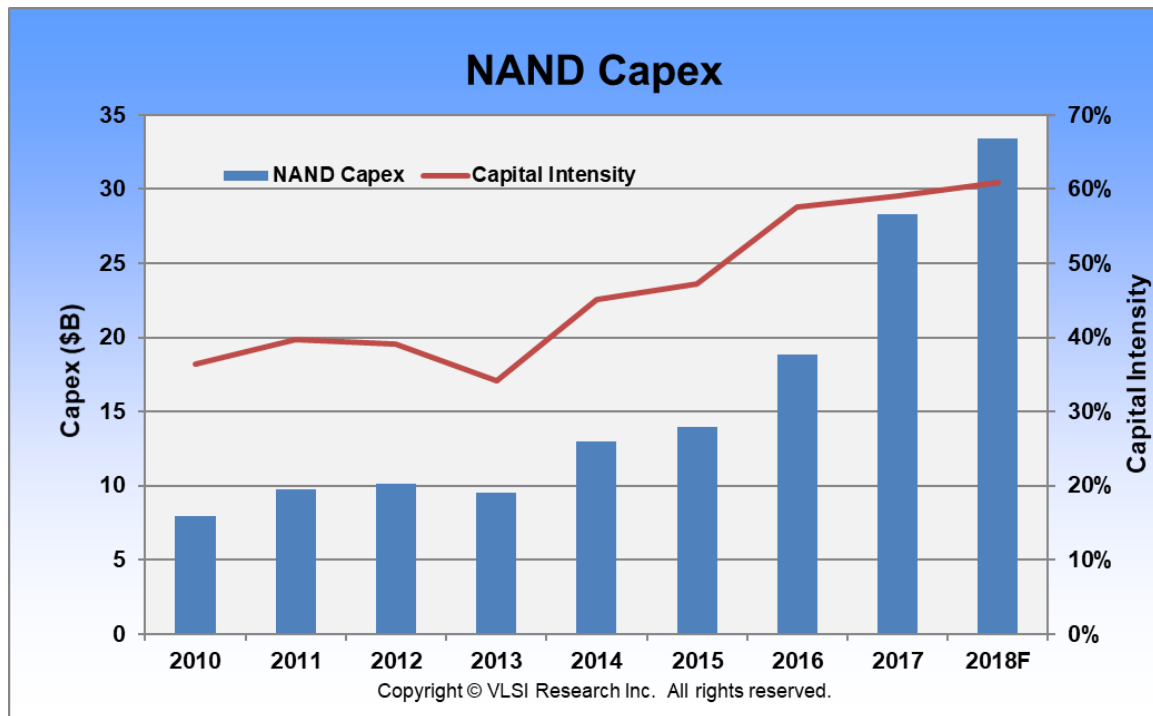
DRAM pricing has become more inelastic

- DRAM content has not changed significantly despite big swings in pricing
- Moving towards an environment where content is more a function of user experience than just cost



