WHITE PAPER

Oracle RAC Database 12c Performance Testing on Kaminario K2 All-Flash Array

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Executive Summary

Enterprises' constant growth and activity drive data usage. The on-demand approach of modern business, where customers demand agility and simplicity, are pushing the envelope of capacity and performance more than ever before. Businesses will rise and fall on their ability to deliver market needs in the fastest way possible. Relational databases, such as Oracle RAC Database 12c, are used to power a variety of applications and environments that support these business-critical applications. For those enterprises and business to be able to accommodate shrinking IT budgets and still gain a competitive advantage, the Kaminario K2 all-flash array is the perfect solution.

Using shared storage places demands on the supporting storage infrastructure. Database software, such as Oracle database, and supporting server operating systems, generate a random blend of I/O requests and create heavy loads that can swamp storage systems. The Kaminario K2 All-Flash Storage Array provides the consistent level of throughput, IOPS and low latencies needed to support this demanding blend of storage I/O. The K2 array combines industry standard enterprise hardware components with the advanced capabilities of the SPEAR™ storage OS to deliver no-compromises real-world CAPEX and OPEX saving of 50% or more over hybrid and legacy hard drive storage.

This technical report covers K2's benefits for Oracle RAC Database 12c running as virtualized servers. Detailed performance test results are provided for a range of Oracle database operations, showing that K2 performs well under all workloads with no degradation in performance or efficiency. Mixed workloads are also tested, proving that there should be no compromises on using shared storage for all use cases.

Introduction to Kaminario K2

Kaminario is leading the revolution in enterprise flash storage by creating the industry's most scalable, intelligent and cost-effective All-Flash Storage Array solution on the market. Built from the ground up to take advantage of the most modern flash SSD capabilities, the K2 all-flash storage array is the only product to feature a true scale-out and scale-up architecture that allows organizations to grow capacity and performance based on their needs. This architecture ensures both data availability and a consistent level of high throughput, IOPS and low latencies needed to support the demanding random I/O generated by business-critical systems like virtualized Oracle database servers.

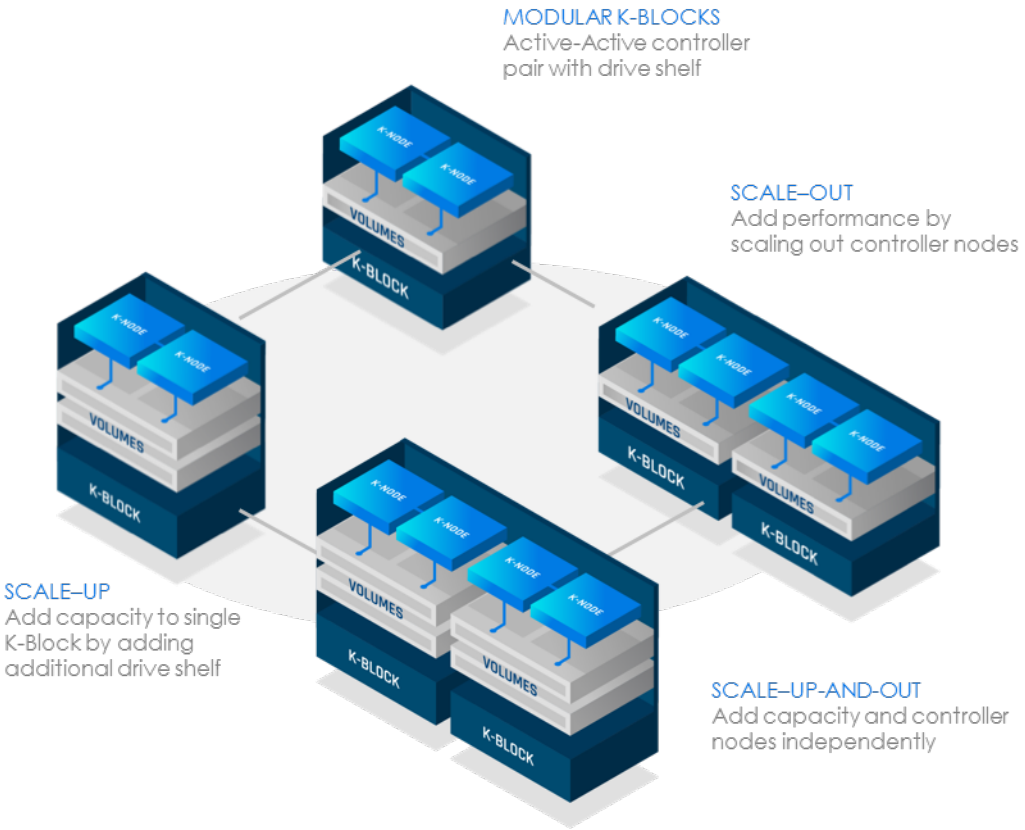


Figure 1: K2 Architecture Diagram

More information on the features and cost effectiveness of the Kaminario's K2 all-flash array can be found on the Kaminario website or the K2 Technical Architecture White Paper.

