

Next Generation Tech – DDR5 & NVMe

Geoffrey Petit – Field Application Engineer



KINGSTON SNAPSHOT

35 years of Technology Innovation & Profitability

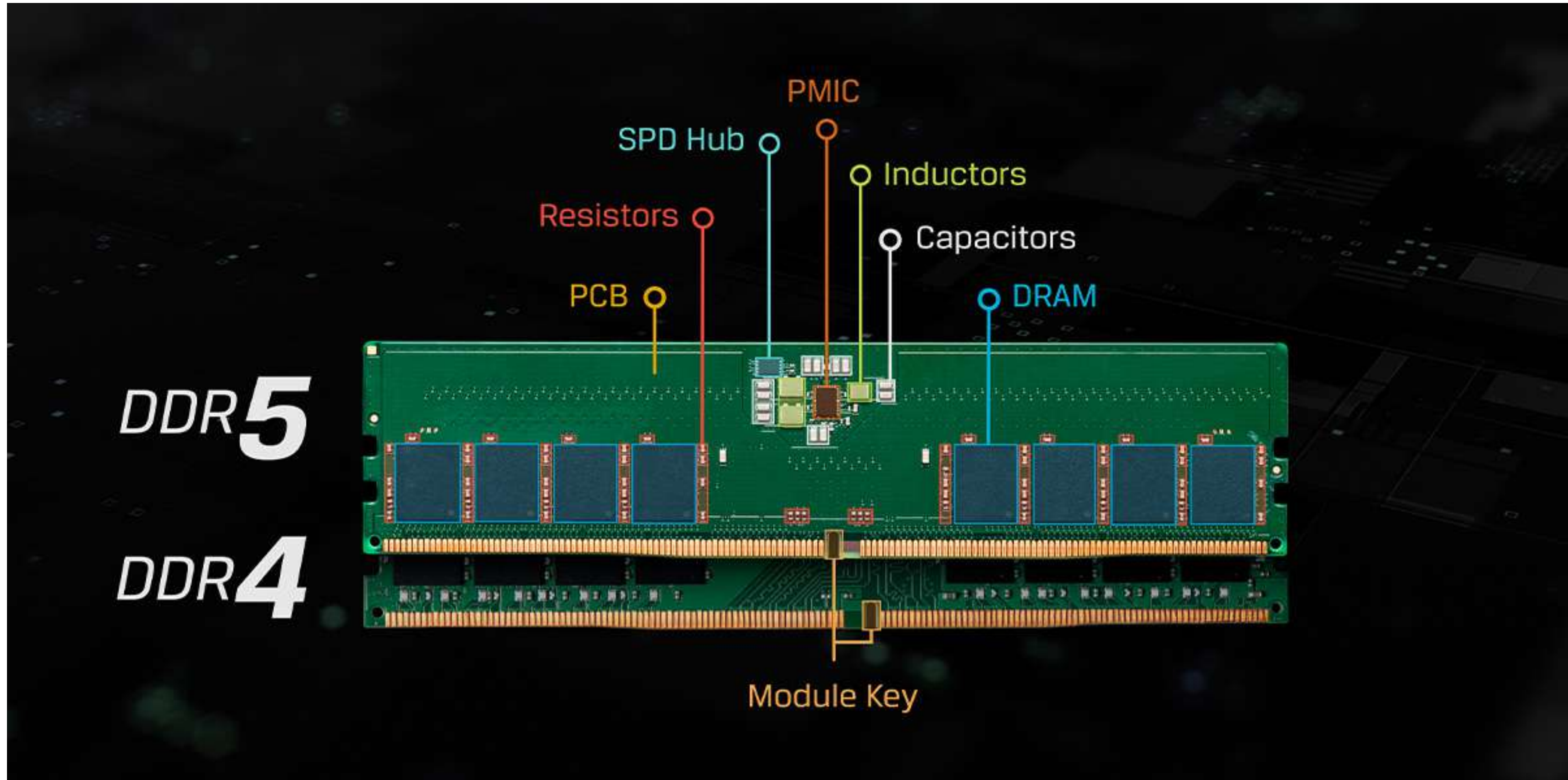
- » Privately Held Company
- » Financially Secure
- » 3,600 Employees Worldwide
- » Worldwide Manufacturing & Testing
- » Focused Business: Memory Modules, Flash Products, Technology Solutions, Logistics Services
- » Products distributed in over 175 Countries and available in over 225,000 locations worldwide
- » Delivering nearly 2M units per day
- » Founded in 1987



