



ORACLE

SAP NetWeaver® Application Server ABAP/Java with Oracle Exadata Cloud@Customer X10M

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Revision History

The following revisions have been made to this document:

DATE	REVISION
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Scope and Assumptions

This document is a reference guide for deploying Oracle databases of the SAP NetWeaver® Application Server ABAP/Java platform on Oracle Exadata Cloud@Customer X10M. It also describes how to optionally implement SAP high availability (HA) by using Oracle Grid Infrastructure with the SAPCTL add-on. Additionally, it describes how to configure a separate server running Oracle Linux 8 as an SAP NetWeaver primary application server connected to an Exadata Cloud@Customer X10M system. Because customers may run any UNIX, Linux, or Windows OS supported by SAP and Oracle on their application servers, they must pay attention to fulfilling the specific prerequisites before installation of SAP or Oracle software.

During deployment and while running SAP NetWeaver Application Server ABAP/Java on Exadata Cloud@Customer, you will likely interact with the several Oracle-specific and SAP-specific work areas. Those are described in Table 2 and Table 3 on the following pages. Table 1 defines some of the terms used within the context of Oracle Exadata Cloud@Customer X10M and this document.

Note: The examples and screenshots in this document may not be 100% accurate in terms of hostnames or IP addresses shown because they are a compilation from earlier documents and the most recent version.

Table 1: Terms Used Within the Context of Oracle Exadata Cloud@Customer X10M and This Document

TERM	DEFINITION
Oracle Exadata Cloud@Customer X10M infrastructure	The physical infrastructure of the customer's Exadata Cloud@Customer X10M system (base, quarter, half, or full rack). The infrastructure typically consists of 2 or more DB servers or Exadata compute nodes, a number of storage servers, plus more components for networking and power supply.
DB server	A database (DB) server is one physical node of the Oracle Exadata Cloud@Customer X10M infrastructure, often referred as an Exadata compute node. It is configured as a KVM-based virtualization host and can run multiple virtual machines (VMs).
VM cluster	A cluster that consists of two or more VMs running on different DB servers.
VM cluster node	A VM with all the components to run Oracle Real Application Clusters (RAC) Databases. This includes the presence of the operating system (OS), Oracle Grid Infrastructure software (Clusterware, ASM, ACFS, and so on), and Oracle Database software. A VM cluster node is also referred as an Oracle Database compute node, and might also be referred to as a VM, KVM guest, or virtual compute node.
Virtual cluster network	Describes the essential VM cluster-specific network data such as the gateway address, netmask, hostnames (short and fully qualified), IP addresses (including virtual IP addresses), DNS, and NTP servers for the client network and the backup network.
VM Cluster Node Subsetting	Allows a VM cluster to span two or more DB servers (up to the maximum number of DB servers available in your Oracle Exadata Cloud@Customer X10M infrastructure). VM Cluster Node Subsetting lets you add new VM cluster nodes to an existing VM cluster if your workload or high availability requirements demand additional resources. VM Cluster Node Subsetting also lets you reduce the number of VM cluster nodes in a VM cluster down to a minimum of two.

Table 2: Oracle-Specific Work Areas

ORACLE WORK AREA	PURPOSE	RELATED NOTES AND COMMENTS
Oracle Cloud Console	Use to manage your Exadata Cloud@Customer infrastructure, and to deploy VM networks and VM clusters.	Register at cloud.oracle.com .
Oracle Linux	Used on all VM cluster nodes. Other customer-provided compute hosts might run different operating systems.	Oracle Linux 8 on VM cluster nodes is managed by using DBaaS tools. Oracle Linux or other operating systems on customer-provided compute hosts have to be managed by the customer. For Oracle Linux 8 see SAP Note 2936683 .
Oracle Grid Infrastructure	Manage the HA of all database services, ACFS, and NFS by using tools like SRVCTL and CRSCTL, as well as application virtual IP addresses.	For HANFS, see MOS Note 1934030.1: ODA (Oracle Database Appliance): HowTo export ACFS (cloudfs) using HANFS .
Oracle Database software	Use MOPatch or OPatch and SAP Bundle Patches to patch existing Oracle Database homes.	SAP Bundle Patch installation is documented in the readme file.
Oracle Automatic Storage Management (ASM)	Manage ASM disk groups by using ASMCMD and SQL*Plus.	None
Oracle Transparent Data Encryption (TDE)	Manage encryption wallets and encryption keys.	See SAP Notes 2591575 and 2799991 .
Oracle Database instances	Manage the SAP database and Oracle initialization parameters recommended by SAP.	For SAP-required Oracle initialization parameters, see SAP Notes 2799900 , 2470660 , and 2470718 .
Oracle Recovery Manager (RMAN)	Back up, restore, and recover your SAP database.	None

Table 3: SAP-Specific Work Areas

SAP WORK AREA	PURPOSE	RELATED NOTES AND COMMENTS
SAP Maintenance Planner	Create a stack.xml file for SAP Software Provisioning Manager (SWPM) and choose the SAP software components that you want to install.	See Maintenance Planner – User Guide .
(Mandatory) SAP Software Provisioning Manager (SWPM)	Use for SWPM-based host preparation and to install your ABAP system central services (ASCS), enqueue replication server (ERS), primary application server (PAS), and SAP database instance.	Always use the latest version of SWPM to avoid issues with new versions of Oracle Database software and new versions of Oracle Linux not supported in older versions of SWPM.

SAP WORK AREA	PURPOSE	RELATED NOTES AND COMMENTS
SAP NetWeaver software stack	Modify SAP instance profiles, and configure RFC connections and SAP transaction code DB13.	SAP instance profiles must be adjusted to configure the correct number of work processes and SAP HA components if using SAPCTL.
SAProuter	Set up and configure SAProuter.	Customers must configure SAProuter at least for SAP EarlyWatch.
SAP Web Dispatcher (optional)	Set up and configure SAP Web Dispatcher.	SAP Web Dispatcher is required only if SAP NetWeaver web transactions are being used, for example, for online (HTTP/S-based) availability checks. See SAP Note 908097 .
SAP GUI	Install SAP GUI components.	None
SAP HA using SAPCTL (optional)	Configure SAP HA for SAP ASCS and ERS by integrating with Oracle Clusterware.	See SAP Note 1496927 to download the SAPCTL software package (includes documentation).
BR*Tools (optional)	Back up, restore, and recover your SAP database.	See SAP Notes 1598594 , 113747 , and 776505 .

Note: Using a VM cluster node for SAP NetWeaver Application Server ABAP/Java instances is supported only for SAP central services. SAP NetWeaver Application Server ABAP/Java instances must be installed on separate servers, provided by the customer, that use Ethernet network connections to all VM cluster nodes within the associated VM cluster network of the Exadata Cloud@Customer X10M system.

This document is *not* a full reference for SAP NetWeaver Application Server ABAP/Java. Rather, it is a description of how to plan and implement an SAP NetWeaver-based solution by using Exadata Cloud@Customer X10M in the customer data center in a supported and verified way. Furthermore, the document describes the implementation of SAP HA by using Oracle Grid Infrastructure, which is an optional method for implementing SAP HA. Customers who require SAP HA can follow any other supported approach.

For systems in which SAP HA is not required or if SAP HA is implemented by using a third-party SAP HA solution (no ASCS or ERS on Exadata compute nodes), you can skip the steps related to installing and configuring SAP ASCS and ERS.

Configuring ACFS is always mandatory for storing shared logs and traces on VM cluster nodes, even if you choose to place `/sapmnt` on an NFS mount not exported by Exadata compute nodes.

This document requires the following knowledge:

- You are familiar with the fundamentals of Exadata Cloud@Customer and Oracle Cloud Infrastructure (OCI). For information, see the following resources:
 - [Exadata Cloud@Customer](#)
 - [Oracle Cloud Infrastructure](#)

- You have advanced administrative skills in SAP NetWeaver Application Server ABAP/Java using Oracle Database and Oracle Linux. For more information, see the following resources:
 - [SAP NetWeaver product page](#)
 - [SAP Community](#)
 - [Oracle Linux documentation](#)
- You are familiar with the documentation for the following products:
 - Oracle Grid Infrastructure 19c and the Oracle Database releases that you use
 - Oracle Linux 8
 - SAP NetWeaver 7.x

About Exadata Cloud@Customer X10M

Exadata Cloud@Customer combines Oracle Database and Oracle Exadata technology with the simplicity, agility, and elasticity of a cloud-based deployment located in customers' own data centers. Exadata Cloud@Customer is ideal for customers who want cloud benefits but cannot move their databases to the public cloud for various reasons: sovereignty laws, industry regulations, corporate policies, security requirements, network latency, or the impracticality of moving databases away from other tightly coupled, on-premises IT infrastructure.

Exadata Cloud@Customer X10M is built on Exadata X10M hardware, offering more CPU cores, more and faster DDR5 memory, new Exadata RDMA Memory (XRMEM), and higher storage capacity compared to the previous generation. Exadata X10M storage servers feature the XRMEM Data Accelerator to boost overall system performance. Innovative RDMA algorithms bypass the network and I/O stack, eliminating expensive CPU interrupts and context switches, reducing latency by more than 10x compared to the traditional network and I/O stack, from 200µs to less than 17µs

Exadata Cloud@Customer X10M has a 100-Gbps RDMA over Converged Ethernet (RoCE) internal network fabric, providing an extremely low-latency interconnect between all database and storage servers. Each server is connected to the RoCE fabric with two 100-Gbps PCIe5 ports, enabling the RoCE fabric to provide an aggregate active-active bandwidth of 200 Gbps between servers.

Exadata Cloud@Customer X10M elastic infrastructure shapes provide database compute and storage resources for any workload and scale for any database size. Flexible shapes range from a quarter rack, 2 database servers, and 3 storage servers, up to 16 total servers in the initial rack and up to 32 database servers and 64 storage servers across multiple racks to meet a variety of CPU processing and storage requirements.

Exadata Cloud@Customer X10M uses Oracle Linux 8 as the operating system for all database servers (KVM hosts and guests) and storage servers.

The following figure shows an architectural overview of Exadata Cloud@Customer X10M.

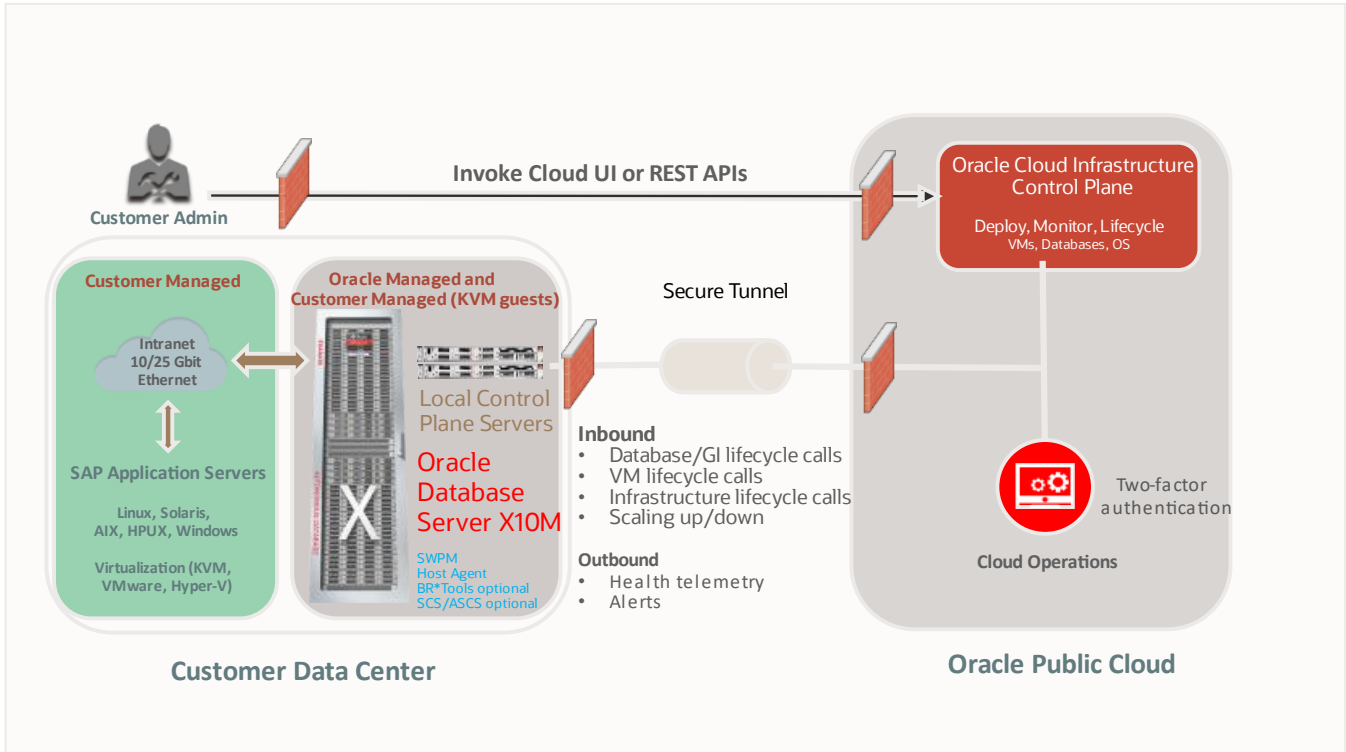


Figure 1: Architecture Overview of Exadata Cloud@Customer X10M with SAP NetWeaver

Oracle manages all aspects of the Exadata Cloud@Customer X10M infrastructure, including firmware upgrades, KVM virtualization host patches, and updates and patches for database tools and Oracle Grid Infrastructure to an image server that runs on the control plane server, which is also part of the Exadata Cloud@Customer X10M infrastructure. Customers are responsible for managing all aspects of the VM cluster nodes (KVM guest), such as creating databases, providing updates and patches for database tools and Oracle Grid Infrastructure, and uploading and installing SAP-specific bundle patches. These responsibilities are illustrated in the following image.

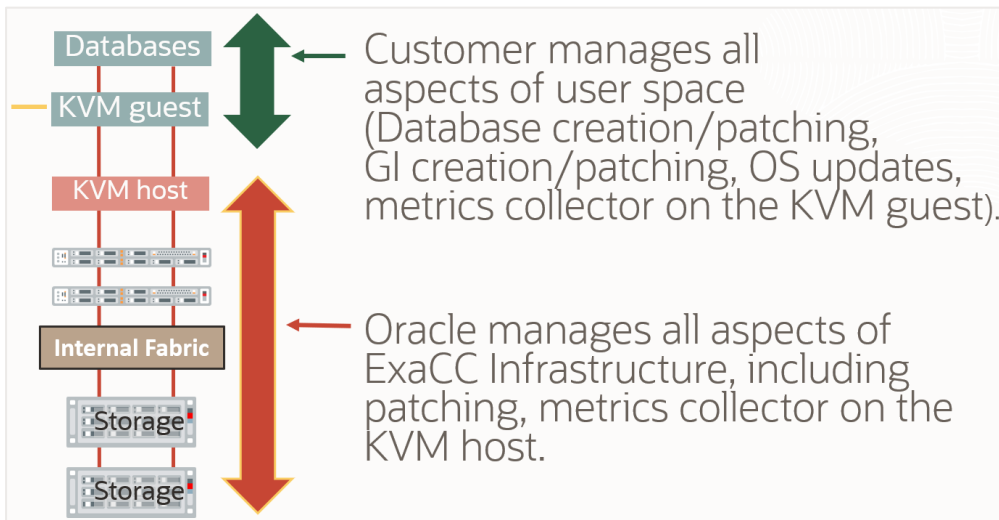


Figure 2: Responsibilities in Exadata Cloud@Customer X10M Management

Virtualization and Databases with Exadata Cloud@Customer X10M

Exadata Cloud@Customer X10M enables full-featured Oracle databases to run on VM cluster nodes in the customer's data center. A VM cluster consists of 2 or more VM cluster nodes. Each VM cluster spans 2 or more DB servers of the underlying Exadata Cloud@Customer X10M infrastructure. In a VM cluster node (KVM guest), the Oracle Grid Infrastructure and Oracle Database instances are deployed. Multiple databases of the same version or different versions can run within each of the VM clusters.

The maximum number of VM clusters that an Exadata Cloud@Customer X10M infrastructure can support is 16, but that number also depends on the number of DB servers available, the size of a VM image (currently 184 GB), and the disk space configured for /u02 in the VM. For details, see [Estimating How Much Local Storage You Can Provision to Your VMs](#).

VM Cluster Node Subsetting lets you choose the DB servers on which the VM cluster nodes belonging to a VM cluster are deployed. VM Cluster Node Subsetting lets you add more VM cluster nodes on free DB servers or remove VM cluster nodes from a VM cluster, freeing resources on the underlying DB servers. Note that if you want to increase the maximum number of VM clusters, you always need to add at least 2 DB servers.

Consider the following important points for virtualization of SAP NetWeaver with Exadata Cloud@Customer X10M:

- Dependencies exist between the expansion stage of an Exadata Cloud@Customer X10M infrastructure and the maximum number of VM clusters available for SAP production environments.
 - 2 DB servers (fully equipped) support 5 VM clusters
 - 4 DB servers support 10 VM clusters
 - 6 DB servers support 15 VM clusters
 - 8 or more DB servers support 16 VM clusters
- The available free space of the filesystems on the internal disk drives should be monitored constantly. We recommend that no changes be made to the structure and the size of the internal filesystems (such as /, /var, or /tmp) that are created during VM cluster deployment. If changes are needed, contact Oracle Cloud operations.
- The amount of local storage per VM determines how many Oracle Database homes (ORACLE_HOME) for a database installation can be deployed within a VM. Oracle Database homes grow over time, and for ongoing maintenance using the required SAP Bundle Patches, multiple copies of an Oracle Database home are needed ([SAP Note 2799959](#)). For SAP NetWeaver deployments, an amount of 200 GB disk space is required for an Oracle Database home and over a time period of three years excluding the fixed overhead per VM of 184 GB for the OS and Grid Infrastructure. The maximum number of SAP NetWeaver databases per VM cluster is determined by how the Oracle Database homes are configured. If an SAP NetWeaver database uses its own Oracle Database home, then only the maximum number of four SAP NetWeaver databases can be used per VM cluster. Using a shared Oracle Database home for multiple SAP NetWeaver databases of the same Oracle Database version allows the use of more SAP NetWeaver databases on a VM cluster. The number of SAP NetWeaver databases using a shared Oracle Database home that can be configured on a VM cluster depends on the sizes of the databases and the amount of main memory required for the database instances running on the VM cluster nodes. Proper careful sizing is required to determine which Exadata Cloud@Customer X10M system is required for running an SAP NetWeaver landscape.
- When you use an Exadata Cloud@Customer system for SAP and non-SAP databases, you must use separate VM clusters for the SAP and non-SAP databases, because of specific configuration, administration, and maintenance aspects of SAP databases. Deploying SAP and non-SAP databases within the same VM cluster is not supported.

- Databases for SAP NetWeaver systems such as ERP, SCM, CRM, and BW must be separated from databases for other SAP products such as Business Objects by using different VM clusters for those different SAP solutions, because of different configuration, administration, and maintenance requirements. Deploying multiple databases of different SAP NetWeaver systems within the same VM cluster is supported.

Oracle Database for SAP with Exadata Cloud@Customer X10M

All options and features certified for on-premises deployments of SAP NetWeaver with Oracle Database 19c are supported and certified for Exadata Cloud@Customer X10M. The support includes Oracle Real Application Clusters (RAC), Oracle Automatic Storage Management (ASM), and Oracle Database In-Memory for on-premises deployments of SAP NetWeaver.

Use only RAC databases with SAP NetWeaver. Configuration, deployment, and maintenance of an SAP NetWeaver system is tailored to RAC databases. All tests and QA actions are performed with RAC databases.

