



Salishan

**How the Coming Sea Change in
Semiconductors is Going to Change HPC**

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Effective End of Moore's Law

Moore's Law was first and foremost a statement about economics. We could shrink transistors and build more of them for about the same cost.

- This has been the basic premise of the semiconductor industry for 50 years and was true up until the last few years.
- Today we can indeed shrink transistors further, but the cost per transistor no longer declines.

We can get something a little more compact

- Perhaps a little less power
- But we pay more for these features now.



What Does This Mean?

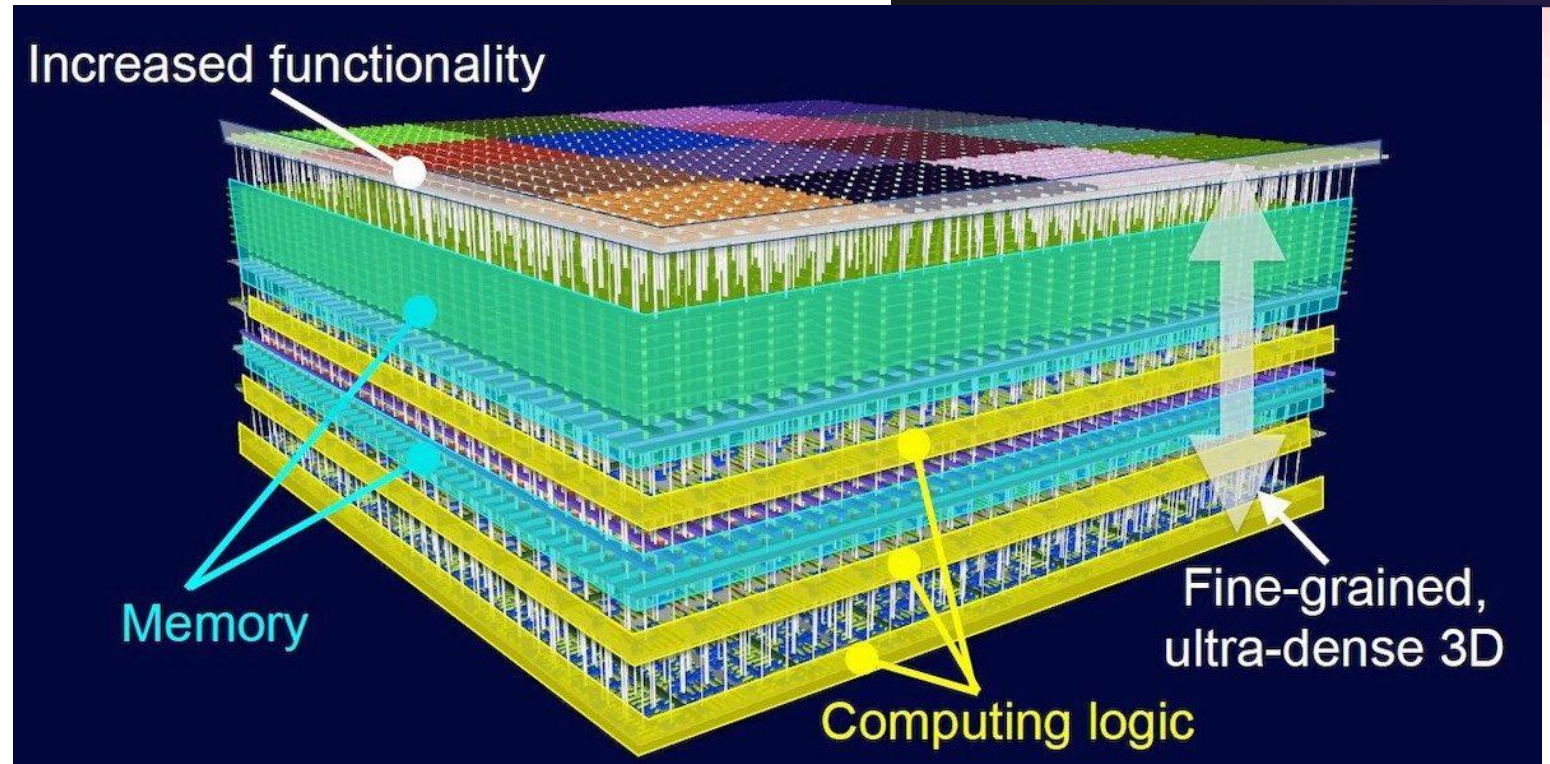
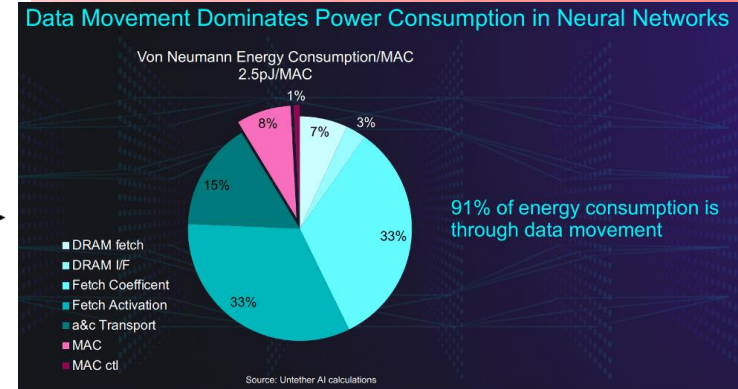
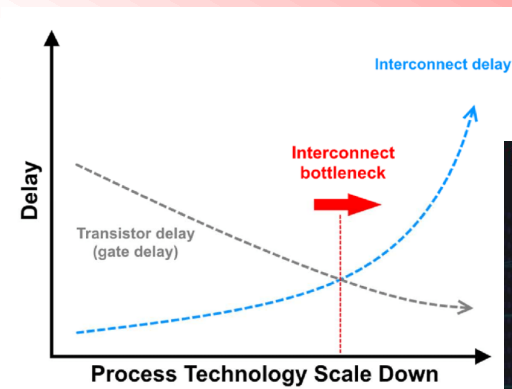
The semiconductor industry is about to undergo a sea change.

