



# **Semiconductor Test Landscape - An Overview -**

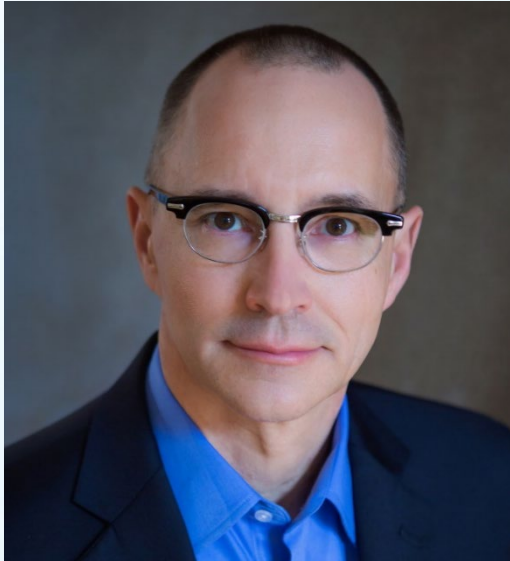
**Jerry Broz, Ph.D.**

**SWTest and SWTest Asia Conference General Chair**

**SVP Technology Development  
International Test Solutions**



# Speaker Biography



**Jerry Broz, Ph.D.**

General Chair for SWTest Conferences

SVP Technology Development  
International Test Solutions

## BIOGRAPHY

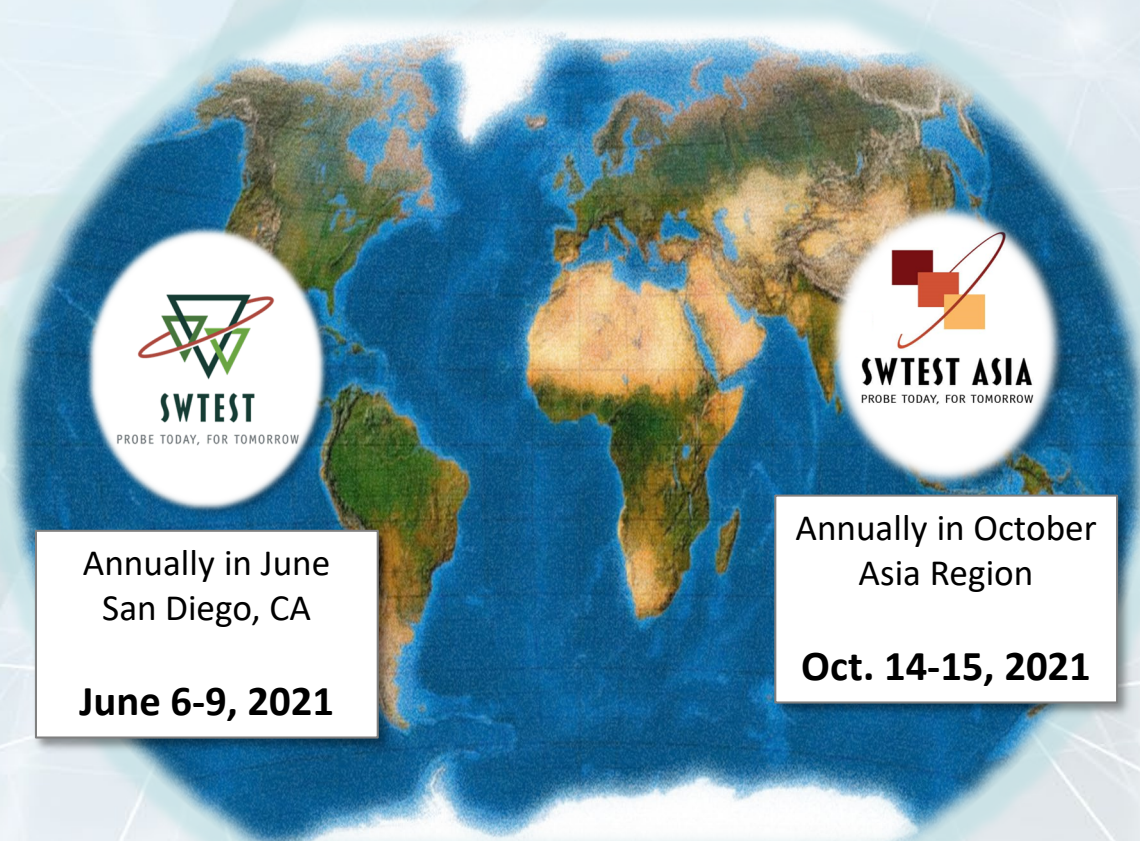
- Dr. Jerry Broz works as the Sr. Vice President of Technology Development at International Test Solutions (ITS). From 2003 to 2016, Dr. Broz worked at ITS where he served as VP of Applications and Sr. Manager for Worldwide Product Support. From 2016 to 2018, he was the Sr. Technical Director for MJC Electronics, Corp.
- For over 10-years he has been the General Chair of the Semiconductor Wafer Test (SWTest) Conference held in San Diego, and SWTest Asia Conference held in Taiwan
- Dr. Broz has authored numerous award-winning publications and holds multiple patents pertaining to wafer-level and package-level test. Dr. Broz received his Ph.D. in Mechanical Engineering from the University of Colorado at Boulder.
- Dr. Broz is a Senior Member of IEEE, an IEEE Golden Core Member, and Co-Chair of the Probes Technical Working Group for the EPS-IEEE Heterogeneous Integration Roadmap Initiative.



# A few words about SWTest Conferences

- **SWTest Conferences are Probe Technology Forums**
  - Wafer Test Professionals and Probing Technologists.
  - Practical solutions to real problems faced by test engineers.
  - End users from IDM and OSAT make up more than 30% of attendees at each conference.
- **Thirty-Two Combined Years of Probe Technology**
  - SWTest conferences have had more than 11K+ attendees in San Diego and Taiwan to discuss probe technology.
  - SWTest Asia brings a “workshop style” conference to the Asia Semiconductor community.
  - Premier exhibits and supplier attendance all in one spot !
- **Informal and Networking Conferences**
  - Focused technical exchange in a relaxed setting
  - Great social activities and informal discussions
  - Benefit golf tournaments that support student travel grants
  - Women in Engineering initiatives
  - Meet new people and have a little fun !
- **Due to travel restrictions and quarantine requirements both SWTest Conferences were cancelled for 2020.**

**More than 11K+ total attendees  
combined in 32 years !**

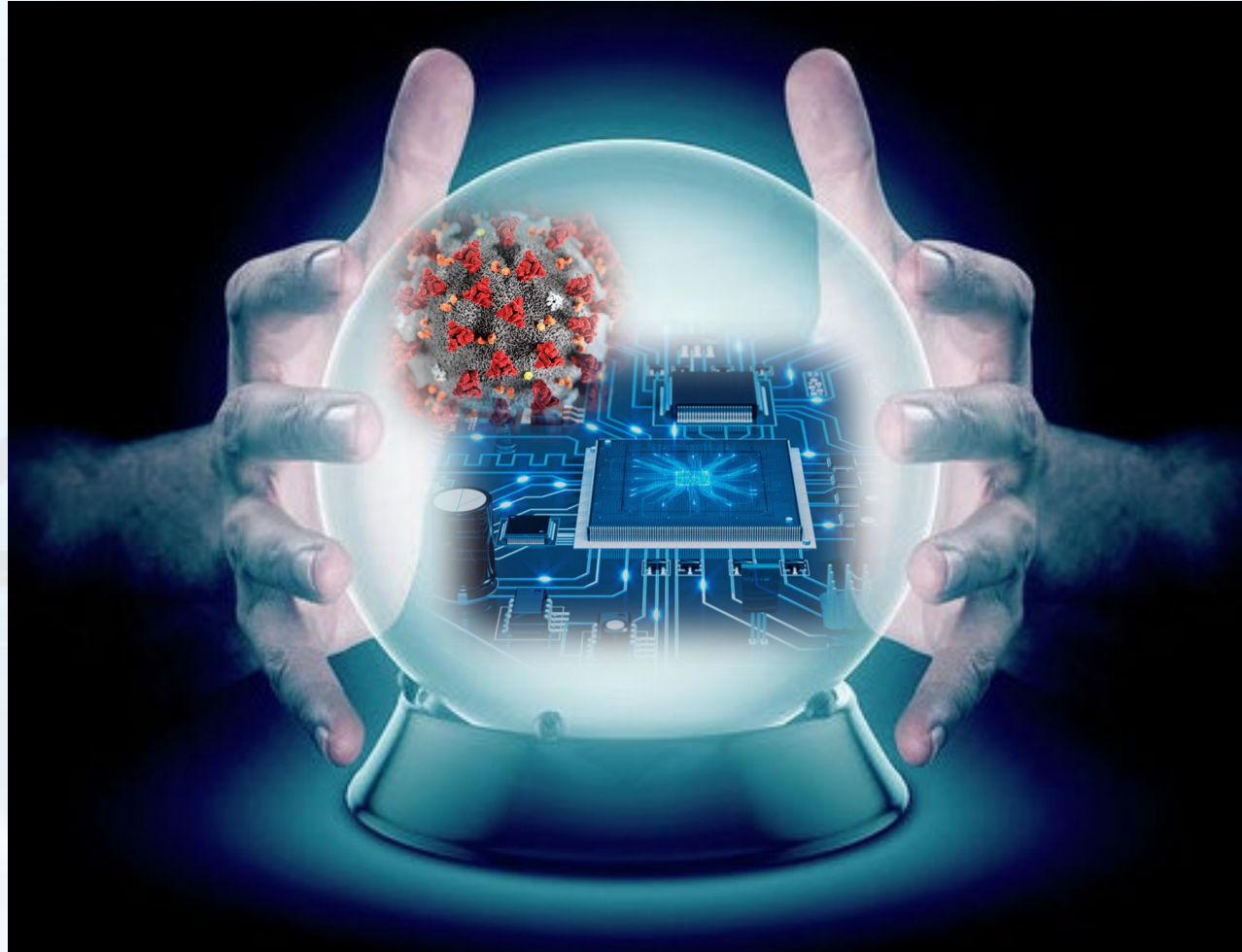


# Agenda

- **Everchanging Semiconductor Landscape**
  - Pre COVID-19 Metrics
- **Weathering Through the Storm**
  - Post COVID-19 Metrics
- **In Closing ...**

