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ORACLE THIRTY YEARS 30

Automatic Storage Management

Oracle Database 11g Release 2

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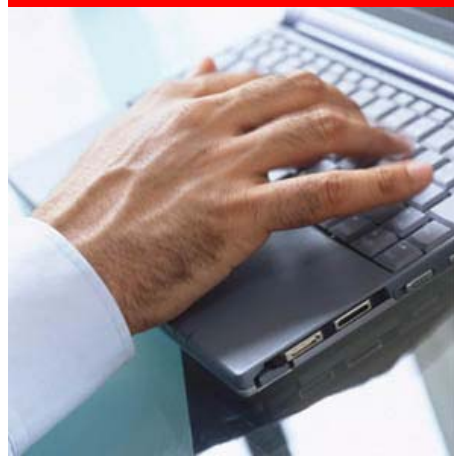

- Storage management challenges
- ASM overview
- *Extending ASM to manage general purpose files*
  - *ASM Volume Manager*
  - *ASM Cluster File System*
  - *ACFS availability and scalability*
- *ASM new enhancements for managing Oracle database files*
- *Installation and configuration tools*
- ASM as an integrated solution
- ASM reference customers

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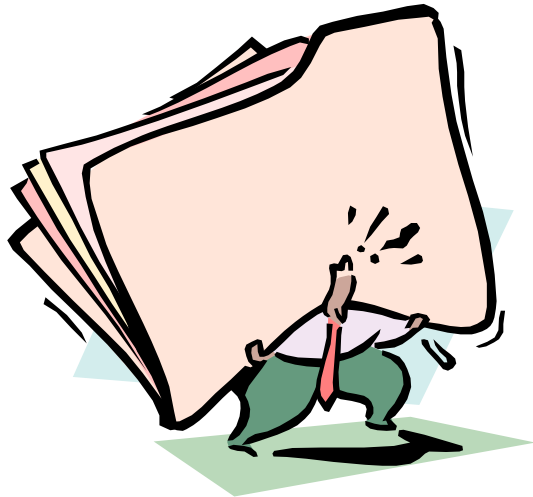
Challenges of Managing Data Explosion



- Complexity in storage and file management
  - Many software layers
  - Lack of a single solution for ALL data
  - Lack of simple and automated tools to manage complexity
- Multi-vendor support logistics and finger pointing
- Complexity of managing performance
  - Eliminating hot spots
- Reducing storage Total Cost of Ownership

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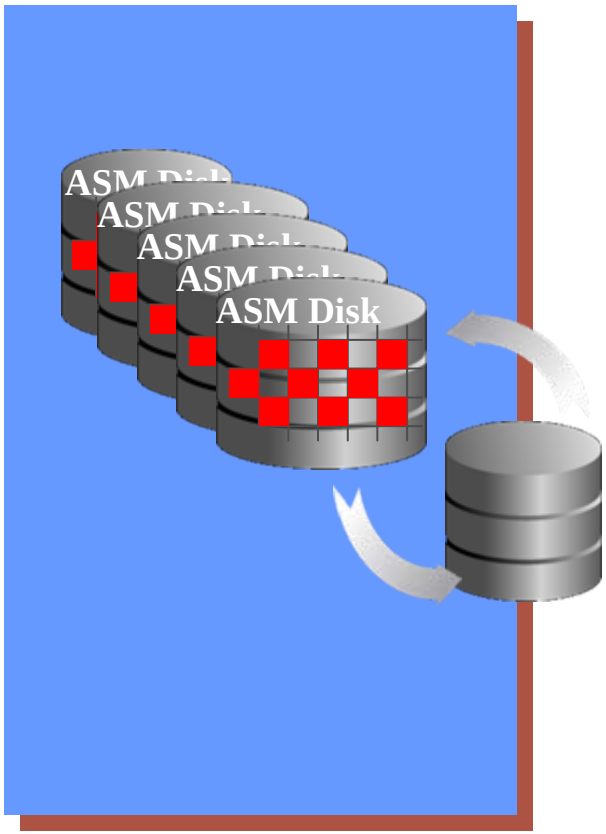
Automatic Storage Management (ASM)

A Volume Manager and File System Integrated in the Database

ASM Disk Group



- Easier to manage than file systems
- Reduces storage costs
- Provides best performance
- Stores all data 11.2