DDR5



DDR5 Components



DDR5

DDR4



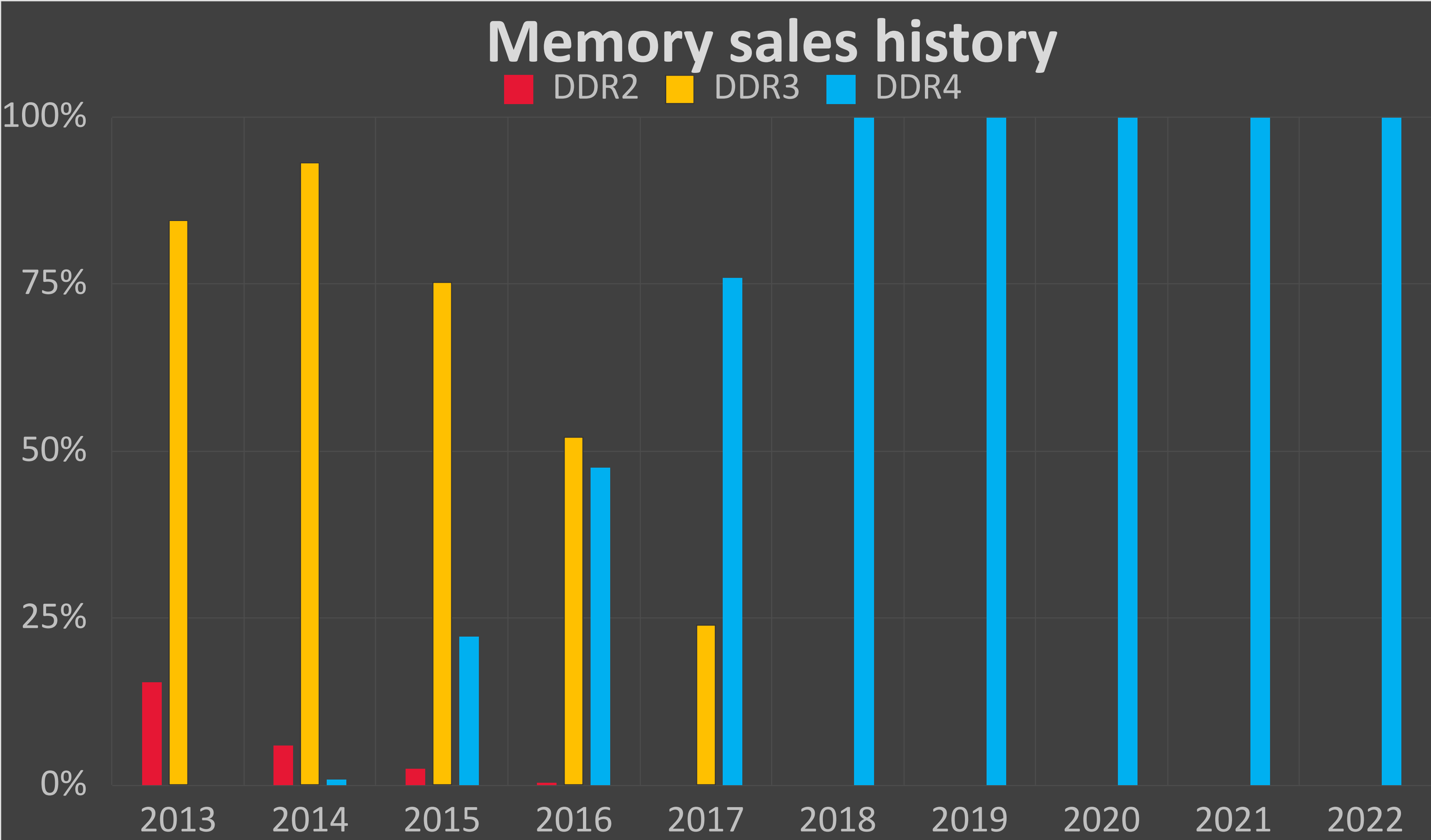
MEMORY ROADMAP



Technology	Data Rate	Module Classification	Peak Bandwidth
DDR3 (1.5V) DDR3L (1.35V)	1333	DDR3-1333/PC3-10600, DDR3L-1333/PC3L-10600	10600 MB/s or 10.6 GB/s
	1600	DDR3-1600/PC3-12800, DDR3L-1600/PC3L-12800	12800 MB/s or 12.8 GB/s
	1866	DDR3-1866/PC3-14900	14900 MB/s or 14.9 GB/s
DDR4 (1.2V)	2133	DDR4-2133 / PC4-2133	17000 MB/s or 17 GB/s
	2400	DDR4-2400 / PC4-2400	19200 MB/s or 19.2 GB/s
	2666	DDR4-2666 / PC4-2666	21300 MB/s or 21.3 GB/s
	2933	DDR4-2933 / PC4-2933	23400 MB/s or 23.4 GB/s
	3200	DDR4-3200 / PC4-3200	25600 MB/s or 25.6 GB/s
DDR5 (1.1V)	4800	DDR5-4800 / PC5-4800	38,400 MB/s or 38.4 GB/s
	5200	DDR5-5200 / PC5-5200	41,600 MB/s or 41.6 GB/s
	5600	DDR5-5600 / PC5-5600	44,800 MB/s or 44.8 GB/s
	6000	DDR5-6000 / PC5-6000	48,000 MB/s or 48.0 GB/s
	6400	DDR5-6400 / PC5-6400	51,200 MB/s or 51.2 GB/s



Server MEMORY adoption rate



Introduction year of new memory generations in the market

DDR2: 2001

DDR3: 2007

DDR4: 2014

DDR5: 2021



DDR5 Specifications

Form Factors

- 288-pin DIMM
- 262-pin SODIMM

Performance (in MT/s)

