NetApp™

Go further, faster

Best Practices for Data Protection and Storage Flexibility

Cathy Wong
Systems Engineer

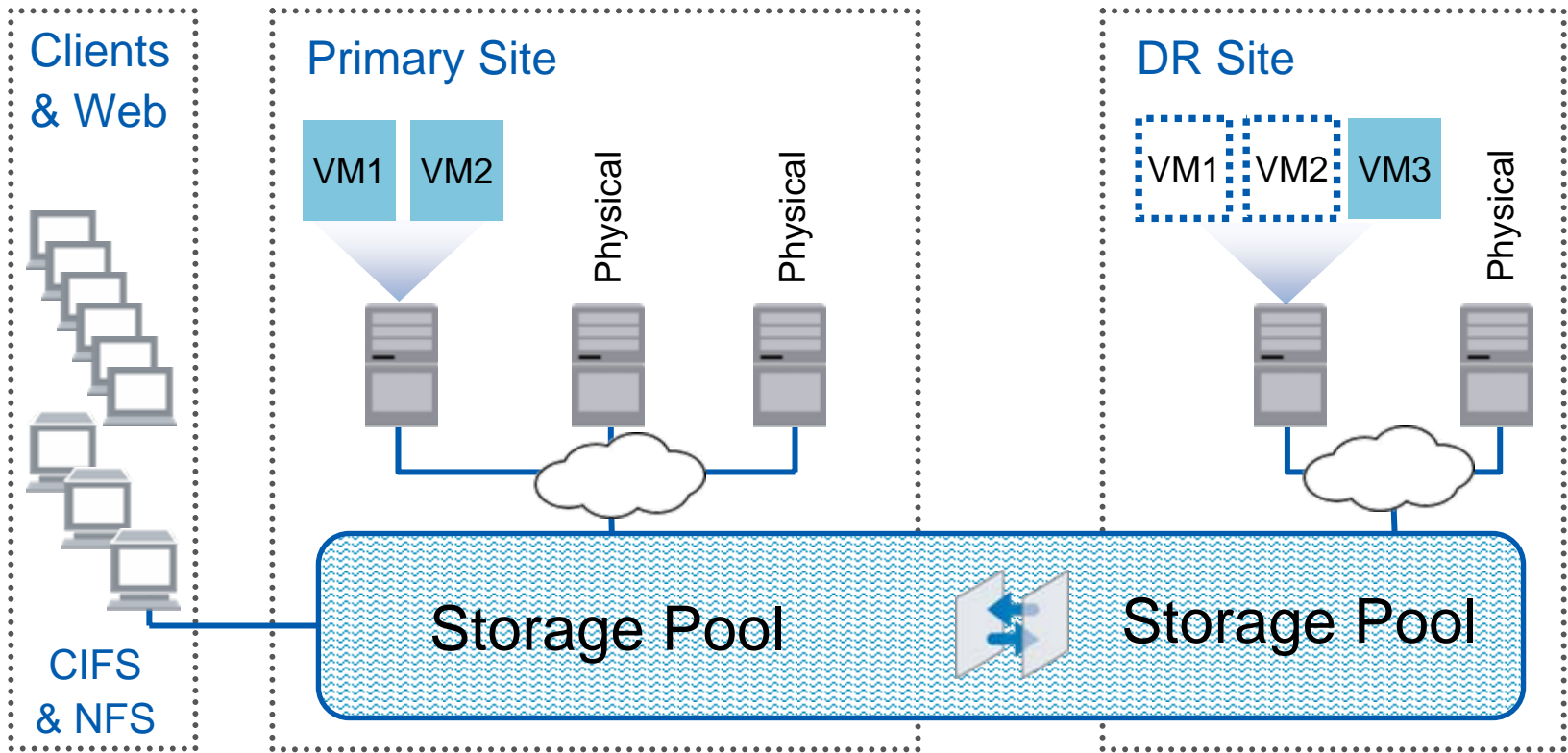7 Aug 2008

Agenda

- **NetApp Basics**
  - Data Protection
  - Storage Flexibility
- **Best Practices for Databases**
- **Best Practices for Virtualization**
- **Questions Throughout**
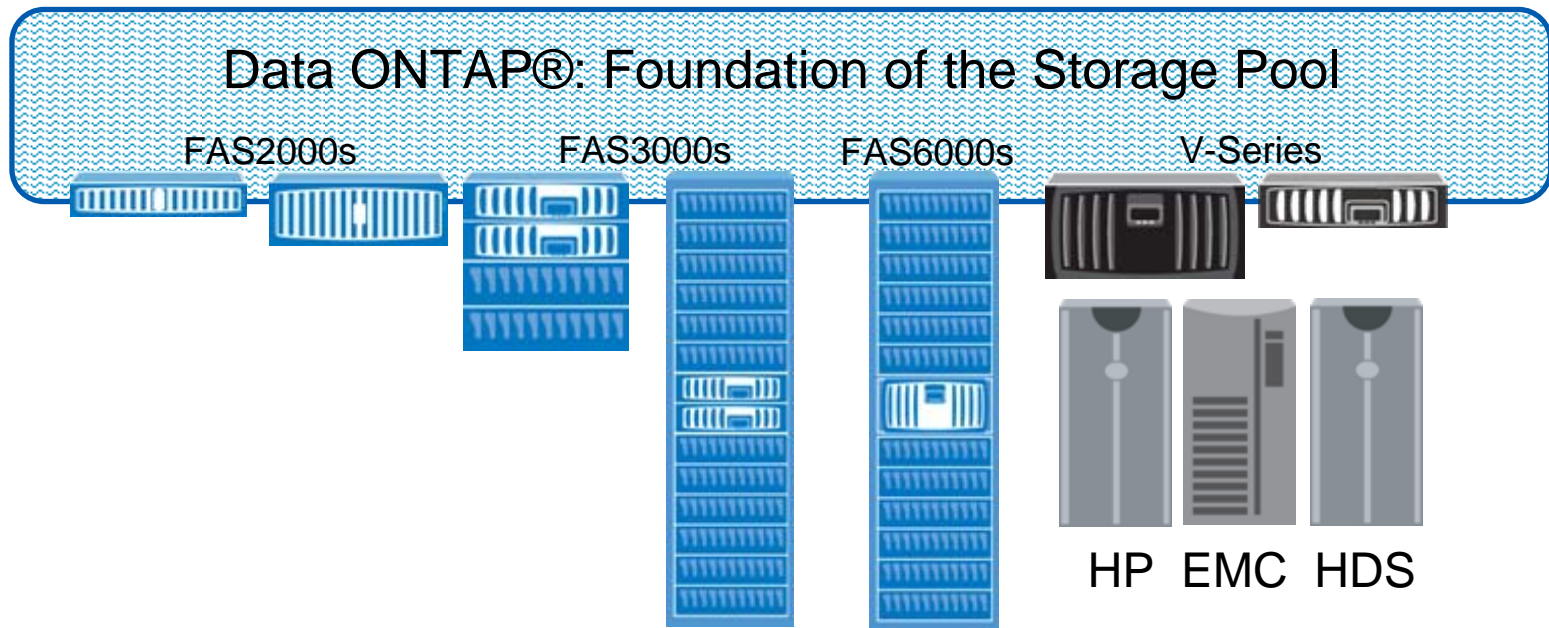
The Evolution of the Data Center

A common storage pool across physical and virtual

The Broadest Range of Unified Storage

Fabric-Attached Storage Family

- Unified storage – NAS, SAN, and iSCSI
- Tiered storage from mission critical to archival
- Common software, interface, and management tools
- Support for heterogeneous storage with V-Series

Data ONTAP®: Foundation of the Storage Pool

FAS2000s   FAS3000s   FAS6000s   V-Series

HP EMC HDS

Today's Storage Needs

Storage Pool Requirements

Storage Pool

Improved data protection
- Hardened platform
- Zero penalty backups
- Rapid recovery

Lower storage costs
- Thin provisioning
- End-to-end deduplication
- Simplified storage management

Increased storage flexibility
- Multiprotocol
- Rapid cloning & provisioning
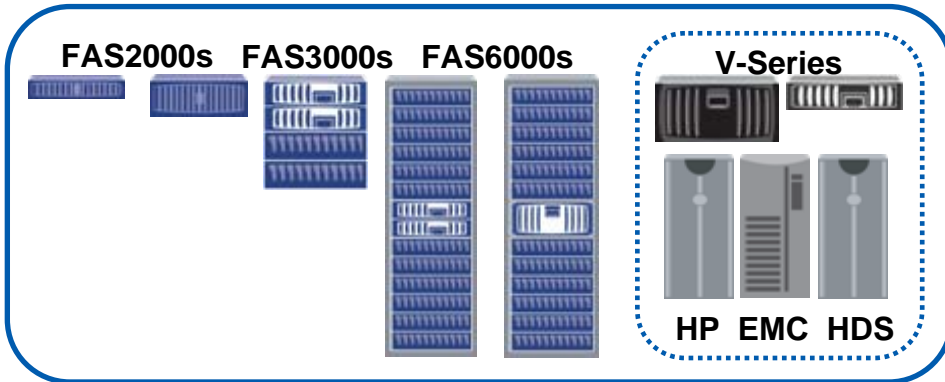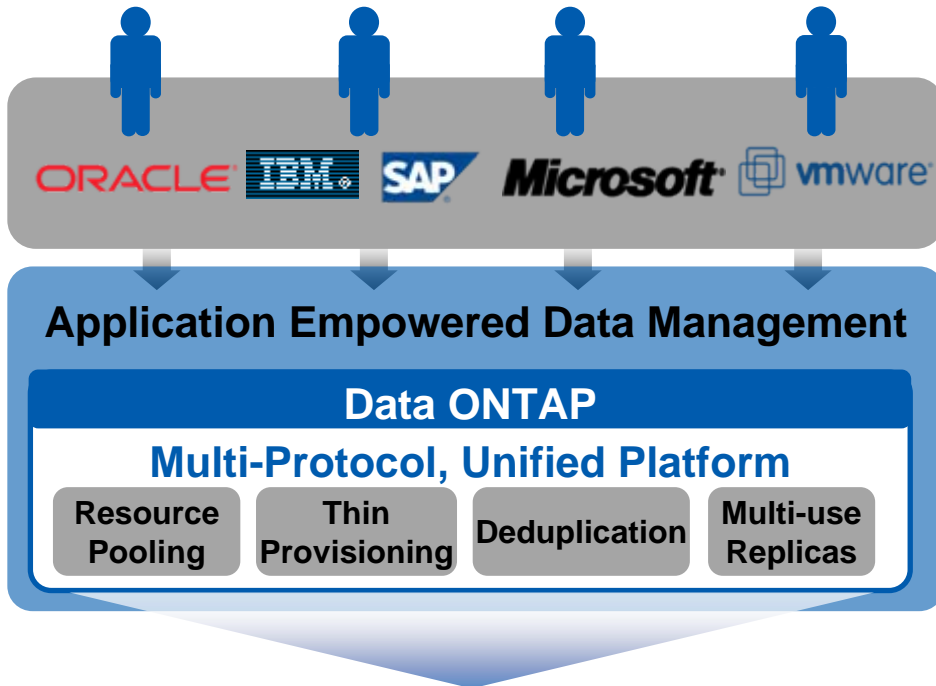- Scales from small to large

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NetApp Best Practices

Data ONTAP
Provides Foundation For Application-Centric Storage

Application Empowered Data Management

Data ONTAP

Multi-Protocol, Unified Platform

Resource Pooling	Thin Provisioning	Deduplication	Multi-use Replicas

FAS2000s   FAS3000s   FAS6000s

V-Series

HP   EMC   HDS

Manage Data from applications:

▶ Application Admin's self-manage within established storage policy
▶ Reduced Admin h/c & training needs
▶ Increase flexibility of entire IT org.
▶ Application Synchronization
▶ Recover from interruptions
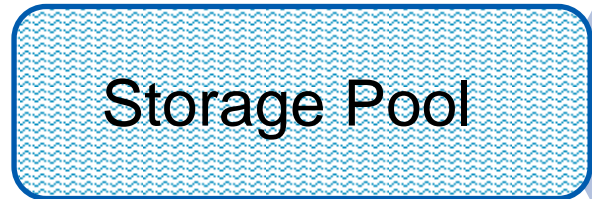
Start with one Storage Virtualization Engine:

▶ Manage storage pools instead of hardware
▶ The heart of Virtualized Data management

Simplify Elements to be Managed:

▶ Select: Capacity, Performance & Cost
▶ Supports: SAN & NAS Protocols
▶ Architected: for availability & simplicity

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Increased storage flexibility

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NetApp Best Practices

Cost-Effective Data Reliability

The Problem

- Double-disk failure is a mathematical certainty
- RAID 5
  - Insufficient protection
- RAID 10
  - Double the cost

NetApp RAID-DP™ Solution

- Protects against double- disk failure
- High performance and fast rebuild
- Same protection and performance as RAID 10 at half the cost

|	RAID 5	RAID 10	RAID-DP
Cost	Low	High	Low
Performance	OK	High	High
Resiliency	OK	High	High
	DAS	Other Storage Vendors	NetApp

Instantaneous Backup, Zero Server Impact

The Problem

- High server utilization
- No spare cycles for backups
- Tape is slow, complex, & expensive
- DR is very difficult

CPU Utilization

Server1 Server2
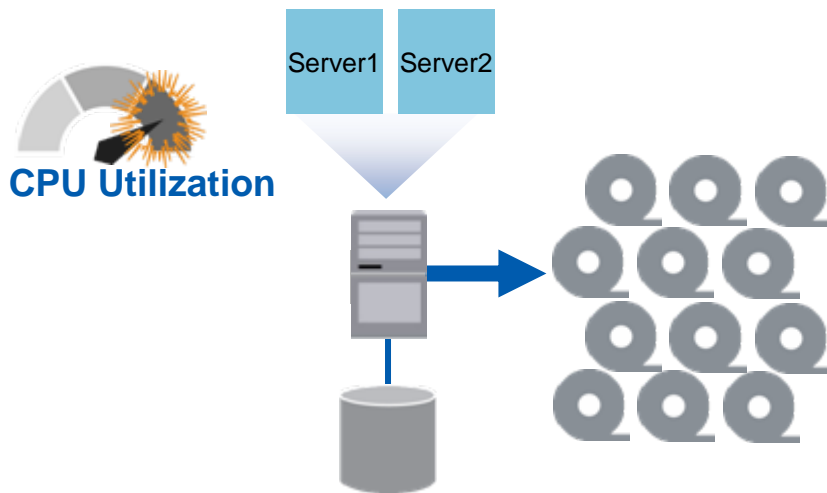
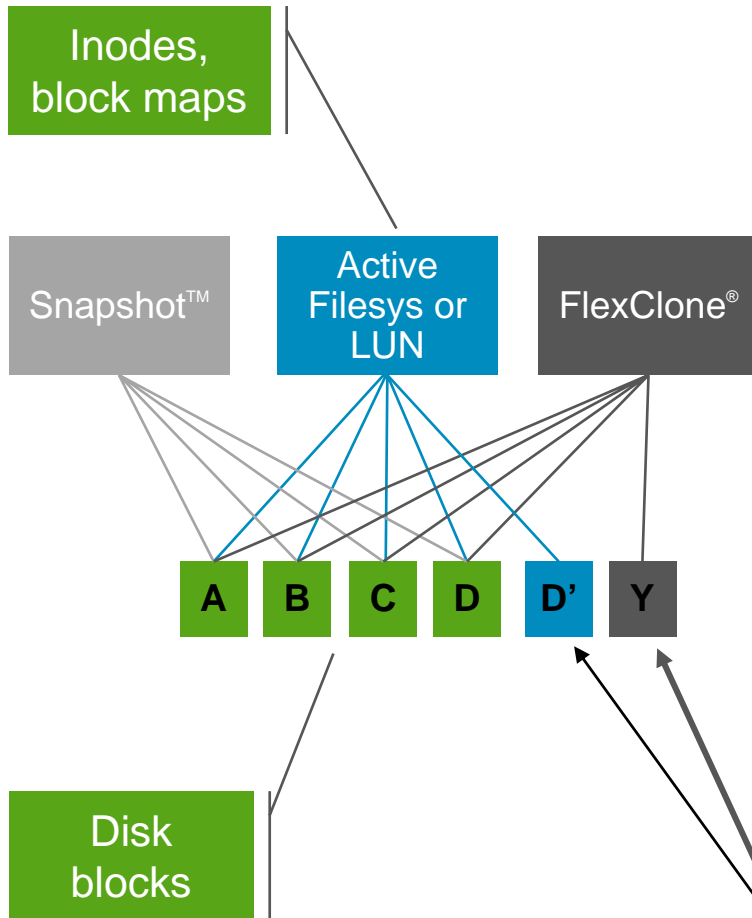**Traditional Backup Is NOT Practical**

NetApp Snapshot™ Solution

- Servers run apps, not background processes
- Instantaneous backup and recovery
- Low storage overhead
- Application consistent

