An Oracle White Paper
December 2011

SAP with Oracle Real Application Clusters 11g Release 2 (RAC) on Microsoft Windows 2008 Release 2
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Introduction

Oracle Real Application Clusters 11g Release 2 (Oracle RAC) and Oracle Automatic Storage Management 11g Release 2 (Oracle ASM) technologies provide unexcelled availability, scalability and performance for your SAP applications.

This document guides you through the most important steps required, to install such a cluster and will also discuss the recommended path to migrate an Oracle Database 10g Release 2 based system (single instance and RAC) to Oracle RAC 11.2.

The pre-installation steps for setting up the underlying cluster hardware and the operating system are also discussed within this document. However, due to the fact that hardware platforms are evolving quickly, the paper can just give some guidelines on what hardware is required and how it should be configured. In addition, as Oracle Global Naming Service (GNS) is recommended for bigger clusters where nodes are dynamically joining and leaving, this kind of cluster configuration is not discussed in detail. Instead the paper focuses on cluster configurations running without GNS. On Microsoft Windows it may be impossible to integrate GNS into some customer’s existing network environments as it requires a DHCP server and DNS server on the same network.

While with Oracle 9i and Oracle 10.2 the Oracle Cluster Filesystem for Windows (OCFS) was the preferred way to share data among a number of cluster nodes OCFS is not supported anymore with SAP and Oracle RAC 11.2 on the Windows platform. Oracle ASM and Oracle ASM Cluster Filesystem (Oracle ACFS) is now the preferred and recommended storage platform and therefore installations with OCFS are not discussed here.

Basic configuration steps on Oracle ASM will be described but more sophisticated Oracle ASM configurations like configurations with more than one storage system or storage based system copies are not covered within this document. These topics are discussed in another whitepaper 'SAP with Oracle Real Application Clusters 11g Release 2 and Oracle Automatic Storage Management 11g Release 2 - Advanced Configurations & Techniques'.

An additional, complementary whitepaper 'Moving your SAP database to Oracle Automatic Storage Management 11g Release 2 - A Best Practices Guide' is available on SAP Developer Network and on Oracle TechNet. It discusses two different ways of moving an existing database from filesystem to Oracle ASM.

SAP specific configuration hints and recommendations will be provided in this document as well as suggestions about basic test scenarios.
Finally the document will provide information about SAP specific configuration steps in order to properly run BR*Tools and database tasks scheduled from SAP application servers.

## Naming Conventions and Terms

<table>
<thead>
<tr>
<th>Name or Synonym</th>
<th>Description / Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oracle ACFS</td>
<td>Oracle ASM Cluster File System is a cluster file system that uses Oracle ASM as the underlying volume manager infrastructure.</td>
</tr>
<tr>
<td>Oracle ASM</td>
<td>Oracle Automatic Storage Management is basically a volume manager for all Oracle Database related files and Oracle ACFS.</td>
</tr>
<tr>
<td>Oracle ASM Disk</td>
<td>An Oracle ASM disk is usually a physical disk with a logical partition on it. On Windows the logical partition is created as an extended partition with a logical volume in it.</td>
</tr>
<tr>
<td>Oracle ASM Disk Group</td>
<td>A number of Oracle ASM disks form an Oracle ASM disk group. An Oracle ASM disk group has 1 or more 'failure groups'. An extended partition can span part of a disk or a whole disk. Logical volumes are created inside an extended partition.</td>
</tr>
<tr>
<td>Failure Group</td>
<td>A named group to which an Oracle ASM disk belongs to. Oracle ASM guarantees to never store the same data twice within a failure group. Redundancy is achieved by distributing the same data to multiple failure groups.</td>
</tr>
<tr>
<td>OCR</td>
<td>Oracle Cluster Repository</td>
</tr>
<tr>
<td>RMAN</td>
<td>Oracle Recovery Manager</td>
</tr>
</tbody>
</table>
| **<DBNAME>** | Specifies the name of the database (e.g. C11).

_<DBNAME>_ is derived from the Oracle initialization parameter 'db_name'. If 'db_unique_name' is set then _<DBNAME>_ is derived from 'db_unique_name'. |
| **<DBSID>** | Specifies the name of the database instance.

For single instance databases _<DBSID>_ usually equals _<DBNAME>_<e.g. C11>_.

With RAC the number of the instance is appended e.g. C111, C112, etc. In some examples below the abbreviation _<DBSIDn>_ will be used where 'n' equals the number of the RAC instance.

The environment variable ORACLE_SID is usually set to _<DBSID>_<or_<ASMSID>>_. This the depends on the environment of the OS user |
| **<SAPSID>** | Specifies the name of the SAP system id.

It is used for OS user names e.g. c11adm as well as for authentication of the OS user with Oracle e.g. OPS$C11ADM. |
| **<IHRDBMS>** | RDBMS Software Installation Home. The shared installation Oracle Home directory where the Oracle RDBMS Software is installed. This is a shared directory on Oracle ACFS. |
| **<OHGRID>** | The local path of the **Oracle Home** where the Grid Software was installed. E.g. 'C:\oracle\GRID\11202', 'C:\oracle\GRID\11203', …

Note that for Grid Software **Oracle Base** it is required to use a local path outside of _<OHGRID>_. Therefore it is recommended to set **Oracle Base** to 'C:\oracle\BASE' during the Grid Software installation. |
| **<OHRDBMS>** | RDBMS Runtime Oracle Home. The runtime path of the Oracle Home where the RDBMS Software was installed. On Microsoft Windows this is the same as **<IHRDBMS>**. E.g. 'C:\oracle\<DBNAME>\11202', 'C:\oracle\<DBNAME>\11203'. |
| **SCAN** | The 'Single Client Access Name' is the name of a virtual host. In DNS the name should resolve to 3 different virtual IP addresses. |
| **NODE-IP** | The IP address of the node on the public network. The NODE-IP cannot failover and therefore identifies a physical cluster node. |
| **SCAN-VIP** | If **SCAN** was configured to resolve to 3 virtual IP addresses the **SCAN-VIP** is one of those. Please refer to [http://www.oracle.com/technetwork/database/clustering/overview/scan-129069.pdf](http://www.oracle.com/technetwork/database/clustering/overview/scan-129069.pdf) on Oracle TechNet for further information about **SCAN**. |
| **NODE-VIP** | The virtual IP address of a cluster node on the public network. The NODE-VIP can switch from one node to another if the owning node fails or is taken offline. |
Installation and Migration Roadmaps

This chapter outlines the recommended installation path for new installations and upgrade path for upgrades from older Oracle single instance or clustered environments to Oracle RAC 11.2 with Oracle ASM. We recommend to always start with new hardware as this will leave your old system untouched and you will be able to abort the migration if unexpected problems arise. Steps that are common between the different installation paths are described in the chapter 'Common Setup and Installation Tasks'.

Note that migrations from Oracle 10.2 single instance to Oracle RAC 11.2 / Oracle ASM 11.2 will not be discussed here.

Each installation/upgrade path is based on the approach that an existing database is being 'RAC enabled', moved to Oracle ASM and then put under the control of Oracle Clusterware. Therefore it is not recommended to upgrade Oracle Clusterware 10.2 to Oracle Clusterware 11.2. Instead the database will be upgraded to Oracle 11.2, enabled for RAC if necessary and finally added to the OCR of a fresh installed Oracle Clusterware 11.2.

Refer to the following SAP notes about Oracle 11.2 and upgrading to Oracle 11.2.

<table>
<thead>
<tr>
<th>Note ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1431800</td>
<td>Oracle 11.2.0: Central Technical Note</td>
</tr>
<tr>
<td>#1431798</td>
<td>Oracle 11.2.0: Database Parameter Settings</td>
</tr>
<tr>
<td>#1503709</td>
<td>Oracle 11.2.0: Patches / Patch collections for 11.2.0.2</td>
</tr>
<tr>
<td>#1631931</td>
<td>Oracle 11.2.0: Patches / Patch collections for 11.2.0.3</td>
</tr>
</tbody>
</table>
New Installation

On Microsoft Windows Oracle ACFS is not supported for SAP installations. This means that it is not possible to install SAP software on Oracle ACFS nor is it possible to install an Oracle RAC 11.2 system directly. If you would install SAP on ACFS SAPINST would fail when it detects that the Oracle RDBMS Home is on Oracle ACFS. Although new versions of SAPINST allow creating databases on Oracle ASM they do not allow Oracle ACFS for the Oracle RDBMS Home.

When using a version of SAPINST that does not support Oracle ASM we recommend to temporarily create local NTFS volumes, perform a complete standard database server installation ('Distributed Installation') with local Oracle RDBMS Home and initial database on NTFS and switch to Oracle ASM/ACFS later when the installation is complete.

When using a version of SAPINST that already supports Oracle ASM we recommend to create a local NTFS volume for the temporary Oracle RDBMS Home and to create the new database on Oracle ASM. After the installation you will just have to remove the temporary Oracle RDBMS Home and use the Oracle RDBMS Home from your Oracle ACFS filesystem.

If your version of SAPINST does not allow specifying the Oracle RDBMS initialization parameter 'compatible' you have to keep the ASM diskgroup parameter 'compatible.rdbms' at '11.2.0' until the SAP installation has finished.

Note that SAPINST creates new databases as single instance databases. Every fresh installed database is configured as a single instance database and requires 'RAC Enabling' which is discussed in a later chapter.

