



ZFS STORAGE  
APPLIANCE

# Realizing the Superior Value of Oracle ZFS Storage Appliance

Cloud Architected with Leadership Storage Efficiency and  
Performance

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## Introduction

Oracle ZFS Storage Appliance is a high performance, general purpose, and multi-protocol storage system that is architected with high performance and flexibility to handle the dynamic and highly randomized IO loads generated by today's cloud environments. It is also co-engineered with Oracle Database to offer superior performance, efficiency, and unequalled value for Oracle Database. Due to its unique cloud-proven architecture, industry-leading storage analytics, and cloud-ready management interface, Oracle ZFS Storage Appliance delivers high performance for applications and storage consolidation, deployment flexibility to simplify your IT environment, and lower management overhead to reduce TCO. Whether you are hosting development and test environments, supporting high-throughput data warehouses, streaming large media files, protecting data or supporting thousands of users in a cloud, the Oracle ZFS Storage Appliance provides the performance and value need to take your business to the next level.

Independent testing shows that common administrative tasks take significantly less time on Oracle ZFS Storage Appliance than on major competitive products, thereby making your IT staff more productive and reducing operating expenses. These benefits are further enhanced in Oracle environments, where co-engineering with Oracle Database enables automated storage tuning and analytics with detailed visibility down to the per-database level, and where Oracle unique data compression typically delivers a 12x reduction in historical data set sizes with a corresponding 40 percent reduction in overall Oracle Database storage capacity requirements. By deploying Oracle ZFS Storage Appliance in your data center, you can:

- » **Achieve beyond-flash transactional performance for OLTP and server virtualization storage workloads.** The Hybrid Storage Pool architecture of Oracle ZFS Storage Appliance provides in-memory performance by delivering 70 percent to 90 percent of I/O operations from DRAM cache.
- » **Accelerate data warehouse loading, data protection, media streaming and other sequential workloads.** Achieve sequential throughput performance comparable to million-dollar arrays at a fraction of the cost.
- » **Reduce operating expenses associated with filer sprawl and storage administration.** The advanced DTrace storage analytics and efficient management tools reduce wasted administration time and increase operational efficiency.
- » **Enhance efficiency and reduce costs in Oracle Database environments.** Oracle co-engineering results in features such as Oracle Intelligent Storage Protocol, Hybrid Columnar Compression, and specific snapshot and Oracle Enterprise Manager integration features that increase productivity for Oracle Database DBAs and storage administrators.

## Sequential Performance and Cost Efficiency

Oracle ZFS Storage Appliance has numerous features that enhance performance for high-throughput sequential workloads like data warehouse loading, media streaming, and data protection. Features are built in that allow for highly effective tuning, including adjustable record sizes and `logbias` settings. Oracle ZFS Storage Appliance supports a wide range of small-to-large record-size settings, making it ideal for sequential workloads where large block sizes often enhance performance significantly.

Setting `logbias` to “throughput” mode causes writes to bypass write accelerator Solid State Drive (SSD) devices for less latency-sensitive workloads, allowing streaming directly to spinning disk for superior sequential write throughput performance. This unique level of adaptability allows administrators to tune for superior performance under sequential workloads compared with competitor products at a similar price point. In fact, at the time of publication, on SPC-2 benchmark top-10 results—which specifically tests sequential workloads including large file workloads, large database queries and video on demand—the three lowest priced configurations were Oracle ZFS Storage Appliance models, showing an excellent price-performance ratio. In fact, ZFS Storage ZS4-4, the predecessor to the current ZS5 Series, posted a 31.4GB/sec result at a SPC-2 Total Price of US\$538,049.73. (Note: SPC’s “Total Price” metric includes three years of support cost).

As shown in Table 1, Oracle ZFS Storage ZS4-4 and ZS3-2 systems are able to achieve Top-10 SPC-2 MBPS throughput performance at lower price points and with superior price/performance than other Top-10 systems. With a reduced level of capital expenditure, customers can load data warehouses faster or stream more sequential media, allowing service-level agreements (SLAs) and performance objectives to be met on a constrained budget. In fact, Oracle ZFS Storage Appliances are the only systems in the top-10 of SPC-2 performance that customers can purchase for less than \$500,000.