Note: Oracle Database 11g Release 2, 12c Release 1, 12c Release 2, and 18c are not supported with SAP on Exadata Cloud@Customer X10M. Oracle Autonomous Database is not certified and supported with SAP.

Oracle Cloud Infrastructure IAM Service

The [Identity and Access Management](#) (IAM) service is relevant for deploying Oracle databases of SAP NetWeaver Application Server ABAP/Java on the Exadata Cloud@Customer. IAM lets you control who has access to your cloud resources and what type of access they have. You can manage complex organizations and rules with logical groups of users and resources, and defining policies is simple. IAM helps you set up administrators, users, and groups, and specify their permissions. It lets you use a single model for authentication and authorization to securely control access and easily manage your IT resources across all of OCI.

Exadata Cloud@Customer Infrastructure

Each Exadata Cloud@Customer infrastructure is based on an Exadata X10M system configuration that contains a number of DB servers (or KVM-based virtualization hosts) and Exadata storage servers, all connected by a high-speed, low-latency, 100-Gbit Ethernet network and intelligent Exadata software. Multiple, full-fledged Oracle RAC instances can be configured to run on VM clusters hosted on Exadata Cloud@Customer X10M infrastructure.

Currently, Oracle offers the following configurations for Exadata Cloud@Customer X10M.

Table 4: Exadata Cloud@Customer X10M Configurations

SYSTEM	NUMBER OF COMPUTE NODES	NUMBER OF EXADATA STORAGE SERVERS
X10M Elastic	2 to 32 nodes (4 to 6,080 OCPUs, and total 2,780 to 44,480 GB RAM)	3 to 64
X10M-L Elastic	2 to 32 nodes (4 to 6,080 OCPUs, and total 4,180 to 66,880 GB RAM)	3 to 64
X10M-XL Elastic	2 to 32 nodes (4 to 6,080 OCPUs and total 5,600 to 89,600 GB RAM)	3 to 64

For up-to-date information about the certification status of all Exadata Cloud@Customer systems, see [SAP Note 2956661](#).

Exadata Cloud@Customer allows elastic scaling of the deployed VM clusters, which enables flexibility in the allocation of compute (CPU, memory, local storage) resources.

Note: In an Exadata Cloud@Customer elastic scaling configuration, a *minimum* of two OCPUS per VM per compute node running an SAP NetWeaver-based database workload is required.

Each VM cluster node (KVM guest) is running on a DB server (KVM-based virtualization host). You have root privileges for the VM cluster nodes (KVM guest) and DBA privileges on the Oracle databases. You can configure the VM cluster nodes according to your requirements. You can also run additional agent software and SAP infrastructure components on the VM cluster nodes to conform to business standards or security monitoring requirements.

On an VM cluster, you can create numerous database deployments for different SAP applications. The number of production databases for SAP systems is determined by the Exadata Cloud@Customer system type, the number of VMs deployed, and how many different database versions are being used.

Note: We do not support using the VM cluster nodes for SAP NetWeaver Application Server ABAP/Java instances *except for* SAP central services.

However, you do not have administrative access to the Exadata infrastructure components—including the physical compute node hardware, network switches, power distribution units (PDUs), and integrated lights-out management (ILOM) interfaces—or the Exadata storage servers, which are all administered by Oracle.

Licenses

Exadata Database Service on Exadata Cloud@Customer is available through a subscription offering that requires a minimum term of four years. Exadata Database Service has the following subscription models:

- Enterprise Edition Extreme Performance Included
- Bring Your Own License (BYOL), which covers the SAP ASFU license

Enterprise Edition Extreme Performance Included

The Enterprise Edition Extreme Performance Included subscription model includes all the features of Oracle Database Enterprise Edition, plus all the Oracle Database Enterprise Manager Packs and all Database Enterprise Edition Options. These include Database In-Memory, RAC, Active Data Guard, Automatic Storage Management (ASM), Partitioning, Advanced Compression, Advanced Security, Database Vault, Real Application Testing, OLAP, Advanced Analytics, and Spatial and Graph. Oracle Multitenant is also included in an Exadata Database Service PaaS subscription.

This subscription model is ideal for customers who do not have existing Oracle Database licenses, or who want to use Oracle Database features beyond what they are currently licensed.

Bring Your Own License (BYOL), SAP ASFU

BYOL is designed to minimize costs when migrating to the cloud. In a BYOL model, customers can deploy their existing Oracle Enterprise Edition and Database Option licenses to run the Exadata Database Service on Exadata Cloud@Customer. The Exadata System software is also included. If you intend to bring your own ASFU license, notify SAP.

Deployment Restrictions with SAP for Exadata Cloud@Customer

The following restrictions apply:

- Only Oracle Database 19c is supported with Oracle Exadata Cloud@Customer X10M.
- Oracle Autonomous Database is not certified with SAP and not supported.
- Oracle Multitenant is not certified and supported with SAP.
- SAP application servers on compute nodes of Exadata Cloud@Customer are not supported.
- SAP central services can be deployed only on compute nodes of the Exadata Cloud@Customer systems for Unicode deployments of SAP NetWeaver Application Server ABAP/Java.
- Non-Unicode deployments of SAP NetWeaver Application Server ABAP/Java cannot use SAP application servers on systems running the Oracle Linux OS.
- All databases must be created by using SAP Software Provisioning Manager (SWPM) either as a new database or as an SAP system copy of an existing database. Alternatively, existing SAP databases can be migrated to Exadata Cloud@Customer, for example, by using Oracle Recovery Manager (RMAN). Migrations of existing databases are discussed in a later section.
- Data encryption is mandatory for all Oracle databases on Exadata Cloud@Customer. Not using data encryption causes certain management operations, such as adding tablespaces, to fail. Oracle 19c databases require SWPM with patch level 36 or later for Oracle Database 19c and Transparent Data Encryption (TDE) support. For all other databases, encryption *must* be enabled as a separate step after successful SAP installation.
- The strong password policy in Exadata Cloud@Customer must be changed for an SAP installation and then reverted after the installed is finished.
- Hostnames must not exceed 13 characters. This applies also to virtual IPs and backup network hostnames.
- The Oracle Grid Infrastructure home is owned by the `grid` OS user. All Oracle Database homes being created must be owned by the `orac1e` OS user. This is also important for patching.

Support

If you encounter any problem with the SAP NetWeaver Application Server ABAP/Java deployment with Exadata Cloud@Customer, log a support message with SAP support and assign it to the support queue BC-DB-ORA.

Customers must purchase Exadata Cloud@Customer directly from Oracle to use the service and get support for it. For details, see [Oracle Cloud Hosting and Delivery Policies](#).

In addition to support for technical issues, use [My Oracle Support](#) if you need to perform the following tasks:

- Reset the password or unlock the account for the tenancy administrator.
- Add or change a tenancy administrator.

Note: [SAP Note 2520061](#) describes the support subscriptions that are needed to run SAP NetWeaver Application Server ABAP/Java on OCI with Oracle Linux.

Documentation

Ensure that you are familiar with the relevant SAP NetWeaver master and installation guides and the referenced SAP notes within. To find planning, installation, patching, and operation documentation for your task, see the [SAP NetWeaver Guide Finder](#).

Become familiar with the product documentation for all the components of your stack: Exadata Cloud@Customer, Oracle Linux, and SAP NetWeaver Application Server ABAP/Java.

Note: [SAP Note 2956661](#) defines all the technical prerequisites for deploying an SAP NetWeaver Application Server ABAP/Java system with Exadata Cloud@Customer. This note is updated regularly, so read it before you start any deployment. Information in the note takes precedence over information in this document.

Workload Size

Estimate the size needed for your SAP installation by using the SAP Quick Sizer tool, and determine the Oracle Database Exadata Cloud@Customer instance type needed for your SAP workload. The following table shows the current instance types certified by SAP. For the most current certification status, see [SAP Note 2956661](#).

Table 5: Certified Exadata Cloud@Customer Instance Types

INSTANCE TYPE	OCPUS ¹	TOTAL MEMORY	TOTAL USABLE STORAGE CAPACITY
ExadataCC.X10M on X10M	4 to 6,080	2,780 to 44,480 GB	240 to 5,120 TB
ExadataCC.X10M on X10M-L	4 to 6,080	4,180 to 66,880 GB	240 to 5,120 TB
ExadataCC.X10M on X10M-XL	4 to 6,080	5,600 to 89,600 GB	240 to 5,120 TB

¹ To run an SAP NetWeaver workload, you need the minimum number of OCPUs.

Presales and consulting teams from Oracle can help you to determine a valid sizing for your planned SAP landscape.

Planning the SAP Deployment

Running SAP NetWeaver Application Server ABAP/Java with Exadata Cloud@Customer X10M requires deployment of numerous cloud resources, preparation of hosts and services, and installation and configuration of the SAP NetWeaver stack. The following illustration gives an overview of the major steps.

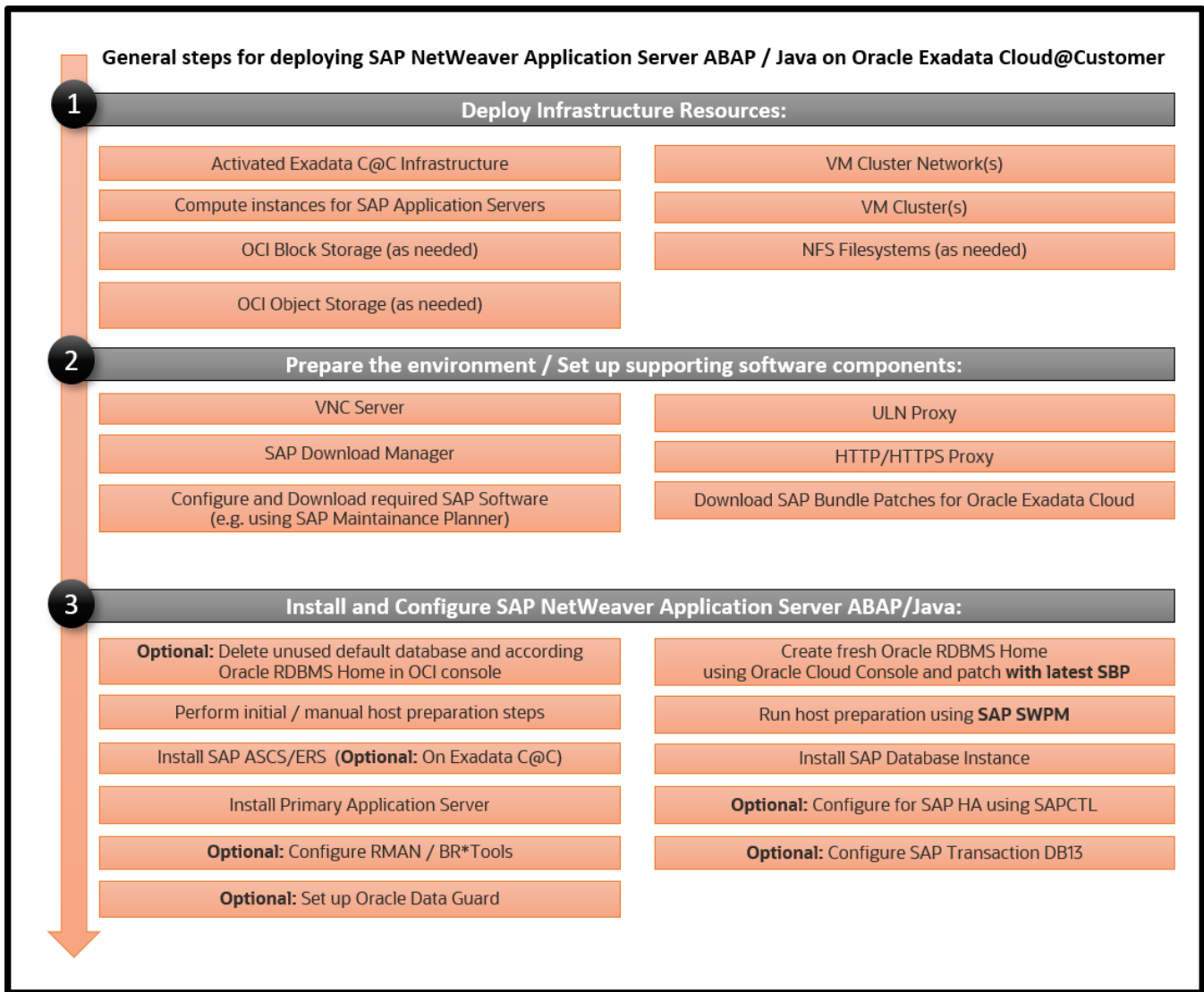


Figure 3: General Steps for Deploying NetWeaver Application Server ABAP/Java with Exadata Cloud@Customer X10M

Use the information in this section to plan your SAP NetWeaver Application Server ABAP/Java deployment with Exadata Cloud@Customer X10M.

This document designs a minimal SAP landscape that consists of an SAP database using a virtual Oracle RAC database cluster (also referred as a VM cluster within this document) running on Exadata Cloud@Customer X10M infrastructure that's connected to a single SAP application server (primary application server, or PAS) on a separate physical host.

A real-world SAP landscape is considered fairly more complex and might consist of multiple SAP application servers from one or more SAP systems connected to multiple instances of one or more RAC databases deployed on one or more VM clusters.

Each VM cluster is deployed with a dedicated VM cluster network that defines all *essential* hostnames, IP addresses, subnet masks, and default gateways, as well as IP addresses for DNS and NTP services. Depending on your requirements (for example, for SAP HA), you might need to consider additional resources.

Exadata Cloud@Customer Requirements

- Login credentials to the [Oracle Cloud Console](#)

The Console is used to manage OCI resources. Your account must be enabled to create resources.

- An *activated* Exadata Cloud@Customer infrastructure and a detailed plan of the VM cluster networks and VM clusters that you plan to deploy
- One or more *additional* servers connected to a VM cluster network where SAP application servers will be installed
- SSH key pairs

You need SSH key pairs to deploy and access your deployed VM clusters on your Exadata Cloud@Customer infrastructure. See [Creating a Key Pair](#). We strongly recommend password protection of key pairs.

- Oracle SAP Bundle Patches for Exadata

For information, see the “Patching Exadata Cloud@Customer X10M: Lifecycle Management for SAP Databases” section later in this document.

- SAP NetWeaver installation media

You need the required media and versions of SAP SWPM, SAP Kernel, and Installation Exports, depending on your installation scenario. You might need access to SAP Marketplace to download SAP software. However, this document assumes that you have already selected and downloaded all the required software components and have them available, for example, on an NFS filesystem.

- Passwords for various resources

General Installation Overview

This section provides an overview of the installation and configuration steps outlined in this document. The detailed steps follow in the later sections.

The first step is to create a VM cluster network and deploy a VM cluster on selected DB servers by using the Oracle Cloud Console. After this first step, you will have an initial VM cluster with a preconfigured Oracle Grid Infrastructure and all basic IP addresses and hostnames required to run an Oracle RAC database:

- Client and backup networks
- IP addresses (node, virtual, and SCAN)
- Hostnames and SCAN names
- SSH-based access to all the deployed compute resources

Before any of the VM cluster nodes in the VM cluster can be used for SAP software—for example, SAP Host Agent, SAP ABAP SAP central services (ASCS), or SAP enqueue replication server (ERS)—or for an SAP database installation with SWPM, you must perform some configuration steps to be able to run SAP SWPM host preparation.

Because SWPM must be run on each VM cluster node of the VM cluster, we recommend using shared media to simplify installation.

The next major steps are as follows:

1. Install Oracle RAC database on the VM cluster nodes. Optionally, to set up SAP HA on the VM cluster, also install the SAP ASCS instance and SAP ERS instance on the VM cluster nodes.
 - a. Prepare the hosts for running SWPM.
 - b. Run SWPM on the VM cluster nodes.
 - c. (Optional) To implement SAP HA by using Oracle Grid Infrastructure with SAPCTL, install the SAP ASCS instance on a shared location on the VM cluster nodes of the VM cluster and complete the required postconfiguration steps—for example, set up BR*Tools, integrate SAP ASCS and ERS with SAPCTL, and configure HA-NFS for `/sapmnt`.
 - d. Create an Oracle RAC database on the VM cluster by using SWPM or by migrating an existing database to Exadata Cloud@Customer.
 - e. (Optional) To implement SAP HA by using Oracle Grid Infrastructure with SAPCTL, install SAP ERS on each VM cluster node of the VM cluster.
 - f. Verify that the database is Oracle RAC.
2. Install the primary application server (PAS) instance on a separate server connected to the VM cluster network.
 - a. Prepare the host for running SWPM.
 - b. Run SWPM to install PAS.
3. Configure the SAP GUI to verify that the SAP system is accessible.

Implementing the Deployment

This section provides the steps for implementing your planned deployment of SAP NetWeaver Application Server ABAP/Java on Exadata Cloud@Customer X10M.

Get Your OCI Account

To get your OCI account, work with your Oracle account team.

Create the VM Cluster Resources

Create the following resources on OCI:

- VM cluster network
- VM cluster

Create the VM Cluster Network

Important: All hostnames must follow SAP naming conventions.

For detailed instructions, see the [Using the Console to Create a VM Cluster Network](#).

1. In the Oracle Cloud Console, open the navigation menu. Click **Oracle Database**, and then click **Oracle Exadata Database Service on Cloud@Customer**.
2. Under **Infrastructure**, click **Exadata Infrastructure**, and select the Exadata infrastructure in which you want to create the VM cluster network.
3. Click **VM Cluster Networks** and then click **Create VM Cluster Network**.

4. Enter the display name for the VM cluster network.
5. Enter the client network details:
 - VLAN ID
 - CIDR block
 - Netmask
 - Gateway
 - Hostname prefix

Tip: Specify two arbitrary characters (for example, xx and yy). Then, in step 9, manually adjust the autogenerated hostnames to match SAP naming conventions.

- Domain name

For example:

Client Network					
VLAN ID: 3002		Netmask: 255.255.252.0		Gateway: 10.133.48.1	
Database servers	State	Address Type	Hostname	Fully Qualified Domain Name	IP Address
dbServer-2	● Allocated	Client network interface	scaqau010201	scaqau010201.us.oracle.com	10.133.49.127
		Virtual IP (VIP)	scaqau010201v	scaqau010201v.us.oracle.com	10.133.49.176
dbServer-1	● Allocated	Client network interface	scaqau010101	scaqau010101.us.oracle.com	10.133.49.126
		Virtual IP (VIP)	scaqau010101v	scaqau010101v.us.oracle.com	10.133.49.130
dbServer-4	● Validated	Client network interface	scaqau010401	scaqau010401.us.oracle.com	10.133.49.129
		Virtual IP (VIP)	scaqau010401v	scaqau010401v.us.oracle.com	10.133.49.178
dbServer-3	● Allocated	Client network interface	scaqau010301	scaqau010301.us.oracle.com	10.133.49.128
		Virtual IP (VIP)	scaqau010301v	scaqau010301v.us.oracle.com	10.133.49.177
Address Type			Hostname	Fully Qualified Domain Name	IP Address
SCAN Addresses			scaqau01c1sc1	scaqau01c1sc1.us.oracle.com	10.133.49.179
					10.133.49.183
					10.133.49.184

6. Enter the backup network details:
 - VLAN ID
 - CIDR block
 - Netmask
 - Gateway
 - Hostname prefix

Tip: Specify two arbitrary characters (for example, xx and yy). Then, in step 9, manually adjust the autogenerated hostnames to match SAP naming conventions.

