Marketplace Report
IoT Future

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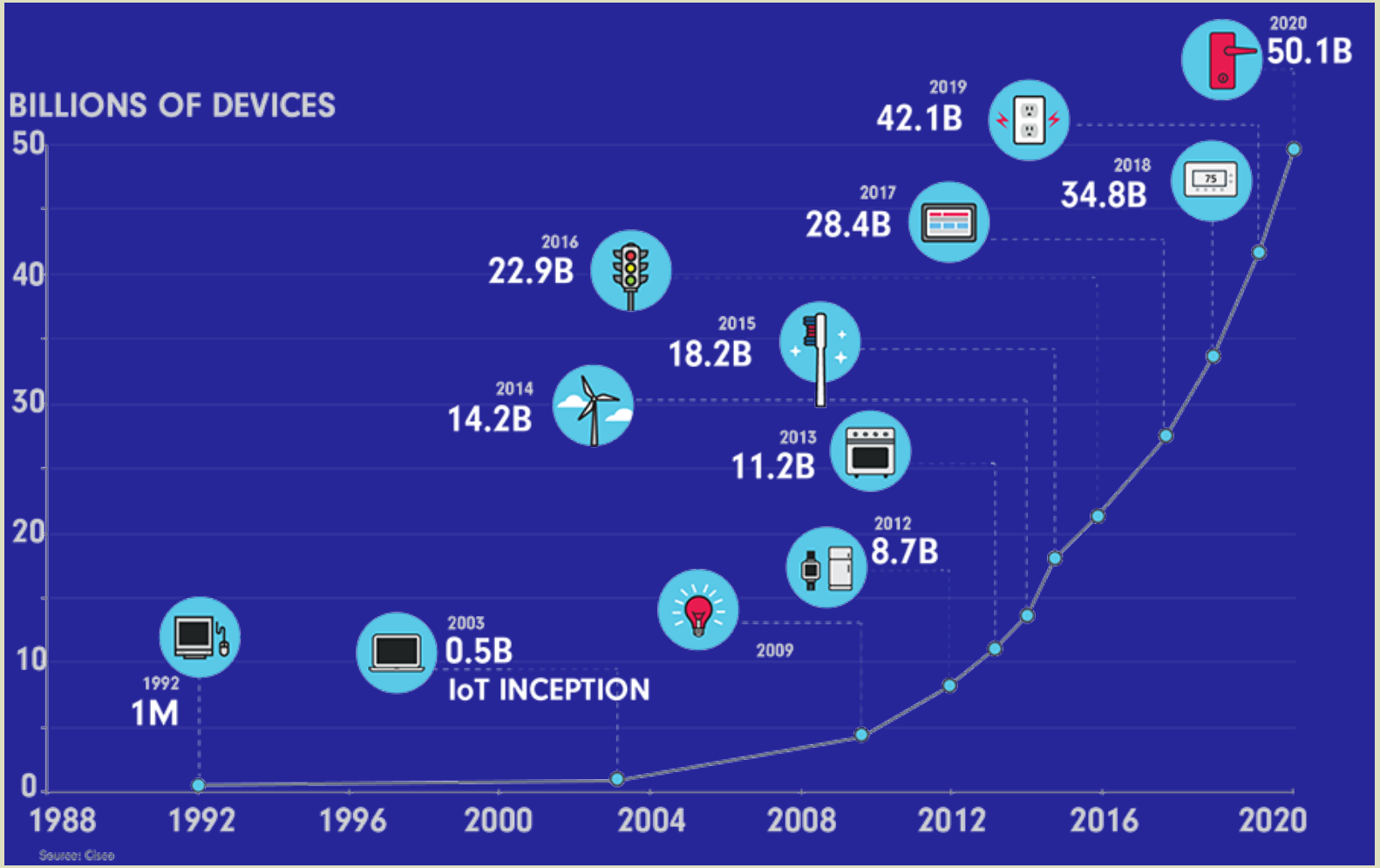
Feldman Engineering Corp.

Virtual Event ● May 3 - 7, 2021

Outline

- Internet of Things (IoT)
  - Exploding Applications
  - Test Challenges
  - Edge Compute
  - Additional Test Challenges
  - In Our Factories
- Socket Market

