

Oracle ZFS Storage Appliance



ZFS STORAGE
APPLIANCE



KEY FEATURES

- High-performance storage architecture optimized for enterprise applications and highly virtualized cloud workloads
- Extreme throughput for IO intensive backup and recovery workloads
- Multipetabyte scalability for all flash, HDD, and hybrid configurations
- Unique and unparalleled automated storage tuning, I/O prioritization, and compression for Oracle Database
- Dynamic caching between DRAM, flash cache, and both all flash and HDD storage
- High-performance NAS, SAN and object protocol support unified on a single platform
- Advanced, intuitive management and fine-grained analytics tools
- Data protection with highly secure AES granular encryption

Oracle ZFS Storage Appliance systems are high-performance unified storage systems that provide NAS, SAN, and object storage capabilities with the extreme performance and superior efficiency required by demanding enterprise applications and unpredictable cloud workloads. As Oracle engineered storage, Oracle ZFS Storage Appliance systems are deeply integrated with Oracle Database, Oracle engineered systems, and Oracle Public Cloud to maximize the return on your Oracle software investment in ways that competitive storage systems are unable to achieve. Oracle ZFS Storage Appliance systems provide material benefits when you need to accelerate mission-critical applications and increase business and IT productivity—enabling you to save valuable resources, reduce risk, and lower your total cost of ownership (TCO).

Extreme Enterprise Storage Performance

Oracle ZFS Storage Appliance systems are based on an advanced hardware and software architecture, including a highly intelligent, multithreading SMP storage OS that makes the most of modern enterprise hardware, enabling you to run multiple workloads and advanced data services without performance degradation. This powerful OS is complemented by the unique Oracle Hybrid Storage Pool feature, which automatically caches data on dynamic random access memory (DRAM) or flash cache to provide optimal performance and exceptional efficiency while ensuring that data remains safely stored on reliable and high capacity solid-state disk (SSD) or hard disk drive (HDD) storage. With this architecture, heavily accessed data is served mostly from cache—up to 90 percent—for extremely high performance without spindle speed limitations, while cost effectively securing and storing data on HDDs.

High-availability (HA) features such as active-active controller clustering for failover, a self-healing file system architecture that ensures end-to-end data integrity, and a rich set of enterprise-class data services make Oracle ZFS Storage Appliance systems an ideal choice for enterprise storage.

KEY BENEFITS

- Accelerate Oracle Database and applications with extreme performance
 - Maximize return on Oracle software investments
 - Accelerate development and testing with instant, no-overhead snapshots and cloning and support for highly virtualized environments
 - Reduce IT complexity, management, and costs by consolidating NAS, SAN, and object storage in a single system
 - Increase IT agility with simultaneous support for production, dev/test, and data protection workloads
 - Reduce the risks and costs of security breaches
- Operate with high availability
- Reduce TCO with superior price per performance and price per terabyte ratios



Figure 1. DRAM-centric architecture

Superior Efficiency

Oracle ZFS Storage Appliance systems feature an advanced set of management and analytics tools that enable storage administrators to provision, manage, and troubleshoot storage in less time than is possible with competitors' systems¹. Rapid deployment of powerful advanced data services (such as snapshots, clones, thin provisioning), four different compression algorithms, and replication are managed via the intuitive browser user interface (BUI) or the command-line interface (CLI).

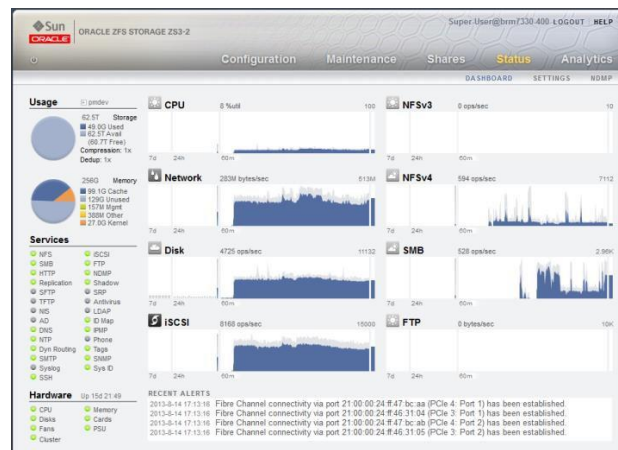


Figure 2. Status view of management software

The DTrace Analytics feature of Oracle ZFS Storage Appliance systems provides real-time analysis and monitoring functionality, enabling unparalleled fine-grained visibility into disk, flash, controller CPU, networking, cache, virtual machine (VM), and other statistics. It does this in a way that uniquely ties client network interface activity back to the disks with everything in between.