**TABLE 1. TOP TEN SPC-2 RESULTS SORTED BY 3-YEAR PRODUCT AND SUPPORT PRICE**

System	SPC-2 MBPS	\$/SPC-2 MBPS	TSC Price	Results ID
Oracle ZFS Storage ZS3-2	16,212.66	\$12.08	\$195,915	<u><a href="#">BE00002</a></u>
Oracle ZFS Storage ZS3-4	17,244.22	\$22.53	\$388,472	<u><a href="#">B00067</a></u>
Oracle ZFS Storage ZS4-4	31,486.22	\$17.09	\$538,050	<u><a href="#">B00072</a></u>
Huawei OceanStor™ 6800 V3	42,801.98	\$16.89	\$722,776	B00076
Kaminario K2 (K2F00000700)	33,477.03	\$29.79	\$997,348	B00068
HP XP7 Storage	43,012.53	\$28.30	\$1,217,462	B00070
HPE 3PAR StoreServ 20850	62,844.45	\$19.93	\$1,252,724	B00075
Fujitsu ETERNUS DX8870 S2	16,038.74	\$79.51	\$1,275,163	<u><a href="#">B00063</a></u>
Fujitsu ETERNUS DX8900 S3	70,120.92	\$24.37	\$1,708,835	B00079
EMC VMAX 400K	55,643.78	\$33.58	\$1,868,568	B00073

All prices in US dollars.

SPC-2 MBPS = the performance metric

\$/SPC-2 MBPS = the price-performance metric

TSC Price = Total Cost of Ownership metric

Results Identifier = A unique identification of the result metric

Complete SPC-2 benchmark results may be found at [http://www.storageperformance.org/results/benchmark\\_results\\_spc2](http://www.storageperformance.org/results/benchmark_results_spc2).

SPC-2, SPC-2/E, SPC-2 MBPS, SPC-2 Price-Performance, and SPC-2 TSC are trademarks of Storage Performance Council (SPC).

Results as of March 17, 2015; for more information see <http://www.storageperformance.org>.

A summary of these results is available on the Top Ten SPC-2 Results website:  
[http://www.storageperformance.org/results/benchmark\\_results\\_spc2\\_top-ten](http://www.storageperformance.org/results/benchmark_results_spc2_top-ten)

## Transactional Workload Performance and Cost Efficiency

Oracle ZFS Storage Appliance has a number of architectural characteristics that enhance transactional workload performance, including database OLTP storage workloads and server highly randomized IO workloads that arise in cloud environments. The use of large amounts of DRAM as a primary cache to accelerate reads is one of the key unique aspects of the DRAM-centric architecture underlying the Oracle ZFS Storage Appliance. As shown in Figure 1, the benefits of serving IO out of DRAM become apparent because DRAM is an order of magnitude faster than flash, and flash is an order of magnitude or more faster than disk.



Figure 1. Relative depiction of storage media response times (not to scale).

The Oracle ZFS Storage Appliance Hybrid Storage Pool architecture, shown in Figure 2, employs a combination of DRAM, flash, and disk to accelerate both read and write performance while retaining disk economics and protecting data integrity and persistency. Field telemetry data shows that, on average, 70 percent to 90 percent of reads are DRAM cache hits, meaning that a majority of reads are delivered directly from DRAM – the fastest media type.

