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Bringing Storage Efficiency to a New Level with Oracle's Unified Storage

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Executive Overview

Exponential data growth is challenging today's IT managers to scale their storage capacity while delivering high performance and staying within tight budgets. Oracle can help ease this pain by offering the first unified storage solution that optimizes performance with Hybrid Storage Pools (HSPs) and delivers radical simplification of storage deployment and management—all at a cost that redefines the economics of storage. Oracle's ZFS Storage Appliances offer a complete integrated solution that can help accelerate business performance and reduce risk. In addition to simplifying storage deployment and management, the appliances can also improve service levels through self-healing capabilities and DTrace Analytics software, which helps IT teams quickly find and fix performance issues.

Introduction

The rapid growth of new digital data demands new storage architectures that offer more flexibility and radically different storage economics. IDC estimates that the total amount of digital information created, captured, and replicated will grow at a rate of 50 percent in 2010—reaching 1.2 million petabytes, and that by the year 2020, the total will be 50 times what it was in 2009.¹ With application storage requirements growing at this tremendous rate, storage costs are skyrocketing. At the same time, a challenging global economy has kept IT budgets flat or declining. IT managers are thus caught in a bind. They are trying to meet the growing needs for increased storage capacity and performance while also containing costs.

¹ IDC, *The Digital Universe Decade — Are You Ready?*, March 2010, <http://www.emc.com/collateral/demos/microsites/idc-digital-universe/iview.htm>.

As storage capacities have grown, traditional means of deploying and managing storage have become outdated. Most of today's storage systems require a highly trained administrator to effectively manage the environment. This adds time and cost to deployment of new storage systems and increases the ongoing cost of managing the environment.

Furthermore, with today's large storage networks, it has become increasingly difficult to troubleshoot and fix storage performance issues. Most tools currently available offer limited visibility because they lack an end-to-end view that encompasses multiple layers from the CPU and application to the storage file system, operating system, and data services.

Customers can no longer tolerate the high costs of traditional storage or massive licensing fees and are looking for new ways to address their growing storage requirements and their challenges in managing storage environments. Today's IT environments require storage solutions that can offer:

- Better performance economics to enable business growth
- Greater storage efficiency to reduce storage costs
- Simplicity and ease-of-use

"Sun has provided a platform for the democratization of the storage industry. We have found the appropriate level of operating system support we need to run our business through the OpenSolaris storage community, which saves significant time and money. I participate in the community daily and see real business value in the projects that are being created by some of the industry's most important players."

— Jason Williams, COO and CTO, DigiTar

What Is Oracle's Unified Storage?

Oracle's Unified Storage systems combine industry standard hardware with intelligent software that enhances observability and simplifies administration. The systems leverage volume servers along with densely packaged high-capacity disk drives and utilize solid-state drives (SSDs) to deliver breakthrough storage performance with exceptional economics. They also include an integrated data services software stack that can help speed up implementation and simplify data management.

Leveraging an industry standard server in place of an expensive, proprietary disk controller reduces both cost and risk because standard components offer economies of scale and have already been proven in other applications. Customers can then purchase high-performance, high-capacity storage systems at much better price/performance levels.

The Oracle Solaris Zettabyte File System (ZFS), which originated in the open source OpenSolaris operating system, is also included in the appliance for no additional licensing fee. Oracle Solaris ZFS provides data services such as compression, data deduplication, mirroring, snapshot, error correction, and system management — all fully integrated. Such services have traditionally been bolted on, ordered individually, and/or required extensive licensing and fees.

ZFS Storage Appliance Capabilities

ZFS Storage Appliances provide all the benefits of unified storage in an easy-to-use appliance package so organizations can dramatically simplify their storage deployment and management while also reducing costs. These appliances change the economics of storage by using a high-performance Hybrid Storage Pool (HSP) architecture that combines the performance characteristics of SSDs with high-capacity hard disk drives (HDDs). The SSDs provide read and write cache, enabling higher performance than traditional storage architectures at up to 35% less cost.

Oracle's Unified Storage systems also provide unmatched simplicity and ease-of-use through an intuitive and powerful browser user interface (BUI) for simplified management. Revolutionary business analytics functionality allows administrators to quickly diagnose and resolve performance issues in production systems.