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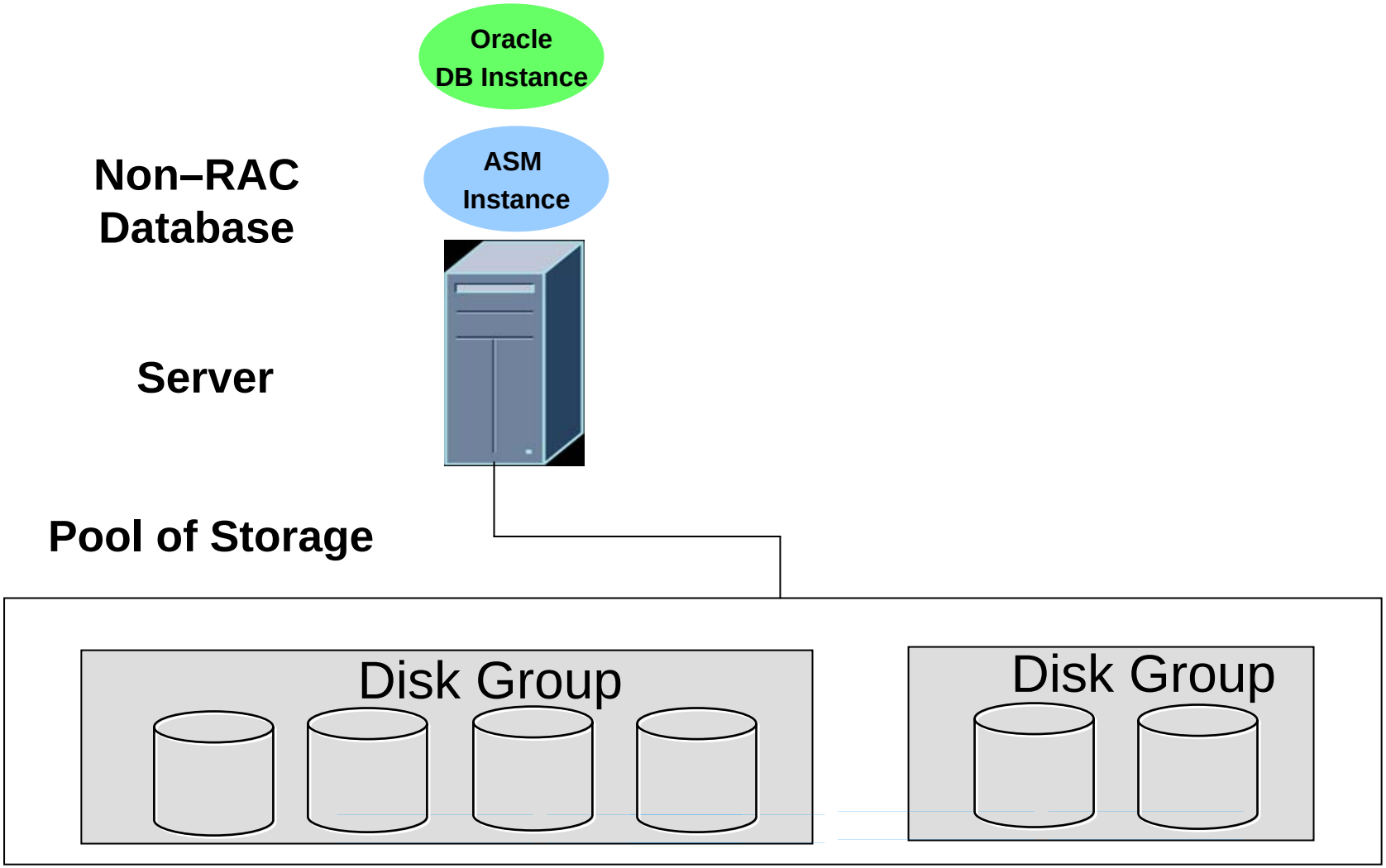
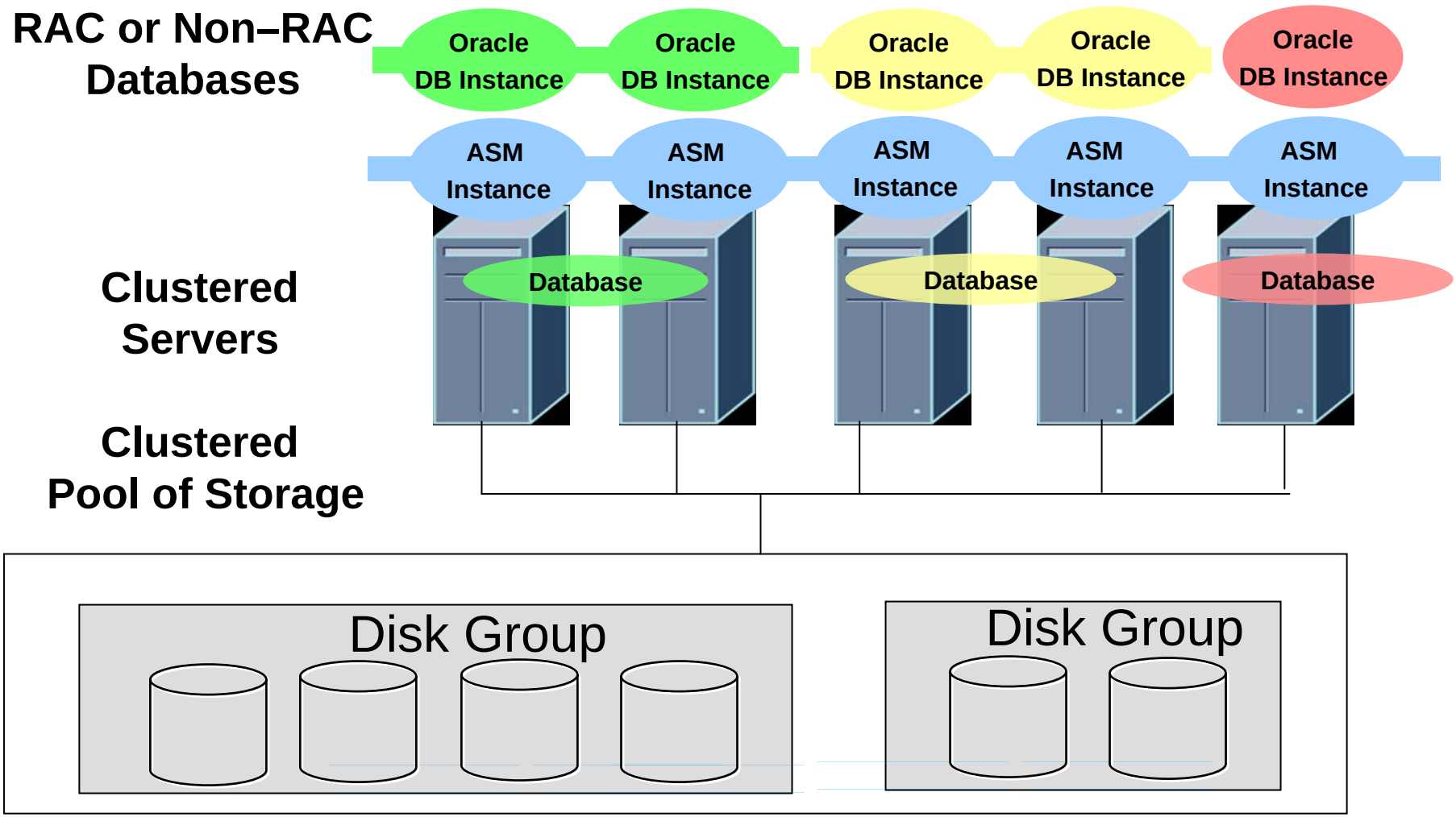
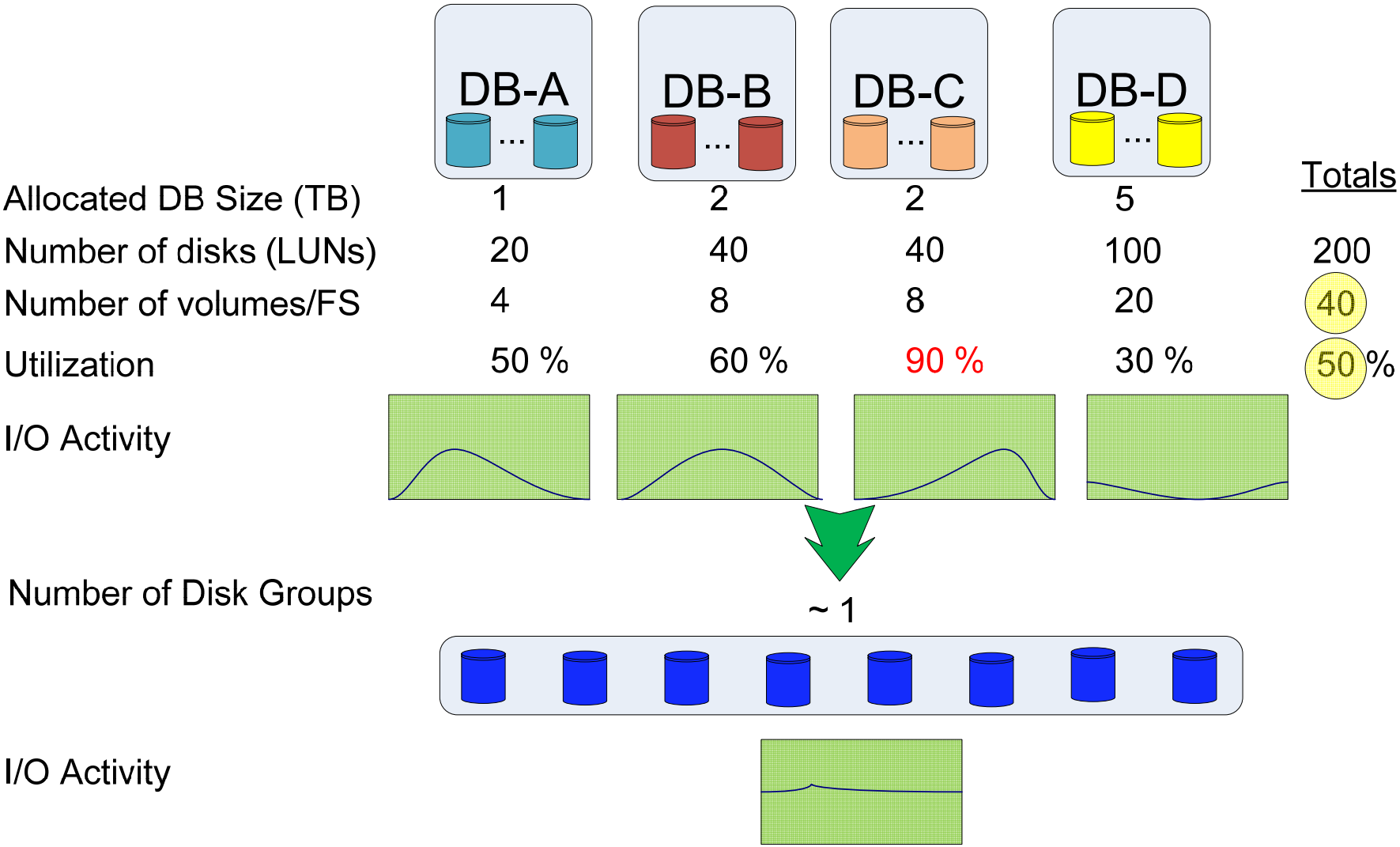
ASM Process Architecture



