



# SWTEST

PROBE TODAY, FOR TOMORROW

**2022 CONFERENCE**

## Welcome to the 31<sup>st</sup> SWTest Conference in San Diego

CARLSBAD

**Jerry Broz, PhD**  
**SWTest General Chair**

June 5 - 8, 2022

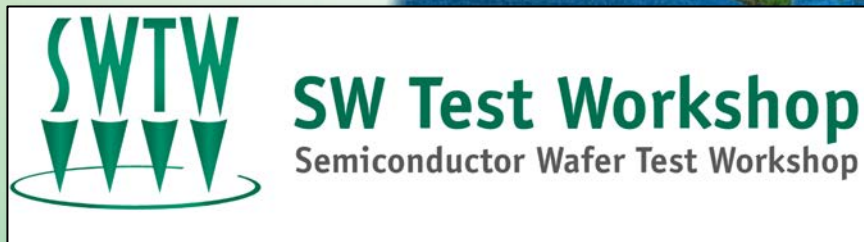
# SWTest 2022 eProceedings Download



Password for Monday = condor  
Password for Tuesday =  
Password for Wednesday =  
Password for ONDemand =

- Each day of the conference will be available in an e-Version for download in a password protected file.
  - Network (SSID) = swtest
  - Session and Expo WiFi Password = swtest2022
  - Download at = <https://www.swtest.org/>
- Free WiFi access will be available during the entire conference to allow attendee access to the downloads.
- Daily passwords to the download files will be announced throughout each day, respectively.
- Non-password locked files will be made available in the SWTest Archives after the conference adjourns.

# 31-years of Probe Technology





# 31-years of Probe Technology



# We Had to Move for 2022 to 2024

Omni - La Costa, Carlsbad, CA



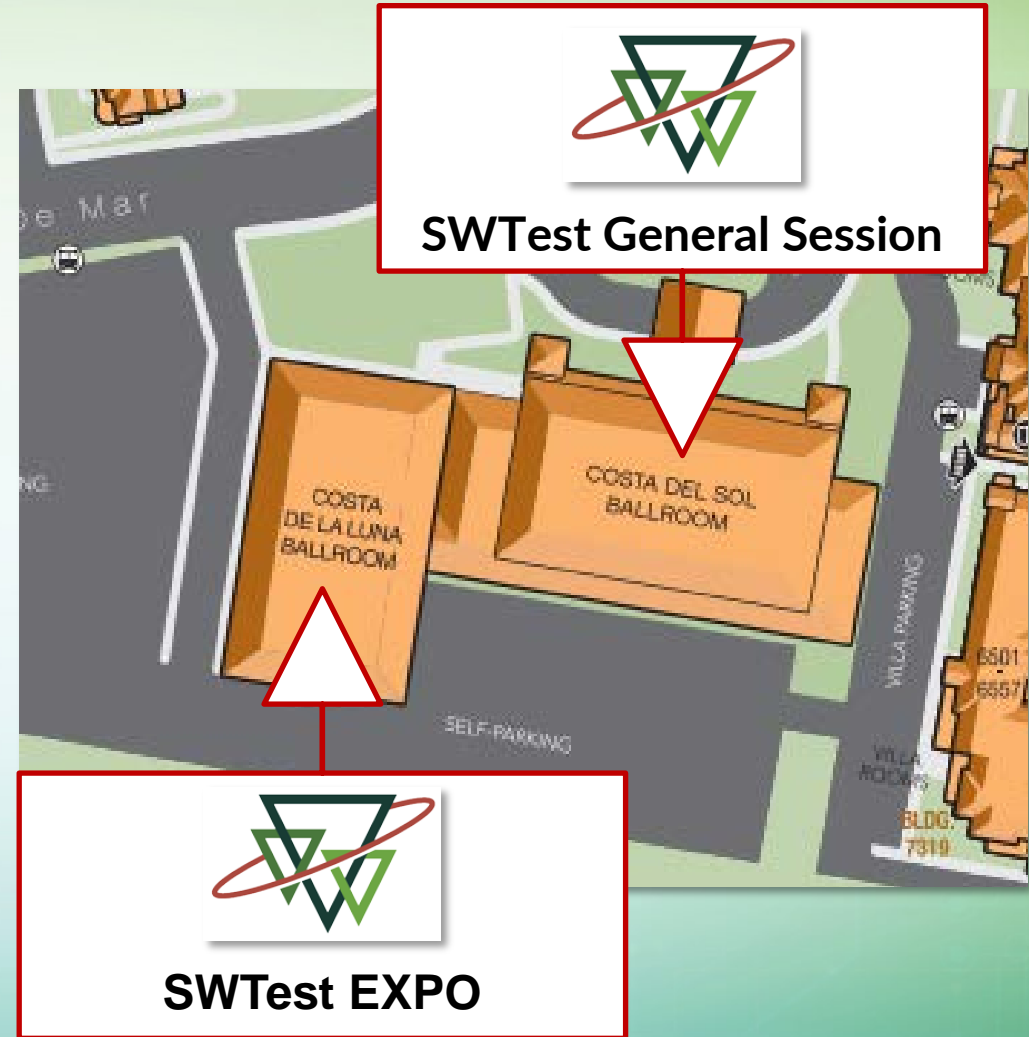
## Dates for Future SWTest Conferences

- **SWTest San Diego**
  - June 5 to 8, 2022
  - June 4 to 7, 2023
  - June 2 to 5, 2024
- **SWTest Asia**
  - Oct 26 to 28, 2022  
Taiwan, Hsinchu
  - October 2023  
Location is TBD

Goodbye to the Rancho Bernardo Inn



# Omni La Costa Property Map





# Sunday Golf on the Legends Course

Annual SWTest Memorial Golf Tournament Held on the Legends Course





# Health and Safety at SWTest 2022

**Masks are Required for Indoor Activities**  
(protect our close-knit, international test community)

**Meals and Social Events will be held Outdoors**

Red Ribbon



Green Ribbon



Orange Ribbon



HANDS



FACE

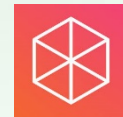


SPACE





# SWTest Conference New Mobile App

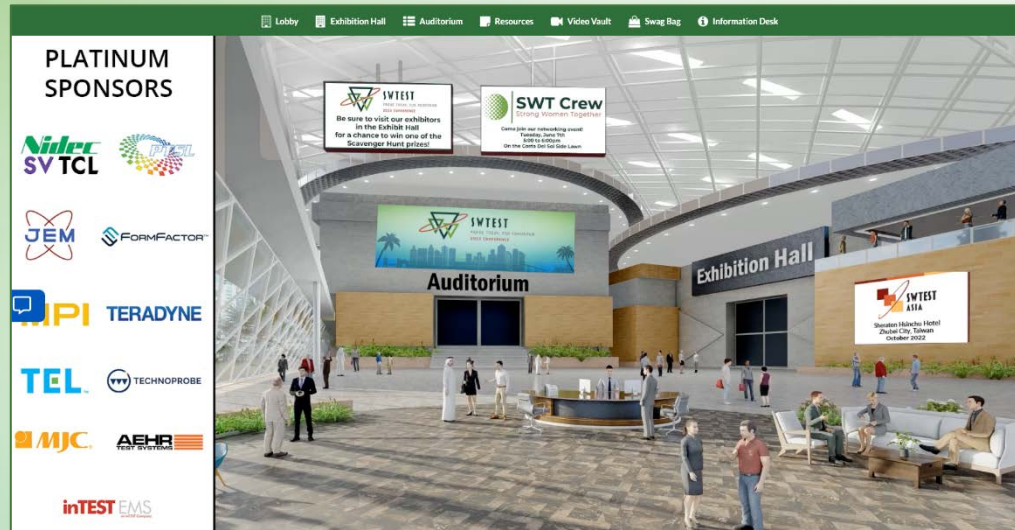


Download the “vFairs” mobile app from respective online stores and enter your registered email.

- Up-to-the-minute Event Info
- Connect with the Sponsors and Exhibitors
- Program Schedule in the Auditorium
- View Exhibitor and Sponsor Videos
- Read the Literature from the Exhibitors
- Connect with Attendees that have “opted-in”
- Find treasure during the Scavenger Hunt

# Virtual Conference at <https://swtest.vfairs.com/>

## Main Lobby



## Auditorium



## Virtual Exhibit Hall





# Semiconductor Wafer Test – SWTest

- SWTest IS a Probe Technology Forum
  - It is “THE” Conference for Wafer Test Professionals
  - Practical solutions to real problems
  - Balanced mixture of semiconductor manufacturer, and supplier as well as collaborative presentations
- Informal Conference
  - Grass roots style conference that is focused technical exchange
  - Great social activities and informal discussions
  - Meet new people and have a little fun !

