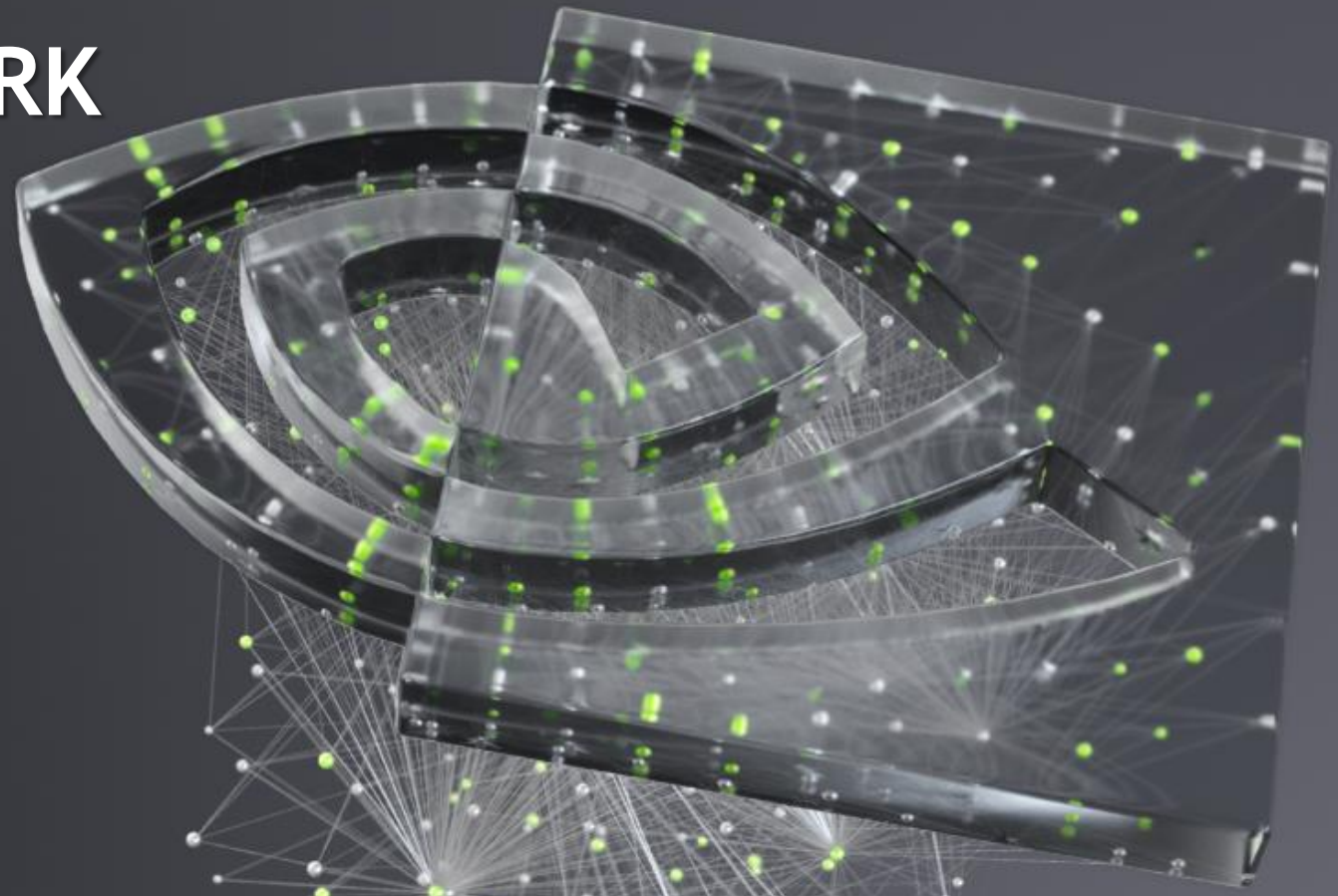
MAKING KGD SILICON WORK IN YOUR SUPPLY CHAIN



DAVID GREENLAW

VP Product Engineering

16-SEP-2020

TOPICS

- CMOS scaling over time
- Growth in compute demand remains exponential
- A100 and DGX-A100
- Types of manufacturing relationships
- Rise of silicon foundries is instructive
- What’s missing in the Adv Pkg discussion
- Summary

30 YEARS – SIMPLIFIED VIEW

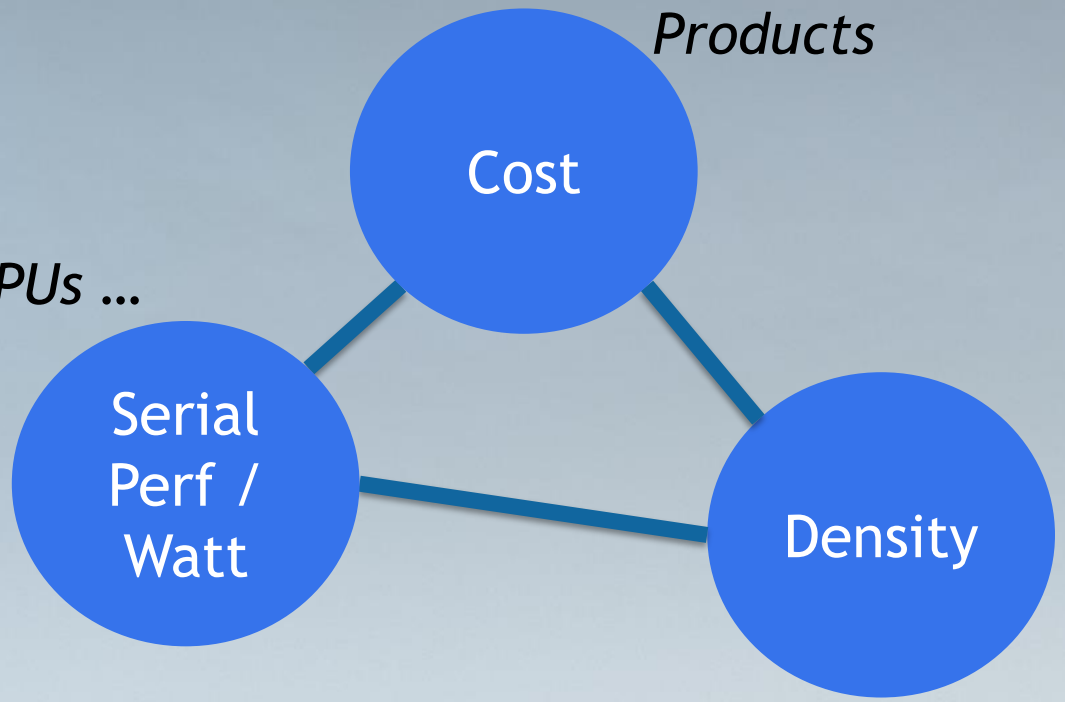
1990s	2000s	2010s
Moore's Law Dominant	Moore's Law Difficult	Moore's Law Slowing
'Heyday' of CMOS Scaling	Increased Scaling R&D $	Less Scaling, more stacking