4400 / **4800** / 5200 / 5600 / 6000 / 6400

Power

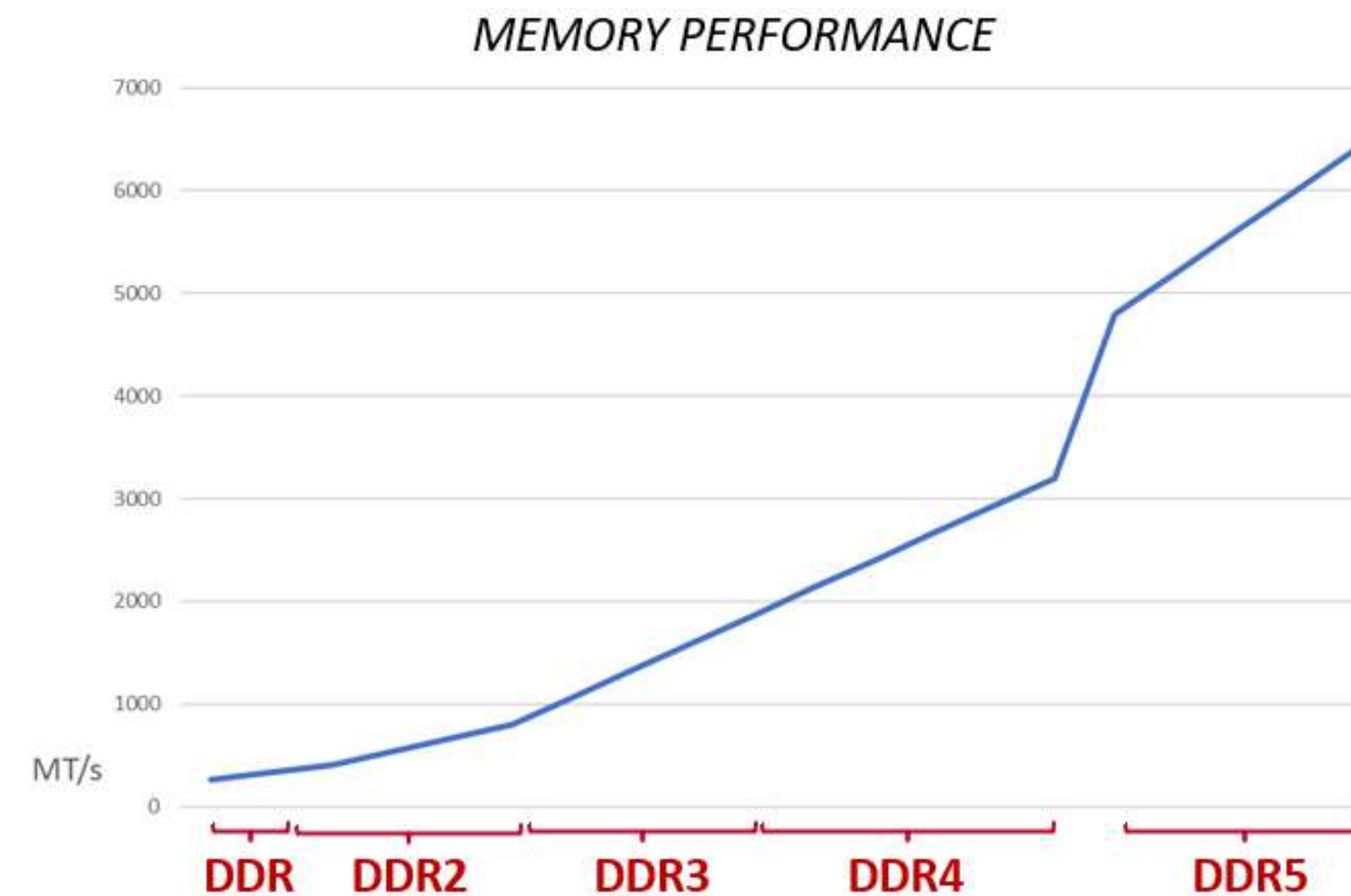