# SWTest Organization

- **SWTest Executive Team**

- Jerry Broz, PhD, General Chair and Sr. Member IEEE
- Rey Rincon, Technical Program Chair
- Maddie Harwood, Finance Chair & Conference Mgmt

SWTest is organized, coordinated, and executed through the efforts of your colleagues.

- **Technical Program Committee**

- John Caldwell, MJC Electronics Corp.
- Darren James, Onto Innovation
- Clark Liu, Taiwan MJC Co. (Taiwan)
- Patrick Mui, JEM America
- Mark Ojeda, Infineon (US)
- Raffaele Vallauri, Technoprobe (Italy)
- Joey Wu, STAr Technologies (Taiwan)

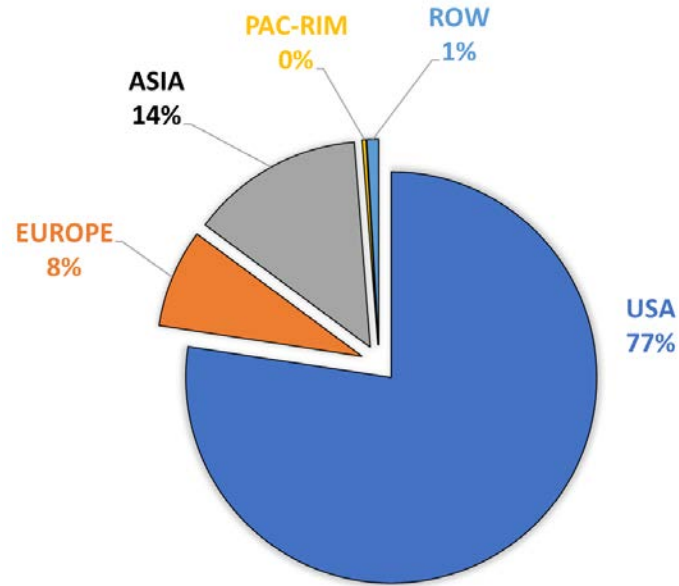
- **Steering Committee**

- Davide Appello, STMicroelectronics (Italy)
- Karen Armendariz, Celadon Systems
- Gunther Boehm, Feinmetall GmbH (Germany)
- Geert Gouwy, IMEC (Belgium)
- Michael Huebner, PhD FormFactor (Germany)
- Joonyeon (JY) Kim, Samsung Electronics (Korea)
- Amy Leong, FormFactor, Inc.
- Grace Liu, PhD, Intel Corp
- Connie Smith, Texas Instruments, Inc.
- Alex Yang, MPI Corporation (Taiwan)



