ZFS Storage Solutions for Unstructured Data Challenges

RB Hooks, III
Hardware CTO, Office of the CTO, Oracle National Security Group
The following is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Oracle’s products remains at the sole discretion of Oracle.
90% Of the World’s Data Has Been Created in the Last 2 Years
And That Data is Estimated to Grow 50X By 2020
Social Data Generated Every Minute

- 695,000 Status updates
- 510,040 Comments
- 204,166,667 Emails
- 2,000,000 Search Queries
- 571 New Websites
Internet Of Things

2012: 9 Billion Devices Connected to Internet
(More than Population of Earth)

2020: 50 Billion Devices Connected to Internet
Mobile Outpacing Internet

6 Billion
Mobile Subscribers

87%
Of World’s Population

Mobile Data Growing 78% CAGR

10.8 Exabytes
Per Month by 2016
Enterprise Data is Growing Faster Than Ever

45 PB+
Maintained by Large Orgs

45%+
Annual Growth

15 of 17
Industry Sectors in U.S. Now Have More Data Than U.S. Library of Congress
The Cost of Poor Data Management
A Good Storage Strategy is Key

• Customers are growing data around 40% a year
• The cost per TB is high $7,500-9,000
• IT budgets only increasing 1-2% a year
• Storage is 10% of IT budgets
• If it's 10%, then IT would need to grow 4% a year just to keep up

Ability to Innovate = zero
Storage Area Networks

In a snapshot

• Positives
  – High-performance Buss Architecture
  – Guaranteed Data Delivery
  – Scalability, Reliability
  – High Data Center Adoption

• Negatives
  – Operating System Support Specific
  – Block-based Architecture
  – Clustered Filesystem Required for Sharing
  – Host-based Data Management
Network Attached Storage

In a snapshot

• **Positives**
  – Low-cost Infrastructure
  – Integrated Operating System Support
  – File Based Architecture
  – Inherit File Sharing
  – Storage Based Data Management

• **Negatives**
  – Packet-based Delivery Methodology
  – High-protocol Overhead
  – No Guaranteed Data Delivery
ORACLE STORAGE

Sun ZFS Storage Appliances
Delivering Best-in-Class NAS Performance, Efficiency, and Oracle Integration


3rd Generation NAS Storage

Sun ZFS Storage 7120
Best value
Full suite of data services

Sun ZFS Storage 7320
Best flexibility
Single or dual controllers

Sun ZFS Storage 7420
Best scalability
High-Availability Environments

Standard features (all models)
Data protocols: FC, iSCSI, IB, NFS, CIFS, WebDAV, FTP, and more (see data sheet)
Advanced data services*: Snap, dedup., compression, analytics, and more (see data sheet)

Clients and applications (all models)
Oracle Solaris • Oracle Linux
Oracle database, middleware, and applications
Oracle VM • VMware • Windows
More than 50 business applications supported

Benefits
Extreme price/performance with reduced operating expenses due to superior management efficiency and analytics
Tight Red Stack integration

* Replication and clones are separately-licensed features
Industry-leading Storage Efficiency

**Application I/O**
- NFS
- CIFS
- IB
- iSCSI
- FC

**Virtual Pool**
- file, volume, and data services

**Storage Pool**
- read flash, write flash, and drives

**Performance**
- Automates storage tiering (HSPs)
- Eliminates distinct file and volume management
- Concurrent block and file I/O, with shared data services

**Data Integrity**
- Entire I/O path validated before data stored
- Eliminates potential for bit rot, phantom writes, etc.

**Analytics**
- Comprehensive and precise file-level view

**Storage OS Software**
- Auto Administration
- System Analytics
- Virtual Storage Pools
- Dynamic Data Tiering
- Modular Scalability
- Oracle SW integration
Most Powerful Analytics Tool Available

• Automatic real-time visualization of application and storage workloads

• Customer use examples of ZFS analytics:
  – System Utilization: Biotech company pinpoints disk bottlenecks (high utilization % or high IOPs) and under-use of disks
  – System Performance: Web Services company resolves client read performance issues by correlating with specific storage write operations
  – Tuning: Finances Services company pinpoints partial-block update issues not seen with NetApp
  – Load balancing: US bank visualizes and rebalances system resources for critical file systems

Database OLTP workload, 8kb block size, random I/O
Independent Study Confirms Simplified Management

36% Faster in administrative tasks
36% Faster to provision new storage
44% Faster to monitor and troubleshoot issues

“Oracle’s ZFS Storage Appliances dramatically outperformed the other vendors and allowed us to decrease our maintenance and management costs by almost 50%.”