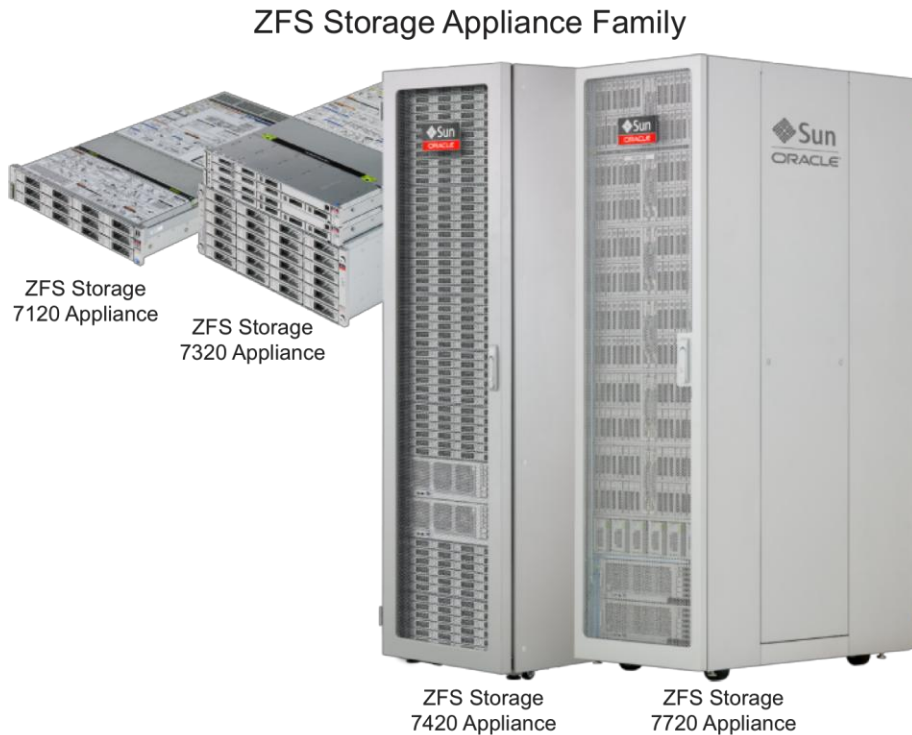


Figure 1. Oracle ZFS Storage Appliance family

Breaking Through Economic and Performance Barriers

Modern servers are fast approaching processing capabilities in excess of 1 million I/O operations per second (IOPS). However, mechanical disk drives have failed to keep up with the server performance growth curve. Today's fastest drives are capable of 300 to 400 IOPS. To achieve a level of storage I/O throughput that matches today's server performance, most storage vendors recommend a large pool of 15K rpm disk drives. In some cases, a large buffer of expensive DRAM is also deployed so that an entire application's working set can be stored in memory to reduce latency.

Not only are these traditional storage architectures complex and costly to acquire, but they are also expensive to operate and manage. High rpm drives consume significantly more power than lower rpm drives. And the software tools that are used to manage these environments typically require a highly trained administrator, adding further costs for ongoing management and making it more challenging to maintain high service levels for storage systems and related applications.

Recent advances in production of flash technology have made SSDs and other flash storage devices much more cost effective, enabling a new approach to tiered storage. Flash technology is interesting because it falls in a price/performance "sweet spot" between mechanical drives and DRAM.

Mechanical disk drives are very cost-efficient for storing data, but they are also relatively slow compared to flash storage. Flash technology can be used to increase the performance of mechanical drives by providing read and write cache that offers better performance and greater power efficiency. Although flash storage is significantly more expensive than mechanical drives, it is also significantly cheaper and denser than DRAM storage.

Taking Advantage of Flash Technology with the Oracle Solaris ZFS File System

Taking advantage of the performance and cost characteristics of flash storage requires an enabling technology that recognizes the performance characteristics of media such as SSDs and can transparently optimize performance across multiple types of media.

Unlike most file systems, Oracle Solaris ZFS recognizes different media types and will optimize how it handles each media type to help maximize file system throughput and application performance. Oracle Solaris ZFS also automates the process of data placement so that administration efforts and the risk of human errors are greatly reduced.

The Oracle Solaris ZFS file system can take advantage of flash storage today by transparently caching data for both reads and writes. Just as Oracle Solaris ZFS recognizes when high-speed serial-attached SCSI (SAS) drives are present and can automatically take advantage of their performance characteristics, so too it recognizes various forms of flash storage, enabling even more significant performance gains.

Caching frequently accessed data in SSDs can help improve application performance or deliver sustained throughput for backup solutions. Because SSDs offer better performance than HDDs, they can help the storage system keep up with server I/O throughput. HDDs can then be used along with the SSDs to store massive data sets in a cost-effective manner. Oracle Solaris ZFS automates the placement of data, thus avoiding the need for sophisticated policies and the high management overhead typically associated with tiered storage solutions. Thus storage administrators don't have to worry about data classification nor setting up and maintaining storage policies.

Hybrid Storage Pools

HSPs typically include DRAM, a read cache, a write cache, and a high-capacity storage area. Each of these different storage categories can be implemented with different types of storage media. However, if performance requirements demand it, an HSP can use high-performance media such as SSDs in all storage categories, including the high-capacity storage area.

As shown in Figure 2, ZFS Storage Appliances use read-optimized and write-optimized SSDs for the read and write caches in the HSP. HDDs are used for the high-capacity storage area. The entire storage infrastructure can then appear as fast as flash storage to its applications, enabling the systems to deliver higher performance at less cost than traditional storage architectures.