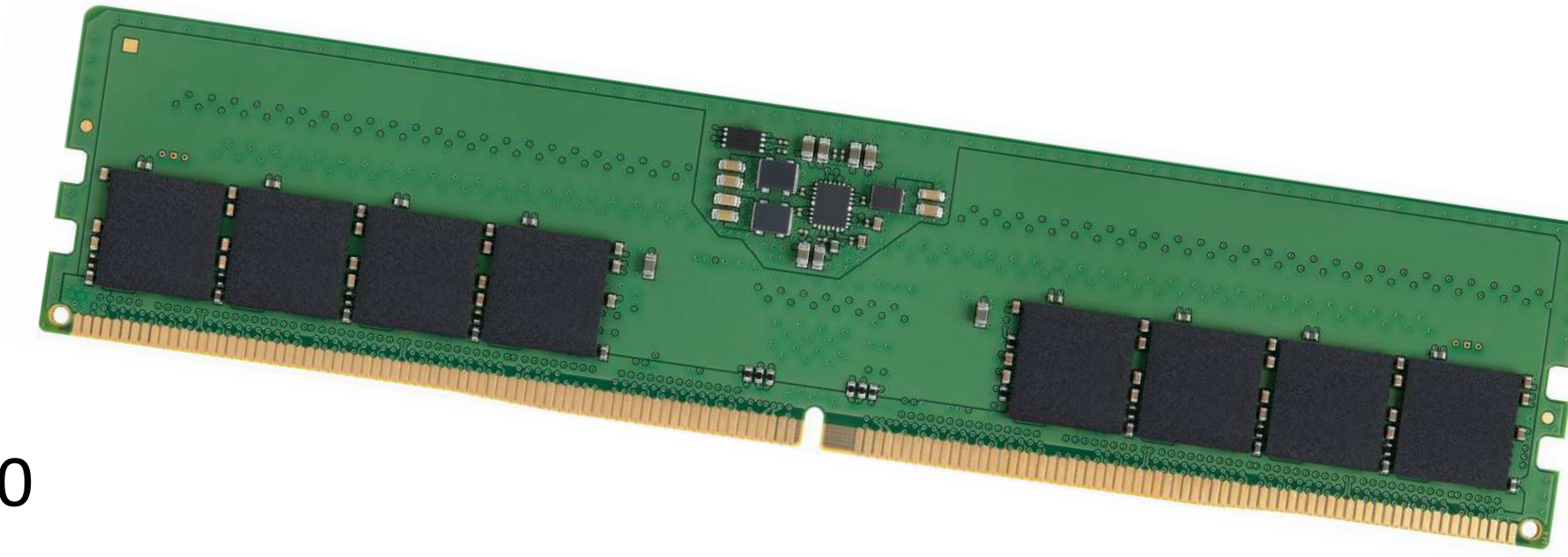
- 1.1 V
- 12V for Hybrid DIMM (3-pins)

