



Unleash Innovation

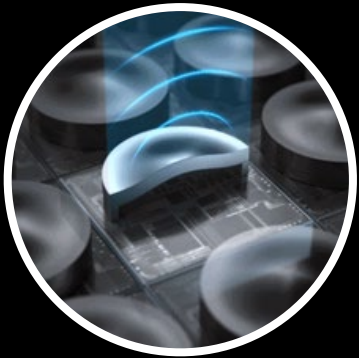


Unleashing the Future of Innovation

Dr. Mark Liu

Chairman of TSMC

Technology Community Joins the Fight Against Global Pandemic



MOBILE MEDICAL
IMAGING



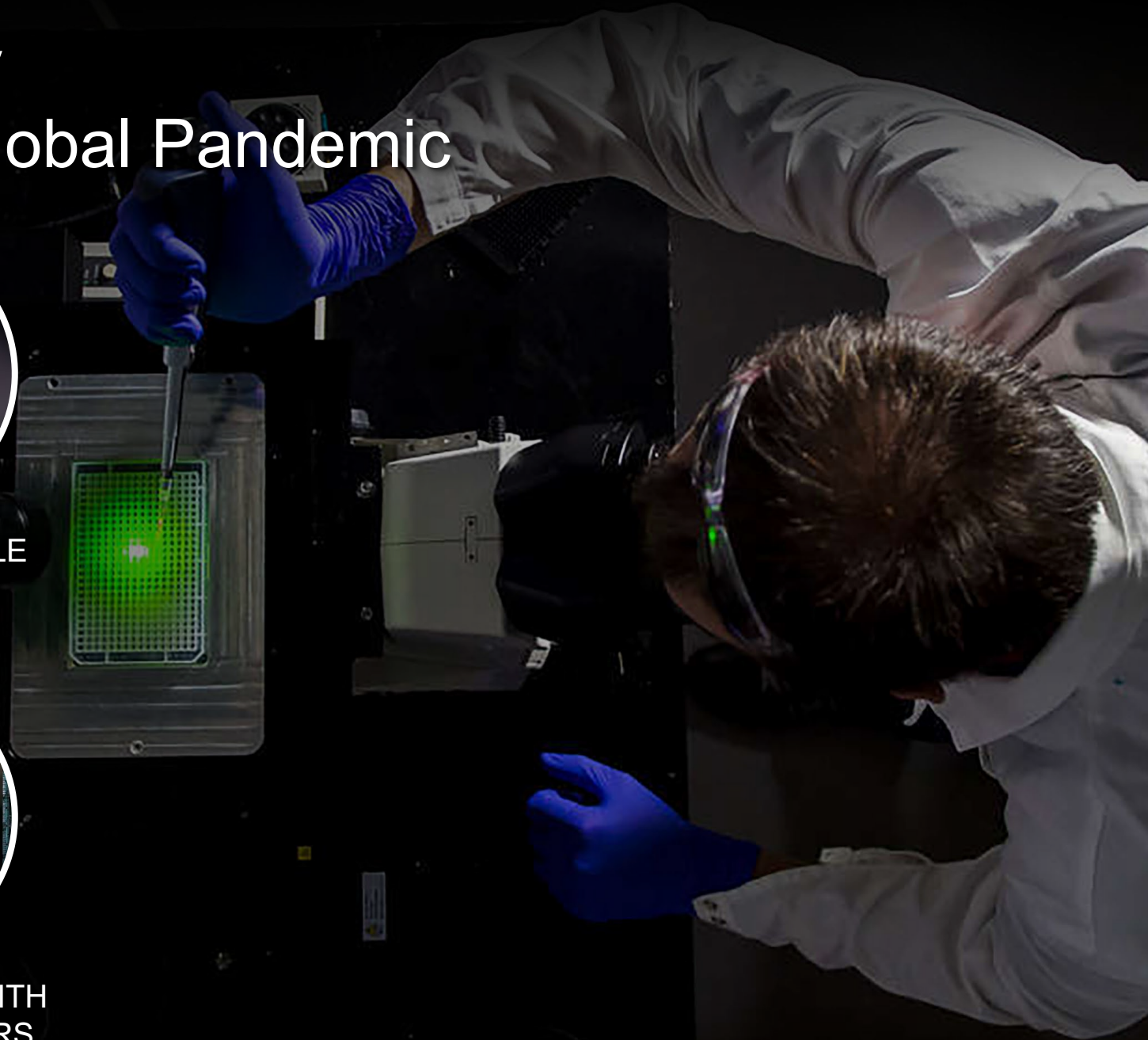
SINGLE MOLECULE
SEQUENCING



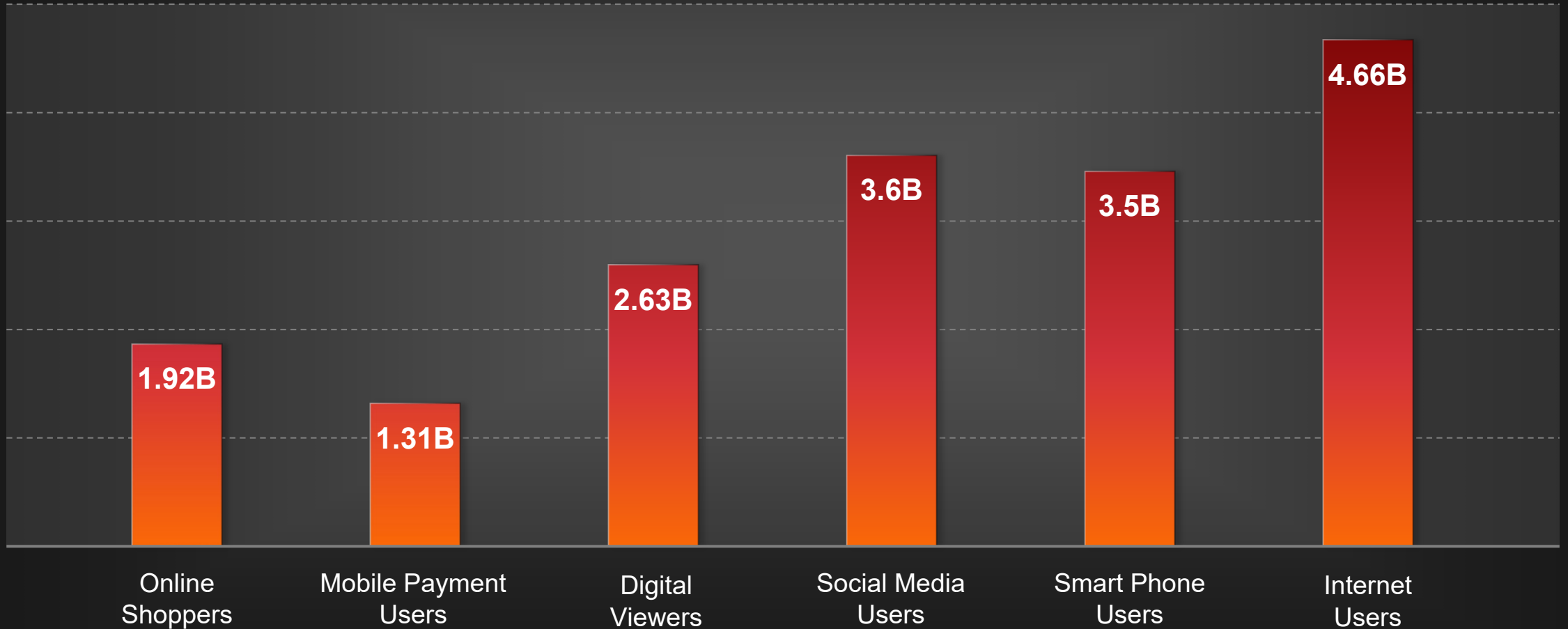
CONTACT
TRACING



FINDING CURES WITH
SUPERCOMPUTERS

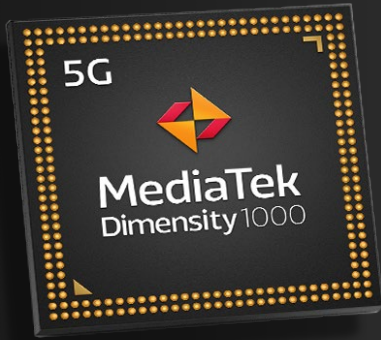


Semiconductor: a Foundational Technology



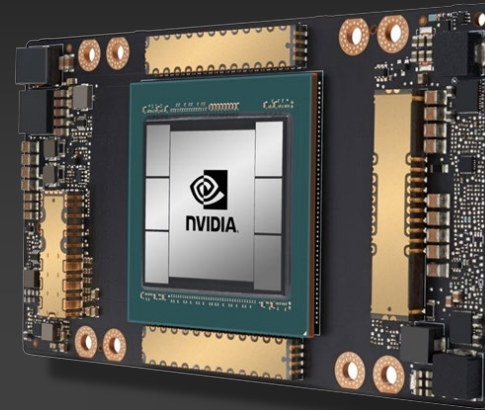
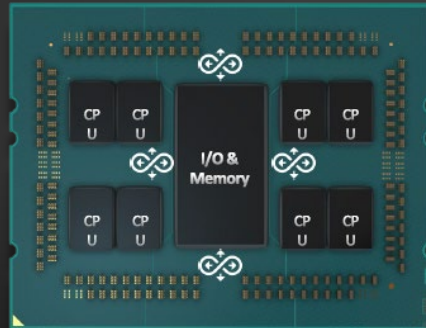
Source: Statista