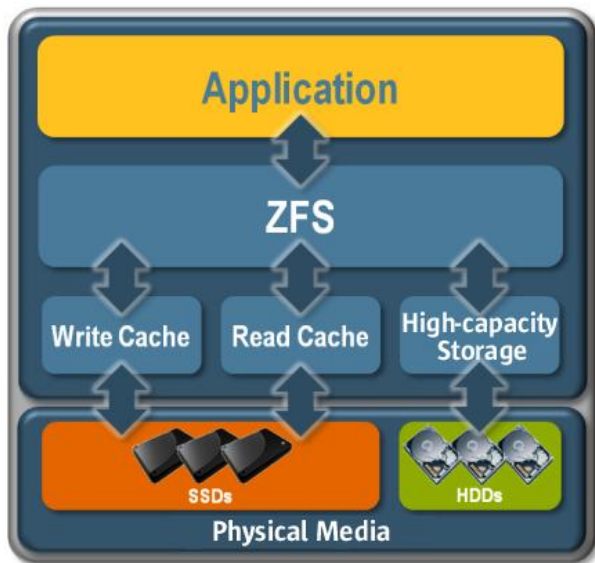


Figure 2. Oracle Solaris ZFS transparently optimizes data placement across HDDs and SSDs to deliver improved throughput.

Oracle Solaris ZFS transparently executes writes to the pool of low-latency SSD media so that writes can be quickly acknowledged, allowing the application to continue processing. The data is then automatically flushed to HDDs as a background task performed by Oracle Solaris ZFS. Another pool of SSD media acts as a read cache, and Oracle Solaris ZFS manages the process of copying frequently accessed data into this read cache where it can be retrieved with very low latency.

Oracle Solaris ZFS looks at usage patterns to determine whether and how to use the different storage media. For example, large synchronous writes, such as video streaming, do not benefit from caching, so Oracle Solaris ZFS does not try to copy this type of data to write cache. Similarly, the read cache is populated based on an intelligent algorithm that takes into account not only the most recently used data, but also anticipated read requests and estimated data to be held in DRAM.

The most significant effect of using HSPs to manage data placement is that flash storage such as SSDs can drive enough performance to enable high-speed Fibre Channel disk drives to be replaced by slower rotation, high-capacity drives. These high-capacity drives enable dramatic cost reductions in storage acquisition costs as well as lower power and cooling costs. At the same time, storage administrators are freed from the laborious task of ongoing storage optimization efforts

"...Hybrid Storage Pools provide quite a lot of cache-speed (or near cache-speed) access to our Oracle data...HSPs were very important in our decision to go forward with the purchase of those machines."

— David Robillard, UNIX team leader & Oracle DBA, Notarius

This HSP approach provides the benefits of high-performance SSDs while still saving money with low-cost high-capacity disk drives. Applications can be completely isolated from slower mechanical disk drives, unlocking new levels of performance and higher ROI.

Increased Storage Efficiency

ZFS Storage Appliances can help save datacenter floor space and reduce storage acquisition costs. The appliances are not only designed for high density, but also help increase storage efficiency through data compression and deduplication.

Data Compression

Oracle Solaris ZFS provides built-in compression that can help reduce the amount of space required to store user data. This in turn increases the effective storage capacity available to applications. Having compression built into the file system (as opposed to deploying an appliance between the client application and storage) not only simplifies the management of complex storage architectures, but can also help minimize the impact on application performance. In addition, there are some cases in which compression can improve system performance due to the fact that compression results in fewer bytes of data, and therefore less I/O traffic to and from disks.

Compression typically provides good results for unstructured data in a file sharing environment, often yielding as much as 50% or more savings in storage space. ZFS Storage Appliances offer four different compression algorithms, enabling administrators to optimize compression for a particular application environment. The best way to determine the affect of compression for a given application environment is to run tests with actual data at various levels of compression and observe the results on disk utilization and application performance.

Data Deduplication

ZFS Storage Appliances also take advantage of the data deduplication feature in Oracle Solaris ZFS. Deduplication identifies and stores only unique blocks of data, and can potentially save significant amounts of storage capacity. For example, without data deduplication, when a 1MB file is emailed to 100 people, the system will store 100 identical copies of the file. By contrast, in a deduplication environment, only one copy of the file is stored.

There are multiple ways to implement deduplication so it's important to understand how the method of implementation might affect storage capacity and application performance. The most

common method of deduplication is post-processing. In this approach, the complete set of data is initially written to disk and then a subsequent pass is made, usually during off hours, to post-process the data and remove duplicate copies. This approach avoids putting a heavy load on the storage system or application during the initial writes. However, it incurs a penalty in the sense that it requires enough extra storage capacity to store the duplicate data until the post-processing is complete.

The alternative is called in-line data deduplication and involves performing the deduplication on the fly while the data is being written. This approach, which is used by ZFS Storage Appliances, has the advantage of avoiding an extra processing step and saving storage capacity during the temporary period when multiple copies of data would be stored in a post-processing approach.

ZFS Storage Appliances can deduplicate across a 576TB pool of storage, a much larger pool than most other deduplication implementations. This is possible because ZFS Storage Appliances take advantage of their large system memory and high performance SSDs to enable the deduplication table (pointers to each unique storage block) to become quite large and still offer excellent performance. In storage solutions where main memory is limited, there is a noticeable performance impact when the deduplication table becomes large enough to spill over into swap space, which means that disk reads are required to access some portions of the table.

ZFS Storage Appliance deduplication can also be performed at the block level rather than at the file level. This means that when saving multiple different versions of large documents such as PowerPoint presentation files, only the blocks that are unique in the different versions would be stored more than once. This can greatly reduce the storage requirements for unstructured data.