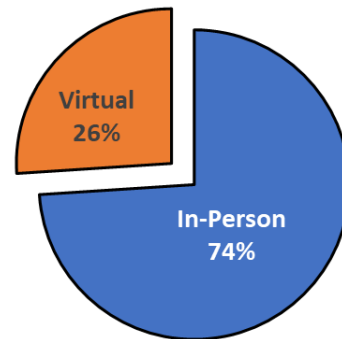
# SWTest 2021 and 2022 Participation

SWTest 2021

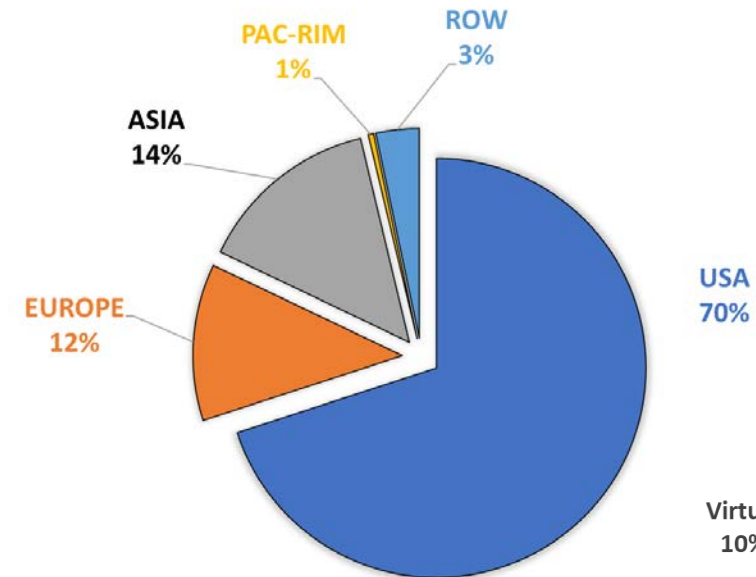


**388 Total Registered**

- 280 On-Site
- 108 Virtual

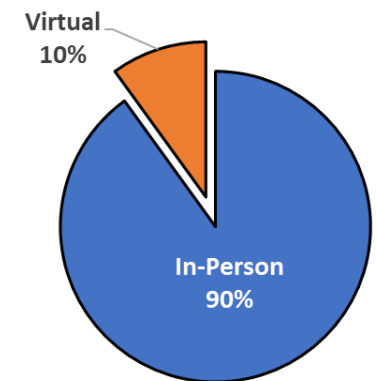


SWTest 2022  
as of 4-June



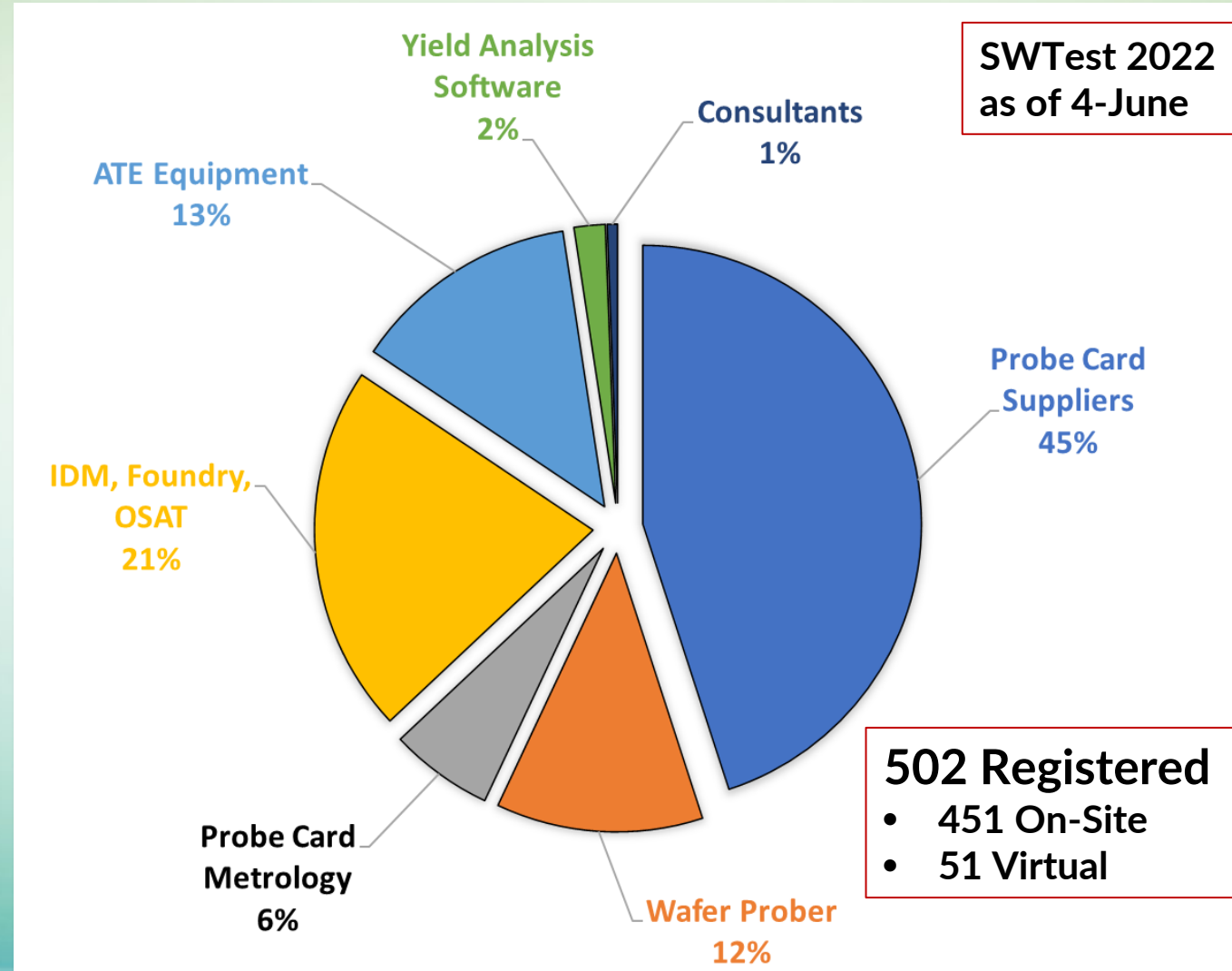
**502 Total Registered**

- 451 On-Site
- 51 Virtual



**23 of the 38 Presentations have International Authors !**

# SWTest 2022 Attendee Demographics





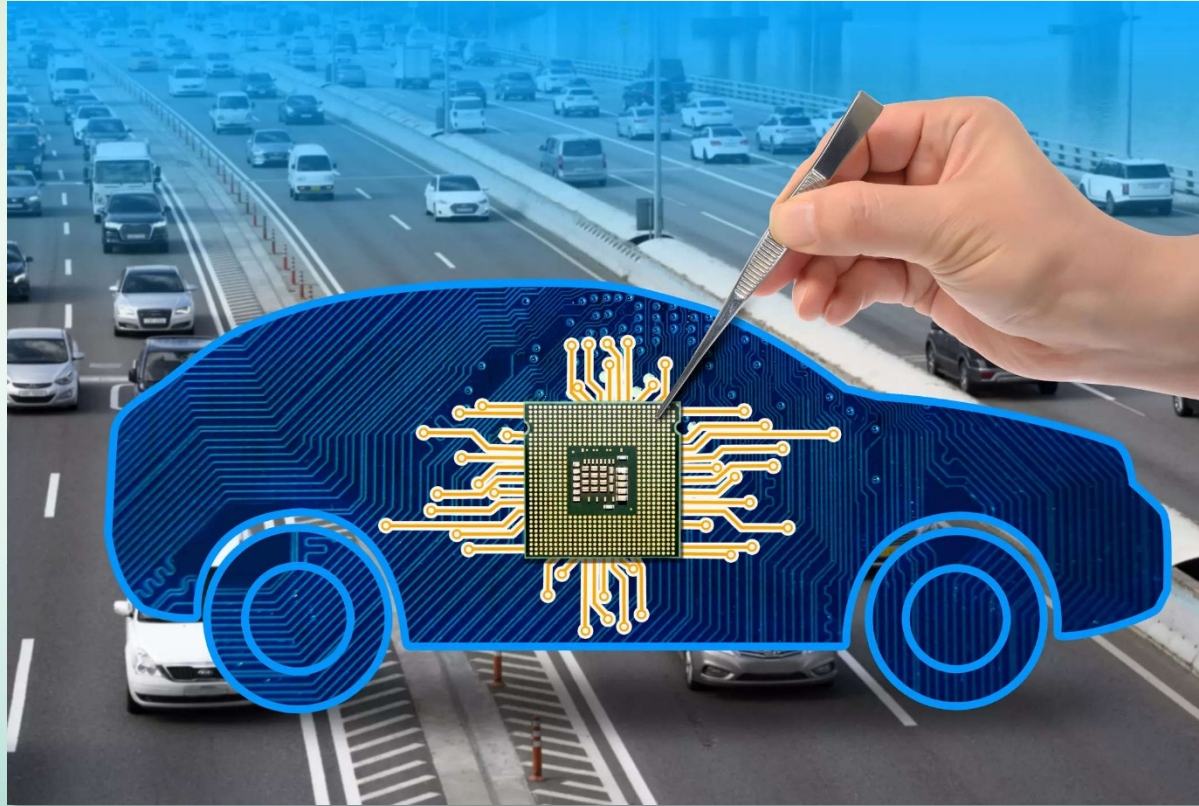
# Phishing for SWTest Mailing List



- ALL attendee information provided to SWTest and SWTest Asia is safe and confidential.
- Attendees must “opt-in” for sharing their contact information through the conference Mobile App
- SWTest mailing lists are not available or sold to anyone ...

Never have and never will !