Democratizing the Most Advanced Si – Unleash Innovation



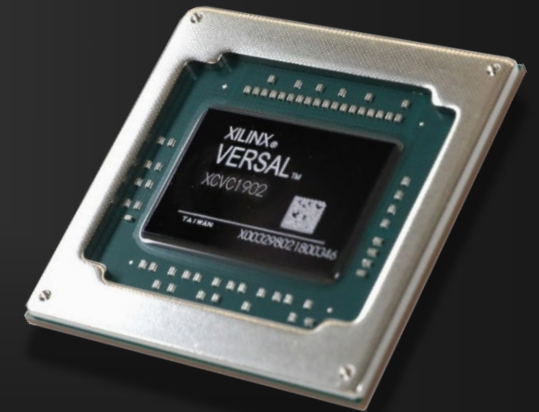
**7-nm 5G MediaTek
Dimensity™ 1000**

**7-nm EPYC™
Gen2 Processor**



**7-nm NVIDIA A100
Tensor Core GPU**

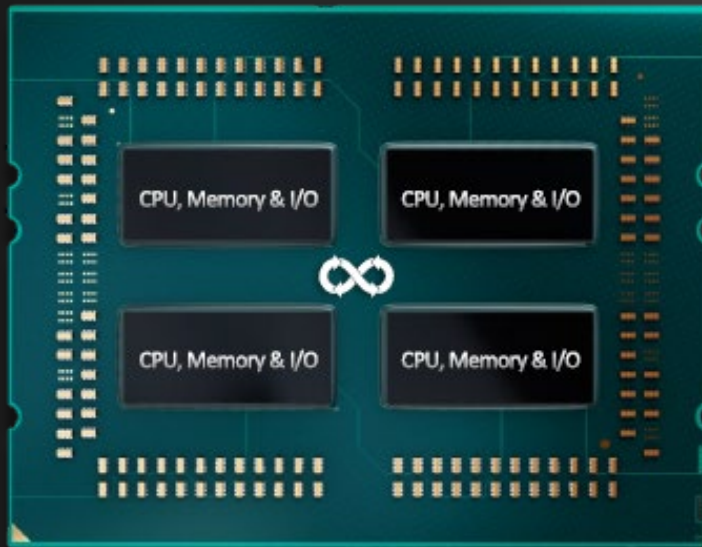
**7-nm Xilinx Versal™
ACAP**



7-nm Processor for Power Efficient Compute

14-nm AMD EPYC™ Gen1 Processor

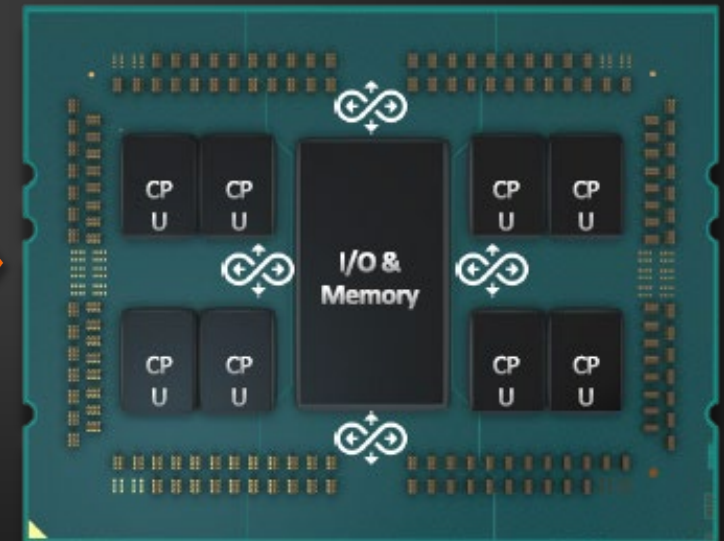
Cores: 8 to 32
Power: Up to 180W
Max. Memory Capability: 2TB



>2X PERFORMANCE
OR
50% POWER REDUCTION

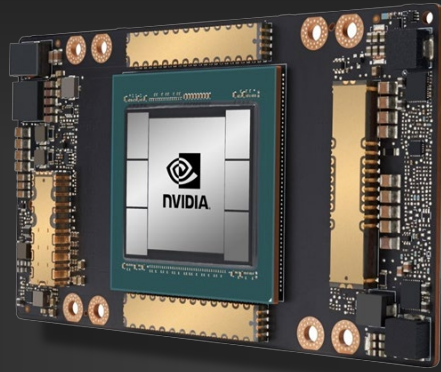
7-nm EPYC™ Gen2 Processor

Cores: 8 to 64
Power: Up to 225W
Max. Memory Capability: 4TB



Source: <https://www.amd.com/en/processors/epyc-7002-series>, disruptivekernel.com

7-nm Accelerator for AI Data Processing



7-nm NVIDIA A100
Tensor Core GPU
(20X Performance Boost)

\$11M, 25 Racks



1/10th
COST

1/20th
POWER

\$1M, 1 Rack

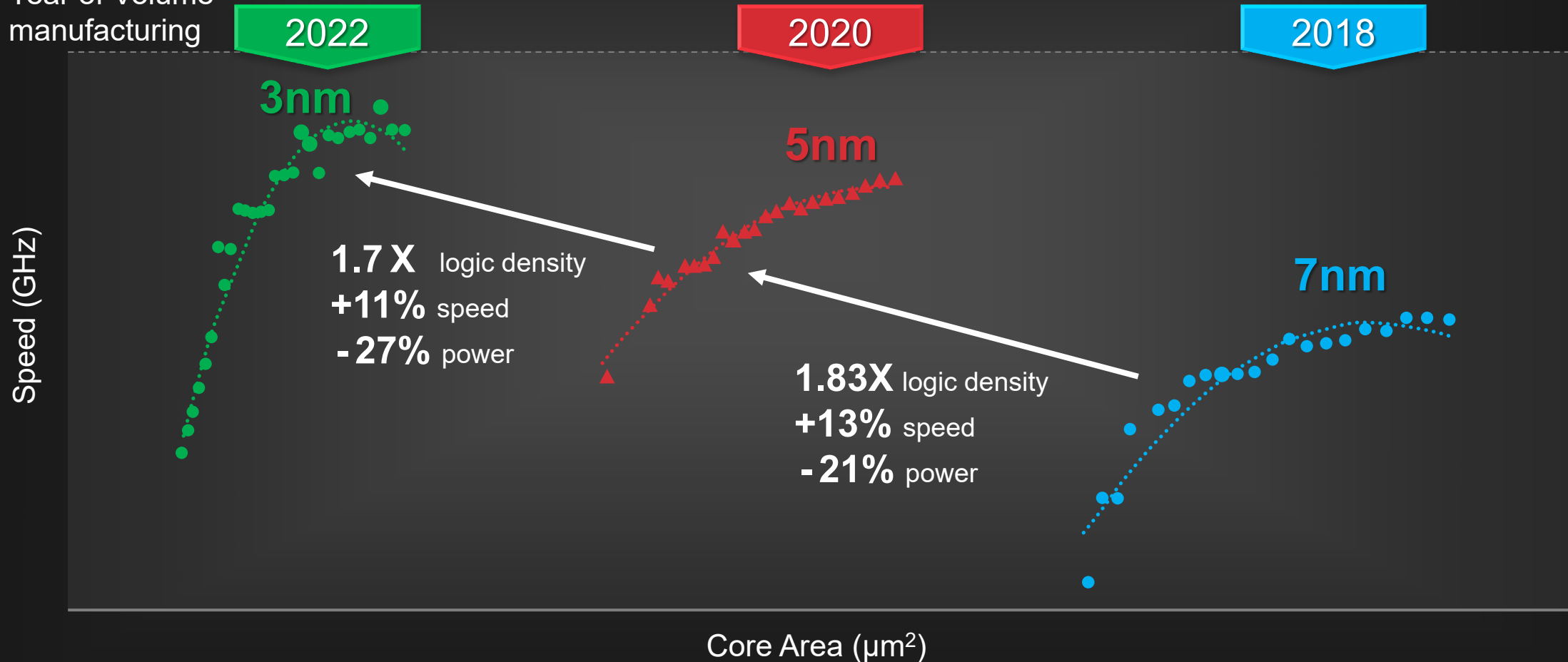


\$1M 28 kW
1/10th
COST
1/20th
POWER

Source: <https://www.nvidia.com/en-us/data-center/a100/>

Chip-Level Metrics: Marching Forward at Historical Rate for Full Nodes

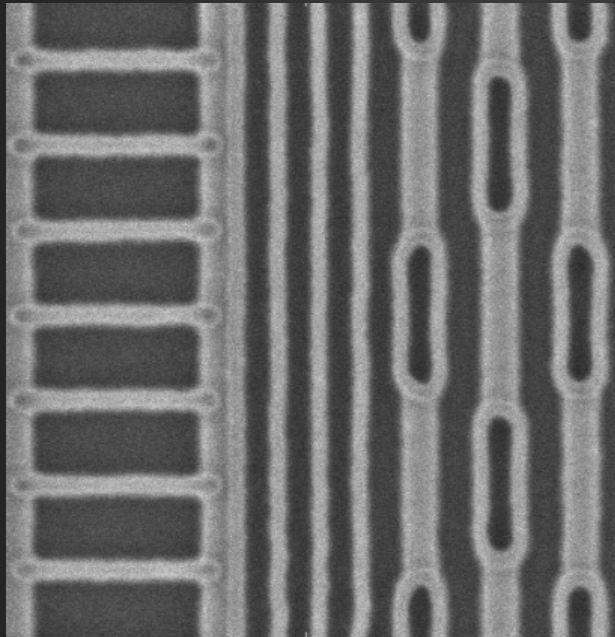
Year of Volume
manufacturing



EUV Breakthrough

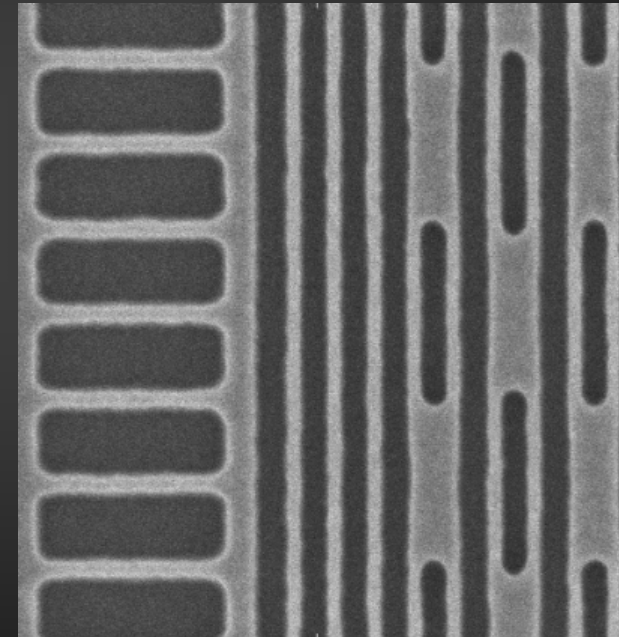
– An Inflection Point for Process Technology