- New ways of accomplishing Moore's law economics and performance are needed.
 - The industry is now looking to use advanced packaging to drive future semiconductors.
 - Better Cost
 - Better Performance
 - Better SWaP



AP Elements: Wiring (Metallization)

- Wire length controls the delay
 - Span of control
- Accounts for majority of power usage
 - Memory fetch



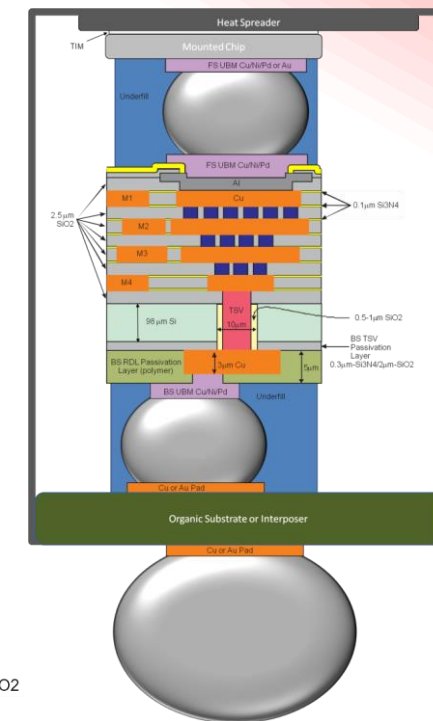
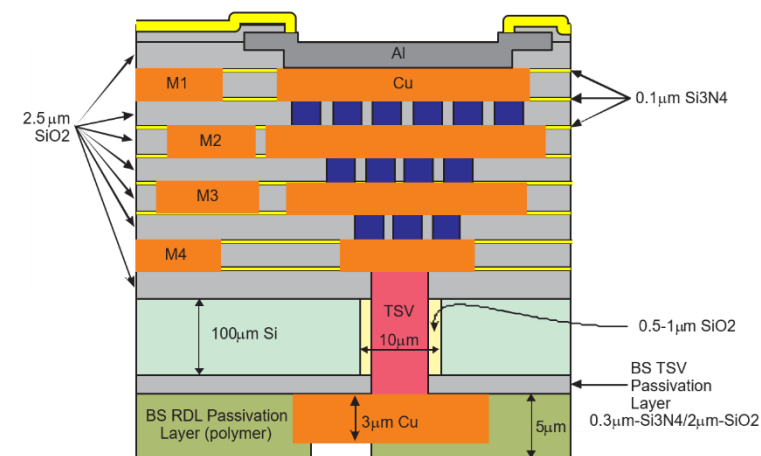
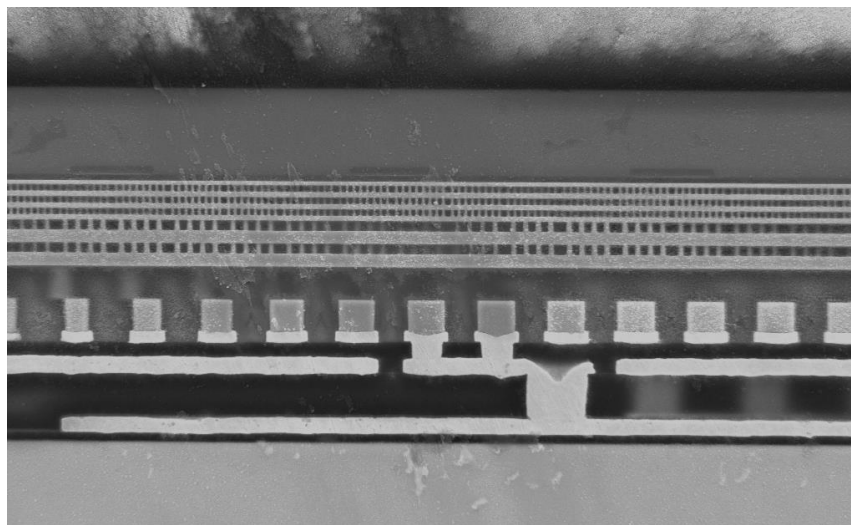
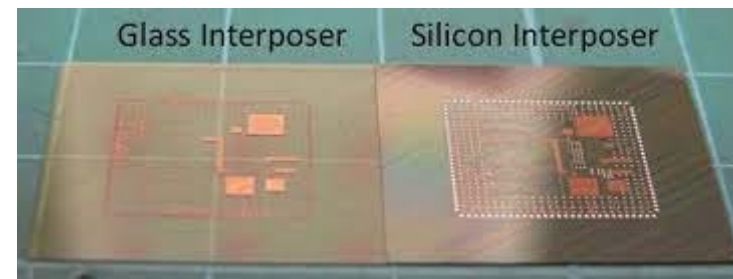
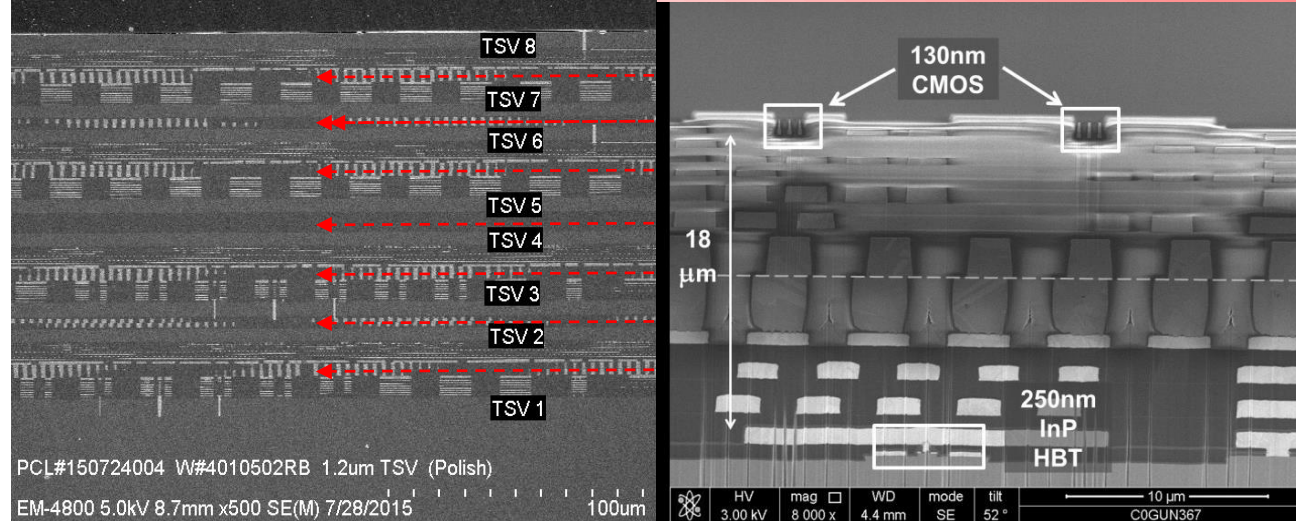
AP Technologies:

Millimeters \Rightarrow Microns

Kilograms \Rightarrow Grams

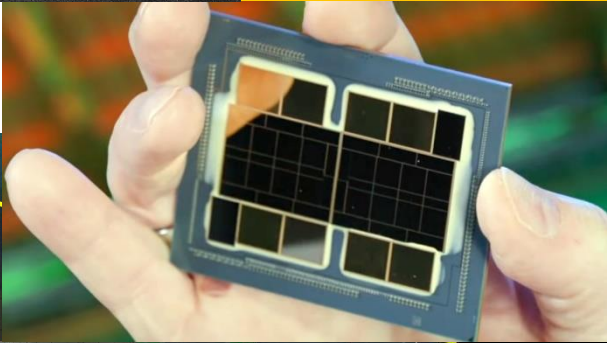
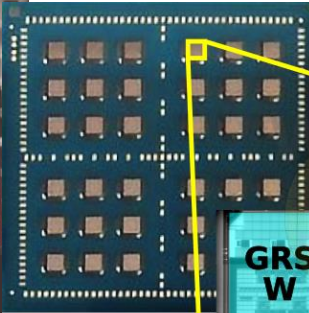
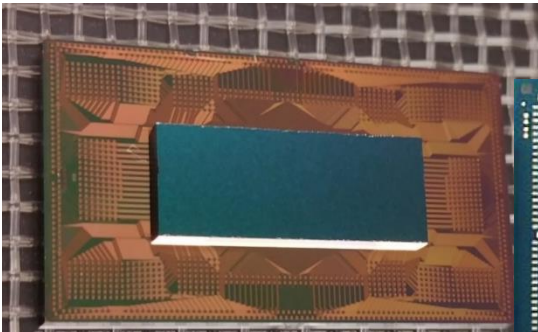
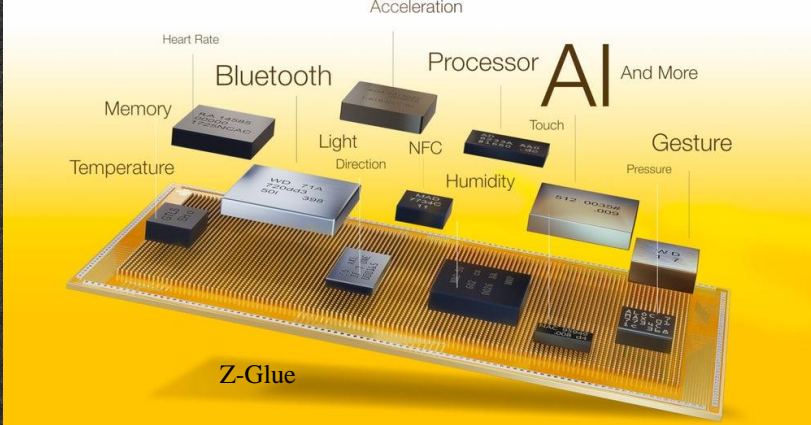
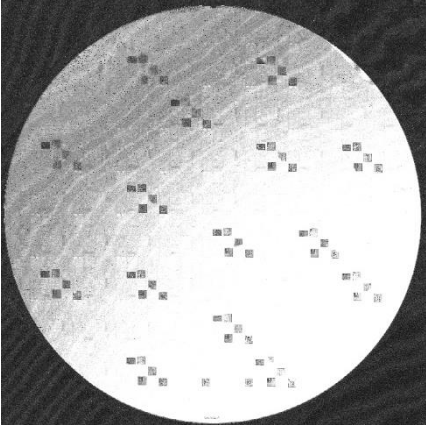
Mixed Materials

Best of Class

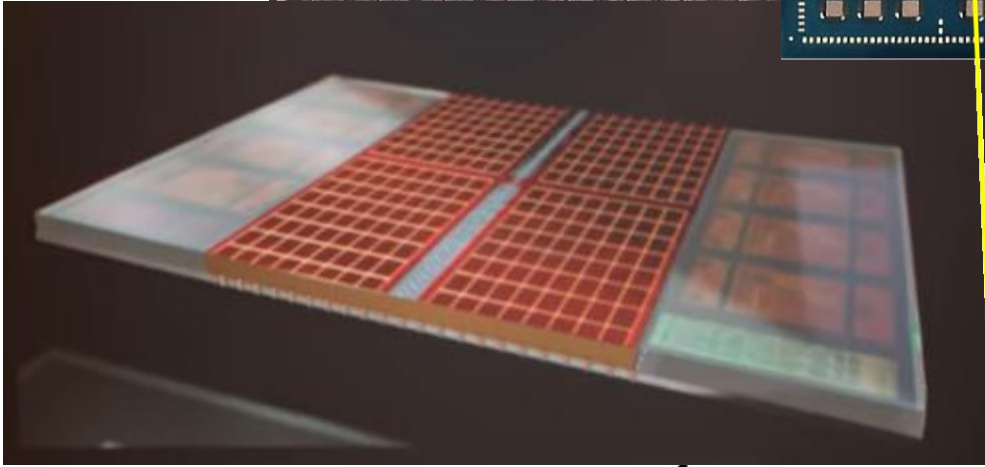


AP Components: Chiplets

- Best of Class Everything
- Easy retargeting
- Lower risk
- IP reuse
- Lower cost