CPU Utilization

Server1 Server2

Storage Pool
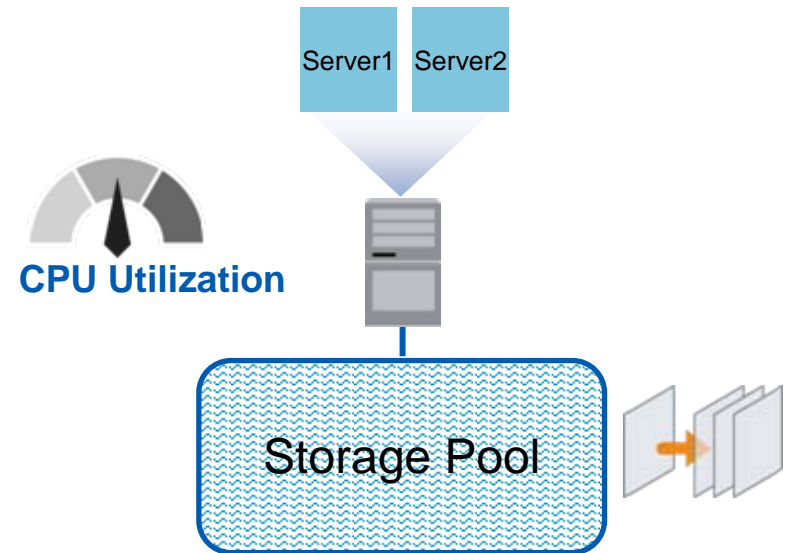
Fast, Affordable, and Simple Backup and Restores

The NetApp Foundation

NetApp's Unique DNA

- WAFL® – <u>W</u>rite <u>A</u>nywhere <u>F</u>ile Layout
  - Core block and file storage services
  - Resiliency features (RAID-DP™)
- Snapshot
  - Near-instantaneous, point-in-time "copy" of file system (vol) or LUN
  - Read-only
- SnapRestore®
  - Near-instantaneous "rollback" of vol or LUN to prior Snapshot copy
- FlexClone
  - Near-instantaneous, WRITABLE "copy" of vol or LUN
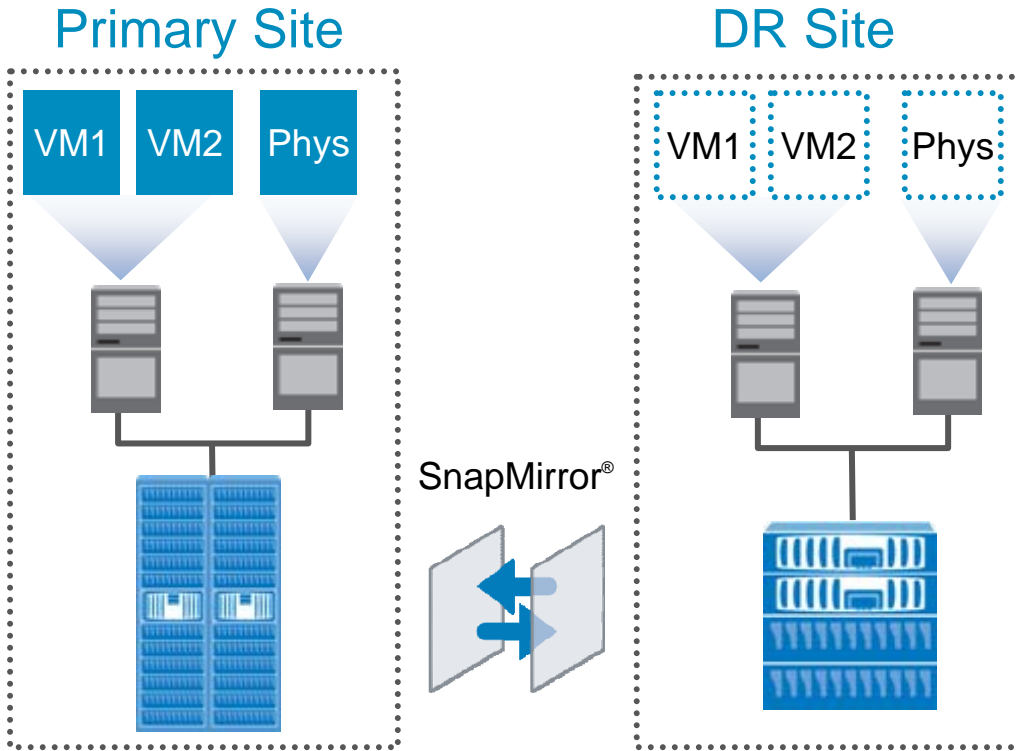 - Same space-sharing characteristics

Summary

Snapshot = A + B + C + D

Active = A + B + C + D'

FlexClone = Snapshot + Y

Incremental storage = <u>2</u> blocks

Simple, Rapid, and Reliable DR

Primary Site

VM1 | VM2 | Phys

SnapMirror®

DR Site

VM1 | VM2 | Phys

- Flexible
  - Async, sync
  - IP or FC
- Simplifies deployment and management
  - Simple setup and recovery
  - Single product across all storage systems
  - Leverages SnapManager®, ensuring replication of application-consistent Snapshot™ copies
- Cost effective
  - Mirrors between FC and ATA systems
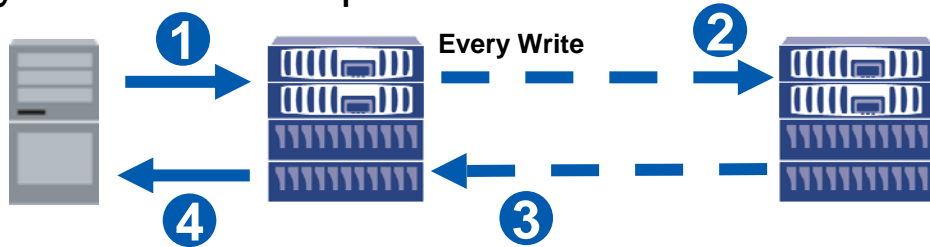 - Uses Snapshot copies—efficient storage and bandwidth

"[NetApp] has really facilitated our move to a virtualized server environment, and that is allowing us to dramatically minimize the risk and duration of any business downtime."

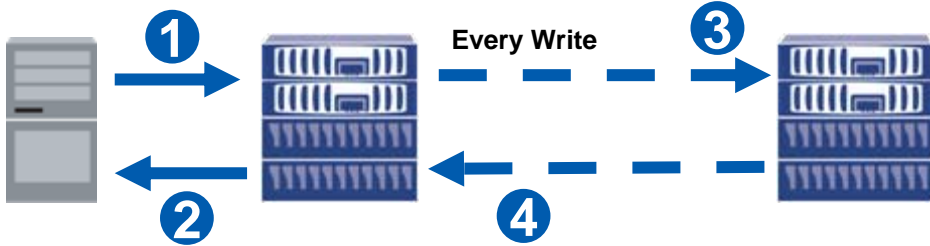George White, CIO, Pennsylvania Office of the Attorney General
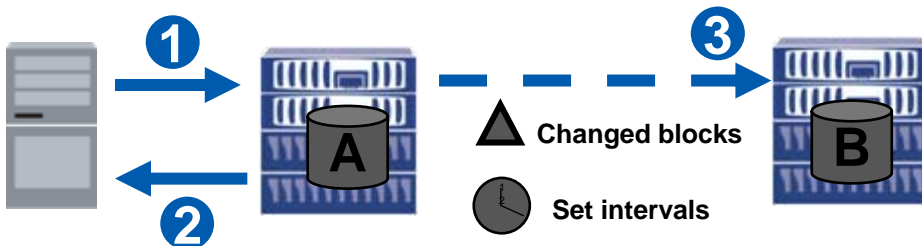
SnapMirror Modes

Synchronous SnapMirror

Every Write

- **No data loss exposure**
- **Replication distance < 100 km**
- **Some performance impact**

Semi-Synchronous SnapMirror

Every Write

- **Seconds of data exposure**
- **Extend beyond 100 km**
- **No performance impact**

Asynchronous SnapMirror

A
B

△ Changed blocks

🕐 Set intervals

- **1 minute - hours of data exposure**
- **No distance limit**
- **No performance impact**

Today's Storage Needs

Storage Pool Requirements

Storage Pool

Improved data protection
- Hardened platform
- Zero penalty backups
- Rapid recovery

Lower storage costs
- Thin provisioning
- End-to-end deduplication
- Simplified storage management

Increased storage flexibility

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NetApp Best Practices

Aggregates and FlexVol™ Volumes:
How they works?

Flexible Volume 1

Flexible Volume 2

Flexible Volume 3

vol1 vol2

vol3

Aggregate

RG1 **RG2** **RG3**
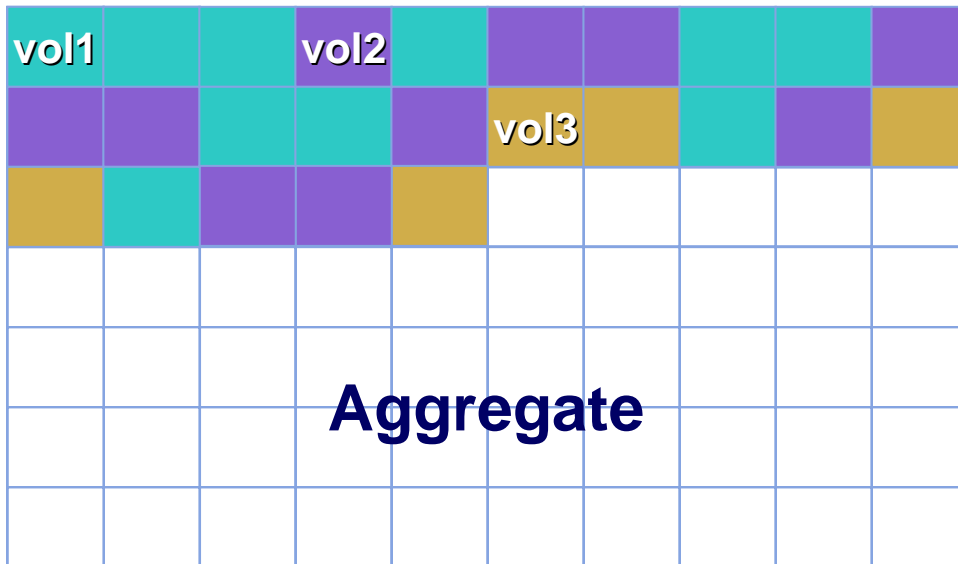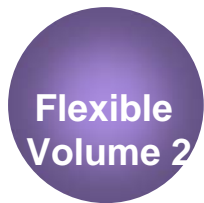
Aggregate

Create an aggregate

Create and populate the flexible volumes

▸ **No pre-allocation of blocks to a specific volume**

▸ **WAFL® allocates space from aggregate as data is written**
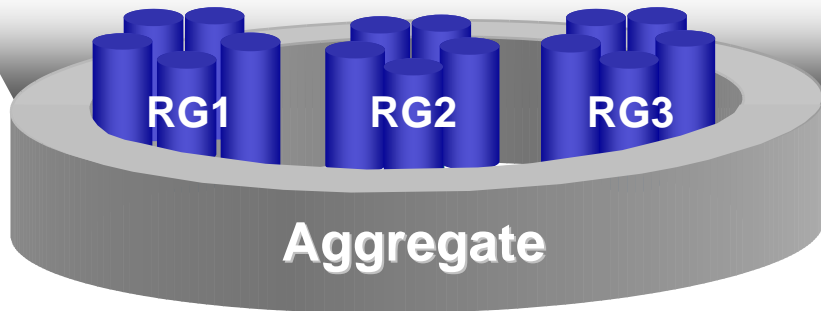
FlexVol™ Volumes: Increasing I/O Performance

Spindle Limit	2	4	3	
Volumes				
Disks				No performance gains
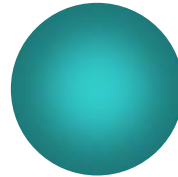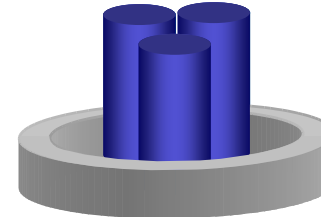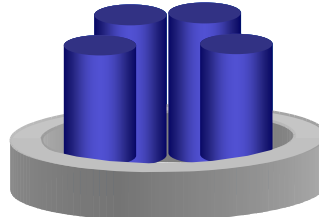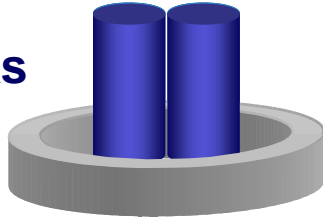
Spindle Limit	9	9	9	
Volumes				
Pooled Disks				**Substantial performance gains**
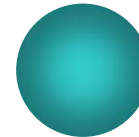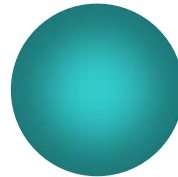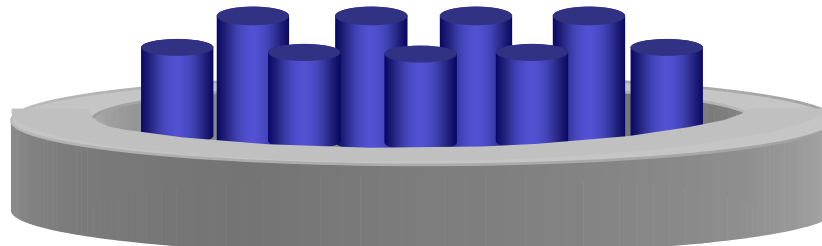
Lower Power, Cooling & Space

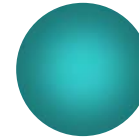Typical: 40% Utilization

NetApp: 70+% Utilization
Buy 50% Less Storage*
Save 50% in Power, Cooling, & Space*

App 3 — waste — 8 spindles

App 2 — waste — 6 spindles

App 1 — waste — 6 spindles

Shared capacity

App 3

App 2

App 1

12 spindles
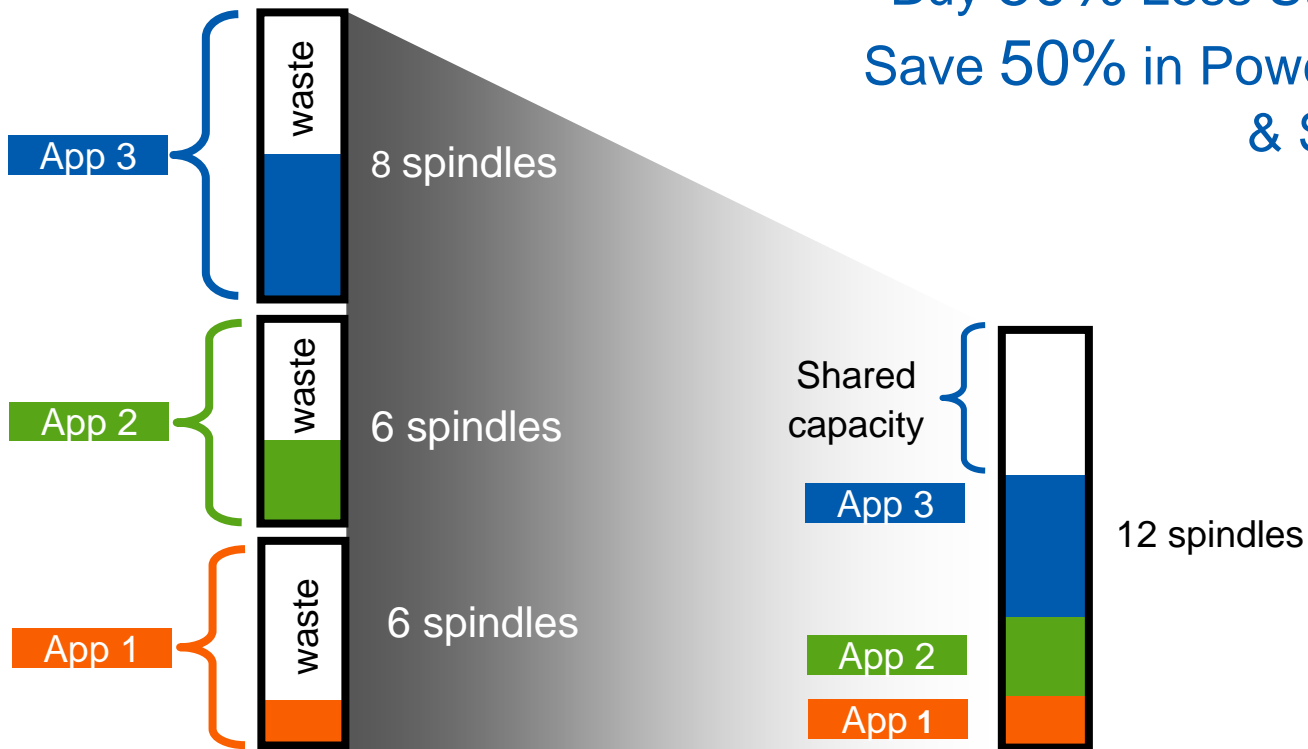
Standard Volume Manager

NetApp Thin Provisioning

Source: Oliver Wyman Study: "Making Green IT a Reality." November 2007.