- Domain name

For example:

Backup Network					
VLAN ID: 3115		Netmask: 255.255.255.0	Gateway: 10.133.79.1		
Database servers	State	Address Type	Hostname	Fully Qualified Domain Name	IP Address
dbServer-2	● Allocated	Backup network interface	scaqau010201b	scaqau010201b.us.oracle.com	10.133.79.41
dbServer-1	● Allocated	Backup network interface	scaqau010101b	scaqau010101b.us.oracle.com	10.133.79.40
dbServer-4	● Validated	Backup network interface	scaqau010401b	scaqau010401b.us.oracle.com	10.133.79.43
dbServer-3	● Allocated	Backup network interface	scaqau010301b	scaqau010301b.us.oracle.com	10.133.79.42

7. Enter the DNS and NTP services information:

- Add all the IP addresses of your DNS servers.
- Add all the IP addresses of your NTP servers.

For example:

DNS and NTP Services	
DNS Servers:	10.31.138.25, 10.231.225.65, 206.223.27.1
NTP Servers:	10.31.138.20, 10.231.225.76, 10.246.6.36

8. Click **Review Configuration**.

The Review Configuration page displays detailed information about the VM cluster network, including the generated hostnames and IP addresses.

9. Click **Edit IP Allocation** and modify the hostname and IP addresses to match your needs. The length of the hostname must not exceed 13 characters. Then, save the changes.

10. Click **Create VM Cluster Network**.

After the VM cluster network is created, it must be validated.

11. On the VM Cluster Network Details page, click the Actions menu for the VM cluster network and select **Validate**.

If validation is successful, you can use the VM cluster network in the next step, creating the VM cluster. This step usually takes a couple of minutes to complete.

Create the VM Cluster

For detailed instructions, see the [Using the Console to Create a VM Cluster](#).

1. In the Oracle Cloud Console, open the navigation menu. Click **Oracle Database**, and then click **Oracle Exadata Database Service on Cloud@Customer**.
2. Under **Infrastructure**, click **Exadata Infrastructure**, and select the Exadata infrastructure in which you want to create the VM cluster.
3. Click **VM Clusters** and then click **Create VM Cluster**.

4. Enter the following information:
 - Compartment
 - Display name
 - VM cluster network (created in the previous step)
 - Grid Infrastructure version (choose 19.0.0.0 or later)
 - DB servers where the VM cluster is being created (click **Change DB Servers** to specify the servers)
 - Number of OCPUs per VM
 - Amount of memory per VM
 - Filesystem size per VM (choose at least 200 GB)
 - Usable Exadata storage
 - SSH keys
 - License type
 - Time zone (under **Advanced Options**) (select a time zone that matches your SAP application servers)
5. Thoroughly check all data entered and click **Create VM Cluster**.
Deployment starts immediately and usually takes several hours.
6. After the initial deployment has completed successfully, apply the latest VM image and Grid Infrastructure patches. VM image and Grid Infrastructure patches must be applied from the Oracle Cloud Console. Grid Infrastructure must be version 19.19 or later.

Set Up the SAP Download Manager

SAP Download Manager helps you download software from the [SAP Software Download Center \(SWDC\)](#) that you have put in the download basket. Install the SAP Download Manager on a bastion host and set the needed S-User and password credentials to download SAP software from the SWDC.

Download Your SAP Software

From the SWDC, download the required installation software for your specific SAP product. With your S-User permissions, you can download the installation media directly or you can use the SAP Download Manager. We recommend storing the software on a shared filesystem.

We also recommend using the SAP Maintenance Planner to compose the required installation and upgrade media and push them to the download basket. You can generate a `stack.xml` file to use with SWPM to provide a consistent set of installation media that matches the contents of your download basket. You can then add more Oracle Database and Oracle Client media from the SAP marketplace before downloading all the media.

Prepare the Exadata Compute Nodes

This section provides the necessary steps for preparing the Exadata compute nodes. The key steps are shown in the following illustration.

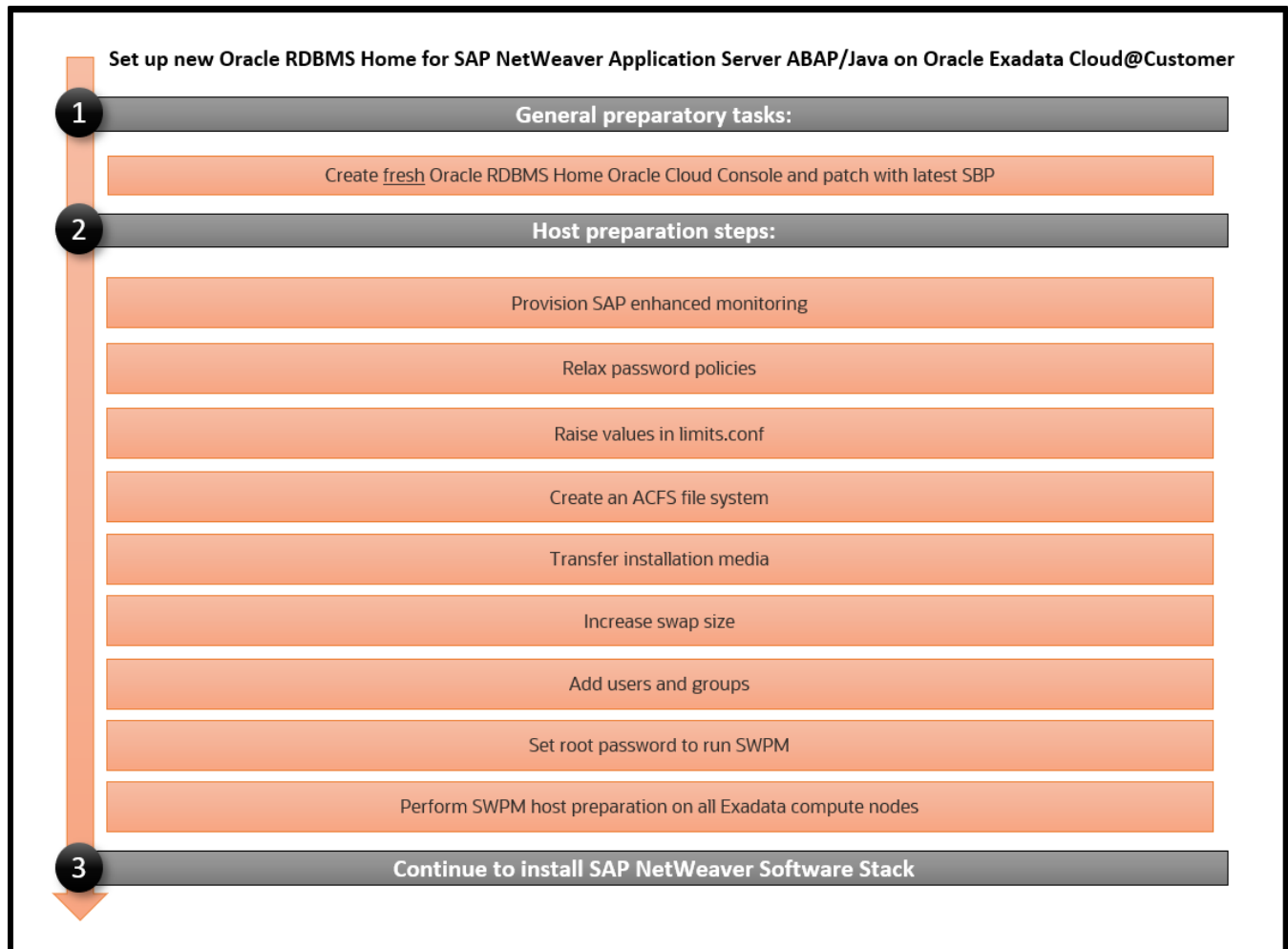


Figure 4: Steps for Setting Up an Oracle Database Home for SAP NetWeaver Application Server ABAP/Java with Exadata Cloud@ Customer

Create a Fresh Oracle Database Home and Patch It with the Latest SAP Bundle Patch

1. In the Oracle Cloud Console, navigate to the VM cluster where you want to create the Oracle Database Home.
2. Under **Resources**, select **Database Homes** and then click **Create Database Home**.
3. In the dialog box, choose a display name and the software version for the Oracle Database Home, and then click **Create Database Home**.
4. After the Oracle Database Home is created, which takes a couple of minutes, apply the latest SAP Bundle Patch for your Oracle Database version.

Note that patching is done *before* SAP database instance installation using SWPM, while catsbp must be run *after* SAP database instance installation.

For more information about SAP Bundle Patches, see “Patching Exadata Cloud@Customer X10M: Lifecycle Management for SAP Databases” later in this document.

Provision SAP Monitoring

For every cloud solution, SAP requires the collection of configuration and performance data for the cloud platform being used.

With Exadata Cloud@Customer, the SAP Host Agent needs to run on all the Exadata compute nodes. Installation of the SAP Host Agent either by using SWPM or manually is described in the [SAP Host Agent Installation](#) SAP documentation topic.

The required version and patch level of the SAP Host Agent are described in [SAP Note 2614080](#).

For SAP monitoring, the SAP Host Agent consumes Exadata Cloud@Customer configuration and performance metrics that are collected by a Linux service called `oraescscol`. This service must be installed and started on each VM cluster node. It is shipped as a Linux RPM called `oraescscol.rpm`.

Part of the `oraescscol.rpm` package is a Python script called `oraecswatcher`. This script is scheduled as a regularly run cron job and ensures that updates of the package are applied automatically and that the `oraescscol` service is being started if it is not running.

Install and Configure the `oraescscol` Package

The required version of `oraescscol.rpm` is already available on each node of the VM cluster after initial deployment. To install and configure it, perform the following steps:

1. As the root user, copy `oraescscol.rpm` from `/u02/opt/dbaas_images/oraescscol.rpm` to `/tmp` and then make `/tmp` your current working directory:

```
[root@nodeN] # cp /u02/opt/dbaas_images/oraescscol.rpm /tmp ; cd /tmp
```

2. Install `oraescscol.rpm`:

```
rpm -i oraescscol.rpm
```

3. Enable the service:

```
systemctl enable oraescscol.service
```

4. Start the service:

```
systemctl start oraescscol.service
```

5. As the root user, add the following cron job into the root user's crontab if it is not already there:

- a. Edit crontab:

```
[root@nodeN] # crontab -e
```

- b. Ensure that crontab contains the following line:

```
*/15 * * * * sudo /usr/bin/python /opt/oracle.oraescscol/oraecswatcher
```

- c. Save crontab:

```
:wq
```

6. Wait two minutes, and then check whether metrics collection works as expected. As the root user, run the following command:

```
[root@nodeN] # curl http://127.0.0.1:18181
```

This should return the XML document for consumption by the SAP Host Agent. For example:

```
.
.
<!-- Provider Health Description #113 -->
<metric category="config" context="vm" last-refresh="1519899668" refresh-interval="60"
type="string" unit="none">
<name>
    Provider Health Description
</name>
<value>
OK
</value>
</metric>
.
.
```

Logs for `oraecscol` are written to `/opt/oracle.oraecscol`.

Note: If this test does not return an XML document at all (for example, you get a “connection refused” error) or returns a status other than OK for Provider Health Description, open a ticket with Oracle Support and ask for the KVM host part of the SAP metrics collector.

An additional step, discussed later in this document, is to complete SAP monitoring setup by registering the VM cluster nodes in SAP transaction RZ21.

Relax the Password Policies

An SAP NetWeaver installation does not work with the Exadata Cloud@Customer strong password policy, so you must modify the policy.

Run the following command as `root` on each VM cluster node:

```
[root@nodeN] # /opt/oracle.cellos/host_access_control pam-auth --deny 10 --lock 60 --pwquality 6 --remember 0
```

With this approach, you still cannot run `su - <someuser>` from the `opc` account because of Linux Privileged Access Management (PAM) policy. Also, you must still switch to `root` via `sudo su -` first. The exceptions from that requirement are the `grid` and `oracle` users.

Raise the Values in the `limits.conf` File

On each VM cluster node, perform the following steps as the `root` user:

1. Open `/etc/security/limits.conf` for editing.
2. Under the `oracle` entries, add the following lines:

```
root    soft    memlock    unlimited
root    hard    memlock    unlimited
```

3. If you will use SAP BR*Tools to perform offline backups, add the following entries for each SAPSID that you will install. These entries are required because SAP BR*Tools will startup-mount a database instance under one of these OS users to perform the offline backup.

```
ora<sid>    soft    memlock    unlimited
ora<sid>    hard    memlock    unlimited
<sid>adm    soft    memlock    unlimited
<sid>adm    hard    memlock    unlimited
```

4. Save and exit the file.

Create a Decently Sized Oracle ACFS

1. Follow the [documentation](#) to create an Oracle ACFS on one node only. For example:

```
[root@nodeN ~]# su - grid
[grid@nodeN ~]$ asmcmd
ASMCMD> lsdg
State      Type  Rebal  Sector  Logical_Sector  Block      AU  Total_MB  Free_MB
Req_mir_free_MB  Usable_file_MB  Offline_disks  Voting_files  Name
MOUNTED  HIGH  N      512      512      4096  4194304  10027008  9523052
278528      3081508      0          Y  DATA1/
MOUNTED  HIGH  N      512      512      4096  4194304  2506752  2504208
69632      811525      0          N  RECOC1/
ASMCMD> volcreate -G DATA1 -s 1024G sapshare_v1
ASMCMD> volinfo -G DATA1 sapshare_v1
Diskgroup Name: DATA1

      Volume Name: SAPSHARE_V1
      Volume Device: /dev/asm/sapshare_v1-461
      State: ENABLED
      Size (MB): 1048576
      Resize Unit (MB): 64
      Redundancy: HIGH
      Stripe Columns: 8
      Stripe Width (K): 1024
      Usage:
      Mountpath:

ASMCMD> exit
[grid@nodeN ~]$ /sbin/mkfs -t acfs /dev/asm/sapshare_v1-461
mkfs.acfs: version                = 19.0.0.0.0
mkfs.acfs: on-disk version        = 46.0
mkfs.acfs: volume                 = /dev/asm/sapshare_v1-461
mkfs.acfs: volume size            = 1099511627776 ( 1.00 TB )
mkfs.acfs: Format complete.
[grid@nodeN ~]$ exit
logout
[root@nodeN ~]# /sbin/acfsutil registry -a /dev/asm/sapshare_v1-461 /sapshare
acfsutil registry: mount point /sapshare successfully added to Oracle Registry
```

The preceding commands create a 1-TB cluster filesystem out of the +DATA1 disk group and mount it to /sapshare. This change is persistent.

2. On a single compute node, run the following commands as root:

```
[root@scaqau010101 ~]# mkdir /sapshare/trans
[root@scaqau010101 ~]# mkdir /sapshare/sapmnt
[root@scaqau010101 ~]# mkdir /sapshare/sapbins
```

3. On each compute node, run the following commands as root (which avoids the /usr/sap directory being in the root filesystem):

```
[root@nodeN] # mkdir /u02/sap ; ln -s /u02/sap /usr/sap
[root@nodeN] # ln -s /sapshare/sapmnt /sapmnt
[root@nodeN] # ln -s /sapshare/trans /usr/sap/trans
[root@nodeN] # chmod 777 /sapshare/sapbins
```

Transfer Your SAP Installation Media

Transfer your SAP installation media. The media must include SAP NetWeaver, SWPM, DBA Tools, the most up-to-date SAP Host Agent, Oracle Client software, and SAPCAR to extract the SAR archives. Refer to SAP Product Availability Matrix (PAM) for suitable installation media. Unpack the archives.

If you put the media on a shared location such as `/sapshare/sapbins`, you have to transfer only once. If you have composed the media required for installation by using the SAP Maintenance Planner and plan to use the `stack.xml` option (`SAPINST_SAPINST_STACK_XML=<stack.xml>`), you should already have all the necessary components for installation.

Increase the Swap Size

Current deployments have 16 GB of swap space by default. If you need more swap space, you can get some space from `/u02`.

Add Groups

SWPM expects the `oper` group, which is not present. On each compute node, run the following commands as root:

```
[root@nodeN] # groupadd --gid 504 oper
[root@nodeN] # usermod oracle -a -G oper
[root@nodeN] # usermod oracle -a -G asmadmin
```

Enter Virtual Hostnames and Their Configuration in `/etc/hosts`

One advantage of clustered environments is the high availability of resources. Oracle Cluster Ready Services (CRS), which is part of Oracle Grid Infrastructure, expands this to more services that support SAP environments to survive individual outages. SAP environments use services for the high-availability resources in the SAP ASCS instance, the SAP ERS instance, and the highly available NFS export.

If you do not want to configure SAP HA by using SAPCTL or HA-NFS on the VM cluster, you can skip the following steps and simply add the hostnames and IP addresses of their NFS servers for `/sapmnt` and their backup share to `/etc/hosts` on all VM cluster nodes.

1. For the SAP ASCS instance, the SAP ERS instance, and the highly available NFS export on each SAP system, identify free private IP addresses in the Exadata client subnet.
2. As root, edit the `/etc/hosts` file and add the virtual IP addresses and hostnames for high availability of SAP and NFS. The hostnames must follow SAP conventions (that is, the maximum hostname length is 13).

For example:

```
10.133.49.182 mfgascs      <- for HA of SAP ASCS instance
10.133.49.181 mfgers      <- for HA of SAP ERS instance
10.133.49.180 mfgnfs      <- for HA of NFS share
```

3. Save and exit the file, and repeat the preceding step on all compute nodes.

Change the Root Password on VM cluster node

As root, change the password for yourself on each compute node. SWPM asks for authentication.

```
[root@nodeN ] # passwd root
```


Run SAP SWPM on VM Cluster Nodes

During the following steps, you run SWPM several times to perform configurations. Current versions of SWPM run in browser mode. Ensure that the VM cluster nodes (IP addresses and ports) can be reached from the computer where you run your browser. If the hostnames of the VM cluster nodes cannot be resolved from the computer where you run your browser, replace the hostnames with the corresponding IP addresses.

When prompted, confirm the security exception, and enter the credentials for root in the login dialog box.

Prepare All VM Cluster Nodes Using SWPM

Perform this step sequentially, node-by-node.

1. Ensure that SWPM temporary files are placed in a directory with enough space:

```
[root@nodeN] # mkdir -p /usr/sap/tmp ; export TMP=/usr/sap/tmp
```

2. Run SWPM host preparation. For example, if you want to run preparations for Kernel 7.50, navigate to **Generic Options**, then **Oracle**, then **Database Tools**, and select **RAC/ASM/Exadata Database Instance Preparation ABAP – Kernel 7.50**.

Note the following guidelines:

- Do *not* provide a `stack.xml` file for host preparations.
 - At any SWPM instance, never use the FQDN option.
 - All hostnames must be short, with a maximum length of 13 characters.
 - At the local listener configuration, keep the default values.
 - At the Oracle Client selection page, select **Oracle Client 19c**.
 - For the grid installation, choose `/u01/app/19.0.0.0/grid`, and for the ASM instance, choose their respective ASM instance name, such as `+ASM1`, `+ASM2`, and so on.
 - You can obtain the name of the SCAN listener from Oracle Cloud Console (use the short name).
 - Verify and, if needed, adjust the hostnames of the VM cluster node.
3. After completing instance preparation on all the VM cluster nodes, on the first node, as the root user, remove all files and directories under the `/usr/sap/<SAPSID>/SYS/exe/uc/linuxx86_64` directory and keep the empty directory. For example, for SAPSID MFG, run:

```
[root@scaqau010101] # rm -rf /usr/sap/MFG/SYS/exe/uc/linuxx86_64/*
```

Install SAP NetWeaver Application Server ABAP/Java

This section describes the steps for installing SAP NetWeaver Application Server ABAP/Java, which includes installing SAP NetWeaver instances such as ASCS, and installing the database instance by using the latest available version of the SAP Software Provisioning Manager (SWPM). As of the creation of this document, this version is patchlevel 36. The key steps are shown in the following illustration.