Metal layer w/ 193i
multiple patterning



IMM 4P4E

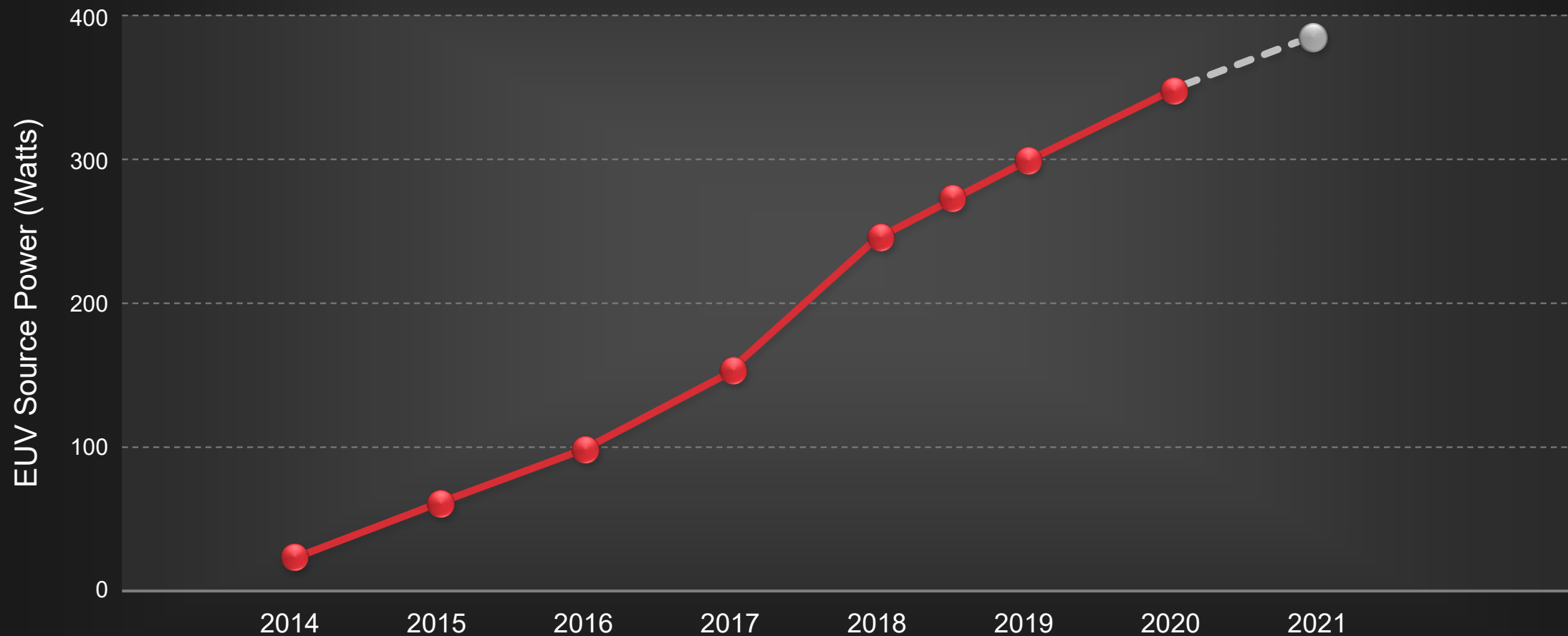
Metal layer w/ EUV
single patterning



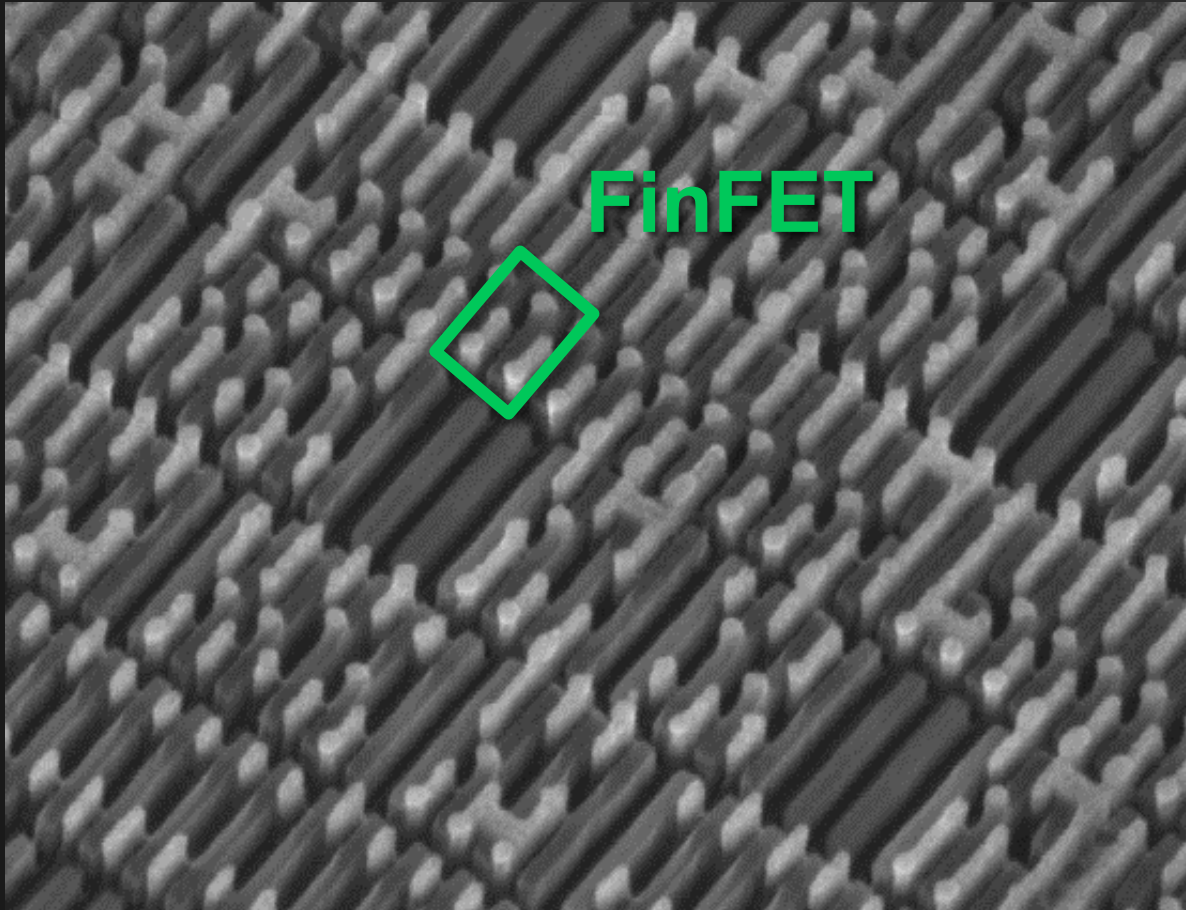
EUV 1P1E

EUV Breakthrough

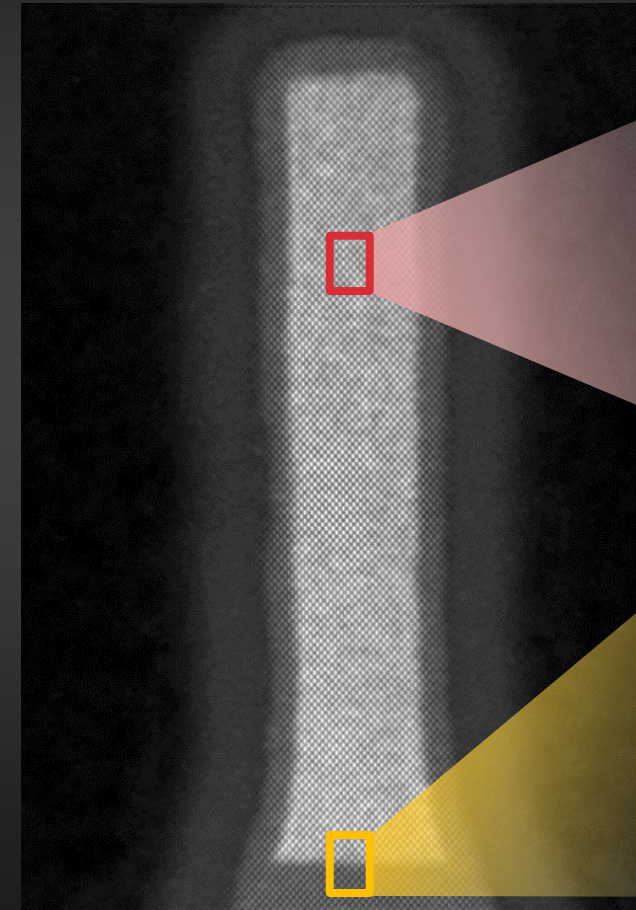
- Next: Increasing *Throughput*



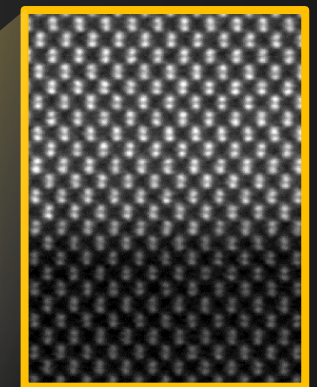
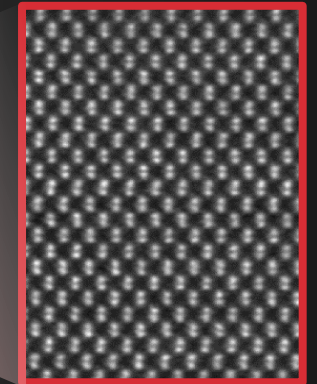
FinFET Featuring **High Mobility Channel**