CMOS SCALING LIMITERS OVER TIME

Timeframe	Limiter	Problem	Simpler Fixes	Final Fix
1980's	Multi-Metal Chip Planarity	Interconnect Scaling	TEOS (improved step coverage), BPSG (flowable oxide), Dep-Etch-Dep gapfill	Chemical-Mechanical Polish
1990's	Multi-Metal Interconnect Capacitance		SiOF, FSG	SiC Etch-Stop-Layers, SiCoH-like dielectrics
1990's	Metal Etch		Resist & Etch engineering	Cu Damascene
2000's	Gate Oxide leakage	Transistor Scaling	Nitrided oxides, also Strain Engineering	High-K Gate Oxides
2000's	Poly Gate Depletion		Advanced Doping/Activation techniques	Metal Gates
2000's	Short Channel Control		Strong Halos, HKMG,	FinFET
2010's	sub-193nm transmissivity through lenses	**Cost of Patterning**	immersion lithography, multi-patterning	EUV

SCALING NOW FOR WHAT YOU NEED MOST

Many Cost Sensitive Products



CPUs …

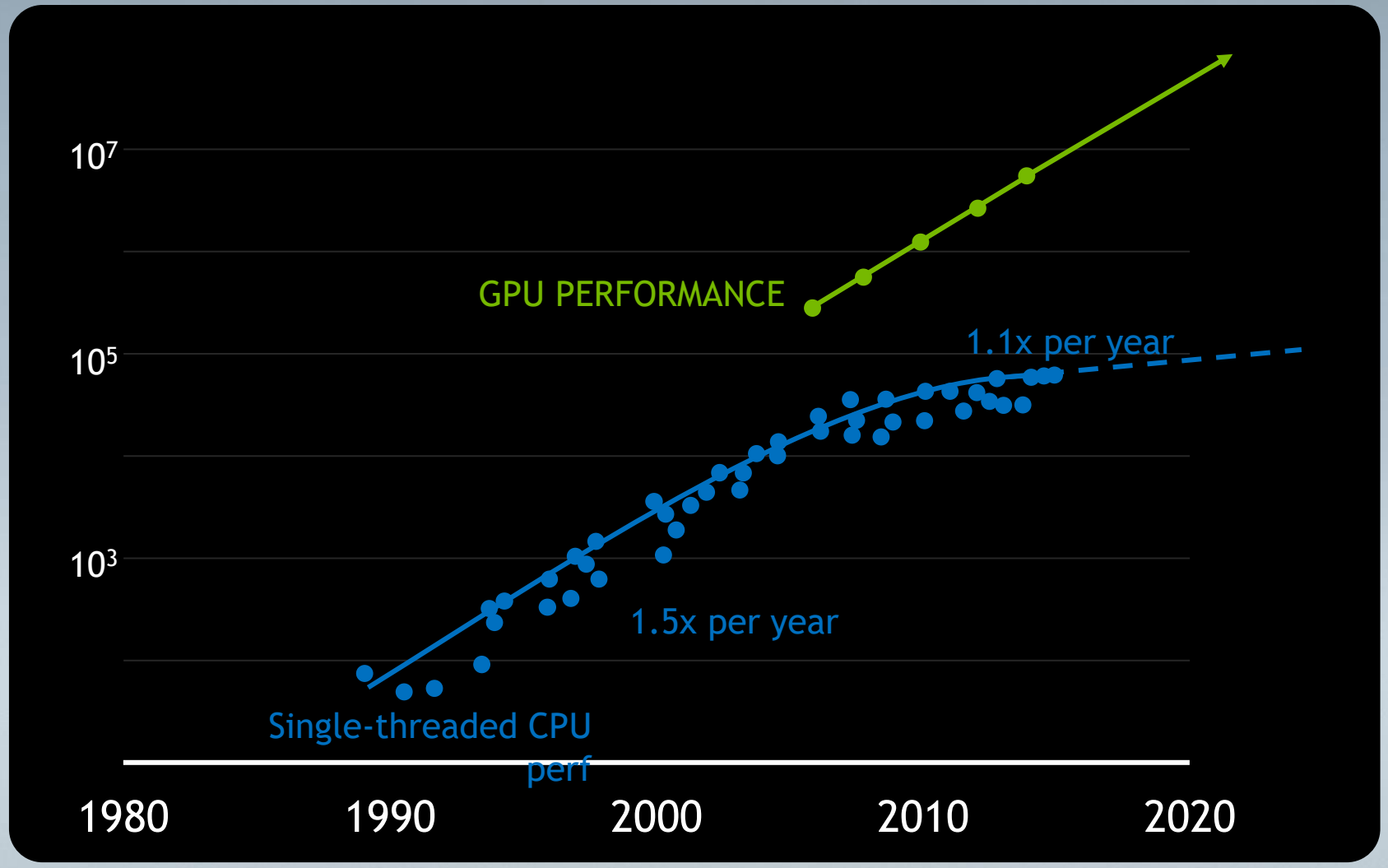
GPUs and other 'inherently parallel' processors