¹ Strategic Focus study

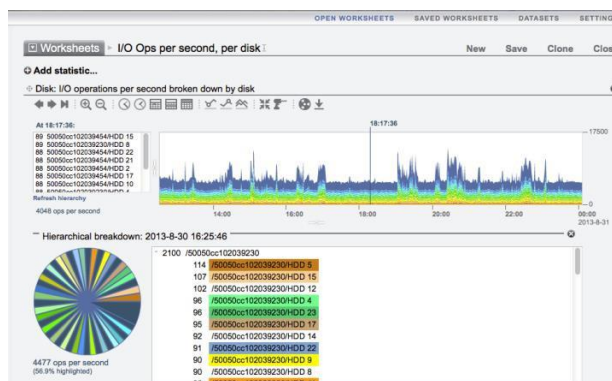


Figure 3. DTrace Analytics example showing I/O operations per second, per disk

This granular visibility—at the I/O or VM level—supports rapid identification and resolution of bottlenecks for superior system performance tuning and troubleshooting, particularly in large-scale virtual server environments. As proven by internal use in Oracle’s IT environment and by independent testing, the management efficiency of Oracle ZFS Storage Appliance systems has a positive and tangible resource impact and improves headcount per gigabyte under management by speeding administrative tasks, resulting in significant operational cost savings.

Oracle Database Integration

Oracle ZFS Storage Appliance systems are deeply integrated with Oracle Database to reduce risk dramatically, increase efficiencies, and lower TCO. Through engineering, developing, testing, and supporting hardware and software together, Oracle engineered storage systems deliver unique advantages to ensure Oracle software runs fastest and most efficiently on Oracle storage systems. Coengineered with Oracle software and with countless documented solutions and best practices, Oracle ZFS Storage Appliance systems remove the guesswork from configuring a total system for success through the following features:

- **Oracle Intelligent Storage Protocol**

Oracle Intelligent Storage Protocol is a unique storage protocol exclusive to Oracle Database 12c and Oracle ZFS Storage Appliance systems. It enables a storage system to receive cues from Oracle Database, providing storage visibility of the database on an unprecedented level. Oracle Database sends cues to the Oracle ZFS Storage Appliance system about each operation, allowing the system to intelligently process I/O and automatically and dynamically tune itself for optimal performance, reducing risk and speeding provisioning by reducing tedious manual operations by 90 percent.

In addition, these capabilities allow Oracle Database to send priority hints to Oracle ZFS Storage Appliance systems with each I/O request so the most critical database operations are given higher priority, thereby enabling databases to run faster with no manual tuning required. They also prevent data blocks associated with high-bandwidth operations, such as Oracle Recovery Manager (Oracle RMAN) backups, from taking up critical space in DRAM cache, freeing it up so latency-sensitive database operations can achieve maximum acceleration. And, with Automatic Workload Repository (AWR)—aware extended analytics capabilities, IT administrators can see Oracle Intelligent Storage Protocol operations by database name, database function, and database file types, and they can do deep drill-downs on the I/O

operations even at the pluggable database level. This provides valuable insights into the nature of database operations leading to faster and more effective troubleshooting efforts especially in complex multitenant Oracle Database 12c environments.