FinFET

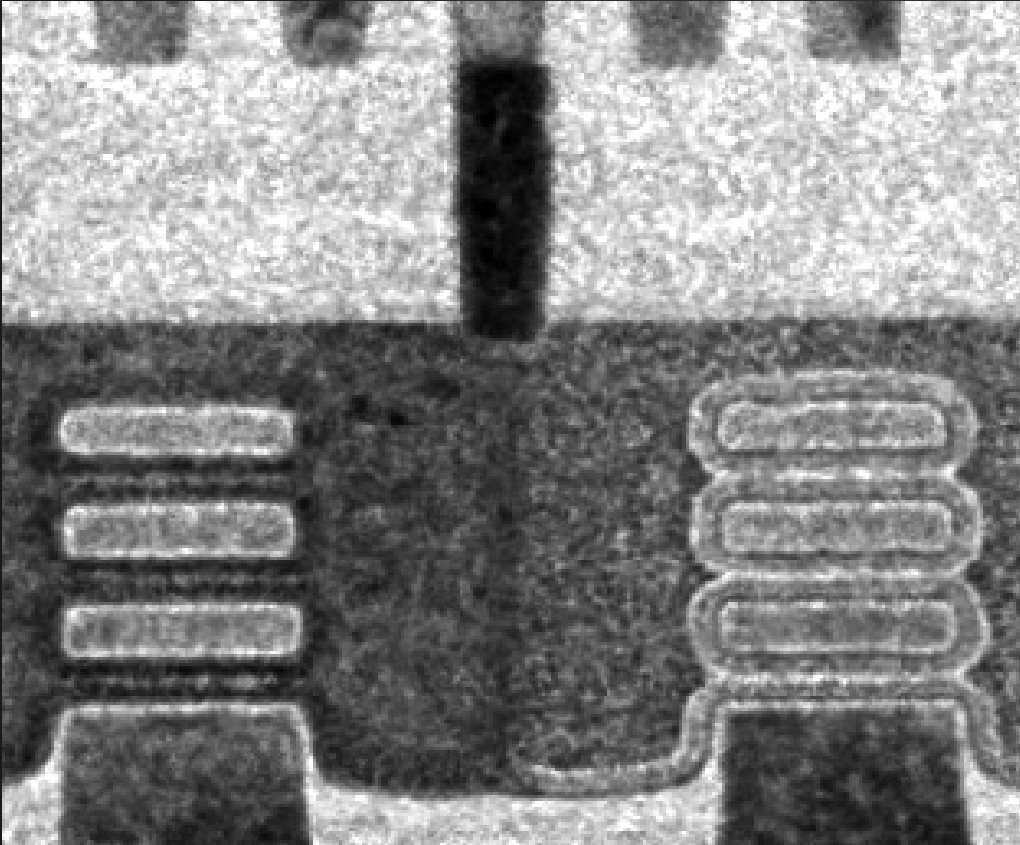


High Mobility Channel

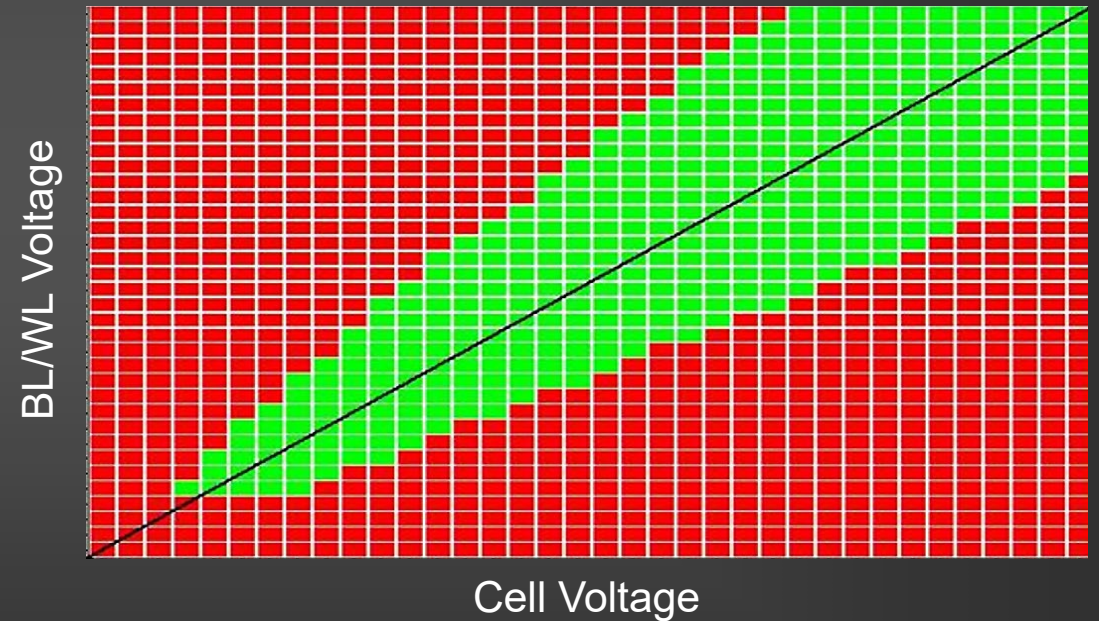


Beyond the FinFET

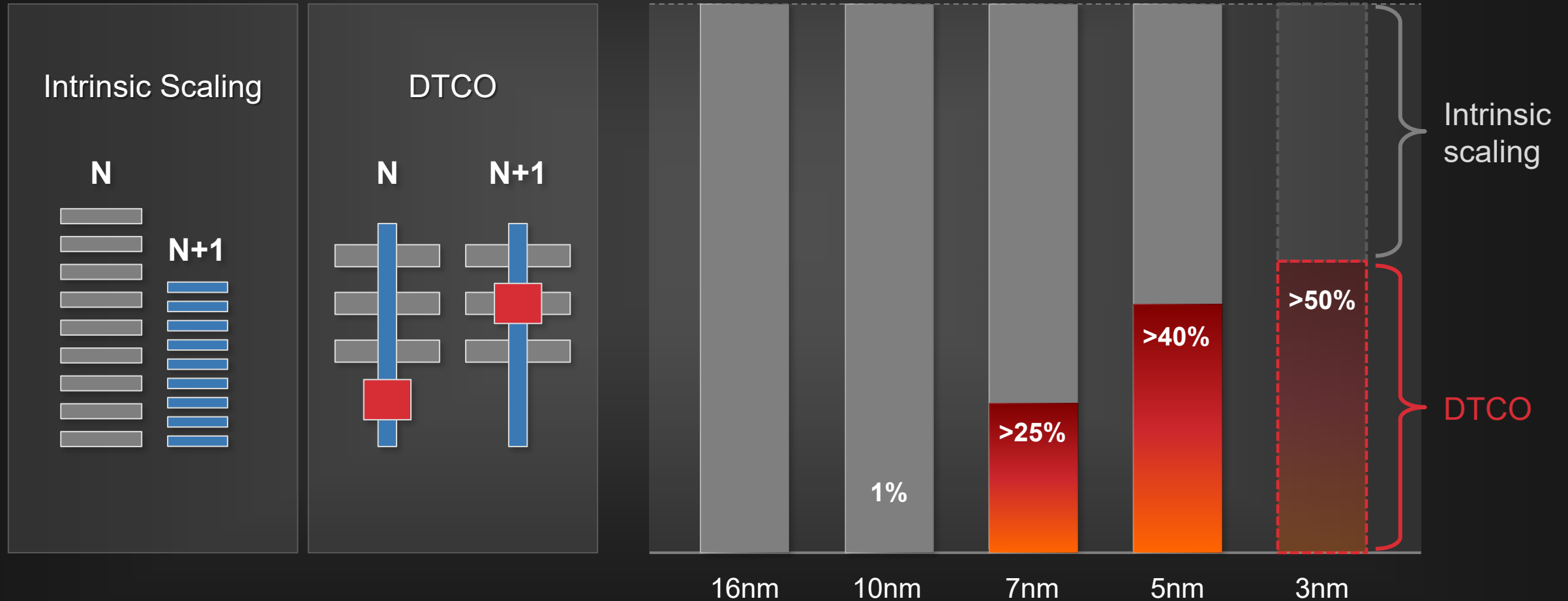
– Nano-sheet Transistor



SRAM fully functional at 0.46V

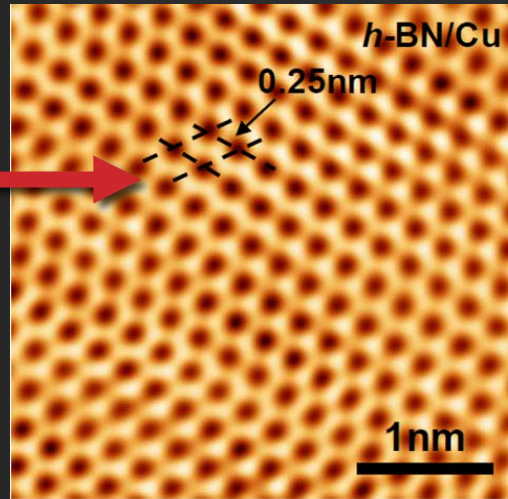


Growing DTCO Contribution to Density Increase