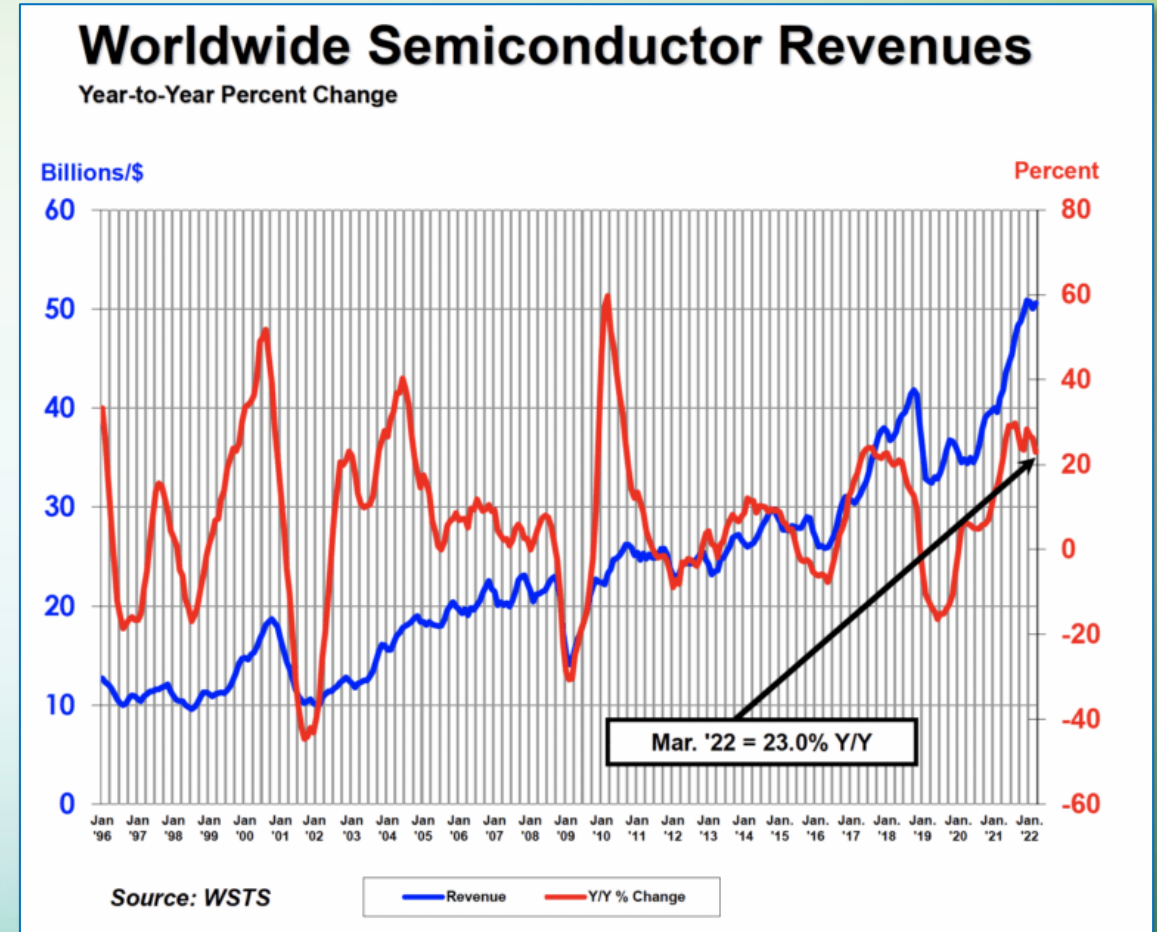
# Ever Changing Semiconductor Landscape





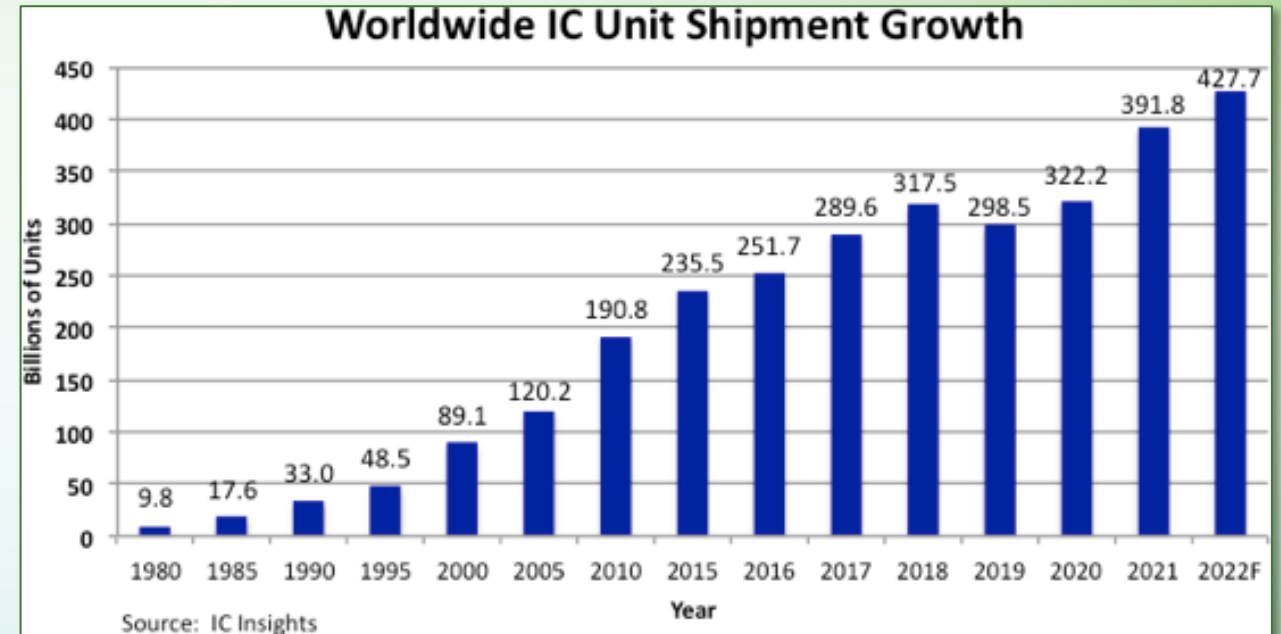
# Semiconductor Growth in 2021

- Worldwide Semiconductor Market was up 26.2 percent in 2021 to US\$ 556 billion
- Largest growth contributors in 2021
  - Analog with 33.1 percent
  - Memory with 30.9 percent
  - Logic with 30.8 percent
  - All other major product categories showed double-digit growth-rates.
- The worldwide semiconductor market is expected to increase by 10.4 percent in 2022.
  - Strongest growth Americas (16.4 percent)
  - Europe (10.8 percent)
  - Japan (9.7 percent)
  - APAC (8.3 percent)



# Semiconductor Growth in 2021

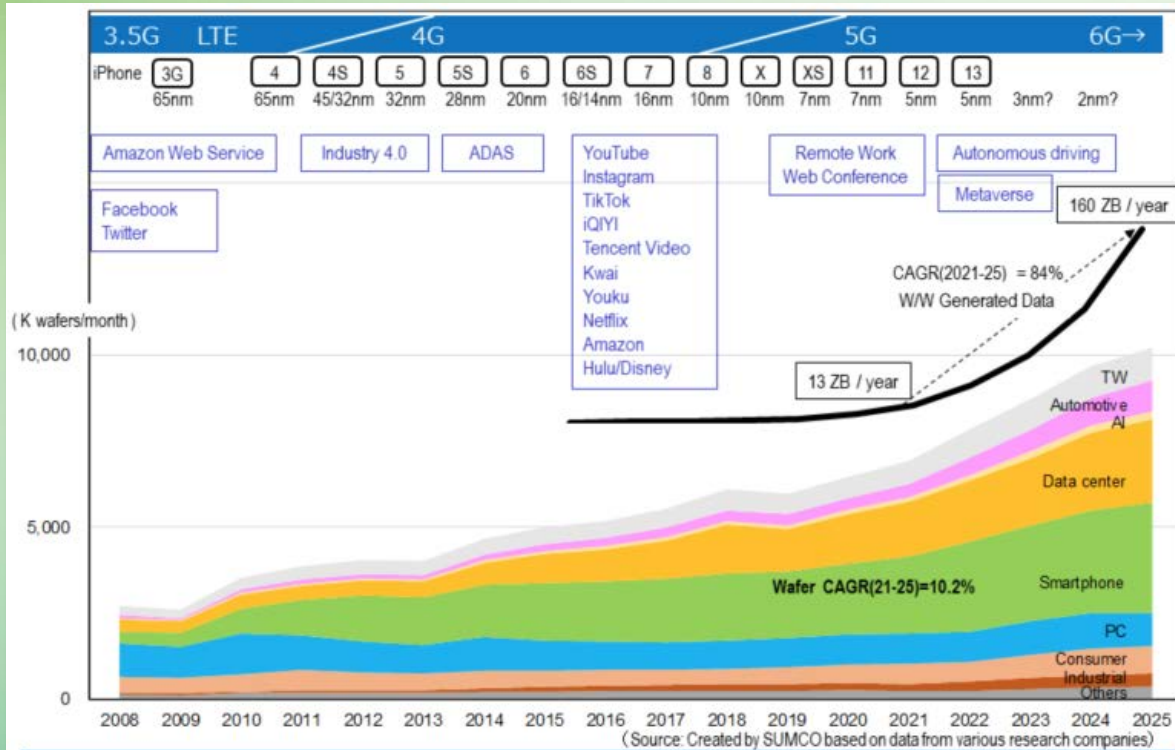
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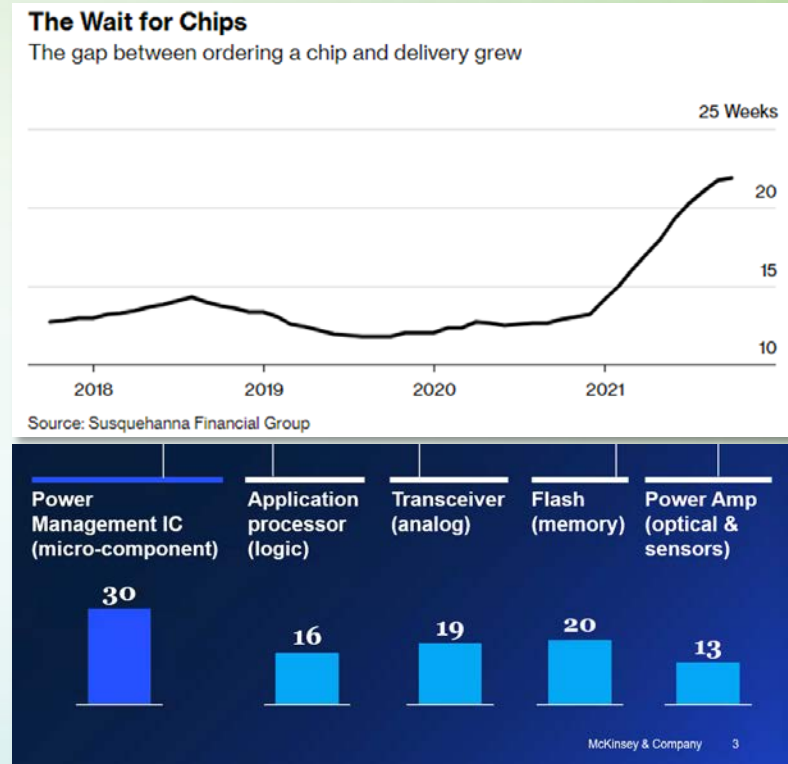
**Global Semiconductor Sales and Units Shipped Reached All-Time Highs in 2021 as the Industry Ramped Up Production Amid the Chip Shortage.**



# Demand Keeps Accelerating

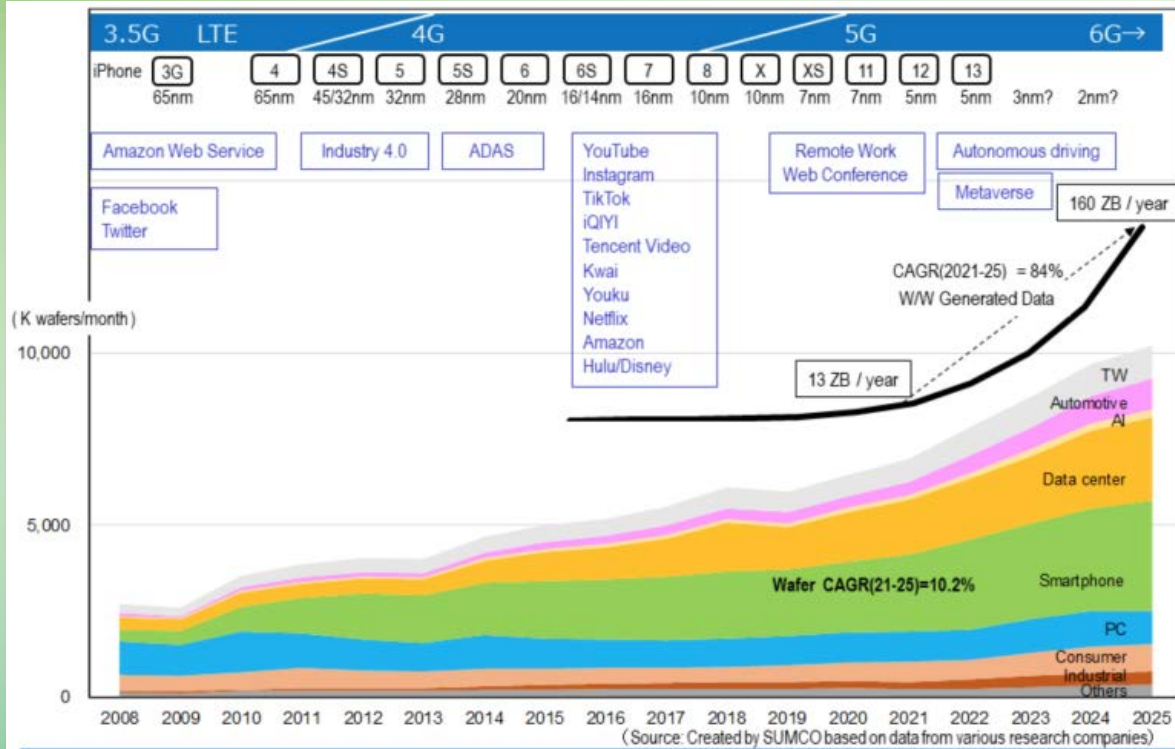


- Due to the global chip demand SUMCO has sold out of 300mm silicon wafers through 2025.
- Entire manufacturing capacity of SUMCO 300mm wafers has been contracted for the next six years.