*Thin Provisioning, clones, & multiprotocol all contribute to savings.

NetApp Deduplication – End-to-End

NetApp Deduplication

Before

After
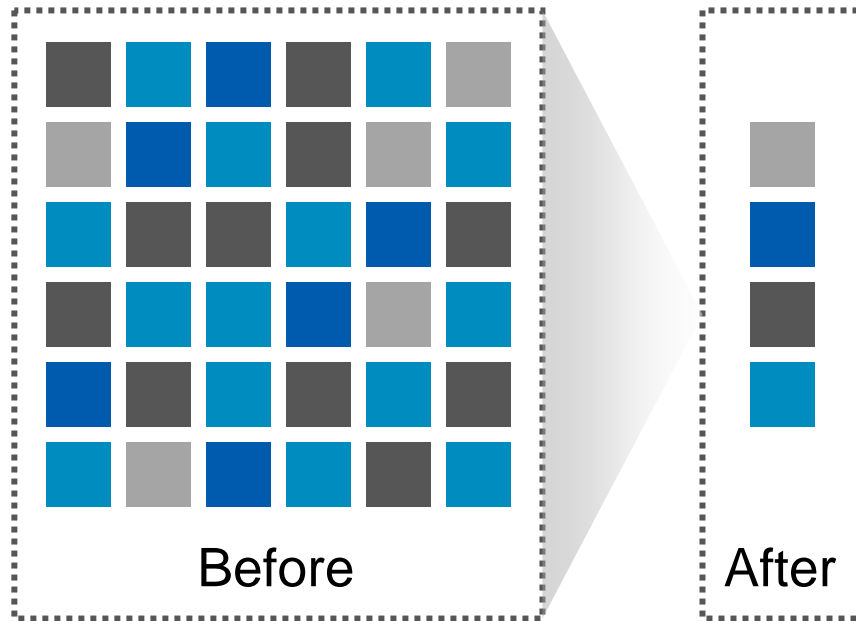
- **Savings across all tiers**
  - Primary, backup, and archival data
  - 50% space savings, or more
  - 95% or greater for backup
- **Integrated with Data ONTAP®**
  - General-purpose volume deduplication
- **Storage-efficient virtualization**
  - OS & application images
  - User home directories

"We decided to utilize NetApp SnapMirror® for replication and Deduplication, and these became a driving factor in our solution [achieving 80% storage savings on VMware® backup data with Deduplication]."

A Global Financial Services Firm

Source: Oliver Wyman VMware Storage Total Cost Comparison Interviews, Aug-Sept 2007

Space Savings Results
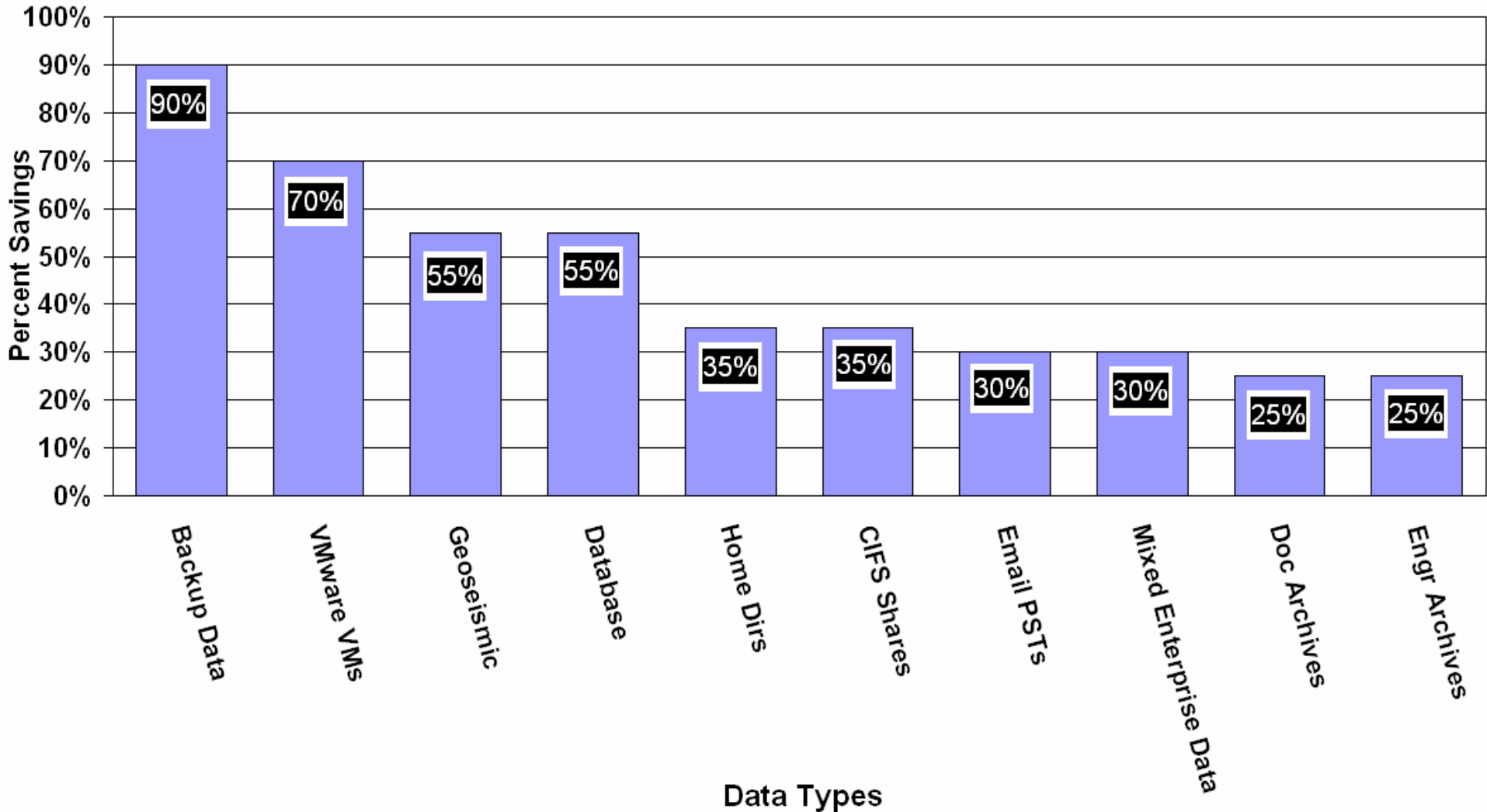
Application-Empowered Data Management
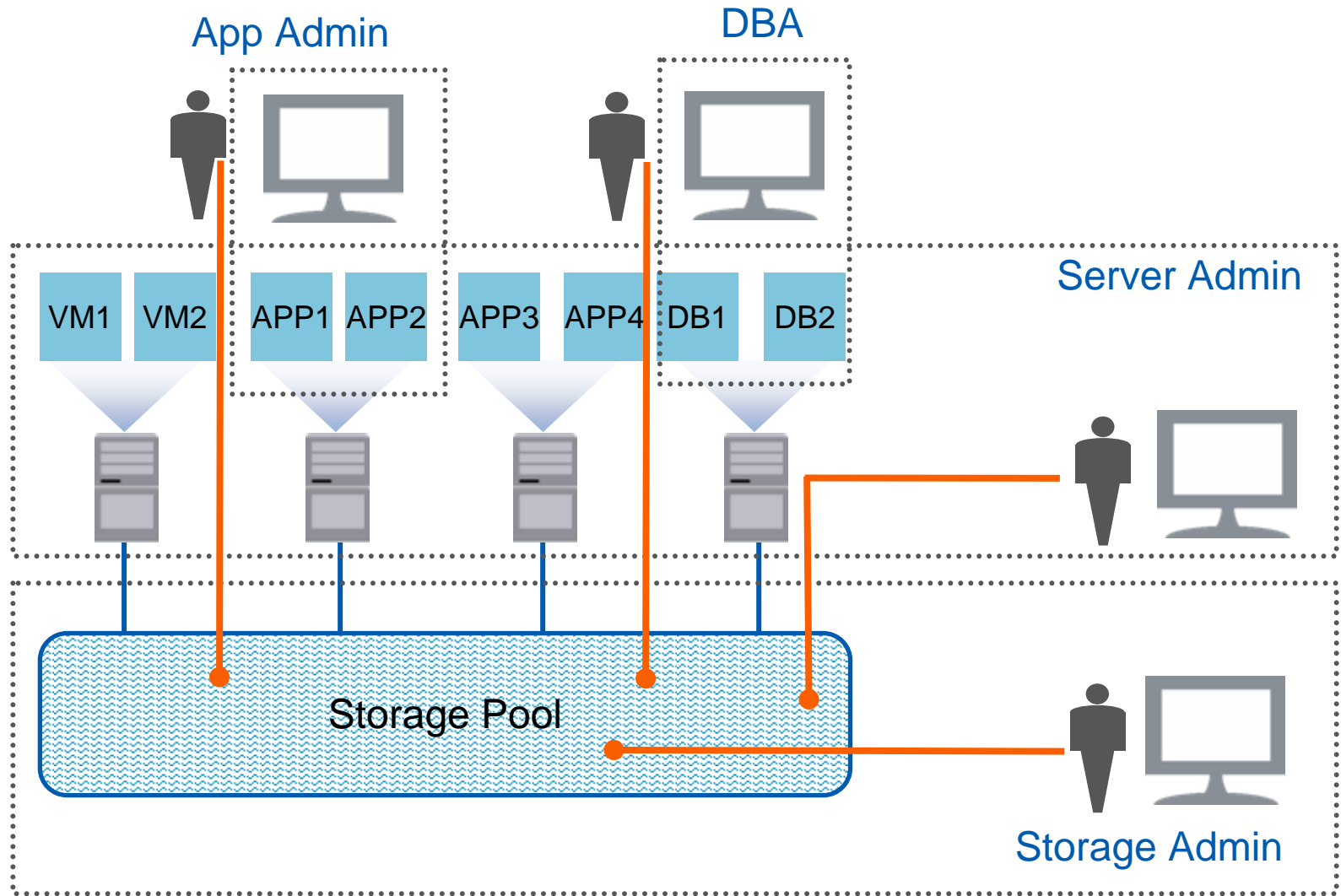
Today's Storage Needs

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Increased storage flexibility
- Multiprotocol
- Rapid cloning & provisioning
- Scales from small to large

+

NetApp Best Practices

Broadest Scalable Storage Architecture

FAS Family of Unified Enterprise Storage Systems

FAS2000

FAS3000

FAS6000

Data ONTAP$^{®}$ Operating System – SAN, NAS, iSCSI

- One architecture
- One application interface
- One management interface
- Total interoperability

Growth Comparison of IP Storage and FC SAN

MARKET DATA

Industry research firm IDC estimates that worldwide Ethernet-based storage systems (NAS and iSCSI SAN) will be a $7.3B market in 2009, $9.2B in 2010, and $10.8B in 2011. iSCSI SAN is growing at a 61% compound annual growth rate (CAGR), followed by NAS at a 13% CAGR. In contrast, FC SAN is growing at a 3% CAGR. As shown in Figure 3, Ethernet storage is projected to have strong growth and is expected to surpass Fibre Channel storage revenue in 2011. A large portion of Ethernet storage growth is projected in new data centers and expansion of existing data centers.
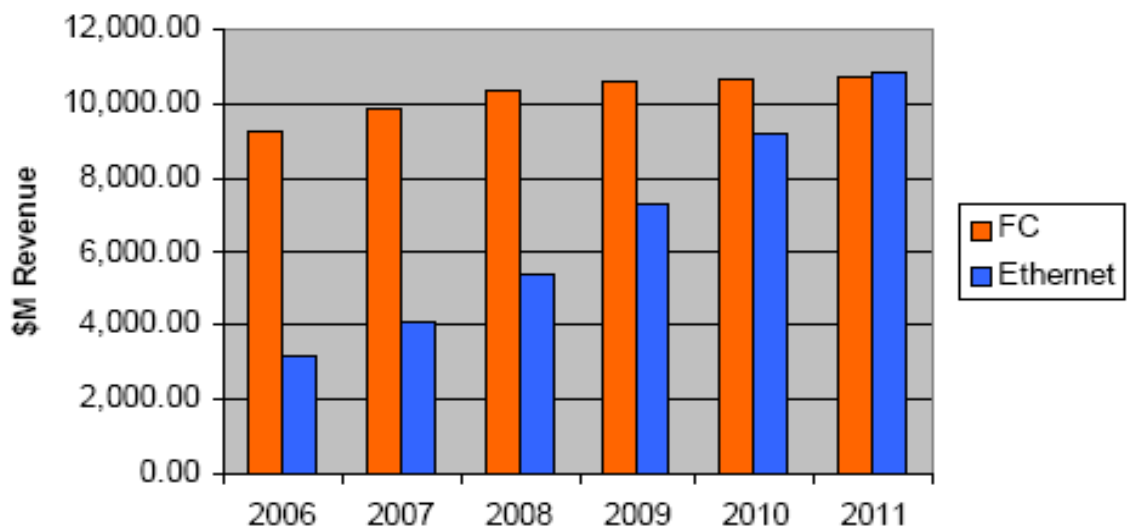
Other Networking Protocols

- Infiniband
  - Primarily used in high-performance computing
  - Penetration into network storage very limited
- 10GigE
  - Needs to be more readily available
  - Still expensive
    - Once costs continue to come down, will become more widely deployed
- FCIP and iFCP
  - Sending Fibre Channel data over IP networks.
  - FCIP (Fibre Channel over IP) is for exchanging data between FC networks across the Internet
  - iFCP (Internet Fibre Channel Protocol) is for extending FC networks across the Internet.
  - Both niche
- Fibre Channel over Ethernet (FCoE) – being developed
  - High performance storage access over lossless (Ethernet enhancement) 10GbE fabrics
  - Transparent access to storage using SAN management methods
  - Lower cost with fewer adapters, cables, and switches
  - Increase application availability by simplifying network and server configuration

8Gb Fibre Channel (FC) SAN Overview

- Next evolution in FC SANs
  - 1Gb ⟷ 2Gb ⟷ 4Gb ⟷ 8Gb
- Builds on 10+ years of FC experience
  - FC SAN is $11B market
- Multicore processors, high-density servers, increased performance in server I/O, and server virtualization are driving the need for increased performance and bandwidth
- Ideal for disk-to-disk backup, archiving, modeling, streaming media, imaging

8Gb Fibre Channel Support - End-to-End (Q4 '08)

Windows, VMware

Linux, AIX, HP-UX, Solaris

HBA HBA HBA HBA HBA HBA HBA HBA

NetApp Sells and Services

– Windows, VMware, Linux, AIX, HP-UX, Solaris
– Native MPIO, Cluster and Veritas SF support

– SnapManager, SnapDrive
– 8Gb Emulex LPe12000x
– 8Gb Qlogic QLE256x

– 8Gb Brocade DCX, 48000
– 8Gb Brocade 300, 5100, 5300
– 8Gb Cisco 9500 series

– 8Gb FAS3000, FAS6000
– 8Gb V3000, V6000
  ▪ 8Gb PCI-E adapter
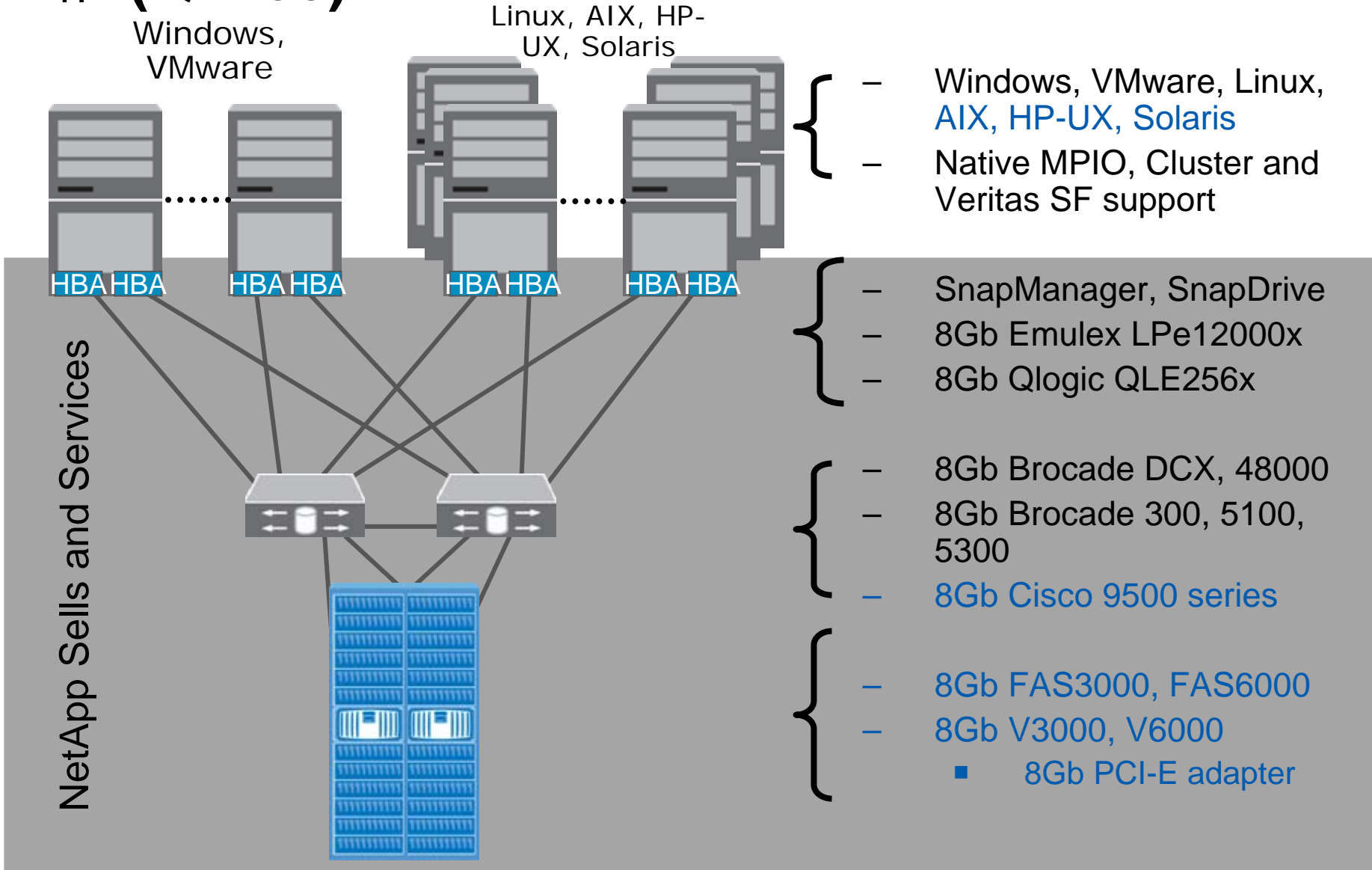
Cloning a File System

▶ Traditional Methods

  – Backup and Restore

  – Replicate data to secondary location and create clones.