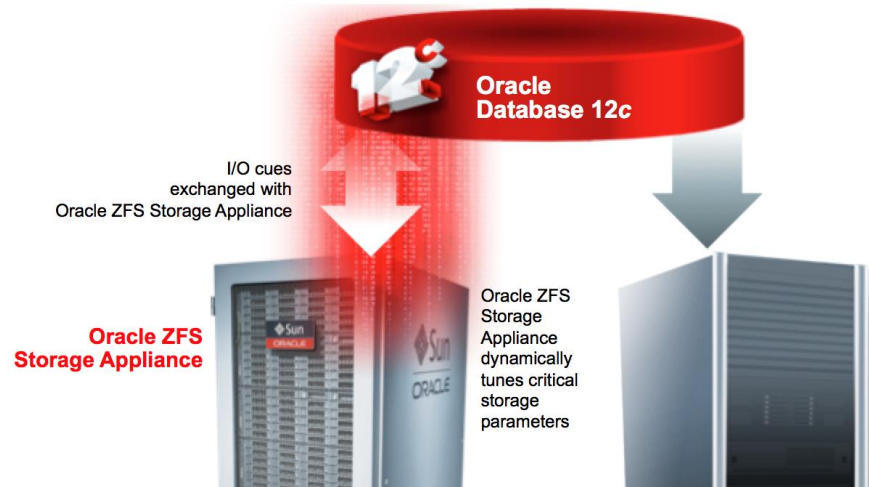


Figure 4. Oracle Database 12c and Oracle Intelligent Storage Protocol

- **Oracle Hybrid Columnar Compression**

Oracle Database workloads for data warehousing, analytics, or archive can achieve a 10x to 50x reduction in their data volumes and can accelerate queries by 3x to 8x by using the Oracle Hybrid Columnar Compression feature of Oracle Database. Available only on Oracle storage products, this maximum data reduction solution for Oracle Database helps you achieve a significant reduction in your storage footprint and associated data center costs. Furthermore, the Automatic Data Optimization feature of Oracle Database 12c enables you to set policies to initiate Oracle Hybrid Columnar Compression and data tiering based on actual data usage to automate the management of data throughout its lifecycle.

- **Oracle Enterprise Manager Plug-in for Oracle ZFS Storage Appliance and Oracle VM Storage Connect Plug-in for Oracle ZFS Storage Appliance**

Oracle Enterprise Manager Plug-in for Oracle ZFS Storage Appliance enables monitoring and provisioning at the share, LUN, or project level for all Oracle ZFS Storage Appliance models for end-to-end management visibility across the enterprise. Oracle VM Storage Connect Plug-in for Oracle ZFS Storage Appliance enables Oracle VM to provision and manage Oracle ZFS Storage Appliance systems for streamlined virtualization implementation. These plugins enable easier implementation, better visibility, and holistic management efficiencies.

Cloud Integration

Traditional storage architectures lack the resources required to support highly virtualized dynamic cloud workloads. Oracle ZFS Storage Appliance systems are:

- **Cloud-architected.** Based on the architectural advantages of a symmetric multiprocessing (SMP) operating system (OS) combined with Oracle ZFS Storage Appliance systems' Hybrid Storage Pool technology, these systems provide a superior design that delivers sustained high performance for consolidated on-premises and private cloud workloads.
- **Cloud-managed.** Oracle ZFS Storage Appliance systems OpenStack and Oracle Enterprise Manager Cloud Control cloud management frameworks with RESTful APIs so you can integrate them into any environment

- **Cloud integrated.** Unlike competitive suppliers that have no public cloud of their own, Oracle ZFS Storage Appliance enables you to integrate your on-premises storage systems with Oracle Public Cloud using powerful cloud gateways and archiving software that reduce on-premises costs and simplify your journey to the cloud.
- **Cloud-proven.** Oracle ZFS Storage Appliance systems have been proven in a variety of private and public cloud implementations worldwide, including over 1.4 exabyte of capacity serving as the storage and data protection backbone of Oracle Public Cloud.

Architecture and Configuration Options

The architecture of Oracle ZFS Storage Appliance systems is based upon three primary components:

- **Software.** The unique, intelligent multithreading SMP storage OS provides enterprise-class data services and robust data protection, while Hybrid Storage Pool technology manages the dynamic caching. Most data services, including the systems' DTrace Analytics feature are included in the base systems.
- **Controller.** A robust, powerful storage controller—which is based on cost-effective, enterprise-grade x86 servers from Oracle—delivers high-performance compute power, massive DRAM, and read flash. Optional dual-controller cluster configurations provide high availability with rapid failover.
- **Storage.** Enterprise-grade storage enclosures are available with either all-flash storage, with HDD storage, or with hybrid flash/disk combinations. They are built using the latest generation of SAS HDDs and/or flash storage combined with read and write flash accelerators for high performance and high availability.

