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12c ASM – The New Frontier

Nitin Vengurlekar
Chief Architect/CTO - Viscosity North America

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A Brief Word on Viscosity

- Partners are all ex-Oracle - from different disciplines
- Offer Database Professional Services and Managed Services
- Focus in Exadata, Virtualization, and all things Database
- Visit us at **viscosityna.com**

Who am I and Why am even speaking☺

- 18 Years with Oracle
- 13 Years in RAC/ASM development and Product Management
- Self Proclaimed “Private Database Cloud” Evangelist
- Follow me on Twitter - @dbcloudshifu

Program Agenda

- ASM Overview – A 5 minute walk through
- Why New ASM Evolution
- ASM Features
  - Flex ASM
  - ASM Optimizations for Engineered Systems
  - ASM Misc Changes
- ASM Walk Through

Safe Harbor Statement

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.

ASM Overview
A 5 minute Walk Thru

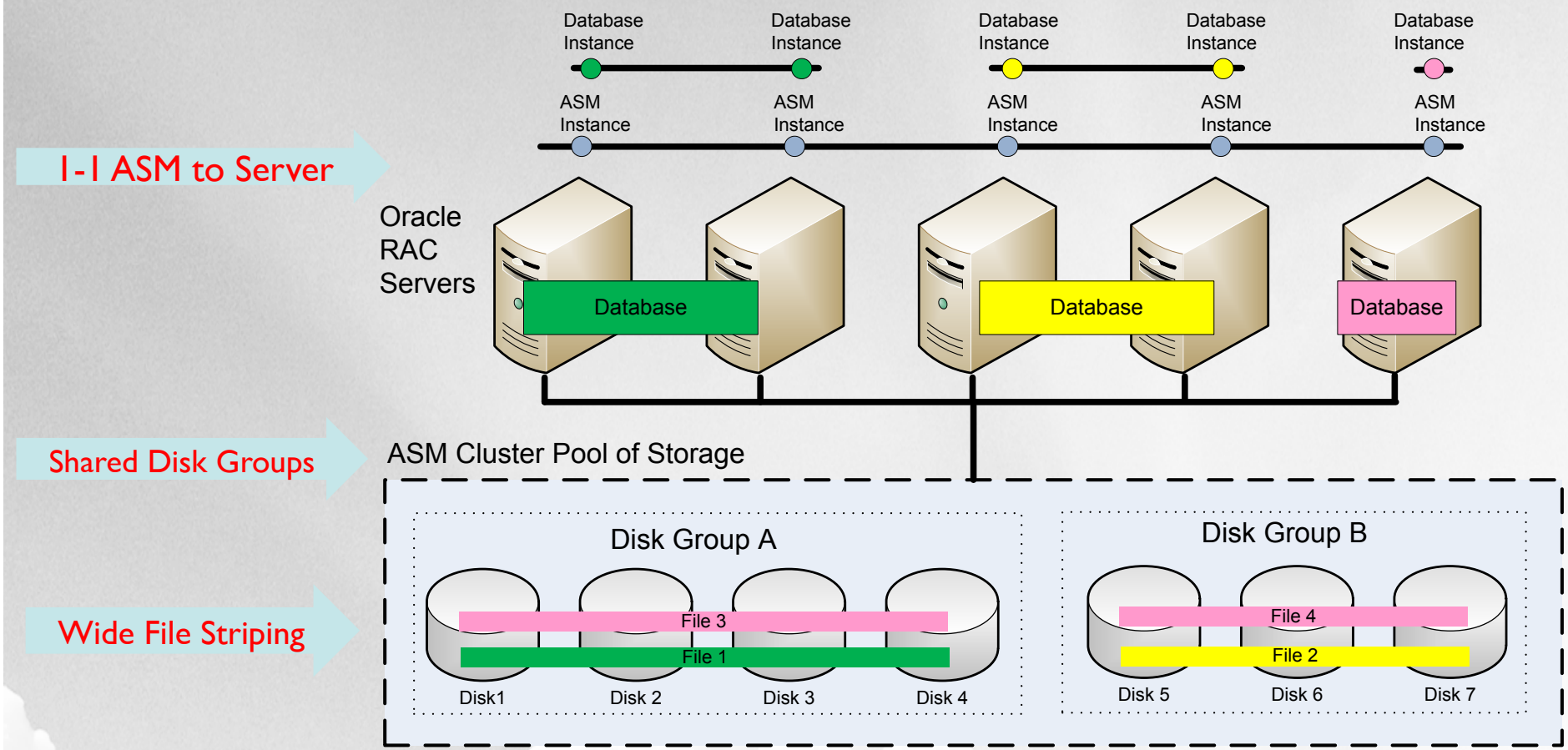
- Automatic Storage Management (ASM) instance
  - Instance that manages the disk group metadata
  - One per node….traditionally ☺

- Disk Groups
  - Logical grouping of disks
  - Sets default file mirroring options

- ASM Disks
  - LUNs presented to ASM

- ASM Files
  - Files that are stored in ASM disk groups are called ASM files, this includes database files and ACFS-ADVM volume files

ASM Legacy Configuration



IT Evolution
Impact and Drivers

- Business drivers change IT behavior
  - Private database Clouds, DBaaS, etc.