Intel



AMD

GRS W	GRS N	GPIO	GRS N	GRS E
GB	PE	PE	PE	PE
RISC-V	PE	PE	PE	PE
	PE	PE	PE	PE
	PE	PE	PE	PE
GRS W	GRS S	JTAG	GRS S	GRS E

nVidia

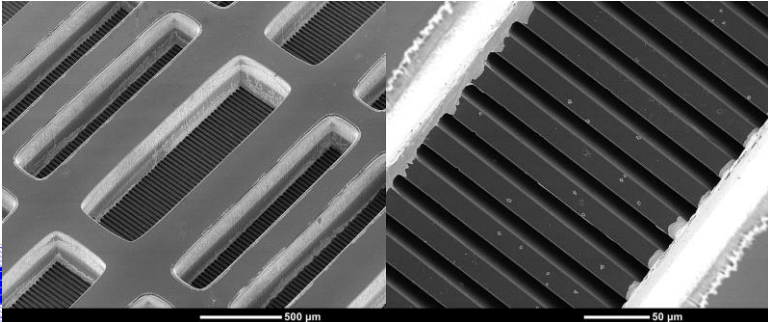


Intel

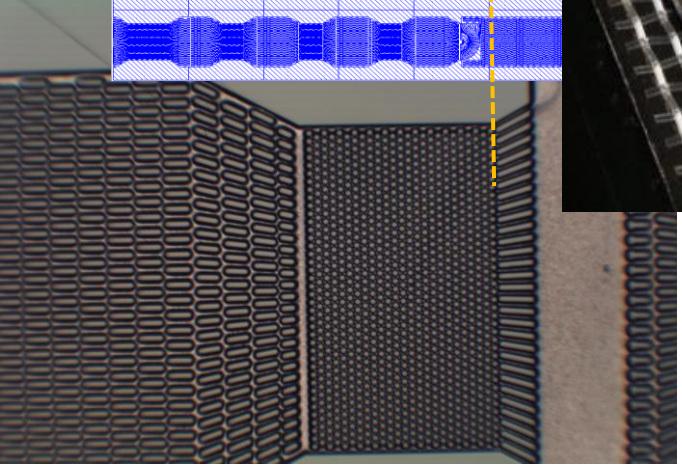
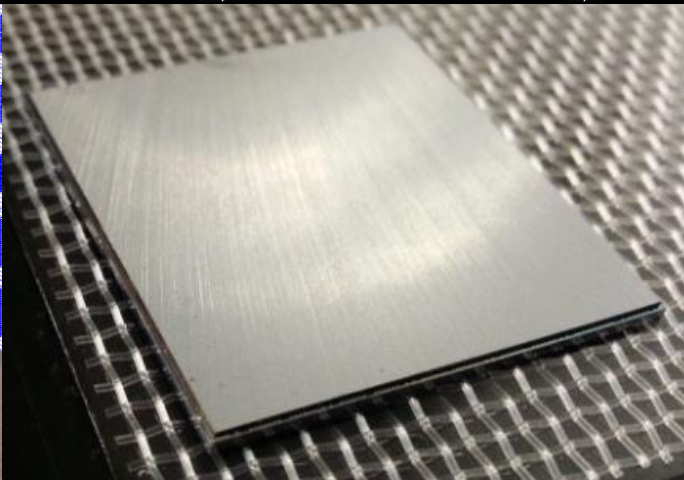
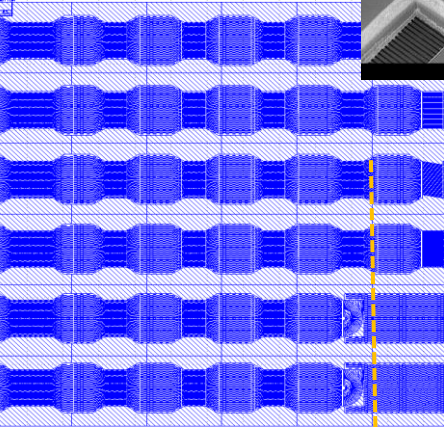
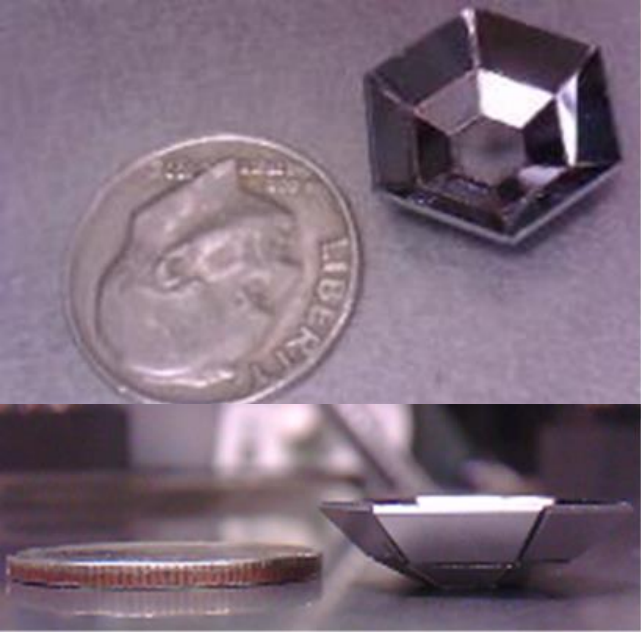
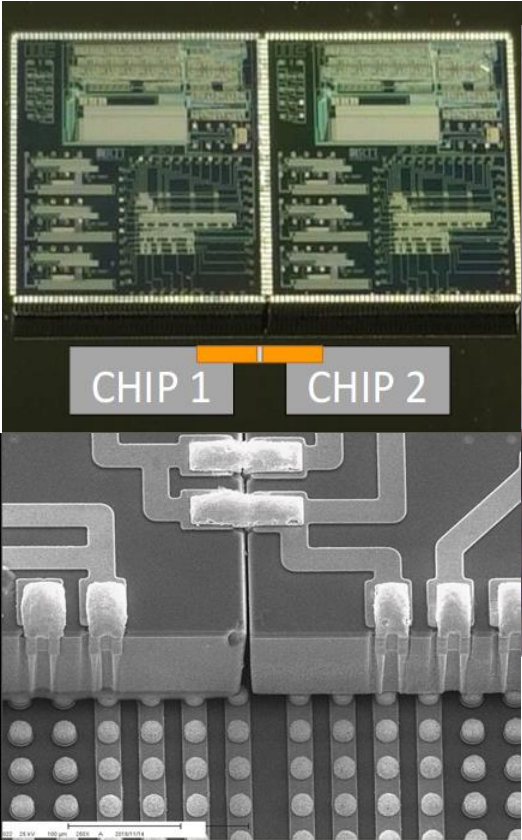