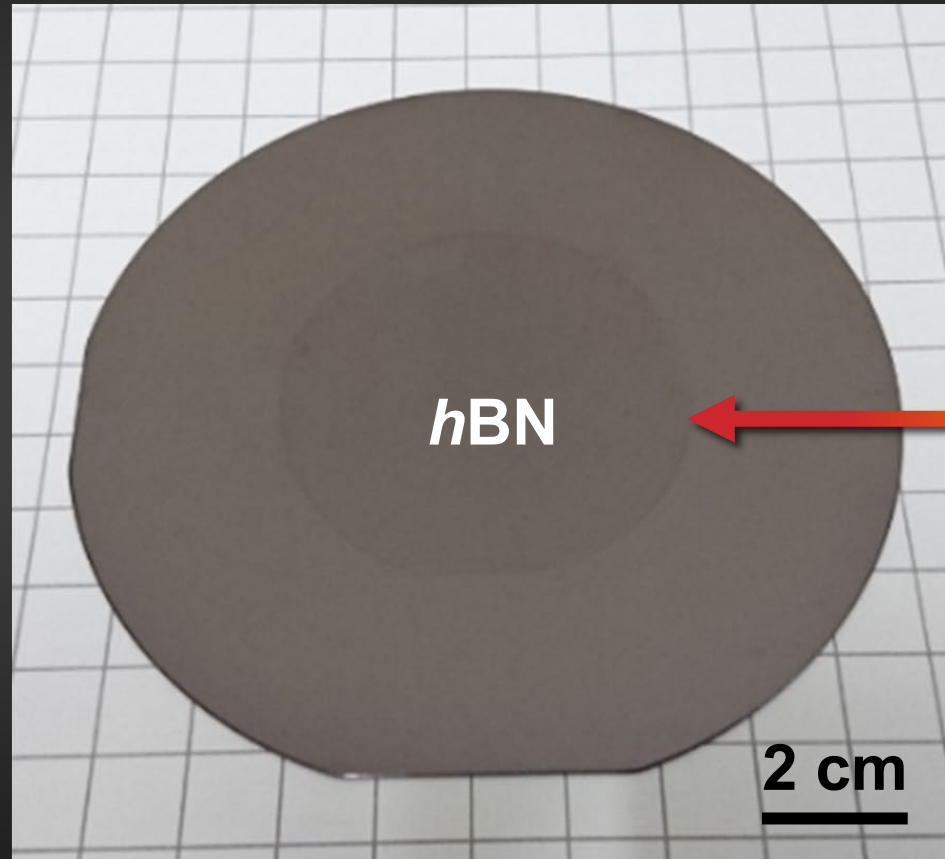
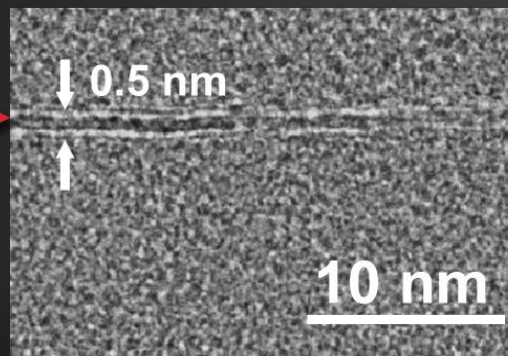


2D Materials for Future Transistors

Single
Crystal
hBN



Single
Atomic
Layer

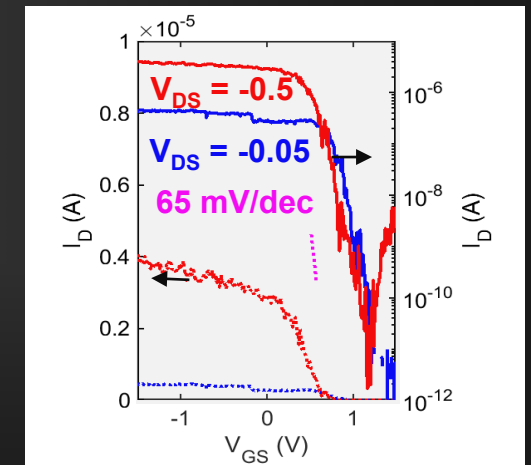
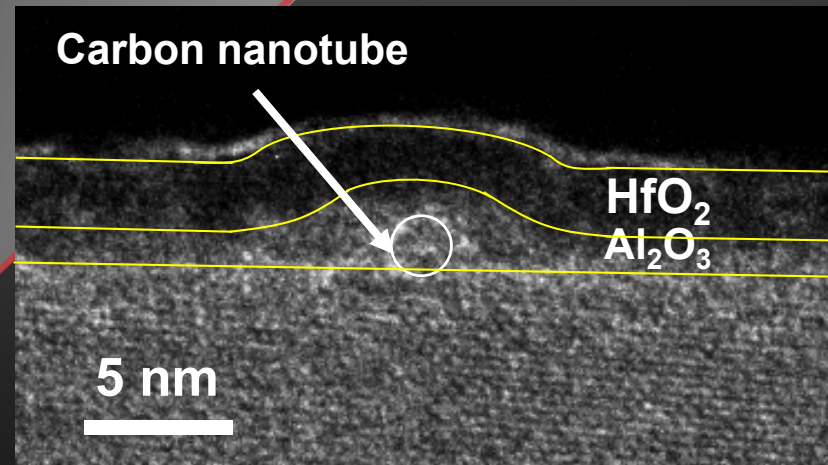
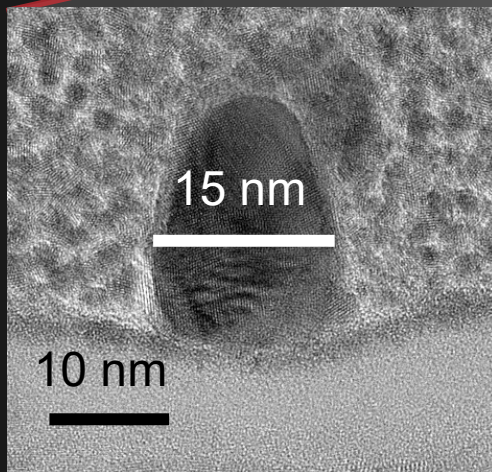
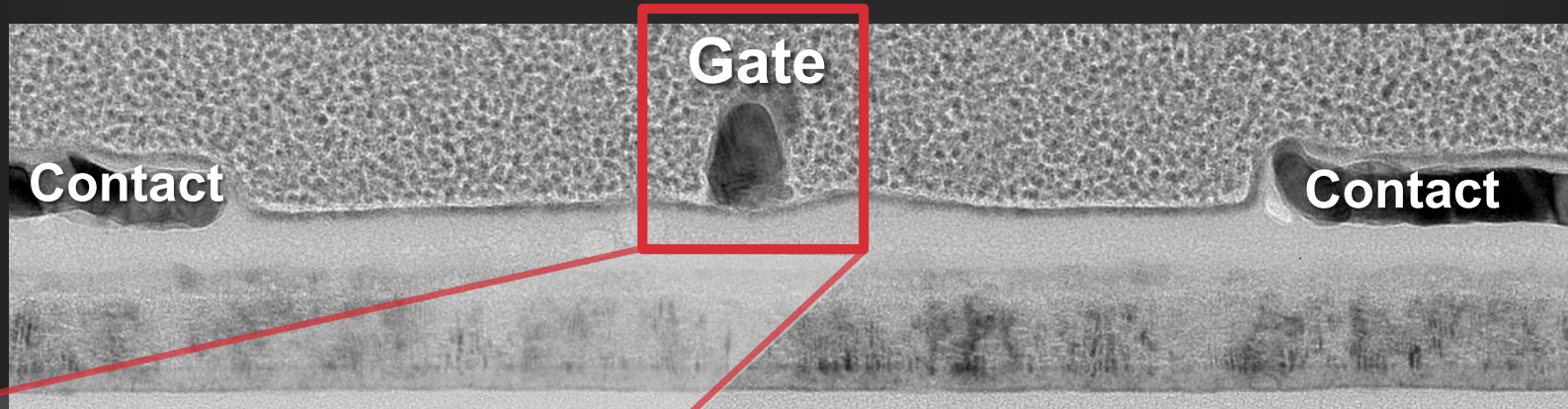


