SSD Controller Scalability to PCIe Gen6 and Beyond

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FMS the Future of Memory and Storage

Outline

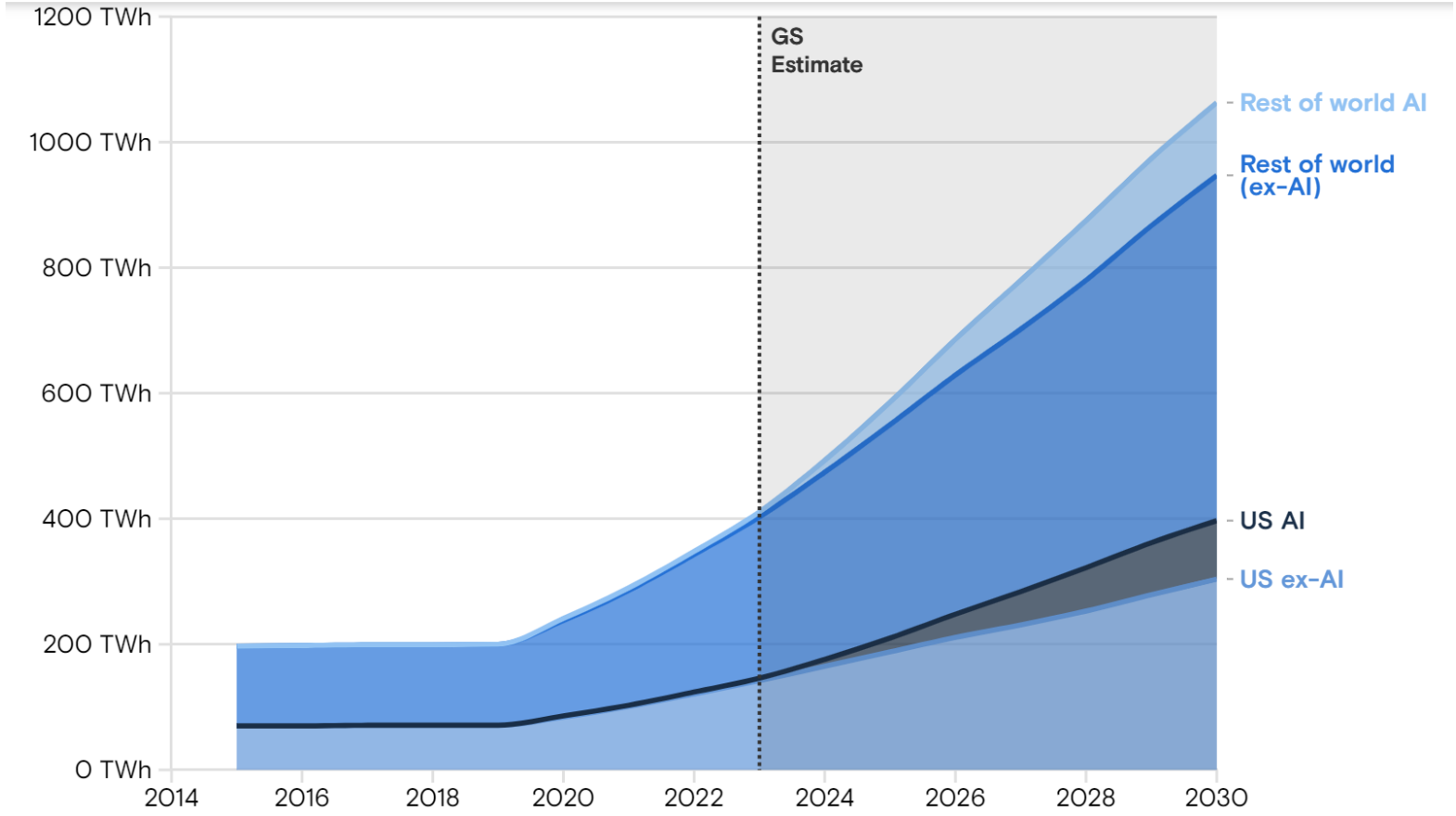
- Data Center Power Demand in AI Era
- SSD Power Consumption Breakdown
- Zero-in on SSD Controller
- Conclusion