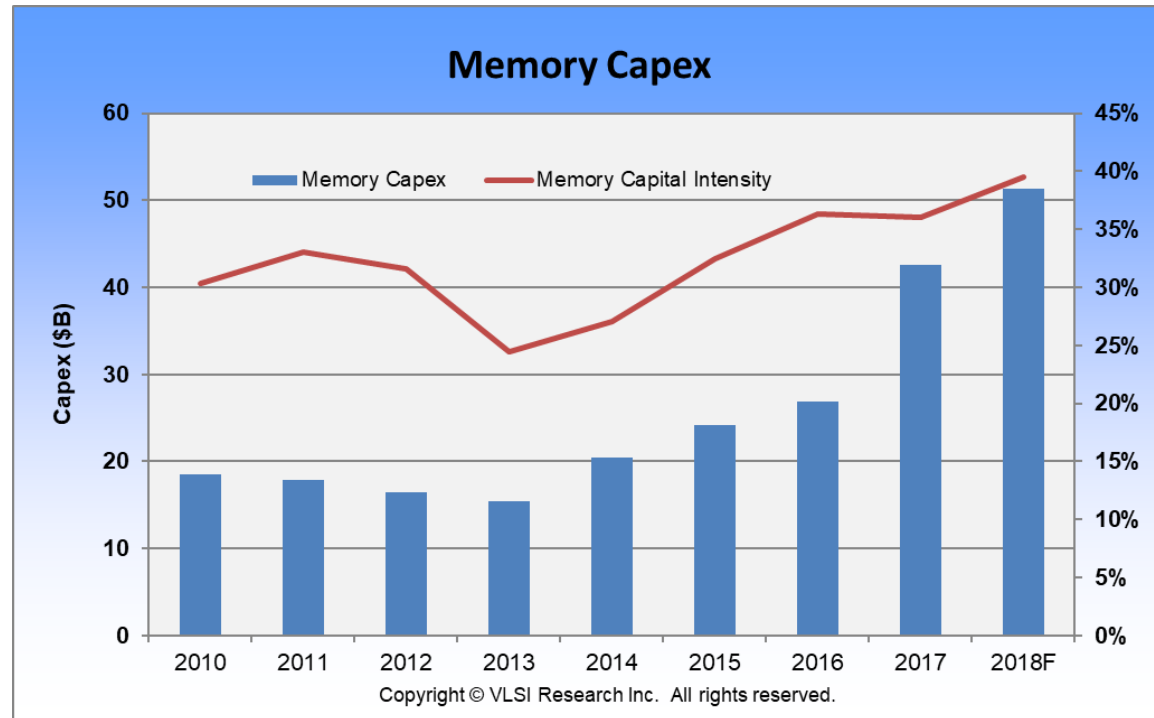
NAND/NVM capex reaches \$30B

- Samsung accounted for 40% of spending
- Some Chinese investment in 2018
- Capital intensity is extremely high



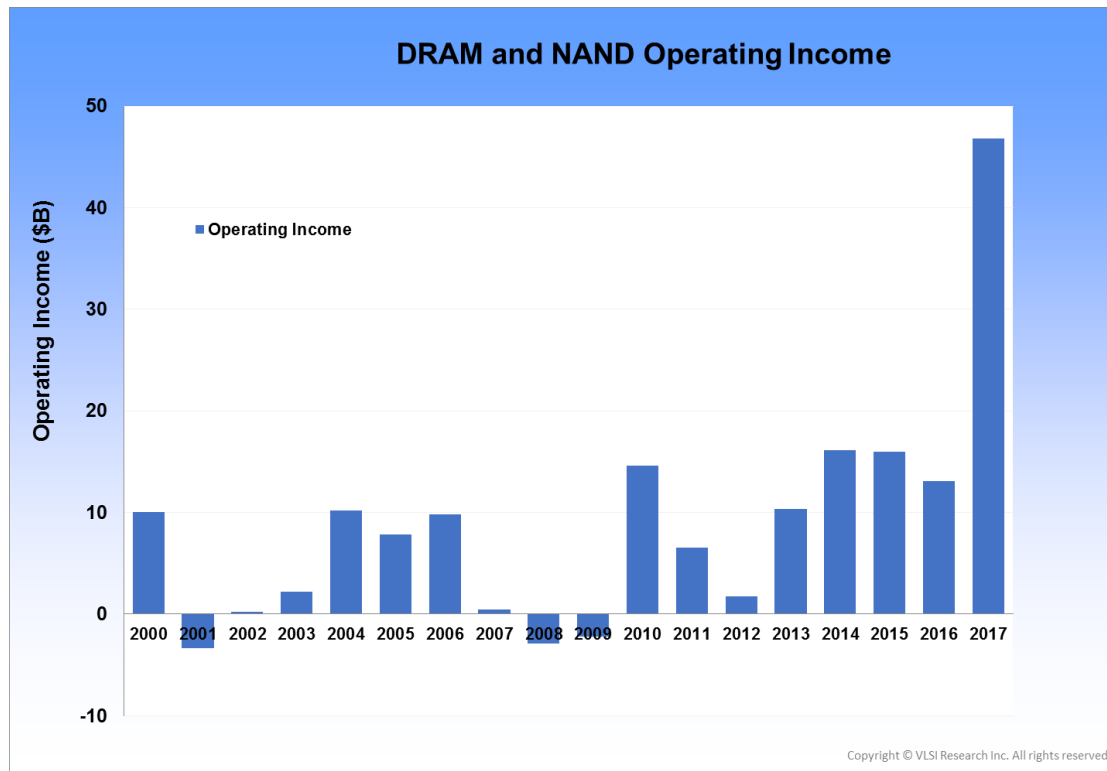
Memory Capex is soaring

- Memory Capex hit \$42B in 2017, more than 50% of total spending
- This level of spending cannot go on forever
 - But forever can be delayed...Gordon Moore