  – Split Mirror (3 Way Mirror)
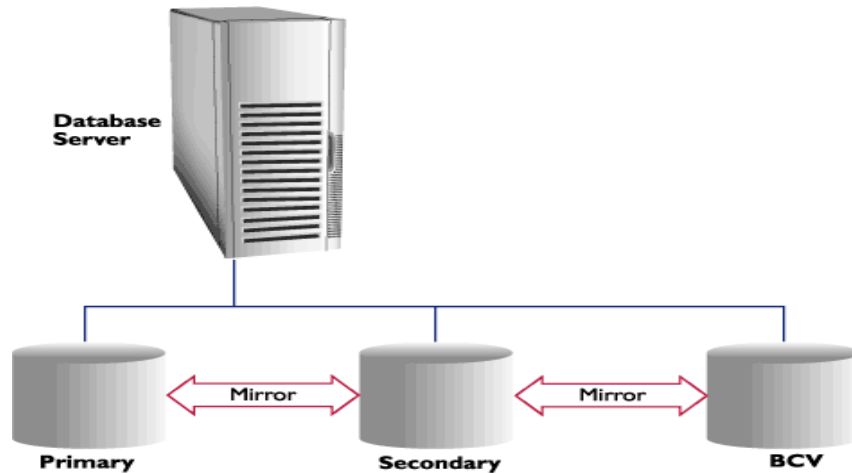
FIGURE 1: Three fully mirrored drive sets

■ NetApp Flexclone is Simpler

Data Base Cloning

Why Clone?

- Copy production database
  - Test & Dev environments
- Mirror for data protection
- DR site enabled for Read/Write
- System upgrade/Deployment test
- Data Mining
- Data warehouse
- More..

Challenges

- Copies whole data set takes very long time
- Copies consume lots of disk
  - < 10% unique data
- Refresh complications

Solution

- FlexClone
  - Instantaneous copies
    - Improved productivity
  - Low overhead
    - Reduced costs

- Faster time to market
- Higher quality
- Lower cost

Database Clone
Method - Traditional Vs NetApp
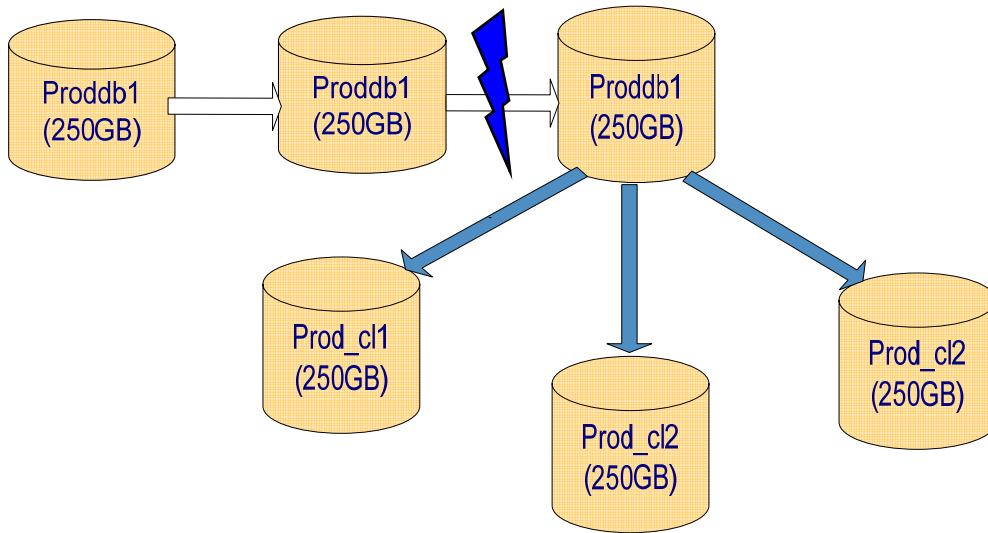
Traditional Clone

Third Mirror	250 GB
Clone	750 GB

Total	1000 GB

NetApp FlexClone

Third Mirror	0 GB
Clone*	0 GB

Total*	0 GB
------------------------------------	

*Negligible space for Snapshot Meta data
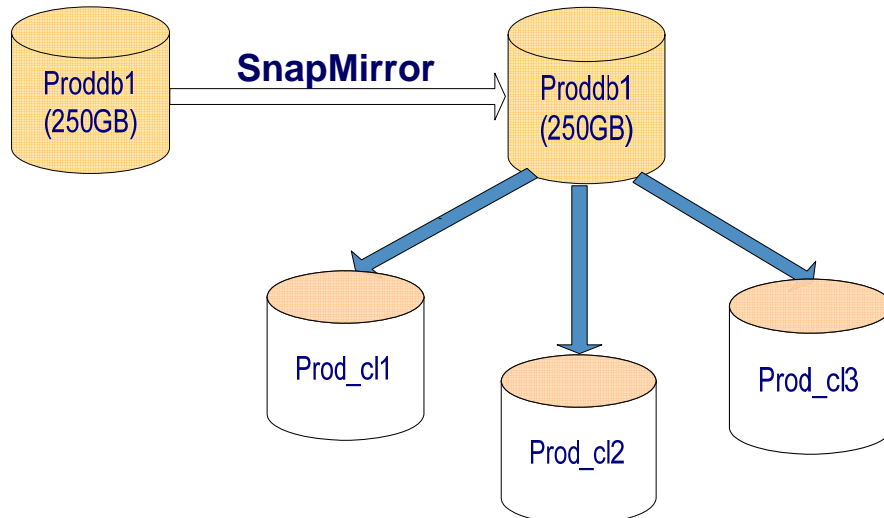
Accelerate Test & Dev Environments in VMs

Traditional Provisioning

27 mins
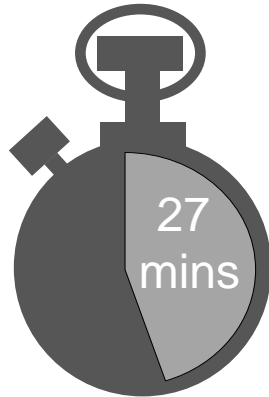
- Time-consuming physical copies
- Slow to provision or reprovision
- Manual and complex
- Not suited for VM provisioning

NetApp Provisioning

3 sec

- Instant copies with FlexClone®
- Quick provisioning with FlexVol®
- Simple commands or policies
- Ideal for dynamic VM environment

"We can simulate every new solution we plan to introduce without interrupting the production, while predicting all the consequences and the risks to the system"

Rami Sasson, Sonol Oil (NetApp and VMware customer)

Fabric-Attached Storage (FAS)

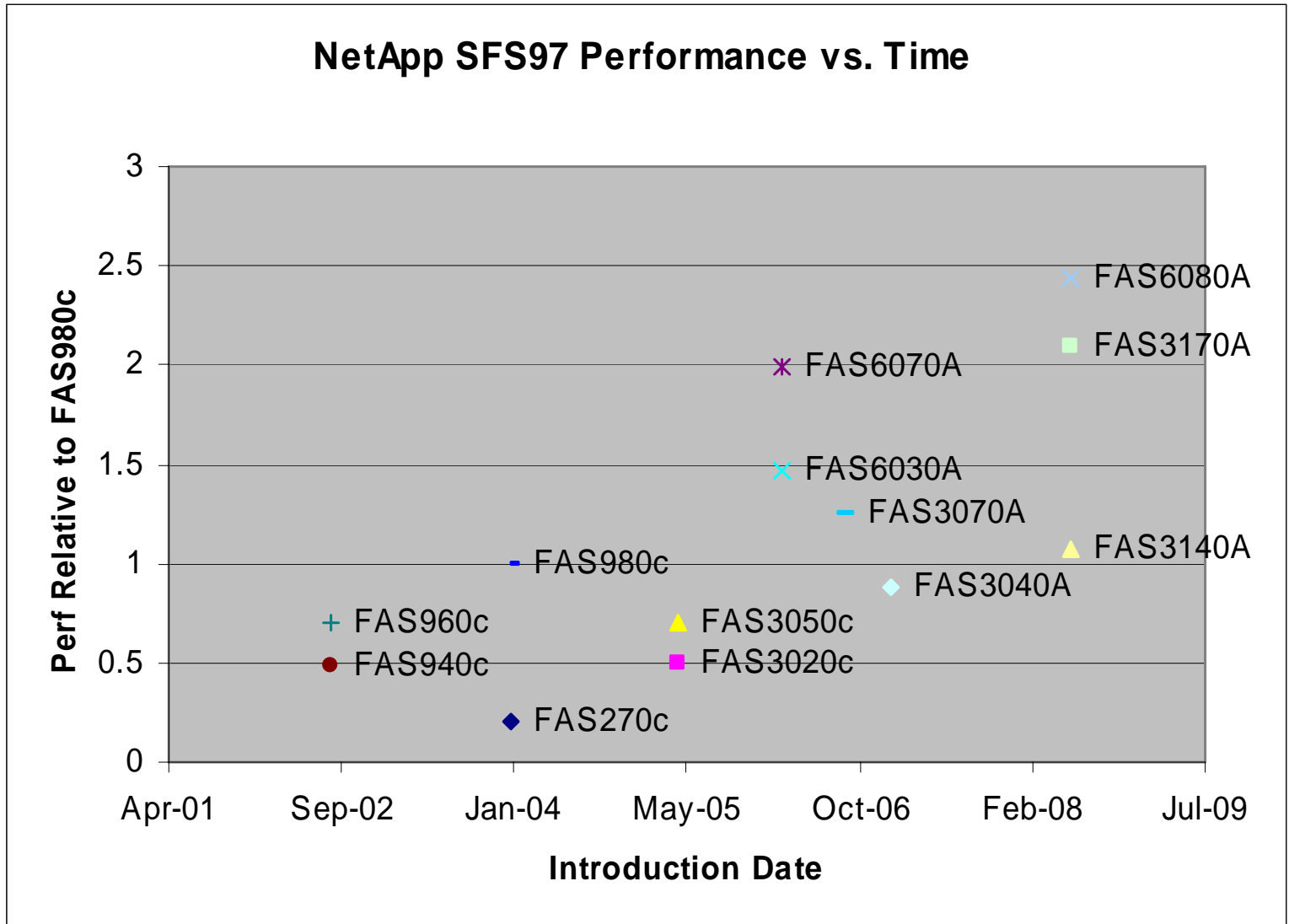| Model	FAS6080	FAS6040	FAS3170	FAS3140	FAS3070	FAS3040	FAS3020	FAS2050	FAS2020	FAS270	FAS250
Front View											
System Capacity Raw Maximum[1]	1,176TB	840TB	840TB	420TB	504TB	336TB	84TB	104TB	68TB	16TB	4TB
Aggregate/Vol Maximum Size[2]	16TB	16TB	16TB	16TB	16TB	16TB	16TB	16TB	8TB	8TB	2TB
Max Back-End FC Loops	14	10	10	6	8	6	4	2	2	1	-
Max Expansion Disk Shelves	84	60	60	30	36	24	12	6	4	3	-
Max Drive Quantity — FC	1,176	840	840	420	504	336	168	84 (external)	56 (external)	56 (14 int + 42 ext)	14 (internal)
Max Drive Quantity — SAS	-	-	-	-	-	-	-	20 (internal)	12 (internal)	-	-
Max Drive Quantity — SATA	1,176	840	840	420	504	336	168[4]	104 (20 int + 84 ext)	68 (12 int + 56 ext)	28 (external)	-
Environmental HA Pair/Single Controller — Height (HA/Single)	12U / 6U	12U / 6U	6U / 6U	6U / 6U	6U / 3U	6U / 3U	6U / 3U	4U / 4U	2U / 2U	3U / 3U	- / 3U
Weight (HA/Single)	242 lb. (109.6 kg) 121 lb. (54.8 kg)	242 lb. (109.6 kg) 121 lb. (54.8 kg)	122 lb. (55.3 kg) 95 lb. (43.1 kg)	122 lb. (55.3 kg) 95 lb. (43.1 kg)	150 lb. (68 kg) 75 lb. (34 kg)	150 lb. (68 kg) 75 lb. (34 kg)	150 lb. (68 kg) 75 lb. (34 kg)	110 lb. (50 kg) with drives	60 lb. (27.2 kg) with drives	77 lb. (35 kg) with drives	77 lb. (35 kg) with drives
AC Power (HA only)	100-120V 11.2A 200-240V 5.8A	100-120V 10.8A 200-240V 5.6A	100-120V 8.1A 200-240V 4A	100-120V 5.9A 200-240V 2.9A	100-120V 7.4A 200-240V 4.2A	100-120V 6.8A 200-240V 3.8A	100-120V 4.8A 200-240V 2.8A	100-120V 5.7A 200-240V 2.9A	100-120V 4.1A 200-240V 2.2A	100-120V 4A 200-240V 2A	100-120V 4A 200-240V 2A
Thermal[3] (HA/Single)	3,740 BTU/hr 1,870 BTU/hr	3,624 BTU/hr 1,812 BTU/hr	2,761 BTU/hr 1,602 BTU/hr	2,026 BTU/hr 1,272 BTU/hr	2,466 BTU/hr 1,233 BTU/hr	2,304 BTU/hr 1,152 BTU/hr	1,610 BTU/hr 805 BTU/hr	2,247 BTU/hr 1,988 BTU/hr	1,587 BTU/hr 1,298 BTU/hr	1,279 BTU/hr	1,178 BTU/hr
Platform Specifications HA Pair/Single Controller — Processor (HA/Single)	8 / 4 64-bit dual-core	4 / 2 64-bit	4 / 2 64-bit dual-core	2 / 1 64-bit dual-core	4 / 2 64-bit dual-core	4 / 2 64-bit	2 / 1 32-bit	2 / 1 32-bit	2 / 1 32-bit	2 / 1 64-bit	1 64-bit
RAM (HA/Single)	64GB / 32GB	32GB / 16GB	32GB / 16GB	8GB / 4GB	16GB / 8GB	8GB / 4GB	4GB / 2GB	4GB / 2GB	2GB / 1GB	2GB / 1GB	512MB
NVRAM (HA/Single)	4GB / 2GB	1GB / 512MB	4GB / 2GB onboard	1GB / 512MB onboard	1GB / 512MB	1GB / 512MB	1GB / 512MB	512MB / 256MB NVMEM	256MB / 128MB NVMEM	256MB / 128MB NVMEM	64MB NVMEM
PCI Slots (HA/Single)	10 / 5 (PCIe) 6 / 3 (PCI-X)	10 / 5 (PCIe) 6 / 3 (PCI-X)	8 / 4 (PCIe)	8 / 4 (PCIe)	6 / 3 (PCIe)	6 / 3 (PCIe)	6 / 3 (PCI-X)	2 / 1 (PCIe)	-	-	-
Ethernet (HA/Single)	12 / 6 GbE RJ45	12 / 6 GbE RJ45	4 / 2 GbE RJ45	4 / 2 GbE RJ45	8 / 4 GbE RJ45	8 / 4 GbE RJ45	8 / 4 GbE RJ45	4 / 2 GbE RJ45	4 / 2 GbE RJ45	4 / 2 GbE RJ45	2 GbE RJ45
FC Ports (HA/Single)	16 / 8 4Gb SFP[8]	16 / 8 4Gb SFP[6]	8 / 4 4Gb SFP[6]	8 / 4 4Gb SFP[6]	8 / 4 4Gb SFP[6]	8 / 4 4Gb SFP[6]	8 / 4 2Gb SFP[7]	4 / 2 4Gb SFP[6]	4 / 2 4Gb SFP[6]	4 / 2 2Gb SFP[7]	1 2Gb SFP[7]
Data ONTAP[8] (Min Release)	7.2.4	7.2.4	7.2.5	7.2.5	7.2.1 10.0.2	7.2.1 10.0.2	7.0.1	7.2.2L1	7.2.2L1	6.5	6.4.3