Power Consumption of AI Era

- AI is poised to drive 160% increase in data center power demand by 2030 per Goldman Sachs.
- In US, AI will represent about 19% of data center power demand.
- A ChatGPT query needs nearly 10 times as much electricity to process as a Google search
- Efficiency gains in electricity usage slows and the AI revolution gathers steam

Global DC Power Consumption

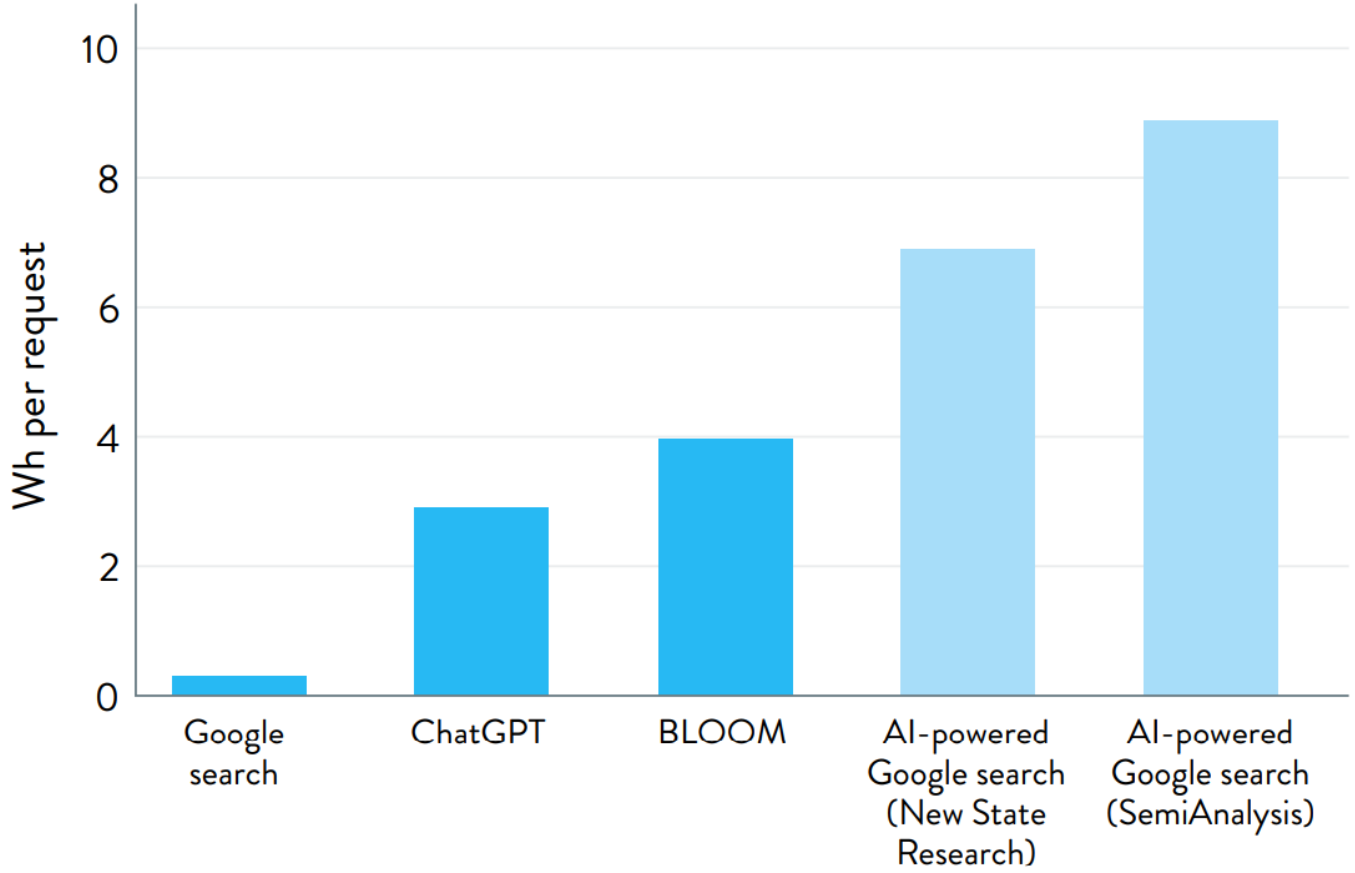
- US alone, AI drives extra 100TWh electricity demand.
- AI to represent about 19% of data center power demand.