Internet of Things

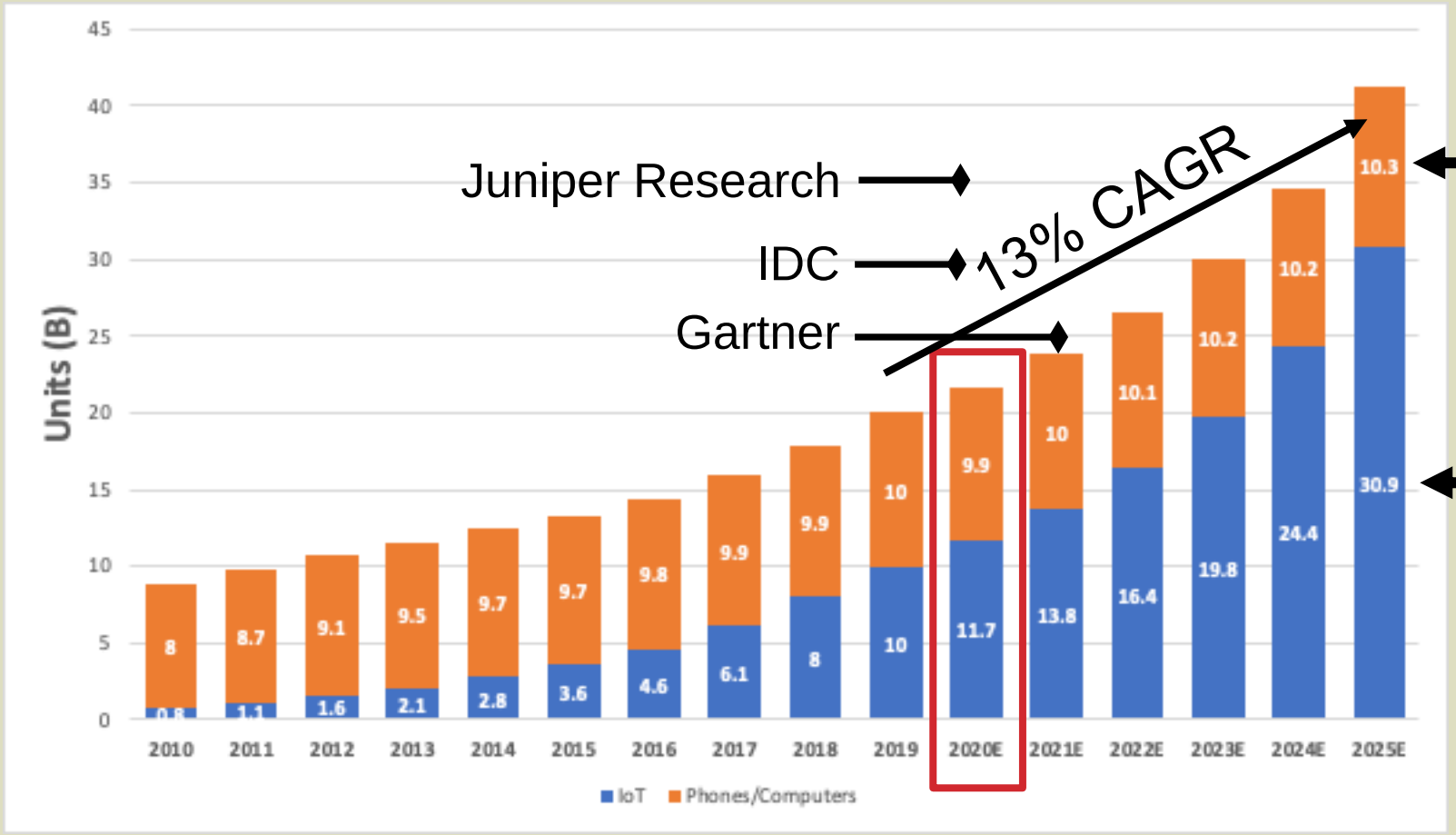


NCTA / Cisco

2014 Forecast

- Billions of devices
- Exabytes/month data
- Typically wireless
- Cost sensitive

Internet Connected Devices



Phones, Computers, Laptops, Tablets … "Replenishment"

IoT

[IoT Analytics - Nov 2020]

Common Consumer IoT Devices









Increasing power ← → Increasing mobility

softwaretetinghelp.com, Ring, Apple, WYZE, Tile

IoT Devices

Attribute	Typical
Internet connected	Wireless Often without human intervention (post setup)
Interacts with the world	Senses, controls, and/or displays
Ubiquitous presence	Placed at point of use Intended to deployed at high volumes
	Low cost desired
	Power efficiency – often battery operated and/or energy harvesting for long periods of time (reduce or eliminate battery replacement)

IoT Device Test Challenges

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Internet connected	Wireless Often without human intervention (post setup)
Interacts with the world	Senses, controls, and/or displays
Ubiquitous presence	Placed at point of use Intended to deployed at high volumes
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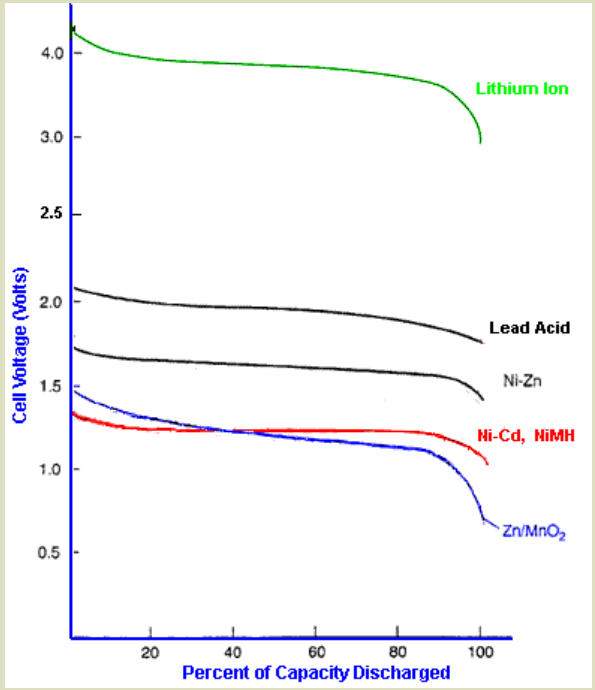
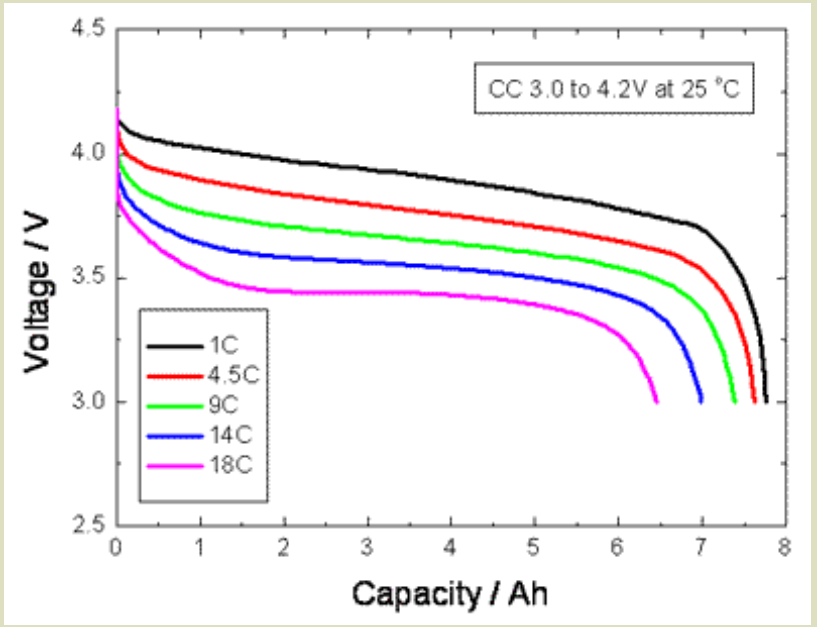
Battery Supply Challenges