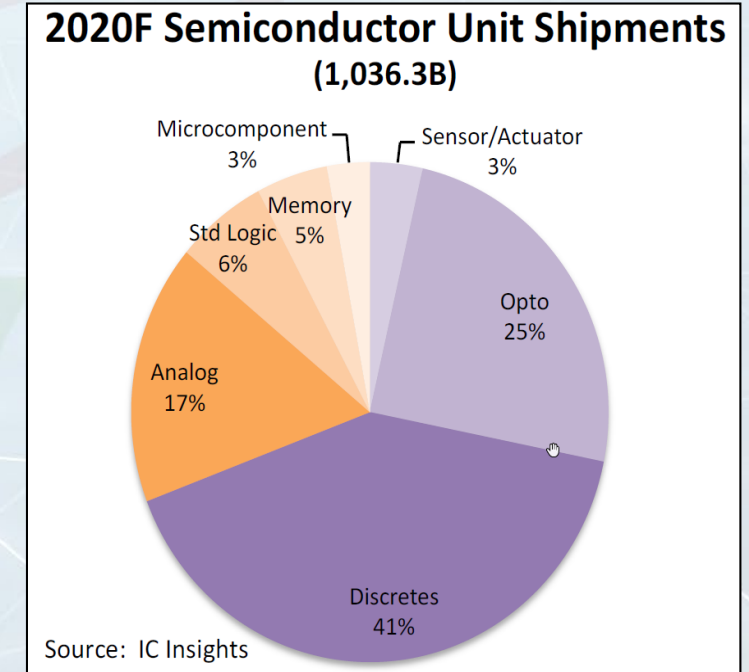
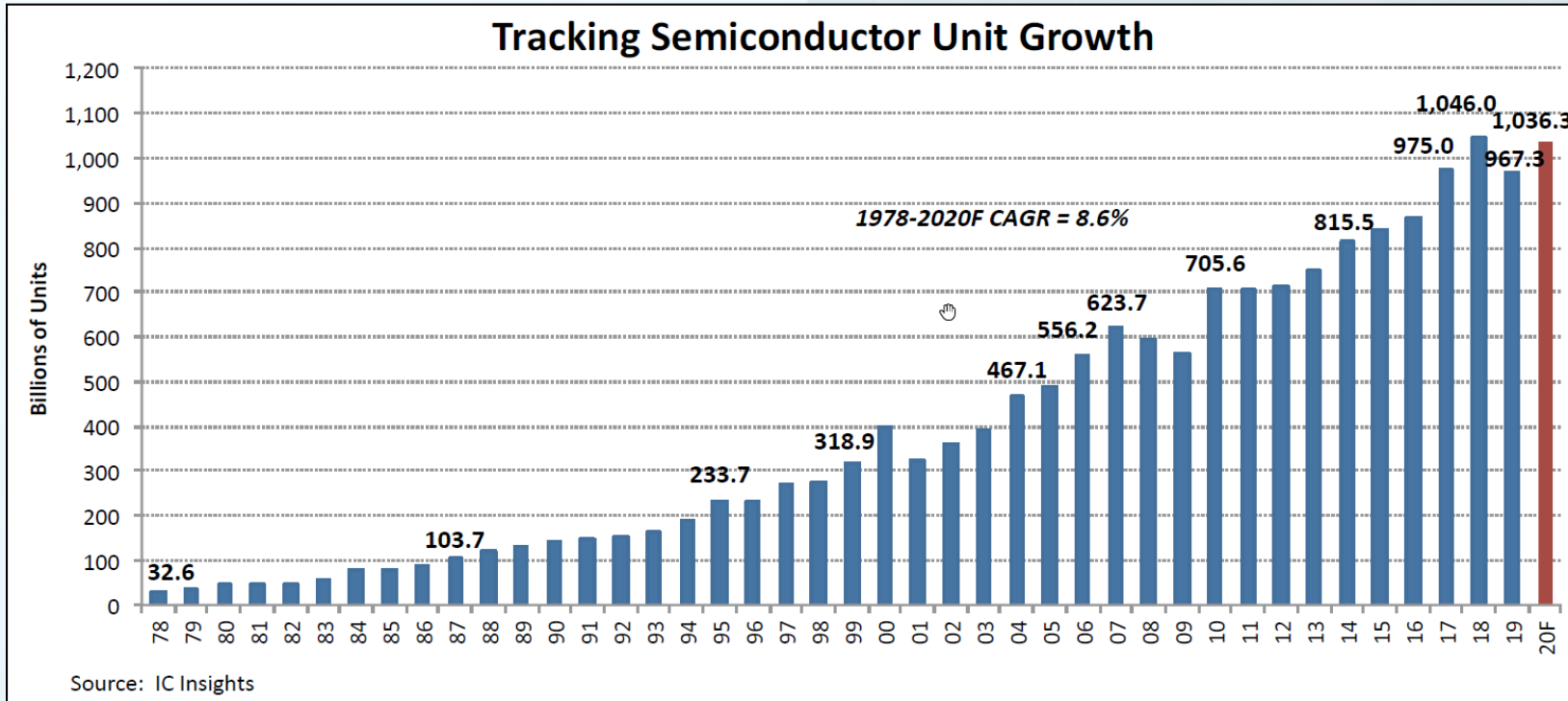


# Ever Changing Semiconductor Landscape



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# Trillion Units were Forecast for 2020 !



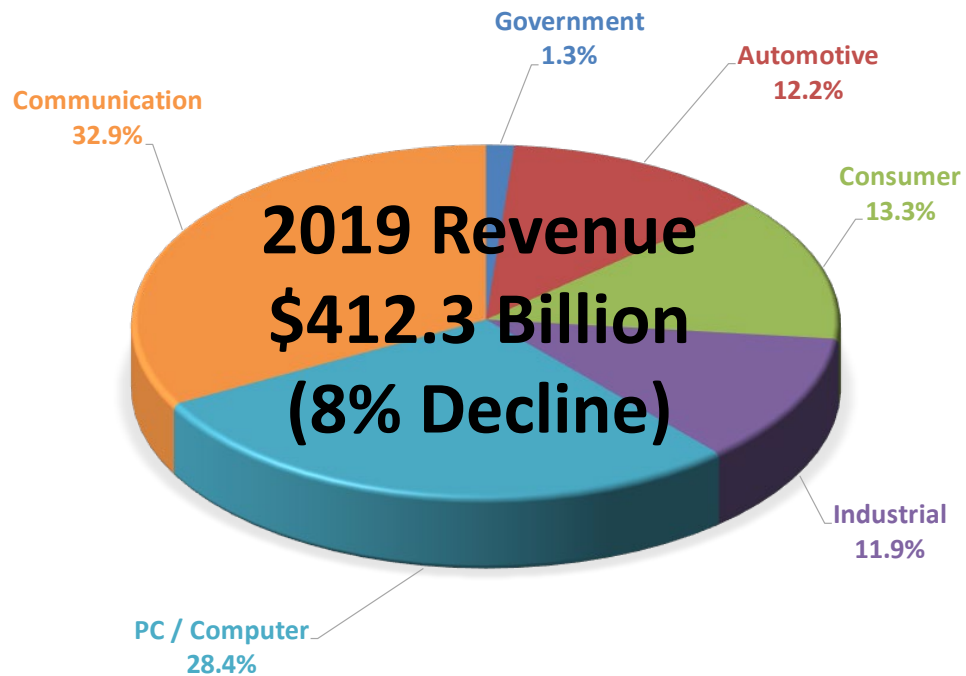
*Semiconductor unit demand has always been predictable at approximately 8% per year. The unit volume seems quite stable and predictable, but the price is not.*