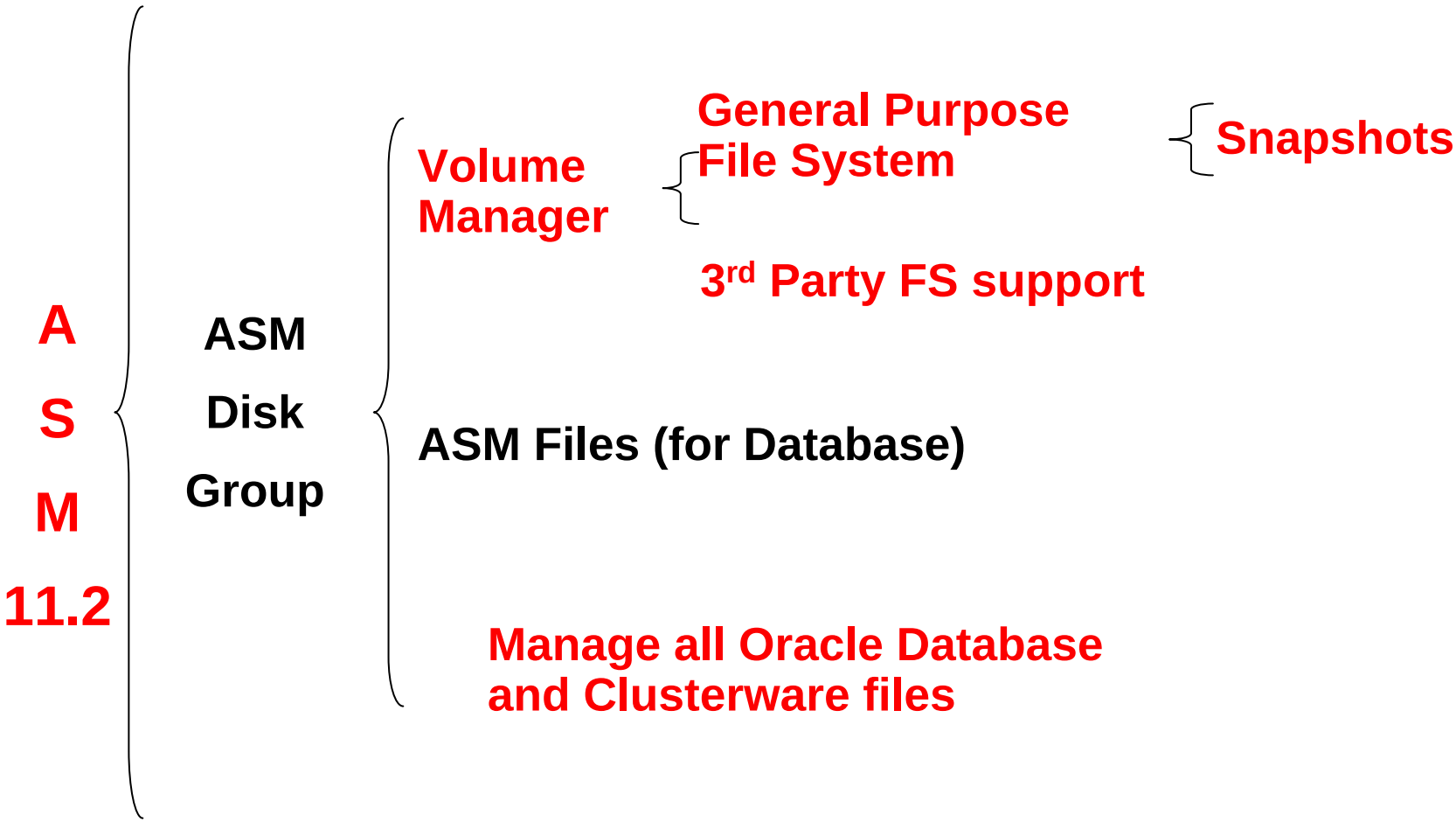
ASM Clusters



ASM Consolidates Storage & Management



Extending ASM to Support ALL Files



ASM Dynamic Volume Manager

(ADVM)

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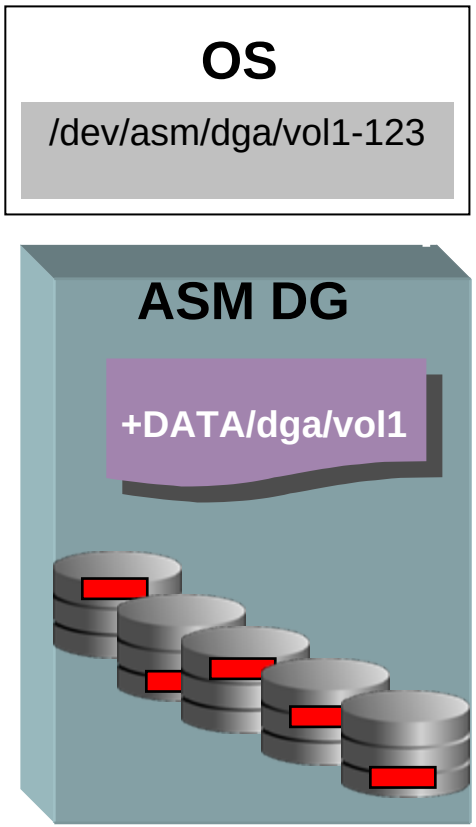
Dynamic Volume Manager and Dynamic Volumes



- A new cluster (and single host) volume management service for both Oracle and general volume applications on Linux, Windows, and UNIX platforms
- Loadable kernel driver
- 'Dynamic Volume' is a new ASM file type – 'asmvol'
  - Example: +DATA/dga/vol1
  - Leverage the full set of ASM features
  - Managed using SQL, ASMCMD, EM
- An OS device file is created automatically when a dynamic volume is created
    - Linux: /dev/asm/dga/vol1
    - Windows: asm_dga_vol1

Note: An AVD volume device may not be used as an OS boot or swap device, nor used as a root file system of the OS

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Creating an ASM Dynamic Volume

```
$ sqlplus / as sysasm
SQL> ALTER DISKGROUP data ADD VOLUME volume1 SIZE 500M;

$ asmcmd
ASMCMD> volcreate -d DATA -s 100M volume2

$ ASMCMD> volinfo -a
```