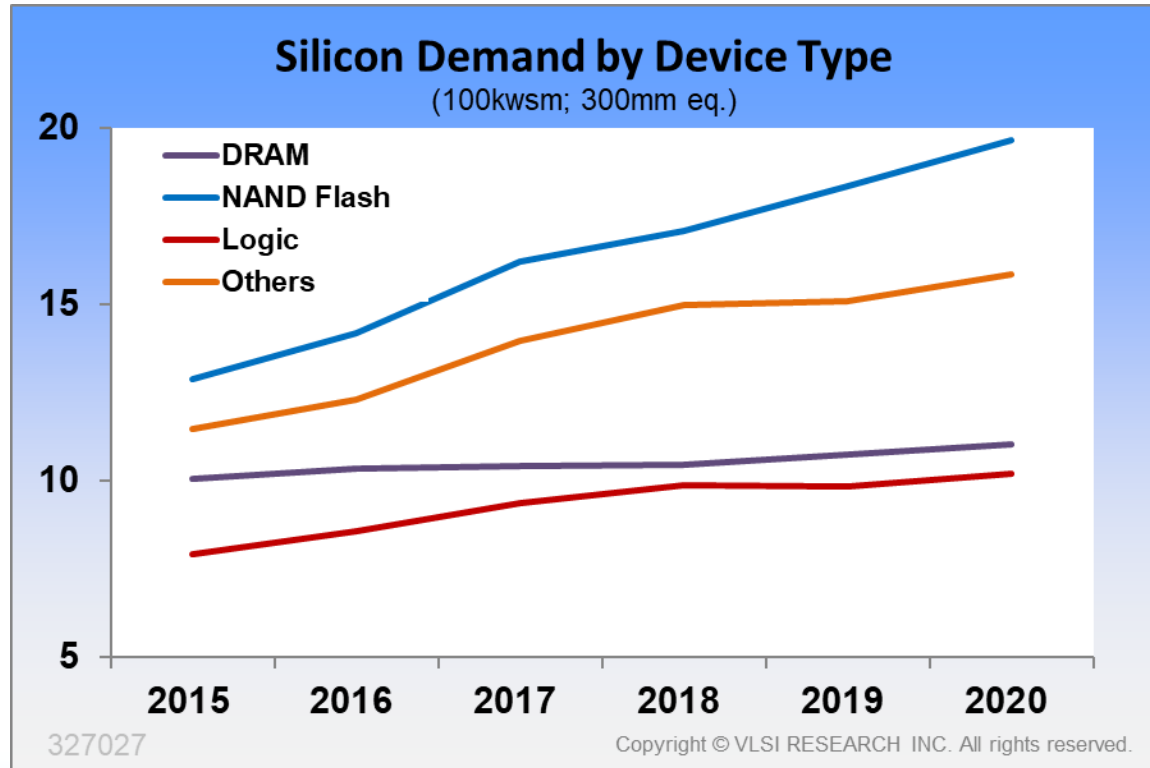
Memory profits rocketed to \$47B in 2017

- They have the money and they will spend it
- Driven by high ASPs
- Memory has become essential
 - *Not optional*