- Dr. Wally Rhines, 2019

**O-S-D devices are forecast to account for 69% of total semiconductor units compared to 31% for ICs.**

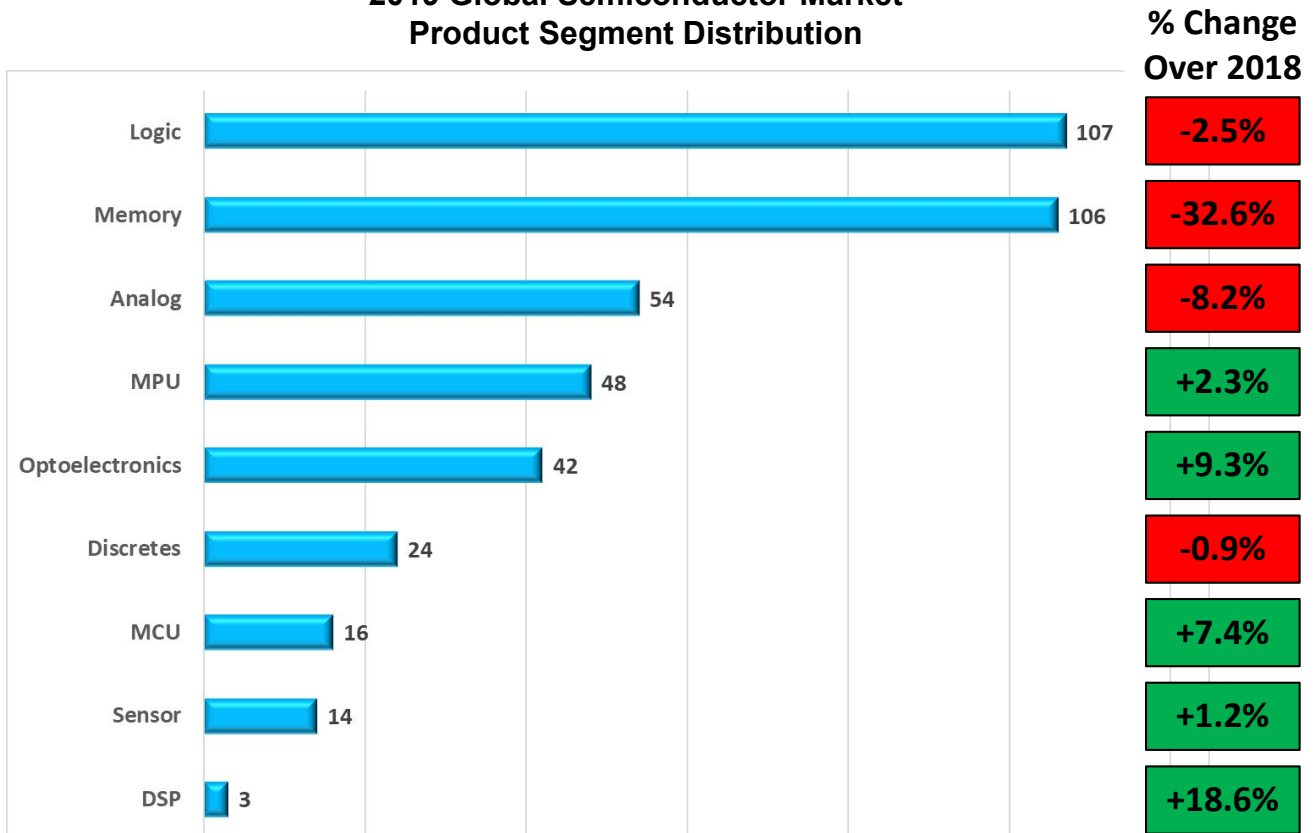
# Where did all these units go?

2019 Global Semiconductor Market  
Semiconductor Demand Distribution



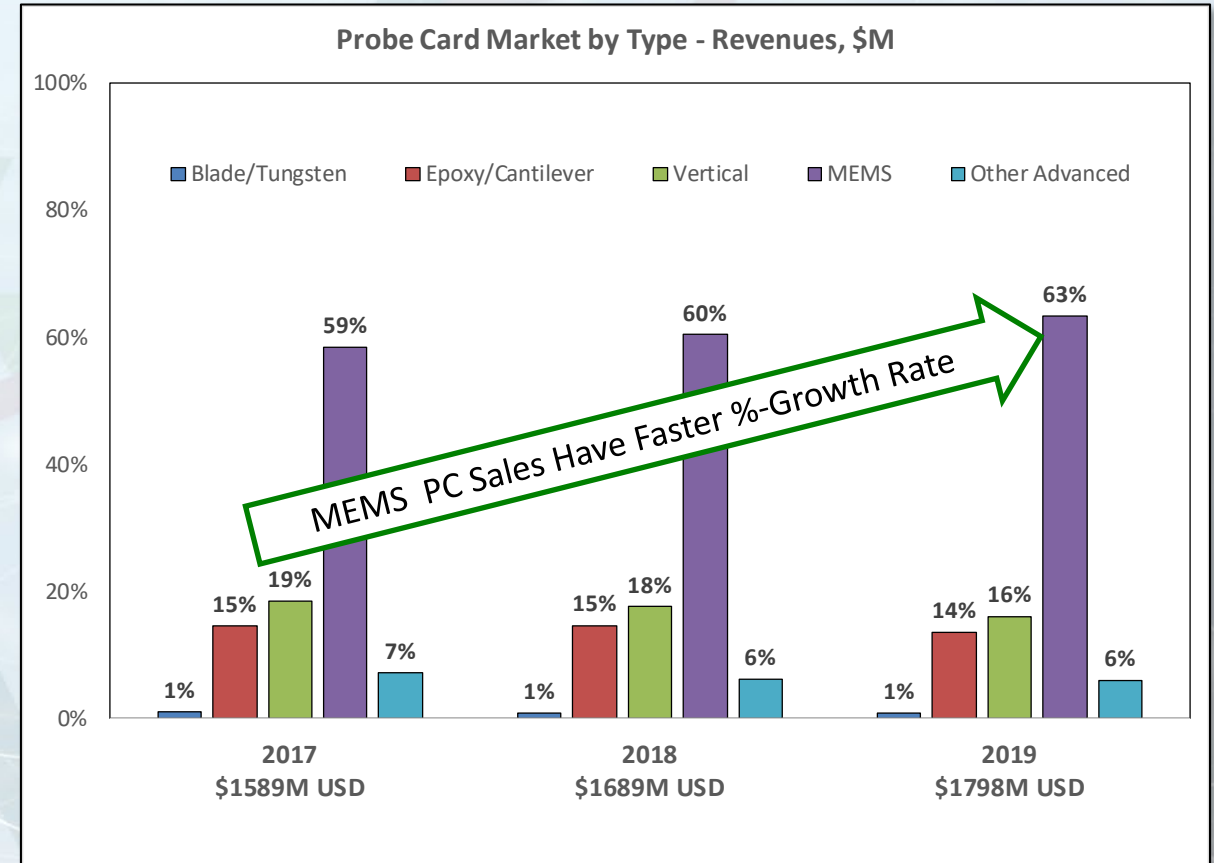
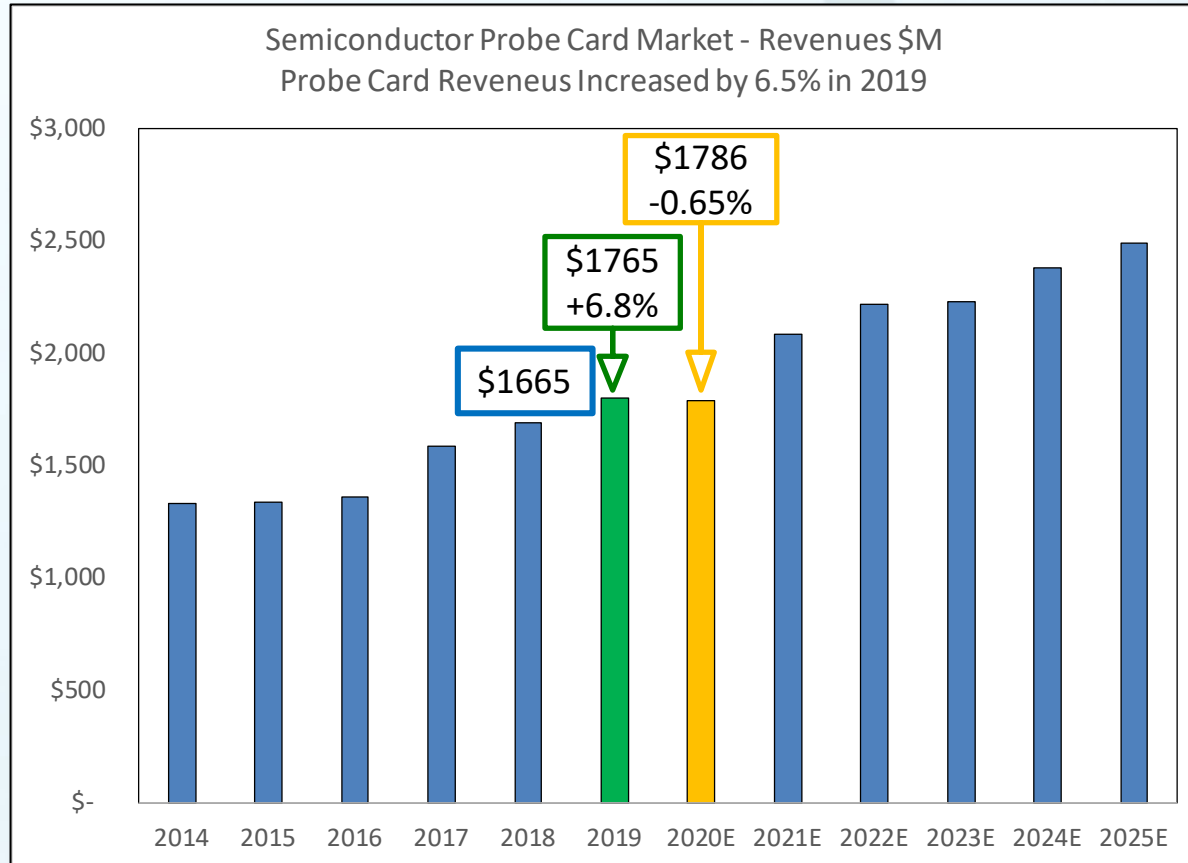
Source: World Semiconductor Trade Statistics (WSTS), SIA Factbook, IC Insights