AP Components Micro-Connections, 3D Construction, & Cooling

Purdue

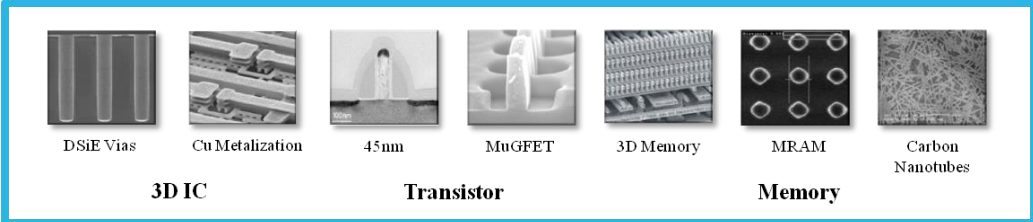
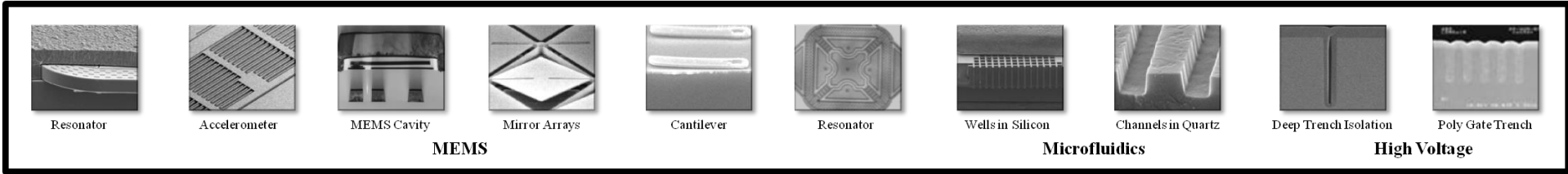
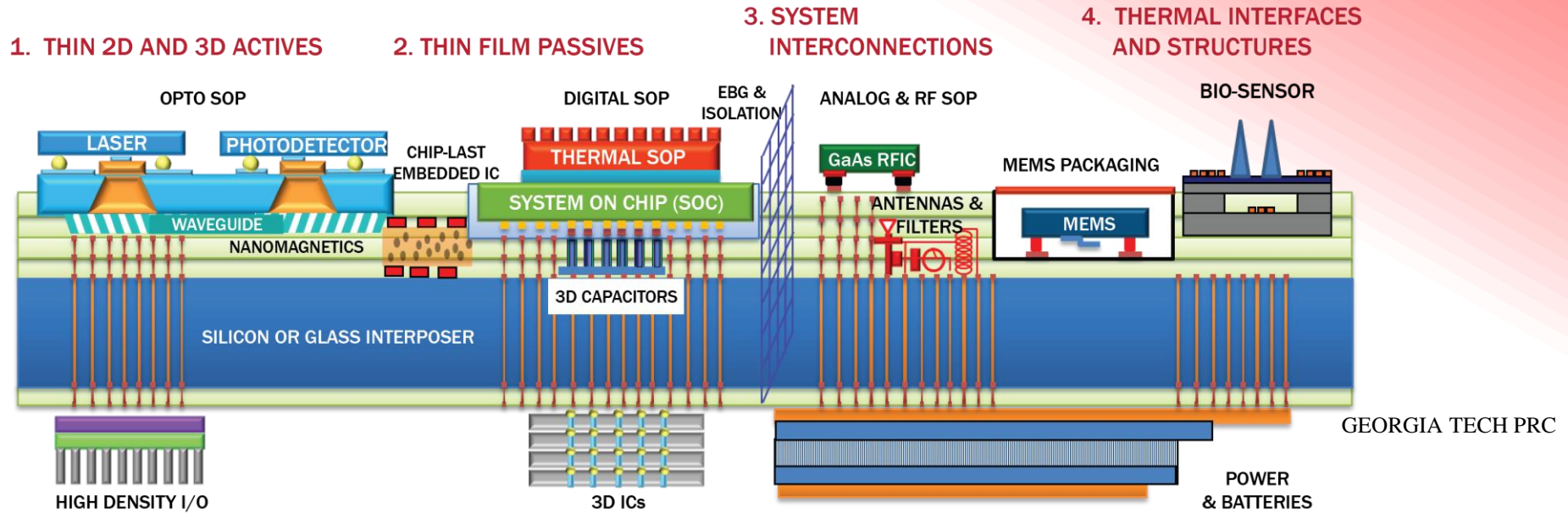