- Focus has been on
  - Consolidation
  - Higher utilization
  - Scalability
  - Flexibility
  - Elasticity/Agility
  - All the above yet don't skimp on the availability

- Customers want to be able scale storage, drive utilization but at same time not sacrifice availability

ASM 12c New Features

Areas of Focus

- Manageability
- Scalability
- Availability
- Elasticity/Agility

ASM New Features

ASM Clustering Features

- Flex ASM
  - ASM Clustering
  - Remote [ASM] Access
  - ASM Network

ASM New Features

But first some clarity on terminology…..

- Standard Cluster
  - All nodes in the clusterare tightly coupled through private network
  - All nodes have direct read/write access to shared storage
  - Option to use FlexASM or not

- Flex Cluster
  - Scale Cluster to large number of nodes
  - Designed as HUB-LEAF topology
  - Hub nodes leverage standard cluster architecture
  - Leaf nodes are very light weight servers, not connected to other leaf nodes, and have no direct access to the storage.
  - Implicitly uses FlexASM

Oracle Grid Infrastructure - Setting up Grid Infrastructure - Step 3 of 19

Select Cluster Type

ORACLE GRID INFRASTRUCTURE 12c

- Software Updates
- Installation Option
- **Cluster Type**
- Installation Type
- Product Languages
- Grid Plug and Play
- Cluster Node Information
- Network Interface Usage
- Grid Infrastructure Manager
- Storage Option
- OCR Storage
- Voting Disk Storage
- Operating System Groups
- Installation Location
- Root script execution
- Prerequisite Checks
- Summary
- Install Product
- Finish

Choose the type of cluster required.

(•) Configure a Standard cluster

Choose this option to configure a group of servers into a single cluster.

( ) Configure a Flex cluster

Flex clusters are highly scalable clusters in which servers can be assigned specific roles to satisfy database or application functions.

