ORACLE
ZFS Storage
Appliance

# Oracle ZFS Storage Appliance

Oracle ZFS Storage Appliance systems provide high-performance unified storage that combine 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).

**Key Business 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 plus 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 with granular encryption
- Reduce TCO with superior price per performance and price per terabyte ratios

## EXTREME ENTERPRISE STORAGE PERFORMANCE

Oracle ZFS Storage Appliance systems are based on an advanced hardware and software architecture. It includes a highly intelligent, multithreading SMP storage operating system that makes the most of modern enterprise hardware and enables you to run multiple workloads and advanced data services without performance degradation. This powerful OS is complemented by the unique Hybrid Storage Pool design, which automatically caches data in dynamic random-access memory (DRAM) and 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 the hybrid storage pool design, heavily accessed data is served mostly from cache—up to 90 percent—to accelerate your applications with extremely high throughput and low latency for diverse, demanding workloads.

Oracle ZFS Storage Appliance also integrates high-availability (HA) features such as active-active controller clustering for failover and a self-healing file system architecture that ensures end-to-end data integrity. By combining reliability with a rich set of enterprise-class data services, Oracle ZFS Storage Appliance systems are an ideal choice to meet your demanding enterprise storage needs.



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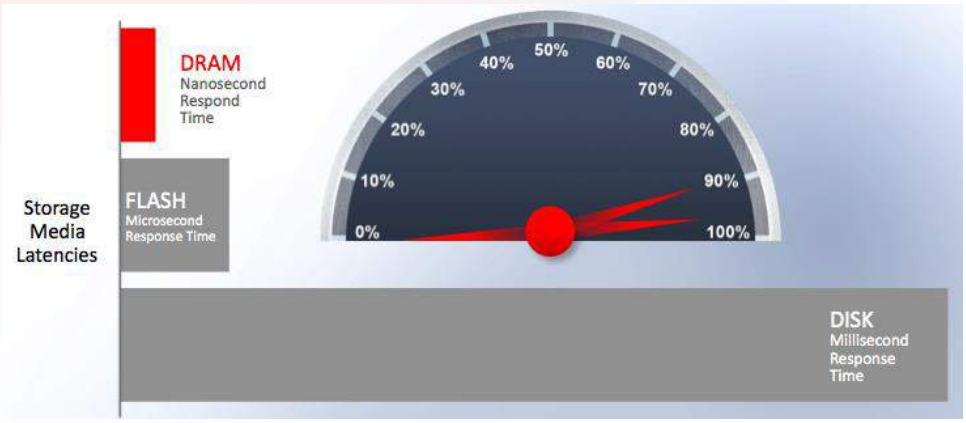


Figure 1. DRAM-centric architecture

## SUPERIOR EFFICIENCY

Oracle ZFS Storage Appliance systems feature an advanced set of management and analytics tools that enable storage administrators to rapidly provision, manage, and troubleshoot storage related issues. Rapid deployment of powerful advanced data services—unlimited snapshots, clones, thin provisioning, five different compression algorithms, and replication are managed via the intuitive browser user interface (BUI) or the command-line interface (CLI).