Relative Performance

NetApp SFS97 Performance vs. Time

Databases

Database Volume Setup

- Pool disks into one large aggregate
  - Separate volumes for data files and log files
- Structure volumes on backup, restore, and replication requirements
  - No data to suggest performance improves/degrades if split up volumes for data files and logs
- RAID group size of 16 disks
  - Additional parity disk provides additional protection
- Turn off automatic snapshots on volumes
  - Want to put database in hot backup mode first

Data Protection with SnapManager for Oracle®

ORACLE®

D A T A B A S E 9i, 10g, 11g

SnapManager for Oracle
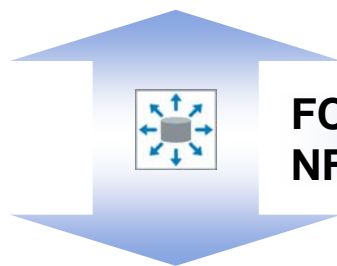
FCP • iSCSI • NFS • Direct NFS
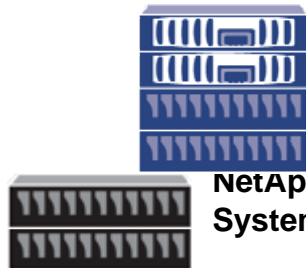
NetApp Storage Systems

- Easy-to-use GUI or CLI integrates with host application
- Automates DB quiescence
- Automates and simplifies complex manual processes – backup/restore and cloning
- Saves administrative time
- Integration with RMAN, RAC, ASM and Direct NFS
- Handles NFS, FC and iSCSI protocols

Concepts: Architecture

Clients

Servers

Storage

root

oracle

SMO Repository

SMO Server

SnapDrive

Filesystem/VolumeManager

O/S CLI

SMO GUI

SMO CLI

RMAN*
*Required for ASM

RMAN Catalog

LSNR

SQL Plus

ASMLib*
*Required for ASM on Linux

Target Database

Data ONTAP

ZAPI

JDBC

HTTPS

CLI

CLI

CLI

JDBC

CLI

CLI

iSCSI/FCP

NFS
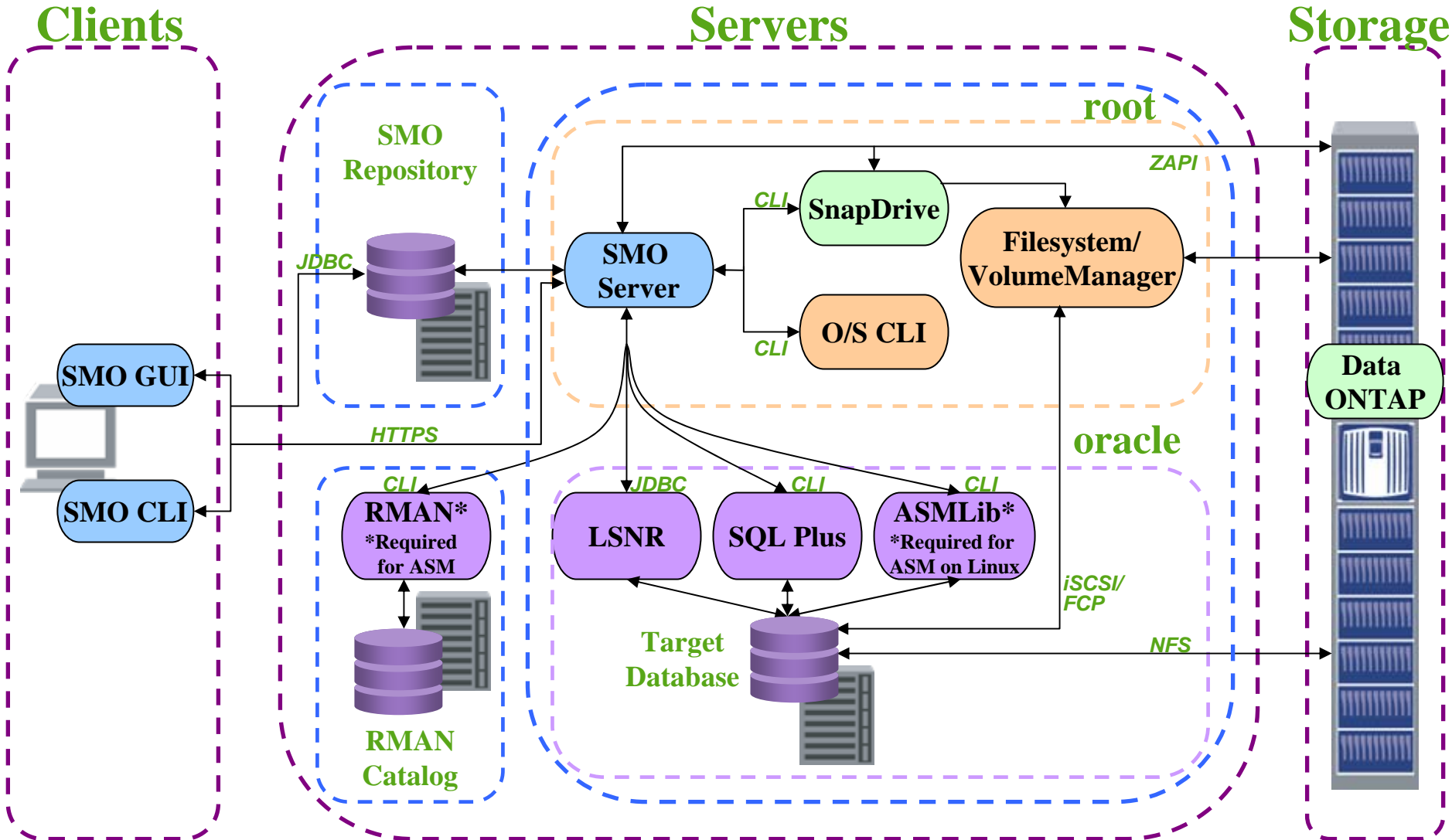
Oracle Data Guard on NetApp

Benefits

- Fast failover because DB is in standby mode
- Network efficient - send-only logs
- Ensures database consistency

Synchronous/Asynchronous

Up to nine Standby copies

Managed fail over/back

Create Test & Dev FlexClone copies from HA/BC Standby

Clients

Primary Site

Clients

Standby Site

Data Changes

Primary Database

Data Guard Broker

Standby Database
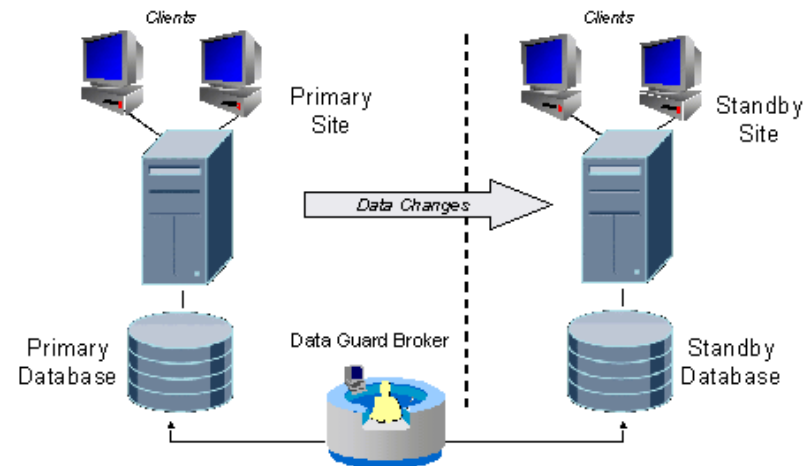
Mixed Scenarios for Data Guard and SnapMirror® Together on NetApp

Initial transfer use case

- Use SnapMirror for initial data transfer
- Use Data Guard for ongoing log transfer

Multi-purpose use case

- Use Data Guard for Oracle DB
- Run Rapid Clone then SnapMirror for Oracle apps
- SnapMirror for non-Oracle data
- Use NetApp FlexClone for test/dev on both

Backup use case

- Use Data Guard for Oracle DB replication
- Use SnapMirror in parallel as a redundant process

Oracle, con't

- NFS mount options
- iSCSI
  - Not gaining a lot of attention or adoption
- SAN
  - Useful where there is an investment in Fibre Channel infrastructure
  - Need database server throughput > 1Gb per second (~100MB per second)

DB2 9 Backup/Restore

Offline Snapshot backup

Stop DB	→	Unmount FS	→	Create Snapshot	→	Start DB
db2stop force		umount /dbdata1		snap create dbdata1 snap1		db2start

Online Snapshot backup

Suspend DB writes	→	Create Snapshot	→	Resume DB writes
db2 set write suspend		snap create dbdata1 snap1		db2 set write resume

Restore from Snapshot backup

Stop DB	→	Unmount FS	→	Restore Snapshot	→	Start DB
db2stop force		umount /dbdata1		snap restore - f -s snap1 dbdata1		db2start
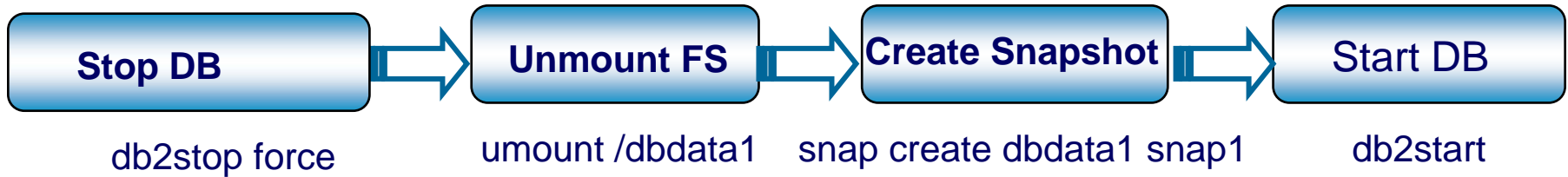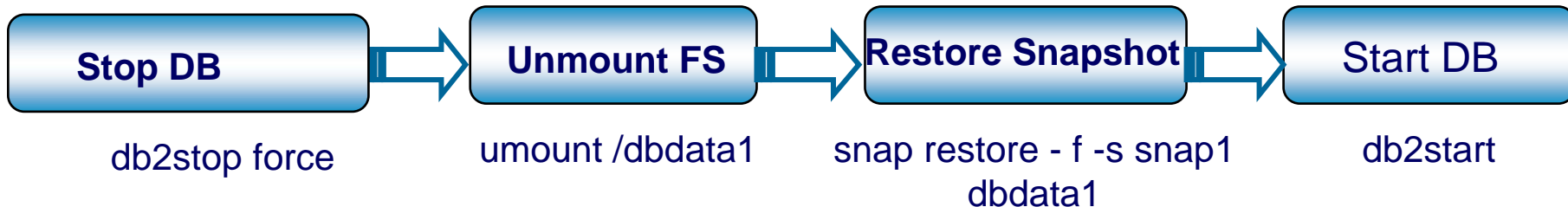
DB2 9.5 Backup/Restore with integrated Snapshot

Offline Snapshot backup

Deactivate DB → **Backup database** → Activate DB

db2 deactivate db

db2 backup db sample use snapshot

db2 backup db sample use snapshot
EXCLUDE LOGS

db2 activate db sample

Online Snapshot backup

Backup database using Snapshot

db2 backup db sample online use snapshot

Restore from Snapshot backup

Stop DB → **Restore database using Snapshot** → Start DB

db2stop force

db2 restore db sample use snapshot

db2start

DB2 HADR

Primary DB

Standby DB

HADR log shipping

NetApp FAS or IBM N Series storage system
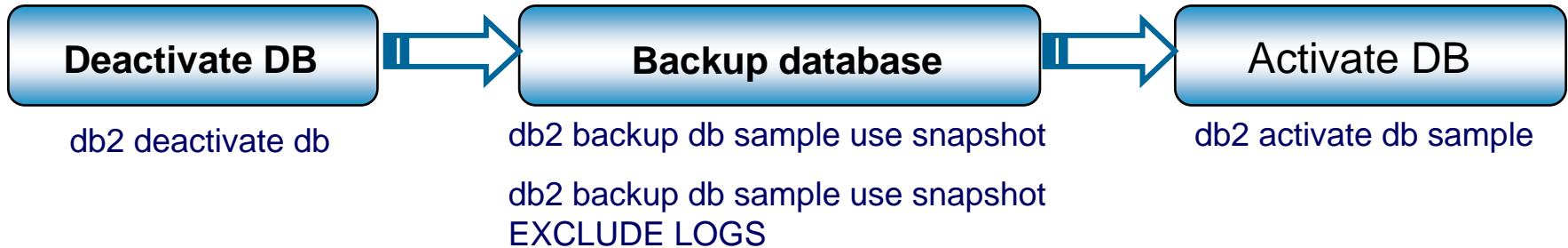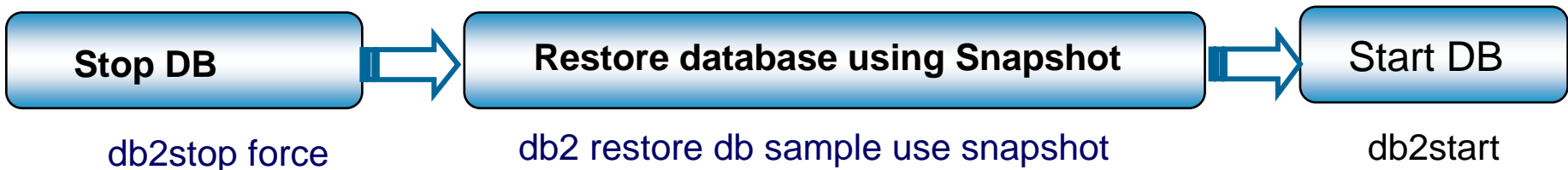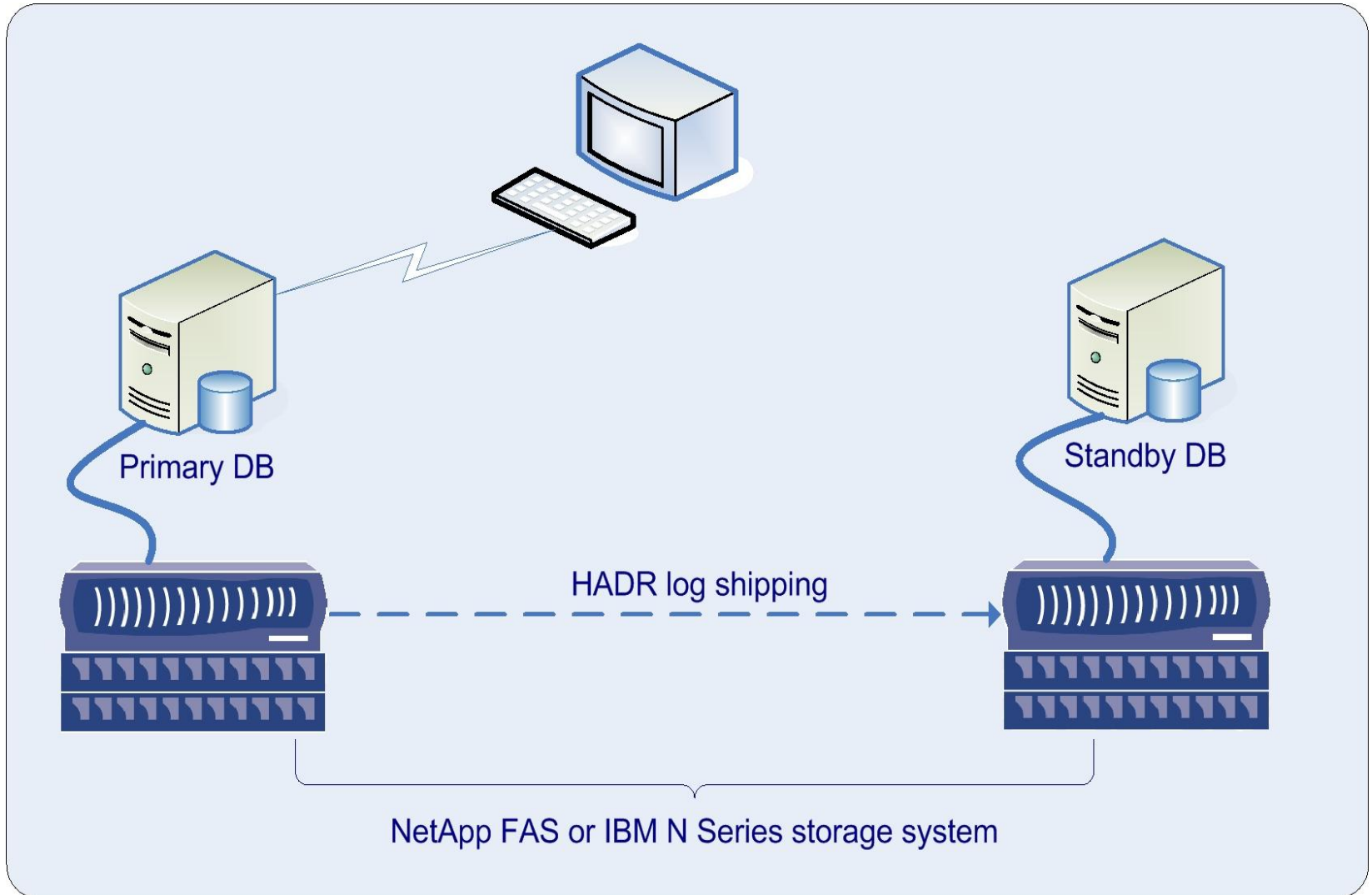
DB2 HADR using SnapMirror