Performing these deduplication functions within the ZFS Storage Appliance where there is ample processing power also offloads deduplication overhead from the application server, helping to maintain high application service levels.

For those customers interested in optimal capacity savings, ZFS Storage Appliances can employ both compression and deduplication on the same data. Oracle Solaris ZFS seamlessly compresses data, which can then be deduplicated, allowing for maximum space savings.

Simple Storage Management

ZFS Storage Appliances provide unmatched simplicity and ease-of-use through innovative storage software that includes a browser-based management interface and unprecedented business analytics functionality in DTrace Analytics software. A rich set of data services and management features (Figure 3) helps simplify administration and improve service levels. All of the software features and data services are available as standard features and are included in the ZFS Storage Appliance without any additional license fees. ZFS Storage Appliances also include a plug-in module for Oracle Enterprise Manager 11g Grid Control. This enables administrators to see an integrated view of the database and its storage systems, including the ability to view multiple systems from a single pane.

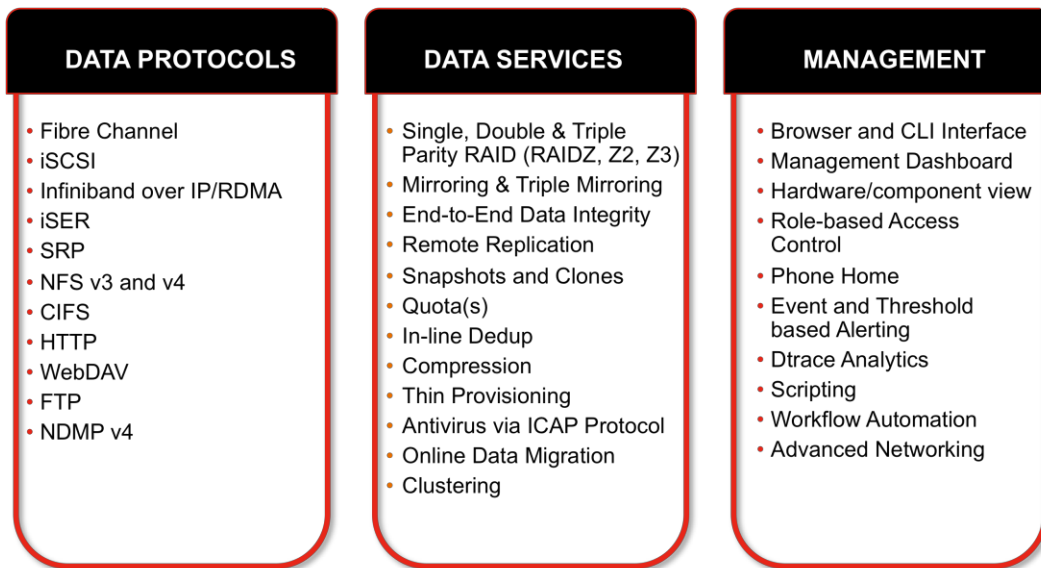


Figure 3. ZFS Storage Appliances include data services for no additional licensing.

A recent study by Edison Group has confirmed that ZFS Storage Appliances indeed help administrators complete their tasks more quickly. The study compared the duration of time as well as the number of steps and clicks to complete various administration tasks on a previous generation Sun Storage 7310 system versus a comparably configured Netapp FAS2040 appliance. Oracle's new ZFS Storage 7320 appliance has a similar set of data services and management features as this previous generation system since it uses a newer version of the same ZFS Storage software.

The key results of the study are highlighted in Figure 4. The Oracle appliance showed the following advantages for administrators:

- 34% less time required to provision and configure the storage and its connectivity
- 31% less time for maintenance and typical configuration changes
- 44% less time spent troubleshooting

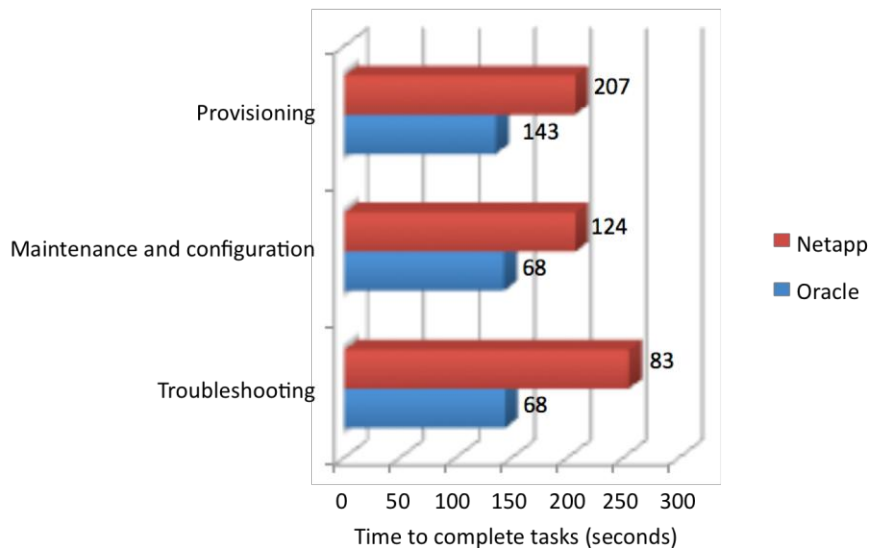


Figure 4. A study by Edison Group showed that ZFS Storage software enables dramatic gains in efficiency over Netapp.