The following steps are required:

- If you do not use new hardware remove any old operating systems and everything that is not needed. Get all the latest drivers for your hardware that might be required for Microsoft Windows 2008 R2.
- Install and prepare the new operating system.
- Install a local – temporary - Oracle RDBMS Home on NTFS.
- Install an SAP database on NTFS if your SAPINST does not support Oracle ASM. Otherwise install the new SAP database on Oracle ASM.
- Install and configure Oracle Grid Infrastructure Home.
- Create all required Oracle ASM disk groups
- Install and configure Oracle RDBMS Home(s) on Oracle ACFS.
- If you installed the database in NTFS move your database to Oracle ASM manually by copying the datafiles using the 'asmcmd' utility. This requires creating a new controlfile on Oracle ASM with the new names of the datafiles.
Alternatively it is possible to use 'RMAN DUPLICATE FROM ACTIVE DATABASE' as described in the whitepaper 'Moving your SAP database to Oracle Automatic Storage Management 11g Release 2 - A Best Practices Guide'. This method is basically meant for moving a database from old server hardware to new server hardware, but it can also be used for local database copies.

- 'RAC Enabling'.
- Install database server specific SAP Software (e.g. SAP BR*Tools).

Migrating from Oracle 11.2 Single Instance

Make sure you have a full backup of your database.

On new hardware

- Install and prepare the new operating system.
- Install and configure Oracle Grid Infrastructure Home.
- Create all required Oracle ASM disk groups
- Install and configure Oracle RDBMS Home(s) on Oracle ACFS. Ensure that your source system is on the same database release and patch level than your target system. E.g. 11.2.0.2 + latest recommended Windows bundle patch.
- Move your database to Oracle ASM as described in the whitepaper 'Moving your SAP database to Oracle Automatic Storage Management 11g Release 2 - A Best Practices Guide'. If you are using the 'RMAN DUPLICATE' method you can create a temporary database instance from the Oracle RDBMS Home(s) installed.
- 'RAC Enabling'.
- Install database server specific SAP Software (e.g. SAP BR*Tools).

On existing hardware

- If you do not use new 'plain' hardware remove any old operating systems and everything that is not needed but keep your NTFS volumes where your database and your old Oracle RDBMS Home resides. Get the latest drivers for your hardware that might be required for Microsoft Windows 2008 R2.
- Install and prepare the new operating system.
- Install and configure Oracle Grid Infrastructure Home.
- Create all required Oracle ASM disk groups
- Install and configure Oracle RDBMS Home(s) on Oracle ACFS. Ensure that your source system is on the same database release and patch level than your target system. E.g. 11.2.0.2 + latest recommended Windows bundle patch.
- Move your database to Oracle ASM using the 'asmcmd' utility or follow the procedure described in the whitepaper 'Moving your SAP database to Oracle Automatic Storage Management 11g Release 2 - A Best Practices Guide'. If you are using the 'RMAN DUPLICATE' method you can create a temporary database instance from the Oracle RDBMS Home(s) installed.
Migrating from Oracle RAC 10.2

Assuming your database is located on OCFS it is strongly recommended to provide new hardware or at least a server where you can exclusively mount all the OCFS volumes and perform the database upgrade to Oracle 11.2.

Make sure you have a full backup of your database!

Migrating to new hardware

- On your new hardware:
  - Install and prepare the new operating system.
  - Install and configure Oracle Grid Infrastructure Home.
  - Create all required Oracle ASM disk groups

- On your old hardware:
  - Shutdown each database instance using 'srvctl' and stop and disable your OracleService<DBSIDn> Service in Windows.
  - Install an Oracle 11.2 RDBMS Home using 11.2.0.2 media and install the latest bundle patch released by SAP.
  - Open a command prompt and set ORACLE_SID to your <DBSID> without the thread number at the end e.g. PRD not PRD1. Set ORACLE_HOME to the Oracle 11.2 home directory.
  - Create a temporary OracleService<DBSID> Service in Windows using 'oradim.exe' from your Oracle 11.2 RDBMS Home.
  - Prepare a database parameter file (pfile) for this database using the SAP recommended init.ora parameters for Oracle 11.2 RDBMS and your RAC specific parameters but with parameter 'cluster_database' set to FALSE.
  - Startup your Oracle Database 10.2 in upgrade mode using the newly installed Oracle 11.2 RDBMS Home and with the newly created pfile to ensure the database opens successfully.
    E.g. sqlplus
      startup upgrade pfile=myupgradepfile.ora
  - If the database instance starts, shutdown the database again and start a manual database upgrade as described in the Oracle documentation and the according SAP notes.

- Move your upgraded database to Oracle ASM as described in the whitepaper 'Moving your SAP database to Oracle Automatic Storage Management 11g Release 2 - A Best Practices Guide'. If you are using the 'RMAN DUPLICATE' method you can create a temporary database instance from one of the installed Oracle 11.2 RDBMS Home(s).
- 'RAC Enabling' - As the database was already RAC enabled not all steps are required.
- Install database server specific SAP Software (e.g. SAP BR*Tools).

### On existing hardware

- Shutdown each database instance using 'srvctl' and stop and disable your OracleService<SIDn> Service in Windows.
- Install an Oracle 11.2 RDBMS Home using 11.2.0.2 media including the latest bundle patch released by SAP.
- Open a command prompt and set ORACLE_SID to your <SID> without the thread number at the end e.g. PRD not PRD1. Set ORACLE_HOME to the 11.2 home directory.
- Create a temporary OracleService<SID> Service in Windows using 'oradim.exe' from your newly installed Oracle 11.2 RDBMS Home.
- Prepare a pfile (e.g. myupgradepfile.ora) for this database using the SAP recommended init.ora parameters for Oracle 11.2 and your RAC specific parameters but with parameter 'cluster_database' set to FALSE.
- Startup your Oracle 10.2 database in upgrade mode using the newly installed Oracle 11.2 RDBMS software and with the newly created pfile to ensure the database opens successfully.
  
  E.g. sqlplus
  
  startup upgrade pfile=myupgradepfile.ora

- If the database instance starts, shutdown the database again and start a manual upgrade (always run oradim from the path where it is installed!).
  - Remove the Oracle 11.2 OracleService<SID> service with oradim.
  - Setup your environment for Oracle 10.2, create a Oracle 10.2 OracleService<SID>, start the database and run the pre-upgrade script as described in the upgrade guide.
  - Shutdown the database and remove the Oracle 10.2 OracleService<SID> service with oradim.
  - Create an Oracle 11.2 OracleService<SID> service with oradim and perform a manual upgrade. Don’t forget to run SAP specific upgrade tasks and scripts.

- Backup the database.
- Remove your old Microsoft Windows installations from the cluster nodes.
- Install and prepare the new operating system.
- Install and configure Oracle Grid Infrastructure Home.
- Create all required Oracle ASM disk groups.
- Restore your database to a file system if required. If you have a copy of your database on a file system or network drive you can continue with moving the database to Oracle ASM.
• Move your database to Oracle ASM manually by copying the datafiles using the 'asmcmd' tool. This requires creating a new controlfile on Oracle ASM with the new names of the datafiles. Alternatively it is possible do use 'RMAN DUPLICATE FROM ACTIVE DATABASE' described in the whitepaper 'Moving your SAP database to Oracle Automatic Storage Management 11g Release 2 - A Best Practices Guide'. This method is basically meant for moving a database from old server hardware to new server hardware but it can be used for local database copies too.

Planning Oracle ASM Diskgroups

Shared disks are often located on an intelligent storage system. Although Oracle ASM is able and designed to work with thumb and cheap JBOD systems we strongly recommend using storage systems that already have built-in fault tolerance.

If your storage already provides fault tolerance we recommend creating all Oracle ASM disk groups with 'external redundancy' with the exception of the Oracle ASM disk group 'OCR' for which we recommend normal redundancy.

Some more advanced storage systems support additional capabilities like offlining and online disks or creating image copies of disks and therefore allow copying complete disk groups within the storage system which provides amazingly fast SAP system copies and disk image based backups. Both are discussed in detail in the whitepaper 'SAP with Oracle Real Application Clusters 11g Release 2 and Oracle Automatic Storage Management 11g Release 2 - Advanced Configurations & Techniques'.

If your storage does not provide any fault tolerance we recommend normal or high redundancy for all Oracle ASM disk groups. For Oracle ASM disk group 'OCR' we always recommend high redundancy.

When calculating space requirements and required number of disks it is always necessary to take the redundancy level of a disk group into account.

OCR and Voting

Oracle Grid Infrastructure requires an Oracle ASM disk group for OCR and Voting Files. We strongly recommend creating an Oracle ASM disk group exclusively for OCR and Voting Files. For storage systems with built-in fault tolerance we recommend using 3 shared disks while JBOD systems should use 5 shared disks. All disks should be of the same size and at least 4GB in size.

The examples shown in this document use 1GB for demonstration purposes only!
The recommended name for this Oracle ASM disk group is ‘+OCR’ but you are free to choose another name.

Oracle ACFS

While Oracle Grid Infrastructure is installed on local disks of each of the cluster nodes Oracle RDBMS Software is installed on Oracle ACFS. Oracle ASM disk groups can contain multiple Oracle ACFS file systems the same way a standard disk can have multiple partitions each with its own file system.

We recommend creating one Oracle ASM disk group for all Oracle ACFS file systems and one Oracle ACFS file system per Oracle RDBMS Home. Keep in mind that with Oracle 11.2 patch sets are being installed out-of-place which means that you will need to reserve enough space for a second or third Oracle RDBMS Home.

The recommended size for each Oracle ACFS file system is at least 20GB for Oracle RDBMS Home, database logs and trace files from each database instance, BR*Tools logs, patch set installation.

The recommended minimum size of the Oracle ASM disk group that holds all the Oracle ACFS file systems therefore is <number of systems> * <size of Oracle ACFS file system>.

The recommended name for this Oracle ASM disk group is ‘+ACFS’.

E.g. for 3 SAP systems we recommend 3 Oracle ACFS file systems (each 20GB or more) on an Oracle ASM disk group with at least 60GB of free space.