2019 Global Semiconductor Market  
Product Segment Distribution



Source: World Semiconductor Trade Statistics (WSTS), SIA Factbook

# Probe Card Market Landscape

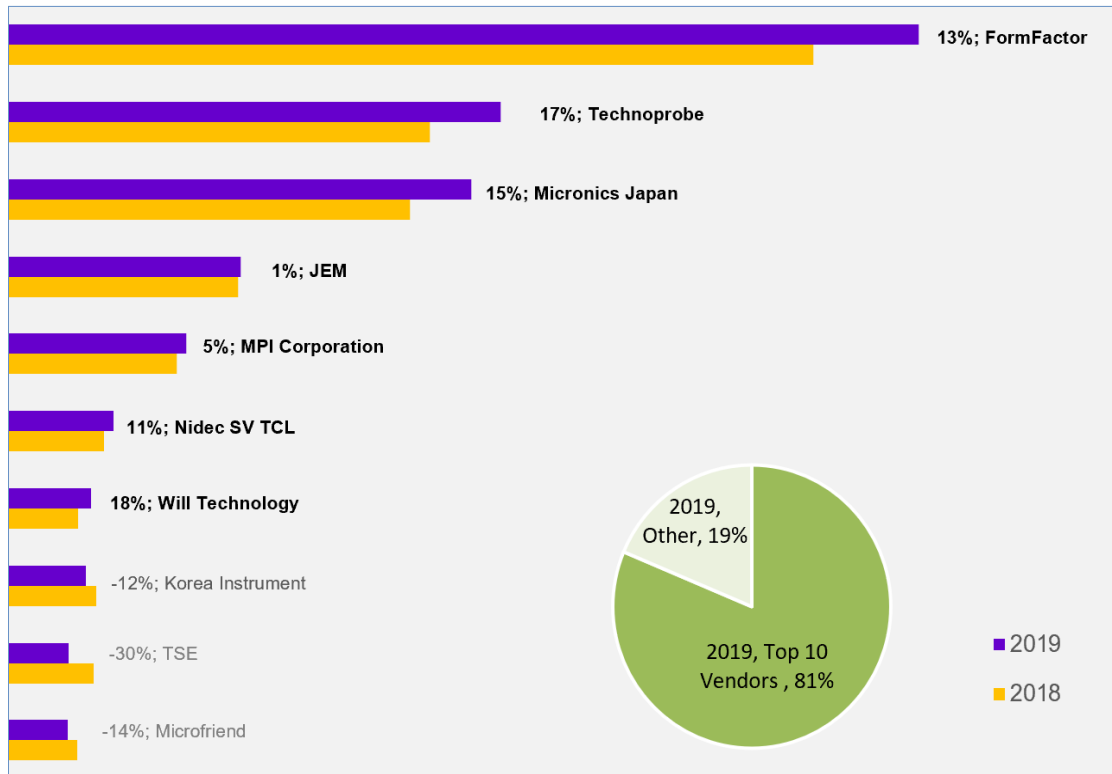




# Top Probe Card Vendors of 2019

## Top 10 Probe Card Vendors 2019, \$M

Annual growth average of top 3 vendors was 15% in 2019

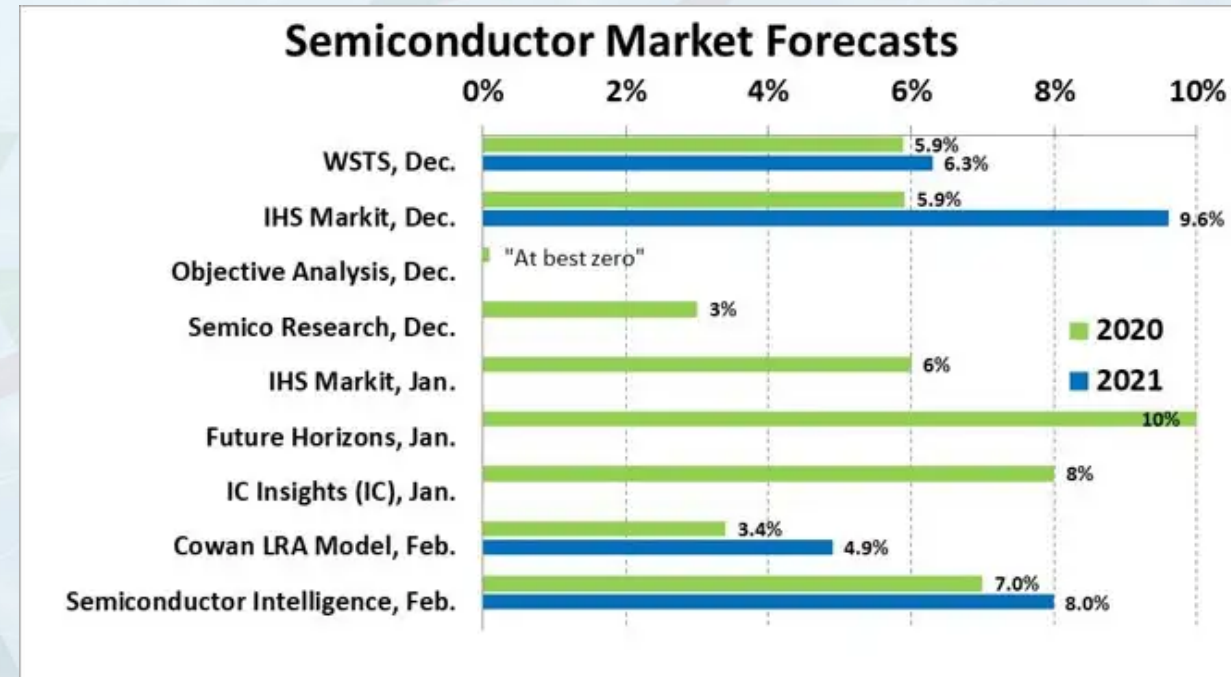


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Rank	Company	2018 \$M USD	2019 \$M USD	Change (%)
1	FormFactor	434.27	491.37	13%
2	Technoprobe	227.10	265.57	17%
3	Micronics Japan	216.51	249.68	15%
4	JEM	123.99	125.18	1%
5	MPI Corporation	90.69	95.56	5%
6	Nidec SV TCL	48.80	56.70	16%
7	Korea Instrument	37.64	44.36	18%
8	TSE	47.39	41.80	-12%
9	Will Technology	45.82	32.12	-30%
10	Microfriend	36.77	31.73	-14%
	Other	346.27	329.31	-4.9%
Semiconductor Probe Cards		1655.25	1763.38	6.5%
Annual Growth			6.8%	

# Expectations for 2020 (Pre-COVID 19)

- **Worldwide Semiconductor Market was down US\$ 409 billion in 2019**
  - Decrease of 12.8% from 2018.
- **WSTS held their 2019 Forecast Meeting from Nov. 19 to 21, 2019**
  - Semiconductor Market was expected to recover in 2020 and show modest growth.
  - Regions are forecasted to grow with an overall market increase of ~5.9%.
  - Memory was expected to drop by 14.2%.



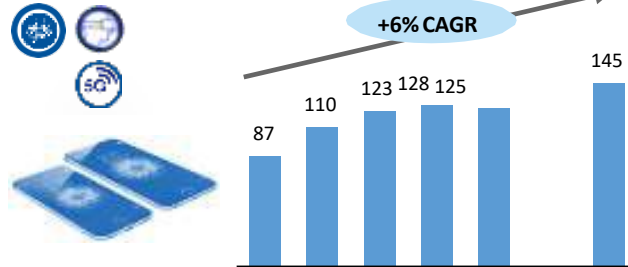
Source: Analyst Reports, Semiconductor Intelligence, SemiWiki

2020 was expected to be a transformative year for multiple sectors

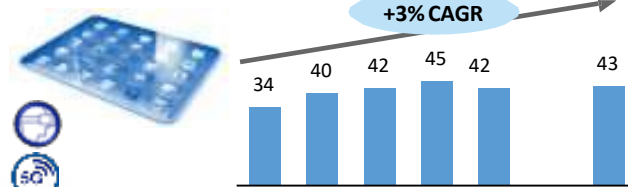
# Need for Advanced Technology is Insatiable !