Two controller models are available:

- **Oracle ZFS Storage ZS5-2.** A midrange unified storage system ideal for use with performance-intensive, dynamic workloads at an attractive price point.
- **Oracle ZFS Storage ZS5-4.** A high-end enterprise unified storage system for workloads demanding extreme performance and scalability at a price point that rivals competitors' midrange and high-end systems.

Both models support high-performance NAS, SAN and object storage access using the same intelligent storage OS, Hybrid Storage Pool technology, and enterprise SAS disk or flash enclosures, but they feature different storage controllers to meet the appropriate level of price/performance required for particular environments.

In addition, Oracle ZFS Storage Appliance Racked System configurations are fully tested, preassembled storage systems that come with replication, cloning, and encryption licenses included at no extra charge. Preconfigured Oracle ZFS Storage Appliance Racked System configurations dramatically shorten deployment and implementation time, optimize performance and availability, and reduce risk and TCO. Additionally, Oracle Platinum Services are available when Oracle ZFS Storage Appliance Racked System are used to back up Oracle Engineered Systems such as Oracle Exadata ensuring maximum uptime and rapid resolution with 24/7 remote fault monitoring, industry-leading response times, and patch deployment services.

Optional Software

In addition to the rich software suite included with the base systems, you can acquire separately licensed software features: remote replication, clones, and encryption.

ORACLE ZFS STORAGE APPLIANCE SPECIFICATIONS

	Oracle ZFS Storage ZS5-2	Oracle ZFS Storage ZS5-4	Oracle ZFS Storage Appliance Racked System ZS5-2	Oracle ZFS Storage Appliance Racked System ZS5-4
Configuration	Module shipment	Module shipment	Assembled, tested, and shipped	Assembled, tested, and shipped
Architecture	Dual-controller HA cluster with external storage enclosures	Dual-controller HA cluster with external storage enclosures	Dual-controller HA cluster with external storage enclosures	Dual-controller HA cluster with external storage enclosures
Processors	4x 18-core 2.3 GHz Intel® Xeon® processors	8x 18-core 2.6 GHz Intel® Xeon® processors	4x 18-core 2.3 GHz Intel® Xeon® processors	8x 18-core 2.6 GHz Intel® Xeon® processors
DRAM cache	768 GB or 1.5 TB	3 TB	1.5 TB	3 TB
Read flash cache	Up to 204 TB	Up to 614 TB	Up to 204 TB	Up to 486 TB

Storage Configurations

Configuration options	<p>Disk storage:</p> <ul style="list-style-type: none"> 12 TB to 3 PB scalability Up to 16 storage shelves, each with 20 or 24 HDDs With 20 HDDs per disk shelf, choice of 1 to 4 read or write SSD accelerators per disk shelf <p>Flash storage:</p> <ul style="list-style-type: none"> 16 TB to 1.2 PB scalability 1 to 16 storage shelves with 20 or 24 SSDs per shelf 	<p>Disk storage:</p> <ul style="list-style-type: none"> 12 TB to 9 PB scalability Up to 48 storage shelves, each with 20 or 24 HDDs With 20 HDDs per disk shelf, choice of 1 to 4 read or write SSD accelerators per disk shelf <p>Flash storage:</p> <ul style="list-style-type: none"> 16 TB to 2.4 PB scalability 1 to 32 storage shelves with 20 or 24 SSDs per shelf 	<p>Disk storage:</p> <ul style="list-style-type: none"> 322 TB to 3 PB scalability 2 to 16 storage shelves with 20 or 24 HDDs per shelf With 20 HDDs per disk shelf, choice of 2 or 4 read or write SSD accelerators per disk shelf <p>Flash storage (field upgrade):</p> <ul style="list-style-type: none"> 16 TB to 1.2 PB scalability 1 to 16 storage shelves with 20 or 24 SSDs per shelf 	<p>Disk storage:</p> <ul style="list-style-type: none"> 322 TB to 7.3 PB scalability 2 to 38 storage shelves with 20 or 24 HDDs per shelf With 20 HDDs per disk shelf, choice of 2 or 4 read or write SSD accelerators per disk shelf <p>Flash storage (field upgrade):</p> <ul style="list-style-type: none"> 16 TB to 2.4 PB scalability 1 to 32 storage shelves with 20 or 24 SSDs per shelf
Storage shelf options	<p>Disk storage:</p> <ul style="list-style-type: none"> Oracle Storage Drive Enclosure DE3-24C: 8 TB, SAS-3, 3.5-inch 7,200 RPM HDDs, 3.2 TB SAS-3, 3.5-inch SSDs, 200 GB SAS-3, 3.5-inch SSDs Oracle Storage Drive Enclosure DE3-24P: 600 GB/1.2 TB SAS-3 2.5-inch 10,000 RPM HDDs, 3.2 TB SAS-3 2.5-inch SSDs, 200 GB SAS-3 2.5-inch SSDs <p>Flash storage: Oracle Storage Drive Enclosure DE3-24P: 800 GB/3.2 TB SAS-3 2.5-inch SSDs</p>			