Performance Tests

To quantify the ability of Kaminario's K2 array to support Oracle database, a set of performance tests were run. Details of the hardware and software configurations used can be found in the appendix at the end of this document. Test results were captured by saving timed screenshot images of the K2 GUI using the Monitor section of the Performance tab to show IOPS, latency and throughput over the test period.

OLTP Workload Performance

Challenge – Online Transaction Processing (OLTP) is the bread and butter of most businesses. OLTP workloads typically involve a large number of small random reads and a smaller number of random writes from numerous users across a broad portion of the database's tables. Traditional legacy HDD-based storage or Hybrid storage (a mix of HDD and flash storage) have difficulties dealing with these random accesses due to the mechanical attributes of the storage media.

The workload used in this test consists of multiple users who read specific data through a primary key on a table of 100 million rows and in addition another set of users update a different table in the database. The workload itself was triggered from a server that that is connected to the 12c Oracle RAC through the Oracle SCAN (Single Client Access Name).

Result - During the test the K2 kept a consistent low latency of ~0.35ms, with IOPS between 40,000 - 44,000. The throughput was between 370MB/s – 430MB/s. The write workload was 10%-25% of the overall throughput as the UPDATE operations were working on a larger dataset and in bigger IOs. Figure 2 below shows these results in the K2 GUI during the OLTP workload test.

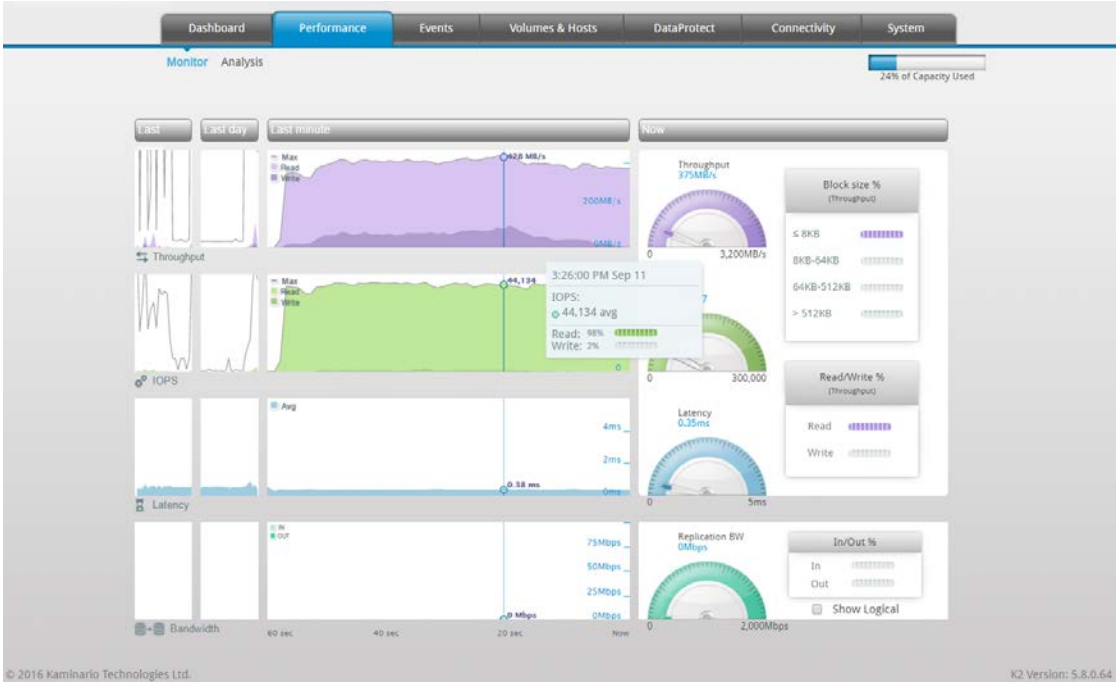


Figure 2: K2 GUI during OLTP Workload Testing

OLAP Workload Performance

Challenge – Online Analytic Processing (OLAP) queries run across the growing databases being generated by most organizations are plagued by long query and reporting times. Prior to OLAP analysis, ETL (Extract, Transform, and Load) processing is often required to load and consolidate data from multiple sources into a single database or data warehouse. OLAP queries and reports accessing the consolidated data can run for an hour or longer and are often limited by the performance of the storage system holding the database. While OLAP mainly involves large reads across multiple database tables, in anything other than the very simplest of queries it also requires extensive write activity to create temporary tables for joins and to save the calculated results to secondary result tables.