Help | < Back | Next > | Install | Cancel

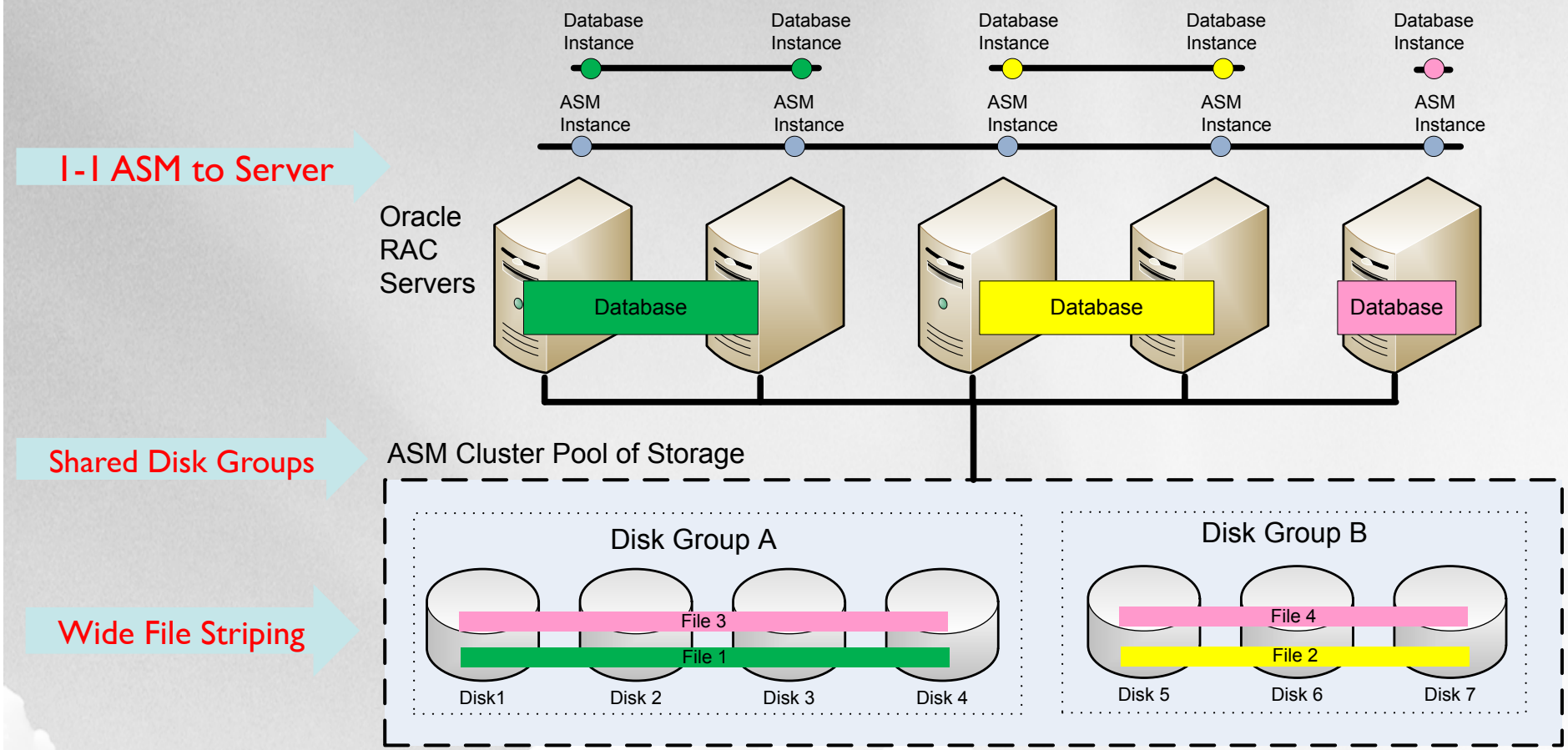
ASM New Features

Flex ASM Clustering

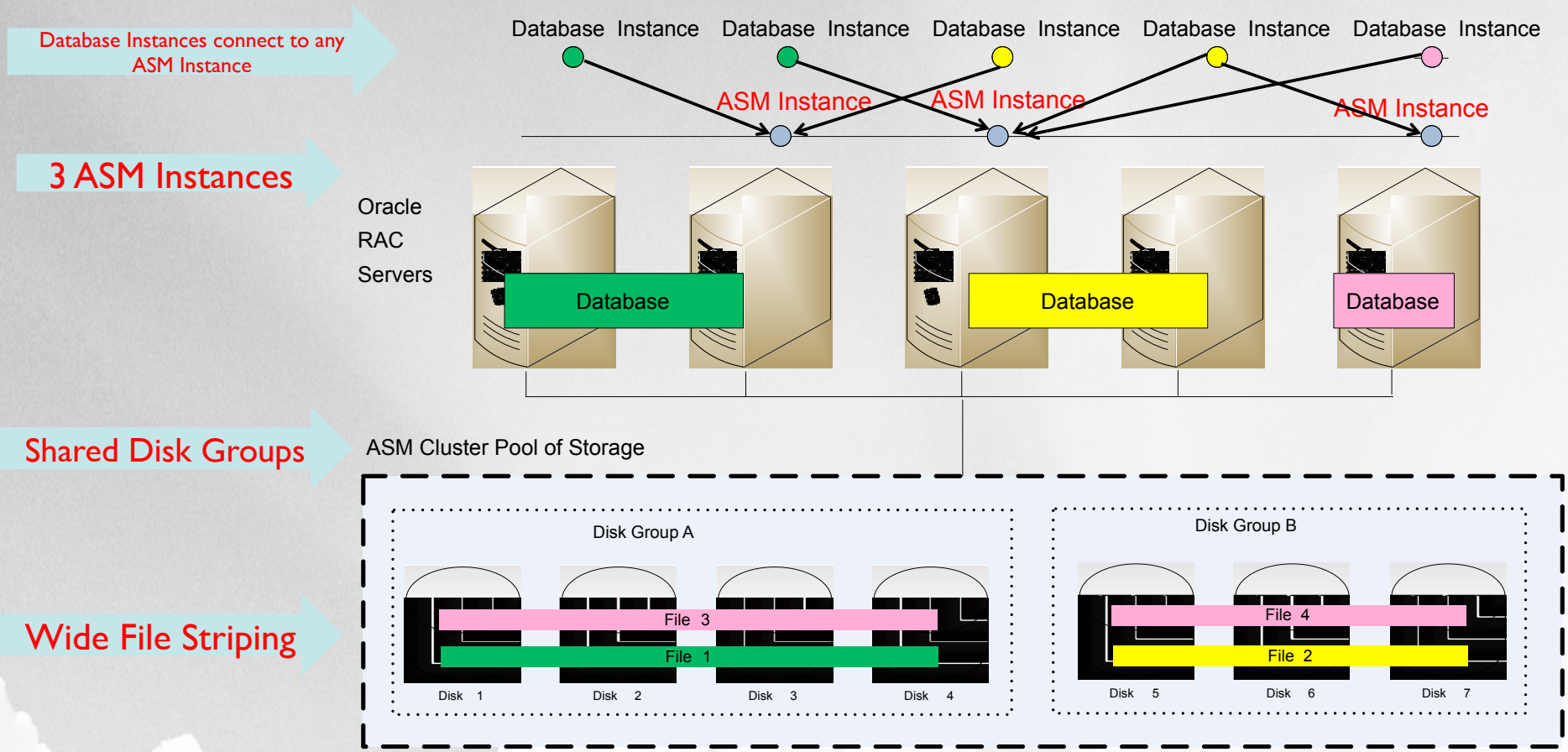
- Three deployment models for ASM Clustering
  - FlexASM – Pure 12c Mode
  - Mixed Mode Configuration
    - Supports pre-12c and 12c Databases
- Configure ASM Clustering in Standard Mode

Scalability/Availability/Agility

ASM Legacy Configuration



Flex ASM Configuration



ASM New Features

Flex ASM Clustering – Pure 12c Mode

- Eliminates requirement for an ASM instance on every cluster node
  - Databases can connect to any available ASM instance
  - Database instances can failover to a secondary ASM instance
  - Option to perform maintenance on ASM without need to stop the RAC databases

- Administrators specify the cardinality of ASM instances (default is 3)
  - Clusterware ensures ASM cardinality is maintained

- Create a new 12c Cluster for 12c Databases only
  - Best for Greenfield, sandbox and for 12c isolation environments

Scalability/Availability

ASM New Features

Flex ASM Clustering - Mixed Mode

- Configure Flex ASM, but set ASM cardinality == # servers in cluster (actually cardinality set to ALL)
- ASM instances run all nodes in the cluster
- Allows 12c Databases to connect remotely to ASM and take advantage of 12c ASM features like failover
- Pre-12c databases will connect locally to ASM and behave like legacy database w.r.t failover