Standard and Optional Interfaces

Integrated network	8x 10 Gb Base-T Ethernet ports
Optional network connectivity	40 GbE, 10 GbE, QDR InfiniBand HCA, 16 Gb FC HBA
Optional tape backup HBA	Dual-channel 16 Gb FC HBA

Maximum Ports per System

10 GbE Base-T/10 GbE Optical/InfiniBand/16 Gb FC/40 GbE	24/16/16/16/16	32/24/16/16/16	24/16/16/16/16	32/24/16/16/16
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Environmental

Operating temperature	5°C to 35°C (41°F to 95°F)
Nonoperating temperature	-40°C to 68°C (-40°F to 154°F)
Operating relative humidity	10%–90% relative humidity, noncondensing
Nonoperating relative humidity	93% relative humidity, noncondensing
Altitude (operating)	0 m to 3,000 m (0 ft. to 9,840 ft.); maximum ambient temperature is derated by 1 degree C per 300 m above 900 m, except in China where regulations may limit installations to a maximum altitude of 2,000 m.
Regulations (meets or exceeds the following requirements)	
Safety	IEC 60950, UL/CSA 60950, EN60950, CB Scheme with all country differences
RFI/EMI	FCC CFR 47 Part 15 Class A, EN 55022 Class A, EN 61000-3-2, EN 61000-3-3, EN 300-386
Immunity	EN55024:1998+A1:2001:+A2:2003

POWER AND THERMAL

Item Description	Typical		Maximum
Oracle ZFS Storage ZS5-2 (controller only)	Refer to Power Calculator		
Oracle ZFS Storage ZS5-4 (controller only)	Refer to Power Calculator		
Oracle Storage Drive Enclosure DE3-24C	Power (W)	283 W	453 W
	Thermal (BTU/hr.)	965.6 BTU/hr.	1,545.7 BTU/hr.
Oracle Storage Drive Enclosure DE3-24P	Power (W)	240 W	452 W
	Thermal (BTU/hr.)	240 BTU/hr.	1,542.3 BTU/hr.
Oracle ZFS Storage Appliance Racked System	Power (W)	5,097 W	7,110 W
Oracle ZFS Storage Appliance Racked System DE3-24C	Power (W)	469 W	699 W
	Thermal (BTU./hr)	1,600 BTU/hr	2,385 BTU/hr

Physical Specifications

Oracle ZFS Storage ZS5-2 (controller only)	Height	87.1 mm (3.43 in.) 2U (rack units)
	Width	445 mm (17.52 in.)
	Depth	640 mm (25.2 in.)
	Weight	17.5 kg (38.5 lb.)
Oracle ZFS Storage ZS5-4 (controller only)	Height	129.9 mm (5.1 in) 3U (rack units)
	Width	436.5 mm (17.2 in.)
	Depth	732 mm (28.8 in.)
	Weight	40 kg (88 lb.) max.
Oracle Storage Drive Enclosure DE3-24C (fully loaded with drives)	Height	175 mm (6.89 in.) 4U (rack units)
	Width	483 mm (19 in.)
	Depth	630 mm (24.8 in.)
	Weight	46 kg (101.41 lb.)
Oracle Storage Drive Enclosure DE3-24P (fully loaded with drives)	Height	87.9 mm (3.46 in.) 2U (rack units)
	Width	483 mm (19 in.)
	Depth	630 mm (24.8 in.)
	Weight	24 kg (52.91 lb.)