To demonstrate how K2's low latency and high throughput can address this potential problem, the following test simulated a data-warehouse running a two-step ETL process, specifically the initial load and a subsequent validation step. The source table consists 100 million rows with a size of 14.3GB. The initial step of the ETL process is processed from the source table to the destination table.

Result - During the first phase of the test (of the ETL process) the database processed 100 million rows and finished in 40 seconds. The workload consisted of 55% reads and 45% writes. The throughput in the test reached ~780 MB/s while the average IOPS was 6500. The latency was under 1ms. The test as seen in the K2 GUI is shown in Figure 3 bellow.

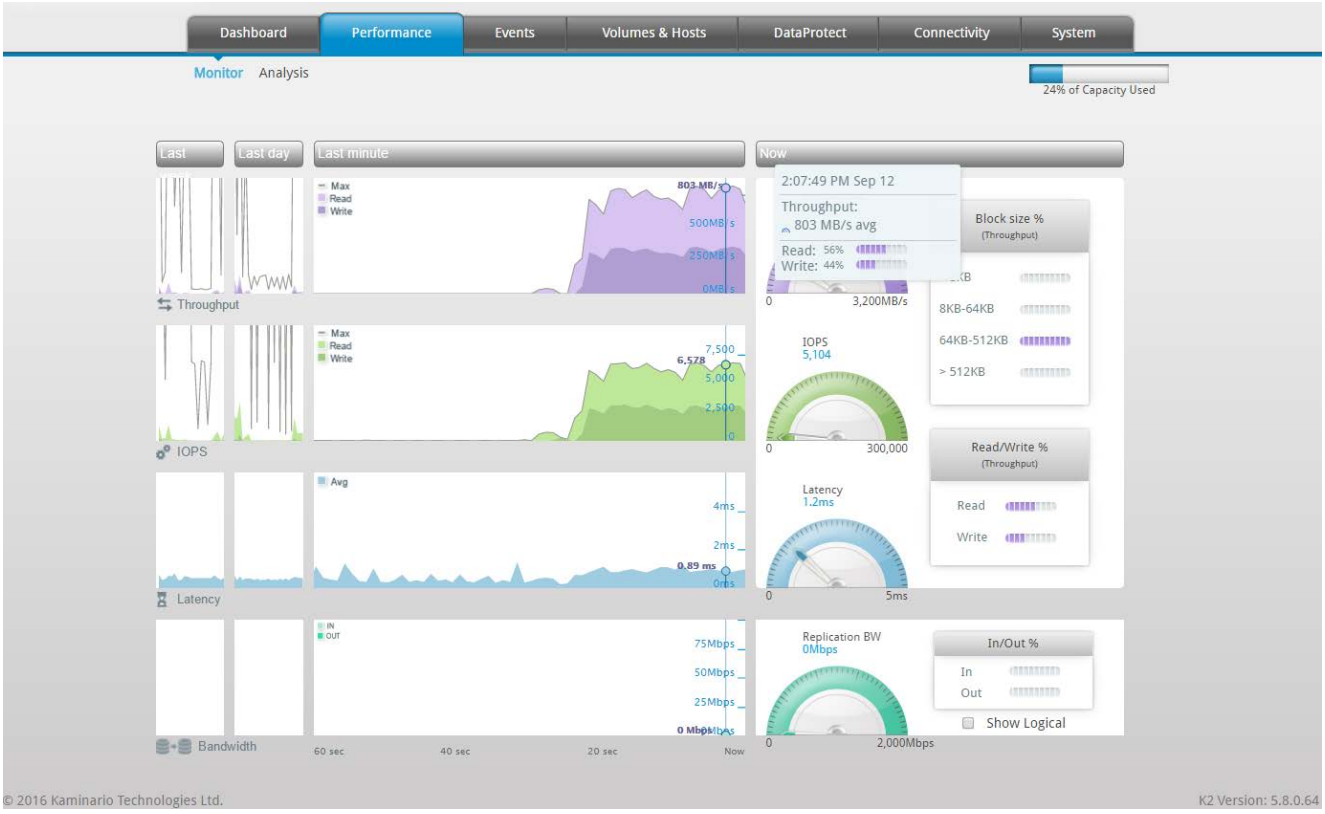


Figure 3: K2 GUI during OLAP Load Testing