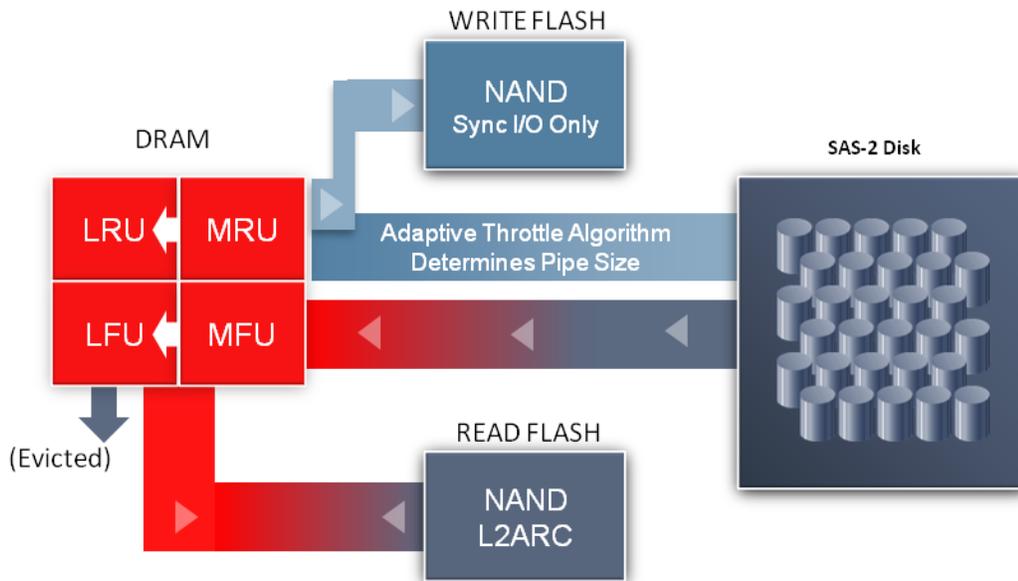


Figure 2. Depiction of the Hybrid Storage Pool architecture of Oracle ZFS Storage Appliance

Further detail on this topic can be found on the white paper [“Architectural Overview of the Oracle ZFS Storage Appliance.”](#) Overall, Oracle ZFS Storage Appliance provides high availability, data integrity and persistency, and the transactional performance required for OLTP and server virtualization storage workloads at a compelling price point.

## Operational Efficiency

Oracle ZFS Storage Appliance is designed to be cloud managed to simplify management and reduce operational expenses. It features a full set of enterprise capabilities that are available through OpenStack, RESTful APIs, Oracle Enterprise Manager, and native command-line (CLI) and browser user interfaces (BUI) to make your management staffs more agile and productive. These tools provide an easy and short learning path for administrators adopting the product and also enable administrators to perform tasks more quickly on an ongoing basis, reducing operating expenses over time. The management tools include the industry’s best storage analytics, based on DTrace, which run directly on the storage controllers and provide comprehensive end-to-end visibility of key statistics throughout the storage stack and the storage networking stack.

With the efficient BUI, shown in Figure 3, administrators can quickly zero in on performance issues and drill down by various details. For example, an administrator could use these tools to break down network traffic by client to quickly identify and then move to identify rogue servers or address the “noisy neighbor” situation that sometimes arises in large-scale cloud environments. These analytics tools remove guesswork, eliminating wasted time and enabling administrators to focus on value-added strategic initiatives rather than continually dealing with ongoing fire drills.