Source: Masanet et al. (2020), Cisco, IEA, Goldman Sachs Research

Goldman Sachs

Electricity consumption per request



Vries, A.D. (2023). The Growing Energy Footprint of Artificial Intelligence. Joule, 7(1), 2191-2194.

EPRI: US Data Center Electricity Consumption

Higher growth consistent with rapid expansion of AI applications and limited efficiency gains

Flat power consumption from energy efficiency gain

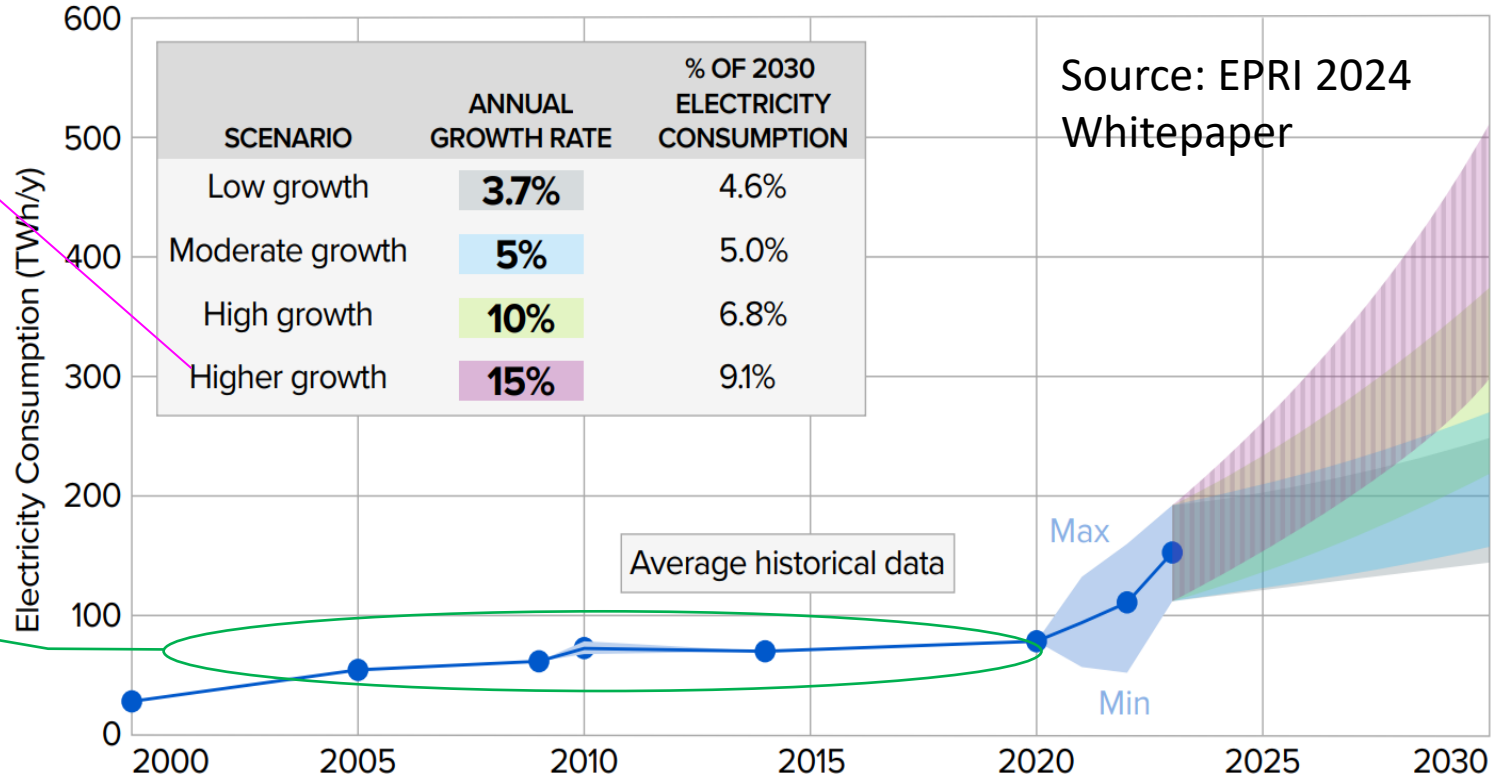
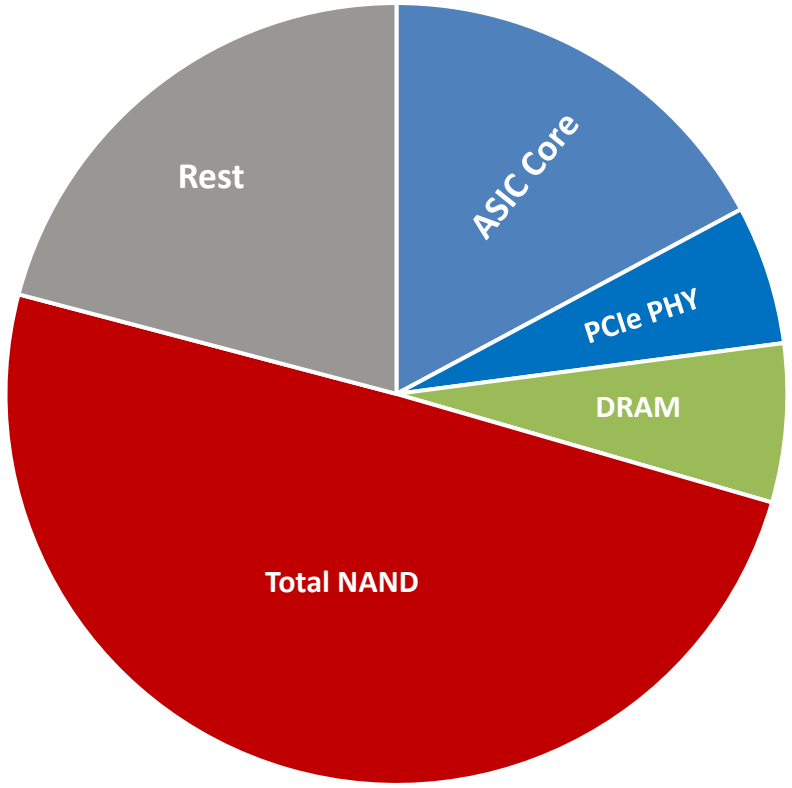