Output fluctuation based upon charge

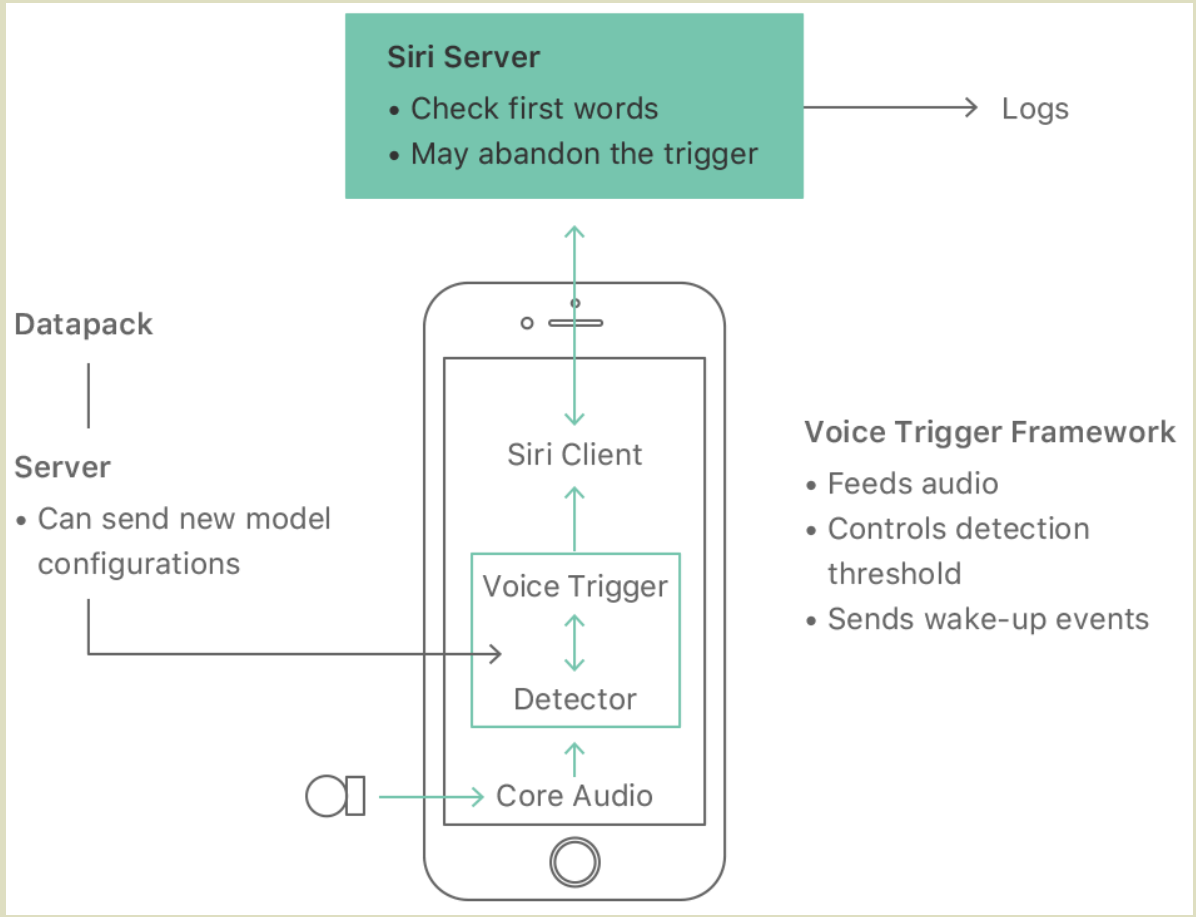


Output fluctuation based upon load & temperature



→ Real batteries are not a constant voltage during operation; how do you properly characterize and test?

Today's Cloud Intelligence



Apple

Speech Processing elements:

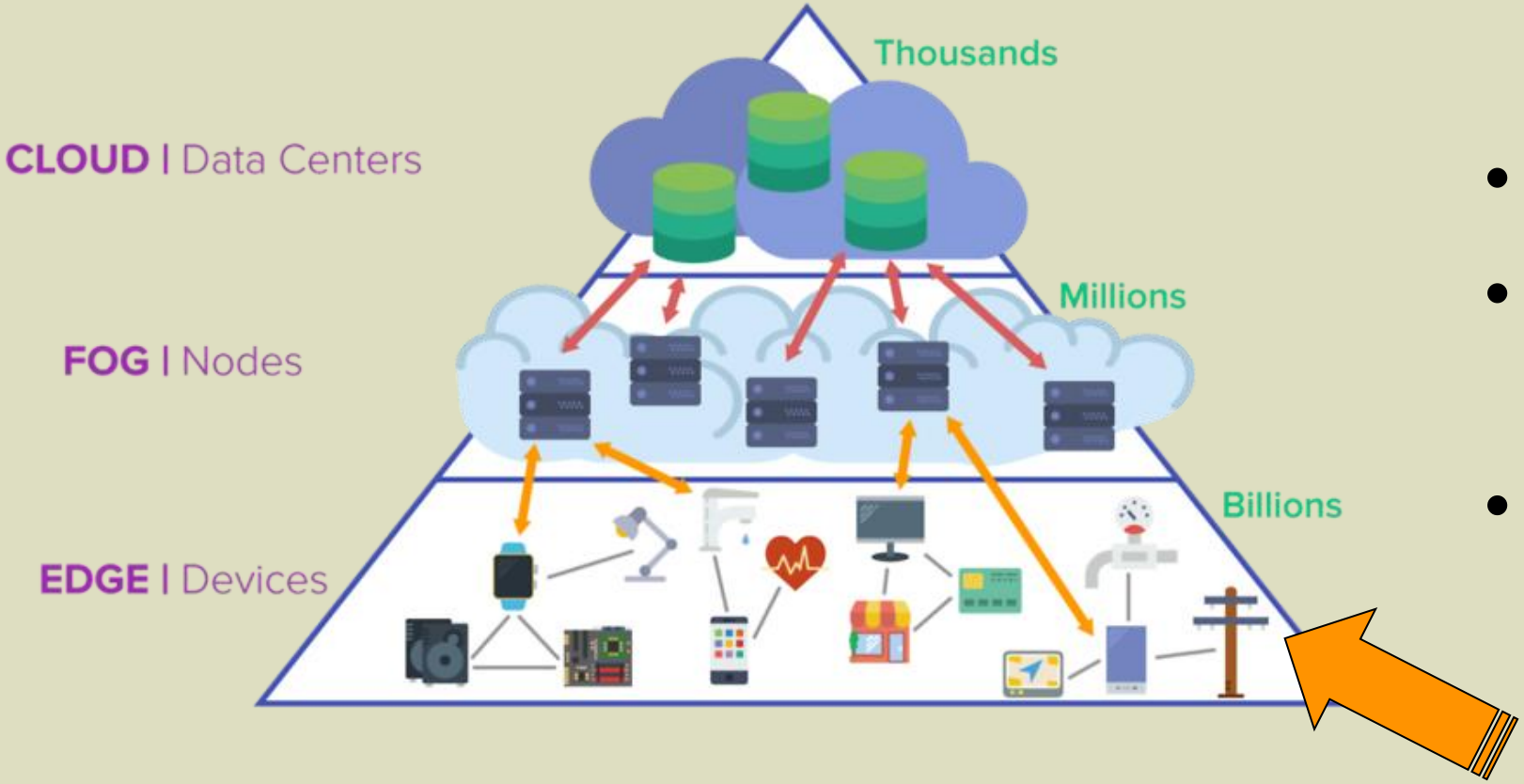
1. "Wake word" on device
   Apple: Always On Processor (AOP) runs Deep Neural Network (DNN) to trigger

2. Speech packets sent to Cloud
   DNN / Machine Learning (ML) interprets; Results returned to smartphone

→ Requires connectivity to operate
(other than very basic commands)