<table>
<thead>
<tr>
<th>Filesystemname</th>
<th>Mountpoint</th>
<th>Size [GB]</th>
</tr>
</thead>
<tbody>
<tr>
<td>C11</td>
<td>C:\ORACLE\C11</td>
<td>20</td>
</tr>
<tr>
<td>C12</td>
<td>C:\ORACLE\C12</td>
<td>20</td>
</tr>
<tr>
<td>C13</td>
<td>C:\ORACLE\C13</td>
<td>20</td>
</tr>
</tbody>
</table>
Database Files

For an SAP installation on Oracle with Oracle ASM we recommend to choose one out of three variants on how to name and configure your Oracle ASM disk groups for database specific files. Which variant you choose depends on your backup strategy which in turn usually depends on the size of your database and required availability.

**Variant 1 – small to medium data volumes, restore time not critical**

Customer has small or medium sized databases where backup and/or restore + recovery of **all** databases can be accomplished by RMAN in a timely fashion.

Example: If a complete Oracle ASM disk group with data files from one or more databases is broken and all data files from all databases need to be restored to a newly created Oracle ASM disk group using RMAN.

**Oracle ASM disk group recommendation:**

<table>
<thead>
<tr>
<th>Oracle ASM Disk Group Name</th>
<th>Stores</th>
</tr>
</thead>
<tbody>
<tr>
<td>+DATA</td>
<td>- All data files</td>
</tr>
<tr>
<td></td>
<td>- All temp files</td>
</tr>
<tr>
<td></td>
<td>- Control file (first copy)</td>
</tr>
<tr>
<td></td>
<td>- Online redo logs (first copy)</td>
</tr>
<tr>
<td>+ARCH</td>
<td>- Control file (second copy)</td>
</tr>
<tr>
<td></td>
<td>- Archived redo logs</td>
</tr>
<tr>
<td>+RECO</td>
<td>- Control file (third copy)</td>
</tr>
<tr>
<td></td>
<td>- Online redo logs (second copy)</td>
</tr>
<tr>
<td></td>
<td>- RMAN backups (optional)</td>
</tr>
<tr>
<td></td>
<td>- Fast recovery area (optional)</td>
</tr>
</tbody>
</table>

**Variant 2 – medium to large data volumes, restore time important**

Customer has databases of medium or large size where backup and/or restore + recovery of all databases cannot be accomplished in a timely fashion.

Usually customers will use RMAN and Split-Mirror techniques in combination.

Major differences to Variant 1 are:

- Separate Oracle ASM disk group for each database
- ’<DBNAME>_' is the prefix for the name of the DATA disk group.
• Optionally a number is appended to the name of the DATA disk group if the database spans over more than one DATA disk group.
• Online redo logs are not stored in the 'DATA' disk groups. Instead online redologs are stored in an additional disk group that is used for the first member of each online redo log group.

Important: Please consider that only a maximum of 63 Oracle ASM disk groups can be configured.

Oracle ASM disk group recommendation:

<table>
<thead>
<tr>
<th>Oracle ASM Disk Group Name</th>
<th>Stores</th>
</tr>
</thead>
<tbody>
<tr>
<td>+&lt;DBNAME&gt;_DATA[#]</td>
<td>- All data files</td>
</tr>
<tr>
<td>e.g. ERP_DATA,</td>
<td>- All temp files</td>
</tr>
<tr>
<td>CRM_DATA,</td>
<td>- Control file (first copy)</td>
</tr>
<tr>
<td>ERP_DATA1 (e.g. for temporary additional space requirements during SAP upgrades or reorganizations)</td>
<td></td>
</tr>
<tr>
<td>+OLOG</td>
<td>- Online redo logs (first copy)</td>
</tr>
<tr>
<td>+ARCH</td>
<td>- Control file (second copy)</td>
</tr>
<tr>
<td></td>
<td>- Archived redo logs</td>
</tr>
<tr>
<td>+RECO</td>
<td>- Control file (third copy)</td>
</tr>
<tr>
<td></td>
<td>- Online redo logs (second copy)</td>
</tr>
<tr>
<td></td>
<td>- RMAN backups</td>
</tr>
<tr>
<td></td>
<td>- Fast recovery area</td>
</tr>
</tbody>
</table>

Variant 3 – very large data and data change volumes, restore time crucial

Customer has very large databases where backup and/or restore + recovery of a single databases cannot be accomplished in a timely fashion.

Usually customers will use RMAN and Split-Mirror techniques in combination.

In this variant each relevant database file type is separated to different Oracle ASM disk groups.

Important: Please consider that only a maximum of 63 Oracle ASM disk groups can be configured.
Oracle ASM disk group recommendation:

<table>
<thead>
<tr>
<th>Oracle ASM Disk Group Name</th>
<th>Stores</th>
</tr>
</thead>
<tbody>
<tr>
<td>+&lt;DBNAME&gt;_DATA[#]</td>
<td>- All data files</td>
</tr>
<tr>
<td>e.g. ERP_DATA,</td>
<td>- All temp files</td>
</tr>
<tr>
<td>CRM_DATA,</td>
<td>- Control file (first copy)</td>
</tr>
<tr>
<td>ERP_DATA1 (e.g. for</td>
<td></td>
</tr>
<tr>
<td>temporary additional</td>
<td></td>
</tr>
<tr>
<td>space requirements</td>
<td></td>
</tr>
<tr>
<td>during SAP upgrades or</td>
<td></td>
</tr>
<tr>
<td>reorganizations)</td>
<td></td>
</tr>
<tr>
<td>+&lt;DBNAME&gt;_ARCH</td>
<td>- Control file (second copy)</td>
</tr>
<tr>
<td>e.g. ERP_ARCH,</td>
<td>- Archived redo logs</td>
</tr>
<tr>
<td>CRM_ARCH</td>
<td></td>
</tr>
<tr>
<td>+&lt;DBNAME&gt;_RECO</td>
<td>- Control file (third copy)</td>
</tr>
<tr>
<td>e.g. ERP_RECO,</td>
<td>- RMAN backups</td>
</tr>
<tr>
<td>CRM_RECO</td>
<td>- Fast recovery area</td>
</tr>
<tr>
<td>+&lt;DBNAME&gt;_OLOG</td>
<td>- Online redo logs (first copy)</td>
</tr>
<tr>
<td>e.g. ERP_OLOG,</td>
<td></td>
</tr>
<tr>
<td>CRM_OLOG</td>
<td></td>
</tr>
<tr>
<td>+&lt;DBNAME&gt;_MLOG</td>
<td>- Online redo logs (second copy)</td>
</tr>
<tr>
<td>e.g. ERP_MLOG,</td>
<td></td>
</tr>
<tr>
<td>CRM_MLOG</td>
<td></td>
</tr>
</tbody>
</table>

Important: Always place all files from one database into the according Oracle ASM disk groups of that database. Never place a file from one database in diskgroups of another database.
Prerequisites for running Oracle Grid Infrastructure 11g Release 2 and Oracle Database 11g Release 2

When starting with Oracle 11g RAC we recommend to study the hard- and software requirements discussed in the according Oracle documentation. We recommend using new cluster hardware as this allows leaving your old system untouched until the configuration of your new system is complete and your system is working properly.

Hardware

Make sure your cluster is build from certified and well tested components. We recommend that each of the cluster nodes has the same number of CPU’s and network interfaces as well as the same amount of memory and local disk space. As Oracle Grid Infrastructure will be installed on a local volume make sure you have enough local disk space for installation and patching.

Note that patch sets for Oracle Grid Infrastructure and Oracle Database are installed out-of-place while patch set updates (or mini patches) are in-place. For Oracle Grid Infrastructure we recommend at least 15GB of free local disk space.

Oracle Grid Infrastructure requires two network interfaces – one for the cluster interconnect and one for the public network. We recommend configuring 4 network interfaces into 2 pairs (teaming).
Shared storage should be attached via fiber channel adaptors. For performance and availability reasons multiple fiber channel links and fiber channel switches between cluster nodes and storage system are recommended. This can be achieved by products like EMC Powerpath for example.

Software

On each cluster node you need to install the same operating system version and patches. We recommend using Microsoft Windows 2008 R2 Server 64Bit as this is the latest and most up-to-date Microsoft operating system. Windows 2003 Server 64Bit is also supported but deprecated and will not be discussed within this document.
Common Setup and Installation Tasks

Preparing Microsoft Windows 2008 for Oracle Grid Infrastructure

Before starting with Oracle Grid Infrastructure installation some mandatory pre-installation steps are required in order to be able to install Oracle Grid Infrastructure successfully.

Windows Registry Changes

Windows Time Synchronization

Ensure that Windows never automatically corrects system time backwards by setting MaxNegPhaseCorrection = 0 under "HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\W32Time\Config" in the Registry.

See Microsoft Knowledge Base #884776.

Windows Interactive Desktop Heapsize

The default size of an interactive desktop heap under Windows 2008 R2 64Bit is 20MB. As all Windows Services that run under the 'LocalSystem' account share the same desktop heap it is recommended to increase the default value of 20MB to 40MB.

If you experience 'TNS-12531: TNS:cannot allocate memory' messages in your listener.log file after several days or weeks uptime it is very likely that you have hit that problem. In addition to the TNS error it is very likely that you will experience a crash of one of the DB or Oracle ASM instances.

Change the second parameter of the key 'SharedSection' under 'HKEY_LOCAL_MACHINE\System\CurrentControlSet\Control\Session Manager\SubSystems\Windows' to meet your requirements.

Note that the value is in kilobytes.