Figure ES-1. *Projections of potential electricity consumption by U.S. data centers: 2023–2030 . % of 2030 electricity consumption projections assume that all other (non-data center) load increases at 1% annually.*

What Can Storage Industry Do

SSD Power Consumption Allocation

- PCIe Gen5 based
- NAND accounted for about 50% total SSD power
- “Rest” includes all unaccounted power: PMICs, Caps, Inductors, ROM, Clock Generator, etc.
- ASIC (Core+PHY) accounts for about 20+%, the second largest piece



PCIE PHY Power

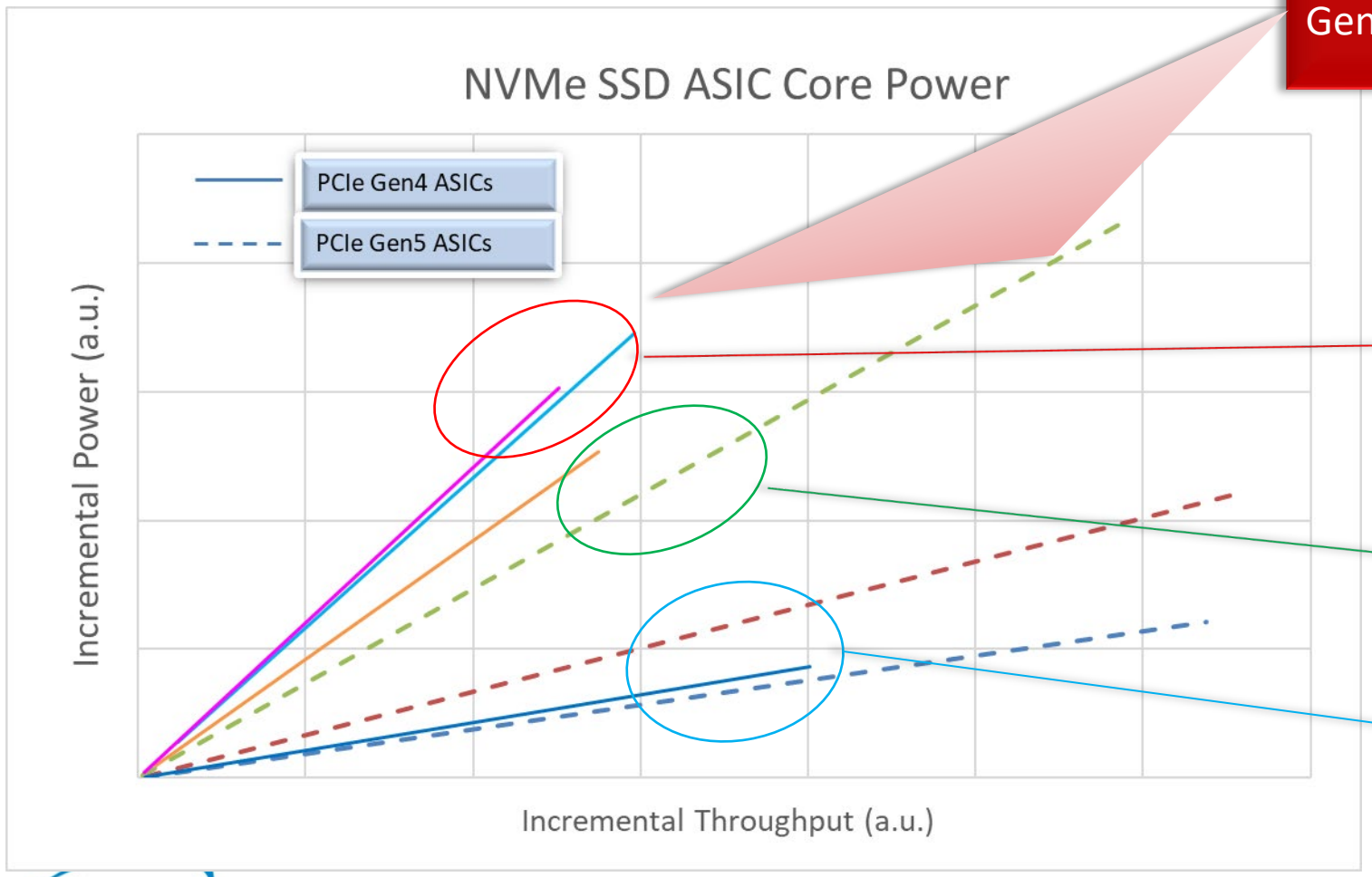
	PCIe Gen4x4	PCIe Gen5x4	PCIe Gen6
Process Node	16~7nm	16~7nm	7~5nm,
Typical Power	~500mW	~1W	~1.5W
	Data	Data	Estimated

- Every generation adds about 500mW even with the process node change

Zero-in on ASIC Core Power

- Distinct voltage, easy comparison among products
- Clear differences depending on architecture choices

ASIC Core Power



Quadruple and Double these for PCIe Gen6 not sustainable

ARM A-core Based

ARM R/M-like core Based

Hardware Accelerated

Summary

- 7 different SSD controllers in PCIe gen4 and gen5 SSDs from 6 different vendors studied for power efficiency and scalability
- SSD controller architecture must be optimized for energy efficiency to maintain the pace of performance scaling
- Architectures with hardware acceleration are better positioned for SSDs in PCIe Gen6 time frame and beyond