IIC



(top left) Quilt Packaging concept cross-section illustration & image of a post-reflowed QP CMOS quilt; (bottom left) SEM image of quilted chip-to-chip seam of >10 micron width; (top right) QP-enabled miniature curved array demonstration article; (bottom right) profile view of QP-enabled miniature curved array.

More Than Moore Technologies



AP Components: Photonics & Quantum

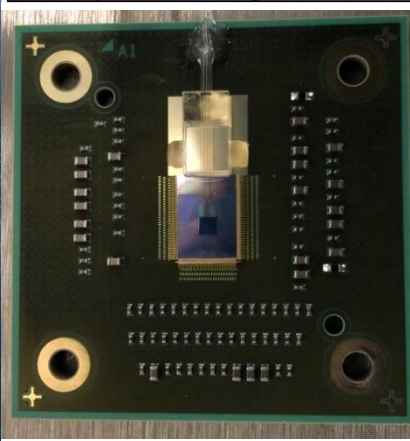
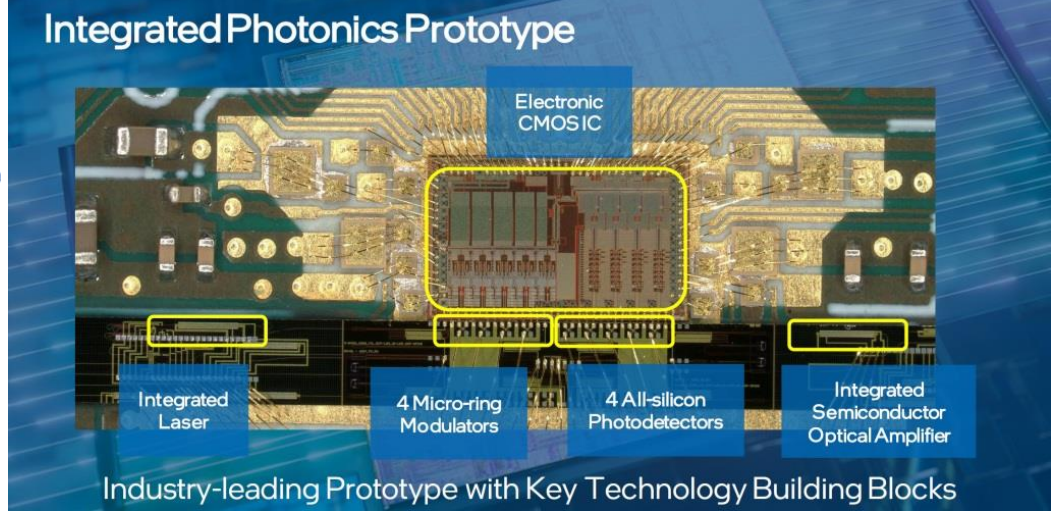
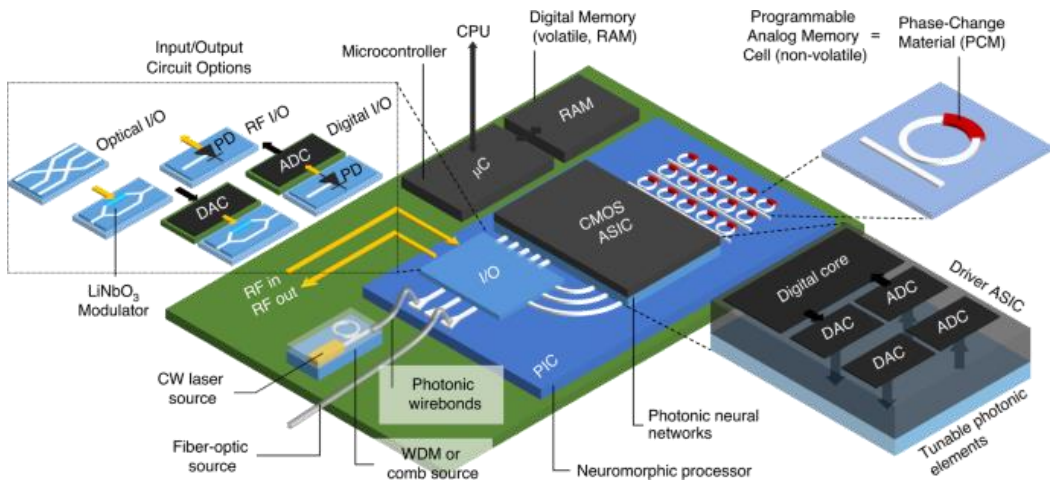