Windows User Account Control and Automatic Elevation

- Turn OFF Windows UAC:
  Control Panel->System and Security->Change User Account Control Settings
- Change automatic elevation settings:
  UAC: Admin approval mode = Disabled
  UAC: Behavior of the elevation prompt for administrators = Elevate without prompting
  UAC: Run all administrators in Admin approval mode = Disabled

Network Infrastructure

Network Interfaces

- Rename the network interfaces and choose speaking names for them. E.g. PUB, OIC.
  Don’t use the name 'PUBLIC' as this will cause an error during the installation.
- Setup IP addresses, subnet mask and DNS of the network interfaces:

- Turn off IP V6 on all interfaces.
- Set the same bind order of all network interfaces. The public interface 'PUB' should be first, Oracle Interconnect 'OIC' second and then the other network interfaces (if any).

- Disable Windows Firewall for all network interfaces on all cluster nodes.
- Disable DHCP Media-Sensing (Microsoft Knowledge Base #239924)
- Turn OFF dynamic resizing of TCP/IP receive window (Microsoft Knowledge Base #934430) by issuing the following command from the command line prompt:
  netsh interface tcp set global autotuning=disabled

- Query state by issuing:
  netsh interface tcp show global
- Reboot and re-check everything. Also check if each NODE-IP and OIC-IP can be pinged.

**DNS**

Each cluster node requires 2 IP addresses and according hostnames on the public network: The node IP address and a node virtual IP address (NODE-VIP). In addition we recommend reserving 3 SCAN virtual IP addresses (SCAN-VIP). Create static entries in your DNS server for forward and reverse lookup.
E.g.

Forward-Lookup:

```
<table>
<thead>
<tr>
<th>Host</th>
<th>IPv4 Address</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>oreacx3v1</td>
<td>192.0.2.200</td>
<td>static</td>
</tr>
<tr>
<td>oreacx3v2</td>
<td>192.0.2.211</td>
<td>static</td>
</tr>
<tr>
<td>oreacx3v3</td>
<td>192.0.2.212</td>
<td>static</td>
</tr>
</tbody>
</table>
```

Reverse-Lookup:

```
<table>
<thead>
<tr>
<th>IPv4 Address</th>
<th>Host</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.0.2.11</td>
<td>oreacx3v1-oic</td>
</tr>
<tr>
<td>192.0.2.12</td>
<td>oreacx3v2-oic</td>
</tr>
<tr>
<td>192.0.2.13</td>
<td>oreacx3v3-oic</td>
</tr>
</tbody>
</table>
```

For Oracle Cluster Interconnect (OIC) no entries are required in DNS but we recommend adding them to the 'hosts' file together with an OIC specific hostname.

E.g.

```
192.168.1.11  oracx3v1-oic
192.168.1.12  oracx3v2-oic
192.168.1.13  oracx3v3-oic
```

Windows Domain and OS Users

With Oracle RAC 11.2 a new user has been introduced that plays several roles:

- Owner of all Oracle software components (Oracle Grid Infrastructure home and Oracle RDBMS home).
- Administrator of Oracle Grid Infrastructure, Oracle ASM and databases.

The recommended name of this user is 'oracle'.

Although the user '<sapsid>adm' still exists and is still required it is only used for running SAP software installed on the cluster nodes. E.g. for executing BR*Tools interactively or for running database related jobs from transaction DB13 via SAP Gateway Service.
• Each cluster node should be member of your Windows Domain
• Create user 'oracle' and user '<sapid>adm' in your Windows domain.
• Add user 'oracle' and '<sapid>adm' to each cluster node's local 'Administrators' group. It is not sufficient to add the user to a group in the Windows domain and to add the group to the local 'Administrators' group.

Oracle Administrator Groups

Create the following local groups on each cluster node and add your 'oracle' user as well as your '<sid>adm' user(s).

You can either create group ORA_DBA and ORA_OPER (recommended) or you can create groups ORA_<SID><instanceno>_DBA and ORA_<SID><instanceno>_OPER for each instance.

Preparing Oracle ASM Disks

When new disks are attached for the first time they are displayed as 'offline' and 'uninitialized'. Set them 'online' in the Windows disk administrator and initialize them. Before new disks can be used with Oracle ASM the disks must be prepared by creating an extended partition and a logical partition on it. This should be done with the 'diskpart' tool.

1) select disk <#>
2) create partition extended
3) create partition logical

Important: When a new logical partition is created Microsoft Windows will ask to format the disk for use with a file system. Do not create a file system on those disks. Make sure that new state of the disk is visible to all nodes by initiating a scan of the SCSI bus or by rebooting the cluster nodes and remove all driveletters from those disks you plan to be Oracle ASM disks. Make sure that nobody formats an Oracle ASM disk with a file system by documenting which disk is used for which purpose.

If you already have connected all shared disks you plan to use for your cluster prepare all the other disks in the same way.

E.g. After preparing 3 shared disks for Oracle Grid Infrastructure installation they should look like shown in the picture below.
Oracle Grid Infrastructure Installation

As described above all installation and configuration steps regarding Oracle Software are performed as 'oracle' user. Make sure you are logged on as this user.

Setting environment variables as needed

The 'oracle' user is used on different cluster nodes with different Oracle Homes (OHGRID and one or more OHRDBMS). Because of this we recommend to create small shell scripts to set the environment variables ORACLE_HOME and ORACLE_SID to the values needed. If you need to switch between the running instances you just need to run the according script.

E.g.

On cluster node oracx3v1:
C:\Users\oracle>type env_asm.cmd
set ORACLE_HOME=C:\ORACLE\GRID\11202
set ORACLE_SID=+ASM1

C:\Users\oracle>type env_c11.cmd
set ORACLE_HOME=C:\ORACLE\C11\11202
set ORACLE_SID=C111

On cluster node oracx3v2:
C:\Users\oracle>type env_asm.cmd
set ORACLE_HOME=C:\ORACLE\GRID\11202
set ORACLE_SID=+ASM2
C:\Users\oracle>type env_c11.cmd
set ORACLE_HOME=C:\ORACLE\C11\11202
set ORACLE_SID=C112

On cluster node oracx3v3:
C:\Users\oracle>type env_asm.cmd
set ORACLE_HOME=C:\ORACLE\GRID\11202
set ORACLE_SID=+ASM3

C:\Users\oracle>type env_c11.cmd
set ORACLE_HOME=C:\ORACLE\C11\11202
set ORACLE_SID=C113

These scripts will be used to set the environment of the 'oracle' user within the whole document.

Initial installation

Extract the installation media, open a command line prompt, move to that location and start 'setup.exe' with the following command line:

setup -J-D-user.language=en

Screen 1: Choose 'Skip software updates' and click <Next>.

Screen 2: Choose 'Install and Configure Oracle Grid Infrastructure for a Cluster' and click <Next>.

Screen 3: Choose 'Advanced Installation' and click <Next>.

Screen 4: Select 'English' as product language and click <Next>. 
Screen 5: Uncheck 'Configure GNS', enter to name of your cluster, the name of your SCAN and port 1521.
E.g.
Screen 6: Enter each node’s hostname and virtual hostname and click <Next>. E.g.

<table>
<thead>
<tr>
<th>Hostname</th>
<th>VirtualIP Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>eneco3c1.oracledev.will.sap.com</td>
<td>eneco3c1_vip.oracledev.will.sap.com</td>
</tr>
<tr>
<td>eneco3c2.oracledev.will.sap.com</td>
<td>eneco3c2_vip.oracledev.will.sap.com</td>
</tr>
<tr>
<td>eneco5c1.oracledev.will.sap.com</td>
<td>eneco5c1_vip.oracledev.will.sap.com</td>
</tr>
</tbody>
</table>
Screen 7: Assign the role of each network interface and click <Next>. E.g.

Screen 8: Choose 'Oracle Automatic Storage Management (Oracle ASM)' and click <Next>.
Screen 9: Enter 'OCR' as the Oracle ASM disk group name, select the redundancy level of the disk group and click 'Stamp Disk'.
Screen 9a: In the popup dialog select 'Add or change label' and click <Next>.
Screen 9b: In the popup dialog select the disks you want to assign a label for and enter 'OCR' as the prefix for them and click <Next>. You can select multiple lines by holding down the <Shift> or <Cntrl> key.
E.g.

Screen 9c: This popup dialog shows what label will be assigned to which disk. Click <Next>.

Screen 9d: Click <Finish>. 
Screen 9: Your screen should now display the recently stamped disks as 'candidate disks'. Select them and click <Next>.

E.g.

Screen 10: Choose 'Use same passwords for this account' enter the password and click <Next>.

Screen 11: Choose 'Do not use Intelligent Platform Management Interface (IPMI)' and click <Next>.

Screen 12: For Oracle Base enter 'C:\ORACLE\BASE' and for Software Location enter 'C:\ORACLE\GRID\11202' and click <Next>.

Screen 13: On the summary screen click <Install> to start the installation.
After the installation and configuration of the Oracle Grid Infrastructure is finished check that Oracle Clusterware is running on all the cluster nodes.

```
crsctl status resource -t
```

Upgrade the compatibility attributes 'COMPATIBLE.ASM', 'COMPATIBLE.RDBMS' and 'COMPATIBLE.ADVM' of disk group 'OCR' to '11.2.0.2.0'. Also choose a DISK_REPAIR_TIME that matches to your type of storage system. For storage systems with built-in fault tolerance you should select very high values (e.g. 240 hours). For storage systems without build-in fault tolerance you may want to keep the default value or even choose a smaller value.