The subsequent second phase ran a SELECT COUNT query on the destination table in order to validate that all data is in place. The SELECT COUNT query generates read only I/O that runs in parallel and produced 2.7 GB/s of throughput and ~12,000 IOPS. The latency was under 1ms. The results are shown in Figure 4 below.

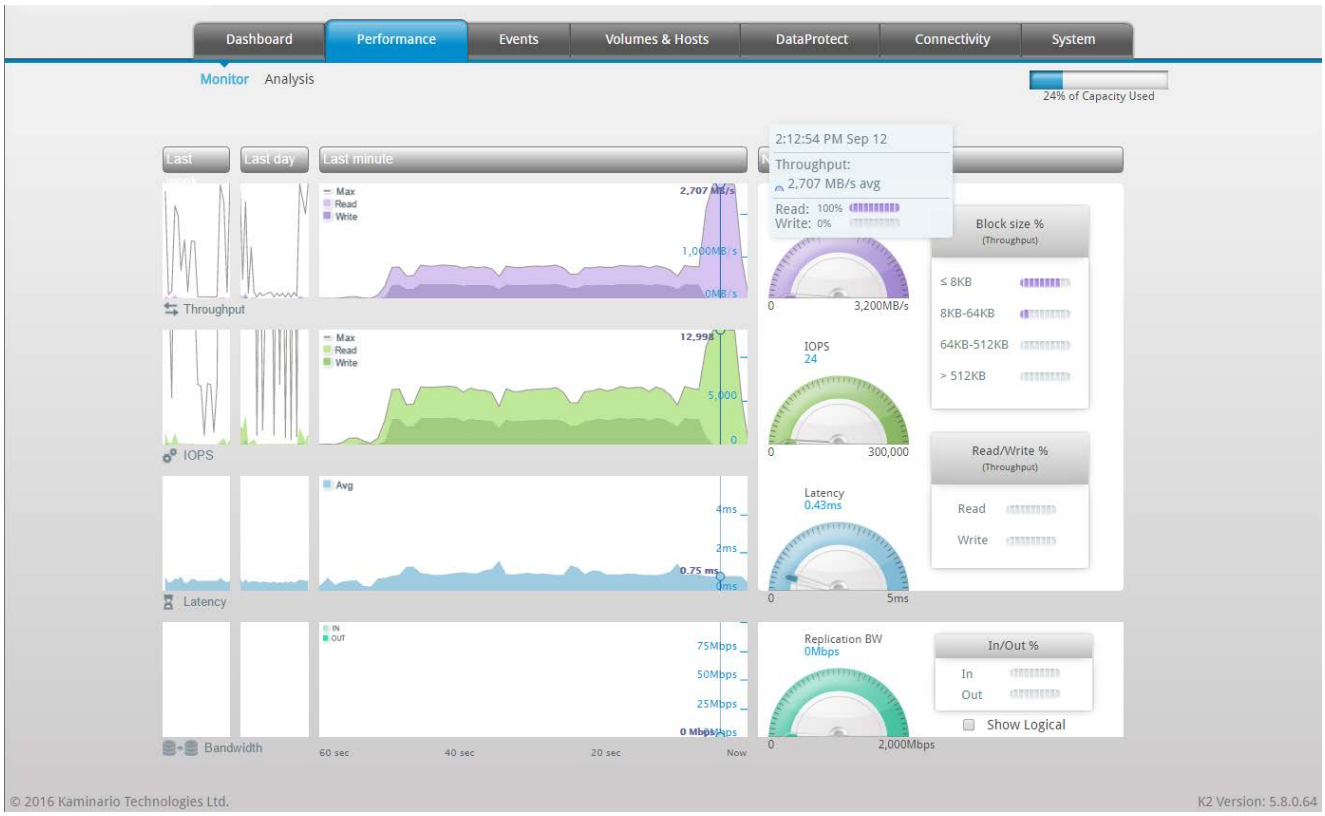


Figure 4: K2 GUI during OLAP Validation Testing

Mixed Workloads

Challenge – Consolidation of database onto shared storage can exacerbate delays due to contention between periodic OLAP queries and production database OLTP transaction activity. To demonstrate K2's adaptive block size capabilities to handle these sorts of complex concurrent workloads and their resulting random blends of I/O, two Oracle instances were run with two different types of concurrent database tests. The first Oracle instance ran the OLTP workload test described previously while at the same time the other Oracle instance ran the OLAP load test script.