Moore's Law used to improve all 3 together…

… so which was "most important" didn't matter

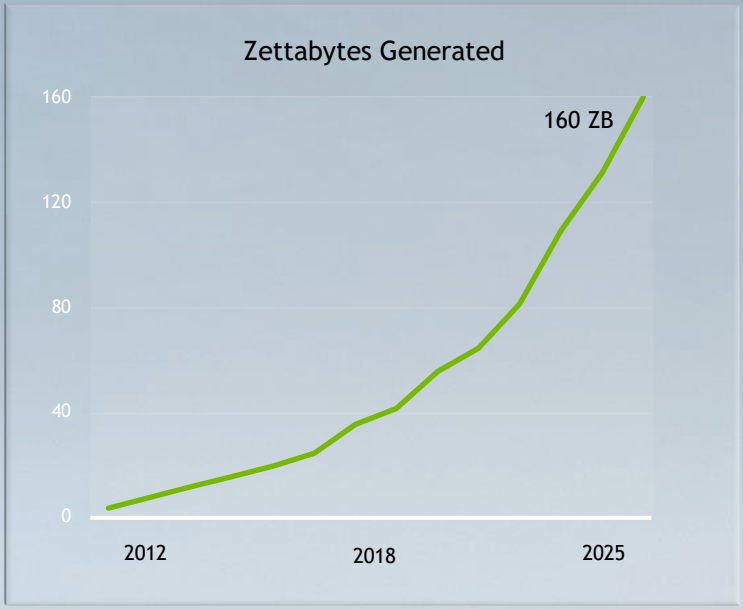
"If you could only pick ONE of these for a ~10% improvement …"

ACCELERATED COMPUTING
1000X EVERY 10 YEARS

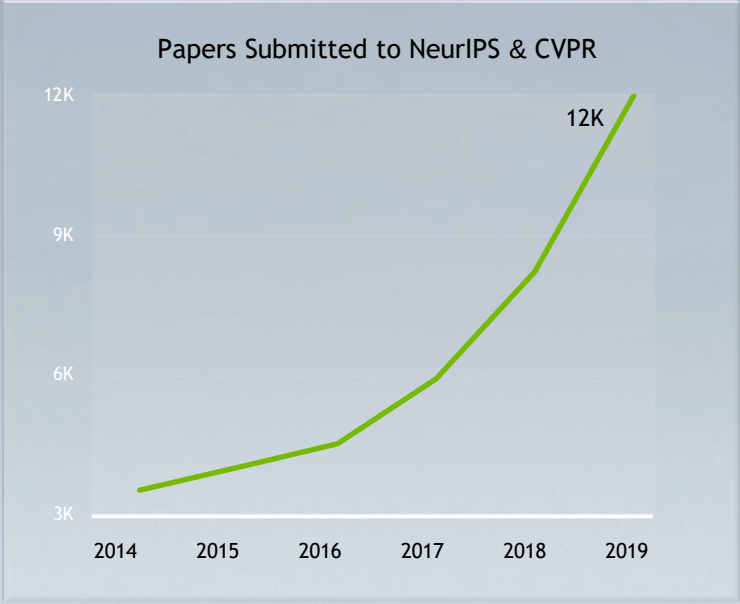


EXPONENTIAL GROWTH IN COMPUTING DEMAND

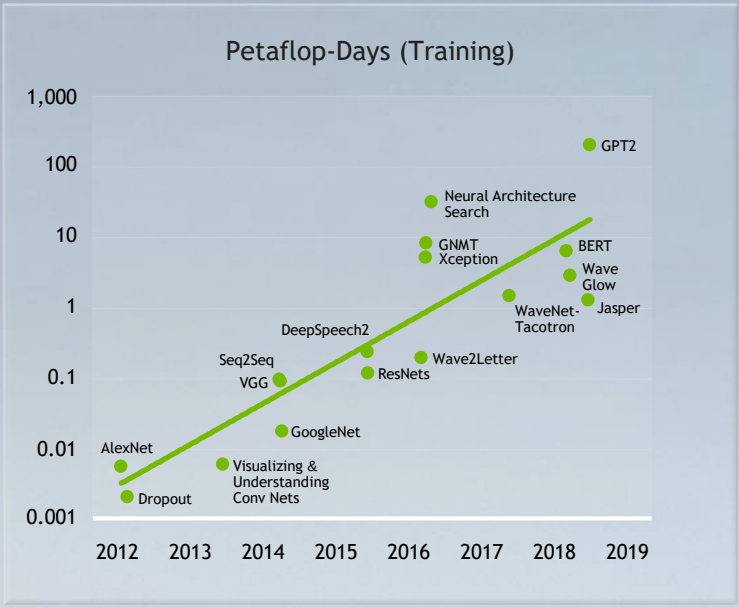
DATA SIZE GROWING



AI RESEARCH GROWING



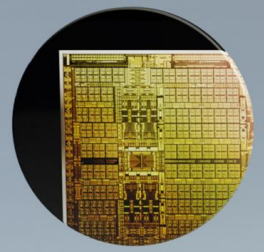
AI MODEL COMPLEXITY GROWING



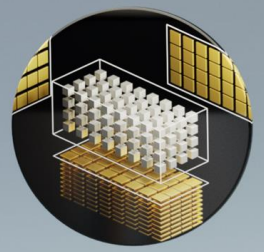
Source: IDC, GitHub, and OpenAI / NVIDIA