E.g.
```
C:\Users\oracle>env_asm.cmd
C:\Users\oracle>set ORACLE_HOME=C:\ORACLE\GRID\11202
C:\Users\oracle>set ORACLE_SID=+ASM1

C:\Users\oracle>sqlplus
SQL*Plus: Release 11.2.0.2.0 Production on Thu Aug 11 11:35:55 2011
Copyright (c) 1982, 2010, Oracle. All rights reserved.

Enter user-name: / as sysasm

Connected to:
Oracle Database 11g Enterprise Edition Release 11.2.0.2.0 - 64bit Production
With the Real Application Clusters and Automatic Storage Management options

SQL> alter diskgroup OCR set attribute 'compatible.asm'='11.2.0.2.0';
Diskgroup altered.

SQL> alter diskgroup OCR set attribute 'compatible.rdbms'='11.2.0.2.0';
Diskgroup altered.

SQL> alter diskgroup OCR set attribute 'compatible.advm'='11.2.0.2.0';
Diskgroup altered.

SQL> alter diskgroup OCR set attribute 'disk_repair_time'='240h';
Diskgroup altered.
```
Creating Oracle ACFS File Systems

An Oracle ACFS file system is created in an Oracle ASM volume. An Oracle ASM volume is a specific Oracle ASM file type (like datafiles from a database) and is distributed over all Oracle ASM disks belonging to the same failure group. If the underlying Oracle ASM diskgroup is configured for normal or high redundancy Oracle ASM Dynamic Volume Manager (ADVM) - which sits between Oracle ACFS and ASM - ensures that the required number of redundant copies of a piece of data are written to Oracle ASM disks in the other failure groups.

To manage Oracle ASM disk groups and Oracle ACFS file systems we use the tool 'asmca'.

Creating a new 'Oracle ACFS' diskgroup

Open a new command prompt and set the environment to work with Oracle Grid Infrastructure and Oracle ASM: env_asm.cmd (created in an earlier chapter)

Screen 1: Shows a list of existing Oracle ASM disk groups. Click <Create>.
Screen 2: Click <Stamp Disks>.
Screen 3: Choose 'Add or change label' and click <Next>.
Screen 4: Choose the disks you want to stamp with an Oracle ASM link and choose a descriptive prefix for the labels e.g. 'Oracle ACFS'. Click <Next>.
Screen 5: This screen allows you the verify the name of the Oracle ASM link that will be written to each disk you selected. Click <Next> if everything is correct.
Screen 6: Click <Finish>

Screen 2: Now you are back on screen 2. Enter a name for the new diskgroup (e.g. 'ACFS'), select the redundancy level and select the disks you want to add to the Oracle ASM diskgroup. Click on 'Show Advanced Options' and enter '11.2.0.2.0' (without quotes) for ASM-, Database- and ADVM compatibility. Finally click <OK> to create the new Oracle ASM diskgroup.
Use this procedure to create all your Oracle ASM disk groups. Always set the compatibility attributes to '11.2.0.2.0' or higher as this will enable some functionalities you may want to use later.
Creating the Oracle ACFS volume

Although it is possible to create just one Oracle ACFS volume and file system for all your Oracle RDBMS Homes we recommend creating one Oracle ACFS volume and file system for each Oracle RDBMS Home for maintenance reasons.

Screen 1: Click the 'Volumes' tab.
Screen 2: This screen shows all existing Oracle ACFS volumes. Click <Create>.
Screen 3: Choose a volume name, select the appropriate Oracle ASM diskgroup, enter the required size of the volume and click <OK>.

Screen 2: Back on screen 2 you will see the newly created Oracle ASM volume.
It is very important to make a note of the name of the volume (e.g. C11) together with the device name (e.g. \\asm-c11-210'). You need the device name when doing ACFS checks at a later time. Oracle ACFS checks as well as Oracle ACFS backups and restores are discussed in chapter Working with Oracle ACFS.

Creating an Oracle ACFS
Click on the 'ASM Cluster File Systems' tab.

Screen 1: This screen show a list of all existing Oracle ASM. Click <Create>
Screen 2: Choose the ACFS volume where you want to create the ACFS on, select 'Database Home File System', enter the mountpoint and click <OK>.
E.g.

Create ASM Cluster File System

Creating the ASM Cluster File System creates the on-disk structure. The file system needs to be mounted before it is available for use.

Volume: C11 : \\asm-c11-210 - 24.0G

Tip: Choose an existing volume device or create a new volume by choosing Create Volume in the dropdown.

Database Home File System

If you create an ASM Cluster File System for installing Oracle database home, it would be registered with Grid Infrastructure as a managed resource. Grid Infrastructure uses this resource to maintain database, ASM and ACFS resource dependencies.

Database Home Mount Point: /UORACLE/C11

General Purpose File System

Registering the ASM Cluster File System Mount Point will allow the file system to be automatically mounted on all nodes.

Mount Point: /UORACLEBASE/asm-mounts/asm_c11

Register Mount Point: Yes

OK  Show Command  Cancel  Help
Screen 1: The newly created ACFS should now be listed.

Check that all cluster nodes have mounted the new file system.

RDBMS Home Installation

The installation of the Oracle RDBMS Home(s) is very similar to installations in a non-clustered environment. The major difference is that during the installation in a cluster each node’s registry is updated and a central inventory is created on each node.

Extract the installation media to a staging directory and open a command prompt. Move to the staging directory and run the following command:

'setup -J-Duser.language=en'

Screen 1: Uncheck 'I wish to receive security updates via My Oracle Support' and click <Next>. You receive the warning that you did not specify your email address. Confirm with <Yes>.

Screen 2: Choose 'Skip software updates' and click <Next>.

Screen 3: Choose 'Install database software only' and click <Next>.

Screen 4: Choose 'Oracle Real Application Clusters database installation' and make sure each cluster node is checked in the listbox below. Click <Next>.

Screen 5: Make sure 'English' is the only selected language in the right listbox and click <Next>.

Screen 6: Choose 'Enterprise Edition' and click 'Select Options'.

Screen 6a: Uncheck all components you don’t need or you don’t have a license for and click <OK>.

Screen 6: Click <Next>
Screen 7: Enter 'Oracle Base' and 'Software Location' and click <Next>.
Note that in this dialog Oracle Base is different from Oracle Base used during the installation of the Oracle Grid Infrastructure. Both directories have to be on Oracle ACFS.
E.g.

![Oracle Database 11g Release 2 Installer - Installing database - Step 7 of 11](image)

Screen 8: Verify the information and start the installation process by clicking <Install>.

Repeat the installation procedure for each additional Oracle RDBMS Home you want to install.
Patching Oracle Grid Home and Oracle RDBMS Homes

How to install patches is well documented in the according patch notes and readme. Although, based on our experience, we recommend some additional steps to avoid problems like open files that cannot be overwritten.

We recommend the following:

- Stop all cluster resources. 'crsctl stop cluster –all'
- On all cluster nodes: Set all Oracle services that are configured to start automatically to start mode 'manual' (OracleObjectService, OracleMTSRecoveryService,OracleOHService).
- Reboot all the cluster nodes
- Stop service 'Microsoft Distributed Transaction Coordinator'
- net stop orafenceservice

At this point every Oracle specific file that may be overwritten during patch operation should be closed.

Check if you need to install a new version of opatch into each Oracle Home before you start patching.

To patch your Grid Home open a new command prompt and set ORACLE_HOME to the Grid Home (e.g. C:\ORACLE\GRID\11202). If you have created shell scripts for switching environments just run the script to set your 'GRID/ASM' environment.

Enter the patch directory and start patching as described in the patch readme.

Follow the instructions in the patch readme in order to patch your Oracle RDBMS Home(s).
RAC Enabling

Database specific changes

All database specific changes can be performed from one cluster node.

Note that with Oracle ASM filenames are generated by 'Oracle Managed Files for ASM'. The parameters 'DB_CREATE_FILE_DEST', 'DB_CREATE_ONLINE_LOG_DEST_n', 'DB_RECOVERY_FILE_DEST' specify the Oracle ASM diskgroup where Oracle will create the files by default. This means that there is no need to specify the filenames for datafiles – OMF will generate a name based on the tablespace name. The names for the controlfiles of the database must be specified as Oracle ASM aliases in the spfile. In the case you need to restore controlfiles there is no need to change the names in the spfile.

Sometimes it makes sense to specify a full filename on Oracle ASM. E.g. if you have manually copied a database from NTFS to Oracle ASM using the 'asmcmd' utility you may want to use aliases for the destination filename in order to create a new controlfile after each database file has been moved to Oracle ASM.

Undo Tablespaces

Ensure that each Oracle RDBMS instance has its own dedicated undo tablespace of the appropriate size.

If you have upgraded from Oracle RAC 10.2 and the number of cluster nodes did not change, you should already have undo tablespaces for all instances and you can skip this step because the undo tablespaces will be available after moving the database to Oracle ASM.

E.g.
create undo tablespace PSAPUNDO1 datafile size 32000M autoextend on;
create undo tablespace PSAPUNDO2 datafile size 32000M autoextend on;

Online Redologs

We recommend using 'DB_CREATE_ONLINE_LOG_DEST_n' to set the default Oracle ASM diskgroup for online redologs and their duplexed mirror.

E.g. If you decided to create dedicated Oracle ASM disk groups for online redologs '+C11OLOG' (OLOG for origlog) and '+C11MLOG' (MLOG for origlog) you should set to
* .DB_CREATE_ONLINE_LOG_DEST_1= '+C11OLOG'
* .DB_CREATE_ONLINE_LOG_DEST_2= '+C11MLOG'

and create new online redolog groups after moving your database to Oracle ASM.

Each RAC instance uses a specific thread for writing redo logs. You therefore need to
create new redologs.

E.g.
alter database add logfile thread 1 group 10 size 250M;
alter database add logfile thread 1 group 11 size 250M;
alter database add logfile thread 1 group 12 size 250M;
alter database add logfile thread 2 group 20 size 250M;
alter database add logfile thread 2 group 21 size 250M;
alter database add logfile thread 2 group 22 size 250M;
.
.
You should add the same number of redo log groups as in a single node environment.
The redo log sizes should also be the same.

If you have plenty of disk space on your Oracle ASM diskgroup, it’s a good idea to use
this additional disk space for more online redologs. This will reduce the chance that the
system requires archived redologs during crash recovery.