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Dynamic Volume SQL*PLUS

Command Examples

- SQL> ALTER DISKGROUP DGROUPA ADD VOLUME vol1 SIZE 10G;
  RESIZE VOLUME vol1 SIZE 15G;
  DROP VOLUME vol1;
  ENABLE VOLUME asmvol1;
- SQL> ALTER DISKGROUP ALL DISABLE VOLUME ALL;
- SQL> ALTER DISKGROUP DGROUPA MODIFY VOLUME asmvol1 USAGE 'acfs';

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Extending ASMCMD for Dynamic Volumes

- asmcmd volcreate dgname volname -s size [-r redundancy] [-w stripe_width] [-c stripe_columns] [-p [hot|cold]] [-i [hot|cold]]
- asmcmd volresize dgname volname -s newsize [-f]
- asmcmd voldelete dgname volname
- asmcmd volenable [-d dgname] [-d dgname -n volname]
- asmcmd voldisable [-d dgname] [-d dgname -n volname]
- asmcmd volset dgname volname [-u usage_message] | [-m mount_path] [-p [hot|cold]] [-i [hot|cold]]
- asmcmd volinfo [-d dgname] [-n volname]

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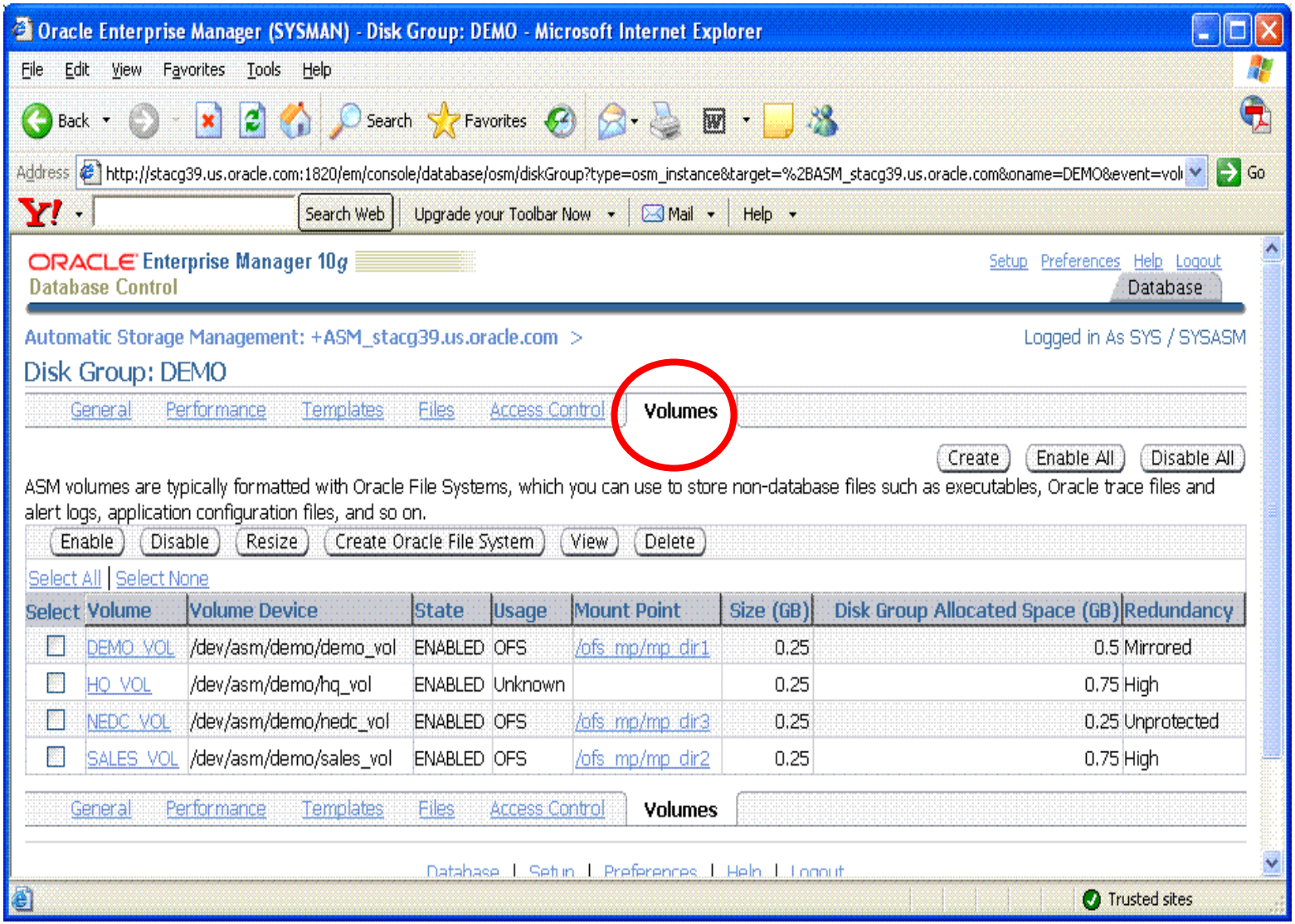
Managing ADVM Dynamic Volumes



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ASM Cluster File System (ACFS)

Managing non-Oracle Database General Purpose files

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What is ASM Cluster File System (ACFS)

- General purpose scalable file system
  - Journaling, extent based
  - Single node and cluster
  - POSIX, X/OPEN file system solution for UNIX/Linux
  - Windows file system solution for Windows platforms
- Accessible through NAS protocols (NFS, CIFS)
- Leverages ASM technology for volume mgt
- Integrated with Oracle Clusterware for cluster support
- Multi OS platform (Linux and Windows at initial release)
- Integrated with Oracle system mgt tools
  - Oracle installation and configuration
  - Enterprise Manager and ASM Storage mgt tools
  - Native OS File System Management tools

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Managing the ACFS File System is Simple

1. Native Linux, UNIX, and Windows OS file system commands and extensions
2. *acfsutil* platform independent commands
3. ASM Configuration Assistant (ASMCA)
4. Enterprise Manager

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Creating an ACFS File System

```
$ mkfs -t acfs -b 4k /dev/asm/volume1-62    ; Create fs on ASM volume

$ su - root
# mount -t acfs /dev/asm/volume1-62 /u01/app/oracle/acfsdata/images
# su – oracle_usr

$ acfsutil registry -a /dev/asm/volume1-62 /u01/app/oracle/acfsdata/images

$ mount –t acfs –o all none none            ; Mount everything in the registry

$ cd /u01/app/oracle/acfsdata/images
$ cp /home/my_images .
```


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Linux-Unix File System APIs

- Standard POSIX and X/OPEN file system APIs and Commands

- access, ar, cat, chattr, chgrp, chmod, chown, cksum, compress, cp, cpio, dd, df, diff, dir, dirname, du, file, find, ***fsck***, fuser, grep, gunzip, gzip, link, ln, lockfile, ls, mkdir, mkfifo, ***mkfs***, mknod, mktemp, more, ***mount***, mv, od, pwd, rcp, rename, rm, rmdir, size, stat, string, sync, tail, tar, unlink, ***unmount***, …

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Linux-Unix Extensions

- Create an ACFS file system

  mkfs [-vf] -t acfs [-b *blksz*] [-n name] *device* [*blocks*]