NVIDIA A100

TSMC 7nm | HBM2 — 1.6 Terabytes per Second | 3D Chip Stack

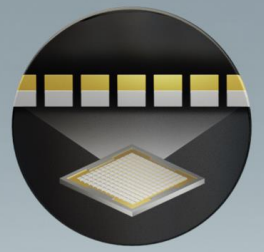


54 BILLION
XTORS

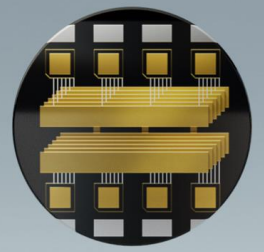


3RD GEN
TENSOR CORES

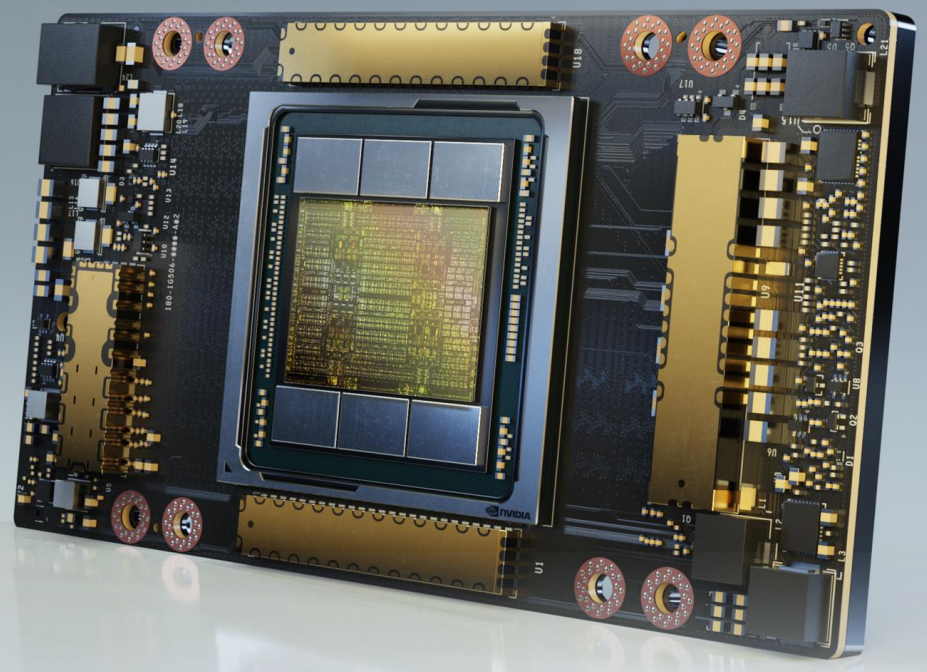
SPARSITY
ACCELERATION



MIG



3RD GEN NVLINK
& NVSWITCH



NVIDIA DGX A100
3RD GENERATION
INTEGRATED AI SYSTEM

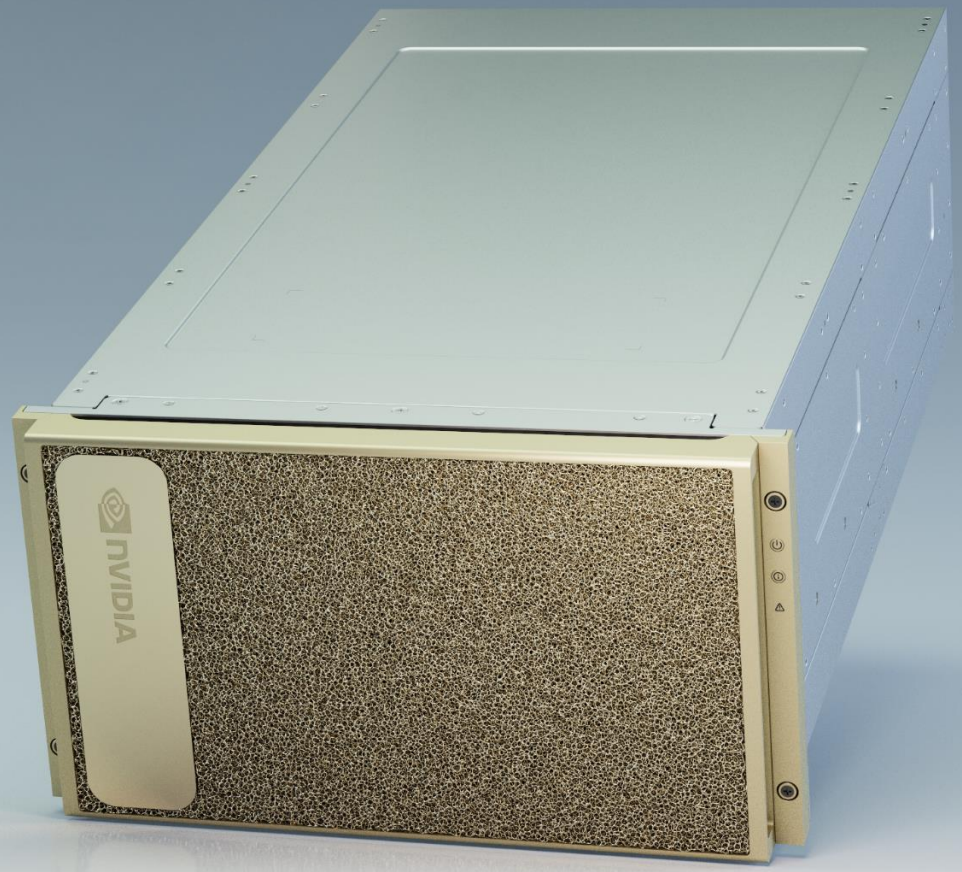
5 PetaFLOPS of Performance in a Single Node