For all new redolog groups that have been added, the corresponding thread has to be
enabled:

alter database enable thread 2;

SPFILE

It is recommended and SAP standard to place the spfile that belongs to a database on
Oracle ASM. SAP BR*Tools will automatically create backups from the spfile on Oracle
ASM and allow to modify initialization parameters directly.

There may be reasons not to place the spfile on Oracle ASM. Note that placing the spfile
traditionally in 'OHRDBMS\dbs' is also supported.

Assuming that you have a pfile with all the initialization parameters create a spfile on
Oracle ASM from it.

E.g.
create spfile= '+DATA/C11/spfile.ora' from pfile= 'C:\temp\finalpfile.ora';
This command creates an Oracle ASM alias that points to the active spfile on Oracle ASM. The alias is required because Oracle ASM will use an OMF name for the newly create spfile and we want to make sure that the spfile is always found under the same name. This is important when we add the database and instances to the cluster repository.

**RAC specific parameters are:**

`*.cluster_database=TRUE`

`*.undo_management=auto`

`<sid><instancenumber>.instancenumber=<instancenumber>`

`<sid><instancenumber>.thread=<threadnumber>`

`<sid><instancenumber>.undo_tablespace='<nameofundotablespace>'`

`<sid><instancenumber>.remote_listener='<scan:port>'`

**Oracle ASM specific parameters are:**

`*.DB>Create_ONLINE_LOG_DEST_1='>+DISKGROUP>'`

`*.DB>Create_ONLINE_LOG_DEST_2='>+DISKGROUP>'`

`*.DB_CREATE_FILE_DEST='>+DISKGROUP>'`

`*.log_archive_dest_1='location='>+DISKGROUP'/<DBNAME>/ORAARCHvalid_for=(ALL_LOGFILES,ALL_ROLES) db_unique_name=<DBNAME>'`

`*.control_files='>+DISKGROUP1'/<DBNAME>/CNTRL<DBNAME>.DBF', '
>+DISKGROUP2'/<DBNAME>/CNTRL<DBNAME>.DBF', '
>+DISKGROUP3'/<DBNAME>/CNTRL<DBNAME>.DBF'`

Optional:

`*.DB_RECOVERY_FILE_DEST='>+DISKGROUP>'`

`*.DB_RECOVERY_FILE_DEST_SIZE=<size>G`

The following example shows a full working example of a real world production system with 3 instances:

`*.first_spare_parameters=1#RECOMMENDED BY ORACLE/SAP FOR 11.2.0 - SAP note 1431798`

`*.fix_control='5099019:ON','5705630:ON','6399597:ON','6430500:ON','6440977:ON','6626018:ON','6972291:ON','8937971:ON','9196440:ON','9495669:ON'

`.IN_MEMORY_UNDO=FALSE`

`.optimizer_adaptive_cursor_sharing=FALSE#RECOMMENDED BY ORACLE/SAP FOR 11.2.0 - SAP note 1431798`

`.optimizer_extended_cursor_sharing_rel='NONE'#RECOMMENDED BY ORACLE/SAP FOR 11.2.0 - SAP note 1431798`

`.optimizer_use_feedback=FALSE#RECOMMENDED BY ORACLE/SAP FOR 11.2.0 - SAP note 1431798`

`.AUDIT_FILE_DEST='C:\Oracle\C11\saptrace\audit'
*.cell_offload_processing=false
*.cluster_database=true
*.compatible='11.2.0.2.0'
*.control_file_record_keep_time=30
*.control_files='+C11_DATA/C11/CNTRLC11.DBF','+C11_ARCH/C11/CNTRLC11.DBF'
*.db_block_size=8192
*.db_cache_size=14G
*.db_create_file_dest='+C11_DATA'
*.db_create_online_log_dest_1='+C11_OLOG'
*.db_create_online_log_dest_2='+C11_MLOG'
*.db_files=1500
*.db_name='C11'
*.DB_RECOVERY_FILE_DEST='+C11_RECO'
*.DB_RECOVERY_FILE_DEST_SIZE=950G
*.DIAGNOSTIC_DEST='C:\Oracle\C11\saptrace'
*.event='10027','10028','10142','10183','10191','38068 level 100','38085','38087','44951 level 1024'#RECOMMENDED BY ORACLE/SAP FOR 11.2.0 - SAP note 1431798
*.fast_start_mttr_target=30
*.filesystemio_options='SETALL'
C111.instance_number=1
C112.instance_number=2
C113.instance_number=3
*.java_pool_size=0
*.log_archive_dest_1='location='+C11_ARCH/C11/ORAARCH valid_for=(ALL_LOGFILES,ALL_ROLES) db_unique_name=C11'
*.log_archive_format='C11ARC%t_%s_%r.dbf'
*.log_checkpoints_to_alert=TRUE
*.MAX_DUMP_FILE_SIZE='20000'
*.open_cursors=800
*.optimizer_index_cost_adj=20
*.os_authent_prefix='ops$'
*.PARALLEL_EXECUTION_MESSAGE_SIZE=16384
*.pga_aggregate_target=5G
*.processes=850
*.QUERY_REWRITE_ENABLED='FALSE'
*.recovery_parallelism=1
*.RECYCLEBIN='OFF'
*.remote_listener='scan.oracledev.wdf.sap.corp:1521'
*.remote_login_passwordfile='exclusive'
*.REMOTE_OS_AUTHENT=TRUE
*.REPLICATION_DEPENDENCY_TRACKING=FALSE
*.sec_case_sensitive_logon=false
*.sessions=1700
*.shared_pool_size=3G
*.star_transformation_enabled='true'
C111.thread=1
C112.thread=2
C113.thread=3
C111.undo_tablespace='PSAPUNDO'
C112.undo_tablespace='PSAPUNDO2'
C113.undo_tablespace='PSAPUND03'

Please note that it is not possible to start the database until “Oracle Administrator Groups” and the Windows services for the instances have been created and the database and its instances have been configured with Oracle Clusterware. By default the Oracle instance will search for the spfile (e.g. 'SPFILEC11.ORA') in 'OHRDBMS/dbs'.

SQL*Net Configuration

Note that with Oracle Grid Infrastructure 11.2 no manual configuration of listener.ora and sqlnet.ora is required on server side except of the SID_LIST_LISTENER entry that is required for BR*Tools to startup/shutdown the database instances from remote. The installation process creates the files listener.ora, sqlnet.ora and endpoints_listener.ora. Oracle Clusterware will automatically updates the listener.ora and endpoint_listener.ora files based on the current status of the listener resources and the database services that have been defined.

With Oracle 11.2 RAC listener.ora, sqlnet.ora and endpoints_listener.ora are located under 'OHGRID\network\admin' and not in one of the Oracle RDBMS Homes. Note that this is a local path and that you have to modify the listener.ora on each cluster node.

E.g. On Node A:
SID_LIST_LISTENER=
{
   SID_LIST=
     (SID_DESC=(SID_NAME=C111) (ORACLE_HOME=C:\ORACLE\C11\11202))
}

E.g. On Node B:
SID_LIST_LISTENER=
{
   SID_LIST=
     (SID_DESC=(SID_NAME=C112) (ORACLE_HOME=C:\ORACLE\C11\11202))
}

On the client side the SAP application servers do not require an address list of all the listeners on each node. Instead each client needs to know to which database service to connect to as well as the name and port of the SCAN. This can be done in two ways: Either by creating a tnsnames.ora or by using the EZCONNECT method (recommend).

When using EZCONNECT set the environment variable dbs_ora_tnsnames to '://<hostname>:<port>/<servicename>.'
If you still want to use tnsnames.ora please see the example below:

```sql
C11.WORLD=
  (DESCRIPTION =
   (ADDRESS_LIST =
    (ADDRESS =
     (COMMUNITY = SAP.WORLD)
     (PROTOCOL = TCP)
     (HOST = scan.oracledev.wdf.sap.corp)
     (PORT = 1521)
    )
   )
  )
  (CONNECT_DATA =
   (SERVICE_NAME = cic11)
  )
)
```

**Oracle Instance Creation**

When creating or removing an Oracle instance service (OracleService<SID>) using oradim make sure you always run oradim from the correct Oracle RDBMS Home and from the cluster node where you want to create the new service. You should never rely on the PATH variable when running oradim.

To create a new instance service:

- open a new command prompt
- set ORACLE_HOME=<OHRDBMS> e.g. C:\ORACLE\C11\11202
- cd %ORACLE_HOME%\bin
- oradim –new –sid <DBSIDn> –startmode=manual

To remove an instance service:

- open a new command prompt
- set ORACLE_HOME=<OHRDBMS> e.g. C:\ORACLE\C11\11202
- cd %ORACLE_HOME%\bin
- oradim –delete –sid <dbsid+instanceno>
E.g. for a database 'C11' that should have instances on 3 cluster nodes you would create 3 new instance services:

Cluster node 1: oradim –new –sid C111 –startmode=manual
Cluster node 2: oradim –new –sid C112 –startmode=manual

Create the Oracle Clusterware Resources

Setup your environment to work with Oracle Grid Infrastructure by calling your shell script that sets up the environment accordingly. E.g. 'env_asm.cmd'.

Add the database. E.g.
srvctl add database -d C11 -o C:\ORACLE\C11\11202 -p +C11_DATA/C11/SPFILEC11.ORA

Add instances that belong to the database. E.g.
srvctl add instance -d C11 -i C111 -n oracx3v1
srvctl add instance -d C11 -i C112 -n oracx3v2
srvctl add instance -d C11 -i C113 -n oracx3v3

Add database services that should be managed by Oracle Clusterware. Each Oracle RAC instance must have a service named like to instance itself and the service must be configured to run on this instance only.