  Example: % mkfs -t acfs /dev/asm/diskgroup/vol1
- Mount an ACFS file system

  mount [-v] -t acfs [-o *options*] *device dir*

  Example: % mount -t acfs /dev/asm/diskgroup/vol1 /oracle/cluster1/myacfs
- Unmount an ACFS file system

  umount [-v] *device*|*dir*
- Check and repair an ACFS file system

  fsck [-avnf] -t acfs [*info*] *device*

  Example: % fsck -t acfs /dev/asm/diskgroup/vol1

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Windows File System APIs

- Windows file management APIs and Commands:

- Assoc, Attrib, Chdir, ***acfschkdsk***, Comp, Copy, Dir, Expand, Fc, Find, Findstr, Flattemp, ***acfsformat*****,** Freedisk, Mkdir, More, ***acfsmountvol*****,** ***acfsdismount***, Move, OpenFiles, Rcp, Rmdir, Replace, Tree, Type, Xcopy, Process Explorer, …

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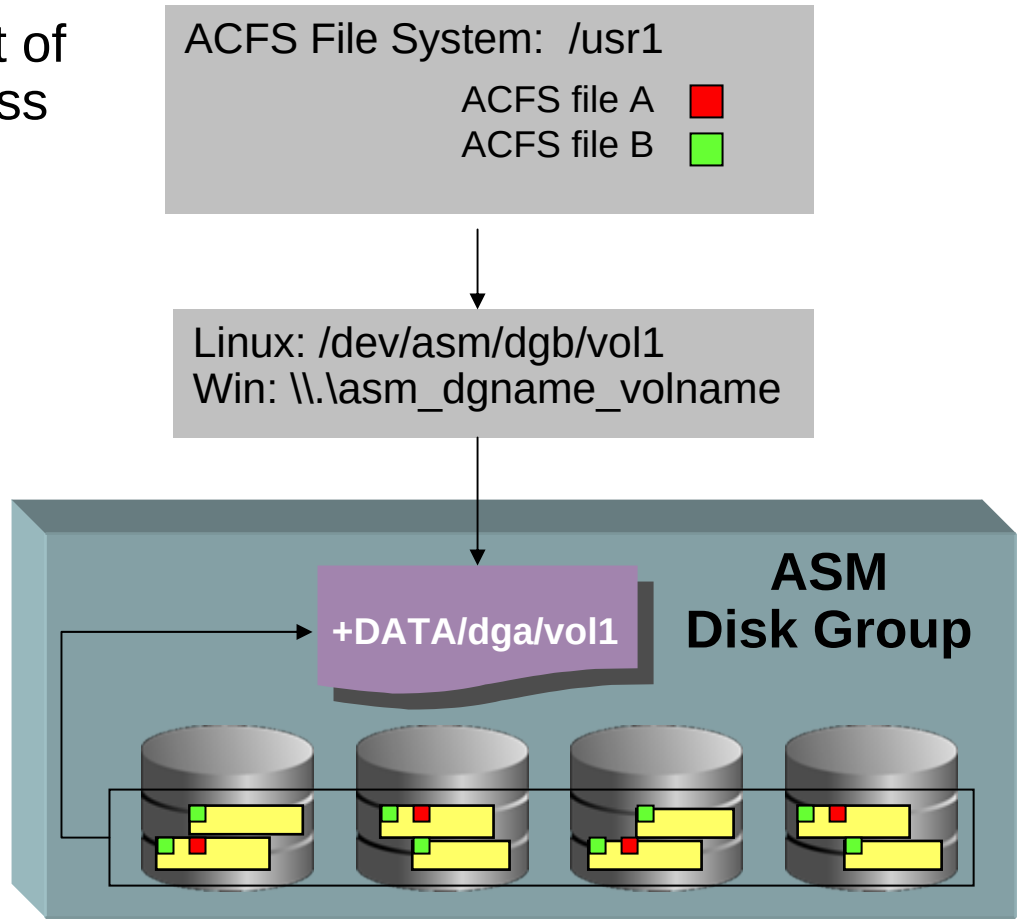
Leveraging ASM for Balanced Distribution of Data

All ACFS files get the benefit of ASM extent distribution across disks in a disk group