The workloads were triggered from a server that connects to the 12c Oracle RAC through the Oracle SCAN. That allows the workload to be spread across the RAC nodes and not overburden a single node.

Result - As seen in Figure 5 below, the K2 handled the workload perfectly and both workloads served as if they were the only workload on the system. The bandwidth reached almost 1 GB/s where the ratio of read and write IOs was around 66% read and 34% write. The IOPS were between 39,000 to 44,000. The latency stayed very low, less than 0.5ms.

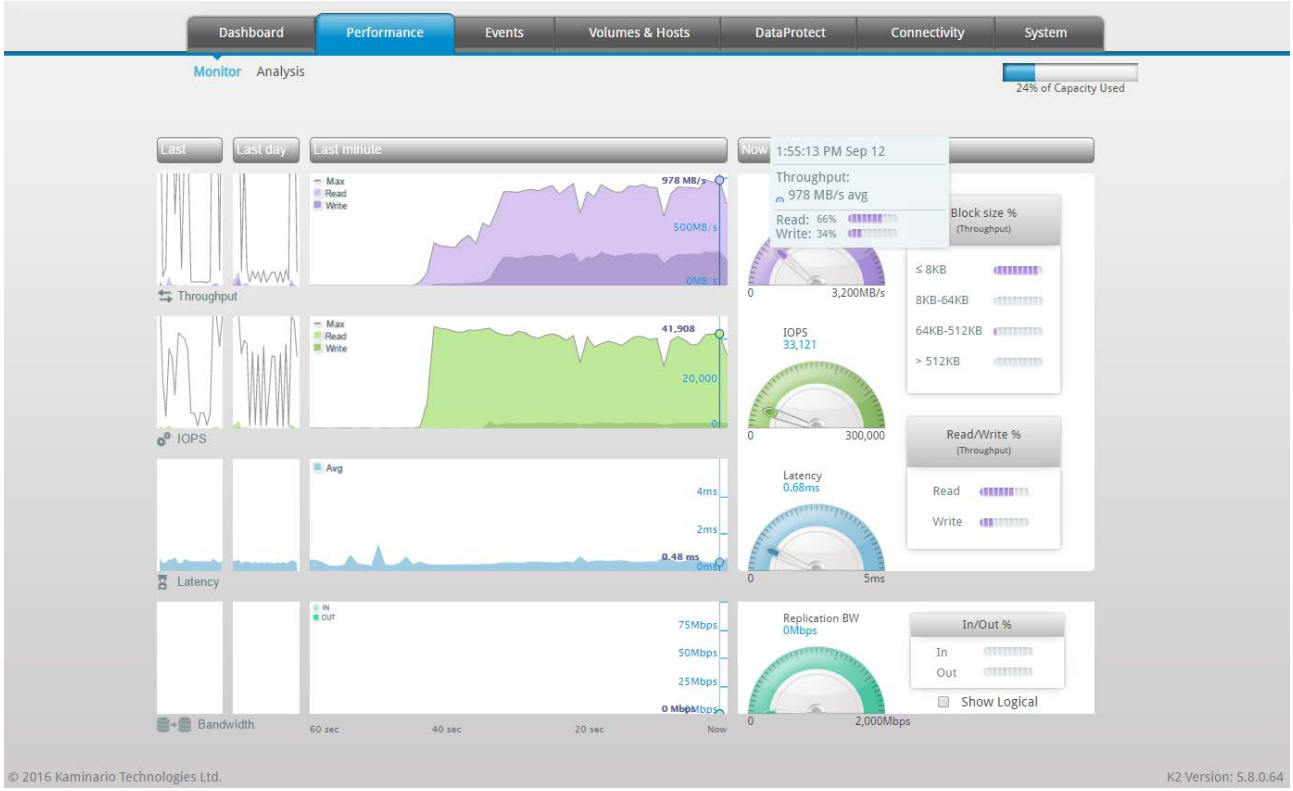


Figure 5: Mixed Workloads Test Results

The test continued with the second phase of the OLAP test, the validation phase. In this phase the K2 handled the load perfectly with 2.7 GB/s of throughput, 13,000 IOPS and latency of 0.8ms, as seen in Figure 6.