These efficiencies in deploying and managing the ZFS Storage Appliances can help the organization achieve business benefits such as:

- Increased revenue — New revenue-generating applications can be deployed more quickly.
- Lower operating expenses — IT service costs can be reduced due to lower deployment and ongoing maintenance costs.
- Reduced risk of business interruptions that affect revenue — Higher application service levels can be achieved when using ZFS Storage Appliances that offer reliable storage, consistent throughput, and rapid troubleshooting.

The following subsections describe in more detail the features of ZFS Storage software that help enable these dramatic improvements in administrative efficiency.

Easy to Deploy

Provisioning and management is dramatically simplified through an easy-to-use management interface that takes the guesswork out of system installation, configuration, and tuning. As illustrated in Figure 5, the browser user interface (BUI) provides an intuitive environment for performing administration tasks, visualizing concepts, and analyzing performance data. In simple configurations, such as when deploying the appliance as a high-speed backup solution, the appliance can literally be set up and configured in minutes. The click-and-drag installation wizard

does not require a highly trained system administrator, thus saving organizations valuable time. For more-complex configurations such as a high-performance file system consisting of multiple storage systems to be shared by virtualized servers, Oracle's professional services offering can help speed deployment and reduce the risk of downtime or data loss.

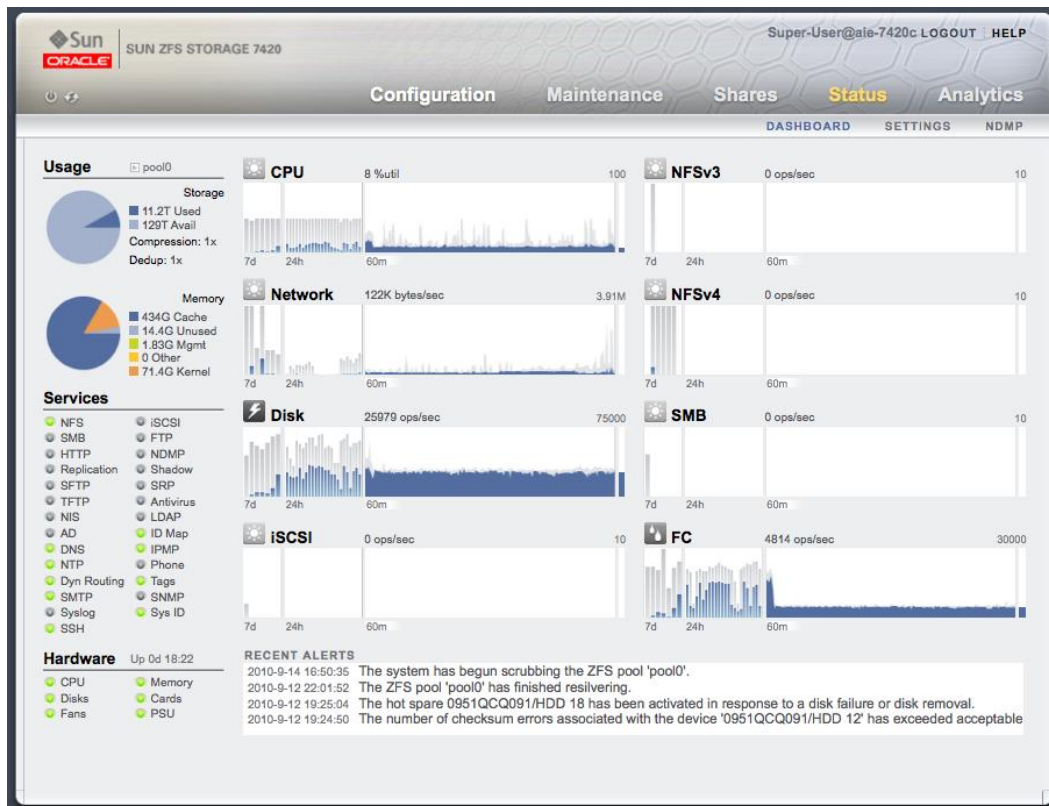


Figure 5. ZFS Storage Appliances help simplify deployment.

With seamless, transparent file sharing and secure access across both UNIX and Microsoft Windows environments, ZFS Storage Appliances also greatly simplify deployment in heterogeneous environments. The systems include native support for the Common Internet File System (CIFS) protocol to simplify integration in Windows file-sharing environments. In addition to Lightweight Access Directory Protocol support, they also include support for Microsoft Active Directory integration and role-based access control — helping to reduce the risk of unauthorized access to data.

A single appliance can also be configured with multiple storage pools so that each pool can be configured differently in support of differing workload requirements. For example, a file-sharing environment may require data compression and deduplication to save space, whereas a database

application might be more focused on data protection and high availability. Using separate pools for these two environments enables them to be maintained on the same appliance while allowing each workload to utilize a different configuration of data services.