## Mobile and PC Maturing

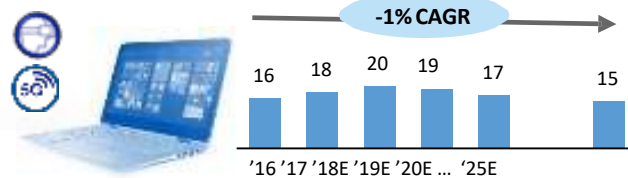
### Smartphones, B\$



### Tablets, B\$

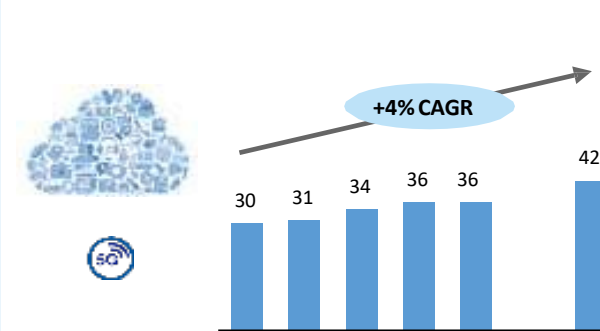


### PCs, B\$

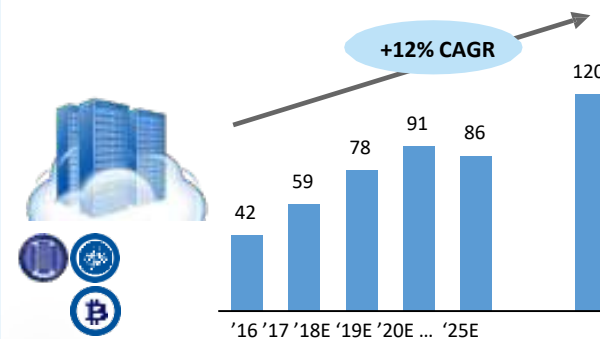


## Continued growth in cloud applications

### Wired & wireless Infrastructure, B\$

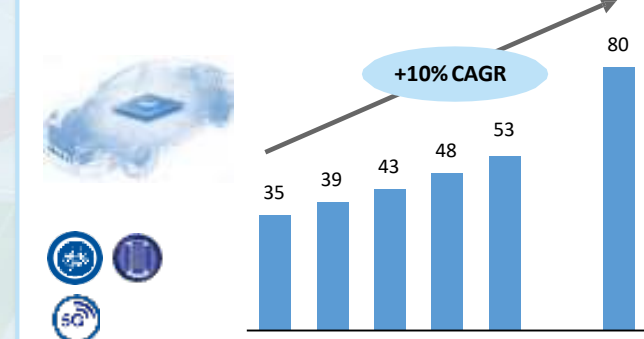


### Servers, Datacenters & Storage, B\$

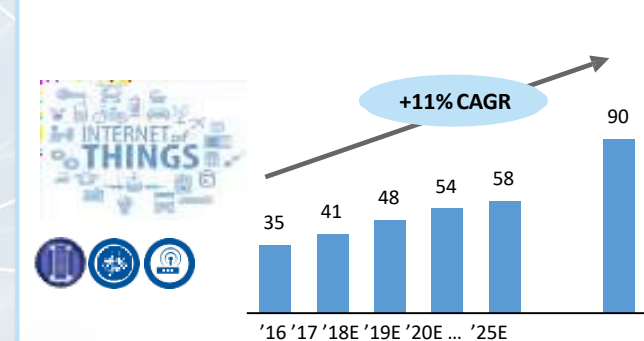


## Emerging connected devices market

### Automotive, B\$



### Industrial Electronics, B\$



Big Data



Artificial Intelligence



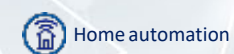
Cryptocurrency



5G connects



Augmented / Virtual Reality



Home automation

Sources: Gartner 2020, ASML at SEMI 3D Package 2020



# Strong YoY Growth “Kicked-Off” 2020 !

## 1Q20 Top 10 Semiconductor Sales Leaders (\$M, Including Foundries)

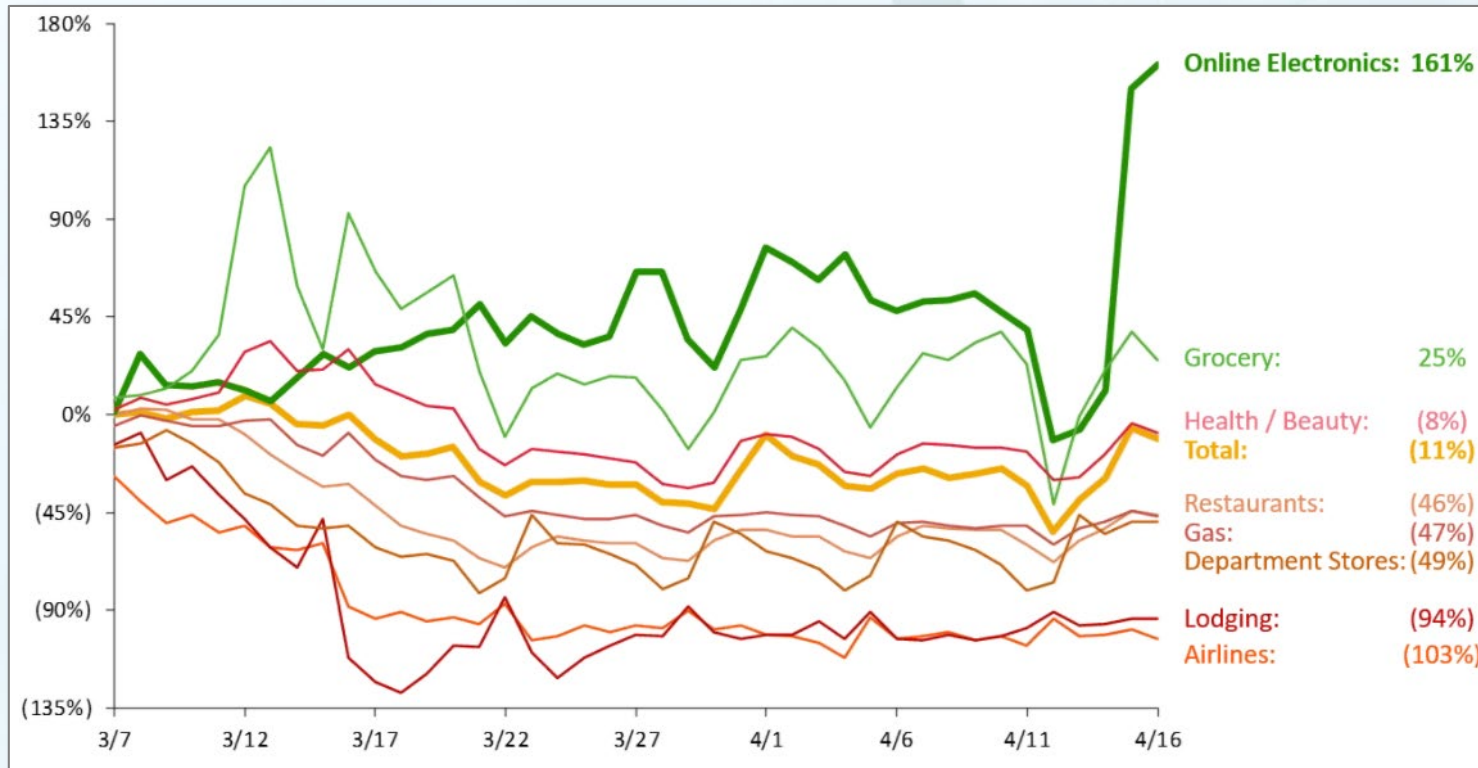
1Q20 Rank	1Q19 Rank	Company	Headquarters	1Q19 Total IC	1Q19 Total O-S-D	1Q19 Total Semi	1Q20 Total IC	1Q20 Total O-S-D	1Q20 Total Semi	1Q20/1Q19 % Change
1	1	Intel	U.S.	15,799	0	15,799	19,508	0	19,508	23%
2	2	Samsung	South Korea	11,992	875	12,867	13,939	858	14,797	15%
3	3	TSMC (1)	Taiwan	7,096	0	7,096	10,319	0	10,319	45%
4	4	SK Hynix	South Korea	5,903	120	6,023	5,829	210	6,039	0%
5	5	Micron	U.S.	5,465	0	5,465	4,795	0	4,795	-12%
6	6	Broadcom Inc. (2)	U.S.	3,764	419	4,183	3,700	410	4,110	-2%
7	7	Qualcomm (2)	U.S.	3,753	0	3,753	4,050	0	4,050	8%
8	8	TI	U.S.	3,199	208	3,407	2,974	190	3,164	-7%
9	11	Nvidia (2)	U.S.	2,215	0	2,215	3,035	0	3,035	37%
10	15	HiSilicon (2)	China	1,735	0	1,735	2,670	0	2,670	54%
—	—	Top-10 Total		60,921	1,622	62,543	70,819	1,668	72,487	16%

(1) Foundry (2) Fabless

Source: Company reports, IC Insights' *Strategic Reviews* database

# COVID-19 Crisis Changed Everything !

## COVID-19 Effects on Consumer Spend (% YoY Growth)



Source: BofA Global Research Reports, April 2020

- China market experienced the biggest decline in electronics shipments (~27% YoY) due to the timing of COVID-19 pandemic.
- Smartphones markets were regionally down by 10% to 21% as COVID-19 impacted both the supply chain and demand of high-end devices.
- Worldwide PC shipments totaled 51.6 million units in the 1Q20, a ~12% decline from the 4Q19 despite increase in demand.
- PC expected to have 16% YoY Growth in 2Q20 as people moved to a work-from-home situation.
- Landline equipment and various PC peripherals such as microphones, webcams, etc., grew between 50.9% to 65.4%