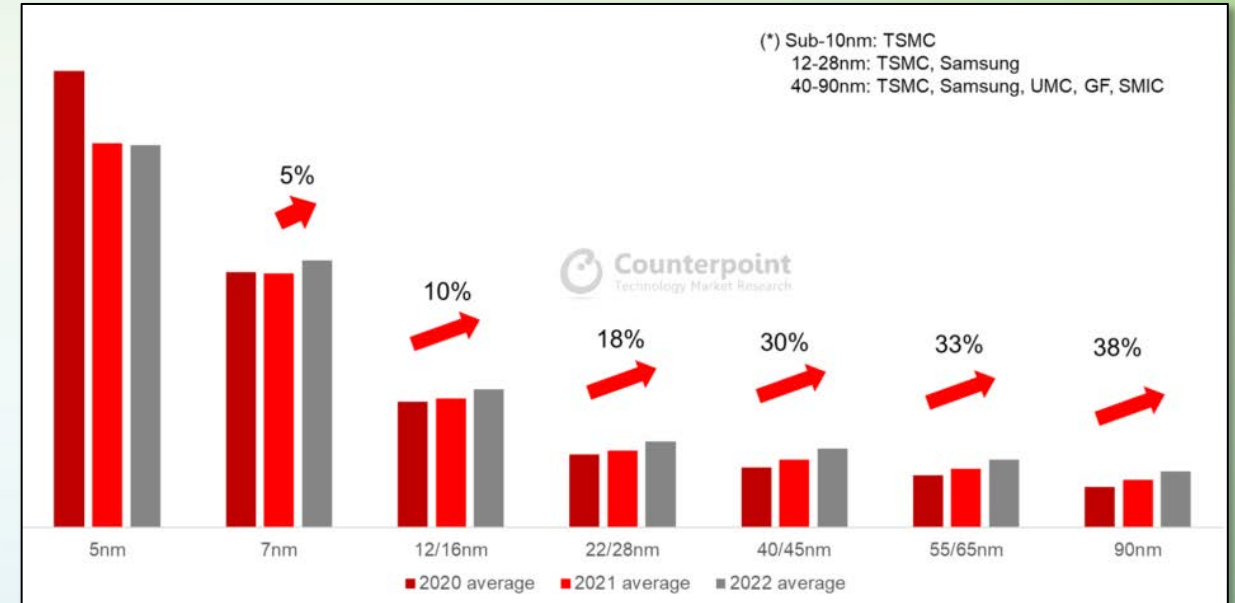


- Gap between ordering a chip and receiving the delivery has increased dramatically.
- Wafer prices at matured nodes have increased by 25-40% since 2020 and are likely to rise another 10-20% by 2022.

# Demand Keeps Accelerating



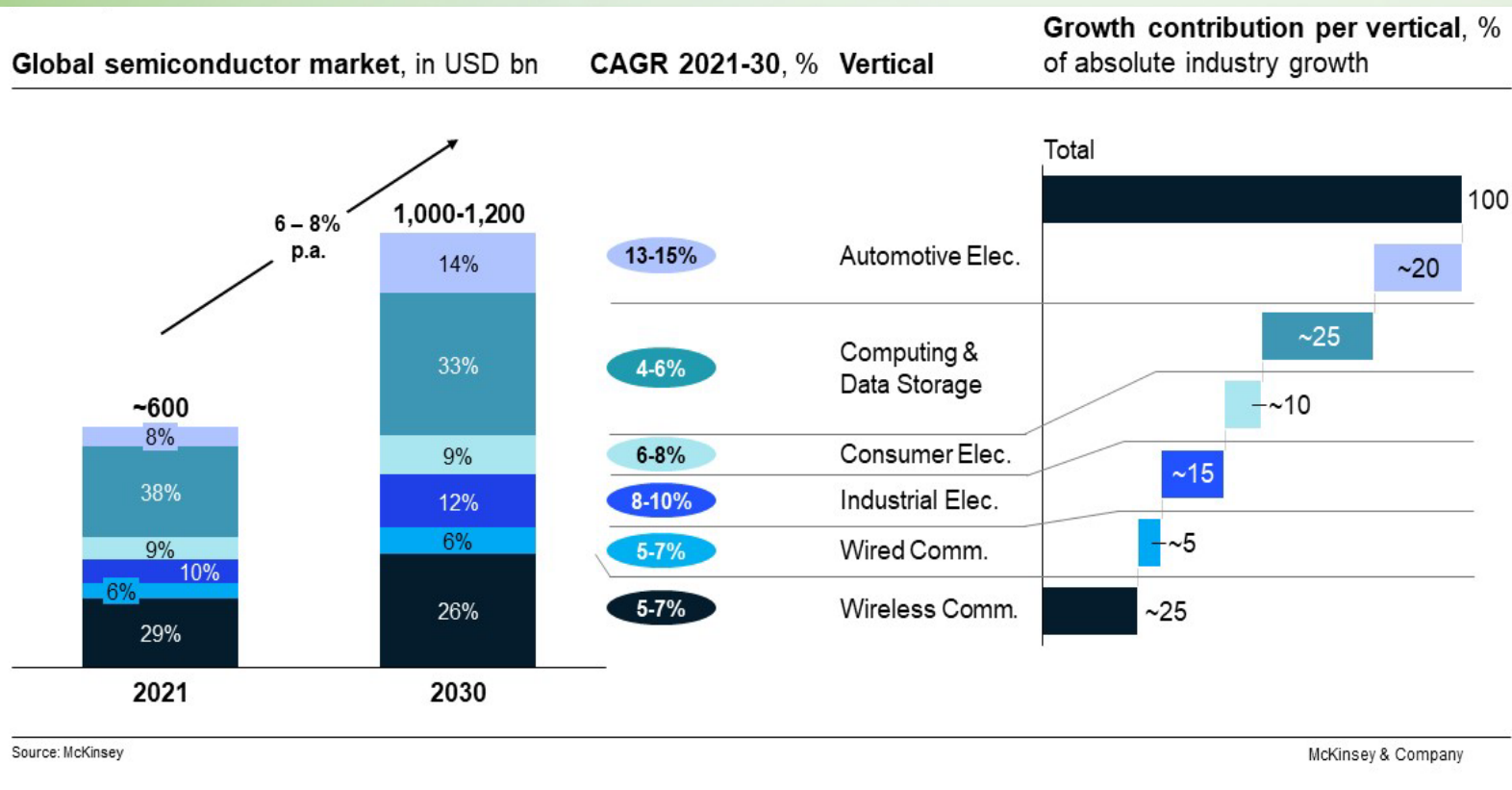
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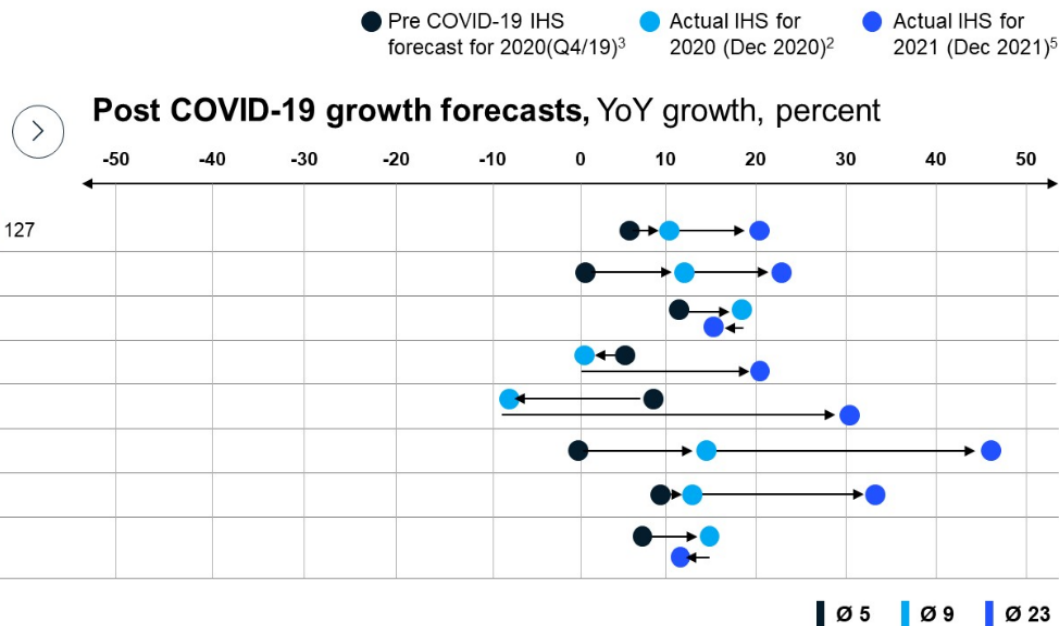
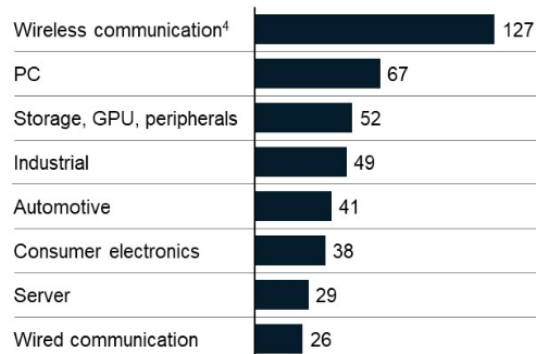
# Overall Growth in Semiconductor