DRAM Densities / DIMM Capacities

- 8Gb, **16Gb**, 24Gb, 32Gb (x4, x8, x16)
- 8GB, 12GB, 16GB, 24GB, 32GB, 48GB, 64GB, 96GB, 128GB, 192GB, 256GB, 384GB, 512GB

Module Types

- Registered DIMM
- Load Reduced DIMM
- ECC Unbuffered DIMM / SODIMM
- Non-ECC Unbuffered DIMM / SODIMM



JEDEC Industry Standard Specifications

Description	DDR5	
Data Rates (Speed in MT/s)	4000, 4400, 4800, 5200, 5600, 6000, 6400 MT/s	
Monolithic DRAM Densities (Gbit)	8Gb, 16Gb, 24Gb, 32Gb, 48Gb, 64Gb	
Package Type and Ballout (x4, x8 / x16)	BGA, 3DS TSV (78, 82 / 102)	
Interface	Voltage (V _{DD} / V _{DDQ} / V _{FP})	1.1 / 1.1 / 1.8 V
	Internal V _{REF}	V _{REFDQ} , V _{REFCA} , V _{REFCS}
	Command/Address	POD (Pseudo Open Drain)
	Equalization	DFE (Dynamic Feedback Equalization)
	Burst Length	BL16 / BC8 / BL32 (optional)
Core Architecture	Number of Banks	<u>32 Banks (8 Bank Groups)</u> 8 BG x 4 banks (16-64Gb x4/x8) 8 BG x 2 banks (8Gb x4/x8) <u>16 Banks (4 Bank Groups)</u> 4 BG x 4 banks (16-64Gb x16) 4 BG x 2 banks (8Gb x16)
	Page Size (x4 / x8 / x16)	1KB / 1KB / 2KB
Prefetch	16n	
DCA (Duty Cycle Adjustment)	DQS and DQ	
Internal DQS Delay Monitoring	DQS interval oscillator	
ODECC (On-die ECC)	128b+8b SEC error check and scrub	
CRC (Cyclic Redundancy Check)	Read/Write	
ODT (On-die Termination)	DQ, DQS, DM, CA bus	
MIR ("Mirror" pin)	Yes	
Bus Inversion	Command/address inversion (CAI)	
CA Training, CS Training	CA training, CS training	
Write Leveling Training Modes	Improved	
Read Training Patterns	Dedicated MRs for user-defined serial, clock, and <u>LFSR</u> - generated training patterns	
Mode registers	Up to 256 x 8 bits	
PRECHARGE Commands	All bank, per bank, and same bank	
REFRESH Commands	All bank and same bank	
Loopback Mode	Yes	



DDR5 Features

- Higher Bandwidth: starting from 4800MT/s JEDEC standards (vs 3200MT/s for DDR4)
- New channel architecture : 2 independent 32-bit addressable subchannels to increase efficiency and lower the latencies of data accesses for the memory controller.
- Better power efficiency and signal integrity thanks to PMIC component on the memory module
- Memory modules with higher capacity thanks to increased DRAM chip Density
- Added temperature sensors on RDIMM & LRDIMM modules to allows for more precise control of system cooling.
- On-Die ECC (Error Correction Code) is a new feature only on DDR5 memory designed to correct bit errors within the DRAM chip.



Enterprise-class / DC SSD Solutions



Benefits of a DC/Enterprise SSD (eSSD vs cSSD)



Enterprise-class or Data Center SSDs have specific NAND/Controller combinations.

Firmware is optimized for Data Center/Enterprise workloads.