Unified System for End-to-End Data Science and AI

Fully Accelerated Stacks — Spark 3.0, RAPIDS, TensorFlow, PyTorch, Triton

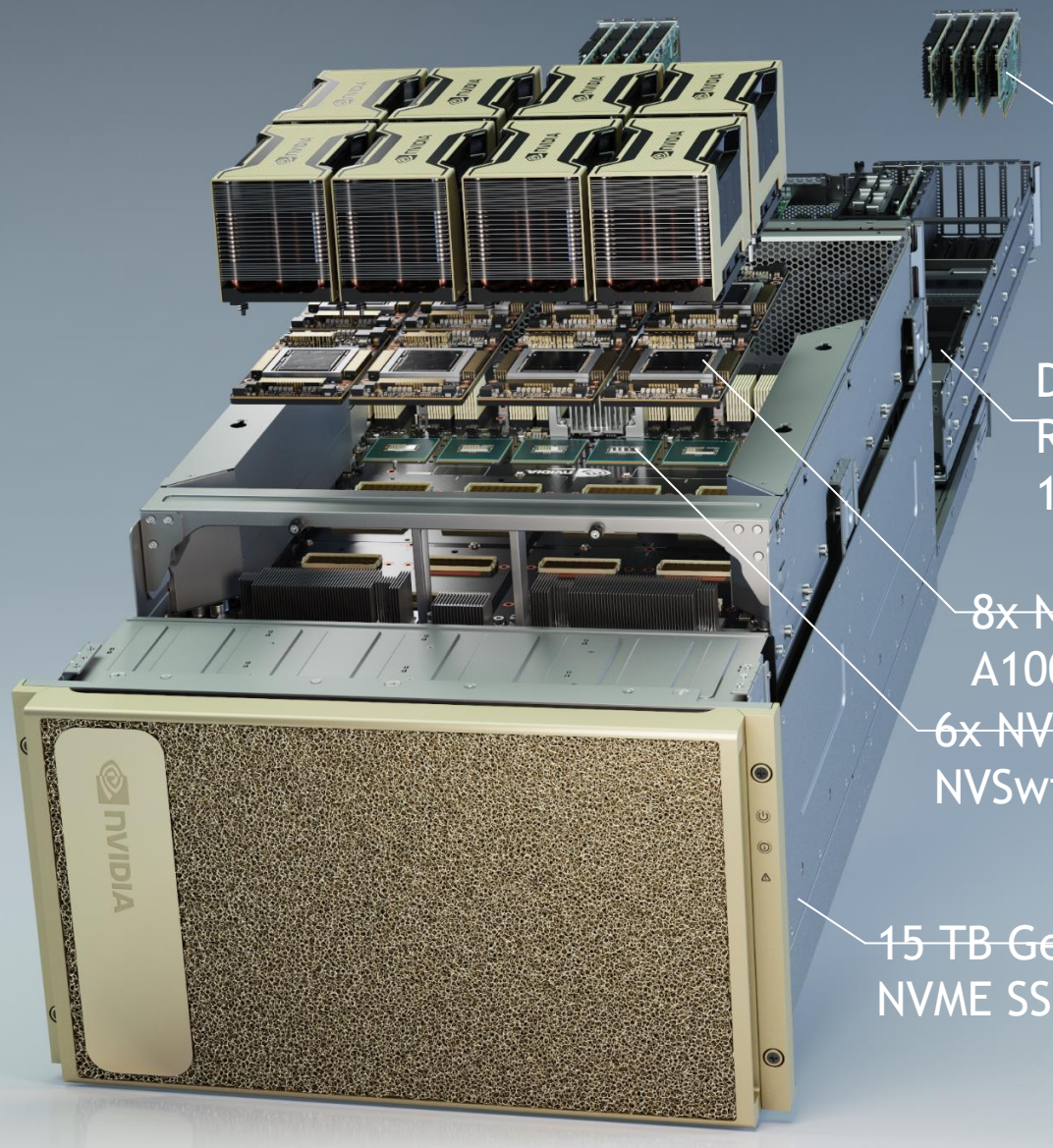
Elastic Scale-Up or Scale-Out Computing

High Scalability with Mellanox Networking



NVIDIA DGX A100
3RD GENERATION
INTEGRATED AI SYSTEM

5 PetaFLOPS of Performance in a Single Node



NVIDIA DGX A100
3RD GENERATION
INTEGRATED AI SYSTEM

5 PetaFLOPS of Performance in a Single Node

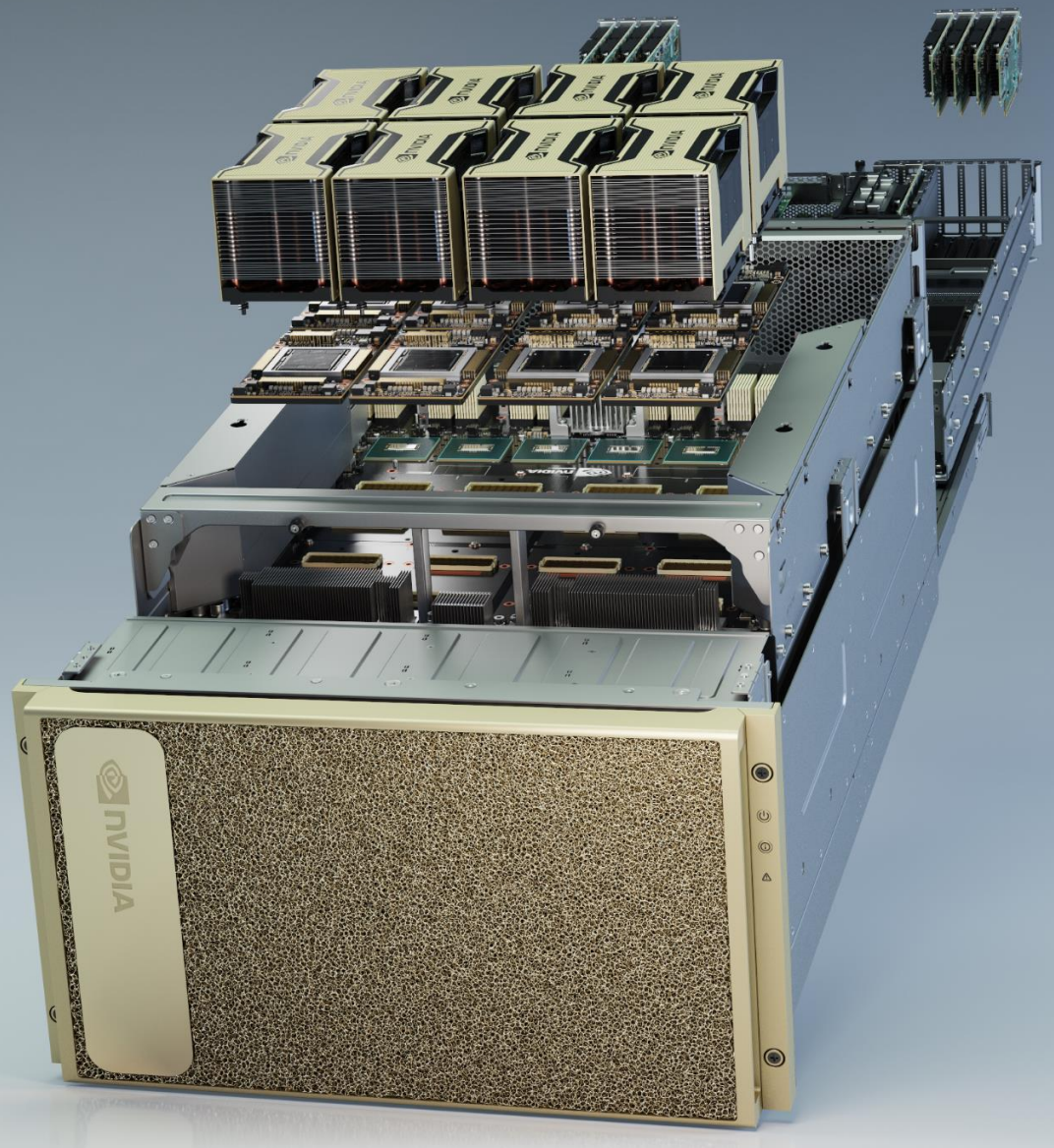
150X AI Compute

40X Memory Bandwidth

40X IO Bandwidth

Compared to High-End CPU server

Available Now at $199K



KGD & ADVANCED PACKAGING: TWO PROBLEMS

What everyone talks about:

- Stacking and Advanced Packaging Technologies
- Compelling Business Cases

Mostly Missing:

- Adopting wafer fab Internal Working Culture onto the assembly floors
  - SPC
  - FMEA
  - 'continuous improvement' all the time …

Mostly Missing:

- Adopting foundry-like External Working Culture
  - Customer Service …

MANUFACTURING RELATIONSHIPS

IDM MODEL

IDM: Owns all Mfg data

Design Data
Silicon Data
Tester Data

Simplest for mfg because all data within one company

FABLESS/FOUNDRY MODEL

Fabless Company:

Design Data
Tester Data

Interactions to connect statistical tester data to statistical silicon data

Silicon Foundry:

Silicon Data

CUSTOMER/SUPPLIER MODEL

Customer Company:

Small pile of failing die
No data …

Interactions inefficient because we have no statistical data about anything

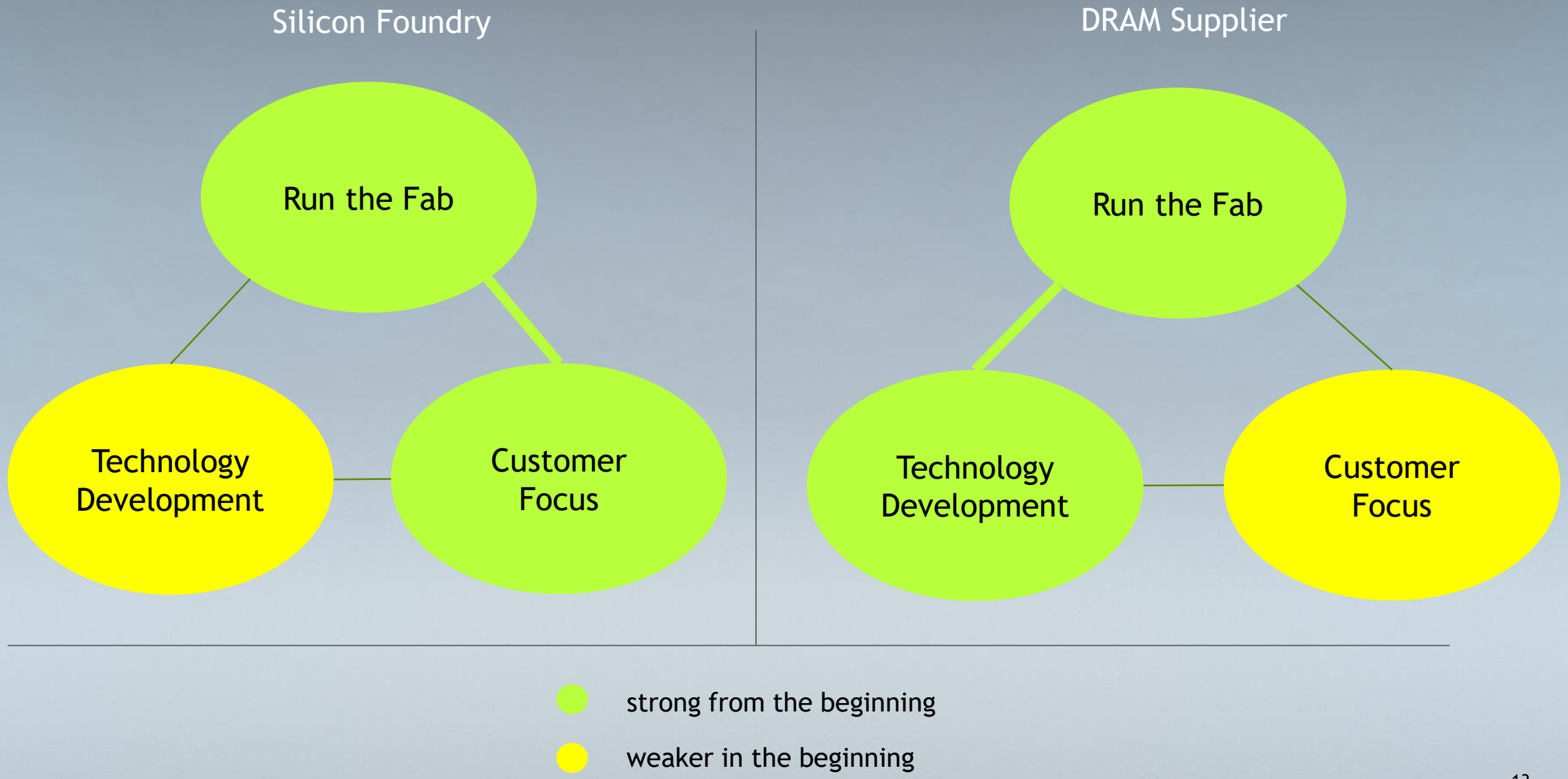
Memory Supplier:

Design Data
Silicon Data
Tester Data

Then: original doubters of the Foundry model could not imagine solving complex problems between 2 companies

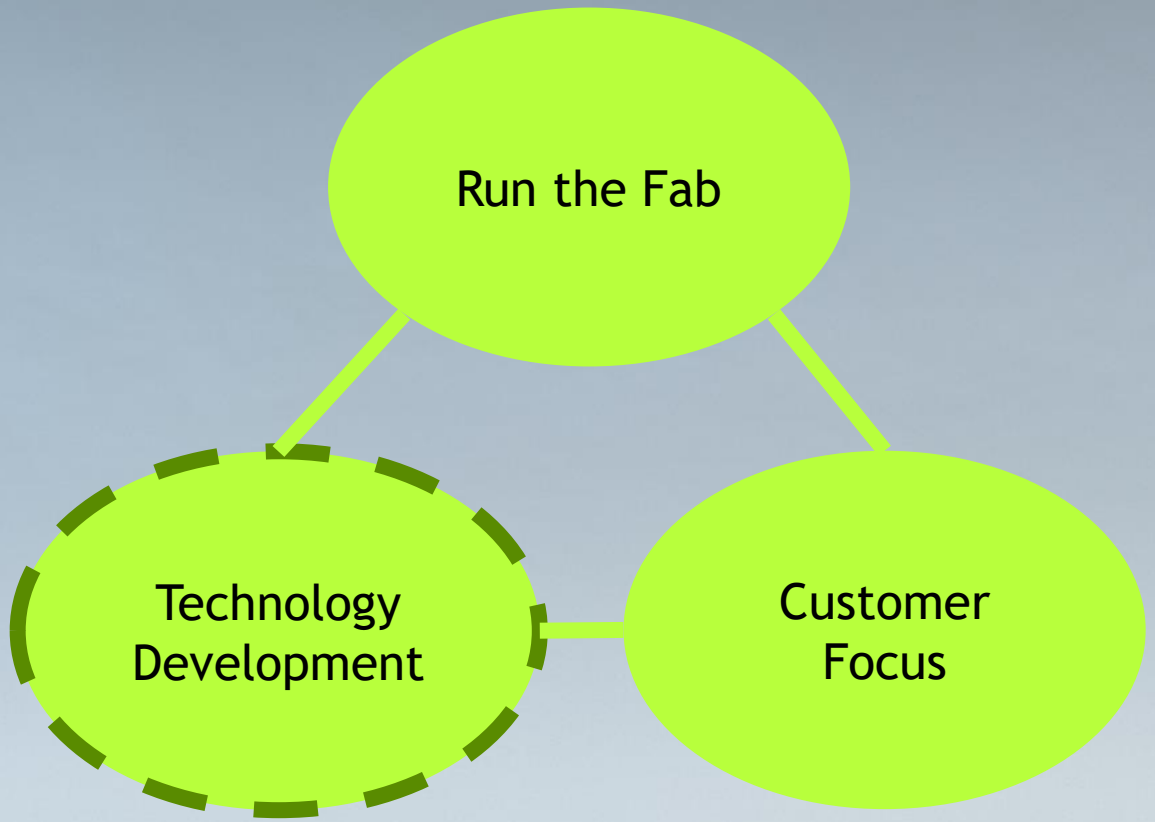
Now: Foundry model works. KGD silicon requires solving complex problems between multiple companies