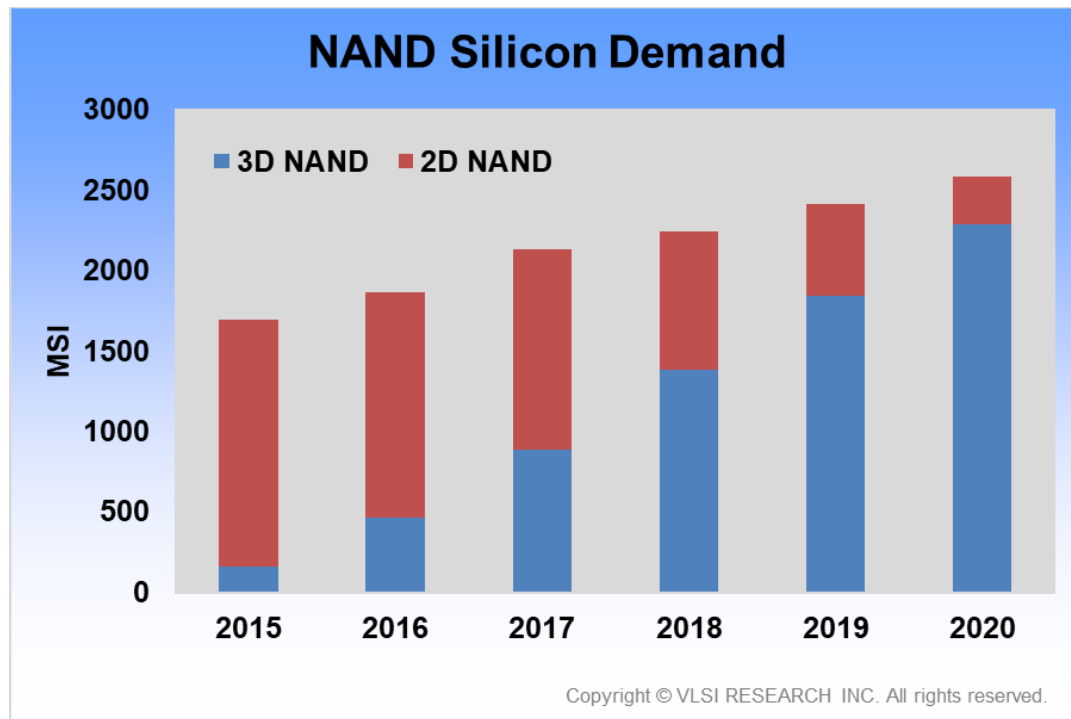
Silicon Demand

- Silicon Demand for NAND and Other devices is growing
- DRAM and Logic are lot more muted
- Overall 5yr CAGR is 5.0%



3D will account for two-thirds of NAND Capacity in 2018

- 2D to 3D crossover in process
- The pace of conversions will slow as more capacity moves to 3D



Equipment Trend for 2018 and 2019

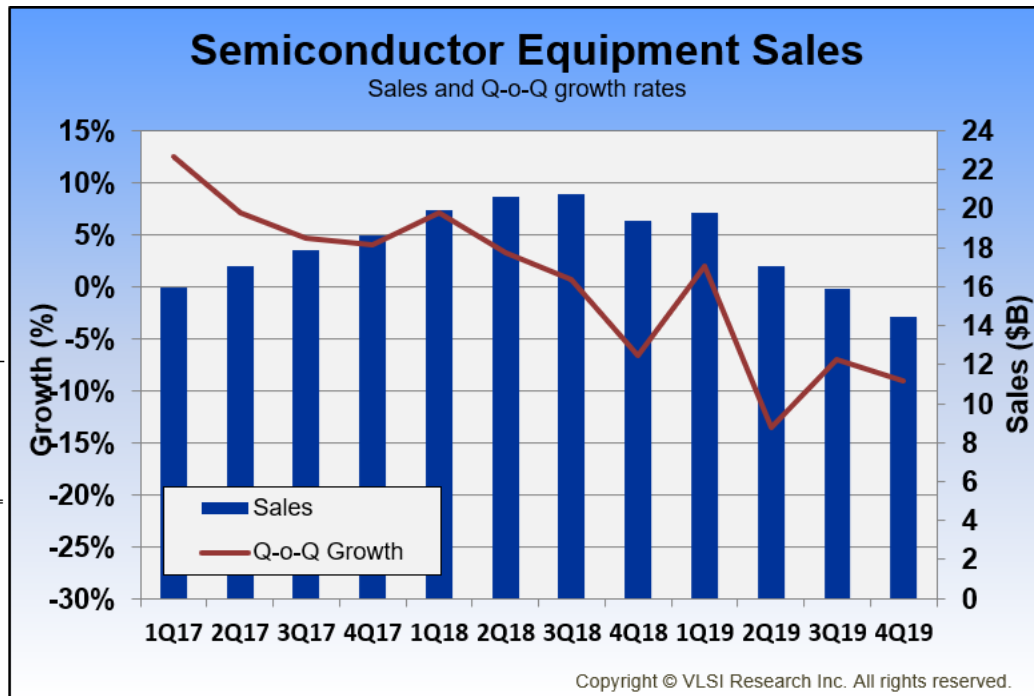
Equipment markets continue positive trend in 2018; Growth is slowing and turning negative in 2019