→ Smartphone compute >> typical IoT

Edge Compute & AI

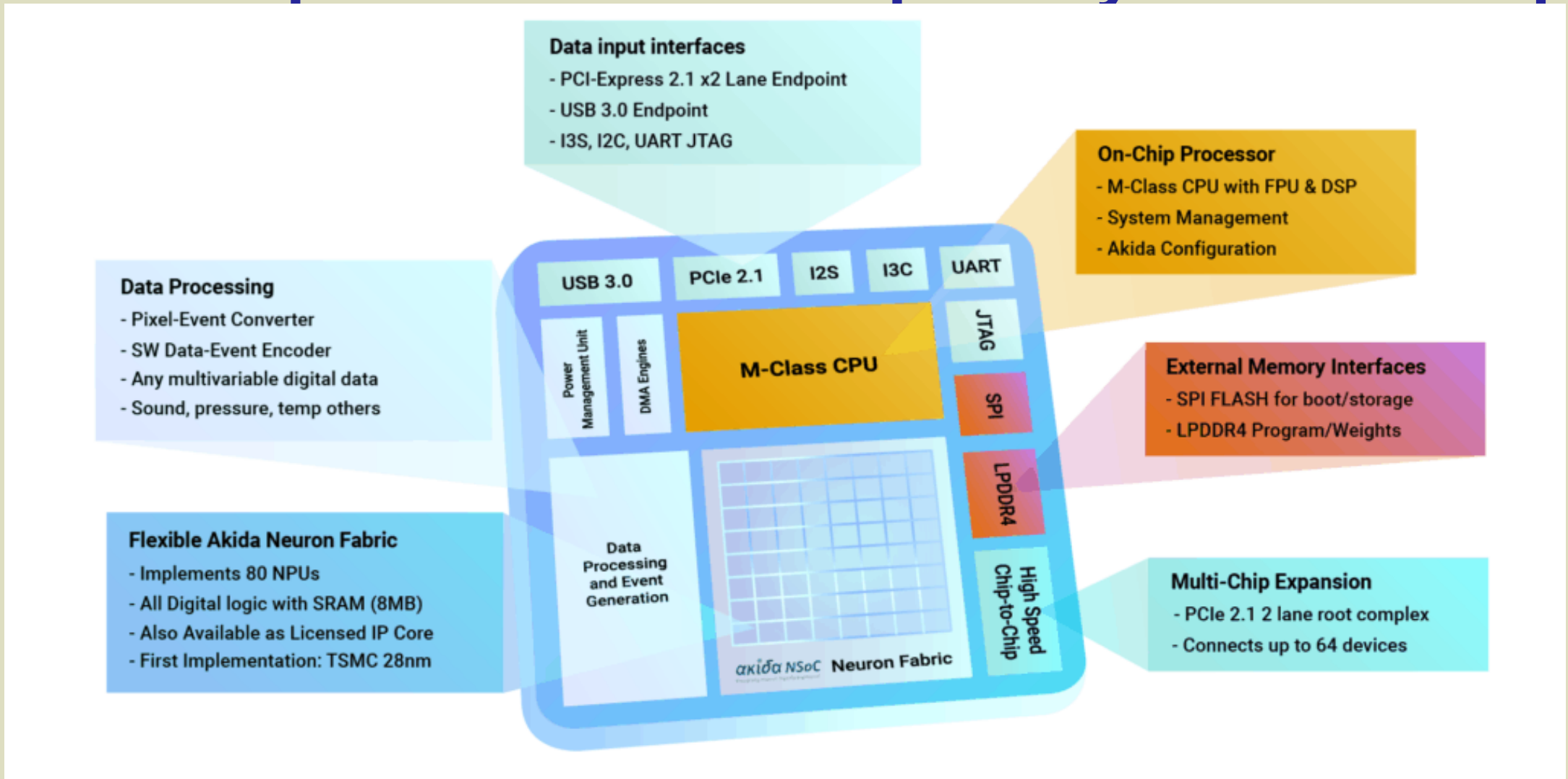


- Faster / low latency
- Power efficiency
- Scale / reduced communication
- Increased privacy

Do the ‘compute’ here

imagimob

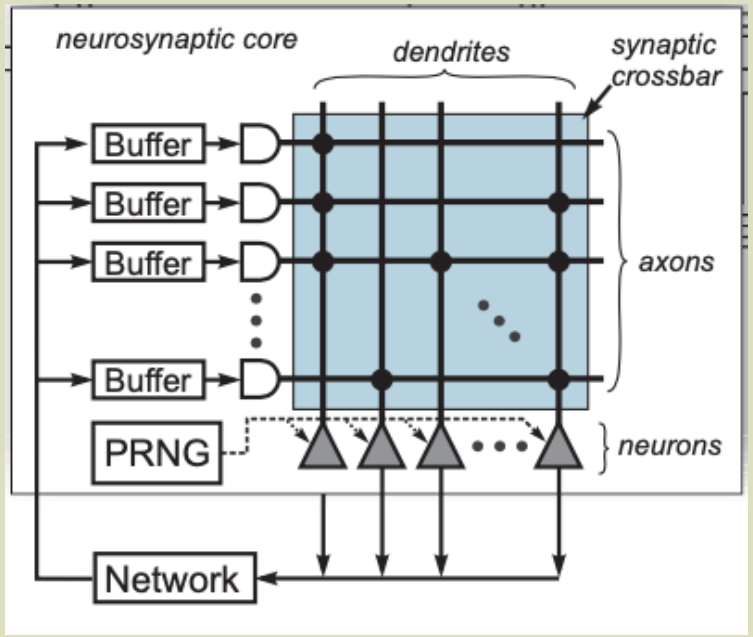
BrainChip Akida Neuromorphic System on Chip