Scalability/Availability

ASM New Features

Flex ASM Clustering - Standard Mode

- ASM Clustering in Standard Mode
  - Install 12c Cluster (non-Flex ASM) & hard-wire ASM to each node.
  - This is same-ol-same-ol model
  - Good for transitioning pre-12c databases to 12c
  - Cannot leverage new ASM connectivity or failover features, because no Flex ASM
  - You can convert from Standard Mode to Flex mode

```
$ ./asmca -silent -convertToFlexASM -asmNetworks eth1/192.168.0.1
-asmListenerPort 1521

$ $ORACLE_BASE/cfgtoollogs/asmca/scripts/converttoFlexASM.sh
```

Scalability/Availability

ASM New Features

Flex ASM - ASM listener

- New global CRS resource to support Flex ASM
- Runs where ASM instance is running
  - ASM instances registers with all ASM listeners
  - Functionally similar to SCAN Listener
- Clients [DB instances] connect to ASM using ASM listener endpoints
  - Clients connect using connect data credentials defined by CSS GMS
  - Clients try best connection (local) first, if no local-node ASM, then connect to (any) remote ASM instance in the cluster
  - Connectivity is load balanced across ASM instances

ASM New Features

Flex ASM - ASM Network

- In previous versions Oracle Clusterware required:
  - A public network for client application access
  - One or more private networks to carry Cache Fusion and ASM traffic within the cluster

- Flex ASM adds option for ASM network,
  - Used for communication between ASM and its clients
  - Extent map shipping across this network
  - OCR metadata bursty traffic on failover or resource state changes
  - SQL*Net credential handling for clients
  - Can continue to share the CSS private network

ASM New Features

Shared Password file

- In Legacy ASM, most Oracle database and ASM related files could be stored in ASM disk groups.
  - The key exception was the password file - both for ASM and database.
- Lack of support could lead to synchronization issues
  - 11gR2 provided cross-instance calls (CIC) to synchronize the password file, but if an instance or node was inactive, then synchronization was not possible, still leaving the password file inconsistent.

ASM New Features

Shared Password file

- In Oracle 12c (for new installations), default orapwd location (for ASM and DB) is ASM
  - Requires compatible.asm set to '12.1'
  - OS authentication used to start ASM via asm agent
  - Disk group location of password file becomes a CRS resource attribute of ASM and database instance.
  - The ASM instance and disk group storing the password file needs to be available before password file authentication is possible for the database
  - orapwd still used to manage password file.. ..asmcmd can also be used

```
$ orapwd file='+CRSDATA' dbuniqueue='yoda' password='oracle1'
$ orapwd asm=y file='+CRSDATA' password='asmoracle1'

ASMCMD [+] > pwget --asm
+CRSDATA/orapwASM
```

Manageability/Agility

ASM New Features

ASM Clustering Support

- After initial configuration, Flex ASM is designed to require minimal monitoring and ongoing management.

- In release 12c, there are no new instance parameters that are specific to Flex ASM.

- The default parameter settings have been adjusted to suit the Flex ASM architecture, making them sufficient to effectively support most situations.

Manageability

ASM New Features

Disk Management Features

- Fast Disk Resync & Checkpoints
- Fast Disk Replacement
- Failure group Repair Timer
- ASM Disk Scrubbing
- Rebalance Optimizations

ASM New Features

Disk Management Optimizations – Scalable Resync

- In Legacy ASM Disk Online operation was single-threaded
  - This usually does not work well when the disk has been offline for a long time or when multiples disks have gone offline

- 12c Fast Disk Resync Feature
  - Allows Admins to throttle the resync operation
  - Power limit can be set for disk resync operations from 1 to 1024

```
SQL> alter diskgroup reco online disk reco_0004 power 16

ASMCMD> online -G reco -D reco_004 -power 16
```

- Resync operation now has a time estimate (EST_MINUTES) in V$ASM_OPERATION

- Relocate and rebalance code is merged

Manageability/Availability

ASM New Features

Disk Management Optimizations – Disk Resync Checkpoints

- In Legacy ASM if Disk Resync operation was interrupted it had to be re-started from the beginning
- 12c ASM Disk resync incorporates disk online "Check Points"
  - Interrupted resync operations are automatically restarted
  - Previously completed phases of the resync are skipped
  - Resync processing restarts at the beginning of the first remaining incomplete phase
    - Every 1000 extents are "batch" cleared in SR

Manageability/Availability

ASM New Features

Disk Management Optimizations – Fast Disk Replacement

- In Legacy ASM, if a disk "truly" failed, it needed to be replaced and re-added to diskgroup
  - This required an expensive re-partnership and rebalance

- 12c ASM allows fast, low-overhead replacement of failed disks
  - Replace new disk in same slot as failed disk

```
SQL>alter diskgroup replace disk rec_0004 with '/dev/
  mapper/mpathe'
```

  - Replacement disk takes the same name as the original disk
  - Replacement disk becomes part of the same failure group as the original disk
  - Replacement disk is re-populated with copies of ASM extents from other disks
  - Disk group rebalance is not needed

Manageability/Availability

ASM New Features

Disk Management Optimizations - Failure Group Repair timer

- ASM 12c allows Failure Group repair time
- Useful for protecting against transient failgroup issues, such as controller issues or poor connectivity in Stretch Clusters
- New disk group attribute, failgroup_repair_time
  - Similar to existing disk repair time
  - Default setting is 24 hours

```
SQL> alter diskgroup reco set attribute 'failgroup_repair_time
  = 36h';
```