Semiconductor Equipment Sales

(worldwide sales, \$M, CY 2017 - 2019)

	2017	2018	2019
Wafer Process Equipment	47326.3	56748.8	44509.7
<i>y-o-y growth</i>	33%	20%	-22%
Test & Related Equipment	4741.8	5241.9	4768.3
<i>y-o-y growth</i>	20%	11%	-9%
Assembly Equipment	4390.5	4940.0	4569.7
<i>y-o-y growth</i>	21%	13%	-7%
Total Systems	56458.6	66930.7	53847.7
<i>y-o-y growth</i>	31%	19%	-20%
Service	13082.6	13764.6	13370.8
<i>y-o-y growth</i>	22%	5%	-3%
Total Semiconductor	69541.1	80695.3	67218.5
<i>y-o-y growth</i>	29.2%	16.0%	-16.7%

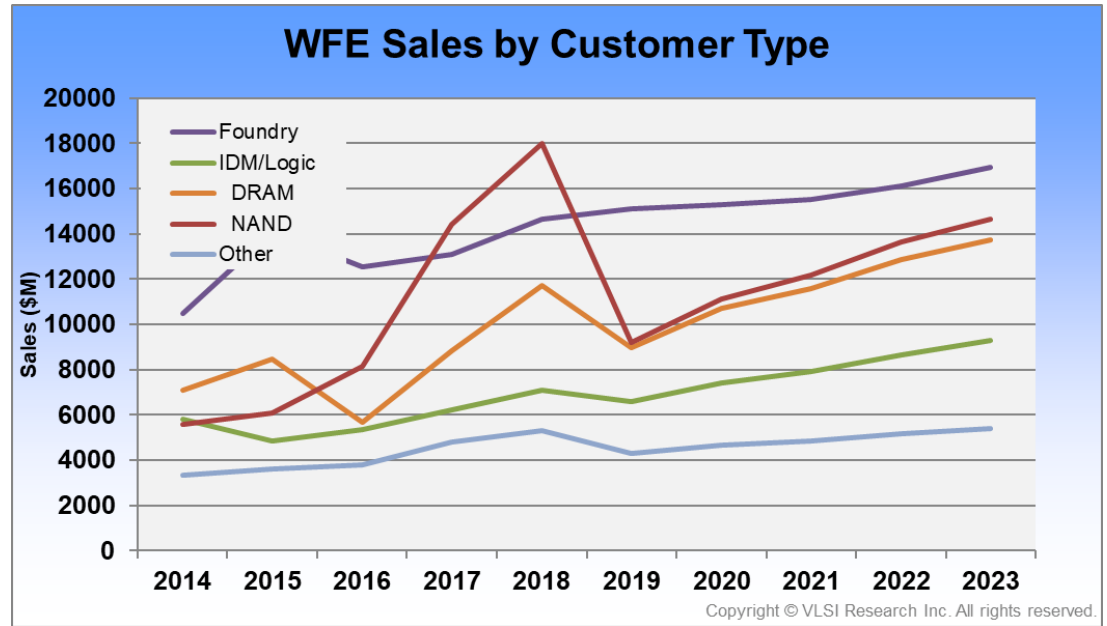
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Old Normal is The New Normal