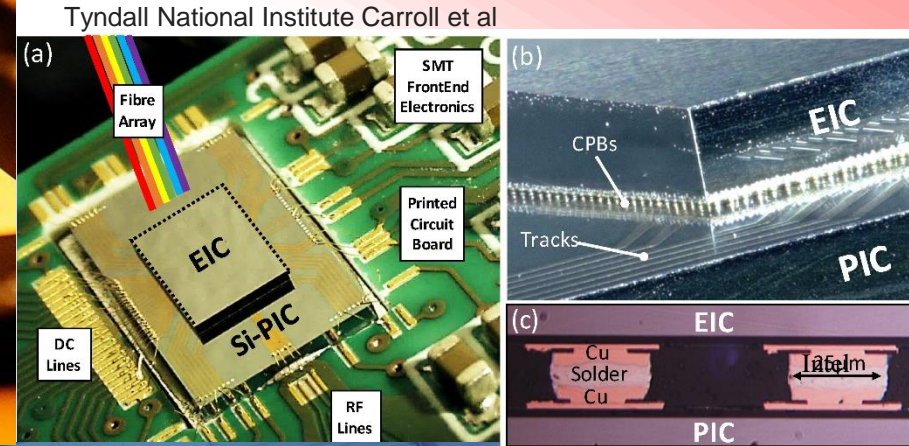
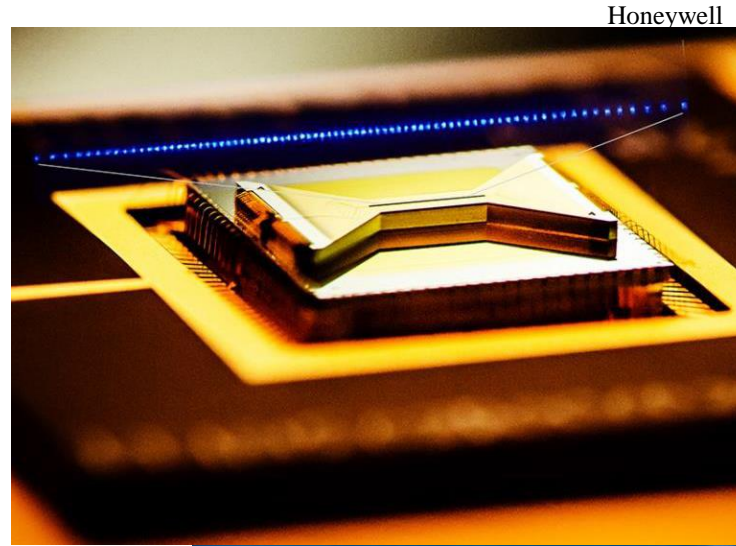
- I/O

- Tb/s, $\ll 100\text{fJ/b}$

- SiP 500ff I/O Load
 - 2.5D 25ff I/O Load
 - 3D 3ff I/O Load

- Processing

- “Quantum Leaps”



Nature 29 January 2021 Shastri

Summary – The Road Ahead

- System level Moore's Law future
- Advanced Packaging is driving an industry revolution
 - Enablement of Next Generation Semiconductors
- Advanced Packaging has SWaP+++
 - Ultimately driven by economics