Manageability/Availability

ASM New Features

Disk Management Optimizations – Data Scrubbing

- The database checks for logical consistency on reading data
  - Currently only if a logical corruption is detected can automatic recovery can be performed using the mirror copies
  - For seldom accessed data, corrupted data could be present in the system for a long time between reads
  - Possibility that all mirrors are corrupted increases over time

- ASM 12c Scrubbing features validates data integrity:
  - New background [master] process SCRB performs cycle
    - Can be offloaded to Cells in Exadata
  - Auto-magic error correction using mirrored data

Availability

ASM New Features

Disk Management Optimizations – Data Scrubbing

- ASM 12c scrubbing occurs in two ways:
  - As part of rebalance operations
    - Requires content.check attribute to enable

```
SQL> alter diskgroup data set attribute 'content.check' = 'TRUE'
```

  - On demand scrubbing
    - Scrubbing can be performed on a Disk Group, on individual files or individual disks

```
SQL> alter diskgroup data scrub repair;
SQL> alter diskgroup data scrub disk data_0004 norepair power
     high;
```

Availability

ASM New Features

Disk Management Optimizations –Rebalance Improvements

- Establish upfront estimates before actually doing a rebalance operation

```
EXPLAIN WORK FOR ALTER DISKGROUP pdbdata DROP DISK pdbdata_0008;
Explained.

SELECT est_work FROM V$ASM_ESTIMATE;
EST_WORK
--------
    2244
```

- Improved accuracy of Rebalance estimates
  - Phase now exposed in v$ASM_OPERATION

- Code optimization of lock acquisition/release signficantly improves rebalance overall elapsed time

Availability

ASM New Features

Engineered Systems Optimizations - Rebalance Offload

- Most extent relocations performed by a rebalance operation offloaded to Exadata Storage Server.
- A single offload request can replace multiple read and write I/O requests.
- Offloading relocations avoids sending data to the ASM host, consequently improving rebalance performance
- Rebalance uses fewer Compute server resources, I/O resources and executes quicker

Scalability

ASM New Features

- Increase maximum number of Disk Groups to 511
  - Previous limit was 63

- ASMCMD Command for renaming ASM Disk

- ASM instance Patch-level verification
  - Patch level verification is disabled during rolling patches

- Replicated Physical Metadata
  - Improves reliability
  - Virtual Metadata has always been replicated with ASM mirroring
  - Largest disk size beyond 2T (support 32P)

Scalability/Manageability/Availability

ASM New Features

ACFS New Features

- Database Files on ACFS
- HANFS Support

ACFS New Features

DB files on ACFS

- ACFS 12c (aka CloudFS) supports all Oracle Database files
  - Users now have a choice - create an Oracle Database on ASM or ACFS
  - Oracle databases created on CloudFS can leverage snapshots (RW,RO)
  - Both provide equivalent performance
- Best Practice for Database files on CloudFS
  - Set stripe columns to `1` for the ADVM volume
    - Disables ADVM volume striping
  - Set `FILESYSTEMIO_OPTIONS=SETALL` in the database init.ora
    - Enables direct I/O for the database, bypassing the OS file system cache

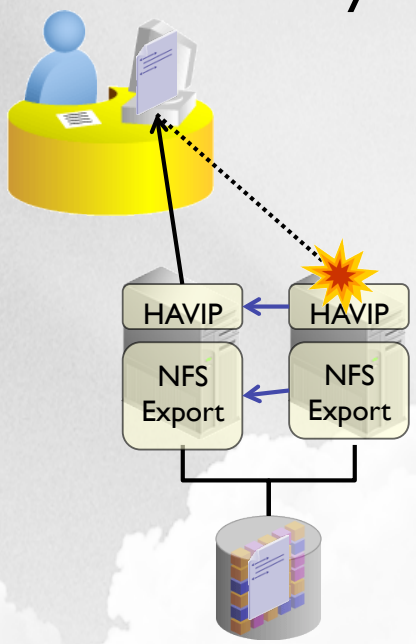
Scalability/Manageability/Availability

ACFS New Features

HANFS

- High Availability NFS (HANFS) provides uninterrupted NFS services:
  - Exported file systems are exposed using Highly Available Virtual IPs (HAVIPs)

- Oracle Clusterware manages the NFS exports and HAVIPs
  - Services are automatically migrated if the current node fails



Scalability/Manageability/Availability

ASM 12C

Install and config

Oracle Grid Infrastructure - Setting up Grid Infrastructure - Step 2 of 17

Select Installation Option

ORACLE GRID INFRASTRUCTURE 12c

- Software Updates
- Installation Option
- Cluster Type
- Product Languages
- Grid Plug and Play
- Cluster Node Information
- Network Interface Usage
- Grid Infrastructure Managemen
- Create ASM Disk Group
- ASM Password
- Operating System Groups
- Installation Location
- Root script execution
- Prerequisite Checks
- Summary
- Install Product
- Finish

(•) Install and Configure Oracle Grid Infrastructure for a Cluster

( ) Install and Configure Oracle Grid Infrastructure for a Standalone Server

( ) Upgrade Oracle Grid Infrastructure or Oracle Automatic Storage Management

( ) Install Oracle Grid Infrastructure Software Only

Help | < Back | Next > | Install | Cancel

Oracle Grid Infrastructure - Setting up Grid Infrastructure - Step 3 of 19

Select Cluster Type

ORACLE GRID INFRASTRUCTURE 12c

- Software Updates
- Installation Option
- **Cluster Type**
- Installation Type
- Product Languages
- Grid Plug and Play
- Cluster Node Information
- Network Interface Usage
- Grid Infrastructure Manager
- Storage Option
- OCR Storage
- Voting Disk Storage
- Operating System Groups
- Installation Location
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- Summary
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- Finish

Choose the type of cluster required.