# Semiconductor Market Trending

Average Selling Prices  
Trending Upwards

2023~25  
\$484Bn

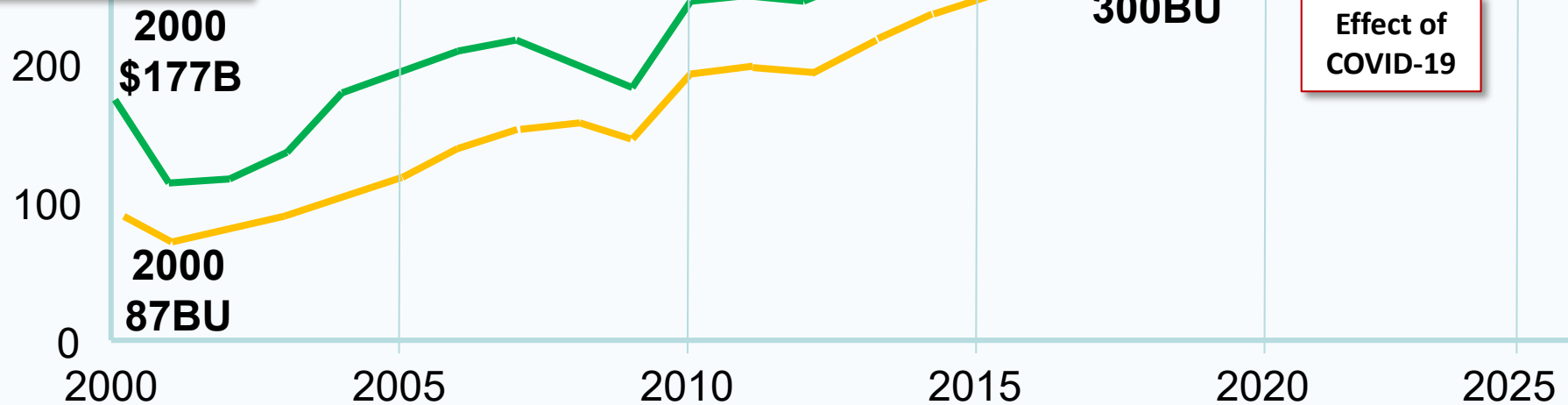
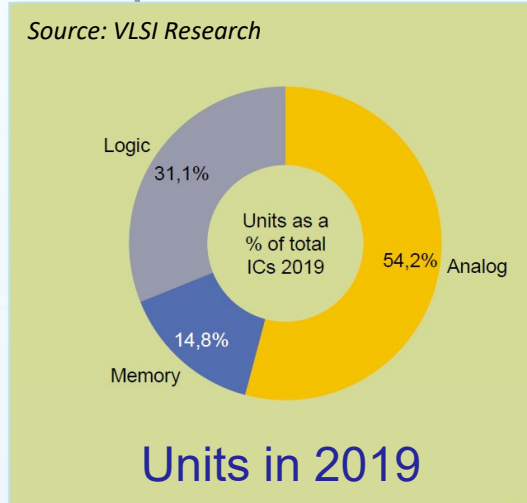
2023~25  
401BU

Units growing faster than revenues  
but the difference is narrowing

2019  
\$354B

2019  
300BU

Effect of  
COVID-19

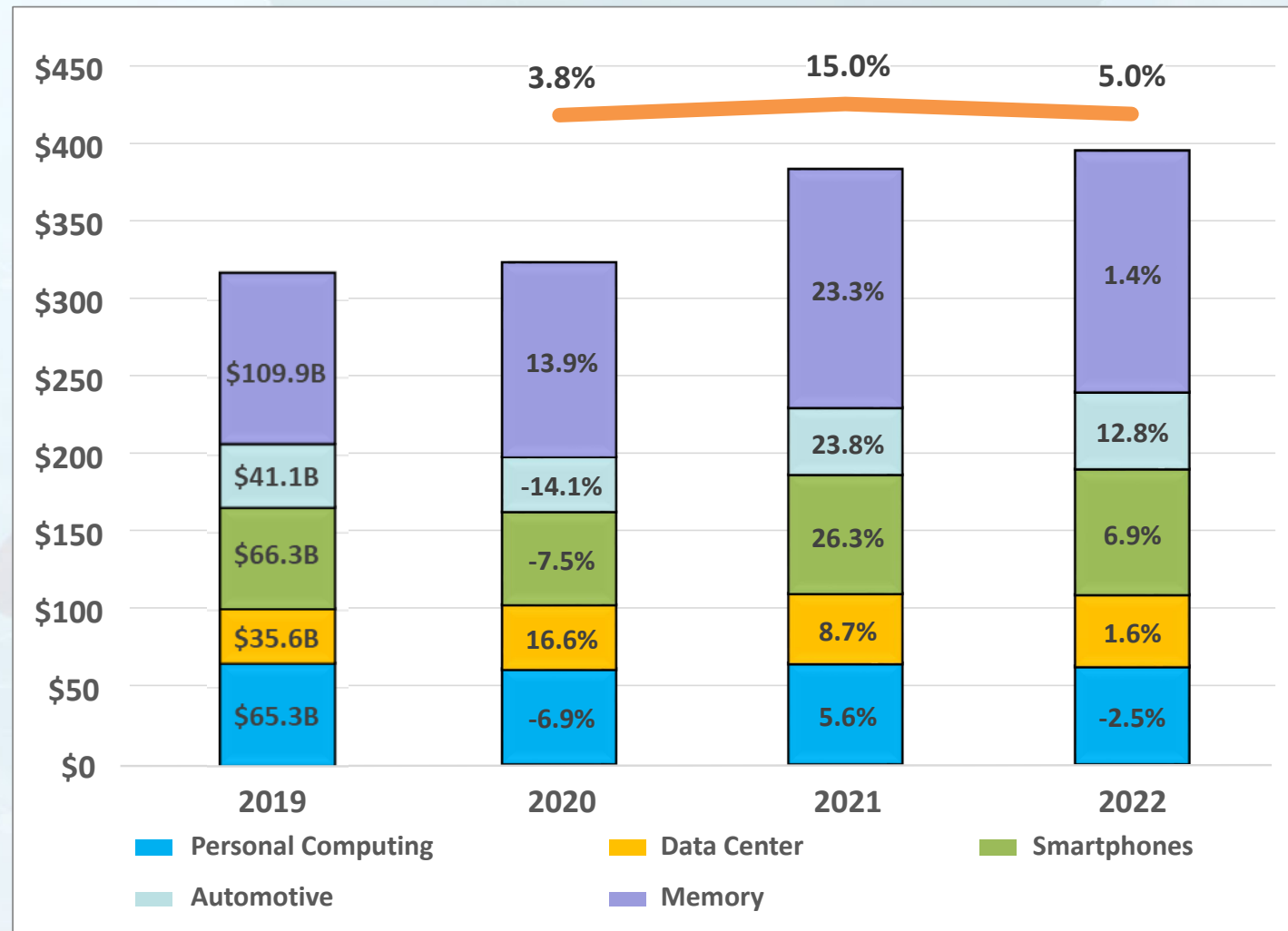


Sources: VLSI Research, TestConX 2019, SWTest Asia 2019, IC Insights

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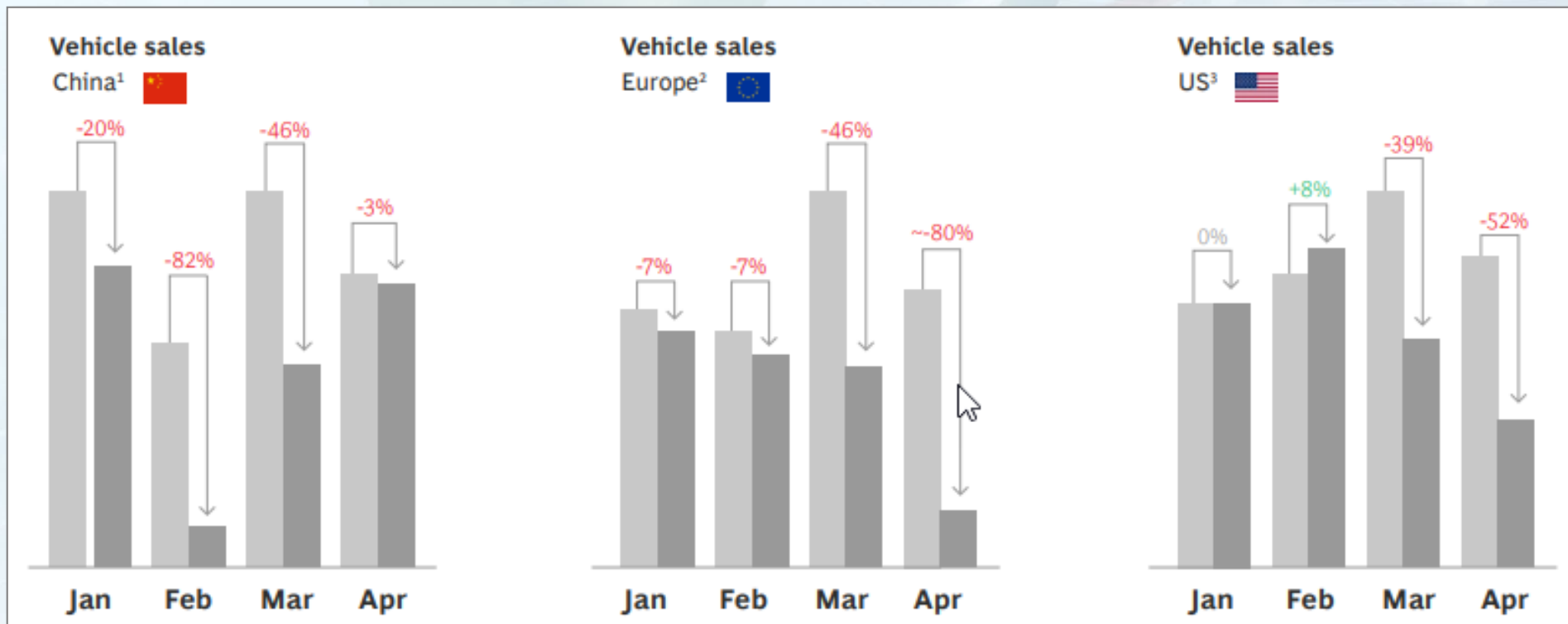
# Weathering COVID-19 on Overall Market



Sources: BofA 2020, BNP 2020, Gartner 2020, IDC 2020, IHS 2020

# Closer Look at Automotive Sector

Automotive sales could decrease 14 to 22% among the China, US and European markets in 2020.