- **About 70 percent of growth is predicted to be driven by three industries.**
- **Automotive:** applications such as autonomous driving and e-mobility and segment would be responsible for as much as 20 percent of industry expansion over the coming years.
- **Computation and data storage:** growth of 4 to 6% fueled by the demand for servers that support applications such as AI and cloud computing.
- **Wireless Communications:** smartphones could account for most of the expansion, amid a shift from lower-tier to mid-tier segments in emerging markets and backed by growth in 5G (and 6G).

# Overall Growth in Semiconductor

**Semiconductor 2019 sales by application<sup>1</sup>,**  
USD billions



1. Products include memory, micro components, logic, analog, discrete, optoelectronic, and sensors/actuators  
 2. The estimates for 2020 were calculated using a 2019 baseline and percentages have been rounded  
 3. As of December 2019  
 4. Includes Chinese inventory effect, growth rate w/o inventory expected to be -4 to -8%  
 5. Growth rate YoY 2020/21 – backwards corrections from HIS might be included in 2020 data

Source: Strategy Analytics; IHS; Expert Interviews

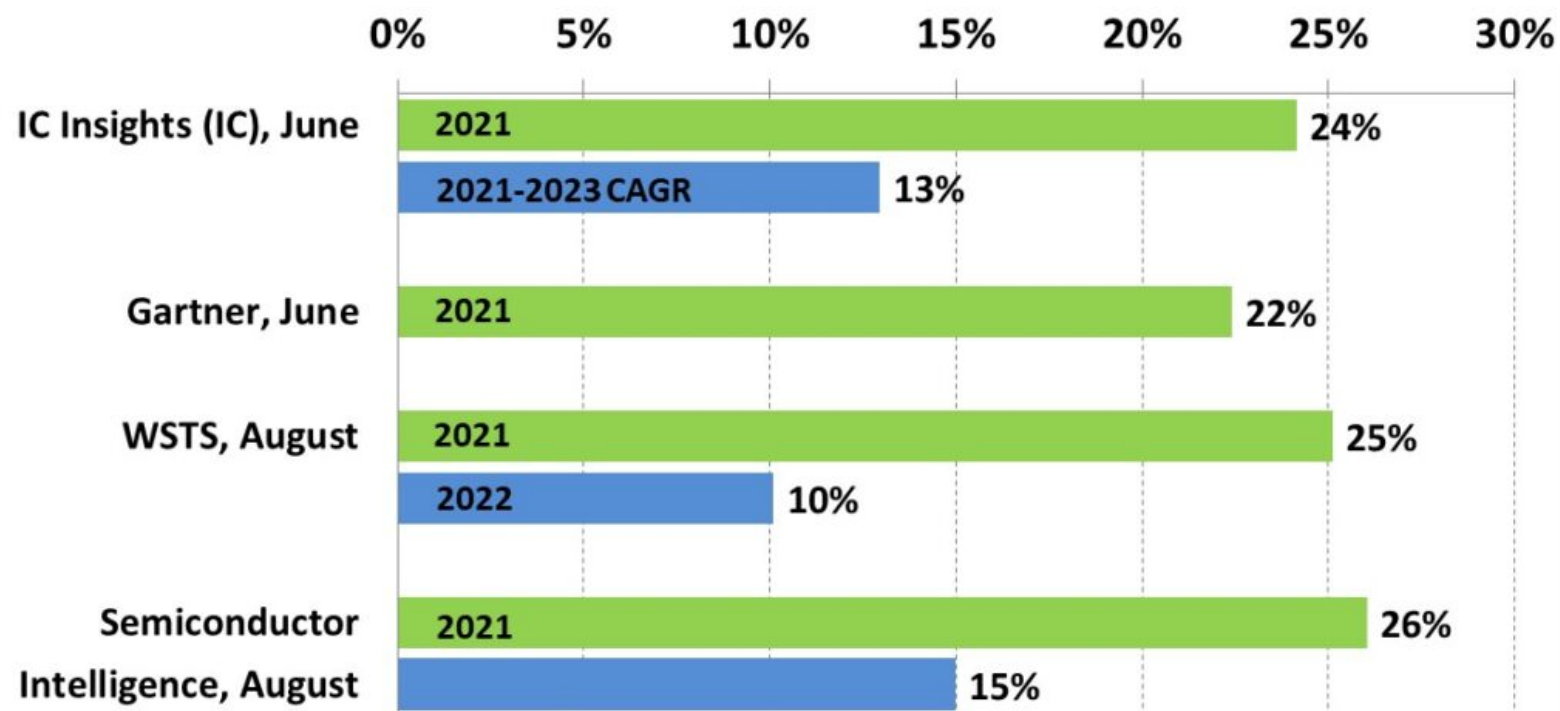
McKinsey & Company 13

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# Overall Growth in Semiconductor

## Semiconductor Market Forecasts



### Current Market Positives

- Strong global recovery
- Increases DRAM and NAND pricing
- Strong 5G Cell Phone replacement cycle
- Strong edge device demand.

### Current Market Challenges

- Shortages of multiple technology nodes
- Shortages of automotive devices
- Silicon wafer supply chain capacity
- Manufacturing capacity additions are limited.

# Worldwide Semiconductor Initiatives



**\$52B**

## **US CHIPS Act**

Incentives for National Semiconductor Technology Center to regain global leadership in advanced chip manufacturing



**\$35B**

## **EU Industrial Alliance on Microelectronics**

European Chips Act for combined public and private investment to rebuild Europe's capacity for high-end microelectronics.



**\$100B+**

## **Made in China 2025**

**China National IC Industry Investment**  
70% domestic self-sufficiency by 2025  
100% domestic self sufficiency by 2030



**\$6.8B**

## **Japan Ministry of Economy, Trade & Industry (METI)**

Gov't fund for advanced semiconductors at a Japan TSMC Fab and \$for advanced chipmaking technology.



**\$45B+**

## **Korean Semiconductor Industry Investment**

Public and Gov't funding to increase foundry capacity through 2030 with investments in scholarship, materials, components, equipment and packaging.