(•) Configure a Standard cluster

Choose this option to configure a group of servers into a single cluster.

( ) Configure a Flex cluster

Flex clusters are highly scalable clusters in which servers can be assigned specific roles to satisfy database or application functions.

Help | < Back | Next > | Install | Cancel

Oracle Grid Infrastructure - Setting up Grid Infrastructure - Step 4 of 19

Select Installation Type

ORACLE GRID INFRASTRUCTURE 12c

- Software Updates
- Installation Option
- Cluster Type
- **Installation Type**
- Product Languages
- Grid Plug and Play
- Cluster Node Information
- Network Interface Usage
- Grid Infrastructure Manager
- Storage Option
- OCR Storage
- Voting Disk Storage
- Operating System Groups
- Installation Location
- Root script execution
- Prerequisite Checks
- Summary
- Install Product
- Finish

○ Typical Installation

Perform a full grid infrastructure installation with basic configuration.

◉ Advanced Installation

Allows advanced configuration options such as alternative storage choices, additional networking flexibility, integration with IPMI.

Help | < Back | Next > | Install | Cancel

Oracle Grid Infrastructure - Setting up Grid Infrastructure - Step 6 of 19

Grid Plug and Play Information

ORACLE GRID INFRASTRUCTURE 12c

- Software Updates
- Installation Option
- Cluster Type
- Installation Type
- Product Languages
- **Grid Plug and Play**
- Cluster Node Information
- Network Interface Usage
- Grid Infrastructure Manager
- Storage Option
- OCR Storage
- Voting Disk Storage
- Operating System Groups
- Installation Location
- Root script execution
- Prerequisite Checks
- Summary
- Install Product
- Finish

Single Client Access Name (SCAN) allows clients to use one name in connection strings to connect to the cluster as a whole. Client connect requests to the SCAN name can be handled by any cluster node.

Cluster Name: rac12c-cluster

SCAN Name: rac12c-scan

SCAN Port: 1521

☐ Configure GNS

☑ Configure nodes Virtual IPs as assigned by the Dynamic Networks

◉ Create a new GNS

GNS VIP Address:

GNS Sub Domain: rac12c.

○ Use Shared GNS

GNS Client Data: Browse...

Help | < Back | Next > | Install | Cancel

Oracle Grid Infrastructure - Setting up Grid Infrastructure - Step 7 of 19

Cluster Node Information

ORACLE GRID INFRASTRUCTURE 12c

- Software Updates
- Installation Option
- Cluster Type
- Installation Type
- Product Languages
- Grid Plug and Play
- **Cluster Node Information**
- Network Interface Usage
- Grid Infrastructure Manager
- Storage Option
- OCR Storage
- Voting Disk Storage
- Operating System Groups
- Installation Location
- Root script execution
- Prerequisite Checks
- Summary
- Install Product
- Finish

Provide the list of nodes to be managed by Oracle Grid Infrastructure with their Public Hostname and Virtual Hostname.

Public Hostname	Virtual Hostname
rac12c1	rac12c1-vip
rac12c2	rac12c2-vip
rac12c3	rac12c3-vip
rac12c4	rac12c4-vip

SSH connectivity... | Use Cluster Configuration File... | Add... | Edit... | Remove

Help | < Back | Next > | Install | Cancel

Oracle Grid Infrastructure - Setting up Grid Infrastructure - Step 8 of 19

Specify Network Interface Usage

ORACLE GRID INFRASTRUCTURE 12c

- Software Updates
- Installation Option
- Cluster Type
- Installation Type
- Product Languages
- Grid Plug and Play
- Cluster Node Information
- **Network Interface Usage**
- Grid Infrastructure Manager
- Storage Option
- OCR Storage
- Voting Disk Storage
- Operating System Groups
- Installation Location
- Root script execution
- Prerequisite Checks
- Summary
- Install Product
- Finish

Private interfaces are used by Oracle Grid Infrastructure for internode traffic.

Interface Name	Subnet	Use for
eth2	172.16.254.0	ASM & Private
eth1	172.16.254.0	Public

Note: If you intend to store Oracle Cluster Registry (OCR) and voting disk files using Oracle Flex Automatic Storage Management (Oracle Flex ASM), then you must designate at least one of the private interface subnets either as "ASM" or as "ASM & Private".

Help | < Back | Next > | Install | Cancel

Oracle Grid Infrastructure - Setting up Grid Infrastructure - Step 10 of 19

Storage Option Information

ORACLE GRID INFRASTRUCTURE 12c

- Software Updates
- Installation Option
- Cluster Type
- Installation Type
- Product Languages
- Grid Plug and Play
- Cluster Node Information
- Network Interface Usage
- Grid Infrastructure Manager
- **Storage Option**
- OCR Storage
- Voting Disk Storage
- Operating System Groups
- Installation Location
- Root script execution
- Prerequisite Checks
- Summary
- Install Product
- Finish

You can place Oracle Cluster Registry (OCR) files and voting disk files on Oracle ASM storage, or on a file system.