A further advantage for heterogeneous environments, ZFS Storage Appliances support more connection options than other leading storage platforms. The ZFS Storage Appliance provides all of the following connection options in a single platform:

- Infiniband (IB)
- Fibre Channel SAN
- Network Attached Storage
- IP-SAN

Easy to Scale

Unlike traditional storage architectures, ZFS Storage Appliances can scale in multiple dimensions to meet specific application needs. As application requirements change, IT managers can choose to

- Increase computational power by adding more CPUs and cache
- Expand total capacity by adding disk drive expansion units
- Increase performance using additional SSDs to cache storage reads and writes

Increasing system throughput in ZFS Storage Appliances is as easy as adding SSDs. Oracle Solaris ZFS is designed to dynamically recognize and add new drives, so the SSDs can be configured as a cache disk without dismounting the file system that is in use. Once this is done, Oracle Solaris ZFS automatically optimizes the file system to use the SSDs as high-speed disks.

A common storage capacity issue is the need to configure databases with room for growth. A database that is expected to grow to 2TB would traditionally have been allocated the full 2TB of capacity from the beginning even though it may initially use only 300GB of space. ZFS Storage Appliances offer thin provisioning for more efficient utilization of storage capacity in these instances. With thin provisioning, this database would be granted its 2TB of space, but the physical media for the 1.7TB of unused capacity would not necessarily have to be in place until database growth made it a requirement.

Easy to Observe, Analyze, and Optimize

DTrace Analytics software, which is based on the award-winning DTrace facility in Oracle Solaris, provides the industry's only comprehensive and intuitive business analytics environment for storage systems. Administrators can drill down for in-depth analysis of key storage subsystems using built-in instrumentation that provides real-time visibility throughout the data path.

Real-time statistical graphs can be used to quickly locate and isolate problems as well as optimize storage performance and capacity use—all while systems continue running in production.

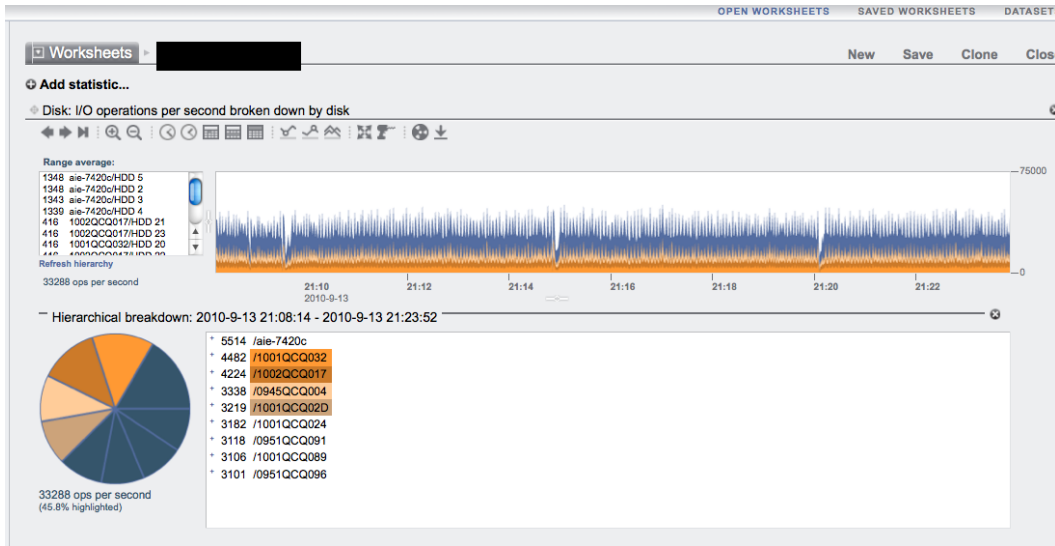


Figure 6. DTrace Analytics software makes it easy to isolate problems and optimize storage performance.

Statistics can also be archived to disk so performance data can be reviewed and analyzed throughout the life of the system. Dedicated archive capacity allows administrators to preserve historical data for up to seven to 10 years. Archive data sets can be suspended or resumed as desired, or they can be destroyed if no longer needed.

DTrace Analytics gives administrators all the tools they need to quickly identify and diagnose system performance issues, perform capacity planning, and debug live storage and networking problems, before they become challenging for the entire network.

Reduced Risk with Industry-Leading Data Protection

ZFS Storage software is the only software that protects data from as many as three drive failures with triple-parity RAID. With disk drives getting larger and many organizations implementing wider striping across more drives for increased performance, a third-parity bit helps reduce the risk of data loss. Triple-parity RAID also offers a great way to increase random read performance for application workloads such as the Oracle database.

Most Comprehensive Self-Healing Storage System

ZFS Storage Appliances take advantage of the Oracle Solaris Fault Management Architecture to automatically and silently detect and diagnose underlying problems using an extensible set of agents. When a faulty component is discovered, the self-healing system automatically responds

by taking the faulty component offline. Automatic data integrity checking and correction is also provided by Oracle Solaris ZFS. If its block-level checksums identify a corrupt block, Oracle Solaris ZFS automatically repairs it, providing self-healing capabilities at the block level.