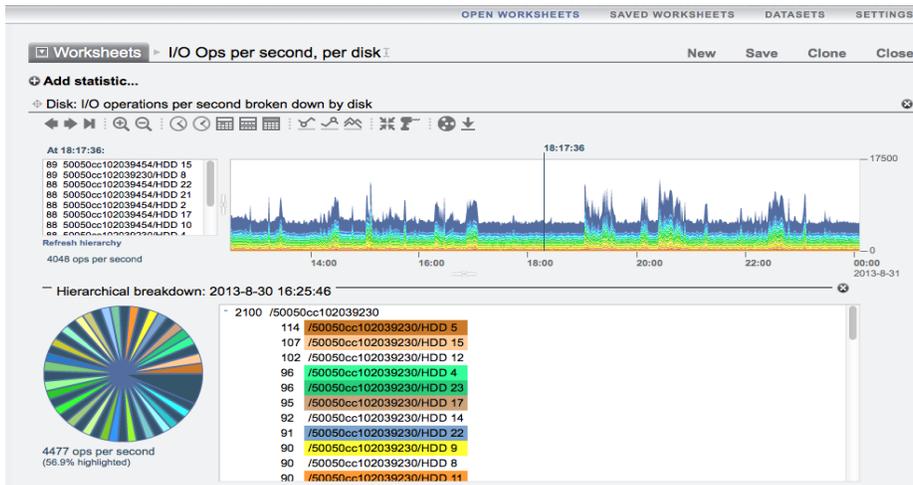


Figure 3. Example of BI tool being used to break down overall disk I/O operations on a per-disk basis

In fact, Strategic Focus Group ran a [usability comparison](#) study of Oracle ZFS Storage Appliance versus the NetApp FAS series and found a 30 percent to 70 percent time efficiency advantage for Oracle ZFS Storage Appliance on a variety of administrative tasks. (See Table 2 for details.) These time savings can result in increased IT personnel productivity and reduced operating expenses over time. To experience these advanced management tools for yourself and to see the superior efficiency, [download the simulator](#).

Table 2. SUMMARY OF RESULTS FROM STRATEGIC FOCUS GROUP'S USABILITY COMPARISON WHITE PAPER

Task Areas	Time Savings Oracle Advantage Over NetApp (%)	Steps Savings Oracle Advantage Over NetApp (%)
1. Total Storage Provisioning	33% less time	19% fewer steps
2. Total Data Protection	34% less time	37% fewer steps
3. Total Storage Management	43% less time	41% fewer steps
4. Total General Management	45% less time	29% fewer steps
5. Total Analytics	73% less time	36% fewer steps

## Oracle Co-engineering

Oracle coengineers hardware and software products to work together. Oracle ZFS Storage Appliance features numerous points of unique integration with Oracle Database and Oracle engineered systems that were developed in this fashion. For example, an Oracle Enterprise Manager plugin allows DBAs to not only monitor storage, but actually provision storage on Oracle ZFS Storage Appliances directly from Oracle Enterprise Manager, as shown in Figure 4. Provisioning can be centrally administered by storage administrators to enable DBAs to modify and provision by “project” within a centrally managed set of constraints, if desired.

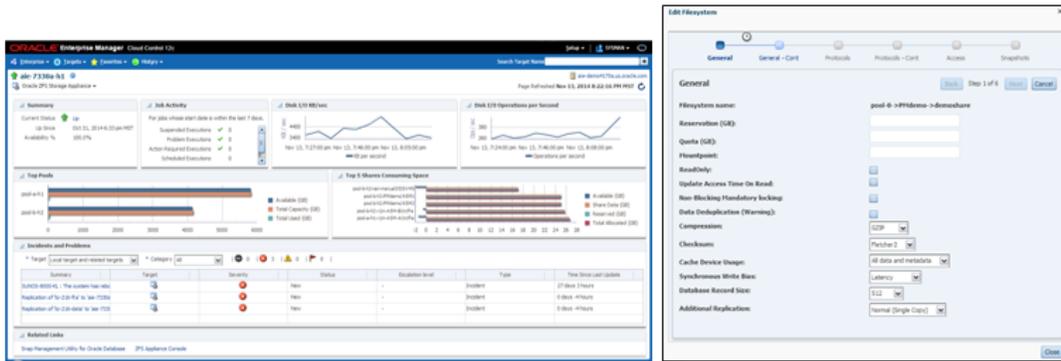


Figure 4. Monitoring and provisioning storage on Oracle ZFS Storage Appliance with the Oracle Enterprise Manager plugin

Also offered are snapshot integration tools, such as Oracle Snap Management Utility for Oracle Database, which allows development and test environments to be provisioned from thin clones on Oracle ZFS Storage Appliance. The Oracle Enterprise Manager 12c database as a service (DBaaS) package includes a “Snap Clone” feature, which is supported on Oracle ZFS Storage Appliance for creating thin clones of Oracle Recovery Manager (Oracle RMAN) images or Data Guard standby databases for provisioning development and test environments or for provisioning data marts in conjunction with other rich DBaaS features available for Oracle Enterprise Manager 12c.