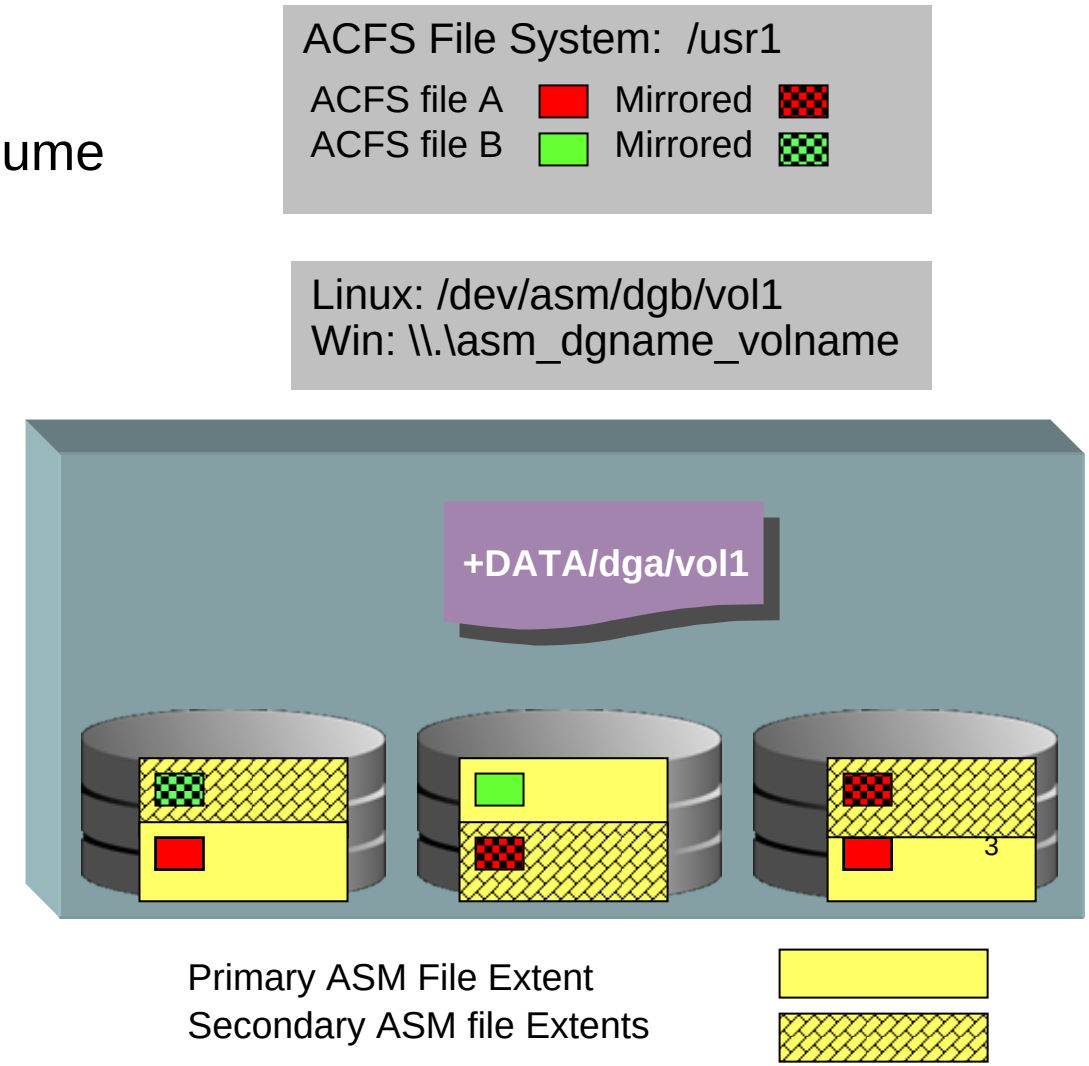
ASM Extent

Leveraging ASM Mirroring and Striping

Files in /usr1 FS are mirrored leveraging ASM Dynamic Volume Mirroring

Dynamic Volumes mirroring attribute is user selectable

- 2-way mirror
- 3-way mirror
- No ASM mirror



ACFS File System Snapshot Data Service

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ACFS Read-Only Snapshots

- Dynamic, fast, space efficient, “point in time” copies of ASM file system files
- An enabler for:
  - On-line backups
  - On-line, disk-based, file backup model using snapshots and individual file recoveries
- Up to 63 snapshot images per ASM file system
- Policy based snapshots:
  - Schedule snapshots on an interval basis: every 5 seconds, every 30 minutes, daily, … with recycling (using EM)
- ACFS CLIs support creation and removal of snapshots
- ACFS Snapshot functions integrated with EM

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ACFS Snapshot Command Examples

- Create an ACFS snapshots
  - Syntax: acfsutil snap create *snap_name mountp*
- Delete ACFS snapshot
  - *acfsutil snap delete snap_name mountp*
- V$ASM_ACFSSNAPSHOTS
  - ***FS_NAME - The ACFS mount point***
  - ***DEVICE_NAME – The device name***
  - ***SNAPSHOT_NAME – Snapshot Name which is a valid directory name***
  - ***SPACE_USED_GB – Space used by the snapshot in GB***
  - ***CREATION_TIME – The time at which the snapshot was created***

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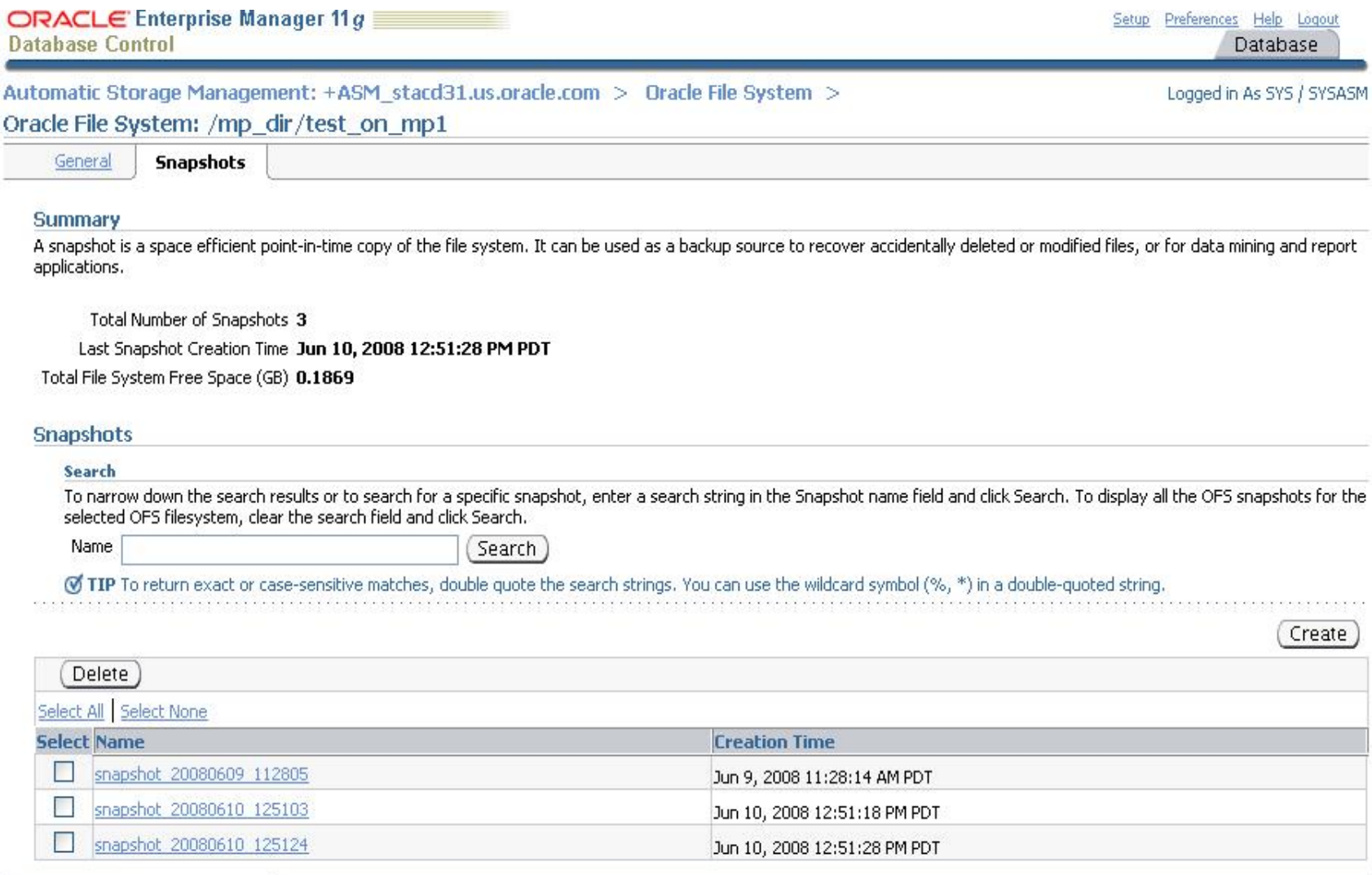
Managing ACFS using EM - Snapshots