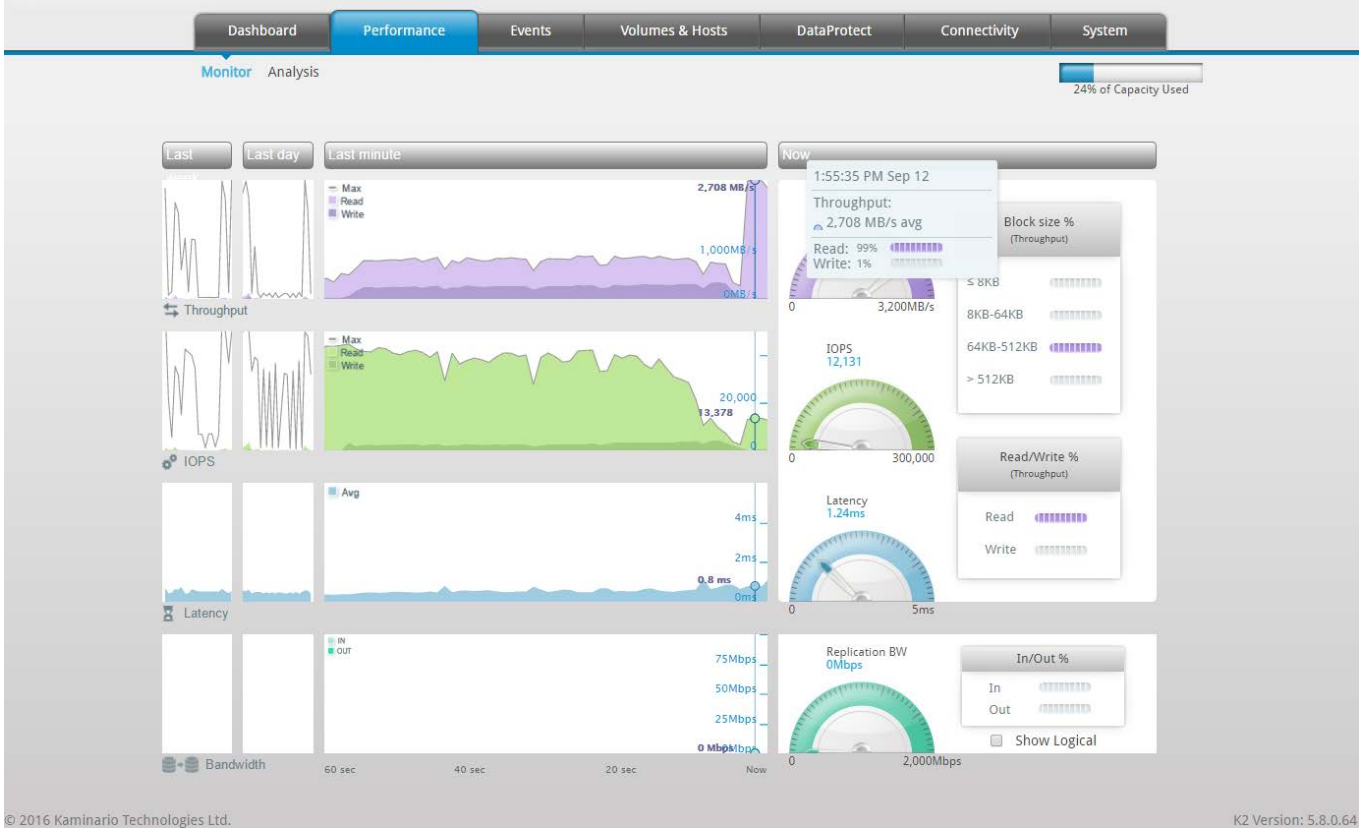


Figure 6: Mixed Workloads - OLAP validation part

K2 Native Compression vs. Oracle Compression

Challenge – K2's native global data compression can reduce the need for storage capacity used to store Oracle database files. By offloading compression processing from the host CPU to the storage array, K2's native compression delivers better capacity savings but with no performance penalties.

A set of four different measurements were made with the same Oracle database content: no Oracle or K2 compression, Oracle's OLTP compression, K2's native compression, or a combination of the two compression methods. The database's schema included the same tables used in the prior OLTP and OLAP tests.

Oracle OLTP compression requires an additional Advanced Compression Option license beyond the Oracle Enterprise Edition license used in other benchmarks in this white paper.