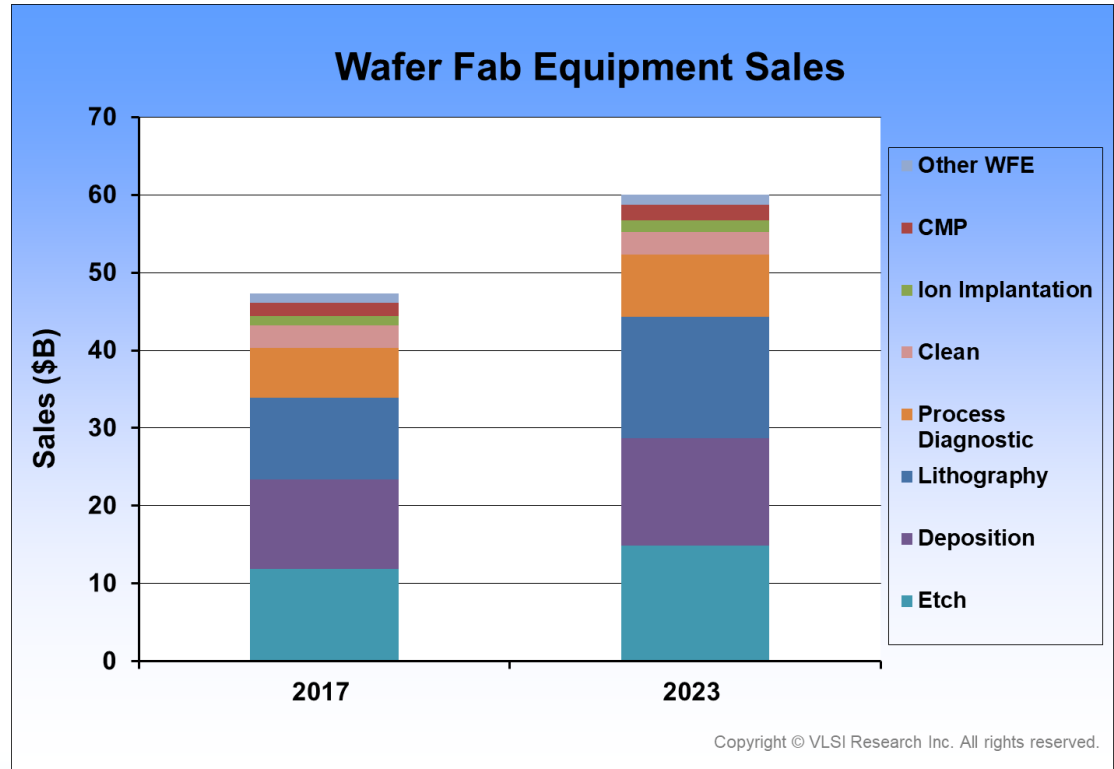
WFE Outlook Scenarios

- 20% decline expected in 2019
 - Retreating to mid-\$40B
- Memory is most volatile segment
 - It always is



Etch, Deposition, and Lithography Lead WFE

- Etch, Deposition, and Lithography are in the \$10B club in 2017
- Etch & Deposition driven by memory
- Lithography
 - EUV has strong customer pull
 - 7nm implementation



VLSI's View

- Semiconductor demand is rolling over to slower growth
- Pressure on memory prices is increasing
- 2018 is good but slowing
- Wafer demand is steady
 - Varies by segment
- Equipment is driven by Lithography, Etch and Deposition
- 2019 Downturn is likely and driven by memory



Questions?

... and backup slides



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Semiconductors

Sales (\$M)

Sales (M Units)

Pricing (\$)

Silicon Demand

Regional Distribution

Packaging Demand

Electronics & Macroeconomy

Reticles

Design Completions

Historical Ratios & Utilization Rates

Diffusion Rates of Chip Making

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Chip Market Research Services
Equipment Database

IC Mfg Equipment Revenue History and Forecast

Mkt Shr & Fcst	Suppliers	
Total		
WFE	MS Yr	MS Qtr
ATE	MS Yr	MS Qtr
Assembly	MS Yr	MS Qtr

Equipment Unit Shipments

HB-LED MFG. EQPT

Background Material

IC Captive Equipment Supplier

IC Regional Equipment Consumption

Equipment Appraisals

Revenue History by Supplier

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