○ Use Standard ASM for storage

Choose this option to configure Local Oracle ASM in this cluster and store OCR and voting disk files on it. ASM instance will be configured on all nodes of the cluster.

◉ Use Oracle Flex ASM for storage

Choose this option to configure OCR and voting disks on ASM storage. ASM instance will be configured on reduced number of cluster nodes.

○ Use Shared File System

Choose this option to configure OCR and voting disk files on an existing shared file system.

Help | < Back | Next > | Install | Cancel

Oracle Grid Infrastructure - Setting up Grid Infrastructure - Step 8 of 17

Grid Infrastructure Management Repository Option

ORACLE GRID INFRASTRUCTURE 12c

- Software Updates
- Installation Option
- Cluster Type
- Product Languages
- Grid Plug and Play
- Cluster Node Information
- Network Interface Usage
- Grid Infrastructure Manageme
- Create ASM Disk Group
- ASM Password
- Operating System Groups
- Installation Location
- Root script execution
- Prerequisite Checks
- Summary
- Install Product
- Finish

As part of setting up Grid Infrastructure software you can optionally configure Grid Infrastructure Management Repository which is a special type of database that will assist in the management operations of Oracle Grid Infrastructure.

Configure Grid Infrastructure Management Repository

- (•) Yes
- ( ) No

Help | < Back | Next > | Install | Cancel

Oracle Grid Infrastructure - Setting up Grid Infrastructure - Step 9 of 17

Create ASM Disk Group

ORACLE GRID INFRASTRUCTURE 12c

- Software Updates
- Installation Option
- Cluster Type
- Product Languages
- Grid Plug and Play
- Cluster Node Information
- Network Interface Usage
- Grid Infrastructure Managemer
- **Create ASM Disk Group**
- ASM Password
- Operating System Groups
- Installation Location
- Root script execution
- Prerequisite Checks
- Summary
- Install Product
- Finish

Select Disk Group characteristics and select disks

Disk group name: DATA

Redundancy: ○ High ○ Normal ◉ External

Allocation Unit Size: 4 MB

Add Disks

◉ Candidate Disks ○ All Disks

☑	Disk Path	Size (in MB)	Status
☑	/dev/sdb	4096	Candidate
☑	/dev/sdc	4096	Candidate
☑	/dev/sdd	4096	Candidate

Change Discovery Path...

Help | < Back | Next > | Install | Cancel

ASM 12c

Implementation

We are running a 4 node RAC cluster with ASM default cardinality

```
[oracle@rac01 trace]$ crsctl get node role status -all
Node 'rac01' active role is 'hub'
Node 'rac03' active role is 'hub'
Node 'rac02' active role is 'hub'
Node 'rac04' active role is 'hub'
```

Running 2 node Serverpool

```
[oracle@rac02 ~]$ srvctl status   serverpool -serverpool naboo
Server pool name: naboo
Active servers count: 2
```

First let's check we are really running in FlexASM mode:

```
[oracle@rac02 ~]$ asmcmd showclustermode
ASM cluster : Flex mode enabled
```

ASM 12c

Implementation

Here's some other important supporting info on FlexASM:

```
[oracle@rac02 ~]$ srvctl config asm -detail
ASM home: /u01/app/12.1.0/grid
Password file: +CRSDATA/orapwASM
ASM listener: LISTENER
ASM is enabled.
ASM instance count: 3
Cluster ASM listener: ASMNET1LSNR_ASM
```

ACFS is also enabled for storing trace data

```
[oracle@rac02 ~]$ srvctl status  filesystem
ACFS file system /u02/app/oracle/acfsmounts is mounted on nodes
rac01,rac02,rac04

srvctl status asm -proxy
ADVM proxy is running on node rac01,rac02,rac03,rac04
```

ASM 12c

Implementation

```
[oracle@rac01 ~]$ crsctl stat res -t
--------------------------------------------------------------------------------
Name           Target  State        Server                   State details
--------------------------------------------------------------------------------
Local Resources
--------------------------------------------------------------------------------
ora.ASMNET1LSNR_ASM.lsnr
               ONLINE  ONLINE       rac01                    STABLE
               ONLINE  ONLINE       rac02                    STABLE
               ONLINE  ONLINE       rac03                    STABLE
               ONLINE  ONLINE       rac04                    STABLE
```

You notice that we have 4 ASM listeners one on each node in the Cluster. You'll see the process as the following on each node:

```
[oracle@rac01 ~]$ ps -ef |grep -i asmnet

ooracle    6646     1  0 12:19 ?        00:00:00 /u01/app/12.1.0/grid/bin/tnslsnr
ASMNET1LSNR_ASM -no_crs_notify -inherit
```