Furthermore, one of the most compelling co-engineering advancements is Oracle Intelligent Storage Protocol (OISP) (shown in Figure 5), which is offered for Oracle ZFS Storage Appliance when used with Oracle Database 12c and is not available with competitive storage systems.

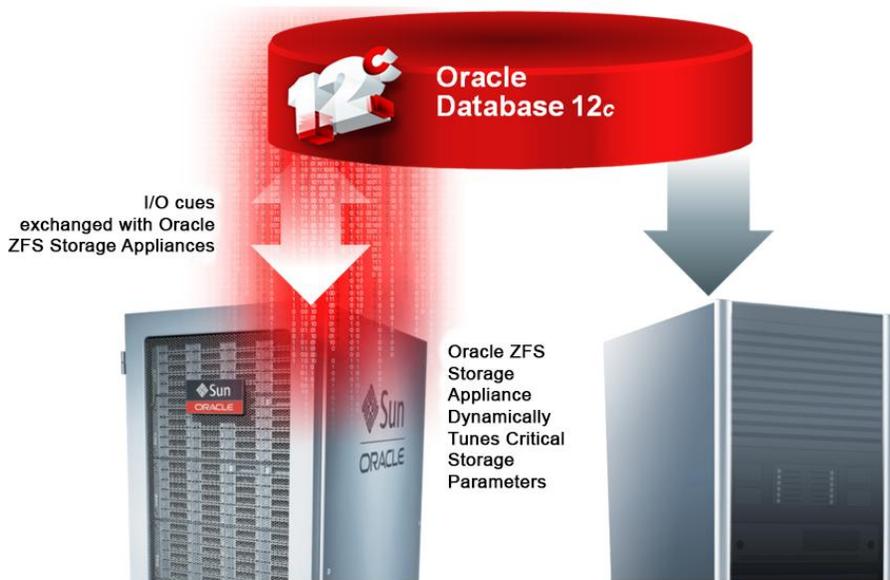


Figure 5. Oracle Intelligent Storage Protocol

OISP is an Oracle unique protocol that enables Oracle Database communicate directly with the Oracle ZFS Storage Appliance to greatly enhance management efficiency and reduce operating costs. By building code into both Oracle Database and Oracle ZFS Storage Appliance that enables a direct line of communication between the two so that information, or “cues,” about the exact database IO request can be conveyed. These real-time cues enable dynamic storage auto-tuning to simplify and expedite management to reflect the changing nature of workloads. For Oracle Database 12c pluggable database, OISP also enables unique advanced per-database analytics with per-pluggable database visibility for troubleshooting and optimization. When compared to non-Oracle storage which only provide visibility at the Oracle Database 12c container database level, the combination of OISP with Oracle ZFS Storage Appliance reduces the number of steps needed to setup and tune an Oracle Database by up to 65%, reducing storage TCO. See the Oracle Intelligent Storage Protocol [data sheet](#) for more information.

Hybrid Columnar Compression, depicted in Figure 6, is also uniquely available on Oracle storage products and can result in 10x to 50x compression for archival database partitions—dramatically saving capacity while accelerating query performance. Hybrid Columnar Compression can be used along with the Automatic Data Optimization and Heat Map features of Oracle Database 12c to further eliminate manual intervention by automating both compression and information lifecycle management (ILM) activities.