It is required to create one database service for your SAP central instance and for each SAP application server you require additional database services (i.e. for n SAP application servers you need n database services where every SAP application server is connected to its own database service) – not counting the instance specific services.

Never configure a database service to run on more than one database instance at the same time. This would create connections from one application server to more than one database instance, which may cause serious performance and availability problems.

E.g.
srvctl add service -d C11 -s C111 -r "C111"
srvctl add service -d C11 -s C112 -r "C112"
srvctl add service -d C11 -s C113 -r "C113"

srvctl add service -d C11 -s C11CI -r "C111" -a "C112,C113"
srvctl add service -d C11 -s C11AS1 -r "C112" -a "C113,C111"
srvctl add service -d C11 -s C11AS2 -r "C113" -a "C111,C112"

Start the database services:
srvctl start service –d C11 (will try to start all services defined for database 'C11')

SAP-specific database changes

DDLOG Sequence
SAP is using a database sequence called “DDLOG” to generate timestamps for various purposes. Therefore SAP needs consecutive numbers returned from DDLOG. To guarantee this in a RAC environment the sequence has to be recreated in “ordered” mode. Please refer to SAP note #743555 for a description on how to do this.

Checking the Setup
In order to check the status of the cluster’s local resources and cluster resources setup the appropriate environment in your command line and run 'crsctl status resource –t' to print a complete list. Note that every resource except 'ora.gsd' and 'ora.oc4j' should have the status shown as 'TARGET ONLINE STATUS ONLINE'.

• Shutdown and power off each cluster node and then reboot them to see if every node comes up properly and all the cluster services are correctly restarted. Note that it can take ~15 minutes until all cluster resource are started.
• Use tnsping to verify that all listeners are reachable and the according services are registered properly.
• Try to connect to each database service.
• Check if database instances can be started and stopped as expected using 'srvctl' utility.
• Check the alert logs for errors.

Reusing Oracle ASM Disks
If a disk is added to an Oracle ASM diskgroup for the first time the disk gets flagged as 'in use'. This means that even if you remove this Oracle ASM disk from the Oracle ASM diskgroup you may not be able to reuse it in the same or another Oracle ASM diskgroup. This is also the case if you decide to re-install Oracle Grid Infrastructure using disks for OCR that have been used earlier.

The easiest way to solve this problem is to format the disk with NTFS and then use the 'diskpart' utility to remove all partitions and recreate them. After this 'asmca' can be used to put a new label on the disk.

Do not forget to issue a 'rescan disks' on the other cluster nodes and to remove driveletters that may have been assigned by Microsoft Windows.
Working with Oracle ACFS

Checking Oracle ACFS

Oracle Grid Infrastructure 11.2 includes a utility to perform offline file system checks. To unmount an mounted Oracle ACFS volume all processes with open handles on that file system must be stopped.

This includes the services 'OracleService<SIDn>' and 'Oracle <DBSIDn> VSS Writer Service' and all other programs (command prompts, tail, etc.) that may have open handles on that file system on all cluster node.

- Shutdown your database that is run out of the Oracle 11.2 RDBMS Home you want to check.
  E.g. `srvctl stop database -d <DBSID>`

- Retrieve the virtual device name of the Oracle ASM volume housing the Oracle ACFS file system.
  E.g. `acfsutil info fs` or the names of the virtual Oracle ASM volumes you wrote down during the installation.

- Stop the file system and wait for unmount to complete.
  E.g. `srvctl stop file system -d `.

If an error is thrown the reason can be one of the following:

1) Unmounting the file system was too slow. Run 'srvctl stop file system...' command again.

2) You still have some files open. Check whether a Windows service is still running or whether another program is still accessing the file system. E.g. A command prompt where you did a 'cd' to a directory on Oracle ACFS requires a handle. So either 'cd' out of the directory or close the command prompt.

E.g.

```
C:\Users\oracle>srvctl stop database -d C11
```

```
C:\Users\oracle>acfsutil info fs
C:\ORACLE\C11
    ACFS Version: 11.2.0.2.0
    flags:        MountPoint,Available
    volumes:      1
    total size:   25769803776
    total free:   21699956736
    primary volume: asm-c11-210
    label:
        flags:        Primary,Available,ADVM
    on-disk version:   39.0
    allocation unit:  4096
```
size:                  25769803776
free:                  2169956736
ADVM diskgroup         ACFS
ADVM resize increment: 268435456
ADVM redundancy:       unprotected
ADVM stripe columns:   4
ADVM stripe width:     131072
number of snapshots:  0
snapshot space usage: 0

C:\Users\oracle>srvctl stop file system -d \\asm-c11-210
PRCR-1065 : Failed to stop resource ora.acfs.c11.acfs
CRS-5014: Agent "C:\ORACLE\GRID\11202\bin\orarootagent.exe"
timed out starting process
"C:\ORACLE\GRID\11202\bin\acfssinglefsmount.bat" for action
"stop": details at "(:CLSN00009:)" in
"C:\ORACLE\GRID\11202\log\oracx3v1\agent\crsd\orarootagent\orarootagent.log"
CRS-5017: The resource action "ora.acfs.c11.acfs stop"
encountered the following error:
(:CLSN00009:)Utils:execCmd aborted
CRS-2675: Stop of 'ora.acfs.c11.acfs' on 'oracx3v1' failed
CRS-2678: 'ora.acfs.c11.acfs' on 'oracx3v1' has experienced an
unrecoverable failure

Trying again...

C:\Users\oracle>srvctl stop file system -d \\asm-c11-210
PRCC-1016 : acfs.c11 was already stopped
PRCR-1005 : Resource ora.acfs.c11.acfs is already stopped
C:\Users\oracle>

• If the file system was unmounted successfully check it with the 'acfschkdsk' utility.
Calling acfschkdsk without any parameters displays a list of options.

C:\Users\oracle>acfschkdsk \\asm-c11-210
version                   = 11.2.0.2.0
*****************************
********** Pass: 1 **********
*****************************
Oracle ASM Cluster File System (ACFS) On-Disk Structure
Version: 39.0
ACFS file system created at: Thu Aug 11 13:33:05 2011
checking primary file system
Files checked in primary file system: 85%
Files checked in primary file system: 100%
Checking if any files are orphaned...
0 orphans found
Checker completed with no errors.

- Restart the file system.

  C:\Users\oracle>srvctl start file system -d \.\asm-c11-210

- Wait for 3-4 minutes and check if each cluster node did mount the file system in the Windows Explorer before you restart your database instances.

Backup and Restore

Oracle ACFS does not support backup tools that rely on Microsoft Windows Volume Shadow Copy Services. Other backup tools that do not require VSS should work fine with Oracle ACFS. We recommend to create a full backup of an Oracle ACFS volume (which basically just holds Oracle 11.2 RDBMS Homes, Oracle ADR specific files and logs generated by BR*Tools) after initial installation and configuration and after each modification of the installed software or of the configuration files (e.g. after patch installations).

Before you start patching Oracle software located on Oracle ACFS you must shutdown the database that is run from that Oracle RDBMS Home and to unmount and check the file system. If the file system has errors – which is very unlikely - we recommend to recreate it and to restore the latest backup.

Configuring BR*Tools for Oracle ASM

SAP has extended the functionality of BR*Tools to support Oracle ASM. Place the init<sid>.sap configuration files for archivelog backup and database backup in the 'sapprof' directory. Note that you need specific configuration files for each cluster node on which you run backups as the init<sid>.sap configuration files need different values for parameter 'asm_ora_sid' on each node.

Example init<sid>.sap files:

Archivelog backup:

  backup_mode = all  
  restore_mode = all  
  backup_type = online  
  backup_dev_type = rman_disk  
  backup_root_dir = C:\oracle\C11\sapbackup
stage_root_dir = C:\oracle\C11\sapbackup
compress = no
compress_cmd = "compress -c $ > $"
uncompress_cmd = "uncompress -c $ > $"
compress_dir = C:\oracle\C11\sapreorg
archive_function = save_delete
archive_copy_dir = C:\oracle\C11\sapbackup
archive_stage_dir = C:\oracle\C11\sapbackup
tape_copy_cmd = cpio
disk_copy_cmd = copy
stage_copy_cmd = rcp
pipe_copy_cmd = rsh
cpio_flags = -ovB
cpio_in_flags = -iuB
cpio_disk_flags = -pdcu
rman_channels = 1
rarman_sess_stmt = ("alter session set optimizer_mode=RULE")
rman_send = ("channel sbt_1 'NSR_ENV=(NSR_SERVER=xxbackapp02-se,NSR_CLIENT=oracx3v1,NSR_DATA_VOLUME_POOL=IDES Oracle 4 Weeks,NSR_GROUP=ArchiveLogs_C11)'"
)
rewind = "mt -f $ rewind"
rewind_offline = "mt -f $ offline"
tape_pos_cmd = "mt -f $ fsf $"
tape_size = 100G
exec_parallel = 0
tape_address = /dev/rmt/0mn
tape_address_rew = /dev/rmt/0m
volume_archive = (SIDA01, SIDA02, SIDA03, SIDA04, SIDA05, SIDA06, SIDA07, SIDA08, SIDA09, SIDA10, SIDA11, SIDA12, SIDA13, SIDA14, SIDA15, SIDA16, SIDA17, SIDA18, SIDA19, SIDA20, SIDA21, SIDA22, SIDA23, SIDA24, SIDA25, SIDA26, SIDA27, SIDA28, SIDA29, SIDA30)
volume_backup = (SIDB01, SIDB02, SIDB03, SIDB04, SIDB05, SIDB06, SIDB07, SIDB08, SIDB09, SIDB10, SIDB11, SIDB12, SIDB13, SIDB14, SIDB15, SIDB16, SIDB17, SIDB18, SIDB19, SIDB20, SIDB21, SIDB22, SIDB23, SIDB24, SIDB25, SIDB26, SIDB27, SIDB28, SIDB29, SIDB30)
expir_period = 14
tape_use_count = 100
parallel_instances = (C111:C:\Oracle\C11\11202@c111,
C112:c:\Oracle\C11\11202@c112,
asm_ora_sid = +ASM1
asm_ora_home = C:\oracle\GRID\11202
asm_root_dir = ASM

The parameter 'asm_ora_sid' must be adjusted to '+ASM2','+ASM3',... to run archivelog backups on a cluster node other than node 1.