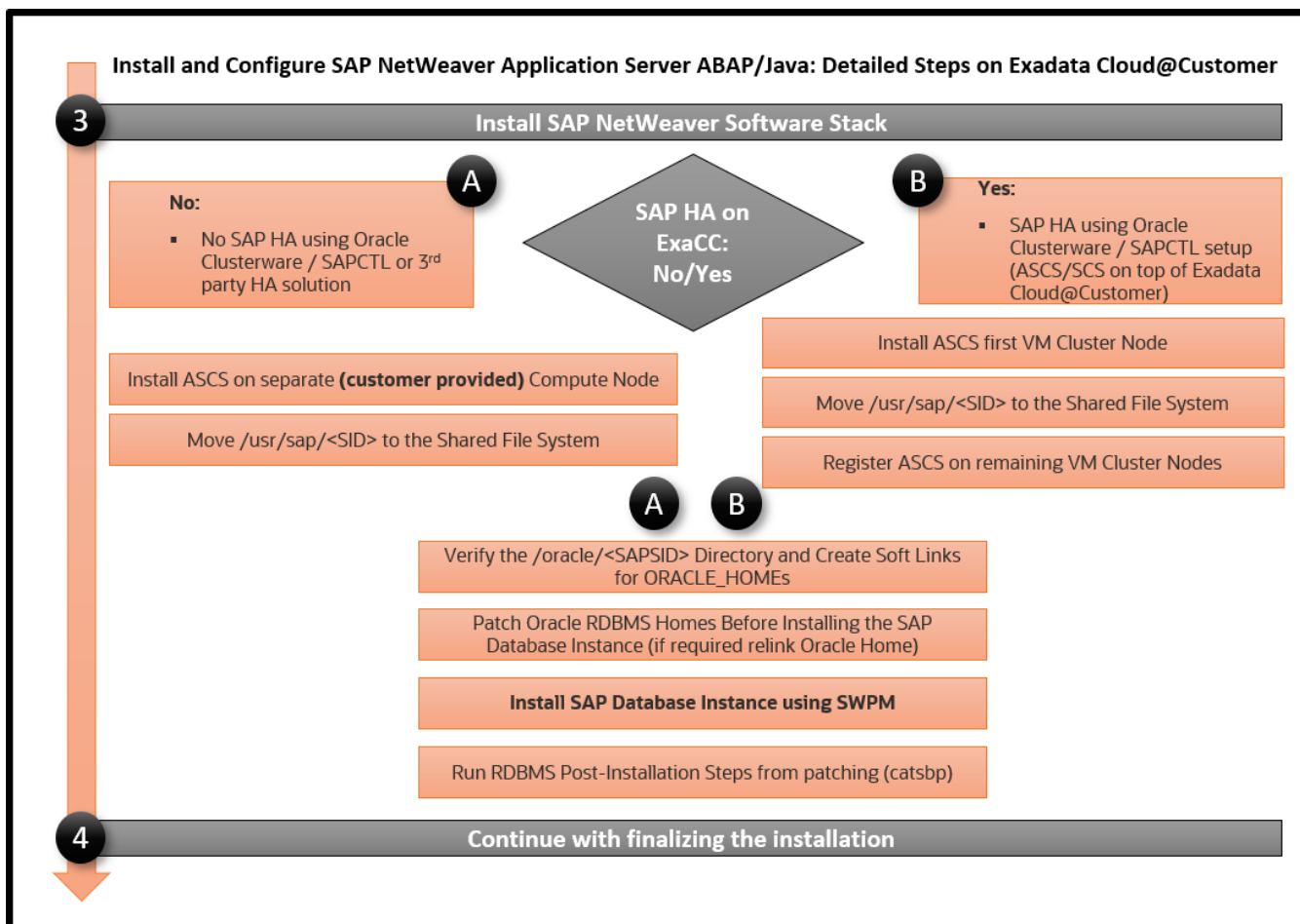


Figure 5: Steps to Install and Configure the SAP NetWeaver Software Stack

Install the ASCS Instance (Optional)

Note: This step is required only if you want to implement SAP HA by using SAPCTL on the VM cluster.

Install the ASCS instance on the first compute node. If you plan to use SAP transaction DB13, select the installation of the **ASCS integrated gateway** during the installation process for all Exadata compute nodes. The ASCS instance installation is on a shared resource for later SAPCTL preparation. Previously, in the “Enter Virtual Hostnames and Their Configuration in /etc/hosts” section, you registered the ASCS virtual IP address (10.133.49.182). Now you start it.

- As root, log in to the first VM cluster node and run the following commands:

```
[root@scaqau010101] # . oraenv [+ASM1]
[root@scaqau010101] # appvipcfg create -network=1 -ip=10.133.49.182 -vipname=tmp -user=root
[root@scaqau010101] # crsctl start res tmp ; crsctl stat res -t
```

- Check the host location of the tmp resource. If it is not on the first node, relocate it to the first node:

```
[root@scaqau010101] # crsctl stat res -t
[root@scaqau010101] # crsctl relocate res tmp -n <current_node_name>
```

Before you can create a database instance, SAP requires you to have an Application Server ABAP central services instance. HA-aware ASCS installations must be on a shared location, namely /usr/sap/<SAPSID>. Use a separate Oracle ACFS or other shared filesystem. In our example, we use the ACFS filesystem mounted at /sapshare and put /usr/sap/<SAPSID> under it.

3. Ensure that SWPM temporary files are placed in a directory with enough space:

```
[root@scaqau010101] # export TMP=/usr/sap/tmp
```

4. Invoke SWPM on the first VM cluster node using the virtual hostname for ASCS by running `./sapinst` `SAPINST_USE_HOSTNAME=mfgascs`, and install the ASCS instance. Choose instance ID `00`. You can provide your `stack.xml` file if you want to use it during installation.

Note the following guidelines:

- At any SWPM instance, never use the FQDN option.
- All hostnames must be short, with a maximum length of 13 characters.
- Verify and, if needed, adjust the hostnames of the cluster member.

Move /usr/sap/<SID> to the Shared Filesystem (Optional)

Note: This step is required only if you want to implement SAP HA by using SAPCTL on the VM cluster.

In this step, you move the local `/usr/sap/<SID>` of the first VM cluster node to the ACFS shared filesystem that you created earlier. Then, you create local symbolic links to this shared location on all the VM cluster nodes.

1. On the first node only, run the following commands:

```
[root@scaqau010101] # cd /usr/sap ; tar -cvf MFG.tar MFG
[root@scaqau010101] # cp MFG.tar /sapshare ; cd /sapshare ; tar -xvf MFG.tar
```

2. On all compute nodes, run the following commands:

```
[root@nodeN] # cd /usr/sap ; rm -f MFG.tar ; mv MFG was.MFGlocal
[root@nodeN] # ln -s /sapshare/MFG MFG ; chown mfgadm:sapsys MFG
```

Install the Enqueue Replication Server (Optional)

Note: This step is required only if you want to implement SAP HA by using SAPCTL on the VM cluster.

Install the enqueue replication server (ERS) on all VM cluster nodes locally (run `sapinst` without arguments or using only the option for a `stack.xml` file). On all nodes, choose the same instance number for ERS, for example, `01`.

On the first node where the ASCS instance is running, perform the following steps:

1. Install the ERS instance.
2. After ERS is installed, run the following commands as `SIDADM`:

```
scaqau010101: mfgadm> sapcontrol -nr 00 -function Stop
scaqau010101: mfgadm> sapcontrol -nr 00 -function StopService
```

On all subsequent nodes, perform the following steps for each node:

1. Relocate the temporary ASCS resource to the current node:

```
[root@nodeN]# . oraenv
+ASM2 (and +ASM3 and so forth)
[root@nodeN]# crsctl relocate res tmp -n <current_node_name>
```

2. Register the ASCS instance with `saphostctl` locally:

```
[root@nodeN]# /usr/sap/hostctrl/exe/saphostctl -function RegisterInstanceService -sid MFG -nr
00 -saplocalhost mfgascs
```

3. Start the ASCS instance:

```
[root@nodeN]# su - mfgadm
nodeN: mfgadm> sapcontrol -nr 00 -function StartService MFG
nodeN: mfgadm> sapcontrol -nr 00 -function Start
```

4. Install the ERS instance.

5. Stop the ASCS instance:

```
[root@nodeN]# su - mfgadm
nodeN: mfgadm> sapcontrol -nr 00 -function Stop
nodeN: mfgadm> sapcontrol -nr 00 -function StopService
```

After ERS is installed on all nodes, perform the following steps:

1. Relocate the temporary ASCS resource back to the first VM cluster node:

```
[root@scaqau010101]# . oraenv
+ASM1
[root@scaqau010101]# crsctl relocate res tmp -n <current_node_name>
```

2. Start the ASCS services manually for the subsequent SAP database instance installation:

```
scaqau010101: mfgadm> sapcontrol -nr 00 -function StartService MFG
scaqau010101: mfgadm> sapcontrol -nr 00 -function Start
scaqau010101: mfgadm> sapcontrol -nr 00 -function GetProcessList
```

At this point, you are finished with the first part of the ASCS and ERS HA configuration. The final steps of SAP HA integration are described later.

Verify the `/oracle/<SAPSID>` Directory and Create Soft Links for Oracle Homes

SAP distinguishes between an *installation* Oracle Database home (called IHRDBMS in this context) and a *runtime* Oracle Database home (called OHRDBMS in this context). The OHRDBMS is usually defined as a soft link named `<version>` (for example, 19) under `/oracle/<SAPSID>/` that points to the IHRDBMS where the Oracle Database software is installed.

On an engineered system, you do not install Oracle Database software; instead, you use the existing and preinstalled database software by creating a soft link to the IHRDBMS intended for use by SAP. The `ORACLE_HOME` environment variable is usually set to OHRDBMS. Wherever SWPM asks for the location of `ORACLE_HOME` for the Oracle Database, use the *runtime* Oracle Database home (OHRDBMS).

For example:

- OHRDBMS is at `/oracle/MFG/19` (where 19 is a symbolic link to IHRDBMS).
- IHRDBMS is at `/u02/app/oracle/product/19.0.0.0/dbhome_2`.
- The `ORACLE_HOME` environment variable is set to `/oracle/MFG/19`.

Perform the following steps:

1. On each VM cluster node, verify whether the following path exists: `/oracle/<SAPSID>/19`

This might come from the host preparation and needs to be fixed.

2. As root on each VM cluster node, run the following command:

```
[root@nodeN] # mv /oracle/<SAPSID>/19 /oracle/<SAPSID>/was.19
```

3. Check your `/etc/oratab` file and ensure that it has an entry for the OHRDBMS that you want to use for the SAP database instance. For example:

```
MFG:/oracle/MFG/19:N
```

4. As the `oracle` user on each VM cluster node, create a soft link for the respective Oracle Database home.

```
[oracle@nodeN] $ ln -s /u02/app/oracle/product/19.0.0.0/dbhome_2 /oracle/<SAPSID>/19
```

Patch Oracle Database Homes Before Installing the Database

Before you can install the SAP database instance, you must patch the Oracle Database software. For instructions, see the “Installing Patches for Oracle Database Software” section. This applies to all compute nodes.

You must also perform the post-installation steps in “Run the Database Post-Installation Steps from Patching.” This applies to all VM cluster nodes.

Install the Database Instance

Obtain the SCAN listener name (short hostname) and node virtual IP addresses via the Oracle Cloud Console or by running the following commands:

```
[root@scaqau010101 ~]# . oraenv
ORACLE_SID = [root] ? +ASM1
The Oracle base has been set to /u01/app/grid
[root@scaqau010101 ~]# srvctl config scan | egrep "IPv4 VIP|SCAN name"
SCAN name: scaqau01c1sc1, Network: 1
SCAN 1 IPv4 VIP: 10.133.49.184
SCAN 2 IPv4 VIP: 10.133.49.179
SCAN 3 IPv4 VIP: 10.133.49.183
[root@scaqau010101 ~]# srvctl config vip -node `hostname -s` | egrep "VIP Name|IPv4 Address"
VIP Name: scaqau010101v.us.oracle.com
VIP IPv4 Address: 10.133.49.130
```

The node virtual IP addresses are required during the next run of SWPM, in which the database is created and loaded.

Adjust SAPDBHOST

Edit `/sapmnt/<SAPSID>/profile/DEFAULT.PFL` to adjust the `SAPDBHOST` parameter to the node where SWPM will run.

```
SAPDBHOST = abc-defgh1
j2ee/dbtype = ora
j2ee/dbname = MFG
j2ee/dbhost = abc-defgh1
```

Run the orabtt Script

1. With the correct environment variable set, run the `orabtt` script on each VM cluster node as the `oracle` user. In this example, `MFG` is used as the `SAPSID`. Adjust the `SAPSID` according to your environment.

```
[oracle@nodeN] $ export ORACLE_HOME=/oracle/MFG/19
[oracle@nodeN] $ORACLE_HOME/sap/orabtt/orabtt.sh -add -dbsid MFG
```

2. Verify as follows:

```
[oracle@nodeN] $ORACLE_HOME/bin/orabase
```

The output should return `/u02/app/oracle`.

Check Entries in /etc/oratab

Oracle CRS activity in the patching phase might destroy entries in /etc/oratab. For each VM cluster node, verify that the Grid Home is present in /etc/oratab. If it is not, add it:

- +ASM1:/u01/app/19.0.0.0/grid:N for the first node
- +ASM2:/u01/app/19.0.0.0/grid:N for the second node, and so on

Ensure That ASCS Is Up on the First Node (Optional)

Note: This step is required only if you want to implement SAP HA by using SAPCTL on the VM cluster.

1. As the root user, ensure that the tmp resource is at the first node:

```
[root@scaqau010101] # . oraenv [+ASM1]
[root@scaqau010101] # crsctl relocate res tmp -n scaqau010101
```

2. As the SIDADM user, run the following command:

```
scaqau010101: mfgadm> sapcontrol -nr 00 -function GetProcessList
```

3. If an error occurs or the connection is refused, run the following commands:

```
scaqau010101: mfgadm> sapcontrol -nr 00 -function StartService MFG
scaqau010101: mfgadm> sapcontrol -nr 00 -function Start
scaqau010101: mfgadm> sapcontrol -nr 00 -function GetProcessList
```

Invoke SWPM as the Root User

1. Run the following commands:

```
[root@scaqau010101] # export TMP=/usr/sap/tmp
[root@scaqau010101] # </path/to/SWPM/>sapinst
```

Provide the stack.xml file as an option if required.

2. For disk groups, choose +DATAC* and +RECOC*.
3. At the Oracle RAC Parameters screen, Init.ora RAC parameters, adjust the following values (MFG is used as an example; adjust accordingly):

```
MFG001.local_listener = scaqau010101v:1521
MFG002.local_listener = scaqau010201v:1521
```

Also perform this step for any additional compute nodes that are being used.

4. When SWPM (patch level 36 and later) asks for encryption of tablespaces, choose TDE for each tablespace listed by SWPM.

This step is mandatory; all data in Oracle Cloud must be encrypted.

At the end of this step, SWPM has finished creating your SAP database and created an `init<SIDxxx>.ora` and password file under `$ORACLE_HOME/dbs` on the first compute node. These files must be created on all subsequent VM cluster nodes later on.

5. Start the database on one instance only before running catsbp in the next step. For example:

```
[root@scaqau010101 ~]# su - oracle
[oracle@scaqau010101 ~]$ . oraenv
ORACLE_SID = [oracle] ? MFG
The Oracle base has been set to /u02/app/oracle
[oracle@scaqau010101 ~]$ export ORACLE_SID=MFG001
[oracle@scaqau010101 ~]$ srvctl stop database -db MFG -stopoption immediate -force
[oracle@scaqau010101 ~]$ sqlplus / as sysdba

SQL*Plus: Release 19.0.0.0.0 - Production on Mon Jun 5 11:45:42 2023

Copyright (c) 1982, 2022, Oracle. All rights reserved.

Connected to an idle instance.

SQL> startup
ORACLE instance started.

Total System Global Area 2.3009E+10 bytes
Fixed Size 23064680 bytes
Variable Size 1.1610E+10 bytes
Database Buffers 1.1341E+10 bytes
Redo Buffers 34705408 bytes
Database mounted.
Database opened.
SQL> exit
```

Run the Database Post-Installation Steps from Patching

From the SAP Bundle Patch README, run catsbp after setting the required environment variables and shut down the database after catsbp finishes successfully.

```
[root@scaqau010101 ~]# su - oracle
[oracle@scaqau010101 ~]$ . oraenv
ORACLE_SID = [oracle] ? MFG
The Oracle base has been set to /u02/app/oracle
[oracle@scaqau010101 ~]$ export ORACLE_SID=MFG001
[oracle@scaqau010101 ~]$ sqlplus / as sysdba

SQL> shutdown immediate;
Database closed.
Database dismounted.
ORACLE instance shut down.
SQL> exit
```

Finalize the Installation

Perform the following steps to finish the database installation, configure RMAN and SAP BR*Tools to perform backups, set up high availability for SAP central services, and install the primary application server.

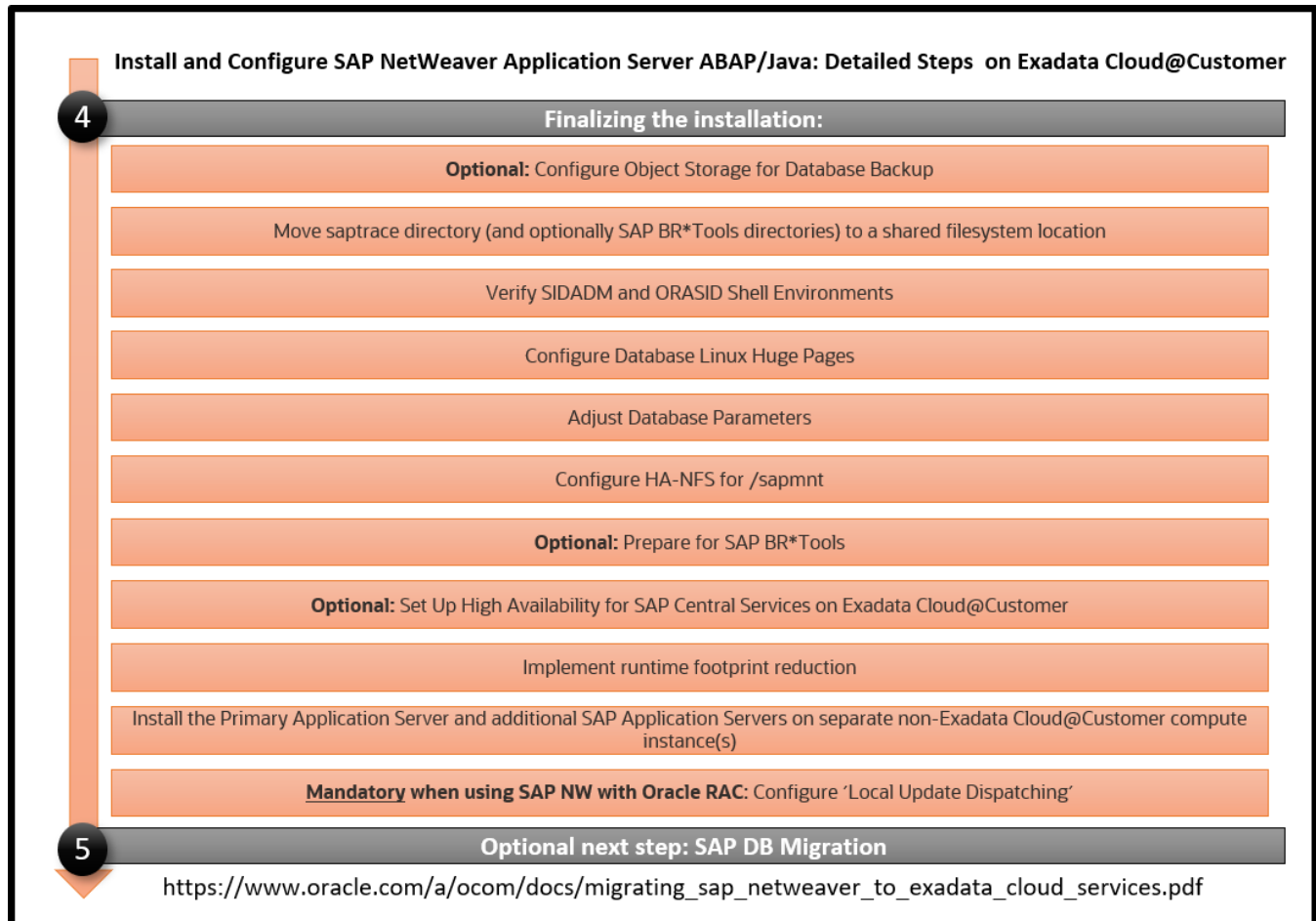


Figure 6: Steps to Finalize the Installation

Move the saptrace Directory and Optionally SAP BR*Tools Directories to a Shared Filesystem Location

Because space in the local filesystems of VM cluster nodes is limited, it is necessary to move the Oracle diagnostic destination, defined by the Oracle initialization parameter `diagnostic_dest`, to a shared filesystem location on ACFS. With SAP, this parameter typically points to the `/oracle/<DBSID>/saptrace` directory, for example, `/oracle/MFG/saptrace`. Moving the diagnostic destination to a shared location is also important for database-specific SAP transactions, where Oracle trace information is checked or viewed in SAP, or for special functions such as end-to-end tracing or monitoring.