Primary database

Standby database

SnapMirror

NetApp FAS or IBM N Series storage system
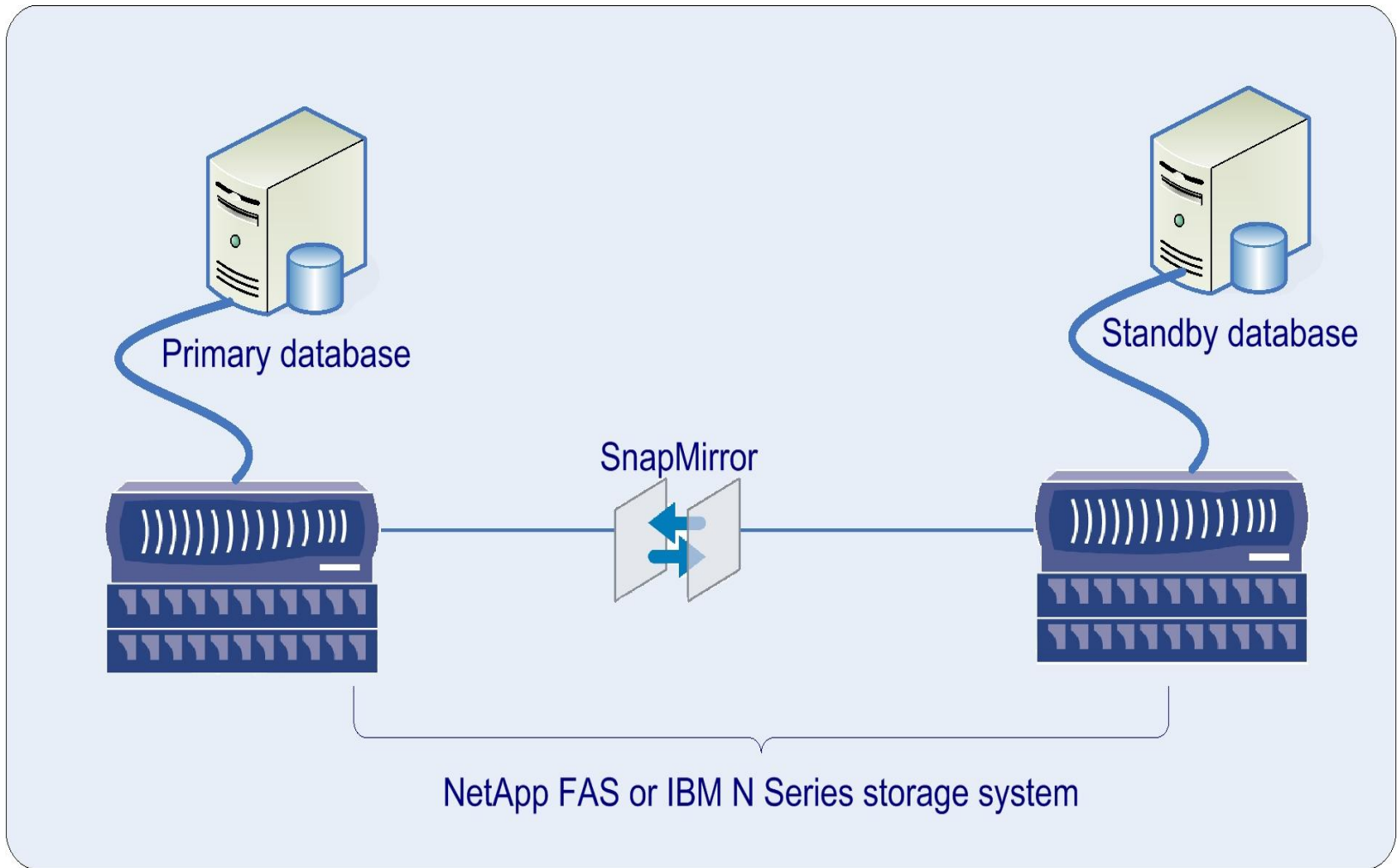
SnapMirror Vs DB2 HADR

SnapMirror

- – License cost
- + Failover using TSA/HACMP
- + Volume based- all the changes for the volume are replicated
- + All the config changes to the db gets moved thru SnapMirror
- + Replication is back loaded, so resulting better performance
- + Application binaries and stored procedures gets replicated
- – Write suspend/resume
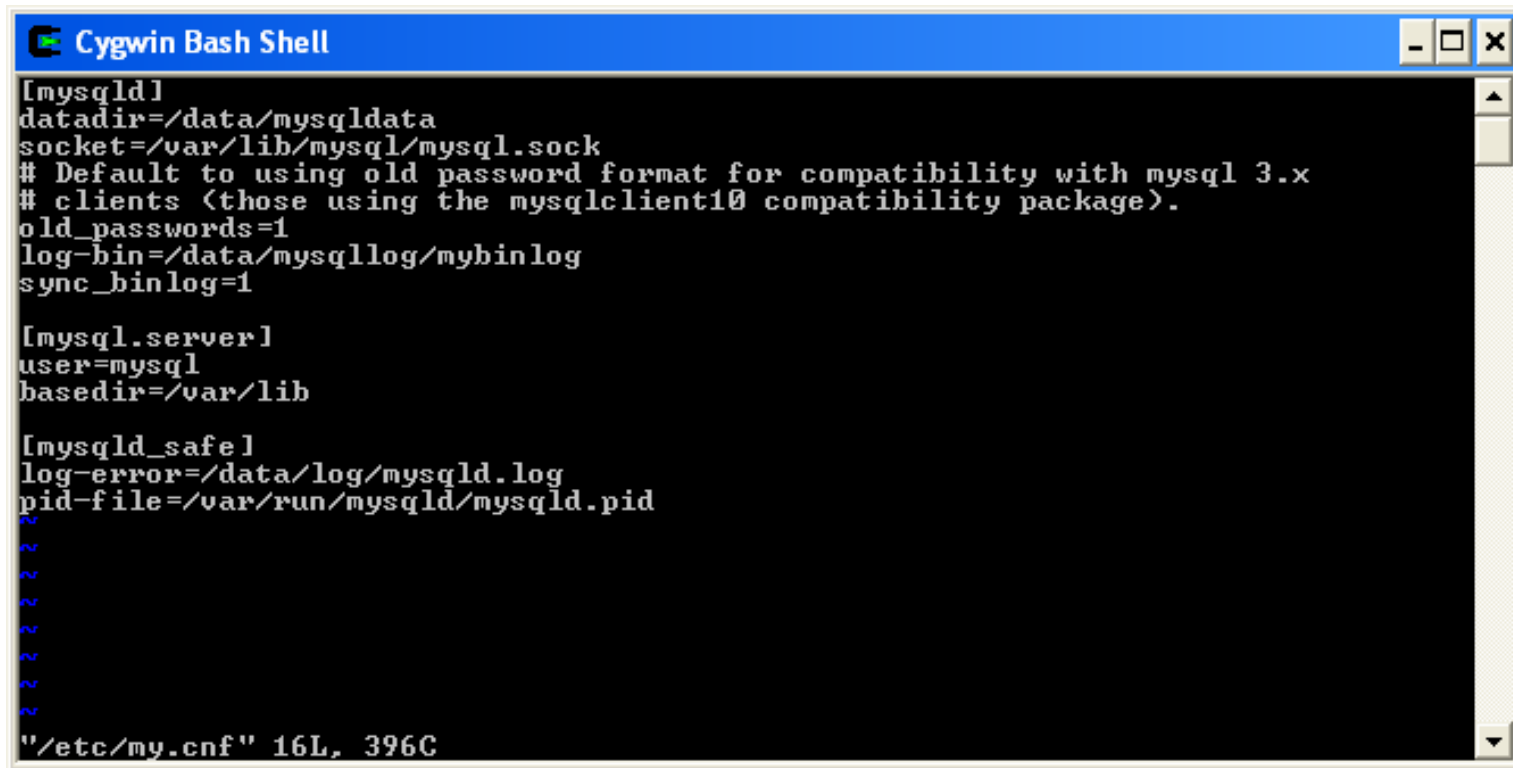
DB2HADR

- – License cost
- + Can be automated using TSA
- – Log base - Transactions which are not logged need manual replication. Ex : conventional DB2 loads will require a re-sync of HADR
- – Config changes to the db are not replicated
- – DB server responsible for replication.
- – Application binaries and stored DB object require manual intervention at standby
- + No write Suspend/Resume

MySQL

- Zmanda Recovery Manager (ZRM) for MySQL
  - http://media.netapp.com/documents/tr-3656.pdf

ZRM Full Backups

NetApp Filer

ZRM server

NFS

/var/lib/mysql-zrm/

MySQL DB → MySQL DB

SnapManager Snapshot
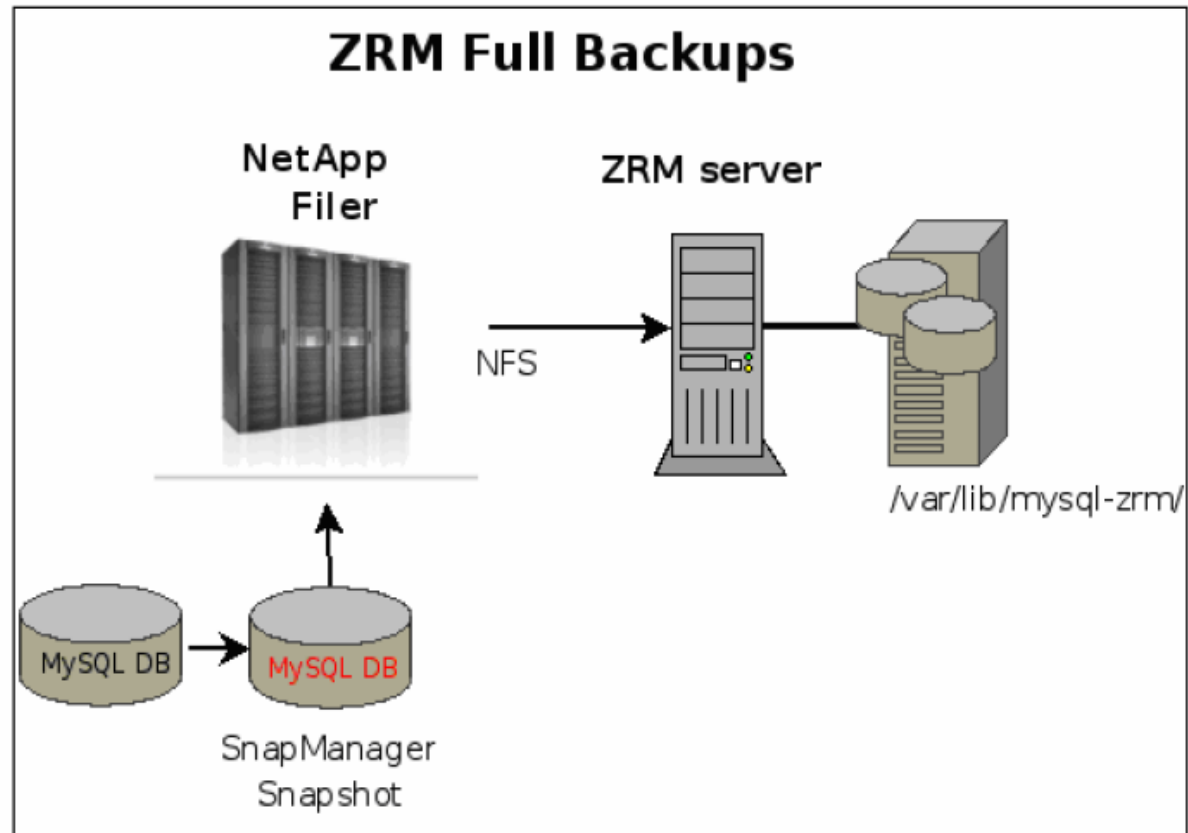
First check the /etc/my.cnf file

```
Cygwin Bash Shell                                              _ □ ×

[mysqld]
datadir=/data/mysqldata
socket=/var/lib/mysql/mysql.sock
# Default to using old password format for compatibility with mysql 3.x
# clients (those using the mysqlclient10 compatibility package).
old_passwords=1
log-bin=/data/mysqllog/mybinlog
sync_binlog=1

[mysql.server]
user=mysql
basedir=/var/lib

[mysqld_safe]
log-error=/data/log/mysqld.log
pid-file=/var/run/mysqld/mysqld.pid
~
~
~
~
~
~
~
~
"/etc/my.cnf" 16L, 396C
```

- Datadir=<path to nfs mount or LUN mount>
- Log-bin=<path to logfile>
- Sync_binlog=1 sync the innodb log and the bin log

To take a consistent snapshot

- Flush Tables with Read Lock;
- Take SnapShot
- Unlock tables;

The Restore Process

- Shutdown MySQL
  - mysqladmin –u root –p shutdown
- Restore desired snapshot
  - Snap restore –s mysqldata.hot.1 MySQLData
- Start the database
  - Might want to prevent users from accessing
- Manually roll forward the logs
  - mysqlbinlog mybinlog.0000001 | mysql –u root -p

SQL Server Best Practices

Primary Data Center

SQL Server

iSCSI or FCP
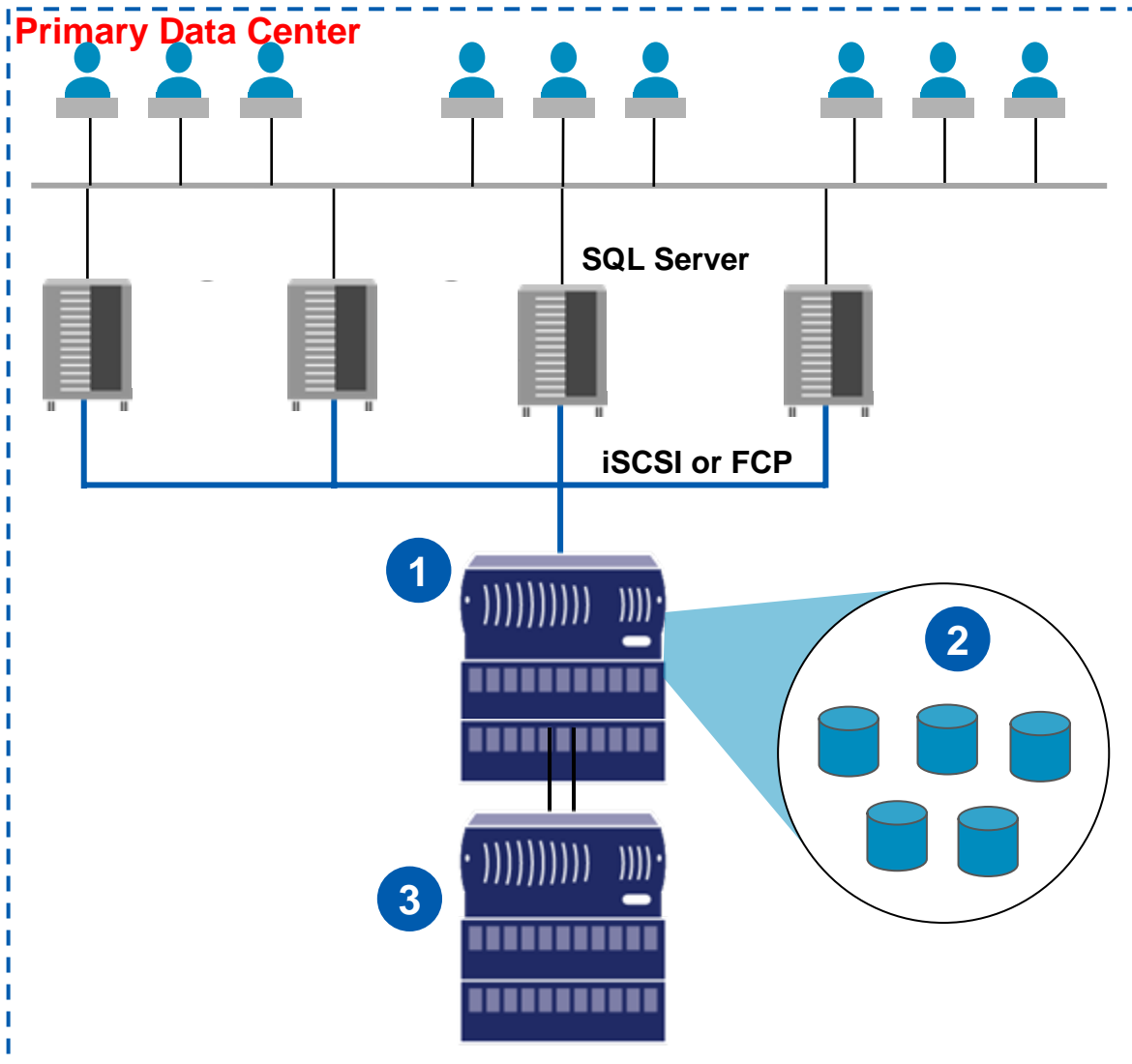
① Consolidate SQL Server storage on NetApp

② **Add disks and expand volumes on the fly without downtime**

③ **Cluster for higher availability**

Benefits:

- Simplified, centralized management
- Shared storage for improved utilization
- Better system availability

SnapManager® for SQL Server®

- Provides integrated data management for SQL Server 2000 and SQL Server 2005 databases
  - Automated, fast, and space-efficient backups using Snapshot™
  - Automated, fast, and granular restore and recovery using SnapRestore™
  - Integrated with SnapMirror™ for database replication
- Provides tight integration with Microsoft technologies such as MSCS, Volume Mount Points.