BrainChip

Test Challenges / Neuron Array

Synaptic Cross Point



Cassidy2014

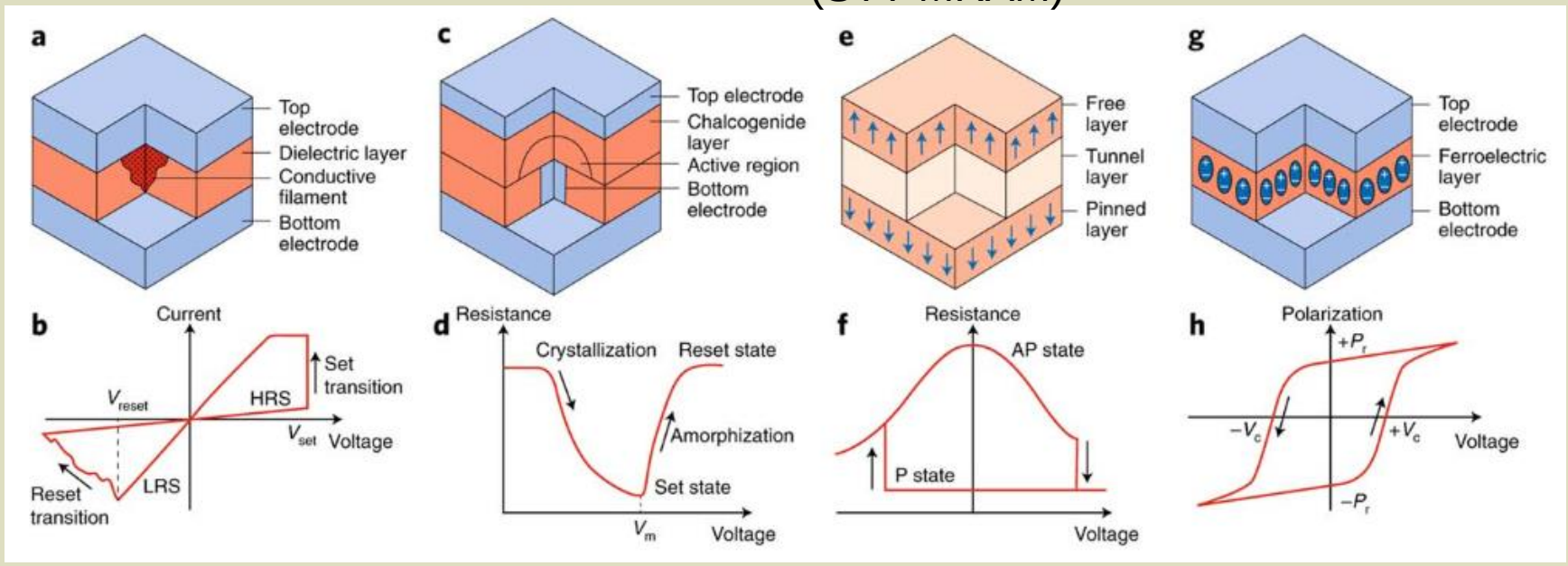
In memory compute RAM

Resistive Switching (RRAM)

Phase Change Memory (PCM)

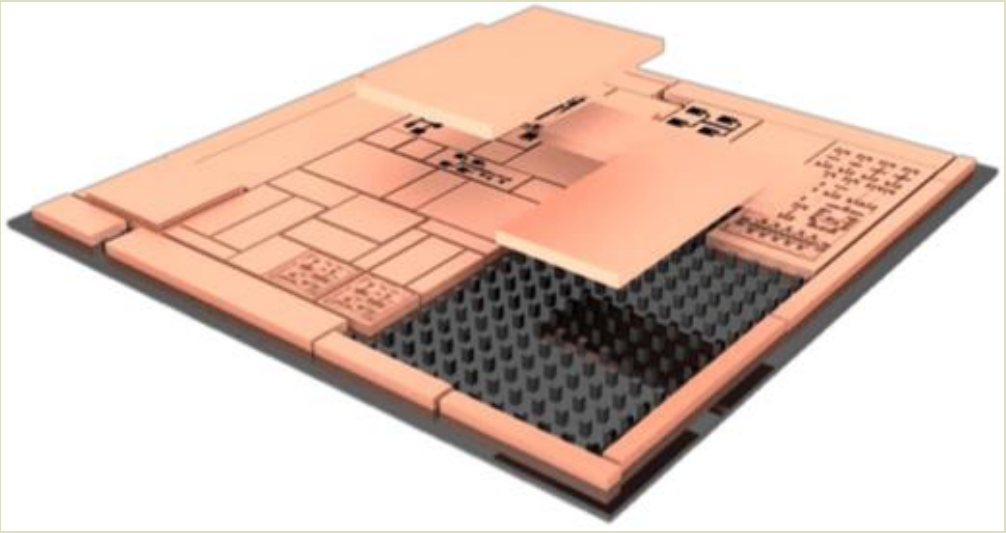
Spin-Transfer Torque Magnetic Memory (STT-MRAM)

Ferroelectric (FeRAM)



Ielmini2020

Test Challenges / Advanced Packaging



“Chiplets”

Advanced packaging may require increased testing at

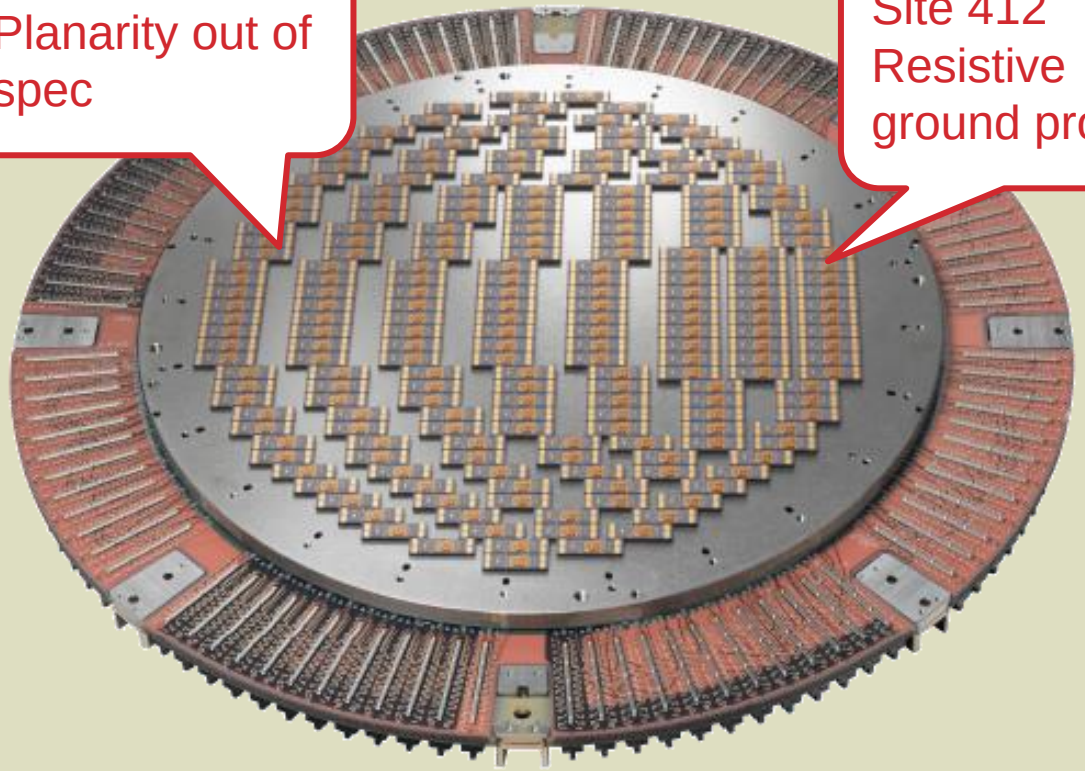
- Additional test insertions
- Extended “Final” / package test
- System Level Test