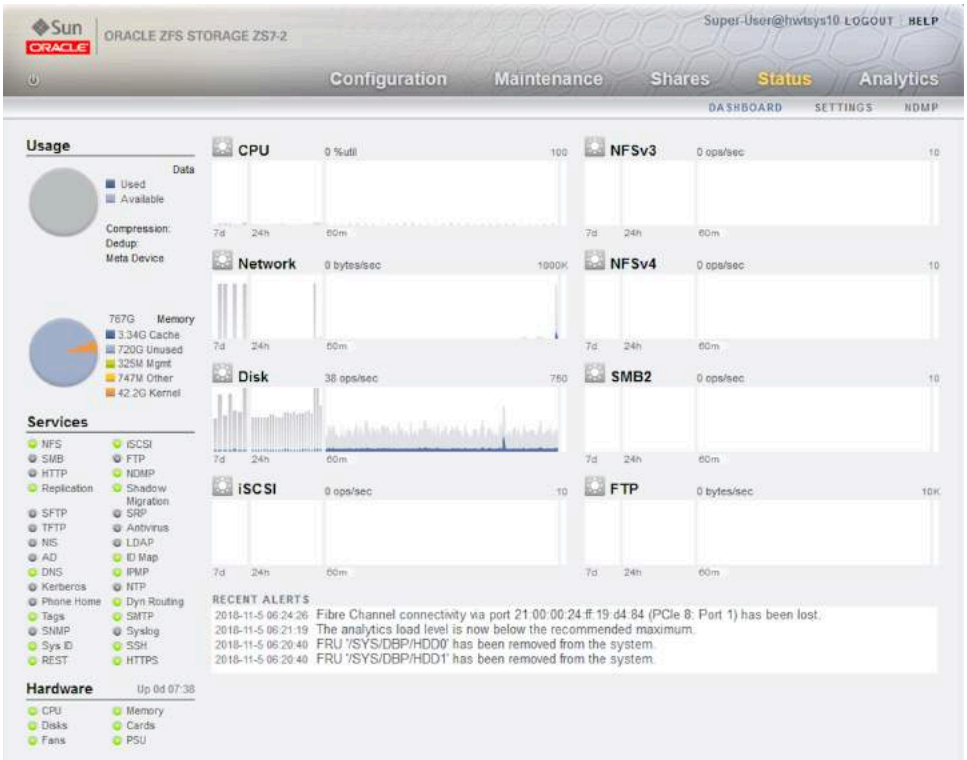


Figure 2. Status view of management software

**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
- Available in all-flash, all HDD, or hybrid configurations

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 storage devices with everything in between.

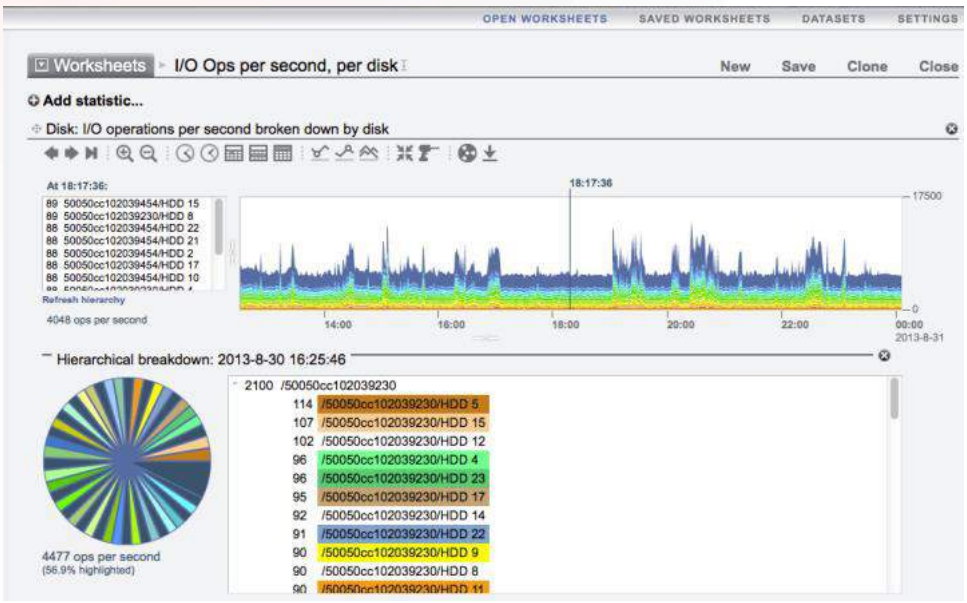

Figure 3. DTrace Analytics example showing I/O operations per second, per disk

This granular visibility—at the I/O, VM, or pluggable database 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 simplifies storage management and significantly increases the number of terabytes of data each administrator can handle, resulting in significant operational cost savings.

## ORACLE DATABASE INTEGRATION

Oracle ZFS Storage Appliance systems are deeply integrated with Oracle Database to improve performance, increase efficiencies, and lower TCO. Through engineering, developing, testing, and supporting hardware and software together, Oracle engineered storage systems deliver unique capabilities that enable Oracle software to run faster and more efficiently. Oracle ZFS Storage Appliance systems are coengineered with Oracle software and supported with documented solutions and best practices that remove the guesswork from configuring a total system for success through the following features:

- **Oracle Intelligent Storage Protocol**
  Oracle Intelligent Storage Protocol (OISP) is a unique storage protocol exclusive to Oracle Database 12*c* and later versions running with Oracle ZFS Storage Appliance systems. It enables a storage system to receive cues from Oracle Database about its data stream at an unprecedented level. Information about the type and importance of each read and write operation are sent from Oracle Database to the Oracle ZFS Storage Appliance system so it can intelligently process I/O and automatically and dynamically tune itself for optimal performance so the most critical database operations are given higher priority, thereby enabling databases to run faster with no manual tuning required. OISP has the added advantage of speeding provisioning by reducing tedious manual operations by 90 percent, which can reduce the risk of human error.