Source: Boston Consulting Group 2020

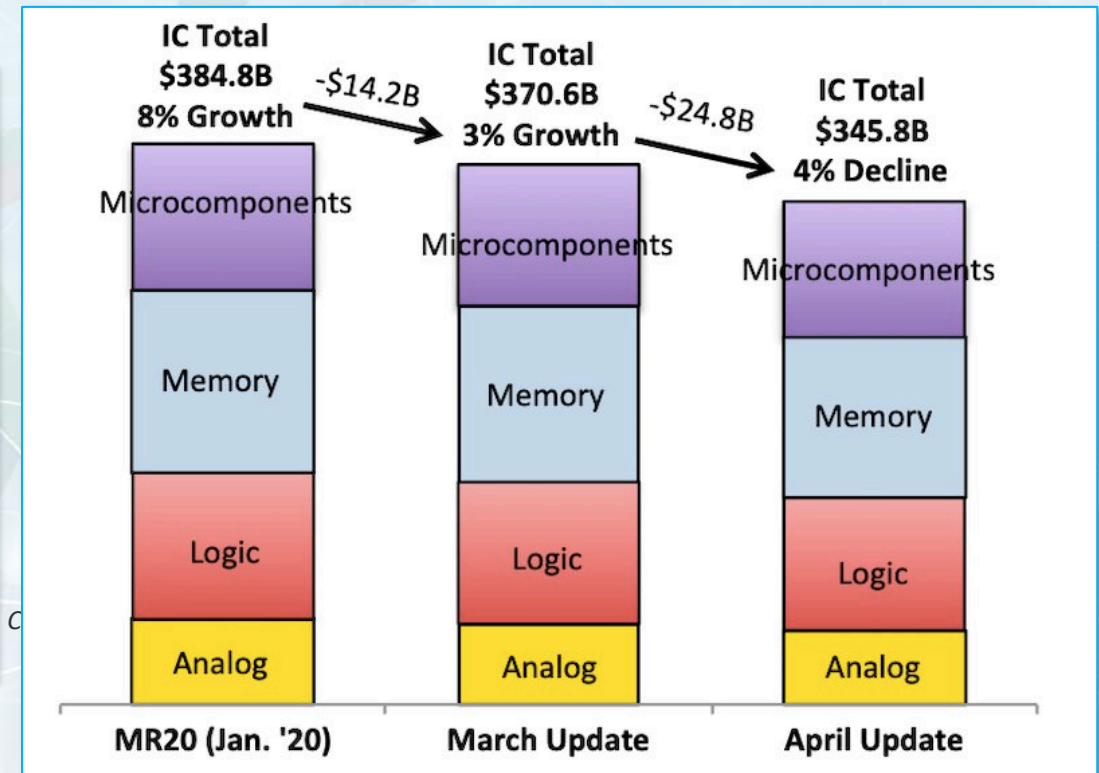
# Closer Look at Automotive Sector

Automotive sales could decrease 14 to 22% among the China, US and European markets in 2020.

## AUTOMOTIVE SEMICONDUCTOR SUPPLY CHAIN

APPLICATION	IMPACT 2020	BY PRODUCT	IMPACT 2020
Safety	-2.33%	Analog	-6.01%
Powertrain	-4.15%	Micro components	-6.75%
Chassis	-2.23%	Discrete/sensors	-3.11%
Infotainment	-2.78%	Optoelectronics	-5.75%
Others	-3.76%	Memory	-4.56%

Source: MarketsandMarkets Strategic Insights 2020



Source: IC Insights



# Sales and Revenue 2Q20 Guidance Revisions

Sampling of 2Q20 Semiconductor  
Sales Guidance (\$M)

Company	Headquarters	1Q20 Total Semi	2Q20 Guidance	2Q20/1Q20 % Change
Intel	U.S.	19,508	18,200	-7%
TSMC (1)	Taiwan	10,319	10,250	-1%
Qualcomm (2)	U.S.	4,050	3,850	-5%
TI	U.S.	3,164	2,750	-13%
Nvidia (3)	U.S.	3,065	3,065	0%
ST	Europe	2,228	2,000	-10%
Infineon (4)	Europe	2,190	1,895	-13%
MediaTek (2)	Taiwan	2,022	2,145	6%
NXP	Europe	2,021	1,800	-11%
AMD (2)	U.S.	1,786	1,850	4%
WD/SanDisk	U.S.	1,752	1,820	4%
Renesas	Japan	1,617	1,520	-6%
UMC (1)	Taiwan	1,404	1,445	3%
Analog Devices	U.S.	1,312	1,319	1%
Microchip	U.S.	1,298	1,259	-3%
ON Semi	U.S.	1,278	1,180	-8%
SMIC (1)	China	905	941	4%
Qorvo	U.S.	788	730	-7%
Skyworks	U.S.	766	690	-10%
Xilinx (2)	U.S.	756	690	-9%
Rohm	Japan	669	625	-7%
<b>Total</b>		<b>62,898</b>	<b>60,024</b>	<b>-5%</b>

(1) Foundry (2) Fabless (3) Excluding Mellanox

(4) Excluding Cypress (purchased in Apr '20) in 2Q20

Source: Company reports, IC Insights' Strategic Reviews database

Top Semiconductor Companies' Revenue

Change versus prior quarter in local currency

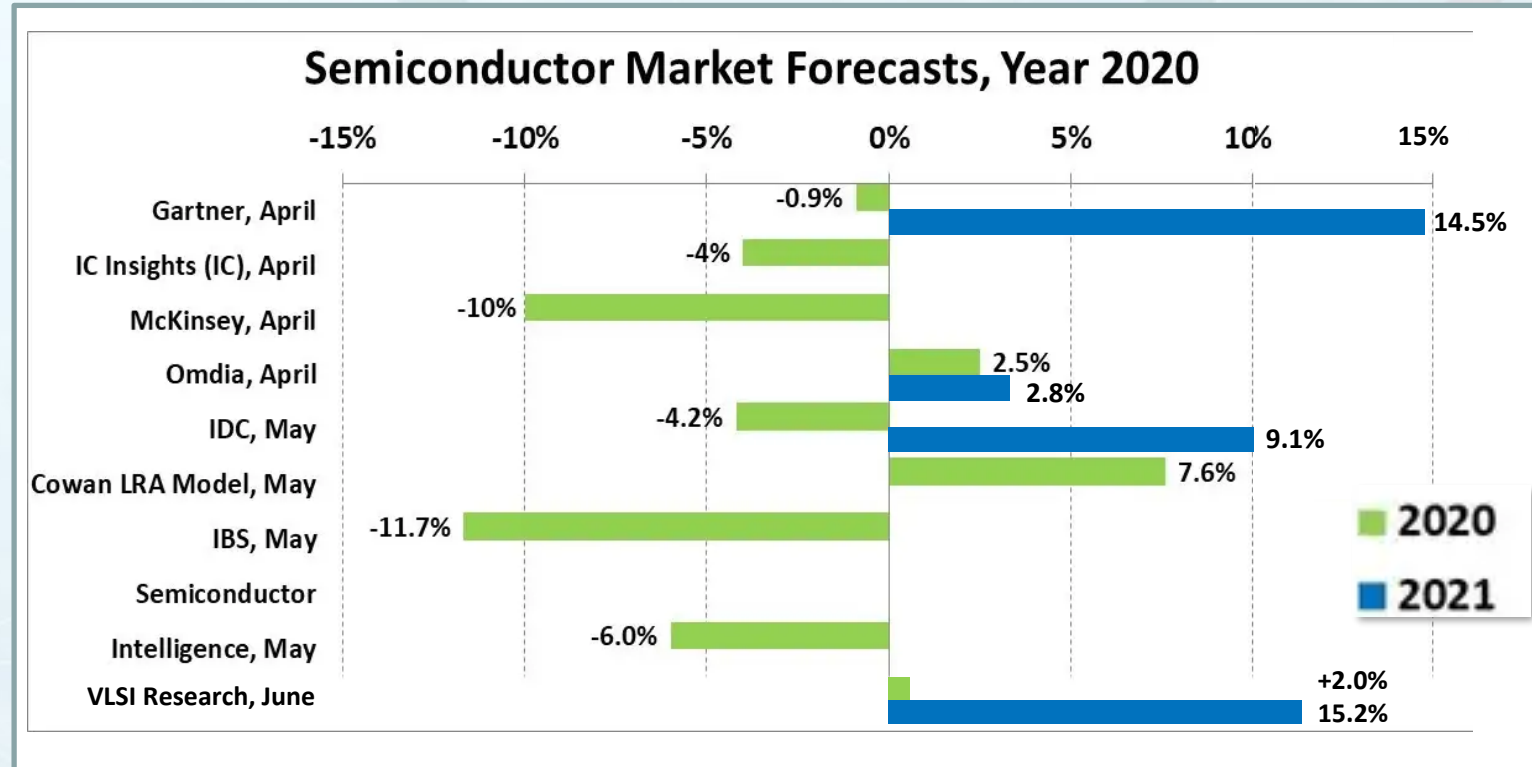
Company	Reported 1Q20	Guidance 2Q20		
		Low	Mid	High
Intel	-1.9%	-6.7%		
Samsung Semiconductor	5.1%	n/a		
SK Hynix	3.9%	n/a		
Micron Technology	-6.7%	-4.1%	2.1%	8.4%
Qualcomm	2.7%	-15.6%	-8.0%	-0.3%
Texas Instruments	-0.6%	-21.6%	-12.9%	-4.2%
Nvidia *	0.4%	12.6%	18.5%	20.9%
STMicroelectronics	-19.0%	-13.8%	-10.3%	-6.8%
Infineon Technologies **	3.7%	-4.3%	5.7%	15.8%
NXP Semiconductors	-12.2%	-15.9%	-10.9%	-6.0%
Kioxia (Toshiba Memory)	9.9%	n/a		