DARPA

IoT in our Factories

Site 37
Planarity out of spec

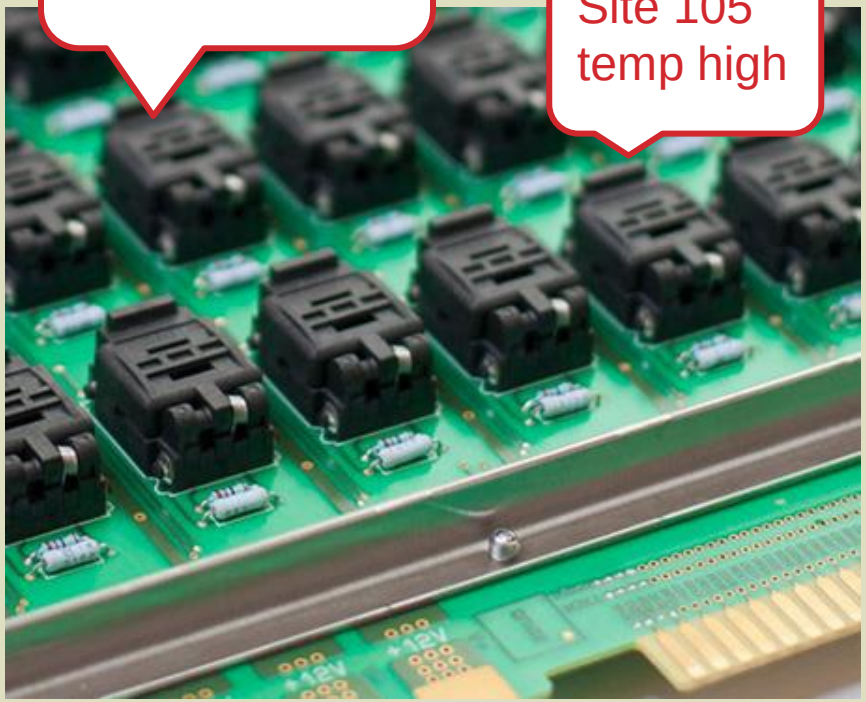
Site 412
Resistive ground probe



FormFactor SmartMatrix

Site 202
time to clean – about to fail

Site 105
temp high



Abrel Products

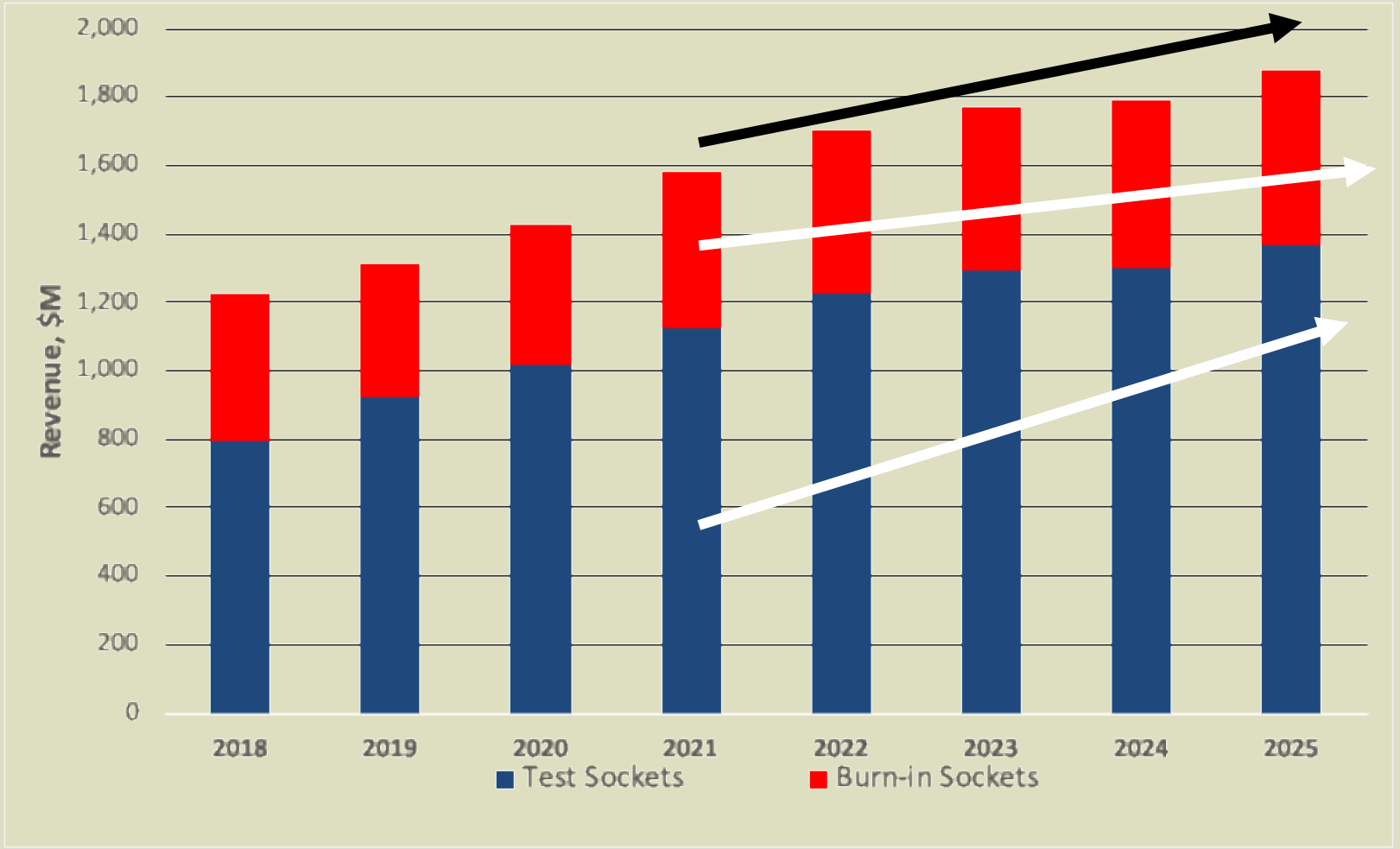
Summary

- Low growth for phones, computers, tablets
  - Greater complexity (new wireless: 5G, 6G…)

- Explosive growth in IoT Devices
  - Complex test challenges
  - Compute at the Edge
  - Industry 4.0 / Fundamental Industrial Change