QoS (Quality of Service)

- IOPS Consistency
- Predictable Low Latency

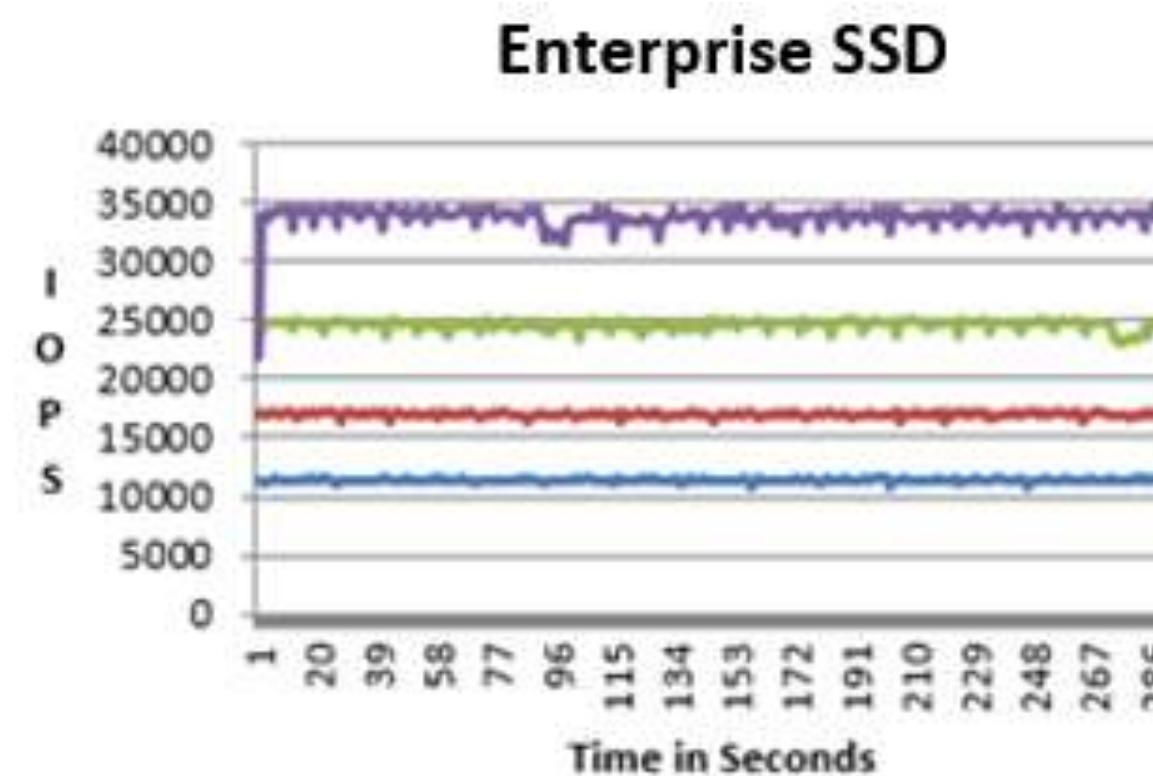
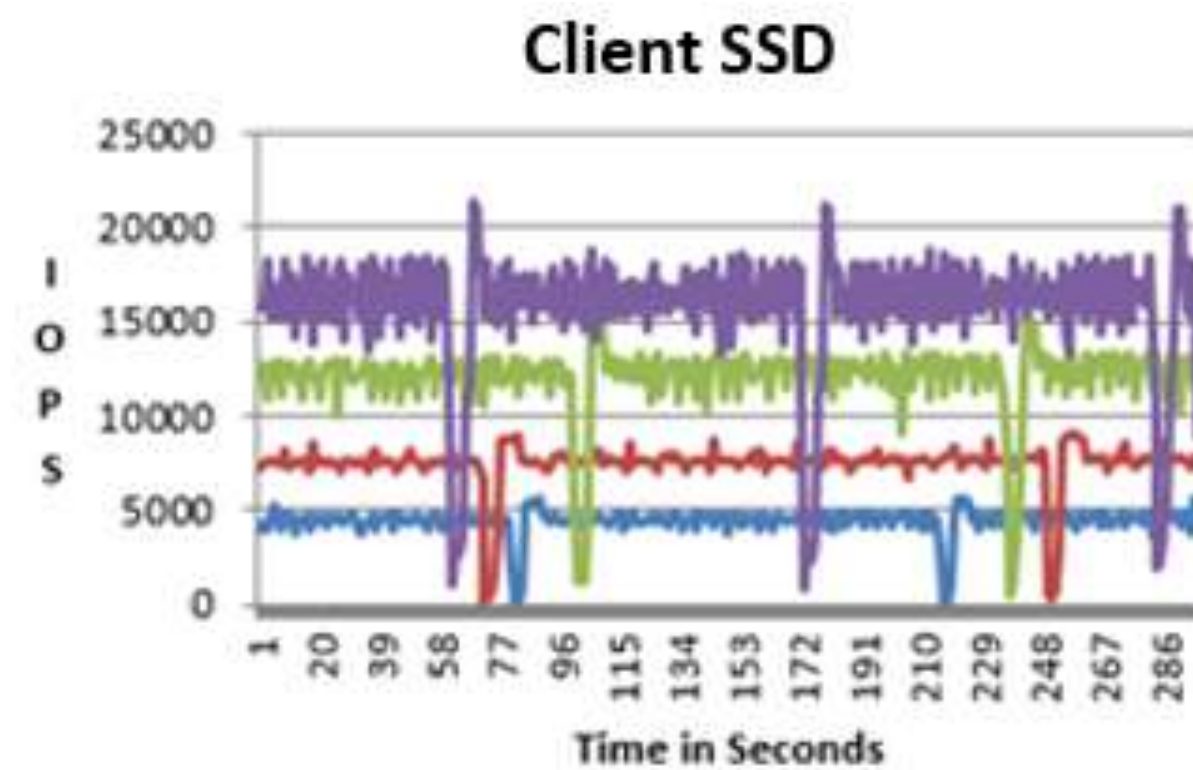