The self-tuning capabilities also prevent data blocks associated with high-bandwidth database 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–aware extended analytics capabilities, IT administrators can see OISP operations by database name, database function, and database file types so 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 and later environments.

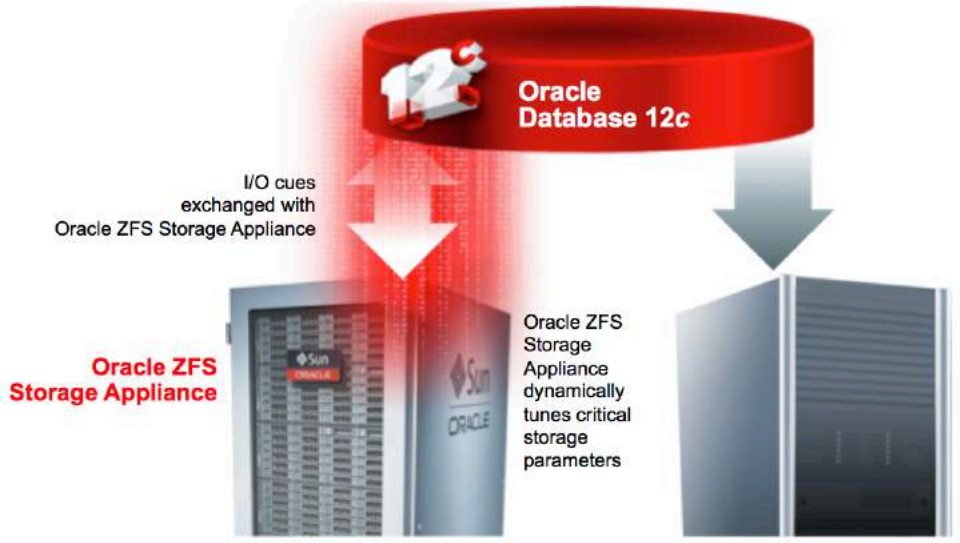


Figure 4. Oracle Database 12*c* and later and Oracle Intelligent Storage Protocol

- **Oracle Hybrid Columnar Compression**
  Oracle Database workloads for data warehousing, analytics, and 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 12*c* and later versions 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 provides end-to-end storage management visibility across the enterprise, and enables monitoring and provisioning at the share, LUN, or project. 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 support 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 a powerful cloud gateway 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 and massive DRAM. Optional dual-controller cluster configurations provide high availability with rapid failover.
- **Storage.** Enterprise-grade storage enclosures are available with either all-flash storage, all HDD storage, or a combination of both SSDs and HDDs that enable you to optimize different storage pools for a wide range of performance and capacity requirements. They are built using the latest generation of SAS HDDs and SSDs combined with read and write flash accelerators for high performance and high availability.

Two controller models are available:

- **Oracle ZFS Storage ZS7-2 mid-range.** A midrange unified storage system ideal for use with performance-intensive, dynamic workloads at an attractive price point.
- **Oracle ZFS Storage ZS7-2 high-end.** A high-end enterprise unified storage system for workloads demanding extreme performance and scalability at a price point that rivals competitive 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.

Racked System

Oracle ZFS Storage Appliance Racked System configurations are fully tested, preassembled storage systems that include replication, cloning, and encryption licenses 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. A network configuration option includes 100GbE switches for connectivity to Oracle Exadata systems for the mission critical RMAN backup use case.