In data warehouses used for business intelligence analysis and reporting, tables are often compressed to save storage capacity. I/O traffic generated during this type of analysis and reporting often includes full table scans, either while generating figures for reports or to validate new rows created during ETL operations. To demonstrate the impact of different compression methods, a full table scan was timed across both compressed and non-compressed tables.

Results – this series of tests showed that K2's native compression delivered better capacity savings compared to the OLTP compression option provided by Oracle. Compared to K2's native compression, using just Oracle OLTP compression resulted in 8% less capacity savings but did improve performance of the full table scan test by 31%.

Combining K2's compression with Oracle OLTP compression saved only an additional 5% of capacity but also improved performance of the full table scan test by 41% as shown in Table 1 below and Figure 7 on the next page.

Compression Method		DB File Size	Compression Savings	Full Table Scan
K2 Compression	OLTP Compression			
		98 GB	None	80 seconds
	√	44 GB	55%	55 seconds
√		36 GB	63%	80 seconds
√	√	31 GB	68%	47 seconds

Table 1: Comparison of K2 and Oracle Compression Methods

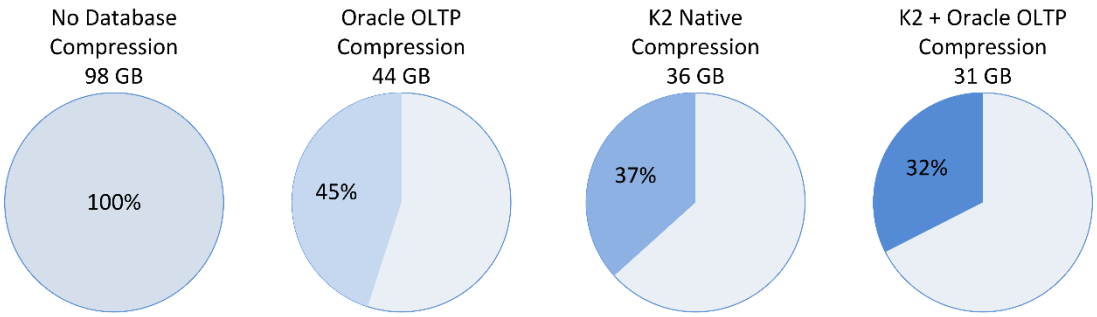


Figure 7: Comparison of K2 and Oracle Compression Methods

The performance improvements seen with Oracle OLTP compression were likely due to a reduction in the amount of data actually read from the K2 array during the full table scan. These improvements may not occur to this degree with other types of Oracle operations. For example, when tested with workloads consisting primarily of record insertions, performance with non-compressed tables can be up to three times faster than when using compressed tables.

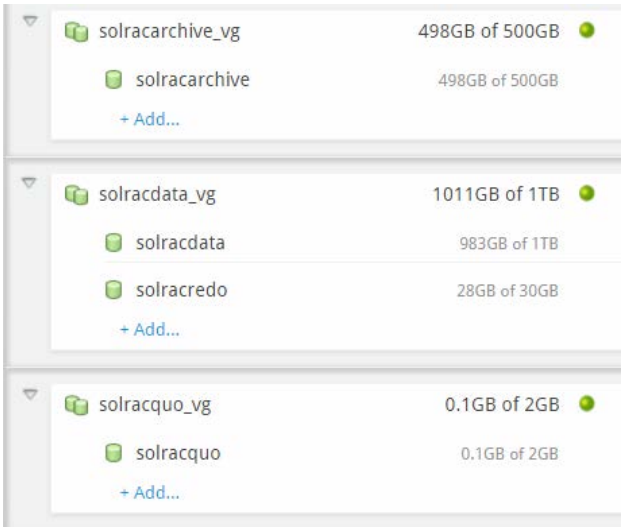
Appendix: Test Configuration Details

K2 Configuration

A K-Block is the building block of the K2 all-flash array; each K-Block consists of 2 active/active storage controllers and one or more SSD shelves. A K2 array can scale-out to multiple K-Blocks. This test environment consisted of a single K-Block K2 with a single SSD shelf. An out-of-box configuration was used for the K2 array and no tuning was performed for any of the specific tests.