If you want to use SAP BR*Tools on all VM cluster nodes—for example, for backup and restore, reorganizations, or database checks—you must also move the SAP BR*Tools-specific directories to a shared filesystem location. If `brbackup` logs are not in a shared filesystem location, you cannot restore and recover your database from a VM cluster node other than the one where the backup was taken.

To perform this action, create new directories on the shared filesystem, and replace the original directories under `/oracle/<DBSID>` with symbolic links that point to the new directories.

The following example uses the ACFS filesystem /sapshare to store all these directories.

1. Shut down the database:

```
[root@scaqau010101 ~]# . oraenv
ORACLE_SID = [root] ? +ASM1
The Oracle base has been set to /u01/app/grid
[root@scaqau010101 ~]# srvctl stop database -d MFG -stopoption immediate
```

2. On one VM cluster node, create the new directories and set the owner and permissions:

```
[root@scaqau010101 ~]# mkdir -p /sapshare/MFG/saptrace
[root@scaqau010101 ~]# mkdir -p /sapshare/MFG/saparch
[root@scaqau010101 ~]# mkdir -p /sapshare/MFG/sapreorg
[root@scaqau010101 ~]# mkdir -p /sapshare/MFG/sapbackup
[root@scaqau010101 ~]# mkdir -p /sapshare/MFG/sapcheck
[root@scaqau010101 ~]# cd /sapshare/MFG
[root@scaqau010101 MFG]# chown oracle:oinstall saptrace saparch sapreorg sapbackup sapcheck
[root@scaqau010101 MFG]# chmod 775 saptrace saparch sapreorg sapbackup sapcheck
```

3. On each VM cluster node, as the oracle user, rename the original directories to keep them:

```
[root@scaqau010101 MFG]# su - oracle
[oracle@scaqau010101 ~]$ cd /oracle/MFG
[oracle@scaqau010101 MFG]$ mv saptrace saptrace.waslocal
[oracle@scaqau010101 MFG]$ mv saparch saparch.waslocal
[oracle@scaqau010101 MFG]$ mv sapreorg sapreorg.waslocal
[oracle@scaqau010101 MFG]$ mv sapbackup sapbackup.waslocal
[oracle@scaqau010101 MFG]$ mv sapcheck sapcheck.waslocal
```

4. On each VM cluster node, as the oracle user, create the following symbolic links:

```
[root@scaqau010101 MFG]# su - oracle
[oracle@scaqau010101 ~]$ cd /oracle/MFG
[oracle@scaqau010101 MFG]$ ln -s /sapshare/MFG/saptrace saptrace
[oracle@scaqau010101 MFG]$ ln -s /sapshare/MFG/saparch saparch
[oracle@scaqau010101 MFG]$ ln -s /sapshare/MFG/sapreorg sapreorg
[oracle@scaqau010101 MFG]$ ln -s /sapshare/MFG/sapbackup sapbackup
[oracle@scaqau010101 MFG]$ ln -s /sapshare/MFG/sapcheck sapcheck
```

Configure Database Linux Huge Pages

Huge pages configuration is provided for the out-of-the-box database but not for custom sizing of the SAP database that is created from SWPM. Therefore, you must run the hugepages script provided by [MOS Note 401749.1](#) when all required databases are running. Adjust the value for `vm.nr_hugepages` in the `/etc/sysctl.conf` file for each VM cluster node accordingly. To use the new huge pages configuration, shut down the SAP systems and all databases, and reboot the nodes.

Check the database instance's `alert_<DBSID>.log` file to determine whether the database instance has allocated all the huge pages. Not doing so affects runtime performance significantly.

Adjust Database Parameters

In addition to the parameters set during installation and patching, adjust your database parameters according to one of the following SAP Notes:

- [SAP Note 2470718 - Oracle Database Parameter 12.2 / 18c / 19c](#)
- [SAP Note 2378252 - Oracle Database Initialization Parameters for SAP NetWeaver Systems](#)

Configure HA-NFS for /sapmnt (Optional)

Note: This step is required only if you want to use the VM cluster for HA-NFS. If you are using an external NFS service, you need only to mount the directories as shown in the next section.

Follow the instructions in [MOS Note 1934030.1: ODA \(Oracle Database Appliance\): HowTo export ACFS \(cloudfs\) using HANFS](#).

1. On all VM cluster nodes, run the following commands as root, with a Grid Infrastructure environment set:

```
[root@nodeN] # systemctl enable rpcbind ; systemctl enable nfs-server
[root@nodeN] # systemctl start rpcbind ; systemctl start nfs-server
```

2. On the first node only, run the following commands:

```
[root@scaqau010101 ~]# srvctl add havip -id hanfsvip_id -address mfgnfs -netnum 1 -description
"hanfs"
[root@scaqau010101 ~]# srvctl add exportfs -id hanfsvip_id -path /sapmnt -name hanfs -options
"rw, sync, no_root_squash" -clients <ip1, ip2, ...>
[root@scaqau010101 ~]# srvctl start havip -id hanfsvip_id
```

Note that the `-clients` parameter lists all IP addresses of the SAP applications servers that mount `/sapmnt` from the VM cluster.

3. Check the status, location, and configuration of the HA-NFS virtual IP address by running the following commands as root:

```
[root@scaqau010101 ~]# srvctl status exportfs -id hanfsvip_id
export file system hanfs is enabled
export file system hanfs is exported on node scaqau010201
[root@scaqau010101 ~]# srvctl config havip
HAVIP exists: /hanfsvip_id/10.133.49.180, network number 1
Description: hanfs
Home Node:
HAVIP is enabled.
HAVIP is individually enabled on nodes:
HAVIP is individually disabled on nodes:
```

Configure RMAN and SAP BR*Tools to Perform Backups to the Filesystem

To back up your database, we recommend providing a dedicated, highly available NFS filesystem and mounting it on each VM cluster node. Ensure that the NFS filesystem is mounted via the backup network. Each VM cluster node should be configured to be able to perform database backups.

The following example shows the basic steps required:

1. On your NFS Filer, export the NFS share with the following options: “`rw, async, no_acl, no_root_squash`”.
2. On each VM cluster node, perform the following steps:
 - a. Create a backup directory and mount the NFS share to it. For example:

```
[root@nodeN ~]# mkdir /backup
[root@nodeN ~]# mount -t nfs <NFSSHOST>:/backup /backup
[root@nodeN ~]# mkdir /backup/sapbackup
[root@nodeN ~]# chown oracle:oinstall /backup/sapbackup
```

- b. Make the mount point persistent by adding it to `/etc/fstab`:

```
<NFSSHOST>:/backup /backup nfs rw,bg 0 0
```

Configure RMAN

Configure backup target directories on one of the VM cluster nodes:

```
[root@scaqau010101 ~]# su - oracle
[oracle@scaqau010101 ~]$ . oraenv
ORACLE_SID = [oracle] ? MFG
The Oracle base has been set to /u02/app/oracle
[oracle@scaqau010101 ~]$ export ORACLE_SID=MFG
[oracle@scaqau010101 ~]$ export ORACLE_SID=MFG001
[oracle@scaqau010101 ~]$ rman target /

Recovery Manager: Release 19.0.0.0.0 - Production on Tue Jun 6 07:06:09 2023

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connected to target database: MFG (DBID=1327265714)

RMAN> CONFIGURE CHANNEL DEVICE TYPE DISK FORMAT '/backup/sapbackup/%U' maxpiecesize 128G;

using target database control file instead of recovery catalog
new RMAN configuration parameters:
CONFIGURE CHANNEL DEVICE TYPE DISK FORMAT '/backup/sapbackup/%U' MAXPIECESIZE 128 G;
new RMAN configuration parameters are successfully stored

RMAN> CONFIGURE CONTROLFILE AUTOBACKUP FORMAT FOR DEVICE TYPE DISK TO '/backup/sapbackup/%F';

new RMAN configuration parameters:
CONFIGURE CONTROLFILE AUTOBACKUP FORMAT FOR DEVICE TYPE DISK TO '/backup/sapbackup/%F';
new RMAN configuration parameters are successfully stored
```

Prepare for SAP BR*Tools

BR*Tools must be at version 7.40 PL 32 or later. Earlier versions are not supported.

1. On each compute node, edit the `/oracle/<DBSID>/sapprof/init<DBSID>.sap` file (for example, `/oracle/MFG/sapprof/initMFG.sap`), and make the following changes on each VM cluster nodes:

```
rman_channels = 16
backup_dev_type = disk
disk_copy_cmd = rman_set
rman_compress = no | yes
backup_type = online
rman_sectionsize = 512M
backup_root_dir = <your backup root directory>
stage_root_dir = <your stage root directory>
archive_copy_dir = <your archive copy directory>
archive_copy_dir2 = <your second archive copy directory>
archive_stage_dir = <your archive stage directory>
```

Notes: The steps described here are for passwordless operation of BR*Tools. With Oracle 12.1 and later, the `remote_os_authent` parameter defaults to `FALSE`. Therefore, BR*Tools needs to connect either with a dedicated user or by using SAP Secure Store because connections made with / don't work.

On Exadata Cloud@Customer, the Oracle ASM instance is running as a user `grid` that cannot write to directories owned by `oracle:oinstall`. Because of this, BR*Tools requires a `775` umask instead of `755` to allow the Oracle ASM instance to copy files to directories owned by `oracle:oinstall`.

Set the following parameter in `/oracle/<DBSID>/sapprof/init<DBSID>.sap`. For example, edit `/oracle/MFG/sapprof/initMFG.sap` and append `_file_mask = 002`.

2. On each VM cluster node as the `oracle` user, verify that `$ORACLE_HOME/dbs` contains the appropriate `init<DBSID><index>.ora` file. If it does not, create it.

Following the previous examples, this file needs to be `initMFG001.ora` on `scaqau010101`, `initMFG002.ora` on `scaqau010201`, and so on. The content of the `init<DBSID><index>.ora` files is always identical:

```
#Generate initsid.ora for ASM spfile
spfile = (+DATA1/MFG/spfileMFG.ora)
```

3. At the same location for each node, as the `oracle` user, you need a password file named `orapw<SID>` and a symbolic link pointing to it. The symbolic link must be named `orapw<SID><INSTANCENUMBER>`. Set the environment to the current `DBSID`, and then run the following commands, replacing `MFG` with the correct ID.

```
[oracle@scaqau010101] $ ln -s /oracle/MFG/19/dbs/orapwMFG /oracle/MFG/19/dbs/orapwMFG001
[oracle@scaqau010101] $ scp /oracle/MFG/19/dbs/orapwMFG
scaqau010201:/oracle/MFG/19/dbs/orapwMFG
```

4. Repeat the `scp` commands for additional compute nodes, if needed, and create the corresponding symbolic links.

```
[oracle@scaqau010201] $ ln -s /oracle/MFG/19/dbs/orapwMFG /oracle/MFG/19/dbs/orapwMFG002
```

5. Ensure that all database instances can be started up properly using `srvctl`:

```
[root@scaqau010101 dbs]# su - oracle
[oracle@scaqau010101 ~]$ . oraenv
ORACLE_SID = [oracle] ? MFG
The Oracle base has been set to /u02/app/oracle
[oracle@scaqau010101 ~]$ srvctl stop database -db MFG
[oracle@scaqau010101 ~]$ srvctl start database -db MFG
```

6. Invoke `sqlplus / as sysdba`, and run the following commands on one host only:

```
SQL> create user brt$adm identified by "somestrongpassword";
```

7. Invoke `sqlplus / as sysdba`, and run the following commands on all VM cluster nodes to update each Oracle password file with the required grants:

```
SQL> grant sapdba to brt$adm;
SQL> grant sysdba, sysoper to brt$adm;
```

All the commands need to succeed. If they do not, fix the password file.

8. On each host, run the following commands:

```
[oracle@nodeN] $ cd /oracle/MFG ; mkdir -p security/rsecssf ; cd security/rsecssf
[oracle@nodeN] $ mkdir key data ; cd /oracle/MFG ; chmod 700 -R security
```

9. Switch to `SIDADM` from `root`, for example, `su - mfgadm`.

10. On each VM cluster node, run the following command:

```
nodeN:mfgadm 21> brconnect -u / -c -f chpass -o 'BRT$ADM' -p '$$99SapSapR3'  
BR0801I BRCONNECT 7.40 (46)  
BR0280I BRCONNECT time stamp: 2023-06-06 07:52:11  
BR0828I Changing password for database user BRT$ADM ...  
  
BR0280I BRCONNECT time stamp: 2023-06-06 07:52:11  
BR0829I Password changed successfully in database for user BRT$ADM  
  
BR0280I BRCONNECT time stamp: 2023-06-06 07:52:11  
BR1525I Setting password for user BRT$ADM in secure storage  
/oracle/MFG/security/rsecssfs/data/SSFS_MFG.DAT ...  
  
BR0280I BRCONNECT time stamp: 2023-06-06 07:52:17  
BR1526I Password set successfully for user BRT$ADM in secure storage  
/oracle/MFG/security/rsecssfs/data/SSFS_MFG.DAT  
  
BR0280I BRCONNECT time stamp: 2023-06-06 07:52:17  
BR0802I BRCONNECT completed successfully
```

11. (Optional) Verify the proper operation of other BR*Tools:

```
nodeN: mfgadm> brspace -u // -c force  
nodeN: mfgadm> brbackup -u // -q  
nodeN: mfgadm> branchive -u // -q
```

Set Up High Availability for SAP Central Services (Optional)

Note: This step is required only if you want to implement SAP HA by using SAPCTL on the VM cluster.

Use the latest `sapctl` package from [SAP Note 1496927](#), which is version 10.0 Patch 0 or later.

Before invoking the `sapctl create` command, you must remove the temporary resource for the ASCS HA IP, `tmp`, that you created earlier. To do this, shut down ASCS, as follows:

```
nodeN: mfgadm> sapcontrol -nr 00 -function Stop  
  
[root@scaqau010101] # . oraenv [+ASM1]  
[root@scaqau010101] # crsctl stop res tmp  
[root@scaqau010101] # appvipcfg delete -vipname=tmp
```

After deploying `sapctl` according to the instructions in [SAP Note 1496927](#), run the following commands, replacing MFG with the correct SAPSID:

```
/usr/sap/sapctl/bin/sapctl create -sapsid MFG -if bondeth0 -nm 255.255.255.0 -net 10.133.48.0 -nodes  
scaqau010101,scaqau010201 -abapenq ASCS00 -abapvip 10.133.49.182 -abapmsport 3900 -abaprep ERS01 -  
aersvip 10.133.49.181 -nx 1  
/usr/sap/sapctl/bin/sapctl start all -sapsid MFG
```

Install the Primary Application Server

The SAP primary application server (PAS) must be installed *on a separate server provided and managed by the customer and attached to the VM cluster network*. This section provides an example of how to install and configure an Oracle Linux 8 server to run the SAP PAS. If you use a different Linux distribution, the steps required to set up the server to meet all requirements might differ from the steps for Oracle Linux 8.

Relax the Password Policy

Before performing the following steps, create a backup of the `/etc/pam.d/system-auth` file and keep it safe for later restoration.

Then, edit the `/etc/pam.d/system-auth` file to remove `use_authok` from the lines starting with `password requisite pam_pwhistory.so` and `password sufficient pam_unix.so`.

Edit `/etc/hosts`

Edit the `/etc/hosts` file with the IP addresses for the following items:

- Exadata compute nodes, node virtual IP addresses, and SCAN names
- IP or virtual IP address for NFS or HA-NFS
- Short hostname for the PAS host itself

For example:

```
10.133.49.126 scaqau010101 # NODE-IP
10.133.49.127 scaqau010201 # NODE-IP
10.133.49.130 scaqau010101v # NODE-VIP
10.133.49.176 scaqau010201v # NODE-VIP
10.133.49.179 scaqau01c1sc1 # SCAN-VIP
10.133.49.183 scaqau01c1sc1 # SCAN-VIP
10.133.49.184 scaqau01c1sc1 # SCAN-VIP

10.133.49.182 mfgascs # for HA of SAP ASCS
10.133.49.181 mfgers # for HA of SAP ERS
10.133.49.180 mfgnfs # for HA of NFS SHARE
```

Ensure That `/usr/sap` Is Not in the Root Filesystem

Earlier in this document, when setting up the Exadata compute nodes, you created a filesystem `/u02`, and then linked `/usr/sap` to `/u02/sap`. Do the same for the PAS, as follows:

```
[root@pas] # mkdir /u02/sap ; ln -s /u02/sap /usr/sap
```

Stop the Local Firewall

Run the following command to stop the local firewall:

```
[root@pas] # systemctl stop firewalld ; systemctl disable firewalld
```

Install Additional Software Packages

Run the following commands:

```
[root@pas] dnf install uuid
[root@pas] dnf install tcsh.x86_64
[root@pas] dnf install oracle-database-preinstall-19c.x86_64
```

Mount `/sapmnt` from HA-NFS or from Another NFS Host

1. Run the following command:

```
[root@pas] # mkdir /sapmnt ; mount -t nfs mfgnfs:/sapshare/sapmnt /sapmnt
```

2. Edit `/etc/fstab` to add `/sapmnt`:

```
mfgnfs:/sapshare/sapmnt /sapmnt nfs rw,bg 0 0
```

3. Save and exit the file.

Start the uidd Daemon

1. Start the uidd daemon and ensure that it comes up at system startup:

```
[root@pas] systemctl start uidd ; systemctl enable uidd
```

2. Adjust the SELinux setting. Edit `/etc/selinux/config` and change `SELINUX=enforcing` to `SELINUX=permissive`.
3. Adjust the time zone to match the Exadata compute nodes. Link `/etc/localtime` to your OS time zone file (Europe/Berlin in the following example):

```
[root@pas] # ln -sf /usr/share/zoneinfo/Europe/Berlin /etc/localtime
```

4. Start `ntpd` and configure it to start automatically:

```
[root@pas] # systemctl start ntpd ; systemctl enable ntpd
```

5. Reboot.

Install and Configure SAP PAS

1. As root, change the password for yourself. SWPM asks for authentication.

```
[root@pas] # passwd root
```

2. Run SWPM:

```
[root@pas] # mkdir -p /usr/sap/tmp ; export TMP=/usr/sap/tmp ;  
[root@pas] # cd /path/to/extracted_SWPM ; ./sapinst SAPINST_GUI_HOSTNAME=<pas-hostname>
```

Optionally, you can provide a `stack.xml` file if you have created one.

The URL for your browser is displayed.