Wafer-scale
Growth and
Transfer

T.-A. Chen et al., Nature, 2020

1D Material for Future Transistors

15-nm Gate Length, SS = 65 mV/dec



G. Pitner et al., IEDM, 2020

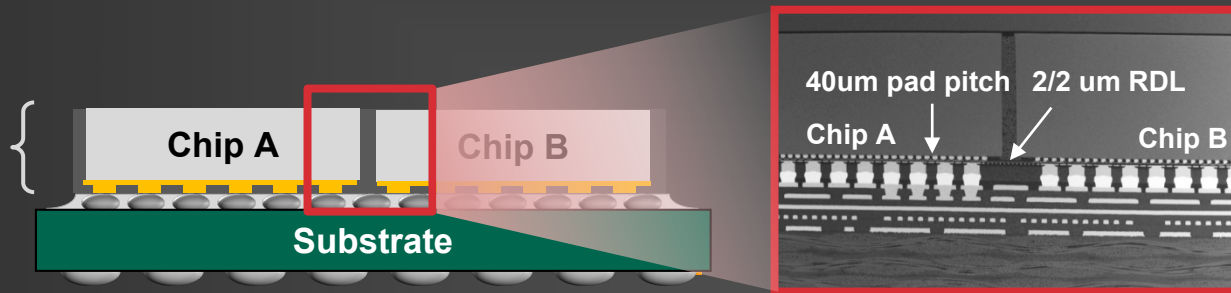
100



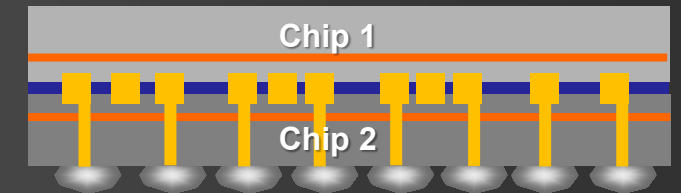
Chip Level

System Integration Using TSMC 3DFabric™

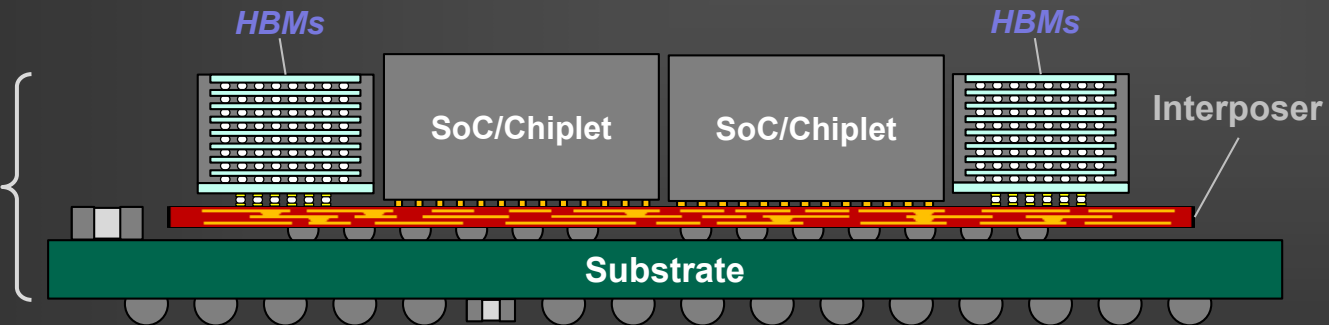
InFO



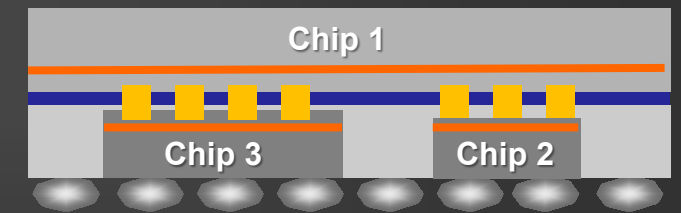
SoIC_WoW



CoWoS®

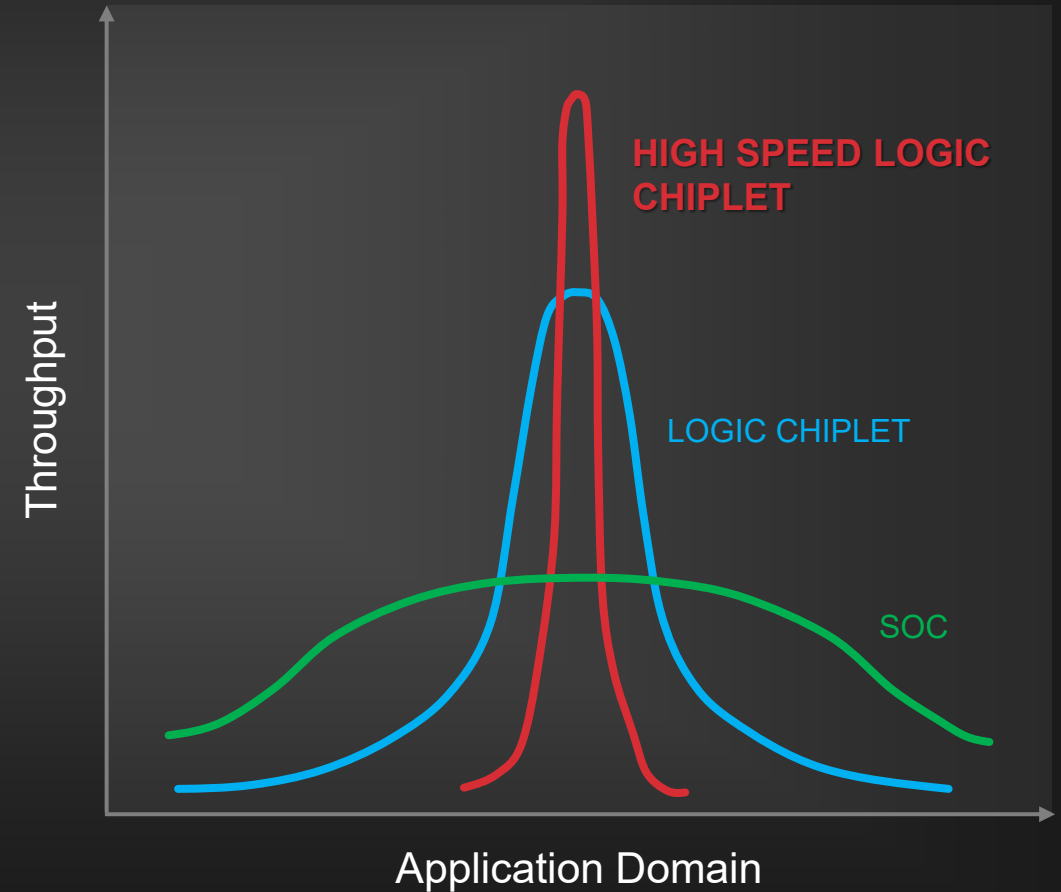
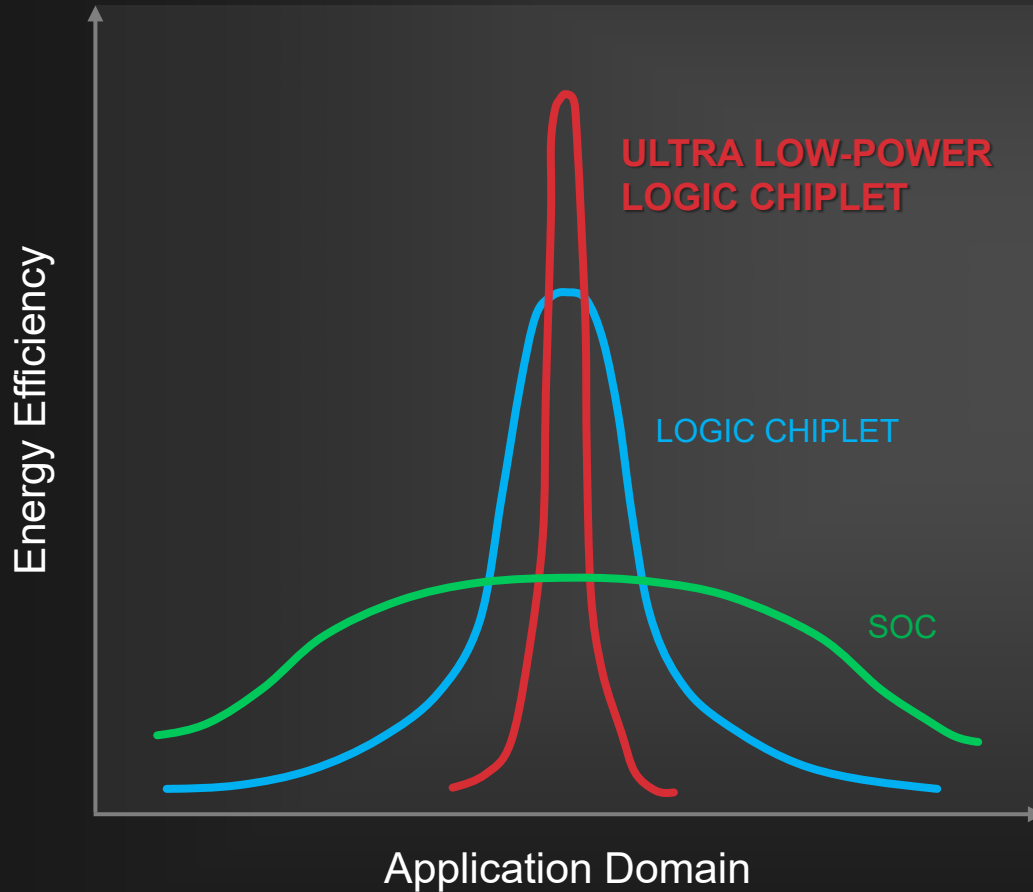