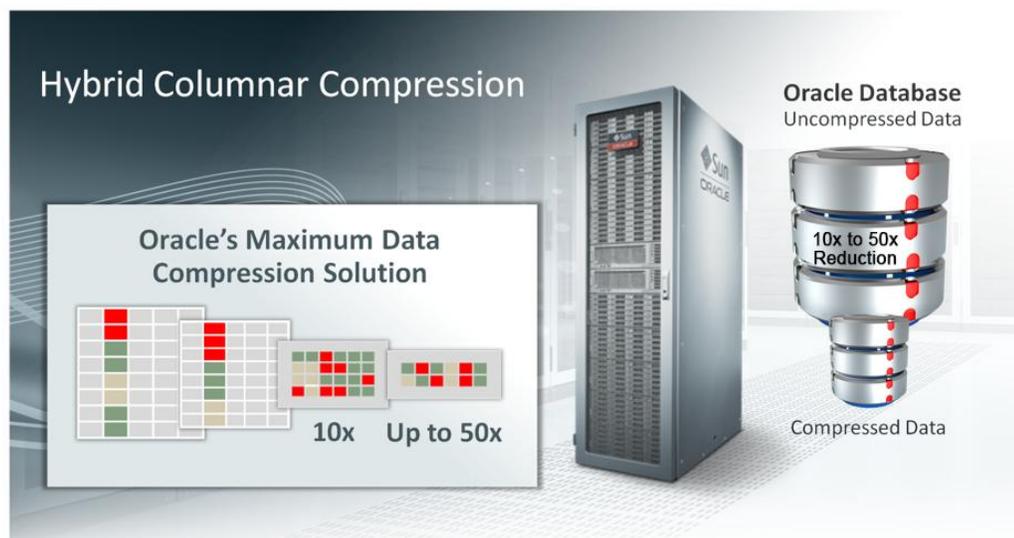


Figure 6. Oracle Hybrid Columnar Compression

These examples of co-engineering between Oracle Database and Oracle ZFS Storage Appliance demonstrate the benefits of using products that are designed together to work together. While Oracle ZFS Storage Appliance excels in performance, efficiency, and management efficiency in many use cases, for Oracle Database workloads, the benefits are compounded by this level of deep co-engineering. This is true whether you are using Oracle ZFS Storage Appliance as a primary storage device for Oracle Database or you are using it for backup, development/test, or as an expansion/tiered storage device in conjunction with Oracle engineered systems, such as Oracle Exadata, Oracle SuperCluster, or Oracle's Virtual Compute Appliance. Table 3 shows example savings.

TABLE 3. EXAMPLE OF SAVINGS FOR A MEDIUM-SIZED ORACLE DATABASE CUSTOMER DUE TO CO-ENGINEERING

Spending Category	Before Co-engineering	Feature	Benefit	Net After Benefits	Savings
Storage Hardware, Support, and Power	\$2,000,000	Hybrid Columnar Compression	» 80% less archive storage » 50% less total storage	\$1,000,000	\$1,000,000
Database Administrators	\$1,200,000	Automatic Data Optimization + Hybrid Columnar Compression	» Database storage administration reduced by 25%	\$900,000	\$300,000
Storage Administrators	\$600,000	Oracle Intelligent Storage Protocol + DTrace	» Database storage tuning reduced by 65% » Overall storage administration reduced by 25%	\$450,000	\$150,000
Lost Productivity Waiting for Oracle Database Test/Dev Clones	\$900,000	Oracle RMAN + Oracle ZFS Storage Snap and Clone	» Wait time reduced by 50%	\$450,000	\$450,000
<b>Total</b>	<b>\$4,700,000</b>			<b>\$2,800,000</b>	<b>\$1,900,000</b>

**40%**

All prices in shown US dollars.



## Conclusion

Whether deploying storage for a cloud, Oracle Database, or some combination of application workloads, Oracle ZFS Storage Appliance is a high-performance, highly efficient, and cost-effective storage option. It also offers superior management and storage analytics tools, providing an abridged learning curve for adoption along with ongoing manageability efficiencies to reduce operational costs over time. These benefits are further heightened in Oracle environments, where deep co-engineering with Oracle Database and Oracle engineered systems compound the economic savings. To learn how Oracle ZFS Storage Appliance can accelerate your storage workloads and reduce both capital and operating expenses for your company, contact Oracle today



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