3. Invoke an SAP recommended browser with the following URL:

```
https://<public_IP_of_PAS>:<port>/sapinst/docs/index.html
```

4. When prompted, confirm a security exception.
5. At the authentication dialog box, enter the root user and its password.
6. When you are prompted to run a script as the `oracle` user on the nodes of the VM cluster, perform the following steps:
 - a. In a separate shell, copy the script to one of the Exadata compute nodes.
 - b. Connect to the node and change the ownership and permission of the script to `oracle:oinstall` and `770`.
 - c. Switch to the `oracle` account, set the environment for the given `ORACLE_HOME`, and run the script.
7. In SWPM, click to continue the installation of PAS.

Revert Changes on VM Cluster Nodes and SAP Application Servers

Now that installation is complete, make the following configuration changes:

1. Revert the changes to password policies on the Exadata compute nodes and the SAP application servers. Namely, restore their backups, such as `/etc/pam.d/system-auth`.
2. If you added SSH keys that were needed for installation purposes only to the `authorized_keys` file or key files, delete them.

Patching Exadata Cloud@Customer X10M: Lifecycle Management for SAP Databases

Important: Do *not* use the Oracle Cloud Console to apply database patches available on OCI. Using these patches for SAP databases is *not* supported. Oracle releases SAP bundle patches for the Oracle Database software on Exadata Cloud@Customer at the SAP Service Marketplace.

An Oracle Database Exadata Cloud@Customer instance requires regular patching at several levels of its software stack:

- Oracle Database software
- Oracle Grid Infrastructure software for systems that do not have the most recent software installed
- Oracle Database Exadata Cloud@Customer tools
- Exadata image (OS)

This section describes how to install patches for the preceding components of an Exadata Cloud@Customer instance running databases for SAP applications. For more general information about Exadata Cloud@Customer versions and patches, see [MOS Note 2333222.1: Exadata Cloud@Customer Software Versions](#).

Oracle manages some components of Exadata Cloud@Customer:

- Exadata storage server hardware (cell), firmware, and software
- Exadata database server hardware, firmware, and the KVM virtualization host
- Storage switch hardware and firmware
- Power distribution units (PDU)

In all but exceptional circumstances, you receive advance communication about updates to these components through the Cloud Notification Portal to help you plan for them. If there are corresponding recommended updates for your compute node VM environment, Oracle also provides notification about these updates. You cannot opt out of updates. For more information, see [MOS Note 2124174.1: Oracle Database Cloud Exadata Service Supported Software Versions and Planning for Updates](#).

Oracle performs any updates to the preceding components in a rolling manner. However, because of limitations in Oracle's connection handling, such a rolling update is not transparent to the SAP applications connected against the Exadata Cloud@Customer databases. Therefore, we strongly recommend shutting down any SAP applications during an update of these components, if the update requires the shutdown of nodes of your Exadata Cloud@Customer instance.

Installing Patches for Oracle Database Software

An Oracle Database Exadata Cloud@Customer instance requires the following bundle patch for an update of its Grid Infrastructure and database components (the patch version shown was current when this document was published):

SAP Bundle Patch 19.19.0.0.0 - 202305 for Oracle Exadata Cloud

Oracle regularly tests and certifies these patches and their successors for SAP databases and makes them available for SAP customers on My Oracle Support (MOS) or the SAP Service Marketplace. You can find up-to-date release information about the patches and their download locations in the following SAP Note:

[SAP Note 2799970 - Oracle Exadata Cloud: Patches for 19c](#)

Note: Do not use the `exadbcpatchmulti` utility from the Exadata Cloud@Customer tools to install any database patches. Do not patch Oracle Database Homes from Oracle Cloud Console. Install them following the instructions from the SAP bundle patch readme instead.

Ensure that the OS environment requirements are fulfilled on all nodes of the Exadata Cloud@Customer instance as described in the “Operating System Environment Requirements” section of the SAP bundle patch readme.

Then, follow the instructions in the “SAP Bundle Patch Installation” section to install the bundle patch for Oracle Exadata Cloud@Customer. This process usually includes the following steps:

1. Install the latest OPatch and MOPatch utilities.
2. Install the database patches in the Oracle Database homes.
3. Run post-installation instructions, most notably the `catsbp` script.

Note: Depending on the content of the bundle patch, its installation can be a non-RAC rolling installation. For more information, see the SAP bundle patch readme.

Updating and Patching Exadata Cloud@Customer and Grid Infrastructure Components

Although the latest SAP Bundle Patch is applied for all SAP-supported Oracle Database homes, all other components (for example, OS, storage nodes, and firmware) must be updated and patched as recommended by Oracle. For more information, see the [Exadata Cloud@Customer Administrator’s Guide](#).

Finish SAP Monitoring Setup

If you install a new SAP system and do not replace the newly created SAP database with a migrated SAP database, you must apply numerous SAP-specific updates, support packages (SUM), and SAP notes. These contain bug fixes required to properly register VM cluster nodes with SAP monitoring.

If you replace the newly created SAP database with another, well-maintained SAP database that was migrated to Exadata Cloud@Customer X10M, these bug fixes will most likely be included in the migrated database.

Finally, follow SAP documentation “[Registering SAP NetWeaver Components and Hosts in CEN](#)” on how to use SAP transaction RZ21 to register the nodes of the VM cluster for SAP central monitoring.

Using SAP Transaction DB13

If you want to schedule your database backups and database verification jobs with SAP transaction DB13, you must ensure that an SAP gateway is running on each of the VM cluster nodes. The easiest way to do this is to install the *ASCS integrated gateway*, as described in the “Install SAP NetWeaver Application Server ABAP/Java” section. With SAPCTL managing SAP HA, the SAP gateway is always available as long as an ASCS instance can be started on one of the VM cluster nodes.

Before you run database-specific jobs from DB13, complete the following tasks:

1. Complete the steps in the “Configure RMAN and SAP BR*Tools to Perform Backups to the Filesystem” section.
2. Install the primary application server (PAS) and possibly additional SAP application servers.

3. Configure and test the RFC connection to the SAP gateway. This is done in SAP transaction SM59. The virtual hostname must be used. For example, the virtual hostname of the ASCS instance is `mfgascs`.

The name of the RFC destination must be concatenated by the static text `SAPXPG_DBDEST_` plus the virtual hostname used for ASCS. For example, the name of the RFC destination is `SAPXPG_DBDEST_MFGASCS`.

On the **Technical Settings** tab, specify the following values:

- For **Activation Type**, select **Start on Explicit Host**.
- For **Program**, enter the full path plus the program name of the `sapxpg` executable. For example, `/use/sap/MFG/SYS/exe/uc/linuxx86_64/sapxpg`.
- For **Target Host**, enter the virtual hostname used for ASCS (for example, `mfgascs`).
- For **Gateway Host**, enter the virtual hostname used for ASCS (for example, `mfgascs`).
- For **Gateway service**, enter the name of the gateway service with the instance number used for ASCS. For example, `sapgw00`. Refer to `/etc/services` to find the appropriate service name.

After successful connection testing, start DB13 and schedule a couple different jobs (for example, “Check database” and “Whole database online + redo log backup”) to see if they work correctly.

If you experience a “logon error” in which `brbackup`, `brarchive`, or `brconnect` cannot connect to the database during jobs started from DB13, check [SAP Note 1764043](#).

Local Update Dispatching

SAP NetWeaver Application ABAP performs updates on the database asynchronously through *update-processes*, also called UPD and UP2 processes. A dialog work process inserts an update job into the VBHDR, VBDATA, and VBMOD tables 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, similar to the dialog-process. If so, 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 can produce a *massive* amount of unnecessary additional data load and should be avoided. To avoid these “non-local updates,” we recommend the following actions:

- Have several update-processes on *each* SAP instance
- Turn off update dispatching and use the local update-processes

To turn off update dispatching, set SAP instance profile parameter `rdisp/vb_dispatching` to `0` as described in [SAP Note 62203](#). Also, set SAP instance profile parameter `rdisp/vb_name` to the name of the local instance (for example, `rdisp/vb_name = app1_MFG_00`).

Migrating Databases

Migration of existing SAP databases is discussed in a separate document, [Migrating SAP NetWeaver Based Systems Within the Scope of Oracle Databases](#). Basically, the recommended general way to migrate an existing SAP database is to set up a new SAP system on Exadata Cloud@Customer and then replace the new SAP database with the migrated one.

Database Backup Options with Exadata Cloud@Customer

On Exadata Cloud@Customer, you can perform database backups in multiple ways. With SAP, you can use one of the Oracle-provided generic methods to back up your SAP database, or use more SAP-integrated methods based on SAP BR*Tools. If you prefer SAP BR*Tools and SAP transaction DB13, you can perform backups either to the filesystem (for example, NFS) or to a backup infrastructure supported by BR*Tools and RMAN.

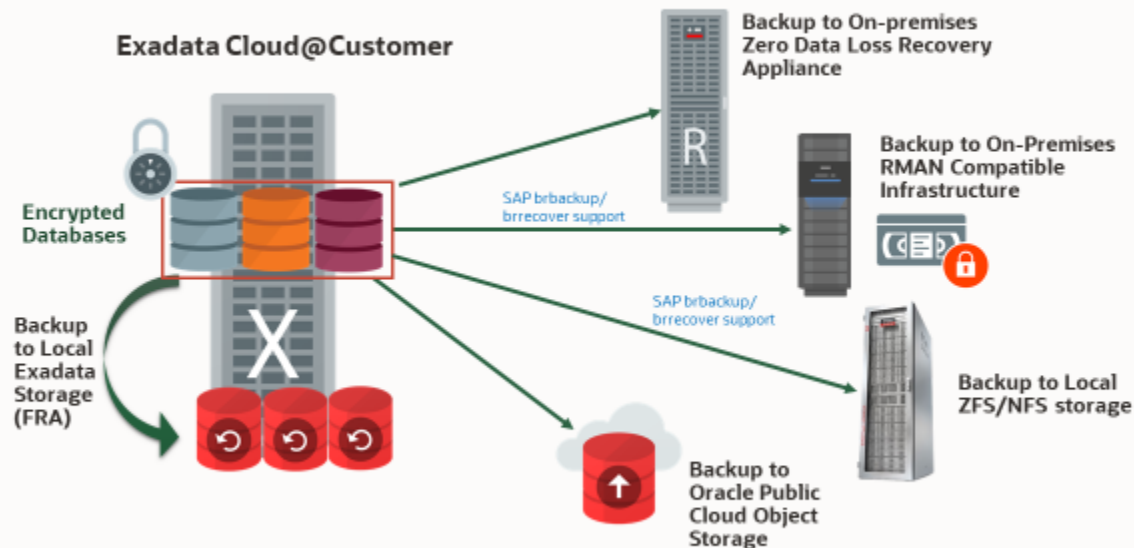


Figure 7: Oracle Database Backup Options with Exadata Cloud@Customer

VM Cluster Node Subsetting

VM Cluster Node Subsetting allows VM clusters to span two or more DB servers in a flexible way by expanding or shrinking the VM cluster. VM cluster nodes can be added to a VM cluster if additional DB servers with enough resources are available. VM cluster nodes can also be removed from a VM cluster if they are no longer needed, to free resources on DB servers. However, from an SAP perspective, add-node and remove-node operations are quite expensive in terms of the labor involved. Consider first whether elastic scaling of compute resources (scaling OCPUs up and down, local storage or memory) is an alternative.

Although VM Cluster Node Subsetting offers flexibility in the number of VM cluster nodes belonging to a VM cluster, adding or removing VM cluster nodes always requires significant changes to the configuration of the VM cluster and is not a simple “one-click” operation.

Customers who use SAP HA with SAPCTL must eventually drop and re-create ASCS and ERS specific cluster resources to reflect the changed configuration. Unless there are good reasons to configure SAP HA with SAPCTL on every VM cluster node that may be available, we recommend that you configure it only on two or three VM cluster nodes to avoid reconfiguration during add-node or remove-node operations. Using two or three VM cluster nodes provides best protection of SAP ASCS and ERS instances while keeping the probability low that SAP HA configuration must be changed.

Notes: Reconfiguration of SAP HA with SAPCTL requires downtime of the SAP central services ASCS and ERS to reconfigure where those services are configured to run.

The relocation of DB services disconnects all affected SAP application servers, which causes them to reconnect to the DB service. This action results in aborted SAP transactions or ABAP short dumps. To avoid these unwanted interruptions, such actions should be issued during planned downtimes or by moving all SAP users and jobs to other SAP application servers, for example when they log on, so that the SAP application server whose DB service is being relocated has no users logged on and is not running any transactions.

Adding Nodes

The add-node operation creates a VM cluster node by cloning it from an arbitrary existing VM cluster node and injecting specific parameters, such as IP addresses and hostnames, for the new VM cluster node. This cloning operation does not cover all aspects required to configure and run the new VM cluster nodes in a supported way, and numerous additional tasks must be performed after the add-node operation is completed.

Prepare Existing VM Cluster Nodes

Run the following commands on each pre-existing VM cluster node to ensure the Autonomous Health Framework (AHF)-specific directories in Oracle Grid Home are accessible by the `grid` user. This is important because new VM cluster nodes are partially cloned from an arbitrary pre-existing VM cluster node under the `grid` user.

```
[root@nodeN ~]# chown grid:oinstall /u01/app/19.0.0.0/grid/srvm/admin/logging.properties
[root@nodeN ~]# chown -R grid:oinstall /u01/app/19.0.0.0/grid/oracle.ahf*
[root@nodeN ~]# chown -R grid:oinstall /u01/app/grid/oracle.ahf*
```

See also [Troubleshooting Exadata Cloud@Customer Systems](#).

Add VM Cluster Nodes

1. Open Oracle Cloud Console and navigate to the VM Cluster Details page of the VM cluster.
2. Under **Resources**, click Virtual Machines.
3. Click Add Virtual Machines.
4. Select the DB servers where you want to add VM cluster nodes.

Note: By default, all available DB servers are selected. You must deselect the DB servers that you do *not* want in the VM cluster.

5. Verify that your selection is correct, and then click **Add Virtual Machines**.

Note that this operation is long-running and can take several hours to complete.

Complete General Post Add-Node Tasks

After the add-node operation is completed, perform the following tasks.

Check the Presence of Oracle RDBMS Home and VM Cluster Nodes in Oracle Central Inventory

After one or more VM cluster nodes have been added, verify that all Oracle RDBMS Home directories and all VM cluster nodes are present in Oracle Central Inventory of all VM cluster nodes, and add the appropriate entries as required and shown in the following example.

1. Edit /u01/app/oraInventory/ContentsXML/inventory.xml.

```
<?xml version="1.0" standalone="yes" ?>
<!-- Copyright (c) 1999, 2023, Oracle and/or its affiliates.
All rights reserved. -->
<!-- Do not modify the contents of this file by hand. -->
<INVENTORY>
  <VERSION_INFO>
    <SAVED_WITH>12.2.0.7.0</SAVED_WITH>
    <MINIMUM_VER>2.1.0.6.0</MINIMUM_VER>
  </VERSION_INFO>
  <HOME_LIST>
    <HOME NAME="OraGiHome19000" LOC="/u01/app/19.0.0.0/grid" TYPE="0" IDX="1" CRS="true"/>
  </HOME_LIST>
  <COMPOSITEHOME_LIST>
  </COMPOSITEHOME_LIST>
</INVENTORY>
```

2. Add the appropriate entries if they are not already present:

```
<?xml version="1.0" standalone="yes" ?>
<!-- Copyright (c) 1999, 2023, Oracle and/or its affiliates.
All rights reserved. -->
<!-- Do not modify the contents of this file by hand. -->
<INVENTORY>
  <VERSION_INFO>
    <SAVED_WITH>12.2.0.7.0</SAVED_WITH>
    <MINIMUM_VER>2.1.0.6.0</MINIMUM_VER>
  </VERSION_INFO>
  <HOME_LIST>
    <HOME NAME="OraGiHome19000" LOC="/u01/app/19.0.0.0/grid" TYPE="0" IDX="1" CRS="true"/>
    <HOME NAME="OraHome1" LOC="/u02/app/oracle/product/19.0.0.0/dbhome_1" TYPE="0" IDX="2">
      <NODE_LIST>
        <NODE NAME="scaqau010101"/>
        <NODE NAME="scaqau010201"/>
        <NODE NAME="scaqau010301"/>
      </NODE_LIST>
    </HOME>
  </HOME_LIST>
  <COMPOSITEHOME_LIST>
  </COMPOSITEHOME_LIST>
</INVENTORY>
```

Change the Owner of the AHF Directories in Oracle Grid Home

Run the following commands on each added VM cluster node to ensure that the AHF-specific directories in Oracle Grid Home are accessible by the grid user:

```
[root@nodeN ~]# chown grid:oinstall /u01/app/19.0.0.0/grid/srvm/admin/logging.properties
[root@nodeN ~]# chown -R grid:oinstall /u01/app/19.0.0.0/grid/oracle.ahf*
[root@nodeN ~]# chown -R grid:oinstall /u01/app/grid/oracle.ahf*
```

Set Correct Permissions on \$GIHOME/network/admin

Because SWPM changes the owner of the /u01/app/19.0.0.0/grid/network/admin directory from oracle:oinstall to grid:oinstall, the permissions on this directory can cause problems writing to listener.ora.

On the new VM cluster nodes, change the owner to match the owner on the pre-existing nodes and change permissions from 755 to 775.

```
sudo chown grid:oinstall /u01/app/19.0.0.0/grid/network/admin
sudo chmod 775 /u01/app/19.0.0.0/grid/network/admin
```

Ensure that the owner and permissions are identical on each node.

Complete Post Add-Node Tasks on the New VM Cluster Nodes

Now perform the following tasks on the new VM cluster nodes.

Create an SAP-Specific /oracle/<SID>/19 Symbolic Link to IHRDBMS

Run the following commands:

```
[root@scaqau010301 ~]# mkdir /oracle
[root@scaqau010301 ~]# mkdir /oracle/MFG
[root@scaqau010301 ~]# chown -R oracle:oinstall /oracle
[root@scaqau010301 ~]# ln -s /u02/app/oracle/product/19.0.0.0/dbhome_1 /oracle/MFG/19
```

Adjust /etc/oratab

Add an entry for each database and each runtime Oracle Database Home. For example:

```
MFG:/oracle/MFG/19:N
```

Install SAP-Enhanced Monitoring

Perform the steps described in the section “Provision SAP Monitoring.”

Relax the Password Policy

Run the following command:

```
[root@scaqau010301 u02]# /opt/oracle.cellos/host_access_control pam-auth --deny 10 --lock 60 --
pwquality 6 --remember 0
[2022-01-17 11:09:52 +0100] [INFO] [IMG-SEC-0805] Deny on login failure count set to 10
[2022-01-17 11:09:52 +0100] [INFO] [IMG-SEC-0806] Account lock_time after one failed login attempt set
to 60
[2022-01-17 11:09:52 +0100] [INFO] [IMG-SEC-0807] Password history (pam_unix remember) set to 0
```

Adjust /etc/security/limits.conf

In the /etc/security/limits.conf file, add the following entries under the oracle entries:

```
root    soft    memlock    unlimited
root    hard    memlock    unlimited
ora<sid> soft    memlock    unlimited
ora<sid> hard    memlock    unlimited
<sid>adm soft    memlock    unlimited
<sid>adm hard    memlock    unlimited
```

Prepare SAP-Specific Shared Directories

If you configured an Oracle ACFS filesystem for `sapshare` containing your SAP binaries and `/sapmnt`, it is mounted automatically.

If `/sapmnt` was located on its own ACFS, expect it to be mounted.

If you are using an external `sapmnt` directory, mount it per node and make the mount persistent in `/etc/fstab` as you did on the pre-existing nodes. Ensure that it's reboot safe.

