

turnkey **Test** and **Automation**
Solution provider™



Chroma's Prospect in Semiconductor Test

14th Sep, 2018

Chroma ATE Inc.



The IC design know-how are
accumulatively be built on maturity of
integrated circuit design as well as **test**



The Taiwan Top 50 Best performing CEO, 2016 (Rank 38)



Harvard Business Review

Founded	1984.11.8
IPO	1996.12 (TAIEX : 2360)
Chairman & CEO	Leo Huang
Employees	Global 2,368; Taiwan 1,729 (2018.01)
Headquarter	Taoyuan, Taiwan

Products:



Test & Measurement Instruments
Automated Test Systems
Intelligent Manufacturing Systems
Turnkey Solutions



Global Operation Sites



43

Operation Sites

93

Distributors

EST. 1999



Netherlands:
Ede

EST. 2017



Germany:
Augsburg

EST. 2008



Japan:
Shin-Yokohama/
Nagoya/ Osaka

EST. 2018



Korea:
Pangyo

EST. 1993



United States:
Irvine, CA
Santa Clara, CA
Chandler, AZ

EST. 2001



United States:
Foothill Ranch, CA
Marlborough, MA
Mexico :
Ciudad Juarez

EST. 1998



China/ Shenzhen

EST. 1999



China/ Beijing

EST. 2000



China/ Shanghai

EST. 2001



China/ Dongguan



Taiwan: Taoyuan (Headquarters)

EST. 2003



Taiwan: Hsinchu

EST. 2009



Taiwan: Kaohsiung

EST. 2006



China/ Suzhou

EST. 2011



China/ Xiamen

EST. 2011



China/ Chongqing

EST. 2016



Quantel : Singapore

Others:

India: New Delhi/ Mumbai/ Bangalore

Thailand: Bangkok

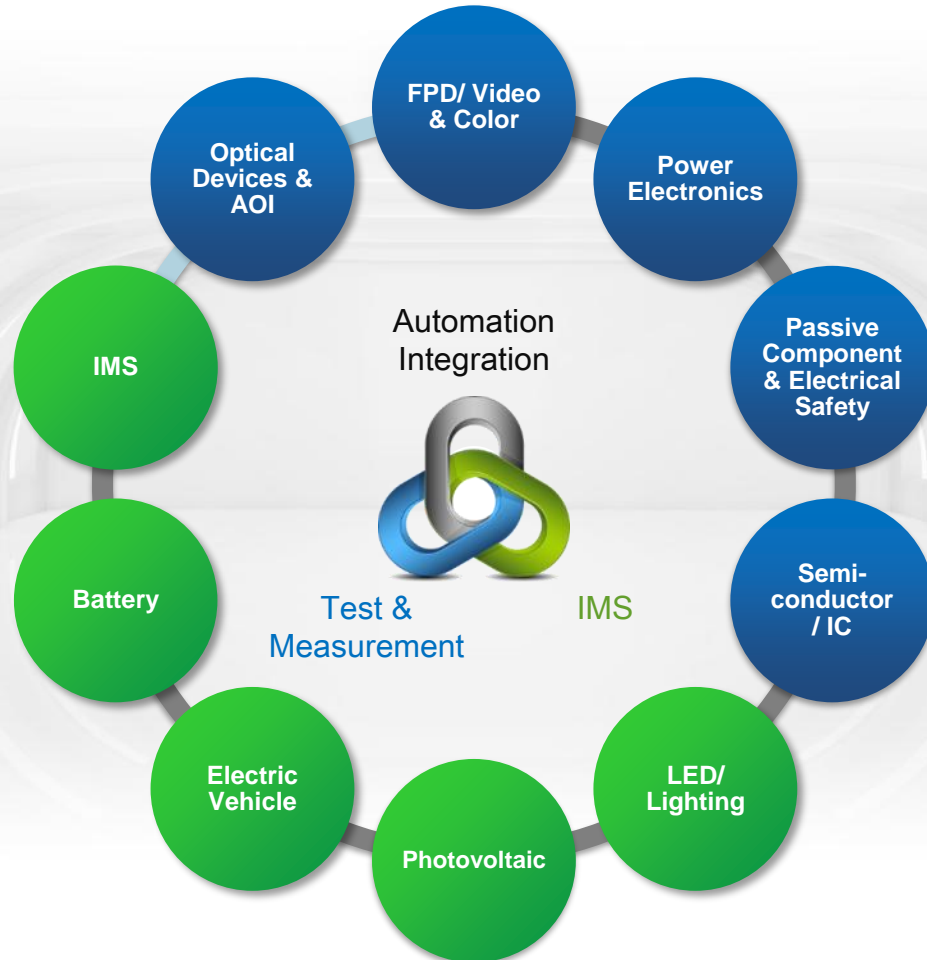
Vietnam: Hanoi/ Ho Chi Minh

Malaysia: Kuala Lumpur/ Penang

Philippines: Manila/ Cebu

Indonesia: Jakarta

Others: Qingdao/ Zhengzhou/ Xian/Hefei/ Chengdu/ Wuhan/ Hangzhou/ Guangzhou/ Hong Kong