A set of 3 different Volume Groups were defined to hold the 4 different RAC LUNs:

1. solracarchive_vg
    a. solracarchive – 500GB
2. solracdata_vg
    a. solracdata – 1TB
    b. solracredo – 30GB
3. solracquo_vg
    a. solracquo – 2GB



Oracle Virtual Servers

Attribute	Specification
OS	Red Hat Enterprise Linux Server release 7.2 (Maipo)
vCPU	8
vMemory	8,192 MB
Virtual SCSI Controller 0 (OS)	LSI Logical Parallel
Virtual disk (OS)– VMDK	100 GB
Virtual SCSI Controller 1	Paravirtual with physical bus sharing
Installed Applications	Oracle Database 12c (12.1.0.2) Oracle ASM for Grid Infrastructure and Database
Number of Virtual Servers	2

ESXi Server Configuration

1. Supermicro 12 X 2.499 GHz Intel® Xeon® E5-2640 CPUs for a total of 24 hyper-threaded cores
2. 256 GB of memory
3. Two dual port 8GB QLogic FC HBA used to connect to a single K-Block K2 array through two redundant 48 ports Brocade FC Switch
4. Total of two (2) ESXi servers

Connectivity

A 1GbE external networks was used for communication between the Oracle virtual machines and the K2 while a separate Fibre Channel (FC) fabric was used to connect the K2 arrays to the ESXi host servers.

A 10GbE was used for internal connectivity between the 2 Oracle RAC virtual machines.

Figure 8 shows the entire testing environment topology:

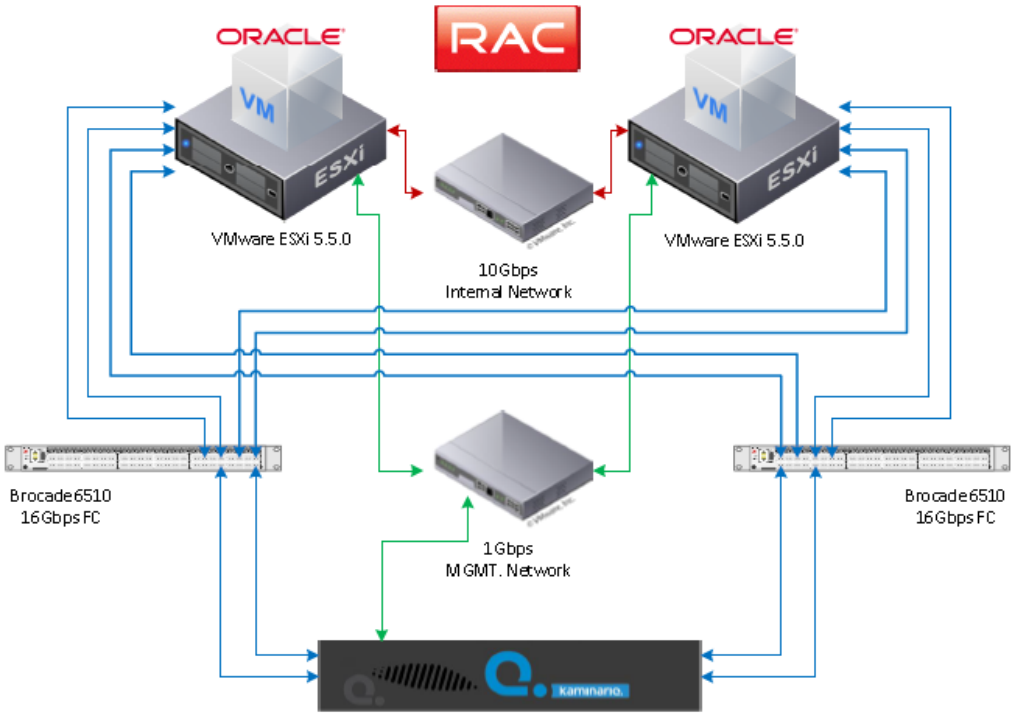


Figure 8: Testing Environment Topology

Contact

Contact a business development representative to answer any questions you may have.

Schedule a Demo

Schedule a demo with an engineer and learn if Kaminario's solution works for you.

Request a Quote

Request a quote for your application from our business development team.

About Kaminario

Kaminario, the leading all-flash storage company, is redefining the future of modern data centers. Its unique solution enables organizations to succeed in today's on-demand world and prepares them to seamlessly handle tomorrow's innovations. Only Kaminario K2 delivers the agility, scalability, performance and economics a data center requires to deal with today's cloud-first, dynamic world and provide real-time data access -- anywhere, anytime. Hundreds of customers rely on the Kaminario K2 all-flash array to power their mission critical applications and safeguard their digital ecosystem. Headquartered in Needham, MA, Kaminario works with an extensive network of resellers and distributors, globally.

For more information, visit www.kaminario.com