SOCKET MARKET

Test and Burn-In Socket Market



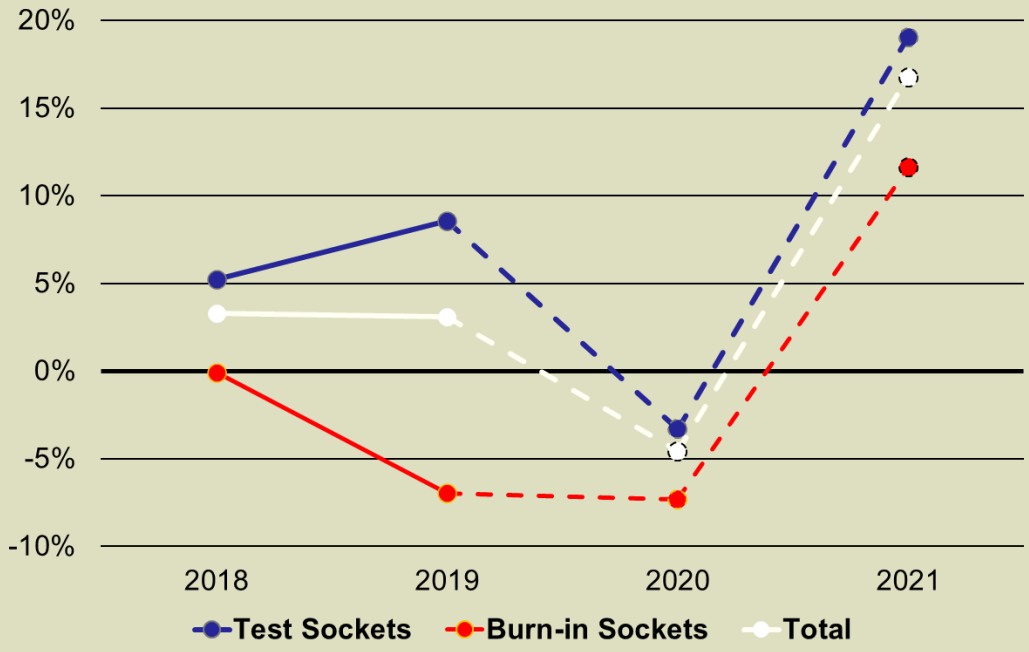
4.5% CAGR

2.9% CAGR

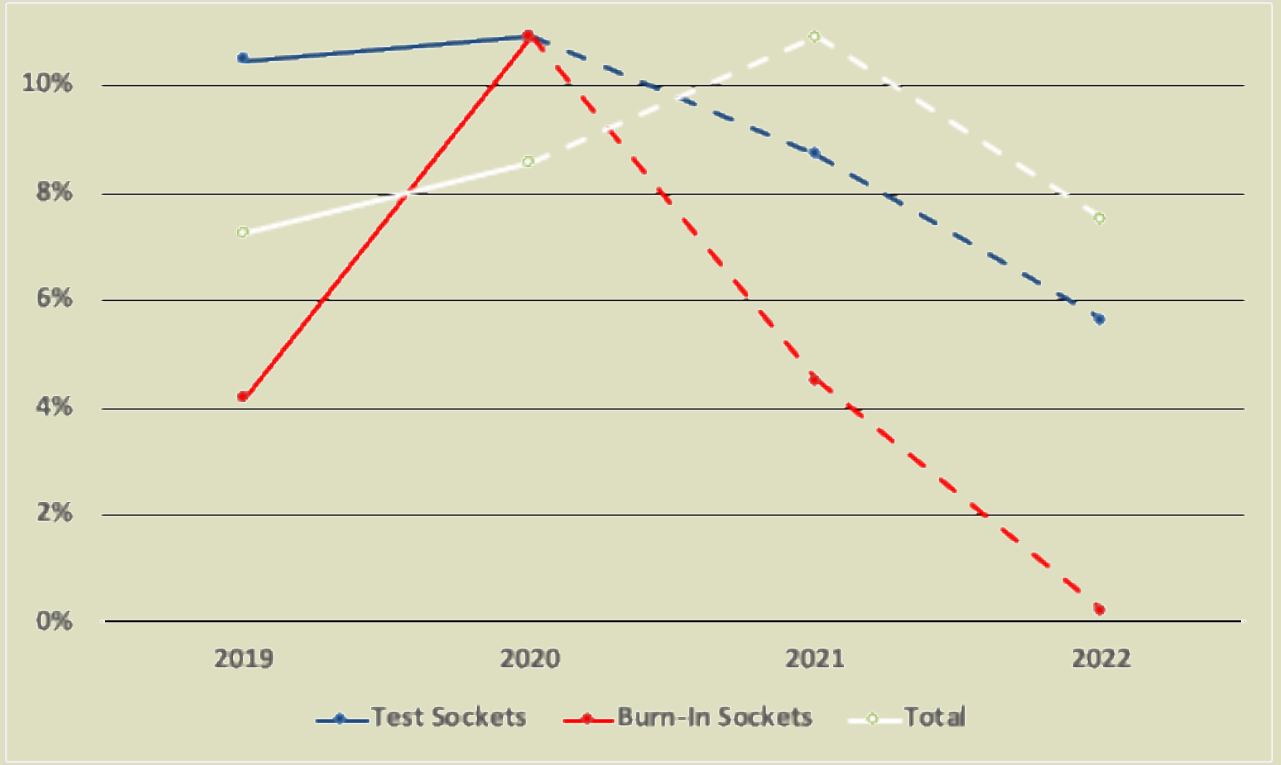
5.1% CAGR

VLSI Research 2020

Short Term Year Over Year (YOY) Change



VLSI Research 2019



VLSI Research 2020

Top Test & Burn-in Vendors 2020

Rank	2019 Overall
1	Enplas
2	Cohu
3	Yamaichi Electronics
4	Yokowo
5	WinWay

Rank	2020 Overall
1	Yamaichi Electronics
2	Enplas
3	Cohu
4	LEENO
5	Yokowo

VLSI Research 2019 & 2020

Top Test & Burn-in Vendors 2020

Rank	Overall	Test Socket	Burn-in Socket
1	Yamaichi Electronics	Cohu	Enplas
2	Enplas	LEENO	Sensata Technologies
3	Cohu	Yokowo	Yamaichi Electronics
4	LEENO	ISC	Micro Contact Solution
5	Yokowo	WinWay	Plastronics

VLSI Research 2020

Acknowledgements

- Socket Market Data courtesy of VLSI Research
  - Thank you John West

- tinyML Foundation www.tinyML.org
  - Enabling ultra-low power Machine Learning at the Edge

References

- Cassidy, A. et al. “Real-Time Scalable Cortical Computing at 46 Giga-Synaptic OPS/Watt with ~100× Speedup in Time-to-Solution and ~100,000× Reduction in Energy-to-Solution.” SC14: International Conference for High Performance Computing, Networking, Storage and Analysis (2014): 27-38.
- Daniele Ielmini and Stefano Ambrogio 2020 *Nanotechnology* **31** 092001.
- E. J. Marinissen *et al*., "IoT: Source of test challenges,” *2016 21th IEEE European Test Symposium (ETS)*, 2016, pp. 1-10, doi: 10.1109/ETS.2016.7519331.