Availability of Test & Automation Turnkey Solutions

40
Product Lines

591+
Models

- Test Instruments



- Automated Test Systems



- Turnkey Solutions





Core Technologies

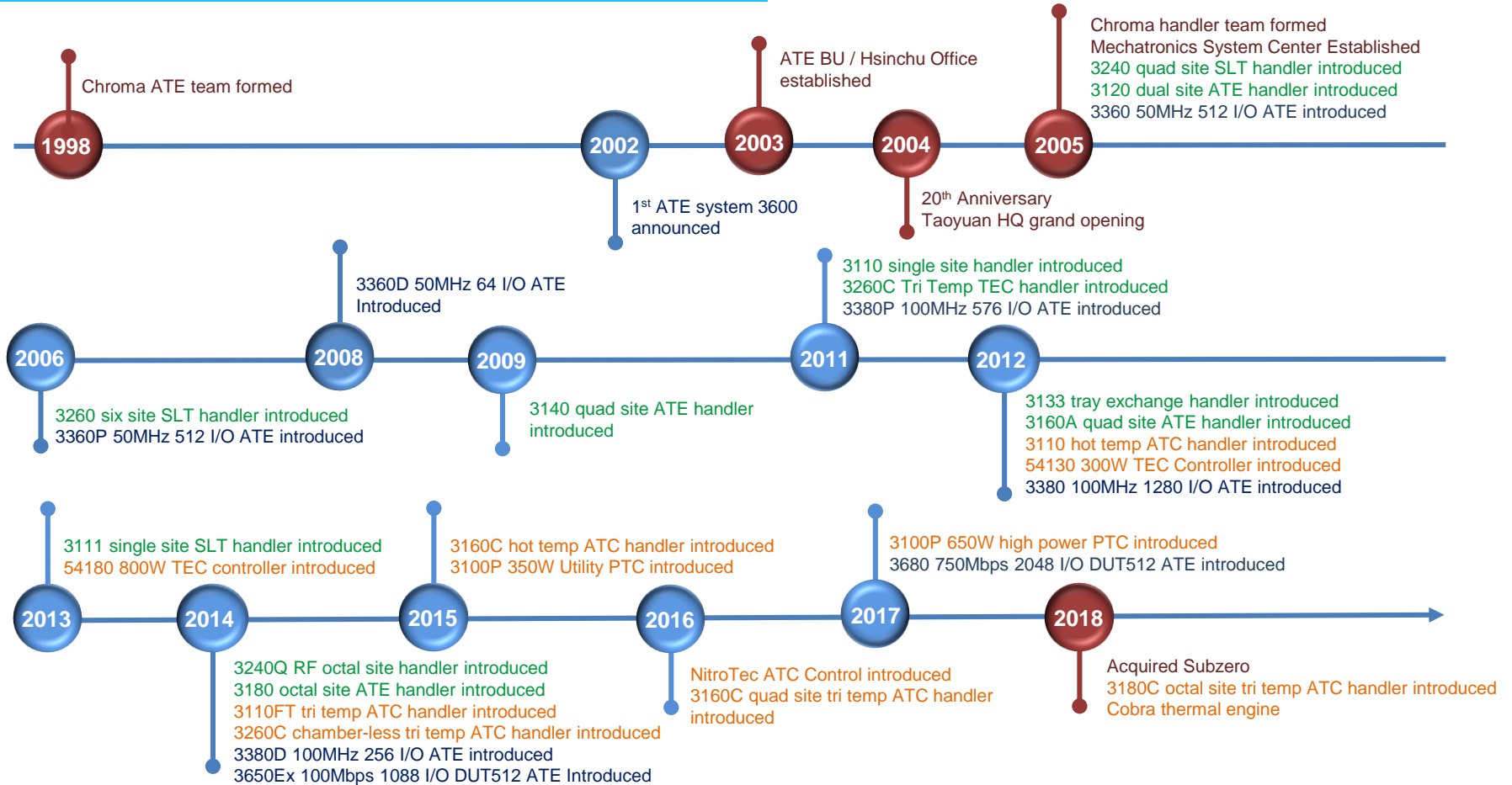


Patents, Worldwide



Patents, Taiwan

Chroma Semiconductor Milestones



Semiconductor/IC Test Solutions

Test Instruments

- PXIe Digital IO Card
- PXI Pin Electronics Module
- PXI DUT Power Supply
- PXI High Precision SMU
- RF IC Tester

Automated Test Systems

- VLSI Test System
- SoC Test System
- CIS Turnkey Solution

Handler Equipment

- Full Range ATC FT Handler
- Multi Sites FT Handler
- RF Solution Integrated Handler
- Hybrid Tri-temp ATC Test Handler
- Intelligent Robotic Test Handler
- Tabletop Single Site Test Handler
- Full Range ATC SLT Handler

Applications

- | | |
|-------------------|--------------------|
| CPU/GPU/MCU | IoT/3C IC |
| LED driver IC | ADC/DAC |
| Analog/Power IC | Super I/O |
| RF IC | Display controller |
| CMOS image sensor | FPGA |
| Mixed signal IC | Chipset |
| Automotive IC | |

Wafer Test / Open Short Test / Final Test



Final Test

System Level Test



Test Instruments

- High Precision Source Measure Unit & PXI Platform
- TEC Controller
- Thermal/Multi-function Data Logger

Automated Test Systems

- VCSEL Wafer Probing Test System
- Wafer Chip Inspection System
- Laser Diode Characterization System
- Laser Diode Burn-in and Reliability Test System
- TO-CAN Package Inspection System
- TOSA/BOSA Temperature Control System

Applications

- VCSEL wafer
- CoC/CoS
- TO-CAN
- TOSA/BOSA



Automated Test Systems

- 3D Optical Profiler
- Multi-functional Dimension Measuring System
- Multi-functional Optical Profiling System
- Wafer Inspection System
- TO-CAN Package Inspection System
- LCoS Cell Automatic Optical Inspection System
- Automatic Optical Solar Wafer/Cell Inspection System

Applications

- | | |
|------------------------------------|-------------------|
| Semiconductor thin-film transistor | VCSEL laser diode |
| Micro-electro-mechanical systems | Photodiode |
| E-paper | LED |
| Portable device metal casing | TO-CAN |
| Portable device cover glass | LCoS cell |
| Battery | Solar wafer/cell |



Chroma introduction

Semiconductor market forecast in 2018

- **WSTS forecast summary**
- **From equipment growth to demand growth**

New era tomorrow

- Energies of the growth
- Escalating Risk to human life

Impact on testing technology

- Aspects beyond current test

Summary

Semiconductor Market to Reach \$463 Billion in 2018

WSTS Forecast Summary

Spring 2018	Amounts in US\$M			Year on Year Growth in %		
	2017	2018	2019	2017	2018	2019
Americas	88,494	100,853	105,521	35.0	14.0	4.6
Europe	38,311	43,430	45,487	17.1	13.4	4.7
Japan	36,595	39,753	41,440	13.3	8.6	4.2
Asia Pacific	248,821	279,375	291,271	19.4	12.3	4.3
Total World - \$M	412,221	463,412	483,719	21.6	12.4	4.4
Discrete Semiconductors	21,651	23,610	24,659	11.5	9.0	4.4
Optoelectronics	34,813	35,986	38,024	8.8	3.4	5.7
Sensors	12,571	13,306	14,118	16.2	5.9	6.1
Integrated Circuits	343,186	390,509	406,918	24.0	13.8	4.2
Analog	53,070	58,095	61,044	10.9	9.5	5.1
Micro	63,934	66,152	68,582	5.5	3.5	3.7
Logic	102,209	109,476	114,747	11.7	7.1	4.8
Memory	123,974	156,786	162,545	61.5	26.5	3.7
Total Products - \$M	412,221	463,412	483,719	21.6	12.4	4.4