The systems include easy-to-understand diagnostic messages. The diagnostic messages are linked to articles in Oracle's knowledgebase to clearly guide administrators through corrective tasks when human intervention is required.

Business Value of Hybrid Storage Pools

The following scenarios illustrate how HSPs can help address some of the most pressing business issues facing today's organizations.

Scenario 1: Reducing Total Cost of Ownership

A customer requires 46TB of storage for a high-performance file system and is concerned about TCO as well as datacenter space. In comparing a popular solution against the ZFS Storage Appliances, the customer finds that the ZFS Storage 7320 appliance not only offers significantly lower costs, but also provides the following key advantages:

- No additional software license fees compared to more than US\$50,000 in software licenses required with the alternative system
- Delivers equivalent throughput and better performance without expensive and power-hungry 15K rpm drives
- Provides the same 46TB capacity in less space with its densely packaged six rack unit (6U) system

When considering operating costs and purchase price, the differences were staggering:

- 63% lower annual operating costs for ongoing maintenance and configuration changes
- 35% lower initial purchase price for the system and required software licenses

Scenario 2: Replacing 15K rpm drives

A regional auto parts distributor with 50 stores is using a 200 high-speed (15K rpm) disk drives to deliver the performance needed for their online repository of parts diagrams. At 300GB per drive, they have a total of 60TB of disk space. Their business is expanding and they have received several new contracts to supply parts to local auto repair shops. As a result, they will need to begin storing many more part diagrams online and will need greater storage capacity as well as increased performance.

Because the new diagrams represent parts for several different automakers and several brands of cars, they take up a lot of space. In addition, the 15K rpm drives consume a lot of energy. The company calculated that it would take 350 of the expensive 300GB 15K rpm drives to store their data. With requests for parts diagrams dispatched approximately every 12 minutes, their transaction volume is considered mid-scale. They wanted to find a solution that would be more cost effective than using 15K rpm drives to store all of their parts diagrams

The required transaction volume can be accommodated by the ZFS Storage 7420 appliance. Much of the working data set can fit into memory and there is a good "hit ratio" from the read SSDs. The 2TB SAS-2 disk drives in the ZFS Storage 7420 appliance provide cost effective storage and low energy consumption, making for an economical and practical solution that also provides good performance.

ZFS Storage Appliance Portfolio

To meet a variety of customer needs for capacity, price, and performance, ZFS Storage Appliances come in four different configurations, including three cluster configurations that offer increased availability.

All systems come bundled with the same ZFS Storage software, which includes data protocols, replication, compression, and DTrace Analytics software. Clustered systems also include an additional software module for cluster software features.

ZFS Storage 7120 Appliance

This entry-level, easy-to-install storage appliance is well suited for small and medium businesses and departments as well as remote offices of large corporations. It uses the same software as the high-end configurations and delivers up to 120TB of raw capacity in a 6U configuration or up to 24TB in a 2U package. The appliance supports two options for its 7,200 rpm SAS drives. Customers can choose 1TB SAS-1 drives, which offer three Gbps throughput, or 2TB SAS-2 drives, which support double the I/O throughput at six Gbps. With the ZFS Storage 7120 system, customers can acquire easy-to-use enterprise data management functionality at entry-level costs.

ZFS Storage 7320 Appliance

The ZFS Storage 7320 system redefines mission-critical entry storage for the enterprise, offering simplified management, performance, efficiency, and seamless expansion to meet today's growing storage needs. It provides a high-availability cluster option with scalability up to 192TBs of raw capacity and supports HSPs that can be configured with up to 2TB of read cache and up to 72GB of write-optimized cache for enhanced application performance. The system uses 7200 rpm SAS-2 drives for high energy efficiency and double the I/O throughput of the previous generation of SAS-1 drives.

ZFS Storage 7420 Appliance

The ZFS 7420 appliance is a scalable unified storage system that offers radically simplified storage management. With up to 1,152TB of raw capacity and up to 64 CPU cores in the cluster configuration, the system delivers superior performance while reducing energy consumption with its HSP architecture. Like the ZFS 7320 appliance, the ZFS 7420 appliance uses 7200 rpm SAS-2 drives for energy efficiency and high I/O performance.

The ZFS Storage 7420 appliance is ideal for organizations with demanding performance requirements and where rapid growth in file-based information is expected. It allows customers to start small (20TB), and then increase storage capacity, computational power, or read/write storage cache to meet their changing business needs. With the ZFS Storage 7420 system, customers achieve maximum scalability and performance combined with conservation of power, space, and cooling. For customers that require maximum protection against downtime, the ZFS Storage 7420 appliance supports a two-node cluster configuration that enhances data availability with cluster fail-over that includes all flash-based write caches. The system features an active-active architecture with no single point of failure, enabling high performance and high availability to maximize business productivity.