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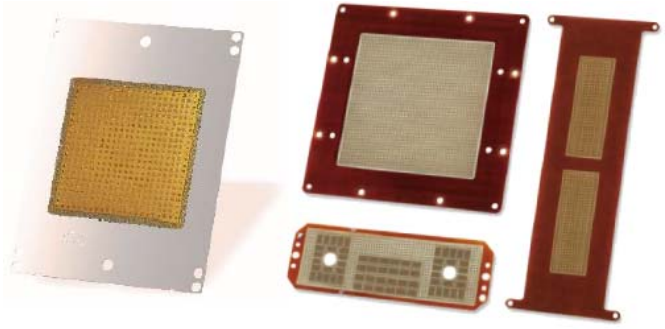
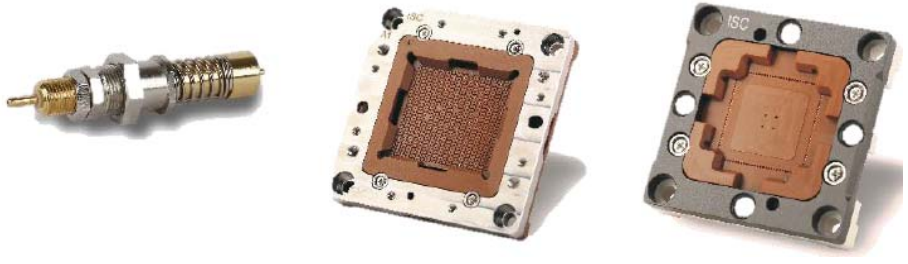
ELASTOMET SOCKET & INTERPOSERS

- High performance and competitive price
- High speed & RF device capability
- Various customized design to meet challenge requirement



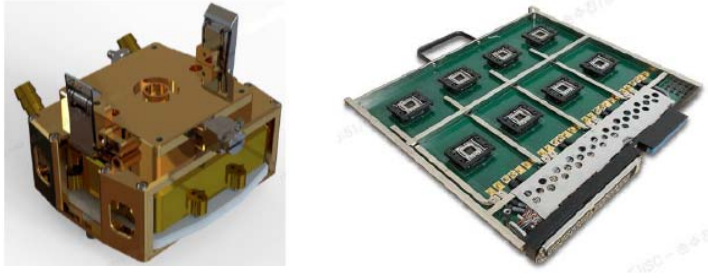
POGO SOCKET SOLUTIONS

- Excellent gap control & long lifespan
- High bandwidth & low contact resistance



THERMAL CONTROL UNIT

- Extreme active temperature control
- Safety auto shut-down temperature monitoring of the device & thermal control unit
- Full FEA analysis & Price competitiveness



BURN-IN SOLUTIONS

- Direct inserting on the board without soldering
- Higher performance BIB solution

CONTACT
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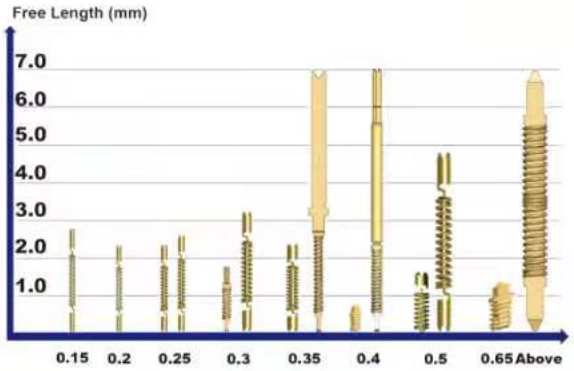
IWIN Co., Ltd. The test probe for high signal integrity at extremely high speed test

Spring probe by stamping



250 kinds of spring probe pin

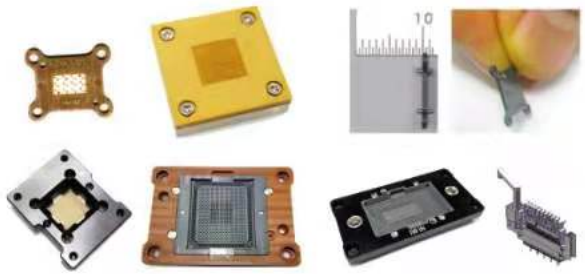
300 kinds of test socket (44,000 Pin count socket possible)

One piece spring probe

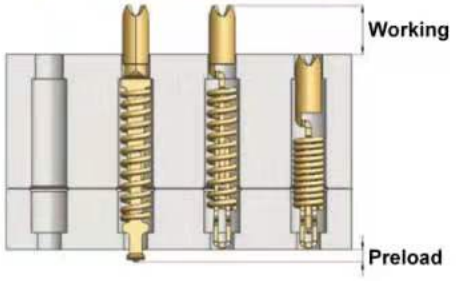
Three piece spring probe

High speed product → 0.63mm free length spring probe pin available

Finest Pitch → 0.15mm Pitch



Spring probe by stamping

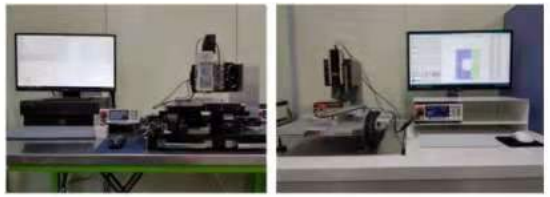


Patented

Pitch(mm)	Free Length(mm)	Current Carrying(Amps)
0.15/0.2/0.25	2.17~	0.5~
0.3	1.5~	1.5~
0.35	2.08~	1.8~
0.4	0.8~	2.5~
0.5	1.5~	3.0~
0.65	1.13~	9.0~
0.8	3.14~	3.0~

Automation

Pin assembly and Quality control



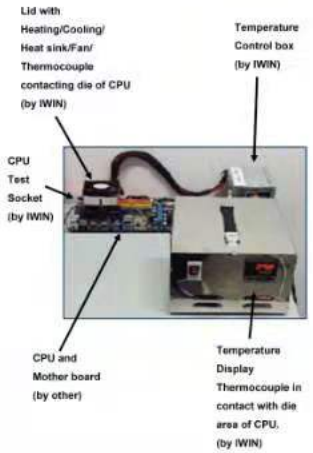
Top Figure: Socket CRES, Force, Stroke test

Bottom Figure: Data displayed

Top Figure: Socket CRES test

Bottom Figure: Data display 5,903 pins socket

Socket and Lid



Pin assembly

(Fully automated machines)

- Stamped piece parts attached to a reel fed into the assembly machine

- Assembled pins can be attached to a reel, or, supply in separate for socket assembly.

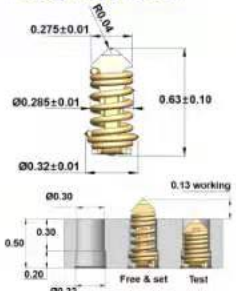
Spring probe pins for High speed

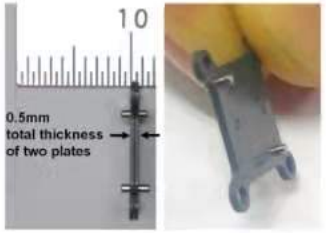
Extremely short spring probes by stamping

One piece spring probe

Three piece spring probe

Design approach





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High Performance Probe solution

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