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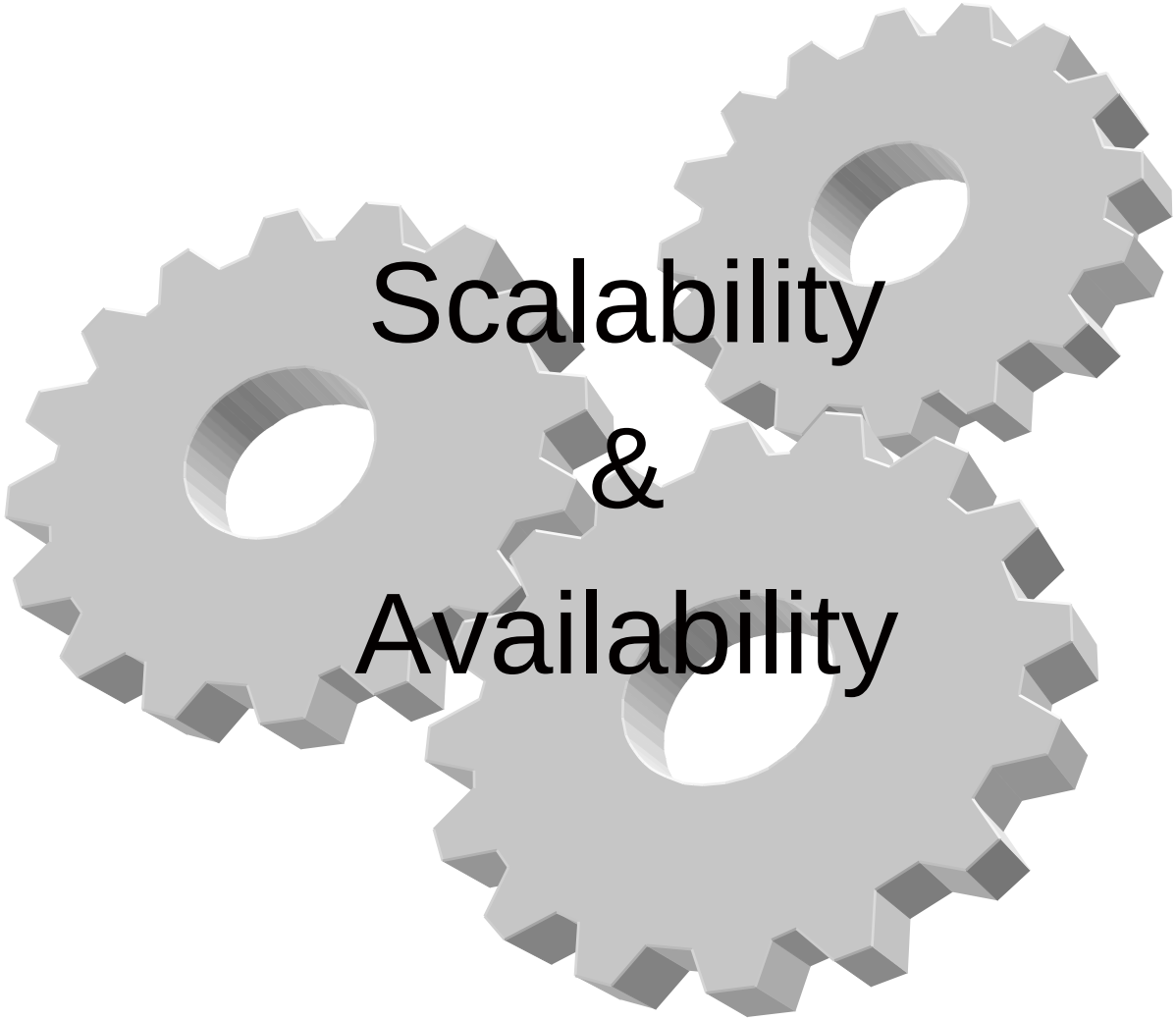
Scalability
&
Availability

Availability

- ACFS is designed to be ‘always on-line’ during storage configuration changes
  - Leverages all the ASM always on-line attributes
  - ASM mirroring (normal and high redundancy)
- ACFS designed to off-line rather than panic the OS under unusual error conditions (metadata corruption or writes failures)
  - ACFS isolates errors to individual file system or ACFS file, taking the appropriate off-line action

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Scalability

- Scales to support large number of cluster nodes
  - Leverages Oracle Clusterware
- Large number of file systems and 100’s of thousands of files in a directory
- Scales to very large capacities
  - Small to exabytes for a file system and files
- Fast directory lookup
  - Designed to scale to thousands of files efficiently

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Managing Oracle Database Files

ASM Enhancements

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ASM 11g Release 2 New Features

- All files on ASM
  - Oracle Cluster Registry, Voting Disk and SPFILE
- Tunable performance
  - Intelligent Data Placement (IDP)
- Improved management
  - Full featured ASMCMD
  - ASM file access control
  - ASM Disk Group rename
  - Datafile to disk mapping
- Installation & configuration mgt
  - ASM Install & Configuration Assistant (ASMCA)

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OCR and Voting Disk on ASM

- OCR is a regular ASM file
  - A new ASM file type
- Voting Disk
  - Stored in selected ASM disks
  - ‘crsctl’ used to specify a disk group for Voting disks
  - ASM auto creates1/3/5 Voting Disks based on Ext/Normal/High redundancy on Failure Groups
  - Quorum failure group
- ASM determines redundancy for OCR and Voting Disk based on disk group redundancy level
- ASM SPFILE is also supported on ASM now

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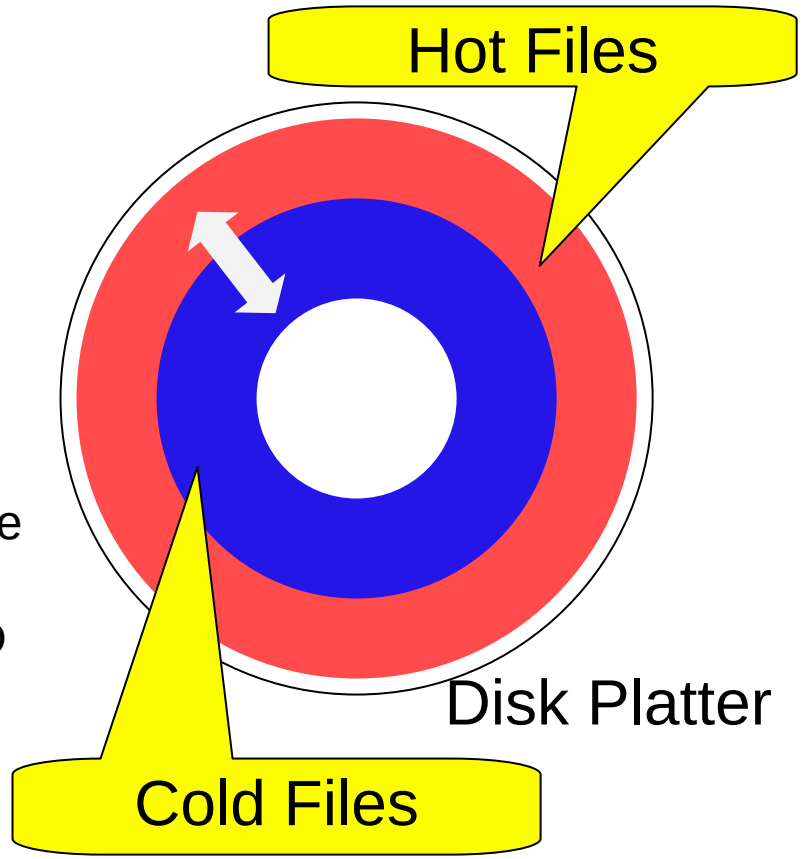
Intelligent Data Placement (IDP)

- Policy-based file placement for hot files on high performance regions of disk
- Leverage disk performance regions on disk drives
  - 50% performance difference from outer to inner tracks
- Classify or mark an ASM file to be HOT/COLD
  - Alter diskgroup dgname modify file ‘xxx’ attributes HOT/COLD or based on a template at creation time
  - Rebalance to migrate the ‘file’ to HOT/COLD IDP region
- IDP regions are dynamic
- New V$ASMFILE recording IO stats
- The IDP feature better leveraged when ASM disks are whole disks



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Complete ASMCMD Functionality

A complete API for the system admin

- Extending ASMCMD to manage:
  - ASM instance (startup/shutdown, init.ora, .)
  - Disk group, disk and failure group (create, mount, add, drop, …)
  - Attribute (list, set)
  - User/Group (add user, change password, …)
  - Template (list, add, alter drop)
  - Iostat and df
  - lsof: list files that are open by ASM
    lsod: list disks that are open by ASM
  - Dynamic Volume

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ASM File Access Control

- Introducing 3 classes of permissions:
  - owner, group, and other
- 3 levels of permissions per class:
  - none, read-only, read-write
- ACL commands apply to OS User names
  - Database users inherit this ACL

```
ALTER DISKGROUP data1 SET ATTRIBUTE
'access_control.enabled' = 'true';
```

```
ALTER DISKGROUP data1 SET ATTRIBUTE
'access_control.umask' = '026';
```

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ASMCMD ACL Commands

Summary of Oracle ASM File Access Control Commands

- chgrp Changes the user group of a file or list of files.
- chmod Changes permissions of a closed file or list of files.
- chown Changes the owner of a closed file or list of files.
- groups List the user groups to which a user belongs.
- grpmod Adds or removes users from an existing user group.
- lsgrp Lists user groups.
- lsusr Lists users in a disk group.
- mkgrp Creates a new user group.
- mkusr Adds a user to disk group.
- passwd Changes the password of a user.
- rmgrp Deletes a user group.
- rmusr Deletes a user from a disk group.