If you are using an external NFS directory for backups, mount it per node, and make the mount persistent in `/etc/fstab` as you did on the pre-existing nodes. Ensure that it's reboot safe.

On each added VM cluster node, a fresh `/u02/sap` directory and a fresh `/usr/sap` symbolic link pointing to it must be created. Check whether a `/u02/sap` directory and a `/usr/sap` symbolic link already exist. If so, move the directory away and delete the symbolic link before you re-create them.

```
[root@scaqau010301 u02]# mv /u02/sap /u02/was.sap # move away cloned /u02/sap directory
[root@scaqau010301 u02]# rm -rf /usr/sap # remove link if existing
[root@scaqau010301 u02]# mkdir /u02/sap # recreate clean /u02/sap
[root@scaqau010301 u02]# ln -s /u02/sap /usr/sap # create new link
```

This demonstrates `sapmnt` was on ACFS `/sapshare`, and the link is lost for good reasons. Rebuild it:

```
[root@scaqau010301 u02]# ln -s /sapshare/sapmnt /sapmnt
[root@scaqau010301 u02]# ln -s /sapshare/trans /usr/sap/trans
```

Create the oper Group and Add the oracle User to It

Run the following commands:

```
[root@scaqau010301] # groupadd --gid 504 oper
[root@scaqau010301] # usermod oracle -a -G oper
[root@scaqau010301] # usermod oracle -a -G asmadmin
```

Add Virtual Hostnames to `/etc/hosts`

Edit the `/etc/hosts` file and add the following virtual IP addresses and hostnames:

```
10.133.49.182 mfgascs <- for HA of SAP ASCS instance
10.133.49.181 mfgers <- for HA of SAP ERS instance
10.133.49.180 mfgnfs <- for HA of NFS share
```

Change the Root Password

Run the following command:

```
[root@scaqau010301 u02]# passwd root
Changing password for user root.
New password:
BAD PASSWORD: The password is shorter than 15 characters
Retype new password:
passwd: all authentication tokens updated successfully.
```

Run SWPM Host Preparation

Run the following commands:

```
[root@scaqau010301 u02]# mkdir -p /usr/sap/tmp ; export TMP=/usr/sap/tmp
[root@scaqau010301 u02]# ./sapinst SAPINST_SAPINST_STACK_XML=/path/to/STACK.XML
```

On the SWPM dialog page, Database RAC Parameters, where the number of instances need to be entered, choose the new number of database instances (after the add-node operation).

On the SWPM dialog page where hostnames and instance numbers are associated, change the hostnames to match the order of the instances (the instances cannot be changed). For example:

	HOST NAME	INSTANCE NUMBER
1	scaqau010101	001
2	scaqau010201	002
3	scaqau010301	003

Copy Directories Under /oracle/<SID>/ Not Created on the New VM Cluster Node

Copy the directories under /oracle/<SID>/ that were not created on the new VM cluster node from one of the pre-existing VM cluster nodes and adjust the ownership:

```
[oracle@scaqau010301 MFG]$ scp -r -p scaqau010101:/oracle/MFG/admin .
[oracle@scaqau010301 MFG]$ scp -r -p scaqau010101:/oracle/MFG/oraarch .
[oracle@scaqau010301 MFG]$ scp -r -p scaqau010101:/oracle/MFG/security .

[root@scaqau010301 MFG]# chown -R oracle:asmadmin admin
[root@scaqau010301 MFG]# chown -R oracle:oinstall oraarch
[root@scaqau010301 MFG]# chown -R oracle:oinstall security
```

Copy the Database Password File from a Pre-existing VM Cluster Node

As the oracle user in the \$ORACLE_HOME/dbs directory, you need a database password file named orapw<SID> and a symbolic link named orapw<SID><INSTANCENUMBER> pointing to it.

Copy the password file from another VM cluster node and create the symbolic link as shown in the following example. Replace the SID MFG with the correct SID for your database.

```
[oracle@scaqau010301] $ scp scaqau010101:/oracle/MFG/19/dbs/orapwMFG /oracle/MFG/19/dbs/orapwMFG
[oracle@scaqau010301] $ ln -s /oracle/MFG/19/dbs/orapwMFG /oracle/MFG/19/dbs/orapw
[oracle@scaqau010301] $ ln -s /oracle/MFG/19/dbs/orapwMFG /oracle/MFG/19/dbs/orapwMFG003
```

Remove Obsolete Files from Oracle Database Home at \$ORACLE_HOME/dbs

Usually, you keep the following files and symbolic links: orapw<SID>, orapw<SID><INSTANCENUMBER>, init<SID>.ora, and init<SID><###>.ora. Back up the files before removing them to ensure that you can restore them if needed.

Create an Instance-Specific pfile in Oracle Database Home at \$ORACLE_HOME/dbs

Run the following commands:

```
oracle@scaqau010301 dbs]$ cp initMFG001.ora initMFG003.ora
[oracle@scaqau010301 dbs]$ cat initMFG003.ora
#Generate initsid.ora for ASM spfile
spfile = (+DATAC1/MFG/spfileMFG.ora)
```


Verify That orabase Returns the Correct Value

Run the following commands:

```
[root@scaqau010301 MFG]# su - oracle
[oracle@scaqau010301 ~]$ . oraenv
ORACLE_SID = [oracle] ? MFG
The Oracle base has been set to /u02/app/oracle
[oracle@scaqau010301 ~]$ export ORACLE_SID=MFG003
[oracle@scaqau010301 ~]$ orabase
/u02/app/oracle

# If orabase doesn't report /u02/app/oracle, execute orabtt:
oracle $ export ORACLE_HOME=/oracle/MFG/19 ; $ORACLE_HOME/sap/orabtt/orabtt.sh -add -dbsid MFG
```

Set s-bit for the User on the Oracle Binary in Oracle RDBMS Home \$ORACLE_HOME/bin

Run the following commands:

```
[oracle@scaqau010301 ~]$ ls -la $ORACLE_HOME/bin/oracle
-rwxr-x--x 1 oracle oinstall 448364608 Jan 19 10:53 /oracle/MFG/19/bin/oracle

[oracle@scaqau010301 ~]$ chmod u+s /oracle/MFG/19/bin/oracle
-rwsr-x--x 1 oracle oinstall 448364608 Jan 19 10:53 /oracle/MFG/19/bin/oracle
```

Complete Post Add-Node Tasks on All VM Cluster Nodes

Now perform the following tasks on all the VM cluster nodes.

Adjust /oracle/MFG/sapprof/initSID.sap

Adjust the /oracle/MFG/sapprof/initSID.sap file so that all instances on all VM cluster nodes are included. For example, change the following lines as shown:

```
parallel_instances = (MFG001:/oracle/MFG/19@MFG001, MFG002:/oracle/MFG/19@MFG002) to
parallel_instances = (MFG001:/oracle/MFG/19@MFG001, MFG002:/oracle/MFG/19@MFG002,
MFG003:/oracle/MFG/19@MFG003)

asm_ora_home = (MFG001:/u01/app/19.0.0.0/grid, MFG002:/u01/app/19.0.0.0/grid) to
asm_ora_home = (MFG001:/u01/app/19.0.0.0/grid, MFG002:/u01/app/19.0.0.0/grid,
MFG003:/u01/app/19.0.0.0/grid)

asm_ora_sid = (MFG001:+ASM1, MFG002:+ASM2) to
asm_ora_sid = (MFG001:+ASM1, MFG002:+ASM2, MFG003:+ASM3)
```

Verify the Value of _file_mask in initSID.sap on All Nodes

Verify that the initSID.sap file on all VM cluster nodes has _file_mask set as follows:

```
_file_mask = 002
```

Add the New Instances to listener.ora on Pre-existing VM Cluster Nodes

On each pre-existing VM cluster node (here scaqau010101 and scaqau010201), add the new instances to listener.ora in GRID_HOME and reload the listener configuration:

```
[root@scaqau010101 MFG]# . oraenv
ORACLE_SID = [+ASM1] ?
The Oracle base remains unchanged with value /u01/app/grid
[root@scaqau010101 MFG]# vi $ORACLE_HOME/network/admin/listener.ora
```

```

SID_LIST_LISTENER =
  (SID_LIST =
    (SID_DESC =
      (SID_NAME = MFG001)
      (ORACLE_HOME = /oracle/MFG/19)
    )
    (SID_DESC =
      (SID_NAME = MFG002)
      (ORACLE_HOME = /oracle/MFG/19)
    )
    (SID_DESC =
      (SID_NAME = MFG003)
      (ORACLE_HOME = /oracle/MFG/19)
    )
  )
)

```

```
[root@scaqau010101 MFG]# lsnrctl reload
```

```

Connecting to (DESCRIPTION=(ADDRESS=(PROTOCOL=IPC)(KEY=LISTENER)))
The command completed successfully

```

```
[root@ scaqau010101 MFG]# lsnrctl status
```

```

Connecting to (DESCRIPTION=(ADDRESS=(PROTOCOL=IPC)(KEY=LISTENER)))
STATUS of the LISTENER
-----

```

```

Alias                LISTENER
Version              TNSLSNR for Linux: Version 19.0.0.0.0 - Production
Start Date           14-JAN-2022 20:23:52
Uptime               2 days 17 hr. 9 min. 3 sec
Trace Level          off
Security              ON: Local OS Authentication
SNMP                 OFF
Listener Parameter File /u01/app/19.0.0.0/grid/network/admin/listener.ora
Listener Log File    /u01/app/grid/diag/tnslsnr/scaqau010101/listener/alert/log.xml

```

```
Listening Endpoints Summary...
```

```

  (DESCRIPTION=(ADDRESS=(PROTOCOL=ipc)(KEY=LISTENER)))
  (DESCRIPTION=(ADDRESS=(PROTOCOL=tcps)(HOST=10.133.49.130)(PORT=2484)))
  (DESCRIPTION=(ADDRESS=(PROTOCOL=tcp)(HOST=10.133.49.126)(PORT=1521)))
  (DESCRIPTION=(ADDRESS=(PROTOCOL=tcp)(HOST=10.133.49.130)(PORT=1521)))

```

```
Services Summary...
```

```

Service "MFG001" has 1 instance(s).
  Instance "MFG001", status UNKNOWN, has 1 handler(s) for this service...
Service "MFG002" has 1 instance(s).
  Instance "MFG002", status UNKNOWN, has 1 handler(s) for this service...
Service "MFG003" has 1 instance(s).
  Instance "MFG003", status UNKNOWN, has 1 handler(s) for this service...
The command completed successfully

```

Complete More Post Add-Node Tasks on the New VM Cluster Nodes

Now perform the following additional tasks on the new VM cluster nodes.

Verify SIDADM and ORASID Shell Environments

Check the shell environment variables as shown in the section **“Error! Reference source not found..”**

Configure HA-NFS for /sapmnt (Optional)

Note: This step is required only if you set up HA-NFS on the VM cluster. If you are using an external NFS service, you need only to mount the directories as shown in the next section.

Run the following commands on the new VM cluster nodes:

```
[root@nodeN] # systemctl enable rpcbind ; systemctl enable nfs-server
[root@nodeN] # systemctl start rpcbind ; systemctl start nfs-server
```

Configure RMAN and SAP BR*Tools

Bring the new VM cluster nodes in line with the pre-existing nodes and complete the steps required as shown in the section “Configure RMAN and SAP BR*Tools to Perform Backups to the Filesystem.”

Move the saptrace Directory and Optionally SAP BR*Tools Directories to an Existing Shared Filesystem Location

As already done on the pre-existing VM cluster nodes during their initial installation, it is necessary to move the Oracle diagnostic destination, defined by the Oracle initialization parameter `diagnostic_dest`, to a shared filesystem location on ACFS. With SAP, this parameter typically points to the `/oracle/<DBSID>/saptrace` directory, for example, `/oracle/MFG/saptrace`. Moving the diagnostic destination to a shared location is also important for database-specific SAP transactions, where Oracle trace information is checked or viewed in SAP, or for special functions like end-to-end tracing or monitoring.

If you want to use SAP BR*Tools on all VM cluster nodes—for example, for backup and restore, reorganizations, or database checks—you must also move the SAP BR*Tools-specific directories to a shared filesystem location. If brbackup logs are not in a shared filesystem location, you cannot restore and recover your database from a VM cluster node other than the one where the backup was taken.

To perform this action, back up the original directories and replace them with symbolic links that point to the existing shared directories under `/oracle/<DBSID>`.

The following example uses the ACFS filesystem `/sapshare` for all these directories. Run these steps on each *new* VM cluster node.

1. As the `oracle` user, rename the original directories to keep them:

```
[root@scaqau010301 MFG]# su - oracle
[oracle@scaqau010301 ~]$ cd /oracle/MFG
[oracle@scaqau010301 MFG]$ mv saptrace saptrace.waslocal
[oracle@scaqau010301 MFG]$ mv saparch saparch.waslocal
[oracle@scaqau010301 MFG]$ mv sapreorg sapreorg.waslocal
[oracle@scaqau010301 MFG]$ mv sapbackup sapbackup.waslocal
[oracle@scaqau010301 MFG]$ mv sapcheck sapcheck.waslocal
```

2. As the `oracle` user, create the following symbolic links:

```
[root@scaqau010301 MFG]# su - oracle
[oracle@scaqau010301 ~]$ cd /oracle/MFG
[oracle@scaqau010301 MFG]$ ln -s /sapshare/MFG/saptrace saptrace
[oracle@scaqau010301 MFG]$ ln -s /sapshare/MFG/saparch saparch
[oracle@scaqau010301 MFG]$ ln -s /sapshare/MFG/sapreorg sapreorg
[oracle@scaqau010301 MFG]$ ln -s /sapshare/MFG/sapbackup sapbackup
[oracle@scaqau010301 MFG]$ ln -s /sapshare/MFG/sapcheck sapcheck
```

Adjust Linux Huge Pages

If you configured Linux Huge Pages according to the instructions in the section “Configure Database Linux Huge Pages,” can copy the determined value for `vm.nr_hugepages` from the pre-existing VM cluster nodes and add it to `/etc/sysctl.conf`.

Reboot the New VM Cluster Nodes

Reboot the new VM cluster nodes and wait until they are fully back online by checking the status with the following command:

```
crsctl stat res -t
```

Complete Post Add-Node Tasks on One of the Pre-existing Nodes

Now perform the following tasks on one of the pre-existing VM cluster nodes.

Add Oracle Initialization Parameters for the New Instance to spfile

Run the following commands:

```
[root@scaqau010101 MFG]# su - oracle
[oracle@scaqau010101 ~]$ . oraenv
ORACLE_SID = [oracle] ? MFG
The Oracle base has been set to /u02/app/oracle
[oracle@scaqau010101 ~]$ export ORACLE_SID=MFG001

alter system set instance_number=3 scope=spfile sid='MFG003';
alter system set instance_name='MFG003' scope=spfile sid='MFG003';
alter system set local_listener='scaqau010301v:1521' scope=spfile sid='MFG003';
alter system set log_archive_format='%t_%s_%r.dbf' scope=spfile sid='MFG003';
alter system set log_archive_trace=0 scope=spfile sid='MFG003';
alter system set thread=3 scope=spfile sid='MFG003';
alter system set undo_tablespace='PSAPUNDO003' scope=spfile sid='MFG003';
alter system set service_names='MFG','MFG003';
```

Add an Undo Tablespace

Add an undo tablespace with SAP naming convention PSAPUNDO### for the new instance:

```
CREATE UNDO TABLESPACE PSAPUNDO003 DATAFILE '+DATAC1' SIZE 700M AUTOEXTEND ON NEXT 20M MAXSIZE 10000M;
```

Add Online Redo Logs

Add online redo logs for the new instance and enable its thread:

```
alter database add logfile thread 3 group 51 '+DATAC1' size <sizeofyourredologs>;
alter database add logfile thread 3 group 52 '+DATAC1' size <sizeofyourredologs>;
alter database add logfile thread 3 group 53 '+DATAC1' size <sizeofyourredologs>;
alter database add logfile thread 3 group 54 '+DATAC1' size <sizeofyourredologs>;
alter database enable thread 3;
```

Add the New Instance to Oracle Cluster Repository and Start It

Run the following commands:

```
[root@scaqau010101 MFG]# su - oracle
[oracle@scaqau010101 ~]$ . oraenv
ORACLE_SID = [oracle] ? MFG
The Oracle base has been set to /u02/app/oracle
[oracle@scaqau010101 ~]$ srvctl add instance -d MFG -i MFG003 -n scaqau010301
[oracle@scaqau010101 ~]$ srvctl start instance -d MFG -i MFG003
```

Check the Distribution of DB Services

After you add one or more VM cluster nodes to a VM cluster, DB services should usually be redistributed across all the VM cluster nodes. You should distribute DB services based on the workload, the according SAP application servers, and the free resources available.

Important: Relocating DB services requires downtime of the SAP application because it causes broken connections, ORA-600 errors, and short dumps for the SAP application.

Modify the DB services by using the `srvctl modify service` command. Then, relocate them to their preferred node by using the `srvctl relocate service` command with the `-force` option. For example:

```
[root@scaqau010101 bin]# srvctl modify service -db MFG -service MFG_D10 -preferred "MFG001" -available
"MFG002,MFG003" -modifyconfig

[root@scaqau010101 bin]# srvctl relocate service -db MFG -service mfg_d10 -oldinst MFG003 -newinst
MFG001 -force
```

Complete SAP HA-Specific Post Add-Node Steps (Optional)

Note: These steps are required only if you implemented SAP HA using SAPCTL and want to make the new VM cluster node available for SAP ASCS and ERS.