25 YEARS AGO

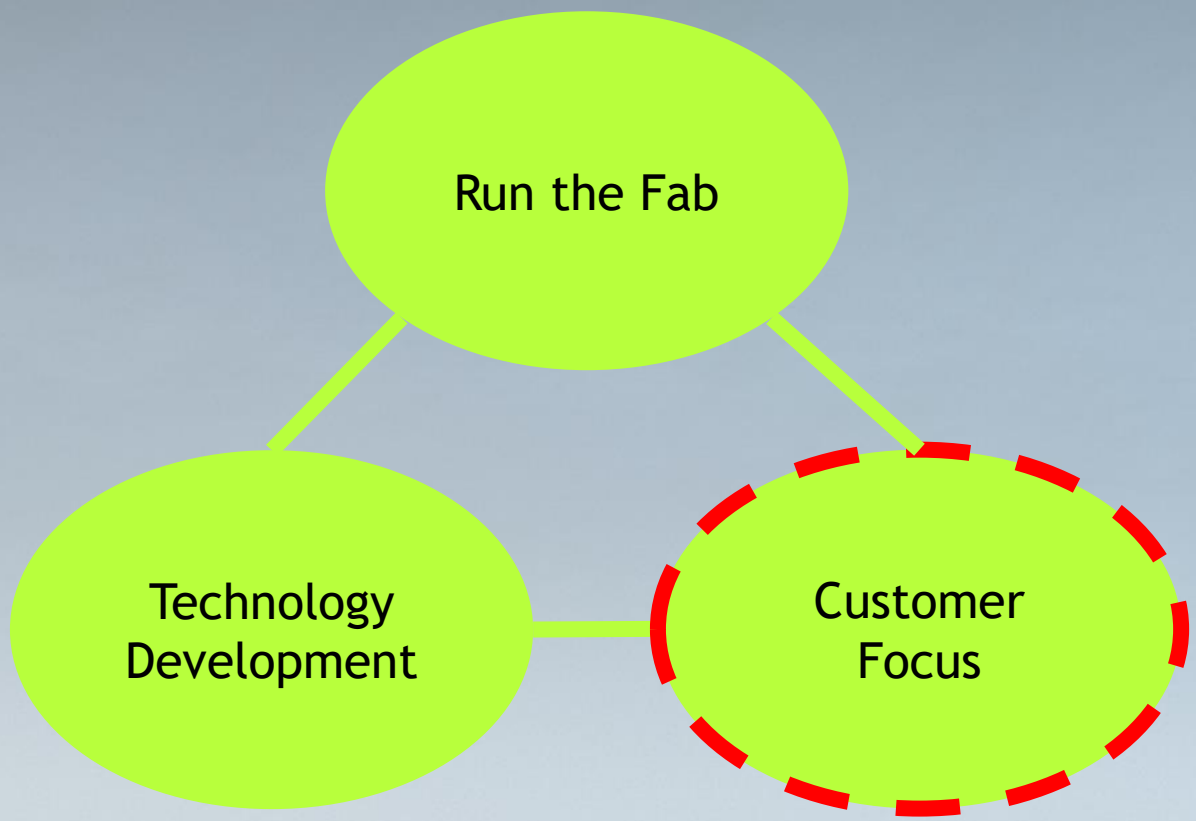

Silicon Foundry
Run the Fab
Technology Development
Customer Focus
DRAM Supplier
Run the Fab
Technology Development
Customer Focus
strong from the beginning
weaker in the beginning

TODAY, LOOKING FORWARD

Silicon Foundry Business



DRAM Business - next 5 years



Slowing Moore's Law Scaling means: "Everyone has to be good at everything"

Corollary: companies moving from Packaging to Advanced Packaging will work on all three…

CUSTOMER FOCUS – WHAT, EXACTLY?

Does NOT mean

- have to always ‘be nice’ to the customer …
- measured in # ppt slides with customer logo
- measured in # teleconf hours/month …
- etc

Means this

- See your customer’s success as key to your own success
- “Own the whole problem”, drive to closure
- Internal leverage from Customer Eng to internal teams…
- Engineers want to work on solving customer problems … connected to their career success

SUMMARY

- Silicon scaling remains limited by cost of patterning
- But exponential growth of compute demand continues
- KGD silicon and Advanced Packaging a part of the solution
- Adv Pkg work: ‘Technology’ and ‘Business’ necessary, but insufficient
  - previous rise of the Foundry/Fabless model is instructive
  - Working Culture is also a key to success:
  - successful Advanced Packaging factories behave more like wafer fabs: SPC, ‘continuous improvement’, etc
  - successful KGD and Packaging suppliers behave more like Foundries: Customer Service, working across supply chain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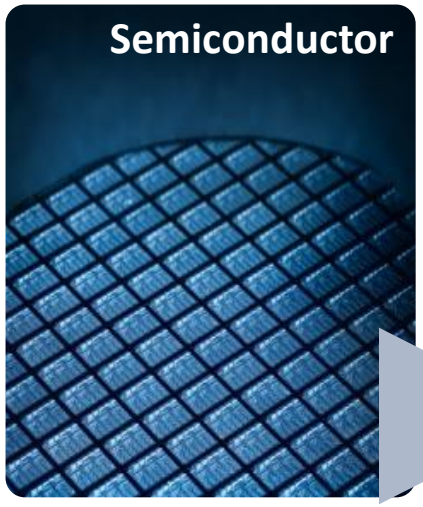
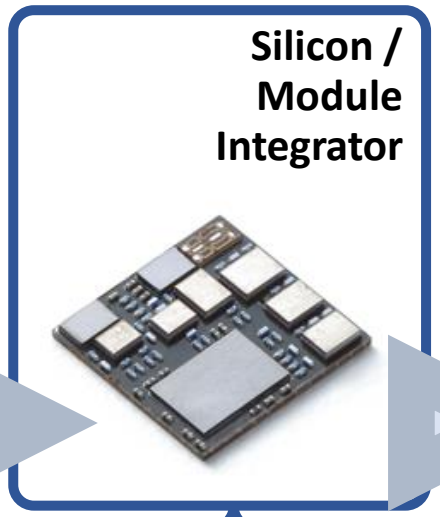
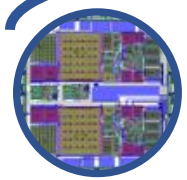
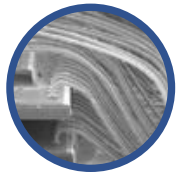





Design


Assembly


Test


Materials


Components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