\* Nvidia includes Mellanox revenue beginning in 2Q20

\*\* Infineon includes Cypress revenue beginning in 2Q20

Source: Semiconductor Intelligence 2020

# Expectations for 2020 Post-COVID



Source: Analyst Reports, WSTS, SIA, Industry Report

# Expectations for 2020 Post-COVID

- **Revised WSTS forecast on June 9, 2020**
  - Semiconductor Market in 2020 is forecast at \$426B US
  - Downgrade of 2020 forecast +5.9% to +3.3% growth.
  - Memory expected to increase ~15% and Logic ~2.9%
  - Wireless and automotive segments could be hardest hit with declines of as much as 21% to 27%, resp.
  - Americas and Asia Pacific are expected to grow.
- **For 2021, global market is expected to grow by 6.2%, driven by growth of memory.**
  - Total market size is expected to surpass 2019 value.
  - PC market segments will see the least growth.
  - Wireless c and automotive segments expected bounce back with growth of up to 19% and 36%, resp.
  - All regions are expected to show positive growth.

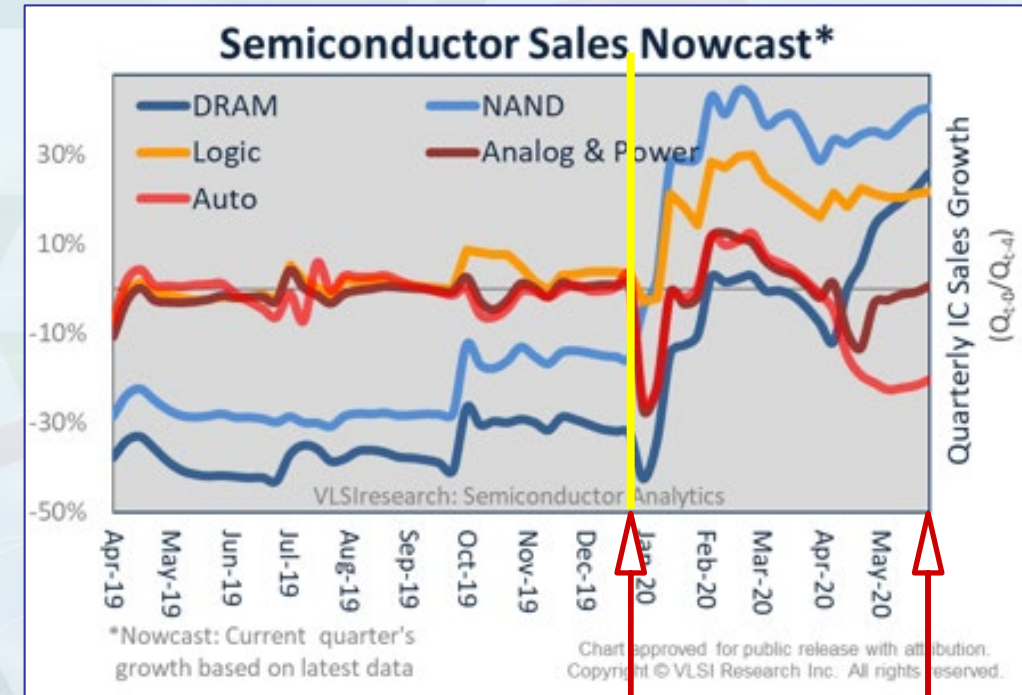
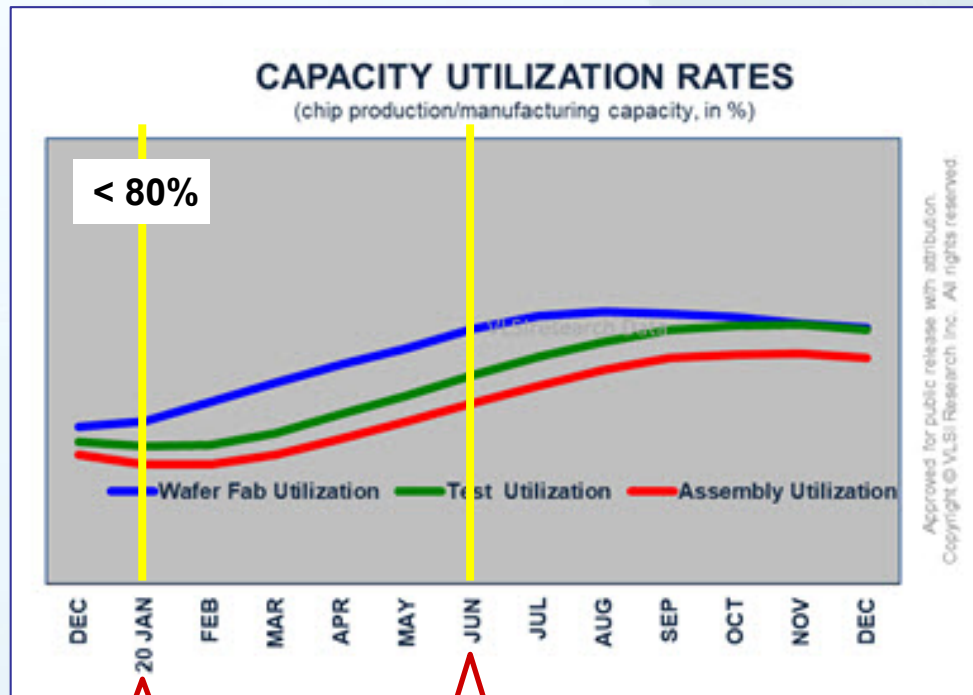
Spring 2020	Amounts in US\$M			Year on Year Growth in %		
	2019	2020	2021	2019	2020	2021
Americas	78,619	88,694	94,598	-23.7	12.8	6.7
Europe	39,816	38,174	40,381	-7.3	-4.1	5.8
Japan	35,993	34,400	35,547	-9.9	-4.4	3.3
Asia Pacific	257,879	264,697	281,725	-8.8	2.6	6.4
Total World - \$M	412,307	425,966	452,252	-12.0	3.3	6.2
Integrated Circuits	333,354	350,986	372,987	-15.2	5.3	6.3
Analog	53,939	50,808	53,809	-8.2	-5.8	5.9
Micro	66,440	68,151	69,129	-1.2	2.6	1.4
Logic	106,535	109,668	113,973	-2.5	2.9	3.9
Memory	106,440	122,358	136,076	-32.6	15.0	11.2
Total Products - \$M	412,307	425,966	452,252	-12.0	3.3	6.2

Note: Numbers in the table are rounded to whole millions of dollars, which may cause totals by region and totals by product group to differ slightly.

Sources: WSTS, SIA Industry Report 2020



# The “Recovery” is Happening



**MILPITAS, Calif. — June 18, 2020** — North America-based manufacturers of semiconductor equipment posted \$2.35B in billings worldwide in May 2020 (three-month average basis). Billings figure is 2.9% higher than the final April 2020 (\$2.28B), and 13.1% higher than the May 2019 billings level of \$2.07B.

# In Closing ...

- **Outlook for the semiconductor market remains uncertain with a possible virus recurrence and near-term demands during the “new normal” are clearly difficult to predict.**
- **Significant differences in demand by end-use markets in the short-term**
  - Markets most likely affected
    - Automotive (especially power devices)
    - Industrial
    - Smartphones (especially high-end devices)
  - Markets least likely affected
    - Datacenters (processors and memory)
    - Medical
    - Artificial Intelligence
- **End-use demands for performance drive the market trends in the long-term**
  - New applications and consumer requirements drive more complex processes, which in-turn drive equipment and material demand
  - 5G and AI remain the key industry drivers
  - Foundry, Advanced Logic, and Memory are staying relatively “healthy”

# Thanks for Attending !

## Questions ?

**Jerry Broz, Ph.D.**

**SWTest and SWTest Asia Conference General Chair**

**SVP Technology Development  
International Test Solutions**



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