Quality of Service

for Kingston Data Centre 500 Series SSDs (DC500R / DC500M)

What is Quality of Service (QoS)?

The Quality of Service (QoS) of an SSD refers to the consistency and predictability of latency (response time) and IOPS (I/Os Per Second) performance while servicing a read/write workload. QoS metrics demonstrate that, given a worst-case workload tested over a period of time, an SSD's latency and IOPS profiles stay within a specified range (typically up to a minimum of 99.9% of the data points over a predetermined period of time) without having unexpected outliers causing a sudden drop in application performance.

Why is QoS important?

For data centres, it is becoming mandatory that SSD performance stays consistent and predictable at all times. IT administrators and storage architects are now drawing a line on what is considered "acceptable levels of performance" when making SSD purchasing decisions. Storage service providers need to be able to manage and guarantee performance levels to their customers with a high level of confidence.

SSDs are built using NAND Flash memory technology and require a controller to manage all I/Os and the NAND Flash. Due to the characteristics of NAND Flash memory, the SSD controller cannot always promptly process host read or write transactions because it must also perform required background NAND Flash management tasks. These background NAND management tasks include garbage collection, the process of clearing invalid data blocks into available space on the SSD, and wear levelling, the even distribution of writes across the entire NAND Flash memory storage that helps extend the life of an SSD. If the SSD firmware is not properly designed to manage these background tasks efficiently for an enterprise application, inconsistent storage performance within an application may not meet the user experience Service Level Agreements (SLAs) required by IT.

Client system workloads generally do not expose these periodic drops in application performance because the typical client workload provides a lot of "idle time" for the SSD controller to perform its data management tasks without any noticeable indication of performance loss by the user. In contrast, a server workload can be very demanding on the SSD. Virtualisation, databases and OLTP applications present a highly random read/write workload pattern to the SSD for extended periods of time. It is therefore essential for the SSD controller firmware to be optimised to deliver consistent and sustained performance levels.

DC500 Series SSDs for Data Centres

Over-Provisioning

Kingston data centre SSDs are designed with a feature called "Over-Provisioning" (OP), a technique by which a portion of the total Flash capacity is set aside specifically for the SSD controller to increase background task efficiencies.

SSDs that are configured with higher levels of OP will generally deliver lower latency and increased write IOPS performance than drives configured with less OP. A larger OP configuration on an SSD also provides the added benefit of increased write endurance, making them a better choice for more write-intensive applications.

Kingston realises that data centre use of SSDs cannot be a "one size fits all" approach and therefore Kingston provides users with the ability to set their own OP configuration to meet their unique performance and service life requirements. Over-provisioning can be configured on Kingston's Enterprise SSDs using the Kingston SSD Manager (KSM) software.

QoS

Kingston data centre SSDs are engineered with both hardware and firmware features to deliver consistent read/write latency and IOPS performance.

SSD latency needs to meet specified service levels for an application workload for 99.9% of the data points, or on an even tighter scale of 99.99% of the data points. SSDs that are optimised around these SLAs will exhibit superior levels of performance predictability.

The table below shows latency QoS at [99.9%, 99.99% and 99.9999%] service levels for the Kingston DC500R and DC500M under 4KB, 100% random read/write workloads.

Kingston DC500R SSD

QoS [msec] (4K, random) QD = 1	480G		960G		1920G		3840G	
	Read	Write	Read	Write	Read	Write	Read	Write
Quality of Service (99.9%)	0.2	0.08	0.2	0.05	0.2	0.04	0.2	0.04
Quality of Service (99.99%)	0.25	0.09	0.2	0.07	0.25	0.1	0.26	0.1
Quality of Service (99.9999%)	1.5	1.1	0.5	0.5	1.5	0.4	1.5	0.4

Kingston DC500M SSD

QoS [msec] (4K, random) QD = 1	480G		960G		1920G		3840G	
	Read	Write	Read	Write	Read	Write	Read	Write
Quality of Service (99.9%)	0.2	0.03	0.2	0.05	0.2	0.05	0.2	0.05
Quality of Service (99.99%)	0.2	0.05	0.2	0.07	0.2	0.07	0.8	0.2
Quality of Service (99.9999%)	1.1	0.6	1.5	0.3	1.1	0.3	0.9	0.6

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Performance Consistency

Performance consistency is based upon the IOPS test results and is calculated as the slowest 1-second interval's IOPS divided by the average IOPS result during the test time. Performance consistency among many client SSDs used in servers is not predictable. Client SSDs are not optimised to provide the consistent I/Os under sustained workloads that enterprise applications require. As previously mentioned, SSDs must perform background operations that can periodically consume much of the internal SSD Controller's bandwidth, temporarily reducing host I/O operations and creating undesirable performance variations.

Kingston data centre SSD firmware is engineered with performance consistency and QoS as key design features.

The table below shows the IOPS performance consistency of the Kingston DC500R and DC500M under 4KB, 100% random read/write workloads. The DC500R and DC500M deliver up to 99% performance consistency for 4KB reads and up to 92% consistency for 4KB writes across the capacity range.

Kingston DC500R SSD

Specification	480G		960G		1920G		3840G	
	Read	Write	Read	Write	Read	Write	Read	Write
Random 4 KB read/write (up to)	99%	92%	98%	88%	98%	87%	98%	92%

Kingston DC500M SSD

Specification	480G		960G		1920G		3840G	
	Read	Write	Read	Write	Read	Write	Read	Write
Random 4 KB read/write (up to)	99%	92%	98%	91%	97%	90%	99%	89%

Designed to meet the needs of today's data centre market segment, DC500R and DC500M are ideally suited for cloud service providers that provide multi-tier performance solutions to their customer base including on-premises applications such as databases, online transaction processing and virtualisation.

Note: Actual performance may vary depending on user hardware and application.

Test system details:
Z370 chipset
Intel i5-8400
16GB DDR4 RAM
Linux 4.15.0-43-generic
Test program: fio-3.12-107g2d644

Conclusion

Kingston data centre SSDs deliver superior quality of service with consistently low-latency operation and superior IOPS. Solutions providers for virtualisation, cloud computing, databases and the financial services market can now take advantage of the consistent performance offered by Kingston data centre SSDs. Kingston data centre SSDs enable Hyperscale data centres with scale-out architectures and complex workloads to deploy reliable, low-cost, high-density Flash-based storage. The DC500R and DC500M are superior SSD solutions for today's diverse storage deployment models that enable data centres to realise the full potential of their storage investment.

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