SoIC_CoW

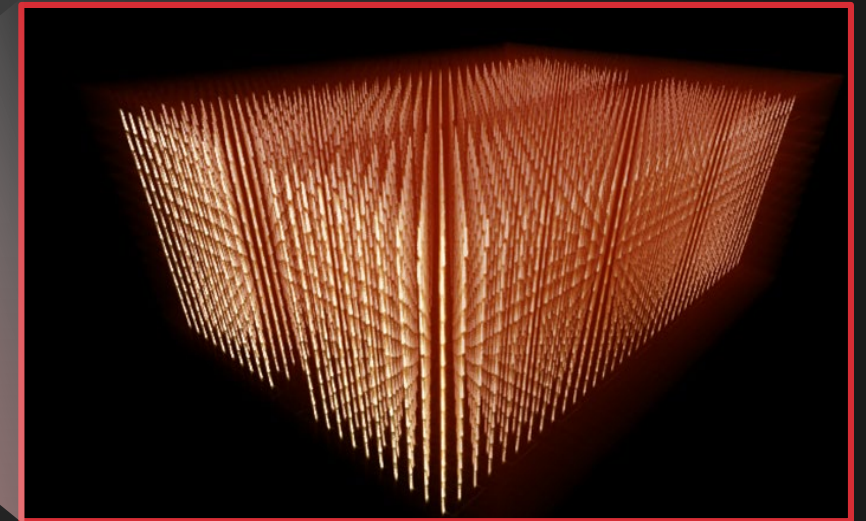
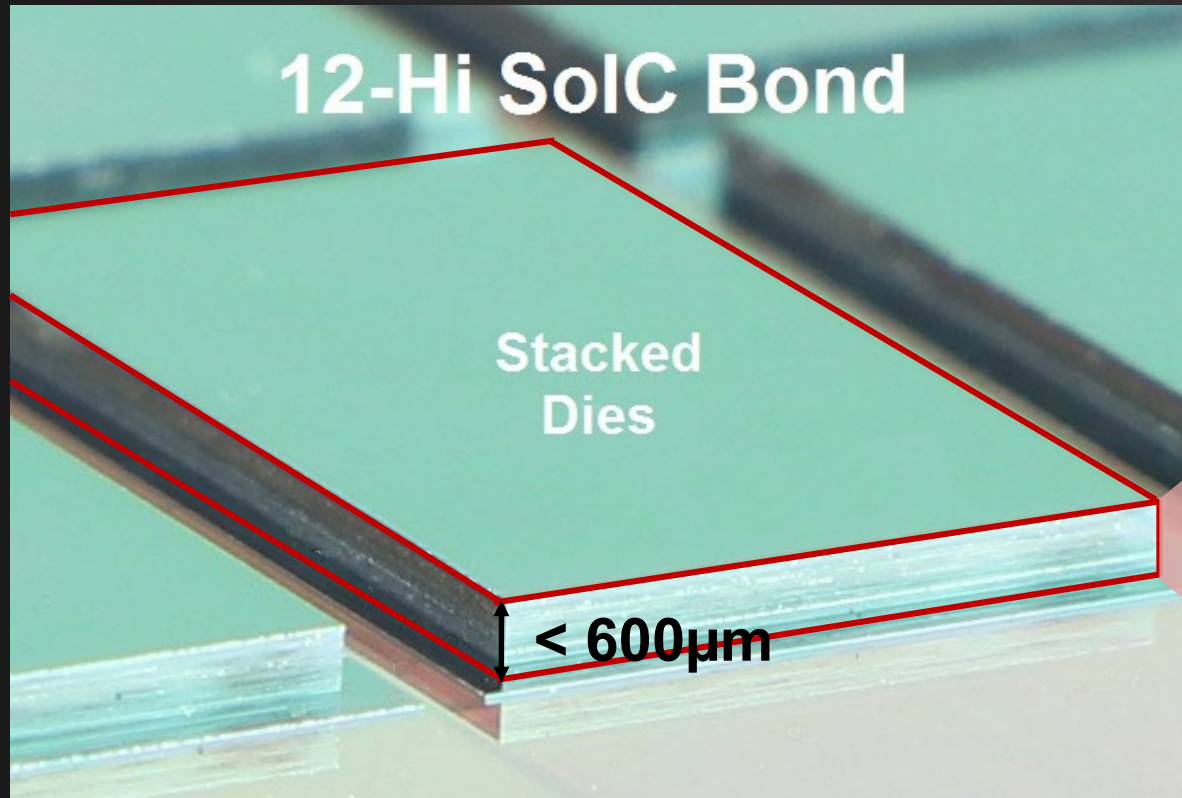