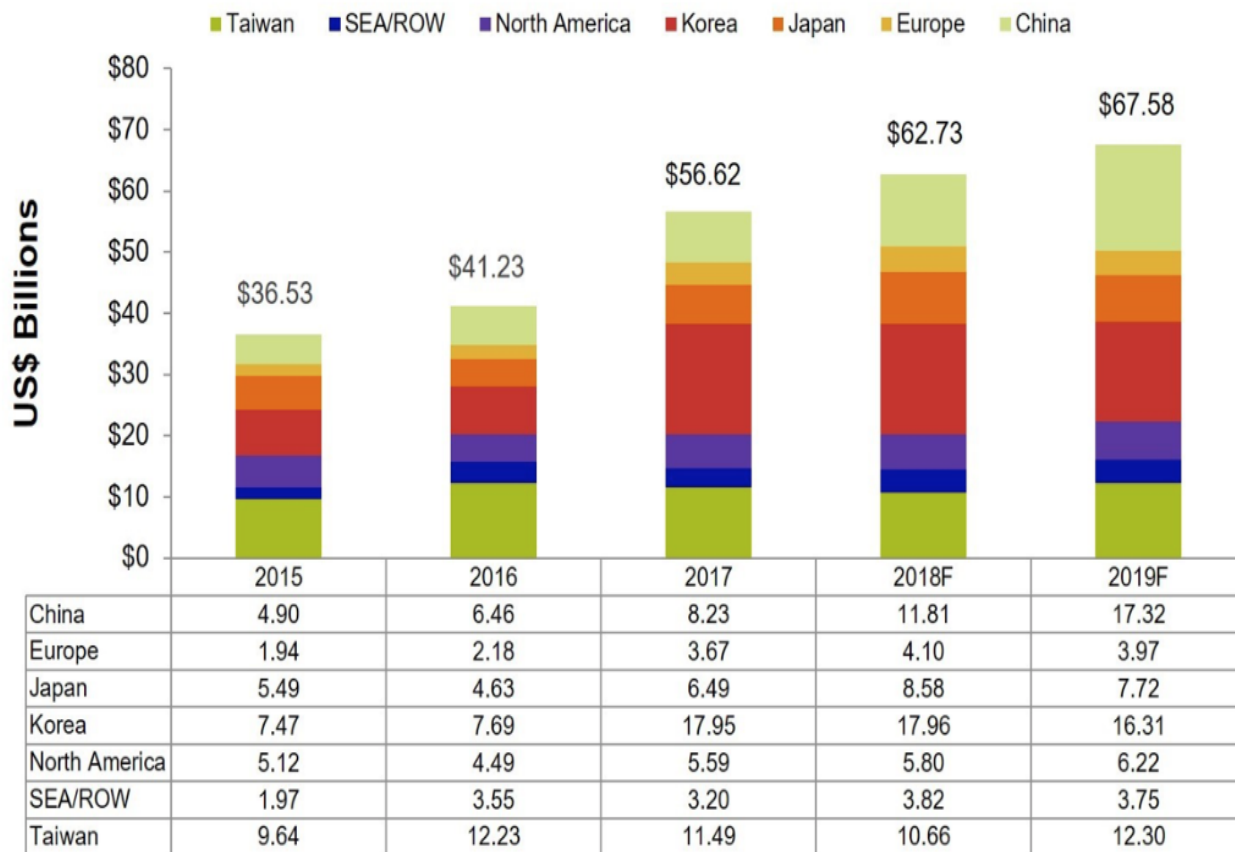
- World Semiconductor Trade Statistics say 2018 sales will eclipse last year by over 12 percent to \$463M

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.