Sources: IC Insights, McKinsey & Co, European Commission, Technode, ASML

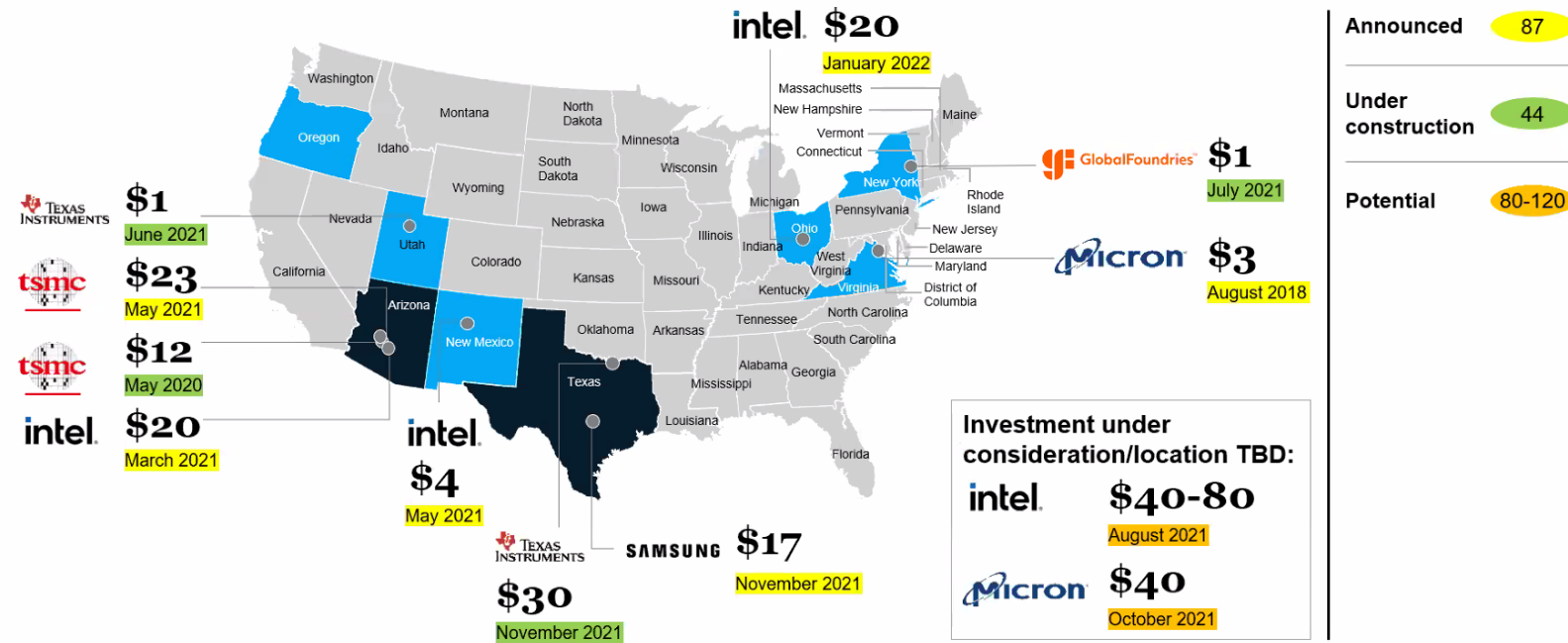


# Semiconductor FAB Construction in US

**In the US alone, major players have announced ~\$130B of new US fab builds with an additional \$80-120B under consideration**

Non-exhaustive

Announced Under construction Potential \$B Announcement date

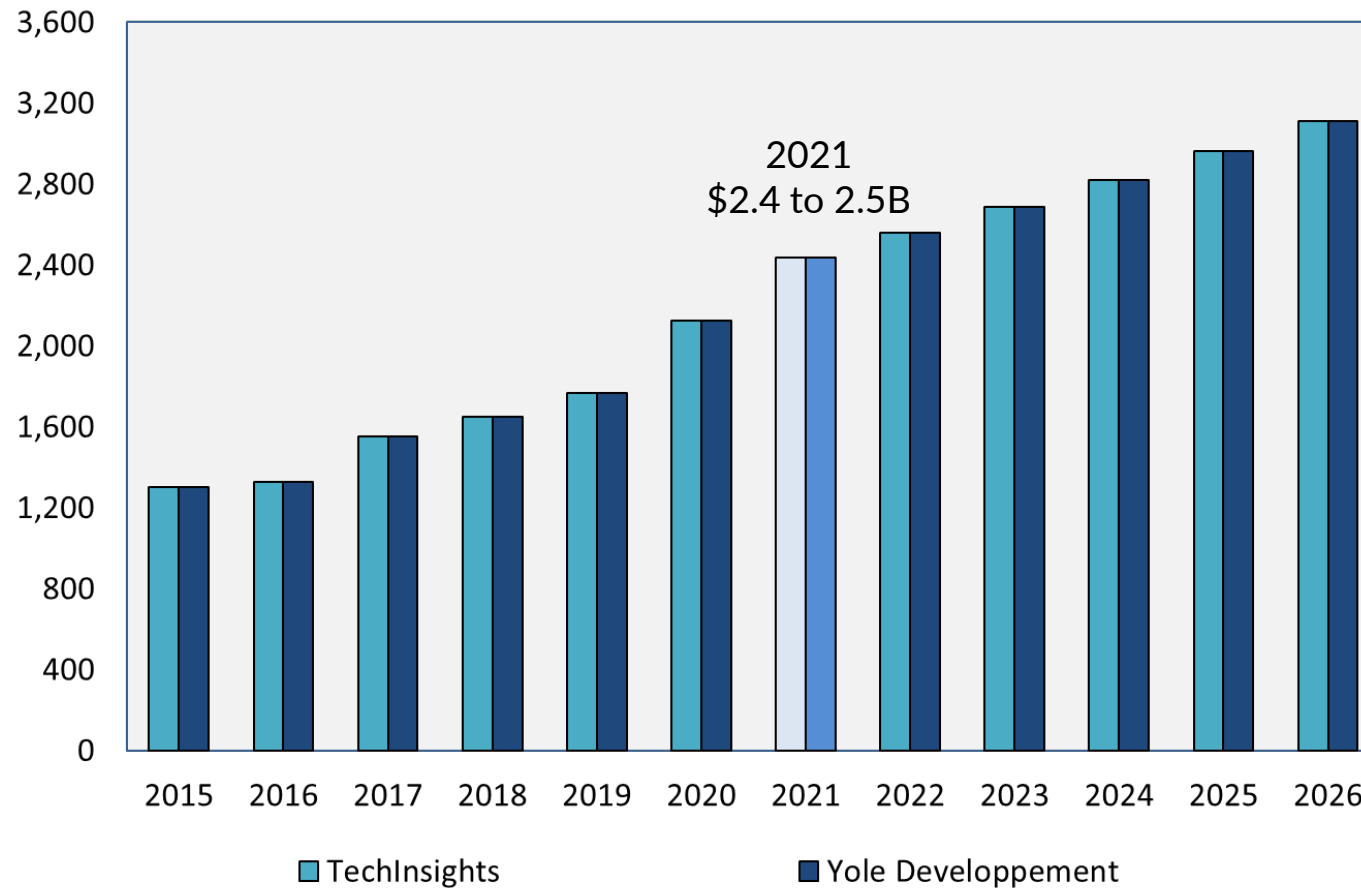


Source: Press release search for each company / municipal location

McKinsey & Company 8

# Probe Card Market Landscape

**Probe Card Revenues (\$M) for Semiconductor Test Grew to ~\$2.5B**  
(Data Generously Provided by TechInsights and Yole Développement)