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. Talk to your account representative to learn the minimum configuration requirements to qualify for Oracle Platinum 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 ZS7-2 MID-RANGE | ORACLE ZFS STORAGE ZS7-2 HIGH-END | ORACLE ZFS STORAGE APPLIANCE RACKED SYSTEM ZS7-2 MID-RANGE | ORACLE ZFS STORAGE APPLIANCE RACKED SYSTEM ZS7-2 HIGH-END |
|---|---|---|---|---|
| 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 (per two controllers) | 4x 24-core 2.1 GHz Intel® Xeon® processors (per two controllers) | 4x 18-core 2.3 GHz Intel® Xeon® processors | 4x 24-core 2.1 GHz Intel® Xeon® processors |
| DRAM Cache | 1 TB or 2 TB (per two controllers) | 3 TB (per two controllers) | 1 TB or 2 TB (2TB on-site installation) | 3 TB (per two controllers) |
| Read Flash Cache | Up to 737 TB | Up to 1.4 PB | Up to 737 TB | Up to 1.4 PB |

**STORAGE CONFIGURATIONS**

| | ORACLE ZFS STORAGE ZS7-2 MID-RANGE | ORACLE ZFS STORAGE ZS7-2 HIGH-END | ORACLE ZFS STORAGE APPLIANCE RACKED SYSTEM ZS7-2 MID-RANGE | ORACLE ZFS STORAGE APPLIANCE RACKED SYSTEM ZS7-2 HIGH-END |
|---|---|---|---|---|
| Disk Storage Options (raw capacity) | • 24 TB to 8 PB scalability<br>• Up to 24 storage shelves, each with 20 or 24 HDDs<br>• With 20 HDDs per disk shelf, choice of 1 to 4 read or write SSD accelerators per disk shelf | • 24 TB to 16 PB scalability<br>• Up to 48 storage shelves, each with 20 or 24 HDDs<br>• With 20 HDDs per disk shelf, choice of 1 to 4 read or write SSD accelerators per disk shelf | • 24 TB to 8 PB scalability<br>• Up to 24 storage shelves, each with 20 or 24 HDDs<br>• With 20 HDDs per disk shelf, choice of 1 to 4 read or write SSD accelerators per disk shelf | • 24 TB to 16 PB scalability<br>• Up to 48 storage shelves, each with 20 or 24 HDDs<br>• With 20 HDDs per disk shelf, choice of 1 to 4 read or write SSD accelerators per disk shelf |
| Flash Storage Options (raw capacity) | • 153 TB to 4.4 PB scalability<br>• 1 to 24 shelves with 20 or 24 SSDs per shelf<br>• With 20 SSDs per shelf, choice of 1 to 4 write SSD accelerator | • 153 TB to 8.8 PB scalability<br>• 1 to 48 shelves with 20 or 24 SSDs per shelf<br>• With 20 SSDs per shelf, choice of 1 to 4 write SSD accelerator | • 153 TB to 4.4 PB scalability<br>• 1 to 24 shelves with 20 or 24 SSDs per shelf<br>• With 20 SSDs per shelf, choice of 1 to 4 write SSD accelerator | • 153 TB to 8.8 PB scalability<br>• 1 to 48 shelves with 20 or 24 SSDs per shelf<br>• With 20 SSDs per shelf, choice of 1 to 4 write SSD accelerator |
| Storage Shelf Options | Disk storage:<br>• Oracle Storage Drive Enclosure DE3-24C: 14 TB, SAS-3, 3.5-inch 7,200 RPM HDDs, 7.68 TB SAS-3, 3.5-inch SSDs, 200 GB SAS-3, 3.5-inch SSDs<br>• Oracle Storage Drive Enclosure DE3-24P: 1.2 TB SAS-3 2.5-inch 10,000 RPM HDDs, 7.68 TB SAS-3 2.5-inch SSDs, 200 GB SAS-3 2.5-inch SSDs<br>Flash storage:<br>• Oracle Storage Drive Enclosure DE3-24P: 7.68 TB SAS-3 2.5-inch SSDs | | | |

**STANDARD AND OPTIONAL INTERFACES**

| | |
|---|---|
| Integrated Network | Management ports only |
| Optional Network Connectivity | 100GbE switch, 10GbE Base-T, 10GbE Optical, 25GbE, QDR InfiniBand HCA, 32Gb FC HBA, 40GbE |
| Optional Tape Backup HBA | Dual-channel 32 Gb FC HBA |