Source: WSTS

From Equipment Growth to Market Development

- SEMI reported that worldwide sales of new semi manufacturing equipment will reach **\$62.7 billion** in 2018, up 10.8% over 2017.
- In 2019, the market will reach **\$67.6 billion**, up 7.7% over 2018



Source: SEMI July 2018, Equipment Market Data Subscription

New equipment. Totals may not add due to rounding

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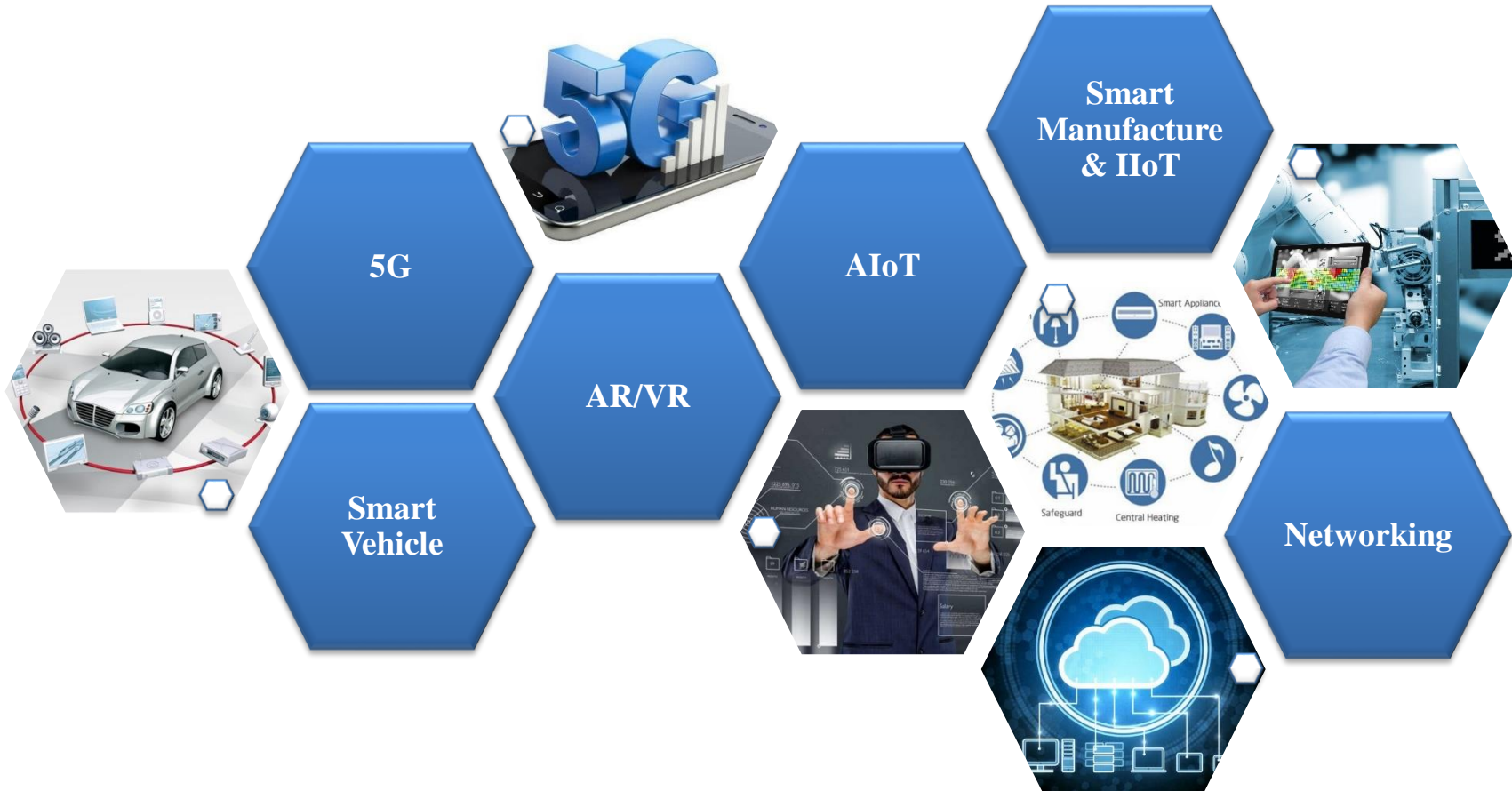
New era tomorrow