**Tech  
Insights**

Thanks to TechInsights

- Risto Puhakka
- Panchami Phadke
- Andrea Lati
- Ha Pham

**YOLE**  
Développement

Thanks to Yole Développement

- John West
- Lin Fu



# Probe Card Technology Trending



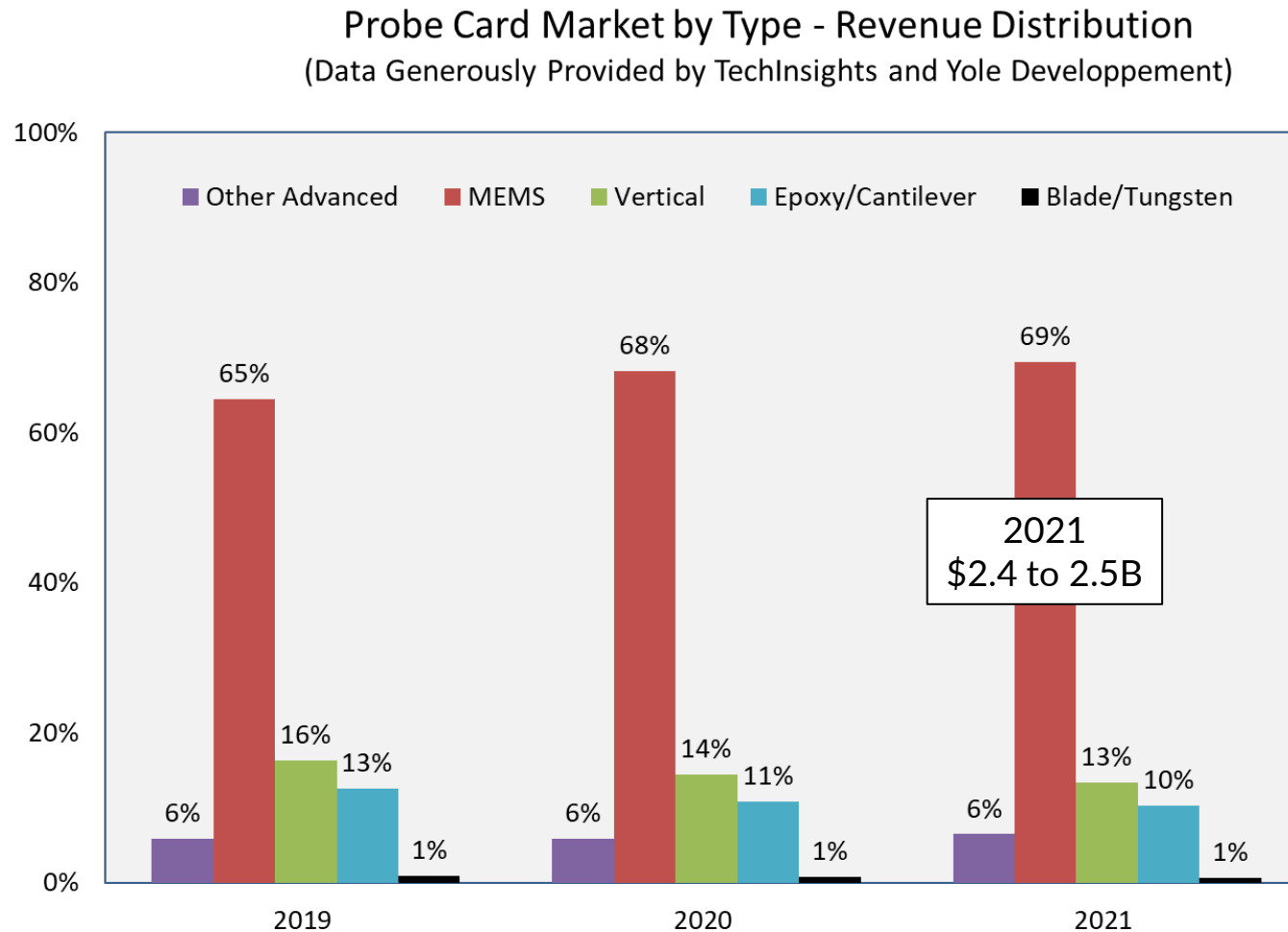
Thanks to TechInsights

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- Ha Pham



Thanks to Yole Développement

- John West
- Lin Fu



# Top Probe Card Vendors of 2021

## Semiconductor Probe Cards

Sales, \$M, Calendar Year

Rank	Company	2020	2021		% Growth
			TechInsights	Yole Développement	
1	FormFactor	581.7	633.3	633.3	9%
2	Technoprobe	372.7	422.5	457.7	13%
3	Micronics Japan	266.3	323.9	323.8	22%
4	JEM	159.4	204.5	198.9	28%
5	MPI Corporation	113.5	132.9	133.9	17%
6	Korea Instrument	63.9	76.4	81.3	20%
7	TSE	51.0	75.8	75.8	49%
8	Nidec SV TCL	59.6	71.8	68.5	20%
9	Chunghwa Precision Test	38.9	60.1	60.1	55%
10	Will Technology	49.0	54.2	56.6	11%
	Other	369.9	394.3	482.8	19%
	Probe Cards	2126.0	2449.7	2572.7	

**Tech  
Insights**

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**SWTEST**

PROBE TODAY, FOR TOMORROW

**2022 CONFERENCE**

# Technical Program Overview

June 5 - 8, 2022

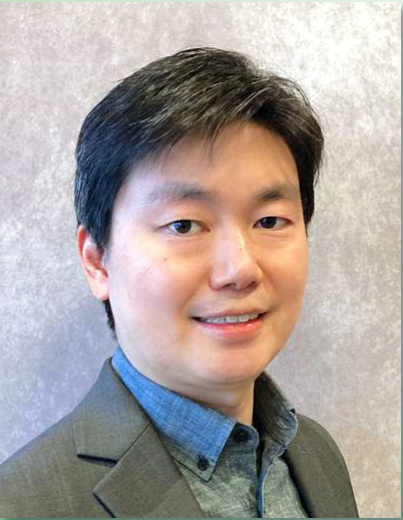
# Technical Program Overview

- **Sunday, June 5**
  - William Mann Memorial Benefit Golf Tournament
- **Monday, June 6**
  - Technical Program with a Visionary Keynote and 1-Technical Session
  - SWTest EXPO with 50-Key Suppliers On-Site and w/ Reception Stations
  - Virtual Expo will be open until July 9, 2022
- **Tuesday, June 7**
  - Technical Program with a Visionary Keynote and 1-Technical Session
  - SWTest EXPO with 50-Key Suppliers On-site
  - Virtual Expo will be open until July 9, 2022
  - Tuesday night outdoor social and networking event with entertainment
- **Wednesday, June 8**
  - Technical Program with 2-Technical sessions
  - Conference adjourns
  - ON-Demand is active from June 9 to July 9, 2022



# Visionary Keynotes

## Architecting Test Solutions for the Next Generation of Compute



**John Yi**

*Product Engineering Organization Fellow*  
**Advanced Micro Devices (AMD)**



## Advanced Packaging and Test Enabling Our Digital Society

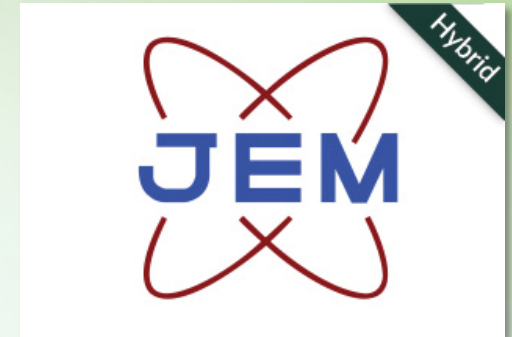


**Rebeca Jimenez**

*Corporate Vice President*  
*Advanced SiP Business Unit*  
**Amkor Technology, Inc**



# Platinum Sponsors (alphabetically)





# Gold Sponsors (alphabetically)



# Silver Sponsors (alphabetically)



# Recognition & Awards

- Best Overall Presentation
  - Best Data Presentation
  - Most “Inspirational” Presentation
  - Best Presentation, Tutorial in Nature
- 
- A presentation from SWTest 2022 will be selected for publication in Chip Scale Review





# SWTest 2022-Hybrid Awards

## Best Presentation, Tutorial in Nature

**Millimeter-Wave Signal Integrity in a Dense Device-Interface-Board (DIB) Environment**

Andrew Westwood (Teradyne, Inc. – USA)



**Andrew Westwood**  
Teradyne - USA

## Most Inspirational Presentation

**Evaluation of a MEMS Probing Solution for Scrub Mark Visibility on Automotive Devices with Nickel Palladium pads**

Karan Maniar (Nidec SV TCL – USA)

Erwin Verardi (STMicroelectronics – Italy)



**Karan Maniar**  
(Nidec SV TCL – USA)



**Erwin Verardi**  
(STMicroelectronics – Italy)

# SWTest 2022-Hybrid Awards

## Best Data Presentation (tie)

Probe to pad alignment improvement over wide temperature range for automotive applications with large probe array size, high parallelism and small pads size

Emanuele Bertarelli, PhD (Technoprobe – Italy)  
Sebastien Usai (STMicroelectronics – France)



**Emmanuelle Bertarelli, PhD**  
Technoprobe - Italy



**Sebastien Usai**  
STMicroelectronics - France

Challenges of Expanding Large Area Active Array for Fine Pitch Vertical Probecards

Cameron Harker (FormFactor – USA)



**Cameron Harker**  
Formfactor - USA

# SWTest 2022-Hybrid Awards

## Best Overall Presentation (tie)

The Digital Revolution: NRZ to PAM4

David Raschko (FormFactor – USA)



**David Raschko**  
Formfactor - USA



# William R. Mann Student Travel Grant



**Bill Mann**  
Founder of SWTest

- Partially funded by the SWTest annual Golf Tournament's "Beat the Pro" hole contest.
- SWTest Conference provides a stipend of up to \$1,000 to cover expenses for travel, hotel accommodations, and student registration.
- **Four Students were Awarded for 2022**
  - Francesco Angione, PhD Student from *Politecnico di Torino, Italy*
  - Francesco Lorenzelli, PhD Student from *KU Leuven, Leuven, Belgium*
  - Melaina Nelson, undergraduate student from *University of Arizona, Phoenix, USA*
  - Florian Tremmel, PhD Student from *University of the Bundeswehr, Munich, Germany*

# Want to Learn More ?

- **Chip Scale Review**  
<https://chipscalereview.com/>



- **Semiconductor Review**  
<https://www.semiconductorreview.com/>



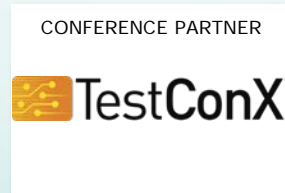
- **IEEE European Test Symposium (ETS)**  
<https://ets2022.upc.edu/>



- **IS-Test Conference**  
<http://www.is-test.com>



- **TestConX**  
*Formerly BiTS Burn In & Test Strategies*  
<https://www.testconx.org/>



- **Yole Développement**  
<http://www.yole.fr/>



- **International Semiconductor Executive Summits (ISES)**  
<https://isesglobal.com/>



- **TechInsights**  
<https://www.techinsights.com/>