Database Backup:
backup_mode = full
restore_mode = all
backup_type = online
backup_dev_type = rman_disk
backup_root_dir = c:\oracle\C11\sapbackup
stage_root_dir = c:\oracle\C11\sapbackup
compress = no
compress_cmd = "compress -c $ > $"
uncompress_cmd = "uncompress -c $ > $"
compress_dir = c:\oracle\C11\sapreorg
archive_function = save_delete
archive_copy_dir = c:\oracle\C11\sapbackup
archive_stage_dir = c:\oracle\C11\sapbackup
tape_copy_cmd = cpio
disk_copy_cmd = copy
stage_copy_cmd = rcp
pipe_copy_cmd = rsh
cpio_flags = -ovB
cpio_in_flags = -iuvB
cpio_disk_flags = -pdcu
rman_channels = 4
rman_fileserset = 1
_rman_sess_stmt = ("alter session set optimizer_mode=RULE")
rman_send = ("channel sbt_1 'NSR_ENV=(NSR_SERVER=xxbackapp02-se,NSR_CLIENT=oracx3v1,NSR_DATA_VOLUME_POOL=IDES Oracle1 4 Weeks,NSR_GROUP=2200xxbackup02sn01ora1)'", "channel sbt_2 'NSR_ENV=(NSR_SERVER=xxbackapp02-se,NSR_CLIENT=oracx3v1,NSR_DATA_VOLUME_POOL=IDES Oracle2 4 Weeks,NSR_GROUP=2200xxbackup02sn01ora2)'", "channel sbt_3 'NSR_ENV=(NSR_SERVER=xxbackapp02-se,NSR_CLIENT=oracx3v1,NSR_DATA_VOLUME_POOL=IDES Oracle3 4 Weeks,NSR_GROUP=2200xxbackup02sn01ora3)'", "channel sbt_4 'NSR_ENV=(NSR_SERVER=xxbackapp02-se,NSR_CLIENT=oracx3v1,NSR_DATA_VOLUME_POOL=IDES Oracle4 4 Weeks,NSR_GROUP=2200xxbackup02sn01ora4)"
rewind = "\texttt{mt -f $ rewind}"
rewind_offline = "\texttt{mt -f $ offline}"
tape_pos_cmd = "\texttt{mt -f $ fsf $}"
tape_size = 100G
exec_parallel = 0
tape_address = /dev/rmt/0mn
tape_address_rew = /dev/rmt/0m
volume_archive = (SIDA01, SIDA02, SIDA03, SIDA04, SIDA05, SIDA06, SIDA07, SIDA08, SIDA09, SIDA10, SIDA11, SIDA12, SIDA13, SIDA14, SIDA15, SIDA16, SIDA17, SIDA18, SIDA19, SIDA20, SIDA21, SIDA22, SIDA23, SIDA24, SIDA25, SIDA26, SIDA27, SIDA28, SIDA29, SIDA30)
volume_backup = (SIDB01, SIDB02, SIDB03, SIDB04, SIDB05, SIDB06, SIDB07, SIDB08, SIDB09, SIDB10, SIDB11, SIDB12, SIDB13, SIDB14, SIDB15, SIDB16, SIDB17, SIDB18, SIDB19, SIDB20, SIDB21, SIDB22, SIDB23, SIDB24, SIDB25, SIDB26, SIDB27, SIDB28, SIDB29, SIDB30)

expir_period = 14
tape_use_count = 100

parallel_instances = (C111:c:\Oracle\C11\11202\C111, C112:c:\Oracle\C11\11202\C112, C113:c:\Oracle\C11\11202\C113)

asm_ora_sid = +ASM1
asm_ora_home = C:\oracle\GRID\11202
asm_root_dir = ASM

SAP Standalone Gateway

In order to be able to run automated database and archivelog backups from transaction 'DB13' install a SAP Standalone Gateway on each of the cluster nodes and extract the latest BR*Tools bundle.

Please refer to the following SAP notes for more information:

\begin{tabular}{|l|l|}
\hline
\texttt{#1025707} & DBA Cockpit: Planning calendar and remote Oracle databases \\
\texttt{#853610} & Configuring transaction DB13C for Oracle \\
\texttt{#1028624} & Overview of DBA Cockpit for Oracle \\
\hline
\end{tabular}
Testing

Failures

One of the most important things before going into production with a new cluster environment is testing. Only by testing the behaviour of the cluster by simulating hardware and software failures ensures that it will react as expected when a real failure occurs. The following two sections describe some essential tests. It is highly recommended not to go into production if those tests do not show the expected results. The list is not complete and customers may think about additional tests that have to be done for their specific cluster environment and HA requirements.

Hardware Failures

Power Loss or Complete Failure of Cluster Node.

Action

One of the most likely failures that may occur is a crash of a cluster node. Simulate a crash by issuing a “hard power-off” for one of the cluster nodes.

Expected Behaviour

One of the remaining nodes should do a crash recovery for the crashed node. Depending on the service definitions and their failover policy the services may be activated on one of the remaining nodes. The whole failover process may take some minutes. To verify whether the failover process is finished run 'crsctl status resource -t'. Check that one of the remaining nodes finished the crash recovery by viewing the alert.logs. Finally the VIP of the failed cluster node and all services should be available as defined.

Action

Power on the shutdown cluster node.

Expected Behaviour

The VIP of the started cluster node that was serviced by one of the remaining cluster nodes should fall back to the rebooted cluster node. All defined Oracle instances (if more than one database instance was running on the node before) should start automatically. All services that fell over to other cluster nodes should stay there. They have to be moved manually to their corresponding nodes using 'srvctl relocate service...'.

Oracle Interconnect Failures

Cluster node has lost its connection to the switch.
Action
Disconnect one cluster node from the switch by unplugging all network cables of the Oracle Interconnect. If you have NIC teaming active (redundant interconnect) also check what happens when you unplug only one network cable.

Expected Behaviour
In a two node RAC cluster one of both nodes should crash. In a three or more node RAC cluster the node where you did unplug the network cables should crash. In both situations the VIP should move to one of the remaining nodes. One of the remaining instances should do the crash recovery for the crashed node. Services should move to the remaining nodes as defined.

(Multiple) Switch Failures with all nodes losing their connection

Action
Turn off or disable the network switch of the Oracle Interconnect.

Expected Behaviour
Regardless of the number of cluster nodes all nodes except one should crash. The remaining node should take over the VIP’s of the crashed nodes, perform a crash recovery and provide the database services as defined.

Storage Failures
One cluster node loses its storage connection.

Action
Unplug one of the cluster nodes from the storage. If you have redundant paths to the storage also check what happens when you unplug only one (fiberchannel-) cable.

Expected Behaviour
The node should crash without automatic reboot. Automatic reboot may be a configuration option in the BIOS of the node.

All cluster nodes lose their storage connection.

Action
Unplug all cluster nodes from the storage or turn off all switches to the storage.

Expected Behaviour
All cluster nodes should crash. After reconnecting the nodes to the storage and rebooting all the nodes the database should be available as expected.
Software Failures

Shutdown abort.

Action
Shutdown an Oracle instance with “shutdown abort”.

Expected Behaviour
The cluster node should stay up and running. One of the remaining Oracle instances should do the crash recovery. All services of the stopped instance should move to the previously defined remaining instances. `crsctl status resource -t` utility should display “OFFLINE” as the target state for the stopped instance.

Kill oracle.exe

Action
Kill oracle.exe with the Windows Task Manager.

Expected Behaviour
The cluster node should stay up and running. One of the remaining Oracle instances should do the crash recovery. All services of the killed instance should move to the previously defined remaining instances. CRS should start the killed instance automatically. All services that moved to other instances should stay there. They have to be relocated manually.

SAP Application Workload

The most important tests to run are workload tests where customers should try to run their SAP applications under simulated business conditions. Testing the performance of core transactions and batch jobs will help to identify and resolve bottlenecks and configuration issues before going into production with your new cluster environment. These tests can be combined with some of the failure test scenarios described earlier.

Check if local update dispatching (described in the next chapter) is active and working as expected with “dpmon.exe” or SAP Management Console. Both tools show the number of times an update process was active.

Check if database service relocation works as expected and every SAP application server can connect to its service.
Additional Performance Recommendations

Using ASSM tablespaces is mandatory. If you still have Non-ASSM tablespaces you must migrate your tables to ASSM tablespaces first.

Use local update dispatching for SAP update-processes

Local Update Dispatching

The SAP application performs updates on the database asynchronously through 'update-processes'. A dialog work process inserts an update job into tables VBHDR, VBDATA, VBMOD and posts the dispatcher process on the central instance to select an update-process to actually perform the update job. This update-process may be connected to another RAC instance, similarly to the dialog-process. If this is the case, the update-process would read the data just written by the dialog-process. To satisfy this read request, all required database blocks have to be shipped over the interconnect from the instance where the data was inserted to the instance where the data has to be read. This approach produces unnecessary additional data load and can be avoided.

In order to avoid these 'non-local updates', it is recommended that you:

- have a number of update-processes on each SAP instance
- turn off update-dispatching and use the local update-processes

To turn off update dispatching, set rdisp/vb_dispatching to 0 as described in SAP note #62203. Also, set rdisp/vb_name to the name of the local instance (e.g. rdisp/vb_name = app1_C11_00).