**MAXIMUM PORTS PER SYSTEM**

| | ORACLE ZFS STORAGE ZS7-2 MID-RANGE | ORACLE ZFS STORAGE ZS7-2 HIGH-END | ORACLE ZFS STORAGE APPLIANCE RACKED SYSTEM ZS7-2 MID-RANGE | ORACLE ZFS STORAGE APPLIANCE RACKED SYSTEM ZS7-2 HIGH-END |
|---|---|---|---|---|
| 10GbE Base-T/ 10GbE Optical/ 25GbE/ QDR InfiniBand/ 32Gb Fibre Channel/ 40GbE | 40/40/20/20/20/20 | 40/40/20/20/20/20 | 40/40/20/20/20/20 | 40/40/20/20/20/20 |

**ENVIRONMENTAL**

| | |
|---|---|
| Operating Temperature | 5°C to 35°C (41°F to 95°F) |
| Nonoperating Temperature | -40°C to 70°C (-40°F to 158°F) |
| Operating Relative Humidity | 10%–90% relative humidity, noncondensing |
| Nonoperating Relative Humidity | 93% relative humidity, noncondensing |
| Altitude (Operating) | 0 m to 3,050 m (0 ft. to 10,007 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. |
| Acoustic Noise | 8.1 Bels A-weighted Operating, and 5.8 Bels A-weighted Idling (measured Sound Power).<br>*Check your local regulations for noise level exposure limits in the workplace that apply to your installation of Oracle equipment and appropriate use of personal protection equipment.* |
| Other | Meets (American Society of Heating, Refrigerating and Air-Conditioning Engineers) ASHRAE Data Center Class A2 |

**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**

| | | TYPICAL | MAXIMUM |
|---|---|---|---|
| Oracle ZFS Storage ZS7-2 mid-range | Power (W) | 550 W | 756 W |
| | Thermal (BTU/hr.) | 1877 BTU/hr. | 2580 BTU/hr. |
| Oracle ZFS Storage ZS7-2 high-end | Power (W) | 569 W | 796 W |
| | Thermal (BTU/hr.) | 1941 BTU/hr. | 2716 BTU/hr. |
| Oracle Storage Drive Enclosure DE3-24C | Power (W) | 294 W | 458 W |
| | Thermal (BTU/hr.) | 1003 BTU/hr. | 1,563 BTU/hr. |
| Oracle Storage Drive Enclosure DE3-24P | Power (W) | 247 W | 457 W |
| | Thermal (BTU/hr.) | 843 BTU/hr. | 1,559 BTU/hr. |
| Oracle ZFS Storage Appliance Racked System (ZS7-2 high-end HA + 9x DE3-24C) | Power (W) | 3,784 W | 5,714 W |
| | Thermal (BTU/hr.) | 12,912 BTU/hr. | 19,497 BTU/hr. |

**PHYSICAL SPECIFICATIONS**

| | TYPICAL | MAXIMUM |
|---|---|---|
| Oracle ZFS Storage ZS7-2 mid-range and high-end (controller only) | Height | 86.9 mm (3.4 in.) 2U (rack units) |
| | Width | 445.0 mm (17.5 in.) |
| | Depth | 759.4 mm (29.9 in.) |
| | Weight | 28.6 kg (63 lb.) fully populated |
| 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 | 86.9 mm (3.4 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 12*c* 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, SMB1/2/2.1/3/3.1, HTTP, WebDAV, FTP/SFTP/FTPS |
| Block-level Protocol | ISCSI, Fibre Channel, iSER, SRP, IP over InfiniBand, RDMA over InfiniBand |
| Object-level Protocol | Amazon S3 and 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 |

| INCLUDED FEATURES | DETAILS |
|---|---|
| RAID | Striping, mirroring, triple mirroring, single-parity, double-parity, triple-parity, wide stripes |
| Remote Management | HTTPS, SSH, SNMP v1/v2c/v3, 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, automatic data validation, and 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 NFS, SMB, and 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 | Two-tier data encryption with strong encryption algorithms (AES 256/192/128), set at the project/share/LUN level or pool level. Encryption keys can be managed in a local keystore or centrally managed with Oracle Key Manager. Data encryption is included in the racked system configuration. |

## 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 ZS7-2 mid-range and high-end when they are used as a backup solution for Oracle Exadata, Oracle SuperCluster, or Oracle Exalogic. Talk to your account representative to learn the minimum configuration requirements to qualify for Oracle Platinum services.

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, Platinum Services, 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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