Pre-existing VM Cluster Node Step

Stop ASCS and ERS on a pre-existing cluster node, as follows:

```
[root@scaqau010101 ~]# /usr/sap/sapctl/bin/sapctl status all -sapsid MFG
sapctl version 10.0 Patch 1    Production Copyright 2019 Oracle. All rights reserved
SAP ABAP Enqueue service is ONLINE on scaqau010101
SAP ABAP Replication service is ONLINE on scaqau010201

[root@scaqau010101 ~]# /usr/sap/sapctl/bin/sapctl stop all -sapsid MFG
sapctl version 10.0 Patch 1    Production Copyright 2019 Oracle. All rights reserved
Stopping SAP ABAP Replication service
Stopping SAP ABAP Enqueue service
SAP ABAP Enqueue service is OFFLINE
SAP ABAP Replication service is OFFLINE
Done
```

New VM Cluster Node Steps

Perform the following steps on a new VM cluster node:

1. Create a link for /usr/sap/<SID> to point to the shared directory:

```
[root@scaqau010301 sap]# mv /usr/sap/MFG /usr/sap/was.MFG
[root@scaqau010301 sap]# ln -s /sapshare/MFG /usr/sap/MFG
[root@scaqau010301 sap]# chown mfgadm:sapsys /usr/sap/MFG
```

2. To register the instance service, relocate the ASCS virtual IP address to the new node:

```
[root@scaqau010301 sap]# crsctl relocate res sap.MFG.abapvip -n scaqau010301
CRS-2673: Attempting to stop 'sap.MFG.abapvip' on ' scaqau010101'
CRS-2677: Stop of 'sap.MFG.abapvip' on ' scaqau010101' succeeded
CRS-2672: Attempting to start 'sap.MFG.abapvip' on ' scaqau010301'
CRS-2676: Start of 'sap.MFG.abapvip' on ' scaqau010301' succeeded
```

3. Register the ASCS instance service:

```
[root@scaqau010301 sap]# /usr/sap/hostctrl/exe/saphostctrl -function RegisterInstanceService -
sid MFG -nr 00 -saplocalhost mfgascsc
Webmethod returned successfully
Operation ID: 525400123CE31EEC9E8CD7E3C62E9C8B

----- Log messages -----
Info: saphostcontrol: Executing 'sapstartsrv'
Info: saphostcontrol: exitcode=0
Info: saphostcontrol: 'sapstartsrv' successfully executed
Info: saphostcontrol: Executing 'sapstartsrv'
Info: saphostcontrol: exitcode=0
Info: saphostcontrol: 'sapstartsrv' successfully executed
```

4. Start the ASCS instance:

```
[root@scaqau010301 ~]# /etc/init.d/sapinit start
### START ASCS IN ORDER TO INSTALL ERS
[root@scaqau010301 ~]# su - mfgadm
scaqau010301:mfgadm 32> sapcontrol -nr 00 -function StartService MFG

StartService
OK
scaqau010301:mfgadm 33> sapcontrol -nr 00 -function Start

Start
OK
```

5. Run SAP SWPM to install an ERS instance.

6. Stop ASCS:

```
[root@scaqau010301]# su - mfgadm
scaqau010301:mfgadm 35> sapcontrol -nr 00 -function Stop

Stop
OK
scaqau010301:mfgadm 36> sapcontrol -nr 00 -function StopService MFG

StopService
OK
```

7. Move the ASCS virtual IP address back to the previous node:

```
[root@scaqau010301]# . oraenv
ORACLE_SID = [root] ? +ASM3
The Oracle base has been set to /u01/app/grid
[root@scaqau010301]# crsctl relocate res sap.MFG.abapvip -n scaqau010101
CRS-2673: Attempting to stop 'sap.MFG.abapvip' on 'scaqau010301'
CRS-2677: Stop of 'sap.MFG.abapvip' on 'scaqau010301' succeeded
CRS-2672: Attempting to start 'sap.MFG.abapvip' on 'scaqau010101'
CRS-2676: Start of 'sap.MFG.abapvip' on 'scaqau010101' succeeded
```

8. Set up SAP HA with SAPCTL. For detailed information, see the section “Scope and Assumptions.”
9. Re-create the SAP HA configuration with all VM cluster nodes having SAP ASCS and ERS installed:

```
[root@scaqau010101 bin]# /usr/sap/sapctl/bin/sapctl stop all -sapsid MFG
sapctl version 10.0 Patch 1 Production Copyright 2019 Oracle. All rights reserved
Stopping SAP ABAP Replication service
Stopping SAP ABAP Enqueue service
SAP ABAP Enqueue service is OFFLINE
SAP ABAP Replication service is OFFLINE
Done
```

```
[root@scaqau010101 bin]# /usr/sap/sapctl/bin/sapctl remove -sapsid MFG
sapctl version 10.0 Patch 1 Production Copyright 2019 Oracle. All rights reserved
CRS-2586: Deletion of a running resource 'ora.net1.network' requires the force option
CRS-4000: Command Delete failed, or completed with errors.
CRS-2586: Deletion of a running resource 'ora.net1.network' requires the force option
CRS-4000: Command Delete failed, or completed with errors.
Done
```

```
[root@scaqau010101 bin]# /usr/sap/sapctl/bin/sapctl create -sapsid MFG -if bondeth0 -nm
255.255.255.0 -net 10.32.184.0 -nodes scaqau010101,scaqau010201,scaqau010301 -abapenq ASCS00 -
abapvip 10.133.49.182 -abapmsport 3900 -abaprep ERS01 -aersvip 10.133.49.181 -nx 1
sapctl version 10.0 Patch 1 Production Copyright 2019 Oracle. All rights reserved
Creating SAP ABAP VIP
Creating SAP ABAP ERS VIP
Creating SAP ABAP Enqueue resource
Creating SAP ABAP Replication resource
Done
```

```
[root@scaqau010101 bin]# /usr/sap/sapctl/bin/sapctl start all -sapsid MFG
sapctl version 10.0 Patch 1 Production Copyright 2019 Oracle. All rights reserved
Starting SAP ABAP Enqueue service
Starting SAP ABAP Replication service
SAP ABAP Enqueue service is ONLINE on scaqau010101
SAP ABAP Replication service is ONLINE on scaqau010201
Done
```

Note: You can ignore the error messages that say resource ora.net1.network cannot be deleted.

10. Confirm that SAP HA works as expected:

```
[root@scaqau010101 bin]# /usr/sap/sapctl/bin/sapctl relocate -sapsid MFG -abaprep ERS01 -to scaqau010301
sapctl version 10.0 Patch 1    Production Copyright 2019 Oracle. All rights reserved
Stopping SAP ABAP Replication service
Stopping SAP ABAP ERS VIP
Relocating SAP ABAP ERS VIP to node scaqau010301
Relocating SAP ABAP Replication service to node scaqau010301
SAP ABAP ERS VIP is ONLINE on scaqau010301
SAP ABAP Replication service is ONLINE on scaqau010301
Done

[root@scaqau010101 bin]# /usr/sap/sapctl/bin/sapctl status all -sapsid MFG
sapctl version 10.0 Patch 1    Production Copyright 2019 Oracle. All rights reserved
SAP ABAP Enqueue service is ONLINE on scaqau010101
SAP ABAP Replication service is ONLINE on scaqau010301

[root@scaqau010101 bin]# /usr/sap/sapctl/bin/sapctl relocate -sapsid MFG -abapenq ASCS00 -to scaqau010301
sapctl version 10.0 Patch 1    Production Copyright 2019 Oracle. All rights reserved
Stopping SAP ABAP Enqueue service
Stopping SAP ABAP VIP
Relocating SAP ABAP VIP to node scaqau010301
Relocating SAP ABAP Enqueue service to node scaqau010301
SAP ABAP VIP is ONLINE on scaqau010301
SAP ABAP Enqueue service is ONLINE on scaqau010301
Done
```

Note: ERS should now move away after some minutes.

```
[root@scaqau010301 bin]# /usr/sap/sapctl/bin/sapctl status all -sapsid MFG
sapctl version 10.0 Patch 1    Production Copyright 2019 Oracle. All rights reserved
SAP ABAP Enqueue service is ONLINE on scaqau010301
SAP ABAP Replication service is ONLINE on scaqau010301
[root@scaqau010301 bin]# /usr/sap/sapctl/bin/sapctl status all -sapsid MFG
sapctl version 10.0 Patch 1    Production Copyright 2019 Oracle. All rights reserved
SAP ABAP Enqueue service is ONLINE on scaqau010301
SAP ABAP Replication service is OFFLINE
[root@scaqau010301 bin]# /usr/sap/sapctl/bin/sapctl status all -sapsid MFG
sapctl version 10.0 Patch 1    Production Copyright 2019 Oracle. All rights reserved
SAP ABAP Enqueue service is ONLINE on scaqau010301
SAP ABAP Replication service is ONLINE on scaqau010201
```

Removing Nodes

This section describes the tasks associated with removing a VM cluster node from a VM cluster.

Reconfigure SAP HA

Note: This step is required only if you implemented SAP HA using SAPCTL on the VM cluster. Reconfiguring SAP HA takes down SAP ASCS and ERS and requires downtime for the SAP application.

If SAP HA using SAPCTL is configured on the VM cluster node that will be removed, then SAP HA must be reconfigured to ensure that SAP ASCS and ERS are running on VM cluster nodes that will *not* be removed.

This reconfiguration is also required if SAP ASCS or SAP ERS is not actively running on the VM cluster node being removed but could run there.

1. Stop the ASCS and ERS instances:

```
[root@scaqau010101 bin]# ./sapctl stop all -sapsid MFG
sapctl version 10.0 Patch 1 Production Copyright 2019 Oracle. All rights reserved
Stopping SAP ABAP Replication service
```

2. Remove all cluster resources associated with the ASCS and ERS instances:

```
[root@ scaqau010101 bin]# ./sapctl remove -sapsid MFG
sapctl version 10.0 Patch 1 Production Copyright 2019 Oracle. All rights reserved
CRS-2586: Deletion of a running resource 'ora.net1.network' requires the force option
CRS-4000: Command Delete failed, or completed with errors.
CRS-2586: Deletion of a running resource 'ora.net1.network' requires the force option
CRS-4000: Command Delete failed, or completed with errors.
Done
```

3. Re-create the cluster resources for the ASCS and ERS instances with the new list of VM cluster nodes:

```
[root@ scaqau010101 bin]# /usr/sap/sapctl/bin/sapctl create -sapsid MFG -if bondeth0 -nm
255.255.255.0 -net 10.32.184.0 -nodes scaqau010101,scaqau010201-abapenq ASCS00 -abapvip
10.133.49.182 -abapmsport 3900 -abaprep ERS01 -aersvip 10.133.49.181 -nx 1
sapctl version 10.0 Patch 1 Production Copyright 2019 Oracle. All rights reserved
Creating SAP ABAP VIP
Creating SAP ABAP ERS VIP
Creating SAP ABAP Enqueue resource
Creating SAP ABAP Replication resource
Done
```

4. Restart the ASCS and ERS instances:

```
[root@scaqau010101 bin]# /usr/sap/sapctl/bin/sapctl start all -sapsid MFG
sapctl version 10.0 Patch 1 Production Copyright 2019 Oracle. All rights reserved
Starting SAP ABAP Enqueue service
Starting SAP ABAP Replication service
SAP ABAP Enqueue service is ONLINE on scaqau010101
SAP ABAP Replication service is ONLINE on scaqau010201
Done
```

Modify DB Service Definitions

Note: Relocate DB Services *only* when the SAP application is stopped. Otherwise, doing so breaks the connection between the SAP application and the database, causes ORA-600 errors in the SAP applications, and causes the creation of short dumps by the SAP application.

If you followed the SAP-specific guidelines for SAP on Oracle RAC Databases, then you configured one dedicated database (DB) service for each SAP application server that connects to the SAP database. These DB services have one preferred database instance and one or more available database instances where they can run if the preferred database instance is not available.

If a VM cluster node (specifically, the DB instances running on the VM cluster node) will be removed from the VM cluster, then all DB services that can run on the VM cluster node must be configured to reflect that change. Distribute

the DB services wisely across the available database instances to ensure that all the VM cluster nodes have a similar workload. Additionally, relocate the DB services to their preferred or available instances by using the `-force` option.

In the following example, assume that DB service MFG_D10 (belonging to SAP application server MFG D10) has instance MFG003 configured as the preferred instance and instances MFG001 and MFG002 as the available instances. Because instance MFG003 will be removed, instance MFG001 is now configured as the preferred instance and instance MFG002 is configured as an available instance.

```
[root@scaqau010101 bin]# srvctl relocate service -db MFG -service mfg_d10 -oldinst MFG003 -newinst MFG001 -force
[root@scaqau010101 bin]# srvctl modify service -db MFG -service MFG_D10 -preferred "MFG001" -available "MFG002" -modifyconfig
```

Remove a VM Cluster Node

1. Open Oracle Cloud Console and navigate to the VM Cluster Details page of the VM cluster.
2. Under Resources, click Virtual Machines.
3. In the list of virtual machines, click the Actions menu for the VM cluster node that you want to remove and click **Terminate**.

Important: Be careful to terminate the correct VM cluster node. This operation is long-running and may take several hours to complete. Wait until the remove-node operation has finished. Do *not* continue with the next steps until then.

Complete Post Remove-Node Steps

After the remove-node operation has completed, perform the following steps on one of the remaining nodes.

Note: Take care to disable the correct thread and drop the correct online redo logs and undo tablespace.

1. Disable obsolete redo log threads and drop unused redo logs. In the following example, node 3 with redo log thread 3 and undo tablespace PSAPUNDO003 are removed.

```
SQL> select group#,thread#,members,status from v$log;
```

GROUP#	THREAD#	MEMBERS	STATUS
11	1	2	INACTIVE
12	1	2	INACTIVE
13	1	2	CURRENT
14	1	2	INACTIVE
21	2	2	INACTIVE
22	2	2	INACTIVE
23	2	2	INACTIVE
24	2	2	CURRENT
41	3	1	INACTIVE
42	3	1	INACTIVE
43	3	1	INACTIVE
44	3	1	INACTIVE
51	4	1	INACTIVE
52	4	1	INACTIVE
53	4	1	CURRENT
54	4	1	UNUSED

```
16 rows selected.
```

```

SQL> alter database disable thread 3;

Database altered.

SQL> alter database drop logfile group 41;

Database altered.

SQL> alter database drop logfile group 42;

Database altered.

SQL> alter database drop logfile group 43;

Database altered.

SQL> alter database drop logfile group 44;

Database altered.

```

- Drop obsolete PSAPUNDO tablespaces:

```

SQL> select tablespace_name from dba_tablespaces;

TABLESPACE_NAME
-----
SYSTEM
SYSaux
PSAPUNDO001
PSAPTEMP
PSAPSR3
PSAPSR3750X
PSAPSR3USR
PSAPUNDO002
PSAPUNDO003
PSAPUNDO004

10 rows selected.

SQL> drop tablespace PSAPUNDO003;

Tablespace dropped.

```

- Remove the obsolete database instance resource from Oracle Cluster Repository:

```

[root@scaqau010101 ~]# . oraenv
ORACLE_SID = [+ASM1] ?
The Oracle base remains unchanged with value /u01/app/grid

[root@scaqau010101 ~]# srvctl remove instance -db MFG -instance MFG003
Remove instance from the database MFG? (y/[n]) y

```

- Remove all remains of the deleted VM cluster node in `init<SID>.sap`.

- Remove the deleted VM cluster node in Oracle Central Inventory of all remaining VM cluster nodes. Edit `/u01/app/oraInventory/ContentsXML/inventory.xml` on all VM cluster nodes.

```
<?xml version="1.0" standalone="yes" ?>
<!-- Copyright (c) 1999, 2023, Oracle and/or its affiliates.
All rights reserved. -->
<!-- Do not modify the contents of this file by hand. -->
<INVENTORY>
  <VERSION_INFO>
    <SAVED_WITH>12.2.0.7.0</SAVED_WITH>
    <MINIMUM_VER>2.1.0.6.0</MINIMUM_VER>
  </VERSION_INFO>
  <HOME_LIST>
    <HOME NAME="OraGiHome19000" LOC="/u01/app/19.0.0.0/grid" TYPE="0" IDX="1" CRS="true"/>
    <HOME NAME="OraHome1" LOC="/u02/app/oracle/product/19.0.0.0/dbhome_1" TYPE="0" IDX="2">
      <NODE_LIST>
        <NODE NAME="scaqau010101"/>
        <NODE NAME="scaqau010201"/>
        <NODE NAME="scaqau010301"/>
      </NODE_LIST>
    </HOME>
  </HOME_LIST>
  <COMPOSITEHOME_LIST>
  </COMPOSITEHOME_LIST>
</INVENTORY>
```

Note: Some cluster resources cannot be removed and remain in Oracle Cluster Repository.

Terminating a Complete VM Cluster

To terminate a whole VM cluster that is no longer needed, follow these steps. At the time this document was written, it is not possible to create a new VM cluster with a database name (SID) that was already used if the prior VM cluster with its databases was not properly terminated. This applies to unregistered databases such as in SAP environments.

- Shut down *all* database instances of all databases running on the VM cluster and remove the database resource:

```
[opc@scaqau010101 ~]$ sudo su -
[root@scaqau010101 ~]# . oraenv
ORACLE_SID = [root] ? +ASM1
The Oracle base has been set to /u01/app/grid
[root@scaqau010101 ~]# srvctl stop database -db MFG -stopoption IMMEDIATE -force
[root@scaqau010101 ~]# srvctl remove database -db MFG
```

- Stop all customer-created ACFS filesystems and drop the underlying volumes:

```
[root@scaqau010101 ~]# srvctl status volume
Volume SAPSHARE_V1 of diskgroup DATA1 for device /dev/asm/sapshare_v1-461 is enabled
Volume SAPSHARE_V1 of diskgroup DATA1 for device /dev/asm/sapshare_v1-461 is running

[root@scaqau010101 ~]# srvctl stop filesystem -device /dev/asm/sapshare_v1-461 -f

srvctl remove filesystem -device /dev/asm/sapshare_v1-461
srvctl remove volume -volume SAPSHARE_V1 -diskgroup DATA1 -force
```

3. Remove database-related files on all ASM disk groups:

```
[root@scaqau010101 ~]# asmcmd
ASMCMD> rm -rf DATA1/MFG
ASMCMD> rm -rf RECOC1/MFG
```

4. Terminate the VM cluster in Oracle Cloud Console.

High Availability with Oracle Data Guard

Oracle Data Guard provides additional high availability for the Oracle Database of an SAP installation with Exadata Cloud@Customer. Only physical standby is supported for an SAP environment. The physical standby database runs on a separate Exadata machine or Oracle Cloud Infrastructure Compute instance that fulfills the same SAP system requirements as the primary database, for example, identical OS user and group IDs. The Oracle Database software must be installed by using the SWPM to the same location as the primary site (`/oracle/<SID>`) and run on the same release and patch level as the primary database. Ensure that you sufficiently test the reconnection of the SAP instances to the standby database.

For more information about using Oracle Data Guard in Exadata Cloud@Customer, see the [Exadata Cloud@Customer documentation](#).

References

SAP

Most of the SAP links require SAP login credentials for access.

SAP Documentation

- [SAP Product Availability Matrix \(PAM\)](#)
- [SAP Software Logistics Toolset \(SL Tools\)](#)
- [SAP Download Manager](#)
- [SAP Software Download Center \(SWDC\)](#)
- [SAP NetWeaver Guide Finder](#)
- [SAP Community Network: Oracle Community](#)
- [SAP Help Portal: TCP/IP Ports of All SAP Products](#)
- [Registering SAP NetWeaver Components and Hosts in CEN](#)

SAP Notes

- [2956661 - SAP NetWeaver on Oracle Database Exadata Cloud@Customer](#)
- [2614080 - SAP on Linux with Oracle Database Exadata Cloud@Customer: Enhanced Monitoring](#)
- [2799970 - Patches for 19c: Oracle Exadata Cloud@Customer](#)
- [2799959 - Patching of Oracle Homes with minimal Downtime \(18c or higher\)](#)
- [2992680 - Managing shared and multiple Oracle Homes on Oracle Engineered Systems](#)
- [1778431 - 2992680 - Managing SAP Installations using Shared Oracle Homes](#)
- [2884306 - Managing SAPDATA_HOME and ORACLE_BASE on Oracle Engineered Systems](#)

- [2470718 - Oracle Database Parameter 12.2 / 18c / 19c](#)
- [2378252 - Oracle Database Initialization Parameters for SAP NetWeaver Systems](#)
- [2520061 - SAP on Oracle Cloud Infrastructure: Support prerequisites](#)
- [611361 - Hostnames of SAP ABAP Platform servers](#)
- [146505 - SAP GUI for the Java Environment](#)
- [2799900 - Central Technical Note for Oracle Database 19c](#)
- [1868094 - Overview: Oracle Security SAP Notes](#)
- [1496927 - Protection of SAP instances through Oracle Clusterware](#)
- [2591575 - Using Oracle Transparent Data Encryption \(TDE\) with SAP NetWeaver](#)
- [2799991 - TDE Encryption Conversions for Tablespaces and Databases](#)
- [1598594 - BR*Tools configuration for Oracle installation using user "oracle"](#)
- [113747 - Owners and authorizations of BR*Tools](#)
- [776505 - ORA-01017/ORA-01031 in BR*Tools on Linux and Solaris 11](#)
- [2422996 - Oracle: OPatch Versions 12.2.0.1.8, 11.2.0.3.18 and Newer](#)
- [3018983 - Additional information to the Oracle technical brief "Migrating SAP NetWeaver based Systems to Oracle Exadata Cloud Solutions"](#)
- [62203 - Update Dispatching and OPS](#)

Oracle

- [Oracle Database Exadata Cloud@Customer Gen 2](#)
- [Oracle Cloud Hosting and Delivery Policies](#)
- [Oracle Database](#)
- [Oracle Linux](#)
- [Oracle-SAP Solutions site](#)

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**SAP NetWeaver® Application Server ABAP/Java with Oracle Exadata Cloud@Customer X10M
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