SnapManager® for SQL Server® – Key Features

Features	Benefits
Rapid hot backup and restore times	• **Maximizes SQL database availability and helps meet stringent SLAs** • **Helps organizations recover from accidental user induced errors or application misbehavior** • **Minimizes SQL downtime and thus reduces cost** • **Increases the ability of SQL Servers to handle large number of databases and/or higher workloads.**
Hot backups to Snapshot copies	• **No performance degradation during backups**
Configuration, Backup, and Restore wizards with standard Windows GUIs	• **Ease of use** • **Virtually no training costs** • **Cost savings**
MSCS Support	• **High availability and enhanced reliability of SQL Server environment**
NetApp® Clustered Failover	• **Further enhances availability of SQL Server**
SnapMirror Integration	• **Increases SQL Server's availability – can replicate the database to a secondary storage system for faster recovery in case of a disaster**

SnapManager® for SQL Server® – Key Features

Features	Benefits
Online disk addition (storage expansion)	• **Increases SQL Server's availability -- additional storage can be added without bringing the SQL Server down**
New Features in SMSQL 2.1	
Volume Mount Point Support	• **Support for Volume Mount Points in order to eliminate the limitation with drive letters**
Fractional Space Reservation (Thin Provisioning)	• **Allows administrators to reserve less than 100% of the LUN size** • **SMSQL will delete backup sets and/or dismount the SQL Server databases before volume becomes full**
Backup of read-only databases	• **SMSQL now allows back up of read-only databases** • **Read-only databases are listed in the configuration wizard, just as normal databases**
Resource database management	• **SMSQL manages resource database that contain system objects included with SQL Server 2005**
Native x64 support	• **Supports 64bit natively on AMD64/EM64T**

Sybase ASE Best Practices

- Configure 4k page sizes
  - Or multiple of 4K
  - 2k pages not optimal for WAFL 4k block size
- Single aggregate yields best performance
- Can put data files and logs into one volume
  - ASE 12.5 +: log rollforward capability integrated by Sybase in snapshots

Sybase ASE Best Practices: Backups

- Snapshot process takes very little time
- Offline backup: Database shut down
- Online backup
  - *quiesce database* command suspends writes
    - Login into ASE or use isql
    - Issue *quiesce database hold* command
    - Take snapshot on the array
    - Release the database hold with *quiesce database release* command
    - Take transaction log dumps
    - Save log dumps to another volume (for restore)

Sybase ASE Best Practices: Restore

- Bring down the ASE server
- Telnet to the array and issue the *snaprestore* command
  - The filer restores to the point-in-time from the snapshot
- Start the server with the *–q* option
- Apply the transaction logs by using the *load transaction* command
  - Do not bring the databases online until all logs have been applied
- Check the database and release it for user access

Virtualization

The NetApp and VMware Global Alliance

- Mutual Global Partners
- All NetApp products are VMware® certified
- Deep engineering level collaboration
- Reference platform for iSCSI and NFS
- Actively engaged at all levels: Executive through Sales
- Joint escalation team
- Over 5,000 joint ESX customers

NetApp Virtualization Alliances

Microsoft

NetApp Global Partner

- Development partner for Viridian
- Many joint customers

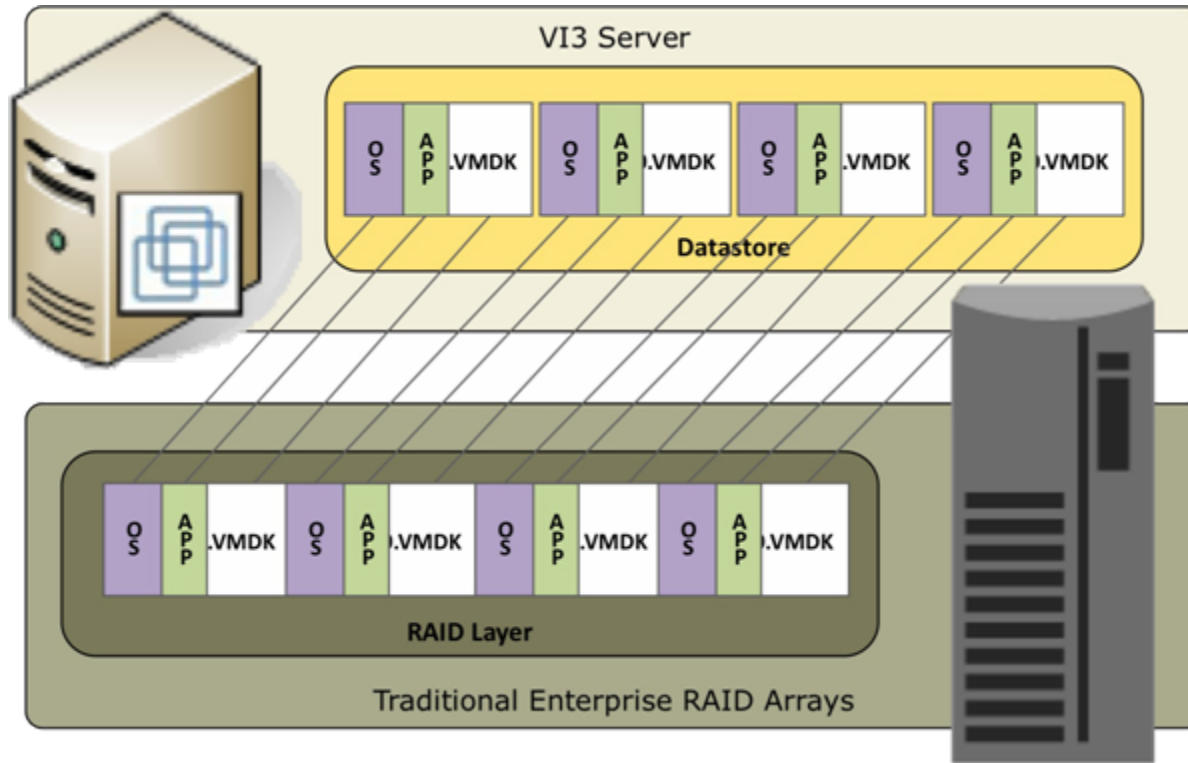**CITRIX** **XenSource™**

NetApp Advantage Partner

- XenServer Adapter for NetApp integrated into XenConsole
- FAS series fully certified
- NetApp is a Xen contributor

VirtualIron

NetApp Advantage Partner

- Development partner for VI v4.0
- FAS series fully certified

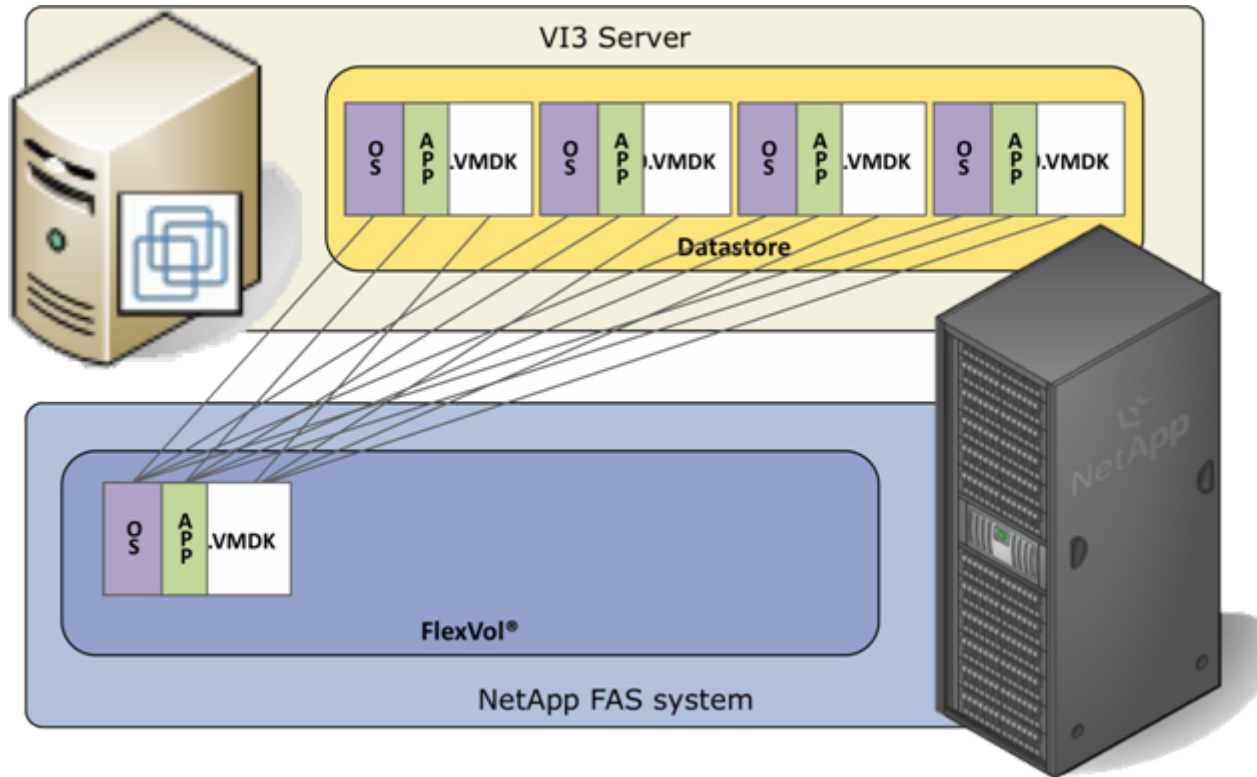# Storage Consumption by Traditional Storage Arrays

VMware deploys VMs via template clones

- Clones are 100% identical

- Including OS and applications

- Clones consume storage equal to size of template

By design VMware® environments are very redundant

Reduce Storage Requirements with NetApp Deduplication

Dedupe removes redundant data

- Reduce OS and applications to a single copy

- VMs only consume storage for their unique data

- Supports FCP, iSCSI, & NFS

- 50% – 70% storage reduction!

NetApp FAS deduplication provides the same benefits as the VMware shared cached memory functionality

NetApp FlexClone Provisioning

- **Instantly provision cloned datastores or RDMs**
  - Supports SAN, iSCSI, & NAS
  - Clones are immediately available
  - Clones require zero additional storage
  - Pointer driven block level replicas
  - Great for VDI, Training, Test & Dev, etc...

> FlexClone allows you to use Site Recovery Manager to test your disaster recovery policies without impacting production
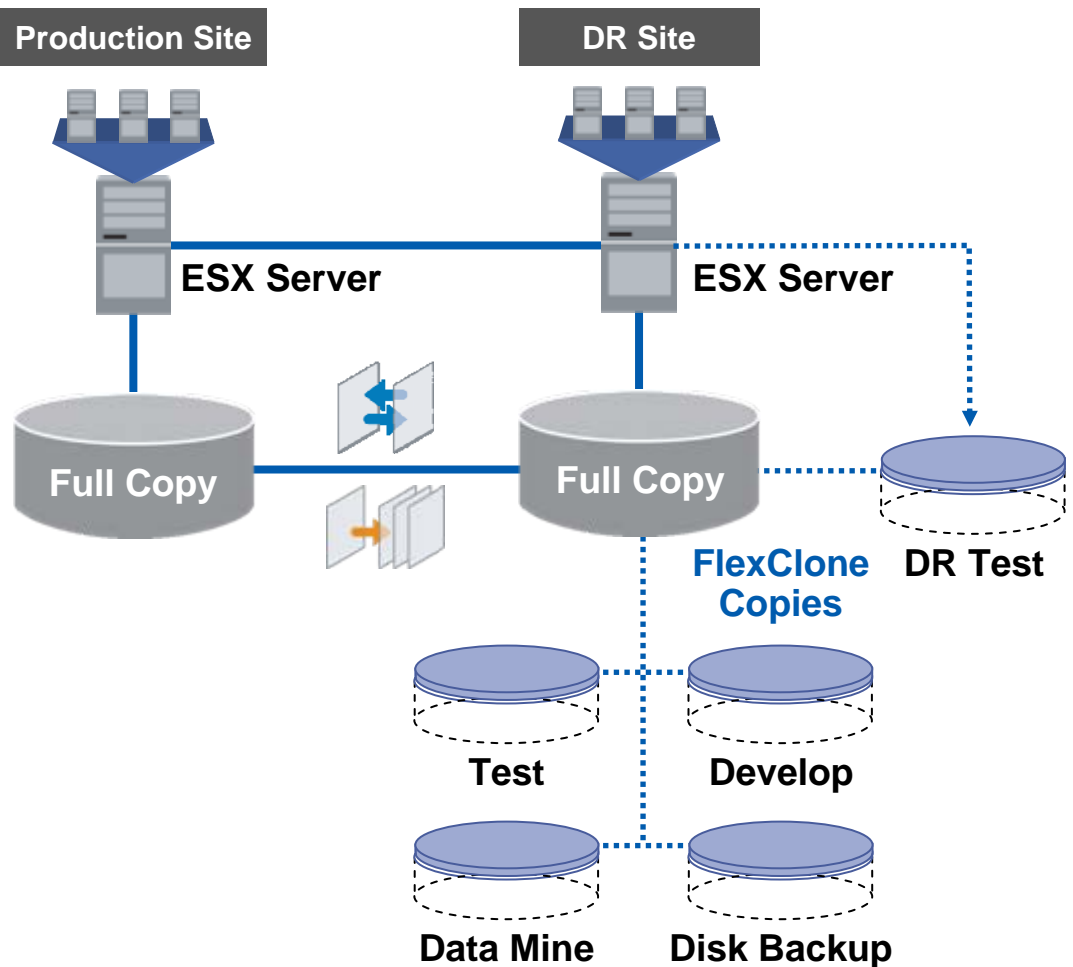
NetApp FlexClone for VDI Solutions
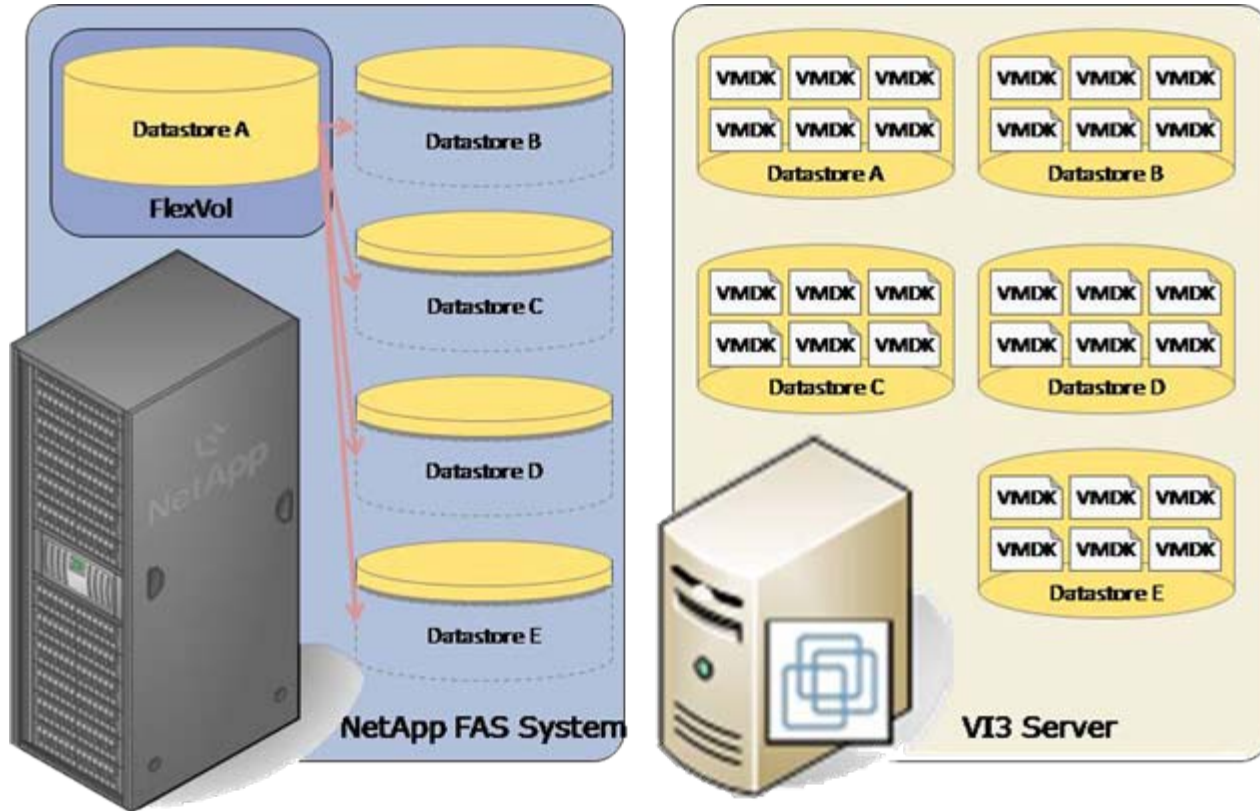
Deploy 1000s of VMs within minutes while not utilizing any additional storage capacity