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ASM Disk Group Rename

Solution

- *renamedg* tool may be used to rename a disk group
- *renamedg* disk_string is used to discover disks to be renamed in a disk group
- Renaming a disk group is a 2 stage process (for safety)
  1. Generates a config file (each line contains description of change to be made to one disk)
  2. uses conf file to perform change

```
$ renamedg -dgname MYOLDDG -newdgname MYNEWDG

$ renamedg -phase one -dgname MYOLDDG -newdgname
MYNEWDG -config /tmp/myrendg.conf

$ renamedg -phase two -config /tmp/myrendg.conf
```


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Other Features

- 4k sector size disk I/O support
  - SECTOR_SIZE disk group attributes is specified during DG creation
  - Possible values are: 512b or 4096b (4k)

- Oracle File Mapping support (OFM)
  - Efficient Oracle File Mapping interface
  - View mapping of datafiles to physical devices
  - Dynamic V$ views used to store mapping info
  - Used with same OFM interfaces

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Installation and Configuration Management

Designed for
DBAs and System Admins

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Oracle Grid Infrastructure

- ASM and Oracle Clusterware integrated and installed in a single ‘Grid Infrastructure’ home
  - Integrated installation, configuration and upgrade
  - Installed using Oracle Universal Installer (OUI)
    - Not a part of database install
  - Option to minimally configure ASM and ACFS
  - Automate creation of Oracle DB Homes on ACFS

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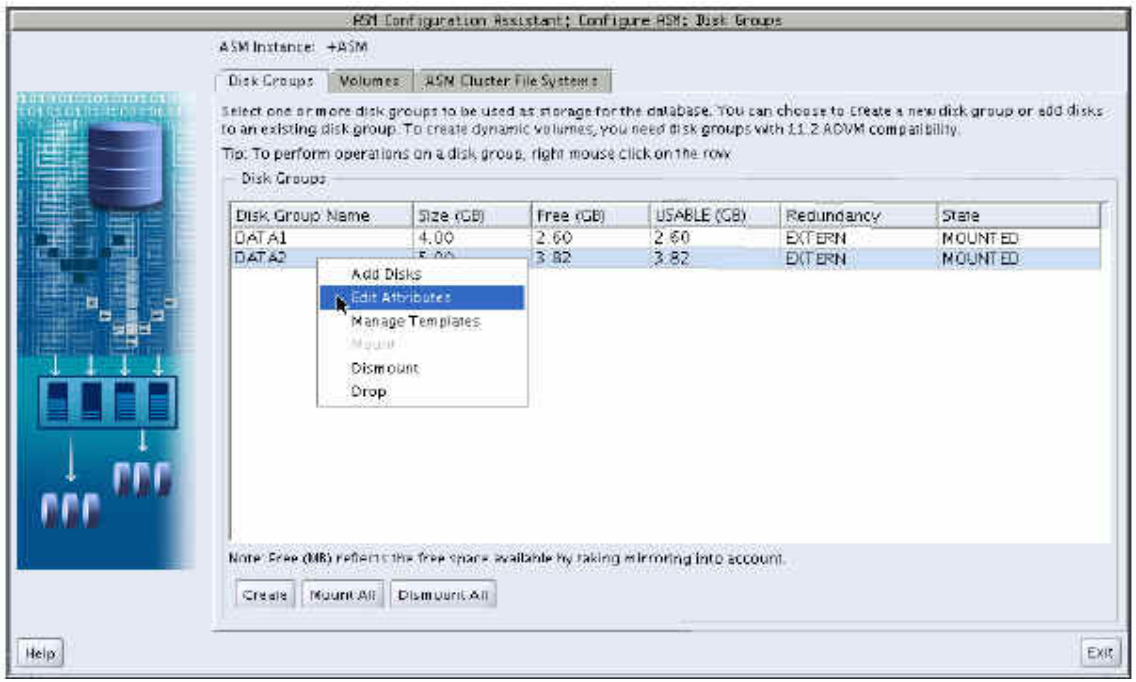
ASM Configuration Assistant (ASMCA)

- Manage DB before db install
- One tool to configure ASM, Dynamic Volumes and ACFS
- Upgrade previous versions of ASM to the current version (11g R2)
- Create & manage Dynamic Volumes
- Create and manage ACFS file systems
  - Create Oracle DB Homes for rdbms binaries to be installed



In Summary…

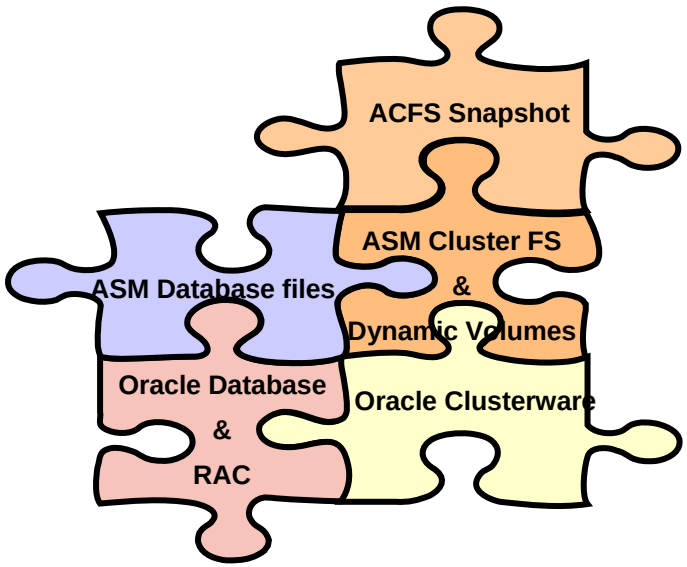
One Integrated Solution for ALL Data

Simple | Low Cost | High Performance | Always On-Line

Scalable | Optimal Utilization

Un-structured Data

Structured Data



Cross Platform
Linux, Windows, Solaris, HP-UX, AIX

One Management Interface

One Install and Configure

One Clusterware Framework

One Vendor for Support

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Value Proposition

- Reduced complexity thru automation
  - No I/O tuning, reshuffling data files
- Simplified solution stack
  - No finger pointing, 3rd party LVM/FS
- Increases utilization and database and application uptime
  - No down-time for storage provisioning or migration
  - Managing storage pool vs. islands
- Single vendor cross-platform integrated solution
  - Bundled and tested as one solution
  - Same cross platform tools to install, configure and manage
- Free

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ASM adoption

- De-facto standard for RAC and grid deployments, >65%
- De-facto standard for VLDB deployments
- Large and growing adoption for single instance deployments, >20%
- Thousands of customers using ASM
- One of the most popular features in the database

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Some ASM Reference Customers In Production

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