ZFS Storage 7720 Appliance

The ZFS 7720 appliance offers a highly scalable bulk storage and backup solution for mid-scale mixed workload environments. It expands to up to 1,440TB of storage capacity and delivers high performance throughput at an affordable price. The system comes configured with 32 CPU cores, up to 512GB of DRAM. It includes a unique integrated backplane that delivers high-speed internal bandwidth to support high aggregate throughput from the built-in SAS-2 network. These characteristics make this appliance a great fit for mixed workloads or for backing up large mission-critical databases. It can also be a cost-effective primary storage solution for non-mission-critical mid-scale applications that require large capacity, simple setup, and low ongoing administration.

CONFIGURATION INFORMATION FOR ZFS STORAGE APPLIANCES

	KEY CUSTOMER REQUIREMENT	MAX STORAGE CAPACITY (RAW)	SPACE (RACK UNITS)	WRITE OPTIMIZED SOLID-STATE DRIVE	READ OPTIMIZED SOLID-STATE DRIVE	CPU CORES
ZFS Storage 7120 Appliance	Low-priced entry- level appliance with all software features	Up to 120TB (12 X 2TB in controller + 48 X 2TB in disk shelves)	2U for controller + 4U for optional disk shelf	96GB	N	4
ZFS Storage 7320 Appliance	Cost-effective mid-range storage appliance	192TB (96 X 2TB)	2U per controller, 4U per disk shelf	Up to 72GB (4 X 18GB SSD) per disk shelf	Up to 2TB (4 x 512GB SSD) per controller	8
ZFS Storage 7420 Appliance	Best price/performance and growth path	1,152TB (576 X 2TB)	3U per controller, 4U per disk shelf	Up to 72GB (4 X 18GB SSD) per disk shelf	Up to 2TB (4 X 512GB SSD) per controller	32 per controller (max 64)
ZFS Storage 7720 Appliance	High-capacity storage for mixed workloads and high-end backup	1,440TB (720 X 2TB)	3U per controller (max 46U)	Up to 432GB (24 X 18GB SSD) per rack (max 864GB)	Up to 2TB (4 X 512GB SSD) per controller	32

Software. Hardware. Complete.

ZFS Storage Appliances are part of the complete, open, and integrated Oracle stack. The stack penetrates every layer of the IT stack, combining the largest and most complete set of industry and business applications software with the flagship Oracle database and the right technology infrastructure to support it. Engineering the entire stack to work together yields higher reliability and greater security as well as stunning performance and low TCO.

Oracle + Sun

Complete, Open, Integrated Systems



- Engineered to work together
- Tested together
- Certified together
- Packaged together
- Deployed together
- Upgraded together
- Managed together
- Supported together

Figure 7. ZFS Storage Appliances are part of a complete, open, and integrated hardware and software stack.

Customers benefit from standardized hardware and software components and certified system configurations, helping to ease the burden of installation, training, and administration. Centralized management of the entire stack also helps to improve service levels and simplify change management while reducing costs. Ultimately, all of this leads to more flexible set of business processes with a lower cost of ownership.

Get Started on the Right Track

While ZFS Storage Appliances offer faster provisioning than competitive storage solutions, Oracle makes it even easier to deploy them with professional services that can help mitigate the risk of downtime, data loss, and costly delays. Oracle's award-winning support and professional and managed services can help reduce costs and speed time to market, while optimizing datacenter power, space, and cooling.

Some service offerings that are specific to the ZFS Storage Appliances include the following:

- **Advanced Installation service for the ZFS Storage Appliance family.** The Oracle Advanced Installation service for the ZFS Storage Appliances goes beyond basic installation to include configuration into an existing storage operational environment, configuration with directory services, and setup of failover configuration. Oracle provides the installation

assistance and expertise required to achieve a smooth, successful startup and to help ensure that systems are running at an optimal level right from the start.

- **Unified Storage Data Migration service.** Minimize disruption and gain full-featured functionality of new technology investments when migrating from other platforms. Customers can achieve faster ROI by leveraging Oracle's deep technical expertise and proven implementation and migration tools.
- **Oracle Premier Support for Systems.** Oracle's expanded technical assistance and comprehensive global support services can help maximize return on IT investment and minimize risk. With 24/7 access to systems specialists and valuable online technical resources, Oracle Premier Support can help customers proactively avoid business interruptions and enhance security.
- **Auto Service Request.** For customers who want maximum protection of their data, Oracle also offers automated services for remotely monitoring and managing storage systems. These remote services are designed to help customers increase service availability, reduce administration time, maintain storage system performance, and manage datacenter environments more efficiently.
- **Oracle Unified Storage System Administration.** These courses are designed to help administrators gain a deep knowledge of ZFS Storage Appliances through knowledge transfer that will allow staff to be more productive.

Conclusion

Oracle's approach to unified storage leverages Sun's more than 40 years of investment in system reliability and scalability to deliver cost-effective solutions that address some of today's most challenging business issues. Oracle's ZFS Storage Appliances bring a new level of simplicity and price/performance to the unified storage market by integrating innovative storage software with flash technology and an open architecture solution.

Customers can benefit by using these new systems to

- Increase application performance and backup performance
- Dramatically reduce the cost of high-performance storage
- Simplify storage deployment and management



Get More Storage Efficiency with Oracle's
Unified Storage
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