Vincent Sourin
Systems Engineer
Bridgestone
Oracle IT Runs on Oracle Storage

Over 150 Petabytes of ZFS Storage in Production Across Oracle IT Data Centers

Results with Oracle’s ZFS Storage Appliances

- 3:1 consolidation replacement of existing NAS platforms
- 12x faster in compute farm workload benchmarks
- 5x faster in database test suite execution
- 3x faster with twice the snap/clone data copies in Oracle application environments
- 50% reduction in tuning and trouble-shooting time

| Global IT |
|-------------------|-------------------|
| • Global voice, network infrastructure and data center operations |
| • IT risk and compliance |
| • Supporting 100K+ internal users and 1.2M+ external users in 145 countries |

| Commercial IT Oracle On Demand |
|-------------------|-------------------|
| • Comprehensive Cloud Products and Services for Business and IT |
| • Supporting over 5.5M users in more than 4,000 environments |
| • ~ 3.2 billion peak database transactions per hour; ~ 5.5 million business transactions per day |

| Product Development IT |
|-------------------|-------------------|
| • Product development operations |
| • Supporting 22K+ developers building over 3K products globally |
| • 10K hosts executing 90K jobs per day |
| • 235K compute hours per day |
Engineered for Extreme Performance

Most Horsepower Possible

- 31x more DRAM
- 8x more processing power
- 4x faster interconnect

Dynamic Storage Tiering

- Automated, real-time data migration from DRAM to multi-class flash, to multi-class disk storage.
- Only software engineered for multi-level flash and disk storage.

Source: 7420 vs. 3270 data sheets
Only Oracle’s Sun ZFS Storage Appliances deliver market-leading performance in all workloads.

- 2x Faster 1/2 the price of NetApp
- 3x Faster 1/5 the price of NetApp
- 10x Faster 1/20 the price of NetApp

OLTP

OLAP

Data Warehouse With Oracle Database
Building a Reputation for Extreme Performance

ZFS Storage Demonstrates Industry-leading Performance in all Storage Benchmarks!

<table>
<thead>
<tr>
<th>SPC-1 OLTP</th>
<th>SPC-2 DSS/OLAP</th>
<th>SPECsfs</th>
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</thead>
<tbody>
<tr>
<td><strong>Oracle (7420)</strong></td>
<td><strong>Oracle (7420)</strong></td>
<td><strong>Oracle (7420)</strong></td>
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<tr>
<td>137,066</td>
<td>107,708</td>
<td>267,000</td>
</tr>
<tr>
<td>68,035</td>
<td>7,4GB/s</td>
<td>134,140</td>
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<tr>
<td>62,261</td>
<td>4.8GB/s</td>
<td>101,183</td>
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<tr>
<td>53,014</td>
<td>3.1GB/s</td>
<td>2.5ms response</td>
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</table>

Sources:
SAN: storageperformance.org
NAS: spec.org/sfs2008/
SPC 1 Benchmark: Storage benchmark that represents a typical database block protocol workload

IOPS

<table>
<thead>
<tr>
<th>Storage System</th>
<th>IOPS</th>
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<tbody>
<tr>
<td>IBM Storwize V7000</td>
<td>~60,000</td>
</tr>
<tr>
<td>NetApp FAS 3270</td>
<td>~60,000</td>
</tr>
<tr>
<td>HDS AMS 2500</td>
<td>~90,000</td>
</tr>
<tr>
<td>Sun ZFS Storage 7420</td>
<td>~120,000</td>
</tr>
</tbody>
</table>

$/$IOPS

<table>
<thead>
<tr>
<th>Storage System</th>
<th>$/$IOPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM Storwize V7000</td>
<td>~$4.00</td>
</tr>
<tr>
<td>NetApp FAS 3270</td>
<td>~$3.00</td>
</tr>
<tr>
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</tr>
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<td>Sun ZFS Storage 7420</td>
<td>~$2.00</td>
</tr>
</tbody>
</table>

Sun ZFS Storage 7420: 2X Price / Performance

**SPC 2 Benchmark**: Storage benchmark that represents performance of block protocol throughput workloads

**Sun ZFS Storage 7420**: 7X Price / Performance

### MBPS

- **HDS USP V**
- **IBM DS8800**
- **Sun ZFS Storage 7420**

### $/MBPS

- **HDS USP V**
- **IBM DS8800**
- **Sun ZFS Storage 7420**

**SPECsfs Benchmark:** Storage benchmark that measures file server throughput and response time, providing a standard method for comparing performance across different vendor platforms.
**SPECsfs Benchmark**: Storage benchmark that measures file server throughput and response time, providing a standard method for comparing performance across different vendor platforms.