Domain Specific Technology

- Go Beyond Individual Chips

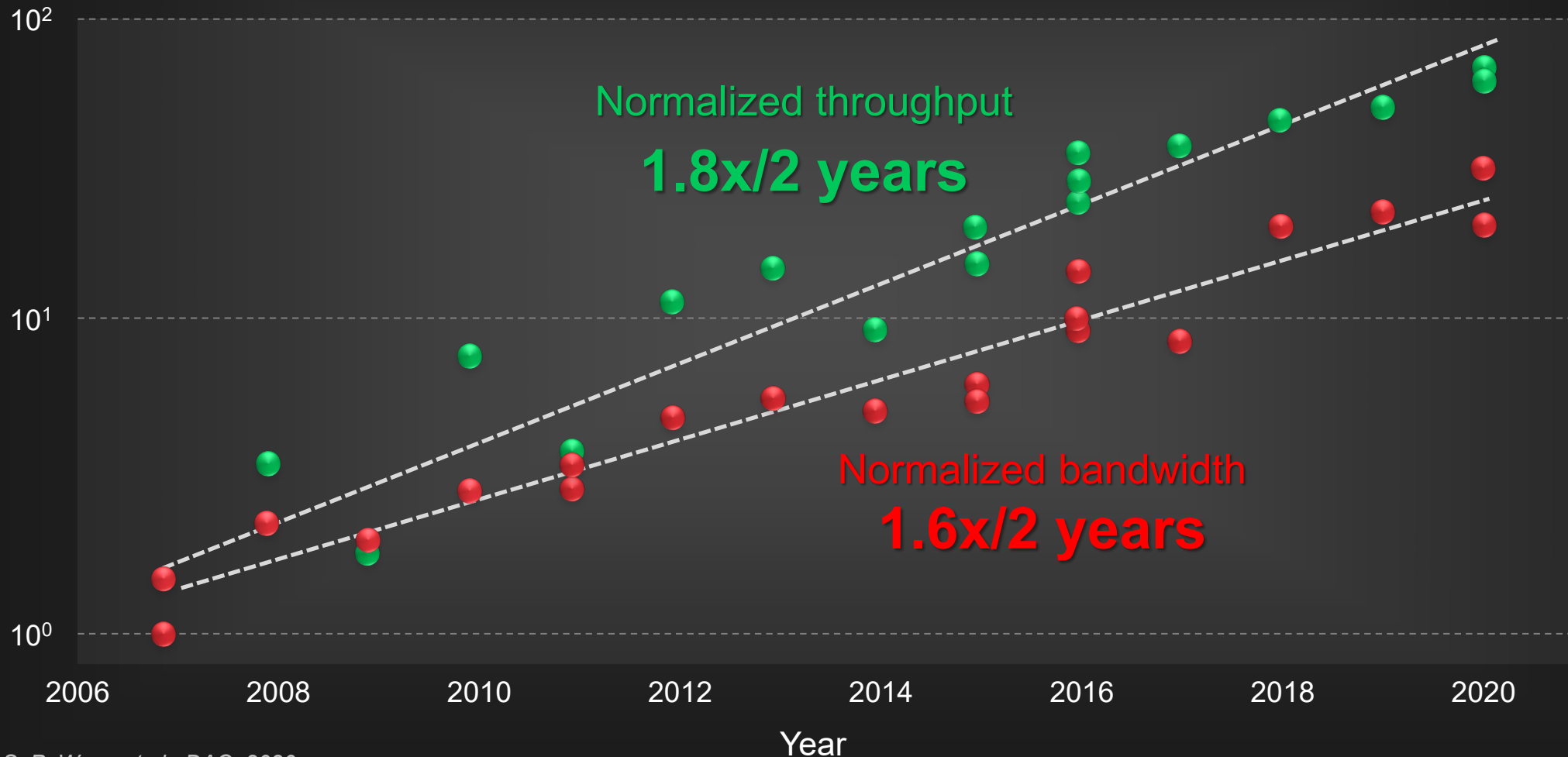


The Future of 3D Stacking



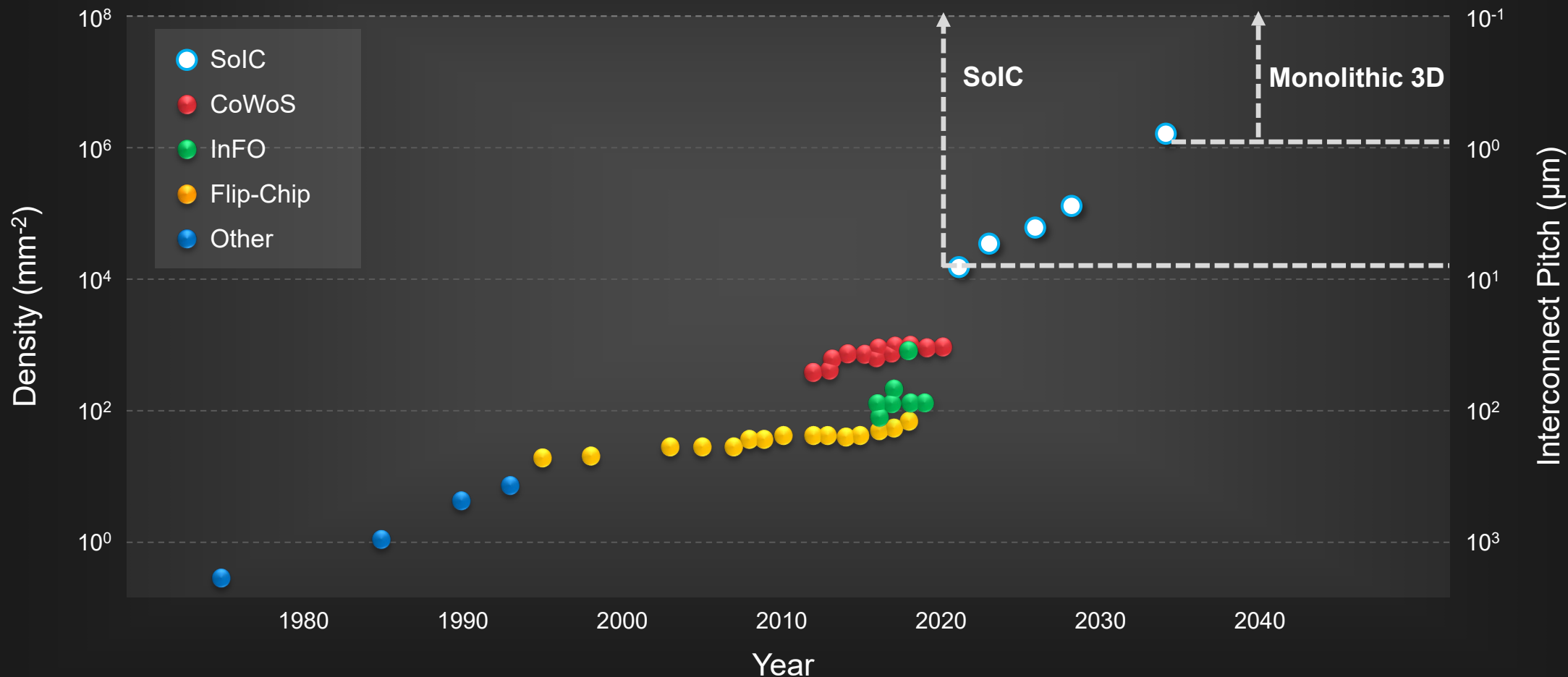
Bandwidth Deficit Limits System Throughput

– Higher I/O Density Needed

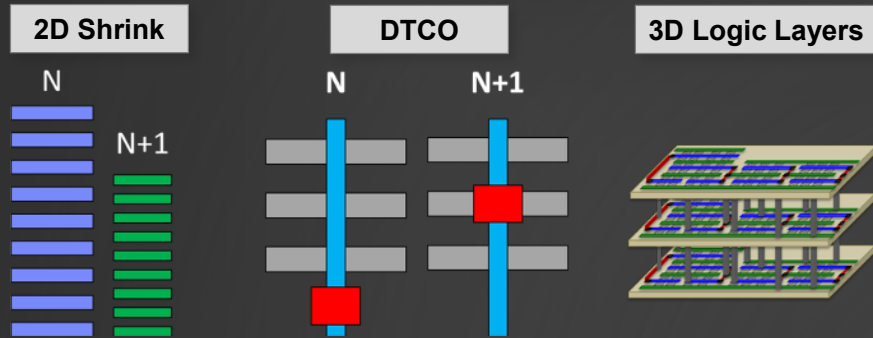


H.-S. P. Wong et al., DAC, 2020

3DFabric™: Potential for Another 10,000X I/O Density Increase

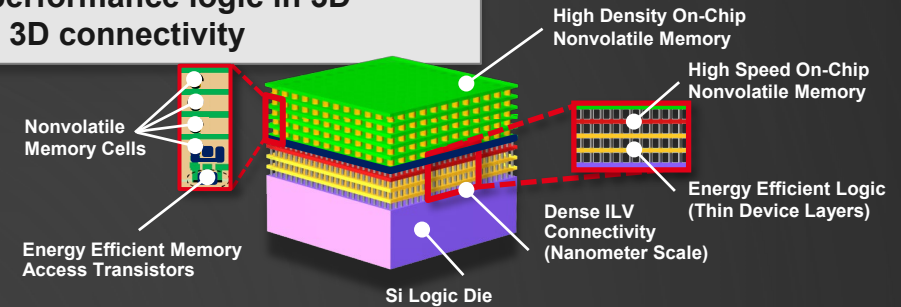


The Future is **SYSTEM INTEGRATION**



More transistors

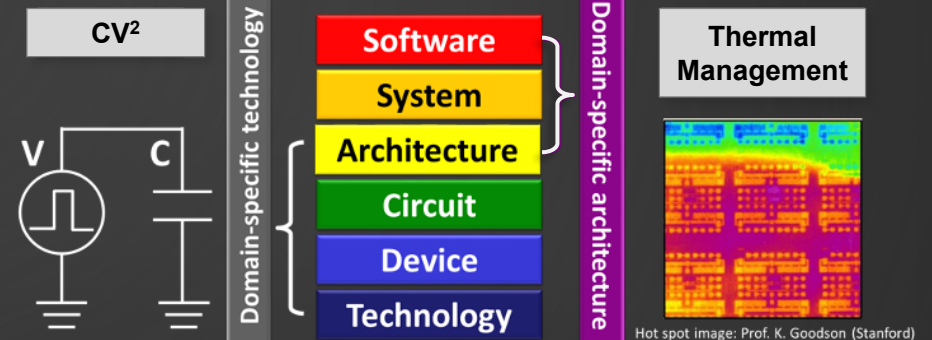
- Local and optimized on-chip memory
- High-performance logic in 3D
- Dense 3D connectivity



More memory



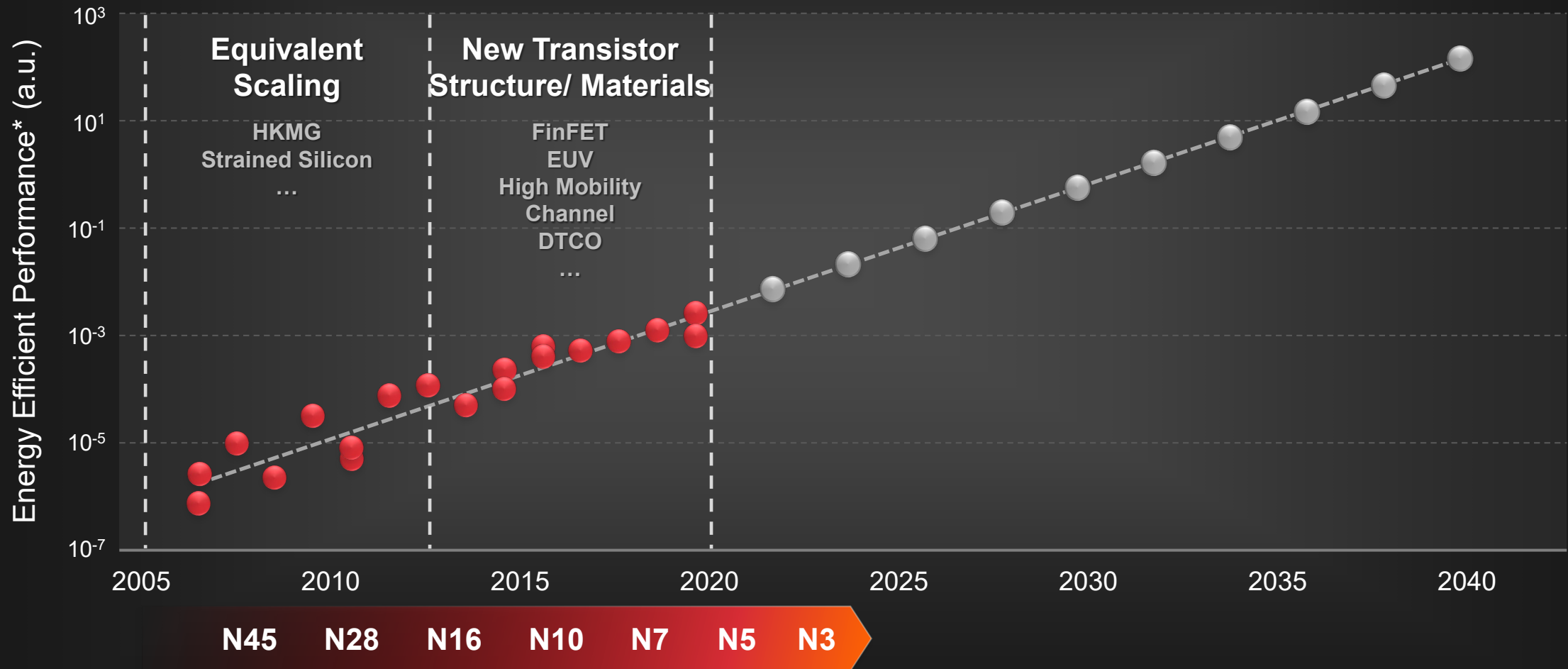
Logic-memory integration



End-to-end optimization

Industry Roadmap

~2X/2-year Historical Rate Continues



* Energy-efficient performance = Throughput $\times$ Throughput/Watt [$1/(fJ.psec)$] ; Based on Published GPU products

Democratizing Innovation

Technologies that Change the World

From a few...

A large crowd of people is gathered at night, many holding up their smartphones to capture photos or videos. The scene is illuminated by warm, yellowish light, possibly from stage lights or street lamps, creating a bokeh effect in the background. The crowd is dense, and the focus is on the backs of many heads and the glowing screens of the phones.

Democratizing Innovation

Technologies that Change the World

From a few... **to many**