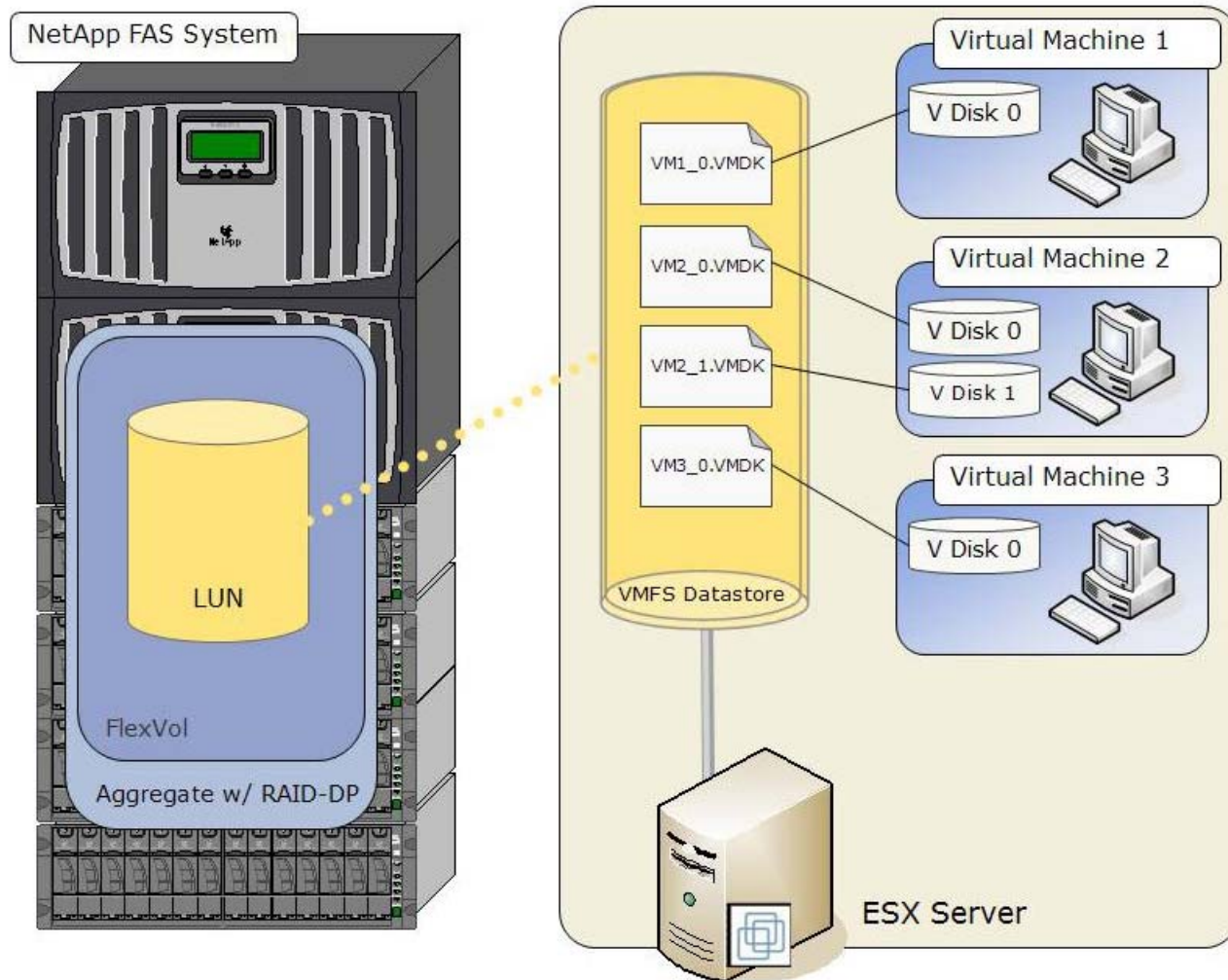# Non-disruptive DR Testing with VMware

- Instantaneous dataset clones for DR testing
- Quick and easy to set up and take down
- Zero disruption to primary environment
- Also for test/dev, data mining, backup offload, and more

VMDKs on VMFS via FCP or iSCSI

NetApp FAS System

LUN

FlexVol

Aggregate w/ RAID-DP

Virtual Machine 1

V Disk 0

VM1_0.VMDK

Virtual Machine 2

V Disk 0

VM2_0.VMDK

VM2_1.VMDK

V Disk 1

VM3_0.VMDK

Virtual Machine 3

V Disk 0

VMFS Datastore

ESX Server

Strengths:
• Most commonly deployed storage format
• Once storage is provisioned the VMware Admins are free to use it as they see fit
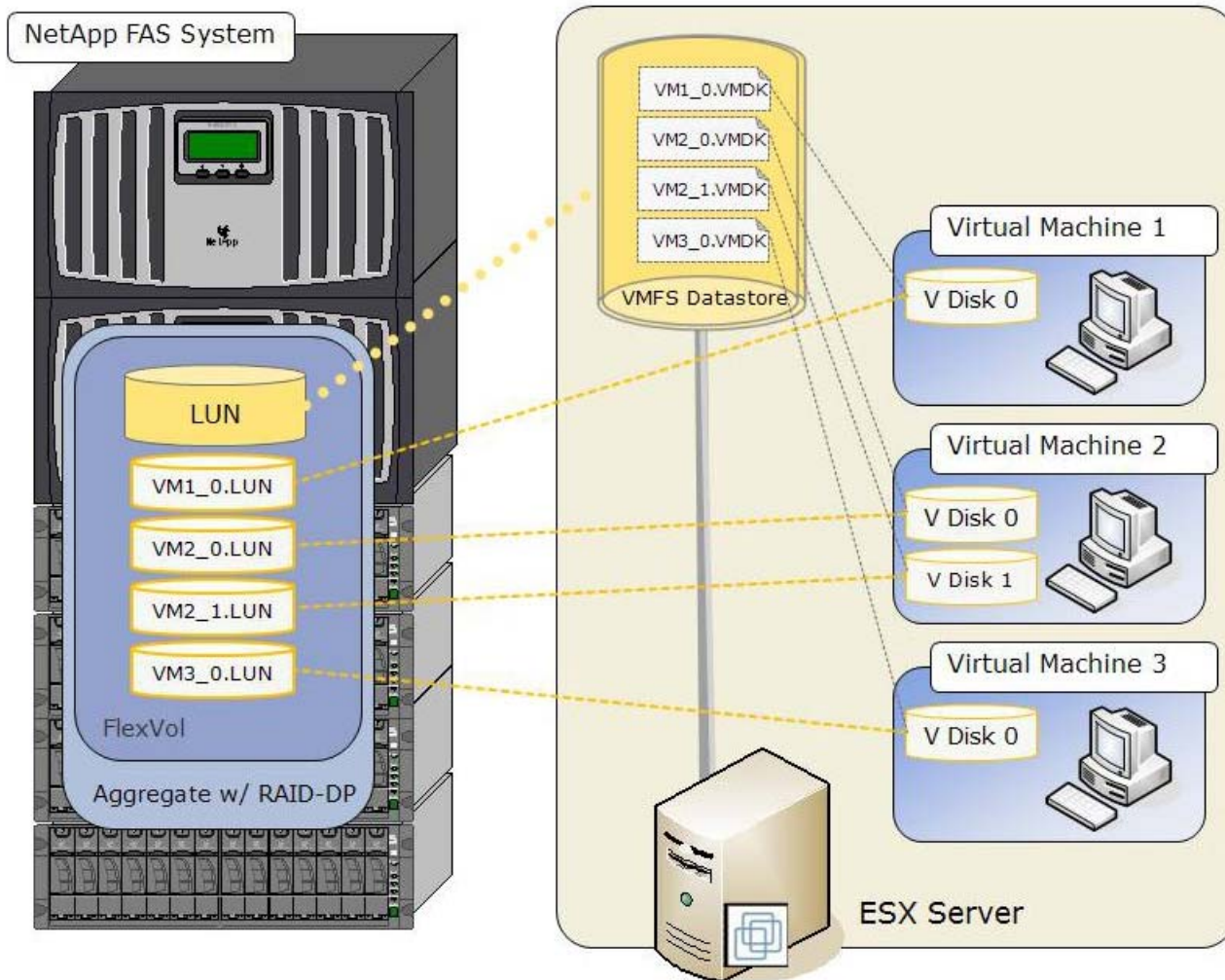• Most operations are available through VirtualCenter

Areas to be Aware:
• More VMDKs = performance degradation
• For performance VMware recommends smaller VMFS file systems
• More file systems = reduced storage utilization
• VMDK storage bottlenecks are very hard to identify
• Snapshots are at the VMFS level

RDMs via FCP or iSCSI

Strengths:
- Recommended by VMware for high IO performance
- Easy disk IO measuring
- Required for VM host side clustering (MSCS)
- Virtual mode RDMs provide support for snapshots and VMotion

Areas to be Aware:
- Introduced in ESX 2.5.x
- Provision Storage and VM Admins are free to use
- Advanced operations are not integrated into VirtualCenter - Scripting required
- ESX LUN restrictions (256) may limit the size of ESX Datacenters
- Mapping files list as being the same size of RDM – actually is ~1MB

VMDKs on NFS
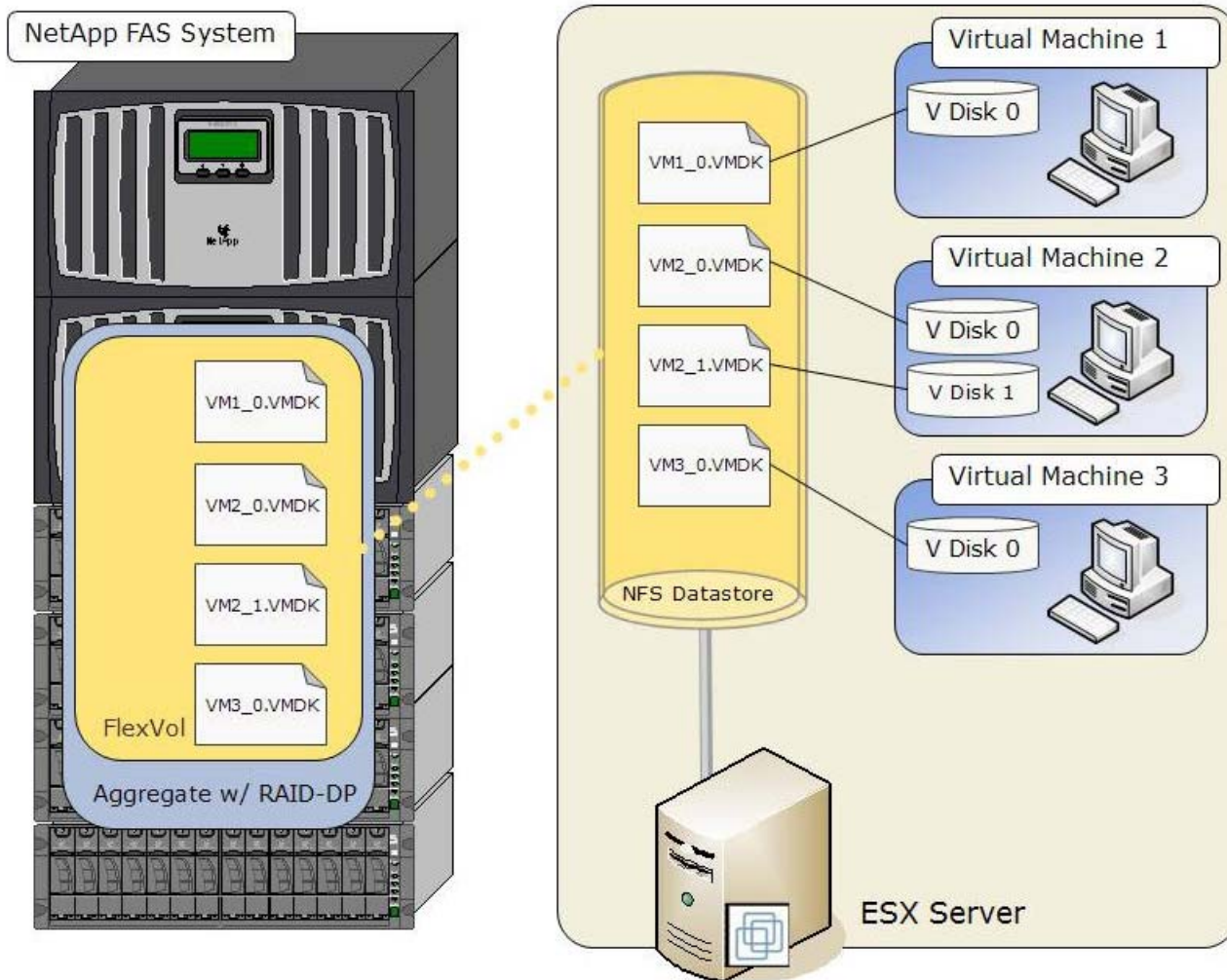
Strengths:
- Inexpensive storage networking
- VMDKs are only available in thin provisioned format
- Reduced storage consumption
- Most operations are available through VirtualCenter
- Easiest storage format to provision

Areas to be Aware:
- Introduced in ESX 3.0
- For scalability / highest storage utilization you may need to implement TOE enabled NICs

Scaling and Manageability Quadrants

VMFS

- 90% of the market
- Server admin mgmt of storage
- Easy, common
- VMFS limits scaling
- With Thin prov A-SIS ready

Scalability → Best

Environment Manageability Best ↑

NFS

VMFS

RDM
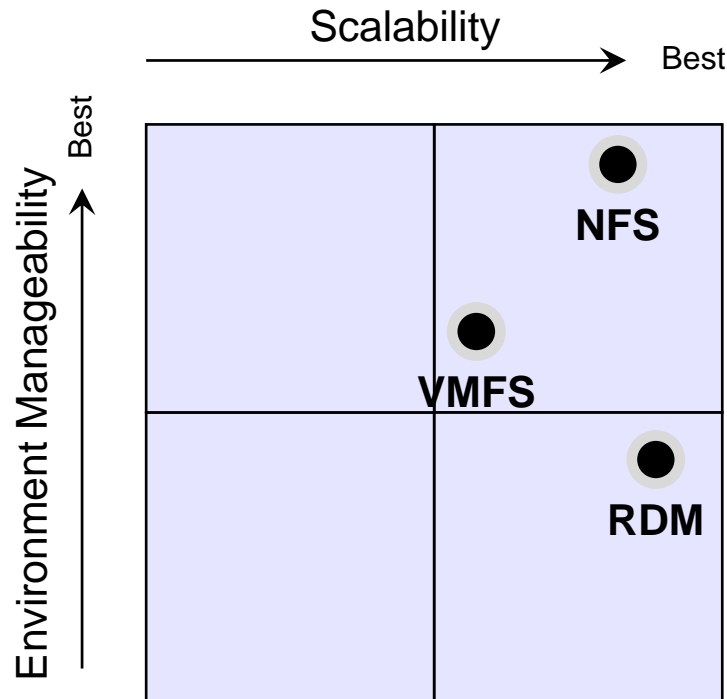
NFS

- NFS is always thin provisioned
- Zero administrator management
- No VMFS bottleneck
- Scales to limit of array or network
- A-SIS ready

RDM

- iSCSI or FCP
- Storage Admin manages all luns
- Fastest single VM perf (FCP)
- Scales to limit of array or network
- Most labor intensive
- Must thin prov LUNs to be A-SIS ready
- NetApp tools will move this up

The choice is yours, NetApp supports them all

Go further, faster

Increase your business flexibility and efficiency

Accelerate and transform your business

Count on a partnership dedicated to your success

Thank You

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