**IOPS**

- NetApp FAS 3270 (2 Node)
- NetApp FAS 6240 (2 Node)
- Isilon (28 node)
- Sun ZFS Storage 7420

**$/IOPS**

- NetApp FAS 3270 (2 Node)
- NetApp FAS 6240 (2 Node)
- Isilon (28 node)
- Sun ZFS Storage 7420

Sun ZFS Storage 7420: 3X Price / Performance

Source: Standard Performance Evaluation Corporation, [www.spec.org](http://www.spec.org) and IDEAS International
Exceeding Enterprise Cloud Extremes

Oracle Cloud Runs on Sun ZFS Storage Appliances
More than 150 Petabytes in Production Across Oracle

Every ZFS Storage Appliance machine powering the Oracle Cloud delivers to cloud storage extremes

- 41,650 concurrent application users
- 47 database instances
- 15.4 million database transactions per hour
- 8 disparate enterprise applications
- 4 storage protocols
- 3 weekly full backups to StorageTek SL3000/T10000 Tape
- Zero downtime environment
ZFS Appliance Monitor

- iPhone application that monitors multiple ZFS Storage Appliances
- Brings the power of DTrace Analytics at your fingertips
- Easily view the health/status of any ZFS Appliance, anywhere
- Ideal for Execs/Storage Admins with need for instant access to information

Graphical and intuitive display of:

- System and component status (disks, CPU, RAM, fans, etc)
- Service status (NFS, iSCSI, SMB, etc)
- Resource & I/O status
- DTrace Analytics (real time statistics via saved worksheets)
- Logs for alert, system, fault, audit, phone home
- Active systems problems (can be marked as repaired via app)
- High level group status including storage use, problems, hardware status
- Storage utilization
- Remote activation of system and component locator LED

Available now on App Store
“It can handle over a hundred threads processing many thousands of IO requests in parallel vs. conventional storage systems that are limited to as little as 8 processing threads and Gigabytes of memory. It is this unique architecture that enables ZFS Storage Appliances to directly integrate with Oracle databases and applications. The results are notably higher efficiencies, flexible on-demand interactions, and greater performance, at much lower costs.”

“Why The Era of General Purpose Storage is Coming to an End”

Marc Staimer, President
Dragon Slayer Consulting
Oracle’s Hybrid Columnar Compression (HCC)

Up to 50x Data Compression
Ideal for: Data Warehousing, Database ILM, DR, Test/Dev

Oracle Exadata
Pillar Axiom
Sun ZFS Storage Appliance

HCC Compresses Databases

3-5x Less Disk Space
3-5x Less Energy Used
3-5x Lower Cost
Versus NetApp or EMC
Snap Manager for Oracle DB
Manage snapshot copies in the ZFS Storage Appliance

- Allows for quick and efficient backup, restore, cloning and provisioning of application instances
- “Application Aware” → Ensures no data loss and consistent backups
- Supports Oracle 10g, 11g, RAC
  - Currently supports NFS/dNFS and iSCSI protocols
  - CLI version for multiple client platforms (Solaris, Linux, Windows)
- Database host support includes Solaris, Linux, Windows
- Snapshot types
  - Hot: Online
  - Cold: Offline
- Snapshot maintenance
  - Automated scheduler
  - Retention policies
  - Custom Attributed (annotate snapshot with metadata)
- Rollback to a snapshot
ZFS Backup Appliance
powered by ZFS

Backup for Oracle’s Engineered Systems
Up to 26TB/h backup, 10TB/h restore
4x faster restores than Data Domain
Scales to 2.6PBs
Breakthrough Storage Economics

- Gain significant cost **savings**
- **Reduce** your footprint and power bill
- **Speed** – better price/performance
- Reduce operational costs with **simple** data management
- Industry leading set of base software features
- Enjoy a single point of contact (SPOC) with Oracle services
Sun ZFS Storage Appliances

Best Analytics
Visualize and resolve issues up to 44% faster than with NetApp

Best Performance
OLTP and Backup performance up to 2x faster than with NetApp

Most Efficient
5x better storage efficiency with HCC for in-database archives

Trusted by Oracle IT
Oracle runs 150+PBs on Sun ZFS Storage Appliances
Hardware and Software

Engineered to Work Together