Tested on server platforms with 3rd party & OEM RAID Controllers.

Higher Endurance Rating tested against enterprise workloads.



Power Loss Protection (PLP)



- Workload 1
- Workload 2
- Workload 3
- Workload 4



SATA

PCIe NVMe

DC450R



- **2.5" SATA Rev 3.0 6Gbps**
- 480GB – 7.68TB
- Read-Centric Workloads
- No Hardware PLP feature
- 5 years warranty

DC500



- **2.5" SATA Rev 3.0 6Gbps**
- 480GB – 7.68TB (up to 3.84TB for DC500M)
- DC500R: Read-Centric Workloads
- DC500M: Mixed-Used Workloads
- With Hardware PLP feature
- 5 years warranty

DC1500M



- **PCIe Gen 3.0 x4 NVMe U.2, 2.5"x15mm**
- 1920G – 7.68TB
- Mixed-Used Workloads
- With Hardware PLP feature
- 5 years warranty

DC1000B

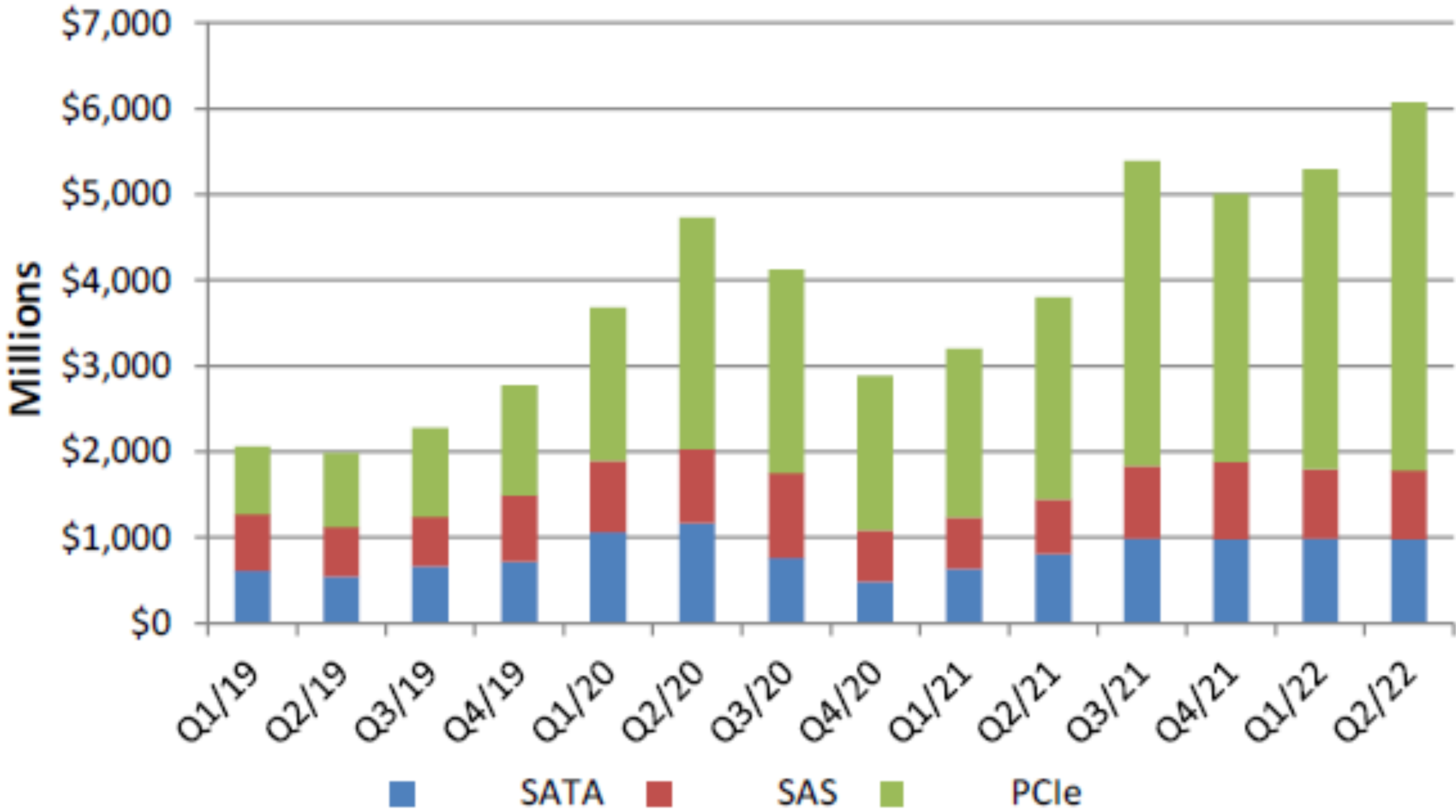


- **PCIe Gen 3.0 x4 NVMe M.2 2280**
- 240GB – 960GB
- Optimized Server Boot Drive
- With Hardware PLP feature
- 5 years warranty



NVMe SSD adoption rate

Enterprise SSD Revenue Trend



Benefits of DDR5 memory & NVMe Enterprise-class SSDs



Improvements brought by DDR5 memory modules help to respond to growing demand for more powerful servers/HPCs. Applications such as AI & ML as well as the increasing number of IoT devices require more and more computing power with improved response time.



NVMe's performance boost will benefit latency-sensitive workloads and other areas such as real-time big data analytics or database environments with heavy workloads. Industries such as healthcare, finance and telecoms all depend on extremely fast computers with high performance and low latency.



The amount of data being created daily has increased exponentially in recent years due to our new ways to communicate, work, purchase goods & services and entertain ourselves. As a result the needs for storage resources is expected to keep growing.



DDR5 memory and NVMe technologies are some of the key elements which will allow future data centers to increase their processing power to respond to the current needs and support the new technologies of tomorrow.



Value added services – Peace of Mind



All Ask an Expert services are free of charge* and you don't even need to be a Kingston customer.

Our product evaluations help you conduct a 'proof of concept' review of our recommendations in your own environment. Plus, Ask an Expert offers you an independent opinion on whether the configuration you're currently using, or planning to use is right for your organisation



KingstonCare is an additional guarantee you can offer to your customers when selling Kingston products, on top of your current service agreement with them and without any extra cost. Kingston will reimburse you for service calls directly related to covered Kingston products or send out one of our contracted service providers, if required. The process will be seamless to your customers. Contact your Kingston representative to find out how you can get the added benefit of service reimbursement.



Why Kingston?

- **35** years of proven industry-leading, patented high-quality technology manufacturing.
- Major investments in technology
- R&D partnerships with ODMs, datacenters, and technology leaders
- Most extensive testing in the industry
- Guaranteed compatibility/certifications
- Unprecedented access to Kingston engineers and experts for technical guidance before, during and after hardware acquisition.
- Industry leading global customer support, warranties, and free live technical support.