ORACLE ZFS STORAGE APPLIANCE SOFTWARE

Included Features	Details
Oracle Intelligent Storage Protocol	Oracle Database 12c sends metadata to Oracle ZFS Storage Appliance systems about each I/O operation, enabling the systems to dynamically tune themselves for optimal performance; provides visibility at the database level and per-pluggable-database level for actionable insight.
File system	Oracle Solaris ZFS (128-bit addressability)
File-level protocol	NFS v2/v3/v4/v4.1, SMB1/2/2.1/3, HTTP, WebDAV, FTP/SFTP/FTPS
Block-level protocol	ISCSI, Fibre Channel, iSER, SRP, IP over InfiniBand, RDMA over InfiniBand
Object-level protocol	OpenStack Swift-compatible object ingest over HTTP or HTTPS
Data compression	Five distinct compression options to balance data reduction with performance for specific workloads
Hybrid Columnar Compression	10x to 50x compression of static Oracle Database data, resulting in a 3x to 5x reduction in storage footprint for data warehousing and long-term storage of information in Oracle Database databases
Data deduplication	Inline, block-level deduplication
Monitoring	DTrace Analytics (for system tuning and debugging), dashboard monitoring for key system performance metrics, plugin available for Oracle Enterprise Manager
Automated serviceability	"Phone home" capability with automatic case creation, configurable alerts
RAID	Striping, mirroring, triple mirroring, single-parity RAID, double-parity RAID, triple-parity RAID, wide stripes
Remote management	HTTPS, SSH, SNMP v1/v2c, IPMI, RESTful API, OpenStack Cinder
Snapshots	Read-only, restore, Microsoft Volume Shadow Copy Service support
Directory services	NIS, AD, LDAP
Data security	Checksum data and metadata, antivirus quarantine
Network services	NTP, DHCP, SMTP
Backup	NDMP v3/v4, ZFS NDMP
Local replication	Replication within the same Oracle ZFS Storage Appliance configuration (single or cluster)
QoS/Throttling	Limit LUN I/O consumption to better balance system resources
Separately Licensed Features	Details
Clones	Writable snapshots (included in racked system configurations)
Remote replication	Replication from one Oracle ZFS Storage Appliance product to another. 1:N, N:1, manual, scheduled, or continuous (included in racked system configurations)
Encryption	Highly secure, easy-to-implement, two-level AES 256/192/128-bit granular data encryption at project/share/LUN level and key management flexibility for data breach protection and security (included in racked system configurations)

Oracle Support

Oracle Premier Support services provide the complete system support you need to proactively manage your Oracle storage systems, with swift resolution and rapid-response hardware service when problems do arise, keeping your business information available 24/7.

Oracle Platinum Services provide an enhanced level of service for supported configurations of Oracle ZFS Storage Appliance Racked System. Oracle Platinum Services is available for Oracle ZFS Storage Appliance Racked System ZS5-4 and Oracle ZFS Storage Appliance Racked System ZS5-2 when they are used as a backup solution for Oracle Exadata, Oracle SuperCluster, or Oracle Exalogic.

With Oracle Advanced Customer Support, you get mission-critical support with a focused support team, proactive guidance to tailor storage systems for optimal performance and increased competitiveness, and preventative monitoring to help you achieve high availability and optimized system performance.

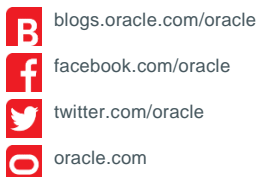
For more information about Oracle Premier Support and Oracle Advanced Customer Support, please speak with your Oracle representative or Oracle authorized partner, or visit oracle.com/support or oracle.com/acs.



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Integrated Cloud Applications & Platform Services

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