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Summary



5G Smart Phone

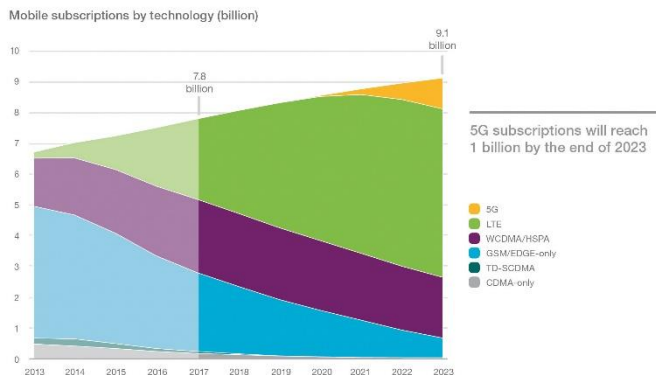
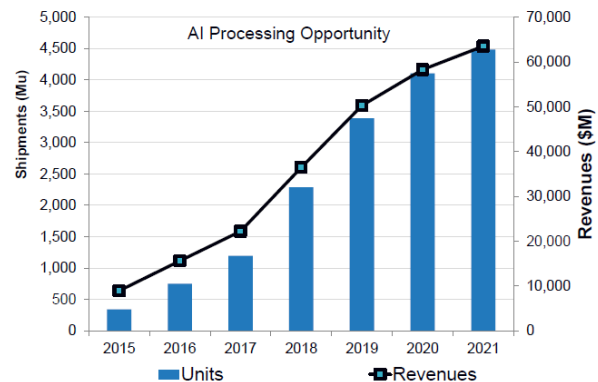
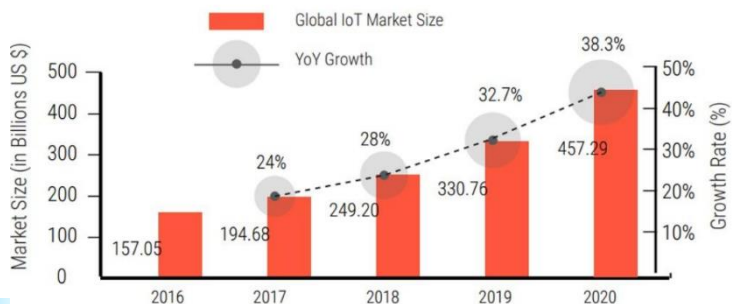


Figure note: IoT connections and Fixed Wireless Access (FWA) subscriptions are not included in the above graph
Ericsson Mobility Report November 2017

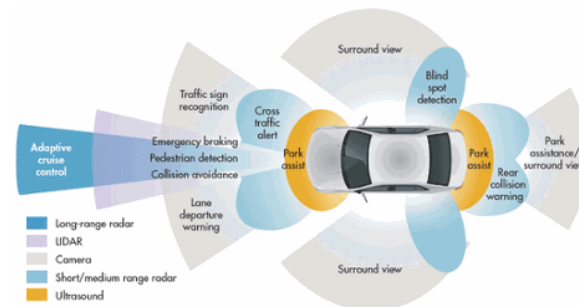
Artificial Intelligence (AI)



Internet of Things (IoT)



Smart Vehicle (ADAS, V2X)



Escalating Risk to Human Life

The rising trend of digital world provide tremendous conveniences to our life, but it also create higher risk to “hurting” people somehow:

- Direct human body damage due to autonomous driving vehicles
- Visual health impacted by distorted AR/VR images or radiation
- Financial loss caused by networks / cloud trading
- Infringing personal privacy due to IoT security leakage



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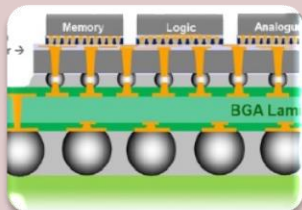
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Aspects beyond current test

Summary

Aspects Beyond Current Test



Variety of
Advanced
Package Test

- Fan-out WLP
- 2.5D / 3D package
- Big Mac SiP
- ASIC

Complexity of
Test Cell
configurations

- ATE-like test cell
- Hybrid testing
- Hardly to be standardized or unified

Heterogeneous
Test interface

- MEMS
- Optical device test
- Image sensor device test
- Silicon photonics test

Fault
Coverage

- Popularity of Structural / stress / pattern test
- Yield oriented test strategy

Liability &
Traceability

- SW based self test
- Device resume and test info storage
- Temperature test

Semiconductor device testing does no longer guarantee functional correctness, safety / reliability oriented test methods is a must; not a wish now

Environmental variances need to be considered in device test

Stimulus and response in semiconductor test are not just digital or analog signals, there are much more

Heterogeneous physical interfaces should increase significantly in device test

Comprehensive test data need to be collected and traceable for liability

Test equipment and test cell are not only ATE/handler/prober, they are now in many different configurations. The impact is on every player.

Keep going beyond



Thank You !