ASM 12c

Implementation

The pdbdata, crsdata and fra disk group resources are started on all nodes except node 4

```
ora.CRSDATA.dg
               ONLINE  ONLINE       rac01                      STABLE
               ONLINE  ONLINE       rac02                      STABLE
               ONLINE  ONLINE       rac03                      STABLE
               OFFLINE OFFLINE      rac04                      STABLE


ora.FRA.dg
               ONLINE  ONLINE       rac01                      STABLE
               ONLINE  ONLINE       rac02                      STABLE
               ONLINE  ONLINE       rac03                      STABLE
               OFFLINE OFFLINE      rac04                      STABLE


ora.PDBDATA.dg
               ONLINE  ONLINE       rac01                      STABLE
               ONLINE  ONLINE       rac02                      STABLE
               ONLINE  ONLINE       rac03                      STABLE
               OFFLINE OFFLINE      rac04                      STABLE
```

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ASM 12c

Implementation

As we mentioned earlier, ASM cardinality is 3:

```
[oracle@rac02 ~]$ srvctl config asm -detail
ASM home: /u01/app/12.1.0/grid
Password file: +CRSDATA/orapwASM
ASM listener: LISTENER
ASM is enabled.
ASM instance count: 3
Cluster ASM listener: ASMNET1LSNR_ASM
```

Since we have a two node Serverpool we have 2 DB instances connecting to 2 of 3 ASM instances…maybe not too not exciting ….since it could be all local connections

```
#crsctl stat res -t

ora.tatooine.db
      1        ONLINE  ONLINE       rac03                    Open,STABLE
      2        ONLINE  ONLINE       rac01                    Open,STABLE
--------------------------------------------------------------------------
```

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ASM 12c

Implementation

```
srvctl modify srvpool -serverpool naboo -min 1 -max 4

Crsctl stat res -t
ora.tatooine.db
      1        ONLINE  ONLINE       rac03                    Open,STABLE
      2        ONLINE  ONLINE       rac01                    Open,STABLE
      3        ONLINE  ONLINE       rac02                    Open,STABLE
      4        ONLINE  ONLINE       rac04                    Open,STABLE

ora.asm
      1        ONLINE  ONLINE       rac03                    STABLE
      2        ONLINE  ONLINE       rac01                    STABLE
      3        ONLINE  ONLINE       rac02                    STABLE


[oracle@rac03 ~]$ srvctl status  asm -detail
ASM is running on rac01,rac02,rac03
ASM is enabled.
```

ASM 12c

Implementation

Database from node4 (where ASM is not running), connects to ASM1 on node1. So, what the does the Database have to say about ASM connectivity:

```
NOTE: ASMB registering with ASM instance as client 0x10001 (reg:1377584805)
NOTE: ASMB connected to ASM instance +ASM1 (Flex mode; client id 0x10001)
NOTE: ASMB rebuilding ASM server state
NOTE: ASMB rebuilt 2 (of 2) groups
SUCCESS: ASMB reconnected & completed ASM server state
```

ASM 12c

Implementation

```
[oracle@rac03 ~]$ asmcmd lsct -g pdbdata
Instance_ID  DB_Name   Status     Software_Version  Compatible_version  Instance_Name  Disk_Gro
          1  +ASM      CONNECTED        12.1.0.1.0          12.1.0.1.0  +ASM1          PDBDATA
          2  +ASM      CONNECTED        12.1.0.1.0          12.1.0.1.0  +ASM2          PDBDATA
          3  +ASM      CONNECTED        12.1.0.1.0          12.1.0.1.0  +ASM3          PDBDATA
          2  tatooine  CONNECTED        12.1.0.1.0          12.1.0.0.0  tatooine_1     PDBDATA
          1  tatooine  CONNECTED        12.1.0.1.0          12.1.0.0.0  tatooine_2     PDBDATA
          3  tatooine  CONNECTED        12.1.0.1.0          12.1.0.0.0  tatooine_3     PDBDATA
          3  tatooine  CONNECTED        12.1.0.1.0          12.1.0.0.0  tatooine_4     PDBDATA

Fri Jan 10 21:29:44 2014
NOTE: ASMB registering with ASM instance as client 0xffffffffffffffff (reg:98557598)
NOTE: ASMB connected to ASM instance +ASM3 (Flex mode; client id 0x10008)
NOTE: initiating MARK startup
Starting background process MARK
```

ASM 12c

Implementation

Let's say we wanted to move a database instance from one ASM instance connection to another ASM for planned outage (patching Clusterware)

```
SQL> alter system relocate client 'tatooine_1:tatooine';

System altered.

NOTE: ASMB registering with ASM instance as client 0x10002 (reg:2531435813)
NOTE: ASMB connected to ASM instance +ASM2 (Flex mode; client id 0x10002)
NOTE: ASMB rebuilding ASM server state
NOTE: ASMB rebuilt 2 (of 2) groups
NOTE: ASMB rebuilt 19 (of 19) allocated files
NOTE: fetching new locked extents from server
NOTE: 0 locks established; 0 pending writes sent to server
SUCCESS: ASMB reconnected & completed ASM server state
Fri Jan 10 21:09:24 2014
NOTE: ASMB relocating from ASM instance +ASM2 (ASM-initiated)
NOTE: ASMB registering with ASM instance as client 0x10002 (reg:3934509467)
NOTE: ASMB connected to ASM instance +ASM2 (Flex mode; client id 0x10002)
NOTE: ASMB rebuilding ASM server state
NOTE: ASMB rebuilt 2 (of 2) groups
NOTE: ASMB rebuilt 19 (of 19) allocated files
NOTE: fetching new locked extents from server
NOTE: 0 locks established; 0 pending writes sent to server
SUCCESS: ASMB reconnected & completed ASM server state
```

Q/A

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